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RESEARCH ARTICLE

LITERATURE REVIEW AND COMPARATIVE ANALYSIS OF PHOTOVOLTAIC ARRAYS AND CONVERTORS

***Vanitha, D. and Rathinakumar, M.**

Department of Electronic and Electrical Engineering, SCSVMV University Kanchipuram-631561

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ABSTRACT

This paper presents a comparative study to find out the by comparing few already proposed models to find out the maximum best possible convertor to help in extracting maximum power point from solar Photovoltaic Cells (PV). This paper is study to find out a better model of solar array, DC convertor topology type (Boost and Buck type) and at last a convertor analysis. On the basis of these analyses a better model can found and be put into practice replacing the older versions. It is envisaged that the work can be useful for professionals for selecting an efficient and simple PV convertor. Though these are not experimentally observed but their experimental results are analyzed to put forth the final results.

1. INTRODUCTION

The increase in the consumption rate of energy can be compared with the rate at which, say, nuclear reaction takes place. In spite of the vivid range of sources available globally, the need is always 'on', to either create new sources of energy or increase the efficiency of the existing ones. One definitely has to take into consideration the amount of energy going waste or remaining unused. The solar energy is one such kind of energy whose major part remains unused, in spite of the existing models of photovoltaic cells (Fig.1) and other solar energy using panels. A photo voltaic (PV) energy conversion system may employ a DC to DC convertor. In many applications it is recommended to include a Maximum Power Point Tracker (MPPT) to transfer the maximum available energy from the PV array to the load. The difference between a conventional and a photovoltaic energy source is that while in a conventional source, energy which is not delivered to the load is not consumed and remains in the source, in photovoltaic energy source the energy is wasted since it is available for free. Therefore an MPPT is included in the PV system making it to operate at its maximum power output. This paper is a comparative study between different solar arrays and its convertor types.

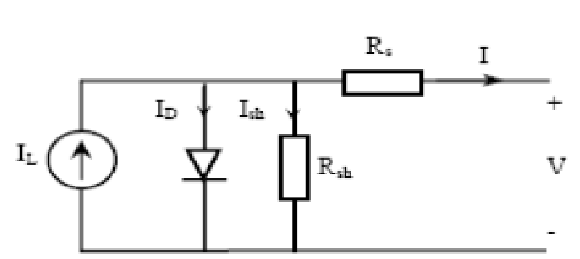

Fig. 1. A Simplified Equivalent Circuit of a PV Cell

****Corresponding author:*** vanithadhanapal@rediffmail.com

2. Solar array selection

In a quest to find out a device or circuit which can efficiently convert the solar energy to equivalent current energy, we analyze the pros and cons of different models. To start with, we begin by comparing simple diode models.

2.1 Single diode Model

A single diode model (Fig.2.1) involves only three parameters namely short circuit, open circuit voltage and the diode ideality factor. In this the output of the current source is directly proportional to the intensity of the light falling on the cell. The accuracy of this model is increased by increasing the temperature dependent diode saturation current, temperature dependent photo current and diode factor. From the output curve (P-I and V-I characteristics) it is seen that it doesn't gives an accurate shape between the maximum power point and the open circuit voltage because of the exclusion of resistance Rs.

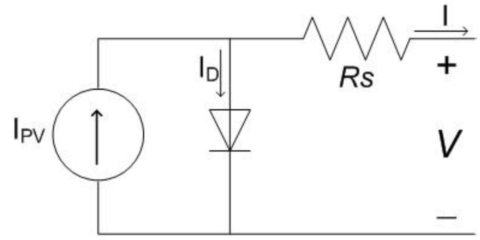

Fig. 2.1. A simplified equivalent circuit of Single diode Model

2.2 Simplified single diode model (SSDM)

This is an improvisation of the single diode model. In this model an additional shunt resistance Rp was seen to be included for taking into consideration the effect of series resistance shown in Fig.2.2. Although it was so accurate than that of the previous one, it deteriorated at low irradiance levels.

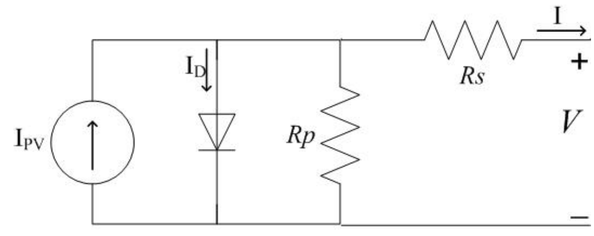

Fig 2.2. A Simplified Equivalent Circuit of a Simplified Single Diode Model

2.3 Two diode Model

The two diode model was proposed keeping in mind the drawbacks of above mentioned two, however is observed that this involves more complexity in terms of number of parameters involved. This model (Fig.2.3) is observed to have a better accuracy at low irradiance levels which allowed for a more accurate prediction of PV system performance.

