A 1 kV Bidirectional DC-DC Converter with 650 V GaN Transistors for Hybrid Electric Transportation

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Abstract

This talk presents a description of a bidirectional 4-level flying capacitor multi-level (FCML) converter for high voltage (> 1 kV) stepdown/step-up conversion needed in hybrid rail and electric vehicle applications. Earlier developments achieved similar input voltage requirements through increased number of levels in the FCML – at the cost of additional transistors, flying capacitors and control complexity. In this presentation, we discuss the application of 650 V GaN transistors and apply a cascaded bootstrap method to supply the isolated gate drivers. The design also employs a single-sided PCB to improve the design flexibility for backside heat sinking. We illustrate the design through an experimental prototype that achieves 1 kV operation at 1.5 kW with excellent flying capacitor balancing, a peak efficiency of 96.6% and a power density of 475 W/in3.