

APPLICATION BRIEF

Situation: The Data Center Power Distribution Approach Is Shifting

With Artificial Intelligence (AI), Machine Learning (ML), hyperscale storage, and High-Performance Computing (HPC) pushing power demands into the stratosphere, data centers are under immense pressure to radically evolve.

Racks that once delivered 10–30 kW are now being asked to supply 100 kW or more—on their way to 150+ kW in some of the most advanced AI-driven facilities. This rapid escalation in rack power density is outpacing the space, thermal, and electrical limits of today's 48 V infrastructure.

As the payloads become denser, hotter, and more power-hungry, a fundamental rethink of rack-level power distribution is underway.

Bourns has anticipated the power distribution requirements energy architects now face with this transformation. This application brief outlines the challenges and trends that must be addressed in powering the future of data centers. It also provides key magnetic solutions being developed by Bourns to support current as well as tomorrow's data center power architecture requirements.

Evolving Trends Shaping Next-Generation Data Centers

Escalating Rack Power Demands

Next-generation ML and AI processors significantly increase chip and rack power. Therefore, power delivery is becoming one of the bottlenecks. As chip power scales exponentially, rack designs can no longer allocate valuable space to AC-DC converters and battery backup systems. Space must be reclaimed for computing payloads that include GPUs, TPUs, and high-speed memory.

Limitations of Today's 48 V Systems

While 48 VDC has served as a reliable intermediate bus voltage for years, its scalability is hitting hard limits, causing new design dilemmas:

- Bulky busbars are needed to handle higher current.
- Connector power handling requires active cooling to prevent thermal issues.
- AC-DC and UPS systems increasingly dominate rack real estate.

The result? 48 V-based architectures struggle to support rack loads above 100 kW efficiently, both electrically and spatially.

The Shift Toward High-Voltage DC

To overcome these limitations, the industry is now exploring a transition to ± 400 VDC architectures, borrowing from the maturity of the EV ecosystem. This evolution enables:

- The relocation of AC-DC and backup systems out of the payload rack, freeing up valuable space.
- Improved power delivery density, enabling smaller conductors and fewer losses compared to 48 VDC.
- Better compatibility with solid state transformers, microgrids, and renewable integration — all paving the way for more sustainable and resilient infrastructure.

Voltage Options Compared

Architecture	Pros	Cons
0–400 VDC	Mature EV components, safer insulation, 2x power delivery	Bulkier cabling, lower efficiency vs. 800 V
0–800 VDC	Lighter, more efficient, better battery density	Higher isolation/safety requirements, newer ecosystem
± 400 VDC	Combines benefits of both 0-400 VDC & 0-800 VDC; higher density and flexibility	More complex wiring (2-3 wires), control complexity

