RESEARCH ARTICLE   OPEN ACCESS

A Novel Approach on Photovoltaic Technologies for Power Injection in Grid Using Matlab-Simulink

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Abstract
The paper presents the simulation of the Solar Photovoltaic module using Matlab Simulink. This model is based on mathematical equations and is described through an equivalent circuit including a photocurrent source, a diode, a series resistor and a shunt resistor. This paper presents integration of the grid distribution network in Indian scenario with solar power technology to meet the additional electrical energy demand of urban as well as rural sectors which are both rapidly expanding. First of all the data of a real life power plant having 24V, 230W Power PV module has been compared and analyzed with that of matlab program output for identical module and it has been find out that a variation in temperature affects the parameters values as well as the performance of the solar module. After the above analysis the design and Simulink implementation for single phase power grid connected PV system has been done. The system includes the PV array model, the integration of the MPPT with boost dc converter , dc to ac inverter, single phase series load connected to ac grid. It is demonstrated that the model works well at different temperature conditions and predicting the General behavior of single-phase grid- connected PV systems .
Index Terms—PV, Photovoltaic models, Photovoltaic power systems, solar radiation, maximum power point.

I. INTRODUCTION

Renewable energy resources are getting priorities in the whole world to decrease the reliance on conventional resources. Solar energy is speedily gaining the focus as an important means of expanding renewable energy uses. Solar photovoltaic (PV) technology is a very attractive renewable energy option for clean energy generation. Photovoltaic (PV) generation is considering increased importance as a Renewable energy source application because of distinctive advantages such as simplicity of allocation, high dependability, absence of fuel cost, low maintenance and lack of noise and wear due to the absence of moving parts. Furthermore, the solar energy characterizes a clean, pollution free and inexhaustible energy source. The electrical system powered by solar arrays requires special design considerations due to varying nature of the solar power generated resulting from unpredictable and sudden changes in weather conditions which change the solar irradiation level as well as the cell operating temperature. Solar tracking system is the most appropriate technology to enhance the efficiency of the solar cells by tracking the sun PV module represents the fundamental power conversion unit of a PV generator system.[1][3] The output characteristics of PV module depends on the solar insolation, the cell temperature and output voltage of PV module. Since PV module has nonlinear characteristics, it is necessary to model it for the design and simulation of maximum power point tracking (MPPT) for PV system applications. The mathematical PV models used in computer simulation have been built. Almost all well-developed PV models describe the output characteristics mainly affected by the solar insolation, cell temperature, and load voltage. Recently, a number of powerful component-based electronics simulation software package have become popular in the design and development of power electronics applications. However, the Sim Power System tool in Matlab/Simulink package offers wind turbine models but no PV model to integrate with current electronics simulation technology. Thus, it is difficult to simulate and analyse in the generic modelling of PV power system. This motivates me to develop a model for PV cell, module, and array using Matlab/Simulink. [2]

The focus of this paper is on solar cell modeling which is discussed in section two. Section three presents the effects of the variation of the solar radiation.

II. PHOTOVOLTAIC MODULE AND ARRAY MODEL

Solar cell is basically a p-n junction fabricated in a thin wafer or layer of semiconductor. The electromagnetic radiation of solar energy can be directly converted to electricity through photovoltaic

effect. Being exposed to the sunlight, photons with energy greater than the band-gap energy of the semiconductor are absorbed and create some electron-hole pairs proportional to the incident irradiation. Under the influence of the internal electric fields of the p-n junction, these carriers are swept apart and create a photocurrent which is directly proportional to solar insolation. Typically, a PV cell generates a voltage around 0.5 to 0.8 volts depending on the semiconductor and the built-up technology. This voltage is low enough as it cannot be of use. Therefore, to get benefit from this technology, tens of PV cells (involving 36 to 72 cells) are connected in series to form a PV module. These modules can be interconnected in series and/or parallel to form a PV panel. In case these modules are connected in series, their voltages are added with the same current. Nevertheless, when they are connected in parallel, their currents are added while the voltage is the same. Then the boost converter is used to step up the voltage level according to the usage and the battery is used to store ihe generated DC output of cell.as the current produced by the Photovoltaic cell is DC so the inverter is used for AC conversion.[4]

