iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 11 **Issue:** V **Month of publication:** May 2023

**DOI:** https://doi.org/10.22214/ijraset.2023.51647

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

# Achieving Maximum Power Point Tracking with Partial Shading

Sherish Fayaz[1], Satish Saini[2], UfaqFayaz[3]
[1]*M. Tech Scholar, Department ofElectrical Engineering, Regional Institute of Management and Technology, MandiGobindgarg, Punjab, India*
[2]*Professor, Department of Electrical Engineering, Regional Institute of Regional Institute of Management and Technology, MandiGobindgarg, Punjab, India*
[3] *Ph.D Scholar, Division of Food Science and Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar Kashmir India*

***Abstract: In the past, gasoline consumption has been high and on the rise, resulting in a massive increase in the production and use of renewable energy. The world's interest in greener energy is increasing, and photovoltaic (PV) solar is becoming more common and expanding in value as a choice. PV energy management and harvesting provide many benefits, but there are some drawbacks, for instance, poor energy conversion efficiency brought on by electrical and optical losses. The rest of these issues might be the most difficult to handle because of the chance element connected to its creation and the partial shading phenomena. Therefore, partial shading reduces the impact on the functionality and is a crucial component of the load torque voltage regulation unit. Even though each method has a unique set of potential downsides, different approaches have been proposed and evaluated in the literature up to this point. The suggested MATLAB computation in this paper creates a PV array structure in three distinct settings under varied partial shading situations. Also, it investigates the performance spanning various colouring patterns of numerous power demand point target tracking.***
***Keywords: Photovoltaic (PV), maximum power point tracking (MPPT), deterministic algorithms, stochastic algorithms***

## I. INTRODUCTION

Even if there is a need and tendency to use clean energy sources more to reduce the world's glaring dependency on conventional energies, alternatives are growing in popularity. However, the population's energy consumption is growing exponentially, putting a race against time on the development of enterprises that provide energy, particularly when it comes to green sources. Solar power has the most potential to alleviate the competitive advantages of any alternative energy source regarding long-term global energy supply issues. It is unquestionably the planet's most potent wellspring of life, producing enough energy on the low stratospheric surface to meet the demands of the whole world civilization hundreds of times over. Thus developing solar energycollecting technology is the most sensible response to the underlying problem of increasing the use of fossil fuels.

The most crucial aspects of solar energy are its reliability, simplicity of stockpiling, and, of nature, the fact that it is currently the most economical, accessible, and environmentally sustainable alternative are all things to take into account. It also draws attention towards individual citizens who want to upgrade their energy system or even build a solo PV-based system in their homes, as well as power energy investors' homes due to its ecologic friendliness, cheap operation, and upkeep expenses [1]. Also, this kind of technology pays for itself rather rapidly. There are two ways to harness solar power. Photovoltaic cell-based nuclear power stations and solar energy plants that work by absorbing photons energize its crystal mass, transform it into an oligomeric shape, and maintain this energetic state for over a couple of decades. It is one of the various systems being researched for collecting and storing solar energy. [2]. In any case, solar power plants are already widespread and will remain so for an extended period. Solar light is instantly converted into energy by PV cells, which provides a variety of perks and features.[3]. Yet, since energy fluctuations are so complicated, accurate management of their entire PV system is necessary for effective energy extraction. As a result, a range of strategies are used to guarantee effective power generation. The term "maximum power point tracking," or MPPT, has grown in use recently. Under any climatic conditions, the MPPT compels the Photovoltaic system to operate at its MPP or highest possible PowerPoint. This paper focuses on the behaviour of several algorithms in reaction to an outside factor that alters the amount of power that Photovoltaic (PV) systems can produce, namely the dark pattern that covers the solar cell array configuration. Moreover, to show if the MPPT approach excels in performance dynamics, the spectrum of shadow dynamics is quite broad. Here, we provide a concise literature review focusing on the various MPPT strategies that are now being employed more often. We discussed the PV cell's operation and the fundamental mathematical equations involved. Briey, it was simulated using models of PV cells.

