EV DC Fast Chargers: Capacitor Solutions

EV charging infrastructure is the backbone of the electrification revolution, enabling fast, reliable energy transfer for electric vehicles at scale. From ultra-fast DC chargers to advanced power conversion systems, this segment demands components that deliver high efficiency, thermal stability, and long-term reliability under extreme electrical loads.

In DC Fast Charging, power levels are climbing fast—350–480 kW chargers are now standard among major CPOs.

The design challenge: A typical charger uses a modular architecture of paralleled 30 kW power blocks. Selecting the right capacitor technology for each power conversion stage is critical to achieving efficiency, thermal performance, and the 15–20 year outdoor service life these systems demand.

CAPACITOR JOBS IN DC FAST CHARGERS

Job 1: EMI Filtering (Three-Phase AC Input)

THE CHALLENGE: Suppress conducted emissions on the 380–600 VAC three-phase input and meet IEC 61000 limits while handling up to 400A RMS per phase at 250 kW.

REQUIREMENTS:

- X1/Y2 safety certification per EN60384-14
- Voltage ratings 310–500 Vrms
- High current capability for three-phase systems
- Compact footprint with adequate creepage distances

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
X1/Y2 Safety MLCCs	Ceramic	310–500 Vrms, 1500 Vdc rated	Highest voltage ceramic safety cap, FlexiCap option
2720 Case Size	Ceramic	5mm creepage distance	Meets safety spacing for 480 VAC systems

Job 2: PFC Boost / DC Bus Capacitance

THE CHALLENGE: Smooth the rectified output from the PFC stage and stabilize the 650–800 VDC bus. Vienna rectifier and T-NPC topologies with SiC MOSFETs are driving higher switching frequencies and tighter ESL requirements.

REQUIREMENTS:

- Voltage rating 800–1400 Vdc
- High ripple current handling
- Low ESR and ESL for SiC switching compatibility (100+ kHz)
- Long operational life for outdoor infrastructure

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
944L Series	DC Link Film	800–1400 Vdc, 90A ripple, 10–15 nH ESL	Purpose-built for high-power PFC stages
StackiCap	MLCC	250V–1.2 kV, high RMS current	HF decoupling close to SiC switches

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Job 3: DC Link (Between PFC and DC-DC Stages)

THE CHALLENGE: Buffer energy between the PFC output and DC-DC input, absorbing ripple from both stages. In DCFC, ripple current—not hold-up time—is the primary sizing driver. Film capacitors are strongly preferred over aluminum electrolytic.

REQUIREMENTS:

- ~25A RMS ripple current per 30 kW module
- Sub-10 mΩ ESR, low ESL (<15 nH)
- Self-healing capability for long outdoor service life
- Compact: 4 film caps replace 10 aluminum electrolytics at 15× less volume

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
944L Series	DC Link Film	33–220 µF, 90A ripple, self-healing	4 caps replace 10 electrolytics, 10× longer life
BLS Series	Automotive Film	125°C rated, AEC-Q200	Infrastructure-grade reliability, 2000 hr 85/85
StackiCap MLCC	Ceramic	Ultra-low ESL	Hybrid: MLCCs within 10mm of switches for HF filtering

Design Note: The optimal DC link combines film capacitors for bulk energy and ripple handling with MLCCs placed close to switching devices for high-frequency decoupling. Film dissipates ~1W each vs. ~8W for aluminum electrolytic—critical in enclosed outdoor cabinets.

Job 4: Resonant Tank (LLC/CLLC DC-DC Converter)

THE CHALLENGE: Form the resonant circuit for soft-switching in LLC or CLLC converters. DAB-ZVT topology is gaining adoption for better efficiency across the wide 200–1000 VDC output range needed to serve both 400V and 800V battery architectures.

REQUIREMENTS:

- Stable capacitance vs. voltage and temperature (C0G dielectric)
- Low loss factor (tan δ)
- Tight tolerance (±5%)
- High ripple current capability

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
C0G HV MLCCs	Ceramic	630–1500V, zero capacitance drift	Lowest loss among ceramics for resonant circuits
Power Film	Film	Low-loss polypropylene	High Q factor for resonant tank applications

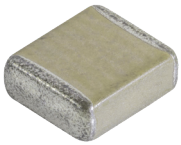
Job 5: Output Filtering (DC to Vehicle Battery)

THE CHALLENGE: Deliver clean DC to the vehicle battery across a wide 200–1000 VDC output range with minimal ripple on the charging current.

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
Aluminum Polymer	Polymer	Low ESR, 10,000+ hr life	Bridges electrolytic capacitance with ceramic-class ESR
MLCCs	Ceramic	Low ESR, high frequency	Supplement polymer for HF smoothing

Job 6: Snubber / Voltage Clamp



THE CHALLENGE: Absorb switching transients and clamp voltage spikes on SiC/GaN power devices operating at dramatically higher dV/dt than legacy silicon IGBTs.

RECOMMENDED PRODUCTS:

Product	Technology	Key Spec	Why It Fits
HV MLCCs	Ceramic	500–1500V, fast response	Ultra-low inductance for SiC/GaN protection
Power Film	Film	High dV/dt, self-healing	Survives repetitive transient energy