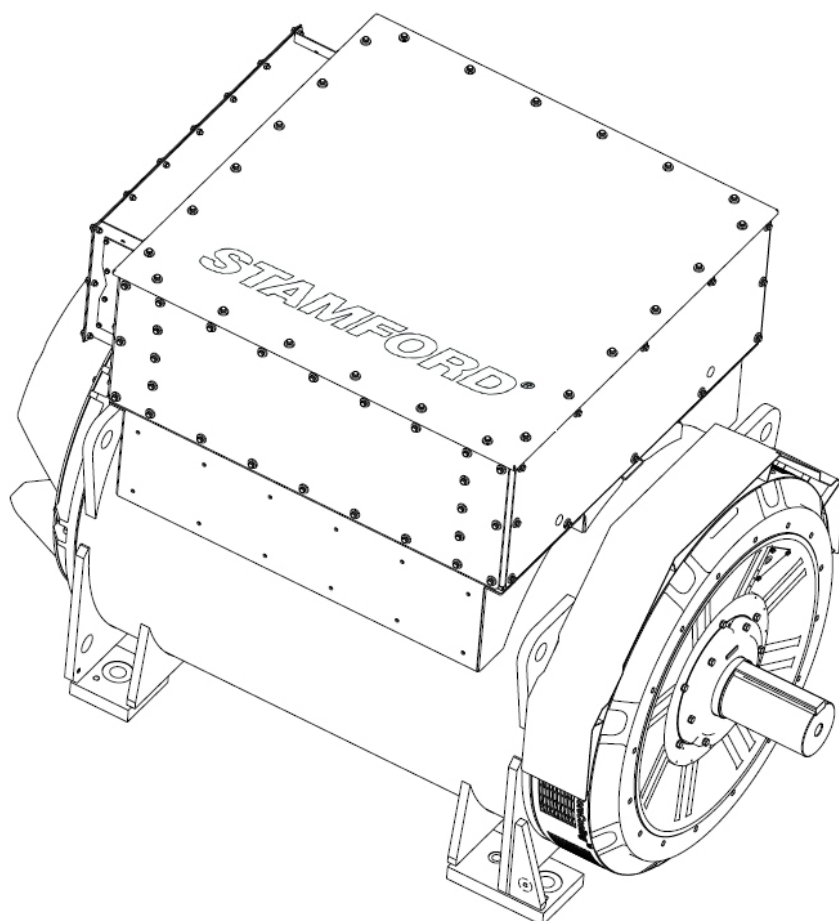


S9

## LOW VOLTAGE ALTERNATOR

Owner Manual





# Table of Contents

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|  |    |
|--|----|
| 1. FOREWORD .....                            | 1  |
| 2. SAFETY PRECAUTIONS.....                   | 3  |
| 3. SAFETY DIRECTIVES AND STANDARDS .....     | 13 |
| 4. INTRODUCTION .....                        | 23 |
| 5. LIFTING, STORAGE AND TRANSPORTATION ..... | 25 |
| 6. APPLICATION OF THE ALTERNATOR .....       | 29 |
| 7. INSTALLATION INTO THE GENERATOR SET ..... | 37 |
| 8. SERVICE AND MAINTENANCE.....              | 47 |
| 9. PARTS IDENTIFICATION.....                 | 73 |
| 10. TECHNICAL DATA.....                      | 79 |
| 11. SERVICE PARTS.....                       | 81 |
| 12. END OF LIFE DISPOSAL .....               | 83 |

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# 1 Foreword

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## 1.1 General

This document is an important guide to the intended use and operation of the product(s) detailed on the front cover. Read the information and procedures in this document. The information and procedures must be obeyed at all times, failure to obey the information and procedures can be considered misuse and can lead to injury, loss or damage to personnel or equipment.

**TABLE 1. COMPANY ADDRESSES**

| <b>Company and European Authorized Representative Addresses</b>   |  |
|---|--|
| Cummins Generator Technologies<br>Fountain Court<br>Lynch Wood<br>Peterborough<br>PE2 6FZ<br>United Kingdom | Cummins Generator Technologies<br>Bvd. Decebal 116A<br>Craiova,<br>Dolj<br>200746<br>Romania |

## 1.2 Legal

The alternator is the intellectual property of Cummins Generator Technologies LTD (also referred to as 'CGT' or 'the manufacturer' or by the brand names 'STAMFORD®' or 'AvK®' within this manual).

STAMFORD®, AvK® and STAMFORD VITA™, MX321™ and MX322™ are registered trademarks of Cummins Generator Technologies LTD. All rights to the alternator, the principle of the machine, the related drawings etc. lie with Cummins Generator Technologies LTD and are subject to copyright law. Copying is only permitted with prior written approval. Copyright Cummins Generator Technologies. All Rights reserved. Cummins and the Cummins logo are registered trademarks of Cummins Inc.

## 1.3 The Manual

This manual contains guidance and instructions for the installation and operation of the equipment specified on the manual front cover. This manual does not include instructions for servicing and maintaining the alternator. Contact Cummins Generator Technologies (CGT) Customer Service for servicing information.

Before operating, the equipment, read this manual. Make sure that all personnel who work on the equipment have access to the manual and all related documentation supplied with it. Misuse, failure to obey the instructions or use of non-approved parts, may invalidate the product warranty and lead to loss injury or damage.

This manual is an essential part of the equipment. Make sure that the manual is available to all applicable personnel throughout the life of the equipment.

The manual is written for skilled electrical and mechanical technicians and engineers, who have prior knowledge and experience of equipment of this type. If in doubt, contact your local CGT subsidiary.

### **NOTICE**

**Information in this manual was correct when published. It may be superseded due to our policy of continuous improvement. Visit [www.stamford-avk.com](http://www.stamford-avk.com) for latest documentation.**

## 1.4 Manual Languages

The manuals for this product are available in the languages shown below, which can be found on the STAMFORD® AvK® website: [www.stamford-avk.com](http://www.stamford-avk.com).

**TABLE 2. S9 LOW VOLTAGE MANUAL LANGUAGES**

| Language, Manual Type and Document Part Number |                      |          |
|--|----------------------|----------|
| Arabic (ar-sa)                                 | Owner                | A073P069 |
| German (de-de)                                 | Owner                | A073P072 |
| English (en-us)                                | Owner                | A073P066 |
| English (en-us)                                | Service <sup>1</sup> | A073P068 |
| Spanish (es-es)                                | Owner                | A073P160 |
| French (fr-fr)                                 | Owner                | A073P071 |
| Italian (it-it)                                | Owner                | A073P073 |
| Japanese (ja-jp)                               | Owner                | A073P161 |
| Polish (pl-pl)                                 | Owner                | A073P162 |
| Portuguese (pt-pt)                             | Owner                | A073P163 |
| Russian (ru-ru)                                | Owner                | A073P164 |
| Swedish (sv-se)                                | Owner                | A073P165 |
| Chinese (zh-cn)                                | Owner                | A073P070 |

<sup>1</sup> Service manuals are only available in English (en-us), to authorized service providers who have completed Cummins accredited product training.


## 2 Safety Precautions


---

### 2.1 Safety Information and Notices used in this Manual

Danger, Warning and Caution panels used in this manual describe the sources of hazards, their consequences and how to avoid injury. Notice panels emphasize important or critical instructions.

|  <b>DANGER</b>              |
|--|
| <i>Danger indicates a hazardous situation which, if not avoided, WILL result in death or serious injury.</i> |

|  <b>WARNING</b>               |
|--|
| <i>Warning indicates a hazardous situation which, if not avoided, COULD result in death or serious injury.</i> |

|  <b>CAUTION</b>                |
|---|
| <i>Caution indicates a hazardous situation which, if not avoided, COULD result in minor or moderate injury.</i> |

| <b>NOTICE</b>  |
|--|
| <b>Notice refers to a method or practice which can result in product damage, or to draw attention to additional information or explanations.</b> |

### 2.2 General Guidance

- These safety precautions are for general guidance. The information is intended to supplement your own safety procedures and applicable rules, laws and regulations.

### 2.3 Training and Skill Requirements for Personnel

Operation, installation, service and maintenance tasks and/or procedures can only be done by personnel, who:

- Have completed related, applicable and approved training.
- Know the equipment, understand the task(s) and procedure(s) and know the related hazards / risks.
- Know and obey site / location specific emergency procedures and applicable laws and regulations.

### 2.4 Risk Assessment

- The installer / operator / service / maintenance company must do a risk assessment to establish all related hazards and risks.
- During operation, access to the alternator must be restricted to personnel who are trained and who know all relevant hazards and risks. Refer to: [Section 2.3 on page 3](#).

## 2.5 Personal Protective Equipment (PPE)

Personnel who install, operate, service or maintain the alternator must:

- Have access to the minimum recommended protective equipment (refer to the figure below). The protective equipment must be approved for the task or procedure.
- Know how to correctly use protective equipment, refer to: [Section 2.3 on page 3](#)
- Use protective equipment as directed by the risk assessment, refer to: [Section 2.4 on page 3](#).



FIGURE 1. MINIMUM RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE)

## 2.6 Tools and Equipment

All personnel must know how to use tools and equipment safely, refer to: [Section 2.3 on page 3](#).

All tools and equipment used, must be:

- Suitable for the task and procedure.
- Electrically insulated (not below the alternator output voltage), refer to: [Section 2.4 on page 3](#).
- In a serviceable condition for safe use.
- Included within the risk assessment, refer to: [Section 2.4 on page 3](#).

## 2.7 Safety Information Signs

Safety information signs are provided on the equipment to indicate hazards and emphasize instructions. Before operating the equipment:

- Personnel must know and understand alternator safety information signs and the associated hazards / risks.



FIGURE 2. EXAMPLE SAFETY INFORMATION SIGNS

Safety information signs vary depending on alternator specification.



## 2.8 Alternator Danger Notices

### DANGER

#### *Live Electrical Conductors*

*Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:*

- *Shut down and isolate the alternator from all energy sources.*
- *Remove or isolate stored energy.*
- *Test isolated parts for electrical isolation using a suitable voltage tester.*
- *Use lock out/tag out safety procedures.*

### DANGER

#### *Testing Live Electrical Conductors*

*Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before testing on or near live electrical conductors:*

- *Take applicable precautions to prevent contact with live conductors, refer to: Safety Precautions Chapter.*
- *Test on or near live conductors, only if absolutely necessary.*
- *Only trained personnel may test on or near live electrical conductors.*
- *Do not test on or near live electrical conductors alone: Another competent person must be present, trained to isolate energy sources and take action in an emergency.*

### DANGER

#### *Rotating Mechanical Parts*

*Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping. To prevent injury:*

- *Before operating the alternator: The rotating coupling between the alternator and prime mover must be covered by a guard or cover.*
- *Before attempting service or maintenance tasks or removing covers from rotating parts: Shut down and isolate the generator set from all energy sources, isolate stored energy and use lock out/tag out safety procedures.*

### DANGER

#### *Testing on Rotating Mechanical Parts*

*Rotating mechanical parts can cause serious injury or death by crushing, severing and trapping. To prevent injury and before removing safety covers for testing:*

- *Take applicable precautions to prevent contact with uncovered rotating mechanical parts, refer to Safety Precautions Chapter.*
- *Test on or near uncovered rotating mechanical parts, only if absolutely necessary.*
- *Do not test on or near uncovered rotating mechanical parts alone: Additional personnel must be present, who know how to isolate energy sources and take action in an emergency.*

**⚠ DANGER**

**Falling Mechanical Parts**  
*Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping. To prevent injury or death and before lifting:*

- *Check the capacity, condition and attachment of lifting equipment.*
- *Check the capacity, condition and attachment of accessories for lifting.*
- *Check the capacity, condition and attachment of lifting point(s) on the load.*
- *Check the mass, integrity and stability of the load.*
- *If available: Install drive end and non-drive end transit fittings to prevent movement and damage to bearings.*
- *Keep the alternator horizontal when lifting.*
- *Do not use alternator lifting points for lifting a complete generator set.*
- *Do not use cooler lifting points for lifting the alternator or a complete generator set.*
- *Do not remove the lifting label attached to one of the lifting points.*

## 2.9 Alternator Warning Notices

**⚠ WARNING**

**Enclosures**  
*Alternators may be installed within an enclosure for environmental protection, noise reduction or transportation reasons. Before entering the enclosure to prevent injury or death, personnel must:*

- *Know the related hazards / risks.*
- *Have a safe access route in to and out of the enclosure, have sufficient ventilation and obey the alternator hazard zones.*
- *Wear the appropriate protective equipment.*

*Additionally when working with Medium or High Voltage alternators:*

- *Enter the enclosure when the alternator is operating, only if absolutely necessary.*
- *To minimize risks to personnel use remote diagnostic, monitoring and measuring systems.*

**⚠ WARNING**

**Terminal Box**  
*Do not modify the terminal box panels or terminal box internal components. Modification(s) can lead to short-circuits or arc-flash events and cause injury or death by electric shock or burns. To prevent injury:*

- *Refer to: Arc-Flash warning in the Safety Precaution Chapter.*
- *Contact STAMFORD® or AvK® customer services ([www.stamford-avk.com](http://www.stamford-avk.com)) for guidance before making modifications to the terminal box panels or internal components.*

**⚠ WARNING****Arc-flash**

- **An arc-flash event within the terminal box, on the alternator windings or at the customer cables exiting the terminal box can result in very hot and rapidly expanding gases, airborne molten copper and exposure to high UV from the flash. This can cause serious injury or death by burns and/or impact from flying debris, visual damage due to the high intensity flash and damage to hearing from the expanding pressure wave.**
- **To prevent injury or death do not approach the alternator during operation unless wearing appropriate personal protective equipment, refer to: Safety Precaution Chapter.**
- **Any operator working close to the alternator during operation must be trained in arc-flash hazard awareness.**

An arc-flash is a phenomenon where a flashover of electric current leaves its intended path and travels through the air from one conductor to another, or to ground. Arc-flash can be caused by many things, such as: material failure, corrosion, or incorrect installation.

It is the responsibility of the installer/operating company to carry out a risk assessment of arc-flash hazard as part of the complete installation, including connection to other energy sources.

When the alternator is connected to other energy sources, the arc-flash can exceed an arc-flash produced by an individual alternator. These additional energy sources can be electrical loads that store energy (e.g. Transformers, capacitors etc.), alternators in parallel or coupled to a mains network.

While arc-flash in an alternator is rare, it is important that the installer/operating company take appropriate measures to ensure the safety of all personnel. In accordance with local electrical safe working practices, all personnel working around the running alternator must be trained in and aware of arc-flash hazards. Appropriate personal protective equipment must be worn when working within the vicinity of the alternator, refer to: Safety Precaution Chapter [Section 2.5 on page 4](#).

**Medium Voltage (MV) and High Voltage (HV) Alternators**

For alternators that produce Medium Voltage (MV) or High Voltage (HV) the following applies:

MV and HV alternators **can be fitted** with two additional warning and information stickers and a pressure relief mesh vent(s) in the terminal box (the pressure relief mesh vent(s) can vary from the one shown in the image below).



**FIGURE 3. ARC-FLASH IMAGES**

If fitted, make sure the pressure relief mesh is secure and intact: Do not remove, obstruct or apply a load to the pressure relief mesh vent(s).

 **WARNING**

**Condensed Water**

**Operating an alternator with condensed water in the windings can cause serious injury by electric shock, burns or exposure to flying debris and particles. To prevent injury and before operating the alternator:**

- **Use anti-condensation heaters (if fitted) to prevent condensation accumulating.**
- **Check for condensed water.**
- **If condensed water is present, drain/remove the water, dry and inspect the alternator, refer to: Maintenance and Servicing Chapter.**

 **WARNING**

**Coupling an Alternator**

**Moving mechanical parts during coupling can cause serious injury by crushing, severing or trapping. When coupling the alternator to a prime-mover or when installing large components, to prevent injury:**

- **Personnel must keep limbs and body parts away from coupling surfaces during coupling and/or installing operations.**

 **WARNING**

**Hazardous Operating Environments (Explosive Atmospheres)**

**The use of the alternators in an explosive atmosphere can cause serious injury or death by burns and / or flying debris, particles and fumes. To prevent injury or death:**

- **Do not install or operate the alternator where the surrounding atmosphere is potentially explosive.**

 **WARNING**

**Hot Surfaces and Fire**

**Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:**

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.**
- **Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).**
- **Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.**

**⚠ WARNING*****Incorrect Electrical Installation and System Protection***

***Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:***

- ***Have completed related, applicable and approved training.***
- ***Know the equipment, understand the task(s) and procedure(s).***
- ***Know related hazards / risks.***
- ***Know and obey site / location specific emergency procedures and applicable laws and regulations.***

**⚠ WARNING*****Live Electrical Conductors***

***Live electrical conductors at the winding terminals can cause serious injury or death by electric shock or burns. After an insulation resistance test, to prevent injury or death:***

- ***Discharge the windings immediately after the test has concluded by shorting to a suitable earth. The windings must discharge for the greater of:***
  1. ***A length of time equal to the duration of the test.***
  - or
  2. ***5 minutes.***

**⚠ WARNING*****Noise***

***Noise from a running alternator can cause serious and permanent hearing damage. To prevent injury:***

- ***Always wear appropriate personal protection equipment. Refer to Personal Protective Equipment paragraph.***

**⚠ WARNING*****Grounding***

***Incorrectly grounded alternators can cause serious injury or death or serious equipment damage by electric shock or electrical malfunction. To avoid equipment damage, injury or death:***

- ***The alternator must be permanently grounded, unless the application or applicable laws and regulations do not permit alternator grounding.***

**⚠ WARNING*****Reconnected Energy Source***

***Accidental reconnection of energy sources during service and maintenance work can cause serious injury or death by electric shock, burns, crushing, severing or trapping. To prevent injury and before starting any service and maintenance work:***

- ***Isolate the alternator from energy sources.***
- ***Prevent alternator use with lock out/tag out safety procedures.***
- ***Do not defeat or bypass the lock out/tag out safety procedures.***

**⚠ WARNING**

***Strong Magnetic Field***

***The strong magnetic field from a permanent magnet generator (PMG) or excitation boost system (EBS), can cause serious injury or death by interference with implanted medical devices. To prevent injury or death:***

- ***Do not work near a permanent magnet generator (PMG) or excitation boost system (EBS) if you have an implanted medical device.***

**⚠ WARNING**

***Incorrect or Improper Use***

***Incorrect or improper use of the alternator may result in equipment damage, serious injury or death. To prevent or equipment damage injury or death:***

- ***Always select the correct specification alternator for the intended use and application.***
- ***Make sure the alternator and prime mover are compatible and suitable for the intended application.***
- ***Always install the alternator in accordance with the original manual(s) and technical drawing(s) supplied with the alternator.***
- ***Obey locally applicable rules and regulations.***
- ***Make sure the alternator is operated in accordance with the manual(s) and within the limits of the alternator rating plate.***
- ***Do not use a damaged or defective alternator.***

***If a defect(s) is discovered:***

- ***Shut down and isolate the alternator from all energy sources.***
- ***Remove or isolate stored energy.***
- ***Use lock out / tag out safety procedures.***
- ***Prevent further use of the alternator until it is repaired and returned to a serviceable condition.***

**⚠ WARNING**

***Removing Safety Covers***

***A hazard exists when alternator safety covers are removed. Ejected debris and particles can cause serious injury or death by impact, severing or puncturing. Exposure to mechanically driven release of debris and particles exists in all directions (horizontally and vertically) where covers are removed. To prevent injury or death:***

- ***Fit the safety labels at the locations shown on the back of the label sheet supplied.***
- ***Observe the safety labels.***
- ***Refer to the service manual before removing covers.***



FIGURE 4. SAFETY LABEL

### ⚠ WARNING

#### ***Exposure to Ejected Debris and Particles***

***Ejected debris and particles can cause serious injury or death by impact, severing or puncturing. Exposure to mechanically driven release of debris and particles exists in all directions (horizontally and vertically) in the areas surrounding the alternator air outlet(s), air inlets(s) and the open shaft end (also commonly known as the Drive End (DE)). To prevent injury or death:***

- ***Keep away from the air inlet(s) and air outlet(s) when the alternator is operating.***
- ***Do not position operator controls near the air inlet(s) or air outlet(s).***
- ***Do not cause overheating by running the alternator outside rating plate parameters.***
- ***Do not overload the alternator.***
- ***Do not operate an alternator displaying excessive vibration.***
- ***Do not synchronize parallel alternators outside the specified parameters.***

### ⚠ WARNING

#### ***Exposure to Particles and Fumes from an Alternator.***

***Particles and fumes can be released in all directions (horizontally and vertically) from where alternator ventilation is installed. To avoid or injury:***

- ***Avoid the areas around ventilation openings, air intake(s) and air outlet(s) when the alternator is operating.***
- ***Use the correct personal protective equipment when working around an alternator.***

### ⚠ WARNING

#### ***Exposure to Particles and Fumes from Alternator Terminal Boxes.***

***Particles and fumes can be released in all directions (horizontally and vertically) from where terminal box pressure release flaps are installed. Terminal box pressure release flap(s) can be located at different positions and orientations. To avoid or injury:***

- ***Personnel must keep away from terminal box pressure release flap(s) during alternator operation.***



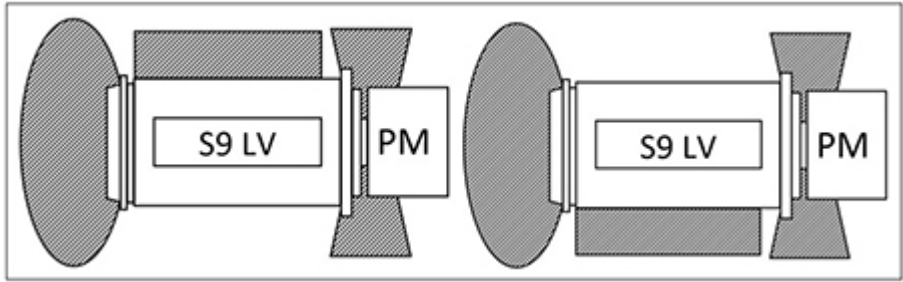


FIGURE 5. S9 LOW VOLTAGE ALTERNATOR HAZARD ZONES

[PM] = Prime Mover / Engine / Drive System

**NOTICE**

The position of the left/right side hazard zone is dependent on the position of the terminal box and vented panels.