One is. selected to display the function of the created shape and form in reaction to the external factors that have the most significant influence. This paper also shows the PV array and solar panel combinations. Also, it describes the most common power converter and distribution combinations for PV systems. Ultimately, a physical solution method is discussed together with the partial shading problem.

## II. OBJECTIVES

This paper's main objective is to evaluate several MPPT techniques.

*1)* To assess how they respond to a situation that changes the quantity of electricity that Solar panels produce.
*2)* To receive a partial shade during extreme weather conditions that cover a solar panel array.
*3)* To define the shadow dynamism range across a significant range and show which MPPT strategy (given the frequency aspects) is most successful.

## III. LITERATURE REVIEW

As determined by the evaluation, the network is located where the pressure gradient that discloses the PV array construction has a clear maximal. The light is continuous and homogenous throughout the entirety of Photovoltaic panels. The treatments most suited to the partially darkened state are discussed as follows. A process of trial and error shifts the set point by altering the voltage value at each time cycle while the actual PV power is being monitored. The next perturbation is actuated based on the power variance that is detected from each two-time step. The next perturbation will occur in the same direction or with the same perturbation sign if the power increases; if the power decreases, the direction of the perturbation will change. till is MPP is attained, which happens when dP/dV = 0, the fundamental operation is repeated. The amount of the perturbation step determines how much the tracker oscillates about the MPP when it gets there. This fundamental MPPT has been studied by several authors, sometimes to strengthen their weak points, sometimes to contrast it with other MPPT procedures, as ~~in~~ [4]; although it is the most generally used approach, the first one acts as a basis. The published experimental findings indicated that the suggested approach could provide a substantially quicker tracking speed. [6].

## IV. METHODOLOGY

### *A. Physic principle*

Photovoltaic cells, another name for solar energy, are machinery that use light from the sun to generate electricity. They do this by using the photoelectric effect of the material that makes them (which is described as the substance's capacity) emit electrons when exposed to a photon beam. The most often used element in the feature above, silicon, is a well-known diode with a mix of properties found in insulator and metal elements, enabling photoconductivity to occur. Moreover, silicon is the most frequently utilized substance to create cells. The physical composition resembles semiconductors very much. It comprises of two differently doped colored slabs at a p-n gates. The n-type component is ~~the~~ gate where the electrons are released, and the element is excessively doped. The conjunction produces an additional "free" electron because it has already been laced with a semiconductor that generates an excess of free electrons in the intermediate orbital layer, like light. While conventional techniques result in a combination's final supply recommended range with no electrons, the p-type layer uses a specific mechanism where the pump's proton is smaller than an octet in the ultimate valence tier, creating a "hole.". Because of the reduction of free electrons and holes, the three different joining create a protective coating in the intersection zone where electrons and holes have filled existing holes. The n-type zone has switched from a positive charge to a negative charge. Inversely, the n-type region never accepts any other number of atoms, and vice versa, because a mild electrical field forms between the opposite fields [18]. The generation of current requires the delivery of the depleting layer with more photon energy. Electronegativity will develop if this energy is substantial enough to penetrate the silica bandgap. barrier.

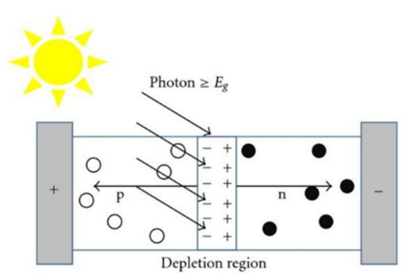



Figure 1 Diode

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

There are several doping materials technologies and methods accessible, even though as technology develops in this century, microchip silicon is now the most commonly used and is expected to continue to do so. CdTe and CIGS have the same conversion rates for sun's electricity (and at the level of Silicon cells) has increased over the past 50 years (from 5% to 20% in all situations), but they still make up less than 10% of the materials used to make cells [19]. (See Figure 3.2.).

