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MAXIMUM POWER POINT TRACKING FOR PHOTOVOLTAIC SYSTEM BY INCREMENTAL CONDUCTANCE METHOD USING BUCK BOOST CONVERTER

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ABSTRACT

Energy, especially alternative source of energy is vital for the development of a country. In future, the world anticipates developing 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, incremental conductance (INC) 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 incremental conductance (INC) 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.

KEYWORDS: Maximum power point tracking (MPPT), Photovoltaic system, Buck boost converter, Incremental conductance method(INC) , Direct current.

1. INTRODUCTION

The demand of electric power is increasing day by day. This situation has necessitated a review of the traditional power system concepts and practices to achieve greater operating flexibility and better utilization of existing power systems. Governments around the world are facing a steadily rising demand on global electric power. To face this challenge, they are striving to put in place regulatory guidelines to aid the adoption of best practices by utilities in terms of the renewable energy applications. It provides the consumers with the ability to monitor and control energy consumption. This is crucial because as the world population grows the electricity demand will also increase, but at the same time, we will need to reduce our electricity consumption to fight "*global warming*" and the*" Energy crisis"*.

According to the current rate of energy consumption, it is expected that the natural fossil fuels would deplete in 2050 and renewable energy sources has to take over the position to meet the future energy demands. Solar energy, the major renewable energy source, has the potential to become an essential component of future global energy production. Conversion of solar radiation to usable form of energy is done by solar cells (solar radiation to electrical energy).Plenty of solar PV (photovoltaic) systems are available in market, but the efficiency and the costs are the two main factors which prevent them from the accessibility of common man.

Silicon Solar cell is a semiconducting device that converts light to Electricity. Silicon solar cell is basically a p-n junction diode; sun light generates an electron-hole pairs on both sides of the junction. The generated holes and electrons diffuse to the junction and are swept away by the electric field, thus producing an electric current through the device. *Second generation cells*, also called thin-film solar cells, are significantly cheaper to produce than first generation cells but have lower efficiencies. The great advantage of second generation, thin-film solar cells, along with low cost, is their flexibility. *Third generation* solar cells are the cutting edge of solar

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technology. Third generation solar cell contains a wide range of potential solar innovations including polymer solar cells, monocrystalline cells (Quantum dot sensitized solar cell) and Dye sensitized solar cells (DSSC).

A Solar Photovoltaic (SPV) system directly converts sunlight into electricity. The basic building device of a SPV system is a SPV cell. Many SPV cells are grouped together to form the modules. Modules are normally formed by a series connection of the SPV cells to get the required output voltage. Modules with large output currents are realized by increasing the surface area of each SPV cell or by connecting them in parallel. A SPVA may be either a module or a group of modules connected in series and parallel configuration.

The output of the SPV system may directly feed the loads or may use a power electronic converter to process it. These converters may be used to serve different purposes like to regulate the variables at the load side, to control the power flow in a grid connected systems, and mainly to track the maximum power available from the source. Model of the SPV system is required to be known to study the converter and other connected system performances.

Recently, much attention has been given towards the study of Photovoltaic (PV) cells and their conversion efficiencies. It is necessary to provide PV systems with Maximum Power Point Tracking (MPPT) controllers in order to draw maximum electrical power from the PV modules under varying loads and atmospheric conditions. MPPT is very important in solar power systems because it reduces the solar array cost by reducing the number of solar panels needed to obtain the desired output power. Photovoltaic power system performance depends on local irradiance and temperature conditions.

In this thesis, the model of photovoltaic module with buck boost DC/DC controller and An MPPT controllers is developed. Energy crisis and environmental issues are driving researchers towards the development of renewable energy sources. In this context, PV energy conversion systems are gaining an increasing interest for an optimum solution. To overcome the problem of low energy conversion efficiency of system and to get the maximum possible efficiency, it is necessary to optimize the design of all PV system components. It is also necessary to provide PV systems with Maximum Power Point Tracking (MPPT) controllers in order to draw the maximum electrical power from the solar generating system under varying atmospheric conditions. MPPT is very important in solar generating system because it reduces the cost needed to obtain the desired output power. The basic structure, control design, and MATLAB/SIMULINK results are presented.

2. PHOTOVOLTAIC SYSTEM

A Photovoltaic (PV) system directly converts solar energy into electrical energy. The basic device of a PV system is the PV cell. Cells may be grouped to form arrays . The voltage and current available at the terminals of a PV device may directly feed small loads such as lighting systems and DC motors or connect to a grid by using proper energy conversion devices. This photovoltaic system consists of main parts such as PV module, charger, battery, inverter and load.

A. Basic configuration

PV array are formed by combine no of solar cell in series and in parallel. A simple solar cell equivalent circuit model is shown in figure 1 . To enhance the performance or rating no of cell are combine. Solar cell are connected in series to provide greater output voltage and combined in parallel to increase the current. Hence a particular PV array is the combination of several PV module connected in series and parallel. A module is the combination of no of solar cells connected in series and parallel.

