



ELECTRIC DRIVES

FOR EVERY DEMAND

**Solutions for the
Marine Industry**

VEM – specialist for drive solutions in the following branches:



Air Separation



Chemical, Oil & Petrochemicals



Food & Beverage



Marine Solutions



Material Handling



Metals



Mining & Minerals



Power Generation



Pulp & Paper



Test Bench



Public Transportation & Rolling Stock



Water & Waste Water

There are currently around 300 million electric machines bearing the VEM badge in use around the world. They are found aboard ships, in trains and trams, and in chemical plants and rolling mills. VEM generators produce electricity as hydropower and wind turbines. The VEM product range embraces variable-speed electric drive systems, special motors and special machines for outputs ranging from 0.06 kW to 100 MW/ 300 MVA, as well as a diversity of drive technology and power generation components.



ELECTRIC DRIVES

FOR EVERY DEMAND

Marine Solutions

Electric drives and systems



Machines from the VEM shipbuilding portfolio are found aboard vessels ranging from cruise liners, via ferries to yachts.

VEM drive solutions for all types of vessel

VEM has been a leading manufacturer of marine electric drive technology for decades. The group's profound know-how is founded on more than 140 years of experience in electrical engineering.

It is against the background of 140 years of tradition that VEM and its employees develop and manufacture generators and motors for marine vessels all over the world. These include cruise liners, yachts, ferries, container ships, chemical tankers and a variety of special-purpose vessels, which are equipped with generators, pod drives or thruster and propulsion units.

Motors and generators with total weights up to 200 tonnes are manufactured on a regular basis for all types of vessels. Examples from the broad portfolio are propeller motors with outputs up to 10 MW for mega-yachts, synchronous generators with outputs up to 30 MVA or 30 MW propulsion units. Such machines are supplied for use on board the latest generation of five star-plus luxury liners, where they satisfy the highest demands relating to low-vibration operation.

Broad output range

Our product range is rounded off with low-voltage machines with outputs up to 18 MW for main and auxiliary drives. These drives, too, are characterised by their extraordinary operational reliability and long service life, effective and environment-friendly operation, a high degree of efficiency and ease of modification.

Such attributes are the key to universal application scenarios for VEM low-voltage machines. In addition, we supply also pole-switching motors in robust grey cast iron versions for the winch drives on cargo vessels, or motors for the air-conditioning systems on modern cruise liners. The common success of all these products stems not least from the high-performance, customer-specific engineering which is typical for our whole shipbuilding portfolio – in strict compliance with the applicable classification rules. We react quickly and flexibly to individual customer wishes, promise comprehensive customer service throughout our business relationship, and guarantee punctual machine delivery and on-site commissioning, even under the most difficult conditions.

At home on the world's oceans

VEM supplies its products to renowned system suppliers and shipyards with decades of outfitting experience. They, in turn, dimension the complete electric drive technology for the vessels and work together with all leading shipbuilding companies across the globe.



Marine certification

Standard for VEM

Motors for marine use must be manufactured to the highest technical standards and in accordance with strict regulations. To guarantee compliance with the special environmental, operational and reliability demands, certification societies monitor work processes at the shipyard and in supplier companies by way of audits and/or acceptance tests during construction, overhauls and repairs to seagoing vessels. Our design and engineering calculations departments go one step further. They already work closely with certification bodies during the development and realisation of new drive solutions, and are thus ideally prepared for successful type approval testing. In this context, electric machines are examined thoroughly under the varying conditions to be expected in later operation, and only receive the corresponding certification once all prescribed criteria are met.

VEM has obtained certification for its shipb supplies from:

- Det Norske Veritas (DNV)
- American Bureau of Shipping (ABS)
- Lloyds Register of Shipping (LR)
- Bureau Veritas (BV)
- Registro Italiano Navale (RINA)
- China Classification Society (CCS)
- Polski Rejestr Statkow (PRS)
- Korean Register (KR)
- Class NK (NK)

Further classification societies upon request!

