

Industry brochure

# ABB drives for marine

## Medium voltage drives for reliable and efficient operations at sea



# ABB — one of the world's leading suppliers of variable speed drives for the marine industry

Reliability is crucial for all operations at sea. Innovative technology must be based on extensive experience.

## Harnessing know-how to your advantage

ABB has been providing medium voltage AC drives to the marine industry for over 40 years. Today its drives are used in applications including:

- propulsion
- pumps
- compressors
- fans

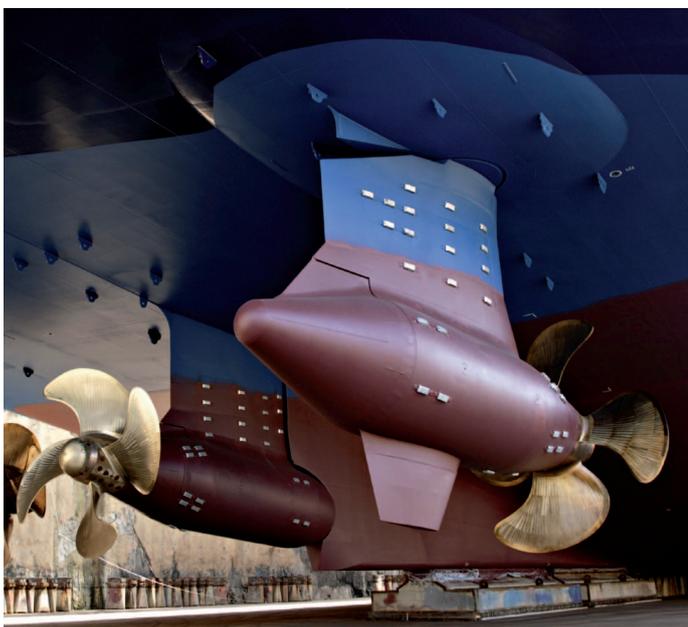
All vessel types and floating structures can benefit from using medium voltage drives in propulsion and auxiliary applications including:

- Cable and pipe layers
- Chemical and product tankers
- Cruise vessels
- Double-acting tankers
- Dredgers
- Drill ships and semi-submersible rigs
- FPSO tankers
- Icebreakers
- Offshore support vessels
- Research and survey vessels
- RoRo and RoPax ferries
- Shuttle tankers

## Medium voltage drives benefits

ABB's extensive know-how in AC drive technology, combined with its long experience in the marine industry, results in innovative drive solutions with unsurpassed performance and reliability. Other benefits include:

- Safety and redundancy
- Reliability
- Low operating costs
- Reduced maintenance
- Low exhaust emissions
- Layout flexibility
- Cost-effective construction
- High performance



Azipod® propulsion system



ACS 6000 variable speed drives controlling Azipod® propulsion motors

# Electric propulsion

Due to its flexibility, energy efficiency and superior performance, electric propulsion is widely used in today's marine technology.

A variable speed propulsion drive system consists of a supply transformer, a frequency converter and a propulsion motor. Propulsion drive power is controlled by the frequency converter, which controls the speed by varying motor frequency and voltage.

