ELECTRIC DRIVES
FOR EVERY DEMAND

Three-phase high-voltage asynchronous motors

Cage rotors, slipring rotors

ELECTRIC DRIVES
FOR EVERY DEMAND

Three-phase, high-voltage asynchronous motors are proven, high-performance drives for all branches of industry. Different types of protection and cooling make them suitable for universal implementation. VEM offers the right solution for every application, with machines that are competitive and in line with market requirements. They are durable and are characterised by their ease of maintenance, modular design, outstanding energetic parameters and low noise emissions. All motors are configured on a customer-specific basis to satisfy the special application criteria. Extensive manufacturing know-how and continuous further development in collaboration with institutes and universities also contribute to the high quality of the products.
Because the machines are suitable for converter-fed operation, they enable customer-specific solutions that offer maximum productivity, maximum efficiency and the highest level of reliability.
For decades, high-voltage machines bearing the VEM trademark have been proving themselves in a wide variety of applications. As drives for pumps, compressors, rotary kilns and mills, as well as in mining applications, the chemical and petrochemical industry, in steel and rolling mills and in the fields of environmental engineering and power generation. Another advantage: The possibility of converter-fed operation brings significant cost savings over the entire service life.
This catalogue contains general technical explanations. Any special requirements can be discussed separately at any time. Prospective customers should contact our in-house sales department or the one of VEM sales offices and agencies around the world.
The products contained in this catalogue are also to be found in our interactive catalogue. The electronic catalogue supports you when selecting and configuring VEM products and offers you the possibility to print out data sheets and enquiries.

Additional information: www.vem-group.com

Three-phase high-voltage asynchronous motors

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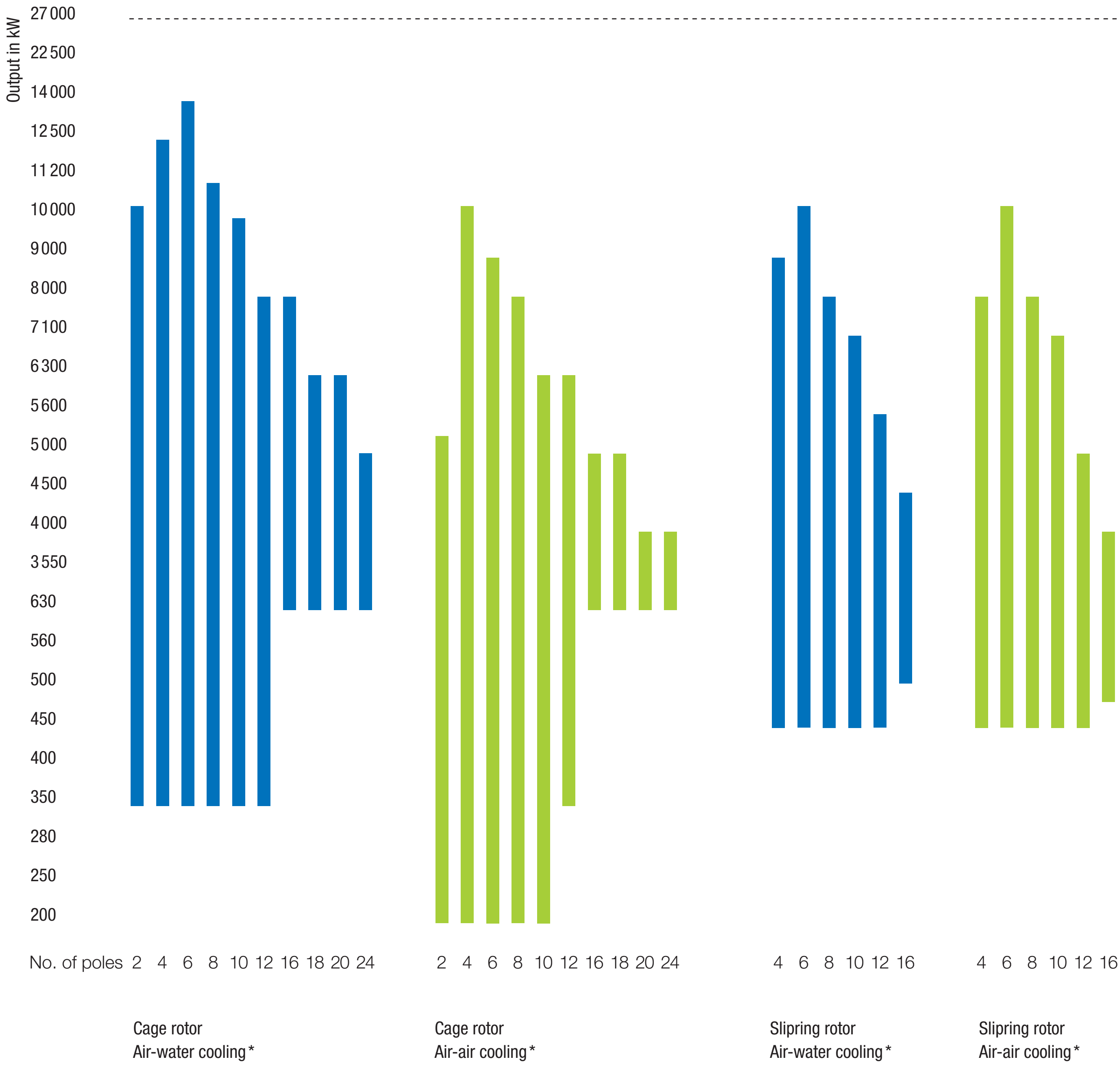
Product range overview 1

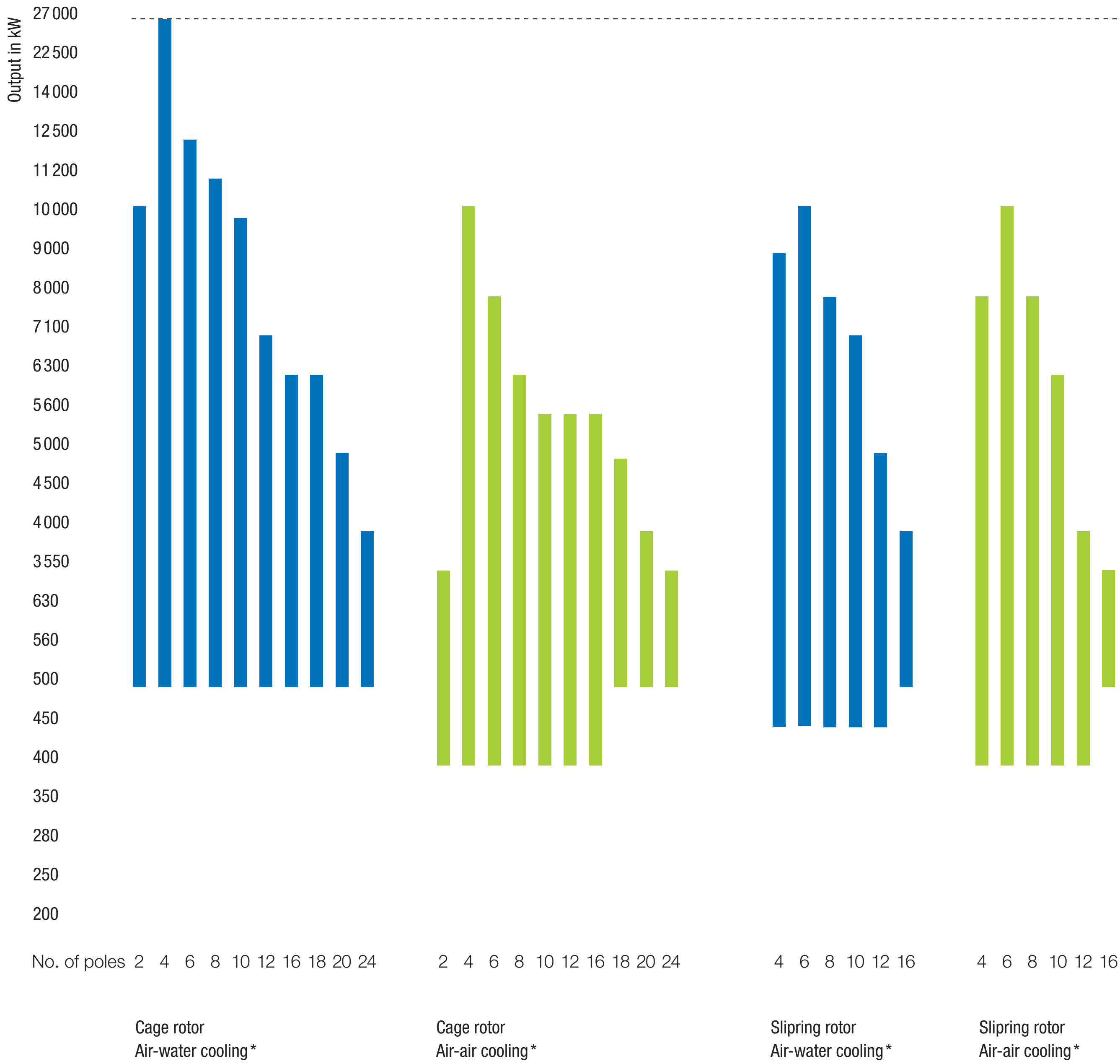
Product range overview

Three-phase high-voltage asynchronous machines 6 kV; 50 Hz; F/B



* other outputs available upon request

Three-phase high-voltage asynchronous machines 10 kV; 50 Hz; F/B



* other outputs available upon request

Type designation
Standards and regulations

Type designation

Sachsenwerk type designations comprise letters and numerals.

