ARTICLE

Multi-megawatt power protection at medium voltage

2017 marks the introduction of ABB's revolutionary ZISC technology – a next generation of medium voltage (MV) uninterruptible power supply (UPS) based on the PCS120 converter platform →1. The high-performance, flexible system expands ABB's MV UPS Portfolio, supplying critical load industries with high-quality power, reliability and efficiency.

The rapid rise of digital data and digital-based device use in the technology sector over the last decade is transforming modern business and society. The need for real-time, reliable data and digital device penetration is unprecedented. The expansion ranges from customer-driven technologies such as the internet of things and personal smart devices to big data driven analytics, and data-dependent businesses such as financial institutions and governmental security agencies.

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Propelling this drive for transformation is the development of extensive infrastructure and ever-increasing investments in electronics manufacturing facilities and enormous data centers. These facilities have been highly impacted by economies of scale, pushing single locations to grow even larger such as hyper-scale data centers with a correspondingly higher power demand – often well into the tens of megawatts.

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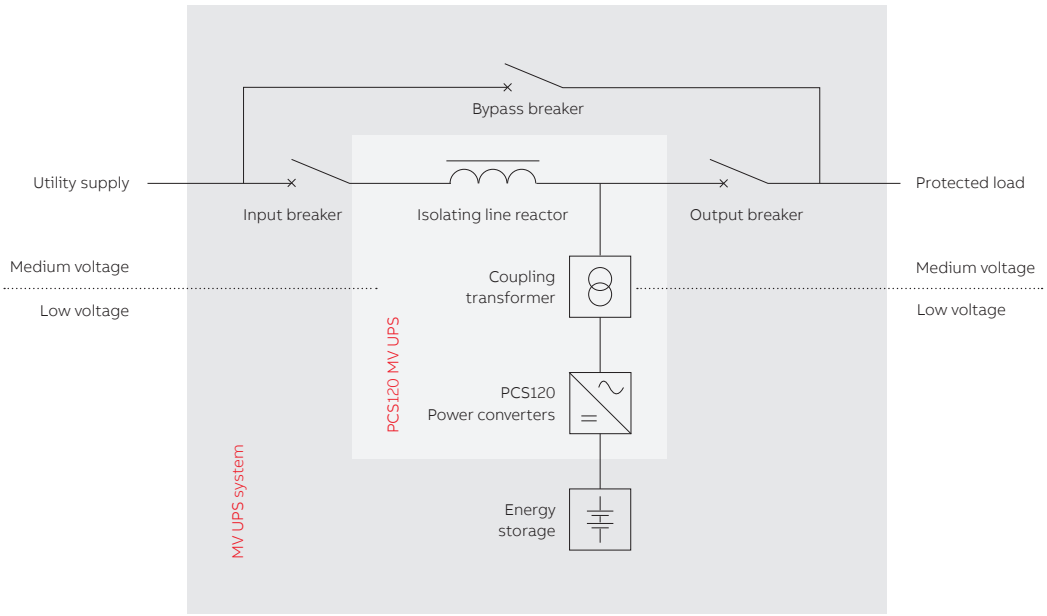
These large-scale facilities rely on a power supply quality much greater than a utility can provide, as dollar losses for downtime in these critical facilities are simply not tolerable. This is valid not only for data centers and semi-conductor factories, but also other critical load industries such as pharmaceutical, chemical, and the food & beverage sectors.

Data centers strive to lower costs and pass on savings to their customers. Benchmarking standards such as PUE (power usage effectiveness) and operating costs analyses are the primary tools used by clients to determine which data center should receive contracts [1]. Because these high tech facilities are characterized by enormous power demands placed on a single location, the absolute requirement of maximum reliability and optimum efficiency is paramount to keep these critical load industries competitive.

Data gathered from data center research [2], for example, specify that the overall downtime cost for a power supply interruption is around $5,600 per minute. With power interruptions lasting on average 90 minutes, the cost of a single downtime event can be well over half a million dollars. Clearly, financial losses of this magnitude are undesirable. To mitigate the possibility of such incidents, critical load industries require extremely reliable power supply as well as robust power distribution and power protection designs.



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01 A ABB's PCS120 MV UPS.

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02 Single line diagram of ABB's ZISC architecture.

