COMPARISON STUDY OF BOOST CONVERTER AND BUCK-BOOST CONVERTER FOR MAXIMUM POWER EXTRACTION FROM SOLAR SYSTEM USING MPPT CONTROLLER

[1]Jagdamba Prasad Sonkar
Department of Electrical Engineering,
M.M.M. University of Technology
Gorakhpur, U.P, India.
Email: er.jagdamba@gmail.com

[2]K.G.Upadhyay & [3]*Rajendra Singh*
Department of Electrical Engineering,
M.M.M. University of Technology
Gorakhpur, U.P, India.
Email: [3]raja03ee4444@outlook.com

ABSTRACT: : A maximum power point tracker (MPPT) play an important role in solar systems, because they improve the efficiency of solar system by increasing power output. Solar cell has non-linear voltage – current characteristic with a particular point where power produced is maximum. The output power of solar system changes with solar irradiance, temperature and so on. For increasing the power obtained from soar cell, it needs to operate solar system at maximum power point .Thus maximum power can be obtained at all operating points with MPPT controllers. MPPT controller controls the electronic dc-dc converter to provide higher power output by adjusting duty cycle of boost converter and buck-boost converter. This paper presents simulation and design of solar system with boost converter and buck-boost converter having incremental conductance maximum power point tracking (MPPT) algorithm for resistive load. MATLB simulation has been used for solar panel output power with MPPT and without MPPT controller

Keywords: Solar panel, MPPT controller, boost converter, buck-boost converter, Matlab/Simulation.

1. INTRODUCTION

The sun is the best energy source for the earth. Solar energy is the most abundant and constant stream of energy it is available directly and indirectly. A lot of solar energy falls on the surface from sun in one day. All these solar energy received from sun in one day, can satisfy the whole worlds demand for more than 20 years. Now we are able to calculate the potential of each renewable energy sources based on today's technology systems.in resent years there has been an increasing interest of using solar energy to supply electrical energy for various applications due to their many advantage, such as cleanness, no noise But output power of solar system depends on solar irradiance, , temperature.to maximize output power of solar system a high efficiency ,low cost DC-DC converter with an approximate maximum power tracking control algorithm is generally used to maintain the terminal voltage of solar panel at optimum values under various solar irradiation. [8, 9, 10]

II. SOLAR CELL MODELING

Solar cell is a device which produces electrical energy by converting solar radiation into direct current electricity using semiconductor materials. A solar panel consists of many solar cells connected in series or parallel depending on requirement. Solar cell have nonlinear voltage current (V-I) characteristics. An accurate current voltage characteristic of a solar cell is required to calculate their performance & improve efficiency of solar power generation system. The solar cells are important sources of renewable energy for electric power generation because they have relatively small size and noiseless operation. To achieve higher voltage and current multiple cells are used. The solar cell current (Ipv) is function of solar cell output voltage Vpv (V-I).The solar cell can be represented by a simple equivalent circuit. As shown in fig. The output current is function of solar radiation, temperature and coefficients. The model contains a current source Ipv, one diode and a series resistance Rs which

represents the inside each cell and in the connection between cells. [3, 5]

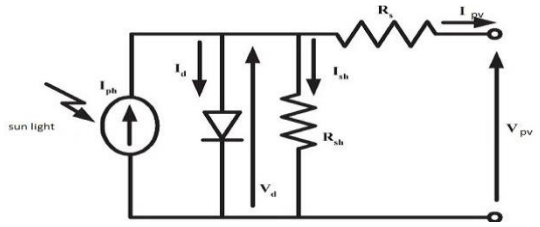

Fig1.Equivalent circuit of solar cell

$I_{pv}=I_{ph}-I_d-I_{sh}$ 1

$I_{pv}=I_{ph}-I_o e^{[q(V+IRs)/KT-1]} - (V+IR_s)/R_{sh}$ 2

Where

I_{pv} & V_{pv} : Cell output current and voltage

K : Boltzmann's constant, $1.38 * 10^{-19}$ J/K

T : Cell temperature in Celsius

q: Electron charge, $1.6*10^{-23}$ C

Rsh : Shunt resistance
Rs : Series resistance

I. MAXIMUM POWER POINT TRACKER

Maximum power point tracking (MPPT) is a control technique to maintain the terminal voltage of the PV panels so that maximum power can be obtained. A MPPT is generally used for obtaining maximum power from solar panel and transferring that power to load. A boost converter act as an interface between solar panel and load. Therefore MPPT controllers are needed to maintain the solar panel operating at its MPP (maximum power point) [1]. There are many MPPT techniques. Some important methods are given as

