# PCS 6000 for large wind turbines
# Medium voltage, full power converters up to 9 MVA

Power and productivity
for a better world™

# ABB medium voltage converters – operating successfully in thousands of installations

The growing importance of regenerative energy has been accompanied by a continuous rise in the demand for wind power. However, state-of-the-art turbines are now attaining such high power ratings that low voltage systems are struggling to cope with the currents and losses occurring in generators, converters and cables.

The logical solution is to use medium voltage converters in large wind turbines – with real benefits when it comes to hardware and system performance.

Over the years, medium voltage technology has become well established. Worldwide, ABB has been a leader in the installation of medium voltage frequency converters. ABB medium voltage converters, with their excellent reputation for high-endurance, reliable operation in the harshest environments, are used in industrial and propulsion drive systems, railway grid entities, static VAr compensators, battery storage and many other demanding applications.

For any large-scale wind turbine, the PCS 6000 medium voltage converter is the perfect match when operating with synchronous and asynchronous generators – whether high- medium- or low-speed designs.

**The PCS 6000 approach – more than delivering a product**

From the early evaluation phase of a new wind turbine to final operation in the wind park, ABB provides first-class customer consulting, support, training and service.

ABB converter specialists are experts in all aspects of the system and will therefore build an electrical drive train that functions perfectly – from the generator through to grid integration.

ABB's life-cycle management involves a highly qualified service team who can rely on supporting software tools for remote monitoring. They will maximize the value of the equipment by maintaining trouble-free operation and ensuring maximum availability.

# PCS 6000 medium voltage converters – for top system performance and gentle turbine operation

**Full generator control**
For optimal active and reactive generator power control, plus maximum wind utilization at any turbine speed.

**DC link decoupling**
For independent grid- and generator-side control without impact from one side to the other.

**Full grid control**
For optimal active and reactive grid power control, plus guaranteed grid-code compliance.

**Gentle generator handling**
For reduced mechanical stress thanks to optimum drive train damping, plus overspeed and overvoltage protection.

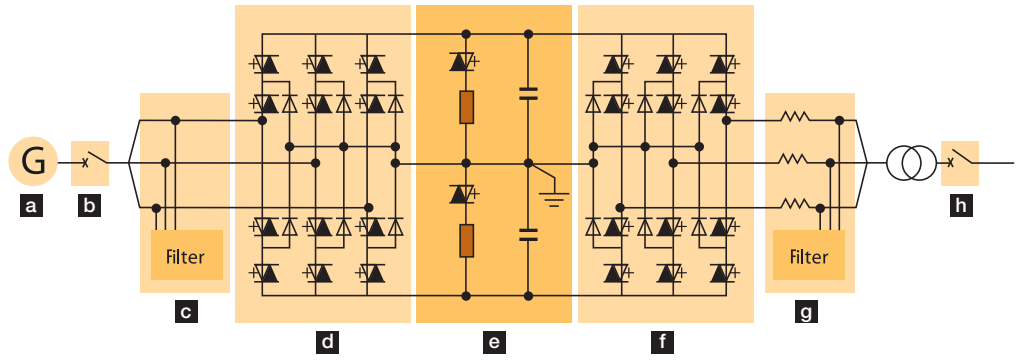
**Dynamic braking chopper**
For low voltage ride-through and safe turbine shutdown, even with a lost grid.

**High and low voltage ride-through**
For keeping the turbine on-line even during a major grid disturbance.

**Motor operation**
For back-to-back testing and precise rotor positioning.

**Precharging soft start**
For zero-current, flicker- and inrush-free grid synchronization.

**Harmonic elimination**
For reduced harmonics into the transformer and the grid.




- a Generator
- b Generator breaker
- c du / dt filter
- d Generator converter
- e DC link / braking chopper
- f Grid converter
- g Line filter
- h Transformer / circuit breaker

When it comes to large turbines, ABB's PCS 6000 medium voltage technology is the right choice. With significantly lower currents, the result is a boost in efficiency, a lower part count, a smaller footprint along with easy cabling and fast installation.

The full power topology of the PCS 6000 gently decouples the turbine's mechanical drive train from the electrical grid, and vice versa, while minimizing turbine stress and allowing compliance with even the strictest grid codes.

