

Portable Power

50 Hz: G625 - G690 - G750XW/XF 60 Hz: G655 - G750 - G800 - G850XW/XF OPERATION & MAINTENANCE MANUAL Original Instruction



This manual contains important safety information and must be made available to personnel who operate and maintain this machine.

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Portable Power

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REFERENCE INFORMATION

Write the correct information for YOUR DIPP generator in the spaces below. Always use these numbers when referring to your DIPP generator.

Generator Serial Number Engine Serial Number

NOTES:

YOUR DIPP DEALER:

ADDRESS:

PHONE:

CE

Doosan Benelux SA Drève Richelle 167 B-1410 Waterloo BELGIUM



Portable Power

FOREWORD

The contents of this manual are considered to be proprietary and confidential to and should not be reproduced without the prior written permission of the company.

Nothing contained in this document is intended to extend any promise, warranty or representation, expressed or implied, regarding the products described herein. Any such warranties or other terms and conditions of sale of products shall be in accordance with the standard terms and conditions of sale for such products, which are available upon request.

This manual contains instructions and technical data to cover all routine operation and scheduled maintenance tasks by operation & maintenance staff. Major overhauls are outside the scope of this manual and should be referred to an authorised service department.

The use of repair parts / lubricants / fluids other than those included within the approved parts list may create hazardous conditions over which the company has no control. Therefore the company cannot be held responsible for equipment in which non-approved repair parts are installed.

The company reserves the right to make changes and improvements to products without notice and without incurring any obligation to make such changes or add such improvements to products sold previously.

The intended uses of this machine are outlined below and examples of unapproved usage are also given, however the company cannot anticipate every application or work situation that may arise.

IF IN DOUBT CONSULT SUPERVISION.

This machine has been designed and supplied for use only in the following specified conditions and applications:

 Operation within the ambient temperature range specified in the GENERAL INFORMATION section of this manual. The use of the machine in any of the situation types listed in table 1:

a) Is not approved,

b) May impair the safety of users and other persons, and

c) May prejudice any claims made against the company.

TABLE 1
Use of the machine outside the ambient temperature range specified in the <i>GENERAL INFORMATION SECTION</i> of this manual.
This machine is not intended and must not be used in potentially explosive atmospheres, including situations where flammable gases or vapours may be present.
Use of the machine fitted with non approved components / lubricants / fluids.
Use of the machine with safety or control components missing or disabled.
Use of the machine for storage or transportation of materials inside or on the enclosure except when contained within the toolbox.
GENERATOR
Use of the generator to supply load(s) greater than those specified.
Use of unsafe or unserviceable electrical equipment connected to the generator.
Use of electrical equipment: (a) Having incorrect voltage and / or frequency ratings. (b) Containing computer equipment and / or similar electronics.

The company accepts no responsibility for errors in translation of this manual from the original English version.

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GENERAL DATA

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GENERAL DATA

UNIT MODEL 50HZ	G625XW/XF	N/A	G690XW/XF	G750XW/XF
Engine Speed - RPM	1500	N/A	1500	1500
UNIT MODEL 60HZ	G655XW/XF	G750XW/XF	G800XW/XF	G850XW/XF
Engine Speed - RPM	1800	1800	1800	1800
Engine Fuel	Diesel	Diesel	Diesel	Diesel
Manufacturer	Doosan	Doosan	Doosan	Doosan
Model	DP180LB	DP222LA	DP222LB	DP222LC
Number of cylinders / Displacement (litres)	V10 / 18	V12 / 22	V12 / 22	V12 / 22
FLUID CAPACITIES		•		
Engine Crankcase Lubricant (litres)	Max.34 Min. 23	Max. 40 Min. 27	Max. 40 Min. 27	Max. 40 Min. 27
Fuel Tank (litres)	ТВА	ТВА	TBA	TBA
Radiator & Engine Coolant (litres)	51	125	125	125
Electrical System	24VDC	24VDC	24VDC	24VDC
UNIT MEASUREMENTS / WEIGHTS (XW)			
Overall length (mm)	5260	6580	6580	6580
Overall width (mm)	2000	2438	2438	2438
Overall height (mm)	2130	3191	3191	3191
Weight (with fuel) (kg)	TBA	TBA	TBA	TBA
Weight (without fuel) (kg)	5450	6485	6485	6485

ELECTRICAL DATA

UNIT MODEL	G625XW/XF	N/A	G690XW/XF	G750XW/XF
Prime Power Rating @ 400V-3Ø, 0.8PF, 50Hz	902 A 625.00 kVA 500.00 kW	N/A N/A N/A	996 A 690.00 kVA 552.00 kW	1083 A 750.00 kVA 600.00 kW
Standby Power Rating @ 400V-3Ø, 0.8PF, 50Hz	996 A 690.00 kVA 552.00 kW	N/A N/A N/A	1097 A 760.00 kVA 608.00 kW	1198 A 830.00 kVA 664.00 kW
Rated Voltage (V)	400,220/380/480- 3Ø	N/A N/A	400,220/380/480- 3Ø	400,220/380/480- 3Ø
Rated Frequency (Hz)	50	N/A	50	50
Rated Power Factor	0.8	N/A	0.8	0.8

UNIT MODEL	G655XW/XF	G750XW/XF	G800XW/XF	G850XW/XF
Prime Power Rating @ 480V-3Ø, 0.8PF, 60Hz	790 A 657.00 kVA 525.60 kW	903 A 751.00 kVA 600.80 kW	962 A 800.00 kVA 640.00 kW	1019 A 847.00 kVA 677.60 kW
Standby Power Rating @ 480V-3Ø, 0.8PF, 60Hz	872 A 725.00 kVA 580.00 kW	998 A 830.00 kVA 664.00 kW	1063 A 884.00 kVA 707.20 kW	1126 A 936.00 kVA 748.80 kW
Rated Voltage (V)	400,220/380/480- 3Ø	400,220/380/480- 3Ø	400,220/380/480- 3Ø	400,220/380/480- 3Ø
Rated Frequency (Hz)	60	60	60	60
Rated Power Factor	0.8	0.8	0.8	0.8

SAFETY

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SAFETY DECALS GRAPHIC FORM AND MEANING OF ISO SYMBOLS

PROHIBITION / MANDATORY	INFORMATION / INSTRUCTIONS	WARNING
WARNING: Electrical shock risk	WARNING - Pressurised component	WARNING - Hot surface.
WARNING - Pressure control.	WARNING - Corrosion risk.	WARNING - Air/gas flow or Air
WARNING - Pressurised vessel.	WARNING - Hot and harmful exhaust gas.	WARNING - Flammable liquid.
Do not stand on any service valve or other parts of the pressure system	Do not operate with the doors or enclosure open	Do not use fork lift truck from this side.
Do not remove the Operating and Maintenance manual and manual holder from this machine.	Do not stack.	Do not operate the machine without the guard being fitted.

Ń		
WARNING - Maintain correct tyre pressure.	WARNING - Before connecting the tow bar or commencing to tow consult the Operation & Maintenance manual.	WARNING - For operating temperature below 0 ℃ (32 °F), consult the Operation & Maintenance manual.
WARNING - Do not undertake any maintenance on this machine until the electrical supply is disconnected and the air pressure is totally relieved.	WARNING - Consult the Operation & Maintenance manual before commencing any maintenance.	Do not breathe the compressed air from this machine.
km/h		
Do not exceed the trailer speed limit.	No naked lights.	Do not open the service valve before the airhose is attached.
	\bigcirc	8
Use fork lift truck from this side only.	Emergency stop.	Tie down point

OPERATION & MAINTENANCE MANUAL

50 Hz: G625 - G690 - G750XW/XF 60 Hz: G655 - G750 - G800 - G850XW/XF



Fill with fuel before start-up



This machine is not designed for operating lifesustaining equipment. It is equipped with a safety shutdown system that will cause the machine to stop operating whenever a shutdown condition is present.

Never operate the machine inside a building without adequate ventilation. Avoid breathing exhaust fumes when working on or near the machine.



A battery contains sulfuric acid and can give off gases which are corrosive and potentially explosive. Avoid contact with skin, eyes, and clothing. In case of contact, flush area immediately with water.

Improper operation of this equipment can cause severe injury or death. Read the Operation & Maintenance manual supplied with this machine before operation or service.

Modification or alteration of this machine CAN result in severe injury or death. Do not alter or modify this machine without the express written consent of the manufacturer.



This machine is equipped with an Auto Start System, which can cause the machine to start at any time. Follow all safety recommendations outlined in this manual to avoid injury to personnel. DISCONNECT BATTERY BEFORE SERVICING.

ACAUTION

Exercise extreme caution when using booster battery. To jump battery, connect ends of one booster cable to the positive (+) terminal of each battery. Connect one end of other cable to the negative (-) terminal of the booster battery and other end to a earth connection away from dead battery (to avoid a spark occurring near any explosive gases that may be present). After starting unit, always disconnect cables in reverse order.

Never inspect or service unit without first disconnecting battery cable(s) to prevent accidental starting.

Wear eye protection while cleaning unit with compressed air, to prevent debris from injuring eyes.

HOT PRESSURISED FLUID - Remove cap slowly to relieve PRESSURE from HOT radiator. Protect skin and eyes. HOT water or steam and chemical additives can cause serious personal injury.

WARNING

Flammable Fuels - Do not fill tank when engine is running.

Do not smoke or use an open flame in the vicinity of the generator set or fuel tank. Do not permit smoking, open flame, or sparks to occur near the battery, fuel, cleaning solvents or other flammable substances and explosive gases.

Do not operate Genset if fuel has been spilled inside or near the unit.

Electrical Shock -

Do not operate electrical equipment while standing in water, on wet earth or with wet hands or shoes.

Use extreme caution when working on electrical components. Battery voltage (12V / 24V DC) is present unless the battery cables have been disconnected. Higher voltage (potentially 480V) is possibly present at all times.



Always treat electrical circuits as if they were energised.

Disable Start Control before attempting any repair service, disconnect all leads to electrical power requirements and disconnect battery to prevent start up.

EARTHING

Comply with applicable electrical codes.



The Generator Set can produce high voltages, which can cause severe injury or death to personnel and damage to equipment. The Generator Set should have proper internal and external earth when required by IEC 364-4-41.

The Generator Set is internally earthed neutral to the frame of the Generator Set. This internal earth connection is essential for proper Generator Set performance and personal protection.

External earthing consists of connecting the generator neutral to a solid earth, and is the responsibility of the operator, when earthing is required by IEC 364-4-41 Protection Against Electric Shock, and other local codes as applicable.

Several methods are employed to externally earth portable generator sets, depending on the intended use and code requirements. In all cases, a continuous length of splice-free copper cable, no smaller than 10 mm², shall be used for the external earth conductor, when earthing is required.

A qualified, licensed electrical contractor, knowledgeable in local codes, should be consulted.

Failure to properly earth the Generator Set can result in severe injury or death.

IF USED AS ALTERNATE POWER SUPPLY

Connect only after the main service entrance switch has been DISCONNECTED and LOCKED OPEN. In addition, circuit overload protection must be provided in accordance with National Electrical Codes and local regulations.

Welding -

Prior to any welding, disconnect alternator relays, diagnostic circuit board, voltage regulator circuit board, meters, circuit breakers and battery cables. Open all circuit breakers, and remove any external connections (except earthing rod). Connect the welding earth as close as possible to the area being welded.

Electrical Loading -

Never make electrical connections with the unit running.

Before placing the unit in operation, verify the electrical rating of the Generator Set and do not exceed generator set ratings.

A CAUTION

Use extreme care to avoid contacting hot surfaces (engine exhaust manifold and piping).

Ensure that adequate ventilation of the cooling system and exhaust gases is maintained at all times.

The following substances are used in the manufacture of this machine and may be hazardous to health if used incorrectly.

- anti-freeze
- engine lubricant
- preservative grease
- rust preventative
- diesel fuel
- battery electrolyte

Avoid ingestion, skin contact and breathing fumes for the following substances: Antifreeze, Engine Lubricating Oil, Preservative Grease, Rust Preventative, Diesel Fuel and Battery Electrolyte.

The following substances may be produced during the operation of this machine and may be hazardous to health:

- Avoid build-up of engine exhaust fumes in confined spaces.
- Avoid breathing exhaust fumes.
- Avoid breathing brake lining dust during maintenance.
- Always operate in a well ventilated area.

WARNINGS

Warnings call attention to instructions which must be followed precisely to avoid injury or death.

CAUTIONS

Cautions call attention to instructions which must be followed precisely to avoid damaging the product, process or its surroundings.

NOTES

Notes are used for supplementary information.

GENERAL INFORMATION

Ensure that the operator reads and understands the decals and consults the manuals before maintenance or operation.

Ensure that the Operation & Maintenance manual, and the manual holder, are not removed permanently from the machine.

Ensure that maintenance personnel are adequately trained, competent and have read the Maintenance Manuals.

Make sure that all protective covers are in place and that the canopy / doors are closed during operation.

The specification of this machine is such that the machine is not suitable for use in flammable gas risk areas. If such an application is required then all local regulations, codes of practice and site rules must be observed. To ensure that the machine can operate in a safe and reliable manner, additional equipment such as gas detection, exhaust spark arresters, and intake (shut-off) valves may be required, dependant on local regulations or the degree of risk involved.

A weekly visual check must be made on all fasteners / fixing screws securing mechanical parts. In particular, safety-related parts such as coupling hitch, drawbar components, road-wheels, and lifting bail should be checked for total security.

All components which are loose, damaged or unserviceable, must be rectified without delay.

Electricity

The human body has a low tolerance for electricity and is a very good conductor. Exposure to electrical shock can results in an interruption of normal heart activity, thermal burns, severe muscle contractions and even death.

Never operate the generator without all protections in place. Controller and busbar doors must be closed at any time during operation.

If live testing is necessary, it should only be performed by properly trained people.

While testing on live electrical equipment, rubber sole shoes and adequate rubber gloves must be worn, and all local regulations must be respected.

Materials

The following substances may be produced during the operation of this machine:

engine exhaust fumes

AVOID INHALATION.

Ensure that adequate ventilation of the cooling system and exhaust gases is maintained at all times.

The following substances are used in the manufacture of this machine and may be hazardous to health if used incorrectly:

- anti-freeze
- engine lubricant
- preservative grease
- rust preventative
- diesel fuel
- battery electrolyte

AVOID INGESTION, SKIN CONTACT AND INHALATION OF FUMES.

Should engine lubricants or fuel come into contact with the eyes, then irrigate with water for at least 5 minutes.

Should engine lubricants or fuel come into contact with the skin, then wash off immediately.

Consult a doctor if large amounts of engine lubricants or fuel are ingested.

Consult a doctor if engine lubricants or fuel are inhaled.

Never give fluids or induce vomiting if the patient is unconscious or having convulsions.

Safety data sheets for engine lubricants and fuel should be obtained from the lubricant supplier.

Battery

Batteries contain corrosive liquid and produce explosive gas. Do not expose to naked lights. Always wear personal protective clothing when handling. When starting the machine from a slave battery ensure that the correct polarity is observed and that connections are secure.

DO NOT ATTEMPT TO SLAVE START A FROZEN BATTERY SINCE THIS MAY CAUSE IT TO EXPLODE.

Radiator

Hot engine coolant and steam can cause injury. Ensure that the radiator filler cap is removed with due care and attention.

Transport

When loading or transporting machines ensure that the specified lifting and tie down points are used.

OPERATING INSTRUCTIONS

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OPERATING INSTRUCTIONS

Never operate unit without first observing all safety warnings and carefully reading the operation & maintenance manual shipped from the factory with this machine.

COMMISSIONING

Upon receipt of the unit, and prior to putting it into service, it is important to adhere strictly to the instructions given below in *PRIOR TO STARTING*.

Ensure that the operator reads and *understands* the decals and consults the manuals before maintenance or operation.

Ensure that the position of the *emergency stop* device is known and recognised by its markings. Ensure that it is functioning correctly and that the method of operation is known.

Attach the battery cables to the battery(s) ensuring that they are tightened securely. Attach the negative cable before attaching the positive cable.

The operating controls and instruments are arranged on the control panel as shown. A description of each panel device is as follows:

Ensure that all transport and packing materials are discarded.

Ensure that the correct fork lift truck slots or marked lifting / tie down points are used whenever the machine is lifted or transported.

