

A High Efficiency, High Density Three-phase CLLC Resonant Converter with a Universally Derived Three-phase Integrated Transformer for Onboard Charger Application

This paper proposes a universal method of integrating magnetizing inductance with built-in leakage inductance based on multiple perfectly coupled transformers (PCTs), as shown in Fig. 1(a).

The integration of built-in leakage inductance can be achieved by connecting several PCTs using a standardized core type for cost considerations, or can be further integrated into a customized core with interleaved magnetomotive force polarities across transformer legs to achieve better flux distribution and smaller core loss. The proposed concept can be applied to single-input single-output and multiple-inputs multiple-outputs integrated transformer applications, as shown in Fig. 1(b). A 3x3 PCT-based integrated transformer built with printed circuit board (PCB) windings was designed for a three-phase CLLC (3PCLLC) resonant converter, which integrates three primary resonant inductors, three secondary resonant inductors, and three transformers into one magnetic core to simplify the complexity of the converter. The effectiveness of the proposed concept was demonstrated through a high efficiency, high power density 3PCLLC dc-dc converter for an 800V, 16.5kW onboard charger (OBC), as shown in Fig. 2(a). The designed converter can achieve a power density of 500 W/in³ and a peak efficiency of 98.8%, as shown in Fig. 2(b).

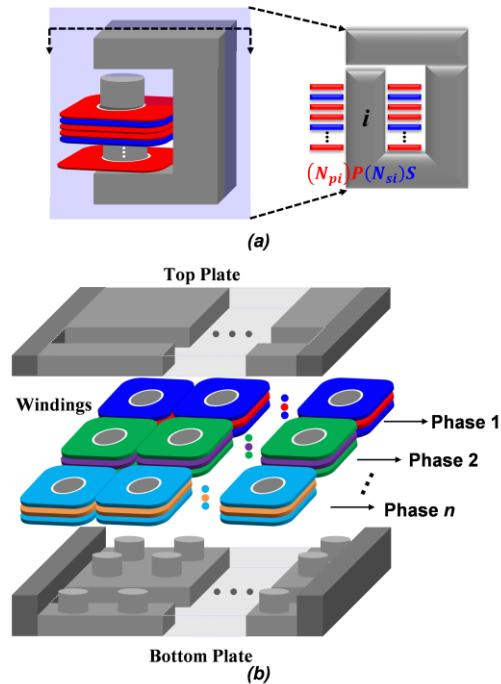
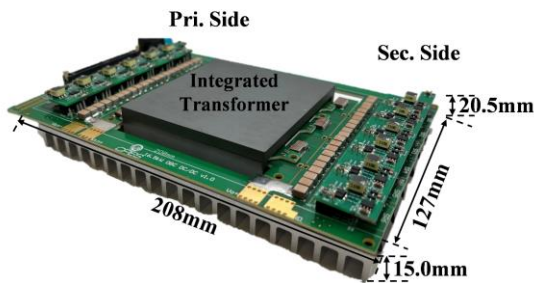
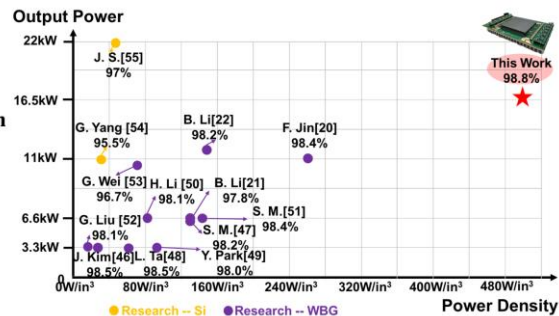


Fig. 1. (a) Perfectly coupled transformer example (b) Transformer structure of a m -inputs m -outputs transformer



(a)



(b)

Fig. 2. (a) Prototype picture (b) Prototype achievement