PJ PRL ET
PANACEA JOURNAL OF ENGINEERING AND TECHNOLOGY

PIJET
INTERNATIONAL JOURNAL
Journal Homepage: www.prlpublisher.com/pjet

Panacea Journal of Engineering and Technology
ISSN: Applied

Research Article **Volume 1 Issue 1**

ANALYSIS AND PERFORMANCE MEASUREMENT OF A STEP-UP DC-DC CONVERTER FOR FUEL CELL APPLICATION

Tanu Tiwari*, Sivendra Singh Thakur
Department of Electrical Engineering, S. A. T. I. Vidisha - 464001 R.G.P.V. University, (M.P.), India

Article history:
Received: Feb 2015
Received in revised form: 1st Feb 2015
Accepted: 1st Feb 2015
Available online: 5th Sep. 2015

Keywords:
Photovoltaic cell, PIC16F84A controller, boost converter, fuel cell etc.

***Corresponding author:**
Tanu Tiwari,
E-mail:
tanu.tiwari04@gmail.com

Abstract

Today solar power generation is consider as the best of the conventional power generation system because it is clean and does not released harmfully gases to the environment. This thesis proposes a new idea for photovoltaic DC to DC converter with high gain and efficiency under wide input voltage range. The study of open loop and closed loop systems with high gain boost converter and its step increase in input voltage. And we are study the open loop boost converter with implemented with clamper circuit adding and this improved DC to DC boost converter is simulated and modelled using matlab. In This converter fed 12v input and provides the 60v constant output voltage of the PV panel output and load. Simulation results of this system will boost up voltage from12 v to 60 v presented and power conversion efficiency is more than 94%. And performance of the converter is also compared with the conventional converter. Thus these comparisons acknowledge that the proposed converter system has the advantages of high gain and high efficiency with the minimum number of components used in circuit.

Introduction

Renewable and sustainable energy sources like as photovoltaic i.e. and fuel cells i.e. are required in power electronic condition. Today's the installation of photovoltaic generation systems is very speedily growing due to concerns related to environmental and global warming. And it also is doing energy security and technology improvements and it also decreasing costs. Fuel Cell and photovoltaic generation system is considered as a clean and environmental friendly source of energy system. The main applications of Fuel Cell and photovoltaic systems are in standalone or grid connected configurations. The Stand-alone photovoltaic and Fuel Cell generation systems are attractive as indispensable electricity source for remote areas. The photovoltaic generation systems has two major problems which are related to low conversion efficiency of about 10% to 12 % especially in low irradiation conditions and the variation of amount of electric power generated by photovoltaic array continuously depend on weather conditions. Therefore this work is carried out to increase the efficiency of the energy produced from the photovoltaic array. The outputs of the Fuel Cell and photovoltaic cells are an unregulated low level DC voltage that needs to be stepped up to a regulated high level. For the many potential applications and boost converter stages are employed for this purpose. There many applications the use of a transformer may provide increased output and input voltage gain are required. There are lots of applications where transformer less power electronic energy converter systems might potentially offer significant advantages including cost and converter size reduction. The DC to DC converters are the frontend component connected between the PV array and the load side. The conventional boost or step up converter cause serious reverse recovery problem and by this increase the rating of all the devices and As a result the conversion efficiency is degraded and the electromagnetic interference problem becomes distinct under these situations. The conversion efficiency Increasing by many modified step up converter topologies have been investigated by many researchers. A Voltage clamped techniques have been incorporated in the converter design to overcome the distinct reverse recovery problem of the output diodes. A high efficiency step up or boost converter is proposed here. Without transformer boost converter with high gain and low current ripple for fuel cell applications is discussed here. Recently a new controller technique to control the boost converter for photovoltaic (PV) power generation system is discussed here .Design technique and application for PV generation system using a soft switching boost converter with SARC is discussed.

The above literatures do not deal with embedded implementation of improved boost converter system for solar system installation. Limitations of the conventional boost converters are analyzed and the conceptual solution for high step up conversion is proposed and this work makes an attempt to implementation of the improved boost converter using PIC16F84A controller.