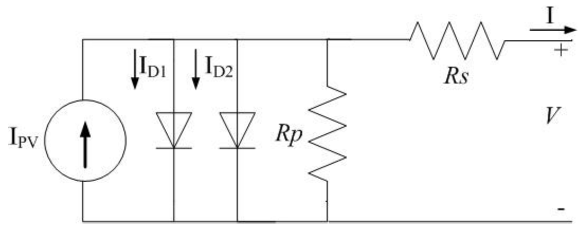

Fig 2.3. A Simplified Equivalent Circuit of Two Diode Model

On comparing and contrasting different parameters involved in determining the most suited diode model for practical applications, the two diode model is expected to give better results than the other two. As a result, the maximum power point can be tracked in an effective way. However the study of experimental results pertaining to all reveals that the simplified single diode model has comparable accuracy levels and simple simulation structure, which helps in consuming less time for simulations also. As a result the SSDM is easy to study and to implement.

3. Convertor's Topology type analysis

One has to really look into the application in which the convertor is used, before selecting among the BOOST and BUCK types of convertors. A buck convertor is generally used to lower the output voltage and on the other hand the boost type topology is used to obtain higher output voltages. In most cases buck type is more efficient. Another difference among the two is that for the buck convertor there are times where current is not flowing into input port, whereas for the boost type current flows constantly into the input port. In spite of the inherent efficiency of the buck topology in systems with conventional sources of energy, the boost topology may be more suitable for PV systems including a MPPT since the convertor operates at continuous current mode extracting as much power as possible from the solar cells. Hence the energy efficiency of the boost convertor may be higher than for the buck convertor. If at certain conditions, one may feel that the output voltage given out by the boost type is more than the desired amount then, invariably buck is the one to choose for.

4. Convertor analysis

In present day scenario there are many new models or circuits proposed for the functioning like a convertor. This part of the analysis is between two of the already proposed soft switching techniques used in PV applications. An extended range ZVS (Zero voltage sources) active clamped current full bridge boost convertor has been done with a soft switching boost convertor using an auxiliary resonant circuit. The former uses the energy stored in the leakage inductance of the transformer and its magnetizing inductance to perform the switching operation whereas the latter uses a resonant circuit in order to carry out the same. Discussing about the ZVS, during closed loop control ZVS isn't maintained for wide range of load variations, in spite of its simplified circuit design. During the study it is said to be found that the Active clamped full bridge isolated boost convertor is successful in maintaining high efficiency for varying load conditions. The increase in leakage current from magnetizing inductance during light load condition results in increase in efficiency compared to the other method. However at full load conditions both maintain equal efficiency. There are some limitations for the following up for the active clamped circuit too. This convertor has a limitation of main switch's duty cycle should be always greater than 0.5. Further the use of HF transformer and a number of MOSFETs and IGBTs and diodes makes the circuit look more complex and also encounters more switching loss during light load condition if ZVS isn't maintained. The soft switching technique working with the help of a resonant circuit (Fig. 4.2) suffers from no such limitations, However it doesn't offer ZVS for a wide range of load variations to during closed loop control which leads to decrease in the efficiency at lower percentage of loads. During open loop, the light load is unable to draw current and hence he switching loss appears to be prominent. But going by the attractive quality of active clamped to enforce the idea of reusability makes it an eco friendly one.

