High Power Density Impedance Control Network DC-DC Converter Utilizing Integrated Magnetic Structure
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Introduction
- Compact high-efficiency converters are required in various applications such as data centers, consumer electronics, and electric vehicles
- Resonant converters good candidates for these applications as they enable high efficiencies through soft-switching
- Conventional resonant converters tend to lose soft switching as operating conditions vary

ICN Resonant Converter Architecture
- To facilitate zero-voltage switching (ZVS) and near zero-current switching (ZCS) susceptance seen by the two inverters is zero when:
  \[ \Delta = 2 \cos^{-1} \left( \frac{V_{IN}}{2V_{OUT}} \right) \]
- Output power is regulated using burst-mode control

Prototype Design and Experimental Results
- Planar EI geometry
- \( n_1 \) turns
- \( n_2 \) turns
- Optimize air-gaps and core geometry to minimize losses
- Analyze via and termination effects

Integrated Magnetics Power Density: 463 W/in³
Conventional Design Power Density: 21 W/in³

Magnectics Integration Approach
- Converter size dominated by magnetic components with three inductors and a transformer
- Need an approach to increase power density while maintaining the wide-range high efficiency characteristic of ICN converter

Summary and Conclusions
- ICN-based resonant converter can achieve ZVS and near-ZCS operation and maintain high efficiency across wide operating ranges
- Magnetics integration enables increase in ICN converter power density by integrating three discrete inductors into a single magnetic structure using two coupled windings
- Integrated magnetics design optimized using 3D FEM simulations
- 550-W 1-MHz quarter-brick ICN converter prototype utilizing integrated magnetic structure achieves >450 W/in³ power density

References