Simulation And Analysis Of Grid Connected Mli Based Solar System

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Abstract: This Paper shows and analyzes the performance of the grid connected solar system which is based on the Multilevel inverter topology for solar PV system. In this paper the grid synchronization has been done of solar PV system. The multilevel inverter topology is used to generate 7- level inverter waveform. The main purpose of this model is to connect the solar system model with the grid. For that MATLAB/SIMULINK modal is used. There are various factor are such as voltage, current waveform, Grid synchronized waveform are presented in this paper.

Keywords — PV solar system, Multi-level inverter (MLI), Grid.

I. INTRODUCTION

Looking at the growing demand many renewable energy sources are used such as solar system, wind system etc. Solar energy can be one of the effective alternative as renewable energy resources. In case of solar photovoltaic the energy is harnessed in dc form. This dc is converted into grid quality ac using the inverter and then fed to utility grid [1].Generally inverter is used to convert the dc supply into ac supply, But recently Multi-level inverter has gained popularity in recent times. They can produce staircase waveform. The waveform generated have low harmonic distortion, low voltage stress, also increased the quality of power [2]. The proposed system in this paper is basically the inverter is cascaded in such manner so that it can produce seven level inverter waveform, such a waveform can be used as the input to the solar system [3]. The Grid connected solar PV system boost converter has been presented. Inverter is used as converter to convert the dc power into ac so that it can be utilized. The array system is designed of 1000W [4]. Stand-alone applications photovoltaic cells are certainly convenient in comparison with other energy sources. The output voltage obtained by MLI consists of seven levels with multicarrier sinusoidal pulse width modulation scheme [5]. The Simulink model used the MOSFET switches & they are cascade to each other. The advantage of this system is that they will invert better quality of supply compare to conventional inverter. At present, one of the key research areas in renewable energy are grid-connected photovoltaic systems. The cost reduction of photovoltaic (PV) panels, environmental benefits, increased demand of energy, integration with existing grid, the key performance criteria are conversion efficiency, maximum power point tracking [6]. A photovoltaic system, or solar PV system is a power system designed to supply usable solar power by means of photo-voltaic. It consists of an arrangement of several components, including solar panels to absorb and directly convert sunlight into electricity, a solar inverter to change the electric current from DC to AC, as well as mounting, cabling and other electrical accessories.

II. GRID CONNECTED SYSTEM

Grid Connected System is the simplest and most cost effective way to connect PV modules to regular utility power. Grid-Connected systems can supply solar power to your home and use utility power as a backup. As long as there is enough electricity flowing in from your PV system, no electricity will flow in from the utility company. If your system is generating more power than you are using, the excess will flow back into the grid, turning your meter backwards.

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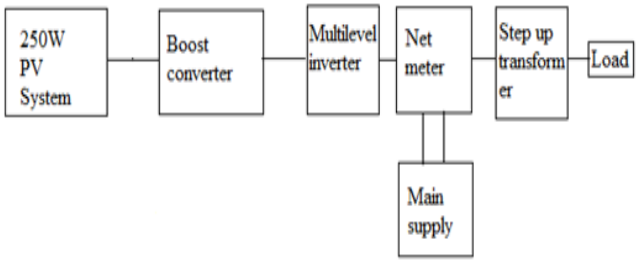
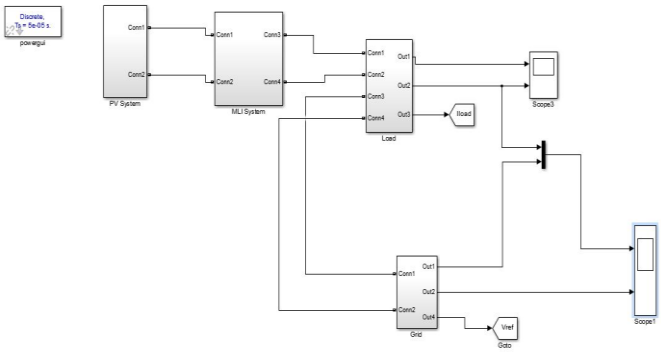


Fig.1 Generalized block diagram of grid connected system

III. SIMULATION MODEL

Using the MATLAB/Simulink model blocks, for all components of the PV system can be collected in a specific library. The library contains the model blocks for a PV system, multilevel inverter, load and grid. The Simulink model is represented for 1000W panel and 7- level inverter topology. Mathematical design & simulation of grid connected photo-voltaic system is done. The power of a PV cell decreases when light intensity decreases and/or temperature increases. The amount of power generated by a PV cell depends on the operating voltage of the PV cell array.



