Planar integrated magnetics design in wide input range DC-DC converter for fuel cell application

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In the most power electronics converters, the overall volume is mainly determined by the number of parts and the size of passive components. Integrated magnetics and planar magnetics techniques therefore have been an excellent option in order to reduce the count and the size of magnetic components, hereby increasing the power density of converters. A new planar integrated magnetics (PIM) technique for a phase-shift plus duty cycle controlled hybrid bi-directional DC/DC converter is presented and investigated in this paper. The main magnetic components including one boost inductor and two independent transformers are integrated into an E-I-E core geometry. Utilizing the flux cancellation as the principle of uncoupling, the transformers and the boost inductor are integrated, to reduce the total ferrite volume and core loss. The transformers and inductor are wound in the outer legs and the center legs respectively. The uncoupling effect between them is determined by the winding connections. The middle I-core provides a shared low reluctance flux path, uncoupling the two independent transformers. With the air gaps shift into the center legs, the magnetizing inductance of transformers will not be decreased due to there is no air gap throughout the flux paths generated by the two transformers. The new PIM structure can be extended to other topologies. To verify the validity of design approach and theoretical analysis, a lab prototype with PIM has been built, and tested. Comparing with the discrete structure, the result demonstrated a great improvement in profile and volume without sacrificing electrical performance.

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