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# Design of PCB Winding Inductors Employing the CFFC-Compensating Fringing Field Concept

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Especially in the automotive sector, the design of power electronic converters is subject to extreme cost pressure. Consequently, each component needs to be optimized regarding material and manufacturing cost. The latter is especially important for magnetic components, as the expensive wire-wrapping process has a significant impact on the overall production costs. In this presentation, a new inductor concept is proposed, where the winding is directly integrated into the printed-circuit-board, while at the same time the usually large high-frequency conduction losses are mitigated. This is achieved by using the fringing field around a single air gap or several (distributed) air gaps for compensating the adverse magnetic skin and proximity fields within the winding (cf. Fig. 1). Consequently, low AC to DC resistance ratios are achieved and the required copper cross-section of the winding can effectively be reduced.

Furthermore, a thermal model for the PCB winding is derived, which allows for designing PCB windings close to the thermal limit and therefore inductors with very high power densities are obtained.

Finally, the effectivity and usability of the proposed inductor design concept is verified by means of experimental measurements of individual PCB winding inductors, as well as by the performance of a complete converter system designed for industrial use, where these inductors are employed (cf. Fig. 3).

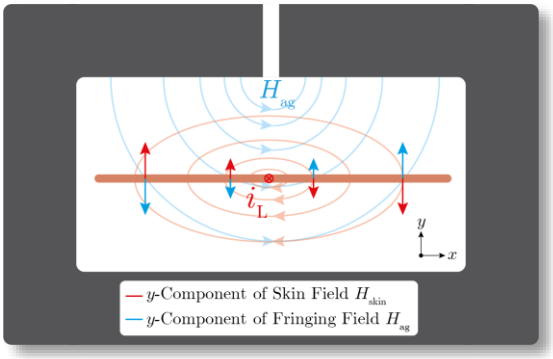


**Fig. 1**: Simplified magnetic fields in a PCB winding inductor.

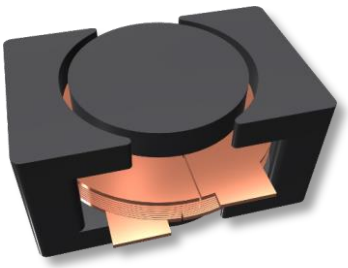

**Fig. 2:** PCB winding inductor employing the CFFC concept.

**Fig. 3:** Three-port resonant converter employing the CFFC concept.

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