

MEDIUM VOLTAGE WIND CONVERTERS

## ABB wind turbine converters

PCS6000, full power converter,  
up to 15 MW





# PCS6000 medium voltage wind turbine converter

Proven technology for efficient operation of large wind turbines and lowest levelized cost of energy.

## Medium voltage converters for large wind turbines

The growing importance of regenerative energy is accompanied by a rise in the demand for wind power. Wind turbines are today attaining such high power ratings that a medium voltage system is the optimum choice. It allows a higher energy production through reduced losses in the electrical drivetrain and lower installation costs by eliminating expensive cable runs.

## Perfect match for large-scale wind turbines

ABB's medium voltage wind turbine converter is the perfect match for large-scale offshore wind turbines. Available up to 15 MW, it can be operated with permanent magnet and induction generators. Its compact footprint allows nacelle or tower installations.

## Lowest cost of energy

The PCS6000 helps to utilize the full potential of wind energy, reliably and economically. It lowers the levelized cost of energy (LCoE) through maximum availability, high efficiency, advanced grid code compliance and easy maintenance.

## Technology proven worldwide

The PCS6000 wind turbine converter is based on ABB's medium voltage frequency converters which are installed in thousands of applications worldwide. With their excellent reputation for reliable operation in the harshest environments, the converters are used in industrial and propulsion drive systems, railway grid entities, static VAR compensators, battery storage, tidal

power plants and many other demanding applications. The first PCS6000 Wind was delivered in 2006.

## The ABB approach – more than delivering a product

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

ABB's converter specialists are experts in all aspects of the electrical system and will build a drivetrain that functions perfectly – from the generator through to grid integration.

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

## PCS6000 features

- Full power converter for wind turbines up to 15 MW
- High efficiency due to medium voltage technology
- High availability due to low parts count and long-life components
- Low life-cycle costs
- Modular design for easy customization
- Advanced support and remote service tools for enhanced reliability, availability and performance

The PCS6000 platform is used in a wide range of applications, such as railway grid entities and tidal power generation (photo © Atlantis Resources)



# Superior system performance

The PCS6000 offers several features that ensure efficient and reliable turbine operation and grid code compliance.

## Full generator control

Optimal generator power control for maximum energy production at any turbine speed.

## Gentle generator handling

Reduced mechanical stress due to drivetrain damping, resulting in a longer lifetime of the equipment.

## Full grid control

Advanced active and reactive grid power control ensures grid code compliance at any time.

## Dynamic braking chopper

Low voltage ride-through and safe and smooth turbine shutdown, even with a lost grid.

## High and low voltage ride-through

Keeps the turbine on-line even during a major grid disturbance.

## Motor operation

Enables hall test, back-to-back testing and precise rotor positioning, simplifying testing and service tasks.

## Precharging soft start

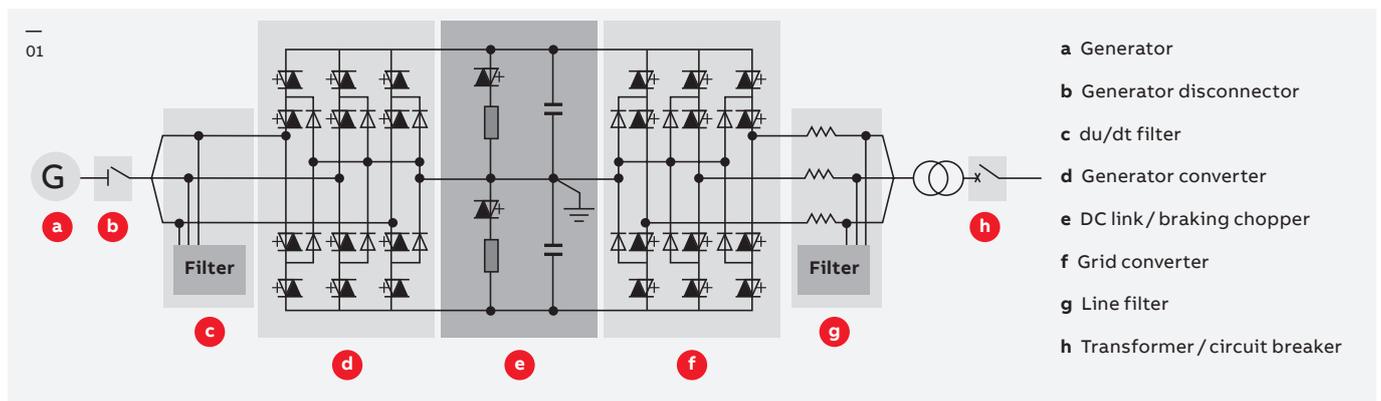
Enables zero-current, flicker- and inrush-free grid synchronization.

