Medium-speed synchronous generators
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Introduction

Synchronous machines have always played a major role in our product range at VEM. We at our Sachsenwerk plant have decades of experience in manufacturing high-voltage machines combined with state-of-the-art expertise in:

- Electromagnetic and structural design
- High-voltage insulation
- Innovative cooling technology
- Programmable logic control systems
- Rationalised cost-efficient production methods

All of these benefits you will find in our new range of medium-speed three-phase high-voltage generators. We planned and designed this generator range to ensure the following characteristics:

- High efficiency
- Long service life
- Low installation and commissioning costs
- Low maintenance
- Low noise emissions

Our synchronous generators are manufactured at the VEM Dresden location’s Sachsenwerk plant, and shipped from there to customers across the globe as stationary installations on land or at sea, on ships and oil platforms.

We serve a wide variety of application areas:

- Continuous power in insular systems and parallel power generation
- Emergency power
- Peak load operation

Our generators may be driven by diesel or gas motors, or water, gas or steam turbines.

Note:
We constantly improve on our products. Versions, technical specifications and images are subject to change, and are only binding on written confirmation by the supplier.
Motors shown in this brochure are examples for information only, and may include accessories only available at additional cost.
Product overview

Our new medium-speed three-phase high-voltage generators in salient pole design are available at 900 mm
to 1,120 mm shaft height with eight to twelve poles.
Other numbers of poles upon request.

Standard design

Voltage: 6.3 (6.6) kV and 10.5 (11.0) kV
Frequency: 50 Hz or 60 Hz
Power factor cos $\phi$: 0.8 ü
Thermal class: 155 (F) utilisation based on 155 (F)

Diesel generators 6.3 and 10.5 kV,
50 Hz, cos $\phi$ 0.8, F/F
Product overview

Our new medium-speed three-phase high-voltage generators in salient pole design are available at 900 mm to 1,120 mm shaft height with eight to twelve poles. Other numbers of poles upon request.

Standard design

**Voltage:** 6.3 (6.6) kV and 10.5 (11.0) kV  
**Frequency:** 50 Hz or 60 Hz  
**Power factor cos $\varphi$:** 0.8 ü  
**Thermal class:** 155 (F) utilization based on 130 (B)

Diesel generators 6.3 and 10.5 kV, 50 Hz, cos $\varphi$ 0.8, F/B

![Chart showing power vs. pole number for diesel generators 6.3 and 10.5 kV.]
Medium-speed synchronous generators

Product overview

IP codes and cooling

<table>
<thead>
<tr>
<th>IP code</th>
<th>IP 23</th>
<th>IP 44</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling type</td>
<td>IK 0 A1</td>
<td>IC 8 A1 W7</td>
</tr>
</tbody>
</table>

Design versions

Our brushless synchronous generators are usually supplied in the following versions:

- IM B20 (IM 1101)
- IM B3 (IM 1001)
- IM B25 (IM 2401)
- IM B16 (IM 1305)

Technical design

Matching electrical output power with the motor’s mechanical power and potential overload requirements depending on intake temperature and local installation height plays an important role in selecting a generator. Additional details such as IP code compliance, cooling type, design, bearings and foundations, and an ideal choice of excitation system and impact on mains stability and quality naturally also play a role in optimising a generator to local conditions. Our project planning department at VEM provides answers to these questions as well as assistance in selecting the right generator.
Type identification

Type identification from our Sachsenwerk plant consist of letters and digits.