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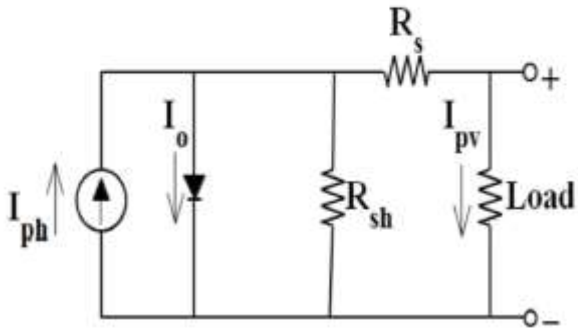

Figure 1 Circuit diagram of a single PV cell

If we draw the above model without taking the internal losses of the current into account . A diode is connected in anti-parallel with the light generated current source. The figure is shown in the figure 2.

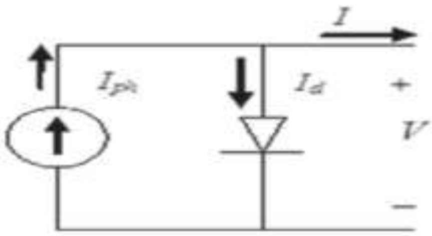

Figure 2 Ideal single diode model

The output current I is obtained by Kirchhoff law:

I = $I_{ph} - I_d$ (1)

Iph is the photocurrent, Id is the diode current which is proportional to the saturation current and is given by the equation

$$I_d = I_0 \left[e^{\left(\frac{V}{A.NS.VT}\right)} - 1 \right] (2)$$

Where V is the voltage imposed on the diode.

The expression of V_T is given by

$$V_T = \frac{K.T_C}{q} \quad (3)$$

I_0 is the reverse saturation or leakage current of the diode (A), V_T = 26 mV at 300 K for silicon cell, Tc is the actual cell temperature (K), k Boltzmann constant 1.381*10e-23 J/K, q is electron charge (1.602 * 10e-19 C).

V_T is called the thermal voltage because of its exclusive dependence of temperature. Ns: is the number of PV cells connected in series. A is the ideality factor. It depends on PV cell technology. It is necessary to underline that A is a con-stant which depends on PV cell technology. All the terms by which, V is divided in equation (2) under exponential function are inversely proportional to cell temperature and so, vary with varying conditions. In this work, this term is designed by ‘a’ and called the thermal volt-age (V), the ideality factor, is considered constant and is chosen 1 .According to technology of the PV cell. The thermal voltage ‘‘a’’ is presented by equation (4)

$$a = \frac{N_S\,.\,A\,.K\,.T_C}{q} = N_s\,.A\,.V_T (4)$$

In reality, it is impossible to neglect the series resistance Rs and the parallel resistance R_P because of their impact on the efficiency of the PV cell and the PV module. When R_S is taken into consideration, equation (2)should take the next form:

$$I_d = I_0\left[exp\left(\frac{V+IR_S}{a}\right)-1\right](5)$$

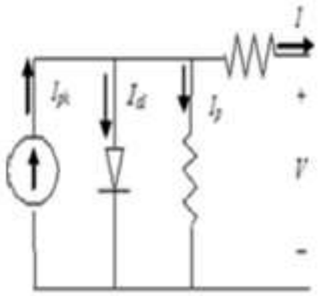

Figure 3 Practical model with Rs and Rp

By applying Kirchhoff law, current will be obtained by the equation:

$I = I_{ph} - I_d - I_P$ (6)

I_P, is the current leak in parallel resistor.

$$I = I_{ph} - I_0\left[exp\left(\frac{V+IR_S}{a}\right)-1\right]-\frac{V+IR_S}{R_P} \quad (7)$$

According to the equation (7), the output current of a module containing N_s cells in series will be:

According to Fig. 3, the output current at the standard test conditions (STC) is:

$$I = I_{ph,ref} - I_{0,ref}\left[exp\left(\frac{V}{a_{ref}}\right)-1\right](8)$$

This equation allows quantifying Iph,ref which cannot be determined otherwise. When the PV cell is short-circuited:

$$I_{sc,ref} = I_{ph,ref} - I_{0,ref}\left[exp\left(\frac{0}{a_{ref}}\right)-1\right] = I_{ph,ref} \qquad (9)$$

But this equation is valid only in ideal case. So, the equality is not correct. And then, equation (10)has to be written as:

$I_{ph,ref} \approx I_{sc,ref}$(10)

The photocurrent depends on both irradiance and temperature:

$$I_{ph} = \frac{G}{G_{ref}}\left(I_{ph,ref} + \mu_{sc}.\Delta T\right) \qquad (11)$$

G: Irradiance (W/m^2), G_{ref} : Irradiance at STC = 1000 W/m^2, $\Delta T = T_c - T_{c,ref}$ (Kelvin), $T_{c,ref}$: Cell temperature at STC = 25 + 273 = 298 K, μ_{SC} : Coefficient temperature of short circuit current (A/K), provided by the manufacturer, $I_{ph,ref}$: Photocurrent (A) at STC.

