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Simulation of Eleven Level Inverter used for PV System

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Abstract: Renewable sector is rapidly growing in recent days. In renewable the solar photovoltaic system is beneficial for all working sectors like industrial, commercial and residential. We all know the output of solar power system is dc & in our country the consumer consumes the ac power. Therefore for power converters are necessary components for solar PV System. Recently, multilevel inverters (MLI) are trending topic for academic & industrial investigator for enhancing the characteristics of system. Form the technical enhancement point of view the paper focuses on the analysis the parameter of eleven level inverter photovoltaic systems. For the analysis of technical parameters of the inverter and solar model we used Matrix Laboratory i.e Mat lab Software; we design & simulate the solar cell model & eleven level inverter with the PV Boost system and analyzed the performance of the system. This paper will help the upcoming researcher for the design of Eleven Level Inverter.

Index Terms **– Multilevel, Solar, Matlab, Boost.**

I. INTRODUCTION

As we know India is a developing country, requirement of electrical energy from grid network increased continuously. Therefore, another option is to use of renewable energy resources to meet energy demand. Now a day's Indian solar sector is growing rapidly & we all know the output of PV system is a dc power & the customer utilizes ac power. So power electronics devices are most essential component of solar power system. To convert dc power into ac power inverter is a necessary device, which converts the dc power, generated from PV System to AC for the utilization of load. Recently, multilevel inverters (MLI) have become best topic for academician & researchers to compare to two-level inverters according to their parameter like lower electromagnetic interference, efficiency, and DC link voltages. This paper describes about the model design of eleven level inverter with the boost system for solar photovoltaic system. A multi-level inverter is an operational device which converts output of PV system i.e. DC to AC with required frequency.

The first introduction of multilevel inverter was described in 1975, it is an three-level inverter similar to advanced several topologies of multilevel inverter. However, the multilevel inverter is based on the ideology of using several direct current sources and number of low-power rated semiconductor switches for a stepped voltage waveform; which aimed at achieving greater levels of power generation. As we know various sources of energy can be used multiple-input, such as batteries, solar PV panels, fuel cells and so on. Now-a-days, the trends in multilevel inverters are mainly focus on the reduction of the switch count, gate driver circuits, and DC supplies to improve fault tolerance and power quality, thereby making the system cost effective for grid-connected Renewable energy system.

In this paper design a model of eleven level inverter for solar power system. We analyzed various technical parameters by using MATLAB Software. We also tried to reduce the harmonics in the system. Our system model consists of solar cell model, Boost Converter & Multilevel inverter system with a load. The basic block diagram of model is shown in the fig.1 below.

Fig 1 Block Diagram of Model

II. LITERATURE REVIEW

Mr.Shubham Aute & Dr S A Naveed in his paper discuss about the performance of a standalone system based on multilevel inverter topology based Solar PV (SPV) system as a dc source. The simulation is carried out in SIMULINK/ MATLAB Software. The simulation is done for the standalone system. Various parameters are analyzed such as RMS grid voltage, current, power & THD of grid current. The multilevel inverter is used in the system, which can efficiently reduce the harmonics in the system when compared with the conventional inverter. [7]

In review of multilevel inverter for PV Energy System Applications, paper reviews multilevel inverters based on their classifications, development, and challenges with practical recommendations in utilizing them in renewable energy systems. Moreover, PV systems with various maximum power point tracking (MPPT) methods have been extensively considered in this paper as well. The importance and the development of a modified multilevel inverter are also highlighted in this review. In general, this paper focuses on utilizing multilevel inverters for PV systems to motivate and guide society to focus on inventing an efficient and economical multilevel inverter that has the combined capabilities of these converters reported in the literature [19].

In this paper, a novel cascaded H- bridge multilevel inverter has been proposed using less number of switches [20].This proposed scheme allows less number of switches for the same level. This is an application oriented system where a novel cascaded H-bridge multilevel inverter fed to an induction motor for the better performance due to fundamental frequency switching system by using optimal PWM Technique (OPWM). High conversion efficiency is also achieved for induction motor drive when it is operated with the proposed method. When the levels are increased, the number of switches used is very less compared to the conventional cascaded H-bridge multilevel inverter. The performance of three phase cascaded H- bridge multilevel inverter with equal dc sources is simulated by using MATLAB platform [20].

