Wind power

Safety and protection for wind turbines

Perfectly coordinated components for low-voltage power distribution

Answers for industry.
Additional system components
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Reliable power supply and distribution

Wind turbines do not only generate electricity – they are also dependent on both a reliable supply of electrical power and on its safe and economical distribution. An additional high priority is the protection of both people and electrical equipment. We offer you products, systems and a comprehensive protection concept for optimal power distribution in wind turbines, thus ensuring that you are always in safe hands.
Safe and efficient use of wind power

Wind is one of the oldest forms of energy. People have been using the potential of wind power to drive machinery for thousands of years. Following the discovery of electricity and the invention of the generator, the idea of using wind power to generate electricity was quite literally hanging in the air. Nowadays, wind turbines of all different sizes and at the most varied of locations convert the kinetic energy of an air flow into electrical power. Wind power is playing an increasingly important role worldwide, due primarily to the fact that it is extremely environmentally friendly – because it is CO₂-neutral – and, unlike fossil fuels, there is an unlimited supply available. Protecting, switching, measuring and monitoring are the basic functions of a low-voltage power distribution system in wind turbines. In this segment and in many others, the name Siemens has been synonymous with innovation, outstanding technology and a reliable partner for many years. Customers around the world rely on our extensive product and system portfolio. You too can enjoy the benefits of maximum safety and optimal functionality!
Distributing power intelligently and safely

Principle of operation
A wind turbine consists of a rotor, a nacelle with machinery and a generator which can be connected to an upstream gearbox, a converter and a tower. Effective monitoring and control technology is essential, since the operating parameters must be constantly adapted to the prevailing wind conditions. Each and every wind turbine is dependent on a reliable electrical power supply, since this is the basic prerequisite for every control system.

Particular challenges
The output from a wind turbine can change rapidly and unpredictably depending on the strength and direction of the wind. There are also constant mechanical and climatic stresses, in particular changing wind loads, low-frequency vibrations and differences in temperature ranging between -40 and +70 °C. Equally, the frequent connection and disconnection of the wind turbine can result in the thermal loading of live components.

Perfectly coordinated components
To reliably maintain the functional capability and availability of the protection devices under these circumstances, components must be used which have a safe range that is matched to the requirements of the wind turbine. Our SENTRON protection, switching, measuring and monitoring devices with optional communication modules provide the ideal solution.

Comprehensive portfolio worldwide
We can offer you an extensive portfolio of low-voltage power distribution components. The consistency, modularity and reliable interaction of our components and systems offer you numerous advantages – throughout their service life and wherever you are in the world.

Highlights
- Safe power supply and distribution thanks to coordinated components
- A high level of protection thanks to first-class protection, switching, measuring and monitoring devices
- A high level of cost effectiveness thanks to intelligent, modular and integrated components

Increasing performance capacity and costs – higher risk

<table>
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<th>Year</th>
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<th>Rotor diameter</th>
<th>Hub height</th>
<th>Annual yield</th>
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<td>400,000 kWh</td>
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<td>2012</td>
<td>6,000 kW</td>
<td>126 m</td>
<td>135 m</td>
<td>approx. 20,000,000 kWh</td>
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Increase in capacity:
In just 20 years, the yield from wind turbines has increased 50-fold. With the current 6 MW turbines and the 10-15 MW turbines which are already in the development phase, this yield will again increase many times over.
The main circuit in a wind turbine is responsible for power generation via the generator and the transmission of power up to the infeed into the grid. The wind powers the generator via the rotor. This generates a voltage with a variable frequency. Behind the generator, a converter is therefore connected to a DC link. This DC link first converts the variable AC voltage into a direct voltage, before converting it back into an AC voltage with a constant power supply frequency and voltage (e.g., 50Hz/690V). This way, the wind turbine can produce grid-compliant power from highly variable wind speeds. The turbine control system constantly monitors and adapts the turbine parameters in order to ensure compliance with the required infeed parameters.

This constant adaptation process results in the frequent switching of the electrical equipment and the constant optimization of the operating parameters by the control system. When disconnecting and reconnecting the generator power to the network, currents of up to several thousand A must be managed, which leads to extreme stress on the electrical equipment.

Our coordinated product portfolio – from SIVACON busbar trunking systems to 3WL air circuit breakers and SITOR semiconductor fuses – ensures the safe, consistent and efficient distribution of the generated power in the main circuit.