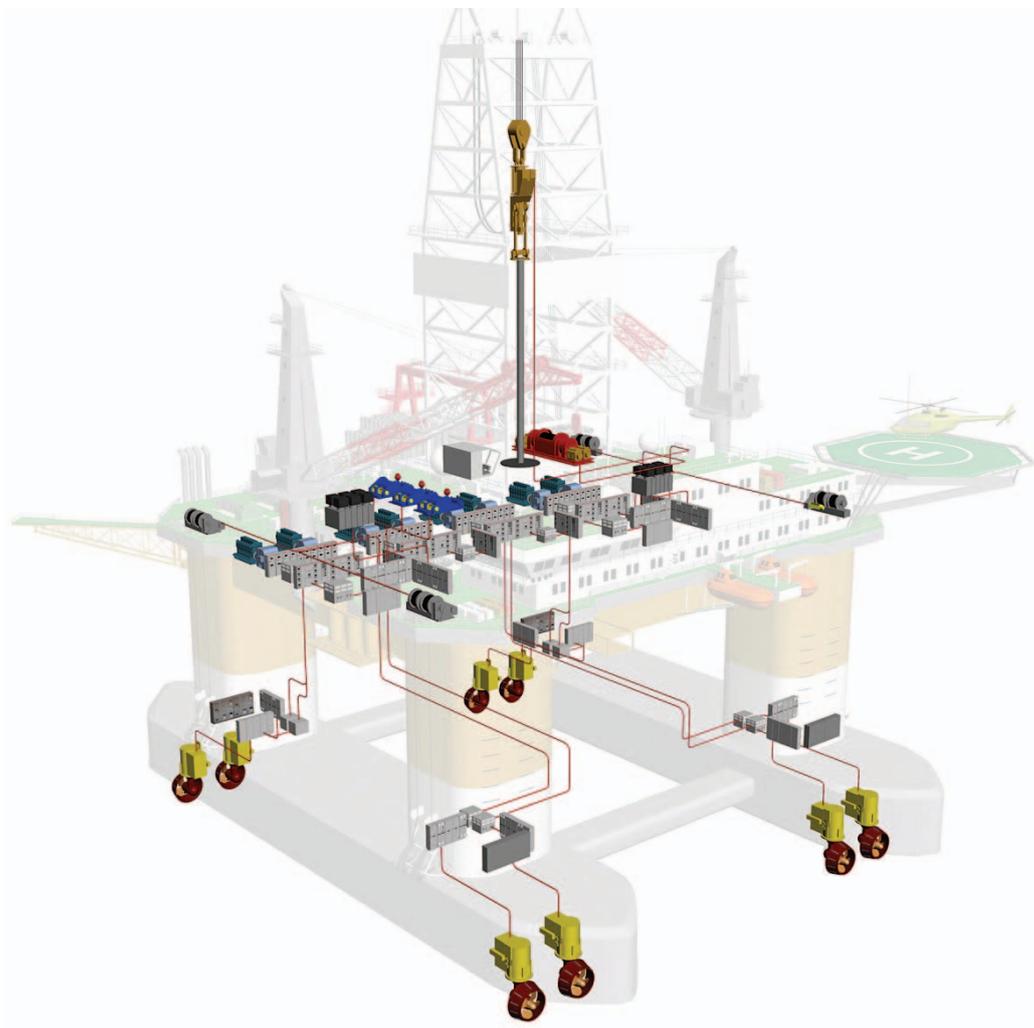
## Single-motor-drive design

Single-motor configurations are commonly used in applications which require large, independent and decentralized drives. For example thruster drives for dynamic positioning of drilling vessels and floating production vessels or main propulsion drives for shuttle tankers, cruise ships and ferries.

## Transformerless solution

Direct generation of the appropriate converter input voltage allows designs without converter transformers. Reactors integrated in the converter provide the necessary decoupling.

The subsequent reduction in total weight and size of the entire system results in a more flexible layout providing additional space for other needs. Fewer components with auxiliary equipment, combined with additional monitoring devices, increase reliability and availability.



