Grid Connected Solar Photovoltaic Array with MPPT Matlab Simulation

Payal Ganvir[1], Radharaman Shaha[2]

[1]PG Student, [2]Assistant Professor

[1,2]Department of Electrical Engineering, Tulsiramji Gaikwad Patil College of Engineering and Technology,
[1,2]Nagpur, Maharashtra, India

ABSTRACT

Now-a-days, due to the problem of generation of electricity and consumption required is not sufficient so, solar generation system is essential. Nowadays, with generates electricity to match the required demand. So this paper is important. Here using, 1 Soltech 1STH-215-P solar panel in SIMULINK. In this paper we are control the renewable energy based solar photovoltaic system using MATLAB. The grid connected MATLAB model is studied under solar radiation and changing weather condition. In this we generate excess amount of electricity and send to the utility grid. Here we used MPPT technique which is implemented in DC-DC step up converter to permit P-V module to give power at maximum power point. The output of this converter is given to the 3-level inverter and it synchronized the utility grid.

Keywords: *Solar Energy; Solar Photovoltaic Array System; Maximum Power Point Tracking Technique; Voltage Source Converter; DC-DC boost converter ;Grid*

1. INTRODUCTION

Due to the growing demand on electricity the limited stock and rising prices of conventional sources (such as coal and petroleum etc) photovoltaic (PV) energy becomes a alternative it is omnipresent freely available environment friendly, less operational and maintenance cost. Thus the demand of PV generation system has to be increased for standalone and grid connected modes of PV system. Tracking is the maximum power point of a photo-voltaic array is usually an essential part of the PV system.

Therefore an efficient maximum power point tracking technique is expected to track the MPP at all environmental condition and then force the PV system to operate at the MPP point. MPPT is an essential component of a PV system. Solar photovoltaic system are one of the fastest growing renewable energy generation system. The energy generated from PV system is depend on environmental factors such as solar irradiation, cloud coverage, wavelength, reflection and ambient temperature. These factors can negatively affect the PV cell conversion efficiency. PV energy system has some advantage such as pollution free, abundant availability, less maintenance. In solar photovoltaic system the optimum efficiency (which is 7-16%) second inverter efficiency (90-97%) and the efficiency of MPPT algorithm (over 98%). In photovoltaic system integrated to grid, the grid inverter is three inverter in this paper it is an important component which invert dc power which is obtain from the P-V system array alternating power to synchronized voltage and frequency of connected utility grid. In this paper the major component are photovoltaic plant, consist of P-V array, MPPT unit, three level inverter, step-up converter and utility grid.

The function of PV array is to convert the solar irradiation which is comes from solar energy into dc power. The MPPT algorithm is also connected to the PV array which allow PV array P-V array to produce maximum power. The unidirectional power is obtained and then changed into ac power with the help of three level inverter and then this ac power is filter through LC filter and fed to utility grid .A boost converter is also to provide link between MPPT and inverter for boost purpose. In order to match inverter output current with the grid voltage and reduce the total harmonic distortion. The voltage source converter is used in this paper.

2. PROBLEM REVIEW

Figure1shows characteristics of power curve for a PV array. The problem Figure 1 shows the characteristic power curve for a PV array. The problem considered by MPPT techniques is to automatically find the voltage Vmpp or current Impp at which a PV array should operate to obtain the maximum power output Pmpp under a given temperature and irradiance.

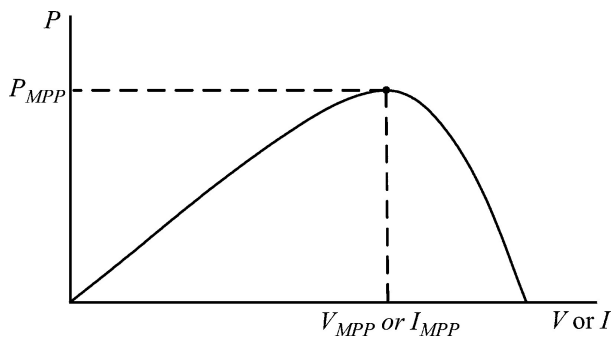**Figure1**. Characteristics of PV array power curve.

