Control of Three Phase Solar Photovoltaic System With Power Quality

Dr.R.Sankar Ganesh[1], Nandhini R [2]
[2] Dept of Power Electronics And Drives
[1, 2] K.S.R. COLLEGE OF ENGINEERING, TIRUCHENGODE.

Abstract- *This paper presents the control model of three phase grid connected photovoltaic generation system with a new approach for reactive power regulation. The model contains a detailed representation of the main components of the system that are the solar panels, DC/DC converter, DC-link, a grid side three phase voltage source inverter (VSI) and output filters to reduce harmonic distortion of line current. In this paper, a complex control scheme including two PI controllers and cooperated with MPPT is proposed to stabilize DC voltage. A three phase grid connected voltage source inverter synchronizes to the grid by a robust phaselocked loop (PLL). The proposed model is simulated in Matlab/Simulink Toolbox. Simulation and experimental results show the high stability and high efficiency of this three-phase grid-connected PV system.*

Keywords- Three phase Grid-connected Inverter; Maximum Power Point Tracking (MPPT); Photovoltaic (PV); Solar Energy.

I. INTRODUCTION

The recent decade has seen a significant increase in the number of solar photovoltaic (PV) installations worldwide.1 Power quality is currently a major concern in the integration of full converter-based renewable energy resources. A weak connection of large solar PV based generation in a power system may cause power quality issues that could lead to disturbances and economic losses. The Saudi Arabia National Renewable Energy Program is currently setting out a targeted road map to quickly branch out the national power generation, stimulate economic growth, and support long-term growth in line with the 2030 vision of an innovative renewable industry.2 Studies have been carried out to discuss power quality issues related to grid tied PV plants. Extensive studies have been presented to address PV-tied grid. David G Infield et al.3 reported on a study of a number of inverters linked to the grid from a comprehensive power quality perspective. The measurements were generated into low-voltage (LV) network by taking individual single-phase inverters under a specific limit of effective conditions and for several converters similarity tied at the same point on the grid. The result was centered around characterized current harmonics, power factor (pf), and injection of direct current. Therefore, due to the similar phases, it has been shown that lower order harmonics reduces cancelation. Here, we propose a method for calculating the acceptable penetration level of residential gridconnected PV inverter system installations based on voltage total harmonic distortion (VTHD) and individual harmonic voltage limits recommended in the relevant Australian harmonic standards published by AA Latheef et al.,4 and also show the possibilities of having a reduced inverter current harmonic magnitude. The impact of using common distributor types was studied to understand the variation of acceptable penetration levels for grid-connected PV inverter systems.

II. LITERATURE SURVEY

1. MORE THAN ENVIRO-FRIENDLY: RENEWABLE ENERGY IS ALSO GOODFOR THE BOTTOM LINE

With the increasing integration of renewable energy generation into high power grids, transmission at the DC level is becoming increasingly more useful than AC transmission. In this regard, emerging applications, such as offshore wind farms, require a high voltage gain DC/DC conversion system to interface with high power transmission networks. This paper presents a new high voltage gain resonant switched-capacitor (RSC) DC/DC converter for high power offshore wind energy systems. The proposed DC/DC converter is characterized by the resonant switching transitions to achieve minimal switching losses and maximum system efficiency. Therefore, a higher switching frequency is conceivable to attain a higher power density. The double stage output voltage of the proposed converter operates at seven times as high as the input voltage with a small device count.

2 DYNAMIC MODELING AND OPERATION STRATEGYFOR A MICROGRID WITH WIND AND PHOTOVOLTAIC RESOURCES

ANY applications powered by batteries call for high performance, high step-up dc–dc converters. As an example, for a high intensity discharge (HID) lamp ballast used in automotive headlamps in which the start-up voltage is up to

400 V, the dc–dc converter needs to boost the 12 V of the battery voltage up to 100 V during steady-state operation. Another example of a high step-up application is the front-end converter with dual inputs. The convergence of computer and telecommunications industries makes the well-defined 48 V battery plant a good choice for offering hours of reserve time during outages of the ac mains . Although both powered by the 48 V dc power plant, the dc-input converter is more efficient and less complex than the uninterruptible power supply (UPS) . The dc-input converter must boost the 48 V of the dc bus voltage to about 380–400 V. Generally speaking, the high step-up dc–dc converters for these applications have the following common features.

1) High step-up voltage gain. Generally, about a tenfold step-up gain is required.
2) High efficiency.
3) No isolation is required.

