

S4 and S6 LV Alternators OWNER MANUAL

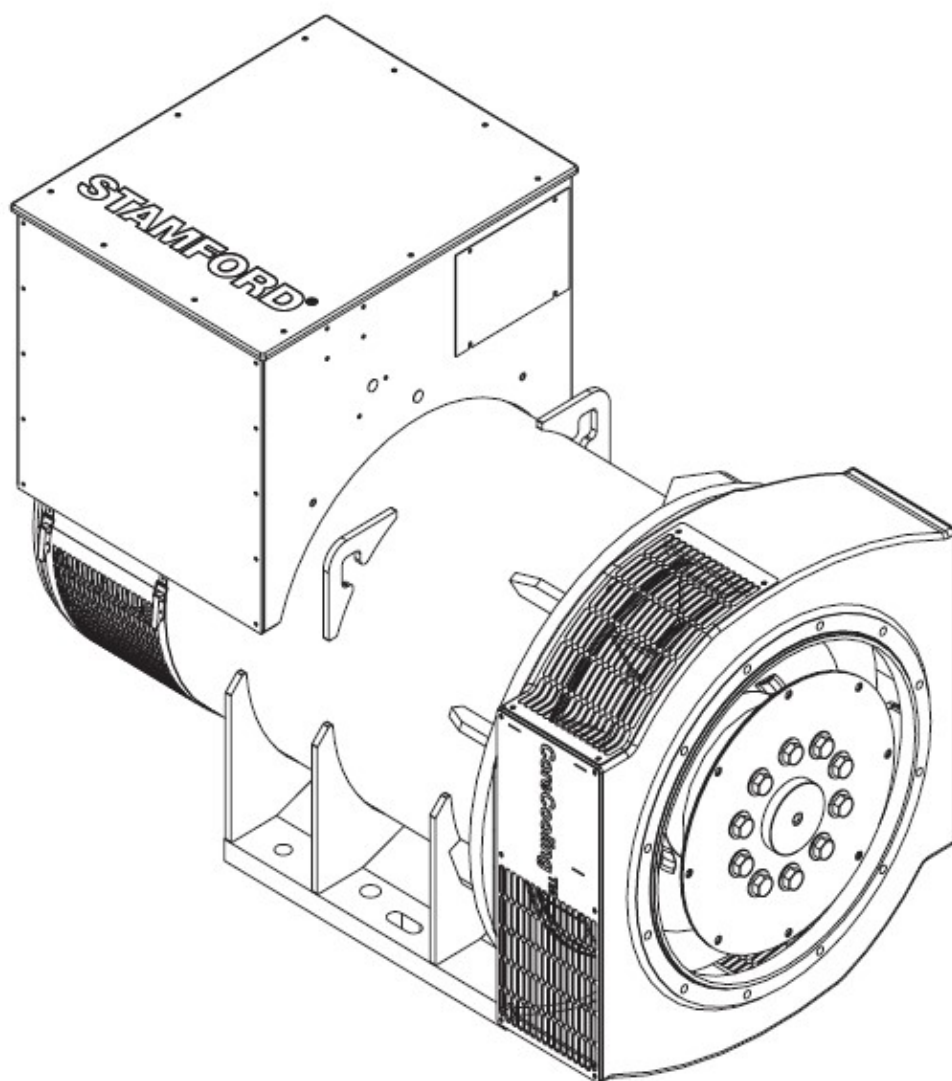


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1 Foreword

1.1 General

This manual forms part of the items supplied and is an important technical guide to the intended use of the alternator. It represents an essential source of information for the user and also for managers for the prevention of injuries and damage to the alternator. The general safety regulations, the specific regulations for the place of use and the precautions described in this document must be followed at all times.

TABLE 1. COMPANY ADDRESSES

Company and European Authorized Representative Addresses	
Cummins Generator Technologies Fountain Court Lynch Wood Peterborough PE2 6FZ United Kingdom	Cummins Generator Technologies Bvd. Decebal 116A Craiova, Dolj 200746 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®', STAMFORD VITA™ or 'AvK®' within this manual).

STAMFORD® STAMFORD VITA™ and AvK® 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 2022, 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 alternator. This manual does not include instructions for servicing and maintaining the alternator. Contact Cummins Generator Technologies (CGT) Customer Service for details.

Before operating the alternator, read this manual and make sure that all personnel who work on the equipment have access to the manual and all additional documentation supplied with it. Misuse and failure to follow the instructions, and the use of non-approved parts, may invalidate the product warranty and lead to potential accidents.

This manual is an essential part of the alternator. Make sure that the manual is available to all users throughout the life of the alternator.

The manual is written for skilled electrical and mechanical technicians and engineers, who have prior knowledge and experience of generating equipment of this type. If in doubt, please seek expert advice or 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. Please visit www.stamford-avk.com for latest documentation.

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2 Safety Precautions

2.1 Safety Information and Notices used in this Manual

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

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

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

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

NOTICE
Notice refers to a method or practice which can result in product damage, or to draw attention to additional information or explanations.

2.2 General Guidance

NOTICE
These safety precautions are for general guidance and supplement your own safety procedures and all locally applicable laws and standards.

NOTICE
Ensure that all personnel are fully aware of location specific rules and procedures in case of accidents, incidents or emergencies.

2.3 Skill Requirements of Personnel

Operation, installation, service and maintenance procedures must only be carried out by experienced and qualified personnel, who are familiar with the procedures and the equipment, who are aware of the requirements of all locally applicable rules and regulations and who have undertaken suitable training.

2.4 Risk Assessment

A risk assessment has been performed on this product by CGT, however a separate risk assessment must be performed by the installer/operator/service/maintenance company to establish all site and personnel-related risks. All affected users must be trained on the identified risks. Access to the power plant/generator set during operation must be restricted to persons who have been trained on these risks; refer to [Section 2.2 on page 3](#) and [Section 2.3 on page 3](#)

2.5 Personal Protective Equipment (PPE)

All persons installing, operating, servicing, maintaining or working in or with a power plant or a generator set **must be**; trained in the safe use of, and wear the appropriate personal protective equipment as directed by the installer/operator/service/maintenance company risk assessment, refer to; [Section 2.4 on page 4](#) .

Minimum recommended personal protective equipment for installation, operation and service / maintenance or working in or with a power plant or a generator set includes:

Eye protection, face protection, ear protection, head protection, overalls that protect the lower arms and legs, safety shoes or safety boots and gloves.



FIGURE 1. MINIMUM RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE)

2.6 Tools and Equipment

All personnel that undertake the, installation, operation, service or maintenance of the alternator must be trained in the safe use/operation of the tools/equipment/machinery they use, refer to; [Section 2.3 on page 3](#) .

All hand operated tools and power operated tools (either battery or mains powered) and large equipment such as, but not limited to; plant equipment/machinery (such as forklifts), lifting appliances (such as cranes/hoists and jacks) and their accessories (such as chains, straps hooks and shackles) used by personnel to undertake the, installation / operation / service / maintenance of the alternator must be:

- Included within the risk assessment carried out by the installer / operator / service / maintenance company, refer to; [Section 2.4 on page 4](#) .
- Suitable for the task and intended use and if required by the risk assessment be electrically insulated to withstand the alternator output voltage, refer to the alternator rating pate information in; [Chapter 4 on page 23](#).
- In a serviceable condition for safe use.

2.7 Safety Information Signs

Safety information signs are provided on the equipment to indicate hazards and emphasize instructions. Become familiar with the signs and the meaning before operating the equipment. To avoid injury, always take the necessary precautions. Sample signs are shown below, these may vary depending on the specification of the alternator.



FIGURE 2. EXAMPLE WARNING SIGNS

2.8 Alternator Danger Notices

DANGER

Falling Mechanical Parts

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

- **Check the capacity, condition and attachment of lifting equipment (crane, hoists and jacks, including attachments to anchor, fix or support the equipment).**
- **Check the capacity, condition and attachment of accessories for lifting (hooks, slings, shackles and eye bolts for attaching loads to lifting equipment).**
- **Check the capacity, condition and attachment of lifting fixtures on the load.**
- **Check the mass, integrity and stability (e.g. unbalanced or shifting center of gravity) of the load.**
- **Fit drive end and non-drive end transit fittings to single bearing alternators to keep the main rotor in the frame.**
- **Keep the alternator horizontal when lifting.**
- **Do not use the lifting points fitted to the alternator for lifting a complete generator set.**
- **Do not use the lifting points fitted to the cooler for lifting the alternator or a complete generator set.**
- **Do not remove the lifting label attached to one of the lifting points.**

DANGER

Testing Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury:

- **Before removing covers over electrical conductors, shut down and isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.**

DANGER

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:

- **Assess risk and test on or near live conductors only if absolutely necessary.**
- **Only trained, competent persons 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.**
- **Place warnings and prevent access by unauthorized persons.**
- **Make sure that tools, test instruments, leads and attachments are designed, inspected and maintained for use on the maximum voltages likely under normal and fault conditions.**
- **Test medium and high voltage (3.3 kV to 13.6 kV) alternators only with specialized instruments and probes, refer to; Tools and Equipment Chapter.**
- **Take suitable precautions to prevent contact with live conductors including personal protective equipment, insulation, barriers and insulated tools.**

⚠ 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, exposed couplings between the alternator and prime mover must be protected by a suitable guard/cover.**
- **Before removing covers from rotating parts, shut down and isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.**
- **Before undertaking service or maintenance tasks shut down and isolate the generator set from all energy sources, remove 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 on or near operational/live rotating mechanical parts:

- **Assess risk and test on or near uncovered rotating mechanical parts only if absolutely necessary.**
- **Only trained, competent persons may test on or near uncovered rotating mechanical parts.**
- **Do not test on or near uncovered rotating mechanical parts alone; another competent person must be present, trained to isolate energy sources and take action in an emergency.**
- **Place warnings and prevent access by unauthorized persons.**
- **Take suitable precautions to prevent contact with uncovered rotating mechanical parts including personal protective equipment and barriers.**

2.9 Alternator Warning Notices

⚠ WARNING

Grounding

The alternator must be permanently grounded, unless the application or local regulations do not permit grounding, (for example: Maritime use). To avoid injury:

- **Parts of the alternator and installation on which inspections, servicing and repair work is carried out must be electrically isolated in accordance with all locally applicable rules and regulations..**
- **Test the electrically isolated parts for electrical isolation using a suitable voltage tester, then ground and short-circuit and also isolate neighboring live parts.**
- **In case of work on high-voltage assemblies, after electrically isolating connect the line cable to ground and short-circuit the components, e.g. capacitors, using a grounding bar.**

⚠ 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 **may 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) may vary from the one shown in the image below).



FIGURE 3. ARC-FLASH IMAGES

If fitted, ensure 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:

- **Use anti-condensation heaters (if fitted) to prevent condensation accumulating.**
- **Before operating the alternator; check for condensed water. If condensed water is present, drain/remove the water, dry and inspect the alternator in accordance with the Maintenance and Servicing Chapter.**

⚠ WARNING

Coupling an Alternator to a Prime Mover

Moving mechanical parts during generator set coupling can cause serious injury by crushing, severing or trapping. To prevent injury:

- **Personnel must keep limbs and body parts away from mating surfaces when coupling the alternator to a prime mover.**
- **Personnel must keep limbs and body parts away from mating surfaces when installing large components, such as; cooling systems and fuel tanks on to the alternator/generator set.**

⚠ 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:

- **Do not install or operate the alternator in an area 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/fire:

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to; Safety Precaution Chapter.**
- **Ensure that no combustible materials (such as packaging) or flammable substances come in to contact with or are stored in close proximity to the anti-condensation heater (if fitted).**
- **Ensure that no combustible material(s) or flammable substances come in to contact with or are stored in close proximity to the alternator or prime mover, including the cooling, ventilation and exhaust system(s) where applicable.**

⚠ WARNING

Incorrect Electrical Installation and System Protection

Incorrect electrical installation and system protection can cause serious injury or death by electric shock and burns. To prevent injury:

- **All personnel who carry out; installation, service or maintenance work or who supervise such work being undertaken must be suitably experienced and qualified.**
- **All personnel must comply with all locally applicable rules and regulations as well as site safety requirements, refer to; Safety Precaution Chapter.**

⚠ WARNING

Incorrect or Improper Use

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

- ***Always select the correct specification alternator for the intended use and application.***
- ***Ensure the alternator and prime mover are technically compatible and practically suitable for the intended application.***
- ***Always install the alternator in accordance with the original manual(s) and technical drawing(s) supplied with the alternator and comply with all locally applicable rules and regulations.***
- ***Ensure 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. Shut down and isolate the alternator set from all energy sources, remove stored energy and use lock out/tag out safety procedures. Prevent further use of the alternator until it is repaired and returned to a serviceable condition.***

⚠ WARNING

Live Electrical Conductors

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

- ***Always discharge the windings immediately after the test has concluded by shorting to earth through an earthing rod for:***
 1. ***A duration equal to the test duration.***
 - or
 2. ***5 minutes.***

Whichever is the longer duration.

⚠ WARNING

Noise

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

- ***Always wear appropriate personal protection equipment; refer to Safety Precaution Chapter.***

⚠ 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:

- ***Before starting any service and maintenance work, use appropriate lock out/tag out safety procedures to keep the generator set isolated from energy sources. Do not defeat or bypass the lock out/tag out safety procedures.***

⚠ WARNING

Safety Cover Removed

A hazard exposed when a safety cover is removed can cause serious injury or death.