Given the increasing proportion of wind turbines in the overall energy mix, it is essential that they contribute to the stability of the grid. The specifications for this are defined in national Grid Codes. The operational management of the wind turbine required for a corresponding reactive power supply and for the stabilization of the public grid results in increased requirements with regard to the regulation algorithms of the power semiconductors and switching devices in the main circuit.
Safe transmission of high currents
High power outputs must be distributed and transmitted in the wind turbine safely and with as little loss as possible. This can be achieved by means of the LD system from the SIVACON 8PS busbar trunking system range which can be fitted both quickly and safely. It is ideally suited to the distribution and conveyance of power within the main circuit for a current range of 1,100 A to 5,000 A.

Flexible power distribution
The LD system is significantly superior to a conventional cable, especially for connecting the generator and converter in the nacelle, where space is often limited. The system is modular in design and offers safe connection conditions. Elbow units are also available, thus ensuring that difficult installation situations can be managed with ease. Use of this system offers significant benefits, particularly in relation to the connection of the nacelle to the power infed in the base of the tower. Thanks to the enclosed design, the secure mounting to the tower and the corresponding contact connections, installation can be carried out in the production plant. This simplifies considerably the effort required for installation and commissioning.

Reliable fire prevention
The busbar also has an important function in regard to fire protection. It has a high thermal loading capacity with regard to the effects of a lightning strike. In accordance with VdS 3523, the fire load is reduced through use of a sheet steel enclosure and the thin epoxy coating of the conductors. Additional safety is provided by the high short-circuit strength of the busbar trunking systems and the outgoing units. The ageing-resistant epoxy coating of the conductors offers additional protection against water in the ventilated IP34 system (sprinkler-suitable) and the IP54 system.

Reduction of EMC problems
In comparison to an unshielded cable, the sheet steel enclosure of the busbar significantly reduces EMC-related interference.

More information
www.siemens.com/lowvoltage/busbar-trunking-systems

Reliable conveyance of the generated power

The SIVACON 8PS busbar trunking system requires very little space and offers maximum safety and reliability.

Highlights
- Maximum short-circuit strength and much lower fire load compared to cables
- Pre-installation in the factory simplifies the on-site installation process
- Sheet steel enclosure to reduce EMC effects to a minimum
Effective protection of the main circuit
The 3WL air circuit breaker protects the main circuit in the event of overload and short circuit. It can be fitted with various electronic releases which enable the tripping characteristic to be optimally adapted to the conditions required. The connection between the generator and the converter, which has to contend with variable frequencies, is protected by the externally controlled 3WL air circuit breaker.

Disconnection and maintenance
The 3WL air circuit breaker is also used for safe disconnection from the network when maintenance work is being carried out. Numerous locking options, e.g. a locking device to prevent unauthorized reconnection, guarantee maximum protection for maintenance staff. Its diagnostics function supports preventive maintenance, e.g. through the replacement of worn main contacts. The optional withdrawable solution makes maintenance and repair work much easier, since the device can be replaced safely and easily if required, using the undetachable crank handle.

With consistent communication capability
Thanks to the comprehensive range of communication options, the 3WL air circuit breaker can be optimally integrated into the wind turbine’s electronic management systems, thereby enabling all operating parameters to be detected in good time and ensuring that the necessary actions can be taken.

Flexible in its range of applications
A motorized operating mechanism enables the device to be switched back on remotely. All versions feature the modular design and share the same complete range of standard accessories. Thanks to its very extensive operating temperature range of -25 to 70 °C and the storage temperature range of -40 to 70 °C, it is ideally suited for use in wind turbines under extreme climatic conditions.

More information
www.siemens.com/lowvoltage/air-circuit-breakers

Switching and protecting the main circuit

Standard-compliant power:
The version with an increased voltage tolerance of 690 V +/- 20% not only satisfies the fundamental LVRT-capability requirement, but also satisfies HVRT requirements for short-term voltage increases arising from regulations such as the German “BDEW – Technical guideline for generating plants connected to the medium-voltage network”.

With three sizes, the 3WL air circuit breaker covers a range from 630 A to 6,300 A. The type rated 2,000 A is the smallest of its class.
Effective protection concept for the converter

Special protection required
The sensitive power semiconductors of the converter react sensitively to short circuits and overload. In the event of uncontrolled failure due to extreme circumstances, this can result in considerable damage and downtime for the entire wind turbine.

