
Multi-Cell & Multi-Level Power Converters

-A Way to Go Beyond The Limit of Si-

Abstract— Power electronics play significant role in industrial applications, power generation and transmission, home appliance, transportation, etc., etc. Power electronics, particularly power semiconductor are progressing on daily bases. Each new generation of power semiconductor introduces new challenges and issues. Some of the issues such as high di/dt and dv/dt in combination with parasitics of the device and package (inductance and capacitance) make almost impossible to fully utilize full advantages of new power semiconductor devices (SiC and GaN). A solution to above mentioned issues, which has been recently under the spot, is multi-level and multi-cell power conversion.

The objective of the seminar is to explore all benefits of multi-cell/multi-level converters. Advantages of these topologies, such as significant reduction of the filter and the dc bus capacitor size will be discussed in details. Moreover, strong impact on the device switching performances including switching losses and the over-voltage stress will be addressed too. Design guidelines for different concepts will be given in details.

This seminar is aimed at power electronics engineers, professionals and graduate students who want to improve their knowledge and understanding of multi-cell & multi-level power converters and their application, nowadays as well as in the near future.

Seminar Content:

1. Fundamentals of Power Conversion

2. Power Converters & Topologies

- 2.1. Voltage & Current Source Converters
- 2.2. Multi-Cell (Parallel Interleaved) Converters
- 2.3. Multi-Level (Series Interleaved) Converters
- 2.4. Series-Parallel Multi-Cell Converters

3. New Issues with New Power Semiconductors

- 3.1. di/dt issue in low voltage & high current applications
- 3.2. dv/dt issue in low current & high voltage applications

4. Parallel Multi-level Integration

- 4.1. Concept of the Intelligent Parallel Multilevel Integration (*IPMI*)
- 4.2. Effects on the Input & Output Filter Parameters and Design
- 4.3. Effects on the device commutation dynamics
 - 4.3.1. Equivalent di/dt and commutation over-voltage
 - 4.3.2. The device di/dt and switching losses
- 4.4. Optimal number of *IPMI* cells for given optimization parameters
- 4.5. Analysis and Design of N-Cell Interleaved converters
 - 4.5.1. I/O Filter Analysis and Design
 - 4.5.2. DC Bus Analysis and Design
 - 4.5.3. Modeling and Control

5. Series Multi-level Integration

- 5.1. Concept of the Intelligent Series Multilevel Integration (*ISMI*)
- 5.2. Effect on the equivalent commutation dv/dt and displacement parasitic capacitance current,
- 5.3. Effects on the Input & Output Filter Parameters and Design
- 5.4. Optimal number of *ISMI* cells for given optimization parameters,
- 5.5. Analysis and Design of N-Level converters

-
- 5.5.1.I/O Filter Analysis and Design
 - 5.5.2.DC Bus Analysis and Design
 - 5.5.3.Modeling and Control

6. Series & Parallel Multilevel Conversion

- 6.1. Concept Definition
- 6.2. ISOP & IPOS converters
- 6.3. Application examples

The Seminar Instructor:

Title: Dr

Name: Petar. J. Grbović

Affiliation 1: Power Conversion Technologies Lab. (PCTL)
HUAWEI Technologies Dusseldorf GmbH

Street Address: Riesstrase 25

City: 80992 Munich, Germany

Affiliation 2: Center of Power Electronics and Drives (C-PED)
Rome TRE University

Street Address: Via Della Vasca Navale 79

City : 00146 Roma, Italy

Cell Phone : +49 (0) 173 746 12 84

E-Mail Address: petar.grbovic@huawei.com
petar.grbovic@gmail.com



Dr. Petar J. Grbović received the Dipl. Eng. (B. Sc) and M.Sc. 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'École Centrale de Lille, France in 2010.

From March 1999 to September 2011 he was with various worldwide R&D centers such as PDL Electronics, Schenider Electric and General Electric. Currently he is with HUAWEI Technologies, Power Conversion Technology Lab. in Nuremberg, Germany. Since 2016 he is a scientific member of Center of Power Electronics and Drives (C-PED), Roma TRE University, Roma, Italy.

Dr. Grbović published over 50 IEEE conference/journal papers, 12 IEEE seminars and a book "Ultra-capacitors in power Conversion Systems: Analysis, Modeling and Design in Theory and Practice". He has 14 patents granted and six patent application pending. The focus of his research is on application of advanced energy storage devices, power converter topologies, advanced power semiconductor devices, control of power converters and semiconductor devices.