INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue5)
Available online at www.ijariit.com

Novel Approach for Residential Grid Connected Solar Photovoltaic System Using Matlab Simulink

Neetu
M.I.T.M Jevra, Hisar
neeturar07@@gmail.com

Surender
M.I.T.M Jevra, Hisar
surenderfageria@gmail.com

***Abstract:** The need for energy is never ending. This is certainly true of electrical energy, which is a large part of total global energy consumption. But growing in tandem with energy needs are the concerns about sustainable development and environmental issues, such as the movement to reduce greenhouse gas emissions. The fossil fuels and nuclear fuels are not renewable and reserves of these fuels will run out some day in the future. The exploitation of solar energy has become an essential measure to address present energy shortages and environmental problems. We have several reasons to be optimistic as there is great excitement about the possibilities opening up before scientific community in the field of solar PV. Therefore today our main focus is to develop renewable energy especially from solar. The government of India also promoting solar energy and also providing a subsidy to peoples so that pollution level means CO_2 emission level decreased. In our research work photo crystalline PV solar panel is used and with help of boost converter DC level increased and this is achieved by MPPT also used PI controller to limit voltage and current. Our main focus is to reduce THD level under 5% as per IEEE standards. Our THD is below the level of IEEE standard*

Keywords: ***MPPT, Total Harmonic Distortion, Renewable Energy, IGBT.***

I. INTRODUCTION

Photovoltaic solar electricity is the most elegant method to produce electricity without moving parts, emissions or noise and all this by converting abundant sunlight without practical limitations. The relevance of solar energy specifically PV can be justified mainly with the factors like scalability, environmental impact and the security of source [1-3].

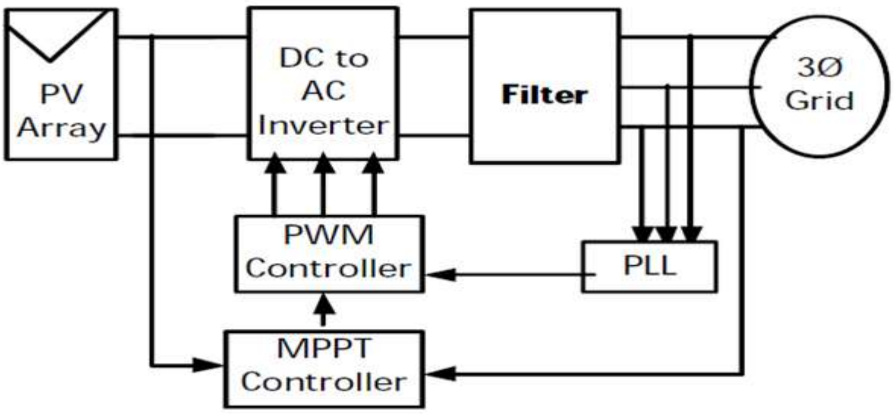


Figure1 Block diagram of PV grid connected inverter

It consists of PV plants, MPPT controller, PWM controller, a power conditioner (inverter), and filter. PV plant converts the sunlight into DC power and a power conditioning unit that converts the DC power to AC power. The generated AC power is injected into the grid and/or utilized by the local loads through the filter. In some cases, the PV system is combined with storage devices which improve the availability of the power. The simple equivalent circuit of the PV cell model is shown in Figure [7-8].

It consists of the ideal current source in parallel with the diode. The practical model of PV cells consists of series resistance (Rs) and parallel resistance (Rp) and is shown Figure

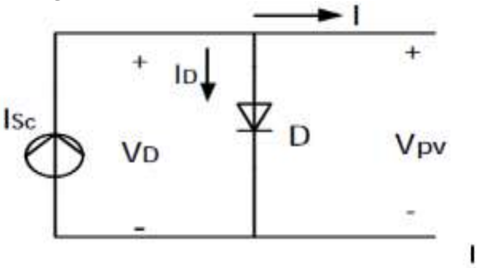


Figure2 Basic equivalent circuit of PV cell

The voltage current (Vg, Ig) relation of the PV plant is given in the equation below

$$I=I_{ph}-I_0\left\{\exp\left(\frac{V+IR_s}{n_s V_t}\right)-1\right\}-\left(\frac{V+IR_s}{R_{sh}}\right)$$

