

Electric Drives for Shipbuilding





VEM drive solutions

Looking back on a 120-year tradition in electromechanical engineering, the Dresden concern VEM Sachsenwerk with its technical capabilities and know-how has for decades been a traditional provider of electric drive technology in shipbuilding.

Each year, 650 employees in a production area of approximately 35,000 m² develop and manufacture generators and motors for countless types of ships for customers from around the world.

The Dresden-based VEM company produces special-purpose machines such as shaft and diesel generators, POD drives, as well as thruster and propulsion motors for use on passenger ships, mega-yachts, high-capacity ferries, container ships, chemical tankers and special-purpose ships.

VEM Sachsenwerk is capable of manufacturing motors and generators with a total weight of up to 200 t for all types of ships.

Propeller drives of 7.5 to 10 MW have been developed for mega-yachts over 90 meters long. Special VEM synchronous generators with up to 60 MW power-generating capacity and propulsion motors with up to 22 MW are used in today's generation of cruise ships. With giant-size ocean liners having given way to "5 star plus" comfort, VEM machines are capable of meeting the highest demands for internal energy supply.



Sailing the seven seas

VEM Sachsenwerk delivers its products to renowned system providers with years of experience in outfitting ships. The providers size the electric drive technology and automation solutions for entire ships, working together with the best shipyards in Europe, Asia and the Americas.

Shared success is based on a high-performance partner like VEM, its products being individually engineered for shipbuilding purposes and manufactured in strict accordance with current classification regulations.

VEM reacts quickly and flexibly, offers its customers comprehensive service, and guarantees the on-time delivery of its machines to shipyards along with on-site installation, even in the most difficult environments.

The range of products for outfitting ships is rounded off by low-voltage machines for various auxiliary equipment drives of VEM motors. Exceptional reliability, a long service life, environmental friendliness due to high efficiency, and modifiability make VEM low-voltage machines universally applicable.

Whether as pole-changing motors in robust gray-cast-iron for winch drives on cargo ships or as weight-optimized motors for air conditioning on cruise ships – VEM products are sailing the seven seas.



seven seas...



VEM motors and generators for use in different types of ships

| | Auxiliary drives, low-voltage up to 500 kW | Auxiliary drives, low and high-voltage | Generators (PTO or Diesel) | Shaft generators | Thruster or transverse-thruster drives | Combi drive | Asynchronous propulsion motors | Synchronous propulsion motors | POD-drive asynchronous and synchronous |
|--------------------------------------|--|--|----------------------------|------------------|--|-------------|--------------------------------|-------------------------------|--|
| Research and special-purpose vessels | ■ | ■ | ■ | □ | ■ | ■ | ■ | □ | ■ |
| Supply-vessels | ■ | ■ | ■ | □ | ■ | ■ | ■ | □ | ■ |
| Ferries | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ |
| Cruise liners | ■ | ■ | ■ | □ | ■ | □ | □ | ■ | ■ |
| Mega-yachts | ■ | ■ | ■ | □ | ■ | □ | ■ | ■ | ■ |
| Container ships | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | □ |
| Tankers oil/LNG | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | □ |
| Marine/navy | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ |

types...



Origin of photo material:
Siemens Norwegen, Project "Bourbon Orca"

Shipbuilding certifications of the VEM Group

Given their environmental and operating conditions and the demands on reliability, motors for use on sea-going vessels have to comply with specific regulations ensuring high technical standards. The processes of constructing, reconstructing and repairing ships are monitored at shipyards and suppliers by means of audits, and sometimes through final acceptance by classification societies. VEM is certified as a shipbuilding supplier by Germanischer Lloyd (GL), the American Bureau of Shipping (ABS), Lloyds Register of Shipping (LR), Bureau Veritas (BV), the China Classification Society (CCS), the Russian Maritime Register of Shipping, Registro Italiano Navale (RINA) and Det Norske Veritas (DNV).

The construction and calculation departments at VEM Sachsenwerk work hand in hand with certification societies even in the development phase, accompanying the manufacture of electric machines all the way to acceptance testing. This allows a wide variety of potential future operating conditions to be taken into account, ensuring, among other things, compliance with ice classes for propulsion motors in various types of ships.

VEM's certification by Bureau Veritas as a shipbuilding supplier was successfully renewed in 2007. (Mode II plant certification – WHP is valid till December 31, 2011)





