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Implementation of Perturb & Observe and Incremental Conductance Algorithm for PV system

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ABSTRACT

Photovoltaic energy is widely being used energy source since it is clean and inexhaustible. PV system must be operated at maximum power point to extract maximum available power from PV arrays. For this purpose, MPPT technique is being used. In this paper modelling of PV system is presented. Two different MPPT techniques are simulated, namely the Perturbation and Observation (P&O) method and the Incremental Conductance method. The conversion efficiency of PV system is improved by using MPPT and DC-DC converter. The simulation results are evaluated via MATLAB Simulink.

KEYWORDS: PV array, boost converter, MPPT, Perturb & Observe (P&O), Incremental Conductance (INC), PI Controller.

1. INTRODUCTION

As technology improves there is high demand for electricity and high electricity demand put stress on the nation's energy infrastructure. Today, 26% of the globe is powered by renewable energy. There are various types of renewable energy sources being used. They are solar, geothermal, bioenergy, wind, and water (hydroelectric). Among all renewable energy sources solar energy is more popular energy source.

As solar panels have become increasingly more popular, more research is carried to improve the efficiency of the panel. In spite of the efficiency being so low, solar panels are being implemented and employed in many places as it is easy to implement, doesn't require maintenance and is residential and commercially friendly. Efficiency of solar cell is increased by a method called maximum power point tracking. MPPT is considered the most appropriate solution to ensure the extraction of maximum power from the PV system. This paper presents the implementation of the P&O and incremental conductance (INC) algorithms in MATLAB/Simulink.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms and objectives. In Section 2 we discuss Methodology. In Section 3 we have the information about PV cell modelling. Section 4 shares information about DC-DC Converter. Section 5 tells us about PI Controller. Section 6 tells us aboout Maximum power point tracking. Section 7 we discuss Simulation and results. Section 8 concludes the paper with references.

OBJECTIVES

To study maximum power point tracking and implementing MPPT algorithm either in code form as well as using Simulink/Simscape. To study modelling of photovoltaic cell and interfacing with MPPT algorithm. To obtain maximum possible power from the PV system using MPPT.

2. METHODOLOGY

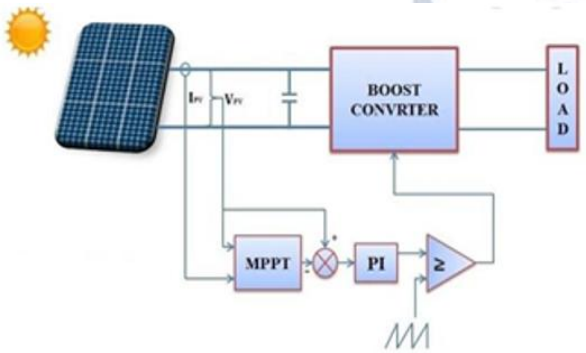

Fig. 1: Block diagram of PV system

The block diagram representation of solar energy conversion system is shown in Fig.1. The system includes PV array, MPPT controller and dc-dc converter. MPPT controller is the important component of the system which extracts maximum power from the PV system. Initially solar voltage and current are sensed. They are given as inputs to the MPPT controller and then solar power is transferred to the converter block.

MPPT algorithm programming is done in MPPT controller block and reference voltage (Vref) is obtained as output. This reference voltage is compared with the actual PV voltage to find the error. This error is fed as input to the PI controller. The output of PI controller provides the required duty ratio for PWM generation. It is compared with the carrier signal and is given to the gate terminal of IGBT. It gives better MPPT as it has closed loop control mechanism. PI controller tuning is done in MATLAB. By properly tuning PI controller oscillations in the output are reduced.

