BOMBARDIER

KTH VETENSKAP OCH KONST

Master's Thesis:

Parallel operation of Silicon Carbide (SiC) Power Semiconductor Modules in a Traction Converter

Background

Wide bandgap semiconductors like SiC and GaN show superior material properties enabling potential power device operation at higher temperatures, voltages and switching speeds than current Si technology. As a result, a new generation of power devices is being developed for power converter applications and traditional Si power devices with limited performance are being replaced with high performing wide bandgap devices. Electric mobility, Traction, Renewable energy and Power grids are some of the large industrial beneficiaries of this change.

On the other hand, many of the material advantages are not fully exploited due to specific material quality, technology limitations, nonoptimized device/converter designs, shortage of efficient controllers/drivers and reliability issues. Presently there is enormous research and development efforts happening in this area, especially for the traction applications. One of the main challenges, is to design the Gate drive units and control/safety principles for the parallel of operation of the SiC power devices, to develop high power traction converters for the future.

Objective

The main objective of the present master thesis project is to develop a model and investigate the parallel operation of SiC power semiconductor devices for the traction converter application. Model based design (MBD) using MATLAB/Simulink (or similar software) is used to develop the converter commutation loop model with paralleled SiC devices. Essential experiments are performed in the Power Semiconductor Laboratory, in Bombardier Västerås, to obtain the required data, which can be usd to compare and fine-tune the Simulink model. The student will cooperate with experts in relevant areas during the project.

The project will include the following main tasks (but not limited to):

1. Developing a simple traction converter commutation loop model in Simulink/PLECS, with paralleled semiconductor switches

2. Inserting limited SiC device properties and gate drive properties into the switch & drive blocks
3. Simulating double pulse & PWM tests to investigate the performance of the model
4. Testing the SiC devices in the PSC lab and obtain the necessary switch performance data to compare and fine-tune the simulation model
5. If time permits, the scope can be extended to the performance optimizations and finding boundary conditions when using paralleled SiC switches

The developed model will be used for the next generation converter design optimizations in the future.

Application

Prerequisites: Relevant background, *e.g.* Electrical Engineering or Engineering Physics. Knowledge and experience in MATLAB/Simulink or similar simulation tool. Previous knowledge of Spice and LabView can benefit during the project but are not mandatory.

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