# Simulation of Maximum Power Point Tracking For PV System with Boost Converter

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**Abstract -** *The rapid increase in the demand for electricity and shortage of fossil fuels we had to pay attention towards renewable energy, solar energy is one of the most popular renewable sources as it is considered pollution free, freely accessible and requires minimum maintenance. In this paper feasibility is checked by using machine learning (ML) which is based on MPPT techniques to utilize maximum power of PV system. Photovoltaic (PV) systems have been used for past several decades. Now a day, with a focus on the green sources of power, PV has become an important source of power for a wide range of applications. Converting light energy into electrical energy, with reduction in costs, helped to create its growth. Despite high efficiency and low cost, our goal is to get maximum energy form solar PV.*

***Key Words***: Photovoltaic Cell, Hill Climbing, Solar Irradiation, Maximum Power Point Tracking, Boost converter.

## 1 .INTRODUCTION

The power generated by a PV system of one or more photovoltaic cells depends on the irradiance, temperature, and the current drawn from the cells. Maximum Power Point Tracking (MPPT) is being used to drawn the maximum power from solar PV systems. The benefits derived from MPPT are such as supply the grid, to charge the batteries and powers the motor. In such applications, the load demands more power than the PV system can generate. In this situation, Maximize the power is drawn by power conversion system from the PV system. There are many type of technique to maximize the power from a PV system, these techniques may be from using simple voltage relationships to more complex multiple sample based analysis. all are Depended on the dynamics of the irradiance.

### 1.1 Solar cell

Solar cells are the fundamental components of photovoltaic panels. A solar cell is an electrical device, made up of silicon cell that converts light energy into electrical energy by the photovoltaic effect. which is a physical and chemical phenomenon. These cells may be connected in series and parallel as well. Each solar cell provides 0.5 - 0.6 volts at 25°C (typically around 0.58V) no matter how big they are.

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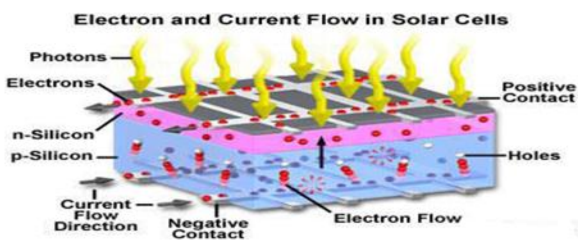
### 1.2 Operating Principle

When light falls on the p-n junction, the light photons can easily penetrate very thin p-type layer easily move inside the junction. Due to which electron-holes pair is formed by the sufficient amount of energy of photon. When light fall on junction it breaks the thermal equilibrium condition of the junction. The free electrons in the depletion region can quickly enter in the n-type side of the junction. Similarly, the holes within the depletion will quickly return to the p-type aspect of the junction. Once, the newly generated free electrons enter in the n-type side, it is not able to cross the junction due to barrier potential of the junction.

Similarly, the newly generated holes once enter in the p-type. It is not able to cross the junction became of same barrier potential of the junction. As the amount of electrons increases on one side, i.e. n-type side of the junction and amount of holes increases more on another side, i.e. the p-type side of the junction, the p-n junction will act as battery cell. A voltage is generated which is called photo voltage. If small load is connected across the junction, there will be a small amount of current flowing through it. Mostly cells are made of silicon but sometimes other materials can also be used. Solar cells work on the photoelectric effect i.e. conversion of electromagnetic radiation into electrical current. The incident radiation generates charge particles which are separated conveniently to flow an electrical current by a suitable design of the structure of the solar cell, as will be mentioned in brief below. A solar cell is basically a p-n junction which is made up of two different kind layers of silicon doped with a small amount of impurity atoms: in case of n layer, atoms with one more valence electron, called donors, and in the case of the p-layer, with one less valence electron, known as acceptors. When the two layers are combined together, near the interface the free electrons of the n-layer are diffused in the p-side, leaving behind an area positively charged by the donors. Similarly, the free holes in the player are diffused in the n-side, leaving behind a region negatively charged by the acceptors. An electrical field is created between the two sides which act as a potential barrier for further flow. The equilibrium is takes place at the junction while the electrons and holes are unable to cross that potential barrier and results are that they cannot move. The electrons and holes are pulled out in opposite directions by electric field so it makes the current to flow in one side only: the movement of electrons from the p-side to the n-side and the movement holes in the opposite direction. A diagram of the p-n junction illustrated the effect of the electric field is shown in Figure 1.



