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Three Phase Grid-Connected Photovoltaic Universal Bridge Inverter Applying a Boost Converter

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Abstract: In this paper, a three phase grid connected universal bridge inverter using a boost converter is suggested for photovoltaic (PV) systems and grid connected systems to improve performance of three phase inverter connected to the grid. The PV grid system has a disadvantage that the output voltage of PV array is low and we need to boost then in order to efficiently convert them into alternating voltage. The boost inductor boosts the output of the PV array to a suitable level so that inverter could convert it into alternating form. The DC/AC inverter is most important part of the PV systems.

Keywords: PV array, Grid connected three phase inverter, MPPT, Boost Converter

1. INTRODUCTION

The grid connected inverter is heart of PV system. The increasing demand of clean energy had forced us to look towards renewable energy resources and solar energy is one of them. It does not pollute the environment and also it is not exhaustible. But due to high installation cost, PV arrays are not used in past. But the rapid growth in semiconductor devices allowed the large scale installation of the PV arrays to be economical.

During past decade we are able to produce very fast acting switches which can handle very large quantity of current and voltage. These switches helped us to build more efficient inverters which allowed us to integrate photo-voltaic array economically to the grid.

The PV array connected to the grid can serve a great purpose since the extra generated energy can be fed to the grid. Also when the PV array is not in use the grid can supply the energy to the individuals.

In India during most part of the year we receive great amount of solar energy if we can efficiently convert it to the electrical form we would be successfully able to tackle the problem of energy crises in most part of the India. It would also help us to ensure sufficient energy supply to the villages in our country. The different type of inverter schemes are used to integrate PV arrays to the grid.

The objective of this paper is to design and simulate a three phase inverter using boost converter with the PV module. The response of the boost converter and three phase inverter is analysed the performance of the system is shown through different response curves.

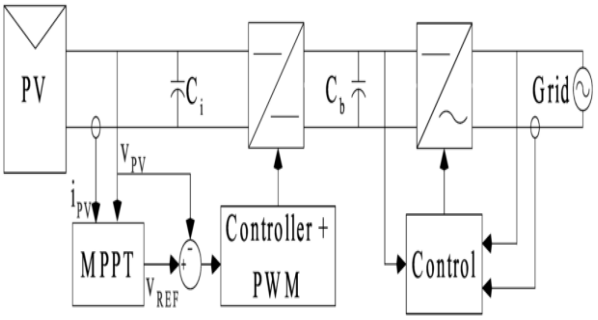

Fig 1(a) Circuit of grid connected PV array

2. PHOTOVOLTAIC ARRAY

Photovoltaic cells are connected electrically in series and/or parallel circuits to produce higher voltages, currents and power levels. Photovoltaic modules consist of PV cell circuits sealed in an environmentally protective laminate, and are the fundamental building blocks of PV systems.

Photovoltaic panels include one or more PV modules assembled as a prewired, field-installable unit. A photovoltaic array is the complete power generating unit, consisting of any number of PV modules and panels.

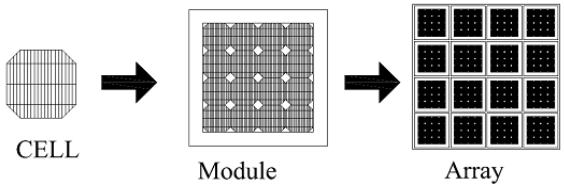

Fig 2(a) PV array

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3. MPPT

MPPT or Maximum Power Point Tracking is algorithm that included in charge controllers used for extracting maximum available power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point' (or peak power voltage). Maximum power varies with solar radiation, ambient temperature andsolar cell temperature.

The major principle of MPPT is to extract the maximum available power from PV module by making them operate at the most efficient voltage (maximum power point). That is to say MPPT checks output of PV modules and compares it to battery voltage then fixes what is the best power that PV module can produce to charge the battery and converts it to the best voltage to get maximum current into the battery. It can also supply power to a DC load, which is connected directly to the battery.

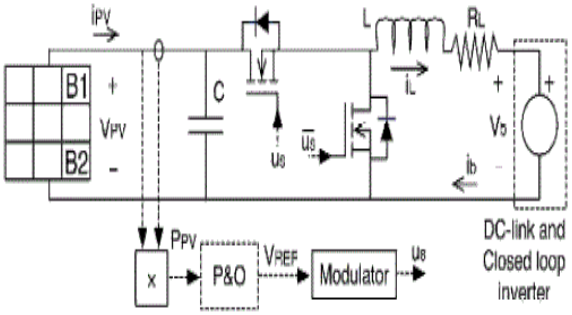

Fig 3(a) Maximum PowerPoint Tracking

4. DC/DC CONVERTER

DC/DC converters are used to change DC voltage level. The DC/DC converter used in this simulation is a boost converter. It is a step up DC converter. The average output voltage of the boost converter is more than the average input voltage but the output current is stepped down. Boost converter can be realised using a number of power switches, here we have used IGBT power switch.