PV system naturally exhibits non -linear characteristics which vary with the radiant intensity and cell temperature. Fig. 1 shows the equivalent circuit models o In order to forecast the power extracted from the solar modules and the module current-voltage (I-V) characteristics; it is significant to model the solar cell. Once the I-V characteristics of a single solar cell are determined using the model, one must then develop that model to determine the behavior of a PV array or module. A Photovoltaic array consists of many solar cells wired in series and in paralleled.[5] A solar cell model is shown in Fig.1. It includes a current source, a diode, a series resistance and a shunt resistance
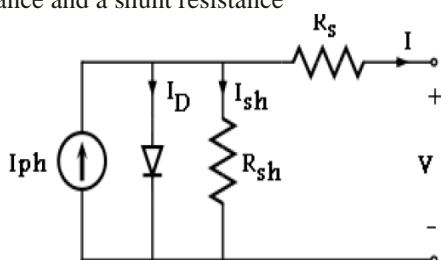

Fig 1. Equivalent Circuit of PV Cell

In view of that, the current to the load can be given as:

$$I = I_{ph} - I_s \left(\exp^{\frac{q(V + Rs\,I)}{NKT}} - 1 \right) - \left(\frac{V + RsI}{Rsh} \right)$$

In this equation, Iph is the photocurrent, Is is the reverse saturation current of the diode, q is the electron charge, V is the voltage across the diode, K is the Boltzmann's constant, T is the junction temperature, N is the ideality factor of the diode, and Rs and Rsh are the series and shunt resistors of the cell, respectively.

As a result, the complete physical behavior of the PV cell is in relation with *Iph, Is*, *Rs* and *Rsh* from one hand and with environmental parameter as the temperature and the solar radiation from the other hand.[7][8]

III. EFFECT OF VARIATIONS IN TEMPERATURE

The temperature increase around the solar cell has a negative impact on the power generation capacity. Increase in temperature is achieved by a decrease in the open circuit voltage value. Increase in temperature causes increase in the band gap of the material and thus more energy is required to cross this barrier. Thus the efficiency of the solar cell is reduced .
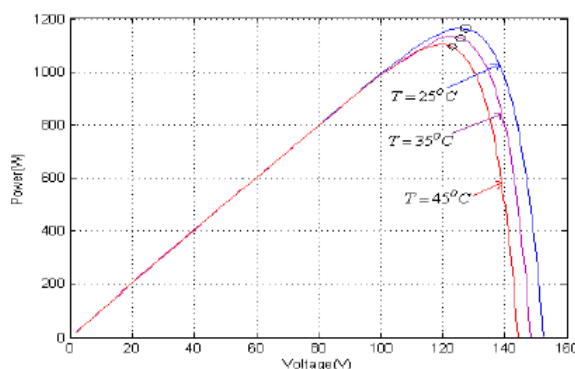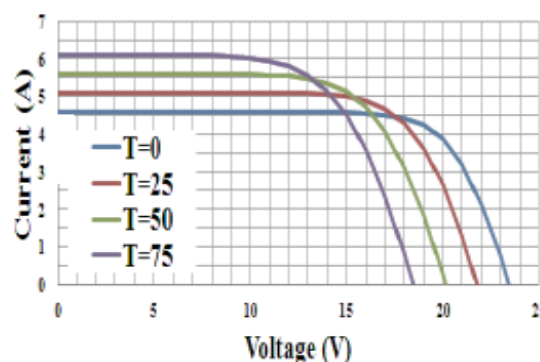

Figure2. Variation of P-V curve with temperature

Figure 3. Variation of I-V with temperature

IV. PURPOSED TOPOLOGY

In this paper first of all the data of a real life power plant having 24V, 230W Power PV module has been compared and analyzed with that of Matlab program output for identical module and it has been find out that a variation in temperature affects the parameters values as well as the performance of the solar module. After the above analysis the design and Simulink implementation for single phase power grid connected pv system has been done. The system as

shown in fig 3.Below includes the PV array model, the integration of the MPPT with boost dc converter, dc to ac inverter, single phase series load connected to ac grid.
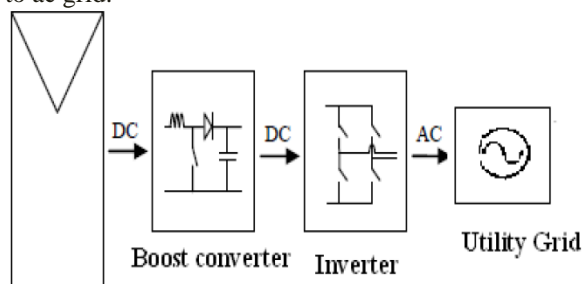

Figure 4.Single phase grid connected PV system

It is verified that the simulink model works well at different temperature conditions and predicting the General behavior of single-phase grid- connected PV systems.