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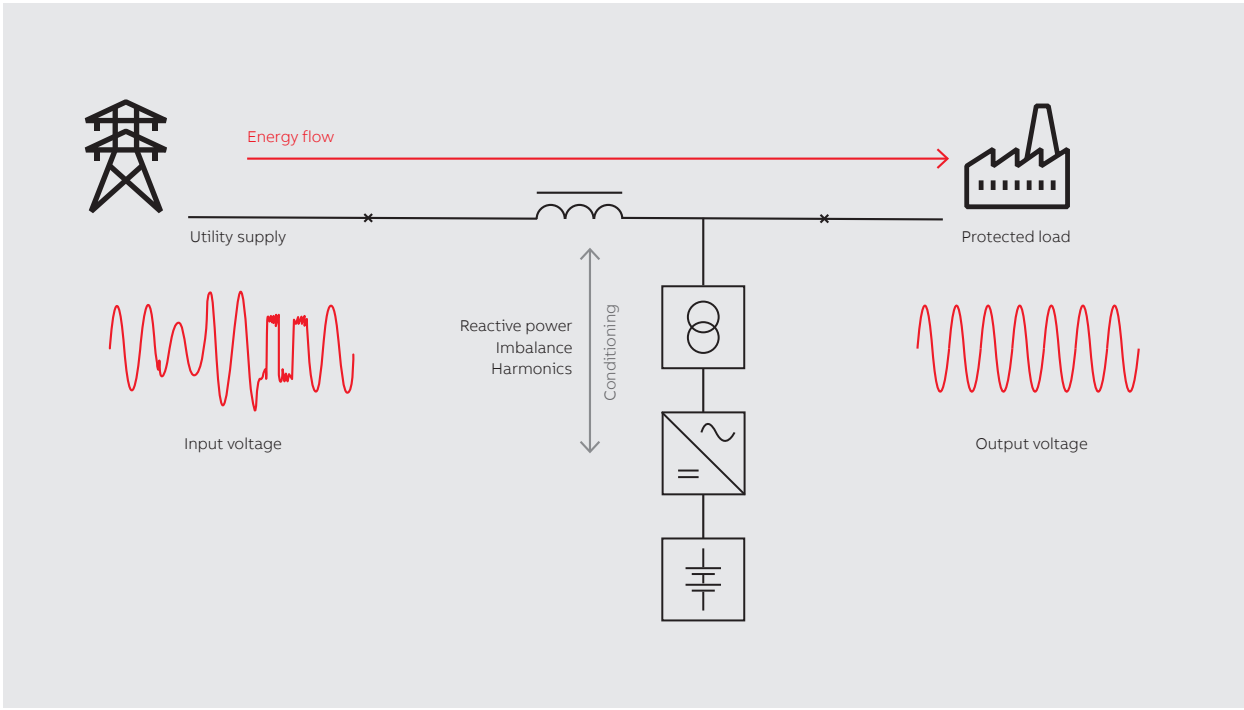
03 PCS120 MV UPS in power conditioning mode resulting in clean continuous power.



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An additional technical challenge is to provide a flexible solution which reconciles the above mentioned needs for an ultra-reliable system design with the cost cutting requirements for enhanced efficiency and minimal operating costs. For these reasons, a medium-voltage power protection and power distribution solution combined with power conversion and storage at low voltage would be the ultimate solution for data centers and other critical load industries.

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By creating the PCS120 MV UPS, which is compatible with a variety of configurations especially the tested fault-tolerant ring bus configuration, ABB has found the optimal product solution.

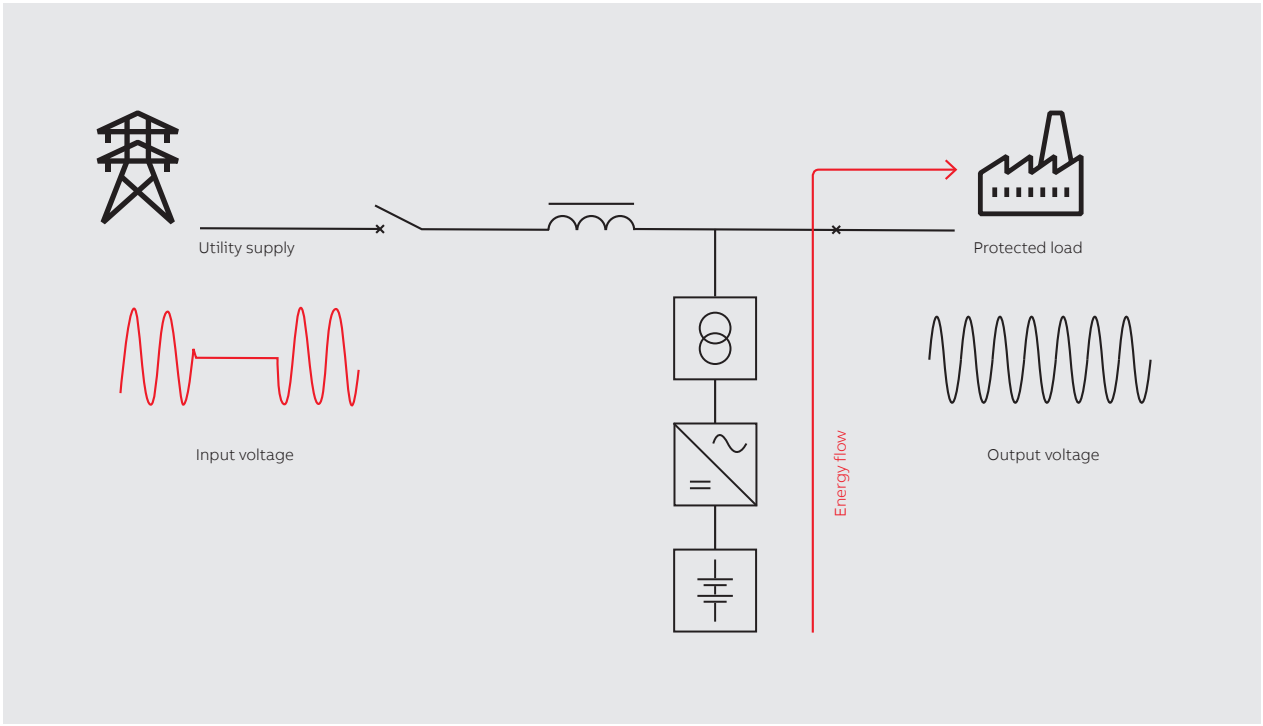
ABB prides itself on being able to find optimal product solutions for its customers' power needs. By creating the PCS120 MV UPS, which is compatible with a variety of configurations especially the tested fault-tolerant ring bus configuration, ABB does just that.

