Journal of Power Electronics (JPE)

Volume 17, Issue 1, 2017, Pages 232-241

Design and Experimental Validation of a Digital Predictive Controller for Variable-Speed Wind Turbine Systems

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Abstract: Advanced control algorithms must be used to make wind power generation truly cost effective and reliable. In this study, we develop a new and simple control scheme that employs model predictive control (MPC), which is used in permanent magnet synchronous generators and grid-connected inverters. The proposed control law is based on two points, namely, MPC-based torque?current control loop is used for the generator-side converter to reach the maximum power point of the wind turbine, and MPC-based direct power control loop is used for the grid-side converter to satisfy the grid code and help improve system stability. Moreover, a simple prediction scheme is developed for the direct-drive wind energy conversion system (WECS) to reduce the computation burden for real-time applications. A small-scale WECS laboratory prototype is built and evaluated to verify the validity of the developed control methods. Acceptable results are obtained from the real-time implementation of the proposed MPC methods for WECS.

Keywords : Maximum Power Point Tracking (MPPT), Model predictive control (MPC), Permanent Magnet Synchronous Generator (PMSG), Wind Energy Conversion System (WECS)