

# Mathematical Modelling and Characteristic Analysis of Partial Shaded Solar Photovoltaic System

Lokesh Kumar Jain<sup>1</sup> · Vikas Kumar Sharma<sup>2</sup> and Dr.Rakesh Kumar Saxena<sup>3</sup>

<sup>1</sup>M.Tech. (Scholar) Department of Electrical Engineering, Global Institute Of Technology, Jaipur, Rajasthan, India

<sup>2</sup>Assistant Professor, Department of Electrical Engineering, Global Institute Of Technology, Jaipur, Rajasthan, India

<sup>3</sup>Professor, Department of Electrical Engineering, Global Institute Of Technology, Jaipur, Rajasthan, India

**Abstract**— Solar energy is a significant segment of the administration's power generation techniques. The exhibition of solar PV Systems is profoundly alluring for topography and structure. For powerful and proficient organized we have to improve operational efficiency of solar photovoltaic system. Design of effective Maximum Power Point Tracking system helps in conveying new geometries shape for the assessment of various techniques to accommodate improvement of yield power and empowers better use of solar range when uniting into gadget clusters. Operational efficiency improvement techniques have been described about utilizing productive choice of Maximum Power Point Tracking calculation for variable irradiance and variable temperature condition. Critical improvement in yield and minimization of losses was accomplished utilizing simulation and procedure simulation stage utilizing proposed philosophy. The intention of this work is to create scientific model for diode proportional Photovoltaic system in MATLAB programming and examined the qualities. Model of network associated solar photovoltaic system was created utilizing fractional shading and variable irradiance condition. The Maximum Power Point Tracking point following is finished by steady conductance, annoy and eyewitness and improved PSO (molecule swarm optimization) technique has been executed in MATLAB.

**Keywords**- Solar Photovoltaics, MPPT, Partial Shading, Grid Connected Solar PV System.

## I. INTRODUCTION

As of late solar, wind, biomass and other sustainable power sources has been of worry because of the expanding a worldwide temperature alteration condition to accomplish. For this situation, the photovoltaic (PV) solar systems in the presentation of enormous, on the grounds that a local location of government appropriations. Notwithstanding the PV yield control during the evening to stop the sensational changes in the power of the sun radiation and air temperature. In an independent design, the photovoltaic power age system is the most reasonable as a spotless energy source, the battery can be utilized to store coordination during the evening use. For some applications, the electric vehicle's capacity PV modules are progressively normal.

India has rich solar energy. The energy assets accessible for local power age and modern use. Diminish costs, improve efficiency and execution of photovoltaic boards over a wide temperature range better of ongoing advancements in photovoltaic innovation. The field has been set up for almost two decades, the boundless utilization of intuitive PV systems to the utility framework of astounding development from independence. There are numerous favorable circumstances of the solar system some of which incorporate appropriation and transmission limit alleviation, top burden shaving, the staggering expense of transmission and conveyance (T and D) system update delayed. In spite of these advantages referenced,

photovoltaic network interconnection, which must consider that it is a ton of specialized issues to be settled before a dependable wellspring of supply. Solar photovoltaic exhibits (PV system), which thus is the arrangement to do a ton of the most interconnected photovoltaic modules. By a solitary power module created is little enough for business use, so modules are associated in arrangement are organized in parallel to shape a variety of capacity to the heap. In association module cluster is like the module cells. Again by the intensity of a solitary module isn't adequate to meet the power needs of most down to earth purposes. From the PV exhibit utilizing an inverter changing over DC control into AC power and yields it to the engine, lighting burdens and different burdens. Modules are associated in arrangement to get a greater amount of the appraised voltage, and afterward in parallel to meet the present determination, as appeared in Figure 1.1.