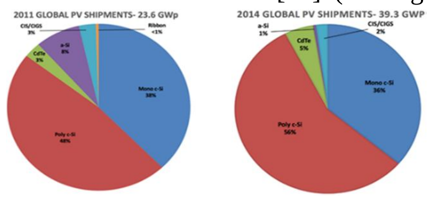



Figure 1 Substances utilized to construct cells.

The value and price of the material kind influence the distribution of these materials' usage and properties through time.
Monocrystalline silicon is the ideal material (mono c-Si). As a result of the presence of polycrystalline silicon (Poly c-Si), It is less efficient and has a less perfect geometry than silicon wafers. Due to this fact, this material's semiconductor is comprised of solid dispersion with predictable properties and is produced via an intricate and expensive process. Its capabilities are so significantly constrained, but the price is reasonable.

1) The cheapest and easiest to produce is silicon dioxide (a-Si). The efficiency of CIGS material is on par with that of polycrystalline silicon, and the cost of assembly is not prohibitive. Its primary drawbacks are the chemical toxicity and scarcity of its primary raw material, indium, which is also extremely expensive due to its high demand ~~due to its low global abundance~~ and application in various other products.
2) CdTe (Cadmium Telluride), a pricey material with a challenging production process
3) Although highly effective, it is unsuitable for most tasks owing to technological limitations. Nonetheless, if cost is not a significant concern, it may be helpful because it has a low cost comparably. As a result, the distribution pattern is evident, with Poly c-Si and Mono c-Si being utilized more frequently and outperforming the other materials.

In any event, assessing modern technology is crucial given the significance of growing renewable energy and its many components being researched worldwide. There is now a ton of fresh content being created, and at any moment, a new one that surpasses all others in every manner may be found.

### B. *Equivalent model circuit*

Overall, and as demonstrated by different estimation methods, there is still a definite trade-off between computing performance in a practical sense as compared to the design of a solar cell in any of its many theoretical forms. In this study, models containing three to nine characteristics are evaluated. The first implementation proved the most challenging but achieved the best representation of the actual model because the auto manufacturer has assisted the metrics with facts.–Conversely, the third model is the most straightforward but also the scariest as it needs to appropriately comport to the entire thing that appears to be accurate. Another area for improvement is that the parameters a model has, the more unpredictable and inaccurate it will be. As it offers a reasonable trade-off compared to other mathematical models, the industry's three most widely utilized factors modeling will be employed in this simulation. The different models will be covered in more detail in the next part, which will also look at the applicability of specific parameters.
Table 1 summarizes the various models' methods along with the relevant parameters.

*Table.1*

| Model | No. of parameters | Parameters |
|---|---|---|
| Ideal single-diode model | 3 | $Iph$, $Id1$, $n1$ |
| Single-diode $R_S$model | 4 | $I_{ph}$, $I_{d1}$, $n_1$, $R_S$ |
| Single-diode $R_{Sh}$model | 5 | $I_{ph}$, $I_{d1}$, $n_1$, $R_S$, $R_{Sh}$ |
| Two-diode model | 7 | $I_{ph}$, $I_{d1}$, $I_{d2}$, $n_1$, $n_2$, $R_S$, $R_{Sh}$ |
| Three-diode model | 9 | $I_{ph}$, $I_{d1}$, $I_{d2}$, $I_{d3}$, $n_1$, $n_2$, $n_3$, $R_S$, $R_{Sh}$ |

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

The "Parameters" column contains a list of the variables that each model utilizes. Idi and ni indicate each diode's charging blocking and distinguishing factor, respectively, and RS stands for the series resistance in that order. Iph stands for photocurrent—RSh, the shunt resistance, while Rse stands for the lumped series resistance.

## V. SYSTEM ARCHITECTURE

### *A. Setup Simulation*

Similar to how a Pv panel is created from the cells that make up a Pv panel, the reconfigured elements are composed of cells.