## 2.11 Alternator Caution Notices

**⚠ CAUTION**

**Hazardous Substances**  
*Hazardous substances can cause minor or moderate injury. Prolonged or repetitive exposure to hazardous substances can cause serious medical conditions. To prevent injury:*

- *Always read and obey the instructions provided by the product manufacturer.*
- *Use, handle and store substances as specified by the product manufacturer.*
- *Always wear appropriate personal protective equipment, refer to Safety Precautions Chapter.*

**⚠ CAUTION**

**Missing Walkways and Handrails**  
*Walkways and handrails temporarily removed for service and maintenance access can cause minor or moderate injury by slips, trips and falls. To prevent injury and before starting work:*

- *Assess the hazards and risks, take applicable precautions for safe working, place warnings and prevent access by unauthorized persons.*

**⚠ CAUTION**

**Dust & Airborne Particles/Fumes**  
*Dust and other airborne particles and fumes can cause minor or moderate injury by irritating the lungs and eyes. Prolonged or repetitive exposure can cause serious medical conditions. To prevent injury:*

- *Use mechanical vacuum extraction to remove dust and airborne particles or fumes.*
- *Ventilate the area fully.*
- *Always wear the appropriate personal protective equipment. Refer to Safety Precautions Chapter.*



# 3 Safety Directives and Standards

---

## 3.1 General

STAMFORD® and AvK® alternators meet applicable national and international directives and standards relevant to alternators. The alternator must be operated within the limits specified in the relevant standards and within the parameters on the alternator rating plate. The alternator must comply with the regulatory requirements of the area/territory it is installed and used within.

Marine alternators meet the requirements of all the major marine classification societies.

This chapter includes EU/UK declaration template examples, where and if applicable.

Where necessary, STAMFORD® and AvK® alternators are supplied with a declaration certificate that displays the product description and unique serial number.

## 3.2 Example: Declarations of Conformity and Incorporation

CGT issue a Declaration of Conformity under the Low Voltage Directive 2006/95/EC. This Declaration is used for all complete products <1000VAC that do not require the customer to provide any additional components to ensure the product meets the health and safety requirements of the Directive.


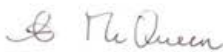
CGT issue a Declaration of Incorporation under the Machinery Directive 2006/42/EC. This Declaration is used for all products <1000VAC that are **not** complete and will require the customer to provide additional components to ensure the product meets the health and safety requirements of the Directive.

Where necessary alternators are supplied with a certificate that displays the product description and unique serial number.


Below are examples of both types of EU and UK 'Declarations of Conformity' and 'Declarations of Incorporation' that STAMFORD® and AvK® alternators can be supplied with.

### NOTICE


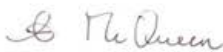
If the certificate is lost, missing or damaged, contact STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com).

| EU DECLARATION OF CONFORMITY   |  |  |
|--|--|---|
| <p>This synchronous low-voltage (&lt;1000VAC) A.C. generator is designed for incorporation into an electricity generating-set and fulfils all the relevant provisions of the following EU Directive(s) when installed in accordance with the installation instructions contained in the product documentation:</p> |  |   |
| 2014/35/EU   | Low Voltage Directive  |   |
| 2014/30/EU   | The Electromagnetic Compatibility (EMC) Directive  |   |
| 2011/65/EU   | Restriction on Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive  |   |
| 2015/863   | Delegated Directive amending Annex II of 2011/65/EU  |   |
| 2019/178   | Delegated Directive amending Annex II of 2011/65/EU  |   |
| 2019/1845  | Delegated Directive amending Annex II of 2011/65/EU  |   |
| <p>and that the standards and/or technical specifications referenced below have been applied:</p>  |  |   |
| EN IEC 61000-6-2:2019  | Electromagnetic compatibility (EMC). Generic standards – Part 6-2: Immunity for industrial environments  |   |
| EN IEC 61000-6-4:2019  | Electromagnetic compatibility (EMC). Generic standards – Part 6-4: Emission standard for industrial environments   |   |
| EN ISO 12100:2010  | Safety of machinery – General principles for design – Risk assessment and risk reduction   |   |
| IEC 60034-1:2017   | Rotating electrical machines - Part 1: Rating and performance  |   |
| ISO 8528-3:2020  | Reciprocating internal combustion engine driven alternating current generating sets - Part 3: Alternating current generators for generating sets   |   |
| BS 5000-3:2006   | Rotating electrical machines of particular types or for particular applications - Part 3: Generators to be driven by reciprocating internal combustion engines - Requirements for resistance to vibration                    |   |
| EN IEC 63000:2018  | Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances   |   |
| <p>This declaration has been issued under the sole responsibility of the manufacturer. The object of this Declaration is in conformity with the relevant Union harmonization Legislation.</p>  |  |   |
| <p>The name and address of authorised representative, authorised to compile the relevant technical documentation, is the Company Secretary, Cummins Generator Technologies Romania, B-dul Decebal Nr. 116A 200746 Craiova Dolj, Romania.</p>   |  |   |
| <p>Signed:</p> <div style="text-align: center; margin-top: 20px;">  </div> <p>Date: 4<sup>th</sup> August 2021</p>  | <p>Name, Title and Address:</p> <p style="margin-left: 20px;">Alastair McQueen<br/>Global Technical Director<br/>Cummins Generator Technologies Romania<br/>B-dul Decebal Nr. 116A<br/>200746, Craiova<br/>Dolj, ROMANIA</p> |   |
| Description:   | Serial Number:   |   |
| <p><small>Registered in England under Registration No. 441273.<br/>Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK</small></p>   |  |   |


**FIGURE 6. EXAMPLE EU DECLARATION OF CONFORMITY - SHEET 1**

| <b>EU DECLARATION OF CONFORMITY</b>  |  |  |
|--|--|--|
| <p>The A.C. Generator utilizes hazardous material exemptions as detailed in Annex III of EU Directive 2011/65/EU</p>   |  |  |
| <p>Products carrying the following descriptions are considered to be out of scope of RoHS Directive 2011/65/EU, intended to be installed in Large Scale Fixed Installations and for installation into a pre-defined and dedicated location, installed and de-installed by professionals:</p> |  |  |
| <p>LV180*<br/>LVSI80*<br/>DSG 99*<br/>DSG 114*<br/>DSG 125*<br/>DSG 144*</p>   |  |  |
| <p>Where "*" represents any combination of letters and characters completing the specific description of the product.</p>  |  |  |
| <p>Registered in England under Registration No. 441273.<br/>Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK</p>  |  |  |
|  |  | 450-16883-J  |



**FIGURE 7. EXAMPLE EU DECLARATION OF CONFORMITY - SHEET 2**

| <b>UK DECLARATION OF CONFORMITY</b>   |  |  |
|---|--|---|
| <p>This synchronous low-voltage (&lt;1000VAC) A.C. generator is designed for incorporation into an electricity generating-set and fulfils all the relevant provisions of the following UK Statutory Instrument(s) when installed in accordance with the installation instructions contained in the product documentation:</p> |  |   |
| S.I. 2016/1101  | The Electrical Equipment (Safety) Regulations  |   |
| S.I. 2016/1091  | The Electromagnetic Compatibility Regulations  |   |
| S.I. 2012/3032  | The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations  |   |
| S.I. 2019/492   | The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (Amendment) Regulations  |   |
| S.I. 2008/1597  | The Supply of Machinery (Safety) Regulations   |   |
| <p>and that the standards and/or technical specifications referenced below have been applied:</p>   |  |   |
| BS EN IEC 61000-6-2:2019  | Electromagnetic compatibility (EMC). Generic standards – Part 6-2: Immunity standard for industrial environments   |   |
| BS EN IEC 61000-6-4:2019  | Electromagnetic compatibility (EMC). Generic standards – Part 6-4: Emission standard for industrial environments   |   |
| BS EN ISO 12100:2010  | Safety of machinery – General principles for design – Risk assessment and risk reduction   |   |
| IEC 60034-1:2017  | Rotating electrical machines: Rating and performance   |   |
| BS ISO 8528-3:2020  | Reciprocating internal combustion engine driven alternating current generating sets - Part 3: Alternating current generators for generating sets                             |   |
| BS EN IEC 63000:2018  | Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances                                     |   |
| <p>This declaration has been issued under the sole responsibility of the manufacturer. The object of this Declaration is in conformity with the relevant UK Legislation.</p>  |  |   |
| <p>The name and address of authorised representative, authorised to compile the relevant technical documentation, is the Company Secretary, Cummins Generator Technologies, Fountain Court, Lynch Wood, Peterborough, UK. PE2 6FZ</p>   |  |   |
| Signed:<br><br><br><br>Date: 4 <sup>th</sup> August 2021   | Name, Title and Address:<br><br>Alastair McQueen<br>Global Technical Director<br>Cummins Generator Technologies<br>Fountain Court, Lynch Wood<br>Peterborough, UK<br>PE2 6FZ |   |
| Description:  |  | Serial Number:  |
| Registered in England under Registration No. 441273.<br>Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK   |  |   |


**FIGURE 8. EXAMPLE UK DECLARATION OF CONFORMITY - SHEET 1**

| <b>UK DECLARATION OF CONFORMITY</b>   |  |  |
|---|--|---|
| <p>The A.C. Generator utilizes hazardous material exemptions as detailed in Annex III of S.I. 2012/2032</p>   |  |   |
| <p>Products carrying the following descriptions are considered to be out of scope of S.I. 2012/2032, intended to be installed in Large Scale Fixed Installations and for installation into a pre-defined and dedicated location, installed and de-installed by professionals:</p> |  |   |
| <p>LVI80*<br/>LVS180*<br/>DSG 99*<br/>DSG 114*<br/>DSG 125*<br/>DSG 144*</p>  |  |   |
| <p>Where "*" represents any combination of letters and characters completing the specific description of the product.</p>   |  |   |
| <p>Registered in England under Registration No. 441273.<br/>Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK</p>   |  |   |
|   |  | 450-16363-J   |

**FIGURE 9. EXAMPLE UK DECLARATION OF CONFORMITY - SHEET 2**

|   |  |  |
|---|--|--|
| <b>2006/42/EC MACHINERY DIRECTIVE<br/>DECLARATION OF INCORPORATION<br/>OF PARTLY COMPLETED MACHINERY</b>  |  |  |
| Function: Synchronous A.C. generator >1000VAC designed for incorporation into an electricity generating-set.  |  |  |
| The partly completed machinery supplied with this declaration:  |  |  |
| <ul style="list-style-type: none"> <li>○ Is designed and constructed solely as a non-functional component to be incorporated into a machine requiring completion.</li> <li>○ Is designed to comply with the provisions of the following EU Directives so far as their level of build will allow:                         <ul style="list-style-type: none"> <li>2014/30/EU            The Electromagnetic Compatibility (EMC) Directive</li> </ul> </li> </ul>  |  |  |
| <ul style="list-style-type: none"> <li>○ Must not be put into service within the European Community ("EC") until the final machinery into which it is to be incorporated has been declared in conformity with the Machinery Directive and all other applicable EC Directives.</li> <li>○ Is designed and constructed to comply with the essential health and safety requirements of the Machinery Directive 2006/42/EC listed on sheet 2 of this Declaration.</li> </ul>  |  |  |
| The relevant technical documentation is compiled in accordance with the provisions of part B of Annex VII of the Machinery Directive. All relevant information about the partly completed machinery will be provided, in writing, on a reasoned request by the appropriate national authority to its authorised representative. The name and address of authorised representative, authorised to compile the relevant technical documentation, is the Company Secretary, Cummins Generator Technologies Romania, B-dul Decebal Nr. 116A 200746 Craiova Dolj, Romania. |  |  |
| The undersigned representing the manufacturer:  |  |  |
| Signed:<br><br><br><br>Date:            4 <sup>th</sup> August 2021  | Name, Title and Address:<br><br>Alastair McQueen<br>Global Technical Director<br>Cummins Generator Technologies Romania<br>B-dul Decebal Nr. 116A<br>200746 Craiova<br>Dolj, ROMANIA |  |
| Description:  | Serial Number  |  |
| Registered in England under Registration No. 441273.<br>Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK   |  |  |
| Sheet   1   | AC48T554-F   |  |

**FIGURE 10. EXAMPLE DECLARATION OF INCORPORATION (>1KV) - SHEET 1**

|  |  |   |
|--|--|---|
| <b>2006/42/EC MACHINERY DIRECTIVE<br/>DECLARATION OF INCORPORATION<br/>OF PARTLY COMPLETED MACHINERY</b>   |  |   |
| <b>ESSENTIAL HEALTH AND SAFETY REQUIREMENTS RELATING TO THE DESIGN<br/>AND CONSTRUCTION OF PARTLY COMPLETED MACHINERY</b>  |  |   |
| <p><b>1.1 General Remarks</b></p> <ul style="list-style-type: none"> <li>▪ 1.1.2 : Principles of safety integration</li> <li>▪ 1.1.3 : Materials and products</li> <li>▪ 1.1.5 : Design of machinery to facilitate its handling</li> </ul> <p><b>1.3 Protection Against Mechanical Hazards</b></p> <ul style="list-style-type: none"> <li>▪ 1.3.1 : Risk of loss of stability</li> <li>▪ 1.3.2 : Risk of break-up during operation</li> <li>▪ 1.3.3 : Risks due to falling or ejected objects</li> <li>▪ 1.3.4 : Risks due to surfaces, edges or angles</li> <li>▪ 1.3.7 : Risks related to moving parts</li> <li>▪ 1.3.8.1 : Moving transmission parts</li> </ul> <p><b>1.4 Guarding *</b></p> <ul style="list-style-type: none"> <li>▪ 1.4.1 : Guards – General requirements *</li> <li>▪ 1.4.2.1 : Fixed guards *</li> </ul> <p><b>1.5 Other Hazards</b></p> <ul style="list-style-type: none"> <li>• 1.5.2 : Static electricity</li> <li>• 1.5.3 : Energy supply other than electric</li> <li>• 1.5.4 : Errors of fitting</li> <li>• 1.5.6 : Fire</li> <li>• 1.5.13 : Emissions of hazardous materials and substances</li> </ul> <p><b>1.7 Information</b></p> <ul style="list-style-type: none"> <li>• 1.7.1 : Information and warnings on the machinery</li> <li>• 1.7.4 : Instructions</li> </ul> | <p style="text-align: center;"><u><b>LEGEND</b></u></p> <ol style="list-style-type: none"> <li>1. Essential Health and Safety Requirements not shown are not considered applicable for this Partly Completed Machinery or must be fulfilled by the assembler of the Machinery.</li> <li>2. Essential Health and Safety Requirements shown are considered applicable for this Partly Completed Machinery and have been fulfilled by the manufacturer to the extent possible, subject to the build requirements of the Machinery assembler, the information contained in the assembly instructions and Cummins bulletins.</li> <li>3. * Customers may request Partly Completed Machinery without some or all guarding attached. In these cases section 1.4 Guarding does not apply and the Essential Health and Safety Requirements for guarding must be fulfilled by the assembler of the Machinery.</li> </ol> |   |
| Sheet   2  |  | Registered in England under Registration No. 441273.<br>Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK |

A073P066


**FIGURE 11. EXAMPLE DECLARATION OF INCORPORATION (>1KV) - SHEET 2**



| <b>SUPPLY OF MACHINERY (SAFETY)<br/>REGULATIONS 2008</b>  |  |  |
|---|--|--|
| <b>DECLARATION OF INCORPORATION<br/>OF PARTLY COMPLETED MACHINERY</b>   |  |  |
| Function: Synchronous A.C. generator > 1000VAC designed for incorporation into an electricity generating-set.   |  |  |
| The partly completed machinery supplied with this declaration:  |  |  |
| <ul style="list-style-type: none"> <li>○ Is designed and constructed solely as a non-functional component to be incorporated into a machine requiring completion.</li> <li>○ Is designed to comply with the provisions of the following EU Directives so far as their level of build will allow:                             <ul style="list-style-type: none"> <li>S.I. 2016/1091      The Electromagnetic Compatibility Regulations</li> </ul> </li> <li>○ Must not be put into service within the UK until the final machinery into which it is to be incorporated has been declared in conformity with the Supply of Machinery (Safety) Regulations 2008 and all other applicable UK Statutory Instruments.</li> <li>○ Is designed and constructed to comply with the essential health and safety requirements of the Supply of Machinery (Safety) Regulations 2008 listed on sheet 2 of this Declaration.</li> </ul> |  |  |
| The relevant technical documentation is compiled in accordance with the provisions of part B of Annex VII of the Machinery Directive. All relevant information about the partly completed machinery will be provided, in writing, on a reasoned request by the appropriate national authority to its authorised representative. The name and address of authorised representative, authorised to compile the relevant technical documentation, is the Company Secretary, Cummins Generator Technologies, Fountain Court, Lynch Wood, Peterborough, UK. PE2 6FZ  |  |  |
| The undersigned representing the manufacturer:  |  |  |
| Signed:<br><br><br><br>Date:      4 <sup>th</sup> August 2021   | Name, Title and Address:<br><br>Alastair McQueen<br>Global Technical Director<br>Cummins Generator Technologies<br>Fountain Court, Lynch Wood<br>Peterborough, UK<br>PE2 6FZ |  |
| <u>Description:</u>   | <u>Serial Number:</u>  |  |
| Registered in England under Registration No. 441273.<br>Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK   |  |  |
| Sheet   3   | A073P066   |  |

**FIGURE 12. EXAMPLE DECLARATION OF INCORPORATION (>1KV) - SHEET 3**



|  |   |  |
|--|---|--|
| <p><b>SUPPLY OF MACHINERY (SAFETY)<br/>REGULATIONS 2008</b></p> <p><b>DECLARATION OF INCORPORATION<br/>OF PARTLY COMPLETED MACHINERY</b></p>   |   |  |
| <p><b>ESSENTIAL HEALTH AND SAFETY REQUIREMENTS RELATING TO THE DESIGN AND<br/>CONSTRUCTION OF PARTLY COMPLETED MACHINERY</b></p>   |   |  |
| <p><b>General Remarks</b></p> <ul style="list-style-type: none"> <li>▪ 1.1.2 : Principles of safety integration</li> <li>▪ 1.1.3 : Materials and products</li> <li>▪ 1.1.5 : Design of machinery to facilitate its handling</li> </ul> <p><b>Protection Against Mechanical Hazards</b></p> <ul style="list-style-type: none"> <li>▪ 1.3.1 : Risk of loss of stability</li> <li>▪ 1.3.2 : Risk of break-up during operation</li> <li>▪ 1.3.3 : Risks due to falling or ejected objects</li> <li>▪ 1.3.4 : Risks due to surfaces, edges or angles</li> <li>▪ 1.3.7 : Risks related to moving parts</li> <li>▪ 1.3.8.1 : Moving transmission parts</li> </ul> <p><b>Guarding *</b></p> <ul style="list-style-type: none"> <li>▪ 1.4.1 : Guards – General requirements *</li> <li>▪ 1.4.2.1 : Fixed guards *</li> </ul> <p><b>Other Hazards</b></p> <ul style="list-style-type: none"> <li>• 1.5.2 : Static electricity</li> <li>• 1.5.3 : Energy supply other than electric</li> <li>• 1.5.4 : Errors of fitting</li> <li>• 1.5.6 : Fire</li> <li>• 1.5.13 : Emissions of hazardous materials and substances</li> </ul> <p><b>Information</b></p> <ul style="list-style-type: none"> <li>• 1.7.1 : Information and warnings on the machinery</li> <li>• 1.7.4 : Instructions</li> </ul> | <p style="text-align: center;"><u>LEGEND</u></p> <p>1 Essential Health and Safety Requirements not shown are not considered applicable for this Partly Completed Machinery or must be fulfilled by the assembler of the Machinery.</p> <p>2 Essential Health and Safety Requirements shown are considered applicable for this Partly Completed Machinery and have been fulfilled by the manufacturer to the extent possible, subject to the build requirements of the Machinery assembler, the information contained in the assembly instructions and Cummins bulletins.</p> <p>3 * Customers may request Partly Completed Machinery without some or all guarding attached. In these cases section 1.4 Guarding does not apply and the Essential Health and Safety Requirements for guarding must be fulfilled by the assembler of the Machinery.</p> |  |
| <p style="font-size: small;">Registered in England under Registration No. 441273.<br/>Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK</p>  |   |  |

A048T564-F

**FIGURE 13. EXAMPLE DECLARATION OF INCORPORATION (>1KV) - SHEET 4**

### 3.3 Additional Information for Electromagnetic Compatibility Compliance (EMC)

Where necessary STAMFORD® and AvK® alternators are designed to meet electromagnetic compatibility compliance emissions and immunity standards for industrial environments. Additional equipment may be required when the alternator is installed in residential, commercial, and light industrial environments.

The installation 'earth/ground' arrangements require the connection of the alternator frame to the site protective earth conductor using a minimum lead length.

#### **NOTICE**

**Cummins Generator Technology is not liable for electromagnetic compatibility compliance if non-genuine STAMFORD® or AvK® brand parts are used for maintenance, servicing or repairs.**

### 3.4 Additional Information for Canadian Standards Association (CSA)

To comply with Canadian Standards Association (CSA) regulations, all external wiring and components must be rated to: At least the alternator rated voltage shown on the alternator rating plate.

# 4 Introduction


## 4.1 General Description

S9 alternators are of brushless rotating field design, available in the following ranges:

- Low Voltage (LV) up to 1000 V, 50 Hz (1500 RPM, 4 pole) and 1000 V, 60 Hz (1800 RPM, 4 pole).
- Medium Voltage (MV) up to 3.3 kV, 50 Hz (1500 RPM, 4 pole) and 4.16 kV, 60 Hz (1800 RPM, 4 pole).
- High Voltage (HV) up to 13.8 kV, 50 Hz (1500 RPM, 4 pole) and 13.8 kV, 60 Hz (1800 RPM, 4 pole).