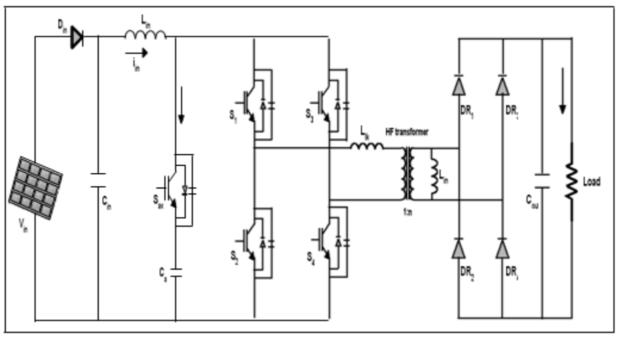

Fig. 4.1. Active Clamped Current Fed Full-bridge Rectifier

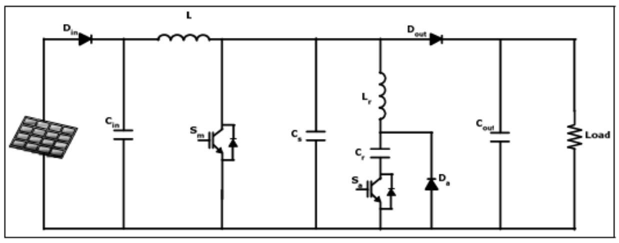

Fig. 4.2. Soft Switching Boost convertor using an auxiliary resonant circuit

5. Conclusion

The increase in the number of electronic gadgets and human population has demanded an increase in the sources of energy to meet the daily survival. Experimentations and simulations have helped in achieving the varied sources of energy, however one does not get to know what and when to use for maximum output. In this paper a comparative study has been done to find the usage of different already present models of solar convertors by comparing and contrasting their experimental results. This helps one in selecting a suitable convertor topology, diode model and at last a good convertor for the required system.

REFERENCES

"Introduction to Photovoltaic systems Maximum Power Point Tracking", Dave Freeman, Application report – SLVA446, Texas Instruments.

A Detailed Comparative Analysis between two Soft Switching techniques used in PV Applications Anup Anurag, *Student Member*, *IEEE,* Satarupa Bal, *Student Member, IEEE,* and B. Chitti Babu, *Member*, *IEEE* Department of Electrical Engineering, National Institute of Technology, Rourkela-769 008 (INDIA) 2012-IEEE.

An investigation of new control method for MPPT in PV array using DC – DC buck – boost converter, Dimosthenis Peftitsis, Georgios Adamidis and Anastasios Balouktsis.

Chan D., and J. Phang, "Analytical methods for the extraction of solar- cell single- and double-diode model parameters from i-v characteristics," Electron Devices, IEEE Transactions on, vol. 34, no. 2, pp. 286– 293,1987.

Comparison study of Maximum power point tracker techniques for PV systems. Hairul Nissah Zainudin, Centre of Foundation of Sciences.2012- IEEE.

Double Linear Approximation Algorithm to achieve Maximum power point tracking for Photo voltaic Arrays, Open Access Energies, ISSN 1996-1073, www.mdpi.com/journal/erergies, Chih-Lung Shen, Department of Electronic Engineering, National Kaohsiung First University of Science andTechnology, Kaohsiung 824, Taiwan

Energy B. S., "What is Maximum Power Point Tracking (MPPT)," vol. 2009.

Energy comparison of MPPT techniques for PV Systems, Roberto Faranda, Sonia Leva.

Implementation of Smart Battery Charger With Low Power Photo Voltaic Energy System Using Buck Convertor, B.Chitti Babu, Dept of Electrical Engg,National Institute Of Technology, Rourkela, ASP, Journal of Low power Electronics Vol 8 1-10,2012.

Jain S., and V. Agarwal, "An integrated hybrid power supply for distributed generation applications fed by nonconventional energy sources," *IEEE Transactions on Energy Conversion,* vol. 23, no.2, June 2008, pp. 622-631.

Pan, C.T.; Chen, J.Y; Chu, C.P.; Huang, Y.S. A fast maximum power point tracker for photovoltaic power systems. In *Proceedings of the 25th Annual Conference of the IEEE Industrial Electronics Society*, San Jose, CA, USA, 29 November–3 December 1999; pp. 390–393.

Rahmam S., M. A. Khallat, and B. H. Chowdhury, A discussion on the diversity in the applications of photo-voltaic system. *IEEE Transactions on Energy Conversion* 3, 738 (1988).

Salam Z., et al., "An improved two-diode photovoltaic (PV) model for PV system," in Proc. Joint Int. Conf. Power Electron., Drives and Energy Syst., India, 2010, pp. 1–5.

Salameh, Z.; Taylor, D. Step-up Maximum power point tracker for photovoltaic arrays. *Sol. Energy* 1990, *44*, 57–61.

Xiao W., H.H. Zeineldin, "A Simple Approach to Modeling and Simulation of Photo Voltaic modules",IEEE Transaction on sustainable Energy, Vol. 3, Iss 1,pp-185-186.2012.

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