. **Fig.2 Block diagram of grid connected system**

Fig.2 shows block diagram of grid connected system, the first block represents the PV system where PV module is used. Solar radiation radiates on the PV panel so that sunrays are converted into the electrical energy. The output of the panel is connected to the multilevel inverter, the purpose of inverter to inject the waveform with less distortion in the system. Load is connected across the system .the grid synchronization is used to synchronize the phase angle and frequency of the system.

The brief description of the various blocks is as follows:

(1) PV System:

The point at which the PV operates at highest efficiency is called the maximum power point (MPP). The light generated current (Ipv.) is the function of solar irradiance and environmental temperature. The little impact has also been shown by the wind speed. Irradiance has direct relation while working temperature has inverse relation to the Ipv.

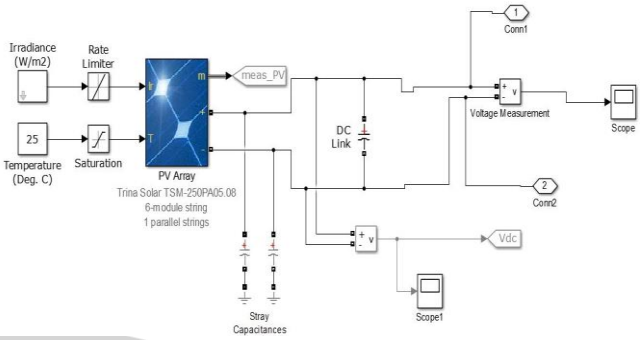


Fig.3 PV system

Fig.3 Shows the PV system where the average temperature around 25^0C. The DC link is used to provide constant DC voltage. The Module used for the PV array system is Trina solar TSM 250PA.It consist of the PV array of 1000W and having 6 strings in series, 1 parallel string. The ratings of PV module are given in table below.

Table 1. Detail description of PV module

Parameter	Rating
Max. Power	249.6W
O.C. voltage	36.7V
Vmp	31V
Voc	-0.36V
Cells per module	60
Isc	8.55

(2) Multilevel inverter:

In this we are using cascade inverter topology. This topology consists of two or more single-phase full bridge converters with their outputs connected in series at the AC side. Thus, each converter creates three different levels of voltage. The major advantages of the Cascaded H-Bridge converters are scalable power rating, modularity, and cost effectiveness. The output voltage of the Cascaded H-Bridge converter is the summation of the output voltage of the

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individual H-bridges. By increasing the number of series H-bridge converters, the output voltage of the converter can be increased, while the switching frequency of the individual H bridge converter can be decreased to achieve the same output waveform quality.

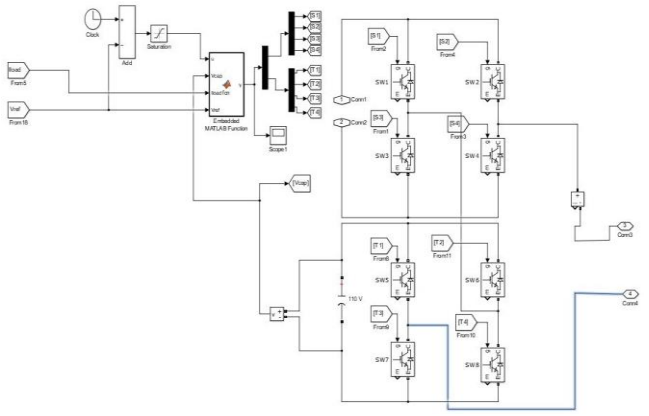

Fig.4 MLI system

Simulation model for MLI system is shown in fig.3. where 8 MOSFET switches are cascade to each other so that it can produce seven level inverter waveform. the variable gate stored is used for MOSFET switch triggering. When it is o then it become off, when it become 1 then it is on. Embedded function is used for this purpose. The switching pattern of the inverter is as given in table 2.

