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Ee 2019, Novi Sad, Serbia - Tutorial Proposal

Tutorial title:

Modular Multilevel Converters – Operating Principles and Applications

Lecturers:

Prof. Drazen Dujic
Mr. Stefan Milovanovic
Power Electronics Laboratory – PEL
Swiss Federal Institute of Technology – EPFL, Lausanne, Switzerland

Objectives:

Medium Voltage Direct Current (MVDC) power distribution networks are currently being considered for various applications, from large wind and solar power collection and distribution grids to marine on-board electrical systems. Research activities in these areas also reveal various technological gaps, predominantly the lack of suitable conversion and protection equipment. In contrast to Solid State Transformers (SSTs), characterized with highly modular converter structures comprising multiple galvanically isolated sub-converter stages, there are other possibilities to realize high-power medium voltage isolated converters employing a single transformer for isolation. The Modular Multilevel Converter (MMC), with its excellent voltage scalability through series-connection of cells, offers such a possibility for various conversion structures needed in MV applications. This will be covered in the tutorial, predominantly focusing on high power MMC-based DC-AC and DC-DC galvanically isolated converters for MVDC applications. Topologies proposed in the literatures, as well as novel topologies proposed by authors, will be covered, analysed and supported by illustrative PLECS simulation examples.

Intended Audience:

The tutorial attendees should be familiar and with interest into medium voltage high power electronics conversion. We expect a strong interest in the proposed tutorial, since the MMC and its topological variations are extremely popular nowadays. Advanced high-power converter topologies are therefore relevant to a broad potential audience, e.g.:

- Master, PhD students and junior research scientists
- Industrial engineers from related sectors
- Senior research scientists from other fields interested in the topic and its challenging aspects

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Tutorial Outline and Proposed Agenda:

PART 1: MMC for DC-AC Conversion (1.5h – 2h)

1. Introduction
   a. MMC Applications, Systems and Technologies
   b. MVDC – LVAC Conversion Technologies
2. Modular Multilevel Converter
   a. Modelling and Control
   b. Modulation schemes
   c. PLECS examples
3. Galvanically Isolated Modular Converter
   a. Integration and Development
   b. Control
   c. PLECS examples

COFFEE BREAK (0.5h)

PART 2: MMC for DC-DC Conversion (1.5h – 2h)

4. Introduction
   a. MVDC Applications, Systems and Technologies
   b. MVDC – LVDC Conversion Technologies
5. High Power DC-DC converters with MFT isolation
   a. MMC-based Dual Active Bridge Topologies
   b. Control considerations
   c. PLECS examples
6. MMC-based DC-DC Converter with Scott Transformer Connection
   a. Motivation
   b. Design and Control
   c. PLECS examples
7. Summary and Q&A

Schedule and Duration:

The tutorial is planned as half a day tutorial or to last somewhere between 3 to 4 hours. Coffee break will be provided halfway through. PLECS illustrative simulations will support theoretical developments and presented tutorial material. Please note that for a successful tutorial delivery, we require two beamers to be provided in the lecture room.

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Biographies:

Drazen Dujic is an Assistant Professor and Head of the Power Electronics Laboratory at EPFL. He received the Dipl.Ing. and MSc degrees from the University of Novi Sad, Novi Sad, Serbia in 2002 and 2005, respectively, and the PhD degree from Liverpool John Moores University, Liverpool, UK in 2008.

From 2003 to 2006, he was a Research Assistant with the Faculty of Technical Sciences at University of Novi Sad. From 2006 to 2009, he was a Research Associate with Liverpool John Moores University. After that he moved to industry and joined ABB Switzerland Ltd, where from 2009 to 2013, he was Scientist and then Principal Scientist with ABB Corporate Research Center in Baden-Dättwil, and from 2013 to 2014 he was R&D Platform Manager with ABB Medium Voltage Drives in Turgi. He is with EPFL since 2014.

His research interests include the areas of design and control of advanced high power electronic systems and high-performance drives, predominantly for the medium voltage applications related to electrical energy generation, conversion and storage. He has authored or co-authored more than 90 scientific publications and has filed eleven patents.

In 2018 he received EPE Outstanding Service Award and, in 2014 The Isao Takahashi Power Electronics Award for Outstanding Achievement in Power Electronics. He is Senior Member of IEEE, EPE Member, and serves as Associate Editor for IEEE Transactions on Power Electronics, IEEE Transactions on Industrial Electronics, IET Electric Power Applications and EPE Journal.

Stefan Milovanovic received his Dipl.Ing. and MSc degrees from the School of Electrical Engineering, University of Belgrade, Serbia, in 2015 and 2016, respectively. From 2015 to 2016 he worked as a graduate teaching assistant at the same institution. Currently, he is pursuing the Ph.D. degree at Power Electronics Laboratory at EPFL, Lausanne, Switzerland. His research interests include High Power DC-DC conversion. He is an IEEE Student Member.