(A)Simulink Model of Grid connected PV system in MATLAB

The simulink model implemented in this paper for power grid connected system with Model working at different temperature conditions have a number of building blocks which are discussed below:

(A.1)Photovoltaic cell

The solar cell was modeled in the single diode format. This consists of a 1 ohm series resistance. This was modeled using the Sim Power System blocks in the MATLAB library. The Simulink model is as shown in figure
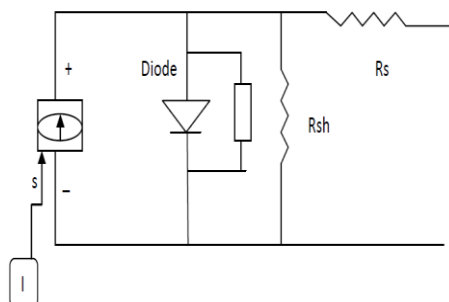

Figure 4.1 solar cell modeled in single Diode format

A controlled current source is utilized to drive the solar cell. The control signal is provided by the I generator unit. The I generator takes into account the number of Series connected, number of parallel connected solar cells and the temperature to determine the input signal from the solar cell .

(B.) Generator Unit

This unit is responsible for providing the input to the solar cell. This block is simulated using the Simulink blocks available in the MATLAB. This unit gives the light generated current using the Characteristic equations modeled in the form of function blocks

(C.)MPPT with Gating Signal Unit

This is the most important unit of the system under consideration. This can be broken down into two different units, namely

