

Design and Simulation of 100kw Grid Connected Solar PV System Using MATLAB/Simulink

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ABSTRACT:In this paper presents the Simulation 100kW grid-connected solar PV system using MATLAB/SIMULINK. Solar array characteristics depend on the solar radiation and temperature these are in non-linear nature its power should vary continuously with weather changing conditions. In this condition, MPPT is used to track the maximum power from the solar array. This Performance evaluation of this system is discussed and then control the output current of the inverter using hysteresis current controller.

KEYWORDS:PV array, MPPT Algorithm, DC-DC Converter, DC-AC Inverter, System Control, Grid-tied.

I. INTRODUCTION

Solar energy is an important source of the electricity production [1]. In the photovoltaic system, photovoltaic arrays or modules made up of semiconducting materials it allows sunlight then it converts directly into electricity. Photovoltaic arrays can provide safe, maintenance-free, reliable and environmentally friendly [2]. In this PV generation system, conversion efficiency is low for the electrical power generation. The electric power generation of the solar arrays changes continuously with climate changing conditions their generated power output is always changing with environmental conditions [3].

Photovoltaic generated power supplied to the grid acquisition is more and more visibility, while the world's power demand is rising [4]. A grid is an interconnected network for delivering electricity from producers to end users. The grid-connected system consisting of generating stations it produces electrical power, distribution lines these are connected to individual end users and high-voltage transmission lines which are connected to a grid. The main advantage of the grid-connected system is the more effective utilization of generated power [5]. The main objective of this paper, the 100kW system is connected to the grid and then observes the performance evaluation of this system using a hysteresis current controller to limit current of the inverter.

In solar PV system, MPPT is used to improve efficiency of the PV system. There are a large number of MPPT techniques presented that are able to track MPPs. An improved method for INC on the basis of variable step is presented but its complexity is more compared to the P&O Technique and MPPT fuzzy logic controllers have good performance under varying atmospheric conditions and exhibit better performance but more impressive, which need special design and familiarity with specific subjects[18]. Comparison among ten different Maximum Power Point Tracking techniques. In particular, twelve different types of solar insolation were considered then the results indicate that the P&O and IC algorithms are in general the most efficient of the analyzed MPPT techniques [9].The comparison for Incremental conductance and Perturb and Observe algorithm suggests clearly that for varying nature of atmosphere, incremental conductance gives better performance than Perturb and Observe algorithm but its complexity is more than P&O technique[20].Perturb and observe (P&O) method is the most ease of implementation, common for simplicity,

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and excellent performance[8] especially for low-cost implementations and the proposed algorithm gives faster response than the conventional algorithms. [13]. It is a simple MPPT setup resulting in a highly efficient system[19]. After detection of text, how text region is filled using an inpainting technique that is given in Section III. Section IV presents experimental results showing results of images tested. Finally, Section V presents conclusion.

II. PROPOSED SYSTEM STRUCTURE

In this paper proposed system consisting of PV array, DC-DC converter, MPPT controller, DC-AC converter, hysteresis current controller and grid connecting equipment. In grid connected PV system with the hysteresis current controller (HCC), which controls the inverter for interfacing the grid. The PV array generated voltage is an increase using DC-DC boost converter then it is fed to three phase inverters. This inverter controlling purpose using hysteresis current controller. These all system block diagram arrangement is shown in fig.1.

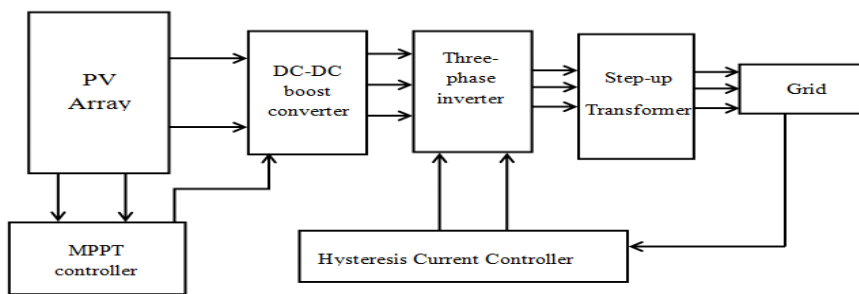


Fig. 1. The basic block diagram of the proposed system

A. PV array modeling

A photovoltaic Panel consists of a number of photovoltaic cells connected in series and parallel formation. It is important to understand the operation of a single photovoltaic cell [7]; solar cell is basically a p-n junction that directly converts solar radiation into electricity. This equivalent circuit consisting of a current source (I_L), diode (I_d) and shunt resistance connected parallel to the diode and a series resistance connected in series to the equivalent circuit as shown in fig 2.

