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ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Ee2017, Novi Sad, Serbia - Tutorial Proposal

Tutorial title:

High Power Medium Frequency Transformer Design Optimization

Lecturers:

Prof. Drazen Dujic
Mr. Marko Mogorovic
Power Electronics Laboratory - PEL
Swiss Federal Institute of Technology – EPFL
Lausanne, Switzerland

Objectives:

With increased interest in Power Electronic Transformers or Solid State Transformers, several technical problems arise related to actual realization of these technologies. Irrespectively of adopted power electronic topologies, these structures are characterized as being modular and having inherently built-in galvanic isolation at medium or high frequency. Designing a high-power high-voltage medium frequency transformer is associated with multiple technical challenges related to electrical, magnetic, dielectric and thermal performance limits encountered in the system. Various technological choices must be carefully considered and selected before being included into a generic multi-objective optimization. Tutorial will provide an overview and address challenges coming from the application area, characteristics of involved materials and available design choices, associated modelling of different elements impacting medium frequency transformer design, as well as optimization process as whole. Multiple illustrative design examples will be critically analysed in terms of their key performance indicators, and supported with practical examples realized by the tutorial instructors themselves.

Intended Audience:

The tutorial attendees should be familiar with basics laws of electromagnetics and have some background in power electronics. We expect a strong interest in the proposed tutorial since the topic of the solid state transformers, where medium frequency transformers are essential part, is extremely popular nowadays. The advanced high-power converter topologies are therefore relevant to a broad potential audience, e.g.:

- Master and 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 (1.5h – 2h)

1. Introduction
    a. Solid State Transformers
    b. Power Electronic Traction Transformer
    c. High Power DC-DC converters with MFT isolation
2. Medium Frequency Transformers
    a. Scaling laws
    b. Requirements
    c. Challenges
3. MFT Design Examples
    a. Railway related designs
    b. Utility related designs
    c. Other state-of-the art designs
4. Electromagnetics
    a. Basic considerations
    b. Geometries of interest
    c. Simplifying assumptions

COFFEE BREAK (0.5h)

PART 2 (1.5h – 2h)

5. Materials
    a. Magnetic materials
    b. Winding materials
    c. Dielectric materials
6. MFT Modelling
    a. Core
    b. Winding
    c. Thermal
7. MFT Design Optimization
    a. Optimization based algorithms
    b. Brute force parametric optimization
    c. Design examples
8. Summary and Q&A

Schedule and Duration:

Tutorial is planned as half a day tutorial or to last somewhere between 3 to 4 hours. Coffee break will be provided halfway through.

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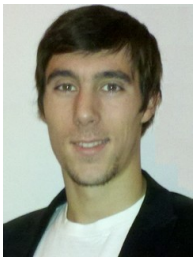
Biographies:

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 80 scientific publications and has filed eleven patents.

In 2014, he received The Isao Takahashi Power Electronics Award for Outstanding Achievement in Power Electronics, presented at International Power Electronics Conference, IPEC-Hiroshima 2014, Japan. He is Senior Member of IEEE, EPE Member, and serves as Associate Editor for IEEE Transactions on Power Electronics, IEEE Transactions on Industrial Electronics and IET Electric Power Applications.



Marko Mogorovic received the Dipl.Ing. degree from the University of Belgrade, Belgrade, Serbia, in 2013 and MSc degree from the École polytechnique fédérale de Lausanne (EPFL), Lausanne, Switzerland, in 20115. Currently, he is pursuing the Ph.D. degree at Power Electronics Laboratory at EPFL, Lausanne, Switzerland. His current research focus is on the design optimization of the high power medium frequency transformers for medium voltage applications and emerging solid state transformers.

He is an IEEE Student Member and EPE Student Member.