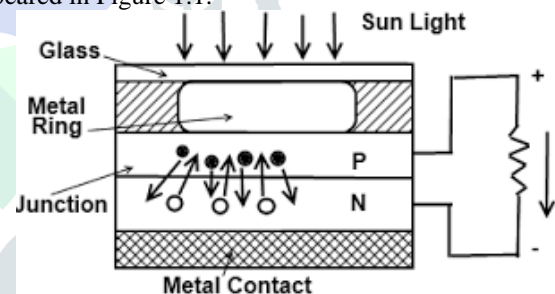


Fig. 1.1. Structure of a PV Cell

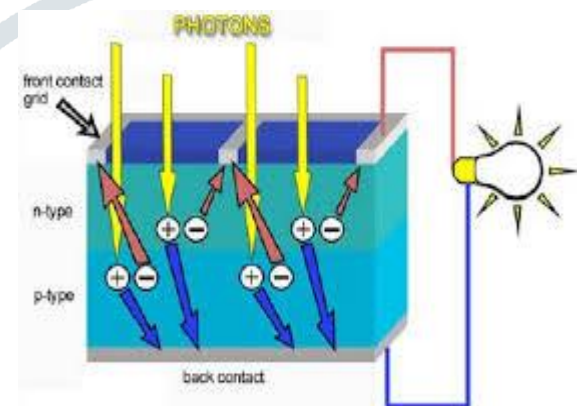


Fig. 1.2. Working of Solar Cell

Spoken to by a little solar cell or a thin semiconductor wafer, electrical attributes not the same as the Shockley diode condition layer made of a p-n intersection. Along these lines, a basic equal circuit of the solar cell are associated in parallel with a diode current source. A photovoltaic exhibit (PV system) which thusly are interconnected in arrangement or in parallel of

a few modules of the PV cells. Framework associated PV system is a system when lattice is associated with PV system and furthermore called utility-intelligent systems. In this kind of system comprise of PV cluster and inverter. Utility-intuitive systems manage AC. Lattice associated system manages high control applications, so is difficult to store this a lot of intensity in battery. Solar cell is made by two sorts of semiconductor materials one is N-type semiconductor and other is P-type semiconductor material for age of power yet Solar cell is producing by various materials.



Figure 1.3 Partial Shaded Solar PV System

The inverter is utilized to change over the immediate current (DC) created by the solar board into a heap of substituting current (AC). Today, numerous financial specialists available depend on battery associations and system systems. Invertors need to decide the extent of the normal power level to be handled and are perfect with the conditions on the system side. Different segments incorporate JS mounting systems, wiring, switches, disconnectors and system screens.

II. PARTIAL SHADING CONDITION

Partial shading is condition of shading of PV module in which low control, instability, complex PV and IV curves are make. Generally, partial shading happens when certain PV cells on a board or a display are disguised from direct sunlight. Research shows that most shading occurs because of enveloping of trees, cloudy spread, building/houses, winged animal droppings, buildup, water and the tilt purpose of solar panel. Complete shading caused a comparable issue yet isn't to consider in partial shading here, trees, structures and fogs are the rule reasons of deficient shade.

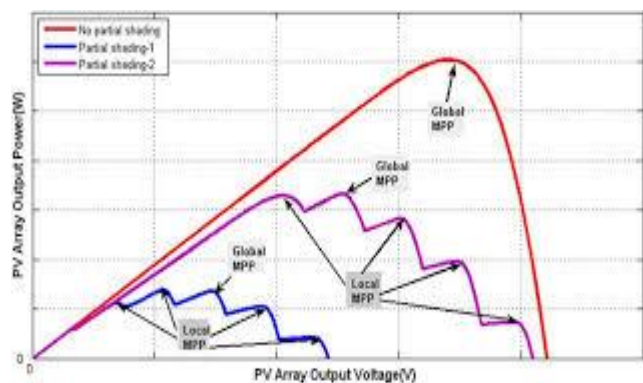


Fig. 1.4 PV characteristics of PV arrayarray

The Maximum power coordinates needs toward be examined and analyzed all together as to check the possible yield excessively discover MPP available all through the system at certain condition. Due to this reason, a MPPT figuring must be

associated with a system to help in following the MPP in all conditions which ought to realizes an extended yield and an improved efficiency. Above figure shows the two adjacent and one worldwide most extraordinary point through which we can say that overall point is achieve once more fluctuation is occur and again neighborhood point is achieve. Distinct most outrageous power isn't achieve under fragmentary shading conditions. difference occur again and again and due to that system efficiency is decay . So to achieve most prominent power point we ought to apply certain estimations to achieve the worldwide greatest power point.

