Announcing the Final Examination of Xi Chen for the degree of Doctor of Philosophy

Time & Location: July 1, 2019 at 9:30 AM in Harris Corporation Engineering Center (HEC) 356
Title: Analysis, Design and Efficiency Optimization of Power Converters for Renewable Energy Applications

DC-DC power converters are widely used in renewable energy-based power generation systems due to the constant demand of high-power density and high-power conversion efficiency. DC-DC converters can be classified into non-isolated and isolated topologies. For non-isolated topologies, they are typically derived from buck, boost, buck-boost or forth order converters and they usually have higher conversion efficiency than isolated topologies. However, with the applications where the isolation is required, LLC resonant converter is an attractive selection because of its soft switching, high power-density, high efficiency, etc.

In low-power applications, such as battery chargers and solar microinverters, increasing switching frequency can reduce the size of passive components, current ripple and root-mean-square current, resulting in higher power-density and lower conduction loss. However, switching losses, gate driving loss and electromagnetic interference may increase as a consequence of higher switching frequency.

Several optimization approaches have been presented to improve the efficiency, power-density and reliability of power converters in this dissertation. In first part, an adaptive switching frequency modulation technique is proposed to improve efficiency based on the precise loss model of a cascaded-buck-boost converter. Due to the major power losses are from the inductor, a new low-profile nanocrystalline inductor is designed to significantly reduce the magnetic loss. To further improve the efficiency, the adaptive switching frequency modulation technique is applied on the converter with designed nanocrystalline inductor.

In second part, a novel dual-input DC-DC converter is developed according to the LLC resonant topology. This design concept minimizes the circuit components by allowing single resonant tank to interface multiple input sources. Semi-active rectifiers are used on the transformer secondary side to improve efficiency while maintaining the voltage gain. Besides, a burst-mode control strategy is proposed to improve the light load efficiency. This control strategy is able to be readily implemented on any power converter since it can be achieved directly through firmware and no circuit modification is needed.

Major: Electrical Engineering

Educational Career:
Bachelor's of Photovoltaic and Solar Energy, BS, 2014, University of New South Wales
Bachelor's of Applied Physics, BS, 2014, South China University of Technology
Master's of Electrical Engineering, MS, 2016, University of Central Florida

Committee in Charge:
Issa Batarseh, Chair, Electrical and Computer Engineering
Wei Sun, Electrical and Computer Engineering
Qun Zhou, Electrical and Computer Engineering
Wasfy Mikhael, Electrical and Computer Engineering
Nasser Kutkut, Electrical and Computer Engineering

Approved for distribution by Issa Batarseh, Committee Chair, on June 6, 2019.

The public is welcome to attend.