S9 alternators have an excitation system which uses various AVR's, powered by a permanent magnet generator (PMG).

## 4.2 Noise

|  WARNING  |
|--|
| <p><b>Noise</b></p> <p><b>Noise from a running alternator can cause serious and permanent hearing damage. To prevent injury:</b></p> <ul style="list-style-type: none"> <li>• <b>Always wear appropriate personal protection equipment. Refer to Personal Protective Equipment paragraph.</b></li> </ul> |

Maximum A-weighted noise emissions may reach 110 dB(A). Contact the supplier for application-specific details.

## 4.3 Alternator Name

TABLE 3. S9 ALTERNATOR NAMING FORMAT

| Example: | S              | 9             | L  | 1        | D                                    | - | C                                | 4               | 2   |
|----------|----------------|---------------|--|----------|--------------------------------------|---|----------------------------------|-----------------|---|
|          | STAMFORD Brand | Family Series | Voltage<br>(L=low, M = medium, H = high) | Revision | Descriptor D = Dedicated, M = Marine |   | Core length (A, B, C, D, E, ...) | Number of poles | Number of bearings<br>(1 = NDE, 2 = DE & NDE) |

## 4.4 Serial Number Location

A unique serial number is stamped on the side of the stator frame and shown on two labels on the outside of the terminal box.

## 4.5 Rating Plate

The self-adhesive rating plate label, supplied with the alternator, must be fixed after the generator set is fully assembled and painted.

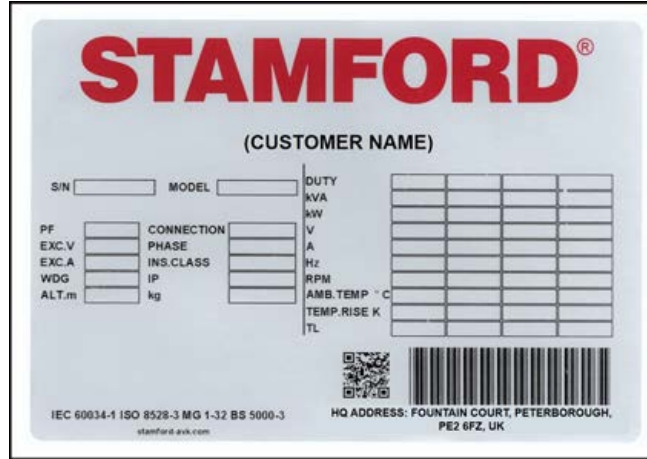


FIGURE 14. GLOBAL STAMFORD ALTERNATOR RATING PLATE

## 4.6 Product Authentication

The STAMFORD® high security, anti-counterfeit hologram is located on the Tracking Label. Check that the dots are visible around the STAMFORD® logo when viewing the hologram from different angles and the word "GENUINE" appears behind the logo. Use a flashlight to see these security features in low ambient light. Check that the alternator is genuine by entering the unique 7 character hologram code at [www.stamford-avk.com/verify](http://www.stamford-avk.com/verify).

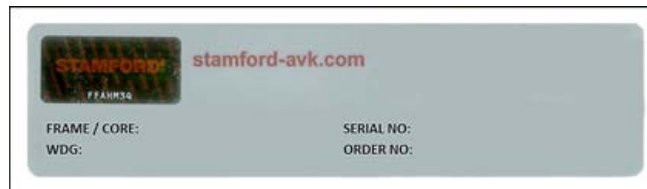


FIGURE 15. TRACKING LABEL



FIGURE 16. DOTS VISIBLE IN LEFT, RIGHT, UPPER AND LOWER VIEWS OF 3D HOLOGRAM

# 5 Lifting, Storage and Transportation

---

## 5.1 General Transport Guidance

Alternators vary in shape, size, weight, and center of gravity. For product information, refer to: The general arrangement drawing, lifting label and transport information supplied with the alternator.

Before loading a vehicle, transporting a load and/or unloading a vehicle:

- Obey applicable rules and regulations relating to transport operations at all times.
- Make sure a sufficient number of applicably configured restraints are used to lash down/secure an alternator to a vehicle.
- Do not position lashing down/securing restraints on or over sensitive components that can be damaged by the restraint.
- Do not position lashing down/securing restraints on paintwork or information/warning labeling. Protect these areas if restrains must be placed over them.
- Before transportation or storage: Apply an anti-corrosion agent to exposed machined surfaces.
- Before transportation or storage: Cover exposed connection points with a sufficient cover, cap or packaging material.
- Before transportation or storage: If necessary, protect bearings from vibration using anti-vibration pads. Do not transport unprotected alternators over an uneven surface.
- Alternators should be supplied on a transport frame if necessary.
- Bearings should be protected from damage by using a transportation lock (if available) when necessary. If a transport lock is supplied with the bearing/alternator it must be installed before transportation.
- Bearings must be protected from corrosion using an applicable anti-corrosion agent.
- Read and obey industry best practice guidance.
- Consult with a transport specialist for advice if necessary.

## 5.2 Lifting the Alternator

### DANGER

#### ***Falling Mechanical Parts***

***Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping. To prevent injury or death and before lifting:***

- ***Check the capacity, condition and attachment of lifting equipment.***
- ***Check the capacity, condition and attachment of accessories for lifting.***
- ***Check the capacity, condition and attachment of lifting point(s) on the load.***
- ***Check the mass, integrity and stability of the load.***
- ***If available: Install drive end and non-drive end transit fittings to prevent movement and damage to bearings.***
- ***Keep the alternator horizontal when lifting.***
- ***Do not use alternator lifting points for lifting a complete generator set.***
- ***Do not use cooler lifting points for lifting the alternator or a complete generator set.***
- ***Do not remove the lifting label attached to one of the lifting points.***

Lift the alternator by shackles attached to the lifting points (lugs or eyes) provided. A label attached to a lifting point shows the correct lifting arrangement. Use chains of sufficient length, and a spreader bar if necessary, to make sure that the chains are vertical when lifting. Make sure that the capacity of the lifting equipment is sufficient for the alternator mass shown on the label attached to the alternator.

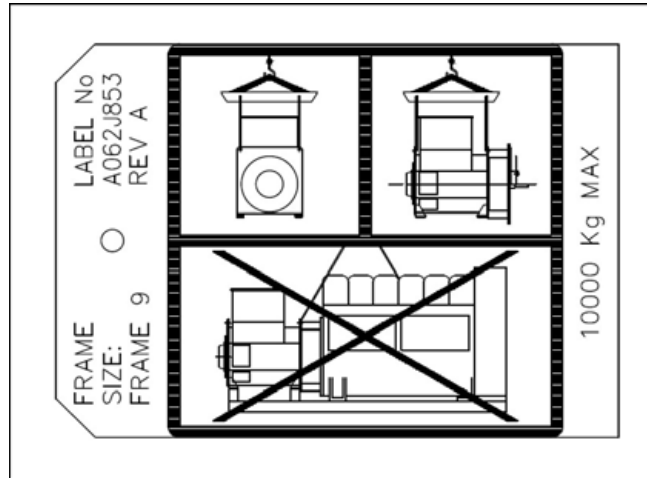


FIGURE 17. EXAMPLE LIFTING LABEL

## 5.3 Alternator Dimensions

Dimensions are included in the data sheet specific to the alternator model. Refer to the rating plate to identify the alternator model.

### NOTICE

Data sheets are available from [www.stamford-avk.com](http://www.stamford-avk.com)

## 5.4 Storage

### WARNING

#### Condensed Water

*Operating an alternator with condensed water in the windings can cause serious injury by electric shock, burns or exposure to flying debris and particles. To prevent injury and before operating the alternator:*

- *Use anti-condensation heaters (if fitted) to prevent condensation accumulating.*
- *Check for condensed water.*
- *If condensed water is present, drain/remove the water, dry and inspect the alternator, refer to: Maintenance and Servicing Chapter.*

**⚠ WARNING****Hot Surfaces and Fire**

**Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:**

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.**
- **Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).**
- **Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.**

If the alternator will not be used immediately, it must be stored in a clean, dry, vibration-free environment. We recommend the use of anti-condensation heaters, when available.

If the alternator can be rotated, turn the rotor a minimum of 6 revolutions every month during storage.

## 5.5 After Storage

After a period of storage, do the pre-running checks to determine the condition of the windings. If the windings are damp or the insulation resistance is low, refer to alternator insulation drying procedure: [Section 8.8.6 on page 70](#).

Before putting the alternator into service, refer to the following table.

**TABLE 4. BEARING STORAGE**

| Bearing Type                   | Not Rotated during Storage   | Rotated during Storage  |
|--------------------------------|--|---|
| <b>Sealed Bearing(s)</b>       | If stored less than 12 months, put the alternator into service.<br>If stored more than 12 months, replace the bearing(s) then put the alternator into service. | If stored less than 24 months, put the alternator into service.<br>If stored more than 24 months, replace the bearing(s) then put the alternator into service.  |
| <b>Re-greasable Bearing(s)</b> | If stored less than 12 months, put the alternator into service.<br>If stored more than 12 months, replace the bearing(s) then put the alternator into service. | If stored less than 6 months, put the alternator into service.<br>If stored between 6 and 24 months, re-grease the bearing(s) during the first run then put the alternator into service.<br>If stored more than 24 months, replace the bearing(s) then put the alternator into service. |

## 5.6 Long-term Storage

When an alternator is stationary, in storage or otherwise, it may be subjected to environmental factors, such as vibration, humidity, temperature and airborne contaminant particles, that could degrade the bearing arrangements.

Contact STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com) for advice in advance if the alternator will be stationary for long periods.

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# 6 Application of the Alternator

It is the customer's responsibility to make sure that the selected alternator is suitable for the final application.

| <b>⚠ WARNING</b>  |  |
|---|--|
| <b><i>Incorrect or Improper Use</i></b>   |  |
| <b><i>Incorrect or improper use of the alternator may result in equipment damage, serious injury or death. To prevent or equipment damage injury or death:</i></b>  |  |
| <ul style="list-style-type: none"><li>• <b><i>Always select the correct specification alternator for the intended use and application.</i></b></li><li>• <b><i>Make sure the alternator and prime mover are compatible and suitable for the intended application.</i></b></li><li>• <b><i>Always install the alternator in accordance with the original manual(s) and technical drawing(s) supplied with the alternator.</i></b></li><li>• <b><i>Obey locally applicable rules and regulations.</i></b></li><li>• <b><i>Make sure the alternator is operated in accordance with the manual(s) and within the limits of the alternator rating plate.</i></b></li><li>• <b><i>Do not use a damaged or defective alternator.</i></b></li></ul> |  |
| <b><i>If a defect(s) is discovered:</i></b>   |  |
| <ul style="list-style-type: none"><li>• <b><i>Shut down and isolate the alternator from all energy sources.</i></b></li><li>• <b><i>Remove or isolate stored energy.</i></b></li><li>• <b><i>Use lock out / tag out safety procedures.</i></b></li><li>• <b><i>Prevent further use of the alternator until it is repaired and returned to a serviceable condition.</i></b></li></ul>  |  |

## 6.1 Environment

The alternators are protected to IP23 as standard. IP23 is not adequate protection for use outdoors without additional measures.

**TABLE 5. ENVIRONMENTAL SPECIFICATION**

|                            |                                  |
|----------------------------|----------------------------------|
| <b>Ambient Temperature</b> | -15 °C to 40 °C (5 °F to 104 °F) |
| <b>Relative Humidity</b>   | < 70%                            |
| <b>Altitude</b>            | < 1000 m (3280 ft)               |

The alternator has been designed for the environment shown in the table. The alternator can operate outside these conditions if it is rated accordingly, refer to the nameplate. If the operating environment is changed after purchase, speak to STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com) for a revised alternator rating.

## 6.2 Air Flow

TABLE 6. S9 LV, MV, HV MINIMUM AIR FLOW AND MAXIMUM PRESSURE DIFFERENCE

| Alternator model and frequency | Minimum Air flow, m <sup>3</sup> /s (ft <sup>3</sup> /min) |             | Maximum intake to outlet pressure difference, mm (in) water gauge |
|--------------------------------|--|-------------|---|
|                                | 50 Hz  | 60 Hz       |   |
| S9 (All Variants)              | 2.78 (5890)  | 3.33 (7056) | 13 (0.5)  |

Make sure that the air inlets and outlets are not obstructed when the alternator is running.

## 6.3 Airborne Contaminants

**⚠ CAUTION**

***Dust & Airborne Particles/Fumes***

***Dust and other airborne particles and fumes can cause minor or moderate injury by irritating the lungs and eyes. Prolonged or repetitive exposure can cause serious medical conditions.***

***To prevent injury:***

- ***Use mechanical vacuum extraction to remove dust and airborne particles or fumes.***
- ***Ventilate the area fully.***
- ***Always wear the appropriate personal protective equipment. Refer to Safety Precautions Chapter.***

**NOTICE**

**Contaminants such as salt, oil, exhaust fumes, chemicals, dust, and sand will reduce the effectiveness of the insulation and the life of the windings. Consider using air filters and an enclosure to protect the alternator.**

## 6.4 Air Filters

Air filters trap airborne particulates above 5 microns. The filters must be cleaned or replaced regularly, depending on site conditions. Check the filters frequently to establish an appropriate service interval.

Alternators with factory-fitted filters are rated to account for the reduced flow rate of cooling air. If filters are retrofitted, the alternator rating must be reduced by 5%.

Air filters do not remove water. Keep the filters dry with additional protection. Wet filters further restrict airflow, causing the alternator to overheat and leading to premature failure of the insulation.

## 6.5 Humid Conditions

The water carrying capacity of air depends on temperature. If the air temperature falls below its saturation point, dew may form on the windings reducing the electrical resistance of the insulation. In humid conditions additional protection may be required, even if the alternator is fitted inside an enclosure. Anti-condensation heaters are fitted as standard.

## 6.6 Anti-Condensation Heaters

### DANGER

#### *Live Electrical Conductors*

*Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:*

- *Shut down and isolate the alternator from all energy sources.*
- *Remove or isolate stored energy.*
- *Test isolated parts for electrical isolation using a suitable voltage tester.*
- *Use lock out/tag out safety procedures.*

### WARNING

#### *Condensed Water*

*Operating an alternator with condensed water in the windings can cause serious injury by electric shock, burns or exposure to flying debris and particles. To prevent injury and before operating the alternator:*

- *Use anti-condensation heaters (if fitted) to prevent condensation accumulating.*
- *Check for condensed water.*
- *If condensed water is present, drain/remove the water, dry and inspect the alternator, refer to: Maintenance and Servicing Chapter.*

### WARNING

#### *Hot Surfaces and Fire*

*Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:*

- *Avoid contact with hot surfaces.*
- *Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.*
- *Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).*
- *Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.*

Power to the anti-condensation heater is supplied from a separate source. Anti-condensation heaters raise the air temperature around the windings to deter condensation forming in humid conditions when the alternator is not operating. Best practice is to energize the heaters automatically when the alternator is off.

## 6.7 Enclosures

**⚠ WARNING**

**Enclosures**

**Alternators may be installed within an enclosure for environmental protection, noise reduction or transportation reasons. Before entering the enclosure to prevent injury or death, personnel must:**

- **Know the related hazards / risks.**
- **Have a safe access route in to and out of the enclosure, have sufficient ventilation and obey the alternator hazard zones.**
- **Wear the appropriate protective equipment.**

**Additionally when working with Medium or High Voltage alternators:**

- **Enter the enclosure when the alternator is operating, only if absolutely necessary.**
- **To minimize risks to personnel use remote diagnostic, monitoring and measuring systems.**

Fit an enclosure to protect the alternator from adverse environmental conditions.

- Make sure that air entering the alternator is of adequate flow rate, free from moisture and contaminants and below the maximum ambient temperature on the rating plate.
- The airflow should be modeled to identify and prevent hot air from re-circulating within the enclosure.
- Make sure there is sufficient access around the alternator for safe maintenance.

## 6.8 Vibration

The alternators are designed to withstand the vibration levels encountered on generator sets built to meet the requirements of ISO 8528-9 and BS 5000-3. (Where ISO 8528 is taken to be broad band measurements and BS5000 refers to the predominant frequency of any vibrations on the generator set).

**NOTICE**

**Exceeding either of the above specifications will have a detrimental effect on the life of the bearings and other components and may invalidate the alternator warranty.**

**NOTICE**

**The terminal box is designed to support the fitted busbars or terminals, transformers, load cables and auxiliary terminal box. Additional mass could cause excessive vibration and lead to failure of the terminal box enclosure and mounting. Refer to the Installation Manual to connect the load cables to the terminal box. Speak to STAMFORD® or AvK® customer services before fixing any additional mass to the terminal box.**

### 6.8.1 Definition of BS5000–3

Alternators shall be capable of continuously withstanding linear vibration levels with amplitudes of 0.25 mm between 5 Hz and 8 Hz, and velocities of 9.0 mm/s RMS between 8 Hz and 200 Hz, when measured at any point directly on the carcass or main frame of the machine. These limits refer only to the predominant frequency of vibration of any complex waveform.

## 6.8.2 Definition of ISO 8528-9

ISO 8528-9 refers to a broad band of frequencies, the broad band is taken to be between 10 Hertz and 1000 Hertz. The table below is an extract from ISO 8528-9 (Table C.1, value 1). This simplified table lists the vibration limits by kVA and speed for acceptable operation of standard generator set designs.

## 6.8.3 Vibration Frequencies

The main vibration frequencies produced by the alternator are as follows:

- 4-pole 1500 RPM 25 Hz
- 4-pole 1800 RPM 30 Hz

Vibrations induced in the alternator by the engine are complex. It is the responsibility of the generator set designer to ensure that the alignment and stiffness of the bedplate and mountings do not allow vibration to exceed BS5000 part 3 and ISO 8528 part 9 limits.

## 6.8.4 Linear Vibration Limits

TABLE 7. S9 VIBRATION LEVEL MEASUREMENTS

| Linear Vibration Levels As Measured On The Alternator - S9 |                            |                                       |                                     |
|--|----------------------------|---------------------------------------|-------------------------------------|
| Engine Speed<br>RPM<br>(min <sup>-1</sup> )                | Power Output<br>S<br>(kVA) | Vibration<br>Displacement<br>RMS (mm) | Vibration<br>Velocity<br>RMS (mm/s) |
| 1 300 ≤n <sub>r</sub><br>≤2 000                            | >250                       | 0.32                                  | 20                                  |
| The broad band is taken as 10 Hz - 1000 Hz                 |                            |                                       |                                     |

## 6.8.5 Linear Vibration Monitoring

We recommend using vibration analyzing equipment to measure vibration at the positions shown below. Check that vibration of the generator set is below the limits stated in the standards. If vibration is above the limits, the generator set builder should investigate the root causes and eliminate them. Best practice is for the generator set builder to take initial readings as a reference and for the user to periodically monitor vibration, according to the recommended service schedule, to detect a deteriorating trend.

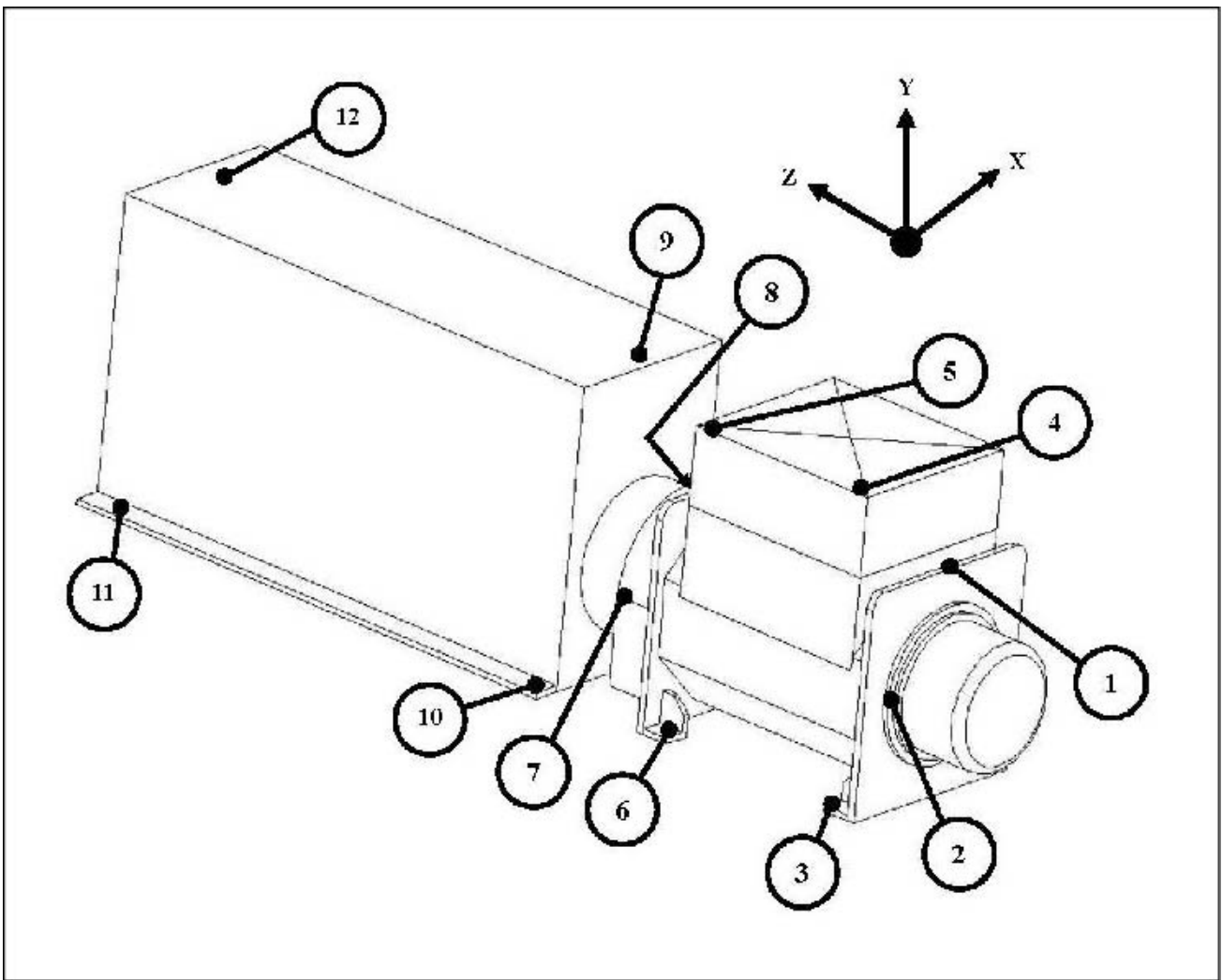


FIGURE 18. VIBRATION MEASUREMENT POSITIONS

## 6.8.6 Excessive Vibration

**⚠ WARNING**

***Exposure to Ejected Debris and Particles***

***Ejected debris and particles can cause serious injury or death by impact, severing or puncturing. Exposure to mechanically driven release of debris and particles exists in all directions (horizontally and vertically) in the areas surrounding the alternator air outlet(s), air inlets(s) and the open shaft end (also commonly known as the Drive End (DE)). To prevent injury or death:***

- ***Keep away from the air inlet(s) and air outlet(s) when the alternator is operating.***
- ***Do not position operator controls near the air inlet(s) or air outlet(s).***
- ***Do not cause overheating by running the alternator outside rating plate parameters.***
- ***Do not overload the alternator.***
- ***Do not operate an alternator displaying excessive vibration.***
- ***Do not synchronize parallel alternators outside the specified parameters.***

If the measured vibration of the generator set is not within the limits:

1. Consult with the generator set manufacturer to reduce vibration to an acceptable level.

2. Speak to STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com) to assess the impact on bearing and alternator life expectancy.