III. METHODOLOGY

IV. SYSTEM DESIGN

4.1 Solar Cell Model

Figure 2 shows the circuit diagram of Solar cell module. From the circuit diagram it is clearly understood that the solar cell model consist of photon current and diode current model. According to solar cell working principle the photon current is directly proportional to the solar irradiation.

From this circuit diagram we can rewrite the equation for the total load current,

Let us consider,

I_p- Photon Current

I_d- Diode Current comes from p-n junction

I_{sh}- Current flowing from shunt resistance

R_{sh} – Shunt Resistance of PV Cell

R_s – Series Resistance of PV Cell

I – Load Current

$$I_P = I_d + I_{sh} + I \quad \text{..... (1)}$$

From the equation (1) we can easily defined the load current.

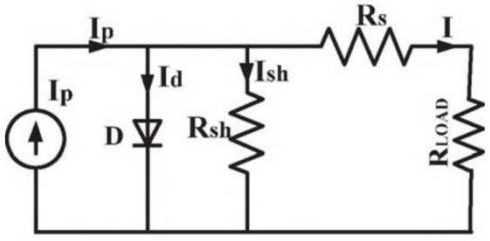

Fig 2 Solar Cell Circuit Diagram

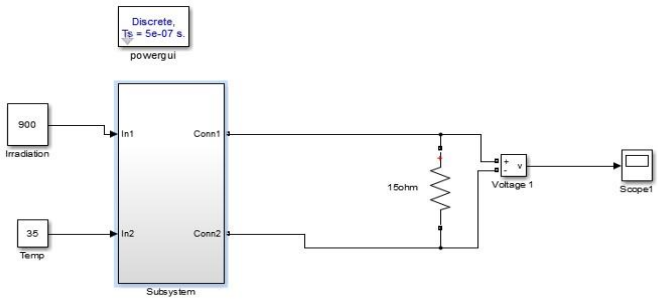

Fig 3 Solar Cell Model in Matlab

4.2 Boost Converter Model

Boost converter is a step up chopper circuit which is generally used to increase the magnitude of dc voltage. This chopper is used to boost the output of solar cell model. So in our model we design the chopper in MATLAB Software. The MATLAB model is shown in the figure 5 & circuit diagram of the boost converter shown in the fig 4.

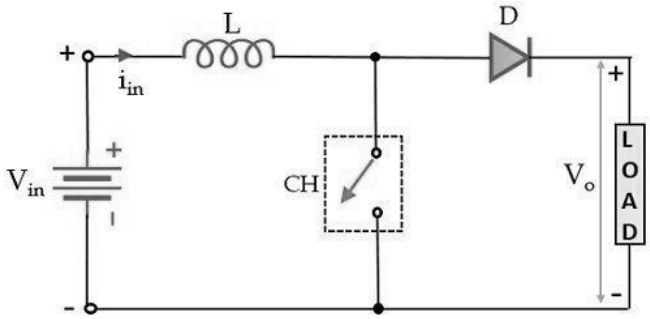

Fig 4. Circuit Diagram of Boost Converter

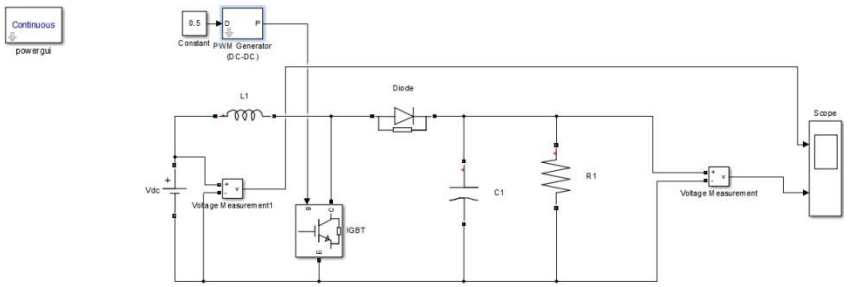

Fig 4. Boost Converter Model in Matlab

4.3 PV Boost Converter Model

This model is combination of solar array and the boost converter. Solar array is consisting of series parallel combination of solar cell model. To increase the magnitude of the voltage we used the boost converter. This model analyzed the various technical parameters like voltage, current and generated power of the system.

