Pv Powered Dc-Dc Boost Converter Charger For Electric Vehicles With 3 Different Voltage Levels

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Abstract: The paper aims to develop a solar powered multi-output efficient converter to charge three different load capacities of an electric vehicle charging station. While implementing the DC sources for multi-output charger it becomes a continuous power supply, cost effective and moreover, installing a renewable energy source such as photovoltaic system (PV) supplies green power. Hysteresis controller is connected in order to control current and to enhance power quality. A battery charger is used where boost converter is connected to it which is more efficient in using PV system. The hysteresis controller which extracts current, raises the voltage and then the battery is placed between PV array and power converter. According to Perturb and Observe method, overshoot appears in starting and slowly decreases till it reaches a stable steady state. The solar based charger is effective for converting the low voltage profile from PV panel to high voltage profile. This high voltage can be controlled and current can be limited by hysteresis controller for an efficient photovoltaic used charger. Battery is connected in between the PV and the converter for day-time charging and night time usage. The proposed converter can give out multiple-output of three different voltages like 8V, 12V, 18V. The PV powered boost converter charger with hysteresis controller is modelled in MATLAB/SIMULINK and the simulation results are verified with a scale down model.

Keywords - Boost converter, hysteresis control, Photovoltaics (PV), Battery charger, Single Input and Multiple Output (SIMO).Keywords - Boost converter, hysteresis control, Photovoltaics (PV), Battery charger, Single Input and Multiple Output (SIMO).

I. INTRODUCTION

The most familiar renewable energy source is Photovoltaic system, which has its own unique characteristics and versatile development and technical advancement [1]. It deals with global warning, clean energy and is pollution free, which is therefore implemented in this system and its output are obtained at different levels. This paper proposes a multi output charger which can charge multiple devices with different capacity. The solar power is stored in a battery to give supply even after the day time [2]. The high potency of dc-dc boost converter is employed for enhancing the low voltage to high value. By using hysteresis controller, current is limited [3]. Three voltage levels notedly 12V, 20V and 48V are obtained at the output. The proposed system is suitable for mobile charging, electric vehicle charging and agriculture motor pump charging. The manufacturing cost of such a charger is low and this high voltage can be controlled efficiently by the hysteresis controller. The battery and the boost converter are connected in parallel with hysteresis controller. The block diagram is shown in Figure.1.

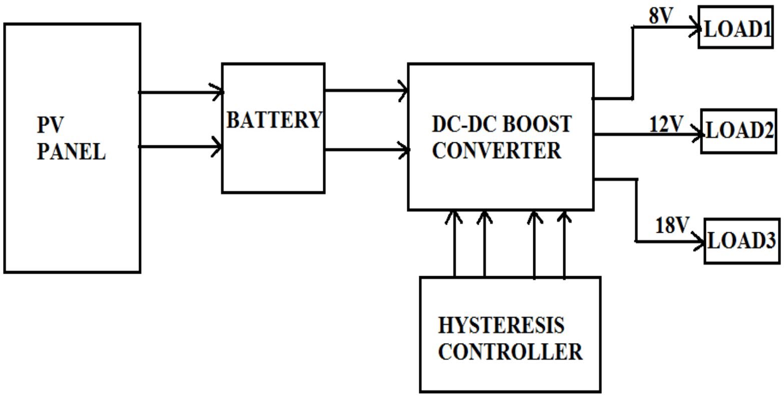

Figure.1 PV powered multi-output charger Block Diagram.

The battery is initially charged by the power from the PV panel and is send to the converter to step-up input voltage. Objective for powered multi-output are;

1. To store the PV power into the battery using the boost converter.
2. To design a Hysteresis controller to achieve current limiting and with fast dynamic response.
3. To obtain multiple voltage output from the converter.

The proposed hysteresis controller operates on the principle of current controlling. To effectively operate the PV system, a current ramp and increase the reliability, a hysteresis controller is used. The PV power is sent to converter, where it is boosted up to desired voltage and supply the load. The battery is connected in parallel to the PV and the boost converter circuit for operation during night times. This controller gives fast dynamic response and is connected to the boost converter.