The shunt resistance R_P is generally regarded as great, so the last term of the relationship (8) should be eliminated for the next approximation. By applying equation (8)at the three most remarkable points at standard test condition: the voltage at open circuit (I = 0, V = $V_{oc,ref}$), the current at short circuit (V = 0, I = $I_{sc,ref}$), and the voltage ($V_{mp,ref}$) and current ($I_{mp,ref}$) at maximum power, the following equations can be written:

$$I_{sc,ref} = I_{ph,ref} - I_{0,ref}\left[exp\left(\frac{I_{scref}.R_s}{a_{ref}}\right) - 1\right](12)$$

$$0 = I_{ph,ref} - I_{0,ref}\left[exp\left(\frac{V_{oc}}{a_{ref}}\right) - 1\right](13)$$

$$I_{pmref} = I_{ph,ref} - I_{0,ref}\left[exp\left(\frac{V_{pm,ref} + I_{pm,ref}R_s}{a_{ref}}\right) - 1\right](14)$$

The (-1) term has to be neglected because it is very smaller than the exponential term. According to equation (11), and by substituting (Iph,ref) in equation (14):

$$0 \approx I_{sc,ref} - I_{0,ref}\left[exp\left(\frac{V_{oc}}{a_{ref}}\right)\right] \qquad (15)$$

So ;

$$I_{0,ref} = I_{s,ref}\left[exp\left(\frac{-V_{oc,ref}}{a}\right)\right] (16)$$

$$I_0 = DT_C^3 \exp\left(\frac{-q\epsilon_G}{A.K}\right) \qquad (17)$$

B. The Characteristics of A PV Cell

A PV cell, when subjected to certain levels of light intensity, gives an output in the form of voltage V (V), current I (A), and power P (W). The values of V, I and P display the performance and help in determining the characteristics of a PV cell where I-V is current - voltage and P-V is power-voltage. The PV cell gives non-linear characteristics which need to be studied and analysed while keeping in mind the factors that affect them. Figure 4 shows the characteristics of a standard PV cell. Here **Isc**is the short-circuit current, VOC is the open-circuit voltage, MPP is the maximum power point, Imp and **Vmp**are the current and voltage at MPP respectively.

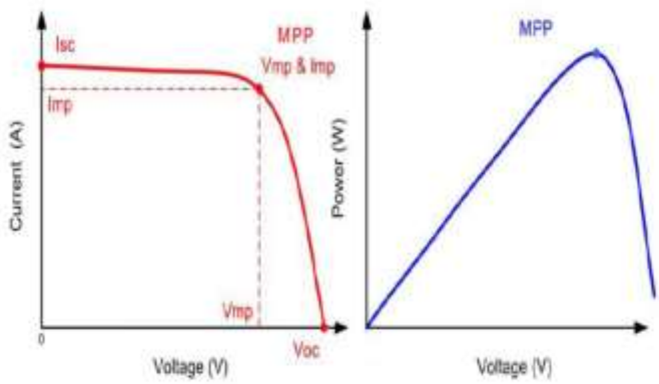

Fig 4 P-V and I-V characteristics of a PV module under STC conditions

C. Characteristics with different in temperature

The PV cell performance depends on factors such as the cell material, atmospheric and cell temperature, intensity of the sunlight, inclination angle towards the sun and the irradiation mismatch of the cells. The most important factors that affect the PV cell are: insolation and temperature, where the greater the insolation, the greater will be the output (I & V) but on the other hand, the higher the temperature of the cell, the lower the

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output voltage (V) will be. Winter weather and high altitude can also result in low insolation values and as with any other electronic device, the solar cells operate better when kept cool. Another important point to consider is that, at VOC the value of ISC is equal to zero and similarly at the point of ISC the value of VOC is equal to zero.

D. Mathematical Modeling of PV Cell

A photovoltaic cell/module is mathematically modeled using single diode equivalent circuit. The various parameters which influence the characteristic of a cell are classified as environmental parameter like irradiance and temperature, internal parameter like ideality constant, Boltzmann constant energy band-gap and charge of electron, electrical parameter like open circuit voltage, short circuit current, series resistance, and shunt resistance .

Based on current-voltage relationship of a solar cell , a mathematical model of single diode PV cell is developed .The representation of an ideal PV cell is represented by a current source and an anti parallel diode connected to it.

In order to study the photovoltaic system in distributed generation network, a modeling and circuit model of the PV array is necessary. A photovoltaic device is a nonlinear device and the parameters depend essentially on sunlight and temperature. The photovoltaic cell converts the sunlight into electricity. The photovoltaic array consists of parallel and series of photovoltaic modules. The cell is grouped together to form the panels or modules. The voltage and current produced at the terminals of a PV can feed a DC load or connect to an inverter to produce AC current. The model of photovoltaic array is obtained from the photovoltaic cells and depends on how the cells are connected.

The basic equation from the theory of semiconductor to describe mathematically the I-V characteristic of the ideal photovoltaic cell. It is a semiconductors diode with p-n junction.

The equations that give the behavior of the PV are:

Delta T=T-Tb; (18)

Delta a S=S/Sb-1; (19)

I sc_ new=I sc*S/S b *(1+a*delta T) ;(20)

I m _new=I m*S/S-b*(1+a*delta T) ; (21)

V o-c _new=Voc*(1-c*delta T)*log (e + b*delta S); (22)

V m _new=V m*(1-c*delta T)*log (e + b*delta S); (23)

C2 = (V m _new/Voc_new-1)*(log(1-Im_new/I sc _new))^(-1); (24)

C1 = (1-Im_new/I sc _new)*exp(-V m/C2/Voc _new); (25)

y=Isc_new-C1*I sc _new*(exp(V/C2/Voc _new)-1); (26)

Where a=0.0025; b=0.5 ; c=0.00288 ; e = 2.7183 ;

T: actual temperature
Tb: reference temperature

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S: actual solar irradiation
S b: reference solar irradiation
I sc: short circuit current
V o-c: open circuit voltage
V: voltage at maximum power
I m: current at maximum power

3. BUCK BOOST CONVERTER

The buck-boost DC-DC converter offers a greater level of capability than the buck converter or the boost converter individually. It as expected extra components may be required to provide the level of functionality needed.

