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Variation in Maximum Power and Maximum Power Point with Different Parameter Analysis

P. V. Ram Kumar, R. S. Mishra, Aman Khurana

(Department of Mechanical Engineering, Delhi Technological University,New Delhi, India)

Email: pvrdce@gmail.com

Abstract : Variation in Maximum power and Maximum power point i.e. voltage at which Maximum Power is observed with different parameters are studied. Parameters are insolation, temperature, series resistance,shunt resistance and reverse saturation current of diode.For this I-V and P-V characteristics with variation of these parameters are analysed.For finding out the Maximum Power Point,Perturb & Observe technique is used.Variation in these points are different with each parameter.All simulation work is done in MATLAB.

Keywords: MPPT, Perturb & Observe, P-V curves, Maximum power

I. INTRODUCTION

The weather and load changes cause the operation of a PV system to vary almost all the times. A dynamic tracking technique is important to ensure maximum power is obtained from the photovoltaic arrays. The following algorithms are the most fundamental MPPT algorithms, and they can be developed using micro controllers. The MPPT algorithm operates based on the truth that the derivative of the output power (P) with respect to the panel voltage (V) is equal to zero at the maximum power point. In the literature, various MPP algorithms are available in order to improve the performance of photovoltaic system by effectively tracking the MPP. However, most widely used MPPT algorithms are considered.[1]

Here, they are:

1. Perturb and Observe (P&O)
2. Incremental Conductance
3. Constant Voltage Method.

1.1 Perturb and Observe (P&O)

The most commonly used MPPT algorithm is P&O method. This algorithm uses simple feedback arrangement and little measured parameters. In this approach, the module voltage is periodically given a perturbation and the corresponding output power is compared with that at the previous perturbing cycle .In this algorithm a slight perturbation is introduce to the system. This perturbation causes the power of the solar module various. If the power increases due to the perturbation then the perturbation is continued in the same direction. After the peak power is reached the power at the MPP is zero and next instant decreases and hence after that the perturbation reverses as shown in Figure 1.

When the stable condition is arrived the algorithm oscillates around the peak power point. The technique is advanced in such a style that it sets a reference voltage of the module corresponding to the peak voltage of the module.[2] A PI controller then acts to transfer the operating point of the module to that particular voltage level. It is observed some power loss due to this perturbation also.

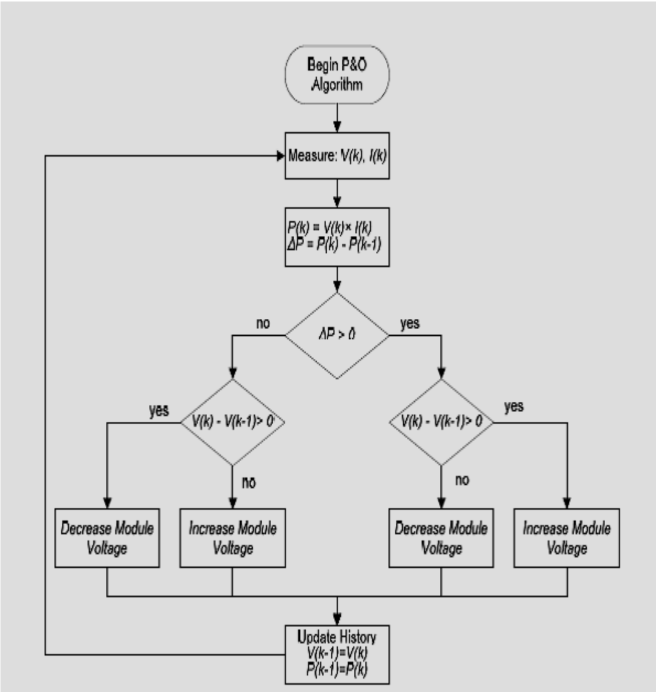

Figure1 Perturb & Observe Algorithm

II. PARAMETERS WHICH IMPACT THE MAXIMUM POWER POINT

- Insolation level
- Temperature
- Series Resistance
- Shunt Resistance
- Diode Reverse Saturation Current

The fundamental equation of PV cell is used to study the model and to analyze and best fit observation data. The model can be used in measuring and understanding the behaviour of photovoltaic cells for certain changes in PV cell parameters. A numerical method is used to analyze the parameters sensitivity of the model to achieve the expected results to understand the deviation of changes in different parameters situation at various conditions respectively. The ideal parameters are used to study the models behaviour. It is also compared the behaviour of current-voltage and power-voltage by comparing with produced maximum power point though it is a challenge to optimize the output with real time simulation.

