Standardization and modularity as the foundation of data center UPS infrastructure
Standardization and modularity as the foundation of data center UPS infrastructure

Executive summary
Data centers are growing ever larger, more numerous and more complex. The way to keep control of costs, availability and reliability, while maintaining flexibility, is to fully exploit standardization and modularity. All ABB’s data center products are designed with standardization and modularity as cornerstones of their architecture. In this paper, we look at how these concepts are embodied in ABB uninterruptible power supplies and the advantages they bring.

Data centers represent one of the least visible but most crucial parts of our modern infrastructure. So reliant has society become on data centers that 100 percent uptime is now often an essential aspect of their operation. Despite all the precautions taken during the design and operation of data centers, situations can arise in which external power is compromised, either in terms of quality or availability. Such events could result in data loss, nonavailability of essential services, risk to hardware and, potentially, financial losses of millions of dollars. For these reasons, highly dependable uninterruptible power supplies (UPSs) are increasingly mission-critical for the data center industry. UPS design must optimize cost of ownership, flexibility, energy usage, reliability and availability. For these reasons, ABB has made standardization and modularization cornerstones of UPS design.

Estimates as to the number of stone blocks used in the Great Pyramid of Giza vary wildly – from half-a-million to over four million. But one thing is certain: Standardized sizing and procedures were used to cut, move and place the blocks. Only by introducing standardization could the mammoth task of building the pyramid be completed in such a short time (a few decades). That the structure still survives, relatively intact, after nearly five thousand years is a testament to the techniques, standardization prominent among them, employed by these ancient master builders.

A vastly more complex structure is silently being constructed all around us today – the immense labyrinth of data upon which our modern society depends. At the nodes of this labyrinth sit data centers, each containing almost unmeasurable quantities of information. Not so long ago these data storage behemoths were the humble “computer rooms” owned by companies of any reasonable size and run by the company IT department. No two rooms
would have had the same infrastructure, even within the same company – one-off designs, expansions and replacements guaranteed that. Over the years, IT infrastructure grew to be of a complexity that could not be designed, deployed, maintained or managed by individual companies and they came to realize that this non-core activity is best handled by experts. Coupled with the explosion of data generated by companies and individuals, this trend has led to an almost exponential growth in the number of data centers.

This article will focus on the advantages that modular and standardized ABB uninterruptible power supplies (UPSs) bring to the data center.

**UPS**

Power disturbances come in many guises: On top of total power outages and blackouts, the voltage may sag or swell over short periods. It may also do so over longer periods – so-called brownouts or overvoltages. And there can be electrical noise on the line, or frequency variation, or harmonics may appear in the voltage.

A UPS remediates all of these.

A UPS will condition incoming power. Spikes, swells, sags, noise and harmonics will all be eliminated. In the case of total power failure, power will be supplied from batteries or other energy storage systems. A backup generator will kick in for longer power outages. This ensures that data center operation is available 24/7 and that no data corruption or loss will occur.

No modern data center can operate without a capable UPS.

**Modularity**

ABB Newave were pioneers in UPS technology. In fact, two of most important current architectural trends in the UPS market today - transformerless and modular UPS –were concepts developed in ABB Newave’s early years. The latter concept is now embodied in ABB Newave’s decentralized parallel architecture (DPA™) – the essence of modularity. With DPA, each 100 kW UPS module contains all the hardware and software required for full system operation. The modules share no common components - each UPS module has its own independent static bypass, rectifier, inverter, logic control, control panel, battery charger and batteries. With all the critical components duplicated and distributed between individual units, potential single points of failure are eliminated. In the unlikely event of one UPS module failing, the overall system will continue to operate normally, but with one module
fewer of capacity. The failed module will be fully disconnected and will not impact the operating modules.

Each module is fully independent and modules can simply be combined like Lego™ bricks as desired. This powerful scalability approach means the UPS can be sized exactly to fit prevailing needs and modules can simply be added as requirements grow (five 100 kW modules can be mounted in one rack and six racks can be configured in parallel to provide a top rating of 3 MW in the Conceptpower DPA 500 model). This means that you only power, cable and cool what you need. Power consumption is the topic of greatest concern for data center operators and the energy savings made by this modular approach over the service life of the UPS are substantial.