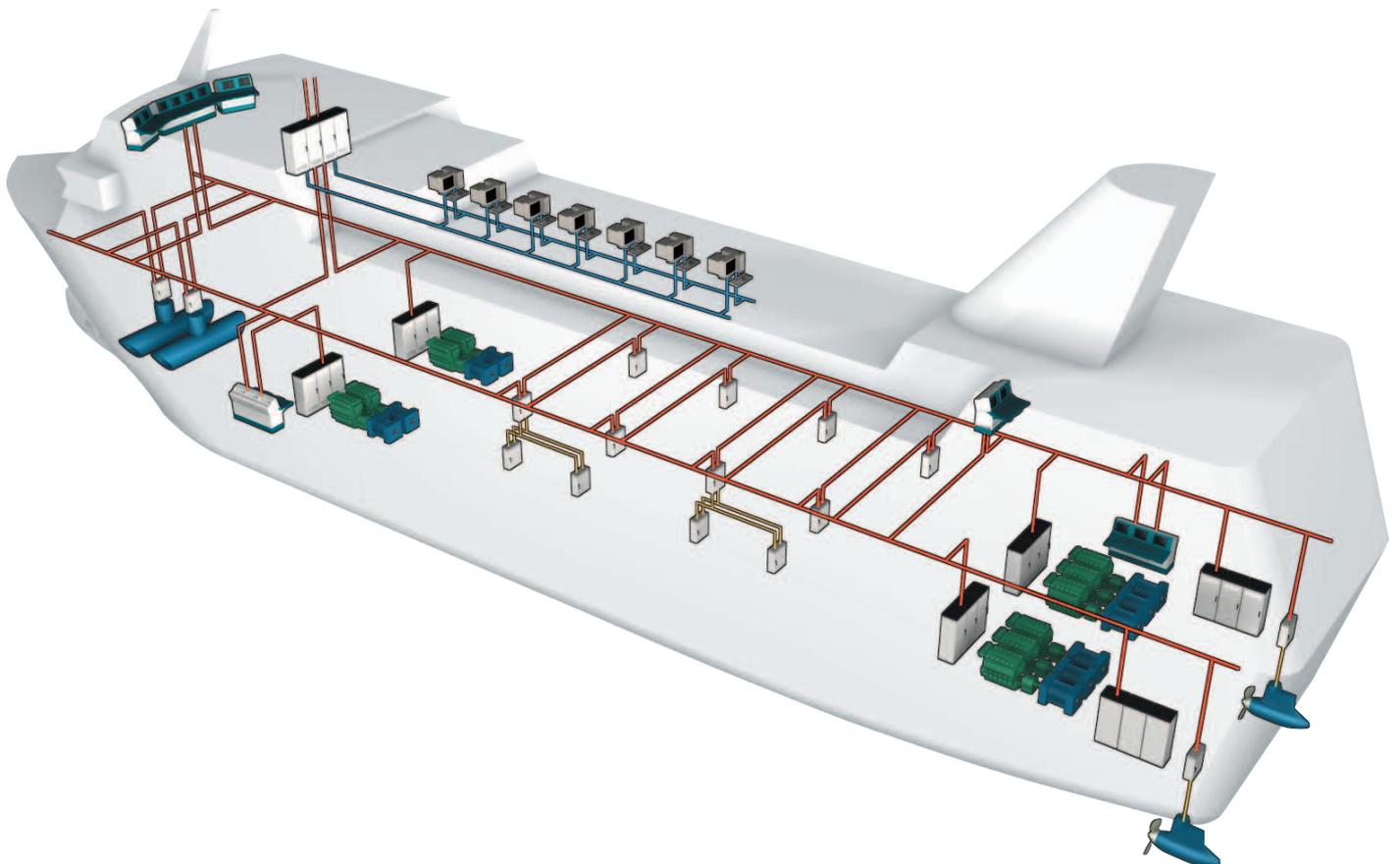
### Multi-motor-drive design

Several motors can be connected to a common DC bus, thus enabling multiple machine operation. Synchronous or induction motors, high or low power, any combination is possible in order to provide the optimum configuration.

In applications with different operation cycles (e.g. thrusters and main propulsion), the ratings of rectifier/inverter modules, main circuit breaker and transformer can be reduced substantially.

### Redundant drive design

Single drives can be configured to allow various schemes for redundancy, offering greater availability of the drive system.



# ACS 6000 (3 – 27 MW)

The ACS 6000 medium voltage drive with its modular concept, is the perfect answer to the requirements of modern propulsion schemes for floating production facilities, dynamically positioned drilling vessels, shuttle tankers, service ships and large passenger vessels.

## Efficiency and reliability

The ACS 6000 uses the IGCT (Integrated Gate Commutated Thyristor) power semiconductor, which is an ideal switch for high-powered medium voltage applications. The use of IGCTs results in low parts count, providing an efficient and reliable drive.

Due to low losses, the IGCT requires less cooling capacity and smaller cooling equipment. The IGCTs fast switching enables the implementation of unique control algorithms.

The IGCT converter design allows the use of a fuseless main circuitry. This increases the availability of the drive since the protective functions are actively controlled by the converter, and the recovery from a fault can be accelerated.

## Modular design requires minimal engineering

The ACS 6000 is available with five sizes of inverter modules (3, 5, 7, 9 and 11 MVA). The optimum configuration for specific applications is achieved by combining the modules with minimum engineering effort.

## Compact and robust marine design

During the design and development phase special care was taken to meet marine and offshore requirements resulting in a small footprint, flexibility and lightweight design. The ACS 6000 meets the requirements of marine certifications, such as Lloyd's, DNV and ABS.