Where
V - Module voltage
I - Module current
I_{ph} - Photon generated current
I0 - Dark saturation current respectively
V_t - Junction thermal voltage, Rs is the series cell resistance and R_{sh} cell shunt resistance
n_s - Number of cells connected in series
Is - saturation current,
K - Boltzmann constant 1.38×10-23 J / K
A - Solar cell ideal factor of the diode,
q - Electron charge 1.6×10-19 C

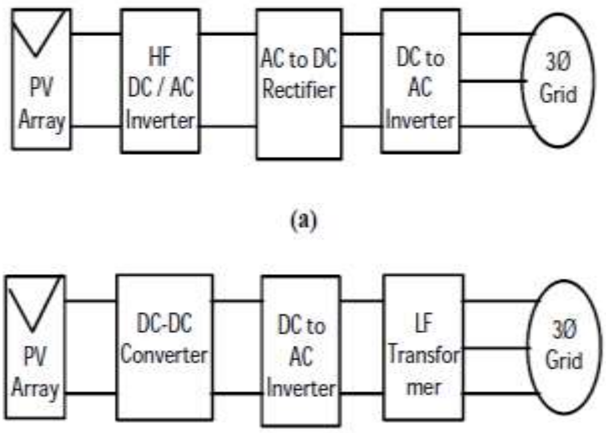


Figure3 Grid connected PV system with transformer galvanic isolation (a) High frequency (HF) DC-DC converter transformer system (b) Low frequency (LF) transformer system

II. LITERATURE SURVEY

More than 170 years ago, in France, the development of the solar cell started from the work of the French experimental physicist Antoine-Cesar Becquerel back in the 19^{th} century. In 1839, Becquerel observed that shining light on an electrode submerged in a conductive solution would create an electric current. In the same year, another French physicist, Edmond Becquerel found that a certain material would produce a small amount of an electric current when it was exposed to light [4-6]. This was described as the photovoltaic (PV) effect. It was an interesting part of science for the next three-quarters of a century. In 1877, Charles Fritts constructed the first true solar cell (made from solid materials) by using junctions formed by coating the semiconducting selenium with an ultrathin, nearly transparent, layer of gold. Fritts's devices were very inefficient, transforming less than 1 percent of the absorbed light into electrical energy. Sera et al (2008) have proposed optimized change in power Perturbation & Observation (dp P&O) algorithm for PV system under fast changing environmental conditions. This method overcomes the drawbacks of conventional P & O methods such as oscillations and slow response time and gives the guidelines for proper tracking direction. But the proposed method consumes more time to reach maximum power point (MPP) than the conventional algorithms. Here constant step size is used for perturbation under a lower change in irradiation condition [12-14]. Abu-Rub et al (2013) have proposed Adaptive Neuro-Fuzzy Inference System (ANFIS) based maximum power point tracking for quasi-Zsource inverter based PV system. This algorithm controls the shoot through duty ratio and modulation index, to maintain the required voltage, current, and frequency as required and harness maximum power from PV plant. Nevertheless, these algorithms require previous knowledge of PV plant characteristics to train the algorithms and result in increased memory space and complex computation. De Brito et al (2013) have presented detailed comparisons of maximum power point tracking (MPPT) techniques for PV applications. This analysis is performed with dc-dc converter based on the amount of energy extracted from PV plant, PV voltage ripple, dynamic response, and use of sensors. Ellabban et al (2009) have presented the design of voltage mode and a current mode controller for Z source inverter. The proposed controller controls the peak dc link voltage by measuring the input and capacitor voltages. The authors have used a small signal modeling for controller design [9-10]. However, the authors did not give attention to shoot through ratio control. Gajanayake et al (2007) demonstrated a multi loop controller for Z-source inverter based distributed generation system. The authors have employed indirect DC link controller for DC side and synchronous reference frame controller on the AC side, which maintains the power quality of the power supply to the grid during disturbances. The controller is designed using state space averaging technique. The proposed system has good voltage regulation and disturbance rejection capability. However, the authors have not given the attention to the resonant problem in the inverter.

