IMPROVING THE PERFORMANCE OF SOLAR PV SYSTEM WITH SEPIC

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ABSTRACT

Solar module is considered as fundamental power transformation unit of Photovoltaic (PV) generation system. The performance of a PV array strongly depends on operating environmental conditions such as operating temperature, solar insolation, shading array configuration. Often PV arrays get shadowed fully or partially by passing cloud, building, poles, trees, etc. Under such partial shading conditions, the operation of PV arrays get more complicated with more than one peak and it is very important to predict the characteristics to obtain possible maximum power. In this paper a modified DC-DC converter is presented for maximum power point tracking (MPPT) with PI controller to improve the performance of PV system. The MATLAB/SIMULINK power system tool box will be used to stimulate the proposed system.

Keywords: Matlab/Simulink, Photovoltaic arrays, Shading effect, DC-DC Converter.

I.INTRODUCTION

Solar energy is the one of the best renewable energy for future applications .So the use of photo voltaic (PV) systems increased with reduced costs and increased efficiency. But the generation of electricity from photo voltaic (PV) system is more expensive than the other non- renewable energy sources. We know that non-conventional sources which are also known as renewable energy resources are becoming more popular now a days as they are available nature free. Renewable energy sources are defined as the sources which can be reproduced from nature again and again once even they used.

There are many advantages with renewable energy resources comparing to non-renewable energy source. Some of the advantages are renewable energy sources are cost free and also pollution free compared to non-renewable resources. Some of the main examples for this renewable resources are solar, wind, tidal etc. Here in this project work we are considering solar as the source and obtaining maximum power from the sun by using maximum power point tracking algorithms (MPPT's). There are many algorithms are used for extracting maximum power such as perturb and observe, incremental conductance, fuzzy control etc. In our daily life, power electronic converters have been widely used, not only for industry applications but also in many electronic products, such as portable devices and consumer electronics. Actually, most electronic devices are not using energy directly from the power system or a battery set. To provide the required voltage or current level to a load, in general, a power electronic converter is interposed between the power source and the load to perform the conversion of the voltage or current level and in addition to regulate the power requirement.

A conventional power electronic converter is supplied from a single input source, but may provide multiple outputs. In the case that two or more voltage or current levels are required by the loads, a transformer with multiple output windings is employed [1], [2]. On the other hand, however, for some applications, the loads may not be powered from a single source but from two or more input sources specified by different voltage, current, and power ratings [3-13]. For example, a solar power based street lamp is mainly supplied from solar cells, but needs a subordinate battery power.

II.SOLAR PHOTOVOLATIC SYSTEM:

a. Photovoltaic Array Modeling:

In the PV network of electrical phenomenon, cell is the necessary part. For the raise in appropriate current, high power and potential difference, the sunlight dependent cells and their region unit joined in non-current or parallel fashion called as PV exhibit are used. In practical applications, each and every cell is similar to diode with the intersection designed by the semiconductor material. When the light weight is absorbed by the electrical marvel sway at the point of intersection, it gives the streams at once. The (current-voltage) and (Power-Voltage) attributes at absolutely unpredictable star intensities of the PV exhibit are represented in figure 3, whereas the often seen existence of most electrical outlet on each yield is shown in power diagram 2.

