Microfabricated Air-core Toroidal Inductor In Very High Frequency Power Converters

Miniaturization of power supplies is required for future intelligent electronic systems e.g. internet of things devices. Inductors play an essential role, and they are by far the most bulky and expensive components in power supplies. This paper presents a miniaturized microelectromechanical systems (MEMS) inductor and its performance in a very high frequency (VHF) power converter. The MEMS inductor is a silicon-embedded air-core toroidal inductor, and it is constructed with through-silicon vias, suspended copper windings, silicon fixtures, and a silicon support die. The air-core inductors outperform the silicon-core inductors with higher quality factor at higher frequency. This is verified by small-signal measurements. A 20-turn air-core inductor achieved an inductance of 44.6 nH and a quality factor of 13.3 at 33 MHz, while a silicon-core inductor with the same geometry has a quality factor of 9 at 20 MHz. A DC-DC class-E boost converter is designed and implemented using the fabricated MEMS air-core inductor and a high-performance 65 V gallium nitride field effect transistor. The VHF converter achieved a peak efficiency of 78 % at the input voltage of 6.5 VDC. The MEMS inductor can carry 1 A RMS AC current at 33 MHz and delivers 10.5 W to the output.

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