3 DYNAMIC RESPONSE OF A STAND-ALONEWIND ENERGY CONVERSION SYSTEM WITH BATTERY ENERGY STORAGE TO A WIND

In stand-alone power supplies have garnered high esteem for reducing atmospheric pollution that are produced by fossil fuel combustion . Distributed generation (DG) units, including both renewable and nonrenewable energy such as photovoltaic (PV) modules, fuel cells (FCs), and wind generators, provide alternative environment-friendly energy to satisfy current electrical demands of consumers. In traditional power systems, power stations with fossil combustion engines that are located far from the consumers require the building of long transmission lines, which is very expensive. Moreover, estimates by the World Bank state that as much as 40% of the world's population lives in villages that are not tied to any utility grid . Therefore, the DG units are often taken as a prime candidate in the building of a small-scale stand-alone generation plant for household electric supply. However, the DG units often have a low output voltage, so they cannot directly support electrical appliances with the same power qualities of the grid in terms of frequency and amplitude. Thus, the design of a power conversion system with two-stage topologies that include a dc–dc converter and a dc–ac inverter, which are commonly used to efficiently interface the low-voltage dc power to the electric utilities, as well as stand-alone power supply, has recently become a major research topic

1.4 OBJECTIVES

The main objectives of this system are as follows:

- The control system includes firstly an AC current controller, designed with the Backstepping control technique, and using p-q Theory for the computation of these reference signals.
- Secondly, a DC bus voltage controller is designed using the sliding mode control technique.

III. EXISTING SYSTEM

A control algorithm for a standalone solar photovoltaic (PV)-diesel-battery hybrid system is implemented in this paper. The proposed system deals with the intermittent nature of the energy generated by the PV array and it also provides power quality improvement. The PV array is integrated through a DC-DC boost converter and controlled using a maximum power point tracking (MPPT) algorithm to obtain the maximum power under varying operating conditions. The battery energy storage system (BESS) is integrated to the diesel engine generator (DG) set for the coordinated load management and power flow within the system. The admittance based control algorithm is used for load balancing, harmonics elimination and reactive power compensation under three phase four-wire linear and nonlinear loads..

Existing Block Diagram

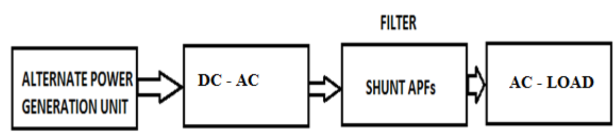


Fig 1.1 Typical power system one-line diagram

IV. PROPOSED SYSTEM

A hybrid system comprise of Photovoltaic (PV), Battery, Ultra capacitor (UC), Fuel Cell (FC) to meet isolated DC load demand. The PV is the primary energy source, whereas battery and SC both are considered for their different power density to supply transient and steady load respectively. To increase the reliability of the system source FC has been chosen to keep the battery fully charged. The battery sources are connected to DC bus by DC-DC converters. A power flow control strategy adapts their variable DC voltage to Bus voltage by means of these converters. In this work, FC is chosen to work for a limited period.

Proposed Block Diagram

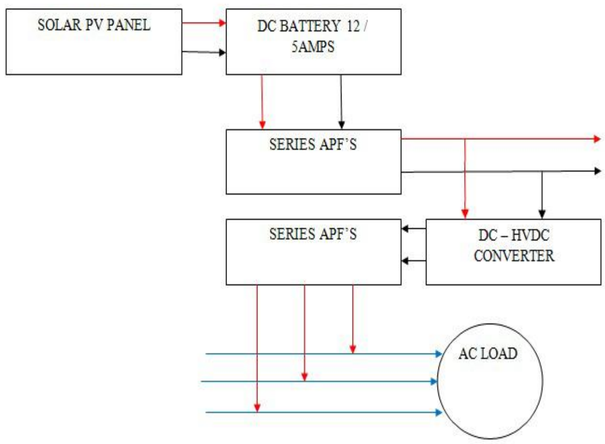
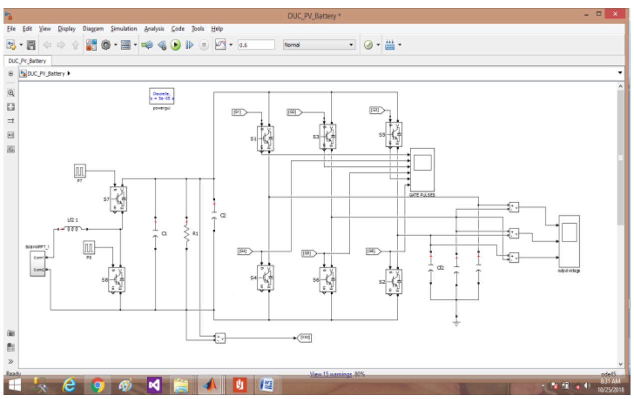


