Implementation of a Grid Connected Photovoltaic Power Electronic Converter

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Abstract

This Paper Generally Design To Optimizing Power And Energy Harvesting From Renewable Systems Approximating Photovoltaic (PV) And Wind Power Coordination Has Been Brief In This Design According To Today Scenario Advancement In The Power Semiconductor Technology (E.G., Wide Band-Gap Devices) Have Pushed .The Conversion Effectiveness Of Power Electronics To Above 98%, Everywhere Though The Dependability Of Power Electronics Is Attractive Of High Concern. As A Result, This Paper Presents The Three Phase DC-AC Inverter Mainly Used In High Power Application Such As Induction Motor, Air-Conditioner And Ventilation Fans, In Industries In Solar Power Plants. The Three Phase Inverters Re Commonly Used To Supply Three-Phase Loads with the Separate Single-Phase Inverters. It Is A Voltage Controller. This Representation Largely Demonstrates A DC-AC Converter. The Simulation Results Have Been Carried Out By MATLAB/ Simulink.
Keywords- DC-AC Converter, VSI, LC Filters, Three Phase Bridge Converter, 3 Leg MOSFET

I. INTRODUCTION

In the present circumstances of global energy sector and renewable source are increasing their extent day by day bases. Having realized the implication of sentence substitute energy resources. In recent years, nonetheless, the number of solar powered homes associated to the controlled electricity grid has increased obviously. These Grid Connected PV Systems have solar panels so as to provide a quantity of or level normally of their power needs during the day time, even as still organism connected to the local electrical grid network throughout the night time. Solar powered PV systems can occasionally produce more electricity than is essentially needed or consumed, in particular during the long hot summer Months. This extra or surplus electricity is either stored in batteries or as in most grid connected PV systems, fed openly flipside addicted to the electrical grid network. In previous words, homes and building that use a grid connected PV system can use a section or all of their energy erequirements with solar energy, and unmoving use power from the standard electrical mains grid all through the night or on cloudy dull and rainy days, open-handed the best of both worlds. Then in grid connected PV systems, electricity flow back-and-forth to and beginning the mains grid according to sunlight conditions and the actual electrical command at that timeline a grid connected PV system, also known as a "grid-tied", or "on-grid" solar system, the PV solar panels or array are electrically connected or "tied" to the local mains electricity grid which feeds electrical energy back into the grid.

The main advantage of a grid connected PV system is its simplicity, relatively low operating and maintenance costs as well as reduced electricity bills. The disadvantage however is that a sufficient number of solar panels need to be installed to generate the required amount of excess power. Reliable and long lasting. The output of solar PV Arrays is dependent on the level of solar irradiance and facade temperature of the array itself. In addition, it is important that the inverter system acquires the capability to operate with high speed and occurrence in generating the pulse-width modulation (PWM) signals.
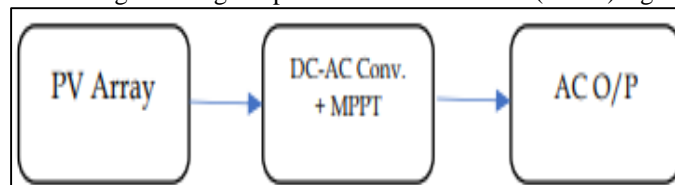

Fig. 1: General block diagram of PV system

II. RESEARCH OBJECTIVE

Renewable energy systems are the future of electric generation systems. This creature the case, equally graduate and undergraduate studies of electric power have to provide practical information about the architecture of solar PV power generation systems. A system that can easily be modified for the purpose of experimentation should be at disposal in the laboratory. The main principle of this paper is to design a grid connected photovoltaic system that can be used in the renewable energy system. The capability of solar modules that are at present in the laboratory is used as the starting point in conniving of the system. The main goal of this paper is to design a grid connected photovoltaic system that can be used in the renewable energy laboratory. "Detailed model of a

100 kW Grid Connected PV Array" is used as the base model [6]. As model based designing technique is to be used, the designed model would be simulated in simulink and once satisfactory results are obtained [9] [10]