## High performance with Direct Torque Control (DTC)

The ACS 6000 uses ABB's motor control platform, Direct Torque Control (DTC) which provides the most accurate torque and speed control ever achieved in medium voltage drives. As a result, control of the drive is immediate and smooth under all conditions.

With DTC, full torque at zero speed can be achieved without the use of speed encoders, thereby reducing maintenance costs and ensuring high availability. DTC also ensures minimum torque ripple and results in reduced machine wear. The high switching frequency generates lower noise levels.

## Key features and benefits

- High power and outstanding reliability increases the safety of the ship and decreases maintenance costs
- Smooth torque over the entire speed range reduces noise and vibration levels
- Compact and lightweight design provide basis for cost-effective construction
- Redundant main propulsion drives provide adequate power for the ship to operate safely if a malfunction occurs
- Minimized energy and fuel consumption
- High immunity to varying climatic conditions and vibrations increases availability

For further information, please see ACS 6000 brochure (3BHT490399R0001).



**Terminal Unit (TEU)**  
Transformer cable connection section for top and bottom entry

**Capacitor Bank Unit (CBU)**  
DC capacitors for smoothing the intermediate DC voltage

**Control Unit (COU) and Terminal Unit (TEU)**  
Contains the power terminals, control swing frame and motor cable connection section for top and bottom entry

**Line Supply Unit (LSU)**  
6- or 12-pulse diode rectifier unit

**Inverter unit (INU)**  
Self-commutated, 6-pulse, 3-level voltage source inverter with IGCT technology

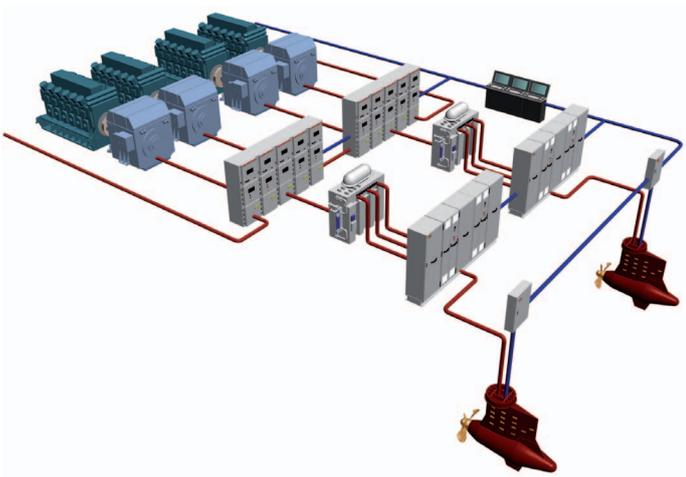
**Water Cooling Unit (WCU)**  
Supplies the cooling system with deionized water for the main power components in LSU, INU and CBU

# Configuration concepts

The design of the ACS 6000 is characterized by its modular structure and the common DC bus concept. Depending on the individual drive requirements and the power demands, different configurations can be realized.

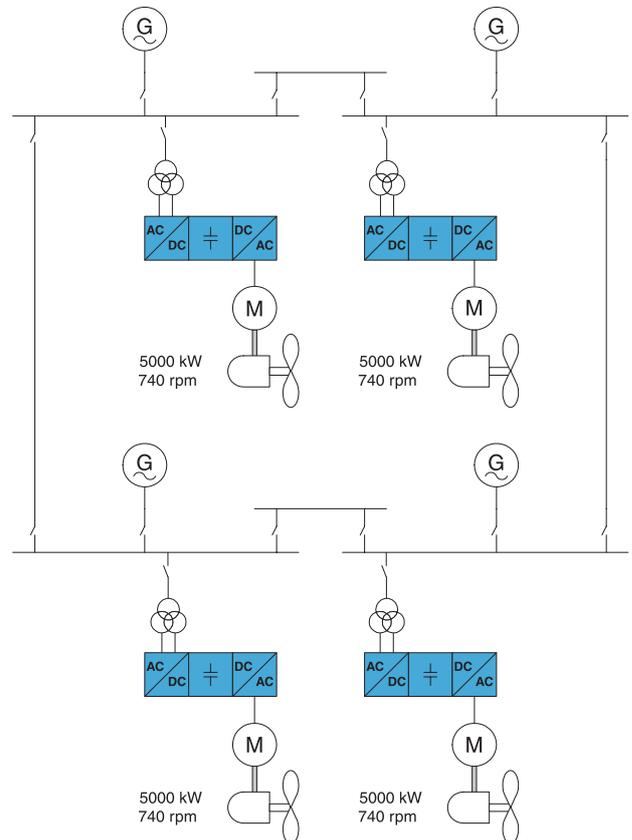
An ACS 6000 drive system is optimized to best fit your application. In addition, installation and commissioning time is reduced due to standardized procedures and documentation.

