power

1|17

A power protection magazine
of the ABB Group

Power correction

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Holger Hannemann
Global sales manager
Power Conditioning Products

The New Year started well. While we had a fantastic summer in New Zealand our customers kept us busy executing their orders from a record-breaking 2016. Thank you again and we hope we can repeat this in 2017.

In this edition we follow up on two projects in Myanmar where we replaced mechanical voltage stabilizers by our PCS100 AVC's. Those stabilizers were far too slow to protect from the typical voltage sags experienced by our new customers. The statistics and cost benefits supplied from the Chatrium hotel after 10 months of operation are very impressive.

We also want to use this forum to introduce some new product innovations from our group. There are updates on the Conceptpower DPA500 480V UL UPS and the next generation of static transfer switches Cyberex® SuperSwitch®4 DSTS was launched with much improved performance features.

Another launch is showing up on the horizon for our next generation medium voltage UPS, the PCS120 MV UPS. We'll talk about this one in more detail in the next issue, but for now have a look at the teaser and keep up to date with the product launch countdown at http://new.abb.com/ups/systems/medium-voltage-ups/zisc.

Our PowerLine DPA UPS is a light industrial UPS suitable to be placed within the harsh industrial environment that many of our customers have on their sites. We talk you through the differences of this offering compared to our commercial UPS.

And finally we have a look at transformer-free versus transformer –based commercial UPS designs.

We hope all of you find some interesting topics to read.

Enjoy this issue of ***power***.

Power Conditioning

Power Solutions

UPS

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Chatrium hotel's dramatic results

Steady power, fuel savings, and emission reduction courtesy of a PCS100 AVC

The Chatrium Hotel in Yangon, Myanmar now uses PCS100 AVC's to provide guests a stable power supply, which has also dramatically reduced the hotel's reliance on generator power.

Background

Two PCS100 AVC's were installed into the hotel in January 2016. The entire hotel is now protected from frequent voltage fluctuations, sags and swells that are common in Myanmar. These events on the power supply grid would otherwise cause interruptions and damages to the hotel's electrical systems, guest's electronic equipment, and it would require frequent use of the hotel's two 1250 kVA generator plants.

The Problem

The Chatrium hotel in Yangon had mechanical voltage regulators installed. But the mechanical voltage regulators could not provide sufficient correction fast enough to manage the fluctuating power supply causing continual interruptions to the operations and facilities. This included lifts, air conditioning, kitchen, restaurant, and bar services creating a high degree of guest inconvenience, and deterioration of the properties control systems. The backup generators support was triggered nearly every day which resulted in the consumption of nearly 500,000 liters of diesel fuel and over 41,000 kg of greenhouse CO2 emissions every year.

ABB's solution

Two 1500 kVA PCS100 AVC units were installed over four days with little interruption to the hotel and commissioned in January 2016. In October 2016, a factory representative took the opportunity to speak with the Deputy Chief Engineer of the Chatrium Hotel, Mr. Chit Min, and view the AVC installation in Myanmar.

Mr. Chit Min said, "The old regulator was large with lots of mechanical parts. It was difficult and expensive to maintain. Since installation nearly a year ago, the AVC has not faulted and we have not had to do any maintenance at all."

The Results

The AVC internal event log revealed that 400 events had occurred on each system and been corrected well within the operating specification. During this period there have been 40 power blackout periods recorded where the generators are then used to supply power to the hotel.

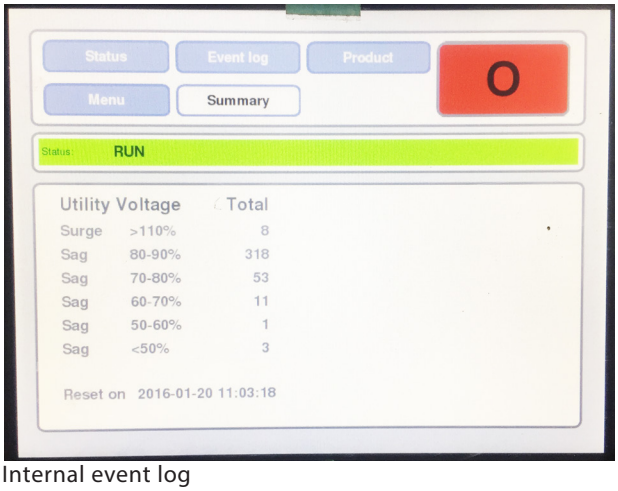
The PCS100 AVC's have had an immediate effect reducing the average generator runtime from three hours per day to one hour per week each. This is due to the voltage correction performance of the PCS100 AVC, events are now corrected to a level where the generator controller no longer needs to command a generator start. Both fuel consumption and greenhouse gas emissions have reduced by more than 95% totaling savings of over US $200,000 in fuel and a reduction of 39,000 kg per year of harmful emissions.