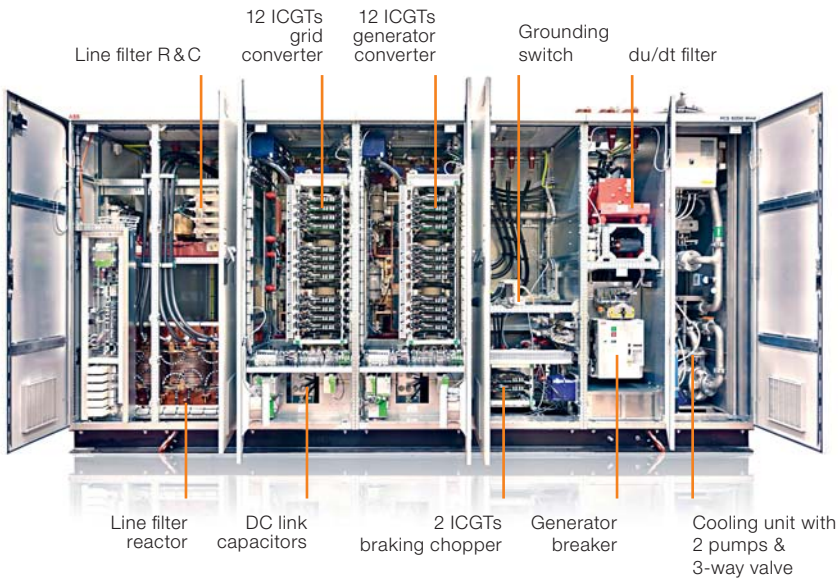
The bottom line? With large wind turbines, the PCS 6000 medium voltage, full power converter is the most sustainable, efficient and economic choice for top performance, grid stability and trouble-free operation.

# PCS 6000 medium voltage converters – fewer parts for maximum reliability

### Only 26 semiconductors
No paralleling of components and therefore a lower part count, higher reliability, less complexity and a smaller footprint.

### Condensation protection
To ensure a safe start-up even in humid environments.

1

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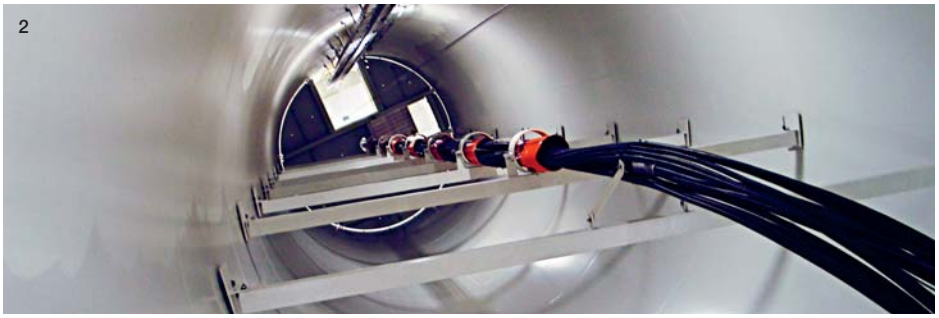
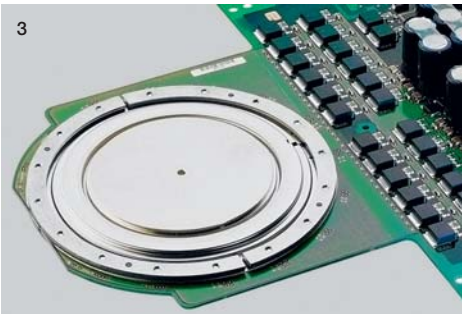


### Effective converter cooling
Trouble-free operation thanks to the integrated closed-loop cooling circuit with redundant pumps and three-way valve.

### Fuseless design
To avoid site visits for fuse replacement after disturbances and allow a remote restart after a cleared failure.

### DC link
Made up of high-quality, maintenance-free industrial film capacitors with a self-healing and internally fused design.

3



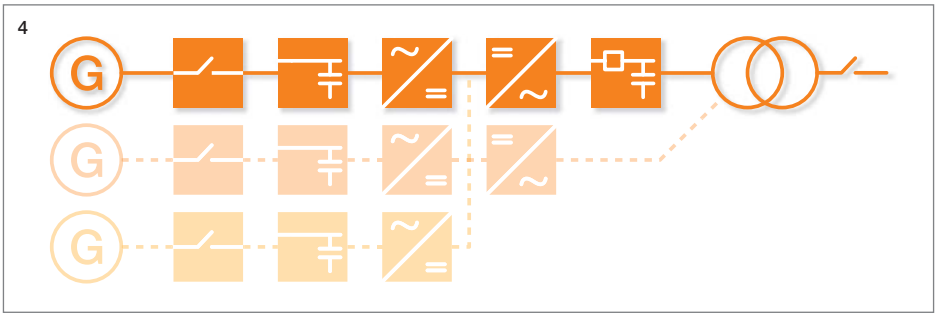
Using ABB's medium voltage technology, the paralleling of devices is not required. This keeps the part count low, resulting in a much lower failure rate compared to other solutions operating at such a power level.

With the emphasis on a well-balanced converter design and the use of high-quality components, the PCS 6000 is a market reference for long life and operational reliability.