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
<th>Content</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Current type</td>
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<tr>
<td>2</td>
<td>Machine type</td>
<td>G, R</td>
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<tr>
<td>3</td>
<td>Cooling, IP code</td>
<td>A, K</td>
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<td>4 and 5</td>
<td>Design type</td>
<td>(encoded)</td>
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<tr>
<td>6 and 7</td>
<td>Shaft height</td>
<td>(encoded)</td>
</tr>
<tr>
<td>8 and 9</td>
<td>Laminated core length</td>
<td>(encoded)</td>
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<tr>
<td>10 and 11</td>
<td>No. of poles, speed</td>
<td>(encoded)</td>
</tr>
<tr>
<td>12 to 14</td>
<td>Additional letter</td>
<td>Code letters for special winding designs, pole types and revision level</td>
</tr>
</tbody>
</table>

Standards and regulations

Our motors comply with all relevant international standards, as well as the current DIN standards and VDE regulations, for standard versions esp. IEC 60034 - DIN EN 60034 (VDE 0530) with the following parts:

- **Part 1** Rating and performance
  - IEC 60034-1 – DIN EN 60034-1 (VDE 0530-1)
- **Part 2** Standard methods for determining losses and efficiency from tests
  - IEC 60034-2- …(several parts) – DIN EN 60034-2- … (VDE 0530-2- …)
- **Part 4** Methods for determining synchronous machine quantities from tests
  - IEC 60034-1 – DIN EN 60034-4 (VDE 0530-4)
- **Part 5** Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification
  - IEC 60034-5 – DIN EN 60034-5 (VDE 0530-5)
- **Part 6** Methods of cooling (IC Code)
  - IEC 60034-6 – DIN EN 60034-6 (VDE 0530-6)
- **Part 7** Classification of types of constructions and mounting arrangements (IM Code)
  - IEC 60034-7 – DIN EN 60034-7 (VDE 0530-7)
- **Part 8** Terminal markings and direction of rotation
  - IEC 60034-8 – DIN EN 60034-8 (VDE 0530-8)
- **Part 9** Noise limits
  - IEC 60034-9 – DIN EN 60034-9 (VDE 0530-9)
- **Part 14** Mechanical vibration of certain machines with shaft heights 56 mm and higher
  - IEC 60034-14 – DIN EN 60034-14 (VDE 0530-14)
- **Part 15** Impulse voltage withstand levels of form-wound stator coils for rotating AC machines
- **Part 18** Partial discharge free electrical insulation systems (Type I) used in rotating electrical machines fed from voltage converters – Qualification and quality control tests
  - IEC 60034-18- … (several parts) – DIN EN 60034-18- … (VDE 0530-18- …)
- **Part 27** Off-line partial discharge measurements on the stator winding insulation of rotating electrical machines
  - DIN CLC/TS 60034-27; VDE V 0530-27
- **Part 29** Equivalent loading and superposition techniques – Indirect testing to determine temperature rise
  - IEC 60034-29 – DIN EN 60034-29 (VDE 0530-29)

as well as

- ISO 10816- … – DIN ISO 10816- … Evaluation of machine vibration by measurements on non-rotating parts (several parts)
- ISO 21940-32 – DIN ISO 21940-32 Shaft and fitment key convention
- ISO 1940- … – DIN ISO 1940- … Balance quality requirements of rigid rotors... (several parts)

We supply to other standards on request such as pending IEC standards and regulations of all major marine classification societies.
Features and operating performance
**Voltage and frequency**

The generators in this range are available in basic designs for rated voltages 6.3 and 10.5 kV for 50 Hz, and 6.6 and 10 kV for 60 Hz. The range for set-point controller amounts to ± 5 % of rated voltage UN. Values in deviation from these nominal voltages and set-point range are available on request.

**Voltage waveform**

Open-circuit line voltage with corresponding winding design is practically sinusoidal. The total harmonic distortion (THD) lies below the limit set [1].

**Stator winding circuit**

The stator winding is connected in star configuration. The neutral point is designed to be open for protection and instrument transformer installation.

**Overload capacity**

Our synchronous generators are designed for an overload of 1.5 times rated current for a period of 120 s, and can be operated for one in six hours at 1.1 times rated current taking overload capacity of internal combustion motors into account. The exciter unit is generously dimensioned for dynamic processes. An excitation system ceiling voltage of approximately 2.3-fold for dynamic events is available.

