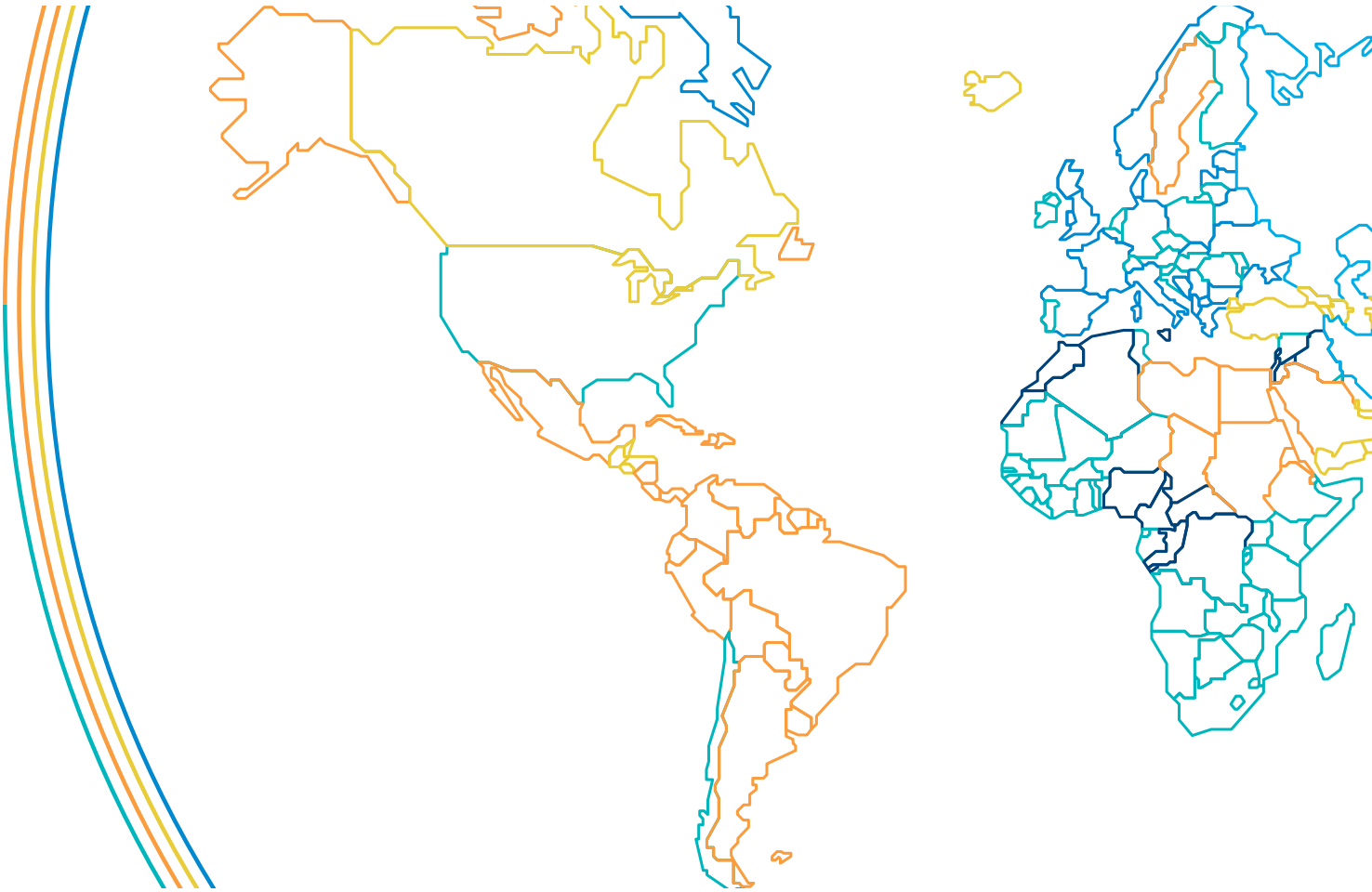
Products and services for wind turbines
Electrical drivetrain solutions and products for turbine subsystems

Power and productivity
for a better world™

Profile



A changing wind market

Demand for wind turbines continues to grow, driven by commitments to reduce CO_2 emissions and to diversify into renewable energy sources. During 2009, the market for wind turbines saw some important changes that place additional demands on turbine manufacturers:

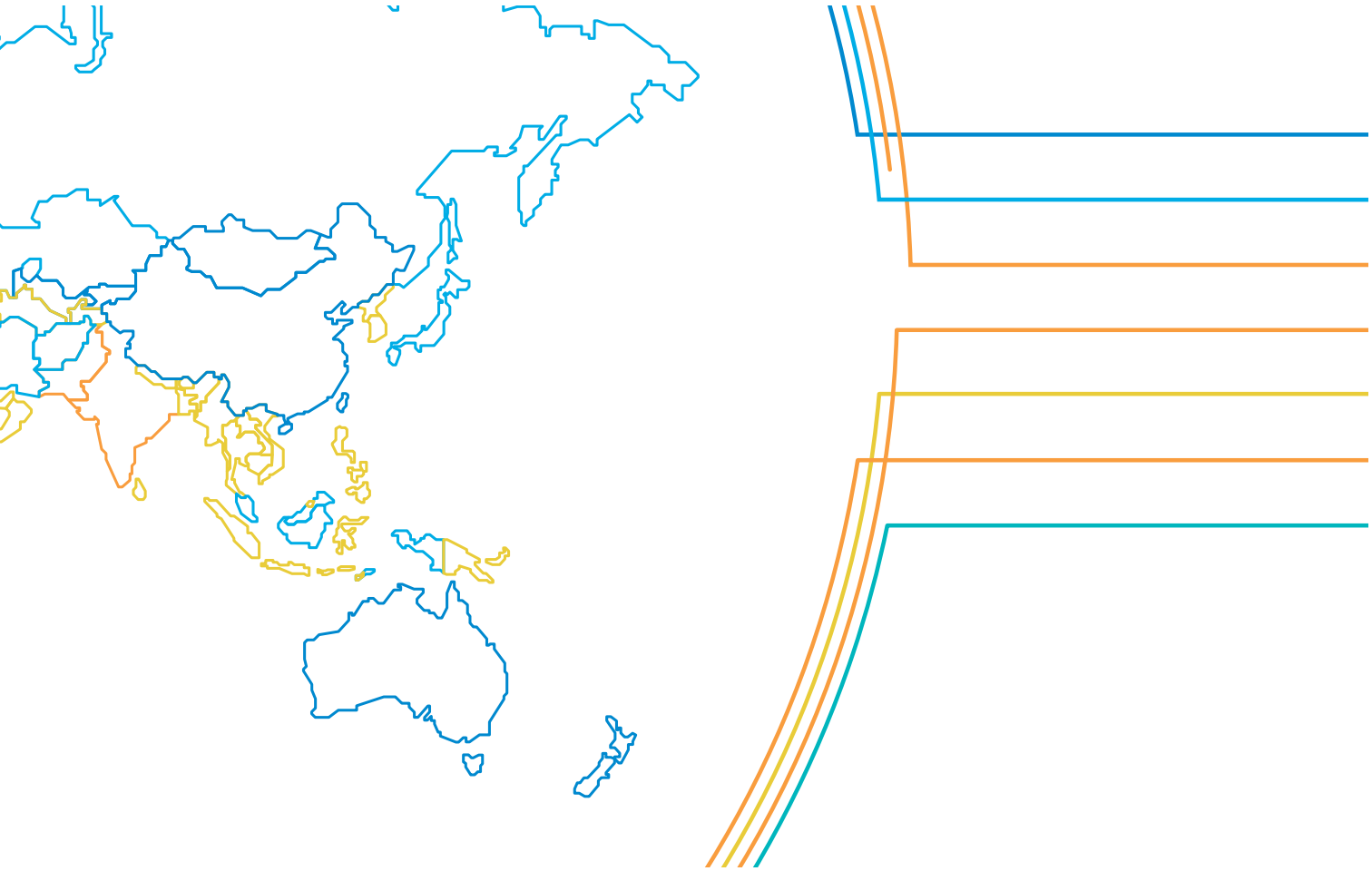
- Raw material prices dropped
- Competition increased
- Investment capital for large projects became more difficult to obtain

This combination of factors requires that turbine manufacturers more than ever need to ensure that their products are worth the investment and have the quality, reliability, and long life cycles investors and wind power plant operators demand.

Choosing a quality partner

Using ABB products helps manufacturers demonstrate the quality and reliability expected in the turbine design. ABB's proven products for wind turbines are designed and built to operate for long life cycles in the variety of harsh operating conditions common to turbines. ABB engineers with years of wind power experience help design the products and work with turbine manufacturers to integrate these products correctly and efficiently into turbine designs.

Another factor in demonstrating a quality design is the availability of service for the products in the turbine. ABB's global service network supports this factor, offering life cycle services for the ABB products installed in a turbine. From regional service hubs to onsite support, ABB service is tailored to turbine manufacturer or wind power plant operator's unique needs. For example, implementing ABB preventive maintenance programs for products like switchgear, generators, motors and converters is a simple and manageable way to maximize the turbine operational life cycle, production, and reduce downtime.



Manufacturing quality

ABB designs global products that are manufactured to the same exacting standards, following the same production processes, and using the same quality materials in its production facilities. This enables ABB to conveniently serve its customers with the same quality products regardless of where they were manufactured.

Find out more

This brochure provides an overview of ABB's products and services for wind turbines. It provides information that can be used when conducting drivetrain studies and proposes ABB product solutions for today's electrical drivetrain concepts. Contact ABB for more information on these products or for more information on ABB's experience in the wind power industry.

