Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 03, March-2018

P&O and Incremental Algorithm Based Solar Maximum Power Point Tracking System

Er. Amanpreet Kaur Sandhu
Electrical & Electronics Engg Dept. CTIEMT
Shahpur Campus Jalandhar
India

Er. S S Matharu
Electrical & Electronics Engg Dept. CTIEMT
Shahpur Campus Jalandhar
India

***Abstract*— MPPT or Maximum Power Point Tracking is algorithm that included in charge controllers used for extracting maximum available power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point' (or peak power voltage). Maximum power varies with solar radiation, ambient temperature and** solar cell**temperature. Many MPPT techniques have been proposed and implemented. These methods include perturb and observe (P&O), fractional open -circuit voltage, fractional short-circuit current, fuzzy logic control (FLC) and ripple correlation control (RCC) app roaches. Some modified techniques which aim to minimize the hardware requirement or to improve the performance have also been proposed. In this research paper , the mathematical model & MPPT with H-BRIDGE are discussed with MATLAB/Simulink and analyze the waveforms with or without MPPT techniques** .

***Keywords*— *MPPT Maximum Power Point Tracking; H Bridge; fuzzy logic control (FLC). ripple correlation control (RCC*)**

INTRODUCTION

In the power sector the demand of energy is not enough to fulfill the day to day requirement this need of energy give rise to use of conventional energy resource. Utilized laterally with conventional systems to meet the energy demand. The Mathematical Model of Simple PV System.

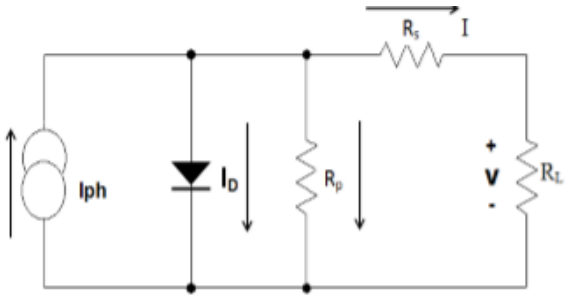


Fig -1: PV single diode model

Fig -1 shows the single diode model of the PV cell that is duly constructed with a parallel current source to the diode, a shunt resistor Rp, a series resistor Rs and a load resistor RL. The basic equations [2,3] from the theory of semiconductors that mathematically describes the I-V characteristics of the ideal photovoltaic are given as follows.

$$I = I_{ph} - I_D \quad (1)$$

where,

$$I_D = I_o \exp((qV/akT) - 1) \quad (2)$$

$$I = I_{ph} - I_o \exp((qV/akT) - 1) \quad (3)$$

In the above equations, Iph represents the current generated by the incident light, I_D is the diode current and Io is the reverse saturation current of the diode, q is the electrical charge, k is the Boltzmann constant, T is the temperature of the p-n junction, and 'a' is the diode ideality factor (constant).

The expression for the photovoltaic current is given by:

$$I = I_{ph} - I_o\left[\exp\left(\frac{V + IR_s}{V_T}\right) - 1\right] - \left(\frac{V + IR_s}{R_p}\right) \quad (4)$$

and expression for voltage is given by

$$V = I_{ph}R_p - IR_p + I_o\left[\exp\left(\frac{V + IR_s}{V_T}\right) - 1\right] - IR_s \quad (5)$$

MPPT TECHNIQUES

1. Perturbation and Observation Method

The Perturbation and Observation Method (P&O) is one of the most popular MPPT method because of its simplicity. The P&O method operates by making small incremental changes in voltage and measurings the resulting change in power. By comparing the current power measurement to the previous power measurement, the P&O method selects the direction for the next perturbation. The direction the next perturbation will take is described in table

Perturbation	Change in Power	Next Perturbation
Positive	Positive	Positive
Positive	Negative	Negative
Negative	Positive	Negative
Negative	Negative	Positive

Table: Table of operation for the P&O, and Hill Climbing MPPT methods.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 03, March-2018

The P&O MPPT method can be implemented using a minimal amount of components; however its speed is limited by the size and the period of the perturbation. The P&O method also has the problems of erroneous responses to quick changing conditions, and in steady state conditions will oscillate around the MPP causing losses. A more advanced technique for choosing direction can be employed by comparing the current power to the two previous power points.