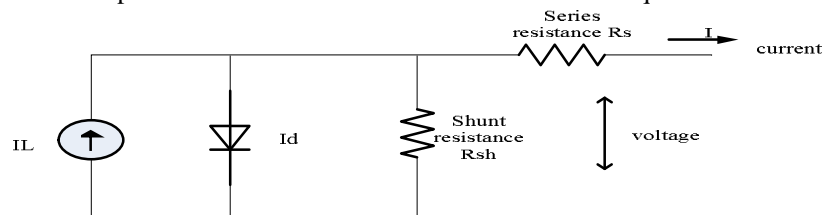


Fig. 2. Represents the solar cell equivalent circuit

A PV array can be defined as the group of several modules connected in series-parallel combinations to generate the required current and voltage [6]. solar radiation and atmospheric temperatures are the inputs to the solar array. In this paper, solar radiation is 1000w/m^2 and 25° temperature is given to the solar array with respect to their changing inputs solar array output should be varies these are shown in fig 3& fig 4.

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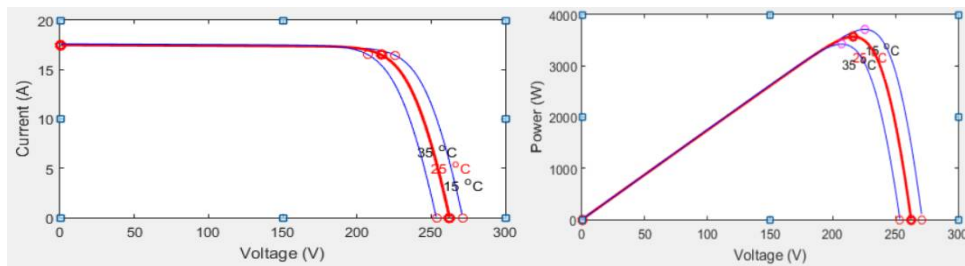


Fig. 3. Output voltage, current and power at different temperatures

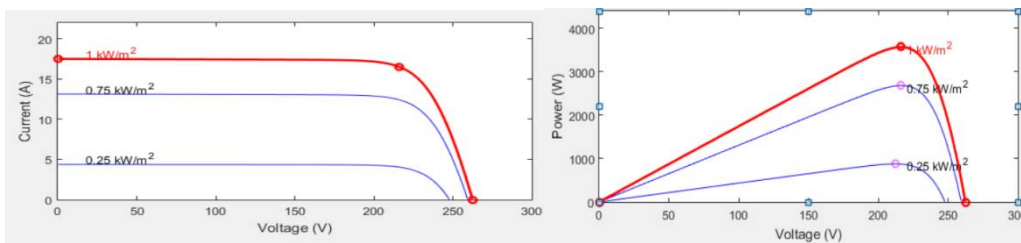


Fig. 4. Output voltage, current and power at different irradiance

B. MPPT controller

Solar radiation and temperature are changes continuously throughout the day with climate changing conditions. Under these conditions, the maximum power point of the PV array changes continuously and hence MPPT technique is used to maintain the PV array's operating point at its MPP [9]. The MPPT technique that generates the control signal which feeds the boost converter. Perturb and observe (P&O) technique is presented in this paper. It is the most widely used technique to track the maximum power from the array. P&O technique operates by regularly Perturbing that is incrementing or decrementing the PV module terminal voltage or current and compares the output power of PV array with that of the preceding perturbation cycle. If the PV array output power is changes due to its operating voltage changes, the control system moves the PV array operating point in that direction and or else the operating point is stimulated in the reverse direction. In the next perturbation cycle the algorithm continues in the same way. Structural flow chart is shown in below fig.5. [10, 11] and perturb and observe (P&O) MPPT technique developed in MATLAB software shown in fig.6.