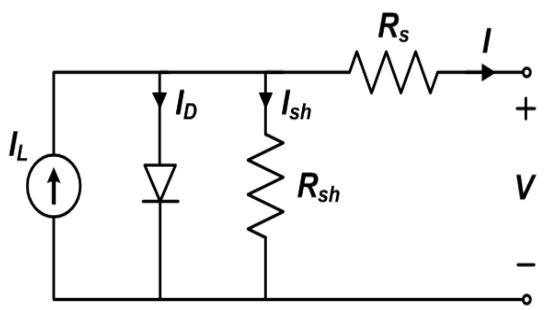




*Figure 2: Equivalent circuit of a solar cell*

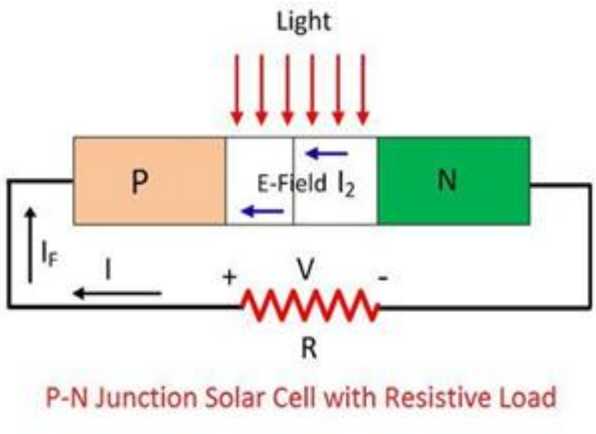



*Figure 1.: Solar cell*

Metallic contacts are inserted at both sides for collecting the electrons and holes so current can flow. In case of the n-layer, which is facing the solar irradiance, the contacts are many metallic strips, as they must allow the light ray to pass to the solar cell, called metallic rods.

The light ray incident on the silicon made semiconductor material may be absorbing or reflected through it. The semiconductor material is used to form PV cell whose conductivity lies between conductor and insulator. This action of semiconductor material is responsible to convert the light energy into electric energy efficiently.

The electrons of the material initiate emitting when the semiconductor material absorbs light. This happens because of light consists small energise packet, called photons. Electron are energised by absorbing the photon and starts moving into the material. Due to impact of an electric field, the particles is moved only in either direction and current starts to flow. The current goes out through the semiconductor metallic electrodes. Consider the figure below shows the PV cell made of silicon and the resistive load is connected across it. The PV cell consists two layer first is P and second is N-type layer of semiconductor material. When these layers are joined together then P-N junction is formed.

## 2. EASE OF USE

The basic aim is to study MPPT and successfully execution of MPPT algorithms either in code form or using the Simulink/Simscape model. Modelling of the solar cell in Simscape/Simulink and interfacing both with the MPPT algorithm to gain the maximum power point operation will be of prime importance. After simulating our result with the help of Simulink/Simscape we would like to implement it on hardware using Field Programmable Gate Array (FPGA).

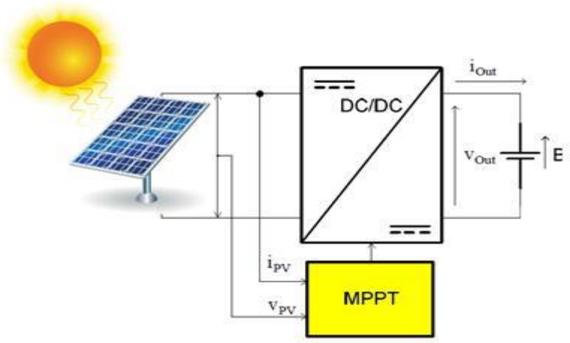



*Figure 3: MPPT Technique with Solar Cell*

### 2.1 Abbreviations and Acronyms

AC - Alternating Current
DC - Direct Current
IGBT - Insulated Gate Bipolar Transistor
LED - Light Emitting Diode
MOSFET – Metal Oxide Semiconductor Field Effect Transistor
RTI - Real Time Interference
SOA -Safe Operating Area