III. GRID SYNCHRONIZATION

Phase information of the grid is obtained by using phase locked loop. The structure of PLL in Simulink is shown in figure 2. The required phase in sequence is obtained. The phase angle is used in dq transformation of in cooperation the voltage and current quantity
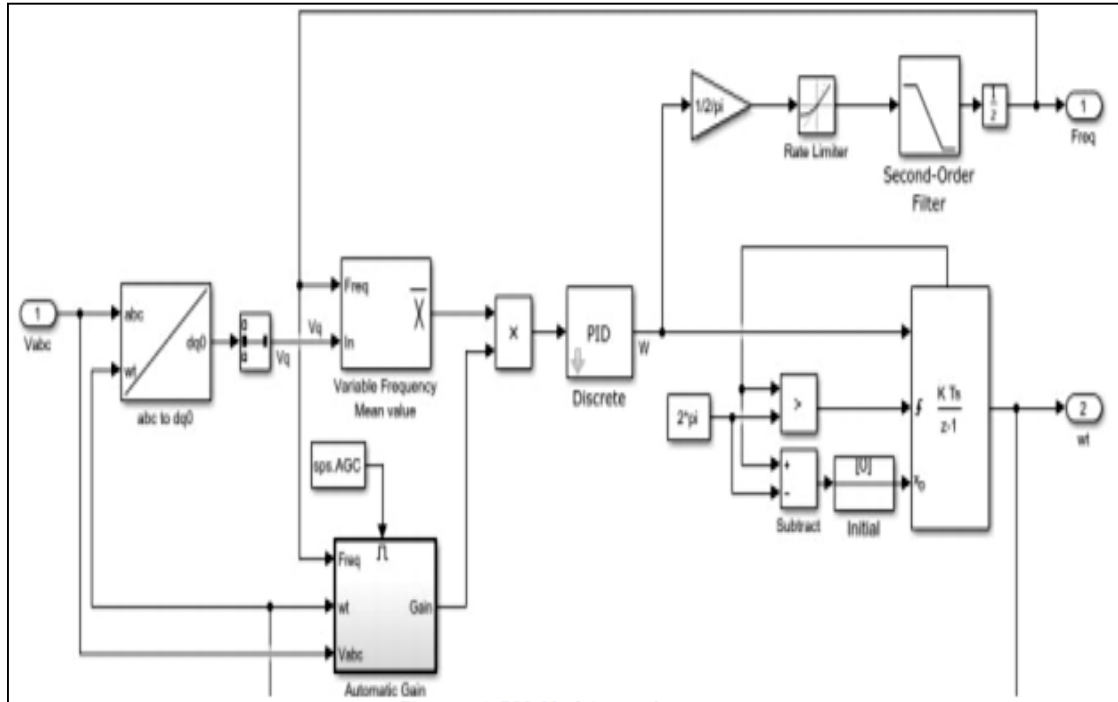

Fig. 2: PLL block internal structure

A. Control Loops

There are two control loops used to balance the power flow on DC and AC side and to increase the authority quality fed into the grid. The outer loop in a voltage loop and the inner loop in a current loop. The voltage loop is used to preserve the DC link voltage constant. When the input power from the solar array change due to difference in irradiance or temperature, the DC link voltage would also change because the power obtained from the array would not match the power delivered to the grid [3]. The function of voltage loop controller is to change the active power reference current so that power obtained from the solar array can be matched to the power delivered to the grid. Voltage loop controller is shown in fig. 3
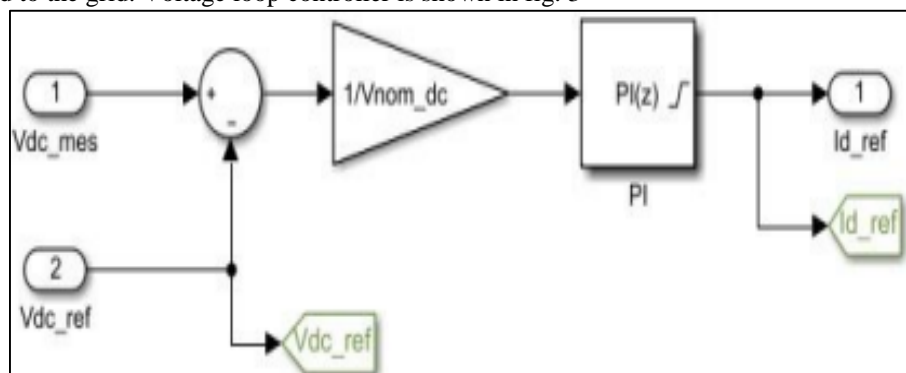

