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Convergence of pv system with Buck-Boost Converter using MPPT Techniques.

Lipika Nanda[1], Sushree Sibani Das[2]

[1]KIIT University, School of Electrical Engineering,
Patia Square, Bhubaneswar, Odisha, India
lipika2k6@gmail.com

[2]PG Scholar,KIIT University, School of Electrical Engineering,
Patia Square, Bhubaneswar, Odisha, India
sushreeshivanidas33@gmail.com

Abstract: Energy , especially alternative source of energy is vital for the development of a country. In future, the world anticipates to develop more of its solar resource potential as an alternative energy source to overcome the persistent shortages and unreliability of power supply. In order to maximize the power output the system components of the photovoltaic system should be optimized. For the optimization maximum power point tracking (MPPT) is a promising technique that grid tie inverters , solar battery chargers and similar devices use to get the maximum possible power from one or more solar panels. Among the different methods used to track the maximum power point, Perturb and Observe method is a type of strategy to optimize the power output of an array. In this method, the controller adjusts the voltage by a small amount from the array and measures power, if the power increases, further adjustments in that direction are tried until power no longer increases. In this research paper the system performance is optimized by perturb and observe method using buck boost converter. By varying the duty cycle of the buck boost converter, the source impedance can be matched to adjust the load impedance to improve the efficiency of the system. The Performance has been studied by the MATLAB/Simulink. A solar module can't transfer maximum power to the load itself due to impedance mismatch. A maximum power point tracking (MPPT) system could be employed to have the maximum power. A new MPPT system has been developed using Buck-Boost type DC-DC converter. The system is highly efficient and robust. PIC16F73 microcontroller has been used to control the DC-DC converter output. PV module output power is measured using microcontroller. The output power is compared with the previous module output power and the duty cycle of the converter is adjusted continuously to track MPP. This process repeats until the output power reaches near to the maximum power point. In this paper, a maximum power point tracking (MPPT) system is developed using two-switch non-inverting buck-boost converter. Perturb and observe (P & O) MPPT algorithm is used to transfer maximum power from the PV panel which is executed using a microcontroller.

Keywords: Maximum power point tracking, Photovoltaic system**,** Buck boost converter, Matlab

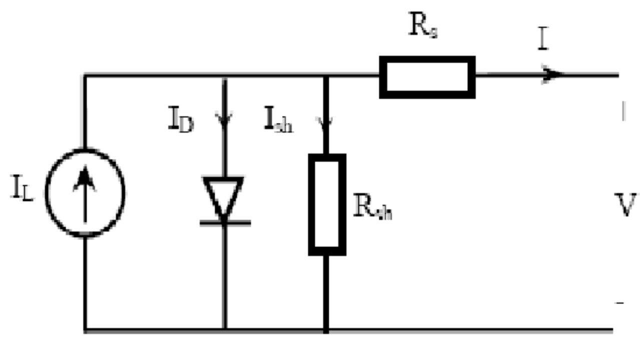
Introduction

The rapid increase in the demand for electricity and the recent change in the environmental conditions such as global warming led to need a new source of energy that is cheaper and sustainable with less carbon emissions. Solar energy has offered promising results in the quest of finding the solution ti the problem. The harnessing of solar energy using pv modules comes with its own problems that arises from the change in insulation conditions.These changes in insulation conditions severely affect the efficiency and output power of the PV modules .A great deal of research has been done to improve the efficiency of the PV modules. A number of methods of how to track the maximum power point of a PV module have been proposed to solve the problem of efficiency and products using these methods have been manufactured and are now commercially available for consumers.