Low-voltage machines for auxiliary drives

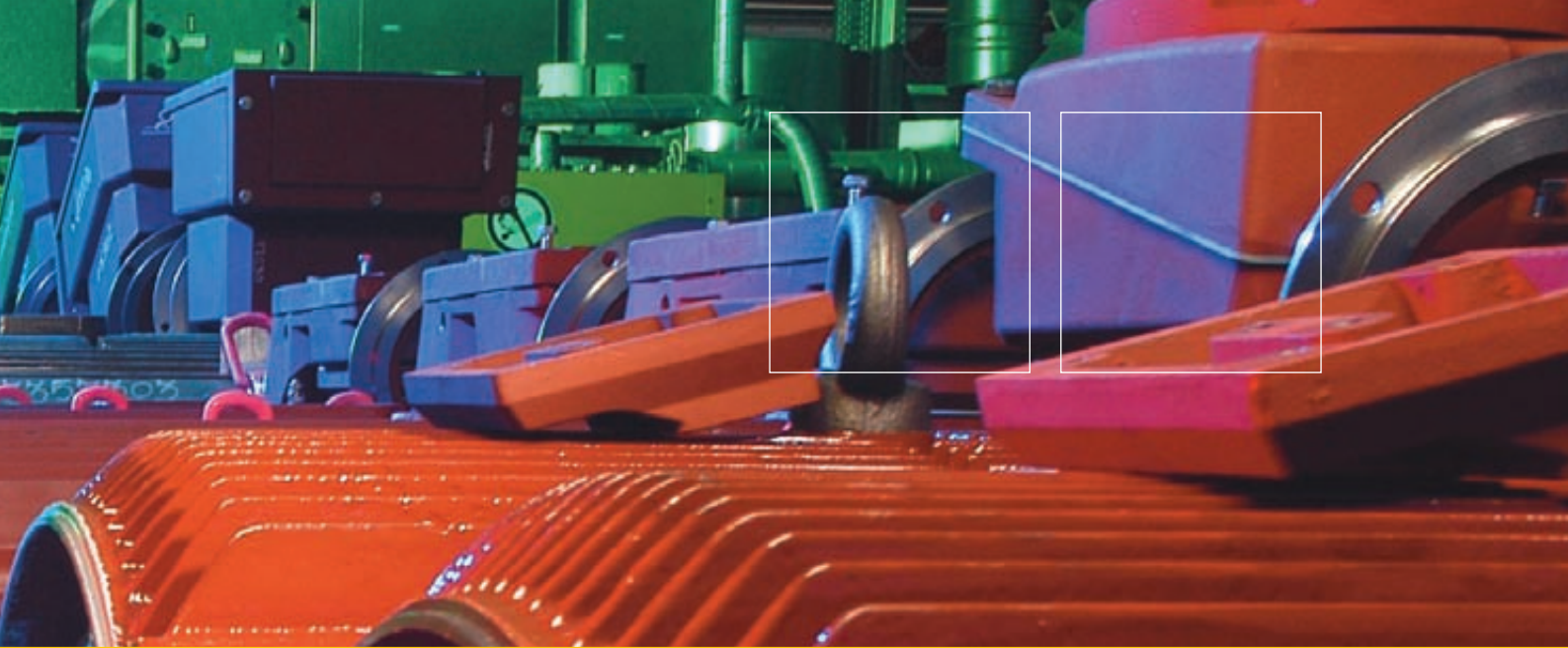
Seawaterproof VEM machines are the right choice when it comes to powering marine auxiliary units.

Designed to meet special environmental and mechanical demands, they are manufactured in accordance with the regulations of national and international classification societies.

The sturdy, low-vibration design of VEM low-voltage machines has proven effective for use on or below deck. For decades now they've been used on passenger and container ships, cargo and fishing ships, tankers and suction dredges, but also on luxury yachts as a safe and reliable means of powering ventilators, pumps, capstans, as well as swing and hoisting gear.



aux



Technical data

Series: asynchronous motors KPER/K11R
dimensions and performance specifications
according to DIN EN 50347 asynchronous
motors KPR/K10R, transnorm design

Frame sizes: 56 – 355

Output range: 0.09 – 490 kW

Protection categories: IP55 according to DIN EN 60034-5,
higher protection categories available as
an option

Cooling method: surface-cooled in conformity with IC 410,
IC 411(DIN EN 60034-6)



Models: IM B3, IM B35, IM B5 and derivative
designs according to DIN EN 60034-7

Ambient temperatures: in accordance with the given regulations
of each classification society

iliary drives...



Auxiliary drives (low and high-voltage)

VEM asynchronous motors designed for the upper low-voltage and medium-voltage range are in wide use in a variety of forms as deck and auxiliary equipment drives.

Our experience in shipbuilding, certified by every relevant classification society, makes VEM products the natural choice not only for propulsion motors and generators.

Sachsenwerk's tried-and-tested standard series "NGA asynchronous motors with gray cast-iron housing" is manufactured with an axle height of 355 to 710. The construction principle guarantees short turn-around times for fast availability.

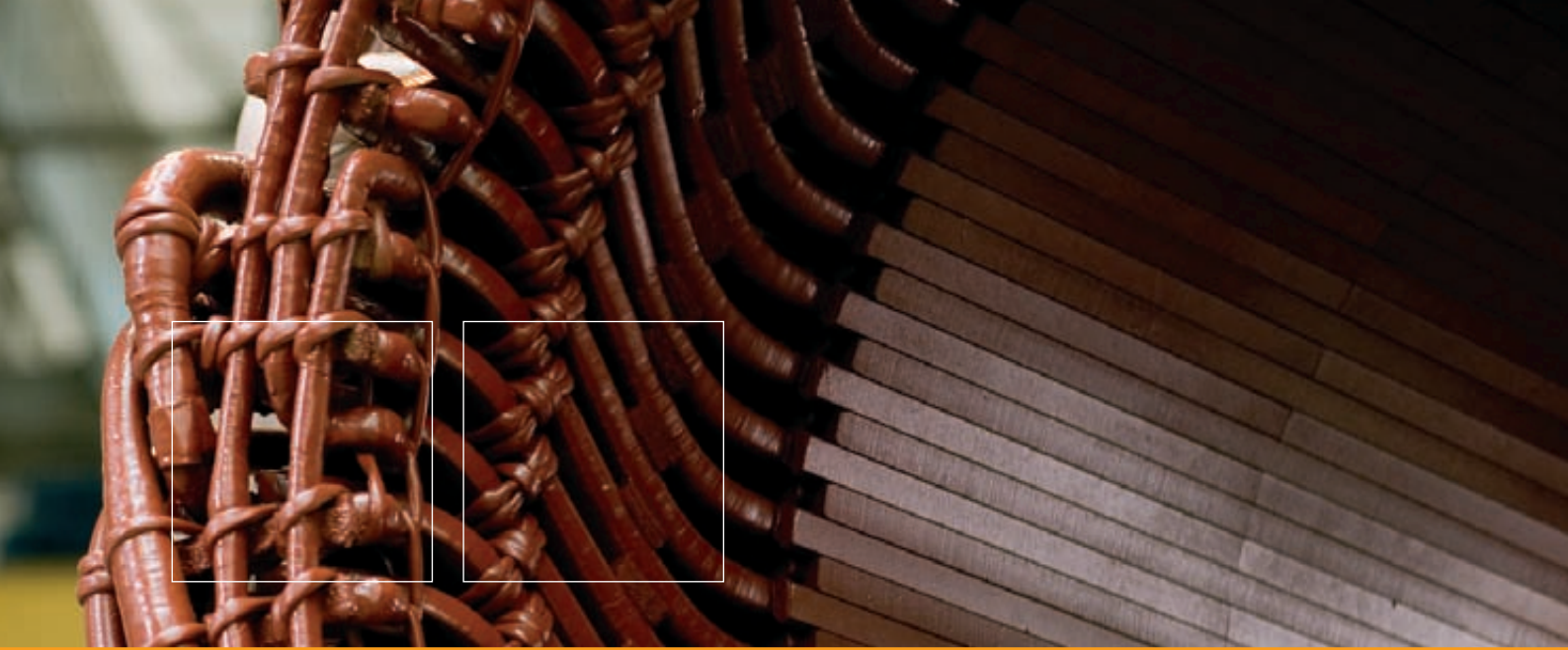
To ensure the necessary constructive flexibility in the installation environment on board, we also offer a range of motors with welded housing.

