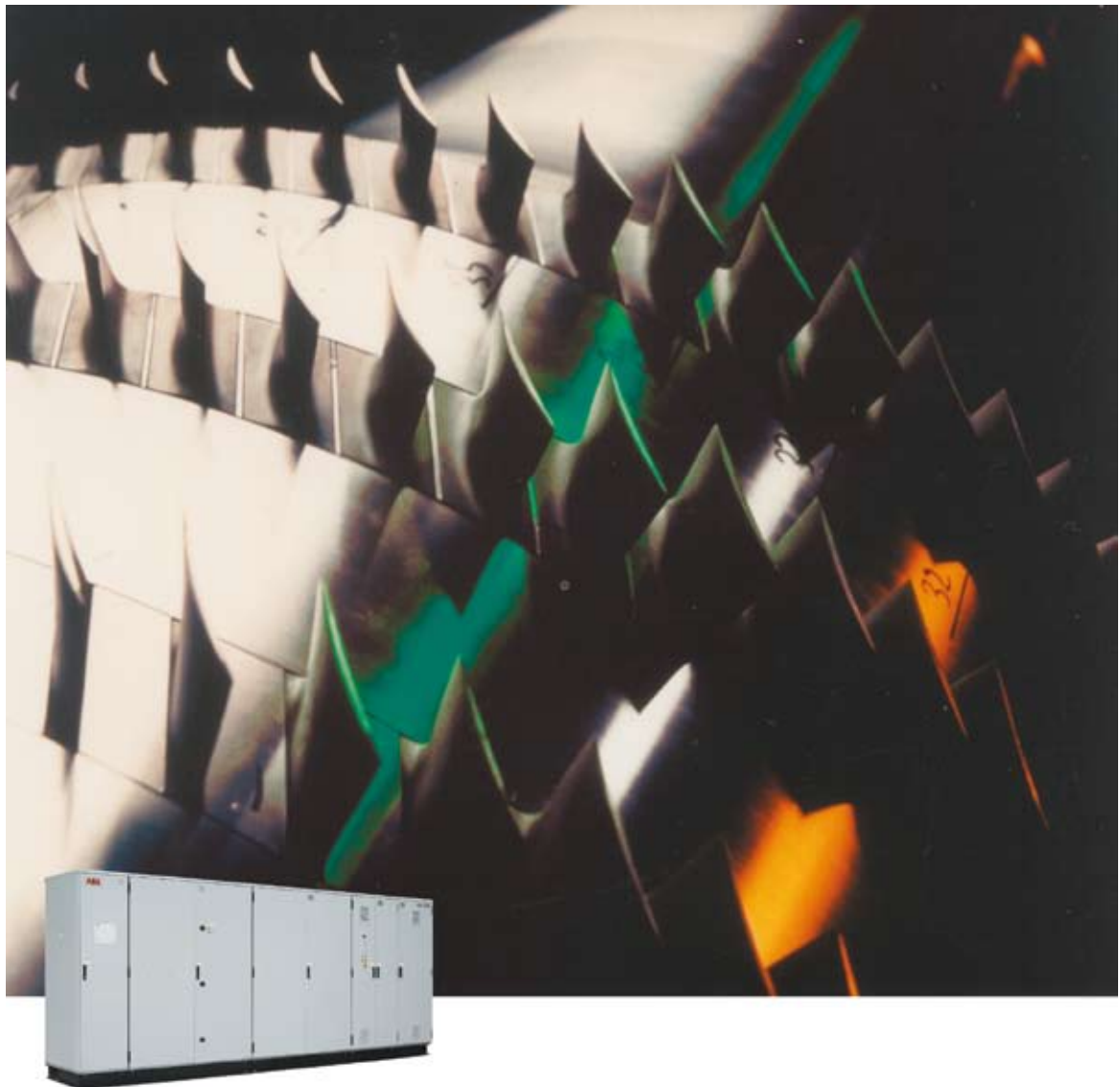


# ABB drives in power generation

Medium voltage drives for more efficient and reliable plant operation



**ABB**



# ABB – the world’s leading supplier of variable speed drives for the power generation industry

Variable speed drives improve the heat rate and net power output and reduce operating costs.