There are several formats that can be used for buck-boost converters:

- $+V_{in}, -V_{out}$:- This configuration of a buck-boost converter circuit uses the same number of components as thesimple buck or boost converters. However this buck-boost regulator or DC-DC converter produces a negative output for a positive input. While this may be required or can be accommodated for a limited number of applications, it is not normally the most convenient format.

When the switch in closed, current builds up through the inductor. When the switch is opened the inductor supplies current through the diode to the load. Obviously the polarities (including the diode) within the buck-boost converter can be reversed to provide a positive output voltage from a negative input voltage.

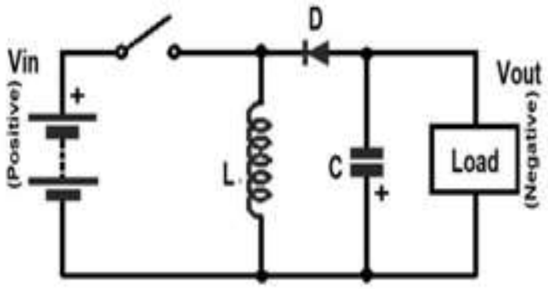

Fig. 5: DC/DC Buck Boost-Converter (negative type)

- $+V_{in}, +V_{out}$:- The second buck-boost converter circuit allows both input and output to be the same polarity. However to achieve this, more components are required. The circuit for this buck boost converter is shown below.

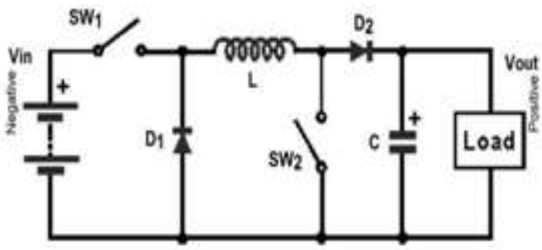

Fig. 6: DC/DC Buck Boost-Converter (Positive Type)

In this circuit, both switches act together, i.e. both are closed or open. When the switches are open, the inductor current builds. At a suitable point, the switches are opened. The inductor then supplies current to the load through a path incorporating both diodes, D_1 and D_2 .

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A . Operation of Buck-Boost Converter

The general configuration of Buck-Boost converter is shown in figure 3.10. A buck-boost Converter can be obtained by cascade connection of the two basic converters:

- the step down converter
- the step up converter

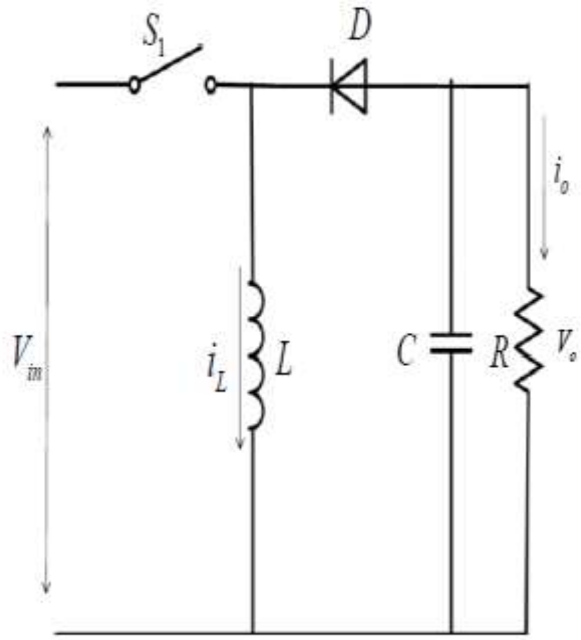

fig 7: configuration of a buck boost converter

The circuit operation can be divided into two modes:

During **mode 1** (Figure 8), the switch $S_1$is turned on and the diode D is reversed biased. In mode 1the input current, which rises, flows through inductor L and switchS_1.

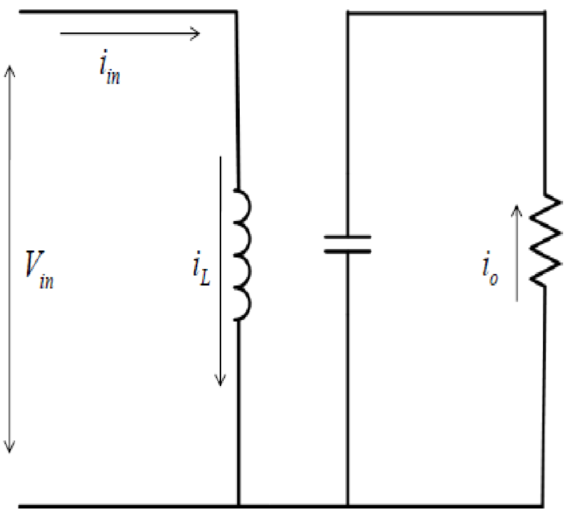

Figure 8: Buck Boost Converter in mode 1

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In **mode 2**(Figure 9), the switch$S_1$is off and the current, which was flowing through the inductor, would flow through *L*, *C*, *D* and load. In this mode the energy stored in the inductor (L*)* is transferred to the load and the inductor current (i_L) falls until the switch S_1 is turned on again in the next cycle.