Apart from various types of foot or flange mounting, the auxiliary drives can also be manufactured with different degrees of protection for lower and upper-deck installation.

Applications include cutter-head drives on work barges and pump motors for suction-dredge ships or tankers.



auxiliar



Technical Data

Output range: 500 – 5,000 kW
Voltage range: 400 – 11,000 V
Frequency: 50Hz, 60 Hz or for inverter operation
Speed range: 500 – 1,800 r.p.m.
Number of poles: 4 to 12
Cooling method: IC 8A1 W7 und IC 01



y drives...



Generators (PTO or diesel)

The need for electricity on ships makes synchronous generators indispensable.

VEM generators are manufactured as nonsalient or salient-pole machines with welded housing and brushless excitation in the IM 1101 model.

The machines are equipped as required, with digital controllers and accompanying monitoring systems.

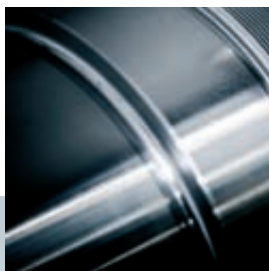
The majority of our generators use sliding bearings with flange mounting, though antifriction bearings may be used for machines with a lower output. Generators with a particularly high output also come with pedestal bearings, along with the complex oil-feed units these require.

As PTO's the generators are offered in 4 or 6-pole models with 50 Hz or 60 Hz field frequency, coupled with high-speed units.

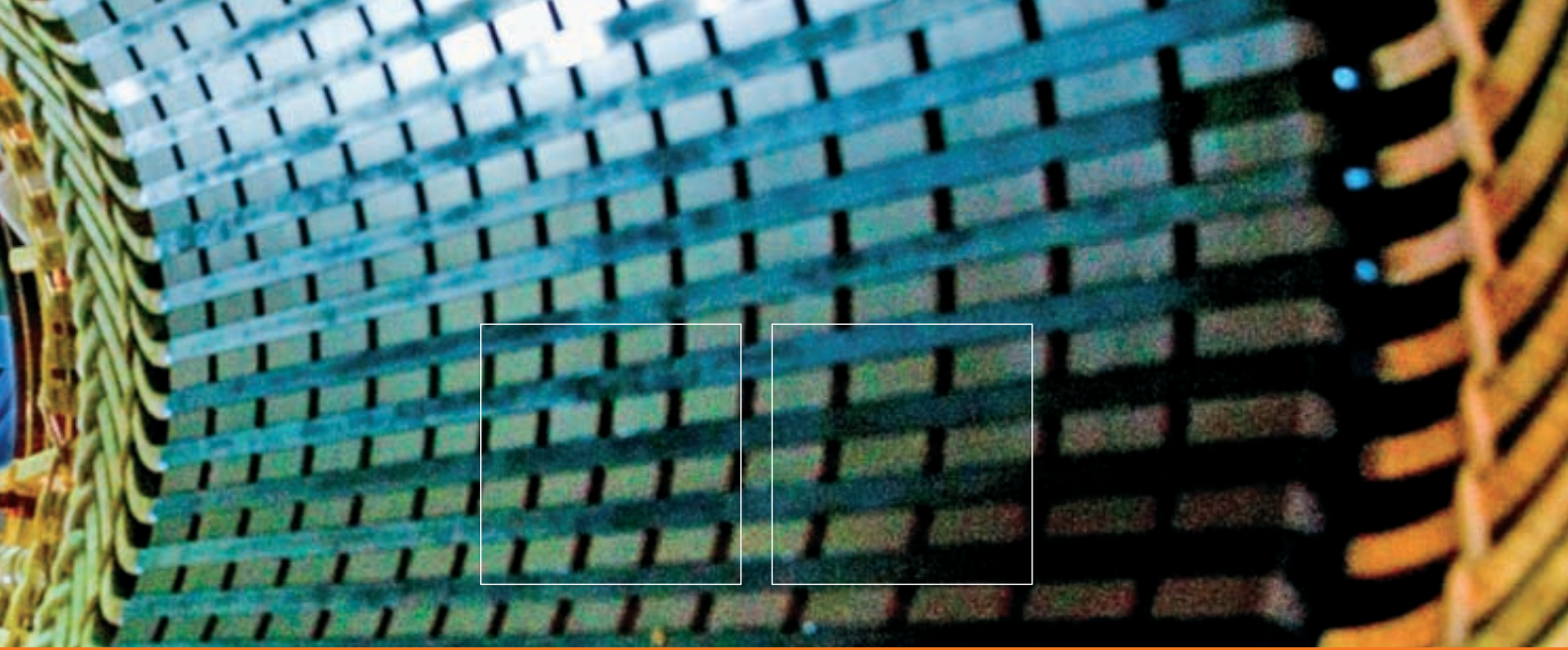
The machines are also designed for operation with frequency converters, in 8, 10, 12 or 14-pole models for use with low-speed high-output diesel motors.