Fig. 3: Contents of Voltage Controller

$$V_{d\_Conv} = V_{d\_mes} - \omega L i_q + \left(K_P + \frac{K_I}{c}\right)\left(i_{d\,(ref)} - i_d\right)$$

$$V_{q\_Conv} = V_{q\_mes} + \omega L i_d + \left(K_P + \frac{K_I}{s}\right)\left(i_{q\,(ref)} - i_q\right)$$

Where, Vd_des and Vq_des are d-axis and q-axis desired voltage references. Vd_mes and Vq_measure d-axis and q-axis measured voltages. id and iq are d-axis and q-axis measured currents. id(ref) is the reference current obtained from voltage control loop and iq(ref) = 0. PWM Generation Grid The grid is modelled as a three-phase voltage source with a Line to Line rms voltage of 400V. A 600W load is connected to the grid as shown in fig. 2
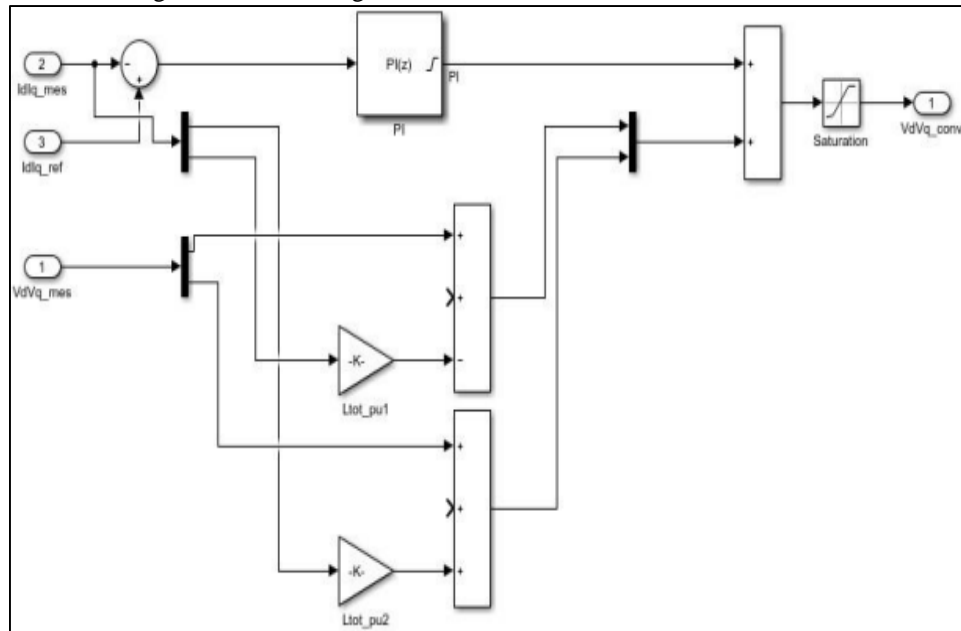

