International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org Volume 2 Issue 2 ǁ February. 2013 ǁ PP.45-50

Enhancement of Solar Photovoltaic Cell by Using Short-Circuit Current Mppt Method

[1]Burri Ankaiah, Jalakanuru Nageswararao[2]

[1]Assistant Professor, Department of Electrical and Electronics Engineering,Vignan Institute of Technology and Science,Vignan Hills,Deshmukhi Village,Pochampally Mandal,Nalgonda District,AndhraPradesh, India- 508284 .
[2]Assistant Professor, Department of Electrical and Electronics Engineering, Global Institute of Engineering & Technology Chilkur (V), Moinabad (M), R.R (dist) Andhra Pradesh, India.

ABSTRACT: Photovoltaic (PV) energy is the most important energy resource since it is clean, pollution free, and inexhaustible. Due to rapid growth in the semiconductor and power electronics techniques, PV energy is of increasing interest in electrical power applications. It is important to operate PV energy conversion systems near the maximum power point to increase the output efficiency of PV arrays. The output power of PV arrays is always changing with weather conditions, i.e., solar irradiation and atmospheric temperature. Therefore, a MPPT control to extract maximum power from the PV arrays at real time becomes indispensable in PV generation system. In recent years, a large number of techniques have been proposed for tracking the maximum power point (MPP). Maximum power point tracking (MPPT) is used in photovoltaic (PV) systems to maximize the photovoltaic array output power, irrespective of the temperature and radiation conditions and of the load electrical characteristics the PV array output power is used to directly control the dc/dc converter, thus reducing the complexity of the system. The resulting system has high-efficiency; lower-cost this paper proposes a maximum-PowerPoint tracking (MPPT) method with a simple algorithm for photovoltaic (PV) power generation systems. The method is based on use of a short circuit current MPPT method of the PV to determine an optimum operating current for the maximum output power. This work proposes on short circuit current Based maximum Power Point Tracking for Photovoltaic System, to have the advantages of low frequency switching.

Keywords: Photovoltaic System, Modeling of PV Arrays, short-circuit current MPPT algorithm

I. INTRODUCTION

Renewable sources of energy acquire growing importance due to its enormous consumption and exhaustion of fossil fuel. Also, solar energy is the most readily available source of energy and it is free. Moreover, solar energy is the best among all the renewable energy sources since, it is non-polluting. Energy supplied by the sun in one hour is equal to the amount of energy required by the human in one year. Photo voltaic arrays are used in many applications such as water pumping, street lighting in rural town, battery charging and grid connected PV systems. As known from a Power-Voltage curve of a solar panel, there is an optimum operating point such that the PV delivers the maximum possible power to the load. The optimum operating point changes with solar irradiation and cell temperature. Therefore, maximum power point tracking is essential for PV panel. A variety of maximum power point tracking (MPPT) methods is available
This paper deals with Short Circuit Current MPPT algorithm method due to its simple approach.

II. PHOTOVOLTAIC CELL

Photovoltaic cell generates electricity from the sun. PV panel works under the phenomenon of photoelectric effect. It directly converts sunlight into electricity. The diagram of PV based system is shown in Fig. 1.