As the market is now flooded with varieties of these MPPT that are meant to improve the efficiency of PV modules under various isolation conditions it is not known how many of these can really deliver on their promise under a variety of field conditions. This research then looks at how a different type of converter affects the output power of the module and also investigates if the MPPT that are said to be highly efficient and do track the true maximum power point under the various conditions .A MPPT is used for extracting the maximum power from the solar PV module and transferring that power to the load. A dc/dc converter (step up/ step down) serves the purpose of transferring maximum power from the solar PV module to the load. A dc/dc converter acts as an interface between the load and the module . By changing the duty cycle the load impedance as seen by the source is varied and matched at the point of the peak power with the source so as to transfer the maximum power. Therefore MPPT techniques are needed to maintain the PV array's operating at its MPP . Many MPPT techniques have been proposed in the literature; example are the Perturb and Observe method , Incremental Conductance methods , Fuzzy Logic Method , etc., In this research paper the system performance is optimized by perturb and observe method using buck boost converter. By varying the duty cycle of the buck boost converter, the source impedance can be matched to adjust the load impedance to improve the efficiency of the system. A solar module can't transfer maximum power to the load itself due to impedance mismatch. A maximum power point tracking (MPPT) system could be employed to have the maximum power. A new MPPT system has been developed using Buck-Boost type DC-DC converter. The system is highly efficient and robust. PIC16F73 microcontroller has been used to control the DC-DC converter output. PV module output power is measured using microcontroller. The output power is compared with the previous module output power and the duty cycle of the converter is adjusted continuously to track MPP. This process repeats until the output power reaches near to the maximum power point. In this paper, a maximum power point tracking (MPPT) system is developed using two-switch non-inverting buck-boost converter. Perturb and observe MPPT algorithm is used to transfer maximum power from the PV panel which is executed using a microcontroller.

2. PV MODULE & ARRAY CHARACTERISTICS:

Basically, PV cell is a p-n junction. When light incident on the pn junction of the solar cell, electron hole pair is generated in the depletion layer of solar cell. So if a load is connected to the terminal of solar cell, the excess charges i.e. a current flow through the load. A solar cell can be represented by a current source parallel with a diode, a high resistance and series with a small resistance as shown .



The model contains a current source , one diode, internal shunt resistance and a series resistance which represents the resistance inside each cell. The net current is the difference between the photo current and the normal diode current.
The characteristics of this module shows the current vs. voltage curve for a PV module at different irradiance show the power vs. voltage curve for a PV module at different irradiance

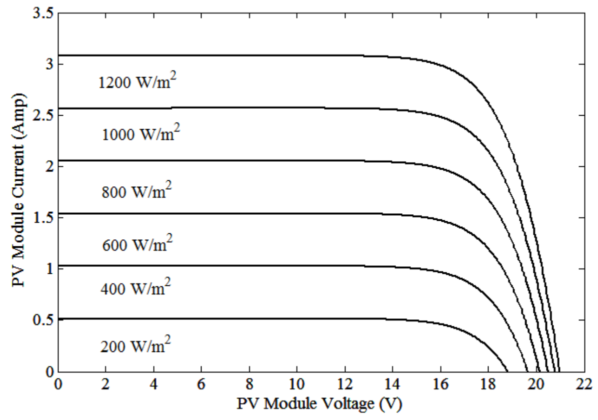


Figure 3. I-V Characteristic at different irradiance

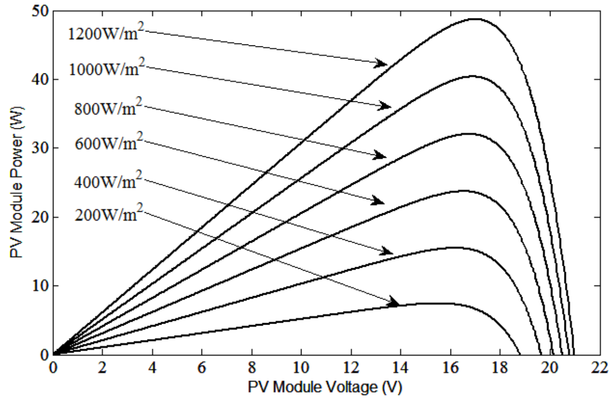


Figure 4. P-V curve at different irradiance

3. BUCK BOOST CONVERTER:

A non-inverting buck-boost converter is essentially a cascaded combination of a buck converter followed by a boost converter, where a single inductor-capacitor is used for both . As the name implies, this converter does not invert the polarities of the output voltage in relation to the polarities of the input. This converter requires the use of two active switches and is designed by combining a buck converter and boost converter design in the same topology. Due to this design this converter can work as Buck-only, Boost-only or Buck-Boost converter.