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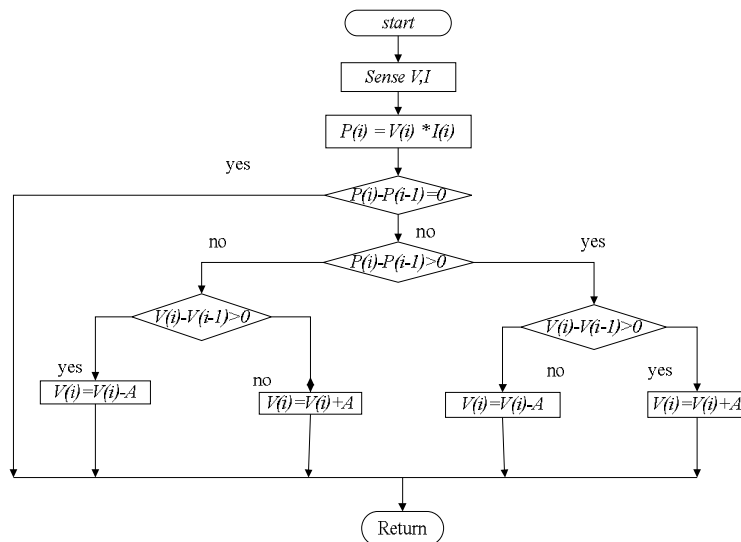


Fig. 5. State-flow chart of P&O MPPT technique

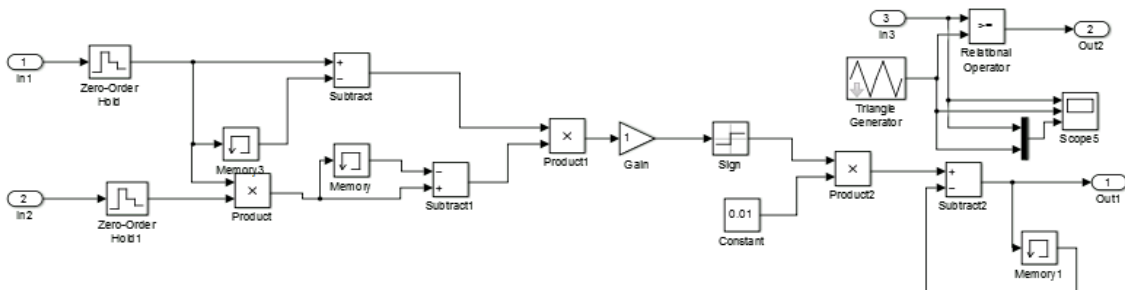


Fig. 6. Perturb and observe (P&O) technique developed in MATLAB

In fig.5. represents the perturb and observe (P&O) MPPT technique. In this paper, to take two input ports, these are the solar array output voltage and currents, which are the inputs to the MPPT controller. This generates the control signal and feeds it to the boost converter IGBT switch. It will generate pulses.

C. DC-DC boost converter

PV array output given as input to the DC-DC boost converter. It should step-up the voltage and step-down the current. A Boost converter is used to implement the maximum power point tracking and to boost and control the output voltage of the PV array [12]. In maximum power transfer theory, the maximum power is being transferred from source to load when the load is matching that source impedance is equal to the load impedance by adjusting the duty cycle of the DC-DC boost converter. The duty cycle can be defined as the ratio between the switch on time of the switch to the total switching period. With continuously varying climate changing conditions, the duty cycle of the DC-DC boost converter has to be adjusted to extract maximum power from the PV array [3]. Boost converters have more advantages: their simplicity, low cost, and high efficiency [13] and high reliability with respect to remaining configurations. In fig [7] a boost converter circuit is developed using MATLAB software where diode D is used to protect the PV array against negative current. Capacitor C is placed here to limit the high-frequency harmonics [3].

