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SOLAR VOLTAGE BOOSTER

Dr A. M. Haque[1], Angana Das[2], Prachi Chakravarti[3], Subin Nair[4], Shubh Shah[5], Jaimin Solanki[6]

[1]Assistant Professor, Department of Power Electronics, VGEC-Chandkheda, Gujarat, India
[2]Student, Department of Power Electronics, VGEC-Chandkheda, Gujarat, India
[3]Student, Department of Power Electronics, VGEC-Chandkheda, Gujarat, India
[4]Student, Department of Power Electronics, VGEC-Chandkheda, Gujarat, India
[5]Student, Department of Power Electronics, VGEC-Chandkheda, Gujarat, India
[6]Student, Department of Power Electronics, VGEC-Chandkheda, Gujarat, India

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Abstract - *The aim of this project is to design and construct a solar voltage booster, using mostly discrete components. The charge controller varies its output to a step of 12V; for a battery of 200Ah rating. The design consists of four stages which include current booster, battery level indicator, battery charge controller and power supply unit. The designed system is very functional, durable, economical, and realizable using locally sourced and affordable components. This work is a prototype of a commercial solar charge controller with protection systems that will prevent damages to the battery associated with unregulated charging and discharging mechanisms. The main purpose of this paper is to introduce an approach to design a DC-DC boost converter with constant output voltage for grid connected photovoltaic application system. The boost converter is designed to step up a fluctuating solar panel voltage to a higher constant DC voltage. It uses voltage feedback to keep the output voltage constant.*

Key Words: **Solar Panel, DC to DC Converter, DC to AC Converter, Power Supply, Voltage Regulator**.

1. INTRODUCTION

A substantial increase of solar power has been observed because of remarkable enhancement in efficiency of solar cells with the improvements of manufacturing technology of panels and simultaneously notably reduced operational cost, almost maintenance free and environmentally friendly. Further, many subsidized policies that have been introduced by government also resulting in rapid growth of this industry [1], [8]-[13].

To harness the power from solar has become a common phenomenon. Though the improvement in the efficiency of solar cell is gained up to 68% eventually against the claim of 85% by the manufacturers. To raise the overall efficiency of the solar system with the advent of power electronics engineering is also continuously performing an important and novel role. Power Electronics is the field of engineering which deals with electronics for the conversion control and conditioning of electrical power for the required applications. There are two places in solar power system where power electronics plays important role. One stage is DC-DC converter system where absorbed low level voltage by solar cell is boosted up at required high level voltage and another stage is DC-AC inverter system where increased DC voltages are efficiently converted into AC [14], [15].

Essentially, by using an extremely high duty cycle, the conventional buck-boost DC-DC converter can provide a very high voltage gain. Nevertheless in actual applications, for a very high duty cycle, the voltage gain is reduced due to the non-ideal elements in circuits such as inductors, capacitors, switches, diodes, etc. Moreover, extremely high duty cycle can produce electromagnetic interference [2] [3], which might reduce the efficiency of the operational circuits. Several researchers have designed models that can achieve high voltage gain while overcoming these disadvantages of conventional converters. High gain can be attained by cascading two or more step-up converter stages [4]-[6]. Extreme duty cycles can be avoided by setting an intermediate voltage between the two stages too. However, due to additional components, the control circuit become more sophisticated and the total efficiency is reduced [3], [6], [7], [16].

Photovoltaic solar systems can be divided into two basic categories – grid connected and off- grid (also called stand alone or isolated) solar systems. The grid connected systems feed the electricity produced by solar panels to the grid using an inverter. When the electricity is needed during night or periods with little sunlight, the energy is taken back from the grid. In isolated systems, the excess electricity is usually stored in batteries during the day and batteries are used to power the appliances in times when photovoltaic panels do not produce enough energy. Solar regulators (also known as charge controllers) play an important role in isolated solar systems. Their

goal is to ensure the batteries are working optimally, mainly to prevent overcharging (by disconnecting solar panels, when batteries are full) and to prevent too deep Discharge (by disconnecting the load when necessary) [19]-[24].

Battery lifetime reduces drastically due to its overcharging and deep discharging. Battery is a very expensive component of a Solar Home System; hence it is necessary to protect batteries from being over charged or deeply discharged. In this regard, a charge controller plays a vital role to protect the battery. One of the best ways to get power to remote, off-grid locations is through Solar Home System (SHS). The system consists of photovoltaic panel, battery, and a solar charge controller. Solar energy is stored into batteries. A solar charge controller regulates the voltage and current that is coming from the solar panels and going to the battery. The charge controller is a switching device that controls the charging and discharging of the battery. This will protect the batteries from damage and hence prolong the lifespan of the battery [25]-[29].