III.PLANNING OF WORK/METHODOLOGY

PV modules and power conditioning systems are connected in different combinations in a solar PV plant. First of all using MPPT voltage level is boosted to solar DC voltage than using PI controller and switching circuit DC which already boosted by MPPT converted into AC. Simulation block diagram is shown below

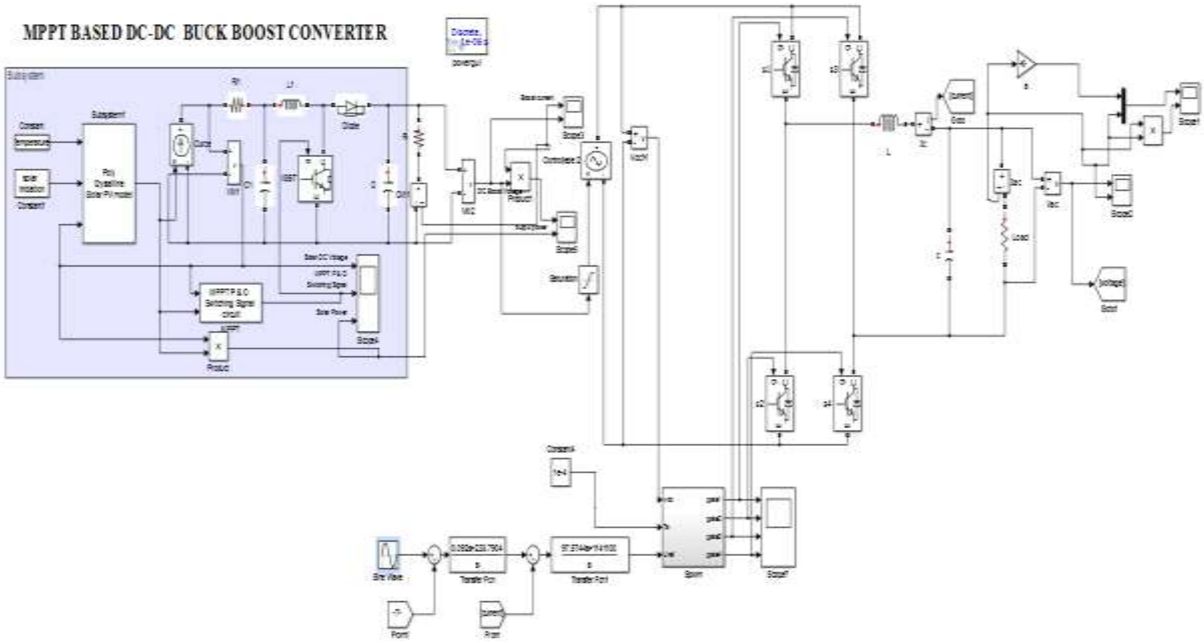


Figure4 System Block Diagram

A. MPPT (MAXIMUM POWER POINT TRACKING)

Maximum Power Point Tracking frequently referred to as MPPT, is an electronic system that operates the PV-Hydro Diesel (PV) modules in a manner that allows the modules to produce all the power. MPPT is not a mechanical tracking system (MTS) that “physically moves” the modules directly at the sun which enhance the efficiency. MPPT is a fully automatic and electronic system that varies the electrical operating point to deliver maximum available power [15-16]. Additional powers harvested from the modules are used to increase battery charge current. MPPT can be used in conjunction with a mechanical tracking system (MTS), but two systems are different from each other completely.