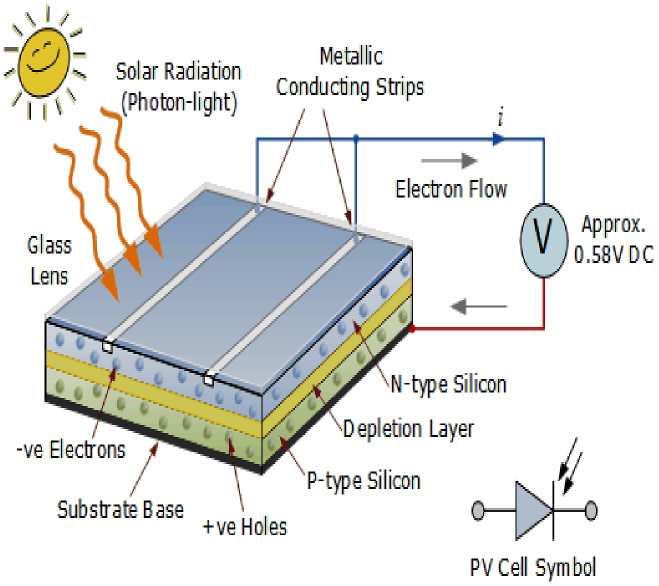

Fig. 1.Circuit Diagram of the PV Cell

The positive and negative charges created by the absorption of photons are thus encouraged to drift to the front and back of the solar cell. The back is completely covered by a metallic contact to remove the charges to the electric load. The collection of charges from the front of the cell is aided by a fine grid of narrow metallic fingers. The p-n junction provides an electrical field that sweeps the electrons in one direction and the positive holes in the other. If the junction is in thermodynamic equilibrium, then the Fermi energy must be uniform throughout. Since the Fermi level is near the top of the gap of an n-doped material and near the bottom of the p-doped side, an electric field must exist at the junction providing the charge separation function of the cell.

III. CONVERSION EFFICIENCY AND POWER OUTPUT

A solar cell usually uses a p-n junction its physical configuration is shown schematically in fig2

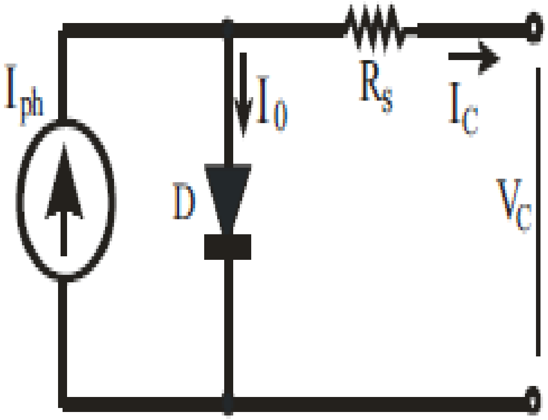

Fig .2 The equivalent circuit of a solar cell

Where

I_c = cell output current
V_c = cell output voltage
I_{ph} = light generated current
I_o = reverse saturation current
Rs = series resistance of the cell

Current and voltage relationship is given by

$$I_i = I_0\left[exp\left(\frac{Ve}{KT}\right) - 1\right]$$

Where

I_o is the saturation current also called the dark current and is applied when a large negative voltage is applied across the diode.

V is the voltage across junction.
e is the electronic charge
k is Boltzmann’s constant
T is the absolute temperature

When light impinges on the junction, electron hole pairs are created at a constant rate providing an electrical flow across the junction. The net current is thus the difference between the normal diode current and light generated current $I_{L.}$ The internal series resistance Rs is mostly due to the high sheet resistance of the diffused layer which is in series with the junction. The light generated current acts as a constant current source supplying the current to either the junction or a useful load depending on the junction characteristic and the value of the external load resistance. The net current I is given by

$$I=I_L - I_i=I_L - I_0\left[exp\left(\frac{Ve}{KT}\right)-1\right]$$

The internal voltage drop in a cell can usually be minimized, and for ideal cell R_s may be assumed equal to zero i.e. $R_s=0$. With these the corresponding I-V plot is given in figure. Open circuit voltage $V_{oc}$for the ideal cell is then given by

$$V_{OC}=\left(\frac{KT}{e}\right)\ln\left[\frac{I_L}{I_o}+1\right]$$

Since $I_L>>I_o$, the 1 in the equation can be neglected. Then open circuit voltage

$$V_{OC}=\frac{KT}{e}\ln\left[\frac{I_L}{I_o}\right]$$

In practice the open circuit voltage of the cell decreases with increasing temperature.
The maximum power that can be derived from the device is given by

