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OBC PFC Boost Inductor Design 11 kW Totem-Pole & 22 kW Vienna, 800 V Platform

A selection guide for the on-board-charger (OBC) power-factor-correction inductor

Item	Detail
Document	OBC PFC Boost Inductor — 11 kW Totem-Pole & 22 kW Vienna (800 V) — Application Note
Application	EV on-board charger (OBC) PFC stage, 800 V battery platform
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ProMagTech — flat-wire & PFC inductors for EV OBC, DC charging, energy storage and industrial power.

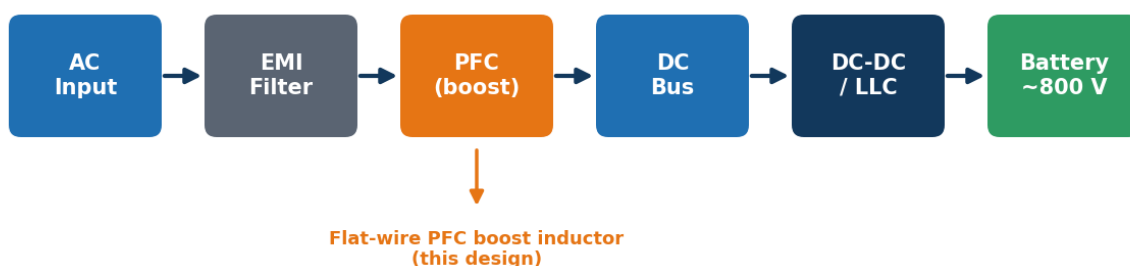
Key Takeaways

- The OBC PFC boost inductor differs by topology: an 11 kW single-phase totem-pole vs a 22 kW three-phase Vienna rectifier.
- Inductance is set jointly by ripple and DC bias — bigger is not better; there is an inductance knee.
- A powder core (soft saturation) holds inductance over a wider DC bias; flat-wire windings cut DCR and temperature rise.
- An 800 V platform demands attention to insulation, creepage and partial discharge (PD).
- Efficiency and temperature-rise figures are design targets, confirmed by sample test data per project.

1. Overview: where the PFC inductor sits in an OBC

An on-board charger (OBC) rectifies grid AC into high-voltage DC for the battery. The PFC (power-factor-correction) stage shapes the input current sinusoidal and boosts it to the DC bus; the PFC boost inductor is the energy-storage and filter heart of that stage, directly setting efficiency, temperature rise and EMI.

Fig. 1 OBC power chain — the PFC inductor sits between EMI and the DC bus



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Fig. 1 — OBC power chain; the PFC boost inductor position.

As battery platforms move to 800 V, the OBC bus and insulation requirements rise, and the PFC inductor must hold inductance and low temperature rise under high current and wide DC bias — the domain of powder cores plus flat-wire windings.

2. Totem-pole (11 kW, single-phase) vs Vienna (22 kW, three-phase)

Item	11 kW Totem-Pole (1-φ)	22 kW Vienna (3-φ)
Phases / inductors	Single-phase, 1 boost inductor	Three-phase, 1 per phase (3 total)
Per-inductor current	High (~48 A class at 230 V in)	Moderate per phase (shared over 3-φ)
Topology	Fewer legs, lower cost, high single-phase current	Balanced 3-φ, low ripple, suits high power
Inductor need	High L + high current + wide DC bias	Moderate L per phase; current-sharing
Typical fsw	65–140 kHz (GaN/SiC)	65–100 kHz (SiC)

Table 1 — Inductor requirements of the two mainstream OBC PFC topologies

3. Key parameters and the inductance knee

PFC inductance is set by ripple current. The boost inductor peak-to-peak ripple:

$$\Delta I_L = (V_{in} \cdot D) / (L \cdot f_s) \quad (D = \text{duty}, f_s = \text{switching freq.})$$

L too small → high ripple → higher core loss, EMI, peak current

L too large → more turns → higher DCR, size, temperature rise

The trade-off point = the inductance knee (sweet spot)

DC bias also matters: inductance rolls off with current. A powder core is soft-saturating and holds inductance over a wider current; a gapped ferrite is hard-saturating and drops sharply at the knee. For the wide current of PFC, powder cores are usually preferred.

Fig. 2 DC-bias behaviour — powder core keeps inductance over a wider current

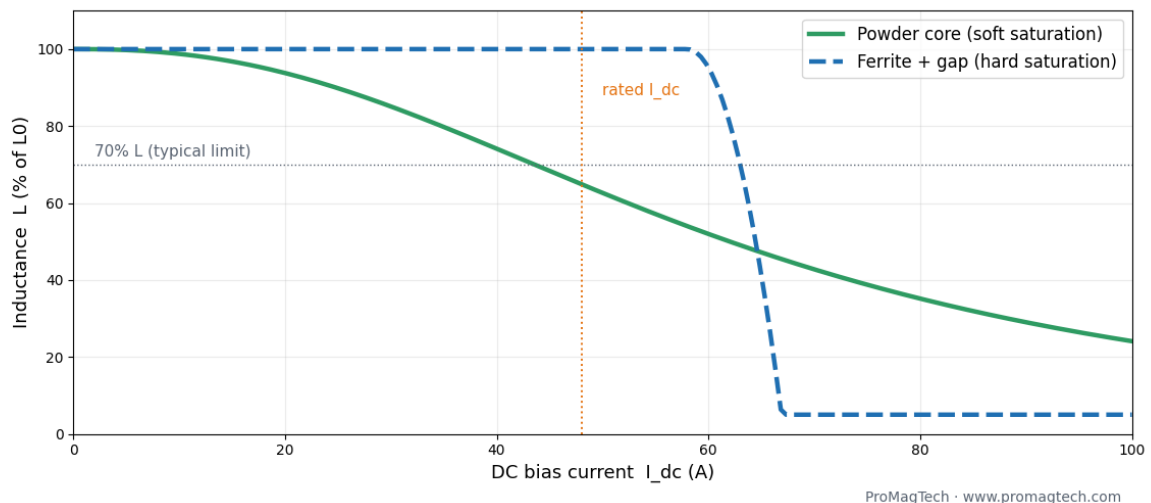


Fig. 2 — DC-bias behaviour: powder core (soft) vs gapped ferrite (hard).