## 6.9 Bearings

### 6.9.1 Re-greasable Bearings

Each bearing housing is connected by a grease pipe to an external grease nipple. A label gives the grease type and quantity, and frequency for re-greasing. The recommended grease is a high specification synthetic compound that must not be mixed with grease of a different specification. Refer to the Service and Maintenance chapter for detailed instructions.

### 6.9.2 Bearing Life

Factors that reduce bearing life or lead to bearing failure include:

- Adverse operating conditions and environment.
- Stress caused by misalignment of the generator set.
- Vibration from the engine that exceeds the limits in BS 5000-3 and ISO 8528-9.
- Long periods (including transportation) when the alternator is stationary and subjected to vibration can cause false brinelling wear (flats on the balls and grooves on the races).
- Humid or wet conditions that cause corrosion and deterioration of the grease by emulsification.

### 6.9.3 Health Monitoring of the Bearings

We recommend that the user checks the bearing condition using vibration monitoring equipment. Best practice is to take initial readings as a reference and periodically monitor the bearings to detect a deteriorating trend. It will then be possible to plan a bearing change at an appropriate generator set or engine service interval.

### 6.9.4 Bearing 'Service Life' Expectancy

Bearing manufacturers recognize that the service life of bearings depends on factors that are outside their control. Rather than quote a service life, practicable replacement intervals are based on the L10 life of the bearing, the type of grease, and the recommendations of the bearing and grease manufacturers.

For general purpose applications: If the correct maintenance is carried out, vibration levels do not exceed the levels stated in ISO 8528-9 and BS5000-3, and the ambient temperature does not exceed 50 °C, plan to replace the bearings within 30,000 hours of operation.

If in doubt regarding any aspect of bearing life of a STAMFORD® alternator, contact the nearest authorized supplier of the alternator or STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com).

### 6.9.5 Standby Applications

Run alternators in standby applications at no load for a minimum of 10 minutes every week. For alternators fitted with regreasable bearings, re-grease the bearings every 6 months, regardless of the number of accumulated running hours.

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# 7 Installation into the Generator Set

## 7.1 Generator Set Coupling

### ⚠ WARNING

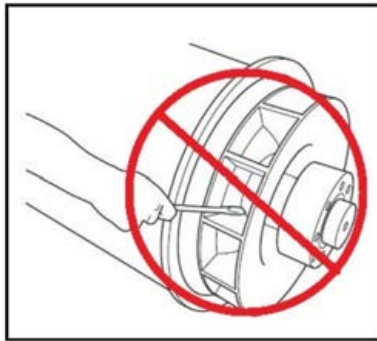
#### *Coupling an Alternator*

*Moving mechanical parts during coupling can cause serious injury by crushing, severing or trapping. When coupling the alternator to a prime-mover or when installing large components, to prevent injury:*

- *Personnel must keep limbs and body parts away from coupling surfaces during coupling and/or installing operations.*

### NOTICE

**Do not attempt to rotate the alternator rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.**



**FIGURE 19. DO NOT ROTATE WITH A LEVER**

Efficient operation and long component life depend on minimizing mechanical stresses on the alternator. When coupled in a generator set, misalignment and vibration interactions with the prime mover engine can cause mechanical stress.

A coupling mass greater than 150 kg will reduce bearing life significantly. Refer to the factory for further information.

Generator sets need a substantial flat continuous bedplate to suit the installation site floor loading, with engine and alternator mounting pads to make a firm base for accurate alignment. The height of all mounting pads must be within 0.25 mm for skid mounting, 3 mm for non-adjustable anti-vibration mounts (AVM) or 10 mm for adjustable height AVMs. Use shims or adjust alignment elements to achieve level. The rotational axes of alternator rotor and engine output shaft must be coaxial (radial alignment) and perpendicular to the same plane (angular alignment). The axial alignment of the alternator and engine coupling must be within 0.5 mm, to allow for thermal expansion without unwanted axial force on the bearings at operating temperature.

Vibration can occur by flexing of the coupling. The alternator is designed for a maximum bending moment not exceeding 275 kgm (2000 lbs ft). Check the maximum bending moment of the engine flange with the engine manufacturer.

Torsional vibrations occur in all engine-driven shaft systems and may be large enough to cause damage at critical speeds. The generator set builder must consider the effect of torsional vibration on the alternator shaft and couplings, referring to the torsional drawings supplied for shaft dimensions and rotor inertia.

Close-coupling of alternator and engine can increase the rigidity of the generator set. Both single and two bearing alternators can be close-coupled. The generator set builder must supply guarding for open-coupled applications.

To prevent rust during transit and storage, the alternator frame spigot, rotor coupling plates and shaft extension have been treated with a rust preventative coating. Remove this before coupling the generator set.

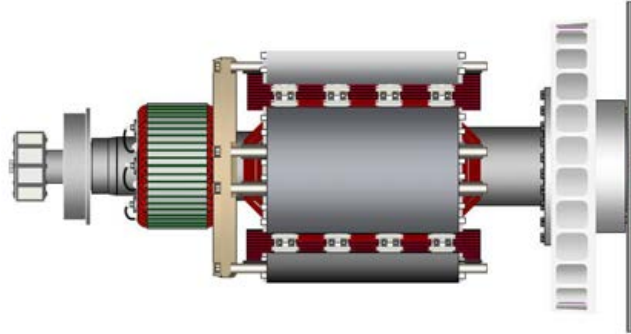


FIGURE 20. SINGLE BEARING ALTERNATOR ROTOR SHOWING COUPLING DISCS BOLTED TO DRIVE END COUPLING HUB (AT RIGHT)

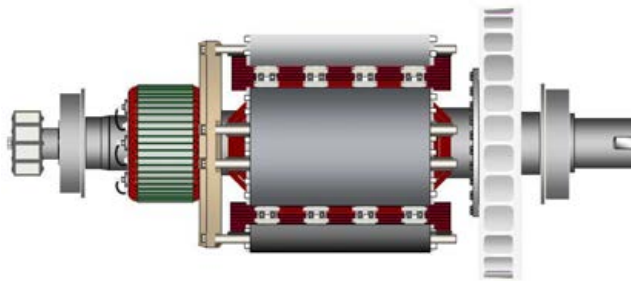


FIGURE 21. TWO BEARING ALTERNATOR ROTOR SHOWING SHAFT WITH KEYWAY FOR FLEXIBLE COUPLING (AT RIGHT)

## 7.2 Single Bearing

**⚠ DANGER**

***Falling Mechanical Parts***

***Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping. To prevent injury or death and before lifting:***

- ***Check the capacity, condition and attachment of lifting equipment.***
- ***Check the capacity, condition and attachment of accessories for lifting.***
- ***Check the capacity, condition and attachment of lifting point(s) on the load.***
- ***Check the mass, integrity and stability of the load.***
- ***If available: Install drive end and non-drive end transit fittings to prevent movement and damage to bearings.***
- ***Keep the alternator horizontal when lifting.***
- ***Do not use alternator lifting points for lifting a complete generator set.***
- ***Do not use cooler lifting points for lifting the alternator or a complete generator set.***
- ***Do not remove the lifting label attached to one of the lifting points.***

1. Check that the bracket which supports the rotor underneath the fan hub is fitted in position.

2. Position the alternator close to the engine and remove the drive end transit bracket that keeps the rotor in place during transport.
3. Remove the air outlet covers from the drive end of the alternator to access the coupling and adaptor bolts.
4. If required, tighten the coupling disc bolts in the sequence shown in [Figure 22 on page 40](#).
5. Check the torque of bolts that fasten the coupling discs to the DE coupling hub in a clockwise direction around the bolt circle.
6. Make sure the coupling discs are concentric with the adaptor spigot. Use alignment studs to ensure that the disc and the flywheel are in alignment.
7. Make sure the axial distance from the coupling mating face on the flywheel to the mating face on the flywheel housing is within 0.5mm of nominal dimension. This ensures that the engine crankshaft float is maintained and the alternator rotor position is neutral, allowing for thermal expansion. There is no axial pre-load thrust on the engine or alternator bearings.
8. Offer the alternator to the engine and engage coupling discs and housing spigots at the same time, pushing the alternator towards the engine until the coupling discs are against the flywheel face and the housing spigots are located.

**NOTICE**

**Do not pull the alternator to the engine using bolts through the flexible discs.**

9. Fit heavy gauge washers under the heads of housing and coupling bolts. Screw in the bolts evenly around the coupling assembly to maintain correct alignment.
10. Tighten the bolts to fix the coupling disc to the flywheel, in the sequence shown in [Figure 23 on page 40](#)
11. Check the torque of each bolt in a clockwise direction around the bolt circle to ensure all the bolts are tight. Refer to the engine manufacturer's manual for correct tightening torque.
12. Remove the rotor support bracket.
13. Replace all covers.

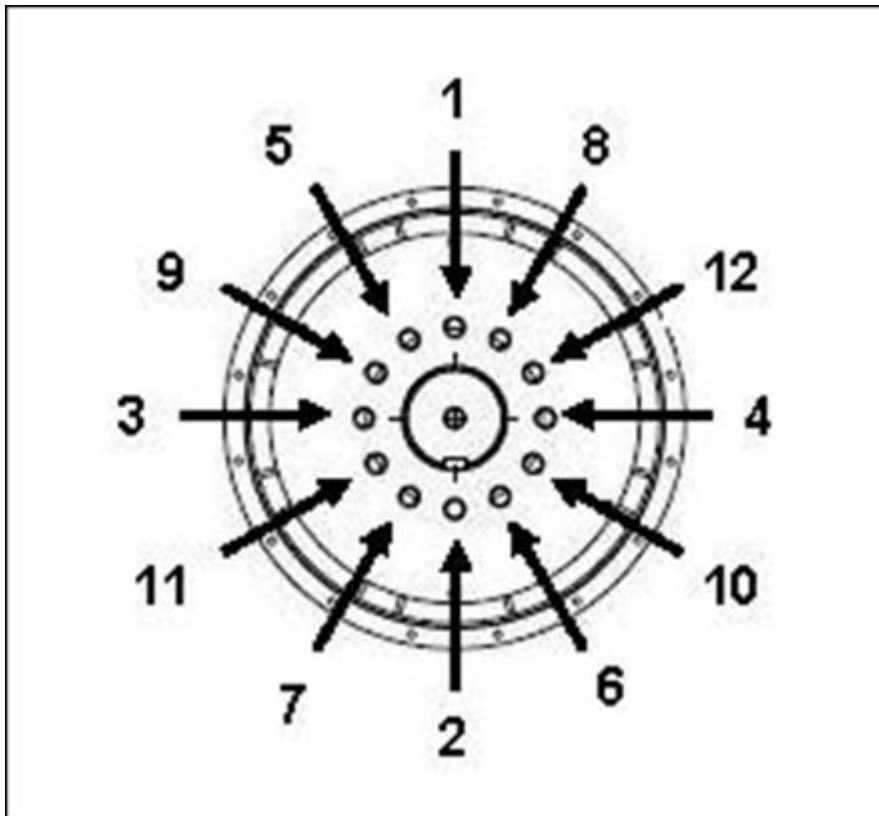


FIGURE 22. FIXING SEQUENCE TO HUB

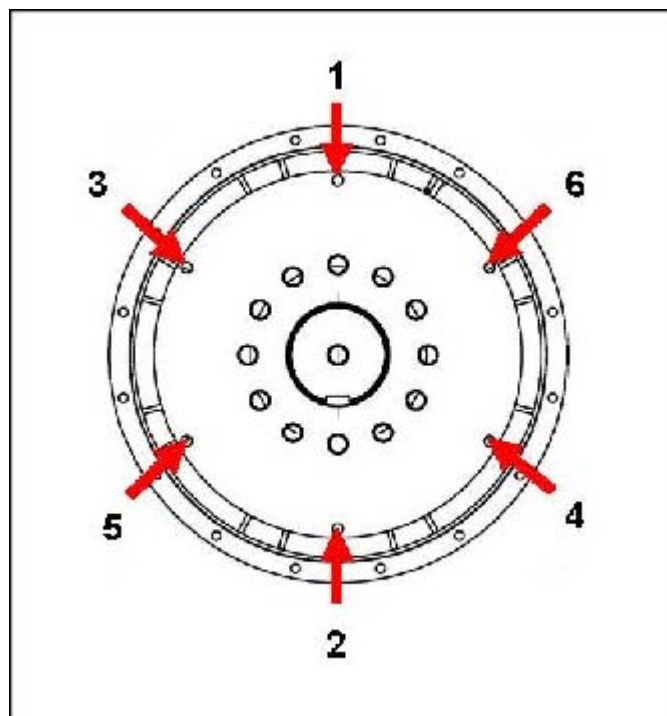


FIGURE 23. FIXING SEQUENCE TO FLYWHEEL

### 7.3 Two Bearing

A flexible coupling, designed to suit the specific engine/alternator combination, is recommended to minimize torsional vibration effects.

If a close coupling adaptor is used the alignment of machined faces must be checked by offering the alternator up to the engine. Shim the alternator feet if necessary.

## 7.4 Pre-Running Checks

Before starting the generator set, test the insulation resistance of windings and check that all connections are tight and in the correct location. Make sure the alternator air path is clear of obstructions. Replace all covers.

## 7.5 Direction of Rotation

As standard, alternator rotation is clockwise, as viewed from the drive end (unless counter-clockwise rotation is specified when ordering). The fan must be changed if the direction of rotation is changed, speak to STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com).

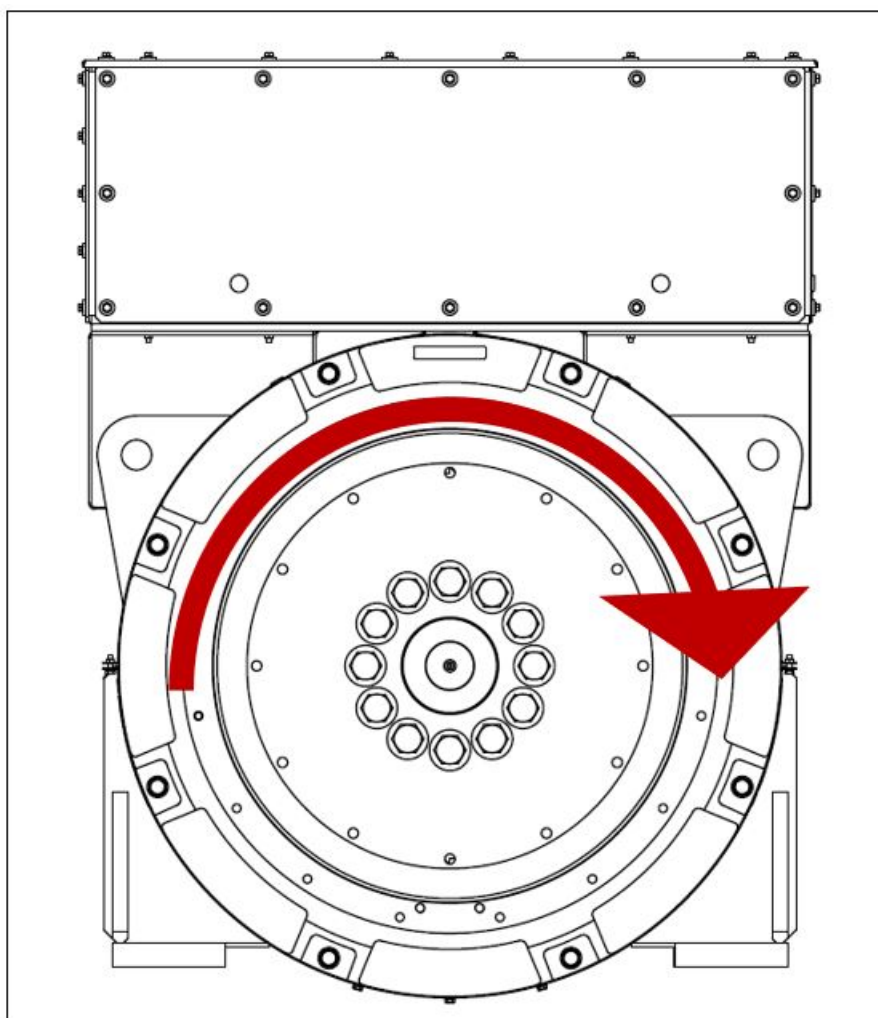


FIGURE 24. DIRECTION OF ROTATION

## 7.6 Phase Rotation

Main stator output is connected for a phase sequence of U V W when the alternator runs clockwise, as viewed from the drive end. If the phase rotation must be reversed, the customer must re-connect the output cables in the terminal box. STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com) for a circuit diagram of 'reverse phase connections'.

## 7.7 Voltage and Frequency

Check that the voltage and frequency shown on the alternator rating plate meet the requirements of the generator set application. Refer to detailed instructions in the AVR manual for adjustments.

## 7.8 AVR Settings

The AVR is factory set for initial running tests. Check that the AVR settings are compatible with your required output. Refer to detailed instructions in the AVR manual for on- and off-load adjustments.

## 7.9 Electrical Connections

### WARNING

#### ***Incorrect Electrical Installation and System Protection***

***Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:***

- ***Have completed related, applicable and approved training.***
- ***Know the equipment, understand the task(s) and procedure(s).***
- ***Know related hazards / risks.***
- ***Know and obey site / location specific emergency procedures and applicable laws and regulations.***

The terminal box is designed to support the fitted busbars or terminals, transformers, load cables and auxiliary terminal box. Additional mass could cause excessive vibration and lead to failure of the terminal box enclosure and mounting. Speak to STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com) before fixing any additional mass to the terminal box. Panels must be removed to be drilled or cut, to prevent swarf entering the terminal box or alternator.

Fault current curves and alternator reactance values are available on request from the factory so that the system designer can calculate the necessary fault protection and/or discrimination.

The installer must check that the alternator frame is bonded to the generator set bedplate, and must bond to site earth. If anti-vibration mounts are fitted between the alternator frame and its bedplate, a suitably-rated earth conductor must bridge across the anti-vibration mount.

Refer to wiring diagrams for electrical connection of the load cables. Electrical connections are made in the terminal box, constructed with removable panels to suit site-specific cable entry and glanding. Route single core cables through the insulated or non-magnetic gland plates supplied. Panels must be removed to be drilled or cut to prevent swarf entering the terminal box or alternator. After wiring, inspect the terminal box, remove all debris using a vacuum cleaner if necessary and check that no internal components are damaged or disturbed.

As standard, the alternator neutral is not bonded to the alternator frame. If required, neutral may be connected to the earth terminal in the terminal box, by a conductor of at least one half of the sectional area of a phase lead.

Load cables must be supported appropriately to avoid a tight radius at the point of entry into the terminal box, clamped at the terminal box gland, and allow at least  $\pm 25$  mm movement by the alternator set on its anti-vibration mountings, without causing excessive stress to the cables and alternator load terminals.

The palm (flattened part) of load cable lugs must be clamped in direct contact with the stator load output terminals so that the whole palm area conducts the output current, as shown in [Figure 25 on page 43](#). The tightening torque of M12 fasteners is 80 Nm on busbars. As specified when ordering, cable lugs can be fixed to top or bottom of the busbar, and by one or two fasteners.



FIGURE 25. CORRECT CABLE CLAMPING

## 7.10 Grid Connection: Voltage Surges and Micro-Interruptions

Consideration should be given to any transient voltages loads generated by connected loads and/or distribution system which could damage the alternator components.

According to the specifics of the application and installation the points below must be considered:

- Loads with characteristics that result in large load step changes.
- Load control by switchgear and power control by any method likely to generate transient voltage spikes.
- Distribution systems susceptible to external influences, such as lightning strikes.
- Applications involving parallel operation to a mains supply, where the risk of a mains disturbance in the form of a micro-interruption could occur.

If the alternator is at risk from voltage surges or micro-interruptions, it is recommended that the installation includes adequate protection of the generation system to meet regulations and installation requirements. It is recommended to seek guidance from specialist protection system designers and associated professional bodies.

## 7.11 Varying Load

Under certain conditions, load variations can reduce alternator life.

Identify any possible risk, especially the following:

- Large capacitive loads (for example Power Factor Correction equipment) can affect alternator stability and cause pole slip.
- Stepped grid voltage variation (for example Tap Changing).

If the alternator is at risk from varying load, include adequate protection into the generator set system by under-excitation protection.