ABB's PCS120 MV adds needed flexibility by providing a static alternative to fit the ring bus arrangement resulting in a highly reliable and efficient solution.

Power protection at medium voltage

Providing power protection at medium voltage yields multiple advantages. Topping the list is the ability to simplify the design of power distribution, in which lower switchgear, transformer and cable counts are needed. Thereby making the system much easier to maintain, manage and supervise. The lower current requirements at medium voltage with an equivalent power demand make this configuration the most efficient system possible. In addition, heating losses are reduced and capital expenditures can be minimized.

Because the typical constraining factor of large low voltage facilities is the current limit of LV switchgear and bus bars, the MV design solves this constraint by allowing larger blocks of power to be provided from a single location. It also enables smarter use of whitespace, since a MV UPS can be placed on less expensive real estate located further away from the loads, such as electric rooms and substations.



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The power distribution system's overall reliability benefits greatly from being operated at medium voltage because less infrastructure equipment such as switchgears are required. Studies also show that the individual reliability of medium voltage devices are significantly greater than the reliability of their LV counterparts [3].

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ABB's ZISC topology backed by the PCS120 converter technology achieves efficiencies of up to 98 percent, significantly better than the segment incumbent rotary UPS system.

ABB's MV Power Protection portfolio
To address the need for MV power protection, ABB introduced the PCS100 MV UPS in 2014. This product solution with a single conversion topology is scalable up to 6 MVA and voltages up to 6.6 kV. As a result of its efficiency the product has been quickly established in the market.

Following the successful operation of the first units, ABB was immediately challenged by customer demand to provide other possible MV power protection solutions. ABB took up the gauntlet to meet customers' needs. This meant developing an approach to include multiple voltage levels – for even larger amounts of power – and the ability of continuous power conditioning in lieu of the industry standard standby topology.

ABB's 134-year history of innovation at the forefront of technology development, provided the framework for ABB engineers to react rapidly. ABB's answer was to create a new ground-breaking medium voltage UPS design, the ZISC (Impedance Isolated Static Conversion) architecture, to satisfy clients' requirements.

PCS120 MV UPS and the ZISC architecture
The ZISC architecture introduced in 2017 is a new topology for the static medium voltage power protection market. The ZISC architecture is based on an isolating line reactor coupled with the new high performance ABB PCS120 power converters →2. By continuously controlling the voltage angle across the reactor, the inverters are able to control the real and reactive power from the utility to the load, without cycling the energy storage.

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04 PCS120 MV UPS in independent mode with seamless transition of the load from the utility to the energy storage supply.

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05 The PCS120 converter platform with 6 power modules per cabinet and built-in system redundancies.

At the same time the PCS120 converters are continuously conditioning and filtering any utility disturbances like harmonics and voltage imbalances

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From a hardware perspective, the PCS 120 MV converter platform modular approach allows unparalleled serviceability and redundancy, while maximizing uptime.

thereby providing reactive current support to the critical loads. →3 This operating mode is known as power conditioning mode. In case the utility power is no longer available, the PCS120 MV UPS opens its input breaker and seamlessly transfers the load to the energy storage, operating now in independent mode.

→4 This robust design concept thereby results in reliable power protection as well as continuous voltage conditioning, thus providing the load with prime power supply at all times.

ABB's ZISC topology backed by the PCS120 converter technology achieves efficiencies of up to 98 percent, significantly better than the segment incumbent rotary UPS system.