1.1 MAIN SUPPLY

The main supply for our boost converter is achieved by using solar energy. Nowadays power generation using solar energy had increased dramatically because it is pollution free as compare to power generation using fossil fuels. Besides, it needs low maintenance and no noise and ware due to the absence of moving parts which make solar power more efficient than other source. Here, we use solar panel which converts the sun irradiation into electric energy using photovoltaic effect. Behind the panel, a diode is fixed which is used for the forward biased operation of the electrical current.

1.2 BATTERY CHARGING

The output voltage from the solar panel is varying depending on the sun irradiation and temperature changes. Thus the battery cannot be charged using this varying output voltage. So that's why, we are using a power supply circuit (Fig. 1) in which we are using a bridge rectifier for the forward biased supply from the solar panel. Capacitors are used for storing energy and as a filter in this circuit. LM7812CT is used to convert the varying DC to constant DC voltage which is used for the charging of battery. LM7805CT is used for 5 volt supply for small equipment. This full circuit acts as a voltage regulator.

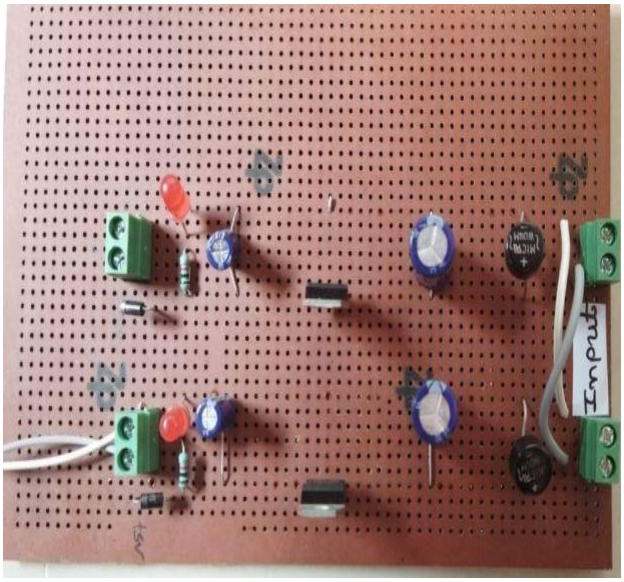

Fig -1: POWER SUPPLY

2. LITERATURE REVIEW

Power generation using solar power had increased dramatically because it is pollution free as compare to power generation using fossil fuel. Besides, it needs low maintenance and no noise and wear due to the absence of moving parts which make solar power attractive to the people. Solar power uses solar panel to convert sun irradiation into electric energy using photovoltaic (PV) effect. The output voltage of a solar panel is varying depending on sun irradiation and temperature. As the sun irradiation and temperature changes, output voltage changing as well. Since the voltage produced is fluctuating, a lot of electronic equipments are unable to be directly connected. Therefore, a DC-DC boost converter with constant output voltage is needed.

The boost converter will step up the solar panel voltage to the suitable voltage required by electronic equipments. For AC electrical equipments, the system requires an additional AC-DC inverter which converts the constant DC voltage to AC voltage. This system is called dual power processing stage system. Any power produced by solar panel is directly deliver to the grid. Batteries are excluded from the system because battery banks need high maintenance which had to be handled carefully in order to have a long lifetime and safe environment. Besides, batteries are the second major cost contributor for the system. Therefore, the exclusion of batteries as the energy storage is economically advantageous.

