EPE'25 – Call for Tutorials

Fundamentals to Understand Parasitic Capacitances in Magnetic Components

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

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Tutorial Objectives:

The parasitic capacitance in magnetic components has been identified as significant challenges in modern power electronic converters, especially with wide-bandgap devices due to the fast switching and higher frequency. This tutorial aims to give a systematic review on the history (since 1910s), fundamental definitions, correct measurements, modeling methodologies and ongoing challenges. Very light mathematical derivations will be introduced during the tutorial, since the end goal aims to let more researchers/engineers be familiar with parasitic capacitance and know where/how to understand and analyze parasitic capacitance during the practical environments.

Target Audience:

It is now a common sense that magnetic components are the bottlenecks to further improve the performance of power electronic converters, especially with wide-bandgap devices. The knowledge shared in this tutorial will benefit researchers and engineers who have a focus on hardware design and research of converters. The topic introduced in this tutorial should be emerging and highly relevant to many audiences, due to the large demands and requests received from EPE 23 and other conferences.

Topical Outline:

Introduction: (Estimated time: 5 minutes)

- Background

Overview: (Estimated time: 20 minutes)

- Inductance vs. Capacitance
- Historical look of parasitic capacitance
- Why should we care it today?

Real Tutorial 1, How to understand/define? (Estimated time: 25 minutes)

- Black-box models
- White-box models
- Inductive-based capacitive coupling/ Capacitive-based capacitive coupling

Real Tutorial 2, How to measure? (Estimated time: 35 minutes)

- LCR meter and impedance analyzer
- Transformer – 6 capacitance model
- Conventional measurement method
- Guarding measurement method

Real Tutorial 3, How to model? (Estimated time: 50 minutes)

- Behavioral based modeling
- Physics based modeling
- Limitations of current modeling methods

Real Tutorial 4, The ongoing challenges (Estimated time: 20 minutes)

- More accurate modeling
- Behaviors after the first resonant frequency
- The role of damping resistance
- Reducing/enlarging parasitic capacitance

Conclusions and Q&A (Estimated time: 15 minutes)

- Take-away
- Q&A

Provisional Schedule of the Tutorial:

Schedule:

09:30 - 11:00 : Introduction / Overview / Tutorial 1/Tutorial 2

11:00 - 11:30 : Coffee break

11:30 - 13:00 : Tutorial 3 / Tutorial 4 / Conclusions

About the Lecturers:

Hongbo Zhao received the Ph.D. degree in Power Electronics from Aalborg University, Denmark in 2021. He was a visiting researcher at the University of Texas at Austin in 2021, a visiting scholar at the University of Galway in 2023, and a visiting professor at the G2ELAB in 2024. He was awarded by Frenetic with the 'Best Magnetic Design' in 2022. He received the Villum Fellowship in 2022. He was selected as a future entrepreneur by the Spin-outs Denmark program in 2023. His idea on next-generation magnetic components was selected as the prestigious 'The Bright Idea Award' from Otto Mønsteds Fond in 2023. He has authored and co-authored around 70 peer-reviewed publications and is the first inventor of 4 pending international patent applications. He was invited to give more than 15 presentations and tutorials at multiple conferences and universities. He is serving as the Associate Editor for IEEE Open Journal of Power Electronics. Currently, he is an assistant professor at AAU Energy, Aalborg University, Denmark.
His research interests include the analysis and packaging of modern magnetic components, as well as the applications of wide bandgap semiconductor devices.