Implemented Boost Converter

In the boost converter load voltage V_0 is more than the source Vs. It is a class of switching mode power supply containing at least two semiconductor switches a diode and a transistor and at least one energy storage element. Filter is made of capacitors in combination with inductors and normally added to the output of the converter to reduce output voltage ripple at the output. Implementing the pulse width modulation techniques on the boost converter a stable output voltage from a non stable input voltage is obtained by changing the duty cycle of the switched input pulse. In this thesis closed loop control of an improved boost converter design is presented by modifying the voltage gain equation which is the function of the duty cycle D. The voltage gain can be increased by adding clamping device. So that minimizes the reverse recovery problem the circuit diagram of the proposed boost converter consisting of additional circuit which includes inductor in the source side L clamping diodes D1, D2 and capacitor C2 used to form a regenerative circuit to sink the reverse recovery high voltage capacitor C1 and an output filter circuit makes with diode D0 and capacitor C0.

The average output voltage is given as

$$V_{0(avg)} = \frac{V_s}{2} \sqrt{D}\,(1-D)^2 \quad (1)$$

where V_s is the input voltage, D is the duty cycle ratio. The load value is

$$R = V^2/P \quad (2)$$

$$I_0 = V_0/R \quad (3)$$

Simulation Results

Simulation is done using Matlab and the results are presented. The Simulink model of an improved DC to DC boost converter for solar installation system is shown in Fig.5 (a). Simulation of the improved boost converter was carried out with the following parameters. V_{IN} = 12 V to 17V and V_O= 60V L= 5 mH *C*= 2000 µF & 30 mF Duty cycle ratio = 65% and load resistance R_L= 10 Ω. Applied is V_{IN} as input voltage in normal condition.V_{IN} of 12 volts is applied as input while assuming external disturbance in the PV panel. The driving pulse of the MOSFET is also shown in Fig. The duty cycle ratio of the pulse is 65%. The output current is shown in Fig. this is 5 A. The DC output voltage is shown in Fig. the steady state value of output voltage is 60 V.

The open loop system with disturbance is shown in Fig. here the open loop system an external disturbance of 5V is applied with the input voltage at 2.55 sec. The input / output voltages of the open loop system with disturbances are shown in Fig. (b) and Fig. (c) Respectively. 12 V is applied as input till 2.5 sec so that the converter produces an output voltage of 60 V. At 2.55an sec with the 12 V input and voltage 5 V is added as disturbance in the input side. At 2.55 sec the output voltage starts to increase from 60 V to 70V for the 12 V input.

Output voltage is compared with a reference voltage. Then induced the error is processed by a PI controller. The output voltages of PI controller adjust the pulse width to maintain the constant output voltage of 60 V. Thus the output voltage reduces and reaches the steady state set value of 60 V at 2.8 sec. In this implemented converter system the response of the system is very faster for system. The delay time rise time and peak time is very fast. It reaches its steady state condition very quickly.

Time response analysis:

The time response specifications of the output voltage are analyzed. Delay time is 0.063 sec Rise time is 0.142 sec peak time is 0.143 sec settling time is 0.38 sec and % of maximum peak overshot is 9.25%

Table 3.1. Performance comparison

Input	**Output voltage(V)**	**Efficiency (%)**

Voltage (V)	Conventional boost converter	Improved boost converter	Conventional boost converter	Improved boost converter
10	27.53	49.87	82.79	92.11
12	33.73	60.15	83.50	93.8
14	38.89	69.06	83.67	93.23
16	44.05	79.16	83.95	93.60
18	50.10	90.14	83.25	93.95

The performance of the proposed boost converter is compared with the performance of the conventional boost converter and the comparison is presented in Table5.1. The proposed and conventional converter performances in open loop system are analyzed for different input voltages. However in closed loop system the converter maintains a constant output voltage for step change in input voltage.

The input verses output voltage comparison of the proposed and conventional boost converter is shown in Fig. For the input of 12 V the conventional boost converter can produce 33.73V but the proposed converter produces 60.15 V. The input voltage and output power comparison is shown in Fig. And input voltage verses efficiency comparison is shown in Fig.5.7. For the input of 12 v the conventional boost converter can deliver an output power of 112.3 W but the proposed converter can deliver an output power of 369 W and For the same input of 12 V the efficiency of the conventional boost converter is 84.3% only but the proposed boost converter give an efficiency of 93.98%.This is almost 10% higher than the conventional boost converter efficiency. The above results it is confirm that the improved boost converter has better performance efficiency than conventional boost converter.

