DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: Improved Design Methods for Robust Single- and Three-Phase ac-dc-ac Power Converters

Location: Pontoppidanstræde 101, Room 23

Time: Thursday 6 August 2015 at 13.00

PhD defendant: Zian Qin

Supervisor: Professor Frede Blaabjerg

Moderator: Professor Francesco Iannuzzo

Opponents: Professor Zhe Chen, Dept. of Energy Technology, Aalborg University (Chairman)
Professor K.Gopakumar, Dept. of Electronic, Indian Institute of Science, Bangalore, INDIA
Professor LIU Jinjun Xian, Jiatung University, Xi'an, Shaanxi, CHINA

All are welcome. The defence will be in English.

After the public defence there will be an informal reception in Pontoppidanstræde 101 room 25/27.

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Abstract:

As the ac-dc-ac converters are widely used interfaces in energy conversion system, they play an important role in reducing cost of energy. Therefore, the objective of this thesis is to study and propose advanced design for robust ac-dc-ac converters, where the voltage stress, the efficiency, the energy density, the cost, the loss distribution, and thermal performance of the converters will all be taken into account. The thesis contains four parts and seven chapters.

The first part – “Preamble” contains only Chapter 1, which presents the introduction and motivation of the whole project as well as the background, the emerging challenges, and the structure of the thesis.

The second part – “Single-Phase AC-DC-AC converters” covers three chapters. Chapter 2 and Chapter 3 propose new modulation methods for single-phase B6 and H6 converters, respectively, to retain the same DC-link voltage with two full-bridges connected back-to-back, and at the same time improve the thermal distribution between the switches, the harmonics, and hence the control flexibility. Chapter 4 studies the active power decoupling methods for single-phase inverters or rectifiers, which is similar to the single-phase ac-dc-ac converter. With active power decoupling the ripple power in the converter can be compensated in a more efficient and more compact way.

The third part – “Three-Phase AC-DC-AC Converters” is composed of two chapters. Chapter 5 studies the nine-switch converter, which is a reduced switch version of two three-phase full-bridges connected back-to-back. Application criteria of the nine-switch converter are investigated to reduce the relatively high stress introduced by the less number of switches. Chapter 6 proposes a rotating speed controller design method to improve the thermal loading of the wind power converter in a system level.

The fourth part – “Conclusions” has only Chapter 7, which gives the conclusion and the contributions in the thesis as well as the proposals for the future work.

Several approaches are proposed in this thesis to achieve a robust design of ac-dc-ac power converters including: 1. new modulation schemes of single-phase B6 and H6 converters for improved performance, 2. an optimal active power decoupling approach for kW-scale single-phase converters to achieve high power density and high efficiency, 3. application criteria of nine-switch converters for improved performance in terms of loss and temperature, 4. a new rotating speed controller design method for power levelling of wind power converters.