3. BOOST CONVERTER (WORKING)

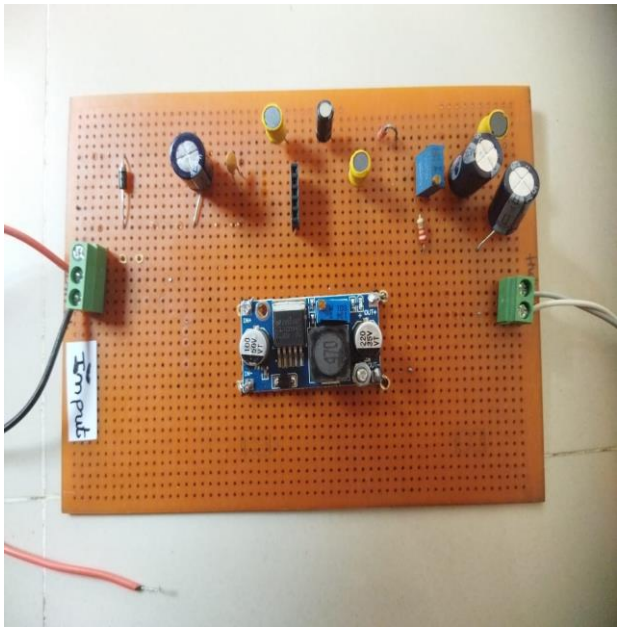

Fig -2: DC to DC Boost Converter PCB

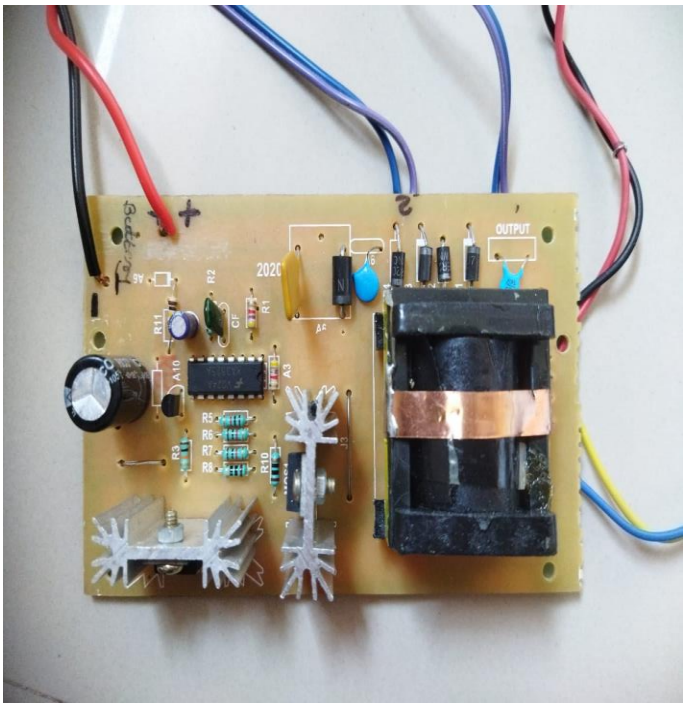

Fig -3: DC to AC Boost Converter PCB

There are two different types of converter used here, one is DC-DC boost converter circuit (Fig. 2) which is used to run DC components and the other is DC-AC boost converter circuit which is used to run AC equipment. In DC-DC boost converter, we use XL6009 IC which boost the DC output from battery. In DC-AC boost converter (Fig. 3), IC3525 is used to convert the DC pulses from the battery to AC voltage. MOSFETs are used for switching this AC pulses from IC 3525. Transformer is used to step the AC voltage to higher amount, for example, it step ups the voltage to 230 volt to light a bulb.

4. CONCLUSION

From the proposed design, the boost converter is able to produce a constant output voltage of 12 V from a variable voltage of solar panel. The boost converter is able to deliver power with the highest efficiency of 95%. Components had been chosen based on the consideration made. 3525 IC AND XL6009 is able to perform the voltage feedback control technique.

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BIOGRAPHIES

Anwarul M. Haque has received his *M. Tech (Electrical) Degree* from Manav Bharti University, Solan, Himanchal Pradesh (HP) in *2012.* He is awarded with *PhD* from JNU, Jodhpur, Rajasthan in *December 2016.* He is honoured with Pedagogical Innovation Award (PIA) 2017 by GIC-GTU G.nagar for Outstanding Contribution in making Innovative Final Year Projects on 14th February 2017. His two patents have been published in Patent Office Journal in September 2018 & May 2019 respectively. His areas of research are Renewable Energy Sources, Electrical Drives & Control, Electrical Power System and Power Electronics.

Angana Das is Student of Power Electronics Engineering at VGEC, Chandkheda, Ahmedabad Gujarat, India. Her area of interest is doing masters form reputed university.

Prachi Chakravarti is Student of Power Electronics Engineering at VGEC, Chandkheda, Ahmedabad Gujarat, India. Her area of interest is to get a respectable job in MNC.

Subin S Nair is Student of Power Electronics Engineering at VGEC, Chandkheda, Ahmedabad Gujarat, India. His area of interest is to do masters Automation / Automobile Engineering from reputed University of CANADA.

Shubh Shah is Student of Power Electronics Engineering at VGEC, Chandkheda, Ahmedabad Gujarat, India. His interest involve in doing masters from NIT / IIT and work for Nation.

Jaimin Solanki is Student of Power Electronics Engineering at VGEC, Chandkheda, Ahmedabad Gujarat, India. He has NCC-C certificate. His future prospect remains job in military & Para military forces.