Letters	Place 1 – 5
Numerals	Place 6 – 9
Numerals/letters	Place 10 – 14 (variable, depending on machine type)

	D	K	K	E	R	6	3	2	1	4		W	E	
Place	1	2	3	4	5	6	7	8	9	10	11	12	13	14

1 **Current type**
D Three-phase – alternating current

2 **Machine type**
K AC asynchronous squirrel-cage motor
S AC asynchronous slipring motor without brush-lifting device*
B AC asynchronous slipring motor with brush-lifting device

3 **Cooling type, protection rating**
E Open-circuit cooling/self-cooling, without superstructures (IP 00; IP 10; IP 20; IP 21; IP 22; IP 23)
A Open-circuit cooling/self-cooling, with superstructures (IP 23; IP 24)
F Open-circuit cooling/self-cooling, pipe connection with internal fan (IP 44; IP 54; IP 55)
L Open-circuit cooling/forced cooling, additional ventilation unit or pipe connection (IP 00; IP 10; IP 20; IP 21; IP 22; IP 23; IP 24)
B Open-circuit cooling/forced cooling, pipe connection (IP 44; IP 54; IP 55)
R Closed-circuit cooling/self-cooling, with air-air cooler (IP 44; IP 54; IP 55)
K Closed-circuit cooling/self-cooling with air-water cooler (IP 44; IP 54; IP 55)
S Closed-circuit cooling/forced cooling, with air-air cooler with additional ventilation unit (IP 44; IP 54; IP 55)
M Closed-circuit cooling/forced cooling, with air-water cooler with additional ventilation unit (IP 44; IP 54; IP 55)

4 and 5 **Design type**
(coded) Bearing arrangement, deviating voltage and frequency, Ex protection, type of construction, heavy starting, etc.

6 and 7 **Frame size**
(coded)

8 and 9 **Length of laminated core**
(coded)

10 and 11 **Number of poles**

12 to 14 **Supplemental letter for rework level and special conditions**

*Short-circuiting and brush lift-off device

Standards and regulations

The motors meet all requirements specified in the applicable international standards:

EN 60034-1 *	Rotating electrical machines
ISO 10816-3	Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 3
ISO 21940-2 *	Mechanical vibration – Rotor balancing

Motors for use in areas subject to explosion hazards are designed in accordance with Directive 2014/34/EU (ATEX) and meet all requirements of the applicable international standards:

EN 60079-0 *	Explosive atmospheres

* and additionally further relevant parts of the specified standard

Upon request, it is possible to supply motors in accordance with other standards, special industry regulations, operator specifications or the rules of the marine classification societies.

Electrical design

3

Voltage and frequency

In the basic design, the motors are dimensioned for a rated voltage of 6 kV and a rated frequency of 50 Hz.

Voltage and frequency fluctuations during operation are permissible in line with the definitions in IEC 60034-1, Section 7.3.

Motors for voltage ranges ≤ 3.3 kV have higher rated outputs and motors for voltage ranges > 6.6 kV lower rated outputs for the same models.

Output and temperature rise

The rated outputs specified in the product range overview apply for continuous operation (S1) at rated frequency, rated voltage, installation altitude ≤ 1 000 m above sea level and either a cooling air inlet temperature of max. 40°C or a cooling water inlet temperature of max. 27°C. The maximum effective temperatures correspond to insulation class B in accordance with IEC 60034, measured using the resistance method. Motors are available with a temperature-rise limit according to insulation class F. Transnorm motors with type of cooling IC 411 are designed for thermal classification F. Deviations from the rated values for the cooling air temperature and the installation altitude result in a percentage change in the maximum possible output as shown in Fig. 1.

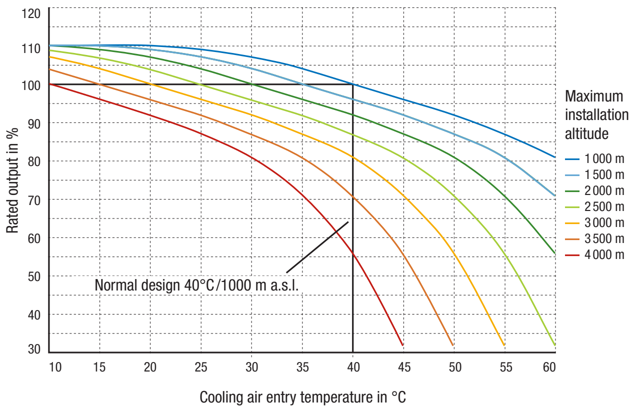


Fig. 1 Influence of the installation altitude and the cooling air inlet temperature on the permissible output

Constant speed

The rated speeds specified in the product range overview apply for operation at rated voltage, rated frequency and rated output (tolerances in accordance with IEC 60034-1). Overspeed testing is performed at 1.2x idle speed. This applies both for 50 Hz machines and for other frequencies. For higher overspeed test speeds, please contact us with your enquiry.

Variable speed/speed control

Slipring motors with converter infeed in the rotor circuit

A converter is used in the electrical circuit of the rotor of slipring motors to regulate the rotational speed with minimal losses by way of a supplemental voltage. The frequency of the supplemental voltage is adapted to the rotor slip frequency of the asynchronous machine (subsynchronous converter cascade, SCC).

Due to the harmonics of the inverter, reduction of the rated output of the motor by approx. 5% is necessary when operating on an SCC. Note that, with reduced rotational speed of the drive motor, the heat dissipation also decreases if self-cooling is used. Consequently, if rotational speed is reduced, the torque must be reduced in accordance with Fig. 2.

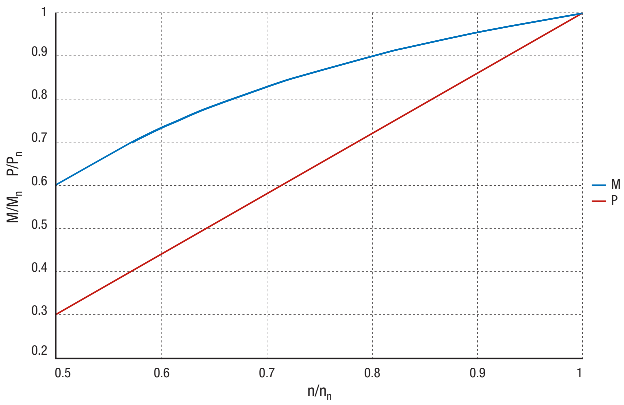
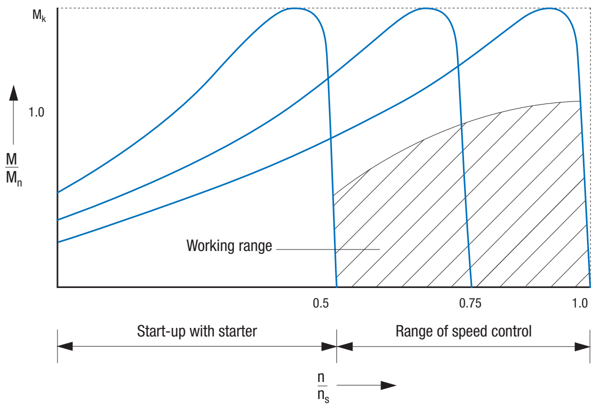


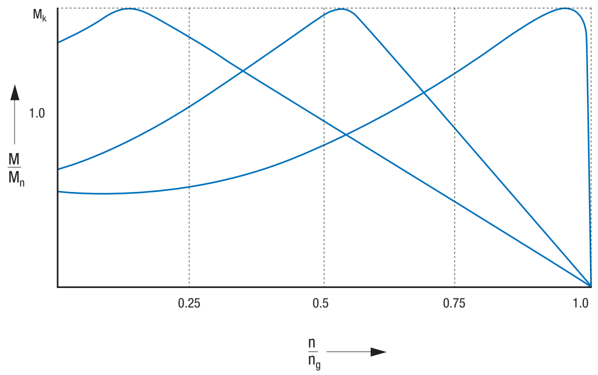
Fig. 2 Power and torque reduction with rotational speed control using an SCC

With slipring motors over 2 MW, the output must be reduced further due to the current displacement in the rotor winding at rotational speeds under 70% nn. The advantages of rotational speed control using a subsynchronous converter cascade are:

– Minimal losses, because the slip power is fed back into the grid
– Cost-effective, because the necessary converter is lower than with a stator circuit feed for a narrow adjusting range (e.g. 0.7 n_n to 1.0 n_n).
– Relatively load-independent rotational speeds compared to a rotational speed controller with slip resistors in the rotor circuit (see Fig. 3).



a) with subsynchronous converter cascade



b) with slip resistance

Fig. 3 Load characteristics of asynchronous motors with slipring rotors

Squirrel-cage motors with converters

Either a current-injecting or voltage-injecting frequency converter is incorporated into the stator current circuit of the squirrel-cage motor. VEM motors are specially adapted for the desired converter-fed operation and drive task, which means that, depending on the converter type and specific requirements of the converter in question, the insulation is adapted and the rated output is optimised. For the most part, the mechanical design corresponds to that of the standard machines. In the case of converter-fed machines, it is necessary to specify the converter design in enquiries.

The windings of the machine are preferably designed as complete former-wound coils – or in special cases as Roebel bar windings – and impregnated using the vacuum-pressure impregnation technology (VPI). Thanks to an extraordinarily high original quality of the winding wires used, the regular winding structure compared to round wire windings with the associated favourable voltage distribution within the coils, and the advantages of the VPI technology for impregnating of the winding head, an extra high level of protection against the voltage peaks that are possible in converter-fed operation is achieved.