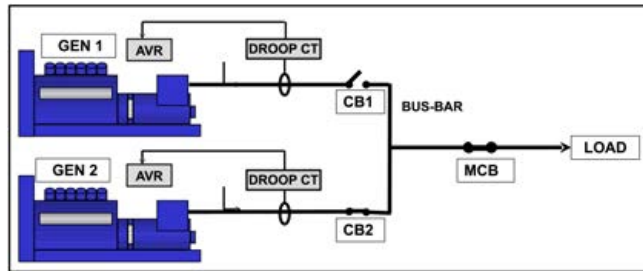
## 7.12 Synchronization

**⚠ WARNING**

**Exposure to Ejected Debris and Particles**  
*Ejected debris and particles can cause serious injury or death by impact, severing or puncturing. Exposure to mechanically driven release of debris and particles exists in all directions (horizontally and vertically) in the areas surrounding the alternator air outlet(s), air inlets(s) and the open shaft end (also commonly known as the Drive End (DE)). To prevent injury or death:*

- *Keep away from the air inlet(s) and air outlet(s) when the alternator is operating.*
- *Do not position operator controls near the air inlet(s) or air outlet(s).*
- *Do not cause overheating by running the alternator outside rating plate parameters.*
- *Do not overload the alternator.*
- *Do not operate an alternator displaying excessive vibration.*
- *Do not synchronize parallel alternators outside the specified parameters.*

### 7.12.1 Parallel or Synchronizing Alternators



**FIGURE 26. PARALLEL OR SYNCHRONIZING ALTERNATORS**

The quadrature droop current transformer (Droop CT) gives a signal proportional to reactive current. The AVR adjusts excitation to reduce circulating current and allow each alternator to share reactive load. A factory-fitted droop CT is pre-set for 5% voltage drop at full-load zero power factor. Refer to the supplied AVR manual for droop adjustment.

- The synchronizing switch/breaker (CB1, CB2) must be of a type that will not cause “contact bounce” when it operates.
- The synchronizing switch/breaker must be adequately rated to withstand the continuous full load current of the alternator.
- The switch/breaker must be able to withstand the rigorous closing cycles during synchronizing and the currents produced if the alternator is paralleled out of synchronization.
- The closing time of the synchronizing switch/breaker must be under the control of the synchronizer settings.
- The switch/breaker must be capable of operation under fault conditions such as short circuits. Alternator data sheets are available.

**NOTICE**

**The fault level may include a contribution from other alternators as well as from the grid/mains utility.**



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The method of synchronizing should be either automatic, or by check synchronizing. The use of manual synchronizing is not recommended. The settings on the synchronizing equipment should be such that the alternator will close smoothly. For the synchronizing equipment to achieve this, the phase sequence must match the parameters in the table below.

**TABLE 8. SYNCHRONIZING EQUIPMENT PARAMETERS**

|                             |                 |
|-----------------------------|-----------------|
| <b>Voltage Difference</b>   | <b>+/- 0.5%</b> |
| <b>Frequency Difference</b> | 0.1 Hz/sec      |
| <b>Phase Angle</b>          | +/- 10°         |
| <b>C/B Closing Time</b>     | 50 ms           |

The voltage difference when paralleling with the grid/mains utility is +/- 3%.

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# 8 Service and Maintenance

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## 8.1 Recommended Service Schedule

Refer to: Safety Precautions in [Chapter 2 on page 3](#) before starting any service and maintenance activity.

Refer to: Parts Identification in [Chapter 9 on page 73](#) for an exploded view of components and fastener information.

The recommended service schedule shows the recommended service activities in table rows, grouped by alternator subsystem. Columns of the table show the types of service activity, whether the alternator must be running, and the service levels. Service frequency is given in running hours or time interval, whichever is sooner. A cross (X) in the cells where a row intersects the columns shows a service activity type and when it is required. An asterisk (\*) shows a service activity done only when necessary.

All service levels in the recommended service schedule can be purchased directly from STAMFORD® or AvK® customer services [www.stamford-avk.com](http://www.stamford-avk.com).

1. Proper service and repair are vital to the reliable operation of your alternator and the safety of anyone coming into contact with the alternator.
2. These service activities are intended to maximize the life of the alternator but shall not vary, extend or change the terms of the manufacturer's standard warranty or your obligations in that warranty.
3. Each service interval is a guide only, and developed on the basis that the alternator was installed and is operated in accordance with the manufacturer's guidelines. If the alternator is located and/or operated in adverse or unusual environmental conditions, the service intervals may need to be more frequent. The alternator should be continually monitored between services to identify any potential failure modes, signs of misuse, or excessive wear and tear.

## 8.1.1 Alternator Service Schedule

TABLE 9. S9 LV ALTERNATOR SERVICE SCHEDULE

| System     | SERVICE ACTIVITY<br><br>X = required<br>* = if necessary | Alternator running | TYPE    |      |       |                | SERVICE LEVEL |                                       |                              |                                 |                                 |   |   |  |
|------------|--|--------------------|---------|------|-------|----------------|---------------|---------------------------------------|------------------------------|---------------------------------|---------------------------------|---|---|--|
|            |  |                    | Inspect | Test | Clean | Refill/Replace | Commission    | Post Commission<br>250 hrs / 0.5 year | Level 1<br>1000 hrs / 1 year | Level 2<br>10,000 hrs / 2 years | Level 3<br>30,000 hrs / 5 years |   |   |  |
| Alternator | Alternator rating  |                    | X       |      |       |                | X             |                                       |                              |                                 |                                 |   |   |  |
|            | Bedplate arrangement                                     |                    | X       |      |       |                | X             |                                       |                              |                                 |                                 |   |   |  |
|            | Coupling arrangement                                     |                    | X       |      |       |                | X             |                                       |                              |                                 | *                               |   | X |  |
|            | Environmental conditions and cleanliness                 |                    | X       |      |       |                | X             | X                                     | X                            | X                               | X                               |   | X |  |
|            | Ambient temperature (inside & outside)                   |                    |         | X    |       |                | X             | X                                     | X                            | X                               | X                               |   | X |  |
|            | Complete machine - damage, loose parts & earth bonds     |                    | X       |      |       |                | X             | X                                     | X                            | X                               | X                               |   | X |  |
|            | Guards, screens, warning and safety labels               |                    | X       |      |       |                | X             | X                                     | X                            | X                               | X                               |   | X |  |
|            | Maintenance access                                       |                    | X       |      |       |                | X             |                                       |                              |                                 |                                 |   |   |  |
|            | Electrical nominal operating conditions & excitation     | X                  |         | X    |       |                | X             | X                                     | X                            | X                               | X                               |   | X |  |
|            | Vibration  | X                  |         | X    |       |                | X             | X                                     | X                            | X                               | X                               |   | X |  |
| Windings   | Condition of windings                                    |                    | X       |      |       |                | X             | X                                     | X                            | X                               | X                               |   | X |  |
|            | Insulation resistance of all windings                    |                    |         | X    |       |                | X             | *                                     | *                            | X                               |                                 | X |   |  |
|            | Insulation resistance of rotor, exciter and PMG          |                    |         | X    |       |                |               | X                                     | X                            |                                 |                                 |   |   |  |
|            | Temperature sensors                                      | X                  |         | X    |       |                | X             | X                                     | X                            | X                               | X                               |   | X |  |
|            | Customer settings for temperature sensors                |                    | X       |      |       |                | X             |                                       |                              |                                 |                                 |   |   |  |

| System                 | SERVICE ACTIVITY<br><br>X = required<br>* = if necessary | Alternator running | TYPE    |      |       |                | SERVICE LEVEL |                                     |                    |         |                   |         |                      |         |
|------------------------|--|--------------------|---------|------|-------|----------------|---------------|-------------------------------------|--------------------|---------|-------------------|---------|----------------------|---------|
|                        |  |                    | Inspect | Test | Clean | Refill/Replace | Commission    | Post Commission                     | 250 hrs / 0.5 year | Level 1 | 1000 hrs / 1 year | Level 2 | 10,000 hrs / 2 years | Level 3 |
| Bearings               | Condition of bearings                                    |                    | X       |      |       |                | X             |                                     |                    |         |                   |         |                      | X       |
|                        | Grease exhaust & trap                                    |                    |         |      | X     |                |               | every 3000 to 3500 hours / 6 months |                    |         |                   |         |                      |         |
|                        | Re-grease re-greasable bearing(s) (C to G core length)   | X                  |         |      |       | X              |               | every 3000 to 3500 hours / 6 months |                    |         |                   |         |                      |         |
|                        | Replace re-greasable bearing(s)                          |                    |         |      |       | X              |               |                                     |                    |         | *                 |         | X                    |         |
|                        | Temperature sensors                                      | X                  |         | X    |       |                | X             | X                                   | X                  | X       | X                 | X       |                      |         |
|                        | Customer settings for temperature sensors                |                    | X       |      |       |                | X             |                                     |                    |         |                   |         |                      |         |
| Terminal Box           | All alternator/customer connections and cabling          |                    | X       |      |       |                | X             | X                                   | X                  | X       | X                 | X       |                      |         |
| Controls & Auxiliaries | Initial AVR & PFC set up                                 | X                  |         | X    |       |                | X             |                                     |                    |         |                   |         |                      |         |
|                        | AVR & PFC settings                                       | X                  |         | X    |       |                |               | X                                   | X                  | X       | X                 | X       |                      |         |
|                        | Customer connection of auxiliaries                       |                    |         | X    |       |                | X             |                                     | X                  | X       | X                 | X       |                      |         |
|                        | Function of auxiliaries                                  |                    |         | X    |       |                | X             | X                                   | X                  | X       | X                 | X       |                      |         |
|                        | Synchronization settings                                 |                    | X       |      |       |                | X             |                                     |                    |         |                   |         |                      |         |
|                        | Synchronization  | X                  |         | X    |       |                | X             | X                                   | X                  | X       | X                 | X       |                      |         |
|                        | Anti condensation heater                                 |                    |         |      |       | X              |               |                                     |                    |         | *                 | X       |                      |         |
| Rectifier              | Diodes and varistors                                     |                    | X       |      |       |                | X             | X                                   | X                  | X       | X                 |         |                      |         |
|                        | Diodes and varistors                                     |                    |         |      |       | X              |               |                                     |                    |         |                   | X       |                      |         |
| Cooling                | Air inlet temperature                                    | X                  |         | X    |       |                | X             | X                                   | X                  | X       | X                 | X       |                      |         |
|                        | Air flow (rate & direction)                              | X                  | X       |      |       |                | X             |                                     |                    |         |                   |         |                      |         |
|                        | Condition of fan   |                    | X       |      |       |                | X             | X                                   | X                  | X       | X                 | X       |                      |         |
|                        | Condition of air filter (where fitted)                   |                    |         | X    |       |                | X             | X                                   | X                  | X       | X                 | X       |                      |         |
|                        | Air filters (where fitted)                               |                    |         |      | X     | X              |               |                                     | *                  | *       | *                 | *       |                      |         |

## 8.2 Bearings

### 8.2.1 Introduction

| <b>NOTICE</b>  |
|--|
| <p>Do not overfill a bearing with grease, the bearing can be damaged.</p> <p>Do not mix lubricant types.</p> <p>Change gloves to handle different lubricant</p> <p>Assemble bearings in static and dust-free conditions, wearing lint free gloves.</p> <p>To prevent damage or contamination, store removed parts and tools in static and dust-free conditions.</p> <p>Do not reuse bearings. Bearings are damaged by the axial force needed to remove it from the rotor shaft.</p> <p>Do not press fit bearing. Bearings are damaged if the insertion force is applied through the bearing balls.</p> <p>Do not try to turn the rotor by levering against the cooling fan vanes. The fan will be damaged.</p> |

The alternator rotor is supported by a bearing at the non-drive end (NDE) and by either a bearing or a coupling to the prime mover at the drive end (DE).

- Lubricate each re-greasable bearing according to the recommended service schedule with the correct quantity and type of grease, also shown on a label fitted at the grease nipple.

### 8.2.2 Safety

| <b>⚠ DANGER</b>  |
|--|
| <p><b><i>Rotating Mechanical Parts</i></b></p> <p><b><i>Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping. To prevent injury:</i></b></p> <ul style="list-style-type: none"><li>• <b><i>Before operating the alternator: The rotating coupling between the alternator and prime mover must be covered by a guard or cover.</i></b></li><li>• <b><i>Before attempting service or maintenance tasks or removing covers from rotating parts: Shut down and isolate the generator set from all energy sources, isolate stored energy and use lock out/tag out safety procedures.</i></b></li></ul> |

| <b>⚠ WARNING</b>   |
|--|
| <p><b><i>Hot Surfaces and Fire</i></b></p> <p><b><i>Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:</i></b></p> <ul style="list-style-type: none"><li>• <b><i>Avoid contact with hot surfaces.</i></b></li><li>• <b><i>Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.</i></b></li><li>• <b><i>Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).</i></b></li><li>• <b><i>Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.</i></b></li></ul> |

**⚠ WARNING****Exposure to Ejected Debris and Particles**

*Ejected debris and particles can cause serious injury or death by impact, severing or puncturing. Exposure to mechanically driven release of debris and particles exists in all directions (horizontally and vertically) in the areas surrounding the alternator air outlet(s), air inlets(s) and the open shaft end (also commonly known as the Drive End (DE)). To prevent injury or death:*

- *Keep away from the air inlet(s) and air outlet(s) when the alternator is operating.*
- *Do not position operator controls near the air inlet(s) or air outlet(s).*
- *Do not cause overheating by running the alternator outside rating plate parameters.*
- *Do not overload the alternator.*
- *Do not operate an alternator displaying excessive vibration.*
- *Do not synchronize parallel alternators outside the specified parameters.*

**⚠ CAUTION****Hazardous Substances**

*Hazardous substances can cause minor or moderate injury. Prolonged or repetitive exposure to hazardous substances can cause serious medical conditions. To prevent injury:*

- *Always read and obey the instructions provided by the product manufacturer.*
- *Use, handle and store substances as specified by the product manufacturer.*
- *Always wear appropriate personal protective equipment, refer to Safety Precautions Chapter.*

## 8.2.3 Re-Grease Bearings

### 8.2.3.1 Requirements

TABLE 10. RE-GREASING: EQUIPMENT REQUIREMENTS

| Requirement                         | Description   |
|-------------------------------------|---|
| Personal Protective Equipment (PPE) | <ul style="list-style-type: none"> <li>• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.</li> </ul> |
| Consumables                         | <ul style="list-style-type: none"> <li>• Lint-free cleaning cloths</li> <li>• Thin disposable gloves</li> </ul>                                       |
| Parts                               | <ul style="list-style-type: none"> <li>• CGT recommended grease</li> </ul>  |
| Tools                               | <ul style="list-style-type: none"> <li>• Grease gun (calibrated for volume or mass)</li> </ul>  |

### 8.2.3.2 Re-grease Method

TABLE 11. S9LV RE-GREASING: GREASE QUANTITY

| Bearing Type                                | Quantity of recommended grease |          |
|---|--------------------------------|----------|
|   | Volume (cm <sup>3</sup> )      | Mass (g) |
| Drive End (S9LV Core length C & D)          | 126                            | 121      |
| Drive End (S9LV Core length E, F)           | 180                            | 173      |
| Drive End (S9LV Core length G)              | 94                             | 90       |
| Non-Drive End (S9LV Core length C, D, E, F) | 157                            | 151      |
| Non-Drive End (S9LV Core length G)          | 97                             | 93       |

1. For each bearing, identify grease nipple, re-greasing label and bearing type.
2. Make sure the new grease is not contaminated. It must be a uniform whitish-beige color of stiff consistency throughout.
3. Clean the grease gun nozzle and grease nipple.
4. Clean the grease exhaust.
5. Where an air filter is fitted, with the alternator stopped, remove the NDE cover and air filter and clean the exhausted grease trap. Afterward, replace the air filter and reinstall the NDE cover.
6. With the alternator running, fit the grease gun to the grease nipple and add the correct quantity of grease.
7. Run the alternator for at least 60 minutes, off-load.
8. Remove the grease trap, clean the grease exhaust and re-fit.
9. Inspect the color and consistency of grease expelled from the exhaust and compare with new grease - whitish-beige of stiff consistency.
10. Replace the bearing if the expelled grease is severely discolored or absent.

|   |
|---|
| <b>NOTICE</b>   |
| <b>If the exhaust grease trap overflows, the stator and rotor windings would be contaminated. Make sure trap is emptied when re-greasing.</b> |



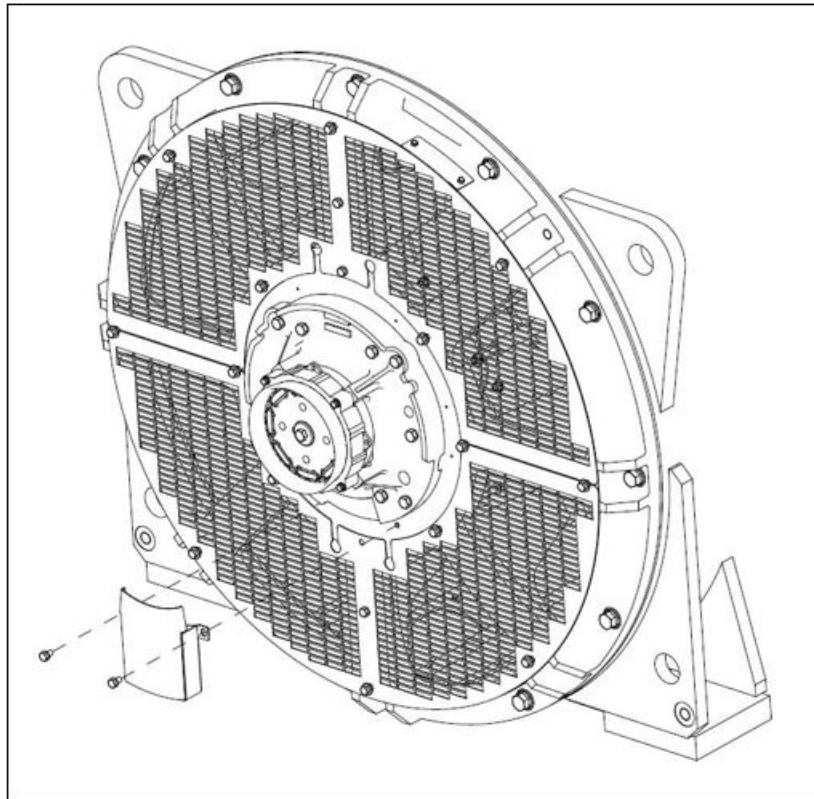


FIGURE 27. GREASE TRAP S9

## 8.3 Controls

### 8.3.1 Introduction

An operating alternator is a harsh environment for control components. Heat and vibration can cause electrical connections to loosen and cables to fail. Routine inspection and test can identify an issue before it becomes a failure that incurs unplanned downtime.

### 8.3.2 Safety

#### **⚠ DANGER**

##### ***Live Electrical Conductors***

***Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:***

- ***Shut down and isolate the alternator from all energy sources.***
- ***Remove or isolate stored energy.***
- ***Test isolated parts for electrical isolation using a suitable voltage tester.***
- ***Use lock out/tag out safety procedures.***

**⚠ WARNING**

**Hot Surfaces and Fire**  
*Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:*

- *Avoid contact with hot surfaces.*
- *Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.*
- *Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).*
- *Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.*

**⚠ WARNING**

**Incorrect Electrical Installation and System Protection**  
*Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:*

- *Have completed related, applicable and approved training.*
- *Know the equipment, understand the task(s) and procedure(s).*
- *Know related hazards / risks.*
- *Know and obey site / location specific emergency procedures and applicable laws and regulations.*

### 8.3.3 Connection Test Requirements

TABLE 12. CONNECTION TEST REQUIREMENTS

| Requirements                               | Description   |
|--|---|
| <b>Personal Protective Equipment (PPE)</b> | <ul style="list-style-type: none"> <li>• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.</li> </ul> |
| <b>Consumables</b>                         | <ul style="list-style-type: none"> <li>• None</li> </ul>  |
| <b>Parts</b>                               | <ul style="list-style-type: none"> <li>• None</li> </ul>  |
| <b>Tools</b>                               | <ul style="list-style-type: none"> <li>• Insulation test meter</li> <li>• Multimeter</li> <li>• Torque wrench</li> </ul>                              |

### 8.3.4 Inspect and Test

1. Remove the terminal box lid
2. Check the tightness of fasteners securing the load cables.
3. Check that cables are firmly clamped at the terminal box gland, and allow ±25 mm movement by an alternator on anti-vibration mounts.
4. Check that all cables are anchored and unstressed within the terminal box.

5. Check all cables for signs of damage caused by vibration, including insulation wear and wire strand breaks.
6. Check that all AVR accessories and current transformers are correctly fitted, and cables pass centrally through current transformers.
7. If an anti-condensation heater is fitted:
  - a. Isolate the supply and measure electrical resistance of the heater element(s). Replace heater element if open circuit.
  - b. Connect together both ends of the heater leads.
  - c. Apply the test voltage between the winding and earth.
  - d. Measure the insulation resistance after 1 minute (IR 1min).
  - e. Discharge the voltage.
  - f. If the measured insulation resistance is less than the minimum acceptable value, replace the heater element(s), refer to: [Table 13 on page 55](#) for values.
8. Test the supply voltage to the anti-condensation heaters (if fitted). 100 VAC to 277 VAC. should be present across each heater element when the alternator is stopped. Refer to the wiring diagram for heater connections.
9. Check that AVR and AVR accessories within the terminal box are clean, securely fitted on anti-vibration mounts, and the cable connectors are firmly attached to the terminals. AVR and AVR accessories do not need further routine servicing.
10. For parallel operation, check that alternator frequency signal cables to the synchronization equipment are securely connected.
11. Refit the terminal box lid.

**TABLE 13. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ANTI-CONDENSATION HEATERS**

|                          | Test Voltage (V) | Minimum Insulation Resistance at 1 minute (MΩ) |            |
|--------------------------|------------------|--|------------|
|                          |                  | New  | In-service |
| Anti-condensation heater | 500              | 10   | 1          |

## 8.4 Cooling System

### 8.4.1 Introduction

The alternators are designed to meet standards supporting EU Directives and UK Statutory Instruments, and are rated for the effect of operating temperature on winding insulation.