3. MPPT TECHNIQUE

There are different methods to track down the maximum power point, a few of which are listed below.
a. Perturb and Observe method
b. Incremental Conductance method
c. Parasitic Capacitance method
d. Constant Voltage method
e. Constant Current method

A. Perturb and Observe method:-

Perturb and Observe is the most regularly utilized MPPT strategy because of its simplicity of execution. The working voltage is expanded the length of (dP/dV) is sure, i.e. the voltage is expanded the length of we get more power. On the off chance that (dP/dV) is detected negative, the working voltage is diminished. The voltage is kept put if (dP/dV) is close to zero inside of a preset band. The time multifaceted nature of this calculation is less however on coming to near to the MPP it doesn't stop at the MPP and continues annoying. This calculation is not suitable when the variety in the sun oriented illumination is high. The voltage never really achieves a careful esteem yet annoys around the most extreme force point (MPP).

b. Incremental Conductance Method:-

In this strategy the PV exhibit's incremental conductance dI/dV to figure the indication of dP/dV. At the point when dI/dV is equivalent and inverse to the estimation of dP/dV (where dP/dV=0) the calculation demonstrates that the greatest force point is come to and it is ended and gives back the comparing benefit of working voltage for MPP. This strategy tracks quickly changing illumination conditions more precisely than P&O.

$$P = V*I$$

Differentiating w. r. t. voltage

$$\frac{dP}{dV} = \frac{d(V*I)}{dV}$$
$$\frac{dP}{dV} = I + V*\left(\frac{dP}{dV}\right)$$

When maximum power point is reached $\frac{dP}{dV}$ = 0. Hence,

$$\frac{dP}{dV} = -\frac{I}{V}$$

c. parasitic capacitance Method :-

This method is an improved version of the incremental conductance method, with the improvement being that the effect of the PV cell's parasitic union capacitance.

d. Constant Voltage Method :-

This strategy is not broadly utilized as the misfortunes amid operation is subject to the connection between the open circuit voltage and the greatest influence point voltage.

The proportion of these two voltages is for the most part consistent for a sun oriented cell, generally around 0.76. Consequently the open circuit voltage is acquired tentatively and the working voltage is acclimated to just 76%.

e. Constant Current Method

It is like the consistent voltage technique, this strategy is subject to the connection between the open circuit current and the most extreme force point current. The proportion of these two streams is by and large consistent for a sun based cell, generally around 0.95. In this manner the short out current is acquired tentatively and the working current is acclimated to 95%.

4. MODEL OF P-V CELL

A simple ideal equivalent circuit model for cell obtain by the parallel combination of an ideal current source and real diode is shown in below.
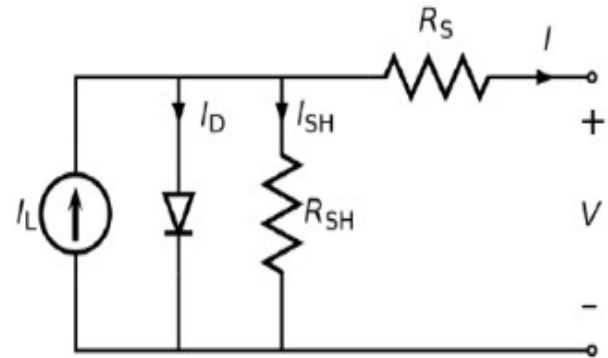

Figure2. Fundamental circuit representation of solar cell

Where:
I: Current of solar cell (A)
Isc: Short circuit current(with assuming no series/shunt resistance)
ID: Saturation current of diode (A)
q : Electron charge (1.6*10-19C)
k : Boltzmann constant (1.38064*10-23J/Kelvin)
T : Temperature in Kelvin (K)
V : Output voltage of solar cell (V)
Rs : Series resistance of solar cell(Ω)
Rsh : Shunt resistance of solar cell (Ω)

5. BOOST/STEP-UP CONVERTER (DC TO DC)

Boost converter gives a dc output voltage which is more than the applied dc input voltage, filter which consisting of inductor and capacitor, is utilized to decrease ripple in dc output voltage and dc output current respectively and is connected at output terminal of the converter. The operating principle step-up/boost converter consist two different states of operation. When switch is on that is switch is close, result an increase in current. When switch is off that is open, result in reducing in inductor current.
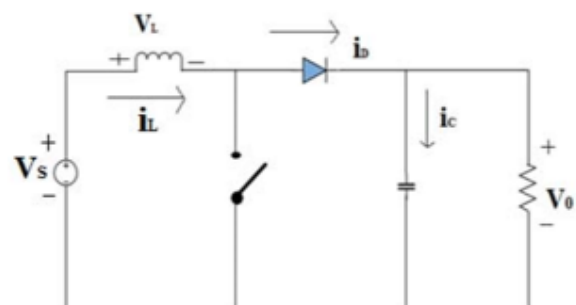
Figure3. Circuit representation of Boost /step up Converter

Output voltage of dc-dc step up converter is given by,

$$Vo = \frac{Vs}{1 - D}$$

Where,

Vo = DC Output voltage of converter.

