Designing of Boost Converter for Photovoltaic Cell using Matrix Converter Topology

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***Abstract*—We are writing this research paper for designing of Boost Converter for Photovoltaic cell using Matrix Converter Topology. Due to increase demand of energy and to make the environmental pollution free, we are using renewable energy in a very wide range. To get more input voltage than the source voltage we take the help of boost converter. We have used MATLAB for the experimental verification and finding the result. So as the demand of renewable energy is increasing so we are designing Boost Converter using Photovoltaic Cell using Matrix Topology.**

Keywords--- PWM, IGBT, PV Cell, bidirectional switch, DC-DC Boost converter, MATLAB simulation

I. INTRODUCTION

Today we are using renewable energy in a wide area because they are green sources and they do not pollute the environment. Now the demand of PV cell is increasing day by day. A photovoltaic cell is a device which uses photovoltaic effect for converting energy of light into electrical energy. The word photovoltaic derives from the photons and voltage because photovoltaic effect is used to convert photons to electricity. PV cell is used to produce low voltage (0.5V to 0.6V) so for producing high voltage using boost converter with matrix converter topology. The input voltage is increased by a power electronic device which is boost converter [1]. In the boost converter the input voltage is increased without use of transformer.

The comparison of carrier signal and reference signal is done by PWM technology. The PWM technique is used to control the output voltage across load for DC to DC converter. PV cell provide low voltage so we use boost converter which helps to boost the voltage without spikes using matrix converter topology. In this we used

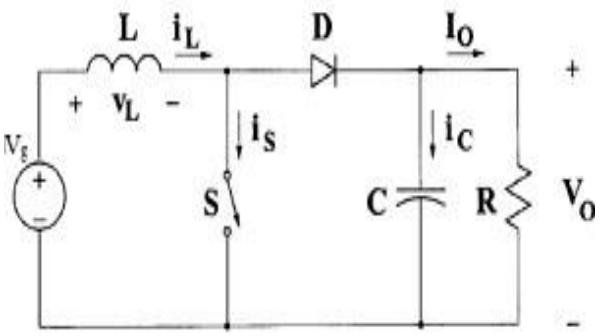
matrix converter topology which was first given by Gyugyi in year 1976. Matrix converter consist of four bi-directional switch. The blockage of voltage
and the conduction of current in either direction is done by the switch which is known as bidirectional. We are using four pair of IGBT which is used for switching purpose. It is used because it is a bipolar device and it is the voltage control device. It has low conduction losses and low switching power losses.

II. THEORY

A. Boost converter

The work of boost converter is to increase the voltage and it is also known as step up chopper. The boost converter is used to give more output voltage than the input voltage. The meaning of boost converter [2] is that by this voltage is increased the input voltage become lesser than output voltage. By the help of DC-DC boost converter the output voltage is increased by the input voltage[3]. By the use of boost converter with PWM converter topology output voltage become approximately 4% more than the input voltage.

Fig 1. Boost DC-DC converter

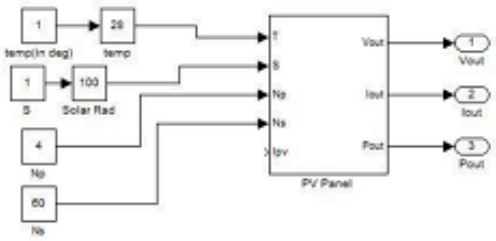


B. Photovoltaic cell

In today world we are using renewable energy in a wide area because renewable energy don't have any effect on the environment. Renewable energy is also known as non-convectional energy. The example of non-convectional energy are bio-energy, solar energy, and wind energy. Now we will discuss about photovoltaic cell, it is a system which is used to convert solar energy into electricity by photovoltaic effect. The material which is used for making photovoltaic cell are single-crystal Silicon, polycrystalline Silicon, Gallium Arsenide (GaAs), Cadmium Telluride (CdTe)[4]. The power generation by the photovoltaic system is increasing day by day but the voltage generation by the photovoltaic cell is low so for getting high voltage from PV cell is obtained by series

connection of number of PV cell and for getting current, connect number of PV cell in parallel by which the photovoltaic model is formed for getting desired output.

Fig 2. PV panel Model



C. Pulse width modulation

The technique which is used for controlling the output of boost converter is known as pulse width modulation (PWM). It is a controlling technique in this pulse width modulation is produces a triangular wave signal which is compared with the reference signal to produce a control signal[5].