III. MATHEMATICAL MODEL

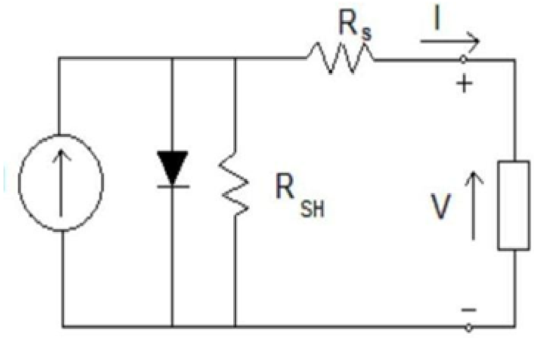

Figure 2.Mathematical model of PV module

The model of the general PV module which consists of a photo current, a diode, a parallel resistor expressing a leakage current, and a series resistor describing an internal resistance to the current flow, is shown in Figure 2.

PV cell output current is given by

$$I = I_{ph} - I_s\left(e^{\left\{\frac{q(V+IR_s)}{k*Tc*A}\right\}} - 1\right) - \frac{V+IR_s}{R_{sh}}$$

Where
I_{ph} = a light-generated current or photocurrent,
I_s= cell saturation of dark current,
q = an electron charge = 1.602 x 10^{-19}C
k = Boltzmann's constant = 1.38 x 10^{-38}J/K
T_c= cell's working temperature,
A = an ideal factor here we are taken 1.498
R_{sh} = shunt resistance
R_s = series resistance

The photocurrent mainly depends on the solar insolation and cell's working temperature, which is described as

$$I_{ph} = [I_{sc} + K_i(T_c - T_{ref})] * G$$

Where
I_{sc} = the cell's short-circuit current
K_i = the cell's short-circuit current temperature coefficient, here we are taken 1.381*e^{-23}
T_{ref}= the cell's reference temperature here we are taken 25°C G = the solar insolation in kW/m^2 here we are taken 1000 W/m^2

On the other hand, the cell's saturation current varies with the cell temperature, which is described as

$$I_s = I_{rs}\left(\frac{T_c}{T_{ref}}\right)^3 e^{\left[\frac{qEg\left(\frac{1}{T_{ref}} - \frac{1}{T_c}\right)}{k\eta}\right]}$$

Where,
I_{rs} = the cell's reverse saturation current at a reference temperature and a solar radiation,
Eg = the band-gap energy of the semiconductor used in the cell.[3]

IV. RESULT AND DISCUSSION

A. Effect of insolation.

As we increase the insolation level Maximum power of the solar cell also increases .As we increase the insolation level, Voltage at which maximum power is observed shifts towards the right. For getting the effect series resistance of 0.1 mΩ and shunt resistance of 10000Ω are taken.

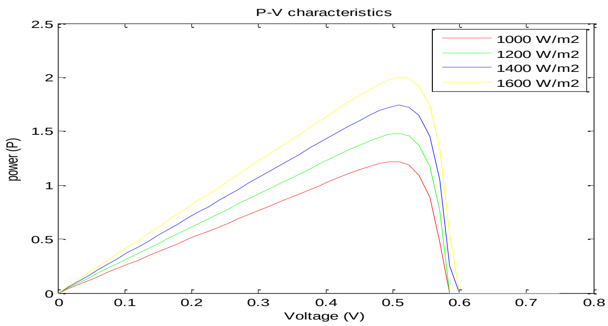

Figure 3 P-V curves with different insolation

For observing the Maximum power and Maximum voltage variation different value of insolation level 1000,1200,1400,1600 W/m^2 are taken. There is significant difference in maximum power with variation of insolation level but difference in maximum voltage is not so significant and as we know both of these two increase with increasing insolation level.

B. Effect of cell temperature.

As we increase the temperature Maximum power decreases and Maximum voltage also decreases. For different value of 25°C,26°C, 27°C and 28°C observation are taken and insolation level of 1100W/m^2 kept same.

