P&O With PI MPPT Control of PV System Connected in Grid

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Abstract: - In this article proposes a nonlinear control method for the PV generator connected in grid. It comprises the PV array, Converter Boost dc-dc, P&O controller and the grid. This document defined an MPPT the approach based on Perturb and Observe with PI control method is presented in a way to make stable the dc voltage by controlling the connected DC/DC Boost converters. To ameliorate the efficiency and robustness of photovoltaic solar power generation and determine a dynamic model of PV system connected in the grid by Matlab/ Simulink that exhibits the features of the system precisely.

Key-Words: - PV; Boost Dc-Dc; P&O-PI; inverter; grid;

1 Introduction

Renewable energy request is rising day by day because to rise in the populace, as wel as the constraints bound to its producing, for example, the impact of contamination and worldwide atmospheric; conduct the pursuits to the progression of the renewable sources of energy.

Renewable resources energy, for example Solar, hydro and wind are pollution free, easily erectable, and boundless so they constitute reliable choices to conventional energy sources [1,2].

But, the effectiveness and execution of these system are still developing. Among them, Photovoltaic systems are mainly utilized as they are light, clean and effortlessly installable. These systems connnected to the grid require important conditions to get a high quality electrical power system.

The Photovoltaic generators display non_linear V-I characteristics. Then again, the optimum operational point changes with cell temperature and irradiation [3]. As a consequence, online monitoring of the mpp the PV generator is an important part of any effective PV system. A variety of MPPT techniques are formed in the literature. The PV is commonly connected to a grid, for this connection the inverter must be utilized to ensure DC/AC conversion. Many inverter structures are utilized [4,5].

This article presents the interfacing of threephase grid connected PV system. The considered PV system is constituted of SunPower SPR-305-WHT solar array type. The model contains an explicit representation of the different elements of the change system as the solar array adapted and control systems. The converter BOOST with an MPPT and PI are used to extricate the maximum power got from the sun and give it to the grid. In all PV based system, the inverter is a now element accountable for the control of power flow between the DC source, and loads or grid so a voltage source inverter (VSI) is utilized to change the DC control into AC power before dispatching it into the grid. Detailed simulation and execution of a threephase grid connected inverter are offered to prove the proposed controller for the PV system connected the grid.

2 PV System Modeling

A lot types of research studied the mathematicals model for the solar cell [6]. The equivalent circuit of the solar cell model is composed of photocurrent diode to speak the PN junction of the solar module; the parallel resistor and series resistor as proved in (see Figure 1). The mathematcal model of solar cell is [7,8].

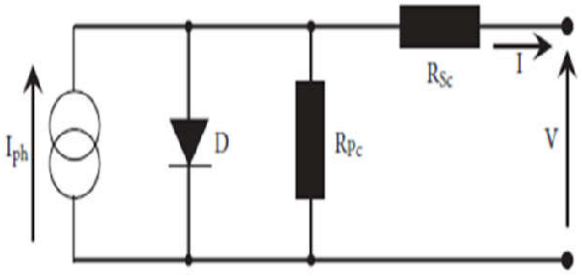


Figure.1 Equivalnt electrical circuit of a solar cell

- Photocurrent Iph

Where, Is: is Current of saturation [A]. Ki : short circut current temperature at Ki= 0.0017 A/K . T & Tr are module operating temperature and Tr = 298, respectively and both are in degree Kelvin, and G is irradiance (W/m2).

$$\text{Iph} = \left[\text{Is} + Ki\left(T - Tr\right)\right] * \frac{G}{1000} \tag{1}$$

- The link between the current I [A] and the voltage V [V] the model in exponential one this equation:

$$\text{ID} = \text{Is}\left[\exp\left(\text{q}\frac{\left(\text{V} + \text{I Rsc}\right)}{\alpha \text{KT}}\right) - 1\right] \tag{2}$$