2. Hill Climbing:
The hill climbing method uses the 'Hill like' nature of the photovoltaic power versus duty cycle curve. It uses the same method for MPPT as the P&O method except it perturbs the duty cycle instead of the voltage.

3. Incremental Conductance Method:

The Incremental Conductance Method (ICM) measures the voltage and current to find the instantaneous conductance, and incremental conductance. This method finds the MPPT by pushing its operating point to the level where change in power over change in voltage equals zero. This can be seen in Figure 1 where the MPP is the point where the slope is zero.

$$\frac{dP}{dV} = \frac{d(V \cdot I)}{V} = V \cdot \frac{dI}{dV} + I$$

Using this equation , the sign of the change in power over change in voltage determines the direction of the next perturbation, and if the result of equation is zero there is no perturbation. Under most conditions the MPPT tends to changes very slowly, so the IMC does not have the issue of oscillation at the maximum power point, like the P&O Method.

The Proposed Model:-

In the proposed model the PV array consists of 86 parallel strings. Each string has 7 SunPower SPR-415E solar cell modules connected in series. The converter is modeled using a 3-level IGBT bridge with PWM-control. The inverter choke RL and a small harmonics filter C are used to filter the harmonics generated by the IGBT bridge. A 250-kVA 250V/25kV three-phase transformer is used to connect the inverter to the utility distribution system. The Maximum Power Point Tracking (MPPT) controller is based on the 'Perturb and Observe' technique. This MPPT system automatically varies the VDC reference signal of the inverter VDC regulator in order to obtain a DC voltage which will extract maximum power from the PV array.

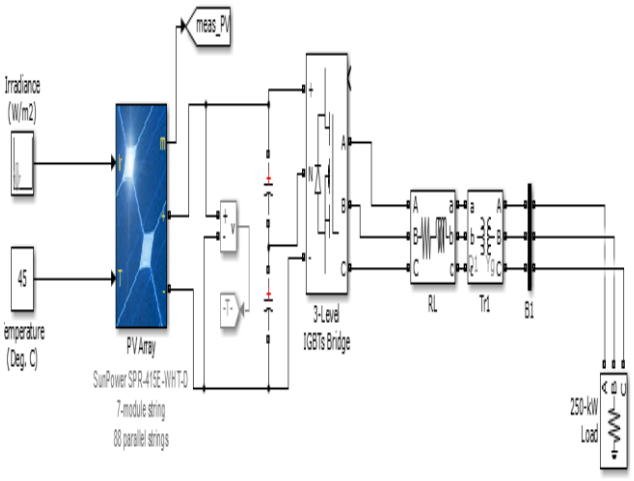
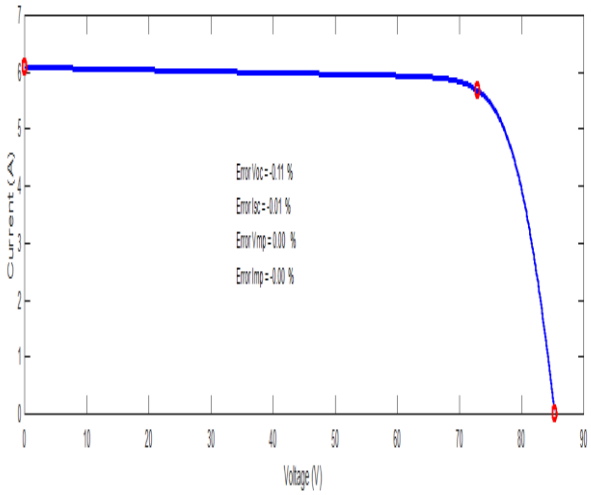
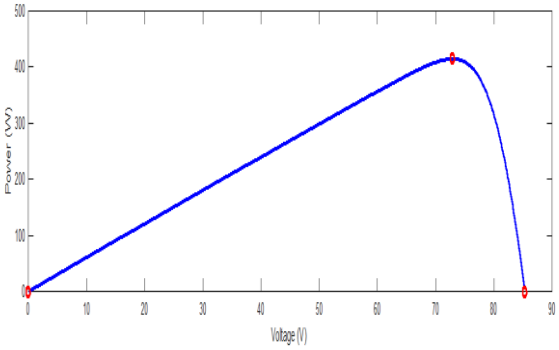


Fig 2 Proposed Array Model



I-V &P-V CURVES OF PV ARRAY



P-V CHARACTERISTICS OF PV MODULE

The PV array consists of 86 parallel strings. Each string has 7 SunPower SPR-415E modules connected in series&plot the I-V and P-V characteristics whole array.

