PROMAGTECH
High-Performance Magnetic Solutions

SELECTION GUIDE · HIGH VOLTAGE EV

800V Platform Inductor Selection:

EV High Voltage Solutions

Insulation spacing, partial-discharge risk, and high-frequency core loss requirements for 800V EV OBC and charging station magnetic components

Applications: 800V EV OBC · EV DC Fast Chargers · 800V Industrial Converters · Grid-Tied Storage

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WEBSITE	www.promagtech.com
EMAIL	zyong@promagtech.cn

1. Key Finding

Key Finding: For 800V EV platforms, insulation spacing, partial discharge risk, and high-frequency core loss typically matter as much as inductance value when selecting or specifying magnetic components. Engineers who treat 800V component selection identically to 400V selection commonly encounter late-stage certification failures.

2. 800V Platform Technical Background

The transition from 400V to 800V EV electrical architecture is being driven by fast-charging requirements. At 400V with 200A, the peak charging power is 80 kW. At 800V with the same conductor gauge, peak charging power doubles to 160 kW, and with 400A capable infrastructure, can reach 320 kW. The 800V architecture reduces cable size and connector cost at the same power level.

Comparison	400V Platform	800V Platform
DC bus voltage	350–450 V	700–920 V (peak up to 950V transient)
Charging current (200 kW)	~444 A	~222 A
Cable cross-section	Larger	Smaller (same power, half current)
Insulation class required	Class E/B	Class F/H; reinforced insulation
Hi-pot test (winding-core)	AC 1500 V	AC 2000–3000 V / 1 min minimum
Partial discharge concern	Moderate	High — PDIV testing required
SiC switching frequency	65–150 kHz	100–300 kHz (higher with SiC)

3. New Requirements for 800V Platform Inductors

3.1 Insulation Design Requirements

The actual DC bus voltage in an 800V EV system can reach 850–950 V including transients. Magnetic component insulation must be designed for the peak working voltage, not the nominal bus voltage.

Requirement	400V System	800V System	Test Standard
Winding-to-core clearance	≥ 1.5 mm	≥ 3.0 mm	IEC 60664-1, Pollution Degree 2
Creepage distance	≥ 3.2 mm	≥ 6.4–8.0 mm	Based on material group and PD
Hi-pot test voltage	AC 1500 V	AC 2000–3000 V	1 minute, no breakdown
Insulation class	Class E/B	Class F/H (155°C / 180°C)	UL 1446 / IEC 60085
Inter-layer insulation	≥ 1× working voltage	≥ 2× working voltage	Project-specific

3.2 Partial Discharge (PD) Control

Partial discharge is the primary mechanism of long-term insulation degradation in 800V power conversion systems. Even at voltage levels below the breakdown strength, repetitive corona discharge in micro-voids erodes insulation material over time, eventually leading to dielectric failure.

Key Design Actions for Partial Discharge Control:

- Specify PDIV (Partial Discharge Inception Voltage) ≥ 1.2 × peak working voltage at sample approval stage
- Eliminate air voids in insulation: use vacuum impregnation or void-free potting compound
- Select low-dielectric-constant insulation film: polyimide (PI) or PPS preferred over PET at 800V
- Avoid sharp edges on winding conductors: radius-form flat wire terminations ≥ 0.5 mm minimum
- Minimise electric field concentration: maintain uniform conductor layer geometry through winding tension control
- Measure PDIV at operating temperature, not only at room temperature (PDIV decreases with temperature)

4. Core Material Selection for 800V Applications

800V platform converters using SiC devices typically switch at 100–300 kHz. Core material selection must simultaneously address high-frequency loss, saturation current margin, and thermal stability at the elevated operating temperature expected in automotive environments.

