

# power



## Complete power

### **ABB launch the PCS100 Medium Voltage UPS – 06**

Designed for mega data centers and critical industrial processes

### **The DPA way – 14**

Why DPA increases UPS availability and lowers cost of ownership

### **Continuous power – 16**

Digital static transfer switches for increased data center reliability

### **Semiconductor protection – 22**

ABB provides power protection to HHGrace in China



Complete power protection at medium voltage? Absolutely. ABB launch the PCS100 Medium Voltage UPS. Watch the video [here](#).

# power



**Pedro Mendieta**

General Manager  
Power Protection, North America  
Discrete Automation and Motion division

On behalf of the Power Solutions family I would like to express our excitement in joining the Power Protection group where our products are a natural fit. Our US team in Richmond, Virginia designs and manufactures Cyberex® products for both industrial and data center environments. We also have an office in Verona, Wisconsin where field engineers with our service brand JT Packard operate from. Our teams are dedicated to providing mission critical power quality products and services for customers worldwide.

Our Cyberex® Industrial UPS products include single-phase UL/IEC UPS systems, industrial power distribution, inverter/static switches and float battery chargers targeting demanding environments found in oil/gas and power generation mar-

kets. The Cyberex® offering for data centers include digital static transfer switches, products for power distribution/remote power distribution and power management. The breadth our products is ideally suited for data center and critical plant protection. Our strong Cyberex and JT Packard service groups ensure that critical power equipment is maintained and serviced with trained and experienced field service technicians.

In this very busy edition of Power you will see that the entire global Power Protection team have been busy releasing new products.

### Product launches:

From the New Zealand based Power Conditioning team, the PCS100 Medium Voltage UPS was launched in China where the country's high technology industries rely on extremely high levels of power. Designed for complete power protection, ABB's PCS100 MV UPS has been targeted specifically to provide clean, reliable and efficient power, as well as lower cost of ownership for customers.

From the Swiss based UPS team the PowerValue 31/11 UPS system entered the market. PowerValue 31/11 T is a true double-conversion online uninterruptible power supply (UPS) that guarantees up to 20 kVA of clean, reliable power for critical single-phase applications. The online double-conversion topology delivers power to the load even in the presence of severe disturbances in the utility.

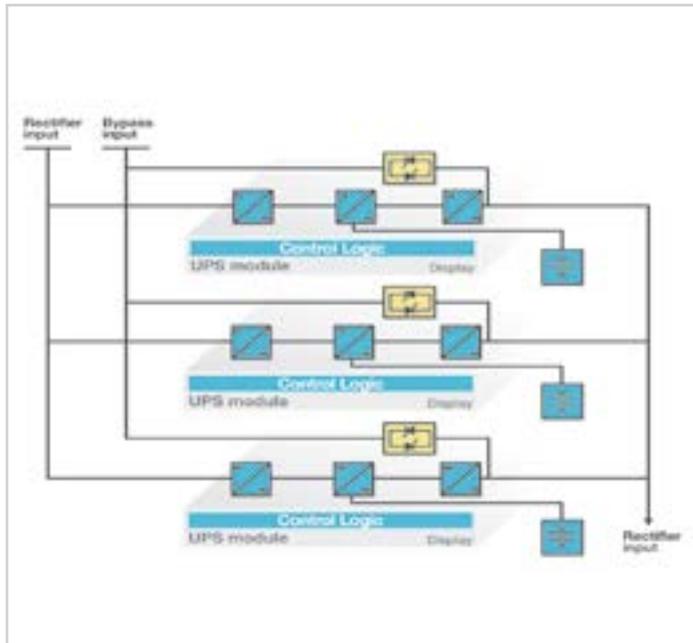
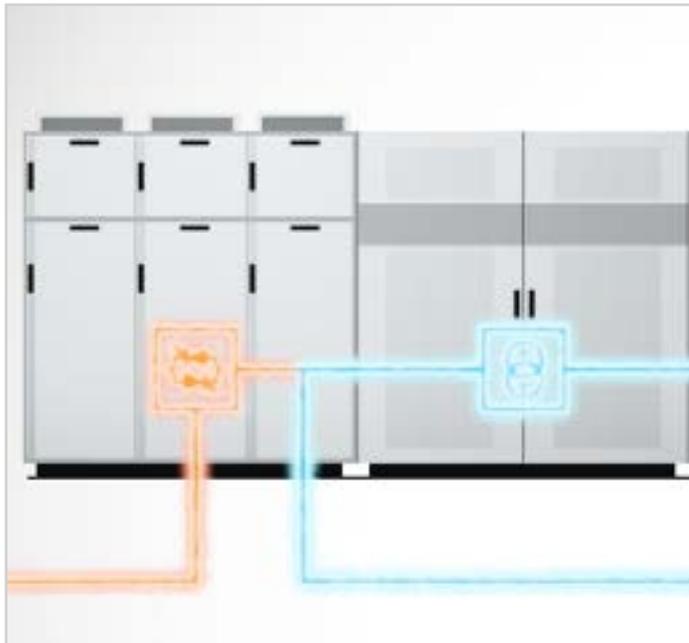
From our US based team the Cyberex® PowerBuilt™ Industrial UPS was launched. The new single-phase

Cyberex PowerBuilt industrial uninterruptible power supply (UPS) system has ratings from 10 kVA to 40 kVA and addresses demanding industrial applications typically found in the oil and gas industry.

Also included are several case studies that illustrate how our products are currently being used. The PCS100 Active Voltage Conditioners are conditioning power in Shanghai Huahong Grace Semiconductor Manufacturing Corporation ("HHGrace") in China. You can also read about the PowerWave 33 UPS improving protection levels, availability and reducing the cost of ownership for global reinsurer Munich Re. Additionally, the recently released PCS100 Reactive Power Conditioner has been applied to reduce current distortion and improve the power factor on ski lifts in Chile.

In response to a number of requests we have included more technical articles describing how our products work and how they can be effectively applied. Our US designed and built digital static transfer switches are reviewed in depth. These sophisticated units provide an ideal way to switch the load between two power sources and have become an established component of all mission-critical data center architectures.

I hope you enjoy reading this issue of Power.



# 06

## ABB launch the PCS100 MV UPS

For complete power protection

# 14

## The DPA way

Increasing UPS availability

### New products

- 06 ABB's PCS100 Medium Voltage UPS**  
Designed for mega data centers and critical industrial processes
- 11 PowerValue 31/11**  
A single-phase UPS with scalable runtime
- 12 Cyberex® PowerBuilt™**  
For system reliability and critical load protection

### Articles

- 14 The DPA way**  
Why DPA increases UPS availability and lowers cost of ownership
- 16 Continuous power**  
Digital static transfer switches for increased data center reliability

### Case studies

- 22 PCS100 Active Voltage Conditioner**  
ABB provides power protection to Shanghai's HHGrace
- 24 PowerWave33**  
Product excellence and lowest total cost of ownership deciding factors
- 25 Energy Storage Power Conversion System**  
Contributing to cost savings and environmental sustainability
- 26 PCS100 Reactive Power Conditioner**  
Improves power quality and reduces the cost of energy to the ski center La Parva in Chile



16

**Continuous power**

DSTS for increased data center reliability

22

**Semiconductor protection**

Case study: ABB provides power protection to HHGrace

24

**PowerWave 33**

Case study: Product excellence for Munich Re



Scan our QR Codes with your smart phone to find web links, videos, or event pages, providing further details about ABB's products or services. Scan the one on the left to subscribe to Insider. To use QR Codes with your smart phone camera, download a free QR Code scanner to your phone.



The Power converters and inverters playlist can now be found on the ABB YouTube channel.

Click [here](#) to watch the latest videos.

