Inside Infineon’s 12 kW AI-Server PSU: Seven Magnetics Design Moves Worth Studying

Technical article for website publication

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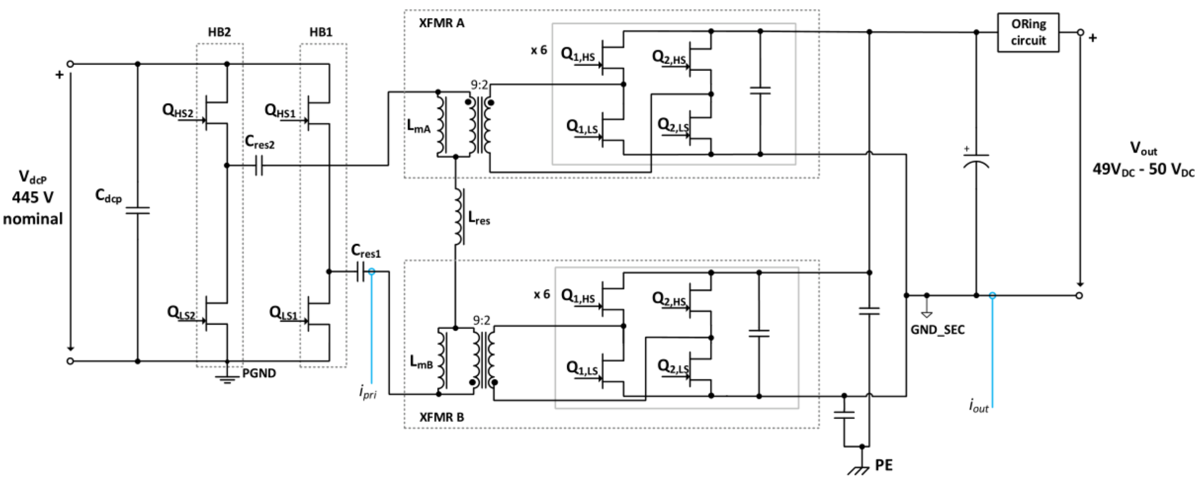
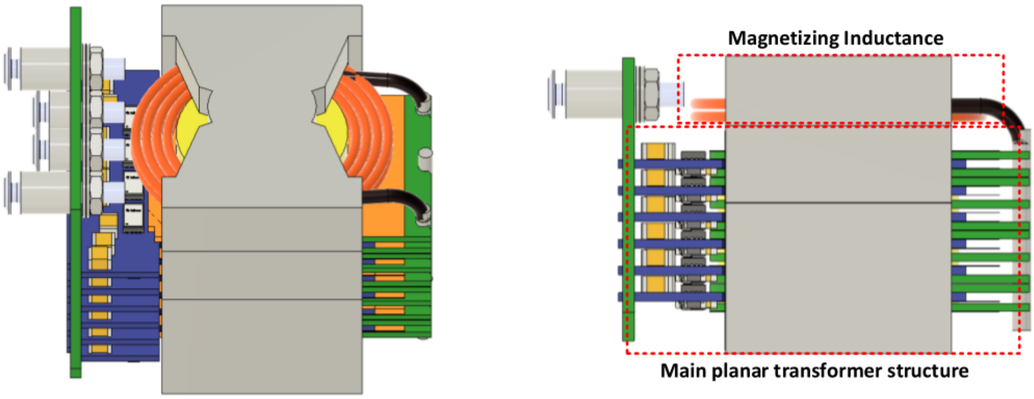
Infineon just showed the industry what a 12 kW, 113 W/in^3 AI data center PSU looks like inside (REF_12KW_HFHD_PSU). Most commentary focuses on the GaN and SiC switches. As a magnetics manufacturer, we read the same application note differently: every single magnetic component in this design breaks a “standard” rule — and each rule-break is a lesson in how 500 kHz-class power density actually gets built. The PSU packs seven types of magnetics into a 40 × 68 × 640 mm chassis: two LLC planar transformers, an external resonant inductor, two PFC boost inductors, an energy-buffer inductor, and two common-mode chokes with integrated differential-mode inductance. Here are the seven moves we found most instructive.



