Constant Power Generation Using Modified MPPTP&O in Solar PV cell connected to grid system

[1]I. Kumaraswamy , [2]V. V. Yashaswini,, [3]V. Anirudh, [4]S. Vishnuteja Goud, [5]K. Keerthana, [6]V. Divyasree

Department of Electrical and Electronics Engineering,SreeVidyanikethanEngineering College, Tirupati, India.
Kumaraswamy.i@vidyanikethan.edu
Yashaswinivaigandla.21@gmail.com
Vasaanirudh333@gmail.com
vishnuteja634@gmail.com
Kandulakeerthana111@gmail.com
divyasreevadithya@gmail.com

Abstract— The utilization of solar power plants is widespread around the world. Because solar power plants rely on irradiance, one of their challenges is the volatility of the electricity generated by the solar panels. The Maximum Power Point Tracking (MPPT) is used in a number of ways to address this issue. Although many approaches have been developed, the Perturb & Observe (P&O) method is popular for MPPT because it is inexpensive and simple to apply. Solar PV is operated at the Maximum Power Point thanks to this P&O MPPT control (MPP). the MPPT P&O control strategy optimizes the output voltage at the load, leading to overvoltage. The main focus of this study is the modification of the MPPT Perturb and Observe (P&O) algorithm using SEPIC converter. Two solar PV operating modes, MPPT mode and CPG mode, can be configured using this method. When solar PV output power is less than the reference power, the MPPT mode maximizes solar PV output power, and when solar PV output power is more than or equal to the reference power, the CPG mode limits the output power of the solar panel.The MPPT P&O-CPG control algorithm system receives voltage and current information from the SEPIC converter.In this proposal, the surplus energy produced is stored in batteries and transmitted to the grid system using a universal bridge.

Keywords—Constantpowergeneration,maximumpowerpointtracking,Perturb & Observe,solar PV, single ended primary inductance converter

1 INTRODUCTION

The solar energy has a main drawback of power instability due to irradiation and low energy conversion efficiency (20-30%). Sometimesdue to change in climatic conditions the generated power in the PV panels may not be constant [1] [2].Therefore, to solve this issue, PV panel's output power and reference power are compared via the MPPT P&O method, which boosts output when output is greater than reference power [3] [4]. Here MPPT does not work under the higher voltages at output, so this review mainly on the controlling of both higher and lower voltages. To say it clearly the MPPT algorithm will compare pre-defined reference voltage as needed [5] [6].

So, this review mainly based on to supply power to grid, for that inverter need to get input range between 200-300v. SEPIC converter is used for Constant Power Generation (CPG). It works under two conditions by pre-defined reference voltage in algorithm. Those two methods are act like step up and step down within the circuit. This all operation can be simulated using MATLAB Simulink software [7] [8].

2 CHARACTERISTICSOFPHOTOVOLTAICMODULE

Numerous solar cells that use sunlight to generate electricity make up the PV module. An ideal current source, series resistance, and parallel resistances make up a PV module. Figure 1 illustrates the I-V and

P-V characteristics, with the voltage on the X-axis and the current and power on the Y-axis [9] [10]. The maximum voltage and current that a PV cell can produce are known as Voc and Isc, respectively. Power is the result of current and voltage. The power will be zero just as it is on the X-axis where the voltage and current are both zero.So, the power curve will increase linearly as shown in the fig.1. The PV cell's maximum power output is known as Pmax [11] [12].

