Journal Article Volume 94, Issue 3 Russian Electrical Engineering Pages 212 – 221

Modified PQ and Hysteresis Current Control in Grid-Connected Single-Phase Inverter for PV System

Abstract

Abstract: This paper proposes a modified PQ method integrated with hysteresis current control (HCC) used in a grid-connected single-phase inverter for photovoltaic (PV) renewable energy system. The main aim is to achieve a smooth control of unidirectional power flow from the solar PV to the inverter and then from the inverter to the load, and yet bidirectional power flows from/into the utility grid. The system configuration consists of PV array, H-bridge single-phase inverter, ac load and ac grid. Incremental Conductance (InCond) algorithm is used to track the maximum power point of active power (P mpp) available from PV array even under varying environmental and load conditions. The inverter switching modulations are achieved by pre-defined double-band HCC which is calculated to minimize total harmonic distortions (THDs) in the ac output waveforms. The modified PQ method ensures that full synchronization is achieved with the utility grid, unity power factor (PF) is always maintained and bidirectional power flow is properly regulated. The proposed controller of the grid-connected single-phase inverter is tested for various operating conditions under varying loads and solar irradiance levels. The results show that the proposed controller can effectively regulate the delivery of active power and reactive power from the inverter to the connected load. The results also prove that the proposed controller successfully allows bidirectional power flow at the grid side. Total harmonics distortions of the voltage and currents are shown to be less than 5% maximum limit, as recommended in IEEE 519 standard. Another merit of the proposed controller is that it guarantees a unity power factor by forcing the grid voltage and current to be in phase without the use of phase locked loop (PLL) technique. Stable DC-link voltage at the inverter side is achieved without the DC boost converter stage. The efficacy of the proposed controller used in the grid-connected single-phase inverter is proven using MATLAB/Simulink.

Keywords

Hysteresis Current Control; Maximum Power Point; Photovoltaic; Single-Phase Inverter; Solar Irradiance