The following illustrates various converter configuration concepts, suitable for high power marine and offshore applications.



## Dynamic positioning of floating vessels: distributed concept

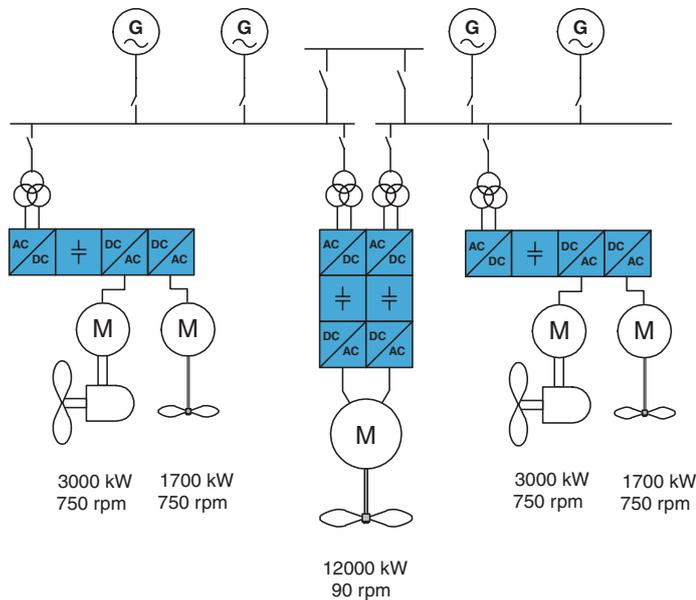
This dynamically positioned offshore drilling rig is equipped with four ACS 6000 single drives. Power generation and propulsion can be separated and distributed to the most convenient locations, resulting in cost-effective construction.



### Propulsion and thruster for shuttle and service vessels: redundant concept

In a redundant main propulsion configuration, the power system can be split. Operation at reduced power is, therefore, maintained in case of partial failure of the converter.

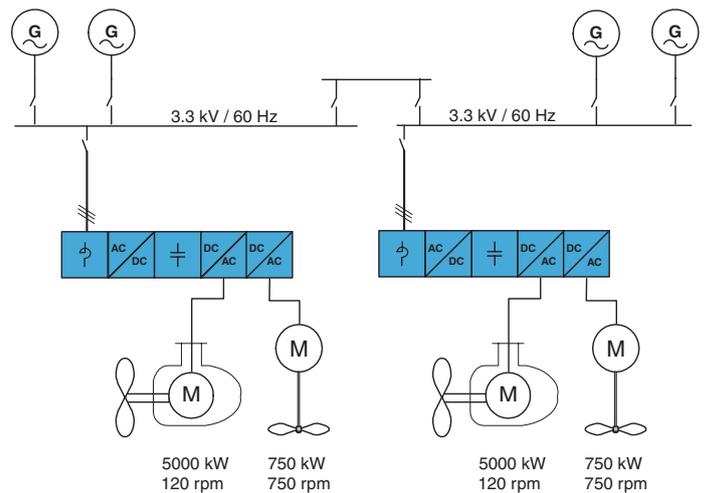
The main propeller (Azimuth or conventional installation with shaft) is driven by a variable speed drive tandem motor, which is fed by a redundant ACS 6000 converter. For positioning and manoeuvring, 2x2 thrusters on a common DC bus (Azimuth and propeller units) are provided. Due to the common DC bus concept the number of transformers, MCBs and cabling can be reduced, resulting in smaller drive system size.



### Main propulsion with thrusters: transformerless multi-motor-drive concept

This service vessel, with two main propulsion Azimuth thrusters, is assisted by two smaller (tunnel) thrusters. This type of configuration is used for smaller power requirements.

The most economic arrangement is with two ACS 6000 multidrives and line reactances instead of transformers.