*1)* As a unique series array is not required to have a blocking diode, the initial configuration is an entire series module array. By adding the energies of each of the comparable voltages, I-V curve was generated using 15 I-V unit curves from their respective step eddies (figure 2)

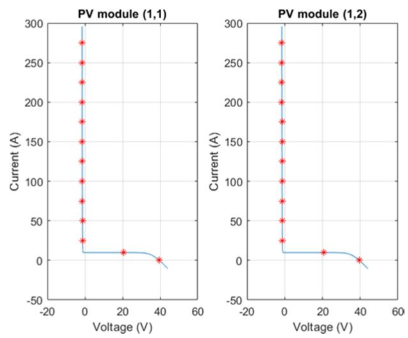



Figure 3Setup 1 for a series: Series sum

*2)* A stage 2 curve addition is required for the series-parallel second sums. Regarding configurations 2 and 3, the voltage sum for the current total for the 3 or 5 cells in the serial is then presented, followed by 5 or 3 rows in series, including that of the blocking diode. Figures 3 and 4 show this technique in the setting of three scenarios visually.

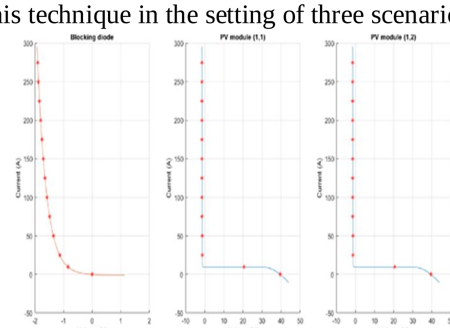


Figure 4Setup 3 of series parallelism; Series sum

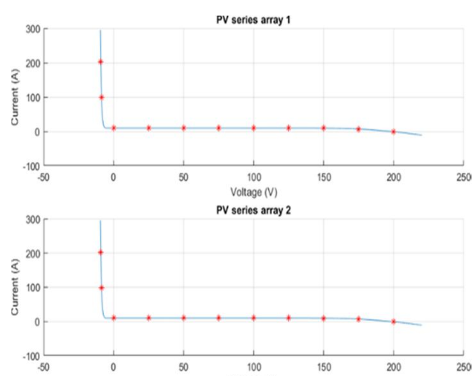



Figure 5 Setup 3 for series parallelism: Parallel sum

The I-V and P-V curves are displayed each time the user specifies the three situations. At 25 °C and 1000 W/m2, Figure 4.14 superimposes the three I-V and P-V profiles from the three separate setups to analyze them.

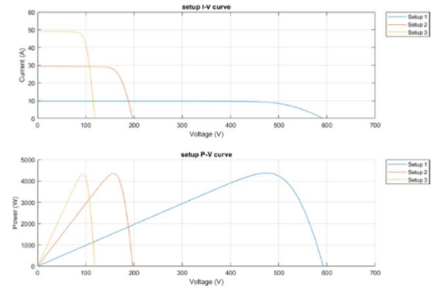


Figure 6Setup 3 of series parallelism; Series sum

Table 2 below provides a summary of various important elements.

Table 2 Physical constants

| Setup | $V_{oc}(V)$ | $I_{sc}(A)$ | MPP (W) |
|---|---|---|---|
| 1 | 592.5039 | 9.8317 | $4.3741 \cdot 10^3$ |
| 2 | 197.5014 | 29.4944 | $4.3510 \cdot 10^3$ |
| 3 | 118.5008 | 49.1564 | $4.3357 \cdot 10^3$ |

According to the reasoning, the rates of Voc and Isc for the three distinct designs are 1:3, 3:5, and 1:5, etc. Setup 3 needs more power than Setup 2. This is because the blocking diode has an additional gate, which causes the system to lose additional power. If the diode were not blocked, the power in the three configuration options would be comparable.

### *B. IV System*

The following step is to determine how to recover the electricity generated by the solar panel system and the requirement of some power converters. In any case, the following section begins with a comprehensive investigation of the several setups that may be used with a Solar panel.