## Flexible harmonic spectrum

Easy adaptation to different grid systems to avoid harmonic resonance problems.

## Island mode operation

Ensures electricity supply to the wind turbine's auxiliary systems when the turbine is not connected to the grid.



01 PCS6000 converter topology

The PCS6000 has a number of features that maximize energy production, increase the lifetime of the equipment and ensure grid code compliance.

ABB's high-performance AC 800PEC controller ensures fast and precise control of the PCS6000's generator-side and grid-side converters. This enables maximum energy production, while,

at the same time, reducing the mechanical stress on the drivetrain. It also lays the foundation for grid code and fault ride-through compliance.

Motor operation for full-speed generator testing allows efficient testing of turbine components. It also enables precise rotor positioning which facilitates installation and allows easy and safe access to the turbine for maintenance.

# High reliability and availability

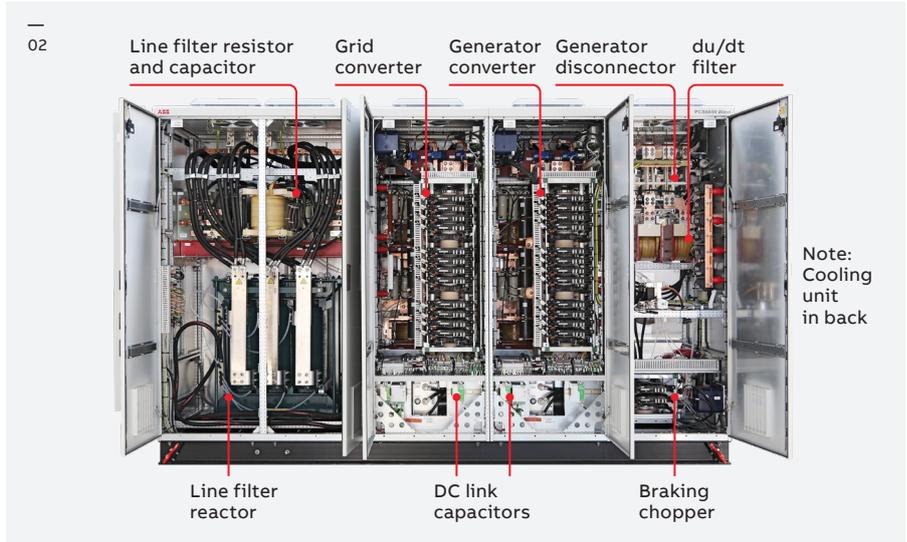
The PCS6000 provides reliable operation in the harshest environments thereby minimizing maintenance.

**Low parts count**

No paralleling of components for a higher reliability and a smaller footprint.

**Long-life components**

Extend component replacement intervals considerably, lowering the converter's life cycle costs.



**Easy maintenance**

Easy access to all converter components reduces the cost and time required for maintenance.

**Fuseless design**

Avoids site visits for fuse replacement after disturbances and ensures a remote restart after a cleared failure.

**Filterless design**

Increases reliability and efficiency when it comes to higher power ratings.

**Support and remote service tools**

Enhance the converter's reliability, availability and performance, reducing downtime and lowering LCoE.

02 Clear design with low parts count

03 Small cross-section of tower cabling

For large turbines, ABB's PCS6000 medium voltage technology is the right platform. Significantly lower currents result in a boost in efficiency, a lower parts count increases reliability, and a smaller footprint along with easy cabling and fast installation reduces CAPEX.