$$P_{max} = V_{mp}.I_{mp}$$

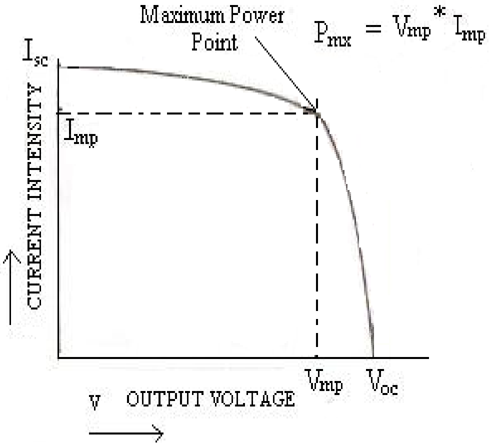

Fig 3 A typical I-V plot for ideal solar cell

Where V_{mp} and I_{mp} are the voltage and current at maximum power point as shown in figure 3.respectively. It can be seen that the maximum efficiency for the cell is obtained by dividing V_{mp} I_{mp} by the total power density of the sunlight $P_{sun.}$ Thus

$$\eta=\frac{V_{mp}\,I_{mp}}{P_{sun}}$$

$$=\left(\frac{I_L E_G}{e\,P_{sun}}\right)\left(\frac{V_{mp}\,I_{mp}}{I_L\,V_{OC}}\right)\left(\frac{e\,V_{OC}}{E_G}\right)$$

[Where E_g= Forbidden energy gap]

The fill factor (FF) for a solar cell is defined as the ratio of two areas shown.

$$FF=\frac{V_{mp}\,I_{mp}}{I_L\,V_{OC}}$$

Solar cell designers, strive to increase the fill factor values, to minimize the internal losses. Maximum – power can be defined in terms of V_{oc} and I_L is given by

$$Pmax= IL \times VOC \times FF$$

A typical value of the fill factor for a good silicon cell is about 0.8.The voltage factor (eV_{oc}/E_g) is determined by the basic properties of the materials in the cell and typically about 0.5 for a silicon cell.

IV. SHORT-CIRCUIT CURRENT MPPT METHOD

This method exploits the assumption of linear relationship between the “cell current corresponding toThe maximum power (IMP)” and the cell-short circuit current (ISC). This relationship can be expressed as: IMP = K . ISC where K is called the current factor.Peak Power of the module lies at about 90% of its short circuit current. The Flowchart of Short-circuit current MPPT is shown fig 4.