## Efficient plant operation

Today, power producers operate in a highly competitive marketplace. Business pressure from market liberalization and rising fuel costs require every producer to look for the most effective ways to convert a bigger share of fuel’s energy into salable kWh. Improving the heat rate of power plants is becoming increasingly important.

A thermal power plant usually consumes 5 – 8 % of the electricity it produces. Processes driven by electric motors typically consume 80 % of this electricity. Implementing electric Variable Speed Drives (VSD) improves the heat rate by increasing the efficiency of these processes.

Cost-efficient operational flexibility is the key to increased production during low and peak demand. An improved heat rate and power output result in higher profitability and faster return on investment. Several small capacity improvements can be an alternative to an investment in a completely new power plant.

The investment in variable speed drives increases plant availability and flexibility through improved process control and reduces emissions and maintenance costs.

ABB supplies drives products and systems for various kinds of processes and applications in the power generation industry:

Gas turbine power plants	GT starters, drives for fuel gas booster compressors, boiler (HRGS) feed-water pumps and cooling water pumps
Steam generating boilers, waste incinerators	Drives for boiler feed-water-, cooling water-, circulation water pumps, FD and ID fans
District heating, Combined Heat and Power	Drives for water circulation pumps in industrial and municipal combined heat and power (CHP) plants
Fuel handling	Drives for conveyors and coal mills
Selective Catalytic Reduction, Flue Gas Desulphurization	Drives for ID booster fans, limestone slurry feed- and absorbent circulation pumps and oxidation air compressors
Pumped storage hydro power plants	Soft starters for hydro turbines
Renewable energy	Drives for geothermal power plants and soft starters for synchronous condensers
Nuclear power plants	Drives for feed-water, condensate recirculation and cooling water pumps

# Benefits of variable speed drives

Variable speed drives for more efficient and reliable plant operation.

## Flow and pressure control

Demand for electrical energy varies over the year, during the day and on an hourly basis. Even at the constant base-load station, the required flow of a fan or a pump varies due to changes in ambient conditions or fuel properties. Due to these varying conditions a continuous control of the processes and equipment, such as centrifugal fans and pumps, is required.

## Benefits

- High availability
- Fast and precise process control under all conditions
- Minimized energy consumption
- Reduced emissions
- Minimized actuator equipment
- Soft starting features for a longer lifetime of electrical and mechanical equipment

## Mechanical vs. electrical control

Processes driven by pumps or fans are usually controlled either electrically with variable speed drives, or mechanically with inlet guide vanes, throttling valves or hydraulic couplings.

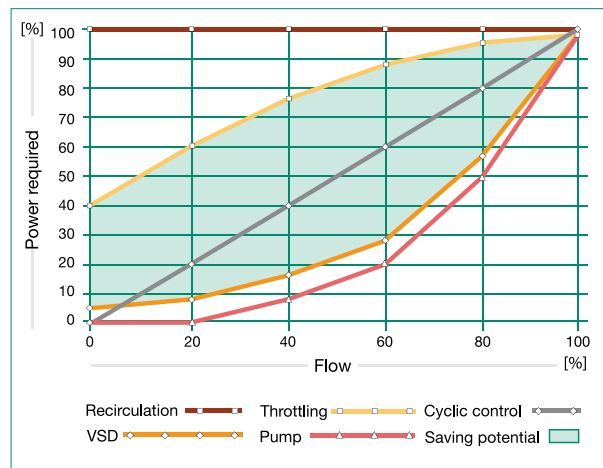
	Electrical	Mechanical
<b>Variable speed</b>	variable speed drive	hydraulic coupling
<b>Fixed speed</b>	on-off	throttling valve or inlet guide vane

With the mechanical fixed-speed solution, it is practically impossible to achieve the optimal process efficiency over the whole control range. With the mechanical variable-speed solution the losses in the hydraulic coupling itself reduce the overall system efficiency. An increase in production capacity usually requires a costly reconstruction of the whole process.

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.

## Power consumption for various pump control methods

Electric variable speed drives allow fans and pumps to be operated at the BEP (Best Efficiency Point) under all operating conditions, thereby achieving maximum process efficiency. Electric variable speed drives are the most efficient control method.