Advanced protection and high-speed converter control are handled by ABB's AC 800PEC controller. All system communication is solely via fiber optical links and is therefore immune to electromagnetic interference.

# PCS 6000 medium voltage converters – for high flexibility and modular design

4

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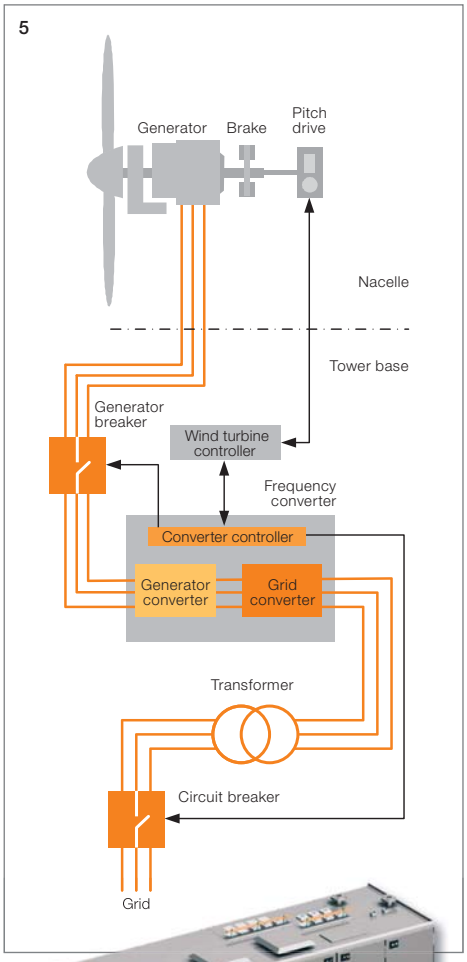


1 Clear design with low parts count
2 Much smaller cross-section of tower cabling
3 Integrated Gate Commutated Thyristor (IGCT)
4 Modular design for customized applications
5 Physical separation of generator and converter
6 Flexible and space-saving layout

6

Back-to-back

Face-to-face

In-line

## PCS 6000 modular design covers any configuration

The PCS 6000 is a modular type of frequency converter that is ideal for the majority of demanding single- or multi-generator applications. The design concept allows maximum flexibility at different power ratings and also customized solutions involving a minimum prototyping and engineering effort.

## The PCS 6000 fits confined spaces

Medium voltage allows easy location of the converter at the base of the tower. The resultant reduction in nacelle weight and easier service access bring major wind turbine design benefits.

The modularity of the PCS 6000 permits the arrangement of the converter modules very flexibly even on a single deck – either back-to-back, face-to-face or in-line.

# PCS 6000 medium voltage converters – facts and figures

| Converter model | PCS 6000 Wind | | |
|---|---|---|---|
| Converter type | 3-level, 4Q, VSI-NPC, fuseless design | | |
| Semiconductor | IGCT | | |
| Capacitors | Self-healing and self-protected film capacitors | | |
| Supported generators | High-, mid- and low-speed permanent magnet asynchronous induction generator static-excited synchronous generator | | |

| Converter data | | | |
|---|---|---|---|
| Converter voltage nom. | 3.3 kV | 4.16 kV | 3.3 kV |
| Generator-side voltage | 0 to 3.4 kV | 0 to 4.3 kV | 0 to 3.4 kV |
| Grid-side voltage | 0 to 3.4 kV | 0 to 4.3 kV | 0 to 3.4 kV |
| Semiconductor type | RC–IGCT | RC–IGCT | Sym.–IGCT |
| Number of IGCTs | 12 + 12 | | |
| Generator-side frequency nom. | 8 – 100 [1] | | |
| Grid-side frequency | 50/60 Hz | | |
| Power rating | 4 MVA | 4.5 MVA | 9 MVA |
| Efficiency at converters rated point | ~0.980 | | |
| Generator side du/dt | < 1.5 kV / µs | | |

| Dimensions [2] [3] | | |
|---|---|---|
| In-line arrangement size (LxWxH mm) | 5100 x 1200 x 2450 | 5700 x 1200 x 2450 |
| Face-to-face arrangement size (LxWxH mm) | 3300 x 1200 x 2450<br>1800 x 1000 x 2450 | 3500 x 1200 x 2450<br>2200 x 1000 x 2450 |
| Back-to-back arrangement size (LxWxH mm) | 2700 x 1200 x 2450<br>2400 x 1000 x 2450 | 2700 x 1200 x 2450<br>3000 x 1000 x 2450 |
| Weight | ~ 5250 kg | ~ 6200 kg |