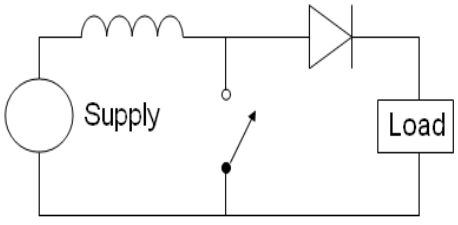

Fig 4(a) Boost converter

5. DC/AC CONVERTER

DC/AC converters are used to convert DC into AC. Inverter is used for converting DC generated by PV module into the AC. This converted AC can be feed to load or power grid. DC/AC converters can also be realised using different type of power switches. We have used IGBT switches. IGBT switches are compact and have great power switching frequency so they can extract more power.

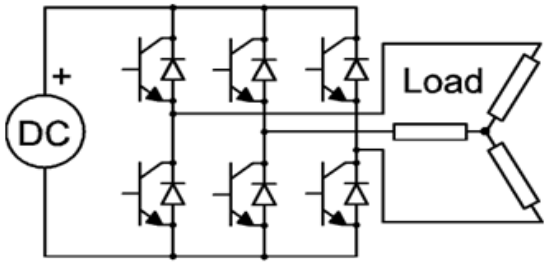

Fig 5(a) Three phase inverter

6. PULSE WIDTH MODULATION GENERATOR

The PWM generator is used to generate pulse width modulation. This technique is used to encode massage to pulsing signal, although it can also be used to encode information for transmission. Its main use is to allow the control of the power supplied to electrical devices. The main advantage of PWM is that power loss in the switching devices is very low.

When a switch is off there is practically no current, and when it is on and power is being transferred to the load, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero.SPWM (Sine–triangle pulse width modulation) signals are used in inverter design (used in solar and wind power applications). These switching signals are fed to the FETs that are used in the device.

7. MATLAB

MATLAB (Matrix Laboratory) is a numerical-computing environment and fourth generation programming language developed by MATHWORK. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interface by using MATLAB we can draw mathematical equations, transfer function and system response to study and also evaluate the system performance.

The system is evaluated by MATLAB and simulation of grid connected PV array using inverter is done. A model is designed through MATLAB for obtaining optimal performance specification and comparative study is done for grid connected PV array.

8. SIMULATION RESULTS

In this paper, simulation work is done using MATLAB software. Power output of PV array is between 20 to 40 Vand reference DC bus voltage is 400V. The grid is a three phase AC with 300V of rms voltage between phase.

