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Design and Simulation Study of Solar Photovoltaic Array using Simulink Model

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Abstract— **This paper proposes to plan the model of photovoltaic solar cell and simulate it, considering the effect of solar irradiations and temperature changes. The PV array is modeled using basic circuit equations. Its voltage current and power voltage characteristics are simulated with different conditions. It is noticed that output characteristics of PV array are affected by environmental conditions and conversion efficiency is low. This model can be used for build a photovoltaic circuit model for any photovoltaic array. All modules which form the photovoltaic system model are independently modeled and validated in Simulink.**

Keywords— ***Photovoltaic, Solar irradiations, Photovoltaic Array***

I. INTRODUCTION

Because of burning of fossil fuels warming caused by ecological troubles, the raising costs of crude oils and natural gases. They encourage continuous conceive to regain power system and its ability. there's a necessitate to seem for plentiful and dirt free power sources because of the exhausted and economic process of oil. alternative energy acts as associate degree facultative renewable energy supply. Among of the systems that use renewable energy sources, electrical phenomenon cells are shows potential, for the explanation that of the inherent character of the structure itself: very little development expenditure (without charge energy), some extent of preservation wants, trustworthy, quiet and untroubled to line up. In accumulation, in an exceedingly few separate applications electrical phenomenon cells ar beyond any doubt appropriate in relationship among extra energy sources, significantly in people areas that aren't simply reached, that is unbeneficial to line up standard power lines[1].

PV module represents the essential power conversion unit of a PV generator system. The output characteristics of PV module depends on the star insolation, the cell temperature and output voltage of PV module. Since PV module has nonlinear characteristics, it's necessary to model it for the planning and simulation of most outlet chase (MPPT) for PV system applications. The mathematical PV models employed in technique are built[4,5]. Developed PV models describe the output characteristics in the main plagued by the star insolation, cell temperature, and cargo voltage. victimization the Sim natural philosophy library in Matlab/Simulink package develops and simulates completely different| the various} models with different conditions. However, the alternative energy may be a supply of energy and its handiness varies wide with time. So, it's terribly essential to form an entire exploitation of alternative energy in existing time.

II. MODELING OF A SOLAR PV MODULE

The photovoltaic cell is really a current supply that manufacture current once lightweight falls on the surface of photovoltaic cell. The equivalent model of a PV device is seen in figure one . The model of ideal PV cell and sensible PV device will clearly be seen in it. one PV cell cannot manufacture enough power and can't be utilized in majority of applications. so as to urge power that's practicable for many of the applications individual cells are connected in series/parallel configurations[4,6]. Such configurations are referred to as PV module/Practical PV device. they're capable of manufacturing output power at the required levels . In literature many models of a sensible PV module are obtainable, but the selection of the only diode based mostly sensible model for our system is predicated on the actual fact that this model incorporates a balanced compromise between accuracy and ease . The governing equation for one star Fig. 1[3]. Equivalent model of a PV device PV cell is given below.

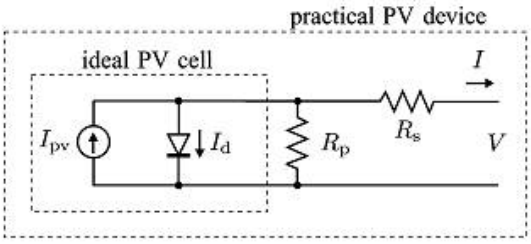

Fig. 1.Equivalent model of a PV device

$$I = I_{pv,cell} - I_{0,cell} \exp\left(\frac{V_d}{nV_t} - 1\right) \quad (1)$$

Where $I_{pv,cell}$ is the current generated by incident light I_d is the Schokley diode current and is equal to $I_{0,cell} \exp\left(\frac{V_d}{nV_t} - 1\right)$

Io, cell is leakage current
V_d is the voltage across diode
V_t is the thermal voltage of diode and is equal to kT/q

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q is the charge on electron
k is Boltzmann constant
T is temperature of p -n junction, in Kelvin

In figure 1 two resistances Rp & Rs can be seen that represents the practical issues of PV array. Here, Rp represents the leakage current to the ground at the borders and Rs models the internal losses due to current flow of the module. Therefore, eq.1 can be modified in terms of R_p & R_s and becomes,

$$I = I_{pv} - I_0 \exp(\frac{V + IR_s}{nV_t} - 1) - \frac{V + IR_s}{R_p} \qquad (2)$$

Where,
Ipv is the PV current of module
Io is the saturation current of module
Vt = NsKT/q is the thermal voltage of the module with Ns cells connected in series.
Based on the equivalent circuit and the output characteristics equation of PV cell, the curve of PV cell's output voltage and output current relationship is shown in Fig.2.Also power and output voltage(output current) is also plotted[4,6].