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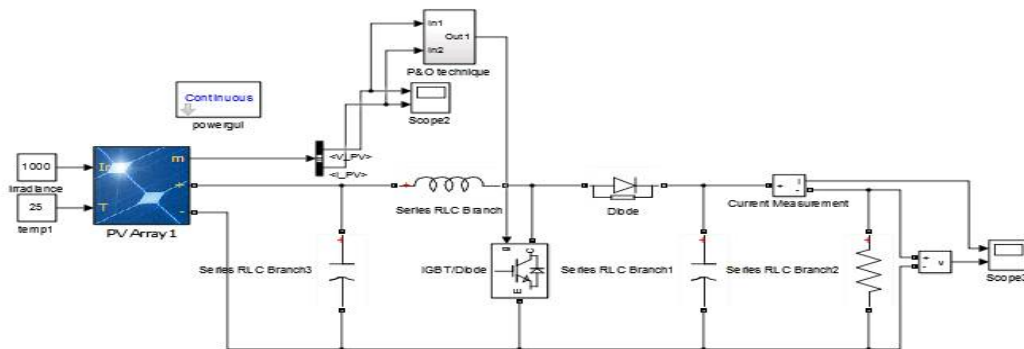


Fig. 7. PV array with boost converter

D. Three phase inverters

The Boost converter is fed to an inverter. It is an electrical device which converts DC source to AC source. Three phase inverters are generally used for high power applications. In inverter design IGBT (insulated gate bipolar transistor) power switches are used to high voltage capability, fast switching compared to other switches and in this paper inverter controlling purpose hysteresis current controller is used. In power electronic circuits, these current control methods play very important role, which are broadly useful in ac motor drives and continuous ac power supplies where the main objective is to produce a sinusoidal ac output[15]. The main advantages of hysteresis current controller are fast response, high tracking accuracy and simplicity. This controlling technique can be implemented by constant switching frequency or variable switching frequency. Constant switching frequency is obtained by modified bandwidth depending on inductance value. In variable switching frequency a constant bandwidth HCC technique controls the current in defined bandwidth [16].

In proposed technique requires defining upper hysteresis band limit and lower hysteresis band limit. In open loop control strategy, the DC output voltage variation is familiar problem due to its load variation, but we can get stable output in this condition close loop strategy is used. In close loop control, comparator compares the output current signal and reference current signal which is given as reference signal. Which reduce the current output error and gives desired output. Where the PI controller should be used to control the generated gate pulses and it is based on the current error. comparison between the given band limit and load current and the switches turns off, when it crosses the upper band limit and the switches are turns on, when current crosses the lower band limit[17]. This controller is developed MTALAB in fig [8].

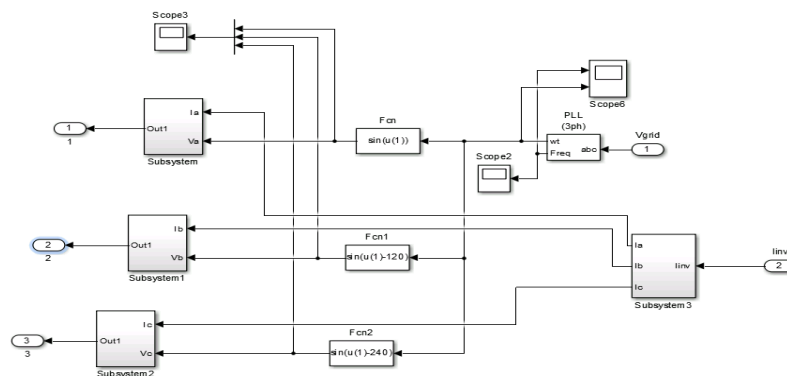


Fig. 8. Hysteresis current controller for inverter current control

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E. Transformer

Transformers consist of two coils primary coil and secondary coil. The Primary coil of the transformer receives energy from the AC source; secondary coil receives energy from the primary winding and delivers it to the load and Transformers are either step-up this means it delivers high voltage to the load or step down this means it delivers lower voltage to the load according to the turns ratio can be defined as the number of turns of the secondary to the primary [14] these equations are shown in [1, 2&3].The main function of transformer is change the ratio of voltage to current delivered from a voltage source to meet the characteristics of the load, in this case keeping the power constant.

