

Through-Silicon-Via Inductor based DC-DC Converters: The Marriage of the Princess and the Dragon

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Abstract

There has been a tremendous research effort in recent years to move DC-DC converters on chip for enhanced performance. However, a major limiting factor to implement on-chip inductive DC-DC converters is the large area overhead induced by spiral inductors. Towards this, we propose to use through-silicon-vias (TSVs), a critical enabling technique in three-dimensional (3D) integrated systems, to implement on-chip inductors for DC-DC converters. While existing literature show that TSV inductors are inferior compared with conventional spiral inductors due to substrate loss for RF applications, we demonstrate that it is not the case for DC-DC converters, which operate at relatively low frequencies. Experimental results show that by replacing conventional spiral inductors with TSV inductors, with almost the same efficiency and output voltage, up to 4.3x and 3.2x inductor area reduction can be achieved for the basic buck converter and the interleaved converter with magnetic coupling, respectively. To the best of our knowledge, this is the very first in-depth study on utilizing TSV inductors for on-chip DC-DC converters in 3D ICs.