Fig. 4: Contents of Voltage Controller

B. Solar Array

With the input signal to PV array as shown in fig 5, the maximum available power, as can be seen from fig 2 and 3 at standard conditions is 600W and voltage at MPP is around 107V. At 500C and 1000W/m2 irradiance, the maximum available power reduces to around 650W and MPP voltage of around 100V.
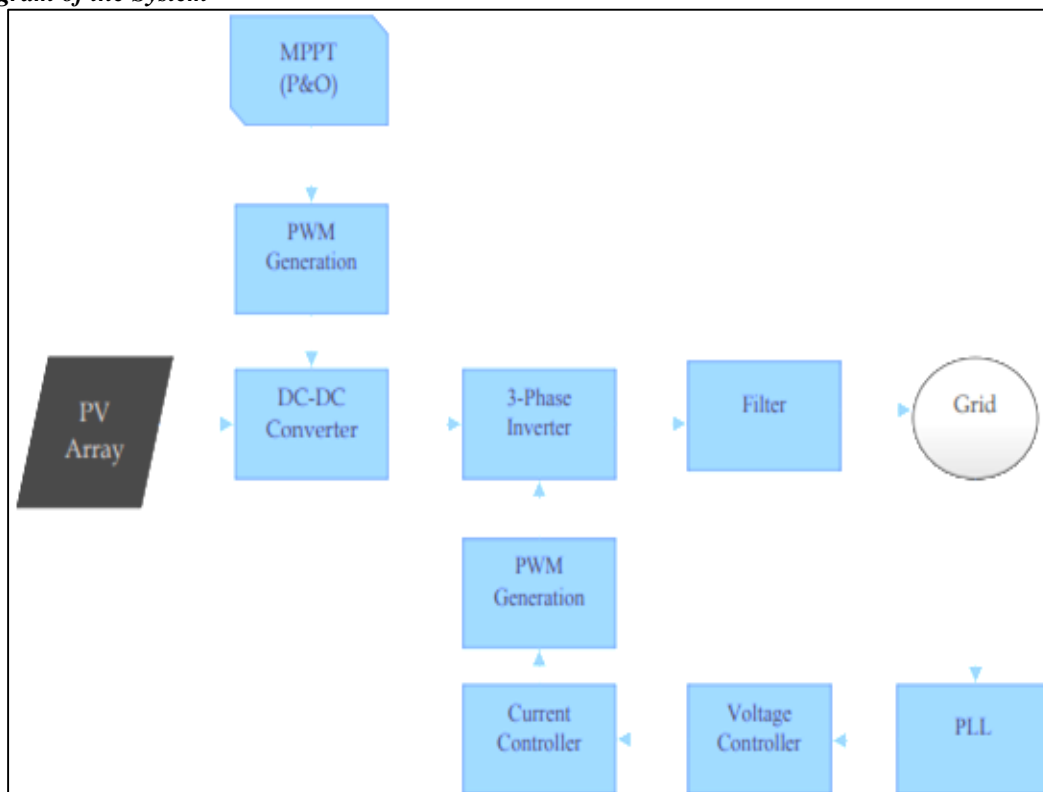
C. Block Diagram of the System

Fig. 5: Block Diagram of the Modelled System

Table 1: PV Array and Boost Converter Parameters

Input Power (max)	600W
Boost Converter input voltage (V_{PV})	109.5V
Input Current (I_{PV})	5.48A
L_{boost}	4.8mH
C_{PV}	30uF
$V_{DC\,Link}$	750V
$C_{DC\,Link}$	100uF
$D_{99.5V}$	0.8673
$D_{109.5V}$	0.8540

Table 2: Other Parameters

System Frequency (f)	50Hz
Grid Voltage (L-L)rms	400V
Inverter Side Filter (L_i)	13mH
Grid Side Filter (L_g)	7.8mH
Filter Capacitor (C_f)	0.6uF
Current Controller gains (kp, ki)	(0.6, 20)
Voltage controller gains (kp,ki)	(7, 800)

