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THREE PHASE PV-BATTERY POWER GENERATION USING THREE PORT CURRENT FED DC-DC CONVERTER FOR DC GRID DISTRIBUTION

K.VENKATESWARI

Research Scholar, Department of EEE, BIHER-BIST, Chennai.

Dr. V. JAYALAKSHMI

Research Supervisor & Associate Professor, Department of EEE, BIHER-BIST, Chennai.

Abstract

This paper introduces a three-port current-fed converter with isolation transformer operating in high frequency and bidirectional power stream. Port I is nourished by a battery bank, port II utilizes a lot of photovoltaic (PV) modules and port III is associated with a dc interface. The topology utilizes three single-stage H-connect cells in the essential side and a three-stage H-connect converter in the optional one. High-frequency seclusion is guaranteed by single-stage transformer associated in an arrangement. The proposed converter also fed with PI based control technique which offers the output voltage control. The three phase three port converter with PI based control has been proposed and the results experimented in MATLAB/SIMULINK and it is compared with the conventional circuit.

Keywords: Three port converter, battery, PV, PI, bidirectional power flow

I. INTRODUCTION

As of now, high boost up DC/DC converters are broadly utilized in numerous mechanical applications, and some of them additionally require the converter has higher efficiency and higher power withstand [1–3]. In recent days many countries meet the power demand, so the generation of renewable energy is increased such as photovoltaic, wind, fuel etc. The sun provides more than enough energy to meet the whole world's energy needs, and unlike fossil fuels, it won't run out anytime soon [4-5]. As a renewable energy source, the only limitation of solar power is our ability to turn it into electricity in an efficient and cost-effective way. No greenhouse gas emissions are released into the atmosphere when you use solar panels to create electricity. And because the sun provides more energy than we'll ever need, electricity from solar power is a very important energy source in the move to clean energy production. After solar panels have been installed, operational costs are quite low compared to other forms of power generation. Fuel isn't required, and this means that solar power can create large amounts of electricity without the uncertainty and expense of securing a fuel supply.

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Battery frameworks have been generally utilized in industry, transportation, storage applications for over a century. Battery storage has been distinguished as an empowering innovation for electric transportation and smart grid applications and battery frameworks can further catalyze the cooperative energy between electric vehicles (EVs) and the electric matrix [1]. In high power applications, for example, EVs and plug in hybrid electric vehicles (PHEVs), the battery packs are generally shaped by battery modules/cells associated in arrangement to expand the voltage, and associated in parallel to build the capacitance. Be that as it may, because of different manufacturing and differing activity conditions the uneven characters lessen the usable energy

Be that as it may, the conventional converters are definitely not proficient to accomplish high efficient and high power withstand capability proficiency at higher power which induces the switching losses and need of heavy heat sink for the switches. At first the converter should be lightweight and minimal as the space inside the vehicle is constrained. This is an issue for high control applications as they more often than not require enormous size of inductors [6-7]. Voltage and current swells are additionally present in most power converters, which are customarily limited utilizing an enormous capacitor. Fundamentally DC-DC converters are utilized to support the boosting of the voltage to required yield voltage and to get the high voltage gain. The converter ought to be worked with the obligation cycle of over 50% to get higher gain in voltage level. The downside of conventional DC-DC converter is low voltage gain as well as high current ripple [8]. Increasing the vitality expending progressively over the impact of sensitive nonlinear loads in power frameworks, the ideal working and great power distributing into an extensive issue.

II. PROPOSED SYSTEM

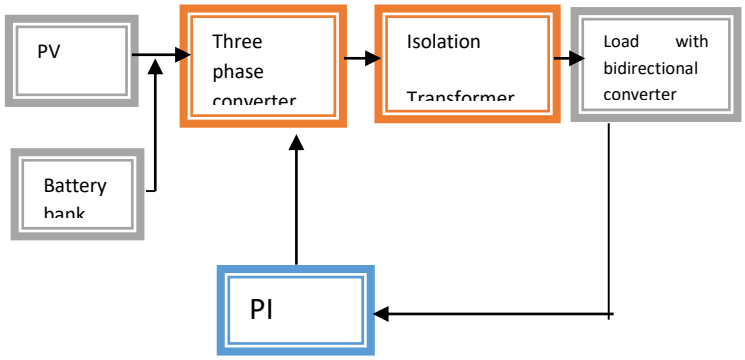

Fig 1. Block diagram of proposed system

This paper proposes the three port three phase converter which is separated by the three phase isolation transformer and it is fed to the AC load with bidirectional power flow. The controllable voltage is attained by the use of PI based control technique. Fig 1 shows the

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block diagram of proposed topology.