When operating the machine ensure that there is sufficient clearance for ventilation and exhaust requirements, observing any specified minimum dimensions (to walls, floors etc.).

Adequate clearance needs to be allowed around and above the machine to permit safe access for specified maintenance tasks.

Ensure that the machine is positioned securely and on a stable foundation. Any risk of movement should be removed by suitable means, especially to avoid strain on any rigid discharge piping.

CONNECTING THE LOAD

Make sure the wires are not cracked or damaged in any way.

Connect the proper phase wire to its corresponding bar L1–L2–L3. Mixing phases connections can result in equipment damage, accidents causing injuries or even death.

Make sure your installation is in compliance with local regulations.

PRIOR TO STARTING

Before starting the engine, carry out the following checks:

1. Engine oil level: Add as required.

DO NOT fill above the top mark on the dipstick. Oil levels anywhere within crosshatch (D) are considered in the acceptable operating range.



- 2. Engine coolant level: Add as required.
- 3. Fuel filter: Drain any accumulation of water. Clean or replace element as required.
- 4. Air cleaner service indicator (if equipped): Service immediately if showing "red" when the engine is running.
- 5. Fuel level in tank: Fill, using CLEAN DIESEL fuel, at the end of the day to minimise condensation.
- 6. Battery: Keep terminals clean and lightly greased.
- 7. Engine belts and hoses: Check for proper fit and / or damage. Service as required.
- 8. Air Vents / Grilles: Both engine radiator and generator cooling air. Check for obstructions (leaves, paper, etc.).
- 9. Visual inspection: Check for excessive fluid leaks, evidence of arcing around control panel, loose wire-routing clamps, etc.

Call a qualified person to make electrical repairs.

Do not remove the cap from a HOT engine radiator. The sudden release of pressure from a heated cooling system can cause severe injury or death.

Use the EMERGENCY STOP button ONLY in the event of an emergency.

NEVER use it for normal shut-down.

Verify the following:

- 1. All external electrical power loads are turned "OFF".
- 2. Main Breaker is "OFF".
- 3. Battery Disconnected Switch is "ON".
- 4. Reset (pull to unlatch) Emergency Stop Button.
- 5. Push the controller "START" Button.



POWER is present upon cranking the engine.



Allow starter to cool for one minute between start attempts.

If engine shuts down, diagnostic lamps will indicate the problem. Correct the problem before continuing.

- 6. Allow the engine to warm-up for 3 to 5 minutes.
- 7. Check the CONTROL Panel for proper voltages. No RED diagnostic lamps should be glowing.
- 8. With main breaker "ON" power is present and available for use.
- 9. Close side doors for optimum cooling of the unit while running.

STOPPING

- 1. Turn off all external electrical power loads.
- 2. Turn Main Breaker "OFF".
- 3. Allow 5 minute cool down.
- 4. Push controller "STOP" Button.
- 5. Wait at least 15 seconds before restarting.
- 6. Fill fuel tank at end of working day to prevent condensate.

CONTROLLER

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

QUICKSTART GUIDE

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

STARTING THE ENGINE



NOTE: For further details, see the section entitled 'OPERATING INSTRUCTIONS' elsewhere in this manual.



NOTE: For further details, see the section entitled 'OPERATING INSTRUCTIONS' elsewhere in this manual.

STOP / RESET MODE

NOTE: If a digital input configured to panel lock is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Stop/Reset Mode is activated by pressing the Stop/Reset Mode 9 button.

The *Stop/Reset* ⁽⁰⁾ icon is displayed to indicate *Stop/Reset Mode* operations.

In Stop/Reset Mode (0), the module removes the generator from load (if necessary) before stopping the engine if it is already running.

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

- Engine speed is zero as detected by the CANbus ECU.
- Generator AC Voltage and Frequency must be zero.
- Engine Charge Alternator Voltage must be zero.
- Oil pressure sensor must indicate low oil pressure.

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

Any latched alarms that have been cleared are reset when *Stop/Reset Mode* 9 is entered.

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

When left in Stop/Reset Mode () with no presses of the fascia buttons and configured for Power Save Mode, the module enters Power Save Mode. To 'wake' the module, press any fascia control buttons.



NOTE: For further details of module configuration, refer to DSE Publication: 057-185 DSE71xx MKII Configuration Software Manual.

MANUAL MODE

NOTE: If a digital input configured to panel lock is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Manual Mode is activated by pressing the Manual Mode (1) button.

The *Manual Mode* (b) icon is displayed to indicate *Manual Mode* (b) operations.

In *Manual Mode* (1), the set does not start automatically.

To begin the starting sequence, press the *Start* U button.

STARTING SEQUENCE

NOTE: There is no *start delay* in this mode of operation.

The fuel relay is energised and the engine is cranked.

NOTE: If the unit has been configured for CAN, compatible ECUs receives the start command via CAN.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start

sequence is terminated and the display shows **!-** *Fail to Start.*

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CANbus link to the engine ECU depending on module configuration.

NOTE: For further details of module configuration, refer to DSE Publication: 057-185 DSE71xx MKII Configuration Software Manual.

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

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

ENGINE RUNNING

Once the engine is running and all starting timers have expired, the animated *Engine Running* $\overset{1}{\diamond}$ icon is displayed.

In *Manual Mode* (1), the load is not transferred to the generator unless a 'loading request' is made. A loading request can come from a number of sources.

- Press the Transfer to Generator Subtron.
- Failure of mains supply (DSE7120 MKII only).
- Activation of an auxiliary input that has been configured to *Remote Start On Load or Auxiliary Mains Fail (DSE7120 MKII Only).*
- Activation of the inbuilt exercise scheduler if configured for 'on load' runs.

NOTE: The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

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

- Press the Open Generator (DSE7110 MKII Only) or Transfer to Mains (DSE7120 MKII Only) button.
- Press the Auto Mode end button to return to automatic mode. The set observes all Auto Mode end stopping timers before beginning the Auto Mode Stopping Sequence.
- Press the *Stop/Reset Mode* **O** button to remove load and stop the generator.
- Activation of an auxiliary input that has been configured to Generator Load Inhibit.

STOPPING SEQUENCE

In *Manual Mode* (1) the set continues to run until either:

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

TEST MODE

NOTE: If a digital input configured to panel lock is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Test Mode is activated by pressing the Test Mode (18) button.

The *Test Mode* (S) icon is displayed to indicate *Test Mode* (S) operations.

In *Test Mode* (1989), the set does not start automatically.

To begin the starting sequence, press the *Start* U button.

STARTING SEQUENCE

NOTE: There is no start delay in this mode of operation.

The fuel relay is energised and the engine is cranked.

NOTE: If the unit has been configured for CAN, compatible ECUs receives the start command via CAN.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start

sequence is terminated and the display shows **!-** *Fail to Start.*

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CANbus link to the engine ECU depending on module configuration.

NOTE: For further details of module configuration, refer to DSE Publication: 057-185 DSE71xx MKII Configuration Software Manual.

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

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

ENGINE RUNNING

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

In *Test Mode* (19), the load is automatically transferred to the generator.

NOTE: The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

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

- Press the *Manual Mode* button followed by the *Open Generator* (DSE7110 MKII Only) or *Transfer to Mains* (DSE7120 MKII Only) button.
- Press the *Auto Mode* button to return to automatic mode. The set observes all *Auto Mode* start requests and stopping timers before beginning the *Auto Mode Stopping Sequence*.
- Press the *Stop/Reset Mode* O button to remove load and stop the generator.
- Activation of an auxiliary input that has been configured to Generator Load Inhibit.

STOPPING SEQUENCE

In *Test Mode* (18) the set continues to run until either:

- The *Stop/Reset Mode* ¹ button is pressed The delayed load outputs are de-activated immediately and the set immediately stops.
- The *Auto Mode* button is pressed. The set observes all *Auto Mode* start requests and stopping timers before beginning the Auto Mode Stopping Sequence.

AUTOMATIC MODE

NOTE: If a digital input configured to external panel lock is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Auto Mode is activated by pressing the Auto Mode embodies button.

The *Auto Mode* ^{CD} icon is displayed to indicate *Auto Mode* ^{CD} operations.

Auto Mode ellows the generator to operate fully automatically, starting and stopping as required with no user intervention.

WAITING IN AUTO MODE

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

Starting requests can be from the following sources:

- Failure of mains supply (DSE7120 MKII only).
- Activation of an auxiliary input that has been configured to Remote Start or Auxiliary Mains Fail (DSE7120 MKII Only).
- Activation of the inbuilt exercise scheduler.

STARTING SEQUENCE

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

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

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

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

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start

sequence is terminated and the display shows **!-- Fail to Start**.

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CANbus link to the engine ECU depending on module configuration.

NOTE: For further details of module configuration, refer to DSE Publication: 057-185 DSE71xx MKII Configuration Software Manual.

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

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

ENGINE RUNNING

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

The generator is placed on load if configured to do so.

NOTE: The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

If all start requests are removed, the stopping sequence begins.

STOPPING SEQUENCE

The *Return Delay* timer operates to ensure that the starting request has been permanently removed and isn't just a short term removal. Should another start request be made during the cooling down period, the set returns on load.

If there are no starting requests at the end of the *Return Delay* timer, the load is removed from the generator to the mains supply and the *cooling* timer is initiated.

The *Cooling Down* timer allows the set to run off load and cool sufficiently before being stopped. This is particularly important where turbo chargers are fitted to the engine.

After the Cooling Down timer has expired, the set is stopped.

ENGINE OPERATION AND MAINTENANCE

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PERFORMANCE AND SPECIFICATIONS

1+/	~ m		Bomarka			
nem		DP180LBS	DP180LBF	DP180LAS	DP180LAF	Remarks
General Informa	tion				•	
Engine types		Water-coole				
Cylinder liner typ	be					
No. of cylinder - bore x stroke (mm)						
Total displaceme	ent (cc)					
Compression ra	tio					
Rotation		Co	unter clockwise v	riewed from flywh	eel	
Firing order			1-6-5-10-2	2-7-3-8-4-9		
Injection timing ((°)(BTDC)	21 °±1 °	19°±1°	21 °±1 °	19°±1°	
Dry weight (kg)			1,2	250	1	With fan
Dimension (L x V	W x H)(mm)		With fan			
Flywheel housing						
Flywheel						
No. of teeth on f	lywheel					
Cooling System	I					
Cooling method						
Coolant	Engine only					
capacity (litres)	With radiator	Approx.				
Coolant flow rate (litres /min)		660	550	660	550	
Pressure cap (kPa)						
Water temperature	Max. for standby and prime	103				
(°C)	Before start of full load					
Water pump						
Туре						
Thermostat	Opening temp. $(^{\circ}C)$					
	Full open temp. (℃)					
	Туре					
Cooling fan	Diameter - blades					

Item		DP180L	Pomorko
		DP180LBS DP180LBF DP180LAS DP180LAF	nemarks
Lubrication System			
Lubrication method		Fully forced pressure feed type	
	Туре	Gear type	
	Driving type	Driven by crankshaft gear	
Oil filter		Full flow, Cartridge type	
Oil capacity	Max.	34	
(litres)	Min.	23	
Lubrication oil	Idle speed	Min. 100	
pressure (kPa)	Governed speed	Min. 250	
Max. oil tempera	iture (°)	120	
	Oil class	Above API CD	
On speemeation	SAE	15W/40	
Fuel System			
Injection pump		Bosch in-line "P" type	
Governor		Electric type	
	Туре	Mechanical type injection pump	
Fuel feed pump	Capacity (litres/hr)	630	
	Туре	Multi-hole (4 hole)	
Injection nozzle	Opening pressure (MPa)	28	
Fuel filter		Full flow, Cartridge type with water drain valve	
Fuel used		Diesel fuel oil	
Intake/Exhaust S	System		
Max. back pressure (kPa)		5.9	
Max intake air	With clean filter element	2.16	
restriction (kPa)	With dirty filter element	6.23	
Cylinder block/head			
Valve system type		Overhead valve type	
No. of valve Intake		1	
(per cylinder)	Exhaust	1	
Valve lashes	Intake	0.25	
(at cold)(mm)	Exhaust	0.35	
	Opening	24° (BTDC)	
Intake valve (°)	Close	36° (ABDC)	
Exhaust valve	Opening	63° (BBDC)	
(°)	Close	27° (ATDC)	
Electrical System			
Alternator voltage - capacity (V - A)		27.5 - 45	
Voltage regulator		Built-in type IC regulator	
Starting motor vo (V - kW)	oltage - capacity	24 - 7.0	
Battery capacity		2-200Ah (recommended)	

Item			Pomarka					
		DP222LAS	DP222LBS	DP222LBF	DP222LCS	DP222LCF	nemarks	
General Information								
Engine types		Water-o						
Cylinder liner typ	pe			Wet type liner				
No. of cylinder - (mm)	bore x stroke							
Total displaceme	ent (cc)							
Compression ra	tio							
Rotation			Counter cloc	kwise viewed f	from flywheel			
Firing order			1-12-5	5-8-3-10-6-7-2-	11-4-9			
Injection timing	(°)(BTDC)	21°±1°	21 °±1 °	19°±1°	21°±1°	19°±1°		
Dry weight (kg)			1	1,420	I	I	With fan	
Dimension (L x	W x H)(mm)		1,73	38 X 1,389 X 1	,258		With fan	
Flywheel housin	g							
Flywheel								
No. of teeth on f	lywheel							
Cooling System								
Cooling method								
Coolant	Engine only							
capacity (litres)	With radiator	Арр						
Coolant flow rate (litres /min)		660	660	550	660	550		
Pressure cap (k	Pa)							
Max. forWaterstandby andtemperatureprime								
(°°)	Before start of full load							
Water pump								
Туре								
Thermostat	Opening temp. $(^{\circ}C)$	71						
	Full open temp. (℃)							
	Туре			Blow Type				
Cooling fan Diameter - blades								

Item			Demonstra							
		DP222LAS	DP222LBS	DP222LBF	DP222LCS	DP222LCF	Remarks			
Lubrication Syste	em		I I		<u> </u>	<u> </u>				
Lubrication meth	nod									
01.0	Туре									
Oil pump	Driving type									
Oil filter			Full f	low, Cartridge	type					
Oil capacity	Max.			40						
(litres)	Min.	27								
	Idle speed	Min. 100								
Lubrication oil pressure (kPa)	Governed		Min. 250							
Max, ail tampara	speed									
wax. on tempera										
Oil specification										
Evel Overtere	SAE			1500/40						
Fuel System		[
Injection pump			Bos	ch in-line "P" t	уре					
Governor				Electric type						
	Туре		Mechanic	cal type injecti	on pump					
Fuel feed pump	Capacity (litres/hr)	630								
	Туре	Multi-hole								
Injection nozzle	Opening pressure (MPa)	28								
Fuel filter		Full flow, Cartridge type with water drain valve								
Fuel used		Diesel fuel oil								
Intake/Exhaust S	System									
Max. back pressure (kPa)				5.9						
Max. intake air restriction (kPa)	With clean filter element			2.16						
	With dirty filter element	6.23								
Cylinder block/head										
Valve system type		Overhead valve type								
No. of valve	Intake			1	· ·					
(per cylinder)	Exhaust	1								
Valve lashes	Intake	0.25								
(at cold)(mm)	Exhaust	0.35								
	Opening	24° (BTDC)								
Intake valve (°)	Close	36° (ABDC)								
Exhaust valvo	Opening	63° (BBDC)								
(°)	Close	27° (ATDC)								
Flectrical System	n			_, (,,,,,,,,))						
Alternator voltage - capacity		27.5 - 45								
(V - A)		Built in type IC regulator								
Starting motor vo	oltage - capacity	24 - 7.0								
Battery capacity		2-200Ah (recommended)								

TECHNICAL INFORMATION

ENGINE MODEL AND SERIAL NUMBER

- The engine model and serial number are located on the engine as illustrated.
- These numbers are required when requesting warranty and ordering parts.



Doos		Doo	san	Infracore
MODEL		BORE		mm
SPEED	rpm	STROKE		mm
STAND-BY	PS(kW)	DISPL.		liters
PRIME	PS(kW)	DATE		
SERIAL NUMBE	r DSAN INFRA	CORE C	o., L	td.