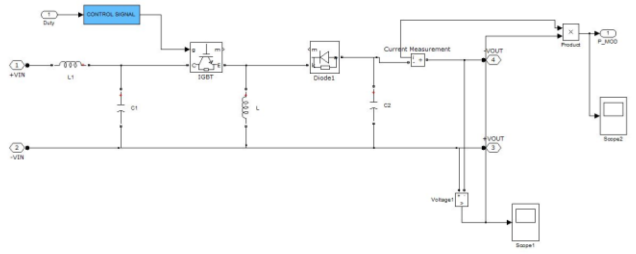
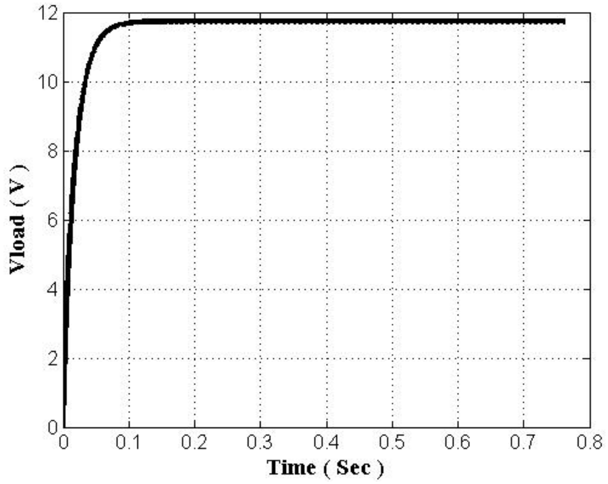


Figure 5 Matlab Model Of Buck Boost Converter.

It provides an output voltage that may be less than or greater than the input voltage –hence the name "buck-boost" ; the output voltage polarity is opposite to that of the input voltage. This regulator is also known as an inverting regulator .During Mode 1, IGBT is turn on and diode D is reversed biased. The input current , which rises ,flows through inductor L and IGBT .During mode 2 , IGBT is switch off and the current ,which was flowing through inductor L, would flow through L,C , diode and the load.The energy stored in inductor L would be transferred to the load and the inductor current would fall until IGBT is switched on again in the next cycle.



Output voltage of non-inverting buck- boost converter operating at buck mode at 60% duty cycle

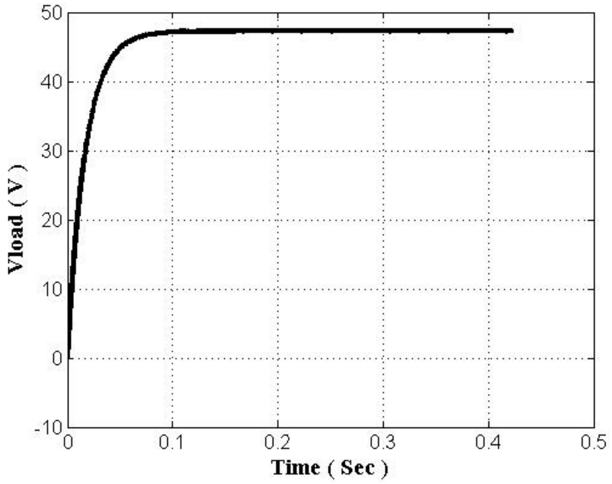


Figure 11. Output voltage of non-inverting buck -boost converter operating at boost mode at 60% duty cycle