Mr. Chit Min and the hotel staff are excited about the performance of the AVC, with the stability of the power supply, the environmental consequence, and the cost savings results. The Chatrium hotel is justifiably proud that the experience they are now able to offer guests fits the luxurious style of the hotel.

"There is such a huge improvement that we do not notice any power fluctuations at all, and our guest experience is the best in Myanmar," said Mr. Chit Min.

PCS100 AVC

ABB's PCS100 AVC is an inverter based system that protects sensitive industrial and commercial loads from voltage disturbances. Providing fast, accurate voltage sag and surge correction as well as continuous voltage regulation and load voltage compensation, the PCS100 AVC has been optimally designed to give required equipment immunity.



Internal event log

Generators:	2 x 1250 kVA 32L Diesel
Average run hours:	Before AVC = ~2200/year
	After AVC = ~120/year
Fuel Consumption:	213.4 L/Hr @ 75% load
	272.1 L/Hr @ 100% load
	Before AVC = ~468,000/year
	After AVC = ~25,000/year
Diesel cost:	US$0.46/L at Oct 2016
Generator Emissions:	Before AVC = ~41,400 kg/year
	After AVC = ~1,950 kg/year

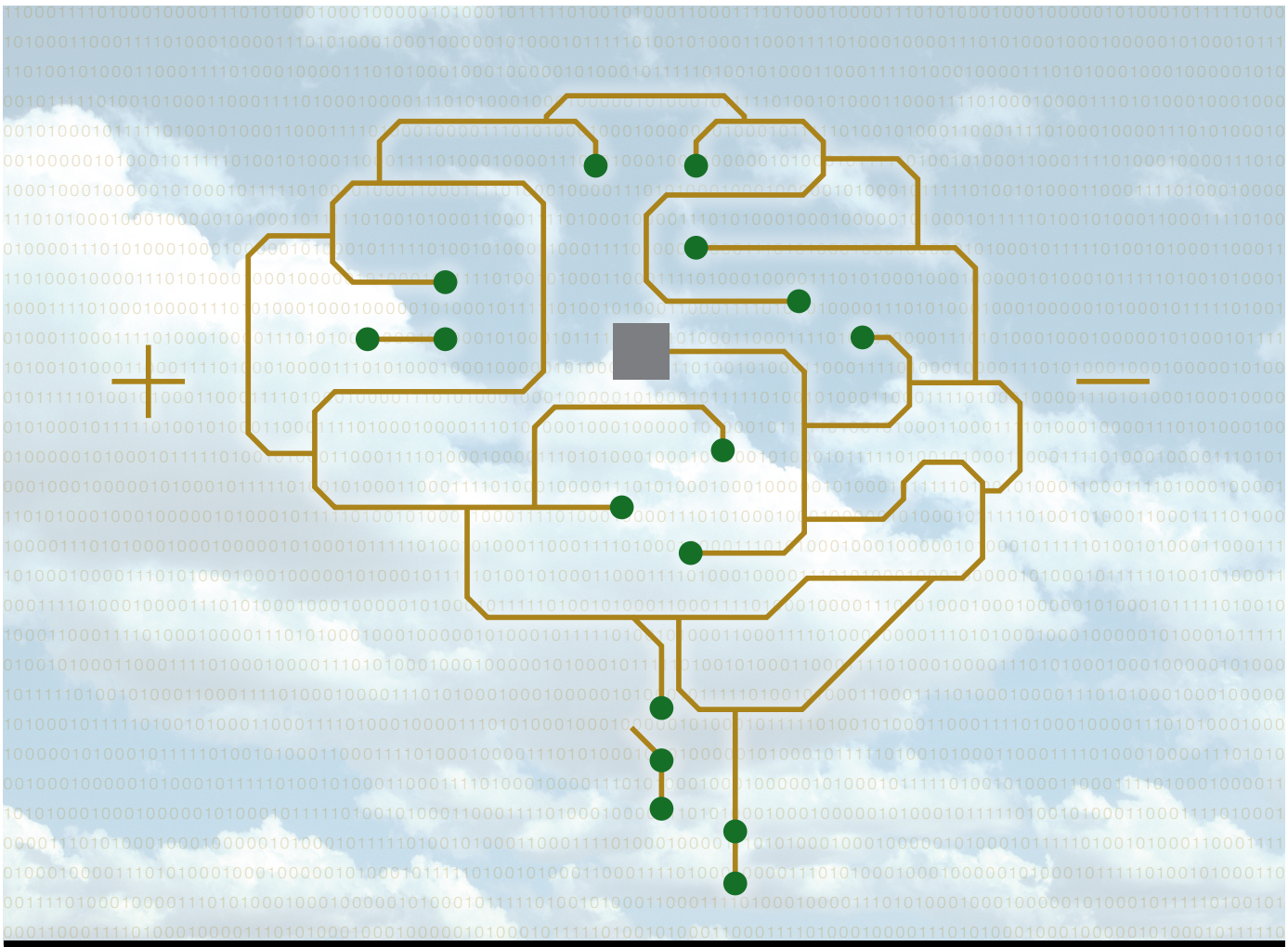
Figures are based on average results from the site.

