DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: High Power Medium Voltage DC/DC Converter Technology for DC Wind Turbines

Location: Pontoppidanstræde 105, room 4.127

Time: Monday 3 September at 13.00

PhD defendant: Mohammadkazem Dowlatabadi

Supervisor: Professor Philip Carne Kjær

Moderator: Szymon Beczkowski

Opponents: Associate Professor Michael Møller Bech, Dept. of Energy Technology, Aalborg University (Chairman)
Professor Drazen Dujic, Power Electronics Laboratory, Ecole polytechnique fédérale de Lausanne, Switzerland
Managing director, dr. Kazuhiro Imaie, Hitachi Hi-Rel Power Electronics Pvt. Ltd., India

All are welcome. The defence will be in English.

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Abstract:

Offshore HVDC-connected wind farms promise reduced electrical losses, lower bill-of material cost and undiminished functionality with the condition the wind plant MV collection network becomes DC, rather than MVAC. One dearly missed building block that would enable the transition to a DC voltage collection, is the DC/DC converter for high power & high voltage (megawatss and kilovolts). The main objective of this thesis was investigation and development of a turbine DC/DC converter proof of concept. The selected topology is based on a single phase series resonant converter, operated with a new modulation scheme, which permits regulation of power from nominal level to zero, in presence of variable input and output DC voltage levels. The circuit was rearranged so that the LC tank is located on the rectifier side of the high-turns ratio transformer combined with frequency control and phase shifted inverter modulation. The modulation scheme was entitled pulse removal technique and it keeps the transformer flux constant from nominal frequency down to DC, always in sub-resonant continuous or discontinuous conduction mode. A design guide line, suitable for a given range of specifications, in the megawatt (5 to 15 MW), kilovolt (±35 to ±50 kV) and kilohertz (0.5 to 5.0 kHz) range is introduced, while medium voltage experimental setups are implemented for characterization of losses, control and voltage sharing. The new method of operation promises reduced transformer size while total losses are kept below 1.5% from zero to nominal power, due to soft-switching characteristics. One experimental setup, rated for 10 kW and 5 kV ouput was assembled to extract losses and test of the control architecture, while a later MV setup for soft-switching characterization of 6.5 kV igbts and diodes is proposed for validation of semiconductors loss model.