Latest Videos

[ABB's PCS100 MV UPS \(4.25 minutes\)](#)



[ABB's power protection video \(3.43 minutes\)](#)



Contact Us

[www.abb.com/pcs100-power-converters](http://www.abb.com/pcs100-power-converters)

**FOR** Power protection  
Grid interconnection  
Energy storage and grid stabilization

[www.abb.com/UPS](http://www.abb.com/UPS)

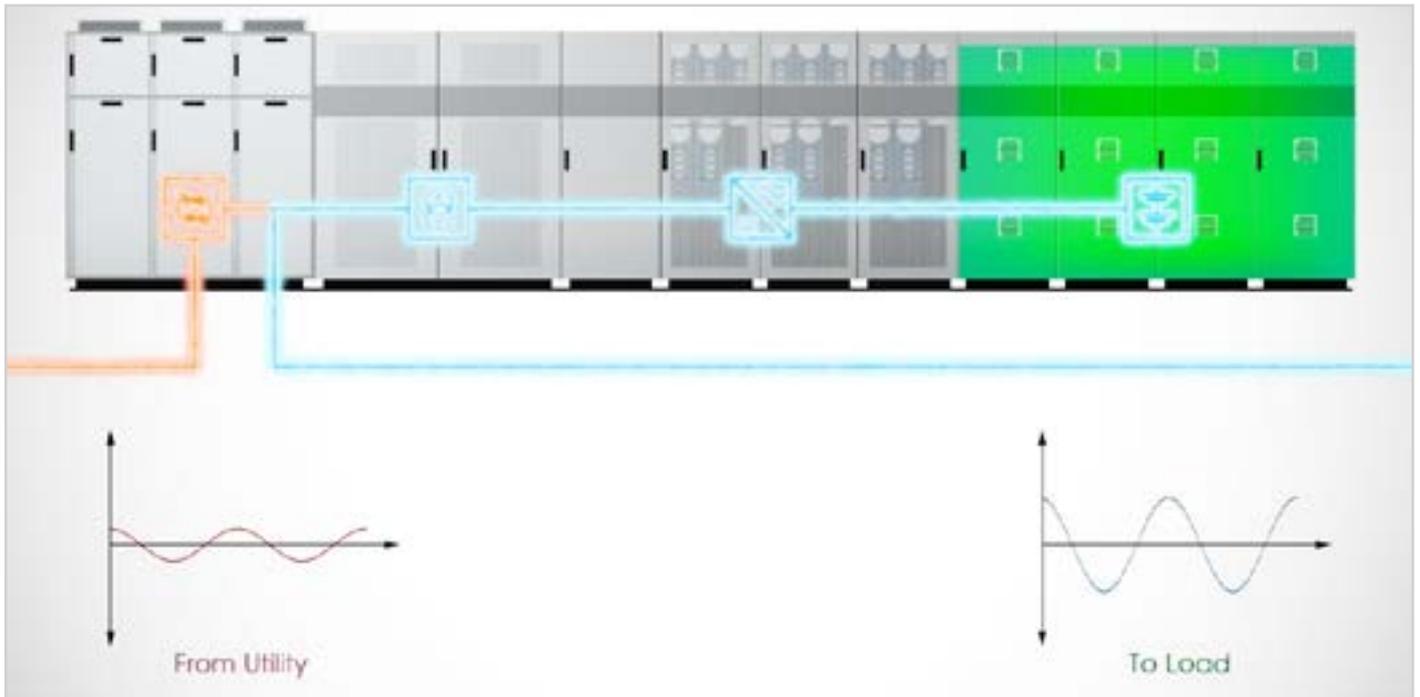
**FOR** UPS and Power Conditioning



# Complete power protection

ABB's PCS100  
Medium Voltage  
UPS.

Complete power protection has never been easier, thanks to the research and development efforts undertaken by ABB. ABB has launched the PCS100 Medium Voltage UPS (PCS100 MV UPS), designed for mega data centers and large critical industries. The PCS100 MV UPS has been targeted specifically to provide clean, reliable and efficient power, as well as lower cost of ownership for customers.



ABB's PCS100 MV UPS detects the sag and instantly takes over the load, continuing to supply the load with a perfect regulated voltage

The product was launched in China on June 18th, where the country's high technology industries rely on massive levels of power. "China is a key market for large UPS products where vast electronic systems in factories draw from tens to hundreds of megawatts of power," commented John Penny, General Manager for ABB's Power Conditioning Global Product Line. "Medium voltage becomes very useful for factory designers who can now locate the power protection equipment more remotely in a centralized location away from the production floors. At the same time, facilities can benefit from the improved reliability, efficiency, ruggedness and small footprint that were the focuses of our design team."

ABB already holds a strong market position in industrial power protection with a substantial installed base of the low voltage PCS100 UPS-I industrial UPS product. For many years these highly efficient and reliable products have protected some of the world largest semiconductor factories in China from voltage sags and outages.

Although the PCS100 MV UPS is industrially rated it is also targeted towards mega-size data centers, which are increasingly being developed to satisfy expansive growth in cloud computing and colocation services. "Mega data centers have very similar characteristics to semiconductor fabrication plants," John Penny noted. "They are equally large scale and both have highly critical loads, and similar electrical and environmental requirements. The trend towards free air cooling and centralized protection makes medium voltage UPS protection with an industrially rated product a very attractive solution."

The PCS100 MV UPS is also applicable for retrofits, allowing for custom designs that suit applications in plants that are currently unprotected or where traditional rotary UPS solutions require replacement. Because the energy storage is kept at low voltage levels, a wide range of energy storage options are available from traditional lead acid batteries to super capacitors and lithium ion batteries.

One of the challenges facing engineers who design is the limited fault current capacity of many traditional static UPS designs. The rugged fault and overload capability of ABB's medium voltage UPS allow for better electrical protection and discrimination, which in itself has a major impact of overall system reliability and availability.

Total cost of ownership is a major consideration when selecting power protection equipment. The PCS100 MV UPS was designed to minimize life cycle costs with very low loss and wide temperature range which reduce cooling costs. Where many commercial UPS have capacitors and other core components selected with a design life of five or fewer years, ABB has added some up-front cost by creating a design life more than 10 years. In terms overall lifetime cost, the reduced maintenance saving is huge. The very small footprint and ability to locate the product remotely from protected load also result in reduced ownership cost.

Download the PCS100 MV UPS brochure [here](#).

To find out more about ABB's PCS100 MV UPS solutions, please visit: [www.abb.com/pcs100-power-converters](http://www.abb.com/pcs100-power-converters).

For product information, email [powerquality.nz@nz.abb.com](mailto:powerquality.nz@nz.abb.com).



# PCS100 MV UPS now online



The PCS100 MV UPS video features animations and a build-up of the product from 2 MVA through to 6 MVA

Watch ABB's  
PCS100 Medium  
Voltage UPS video  
on YouTube.

ABB's PCS100 MV UPS video features animations of the product's technology including a build up of the system, from 2 to 6 MVA. Further features are, industry leading efficiency, modular design with integrated redundancy, very high fault current capacity and generator walk-in algorithm for a controlled transfer of the load to backup generators.

For data centers solutions, the PCS100 MV UPS can be installed into the electrical supply to protect the complete supply to the data center or alternatively just server or mechanical loads. Installing the UPS protection at medium voltage provides the most energy efficient configuration and allows the possibility of installation outside the main data center building. Using the PCS100 MV UPS to protect critical manufacturing processes ensures complete plant protection with the lowest operating costs. Retrofit is also possible by providing protection at the incoming medium voltage level.

Watch the PCS100 MV UPS video [here](#) on YouTube.

Watch the PCS100 MV UPS video [here](#) on ABB.

To find out more about ABB's PCS100 MV UPS marketing material, please click [here](#).



# PCS100 MV UPS

## 2,4,6 MVA



Designed for large manufacturing plants through to mega data centers, ABB's PCS100 Medium Voltage UPS is the solution for any high powered industry. With multi megawatt ratings, allows customers to choose the solution that best suits their applications.