**Short-circuit behaviour**

**Sudden short-circuit current**

The peak value for sudden short-circuit current in a short-circuited three-phase generator magnetised to rated voltage is substantially lower than the

\[ I_\text{s} \leq 21 \times I_N \]  

limit according to [1].

**Sustained short-circuit current**

The auxillary generator winding and excitation system are matched in such a way as to generate a necessary short-circuit current of approximately 3 x I N for t ≤ 5 s on a three-phase terminal short circuit.

**Unbalanced load**

A generously dimensioned damper cage allows for unbalanced load. Our synchronous generators are suitable for permanent unbalanced load of I2/IN ≤ 10 % (inverse current/ rated current). However, we recommend aiming towards a balanced load for optimal operation.

**Dynamic voltage behaviour**

Sudden load changes result in voltage changes (AU), which are mainly determined by transient generator dimensions and external connection conditions such as

- Output on connection
- cos ϕ during connection
- Generator at open circuit or on load

Connections on load of around I N and cos ϕ ≤ 0.4 will likely lead to transient voltage drops of ΔU 15–25 %. Transient generator voltage behaviour depends on the time constant in the main generator, exciter and control system. A generously dimensioned excitation system ensures short settling times. The transient voltage settling time is around 600 ms depending on the number of poles and generator output. The generator first reaches the voltage tolerance range after about 300 ms, and remains within the static voltage tolerance range specified after settling.

**Power plant properties and system feedback**

The generator, excitation system and voltage controller are perfectly matched to meet the necessary legal requirements for power plants and permissible system feedback for supplying power to the national grid.

The requirements and limits on connection to the medium, high and very high-voltage grid in Germany are mainly defined in [5] and [6] with compliance documented by a unit certificate according to [7]. This unit certificate must be issued by an accredited certification body with the necessary measurements carried out by a testing laboratory accredited in accordance with EN 17025.

We provide support for the certification process on request. This may involve providing a configured simulation model of the electrical system consisting of generator, excitation system and voltage controller [8]; we can also carry out some of the tests and validations for the simulation model required by [9] according to [8] using our own testing facilities. These include harmonic measurements, reactive power supply and some of the measurements involved in low-voltage ride through (LVRT) testing before delivery, which greatly reduces the time and effort that you as our customer will need for commissioning.

**Marine classification**

Depending on the classification regulations, the limits on permissible winding temperatures are somewhat lower than in [1]. This might require corresponding derating.

<table>
<thead>
<tr>
<th>Overload requirements/ permissible temperature rise</th>
<th>Classification regulation</th>
<th>Coolant temperature [°C]</th>
<th>Permissible stator winding heating 155 [°K]</th>
<th>Overload and duration</th>
<th>S/SN</th>
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<tr>
<td></td>
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<td>40</td>
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<td>30 s</td>
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<td>2 min</td>
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<td></td>
<td>American Bureau of Shipping</td>
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<td>90</td>
<td>-</td>
<td>0.925</td>
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</table>
Brushless excitation system

A uniform excitation principle is used across the entire output range. By default, an auxiliary winding supplies the exciter unit (Figure 1) to separate it from the voltage level of the main generator. A separately installed permanent-magnet pilot exciter may optionally replace the auxiliary winding supply to the exciter unit (Figure 2).

A three-phase external pole exciter built into the N-side supplies the excitation current to the pole winding of the main generator, ensuring more than sufficient power for all operating conditions while maintaining continuous short-circuit current. The rectified auxiliary voltage from the auxiliary winding or auxiliary exciter is supplied to the controller, which then supplies the necessary excitation current to the exciter depending on operating state.

Figure 1: Block diagram: brushless excitation system with auxiliary winding

Figure 2: Block diagram: brushless excitation system with permanent magnet generator

Excitation system with digital controller

The brushless excitation system with an AC exciter, rotating rectifier bridge, and over-voltage protection circuitry is designed according to established principles. Over-sizing ensures that all operating points are kept within the stable generator power graph as well as overloads, fulfilling all dynamic requirements that apply.