## Energy savings and reduced emissions

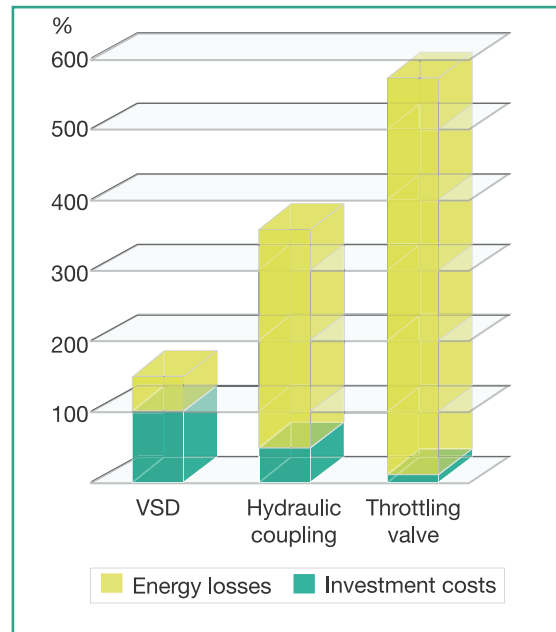
Energy saving has never been higher on the agenda than today. People have become increasingly aware of the correlation between wasting energy and environmental damage and acknowledge the benefits of conserving energy by technical means.

Since pumps and fans 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 or a fan running at half speed consumes as little as one eighth of the energy compared to one running at full speed.

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

## Soft starting

Accelerating rotating machinery with heavy load torque and/or high mass moment of inertia, such as ID fans and synchronous condensers, imposes large stresses on the electrical supply network and on the mechanical parts of the shaft string. A direct-on-line started electric motor can cause starting currents of up to six times the nominal current, or more. This will cause voltage drops that are likely to disturb the process, especially if the supply network is weak.



Comparison of investment costs and energy losses of different control methods.\*

Soft starting with variable speed drives results in the following benefits:

- No process disturbance due to voltage drops; no trips of other electrical devices connected to the same bus
- No excessive thermal or mechanical stress on the motor, resulting in a longer lifetime
- Immediate start-up without warming-up delay (e.g. steam turbines)
- Controlled and smooth start-up

ABB has more than 30 years experience in the design and manufacturing of static starting devices, which became the standard starting technology for heavy-duty gas turbines and pumped storage hydro turbines.

\*Calculated for a 1300 kW (1740 hp) pump application, for three years operation

# Variable speed drives for power generation applications

Various processes and applications in the power industry benefit from the implementation of variable speed drives.

## Pumps

- Boiler feed-water pump
- Condensate extraction pump
- Cooling water pump
- District heating circulation pump
- Limestone slurry feed- and absorbent circulation pump