$$I = I_{ph} - I_D - I_{sh} \qquad (1)$$

$$I = Iph - I_o [\exp (q V_D / nKT)] - (v_D / R_S) \qquad (2)$$

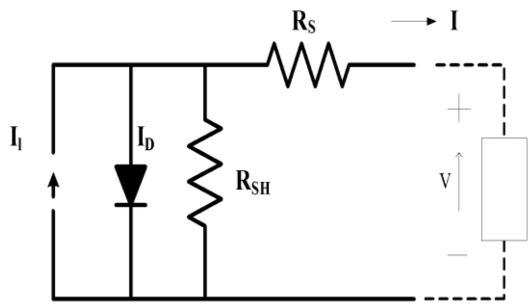

Figure 1: PV Electrical Equivalent circuit

Solar cell output power is given as the product of V and I

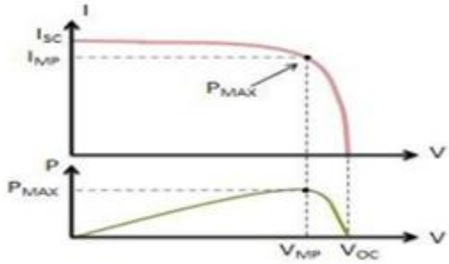

Figure 2: Response of output characteristics of PV Array

III.DC-DC CONVERTER:

A. BOOST CONVERTER

A boost converter is one of the DC-DC converter. Which is used for increasing the output voltage? The name itself says that its main function is boosting operation. Boosting means stepping up i.e. increasing the output. Buck-Boost converter also one of the type of Boost converter but it is the combination of both Buck and Boost means it is capable of doing both step up and step down operations. But there are some disadvantages of these converters those are, Buck-Boost converters suffer from high amount of input ripple. These ripples create harmonics. The CUK and Buck-Boost converters operation causes large amount of electrical stress on components this can lead to device failure or overheating. The diagrammatic representation of Boost type converter is shown in the figure which contains semiconductor devices, and inductor, capacitors which acts as filters to reduce the amount of ripples at the output side.

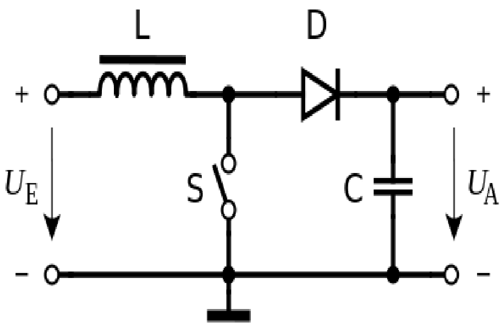

Figure: 3 Shows the circuit design of DC-Dc converter

IV.PERTURB AND OBSERVE MPPT ALGORITHM:

In this type of MPPT algorithm requires external circuit to repeatedly perturb the array voltage and subsequently measure the resulting change in the output power. The main disadvantage of this algorithm is it forces the system to oscillate around MPP instead of continuously tracking it. This algorithm fails under rapidly changing environment. The major disadvantage of P&O algorithm is during rapid fluctuations of insolation the algorithm is likely to lose its direction while tracking true MPP. So that is this algorithm is not preferable under rapidly changing environmental conditions. The advanced version P&O is incremental conductance algorithm it is designed to overcome the drawbacks of P&O algorithm under rapidly changing environmental conditions in this algorithm the increase and decrease operations are performed continuously to achieve maximum power point in one direction. The output is continuously compared with previous to have better output.

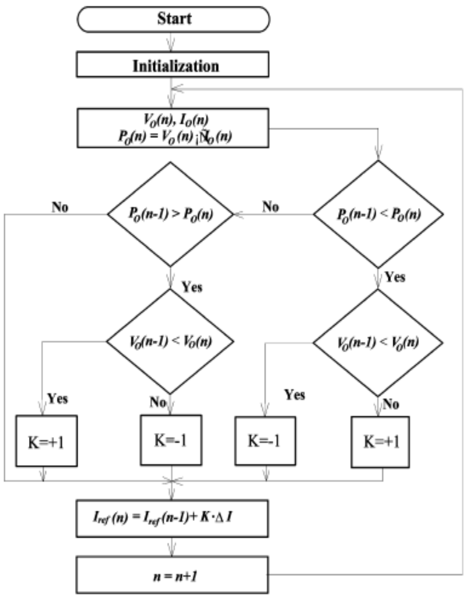

Figure 4: Flow Chart representation of P&O Technique

V.MATHEMATICAL MODELLING OF PV SYSTEM:

PV cells are grouped in larger units called PV modules which are further interconnected in a parallel-series configuration to form PV arrays.