Simulation Results

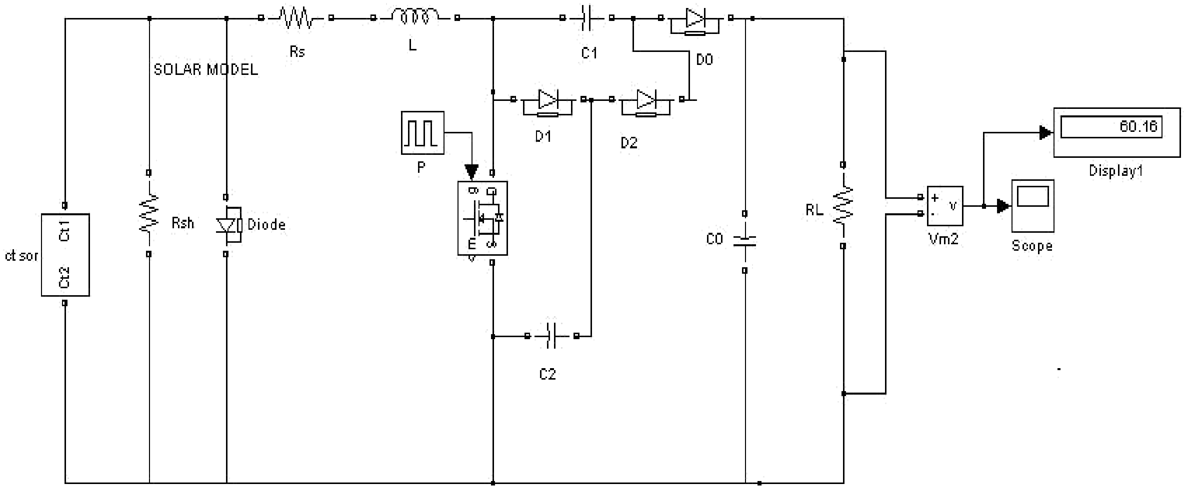
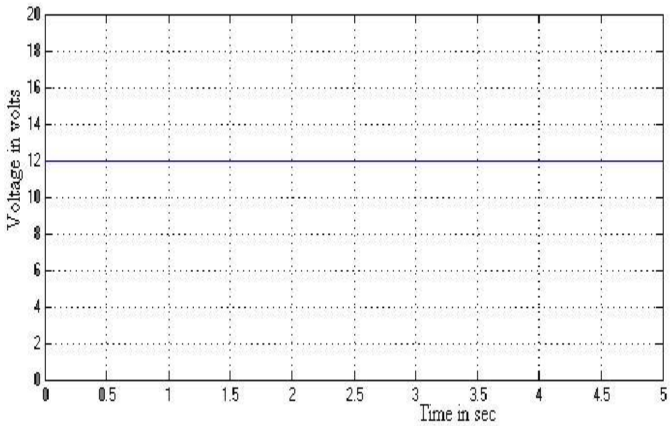
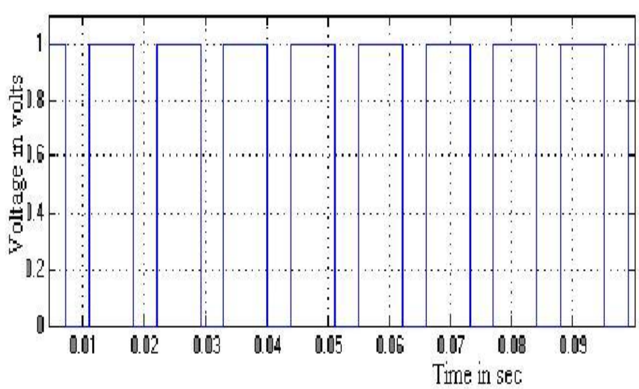
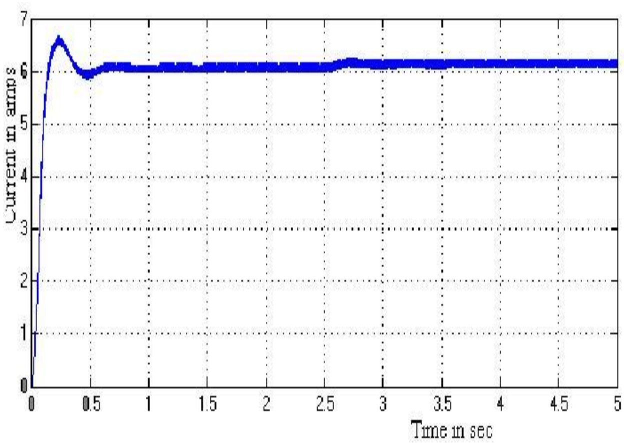