To prevent injury:

- **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

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:

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

⚠ 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; observe the below points while the alternator is operating:

- **Keep away from the air inlet(s) and air outlet(s) when the alternator is running.**
- **Do not put operator controls near the air inlet(s) and air outlet(s).**
- **Do not cause overheating by running the alternator outside rating plate parameters.**
- **Do not overload the alternator.**
- **Do not run an alternator with 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 any ventilation opening is fitted. To avoid injury:

- **Avoid the areas around all ventilation openings, air intake(s) and air outlet(s) when the alternator is operating.**

⚠ WARNING

Exposure to Particles and Fumes from Alternator Terminal Boxes.

Particles and fumes can be released in all directions (horizontally and vertically) from where any ventilation opening is fitted. To avoid injury:

- **Depending on the machine design, the pressure release flap can be located at different positions, orientations, and directions, according to alternator configuration.**
- **It is important to identify the position(s) of the pressure release flap(s) and avoid them during alternator operation.**

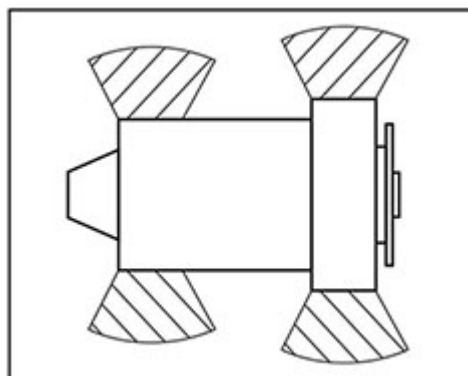


FIGURE 5. S4/S6 HV HAZARD ZONES

2.10 Alternator Caution Notices

CAUTION

Hazardous Substances

Contact with hazardous substances such as; oils, grease, lubricants, fuel, adhesive, desiccants (drying agents), battery acid, cleaning agents, solvent or corrosive substances, paint, polyester resin and/or plastic residues can cause minor or moderate injury by contact/inhalation. Prolonged/repetitive exposure may lead to more serious medical conditions developing. To prevent injury:

- **Always read and comply with the information provided by the product manufacturer, use, handle and store substances accordingly.**
- **Always wear appropriate personal protection equipment, as per product manufacturer information and the Safety Precaution Chapter.**

CAUTION

Missing Walkways and Handrails

Walkways and handrails removed for service and maintenance access can cause minor or moderate injury by slips, trips and falls. To prevent injury:

- **Before starting work, assess the risks, take precautions for safe working, place warnings and prevent access by unauthorized persons.**

CAUTION

Dust & Airborne Particles/Fumes

Inhaling dust and other airborne particles/fumes can cause minor or moderate injury by irritating the lungs and eyes. Repetitive/prolonged exposure may cause serious chronic medical conditions to develop. To prevent injury:

- **Use mechanical vacuum extraction to remove dust and airborne particles/fumes where appropriate.**
- **Ventilate the area appropriately.**
- **Always wear the appropriate personal protection 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.

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

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

All 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

The appropriate type of certificate will be supplied with each alternator, depending on the alternators measured output (<1000VAC or >1000VAC).

Alternators are supplied with a declaration 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 are supplied with.

NOTICE

If the certificate is lost, missing or damaged; please contact STAMFORD® or AvK® customer services www.stamford-avk.com.

EU DECLARATION OF CONFORMITY



This synchronous low-voltage (<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:


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

and that the standards and/or technical specifications referenced below have been applied:

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

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.

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.

Signed:  Date: 4 th August 2021	Name, Title and Address: Alastair McQueen Global Technical Director Cummins Generator Technologies Romania B-dul Decebal Nr. 116A 200746, Craiova Dolj, ROMANIA
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Description:

Serial Number:

Registered in England under Registration No. 441273.
 Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK

450-16383-J

FIGURE 6. EXAMPLE EU DECLARATION OF CONFORMITY - SHEET 1

EU DECLARATION OF CONFORMITY



The A.C. Generator utilizes hazardous material exemptions as detailed in Annex III of EU Directive 2011/65/EU

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:

LV180*
LVSI80*
DSG 99*
DSG 114*
DSG 125*
DSG 144*

Where "*" represents any combination of letters and characters completing the specific description of the product.

Registered in England under Registration No. 441273.
Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK

450-16583-J

FIGURE 7. EXAMPLE EU DECLARATION OF CONFORMITY - SHEET 2

UK DECLARATION OF CONFORMITY



This synchronous low-voltage (<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:


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

and that the standards and/or technical specifications referenced below have been applied:

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

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.

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

Signed:  Date: 4 th August 2021	Name, Title and Address: Alastair McQueen Global Technical Director Cummins Generator Technologies Fountain Court, Lynch Wood Peterborough, UK PE2 6FZ
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Description:

Serial Number:

Registered in England under Registration No. 441273.
 Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK

450-16383-J

FIGURE 8. EXAMPLE UK DECLARATION OF CONFORMITY - SHEET 1

UK DECLARATION OF CONFORMITY



The A.C. Generator utilizes hazardous material exemptions as detailed in Annex III of S.I. 2012/2032

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:

LVI80*

LVSI80*

DSG 99*

DSG 114*

DSG 125*

DSG 144*

Where "*" represents any combination of letters and characters completing the specific description of the product.

Registered in England under Registration No. 441273.
Cummins Generator Technologies Ltd. Registered Office: Fountain Court, Lynch Wood, Peterborough, PE2 6FZ UK

450-16383-J

FIGURE 9. EXAMPLE UK DECLARATION OF CONFORMITY - SHEET 2

**2006/42/EC MACHINERY DIRECTIVE
DECLARATION OF INCORPORATION
OF PARTLY COMPLETED MACHINERY**



**ESSENTIAL HEALTH AND SAFETY REQUIREMENTS RELATING TO THE DESIGN
AND CONSTRUCTION OF PARTLY COMPLETED MACHINERY**

<p>1.1 General Remarks</p> <ul style="list-style-type: none"> ▪ 1.1.2 : Principles of safety integration ▪ 1.1.3 : Materials and products ▪ 1.1.5 : Design of machinery to facilitate its handling <p>1.3 Protection Against Mechanical Hazards</p> <ul style="list-style-type: none"> ▪ 1.3.1 : Risk of loss of stability ▪ 1.3.2 : Risk of break-up during operation ▪ 1.3.3 : Risks due to falling or ejected objects ▪ 1.3.4 : Risks due to surfaces, edges or angles ▪ 1.3.7 : Risks related to moving parts ▪ 1.3.8.1 : Moving transmission parts <p>1.4 Guarding *</p> <ul style="list-style-type: none"> ▪ 1.4.1 : Guards – General requirements * ▪ 1.4.2.1 : Fixed guards * <p>1.5 Other Hazards</p> <ul style="list-style-type: none"> • 1.5.2 : Static electricity • 1.5.3 : Energy supply other than electric • 1.5.4 : Errors of fitting • 1.5.6 : Fire • 1.5.13 : Emissions of hazardous materials and substances <p>1.7 Information</p> <ul style="list-style-type: none"> • 1.7.1 : Information and warnings on the machinery • 1.7.4 : Instructions 	<p style="text-align: center;">LEGEND</p> <ol style="list-style-type: none"> 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. 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. 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.
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FIGURE 11. EXAMPLE DECLARATION OF INCORPORATION (>1KV) - SHEET 2

**SUPPLY OF MACHINERY (SAFETY)
REGULATIONS 2008
DECLARATION OF INCORPORATION
OF PARTLY COMPLETED MACHINERY**



Function: Synchronous A.C. generator > 1000VAC designed for incorporation into an electricity generating-set.

The partly completed machinery supplied with this declaration:

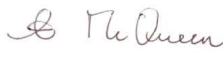
- Is designed and constructed solely as a non-functional component to be incorporated into a machine requiring completion.
- Is designed to comply with the provisions of the following EU Directives so far as their level of build will allow:

S.I. 2016/1091 The Electromagnetic Compatibility Regulations

- 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.
- 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.

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:

<p>Signed:</p>  <p>Date: 4th August 2021</p>	<p>Name, Title and Address:</p> <p>Alastair McQueen Global Technical Director Cummins Generator Technologies Fountain Court, Lynch Wood Peterborough, UK PE2 6FZ</p>
--	--

Description:

Serial Number:

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

**SUPPLY OF MACHINERY (SAFETY)
REGULATIONS 2008
DECLARATION OF INCORPORATION
OF PARTLY COMPLETED MACHINERY**



**ESSENTIAL HEALTH AND SAFETY REQUIREMENTS RELATING TO THE DESIGN AND
CONSTRUCTION OF PARTLY COMPLETED MACHINERY**

<p>General Remarks</p> <ul style="list-style-type: none"> ▪ 1.1.2 : Principles of safety integration ▪ 1.1.3 : Materials and products ▪ 1.1.5 : Design of machinery to facilitate its handling <p>Protection Against Mechanical Hazards</p> <ul style="list-style-type: none"> ▪ 1.3.1 : Risk of loss of stability ▪ 1.3.2 : Risk of break-up during operation ▪ 1.3.3 : Risks due to falling or ejected objects ▪ 1.3.4 : Risks due to surfaces, edges or angles ▪ 1.3.7 : Risks related to moving parts ▪ 1.3.8.1 : Moving transmission parts <p>Guarding *</p> <ul style="list-style-type: none"> ▪ 1.4.1 : Guards – General requirements * ▪ 1.4.2.1 : Fixed guards * <p>Other Hazards</p> <ul style="list-style-type: none"> • 1.5.2 : Static electricity • 1.5.3 : Energy supply other than electric • 1.5.4 : Errors of fitting • 1.5.6 : Fire • 1.5.13 : Emissions of hazardous materials and substances <p>Information</p> <ul style="list-style-type: none"> • 1.7.1 : Information and warnings on the machinery • 1.7.4 : Instructions 	<p style="text-align: center;">LEGEND</p> <ol style="list-style-type: none"> 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. 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. 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.
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FIGURE 13. EXAMPLE DECLARATION OF INCORPORATION (>1KV) - SHEET 4

3.3 Additional Information for Electromagnetic Compatibility Compliance (EMC)

All 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.

Operation, installation, service and maintenance procedures must only be carried out by experienced and qualified personnel, who are familiar with the procedures and the equipment, who are aware of the requirements of all locally applicable rules and regulations and who have undertaken suitable training. Refer to; [Section 2.3 on page 3](#).

NOTICE

Cummins Generator Technology is not liable for electromagnetic compatibility compliance if unauthorized parts, not of; STAMFORD® or AvK® brand(s), 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 at the alternator rated voltage shown on the rating plate label.

The following markings of the alternator rating plate are covered in scope of CSA certification:

- Frame and Model Number
- Date Coded Serial Number
- Output in Voltage, Amps, Frequency, and kVA
- Rated Load Speed in RPM
- Direction of Rotation (only if unidirectional)
- Power Factor (PF)
- No of Phases
- Excitation Voltage
- Excitation Current
- Class of Insulation
- Type of Rating
- Ambient Temperature.

4 Introduction

4.1 General Description

S4 and S6 alternators are of brushless rotating field design, available up to 690 V, 50 Hz (1500 RPM, 4 pole) or 60 Hz (1800 RPM, 4 pole), and built to meet BS5000 Part 3 and international standards.

S4 alternators are available self-excited, where excitation power is from the main output windings.

S4 and S6 alternators are available separately-excited, where a permanent magnet generator (PMG) supplies excitation power.

4.2 Noise

⚠ WARNING
<p>Noise <i>Noise from a running alternator can cause serious injury by permanent hearing damage. To prevent injury:</i></p> <ul style="list-style-type: none"> <i>Always wear appropriate personal protection equipment; refer to Safety Precaution Chapter.</i>

Maximum A-weighted noise emissions may reach 109 dB(A). Contact the supplier for application-specific details.

4.3 Alternator Name

TABLE 2. S4, S5 & S6 ALTERNATOR NAMING FORMAT

Example:	S	4	L	1	D	-	C	4	2
	STAMFORD Brand	Family Series	Voltage (L = low, M = medium, H = high)	Revision	Descriptor (D = dedicated (industrial), G = grid code, M = marine, S = special (industrial))		Core length (C, D, E, ...)	Number of poles	Number of bearings (1 = NDE, 2 = DE & NDE)

4.4 Serial Number Location

A unique serial number is stamped into the upper section of the frame.

4.5 Rating Plate

The fixed rating plate label states the intended operating parameters of the alternator.

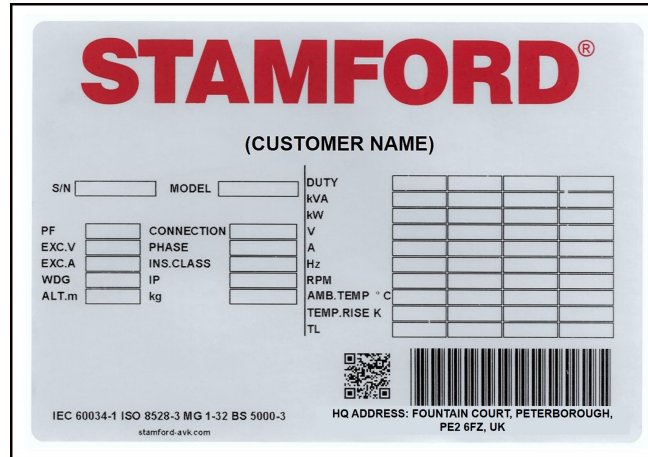


FIGURE 14. GLOBAL STAMFORD AC ALTERNATOR RATING PLATE

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.

