TUTORIAL PROPOSAL

TITLE
Characterization and impact of SiC and GaN on Power Drive Systems

NAME AND AFFILIATION OF THE AUTHORS
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SCOPE AND BENEFITS
This is a general tutorial where one of the objectives is to show/review the advantages of Wide Bandgap components to reduce losses, size and weight of power drive systems. However, the main goal is to present all the negative effects of this technology on overvoltages that could appear on motors connected to the WBG inverter as well as on the EMI filter size and weight. Different solutions to prevent these negative effects will be explained in details in order to show power electronic designers how to make the most out of WBG components.

CONTENTS
Introduction:
estimated time, 10 minutes
- Power electronic integration (issues, solutions)
- Wide Bandgap (WBG) components and advanced converter topologies

SiC and GaN Overview:
estimated time, 20 minutes
- WBG physics
- Chronology of WBG components manufacturing
- WBG manufacturers (from prototype to mass production)
- WBG transistors (MOSFET, JFET, BJT…)
- Example of commercially available components
- Vertical or lateral structure
- WBG component packaging
- Advantages and disadvantages

WBG Market (Components and Applications):
estimated time, 10 minutes
- Price of different components and technologies
- SiC and GaN transistor market
- Applications using WBG components

Characterization of Wide Bandgap Transistors:
estimated time, 50 minutes

- Transistor characteristics
- Switching characteristics of MOSFET components (deep explanation)
- Characterization of switching losses
- Disadvantages of classical method (double pulse)
- Presentation of switching energy measurement method adapted to WBG components (modified opposition method)
- Example of results using this new method
- Importance of precise switching energy measurements in the design of high efficiency and high power density converters

WBG Components on a power drive system:
estimated time, 40 minutes

- Comparison between Si and SiC three-phase inverters for aircraft applications
- Characterization of switching losses, dv/dt and overvoltage for different driver/transistor parameters (gate resistance and voltage, dead time, switched current and voltage…)
- Design and characterization of a 15kVA/540V three-phase inverter for aircraft applications using SiC MOSFET
- Comparison between results obtained in the real converter and calculated using the proposed switching loss characterization method
- Impact of switching speed and overvoltage in conducted common-mode EMI
- Impact of switching speed and overshoot during commutation on overvoltage in cables and motors connected to converters
- Global impact of SiC MOSFET in a power drive system
- Trade-off between losses and weight in a power drive system for aircraft applications

Improving system efficiency and reducing EMI and overvoltage by reducing parasitics:
estimated time, 40 minutes

- Influence of parasitics on switching losses, dv/dt and overvoltage
- Packaging solutions of SiC power modules to reduce parasitics
- Design of SiC power module designed to reduce losses, overvoltage and EMI issues
- Characterization of the designed SiC power module
- Comparison with commercial SiC power modules and discrete components
- Solutions to improve efficiency and power density for three-phase SiC inverter

Conclusions:
estimated time, 10 minutes

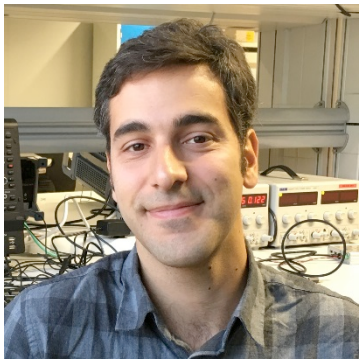
- Advantages and disadvantages of WBG components
- IRT Saint-Exupery's view on the technology development for the use of WBG components in aircraft applications

Schedule:
09:30 - 11:00 Introduction; SiC and GaN Overview; Characterization of WBG Transistors.
11:00 - 11:30 Coffee break
11.30 - 13:00 WBG Components on a power drive system; Improving system efficiency and reducing EMI and overvoltage by reducing parasitics; Conclusions.

Monday, 7 September 2020 - Tutorial day (Location: INSA Lyon, LyonTech-la Doua , 20, avenue Albert Einstein – 69621 Villeurbanne CEDEX.France)

WHO SHOULD ATTEND
This tutorial is addressed to engineers and academics with intermediate level on power electronics and semiconductors, and who desires to understand why SiC and GaN transistors will revolutionize power electronics, and what are the main issues related to these components and how to use them the best way possible

ABOUT THE INSTRUCTORS



Bernardo Cougo received the B.S. degree in electrical engineering from the UFMG/Brazil, and at University of Texas at Austin/USA. He obtained his M.Sc. degree in electrical engineering from UFMG, and his Ph.D. degree from the Institut National Polytechnique (INPT), Toulouse, France, in 2010.
He worked as a post-doctorate fellow at the PES Laboratory, at ETH-Zurich, in Switzerland and also at LAAS and LAPLACE laboratories in Toulouse, France. His is currently working as a Power Electronics Expert at the French Institute of Research IRT Saint-Exupery.
He has taught in different universities in Brazil and France, and he is currently a lecturer at ENSEEIHT/INP on subjects related to power electronics integration and Wide Bandgap semiconductors.
He advises several Ph.D. students and Post-doctorate fellows on research projects related to SiC and GaN power module and converters, mainly for aircraft applications. He has more than 60 publications since 2008 about power electronics integration and WBG semiconductor characterization and applications.