III. Material and Methods

In this section the implementation of three phase three port current fed inverter with PI control technique is explained in detail.

Photovoltaic System

In a distribution system, the solar generates power from sunlight radiation. Solar PV system includes different components that should be selected according to your system type, site location and applications. The major components for solar PV system are Solar Panels or PV Modules, Solar charge controller, Inverter, Battery bank and Loads (appliances). PV module converts sunlight into DC electricity. Solar charge controller regulates the voltage and current coming from the PV panels going to battery and prevents battery overcharging and prolongs the battery life. A solar inverter or PV inverter, is a type of electrical converter which converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. Solar power inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking. In the past, the PV system has generally used one central inverter (String inverter) to cover all PV modules due to the low cost. However, such a system has a serious disadvantage in that the performance of all the PV modules can be drastically reduced if one module experiences a period of shade. To solve the shading problem, a micro-inverter that sits on the back of each PV module was proposed.The PV array is designed by connecting more PV cell. The derived form of a current-voltage equation is given by

$$I_{pv} = N_{primary}\left\{ I_{ph} - I_0\left\{ \exp\left(\frac{qv_{pv}}{nN_s KT} \right) \right\} \right\} \qquad (1)$$

Where in the above equation (1) current and Voltage of photovoltaic array is denoted by Ipv and Vsolar respectively, short circuit current of a photovoltaic array and saturation current are denoted by Iph and I0 respectively. The circuit diagram of the photovoltaic cell is shown in Fig 2.

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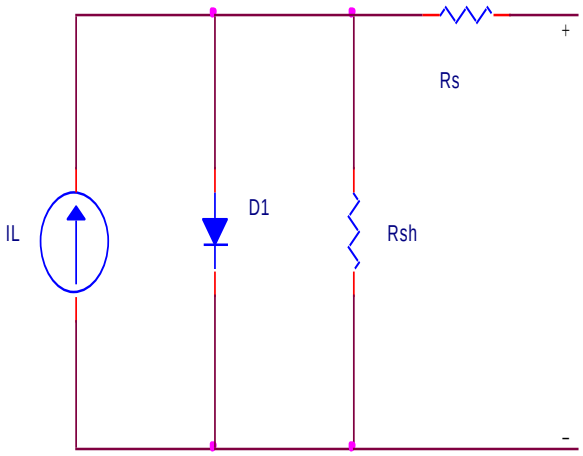

Fig 2. Circuit diagram of photovoltaic cell

A. Three-Port Isolated Three-Phase Current-Fed DC-DC Converter

The proposed methodology consists of three ports shown in fig 3. Port I consists of battery bank, port II consists of PV panel and port III consists of DC link. The port I battery bank voltage and PV panel port II power are added to give the added power to the DC link voltage at port III. The transformer is used to give the protection against the high voltage transfer. The port III side converter is provided with the bidirectional power flow converter. The bidirectional has the capability of transferring the power in the both sides. The operation includes the AC to DC during left to right side transfer as well as DC to AC during.

P1+ P2 =P3 (2)