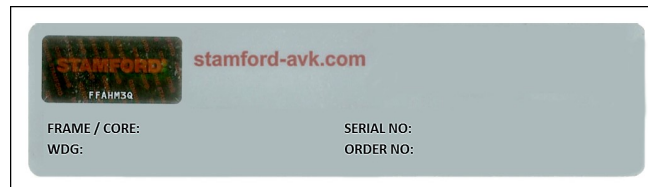



FIGURE 15. TRACKING LABEL



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

5 Application of the Alternator

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

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

5.1 Environment

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

TABLE 3. ENVIRONMENTAL SPECIFICATION

Ambient Temperature	-15 °C to 40 °C (5 °F to 104 °F)
Relative Humidity	< 70%
Altitude	< 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; the nameplate gives details. If the operating environment is changed after purchase, refer to the factory for a revised alternator rating.

5.2 Air Flow

TABLE 4. MINIMUM AIR FLOW AND MAXIMUM PRESSURE DIFFERENCE

Alternator model and frequency	Minimum Air flow, m ³ /s (ft ³ /min)		Maximum intake to outlet pressure difference, mm (in) water gauge
	50 Hz	60 Hz	
S4	0.8 (1700)	0.99 (2100)	6 (0.25)
S6 (E-F cores)	1.4 (2967)	1.8 (3808)	6 (0.25)
S6 (G-H cores)	1.8 (3814)	2.2 (4662)	6 (0.25)

Make sure that the air inlets and outlets are not blocked while the alternator is running.

5.3 Airborne Contaminants

CAUTION

Dust & Airborne Particles/Fumes

Inhaling dust and other airborne particles/fumes can cause minor or moderate injury by irritating the lungs and eyes. Repetitive/prolonged exposure may cause serious chronic medical conditions to develop. To prevent injury:

- *Use mechanical vacuum extraction to remove dust and airborne particles/fumes where appropriate.*
- *Ventilate the area appropriately.*
- *Always wear the appropriate personal protection 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.

5.4 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.

5.5 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 supplied on request.

5.6 Anti-Condensation Heaters

DANGER

Testing Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury:

- *Before removing covers over electrical conductors, shut down and isolate the generator set from all energy sources, remove stored energy and 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:

- **Use anti-condensation heaters (if fitted) to prevent condensation accumulating.**
- **Before operating the alternator; check for condensed water. If condensed water is present, drain/remove the water, dry and inspect the alternator in accordance with the 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/fire:

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to; Safety Precaution Chapter.**
- **Ensure that no combustible materials (such as packaging) or flammable substances come in to contact with or are stored in close proximity to the anti-condensation heater (if fitted).**
- **Ensure that no combustible material(s) or flammable substances come in to contact with or are stored in close proximity to the alternator or prime mover, including the cooling, 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.

5.7 Enclosures

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.

5.8 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. Refer to CGT before fixing any additional mass to the terminal box.

5.8.1 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.

5.8.2 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.

5.8.3 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.

5.8.4 Linear Vibration Limits

TABLE 5. S4 S5 AND S6 VIBRATION LEVEL MEASUREMENTS

Linear Vibration Levels As Measured On The Alternator S4_S6			
Engine Speed RPM (min ⁻¹)	Power Output S (kVA)	Vibration Displacement RMS (mm)	Vibration Velocity RMS (mm/s)
1 300 ≤n _r <2 000	>250	0.32	20
720 ≤n _r <1 300	≥250 but ≤1 250	0.32	20

The broad band is taken as 10 Hz - 1000 Hz

5.8.5 Linear Vibration Monitoring

We recommend using vibration analysing equipment to measure vibration at all of the 12 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.

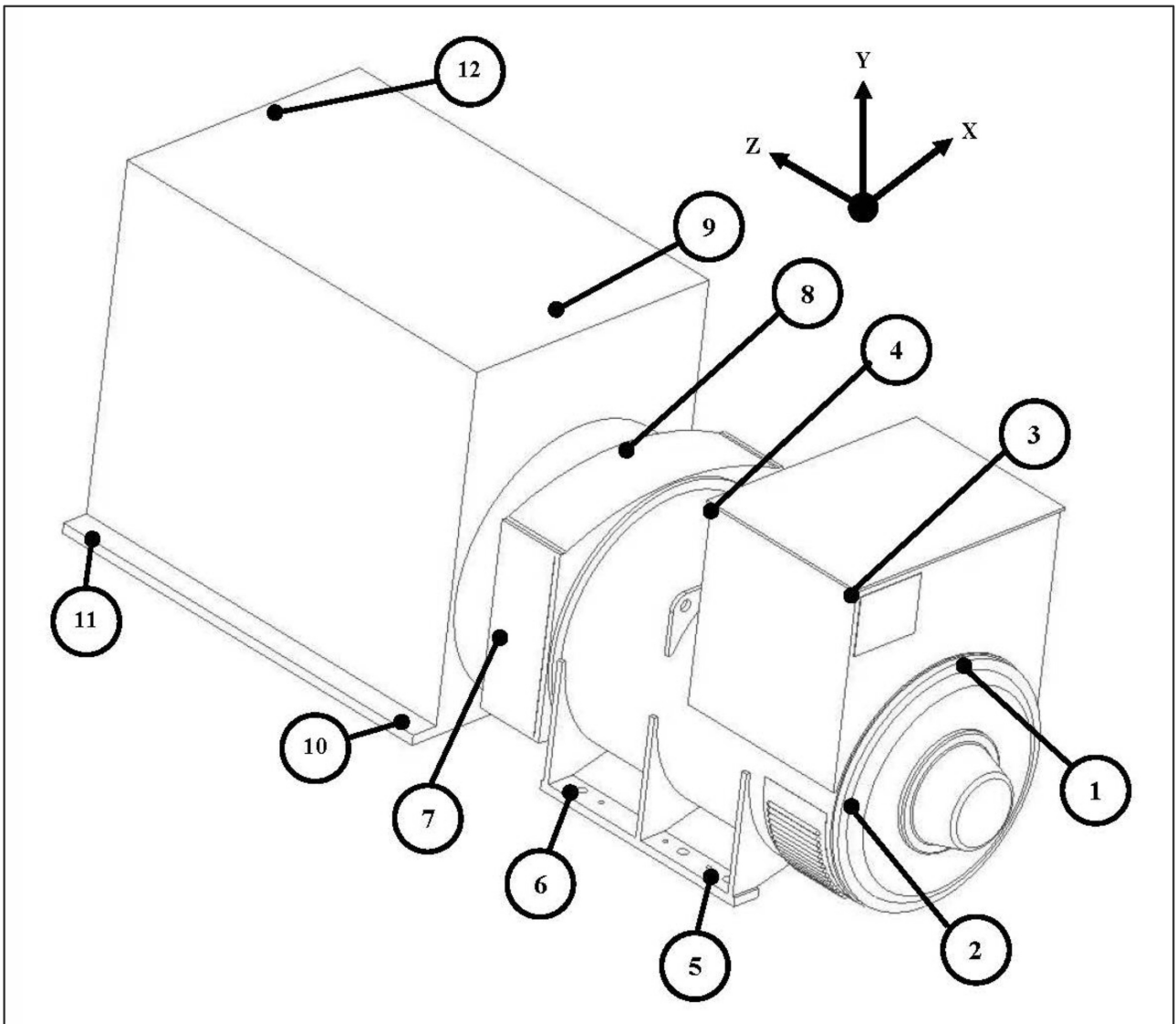


FIGURE 17. VIBRATION MEASUREMENT LOCATIONS

5.8.6 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; observe the below points while the alternator is operating:

- ***Keep away from the air inlet(s) and air outlet(s) when the alternator is running.***
- ***Do not put operator controls near the air inlet(s) and air outlet(s).***
- ***Do not cause overheating by running the alternator outside rating plate parameters.***
- ***Do not overload the alternator.***
- ***Do not run an alternator with 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. Contact CGT Customer Service to assess the impact on bearing and alternator life expectancy.

5.9 Bearings

5.9.1 Sealed Bearings

Inspect sealed-for-life bearings periodically, according to the recommended service schedule in this manual. Check for signs of wear, fretting or other detrimental features. Damage to seals, grease leakage or discoloration of the bearing races indicate that the bearing may need to be replaced.

5.9.2 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.

5.9.3 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.

5.9.4 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.

5.9.5 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 contact CGT Customer Service.

5.9.6 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.

6 Installation into the Generator Set

6.1 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

6.2 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 and before lifting:

- ***Check the capacity, condition and attachment of lifting equipment (crane, hoists and jacks, including attachments to anchor, fix or support the equipment).***
- ***Check the capacity, condition and attachment of accessories for lifting (hooks, slings, shackles and eye bolts for attaching loads to lifting equipment).***
- ***Check the capacity, condition and attachment of lifting fixtures on the load.***
- ***Check the mass, integrity and stability (e.g. unbalanced or shifting center of gravity) of the load.***
- ***Fit drive end and non-drive end transit fittings to single bearing alternators to keep the main rotor in the frame.***
- ***Keep the alternator horizontal when lifting.***
- ***Do not use the lifting points fitted to the alternator for lifting a complete generator set.***
- ***Do not use the lifting points fitted to the cooler 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 hooks or 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.

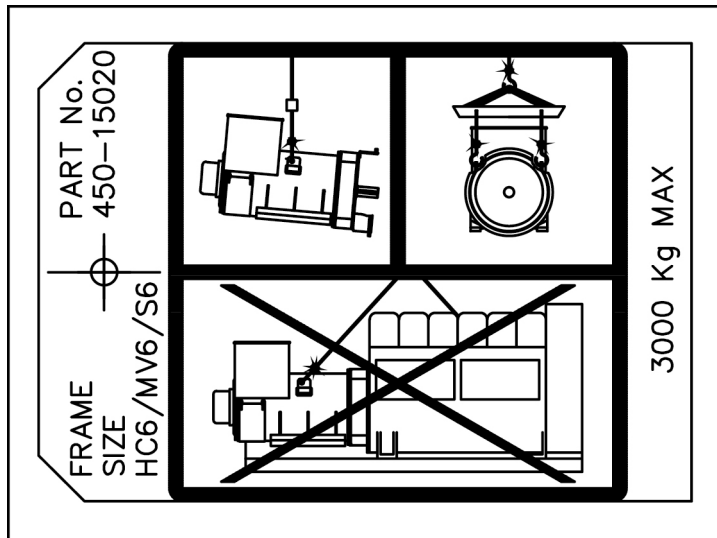


FIGURE 18. LIFTING LABEL

6.3 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:

- **Use anti-condensation heaters (if fitted) to prevent condensation accumulating.**
- **Before operating the alternator; check for condensed water. If condensed water is present, drain/remove the water, dry and inspect the alternator in accordance with the 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/fire:

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to; Safety Precaution Chapter.**
- **Ensure that no combustible materials (such as packaging) or flammable substances come in to contact with or are stored in close proximity to the anti-condensation heater (if fitted).**
- **Ensure that no combustible material(s) or flammable substances come in to contact with or are stored in close proximity to the alternator or prime mover, including the cooling, 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.

6.3.1 After Storage

After a period of storage, carry out the pre-running checks to determine the condition of the windings. If the windings are damp or the insulation resistance is low, follow one of the drying out procedures (see [Chapter 7 on page 41](#)).

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

TABLE 6. BEARING STORAGE


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

6.3.2 Storage Instruction

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 CGT Customer Service for advice in advance if the alternator will be stationary for long periods.

6.4 Generator Set Coupling

 WARNING
<p><i>Coupling an Alternator to a Prime Mover</i> <i>Moving mechanical parts during generator set coupling can cause serious injury by crushing, severing or trapping. To prevent injury:</i></p> <ul style="list-style-type: none"> • <i>Personnel must keep limbs and body parts away from mating surfaces when coupling the alternator to a prime mover.</i> • <i>Personnel must keep limbs and body parts away from mating surfaces when installing large components, such as; cooling systems and fuel tanks on to the alternator/generator set.</i>

Efficient operation and long component life depend on minimizing mechanical stresses on and damage to the alternator. When coupled in a generator set, misalignment and vibration interactions with the prime mover engine can cause mechanical stress. In addition, rotating the alternator rotor using a lever against the vanes of the cooling fan will damage the fan. The fan is not designed to withstand such forces.

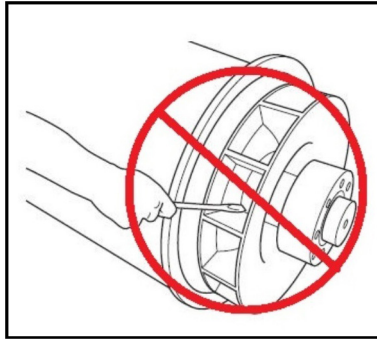


FIGURE 19. DO NOT ROTATE THE ALTERNATOR ROTOR WITH A LEVER

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 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 140 kgm (1000 lbs ft) for frame sizes 4 and 5, and not exceeding 275 kgm (2000 lbs ft) for frame size 6. Check the maximum bending moment of the engine flange with the engine manufacturer.

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.