3. PV CELL MODELLING

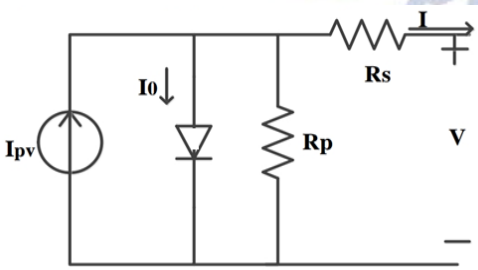

Fig. 2: Practical equivalent circuit of a PV cell

$$I = I_{pv} - I_0\left[e^{\left(\frac{V+R_S I}{\alpha V_t}\right)} - 1\right] - \frac{V+R_S I}{R_p}.$$

Parameter Specifications of PV module

1. Open circuit voltage Voc = 37.6V
2. Short circuit current Isc = 8.55A
3. Maximum power output = 249.86W
4. Voltage at maximum power Vmp =31V
5. Current at maximum power point Imp =8.06A

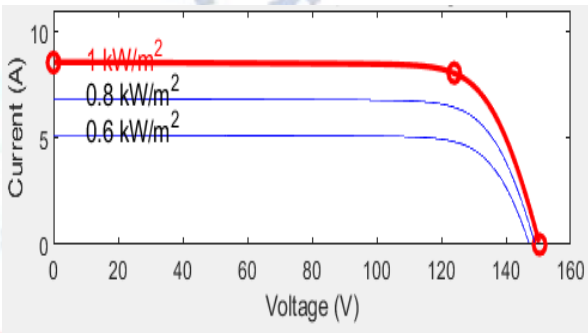

Fig. 3: Current vs. Voltage plot for varying irradiance at constant temperature

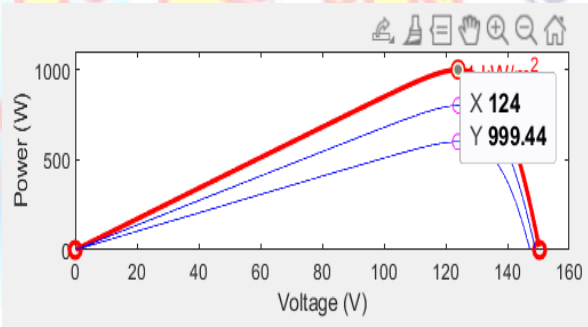

Fig.4: Power vs. voltage plot for varying irradiance at constant temperature

- To produce 1KW power capacity 4 series and 1 parallel module will be required.

Rated power = 4*1*Pmp = 4*1*249.86 = 999.44W=1KW

4. DC-DC CONVERTER

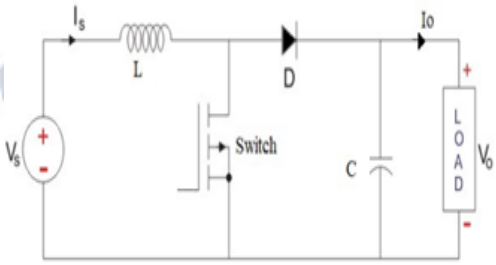

Fig. 5: DC-DC boost converter circuit

DC-DC boost converter is the interconnection between the PV panel and the load. The boost converter

is controlled through a pulse width modulation (PWM) signal produced by the MPPT-based controller.

Design of Boost converter

- Inductance: L=Vip–(Vop – Vip)/fs*ΔI*Vop
  Inductance = L = 27.65mH
- Capacitance:C=Iop–(Vo*Vin)/fs*ΔV*Vop
  Capacitor = C = 166.6microFarad
- Switching frequency = 25KHz

5.PI CONTROLLER

As the name suggests it is a combination of proportional and an integral controller. The output is the summation of proportional and integral of the error signal. It is one of the most widely used controller as it reduces steady state error drastically.

6.MAXIMUM POWERPOINT TRACKING

It is an operating point at which maximum power can be extracted from the system so as to boost the efficiency of the solar panel, MPPT is employed. There are different algorithms that are being used to control the MPPT. The algorithms that are most commonly used are the PERTURB AND OBSERVE and INCREMENTAL CONDUCTANCE methods which are presented in this study.

1] PERTURB AND OBSERVE METHOD

The perturb and observe (P&O) algorithm is generally the most commonly used MPPT algorithm for the PV generator. It has simple structure, low cost and easy to implement.

The behaviour of solar panel indicating MPP is shown below in Fig. 6.