The operation of motors on frequency converters results in a higher noise level than is the case with sinusoidal grid parameters.

According to IEC 60034-9, the guide values in this regard are:

Converter type	Increase in the noise level L_{PA} in dB
I converter U converter (pulse frequency < 700 Hz)	1 – 4 1 – 15

In converter-fed operation, the increase in the noise level depends on factors such as:
– Pulse frequency
– Pulse pattern
– Output filter

The advantages of frequency converters for rotational speed regulation on a squirrel-cage motor are:
– Optimal adjustment of rotational speed and torque of the motor to the technological requirements of the driven machine
– Optimal efficiency over an extremely broad output and rotational speed range.
– Power feed from the grid with an excellent power factor (U converter)
– Energy recovery into the grid can be implemented
– Good synchronicity for multi-motor drives
– High rotational speed constancy with variable load
– Broad rotational speed range can be achieved with minimum losses (see Fig. 4)

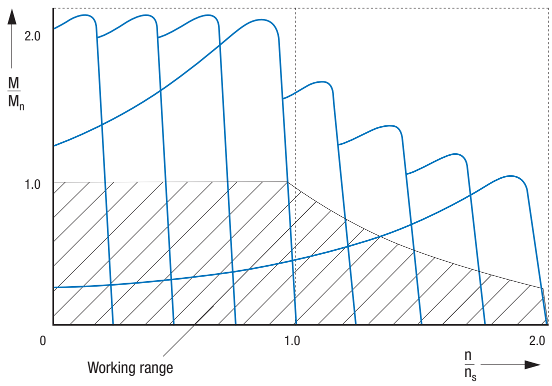


Fig. 4 Torque characteristic of a synchronous motor with cage rotors under frequency-voltage control

On all converter-fed motors, one bearing is insulated to avoid bearing currents, insofar as the feed is realised via an I converter or U converter with a motor-side output voltage up to 690 V. In the case of motors operated on medium-voltage converters, two insulated bearings and an earthing brush are used, unless specified otherwise.

Motors for driven machines with relatively constant moments, e.g. mill drives, compressor drives and rolling mill drives, are frequently equipped with an external ventilation unit.

Start-up

Asynchronous motors with cage rotors

Normal start-up

All outputs specified in the product range overview permit direct start-up on the grid. This simple start-up procedure should always be used, if allowed by the grid conditions or the machines to be driven.

The size of the machines is determined by:
– The level of the rated power
– The loss energy that must be stored in the motor during run-up

This is the kinetic energy that is required for acceleration of the driven machine, the motor rotor, and additional masses.

The motor types specified in the product range overview are dimensioned for normal start-up procedures. They can accelerate driven machines to the rated rotational speed with constant, quadratically increasing or similar torque curves (see Fig. 5). With quadratically increasing torque, a ratio of maximum torque of the driven machine to nominal torque of the motor of 0.9 is assumed. For motors with an output > 7 MW, a throttled start-up is the basis. In this case, the voltage drop in the grid must not exceed a maximum of 10%.

Characteristics: M = fn(n), I = f(n)
Type: DKREQ 5627-2WE

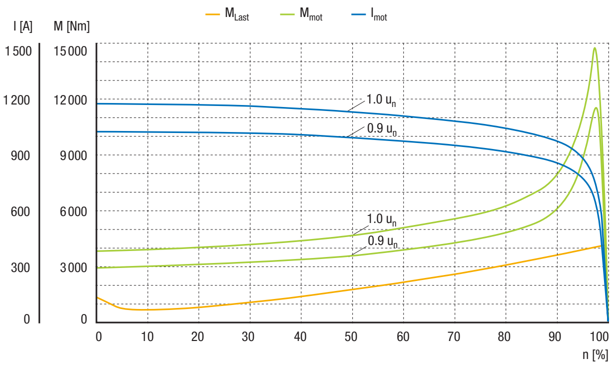


Fig. 5 Torques and start-up characteristic of a 2-pole motor during start-up

If lower torque loads are placed on the motor at start-up, then higher voltage drops in the grid are also possible. The motor torque/motor current decreases more markedly than the square/linear ratio of line voltage to rated voltage due to the saturation.

For example:

$$M_{70\%} = \left(\frac{M_{70\%}}{M_{100\%}}\right) \cdot A \cdot M_{100\%}$$

A = Correction factor, where A < 1

The time period for start-up is determined by the total moment of inertia, the rated rotational speed and the acceleration torque (motor torque – passive torque of the driven machine).

This results in:

$$t_a = \left(\frac{J_{tot}\, n_N}{M_{accel}}\right) \cdot 0.105$$

t_a = Start-up time (s)
J_{tot} = Total moment of inertia (kgm^2)
n_N = Rated rotational speed (rpm)
M_{accel} = Acceleration torque (Nm)

For an initial rough calculation, it suffices to graphically estimate the acceleration torque. Precise calculations are performed using iterative methods. In the basic design, the switching frequency is up to 1 000 switching cycles per year, unless agreed otherwise.

Motors with cage rotors in frame sizes 355 to 800 are suitable for automatic grid changeovers without residual voltage restrictions. This requirement must be specified by the purchaser.

High-inertia starting

If the drive tasks impose higher requirements with regard to the direct start-up of motors with cage rotors, such as high moments of inertia or high load torques accompanied by an increased voltage drop, the motor must be specially configured.

Characteristics: M = f(n)
Type: DKRAF 6331-4WF

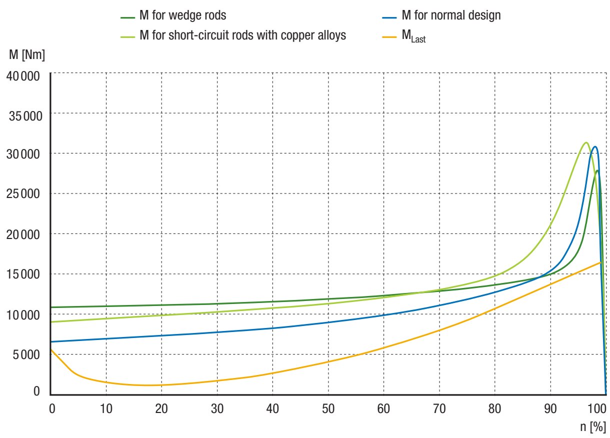


Fig. 6 Torque characteristics for different squirrel-cage rotor designs

Greater torques can be realised through the use of different copper alloys or bar shapes in the rotor.

Start-up via starter transformers

If particularly low start-up currents are necessary to allow for weaker supply systems, this start-up procedure is used. In this connection, it must be ensured that the passive torque of the drive machine displays low values (throttling) at the time of start-up.

Start-up via start-up converter

This start-up procedure is used when the passive torque of the driven machine cannot be throttled during start-up, high moments of inertia must be accelerated and/or special requirements apply with regard to limitation of the start-up current.

Asynchronous motors with slipring rotor

These motors are designed for difficult start-up conditions. With the aid of resistors in the rotor circuit, both the motor current and the motor torque can be set within broad ranges during start-up.
With external discrete supplemental resistors, the motor torque can be stepped as shown in Fig. 7.

Characteristics: M = f(n)
Type: DSRAJ 6329-6WF

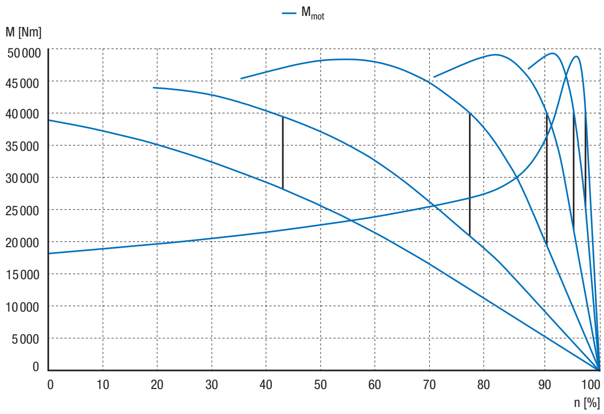


Fig. 7 Torque at start-up for a slipring motor with supplemental resistors

If a constant motor current is required over the entire start-up procedure, then variable liquid starters must be used. Through regulated electrode drives in the liquid starter, current and torque can be adjusted within narrow limits, such that long start-up times are possible even for high motor outputs.

After completion of the ramp-up, it is possible to short-circuit the rotor circuit of the starter-assisted slipring motors with the aid of an automatic brush lift-off device (option), which lifts the brushes off the sliprings. With slipring rotors, grid changeovers and interruptions must be avoided.

Structural description

4

Cast construction (up to shaft height 710 mm)

The motor series up to shaft height 710 mm is based on a modular design principle. The construction consists of the following parts: A cast housing accommodating the laminated stator core, two grey cast iron end shields and two bearing heads. These construction elements are bolted together axially. The contiguous centring of the assemblies relative to each other means that no gap inspection is necessary, even after dismantling. Radially arranged guides assure precisely tangential positioning of the end shields and stator housing after dismantling. The laminated stator core is fixed in place in the housing via a press fit, and subsequently wound. With type of construction IM V1, the drive-side end shield possesses an integrally cast flange for installation of the motor.