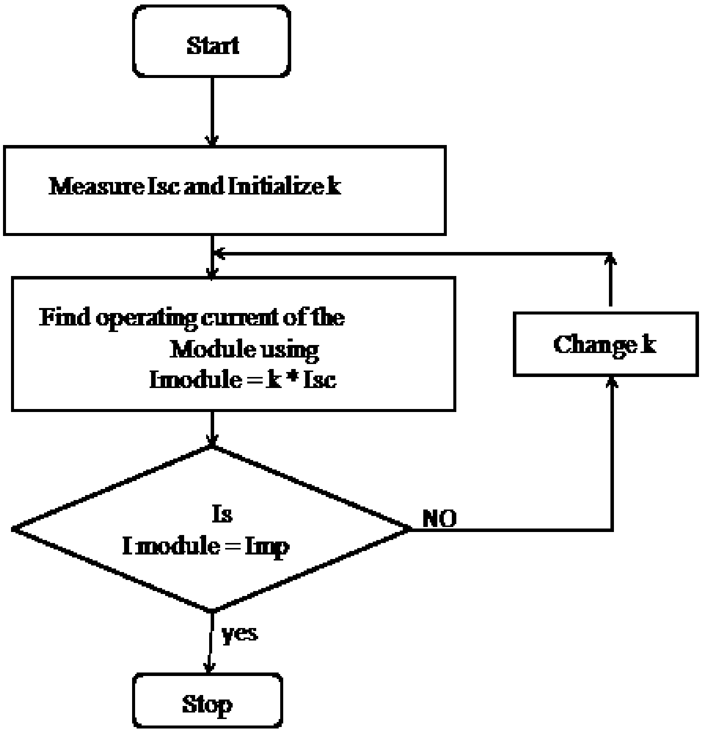

Fig 4.Flow Chart For the Short-Circuit Method

V. SIMULATION CIRCUIT

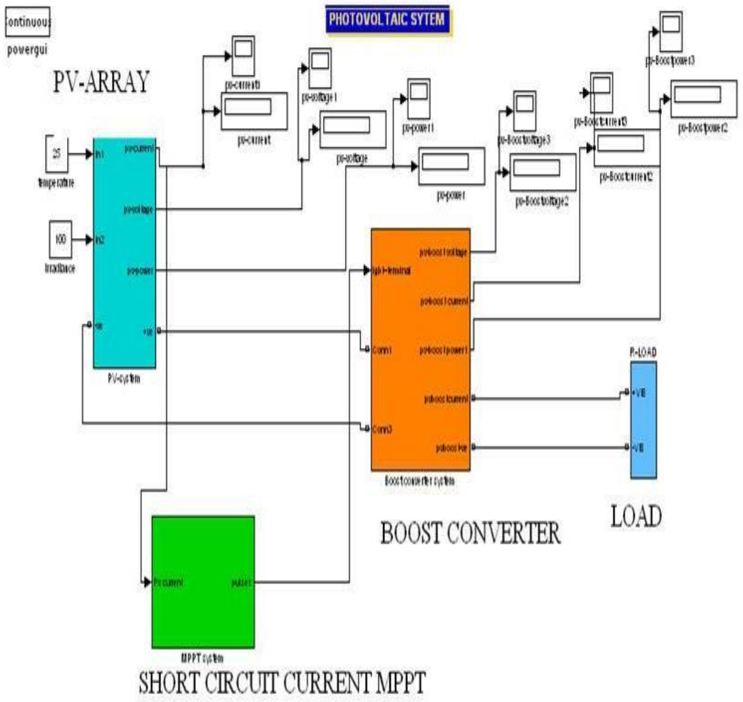

Fig5.Simulation Circuit of the Short-Circuit Method

VI. SIMULATION RESULT

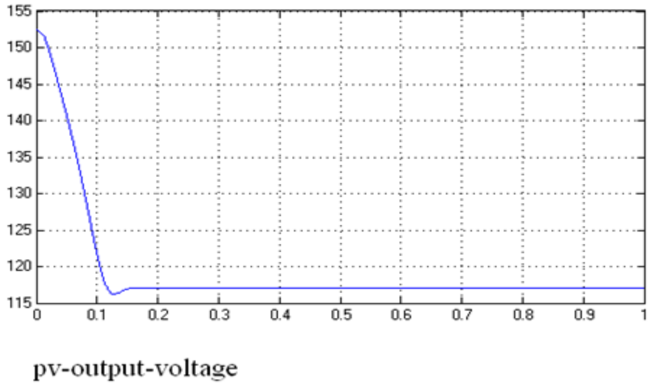

Fig.6.1 PV Module Output Voltage with MPPT Controller

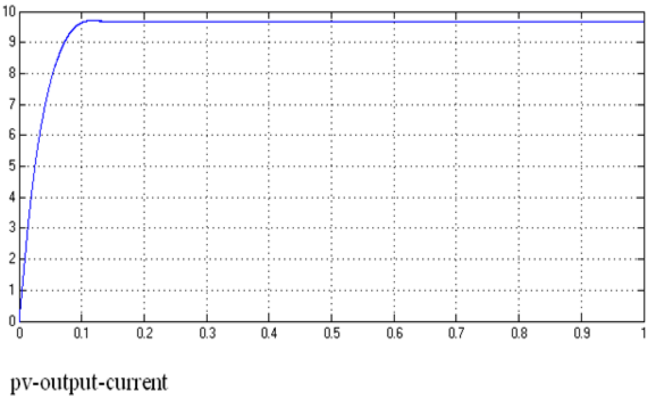

Fig 6 .2 PV Module Output Current with MPPT Controller

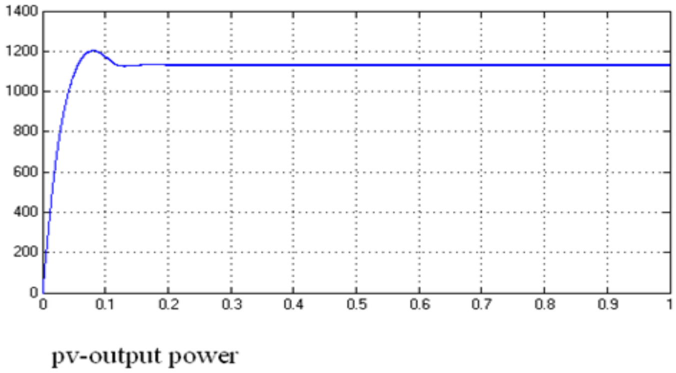

Fig.6.3 PV Module Output Power with MPPT Controller

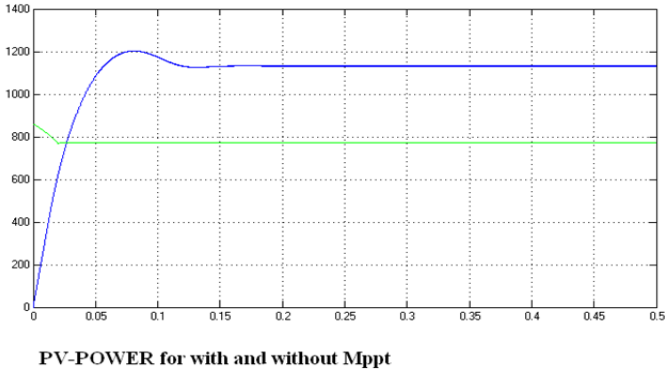

Fig.6.4Comparison of Power with and without MPPT control

VII. CONCLUSION

The paper proposes a simple short-circuit current method .The proposed MPPT algorithm is called short-circuit current MPPT Method. However, by using this MPPT method we have increased efficiency .This method compute the maximum power and controls directly the extracted power from the PV. The proposed method offers different advantages which are: good tracking efficiency, response is high and well control for the extracted power.

ACKNOWLEDGMENT

