(1)

-Wind Power Grid Integration using Passive Filter for IPMSG Diode Rectifier and Simple MPPT Control for Grid-Side Inverter

Tarek Ahmed, K. Nishida and M. Nakaoka

Abstract:

In this paper, a 1.5 kW Interior Permanent Magnet Synchronous Generator (IPMSG) with a power conditioner for the grid integration of a variable-speed wind turbine is developed. The power-conditioning system consists of a series-type 12-pulse diode rectifier powered by a phase shifting transformer and then cascaded to a PWM voltage source inverter. The PWM inverter is utilized to supply sinusoidal currents to the utility line by controlling the active and reactive current components in the q-d rotating reference frame. While the q-axis active current of the PWM inverter is regulated to follow an optimized active current reference so as to track the maximum power of the wind turbine. The d-axis reactive current can be adjusted to control the reactive power and voltage. In order to track the maximum power of the wind turbine, the optimal active current reference is determined by using a simple MPPT algorithm which requires only three sensors. Moreover, the phase angle of the utility voltage is detected using a simple electronic circuit consisting of both a zero-crossing voltage detecting circuit and a counter circuit employed with a crystal oscillator. At the generator terminals, a passive filter is designed not only to decrease the harmonic voltages and currents observed at the terminals of the IPMSG but also to improve the generator efficiency. The laboratory results indicate that the losses in the IPMSG can be effectively reduced by setting a passive filter at the generator terminals.

Keywords:

Diode Rectifier, Interior Permanent Magnet Synchronous Generator, Passive Filter, PWM Inverter, Wind Energy

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(2)

Integrating the Electrical Power from Wave Energy Plant into the UK National Grid

Tarek Ahmed

Abstract:

In this paper, multiple offshore wave energy converters with different output characteristics are connected to one power distribution substation. The connection between the power take-off of the different wave energy converters and the electrical power transmission system is presented in order to investigate whether multiple wave energy converters can augment energy yield and improve network integration capabilities. Moreover, the model of an array of wave energy converters is developed with the goal of analyzing the effects of the offshore wave farm on the electrical network to which it is connected. It is also developed to ensure that the electricity generated by the array is sufficiently controllable, and of a quality that can be integrate into the electricity supply network without unduly increasing the cost of connection, production or delivery.

Keywords:

Electrical Power Generation Systems, Induction and PM Generator, Inverter, Wave Energy

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(3)

Cost-Effective Deadbeat Current Control for Wind-Energy Inverter Application With LCL Filter

Katsumi Nishida, Tarek Ahmed, and Mutsuo Nakaoka

Abstract:

This paper proposes appropriate analytical expressions for a deadbeat control system to be implemented in the output inductor–capacitor–inductor (LCL) filter of a grid-connected inverter. Unlike in a conventional analysis, the proposed control algorithm with a settling time of three sampling periods is derived from the system transfer function in the discretized time domain instead of the Laplace s-domain. Furthermore, when introducing the deadbeat control, the independent control of the integrated active power and that of the reactive power are also made possible. The experimental results of the proposed deadbeat control system indicate that the feedbacks from both grid and inverter currents have similarly high capabilities in attenuating switching frequency components and damping resonance. Such proficiency is brought about because the remaining two undetected control variables of the LCL filter are taken as estimates in the DSP when introduced to the state observer. However, feedback from the grid currents can be seen to significantly reduce the total harmonic distortion of the actual grid currents themselves.

Keywords:

Active damping methods, deadbeat control and adaptive predictor, grid and inverter current feedbacks, grid-connected inverter, LCL filter.

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(4)

A Novel Finite-Time Settling Control Algorithm Designed for Grid-Connected Three-Phase Inverter With an LCL-Type Filter

Katsumi Nishida, Tarek Ahmed, and Mutsuo Nakaoka

Abstract:

In this paper, a cost-effective finite-time settling current control system for a utility-interactive three-phase voltage source inverter system with an inductor–capacitor–inductor (LCL)-type filter is originally designed and developed. The discrete-time system equation of the LCL-type filter is first simply derived in the □□□ stationary reference frame. Then, the finite time of a three-sampling-period settling control algorithm is derived in the form of state feedback, whereas the required numbers of sensors are reduced by introducing an identification algorithm. Moreover, the implementation of the novel control scheme achieves the time-optimum response of a 3-D controlled variable in the LCL-type filter when damping the LC resonance strongly. The effectiveness of the proposed finite-time settling control algorithm is substantially confirmed by the simulation and experimental results of inverter, static synchronous compensator, and rectifier modes of operation.

Keywords:

Adaptive predictor, finite-time settling control, grid integration of renewable energy sources, inductor–capacitor– inductor (LCL) filter, LCL resonance, state identification algorithm.

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