STORM POWER COMPONENTS

Industry Spotlight

Powering AI Data Centers: What Rising Rack Density Means for Busbar Design

A traditional enterprise data center rack draws roughly 5 to 10 kW. An NVIDIA GB200 NVL72 rack draws about 120 kW, and the GB300 NVL72 runs up to 142 kW. Roadmaps for the next rack generation go much further. NVIDIA's Kyber architecture targets roughly 600 kW per rack for Rubin Ultra, with 1 MW racks discussed beyond that.

That jump in power requirements changes the electrical design problem. Moving this much power inside a rack, a row, and a data hall comes down to conductors, joints, insulation, and heat. Those are busbar problems. This article covers what higher density means for busbar design, and where early engineering decisions pay off.



Why is current the first constraint?

Power is voltage times current. Today's AI racks distribute power at about 54 VDC inside the rack, so rising power means rising current. Using the figures in this analysis of 800 VDC architectures, a 1 MW rack at 54 V carries roughly 18,500 A. The same rack at 800 V carries about 1,250 A.

NVIDIA states that powering a 1 MW rack at 54 VDC requires up to 200 kg of copper busbar. It also says that at the 1 MW scale, 54 VDC power shelves would consume up to 64U of rack space, leaving no room for other components. Vertiv puts the breaking point for the traditional approach between 350 and 400 kW per rack, where connector sizes, busbars, and the volume of copper "start to run out of room." The industry response is a move to 800 VDC distribution. NVIDIA reports that 800 V busways allow 85% more power through the same conductor size and reduce copper requirements by 45%.

Industry Spotlight:

Busbar Designs for Powering AI Data Centers with Rising Rack Density

For busbar designers, these changes are driving two overlapping problem sets.

Problem set 1: Very high current at low voltage

Racks built today still rely on 48 to 54 VDC distribution, and some rack-scale systems specify busbars rated to ±48 V and 1,400 A. At these currents, small inefficiencies add up quickly.

- **Conductor sizing and thermal rise.** Ampacity tables are a starting point, but real parts have bends, tabs, holes, and multiple input and output connections. Those features concentrate current and create hot spots that a simple table will not predict. The Storm Bus Bar Profile vs. Current Density Sizing Guide is a good first-pass tool, which can be validated via Storm's in-house testing processes.
- **Joint resistance.** At thousands of amps, a bolted joint with a few extra micro-ohms of contact resistance becomes a heat source and a long-term reliability risk. Plating choice matters here. Tin offers low contact resistance at low cost, nickel suits harsher environments, and silver supports high-temperature, low-resistance joints. For aluminum busbars, which are attractive for weight and cost, Storm applies an electroless nickel strike before the final finish to create a reliable joint interface. See Storm's plating design guide for the full trade-off matrix.
- **Material selection.** Copper carries more current per unit of cross-section. Aluminum is lighter and often cheaper at scale. The right answer depends on current density, available space, weight limits, and joint design. Storm stocks more than one million pounds of copper and aluminum at its Decatur, Tennessee facility, which helps with both prototypes and production ramps.

Problem set 2: Higher voltage and faster switching

As architectures move toward 800 VDC and silicon carbide and gallium nitride power stages, the design priorities shift.

- **Insulation system.** Lower current allows thinner conductors, but higher voltage raises requirements for dielectric strength, creepage, and clearance. Laminated busbars from Storm bond conductor layers with thin dielectrics, typically 5 to 10 mils thick, in materials ranging from Mylar and epoxy glass to Kapton and epoxy powder coat. Each material trades off temperature rating, dielectric strength, dielectric constant, and cost. Edge treatment also matters, with open edge, pinch seal, epoxy-filled, and FR4 edge protection options available.
- **Low inductance.** Fast-switching converters need a low-inductance power loop to limit voltage overshoot and electromagnetic noise. A multi-layer laminated busbar places oppositely charged conductors in close, parallel layers so their magnetic fields cancel, which reduces stray inductance compared with discrete conductors or cable. The fused structure also resists vibration damage.
- **Partial discharge.** At higher voltages, tiny air gaps or surface imperfections within the insulation can cause partial discharge. Left unchecked, it erodes the insulation over time and can lead to failure. Storm runs partial discharge testing when specified for higher-voltage systems. Designers should call it out on the drawing early, not after a field failure.
- **Dielectric testing at the right level.** Storm generally runs HiPot tests at 2 times operating voltage plus 1,000 V. For an illustrative 800 V working voltage, that is 2,600 V. Final test levels should come from your system specification and applicable standards.
- **Flexbraid Options.** Flexible connections help with assembly. Hot-swappable trays, tolerance stack-ups, and vibration all create mechanical stress on rigid joints. Storm's standard UL recognized FlexBraid connectors are available in single to four-braid configurations, including custom braids up to 6" wide and around 4300 Amps each. They provide flexibility in tight spaces and isolate rigid busbars from movement.

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A pre-release checklist for AI power busbars

Before releasing a busbar drawing for an AI rack or power distribution application, confirm the following:

1. **Current profile:** Continuous and peak current, duty cycle, and ambient conditions are defined.
2. **Joint design:** Plating, hardware, torque, and surface prep are specified together.
3. **Voltage class:** Working voltage, insulation material, edge protection, and creepage and clearance are defined.
4. **Test plan:** HiPot, partial discharge, and insulation resistance (Megger) tests are called out with acceptance limits.
5. **Cooling approach:** Air, liquid, or conduction paths are identified before conductor layout is locked.
6. **Fully dimensioned prints:** Complete drawings reduce questions and lead time. See Storm's guidance on better drawings.
7. **Volume plan:** Prototype quantities and production ramps are matched to material availability.

Working with Storm Power

Storm Power Components has manufactured custom electroplated and insulated busbars since 1990. The Tennessee facility is AS9100D and ISO 9001:2015 certified, and all capabilities, including fabrication, plating, lamination, flexible connectors, and electrical testing, are available under one roof. Storm's engineers support busbar design from concept and material selection through DFM guidance and testing.

If your team is developing power distribution for high-density compute datacenters, talk to Storm early. A short design review can prevent costly redesigns later. **Request a Quote. Call 800-394-4804**

