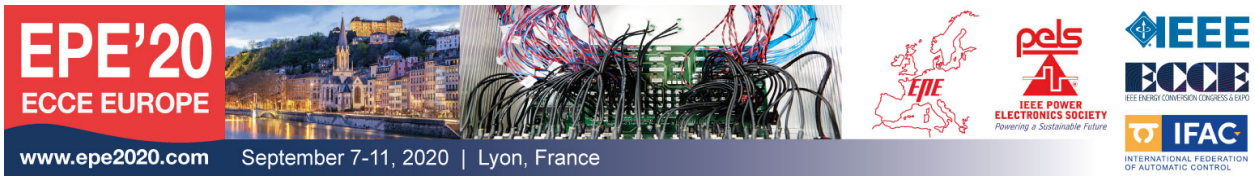

Tutorial at EPE 2020:

Electronic Design Automation and optimization algorithms for the next generation of optimal power converters

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SCOPE AND BENEFITS

The aim of the tutorial is to present in the first part an overview of the existing methods and software for automated optimal design of power converters. Then in a second time a deep look inside algorithms and modeling is taken. Finally success stories of optimal converter design for industrial partners are presented as example of the performance of such methods.

Electronic Design Automation (EDA) is a computer methodology using optimization algorithms that select optimal parameters and components achieving the highest power densities and efficiencies for the lowest prices.
For the power electronics designer the main challenges are dealing with:

- Multi-physics interactions and high numbers of control parameter;
- Discrete parameter such as the type of components and topologies;
- The emerging technologies such as wide band gap semiconductors must be integrated without years of feedback;
- Market components availability;
- Multiple objectives and constraints.

It becomes nearly impossible for a designer to guarantee the converter with the optimal solution for several objectives respecting lots of constraints by hand design.
Moreover, the computation time required to iterate over all possible solutions is:

- Either too large if one wants to simulate whole power converter candidates with all their multiphysic complexity even for the best computers;
- Either implementing too simple models that lead to practically suboptimal solutions, especially for highly integrated systems.

For the business the main challenges is achieving high performance with lowest price and very short time to market to stay competitive.
The EDA methods based on optimization algorithms are the best candidates to optimize power electronics systems in energy efficiency, size, thermal performance, EMI performance and costs, and to identify the design limits imposed by the currently available and emerging technologies.

WHO SHOULD ATTEND
The tutorial is made for power electronic designer beginner to expert, from academia or industry. No solid mathematical background is required. The attendees will acquire the knowledge of existing methods and tools for optimal design, where to find them and in which context they should use them. They will be able at the end of the tutorial to select the methods they'd like to develop in their lab or company.

SCHEDULE
09:30 – 11:10 Introduction & 1st Part
11:00 – 11:30 Coffee break
11:30 – 13:00 2nd Part & Conclusions

CONTENTS

Introduction 10mins
Presentation of why automated design with optimization will become the tool that a designer cannot work without.

1st Part 1h20

- Presentation of the main optimization methods
    - Combinatory
    - Determinist
    - Stochastic
- Presentation of most used optimization algorithms and their convergence mechanism. Advantages and drawbacks. E.g. Geometric Programming, NSGA-II, Conjugate Gradient, SQP.
- Talk about power converter multi-physic modeling and impact on optimal design
    - Polynomial modeling approach
    - 'Imaginary' representation of power converter
    - Multi-software for multi-physic simulation
    - Analytical modeling versus Finite Element Analysis
    - Discrete modeling of power converter
- Talk about model accuracy versus optimal design pertinence.
- Tips and model examples.

Coffee Break

2nd Part 1h20

- Presentation of existing commercial software, Matlab optimization toolbox and open-source tools.
- Presentation of open-source Grid Evolutionary Multi-Objective Genetic Algorithm Matlab platform developed by the author and used with industrial partners.
- Industrial success stories of high efficiency with low price power converters and dramatically reduced time to market thanks to Electronic Design Automation.
    - 500kVA and 3MW UPS, Schneider Electric ITB (FR).
    - 22kW fast DC Charger for electrical vehicle, Green Motion (CH).
    - 25kW multi-level GaN based Flying Capacitor (CH).
    - 3kVA PFC with coupled magnetics, Simatec (CH).

Conclusions & Perspectives 10mins
What needs to be achieved in the future for a total automated design of power converter?

ABOUT THE INSTRUCTORS
Timothe Delaforge was born in Grenoble, France. He graduated from the French superior mathematical prep school with special mention in 2009. He received the Ing. Degree in power electronics from Univ. Grenoble Alpes in 2012 and the Ph.D degree with the highest honors in 2015.

He achieved his PhD in collaboration with Schneider Electric ITB. He developed an electronic automated design tool for Schneider Electric. He was part of the fast prototyping of a 500kVA UPS and the new SE1 3MW solar inverter from Schneider Electric. He specialized in magnetics modeling and design and optimization algorithms.

He is currently senior researcher at the Bern University of Applied Sciences in Switzerland. He is in charge of power converter hardware design, modeling and innovation for industrial partners such as Bombardier Transportation, Studer Innotec or GreenMotion (Swiss leader in electrical vehicle charging solutions).
He is involved in research on optimization methods; high efficiency high power density power converters; new magnetics; GaN and SiC based multi-level converter with focus on parasitic cancellation and extremely efficient cooling; gate drivers for medium voltage 15kV application and next generation electrical based communication.
He has been working on automated design and optimization for 8 years. He developed private software for automated design and he is now developing an open-source tool for both academics and industrials. He is part of expert talks on automated design and consequently has a very good knowledge of last advancement in this area and inside look on what the industry is doing.