ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

High Gain DC-DC Boost Converter for PV Applications

S.Shudhandhiran[1], A.Rahamadullah[2], A.Zubair[3], N.Rajesh[4], S.Ramprasath[5]

UG Scholar, EEE, Saranathan College of Engineering, Trichy, India [1,2,3,4]
Assistant Professor, EEE, Saranathan College of Engineering Trichy, India[5]

Abstract— In this paper the simulation of a High Gain DC – DC Quadratic Boost Converter is presented. Inductors and capacitors were designed to ensure a high gain. Also the presence of single switch reduces the losses and results in high efficiency. The control technique can be optimized by adding a MPPT system by using Hill Climbing method.

Keywords— boost converter; quadratic converter; PV applications;

I. INTRODUCTION

Conversion of solar energy to electrical energy using photovoltaic cell is a developing technology whose worldwide usage is continuously growing. Though the cost of PV cell and their associate devices are reduced dramatically, in some developing countries the selling price of devices such as charge controllers, boost converters and micro inverters are high. The fact is that selling price is two to three times of the actual manufacturing cost. As countries like INDIA depends more on solar energy due to availability of high solar potential in almost all areas, the cost reduction of devices for Photovoltaic applications are needed.

In a year around 300 days are sunny days and hence solar power can be harvested for about 3600 hours per year. The PV panel offers low voltage and power fluctuations, and so it is necessary to boost the low voltage to obtain required voltage and maximum power should be extracted. The Quadratic DC – DC Boost Converter is used to boost the voltage obtained from solar panel. QBC is used as they have parameters such as high voltage gain, low losses and high efficiency due to which they are better than other converters, particularly for photovoltaic applications.

In order to extract maximum power the Maximum Power Point Tracking system can be implemented using Perturb & Observe (P & O) algorithm. The Quadratic Boost Converter for PV application is simulated using MATLAB/Simulink. The simulation results are shown as a proof for performance of QBC. The block diagram of the PV system using QBC is shown in Fig.1.

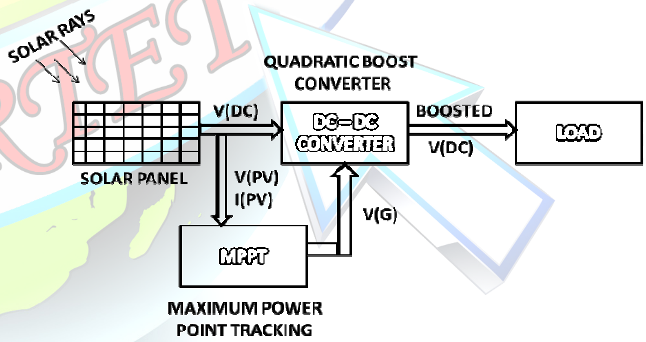

Fig.1: Block diagram of the PV system using Quadratic Boost Converter.

The solar panel converts solar energy in to electrical energy, the instantaneous voltage and current of the panel are measured continuously and given to MPPT. Based on panel current and voltage the MPPT generates a gate pulse, the gate pulse is fed to the gate terminal of the switch through driver circuit so that maximum power is extracted from the panel. In other hand QBC boosts the output voltage of the panel to the required level based on applications. Then the boosted DC voltage is fed to the load.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

II. CHARACTERISTIC AND PARAMETERS OF A PHOTOVOLTAIC CELL

The PV cell generates electricity from sun light. The equivalent circuit of solar cell is shown in Fig.2.

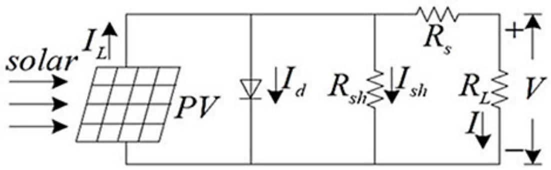

Fig.2: The equivalent circuit of a Photovoltaic cell.

