Two-Stage Power Distribution: An Essential Strategy to Future Proof the Data Center

Adapting to Change

Concern over the pace of technology change is increasing among data center managers. This was reflected in the fall 2014 Data Center Users' Group™ (DCUG) member survey, sponsored by Emerson Network Power. When asked to identify their top facility/network concerns, respondents cited technology changes as the second biggest concern – just one percentage point behind their top concern, adequate monitoring/data center management capabilities. Just one year earlier, concern over technology change was ranked fifth.

One way businesses have traditionally planned for change in the data center was by oversizing infrastructure systems and letting the data center grow into its infrastructure. There are two problems with this approach. First it is inefficient in terms of capital and energy. Businesses are no longer willing or able to support large blocks of unused infrastructure capacity. In addition, as the number of devices within each rack continues to grow, inflexible power distribution architectures can slow growth and delay deployment of new equipment—even when plenty of "power capacity" still exists.

Businesses are now moving to more inherently scalable data center designs to delay investments in infrastructure until they are needed. As part of these designs they are implementing a two-stage power distribution architecture, which provides greater flexibility in dealing with change.

How it Works

Having the right power distribution system can play a significant role in achieving high levels of application availability and scalability.

Single-Stage Distribution

In traditional power distribution designs (often referred to as single-stage distribution) the UPS feeds a required number of centralized power distribution units (PDUs), which then distribute power directly to equipment in the rack (Figure 1). This was adequate when the number of servers and racks was relatively low, spread out and the pace of technology change was slower. However, this approach can present scalability, flexibility and efficiency challenges for today's dynamic, higher-density data centers.

For instance, each centralized PDU has a set number of breakers that feed power to the racks. Data centers often expend all of the available breaker positions before they run out of rack or server space, resulting in stranded capacity. The only way to add new equipment or racks is to install another PDU, which is an added expense and could potentially disrupt data center operation. This also hinders incremental growth and could put unnecessary delay on the needed capacity growth. The traditional single-stage PDU still works well in the under 150-225 kVA sizes with 84 to 126 poles.

Another issue with this approach is the congestion caused by all the cabling needed as these PDU had between 84 and 168 poles which requires a large number of flex conduits under the floor which usually impedes airflow and can cause cooling issues.

In 2011 OSHA under regulation 29 CFR 1910.333(a)(1) which requires "Live parts to which an employee could be exposed must be de-energized before the