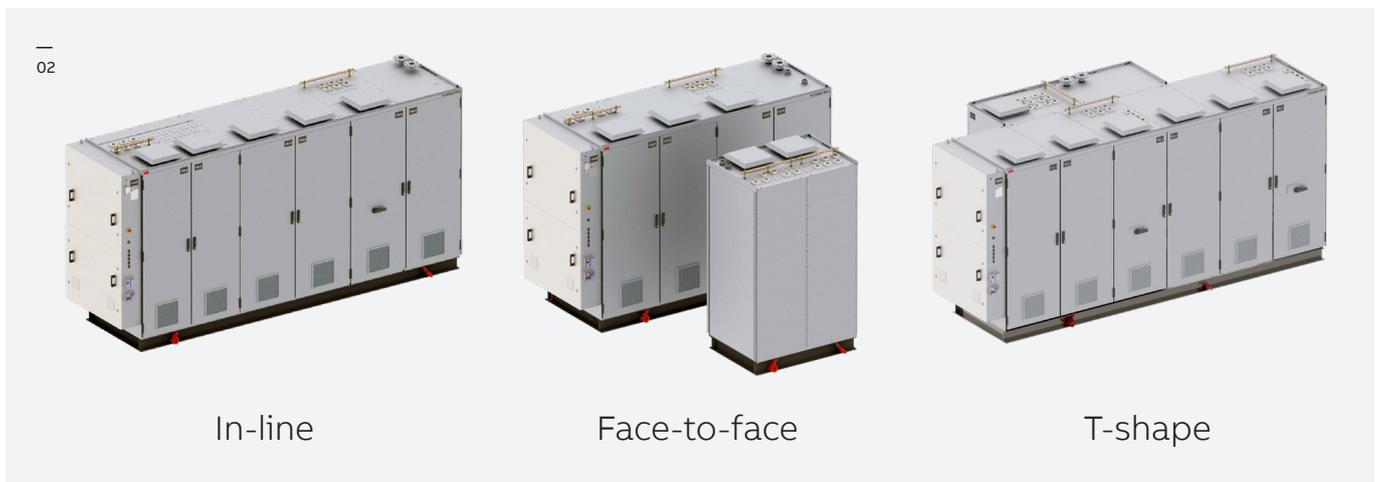
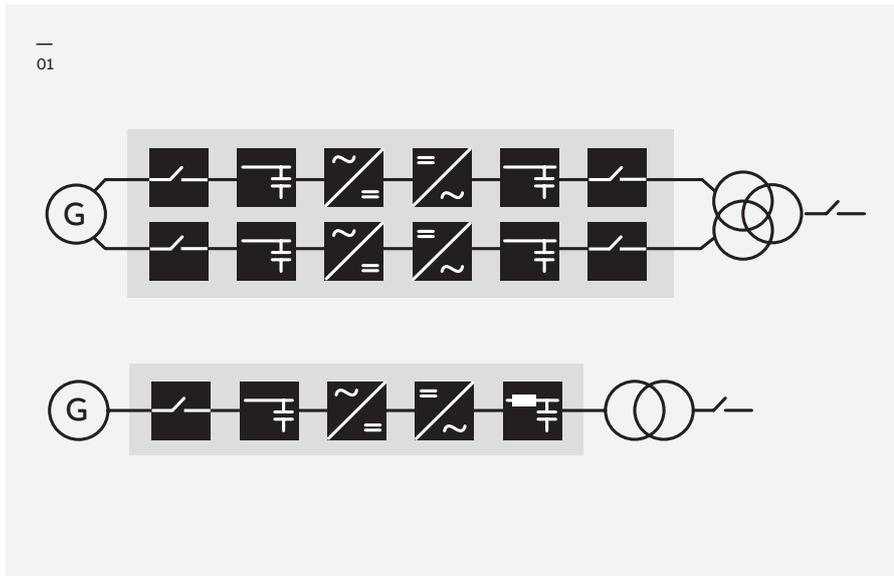
the PCS6000 is a market reference for long life and operational reliability.

It is the most sustainable, efficient and economic choice for top performance, grid stability and trouble-free operation.

With the emphasis on a well-balanced converter design and the use of high-quality components,

# Modular design for high flexibility

The PCS6000's modular design enables tower and nacelle installations and easy customization.



01 Standardized modules are easily combined for customized solutions up to 12 MW

02 The modularity permits a flexible arrangement of the converter modules even on a single deck – either in-line, face-to-face or T-shape

## Modular design for easy customization

The PCS6000 is a modular frequency converter that is ideal for demanding single- or multi-generator applications. The design concept allows maximum flexibility at different power ratings. Standardized modules can be combined for customized solutions with minimum prototyping and engineering effort.

## Fits confined spaces

The converter's modularity allows a tailored mechanical arrangement of the components, depending whether it is placed in the tower, the nacelle or a separate container outside the turbine. Placing it in the tower results in a reduction in nacelle weight and easier service access.

# ABB wind turbine drivetrain packages

ABB provides optimized electrical drivetrain packages, including generator and converter, that work in perfect synchronization.