High operational reliability
A particularly fast protective device is required for protection. SITOR semiconductor fuses are the ideal solution for meeting these requirements as they are impervious to the variable frequencies on the generator side. Moreover, they have a high varying load factor which ensures a high level of operational reliability – even when subject to constant load change – and, thanks to their super-quick disconnect characteristic, offer much faster protection than all other protection devices.

Increased system availability
The optional fuse monitor signals the current condition to the wind turbine’s communication systems. This increases system transparency and, therefore, system availability.

Simple planning, reliable operation
SITOR semiconductor fuses are available in various designs for different performance classes and for a range of installation and mounting requirements. They are clearly classified by operational class and in accordance with their function and are tested with regard to heat dissipation and maximum current loading, thereby simplifying the planning and dimensioning process. Possible damage is therefore prevented.

More information
www.siemens.com/lowvoltage/fuse-systems

Highlights
- Effective protection of the sensitive power semiconductor with SITOR semiconductor fuses
- Super-quick disconnect characteristic of SITOR semiconductor fuses
- Increased system availability thanks to optional fuse monitoring
- Flexible installation thanks to a range of designs and mounting options

SITOR semiconductor fuses reliably protect power semiconductors against the effects of a short circuit.
Solutions for reactive-power compensation units

Optimal power factor
With certain system configurations, reactive-power compensation units must be provided in the main circuit of the wind turbine in order to comply with requirements relating to the cos phi range, such as those defined in the Grid Codes.

Protection of the compensation units
NH fuse systems provide reactive-power compensation units with reliable protection against short circuits. The fuse status can be queried remotely using the corresponding monitoring system.

Rapid reactive-power compensation
With the thyristor modules of the TSMLC and TSM-HV series, we offer the main components, the “electronic switch” for dynamic power factor control units. Thanks to the robust technology of these components, they offer excellent reliability. The modules are wear-free, maintenance-free and self-monitoring.

Conventional switching
The 3RT16 capacitor contactors are specially designed for switching the capacitor modules. The capacitors are precharged by means of the mounted leading NO contacts and resistors – only then do the main contacts close. This prevents disturbances in the network and welding of the contactors, thereby protecting the contactors.

Reliable capacitor technology
Thanks to their long durability, the use of self-restoring capacitors offers maximum safety and reliability.

High power factor through controllers
The controllers for reactive-power compensation units are of the utmost importance for the system. They measure the current power factor and activate or deactivate capacitor groups depending on the desired cos phi value.

Reliable control of compensation
The MMI6000 Multi Measuring Interface allows for the direct detection of dangerous network conditions and switches capacitor levels off for as long as the dangerous situation continues.
Comprehensive protection
Electrical equipment guarantees the vital functions of the wind turbine, e.g. pitch and yaw control systems and ventilation or hydraulic systems. Equipment of this kind must be fitted with coordinated components in order to ensure effective protection against overvoltages, overloads and short circuits.

Maintaining functionality
Safe power distribution inside the wind turbine is therefore of fundamental importance for maintaining electrical functionality, particularly in the event of a hazardous situation.

Compliance with standards
The design of electrical equipment for wind turbines must comply with DIN EN 61400-1 and its associated reference standards and guidelines, such as the Germanischer Lloyd 2010 guideline for the certification of wind turbines, for example.

Safe power supply for the auxiliary circuits

Highlights
- A safe power supply guarantees maximum functionality
- Reliable protection against overvoltage, overload and short circuits
- Products certified worldwide for the standard-compliant installation of protection concepts
Intelligent pitch system
Pitch technology is an important component of every wind turbine. It allows for the optimal exploitation of the wind potential and measures, monitors and controls the rotor blades’ angle of attack. It is used both to start-up the wind turbine and to control the power output during operation in spite of changing wind conditions, with the aim of maximizing yield. Furthermore, the adjustment of the blades enables wind loads on the wind turbine to be reduced, as is sometimes necessary during extreme wind conditions.

Protection in emergencies
The blades’ pitch system is also used for controlled or emergency disconnection, e.g. when a storm is approaching, by automatically turning the rotor blades out of the wind. This important safety function must also be guaranteed in the event of a power failure inside the wind turbine. The electrical pitch control is therefore generally fitted with an emergency power supply. In addition to electrical pitch systems, there are also hydraulic systems. With a hydraulic system, the power stored in a hydraulic accumulator is used to reset the rotor blades in the event of a fault. In both cases, a brake holds the rotor blades in the secured feathering position.