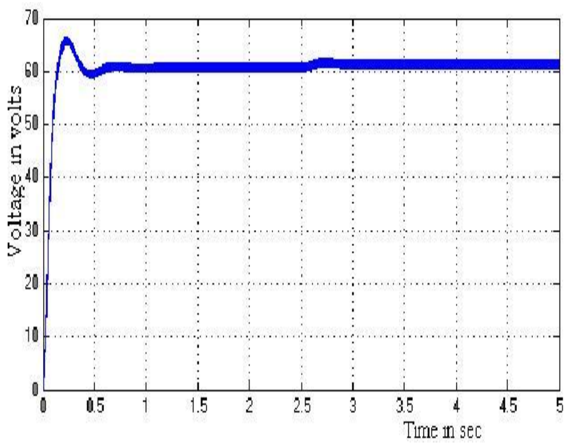
Fig.4.1 Improved DC to DC boost converter





(b) Input voltage, **(c) driving pulses for switch**





(d) Output current **(e) DC output voltage.**

Conclusion

In this paper, an improved boost converter is designed developed and implemented for a solar installation system. This thesis proposes a new idea for photovoltaic DC to DC converter with high gain and efficiency under wide input voltage range. The converter topology is selected after researching and comparing various topologies. The open loop system of the converter is presented. The designed circuit is modelled and simulated using matlab and it is implemented using embedded controller and lab tested. The simulation results of this system are compared with the conventional boost converter and its time response analysis is made. These improved boost converters continuously provide constant output voltage even with disturbance at the input voltage side. It is observed that the proposed improved boost converter system has the advantages of high efficiency fast response and low ripple content and reduced switching component. Thus the simulation results confirmed that the improved DC to DC boost converter gives better performance efficiency than conventional boost converter.

References

1. Nakayama H. Stand-alone photovoltaic generation system with combined storage using lead battery and EDLC. In: *Proc. of the Power Electronics and Motion Control Conference*, 2008:1877-1883.
2. Salas V, Barrado A, Lazaro A. Review of the maximum power point tracking algorithms for stand-alone photovoltaic systems. *Solar Energy Materials & Solar Cells*, 2006:1555-1578.
3. Xue Y, Chang L, Kjaer SB, Bordonau J, Shimizu T. Topologies of single-phase inverters for small distributed power generators: an overview. *IEEE Trans. PowerElectronics*, 2004; 19(5):1305-1314.
4. Wai RY, Duan L, Jheng K-H. High-efficiency bidirectional dc-dc converter with high-voltage gain. *IET Power Electronics*, 2012; 5(2):173-184.
5. Wai RY. High-performance stand-alone photovoltaic generation system. *IEEE Transaction on Industrial Electronics*, 2007; 55:240-250.
6. Tseng KC, Liang TJ., Novel high-efficiency step-up converter. *IEE Proc. Electr. Power Appl*., 2004; 151(2):182-190.
7. Park C, Yang J, Choi S, Nam S. A transformer-less boost converter with high gain and low current ripple for fuel cell applications. In: *Proc. of Korean Institute of Power Electronics Conf*., 2006:348-51.
8. Khatib TNT, Mohamed A, Amin N. A new controller scheme for photovoltaics power generation systems. *European Journal of Scientific Research*, 2009; 33(3):515-24.
9. Park SH, Cha GR, Jung YC, Won CY. Design and application for PV generation system using a soft-switching boost converter with SARC. *IEEE Transaction on Industrial Electronics*, 2010; 57(2):515-22.