Project "BC-Ferries"
Flensburger Schiffbau Gesellschaft / Germany
DRKSX 1036-12WS
4,800 kVA, 6,600 V, 600 r.p.m., IM 1101, IC 8A1W7

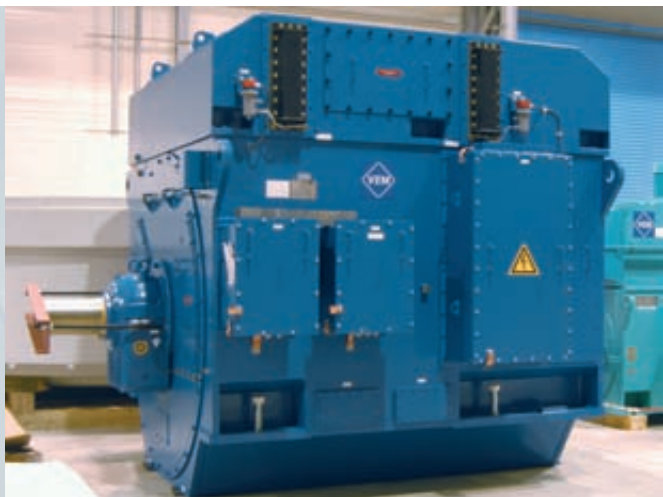


gen



Technical Data

Output range: 500 kVA – 30,000 kVA
 Voltage: 400 V – 11,000 V
 Speed range: 500 – 1,800 r.p.m.
 Number of poles: 4 to 14
 Cooling method: IC 8A1W7



Project "Seabourn 2"
 Mariotti shipyard Genoa/Italy
DRKSX 1032-10WS
 6,920 kVA, 6,600 V, 720 r.p.m., IM 1101, IC 8A1W7



Project "Maersk: Anchor-Handling-Tug-Ship"
 Volkswerft Stralsund/Germany
PTO-generators in tandem
 2 x DRKSX 6321-4UA
 2 x 3,250 kVA, 670 V, 1,800 r.p.m., IM 1101, IC 8A1W7

erators...



Shaft generators

The use of shaft generators in modern shipbuilding allows fuel consumption to be reduced in comparison to the use of conventional, separate diesel units. These special-purpose machines are located right on the main shaft between diesel engine and propeller. The energy needed on the ship can therefore be produced with the help of heavy oil, increasing overall energy efficiency compared with high-speed diesel units. The benefits are substantial, particularly in the case of container cargo ships with their considerable power requirements due to the refrigerated containers on board.

VEM sizes these generators for use with synchronous converters as well as for pulse-width modulated (PWM) converters.

The machines are also designed to work as boosters or in "Power Take Home" mode. Booster mode conveys additional motor output to the propeller shaft under certain operating conditions, whereas Power Take Home operation is used to compensate a breakdown of the main machine. The shaft generator can thus function as a drive motor, safely bringing the ship to the nearest harbor.

The shaft generator's stator is delivered directly to the shipyard for installation. The salient pole is installed on-site, right on the ship's main shaft, and can be carried out by the VEM service team. The machines are designed for a protection degree of IP 44, complete with air-to-water heat exchanger.

*Project "chemical tanker Ceres",
Szeczin shipyard/Poland*

DGMUW 1622-16U

1,500 kVA / 1,760 kW, 425 V, 67 – 105 r.p.m.,
IM 5406, IC 8A6W7



Technical Data

| | |
|------------------|---|
| Voltage: | 400 – 6,600 V |
| Frequency range: | 7 Hz ...10 Hz ...20 Hz (on a frequency converter) |
| Speed range: | 40 r.p.m. ...100 r.p.m. ... 200 r.p.m. |
| Output: | 500 kVA / 500 kW – 7,500 kVA / 7,500 kW |
| Number of poles: | 16 (24 upon request) |

shaft-gene



*Project "container ship for Hapag Lloyd",
HHI shipyard/Korea*
DGMUX 1645-16W
5,000 kVA, 6.400 V, 65 – 94 r.p.m., IM 5406, IC 8A6W7

*Project "Uljanik",
Uljanik shipyard/Croatia*
DGMUW 1135-16U
1,600 kVA, 590 V, 90 – 108 r.p.m., IM 5406, IC 8A6 W7



rators...



Thruster drives

Electrical motors are used on almost all types of ships, e.g., as thrusters, but also as pump jets. As positioning systems they are indispensable on larger ships nowadays. They also play an important role on pipe and cable-laying ships, as well as on crane barges.

For special-purpose ships of this sort, the bow or stern thrusters can have an output of up to 5 MW.

The motors are manufactured in the IM 3011 or IM 1001 models with an added air-to-water heat exchanger for a protection degree of IP 54 or open-circuit air cooled for a protection degree of IP23. In addition to VEM's standard NGA series with gray cast-iron housings, welded housings can also be made-to-order.

