School of Electrical, Computer and Energy Engineering

PhD Final Oral Defense

Robust control of wide bandgap power electronics device enabled smart grid

by
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Nov. 6 2017
10:00 am – 12:00 pm
ERC 593

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Abstract
In recent years, wide bandgap (WBG) devices in power electronics area are getting attentions. Its fast switching speed enables power converters with higher power density and higher efficiency. On the other hand, smart grid technologies are getting mature due to new battery and computer technologies. This dissertation deals with two applications: silicon carbide (SiC) device used for medium voltage level interface (7:2 kV to 240 V) and gallium nitride (GaN) device used for low voltage level interface (240 V/120 V). A 20 kW SiC solid state transformer (SST) is designed with 6 kHz switching frequency rectifier, 15 kHz dual half bridge, 20 kHz inverter and 20 kHz buck converter. Three robust control design methods are proposed for smart grid operations. For low voltage level application, a 3.3 kW smart grid hardware is built with 3 GaN inverters. Each inverter is formed by a 200 kHz boost stage and 100 kHz switching frequency rectifier stage. Each inverter is tested to process 2.2 kW power with overall efficiency of 96.5 % at room temperature. At last, the three GaN inverters smart grid achieved the function of grid connected to islanded mode smooth transition.