# Variable speed drives for auxiliary applications such as pumps and compressors

Auxiliary motors controlled by variable speed drives will consume significantly less energy than fixed-speed motors.

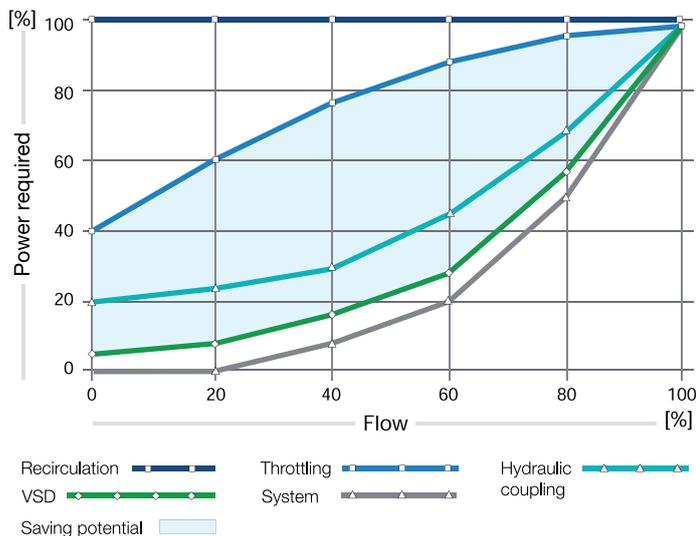
Applications such as dredge pumps, cutter motors, cargo pumps, compressors and heavy load cranes, can benefit from electric variable speed control.

## Mechanical versus electrical control

Pumps are usually controlled either electrically with variable speed drives, or mechanically with inlet guide vanes, throttling valves or hydraulic couplings.

With mechanical fixed-speed control, it is difficult to achieve the optimal process efficiency over the entire control range. With electric variable speed drives, changing the production volume is simply achieved by changing the motor speed. This saves energy, decreases CO<sub>2</sub> emissions and minimizes the total operating costs.

Electric variable speed drives provide the most efficient process control.



Power consumption for various pump control methods

## Benefits to auxiliary applications

- High availability
- Fast and precise process control under all conditions
- Lower energy consumption
- Reduced emissions
- Minimal actuator equipment

## Energy savings and reduced emissions

Since pumps typically run at partial load, huge energy savings can be achieved by controlling their speed with variable speed drives. A small reduction in speed can make a big reduction in the energy consumption. A pump running at half speed may consume as little as one eighth of the energy compared to one running at full speed.

By employing variable speed drives on pumps, instead of using throttling or damping devices or inlet guide vanes, the energy bill can be reduced by as much as 60 percent. Consequently, electric variable speed drives also help to reduce NO<sub>x</sub> and CO<sub>2</sub> emissions.

# ACS 1000 (315 – 5,000 kW)

The ACS 1000 family of drives is one of the most successful drives in its class, providing marine auxiliary applications with simple and reliable power control.

## Power control of induction motors

The ACS 1000 family of drives provides speed and torque control of 315 to 5,000 kW induction motors with voltages of 2.3, 3.3, 4.0 and 4.16 kV.

An output sine filter designed by ABB, eliminates voltage reflections and common mode voltages, making the drive suitable for standard motors and retrofit applications.

The water-cooled ACS 1000 and the air-cooled ACS 1000 with integrated transformer (ACS 1000i) will meet the requirements of marine certifications, such as ABS, DNV and CCS.

## Key features and benefits

- Retrofit-ready for existing motors and suitable for most medium voltage applications
- Output sine filter for pure sinusoidal voltage and current output: standard motors, no motor derating, no voltage stress and no common mode voltages on the motor insulation
- Fuseless design for reliable, non-aging, maintenance-free circuit protection
- DTC for exceptionally accurate torque and speed control performance
- Integrated or separate input transformer for highest system design flexibility

For further information, please see ACS 1000 brochure (3BHT490400R0001).



# Motors and transformers

ABB drive packages include medium voltage converters, motors and transformers.

## Converter motors

ABB's converter motors – including induction and synchronous – have earned an excellent reputation for performance and reliability.

Synchronous motors are best suited for high power and high torque applications such as main propulsion of LNG tankers, cruise ships, ice-going vessels and ferries which require high overloadability across the entire speed range. In addition, synchronous motors offer the benefits of high efficiency and high performance.