Table2. Switching sequence of Simulink model of MLI

Voltage level	S1	S2	S3	S4	S5	S6	S7	S8
220V	0	1	1	0	0	1	1	0
110V	0	1	1	0	0	1	0	0
0	0	0	0	0	0	0	0	0
-110V	0	0	0	1	1	0	0	1
-220V	1	0	0	1	1	0	0	1

(3) Grid system:

The grid system where it is useful for to connect the solar system with the grid. But while synchronizing with grid system it is important that it should be fulfilled the phase angle and match frequency with the system. Fourier block is used to adjust the phase angle of ac source and synchronizer block synchronized with grid.

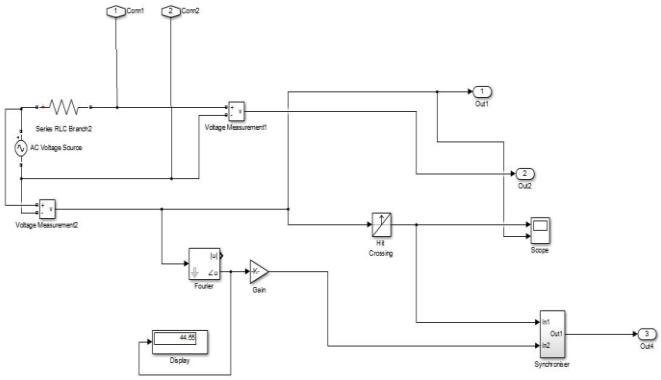

Fig.5 Grid system

Fig.5 shows that its having two input from load and having two display the change in phase angle, we can change phase shift by 60^0 C. Scope is used to observe the output waveform, In grid ac voltage is used along with RLC circuit. for grid synchronization phase should must be same, if both signal are in phase then higher voltage at output is observed and if they are not in phase then lower output voltage is observed. Zero crossing detector (heat crossing block) is used to detect rising slope detection of waveform of grid. Whenever it crosses the zero level, signals goes high for positive slope and it goes low for negative slope and we get the synchronized sine wave.

IV. RESULT AND DISCUSSION

The below Fig.6 shows the output voltage of PV module.

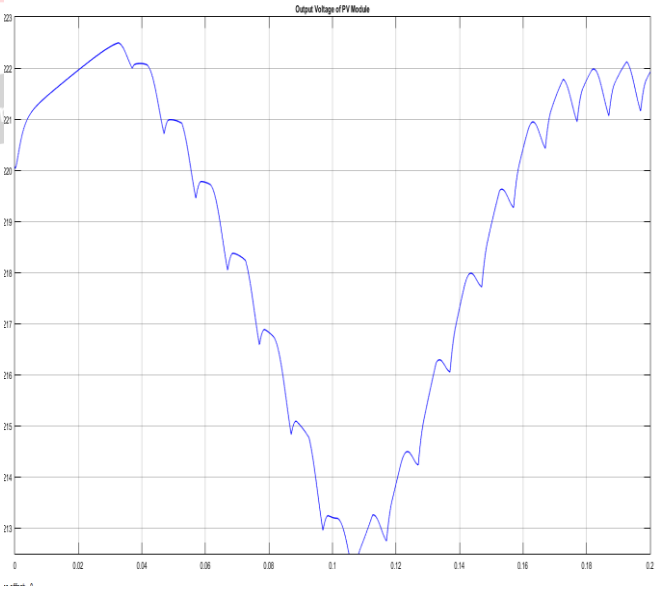

Fig.6 Output voltage of PV module

As the irradiance and temperature on solar rays on PV cell is not same overall the output voltage may vary according to day time and temperature. It may vary from 220V-224 V.