Emissions have been calculated using Emission Estimation for Combustion Engines published by Department of the Environment, Water, Heritage and the Arts, Canberra, ACT

Recommended model for Hospitality application; PCS100 AVC-20

Utility - Input	
Power Range	250 – 3000 kVA
Maximum Continuous Supply Voltage	130%
Nominal supply frequency	50 Hz or 60 Hz
Power system	3 phase + Neutral (4-Wire) Centre ground referenced (TN-S)
Outage – control ride through	> 600 ms
Performance	
Efficiency	Typically > 99%
Voltage variation detection time	< 250 µs
Voltage regulation time	< 20 ms for any voltage deviation within the specification
Voltage regulation accuracy	±1% typical, ±2% max.
Continuous voltage regulation range	+/-20% with load power factor 0.75

For full specifications refer to technical catalogue



Intelligence in a UPS?

Absolutely.

Availability is everything in a UPS, making ABB's Conceptpower decentralized parallel architecture (DPA) design the preferred choice, ensuring power is always on when you need it. Each highly reliable standardized module is self-contained and can be online-swapped at any time, ensuring 99.9999 percent availability, making routine maintenance safe and easy. With class-leading efficiency of up to 96 percent, your power consumption and cooling effort are minimized. And, by adding expansion modules only when required, you only pay for the power you need. **www.abb.com/datacenters**

PCS100 AVC-40 bound for Myanmar

ABB received an order for two x 300 kVA PCS100 AVC-40's, which were installed in an industry-leading brewery in Myanmar

ABB's customer is in the fast growing beverage industry and is one of the biggest brewers since 2011. The local sales team started this process in the middle of 2015 and during their first visit, it was found that the current power protection solution used were servo controlled voltage regulators, which are also called stabilizers. These were protecting instruments, PLC and AC drives. The customer was still facing problems due to sudden fluctuation of utility supply and it was obvious that the existing voltage stabilizers were not fast enough to maintain a stable output voltage.

ABB's solution

The customer has adopted ABB's technology and two PCS100 AVC 40's were implemented to protect the bottling and packaging lines.

Voltage sags have been identified in many international studies as one of the most costly power quality problems for continuous process industry. Typically, they originate from lightning and system faults, which cause sensitive loads to trip. For some customers this can just be an inconvenience, but for many it results in expensive product loss and downtime.