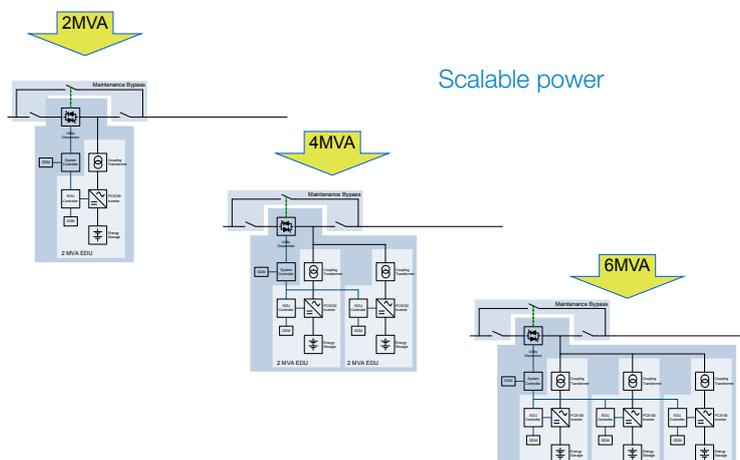


### Advantages

- Complete power protection: When installed at medium voltage levels, the PCS100 MV UPS can be put in less crowded spaces away from the target devices.
- Lowest total cost of ownership: The unparalleled efficiency of the PCS100 MV UPS, its minimized maintenance costs and small system footprint minimize ownership costs. The fact that the energy storage and converter is at the low voltage level also greatly simplifies maintenance and reduces system cost.
- Retrofit possibilities: The PCS100 MV UPS has many retrofit possibilities that allow custom designs that suit applications in plants that are currently unprotected or where traditional rotary UPS solutions require replacement.

### Scalable Solution 2,4,6 MVA

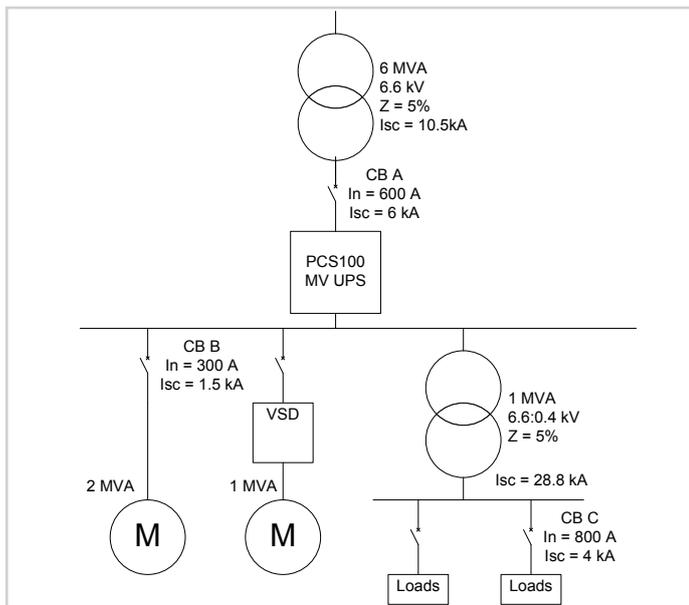
Add 2 MVA EDUs at a later date



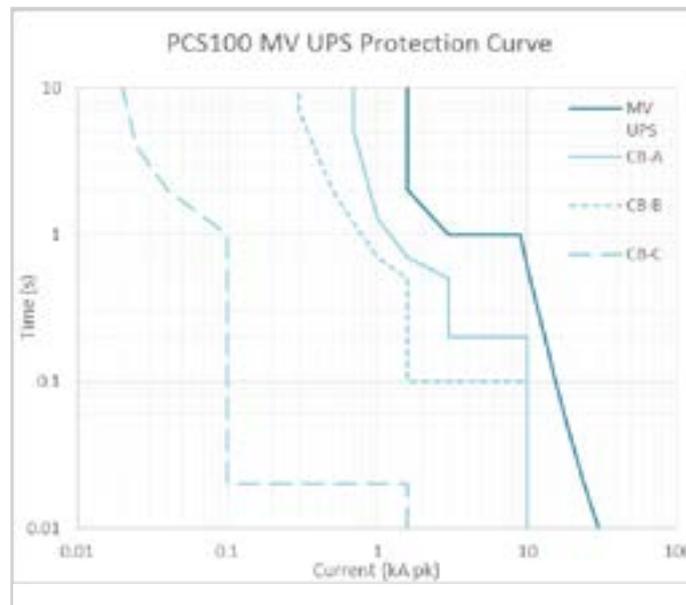
### Specifications

#### Technical details

Item	Value	
Nominal Voltage	6.6 kV	(to 15kV class stage 2)
Power Frequency Withstand	20 kV	
Basic impulse level (BIL)	60 kV	
Power	2, 4 & 6 MVA	(to 12 MVA stage 2)
Power factor (pf)	0.7 lag to 0.9 lead	
Autonomy (capacitors)	1 s	At 1.0 pf, valid for 15 years
Autonomy (batteries)	15 minutes	At full load
Event detection	<500 µs	
Transfer performance (under voltage)	Class 2	Per IEC 62040-3
Transfer performance (over voltage)	Class 1	Per IEC 62040-Comments 3
Maximum motor load	25%	Excludes motors on VSD
Efficiency	>99.5%	



A simplified MV critical process single line diagram (SLD)



This graph shows the PCS100 MV UPS and circuit breaker withstand times vs. current

# High fault rating makes circuit protection easy.

Installing power protection equipment does not always mean you need to redesign your circuit protection. The PCS100 MV UPS has a high fault current rating meaning circuit protection can operate as expected.

## The truth about UPS fault current levels

Not all UPSs can provide the necessary current levels to trip protection in the case of a fault. This often means a compromise is made when installing power protection equipment, or protection devices must be replaced for more sensitive types, adding cost and increasing the risk of nuisance tripping.

## PCS100 MV UPS Operation

ABB's PCS100 MV UPS uses robust semiconductor technology (manufactured by ABB) to connect the utility to the load. During normal operation it is this semiconductor switch that will conduct fault currents in the event of a downstream fault. Other UPSs may limit their current on the output. This current may be insufficient to trip the protection device, and isolate the fault, before the UPS must trip to protect itself. If the UPS trips, then all the loads are dropped, rather than just isolating the fault.

## What happens with faults in the LV network?

If a short circuit was to happen in a downstream LV branch, then the peak fault current will be limited by the step-down transformer. In the example SLD, a fault in one of the LV loads will result in 1.8 kA flowing in the UPS (300 percent current). The PCS100 MV UPS can tolerate this level of current with ample time for the LV circuit breaker (CB-C) to clear and keep the rest of the plant running.

## What happens with faults in the MV network?

At medium voltage the peak fault currents are limited only by the impedance of the upstream feeder. In the example SLD, a fault current of 10.5 kA will be flowing in the UPS if there is a fault in the MV motor or VSD. The PCS100 MV UPS can tolerate this current for up to 1 second, allowing time for circuit breakers to clear. If fuses are employed then higher fault levels can be tolerated due to the faster clearing time of fuses.

To find out more about ABB's PCS100 MV UPS solutions, please visit: [www.abb.com/pcs100-power-converters](http://www.abb.com/pcs100-power-converters).

For product information, email [powerquality.nz@nz.abb.com](mailto:powerquality.nz@nz.abb.com).



# PowerValue 31/11

Up  
to  
**4**  
UPSs in  
parallel



Up  
to  
**4**  
battery  
cabinets in  
parallel

## A single-phase UPS with scalable runtime.

PowerValue 31/11 T is a true double-conversion online uninterruptible power supply (UPS) that guarantees up to 20 kVA of clean, reliable power for critical single-phase applications. The online double conversion topology delivers power to the load even in the presence of severe disturbances in the utility.

ABB's new compact PowerValue 31/11 T UPS incorporates all the features necessary to deliver reliable power, low running costs, long battery life, easy maintenance and full flexibility for the user. Available in tower format, this UPS features double conversion, voltage and frequency independent (VFI) topology that protects against all supply failures. 10 and 20 kVA versions are available – and up to four units can be configured in parallel to boost power capability or provide redundancy.

Three-phase or single-phase inputs can be accommodated and this choice is configurable in the field for maximum flexibility. Further, the PowerValue 31/11 T UPS can handle single or dual inputs – allowing the customer to manage two independent power sources. The integrated manual bypass switch simplifies maintenance and reduces need for external switchgears. The UPS unit can operate as frequency converter (50 Hz to/from 60 Hz).

The compact solution offers different autonomy variations with in-built batteries or additional battery cabinets. With internal batteries the UPS can achieve 5-16 min runtime. Simple to install and with a small footprint, the PowerValue 31/11 T produces stable, regulated, transient-free, pure sine-wave AC power with extremely tight output voltage regulation.