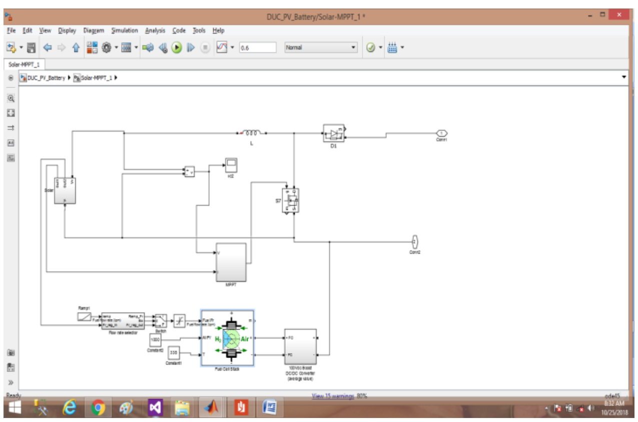
FIG 1.2 Proposed Block Diagram

V. SIMULATION OUTPUT



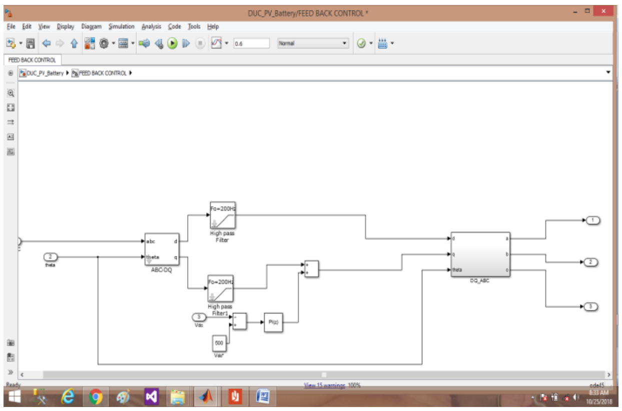
The performance of solar PV integrated Unified Power Quality Conditioner (UPQC) is analyzed and evaluated in the various conditions that is discussed in this section. The system PV is consists of series compensator and shunt compensator that are simulated through MATLAB/Simulink software. The load is used asa nonlinear load consisting of three phase diode bridge rectifier with R-L load. The FFT analysis are also discussed in this section

SOLAR CELL WITH MPPT



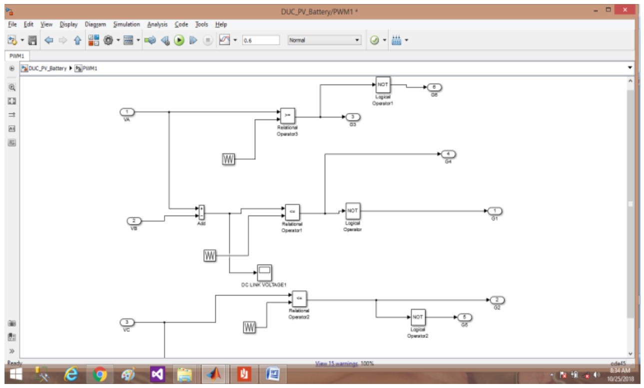
The price of the photovoltaic modules, together with their increasing efficiency, put solid-state inverters under the spot lights as enabling technology for integrating PV systems into grid. Grid synchronization unit plays important role for grid connected SPV systems. The given system consists of a SPV array, DC/DC boost converter and a three phase voltage source converter with grid synchronization control schemes.

PI LOGIC



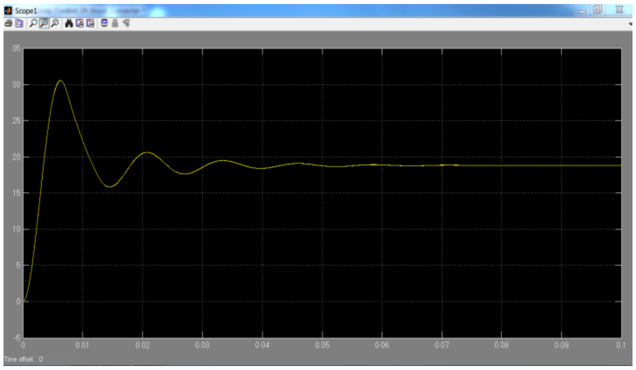
PI control is needed for non-integrating processes, meaning any process that eventually returns to the same output given the same set of inputs and disturbances. A P-only controller is best suited to integrating processes. Common tuning correlations for PI control are the ITAE (Integral of Time-weighted Absolute Error) method and IMC (Internal Model Control).