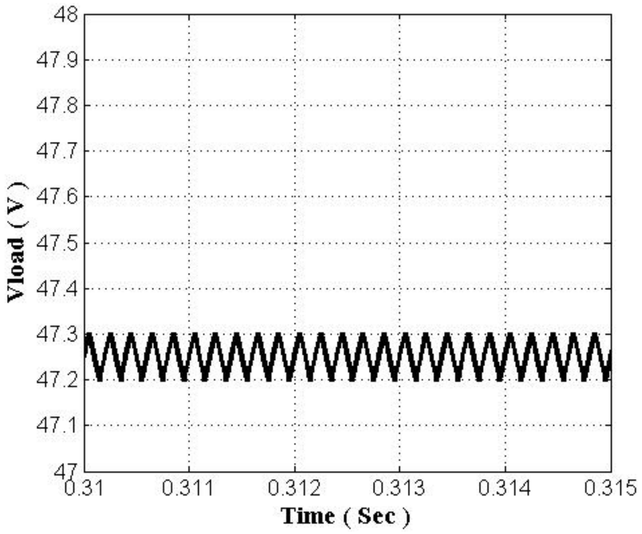


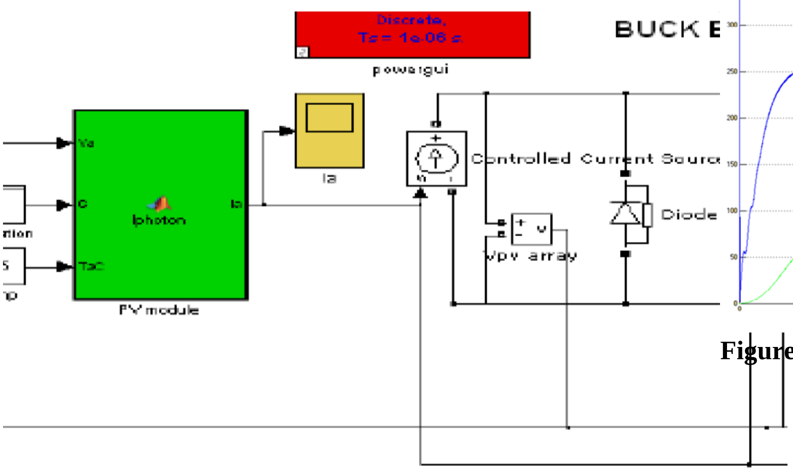
Figure 12. Output ripple voltage of non-inverting buck boost converter.

4.. MAXIMUM POWER POINT TRACKING:

There are many algorithms for maximum power point tracking. Among them P & O is most widely used algorithm. It is a kind of “hill-climbing” method. In figure 4 P-V curve is shown. In this curve, on the right side of MPP the change in power with respect to voltage dP/dV< 0 and on the left dP/dV> 0 [9].

If the operating voltage is perturbed in certain direction, if dP/dV> 0 the panels operating point is moved closer to MPP. If dP/dV< 0 the operating point of the panel moves away from the MPP. Then P & O algorithm reverses the direction of perturbation [10]. The P & O method is easy to implement and it needs lesser calculation. However, it has some disadvantages such as slow response, wrong tracking under rapid changing atmospheric condition and oscillation around MPP [10]-[12]. The flow chart of the implemented P & O algorithm .nThe algorithm works in this way. Present power P(k) is calculated using present voltage V(k) and current I(k). Then it is compared with the previous power P(k-1). If the power increases, the voltage is changed in the same direction. Otherwise the voltage direction is changed. The efficiency of a solar cell is very low. In order to increase the efficiency, methods are to be undertaken to match the source and load properly. One such method is the Maximum Power Point Tracking (MPPT). This is a technique used to obtain the maximum possible power from a varying source. In photovoltaic systems the I-V curve is non-linear, thereby making it difficult to be used to power a certain load. This is done by utilizing a boost converter whose duty cycle is varied by using a MPPT algorithm. Maximum power point plays an important role in photovoltaic system because they maximize the power output from a PV system for a given set of conditions, and therefore maximize the array efficiency. There are different methods used to track the maximum power point are 1. Perturb and Observe method, 2. Incremental Conductance method, 3. Parasitic Capacitance method and 4. Constant Voltage method Among the different methods used to track the maximum power point, Perturb and Observe method is the most widely used method in PV MPPTs and is highly competitive against other MPPT methods.. Perturb and Observe method is a slight perturbation is introduce system .This perturbation causes the power of the solar module changes. If the power increases due to the perturbation then the perturbation is continued in that direction [15]. After the peak power is reached the power at the next instant decreases and hence after that the perturbation reverses. When the steady state is reached the method oscillates around the peak point. In order to keep the power variation small the perturbation size is kept very small. The method is developed in such a manner that it sets a reference voltage of the module corresponding to the peak voltage of the module. A PI controller then acts moving the operating point of the module to that particular voltage level. It is observed that there some power loss due to this perturbation also the fails to track the power under fast varying atmospheric conditions. But still this method is very popular and simple[7].