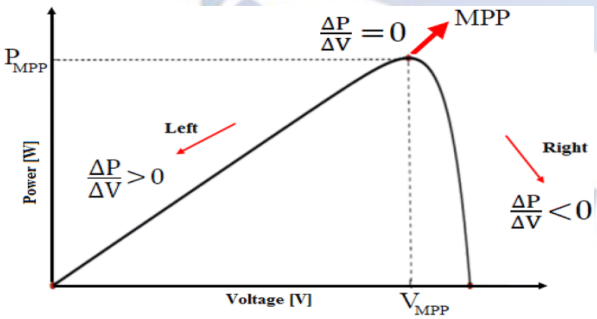

Fig. 6: Behaviour of solar panel indicating MPP

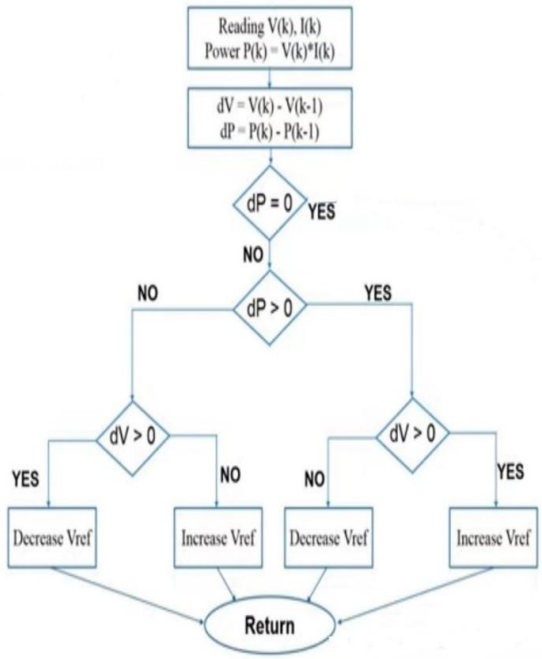

Fig. 7: Flowchart of the P&O algorithm

2] INCREMENTAL CONDUCTANCE

In incremental conductance (INC) algorithm, to predict the effect of a voltage change the controller measures incremental changes in PV array voltage and current. This method requires more computation in the controller. The INC algorithm calculates the maximum power point by comparison of the incremental conductance (ΔI/ΔV) with the array conductance (I/V).

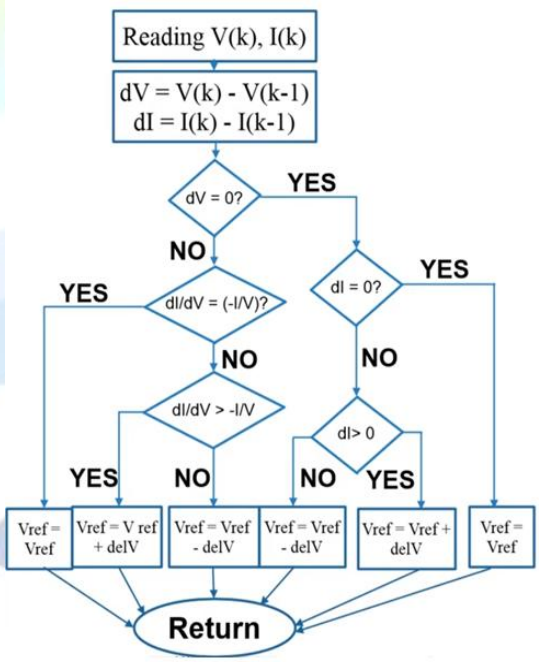

Fig 8: Flowchart of the INC algorithm

7.SIMULATION AND RESULTS

A PV system of 1KW is simulated in MATLAB and results are obtained. A PV system is connected to the load

through a boost converter. The switch of the converter is controlled by a PWM signal from a MPPT control.

