Analysis of PV System by using Pertube and Observe MPPT Method

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Abstract— Recently the Renewable Energy Resources are widely used to generate the electricity. In the proposed paper we are analyze the PV system when incremental conductance method is used for maximum power point tracking. PV module is connected to dc boost converter and its switch is controlled by Perturb and Observe algorithm to tracking the maximum power point. The generated DC power is converted to AC power by using the three phase voltage source inverter. The switches of inverter are controlled by sinusoidal pulse width modulation. Matlab/Simulink tool is used for design the proposed system.

Key words: PV Module, P&O, MPPT, VSI, Matlab

I. INTRODUCTION

Due to limited fossil fuel, the power generation through traditional resources is not able to fulfill the load demands of electricity. Because of this Renewable energy resource is used for power generation to meet the load demands. These resources are free like Solar, Wind etc. Recently solar energy and wind energy are widely used for electricity generation. Presently the researcher fellows are trying to find the reliable technique for tracking maximum power point. By using these techniques we can achieved maximum output from the renewable energy resources like solar and wind. The controlling of both resources are difficult due to intermittent nature. This is the reason why this field is most scoping area of research. The various maximum power point tracking algorithms are used to get maximum output form these resources. In the proposed system Perturb and observe algorithms used for maximum power point tracking. And various power converters are used to step up the generated voltage of PV module. The output of solar is Dc so there is requirement of inverter to convert it to DC to AC for further used. The Voltage Source Inverter is used for converting DC to AC. Pulse width modulation is used to control the output of inverter. This technique is used to control the power electronic switches which are design part of inverter. The output of inverters consist of harmonics, because of this L-C filter is also used for improving the output voltage of inverter. This filter is connected between the inverter output and load.

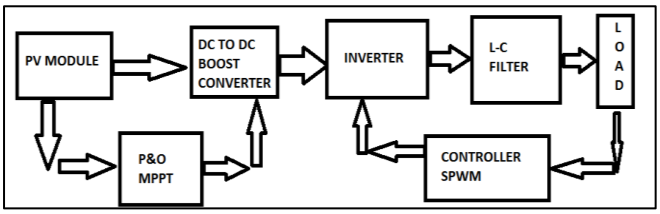

Fig. 1: Proposed system

The proposed system consist of PV module[1-3] which is connected to DC boost converter[4-7] .The MPPT algorithm P&O [8-9] control the duty cycle of boost converter to achive the maximum power from PV module.with the help of this algorithm we step up the dc voltage.This step up DC voltage is futher applied on three phase VSI inverter[5,9-10] which converts it to AC voltage.The switches of inverter is controlled by sinosoidal pulse width modulation by the voltage regulator.After this a L-C filter is connected between inverter and load to improve supply by reducing thr total harmonic distrotion .The load are both R-load and R-L-load.Matlab/Simulink tool is used for design and analyse the proposed system.

II. SYSTEM DESCRIPTION & SIMULATION

A. PV Module

A number of solar cell connected in series which takes solar irradiation as input and converted into electrical energy is called PV module. The mathematical representation of module is discussed below,

$$I_{PV} = I_{gc} - I_0 \left[\exp^{\frac{ev_d}{KFT_C}} - 1 \right] - \frac{V_d}{R_P} \quad (1)$$

Where

I_{gc} -Light generating current

I_0 -Saturation current

e-Electric charge (1.6×10^{-19} c),

K-Boltzmann’s constant (1.38×10^{-23} J/K)

F-Cell idealizing factor

T_C-Absolute Temperature

Vd-Diode voltage and Rp -Parallel resistance.