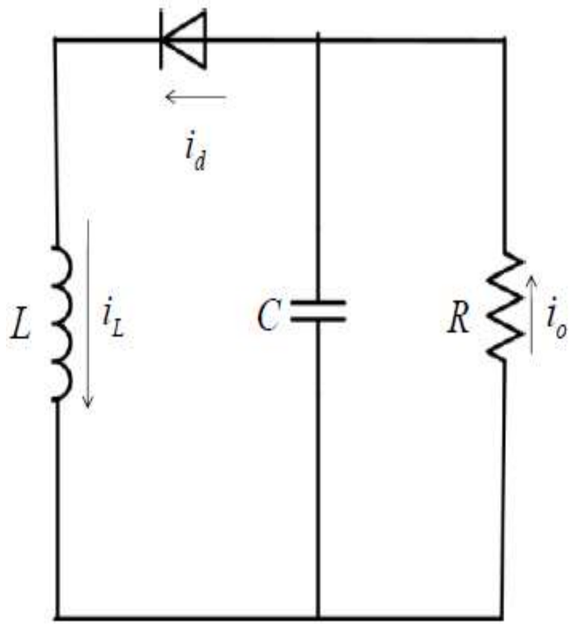

Figure 9: Buck Boost Converter in mode 2

The waveforms for the steady-state voltage and current are shown in Figure 10.

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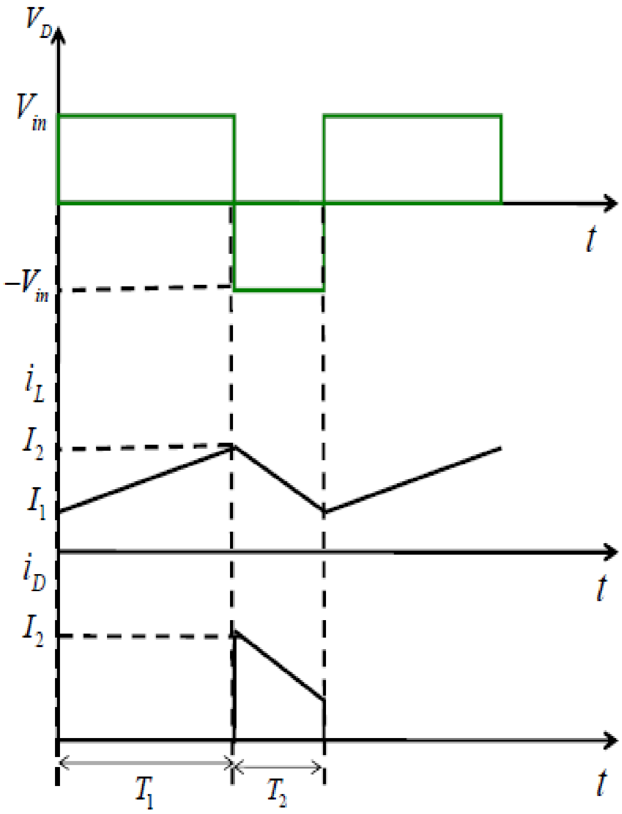

Figure 10: Current and voltage waveforms of Buck Boost Converter

Here,

V_d is the voltage across the diode
i_d is the current through the diode
i_L is the current through the inductor

4. MAXIMUM POWER POINT TRACKING

Energy crisis and environmental issues are driving researchers towards the development of renewable energy sources. In this context, PV energy conversion systems are gaining an increasing interest for an optimum solution. To overcome the problem of low energy conversion efficiency of system and to get the maximum possible efficiency, it is necessary to optimize the design of all PV system components. It is also necessary to provide PV systems with Maximum Power Point Tracking (MPPT) controllers in order to draw the maximum electrical power from the solar generating system under varying atmospheric conditions. MPPT is very important in solar generating system because it reduces the cost needed to obtain the desired output power.

A. Design principle of maximum power point tracking

Maximum power point plays an important role in PV energy conversion system because they maximize the power output from a PV system for a given set of conditions, and therefore maximize the system 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
4. Constant Voltage method
5. Constant current method
6. Fuzzy logic

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7. Neural network
8. Ripple correlation control

Among the different methods used to track the maximum power point, Incremental Conductance method is used as MPPT techniques for the test system.

B. Maximum Power Point Tracking

An effective control algorithm provides the key to delivering power efficiently to the battery. Regular charge controllers that do not feature the control algorithm act as line regulators. If excess power is drawn from the source, the circuit dissipates 20% to 60% of the extra power through an ohmic load, resulting in heat release and ultimately a waste of excess energy.

The current standard controller is the maximum power point tracker (MPPT). A variety of MPPTs are commercially available with 94% - 98% efficiency regarding the energy required to run the controller components. In order for the MPPT to control the switch of the switching-power supply effectively, the algorithm employed must be suitable for the desired use.

