
**EPE'25 – Call for Tutorials**

# EMC simulation for Power Electronics

## Name(s) and Affiliation(s) of the Lecturer(s):

*The team of lecturers is not decided yet. This is a likely proposal.*

**Prof. Dr. Jan Hansen**
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## Tutorial Objectives:

After explaining basic terminus and concepts of electromagnetic compatibility (EMC), the tutorial shall give an overview of modeling and simulation approaches, typical challenges and bottlenecks dealing with electromagnetic interference (with focus on but not exclusively conducted emissions) for modern power electronics circuits. The workshop gives a structured guideline on how to build and run simulation models of power electronics with switching transistors, including SiC, and magnetic filter components like common mode chokes (CMC). The audience shall understand the goals and limits of different modeling approaches. Practical examples are shown, employing commercial simulation tools like Ansys Electronics, Dassault CST Microwave Studio, Keysight Pathwave ADS, PLECS, LTSpice, QSpice.

## Target Audience:

**In this paragraph, please describe the target audience of the tutorial that you propose. Please make sure the target audience is clearly described.**

Power Electronic engineers and researchers dealing with system, circuit or component design and transient or frequency-domain simulation. Engineers and researchers working on EMI filter design, electric component modeling, behavioral modeling, or conducting EMC tests.

## Topical Outline:

**Introduction: (Estimated time: 30 minutes)**

- EMI sources and coupling paths
- Conducted emission tests and their importance for EMI qualification of power electronics
- The Challenges of modeling the EMI of power electronics
- The modeling approaches and their goals
- Modeling in Industry: Model shaping along the product development process

**Theme 1: Passive and active component modeling (60 minutes)**

- PCBs (layout parasitics, loop inductance)
- Magnetics (ferrites, Nanocrystallines, Common-Mode Chokes, Coupled Inductors)
- Transistors

**Theme 2: Modelling of Power Electronics Circuits for EMC simulation (60 minutes)**

- Building bridges between power electronics modeling approaches for control, losses and EMC
- PLECS, SPICE and S-parameter models
- Circuit models and their properties, required subcomponent models
- Accuracy and limits

**Theme 3: EMI Filter Design by simulation (40 minutes)**

- Common-mode and differential mode
- Employing Python for rapid design studies

**Theme 4: Application of Machine Learning in EMC modeling (40 minutes)**

- Machine Learning techniques
- Examples of trained models
- Multi-Objective Optimization and further applications

**Theme 5: System Modeling at high (f > 30 MHz) frequencies (30 minutes)**

- Constructing and running 3D models
- Assembly elements, subcomponent models
- Accuracy and limits

**Conclusions (20 minutes)**

- State-of-the-art in EMC simulation
- Bottlenecks

**<u>Provisional Schedule of the Tutorial:</u>**

Schedule:

09:00 – 11:30 : Introduction / Theme 1 / Theme 2
11:30 -13:00 : Coffee break / Lunch Break

13:00 – 14:30 : Theme 3 / Theme 4
14:30 – 15:00 : Coffee break
15:00 – 16:00 : Theme 5. / Conclusions

**About the Lecturers:**

**Prof. Jan Hansen** received the B.Sc. degree in mathematics/physics from Trent University, Peterborough, ON, Canada, in 1995, the Diploma in physics from Freiburg University, Freiburg, Breisgau, Germany, in 1998, and the Ph.D. degree in wireless communications from ETH Zurich, Zurich, Switzerland, in 2003.,After completing the Ph.D. degree, he was with the Information Systems Laboratory, Stanford University, Stanford, CA, USA, working in digital communication theory, channel modeling, and wave propagation. He then joined Robert Bosch GmbH, Stuttgart, Germany, to work in electromagnetic compatibility (EMC) simulation, eventually serving as head of the simulation team in Bosch's Automotive Electronics' EMC Department. Since 2022, he has been an Assistant Professor with the Institute of Electronics, Graz University of Technology. His primary research interests include the development of EMC simulation methods, electromagnetic modeling, and the application of machine learning techniques.

**Dr. Christian Riener** worked at NXP Semiconductors Austria as RF Validation Engineer and Analog Design Engineer before he joined Graz University of Technology as University Assistant in 2020. In 2024 he received the Ph.D. degree for his work in fundamental theory of electromagnetic and numerical simulation. Since 2024 he is Researcher in the Power Electronics division of Silicon Austria Labs, working on EMC simulation for power electronic applications.

**Patrick Dominik Gsoels, MSc**. was almost 7 years with NXP Semiconductors Austria as Analog Design Engineer with focus on behavioral modeling before he joined Silicon Austria Labs and the Christian Doppler Laboratory for EMC Aware Robust Electronic Systems. beginning of 2024 to pursue his Ph.D. degree. His expertise is in Multi-Objective Optimisation (MMO) and Model Calibration for EMC in Power Electronics.

**Dr. Herbert Hackl** received the B.Sc., M.Sc., and Ph.D. degrees in electrical engineering from the Graz University of Technology,

Graz, Austria, in 2012, 2014 and 2019, respectively. He is currently a Senior Scientist with Silicon Austria Labs (SAL), Graz, Austria, where his field of research includes the simulation of electromagnetic compatibility and coexistence with focus on model-based design of power electronic circuits and systems.