Integrated diagnostics function
The condition diagnostics function integrated in the pitch system saves the need for additional sensors and it can be fully integrated into the wind turbine’s condition monitoring system.

Effective safety functionality
Our high-quality protective components protect all of the various operating mechanisms in the wind turbine against overload, short circuits and overvoltage. They therefore ensure interruption-free operation. Our product range has a solution for every requirement: from thermal and solid-state overload relays to circuit breakers for challenging applications.
An efficient yaw system
The yaw system enables the nacelle to be optimally positioned in the wind at all times and allows this position to be readjusted if the permitted deviation between the wind direction and the nacelle is exceeded. This is achieved by means of a sensor which signals the wind direction to a control system, which in turn starts up the servomotors if required. Movements around the vertical axis result in strong section moduli on the rotor and on the rest of the structure. Wind direction tracking control therefore takes place slowly and with high levels of damping by means of soft starters or frequency converters.

A reliable yaw control system
The control system is responsible for the synchronized control of many motors. A redundant design of the yaw system results in maximum reliability of operation, even in hazardous situations. The motors and the control system must therefore be protected against overvoltages, overload and short circuits. We offer a comprehensive portfolio of products for this purpose. With proven safety concepts for a long serviceable life and the protection of your investment, our products satisfy all requirements and guarantee maximum reliability of operation.

Supportive heating/cooling systems
No matter what the weather – operating temperatures which remain as constant as possible are a basic prerequisite for the low-wear operation of a wind turbine. Heating or cooling systems are therefore used to keep the temperature of the generator, gear oil, electronic components and control cabinets constant.

The hydraulic systems also have an important function, since they perform tasks such as braking, cooling and lubricating.

Highlights
- Interruption-free operation thanks to a comprehensive protection concept for electrical operating mechanisms
- Maximum availability thanks to the redundant control of several motors
- Protection of the mechanics and prevention of current peaks on start-up thanks to the use of soft starters

Reliable drive technology, even under difficult conditions.

Hydraulic systems with excellent fault tolerance
Hydraulic systems perform important functions such as parking brakes (rotor, yaw), the lubrication of gear components, or the control of hydraulic pitch systems. Standard IEC 60204 for protection devices requires an effective protection concept against overload and short circuits for electrical operating mechanisms.
A focus on aircraft safety
Wind turbines with a height in excess of 100 meters must be fitted with obstruction lighting for reasons of aircraft safety. Color identification is sufficient during daylight hours, but obstruction lighting is essential at night. If the total height of the turbine is in excess of 150 meters, an obstruction light must be fitted to the tower in addition to the lights on the nacelle.

Redundant safety functionality
These lights on the tower must be fitted at intervals of 45 meters. Two separate lights must generally be fitted to the nacelle. In order to ensure the fault-free operation of this important safety function, a reliable power supply including an emergency power supply from batteries is essential. An important prerequisite for the obstacle and tower lighting is adequate, graded lightning protection. We supply the necessary components for this purpose.

Highlights
- Safety for aircraft thanks to the fault-free operation of obstruction lighting
- Reliable operation of lighting thanks to high-quality products and an emergency power supply
- Protection of the electrical installation and systems thanks to a graded lightning and over-voltage protection concept

Fault-free operation of lighting

Auxiliary circuit overview

There are two separate obstruction lights on the nacelle. The fault-free operation of these lights improves safety for aircraft.
High infeed protection for the auxiliary circuits

Requirement-based power supply
A transformer ensures the power supply for the control and auxiliary circuits with the necessary voltage level (e.g. AC 400V/230V).

3VL molded-case circuit breakers
The compact 3VL molded-case circuit breaker provides the transformer with maximum protection against short circuits and overload. Available in a power range from 16 to 1,600 A, it does not exhibit any derating in ambient temperatures up to 50 °C. It is available with both thermal-magnetic and electronic overcurrent release and is therefore both flexible and adaptable. Due to alarm signals and diagnostic functions, preventative action is always possible before a breakdown occurs. A comprehensive communication concept provides the connection to the diagnostic and remote control systems of the wind turbine.

Fuse switch disconnectors
The 3NP1 fuse switch disconnector can also be used here instead of the molded-case circuit breaker. This component is particularly well-suited for use in wind turbines thanks to its compact design, its low weight, its high current carrying capacity and its associated low derating. It is available in five different sizes for the performance range up to 630 A. It can be installed quickly and safely using the bus-bar systems which are available as an optional extra.

