EPE Tutorial

TITLE

EMC Design Fundamentals and EMI Mitigation Techniques in High Power Converters

NAME AND AFFILIATION OF THE AUTHORS

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SCOPE AND BENEFITS

This tutorial is intended to address the EMC problems in the high power medium voltage converters and explain the related EMC design steps based on IEC standards. It describes how EMC applies to systems and installations, and also explains proven best EMC practices (implementation of EMC zones, bonding, earthing, when to use filter or shielding, cable layout and cable segregation, preventing grounding loop, routing within the system) in design, assembly and installation to optimize the essential reduction and conform to the standards of electromagnetic compatibility. The tutorial also covers the mechanical instructions when developing new converter design or evaluating existing solutions. The scope of the lecture would be very valuable to those power electronics engineers, mechanical engineers and researchers who are confronted with the practical problems of implementing EMC requirements in their applications and who need a guide to the methods that can be used immediately without performing complex mathematics.

CONTENTS

The tutorial focuses on the practical electromagnetic design issues on power electronics converters. The main contents of the proposed tutorial are described in the following outline. The tutorial is divided into two sections, each addressing a key topic, and presented in the outline below:

- Introduction
- Overview on Electromagnetic Basics
  - Absorptivity, reflectivity and transmissivity
  - Shielding
  - Eddy currents
  - Skin effect
  - Proximity effect
  - Magnetic conduit effect
- Coupling Mechanisms
  - Radiative coupling
  - Near field coupling
  - Conductive coupling
  - Reducing inductive and capacitive couplings
- Design Process
  - Pre-study (Identify the requirements from the related standards)
  - EMC related - System design

- EMC related - Electrical design
  - Zoning
  - Cable segregation and routing
  - Bonding and straps
  - Grounding on PCB level
  - Grounding on system level
  - Shielding
- EMC related - Mechanical design
  - Apertures
  - Seams
  - Cable penetrations
  - Corrosion

- Mitigation Methods and Best Application Practices
- Related Standards and Tests
- Summary

Monday, 11 September 2017 - Tutorial day (Location: WUT, Warsaw, Poland)

13:00 - 14:00 : Lunch break and registration for the afternoon tutorials

14:00 - 15:30 : Tutorial Part 1: Three elements (victim, source and coupling path) are essential to an EMC problem, therefore in the first section of the tutorial identification of the source, receptor and the coupling path will be explained and the methods to reduce the couplings will be shown. At the same time, when designing for immunity the system´s intended environment should be known; therefore how to identify the EMI environment of a MV converter based on standards will also be given.

15:30 - 16:00 : Coffee break

16:00 - 17:30 : Tutorial Part 2: In the second part of the tutorial zoning, shielding, cable segregation, cable routing and the effects of apertures, seams and cable penetrations will be explained based on practical examples. Since most of the EMC problems are caused by improper grounding the examples of sufficient grounding will be described. At the end of the presentation an overview of the EMI standards (how to identify the limits and how to measure) will be given.

WHO SHOULD ATTEND

This tutorial introduces basic theory and practical solutions for the EMI in power electronics systems. The scope of the lecture would be very valuable to those power electronics engineers and researchers from university and industry who are faced with EMC problems in their applications and who need practical solutions. The presentation aims to give a guide to the methods that can be used straight away without performing complex mathematics.

Technical Level: - Moderate -
The attendees should have a basic level of knowledge in power electronics and EMC topics. Having some background in power systems and mechanical design aspects in power electronics is beneficial, but not a prerequisite.

ABOUT THE INSTRUCTORS

Ilknur Colak received her MSc. and PhD. in electrical engineering from Istanbul Technical University, Istanbul, Turkey. From 1998 to 2000 she worked as a teaching assistant in the Informatics Institute of Istanbul Technical University. After following two years of power electronics research engineering experience in industry, she worked as a research scientist in TUBITAK (The Scientific and Technological Research Council of Turkey) where she was responsible of high power resonant converters, hybrid/electrical vehicles, drives for power traction applications, battery chargers for military applications, etc. From 2008 to 2010 she worked as an R&D manager in OZDISAN where she was leading a power electronics research team in the field of DC/DC converters, inverters, UPS, etc. She was also responsible for knowledge management and education of engineers within the company. In 2010 she joined to CERN (The European Organization for Nuclear Research) as a research scientist where she designed the first space vector modulation controlled multilevel converter for the LHC accelerators. Between 2012 and 2016 Dr. Colak worked with ABB Power Converter Solutions group, Turgi, Switzerland, as senior lead researcher, where she was working on high power modular multilevel converter for medium voltage applications. As a system research engineer, her research area includes multilevel topologies, modulation schemes at low pulse-ratios, transformerless concepts, high power resonant converters, NPC, ANPC topologies, insulation coordination, EMC and grounding on high power applications, reliability of power electronic systems, solar energies and wave energy conversion systems. She is main author of 11 scientific papers and the invertor or two patent applications. Since November 2016 Ilknur Colak is with Maschinenfabrik Reinhausen - MR as Power Electronics Project Manager.