Available up to 18 MW, squirrel cage induction motors are versatile, reliable and simple. Typical applications are thrusters of drilling vessels and pumps.

## Converter transformers

Converter transformers are especially designed for operation with variable speed drives. They adapt the converter to the supply network and provide a galvanic isolation between drive and supply network.

Converter transformers are available for nearly all ratings. Secondary voltages are optimized to match the converter and motor voltage. Oil or dry types for indoor or outdoor mounting are available. Busbar connections can also be provided.



# Testing, service and support

ABB drives are backed by comprehensive service and support, from the customer's initial inquiry throughout the entire life cycle of the drive system.

## Testing

ABB is committed to ensuring the reliability of every drive it delivers. To verify that quality standards and customer requirements are fully met every component of a drive is subjected to thorough testing in ABB's modern test facilities.

Routine tests and functional tests form an integral part of the scope of supply of ABB's medium voltage drives. They are performed in accordance with international standards and ABB quality assurance procedures.

Additionally, ABB can perform a combined test with the complete drive system – including transformer, converter and motor – to verify the performance and to ensure a smooth integration into the customer's facility.

## Installation and commissioning

Proper installation and commissioning of the equipment, done by qualified and certified commissioning engineers, reduces start-up time, increases safety and reliability and decreases life-cycle costs. In addition, operators can be given practical training by experienced specialists on site.

## Life-cycle management

ABB's drive life-cycle management model maximizes the value of the equipment and maintenance investment by maintaining high availability, eliminating unplanned repair costs and extending the lifetime of the drive.

Life-cycle management includes:

- providing spare parts and expertise throughout the life cycle
- providing efficient product support and maintenance for improved reliability
- adding functionality to the initial product
- providing a smooth transition to a new technology at the end of the life cycle

## Training

ABB provides extensive training for its medium voltage drives. A range of training programs is offered from basic tutorials to programs tailored to the customer's specific needs.

## Global network, local presence

After sales service is an integral part of providing the customer with a reliable and efficient drive system. The ABB Group of companies operates in more than 100 countries and has a worldwide network of service operations.



## Services for ABB's medium voltage drives

- Supervision of installation and commissioning
- Training
- Remote diagnostics
- Customized maintenance contracts
- Local support
- 24 x 365 support line
- Spare parts and logistics network
- Worldwide service network

## Remote services

ABB drives are available with an intelligent monitoring and diagnostics system, which enables timely and qualified technical assistance via secure remote communication links.

### DriveMonitor™

DriveMonitor™ is a key component of ABB remote services. It is an intelligent monitoring and diagnostics system, which allows secure access to the drive and other components from any location in the world.