Important contribution to reliable operation
NH fuse systems in sizes 000 to 3 protect downstream system components and loads against overload and short circuits. The devices can be fitted with an electronic or electromechanical fuse monitor, which is integrated into the diagnostics system of the wind turbine’s control system. The current switching state can be signaled by means of an optional auxiliary switch. The removal of the fuse without touching it offers enhanced safety for maintenance staff.

More information
www.siemens.com/lowvoltage/molded-case-circuit-breakers
www.siemens.com/lowvoltage/fuse-switch-disconnectors

Highlights
- A safe and requirement-based power supply for the control and auxiliary circuits
- Flexible adaptation to the required tripping characteristic
- High current carrying capacity with associated low derating
- Increased system transparency thanks to integration into the communication systems of the wind turbine

Optimal overload and short circuit protection by the 3VL molded-case circuit breaker and the 3NP1 fuse switch disconnector.
Perfect protection for auxiliary circuits

Optimal protection
In the event of thermal overload and short circuits in the wind turbine’s electrical system, miniature circuit breakers or fuse systems offer perfect protection for the electrical equipment of the control and auxiliary circuits.

Effective personal safety
A miniature circuit breaker combined with a residual current operated circuit breaker (RCBO) also provides protection against dangerous electric shocks in the event of an excessive contact voltage due to an insulation fault. Only UC-sensitive residual current operated circuit breakers of types B and B+ also guarantee maximum protection when smooth DC residual currents occur. These can occur with frequency converters or defective switching network components which are frequently used in wind turbines.

A wide range of functions
Further key functions are available thanks to an extensive range of accessories:

- remote tripping, remote reconnection and remote querying of switching states.
- Optimized installation mechanisms save time when mounting components.

Monitoring residual currents
Preventive system protection can be achieved by using a residual current monitor. This device monitors residual currents occurring in the auxiliary circuits, which indicate an insulation fault and may lead to significant damage or downtime. Thanks to a signal when threshold values are exceeded, action can be taken, such as preventive maintenance or putting the system into a safe state. This increases system safety and operational reliability, as well as reducing costs. The auxiliary circuits should also be integrated into the wind turbine’s overvoltage protection system.

More information
www.siemens.com/lowvoltage/protecting

Highlights
- Maximum safety thanks to line protection against overload and short circuits
- UC-sensitive residual current operated circuit breaker for maximum personal safety
- Increased system availability thanks to remote reconnection with the assistance of motorized operating mechanisms
- Early detection and signaling of residual currents prevents system downtimes

Simple configuration of applications thanks to multiple combination options:

1. 5SM2 RC unit for personal safety and protection against electrically ignited blazes
2. 5SY miniature circuit breaker, 4-pole
3. 5ST3 remote-controlled operating mechanism for remote switching of the MCB
4. 5ST3 undervoltage releases protect downstream loads in the circuit against risks from undervoltage
5. 5ST3 auxiliary switches and 5ST3 fault signal contacts for displaying switching state or protective tripping
Requirement-based motor protection concepts

Modules for every requirement
The comprehensive and graded SIRIUS/SENTRON modular system is available for all types of electrical operating mechanisms in a wind turbine and offers a wide range of options for switching, protecting and starting these operating mechanisms. This system is a modular range of perfectly coordinated standard components. They can easily be combined with one another and, to a large extent, use the same accessories.

Variable, customized control
The motor can be controlled in three ways: simple, normal switching duty, soft starting or speed-variable operation, as is required for cooling fan motors with a higher output, for example. All control concepts guarantee reliable overload and short-circuit protection. Intrinsic protection of the soft starter and the frequency converter is provided by SITOR semiconductor fuses. Type 2 coordination can thereby be achieved.

Safe disconnection of the operating mechanisms
Thanks to our versatile switchdisconnectors, the operating mechanisms can be disconnected safely and reliably from the network for maintenance work or changes.

Comprehensive monitoring
Monitoring relays are used to monitor the motors for problems such as overcurrent and undercurrent, broken cables or phase failure. The status and fault signals can be integrated into the wind turbine’s communication systems via digital inputs from control systems or IO-link.