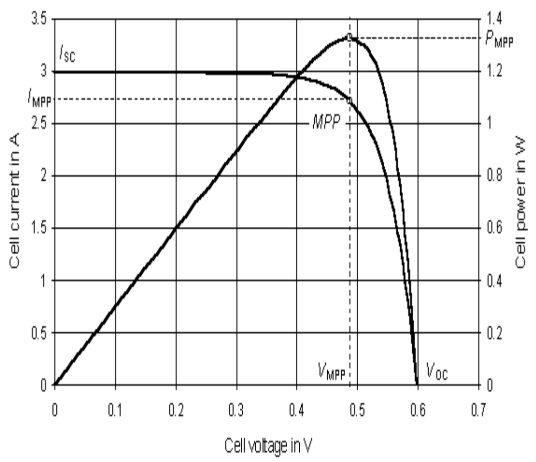



*Figure 4 : Important points in the characteristic curves of a solar panel.*

### 2.2 Equivalent circuit of a solar cell

The Solar cell is shown in figure 1. With the help of following equation we can find the current.:

$$I = I_L - I_0\left(e^{\frac{q(V+IR_S)}{kT}} - 1\right) - \frac{V+IR_S}{R_{sh}} \quad (1)$$

Where I are output current solar cell and V are output voltage solar cell respectively, I0 = the dark saturation current, q = the charge of an electron, a = the diode quality (ideality) factor, k =the Boltzmann constant, T = the absolute temperature and RS and RSH are the series and shunt resistances of the solar cell. RS is the series resistance offered by the contacts and the bulk semiconductor material of the solar cell. It is associated with the non-ideal nature of the p–n junction and the presence of impurities near the edges of the cell that provide a short-circuit path around the junction. In an ideal case RS would be zero and RSH would be infinite. However, this ideal scenario is not possible and manufacturers try to minimize the effect of both resistances to improve their product.

Sometimes, to simplify the model, the effect of shunt resistance is not considered, i.e. RSH (Shunt resistance) is infinite, so the last term in equation (1) is neglected.

### 2.3 Open circuit voltage, short circuit current and maximum power point.

Two main points of the current-voltage characteristic must be pointed out: the open circuit voltage VOC and the short circuit current ISC. At both points the generated power is zero. VOC can be calculated from (1) when the output current of the cell is zero, i.e. I=0 and the shunt resistance RSH will be neglected. It is represented by equation (2). The short circuit current ISC is the current at V = 0 and is almost equal to the light generated current IL as shown in equation (3).

$$V_{oc} \approx \frac{nkT}{q}\ln\left(\frac{I_L}{I_o}+1\right) \quad (3)$$

$$I_{SC} \approx I_L \quad (4)$$

Maximum power is generated when the solar cell at a point of the current-voltage characteristic where the product VI is maximum. This point is known as the MPP and is unique, as can be seen in Figure 1, where the previous points are represented.

### 3. BOOST CONVERTER

The boost converter is implemented to boost up variable input voltage and provide constant output voltage. It can step up input range of 6-23volts to constant output voltage 24 volts with the help of feedback loop is used. PWM waves are produced by comparing output voltage with reference voltage which is used to control the switching action by using 6 FPGA kit.

**Table -1:** Electrical Characteristics Data of Green Solar India37W (AT-37) PV Module

| Electrical Characteristics | |
|---|---|
| Maximum power - Pmax | 36.917 W |
| Voltage at Pmax – Vmp | 17.905 V |
| Current at Pmax – Imp | 2.062 A |
| Short-circuit current – Isc | 2.226 A |
| Open-circuit voltage – Voc | 21.425 V |

| | |
|---|---|
| Total number of cells in series (Ns) | 36 |
| Total number of cells in parallel (Np) | 1 |

**Table -2:** Specification for Boost Converter

| Specification for Boost Converter | |
|---|---|
| **Component** | **Value** |
| Inductor | 290µH |
| MOSFET 1N5408 | IRF 840 |
| Power Diode | IN5408 |
| Input Capacitor | 470µF |
| Output Capacitor | 330 µF |
| Resistive Load | 50Ω, 50W |

## 4. DIFFERENT MPPT TECHNIQUES

There are different techniques used to track the maximum power point. Few of the most popular techniques are:

