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FPGA-based Digital Control Development for a Wind Turbine Inverter

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The Field Programmable Gate Array (FPGA) offers opportunities for improved performance and design flexibility for digital control of power electronics. However, the complexity of Hardware Description Language (HDL) coding can be a barrier for the design engineer. This presentation will describe a system modeling and development environment for FPGA-based digital control that also has the ability to auto-generate HDL code. The method uses Altera DSP Builder technology in a MATLAB / SIMULINK environment to develop a digital power electronics controller. Altera DSP Builder libraries will be presented along with debug tools, Advanced DSP Builder capabilities and existing target hardware. This design flow allows the user to build floating point designs in low cost Cyclone class FPGAs.

The presentation will take attendees through the complete design process of a current control loop for a wind grid-tie inverter. This includes basic control design and linear simulation using Matlab/Simulink and SimPowerSystems. The linear control blocks are then replaced with DSP Builder blocks and simulation results compared. VHDL code will then be auto-generated, compiled and loaded onto a grid-tie inverter control board for actual demonstration. A 3-phase grid-tie inverter with active and reactive power control will be presented. The controller is built with Altera Advanced DSP builder blocks with math functions that have floating point capability. This includes 3-phase PLL, synchronous PI and proportional resonant controllers. The development process will be presented along with actual results from a 10kW wind turbine grid-tie converter.

Keywords: FPGA; digital control; wind turbine; grid-tie inverter