The digital controller provides the following basic functions to the operator:
- Voltage regulation (± 0.5 %)
- Remote set-point adjustment by external contacts
- Reactive droop
- Frequency-dependent voltage division
- Excitation current limit
- Automatic remanent voltage build-up
- Automatic de-excitation on shut-down
- Fast de-excitation
- Excitation error messaging
- Plug-in configuration and diagnostics

Optional additional functions:
- Generator current limit
- Reactive power or cos ϕ control
- Internal or external reactive power specification
- Reactive power limitation
- Mode selection by external contacts
- Rotating diode defect messaging

Exciter and generator currents are limited using a time-dependent threshold to take both the dynamics and the permissible generator heating into account.

The exciter is installed in a cabinet for wall mounting, and is equipped with an interface for convenient configuration and diagnostics via notebook. The configuration notebook is available as an option.

The excitation system may also be extended by the following functions without requiring mechanical changes:
- Battery excitation
- Load-angle limit
- Line compensation
- Switchable active power stabilisation

The exciter is certified for the following marine classifications:
- Lloyd’s Register
- Bureau Veritas
- Rina

The system is connected via cable connection to the terminal strip in the machine’s auxiliary terminal box.
The excitation system may optionally be extended to the generator control cabinet, which may include the following functions:

- Brushless rotor earth fault and rotor measurement recording
- Generator protection with the following functions (not-exhaustive):
  - ANSI 87  - Generator differential protection
  - ANSI 64G  - Stator earth fault protection
  - ANSI 32R  - Reverse power protection
  - ANSI 40  - Under-excitation protection
  - ANSI 46  - Unbalanced load protection (two-stage)
  - ANSI 61  - Over-current protection with under-voltage preservation
  - ANSI 51V  - Inverse time overcurrent protection
  - ANSI 27  - Under-voltage protection
  - ANSI 81  - Frequency protection
  - ANSI 59  - Over-excitation protection
  - ANSI 40  - Under-excitation protection
  - ANSI 64R (1–3 Hz)  - Rotor earth fault protection 1–3 Hz
  - ANSI 50BF  - Breaker failure protection
- Generator synchronisation (several synchronising points)

The unit is mounted into a standing cabinet.
Structural design

Our three-phase synchronous generators mainly consist of the following assemblies: stator, rotor, bearing shields, friction bearings, an exciter and ventilation hood.

Stator

The stator consists of a welded construction with the stator laminated core shrunk-in. The stator core assembly consists of insulated dynamo core segments axially clamped on by extrusion billets. The three-phase two-layer winding lies in the open slots in the laminated core. The preformed coils consist of flat copper wire with mica sheet insulation. The main insulation consists of low-binder mica-glass cloth tape. Low-impedance corona shielding on the slot part and high-impedance corona shielding on the slot end to prevent corona discharges. The fully insulated coils are secured using slot closures in the slots. The circuit connections are brazed on. The stator winding is vacuum pressure-impregnated using epoxy resin (insulation VEMoDLUR®-VPI-155).

Rotor

The rotor consists of a forged shaft, shrunk-on rotor yoke with poles, and the exciter rotor. Directly wound laminate cores with salient poles or directly wound individual poles mounted onto the rotor yoke may be used depending on generator size. The field coils consist of copper wire with vitreous enamel insulation. Vacuum-pressure impregnation and field-coil supports arranged in the gaps between the poles ensure the required resistance to stress caused by centrifugal forces. A damper winding consisting of copper rods soldered to the damper segments is mounted onto the heads of the poles. All rotors are dimensioned for 60 Hz operation. The rotor core is pressed on using pressure plates connected to the shaft.

Bearing shields

The bearing shields are designed as welded pot bearing shields. The centring between the end plates and stator eliminate the need for air gap checks, even after dismantling. Radially mounted guides ensure precise tangential positioning of the bearing shields against the stator housing after dismantling.

