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Simulation of Closed Loop Controlled Boost Converter for PV System

Mrs Yogini V Dhotre
ME Student, Electrical Dept
AISSMS COE
Pune, India
yogini.dhotre@gmail.com

Mr Ponkshe V.S.
Assistant Professor, Electrical Dept
AISSMS COE
Pune, India
vsponkshe@rediffmail.com

Abstract: One of the major concerns in the power sector is the day-to-day increasing power demand but the unavailability of enough resources to meet the power demand using the conventional energy sources. Thus everyone demands for the renewable sources of energy along with the existing the conventional systems to fulfill the energy demand. Photovoltaic system is becoming an important renewable energy sources due to advantages like low maintenance cost, absence of moving / revolving parts, and pollution-free energy conversion process. Due to low output voltage of PV panels boost converter is preferred for voltage boosting purpose. This paper presents Open loop and closed loop controlled systems with blocks of simulink. In this system PID controller is used instead of PI controller to reduce oscillations in output voltage to achieve stabilized output voltage for Battery charging. Output of Boost converter (Boost Voltage) is used for Battery Charging which one can be utilized in various Applications. This system with boost converter will provides not only fast response but also reduce hardware.

Keywords: *PV cells, Boost converter, Battery.*

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I. INTRODUCTION

One of the major concerns in the power sector is the day-to-day increasing power demand but the unavailability of enough resources to meet the power demand using the conventional energy sources. We prefer the renewable sources of energy along with conventional systems to meet the energy demand. Renewable energy sources are an attractive issue due to environmental protection.PV system is one of the important topics in renewable energy sources. Photovoltaic (PV) sources provide one of the powerful contributions to the electricity generation. PV renewable energy source have some major advantages such as low maintenance charge, pollution-free power conversion process, also it does not require any moving or revolving parts. The grid-connected system for reducing the power from the utility and the stand-alone system for providing the load power without the utility. In case of stand-alone system is usage, batteries are required for energy storage. Electricity generations of PV panels are strongly related with Sun radiation intensity still intensity is not stable. Due to low output voltage of PV panels boost converter is preferred for voltage boosting purpose. The primary function of a charge controller is to protect the battery from overcharge and over discharge in a stand-alone PV system. Renewable sources like wind energy and solar energy are the prime energy sources which are being utilized in this regard[1]. The continuous use of fossil fuels has caused the fossil fuel deposit to be reduced and has drastically affected the environment depleting the biosphere and cumulatively adding to global warming. Because of combustion of fossil fuels global warming caused by environmental problems, the raising prices of crude oils and natural gases. They prefer continual effort to improve energy system and its efficiency. There is a need to search for abundant and clean energy sources due to the depleted and increasing prices of oil. Solar power acts as an alternative renewable energy source. Photovoltaic cells are used as renewable energy system. Photovoltaic (PV) cells can be used to generate dc voltages and given to Boost converter. DC-DC converters with step-up/step-down characteristic are required to produce a regulated output voltage from the PV panel, by accumulating the energy temporarily and then releasing that energy to the output at a different voltage[2]. Solar power can be a standalone generating unit or can be a grid connected generating unit depending on the availability of a existing grid. Thus where the availability of grids is very low it can be used to power rural areas. solar power is the portable operation wherever essential. In order to deal with the present power crisis one has to develop an efficient manner in which power has to be extracted from the incoming Sun radiation. The power conversion mechanisms have been highly reduced in size in the past few years. The evolution in power electronics and material science has support engineers to come up very insignificant but powerful systems to resist the high power demand but major drawback of this system is the increased density of power. For the use of multi-input converter units that can completely handle the voltage fluctuations trend has set in. The constant growth in the development of the solar cells manufacturing technology would precisely mate the application of these technologies practicable on a wider base than what the scenario is now.

II PV CELL SYSTEM

Solar cell can convert the energy of sunlight directly in to electrical energy. A equivalent circuit of a solar cell consists of a current source in parallel with a diode variable resistor is connected to the solar cell dynamo as a load. Relationship between the current and voltage may be determined from the diode characteristics equation:

$$I = Iph - Io\ (e^{qv/kT-1}) = Iph - Id \quad (1)$$

Where *k* is the Boltzmann constant
q is the electron charge,
,*Iph* is the photocurrent,
Io is the reverse saturation current,
I d is the diode current and

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T is the solar cell operating temperature (K).