The PCS100 AVC-40 is an active voltage conditioner designed to solve these problems. It is a high performance power electronic system, designed for industrial and large commercial applications. It responds instantly to power quality events, providing continuous regulation of voltage.

To find out more about ABB's power protection solutions:

Web: **www.abb.com/ups**
Email: **powerconditioning@abb.com**

Superior voltage conditioning for commercial and industrial applications?

Certainly.

The PCS100 AVC 40 is designed for sag correction in large commercial and industrial applications. Available in ratings from 150 kVA to 3600 kVA, the PCS100 AVC-40 offers continuous protection from the most common utility voltage problems found in modern power networks. Fail-safe worry-free operation even in harsh electrical environments and a faster return on investment due to low operation costs will ensure your business is protected from power quality events. Visit www.abb.com/ups

ABB expands its modular UPS product offering for data centers

480 V UL version of Conceptpower DPA 500, now with optimized 300 kW UPS cabinets

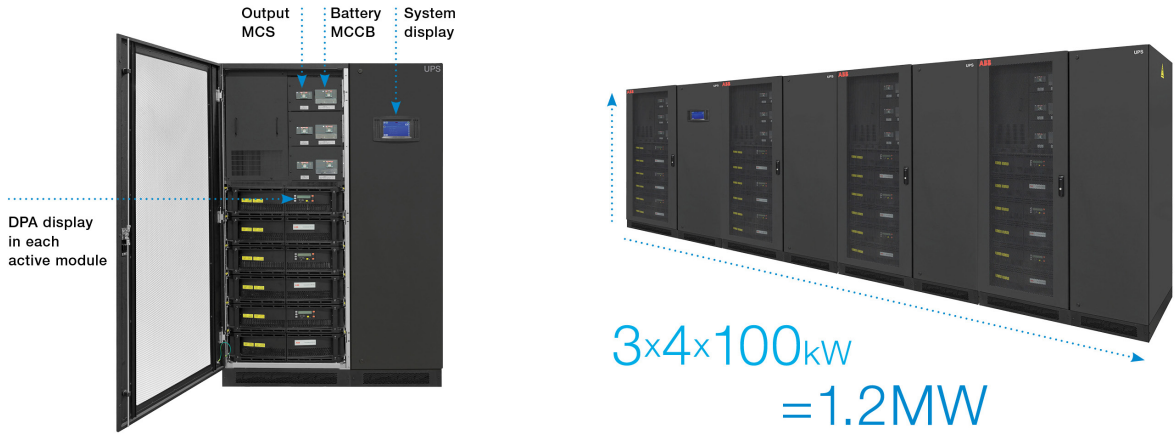


ABB has expanded the Conceptpower DPA 500 480 V UL offering to include an optimized modular 300 kW UPS solution for mid-sized and data centers, server rooms and other IT infrastructure applications.

Building on the true online, double conversion UPS design of the Conceptpower DPA 500, this compact 300 kW system allows for three 100 kW module sets within each UPS cabinet, up to four cabinets can be configured in parallel for up to 1.2 MW of clean reliable power, adding more flexibility to the specific needs of the installation. Easy to deploy UPS module sets can be added to the system as power requirements grow, thus avoiding the need to over specify the initial design configuration.

“Market trends validate the modular approach to data center design and construction, enabling the right-sizing of infrastructure and reducing the initial capital investment towards meeting future needs,” said Laura Ortiz, UPS Product Manager in ABB’s Power Protection product group. “Conceptpower DPA UPS systems enable data centers to add capacity only when needed, allowing companies to operate in smaller footprints, hence saving on both capital and operational expenses.”

The Conceptpower DPA 500 boasts the lowest total cost of ownership compared to other UPS systems by offering high energy efficiency, scalability and an optimized modular design to enable easy front access only serviceability. A class-leading energy efficiency, with up to 96.5 percent, significantly reduces system running costs and cooling expenses. More importantly, the efficiency is optimized and significant savings are achievable under every working condition. The straightforward nature of the Conceptpower DPA simplifies every step of the deployment process, from planning through installation and commissioning to full use. Flexible setup, with top or bottom cable entry frames and fast maintenance mean lower operating and maintenance costs.