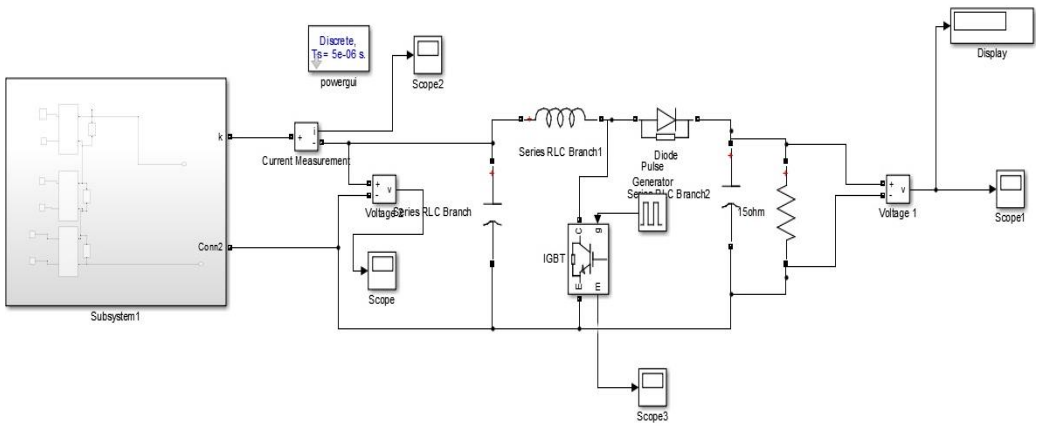

Fig 5 PV Boost Converter Model in Matlab

4.4 Eleven Level Inverter Module

A multilevel inverter is a power electronic device that effectively provides the required alternating voltage stage at the output using multiple lower stage DC voltages as an input provides. Typically, a two-level inverter is used in order to get the AC voltage from DC voltage. Nowadays the difficulty arises what's the need of using multilevel inverter when we have two-level inverter. In order to solve this problem, firstly we want to look at the idea of multilevel inverter. The circuit diagram of eleven level inverter is shown in figure 8. We design the MATLAB model of Eleven Level Inverter. This model consist of power switches to convert dc power into ac power. This is simple cascade H bridge system with separate DC Source. The input DC Source is given from Boost Converter. At the output we connected R-L Load.