EI6OM012

EI6OM011

Engine serial No. (example 1 : DE12T)
EBHOA900001
Serial No.
Production Year (2009)
Engine Model Suffix (EBHOA)
Engine serial No. (example 2 : P126TI series) EDIOA900001
Serial No.
Production Year (2009)
Engine Model Suffix (EDIOA ~ EDIOE)
Engine serial No. (example 3 : PU126TI) EDIPA900001



REGULAR INSPECTION -(DP180 AND DP222 ENGINES)

GENERAL INFORMATION

After purchasing an engine, over time, each of the engine's parts will age and the initial engine performance cannot be maintained.

Regular inspection and replacement of components according to the recommended regular inspection table allows you to maintain an engine with the optimum conditions and best performance for a long period and prevent unexpected accidents in advance.

Users are responsible for the proper operation and maintenance of engines. Engines should be inspected and replaced by officially-certified technicians in a workspace with the specified tools and facilities. Observe the following instructions to perform inspections.

- 1. Perform inspections on a flat floor without a slope.
- 2. Excluding extreme circumstances, only perform inspection while the engine is stopped.
- 3. Disconnect the '-' terminal of the battery before performing an inspection.
- 4. Perform inspection in a well ventilated space.
- 5. Use a wooden prop or lift when working under the engine.

DANGER

Wait until the engine is sufficiently cooled before starting inspection after operating the engine. Failure to observe this may result in serious burns.

You may be poisoned by the emissions when starting an engine in a closed space. Perform inspection in a well-ventilate space.

Unless it is absolutely necessary, do not perform inspection under an engine.

When carrying out engine inspection or maintenance, ensure there are no naked flames within the vicinity of the machine. Fuel, oil, or batteries may generate gas, causing fire.

If inspecting the engine while it is running, do not wear accessories such as necklaces, rings, watches or gloves. Such accessories may become stuck in rotating parts while the engine is running and may cause serious bodily injury.

Incorrect inspection methods may cause engine faults.

Cleaning an engine with liquids such as water or wax may cause breakdown of electrical parts.

Be careful when handling batteries, cables, and electrical wirings because current flows through those parts.

Do not put heavy things or apply excessive force or impact on the fuel-related units.

Ensure that the battery terminals ('+' and '-') are connected to the correct terminal. Connecting the '+' and '-' terminals to the wrong terminal may cause damage to the electrical unit parts and fire.

ROUTINE INSPECTION

Routine inspection is an inspection performed by an engine operator before operating the engine. It should be performed to protect operator's safety, as well as the engine.

The following is a minimal check list.

- 1. Check whether the engine smoothly starts and the levels of fuel, oil, and coolant are within the normal range.
- 2. Check if any discharged emissions are coloured and if the exhaust contains toxic gas elements.
- 3. Check whether abnormal noise occurs after starting an engine or not.
- 4. Check whether oil or water is leaking.
REGULAR INSPECTION TABLE

GENERAL CONDITIONS

Regular inspection and replacement according to the recommended regular inspection table allows the engine to be maintained with optimum conditions and best performance for a long period and prevent unexpected accidents in advance.

(o :Inspection and Adjustment, • : Replacement)

Check Points				Inspe	ction in	terval (H	lours)			Remark
	Daily	First 50	200	400	800	1,600	3,200	1 Year	2 Year	
Coolant system	J	I				1		J	1 1	
Check of coolant level	0									
V-belt tension, adjusting if necessary	0									
Check of coolant hose & clamp	0									
Concentration of antifreeze solution			0							
Replace V-belt						•			•	
Cleaning of water jacket and radiator								0		
Change of coolant								•		
Replace of coolant hose & clamp									•	
Lubrication system		1				_!	l		<u> </u>	
Check of engine oil level	0									
Engine exterior for loss of oil	0									
Oil Separator for oil leaks	0									
Change of Engine oil ^a		•	•					•		
Change of Oil Filter ^a		•	٠					•		
Replace Oil Hoses, Clamps									•	
Intake/Exhaust system						_			II	
Check of exhaust gas colour	0									
Check of air or gas leak	0									
Check of air cleaner indicator	0									
Clean of air filter element			0							
Replace air filter element				•						
Replace Air hoses, Clamps									•	

(o :Inspection and Adjustment, • : Replacement)

				Inspe	ction in	terval (H	erval (Hours)			
Check Points	Daily	First 50	200	400	800	1,600	3,200	1 Year	2 Year	Remark
Fuel System		1		J		1			1	
Fuel lines for leaks	0									
Drain Fuel filter / Water separator	0									
Check of fuel stop lever	0									
Engine Clean fuel pre-filter		0		0						
Replace Fuel filter		•		•						
Replace Water separator filter		•		•						
Drain Water & Sediment from fuel tank				0						
Check of Injectors, replace if						0				
necessary ^a						Ŭ				
Replace Fuel Hoses, Clamps									•	
Electrical system										
Engine alarms	0									
Check of battery charging	0									
Magnetic pick up and adjust								0		
Cylinder head	1	1	I			-1	l		1	
Cylinder head valve and valve seats							0			
Check of valve clearance										If necessary

a. If the sulfur content of fuel is > 0.02wt%, the changer or check intervals should be halved.

USE OF GENUINE PARTS

An engine consists of many parts which are mechanically harmonized. To prevent engine faults in advance and use engines with best performance for a long period, maintenance and replacement of expendable parts should be conducted regularly.

Use of genuine parts is recommended. Using unauthorized or remanufactured parts may cause critical damage and faults to engine for which Doosan shall not be held liable.

COOLING SYSTEM

GENERAL INFORMATION

The coolant should be replaced according to the cycle specified in the inspection interval table. If the coolant gets dirty, the engine is overheated, and the coolant overflows in the thermal expansion tank.

COOLANT STANDARDS

It is recommended that the antifreeze is added in a concentration of approximately 40~50% of the entire coolant. The antifreeze prevents the freezing and corrosion of the system, and increases the boiling point of coolant. In winter, the amount of antifreeze may need to be changed to suit the ambient temperature as shown in the table below. The freezing point per antifreeze ratio shown in the table may differ slightly depending on the antifreeze type. For more information, see the specifications provided by the manufacturer. Whenever coolant (water) is added to replenish the amount reduced by engine operation, the antifreeze portion is decreased. Therefore, the antifreeze level must be increased to the proper level after replenishing the coolant.

· concentration of antifreeze during winter

Ambient temperature (°C)	Coolant (℃)	Antifreeze (%)
Above -10	85	15
-10	80	20
-15	73	27
-20	67	33
-25	60	40
-30	56	44
-40	50	50

CAPACITY OF COOLANT

Engino Modo	Coolant capacity (litres)			
Engine Mode	Inside engine	With radiator		
DP180L DP 222L	About 21	About 91 (Air on 43℃)		
	About 21	About 114 (Air on 43℃)		
	About 23	About 114 (Air on 43℃)		
		About 125 (Air on 52°C)		

CHECKING THE COOLANT



If the radiator cap is opened to exchange or replenish coolant while the engine is overheated, hot water will spurt out and may cause serious burns. If it is absolutely necessary to open the radiator cap while the engine is overheated, wrap the radiator cap with a cloth and slowly open the cap in two steps until the steam pressure has been released from the inside. After the steam pressure has been completely released, remove the radiator cap.

- 1. Use clean tap water for the engine coolant.
- 2. Add 40% of antifreeze to the coolant to prevent corrosion and freezing.
- 3. Periodically check coolant to maintain the concentration of antifreeze and additives.

DANGER

If the antifreeze and corrosion inhibitor is kept at the proper level, corrosion of the engine will be prevented effectively and engine quality will be maintained. Be careful that, if managed improperly, it can give a fatal impact on the coolant pump and cylinder liner.

- 4. The engine cylinder liner is of a wet type which specially requires good coolant flow.
- 5. Check the concentration of antifreeze and corrosion inhibitor using the coolant test sheet.

MEASUREMENT OF COOLANT CONCENTRATION

Special Tools

Figure	Product Number/Name
test sheet	60.99901-0038 CC2602M
C) B) A)	Coolant test sheet

The coolant concentration can be measured as follows:

1. If the engine coolant temperature is within a range of $10 \sim 55 \,^{\circ}$ C, drain the coolant and fill half a plastic cup with it.

When taking out a sample of coolant from the supplementary tank, it is difficult to measure the precise concentration. Always take out sample by opening the drain plug of coolant.

- Soak the test sheet in the coolant and take it out after 3 ~ 5 seconds. Shake the sheet to remove the remaining coolant.
- 3. Wait for approximately 45 seconds until the test sheet changes its colour.



Measurement time should not exceed 75 seconds. The colour changes as time passes.

4. Check the colour on test sheet.



1) Compare the colour of part (A) on the test sheet to the colour of GLYCOL/FREEZEPOINT (End pad) of the standard colour table.

2) Compare the colour of the test sheet (B) to the colour of MOLYBDATE (Middle pad) of the standard colour table.

3) Compare the colour of the test sheet (C) to the colour of NITRITE of the standard colour table.

5. Compare and confirm the parts with identical colours on the test sheet and the standard colour table.



1) Compare the changed pink colour part A of the test sheet with the GLYOOL/FREEZEPOINT (End pad) of the standard colour table on top of the container and confirm the concentration. The concentration indication has to be within the colour scope of $33{\sim}50\%$

2) The state of additives for anticorrosion is shown on the point where the colour of MOLYBDATE (Middle pad) on the standard colour table (which is identical with the Middle (B) of the test sheet) is crossed with the colour of NITRITE on the standard colour table (which is identical with the (C) of the test sheet). It should be maintained at the optimum range, in the green section between 0.3 to 0.8.

3) If the measurement result is below 0.3, replenish anticorrosion additives (DCA4). If it is above 0.8, drain a little coolant and then add clean tap water to adjust the concentration.



If the colour on the test sheet does not match the colour of the standard colour table, find a middle colour on the standard colour table. For example, if the colour of (C) of the test sheet matches D and F on the NITRITE of the standard colour table, select E.

To prevent corrosion inside of the engine cooling unit, drain the coolant and replace it with new coolant once a year.

DISCHARGING THE COOLANT

The coolant can be drained as follows:

- 1. Ensure that the engine and radiator are cooled.
- 2. Open the radiator cap.



Never open the radiator cap while the engine is overheated. If the radiator cap is opened while the engine is overheated, hot water will spurt out and may cause serious burns. Open the radiator cap after ensuring that the engine has been cooled sufficiently.

Mark and separately manage the containers for storing coolant from beverage containers to avoid confusion. If coolant is ingested, see a doctor immediately.

3. Loosen the drain valve s located under the radiator to drain the coolant.



4. Disassemble the coolant drain plug of the cylinder block, and drain it to a container.



5. Drain cooling water in the oil cooler.



1) Loosen the drain plug (A) of the oil cooler cover and then drain cooling water.

CHARGING THE COOLANT

- 1. Ensure that the engine is cool.
- 2. Open the radiator cap.



Never open the radiator cap while the engine is overheated. If the radiator cap is opened while the engine is overheated, hot water will spurt out and may cause serious burns. Open the radiator cap after ensuring that the engine has been cooled sufficiently.

Mark and separately manage the containers for storing coolant from beverage containers to avoid confusion. If coolant is ingested, see a doctor immediately. 3. Pour in the coolant slowly.

Be careful not to let foreign substances flow into the engine when replenishing coolant.

- 4. Ensure that there is no air in the cooling system.
- 5. After checking the coolant level when the engine is warmed up, replenish coolant if necessary.

DANGER

If the engine is hot, wrap the coolant pressure cap with a cloth upon opening it so that the steam may be discharged. This can prevent burning by the hot steam coming out of the cap inlet.

Do not mix antifreezes from different manufacturers.

Do not mix the coolant with different concentrations.

Do not add antirust which is not recommended by us.

As insufficient coolant concentration may cause corrosion or freezing, alternatively, an excessive concentration may degrade the cooling performance. Mix coolant with 40% antifreeze and $3\sim5\%$ additives (DCA4) to prevent corrosion.



Discard exchanged coolant according to the regulations set forth by the relevant authorities. Disposing of exchanged coolant into the ground, sewers, drains, rivers, or the sea will cause serious environmental pollution. Violation of regulations regarding discard of coolant without observing the handling regulations, will be punished.

CLEANING THE COOLING CIRCUIT

If the internal coolant circuit is contaminated by corrosion or foreign substances, the cooling effect is reduced. The resistance in the coolant circuit may damage the mechanical seal of the coolant pump.

The reduced performance in the cooling circuit may be caused by use of incorrect type or quantity of antifreeze or corrosion inhibitor, or by use of coolant without such ingredients. If the coolant pump leaks or the coolant is severely contaminated within the first 6 months of operation (e.g., the coolant colour becomes discolouredbrown, grey or black depending on the degree of contamination), clean the cooling system in the following way before removing the cooling pump.

- 1. Drain the coolant.
- 2. To clean the cooling circuit swiftly, remove the thermostat.
- 3. Mix water and 1.5% of cleaning solution and fill the cooling circuit with this liquid.
- 4. Load the engine. When the coolant temperature reaches 60 °C, run the engine for approximately 15 minutes.
- 5. Drain the cleansing solution.
- 6. Repeat step 3 and 4 above.
- 7. Fill the cooling circuit with hot water.
- 8. While running the engine at idle speed for 30 minutes, check if there is any leakage in the drain plug and coolant line. If the coolant is insufficient, replenish it.

CAUTION

Clean the cooling circuit regularly with cleansing solution.

INTER COOLER

The air cooler adopts an air cooling fan, which has sufficient cooling capacity. The life and performance of an air cooler greatly depends on the intake air conditions. Dirty air may contaminate and clog the cooling pins. This results in reduced engine power or engine failure. Always check the intake system for air leak, damage or contamination of the air filter.



To keep the optimum performance of the air cooler, clean it regularly.

LUBRICATION SYSTEM

GENERAL INFORMATION

Engine oil lubricates, cools, seals, prevents corrosion, and cleans engines, enhancing engine performance and extending the engine's lifetime. If a vehicle is continuously driven while engine oil is insufficient, the moving parts of the engine may get stuck, causing engine faults.

Engine oil should be checked through the oil level gauge and replenished if required. Oil level should be checked while the engine is stopped. To check the oil level, turn off the engine while it is running and wait for $5 \sim 10$ minutes to allow the engine oil to flow back into the oil pan. The engine oil level should indicate between the upper limit and the lower limit of the oil level gauge.

Engine oil should be periodically replaced based on the regular inspection table and the oil filter and the cartridge should be replaced as the engine oil is replaced.

ENGINE OIL STANDARDS

Use the specified engine oil suitable for the environment and conditions of the site where the engine will be used.



Engine Model and Product Code	SAE Classification	Oil Class
DP180L	SAE 15W40	API CD or above
DP 222L	SAE 15W40	API CD or above

NOTE: Use of Doosan genuine engine oil is recommended.

ENGINE OIL CAPACITY

Replenish the engine oil based on the following recommended oil amount.

Engine Model	Engine oil capacity (litres)			
Lingine model	Max.	Min.		
DP180L	34	23		
DP222L	40	27		

CHECKING THE ENGINE OIL

Check the oil level every day using an oil level gauge.

- 1. The oil level should be checked when the engine is stopped and on an even level. If the engine has been running prior to checking, wait for 5~10 minutes to allow the engine oil to flow back into the oil pan.
- 2. Pull out the oil level gauge, and clean the indication line of the oil level gauge with a clean cloth.



Cleaning the indication line of the oil level gauge with a dirty cloth allows foreign substances to get into the engine, causing damage to the engine.



3. Insert the oil level gauge, and then remove it to check the engine oil level, viscosity, and contamination. Replenish or replace the engine oil if required.



1) Check the oil level every day using the oil level gauge.

2) Check if the oil level is between the upper limit (A) and the lower limit (B) of the oil level gauge.

3) If engine oil level is below the lower limit (B) or not on the gauge at all, replenish engine oil.

4) Check condition of engine oil. If it is polluted, replace it with new oil.

Do not fill the engine oil above the upper limit. Exceeding the upper limit may damage the engine.

Be careful not to let foreign substances flow into the engine when replenishing engine oil.

REPLACEMENT OF ENGINE OIL

Check the oil level using the oil level gauge and replenish it if required. Replace the engine oil in the following steps when the engine is warm after running.

- 1. Pull out the oil level gauge.
- 2. Open the drain plug of the oil pan to drain the engine oil from the container.