1) Perturb and Observe (P&O) method
2) Incremental conductance (IC) method
3) Constant Voltage method
4) Constant Current method
5) Parasitic Capacitance method

II. INCREMENTAL CONDUCTANCE METHOD

The Incremental conductance method is basically based on the fact that the slope of solar panel power (P-V) curve is zero at the maximum power point also positive on the left of the MPP (maximum power point) and negative on right of maximum power point [2].

dp/dv =0,at maximum power point
dp/dv>o ,left of maximum power point
dp/dv <0 ,right of maximum power point

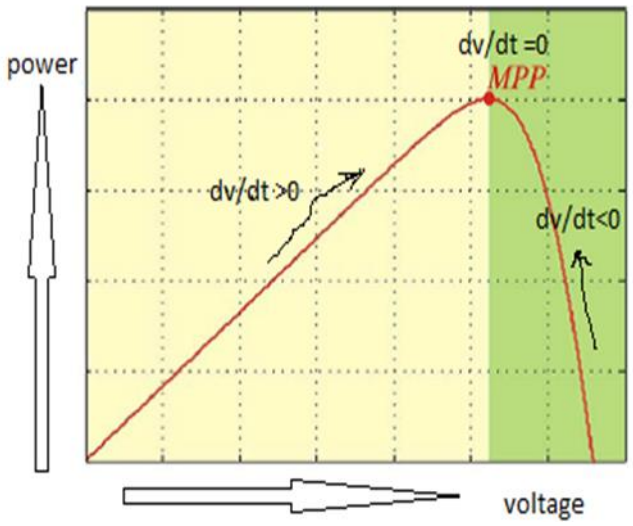

Fig2.Photovoltaic output power and photovoltaic output power derivative in function of the output voltage

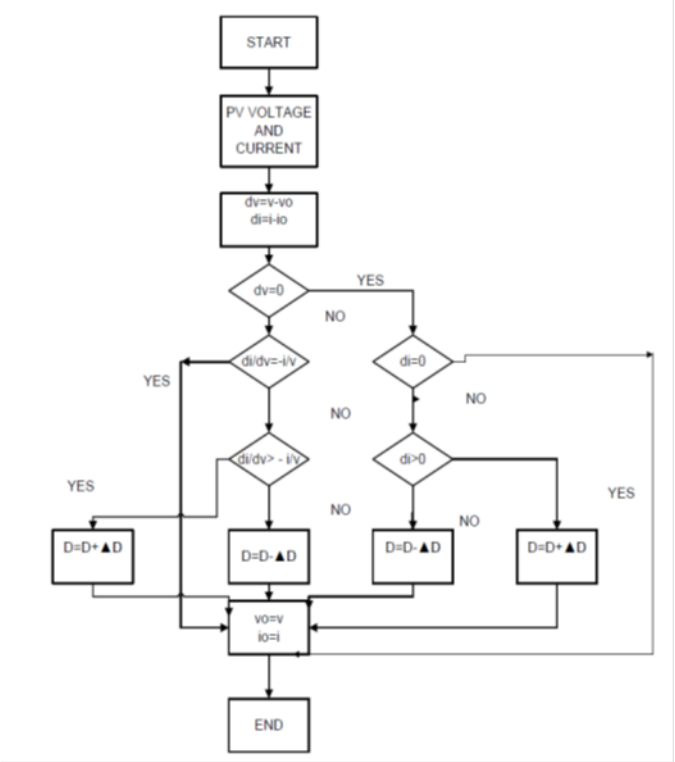

Fig3.Flowchart for Incremental conductance algorithms for MPPT controller

I. BOOST CONVERRTER

The Boost converter is also called as a step up converter. It Converts a low input voltage to high output voltage; since power must be conserved the output current is lower than the source current.

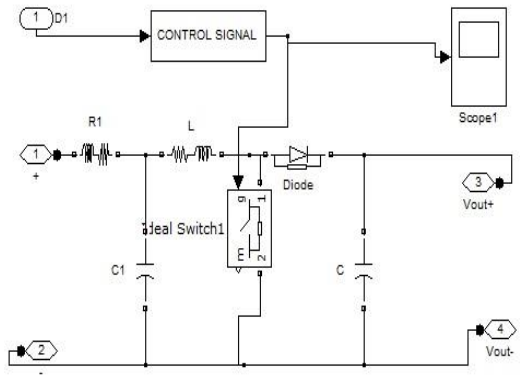

Fig4. Boost converter Simulink model

Fig4 shows the circuit diagram of boost converter. Boost converter increase the input voltage to a required output voltage magnitude without the use of a transformer .the main elements of boost converter are an inductor, a diode, high frequency switch. The output voltage can be changed by varying the duty cycle of the switch. When switch is closed and inductor gets charged by the source through the switch. The charging current is exponential in nature. When the switch is opened and a diode is forward biased now the inductor discharges and together with the source charges the capacitor and meets the load demands. The load current variation is very small and it can be assumed constant throughout the operation.

VI. BUCK-BOOST CONVERTER

A buck-boost converter provides an output voltage that may be less than or greater than the input voltage. This converter is cascade connection of step- up & step down chopper. This regulator is also known as inverting regulator.

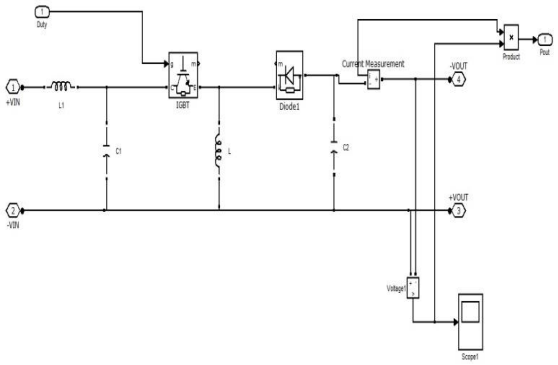

Fig5.Simulink model of buck-boost converter

Fig5 shows the circuit diagram of buck-boost converter. Buck-boost converter can increase or decrease the input voltage to a required output voltage magnitude without the use of a transformer .The main elements of buck-boost converter are an inductor, a diode, high frequency switch. The output voltage can be changed by varying the duty cycle of the switch. The load current variation is very small and it can be assumed constant throughout the operation.

VII. SIMULATION OFSOLAR PANEL MPPT DC CONVERTERS WITH R LOAD

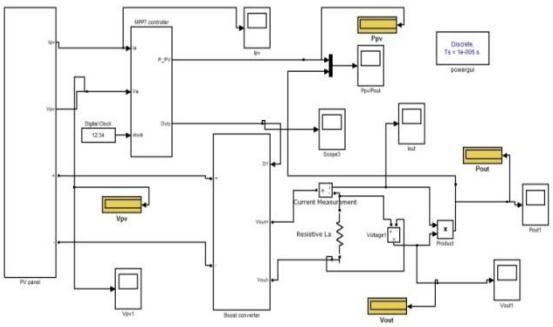

Fig6.Simulink model of solar panel system using boost converter

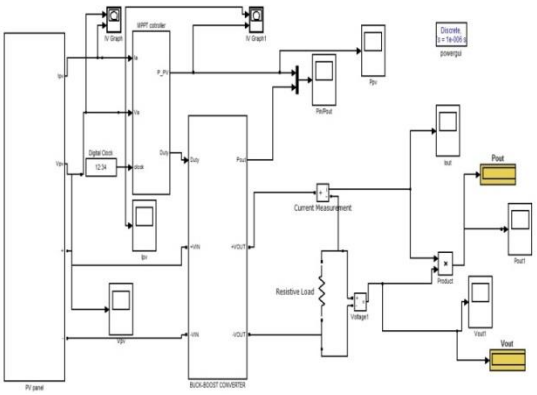

Fig7.Simulink model of solar system using buck-boost converter and MPPT converter

