Inverters are widely used in photovoltaic (PV) based power generation systems. Most of these systems have been based on medium to high power string inverters. Microinverters have been shown to have advantages over their string inverter counterparts in both grid-tied PV energy harvesting and standalone micro-grid systems with energy storage. Some of these advantages are simplified installation, elimination of high voltage dc wiring, higher system reliability and improved energy harvesting. In low power applications such as solar microinverters, increasing the switching frequency can reduce the size of passive components resulting in higher power density. However, switching losses and electromagnetic interference (EMI) may increase as a consequence of higher switching frequency. Soft switching techniques have been proposed to overcome these issues.

Zero voltage switching (ZVS) boundary conduction mode (BCM) peak current control is a promising soft switching candidate for low power applications where the switching losses are usually dominant. For this purpose, three different peak current mode control methods have been introduced: BCM with fixed reverse current, BCM with variable reverse current, and BCM with fixed bandwidth. In these modulation methods, the inductor current is bidirectional during switching cycle to achieve turn-on ZVS. Although BCM control results in increased rms current, conduction losses and core losses when compared to continuous conduction mode (CCM), switching losses are greatly reduced.

This dissertation presents several innovative control techniques which are used to increase efficiency and power density while reducing cost. Dynamic dead time optimization and dual zone modulation techniques have been proposed in this dissertation to significantly improve the microinverter efficiency. In addition, an advanced DC link voltage control has been proposed to increase the microinverter power density. This concept minimizes the storage capacitance by allowing greater voltage ripple on the DC link. Therefore, the microinverter reliability can be significantly increased by replacing electrolytic capacitors with film capacitors.

Major: Electrical Engineering

Educational Career:
Bachelor's of Electrical Engineering, BS, 2009, Babol University of Technology
Master's of Electrical Engineering, MS, 2011, Iran University of Science and Technology

Committee in Charge:
Prof. Issa Batarseh, Chair, Electrical & Computer Engineering
Kalpathy Sundaram, Electrical & Computer Engineering
Nasser Kutkut, Electrical & Computer Engineering
Wasfy Mikhael, Electrical & Computer Engineering
Wei Sun, Electrical & Computer Engineering

Approved for distribution by Prof. Issa Batarseh, Committee Chair, on May 4, 2017.

The public is welcome to attend.