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SIMULATION CIRCUIT

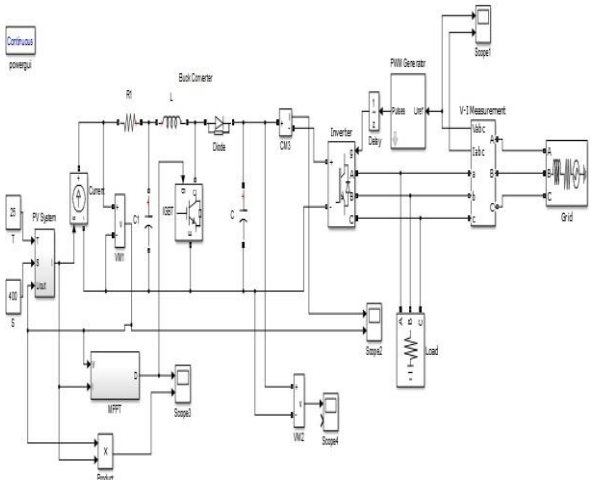

Fig 8(a) Circuit diagram of Grid connected PV array

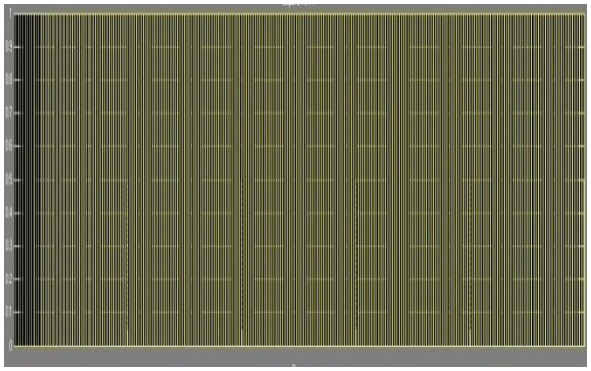

Fig 8(b) Plot of MPPT

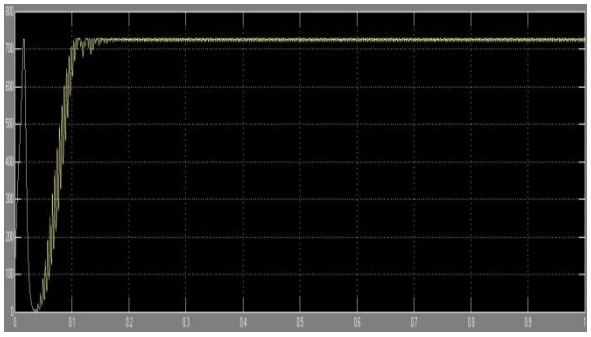

Fig 8(c)Output of PV array

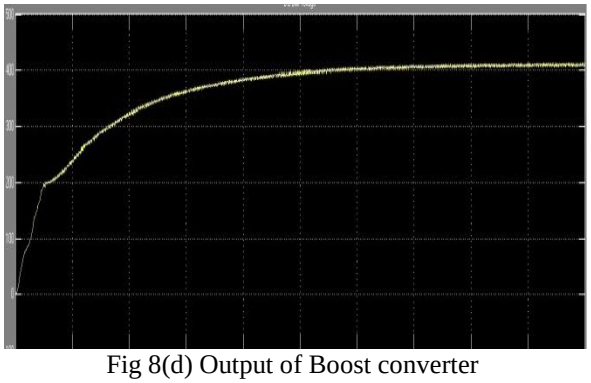

Fig 8(d) Output of Boost converter

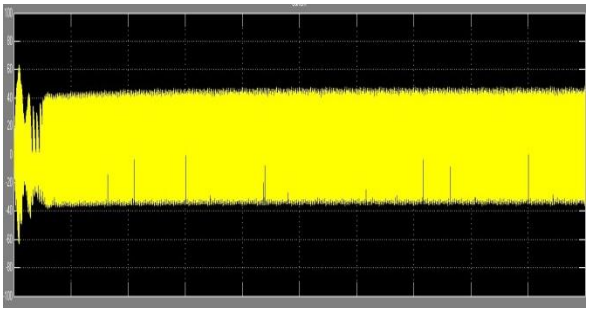

Fig 8(e) DC bus current

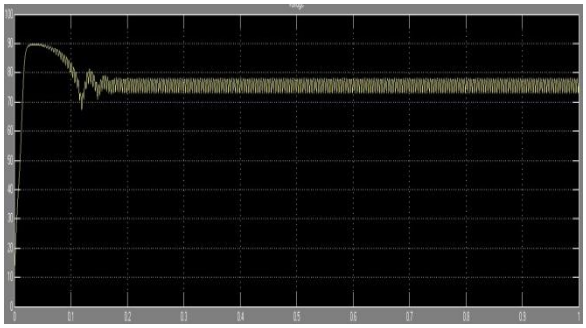

Fig 8 (f) DC bus voltage

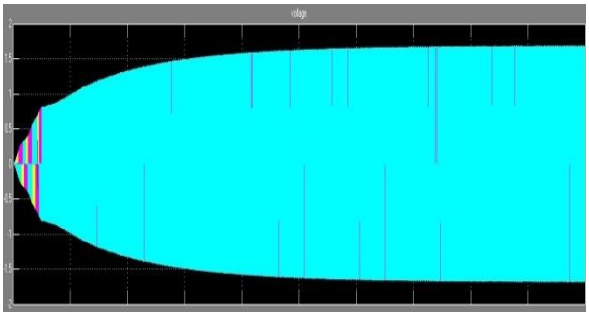

Fig 8(g) Three Phase AC grid Voltage

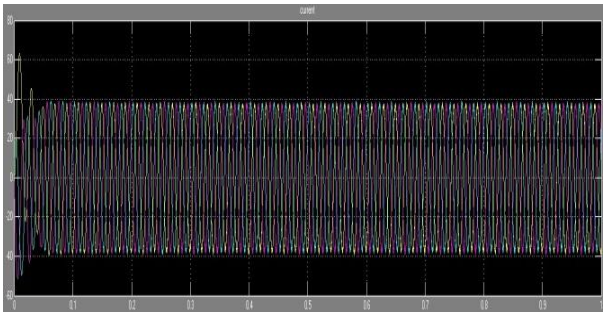

Fig 8 (h) three phase AC grid current

9. CONCLUSION

In this paper the, a three phase grid connected inverter using boost converter is proposed for photovoltaic generation system. The use of boost converter is very helpful due to it the boosting ability is greatly enhanced. The solar panel module of average voltage 80V is boosted up to average 415V, inverted and fed to the three phase AC grid having rms voltage of 300V(phase to phase).

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BIOGRAPHY

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