The Conceptpower DPA 500 is part of ABB’s broad range of products and integrated solutions that ensure data centers operate with optimum reliability and efficiency. From power distribution systems to enterprise management and grid connections, ABB provides savings in installation, energy, space and maintenance.

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ABB's Cyberex® SuperSwitch®4

The 208 V and 480 V SuperSwitch®4 digital static transfer switches (DSTS) offer improved power quality detection, reliability, and serviceability

ABB has improved upon the recently launched Cyberex® SuperSwitch®4 DSTS product line with new designs for 250A & 400A requiring front access only for installation, operation, and maintenance. The new front access SuperSwitch®4 designs will continue to redefine power reliability and safety with its user friendly design, improved serviceability, and best in class performance.

The front access SuperSwitch®4 models perfectly balance both safety and accessibility concerns with further compartmentalization between the input/output connections, molded case switches, and logic components while ensuring installation can be conducted via the front of the unit only. While keeping same state of the art 10.4" LED color touch screen display, intuitive software-guided bypass features and externally accessible customer USB connection, the new front access SuperSwitch®4 models also include an isolated UIB compartment for customer connections that is centrally located at the top of the unit and can be accessed either from the front or the top of the unit. By eliminating the side clearance requirement for installation or thermal scanning of breaker connections, the front access SuperSwitch®4 design also effectively reduces the required floor space by 30 percent, thus allowing customers the ability to fully optimize the usage of valuable white space.

The SuperSwitch®4 is designed with a 'true' fault-tolerant architecture, ensuring there is truly no single point of failure by utilizing our patented transfer algorithms and robust electrical components. It boasts improved power quality detection that is immune to harmonics and load imbalance between the phases. In applications with downstream transformers, the SuperSwitch®4 limits potential high transient inrush currents using state of the art digital signal processors and a newly developed algorithm, called Real Time Flux Control™ for dynamic inrush restraint (DIR). The results of this innovative approach is out of phase transfers up to 25 percent faster and inrush currents that are 40 percent lower than the SuperSwitch®3. This intelligent proprietary technology ensures performance that exceeds CBEMA and ITIC standards, regardless of phase drift between sources.

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ABB's uninterruptible power supplies: Light industrial UPS versus commercial UPS

ABB offers UPSs with different architectures, different features and a wide range of power capabilities. However, up until now, these UPSs have had one thing in common: They were designed for relatively friendly environments where the heating, cooling, ventilation and humidity are permanently controlled, and where there is no risk of biological attacks and very low levels of chemical contamination. Examples of such settings are control rooms or data centers in banks, hospitals, educational establishments, telecommunications hubs, server rooms.

Of course, a large number of industrial settings are not so obliging when it comes to providing a friendly environment. Dust, moisture, vibration, excessive heat, corrosive air contamination, lack of space and manhandling are just some of the challenges that a UPS would have to face in industrial process plants, factories, electrical substations, oil and gas installations etc.

For this reason, in 2016 ABB introduced a new modular UPS for use in these light industrial applications: ABB's PowerLine DPA UPS.

PowerLine DPA's IP31-rated protection can easily cope with dust, water condensation, humidity (up to 95 percent), excessive heat, corrosive or biological air contamination and rough manhandling. ABB's PowerLine DPA can provide power in the range of 20 kVA to 120 kVA and is designed to operate in a temperature range of -5 to +45 C without power derating.

When environmental conditions are not clean, the risk can increase, so the top priority has been given to the safety aspects and the UPS features a high degree of protection for users and maintenance staff. The ABB PowerLine DPA UPS has a robust mechanical design suitable for rough environments (water protection up to IP42, anti-corrosion treatment, anti-condensation heater, dust filter, etc) as well as an electrical design that protects against short circuiting and overloading. It provides galvanic isolation up and downstream, employs halogen-free cables so no toxic gases are emitted in case of fire, and has a cold start capability in case of power blackout.

Lack of space is a problem that is frequently encountered in industrial environments, so the PowerLine DPA UPS has not only a small footprint but, unlike other ABB's UPSs, it also has a cable entry at the front (top and bottom), which eliminates the necessity for rear access and the associated extra space this entails. Ventilation flows from the front to the top, which means the UPS can be placed right up against a wall and lifting eyes support easy transportation and installation.