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(1) I-V & P-V CHARACTERISTICS OF PV MODULE

The IV and PV curve from array has shown in Fig. 7 under the time varying input of irradiance and ambient temperature. The open circuit voltage of array was about 250V and short circuit current was 8.5A. It has found that increase in irradiance caused array current to increase while small reduction of array voltage but ambient temperature has reverse relation unlike irradiance. At very low irradiance, array voltage has dropped below the threshold voltage level.

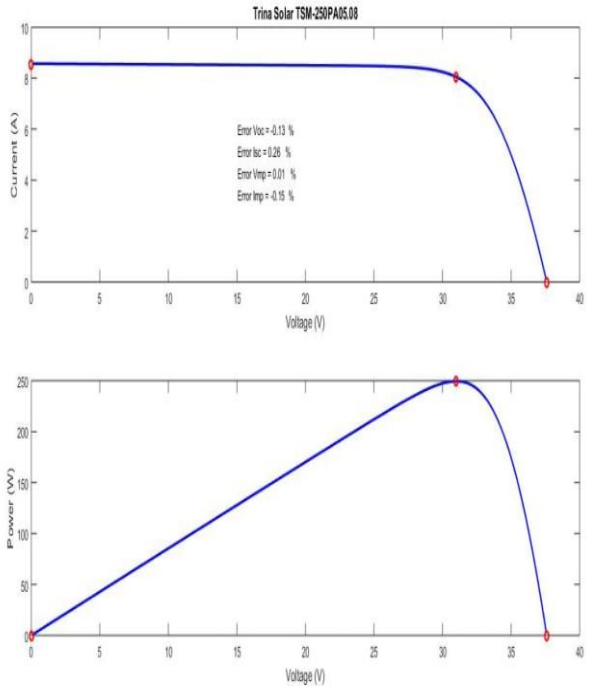

Fig.7 PV module characteristics

(2) MULTILEVEL OUTPUT WITH FILTER:

Fig.8 shows the output waveform of the multilevel inverter with passive filter, after the synchronization with the grid initially it will take one cycle to read the phase angle and frequency and then it will match with the grid. The filter used is L-C filter, which inject the waveform with less distortion.

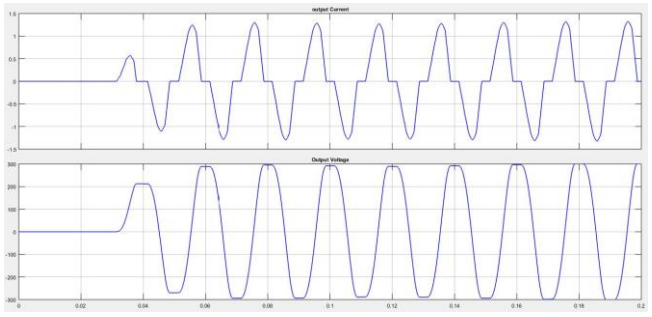

Fig.8 MLI Output with filter

Filter is used for the smoothing of waveform and to get pure sinusoidal shape of waveform.

(3) MULTILEVEL OUTPUT WITHOUT FILTER:

Fig.9 shows the output of the MLI system which can produce the 7 stepped output voltage. The duration of individual switches to get triggered is near about 0.2 mili second. From Fig.9 the upper waveform is of output current and lower waveform of output voltage.

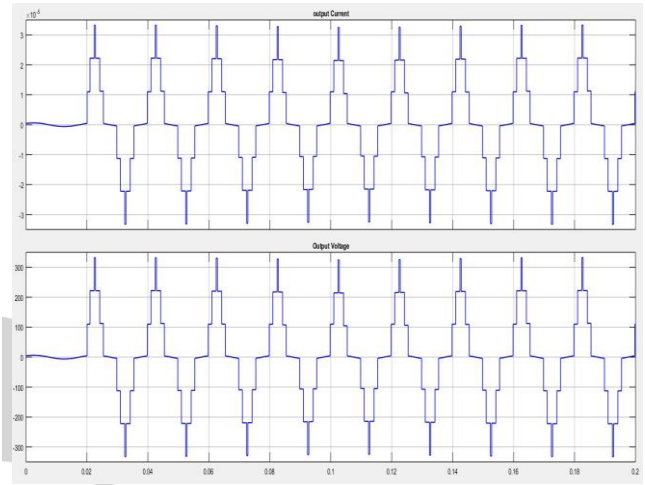

Fig.9 MLI Output without filter

Thus without filter multilevel will generate the stepped output waveform.