C. Incremental Conductance method

This method uses the incremental conductance dI/dV to compute the sign of dP/dV. When $dI/dV$is equal and opposite to the value of I/V (where dP/dV=0) the algorithm knows that the maximum power point is reached and thus it terminates and returns the corresponding value of operating voltage for MPP. This method tracks rapidly changing irradiation conditions more accurately than P&O method. One complexity in this method is that it requires many sensors to operate and hence is economically less effective.

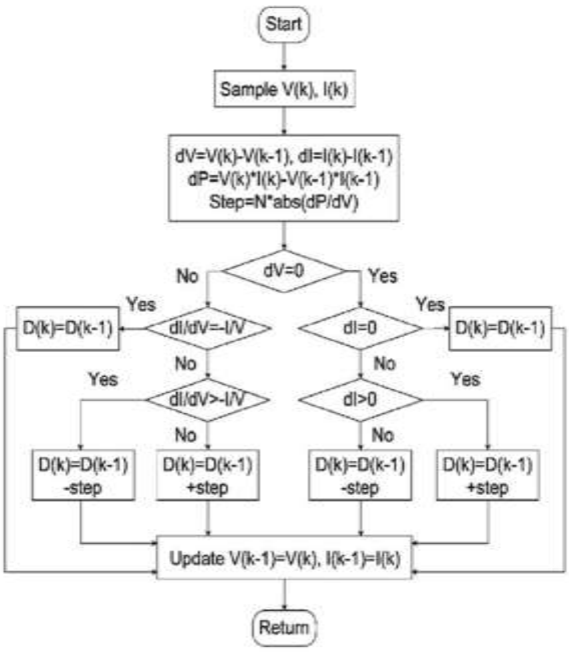

Fig 11 : Flow chart of INC algorithm

Implementation of Incremental Conductance method is done through Matlab programming. The output voltage and current from the source are monitored upon which the MPPT controller relies to calculate the conductance and incremental conductance and makes its decision by increasing or decreasing duty ratio output. The program flow chart for this algorithm is shown in Fig 11. The operating output current (Iin (k)) and voltage (Vin (k)) are measured from the solar panel. The incremental changes dV and dI are approximated by comparing the most recent measured values for (Vin (k)) and (Iin (k)) with those measured in the previous cycle (Vin (k - 1)) and (Iin (k - 1)). Then G and ΔG are computed as shown above . From equation 3.7, if dP/dV = 0 (i.e. G = ΔG) is

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true, then the system operates at the MPP and no change in operating voltage is necessary, thus the adjustment step is bypassed i.e. no adjustment for the duty ratio and the current cycleends. If equation 3.7 is false, equation 3.6 and 3.8 are used to determine whether the system is operating at a voltage greater or less than the MPP voltage and hence to increase or decrease the duty ratio by a step-size of some value accordingly.

If the system is operating at the MPP during the previous cycle, the incremental change of the operating voltage is zero (dV = 0). This would lead to a division by zero i.e. ΔG = dI ÷dV = dI ÷0, which is impossible for calculation. To avoid this, the condition (dV = 0) is checked first and if true leads to another branch in the algorithm with further tests on possible changes of the panel's operating conditions. Since the voltage dV = 0, that means the voltage has not changed; now the only useful information about possible changes are found from the current measurement. If dI is equal to zero, the operating conditions have not changed and therefore the adjustment of the system voltage is bypassed. If dI> 0, the duty ratio is increased by step size and if dI< 0, the duty ratio is decreased by step size. The program then returns and starts tracking again until the MPP is reached. The maximum duty cycle ratio is set at 90% and the minimum is at 10% and hence contributes to the efficient power transfer of the converter.

5. SIMULATION RESULTS

A model is constructed in MATLAB Simulink to create a standalone PV generated system . The samples of the various waveforms are taken for further analysis. The simulink model is given by figure 12.