Highlights

- ABB is a global company with more than 117,000 employees in around 100 countries
- ABB has decades of experience in the wind industry, starting in the mid 1970's
- ABB produces electrical drivetrain solutions for all of today's turbine concepts
- ABB products are used throughout a turbine's subsystems
- ABB is globally active in grid code specification working groups
- Global manufacturing footprint
- Global products
- Global life cycle services

Turbine systems

Turbines are comprised of many subsystems working in unison so that the turbine efficiently and safely produces power. ABB products are used throughout these subsystems, from the emergency stop button to the generator. The function of each subsystem is briefly described here.

Electrical drivetrain
This system is the main electrical production system of the turbine and is comprised primarily of the generator and converter, as well as the stator contactor and breaker.

Grid connection system
This system is responsible for connecting power produced from an individual turbine to the wind power plant's network connection point (connection to the power collection system). This includes the turbine's transformer and switchgear components.

Turbine control and protection system
This system is responsible for turbine control and operation, including rotor speed, turbine orientation, startup and shutdown. The protection function guards against conditions such as over-speed, generator overload, and even excessive vibrations.

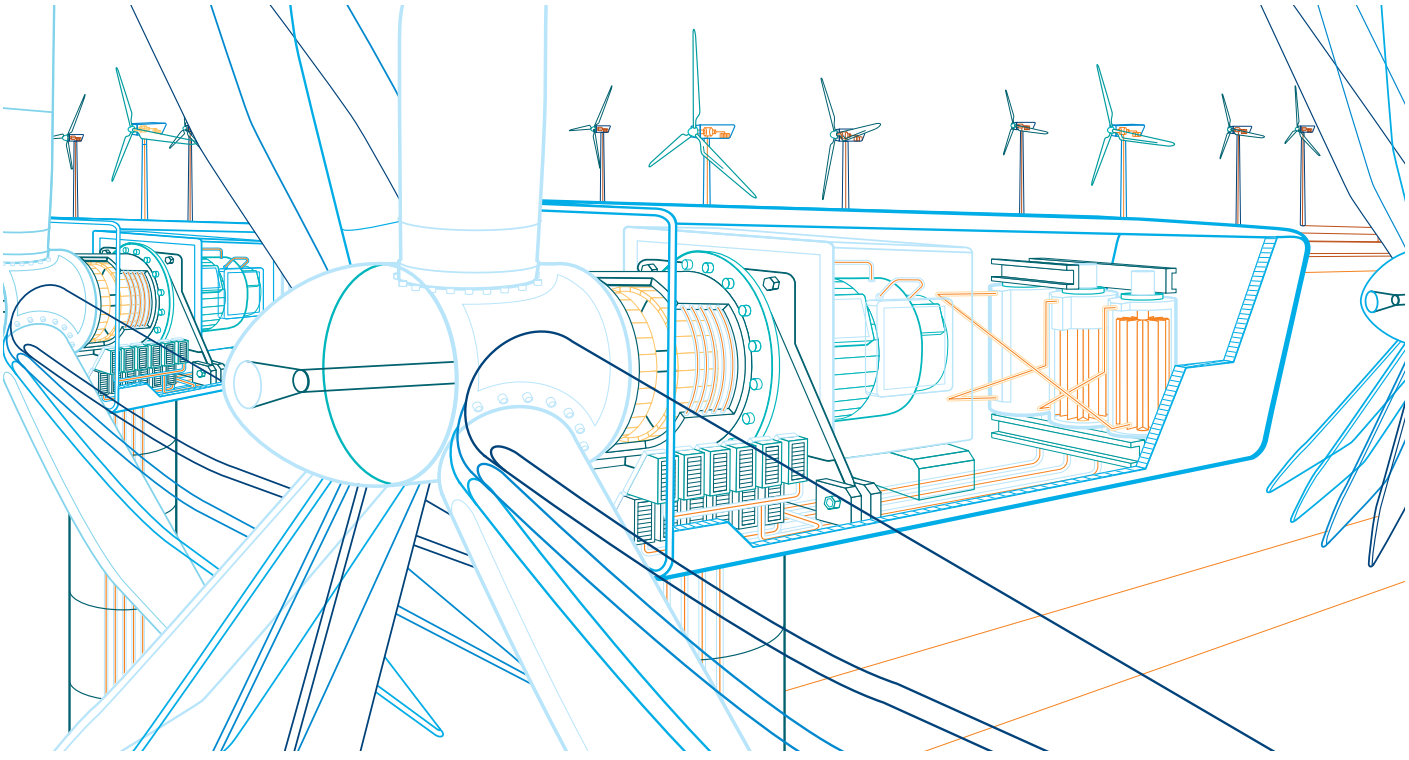
Yaw and pitch systems
The yaw system orients the turbine by rotating the nacelle into the desired position. This system uses motors and gears for the rotation, and braking systems to retain the orientation. The pitch system controls the orientation of the turbine blades in relation to the wind.

Electrical protection and disconnect systems
The protection system ensures that the turbine's electrical subsystems are protected against unsafe conditions resulting from fault conditions, and isolates those failures from other electrical systems in the turbine. The electrical disconnect system exists to ensure that the turbine's electrical system can be disconnected safely allowing for maintenance and other in-turbine work.

Lightning protection system
This system protects the turbine's electrical systems from adverse effects caused by lightning strikes on the turbine.

Hydraulic and cooling systems
These systems are responsible for ensuring the flow of liquids and air used in the turbine. These may include liquid-cooling systems, heat-exchange systems, or braking systems.

Auxiliary systems
Auxiliary systems are any other system or subsystem within the turbine that do not fall within one of the mentioned systems



Turbine electrical drivetrain concepts

Today's concepts

For today's utility scale wind turbines there are two main electrical drivetrain concepts, doubly-fed and full converter. The primary difference in these concepts is the type and size of generator used and the function of the converter. The full converter concepts can be further categorized into three types, low-speed (also known as direct-drive), medium-speed, and high-speed. ABB produces products for all of these concepts.

Full converter concepts are increasing market share

While the market has largely been dominated by the doubly-fed concept, the full converter concepts are quickly gaining market share. There are several factors driving this shift, including grid code compliance and optimized power generation at slower wind speeds.

Evaluating concepts

Each of the electrical drivetrain concepts results in different turbine weights, sizes and maintenance needs. The selection of the electrical drivetrain concept needs to be done carefully, weighing all of the requirements of the turbine with the needed certifications and grid code specifications that are applicable once the turbine is installed.

Engineering partner

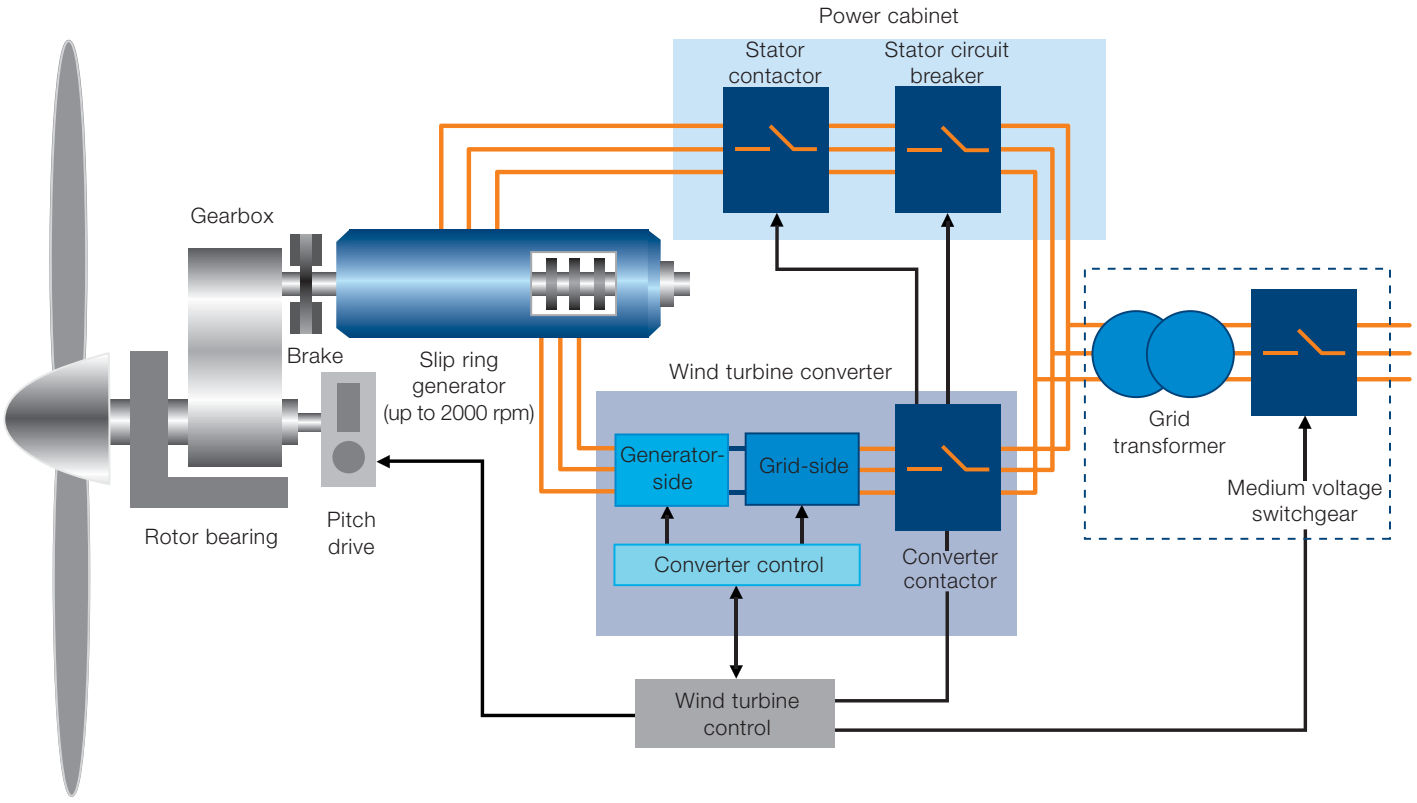
Once the electrical drivetrain concept is selected, expert ABB engineers are available to work with the manufacturer to discuss and integrate ABB products into the turbine engineering drawings, specifications, and plans. Turbine manufacturers are able to benefit from ABB's experience, resulting in design cost savings and increased efficiencies.