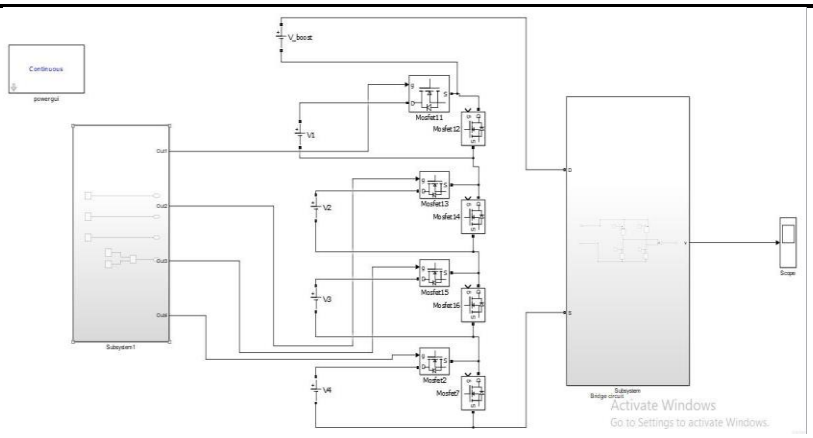

Fig 6 Eleven Level Inverter Model in Matlab

V. RESULTS

5.1 Result of Solar Cell Model

Parameter	Values
Output Voltage Generated	38.4 V

Table 1 Result of Solar Cell Module

Fig 7 Output of Solar Cell

5.2 Result of Boost Converter Module

Parameter	Values
Input Voltage	121.7 V
Step Up Voltage	244 V

Table 2 Parameters of Boost Converter

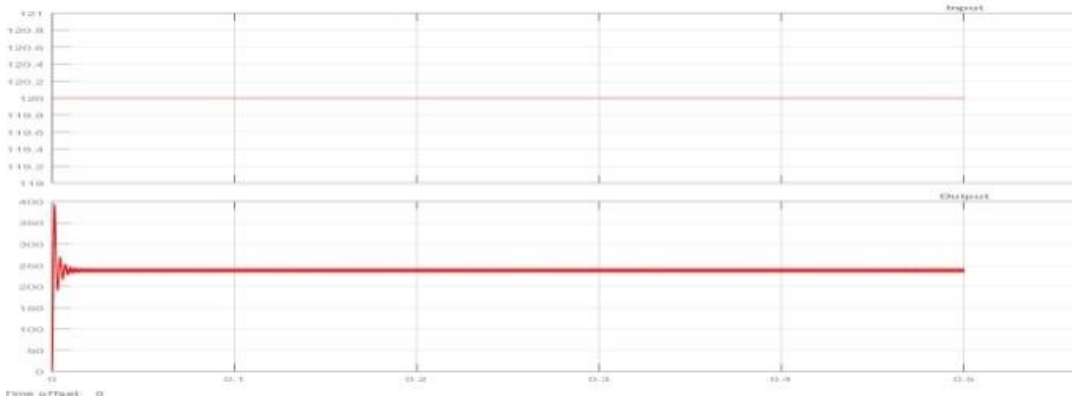

Fig 8 Output of Boost Converter

5.3 Result of PV Boost Converter Module

Parameter	Values
Output Voltage of Solar Array	121.9 V
Output Current of Solar Array	7.73 A
Output Power of Solar Array	942 W
Output Voltage of Boost Converter	244 V