IV. SIMULATION RESULTS AND DISCUSSION

The results obtained from the designed model are presented. The simulation is run for 2.5s with a sampling time of 1 us. The input signals to the PV array are time varying irradiance and temperature which are depicted in figure 5.
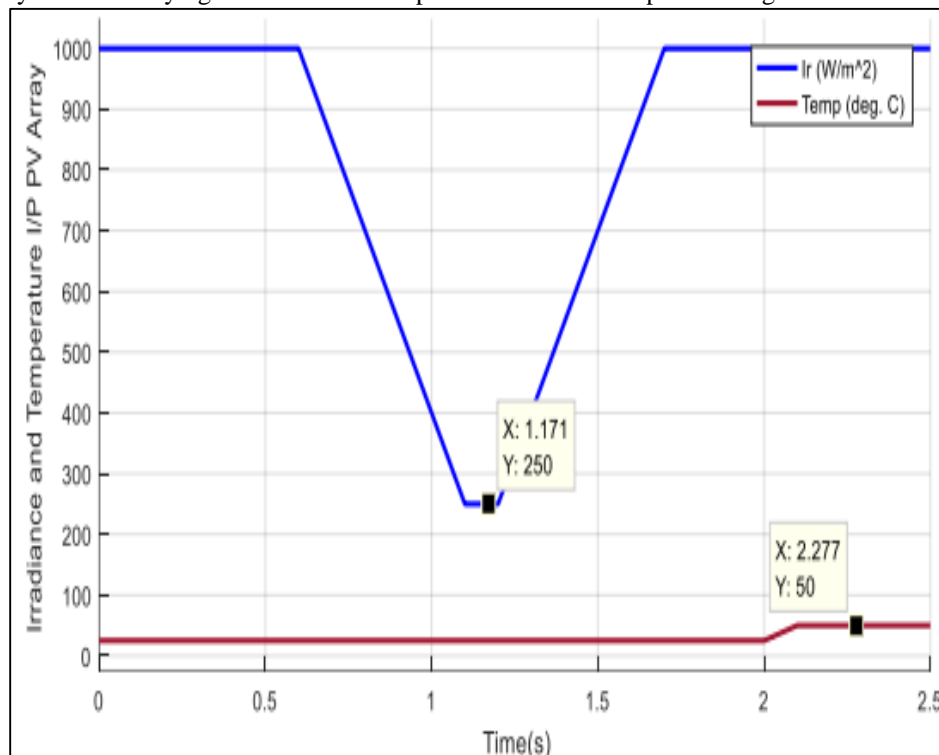

Fig. 6: Inputs to PV array

DC-DC Converter. The DC-DC converter boosts the voltage of PV array to the needed power of 750V and helps in the application of Perturb and Observe algorithm of MPPT. Fig 7 shows
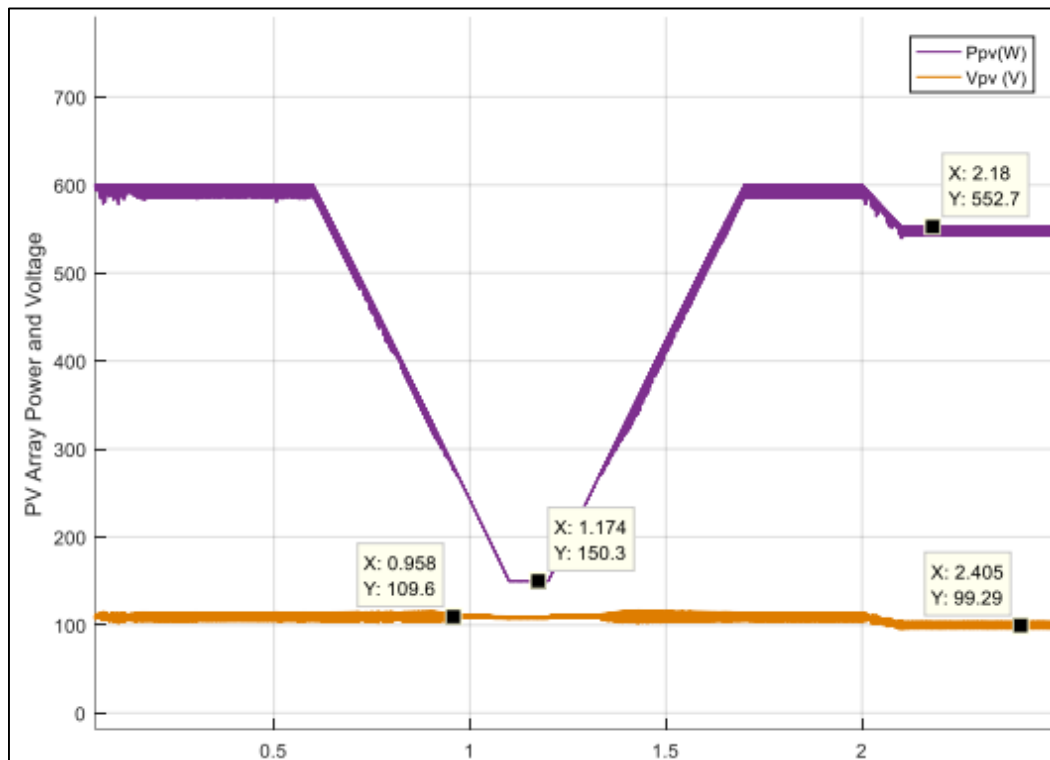
Fig. 7: Output Power of Array and MPP Voltage (MPP Tracking)