Fig 3. PWM model

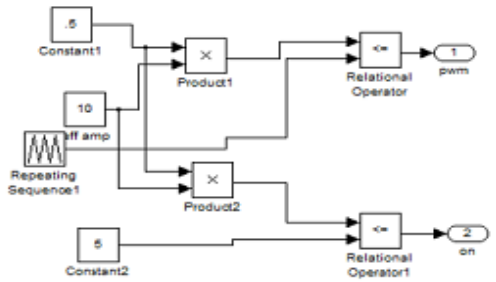
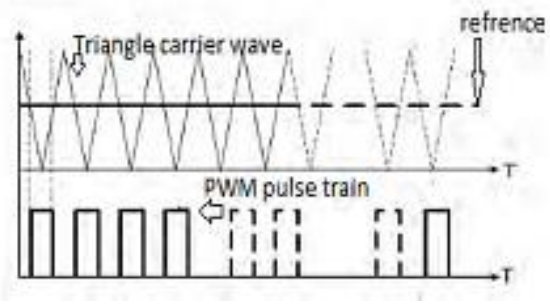


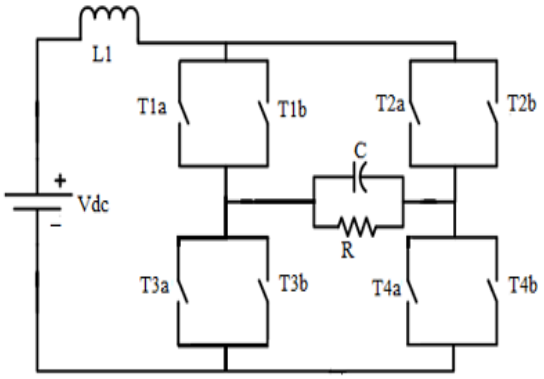
Fig 4. PWM formation



D. Boost DC-DC converter using matrix Converter topology

Four switches which is bidirectional and a load which is resistive is used in the Boost converter using matrix converter topology. By the help of matrix converter topology the performance become better and the issues related to power quality is also resolved.

Fig 5. boost DC-DC converter using matrix converter topology



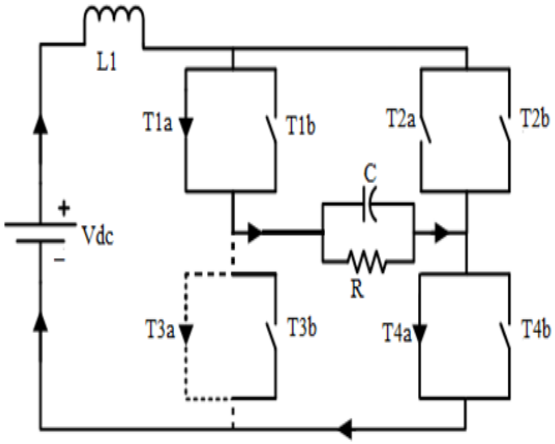
III. BOOSTING OPERATION OF DC-DC BOOST CONVERTER

There are two modes of operation of boosting operation of DC-DC boost converter. The first mode is the charging state and the second mode is the discharging state. In the charging state T1a and T3a becomes on and the current flow through inductor get increased. In the discharging state T2a and T4a get on but T3a become off and current passed through load and inductor get started discharge [6].

Table 1. Switching Strategies

Mode 1 Charging state	T1a,T3a (ON)	T1b,T2a,T2b,T3b,T4b (OFF)
Mode 2 Discharging state	T1a,T4a (ON)	T1b,T2a,T2b,T3b,T4b (OFF)

Fig 6. Mode 1 and 2 operation circuit



IV. SIMULATION AND RESULT

Table 2. Parameters for model

Components	Value
Input voltage source (PV cell)	10 v
Output capacitor (C)	205μf
Boost inductor (L1)	30μH
Modulation index	0.5,0.7
Carrier signal frequency	5 KHZ, 10KHZ
Output resistance (R)	30Ω

Fig 7. Model of a DC-DC Boost converter using matrix converter topology in MATLAB Simulation

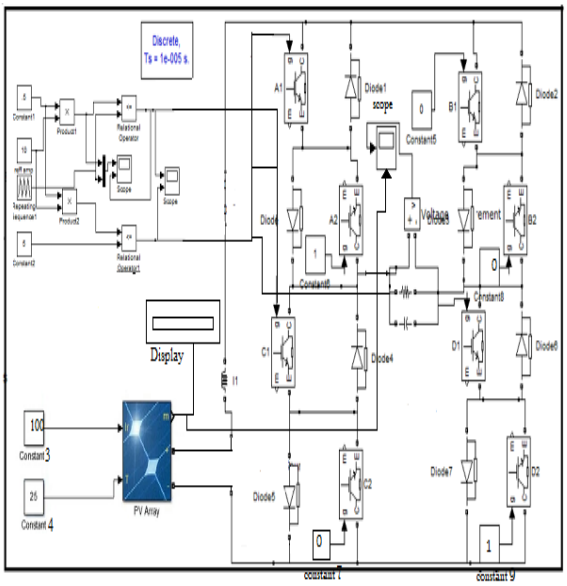


Fig 8. Model of PWM in MATLAB Simulation

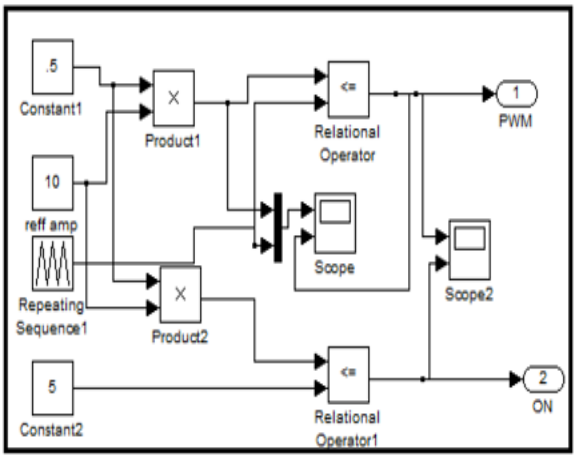


Fig 9. Simulation Result (Vin=10V, Vout=41V) for switching frequency 5KHZ, modulating index is 0.5