Vs = DC Input voltage of converter.

D= Duty ratio.

Hence, by varying duty ratio we can obtain constant voltage at maximumpower with the help of MPP technique.

6. CONTROLLER

It is consisting of two controller which is power controller and current controller. Power controller senses the grid voltage and current and provides the corresponding grid active and reactive power as per requirement of the circuit. Power controller also sense three level inverter output voltages and current and provide the active and reactive power respectively. The main purpose of current controller is to provide triggering pulse according to reference values.

7. PV CHARACTERISTIC

PV1 is a subsystem when double click on it subsystem mask will open. In this we can change the value of short circuit current, open circuit voltage current at Pmax voltage at Pmax. In the first PV module (1) block actual P-V, I-V characteristic system is constructed. This output Vpv and Ppv is given at output.
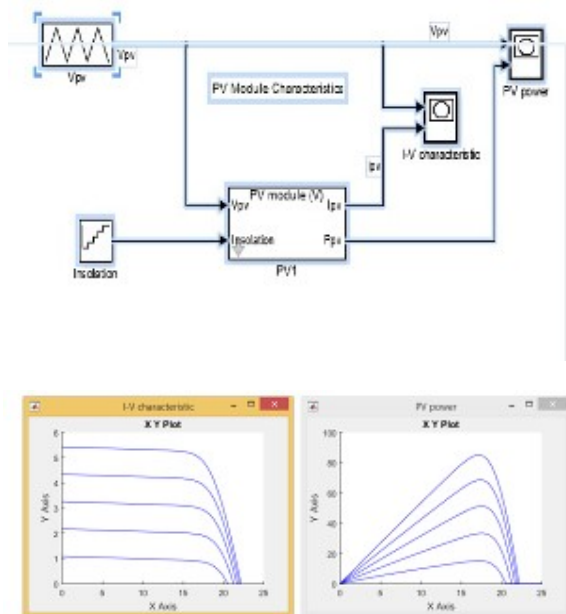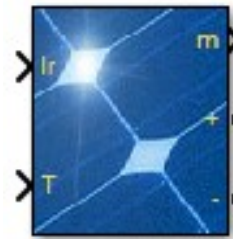

Figure4. PV CHARACTERISTIC

To view circuit inside in this block right click on the block select mask and look under mask. Now circuit inside the block will be displayed.
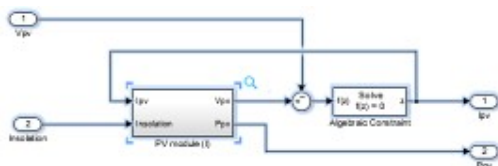
When double click on the PV module(1) block inside the circuit will display.

8. PV Array

Implement PV array modules

The PV Array block is a five parameter model using a current source IL (light-generated current), diode (I0 and nI parameters), series resistance Rs, and shunt resistance Rsh to represent the irradiance- and temperature-dependent I-V characteristics of the module.