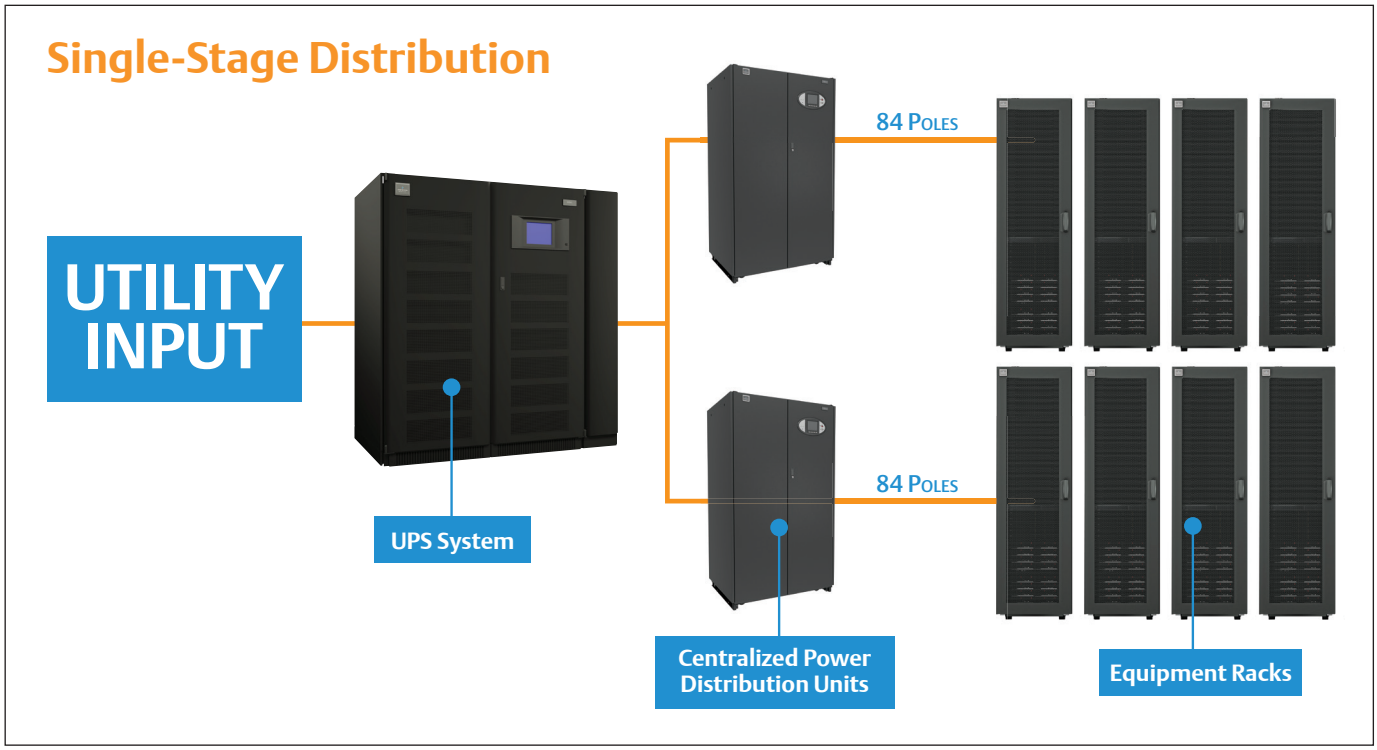


Figure 1

employee can work on or near them" dramatically changed the way we employ PDUs in a data center. Under this regulation OSHA requires the entire PDU be shut down anytime work is done in the PDU or a circuit added. This causes significant issues in the data center as the IT equipment powered by that PDU must be shut down. Because of the open area between panelboards you cannot just shut down one panelboard while the rest are energized but must shut down the entire PDU.

Two-Stage Distribution

Two-stage power distribution represents a proven alternative that compartmentalizes distribution between the UPS and the server to enable greater flexibility and scalability, and more effective use of valuable data center floor space (Figure 2) and partially mitigates the impact of the OSHA regulation. In two-stage distribution the PDU section takes 480 or 600V input, contains a transformer to step down to 240/415V or 120/208V and provides a separately derived Neutral to Ground bond for proper IT server grounding. This approach works best in the 300 to 500 kVA range.