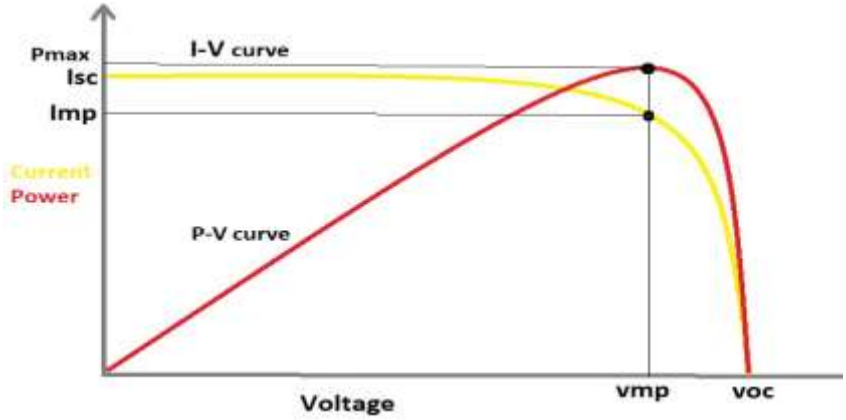

Fig. 1. I-V and P-V characteristics of PV module

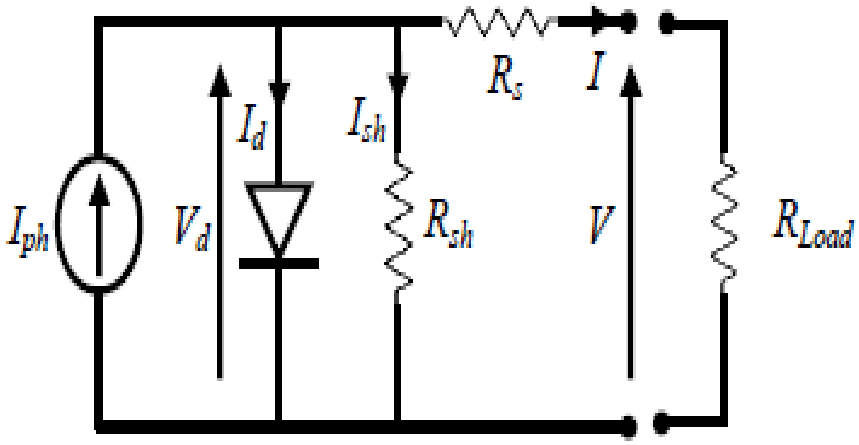

Fig.2. Equivalentcircuitofthephotovoltaiccell

3 SEPICTYPEDC-DCCONVERTER

An example of a DC/DC converter is the single-ended primary-inductor converter (SEPIC), which enables the electrical potential (voltage) at its output to be greater, lower, or equal to that at its input. The duty cycle of the control switch regulates the SEPIC's output.

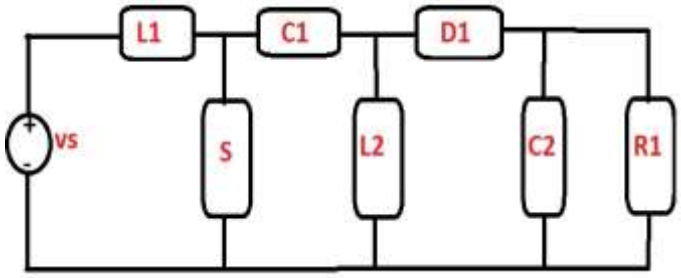

Fig. 3. SEPIC converter

In the SEPIC converter, the input voltage charges the inductor L1 while the capacitor C1 charges the inductor L2 if the pulse is high or the switch is on. Capacitor C2 will preserve the output while the diode is off. The output of the inductor passes through the diode to the load and charges the capacitors if the pulse is low or the switch is off. The output will increase as the duty cycle percentage increases. This is because the voltage of the inductors will increase the largerthey charge.

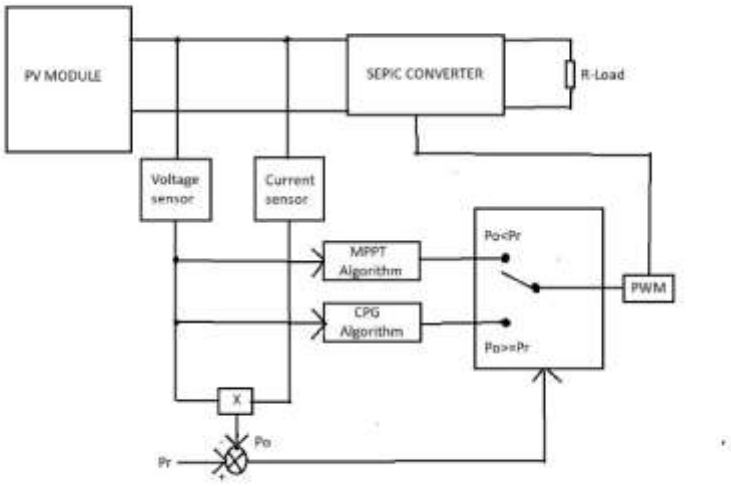

Fig.4. Block Diagram of MPPT P&O-CPG Operational Principles

Without altering its polarity, the SEPIC converter can create an output voltage that is either larger or smaller than the input voltage. The SEPIC converter's current and voltage sensors are used to transmit current and voltage data to the MPPT P&O CPG control algorithm system.

4 DESIGN OF MPPT P&O-CPG

It has two modes in this MPPT P&O-CPG technique. Both MPPT and CPG modes are available. based on the reference power and the solar panel output power (PPV) (Pref). The MPPT mode is engaged if the solar panel output power (PPV) is less than the reference power (Pref), while the CPG mode is activated if the PPV is greater than Pref. The SEPIC Converter's duty cycle will depend on the active mode.