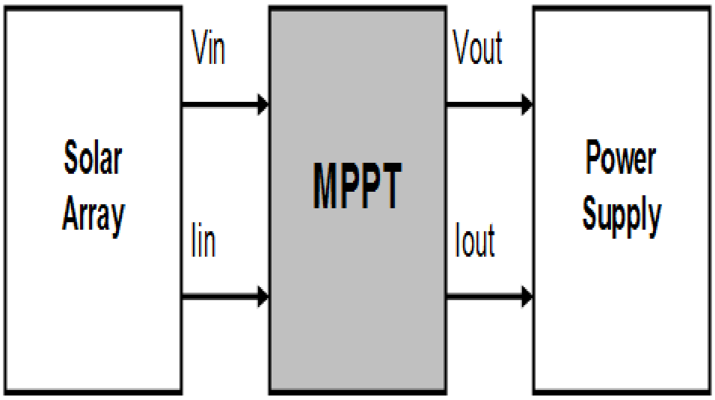


Figure5 Basic Block Diagram of MPPT

B. Working Principle of MPPT

In the rule of MPPT, it can be compatible with high power transfer theory. The current delivered from a place to load the maximized input resistance which is looked to match the supply resistance. Therefore, transfer the best current from [8] panel to load the internal resistance of panel which has got to match the resistance looked by PV panel. For fast load, similar resistance can be seen with the panel that can adjust to modify the power device of the duty cycle.

C. Need for MPPT

All types of solar installations will benefit by using MPPT technology. The higher the module operating voltage much more advantage will be gained by you using MPPT. Recreational Vehicles (RV) for solar modules have very limited or minimum roof space. If module not rotated properly, considerable power is lost in the winter months due to the sun's low angle. To overcome these types of limitations, it is very important to transfer all the power you can by using MPPT technology and mainly this type of problem arises in winter [17-18]. MPPT will allow you to wire the PV modules in series for high voltage for off-grid systems, even up to 600 volts DC and very beneficial for long wire runs as the higher the operating voltage, the smaller the wire can be for a given length.