A good choice

Marine motors from VEM

Standard and transnorm motors as auxiliary drives in seawater-protected versions are designed to withstand the special climatic and mechanical stresses of use at sea.

Millions of VEM low-voltage motors are operating reliably aboard cruise liners such as those of the AIDA fleet, on container and cargo vessels, trawlers, tankers, dredgers and many other special vessels, including the deep ocean research vessel "Sonne" of the German Federal Ministry of Education and Research.

Depending on the task in hand, these motors drive compressors, anchor capstans and mooring winches, lifting gear, the fans of cooling and air-conditioning systems, or pumps for oils, fuels and service or extinguisher water. VEM low-voltage motors can be supplied with various types of ignition protection for use as auxiliary drives in areas subject to explosion hazards.

VEM low-voltage motors are used for both essential and non-essential services.





To meet the high demands in terms of reliability and resistance to the influences of a marine climate, the motors are supplied in grey cast iron versions. This robust, low-vibration design, in combination with a corresponding paint finish, also offers optimum corrosion protection, as already proven by many thousands of installations.

In contrast to a standard motor, motors for marine use possess brass or stainless steel rating plates and cable glands, and are designed with an external earthing connection.

Individual combinations of foot and flange mounting enable VEM low-voltage motors to be used for a broad diversity of applications, also under complicated installation conditions.

Technical data

Sizes: 56 – 450

Output range: 0.06 – 1 500 kW

Voltage/frequency: All common voltages, 50/60 Hz

Efficiency class: IE2 or IE3 up to IE4 to IEC/EN 60034-30-1

Type of protection: IP 55, optionally IP 56 to IEC/EN 60034-5

Type of cooling: IC 410, IC 411, IC 416 to IEC/EN 60034-6, (IC 71W upon request)

Type of construction: IM B3, IM B35, IM B5, V1 and derived types to IEC/EN 60034-7

Ambient temperatures: In accordance with the specifications of the individual classification society, higher ambient temperatures possible upon request

Explosion protection: Motors for use in Zone 1, Zone 2, Zone 21 and Zone 22 available as optional versions