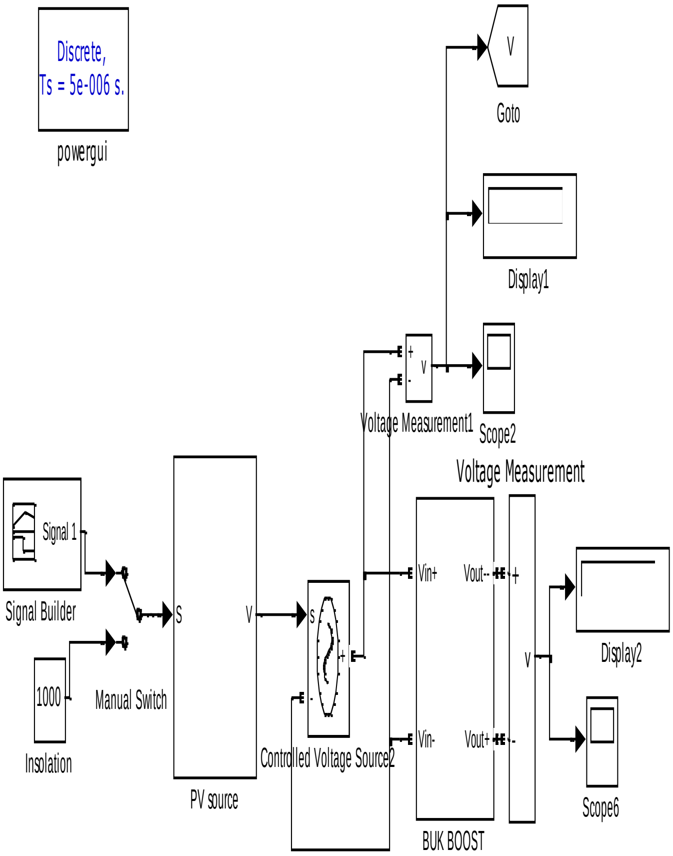

Figure 12 Simulink model of the solar generating system

A. Simulink diagram of photovoltaic module

The simulation of photovoltaic module is done in the mat lab Simulink environment. Here all the equation required for mathematical modeling of photovoltaic module as explained in previous chapter is simulated step

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by step using mat lab software. The Simulink model of mathematical equation of the test photovoltaic system is shown in the figure 13.

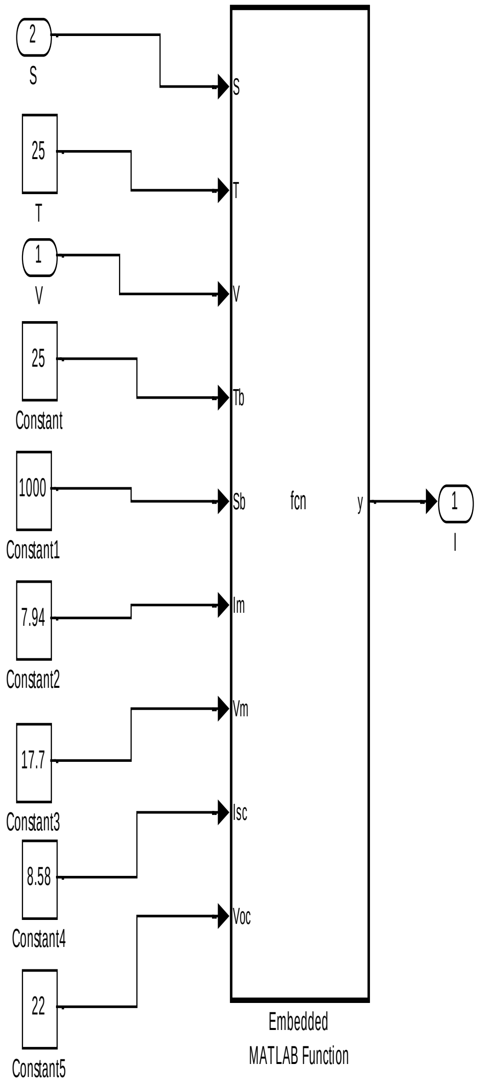

Fig. 13Simulink model of PV module

The PV system is simulated both for constant input such as temperature and solar irradiation ,and also simulated with variable input .The PV cell performance depends on both factors atmospheric and cell temperature, intensity of the sunlight , greater the intensity, the greater will be the output (I & V) but on the other hand, the higher the temperature of the cell, the lower the output voltage (V) will be. Another important point to consider is that, at VOC the value of ISC is equal to zero and similarly at the point of ISC the value of VOC is equal to zero **.**

B. Simulink model of buck-boost converter

The simulation of buck boost converter is done in the mat lab simulink environment. Here a IGBT switch is used to model the buck boost converter. The simulink model of the proposed switching converter is shown in the figure 14.

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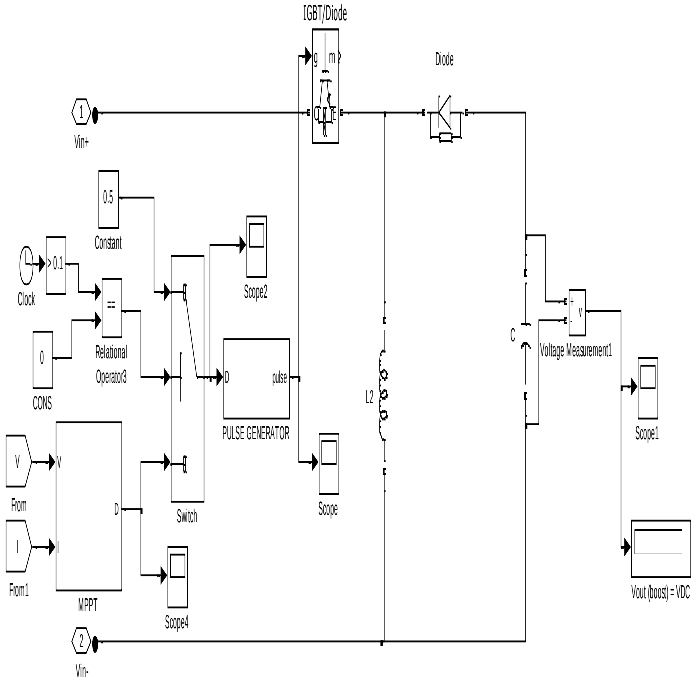

Figure 14 Buck - Boost simulink model

The gate pulse of a IGBT switch is controlled with the help of MPPT technology. Here in proposed topology the incremental conductance method is used as an MPPT method. As per the previous chapter, the advantage of using this method to track MPP is that it is more efficient than the P&O method in a way that it is able to correctly locate the operating point of the PV array. There is a tradeoff between the power efficiency and reliability of tracking MPP. Since the P&O method will move away from the power operating point under rapidly changing light condition and not be able to go back to the maximum operating point quickly, this will lead to the inefficient use of the PV array and hence this affects the whole system performance of tracking MPP. Other advantage of using this method is it does not depend on the device physics. In figure 5.4 the simulink model of incremental conductance (INC) based MPPT is shown.