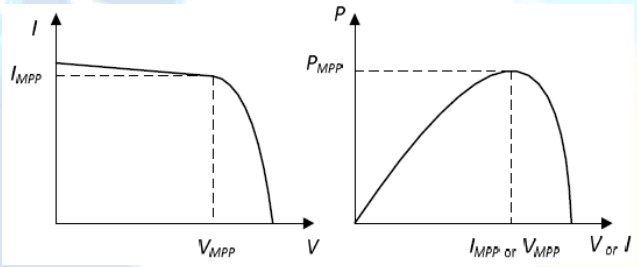

Fig. 2. Typical photovoltaic cell characteristics: a) I-V curve b) P-I curve

III. MODELING OF A SOLAR PV MODULE

In Simulink the solar cell can be modeled with three modeling systems[2]. The first possibility of modeling can be done with instruments which can implement any differential equation or algebraic relationship of a highly complex mathematical model. Another possibility is given by Simscape™, which allows direct modeling using physical components of the electric field (resistors, capacitors, diodes) to implement exactly the same mathematical equation.

The solar cell block given in Sim Electronics® library allows choosing one of two models: a model with 8 parameters in which the previous equation describes the output current, and a model with 5 parameters if for this equation is applied the following simplifying assumptions: the impedance of the parallel resistor is infinite and the saturation current of the second diode is zero. The model with 5 parameters allows optimization of this block according to the equivalent circuit model parameters or by short circuit current and open circuit voltage[3].

IV. MODEL OF PHOTOVOLTAIC ARRAY

The model shown in Figure 3(a) represents a PV cell array connected to a variable resistor. This resistor has a sine wave input through signal generator. Inside the array subsystem are 6 rows of photovoltaic solar cells connected in series 3(b), formed by 6 solar cells of Sim Electronics library 3(c). This structure can be built in any configurations by connecting multiple strings of solar cells in series or in parallel[2]. Control of solar radiation is realized by Pulse generator block.