- Whereas, the output current of the solar cell:

$$\text{I} = \text{Iph} - \text{ID} - \text{Ipc} \tag{3}$$

$$\text{I} = \text{Iph} - \text{Is}\left[\exp\left(\text{q}\frac{\left(\text{V} + \text{I Rsc}\right)}{\alpha \text{KT}}\right) - 1\right] - \frac{\left(\text{V} + \text{I Rsc}\right)}{\text{Rpc}} \tag{4}$$

Where Rsc is the parameter of resistance of series of the cell [Ω], Rpc is the parameter of resistance shunting [Ω], α is The parameter of diode (usually α = 1.2), T is the cellular temperature [K], q is the load of an electron $\left(1.6021 * 10^{-19} C\right)$, k is constant Boltzmann $\left(1.3854 * 10^{-23} JK^{-1}\right)$.

3 BOOST Converter

Boost converter used to increase voltge for inverter circuit and also it uses to control MPPT by using Perturb and Observe control and pulsewidth modulation method to produce a pulse for drive MOSFET. The output voltage of boost converter can calculate from “Eq. (5)” [9].

$$\frac{Vo}{Vin} = \frac{1}{(1 - D)} \tag{5}$$

Where: Vin = input voltage (outpt voltage of PV array), Vo = output voltage, D = duty cycl of the power switch.

The procedure of assimilation and energy injection is completed via a mixture of 4 elements that are an output capacitor, a diode, an electronic switch and an inductor [10]. The link of a converter has indicated in (see Figure2).

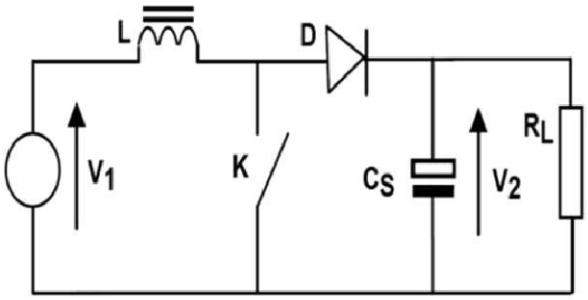


Figure.2 Electric circuit of the converter Boost

4 MPPT

The command MPPT varies the duty cycl of the Converter in order that the power provided via the panel PV is maximum in its frontiers. For the most part, it is founded on the variety of the duty cycle until taking place on the PPM giving to the development of the variables of entree of the Converter (Ipv & Vpv).

There is many MPPT control algorithms however the more popularly utilized in commercial converters is the P & O algorithm, which is dependent on the effectiveness of MPPT. The diagram of the algorithm is presented in (see Figure 3a and Figure 3b) (see Figure 3a and Figure 3b) demonstrate the synoptic view of the MPPT command bind with the PI controller to prove the exposure of the PV model and the P&O MPPT algorithm, Vref illustrates the array voltage.

Th PI controller, which is being utilized for the voltage control and drives thePV system voltage towards the MPPT voltage. The outpt of the control loops is fed to the comparator which generates the PWM to drive the boost converter ensuring that the system operates at the desired maximum power point.

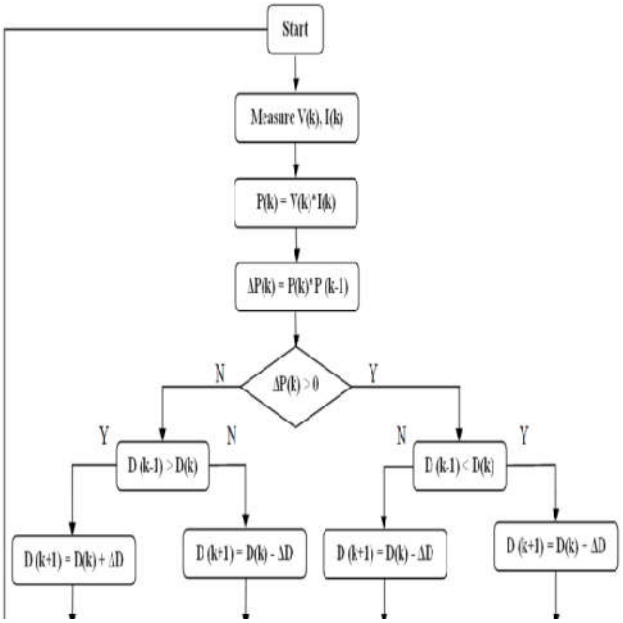


Figure.3.(a) Flowchart of the Perturb and Obserave (P&O)