- 3. After draining the engine oil, replace the drain plug of the oil pan.
- 4. Fill the engine oil into the cartridge of the oil filter.
- 5. Fill the engine oil through the oil filler cap..
- 6. Run the engine at idle speed for several minutes so the oil can circulate through the lubrication system.
- 7. Stop the engine and wait for approximately 10 minutes. Check the oil level and fill the oil if required.



Prolonged and repeated contact of skin with engine oil may lead to shrinking, dryness of skin and even cause dermatitis.

Do not expose skin with exchanged engine oil for a long period.

Always wear work clothes and gloves.

When skin is stained with engine oil, immediately wash it with water, soap or hand cleaners.

Do not clean skin with gasoline, fuel, thinner, or solvent.

Apply a skin protective cream after cleaning from oil.

Do not put oil-stained gloves or cloth in pockets.

A WARNING

Discard exchanged oil according to the regulations set forth by the relevant authorities. Disposing of discharged oil into the ground, sewers, drains, rivers, or the sea will cause serious environmental pollution. Violation of regulations regarding discard of engine oil without observing the handling regulations, will be punished.

REPLACEMENT OF ENGINE FILTER

Check the oil pressure and leakage, and replace the oil filter if required. Whenever replacing the oil, the oil filter cartridge should also be replaced with.

- 1. Using an oil filter wrench, loosen the cartridge by turning it counterclockwise.
- 2. Wipe the oil filter head and cartridge contact thoroughly, and make sure that the oil filter cartridge is positioned properly.
- 3. Apply a small amount of oil to the O-ring area of the cartridge. Screw the cartridge on until the O-ring surface makes contact, and turn it 3/4 to 1 turn using a wrench until sealed.

When replacing the oil filter cartridge, be sure to use the genuine Doosan part.

FUEL SYSTEM

GENERAL INFORMATION

The fuel injection pump and nozzle are composed of very sophisticated components with high precision. If fuel is mixed with foreign substance, it may block the nozzle or the fuel injection pump components may become seized. Ensure the fuel system is clean at all times.



Use approved fuel only. Use of non approved fuel may cause critical damage and faults to the engine.

Replenish fuel while the engine is stopped.

FUEL STANDARDS

The quality of fuel is very important to satisfy the engine performance, extension of engine life and the allowable exhaust gas level. Doosan engines are designed to use diesel fuel available in the local market. If the optimum engine performance is required, select the proper fuel by referring to the fuel selection table below.

Low Sulfur Diesel

Fuel	Ingredients	Unit	Standard	Product
Specific Gravity		(kg/litres)	-	0.83
Flash Point		(° °)	> 40	47.8
Viscosity (40 °C)		(cSt)	1.955	2.459
Sulfur content		(wt%)	< 0.05	0.038
Cloud point		(°°)	-	-3
Pour Point		(°°)	< -17.5	-27.2
Low temperature fil	Iter clogging point	(°°)	< -12	-18
Colour (ASTM)			< 2.5	0.7
Carbon Residue (10%) Distillation residue (wt)		(%)	< 0.15	0.08
Total acid value		(mg KOH/g)	< 0.40	0.03
Copper corrosion (100 <i>°</i> C, 3 hrs)		< 1	1 - a
Ash content (wt)		(%)	< 0.01	0.001
Moisture and Precipitate		(vol. %)	< 0.01	0.005
Cetane Index			> 45	52
Distillation test temperature	50% Distillation Point	(°°)	-	264.4
	90% Distillation Point	(°°)	< 360	344.3

NOTE: High sulphur content in diesel fuel - Doosan diesel fuel engines can be operated with fuels whose sulphur content is max. 0.05wt%. Fuels with a sulphur content of > 0.05wt% are not permitted as they result in increased corrosion and greatly reduce the service life of engines. The oil change intervals must be halved if the sulphur content is > 0.02wt%.

WATER DRAINING FROM FUEL FILTER

REPLACING FUEL FILTER

An oil filter has two functions: oil filtering and water separation.

- 1. The water separation function of the fuel filter drains water and sediment from the water separator.
- 2. Stop the engine, and loosen the drain plug for water separation manually.



- Turn the drain plug (A) for water separation counterclockwise 2~3 times until water is drained. Drain the water in the cartridge until fuel is discharged.
- 4. Tighten the drain plug for water separation by turning it clockwise.

DANGER

Fuel may be drained when water is drained from the fuel filter. Fuel is highly inflammable. Fire may occur when if there are naked flames or sparks near the engine when draining water from the fuel filter.

Do not tighten the plug excessively because it may damage the screw.

Check the fuel filter regularly and drain the water in the fuel filter. If water enters the fuel system it will cause serious failure and may damage the fuel filter or reduce performance. Water in the fuel system may stop the engine.

Use approved fuel only. Use of non approved fuel may result in increased water in the fuel filter.



- 1. Clean the area around the fuel filter head (3).
- 2. Disassemble the cartridge (2) by turning it counterclockwise with a fuel filter wrench.

Do not reuse the cartridge; replace them with new ones.

- 3. Remove the fuel filter screw adapter seal ring (4).
- 4. Clean the gasket contact of the fuel filter head (3).
- 5. Check the position of the new cartridge adapter seal ring (4).
- 6. Apply thin coat of clean oil to the O-ring (5) area of the cartridge, and fill the cartridge with fuel.
- 7. Screw the cartridge to the fuel filter head.
- 8. Tighten the cartridge by hand until the O-ring contacts the fuel filter head surface.

9. Tighten it by 3/4 to 1 turn with a fuel filter wrench.



If the cartridge is tightened excessively, the screw may be distorted or the O-ring damaged.

PREVENTING FUEL CONTAMINATION

Most of the fuel contaminations encountered while using the alternator engine are caused by water and propagation of microbes.

Improper handling of fuel can lead to contamination. Propagation of microbes requires water contained in the fuel. To prevent propagation of microbes, keep the water as low as possible in the storage tank.

FUEL INJECTION PUMP

- If the fuel injection pump housing is cracked or damaged, replace it.
- Ensure the idle operaion and speed control lever's sealing device was not removed.
- Ensure the idling or speed control lever's sealing line is not damaged.
- Do not modify the fuel injection pump if the sealing line is damaged. Such modifications will void the warranty.
- If the fuel injection pump is found to be damaged, it should only be repaired by authorised personnel.
- The adjustment and test of the fuel injection pump must be conducted using an appropriate tester.

If any parts that contain a seal ring (copper seal ring, rubber coating seal ring, etc.) are disassembled, then replace the seal ring with a new one. Failure to do so may cause leakage in the fuel filter connections preventing normal functioning.

CLEANING THE FUEL PRE-FILTER

The fuel pre-filter should be cleaned periodically through disassembly. The fuel pre-filter is mounted individually for easy maintenance. Open the cover of the pre-filter and clean the element with compressed air first, and then rinse it with diesel fuel to remove foreign substances.



AIR BLEEDING IN THE FUEL CIRCUIT

Air must be bled from the fuel system when the fuel filter or injection pump are replaced, or air has entered the fuel system due to insufficient fuel.



- 1. Loosen the air bleeding plug (B) on the fuel filter.
- 2. Operate the priming pump by hand to bleed air inside the fuel circuit.

3. Operate the priming pump until the air is discharged completely.

DANGER

Fuel is highly inflammable. Fire may occur if there are naked flames or sparks near the engine when air bleeding in the fuel circuit from the priming pump.

If any parts that contain a seal ring (copper seal ring, rubber coating seal ring, etc.) are disassembled, then replace the seal ring with a new one. Failure to do so may cause leakage in the fuel filter connections preventing normal functioning.

INJECTOR MAINTENANCE

- The injectors are designed to spray the fuel delivered by the injection pump directly into the spherical combustion chamber in the piston crown.
- The injector consists of the nozzle and the nozzle holder.
- A copper gasket fitted to the injector ensures gas-tight seating and good heat dissipation.
- The opening pressure of the nozzle is adjusted by means of shims at the compression spring.



- 2. Cap nut 8. Nozzle holder
- 3. Compression spring 9. Connect tube for
- 4. Compression pin 10. Shim
- 5. Cap nut for fixed nozzle 11. Pin
 - 12. Nozzle bush

overflow

FUEL INJECTION NOZZLE

6. Nozzle

1. Install a nozzle to the nozzle tester.



- 2. Check the fuel injection pressure. If the pressure does not satisfy the reference value, adjust the injection pressure of the nozzle using an adjustment shim.
- 3. Check the nozzle spray status. If it is defective, replace the nozzle.

As the injection nozzle is designed to operate under high pressure, it should be handled with care.

Always keep hands away from the fuel jet, as there is a risk of injury. Do not inhale the atomized fuel oil. If possible, work under an extraction system.



Engine	Nozzle injection pressure (Mpa)	
DP180L	DP180LBS	28
	DP180LBF	28
	DP180LAS	28
	DP180LAF	28
DP222L	DP222LAS	28
	DP222LBS	28
	DP222LBF	28
	DP222LCS	28
	DP222LCF	28

REMOVAL OF NOZZLE

- 1. Remove fuel injection pipe between nozzle holder and injection pump.
- 2. Remove fuel return pipe.
- 3. Loosen the Union screw (A) of nozzle holder with Nozzle plug socket (EI.03004-0225).
- 4. Remove nozzle holder with sealing from the cylinder head.



INSTALLATION NOZZLE

- 1. Clean seat in cylinder head.
- 2. Insert nozzle holder with new gasket.
- 3. Tighten union nut with 12 kgf•m.

12 kgf•m

4. Install injection lines free of constraint. Install leak fuel lines, screw delivery pipe at nozzle holder and at the injection pump.

A CAUTION

The injection lines are designed for high operating pressure and should be handled with particular care.

When mounting the pipes to the engine ensure they are properly fitted.

Do not bend pipes when replacing the nozzles.

Do not mount any misshapen pipes.

Avoid bending pipe ends by more than 2 to 3 degrees.

In case of faults in the injection system which might have resulted in excessive operating pressures, replace both the failed part and the injection line.

NOTE FOR CLEANING NOZZLE

- Clean nozzle body externally from soot and carbon. When cleaning several nozzles at the same time, make sure nozzle bodies and needles are not mixed up. Visually inspect needle and body.
- Do not clean the nozzle if the seat of the needle is indented or the pintle is damaged. If this occurs the nozzle should be replaced.
- Clean annular groove with scraper over full circumference. Wash out dislodged carbon deposits and dirt.
- Scrape needle seat with cleaning cutter. Dip cutter in test oil before use. The cutter can also be clamped in a lathe.
- Polish needle seat with wooden cleaning tool by chucking the needle in a lathe at the pintle end.
- Clean the spray holes of nozzles by chucking a cleaning needle of suitable diameter in the collet. If the carbon deposits in the spray holes cannot be removed by rotating and pressing, have the needle

project only slightly from the collet and drive out the carbon by lightly tapping on the tool.

- Before reassembly thoroughly wash nozzle body and needle in clean test oil.
- Hold the needle at the pintle end only; to avoid corrosion do not touch the lapped surfaces of the needle with your fingers.
- Thoroughly clean all other parts of the nozzle holder with clean fuel.
- Check nozzle discharge pressure in nozzle tester. The edge-type filter should not be pressed into the nozzle holder by more than approximately 5mm. If this depth is exceeded the injector must be replaced.

CHECKING THE INJECTION TIMING

- 1. Remove the plug screw on the flywheel housing cover.
- **NOTE:** In some cases it is necessary to remove the cover assembly.
- 2. Turn the crank pulley so that the mark on pointer provided on the injection pump coincides with matching mark (FB) on the flange surface of the drive gear.



 To check the injection timing degree, ensure the V-type edge of the flywheel housing sight hole coincides with the engine injection timing degree marked on the flywheel corresponding to the fuel delivery position.



Engir	Injection Timing (°)	
DP180L	DP180LBS	21°±1°
	DP180LBF	19°±1 °
	DP180LAS	21°±1°
	DP180LAF	19°±1 °
DP222L	DP222LAS	21°±1°
	DP222LBS	21°±1°
	DP222LBF	19°±1 °
	DP222LCS	21°±1°
	DP222LCF	19°±1 °

ADJUSTING INJECTION TIMING

If upper pre-checked injection timing degree is wrong, follow the procedure below.

1. Loosen the fixing bolts (M8) of the injection pump driving gear in order to adjust the injection timing slightly.



- 2. Turn the crank pulley clockwise until V-groove of the flywheel housing sight hole is aligned with the injection timing degree of the engine.
- 3. Ensure the mark on pointer provided in the injection pump corresponds with the matching mark (FB) on the flange surface of the drive gear by turning the flange in the oblong holes of the drive gear.
- 4. Tighten the bolt (M8) to specified torque, (2.2 kgf⋅m) being careful not to move the drive gear.
- 5. Once the fastening bolts are completely tightened check the start point (injection timing degree) of fuel delivery setting. Correct again using the above procedure if necessary.

INTAKE/EXHAUST SYSTEM

GENERAL INFORMATION

The air filter purifies dust and foreign substances included in the air and supplies clean air into the engine. The air filter is directly related to engine lifetime, emissions, and engine output. Periodically check, clean, and replace the air filter.



Do not operate the engine without the air filter.

Use specified air filters only. Using unauthorized or remanufactured air filters may result in critical faults.

Foreign substances in the engine may cause abrasion inside the engine.

Immediately exchange a damaged air filter with a new one.

Be careful not to let foreign substances flow into engine or damage the air filter related electric apparatus when replacing an air filter.

Be careful not to let dust inside when assembling the air filter.

AIR FILTER

- Air cleaner is mounted on the engine to purify the air for combustion.
- The intervals at which the air cleaner requires servicing depend on the specific operating conditions encountered.
- Clogged air filters may cause black smoke and reduce power.
- A check should be made from time to time to see that the fastening elements securing the air cleaner to the intake manifold seal the connection tightly.
- Any ingress of unfiltered air is liable to cause a high rate of cylinder and piston wear.

Allowed only when the engine is stopped.

- 1. Empty the dust bucket periodically. The dust should not exceed the half of the dust bucket capacity.
- 2. Disassemble the dust bucket by removing two clamps. Remove the dust bucket cover and empty the dust inside.
- 3. Assemble the cover and dust bucket accurately with care.
- 4. For easy alignment, the cover has dent and the dust collector has a protrusion. Here is the position where a filter is mounted horizontally, check the "TOP" mark on the air filter canister.





- 1. Air cleaner assembly.
- 2. Air cleaner element

CLEANING OF THE AIR FILTER ELEMENT

Clean the air filter element by using the most suitable method for the work environment among the three methods stated below.

1. Use compressed air to clean the air filter element.



1) Use an air gun at a 90° angle from the inside of the element.

2) Move air gun up and down the element to blow air from inside to outside there is no more dust in the element.

3) Do not use compressed air pressure exceeding 5 bars.



Always wear protective goggles before starting work in order to prevent injury from dust or foreign substances in the element.

2. Clean the element by washing it.



1) Before washing the element, clean the element by using compressed air as described above.

2) Soak the element in the warm cleaning solvent for 10 minutes and then shake it back and forth for approximately 5 minutes.

3) Rinse the element with clean water, drain the water, and then dry it at room temperature. Fully dry the element before reassembling.



Never use steam spray, gasoline, alkali or hot cleansing solution to clean the element.

3. In an emergency, temporarily clean the element by using the following method.

1) Tap the end plate of the element to clean it temporarily.



This method should only be used in an emergency when cleaning of element is necessary and no compressed air or cleansing solution is available.

Under no circumstances should the surface of the element be hit or beaten with a hard object to shake the dust off.



- **NOTE:** Before reassembling the element, make sure that the filter paper is not wrinkled, the state of rubber sealing is good, and the element is not deformed.
- **NOTE:** Do not reuse damaged elements under any circumstances. When in doubt, replace the element with a new one.

CHANGING THE AIR FILTER ELEMENT

1. Remove the hex nut, remove the dirty element.



- 2. Clean or replace with a new element.
- 3. Clean the inside of the filter housing with a damp cloth.
- 4. Replace end cap.



Do not let dust enter the end of the air filter.

TURBOCHARGER

The Turbocharger does not need specific maintenance. When replacing the engine oil, check the oil pipe for leakage or clogging.

- Handle the air filter with special care to prevent foreign substances from getting in.
- The turbocharged compressed air and exhaust gas pipe should be checked periodically for air leakage. Any air can cause the engine to overheat.

Be careful not to bend the turbocharged compressed air and exhaust gas pipe.