The LLC stage: full-bridge primary, two 9:2 transformers, GaN synchronous rectification — Source: Infineon AN, Fig. 33

1. Two transformers, not one

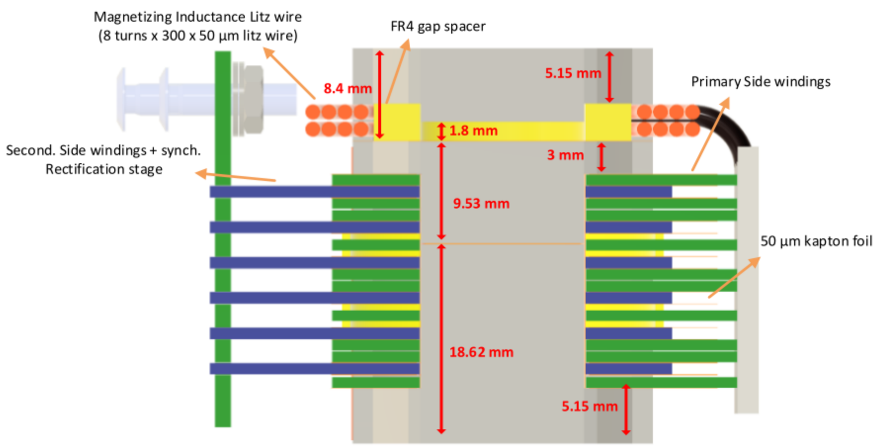
The LLC stage uses two identical 9:2 planar transformers — primaries in series, secondaries in parallel (effective 18:2). Series primaries halve the voltage stress per unit and force identical magnetizing current through both cores, so the two outputs current-share naturally, with no balancing circuit. At 50 V / 240 A output, paralleled secondaries halve the copper loss problem before a single turn is wound.



Hybrid planar transformer: planar body + top-mounted Litz coil — Source: Infineon AN, Fig. 11

2. The magnetizing inductance lives OUTSIDE the transformer

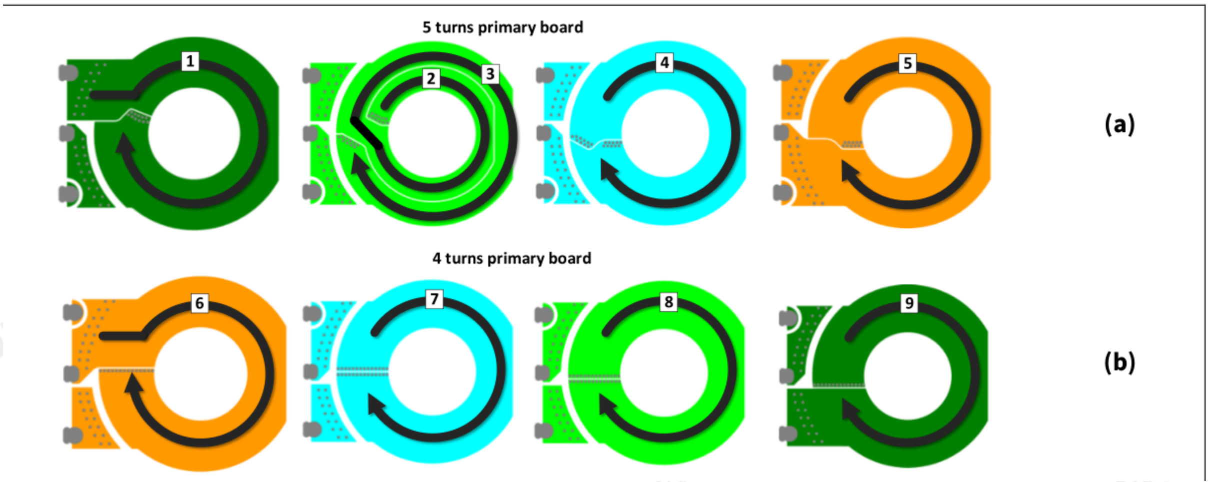
The main core (PQ40, DMEGC DMR59, 37 mm tall to clear the 40 mm OCP height limit) is gapped with nothing but a 50 µm Kapton tape — so primary inductance is far too high for ZVS. The fix: an 8-turn, 300 × 50 µm Litz coil sitting on top of the core, electrically in parallel with the primary, with a 1.8 mm top gap. An FR4 spacer keeps the Litz wire away from the gap’ s fringing flux — the cheapest possible cure for the classic burnt-winding failure mode.