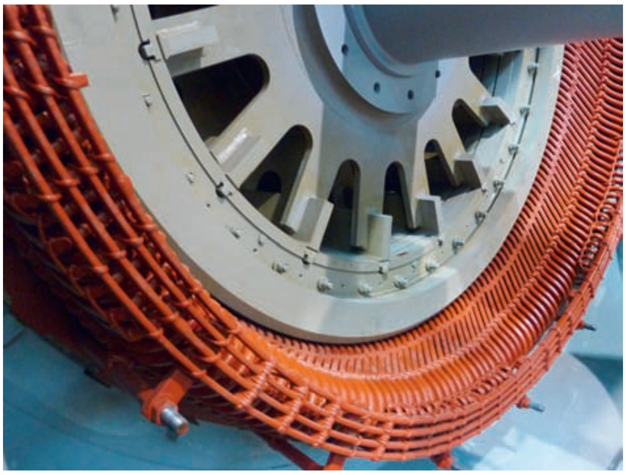
Welded construction (from shaft height 800 mm)

The stator housing consists of a welded construction. The end shields accommodate the bearing heads. The laminated stator core is shrink-fitted into the stator housing. A feather key is used to take up the short-circuit torque. The contiguous centring of the assemblies relative to each other means that no gap inspection is necessary, even after dismantling.

Stator winding

The three-phase, two-layer winding rests in the open slots of the laminated core. The complete former-wound coils are manufactured from flat copper wire insulated with mica film. The main insulation of the coils consists of low-binder mica/glass-fabric tapes. To avoid corona discharges, a low-ohm protective mica coating is applied in the slot part, and a high-ohm protective mica coating is applied at the slot end.

The completely insulated coils are fixed in place in the slots with slot closures. The coil connectors are brazed. The stator winding is impregnated using an epoxy resin in a vacuum-pressure process (insulation system VEMoDUR®-VPI-155).



Rotor construction

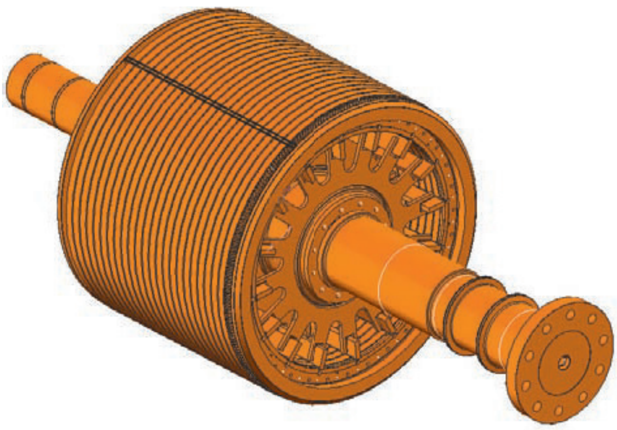
Depending on the machine size, the rotor is designed as a solid or welded spline shaft. The laminated rotor core consists of circular or overlapped segmental laminations of electrical sheet. The core is braced axially by way of clamping bolts.

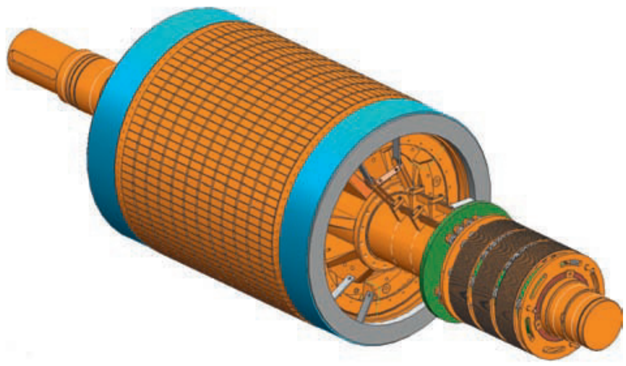
Short-circuit rotor

Exclusively bar rotor windings are used. The copper or copper alloy rotor bars are inductively soldered to the short-circuit rings. If mechanically required, 2-pole rotors are designed with additional non-magnetic shrink rings or else the connection to the short-circuit bar is realised with the short-circuit disc by way of special wedging.

Slipring rotor

The rotor winding consists of a two-layer rotor winding is impregnated using an epoxy resin in a vacuum-pressure process (insulation system VEMoDUR®-VPI-155). The winding heads are retained with glass tapes to compensate the centrifugal forces. The winding ends are routed to the slipring studs. The sliprings are seated freely on a hub and are insulated axially from each other by way of porcelain insulators. The sliprings themselves are made of stainless steel. Thanks to spiral-shaped slotting of the running surface, the cooling effect is increased, while at the same time the slots keep the brush running surface clean.





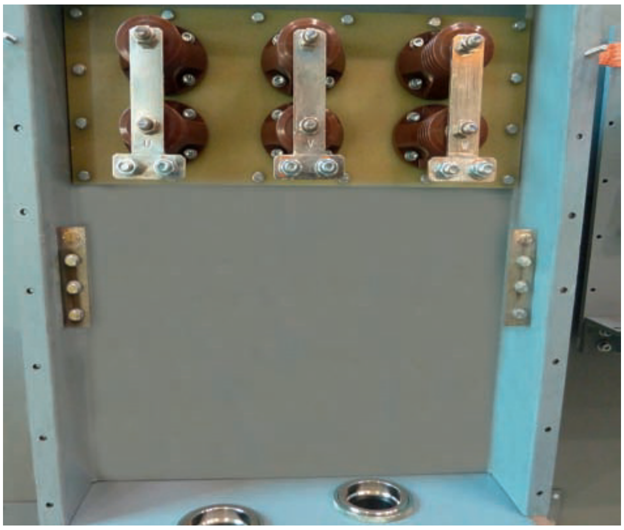
Winding connections

Stator terminal box

The terminal boxes are designed with an IP 55 protection rating. The divided terminal box is a welded construction and possesses a pre-determined break point in the lower part for pressure relief in the event of a short-circuit.

The terminal box can be positioned on either the right or the left with type of construction IM B3.

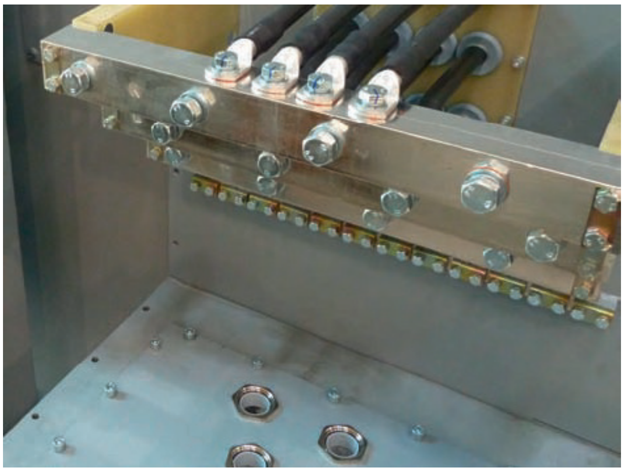
Cable entry is from below, unless agreed otherwise. In the basic design, there are terminal boxes for up to 400 A and 800 A for each of the voltage levels 6 kV and 10 kV. The neutral point can be routed out into a second terminal box on the opposite side. Special designs with current converters, surge protection and increased short-circuit resistance up to 50 kA for a duration of up to 0.3 s are possible.



Example of a stator terminal box

Terminal box for rotor connection (≤ 3 kV)

The rotor terminal box is a welded construction and is designed for a protection rating of IP 55. The connection cables are routed onto busbars. The busbars are connected with the brush bridge by way of cables.



Example of a rotor terminal box

Bearings

Roller bearings

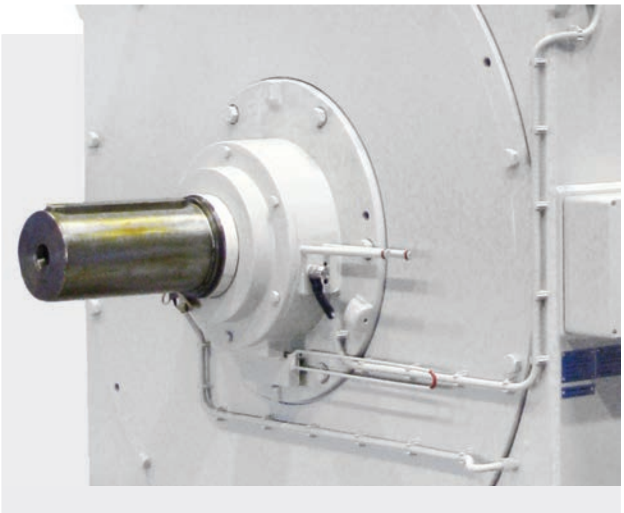
The motor bearings are designed according to the principle of a fixed bearing on the drive side (D-end) and a floating bearing on the non-drive side (N-end). The standard design consists of a deep-groove ball bearing on each side, with the ball bearings being pre-loaded by way of compression springs. On machines from frame size 710, a double bearing consisting of a cylindrical roller bearing and a deep-groove ball bearing is arranged on the D-end (fixed bearing); the N-end is a single cylindrical roller bearing. The fixed bearing takes up any axial forces which arise. The calculated nominal service life (Lh10) of the bearing is ≥ 50 000 hours. Designs with special bearing arrangements to handle greater radial and axial forces are possible on request. In the standard design, the bearings are sealed to the inside and outside with gap seals. They are maintenance-free and protect against any ingress of dust or spray water. For special installation conditions, designs with labyrinth or double labyrinth seals are possible.

The bearings are factory-lubricated with lithium-saponified grease in accordance with DIN 51825. To avoid overlubrication of the bearings, all bearings are fitted with a grease quantity regulator. In the bearing housing, old grease is separated via LAG baffle plates and centrifugal discs. The old grease is removed via a grease collector in the outer bearing cover.

The bearings can be relubricated via lubricating nipples.