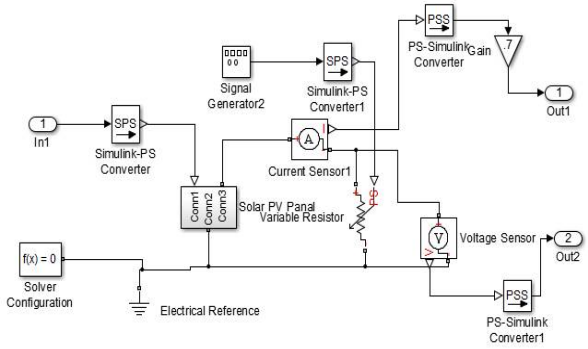

Fig. 3(a). Different components PV cell model

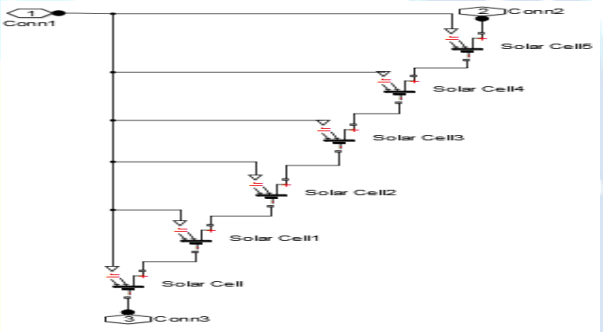

Fig. 3(c). series and parallel configuration of solar cells

The Simulink Model of photovoltaic arrays are shown below in figure 4

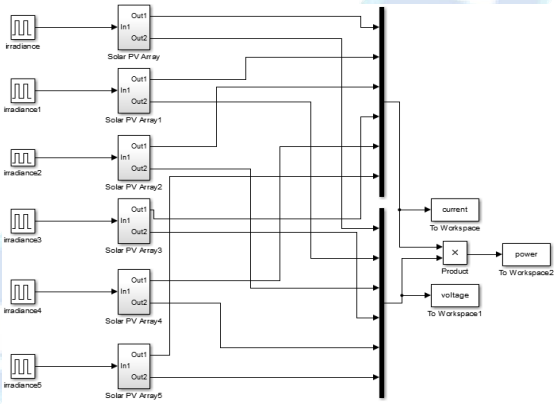

Fig. 4. Simulink Model of photovoltaic arrays

The advantage of using of this high level of implementation is to create a simple equivalent circuit, which have much more complex parameters, including the effect of temperature in the device which is very important for behavior of this type of system. The photovoltaic panel model is

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validated by simulating at a value of irradiance of 1000 w/m^2 and a temperature of 25°*C*.

TABLE I. THE PARAMETERS OF A SINGLE SOLAR CELL

Parameter	Value
Short-circuit current [A]	I_{SC}= 7.34
Open-circuit voltage [V]	V_{OC}= 0.6
Quality factor	N = 1.5
Series resistance [Ω]	Rs= 0
First order temperature coefficient for *I ph* [1/K]	TIPH1 = 0
Temperature exponent for Is	TXIS1 = 3
Temperature exponent for Rs	TRS1 = 0
Parameter extraction temperature [°C]	Tmeas=25^{0}C
Fixed circuit temperature [°C]	TFIXED = 25^{0}C

V. RESULTS

A. The result of simulation with change in solar radiation at temperature 25°C.

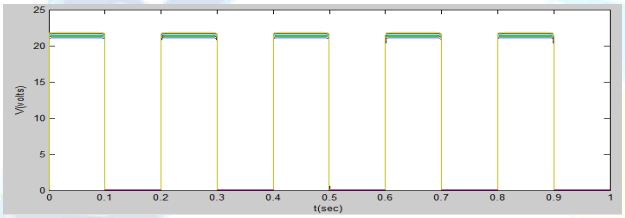

Fig. 5.Voltage Signal

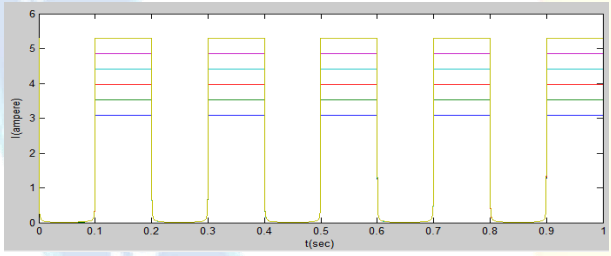

Fig. 6.Current Signal

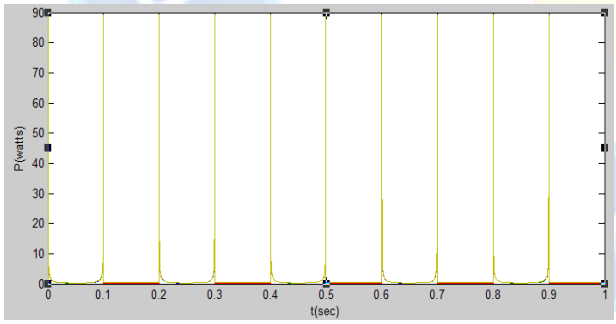

Fig. 7. Power Signal

The characteristic V-I curve for radiation incident on the photovoltaic cells is amended as shown in Figure 8. If the irradiance decreases, the photovoltaic current generated decreases proportionally to that, and variation of no-load voltage is very small.

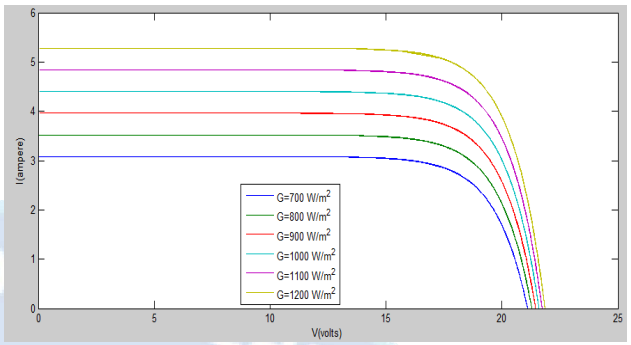

Fig. 8. VI characteristics for different values of solar radiation at temperature of 25^{0}C