### *C. The Partial Shading Issues*

#### *1) Effects on System Efficiency*

In previous chapters, we examined how the I-V and P-V curve shapes of the Pv were impacted by ultraviolet irradiance and the environment's temperature. To restore the power system's efficiency, a specific control is needed for the MPP position modification.
The focus changes and becomes much more difficult when there is some shading. It is typical and occasionally unavoidable because everyday elements like neighboring trees, chimneys, or clouds may cause it. Because the morphology of the I-V and P-V contours, independent extensions of the curves with partial shading, are mismatched, a P-V formation with both a global maximum and local maxima is produced.
The bypass diodes bring about these diverse forms that are employed to use an additional tunnel for power, including less revealed sections and avert the "hot spot" action [7], which destroys those shadowed cells that take the system's power generally. Consequently, different curve topologies will lead to many maximums, as illustrated in Figure 6, instead of losing one whole line of power as was initially predicted.

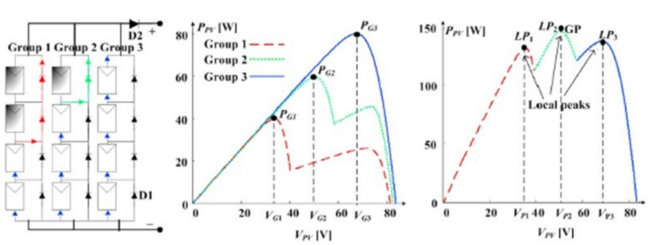


Figure 7Effectiveness of intermittency

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538*
*Volume 11 Issue V May 2023- Available at www.ijraset.com*

Specific trackers, like deterministic-based systems, can perform well even when the temperature and irradiance change. It is necessary to employ sensors that could detect an incorrect peak in the curves with several ups and downs of the graphs; a new approach will be required to avoid them and locate the highest peak. When a full shadow transient is present, simulating.

The preparation and shadow setup for the following simulation phase is depicted in (figure 7), which entails using a MATLAB image tool on a matrix that depicts the test environment area.

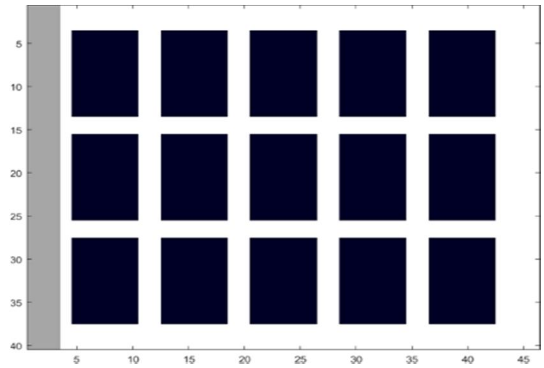


Figure 8 Complete shadow fleeting

The Pv systems come across the photoelectric modules' eventual blackness. The grey region represents the navy-blue cubes in the matrices, and the white area is simply the space between modules.

Each unit is around the same width as a single-plane photovoltaic effect. The field saturation speed will sufficiently cover about one PV cell each time step (10 cm/(timestep)). The insufficiency is because the simulation aims to analyze the P-V curve's growth. As a result, it is described as a quick action to avoid oversaturating the plot.

Figure 8 depicts the P-V curves for the three settings.

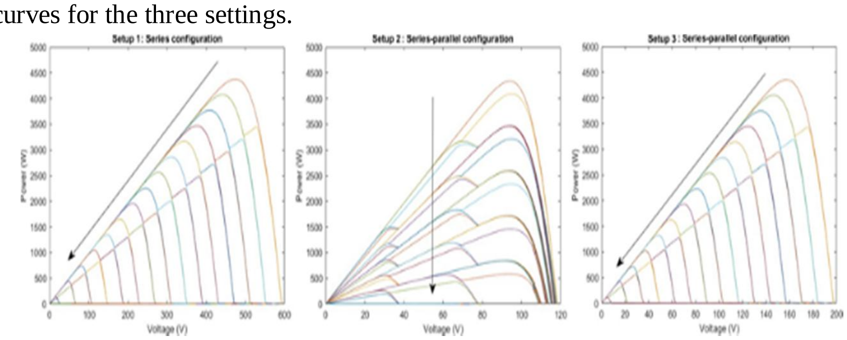



Figure 9P-V slopes with dark flicker.