The photovoltaic panel can be modelled mathematically as given in equations

Modulo-Photo Current Can be expressed as:

$$I_{ph} = [I_{SCr} + K_i(T - 298)] * \lambda / 1000$$

Module reverse saturation current – Irs

$$I_{rs} = I_{SCr} / [\exp(qV_{OC} / N_S kAT) - 1]$$

The module saturation current I0 varies with the cell temperature, which is given by

$$I_0 = I_{rs}[\frac{T}{T_r}]^3 \exp[\frac{q * E_{g0}}{Bk}\left\{\frac{1}{T_r} - \frac{1}{T}\right\}]$$

The PV output Current is given as,

$$I_{PV} = N_P * I_{ph} - N_P * I_0[\exp\left\{\frac{q*(V_{PV} + I_{PV}R_s)}{N_S AkT}\right\} - 1]$$

VI.SIMULATION RESULTS:

Here in this project work a real time organisation was taken for analysis and developed under DC-DC converter such as SEPIC. A block diagram of the stage by stage model based upon the equations of PV model is represented in Simulink environment as given in Figures 5 to 10. These models are developed in moderate complexity to include the temperature dependence of the photo current source, the saturation current through the diode, and a series resistance is considered based upon the shackle diode equation as shown in above section.

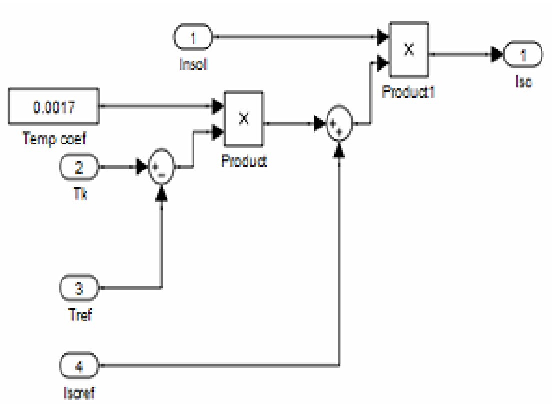

Figure 5: Model for I_{SC} at a given temprature

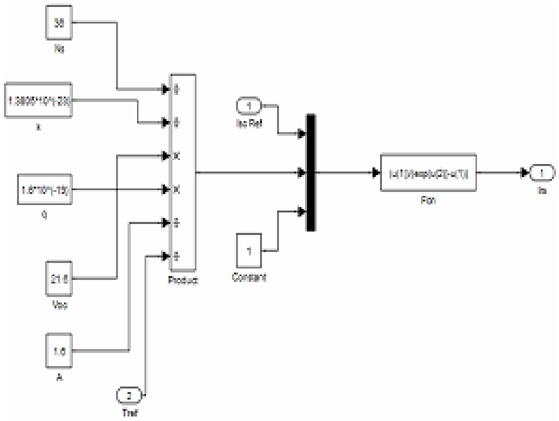

Figure 6: Model for reverse saturation current through the diode

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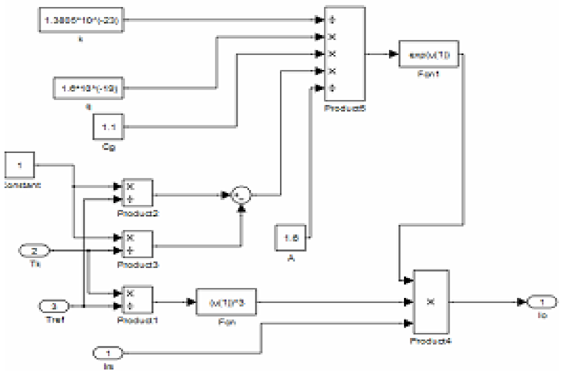

Figure 7: Model takes reverse saturation current, module reference temperature and the module operating temperature as input and calculates module saturation current