• If the impeller is severely contaminated, soak only the wheel in a solvent and clean it thoroughly with a rigid brush. Be sure to soak only impeller. The turbocharger should be supported by a bearing housing, not by an impeller.

ROUTINE CHECK AND SERVING THE TURBOCHARGER

The turbocharger performance is affected by the maintenance state of the engine. Regularly perform inspection and maintenance as specified in order to maintain turbocharger performance.

1. Intake system

The air filter should be carefully managed. For a wet type air filter, the intake resistance should be as small as possible.

2. Exhaust system

When exhaust gas leaks from the exhaust pipe or turbocharger joint, supercharging efficiency is lowered. Ensure there is no gas leakage as this can cause serious burns. Heat resistant nuts are used for parts which become hot during operation, such as the turbine seal. These nuts must not be mixed with other nuts. The screw burn prevention paint should be applied to the assembly nuts at the specified positions.

3. Fuel system

If the spray status of the fuel injection nozzle is not good, or the injection timing is not correct, the exhaust gas temperature increases to give a negative impact on the turbocharger. Ensure that the nozzle is tested.

4. Lubrication system

Ensure that the correct grade of oil is used and the oil filter cartridge is replaced according to the maintenance schedule. Degradation of engine oil has a negative effect on the turbocharger, as well as the engine body.

DISASSEMBLY AND CLEANING A TURBOCHARGER

Remove the turbocharger from the engine to clean or inspect it. Be sure to seal the oil inlet and outlet with tape, etc.

CYLINDER BLOCK/HEAD

VALVE CLEARANCE

Adjust the valve clearance.

- When disassembling the engine or cylinder head.
- When there is excessive noise in the valve connection.
- When the engine runs abnormally even if the fuel injection system is normal.

ADJUSTING THE VALVE CLEARANCE



• 8 Cylinder engine



• 10 Cylinder engine



• 12 Cylinder engine



- 1. Rotate the crankshaft so that #1. cylinder may be positioned at the compression TDC (Top Dead Centre).
- **NOTE:** #1. Cylinder is located at the side near the cooling water pump.
- **NOTE:** In case of 8/12 cylinder engine, #6. cylinder is positioned at the valve overlap when #1. cylinder is positioned at the compression TDC (Top Dead Centre).
- **NOTE:** In case of 10 cylinder engine, #7. cylinder is positioned at the valve overlap when #1. cylinder is positoned at the compression TDC (Top Dead Centre).
- 2. Loosen the lock nut of the #1. cylinder rocker arm.
- 3. Push the feeler gauge between a rocker arm and a valve stem.
- 4. Adjust the clearance screw respectively and then tighten with the lock nut.
- 5. Only adjust the valve clearance when the engine is cold.

Engine Model		In. valve	Ex. valve
	DP180LBS	0.25mm	0.35mm
	DP180LBF	0.25mm	0.35mm
DI TOOL	DP180LAS	0.25mm	0.35mm
	DP180LAF	0.25mm	0.35mm
	DP222LAS	0.25mm	0.35mm
	DP222LBS	0.25mm	0.35mm
DP222L	DP222LBF	0.25mm	0.35mm
	DP222LCS	0.25mm	0.35mm
	DP222LCF	0.25mm	0.35mm

- 6. Rotate the crankshaft. When a cylinder reaches the compression TDC (Top Dead Centre), adjust the valve clearance of the cylinder.
- 7. When a cylinder valve overlap, adjust the valve clearance cylinder of the compression TDC (Top Dead Centre), as follows.
- 8 cylinder engine (DP158L)

Valve overlap cylinder No.							
1	5	7	2	6	3	4	8
6	3	4	8	1	5	7	2
A	djustir	ng valv	e cylin	der No	. (In./E)	k. Valve	e)

• 10 cylinder engine (DP180L)

Valve overlap cylinder No.									
1	6	5	10	2	7	3	8	4	9
7	3	8	4	9	1	6	5	10	2
	Adjusting valve cylinder No. (In./Ex. Valve)								

• 12 cyliner engine (DP222L)

	Valve overlap cylinder No.										
1	12	5	8	3	10	6	7	2	11	4	9
6	7	2	11	4	9	1	12	5	8	3	10
	Adj	ustir	ng va	lve o	cylin	der N	lo. (I	n./Ex	k. Va	lve)	

TIGHTENING CYLINDER HEAD BOLT

1. Retightening cylinder head bolt on new engine.



1) The cylinder heads are mounted with cylinder head bolts which are tightened by the angle of rotation method.

2) On new engines the cylinder head bolts are tightened up for the first time at the factory after the engine has been broken in.

3) After the first 400 hours of operation retighten cylinder head bolts 1 to 4 in the order shown in the figure above by a further 90° (1/4 revolution).



The two outer screws (intake and exhaust sides) must not be retightened.

The cylinder head bolts to be retightened must not be loosened first, but simply tightened by a further 90° (1/4 revolution) from their actual position.

2. Tightening cylinder head bolts after a repair. (Engine cold).



- 1. Tighten temporarily 1~2 threads by hands.
- 2. 1st step: Tighten to approximately 8kgf•m with a wrench.
- 3. 2nd step: Tighten to approximately 15kgf•m with a wrench.
- 4. 3rd step: Rotate 90° with a wrench.
- 5. Final step: Rotate 90° with a wrench.

Excessive torque may damage the cylinder head gasket, cylinder liner flange and cylinder head bolt. Ensure to use the specified torque settings.

When tightening cylinder head bolts after a repair, always adjust the valve clearance.

6. After the first 10 to 20 hours of operation after a repair turn the cylinder head bolts by a further 90° (1/4 revolution).

Do not loosen cylinder head bolts before re-tightening. Tighten them by turning by a further $90^{\circ}(1/4 \text{ revolution})$ from their actual position.

7. After 400 hours of operation turn the cylinder head bolts by a further 90° (1/4 revolution).

The two outside screws (intake and exhaust side) must not be retightened.

Do not loosen cylinder head bolts before re-tightening. Tighten them by turning by a further $90^{\circ}(1/4 \text{ revolution})$ from their actual position.

When a cylinder head has been removed the cylinder head gasket must always be changed.

CYLINDER COMPRESSION PRESSURE

- 1. Start and warm up the engine.
- 2. Stop the engine and disassemble the fuel injection nozzle holder assembly.
- 3. Install a special tool, compression pressure gauge adapter (EU.2-0532), in the fuel injection nozzle holder hole.



4. Connect the compression pressure gauge to the adapter.

Standard	Above 28kg/cm ²
Tolerance limit	24kg/cm ²
Difference between each cylinder	Within ±10%

ELECTRICAL SYSTEM

BATTERY

- Check the battery for cracks and ensure there is no electrolyte leakage. Replace the battery if defective.
- Check the amount of electrolyte, and replenish distilled water if insufficient.
- Check the specific gravity of electrolyte. If it is below the specified value (1.12 ~ 1.28), replenish it.



STARTER

When servicing the engine, immerse the starter motor's pinion gear and ring gear in the fuel, wash them completely, and apply grease again. When cleaning the surrounding of engine, ensure that no water enters the starter.



Starter should be protected from humidity at all times.

Before working on the electrical system, be sure to disconnect the ground wire ("-" minus wire) of the battery. Short circuit may occur while working on the electrical system. Reconnect the ground wire last after completing all of work.

OTHERS/DRIVING SYSTEM

V-BELT

The tension of the V-belts should be checked daily.

1. Change the V-belts if necessary.

1) If wear or differing tensions are found in a multiple V-belt drive, always replace the complete set of V-belts.

2. Checking condition.

1) Check V-belts for cracks, oil, overheating and wear.

3. Testing by hand.



1) Test the V-belt tension by pressing the V-belt in the centre between pulleys. $10\sim15$ mm deflection is normal.

2) To check the V-belt tension more accurately, use a V-belt tension gauge.

- 4. Tension measurement.
 - 1) Lower indicator arm (1) into the scale.



2) Apply tester to belt at a point midway between two pulleys so that edge of contact surface (2) is flush with the V-belt.



3) Slowly depress pad (3) until the spring can be heard to disengage. This will cause the indicator (1) to move upwards.

NOTE: If pressure is maintained after the spring has disengaged a false reading will be obtained.

4) Read the tension value at the point that the top surface of indicator arm (1) intersects with the scale.

5) Before taking readings, ensure that the indicator arm remains in its position.

NOTE: If the value measured deviates from the setting value specified, the V-belt tension must be corrected according to the following table.

		Tension from a Tension Meter						
Туре	Belt width	New be	Poplacomont					
	(mm)	Upon installation	After 10 minutes	required				
М	8.5	50	45	40				
Α	11.8	55	50	45				
В	15.5	75	70	60				
С	20.2	75	70	60				
3V-2	18.8	90~100	70~80	60				
3V-4	39.4	180~200	140~160	120				
3V-6	60.0	270~300	210~240	180				

5. Tension adjustment and V-belt replacement.



- 1) Loosen the fixing bolt (1).
- 2) Loosen the lock nut (2).
- 3) Adjust the bolt (3) until belt have correct tension.
- 4) Tighten the fixing bolt (1) and nut (2).

5) To replace the V-belt, loosen the fixing bolts (1) and the lock nut (2) and push the tension pulley inwards by turning the adjusting bolt (3) counter clockwise.



- 6) Loosen the mounting bolts (B).
- 7) Loosen the lock nut (A).

8) Adjust the nut (C) until the belt tension has correct tensions.

- 9) Retighten the lock nut (A) and the mounting bolt (B).
- 10) To replace the belt, loosen the lock nut and push the alternator inwards.

ALTERNATOR INSTALLATION AND MAINTENANCE

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LSA 49.1 - 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.

- The type of machine.
- The full code number of the generator.
- The serial number.

WARNING SYMBOLS

Some operations described in this manual are preceded with symbols that are added to alert for the possible risk of accidents. It is important to understand the following symbols.

A CAUTION

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.

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.



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.

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RECEIPT

STANDARDS AND SAFETY MEASURES

Our alternators comply with most international standards.

See the EC Declaration of Incorporation on the last page.

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.

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.

So that you can identify your alternator quickly and accurately, we suggest you fill in its specifications on the nameplate below.

STORAGE

Prior to commissioning, machines should be stored:

- away from humidity (< 90%); after a long period of storage, check the machine insulation. To prevent the bearings from becoming marked, do not store in an environment with significant vibration.

APPLICATION

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

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	IP	RATINGS
N°:	Date :	Voltage V
r.p.m.	Hz Weight : kg	Phase
P.F. : Th	.class. Altitude : m	Conn.
A.V.R.	Excit.	Contin.
Excit. values	full load : V / A	B.R.
	at no load : A	40°C.
D.E. bearing		Std by
N.D.E. beari	ng	
(Ch-		27°C
c Us		

TECHNICAL CHARACTERISTICS

ELECTRICAL CHARACTERISTICS

PARTNER LSA 49.1 alternator is a machine without sliprings or revolving field brushes, wound as "2/3 pitch"; 6 or 12-wire, with class H insulation and a field excitation system available in either AREP or "SHUNT+PMG" version (see diagrams and AVR maintenance manual).

Electrical options

- Stator temperature detection sensors

- Space heaters

- Terminal box with connector links for mounting protection or measurement C.T.

In order to conform to standard EN 61000- 6.3, EN 61000-6.2, the R 791 interference suppression kit is needed.

MECHANICAL CHARACTERISTICS

- Steel frame
 - Cast iron end shields
 - Greasable ball bearings
 - Mounting arrangements:

IM 1201 (MD 35) foot and flange mounted, singlebearing 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

Mechanical options

- Protection against harsh environments

- Air inlet filter, air outlet labyrinth seals: IP 44 To prevent excessive temperature rise caused by clogged filters, it is advisable to monitor the stator winding with thermal sensors (PTC or PT100).



SHUNT + PMG system with R 450



INSTALLATION

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

ASSEMBLY



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

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

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 machine.



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



Single-bearing coupling

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 machine is securely bedded in position during coupling.

Check that there is lateral play on the crankshaft.

Double-bearing coupling

- 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.**

Location

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

CHECKS PRIOR TO FIRST USE

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.

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 $^{\circ}$ 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.

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

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 later in this manual).

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.

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





Option connection diagram



COMMISSIONING

WARNING

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.



- The alternator earth terminal inside the terminal box is connected to the electrical earth circuit.

- The earth terminal (ref 28) is connected to the frame. The connections inside the terminal box must never be subjected to stress due to cables connected by the user.



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 later in this manual).

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 later in this manual). If the machine still operates incorrectly, the cause of the malfunction must be located (See later in this manual).

SETTING UP

A WARNING

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.
SERVICING - MAINTENANCE

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.





During and after running, the alternator will reach temperatures hot enough to cause injury, such as burns.

ROUTINE MAINTENANCE

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.

Electrical servicing

Commercially-available volatile degreasing agents can be used.

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.

Mechanical servicing



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

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

Dusting: Use an air gun.

If 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 later in this manual).

BEARINGS

As an option, the bearings are regreasable	Regreasing interval: 4500 hrs of operation DE bearing: Amount of grease: 60 gr NDE bearing: Amount of grease: 50 gr
Standard grease	LITHIUM - standard - NLGI 3
Grease used in the factory	ESSO - Unirex N3



It is imperative to lubricate the alternator during operation and on first use. Before using another grease, check for compatibility with the original one.

MECHANICAL DEFECTS

Fault		Action	
Excessive overheating of one or both bearings (bearing temperature 80 ℃ above the ambient temperature)(With or without abnormal bearing noise).		 If the bearing has turned blue or if the grease has turned black, change the bearing. Bearing not fully locked (abnormal play in the bearing cage). End shields incorrectly aligned. 	
Abnormal temperature	Excessive overheating of alternator frame (more than 40 °C above the ambient temperature).	 Air flow (inlet-outlet) partially clogged or hot air is being recycled from the alternator or engine. Alternator operating at too high a voltage (>105% of Un on load). Alternator overloaded. 	
Vibrations	Too much vibration.	 Misalignment (coupling). Defective mounting or play in coupling. Rotor balancing fault (Engine - Alternator). 	
	Excessive vibration and humming noise coming from the machine.	- Phase imbalance. - Stator short-circuit.	
Abnormal noise	Alternator damaged by a significant impact, followed by humming and vibration.	 System short-circuit. Misparalleling. Possible consequences. Broken or damaged coupling. Broken or bent shaft end. Shifting and short-circuit of main field. Fan fractured or coming loose on shaft. Irreparable damage to rotating diodes/AVR, surge suppressor. 	

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. - Main field winding short-circuited - Check the resistance
		Speed too low.	Increase the drive speed (do not touch the AVR voltage pot. (P2) before running at the correct speed).

Voltage too high.	Adjust AVR voltage potentiometer.	Adjustment ineffective.	- Faulty AVR. - 1 faulty diode
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 EAREP / PMG < 10V	- Check the speed (or LAM set too high)
		Voltage between E+ and EAREP / PMG > 15V	 Faulty rotating diodes. Short-circuit in the revolving field coil. Check the resistance. Faulty exciter armature.
Voltage disappears during operation.	Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components.	The voltage does not return to the rated value.	 Exciter winding open circuit. Faulty exciter armature. Faulty AVR. Main field open circuit or short-circuited

Checking the winding

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



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

CHECKING THE DIODE BRIDGE

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



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. detection, auxiliary windings).

ASSEMBLY B



ACAUTION

During the warranty period, this operation should only be carried out in an 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 before choosing the lifting method.



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 puller (U35) / (U32/350)

Screw tightening torque

See later in this manual.

Access to diodes

- Open the air intake grille (51).
- Disconnect the diodes.

- Disconnect the diodes using an ohmmeter or a battery lamp.

- Remove the surge suppressor (347).

- Remove the 6 "H" mounting nuts for the diode bridges on the support.

- Change the fitted caps, respecting the polarity.

Access to connections and the regulation system

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

Replacing the NDE bearing on alternators connected to a diesel engine

- Remove the lid of the protective cover (48) and the AVR inspection door (466).
- Disconnect the AVR.
- Take off the panels (367 and 368) and the grilles (254 and 255).
- Disconnect the stator connections (T1 to T12).
- Remove the neutral link (278).
- Take out the connector link assembly (281 + 279).
- Take out the connection plate assembly (281 + 270).

- Remove the rear cross-member (269) and the rear panel (365).