## Fans

- Primary air fan
- Secondary air fan
- ID fan
- ID booster fan

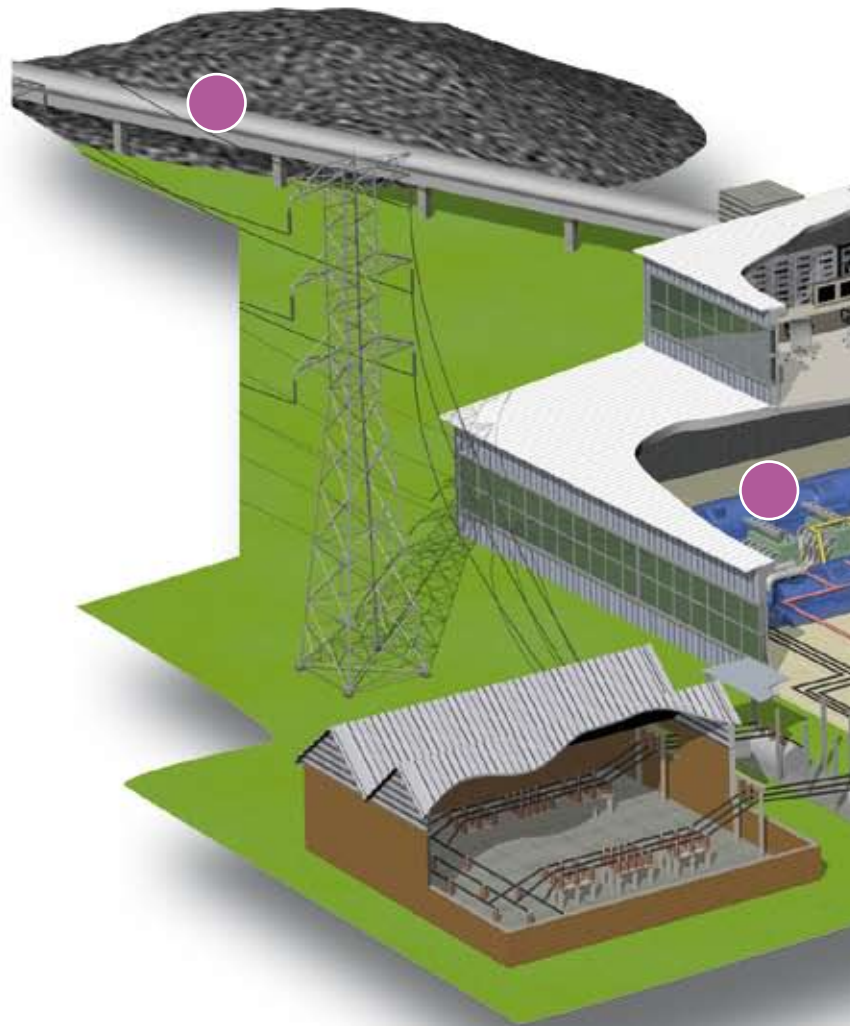
## Other

- Conveyor
- Coal mill
- Oxidation air compressor
- Gas turbine starter
- Fuel gas booster compressor

## Feed-water pumps

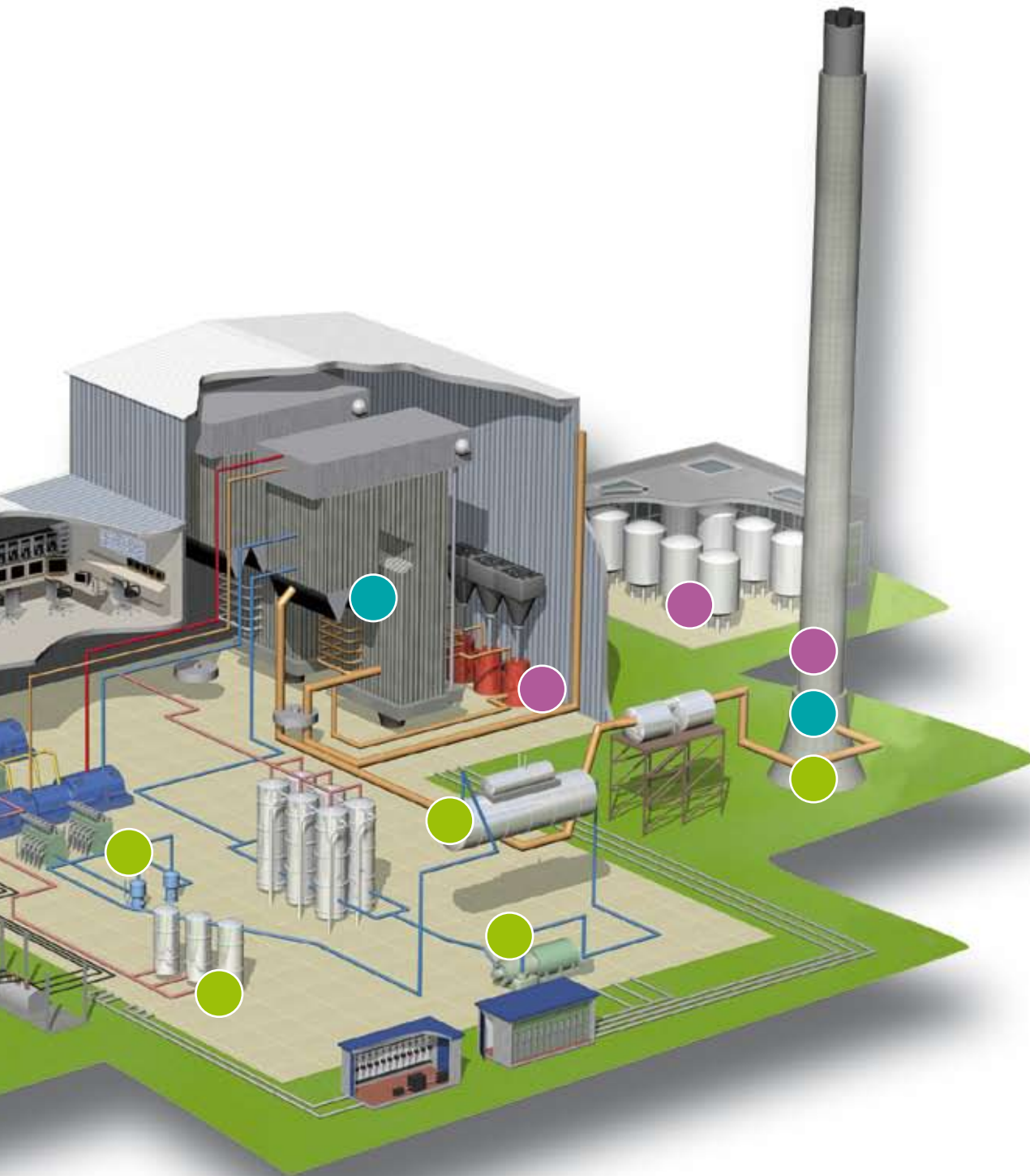
Feed-water pumps are characterized by high reliability requirements and fairly high dynamics during plant load changes. They normally make the biggest contribution to the plant's own energy consumption.