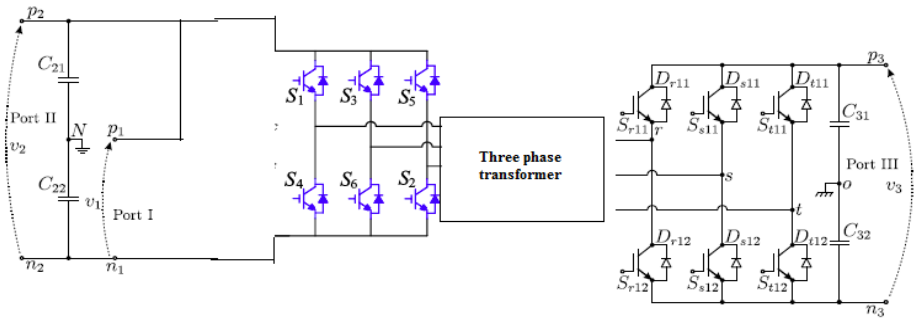

Fig 3. Circuit Diagram of conventional converter

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IV. CONTROL TECHINQUE

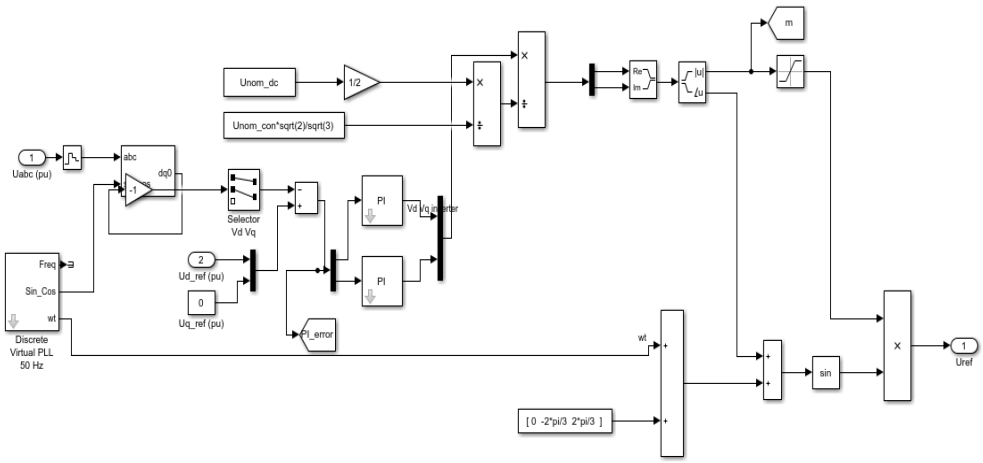

Fig 4. Control scheme for output voltage control

The output load voltage as shown in fig 4 is taken as input and they are converter D-Q component by parks transformation. The converted d-q component is compared with the reference value of d-q component through the PI controller.

A. PI controller

Proportional-Integral controller (PI controller) shown in fig 5 is a feedback instrument which is generally utilized in controllers being utilized in ventures. A PI controller figures a value of error. The error value is calculated by subtracting the measured value and ideal set point. The controller endeavors to limit the value of the error by modifying the procedure using a controlled variable. The PI control strategy consists of two parameters namely Kp& Ki. The Kp is the proportional gain, Ki is the integral gain. There are various method of tuning these values.

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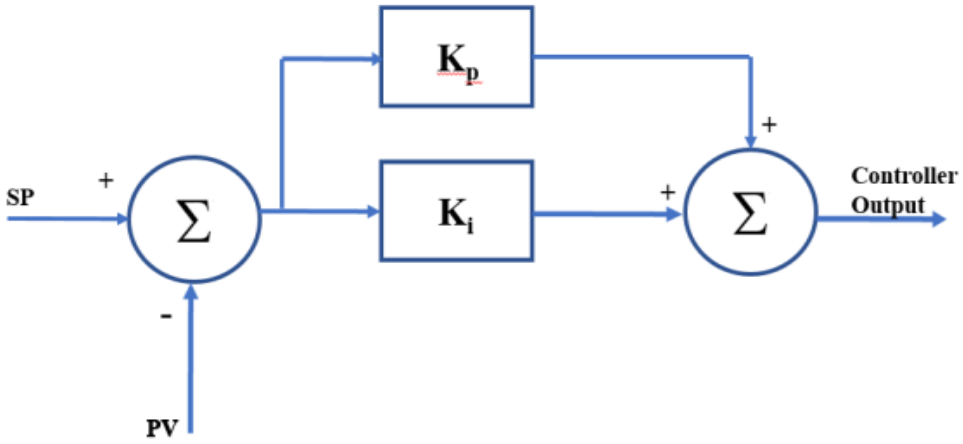

Fig 5 . PI block diagram

V. SIMULATION RESULTS

Fig 6 shows the overall simulation diagram of three port converter. Fig 7 shows the input voltage of PV. Fig 8 shows the battery voltage. Fig 9 shows the three phase output voltage using three port converter. Fig 10 shows the bidirectional converter output voltage for the load.