Relubrication can be done without interrupting motor operation. The appropriate relubrication intervals and quantities are specified on an instruction plate next to the lubricating nipple.

From frame size 500, all motors have an insulated bearing on the N-end to avoid harmful bearing currents. Upon request, smaller sizes can also be designed with an insulated bearing.



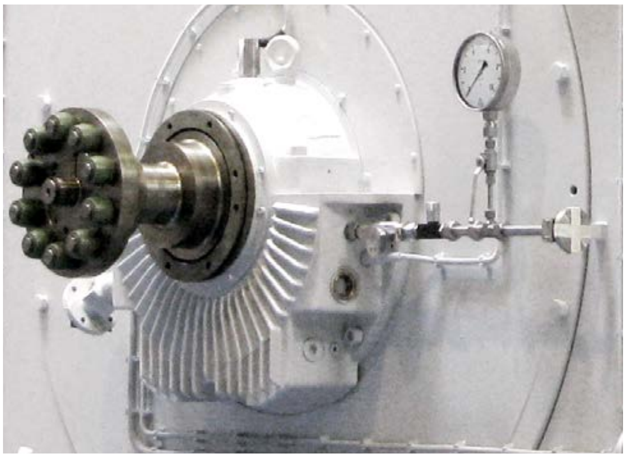
Slide bearings

Slide bearings are designed as centre-flange or side-flange bearings and are bolted onto the centring element of the end shield.

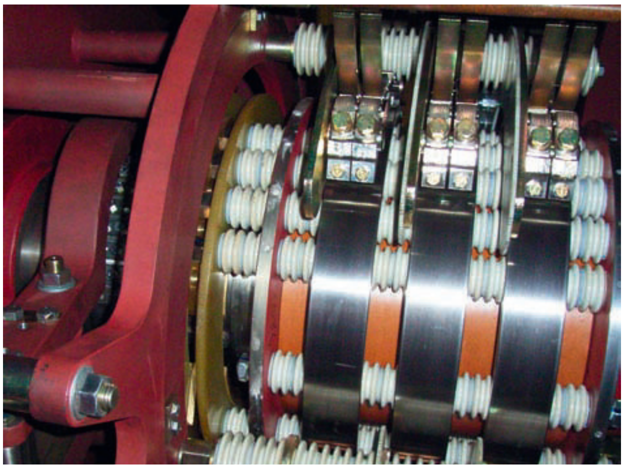
The bearings possess a horizontally divided housing, a divided bearing shell lined with bearing metal, a lubricating ring and various seals. In its basic version, the bearing has an IP 44 protection rating. Higher protection ratings (IP 54) are achieved with additional seals.

Slide bearings are normally designed as floating bearings and do not take up axial forces. They can be supplied in many different designs, depending on individual requirements, for example with ring oil lubrication, flushing oil lubrication, hydrostatic shaft lift, water cooling, insulation, as well as fixed bearings. Upon request, any required oil systems can also be ordered.

Motors in type of construction IM V1 possess a combined pressure and guide bearing at the top. At the bottom, they are provided with a guide bearing. Upon customer request, arrangements with a supporting and guide bearing at the bottom and a second guide bearing at the top can also be implemented.



Short-circuiting and brush lift-off device



Short-circuiting and brush lift-off device

Slipring motors from frame size 400 can be equipped with a short-circuit and brush lift-off device.

A short-circuiting and brush lift-off device is used to operate a slipring motor as if it were a cage motor after ramp-up. This design is suitable for motors which are used for extended periods of operation with a low starting frequency.

In the case of a motor with short-circuiting and brush lift-off device, the winding ends of the rotor winding are routed to a special slipring with a brass segment on each phase. These brass segments are short-circuited via a short-circuiting hub, which incorporates flexible contact elements and is arranged axially on the motor shaft such that it can slide. The brush bridge possesses brush holders which can be lifted off the slipring by way of levers. The short-circuiting and brush lift-off device is driven by a worm gear motor mounted laterally on the motor. Two inductive sensors supply the signals for an external controller for the short-circuiting and brush lift-off device.

Cooling

Internal air circuit

The internal air circuit is driven by radial or axial fans arranged on the shaft. The air is routed either axially or radially, depending on motor size and rotational speed.

Observe the increased noise emissions and reduced efficiency when using radial fans which are not dependent on the direction of rotation.

Air-water cooling (IC 81 W)

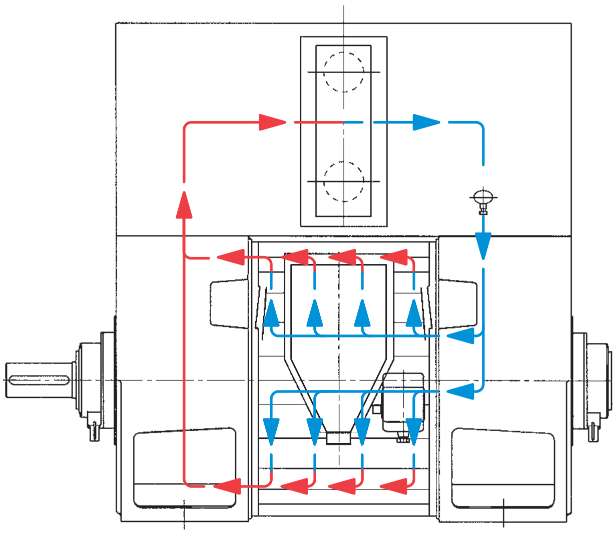
With air-water cooling, the outlet air from the motor flows through a hood which is designed as a welded construction. The air-water heat exchanger is designed as a finned-tube heat exchanger and is inserted into the hood as a module. The material selected for the cooling tubes and water chambers is dependent on the quality of the cooling water. Double-tube coolers can be used for special applications. The internal cooling circuit must be separated from the environment by way of seals appropriate to the desired degree of motor protection.

The motors are thus suitable for installation in situations where the air to be used for cooling is not sufficiently clean or where the machines must be protected against external influences, such as the weather or atmosphere.

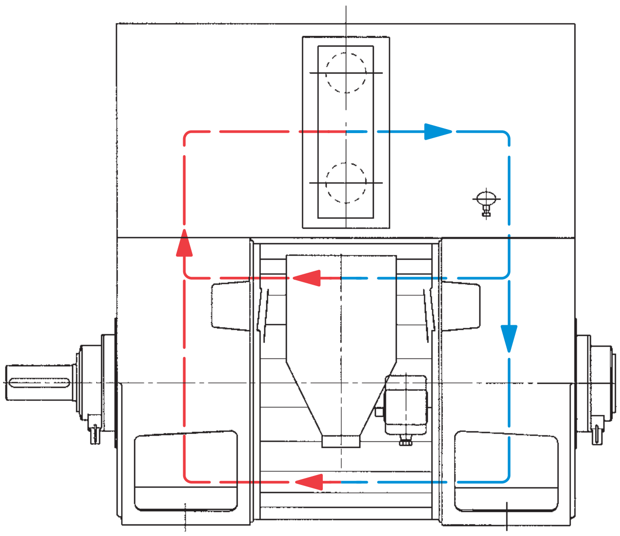
Redundant cooler designs, as well as water-side regulators and facilities to monitor the water and air can be realised upon request. A leak detector is available for cooler monitoring.

Likewise, the integration of sound-insulation measures in the recirculated air housing is possible.

The internal cooling circuit for air-water cooling can also be driven by a separate ventilation unit in the cooler hood. In this case, the motor corresponds to type of cooling IC 8 A6 W7 and is suitable for variable rotational speeds.



Radially ventilated motor with air-water cooling



Axially ventilated motor with air-water cooling

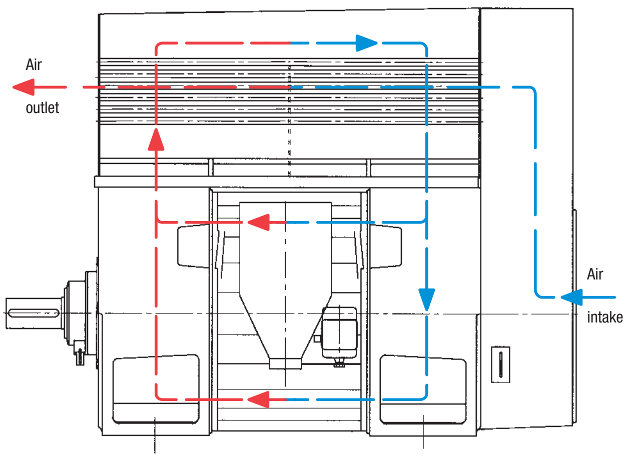
Air-air cooling (IC 611)

With air-air cooling, the outlet air from the motor flows through a hood that is designed as a welded construction. In this hood, there are aluminium tubes which are rolled into the end faces of the hood at their ends. This arrangement forms the air-air heat exchanger. The outlet air flows around the aluminium tubes and is recooled by the secondary air flow within the tubes. The secondary air flow is driven by an N-end fan arranged on the motor shaft.