I-V and P-V characteristic of PV cell are shown in Fig. 3 & 4.

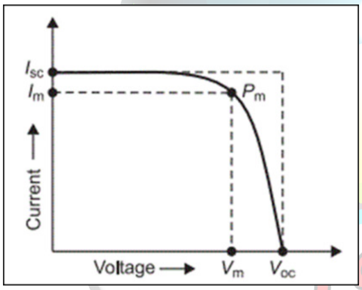

Fig. 3: I-V characteristic of PV cell.

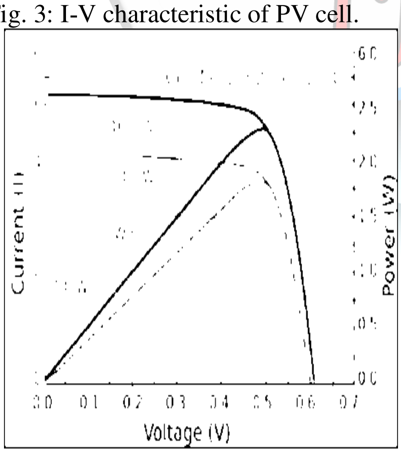

Fig. 4: P-V characteristic of PV cell.

Open circuit and Short circuit characteristic of PV cell are shown in Fig. 5 & 6.

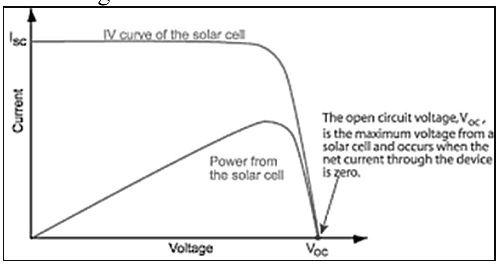

Fig. 5: Open circuit characteristic of PV cell.

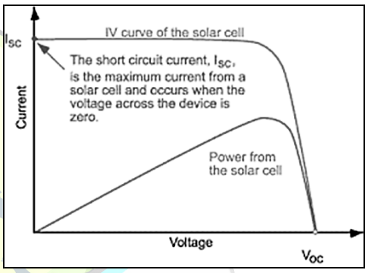

Fig. 6: Short circuit characteristic of PV cell.

The basic equation of parameters of PV cell is given in Fig. 7, 8 & 9.

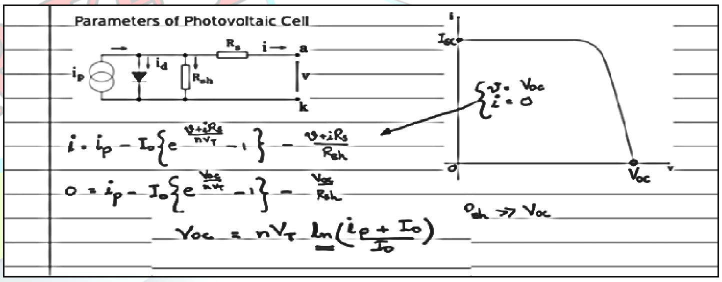

Fig. 7: Open circuit voltage.

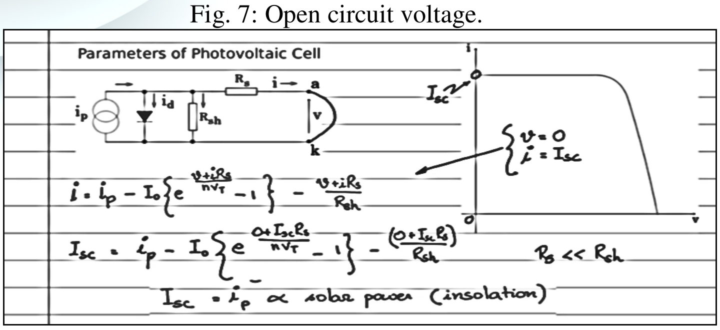

Fig. 8: Short circuit current.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