To ensure compatibility with the networking and distributed intelligence that is becoming prevalent in light industrial installations, the PowerLine UPS - like other ABB's UPSs - can be supplied with relay boards and a network management card to allow environmental monitoring, extensive alarm handling and dispatching, redundant UPS monitoring, integration into multivendor and multiplatform environments and the supply of UPS data to Web applications.

The PowerLine UPS is similar to some other ABB's UPSs in another way too. It is built on ABB's unique and proven decentralized parallel architecture (DPA). The modular nature of DPA delivers not only the best availability but also the best serviceability and flexibility. Modules can be replaced without switching to bypass the whole system or powering off, so routine maintenance is simple.

ABB commercial UPS	ABB's "Light" industrial UPS
Applications: Data center in banks, hospitals, offices, airports, central train stations	Applications: Digital automation and control systems, instrumentation, communication and electronic devices in manufacturing, transportation and utilities.
The interruption of AC power may disrupt data processing and telecommunications but does not create an inherent risk of injury to people and property.	The interruption of the AC power may result in the loss of finished products or hundreds of person-hours resetting the production equipment.
Aimed at: business continuity and data protection.	Aimed at: 24/7 operation, personnel and operational safety.
Key attributes for control room and data center infrastructure are energy efficiency, power expansion capability, optimized footprint, optimized cooling system, standardized power blocks and N+1 redundancy, remote control & monitoring.	Key attributes for manufacturing plants and industrial control rooms are continuous operation, parallel redundant operation, galvanic isolation, system degree of protection, short-circuit and overload capability, safety, fire protection, integration into the electrical control system.
Manufacturing process order: Configure to Order.	Manufacturing process order: Engineer to Order.

Essential difference between commercial and light industrial UPS

ABB's commercial UPS	ABB's PowerLine DPA
	

Environmental characteristics

Control room is clean and the temperature and humidity are controlled by HVAC	Neither the temperature nor the humidity is controlled
Operating temperature range: up to 40°C	Operating temperature range: up to 45°C (without power derating)
Humidity: 0 **percent** to 95 **percent** without water condensation	Humidity: 0 **percent** to 95 **percent** with water condensation
Non air contaminants	Air contaminants: often dusty and corrosive

Mechanical UPS characteristics

Ingress protection: Up to IP21	Ingress protection: up to IP42
Low-toxicity and low-smoke cable (optional)	Low-toxicity and low-smoke cable
Ventilation: forced with monitored fans from front to the back	Ventilation: forced with monitored and redundant fans (N+1) from front to the top
Operating and maintenance access: front access	Operating and maintenance access: front access

Essential difference between commercial and light industrial UPS

ABB's commercial UPS	ABB's PowerLine DPA
Electrical characteristics	
System power range: 10 kW – 5 MW	System power range: 20 kVA – 120 kVA
System configuration: - single - parallel (N+1)	System configuration: - single - parallel (N+1) - parallel-redundant (two identical fully segregated 100% rated UPS units)
Power factor = 1	Power factor > 0.9
Efficiency > 96 percent	Efficiency > 90 percent
Non input galvanic isolation	Input and output galvanic isolation (optional)
UPS topology: transformer-less	Input/bypass/output transformer usually specified for galvanic isolation or step up/down transformer
Non overload and short-circuit UPS input protection	Overload and short-circuit UPS input protection
Manual bypass switch	Manual bypass switch
UPS battery	
Autonomy: 5-60 min	Autonomy: Up to 8 hours
Battery type: VLRA & Ni-cd	Battery type: VLRA & Ni-cd
Internal batteries (optional)	External batteries
Overload and short-circuit battery protection	Overload and short-circuit battery protection
Control and monitoring	
Central graphical control panel with touch screen display (optional)	Central control panel with graphical display, control keys and programmable alarms and indications
Fixed input & output relay	Programmable input & output relay
Network communication interfaces (SNMP, Modbus) allowing integration to the building management systems (optional)	Network communication interfaces (SNMP, Modbus) allowing integration to the electrical digital system or SCADA systems
Product performance	
UPS design life: up to 10 years	UPS design life: up to 15 years
International standard: IEC-62040-1 Safety IEC-62040-2 Electromagnetic Compatibility (EMC) IEC-62040-3 Performance IEC-62040-4 Environmental aspects	International standard: IEC-62040-1 Safety IEC-62040-2 Electromagnetic Compatibility (EMC) IEC-62040-3 Performance IEC-62040-4 Environmental aspects
In compliance with EN 50171 Central Power supply system (optional)	
UPS documentation	
General technical data sheet, general arrangement, operating and maintenance manual	On project basis technical data sheet, general arrangement, electrical wiring and operating & maintenance manual