The machines can be operated directly through the mains (DOL) in S1 or S2 mode or through a frequency converter. Variable-speed control is essential, however, when using them as positioning drives.



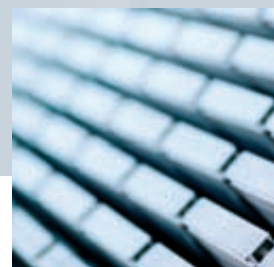
*Project "Research vessel Maria S. Merian",
Kröger Shipyard/Germany*

DKMJW 4516-6U

1,000 kW, 610 V on a frequency converter, 0 – 1,200 r.p.m.,
IM 3011, IC 8A6W7

Technical Data

| | |
|------------------------|--------------------|
| Voltage: | 400 V – 11,000 V |
| Output range: | 500 – 5,000 kW |
| Speed range: | 900 – 1,800 r.p.m. |
| Number of poles: | 4, 6 or 8 |
| Protection categories: | IP 54, IP 23 |

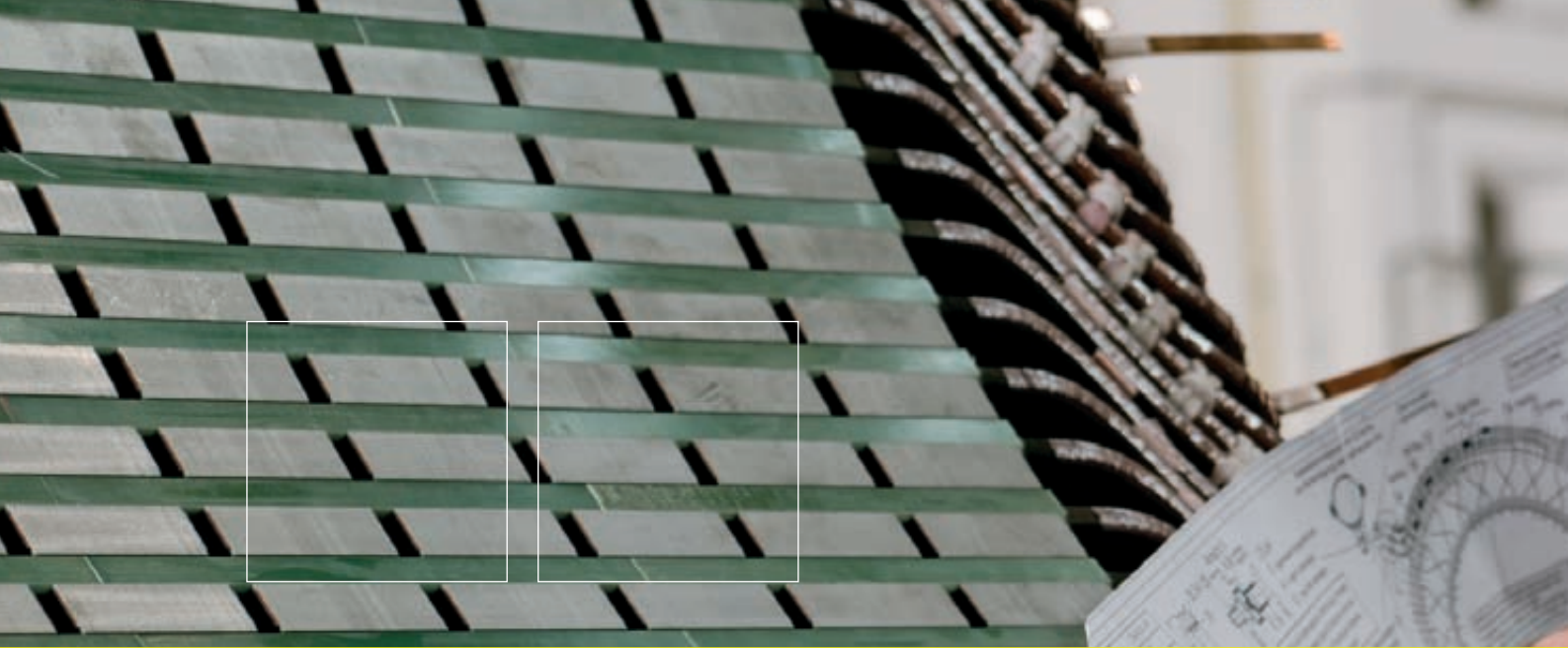




Project "Pipe fitter ship Solitaire"
DTMTZ 9038-6Y
4,300 kW, 2 x 1.250 V, 465 r.p.m., IM 3011, IC 8A6W7

Project "Cruiseliners AIDA I-VI",
Meyer Shipyard / Germany
DKKJT 7124-8WF
2,300 kW, 11,000 V, 900 r.p.m., IM 4011, IC 8A1W7

thruster...



Combi drives

VEM propulsion motors as “combi drives” with outputs of 2.75 MW and 3.3 MW are another successful motor series. This new drive concept was developed by VEM in cooperation with the SCHOTTEL company, manufacturer of rudder propellers and propulsion units. The combi drive is the result of combining the compact design of POD drives with the robust technology of standard drives.

Through the consistent use of 3-D CAD systems beginning in the design phase, manufacturing is carried out under constant monitoring and control for optimal integration in the overall drive system.