Figure5. SIMULINK Model of Solar Cell with MPPT and Boost Converter

Input Parameter: Temperature in deg celcius =25

Incident Solar Radiation in Watt per meter square=1000

Circuit parameter: R1=1ohm

C=0.002F

Inductance L= 0.01H

Load resistance R=1 ohm
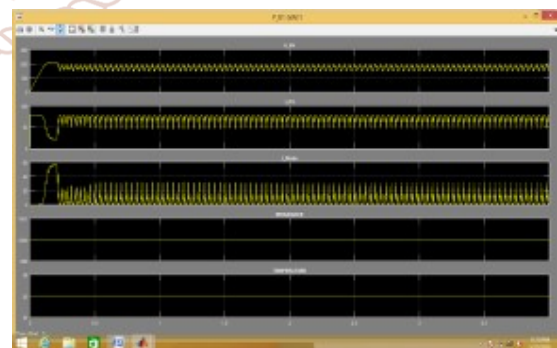
Figure6 . Power Output of the PV module
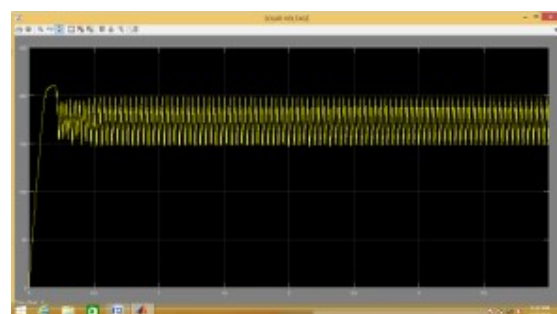
Figure 7. Voltage output of the PV module
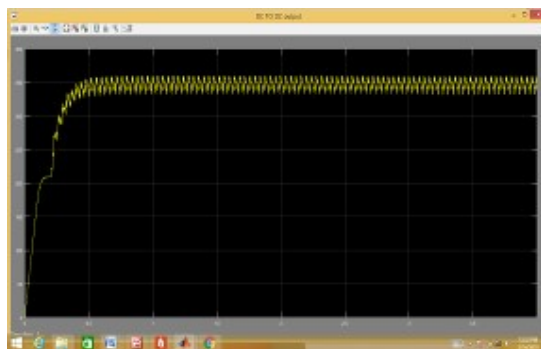
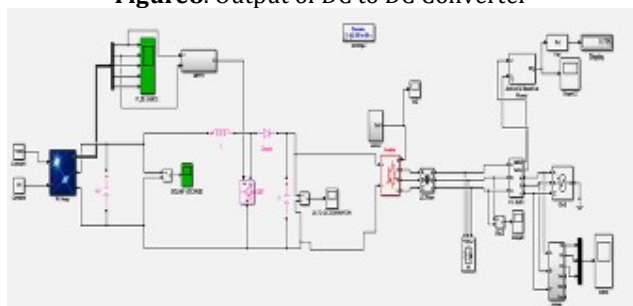**Figure8**. Output of DC to DC Converter

Figure9. SIMULINK model of Solar Cell with MPPT and Boost Converter connected to grid
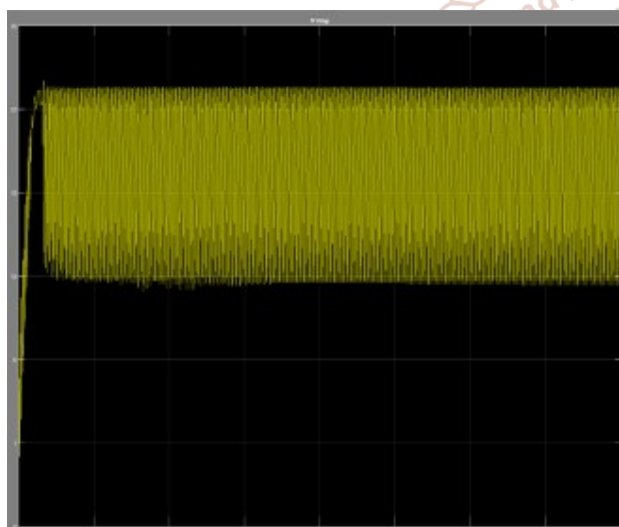