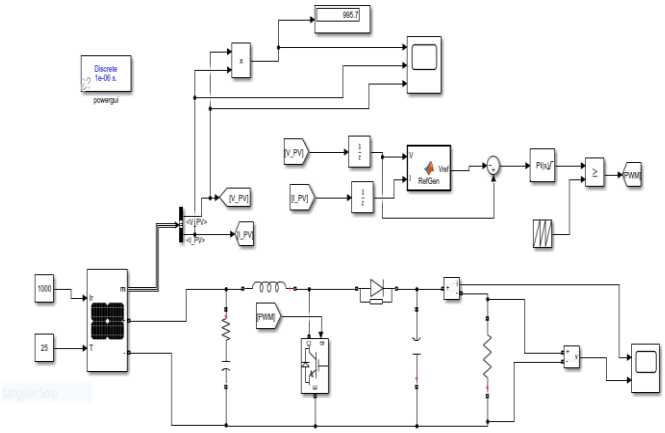

Fig. 9: Simulink model of PV system with Perturb and Observe (P&O) algorithm

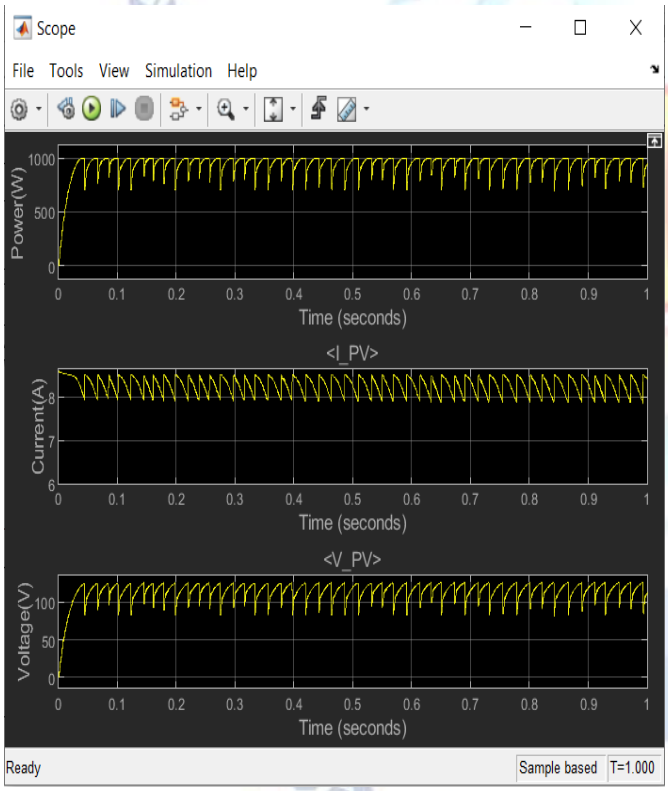

Fig. 10: PV array power, current and voltage according to time with P&O without tuning PI controller

After properly tuning PI controller oscillations are reduced.

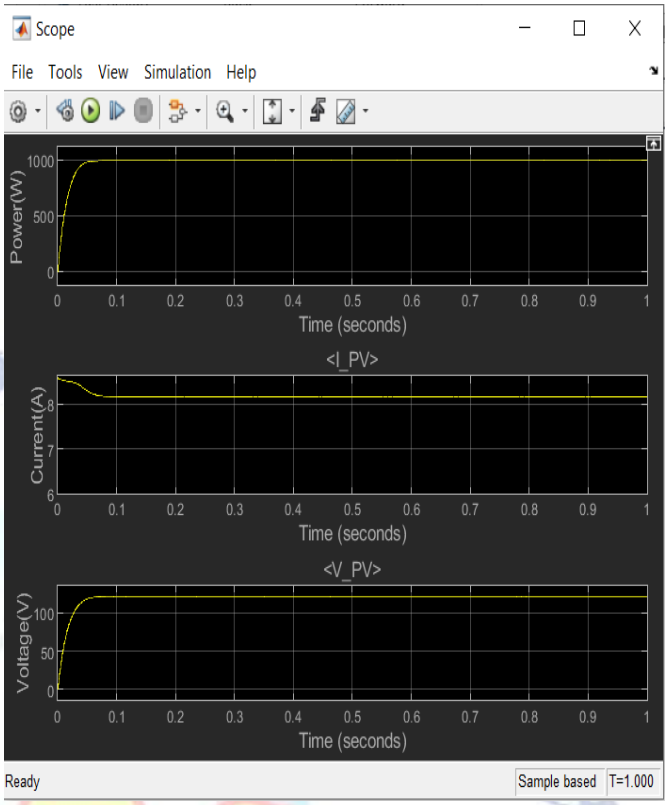

Fig. 11: PV array power, current and voltage according to time with P&O algorithm