The new PowerValue 31/11 T from 10 to 20 kVA will replace the former PowerValue UPS system from 7.5 to 20 kVA

For more information visit: [www.abb.com/ups](http://www.abb.com/ups).



# UPS technology

## PowerBuilt UPS offers faster and more accurate fault detection.



**The new Cyberex® PowerBuilt™ industrial uninterruptible power supply (UPS) features a proprietary amplitude detection control design resulting in faster, more accurate fault sensing for system reliability and critical load protection.**

The Cyberex PowerBuilt is a true online double-conversion industrial UPS designed to support the continuing demand from downstream refining and petrochemical processing, upstream oil and gas processing, power generation, and the growing regulatory and safety needs of today's industrial complexes. The PowerBuilt™ Series UPS is designed to UL 1778 safety and IEC 62040-3 performance standards, therefore, it can be scaled to meet changing electrical requirements and is adaptable to the most stringent technical specification.

The newly developed intelligent control logic internal to the Cyberex PowerBuilt industrial UPS, is the silent sentry that continuously safeguards the system to ensure uninterrupted operation.

The Cyberex PowerBuilt industrial UPS is equipped with an unmatched user interface with full-color touch screen graphical user interface (GUI) for self-guided serviceability with minimal engagement, as well as the latest communication protocols. It also features a patented digital static transfer switch design, which enhances system performance through increased redundancy and reliability. The fully rated switch provides better protection of critical loads from input power transients and interruptions by eliminating any single point of failure.

The conventional zero-crossing methods used for fault detection require multiple measuring periods that must be computed over phase noise. The PowerBuilt Series' UPS phase-locked loops (PLL) control system is a proprietary correlation method that enables precise measurements of an input/output waveform, resulting in shorter measurement periods and rapid reaction to protect the critical load during a power quality event.

The threat of lost production or the possibility of damage to work in process is a central manufacturing concern. The Cyberex PowerBuilt industrial UPS features an innovative insulated gate bipolar transistor (IGBT)-based pulse-width modulation (PWM) inverter design that employs active current limitation for higher short circuit tolerance. The active short-circuit method ensures the best possible current clearing waveform, while still protecting the inverter from catastrophic failure. In the event of a load side short circuit or over-current that cannot be supplied by the inverter, the UPS logic will transfer away from the active inverter source, thereby preventing the fault condition from damaging the inverter.

For more information visit:

[www.tnbpowersolutions.com/cyberex\\_powerbuilt\\_industrial\\_ups](http://www.tnbpowersolutions.com/cyberex_powerbuilt_industrial_ups).



# New – ABB power protection video



ABB offer UPS and power conditioning solutions for every commercial or industrial application

Need power protection for your business? Watch ABB's UPS and power conditioning video [here](#).

In March this year, Thomas and Betts power solutions team was integrated into ABB's Power Protection product group. The already existing group consisted of commercial and industrial UPSs, along with power conditioning products such as the PCS100 Active Voltage Conditioner and the PCS100 Reactive Power Conditioner.

ABB has produced a video outlining the various power protection solutions available and how these solutions provide continuous and seamless operation to your business.

Watch ABB's power protection video [here](#) on ABB.  
Watch ABB's power protection video [here](#) on YouTube.

For more information contact your local ABB representative or visit: [www.abb.com/ups](http://www.abb.com/ups).



# The DPA way

Why decentralized parallel architecture (DPA) increases UPS availability and lowers cost of ownership.

The fact that an enterprise installs an uninterruptible power supply (UPS) in the first place shows they are concerned that their critical load is assured a continuous source of clean power. Once the UPS is installed, however, it itself becomes a focus of reliability – for what use is it if it fails just when it is needed? In many cases, the result of a UPS failure can be catastrophic – imagine a large data center, for instance, going offline and the chaos that could cause to credit card companies, banks or other organizations. For this reason, the most critical loads are protected by the very best UPS design - decentralized parallel architecture (DPA). DPA not only provides the best availability, but also the best serviceability, scalability and flexibility. Taken together, these features all deliver a low total cost of ownership (TCO).

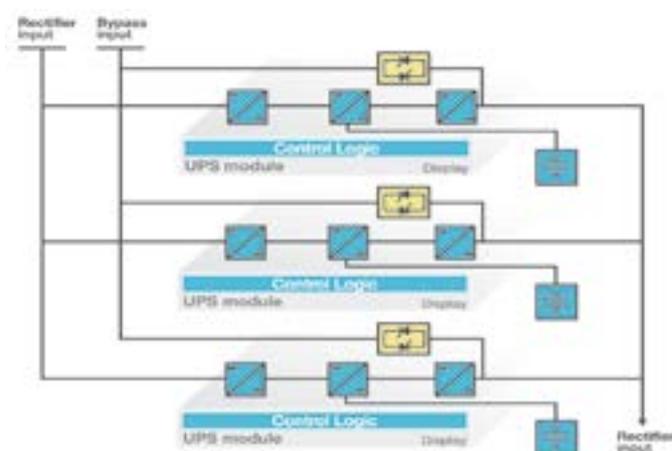
## Availability

Availability is a measure of how much time per year a system is up and available, and is one of the most important reliability parameters for IT equipment. Power availability is the most significant single component of a system's availability and is a measure of how much time per year a computer system has acceptable power. Since power problems are the largest single cause of computer downtime, increasing power availability is the most effective way to increase overall system availability.

Power availability has two components: mean time between failures (MTBF) and mean time to repair (MTTR). Therefore, two most important issues in increasing power availability are increasing the MTBF and decreasing the MTTR of the power protection system.

## DPA architecture

UPS systems with a centralized parallel architecture (CPA) have some degree of hierarchical, centralized control or hardware (e.g. static bypass). This renders them vulnerable should a fault occur on one of these centralized components; one fault can bring down the



Each UPS module has all the hardware and software it needs for autonomous operation; there are no shared critical elements

entire UPS. With DPA, on the other hand, the UPS is modularized and each module has all the hardware and software needed for autonomous operation - rectifier, inverter, battery converter, static bypass switch, back-feed protection, control logic, display, and mimic diagram for monitoring and control. A module's output is not affected by failures elsewhere in the UPS. If redundancy is provided for, i.e. there are more modules than needed to supply the critical load, then one or more modules can be lost without jeopardizing the load. In other words, a multimodule system is fault tolerant and there are no single points of failure. Availability is maximized.

The only UPS elements common to all modules are contained in the mechanical frame that accommodates the UPS modules - I/O connection, customer interface signaling, maintenance bypass and, in some models, a system display. These elements are non-critical for UPS operation.

## DPA - load transfer and load sharing

The CPU in each UPS module continuously monitors the status of its inverter, bypass and loading, and shares this information with the other CPUs. In the event of a fault, the CPU of each module reports the availability of the module's inverter and bypass to the module system logic. Based on this information, the modules then usually come to a unanimous decision as to whether the critical load should remain on the inverter or be transferred to the bypass. On rare occasions, one or more modules might deviate from the majority decision, in which case the majority decision stands. In the case of a split vote, the loads remains on the inverter as it is a more reliable source than the raw mains power supply.

It can be seen that all modules have equal decision-making power and none of the CPUs is master.

When it comes to load sharing, the situation is different. Here, one module is designated as the master and all the remaining modules are slaves. Cross-currents between the modules must be avoided in order to ensure a good supply quality so the master's control circuit continuously monitors the current in each module and, if it has deviated from what it should be, a message is sent to the relevant modules to regulate their current. Should a master module fail, the next module takes over as master.

These DPA decision making and load sharing features are at the core of DPA's ability to maximize system availability.

### Modularity and redundancy

The surest way to increase availability of power is to optimize the redundancy of the UPS system and to minimize its maintenance and repair time. One major advantage of DPA's modularity is the ease with which redundancy can be accommodated.

If N UPS modules are needed to cover the power needs of a particular critical load, then, often, one extra module is used so that even if one module subsequently fails there are still enough healthy modules left to power the load. This is called N+1 redundancy. Of course, an entire second set of N modules could be held in reserve – this is even more reliable and is called 2N redundancy. To further improve reliability one module extra could be added to each set, giving 2N+1 redundancy, and so on, though 2N+1 is usually quite sufficient to cover most premium reliability and availability requirements.