Core Material	Frequency Range	800V Advantage	800V Caution
Ferrite (MnZn)	100 kHz – 1 MHz	Lowest core loss at high frequency; readily available gapped geometries	Hard saturation — requires careful Isat design margin; check 105°C Bsat
Nanocrystalline	1 kHz – 500 kHz	High permeability; very low loss; good high-temperature Bsat stability	Higher cost; brittle core requires careful mechanical design
Iron Silicon Aluminium	10 kHz – 300 kHz	Soft saturation; good DC bias stability; automotive temperature range	Higher AC loss than ferrite above 150 kHz
Iron Powder	10 kHz – 200 kHz	Lowest cost; excellent soft saturation	High AC loss above 100 kHz; Bsat decreases significantly at 100°C

5. Winding Technology for 800V Components

5.1 Why Flat Wire Is Typically Required Above 30 A

At the current levels encountered in 800V OBC and charging station PFC stages (15–80 A depending on power level), flat wire winding provides 20–30% lower DCR than round wire in the same core window. For 800V systems where package height is constrained (automotive mounting envelopes) and temperature rise must be minimised to protect Class F/H insulation, this thermal advantage is frequently the deciding factor.

5.2 Insulation Film Selection for 800V Winding

Insulation Material	Dielectric Strength	Max Operating Temp	Recommended For 800V?
PET (Polyester) film	150–250 V/μm	105–130°C	Not recommended — limited thermal class, reduced PDIV margin
PI (Polyimide, e.g. Kapton)	200–300 V/μm	220°C	Recommended — high thermal class, good PDIV margin
PPS (Polyphenylene Sulfide)	150–200 V/μm	180°C	Recommended — good dimensional stability, 800V compatible
Nomex (Aramid)	20–30 V/μm (paper)	220°C	Use for slot liner / mechanical protection; not as primary film
Thermally conductive film	100–200 V/μm	180°C	For premium thermal path; check PDIV before specifying

6. Specification Requirements for 800V Magnetic Components

Always Specify for 800V Platform Components:

- Peak working voltage (V DC or V AC peak) — do not use nominal bus voltage alone
- Hi-pot test voltage and duration — minimum AC 2000 V / 1 min for 800V systems
- PDIV requirement — specify PDIV > 1.2 × peak working voltage
- Insulation class — specify Class F (155°C) or Class H (180°C) for automotive under-hood
- Creepage and clearance — state IEC 60664-1 pollution degree and material group
- Operating temperature range including maximum ambient — verify Bsat and PDIV at temperature extremes
- AEC-Q200 compliance if automotive qualification is required

7. FAQ

Q1: What is the main engineering decision in 800V component selection?

Matching electrical stress (insulation design), switching frequency (core material), thermal path (winding technology), and mechanical envelope before confirming the magnetic component

structure. Engineers who start with inductance value alone and add insulation requirements later routinely encounter conflicts that require redesign.

Q2: Which parameters should be provided for a custom 800V component review?

Provide: input and output voltage range (including transients), switching frequency, current waveform (RMS, peak, ripple), target inductance or turns ratio, temperature rise limit, insulation requirement (hi-pot voltage, PDIV target, creepage), package dimensions, certification requirements, and annual quantity.

Q3: Can the values in this guide be used in production directly?

No. The values in this guide are engineering references. Production values must be confirmed through approved samples, DC bias measurement, DCR at operating temperature, hi-pot testing, PDIV measurement, and thermal validation at rated current before production release.

8. Contact and Related Resources

Resource	URL
20–60 kW PFC Inductor Design Guide	promagtech.com/technical-resources/20-60kw-pfc-inductor-selection-guide.html
Flat Wire vs Round Wire Selection Guide	promagtech.com/technical-resources/flat-wire-vs-round-wire-inductors.html
High Power Density White Paper	promagtech.com/technical-resources/high-power-density-flat-wire-magnetics-white-paper.html
Charging Station PFC Inductor Product	promagtech.com/products/charging-pile-pfc.html
PFC Boost Flat Wire Inductor Product	promagtech.com/products/pfc-boost-inductor.html

Shenzhen PROMAGTECH Co., Ltd.

zyong@promagtech.cn

WhatsApp: +86 135 3765 8938

www.promagtech.com

Response Commitment

- Preliminary design assessment within 24 hours of complete specification
- Formal quotation within 3 business days
- Sample delivery: 5–7 business days (standard custom design)