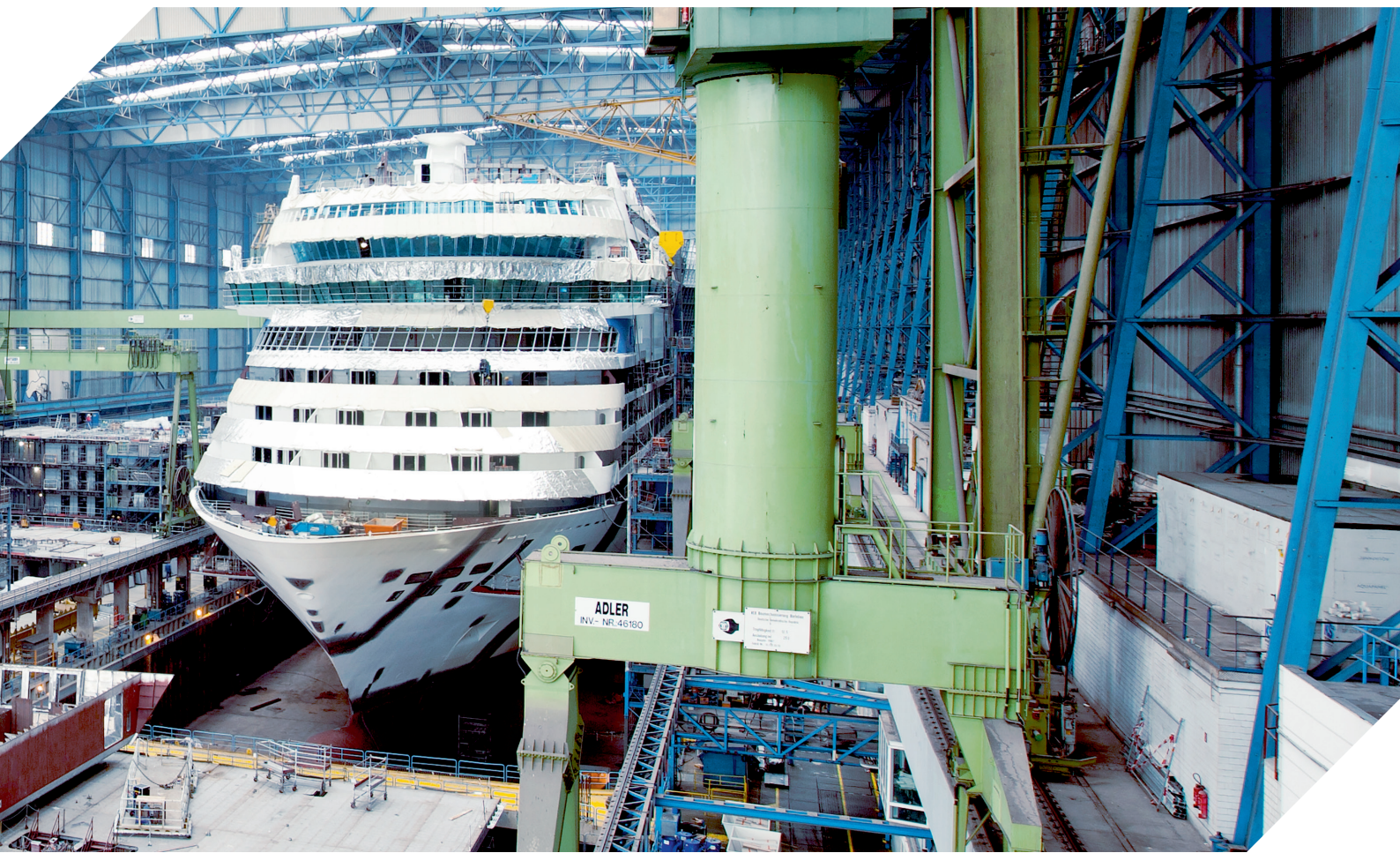
Auxiliary drives (low voltage)

Versatility is the key

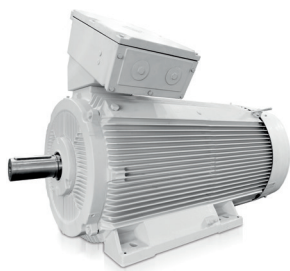
In addition to versions with IP 55 protection for installation in closed machine rooms under deck, motors can also be supplied with higher protection ratings (e.g. IP 56) by customer request. Motors without external fans with degree of protection IP 56 can also be used as drives for on-deck lifting gear.

Growing environmental awareness and the opportunity for sustained reductions in energy consumption are encouraging more and more ship owners to consider energy-saving motors for their auxiliary drives.

EU legislation does not stipulate the use of energy-saving motors on board ships, but the interest in such drives is increasing significantly nevertheless. Customers can here choose from an extensive range of proven energy-saving motors from VEM.



Modifications with marine brake and encoder upon request



Transnorm energy-saving motor IE4, 1 000 kW



Three-phase motor in marine version, size 132



Explosion-protected marine motor, 2.5 kW

VEM generators

Fail-safe on-board power supplies

The energy demands to be met on seagoing vessels mean that synchronous generators are essential. We supply such machines in non-salient and salient pole versions in various designs with welded housings and brushless excitation. They are furthermore equipped with digital controllers and corresponding monitoring systems in accordance with individual requirements. Both antifriction roller bearings and flanged slide bearings are used. In the case of generators for higher outputs, we can also design the bearings as pedestal bearings with the appropriate complex lubrication.

VEM additionally offers a complete generator series in 8-, 10-, 12- or 14-pole versions for voltages from 6 to 11 kV and frequencies of 50 and 60 Hz, including the necessary exciter units, for combination with low speed, high-output diesel engines.