MPPT P&O-CPG Algorithm:

Step1: Initialize the Reference Power.

Step2: Read the input, output voltages and currents by using current & voltage sensors.
Step 3: Calculate the output power (Po=Vi*Ii).
Step 4: Compare the output power and reference power of solar panel.
Step 5: MPPT mode is enabled if output power is less than or equal to reference power.
Step 6: CPG mode is enabled if output power is higher than reference power.
Step 7: The SEPIC converter's duty cycle can be calculated for this active mode.
Step 8: Until the MPP is attained, this procedure is continuously performed.

Modified MPPT P&O-CPG Algorithm:

Step 1: Measure the initial voltage and the initial current.
Step 2: The initial and prior powers should be compared.
Step 3: If initial power and the previous power is equal to zero then MPP is reached.
Step 4: If initial power and previous power is greater than zero then compare the initial voltage and previous voltage.
Step 5: Reduce the reference voltage if the initial voltage and the prior voltage are both larger than zero. Increase the reference voltage if the initial voltage and the prior voltage are both less than or equal to zero.
Step 6: If initial power and previous power is less than or equal to zero then compare the initial voltage and previous voltage.
Step7: Repeat the Step5.
Step8: Up till the MPP is attained, this procedure is periodically repeated.

Both approaches are nearly identical, however in the modified MPPT P&O approach, the Vref value is in the opposite direction.

Here, after establishing constant power generation and overcoming the overvoltage in solar PV cell, the generated power is needed to sent to the grid system. This is done with the help of universal bridge. Universal Bridge is connected to the SEPIC converter and the produced power is sent to the grid system.

The proposed method's arrangement is shown in Fig. 5.

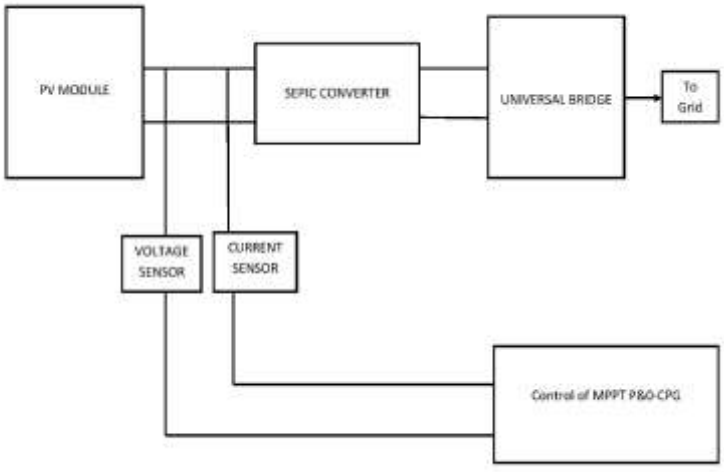

Fig. 5. Block Diagram of the whole circuit for proposed method

5 SIMULATION RESULT

The suggested MPPT P&O-CPG method is conducted and simulated using two reference power values (15KW and 25KW) for irradiance values of 1000 W/m^2 and 500 W/m^2, in order to examine the performance of the approach.

The suggested MPPT P&O-CPG method's simulated results are shown in Figure 6 on a 25x100 WP solar panel with irradiances of 1000W/m^2 and 500W/m^2, respectively.