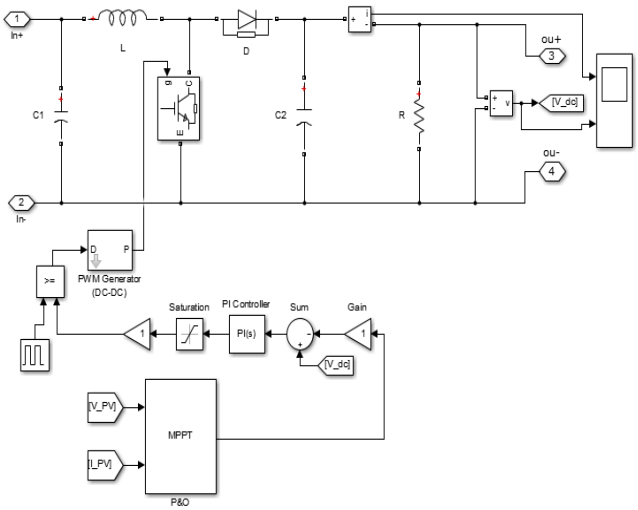


Figure. 3.(b) Simulink model of converter Boost and P&O with PI MPPT

(see Figure3) indicates the flowchar of the P&O algorithm for example, he is to be executed in the microprocessor of control with PI; the model in Simulink is presented by the (see Figure4) down:

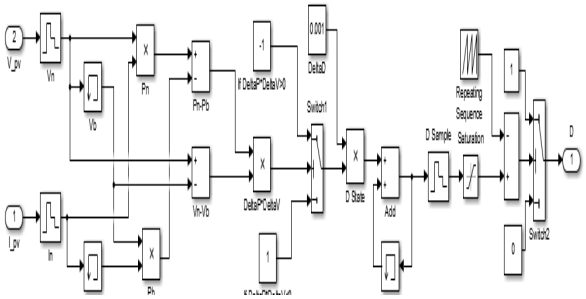


Figure.4 Model Simulink for P&O MPPT

5 Inverter Treephase

The treephase inverters are used to change DC/AC voltage and supply the energy to the load and grid across LC filter circuit. The inverter must be controlled so as to obtain alower harmonic voltage in to obtain a good quality of supply. Numerous PWM techniques are used to change the inverter circuit.

The tree-phase inverters are utilized in SPV systems connected to the grid. A 3phase inverter is a six-steps inverter. It uses at least six devices. As indicated above, the family of transistors devices is currently very broadly used in inverter circuits. Indeed, the utilization of IGBT in the threephase inverter is increasing. A capacitor joined to the input terminals a tendency to do the continuous input voltage constant. This capacitor also removes harmonics returned to the source. In the formulation of the inverter, a step is given as a variation in the terminating starting with one IGBT to the next IGBT in the correct order. An LC-type filter is used to impart a 50Hz frequency output to loads of the consumers and the power grid. Different components define the pick of the filter capacitor and inductance. As a general rule, so as to suppress taller order harmonics, the filter resonance frequency must be more than six times the desired output frequency [12].