ABB's drivetrain experts support turbine manufacturers in designing and dimensioning the drivetrain components and provide support in the grid code certification process.

## ABB generators

ABB has supplied more than 35,000 generators over the last 30 years to leading wind turbine customers worldwide. It offers a complete range of wind turbine generators, supporting all drivetrain concepts. ABB has been the leader in permanent magnet generator (PMG) technology since the 1990s.

The standard power range is from 1 to 12 MW, with generators available up to 20 MW and 15 kV.

ABB generators are designed for harsh operating conditions. The high performance insulation system and the rigid form-wound windings guarantee a long lifetime with high overload capability, even with the continuously changing loads common to wind turbines. The bearing construction is designed for reliable operation with long service intervals.

## Comprehensive testing

ABB is committed to ensuring the reliability of every wind turbine drivetrain package it delivers. To ensure that quality standards and customer requirements are fully met, the equipment is subjected to thorough testing and simulations in ABB's test facilities.

In addition, ABB is able to perform tests of the complete drivetrain to verify its performance and grid code compliance. This simplifies turbine certification and reduces on-site testing costs.

## Grid code compliance

The wind turbine converter plays a central role in the turbine's grid code compliance. The PCS6000 is subjected to fault ride-through and power quality tests to ensure grid code compliance. Comprehensive real-time simulations of typical grid disturbances are performed to ensure the PCS6000 can withstand grid disturbances and complies with all standards. This simplifies turbine certification and cuts on-site testing costs.



# Service and support

The PCS6000 is backed by comprehensive life-cycle services that ensure trouble-free operation and maximum availability.

ABB engineers not only work with turbine manufacturers during the design and converter specification phase, but provide their services throughout the entire life cycle of the converters.

## Installation and commissioning

ABB provides dedicated converter training for installation and commissioning for wind turbine manufacturers. ABB can support turbine manufacturers during installation and commissioning. Its certified commissioning engineers have extensive knowhow and experience.

## Technical support

ABB provides remote services for fast failure analysis as part of its maintenance program. On customer request, a 24/7 support line and on-site field support can be provided.

## Training

ABB provides a wide selection of wind turbine converter training to turbine manufacturers and wind farm operators.

## Preventive maintenance

Implementing ABB's converter-specific preventive maintenance schedules reduces the risk of failure and increases the lifetime of the converter, lowering overall operational costs. ABB's preventive maintenance kits contain all the genuine ABB spare parts needed for a specific maintenance task, simplifying preventive maintenance.

## Dedicated support and remote service tools

ABB's PCS Service Suite is an intelligent monitoring and service tool that allows trained and authorized customers to monitor wind turbine converters remotely, identify possible performance issues at an early stage and initiate service tasks.

The tool significantly enhances the converter's reliability, availability and performance, reducing unplanned downtime and lowering the levelized cost of energy (LCoE).



**Spares and consumables**

Having the right spare parts available at the correct locations needs to be well planned to ensure the highest wind turbine energy production. ABB can help plan spare part stocking throughout the life cycle of the wind turbine.

**Service agreements**

Depending on the needs of the turbine manufacturer or wind farm operator, ABB can bundle individual services in one contract. A contract can be made at any stage of the wind turbine converter's service life.