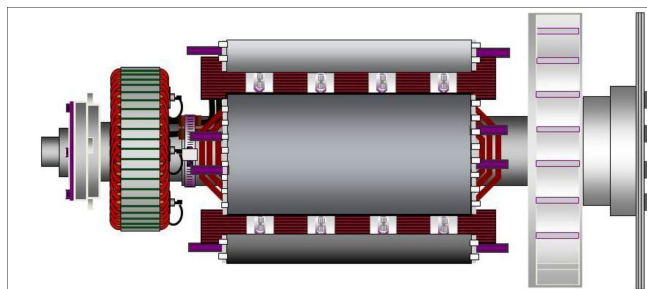


FIGURE 20. SINGLE BEARING ALTERNATOR ROTOR SHOWING COUPLING DISCS BOLTED TO DRIVE END COUPLING HUB AT RIGHT

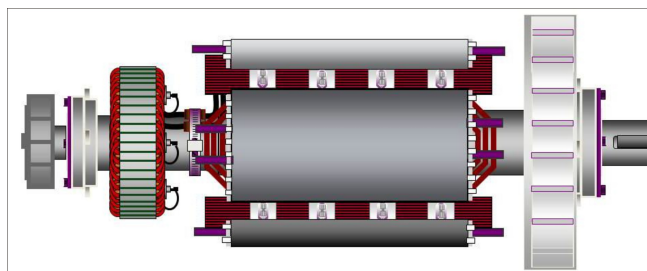


FIGURE 21. TWO BEARING ALTERNATOR ROTOR SHOWING SHAFT WITH KEYWAY FOR FLEXIBLE COUPLING AT RIGHT

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.

6.5 Single Bearing

DANGER

Falling Mechanical Parts

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

- **Check the capacity, condition and attachment of lifting equipment (crane, hoists and jacks, including attachments to anchor, fix or support the equipment).**
- **Check the capacity, condition and attachment of accessories for lifting (hooks, slings, shackles and eye bolts for attaching loads to lifting equipment).**
- **Check the capacity, condition and attachment of lifting fixtures on the load.**
- **Check the mass, integrity and stability (e.g. unbalanced or shifting center of gravity) of the load.**
- **Fit drive end and non-drive end transit fittings to single bearing alternators to keep the main rotor in the frame.**
- **Keep the alternator horizontal when lifting.**
- **Do not use the lifting points fitted to the alternator for lifting a complete generator set.**
- **Do not use the lifting points fitted to the cooler for lifting the alternator or a complete generator set.**
- **Do not remove the lifting label attached to one of the lifting points.**

1. Remove the drive end transit bracket that keeps the rotor in place during transport.
2. Remove the air outlet covers from the drive end of the alternator to access the coupling and adaptor bolts.
3. Make sure the coupling discs are concentric with the adaptor.
4. Fit two alignment dowels into flywheel bolt holes 180 degrees apart to help align the disc and the flywheel.
5. Lift and offer the alternator to the engine, barring the engine over by hand to align discs and flywheel.
6. Engage the alignment dowels into coupling disc bolt holes and push the alternator towards the engine until the coupling discs are against the flywheel face.

NOTICE

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

7. Fit the adaptor bolts, using heavy gauge washers under the heads. Tighten the adapter bolts evenly around the adapter.
8. 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.
9. Remove the alignment dowels. Fit the coupling bolts, using heavy gauge washers under the heads.
10. Tighten the bolts to fix the coupling disc to the flywheel in the sequence shown in [Figure 22 on page 36](#).
11. Check the torque of each bolt in a clockwise direction around the bolt circle to ensure all the bolts are tight.
12. Remove the rotor support bracket, if supplied.
13. Replace all covers.

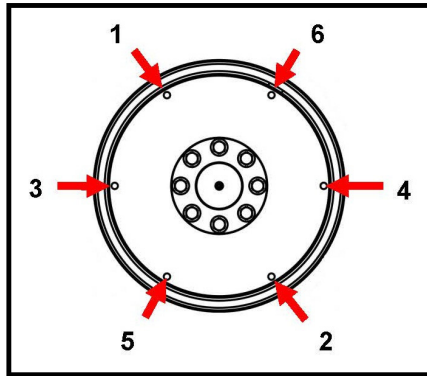


FIGURE 22. FIXING SEQUENCE

6.6 Two Bearing

A flexible coupling, designed to suit the specific engine/alternator combination, is recommended to minimise 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.

6.7 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.

6.8 Direction of Rotation

The fan is designed for clockwise rotation, as viewed from the drive end of the alternator (unless otherwise specified when ordered). If the alternator must run counter-clockwise, please seek advice from CGT Customer Service.

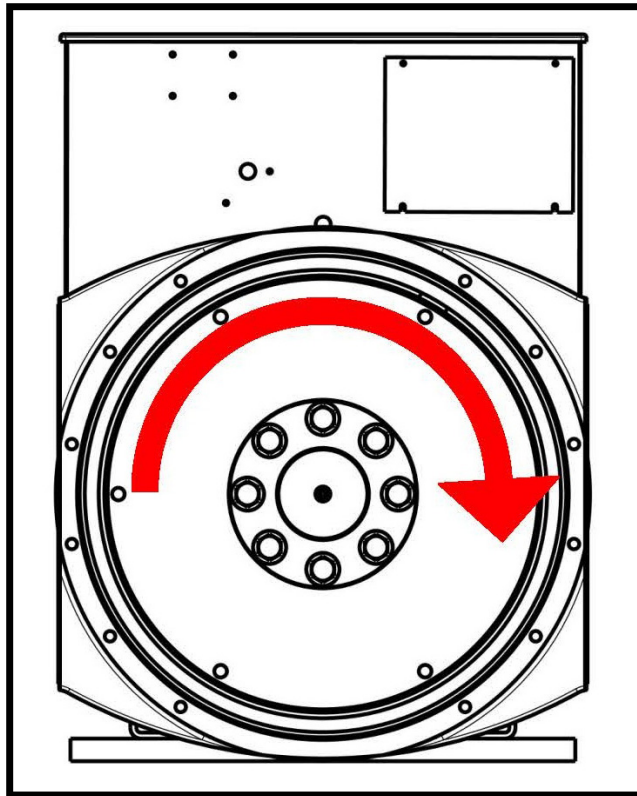


FIGURE 23. DIRECTION OF ROTATION

6.9 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. Contact CGT Customer Service for a circuit diagram of 'reverse phase connections'.

6.10 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.

6.11 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.

6.12 Electrical Connections

WARNING

Incorrect Electrical Installation and System Protection

Incorrect electrical installation and system protection can cause serious injury or death by electric shock and burns. To prevent injury:

- ***All personnel who carry out; installation, service or maintenance work or who supervise such work being undertaken must be suitably experienced and qualified.***
- ***All personnel must comply with all locally applicable rules and regulations as well as site safety requirements, refer to; Safety Precaution Chapter.***

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 CGT 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.

NOTICE

Verdigris may appear on un-plated busbars due to ageing or environmental exposure. Busbars may be cleaned before connections are made, with a suitable cleaning solution (pH value = 2.4) or using other suitable methods. Busbars must be removed from the alternator during cleaning. Suitable PPE must be worn at all times.

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. 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 ± 25 mm movement by the generator set on its anti-vibration mountings, without causing excessive stress to the cables and alternator load terminals.

6.13 Grid Connection: Voltage Surges and Micro-Interruptions

Take precautions to prevent transient voltages generated by the connected load and/or the distribution system from causing damage to the alternator components.

To identify any possible risk, all aspects of the alternator's proposed application should be considered, especially the following:

- 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, usually with surge arrestors and suppressors, to meet regulations and installation requirements. Best practice is to fit protective devices close to the output terminals. Refer to guidance from professional bodies and specialist equipment suppliers for further advice.

6.14 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.

6.15 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; observe the below points while the alternator is operating:

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

6.15.1 Parallel or Synchronizing Alternators

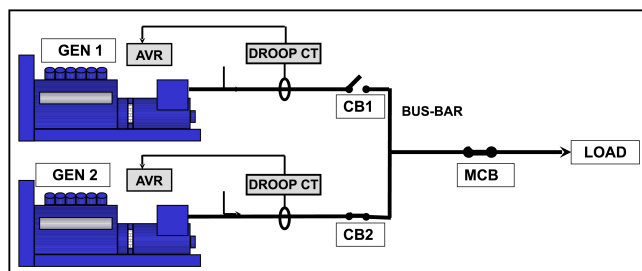


FIGURE 24. PARALLEL OR SYNCHRONIZING ALTERNATORS

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 synchronism.
- The closing time of the synchronizing switch/breaker must be under the control of the synchroniser 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.

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 7. SYNCHRONIZING EQUIPMENT PARAMETERS

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

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

7 Service and Maintenance

7.1 Recommended Service Schedule

Refer to Safety Precautions section ([Chapter 2 on page 3](#)) of this manual before starting any service and maintenance activity.

Refer to Parts Identification section ([Chapter 8 on page 65](#)) 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 CGT Customer Service. For details of your nearest service outlet visit 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.

TABLE 8. ALTERNATOR SERVICE SCHEDULE

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

System	SERVICE ACTIVITY X = required * = if necessary	Alternator running	TYPE				SERVICE LEVEL						
			Inspect	Test	Clean	Replace	Commission	Post Commission 250 hrs / 0.5 year	Level 1 1000 hrs / 1 year	Level 2 10,000 hrs / 2 years	Level 3 30,000 hrs / 5 years		
Bearings	Condition of bearings		X				X						X
	Grease exhaust & trap				X			X	X	X			X
	Grease in re-greasable bearing(s)	X				X		every 4000 to 4500 hours / 6 months					
	Sealed bearing(s)		X					every 4000 to 4500 hours					
	Re-greasable & sealed bearing(s)					X				*			X
	Temperature sensors	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
Controls & Auxiliaries	Initial AVR & PFC set up	X		X			X						
	AVR & PFC settings	X		X				X	X	X			X
	Customer connection of auxiliaries			X			X		X	X			X
	Function of auxiliaries			X			X	X	X	X			X
	Synchronization settings		X				X						
	Synchronization	X		X			X	X	X	X			X
	Anti condensation heater					X					*		X
Rectifier	Diodes and varistors		X				X	X	X	X			
	Diodes and varistors					X							X
Cooling	Air inlet temperature	X		X			X	X	X	X			X
	Air flow (rate & direction)	X	X				X						
	Condition of fan		X				X	X	X	X			X
	Condition of air filter (where fitted)			X			X	X	X	X			X
	Air filters (where fitted)				X	X			*	*			*

* For stand-alone alternator only.

7.2 Bearings

7.2.1 Introduction

NOTICE

Do not overfill a bearing with grease; the bearing may be damaged.

Do not mix lubricant types. Change gloves to handle different lubricant

Assemble bearings in static- and dust-free conditions while wearing lint free gloves.

Store removed parts and tools in static- and dust-free conditions, to prevent damage or contamination.

A bearing is damaged by the axial force needed to remove it from the rotor shaft. Do not reuse a bearing.

A bearing is damaged if the insertion force is applied through the bearing balls. Do not press fit the outer race by force on the inner race, or vice versa.

Do not try to turn the rotor by levering against the cooling fan vanes. The fan will be damaged.

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.
- Inspect each sealed bearing according to the recommended service schedule. Seek advice from CGT Customer Service if grease has leaked out of the bearing, notifying the bearing type and quantity leaked.

7.2.2 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, exposed couplings between the alternator and prime mover must be protected by a suitable guard/cover.***
- ***Before removing covers from rotating parts, shut down and isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.***
- ***Before undertaking service or maintenance tasks shut down and isolate the generator set from all energy sources, remove 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/fire:

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to; Safety Precaution Chapter.**
- **Ensure that no combustible materials (such as packaging) or flammable substances come in to contact with or are stored in close proximity to the anti-condensation heater (if fitted).**
- **Ensure that no combustible material(s) or flammable substances come in to contact with or are stored in close proximity to the alternator or prime mover, including the cooling, ventilation and exhaust system(s) where applicable.**

⚠ 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; observe the below points while the alternator is operating:

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

⚠ CAUTION

Hazardous Substances

Contact with hazardous substances such as; oils, grease, lubricants, fuel, adhesive, desiccants (drying agents), battery acid, cleaning agents, solvent or corrosive substances, paint, polyester resin and/or plastic residues can cause minor or moderate injury by contact/inhalation. Prolonged/repetitive exposure may lead to more serious medical conditions developing. To prevent injury:

- **Always read and comply with the information provided by the product manufacturer, use, handle and store substances accordingly.**
- **Always wear appropriate personal protection equipment, as per product manufacturer information and the Safety Precaution Chapter.**

NOTICE

Do not overfill a bearing with grease; the bearing may be damaged.
Do not mix lubricant types. Change gloves to handle different lubricant
Assemble bearings in static- and dust-free conditions while wearing lint free gloves.
Store removed parts and tools in static- and dust-free conditions, to prevent damage or contamination.
A bearing is damaged by the axial force needed to remove it from the rotor shaft. Do not reuse a bearing.
A bearing is damaged if the insertion force is applied through the bearing balls. Do not press fit the outer race by force on the inner race, or vice versa.
Do not try to turn the rotor by levering against the cooling fan vanes. The fan will be damaged.