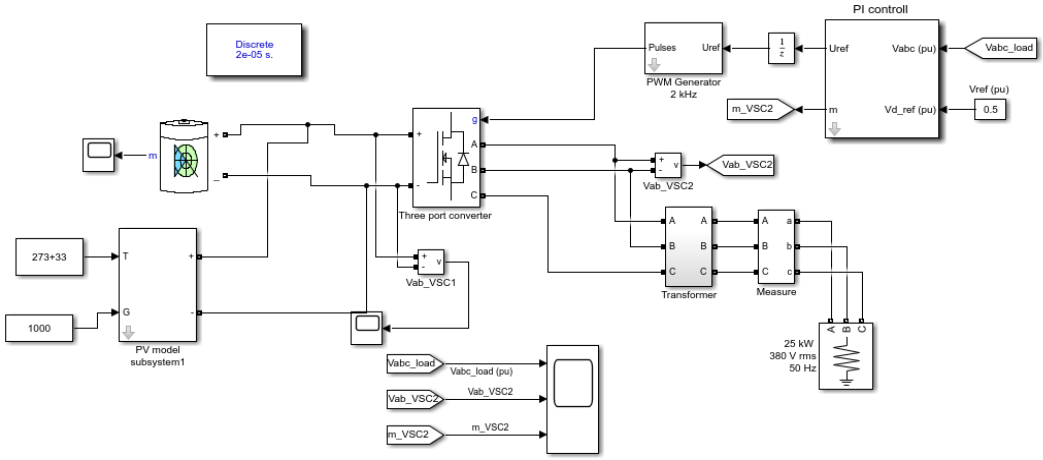

Fig 6. Overall Simulation Diagram

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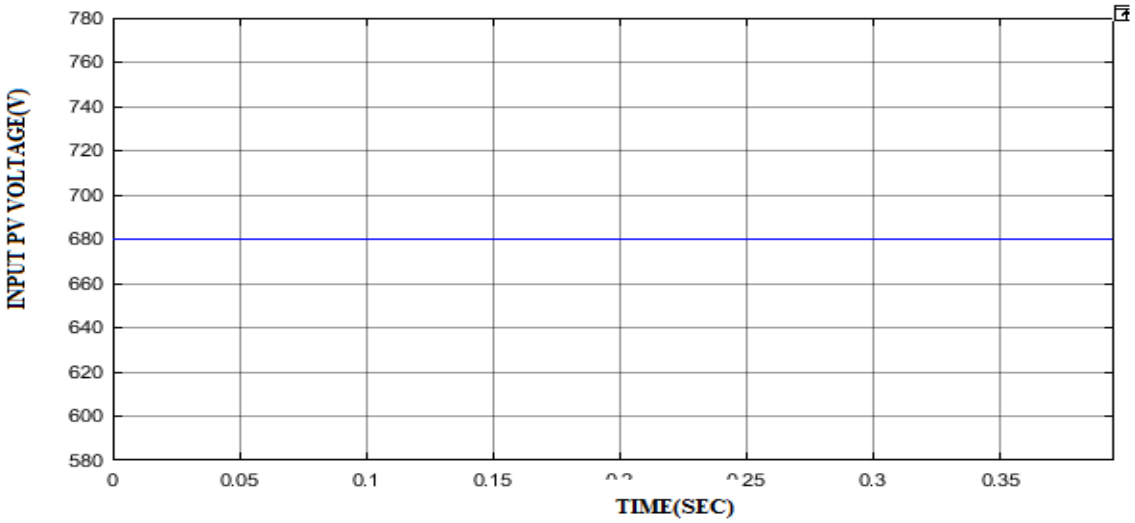