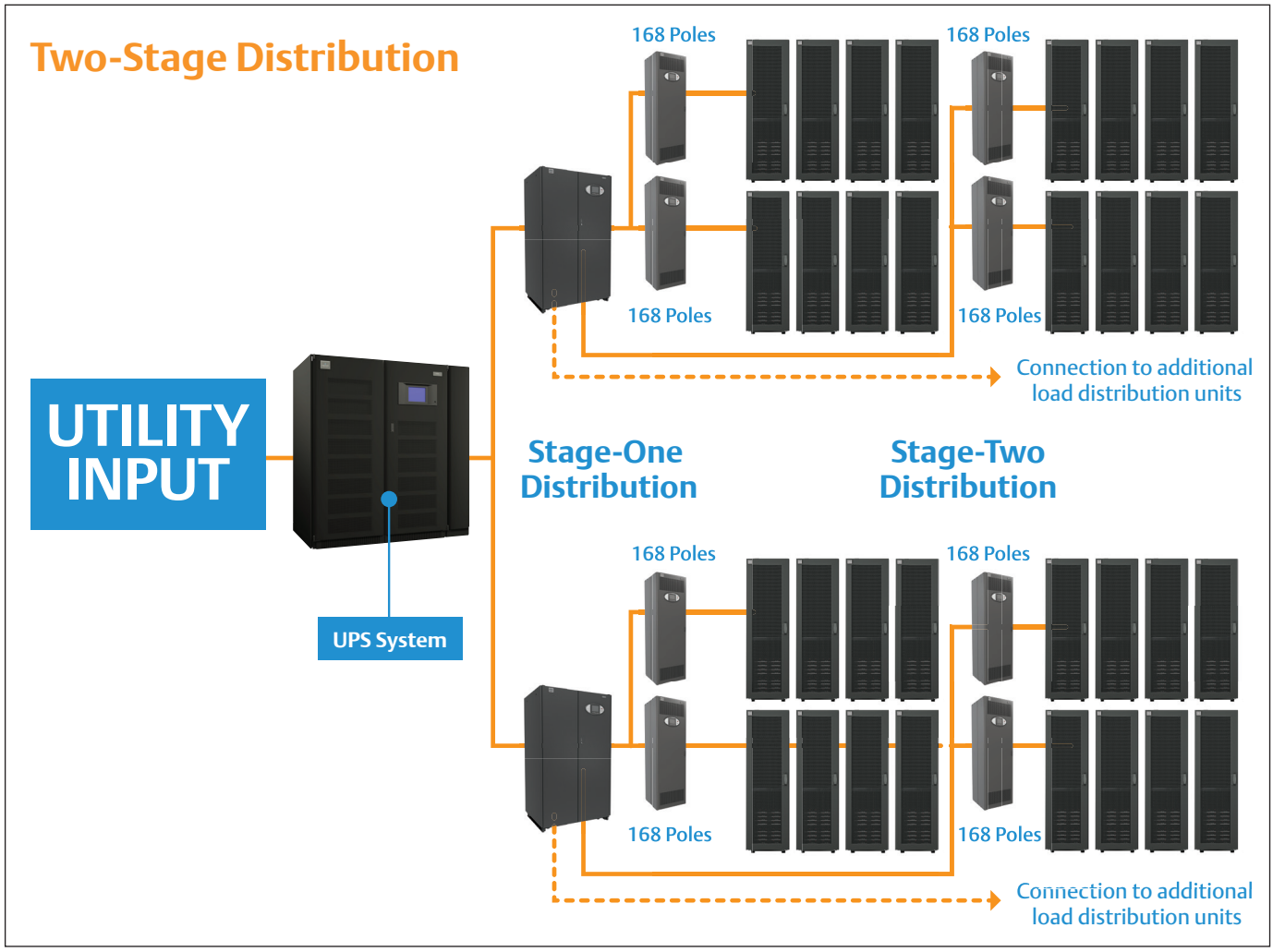


Figure 2

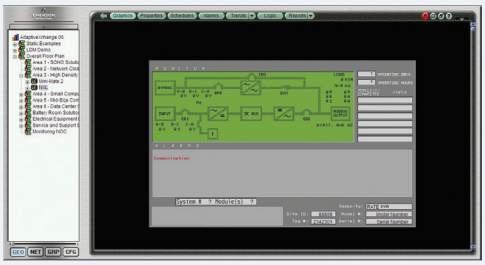
The first stage PDU includes most of the components that exist in a traditional PDU except the panelboard have been removed and replaced with 4-12 250-400A sub-feed breakers that feed out to Remote Power Panels (RPP). The floor-mounted RPPs provide the flexibility to add plug-in output breakers of different ratings as needed. The RPP feeds out to Rack PDUs installed in the IT cabinets which power the installed servers and other IT equipment. The RPP is available in two configurations: in an IT cabinet format or in a panel format. The IT cabinet format is 24" wide and 38" deep so it easily can be positioned on the end or in the center of rack rows. The IT cabinet configuration usually has one 400A 84 pole or two 225A 42 pole panelboards in the front and the same in the rear, and is usually fed with two feeds, one for the front and one for the rear. If specified completely barriered between front and rear then the one side can be shut down for servicing while the other is energized. The panelboard RPP is a single 12" x 24" panel with one circuit and one 400A 84 pole panelboard. They can be mounted singularly or in pairs against a wall or cage, or two back to back, which become a drop-in replacement for a floor tile. The RPP is fed with a single input from the PDU, which limits disruption of airflow and all the branch circuits are short and run directly under the row of racks, which limits underfloor air dams and allows the area under the aisles to remain free to distribute cooling air.