The behaviour of Setups 1 and 3 remains the same. Figures 4.6, 4.7, and 4.8 depict the combinations more clearly. Setups 1 and 3 have the darkness falling in the same plane. However, configuration 2 has antenna arrays adjacent to the shadowing progress boundary.

### *D. Scenario Comparison*

There are many prior considerations to take into account when differentiating algorithms in various situations.

*1)* The module's P-V curve form was modified incrementally and step-by-step using the adaptive shading scenario. Both stochastic and deterministic techniques would act differently from a static curve shape-seeking technique. Gaussian methods often perform poorly while monitoring volatile performance parameters, and as the dynamic situation becomes more intense, their performance worsens Intensely. To check the significance of stoichiometric approaches in the PV arrangement, this research examined how the algorithm utilized the various dynamic settings that impacted the PV array's efficiency. It was found that the deterministic algorithms experienced a significant loss in efficiency when it was examined at a local maximum. Remembering that a stochastic algorithm might quickly enter a vertical asymptote just by being probabilistic is crucial. The issue is that even while this stochastic technique outperforms deterministic methods in this instance, it only follows that they can ultimately get beyond the partial shading barrier.

2) Deterministic methods that adhere to a primarily consistent call-in order, open-circuit potential, and 12v are examples of references that don't have the same difficulties as other methods., despite shading having a significant impact on their performance. The geometry of the shadow shape is the most crucial factor to consider in this situation. This final array setup or the resolution of partial shading difficulties were the main attributes of this research. Because it utilized the actual array structure, this form of control employs a different methodology than the MPPT algorithm (like the configurations seen in Figure 4.5). Using a Total-Cross-Tied array, several publications, such as [11], recommend constructing a new power curve by reorganizing the P-V curve. The previously referenced article used these simulated shadow patterns (figure 9) to assess the changing MPP attained due to the PV array reconfiguration. The outcome was that moving modules physically resulted in a higher MPP point than the standard TCT in large-form shadowed arrangements with a fixed power supply (PRM-FEC).

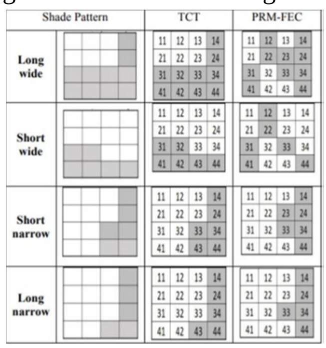


Figure 10 Shadow patterns

Although this method has nothing to do with MPPT control, it was fascinating and provided a different solution control problems with PV systems.

## VI. SIMULATION AND RESULTS

This work employed MATLAB, which simulated the effectiveness of various MPPT methods at various shading rates. Under different partial shade situations, the outcome is three different PV sets.

