The Design of a Multilayer Planar Transformer for DC/DC Converter with a Resonant Inverter

M. Puskarczyk[1], R. Jez [1]

[1]ABB Corporate Research Center, Krakow, Poland

Abstract

The main advantage of the planar coil over conventionally wounded inductive device is that parameters of the planar one are fully repeatable and controllable and it also refers to parasitic parameters. Although manufacturing a few wound coils with equal inductance currently does not present a problem, it is quite difficult to produce several such devices with precisely controlled leakage inductance, especially if the inductive coupling should not be full. The leakage inductance depends strongly on the winding structure - that is the location of each turn. Thus, it could differ significantly between a few coils with the same core and the same turns number. A planar coil is a device where all turns are made as tracks on a multilayer PCB and form helixes. Therefore, in each produced coil the windings are placed exactly in the same position in relation to each other and to the core segments. It allows to control the leakage inductance, which is critical in some applications, like in resonate inverters where a transformer could be made of a series of planar coils using a common core.

Some expressions for the inductance of planar coils of various shape are already known, however these coils are intended to operate in the radio-frequency region and with low power. Their size and maximum inductance make them useless for power electronics applications [1].

This work presents the analysis of a medium-power planar transformer properties. They depend mostly on the electromagnetic field variations and the field spatial distribution (Figure 1). Therefore, the Finite Element Method (FEM) has been used to analyze their impact on the device's performance. The usable range of geometrical parameters for coils forming this device has been determined. The process of designing a planar transformer has been described along with FEM simulations illustrating its stages. These models are based on equations provided by the COMSOL Multiphysics® AC/DC Module and the Magnetic Field interface. Following the derived design procedure a prototype of a planar transformer has been designed and manufactured. Measurements of the device confirm the accuracy of the simulation model.

Reference

[1] Sunderarajan S. Mohan, Maria del Mar Hershenson, et al., Simple Accurate Expressions for Planar Spiral Inductances,IEEE Journal Of Solid-State Circuits, vol. 34, no. 10, October 1999

Figures used in the abstract

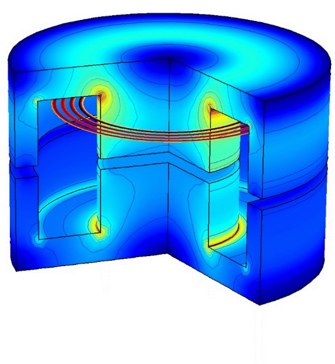

Figure 1: The Comsol AC/DC module has been used to analyze a magnetic flux density in the planar transformer core and the current density in the windings