The following section provides a more detailed overview of each of the electrical drivetrain concepts for use by manufacturers during their concept studies.

Electrical drivetrain concepts
Doubly-fed

Doubly-fed concept
This concept uses a wound rotor, asynchronous generator where the rotor windings are connected to a small converter using slip-rings and brushes. The generator feeds two-thirds of the nominal power from the directly connected stator and the one-third from the rotor. The converter is used to control the generator's speed and power factor, allowing a wider speed range for power production as well as the ability to feed reactive power to support the grid. A small, partial converter dimensioned to one-third of the nominal power can be used because it enables a speed range of approximately +/-30% of the nominal speed, which is sufficient for the wind turbine application.

Advantages compared to constant speed turbines:
- Enables variable speed operation for increased kilowatt-hour production
- Uses a small converter, one-third of the nominal power
- Supplies reactive power for grid support
- High total system efficiency
- Is a technical and economical solution for grid code compliance

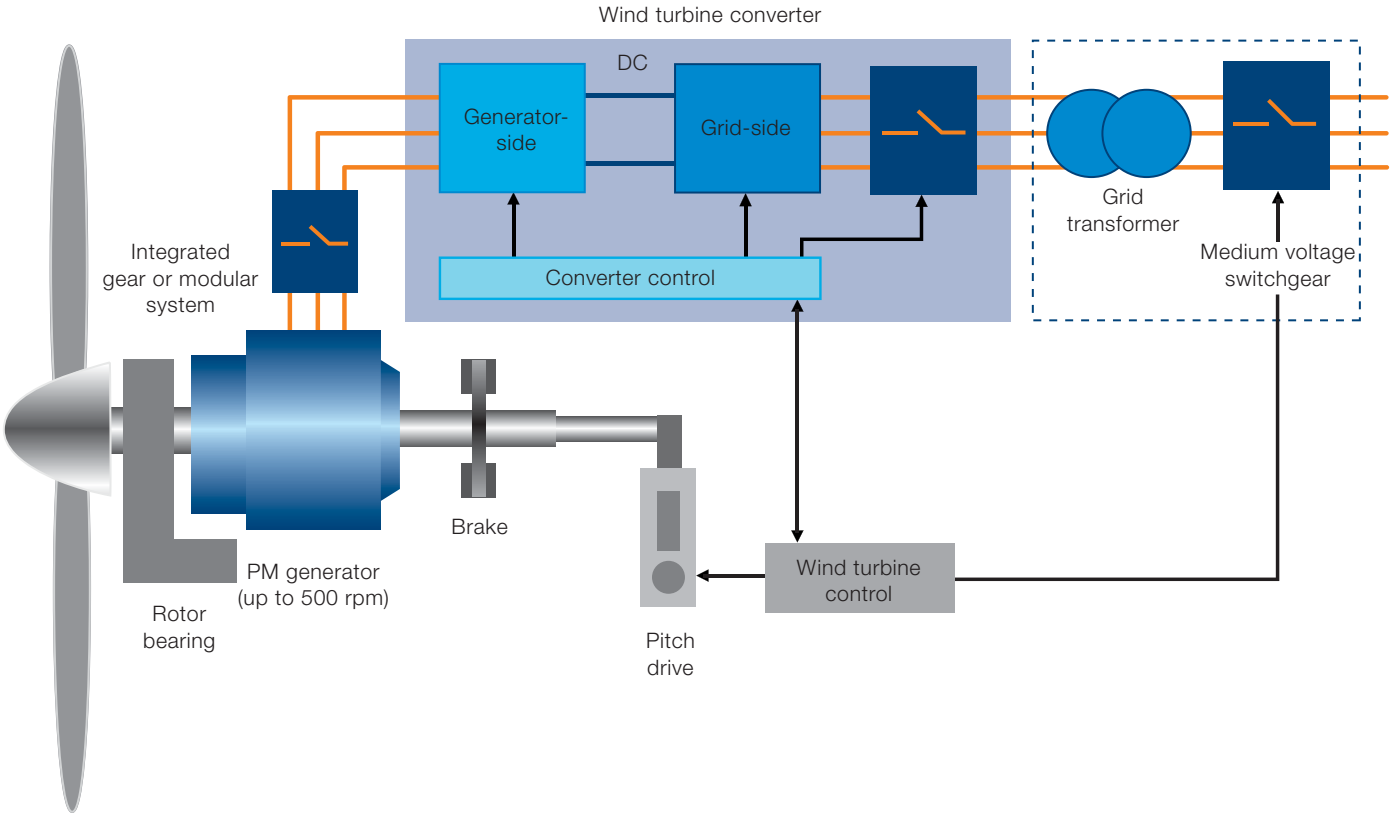


Electrical drivetrain concepts
Full converter

Full converter concept
In the full converter concept, the converter decouples the generator and the mechanical drivetrain from the grid. All of the generated power flows through the converter to the grid. Synchronous (permanent magnet) and asynchronous generators are typically used. The converter provides the generators torque and speed control.

There are three main full converter concepts: high-speed, medium-speed, and low-speed which use different gearbox and generator solutions.

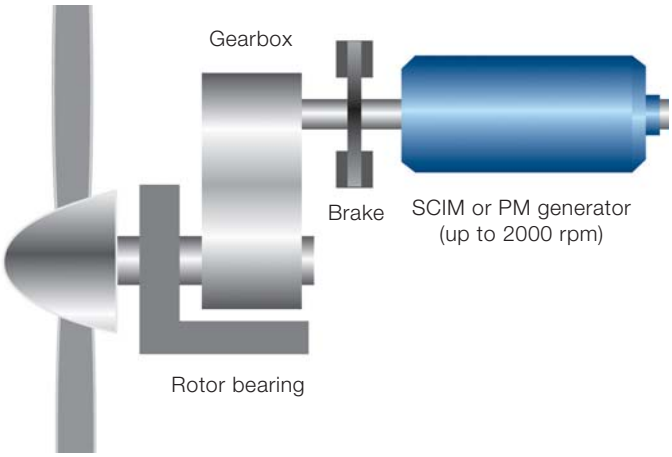
Advantages compared to the doubly-fed concept:
- Decouples the generator from the grid
- Reduces mechanical shocks on the turbine during grid faults
- Increased grid code compliance
- Enables full speed range
- Increased annual power yield
- Full reactive power production
- Full control of the power



Electrical drivetrain concepts
Full converter

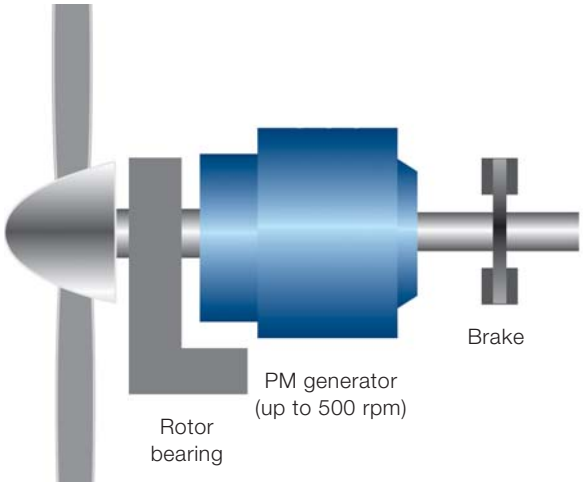
High-speed full converter concept
The high-speed full converter (HSFC) concept is mechanically similar to the doubly-fed type, using a normal three stage gear box and a small size, high-speed permanent magnet generator (up to 2000 rpm). Asynchronous generators are also used.

Advantages:
- Lowest generator weight and smallest size
- Can be used to upgrade existing doubly-fed designs



Medium-speed full converter concept
With the medium-speed full converter (MSFC) concept, either a single or two stage gear box is used with a compact, medium-speed permanent magnet generator (up to 500 rpm).

Advantages:
- Lower speeds reduce mechanical stress
- Low weight and size



Low-speed full converter concept
The low-speed full converter (LSFC) concept, also known as the gearless direct-drive concept, uses a large diameter, low-speed generator (up to 30 rpm). Permanent magnet or separately excited synchronous generators are typically used.