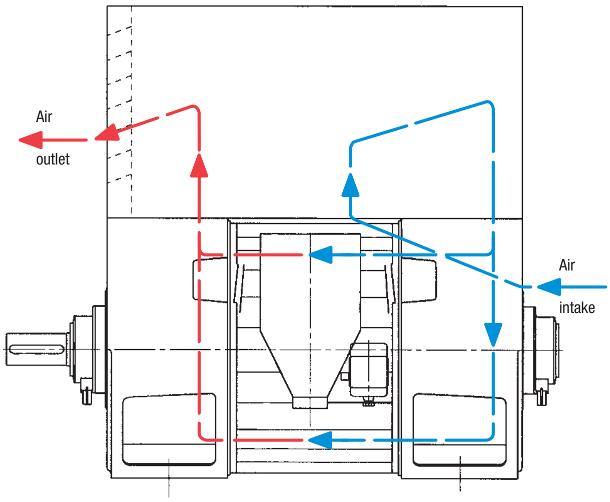
The secondary fan is covered by a hood with intake opening. The internal cooling circuit must be separated from the environment by way of seals appropriate to the desired degree of motor protection. With air-air cooling, the internal cooling circuit and the secondary air flow are driven by separate ventilation units. Accordingly, the motor corresponds to type of cooling IC 6 A6 A6 and is suitable for variable rotational speeds.

Open-circuit cooling (IC 01)

With open-circuit cooling, the cooling air is drawn in via a hood. The outlet air from the motor is blown out of the same hood on the D-end with appropriate separation from the motor intake air. The hood is designed as a welded construction and serves to keep the warm and cold air flows separated. Open-circuit cooling can be used where the ambient air is suitable for machine cooling. Through the use of a separate ventilation unit for the cooling air flow, the motor corresponds to type of cooling IC 0 A6 and is thus suitable for variable rotational speeds.



Axially ventilated motor with air-air cooling



Axially ventilated motor with open-circuit cooling

VEMoDUR insulation system

5

VEMoDUR insulation system

The operational reliability of electrical machines is influenced decisively by the quality of their winding insulation. Technical solutions which comply with international standards in their quality parameters and thus ensure products with high reliability and a long service life, are and have always been characteristic of the insulation technology used by VEM. The VPI technology is used for the insulation of high-voltage machines in all output ranges. The associated insulation system

VEMoDUR

was developed by Sachsenwerk and has been tested in accordance with [1]. Thanks to decades of operational experience, it is also available as a reference system for future comparative functional evaluations in accordance with [2]. The components of the insulation system, which comprises a winding and main insulation with a high proportion of mica, in addition to epoxy resin, are optimally matched. During the impregnation process, the insulation is subject to continuous monitoring and relevant parameters such as

– viscosity of the resin
– impregnation and curing temperature
– pressure holding times
– underpressure and overpressure
– PD level measurements

are verified and documented. The insulation is cured under rotation.

The VPI process guarantees high mechanical strength, particularly of the winding heads, as well as outstanding dielectric strength. This applies especially for breakdown voltages. Rated surge voltages in accordance with [3] are guaranteed with high certainty for all generators.

The insulation system is characterised by its high climate resistance, i.e. the winding is insensitive to moisture and aggressive atmospheres.

In the course of individual testing, intermediate and final electrical tests are performed to verify the insulation resistance, including a surge test and partial discharge test. Upon customer request, these test steps can be agreed and performed separately.

[1] IEC 60034-18
[2] VEM publication “Long-term thermal stability of the insulation system VEMoDUR®-VPI-155”
[3] IEC 60034-15:2010-02

Explosion-protected motors

6

Explosion-protected motors

Special regulations and ordinances apply for the installation of motors in environments subject to explosion hazards. Such environments can be classified into different zones in accordance with EN 60079-10. All equipment, and thus also electrical machines, must provide a level of explosion protection appropriate to the zone classification.

The type of explosion protection is verified in accordance with EU Directive 2014/34/EU (ATEX Directive) through testing performed by a recognised test authority (notified body), which subsequently issues an EU type examination certificate or a conformity certificate. in accordance with the ATEX Directive, an EU declaration of conformity can also be issued without testing by a recognised test authority for machines with explosion protection type Ex nA, EX ec, Ex pzc and Ex tc.

VEM offers the following types of explosion protection:
For areas subject to explosion hazard due to gases or vapours:

– Pressurised enclosure	Ex pxb or Ex pzc (in accordance with IEC 60079-0 and IEC 60079-2)
– Increased safety	Ex eb or Ex ec (in accordance with IEC 60079-0 and IEC 60079-7)
– Non-sparking device	Ex nA (in accordance with IEC 60079-0 and IEC 60079-15)

for areas subject to explosion hazard due to dusts:

– Protection by enclosure	Ex tb or Ex tc (in accordance with IEC 60079-0 and IEC 60079-31)

For machines with rated voltages $U_N \geq 6$ kV, a system test for the complete insulation system must be performed in an ignitable atmosphere for the explosion protection types Ex e and Ex n. For the insulation system VEMoDUR®-PI-155, corresponding test reports have been obtained from the notified bodies PTB-Braunschweig and IBExU Freiberg for 6.6 and 11 kV stator windings.

Quality assurance
Documentation
Shipping, packing and installation
Service

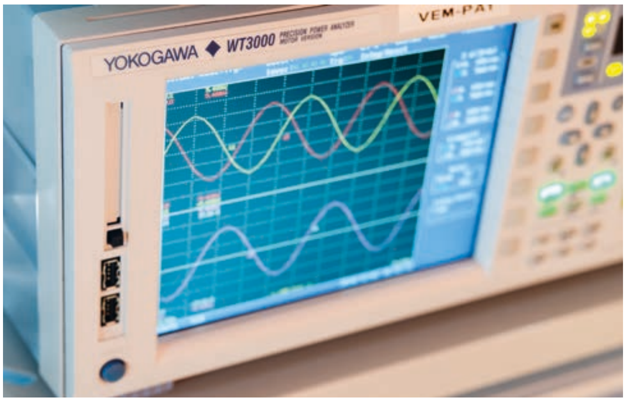
Quality assurance

The constantly high quality of our products, a high level of customer satisfaction and sustainable processes are inherent to our corporate philosophy and thus elementary principles for all thoughts and actions.

VEM's quality management system is an integrated management system comprising certified systems in accordance with DIN EN ISO 9001, DIN EN ISO 14001 and DIN EN ISO 5001.

Our quality assurance organisation monitors the entire manufacturing process of our products, from the receiving of incoming goods, via the production process, through to final testing and delivery of the machine. This is ensured by a team of experts with specific know-how, for example in the 3D measuring chamber.

At the end of the assembly process, every machine is subjected to an internal final test in one of our test bays. The scope of each test is determined by the applicable standards and regulations, special customer requirements and the internal demands of the various technical departments. We differentiate between a standard "routine test" in accordance with IEC 60034-1 and an extended "type test". Depending on the type of project, tests are monitored and approved by classification societies, regulatory authorities or independent third parties. Customer acceptances are also possible upon request.



In our test bay, load tests are possible over a broad speed range with up to 6 MW continuous load. The variable-frequency infeed with a voltage range from 400 V to 15 kV permits optimum adaptation to the test requirements of a wide variety of machine designs. Extensive measurement equipment enables us to perform special tests, such as thermal imaging, structure-borne sound measurements or partial discharge diagnostics.

The results of the tests are documented in a test log or test report. Upon delivery release, a 3.1 certificate in accordance with EN 10204 is added to the documentation of every machine. The most important test results are summarised in a clear and understandable manner in the certificate.

Documentation

Unless agreed otherwise, the documentation package "Operating and Maintenance Manual" contains the following documents:
– Safety instructions
– Relevant EU Declaration of Conformity
– Description / technical data
– Dimensional drawing – motor
– Dimensional drawing – cable connection
– Connection diagrams
– Installation/assembly instructions
– Commissioning instructions
– Operating instructions
– Repair instructions
– Maintenance instructions
– Spare parts list
– Test certificate/log book
– Supplemental operating manuals (options, third-party suppliers)

Additional documentation must be contractually agreed.

Documentation is provided in two copies at the time of delivery of the product. Alongside German and English, the documentation can also be provided in other contractually agreed languages. In this case, additional costs may be incurred for the translation.

Packing, shipment and installation

The type of packing depends on the structural design of the machines and the agreed transport and storage conditions.

All packing requests which are in accordance with the HPE Directive can be realised. To this end, cooperation partners are available to perform packing either at the own facilities or on VEM premises.

Products may be shipped assembled or in a disassembled state, depending on dimensions, weights and contractual agreements. Longstanding collaboration with specialist companies guarantees successful transport of even the most bulky parts.

We recommend having the required installation and commissioning work performed by our specialised personnel.

If the customer performs the work himself or by commissioning a third party, the work must be documented appropriately. This can be done in Chapter 9 of the VEM Operating and Maintenance Manual or in another form.

It is to be observed, however, that liability and warranty on the part of VEM are excluded if corresponding proof cannot be provided.

Service

After delivery of your drive, our customer service organisation is available to you as a point of first contact. The customer service team supports you as the operator of high-quality machines and systems with a broad portfolio of services.

Test facility services and contract manufacturing
Thanks to our modern and high-performance testing equipment, we are in a position to offer you extensive test facility services, such as individual tests, type tests and system tests, as a neutral partner. Upon request, we also perform special tests within the framework of product development. Our company can call on the necessary specialists, as well as extensive experience with the test demands of the most varied acceptance organisations in Germany and abroad. We prepare detailed test plans pursuant to your enquiry.

Mechanical analyses for status and fault diagnostics
Knowledge of the current status of technical equipment, as well as awareness of possible failures prior to the actual occurrence of damage, extend the service life and avoid expensive failures and repair time. In this regard, VEM prepares and evaluates vibration analyses which, in addition to the motors and generators, can also include your plant-specific environment.