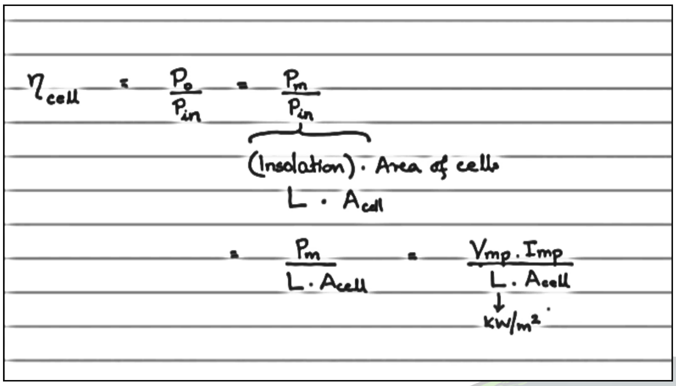

Fig. 9: Cell efficiency.

Table1: The specification of PV cell.

S.No	Specifications		Ratings
1.	Rated Maximum Power	P_{max} [W]	255
2.	Open Circuit Voltage	V_{oc} [V]	37.8
3.	Rated Voltage	V_{mpp} [V]	31.4
4.	Short Circuit Current	I_{sc} [A]	8.66
5.	Rated Current	I_{mpp} [A]	8.15
6.	Tolerance	[%]	+/- 3
7.	Safety Class	II	1000 V_{dc}

III. DESIGN OF QUADRATIC BOOST CONVERTER

The proposed Quadratic Boost Converter for PV application is shown in the Fig. 10.

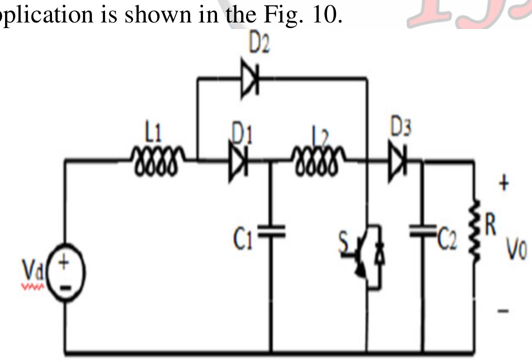

Fig. 10: Circuit diagram of Quadratic Boost converter for PV application.

The circuit comprises of a single power MOSFET switch, S, three diodes, D_1, D_2 & D_3, two capacitors, C_1 & C_2, two inductors L_1 & L_2 and a load resistor R.

There are two modes of operation in steady state analysis of Quadratic Boost Converter as follows.

MODE 1: When switch is ON

The equivalent circuit of the converter is shown in Fig.11.

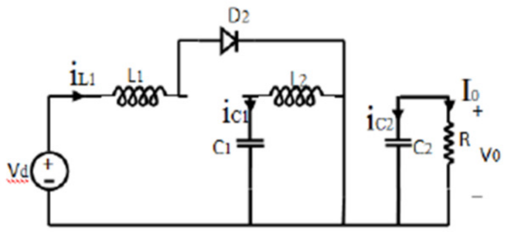

Fig.11: The equivalent circuit of the converter during ON state.

In this period switch, S& diode, D_2 are ON and diodes D_1& D_3 are OFF.

MODE 2: When switch is OFF

The equivalent circuit of the converter is shown in Fig.12.

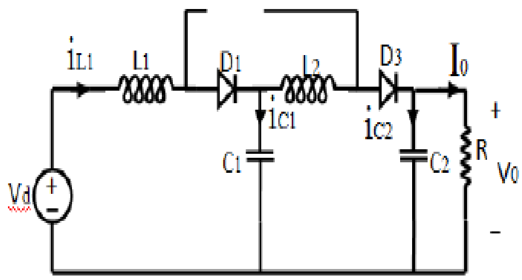

Fig.12: The equivalent circuit of the converter during OFF state.