PLUSE COMPARISION



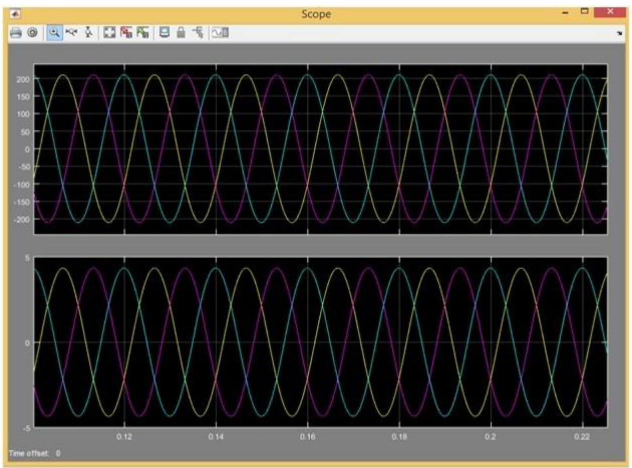
The MATLAB simulated model of a 3-phase grid connected system is shown in the Figure 5.10 which incorporate a PV array connected to a DC-DC boost converter, a DC to AC three phase voltage source inverter, a three phase 415 V grid with the above mentioned load connected at PCC point.

SOLAR PANEL OUTPUT



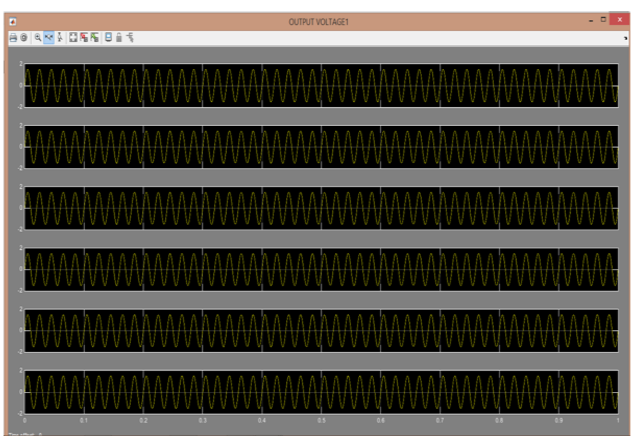
Solar Panel Nominal Voltage – 18V

THREE PHASE OUTPUT



Phase Voltage - 210v, Current – 5Amps

GATE PLUSE



G1, G2, G3, G4, G5, and G6 – those gate pulses are nearby sine wave because output waveform is in sine wave

VI. CONCLUSION

This paper successfully developed a high step-up isolated converter with two input power sources using voltage-clamped and soft-switching techniques. In the stand-alone state, the properties of current sharing and soft switching guarantee that both conduction and switching losses can be reduced for high efficient conversion. In the united power supply state, the maximum efficiency of the proposed converter could be higher than 95%, because the conduction loss can be effectively reduced by topological design of series connection of two input circuits. In the charge and discharge state, the conversion efficiency slightly decreases because higher current loading on switches is caused by opposite inductor currents. Fortunately, the function of bidirectional power flow can be achieved without an auxiliary power converter.

REFERENCES

[1] G. Martin, “Renewable energy gets the ‘green’ light in Chicago,”IEEEPower Energy Mag., vol. 12, no. 6, pp. 34–39, Nov./Dec. 2003.

[2] S. Al-Hallaj, “More than enviro-friendly: Renewable energy is also goodfor the bottom line,”IEEE Power Energy Mag., vol. 2, no. 3, pp. 16–22,May/Jun. 2004.

[3] P. Fairley, “The greening of GE,”IEEE Spectr., vol. 42, no. 7, pp. 28–33,Jul. 2005.

[4] R. C. Dugan, T. S. Key, and G. J. Ball, “Distributed resources standards,”IEEE Ind. Appl. Mag., vol. 12, no. 1, pp. 27–34, Jan./Feb. 2006.

[5] F. Blaabjerg, Z. Chen, and S. B. Kjaer, “Power electronics as efficientinterface in dispersed power generation systems,” IEEE Trans. PowerElectron., vol. 19, no. 5, pp. 1184–1194, Sep. 2004.