### Scalability

As UPS power requirements change – if a data center is expanded for example – the modular nature of DPA makes it really easy to add modules and increase the power capabilities. So, you don't have to overspecify the initial configuration to cater for future expansion, you just add modules when needed. This means that you only cable, power and cool what you need. Power consumption is the topic of greatest concern for most operators and the energy savings made by the modular approach over the service life of the UPS are substantial.

### Hot-swapping and serviceability

Modules can be hot-swapped, i.e. removed or inserted, without risk to the critical load and without the need to power down or transfer to raw mains supply. This unique aspect of modularity directly addresses continuous uptime requirements, significantly reduces MTTR, reduces inventory levels of specialist spare parts and simplifies system upgrades. This approach pays off too when it comes to serviceability and availability. Online swapping of modules means you do not have to switch off during replacements, so there is no downtime and the service personnel do not need special skills. Spares can be held on-site or at a nearby service center. Not only does this improve availability but it also reduces cost as service engineers spend less time onsite, and any risks of data or production loss are minimized. Inventory levels of specialist spare parts are reduced, too.

This online-swap technology, as well as having a significant impact on cost, can also help achieve six nines (99.9999 percent) availability - highly desirable for installations in pursuit of zero downtime.

### Energy and space costs

The modularity and scalability described have a major positive impact on achieving a low cost of ownership, but costs are held down too by DPA designs that have best-in-class energy efficiency. ABB's Conceptpower DPA 500, for example, operates with an efficiency of up to 96 percent. Its efficiency curve is very flat so there are significant savings in every working regime. Further, cooling costs can be substantial and, because less power is consumed, high-efficiency modular UPSs require less cooling effort, creating further savings.

Modularity lends itself well to keeping UPS footprint small, too, which is ideal where real estate is limited and expensive. A modular UPS rack has a small footprint and when extra modules are added, no extra floor space is taken up.

### Standardized modules

DPA modules are standardized which keeps costs low. A straightforward, standardized modular concept simplifies and speeds every step of the deployment process - from planning, through installation and commissioning to final use. High-quality standardized products significantly reduce intervention time during maintenance or in the event of failure. Components can be changed quickly and easily and service is simplified.

The better quality that results from the mass production and testing of standardized modules has a direct positive impact on reliability and, thus availability. Modular systems with standardized connections can be pre-wired and field-configured at the factory allowing for more thorough testing, and standardized connections reduce the risk of bad connections in the field – one of the biggest problems during any electrical commissioning. In addition, modular components can be returned to the manufacturer for service, which greatly improves repair quality. The ability to perform factory repair is a significant reliability advantage that leads to a future higher availability of the repaired unit.

### DPA

Highly dependable UPSs are increasingly mission-critical for many parts of industry. DPA delivers unparalleled UPS availability and the serviceability, scalability, flexibility and low energy usage made possible by the modular DPA approach deliver a very attractive TCO. There are no better UPS architectures available to those users whose critical electrical loads represent a valuable commercial asset that must be kept powered at all costs.

For more information visit: [www.abb.com/ups](http://www.abb.com/ups).





# Continuous power

Digital static transfer switches for increased data center reliability.

The information flowing through data centers is, in many cases, essential to the smooth running of modern society. For this reason, it is vital that a data center is available at all times. The power grid cannot always be relied upon, and, consequently, every data center has a backup power scheme. When the grid power degrades or disappears this fact must be instantly rec-

ognized and the backup power must be brought in so quickly that the changeover is invisible to the data center. Static transfer switches provide an ideal way to do this and these sophisticated products have become an established component of all mission-critical data center architectures.

(“preferred” and “alternate”) that remain isolated from each other in all operating modes.

The power quality (PQ) on each source is continuously monitored in terms of its voltage, phase and waveform. If a source’s PQ falls outside user-defined limits for a set period of time, the DSTS makes the decision to transfer to the other source. Typically, the switching time from the detection of an anomaly to completion of the transfer is one-quarter of a voltage cycle, or about four milliseconds. The switching technique employed is an open transition or “break before make” transfer. In this way, a data center load can be protected from even very short interruptions, or from any surges or sags in the primary power source.

ABB’s DSTS discussed in the subsequent sections are three-phase units operating between 100 and 4,000 A, at 208 to 600 V → 1.

## 1 An ABB DSTS



**A** transfer switch is an electrical device that switches a load between two power sources, either manually or automatically. Thirty years ago, Cyberex, a member of the ABB Group, revolutionized power distribution with its invention of the digital static transfer switch (DSTS). Since then, Cyberex has installed more units than any other manufacturer. ABB’s DSTS uses power semiconductors, specifically silicon-controlled rectifiers (SCRs), as high-speed, open-transition switching devices to deliver quality power to a customer’s critical load. “Digital” refers to the technologies implemented – namely, digital signal processing (DSP) hardware and patented software that performs real-time analysis of the source waveforms and logic control of the DSTS.

### Basic STS characteristics

ABB’s two-source DSTSs are designed to power mission-critical loads where continuous conditioned power and zero downtime are required [1,2]. The DSTS is fed by two independent power sources

To make the device maintainable without causing downtime, the design of the ABB DSTS includes plug-in style molded case switches (MCSs) that provide isolation for regular maintenance and guided bypass. The MCS provides short-circuit interrupt capability, while eliminating nuisance tripping arising from the lack of an overload trip element. A traditional two-source DSTS incorporates six MCSs: two for source inputs (isolated), two for bypass (maintenance) and two parallel MCSs at the output to ensure no single point of failure through the switching elements and to electrically isolate the SCRs when maintenance is required → 2.

### Reliability

The features described above are not the only aspects that enhance ABB’s DSTS reliability:

- Type II rated SCRs provide optimal fault clearing capability that coordinates with upstream protection.
- Redundant output switches prevent a single point of failure.

- Infrared ports allow thermal monitoring of critical load connections, without introducing risk by removing equipment panels.
- Redundant power supplies prevent logic failures.
- Redundant cooling fans with failure sensing avoid overheating or load loss due to fan failure.
- Shorted SCR detection prevents load loss should an outage occur.
- Downstream fault detection and isolation prevents the propagation of high-current faults to other upstream distribution systems.

**The STS is fed by two independent power sources that remain isolated from each other in all operating modes and each source’s voltage, phase and waveform is continuously monitored.**

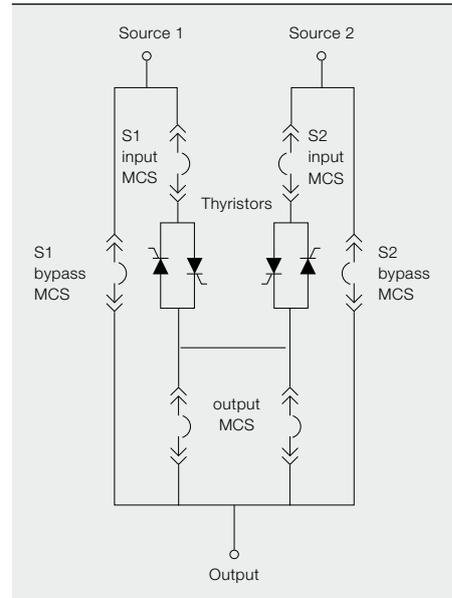
In addition, since 2004 an availability of 99.9999 percent, or six nines, has been observed for the DSTS. Further, it displays an operating efficiency of 99.60 percent at half load and 99.73 percent at full load.

### Title picture

The ABB digital static transfer switch can instantaneously transfer power sources discretely when the preferred source falters in any way. The end result is continuous conditioned power to a data center’s critical load.

With dynamic inrush restraint enabled, peak inrush current can be limited to less than 120 percent of the peak full-load current of the transformer.

## 2 Single-line diagram of a typical six-MCS STS



### Data center availability

In today's business environment, data centers are required to operate at extremely high reliability and efficiency levels. Data center availability, a metric known as "nines" → 3, is generally expressed as:

$$\text{Availability} = \frac{MTBF}{(MTBF+MTTR)}$$

where:

*MTBF* = mean time between failures = uptime

*MTTR* = mean time to repair = downtime.