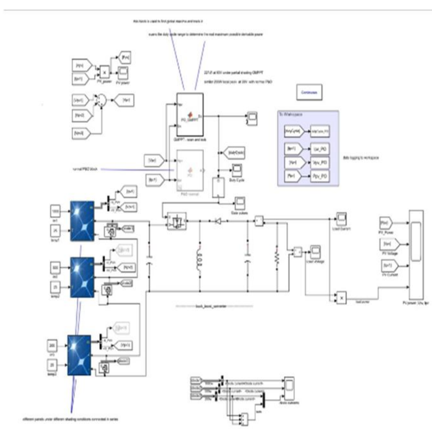


Figure 11 Model for a full simulation

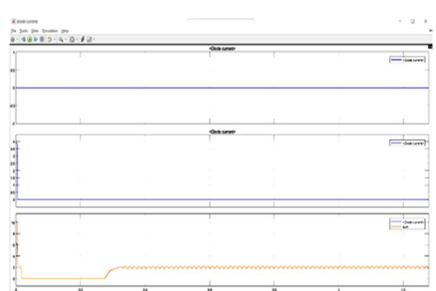


Figure 12 Currents in Diodes

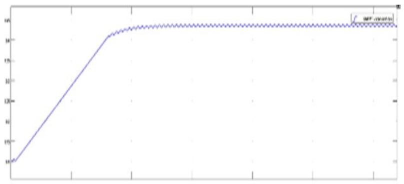


Figure 13 Duty Cycle

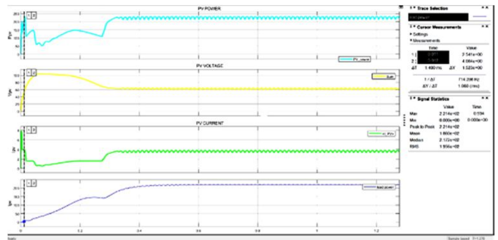


Figure 14Output

## VII. CONCLUSION

According to the data, using perturbation and observation independently to maximize power point is not conceivable. To apply a search algorithm and to locate the most credible feasible power, it is crucial to do a comprehensive scan covering the entire duty cycle. The tracking algorithm in this work is given significant importance and comes in command. After a few repetitions, the scanning finished, which allowed us to have additional tracking control by monitoring the maximum power point. Nevertheless, there may be a 0.5 percent power reduction as a result. Our system had a maximum power of 232 watts and 221 watts at its peak.

## REFERENCES

[1] Chih-Chiang Hua and Yi-min Chen. Modified perturb and observed MPPT with zero oscillation in steady-state for PV systems under partially shaded conditions. In 2017 IEEE Conference on Energy Conversion (CENCON), pages 5–9. IEEE, oct 2017.

[2] Fiseha Mekonnen Guangul and Girma T. Chala. Solar Energy as Renewable Energy Source: SWOT Analysis. In 2019 4th MEC International Conference on Big Data and Smart City (ICBDSC), pages 1–5. IEEE, jan 2019.

[3] H. Patel and V. Agarwal. Maximum Power Point Tracking Scheme for PV Systems Operating Under Partially Shaded Conditions. IEEE Transactions on Industrial Electronics, 55(4):1689–1698, apr 2008.

[4] M Praful Raj and Ann Mary Joshua. Modeling and performance analysis of perturb & observe, incremental conductance and fuzzy logic MPPT controllers. In 2017 International Conference on Advances in Electrical Technology for Green Energy (ICAETGT), pages 13–18. IEEE, sep 2017.

[5] Mohammad Jobayer Hossain, Bibek Tiwari, and Indranil Bhattacharya. An adaptive step size incremental conductance method for faster maximum power point tracking. In 2016 IEEE 43rd Photovoltaic Specialists Conference (PVSC), pages 3230–3233. IEEE, jun 2016.