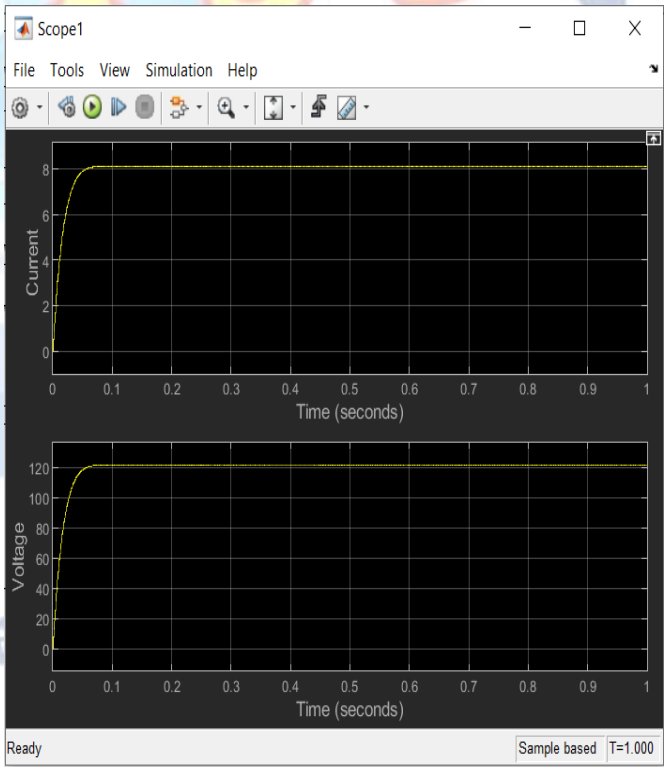

Fig. 12: Current vs. time and Voltage vs. time plot for the load with P&O algorithm