Advantages:
- No gearbox

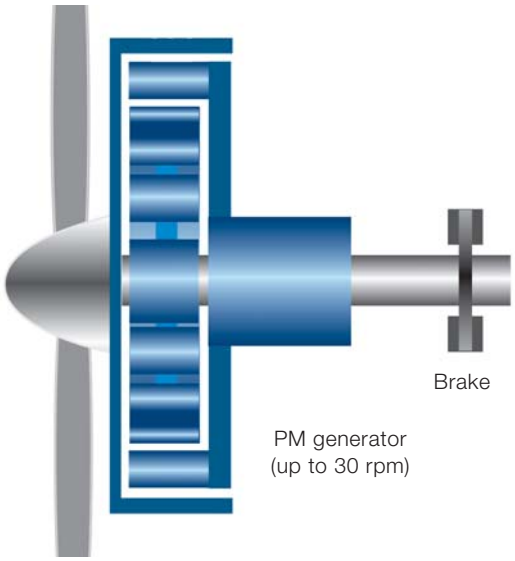


ABB electrical drivetrain package
For doubly-fed concepts

ABB's offering for the doubly-fed concept includes slip-ring generators and converters, for both onshore and offshore wind turbines. The main circuit breaker and contactors complete the ABB drivetrain offering. This package provides a proven solution for turbine manufacturers.

Doubly-fed generators

ABB doubly-fed generators enable continuous production of reactive power and have high efficiency for maximized kilowatt hour production, with low life time operational costs.

The robust rotor design uses a special carbon fiber winding-end support ring that can withstand sudden, uncontrolled over speeds. The increased rotor insulation allows a wide range of converters to be used. Minimized low total harmonic distortion (THD) specifically on the 5th and 7th order, offers high power quality. ABB has over 50 years of design experience in making reliable slip-ring units. This experience is used for the demanding wind power application. The optimized cooling air flow and use of the correct brush materials, as well as the expertise of the leading slip-ring manufactures results in reliable operation. ABB's proven bearing-end shield insulation construction protects against harmful bearing currents.

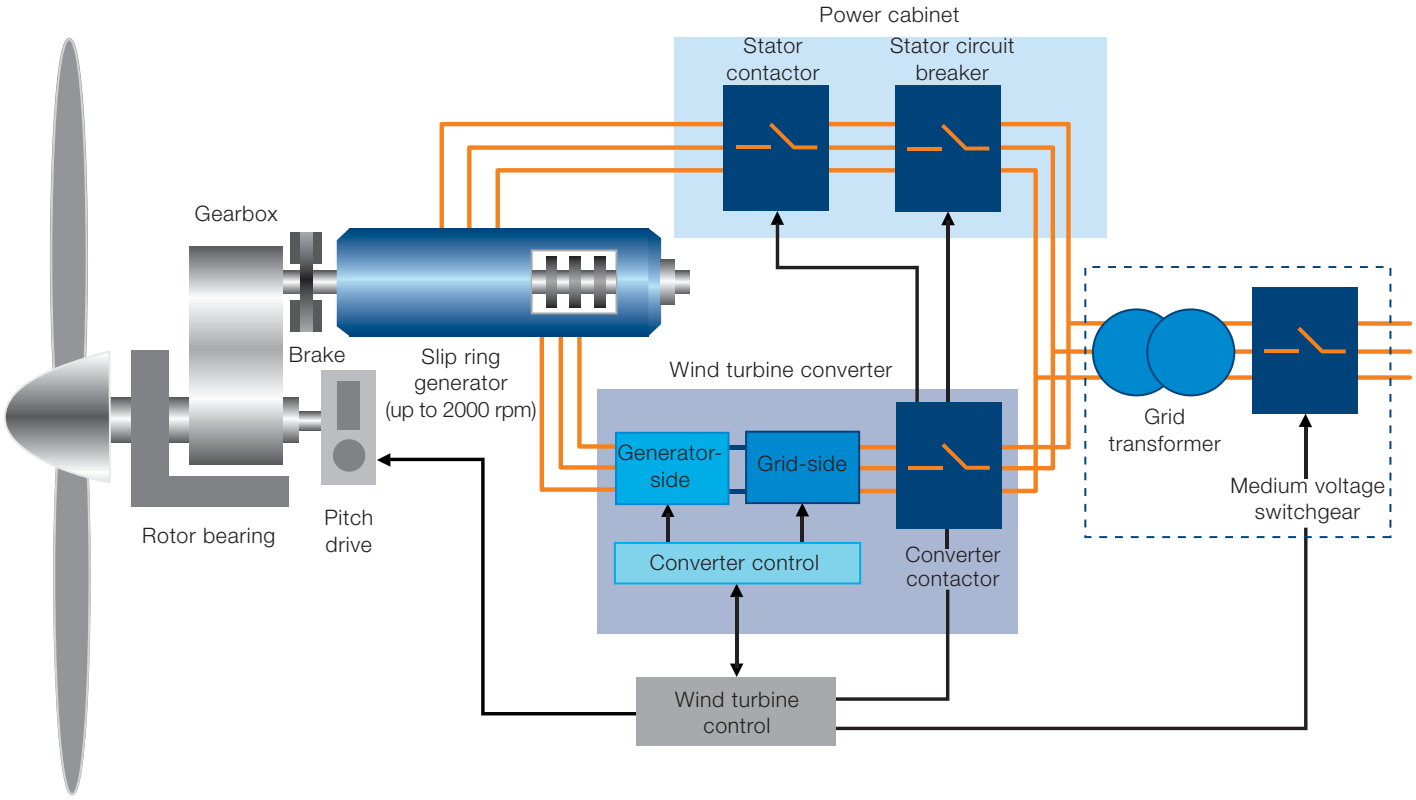
High voltage insulation technology, small size, and a flexible modular construction for easy integration in different turbine designs is standard with ABB doubly-fed generators.

- Up to 5 MW
- 690 to 12,000 V
- 2.5 kV rotor insulation
- Power factor 0.9 inductive - 1 - 0.9 capacitive
- Operational speed range 700 to 2000 rpm
- Maximum over speed up to 3000 rpm
- Air or water cooling

Doubly-fed wind turbine converters

ABB's doubly-fed converters synchronize the generator to the grid. They provide dynamic active and reactive power, fault ride-through, and low voltage ride-through. Direct torque control provides the speed and torque reference to the generator, and monitors generator torque 40,000 times a second. Liquid-cooled models offer completely enclosed cabinets for increased protection from harsh ambient conditions such as dust, salt, sand, and high humidity.

- 0.85 to 3.8 MW
- Direct torque control (DTC) for generator control
- Active and reactive power control
- Grid code support
- IGBT power modules with integrated DC capacitors and control electronics
- Very low total harmonic distortion (THD)
- Air or liquid-cooling
- Liquid-cooled models have completely enclosed cabinets



Coordinated breaker and contactor solutions

Both grid disturbances and normal turbine operation result in frequent connection and disconnection of the turbine's power circuit. This repeated switching can cause transient over-voltages and tripping which reduces kilowatt-hour production. The ABB solution is to use a coordinated breaker and contactor solution with ABB breakers for protection and ABB contactors for switching.

Specific surge protective devices (SPD)

Wind turbines are at a high risk for lightning strikes. Installing surge protective devices in the electrical drivetrain increases the reliability of the turbine. ABB developed specific surge protection solutions to protect all the equipment within the electrical drivetrain, including the generator, converter, contactor and breaker.

ABB services

Implementing ABB services for generators and converters, such as preventive maintenance, extends the life time of the product and helps ensure continuous, optimized kilowatt-hour production and reduces turbine downtime. These services, which include spare part management, onsite service, refurbishment, and training, are available globally and support turbine manufacturers during turbine planning and construction, as well as the wind power plant owner or operator throughout the turbine's life cycle. ABB service contracts are customizable, tailored to meet the needs of manufacturers and operators.

Global products

ABB products, including the generators and converters, are global products which are manufactured locally to the same quality standards. This ensures that the high-volume, high-quality products are available to meet customer expectations and needs.

ABB electrical drivetrain package
For high-speed full converter concepts

ABB's offering for high-speed full converter concepts includes permanent magnet and asynchronous generators and full power converters. The generators and converters are suitable for onshore or offshore turbines. Generator stator contactors and main circuit breakers complete the ABB drivetrain offering.

ABB permanent magnet generators

ABB's proven high voltage insulation technology and vacuum pressure impregnation system maximize the operational life time and enable a high momentary overload capacity. All of the ABB generators offer maximum efficiency at all speeds, especially at low wind speeds with a robust design and low maintenance.

The extensive ABB permanent magnet generator design expertise and experience ensures:

- The specific magnetic circuit design necessary for each of the low, medium or high-speed concepts
- The selection of the right neodymium magnet properties available on the market for each individual case
- Correct dimensioning and low operating temperature prevents demagnetization, even during fault situations
- Reliable fastening of the magnets, optimized for all the different rated speeds, for low, medium, and mechanically demanding high-speed applications
- The expertise in serial production of low, medium and high-speed concepts involving assemblies of strong magnets

High-speed generators

ABB's high-speed permanent magnet generators provide high power from the smallest frame size, with the highest efficiency over the whole speed range. ABB asynchronous generators can also be used in this high-speed concept.