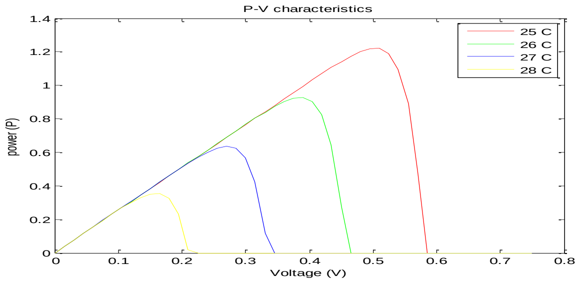

Figure 4 P-V curves with different Temperature

C. Effect of series resistance.

By increasing the value of series resistance, there are decrease in Maximum power and Maximum voltage. Different value of series resistance of 1 μΩ, 2 μΩ,3 μΩ,4 μΩ are taken for the shunt resistance of 10000Ω.As we can see from the results Maximum power and Maximum voltage decrease as we increase the series resistance

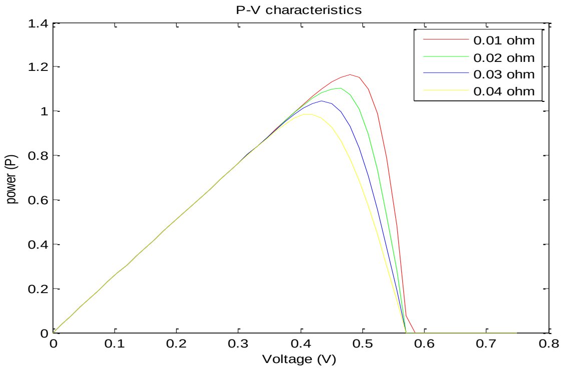

Figure 5 P-V curves with different series resistance

D. Effect of shunt resistance.

As we increase the shunt resistance there is increase of Maximum voltage and Maximum power and as we know value of shunt resistance is generally very high so there is not so significant difference in Maximum voltage and Maximum power values. Observation are taken on different value of shunt resistance of 1ohm, 4 ohm, 5000 ohm .

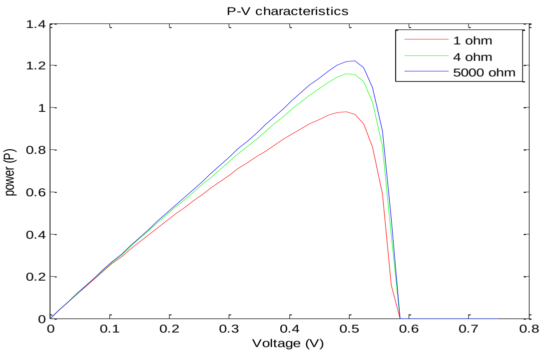

Figure 6 P-V curves with different shunt resistances

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E. Effect of saturation current.

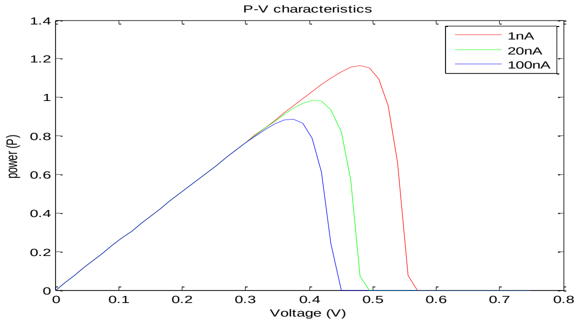

Figure 7 P-V curves with different saturation current

As saturation current increases Maximum voltage and Maximum power decrease. Series resistance of 10 μΩ and shunt resistance of 10000Ω are taken for the result.[4]

V. CONCLUSION

Maximum power increases with increaseing insolation.Voltage at maximum power also shifts towards the right with increasing insolation. With increase in temperature level maximum power decreases and maximum power shifts towards the left. With variation of series resistance there is no such significant change in current voltage (I-V) & power voltage (P-V) curve. Although maximum power and that point decreases. As we increase the shunt resistance there is increase of maximum voltage and maximum power.With increase in diode reverse sasturation current maximum power and maximum voltage decrease.

REFERENCES

[1] Atallah, Ahmed M., Almoataz Y. Abdelaziz, and Raihan S. Jumaah. "Implementation of perturb and observe MPPT of PV system with direct control method using buck and buck-boost converters." Emerging Trends in Electrical, Electronics & Instrumentation Engineering: An international Journal (EEIEJ) 1.1 (2014): 31-44.

[2] Vikrant A. Chaudhari, "Automatic Peak Power Tracker for Solar PV Modules Using Dspace Software," in Maulana Azad National Institute of Technology. Master Thesis of Technology in Energy. Bhopal: Deemed University, 2005.

[3] Pandiarajan, N., & Muthu, R. (2011, January). Mathematical modeling of photovoltaic module with Simulink. In Electrical Energy Systems (ICEES), 2011 1st International Conference on (pp. 258-263). IEEE.

[4] Salas, V. "Review of the maximum power point tracking algorithms for stand-alone photovoltaic systems." Solar energy materials and solar cells90.11 (2006): 1555-1578.