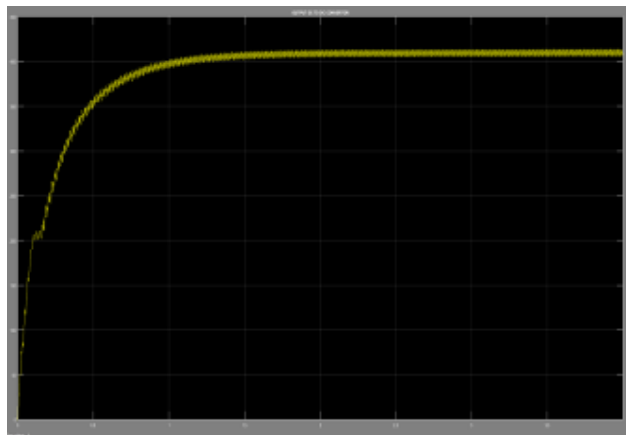**Figure10.**Voltage Output waveform
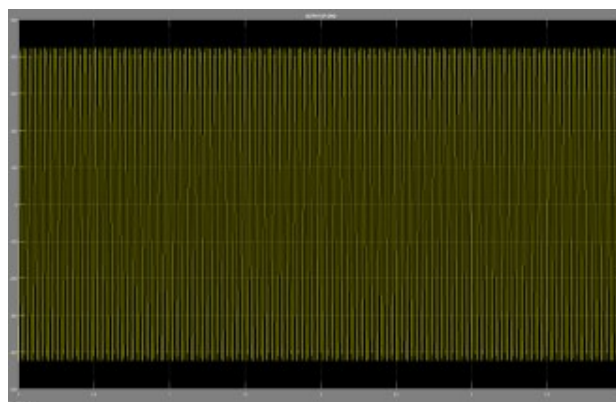

Figure11.Output of DC to DC converter

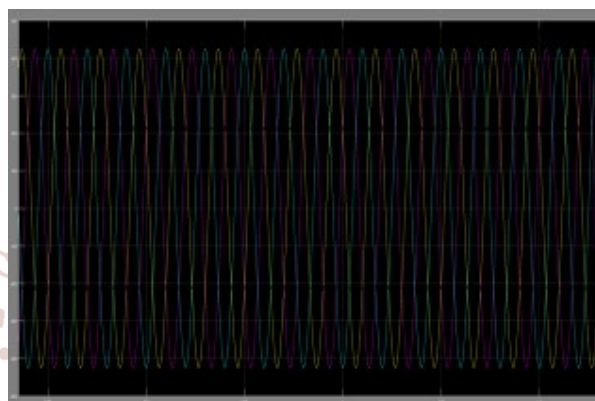**Figure12.**Output of Grid for single phase

Figure13. Output of grid for three phase

9. CONCLUSION:

The P-V, I-V characteristic is shown above. The model explains solar P-V cell is the effect of physical environmental condition based on solar radiation and cell temperature. The voltage source controller is used to synchronize P-V cell plant, step-up converter and inverter with utility grid. The model is used a tool to forecast the nature of grid connected P-V plant under solar radiation and temperature change. The various waveforms were obtained by using the plot mechanism in MATLAB. There is a small loss of power from the solar panel side to the boost converter output side. This can attributed to the switching losses and the losses in the inductor and capacitor of the boost converter.

REFERENCES

[1] J. Dadkhah , M. Niroomand, " Real-Time MPPT Optimization of PV Systems by Means of DCD-RLS Based Identification" Member IEEE, Department of Electrical Engineering, University of Isfahan, Isfahan, Iran. mehdi_niroomand@eng.ui.ac.ir 2018.

[2] Mashood Nasir, Student Member IEEE, Hassan Abbas Khan, Member IEEE, Arif Hussain, Laeeq Mateen and Nauman Ahmad Zaffar, Member IEEE, "Solar PV-based Scalable DC Microgrid for Rural Electrification in Developing Regions,"2017.

[3] Morcos Metry Student Member, IEEE Renewable Energy & Advanced Power Electronics Research Laboratory Texas A&M University College Station, TX 77843, USA morcos.m.metry@ieee.org, "MPPT of Photovoltaic Systems Using Sensorless Current-Based Model Predictive Control,"2016.

[4] Ramdan B. A. Koad, Ahmed F. Zobaa, Senior Member, IEEE and Adel El-Shahat, Member, IEEE, "A Novel MPPT Algorithm Based on Particle Swarm Optimisation for Photovoltaic Systems,"2016.

[5] Mohammad B. Shadmand, Student Member, IEEE, Robert S. Balog, Senior Member, IEEE, and Haitham Abu-Rub, Senior Member, IEEE, "Model Predictive Control of PV Sources in a Smart DC Distribution System: Maximum Power Point Tracking and Droop Control,"2014.

[6] Bidyadhar Subudhi, Senior Member, IEEE, and Raseswari Pradhan, "A Comparative Study on Maximum Power Point Tracking Techniques for Photovoltaic Power Systems,"2013.

[7] Trishan Esram, Student Member, IEEE, and Patrick L. Chapman, Senior Member, IEEE," Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques,"2007.