**Global network, local presence**

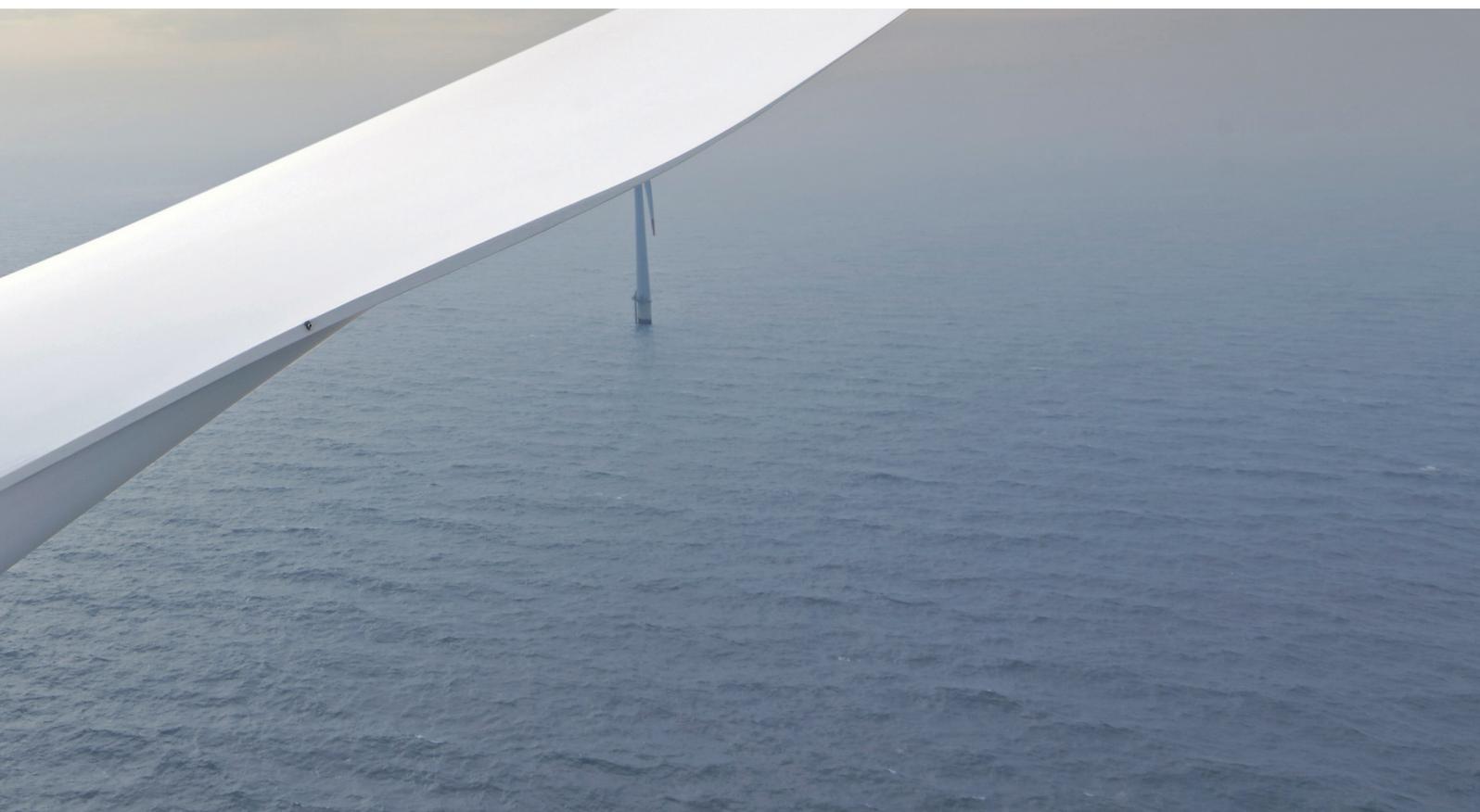
ABB's global presence and worldwide organization, with its network of selected partners, provide local support, training and services as and when required.

**Services for ABB wind turbine converters**

- Installation and commissioning
- Grid integration support
- On-site support
- Training
- Remote diagnostics
- 24/7 support line
- Maintenance
- Customized maintenance contracts
- Spare parts and logistics network
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**Benefits**

- Reduced down- and recovery time
- Lifetime extension of converter
- Enhanced operational efficiency
- Lowered capital expenditure
- Improved cost control



# Data sheet PCS6000

<b>Converter model</b>		<b>PCS6000 Wind</b>
Converter type	3-level, 4Q, VSI-NPC, fuseless design	
Power range	up to 12 MW	
Nominal voltage	3.3 kV	
Semiconductor type	IGCT	
Capacitors	Self-healing and self-protected film capacitors	
Supported generators	High-, medium- and low-speed permanent magnet generators, asynchronous induction generators, static-excited synchronous generators	
<b>Cooling</b>		
Converter cooling	Closed-loop cooling unit with deionized water / glycol mix coolant	
Coolant inlet temperature	Up to 45 °C <sup>1)</sup>	
Pumps	1 pump or 2 pumps with automatic changeover	
Heat exchanger	Water-air (external) / water-water (internal)	
Instrumentation / transmitters	Temperature, pressure, conductivity	
Deionization	Automatic by deionizer resin	
Deaeration	Automatic by deaeration valve	
Temperature control	Control logic / motor-driven valve	
<b>Braking chopper / resistor</b>		
Chopper semiconductor	IGCT	
Braking resistor capacity	15 MJ / 30 MJ <sup>2)</sup>	
Braking resistor size (LxWxH mm)	1160 x 670 x 660 / 1160 x 670 x 1030	
Braking resistor weight	~ 200 kg / ~ 400 kg	
Braking resistor cooling	Ambient air	
<b>Control</b>		
Controller	ABB	
Generator-side control	Pulse width modulation	
Grid-side control	Optimized pulse pattern	
Fieldbus interface	Profibus DP, Profinet IO, Modbus TCP, EtherCAT, CANopen	
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	Power factor / reactive power	
Special operation modes	Positioning / test / static VAR compensation / island mode	
Local control	Emergency off	
Local indication	Production, grid disconnecter closed, DC link switch closed / released, rotor locked	