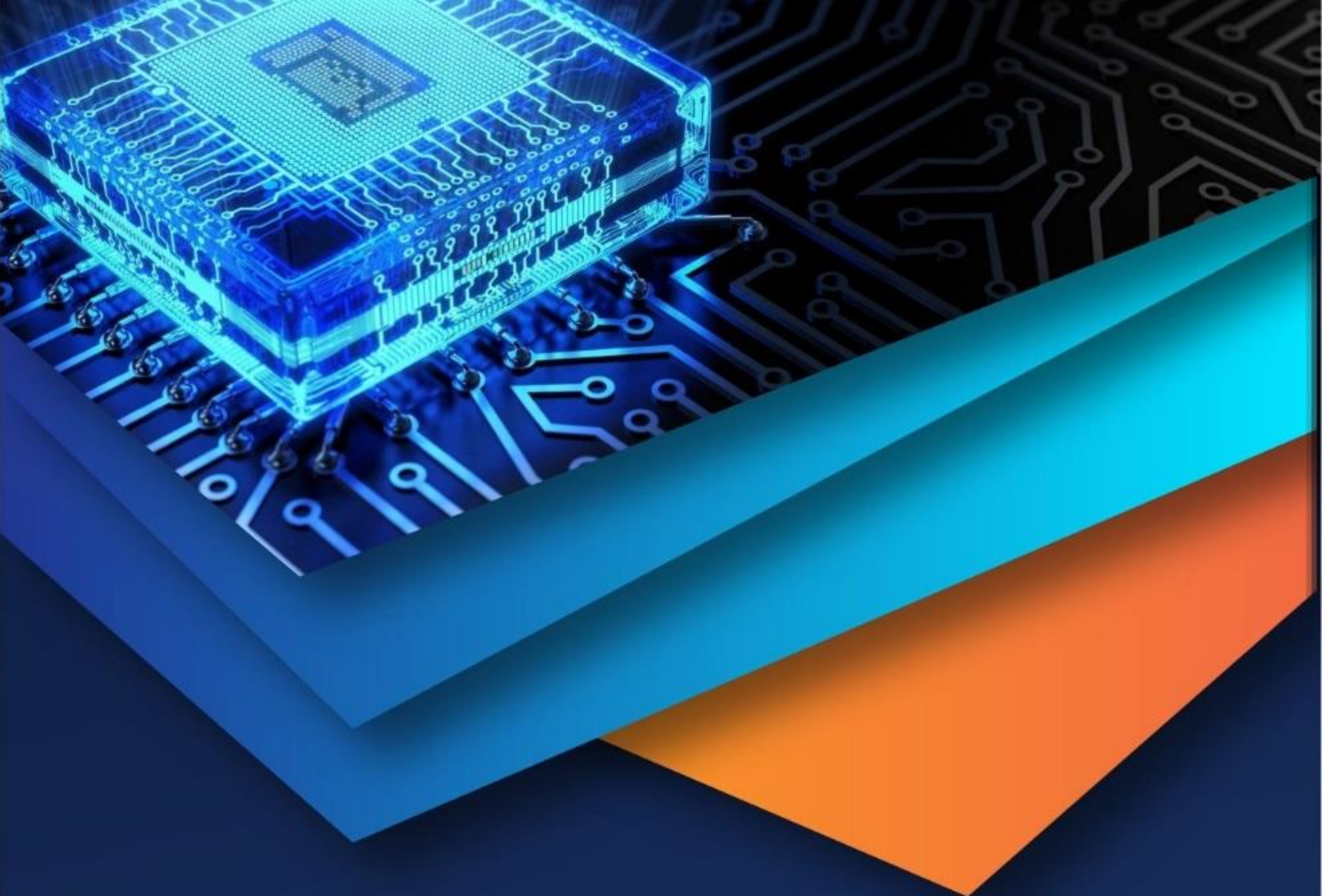
[6] Mohammad TaghiAmeli, Saeid Moslehpour, and Mehdi Shamlo. Economical load distribution in power networks that include hybrid solar power plants. Electric Power Systems Research, 78(7):1147–1152, jul 2008.

[7] Nabil Karami, Nazih Moubayed, and Rachid Outbib. General review and classification of different MPPT Techniques. Renewable and Sustainable Energy Reviews, 68:1–18, feb 2017.

[8] NoppadolKhaehintung, TheerayodWiangtong, and PhaophakSirisuk. FPGA Implementation of MPPT Using Variable Step-Size P&O Algorithm for PV Applications. In 2006 International Symposium on Communications and Information Technologies, pages 212–215. IEEE, oct 2006.

[9] TiongMeng Chung TiongMeng Chung, H. Daniyal, M.H. Sulaiman, and M.S. Bakar. Comparative study of P&O and modified incremental conductance algorithm in solar maximum power point tracking. In 4th IET Clean Energy and Technology Conference (CEAT 2016), pages 43 (6 .)–43 (6 .). Institution of Engineering and Technology, 2016.

[10] Zhihang Wang, Anna Roffey, Raul Losantos, Anders Lennartson, Martyn Jevric, Anne U. Petersen, Maria Quant, AmbraDreos, Xin Wen, Diego Sampedro, Karl Börjesson, and Kasper Moth-Poulsen. Macroscopic heat release in a molecular solar thermal energy storage system. Energy & Environmental Science, 12(1):187–193, jan 2019.




10.22214/IJRASET

INDEX COPERNICUS 45.98

ISRA JIF IMPACT FACTOR: 7.129

SJIFactor TOGETHER WE REACH THE GOAL IMPACT FACTOR: 7.429

ISI


# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY