Peak Power Extraction from Solar System using Boost Converter and MPPT Controller

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Abstract— A maximum power point tracker (MPPT) has important role in photovoltaic systems, because they increase the efficiency of photovoltaic system by increasing power output. Solar cell has non-linear voltage –current characteristic with a unique point where power produced is maximum. The output power of solar cell changes with solar irradiance, temperature and so on. To increase the power obtained from soar cell, it is necessary to operate solar panel at maximum power point .Thus maximum power can be obtained at all operating points with MPPT controllers. MPPT controller drives the electronic dc-dc converter to provide higher power output by adjusting duty cycle of boost converter. This paper presents simulation and design of solar system using boost converter and 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.

Key words: Solar panel, MPPT controller, boost converter, Matlab/Simulation

I. 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

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]

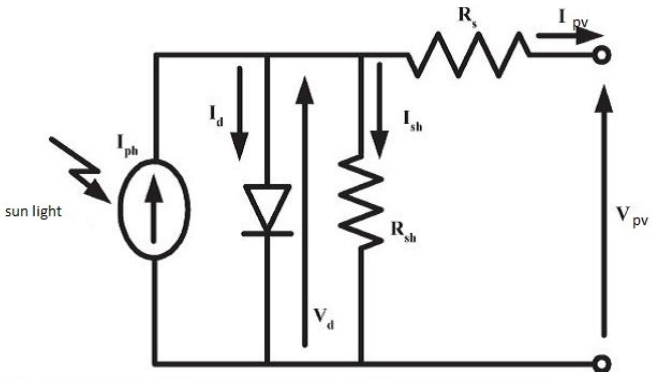

Fig. 1: Equivalent circuit of solar cell

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

III. 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

IV. 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

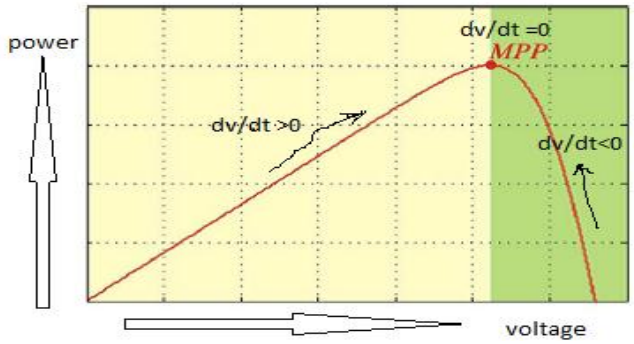

Fig. 2: Photovoltaic output power and photovoltaic output power derivativein function of the output voltage