6.SOLAR PV MODULE _MPPT BUCK BOOST CONVERTER WITH R LOAD



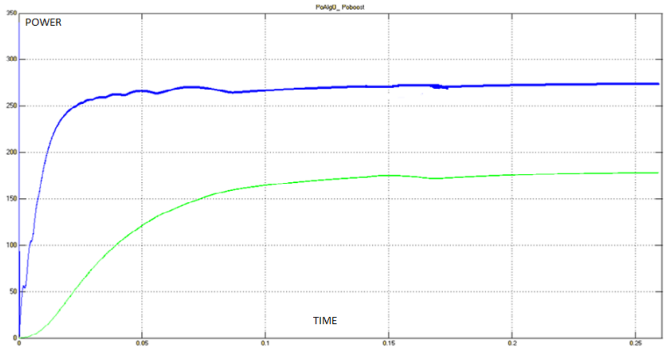
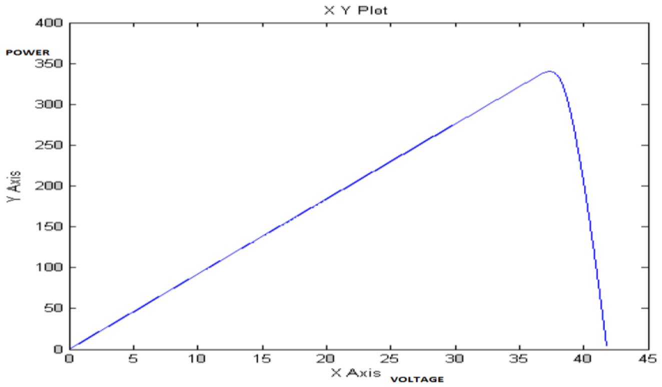


Figure 1: Testing data- load current (amperes)



V-I Plot Of Solar Cells

Table 1 .Output value for PV panel

MPPT METHOD	*Output Voltage(V)*	Efficiency(%)
Perturb and Observe	48.2	90

7.SIMULATION RESULTS:

In this paper, the simulation model is developed with MATLAB/SIMULINK. The simulation model of the proposed method is shown in Fig.5 and the waveforms are shown in fig .6. The proposed circuit needs independent dc source which is supplied from photovoltaic cell. The inputs are fed by voltage and current of the PV terminals, while the output provides duty cycle for the buck boost converter. The input voltage is 24V and the output voltage after being buck boosted up is 48.2V and shown in fig.6. Buck Boost converter controls the output voltage by varying the duty cycle *k*, of the switch and the value of k is 0.67 which is calculated using the formulae **Vo = Vs*k / 1-k.** If we vary the pulse width of the pulse generator various voltage ranges at the output can be obtained. Once the buck boost converter injected the power from the pv panel and the PID controller starts function, it varies the value of duty cycle which will change the input value that is sensed by the PID controller. By using the PID controller the error has been minimized in the system and the efficiency is improved.Table.1. below shows the output values for PV panel.

The PV cell temperature is maintained constant at 25 degree Celsius and the solar intensity is varied in steps up to the rated value of 1200W/meter square. It is seen from the figure .7 that the current slightly increase with increasing intensity thereby increasing the power output of the solar cell.

8. Conclusion:

According to the Simulink model of solar cell with boost converter and MPPT system using INC method we conclude that The MPPT controller adjusts the duty cycle of the boost converter on the event of any change in the irradiance to deliver maximum power possible.

Even though the P&O and INC method tracks the maximum power under varying atmospheric condition, the INC method tracks the maximum power efficiently than P&O method. The MPPT method simulated is also able to improve the dynamic and steady state performance of the PV system. This work proposes a two-switch non-inverting buck-boost converter based Maximum Power Point Tracking System. The proposed converter is about 94% efficient. A greater output power is achieved when MPPT system is connected to the load compared to load without MPPT system. So for higher loads low cost.

MPPT system could be a better choice to get maximum available power from the solar module

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