Installation and commissioning
The increasing complexity of machines and systems, diverse on-site circumstances and work under high deadline pressure can only be managed by experienced specialists. Our field installation team meets these requirements worldwide, over and over again. Together with you, we elaborate project schedules, provide qualified personnel on site for installation or supervisory tasks, and remain at your side with engineering support until successful commissioning. Detailed reports and measurement logs document the quality of the work performed.

Technical services
We support you throughout the limitation period for liability for defects, and in addition offer you selected service modules to safeguard the constant availability of your equipment after commissioning. Object-based service agreements define the specific form and scope of our services. Our team works closely with the internal technical departments such as the calculation and design offices. They can advise you in all questions concerning drives and the associated peripheral equipment.

On-call service
You can reach us Mondays to Fridays from 8:00 to 17:00, except public holidays. Agreements specifying more extensive on-call service can also be reached.

Maintenance
Experienced employees are available to help you elaborate service and maintenance schedules. We would also glad to handle the necessary work on your drives.

Inspection
In the course of inspections, we assess the actual status of your drives from the mechanical and electrical perspectives. We determine the causes of abnormal wear, derive necessary consequences and draw up spare parts recommendations. If the machines are operated and maintained as prescribed, an extension of warranty can be agreed.

Repair
As an economical alternative to a new drive, we offer high-quality repairs and the refurbishment of electrical machines. This work is usually performed in our factory.

Training
We can train your personnel on site or at our factory.

Spare parts
Our competent team is your point of contact for all technical and commercial questions concerning spare parts procurement and stocking. A spare parts stock on site is useful to enable fast service in the event of a fault. In this context, we would be glad to prepare a suitable recommendation for you. Upon request, we can also keep an emergency spare parts stock for you at our Dresden factory.

General instructions

Unless expressly requested and offered otherwise, our machines are designed on the following basis:
- Machines are manufactured with the VEMoDUR insulation system.
- The paint finish is applied in accordance with the Sachsenwerk standard SW-N 848-001 and the following standards
  DIN EN ISO 12944
  DIN EN ISO 8501-3
  DIN EN ISO 8501-4
  DIN EN ISO 8502-3
  DIN EN ISO 8502-6/-9
  DIN EN ISO 8503
  DIN EN ISO 8504
  DIN 67530 (ISO 2810)
  DIN EN ISO 2409
  DIN EN ISO 16276
  DIN EN ISO 4624
  DBS 918 301
  DIN EN 45545
- The machine's direction of rotation is clockwise when viewed from the drive end (DE). The terminal box is mounted on the right.
- The cooler is on the machine and water connection is arranged on the left when viewed from the drive end (DE).
- Water cooler without water-side monitoring up to the connection flange.
- Without cable stuffing box
- PT 100 for winding and bearings as 2-conductor circuit without tripping device, from the terminal box connection in 2-conductor, 3-conductor and 4-conductor design.
- Mechanical vibration compliant with the limit values specified in IEC 60034-14 and verified in the VEM test bay.
- Vibration monitoring without evaluation device.
- VEM assumes the use of an insulated coupling.

Schematic diagram

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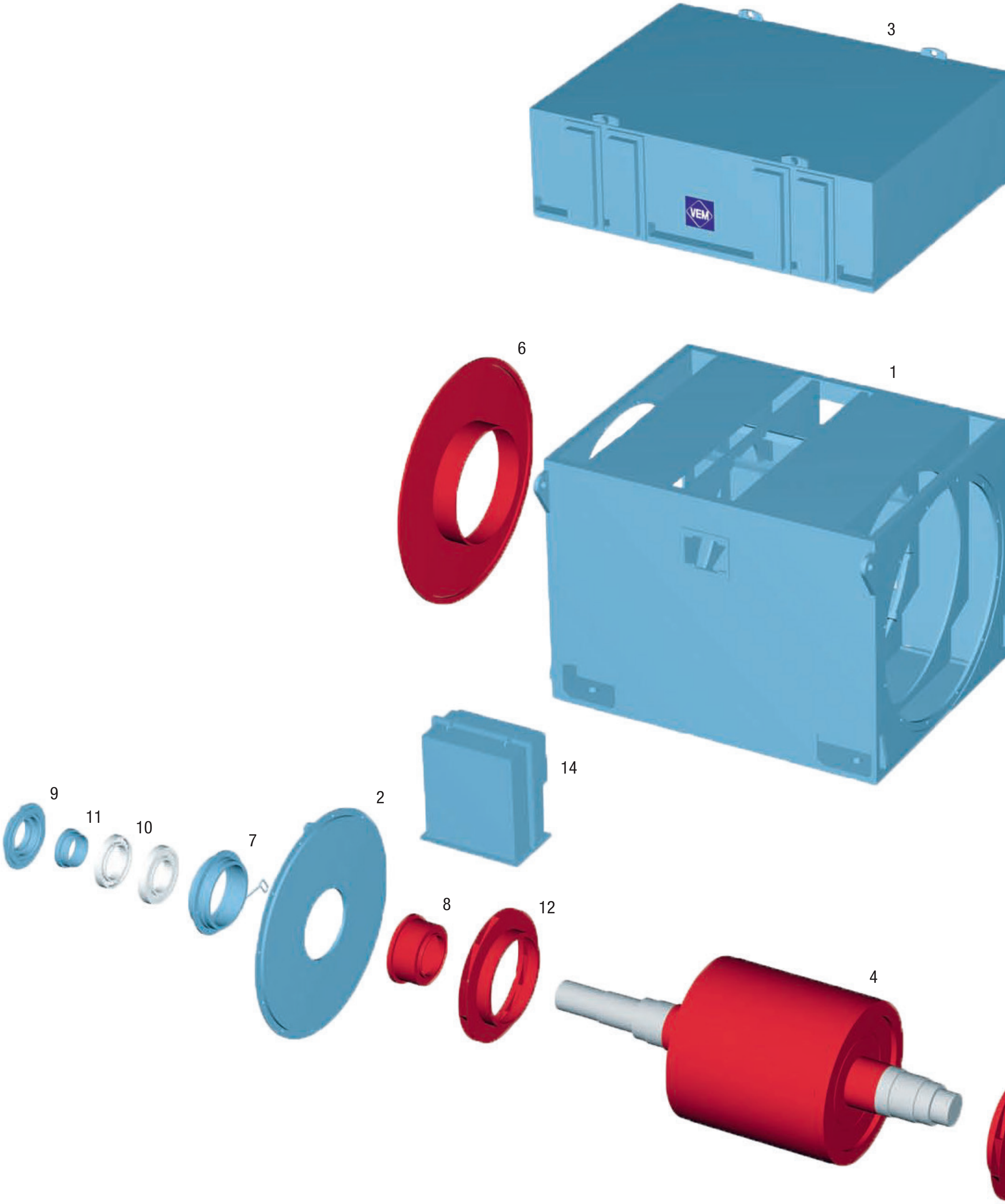
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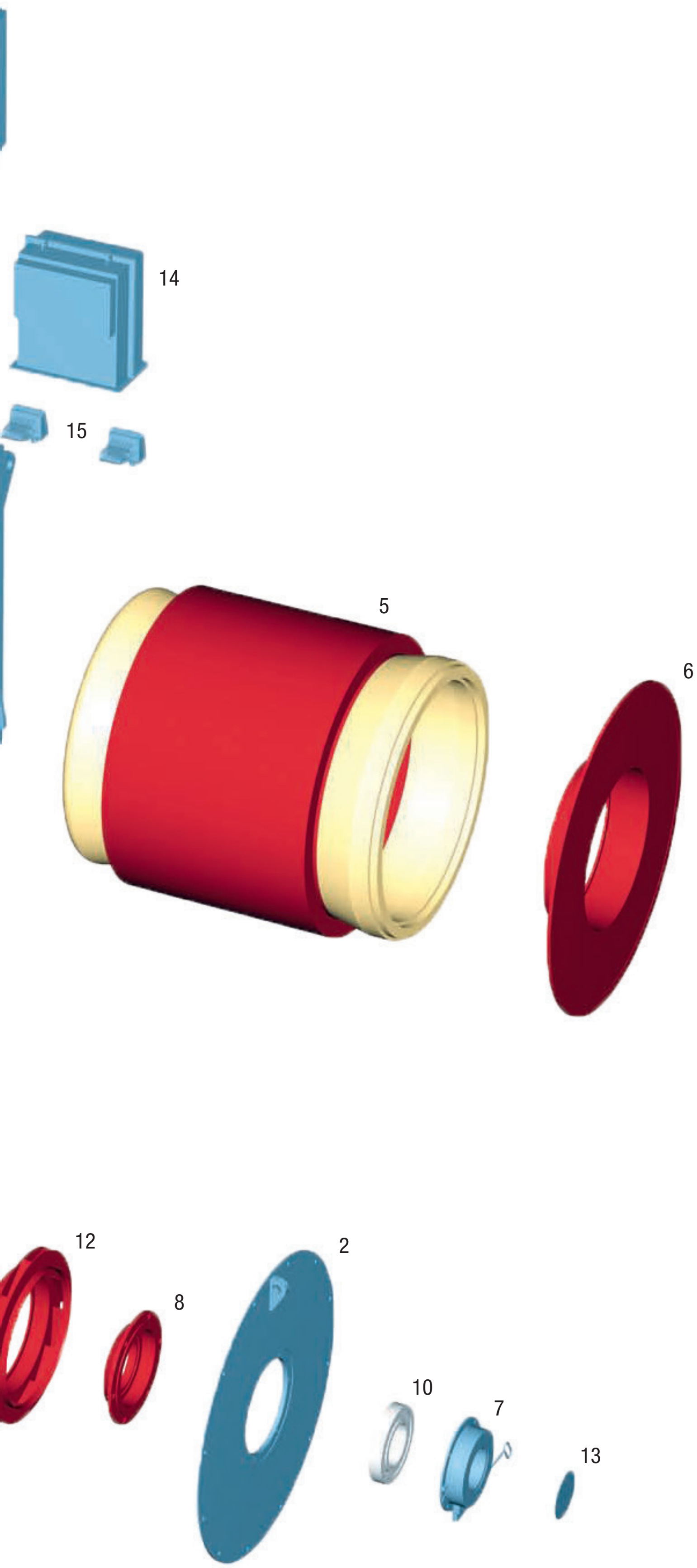
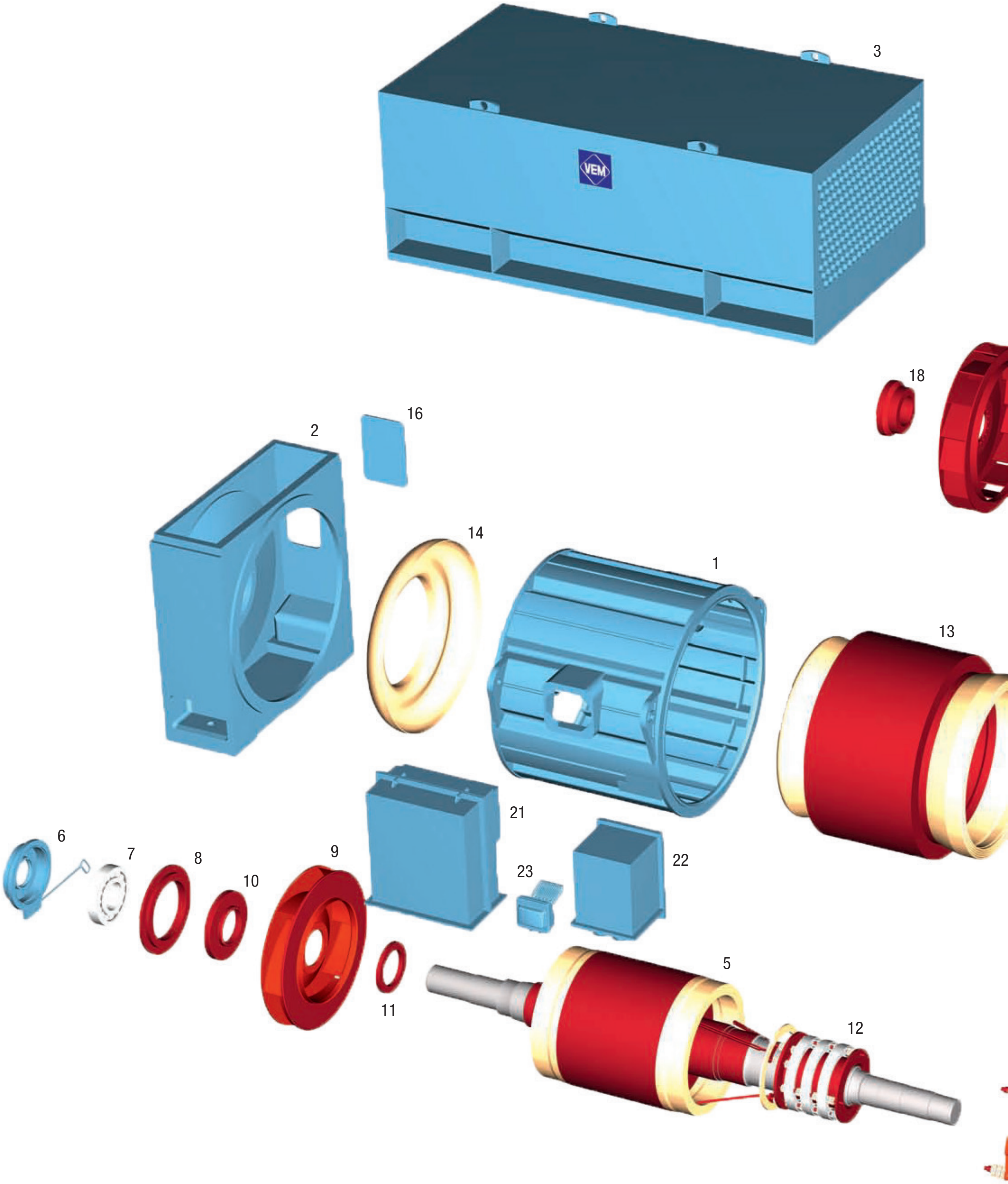
Three-phase high-voltage asynchronous motor with slipring rotor, air-water cooling, welded housing