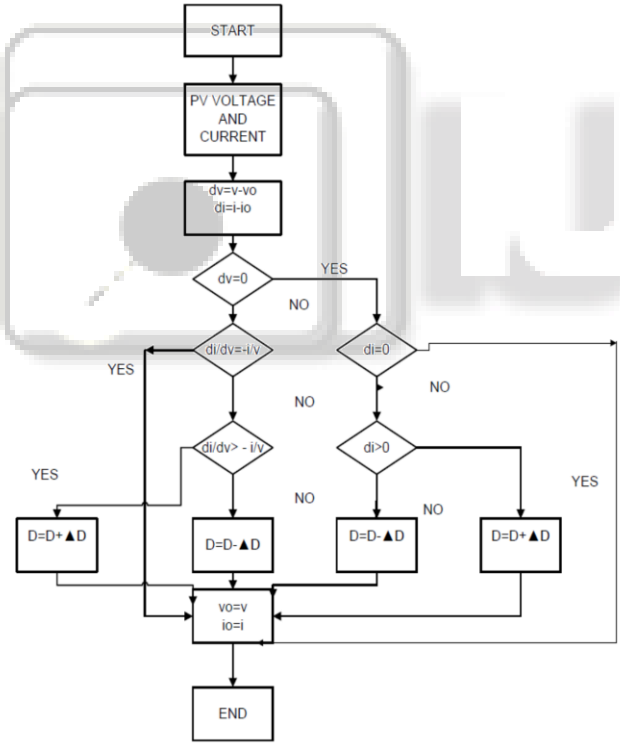

Fig. 3: Flowchart for Incremental conductance algorithms for MPPT controller

V. 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.

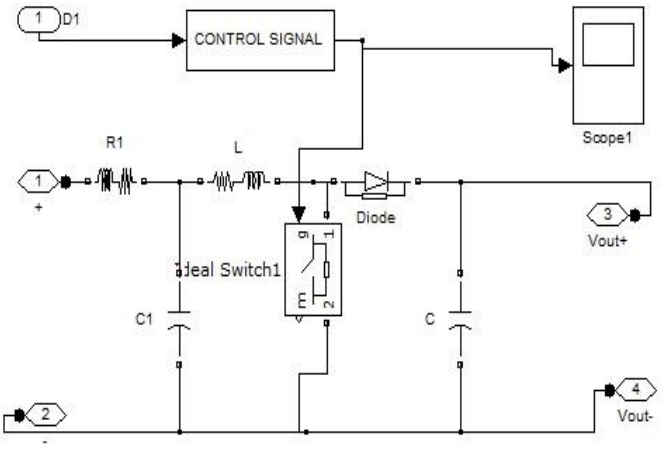

Fig. 4: Boost converter Simulink model

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. SIMULATION OF SOLAR PANEL MPPT BOOST CONVERTER WITH R LOAD

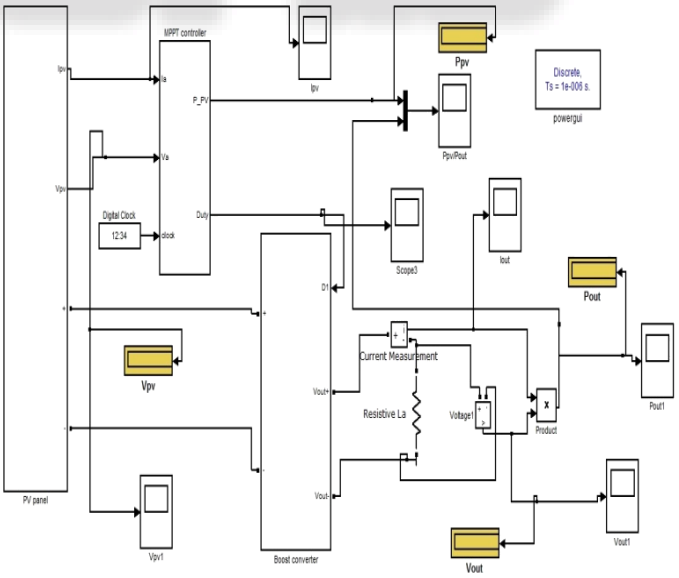

Fig. 5: Simulink model of solar panel system

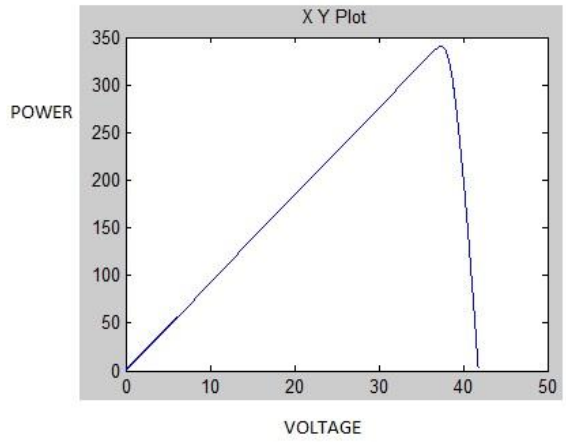

Fig. 6: P-V characteristics of a PV module

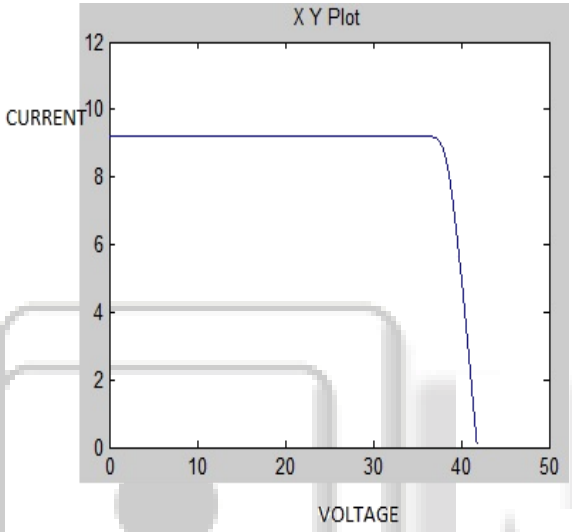

Fig. 7: I-V characteristics of a PV module

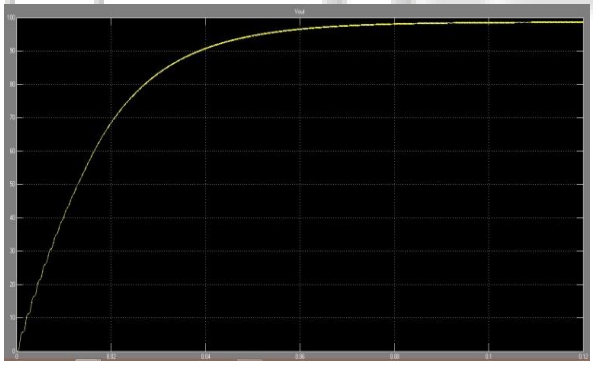

Fig. 8: PV output voltage with MPPT controller

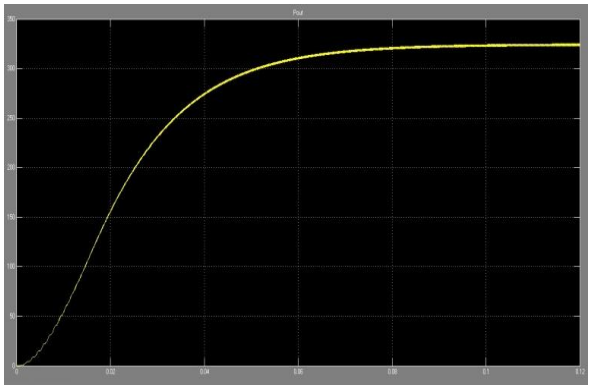

Fig. 9: Output power with MPPT controller