More information
www.siemens.com/sirius
www.siemens.com/lowvoltage/protecting

Highlights
- Extensive modular system for controlling, protecting and monitoring the operating mechanisms
- Integrated soft starting and speed-variable operation for requirement-based control
- Diverse diagnostics functions and integration of these into the wind turbine’s communication systems
- Use of SITOR semiconductor fuses to achieve type 2 coordination

A modular system consisting of standard components is available to switch, protect and start the various electrical operating mechanisms. The components are perfectly coordinated and can be combined with ease.
## Motor protection concepts

<table>
<thead>
<tr>
<th>No.</th>
<th>Circuit diagram</th>
<th>Product combination</th>
<th>Application</th>
<th>Function</th>
</tr>
</thead>
</table>
| 1   | ![Image](1)     | ![Image](2)         | Single-phase small loads, e.g. fans in control cabinets | - Miniature circuit breaker with motor protection characteristic C for protection against overload and short circuits  
- Insta contactor for normal switching duty |
| 2   | ![Image](3)     | ![Image](4)         | Pump motors, e.g. for cooling water or gear oil without requirements for speed-variable operation | - Motor-protective circuit breaker for protection against short circuits  
- Alternative cost-effective solution: fused motor starter combination, especially for use for motor feeders  
- SIRIUS contactors for normal switching duty  
- Overload relays for protection against overloading of the motor |
| 3   | ![Image](5)     | ![Image](6)         | Motors which are operated with soft starters, e.g. service crane | - Motor-protective circuit breaker with overload relay function for protection against short circuit and overload in just one device  
- Soft starter for the soft, protective starting of motors |
| 4   | ![Image](7)     | ![Image](8)         | Protection of motors which are operated with soft starters, e.g. tower elevator when there are special requirements in order to achieve type 2 coordination | - Switch disconnector with fuses for semiconductor and line protection through SITOR semiconductor fuse in order to achieve type 2 coordination  
- Door-coupling rotary operating mechanism allows isolation outside the control cabinet for maintenance purposes  
- Soft starter for the soft, protective starting of motors  
- Overload relay for overload protection of the motor |
| 5   | ![Image](9)     | ![Image](10)        | Speed-variable operation of e.g. cooling fans motors which are controlled in accordance with the ambient temperatures inside the nacelle | - SITOR semiconductor fuse for the cost-effective protection of the power semiconductors of the frequency converter  
- Achieving type 2 coordination  
- Contactor for normal switching duty  
- Frequency converter for generating variable motor speeds. The protective function against overload is covered by the frequency converter |
<table>
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<tr>
<th>No.</th>
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<th>Application</th>
<th>Function</th>
</tr>
</thead>
</table>
| 6   | ![Circuit Diagram](image1) | ![Product Combination](image2) | Control of e. g. soft-starting yaw operating mechanisms | – Compact feeders combine a circuit breaker, solid-state overload relay and contactor in just one device
– Low variance of devices thanks to wide setting ranges
– Soft starter for the soft, protective starting of motors |
| 7   | ![Circuit Diagram](image3) | ![Product Combination](image4) | It is important that motors can be put back into operation as quickly as possible following a fault, especially in the case of motors which relate to safety functions | – Repair switch for manual isolation, e. g. for maintenance purposes or for the emergency-stop function
– SITOR semiconductor fuse to protect the semiconductor of the high-quality frequency converter against short circuits. Achieving type 2 coordination. Rapid putting back into operation following a fault by replacing the fuse
– Decentralized frequency converter for generating variable motor speeds. The protective function against overload is covered by the frequency converter. The device is suitable for use in harsh ambient conditions |

Operating mechanisms must also function reliably under extreme ambient conditions.
### Optimal cabinet air conditioning and lighting

#### Constant operating temperatures
Whether it is hot, cold or humid, when the ambient conditions are harsh, wind turbine control cabinets can be affected by overheating or condensation. The cabinets should therefore be air-conditioned to prevent this. We offer a wide range of air-conditioning equipment, e.g. filter fans, air-conditioning/cooling devices, heat exchangers, heater units/fan heaters, thermostats and hygrostats. When selecting individual air-conditioning components, the ambient temperature, the power losses of the installed devices, the maximum permissible device temperatures and the heat dissipation capacity of the cabinet used are all factors to be considered. In addition, the required degree of protection must be taken into account.

#### Optimal lighting conditions
Good visibility is a basic prerequisite for fault diagnosis and maintenance work inside the control cabinet. Our cabinet lights are therefore specially designed for use in switchboards and control cabinets. In cabinets and enclosures with a high density of electrical/electronic devices, use of the SL025 slimline lighting is ideal.