The PV system requires storage to meet the energy demand during period of low solar irradiation and night time. Battery storage in a solar system should be properly controlled to avoid catastrophic operating condition like over charging or frequent deep discharging. To regulate the charge transfer and prevent the battery from being excessively charged and discharged charge controllers are used. Battery storage in a solar system should be properly controlled to avoid catastrophic operating condition like over charging or frequent deep discharging .Switch mode DC to DC converters are used to match the output of a PV generator to a changing load. DC to DC converters permit the charge current to be reduced continuously in such a way that the resulting battery voltage is maintained at a specified value. A photovoltaic energy conversion system block diagram is shown in Fig. 1.

Fig 1.Block Diagram

III. RESULTS(SIMULATION)

Boost converter for pv system for Open loop is shown in Fig. 2, Fig. 2a represents DC input voltage ,fig.2b represents output current and Fig. 2c represents DC output voltage. Results of Simulation using Matlab are presented.

Simulation studies is carried out by using following data

Input Voltage: 15 V
Output Voltage: 24 V
LF: 2.2mH
CF: 470μF
Battery 24v,7AH

In this system input to boost converter is output from PV panel. Output of PV panel is not constant hence input to boost converter is also variable .Thus final output of boost converter is not constant, it is variable which is not applicable for battery charging . Constant output voltage is needed for battery charging .This is the drawback of open loop system.

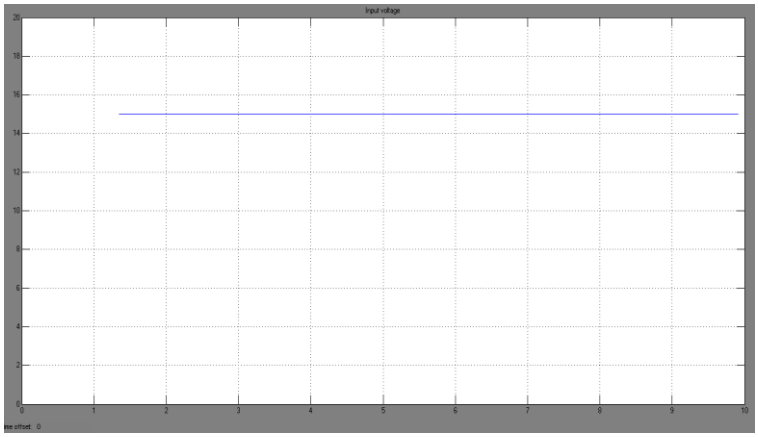

Fig No.2a Open loop Input Voltage

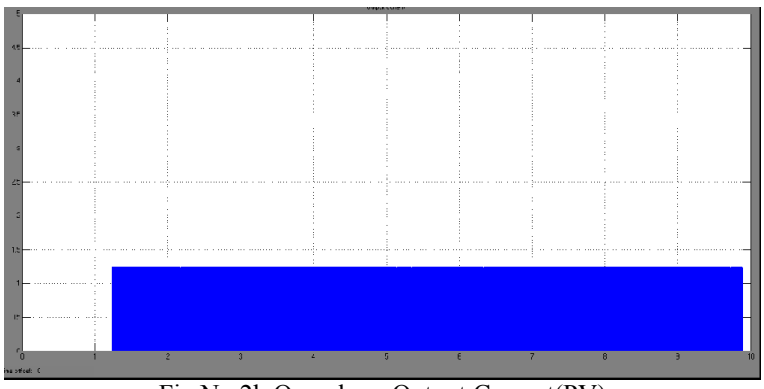

Fig No.2b Open loop Output Current(PV)

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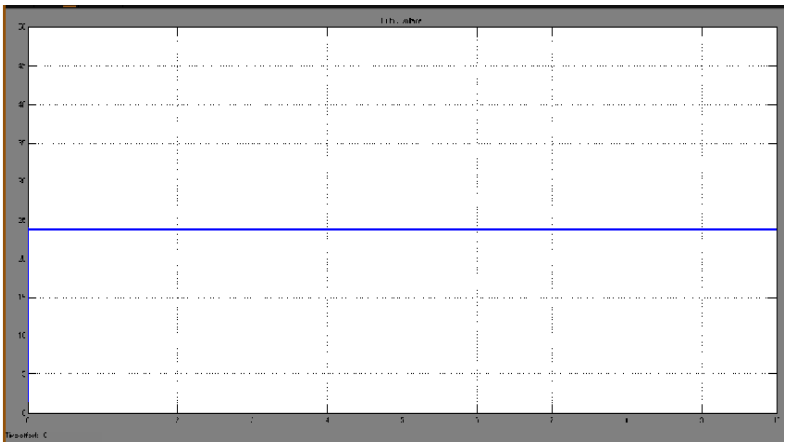