Fig 7. Input PV voltage

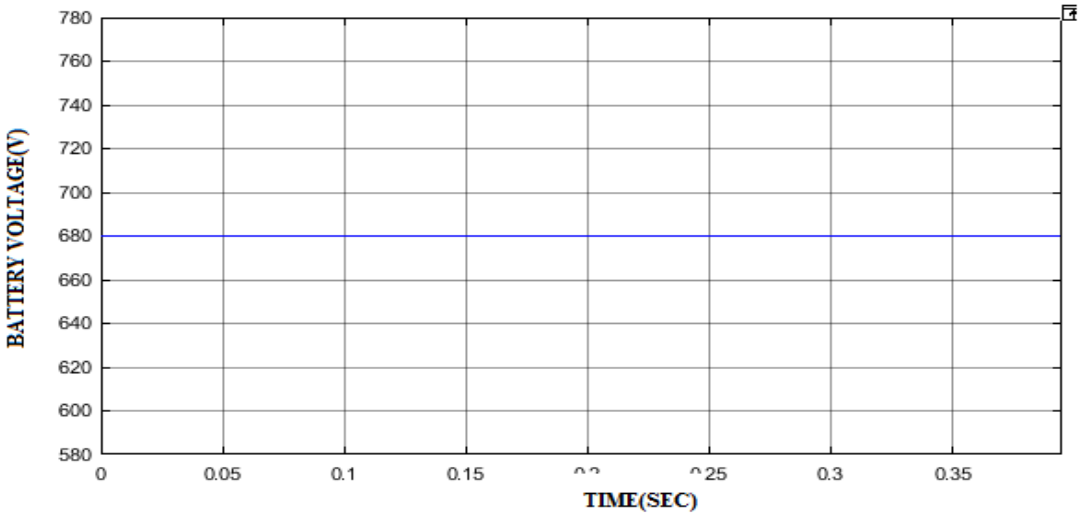

Fig 8. Battery voltage

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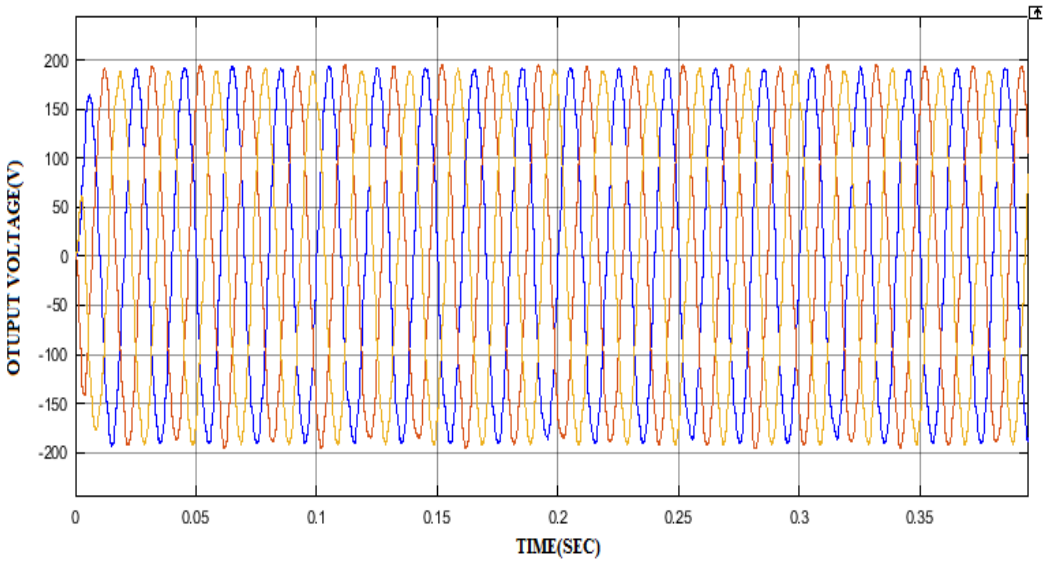

Fig 9. Output voltage from three port converter

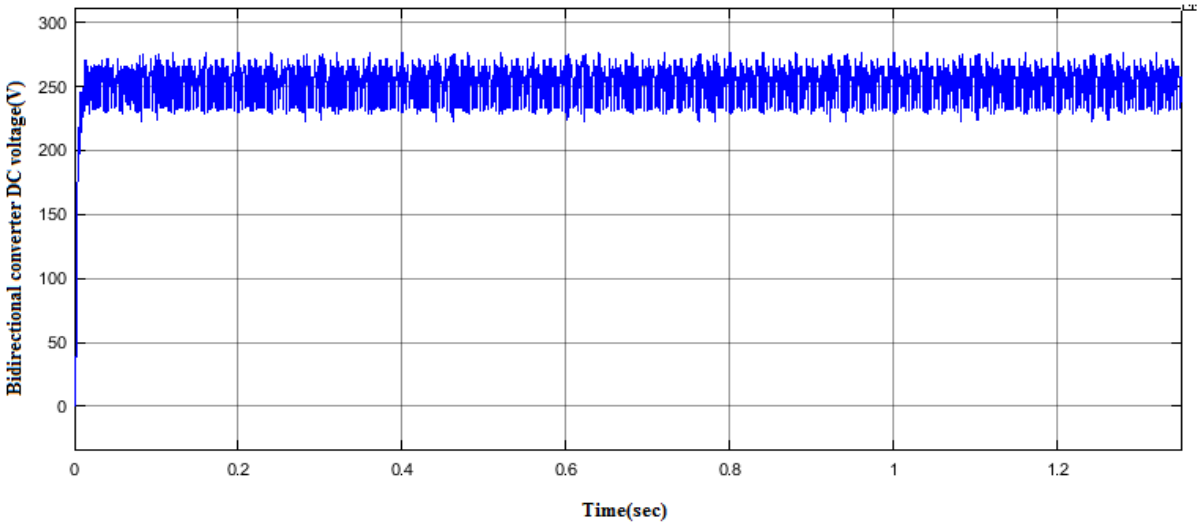

Fig 10. Biderctional converter voltage for load

VI. CONCLUSION

The proposed paper implements three port converter with PI control. The PI based control offers the quick settling time of the output voltage with high accuracy. The three

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port convert with high isolation transformer with leakage inductance offers a high isolation protection with reduced leakage currents. The three port converter is added with bidirectional converter which offers the transferring both DC and AC power to the circuit.

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