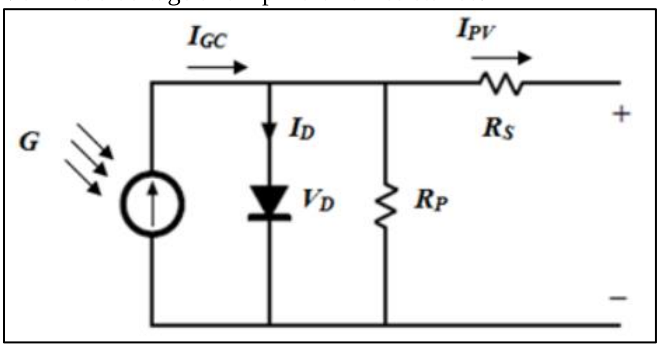

Fig. 2: PV module circuit diagram

The photocurrent depends upon the solar irradiation and temperature. I_{gc} Also express as follows

$$I_{gc} = [\mu_{sc}(T_c - T_r) + I_{SC}] + I_r \quad (2)$$

Where

μ_{sc} -Temperature coefficient of cell’s short circuit current

T_r - Cell’s reference temperature,

I_{SC} - Short circuit current at 25* C and 1 kw/m^2, and I_r is the solar irradiation in kW/m^2.

$$I_0 = I_{0\alpha}\left(\frac{T_C}{T_r}\right)^3 \exp\left[\frac{eV_g}{KF}\left(\frac{1}{T_r}-\frac{1}{T_C}\right)\right] \quad (3)$$

Where

$I_{0\alpha}$ - Cell's saturation current and

$$I_{0\alpha} = \frac{I_{sc}}{\exp^{\frac{(eVoc)}{KFT_C}}} \quad (4)$$

Where, V_g - Band gap energy of used semiconductor

Voc - Cell open circuit voltage.

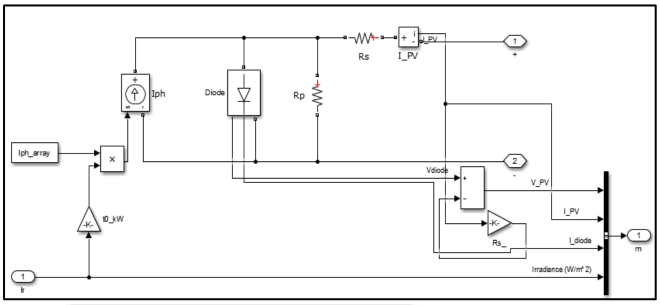

Fig. 3: Simulink circuit of PV

The figure 3 shows the Simulink circuit diagram of PV. We selected Canadian solar CS5P-220M module. Figure 4 displays single solar cell module and figure 5 displays P-V and I-V curve of single module.