- 1 to 6 MW
- 690 to 3300 V
- Typical rated speed 1000 to 2000 rpm
- Proven fatigue-resistant magnet fastening

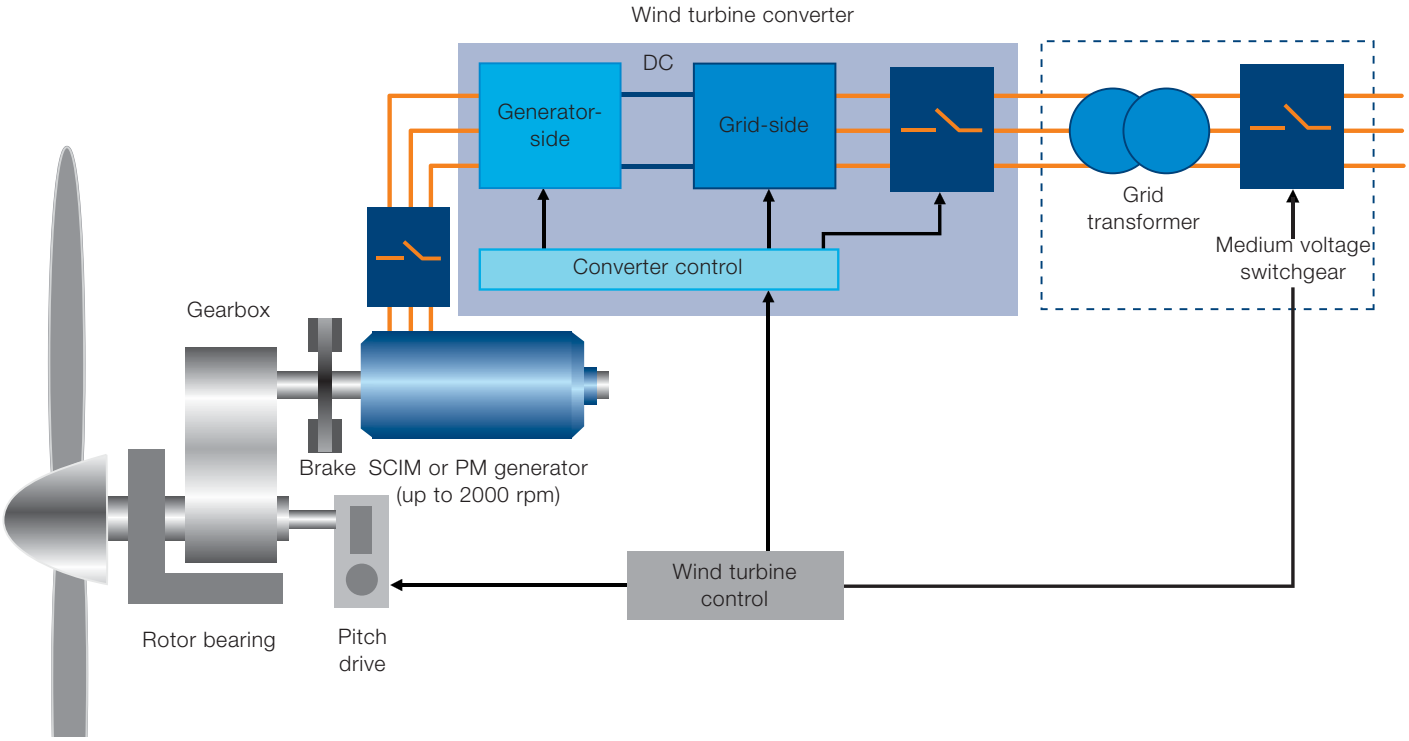
Wind turbine converters

Full power converters isolate the generator from the grid and provide the fault ride-through, low voltage ride-through, and dynamic and flexible grid code support including active and reactive power control. ABB offers a selection of both low voltage and medium voltage wind turbine converters. The converters set and monitor the generator's torque and speed reference, and guard against sudden jolts caused by grid disturbances that would otherwise add mechanical stress on the drivetrain. ABB full power converters are suitable for both onshore and offshore turbines.

Low voltage full power converters

ABB's direct torque control (DTC) monitors the generators torque 40,000 times per second, enabling the most efficient generator control, providing the foundation for grid code and fault ride-through compliance. Liquid-cooling transfers the heat from the converter to outside the turbine and enables the cabinets to be completely enclosed, with no openings keeping salty, sandy, and dusty air out. Converters over 2 MW offer a design option to use parallel connected sub-converters for increased efficiency and optimized turbine installation.

- 0.8 to 6 MW
- Liquid-cooled, fully enclosed cabinets
- Air-cooled model up to 1 MW
- Grid-side contactor or breaker for safe connection and disconnection
- IGBT power modules with integrated DC capacitors and control electronics
- Reduces torsional oscillations (active drivetrain dampening)
- Very low total harmonic distortion (THD)



- Rotor positioning
- Motorized generator test run
- Installable in the tower base or nacelle

Medium voltage full power converters

Designed for larger turbines, ABB's medium voltage full power converters use IGCT semiconductor technology which reduces the part count and results in very low converter losses. The converters are designed for tower base installation and enable low cost and efficient cable installation to the generator. The converters provide fault ride-through and grid code compliance.

- 2.5 to 10 MW
- 3.3 kV, 4-quadrant, 3-level topology
- Liquid-cooled power modules
- IGCT technology
- Harmonic elimination control algorithm
- High efficiency
- Integrated cooling unit
- Integrated generator breaker
- Smaller and lighter cables
- Installed in the tower base
- Rotor positioning
- Motorized generator test run

Coordinated breaker and contactor solutions

Both grid disturbances and normal turbine operation result in frequent connection and disconnection of the turbine's power circuit. To maximize kilowatt-hour production throughout the life time of the turbine, ABB's solution is to use a coordinated breaker and contactor solution with ABB breakers for protection and ABB contactors for switching.

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ABB services

Implementing ABB services for generators and converters, such as preventive maintenance, extends the life time of the product and helps ensure continuous, optimized kilowatt-hour production and reduces turbine downtime. These services, which include spare part management, onsite service, refurbishment, and training, are available globally and support turbine manufacturers during turbine planning and construction, as well as the wind power plant owner or operator throughout the turbine's life cycle. ABB service contracts are customizable, tailored to meet the needs of manufacturers and operators.

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ABB electrical drivetrain package
For medium-speed full converter concepts

ABB's offering for medium-speed full converter concepts includes permanent magnet generators and full power converters. The generators and converters are suitable for onshore or offshore turbines. Generator stator contactors and main circuit breakers complete the ABB drivetrain offering.

ABB permanent magnet generators
ABB's proven high voltage insulation technology and vacuum pressure impregnation system maximize the operational life time and enable a high momentary overload capacity. All of the ABB generators offer maximum efficiency at all speeds, especially at low wind speeds with a robust design and low maintenance.

The extensive ABB permanent magnet generator design expertise and experience ensures:

- The specific magnetic circuit design necessary for each of the low, medium or high-speed concepts
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- Correct dimensioning and low operating temperature prevents demagnetization, even during fault situations
- Reliable fastening of the magnets, optimized for all the different rated speeds, for low, medium, and mechanically demanding high-speed applications
- The expertise in serial production of low, medium and high-speed concepts involving assemblies of strong magnets

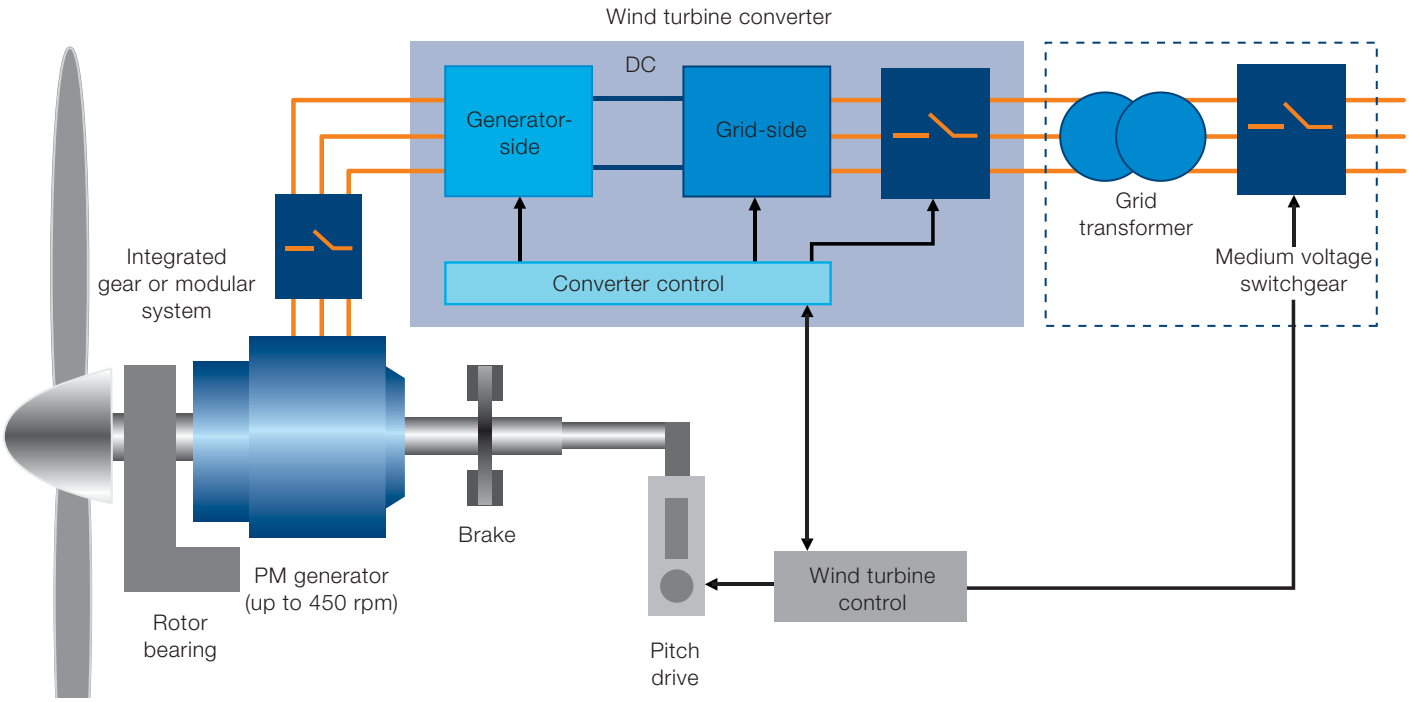
Medium-speed generators
ABB medium-speed permanent magnet generators are integrated with the gearbox to provide a very compact design with the highest efficiency over the whole speed range. A separate modular design is also available.

