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Active Power Sharing and Reactive Power Compensation in a Grid-tied Photovoltaic System

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Abstract

In the present scenario of energy crisis, researches on non-conventional energy sources have grown appreciably. The electrical energy derived from the PV panel is considered as the most useful natural resources. This paper deals with the operation and control of a grid interfaced PV system. Inverter control is achieved by using adaptive hysteresis current control scheme. The proposed inverter control technique interfaces renewable energy source and the AC bus of micro grid. It provides the possibility of injecting power from the renewable sources and favours reactive power compensation. The resulting controller is simulated in MATLAB/SIMULINK and results are analyzed.

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*Keywords:*Active Power Injection, DC-DC Boost Converter, Hysteresis Controller, Photovoltaic System, MPPT Algorithm, SRF.

1. Introduction

Renewable energy resources play a vital role in generating power in the current era. Besides reducing the emission of greenhouse gases, the flexibility to the energy resource is provided by reducing the dependence on fossil fuels. Among renewable resources, the photovoltaic (PV) generator is more popular due to its clean and environment

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friendly. Grid integration of PV power generation system has the advantage of most effective utilization of generated power. However, the technical requirements from both the PV system and the utility power grid side system need to be satisfied to ensure the safety of the PV installer and the reliability of the utility grid [1].
In the current scenario of energy crisis studies are being conducted on feasibility of using grid interfaced inverters fed from photovoltaic arrays, fuel cells etc [2]. Output current at the inverter determines the quality of photovoltaic power. This necessitates the use of efficient current control scheme for grid connected inverters [3].

The concept of using active power filters for reactive power compensation was proposed a while ago. Since then, the theories and applications of active power filters have got a great attention. Among the common current control techniques used for active power filtering, hysteresis current control method is more popular due to its quick current controllability and easier implementation. However, the current control with a fixed hysteresis band has the draw back of varying switching frequency within the band because peak to peak current ripple is to be controlled at all points of the fundamental frequency. To overcome this problem, adaptive hysteresis current control scheme can be used [4].

This work proposes effective utilization of photovoltaic system for injecting real power and compensating reactive power compensation. Three phase grid connected voltage source inverter interfaces PV system with the grid. Inverter control is achieved by adaptive hysteresis current controller. Reference current extraction has been done with synchronous reference frame method. Section 2 gives a description about the system configuration under study. Section 3 describes the control strategies. Section 4 discusses the Simulation and experimental results. Section 5 concludes the work with future scope.

2. System Configuration

Voltage source inverter based three phase grid connected inverter with adaptive hysteresis current control circuit is employed in this work. It acts as a shunt active power filter and is in parallel with the loads at the Point of Common Coupling (PCC). System configuration is shown in Figure 1. A nonlinear load is connected to three phase grid source and PV system is connected in parallel to it. Synchronous reference frame method (SRF) is used for extracting the reference current and the reference current is compared with the filter current in the hysteresis loop and corresponding pulses are given for inverter switching. Current waveform for cancelling out the harmonics is attained with Voltage Source Inverter (VSI) and interfacing inductor. Inductor provides smoothing and isolation for high frequency components. Desired current waveform is obtained by controlling the switching of Insulated Gate Bipolar Transistor (IGBT) switches in the inverter.

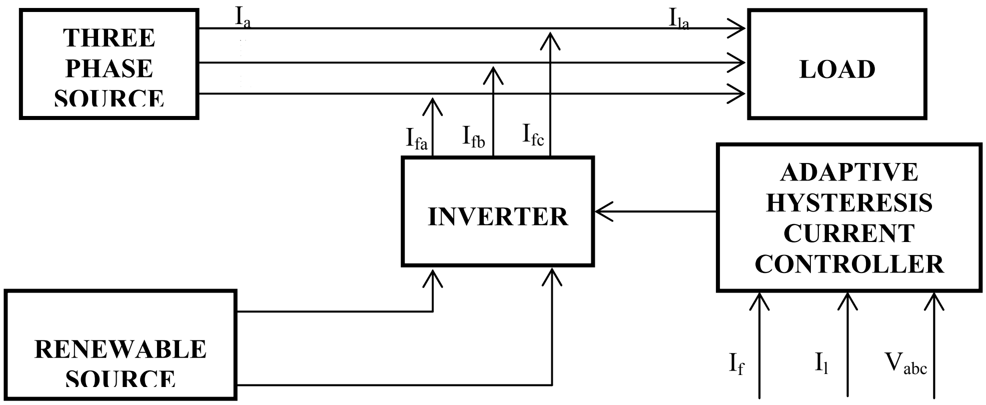

Fig.1.System Configuration: Block Diagram

PV system is equipped with MPPT control, DC-DC converter and a bidirectional inverter. Referring to the Fig. 2,PV module can be modeled by using Kirchhoff's law of current and voltage[3].

$$I_{dc}=I_g - I_D - (V_D / Rp) \quad (1)$$

$$V_{dc}=V_D - R_s I_{dc} \quad (2)$$