$$V_2 = \frac{n_2}{n_1} V_1 \tag{1}$$

$$I_2 = \frac{n_1}{n_2} I_1 \tag{2}$$

$$P = V_1 I_1 = V_2 I_2 \tag{3}$$

Where: V_1 is the voltage and I_1 is the current received from the source to the primary coil; V_2, I_2 are the voltage and current delivered to the load from the secondary coil; n_1, n_2 are the number of turns of the primary and secondary coils.

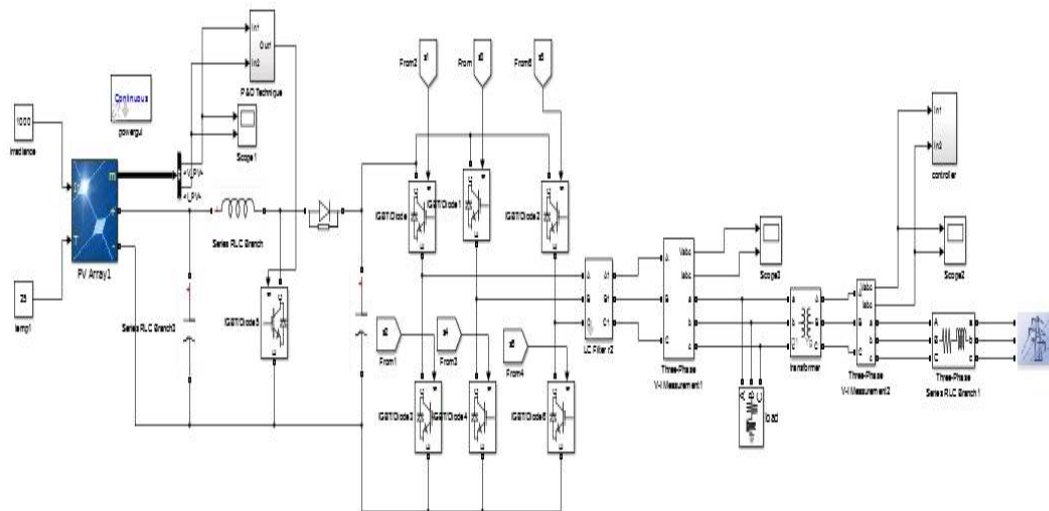


Fig. 9. Simulation model of 100kW grid-tied PV system

After applying all these 4 steps, we get a filtered image that contains only text regions.

III. RESULTS AND DISCUSSION

In this model simulation model proposes the 100KW grid-connected PV system using MATLAB software. The PV array delivering the maximum power at 1000w/m^2 solar radiation and 25° temperature. The array consisting of 51 parallel strings and 7 series strings each string consisting of 60 modules. PV array generates voltage, current this output wave form is shown in fig[10].MPPT controller is used to track the maximum power the PV array. This output is fed to the boost converter which step-up the voltage by adjusting of the duty ratio and output of the boost converter is shown in fig [11].

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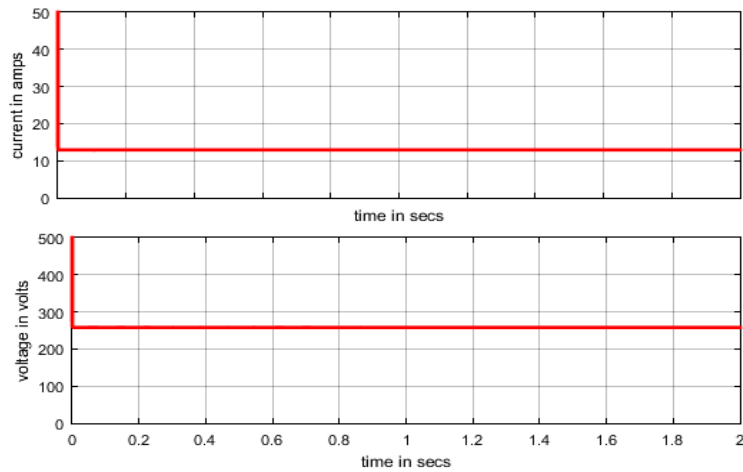