#### More information
SIVACON, ALPHA Catalog LV 10.2 Chapter 16; 17

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**Highlights**
- Operation-compatible climate in the control cabinet in every type of weather
- Effective protection against overheating and mold formation
- Wide-ranging portfolio of air-conditioning equipment for the most varied requirements
- Optimal visibility thanks to compact cabinet lights

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**The control cabinet air conditioning ensures constant operating temperatures in all control cabinets, no matter what the weather.**

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**Optimum and long air duct for cabinet air-conditioning**

- **35 °C**
  - Warm air from control system
- **25 °C**
  - Cold air return
- **55 °C**

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**The control cabinet lighting offers maintenance staff optimal visibility for maintenance and repair work.**
Safe disconnection from the network during maintenance

Safe disconnection from the network is essential
In any part of the wind turbine where maintenance work or repairs are required, the relevant system must be disconnected in advance. Switch disconnectors perform this task with complete reliability.

Reliable disconnection
Switch disconnectors are suitable for disconnection from the network. They also function as main control, EMERGENCY-STOP, repair or transfer switches. These versatile, top-quality devices in a three-pole or four-pole design allow for safe disconnection or switching under load. After disconnection from the network, main and EMERGENCY-STOP switches can be used to safely isolate the electrical system or to switch auxiliary circuits, induction motors or other loads.

Optimal protection
The rotary operating mechanism has the option of locking capability which prevents unauthorized reconnection, increases safety for maintenance staff and therefore guarantees optimal use as a maintenance or repair switch. With the corresponding color identification of the handle, the device can also be used as an EMERGENCY-STOP switch.

More information
www.siemens.com/lowvoltage/switch-disconnectors

Highlights
- Reliable protection of maintenance staff against unauthorized reconnection
- Safe disconnection of the auxiliary circuits and loads from the network
- Further options, e.g. as an EMERGENCY-STOP switch for increased safety in hazardous situations

Additional system components: solutions

The high-quality switch disconnectors for safe and reliable disconnection from the network.
Comprehensive overvoltage protection
A wind turbine is generally the highest point in the landscape or in the water and is therefore at particular risk of being struck by lightning. Lightning and overvoltages can cause significant damage and may even result in the complete loss of the wind turbine. Thanks to our graded portfolio, suitable lightning and overvoltage protection can be achieved for every type of wind turbine.

Graded lightning protection concept
A lightning protection concept with the necessary lightning protection measures is drawn up on the basis of a thorough risk assessment. The risk assessment must be based on the maximum risk possible (risk level I) in accordance with IEC 62305/IEC 61400-24 and must take account of the possible lightning paths, e.g. from the rotor blade to the base via the nacelle. Distinction is made between the various risk zones (Lightning Protection Zones, LPZ). In addition to the lightning partial current which can be expected, switching surges must also be taken into account.

Requirement-based portfolio
In order to protect electrical equipment, we offer a graded portfolio of surge arresters of types 1, 2 and 3. Through remote signaling, devices that have been triggered can be signaled to the wind turbine’s communication system. The replaceable modules enable the overvoltage protection to be restored as quickly as possible.

Reliable protection of data lines
It is not only the supply circuit equipment which needs to be protected – data lines also require protection. Depending on the communication medium (e.g. PROFINET, PROFINET, I/O), various overvoltage protection devices should be used.

More information
www.siemens.com/lowvoltage/overvoltage-protection-devices

By using our graded portfolio, you can protect not only the supply circuit equipment, but also the data lines.
High system transparency with measuring devices

Recording, measuring and evaluating
Within the electric circuits of a wind turbine, measurement technology allows for the precise display and reliable monitoring of electric variables. This enables recording of the infeed quality into the power supply companies’ network, as well as of critical measured quantities that may indicate possible operational faults or overloads.

Fully informed in good time
By recording changes in harmonic or current mean values, critical system states and system component defects can be detected at an early stage and subsequent damage, e.g. damage caused by fire, can be prevented. Measurement of the infeed quality is also becoming increasingly important with regard to compliance with national Grid Codes.

Reliable through communication
Thanks to their many communication options, the high-quality 7KM PAC measuring devices can be very easily integrated into higher-level communication systems of the wind turbine or wind park control rooms for further processing of the measured data. Communication can take place via PROFINET, PROFIBUS-DP, Modbus RTU, Modbus TCP, M-Bus or, in the simplest of cases, via digital inputs and outputs.