**BS EN 60085 (≡ IEC 60085) Electrical insulation – Thermal Evaluation and Designation** classifies insulation capability by the maximum operating temperature for a reasonable design and service life. When considering thermal design life, thermal conditioning of insulation system components and their combination are predominantly influenced by the level of thermal stress applied to the system. Additional, single or a combination of factors such as mechanical, electrical and environmental stress, may cause degradation over time, but these are considered secondary when considering thermal degradation of an insulation system.

If the operating environment differs from the values shown on the rating plate, rated output must be reduced by

- 3% for class H utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C

- 3.5% for class F utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C
- 4.5% for class B utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C
- 3% for every 500 m increase in altitude above 1000 m, up to 4000 m\*, due to the reduced thermal capacity of lower density air, and
- 5% if air filters are fitted due to restricted air flow.

**NOTICE**

**The values above are cumulative dependent on environmental conditions.**

Efficient cooling depends on maintaining the condition of the cooling fan, air filters and gaskets.


\* The following changes to the insulation system of medium and high voltage alternators, must be applied to minimize the adverse effects of operating at higher altitudes, to ensure normal operational life expectancy. The changes are calculated according to the specific alternator design and Pashen's Curve.

- Up to 1500 m elevation: No change to insulation system required
- 1500 - 3000 m elevation: Requires a change to the insulation system design to meet altitude operational requirements. Maximum system voltage (Un) designs up to 11 kV. This design upgrade is factory manufactured only.
- 3000 - 4000 m elevation: Requires a change to the insulation system design to meet altitude operational requirements. Maximum system voltage (Un) designs up to 6.6 kV. This design upgrade is factory manufactured only.

**NOTICE**

**For alternators with nominal design voltage above 1.1 kV, thermal derate due to the change in insulation system design to meet higher altitude operational conditions above 1000 MASL cannot be assumed based on standard derate factors. Advice must be obtained from Cummins Generator Technologies, as special considerations are required to allow for increased insulation systems thermal transfer capabilities.**

## 8.4.2 Safety

** DANGER**

***Rotating Mechanical Parts***  
***Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping. To prevent injury:***

- ***Before operating the alternator: The rotating coupling between the alternator and prime mover must be covered by a guard or cover.***
- ***Before attempting service or maintenance tasks or removing covers from rotating parts: Shut down and isolate the generator set from all energy sources, isolate stored energy and use lock out/tag out safety procedures.***

**⚠ WARNING****Hot Surfaces and Fire**

**Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:**

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.**
- **Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).**
- **Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.**

**⚠ CAUTION****Dust & Airborne Particles/Fumes**

**Dust and other airborne particles and fumes can cause minor or moderate injury by irritating the lungs and eyes. Prolonged or repetitive exposure can cause serious medical conditions. To prevent injury:**

- **Use mechanical vacuum extraction to remove dust and airborne particles or fumes.**
- **Ventilate the area fully.**
- **Always wear the appropriate personal protective equipment. Refer to Safety Precautions Chapter.**

**NOTICE**

**Do not attempt to rotate the alternator rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.**

**NOTICE**

**Filters are designed to remove dust, not moisture. Wet filter elements can cause reduced air flow and overheating. Do not allow filter elements to get wet.**

## 8.4.3 Cooling System Test Requirements

TABLE 14. COOLING SYSTEM TEST REQUIREMENTS

| Requirements                        | Description   |
|-------------------------------------|---|
| Personal Protective Equipment (PPE) | <ul style="list-style-type: none"> <li>• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.</li> </ul> |
| Consumables                         | <ul style="list-style-type: none"> <li>• Lint-free cleaning cloths</li> <li>• Thin disposable gloves</li> </ul>                                       |
| Parts                               | <ul style="list-style-type: none"> <li>• Air filters (if fitted)</li> <li>• Air filter sealing gaskets (if fitted)</li> </ul>                         |
| Tools                               | <ul style="list-style-type: none"> <li>• None</li> </ul>  |

## 8.4.4 Inspect and Clean

1. Inspect the fan for damaged vanes and cracks.
2. Remove air filters (at the fan and terminal box, if fitted) from their frames.
3. Wash and dry the air filters and gaskets to remove contaminant particles.
4. Inspect the filters and gaskets for damage and replace, as necessary.
5. Install the filters and gaskets.
6. Reinstall the generator set for running.
7. Make sure the air inlets and outlets are not blocked.

## 8.5 Coupling

### 8.5.1 Introduction

Efficient operation and long component life rely on minimizing mechanical stresses on the alternator. When coupled in a generator set, misalignment and vibration interactions with the prime mover engine can cause mechanical stress.

The rotational axes of alternator rotor and engine output shaft must be coaxial (radial and angular alignment).

Torsional vibration can cause damage to internal combustion engine shaft-driven systems, if not controlled. The generator set manufacturer is responsible for assessing the effect of torsional vibration on the alternator: Rotor dimensions and inertia, and coupling details are available on request.

### 8.5.2 Safety

#### NOTICE

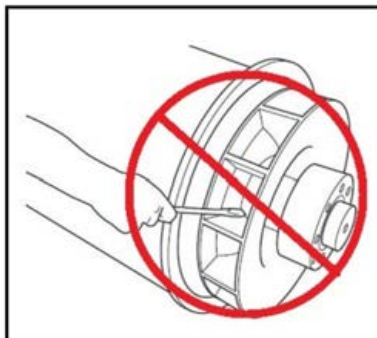
**Do not attempt to rotate the alternator rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.**

#### ⚠ WARNING

##### ***Coupling an Alternator***

***Moving mechanical parts during coupling can cause serious injury by crushing, severing or trapping. When coupling the alternator to a prime-mover or when installing large components, to prevent injury:***

- ***Personnel must keep limbs and body parts away from coupling surfaces during coupling and/or installing operations.***



**FIGURE 28. DO NOT ROTATE THE ALTERNATOR ROTOR WITH A LEVER**

## 8.5.3 Coupling Test Requirements

TABLE 15. COUPLING TEST REQUIREMENTS

| Requirements                        | Description   |
|-------------------------------------|---|
| Personal Protective Equipment (PPE) | <ul style="list-style-type: none"> <li>Wear appropriate protective equipment as directed by site rules and risk assessment requirements.</li> </ul> |
| Consumables                         | <ul style="list-style-type: none"> <li>None</li> </ul>  |
| Parts                               | <ul style="list-style-type: none"> <li>None</li> </ul>  |
| Tools                               | <ul style="list-style-type: none"> <li>Dial gauge</li> <li>Torque wrench</li> </ul>   |

## 8.5.4 Inspect Mounting Points

1. Check the generator set bedplate and mounting pads are in good condition, not cracked.
2. Check that rubber in anti-vibration mounts has not perished.
3. Check vibration monitoring historical records for a trend of increasing vibration.

### 8.5.4.1 Single Bearing Coupling

1. Remove the DE adaptor screen and cover to access the coupling.
2. Check that the coupling discs are not damaged, cracked or distorted, and the coupling disc holes are not elongated. If any are damaged, replace the complete set of discs.
3. Check tightness of bolts fixing the coupling discs to the engine flywheel. Tighten in the sequence shown for alternator coupling in the Installation chapter, to the torque recommended by the engine manufacturer.
4. Replace the DE adaptor screen and drip proof cover.

## 8.6 Rectifier System

### 8.6.1 Introduction

The rectifier converts alternating current (AC) induced in the exciter rotor windings into direct current (DC) to magnetize the main rotor poles. The rectifier comprises two semicircular annular positive and negative plates, each with three diodes. In addition to connecting to the main rotor, the DC output of the rectifier also connects to a matched pair of varistors (one at each end of the plates) and two pairs of resistors, if fitted (mounted into holes in the exciter rotor). These additional components protect the rectifier from voltage spikes and surge voltages that may be present on the rotor under various loading conditions of the alternator.

Diodes provide a low resistance to current in one direction only: Positive current will flow from anode to cathode, or another way of viewing it is that negative current will flow from cathode to anode.

The exciter rotor windings are connected to 3 diode anodes to form the positive plate and to 3 diode cathodes to form the negative plate to give full wave rectification from AC to DC. The rectifier is mounted on, and rotates with, the exciter rotor at the non-drive end (NDE).

## 8.6.2 Safety

**⚠ DANGER**

**Live Electrical Conductors**  
*Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:*

- *Shut down and isolate the alternator from all energy sources.*
- *Remove or isolate stored energy.*
- *Test isolated parts for electrical isolation using a suitable voltage tester.*
- *Use lock out/tag out safety procedures.*

**⚠ DANGER**

**Rotating Mechanical Parts**  
*Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping. To prevent injury:*

- *Before operating the alternator: The rotating coupling between the alternator and prime mover must be covered by a guard or cover.*
- *Before attempting service or maintenance tasks or removing covers from rotating parts: Shut down and isolate the generator set from all energy sources, isolate stored energy and use lock out/tag out safety procedures.*

**⚠ WARNING**

**Incorrect Electrical Installation and System Protection**  
*Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:*

- *Have completed related, applicable and approved training.*
- *Know the equipment, understand the task(s) and procedure(s).*
- *Know related hazards / risks.*
- *Know and obey site / location specific emergency procedures and applicable laws and regulations.*

## 8.6.3 Requirements

**TABLE 16. RECTIFIER SYSTEM: TEST AND REPLACE COMPONENT REQUIREMENTS**

|                                     |   |
|-------------------------------------|---|
| Personal Protective Equipment (PPE) | <ul style="list-style-type: none"> <li>• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.</li> </ul>   |
| Consumables                         | <ul style="list-style-type: none"> <li>• Dow Corning Silicone heat sink compound type 340 or similar.</li> <li>• Duralco 4461N Amber Electrically Resistant Epoxy [Part: 030-02668]. If Resistors are fitted.</li> <li>• Vidaflex 942 Acrylic 3mm sleeving [Part: 030-01548]. If Resistors are fitted.</li> <li>• Vidaflex 942 Acrylic 5mm sleeving [Part: 030-01550]. If Resistors are fitted.</li> <li>• Sumitube B2 Polyolefin heat shrink 9.5mm tubing [Part: 030-04179]. If Resistors are fitted.</li> </ul> |



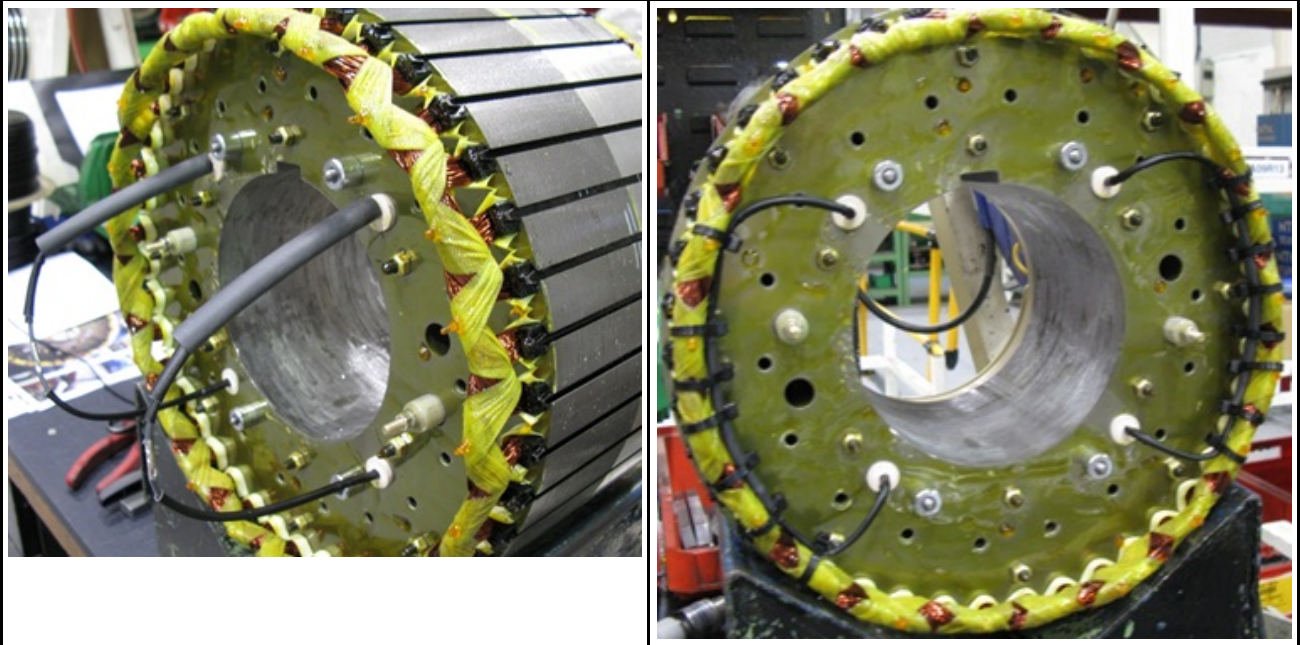
|       |  |
|-------|--|
| Parts | <ul style="list-style-type: none"> <li>• Kit of three Anode lead Diodes and three Cathode lead Diodes (all from the same manufacturer).</li> <li>• Kit of two metal-oxide Varistors (same type, same manufacturer, same voltage grading: A, B, C, D, E, F).</li> <li>• Kit of four Snubber Resistors (same type, same manufacturer). If fitted.</li> </ul> |
| Tools | <ul style="list-style-type: none"> <li>• Multimeter.</li> <li>• Insulation tester.</li> <li>• Torque wrench.</li> <li>• Resistor removal tool. If Resistors are fitted.</li> <li>• Hammer. If Resistors are fitted.</li> <li>• Round file. If Resistors are fitted.</li> </ul>   |

## 8.6.4 Test and Replace Resistors - If Fitted

1. Inspect the visible ends of all four resistors.
2. Resistor is faulty if there are any signs of discoloration or overheating.
3. Break the electrical circuit by removing fasteners from one resistor of each pair. Store fasteners and washers.
4. Measure the total resistance of both resistor pairs, using the ohms range of a digital multimeter.
5. Resistors are faulty if the total resistance of a resistor pair is outside the range  $160 \Omega \pm 10 \%$ .
6. If resistors are faulty, replace all four resistors:
  - a. Remove the fasteners from the existing resistors.
  - b. Label and disconnect the six exciter rotor winding leads at the insulated terminal posts.
  - c. Label and disconnect the two main rotor winding leads at the terminals on the rectifier plate.
  - d. Disconnect a lead from both varistors to allow the rectifier plates to be removed separately.
  - e. Note the rotational position of the rectifier plates. Use a 5 mm Allen key to remove four M6 x 120 fasteners and both plates (complete with diodes) from the exciter rotor.
  - f. Cut the leads and connecting the bases of both resistor pairs.
  - g. Remove each resistor:
    - i. Resistors may disintegrate during removal. Position covers and vacuum extraction to collect any ceramic fragments.
    - ii. At the NDE, align the cylindrical removal tool squarely over the threaded terminal and onto the ceramic body of the resistor.
    - iii. Strike the free end of the tool sharply with a hammer to break the glue seal and then drive the resistor out of the hole towards the drive end.
  - h. Use a round file to remove resin from the rotor core holes. Clean with a lint-free cloth.
  - i. Loose fit a replacement resistor into each cleaned hole to check that all resin has been removed.
  - j. Apply 2 gm of epoxy and insert a replacement resistor into a rotor core hole, threaded post towards the rectifier plate position. Rotate the resistor to coat its surface evenly. Position the resistor so its base protrudes 3 mm from the core.
  - k. Repeat with the remaining three replacement resistors.
  - l. Leave the epoxy to cure.

- m. Fit a nut and a spring and flat washer on the M6 threaded post of each resistor.
- n. Refit the complete rectifier assembly onto the exciter rotor.
- o. Apply thread lock and fit a flat washer and stover nut on the M6 threaded post of each resistor. Ensure good electrical contact with the rectifier plate.
- p. Refer to the images and the steps below to finish and secure the resistor leads.

**TABLE 17. RESISTOR LEAD CONNECTIONS**



- q. Sleeve each resistor lead with 3 x 130 mm Vidaflex 942.
  - r. Sleeve two of the resistor leads (which are electrically connected through the rectifier plate) with 5 x 70 mm Vidaflex 942 and 9.5 x 100 mm heat shrink tubing (030-04179).
  - s. Connect by a crimped ferrule (003-09103) with the remaining resistor leads (electrically connected on the other rectifier plate) as shown.
  - t. Slide the 5 x 70 mm Vidaflex 942 and 9.5 x 100 mm heat shrink tubing over the ferrule and shrink the tube by heating.
  - u. Secure both lead assemblies to the inside of the exciter rotor windings with seven heat-stabilized cable ties (052-45017). Position the cable tie heads to the inside.
7. Replace both varistors with a matching pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F) (see below).
  8. Replace all diodes (see below).
  9. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

## 8.6.5 Test and Replace Varistors

1. Inspect both varistors.
2. Record varistor as faulty if there are signs of overheating (discoloration, blisters, melting) or disintegration. Check for loose connectors vs. varistor body.
3. Disconnect the varistor leads.
4. A serviceable varistor will read open circuit in both directions using a multimeter (set in the Ohms ( $\Omega$ ) range). A faulty varistor can read short circuit in both directions and/or it may be physically damaged.

5. If either varistor is faulty, replace both varistors with a matched pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F) and replace all diodes.
6. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

## 8.6.6 Test and Replace Diodes

### NOTICE

**Do not tighten a diode above the stated torque. The diode will be damaged.**

1. Disconnect the lead of one diode where it joins the windings at the insulated terminal post. Store fastener and washers.
2. Measure the voltage drop across the diode in the forward direction, using the diode test function of a multimeter.
3. Measure the resistance across the diode in the reverse direction, using the 1000 VDC test voltage of an insulation tester.
4. Diode is faulty if the voltage drop in the forward direction is outside the range 0.3–0.9 VDC, or the resistance is below 20 M $\Omega$  in the reverse direction.
5. Repeat the tests for the five remaining diodes.
6. If any diode is faulty, replace the full set of six diodes (same type, same manufacturer):
  - a. Remove diode(s).
  - b. Apply a small amount of heat sink compound **only** to the base of the replacement diode(s), not the threads.
  - c. Check polarity of diode(s).
  - d. Screw each replacement diode into a threaded hole in the rectifier plate.
  - e. Apply 2.6–3.1 Nm (23–27.4 in-lb) torque to give good mechanical, electrical and thermal contact.
  - f. Replace both varistors with a matched pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F)
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

## 8.7 Temperature Sensors

### 8.7.1 Introduction

The alternators are designed to meet standards supporting EU Safety Directives, and recommended operating temperatures. Temperature sensors (where fitted) detect abnormal overheating of the main stator windings and bearing(s). Sensors are of Resistance Temperature Detector (RTD) type, with three wires terminated at a terminal block in the auxiliary terminal box. The resistance of Platinum (PT100) RTD sensors increases linearly with temperature.

**TABLE 18. RESISTANCE (Ω) OF PT100 SENSOR BETWEEN 40 TO 180 °C**

| Temperature (°C) |        | +1 °C  | + 2 °C | +3 °C  | + 4 °C | + 5 °C | + 6 °C | + 7 °C | + 8 °C | + 9 °C |
|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 40.00            | 115.54 | 115.93 | 116.31 | 116.70 | 117.08 | 117.47 | 117.86 | 118.24 | 118.63 | 119.01 |
| 50.00            | 119.40 | 119.78 | 120.17 | 120.55 | 120.94 | 121.32 | 121.71 | 122.09 | 122.47 | 122.86 |
| 60.00            | 123.24 | 123.63 | 124.01 | 124.39 | 124.78 | 125.16 | 125.54 | 125.93 | 126.31 | 126.69 |
| 70.00            | 127.08 | 127.46 | 127.84 | 128.22 | 128.61 | 128.99 | 129.37 | 129.75 | 130.13 | 130.52 |
| 80.00            | 130.90 | 131.28 | 131.66 | 132.04 | 132.42 | 132.80 | 133.18 | 133.57 | 133.95 | 134.33 |
| 90.00            | 134.71 | 135.09 | 135.47 | 135.85 | 136.23 | 136.61 | 136.99 | 137.37 | 137.75 | 138.13 |
| 100.00           | 138.51 | 138.88 | 139.26 | 139.64 | 140.02 | 140.40 | 140.78 | 141.16 | 141.54 | 141.91 |
| 110.00           | 142.29 | 142.67 | 143.05 | 143.43 | 143.80 | 144.18 | 144.56 | 144.94 | 145.31 | 145.69 |
| 120.00           | 146.07 | 146.44 | 146.82 | 147.20 | 147.57 | 147.95 | 148.33 | 148.70 | 149.08 | 149.46 |
| 130.00           | 149.83 | 150.21 | 150.58 | 150.96 | 151.33 | 151.71 | 152.08 | 152.46 | 152.83 | 153.21 |
| 140.00           | 153.58 | 153.96 | 154.33 | 154.71 | 155.08 | 155.46 | 155.83 | 156.20 | 156.58 | 156.95 |
| 150.00           | 157.33 | 157.70 | 158.07 | 158.45 | 158.82 | 159.19 | 159.56 | 159.94 | 160.31 | 160.68 |
| 160.00           | 161.05 | 161.43 | 161.80 | 162.17 | 162.54 | 162.91 | 163.29 | 163.66 | 164.03 | 164.40 |
| 170.00           | 164.77 | 165.14 | 165.51 | 165.89 | 166.26 | 166.63 | 167.00 | 167.37 | 167.74 | 168.11 |
| 180.00           | 168.48 | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    |

Customer-supplied external equipment may be connected to monitor the sensors and generate signals to raise an alarm and to shut down the generator set.

**BS EN 60085 (≅ IEC 60085) Electrical insulation – Thermal Evaluation and Designation** classifies insulation of windings by the maximum operating temperature for a reasonable service life. To avoid damage to windings, signals should be set, appropriate to the insulation class shown on the alternator rating plate.