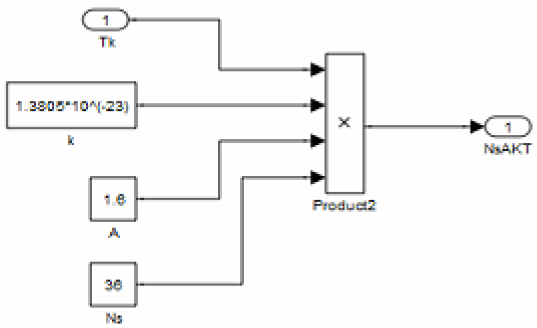

Figure 8: Model takes operating temperature in Kelvin and calculates the product NsAkT

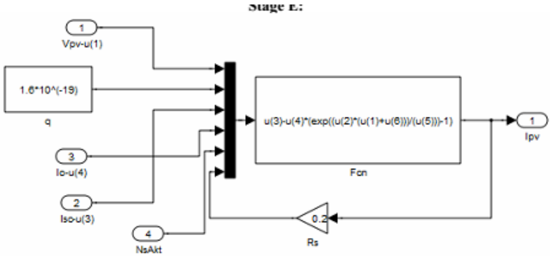

Figure 9: Model executes the function given by equation I_{PV}

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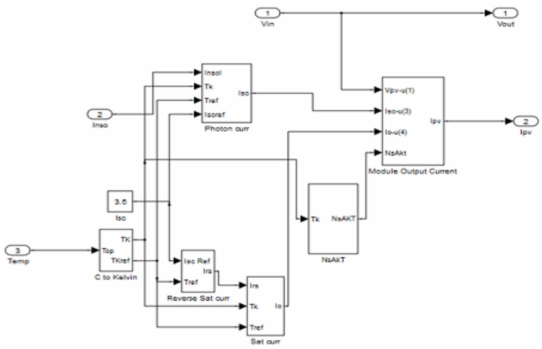

Figure 10: Model contains all the six model interconnected together

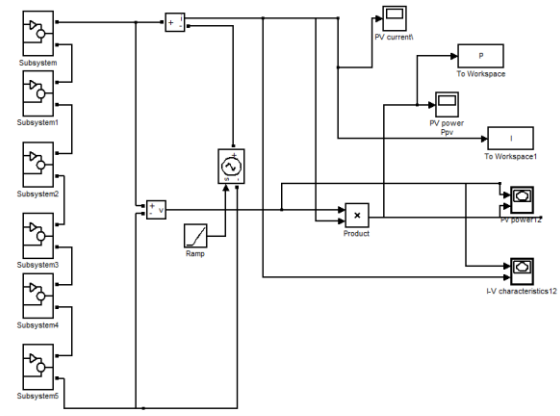

Figure 11: Simulation model for PV array with shading effect

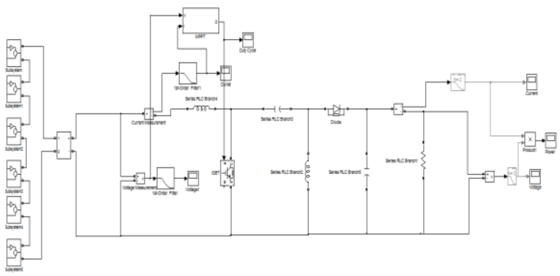

Figure 12: Simulation model for PV array with shading effect under DC-DC Converter