1 Housing
2 End shield
3 Heat exchanger
4 Cage rotor
5 Laminated stator core with winding
6 Air baffle plate
7 Bearing housing with grease collector
8 Inner bearing cover
9 Outer bearing cover
10 Roller bearing
11 Bearing bushing
12 Fan
13 Cover
14 Terminal box
15 Anti-condensation heater

8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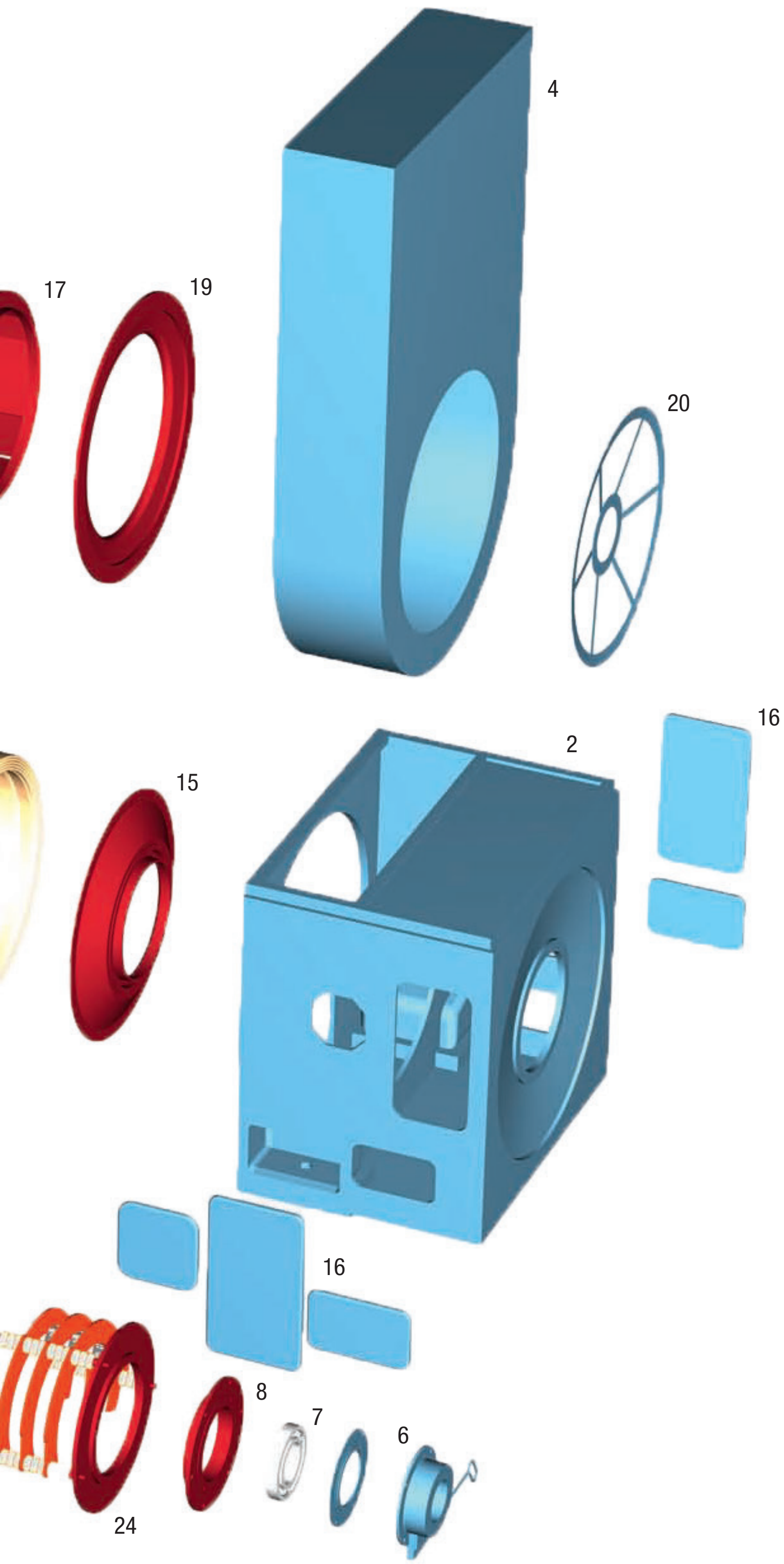
Three-phase high-voltage asynchronous motor with slipring rotor, air-air cooling, cast-iron housing



1 Housing
2 End shield
3 Heat exchanger
4 External fan housing
5 Rotor with winding
6 Bearing housing with external bearing cover and grease collec-
tor
7 Roller bearing
8 Inner bearing cover
9 Internal fan
10 Fan hub
11 Balancing ring
12 Slipring body
13 Laminated stator core with winding
14 Air baffle plate
15 Sealing ring
16 Cover
17 External fan
18 Fan hub for external fan
19 Air baffle plate
20 Intake grille
21 Terminal box (stator)
22 Terminal box (rotor)
23 Anti-condensation heater
24 Brush bridge

ELECTRIC DRIVES

FOR EVERY DEMAND

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