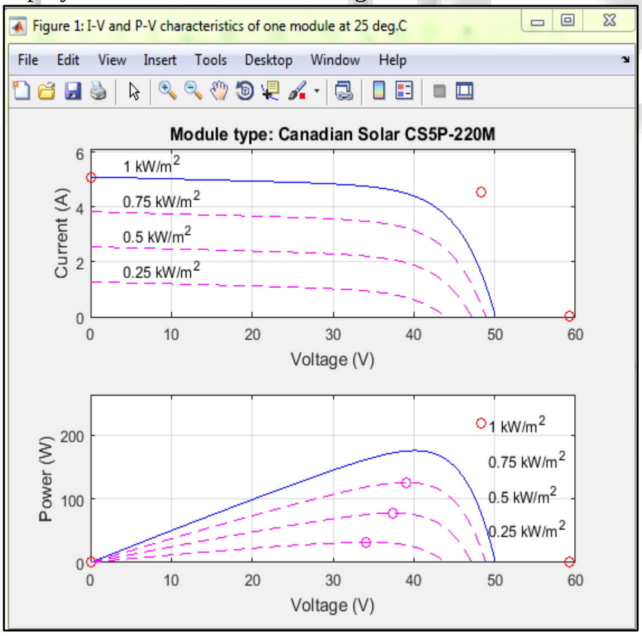

Fig. 4: I-V and P-V characteristics of one module

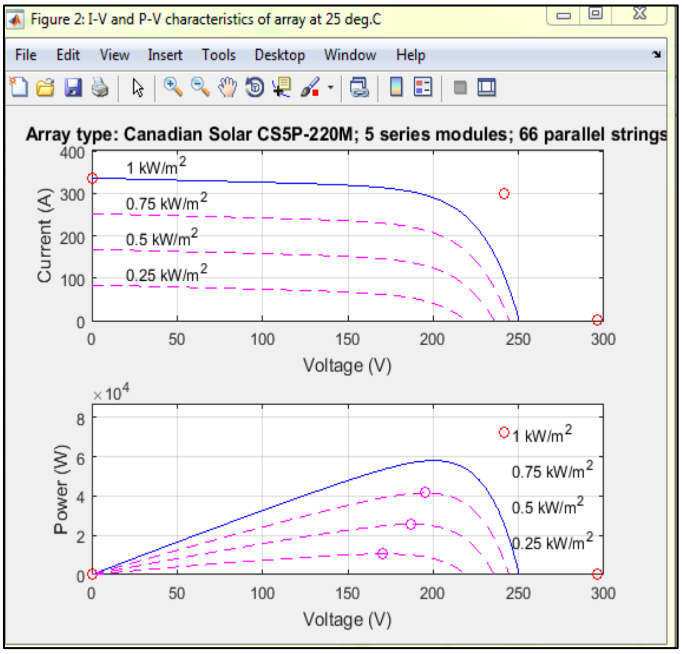

Fig. 5: I-V and P-V characteristics of Array

B. MPPT Algorithm

The various algorithms are used for maximum power point tracking in solar system. In the proposed system Perturb and Observe algorithm is used to obtain maximum power point for generate maximum output from PV module. The figure 6 shows the algorithm of this method.

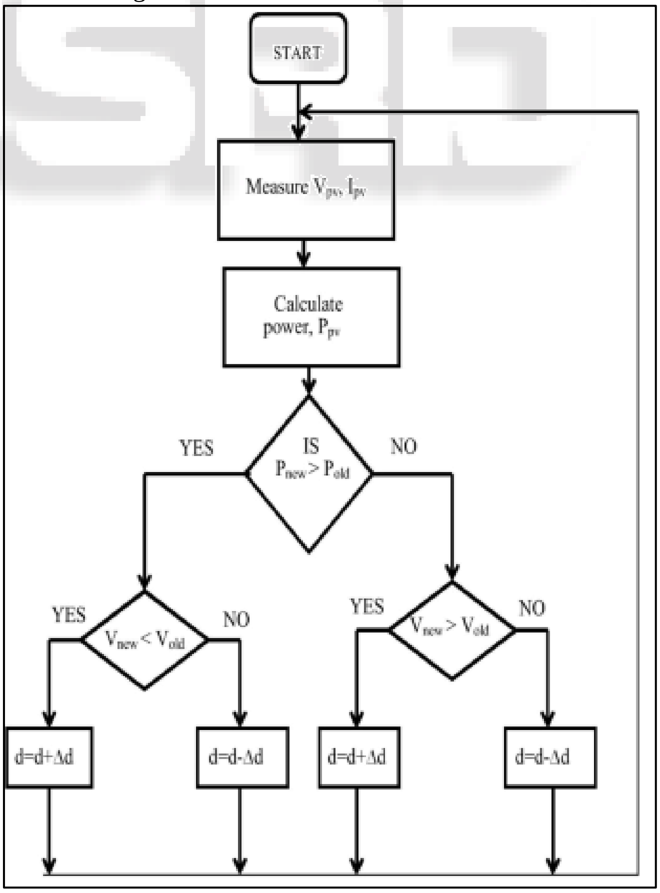

Fig. 6: Control flow chart of Perturb and Observe

C. DC to dc Boost Converter

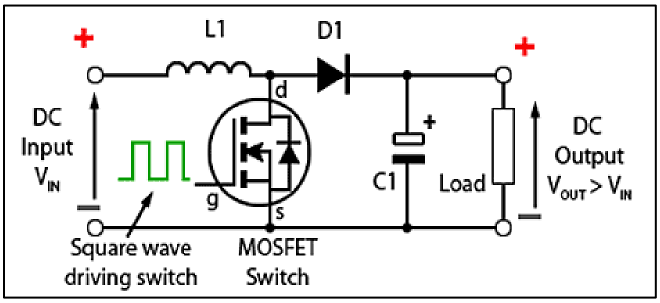

Fig. 7: Dc to dc Boost converter

The boost converter circuit consist of a MOSFET switch.By varing the duty cycle of this switch we can achive the boost voltage.This switch duty cycle is contrilled by MPPT algorithm to obtain the maximum power point voltage in the proposed system.