II. SYSTEM DESCRIPTION

The PV system modeling and control strategy for multiple voltage levels is delineate during this section.

A. PV system modeling

The series and parallel configuration of photovoltaic cells constitutes the PV panel or module. When the photo voltaic cells are linked in series, it gives excessive voltage and if it's far linked in parallel it gives excessive current. The output voltage of the photo voltaic cell could be very low (around 0.5). Many photo voltaic cells are configured to acquire most extract the required output power. Usually the configuration is in terms of 36 or 76 cells connected in collection to shape the PV module. Here 36 cells are related in module.

$$\frac{\beta(V_{A,PV,k} - V_{A,k})}{X_{A,PV,k}} + \frac{V_{A,k-1} - V_{A,k}}{Z_f} + \frac{V_{A,k+1} - V_{A,k}}{Z_f} + \frac{V_{N,k} - V_{A,K}}{Z_{A,L,k}} = 0$$

(1)

Where Z_f gives the value of feeder resistance across 2 adjacent nodes in the section, VA, I, I = 1, n gives the value of the single-phase node voltage of the section A. $Z_{A, I, k}$ is the load resistance of k^{th} node of section A. $V_{N, k}$ is the neutral voltage across the k^{th} node. $V_{A, PV, k}$ is the output voltage from the PV system and resistance connected to the K^{th} node of section A. Similarly, the equations can be evaluated for B phase and C phase. The dominant constant is adequate to one, once a PV panel is connected to the K^{th} node, otherwise its value is zero.

Considering the neutral line Z_n, is the feeder resistance between 2 adjacent nodes.

$$P_{PV,k} = \frac{|V_{A,PV,k}||V_k|}{X_{PV,k}} \sin(\delta PV, k - \delta_k)$$

(2)

$$Q_{PV,k} = \frac{|V_k|}{X_{PV,k}}\left(V_{PV,k} - \cos(\delta_{PV,k} - \delta_k)\right)$$

(3)

Here $X_{PV,k}$ and $Q_{PV,k}$ is the active and reactive power component of the PV connected to K^{th} node. $P_{PV,k}$ and $Q_{PV,k}$ is assumed to be constant, $|V_k|$ and $|V_{PV,k}|$ are known and might be calculated. During Unity power factor operation of the Pv system the value of $Q_{PV,k}$ is zero.

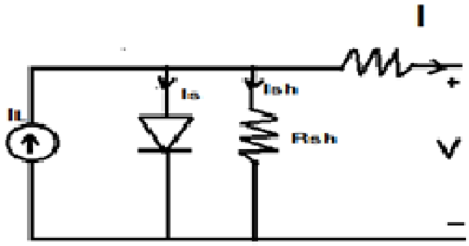

Figure.2 Equivalent circuit of a single PV cell

The equation for the equivalent circuit in figure 2 is derived using the Kirchhoff's current law.
The value of current I is given by

$I = I_l – I_d - I_{sh}$

(4)

Here, I_l represent the generated current with light within the cell, I_d is the lost current due to voltage - dependent current during recombination, and I_{sh} represent the loss due to shunt resistance.

$I_d = I_0$ [exp n - 1]

(5)

Where n is that the diode quality issue (unit less, sometimes between one and a couple of for one junction cell), I_0 is the saturation current and V_T is the thermal voltage given by

$$V_T = \frac{kTc}{q}$$

(6)

$$I = I_L - I_0\left[\exp\left(\frac{V + IR_s}{nV_T}\right)\right] - 1 - \frac{V + IR_s}{R_{sh}}$$

(7)

