# Comparative Study of Solar PV MPPT by Incremental Conductance and Perturbation and Observation Method

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**Abstract**

Due to high polluting factor and limited conventional energy sources, it is now worldwide accepted that renewable energy is the suitable alternative for the existing power generation method. Out of the several renewable sources available for energy generation, solar PV is gaining more popularity. Due to its modularity, nonmoving parts, portability and clean energy production capacity it's attracting more attention. In this paper two different algorithms of solar PV MPPT such as Perturbation & Observation and Incremental Conductance MPPT have been analyzed and compared to show which one is most efficient.

**Keywords:** Solar PV, Simulation MPPT, Incremental Conductance, Perturb and Observation

## Introduction

The proper utilization of solar energy is an important aspect which can cope with the global energy crisis at present. In order to increase the efficiency in other words to reduce the cost of solar power by tracking the maximum power point is very important. Analysis showed that: to improve the efficiency of solar power, we can study in the technical aspects of the conversion efficiency of solar panels - in the solar energy application of automatic tracking system device i.e. the maximum power point tracking technology.

This paper reports the tracking of maximum solar power out of the PV array. Out of different techniques Perturbation & Observation and Incremental Conductance methods are taken into consideration for modeling MPPT with different patterns of irradiance. The main objective is to obtain the maximum power of grid connected solar PV. Incremental conductance method of MPPT and Perturbation and Observation method of MPPT are modeled with different irradiance and compared on the basis of output voltage and power.

## Solar PV Cell

Solar PV cell gets sufficient radiation it produces power and that can be fed to the grid. The DC voltage generated from the panel is highly fluctuating and intermittent as the sunshine is not constant. So this DC voltage is amplified by providing to the boost converter and then inverted to get the constant AC after passing it through the transformer which is then supplied to the grid. But the power obtained is not the optimum one as maximum voltage and current are not trapped due to variable irradiation. The proposed block diagram for the overall system is shown in Fig. 1. The Cell parameters for the PV array are shown in table 1. The Load current supplied by the solar PV cell is shown below[4][5]:

$$I_L = I_{sc} - I_0\left[e^{\frac{q(v+IR)}{m\eta KT}} - 1\right] \quad (1)$$

Where

m = photovoltaic cells in each module

q = electron charge

k = Boltzmann constant

Io = reverse saturated current

T = Temperature in k

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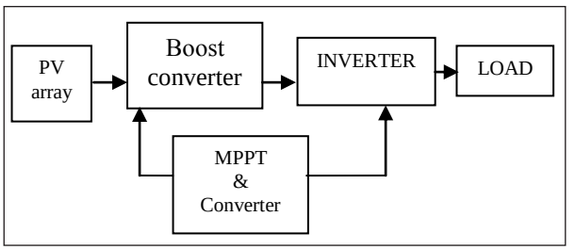


**Fig. 1: Block Diagram for MPPT Controller**

**Table: 1. Cell Parameters**

| *Parameters* | *Values* |
|---|---|
| Temperature | 298K |
| Cells in PV | 36 |
| Max. Irradiance1 | 1000W/m$^2$ |
| Max. Irradiance2 | 750W/m$^2$ |
| $V_{o.c}$ | 21.7V |

## Modelling of MPPT Techniques

MPPT or "maximum powerpoint tracking"technique is used to track the MPP at all environmental conditions and then direct the PV system to operate at that maximum Power point. MPPT is an inherent component of PV systems. There are different techniques of MPPT available such as curve fitting Technique, fractional short circuit current technique, fractional open circuit voltage technique, one cycle control technique, Perturbation & Observation technique, Incremental Conductance technique. Out of which we have implemented P&O technique and Inc–Cond technique for our designed 100KW grid connected solar PV system.

### 1. MPPT using P&O Method

In this method first the power generated ($P_g$) was calculated and then it was compared with the perturbed power ($P_p$) by taking a incremental change in voltage. If

$P_p$ is greater than $P_g$ then it should go in the incremental direction, otherwise the voltage should be decremented by the amount of fixed step size. When the difference in $P_p$ and $P_g$ becomes zero or remain in the defined region then MPPT will stop running the algorithm. [5] The flow chart and control model for the MPPT using P & O method in MATLAB-Simulink is shown in fig.2 and Fig.3 respectively.