- 1 to 6 MW
- Typical rated speed 120 to 450 rpm
- 690 to 3300 V

Wind turbine converters
Full power converters isolate the generator from the grid and provide the fault ride-through, low voltage ride-through, and dynamic and flexible grid code support including active and reactive power control. ABB offers a selection of both low voltage and medium voltage wind turbine converters. The converters set and monitor the generator's torque and speed reference, and guard against sudden jolts caused by grid disturbances that would otherwise add mechanical stress on the drivetrain. ABB full power converters are suitable for both onshore and offshore turbines.

Low voltage full power converters
ABB's direct torque control (DTC) monitors the generators torque 40,000 times per second, enabling the most efficient generator control, providing the foundation for grid code and fault ride-through compliance. Liquid-cooling transfers the heat from the converter to outside the turbine and enables the cabinets to be completely enclosed, with no openings keeping salty, sandy, and dusty air out. Converters over 2 MW offer a design option to use parallel connected sub-converters for increased efficiency and optimized turbine installation.

- 0.8 to 6 MW
- Liquid-cooled, fully enclosed cabinets
- Air-cooled model up to 1 MW
- Grid-side contactor or breaker for safe connection and disconnection
- IGBT power modules with integrated DC capacitors and control electronics
- Reduces torsional oscillations (active drivetrain dampening)
- Very low total harmonic distortion (THD)
- Rotor positioning
- Motorized generator test run
- Installable in the tower base or nacelle



Medium voltage full power converters

Designed for larger turbines, ABB's medium voltage full power converters use IGCT semiconductor technology which reduces the part count and results in very low converter losses. The converters are designed for tower base installation and enable low cost and efficient cable installation to the generator. The converters provide fault ride-through and grid code compliance.

- 2.5 to 10 MW
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Low-speed generators
ABB low-speed permanent magnet generators form a structurally integrated unit with the wind turbine. Inner and outer rotor designs are available. They enable the smallest low-speed design with the highest efficiency in the whole speed range.

- 1.5 to 3 MW, higher powers are available
- Typical rated speed14 to 30 rpm
- 690 to 3300 V

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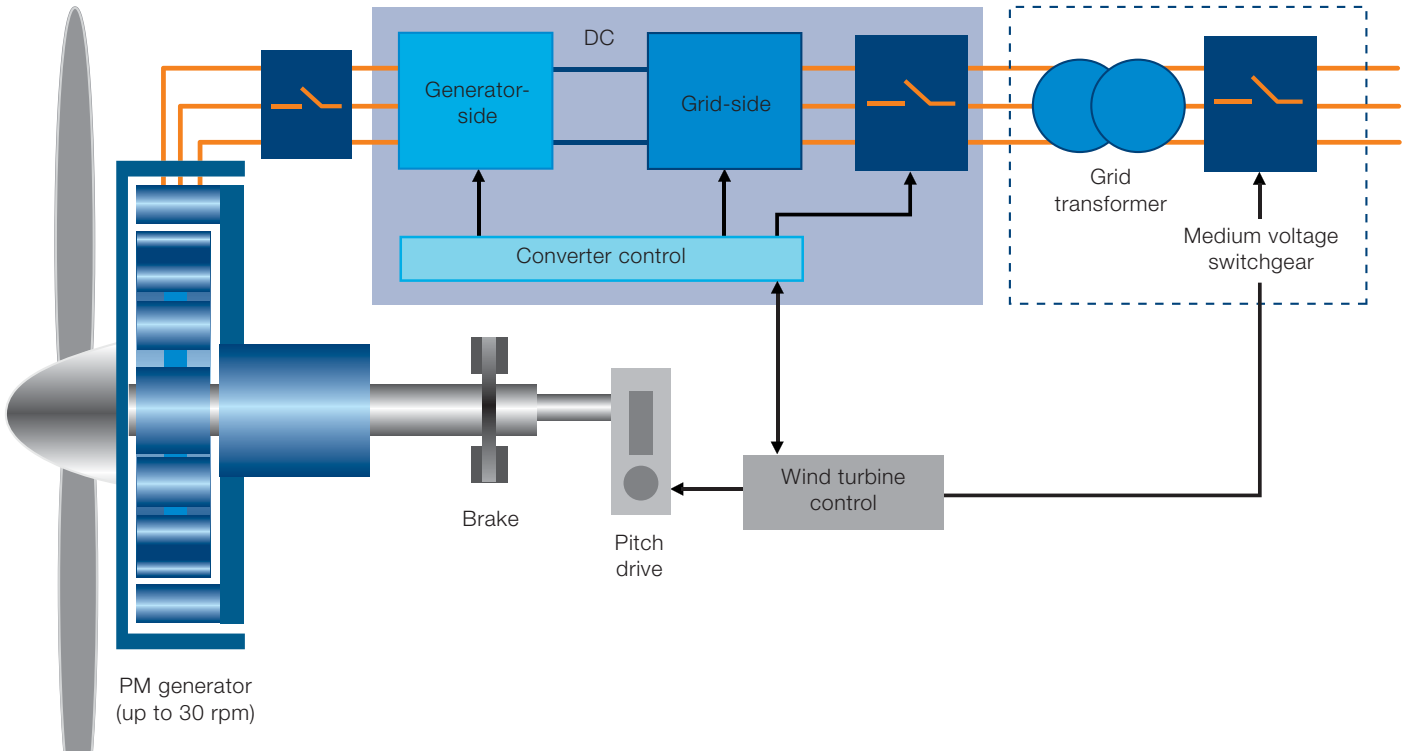
Wind turbine converter



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Global products

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Grid connection products

Grid connection products enable the distribution of the generated power from the turbine to the wind power plant's collection network. The turbine's transformer and switchgear are the main components of this system.

Transformers

ABB transformers have a compact design that allows the transformer to be installed through the tower door, without disassembly. They are engineered to reduce losses and operate in environments with high vibrations as well as harsh ambient conditions where salt, sand, dust, and relative humidity of 100% are common.

- Dry transformers up to 72.5 kV and 40 MVA
- Liquid filled transformers up to 72.5 kV and 40 MVA
- Classes E2, C2, F1
- Multiple forced cooling system solutions
- Insulation system temperature up to 180 °C for dry transformers
- Organic liquid cooling options
- Suitable for onshore and offshore wind turbines

Switchgear

ABB's SafeWind is a compact switchgear solution for all voltage levels. It provides switching and protection of wind power plant networks in harsh operating environments. It has both IEC and Chinese GB approval, and is the only product approved for the 40.5 kV GB standard. The slim design width of 420 mm for a 36 kV circuit breaker module allows it to fit through tower doors during installation. Both compact and modular solutions are available in a variety of configurations.

- Solutions available for 12 kV, 24 kV, 36 kV and 40.5 kV
- Suitable for onshore and offshore wind turbines
- Combination of standardized modules provides full application flexibility
- Switch fuse or circuit breaker protection
- Advanced solutions for arc protection available
- Wide scope of protection and communication solutions
- Optional sequential closing system for T-off (turbine)

Turbine control and protection products

The turbine control and protection system ensures that the turbine operation is within defined values. The PLC is used for overall turbine control logic.

PLC

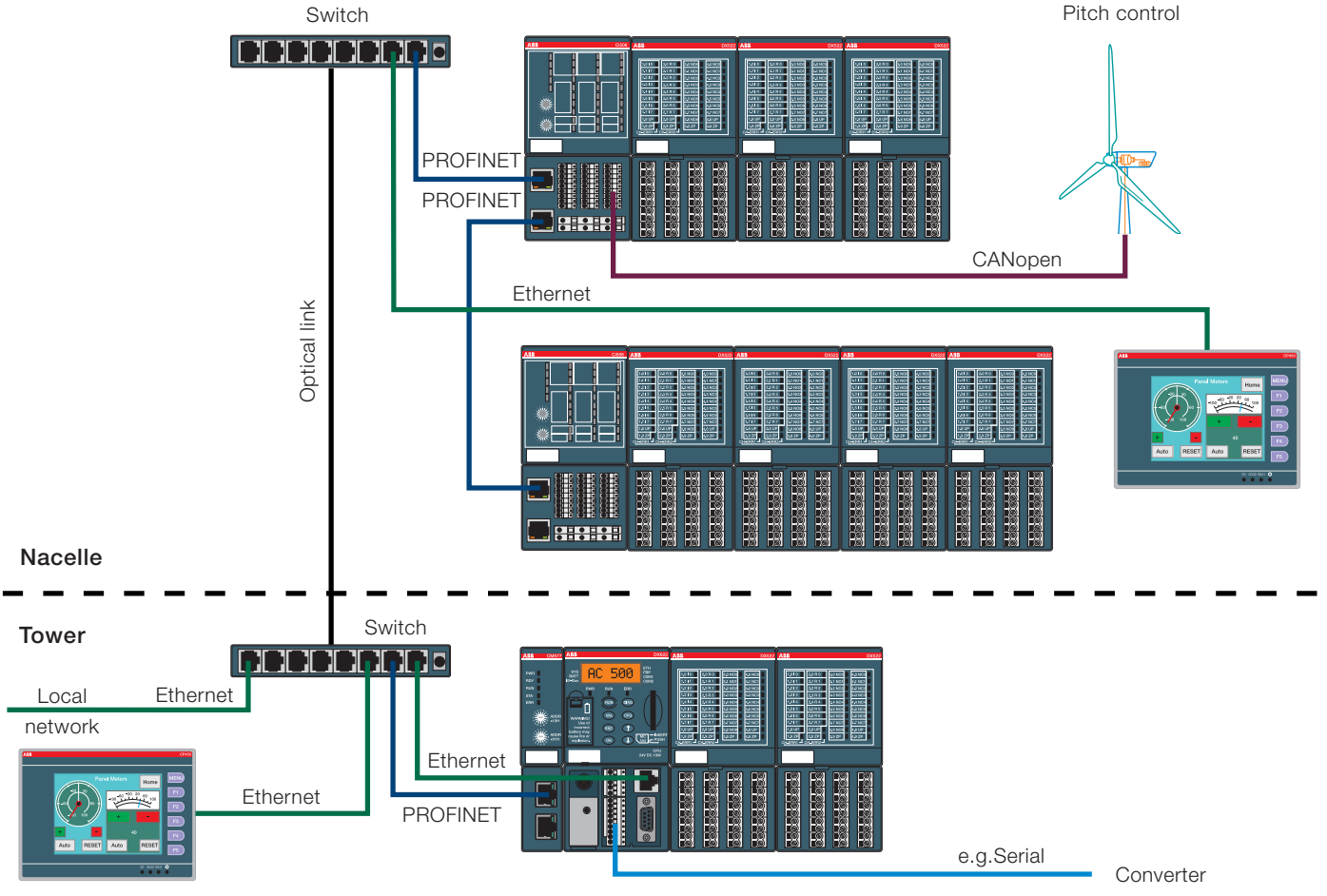
The ABB AC500 PLC is the key component for wind turbine control. The PLC provides the fastest program execution available, and enables a high level of protection to safeguard the control program's intellectual property. The PLC is used to set the reference speeds, turbine orientation to the wind, and for turbine startup and shutdown operations.