Thus, as reliability and maintainability increase, so does availability. The need for a common standard to classify data centers' reliability and maintainability became apparent in the mid-1990s. To address this, the Uptime Institute developed a four-tiered classification benchmark that has been utilized since 1995 → 3.

### Data center architecture – DSTS relevance

Some simple configurations seen in data centers can highlight the importance and flexibility of the DSTS.

#### Parallel redundant (N+1) design

In general, an N+1 redundant design consists of paralleled UPS modules of the same capacity and configuration connected to a common output bus → 4a. The configuration is considered N+1 redundant if a system (N) has at least one additional autonomous backup element (+1). The extra UPS module gives better availability than the N configuration and the structure makes expansion easy

should facility requirements increase. The configuration does, however, have some disadvantages:

- Single point of failure with common load bus and single-corded loads
- Faults will propagate through each parallel redundant module
- Low efficiency due to light loading on the UPSs
- UPS modules must be the same rating

#### Distributed redundant design

A distributed redundant, or "catcher," design boasts independent input and output feeds from three or more UPS modules that are coupled with two or more STSs → 4b. Advantages compared with parallel redundant (N+1) architectures are:

- High availability at a lower cost
- Higher efficiency than parallel redundant and 2(N+1) designs
- Increased number of points of conditioned power, through UPS and DSTS
- Faults will propagate through one UPS module only
- Reduces single points of failure

The disadvantage is:

- DSTS cannot support multiple, concurrent UPS failures.

#### System plus system redundant with no STS (2N)

System plus system redundant (2N) topologies are the most reliable, and most expensive designs in the data center

### 3 The four-tier classification of data centers

Tier level	Availability (%)	Downtime (hr/yr)	Average downtime over 20 years	Common names	Requirements
Tier I	99.671	28.82	96.07	N	Nonredundant capacity components and single, nonredundant distribution path to server loads
Tier II	99.741	22.69	75.63	Parallel redundant N+1	Redundant capacity components and single, nonredundant distribution path to server loads
Tier III	99.982	1.58	5.26	Distributed redundant	Redundant capacity components and redundant distribution paths to server loads
Tier IV	99.995	0.44	1.46	System plus system multiple parallel bus 2N, 2N+1, 2N+2	Multiple isolated systems containing redundant capacity components and multiple, active distribution paths to server loads

The ABB DSTS can be applied as a two- or three-source utility switch for higher-availability applications.

world → 5a. Typically, dual-corded loads are implemented. Advantages are:

- Separate power sources and paths eliminate single points of failure throughout the architecture
- Redundancy throughout the entire system
- Ability to service upstream equipment like switchgear without going into bypass mode
- Continuous conditioned power

The disadvantages are:

- High cost and large footprint
- Less efficient due to being lightly loaded
- Does not maintain power to both inputs of a dual-corded load in the event of UPS failure

#### System plus system redundant with STS

By definition, Tier III and Tier IV systems supply continuous power to redundant dual-corded loads. However, they do not provide redundant power availability to dual-corded loads that require quality power to not just one, but both cords continuously. One way to provide this supplementary reliability is by applying STSs → 5b.

The advantages of this approach are:

- Highest level of availability
- Continuous, multiple points of conditioned power
- Separate power sources and paths eliminate single points of failure throughout the architecture (redundant throughout)

- Ability to service upstream equipment, like switchgear, without going into bypass mode
- The STS provides redundancy for dual-cord loads and protects against either source failing
- Effectively removes power quality issues upstream without causing a disturbance downstream

The disadvantages are:

- High cost and large footprint
- Low efficiency due to light loading on the UPSs

#### Upstream comparisons

Upstream, there will typically be a utility and backup generator, which are switched by an automatic transfer switch (ATS) → 6a. Though low-cost, this solution involves longer contact transfer times, delayed power generation startup and unpredictable generator performance.

ABB's DSTS can be applied as a two- or three-source utility switch for higher-availability applications → 6b. The probability of a simultaneous power outage on a fully redundant, dual-feed system is relatively low. By implementing two independent feeds from separate substations, ABB's DSTS can provide protection, switching power and speeds, and plant-wide distribution efficiencies superior to ATS. Cyberex has installed numerous large DSTSs at power entry points in data centers and industrial facilities. Though

Digital signal processing hardware and patented software performs real-time analysis of the waveforms and STS logic control.

4 Parallel redundant (N+1) design with 4 loads vs. distributed redundant “catcher” design

Parallel redundant (N+1) UPS – single-corded load	
Availability (%)	99.976 (three nines)
Downtime (h/yr)	2.08
Power interruptions/20 yr	6.95
Cost (\$)	1.7 million

4a (N+1) design

Distributed redundant catcher with STS – single-corded load	
Availability (%)	99.976 (three nines)
Downtime (h/yr)	2.10
Power interruptions/20 yr	6.99
Cost (\$)	1.28 million

4b Distributed redundant “catcher” design

5 System plus system redundant with no STS vs. system plus system redundant with STS

Dual UPS – dual-corded load	
Availability (%)	99.987 (three nines)
Downtime (h/yr)	1.12
Power interruptions/20 yr	3.73
Cost (\$)	460,000

5a System plus system redundant with no STS (2N)

Dual UPS with STS – dual-corded load	
Availability (%)	99.99999 (seven nines)
Downtime (h/yr)	0.0005
Power interruptions/20 yr	0.0017
Cost (\$)	540,000

5b With STS (2N)

UPS = uninterruptible power supply / PDU = power distribution unit

more expensive than the ATS approach, and requiring two utility sources, the DSTS approach has many advantages, including:

- Highest level of upstream availability
- The DSTS removes all power anomalies propagated from the utilities and distributes continuous power to all downstream components
- Ability to service one utility source while providing continuous conditioned power from a second utility source
- Extremely high electrical distribution efficiency levels

- Flexibility to add a third source (eg, backup generator)
- Lower cost than UPS

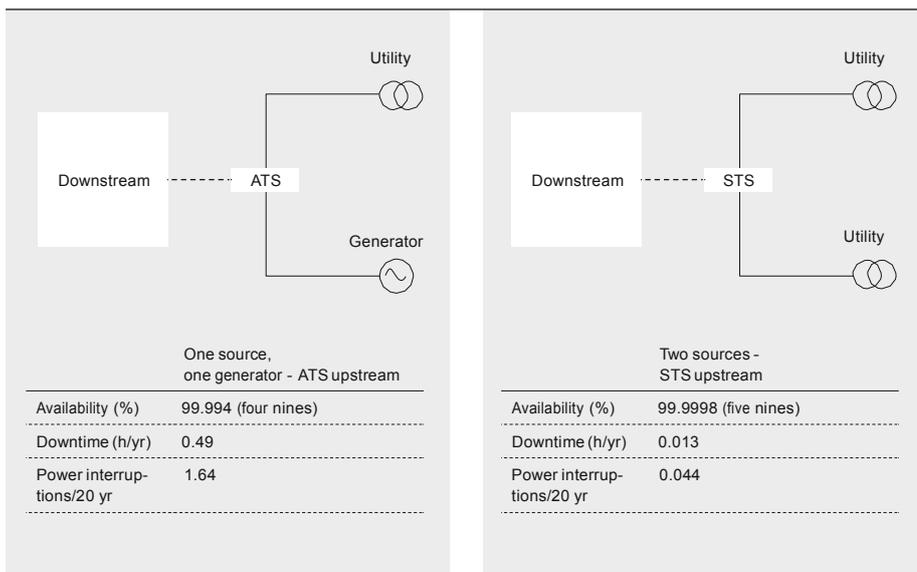
Digital STS advanced features

Apart from the advantages described above, the DSTS has further features worth noting.