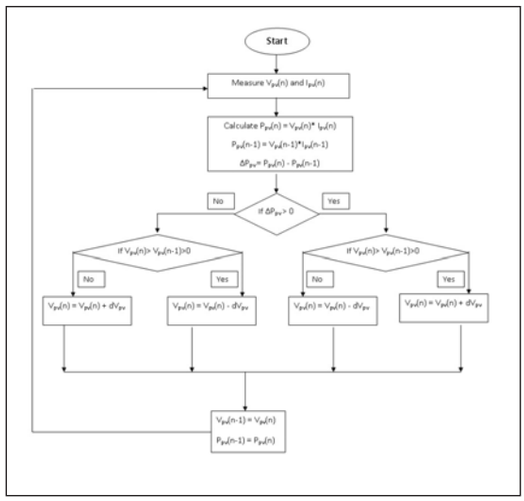


**Fig. 2:** Flow Chart for P&O Technique

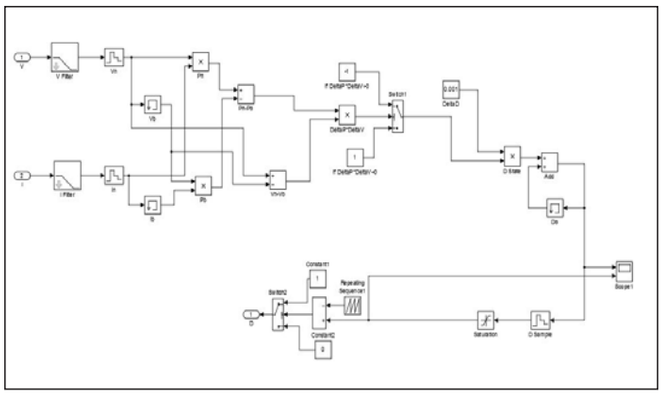

**Fig. 3: Control Model of MPPT using P&O**

### 2. MPPT using Inc-Cond Method

Due to limitation of P & O method such as step size & oscillation around the operating point, the Inc-Cond technique is widely used. This method uses reliable decision making capability for step size based on current status resulting response is faster & tracking result is good with small step size. For the PV system, the relationship between power, voltage & current is given by the equation-2 [6].

$$\frac{dP}{dV} = \frac{d(IV)}{dV} = I + V\frac{dI}{dV} = I + V\frac{\Delta I}{\Delta V} \qquad (2)$$

Comparing incremental conductance with instantaneous conductance, the maximum power point can be tracked. The Flow chart of Inc-Cond method is shown in the Fig. 4 below.

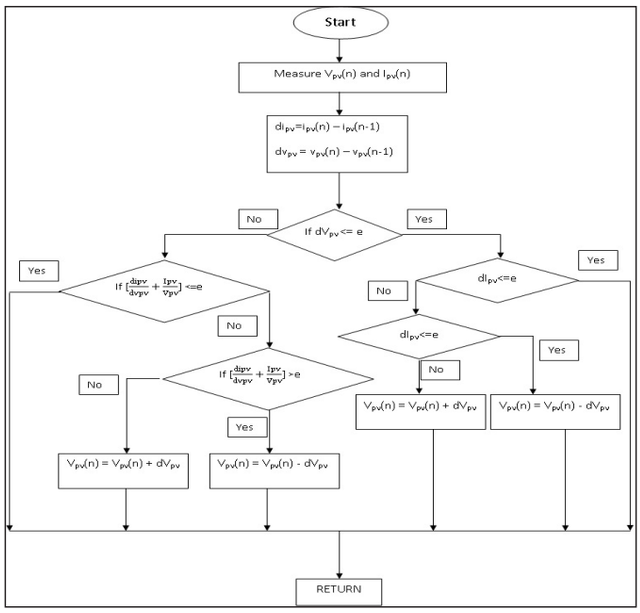


**Fig. 4: Flow Chart for Inc-Cond Method**

The control model for the Inc-Cond method in Matlab Simulink environment is shown in the fig.5