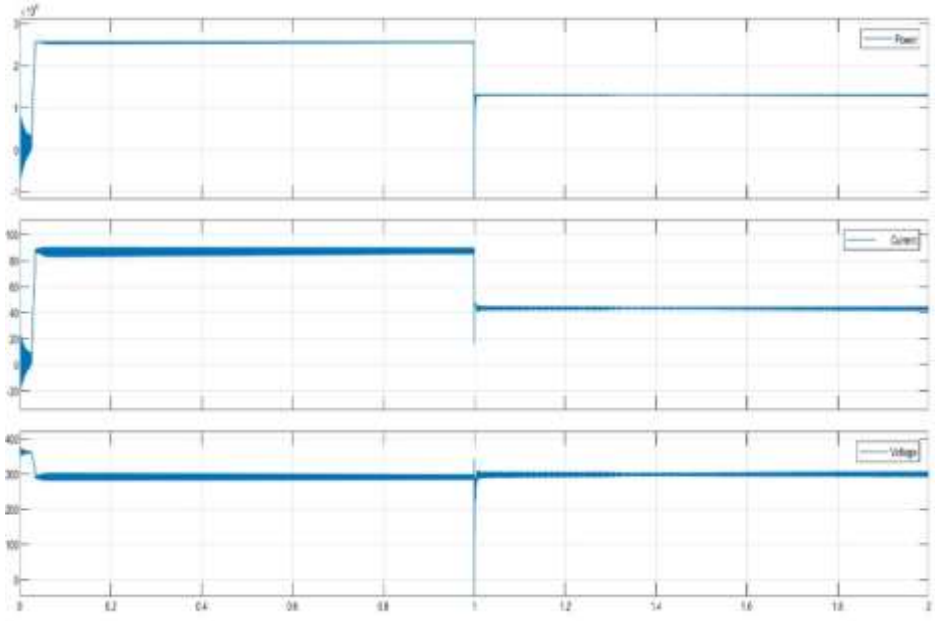

Fig. 6.output of Pout(Watt), Vout(Volt) and Iout(Amp) response to 1000W/m^2 and 500W/m^2 irradiance using MPPT P&O-CPG.

Fig. 7 below shows the output of voltage, current and power respectively for the grid system and x-axis shows time in ms. The expected output voltage from the solar PV system is >230v. The output voltage obtained is >300v and satisfies the condition. And also the power obtained is sent to the grid system.

Here the produced power is used to the extent of need and remaining is sent to the grid system using universal bridge.

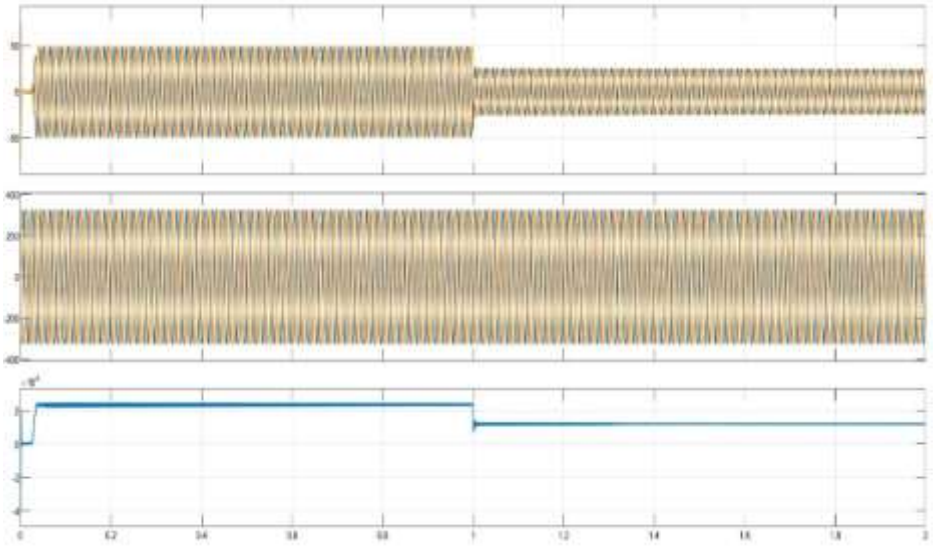

Fig. 7. Output of voltage, current and power in grid system

6 CONCLUSION

In this paper, analysis of the MPPT P&O CPG approach to solar panel control connected to grid system which will be working in two modes, MPPT mode and CPG mode, to prevent load overvoltage. This MPPT P&O CPG approach was tested by MATLAB simulation.According to the simulation results, the MPPT mode will be activated when the solar panel output power is less than or equal to the reference power (PPV=Pref). When the output power of the solar panel exceeds the reference power (PPV > Pref), CPG mode is activated.Here the SEPIC converter can be used to boost up the voltage and it is connected to the solar PV module of 25KWP.By using the Universal bridge converter we can transfer power to the grid . Thus, finally what ever the power generated by the solar system can be transferred to the grid with constant power by using this MPPT P&O CPG approach.

7 LITERATURE REVIEW

1. The limitations of the Perturb & Observe (P&O) approach in Maximum Power Point Tracking (MPPT)—low convergence time, excessive vibration around the MPP, and drift problems—are discussed in this study as potential solutions. MATLABSIMULINK is used to carry out the simulation.

2. This research describes a modified maximum power point tracking (MPPT) technique based on output sensing control for load protection. A flaw in all MPPTs is load protection. This solution introduces movement of the control sensors from input to output side of controller accordingly in order to address this flaw without the requirement to instal more sensors.

3. The four maximum power point tracking methods—Perturb and Observe (P&O), Incremental Conductance (InC), fuzzy logic-based tracking methodology, and a lesser-known approach employing simply photovoltaic current measurement—are all thoroughly compared in this research. According to the simulation results, the suggested fuzzy logic controller (FLC) can track the maximum power more quickly and is the most efficient than the other techniques.