More information
www.siemens.com/lowvoltage/measuring

By measuring, providing and communicating the consumption data and electrical characteristics, system transparency is increased.
Accessible information at all times
The basic prerequisite for complete transparency across all levels of a wind turbine is communication. It is communication which enables the provision of important operating parameters, a comprehensive diagnostics function and effective management of measured values, not only inside the wind turbine itself, but also extending as far as connection to the wind park control system. Any system failures can be prevented in good time by:

- **Setting threshold values**
  Upper and lower limits for electrical variables
- **Preventive maintenance**
  Operating cycle display / Operating hours counter
- **Diagnostics**
  Indications of state through changes/tripped signals
- **Observation**
  Status display of measured values

Integrated communication makes diagnostics and control an easier process and increases the availability of wind turbines.

Various communication classes allow for flexible adaptation to the relevant requirements: from local display to a fully integrated communication system with evaluation functions.

Additional system components: solutions

**Flexible adaptation through graded communication classes**

- **Basic functions:**
  - Forwarding of data to other systems via bus systems
    - PROFIBUS
    - Modbus
    - Ethernet
  - Measurement function in the circuit breaker
  - Further processing of measured values and diagnostics/status signals in process control systems

**Configuration examples:**

(01) Forwarding of status signals via a configurable CubicleBus digital output module, e.g.:
  - Ready-to-close status
  - Connected position
  - Limit violation signal (e.g. temperature, current ...)
  - Reason for tripping signal (e.g. short circuit, overload ...)

(02) Collection of switching state data (e.g. ACB, SPD, LS, RCM) via DI to 7KM PAC4200 and forwarding the status information to PN (use of 7KM PAC in addition to the main measurement function)
The right product
Our portfolio comprises products to meet every requirement: from a simple status display to extensive diagnostics functions and communication interfaces to all common wind turbine control systems.

Extensive diagnostics functions
In addition to its protective and switching functions, the 3WL air circuit breaker is also equipped with extensive diagnostics functions. This means that many measured values and basic parameters can be recorded, such as current and voltage, temperature inside the circuit breaker or operating cycle figures. Thanks to a range of communication modules, a connection can be made to various bus systems in the wind turbine.

Wide range of communication
The 7KT/7KM PAC measuring devices are also equipped with a wide range of measurement functions and are used in both the main and auxiliary circuits of the wind turbine to record important electrical characteristics. Thanks to a large number of communication interfaces, the devices can communicate with common control systems in wind turbines.

Electronic fuse monitoring
In addition to its protective and switching function, the 3NP1 fuse switch disconnector can also be fitted with electronic fuse monitoring. Connected to various bus systems, important operating state information can then be forwarded.

More information
www.siemens.com/lowvoltage/communication

Highlights
- Optimal system transparency thanks to communication-capable products
- Increased system availability thanks to preventive maintenance and diagnostics functions
- Flexible adaptation to requirements thanks to graded communication classes
- Fully informed thanks to intelligent measurement technology
Efficiency and safety worldwide
We offer the world’s most comprehensive portfolio of electrical and electronic drive solutions, automation and communication components and power distribution systems for wind turbines. In addition to this, we also offer fire detection and fire extinguishing systems. The consistency, modularity and intelligence of our components and systems offer you numerous advantages – throughout their service life and wherever you are in the world.

Integrated solutions as required
With the Totally Integrated Automation (TIA) and Totally Integrated Power (TIP) system architecture, we offer an integrated basis for the realization of customized automation and power distribution solutions.

Many years of industrial know-how
Industrial expertise – including from other industrial sectors – is also highly beneficial in the wind industry. For example, the conceptual approach of the automobile industry with regard to manufacture, logistics, product development and Digital Factory can also be applied to the wind industry.

A strong partner
As an expert and reliable technological partner of many years’ standing within the industry for (engineering) software and hardware components, we offer our customers not only proven products and systems, but also extensive service and support, from initial information on planning, engineering and ordering through to commissioning, on-going operation and technical service. Proximity to our customers is guaranteed, thanks to our worldwide production, sales and service branches.

Everything from one source
Thanks to our bundled products and services, you can enjoy the benefits of consistent, uniform processes, integrated concepts, reliable products and a local presence in the major wind markets of the world.

More information
www.siemens.com/wind-equipment
Any questions? 
One click – well-informed

LV Explorer – Discover Low Voltage in 3D

Get comprehensive and specific information about our products with the help of 3D animations, trailers and technical information.

www.siemens.com/lowvoltage/lv-explorer

Always at your disposal: our extensive support

We provide you with support from planning through commissioning and operation.

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