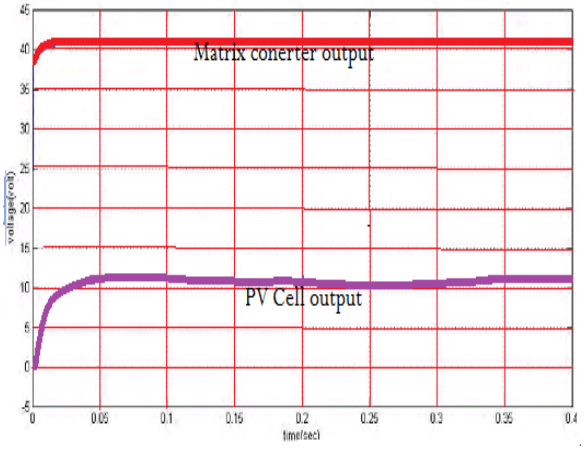


Fig 10. Simulation Result(Vin=10V, Vout=43V) for switching frequency 10KHZ, modulation index is 0.5

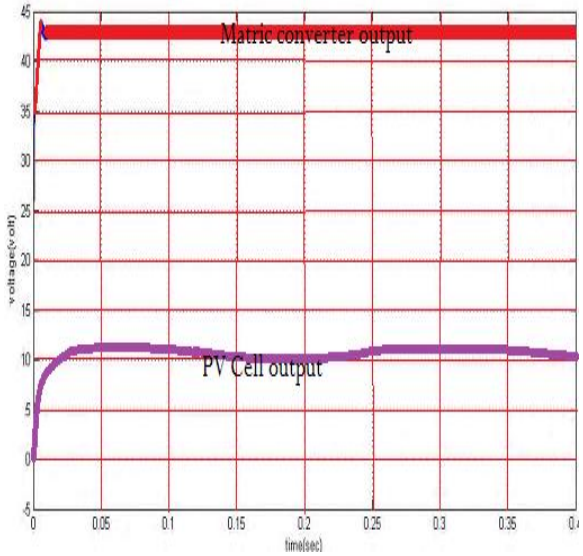


Fig 11. Simulation Result (Vin=10V, Vout=43V) for switching frequency 5KHZ, modulation index is 0.7

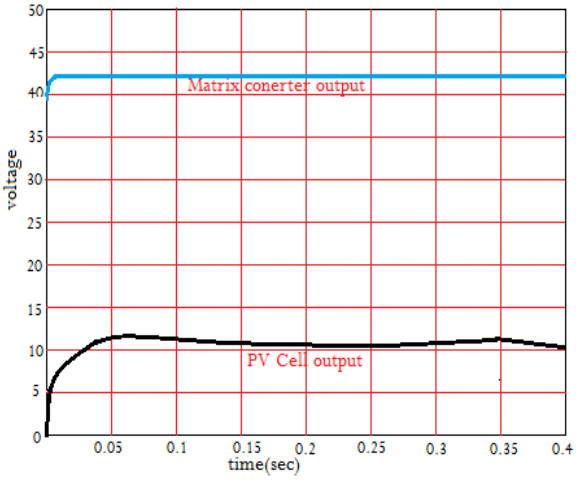
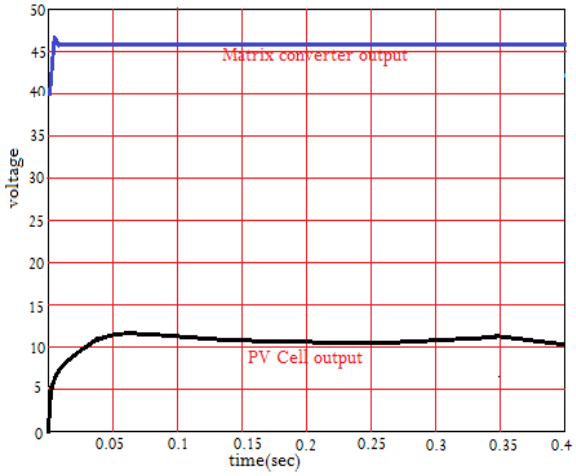


Fig 12. Simulation Result (Vin=10V, Vout=46V) for switching frequency 10KHZ, modulation index is 0.7



V. CONCLUSION

The suitable switching scheme has used for the designing of boost converter. The photovoltaic cell has the less voltage in the output end so by using the boost converter the voltage is boost and PWM technique and Matrix converter topology is used in this model so by the help of this converter the photovoltaic cell can be used for high voltage application successful simulation is done by using MATLAB and we have observe that output voltage is approximately 4% more than the input voltage.

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