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KEY NOTE

"Current Source PWM Converters -From Past to the Future-"

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Abstract: Power electronics and switching mode power converters in general are today part of every segment of our life. Any piece of electric equipment we have today is somehow based on power electronics and switching mode power converters; home appliance, industrial equipment, renewable energy, automotive, avionic, ICT, military, etc., etc. Conversion efficiency, specific power, power density and converter cost are today the most critical requirements for new applications. One way to increase the conversion efficiency and reduce cost/size/weight is to deploy multi-level and/or multi-cell converters and partial power processing power converters.

Historically, very first power converters were Voltage Source Converters (VSC) based on the vacuum tubes as power switches. The first work on Vacuum Tube based VSC was reported in early 1930s. Then, with the invention of Bipolar Junction Transistor (BJT) and then Silicon Controlled Rectifiers (SCRs), the Current Source Converter topology become dominant. Until late 1980s, the CSC dominated in most of industrial applications, such as Variable Speed Drives and high-power grid connected converters. With the invention of the Metal Oxide Silicon Field Effect Transistors (MOSFETs) in late 1970s and the Insulated Gate Bipolar Transistors (IGBTs) in late 1980, the Voltage Source Converters become again dominant, especially in low-medium voltage and low-medium power applications. Today, majority of power conversion applications are based on PWM VSC with MOSFETs, IGBTs or IGCTs, depending on the voltage and power rating.

In recent years we have seen strong intertest in PWM Current Source Converters (CSCs). It can be proven that in some applications the CSCs could be superior over the VSCs. However, so far, there is not significant penetration of CSCs into real applications such as industry, renewables, automotive and ICT. The main issue is the fact that until today there is not available switch with Bi-Directional voltage blocking capability.

The Key Note will start with a short introduction and comparison of Voltage and Current Source Converters. Then, One-Quadrant (1Q) and multi-Quadrant (2Q &4Q) CSCs will be presented and analyzed. Analysis of CSC cell and design guidelines will be given. Three-phase single-cell and multi-cell interleaved CSCs will be briefly addressed. Power semiconductor switches with Bi-Directional voltage blocking capability, in particular Monolithic Bi-Directional GaN switch will be addressed. Finally, the Key Note will be concluded with several real-life case studies and design details.

Short biography:

Univ.-Prof. Dr. Petar J. Grbović received the Dipl. Ing. (B. Sc.) and the Magister degrees from the School of Electrical Engineering, University of Belgrade, Serbia, in 1999 and 2005, and the Doctor (Ph.D) degree from the Laboratoire 'Électrotechnique et d'Électronique de Puissance de Lille, l'Ecole Centrale de Lille, France in 2010.

From March 1999 to February 2003, he was an R/D Engineer with RDA Co, Belgrade. From November 2000 to June 2001, he was a Consulting Engineer with CESET Italy (a division of Emerson Appliance Motors Europe). From March 2003 to April 2005, he was with the R&D Department, PDL Electronics, Ltd., Napier, New Zealand. Since April 2005 until July 2010, he was working with Schneider Toshiba Inverter Europe, Pacy-Sur-Eure, France, as Power Electronics Group Expert. Since September 2010 until August 2011, he was with General Electric Global Research, Munich, Germany. Since September 2011 until September 2018, he was with HUAWEI Technologies, Europe Energy Competence Centre in Munich/Nuremberg, Germany, where he worked as a Senior Expert in the area of power electronics and power conversion. In March 2016 he was appointed to position of the scientific committee of Centre of Power Electronics and Drives, C-PED Lab., Roma TRE University, Italy. In June 2018 he was appointed to position of Full Professor at Innsbruck Power Electronics Laboratory (the i-PEL), the University of Innsbruck, Austria.

The focus of his research is on application of advanced energy storage devices, active gate driving for high power IGBTs and SiC MOSFETs, power converter topologies, advanced power semiconductor devices and control of power converters and semiconductor switches.

Prof. Grbović published 30 IEEE journal papers, 60 IEEE conference papers, 24 IEEE Key Notes and a book "Ultra-capacitors in power Conversion Systems: Analysis, Modelling and Design in Theory and Practice". He has 17 US & EP patents granted and 9 international patent applications pending.