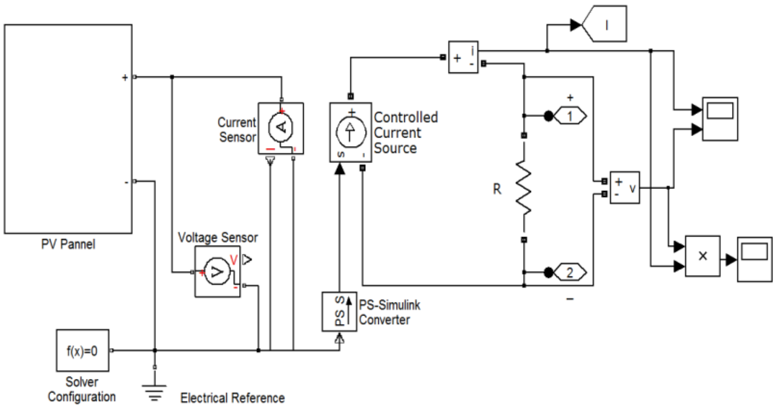

Figure. 3. Modelling of solar PV system

Since the PV power is intermittent in nature a effective battery storage system with associated control is required to continuously operate and also to store the excess PV power. Battery assembly is done with the step-up converter to boost the supply. The circuit shown in Figure.3 is the PV model, in which the 36 cells PV panel configuration is used. The excess PV power is stored in the battery which feed the converter.

B. Solar with converter circuit

High efficiency is obtained by using this converter for boosting the voltage from photovoltaic cell. This voltage is divided into three different level outputs. The high current will be induced in the circuit, so we provide a controller for the converter. The hysteresis controller is limiting current and present to obtain high voltage. The proposed boost converter operates with a typical single switch like that of an ordinary boost converter. But the hysteresis controller provides the required pulses at 3 different modes and three different voltages are obtained.

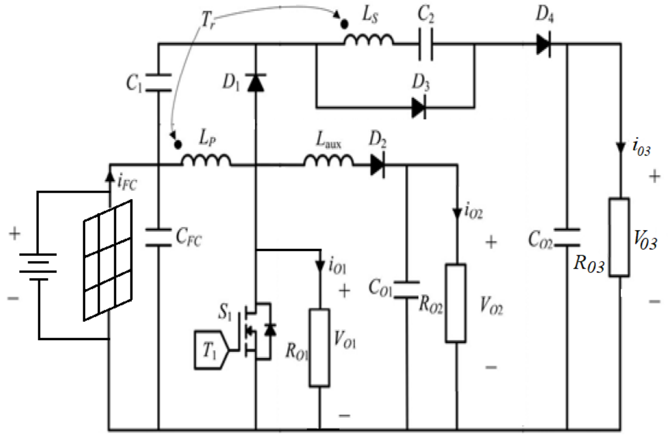

Figure.4. boost converter

C. **Hysteresis controller:**

In PV systems implementation, MPPT techniques is used, but here hysteresis controller is chosen for fast response effective control. Three different pulses are generated and given to the same thyristor at different delay time. This change in delay time gives the required output voltage at various levels. The design of hysteresis controller is shown in figure 5 using a PI controller.

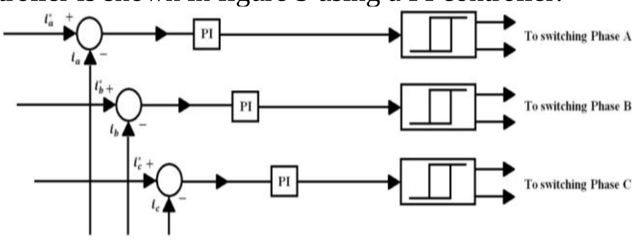

Figure. 5. Hysteresis controller block diagram

The controller operates on a common reference and with different tolerance levels. So a difference in pulses is created based upon the tolerance level of the reference voltage at various duration. The various phase voltages are obtained at different phase angles of the tolerance wave.

The hysteresis has a linear mode of operation and simple design. The switching frequency depends on the modulation index of the strategy. The inductance plays a major role in determining the output voltage levels. Therefore, the inductance are properly designed to achieve proper values at the output. It differs from the current controller but the voltage is controlled in a hysteresis controller using the current control. The frequency of the switching circuit is changed by controlling the time delay through the controller loop.

SIMULATION AND HARDWARER RESULTS

The circuit was modelled in MATLAB and the output curves were plotted to test the performance of the system. The output values are tabulated in Table I and the circuit model is shown in figure 6. The hysteresis controller is shown in figure 7 which is modelled using the PI controller.