- Industry leading program execution times
- Programming in accordance with international standards (IEC 61131)
- Multiple communication (fieldbus) options
- Very flexible I/O's – configurable as either inputs or outputs
- Modular design, saves control cabinet space

PLC and system interface products

ABB offer the largest selection of electronic products and relays in one product family, including timers, measuring and monitoring relays, signal converters, relays, optocouplers, power supplies and safety solutions. The ABB low temperature signal converter is the only one with a low temperature rating of -40 °C.

Wind turbine control using ABB's AC500 PLC



Motor control and protection

ABB produces safe and reliable products and solutions for all motor applications. These solutions are available for different motor types, and enable different starting methods as well as coordinated solutions for protection and control of motors. Products include AC and DC drives, softstarters, contactors, manual motor starters, back-up breakers/short-circuit limiters, temperature monitoring relays, and overload relays. In addition, motor starters can be integrated on the SMISSLINE plug-in system to reduce space, wiring complexity and installation time.

Limit switches

ABB limit switches are used as part of the turbine control system to monitor and protect against excessive vibrations. Used for electrical signaling of a mechanical position, the limit switches are activated when vibration in the turbine exceeds the switch's limits, signaling the PLC to activate protective turbine controls.

Push buttons, switches and pilot lights

ABB's offering of push buttons, switches and pilot lights are used throughout the turbine for control and visual indications.

DIN-rail products

DIN-rail mounted electrical parts are used in many of the electrical cabinets in the turbine. The ABB range of DIN-rail products includes high performance miniature circuit breakers, miniature circuit breakers, residual current devices, surge protective devices, contactors, pilot devices, timers, and electricity meters. These products are available in a wide range of power ratings and voltages.

Terminal blocks

ABB terminal blocks are used in electrical panels and boards within the turbine. They provide the connection point for systems where point-to-point connection between systems is used.

Switch mode power supplies

Switch mode power supplies are used for systems requiring reliable DC power supplies. ABB power supplies use primary switch mode technology that reduces heat loss and increases efficiency. A power reserve of up to 50% protects against loads that have high startup draws on power.

Yaw and pitch system products

The yaw and pitch systems are responsible for mechanical movement of the turbine's nacelle, turning the nacelle into the wind, as well as the blade's orientation to the wind.

PLC
The ABB AC500 PLC is the key component for wind turbine control of the yaw and pitch systems. The ABB PLC provides the fastest program execution available, and enables a high level of protection to safeguard the control program's intellectual property.

Brake motors for yaw and pitch control
ABB brake motors are tailored to meet the needs of the yaw system and are used to drive gears that adjust the orientation of the turbine. Pitch systems (often hydraulic) use motors to adjust the pitch of the blades.

- Typically 6-pole motors
- 1.1 to 4 kW, larger sizes available

Yaw system drives
ABB drives are used either individually, or as part of a master/follower solution to adjust the turbine's yaw. The drives are connected to the turbine's control PLC. Using drives to control the yaw motors reduces mechanical stress and excessive vibrations during movement.

Back-up breaker/Short-circuit limiter
ABB's short-circuit limiter breakers, WT63 and S800S-SCL-SR, are used for coordinated protection in motor applications up to 690 V, enabling selectivity and minimized installation space when used as back-up for several motor starters.

Softstarters
ABB softstarters are used for reducing mechanical stress from yaw and pitch motor startup. They reduce initial motor starting current draw and enable smooth motor acceleration and deceleration.

Lightning protection products

Unprotected electrical system inside a turbine can be damaged as a result of direct lightning strikes on the turbine. To protect against damage and loss of production as a result of a lightning strike, ABB protection products are used throughout the turbine.

Surge protection

ABB's surge protection devices (SPD) protect systems throughout the turbine from direct lightning strikes, both Type 1 and Type 2. ABB's SPD's also protect from switching impulse current.

- From 24 V to 690 V electrical systems
- Provides equipment protection
- Reduces downtime resulting from equipment reset
- Helps prevent damage due to over voltage and impulse currents

Electrical protection and disconnect products

Turbine electrical protection and disconnect products are used to protect the turbine's equipment from electrical damage caused by faults or other failures of one or another system. They are also used to safely disconnect the turbine to enable maintenance or service within the turbine.

Arc Guard

ABB's Arc Guard system provides arc fault protection for medium voltage switchgear, transformers and low voltage switchgear panels. The modular system provides fast protection, using optical sensors and optical communication to monitor up to 30 sensors connected in the system. It has a functional safety rating of SIL2. The system can be wall or DIN-rail mounted.

- Functional safety SIL2
- Increased safety
- Full text display
- Up to 30 detectors can be connected

Safety

ABB products and solutions for turbine safety systems include safety controller and safety relays for machine safety, as well as various monitoring and protection products.

Contactors

ABB contactors offer the most modern design on the market, and provide a coordinated and tested solution with ABB breaker products. The contactors are highly reliable and can handle large variations in control voltage. A low voltage ride-through version works without a separate UPS for control voltage.

- High current ratings, up to 2,050 A
- Electronic coil is less sensitive to voltage drops
- Low voltage ride-through version available
- Modern, compact design
- Easy installation, wiring and maintenance

Breakers

Tmax moulded case circuit breakers and Emax air circuit breakers are designed for standard wind turbine and variable frequency (0 to 200 Hz) applications. They are used for main circuit and sub distribution protection, up to 6,300 A. They are available according to the main international certifications and standards, including IEC 60947, UL 489, UL 1066, GOST and CCC.

Modular protection system and DIN-rail products

ABB's modular SMISSLINE plug-in system of protection products uses integrated bus bars to reduce system wiring complexity, installation time and space. Both replacement of devices and expansion are easily managed. SMISSLINE devices include supply terminals, miniature circuit breakers, residual current operated circuit breakers, surge arrestors, switch disconnectors, motor protection circuit breakers, auxiliary and signal contacts.

In addition to the SMISSLINE products, ABB products include traditional DIN-rail mounted high performance miniature circuit breakers, miniature circuit breakers, residual current devices, surge protective devices, and electricity meters.

Insulation monitoring relays

Wind turbines are unearthed systems, and both 3-phase mains or DC mains may be monitored for insulation faults. ABB's monitoring relays are used to directly measure the insulation resistance in unearthed AC and DC electrical systems with voltage levels up to 690 VAC and 1000 VDC.

Hydraulic and cooling system products

Turbine systems are supported by hydraulic pumping and cooling systems that are used to transfer heat losses from equipment, such as converters and generators, outside of the turbine. ABB products such as motors and drives are used in these systems.

Motor control and protection

ABB produces safe and reliable products and solutions for all motor applications. These solutions are available for different motor types, and enable different starting methods as well as coordinated solutions for protection and control of motors. Products include AC and DC drives, softstarters, contactors, manual motor starters, back-up breakers/short-circuit limiters, temperature monitoring relays, and overload relays. In addition, motor starters can be integrated on the SMISSLINE plug-in system to reduce space, wiring complexity and installation time.

Motors for pumping

ABB AC motors are used in hydraulic pump applications in the turbine. They are available from 2 to 8 poles, 0.06 to 55 kW, for all common voltages, and are available with IE3 premium efficiency requirements.

Motors for generator cooling

ABB's motors are used to power the generator's heat exchange and ventilation systems. They are tailored for the operating requirements unique to the installation in the turbine's nacelle.

- Typically 0.75 to 7.5 kW
- 2, 4, or 6 pole motors
- Two speed 2/4, 4/8, or 4/6 pole motors available

Low voltage AC drives for pumps and fans

ABB has developed drives with built-in pump and fan applications that are designed to improve pump and fan performance and efficiency. The drives also reduce mechanical wear on systems by providing pump and fan protection functions such as soft pipe filling, multi-pump control, preventing pump dry-run, and configurable fan application settings.

