University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

HAO CHEN

BEng (University of Victoria, 2012)

"High-Frequency Isolated Dual-Bridge Series Resonant DC-to-DC Converters for Capacitor Semi-Active Hybrid Energy Storage System"

Department of Electrical and Computer Engineering

Monday, July 20, 2015
2:00 P.M.
Engineering and Computer Science Building
Room 467

Supervisory Committee:
Dr. Ashoka K.S. Bhat, Department of Electrical and Computer Engineering, University of Victoria (Supervisor)
Dr. Subhasis Nandi, Department of Electrical and Computer Engineering, UVic (Member)

External Examiner:
Dr. Zuomin Dong, Department of Mechanical Engineering, UVic

Chair of Oral Examination:
Dr. Phalguni Mukhopadhyaya, Department of Mechanical Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

In this thesis, a capacitor semi-active hybrid energy storage system for electric vehicle is proposed. A DC-to-DC bi-directional converter is required to couple the supercapacitor to the system DC bus.

Through literature reviews, it was decided that a dual-bridge resonant converter with HF transformer isolation is best suited for the hybrid energy storage application. First, a dual-bridge series resonant converter with capacitive output filter is proposed. Modified gating scheme is applied to the converter instead of the 50% duty cycle gating scheme. Comparing to the 50% duty cycle gating scheme where only four switches work in ZVS, The modified gating scheme allows all eight switches working in ZVS at design point with high load level, and seven switches working in ZVS under other conditions. Next, a dual-bridge LCL-type series resonant converter with capacitive output filter is proposed. Similarly, the modified gating scheme is applied to the converter. This converter shows further improvement in ZVS ability. Operating principles, design examples, simulation results and experimental results of the two newly proposed converters are also presented. In the last part of the thesis, a capacitor semi-active hybrid energy storage system is built to test if the proposed converters are compatible to the system. The dual-bridge LCL-type series resonant converter is placed in parallel to the supercapacitor. The simulation and experimental results of the hybrid energy storage system match closely to the theoretical waveforms.