Friction bearing

The friction bearings are designed as side flange-mounted bearings screwed to the centring on the bearing shield, and are fitted with a horizontally split casing, a split bearing shell with cast bearing metal, an oil ring and various seals. The bearings comply with IP 44 in the basic version. Additional seals may be used for compliance with higher levels of protection (IP 55).

The friction bearings are normally designed as floating bearings, and do not take axial loads. They may be supplied in various designs depending on the specific requirements, including ring oil lubrication, winding oil lubrication, hydrostatic shaft lifting, water cooling, insulated and as a fixed bearing. Any necessary lubrication fittings are available on request.

Exciter

The exciter is designed as an external pole machine. The exciter is mounted within the generator. The rotor and the rotating rectifier bridge in the exciter are mounted onto a common hub on the generator shaft.

Ventilation hood

The ventilation hood design depends on ventilation type. The inlet and outlet air grilles are arranged on the D and N sides on the left and right in the ventilation hood for ventilation type IC 0 A1 with draft ventilation. Generators in this design comply with IP 23. The air-water heat exchanger is mounted into the ventilation hood in ventilation type IC 8 A1 W7 with air-water cooling. Generators in this design comply with IP 54. Air-water heat exchangers may be designed as double-pipe coolers on request.

The main and auxiliary ventilation terminals as well as current and voltage transformers are located in the ventilation hood in all ventilation types. The main connection cable may lead into the hood from the left or right, and from above or below. The auxiliary power cable leads in from the N side from above or below. All entry plates are not drilled. Bolted cable fastenings or packing frames are also available on request.

Monitoring

The generator is monitored as follows:

- 3 PT 100 in the stator winding + 3 in reserve
- 1 double PT 100 per bearing shell
- The monitor cable may be connected from the terminals using the four-wire technique.

More monitoring elements may be added on request, such as a PT 100 for cooling air, leakage protection, oil level indicator, oil sump thermometer and shaft vibration monitoring.
VEMoDUR insulation system
VEMoDUR insulation system

Winding insulation quality plays a major role in operational reliability in electrical machines. VEM Sachsenwerk GmbH's insulation system have always featured technical solutions that meet international standards in quality parameters while ensuring high levels of reliability and long lifetimes.

We use the VPI technique in every area of high-voltage equipment insulation; we developed VEMoDUR®-VPI-155 at our Sachsenwerk plant and tested it according to [2].

This insulation system has come to be a reference system for future comparative functional assessment according to [3] after decades of operating experience.

The insulation system's components consisting of winding and main insulation with high proportions of mica and epoxy resin are perfectly matched to one another. Our insulation systems are subject to permanent monitoring during the impregnation process for parameters such as:

- Resin viscosity
- Impregnation and curing temperature
- Pressure dwell times
- Low and high pressure
- PD level measurements

The insulation hardens in a rotational hardening process.

The VPI process ensures high mechanical strength especially in the windings, and excellent electrical resistance especially in high flash-over voltages, while reliably ensuring rated impulse voltages according to [4] in any generator.

The insulation system features a high resistance to humidity—that is, the winding is insensitive to humidity and corrosive gases.

Routine tests include intermediate and final electrical testing on insulation strength including sudden and partial discharge testing, which may be separately agreed and performed on request.
Medium-speed synchronous generators

Quality assurance

Consistently high product quality, high customer satisfaction levels and sustainable processes are part of our company policy, and central to our working approach in theory and practice.

We at VEM Sachsenwerk GmbH have an integrated quality management system certified according to the International Railway Industry Standard (IRIS) Revision G2 as well as DIN EN ISO 9001:2008 and DIN EN ISO 14001:2009.

Our Quality Assurance department monitors the entire production process beginning with development, goods inward inspection and production processes up to final testing and delivery. We have around fifty experts in disciplines such as 3D measurement.