Table 3 Parameters of Solar PV Boost Model

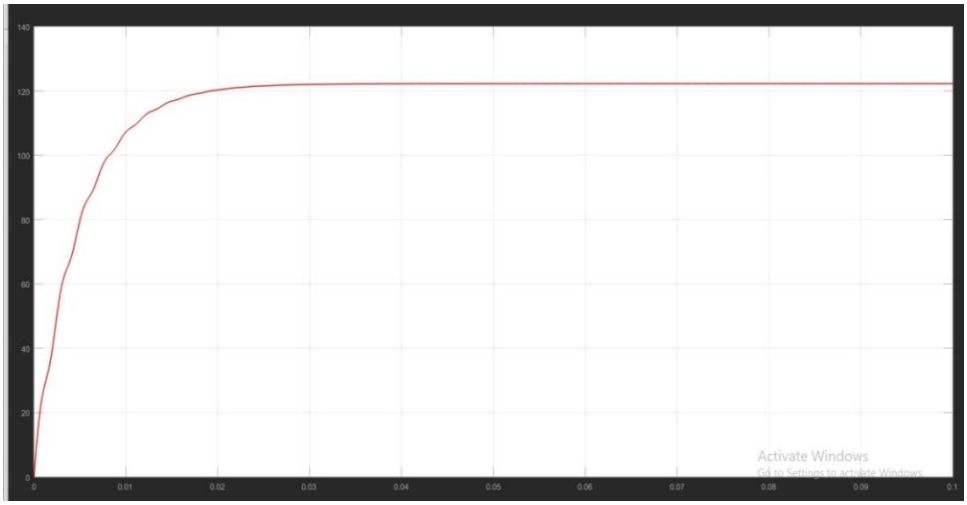

Fig 7 Output Voltage of PV Boost System Converter

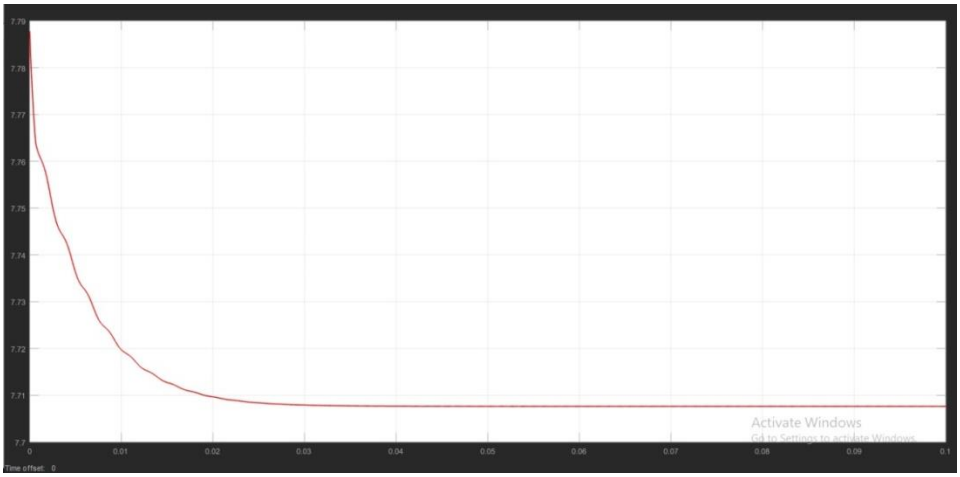

Figure 13 Output Current of PV Array

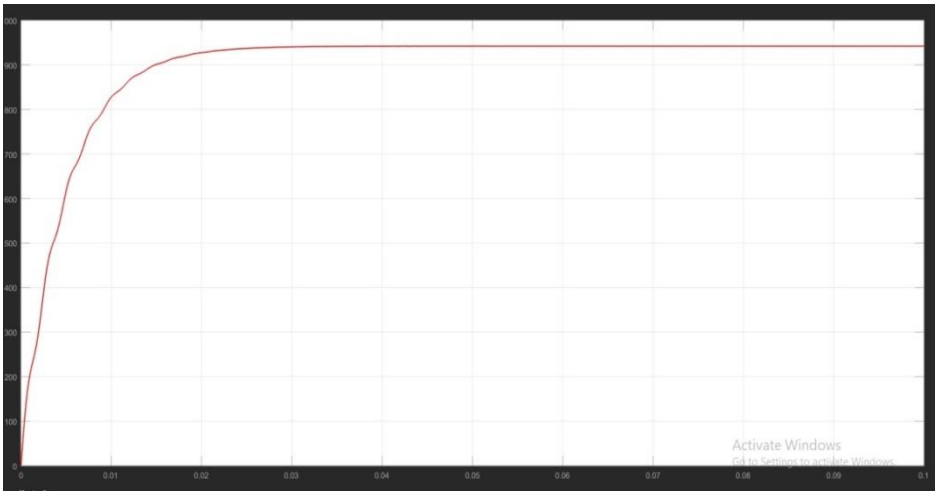

Figure 13 Output Power of PV Array

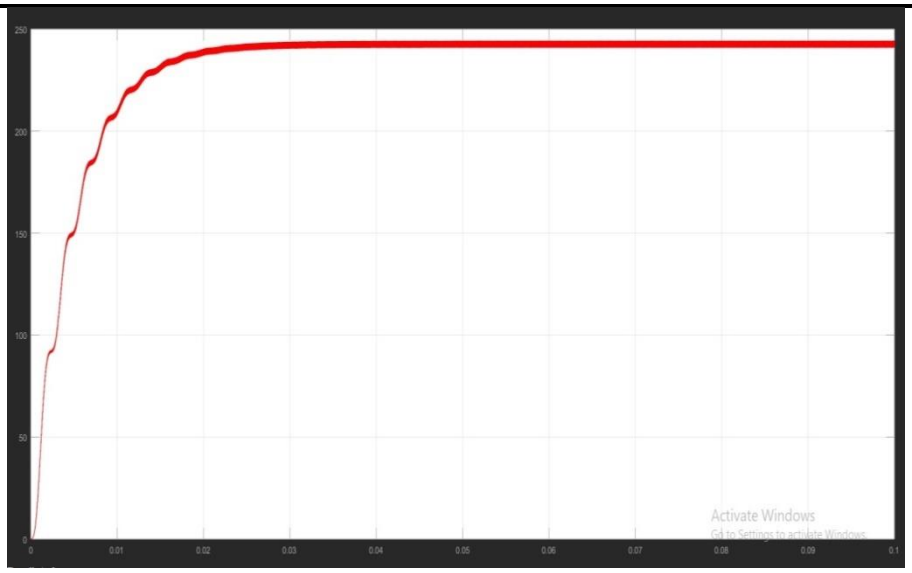

Figure 14 Output of PV Boost Converter

5.4 Harmonic Analysis of Eleven Level Inverter

Cycle	THD %
3 Cycle	5.36 %
5 Cycle	5.40%
7 Cycle	5.42%
15 Cycle	5.43%
17 Cycle	5.43%
19 Cycle	5.44%

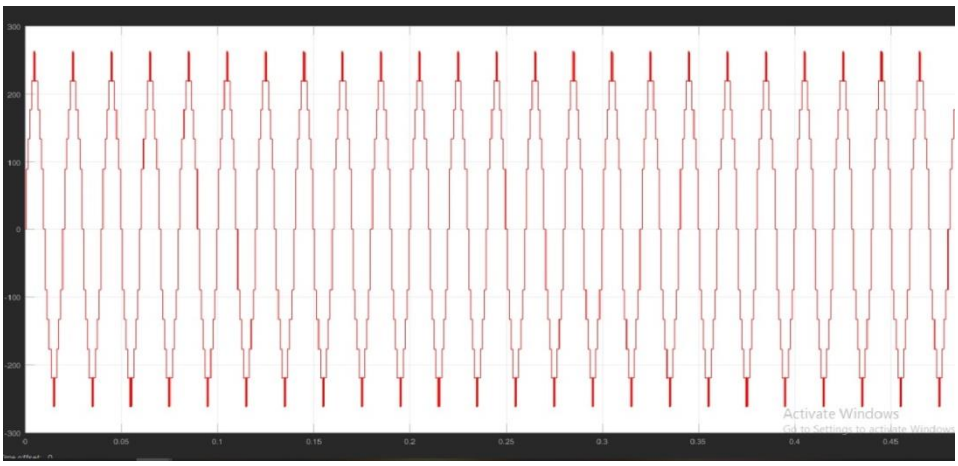

Figure 15 Output of Eleven Level Inverter