Cross-section: 1.8 mm top gap, FR4 spacers, 50 µm Kapton isolation — Source: Infineon AN, Fig. 37

3. A 9-turn winding made of two PCBs

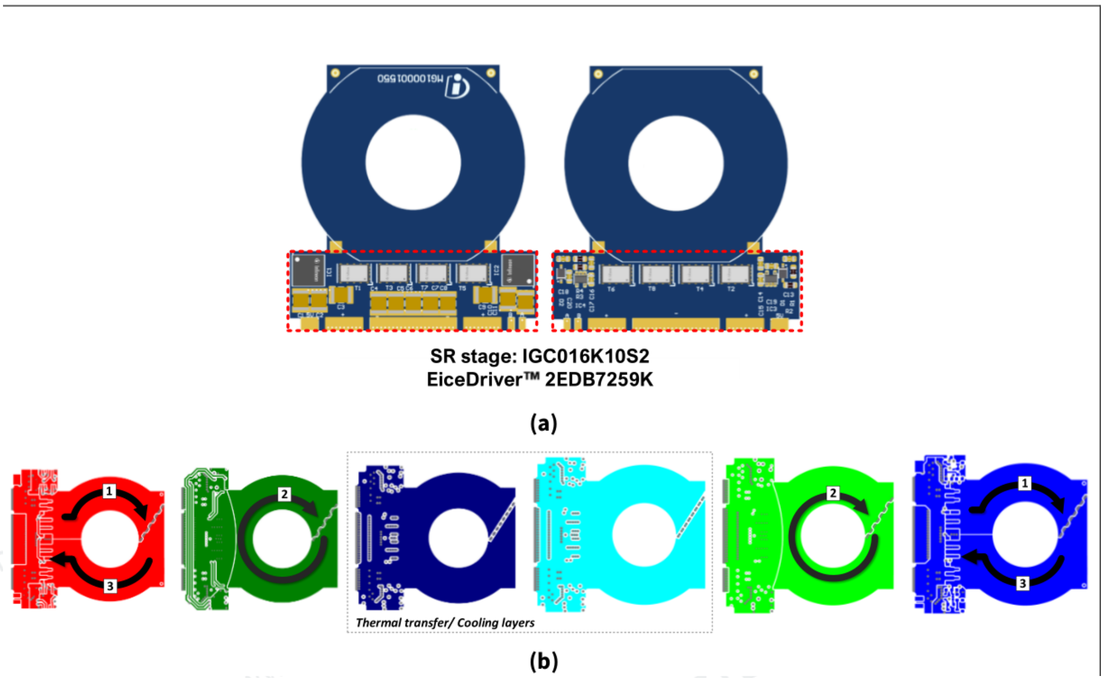
Nine primary turns on a planar structure is awkward — so Infineon designed two 6-layer boards (5T + 4T) connected in series, then paralleled five of each to kill AC resistance. Outer copper layers are etched back for clearance and creepage. Kapton film plus FR4 spacers between primary and secondary boards trade a little leakage inductance for a large drop in interwinding capacitance — better EMI and easier ZVS in one move.