Dynamic inrush restraint (DIR)

DIR limits downstream transformer inrush current when switching between two sources that are out of phase. This is done by continuously monitoring the transformer flux and precise timing of

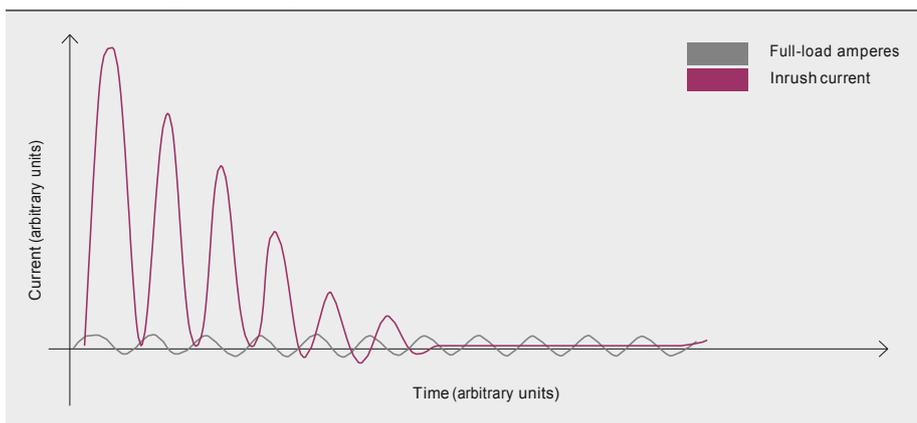
## 6 Upstream comparisons



6a Utility and generator with ATS

6b Dual-utility source with STS

## 7 Transformer inrush current (can be up to 7,200 A for a full-load Ampere value of 600 A) when not using the DIR algorithm.



the transfer so the flux does not exceed the saturation point of the transformer's core. Energizing a transformer results in a potential peak inrush current of 5 to 12 times full-load ampacity (FLA); transferring between out-of-phase sources results in a peak inrush current of up to 20 times FLA → 7.

With DIR enabled, peak inrush current can be limited to less than 1.2 times full-load current of the transformer.

### PQ/sensing algorithms

Two DSPs sample the sources 10,000 times per second and utilize patented algorithms to detect source disruptions and failures in less than 2 ms, thus enabling transfers within a quarter cycle.

### Smooth transfer

The DSTS source transfer algorithm transfers from an active set of SCRs to an inactive set by removing a gate signal from two parallel-connected, opposite-sense, current-carrying SCRs that, in combination, carry AC in either direction. The transfer process is simple:

- 1) Removal of a gating signal on the active source, due to the detection of poor PQ or a manual transfer request.
- 2) Current is sensed through the two active SCRs to determine the current-carrying state of each device over a specific period.
- 3) Once both states are determined, a gate signal is applied to the corresponding SCR in the inactive set. This enables current flow through this device while simultaneously preventing current from passing between the sources.

- 4) Once the SCR naturally commutates off, the gate signal is enabled on the reciprocal device to complete the transfer.

### Reliability delivers availability

ABB's DSTS can effectively remove upstream power quality issues without causing a disturbance downstream. It can be a cost-effective replacement for an upstream ATS or even a facility-wide UPS system – generating improved levels of reliability while drastically reducing footprint, managing higher electrical efficiencies, and reducing overall cost.

In system plus system redundant configurations, the highest level of availability can be achieved by providing mutual, dual-bus feeds to a DSTS. This architecture provides multiple layers of redundancy that eliminate single points of failure, down to and including dual-cord load power supplies. Finally, a DSTS also provides superior fault isolation and increased protection during maintenance, ensuring continuous conditioned power is delivered to a customer's critical load.

For more information visit:

[www.tnbpowersolutions.com/digital-static-transfer-switches](http://www.tnbpowersolutions.com/digital-static-transfer-switches)

**Article source:** Christopher Belcastro and Hans Pfitzer, ABB Review.





# Semiconductor protection

ABB provides power protection to Shanghai Huahong Grace Semiconductor Manufacturing Corporation (HHGrace).

**ABB has successfully installed two PCS100 Active Voltage Conditioners (PCS100 AVCs) to ensure HHGrace, a world-leading 8-inch foundry, to protect its semiconductor production line from potentially crippling power disruptions. This will enable HHGrace to produce a continuous supply of chips for their customers.**

The semiconductor industry has one of the most sensitive processes. The process demands extremely clean air, water and electrical supplies. Without these necessities, extremely sensitive equipment can be damaged due to the disruption of voltage sags. This could potentially damage resources and materials wasted for each production line in the semiconductor process. ABB's PCS100 AVCs has a high efficiency rate exceeding 98 percent, making the units extremely reliable, giving HHGrace immunity from voltage sags that occur on the AC supply network.

For HHGrace, expansion of their plant was needed in order to cater to the growing demand of silicon chips to their customers. The tools and processes needed to produce the silicon chips such as dry and wet etching, die preparation and packaging are sensitive to voltage sags that are caused by external environmental factors. A maintenance free reliable solution was required to protect these critical loads, with sag correction performance accompanied by local service. ABB was not only able to provide local support but was able to deliver and install a power protection solution that could withstand and correct the ongoing voltage sags that arose within the plant.

In the past ten years, HHGrace has experienced over 100 voltage sags in their plant. Since installation this year in May, the PCS100 AVCs has protected HHGrace against a power quality event, eliminating potential production shutdown and loss of materials and resources. HHGrace commented on the PCS100 AVC technology and the features it provides, "the PCS100 AVC has some unique performance features such as continuous voltage regulation."

ABB has a proven track record in the semiconductor industry, providing solutions to some of the biggest semiconductor factories around the world. ABB's PCS100 Active Voltage Conditioner is a "battery free" solution to the most common utility problem, voltage sags, along with swell protection and continuous voltage regulation. The PCS100 Reactive Power Conditioner is designed for correcting power factor, low order harmonics and imbalance issues often created by some semiconductor tool loads. The PCS100 RPC reduces system current thus enhancing energy efficiency and power system capacity. The PCS100 UPS-I is tailored towards the demands of industrial applications such as sensitive tools, motors, drives etc. It also provides protection during deep sag and swell events, plus outages lasting between seconds and minutes depending on storage (super capacitors or batteries) and system loading. Payback time for a PCS100 UPS-I is typically less than 12 months as the problems it protects the plant from can be so expensive. The ultra-fast transfer time of less than 2 milliseconds, the exceptionally small footprint – 50 percent smaller than competing solutions, and the long and more economical operating life are also attractive features of the PCS100 UPS-I. For complete power protection of large sensitive and critical loads, ABB's PCS100 Medium Voltage UPS (PCS100 MV UPS) is the solution. The PCS100 MV UPS can be installed to protect the complete supply or just selected sensitive loads.



ABB's 300 kVA PCS100 AVC to ensure HHGrace is protected against power disruptions

The modular and scalable architecture of ABB's PCS100 power protection portfolio enables compatibility between the systems, ensuring success in combatting common power protection challenges. Semiconductor companies can add ABB's power conditioning systems, such as the PCS100 Active Voltage Conditioner, UPS-I or the Reactive Power Conditioner to their existing plants although many companies choose to apply the products extensively on new FAB builds.

### HHGrace

Shanghai Huahong Grace Semiconductor Manufacturing Corporation ("HHGrace") is one of the world's leading 8-inch pure-play wafer foundries. With three 8-inch wafer fabrication facilities in Zhangjiang and Jinqiao of Shanghai, HHGrace offers production capacity over 124,000 8-inch wafers per month. With its headquarters located in Shanghai, China, HHGrace extends its sales and technical supports to customers in Taiwan, Japan, North America and Europe.

Download ABB's PCS100 AVC brochure [here](#).

Watch the PCS100 AVC product video [here](#).

To find out more about ABB's PCS100 AVC range, please visit: [www.abb.com/pcs100-power-converters](http://www.abb.com/pcs100-power-converters).





## PowerWave 33 for Munich Re – product excellence and lowest total cost of ownership deciding factors.

With annual revenues of over 50 billion Euro, Munich Re is the world's largest reinsurer. When Munich Re wanted to modernize and extend their computing center they chose ABB uninterruptible power supply (UPS) systems to do so. Munich Re had done their sums carefully. ABB's PowerWave 33 provided them with the performance that they needed and the total cost of ownership, calculated over 15 years, was the most attractive available.