Technical data

Output range: 500 – 25 000 kVA

Voltage range: 400 – 11 000 V

Frequency range: 7 - 60 Hz

Speed range: 30 – 2 100 rpm

Type of cooling: IC 8A1 W7, IC 8A6 W7, IC 7A1W7

Type of protection: ≥ IP 44



Cost savings with high-power VEM shaft generators

The VEM product portfolio also includes high-power shaft generators with IP 44 protection and air water heat exchangers. In modern shipbuilding, the use of such generators reduces fuel consumption significantly compared to conventional configurations with a separate diesel unit. They are mounted directly on the main shaft between the diesel engine and the propeller, and are able to generate all the energy required on board. On container ships, for example, where electricity demand is especially high to maintain the cooling for refrigerated containers, our shaft generators are greatly superior to fast-running diesel generators in terms of energy efficiency. We design generators both for combination with passive rectifiers and for converter-fed operation.

In addition, they can function as either boosters or “power take home” systems. The latter operating mode enables the crew to compensate any failure of the main engine. The shaft generator acts as a drive motor to bring the vessel safely to the nearest port. In booster mode, on the other hand, additional drive power can be transferred onto the propeller shaft in certain navigation situations. The stators of shaft generators are delivered to the shipyard, where our service technicians can also mount the salient poles or PM rotor directly onto the main shaft of the vessel, if required.

Technical data

Output range: 500 kVA – 16 000 kVA

Voltage range: 400 – 6 600 V

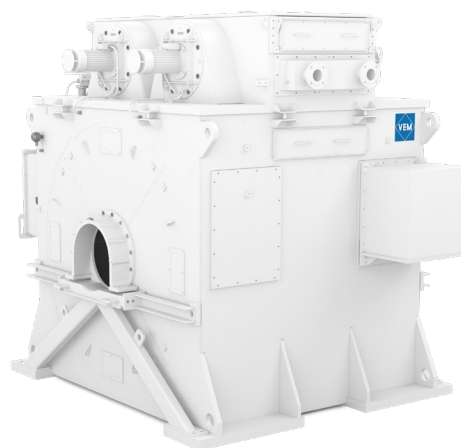
Frequency range: 7 – 20 Hz
(on frequency converter)

Speed range: 30 – 200 rpm

Number of poles: 16 - 38

Type of cooling: IC 8A6 W7

Type of protection: $\geq$ IP 44



Shaft generator for marine use, up to 16 MVA

VEM thruster drives

When precise positioning counts

Electric motors are used as drives for thrusters and pump jets on almost all types of vessel. These systems are in the mean-time standard features for larger vessels, and they also play an important role for the exact positioning of pipe layers, cable layers and floating cranes. The bow and stern thruster drives for such special-purpose vessels deliver outputs up to 5 MW. Our motors are offered in IM 3011 and IM 1001 designs with a built-on air-water heat exchanger for type of protection IP 54 or with open circuit ventilation for type of protection IP 23. In addition to the VEM standard series with grey cast iron housing, custom-welded housings can also be supplied upon request. The machines are intended for operation either as direct drives (DOL) in S1 or S2 mode or in conjunction with a frequency converter. A variable-speed controller is imperative for positioning drives.



Thruster motor for marine use, up to 5 MW

Technical data

Output range: 500 – 5 000 kW

Voltage range: 400 – 11 000 V

Frequency range: 50/60 Hz, variable on converter

Speed range: 0 – 2 100 rpm

Number of poles: 4, 6 or 8

Type of cooling: IC 01, IC 8A1W7

Type of protection: IP 54, IP 23



VEM compact water-jacket-cooled motors

Also
available with
permanent
magnet
motors

The best of two motor worlds

VEM water-jacket-cooled motors with outputs from 1 MW to 18 MW, for example for use in propeller drives, are another very successful motor series. This innovative drive concept was developed in cooperation with leading manufacturers of propulsion and manoeuvring systems. It combines the compact pod design with the robust engineering of a standard drive. The consistent use of 3D CAD systems already at the design phase enables us to monitor every aspect of the mechanical implementation and guarantees an optimum production process.