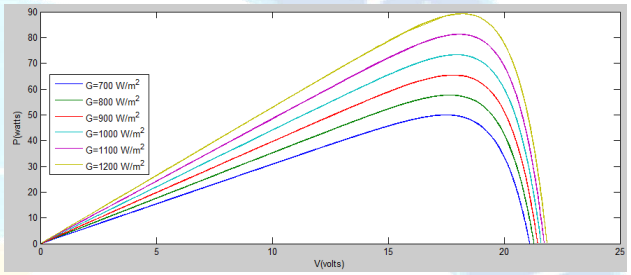

Fig. 9. VP characteristics for different values of solar radiation at temperature of 25^{0}C

B. The result of simulation with change in temperature with constant solar radiation (G=1000 w/m^2)

As shown in Figure 10, when the temperature of module increases the voltage decreases and the produced current remains practically constant. In terms of produced electric power is a reduction in the performance of the photovoltaic panels.

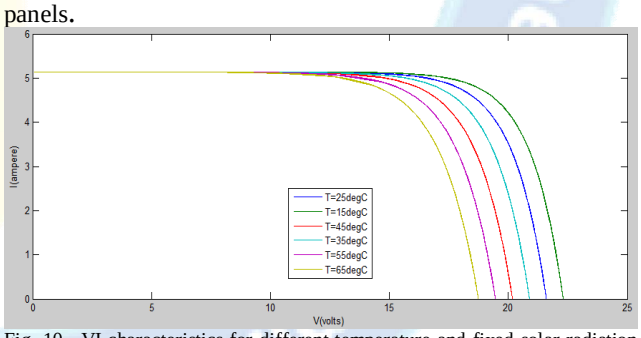

Fig. 10. VI characteristics for different temperature and fixed solar radiation (G=1000 w/m^2)

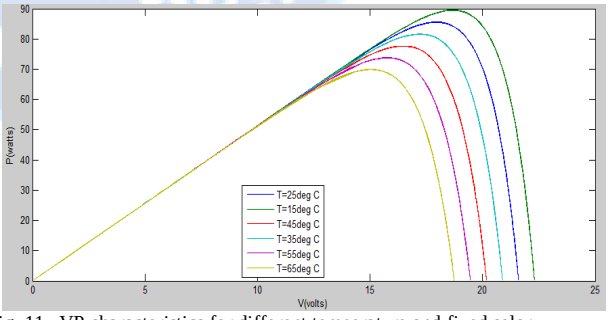

Fig. 11. VP characteristics for different temperature and fixed solar radiation (G=1000 w/m^2)

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From Figure 9 is observed that for an irradiance of 1000*w* /*m* ^{2}obtained a maximum power of 70 W and for an irradiation of 1200 *w* /m^2, the photovoltaic panel can provide a maximum power of 90 W. That gives an idea of measure in that the power produced by a photovoltaic array is affected by changing of irradiance.

VI. CONCLUSION

In this paper complete model of the PV system containing solar PV cell, is simulated in SIMULINK. The I-V and P-V characteristics of solar module are obtained for different values of insolation and temperature. It is observed that the characteristics obtained using this method is matching with the theoretical and simulations. Also from this model, maximum value of voltage Vmp, maximum value of current Imp and maximum value of power Pmax are obtained. This paper analyzed the implementation of a method for modeling in MATLAB® /Simulink® of photovoltaic arrays and modeling using experimental data. To build photovoltaic panel was used the Solar Cell block. The simulation results show that the proposed method is efficient in terms of modeling of the functioning of the photovoltaic system.

References

[1] **ABB,** Technical Application Papers No.10 Photovoltaic plants.

[2] www.mathworks.com, **Osorio, C.,** Recorded Webinar- Model-Based Design for Solar Power Systems**.**

[3] www.mathworks.com, Help - Solar Cell Blocks.

[4] T.Markvart, "Solar Electricity", John Wiley & Sons,1994.

[5] R. Messenger and J. Ventre, Photovoltaic Systems Engineering, CRC Press, 2000, pp.41-51.

[6] G. R.Walker and P. C. Sernia, "Cascaded DC- DC converter connection of photovoltaic modules," IEEE Trans Power Electronics., vol. 19, no. 4, pp. 1130–1139, Jul. 2004.

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