I offer my sincere thanks to God and my family for giving me an opportunity to dedicate my time and energy.. The first author is thankful to **C.HARINATHA REDDY** Head of Electrical and Electronics Engineering Department, for his constant support and guidance. Special thanks to Vignan Institute of Technology and Science, for encouraging.

REFERENCES

[1]. [1] Balakrishna S, Keyna Chung, Chua Han Bing, Veeramani S, Rajamohan G, "Design and Simulation of Microcontroller Based MPPT using Incremental Conductance Algorithm", Proceedings of 2nd International Conference on Electrical and Computer Engineering 2005, pp 144 -148, Ethiopia, 2005

[2]. [2] D. P. Hohm and M. E. Ropp, "Comparative Study of Maximum Power Point Tracking Algorithms Using an Experimental, Programmable, Maximum Power Point Tracking Test Bed", IEEE Proc. of photovoltaic specialists conference, pp1699-1702, 2000.

[3]. [3] D.P. Hohm, D.P, M.E. Ropp, "Comparative Study of Maximum Power Point Tracking Algorithms, Journal of Progress in Photovoltaics: Research and Applications, Wiley Interscience, vol. 11, no. 1, pp. 47-62, 2003

[4]. [4] E. Koutroulis, et. Al, "Development of a Microcontroller-base photovoltaic maximum power tracking control system", IEEETrans. On power Electron, VOl.16, No. 1, PP.46-54, 2001.