Shows the varying duty cycle of the switch of the boost converter for extracting maximum power from the array. When the panel voltage decreases at 1000W/m2 and 500C, the duty cycle increases to around 0.8670. The duty cycle of the boost converter drops to 0.64 when the maximum power available is 150W at 250W/m2 and 250C. This is because duty cycle and array voltage have indirect relationship. With change in irradiance, the array voltage tries to decrease, which can lead to system being knocked off the maximum power point. The DC Link Voltage is held constant by the voltage control loop.
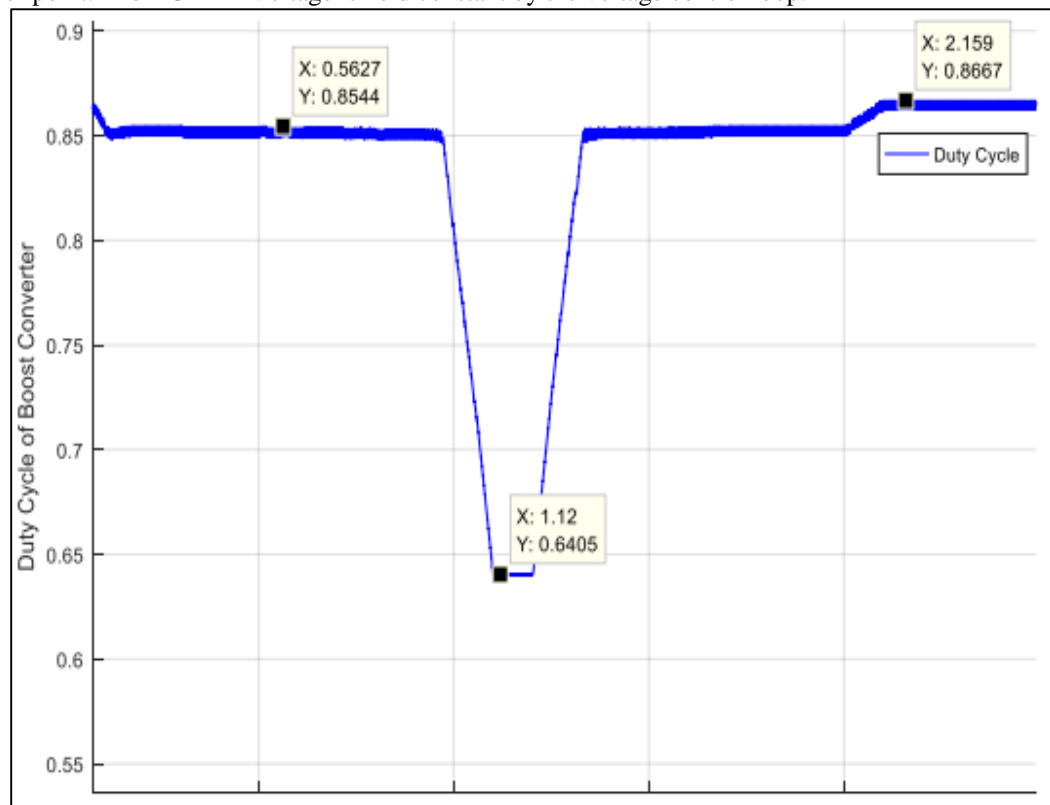