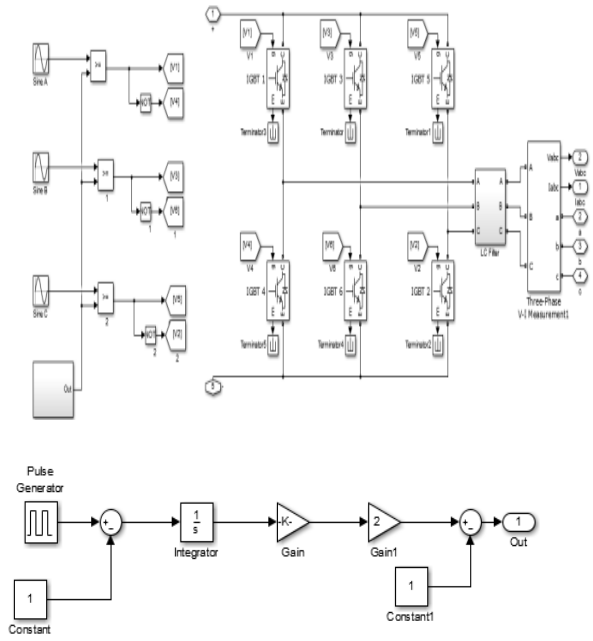


Figure.5 Model Simulink for Inverter and pwm reference generator

The technique selected for this application was SPWM (SinusoidalPulseWidthModulation), it permits the control of the magnitude, phase, and frequency of the generated AC wave form. It demands 3 references sinusoidal wave form (for 3-phase tasks) of a similar frequency as the needed output wave form and one tall frequency triangle wave form is recognized as the transporter signal. The method is finished via Comparison the magnitudes of the sinusoidal and triangle wave form. At the point when the amplitude of the modulating signal is tall than that of the transporter signal, the upperswitch in the equivalent phase branch in the (see Figure5) is started.

6 Simulation and Results

The PV array system comprises of forty SunPower SPR-305-WHT modules: 5 modules series and 66 parallel strings. (see Table 1) demonstrates the electrical characteristics of the PV module (Rs, Rp, Isat, Iph is the model parameters for one module)

Table 1: Electrical characteristics of the SunPower SPR-305-WHT PV module

Voc	64.2 V
Isc	5.96 A
Vmp	54.7 V
Imp	5.58 V
Isat	1.1753 e-8 A
Iph	5.9602 A
Rs	0.037998Ω
Rp	993.51 Ω

The SunPower SPR-305WHT PV module modeling is confirmed. (see Figure 6) shows the curve (I-V and P-V) of the single module with various varieties of irradiation and of the 5 series modules, 66 parallel strings. These curves prove that, as appeared in the electrical model, the current and the voltage therefore depend on the temperature varieties and irradiation variations of the module. The got results correspond to the maker's data sheet of SunPower SPR-305-WHT.

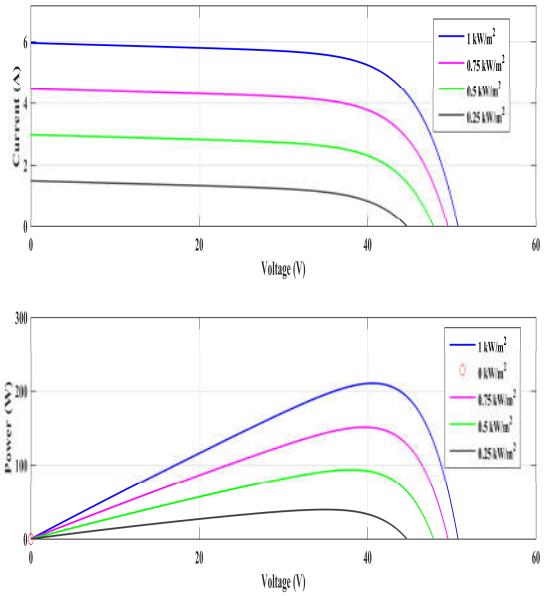


Figure. 6.a: P-V and IV characteristics of one module at 25 deg

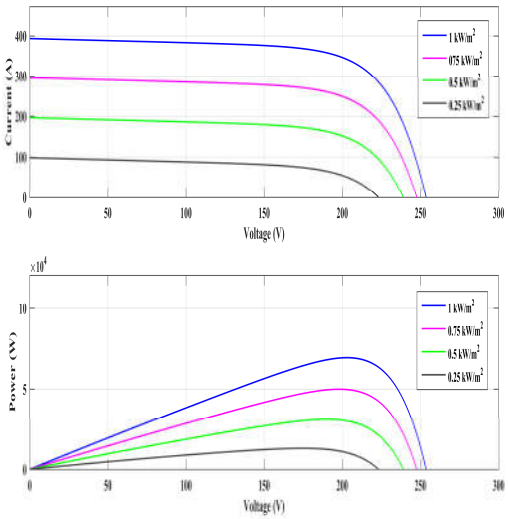


Figure 6.b: IV and P-V Sun Power SPR-305-WHT_5 series modules_66 parallel strings