5-turn and 4-turn primary boards, layer by layer — Source: Infineon AN, Fig. 38

4. The rectifier is part of the winding

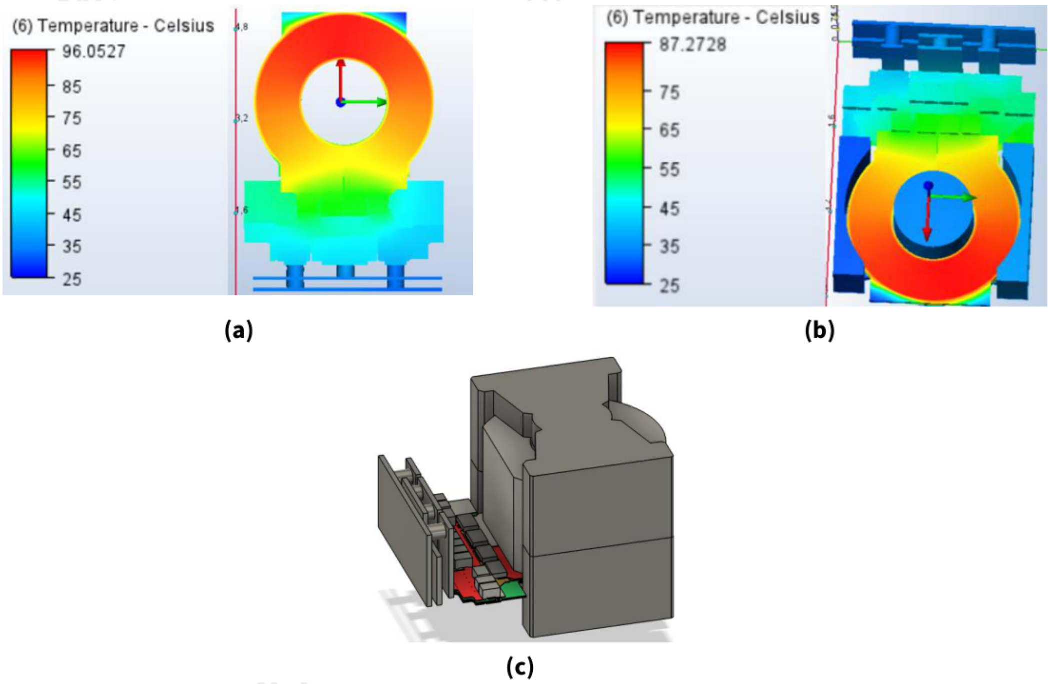
Each 2-turn secondary board carries its own full-bridge synchronous rectifier: 100 V MV CoolGaN (1.6 mΩ) plus drivers, mounted directly on the winding PCB. Six boards in parallel per transformer — 96 GaN devices total. The commutation loop shrinks to millimeters, which is the structural precondition for clean SR switching above 300 kHz.



Secondary boards with embedded SR stage and cooling layers — Source: Infineon AN, Fig. 39

5. Two “useless” copper layers that drop the hot spot ~10%

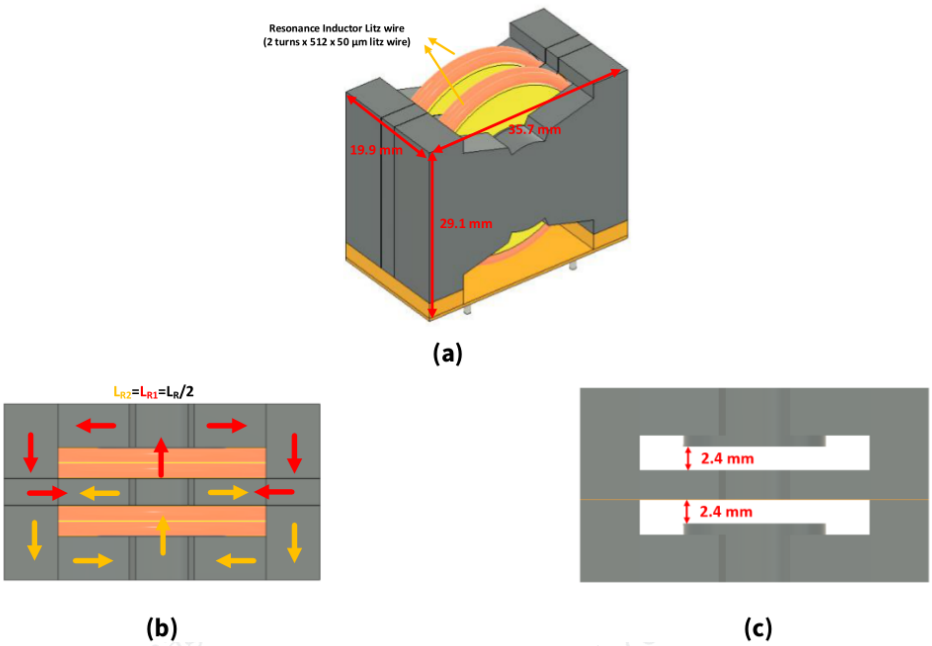
The secondary needs only 4 layers; the board has 6. The two spare layers carry 35 µm copper used purely for heat transfer, tied to the output busbar. Simulated hot spot: 96.1 °C → 87.3 °C at identical losses. Nearly zero BOM cost. This is the kind of detail that separates a datasheet transformer from a thermally-integrated one.