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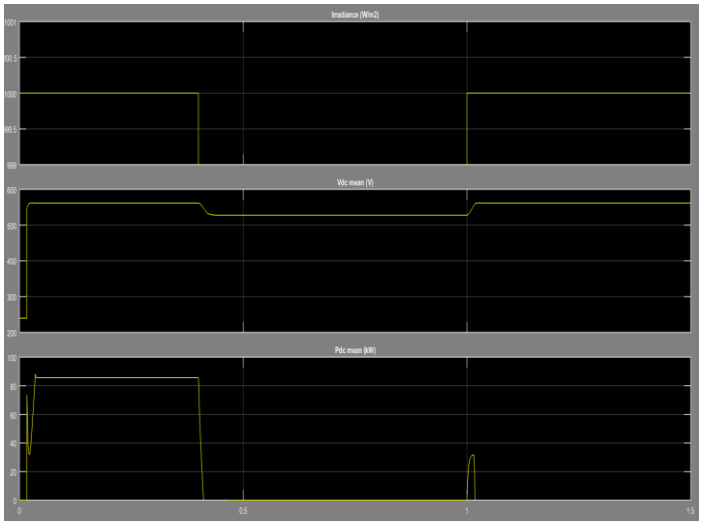

.Fig 3.Voltage and current irradiance waveforms without MPPT techniques .(DC Parameters)

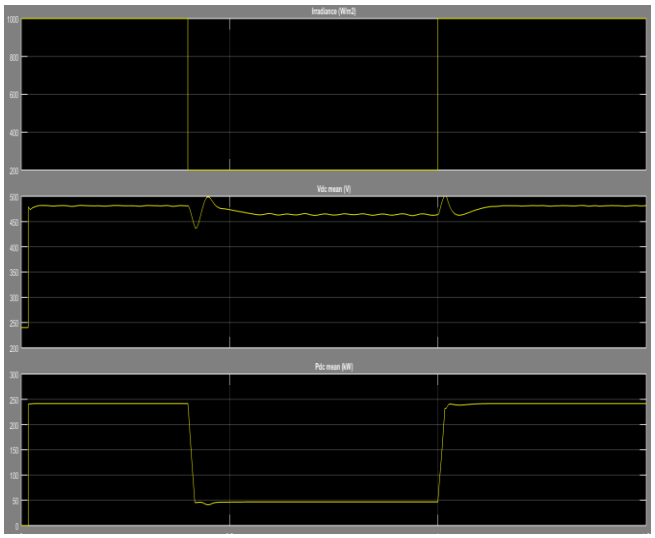

Fig 4.Voltage and current irradiance waveforms with MPPT techniques (DC Parameters)