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C. Simulink model of MPPT

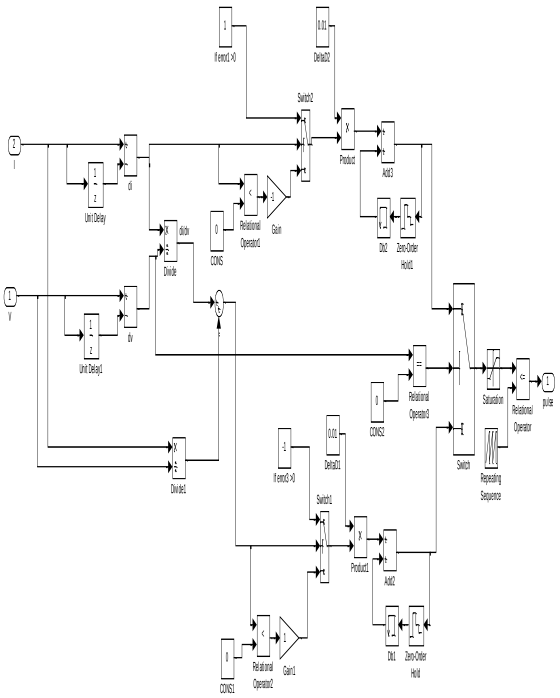

Figure 15 MPPT simulink Model with INC algorithm

First the output voltage (V) and output current (I) of a solar module is sensed which are the inputs of the MPPT block. Then the change in voltage (dV) and change in current (dI) are calculated. With the help of mathematical block the value of $\frac{dI}{dV}$ is determined which is used to generate the reference signal by using MPPT INC algorithm which is compared with a repeating sequence signal to provide required gate pulse for the IGBT switch.

Mathematics of the Incremental Conductance method is discussed below. The output power from the source can be expressed as

We know,

$$P = V * I \quad (27)$$

$$\frac{dP}{dV} = \frac{d(VI)}{dV} \quad (28)$$

$$\frac{dP}{dV} = I\frac{d(V)}{dV} + V\frac{d(I)}{dV} \quad (29)$$

$$\frac{dP}{dV} = I + V\frac{d(I)}{dV} \quad (30)$$

$$\left(\frac{1}{V}\right)\frac{dP}{dV} = \left(\frac{I}{V}\right) + \frac{d(I)}{dV} \quad (31)$$

But conductance G = $\frac{I}{V}$,
And the incremental conductance ΔG = $\frac{dI}{dV}$

It is learnt that the operating voltage is below the voltage at the maximum power point if the conductance is larger than the incremental conductance and vice versa. The job of this method is therefore to search the voltage operating point at which the conductance is equal to the incremental conductance. These ideas are expressed by equations 32, 33, 34 and are graphically shown in Fig 16.

$$\frac{dP}{dV} < 0 \quad ; \text{if } G < \Delta G \qquad (32)$$
$$\frac{dP}{dV} = 0 \quad ; \text{if } G = \Delta G \qquad (33)$$
$$\frac{dP}{dV} > 0 \; ; \text{if } G > \Delta G \qquad (34)$$

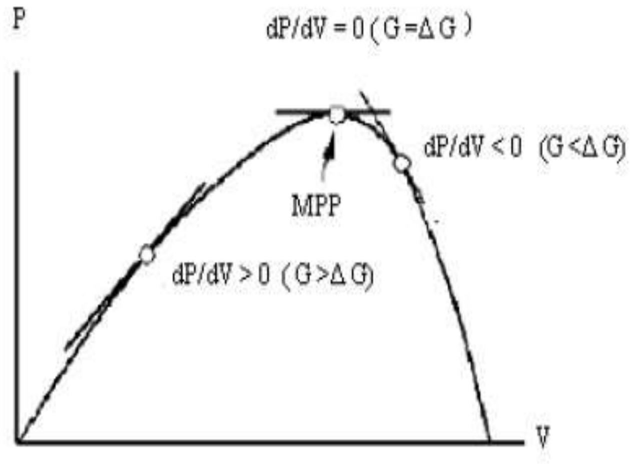

Fig: 16 The P-V curve

6. CONCLUSION

In the Present Work, the maximum power point tracking is successfully carried out by this research using Incremental conductance (INC) method. The PV module working on photovoltaic effect actually improves the system efficiency. Compared to other methods of maximum power point tracking, the Incremental conductance (INC) method seems to be easy for the optimization of the photovoltaic system 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 which improves the efficiency of the system. The Performance has been studied by the MATLAB/Simulink. In future, the maximum power point tracking could be carried out without the use of controllers in order to reduce the cost and complications of hardware can be removed.

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