Diana Garcia,
Industrial UPS Product Manager
ABB Power Protection SA

UPS design: Transformer-free vs transformer-based

The function of the transformer in a UPS

Why do uninterruptible power supplies have transformers? The answer lies in one of the most common uses of a transformer: to step up output voltage.

The new power converters brought in around the beginning of this century brought not only significant customer benefits but also removed the necessity to have a transformer. The age of transformer-free UPS was thus born. Subsequent evolution was rapid: Thyristor-based designs – with six-pulse, then later, 12-pulse, thyristor bridges - quickly gave way to today's topology, which is built using IGBTs (insulated-gate bipolar transistors). Now, virtually all double conversion UPSs have IGBT power converters and are transformer-free.

Transformer-based UPS

In a transformer-based UPS, when the mains supply is available, the power flows through the rectifier, inverter and transformer to the output to supply the critical load. This working mode is called double conversion mode. In double conversion mode, the battery is constantly kept fully charged. During power outages, the battery feeds the inverter, which then supplies uninterrupted power to the critical load through the transformer.

The static bypass acts as an emergency path that is switched in when there is a problem on the double conversion path such as an overload, over temperature or output short circuit. As its name suggests, the maintenance bypass switch connects input to output and allows the UPS to be bypassed. Other switches then allow the unit to be isolated and serviced.

Transformer-free UPS

The working principle of a transformer-free UPS is the same as that of a transformer-based UPS except that - because the IGBTs can handle high voltages there is no need for a step-up transformer after the inverter. This boosts energy efficiency - typically from 90 to 96 percent - which is the industry-standard. Furthermore, transformer-free UPSs are lighter and have a smaller footprint – reducing investment and running costs.

Because of the higher voltage involved in transformer-free UPSs, an additional converter is introduced between the DC bus and the battery. This converter allows a constant and precise control of the batteries and provides a clean DC voltage with no ripple, which maximizes the battery lifetime.

But the advantages do not stop there. Total harmonic distortion is reduced dramatically and the input power factor (PF) is resistive thanks to active control of the input currents. This means that the devices upstream of the UPS (eg, generators) do not have to be oversized by a factor of 1.5 (or even more) as is usual with transformer-based UPS.

Some other differences can be identified. The output impedance and the dynamic response to unbalanced loads are better with a transformer-free UPS thanks to the direct control of the output sine wave and the fact that each phase is controlled independently. The output short-circuit capability of the inverter is also better than a transformer-based UPS.