We have designed the motor such that it can be integrated vertically into the suspension tube of the propeller drive. Cooling is by way of a water jacket, which makes optimum use of the installation volume but also demands a sophisticated design. The same applies with regard to ventilation and heat dissipation from the motor. A complex bearing and the special oil supply system of the gearbox guarantee a long service life. At the same time, considerable testing is performed to ensure proper sealing for the machine cooling and bearing lubrication and thus the high availability of the motor. The elimination of a separate above-water gearbox increases the efficiency of the drive.

Benefits of the drive concept:

- **Extremely compact unit with integrated motor**
- **Minimised installation costs at the shipyard**
- **Increased efficiency through elimination of a separate gearbox**
- **External testing is possible before installation**
- **Simple access to the installed drive**



Water-jacket-cooled motors up to 16 MW

Technical data

Output range: 1 000 – 18 000 kW

Voltage range: 690 – 6 600 V on converter

Frequency range: 5 – 100 Hz

Speed range: up to 3 000 rpm

Number of poles: depending on application

Type of cooling: IC 7A1W7

Type of protection: IP 54

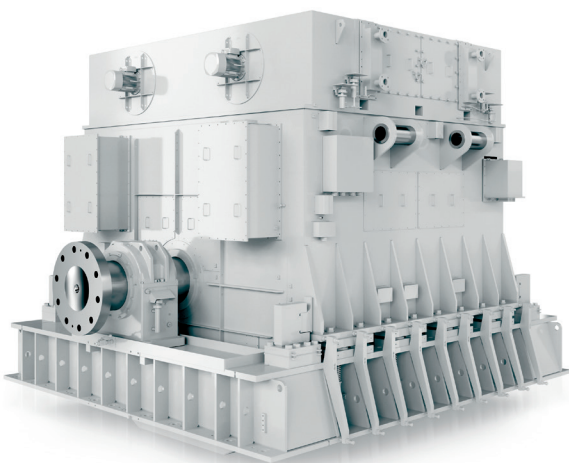
VEM induction propulsion motors

High availability is decisive

Large slow-running asynchronous motors are becoming increasingly common as drive units for modern diesel-electric vessels. Appropriate VEM machines are supplied primarily as welded constructions and in various designs incorporating slide bearings for quiet and low-vibration operation. These motors can be configured either for operation on a medium-voltage converter or with up to four separate winding systems for low-voltage converters for the higher output range. This provides for economical operation of the unit. It is furthermore possible to use a soft starter and to operate the motor directly on the on board power supply. Minimal space requirements and high availability are thus guaranteed.

Overview of possible drive variants:

- Operation on a PWM converter, in some cases with several winding systems
- Soft start-up for smooth transition to maximum output
- Combination of direct and controlled drive (tandem)
- ultra-silent (e. g. DNV SILENT-R)



Asynchronous motor, up to 20 MW

Also
available in
tandem design

Technical data

Output range: 2 000 – 20 000 kW

Voltage range: 400 – 11 000 V for direct drives,
500 – 6 600 V for converter-fed operation

Frequency range: 5 – 70 Hz

Speed range: 125 – 1 800 rpm

Number of poles: 8 to 24

Type of cooling: IC 8A6W7

Type of protection: $\geq$ IP 44

VEM synchronous and PM propulsion motors

All-purpose drives for high torques

Also
available in
tandem design

Synchronous motors can be considered the standard drives for electric vessel propulsion systems, especially where high torques apply. They are often designed with two separate winding systems and configured for operation on low-voltage or medium-voltage converters. VEM machines are to be found as drives on cruise liners, for example, where quiet operation is absolutely essential. They are similarly an ideal choice for mega-yachts. Another characteristic of our synchronous propulsion motors is their extremely high availability, a factor which is a top priority for installations on board navy vessels.

Slow-running synchronous propulsion motors with separate base frames and additional custom vibration damping play a special role within our product portfolio. The variable concept for welded housing constructions enables us to adapt the machine design to the particular installation requirements on board.