We subject every machine to a final internal inspection at our own testing facilities after manufacture. The particular machine’s test scope will depend on the standards and regulations that apply, as well as on customer specifications and internal regulations from a variety of departments.

We distinguish between routine tests applied as standard according to IEC 60034-1 – DIN EN 60034-1, and extended type tests. Depending on project type, the tests are supervised for acceptance by classification organisations, monitoring institutions and independent third-party watchdogs, and you as our customer also have the option of performing your own acceptance test.

Our state-of-the-art testing facilities for large machines are dimensioned for up to 6 MW continuous load over a wide speed range. A variable-frequency power supply with voltages ranging from 400 V to 15 kV allows for optimisation to testing requirements for a variety of machine types. Our extensive measurement equipment supports specific tests including thermography, structure-borne noise measurement, and partial discharge diagnosis.

The results of our tests are documented in a test protocol or test report. Each machine is released for delivery together with a 3.1 certificate according to EN 10204 as part of the documentation, which includes a clear summary of key test findings.

Documentation

Unless otherwise agreed, the operation and maintenance manual includes the documents listed below:

- EC declaration of incorporation
- Description and specifications
- Motor dimension drawing
- Cable connection dimension drawing
- Wiring diagrams
- Installation and assembly
- Commissioning
- Operation
- Maintenance
- Servicing
- Spare parts list
- Test certificate and log book
- Additional operating manuals (options, third-party suppliers)

Any additional documentation scope must be contractually agreed. The documentation is provided in two copies on delivery of the product. The documentation is available in all European Community languages.

Additional copies, expanded documentation scope, and translations into other languages will be charged separately.

Shipping, packaging, assembly

The type of packaging will depend on the structural machine design and the agreed transport and storage conditions.

We comply with any type of packaging requirement according to the HPE packaging guidelines. Our contractors pack the goods on site or at VEM.

Goods may be shipped assembled or in parts depending on weights and measures as well as contract terms.

We have long-standing arrangements with specialised companies for oversize shipments. We recommend that you have the required installation and commissioning services performed by our expert staff.

Any work to be performed or commissioned by the customer to a third party must be documented accordingly.

Failure to provide such documentation will result in loss of manufacturer liability and guarantee.

Service

Please contact our Customer Services department for queries regarding delivery. Our team supports operators of high-quality machines and systems with a wide range of services.

Testing centre services and contract manufacturing

Our powerful state-of-the-art testing technology allows us as a manufacturer-independent contractor to supply a full range of testing services such as routine, type and system testing. We also perform special tests on new products on request.

Our company has the necessary qualified staff and extensive experience in testing requirements of various acceptance testing organisations inside and outside Germany. Detailed test plans are available on request.

Mechanical calculations for condition and fault diagnostics

Awareness on the current state of technical systems as well as possible equipment failure before lasting damage is caused increases equipment lifetime while avoiding costly downtime and lengthy repairs. VEM draws up and evaluates vibration analyses that take your specific operating situation into account alongside the actual machines to be tested.

Assembly and start-up

Installation, commissioning, repairs and inspections on heavy industrial machines require extensive experience and sensitivity. It takes very experienced professionals to deal with the increasing complexity of machines and equipment as well as the local situation and the tight deadlines involved. Our field installation team has repeatedly proven our aptitude for satisfying these requirements the world over.

We develop project schedules together with our customers, acting locally with qualified staff in installing equipment or providing engineering supervision and support up to successful commissioning. Our detailed reports and measurement protocols document the quality of our services.

Technical services

We provide support for material faults within the statute of limitations, and also offer selected service modules to keep your equipment constantly available after commissioning. We provide property-related service agreements to define the nature and scope of our services.

Our team works closely with internal departments such as Planning and Design. We can advise you on all aspects of operating the machine and related peripherals.

On-call service

You can reach us from 8 AM to 5 PM CET/CEST on Mondays to Fridays except on public holidays. Further on-call availability is available by agreement.

