



IEEE ENERGY CONVERSION CONGRESS & EXPO | PITTSBURGH, PA, USA | SEPTEMBER 14-18, 2014

Tutorial Proposal Form

1. Title of Tutorial:

Power semiconductor modules: Design, Applications, Manufacturing & Reliability

2. Abstract: (500 word limit. If the tutorial is accepted, this abstract will be published in the conference web page, program, and proceedings)

This tutorial will provide an overview of power semiconductor modules in automotive HEV/EV inverter applications. The tutorial will cover four major aspects of power module: design, applications, manufacturing and reliability. These four aspects are inter-related. A power module is designed to meet specific HEV/EV inverter applications. The broad module reliability specification is also driven by the applications requirements (vehicle drive cycles). However, the specific module reliability target will depend on module design (material, size etc.) and manufacturing process.

The tutorial will cover the basics of power module design: structure, interconnections, thermal and electrical performance. Although the focus of this tutorial is power module design, the fundamentals of the semiconductor devices (IGBT/diodes) used in these modules will be summarized. The design of the power module strongly depends on the device characteristics. The characteristics of the devices can be tuned to optimize power module performance. Both the device and module performance strongly influences the inverter efficiency, which, in turn, impacts MPG rating of the vehicle. Heat losses from the devices and module thermal performance determine the silicon and module size and therefore the cost of the inverter. The mechanical stresses that vehicle operating conditions (duty cycle) imposes on an inverter also depends on device and module characteristics. The tutorial will connect various aspects of power device and module characteristics for Hybrid-Electric Vehicle inverter applications.

Basic production processes will be discussed via a video of actual module production facility. A brief introduction to simulations for life time expectation of the modules will be presented and a couple of practical examples will be discussed. Special emphasis will be provided on the influence of power module design on lifetime and the impact of various external thermal and electrical parameters.

The tutorial will prepare engineers and managers to answer in three questions: 1) how does the power device and module characteristics impact fuel economy? 2) how can I specify power module reliability requirements based on vehicle drive cycles? and 3) how is power module designed, manufactured and qualified?

3. Outline of the tutorial: (4 hours tutorial).

- Overview: Semiconductor challenges in electrified powertrain
- Basics of IGBT & diodes: design & characteristics
- Power module main features: design & characteristics
- IGBT Module parameters/data sheet review
- Power Module Production Process
- Failure Modes and Reliability
- Power Module testing and qualification
- Power module performance and reliability trade-off
- Summary

4. Lead Instructor:

Title: Dr.
Name: Andre Christmann
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5. Other Instructors (Name / Affiliation & contact information)

N. a.

6. Instructor Bios: ~150 words each (Please provide a brief biography of each instructor, describing the qualifications for presenting the proposed tutorial, including the work and publications that are most relevant to the proposal)



Dr. André Christmann
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Dr. Andre Christmann is a specialist in power module design at Infineon and he has over 12 years' experience in this area. After completing his Ph. D. degree from Ruhr-Universität Bochum in 2000, Dr. Christmann worked for 3 years at the Fraunhofer Institute for Microelectronic Circuits and Systems (IMS Duisburg, Germany) in the area of power semiconductor development. From 2004 – 2011, he was responsible for the development of power semiconductor modules for hybrid-electric vehicle applications at Infineon Technologies AG (Warstein, Germany). During this time he designed HybridPACK1 module, which became an industry wide standard footprint for automotive power module. In 2011, he transferred to Infineon North America where he took over a position as Senior Specialist for Technology and Innovation in the area of power modules.

Dr. Christmann is author/co-author of several publications, lead classes in seminars and gave presentations on international conferences like APE (International Exhibition and Conference for Automotive Power Electronics; Paris, France) and PCIM (International Exhibition and Conference for Power Conversion Intelligent Motion; Nuremberg, Germany). He also holds patents on power module design.