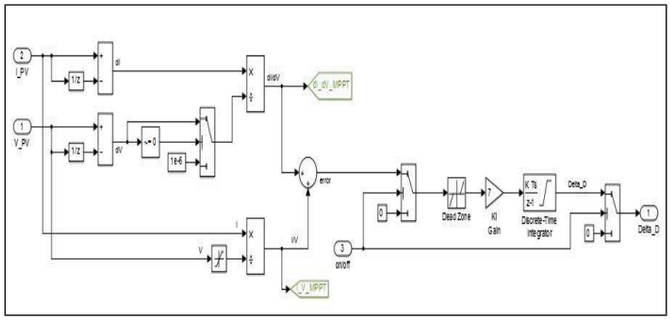


**Fig. 5: Control Model of MPPT using Inc-Cond**

## Simulation and Result:

The MPPT model shown in fig.6 is simulated in Matlab Simulink environment by taking two different virtual solar radiation i.e. 1000W/m$^2$ and 750 W/m$^2$. Then the result of both the techniques i.e. P&O and Inc-Cond methods are analyzed. Also the behavior of the system in terms of output power with respect to different irradiances is observed.

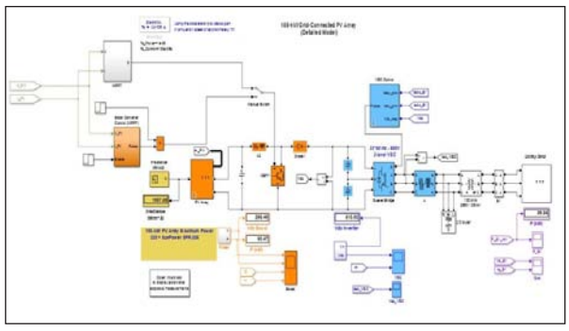

**Fig. 6: Modelling of MPPT using PV array.**

The model is simulated by taking irradiance of 1000w/m$^2$ and the waveforms of irradiance and corresponding output power, voltage and current for Inc-Cond are shown in the fig. 7, fig.8 and fig.9 respectively.

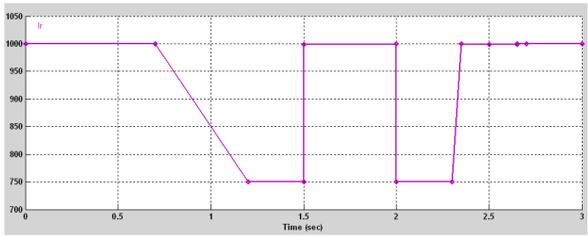


**Fig. 7: Waveform for irradiance with max 1000W/m$^2$.**

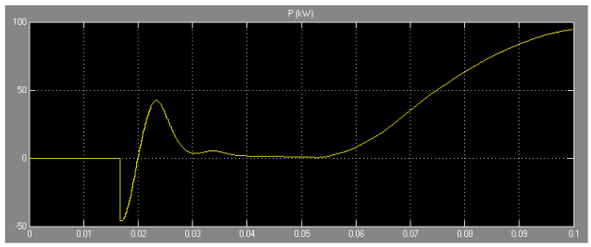


**Fig. 8: Output Power Waveform for Inc-Cond MPPT**

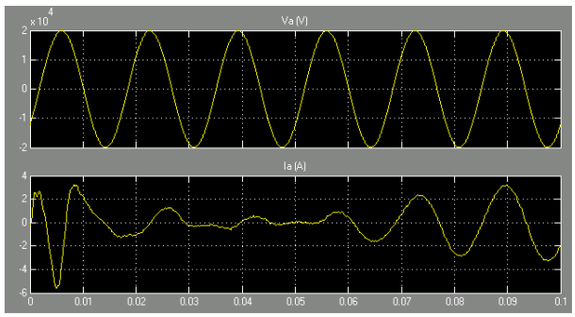


**Fig. 9: Voltage and Current waveform for Inc-Cond MPPT**

Also the model is simulated by using P&O technique with irradiance of 1000 w/m$^2$ and the waveforms of corresponding output power, voltage and current are shown in the fig. 10 and fig.11 respectively.