**TABLE 19. ALARM AND SHUTDOWN TEMPERATURE SETTINGS FOR WINDINGS**

| Windings insulation | Max. Continuous temperature (°C) | Alarm temperature (°C) | Shutdown temperature (°C) |
|---------------------|----------------------------------|------------------------|---------------------------|
| Class B             | 130                              | 120                    | 140                       |
| Class F             | 155                              | 145                    | 165                       |
| Class H             | 180                              | 170                    | 190                       |

To detect overheating of bearings, control signals should be set according to the following table.

**TABLE 20. ALARM AND SHUTDOWN TEMPERATURE SETTINGS FOR BEARINGS**

| Bearings              | Alarm temperature (°C) | Shutdown temperature (°C) |
|-----------------------|------------------------|---------------------------|
| Drive end bearing     | 45 + maximum ambient   | 50 + maximum ambient      |
| Non-drive end bearing | 40 + maximum ambient   | 45 + maximum ambient      |

## 8.7.2 Safety

### DANGER

#### *Live Electrical Conductors*

*Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:*

- *Shut down and isolate the alternator from all energy sources.*
- *Remove or isolate stored energy.*
- *Test isolated parts for electrical isolation using a suitable voltage tester.*
- *Use lock out/tag out safety procedures.*

### WARNING

#### *Hot Surfaces and Fire*

*Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:*

- *Avoid contact with hot surfaces.*
- *Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.*
- *Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).*
- *Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.*

## 8.7.3 Test RTD Temperature Sensors

1. Remove the auxiliary terminal box lid.
2. Identify the sensor leads at the terminal block and where each sensor is fitted.
3. Measure the resistance between the white and each red wire of one sensor.
4. Calculate the sensor temperature from the measured resistance.
5. Compare calculated temperature with temperature indicated by external monitoring equipment (if available).
6. Compare alarm and shutdown signal settings (if available) with recommended settings.
7. Repeat steps 3 to 7 for each sensor.
8. Refit the auxiliary terminal box lid.
9. Replace any faulty sensors.
10. Note: Main stator RTD are not replaceable. Bearing RTD are replaceable.

## 8.8 Windings

### 8.8.1 Introduction

#### NOTICE

**Disconnect all control wiring and customer load leads from alternator winding connections before conducting these tests.**

| <b>NOTICE</b>  |
|--|
| <p><b>The Automatic Voltage Regulator (AVR) contains electronic components which would be damaged by high voltage applied during insulation resistance tests. The AVR must be disconnected before doing any insulation resistance test. Temperature sensors must be grounded to earth before doing any insulation resistance test.</b></p> <p><b>Damp or dirty windings have a lower electrical resistance and could be damaged by insulation resistance tests at high voltage. If in doubt, test the resistance at low voltage (500 V) first.</b></p> |

Alternator performance depends on good electrical insulation of the windings. Electrical, mechanical and thermal stresses, and chemical and environmental contamination, cause the insulation to degrade. Various diagnostic tests indicate the condition of insulation by charging or discharging a test voltage on isolated windings, measuring current flow, and calculating the electrical resistance by Ohm's law.

When a DC test voltage is first applied, three currents can flow:

- **Capacitive Current:** To charge the winding to the test voltage (decays to zero in seconds),
- **Polarizing Current:** To align the insulation molecules to the applied electric field (decays to near-zero in ten minutes), and
- **Leakage Current:** Discharge to earth where the insulation resistance is lowered by moisture and contamination (increases to a constant in seconds).

For an insulation resistance test, a single measurement is made one minute after a DC test voltage is applied, when capacitive current has ended. For the polarization index test, a second measurement is made after ten minutes. An acceptable result is where the second insulation resistance measurement is at least double the first, because the polarization current has decayed. In poor insulation, where leakage current dominates, the two values are similar. A dedicated Insulation Tester takes accurate, reliable measurements and may automate some tests.

## 8.8.2 Safety

| <b>⚠ DANGER</b>   |
|---|
| <p><b><i>Live Electrical Conductors</i></b></p> <p><b><i>Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:</i></b></p> <ul style="list-style-type: none"> <li>• <b><i>Shut down and isolate the alternator from all energy sources.</i></b></li> <li>• <b><i>Remove or isolate stored energy.</i></b></li> <li>• <b><i>Test isolated parts for electrical isolation using a suitable voltage tester.</i></b></li> <li>• <b><i>Use lock out/tag out safety procedures.</i></b></li> </ul> |

| <b>⚠ DANGER</b>  |
|--|
| <p><b><i>Testing Live Electrical Conductors</i></b></p> <p><b><i>Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before testing on or near live electrical conductors:</i></b></p> <ul style="list-style-type: none"> <li>• <b><i>Take applicable precautions to prevent contact with live conductors, refer to: Safety Precautions Chapter.</i></b></li> <li>• <b><i>Test on or near live conductors, only if absolutely necessary.</i></b></li> <li>• <b><i>Only trained personnel may test on or near live electrical conductors.</i></b></li> <li>• <b><i>Do not test on or near live electrical conductors alone: Another competent person must be present, trained to isolate energy sources and take action in an emergency.</i></b></li> </ul> |

**⚠ WARNING****Condensed Water**

**Operating an alternator with condensed water in the windings can cause serious injury by electric shock, burns or exposure to flying debris and particles. To prevent injury and before operating the alternator:**

- **Use anti-condensation heaters (if fitted) to prevent condensation accumulating.**
- **Check for condensed water.**
- **If condensed water is present, drain/remove the water, dry and inspect the alternator, refer to: Maintenance and Servicing Chapter.**

**⚠ WARNING****Exposure to Particles and Fumes from an Alternator.**

**Particles and fumes can be released in all directions (horizontally and vertically) from where alternator ventilation is installed. To avoid or injury:**

- **Avoid the areas around ventilation openings, air intake(s) and air outlet(s) when the alternator is operating.**
- **Use the correct personal protective equipment when working around an alternator.**

**⚠ WARNING****Live Electrical Conductors**

**Live electrical conductors at the winding terminals can cause serious injury or death by electric shock or burns. After an insulation resistance test, to prevent injury or death:**

- **Discharge the windings immediately after the test has concluded by shorting to a suitable earth. The windings must discharge for the greater of:**
  1. **A length of time equal to the duration of the test.**
  - or
  2. **5 minutes.**

**⚠ WARNING****Incorrect Electrical Installation and System Protection**

**Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:**

- **Have completed related, applicable and approved training.**
- **Know the equipment, understand the task(s) and procedure(s).**
- **Know related hazards / risks.**
- **Know and obey site / location specific emergency procedures and applicable laws and regulations.**

### 8.8.3 Requirements

TABLE 21. WINDING TEST REQUIREMENTS

| Requirement                         | Description   |
|-------------------------------------|---|
| Personal Protective Equipment (PPE) | <ul style="list-style-type: none"> <li>Wear appropriate protective equipment as directed by site rules and risk assessment requirements.</li> </ul>   |
| Consumables                         | <ul style="list-style-type: none"> <li>None</li> </ul>  |
| Parts                               | <ul style="list-style-type: none"> <li>None</li> </ul>  |
| Tools                               | <ul style="list-style-type: none"> <li>Insulation test meter</li> <li>Multimeter</li> <li>Milliohm meter or microohm meter</li> <li>Clamp ammeter</li> <li>Infrared thermometer</li> <li>Earth rod</li> </ul> |

### 8.8.4 Test the Electrical Resistance of Windings

1. Stop the alternator.
2. Verify the electrical resistance of the exciter field (stator) winding:
  - a. Disconnect the exciter field leads F1 and F2 from the AVR.
  - b. Measure and record the electrical resistance between F1 and F2 leads with a multimeter.
  - c. Reconnect the exciter field leads F1 and F2.
  - d. Make sure the fasteners are secure.
3. Verify the electrical resistance of the exciter armature (rotor) winding:
  - a. Mark the leads attached to diodes on one of the two rectifier plates.
  - b. Disconnect all exciter rotor leads from all diodes at the rectifier.
  - c. Measure and record the electrical resistance between pairs of marked leads (between phase windings). A specialist micro ohmmeter must be used.
  - d. Reconnect all exciter rotor leads to the diodes.
  - e. Make sure the fasteners are secure.
4. Verify the electrical resistance of the main field (rotor) winding:
  - a. Disconnect the two main rotor d.c. leads from the rectifier plates.
  - b. Measure and record the electrical resistance between the main rotor leads. A specialist micro ohmmeter must be used.
  - c. Reconnect the two main rotor d.c. leads to the rectifier plates.
  - d. Make sure the fasteners are secure.
5. Verify the electrical resistance of the main armature (stator) winding:
  - a. Disconnect the leads of the main stator from the output terminals.
  - b. Measure and record the electrical resistance between U1 and U2 leads and between U5 and U6 (if present). A specialist micro ohmmeter must be used.



- c. Measure and record the electrical resistance between V1 and V2 leads and between V5 and V6 (if present). A specialist micro ohmmeter must be used.
  - d. Measure and record the electrical resistance between W1 and W2 leads and between W5 and W6 (if present). A specialist micro ohmmeter must be used.
  - e. Reconnect the leads to the output terminals, as before.
  - f. Make sure the fasteners are secure.
6. Verify the electrical resistance of the PMG armature (stator) winding:
    - a. Disconnect the three PMG output leads P2, P3 and P4 from the AVR.
    - b. Measure and record the electrical resistance between pairs of the PMG output leads, with a multimeter.
    - c. Reconnect the three PMG output leads P2, P3 and P4 to the AVR.
    - d. Make sure the fasteners are secure.
  7. Refer to the winding resistance table in: [Chapter 10 on page 79](#) to verify the measured resistances of all windings agree with the reference values.

## 8.8.5 Test the Insulation Resistance of Windings

### NOTICE

The alternator must not be put into service until the minimum insulation resistance is achieved.

**TABLE 22. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS**

|  | Test Voltage (V) | Minimum Insulation Resistance at 1 minute (IR <sub>1min</sub> ) (MΩ) |            | Minimum Polarization Index (PI = (IR <sub>10min</sub> ) / (IR <sub>1min</sub> )) |
|--|------------------|--|------------|--|
|  |                  | New  | In-service |  |
| Low Voltage stators up to 1kV (each phase)     | 1000             | 10   | 5          | N/A  |
| PMG stator                                     | 500              | 5  | 3          | N/A  |
| Exciter stator                                 | 500              | 10   | 5          | N/A  |
| Exciter rotor, rectifier & main rotor combined | 1000             | 200  | 100        | N/A  |

1. Inspect the windings for mechanical damage or discoloration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. For Low Voltage (LV) main stators:
  - a. Disconnect the neutral to earth conductor (if fitted).
  - b. Connect together the three leads of all phase windings (if possible).
  - c. Apply the test voltage from the table between any phase lead and earth.
  - d. Measure the insulation resistance after 1 minute (IR1min).
  - e. Discharge the test voltage with an earth rod for five minutes.
  - f. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
  - g. Reconnect neutral to earth conductor (if fitted).

3. For PMG and exciter stators, and combined exciter and main rotors:
  - a. Connect together both ends of the winding (if possible).
  - b. Apply the test voltage from the table between the winding and earth.
  - c. Measure the insulation resistance after 1 minute ( $IR_{1min}$ ).
  - d. Discharge the test voltage with an earth rod for five minutes.
  - e. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
  - f. Repeat the method for each winding.
  - g. Remove the connections made for testing.

## 8.8.6 Dry the Insulation

Use the methods below to dry the insulation of the main stator windings. To prevent damage as water vapor is expelled from the insulation, make sure the winding temperature does not increase faster than 5 °C per hour or exceed 90 °C.

Plot the insulation resistance graph to show when drying is complete.

### 8.8.6.1 Dry with Ambient Air

In many cases, the alternator can be dried sufficiently using its own cooling system. Disconnect the cables from the X+ (F1) and XX- (F2) terminals of the AVR so there is no excitation voltage supply to the exciter stator. Run the generator set in this de-excited state. Air must flow freely through the alternator to remove the moisture. Operate the anti-condensation heater (if fitted) to assist the drying effect of the air flow.

After drying is complete, re-connect the cables between the exciter stator and AVR. If the generator set is not put into service immediately, turn on the anti-condensation heater (if fitted) and retest the insulation resistance before use.

### 8.8.6.2 Dry with Hot Air

Direct the hot air from one or two 1 to 3 kW electrical fan heaters into the alternator air inlet. Make sure each heat source at least 300 mm away from the windings to avoid scorching or over-heating damage to the insulation. Air must flow freely through the alternator to remove the moisture.

After drying, remove the fan heaters and re-commission as appropriate.

If the generator set is not put into service immediately, turn on the anti-condensation heaters (where fitted) and retest the insulation resistance before use.

### 8.8.6.3 Short Circuit Method

#### DANGER

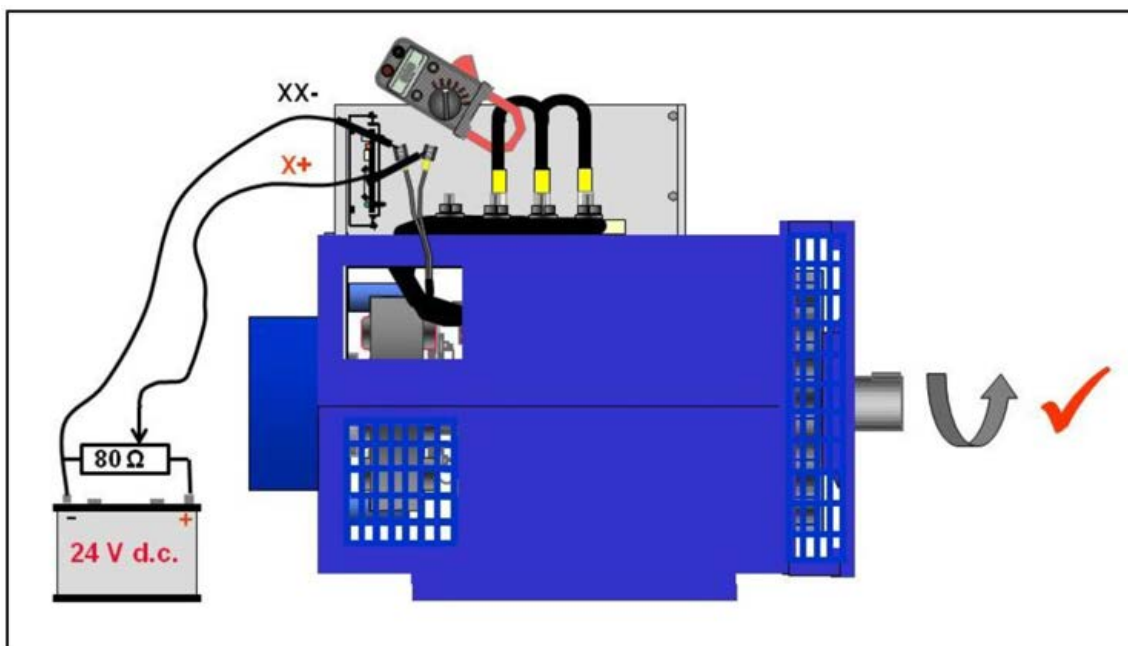
##### ***Live Electrical Conductors***

***Live electrical conductors at output and AVR terminals and AVR heat sink can cause serious injury or death by electric shock and burns.***

***Some winding designs may produce a voltage between the three shorted phases and neutral. To prevent injury, do not touch the phase or neutral terminals during the short circuit run.***

#### NOTICE

**The short circuit must not be applied with the AVR connected in circuit. Current in excess of the rated alternator current will cause damage to the windings.**

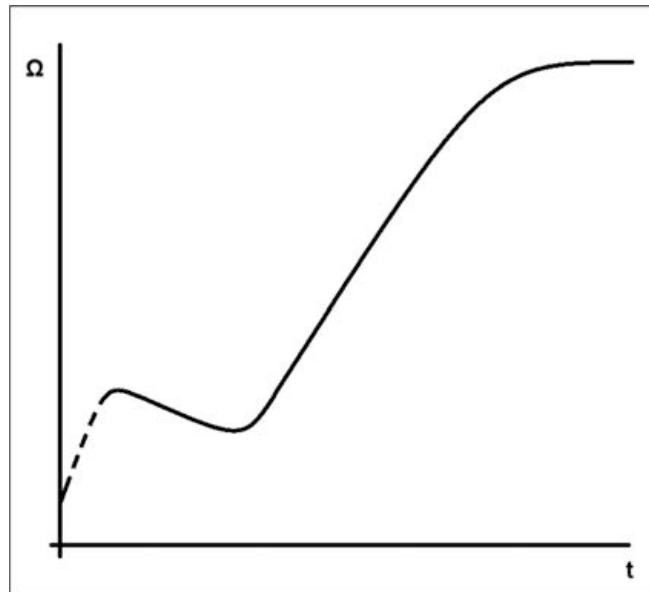


**FIGURE 29. SHORT CIRCUIT METHOD**

1. Bolt a shorting link, capable of taking full load current, across the main load terminals of the alternator.
2. Disconnect the exciter stator cables from terminals X+ (F1) and XX- (F2) of the AVR.
3. Connect a variable 0 to 24 VDC external supply, of 2 A current capacity, to the exciter stator cables: positive to X+ (F1) cable and negative to XX- (F2) cable.
4. Position a clamp ammeter to measure the AC current in the shorting link.
5. Set the DC supply voltage to zero and start the generator set. Slowly increase the DC voltage to pass current through the exciter stator winding. As the excitation current increases, so does the main stator current which flows through the shorting link. The measured current must not exceed 80% of the rated output current of the alternator.
6. Before every measurement of insulation resistance, stop the alternator and remove the excitation supply.
7. After drying is complete, remove the external supply, remove the shorting link and re-connect the exciter stator cables at the AVR.
8. If the generator set is not put into service immediately, turn on the anti-condensation heaters (where fitted) and retest the insulation resistance before use.

#### 8.8.6.4 Plot IR Graph

Whichever method is used to dry out the alternator, measure the insulation resistance and temperature (if sensors fitted) of the main stator windings every 15 to 30 minutes. Plot a graph of insulation resistance, IR (y axis) against time, t (x axis).



**FIGURE 30. INSULATION RESISTANCE GRAPH**

A typical curve shows an initial increase in resistance, a fall and then a gradual rise to a steady state. If the windings are only slightly damp the dotted portion of the curve may not appear. Continue drying for another hour after steady state is reached.

**NOTICE**

**The alternator must not be put into service until the minimum insulation resistance is achieved.**

# 9 Parts Identification

## 9.1 S9 Low Voltage Single Bearing Alternator

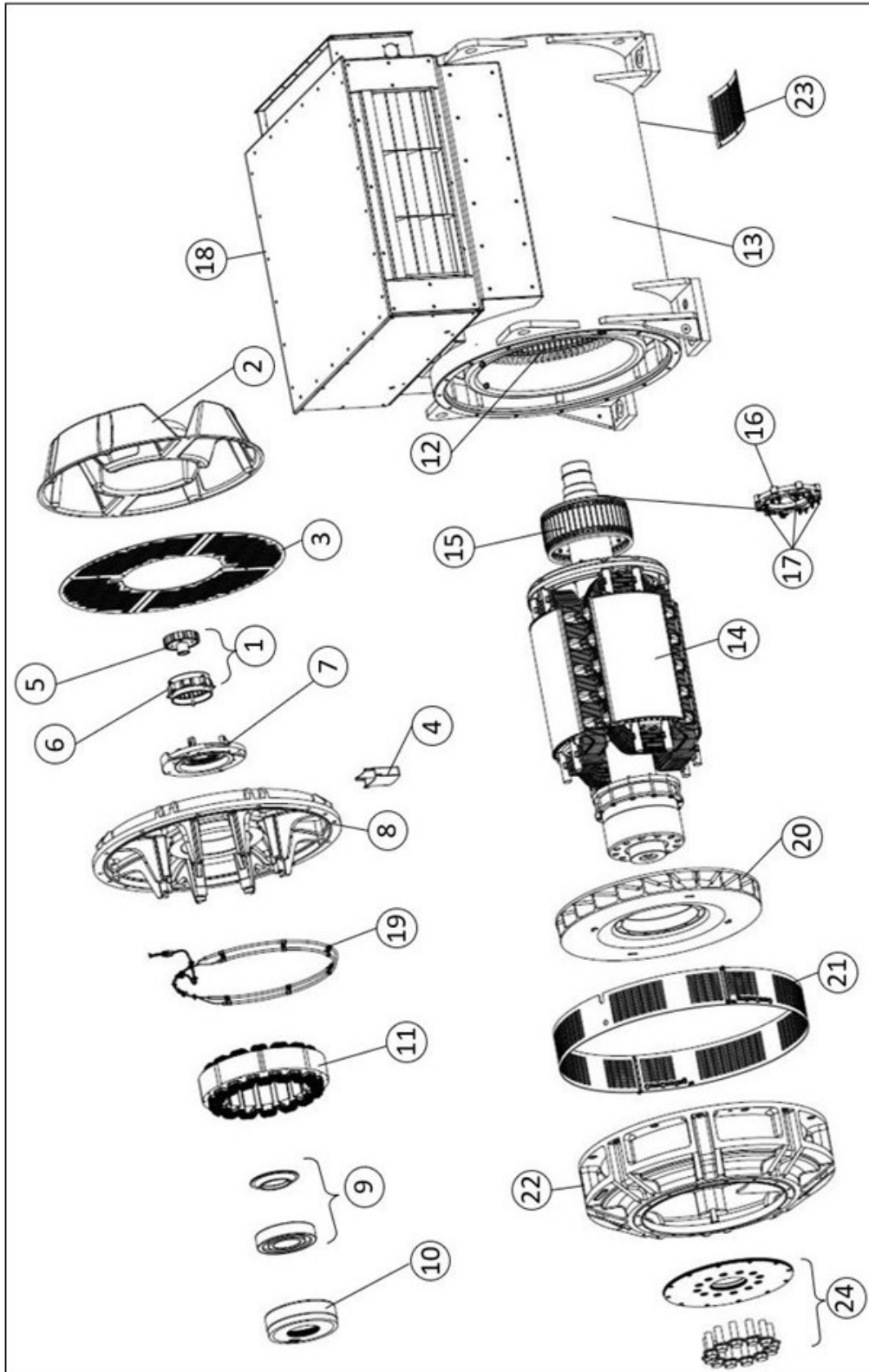


FIGURE 31. S9 LOW VOLTAGE SINGLE BEARING ALTERNATOR

## 9.2 S9 Low Voltage Single Bearing Parts and Fasteners

TABLE 23. S9 LOW VOLTAGE SINGLE BEARING PARTS AND FASTENERS

| Reference | Component                            | Fastener      | Quantity | Torque (Nm) |
|-----------|--------------------------------------|---------------|----------|-------------|
| 1         | Complete PMG Parts                   | N/A           | N/A      | N/A         |
| 2         | Air Inlet Cover                      | M8 x 20       | 14       | 10          |
| 3         | Air Inlet Screen (Axial)             | M8 x 14       | 3        | 25          |
| 4         | Grease Trap                          | M8 x 14       | 2        | 25          |
| 5         | PMG Rotor                            | M10 x 100     | 1        | 48          |
| 6         | PMG Stator                           | M6 x 45       | 4        | 10          |
| 7         | NDE Bearing Cap (C-D Cores)          | M10 x 50      | 4        | 48          |
| 8         | NDE Bracket (173 kg)                 | M16 x 55      | 12       | 206         |
| 9         | NDE Bearing                          | N/A           | N/A      | N/A         |
| 10        | NDE Bearing Cartridge (C-D Cores)    | M10 x 50      | 6        | 48          |
| 11        | Exciter Stator (C-D Cores)           | M8 x 120      | 8        | 25          |
| 12        | Main Stator                          | N/A           | N/A      | N/A         |
| 13        | Main Frame                           | N/A           | N/A      | N/A         |
| 14        | Main Rotor                           | N/A           | N/A      | N/A         |
| 15        | Exciter Rotor                        | N/A           | N/A      | N/A         |
| 16        | Rectifier Assembly                   | M8 Stover Nut | 8        | 20          |
| 17        | Diode/Varistor                       | N/A           | N/A      | N/A         |
| 18        | Terminal Box                         | N/A           | N/A      | N/A         |
| 19        | Anti-condensation Heaters            | M6 x 20       | 8        | 10          |
| 20        | Fan                                  | M10 x 100     | 12       | 45          |
| 21        | DE Air Outlet Screen                 | M8 x 25       | 4        | 25          |
| 22        | DE Adapter (1 Bearing)               | M16 x 55      | 16       | 206         |
| 23        | NDE Air Inlet Screen (Radial)        | M8 x 14       | 6        | 25          |
| 24        | DE Coupling Discs (1 Bearing) SAE 18 | M30 x 90      | 12       | 1350        |
| 24        | DE Coupling Discs (1 Bearing) SAE 21 | M30 x 70      | 12       | 1350        |