<b>Electrical interface</b>	
Generator-side connections	From top (Pfisterer P3)
Grid-side connections	From top (Pfisterer P3)
Braking resistor connections	From back (Pfisterer P3)
Control connections	From bottom (terminals inside control cabinet)
<b>Enclosure</b>	
Constructional design	1.5 mm carbon steel, edge bended sheets on solid base-frame MNS system, riveted and bolted
Degree of protection	IP54
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
<b>Environmental limits</b>	
Ambient temperature	Transport -25 to +70 °C Storage -25 to +55 °C Operation -10 to +45 °C <sup>3)</sup>
Altitude	0 to 1000 m
<b>Product compliance</b>	
Product markings	CE (acc. 2014/35/EU, 2014/30/EU) DNV-GL (acc. GL-IV-2:2012) CGC (acc. CGC-R46022:2011)
Quality management system	ISO 9001:2008
Environmental management system	ISO 14001:2004
Occupational health and safety management system	OHSAS 18001:2007

<b>Example configurations</b>			
Power rating <sup>4)</sup>	7 MW / 8.5 MVA	10 MW / 12 MVA	12 MW / 14.5 MVA <sup>5)</sup>
Generator winding system	Single	Single	Double
Nominal generator voltage	3.3 kV	3.3 kV	3.3 kV
Generator-side voltage range	0 to 3.4 kV	0 to 3.4 kV	0 to 3.4 kV
Grid-side voltage range	0 to 3.4 kV	0 to 3.4 kV	0 to 3.4 kV
Number of IGBTs	12 + 12	12 + 24	24 + 24
Nominal generator-side frequency range	0 to 120 Hz <sup>6)</sup>	0 to 120 Hz <sup>6)</sup>	0 to 120 Hz <sup>6)</sup>
Grid-side frequency	50 or 60 Hz	50 or 60 Hz	50 or 60 Hz
Efficiency at converter's rated point	~ 0.98 %	~ 0.98 %	~ 0.98 %
Generator-side du/dt	< 1.5 kV/μs	< 1.5 kV/μs	< 1.5 kV/μs
Grid-side filter	Sine filter	du/dt filter	du/dt filter
<b>Dimensions</b>			
In-line arrangement (LxWxH mm)	4960 x 1280 x 2460	5160 x 1280 x 2460	5960 x 1280 x 2460
T-shape arrangement (LxWxH mm)	On request	4360 x 2100 x 2460	5160 x 2100 x 2460
Face-to-face (two cabinets) arrangement (LxWxH mm)	3550 x 1280 x 2450 1450 x 1080 x 2450	on request	on request
Back-to-back arrangement (LxWxH mm)	3550 x 2280 x 2450	on request	on request
Weight	~ 5300 kg	~ 6200 kg	~ 7300 kg
<b>Coolant connections</b>			
	DN80 from top	DN80 from top	DN80 from top
<b>Auxiliary supply</b>			
Auxiliary supply voltage	3-phase, 400 V, 50 or 60 Hz	3-phase, 400 V, 50 or 60 Hz	3-phase, 400 V, 50 or 60 Hz
Auxiliary supply power	~ 8 kW	~ 8 kW	~12 kW

**Notes:**

- <sup>1)</sup> Higher temperatures possible on request
- <sup>2)</sup> Other braking resistor capacities possible on request
- <sup>3)</sup> Other ambient temperatures possible on request
- <sup>4)</sup> Power rating indicative (depends on generator frequency, cooling and grid code requirements)
- <sup>5)</sup> Redundant version possible on request
- <sup>6)</sup> Other generator-side frequencies possible on request

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For more information, please contact  
your local ABB representative or visit

[abb.com/power-converters-inverters/wind-turbines](http://abb.com/power-converters-inverters/wind-turbines)  
[abb.com/windpower](http://abb.com/windpower)

PCS6000 webpage



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