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Control of grid-connected residential solar-PV system using novel adaptive linear combiner filter for power quality improvement

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ABSTRACT

A grid-connected residential photovoltaic (PV) system has been proposed using novel adaptive linear combiner filter-based control for power quality (PQ) improvement. In the present work, novel adaptive linear combiner (ALC) filter-based control-based control has been proposed to generate reference current. MATLAB/Simulink software is used to develop the two-stage grid-connected residential PV. The proposed control is tested in MATLAB/Simulink2018(a) under nonlinear, linear load and variable input and validated experimentally on prototype hardware. The performance of the proposed ALC filter-based control has been analyzed and compared with that of conventional synchronous d-q control. It has been observed from results that THD in grid current using proposed control is 3.74% whereas using conventional d-q control THD is 4.75%. Proposed control provides more efficient performance by improving the PQ of the system by compensating the harmonics and reactive load demand. Harmonic distortion in the grid current is within the limits as per IEEE-1547. Furthermore, proposed control has better transient response viz. settling time, under shoot and overshoot in DC link voltage during grid connection of rooftop PV system and provides, reduced complexity due to absence of phase lock loop (PLL), thus less sampling time, better accuracy, ease of implementation, and adaptability.

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Introduction

Due to the increasing electricity demand, the world's future is shifting toward distributed generation (DG) using renewable energy sources (RES), as they are green and environment friendly in nature. Among all the RES, solar energy is better due to its unique features such as an abundance of solar insolation, ease of installation, ease of maintenance, no moving parts, negligible level of pollution, etc., hence grid integration of solar PV system is gaining much interest. It also helps in sustainable and reliable supply systems along with the utility grid. The growing interest in grid-integrated photovoltaic (PV) systems leads to residential PV converters connected to the grid are used. The main purpose of the grid-connected residential PV system is that it supplies load requirements and excess power is fed back to the grid. Whenever the power of the residential PV system is not sufficient to fulfil load requirements, the distribution grid supplies the deficit power. Residential PV system reduces the burden on the residential distribution grid (Zangeneh Bighash et al. 2018). It can be set up in rural areas, developing cities and on the rooftop of domestic buildings (Khooban, Member, and Gheisarnejad 2020; Gheisarnejad et al. 2019). Generally, grid-connected residential PV systems are installed globally at a large scale. Further, PV power generation is dependent on operating temperature and irradiance level which leads to fluctuations in voltage and power. Therefore, it is very challenging to achieve maximum power from residential solar PV arrays under varying operating conditions.

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