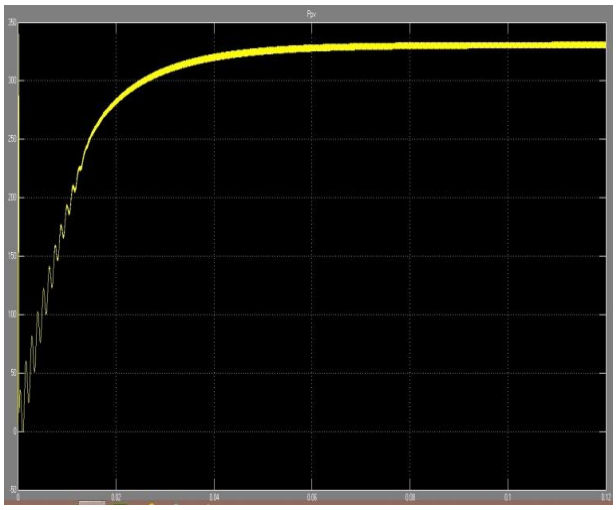

Fig. 10: PV output power without MPPT controller

Table for system parameter.

Maximum power	333W
Voltage at Pmax(Vmax)	37.5V
Warranted minimum Pmax	324W
Current at Pmax	4.2A
Short circuit current	9.2A
Open circuit voltage	41.77 V

Table 1

VII. CONCLUSION

According to the simulation of solar cell with boost converter and MPPT controller utilizing Incrementalconductance method. It can be concluded that MPPT controller play a important role in solar system. MPPT controller adjusts duty cycle of the boost converter on the event of any variation in irradiance to provide the maximum power possible. The MPPT method simulated is able to improve the dynamic and steady state performance of solar system.

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