7.2.3 Re-Grease Bearings

7.2.3.1 Requirements

TABLE 9. RE-GREASING: EQUIPMENT REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	Wear mandatory personal protective equipment for the site.
Consumables	<ul style="list-style-type: none">• Lint-free cleaning cloths• Thin disposable gloves
Parts	CGT recommended grease
Tools	Grease gun (calibrated for volume or mass)

7.2.3.2 Re-Grease Method

TABLE 10. REGREASING: GREASE QUANTITY

Bearing Type	Quantity of recommended grease	
	Volume (cm ³)	Mass (g)
Drive End (S6)	69	66
Non-drive End (S6)	55	53

1. For each bearing, identify the 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 and of stiff consistency throughout.
3. Clean the grease gun nozzle and grease nipple.
4. Clean the grease exhaust.
5. Fit the grease gun to the grease nipple and add the correct quantity of grease.
6. Run the alternator for at least 60 minutes, off- or on-load.
7. Clean the grease exhaust.
8. Inspect the color and consistency of the grease expelled from the exhaust and compare with the new grease, which should be whitish-beige and of stiff consistency.

-
9. Replace the bearing if the expelled grease is severely discolored or absent.

7.3 Controls

7.3.1 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.

7.3.2 Safety

DANGER

Testing Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury:

- **Before removing covers over electrical conductors, shut down and isolate the generator set from all energy sources, remove 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/fire:

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to; Safety Precaution Chapter.**
- **Ensure that no combustible materials (such as packaging) or flammable substances come in to contact with or are stored in close proximity to the anti-condensation heater (if fitted).**
- **Ensure that no combustible material(s) or flammable substances come in to contact with or are stored in close proximity to the alternator or prime mover, including the cooling, ventilation and exhaust system(s) where applicable.**

WARNING

Incorrect Electrical Installation and System Protection

Incorrect electrical installation and system protection can cause serious injury or death by electric shock and burns. To prevent injury:

- **All personnel who carry out; installation, service or maintenance work or who supervise such work being undertaken must be suitably experienced and qualified.**
- **All personnel must comply with all locally applicable rules and regulations as well as site safety requirements, refer to; Safety Precaution Chapter.**

7.3.3 Connection Test Requirements

TABLE 11. CONNECTION TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	Wear mandatory personal protective equipment for the site
Consumables	None
Parts	None
Tools	<ul style="list-style-type: none">• Insulation test meter• Multimeter• Torque wrench

7.3.4 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.
6. Check that AVR accessories and current transformers are correctly fitted, and cables pass centrally through current transformers (if fitted).
7. If an anti-condensation heater is fitted:
 - a. Isolate the supply and measure the electrical resistance of the heater element(s). Replace the 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 test voltage.
 - f. If the measured insulation resistance is less than the minimum acceptable level, replace the heater element. See [Table 12 on page 49](#) for values.
8. Test the supply voltage to the anti-condensation heater at the heater connection box. 120 VAC or 240 VAC. (depending on cartridge option and shown on a label) should be present when the alternator is stopped.
9. Check that the AVR and AVR accessories fitted in the terminal box are clean, securely fitted on anti-vibration mounts, and the cable connectors are firmly attached to the terminals.
10. For parallel operation, check that the synchronization control cables are securely connected.
11. Refit and secure the terminal box lid.

TABLE 12. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ANTI-CONDENSATION HEATERS

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

7.4 Cooling System

7.4.1 Introduction

NOTICE

The values below are cumulative dependent on environmental conditions. Efficient cooling depends on maintaining the condition of the cooling fan, air filters and gaskets.

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 by the maximum operating temperature for a reasonable service life. Although chemical contamination and electrical and mechanical stresses also contribute, temperature is the dominant aging factor. Fan cooling maintains a stable operating temperature below the insulation class limit.

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

- 3% for class H Insulation 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.

7.4.2 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, exposed couplings between the alternator and prime mover must be protected by a suitable guard/cover.***
- ***Before removing covers from rotating parts, shut down and isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.***
- ***Before undertaking service or maintenance tasks shut down and isolate the generator set from all energy sources, remove 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/fire:

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to; Safety Precaution Chapter.**
- **Ensure that no combustible materials (such as packaging) or flammable substances come in to contact with or are stored in close proximity to the anti-condensation heater (if fitted).**
- **Ensure that no combustible material(s) or flammable substances come in to contact with or are stored in close proximity to the alternator or prime mover, including the cooling, ventilation and exhaust system(s) where applicable.**

⚠ CAUTION

Dust & Airborne Particles/Fumes

Inhaling dust and other airborne particles/fumes can cause minor or moderate injury by irritating the lungs and eyes. Repetitive/prolonged exposure may cause serious chronic medical conditions to develop. To prevent injury:

- **Use mechanical vacuum extraction to remove dust and airborne particles/fumes where appropriate.**
- **Ventilate the area appropriately.**
- **Always wear the appropriate personal protection 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.

7.4.3 Cooling System Test Requirements

TABLE 13. COOLING SYSTEM TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	<ul style="list-style-type: none">• Wear mandatory site PPE• Wear eye protection• Wear respiratory protection
Consumables	<ul style="list-style-type: none">• Lint-free cleaning cloths• Thin disposable gloves
Parts	<ul style="list-style-type: none">• Air filters (if fitted)• Air filter sealing gaskets (if fitted)
Tools	None

7.4.4 Inspect and Clean

NOTICE

A sensor detects the differential pressure caused by blocked filters. If the sensor trips, inspect and clean the air filters more frequently.

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

7.5 Coupling

7.5.1 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.

7.5.2 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 to a Prime Mover

Moving mechanical parts during generator set coupling can cause serious injury by crushing, severing or trapping. To prevent injury:

- *Personnel must keep limbs and body parts away from mating surfaces when coupling the alternator to a prime mover.*
- *Personnel must keep limbs and body parts away from mating surfaces when installing large components, such as; cooling systems and fuel tanks on to the alternator/generator set.*

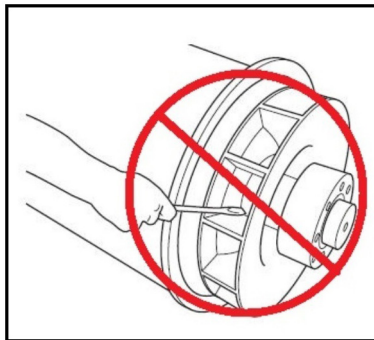


FIGURE 25. DO NOT ROTATE THE ALTERNATOR ROTOR WITH A LEVER

7.5.3 Coupling Test Requirements

TABLE 14. COUPLING TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	Wear mandatory personal protective equipment for the site.
Consumables	None
Parts	None
Tools	<ul style="list-style-type: none"> • Dial gauge • Torque wrench

7.5.4 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.

7.5.4.1 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.

7.6 Rectifier System

7.6.1 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 varistor. The varistor protects 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).

7.6.2 Safety

DANGER

Testing Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury:

- ***Before removing covers over electrical conductors, shut down and isolate the generator set from all energy sources, remove stored energy and 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, exposed couplings between the alternator and prime mover must be protected by a suitable guard/cover.***
- ***Before removing covers from rotating parts, shut down and isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.***
- ***Before undertaking service or maintenance tasks shut down and isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.***

⚠ WARNING

Incorrect Electrical Installation and System Protection

Incorrect electrical installation and system protection can cause serious injury or death by electric shock and burns. To prevent injury:

- ***All personnel who carry out; installation, service or maintenance work or who supervise such work being undertaken must be suitably experienced and qualified.***
- ***All personnel must comply with all locally applicable rules and regulations as well as site safety requirements, refer to; Safety Precaution Chapter.***

7.6.3 Test and Replace Rectifier System Component Requirements

TABLE 15. RECIFIER SYSTEM TEST AND REPLACE REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	Wear appropriate PPE
Consumables	<ul style="list-style-type: none">• Loctite 241 thread locking adhesive• Dow Corning silicone heat sink compound type 340 or similar
Parts	<ul style="list-style-type: none">• Full set of three anode lead diodes and three cathode lead diodes (all from the same manufacturer)• One metal-oxide varistor
Tools	<ul style="list-style-type: none">• Insulation tester• Multimeter• Torque wrench

7.6.4 Test and Replace Varistor

1. Inspect the varistor, (if fitted).
2. Record varistor as faulty if there are signs of overheating (discoloration, blisters, melting) or disintegration.
3. Disconnect one varistor lead. Store fastener and washers.
4. Measure the resistance across the varistor. Good varistors have a resistance greater than 100 MΩ.
5. Record the varistor as faulty if the resistance is short circuit or open circuit in either direction. (Some multimeters will read O.L. at high resistance levels. Please be aware of the limits of your tools.)
6. If the varistor is faulty, replace it and replace all diodes.
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

7.6.5 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 to 0.9 VDC, or the resistance is below 20 M Ω 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 to 3.1 Nm (23 to 27.4 in-lb) torque to give good mechanical, electrical and thermal contact.
 - f. Replace the varistor.
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

7.7 Temperature Sensors

7.7.1 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 two types: Resistance Temperature Detector (RTD) sensors, with three wires, and Positive Temperature Coefficient (PTC) thermistors, with two wires, which are connected to a terminal block in the auxiliary or main terminal box. The resistance of Platinum (PT100) RTD sensors increases linearly with temperature.

TABLE 16. 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									

PTC thermistors are characterised by a sudden increase in resistance at a reference “switching” temperature. Customer-supplied external equipment may be connected to monitor the sensors and generate signals to raise an alarm and to shutdown 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 17. 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 18. 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

7.7.2 Safety

DANGER

Testing Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury:

- **Before removing covers over electrical conductors, shut down and isolate the generator set from all energy sources, remove 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/fire:

- **Avoid contact with hot surfaces.**
- **Always wear the appropriate personal protection equipment, refer to; Safety Precaution Chapter.**
- **Ensure that no combustible materials (such as packaging) or flammable substances come in to contact with or are stored in close proximity to the anti-condensation heater (if fitted).**
- **Ensure that no combustible material(s) or flammable substances come in to contact with or are stored in close proximity to the alternator or prime mover, including the cooling, ventilation and exhaust system(s) where applicable.**

7.7.3 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. Contact Cummins Customer Service Help Desk to replace faulty sensors. Main stator RTD are not replaceable. Bearing RTD are replaceable.

7.7.4 Test PTC 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 two wires.
4. Sensor is faulty if resistance shows open circuit (infinity Ω) or short circuit (zero Ω).
5. Repeat steps 3 to 5 for each sensor.
6. Stop the alternator and inspect the change in resistance as the stator winding cools.
7. Sensor is faulty if resistance does not change or change is not smooth.

8. Repeat steps 6 and 7 for each sensor.
9. Refit the auxiliary terminal box lid.
10. Contact Cummins Customer Service Help Desk to replace faulty sensors.

7.8 Windings

7.8.1 High Voltage Test

NOTICE

Windings have been tested at high voltage during manufacture. Repeated high voltage tests may degrade the insulation and reduce operating life. If a further test is required at installation for customer acceptance, it must be done at a reduced voltage, $V = 0.8 \times (2 \times \text{Rated Voltage} + 1000)$. Once in service, any further tests for maintenance purposes must be done after passing visual checks and insulation resistance tests, and at a reduced voltage, $V = (1.5 \times \text{Rated Voltage})$.

7.8.2 Introduction

NOTICE

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

NOTICE

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.

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.

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.

7.8.3 Safety

DANGER

Testing Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury:

- *Before removing covers over electrical conductors, shut down and isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.*

DANGER

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:

- *Assess risk and test on or near live conductors only if absolutely necessary.*
- *Only trained, competent persons 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.*
- *Place warnings and prevent access by unauthorized persons.*
- *Make sure that tools, test instruments, leads and attachments are designed, inspected and maintained for use on the maximum voltages likely under normal and fault conditions.*
- *Test medium and high voltage (3.3 kV to 13.6 kV) alternators only with specialized instruments and probes, refer to; Tools and Equipment Chapter.*
- *Take suitable precautions to prevent contact with live conductors including personal protective equipment, insulation, barriers and insulated tools.*

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:

- *Use anti-condensation heaters (if fitted) to prevent condensation accumulating.*
- *Before operating the alternator; check for condensed water. If condensed water is present, drain/remove the water, dry and inspect the alternator in accordance with the 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 any ventilation opening is fitted. To avoid injury:

- *Avoid the areas around all ventilation openings, air intake(s) and air outlet(s) when the alternator is operating.*

⚠ WARNING

Live Electrical Conductors

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

- **Always discharge the windings immediately after the test has concluded by shorting to earth through an earthing rod for:**
 1. **A duration equal to the test duration.**
 - or**
 2. **5 minutes.**

Whichever is the longer duration.

⚠ WARNING

Incorrect Electrical Installation and System Protection

Incorrect electrical installation and system protection can cause serious injury or death by electric shock and burns. To prevent injury:

- **All personnel who carry out; installation, service or maintenance work or who supervise such work being undertaken must be suitably experienced and qualified.**
- **All personnel must comply with all locally applicable rules and regulations as well as site safety requirements, refer to; Safety Precaution Chapter.**

7.8.4 Requirements

TABLE 19. WINDING TEST REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	Wear mandatory personal protective equipment for the site.
Consumables	None
Parts	None
Tools	<ul style="list-style-type: none">• Insulation test meter• Multimeter• Milliohm meter or microohm meter• Clamp ammeter• Infrared thermometer• Earth rod

7.8.5 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 DC 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 DC 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, if fitted:
 - 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 Technical Data ([Chapter 9 on page 75](#)) to verify the measured resistances of all windings agree with the reference values.