- Remove the air intake grille (51).
- Remove the 4 bearing thrust screws (78).
- Remove all 4 screws (37).
- Take out the bearing (36).

- Remove the ball bearing (70) using a puller with a central screw (see fig. below).



- Check the state of the "O" ring (349) and, if necessary, change it.

- Fit the new bearing, after heating it by induction at approximately 80 °C.



Replace the dismantled bearing with a new one.

Replacing the DE bearing

- Take out the screws (31) and (62).
- Take out the bearing (30).
- Take out the circlips (284).

- Remove the ball bearing (60) using a puller with a central screw.

- Fit the new bearing, after heating it by induction at approximately 80 ℃.

Replace the dismantled bearing with a new one.

Complete dismantling

- Take out the DE bearing (30) as described in this manual.

- Support the DE rotor (4) with a strap or with a support constructed following the drawing below.



- After extracting the rotor, be careful not to damage the fan and place the revolving field on special V-blocks.

- Remove the NDE bearing ball bearing cover.

- Knock lightly on the shaft end on the opposite side from the coupling using a small mallet.

- Move the strap as the rotor moves in order to distribute the weight over it.

- Remove the NDE bearing following the instructions in this manual.

Reassembling the bearings

- Place the "O" ring seal (349) and the preloading wavy washer (79) in the bearing seat (36).

- Position on the stator (1), bearings (30) and (36).

- Tighten screws (31) and (37).

- Tilt the inner bearing retainer (78) upwards in order to lubricate the bearing.

- Tighten the 4 HM10 screws on the inner bearing retainer (78).

- Fit the air intake grille (51).

- Replace the rear cross-member (269) and the rear panel (365).

- Replace the connection plate assembly (281 + 270).
- Replace the connector link assembly (281 + 279).
- Replace the neutral link (278).
- Connect the stator connections (T1 to T12) and the sensing wires.
- Refit the panels (367) and 368) and the grilles 254 and 255).
- Reconnect the AVR.

- Refit thelid of the protective cover (48) and the inspection door of the AVR (466).



Reassembling the rotor

On single bearing alternators:

- Slide the rotor into the stator and position it as shown in fig above.

- Tilt the inner bearing retainer (78) upwards in order to lubricate the bearing.

- Tighten the 4 HM10 screws on the inner bearing retainer (78).

- Fit the flange and check that the alternator assembly is correctly mounted and that all screws are tightened.

On two-bearing alternators:

- Slide the rotor into the stator and position it as shown in the figure above.

- Tilt the inner bearing retainer (78) upwards in order to lubricate the bearing.

- Tilt the inner bearing retainer (68) upwards in order to lubricate the bearing.

- Tighten the 4 HM10 screws on the inner bearing retainer (68 and 78).-

Fit the circlips (284).

- Check that the alternator assembly is correctly mounted and that all screws are tightened.

NOTE: If the rotor has been fully rewound, it must be rebalanced.

A WARNING

After operational testing, replace all access panels or covers.

Dismantling and reassembly of the filters

- Remove the grille (417) then take out the filter (418), as shown below. Change the filter if necessary; please see later in this manual for cleaning the filter.

To replace, follow the instructions in reverse order.



INSTALLATION AND MAINTENANCE OF THE PMG

For the LSA 49.1, the PMG reference is : PMG 3. See the PMG manual ref : 4211.

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 \pm 10% and may be changed without prior notification (for exact values, consult the test report).

Resistances of main windings at 20 °C

Average values for 6 winding - (12 wires)

LSA 49.1	Stator L/N	Rotor	Field	Armature
M5	0,0044	0,38	12	0,08
L9	0,0023	0,43	12	0,08

Field excitation current i exc (A) 50 - 60 Hz

LSA 49.1	No load	At rated load
M5	0,9	3,2
L9	0,9	3,3

Table of weights

LSA 49.1	Total weight (kg)	Rotor (kg)
M5	1620	620
L9	1820	700



After operational testing, it is essential to replace all access panels or covers.

SPARE PARTS

FIRST MAINTENANCE PARTS

Emergency repair kits are available as an option. They contain the following items:

Emergency kit AREP	ALT 491 KS 001
AVR R 450	-
Diode bridge assembly	-
Surge suppressor	-

Single-bearing kit	ALT 491 KB 002
Non drive end bearing	-
«O» ring	-
Preloading (wavy) washer	-

Double-bearing kit	ALT 491 KB 001
Non drive end bearing	-
Drive end bearing	-
«O» ring	-
Preloading (wavy) washer	-

Double-bearing kit L11	ALT 491 KB 003		
Non drive end bearing	-		
Drive end bearing	-		
«O» ring	-		
Preloading (wavy) washer	-		

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.

A WARNING

After operational testing, it is essential to replace all access panels or covers.

ACCESSORIES

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.



The power supply is present when the machine has stopped.

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 bearings.

These sensors must be linked to adapted detection relays (supplied optionally).

Cold resistance of cold thermistor sensors: 100 to 250 Ohms per sensor.



After operational testing, it is essential to replace all access panels or covers.

EXPLODED VIEW, PARTS LIST AND TIGHTENING TORQUE

LSA 49.1 SINGLE-BEARING



LSA 49.1 SINGLE-BEARING

Ref.	Qty	Description	Screw Ø	Torque N.m
1	1	Stator assembly	-	-
4	1	Rotor assembly	-	-
15	1	Turbine	-	-
18	1	Balancing disc	-	-
21	1	Lifting ring	-	-
22	1	Shaft extension key	-	-
28	1	Earth terminal	M12	35
30	1	Drive end shield	-	-
31	6	Fixing screws	M14	110
33	1	Protective guard	-	-
34	2	Fixing screws	M6	4
36	1	Exciter end shield	-	-
37	4	Fixing screws	M14	110
41	1	Front panel	-	-
48	1	Top panel	-	-
49	-	Cover screws	M6	5
51	1	Air intake guard	-	-
53	1	Plug	-	-
59	1	Cover inspection door	-	-
60	1	Drive end bearing	-	-
62	4	Fixing screws	M12	69
68	4	Inner bearing retainer	-	-
70	1	Non drive end bearing	-	-
71	1	Outer bearing retainer	-	-
72	1	Inner bearing retainer	-	-
78	1	Inner bearing retainer	-	-
79	1	Preloading (wavy) washer	-	-
90	1	Exciter field	-	-
91	4	Fixing screws	M6	8,3
100	1	Exciter armature	-	-
107	1	Crescent support	-	-
172	-	Isolator	-	-

Ref.	Qty	Description	Screw Ø	Torque N.m
177	2	AVR support stirrup	-	-
198	1	AVR	-	-
254	1	Right air intake guard	-	-
255	1	Left air intake guard	-	-
268	1	DE cross-member	-	-
269	1	NDE cross-member		
270	3	Connection plate	-	-
277	3 or 4	Copper bar support	-	-
278	1	Neutral link	-	-
279	6 or 8	Connection bar	-	-
280	3 or 4	Plastic bar support	-	-
281	2	Cover crosspiece	-	-
282	2	Cover spacer	-	-
283	4 or 6	Plastic or copper support	-	-
284	1	Circlip	-	-
320	1	Coupling sleeve	-	-
321	1	Sleeve key	-	-
322	3	Coupling disc	-	-
323	8	Fixing screws	M20	340
325	-	Spacer shim	-	-
343	1	Diode bridge assembly	M6	10
347	1	Surge suppressor (+ PCB)	-	-
349	1	O ring seal	-	-
364	1	AVR support	-	-
365	1	Cover rear panel	-	-
367	1	Left side panel	-	-
368	1	Right side panel	-	-
371	4	Damper	-	-
417	1	Air filter guard	-	-
418	1	Filter element	-	-

MAIN BREAKER OPERATION

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GENERAL

TYPES AND DESCRIPTIONS

TemPower2 is available in types shown in Tables 3 and 4.

Table 3 Standard types

Frame size (/	۹)			80	00	12	250	16	00	20	00	25	00	32	00	40	00	40	00
Туре				AR2	208S	AR2	212S	AR2	16S	AR2	20S	AR3	25S	AR3	32S	AR44	IOSB	AR4	40S
Max rated a	urropt	IEC, EI	N, AS																
$[/_n]$ (A) *1, *2	Irrent	JIS		80	00	12	250	16	00	20	00	25	00	32	00	40	00	40	00
		Marine	use																
N-phase rate	d current	(A)		80	00	12	250	16	00	20	00	25	00	32	00	40	00	40	00
Number of po	oles *3, *4			3	4	3	4	3	4	3	4		3	4	3	4	3	4	3
Dielectric withstand voltage [Ui] (50/60Hz) *5			10	1000 1000 1000 100		00	10	00	1000		10	00	10	00					
Operating vo (50/60Hz) *6	ltage [Ue]			69	90	69	90	69	90	69	90	69	90	69	90	69	90	69	90
Rated breaki	ng/making	current	[kA sym	n rms/ł	<a pea<="" td=""><td>ak]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td>	ak]													
IEC ,EN, AS	[/ _{CS} = /	AC 690	0V *8				50/	105					65/	143		85/	187	75/	165
CUI JIS C 8201-2 Ann.1 Ann.2	-1	AC 440	V				65/14	3 *10					85/18	7 *10		100/	220	100/	220
NK *7		AC 690	V				50/	115					65/	153		*1	4	75/	179
INTX 7		AC 450	V		65/153 *10 85/201 *10							*1	*14		245				
DC 600V *9)V *9								40	/40								
DC 250V		VC								-10/	-0								
Rated short-time current [/ _{CW}] [kA rms] (1 sec.)					6	5					8	5		10	00	10)0		
Rated latchin	g current	(kA)		65						8	5		8	5	10)0			
	Mechanical with maintenance		300	000	30000		300	000	25000		200	000	200	000	15000		150	000	
Endurance in number	Mechanical without maintenance		150	000	15000		150	000	12000		10000		10000		8000		8000		
of ON-OFF cycles *11	Electrical maintena	without	460V	120	000	12(000	120	000	100	000	70	00	70	00	30	00	30	00
	Electrical maintena	without	690V	100	000	100	000	100	000	70	00	50	00	50	00	25	00	25	00
Installation										Draw	-out o	r fixed	type						
Mass (kg) for	draw-out	type		73	86	73	86	76	90	79	94	105	125	105	125	126	158	139	176
External dime	ensions (n	nm)																	
			а	360	445	360	445	360	445	360	445	466	586	466	586	-	-	-	-
Fixed type		ſ₽	b						46	60						-		-	
*12			С						29	90						-		-	
			d						7	5						-		-	
			а	354	439	354	439	354	439	354	439	460	580	460	580	460	580	631	801
Drawout	Ь		b						46	60						46	60	46	30
type *13			С						34	15						34	5	37	′5
			d						4	0						14	0	5	3

Table 3 Standard types (Cont'd)

Frame size (A)		800	1250	1600	2000	2500	3200	4000	4000		
Туре		AR208S	AR212S	AR216S	AR220S	AR325S	AR332S	AR440SB	AR440S		
Connection method	Line side		Vertica	al, horizonta	l or front ter	minals		Vertical terminals	Vertical terminals		
Connection method	Load side		Vertica	al, horizonta	l or front ter	minals		Vertical terminals	Vertical terminals		
Control circuit terminal	type				Screw te	erminals					
Spring charging method	b			Ν	lanual or m	otor chargin	g				
Overcurrent release (O	CR)		No C	OCR, or L-ch	aracteristic	for general	feeder prote	ection			
Operation indication		Group indication									
	Tripping coil (TC)	Standard equipment for OCR-equipped ACB									
Tripping device	Shunt trip device (SHT)	Optional									
	Undervoltage trip device (UVT)	Optional									
Auxiliary switches	Number of switches		4℃ (standa	ard), 7℃ or	10℃; availa	able for gene	eral feeder o	or microload			
	Terminal type				Screw te	erminals					
Rated voltage	Operation power	AC1	AC100 - 120V, AC200 - 240V, DC100 - 125V, DC200 - 250V, DC24V or DC48V								

*1: Ambient temperature: 40 °C (45 °C for marine used)

*2: With horizontal terminals for AR208S - 216S and vertical terminals for AR220S - 440S

*3: For 2-pole applications, use two poles at both ends.

*4: 4-pole ACBs are not applicable to power distribution IT systems unless N-phase protection is provided.

*5: Varies depending on applicable standards. AC1000V applies to ACBs conforming to IEC60947-2 and JIS C8201-2.

*6: Varies depending on applicable standards. AC690V applies to ACBs conforming to IEC60947-2 and JIS C8201-2.

*7: Applicable to 3-pole ACBs with INST or MCR.

*8: For applicability to power distribution IT systems, consult us

*9: A special version of the ACB is necessary above 250V DC. Contact Terasaki for details.

*10: For AC500V

*11: Expected service life based on endurance test. The service life of ACB depends on the working and environmental conditions. Refer to "Maintenance, Inspection and Parts Replacement".

*12: For both vertical and horizontal terminals

*13: This manual covers draw-out type ACBs.

*14: In applying or going to apply.

Table 6 shows the dielectric withstand voltage and the insulation resistance of the ACBs.

Do not perform dielectric withstand/insulation resistance tests under other conditions than specified. Doing so may cause a malfunction.

Table 6 Dielectric withstand voltage and insulation resistance

Circuit			Dielectric withstand volta	age (50/60Hz)		Impulse withstand voltage <i>U</i> imp	Insulation resistance (DC500V Megger used)
Main circuit			Between poles, and terminal group and ground	AC3500V	1 minute	12kV	300MOhms
	Auxiliary	For general feeder	Between terminal group and ground	AC2500V	1 minute	6kV	100MOhms
Control	Switches	For microload	Between terminal group and ground	AC2000V	1 minute	4kV	100MOhms
circuit	Position s	witches	Between terminal group and ground	AC2000V	1 minute	4kV	100MOhms
	Overcurre	ent release	Between terminal group and ground	AC2000V	1 minute	4kV	100MOhms
	Undervoltage trip device, Reverse power trip device		Between terminal group and ground	AC2500V	1 minute	6kV	100MOhms
Other ac	cessories		Between terminal group and ground	AC2000V	1 minute	4kV	100MOhms

The above data applies to new ACBs. Device terminals within ACBs are not covered. Use a DC500V Megger to measure the insulation resistance.

Table 7 shows the internal resistance and power consumption of the ACBs.

Table 7 Internal resistance and power consumption

Туре	AR208S	AR212S	AR216S	AR220S	AR325S	AR332S	AR440SB	AR440S	
Frame size (A)	800	1250	1600	2000	2500	3200	4000	4000	-
DC internal resistance (mOhms) (for 1-pole ACB)	0.033	0.033	0.028	0.024	0.014	0.014	0.017	0.014	
AC power consumption (W) (for 3-pole ACB)	200	350	350	490	600	780	1650	1060	
Туре	AR212H	AR216H	AR220H	AR316H	AR320H	AR325H	AR332H	AR420H	AR440H
Frame size (A)	1250	1600	2000	1600	2000	2500	3200	2000	4000
DC internal resistance (mOhms) (for 1-pole ACB)	0.024	0.024	0.024	0.014	0.014	0.014	0.014	0.014	0.014
AC power consumption (W) (for 3-pole ACB)	260	350	490	310	430	600	780	*1	1060

*1: Contact us.