Traditionally, pump drivers have been selected focusing on reliability at the expense of efficiency. With today's variable speed drive technology both targets can be met without compromise. Furthermore, mechanical maintenance costs can be reduced by controlling the feed-water flow with variable speed drives instead of throttling control valves.



## Flue gas fans

High control accuracy, excellent energy economy and reduced maintenance costs are achieved with variable speed drives for all fans in the power generation process, including Forced Draft (FD), Induced Draft (ID) and cooling tower fans.



### **Soft starting**

During the starting process, variable speed drives act as soft starters. They progressively increase the motor voltage and frequency and smoothly accelerate the load to its rated speed, eliminating the stress on electrical and mechanical equipment. Maintenance costs will be reduced and the lifetime of the equipment extended. High starting currents and voltage dips in the supply network, which might cause process disturbances, are eliminated.

# Medium voltage drives

For more than 100 years ABB has provided drive products and systems to customers in different industries. ABB's unrivalled experience in AC drives technology, combined with its long experience in the field of power generation, results in innovative drive solutions with unsurpassed performance and reliability.

ABB offers the entire range of medium voltage drives and soft starters for applications in the power range from 315 kW to more than 100 MW.

## ACS 1000

The ACS 1000 medium voltage drive is an unbeatable solution for auxiliary processes in the power industry. Due to its unique output sine filter, that eliminates common mode voltages and voltage reflections, the ACS 1000 is suitable for both retrofit applications and new standard motors.

The ACS 1000i is a fully integrated standard drive which includes input transformer and input contactor.

## ACS 5000

The ACS 5000 can be applied to standard industrial motors (induction and synchronous) up to 6.9 kV.

The ACS 5000 is ideal for power plants where applications such as Induced and Forced Draft fans, feed-water and cooling water pumps are usually mechanically controlled. Retrofitting these high-powered applications with the ACS 5000 will result in significant improvements in efficiency and reliability.



ACS 1000, 315 kW - 5 MW

ACS 5000, 2 - 22 MW

ACS 6000, 3 - 27 MW

MEGADRIVE-LCI, 2 - 72 MW  
(higher on request)

## ACS 6000

ABB's ACS 6000 is a modular drive designed for the most dynamic and powerful single or multi-motor applications for both synchronous and induction motors.

Inter-related motors can be connected to the same ACS 6000 via a common DC bus, enabling multi-machine operation with only one supply unit. For applications such as conveyor belts with up- and downhill conveying, the common DC-bus principle offers a solution with optimum efficiency and energy flow between motors of motoring and generating mode.

## MEGADRIVE-LCI

ABB's MEGADRIVE-LCI is an optimal solution for high voltage and high power converter applications. They are also available as soft starters for applications with synchronous machines.