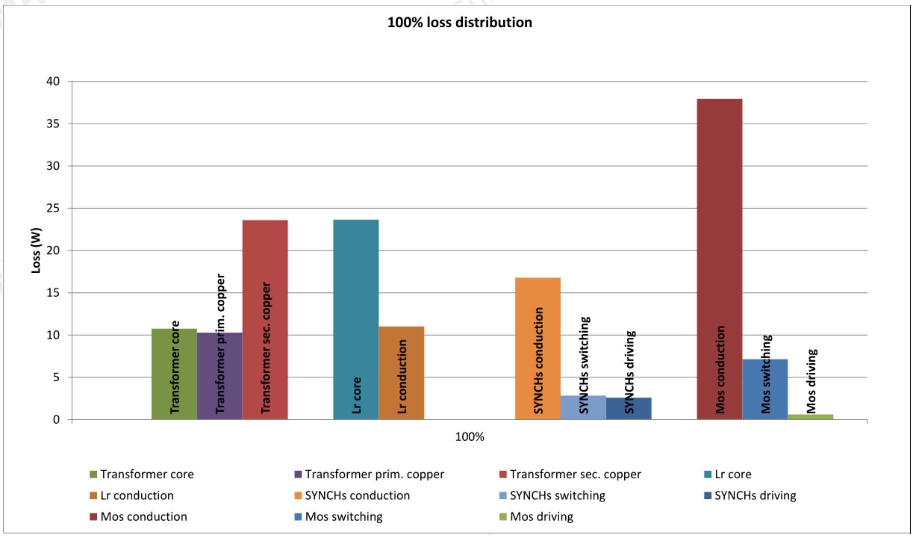
Thermal simulation, without vs. with cooling layers — Source: Infineon AN, Fig. 40

6. A resonant inductor that cancels its own flux

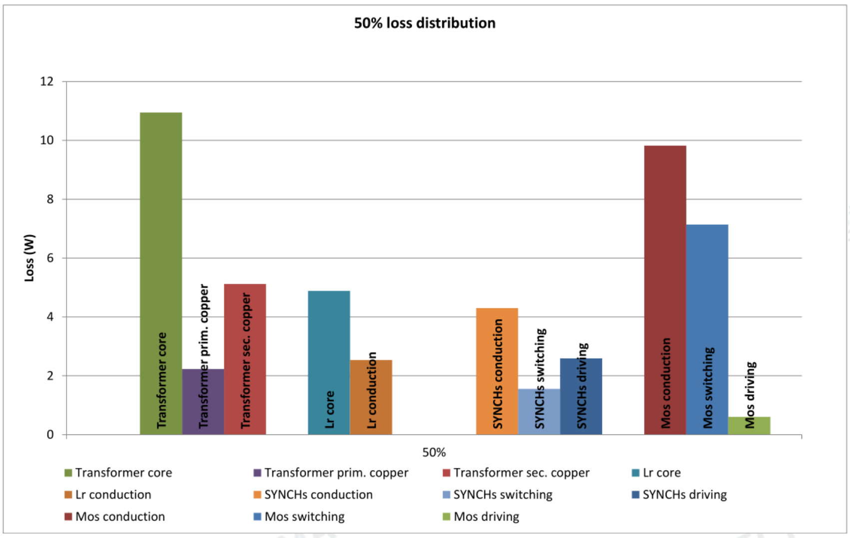
With the transformer window packed full of PCBs, leakage inductance was not available as L_r. The external 1.65 µH inductor (custom PQ35, DMR59, 2 × 2.4 mm gaps, 2 turns of 512-strand Litz) is split into two 0.825 µH chambers wound so their flux cancels in the center I-piece — carving the core-loss hot zone out of the magnetic path. At full load the L_r core still dissipates ~23.5 W; without cancellation it would be worse. The full-load loss breakdown puts the magnetics — transformer core and copper plus L_r — at roughly 79 W, on par with all the semiconductors in the LLC stage combined: at these frequencies, magnetics are no longer a footnote.



Two-chamber resonant inductor with flux cancellation — Source: Infineon AN, Fig. 41