Since each RPP is totally separate and isolated it can be shut down for servicing or circuit addition without affecting the other RPPs or the PDU itself. In a dual cord enviroment the IT equipment remains powered if the two cords are fed off of different RPPs or better yet, off of different PDU/RPP sets. When servicing, power would be shut off to one cord while the other remains energized, which should keep the IT equipment up and running.

Case in Point:
A major healthcare provider implemented this two-stage power distribution architecture.

In short order they were able to:

- Meet business goals of adding over 100 new servers per year to support new initiatives and applications
- Increased their scalability and flexibility to create a dynamic infrastructure
- Activated branch circuit monitoring that measures the electrical load every second and communicates to temperature sensors in the racks
- Combined with Liebert SiteScan, critical site monitoring and management software
- Enhanced overall availability and efficiency



When servers were fed directly by two pole 20A circuits the traditional 225A 42 pole panelboard worked well. However, today the servers are fed by Rack PDUs which require 3 pole 30-60A breakers, which quickly overload the 225A capacity of the traditional panelboards. The solution is to go to 400A

panelboard which can feed nearly twice as many 30-60A Rack PDUs as the traditional 225A panelboard. With dual cords you must feed each with two circuits which doubles the number of circuits that the RPP must have which has led to the 84 pole panelboard being deployed.

The use of two stages separates deliverable capacity and physical distribution capability into separate systems to eliminate the breaker space limitations of the traditional PDU. The RPP unit can be configured to meet the specific requirements of the technology it directly supports, while the PDU remains unchanged.

If the PDUs are sized properly, a series of growth cycles can be supported by adding breakers to the PDU and additional RPPs as required. This creates the ability to rapidly and cost-effectively scale the power distribution system. If the future breakers are installed initially and run out to underfloor J-boxes, then adding new RPPs can be accomplished without disrupting operations.

This is ideal for data centers that are based on modular design. It also eliminates the possibility of stranded capacity and increases utilization rates.

Another advantage of this approach is its affect on data center airflow. With two-stage distribution, under-floor cabling is significantly reduced. Cross-aisle cabling is limited to the feeds that run from the PDU to the RPP. Distribution from the RPP, which are typically placed alongside IT equipment racks, runs vertically below, or through, the racks, keeping cold aisles free from power cables, as well as reducing the lengths of cable needed to feed the rack-level equipment.

This has the added benefit of enhancing the efficiency of the distribution system by enabling fewer, larger power paths from the UPS to the PDU and shorter paths from the RPP to the Rack PDU at the point of consumption. Finally, two-stage power distribution increases rack-level flexibility, enabling data centers to efficiently and rapidly adapt to changing equipment requirements and increasing densities.

Increasing Data Center Intelligence

As the last link in the power chain delivering critical power to IT loads, intelligent rack PDUs (Figure 3) are a strategic asset for achieving high availability through elevated levels of responsiveness to change in data center capacities and densities. They enable improved control by providing continuous measurement of volts, amps and watts being delivered through each receptacle. This provides greater visibility into increased power utilization driven by virtualization and consolidation. It can also be used for charge backs, to identify unused rack equipment drawing power, and to help quantify data center efficiency.

Figure 3

Alternately, a busway (Figure 4) can be used to support distribution to the rack. The busway runs across the top of the row or below the raised floor. When run above the rack, the busway gets power distribution cabling out from under the raised floor, eliminating obstacles to cold air distribution. The busway provides the flexibility to add or modify rack layouts and change receptacle requirements without risking power system downtime. Busway distribution is proving to be an effective option that makes it easy to reconfigure and add power for new equipment.

Figure 4

Conclusion

As the data center becomes more dynamic, there is a growing need for a power system infrastructure capable of rapidly adjusting to changes in the number, density and location of equipment in the data center.

Two-stage power distribution, which separates primary PDU distribution from load-level RPP distribution, offers IT professionals the ability to distribute power to the rack to support high availability and better resource utilization. It delivers more granular power distribution, lower PUE and incremental growth that maximize efficiency and supports fast deployment.

Benefits Summary of Two-Stage Power Distribution

- Enables greater IT flexibility and scalability
- More effective use of floor space
- Reduces stranded capacity and increases utilization rates
- Improves data center airflow
- Enhance efficiency levels of the distribution system

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