The working of boost converter is as follows

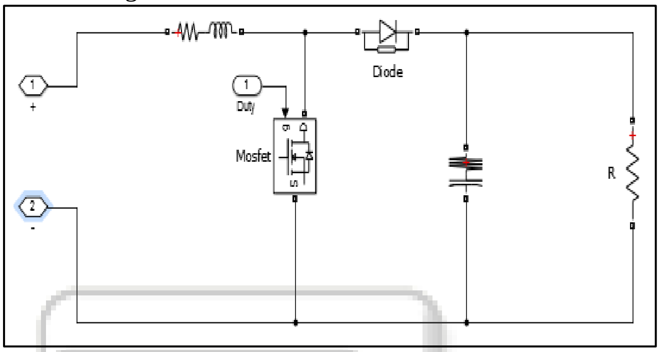

Fig. 8: Boost converter design in Simulink

When MOSFET switch is ON

$$\Delta i = \frac{(V_{IN} - V_{Trans})}{L} T_{ON} \qquad (4)$$

When MOSFET switch is OFF

$$\Delta i = \left(\frac{(V_{out} - V_{in} + V_D}{L} \right) T_{OFF} \qquad (5)$$

P&O algorithm is used to control duty cycle of dc boost converter. Because of this controlling boost converter increased the voltage level.

D. Three phase Inverter (VSI)

In the proposed system we used three phase inverter to convert power dc to ac system. The sinusoidal pulse width modulation is used to obtain the desired output form the inverter.

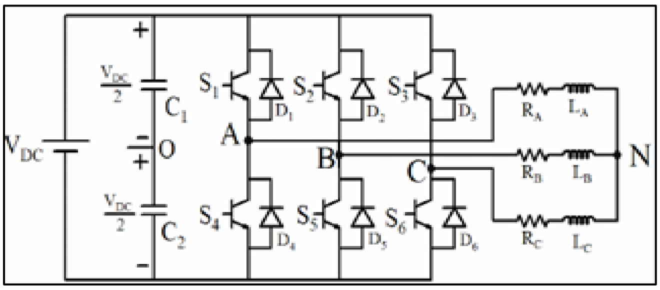

Fig. 9: Three Phase Inverter

In the Simulink we used Universal bridge which have same circuit diagram as shown in figure 9.This Universal bridge is used both as rectifier and inverter by changing properties of Universal bridge.

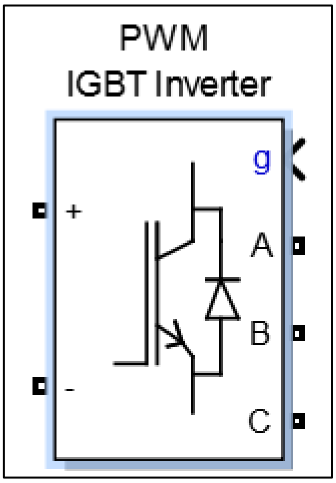

Fig. 10: Universal Bridge

The sinosiodal pulse with modulation is used in proposed system.IN SPWM the reference signal is compared with the carriesr signal and on the basis of this comparison the swithching pulses are generataed to control the switches of inverter to obtain the desired output waveform.The output of the inverter is futher appiled to filter(L-C) which reduces the THD of output waveform to increase the performance of the system.Voltage regulator is also uesd as controller in proposed system to provide reference signal.

III. Result & Discussion

The proposed system is designed on Matlab/Simulink environment.