The Munich Re computer center was equipped with a 8 x 120 kVA single-block UPS that no longer fulfilled requirements. ABB replaced this with a 2 x 3 x 300 kVA PowerWave 33 system. In addition, for additional power security, the existing single power bus was replaced by a dual-feed system.

The work was carried out in two phases. Firstly, a new power bus was installed in parallel with the existing bus. In the second step, the existing bus was replaced by the second of the new dual feeds and the existing UPS (including batteries) was replaced by the new PowerWave 33. The customer requested the option of adding an additional four units to each power bus at a future date; the present configuration makes this simple.

ABB's representative Stefan Freimann says, "close cooperation between planners, the project manager, engineers and those responsible for the eventual running of the installation ensured a smooth project delivery." ABB's project manager Daniel Haller added, "alongside the technical excellence of the product, deciding factors were the exceptional energy efficiency, low maintenance costs and the operational savings these will deliver over the next 15 years. The operating costs formed a central part of the client's cost calculation."

For more information visit: [www.abb.com/ups](http://www.abb.com/ups).



# Energy Storage Power Conversion System (PCS) contributes to cost savings and environmental sustainability.



**ABB in Indonesia has supplied a 240 kW EssPro Energy Storage Power Conversion System (PCS) for a pilot project set up on a picturesque Indonesian island, Kei Besar. Thanks to the applied solution, the state utility company has considerably reduced power generation costs, at the same time cutting both air and noise pollution, thus bringing not only financial, but also environmental benefits to the local community.**

Kei Besar is one of hundreds of islands scattered all over Banda Sea. Due to its remote location, the only electricity source used in the region came from a diesel power plant operated by Indonesia's state utility company, PT PLN (Persero).

## Challenge

The continuous increase of fuel price, as well as ageing components of the diesel engines, resulted in enormous power generation costs, which eventually became unaffordable for both the electricity producer and the surrounding community. As a consequence, the electricity service period was limited to eighteen hours a day (from 6 p.m. to 12 a.m.).

## Solution

To address the need for power while reducing the usage of the existing diesel generators, PLN has set up a pilot project based around a solar PV power plant with battery energy storage system (BESS).

As part of the BESS installation, ABB has provided a 240 kW EssPro PCS which primarily aims at controlling the process of battery charging and discharging. In addition, during the diesel power plant operation time ('On Period') with the PV solar plant running in parallel and supplying power to the load, the EssPro runs in power flow control mode, delivering certain amount of power to the grid.

During the 'Off Period', in turn, when the load is disconnected and the PV solar power plant continues to operate in island mode, the EssPro switches to voltage and frequency control mode, absorbing power from solar inverters so it can be used during the 'On Period'. Finally, by instantaneously regulating voltage and frequency, ABB's EssPro ensures stability and reliability of the power supply.

## Benefits

ABB's EssPro PCS constitutes a superior response to the challenges posed by energy storage and power quality in a wide range of applications.

## Modular design

ABB's EssPro PCS ranges from 50 kVA to 30 MVA. One of the key features of the system is its modular construction, which accounts for the platform's extreme reliability. Modular inverter blocks also make the system highly configurable and versatile, thereby enabling both indoor and outdoor placement.

## Seamless integration

The EssPro PCS solution is easily deployable in terms of installation time and space requirements. Furthermore, low operational costs derive from its high efficiency and low maintenance.

For more information visit: [www.abb.com/converters-inverters](http://www.abb.com/converters-inverters). (Converters for energy storage and grid stabilization).





La Parva ski field in Chile

# High altitudes

PCS100 Reactive Power Conditioner improves power quality and reduces the cost of energy to the ski center La Parva in Chile.

# The PCS100 RPC is designed to improve power factor, lower order harmonics and current imbalance.



Forty-one kms east of Santiago, the La Parva ski center is one of the premier resorts in Chile. ABB has provided a power protection solution designed to improve the power factor and reduce harmonics produced by the DC variable speed motor drives powering the, “Alpha” and “Aguila” ski lifts. With over 200,000 visits per season, it is essential that all operations, such as the ski lifts, are available throughout the season.

The ski season runs from June to late September, and on a good year can extend into October. At the heart of the Andes the village is at 2750m with the ski lifts rising from there. Poor power factor and harmonics produced by DC motor drives can be difficult to correct, and contribute to voltage drop and distortion along with loss and reduced headroom in upstream power distribution.

Although picturesque, the remote location had the downfall of a relatively weak electrical supply connection to the ski center. When this was combined with poor power factor and harmonics created by the ski lifts, problems were identified that needed correction. After discussions between ABB and the ski center operator, a solution was selected that actively filtered the current drawn by two of the ski lifts. ABB provided two PCS100 RPCs which measure the current drawn by the lifts and inject compensating current to cancel some of the 5th and 7th harmonics along with 50 Hz reactive current draw. This will reduce system loss, voltage drop and harmonic voltage distortion on the ski center electric supply.

By reducing the system losses, enhanced energy efficiency can now be achieved. La Parva’s Operations Manager, Marcelo Scheihing commented on the performance already seen by installing one of ABB’s PCS100 RPCs. “We have installed one of the two PCS100 RPCs, ... there have been no failures, so we can think that the solution installed is working.” Marcelo further commented on the service and support that ABB has provided so far, “it was decided that the solution proposed by ABB was the most desirable in addition to providing support in the process of installing the system offered.”

The PCS100 RPC is rated for applications from 100 kVA to 2,000 kVA and uses high-speed IGBT inverter technology to control reactive power flow into the AC network. The inverter technology employed means the compensation is stepless, unlike many other solutions, which minimizes disturbances and ensures seamless power conditioning. The highly reliable modular redundant design means the system is scalable and can be easily expanded as the resorts power needs grow. In addition, if one of the power modules fails, the system will not trip, but will continue to operate at reduced capacity. Because the granularity is small, La Parva ski center can get full redundancy at very low cost. This level of reliability at such low cost is unique in the industry

## La Parva

The smallest of the three Valleys resorts (Valle Nevado and El Colorado), La Parva ski resort has great skiing from beginner to expert, with a huge swathe for intermediates and advanced-intermediates, a decent terrain park, and amazing access to the Andes backcountry. La Parva’s terrain park is being fully redesigned for 2014 and will host a mix of features and jumps (airbag jump), aimed to give skiers and riders the ability to improve. The resort consists of 20 runs and 14 ski lifts and has an elevation of 2,670 m to 3,630 m.

Download ABB’s PCS100 RPC brochure [here](#).

Watch the PCS100 RPC product video [here](#).

To find out more about ABB’s PCS100 RPC range, please visit: [www.abb.com/pcs100-power-converters](http://www.abb.com/pcs100-power-converters).



# Powerful collaboration



## Power protection

### 06. Data center power

A complete data center solution by ABB

### 09. Efficiency in the field

PowerValue 11 RT UPS – for those who value their power

### 10. White gold

Continuous production for Sibur Plastic's main workshop

## Energy storage

### 14. Energy efficiency

Facilitating a research project at the Lodz University in Poland

## Industry focus

### 16. Oil and gas

ABB's solutions for oil and gas

# Stabilizing voltage



## Power protection

### 06. Demand for chip-based products

ABB's solutions for the semiconductor industry

### 08. Oil and gas industry in Russia

Future investment for Gubkinskiy GPP

### 10. Rail power

ABB provide UPS support for the North-South Railway in Saudi Arabia

### 12. Industrial UPS in a data center

Is it time for industrial UPS systems in data centers?

## Grid stabilization

### 16. Harnessing the power of the ship

ABB converter technology help save 20 percent fuel on ships

To receive one of the back issues shown above email: [sophie.benson-warner@nz.abb.com](mailto:sophie.benson-warner@nz.abb.com)



## PCS100 MV UPS. Complete power protection at medium voltage.



Designed for mega data centers, ABB's PCS100 Medium Voltage UPS is the solution for protecting critical processes. Power ratings up to 6 MVA allows customers to choose the solution that best suits their application. With an efficiency well in excess of 99 percent and a wide range of energy storage options, ABB's PCS100 MV UPS is the ideal solution for your power protection needs. Visit [www.abb.com/pcs100-power-converters](http://www.abb.com/pcs100-power-converters).

Power and productivity  
for a better world™