Design Challenges & Opportunities

Challenges

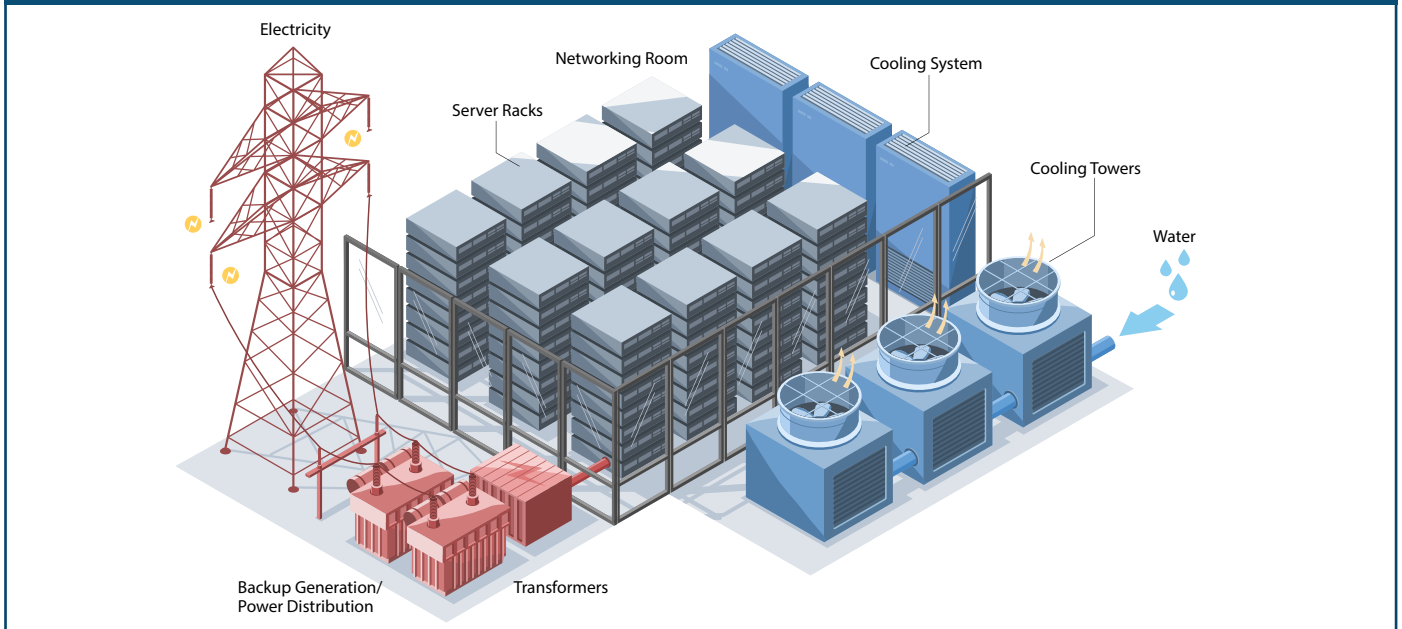
- **Safety:** Arc flash, touch current risks, and high-voltage cable management introduce new reliability and compliance issues.
- **Compatibility:** Legacy 48 V payloads cannot directly interface with ± 400 VDC systems.
- **Infrastructure Cost:** Implementing ± 400 VDC requires rethinking rack infrastructure, grounding schemes, and the need to facilitate power flows without compromising benefits from rack DC distribution.

Opportunities

- **Energy Efficiency:** Higher-voltage systems reduce I^2R losses and boost Power Usage Effectiveness (PUE).
- **Future-Proofing:** Systems built around ± 400 VDC are better prepared for next-generation AI and ML loads, which are 10 times more energy-intensive than traditional workloads.
- **Microgrid Integration:** The transition to ± 400 VDC dovetails with the advancements achieved with solid state transformers and direct renewable energy inputs, aligning with ESG and sustainability goals.

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Main Components of a Typical Data Center



Solution: Bourns Magnetics Innovation

As power distribution systems evolve, so too must the passive components in order to help ensure clean, reliable, and efficient energy delivery. Bourns is already innovating across its entire magnetic products portfolio to supply the right capabilities needed for this next chapter:

1. High-Voltage Transformers and Inductors

Engineered for operation at 400–800 VDC, Bourns® power transformers and power inductors enable compact, thermally stable, and efficient voltage conversion stages for emerging DC-DC designs that include onboard payload racks or those centralized in sidecar power shelves.

2. EMI Suppression and Common Mode Chokes

Higher voltages and faster switching speeds increase EMI/RFI risk. Bourns® common mode chokes provide essential filtering that helps maintain signal integrity and standards compliance and supports PCB footprint limitations.

3. Custom Magnetics for DC Power Distribution

From busbar-mounted power modules to high-density energy storage interfaces, Bourns has extensive experience in delivering application-specific custom magnetics designs that support space-constrained, thermally demanding, and safety-critical data center deployments.

Benefits: Collaborative Innovation for What's Next

Bourns engineers recognize the urgency of enabling the industry's transition to a more powerful, efficient, and sustainable data center infrastructure. That's why Bourns is working in close collaboration with OEMs, cloud providers, and rack designers to develop:

- Advanced ± 400 VDC interface components, including isolation transformers, power inductors, filters, and custom magnetics.
- Conversion solutions to bridge legacy 48 V systems with emerging ± 400 VDC infrastructure, such as 400 V-to-48 V shelves.
- Modular, scalable magnetic solutions for sidecar power racks that support future-ready compute payloads.

Future-Proofing Data Centers Starts with Smarter Power

Data centers must evolve—not just in compute capability, but in the way they manage power. The shift to ± 400 VDC is no longer a theoretical future; it is a near-term necessity. With Bourns as a trusted partner for state-of-the-art power distribution solutions, data center architects and operators can confidently transition to the next generation of power delivery, unlocking higher densities, greater efficiencies, and supporting what's needed to power the future – rack by rack.