1) Perturb and Observe (hill climbing method)
2) Incremental Conductance method
3) Neural networks
4) Fuzzy logic
5) Fractional open circuit voltage
6) Fractional short circuit current

## 5. SIMULATION OF MPPT FOR PV SYSTEM WITH BOOST CONVERTER

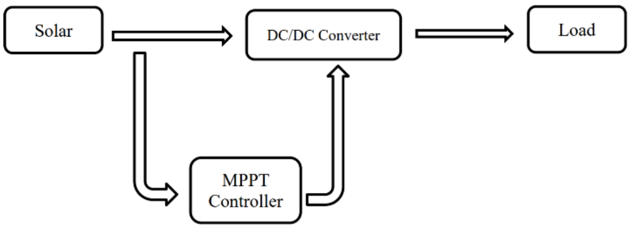



*Figure 5: MPPT Block Scheme*

In the source side we operate a boost convertor connected to a solar panel in order to increase the output voltage so that it can be used for different applications like motor load. by changing the duty cycle of the boost converter appropriately we are able to match the source impedance with that of the load impedance.

## 6. SIMULATION OF MPPT FOR PV SYSTEM WITH BOOST CONVERTER

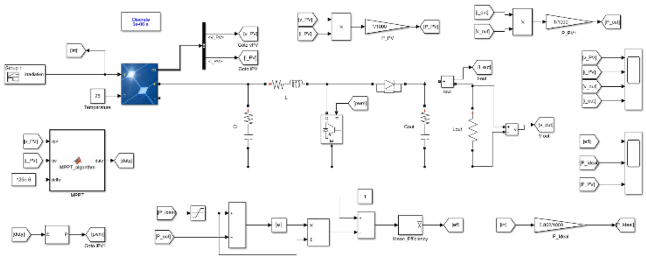


*Figure 6: Simulation model of Proposed Model*

## 6. RESULT AND DISSCUSSION

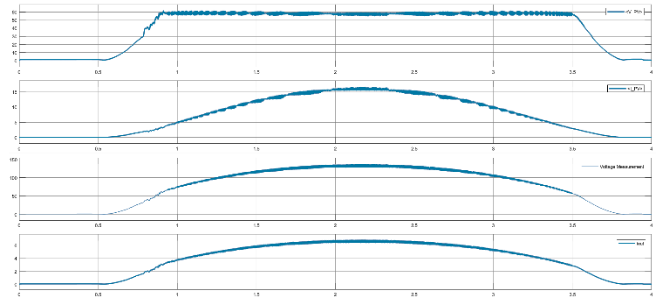


*Figure 7: 1 Input Voltages and Input Current from PV Panel*

I use a duty signal to determine the duty ration of PWM Because of we want to control the power by depending on maximum power point, it should be depend on irradiation. MPPT algorithms determines the MPPs by search the dP/dV=0 derivative. When the power is not changing and voltage is not changing the derivate will be zero and the point will be maximum.

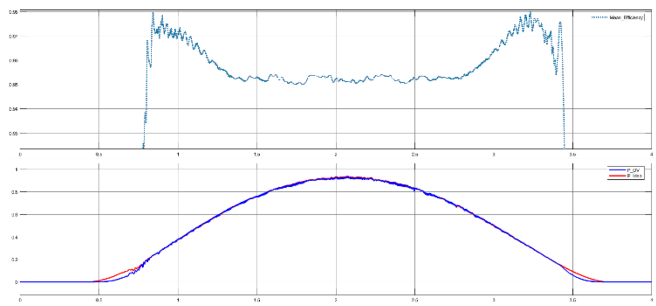


*Figure8: (a) Efficiency without MPPT with boost converter (b) Efficiency with MPPT with boost converter*

## 7. CONCLUSIONS

`MPPT Techniques is chosen on the basis of implementation costs, number of sensors required, and complexity. The tracker operated at regularly occurring intervals of incrementing or decrementing the solar array voltage. MPPT Plays a big role in PV system because it maximizes the power output from a PV system for given set of environment changes and load variations, and therefore it maximizes array efficiency and Reduce the overall system cost. The MPP varies depending on the cell temperature and irradiation, therefore suitable algorithms must be developed to track the MPP and maintain the operation of the system as close as possible to this point.

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