Fig No.2c Open loop Output Voltage

To overcome disadvantage of open loop system , closed loop system is preferred. Boost converter for pv system for Closed loop is represented by Fig. 3, DC input voltage is represented by Fig. 3a,Output current is represented by fig.3b and DC output voltage is represented by Fig. 3c. Results of Simulation using Matlab are presented.
Simulation studies is carried out by using following data :

Input Voltage: 15 V
Output Voltage: 24 V
LF: 2.2mH
CF: 470 µF
Battery 24v,7AH

In closed loop system PID controller is used to maintain output voltage constant

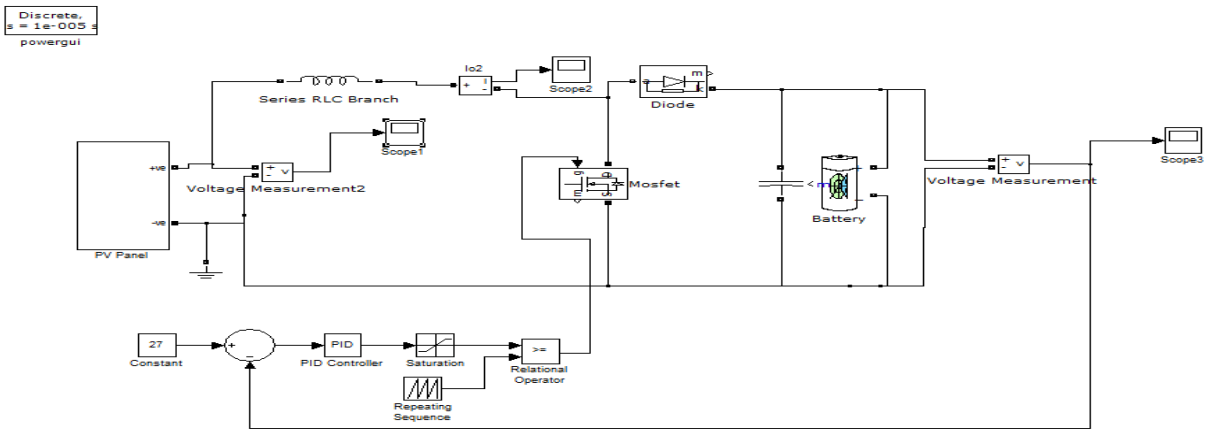

Fig No.3 Closed Loop Simulink Model

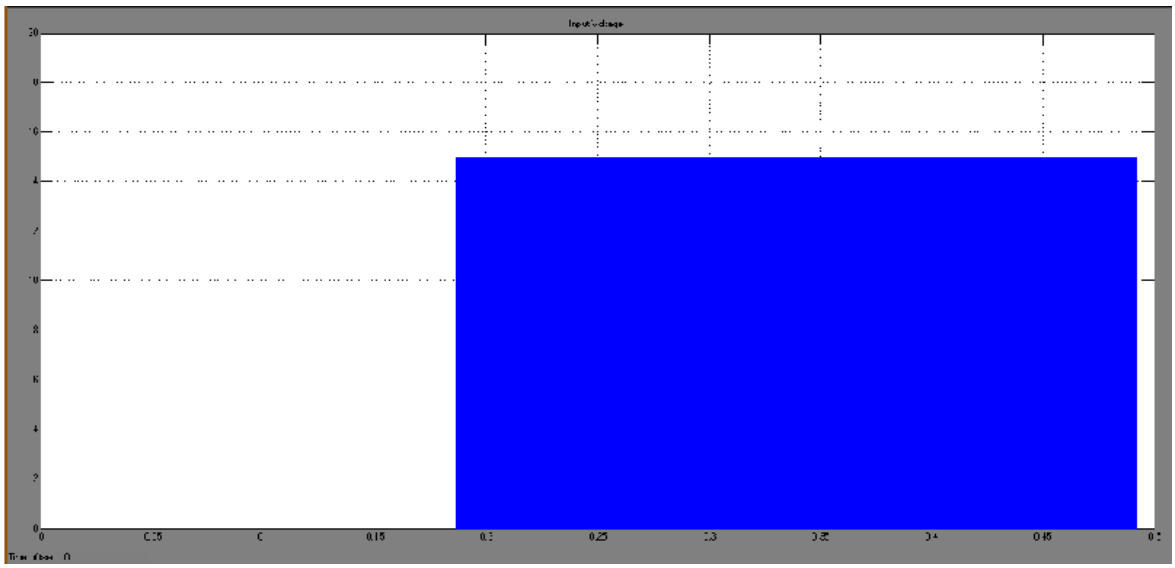

Fig No.3a Closed loop Input Voltage

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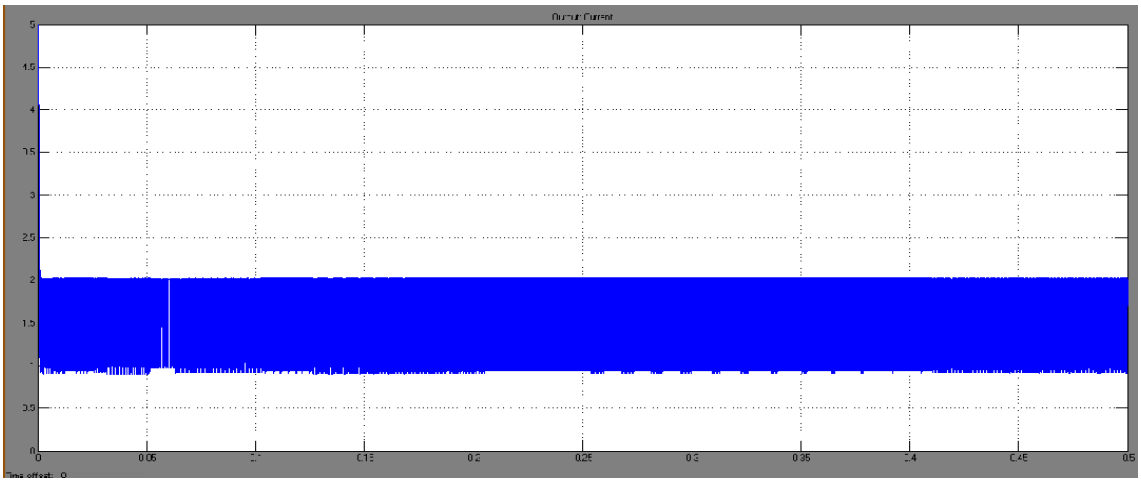

Fig No.3b Closed loop Output Current (PV)

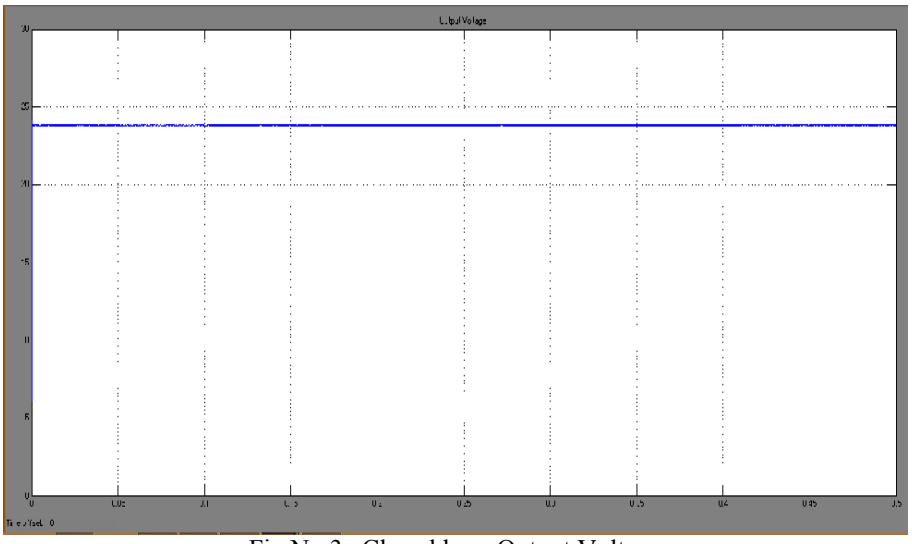

Fig No.3c Closed loop Output Voltage

IV. CONTROL ACTION OF CONTROLLER

CLOSED LOOP RESPONSE	RISE TIME	OVERSHOOT	SETTLING TIME	STEADY STATE ERROR
Kp ↑	Decrease	Increase	Small Change	Decrease
Ki ↑	Decrease	Increase	Increase	Eliminate
Kd ↑	Small Change	Decrease	Decrease	Small Change

V. CONCLUSION

Simulation of open loop and closed loop controlled boost converter system for PV system is presented in this paper. PID controller is used instead of PI controller to reduce oscillations in output voltage to achieve stabilized output voltage required for battery charging. Drawback of open loop system is overcome by using closed loop system. The closed loop system is able to maintain constant output voltage and same is used for battery charging. This converter has advantages like reduced hardware, good output voltage regulation. Thus the boost converter improves the voltage

level from 15 V to as per requirement and PID controller is capable of maintaining constant output voltage.

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