University of Stuttgart
Institute of Robust Power Semiconductor Systems

ENSI CAEN

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Bachelor's thesis
Research project
Master's thesis

Power electronics

High-Frequency Characterisation and Modelling of Ceramic Capacitors for Fast-Switching Power Applications

Topic first announced on 01.12.2024
Valid until 03.11.25

The topic is suitable for adaptation to
- ✓ Master's thesis (6 months)
- ✓ Bachelor's thesis (3 months)
- ✓ Research proejct (3 months)

Motivation

Together with the wide-bandgap semicondcutor based power transistors, such as SiC power MOSFETs and GaN power HEMTs, ceramic capacitors form the basic building blocks of fast-switching high current and voltage commutation cells and power modules in high power density switched-mode power converters.

The power capacitors must follow suit with the power transistors in high-frequency capabilities, in order not to become the bottleneck for switching loss energy and thermal management, and accurate simulation models of the capacitors' high-frequency characteristcs must be developed for the reliable design of fast-switching power modules.

Scientific problem statement

In this research work, state-of-the-art commercially available ceramic capacitors will be characterised and modelled in terms of their high-frequency characteristics up to the microwave frequency range. Compact, equivalent-circuit based models are developed including non-linearities and thermal characteristics, expanding the current state of the art towards high-fidelity models for ceramic capacitors in power electronics applications.

Work programme

The work is carried out in collaboration at University of Stuttgart, Germany, and at ENSI Caen, France. The final work programme is determined in trilateral planification between the tutors and the student and can comprise

- Survey of the prevailing state of the art
- Microwave characterisation of ceramic capacitors at ILH, including the design of dedicated test breadboards
- Model development, implementation in VerilogA and verification at ENSI Caen
- Optional: power module breadboard design and experimental validation at ILH

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