4. Perturb and Observe (P&O), Incremental Conductance (InC), a fuzzy logic-based tracking methodology, and a lesser-knownemploying simply photovoltaic current monitoring are the four maximum power tracking techniques that are the subject of this paper's extensive comparative analysis. According on simulation results, the suggested fuzzy logic controller (FLC) can track maximum power more quickly and steadily than the other approaches under study.

8 REFERENCES

1. Sandeep Saket, Sachindra Kumar Verma, “Modified MPPT Algorithm for PV System Based on P&O” International Journal of Research Publication and Reviews, Vol 2, no 12, pp633-639,December 2021.
2. M. Hassani, S. Mekhilef, A. Patrick Hu, and N. R. Watson, "A novel MPPT algorithm for load protection based on output sensing control," IEEE Ninth International Conference on Power Electronics and Drive Systems (PEDS), pp. 1120-1124, 2011.
3. D. Beriber, and A. Talha, "MPPT techniques for PV systems," 4th International Conference on Power Engineering, Energy and Electrical Drives, pp. 1437-1442, 2013.
4. E. Prasetyono, D. O. Anggriawan, A. Z. Firmansyah, and N. A. Windarko, "A modified MPPT algorithm using incremental conductance for constant power generation of photovoltaic systems," Engineering Technology and Applications (IES-ETA) International Electronics Symposium on, pp. 1-6, 2017.
5. N. Moubayed, A. El-Ali, and R. Outbib, “Comparison of two MPPT techniques for PV system,” WSEAS Trans Environ Dev, 2009.
6. Gaga, F. Errahimi, and N. Es-Sbai, "Design and implementation of MPPT solar system based on the enhanced P&O algorithm using labview," International Renewable and Sustainable Energy Conference (IRSEC), pp. 203-208, 2014.
7. N. Femia, G. Petrone, G. Spagnuolo, and M. Vitelli, "Optimization of perturb and observe maximum power point tracking method," IEEE Transactions on Power Electronics, vol. 20, no. 4, pp. 963-973, July 2005.

8. Y. Yang, F. Blaabjerg, and H. Wang, "Constant power generation of photovoltaic systems considering the distributed grid capacity," IEEE Applied Power Electronics Conference and Exposition (APEC), pp. 379- 385, 2014.
9. Sangwongwanich, Y. Yang, and F. Blaabjerg, "High-performance constant power generation in grid-connected PV systems," IEEE Transactions On Power Electronics, vol. 31, no. 3, pp 1822- 1825, March 2016.
10. T. Bhavin, B. Patel, J. Desai, and K. Sonwane, "Analysis of SEPIC converter," International Journal of Engineering Development and Research (IJEDR), vol. 6, issue 2, 2018.
11. H. Suryoatmojo, R. M. Hakim, D. C. Riawan, R. Mardiyanto, S. Anam, E. Setijadi, and M. Ashari, "MPPT Based on Modified Incremental Conductance Algorithm for Solar Powered UAV," International Seminar on Intelligent Technology and Its Applications (ISITIA), pp. 108-113, 2019.
12. Soedibyo, S. Anam, I. Hafidz, G. R. Zulkarnain, and M. Ashari, "MPPT design on solar farm using perturb and observe technique considering tilt angle and partial shading in giligenting island," International Seminar on Intelligent Technology and Its Applications (ISITIA), pp. 222-226, 2017.
13. Q. A. Sias and I. Robandi, "Recurrence Perturb and Observe algorithm for MPPT optimization under shaded condition," International Seminar on Intelligent Technology and Its Applications (ISITIA), pp. 533-538, 2016.
14. D.K.Gupta, A. Srinivasulu, et al.,"Load Frequency Control Using Hybrid Intelligent Optimization technique for Multi-Source Power Systems", Energies, 2021, 14(6), 1581; doi:10.3390/en14061581.ISSN:1996-1073.
15. S .Sreelakshmi, M. S. Sujatha, Jammy Ramesh Rahul, " Improved Seven level Multilevel DC-Link Inverter with Novel Carrier PWM Technique", Journal of Circuits Systems and Computers, DOI.org/10.1142/S0218126623501086, 2023.
16. D.K.Gupta, A. Srinivasulu, et al.,"Hybrid Gravitational-Firefly Algorithm based Load Frequency Control for Hydrothermal Two-area System", Mathematics, 2021, 9(7), 712; doi:10.3390/math9070712.
17. S .Sreelakshmi, M. S. Sujatha, Jammy Ramesh Rahul, " Multi-level inverter with novel carrier pulse width modulation technique for high voltage applications " , Indonesian Journal of Electrical Engineering and Computer Science Vol. 26, No. 2, May 2022, pp. 667~674.