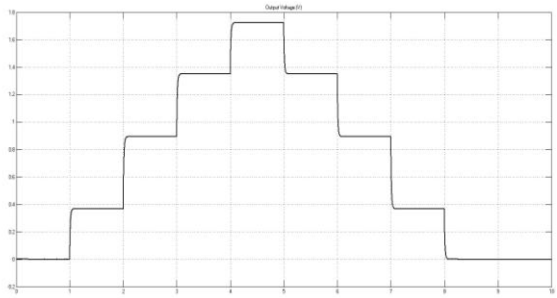

Figure 13: Simulation result for I-V Characterstics without Shading Effect

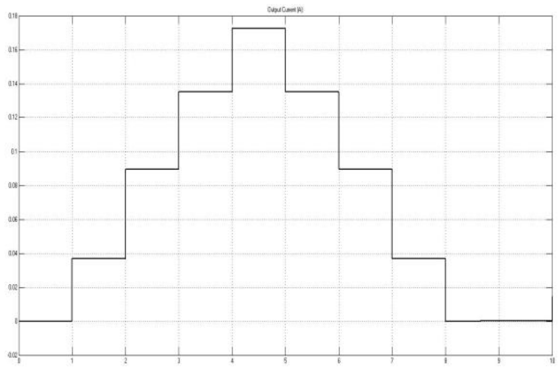

Figure 14: Simulation result for P-V Characterstics without Shading Effect

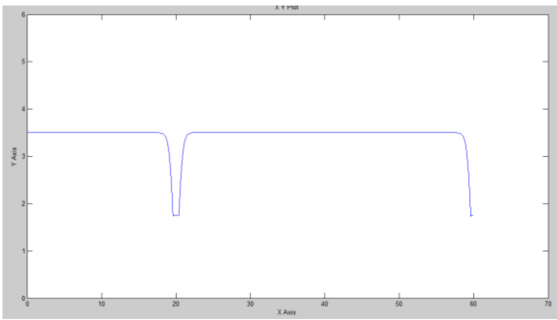

Figure 13: Simulation result for I-V Characterstics with Shading Effect (3-pannels)

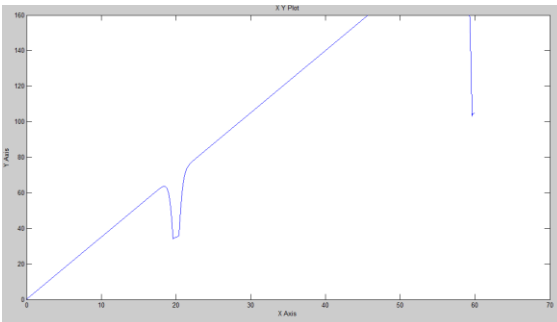

Figure 14: Simulation result for P-V Characterstics with Shading Effect (3-pannels)

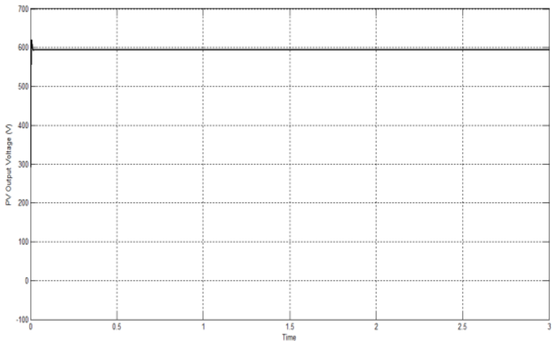

Figure 15: Simulation result for Output Voltage from Converter

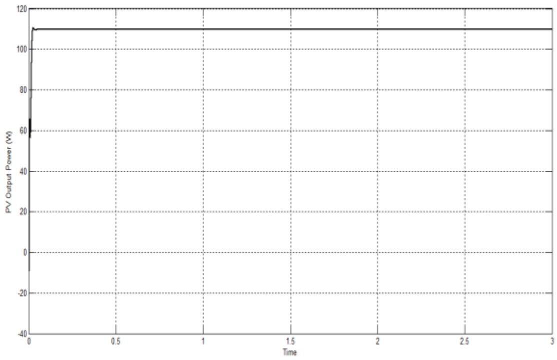

Figure 15: Simulation result for Output Power from Converter

VII.CONCLUSION

A Matlab/Simulink model for the solar PV cells, modules, and array is developed and presented in this paper. This model is based on the fundamental circuit equations of a solar PV array taking into the effects of physical and environmental parameters such as cell temperature, solar irradiation and shading condition. As a result of the study, the proposed model seems to be easy for other researchers to follow to build the model and study by themselves because it is based on the Equations from the mathematical modelling. In addition, the proposed model is also used effectively to study the effect of shadow on operating characteristics of solar PV system with DC-DC converter for improving the output power.

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