7.8.6 Test the Insulation Resistance of Windings

NOTICE

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

TABLE 20. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

Part	Test Voltage (V)	Minimum Insulation Resistance at 1 Minute (MΩ)	
		New	In-Service
Main Stator	500	10	5
PMG Stator	500	5	3
Exciter Stator	500	10	5
Exciter Rotor, Rectifier & Main Rotor Combined	500	10	5

1. Inspect the windings for mechanical damage or discoloration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. For main stators:
 - a. Disconnect the neutral to earth conductor (if fitted).
 - b. Connect together the three leads of all phase windings (if possible) or carry out the test at individual lead ends.
 - c. Apply the test voltage from the table between any phase lead and earth.
 - d. Measure the insulation resistance after 1 minute (IR_{1min}).
 - 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 the ends of the winding together (if possible) or carry out the test at individual lead ends.
 - 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.

7.8.7 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.

7.8.7.1 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.

7.8.7.2 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 is 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.

7.8.7.3 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).

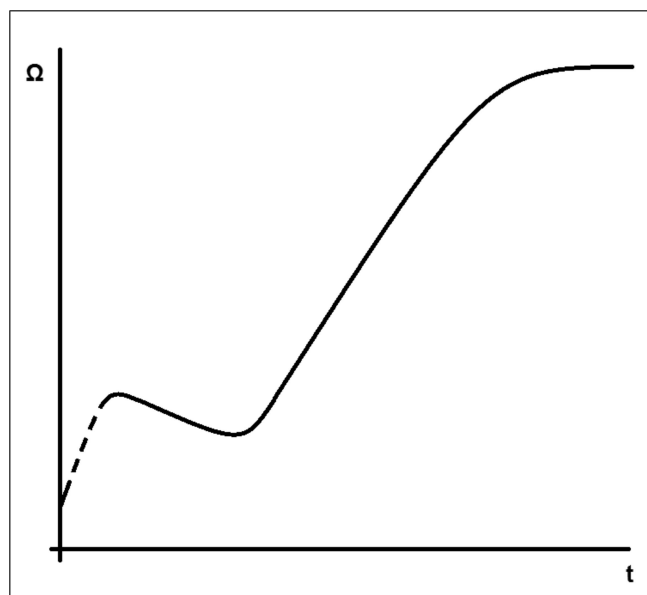


FIGURE 26. INSULATION RESISTANCE GRAPH

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.

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8 Parts Identification

8.1 S4 Single Bearing Alternator

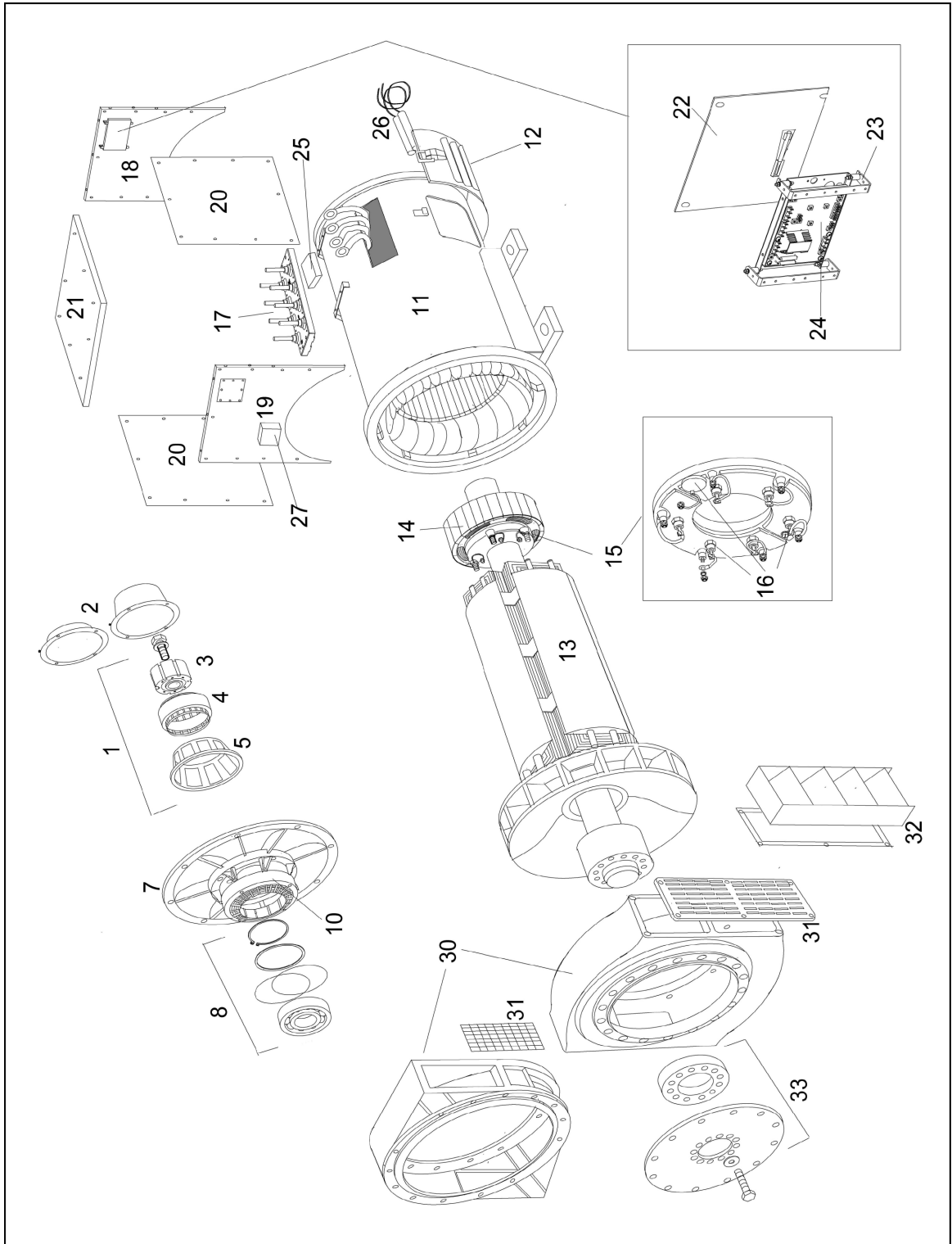


FIGURE 27. S4 SINGLE BEARING ALTERNATOR

8.2 S4 Single Bearing Alternator (Dedicated)

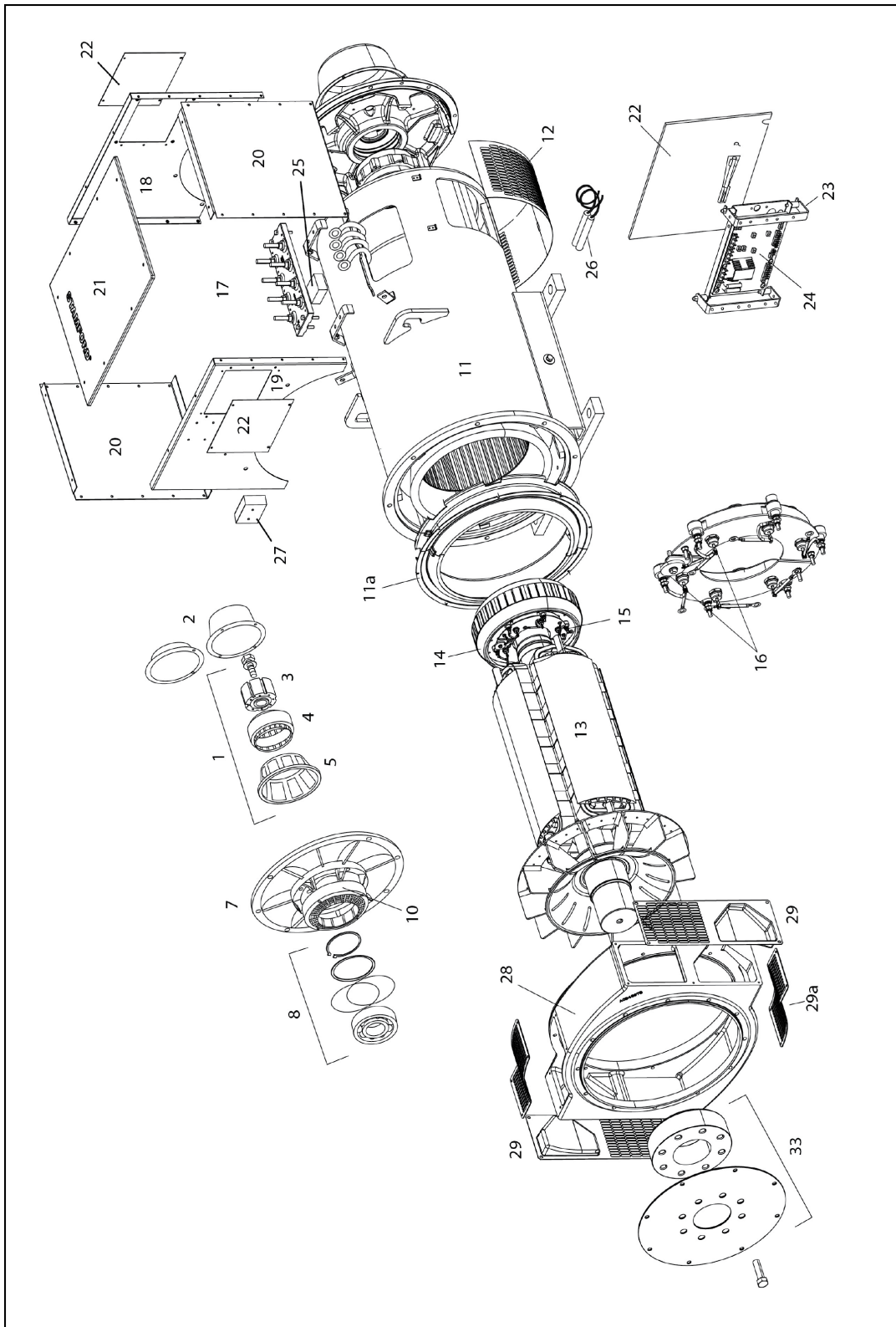


FIGURE 28. S4 SINGLE BEARING ALTERNATOR (DEDICATED)