Technical data

Output range: 5 000 – 30 000 kW

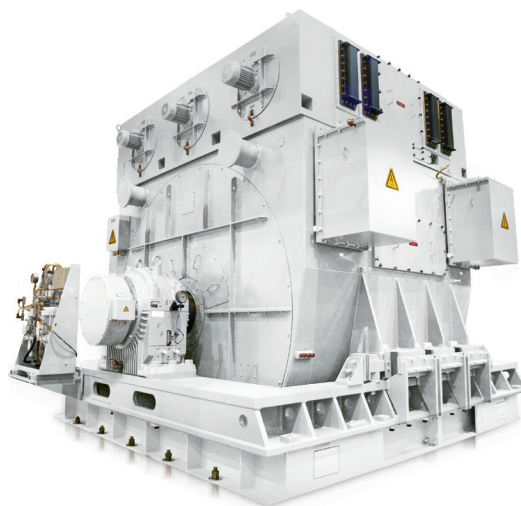
Voltage range: 690 – 6 600 V
for converter-fed operation

Frequency range: 5 – 75 Hz

Speed range: 90 – 600 rpm (1200 rpm)

Type of cooling: IC 8A6W7

Type of protection: $\geq$ IP 44



Synchronous propulsion motor, up to 30 MW



VEM drives for pod applications

Efficiency paired with robust design

The VEM product range for modern marine propulsion systems would not be complete without drives for pod applications. These units are equipped with either PM or asynchronous motors, depending on the application requirements and the conditions under which the vessel operates. The motors consist of a laminated package for the stator and rotor, mounted in direct contact with the shaft of the rotor and the outer housing of the stator. Thanks to direct cooling of the rotor with seawater and the custom design of the rotor bars, motor operation is especially efficient. POD drives possess a small internal air-cooling circuit which also provides heat to prevent condensation when the motor is idle. Where higher outputs are required, synchronous motors with electrical or permanent-magnet excitation are used.

The synchronous principle is well suited to accommodate the larger air gaps necessitated by a relatively wide bearing span. The insulation system of the drive motors is designed for converter-fed operation, using low voltage for the lower output range and medium voltage for higher outputs. The

preformed VPI-impregnated coils, which are specially designed for non-sinusoidal voltages, combine mechanical rigidity with optimum and even temperature distribution within the winding.

Technical data

Output range: 1 000 – 20 000 kW

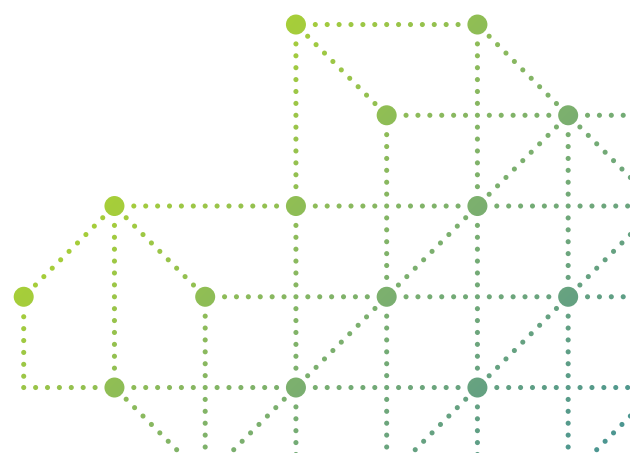
Voltage range: 690 – 4 500 V on converter

Frequency range: 5 – 50 Hz

Speed range: 100 – 300 rpm

Number of poles: 12 to 24

Also
available with
permanent
magnet
motors



Our Service – Good reasons for VEM

24/7

- Product range from single motors to complete drive systems
- Own design engineers develop tailored solutions
- Flexibility thanks to a high proportion of in-house manufacturing
- Fast response times
- Worldwide service availability
- 24h delivery service for stock motors (online warehouse)
- 1 500 highly motivated and qualified employees

Made in Germany

- Durable and robust under extreme conditions
- Environment-friendly and energy-efficient
- Low life-cycle costs



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