Maintenance

We have experienced staff available for preparing service and maintenance plans. We are pleased to offer the necessary services for your drives.

Inspection

Inspections include the current electrical and mechanical condition of your drives.

We determine causes for conspicuous wear for appropriate counteraction, and recommend spare parts as necessary. We also advise on guarantee extension agreements as long as your machines are properly operated and maintained.

Repairs

We also provide high-quality repair and revamp services for electrical machines as a cost-effective alternative to new machine purchases; these services are usually carried out at our plant.

Training

We train customer staff locally or at our plant.

Spares parts

Please contact our expert team for any technical and commercial queries you might have about spare parts and inventory. A stock of spare parts on site will help us provide prompt service in the event of damage. We would be pleased to draw up an appropriate recommendation. We will also keep your reserve parts on store in Dresden on request.

General notes

Unless expressly stated otherwise, our machines are manufactured and supplied as follows:

- Manufacturing with the VEMoDUR insulation system
- Coating according to the Sachsenwerk SW-N 170-044 standard based on DIN EN ISO 12944/21-1, DIN 55268 Parts 8 and 9 and other applicable standards.
- The direction of rotation of the machine is clockwise as viewed from the drive end (DE). The terminal box is located on the right.
- The cooler is located on the machine and the water connection is mounted on the left as viewed from the drive end (DE).
- The water radiator has no water supply monitoring up to connection flange.
- No cable gland
- PT 100 for winding and bearing in 2-wire circuit without trigger, 2, 3 and 4-wire versions from terminal box connection.
- Mechanical vibrations comply with limits in IEC 60034-14 – DIN EN 60034-14 as documented in the VEM testing facility.
- Vibration monitoring without evaluation unit.
- VEM requires the use of an insulated coupling.
Medium-speed synchronous generators

Technical datas and dimensions
Technical data

Generators 6.3 kV, 50 Hz

cos \(\phi = 0.8\) (+), utilisation F/F

<table>
<thead>
<tr>
<th>Type</th>
<th>Apparent power</th>
<th>Active power</th>
<th>Mech. power</th>
<th>Nominal power</th>
<th>Speed</th>
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<th>(n = 3/4)</th>
<th>(n = 2/4)</th>
<th>Reactance</th>
<th>Reactions</th>
<th>Efficiency</th>
<th>Reactions</th>
<th>Time constants</th>
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<td>8000</td>
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Generators 6.6 kV, 60 Hz

cos \(\phi = 0.8\) (+), utilisation F/F

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Note: The table continues with similar entries for other generators.
### Technical datatas and dimensions

#### Medium-speed synchronous generators

**Medium-speed synchronous generators**

**Technical datatas and dimensions**

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### Dimension tables for generators in version IC 0 A1; IP 23; IM B3

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**DRAS. 9036-10WS**

- Total mass
- Rotor mass
- Dimensions mm

---

**DRAS. 9024-10WS**

- Dimensions mm
- Type
- kg
- kg/m³

---

**DRAS. 9022-12WS**

- Total mass
- Rotor mass
- Dimensions mm

---

**DRAS. 8036-12WS**

- Dimensions mm
- Type
- kg
- kg/m³

---

**DRAS. 8028-12WS**

- Dimensions mm
- Type
- kg
- kg/m³

---

**DRAS. 8024-12WS**

- Dimensions mm
- Type
- kg
- kg/m³
Medium-speed synchronous generators

Legend

[1] IEC 60034-1 – DIN EN 60034-1
[6] Transmission Code 2007, Netz- und Systemregeln der deutschen Übertragungsnetzbetreiber (Grid code for German power transmission companies)
[7] FGW – Technical Guideline for production units and equipment, Part 6: Bestimmung der elektrischen Eigenschaften von Erzeugungseinheiten und -anlagen am Mittel-, Hoch- und Höchstspannungsnetz (Certification of electrical properties in power-generation units and plants in the medium, high and very high-voltage grid)
Medium-speed synchronous generators

Notizen