

Master Thesis in Electrical Engineering at Energy Lab

Thermal Modeling and Operational Limit Determination of Semiconductor Devices for DCCB Applications

Thesis Description:

Solid-state circuit breakers (SSCBs) are increasingly recognized as fast and reliable solutions for fault interruption in DC microgrids. The rapid rise of fault current in low-inductance DC systems makes the optimal design of SSCBs particularly challenging. During normal operation, the breaker must conduct the system's nominal current with minimal losses. However, during a fault, it must also withstand a rapidly increasing overcurrent until the interruption sequence is completed. In microgrids with large DC-link capacitors, fault currents can reach several times the semiconductor's rated current within microseconds. Although this extreme overcurrent lasts only for a short duration, it critically stresses the device. The short-time current capability of a semiconductor therefore differs significantly from its continuous current rating. Accurate identification of this transient current limit is essential for creating both technically reliable and cost-efficient SSCB designs. This thesis investigates the thermal behavior of semiconductor devices under microsecond-scale fault conditions. The goal is to extract precise short-time current limits using FEM-based thermal modeling to enable optimized SSCB design for DC microgrid applications.

Milestones:

- Developing the lumped-parameter thermal network models for multiple semiconductor types (MOSFET, IGBT, Thyristor) and deriving their corresponding current limits using the lumped-parameter framework.
- Establishing the FEM-based thermal models for the various semiconductor devices, explicitly incorporating bond-wire geometry and thermal behavior.
- Determination of the current-carrying limits of each semiconductor technology across multiple time resolutions using both lumped-parameter and FEM-based thermal analyses.

Your Profile:

- Experience with Matlab/Simulink
- Proficient in performing FEM-based thermal simulations using COMSOL Multiphysics
- Language: German or English

You will learn:

- Thermal modeling of semiconductor devices
- Application of FEM-based techniques for thermal analysis
- Simulating scenarios and analyzing data

Contact:



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