Human error is reduced too: Because things are so simple, wiring errors are eliminated and configuration and reconfiguration are child’s play.

Vertical scalability: one to five modules in one single cabinet

Horizontal scalability: cabinets in parallel configuration up to 3 MW

Diagram 1: Scalability up to 3 MW

Hot-swapping
Modules can be hot-swapped too, 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 mean time to repair (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.
This online-swap technology, along with significant reductions in repair time, can help achieve so-called six nines (99.9999 percent) availability - highly desirable for data centers in pursuit of zero downtime.

**Cost of ownership**

The modularity and scalability described help minimize the cost of ownership, but costs are held down too by implementing 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 in data centers are substantial. 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 – ideal for data centers, where real estate can be restricted and expensive. A modular UPS rack has a small footprint and when extra modules are added, no extra floor space is taken up.

But the advantages of standardization and modularity go further as installation and servicing costs are also kept low: A straightforward, standardized modular concept simplifies and speeds every step of the deployment process - from planning, through installation and commissioning to full use. High-quality standardized products significantly reduce intervention time during maintenance or in the event of failure - components can be changed quickly and easily, service is simplified and modules can even be hot-swapped. Agility is maximized.

**Diagram 2:** Centralized UPS solution (large and small data centers can now be built by using the same pre-designed, pre-manufactured and pretested sub-systems as building blocks)
Standardization also enables the use of ready-made interfaces and management modules, and simplifies integration with data center systems, such as ABB’s Decathlon data center monitoring software [1]. Such standardized equipment monitoring systems provide simple management tools that promote predictive maintenance so that problems can be identified before they become significant. This reduces reliance on scheduled preventative.

**Reliability and availability**

UPSs play a vital role in ensuring IT reliability and, thus, data availability. As a result, the reliability of the UPS itself is a major consideration. Any time a UPS fails and becomes unavailable, mission-critical electrical loads are put at risk. 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.

Mean time between failures (MTBF) and MTTR are common parameters in the UPS industry and both impact system availability. Availability, a measure of how good the system is, is formally defined as:

\[ \text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}} \times 100\% \]
Modular UPS designs minimize the system's MTTR. The modular DPA concept allows the modules to work as one system but without interdependence. Quick and simple repair by swapping modules, which can be held as spares on-site or at a nearby service center, minimizes the system's MTTR. Not only does this improve availability but it also reduces cost as service engineers need less training and spend less time on-site, and any risks of data or production loss are minimized. Inventory levels of specialist spare parts are reduced.

Modularization can increase the number of components in a UPS and the number of interconnections. At first sight, this may risk reliability degradation, but, in fact, the overriding advantages of modularization more than compensate: The better quality that results from the mass production and testing made possible by standardization has a direct positive impact on reliability; 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 from bad connections in the field – one of the biggest bugbears in any technical setting. In addition, modular components can be returned to the manufacturer for service, which greatly improves repair quality - factory-repaired UPS power modules are many times less likely to cause outages, introduce new defects or inhibit return to fully operational status compared with field-repaired modules. The ability to perform factory repair is a significant reliability advantage [2].

**Future key elements**

Historically, the processes and physical infrastructure in data centers have grown in a largely uncontrolled way. ABB’s approach to this problem is to supply turnkey solutions that provide most of the datacenter infrastructure and that rely heavily on standardization and modularity to ensure that data center processes and equipment are optimized. This minimizes the total cost of ownership for the data center owner or operator, while providing him with a flexible, reliable, agile and environmentally attractive infrastructure. The overwhelming benefits of modular UPSs have been taken as a case in point to illustrate the many advantages of this approach. ABB Newave were pioneers in UPS technology and see standardization and modularity as key elements in data center design for the foreseeable future - not just for UPS systems but for all the systems found in a data center.

**References**