Advantages of the combi concept

- extremely compact unit with integrated drive motor
- minimal installation costs at the shipyard
- greater efficiency by eliminating above-water gearbox
- external testing on testbed possible before installation
- easily accessible after installation

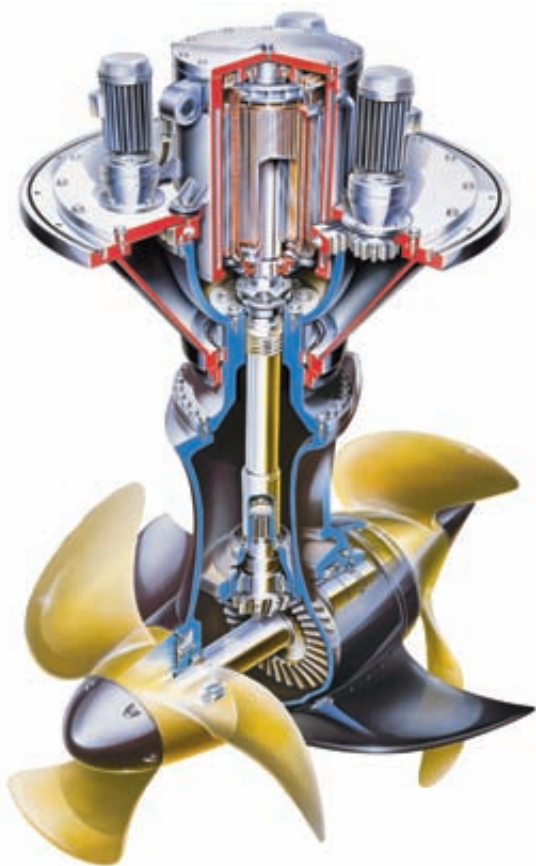


Technical Data

| | |
|------------------------|--------------------|
| Voltage: | 675 V |
| Output range: | 2,750 – 3,300 kW |
| Speed range: | 750 ... 800 r.p.m. |
| Number of poles: | 8 |
| Protection categories: | IP 54 |



combi



The drive motor is designed to be integrated vertically into the support tube of the rudder-propeller. Cooling takes place by means of a water jacket, making optimal use of space, but also demanding a sophisticated design. Complex mounting with integrated gear lubrication guarantees an exceptionally long service life. Exhaustive testing procedures are conducted on cooling-system seals and bearing lubrication, ensuring the motor's operational availability. The elimination of the above-water gearbox results in higher system efficiency.

Project "Schottel SCD 2020/LNG-Ferries"

DKWUZ 7131-8U

2,750 kW, 675 V on a frequency converter, 0 – 800 r.p.m.,

IM 4011, IC 8A1W7

drives...



Asynchronous propulsion motors

Large, low-speed asynchronous motors are becoming more and more common as a means of powering diesel-electric ships. The corresponding motors from VEM Sachsenwerk are predominantly supplied in the IM 1001 and IM 1102 models in combination with sliding bearings for low noise and vibration levels.

VEM asynchronous machines are also used in a variety of other drive systems in shipbuilding. For the low-output range, in particular, VEM supplies direct-drive systems linked to the propeller via the gear unit.

These motors are designed for use with medium-voltage converters. But it will be also possible to have a design with 4 independent winding systems for LV – inverter operation in the upper power range.

Possible drive variants:

- direct drive (DOL)
- startup with a soft starter till maximum outputn
- operation with a PMW converter, sometimes with multiple winding systems
- combination of direct and regulated drive (tandem)

Asynchronous machines are characterized by the rugged design of their rotor winding, guaranteeing high operational availability and efficiency. The use of modern PMW converters in low and medium-voltage designs also enables variable-speed operation.

Technical Data

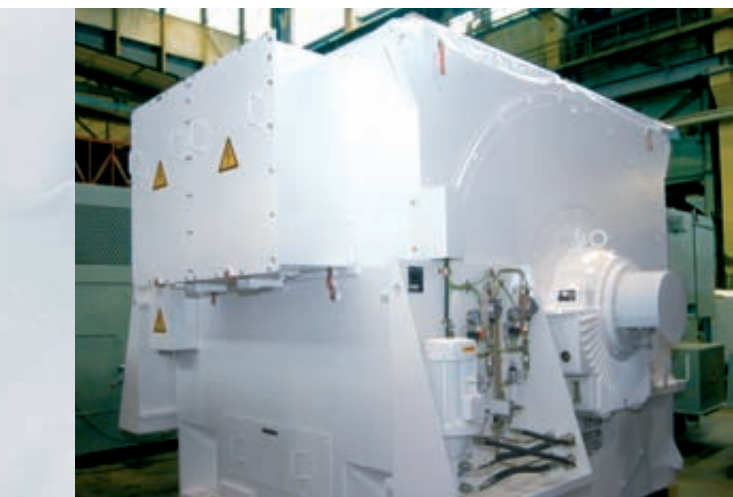
| | |
|------------------|---|
| Voltage: | 400 V – 11.000 V for direct drive 500 V – 4.500 V for inverter operation |
| Output range: | 500 – 15,000 kW |
| Speed range: | 125 – 1,800 r.p.m. |
| Number of poles: | 4 to 16 |



*Project "BC Ferries"
Flensburger Shipyard/Germany*

DKMUX 1040-10WE
11,000 kW, 6,600 V on soft starter, 717 r.p.m., IM 1001,
IC 8A6W7





Project "MY NB 681",
Kusch Shipyard/Germany
DKMEF 1240-16V
5,000 kW, 2 x 4,160 V, 200 r.p.m., IM 1101, IC 8A6W7

Project "AX 104-M/V Bourbon Orca",
Ulstein Yard/Norway
Tandem drive with added air-to-water heat exchanger
DKMCB 7135-12U
3,000 kW, 675 V (with converter), 0 – 600 – 720 r.p.m.,
IM 1001, IC 8A6W7
DKKAB 7122-10U
2,000 kW, 690 V (DOL), 720 r.p.m., IM 1001, IC 8A6W7

nchronous...