| Auxiliary supply | | |
|---|---|---|
| Auxiliary supply voltage | 3-phase, 400 V, 50/60 Hz | |
| Auxiliary supply power | ~ 8 kW | ~ 12 kW |

| Cooling | | |
|---|---|---|
| Converter cooling | Closed-loop cooling unit deionized water / glycol mix coolant | |
| Coolant inlet temperature | Up to 45°C [4] | |
| Pumps | 2 pumps with automatic changeover, 100 % redundancy with check valves | |
| Heat exchanger | Water-air (external) / water-water (internal) | |
| Coolant connections | DN 50 | DN65 |
| Instrumentation / transmitters | Temperature, pressure, conductivity | |
| Deionization | Automatic by deionizer resign | |
| Deaeration | Automatic by deaeration valve | |
| Temperature control | Control logic / motor-driven three-way valve | |

[1] other generator-side frequencies possible on request
[2] including cooling and generator breaker / without braking resistor
[3] other arrangements possible on request
[4] higher temperatures possible on request

| Converter design cases | | | | | |
|---|---|---|---|---|---|
| Turbine power ratings | 3 MW | 4 MW | 5 MW | 6 MW | 7 MW [5] |
| Converter rating on generator side | ~ 3.3 MVA | ~ 4.4 MVA | ~ 5.5 MVA | ~ 6.6 MVA | ~ 7.7 MVA |
| Converter rating on grid side | | | | | |
| @ TenneT grid code | ~ 3.7 MVA | ~ 5.0 MVA | ~ 6.2 MVA | ~ 7.5 MVA | ~ 8.7 MVA |
| @ UK grid code | ~ 3.6 MVA | ~ 4.8 MVA | ~ 6.0 MVA | ~ 7.2 MVA | ~ 8.4 MVA |

[5] to be clarified with coolant temperatures / generator frequency

## Generator breaker

| | | |
|---|---|---|
| Type | ABB VD4 X0 | |
| Insulation / safety | Vacuum breaker / ground switch included | |
| Rated voltage | 6.6 kV | |
| Rated current | 800 A | 1250 A / 1700 A |
| Mechanical cycles | 30000 | |

## Braking chopper / resistor

| | |
|---|---|
| Chopper semiconductor | IGCT |
| Braking resistor type | Cast iron |
| Braking resistor capacity | 15 MJ / 30 MJ |
| Braking resistor size (LxWxH mm) | 1200 x 400 x 1030 / 1200 x 650 x 1030 |
| Braking resistor weight | ~ 200 kg / ~ 400 kg |
| Braking resistor cooling | Ambient air |

## Control

| | |
|---|---|
| Controller | ABB AC 800PEC |
| Generator-side control | Pulse width modulation |
| Grid-side control | Optimized pulse pattern |
| Field bus interface | Profibus DP / DPV1, Profinet IO, Modbus TCP, EtherCat, CANopen, InterBus |
| Ethernet | Service and maintenance access with software tool for Windows via installed IPC; VPN remote access ready |
| Transient recorder | Ring buffer, high resolution |
| Service IPC | Trending, data logger, remote access |
| Operation modes | Off / standby / production |
| Generator-side setpoints | Torque / power |
| Grid-side setpoints | Power factor / reactive power |
| Special operation modes | Positioning / test / static VAr compensation |
| Local control | Emergency off, local / remote control key switch |
| Local indication | Production, grid-breaker closed, DC link switch closed / released, rotor locked |

## Electrical interface

| | |
|---|---|
| Generator-side connections | From top (Pfisterer P3-AF01) |
| Gide-side connections | From top (Pfisterer P3-AF01) |
| Braking resistor connections | From back (Pfisterer P3-AF01) |
| Control connections | From bottom (wire terminals inside control cabinet) |
| Grid-side transducers | From high voltage side CT, VT [6] |

## Enclosure

| | |
|---|---|
| Constructional design | 1.5 mm carbon steel, edge bended sheets on solid base-frame MNS system, riveted and bolted |
| Degree of protection | IP 54 |
| Enclosure color | RAL 7035 |
| Corrosion protection | Powder and / or zinc coating |
| Door locking | Mechanical security interlocking door release when grounded |
| Anticondensation | Humidity-, temperature-sensor, control logic and space-heater protection |
| Lifting | Bottom lifting with removable eyebolts |

## Environmental limits

| | |
|---|---|
| Ambient temperature | Transport -40 to +70 °C<br>Storage -40 to +70 °C<br>Operation -15 to +50 °C [7] |
| Altitude | 0 – 1000 m |

## Service

24/365 support line, product expert remote diagnostic

Worldwide service and spare part network

[6] CT/VT included in HV switchgear, not in PCS 6000 scope
[7] other ambient temperatures on request

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3BHS351272 E01 Rev. A

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