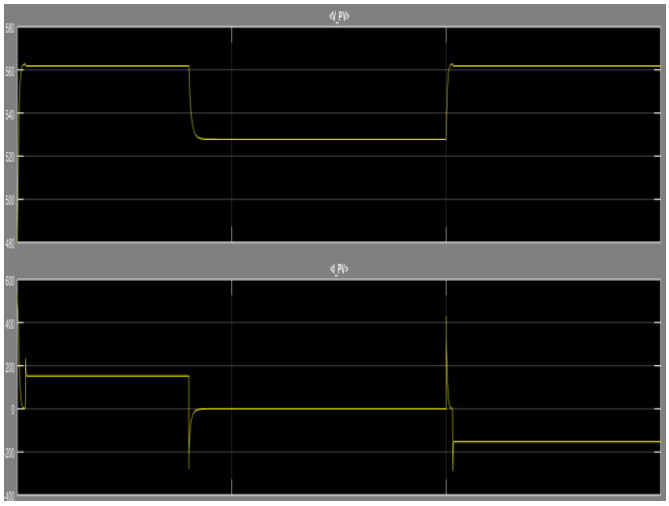

Fig 5.Voltage and current waveforms without MPPT techniques

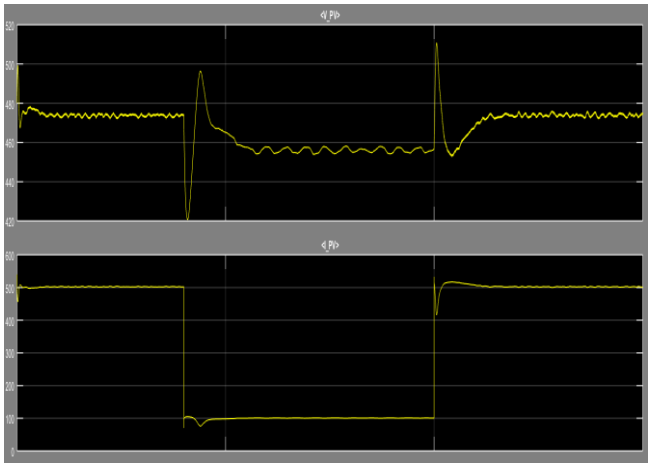

Fig 6.Voltage and current waveforms with MPPT techniques

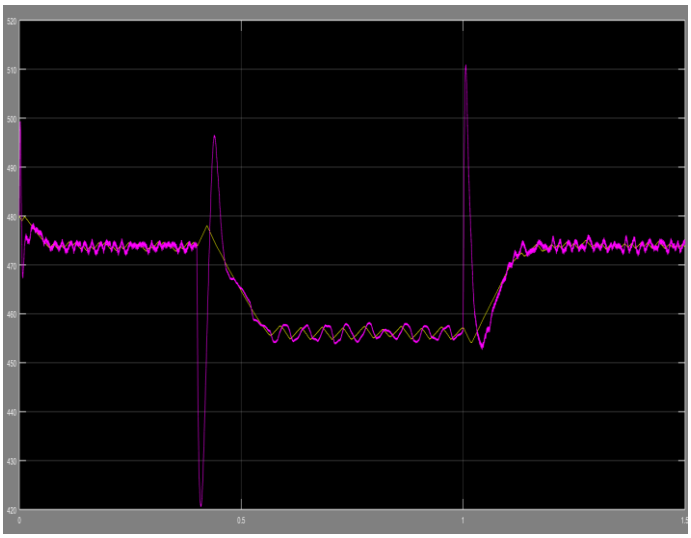

Fig 7.Waveforms of Vdc ref and Vdc means

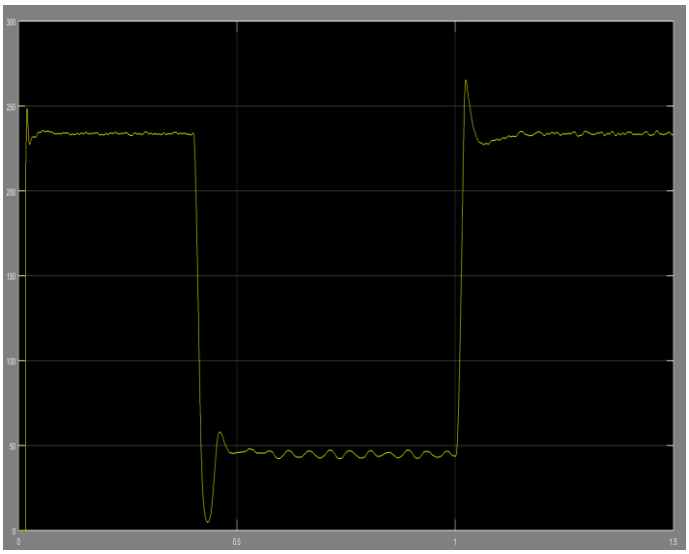

Fig 8.Power waveforms of test system

International Journal of Engineering Research & Technology (IJERT)
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Vol. 7 Issue 03, March-2018

CONCLUSION

MPPT techniques plays very important role while designing PV array module/system .Without MPPT techniques there observed much fluctuations and low efficiency in power output but with MPPT techniques improved efficiency and power output has been obtained.

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