Synchronous propulsion motors

Synchronous propulsion motors are the standard drive for electric propulsion systems on ships, particularly for high-torque applications. These machines are manufactured with two separate winding systems and are sized for use with medium-voltage synchronous converters.

Applications range from powering mega-yachts, where quiet operation is absolutely essential, to more robust drive systems for tankers and cruise liners, as well as for navy vessels, the latter requiring extremely high operational availability.

Of particular note in VEM Sachsenwerk's production range are low-speed machines with a separate base frame capable of being equipped with additional vibration dampers. The sliding bearings used in these models, together with the oil-feed units, are designed to operate even at extremely low rotational speeds and are equipped with "hydrostatic units."

A variable welded-housing-construction concept enables the machines to be adapted to the specific installation environments on board a variety of ships.



*Project "Norwegian Sun",
Lloyd Yard/Germany*

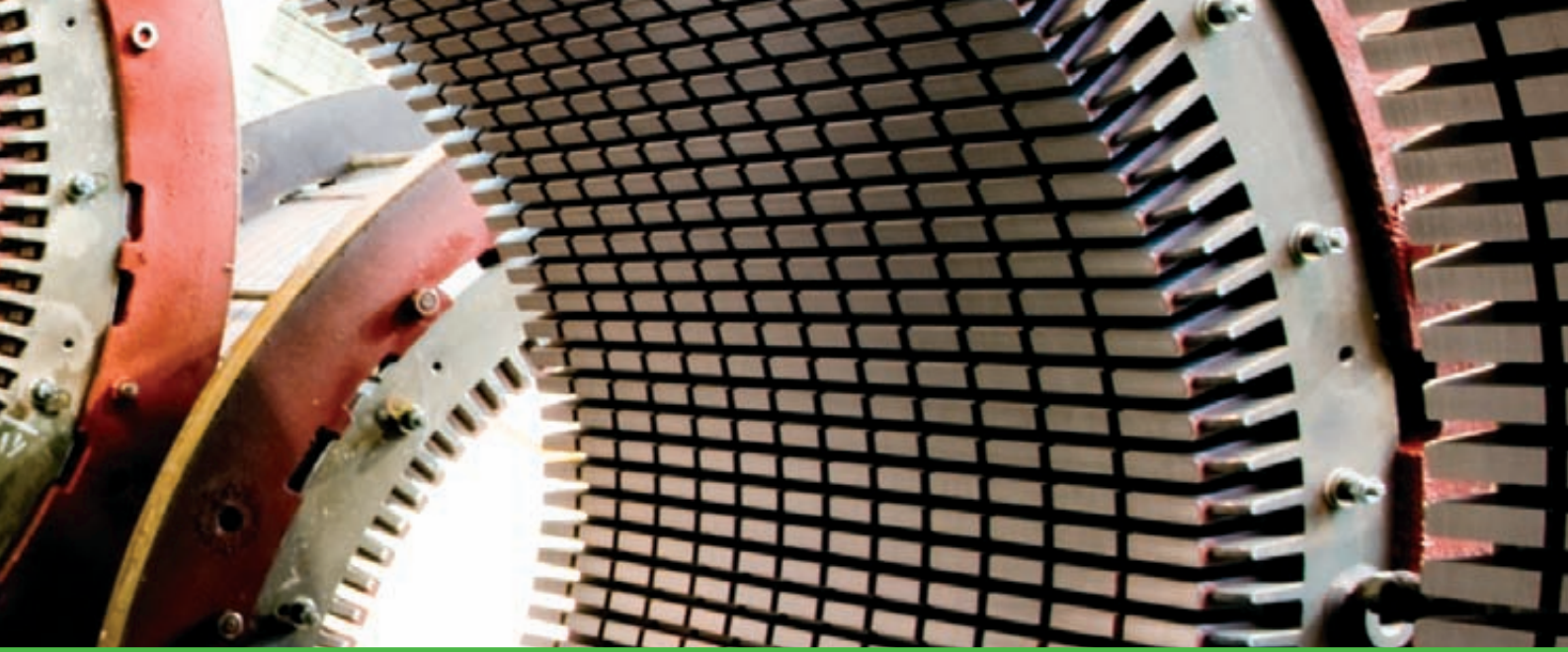
DTMYZ 3070-16

15,000 kW, 2 x 2,900 V, 0 – 140 r.p.m., IM 7315, IC W37A97

Technical Data

| | |
|------------------|--------------------------------------|
| Voltage: | 690 – 4,500 V for inverter operation |
| Output range: | 5,000 – 30,000 kW |
| Speed range: | 120 – 200 r.p.m. – (1,200 r.p.m.) |
| Number of poles: | 16 (6 to 24 upon request) |