Fig. 10. Output voltage and current of PV array

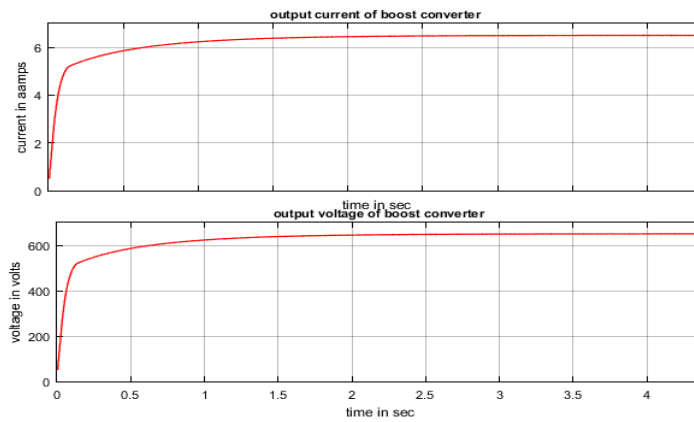


Fig. 11. Voltage and current from the boost converter

The boost converter output is fed to the DC-AC three phase inverter, hysteresis current controller is used to limit the inverter current. LC filter is used to remove the unwanted frequency components from the inverter. Three phase supply is fed to the step-up transformer, function of the transformer is voltage source output power constant, the voltage and current ratio should be changes, power output fed to grid and this system arrangement in shown in fig.9. These outputs from simulation models are shown in fig12 and fig13.

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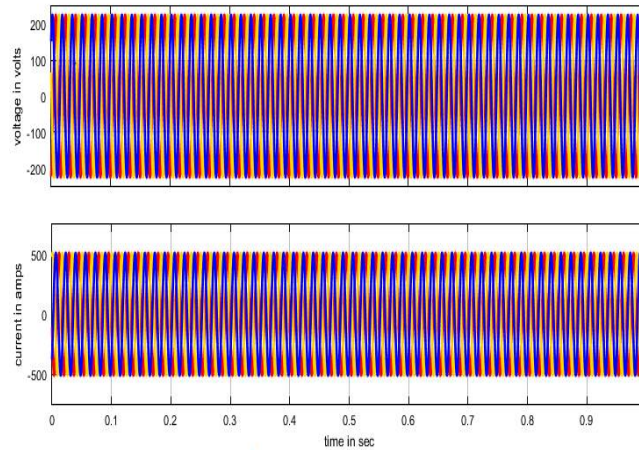


Fig. 12. Voltage and current from the inverter

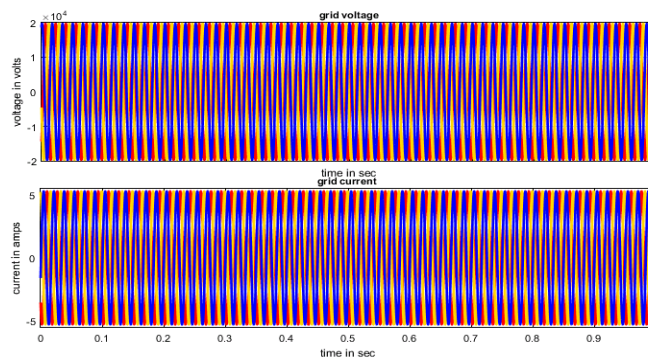


Fig. 13. Represents grid voltage & grid current

IV. CONCLUSION

In this paper describes the 100kW solar PV grid connected PV system designed in MATLAB/Simulink and observes the performance evaluation of the system. Solar PV system is taken as a primary resource. Three phase inverter is used to converting the DC to sinusoidal AC output. In hysteresis current controller PLL is used to tracks the phase and frequency from the grid output and generate pulses for inverter. The main advantages of hysteresis controller are easy implementation and speedy response.

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