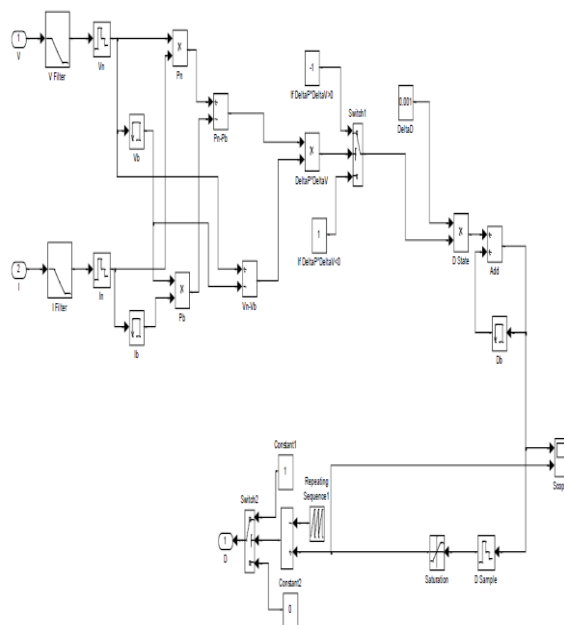1. The MPPT unit

2. The gating signal generator unit .

Figure 4.2 MPPT with gating signal

V. RESULTS AND DISCUSSIONS

Some data from real life power plant has been taken and can be seen from the data that 24V, 230W power PV module has been tested at different temperature conditions and the results have been recorded for changing values of different parameters w.r.t temperature that takes place. The changing values of some of parameters like maximum power output, series resistance, efficiency has been taken here for the analysis and has been compared with the Matlab program output of identical module.
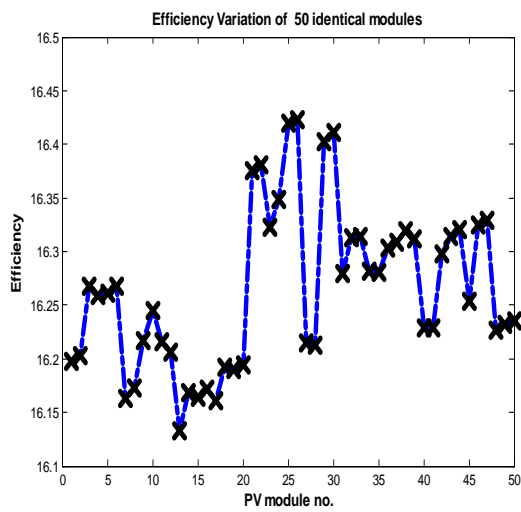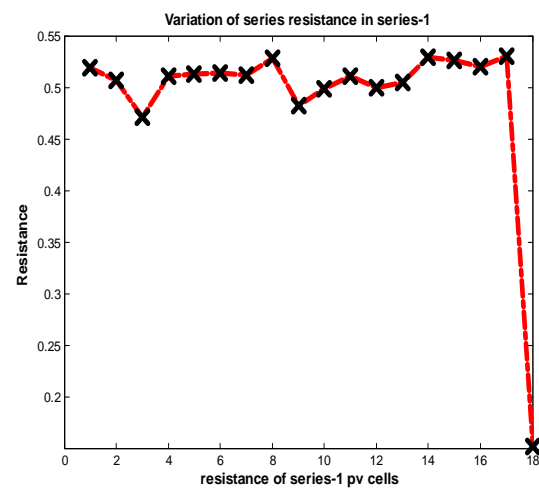
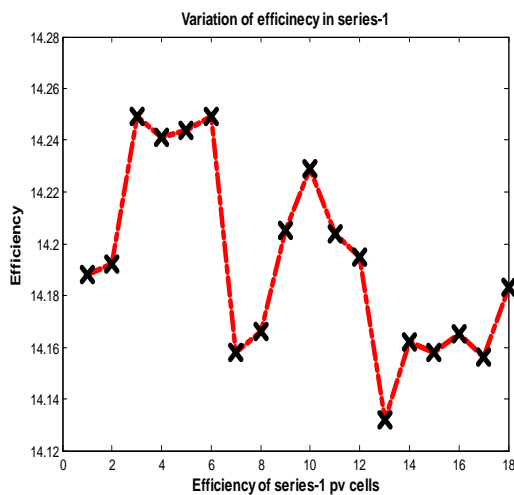Figure 5.1 MPPT with gating signal

Figure 5.2 variations of efficiency

Figure 5.3 Variation of series resistance in identical module

Figure 5.4 Variations of series resistance

Figure 5.5 Maximum power output variations

VI. CONCLUSION

In this paper a photovoltaic technology was studied for power injection in grid. First of all the data of a real life power plant has been compared and analyzed with that of matlab program output for identical module and it has been find out that a variation in temperature affects the parameters values as well as the performance of the solar module and this analysis is predicting the General behavior of the solar cell at different temperature conditions.

REFERENCES

[1]   A.Ashwin   Kumar ,2010,"*A study on non renewable energy resources in India*", International Conference on Environmental Engineering and Applications.

[2]   A. Ashwin Kumar, 2010,"*A study on renewable energy resources in India*", International Conference on Environmental Engineering and Applications, pp. 49-53.

[3]   A. Demirbas,2005, "*Potential applications of renewable energy sources, biomass*

combustion problems in boiler power systems and combustion related environmental issues", Progress in Energy and Combustion Science, vol 31, pp 171-192.

[4] A. Durgadevi, S. Arulselvi, S.P.Natarajan, 2011,"*Photovoltaic Modeling and Its Characteristics*", Proceedings of ICETECT,pp 469-475.

[5] A. Kassem and M. Hamad "*A Microcontroller-Based Multi-Function Solar Tracking System.*

[6] A. P. Agalgaonkar, S. V. Kulkarni, and S. A. Khaparde,2006 "*Evaluation of configuration plans for DGs in developing countries using advanced planning techniques,*" IEEE Trans. Power Syst., vol. 21, no. 2, pp. 973–981.

[7] A.Z.M.Shahriar Muttalib, Ahmed Mortuza Saleque, Nawjif Md. Anamul Hasan, 2012,"*Design and Simulation of an Inverter with High Frequency Sinusoidal PWM Switching Technique for Harmonic Reduction in a Standalone/ Utility Grid Synchronized Photovoltaic System*" IEEE/OSA/IAPR International Conference on Informatics, Electronics & Vision, pp. 1168-1173.

[8] A. Zahedi,1994, "*Energy, People, Environment, Development of an integrated renewable energy and energy storage system, an uninterruptible power supply for people and for better environment,*" The International Conference on Systems, Man, and Cybernetics,Humans, Information and Technology', Vol. 3 pp. 2692-2695.