(4)GRID SYNCHRONIZATION WITH FILTER

For grid synchronization phase angle, frequency and line voltage of grid must be same with PV module.

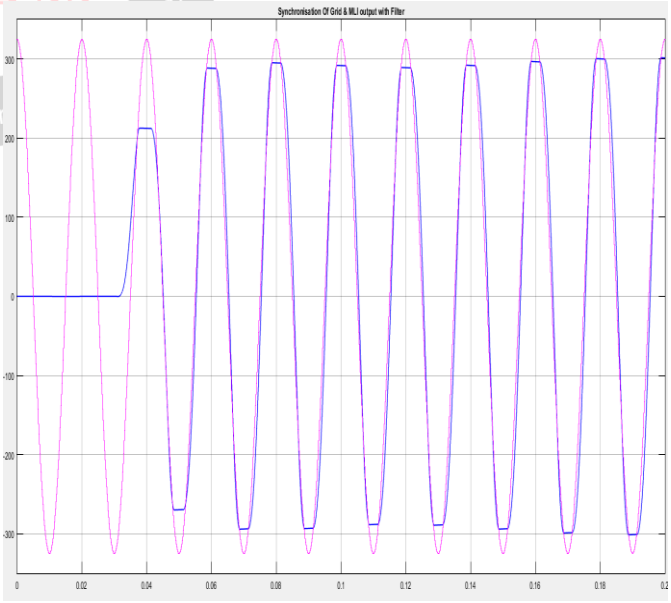

Fig.10 Grid synchronization with filter

The above Fig. 10 shows the synchronized grid output with LC filter. Where pink is grid waveform & blue is solar waveform. Both waveform is having same frequency i.e.

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50Hz and same phase angle. Thus by using Zero crossing detector method synchronization is obtained.

(5)GRID SYNCHRONIZATION WITHOUT FILTER

The below Fig. 11 shows the grid synchronization without filter, The duration of individual switches to get triggered is near about 0.2 mili second. Thus the upper waveform is synchronized waveform of grid without filter and lower waveform is its output voltage.

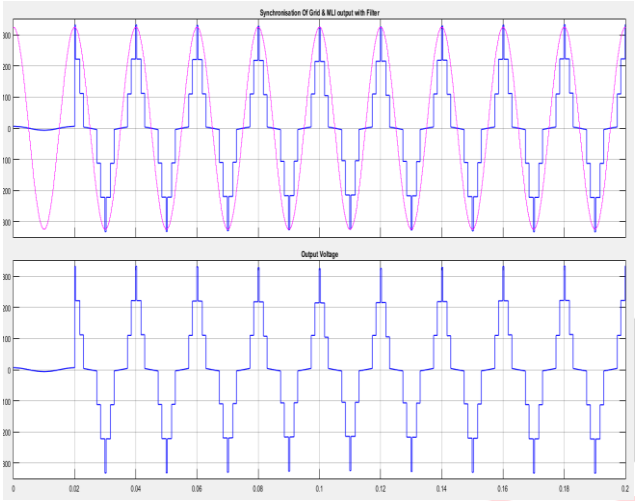

Fig.11 Grid synchronization without filter

V. CONCLUSION

In this proposed system, the simulation and analysis of the grid connected solar system has been carried out. It shows that, MLI based solar system has many advantages and it will inject better quality of supply in the system. The synchronization with the grid is carried out by matching phase angle and frequency with the system.

VI. REFERENCES

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