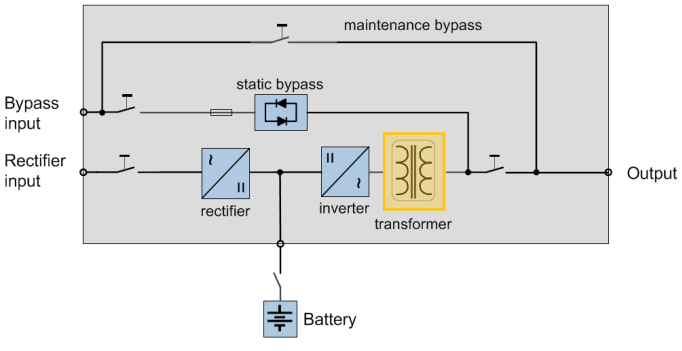

Figure 1: single-line diagram of a transformer-based UPS

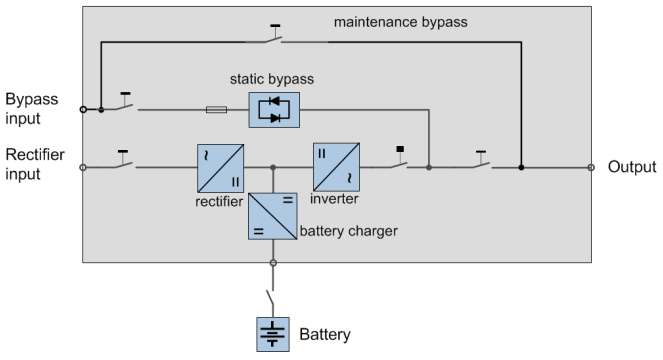

Figure 2: single-line diagram of a transformer-free UPS

Major technical specification differences (typical)

Table 1: summary of the major technical differences between the two topologies.

#		Transformer-based	Transformer-free
1	Efficiency on double conversion mode	90-92 percent	95-96 percent
2	Efficiency on eco-mode	99 percent	99 percent
3	Current total harmonic distortion (THDi)	30 percent (6-pulse thyristor-based rectifier) 12 percent (12- pulse thyristor-based rectifier) 3-4 percent (IGBT rectifier)	3-4 percent
4	Input PF	Low on partial load	0.99 – 0.97 at full and partial load
5	AC ripple on battery	Without battery charger more than 5 percent with battery charger 0.2 percent	0.2 percent
6	Allowed number of battery blocks in series (12 V)	Fix (typically 40)	Variable from 30 to 50
7	Output impedance	High (worse)	Low (better)
8	Output fault clearing capability on inverter	Typically up to 5 x In	Typically up to 3 x In Up to 4-5 x In or even higher may be option with more cost
9	Output fault clearing capability on bypass	Up to 10 x In	Up to 10 x In
10	Dynamic response	Poor, unbalanced loads affect output voltages	Ideal, direct control of the output sine wave, each phase is controlled independently. Thus, unbalanced loads do not affect the output voltages
11	Weight (one 500 kVA unit)	2.2 – 2.6 tons	1 ton

Major differences for the customers (effect on the customer benefits)

Table 2: summary of the major differences between the two topologies for the customers.

#		Transformer-based	Transformer-free
1	Investment cost	$$$ due to higher UPS cost, higher installation cost (oversizing of the system upstream of the UPS) and larger footprint.	$$
2	Operational cost	$$$ due to lower efficiency means higher energy costs for both UPS and cooling.	$ Higher efficiency reduced power losses and less cooling. Over many years, the saving is significant.
3	Environmental impact for production and transport to final location	Higher than transformer-free due to more components (transformer) and bigger mechanical size for the unit	Lower than transformer-based thanks to the same arguments
4	Environmental impact for operating the product	Lower efficiency means higher power losses thus more energy needed for cooling.	Higher efficiency means less power loss and less energy needed for cooling
5	Battery life (lead-acid)	May be reduced due to AC ripple	Up to 12 years

UPS performance criteria will never be perfectly matched in practice and the best solution will be the best compromise. The type of application, the criticality of the business dependent on the power supply, the user's business model, etc. will determine which compromise is selected. From the comparisons above, it is clear that the transformer-free UPS design is better, which is why it now dominates the market. However, both designs provide the fundamental functionalities of a double conversion UPS, maintain the key characteristics such as availability and reliability and they have equal lifetimes.

Author:
Carlo Kufahl
Product Manager 3-phase UPS
ABB power protection products

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Continuous power

09. First Active Voltage Conditioner comissioned in Nigeria
PCS100 AVC-40 installed in Abuja, Nigeria

14. Ready to toast
UPS systems by ABB protect Krombacher's production, filling and logistics center

17. Powering the railways
Reliable UPS's for railway applications

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Power solutions

06. ABB's UPS on show in Vietnam
Key power protection featured at power and automation show

09. ABB India's first shore-to-ship power supply
PCS100 SFC end to endsolution installed at Tuticorin port to significantly reduce carbon footprint

14. Power factor and the uninterruptible power supply
Power factor has to be taken into account when specifying a UPS

To receive one of the back issues shown above, email: powerconditioning@abb.com