Tutorial #6

GaN-Based High-Efficiency High-Density Power Converters for Future Data Center

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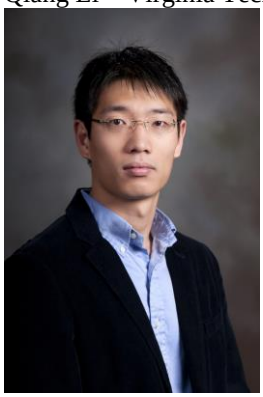

Biography

Qiang Li received the B.S. and M.S. degrees from Zhejiang University, China, in 2003 and 2006, respectively and the Ph.D. degree from Virginia Tech, Blacksburg, VA, in 2011. He is currently an assistant professor in Center for Power Electronics Systems at Virginia Tech. His research interests include high-frequency power conversion, magnetics and EMI, and high-density electronics packaging.

Abstract

Majority of the data centers built to date were based on the available off-the-shelf silicon-based equipment and they consume a huge amount of energy – by 2020, it is estimated they will use as much as 10 percent of the world electricity. For future data center, the distributed power conversion system have to be very efficient and with high power density. With recent advances made in Gallium-Nitride (GaN) power devices, this new generation of switches can be operated with significantly higher frequency compared to their silicon counterparts. It has been demonstrated that an increase of switching frequency by a factor of 10-20 is possible along with improved efficiency. In this presentation, two design examples of GaN based high-efficiency high-density DC/DC converters for data center applications will be discussed. The first one is a 1MHz 800W 380V/12V LLC converter with matrix transformer. It achieves a peak efficiency of 97.6% and a power density of 900W/in^3, which is the highest density has ever been reported for 380V/12V LLC. The second one is an 80W single stage 48V/1V converter. It is a quasi-parallel converter that uses a high efficiency unregulated LLC converter to deliver most power to the load with small power flowing through a buck converter responsible for regulating the output voltage. It achieves a peak efficiency of 93.4% and a power density of 420W/in^3. In both of these designs, the magnetics are distributed in the form of matrix transformers and are integrated with PCB winding with significantly improved manufacturability and reduced cost.