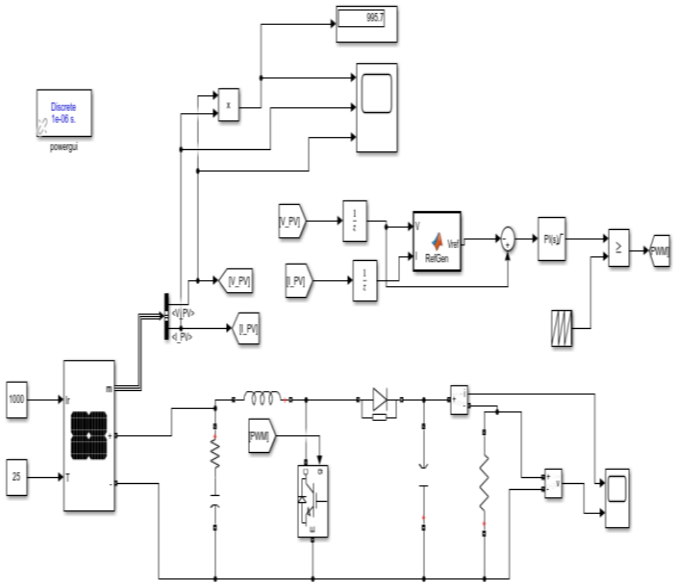

Fig. 13: Simulink model of PV system with implemented INC algorithm

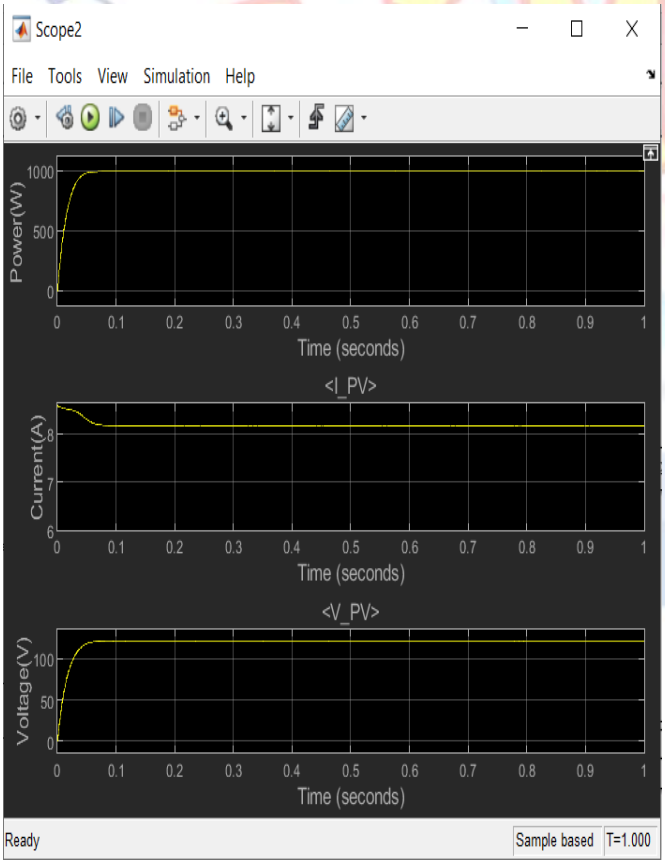

Fig. 14: PV array power, current and voltage according to time with INC algorithm

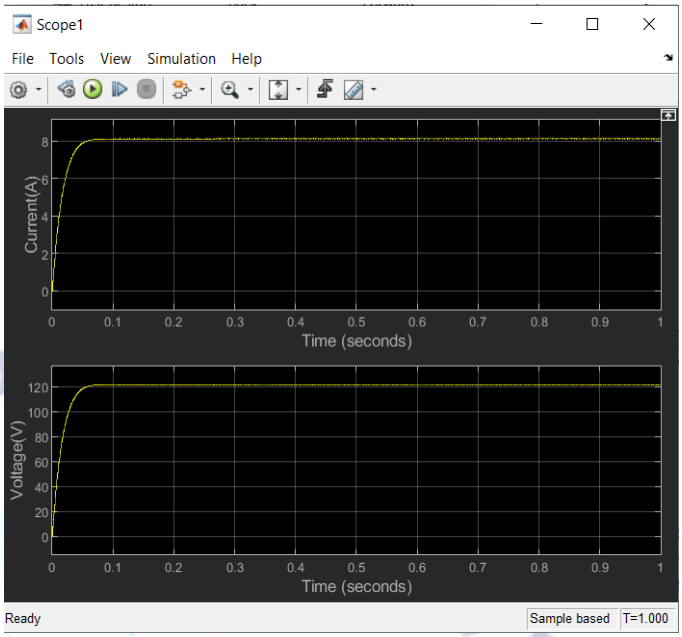

Fig. 15: Current vs. time and Voltage vs. time plot for the load with INC algorithm

8.CONCLUSION

The MPPT techniques are implemented using perturb and observe (P&O) and incremental conductance (INC) with boost converter topology. The extracted power from PV system by a MPPT control is improved for different levels of the illumination by properly tuning PI controller.

Maximum power is tracked by using MPPT and DC-DC boost converter. P and O algorithm gives good response under varying irradiance and constant temperature. INC algorithm can find rapidly and accurately the MPP with less oscillations. A PV system of 1KW is modelled and simulated in MATLAB.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Muhammad Hammad Uddin, Muhammad Ali Baig, Muhammad Ali, "Comparison of 'Perturb & Observe' and 'Incremental Conductance' Maximum Power Point Tracking algorithm on real environmental conditions": 2016 International Conference on Computing, Electronic and Electrical Engineering (ICE Cube) 2016.

[2] M. C. Argyrou, Paul Christodoulides and Soteris A. Kalogirou, "Modeling of a photovoltaic system with different MPPT techniques using MATLAB/Simulink", 2018 IEEE International Energy Conference (ENERGYCON), 2018, pp. 1-6, doi:10.1109/ENERGYCON.2018.8398734.

[3] N. A. Zainal, Ajisman, and A. R. Yusoff, "Modelling of Photovoltaic Module Using Matlab Simulink," in IOP Conference Series: Materials Science and Engineering, 2016, vol. 114, no. 1.

[4] D. GUIZA, D. OUNNAS, Y. SOUFI and M. MAAMRI, "Implementation of Perturb and Observe Based MPPT Algorithm for Photovoltaic System," Power [W], 20, 40.

[5] Murari Lal Azad, Soumya Das, Pradeep Kumar Sadhu, Biplap Satpati, Angh Gupta, "P&O algorithn based MPPT technique for solar PV system under different weather condition" ICCPCT, 2014.