

# PCS 6000 - Static Frequency Converters

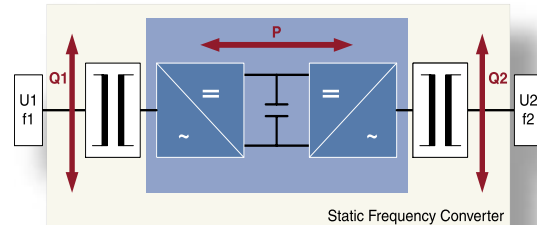
Modular Power Electronics



# Standardized high power network interconnections

ABBs compact PCS 6000 (Power Converter System) represents a quantum leap in high power technology, particularly in terms of technical performance and economic operation. The PCS 6000 is an efficient and effective power system package that is specifically designed to interconnect normally incompatible networks. The flexibility of the system allows it to be applied to a wide range of applications. The PCS 6000 is particularly competitive in terms of installation time and space requirements. Furthermore the high efficiency and low maintenance lead to low operational costs.

This new generation of modular high power static frequency converters is designed for applications of up to 32 MVA per unit. Higher powers can be achieved by easily paralleling multiple PCS 6000 systems.



*Schematic diagram of a static frequency converter*



## Typical applications of the standardized PCS 6000:

- Interconnecting networks with different frequencies
- Railway network interconnections and load balancing (connecting single-phase railway networks to the three phase grid)
- Electrical docking stations (e.g. in harbor applications for the different electrical systems of large ships)
- Special industrial applications (e.g. Dynamic Voltage Restorer or STATCOM functionality)
- Connecting special synchronous machines or processes to an existing network

## Independent reactive power control

In addition to the above-mentioned applications, the PCS 6000 static frequency converter can also be used as an independent reactive power control device in the two networks. The PCS 6000 can fulfill the reactive power requirements of both networks. The selection of the installation location is made much easier due to the high level of reactive power controlability. Furthermore, networks with a high harmonic content or asymmetrical loading can be coupled to the national grid. In such cases additional investment and space for filter and compensation components can be avoided by applying the PCS 6000.

## Case study: Reliability and availability

Since 2000 nine standard static frequency converters have been delivered and installed for the German railways (Deutsche Bahn AG). By the end of 2004 the converters had accumulated a total of 305 converter months of operation. With this operational data the availability and the reliability of the converter has been analyzed and verified.

The contractually guaranteed availability was exceeded by far.

**The mean value of the availability of all converters has been 99.99 %**



## Increased Customer Benefit.

- Low investment costs
- Short delivery and commissioning time
- Modest space requirements with minimum construction work
- Field-proven highest reliability due to low parts count and robust IGCT technology
- Minimum down times for service and maintenance
- State of the art diagnostics
- Easy menu-based operation
- Simple integration into existing protection schemes
- Compensation of asymmetrical loads through single-phase control
- Independent control of reactive power for both networks
- Energy management through load flow in both network directions
- Low operating costs due to high efficiency (also under partial-load conditions)

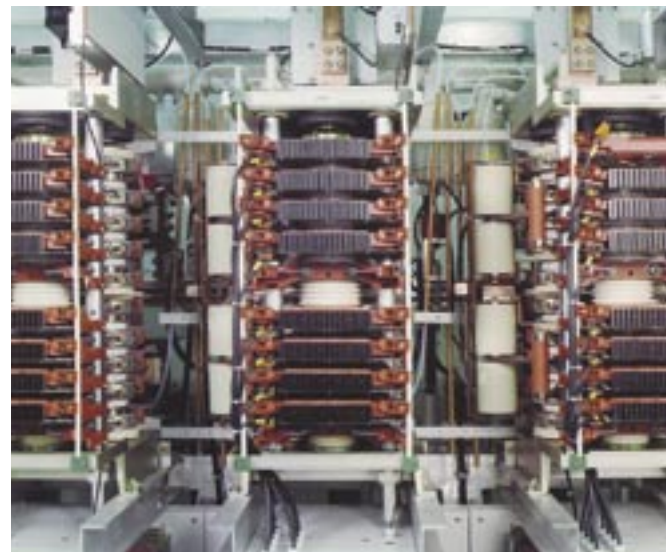
### Space savings

The PCS 6000 has an exceptionally high power density. Traditional thyristor or GTO converters require bulky and costly harmonic filters. Not only is the PCS 6000 designed to reduce the harmonics generated, but these filters can be down-sized by the application of a newly developed optimized pulse pattern in combination with the three-level IGCT converter design.

The converter is installed, along with other interface equipment, in a portable purpose built container having an optimized footprint, which also reduces the required construction work.

### Time savings

ABB has ensured that the design concept of the modular container system reduces the on site construction time to a minimum. The converter equipment is pre-assembled and tested to the highest standards, and is shipped to site as a container package ready for immediate installation. Thanks to the high degree of standardization, the defined interfaces and the menu based operations the on site commissioning work can be reduced to a few days. Due to the modular design the system even can be relocated to a new site within a short time.



### IGCT technology

The PCS 6000 uses advanced IGCT technology (Integrated Gate Commutated Thyristor) that has been developed by ABB from a proven bipolar semiconductor background (GTO). The PCS 6000 converters are based upon the IGCT PEBC (Power Electronic Building Block). This block can either be used as an H-bridge or as a two phase module. This standardization allows systems to be realized with lower engineering and design costs and therefore directly affects the customer's end costs.



### Operational savings

The most important factors for a cost effective operation are the efficiency, the reliability, the maintenance costs and the availability of the system.