III. SIMULATION & RESULT

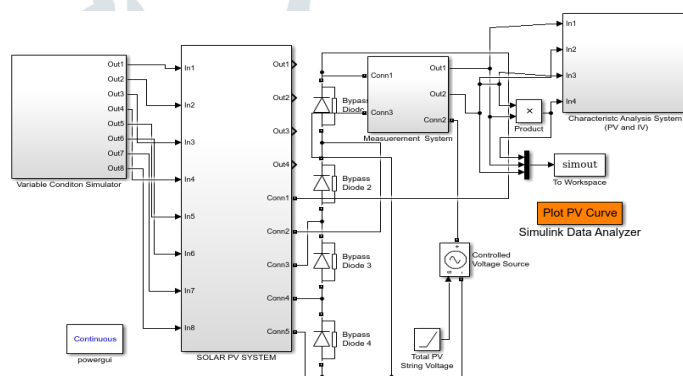


Figure 6. Mathemeatical Model of Partial Shading Condition in Solar PV System

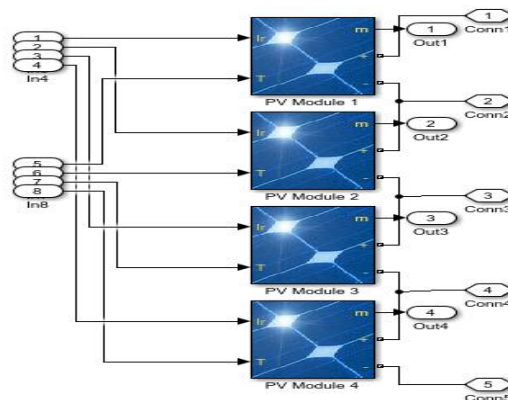
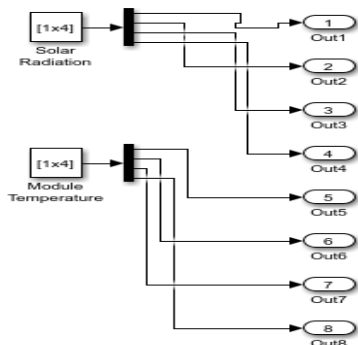
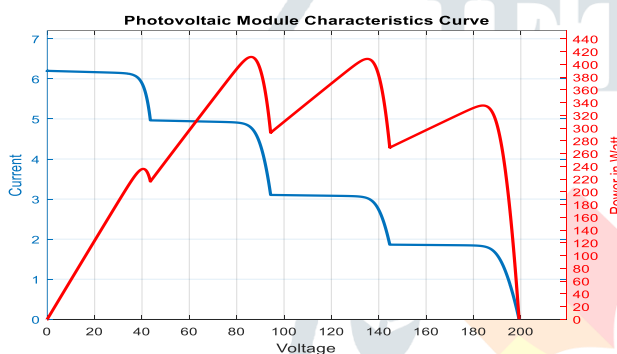


Figure 7. Connection of PV String

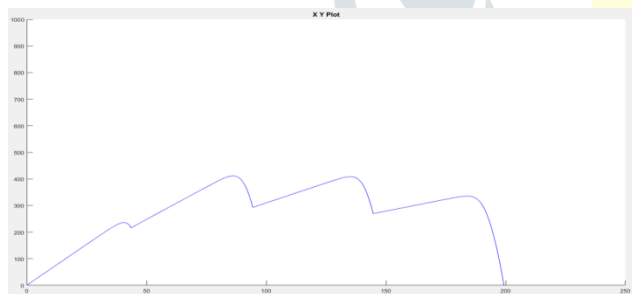


**Figure 8. Connection of Variable Irradiance and Variable temperature in PV String**

A progressively broad somewhat concealed PV string with n diverse irradi-ance estimations of  $G_1, \dots, G_n$ ,  $G_1 > G_2 > \dots > G_n$ , is partitioned into n sub-strings and their PV module quantities of their substrings are, individually,  $N_1, \dots, N_n$ . In light of the simulation results displayed in this area.

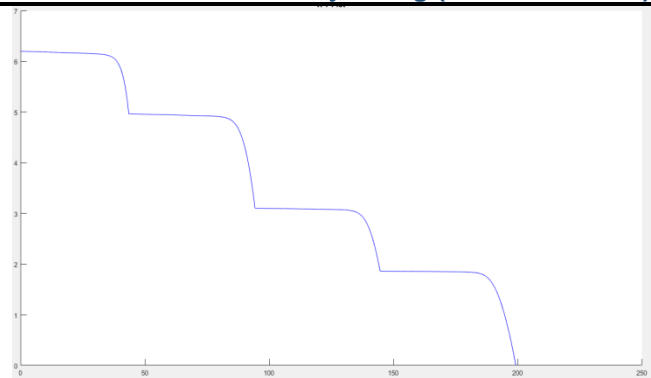


**Figure 9. P-V & I-V Characteristics of PV Array Under Partial Shading condition**



**Figure 10. P-V Characteristics of PV Array Under Partial Shading condition**

Given a PV cluster comprising of N PV modules are organized into  $N_p$  PV module strings associated in parallel, each string with  $N_s$  PV modules in arrangement, where  $N = N_s \times N_p$ . It is required to acquire the whole V-I and V-P qualities bends for one to learn and under-stand the conduct of a PV cluster in a mind boggling situation end.



**Figure 11. I-V Characteristics of PV Array Under Partial Shading condition**

II. CONCLUSION

This paper at first introduces the fragmentary shading condition assessment instruments like MATLAB and PV-Syst for analyzing inadequate shading condition. This paper revolve around the typical for photovoltaic system. A mathematical model has been investigated using MATLAB to get with the effect of variable irradiance and variable temperature on PV and IV typical for solar photovoltaic system. This assessment is important in mulling over fragmentary shading condition sway on following most noteworthy power point in such circumstance. This assessment will help in use of MPPT figuring in deficient shading scenatio for efficiency improvement objective.in incomplete shading scenatio for efficiency improvement objective.

III. REFERENCES

[1] M. G. Villalva, J. R. Gazoli, and E. R. Filho, "Comprehensive approach to modeling and simulation of photovoltaic arrays," IEEE Trans. Power Electron., vol. 24, no. 5, pp. 1198-1208, May 2009.

[2] T. Eswam and P. L. Chapman, "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques," IEEE Trans. Energy Convers., vol. 22, no. 2, pp. 439-449, 2007.

[3] Bilal, Babar. "Implementation of artificial bee colony algorithm on maximum power point tracking for PV modules." In Advanced Topics in Electrical Engineering (ATEE), 8th International Symposium on, pp. 1-4. IEEE, 2013.

[4] Z. Cheng, H. Zhou, and H. Yang, "Research on MPPT control of PV system based on PSO algorithm," 2010 Chinese Control Decis. Conf. CCDC 2010, pp. 887-892, 2010.

[5] Li, Shuhui, and Huiying Zheng. "Energy extraction characteristic study of solar photovoltaic cells and modules." In Power and Energy Society General Meeting, 2011 IEEE, pp. 1-7. IEEE, 2011.

