

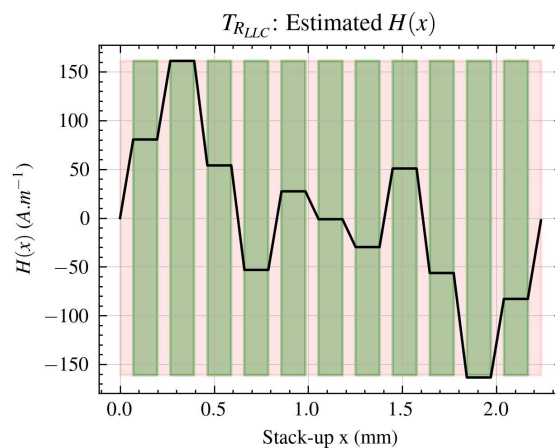
Optimized Planar Transformer for a Multi-Output LLC Converter

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European Space Power Conference (ESPC 2026), Estoril, Portugal — session EPM-7a, Thursday 8 October 2026

Abstract

This paper presents the design, optimization and validation of a planar transformer for a 203 W multi-output LLC resonant converter operating from a 36 V input with two secondary outputs at 12 V and 30 V. The proposed approach is a systematic optimization of the winding arrangement based on the spatial control of the magnetomotive force (MMF) distribution inside the winding window: windings are assigned to printed-circuit-board layers so as to minimize the stored leakage energy, that is, the integral of the squared field intensity along the stack-up. In a multi-output structure this objective cannot be a single scalar, since each secondary imposes its own leakage constraint; it is therefore posed on the full leakage matrix of the four-winding structure under manufacturing and creepage constraints. The method combines MMF shaping, multilayer interleaving optimization, two-dimensional extraction of the winding resistances and of the interwinding capacitance, and three-dimensional finite-element validation on an ER32 ferrite core. Core losses are evaluated by finite-element integration with a data-driven material model applied element by element to the flux-density map; separating the effects at play shows that the waveform assumption of the manufacturer's curves and the choice of volume basis each weigh about 20 %, whereas resolving the flux distribution spatially changes the result by only 2 %. A comparative loss analysis against the measured impedances of the previous litz-wire transformer gives a predicted loss reduction of 50 % at constant architecture and 52 % including the removal of one output rail. The results confirm that direct optimization of the magnetic field distribution is an effective strategy for high power density planar LLC transformers, in particular under asymmetrical multi-output loading. The one-month interval allowed for the manuscript did not permit the experimental campaign to be completed; it is under way and its results will be presented at the conference. This study is part of the ADHA (Advanced Data Handling Architecture) project.



Estimated field intensity $H(x)$ along the twelve-layer stack-up of the transformer.

Keywords: planar transformer, LLC converter, magnetomotive force optimization, multi-output converter, finite element modeling, leakage matrix, data-driven core loss.

The full paper was presented at the European Space Power Conference (ESPC 2026), Estoril, Portugal, 5–9 October 2026. A copy is available on request: contact@powcoma.com.