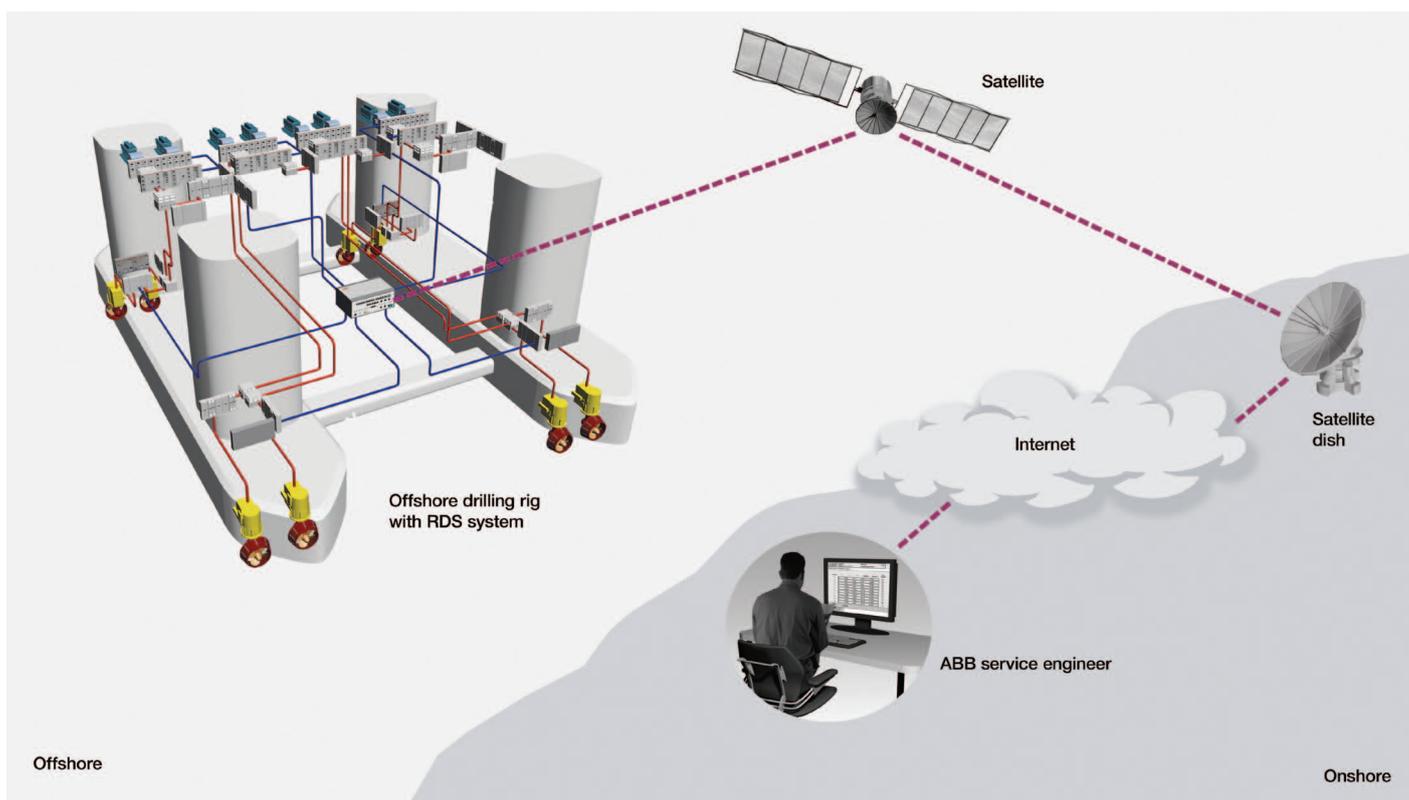
The optional tool consists of a hardware module, as well as a software layer that automatically collects and analyzes selected drive signals and parameters.

Long-term monitoring functions deliver important information on equipment status, maintenance tasks needed and possible performance improvements.

With extra diagnostic packages, DriveMonitor™ can also monitor other drive system components, such as main circuit breaker, transformer and the driven machine.

### Timely and qualified assistance from ABB

When required, an authorized ABB service engineer can log on to the diagnostic system installed on a vessel and guide the customer through a fast and efficient troubleshooting process. This helps to cut maintenance costs by reducing on-site work.



## Applications and references

To date, ABB has installed medium voltage drives with a total rated power in excess of 7,500 MW for applications in the marine industry. Below are some examples.



Oasis of the Seas, cruise liner  
3 x 20 MW propulsion drives



TyCom Reliance, cable layer  
2 x 3.1 MW propulsion drives  
2 x 3.1 MW thruster drives



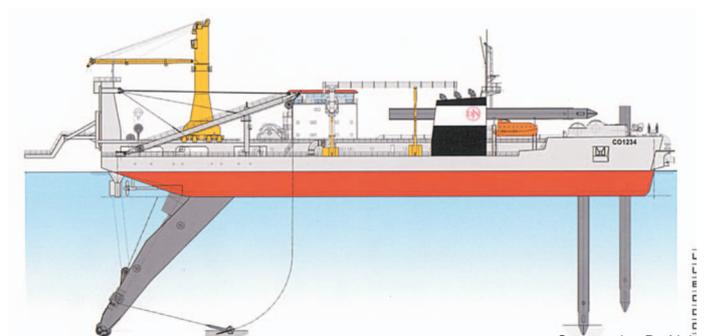
Tempra and Mastera, double-acting tankers  
16 MW propulsion drive



Deepwater Millennium, drilling vessel  
6 x 4 MW propulsion drives



Shin-Nihonkai, ferries  
17.6 MW redundant propulsion drive



Jan De Nul, self-propelled cutter suction dredger  
2 x 6 MW cutter and propulsion drives  
2 x 6 MW inboard pumps  
2 x 4 MW submerged pumps

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