8.3 S4 Two Bearing Alternator

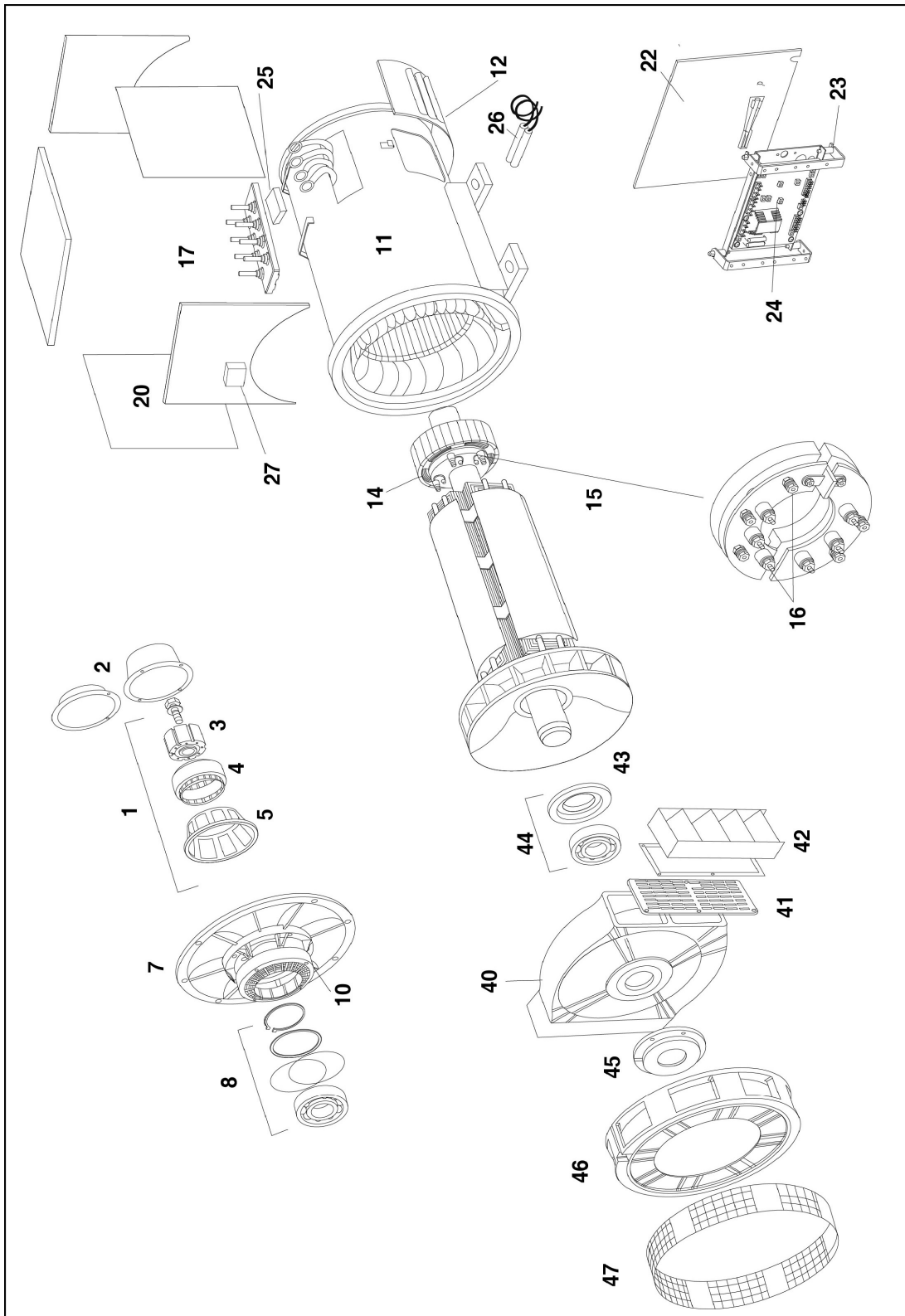


FIGURE 29. S4 TWO BEARING ALTERNATOR

8.4 S6 Single Bearing Alternator

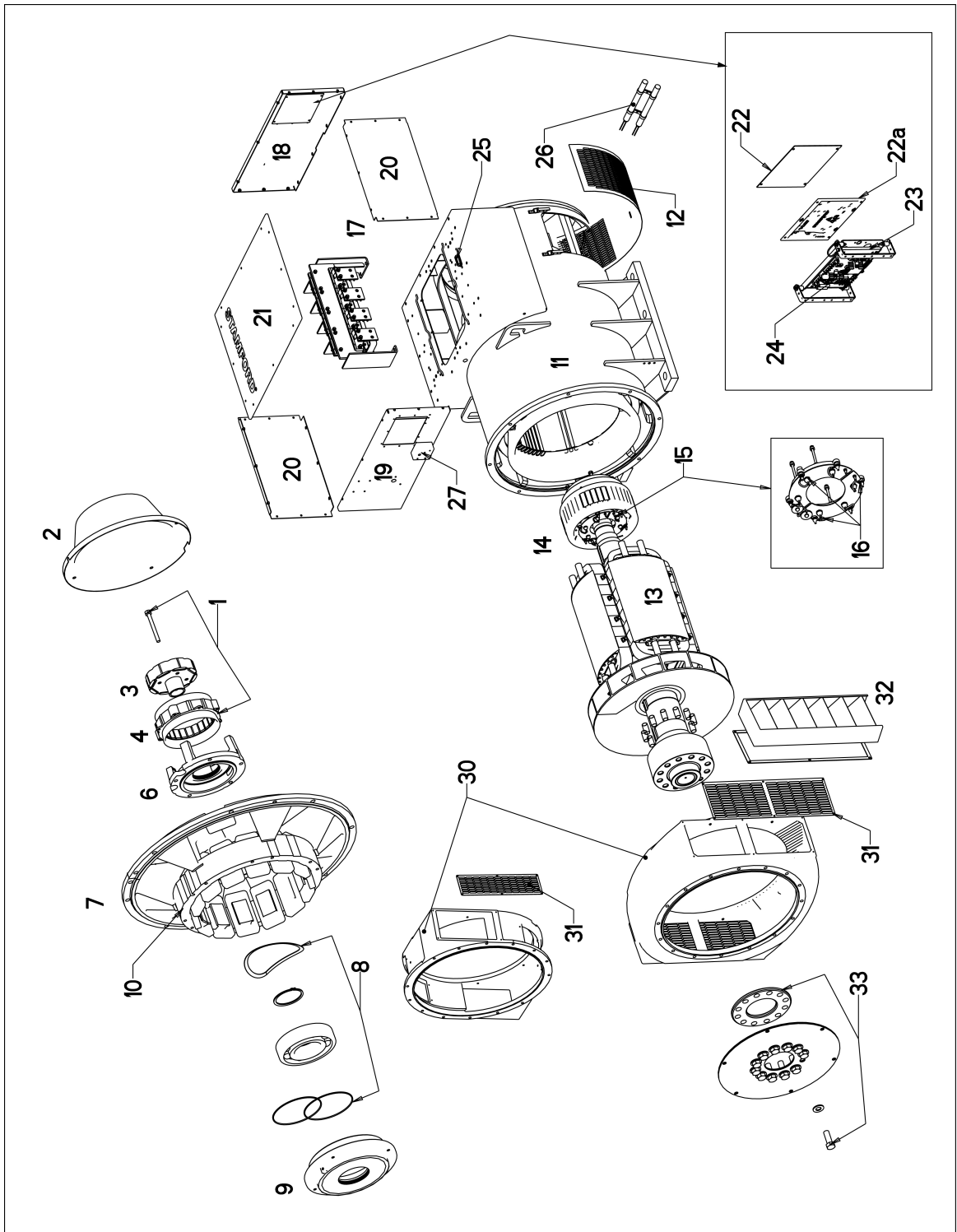


FIGURE 30. S6 SINGLE BEARING ALTERNATOR

8.5 S6 Single Bearing Alternator (Dedicated)

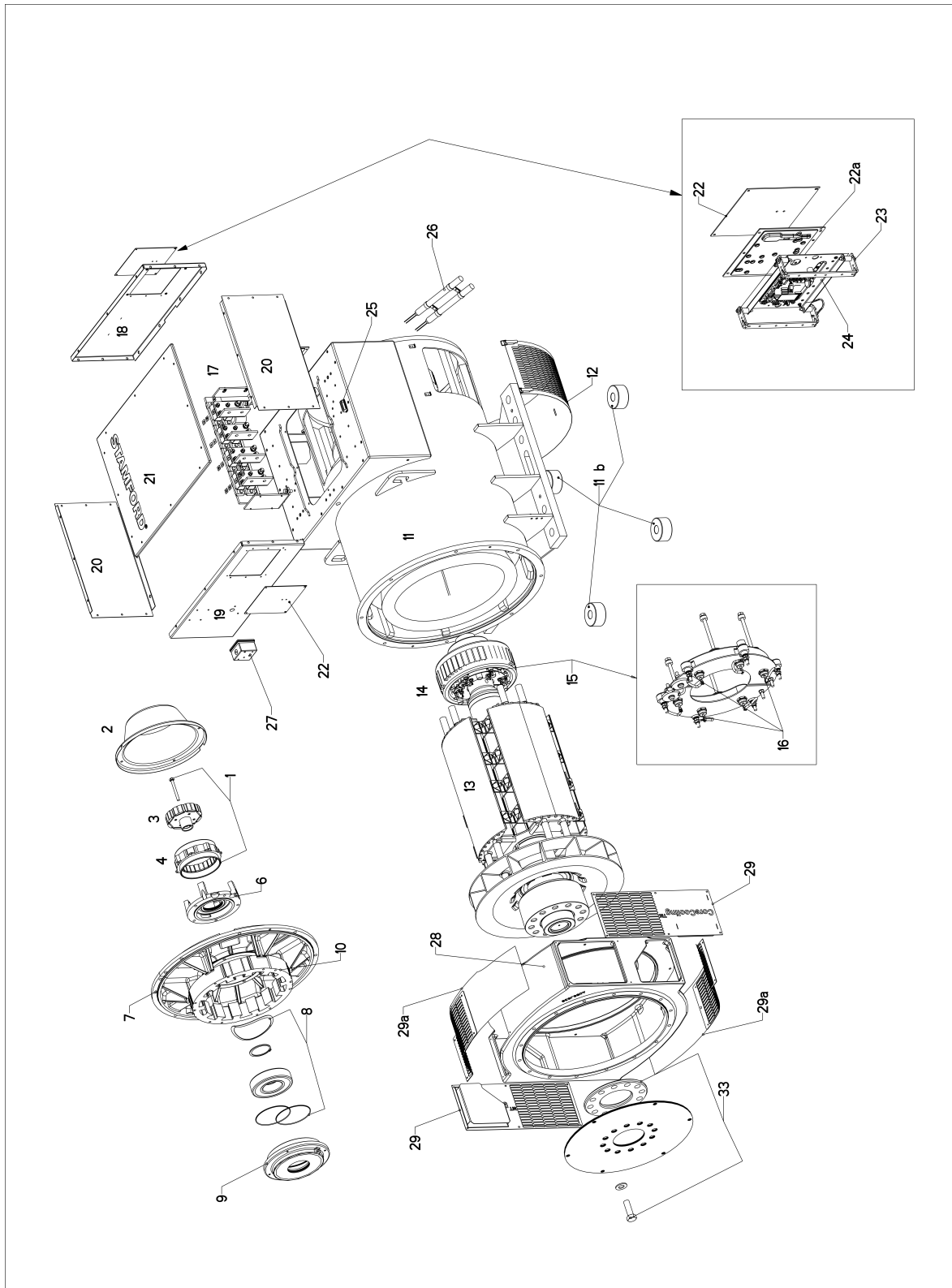


FIGURE 31. S6 SINGLE BEARING ALTERNATOR (DEDICATED)