[5]. [5] E. Solodovnik, S. Liu and R. Dougal, "Power Controller Design for Maximum Power Tracking in Solar Installations" IEEE Transactions on Power Electronics, Vol. 19, No. 5, pp.1295-1304, 2004.

[6]. [6] Francisco M. Gonzalez-Longatt, "Model of Photovoltaic Module in MatlabTM", 2DO CONGRESO IBERO AMERICANO DE ESTUDIANTES DE INGENIERIA ELECTRICA, ELECTRONICA Y COMPUTACION(II CIBELEC 2005).

[7]. [7] Hussein, K.H., Murta,I., Hoshino,T., Osakada,M., "Maximum photovoltaic power tracking: an algorithm for rapidly changing atmospheric conditions", IEEE Proceedings of Generation,

[8]. Transmission and Distribution, vol. 142, No.1, 1995.

[9]. [8] Hussein, K.H., Murta,I., Hoshino,T., Osakada,M.,"Maximum photovoltaic power tracking: an algorithm for rapidly changing atmospheric conditions", IEEE Proceedings of Generation,Transmission and Distribution, vol. 142, No.1, 1995.

[10]. [9] Huan-Liang Tsai, Ci-Siang Tu and Yi-Jie Su, "Development of Generalized Photovoltaic Modeling Using MATLAB/Simulink, Proceedings of the World Congress on Engineering and Computer Science 2008 WCECS 2008, October 22-24, 2008, San Francisco, USA

[11]. [10] I.H. Altas and A.M. Sharaf, "A Novel On-Line MPP Search Algorithm For PV Arrays", IEEE Transactions on Energy Conversion, Vol. 11, No. 4, December 1996.

[12]. [11] J.A.Jiang et. Al.,"Maximum Power Tracking for Photovoltaic Power Systems," Tamkang Journal of Science and Engineering, Vol. 8, No. 2, pp. 147-153, 2005.

[13]. [12] Keyna Chung, Design and Simulation of MPPT Using Incremental Conductance Technique, B. Eng. Thesis, Curtin University of Technology, Sarawak, Malaysia, 2005.

[14]. [13] Rafia Akhter and Aminul Hoque, "Analysis of a PWM Boost Inverter for Solar Home Application", Proceedings of World Academy Of Science, Engineering And Technology Volume 17 December 2006 ISSN 1307-6884.

[15]. [14] S. Jain and V. Agarwal, "A New Algorithm for Rapid Tracking of Approximate Maximum Power Point in Photovoltaic Systems"' IEEE Power Electronic Letter, Vol.2, pp. 16-19, Mar.2004.

[16]. [15] S. Balakrishna, V. Gajendra, M. Mohan, M. Suresh,"Design Aspects Of Microcontroller Based Maximum Power Point Tracking Controller For PV System", Proceedings of 2nd International Conference on Mechatronics 2005, Vol.1, pp 263– 269, Malaysia, 2005

[17]. [16] T. Noguchi, S. Togashi, and R. Nakamoto, "Shortcurrent pulse-based Maximum Power Point Tracking Method for Multiple Photovoltaic-and-Converter Module System", IEEE Trans on Ind. Elec., Vol. 49, 2002.

[18]. [17] Wichert B, Control of PV Diesel Hybrid Energy Systems, PhD Thesis, Curtin University of Technology, Western Australia, 2000.

[19]. [18] W. Swiegers, J. Enslin, "An lntearated Maximum Power Point Tracker For Photovoltaic Panels", Proceedings of IEEE International Symposium on Industrial Electronics, Vol. 1, 40- 44, 1998.

[20]. [19] Y.Kuo, et. Al., "Maximum power point tracking controller for photovoltaic energy conversion system", IEEE Trans. Ind. Electron., Vol.48, pp. 594-601, 2001.

[21]. [20] Yang Chen and Keyue Ma Smedley,"Cost-Effective Single-Stage Inverter With Maximum Power Point Tracking, IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 19, NO:5, SEPTEMBER 2004.