Algorithm MPPT P&O with PI is applied to a PV array. They got PV array current, voltage, Power and irradiance can be seen in (see Figure 7). This figure demonstrate that the algorithm progressively converges towards the current Imp= 4.5 A, the voltage Vmp =321V, and the power peak 4800W, when irradiation reaches the maximum value 1000 W/m² and at temperature of 25 C. It is too observed that PV array current get the same variation form of irradiation G; this confirms the electric model of PV.

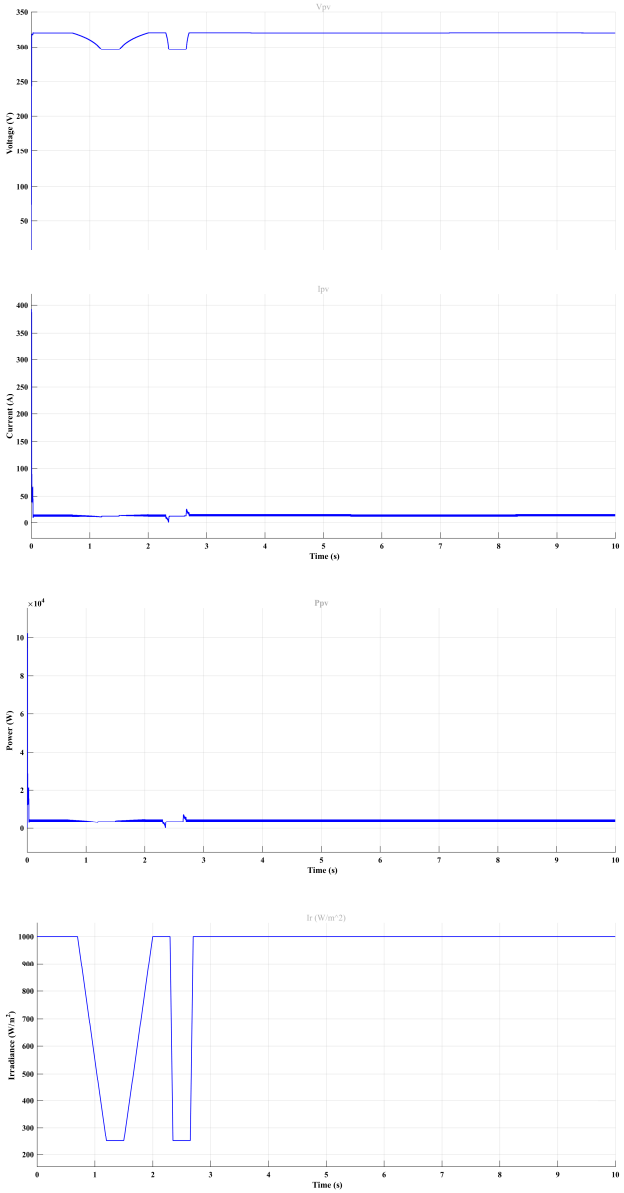


Figure.7 Voltage, current, Power and irradiance the PV array

(see Figure 8) shows the outpt of the boost converter and we can view that the boost circuit successfully increased the input voltage of 320 V that is the outpt of the PV array to 644 V.