synch



*Project "Megayacht Eclipse",
Blohm+Voss Shipyard/Germany*

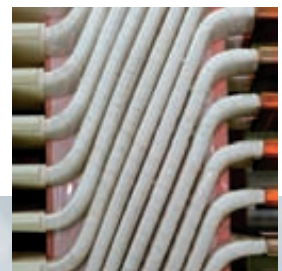
DTMSZ 2542-16YS

6,500 kW, 2 x 1,900 V, 0 – 180 r.p.m., IM 7315, IC 8A6W7

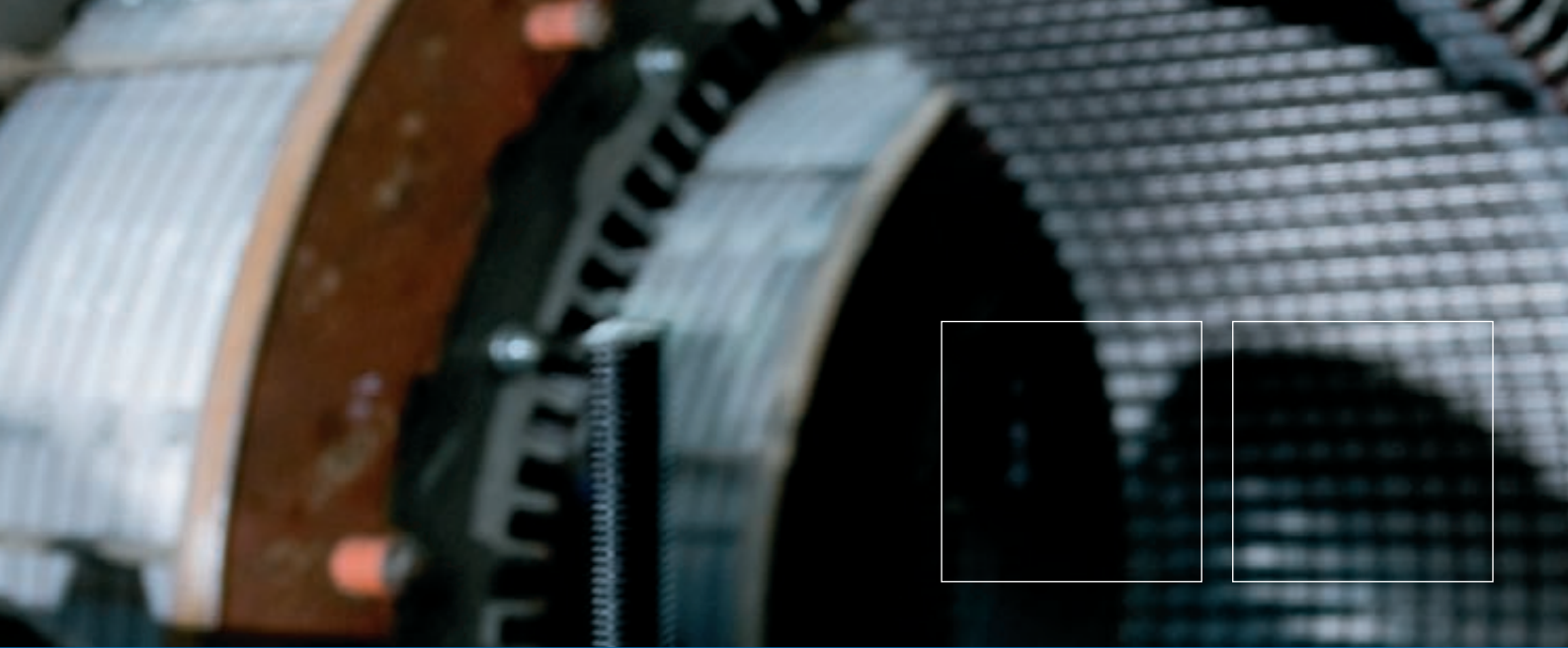
*Project "Seabourn",
Mariotti Shipyard/Italy*

DTMSZ 2549-16YS

7,500 kW, 2 x 2,500 V, 0 – 170 r.p.m., IM 7315, IC 8A6W7



ronous...



POD drives (asynchronous and synchronous)

VEM's range of products for state-of-the-art marine propulsion also includes POD drives. These are supplied with a power rating of between 2 to 7 megawatts. The drives are equipped with asynchronous or synchronous motors, depending on the vessel's requirements and operating conditions.

The Electric Propulsor (SEP), specially developed for SCHOTTEL, is an asynchronous motor. It is characterized by the maintenance-free and compact design of its rotor and thus its efficient operation.

The single-rotation motor consists of a laminated package for stator and rotor. The package is in direct contact with the hollow shaft of the rotor, i.e., with the external housing of the stator. Particularly high efficiency is achieved through direct cooling of the rotor with seawater and the special (rod-shape) rotor-bar design.

SEP drives are equipped with a small internal air refrigeration cycle and are likewise used as anti-condensation heaters when idle.

In the higher output range, synchronous machines with brushless excitation or permanent magnetic excitation are used. The greater air-gap measurements required due to relatively large bearing clearances can be easily implemented with the synchronous principle.

The motors' isolation system is designed for operation with frequency converters, low voltage being used in the lower output range and medium voltage being used in the higher output range. The preformed coils, specially developed for non-sinusoidal voltages and VPI-impregnated, combine mechanical rigidity with an optimal and even temperature distribution within the coil.

*Project "Seven Seas Voyager",
Mariotti Shipyard/Italy*

DTLSZ 1077-12

7,000 kW, 1.900 V, 170 r.p.m., IM 5009



Technical Data

| | |
|----------------------|--------------------------------------|
| Operating principle: | asynchronous, synchronous brushless |
| Output range: | 690 – 4,500 V for inverter operation |
| Speed range: | 120 – 250 r.p.m. |
| Leistungsbereich: | 2,000 - 15,000 kW |
| Number of poles: | 16 |

pod drives



*Project "Schottel SEP-5",
Royal Schelde Yard/Netherlands*
DKWUZ 9088-12V
5,500 kW, 3,300 V, 212 r.p.m., IM 5009

*Project "Schottel SEP-2",
Peene Yard/Germany*
DKWUZ 6357-12U
2,050 kW, 615 V, 242 r.p.m., IM 5009



Low-voltage machines for auxiliary-drives

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High-voltage machines and low-voltage machines, transnorm machines

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we get things moving

