



AI Datacenter Power Electronics: Capacitor Solutions

THE AI DATACENTER OPPORTUNITY

AI server racks now consume 60-140 kW each, with NVIDIA's GB200 NVL72 systems operating at approximately 120 kW per rack. Industry roadmaps indicate flagship AI racks will reach 600 kW by late 2027 with the introduction of Rubin Ultra NVL576 systems, reflecting a fundamental shift in datacenter power architecture.

The industry is transitioning from 54 VDC in-rack distribution to 800 VDC architecture. NVIDIA's published 800 VDC reference design enables 85% more power transmission through the same conductor size while reducing copper requirements by 45% compared to traditional 415 VAC distribution.

The design challenge: Power supply units have scaled from 3.3 kW to 12+ kW per unit, requiring capacitors that can handle extreme ripple currents, provide reliable hold-up time, and absorb violent load transients. GPU clusters surge from idle to full load in milliseconds during training batch initialization, repeating every 1-2 seconds—a demand profile traditional power infrastructure cannot handle.

CAPACITOR JOBS IN AI DATACENTER POWER SYSTEMS

Job 1: DC Link / Hold-up Time

THE CHALLENGE: Smooth rectified voltage, stabilize the high-voltage DC bus (400V-800V), and provide 20ms hold-up time at full load during line-cycle dropouts. A 12 kW PSU requires 240 joules of stored energy.

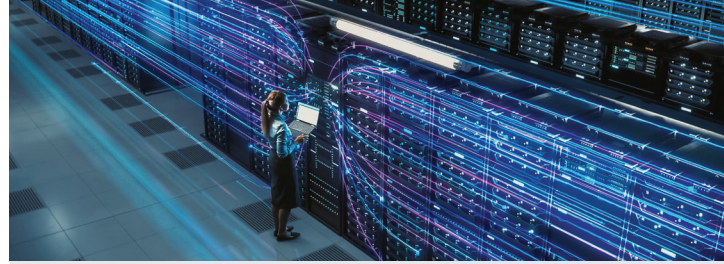
REQUIREMENTS:

- High ripple current handling (>50A RMS)
- Low ESR and ESL for fast switching (GaN/SiC compatible)
- Long operational life (100,000+ hours)
- Voltage ratings 800-1400 VDC



RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
944L Series	DC Link Film	90A ripple, 10-15nH ESL	Industry-leading ripple current
BLS Series	Automotive Film	125°C, AEC-Q200	Extended temperature
AI Electrolytic	AI Elec	High capacitance density	Bulk energy storage



Job 2: LLC Resonant Tank

THE CHALLENGE: Enable soft-switching in LLC converters for 98%+ Titanium-rated efficiency. Capacitance must remain stable across voltage and temperature—any drift degrades efficiency.

REQUIREMENTS:

- Stable capacitance (C0G dielectric preferred)
- High voltage rating (630-1500 VDC)
- Ultra-low loss ($\tan \delta$)
- Tight tolerance ($\pm 5\%$ or better)

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
C0G HV MLCC	Ceramic	630-1500V, stable vs. bias	Replaces film, smaller
StackiCap	Hybrid MLCC	250V-1.2kV	HF filtering + bulk
Power Film	Polypropylene	Low loss, self-healing	High Q resonant circuits



Job 3: EMI Filtering (AC Input)

THE CHALLENGE: Suppress common-mode noise at the AC input while meeting safety standards (IEC 62368-1, FCC Class A). Y-capacitors must limit leakage current while bridging isolation barriers.

REQUIREMENTS:

- Safety certification (X1/Y2 per EN60384-14)
- Open-circuit failure mode
- High working voltage (310-500 Vrms)

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
X1/Y2 Safety MLCC	Ceramic	500 Vrms (highest in ceramic)	60% smaller than film Y-caps
FlexiCap X1/Y2	Ceramic	Flexible termination	Thermal cycling reliability



Job 4: VRM Output Filtering

THE CHALLENGE: Deliver clean DC to GPU loads requiring 700-1200W per chip at sub-1V core voltages. Current slew rates exceed 1000 A/ μ s during load transients.

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
Aluminum Polymer	Al Polymer	Low ESR, 10,000+ hr life	Fast response, no dry-out
SV Series	Stacked MLCC	Smaller than electrolytic	Reduces board footprint





Job 5: Peak Shaving / Transient Absorption

THE CHALLENGE: Absorb GPU load transients (0-200% in 500µs) occurring every 1-2 seconds during AI training. These violent fluctuations can threaten grid stability.

INDUSTRY VALIDATION: NVIDIA GB300 NVL72 systems integrate supercapacitors as a standard feature in the power supply architecture to smooth power spikes and reduce peak grid demand by up to 30%. This approach addresses the synchronous power behavior of large-scale GPU clusters, where thousands of accelerators operate in lockstep and create coordinated demand spikes during training workloads.



RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
Supercapacitor Modules	EDLC Supercap	Up to 3000F, 0.29mΩ ESR	High-current transients
DGH/DSF Modules	3-Cell Module	6.9-9.0V, internal balancing	PCB-ready
Hybrid LIC	Li-ion Capacitor	Higher energy density	Extended hold-up



Why Knowles + Cornell Dubilier

COMPLETE PORTFOLIO: MLCCs, film, aluminum electrolytic, aluminum polymer, and supercapacitors—the right technology for every job.

800V ARCHITECTURE READY: Products qualified for the emerging 800 VDC datacenter standard. 944L delivers 10-15nH ESL compatible with GaN and SiC switching speeds.

DESIGN SUPPORT: CDE thermal and life calculators for accurate hold-up time sizing. Application engineering for custom DC link assemblies.

PROVEN RELIABILITY: 944L validated to 100,000+ hours. Supercapacitors rated for 500,000+ charge/discharge cycles.