[6] M. Miyatake, F. Toriumi, T. Endo, and N. Fujii, "A Novel maximum power point tracker controlling several converters connected to photovoltaic arrays with particle swarm optimization technique," 2007 Eur. Conf. Power Electron. Appl., pp. 1-10, 2007.

[7] C.-L. Liu, Y.-F. Luo, J.-W. Huang, and Y.-H. Liu, "A PSO-based MPPT algorithm for photovoltaic systems subject to inhomogeneous insolation," 6th Int. Conf. Soft Comput. Intell. Syst. 13th Int. Symp. Adv. Intell. Syst., no. 1, pp. 721-726, 2012

[8] M. C. Di Vincenzo and D. Inf, "Artificial Neural Network for real time modelling of photovoltaic system under partial shading," 2010

IEEE Int. Conf. Sustain. Energy Technol., pp. 1–5, 2010.

[9] A real maximum power point tracking method for mismatching compensation in PV array under partially shaded conditions," IEEE Trans. Power Electron., vol. 26, no. 4, pp. 1001–1009, 2011.

[10] Q. Duan, J. Leng, P. Duan, B. Hu, and M. Mao, "An Improved Variable Step PO and Global Scanning MPPT Method for PV Systems under Partial Shading Condition," in 7th International Conference on Intelligent Human-Machine Systems and Cybernetics, pp. 382–386, 2015.

[11] P. Lei, Y. Li, and J. E. Seem, "Sequential ESC-based global MPPT control for photovoltaic array with variable shading" ,IEEE Transactions on Sustainable Energy, vol. 2, no. 3, pp. 348–358, 2011.

[12] B. N. Alajmi, K. H. Ahmed, S. J. Finney, B. W. Williams, and B.

Wayne Williams, "A Maximum Power Point Tracking Technique for Partially Shaded Photovoltaic Systems in Micro grids" ,IEEE Transactions on Industrial Electronics, vol. 60, no. 4, pp. 1596–1606, 2011.

[13] K. Chen, S. Tian, Y. Cheng, and L. Bai, "An Improved MPPT Controller for Photovoltaic System Under Partial Shading Condition," Sustain. Energy, IEEE Trans., vol. 5, no. 3, pp. 978–985, 2014.

[14] J. Ahmed, S. Member, and Z. Salam, "An Improved Method to

Predict the Position of Maximum Power Point During Partial Shading for PV Arrays," IEEE Trans. Ind. Informatics, vol. 11, no. 6, pp.

1378–1387, 2015.

[15] Hariharan, M. Chakkarapani, G. S. Ilango, C. Nagamani, and S.

Member, "A Method to Detect Photovoltaic Array Faults and Partial

Shading in PV Systems," IEEE J. Photovoltaics, pp. 1–8, 2016.

[16] Uzunoglu, M., and M. S. Alam. "Dynamic modeling, design, and simulation of a combined PEM fuel cell and ultracapacitor system for stand-alone residential applications." IEEE Transactions on Energy Conversion 21.3 (2006): 767-775.

[17] Onar, O. C., M. Uzunoglu, and M. S. Alam. "Modeling, control and simulation of an autonomous wind turbine/photovoltaic/fuel cell/ultra-capacitor hybrid power system." Journal of Power Sources 185.2 (2008): 1273-1283.

[18] Hidaka, Yasuhito, and Koji Kawahara. "Modeling of a hybrid system of photovoltaic and fuel cell for operational strategy in residential use." Universities Power Engineering Conference (UPEC), 2012 47th International. IEEE, 2012.

[19] Gaonkar, D. N., and Sanjeev Nayak. "Modeling and performance analysis of microturbine based Distributed Generation system," "a review". Energytech, 2011 IEEE. IEEE, 2011.

[20] Khan, M. J., and M. T. Iqbal. "Pre-feasibility study of stand-alone hybrid energy systems for applications in Newfoundland." Renewable energy 30.6 (2005): 835-854.