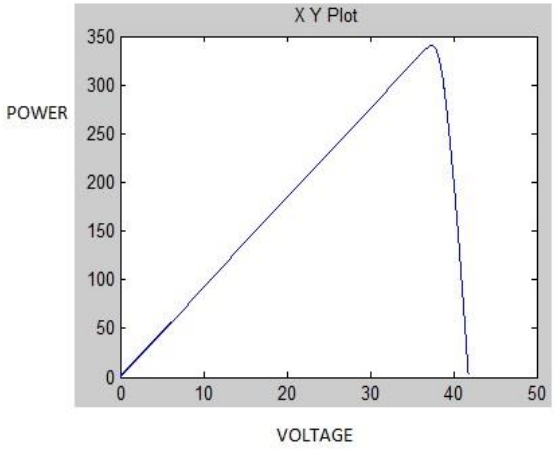

Fig8. P-V characteristics of a PV module

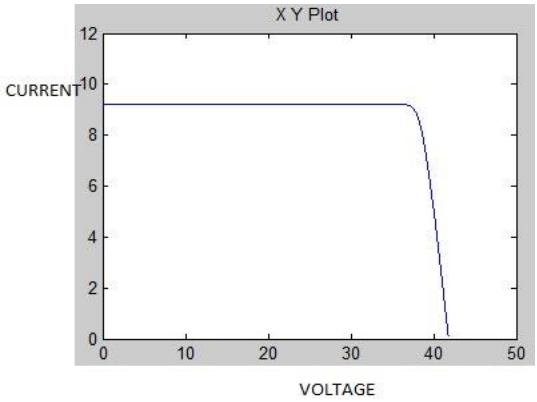

Fig9. I-V characteristics of a PV module

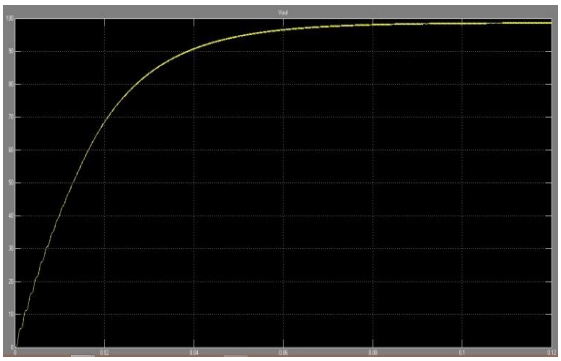

Fig10. PV output voltage with MPPT controller and boost converter

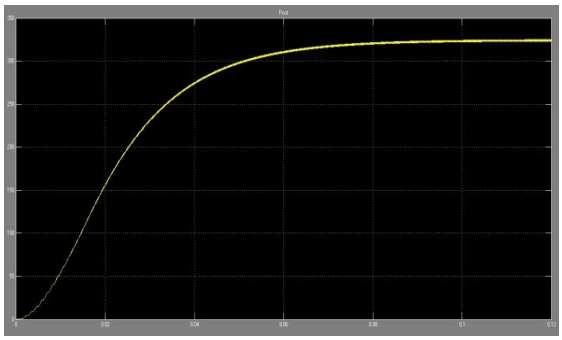

Fig11.Output power with MPPT controller and boost converter

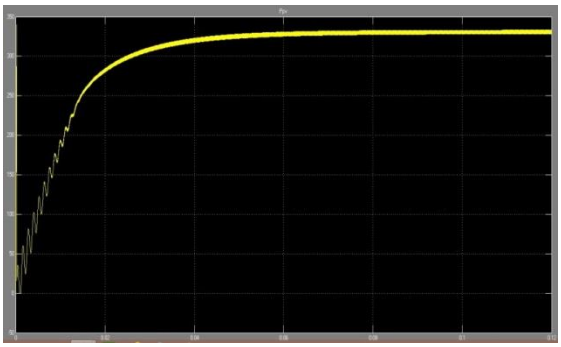

Fig12.PV output power without MPPT controller and boost converter

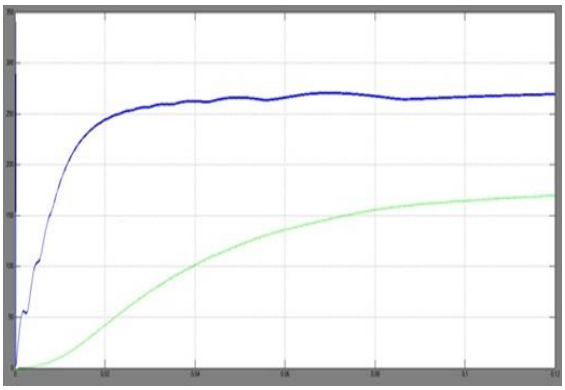

Fig13.Solar output power without MPPT controller and buck-boost converter and output power with MPPT controller having buck-boost converter.

VIII. CONCLUSIONS

According to the simulation of solar system with boost converter and with buck-boost converter having same MPPT controller utilizing Incremental Conductance method. It is concluded that MPPT controller play a important role in solar system. MPPT controller adjusts duty cycle of the boost converter and buck-boost converter on the event of any variation in irradiance to provide the maximum power possible. From simulation results solar system with boost converter provides more solar power than solar system with buck-boost converter having same MPPT controller. The MPPT method simulated is able to improve the dynamic and steady state performance of solar system.

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