Standard designs are available for ratings up to 72 MW, engineered designs for more than 100 MW.

# Technology highlights

Reliability is the main guiding principle of ABB's research and development activities for medium voltage drives.



## Direct Torque Control (DTC)

ABB's award-winning control platform, Direct Torque Control (DTC), results in the highest torque and speed performance ever achieved in medium voltage drives. Control of the drive is immediate and smooth under all conditions.

## Power Loss RideThrough

Due to its RideThrough function, the drive system is able to withstand disturbances of the power supply. The drive will continue to operate in an active but non-torque producing mode if the incoming supply voltage is cut off. The drive will be active as long as the motor rotates and generates energy to the drive. It will resume normal operation immediately upon return of power supply.

## Superior semiconductor switching devices

ABB has developed a high power switch called IGCT (Integrated Gate Commutated Thyristor) to allow the use of modern control algorithms, which can eliminate harmonics, improve dynamic response time, and maintain or even control the power factor. This results in a reliable, compact and service-friendly drive.

The diode and the line commutated thyristor still hold the top position for very high power, lowest losses and highest reliability, but they do not allow the use of modern control algorithms.

## Low losses

The inherently low total losses of the IGCT require low cooling capacity and small cooling equipment.

## Low parts count

The fewer the parts the higher the reliability. ABB uses high power semiconductor switching devices and a topology that brings down the parts count to a minimum.

## Fuseless design

All ABB medium voltage drives are designed to operate safely without fuses. This results in less spare parts and fast re-starting should an overcurrent trip occur.

## Encoderless

Encoders have an exposed position on the motor and are known to cause failures. ABB's medium voltage drives can operate without encoder.

## DriveMonitor™

ABB medium voltage drives are available with an intelligent monitoring and diagnostics system, which allows secure access to the drive from any location in the world.

DriveMonitor™ supports monitoring, configuration and diagnostics of ABB drives independent of the implemented control method, thus also enabling the connection of existing installations.

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

# Components of variable speed drive systems

An electric variable speed drive system consists of input isolation transformer, frequency converter and electric motor.

ABB can offer the complete variable speed drive system or assist in selecting components that match the process requirements. ABB's equipment is known for its state-of-the-art technology, high efficiency and reliability and worldwide support.

## High voltage motors

ABB's high voltage motors have earned an excellent reputation for performance and reliability. The product range consists of both induction and synchronous motors.

**Induction motors** are the workhorses of the industry due to their versatility, reliability and simplicity. In the power range up to 10 MW, a squirrel cage induction motor is usually the first choice. They are available up to 18 MW.

**Synchronous motors** are typically considered for higher power ratings (e.g. above 8 MW to more than 100 MW). In addition to their high power capabilities, synchronous motors offer the benefits of high efficiency and high performance through the utilization of different rotor designs.

## Input isolation transformers

An input isolation transformer has two functions: it adjusts the network supply voltage to match the selected converter and it protects the motor from common-mode voltages. ABB input isolation transformers are specifically designed for operation with variable speed drives.

ABB's input isolation transformers are available for all ratings and primary voltages. Oil or dry type transformers are available for indoor or outdoor mounting. The separate transformer allows flexible installation, which can be next to the drive or, when space is limited, in another location.



*Induction motor*



*Input isolation transformer*

# Testing, service and support

ABB drives are backed by unrivalled 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

Substantial benefits can be gained from proper installation and commissioning of the equipment. Predictive testing and inspection, in addition to traditional operational parameter setting, done by ABB's qualified and certified commissioning engineers, will reduce start-up time, increase safety and reliability and decrease 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 provides customers with the maximum profit for their purchased assets by maintaining high availability, eliminating unplanned repair costs and extending the lifetime of the drive. Life-cycle management maximizes the value of the equipment and maintenance investment by:

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

## Training

Extensive training for ABB's medium voltage drives can be provided at the ABB University. A range of training programs is offered from basic tutorials to programs tailored to the customer's specific needs. → [www.abb.com/abbuniversity](http://www.abb.com/abbuniversity)

## 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. Wherever you are, ABB is there for you.

## Services for ABB's medium voltage drives

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



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