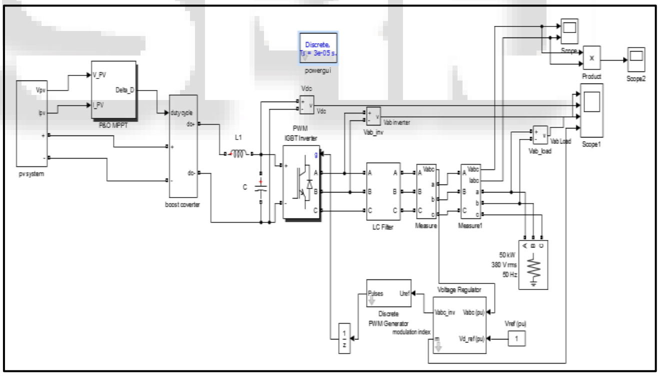

Fig. 11. Proposed system desgin in Matlab/Simulink

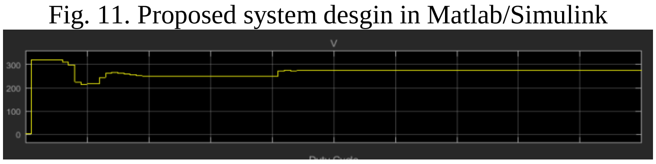

Fig. 12: PV module output voltage (280 volt)

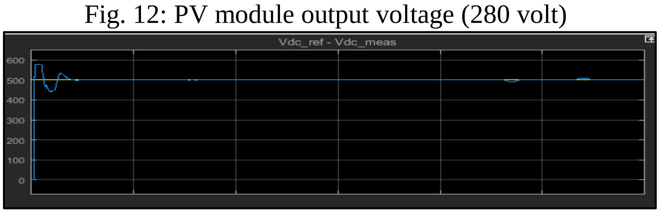

Fig. 13: Boost converter output

Figure 12 display dc voltage generated by PV module which is 280 volt. This output voltage is further applied to boost converter which is controlled by MPPT algorithm. The figure 13 shows the output of boost converter which is step up by 280 volt to 500 volt. The starting waveform is show the transient behavior and after few time achieved to steady state.

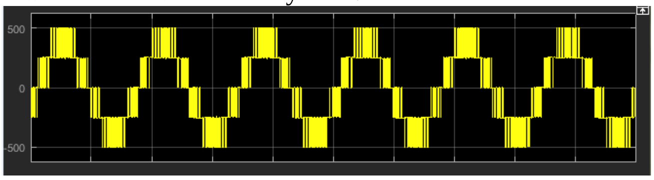

Fig. 14: Inverter output voltage

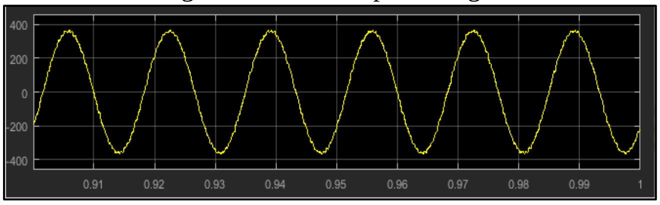

Fig. 15: Filter output

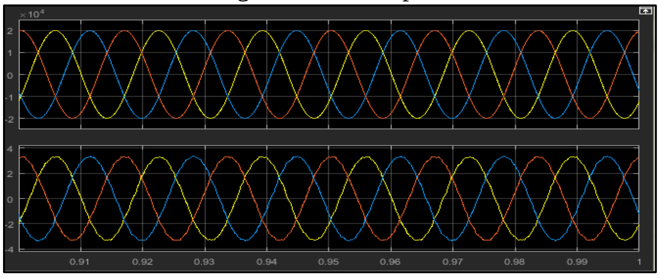
Fig. 16: Load voltage and current

IV. Conclusion

The proposed system is generated the DC power and convert it into AC power with help of power electronics converters. The controlling schemes are used to generate the desired output. Future scope of the system is used SVPWM (Space Vector Pulse width Modulation. Which gives the better controlling and also step up voltage as compared to SPWM.

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