University of Stuttgart

Institute of Robust Power Semiconductor Systems

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Valid until 30.09.25

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

Bachelor's thesis
Research project
Master's thesis

Power electronics

Waveform Shaping in Fast-Switching Wide Bandgap Power Transistor Based Commutation Cells

Motivation

Modern wide bandgap semiconductor based power transistors, such as SiC power MOSFETs and GaN power HEMTs, allow for extremely fast voltage and current switching on the nanosecond scale, resulting in increased power densities in power converters.

The control of the switching waveforms of such fast-switching power electronic sub-systems becomes a major challenge, but is indispensible both for maintaining electro-magnetic compatibility and for the limitation of switching loss energies.

Scientific problem statement

In this research work, several techniques in the design of the gate loop of power commutation cells based on GaN power transistors in view of waveform shaping for an optimum tradeoff between electro-magnetic emission and switching loss energy are investigated in theory, simulation and measurement and compared to the prevailing state of the art.

Work programme

The final work programme is determined in bilateral planification between the tutor and the student and can comprise

- Survey of the prevailing state of the art
- Theoretical investigation of gate-loop concepts for waveform shaping, including multi-level gate drivers such as Bosch EG120, nonlinear external gate resistance and novel proprietary GaN power transistors with custom gate structure
- Circuit-level switching waveform simulations in ADS
- On-wafer measurements of novel proprietary GaN power transistors with custom gate structure
- Experimental validation of selected gate loop concepts in custom-designed breadboard demonstrators

Bosch EG120 gate driver with variable gate current profiles
https://www.bosch-semiconductors.com/system-ics/powertrain/eg120/