Table 8 shows applicable current of the ACBs. The applicable current varies depending on the ambient temperatures. **Table 8 Dependence of applicable current on ambient temperature**

Turne and sendor		AR208S	AR212S	AR216S	AR220S	AR325S	AR332S	AR440SB	AR440S	
Type and conduc	ctor size	2×50×5t	2×80×5t	2×100×5t	3×100×5t	2×100x10t	3×100×10t	4×150×10t	4×150×6t	-
Standard	Temperature			•	Curr	ent (A)				
IEC60947-2	40 ℃ (standard ambient temperature)	800	1250	1600	2000	2500	3200	4000	4000	
EN60947-2	45 <i>°</i> C	800	1250	1600	2000	2500	3200	4000	4000	
JIS C8201-2-1	50°C	800	1250	1600	2000	2500	3200	3940	4000	
Ann.1 Ann.2	55℃	800	1200	1540	1820	2500	2990	3820	3940	
	60 <i>°</i> C	800	1150	1460	1740	2400	2850	3690	3760	
	40℃ (standard ambient temperature)	800	1250	1540	2000	2500	3200	3310	3700	
NEMA,SG-3	45 <i>°</i> C	800	1190	1470	1960	2500	3010	3200	3580	
ANSI C37.13	50°C	800	1130	1390	1860	2440	2860	3100	3470	
	55℃	790	1070	1310	1750	2300	2690	2980	3350	
	60 <i>°</i> C	740	1000	1230	1640	2150	2520	2870	3140	
	40 ℃ (standard ambient temperature)	800	1100	1460	1740	2370	2610	2870	3230	
JEC-160	45℃	800	1060	1400	1680	2280	2510	2750	3100	
	50℃	800	1010	1340	1600	2180	2400	2620	2970	
	55℃	770	960	1280	1530	2080	2290	2490	2830	
	60 <i>°</i> C	730	920	1220	1450	1970	2170	2360	2690	
Type and conduc	ctor size	AR212H	AR216H	AR220H	AR316H	AR320H	AR325H	AR332H	AR420H	AR440H
Type and conduc		2×80×5t	2×100×5t	3×100×5t	2×100×5t	3×100×5t	2×100×10t	3×100×10t	2×150×6t	4×150×6t
Standard	Temperature		-	-		Current (A)	-	-	-
IEC60947-2	40 ℃ (standard ambient temperature)	1250	1600	2000	1600	2000	2500	3200	2000	4000
EN60947-2 AS3947-2	45 <i>°</i> C	1250	1600	2000	1600	2000	2500	3200	2000	4000
JIS C8201-2-1	50 <i>°</i> C	1250	1600	2000	1600	2000	2500	3200	2000	4000
Ann.1 Ann.2	55℃	1250	1600	1820	1600	2000	2500	2990	2000	3940
	60 <i>°</i> C	1250	1550	1740	1600	2000	2400	2850	2000	3760
	40 ℃ (standard ambient temperature)	1250	1600	2000	1600	2000	2500	3200	*1	3700
NEMA,SG-3	45 <i>°</i> C	1250	1600	1960	1600	2000	2500	3010	*1	3580
ANSI C37.13	50℃	1250	1600	1860	1600	2000	2440	2860	*1	3470
	55℃	1250	1510	1750	1600	1950	2300	2690	*1	3350
	60 <i>°</i> C	1240	1420	1640	1550	1830	2150	2520	*1	3140
	40 ℃ (standard ambient temperature)	1250	1500	1740	1600	2000	2370	2610	*1	3230
JEC-160	45 <i>°</i> C	1250	1440	1680	1600	2000	2280	2510	*1	3100
	50 <i>°</i> C	1250	1380	1600	1600	2000	2180	2400	*1	2970
	55℃	1250	1310	1530	1600	1920	2080	2290	*1	2830
						1	4070	0470		0000

*1: Contact us.

NOTE: For AR208S, AR212S and AR216S, it is assumed that main circuit terminals are of horizontal type at both the line and load sides. For other types, it is assumed that main circuit terminals are of vertical type at both the line and load sides. The above values may vary depending on the switchboard configuration.

PARTS AND FUNCTIONS

Fig. 14 provides a general views of the ACB.





1 ACB Consists of breaker body (3) and draw-out cradle (2). 2 Draw-out cradle Comes with main circuit terminals (48), control circuit terminals (38), auxiliary switches (41), and position switches (37). 3 Breaker body Contains the ON-OFF mechanism, the closing coil, the tripping device, and overcurrent release (19). 4 OFF button Push to open the ACB. 5 ON button Push to close the ACB. 6 **ON-OFF** indicator Shows "OFF" when the ACB is open and "ON" when it is closed. 7 Charge indicator Shows "CHARGED" when the closing springs are charged and "DISCHARGED" when it is released. 8 Charging handle Pump to charge the closing springs. 9 Indicates the present breaker body position: CONN., TEST, or ISOLATED. Position indicator 10 Grip Hold to draw out the breaker body. 11 Draw-out handle insertion Insert the draw-out handle into this hole to move the breaker body. hole Release button 12 Push to move the breaker body from the TEST position. 13 Position padlock lever Accommodates up to three padlocks to lock the breaker body in the CONN., TEST or ISOLATED position. (Padlocks are not supplied. Use padlocks with a 6 (optional) mm-diameter shackle.) 14 Lock-in-OFF plate Padlocking this plate allows the ACB to be locked in the open (OFF) state. (optional) (Padlocks are not supplied. Use padlocks with a 6 mm-diameter shackle.) 15 **ON-OFF** button cover Provides protection against inadvertent button operation and can be padlocked. (Padlocks are not supplied. Use padlocks with a 6 mm-diameter shackle.) Up to three padlocks can be installed. Reads the number of ON-OFF cycles. It counts a series of operations from **ON-OFF** cycle counter 16 (optional) close to open as one cycle. 17 OCR cover Padlocking this plate prevents settings of overcurrent release ?18 to be inadvertently changed. (Padlocks are not supplied. Use padlocks with a 6 mmdiameter shackle.) 18 This protective device is supplied power via the power CT installed in the ACB Overcurrent release (OCR) main circuit. When the current sensor detects an overcurrent in the main circuit, the OCR instructs the magnet hold trigger (MHT) to trip open the ACB. 19 Front cover A plastic cover of the breaker body front panel. 20 Rating nameplate Indicates the type, applicable standards and rated breaking capacity of the ACB. 22 Specification nameplate Indicates the number of poles, operation method, accessories, and serial number of the ACB. 23 Breaker body roller Allows breaker body (3) to be moved on draw-out rail (31). 24 Main circuit contact Closes when the breaker body is in the CONN. position. 25 Closes when the breaker body is in the CONN. or TEST position. Control circuit contact 26 Arc chamber Extinguishes the arc that occurs in the breaking operation. Two arc chambers are fitted per pole. 27 Current sensor Converts the current in the main circuit into a voltage signal in proportion to the magnitude of the current and sends the signal to overcurrent release (18). 28 Mold cover A plastic cover of the breaker body side face. 29 Mold base A plastic cover of the breaker body rear face. 30 Breaker fixing bolt Allows the breaker body to be locked in the CONN. position even if the ACB is subject to strong vibrations. Standard equipped on ACBs that conform to ship (red)(optional)

classification society rules.

31	Draw-out rail	Lise to draw out the breaker body from the draw-out cradle							
32	Draw-out rail end	Refer to "Operation Precautions".							
33	Hook pin	Refer to "Operation Precautions".							
34	Body stopper	Prevents the breaker body from falling when the body is drawn out from the draw-out cradle.							
35	Body stopper shaft	Refer to "Operation Precautions".							
36	Rail stopper (red)	Allows the draw-out rail to be locked in the drawn-out or retracted state.							
37	Position switches (optional)	Indicate the present breaker body position: CONN., TEST, ISOLATED or INSERTED. The position switches are available in 2C or 4C configuration. Connections to the position switches are made through M4 screws.							
38	Control circuit terminals	Allow connections of external control wire to the control circuits. Wire connections are made through M4 screw terminals. Fig. 15 shows the control circuit terminals.							

		Fig. 15 Control circuit terminals
39	Control terminal block cover (optional)	Protects the position switches, the control circuit terminals and the auxiliary switches from damage.
40	Cover fixing screw	Secures the control terminal block cover.
41	Auxiliary switches (optional)	Indicate the state of the ACB (ON or OFF). The auxiliary switches are available in 4C configuration (standard), or 7C or 10C configuration (optional). Connections to the switches are made through M4 screw terminals.
42	Terminal block	Contains position switches (36), control circuit terminals (37), and auxiliary switches (38).
44	Ground terminal M8 tapped hole	Allows connection of a ground terminal.
45	Gas exhaust port	Allows the arc gas to be discharged from arc chamber (25) in a horizontal direction when the ACB trips open.
46	Arc gas barrier	Prevents the arc gas from being discharged upwards from arc chamber (25) when the ACB trips open.
47	Breaker draw-out arm	Is retracted in the draw-out cradle when the breaker body is in the CONN. position.

48 Main circuit terminals

Allow connections of external conductors. These terminals are available in three configurations as shown in Fig. 16.

	Vertical terminals	Horizontal terminals	Front terminals
		Fig. 16 Main circuit terminals	
49	Lifting hole (ø20mm)	Allows lifting attachments or wire ropes	s to be used for lifting the ACB.
50	Protrusion	Refer to "Operation Precautions".	

51 Draw-out handle (removable)

Use to draw out /insert the breaker body from/into the draw-out cradle.

CHARGING AND OPENING OPERATION



Never touch live terminal parts. Otherwise, electric shock may result.

Do not force down the charging handle after completion of manual charging operation. Doing so may cause a malfunction.

The permissible operating voltage of the spring charging motor is 85 to 110% of the rated ac voltage or 75 to 110% of the rated dc voltage. Be sure to supply a voltage within the above ranges to the motor. Otherwise, burnout may result.

Repeated open/close operation by the motor charging mechanism without pause should not exceed 15 times. If repeated continuous open/close operation is inevitable, a pause of at least 20 minutes should be provided after the repetitions of 15 times. Otherwise, a spring charging motor may be burnt out. Do not bring your hand or face close to arc gas vent of the arc chamber while the ACB is energized. Otherwise, a burn may result from high-temperature arc gas blowing out of the arc gas vent when the ACB trips open.

If the ACB trips open automatically, remove the cause of tripping operation before re-closing the ACB. Otherwise, a fire could result.

If the ACB has the breaker fixing bolts, make sure the bolts on both sides are securely tightened before using the ACB. Loosened fixing bolts may cause a malfunction of the ACB, in particular when it is installed in such an area that is subject to strong vibrations.

The ACBs are available in two types in terms of the closing spring charging method and the remote operation capability: a manual charging type and a motor charging type. The manual charging type requires the charging and ON-OFF (close/open) operation to be done manually while the motor charging type allows the operation to be done either manually or by using a motor.

CHARGING OPERATION

The ACB can be closed only when the closing springs have been charged. Be sure to charge the closing springs before closing the ACB. The charging operation is permitted, regardless of whether the ACB is ON (closed) or OFF (open). The procedure for charging the closing springs is as follows:

Manual charging

Pump the charging handle (Fig. 23 (2)) until the charge indicator (Fig. 23 (1)) shows "CHARGED" Pumping the handle with the full stroke 10 - 13 times will fully charge the closing springs.



Fig. 23 Charging and opening operation

Motor charging

When the charge indicator (Fig. 23 (1)) changes to "DISCHARGED" while the specified operation voltage is applied to the control circuit terminals [02] and [22], the charging motor is activated to start charging the closing springs. Upon completion of the charging operation, the charge indicator shows "CHARGED" and the charging motor is automatically deactivated. The time required for the motor charging operation depends on the operation voltage or the ACB types, but does not exceed 10 seconds.

CLOSING OPERATION

The ACB closing operation is not permitted unless all of the following conditions are met.

- 1. The charge indicator (Fig. 23 (1)) shows "CHARGED".
- The position indicator (Fig. 23 (3)) shows "CONN.", "TEST" or "ISOLATED" (a halfway position not permitted).
- 3. The draw-out handle is not inserted in the draw-out handle insertion hole (Fig. 23 (5)).
- 4. The OFF button (Fig. 23 (6)) is not locked with the lock-in-OFF plate (Fig. 23 (7)).
- 5. The specified voltage is supplied to the undervoltage trip device.

The control power of the overcurrent release (OCR) must be supplied before closing operation in order that the internal program can be started. If the OCR trips open directly after the control power is supplied to the OCR, operation indication may be incorrect.

Manual closing

Open the ON-OFF button cover (Fig. 23 (8)) and press the ON button (Fig. 23 (9)). The ACB will be closed with a sound. The ON-OFF indicator (Fig. 23 (10)) shows "ON" and the charge indicator (Fig. 23 (1)) shows "DISCHARGED".

Electrical closing

Press the ON switch shown in Fig. 17,19. The latch release coil (LRC) (Fig. 17,19) will be excited and the ACB is closed with a sound. The ON-OFF indicator (Fig. 23 (10)) shows "ON", the charge indicator (Fig. 23 (1)) shows "DISCHARGED", and the charging motor starts charging the closing springs.

OPENING OPERATION

Manual opening

Open the ON-OFF button cover (Fig. 23 (8)) and press the OFF button (Fig. 23 (16)). The ACB will trip open with a sound. The ON-OFF indicator (Fig. 23 (10)) shows "OFF".

Electrical opening

Press the OFF switch shown in Fig. 17,19. The shunt trip device (SHT) or the fixed type undervoltage trip device (Fig. 17,19) will be excited so that the ACB trips open with a sound. The ON-OFF indicator (Fig. 23 (10)) shows "OFF".

MOTION OF TRIP INDICATION AND SPRING CHARGE INDICATION SWITCHES

The trip indication and spring charge indication switches provide the breaker status as shown in Table 16. Table 17 Motion of trip indication and spring charge indication switches

Type of OCR	Operation	Contact output										
		Terminal No. See Fig. 17		State								
			Closing	ı spring		ACB open						
			Charged	Discharged	ACB closed	Not ready to close *	Ready to close *					
All	Trip	[05], [17]	No change	No change	OFF	ON	OFF					
	Spring charge	[05], [27]	ON	OFF	No change	No change	No change					

* "Ready to close" means that all of the following conditions are met:

- 1. The closing springs are charged.
- 2. Opening operation is complete (At least 40 ms has elapsed after trip signal was produced).
- 3. The OFF button is released.
- 4. The specified voltage is applied to the undervoltage trip device (if equipped).

Motion of operation mechanisms

Figs. 24 - 27 illustrate the motion of the charging and ON-OFF mechanisms.



Fig. 24 Closing motion 1 (discharge motion)

For manual closing operation, ON button (1) rotates counterclockwise. For electrical closing operation, push rod (1) protrudes downward from the latch release coil (LRC) and charge latch trigger (2) rotates clockwise. This rotates closing trigger shaft (3) clockwise and closing release lever (4) disengages from a semicircular pawl and rotates clockwise. And charging cam (5) rotates counterclockwise, so that charging lever (7) disengages from closing spring (6) and rotates counterclockwise. Closing cam (8) is pushed up by charging lever (7) and rotates clockwise. At this time, each component is positioned as shown in Fig. 26. Continued to Fig. 25.



Fig. 25 Closing motion 2

Closing cam (8) rotating clockwise causes closing link and top link (9) to be pushed straight. This rotates closing toggle cam (10) connected with closing link (9) counterclockwise, so that crossbar (11) rotates clockwise and thus moving contact (12) comes in contact with stationary contact (13). At this time, each component is positioned as shown in Fig. 27.



Fig. 26 Charging motion

The charging handle or the charging motor provides a counterclockwise rotation to charging cam (1). This rotates closing release lever (2) and closing tripper lever (3) counterclockwise and a semicircular pawl engages with closing release lever (2). And charging lever (4) rotates clockwise so that closing spring (5) is compressed and closing cam 5 rotates counterclockwise. At this time, each component is positioned as shown in Fig. 24.



Fig. 27 Opening motion

For manual opening operation, OFF button (1) rotates counterclockwise and trip linkage (2) rotates clockwise. For electrical opening operation, push rod (1) protrudes downward from the shunt trip device (SHT) or the undervoltage trip device (UVT). For tripping operation by the overcurrent release (OCR), moving core (1) protrudes downward from the magnet hold trigger (MHT) and trip linkage (2) rotates counterclockwise. (Parts marked with an asterisk (*) are trip pins. To avoid superposition in the figure, magnet hold trigger related parts are drawn in positions that are different from actual positions. This rotates trip trigger shaft (3) counterclockwise and trip lever B (4) disengages from a semicircular pawl and rotates counterclockwise. And trip lever A (5) rotates counterclockwise, trip link (6) moves to a lower right direction and closing toggle cam (7) rotates clockwise. The force of closing spring (9) and contact spring (10) rotates crossbar (8) counterclockwise, so that moving contact (10) is parted from stationary contact (12). At this time, each component is positioned as shown in Fig. 25.

DRAW-OUT AND INSERTION OPERATION

GENERAL

The draw-out type ACB consists of the breaker body and the draw-out cradle. The main and control circuit terminals are installed on the draw-out cradle, which permits you to draw out and inspect or service the breaker body without the need for removing wiring from the terminals.

The draw-out mechanism allows you to move the breaker body to any of the four positions as shown in Fig. 28. The switchboard panel door can be shut with the breaker body drawn out to the CONN., TEST or ISOLATED position.