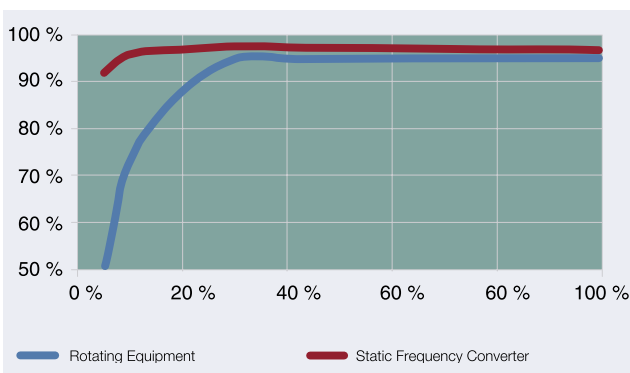
The efficiency of the PCS 6000 converter, especially under partial load conditions, is far superior to that of a rotating frequency converter solution (see block „Case study: Efficiency“). This has a major impact on the life cycle costs. The investment in a PCS 6000 converter already achieves a payback within a short time frame.

In addition the PCS 6000 converters have a field proven reliability due to the low parts count and the rugged IGCT technology. The unplanned downtimes of such an installation are infrequent and short. This combined with the low system maintenance requirements leads to an extremely high system availability (see block „Case study: Reliability and Availability“).

### Further saving potential

Each PCS 6000 frequency converter module functions as an independent unit with its own operating parameters and programming. This modular concept allows for an increase in the power handling capacity of a frequency converter site by installing several units in parallel. Thus the design allows for scalable power and for redundancy. Furthermore the supervisory control system can switch converters in and out under partial load conditions in order to optimize operating costs. The versatility of ABB's PCS 6000 converter and its modern technology open up new possibilities for network operators to devise new strategies with respect to energy management and cost structuring.

### Case Study: Efficiency



Efficiency comparison

Based on operational data from 2003 a comparison between a rotating frequency converter solution and a PCS 6000 used as grid coupling between the three phase power grid and the single phase railway grid has been made with respect to efficiency and costs.

The graph shows the efficiency of both solutions as a function of the load. The big advantage of the static converter in the partial load range is plain to see. Even under full load conditions a higher efficiency is achieved.

It is clear that the PCS 6000 achieves a major saving in energy costs, and therefore much lower life cycle costs than a rotating solution.

# ABB's leading converter technologies



## September 2000: Worlds largest DVR installation

ABB delivered and commissioned two of the world's largest Power Quality devices during the summer of 2000.

The main function of those devices is to compensate temporary voltage sags caused by disturbances and faults in the power grid. Such devices are commonly called Dynamic Voltage Restorers (DVR). What is unique with the devices described here is their rating, since each unit serves a load of up to 22.5 MVA. Since the installation these DVRs successfully compensated approximately 300 voltage dips per year and with that avoided costly interruptions to the customer's semiconductor manufacturing process.



## May 2002: Six Standard Converters as railway grid coupling

The railway converter station in Limburg, Germany feeds the 110 kV 16.7 Hz supply network of Deutsche Bahn AG and helps to secure the energy supply for the new high speed train line from Cologne to Frankfurt. The converter station enables power flow in both directions. The whole installation is remotely controlled from the power control centre in Frankfurt. For the first phase of the project ABB delivered six standard converter units as railway grid couplings for this converter station.



## September 2003: Worlds largest Battery Energy Storage System

In September 2003, the Battery Energy Storage System (BESS) for Golden Valley Electric Association in Fairbanks, Alaska went into operation. The BESS will automatically pick up 27 megawatts of load for 15 minutes (or 40 MW for 7 minutes) in case of a grid failure. Fifteen minutes is sufficient to start up and bring local generation online. ABB's scope of supply for this ambitious turn key project included the power electronics, the project management and the system integration. In the first 15 months of operation around 300'000 potential consumer outages have been avoided due to the installation.



## April 2005: Two 19 MW grid couplings with 32 MVA STATCOM functionality

AC arc furnaces are a major source of grid disturbances. The frequent interruption of the arc leads to strong voltage fluctuations and unbalance between phases. For this reason INCO was unable to use its own thermal power station to supply the nickel arc furnaces in its plant in Sulawesi, Indonesia. With the PCS 6000 it is now possible to exchange loads of up to 38 MW between the company-owned thermal and hydro grids. The converters additionally operate as 64 MVA STATCOM for the grid supplying the furnace. With the single phase control of the STATCOM it is possible to compensate the unbalanced load and at the same time supply the required reactive power to stabilize the grid voltage.

## Characteristics:

- Connection voltages from 6 kV to 220 kV
- Nominal power of up to 32 MVA (Single Module with continuous load)
- Simple combination of single modules in parallel for larger installations
- Continually adjustable power factor (capacitive and inductive)
- Frequency range from 5 Hz to 60 Hz
- Field proven availability of more than 99.5 %
- Overall efficiency (Including transformers) > 97.0 %
- Adjustable response time to sudden load changes or load asymmetries < 10 ms
- Change of the power flow direction typically possible within half a period
- Minimum maintenance work of one day per year
- Independent selection of operating modes for P/f, Q/V, variable and / or fixed frequency ratio
- Complies with all relevant IEC, EN, and railway authority standards
- Pre-equipped for data transmission via telephone modem or Internet
- Less than 200 m<sup>2</sup> footprint is required per converter system including transformers.



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