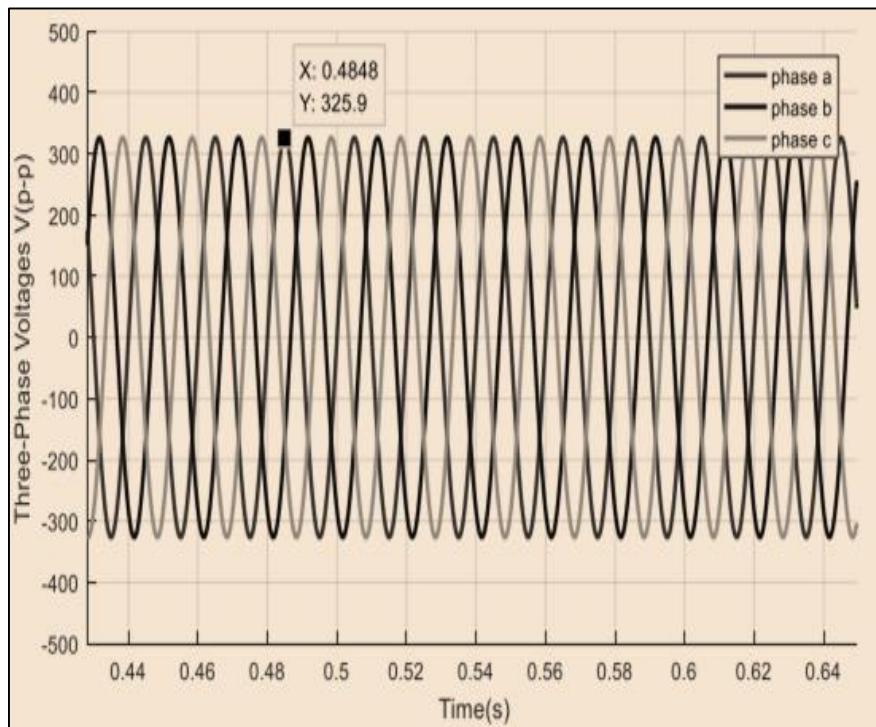Fig. 8: Duty Cycle of Boost Converter

Fig. 9: Three-Phase Voltage Waveform of Inverter/Grid

The three-phase current injected into the grid is shown in fig. 8. The magnitude of current of each phase is around 0.85 A (rms). The magnitude of harmonics present in the injected current w.r.t the magnitude of current at fundamental frequency for phase A and Total Harmonic Distortion of the injected current is shown in fig.9. Which is in reasonable limits
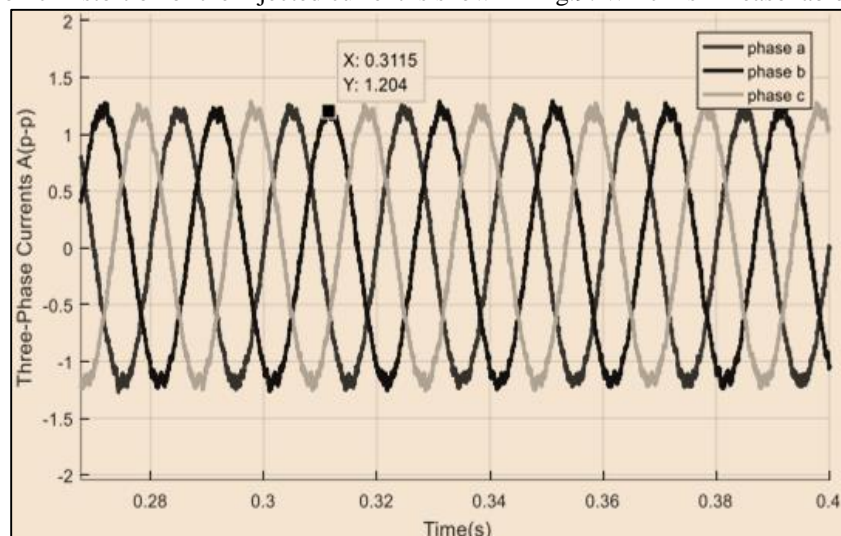

Fig. 10: Injected Current into the Grid

V. CONCLUSION

The task of designing a three-phase grid connected photovoltaic system. The designed system is a single string system with two power processing stages namely, the DC-DC converter and DC-AC converter. Perturb and Observe MPPT algorithm is used for tracking of maximum power point, so that the system can be operated at maximum ratings for a given environmental condition. The simulation results are then studied and on achieving the desired results.

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