Announcing the Final Examination of Mahmood Alharbi for the degree of Doctor of Philosophy

Time & Location: July 30, 2018 at 2:30 PM in HEC 450
Title: Design and Implementation of PV-Firming and Optimization Algorithms for Three-Port Microinverters

With the demand increase for electricity, the ever-increasing awareness of environmental issues, coupled with rolling blackouts, the role of renewable energy generation is increasing along with the thirst for electricity and awareness of environmental issues. This research proposes the design and implementation of PV firming and optimization algorithms for three-port microinverters.

Novel strategies are proposed for harvesting stable solar power in spite of intermittent solar irradiance. PV firming is implemented using a panel-level three-port grid-tied PV microinverter system instead of the traditional high-power energy storage and management system at the utility scale. The microinverter system consists of a flyback converter and an H-bridge inverter/rectifier, with a battery connected to the DC link. The key to these strategies lies in using static and dynamic algorithms to generate a smooth PV reference power. The outcomes are applied to various control methods to charge/discharge the battery so that a stable power generation profile is obtained. In addition, frequency-based optimization for the inverter stage is presented.

One of the design parameters of grid-tied single-phase H-bridge sinusoidal pulse-width modulation (SPWM) microinverters is switching frequency. The selection of the switching frequency is a tradeoff between improving the power quality by reducing the total harmonic distortion (THD), and improving the efficiency by reducing the switching loss. Two algorithms are proposed for optimizing both the power quality and the efficiency of the microinverter. They do this by using a frequency tracking technique that requires no hardware modification. The first algorithm tracks the optimal switching frequency for maximum efficiency at a given THD value. The second maximizes the power quality of the H-bridge micro-inverter by tracking the switching frequency that corresponds to the minimum THD.

Real-time PV intermittency and usable capacity data were evaluated and then further analyzed in MATLAB/SIMULINK to validate the PV firming control. The proposed PV firming and optimization algorithms were experimentally verified, and the results evaluated. Finally, A summary of key conclusions and future work to optimize the presented topology and algorithms are presented.

Major: Electrical Engineering

Educational Career:
Bachelor's of Electrical Engineering, BS, 2010, Taibah University
Master's of Electrical Engineering, MS, 2014, University of Colorado Colorado Springs

Committee in Charge:
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Approved for distribution by Issa Batarseh, Committee Chair, on July 16, 2018.

The public is welcome to attend.