Contribution ID: **529** Type: **Poster Presentation of 1h45m**

Embedded flexible Fe-Si-Al powder composite-film inductor for a Low Power DC-DC Converters

Wednesday 30 August 2017 13:15 (1h 45m)

An embedded flexible inductor constructed using Fe-Si-Al powder composite films and a low power DC-DC converter using this inductor are proposed. Composite films, with a μR of 40, are composed of mixed Fe-Si-Al flaked powders and ethylene propylene diene monomer (EPDM) rubber. The embedded flexible circuits have etched spiral copper traces with 18 turns for two layers. The copper trace is patterned with a 30-μm thickness, 100-μm width, and a 100-μm pitch. With respect to the performance, the simulated inductance and copper resistance using a Maxwell 3D tool are 5 uH and 0.77 Ω , respectively, whereas the measured results are 5.0 uH and 0.72 Ω , respectively, for the proposed embedded flexible inductor. The performances are also simulated by folding the fabricated flexible inductor (to 0°, 45°, 90°, and above 90°) using the Maxwell 3D tool. Additionally, it is confirmed that the inductance of this flexible inductor has a good linearity at high frequencies of a few-MHz. To verify its usefulness, the flexible inductor with dimensions of 10 mm x 7 mm x 0.3 mm is applied to a DC-DC Boost converter fabricated on a flexible printed circuit board, 10 mm x 23 mm x 2.42 mm. The specifications for the fabricated DC-DC converter include an output power of 2 W (5 V/400 mA) and a switching frequency of 1.2 MHz. The fabricated DC-DC Boost converter is tested by folding the fabricated flexible inductor (to 0°, 45°, 90°, and above 90°); the results are highly similar and a maximum efficiency of 84% was obtained.

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Session Classification: Wed-Af-Po3.08

Track Classification: E9 - Novel and Other Applications