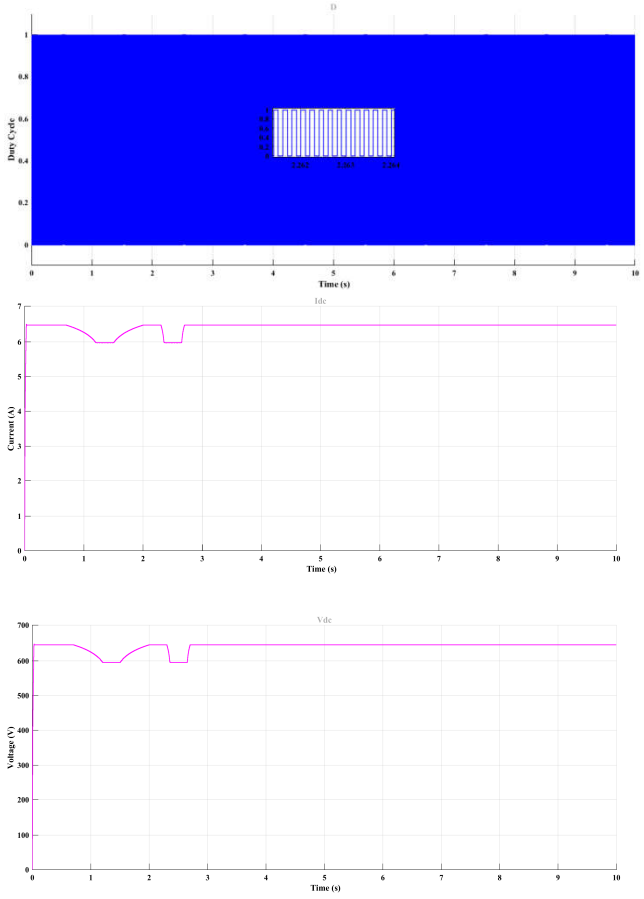
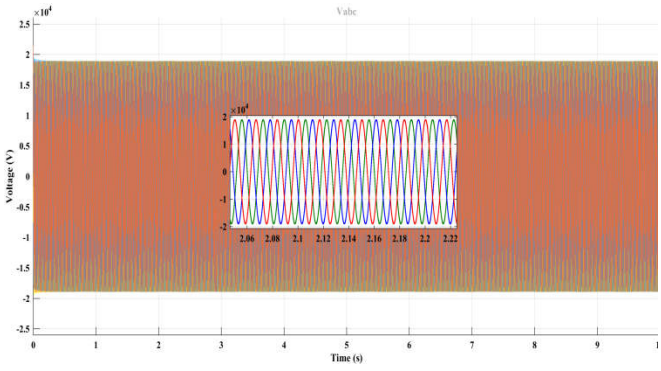


Figure.8 Duty Cycle, Output Current and Voltage of the Boost converter

(see Figure 9) shows the output current and voltage injected to Grid which gives an ideal sinusoid, this shows that the system PV has been effectively integrated with the grid which is rated at 640 V & 60 Hz.



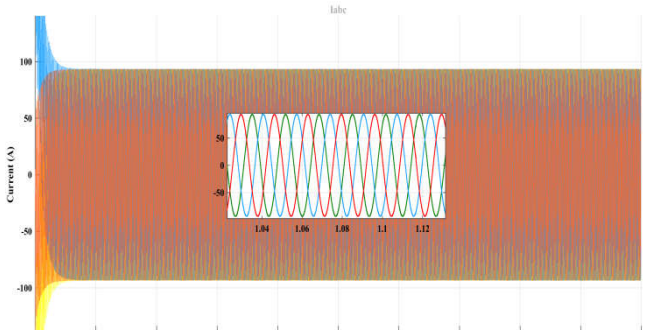


Figure.9 Output Voltage, Current injected to Grid

7 Conclusions

That document describe the interface of the PV system connected in grid, Define his elements, and discuss how to function. The MPPT command obtained the maximm power of the PV array with great effectiveness in dynamic reaction time.

All results in the simulation got according to MATLAB/Simulink, indicate dynamic conduct and the control production which gave a perfect sinusoidal for the current and voltage the inverter output, its power quality output meets of photovoltaic system connected in grid gives great results and demonstrate that the control system is effective.

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