Operation Durability

The AR series ACBs are designed to ensure the operation durability of 100 draw-out and insertion cycles in conformance to IEC 60947-1 and JIS C8201-2 (one cycle means that the breaker body is drawn out from the CONN. position to the Removed position and inserted back to the CONN. position). Draw-out and insertion operation of more than 100 cycles could abrade the main circuit contacts, resulting in an overheat of the contacts during energization.



Never touch live terminal parts. Otherwise, electric shock may result.

Do not leave the ACB body in the removed position. The weight of the ACB may cause serious injury.



If the ACB has the breaker fixing bolts, be sure to loosen the bolts on both sides before draw-out operation. Otherwise, damage to the ACB may result.

Make sure the draw-out cradle is secured with mounting screws before drawing out the breaker body. Otherwise, the draw-out operation may cause the breaker body or the draw-out cradle to fall, resulting in damage to the ACB or personal injury.

When retracting the draw-out rail into the draw-out cradle, be sure to push the rail end. Do not hold the hook pin, body stopper, or body stopper shaft. Doing so may cause your fingers to be pinched, resulting in injury.

Use the separate draw-out handle to draw-out the breaker body.

• Moving the breaker body from the CONN. position to the TEST position

- 1. Open the ACB. (If the ACB remains closed, the drawout handle (Fig. 29 (1)) cannot be inserted).
- 2. Loosen the breaker fixing bolts (Fig. 29 (2)), if used, to unlock the breaker body (Fig. 29 (3)).
- 3. Unlock the position lock lever (Fig. 29 (14)) if locked.
- 4. Insert the draw-out handle into the draw-out handle insertion hole (Fig. 29 (4)). And slowly turn counterclockwise until the handle cannot be turned. The position indicator (Fig. 29 (5)) shows "TEST".
- When the main circuit is disconnected at the disconnect contacts, the breaker body will be slightly pushed forward by the spring action of the main circuit disconnect contacts. At this moment, a bang sound will be heard. This sound does not mean a malfunction.
- The ACB cannot be closed as long as the draw-out handle is in the draw-out handle insertion hole. To close the ACB e.g., for ON-OFF testing, remove the draw-out handle.



• Moving the breaker body from the TEST position to the ISOLATED position

- 1. Open the ACB. (If the ACB remains closed, the drawout handle (Fig. 29 (1)) cannot be inserted).
- 2. Press the release button (Fig. 29 (6)). The release button will be locked depressed.
- 3. Unlock the position lock lever (Fig. 29 (14)) if locked.
- 4. Insert the draw-out handle into the draw-out handle insertion hole (Fig. 29 (4)). And slowly turn counterclockwise until a freewheeling sound is heard. The position indicator (Fig. 29 (5)) shows "ISOLATED". Turning the draw-out handle will unlock the release button.
- 5. Remove the draw-out handle.

• Moving the breaker body from the ISOLATED position to the removed position

- 1. Make sure the draw-out cradle (Fig. 29 (7)) is secured with mounting screws.
- 2. Unlock the position lock lever (Fig. 29 (14)) if locked.
- 3. Push the rail stoppers (Fig. 29 (8)) outward on both sides of the draw-out cradle to unlock the draw-out rail (Fig. 29 (9)), and then uphold and pull out the rail until it stops. The draw-out rail will be locked again by the stoppers. (The breaker body cannot be drawn out unless the rail is locked).
- 4. Holding both the grips (Fig. 29 (10)), draw out the breaker body until it stops.
- If the ACB is equipped with the communication terminal block, pull out the hand connector (Fig. 29 (15)) from the communication terminal block while drawing out the breaker body. Make sure the hand connector and control wire of the ACB are not snagged when drawing out the breaker body again.
- If the ACB is equipped with an optional autodischarging device (Fig. 29 (11)), the closing springs of the ACB will be automatically discharged with a mechanical sound. This sound does not mean a malfunction.
- Do not leave the ACB body on the draw-out rail pulled out.
- 5. Use an optional lifter or lifting plate to transfer the breaker body (Fig. 29 (3)) to a safe place.

PUTTING THE BREAKER BODY BACK INTO THE DRAW-OUT CRADLE

Never touch live terminal parts. Otherwise, electric shock may result.

Do not leave the ACB body in the removed position. The weight of the ACB may cause serious injury.

Make sure the draw-out cradle is secured with mounting screws before inserting the breaker body into the draw-out cradle. Otherwise, the insertion operation may cause the breaker body or the drawout cradle to fall, resulting in damage to the ACB or personal injury.

When retracting the draw-out rail into the draw-out cradle, be sure to push the rail end. Do not hold the hook pin, body stopper, or body stopper shaft. Doing so may cause your fingers to be pinched, resulting in injury.

Do not forcedly turn the draw-out handle clockwise when the breaker body is in the CONN. Position. Doing so may cause a malfunction.

If the ACB has the breaker fixing bolts, make sure the bolts on both sides are securely tightened before using the ACB. Loosened fixing bolts may cause a malfunction of the ACB, in particular when it is installed in such an area that is subject to strong vibrations.

Use the separate draw-out handle to insert the breaker body.

Putting the breaker body back to the ISOLATED position

- 1. Make sure the draw-out cradle (Fig. 29 (7)) is secured with mounting screws.
- 2. Push the rail stoppers (Fig. 29 (8)) outward on both sides of the draw-out cradle to unlock the draw-out rail (Fig. 29 (9)), and then uphold and pull out the rail until it stops. The draw-out rail will be locked again by the stoppers. (The breaker body (Fig. 29 (3)) cannot be inserted unless the rail is locked).
- Use an optional lifter or lifting plate to place the breaker body rollers (Fig. 30) on the draw-out rail (Fig. 30).

- Do not leave the ACB body on the draw-out rail pulled out.
- 4. Make sure the breaker fixing bolts (Fig. 29 (2)), if fitted, are loosened and not arrest the breaker body.
- 5. Make sure the hand connector (Fig. 29 (15)) of the communication terminal block, if fitted, is so positioned that it does not get caught between the breaker body and the draw-out cradle.
- 6. If the ACB has the breaker fixing bolts (Fig. 29 (2)), make sure the bolts are loosened and, holding both the grips (Fig. 29 (10)), firmly push the breaker body into the draw-out cradle.
- If the ACB is equipped with the communication terminal block, plug the hand connector (Fig. 29 (15)) into the communication terminal block while pushing the breaker body. Into the draw-out cradle. Make sure the hand connector and control wire of the ACB are not snagged when pushing the breaker body into the draw-out cradle.
- 7. Push the rail stoppers (Fig. 29 (8)) outward on both sides of the draw-out cradle (Fig. 29 (12)) to unlock the draw-out rail, and then push the rail ends to insert the rail until it stops. The draw-out rail will be locked again by the stoppers.



Moving the breaker body from the ISOLATED position to the TEST position

- 1. Make sure the ON-OFF indicator (Fig. 29 (13)) shows "OFF". (If the ACB remains closed, the draw-out handle (Fig. 29 (1)) cannot be inserted).
- 2. Unlock the position lock lever (Fig. 29 (14)) if locked.
- 3. Insert the draw-out handle into the draw-out handle insertion hole (Fig. 29 (4)). And slowly turn clockwise until the handle cannot be turned. The position indicator (Fig. 29 (5)) shows "TEST".
- The ACB cannot be closed as long as the draw-out handle is in the draw-out handle insertion hole. To close the ACB e.g., for ON-OFF testing, remove the draw-out handle.

Moving the breaker body from the TEST position to the CONN. position

1. Open the ACB. (If the ACB remains closed, the draw-

out handle (Fig. 29 (1)) cannot be inserted).

- 2. Unlock the position lock lever (Fig. 29 (14)) if locked.
- 3. Press the release button (Fig. 29 (6)). The release button will be locked depressed.
- 4. Insert the draw-out handle into the draw-out handle insertion hole (Fig. 29 (4)). And turn clockwise until the handle cannot be turned with its max. operating torque (14.7 N-m).

The position indicator (Fig. 29 (5)) shows "CONN." Turning the draw-out handle will unlock the release button.



- When the main contact starts engaging, the force required to turn the handle will increase as shown in Fig. 31. This symptom does not mean a malfunction. Continue to turn the handle. Rotating the handle more 13 or 14 turns moves the breaker body to the CONN. position, where the handle cannot be turned with its max. operating torque.
- 5. Remove the draw-out handle.
- 6. Tighten the breaker fixing bolts (Fig. 29 (2)), if used, to lock the breaker body.

CONTACT STATUS OF AUXILIARY AND POSITION SWITCHES

Tables 18 and 19 show the contact status of auxiliary switches and position switches respectively. Table 18-1 Contact status of auxiliary switches

Breaker body position	ACB state ON	ACB state OFF	Status of a-contact	Status of b-contact
CONN			ON	OFF
OONN.			OFF	ON
TEST			ON	OFF
1231	l		OFF	ON
			ON	OFF
ISOLATED			OFF	ON
Bemoved			ON	OFF
nemoved			OFF	ON

Table 18-2 Contact status of auxiliary switches (When pursuant to ship classification society rules)

Breaker body position	ACB state ON	ACB state OFF	Status of a-contact	Status of b-contact
CONN.			ON	OFF
			OFF	ON
TEST			ON	OFF
			OFF	ON
ISOLATED			ON	OFF
			OFF	ON
Removed			ON	OFF
			OFF	ON

Table 19 Contact status of position switches

Switch	ISOLATED	TEST	CONN.	Status of a-contact	Status of b-contact
CONN. position indication				ON	OFF
				OFF	ON
TEST position indication				ON	OFF
				OFF	ON
ISOLATED position		ON	OFF		
indication				OFF	ON
Inserted position indication *				ON	OFF
				OFF	ON

* "Inserted" means that the breaker body is in the CONN., TEST, or ISOLATED position.

ON-OFF BUTTON COVER LOCKING PROCEDURE

Lock the button cover using a padlock with ø6 shackle (up to 3 padlocks can be used) as shown in Fig. 32. The ON-OFF button cover is locked and the ON and OFF buttons cannot be operated.



LOCK IN OFF PROCEDURE

- 1. Open the OFF button cover shown in Fig. 33.
- 2. Raise the OFF-lock tab and close the button cover.
- 3. Lock the button cover using a padlock with ø6 shackle (up to 3 padlocks can be used) as shown in Fig. 33. The OFF button is locked depressed, which disables the ON button.



POSITION LOCK LEVER LOCKING PROCEDURE

- 1. Move the breaker body to the desired position (CONN, TEST or ISOLATED).
- 2. Pull out the position lock lever shown in Fig. 34.
- 3. Lock the position padlock lever using a padlock with ø6 shackle (up to 3 padlocks can be used) as shown in Fig. 34. This prevents the draw-out handle from being inserted into the draw-out handle insertion hole, i.e., the breaker position cannot be changed.



BREAKER FIXING BOLT SECURING PROCEDURE

- 1. Move the breaker body to the CONN. position.
- 2. Loosen the breaker fixing bolt shown in Fig. 35, move the spring and flat washers close to the bolt head and push the bolt into the U-notch of the grip.
- 3. Tighten the breaker fixing bolt using the draw-out handle. This procedure is required for both the sides of the ACB.



OCR COVER LOCKING PROCEDURE

Lock the OCR cover using a padlock with ø6 shackle as shown in Fig. 36. The OCR cover cannot be opened, which prevents OCR settings from being changed.





WARRANTY CONDITIONS

GLOBAL EXPORT GENERATORS

Doosan Benelux SA warrants to its authorized dealers who in turn warrant to the end-user / owner that each new Doosan Global Export Generator will be free from defects in material and workmanship for twelve (12) months from the date of delivery to the end user / owner or 2000 hours of machine usage, whichever occurs first. During the warranty period, the authorized Doosan dealer shall repair or replace, at Doosan Benelux SA's option, without charge for parts, labour and travel of technicians, any part of the Doosan product which fails because of defects in material or workmanship. The enduser / owner shall provide the authorized Doosan dealer with prompt written notice of the defect and allow reasonable time for replacement or repair. Doosan Benelux SA may, at its option, request failed parts to be returned to the factory or to any other designated location. Transportation of the Doosan Benelux SA product to the authorized Doosan dealer for warranty work is the responsibility of the end-user / owner. Service schedules must be adhered to, documented and genuine parts / lubricants must be used. Coverage for batteries and engine fuel system parts (glow plugs, fuel injection pumps, injectors) is reduced as failures generally originate from factors not under Doosan's control such as, but not limited to, prolonged storage, abuse or fuel quality. Reduced coverage is, depending on the component, limited from 50 to 500 operating hours and 6 months after delivery to the end customer.

The warranty does not cover:

Oils and lubricants, coolant fluids, filter elements, brake linings, tune-up parts, bulbs, fuses, alternator fan belts, drive belts, pins, bushings and other high-wear items, damages resulting from abuse, accidents, alterations not approved by Doosan Benelux SA, air flow obstructions, failure to maintain or use the Doosan product according to the instructions applicable to it, fuel system cleaning, engine tune-up, adjustments or slight defects which generally do not affect the reliability of the machine. DOOSAN BENELUX SA EXCLUDES OTHER CONDITIONS, WARRANTIES OR REPRESENTATIONS OF ALL KINDS, EXPRESSED OR IMPLIED. STATUTORY OR OTHERWISE (EXCEPT THAT OF TITLE) INCLUDING ALL IMPLIED WARRANTIES AND CONDITIONS RELATING TO MERCHANTABILITY, SATISFACTORY QUALITY AND FITNESS FOR A PURPOSE. CORRECTIONS PARTICULAR BY DOOSAN BENELUX SA OF NONCONFORMITIES WHETHER PATENT OR LATENT, IN THE MANNER AND FOR THE TIME PERIOD PROVIDED ABOVE, CONSTITUTE FULFILLMENT SHALL OF ALL LIABILITIES OF DOOSAN BENELUX SA FOR SUCH NONCONFORMITIES. WHETHER BASED ON CONTRACT, WARRANTY, TORT, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE WITH RESPECT TO OR ARISING OUT OF SUCH PRODUCT. THE REMEDIES OF THE END-USER / OWNER SET FORTH UNDER THE PROVISIONS OF THE WARRANTY OUTLINED ABOVE ARE EXCLUSIVE AND THE TOTAL LIABILITY OF DOOSAN BENELUX INCLUDING ANY HOLDING, SUBSIDIARY, SA ASSOCIATED OR AFFILIATED COMPANY OR DISTRIBUTOR WITH RESPECT TO THIS SALE OR THE PRODUCT AND SERVICE FURNISHED HEREUNDER CONNECTION WITH IN THF PERFORMANCE OR BREACH THEREOF, OR FROM DELIVERY, INSTALLATION, REPAIR OR TECHNICAL DIRECTION COVERED BY OR FURNISHED UNDER THIS SALE, WHETHER BASED ON CONTRACT, TORT, NEGLIGENCE, WARRANTY, INDEMNITY. STRICT LIABILITY OR OTHERWISE SHALL NOT EXCEED THE PURCHASE PRICE OF THE PRODUCT UPON WHICH SUCH LIABILITY IS BASED. DOOSAN BENELUX SA INCLUDING ANY HOLDING. SUBSIDIARY. ASSOCIATED OR AFFILIATED COMPANY AND DISTRIBUTOR SHALL IN NO EVENT BE LIABLE TO THE END-USER / OWNER, ANY SUCCESSORS IN INTEREST OR ANY BENEFICIARY OR ASSIGNEE RELATING TO THIS SALE FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES ARISING OUT OF THIS SALE OR BY ANY BREACH THEREOF. OR ANY DEFECT IN, OR FAILURE OF, OR MALFUNCTION OF THE PRODUCT UNDER THIS SALE, WHETHER BASED UPON LOSS OF USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL, WORK STOPPAGE, IMPAIRMENT OF OTHER GOODS, LOSS BY REASON OF SHUTDOWN OR NON-OPERATION, INCREASED EXPENSES OF OPERATION OR CLAIMS OF USER OR CUSTOMERS OF THE USER FOR SERVICE INTERRUPTION WHETHER OR NOT SUCH LOSS OR DAMAGE IS BASED ON CONTRACT. WARRANTY. NEGLIGENCE. TORT. INDEMNITY. STRICT LIABILITY OR OTHERWISE.



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