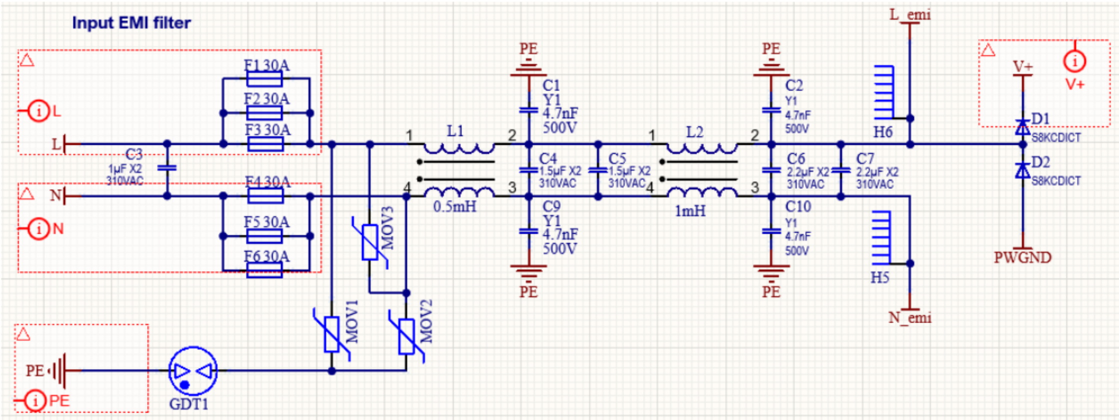
LLC power-loss breakdown at 100% load — Source: Infineon AN, Fig. 35



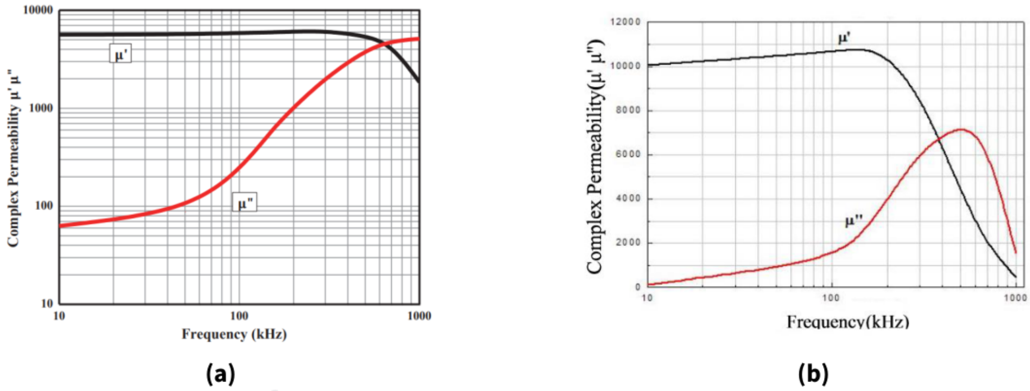
LLC power-loss breakdown at 50% load: transformer core loss becomes the No.1 item — Source: Infineon AN, Fig. 36

7. EMI chokes that swallowed the DM inductor — and toroids that protect the sensors

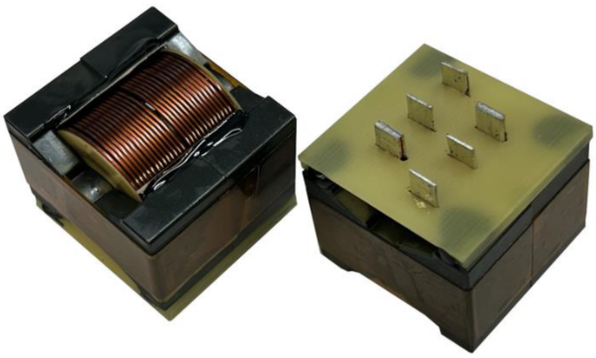
Both common-mode chokes integrate a magnetic shunt (NO 30-16 electrical steel) that deliberately raises leakage flux — creating the differential-mode inductance inside the CM choke and deleting a whole component from the filter. Windings are 0.6 × 5 mm flat copper wire for the high RMS input current. Material pairing does the frequency split: R5KZ (0.5 mH, grid side) holds permeability at high frequency; R10KZ (1.0 mH, converter side) brings high initial permeability for the low band. Two materials, one filter, full-spectrum attenuation.