4. Material choice: powder core vs ferrite, and flat wire

Material	Saturation	Core loss (HF)	Use
Powder (Sendust/High-Flux/MPP)	Soft, wide DC bias	Medium	Preferred for PFC boost
Ferrite + gap	Hard	Low	HF, lower current; control fringing loss
Amorphous / nanocrystalline	—	Low	Specific HF / CM cases

Table 2 — Common PFC inductor core materials

Why flat-wire (edge-wound) windings: high copper fill → lower DCR, lower temperature rise and slower AC-resistance growth at high frequency. For an efficiency- and space-constrained OBC, flat wire is the way to cut loss and volume at the same time.

Differentiator ProMagTech pairs a powder core's wide DC bias with flat wire's low DCR to control both inductance roll-off and temperature rise on an 800 V platform — backed by sample test data.

5. 800 V platform: insulation, creepage and partial discharge

- **Insulation / creepage:** bus and inter-turn voltages rise with 800 V; design creepage and clearance for reinforced insulation and select high-voltage wire.
- **Partial discharge (PD):** high voltage can start PD in inter-turn / inter-layer voids, degrading insulation over time; design and test PD inception voltage.
- **Temperature rise:** with high current and voltage, temperature rise is both an efficiency and an insulation-life issue.

6. Loss and temperature-rise targets (design targets)

Item	Source	Note
Copper loss	$DCR \times I_{rms}^2$	flat wire lowers DCR; AC term at HF
Core loss	ripple flux	control ripple at the knee; pick material for the operating point
Target: PFC efficiency	high	confirmed by sample test (SiC/ GaN reach high efficiency)
Target: inductor temp rise	low	double-side / forced-air cooling, set by limits and life

Table 3 — Loss and targets (engineering estimates, sample-confirmed)

7. Validation & test

Validation item	Method / instrument	Acceptance
Inductance & DC bias	LCR + DC bias source	$L \geq \text{spec}$ at rated current
Saturation current I_{sat}	Bias sweep	meets peak-current margin
DCR	Micro-ohm meter	$\leq \text{spec}$
Ripple / temp rise	Oscilloscope + IR / thermocouple	within limit
Insulation / hi-pot / PD	Hi-pot + PD test	pass per spec
Batch consistency	Sampling	parameter spread $< \pm \text{spec}$

Table 4 — Validation checklist

8. Manufacturing & quality

- **Winding:** flat-wire (edge-wound) multilayer construction for low DCR and low AC loss.
- **Core:** powder core for wide DC bias or ferrite for HF, chosen at the operating point; gap and fringing-loss control.
- **Inspection scope:** inductance, DCR, DC bias, saturation current, turns ratio, hi-pot and insulation resistance per approved sample record.

9. Frequently Asked Questions

How do I choose OBC PFC inductance?

From ripple current: $\Delta I_L = V_{in} \cdot D / (L \cdot f_s)$. Too small means high ripple, too large means high DCR — take the inductance knee, then check saturation margin with DC bias.

How do totem-pole and Vienna inductor needs differ?

Totem-pole is single-phase, single inductor, high current — needing high L and wide DC bias; Vienna is three-phase, moderate per-phase current, emphasising current sharing and consistency.

Why are powder cores common for PFC inductors?

Powder cores are soft-saturating, so inductance rolls off gently over wide DC bias, suiting the wide current of PFC; ferrites hard-saturate and suit HF, lower current.

What does flat wire do for an OBC?

High copper fill → lower DCR, lower temperature rise and slower AC-resistance growth at HF — key for efficiency- and space-sensitive OBCs.

What matters for an 800 V platform inductor?

Design creepage/clearance for reinforced insulation and design/test partial discharge (PD); temperature rise affects insulation life.

Does ProMagTech make custom OBC PFC inductors?

Yes — custom flat-wire and PFC inductors with DC-bias / saturation / temperature-rise review and samples.



10. Glossary

- **PFC** — Power-factor correction — shapes input current sinusoidal and boosts it, cutting harmonics and raising power factor.
- **Totem-pole PFC** — An efficient bridgeless PFC topology, common in single-phase OBCs with GaN/SiC.
- **Vienna PFC** — A three-phase three-level PFC rectifier, suited to high-power (e.g. 22 kW) OBCs.
- **DC bias** — The roll-off of inductance under DC current; powder cores soft-saturate, ferrites hard-saturate.
- **Powder core** — Sendust/High-Flux/MPP pressed-powder cores with distributed gap and soft saturation, common in PFC.

11. References

- ProMagTech — 20-60 kW PFC inductor and OBC PFC inductor selection guides (promagtech.com/technical-resources).
- ProMagTech — Flat-wire vs round-wire inductors; 800 V platform inductor selection guide.
- ProMagTech — 1 MHz 3.3 kW matrix planar transformer (800 V HVDC) design overview.

12. About ProMagTech

SHENZHEN PROMAGTECH CO.,LTD (founded 2013, Shenzhen) designs and manufactures flat-wire inductors, planar transformers, common-mode chokes and PFC inductors for EV OBC and DC charging, energy-storage PCS, solar inverters and industrial power.

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