Tutorial Title:

Design Strategies for High-Power, High-Current, Isolated DC/DC Converters using Soft-Switching Technology and Silicon Carbide Transistors

Organizer:

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Abstract:

Engineers must be familiar with and understand the many nuances of their design space to create a successful product. It takes time and experience to gain this knowledge. This tutorial lowers the learning curve for engineers (and researchers) developing isolated DC/DC converters. It presents design guidelines for implementing silicon carbide (SiC) power devices in isolated DC/DC converters that use soft-switching technology. It targets hardware with a high conversion ratio at power levels of 2 kW and beyond. In these applications, the high-voltage terminals operate at hundreds of volts and the low-voltage terminals conduct several hundred amps. . It covers both isolated DC/DC converters and active rectifiers based on isolated DC/DC converters. Overall, the knowledge and experience shared are broadly applicable to multiple industries and applications.

The tutorial begins with an overview of isolated DC/DC converter applications in the automotive and aerospace fields as well as their associated design challenges. Then, it outlines how one selects a power supply topology for a given application using the specified metrics – cost, reliability, compatibility, size, and weight. Next, the attention turns to SiC power devices. The presenters compare SiC components to traditional power devices like silicon (Si) MOSFETs and IGBTs. This comparison includes datasheet analysis and experimental validation. This is followed by a discussion on passive components. Afterward, the tutorial reviews soft-switching technology and then dives into multiple topologies. Finally, the speakers address high-current, high-frequency transformers. They present various design strategies and provide experimental results for multiple implementation methods. The talk ends with a summary of the main talking points.

Upon completion of the tutorial, audience members will feel more comfortable using SiC components in their designs, regardless of the topology or application. They will also be more confident selecting an isolated DC/DC converter for their application, implementing soft-switching technology, and specifying the resonant components for their design.

Bio:

Mark J. Scott received his B.S., M.S., and Ph.D. degrees in Electrical and Computer Engineering from The Ohio State University in 2005, 2013, and 2015, respectively. His work experience includes developing and installing industrial automation systems and validating power electronics for automotive applications. Currently, he is an assistant professor at Miami University in Oxford, Ohio, USA.

Dr. Scott researches the design trade-offs of using silicon carbide (SiC) and gallium nitride (GaN) power devices in isolated DC/DC converters and active rectifiers used in electrified transportation. He also explores prognostic and health management techniques for power conversion hardware.

Alexander Isurin received an M.S. in Electrical Engineering from the University of Electrical Communication in St. Petersburg, Russia. His design experience includes electronic welding devices, charging for electric vehicles, custom industrial power supplies at high power levels. He is the author of numerous patents for power conversion topologies, control of power conversion hardware, and semiconductor gate drive design strategies. His technology has been and continues to be implemented into automotive applications. His current research interests include high-frequency power conversion using soft switch technology, with an emphasis on cost-effectiveness and high efficiency.