Softstarters

ABB softstarters are used for reducing mechanical stress from motor startup. They are used with motors for hydraulic systems. They reduce initial motor starting current draw and enable smooth motor acceleration and deceleration.

Back-up breaker/Short-circuit limiter

ABB's short-circuit limiter breakers, WT63 and S800S-SCL-SR, are used for coordinated protection in motor applications up to 690 V, enabling selectivity and minimized installation space when used as back-up for several motor starters.

Auxiliary system products

There are many smaller supporting systems in a turbine, from lift systems used to bring equipment and parts to the nacelle, to circulation fans and internal lighting & electrical connections. ABB products are used throughout these systems.

Motor control and protection
ABB produces safe and reliable products and solutions for all motor applications. These solutions are available for different motor types, and enable different starting methods as well as coordinated solutions for protection and control of motors. Products include AC and DC drives, softstarters, contactors, manual motor starters, back-up breakers/short-circuit limiters, temperature monitoring relays, and overload relays. In addition, motor starters can be integrated on the SMISSLINE plug-in system to reduce space, wiring complexity and installation time.

Low voltage motors
ABB has a large selection of AC motors that are used in turbines. ABB motors are used for hydraulic pumping systems, cooling systems, winches and lift systems, compressors and fan systems.

Low voltage drives
AC drives are used to efficiently and accurately control AC motors. With the widest selection of drives on the market, and support for all fieldbus communication used in turbines, the drives can be intelligently integrated into systems. Using drives reduces startup stresses, and enables precise control of the motor. This results in a more efficient system with reduced mechanical wear helping to increase turbine uptime.

Softstarters
ABB softstarters are used for reducing mechanical stress from motor startup. They reduce initial motor starting current draw and enable smooth motor acceleration and deceleration.

Switch mode power supplies
Switch mode power supplies are used for systems requiring reliable DC power supplies. ABB power supplies use primary switch mode technology that reduces heat loss and increases efficiency. A power reserve of up to 50% protects against loads that have high startup draws on power.

- Wide range of DC output voltages
- Wide range of AC or DC supply voltages
- Suitable for ambient temperature range of -25 to 70 °C

Back-up breaker/Short-circuit limiter
ABB's short-circuit limiter breakers, WT63 and S800S-SCL-SR, are used for coordinated protection in motor applications up to 690 V, enabling selectivity and minimized installation space when used as back-up for several motor starters.

Push buttons, switches and pilot lights
ABB's offering of push buttons, switches and pilot lights are used throughout the turbine for control and visual indications.

Enclosures
ABB metal structure enclosures enable easy integration of electrical components especially ABB products. They are available in a variety of sizes, from small wall mounted models to floor standing cabinets. Customization options for doors, cable entry, mounting holes and other items enable manufactures to design optimal installation plans.

Terminal blocks
ABB terminal blocks are used in electrical panels and boards within the turbine. They provide the connection point for systems where point-to-point connection between systems is used.

DIN-rail products
DIN-rail mounted electrical parts are used in many of the electrical cabinets in the turbine. The ABB range of DIN-rail products includes high performance miniature circuit breakers, miniature circuit breakers, residual current devices, surge protective devices, contactors, pilot devices, timers, and electricity meters. These products are available in a wide range of power ratings and voltages.


ABB
MCB-10
SE
IEC 60947-5-1
EN 60947-5-1
AC-15 400V~ 6A
230V~ 6A
120V~ 4A
LISTED IND. CONT. EQ. 51B6
A600 Q600


-3 NO
ABB
CA5 -10
-4 NO

Expertise
Grid codes

Increasing generation drives regulation
As the installed capacity of wind power plants increases, the share of power they provide to the transmission network also increases. This means that during times of grid fault, the way a wind power plant is able to respond with the fault has a significant impact on the stability of transmission grid.

To regulate these conditions, utility companies have developed regional grid code specifications wind power plants must meet. These grid codes, which outline grid fault conditions and the expected wind turbine behavior in response to these conditions, are becoming more demanding, and vary from country to country. The wind turbine converter plays an important role in helping the wind turbine meet these grid code requirements and to obtain the necessary operational certification.

Fault ride-though laboratory
A common requirement for all grid codes is a fault ride-though capability where the wind power plant and the turbines must be capable of operating continuously at reduced voltage, and must not trip off-line because of transient voltages.

To test these grid codes, ABB developed a multi-megawatt fault ride-through laboratory. It is designed to replicate both doubly-fed and full converter turbines. The test equipment includes generators, converters, transformers, switchgear, and is connected to a 20 kV transmission line.

Controlled testing with custom software
Laboratory engineers are able to test ABB products in a controlled and repeatable environment. Customized testing software is used to configure the test conditions, which may be taken from individual grid code specifications. Tests may include three-phase, two-phase, or single-phase voltage dips, or even a sequence of faults developing from single-phase earth faults to three-phase short circuits.

This laboratory testing helps reduce on-site testing costs by replacing the variability of the wind with a speed controlled motor driving the generators.

Turbine certification support
Turbine certifications are based on the grid codes used in the region the turbine will be installed. When turbine manufacturers are applying for turbine certification, ABB engineers can help the turbine manufacturer use and maximize the converter's technology to meet the requirements of the grid code.

Globally active
ABB stays globally active in grid code working groups and standards definition to ensure ABB's products continue to meet manufacturer's needs.

Expertise
Permanent magnet generator technology

ABB has been developing permanent magnet applications since the mid 1990's, for both the wind industry and the very demanding marine industry. This experience provides the foundation for ABB's know-how, ensuring the most critical factors for the efficient and long operation of a permanent magnet generator are addressed. This expertise is used for each of the high, medium, and low-speed generators ABB develops.

Electrical and mechanical design
There are many factors that ABB addresses in the design that affect the quality, and proper operation of the generator, as well as the maximum kilowatt-hour production. These include the magnetic circuit design itself, the magnet material selection, the correct positioning in each individual case, stabilizing and aging of the magnets, corrosion protection and the reliable fastening of the magnets in these mechanically demanding applications.

Magnetic circuit design
The magnetic circuit design is the most critical factor for the proper operation of a permanent magnet generator. ABB has experience in designing many different low, medium and high-speed applications up to 6 MW. This expertise is used to ensure correct dimensioning and a low operating temperature, preventing demagnetization, even during fault situations, and also to ensure the correct positioning and fastening of the magnets for the different rated speeds.

Standard generator designs
ABB builds on proven technical solutions and offers standard generator designs for all of the main full converter concepts. These high, medium, and low-speed designs are totally unique from each other leading to different mechanical and magnetic circuit designs. Turbine manufacturers benefit from these standard solutions, which are used as the basis for each custom application, reducing development costs and time, as well as the increasing the reliability and success of the turbine's project execution.

Series production
High-strength permanent magnets present unique challenges during manufacturing. ABB has developed special procedures and tools that enable safe and fast series production of high-quality products for low, medium, and high-speed concepts.

An experienced global partner
The low and medium speed concepts involve a high degree of integration into the turbine construction, which is a very challenging task. Selecting the right partner to build the generator has a direct affect on the turbine development schedule, budget and delivery. ABB has been developing and delivering permanent magnet generators for wind turbines since 2000. This experience helps turbine manufacturers remain both on schedule and within budget.

Leading wind turbine manufacturers trust ABB expertise, and today most of the megawatt-class permanent magnet generators operating in Europe and North America were built by ABB.

Services

ABB life cycle services provide investment peace of mind

ABB's portfolio of life cycle services is designed to increase a customer's return on investment and keep ABB products operating a highest efficiency levels throughout their individual product life cycles.

Comprehensive services portfolio

ABB's services span the entire product ownership life cycle, from pre-purchase engineering, installation and commissioning, technical support, online and classroom training, preventive maintenance schedules, spare part kits, spare parts management, to retrofit and refurbishment.

Custom made service contracts

Each turbine manufacturer or wind power plant operator has a unique need for services. ABB helps provide customers with the right mix based on service contracts. ABB can bundle individual services into one contract. Contracts can be made at any stage of product ownership, throughout the products life cycle. Contracts may be comprised of a mix of services, including spare parts agreements, preventive or corrective maintenance agreements, technical support, and training.

Service contracts provide customers with improved cost controls, increased operational efficiency, lower capital expenditures, reduced downtime and extended product life time.

Training improves efficiency and performance

Wind turbines are complex machines. Understanding how to efficiently integrate and operate ABB products provides the basis for improved product quality and reduced production costs. ABB training is available for many products. Wind turbine manufacturers, power plant operators and service providers may attend training at ABB training centers, online through e-learning classes, or even at their own site. Training also helps keep wind turbine manufacturers and wind power plant operator engineers up-to-date with the latest product developments and information.

Engineering and technical support

Wind turbines require sophisticated engineering. ABB's engineers work with turbine manufacturers during the product specification phase to ensure all of the technical questions and issues are addressed. Engineering and technical support is available by phone, email, or on-site visits, as agreed in an ABB services contract.

Regional service hubs

ABB has positioned regional service hubs around the world to provide certified service for ABB products. The service hubs perform repair, refurbishment, and retrofit work. These services help wind power plant owners improve turbine production and reliability.

Highlights

- Global services for the complete life cycle
- Tailor made service contracts
- Classroom and online training
- Pre-sales engineering
- Regional service hubs
- Spare parts management

Contact us

www.abb.com/windpower

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for a better world™