In this period, diodes D_1& D_3 are ON and switch, S& diode, D_2 are OFF.

Component	Description	Model
C1	40uF	
C2	10uF	
L1	7.81mH	
L2	31.25mH	
D1, D2, D3	400V 6A	3NIX
MOSFET	150V	IRF840

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

IV. SIMULATION OF QUADRATIC BOOST CONVERTER

The simulated circuit is shown in the Fig. 13.

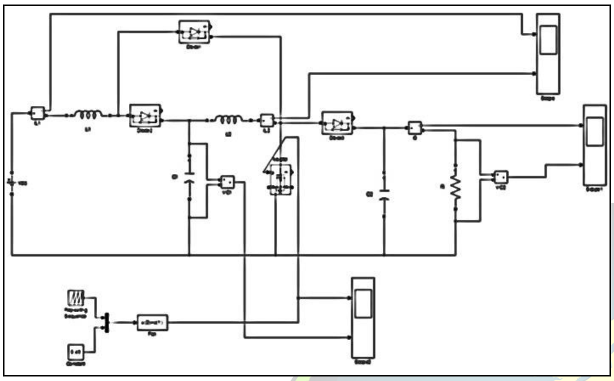

Fig. 13: Quadratic Boost Converter.

The expression for output voltage of Quadratic Boost Converter is given by

$$V_{out} = \frac{V_{in}}{(1-D)^2}$$

Hence, 30 volt DC input is boosted to 120 volt DC.

The inductor current, gate pulse and output voltage waveform are shown in the Fig. 14, 15& 16.

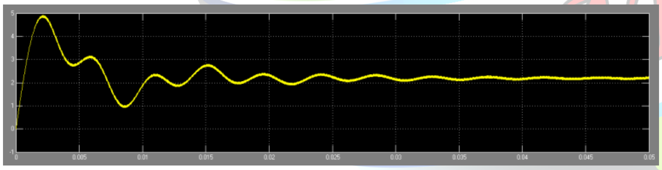

Fig. 14: Inductor current waveform

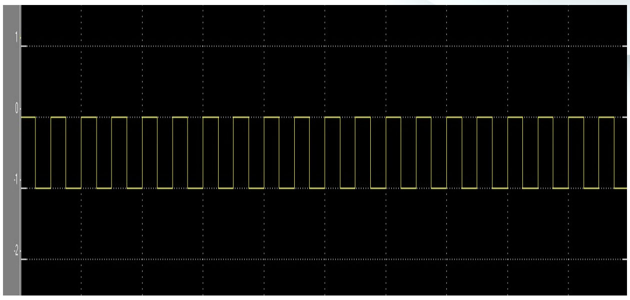

Fig. 15: Gate pulse waveform

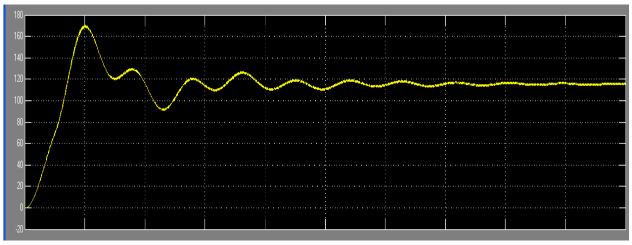

Fig. 16: Output voltage waveform

V. CONCLUSION

The simulation of Quadratic Boost Converter for PV applications has been presented. The QBC was designed properly in order to meet the requirement of PV applications. The circuit was able to perform adequate boost action, from input of 30V DC a boosted output of 120V was obtained.

REFERENCE

1) **Overview of Single-Phase Grid-Connected Photovoltaic Systems Article in Electric Power Components and Systems** · July DOI: 10.1080/15325008.2015.1031296
2) **Mathematical Modeling and Analysis of Solar PV Based Modified Quadratic Boost Converter for Extraction of Maximum Power** Appl. Math. Inf. Sci. **11**, No. 5, 1389-1397 (2017)