Dual-stage input EMI filter: L1 0.5 mH (grid side), L2 1.0 mH (converter side) — Source: Infineon AN, Fig. 21

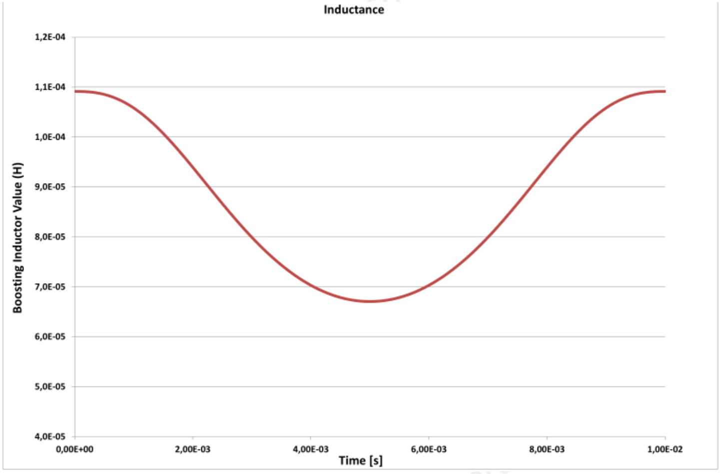


Complex permeability: R5KZ (a) vs R10KZ (b) — Source: Infineon AN, Fig. 22

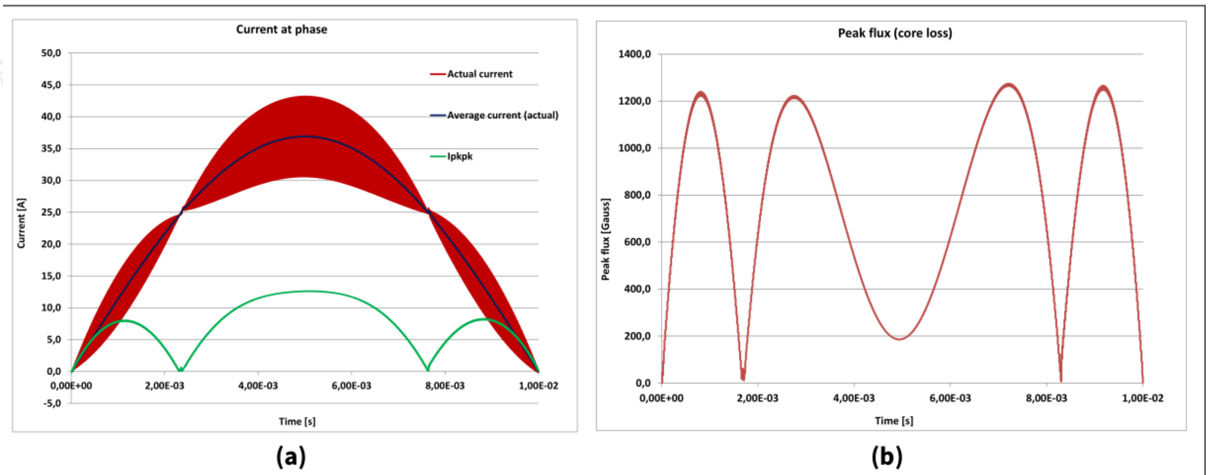


CM choke with integrated DM inductance, flat-wire winding — Source: Infineon AN, Fig. 23

The PFC boost inductors follow the same system-level logic: two stacked CH270060GT high-flux powder toroids per phase (27 turns, 1.8 mm wire, 109 µH at zero bias, ~67 µH at full-load peak current). A toroid keeps stray flux inside the core — protecting the adjacent magnetoresistive current sensors from distortion and the stainless-steel chassis from eddy-current heating. The energy-buffer inductor reuses the same cores (39 turns, 1.6 mm wire, 230 µH) to deliver the 20 ms hold-up and grid-shaping functions.



PFC boost inductance vs. DC bias across the AC half-cycle (109 → ~67 µH) — Source: Infineon AN, Fig. 24



PFC phase current envelope and per-cycle peak flux density — Source: Infineon AN, Fig. 25

The manufacturing takeaway

High-frequency power density is no longer won at the switch — it is won in the magnetics: flat-wire windings, PCB-stack transformers with embedded semiconductors, engineered gaps with fringing-flux management, and shunt-integrated EMI chokes. Every one of these is a manufacturing capability before it is a design idea.

At PROMAGTECH (www.promagtech.com) we design and build flat-wire power inductors and transformers for exactly this class of application. If you are developing high-density PSUs, on-board chargers or DC-DC stages and your magnetics are the bottleneck — tell us your operating conditions and we will evaluate a solution with you.

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Revision History

Rev	Date	Description	Prepared	Approved
A/0	2026-08-06	First issue (LinkedIn edition, EN + CN review copy)	angler	angler
A/1	2026-08-06	Website edition: English only; usage notice revised; PFC/loss data and figures added	angler	angler