System quantities	Values
PV Output voltage and current	(Min7V-max13V), 1Amps

Input voltage of converter	6V-12V, 1Amps
Total maximum boosted output voltage of converter	50V, 2Amps
Simulation output voltages of multiple loads	10V, 12.5V, 20V
Measured value of output voltages of load	8V, 12V, 18V

TABLE I. Design values for simulation

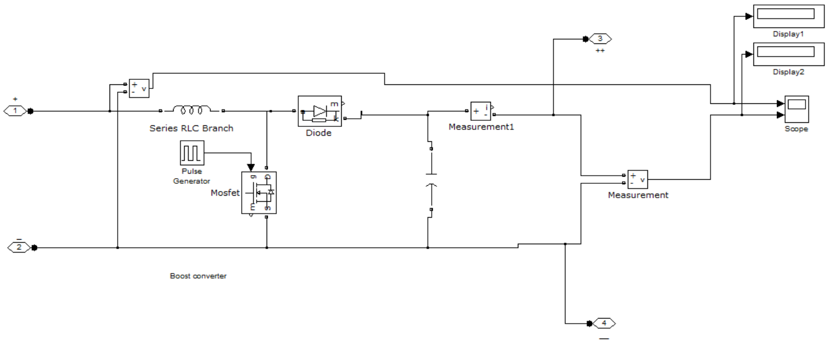

Figure. 6. Model of the overall system

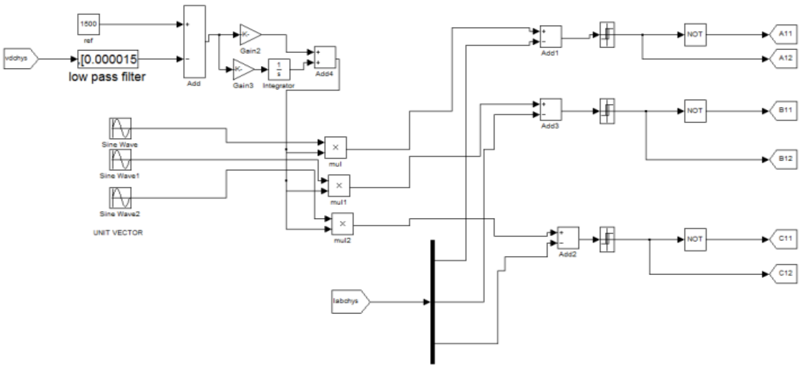

Figure. 7. Hysteresis Simulation circuit diagram Controller

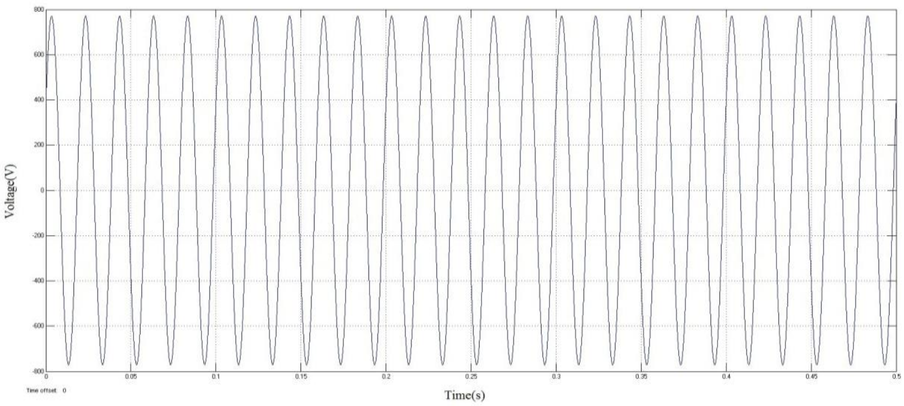

Figure. 8. Supply Voltage

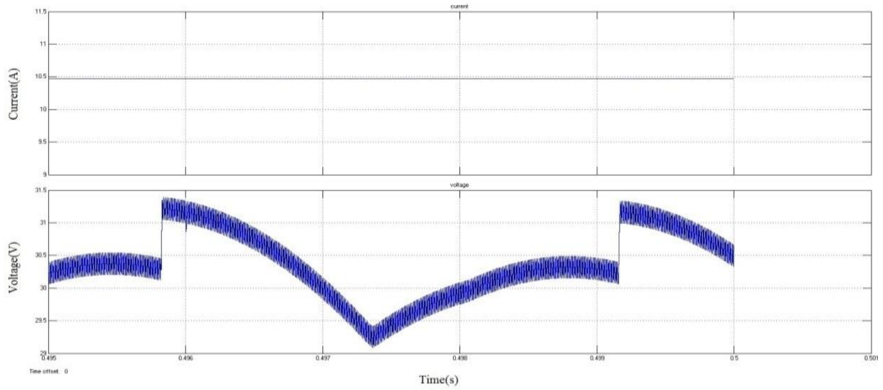

Figure. 9. Photovoltaic voltage and current

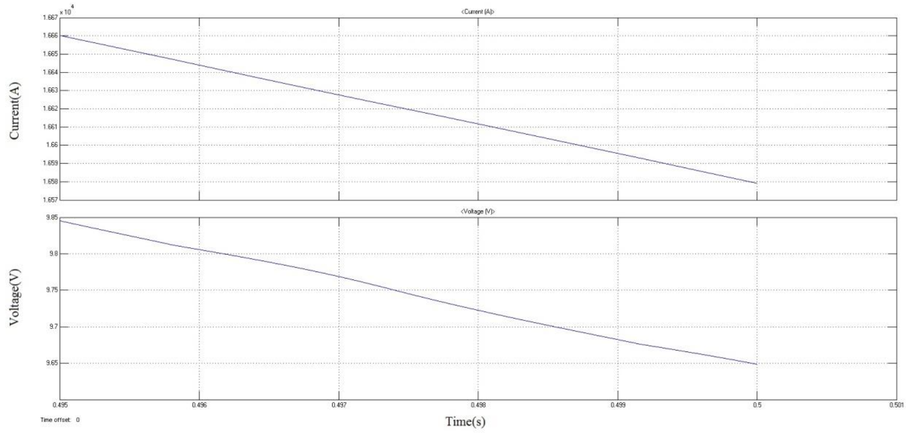

Figure. 10. Battery charger voltage and current

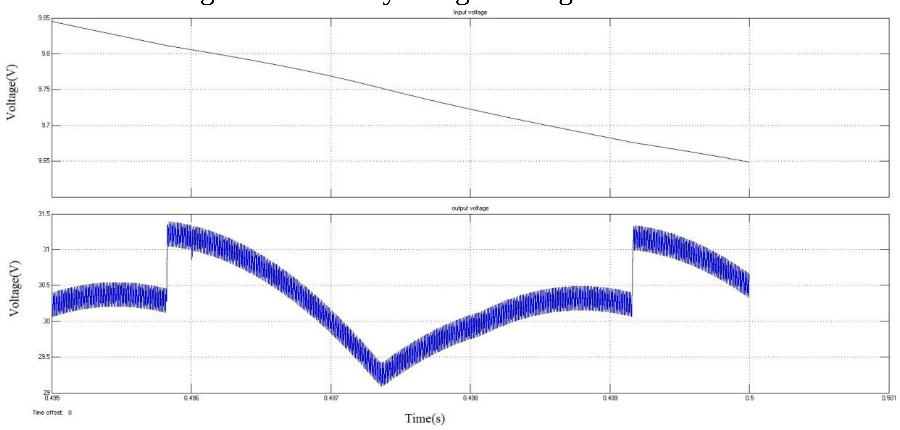

Figure. 11. Boost converter input and output

III. CONCLUSION

The proposed solar based PV charger can extract optimum energy to supply three different voltages to 3 different loads. The low power produced by the PV is boosted using the converter. The PV source provides power to converter to give higher voltage than actual voltage. The PV charger is essential to charge different loads in a beneficial way as using renewable energy. The effectiveness of the proposed scheme solar charger to supply essential different voltages in a same time. It may reduce a demand of power while using renewable source and using the hysteresis controller is more efficient controller which limits the current and supplies maximum voltage. The proposed system provides a essential converter and controller of multiple-output charger. Simulations results are evident that the proposed system can be effectively utilized to a charging station for electric vehicles wherein different voltages are required.

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