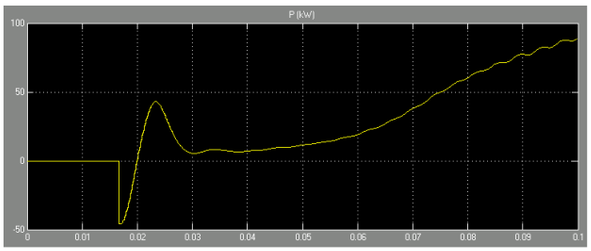


**Fig. 10: Output power waveform for P&O**

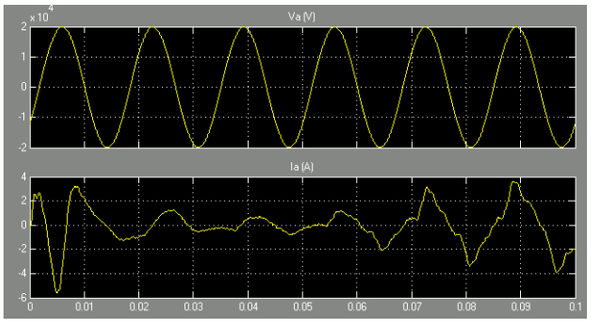


**Fig. 11: Voltage and Current waveform for P&O**

From the output power waveform shown in fig. 6 and 8, it is found that maximum power obtained with method Inc-Cond is 95 KW and with P&O is 90 KW. Similarly, for irradiance 750W/m$^2$ output waveform of power and voltage , current for Inc-Cond method are shown in fig. 12, fig. 13 and fig.14 respectively.

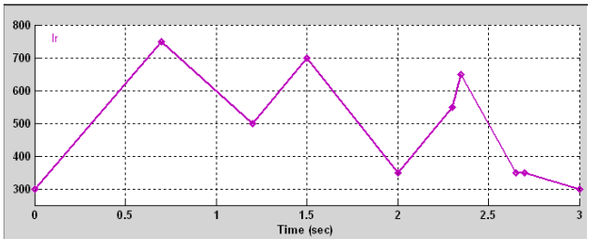


**Fig. 12: Waveform for irradiance with max 750W/m$^2$**

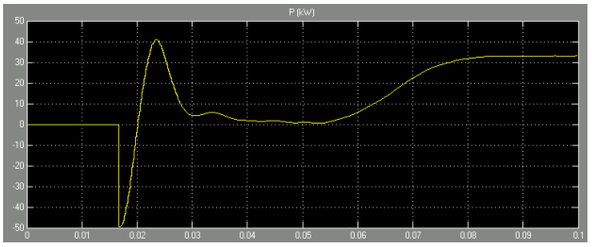


**Fig. 13: Output power waveform for Inc-Cond MPPT**

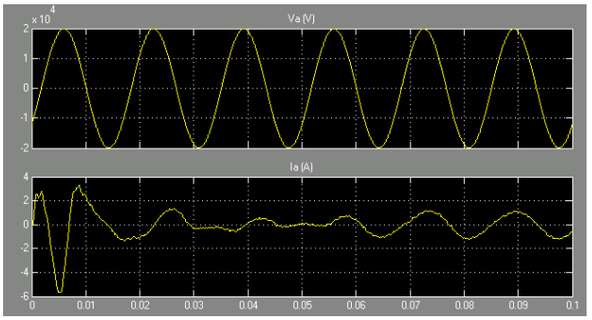


**Fig. 14: Voltage and Current waveform for Inc-Cond**

## Conclusion and Future Work:

In this paper two different atmospheric conditions have been taken and two MPPT methods are used to study the effect on power, voltage and current. It is found that Inc-Cond technique for MPPT provides higher value of output power in comparison to Perturbation and Observation technique.

In future we can improve the performance of controller by introducing fractional parameters as well as with fuzzy controller in addition to developed fractional controller.

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