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# Harmonic and Reactive Power Compensation of Grid Connected Photovoltaic System

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**Abstract**

Distributed Generation (DG) is predicted to play an important role in the electric power system in near future. It is widely accepted that photo voltaic generation is currently attracting attention to meet users' need in the distributed generation market. In order to investigate the ability of photo voltaic (PV) units in distribution systems, their efficient modeling is required. This paper presents a dynamic model of a PV generation system. The increasing application of nonlinear loads may cause distribution system power quality issues. In order to utilize distributed generation (DG) unit interfacing converters to actively compensate harmonics, this paper proposes an enhanced control approach. In this paper, synchronous reference frame strategy has been chosen and a grid connected photo voltaic generation system (PVG) can send the active power to the grid, compensate harmonics and absorb the reactive power that the local loads generated. The converter controller models are implemented in the MATLAB / SIMULINK. The performance of the implemented PV model is studied with an isolated load. Synchronous reference frame strategy is used to generate current reference for compensation and conventional PI controllers are used for control. The strategy utilizes co-ordinate transformations to separate the reactive and harmonic content in the load current. The design of the closed loop controllers is kept simple by modelling them as first order systems. The simulation studies showed good results with the reactive current compensation giving almost ideal result of near unity power factor and harmonic currents getting compensated to a larger extent.



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*Keywords:* Distributed Generation, grid-connected PV system, Power quality, Reactive power compensation, synchronous reference frame strategy.

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## 1. Introduction

Distributed Generation (DG) can be defined as electric power generation with in the distribution networks or on the consumer side of the network. To utilize interfacing converters to compensate harmonics an enhanced current control approach is introduced in [1]. With inverter control, the active and reactive power requirement of the load can be satisfied [2].Distributed generation (DG) units interfaced with static inverters are being applied and focused increasingly due to the fact that conventional electric power systems are being more and more stressed by expanding power demand, limit of power delivery capability, complications in building new transmission lines, and blackouts [5-9]. Power quality, safety and environmental concerns and commercial incentives are making alternative energy sources [3] [4] popular.Various control techniques are presented in [10]. This paper deals with the modelling, simulation and harmonics and reactive power compensation of grid connected PV based distributed generation. In the present study, the synchronous reference frame strategy is used to generate current reference for compensation and conventional PI controllers are used for control. The synchronous reference frame strategy utilizes co-ordinate transformations to separate the reactive and harmonic content in the load current. The control techniques proposed in [11] minimizes the number of measurements and sensors.[12] presents the operation of grid connected DG system driven by dc-dc step-up converter and a dc-ac voltage source inverter and the design, modelling and control of power converters for power quality improvement in a grid-connected DG system is presented in [13]

**Nomenclature**

| | |
|---|---|
| Vdc | DC bus voltage |
| $id^*$ | Direct axis reference current |
| iq* | Quadrature axis reference current |
| Vpcc | Point of Common Coupling Voltage |

## 2. Architecture of the proposed system

Grid connected PV based distributed generation system converts electrical energy in to same amplitude, frequency and phase with the power grid and also provide electrical energy to the local loads. The block diagram representation of the proposed system is shown in Fig. 1.

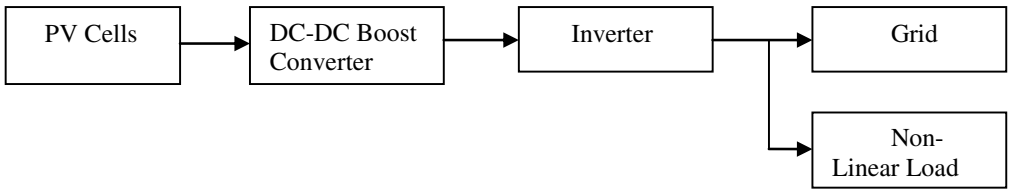


Fig. 1. Block diagram representation of the proposed system.

The basic element of grid connected PV system is the three phase inverter. Inverters are an important component of the grid-connected system whose role is to convert DC into AC of the same amplitude, frequency, and in phase with the grid. In addition, the inverters should be of high validity and reliability, and ensure the security of the local loads and the power grid. With the non-linear local loads widely used, the harmonic sources are more and more, and whose impact to power quality cannot be ignored. The control of mostly existent grid-connected system is to gain the unity-power factor, Voltage sag and swell, which can guarantee the efficiency of energy transfer, but ignored the need of compensating reactive power and harmonic with the principle of proximity. In this paper, based on the synchronous reference frame strategy, detection of reactive power and harmonic current, and the control strategy of