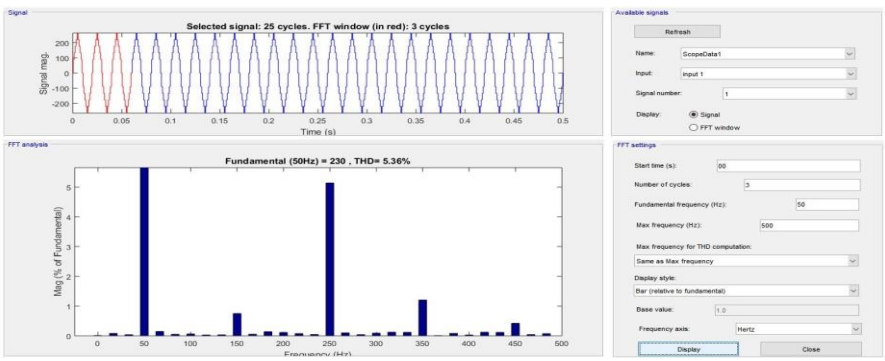

Figure 16 FFT Analysis for 3 cycles

VI. CONCLUSION

In this paper we design the model of solar PV system with eleven level inverter. This system is fully design in MATLAB Software we analyze various parameters of the system as discussed. The Eleven Level inverter is cascaded based with separate dc source. For 3 cycles the THD is 5.36% at maximum frequency of 500 Hz. The output of eleven level inverter is around 230 V AC. Hence we have successfully design the system of multilevel inverter having less THD.

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