## 9.3 S9 Low Voltage Two Bearing Alternator

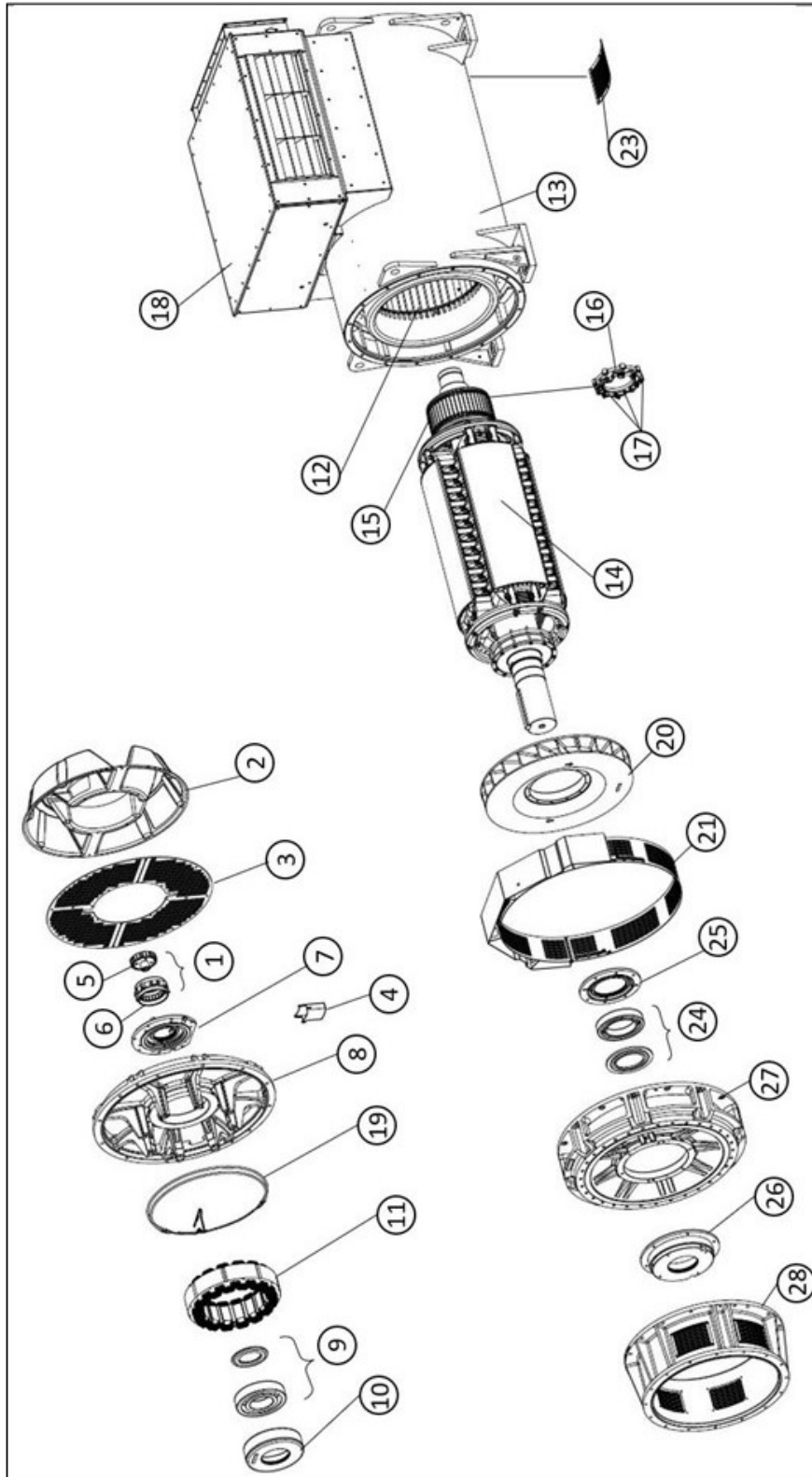


FIGURE 32. S9 LOW VOLTAGE TWO BEARING ALTERNATOR

## 9.4 S9 Low Voltage Two Bearing Parts and Fasteners

TABLE 24. S9 LOW VOLTAGE TWO BEARING PARTS AND FASTENERS

| Reference | Component                                  | Fastener      | Quantity | Torque (Nm) |
|-----------|--|---------------|----------|-------------|
| 1         | Complete PMG Parts                         | N/A           | N/A      | N/A         |
| 2         | Air Inlet Cover                            | M8 x 20       | 14       | 10          |
| 3         | Air Inlet Screen (Axial)                   | M8 x 14       | 3        | 25          |
| 4         | Grease Trap                                | M8 x 14       | 2        | 25          |
| 5         | PMG Rotor                                  | M10 x 100     | 1        | 48          |
| 6         | PMG Stator                                 | M6 x 45       | 4        | 10          |
| 7         | NDE Bearing Cap (C-F Cores)                | M10 x 50      | 4        | 48          |
| 7         | NDE Bearing Cap (G Core)                   | M12 x 50      | 7        | 84          |
| 8         | NDE Bracket (173 kg)                       | M16 x 55      | 12       | 206         |
| 9         | NDE Bearing                                | N/A           | N/A      | N/A         |
| 10        | NDE Bearing Cartridge (C-F Cores)          | M10 x 50      | 6        | 48          |
| 10        | NDE Bearing Cartridge (G Core)             | M12 x 50      | 6        | 84          |
| 11        | Exciter Stator (C-D Cores)                 | M8 x 120      | 8        | 25          |
| 11        | Exciter Stator (E-G Cores)                 | M8 x 150      | 8        | 25          |
| 12        | Main Stator                                | N/A           | N/A      | N/A         |
| 13        | Main Frame                                 | N/A           | N/A      | N/A         |
| 14        | Main Rotor                                 | N/A           | N/A      | N/A         |
| 15        | Exciter Rotor                              | N/A           | N/A      | N/A         |
| 16        | Rectifier Assembly                         | M8 Stover Nut | 8        | 20          |
| 17        | Diode/Varistor                             | N/A           | N/A      | N/A         |
| 18        | Terminal Box                               | N/A           | N/A      | N/A         |
| 19        | Anti-condensation Heaters                  | M6 x 20       | 8        | 10          |
| 20        | Fan  | M10 x 100     | 12       | 45          |
| 21        | DE Air Outlet Screen                       | M8 x 25       | 4        | 25          |
| 22        | DE Adapter (1 Bearing)                     | M16 x 55      | 16       | 206         |
| 23        | NDE Air Inlet Screen (Radial)              | M8 x 14       | 6        | 25          |
| 24        | DE Bearing (2 Bearing)                     | N/A           | N/A      | N/A         |
| 25        | DE Bearing Cartridge (2 bearing C-D cores) | M10 x 75      | 6        | 48          |
| 25        | DE Bearing Cartridge (2 bearing E-F cores) | M12 x 90      | 6        | 84          |
| 25        | DE Bearing Cartridge (2 bearing G cores)   | M12 x 75      | 6        | 84          |
| 26        | DE Bearing Cap (2 bearing C-D cores)       | M10 x 45      | 6        | 48          |
| 26        | DE Bearing Cap (2 bearing E-F cores)       | M10 x 45      | 6        | 48          |
| 26        | DE Bearing Cap (2 bearing G core)          | M10 x 120     | 4        | 48          |



| Reference | Component              | Fastener | Quantity | Torque (Nm) |
|-----------|------------------------|----------|----------|-------------|
| 27        | DE Bracket (2 bearing) | M16 x 55 | 16       | 206         |
| 28        | De Adapter (2 bearing) | M16 x 60 | 16       | 206         |

## 9.5 S9 Low Voltage Terminal Box

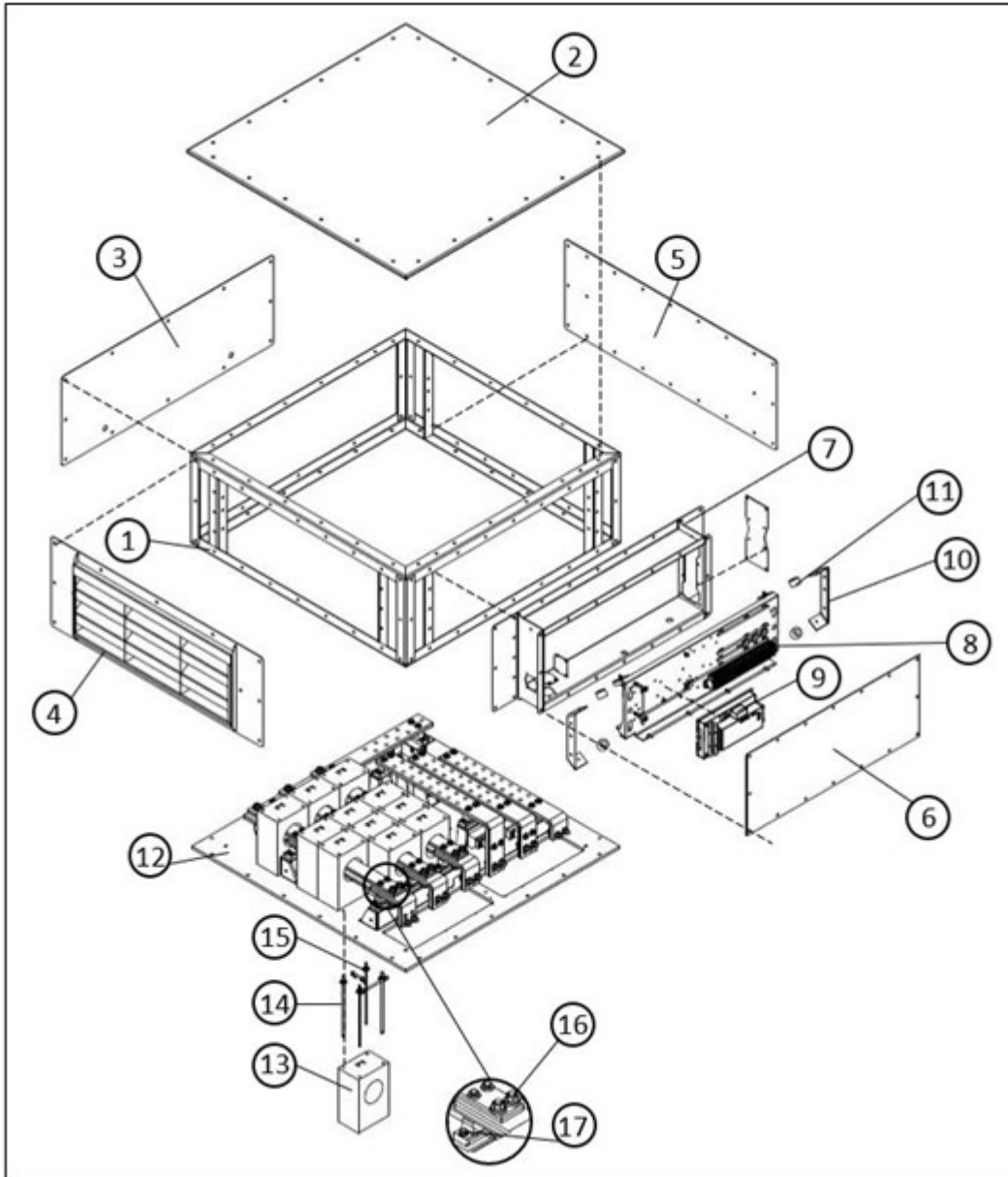


FIGURE 33. S9 LOW VOLTAGE TERMINAL BOX

## 9.6 S9 Low Voltage Terminal Box Parts and Fasteners

TABLE 25. S9 LOW VOLTAGE TERMINAL BOX PARTS AND FASTENERS

| Reference | Component                                 | Fastener | Torque (Nm) |
|-----------|---|----------|-------------|
| 1         | Terminal Box Frame                        | M8 x 25  | 25          |
| 2         | Terminal Box Lid                          | M8 x 25  | 25          |
| 3         | Terminal Box Panel                        | M8 x 25  | 25          |
| 4         | Terminal Box Louvered Panel               | M8 x 25  | 25          |
| 5         | Gland Plate                               | M8 x 25  | 25          |
| 6         | Auxiliary Terminal Box Cover              | M8 x 25  | 30          |
| 7         | Auxiliary Terminal Box                    | M8 x 25  | 30          |
| 8         | Auxiliary Terminal Box Panel              | M8 x 25  | 30          |
| 9         | Automatic Voltage Regulator (AVR)         | M8 x 16  | 12          |
| 10        | Anti-Vibration Mount (AVM) Fixing Bracket | M6       | 12          |
| 11        | AVM                                       | ...      | ...         |
| 12        | Terminal Box Base Plate                   | M8 x 35  | 30          |
| 13        | Current Transformer (CT)                  | ...      | ...         |
| 14        | CT Stud                                   | ...      | ...         |
| 15        | CT Nut                                    | M8       | 22          |
| 16        | Bus Bar Fixing Screw                      | M8 x 55  | 30          |

# 10 Technical Data

## NOTICE

Compare measurements with the technical data sheet and the test certificate supplied with the alternator.

## 10.1 S9 Low Voltage Winding Resistances

TABLE 26. S9 LOW VOLTAGE WINDING RESISTANCES (2/3 PITCH)

| Alternator        | Resistance of windings at 22 °C (measured values should be within 10%) |                             |                                   |                         |                                |               |
|-------------------|--|-----------------------------|-----------------------------------|-------------------------|--------------------------------|---------------|
|                   | (U1-U2)<br>(V1-V2)<br>(W1-W2)  | Exciter<br>Stator<br>(Ohms) | Exciter<br>Rotor<br>L-L<br>(Ohms) | Main<br>Rotor<br>(Ohms) | PMG<br>Stator<br>L-L<br>(Ohms) | Amb.<br>Temp. |
| <b>S9L1D - C4</b> | 0.000530   | 13.8                        | 0.0603                            | 1.304                   | 3.80                           | 22            |
| <b>S9L1D - D4</b> | 0.000440   | 13.8                        | 0.0603                            | 1.363                   | 3.80                           | 22            |
| <b>S9L1D - E4</b> | 0.0003292  | 16.1                        | 0.0683                            | 1.56                    | 3.80                           | 22            |
| <b>S9L1D - F4</b> | 0.000281   | 11.2                        | 0.0320                            | 0.741                   | 3.80                           | 22            |
| <b>S9L1D - G4</b> | 0.0002306  | 11.2                        | 0.0320                            | 0.829                   | 3.80                           | 22            |

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# 11 Service Parts

Servicing and repairing your alternator with genuine STAMFORD® or AvK® parts is critical to the life and reliability of the product. For further parts information and details of your nearest outlet visit [www.stamford-avk.com](http://www.stamford-avk.com).

## 11.1 Parts Orders

When ordering parts the machine serial number or machine identity number and type should be quoted, together with the part description. The machine serial number can be found on the name plate or frame.

## 11.2 Customer Service

CGT service engineers are experienced professionals, trained extensively to deliver the best support possible. Our global service offers:

- On-site a.c. alternator commissioning
- On-site bearing maintenance & bearing condition monitoring
- On-site insulation integrity checks
- On-site AVR & accessories set-up

For details of your nearest service outlet visit [www.stamford-avk.com](http://www.stamford-avk.com).

## 11.3 Recommended Service Parts

In critical applications a set of these service spares should be held with the alternator.

TABLE 27. S9 LV SERVICE PARTS

| Part   | Number      |
|--|-------------|
| DECS100-B11 (if fitted)  | A054S072    |
| DECS150 AVR (if fitted)  | A060B914    |
| DM110 AVR (if fitted)  | E000-23800  |
| UNITROL1010 (if fitted)  | Contact CGT |
| Rectifier replacement kit (6 diodes, 2 varistors)                              | A063M677    |
| PMG repair kit   | 45-1082     |
| Grease (400g)  | 45-0281     |
| <b>S9 1 Bearing</b>  |             |
| Regreasable NDE bearing kit complete with cap and cartridge (C-D core lengths) | 45-1118     |
| <b>S9 2 Bearing</b>  |             |
| Regreasable NDE bearing kit complete with cap and cartridge (C-F core lengths) | 45-1118     |
| Regreasable NDE bearing kit complete with cap and cartridge (G core lengths)   | A063M672    |

| <b>Part</b>   | <b>Number</b> |
|---|---------------|
| Regreasable DE bearing kit complete with cap and cartridge (C-D core lengths)           | 45-1119       |
| Regreasable DE bearing kit complete with cap and cartridge (E-F core lengths)           | 45-1120       |
| Regreasable DE bearing kit complete with caps and cartridge (G core lengths)            | A063M671      |
| Regreasable NDE and DE bearing kit complete with caps and cartridges (C-D core lengths) | 45-1151       |
| Regreasable NDE and DE bearing kit complete with caps and cartridges (E-F core lengths) | 45-1152       |
| Regreasable NDE and DE bearing kit complete with caps and cartridges (G core lengths)   | A063M674      |

## 11.4 Klüber Asonic GHY72 Grease

All bearings trials and calculated life expectancy are based on the use of Klüber Asonic GHY72.

# 12 End of Life Disposal

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## 12.1 General Guidance

When disposing of an alternator, component parts or packaging:

1. When processing waste materials obey applicable rules and regulations.
2. Process waste in an environmentally responsible manner, reuse, reclaim and/or recycle materials where applicable.
3. If necessary, speak to a waste processing company for advise and guidance.

## 12.2 Packaging Material

After the alternator, replacement components or service items have arrived, the packing material must be disposed of.

- Wooden packaging must be recycled. However, wood treated with preservative chemicals must be processed appropriately. **Do not burn chemically treated wood.**
- Plastic packaging must be recycled.
- Paper and cardboard packaging must be recycled.
- Anti-corrosion agents can be removed using a cleaning agent and a cloth. The cloth must be disposed as contaminated waste, refer to [Section 12.4 on page 84](#).
- Desiccants/drying agents must be disposed of as hazardous waste, refer to [Section 12.4 on page 84](#)

## 12.3 Recyclable Material

Separate items containing recyclable base materials, such as: iron, copper and steel, by removing non-recyclable and/or hazardous materials from alternator components.

- Items containing: iron, steel and copper can now be recycled via specialized material recycling companies.
- Separate the removed material into hazardous waste and non-hazardous waste. Obey applicable rules and regulations.
  - Dispose of any contaminated and/or hazardous materials as hazardous waste, refer to: [Section 12.4 on page 84](#).
  - Non-hazardous materials that cannot be reused, re-purposed or recycled can now be processed as general waste.

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## 12.4 Hazardous or Contaminated Waste

**⚠ CAUTION**

***Hazardous Substances***

***Hazardous substances can cause minor or moderate injury. Prolonged or repetitive exposure to hazardous substances can cause serious medical conditions. To prevent injury:***

- ***Always read and obey the instructions provided by the product manufacturer.***
- ***Use, handle and store substances as specified by the product manufacturer.***
- ***Always wear appropriate personal protective equipment, refer to Safety Precautions Chapter.***

Waste materials such as, but not limited to: oil, grease, lubricant, fuel, adhesive, desiccants (drying agents), battery acid, cleaning agent, solvent or corrosive substance, paint, polyester resin and/or plastic residues or articles contaminated with such substances are designated as 'Hazardous Waste' by international regulations.

- Obey applicable rules and regulations when handling, storing, transporting, processing and/or disposing of hazardous waste.
- If necessary, speak to a hazardous waste disposal company for assistance and/or advise in the disposal of hazardous waste or contaminated articles.





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