"Everything should be made as simple as possible, but not simpler." – Albert Einstein
The beauty of the ZISC design lies in its duet of simplicity and robustness. The only equipment kept at medium voltage are the isolating line reactor and the coupling transformer. This enables the ZISC technology to be easily adapted to multiple voltage levels and power requirements. Paralleling is also easily performed, achieving power ratings in the range of over 40 MVA under different configurations.

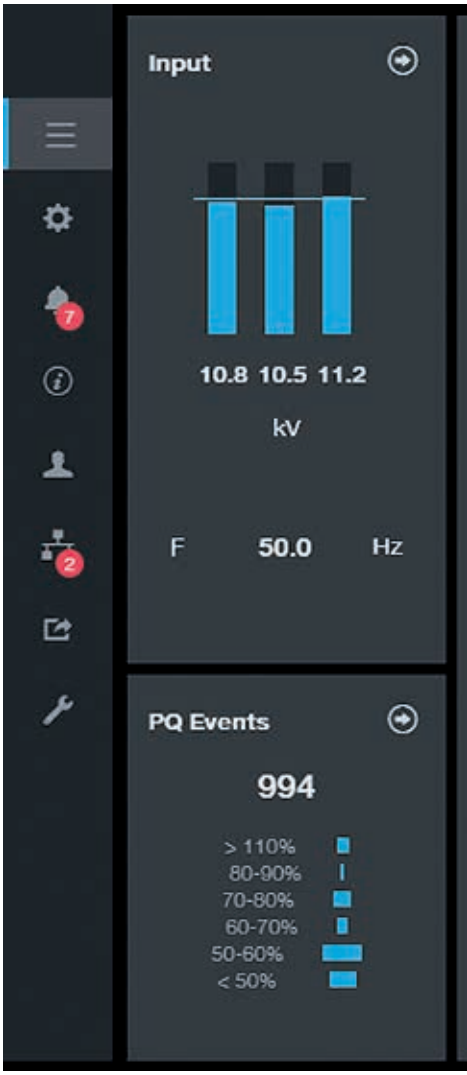
By having the power conversion and energy storage at low voltage ABB customers maintain the familiar LV experience characterized by functionality, maintainability and, most significantly, the modularity of a low voltage system like the PCS120 converter platform.

The PCS120 converter platform
The PCS120 converter platform, was one of the major facilitators of the ZISC technology. Defined by double the power density of its predecessor, the PCS100, the PCS120 relies on the same modular approach. The PCS120 converter platform is ABB's answer to innovative design in power electronics. →5

With its many years on the forefront of technology development, that drove ABB's insight towards a new ground-breaking medium voltage UPS design, the ZISC architecture.

At the heart of the UPS system, the PCS120 converter platform is not only a new concept in terms of product robustness and reliability but is novel in its connectivity potential. The brandnew ABB-engineered interface is integral in terms of the analysis of power quality events. Maintenance and supervision are also improved by combining trending analytics with proactive digital services aligned with the ABB Ability™ platform →6.

From a hardware perspective, the modular approach of the design allows unparalleled serviceability and redundancy, while maximizing uptime. For instance, in the unlikely event of a module failure, the system isolates the module and continues to run with marginally reduced output power capability. At the same time, the smart control delivers a notification of the event to the supervisory system so that maintenance technicians can schedule the next site visit at their convenience. Automatic smart firmware management tools and a new slide-in modular design ensure customers that the product has excellent maintainability as well as painless spare part management.



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06 PCS120 MV UPS new digital interface with extensive event analysis capability and pro-active serviceability.

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References
[1] M. Stansberry, “Uptime Institute Data Center Industry Survey 2015.” Uptime Institute, 2015.

[2] Emerson Network Power, “Understanding the Cost of Data Center Downtime: An Analysis of the Financial Impact on Infrastructure Vulnerability,” White Paper, 2011.

[3] CCG Facilities Integration Incorporated, “Medium Voltage Electrical Systems for Data Centers.”, 15 Sept. 2012.

One ABB
In addition to the PCS120 MV UPS system, ABB’s global portfolio of products also include the Unigear Digital medium voltage switchgear as well as ABB’s own digital protection relays. The digital IEC 61850 integration between the PCS120 MV UPS and the switchgear provides added reliability with distributed control capabilities. The comprehensive in-house package is designed for a seamless connection to the ABB Ability platform.

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Moreover, ABB’s unified corporate structure, with local organizations across the world, provide customer support as well as dedicated project management teams to make sure project deliverables and schedules are kept.

The “One ABB” solution offers medium voltage power protection customers a one-stop-shop with an array of excellent products as exemplified by the ZISC architecture and PCS120 MV UPS as well as the previously described services. Thereby following the ABB philosophy of meeting customer demands in a rapidly developing and competitive market. ●

To find out more about ABB's power protection solutions:
www.abb.com/ups
powerconditioing@abb.com