8.6 S6 Two Bearing Alternator

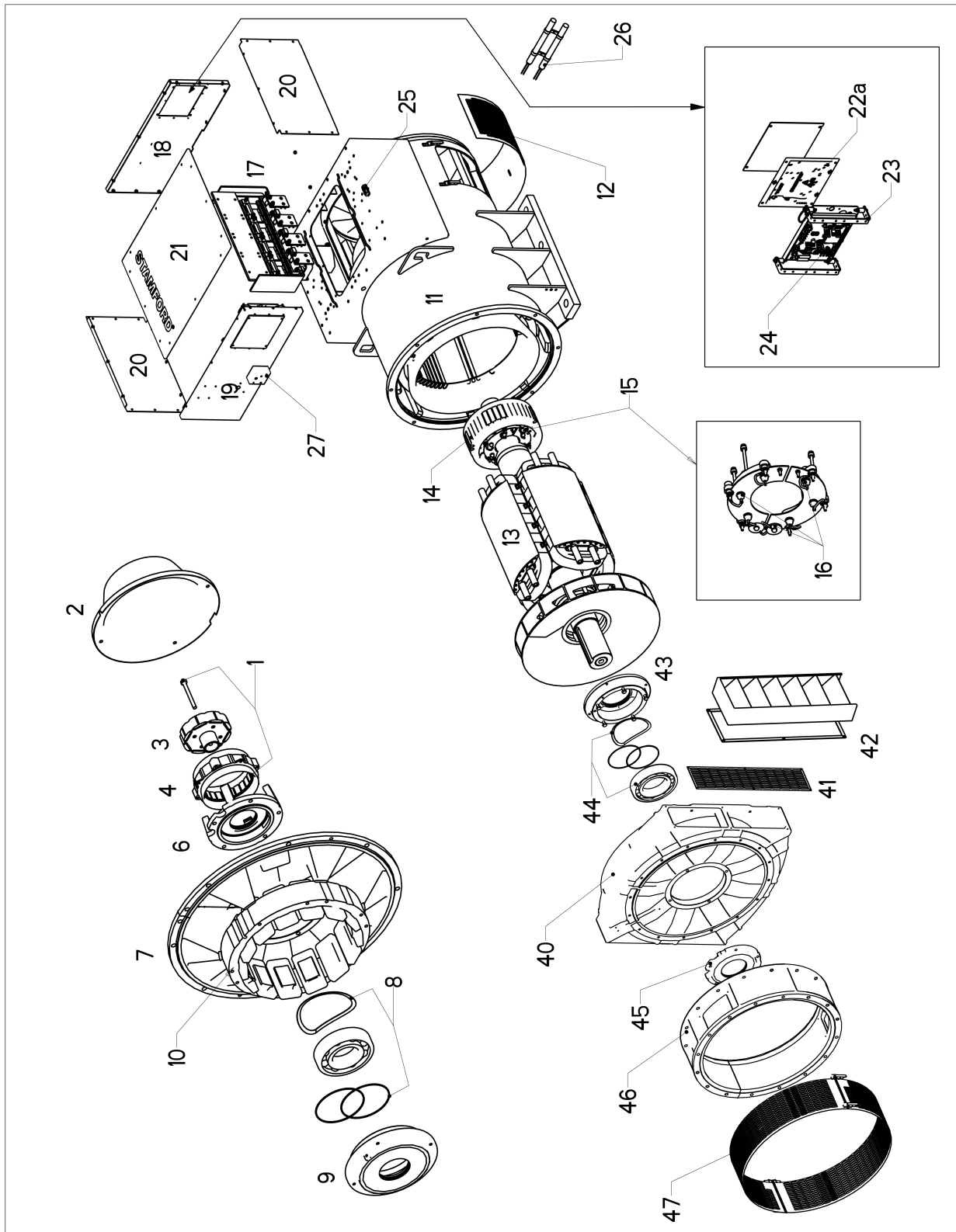


FIGURE 32. S6 TWO BEARING ALTERNATOR

8.7 S6 Two Bearing Alternator (Dedicated)

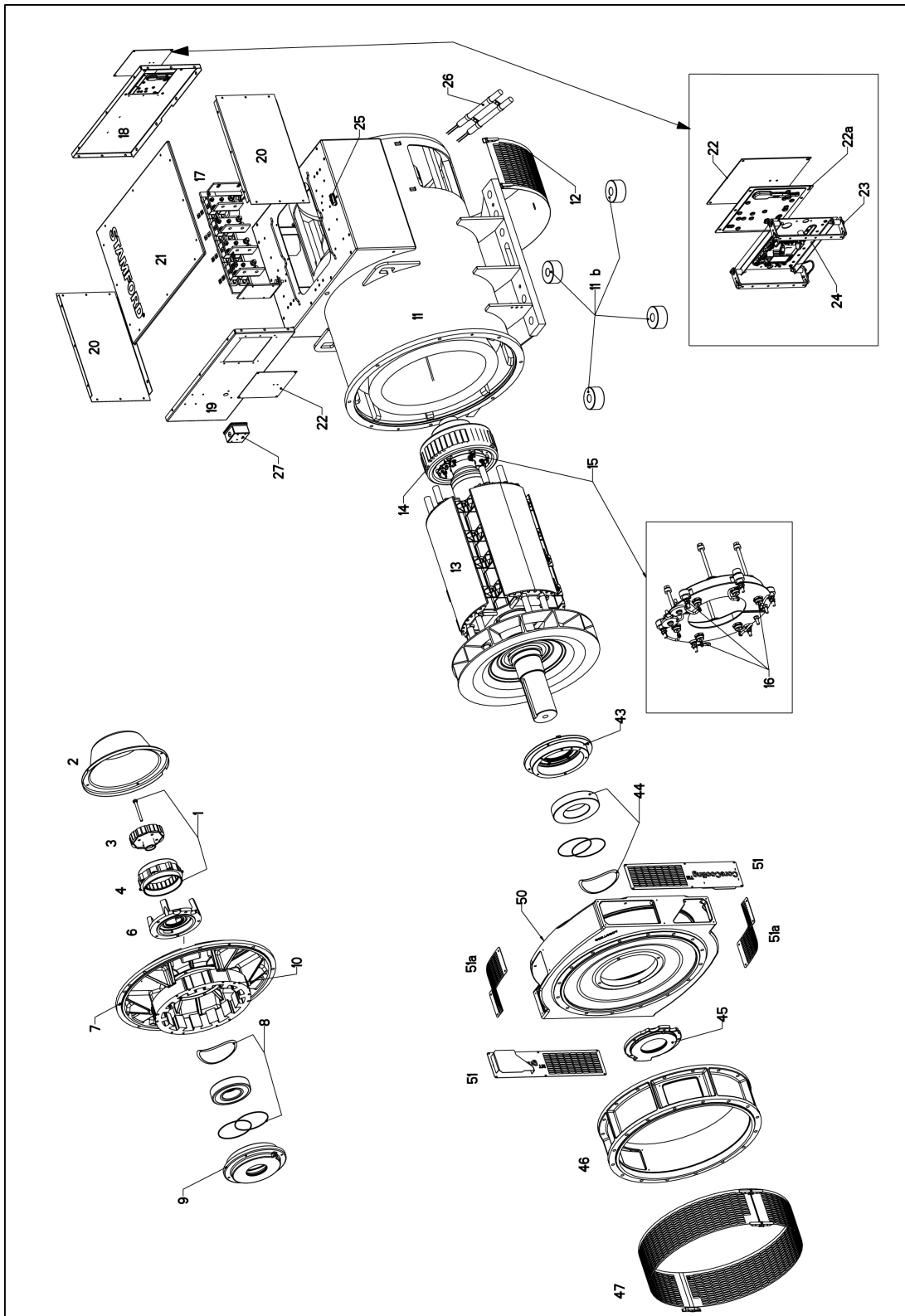


FIGURE 33. S6 TWO BEARING ALTERNATOR (DEDICATED)

8.8 S4 Parts and Fasteners

TABLE 21. S4 PARTS AND FASTENERS

Ref	Component	Fastener	Quantity	Torque (Nm)
1	Complete PMG parts	-	-	-
2	PMG Cover/non-PMG Cover	M6 x 16	4	10
3	PMG Rotor	M10 x 100	1	50
4	PMG Stator	M6 x 45	4	10
5	PMG Crown	-	-	-
6	No referencing	-	-	-
7	NDE Bracket	M10 x 35	8	50
8	Complete NDE Bearing parts	-	-	-
9	No referencing	-	-	-
10	Exciter Stator	M8	6	26
11	Main Frame	-	-	-
11a	Baffle	-	-	-
12	Air Inlet Cover	Split pin	-	-
13	Main Rotor	-	-	-
14	Exciter Rotor	-	-	-
15	Rectifier Assembly	M6 x 65	4	10
16	Diode/Varistor	-	-	2.6 - 3.1
17	Main Terminals	M12	8	50
18	Terminal Box End Panel NDE	M10 x 35	4	50
19	Terminal Box End Panel DE	M10 x 25	2	50
20	Terminal Box Side Panel	M6 x 12	10 each	6
21	Terminal Box Lid	M6 x 12	8	6
22	AVR Cover Plate	M5 x 12	4	5
23	AVR Mounting Bracket	M5 x 12	6	5
24	AVR	M5 x 30	4	5
25	Auxilliary Terminal Board	M6 x 25	8	10
26	Anti-condensation Heater	M6	2	n/c
27	Heater terminal Box	M5 x 12	1	5
		M5 x 16	1	5
28	DE Adaptor - Dedicated (1 Bearing)	M12 x 40	8	95
29 29a	DE Air Outlet Screens - Dedicated (1 Bearing)	M5 x 12	20	5
30	DE Adapter (1 Bearing)	M12 x 40	8	95

Ref	Component	Fastener	Quantity	Torque (Nm)
31	DE Air Outlet Screen (1 Bearing)	M5 x 12	12	5
32	DE Louvres (1 Bearing)	M5 x 16	12	5
33	DE Coupling Hub and Coupling Discs (1 Bearing)	M20 various	8	479
34 - 39	No referencing	-	-	-
40	DE Bracket - Standard (2 Bearing)	M12 x 40	8	95
41	DE Air Outlet Screen - Standard (2 Bearing)	M5 x 12	12	5
42	DE Louvres - Standard (2 Bearing)	M5 x 16	12	5
43	DE Bearing Cartridge (2 Bearing)	M10 x 50	4	50
44	Complete DE Bearing parts (2 Bearing)	-	-	-
45	DE Bearing Cap (2 Bearing)	M10 x 30	4	50
46	DE Adapter - Standard (2 Bearing)	M12 x 40	8	95
47	DE Adaptor Screen - Standard (2 Bearing)	M5 x 12	12	5

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9 Technical Data

NOTICE

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

9.1 S4 Winding Resistances

TABLE 22. S4 WINDING RESISTANCES

Alternator	Resistance of windings at 22 °C (measured values should be within 10%)									
	Main Stator (lead - lead) (Ohms)						Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, (if fitted) L-L (Ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	17 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	13 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	14 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	25 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	27 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)				
S4L1-C4	0.0083	0.0115	n/a	0.0055	0.0020	0.0154	18	0.136	0.92	3.8
S4L1-D4	0.0062	0.0100	n/a	0.0045	0.0160	0.013	18	0.136	1.05	3.8
S4L1-E4	0.0045	0.0075	n/a	n/a	0.0140	0.0100	18	0.136	1.19	3.8
S4L1-F4	0.0037	0.0055	0.0060	n/a	0.0105	0.0075	18	0.136	1.37	3.8
S4L1-G4	0.0033	n/a	n/a	n/a	n/a	n/a	18	0.136	1.44	3.8

9.2 S6 Winding Resistances

TABLE 23. S6 WINDING RESISTANCES

Alternator	Resistance of windings at 22 °C (measured values should be within 10%)									
	Main Stator (lead-lead) (Ohms)						Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	312 (U1-U2) (V1-V2) (W1-W2)	07 (U1-U2) (V1-V2) (W1-W2) 17 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	13 (U1-U2) (V1-V2) (W1-W2) 14 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	25 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6) 26 (U1-U2) (V1-V2) (W1-W2)	27 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6) 28 (U1-U2) (V1-V2) (W1-W2)				
S6L1-C4	n/a	n/a	0.0055	0.0020	0.0090	0.0075				
S6L1-D4	n/a	n/a	0.0036	0.0019	0.0080	n/a	17	0.158	1.88	3.8
S6L1-E4	n/a	n/a	0.0030	0.0015	0.006	n/a	17	0.158	2.09	3.8
S6L1-F4	n/a	n/a	0.0026	0.0010	0.0045	0.0030	17	0.158	2.36	3.8
S6L1-G4	n/a	n/a	0.0026	0.0013	0.0048	0.0031	17.5	0.126	1.67	3.8
S6L1-H4	n/a	n/a	0.0026	0.0013	0.0048	0.0031	17.5	0.126	1.67	3.8
S6L1D-C4	0.0017	0.0033	n/a	n/a	n/a	n/a	18.33	0.19	1.62	3.8
S6L1D-D4	0.0011	0.0021	n/a	n/a	n/a	n/a	18.33	0.19	1.81	3.8
S6L1D-E4	0.0011	0.0022	n/a	n/a	n/a	n/a	19.41	0.2	1.9	3.8
S6L1D-F4	0.0009	0.0018	n/a	n/a	n/a	n/a	19.41	0.2	2.11	3.8
S6L1D-G4	n/a	0.0018	n/a	n/a	n/a	n/a	19.41	0.2	2.22	3.8
S6L1D-H4	n/a	0.0014	n/a	n/a	n/a	n/a	19.41	0.2	2.4	3.8

10 Service Parts

Servicing and repairing your alternator with Genuine STAMFORD® parts is critical to ensure maximum life and reliability of your product. For further parts information and details of your nearest outlet visit www.stamford-avk.com/parts.

10.1 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.

10.2 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.

10.3 Recommended Service Parts

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

TABLE 24. S4 SERVICE PARTS

Part	Number
Rectifier set (3 forward & 3 reverse diodes with varistors)	RSK-5001
Rotating rectifier assembly	760-11216
MX321™ AVR (if fitted)	E000-23212/1P
MX341 AVR (if fitted)	E000-23412/1P
AS440 AVR (if fitted)	E000-24403/1P
Sealed Bearing DE	45-0319
Sealed Bearing NDE	45-0320

TABLE 25. S6 SERVICE PARTS

Part	Number
Rectifier set (3 forward & 3 reverse diodes with varistors)	RSK-6001
Rotating rectifier assembly	450-16025
MX321™ AVR (if fitted)	E000-23212/1P

Part	Number
MX341 AVR (if fitted)	E000-23412/1P
DECS 100-B11 digital AVR (if fitted)	A054S072
S6 1 Bearing	
Sealed Bearing NDE Kit	45-0340
Re-greasable Bearing NDE Kit	45-0343
S6 2 Bearing	
Sealed Bearing DE Kit	45-0339
Sealed Bearing NDE Kit	45-0340
Re-greasable Bearing DE Kit	45-0342
Re-greasable Bearing NDE Kit	45-0343

10.4 Klüber Asonic GHY72 Grease

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

11 End of Life Disposal

11.1 General Guidance

When disposing of an alternator, component parts or packaging:

1. Always process materials in accordance with all locally applicable rules and regulations.
2. Always process waste in an environmentally responsible manner, always reuse, reclaim and / or recycle materials wherever possible.
3. Consult with local specialized waste disposal / processing / recycling companies for assistance / advise in disposing of an alternator, component parts or packaging .

11.2 Packaging Material

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

- Wooden packaging can be recycled. However, wood treated with preservative chemicals must be processed appropriately. **Do not burn chemically treated wood.**
- All plastic packaging can be recycled.
- All paper and cardboard packaging can be recycled.
- Anti-corrosion agents that cover the surface of the alternator can be cleaned using a cleaning agent and a cloth. The cloth is to be disposed as contaminated waste, refer to [Section 11.4](#).
- Desiccants/drying agents are to be disposed of as hazardous waste, refer to [Section 11.4](#)

11.3 Recyclable Material

Separate items containing recyclable base materials, such as; iron, copper and steel, by removing non-recyclable and/or hazardous materials from them such as oils, grease, lubricants, fuel, adhesive, desiccants (drying agents), battery acid, cleaning agents, solvent or corrosive substances, paint, polyester resin, insulation tape or plastics residues from all components.

- Items containing; iron, steel and copper can now be recycled via specialized material recycling companies.
- Separate the removed material in to hazardous waste and non-hazardous waste in accordance with local rules and regulations.
 - Dispose of any hazardous materials as hazardous waste, refer to [Section 11.4](#).
 - All non-hazardous materials that cannot be reused, re-purposed or recycled can now be processed as general waste.

11.4 Hazardous or Contaminated Waste

⚠ CAUTION

Hazardous Substances

Contact with hazardous substances such as; oils, grease, lubricants, fuel, adhesive, desiccants (drying agents), battery acid, cleaning agents, solvent or corrosive substances, paint, polyester resin and/or plastic residues can cause minor or moderate injury by contact/inhalation. Prolonged/repetitive exposure may lead to more serious medical conditions developing. To prevent injury:

- ***Always read and comply with the information provided by the product manufacturer, use, handle and store substances accordingly.***
- ***Always wear appropriate personal protection equipment, as per product manufacturer information and the Safety Precaution Chapter.***

Waste material such as, but not limited to; oils, grease, lubricants, fuel, adhesive, desiccants (drying agents), battery acid, cleaning agents, solvent or corrosive substances, paint, polyester resin or plastic residues or articles contaminated with such substances may be considered hazardous waste by locally applicable regulations.

- Always handle, store, transport, process and dispose of these types of waste in accordance with locally applicable rules and regulations.
- Consult a specialized waste disposal company for assistance/advise in disposing of hazardous waste or contaminated articles if required.

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