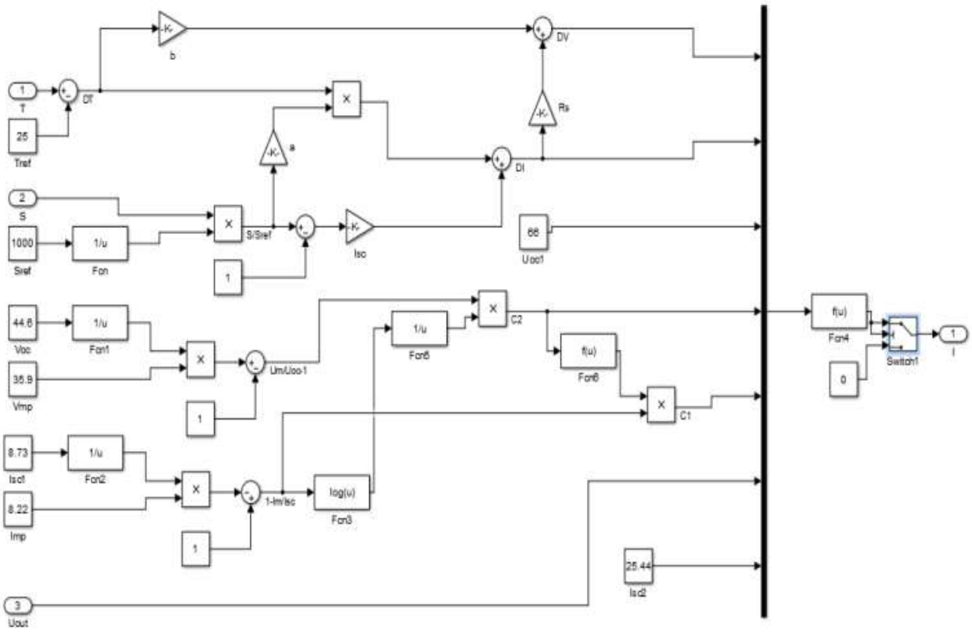


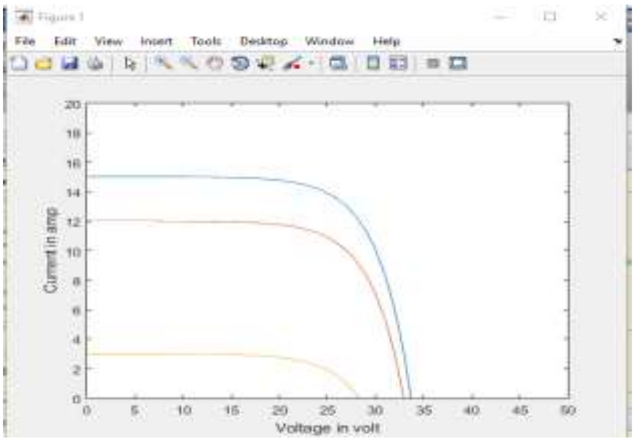
Figure: 6 Poly Crystalline Solar PV Module Internal Diagram

IV. SOFTWARE USED AND SIMULATION RESULT

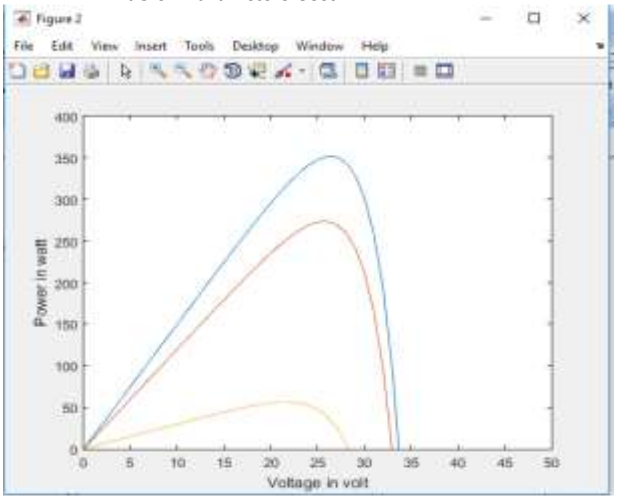
Software: MATLAB Version R2015a: It is powerful software that provides an environment for numerical computation as well as a graphical display of outputs. In Matlab, the data input is in the ASCII format as well as binary format. It is a high-performance language for technical computing integrates computation, visualization, and programming in a simple way where problems and solutions are expressed in familiar mathematical notation.s

Sr. No	Parameters Name	Parameters Value
1	Solar Temp.	273+28
2	Reference Temp in Fahrenheit	40
3	Reference Temp in Kelvin	Tr=((Tr1-32)*(5/9))+273
4	Solar radiation in mW/sq.cm	S=[100 80 20]
5	Short Circuit Current at ref. temp. in A	3.75
6	Boltzmann constant	k=1.38065*10^(-23)
7	Charge of an electron	q=1.6022*10^(-19)

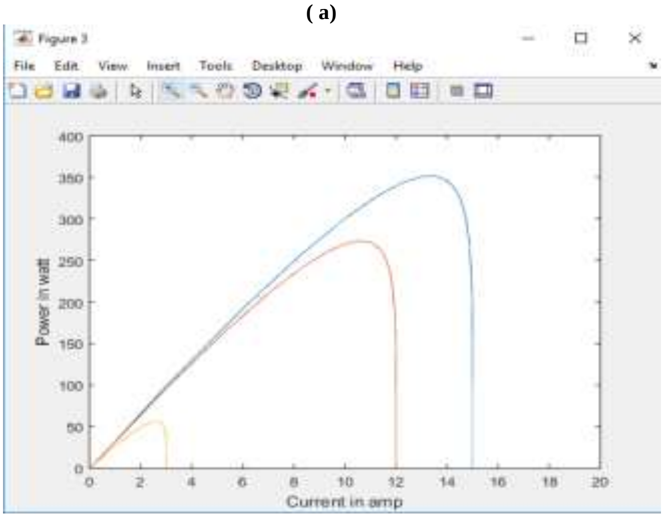
Table I Parameters Used



(a)



(b)



(C)

Figure7 (a) Solar result curve between Voltage and Current (b) Solar result curve between Power and Voltage (c) Solar result curve between Current and Power

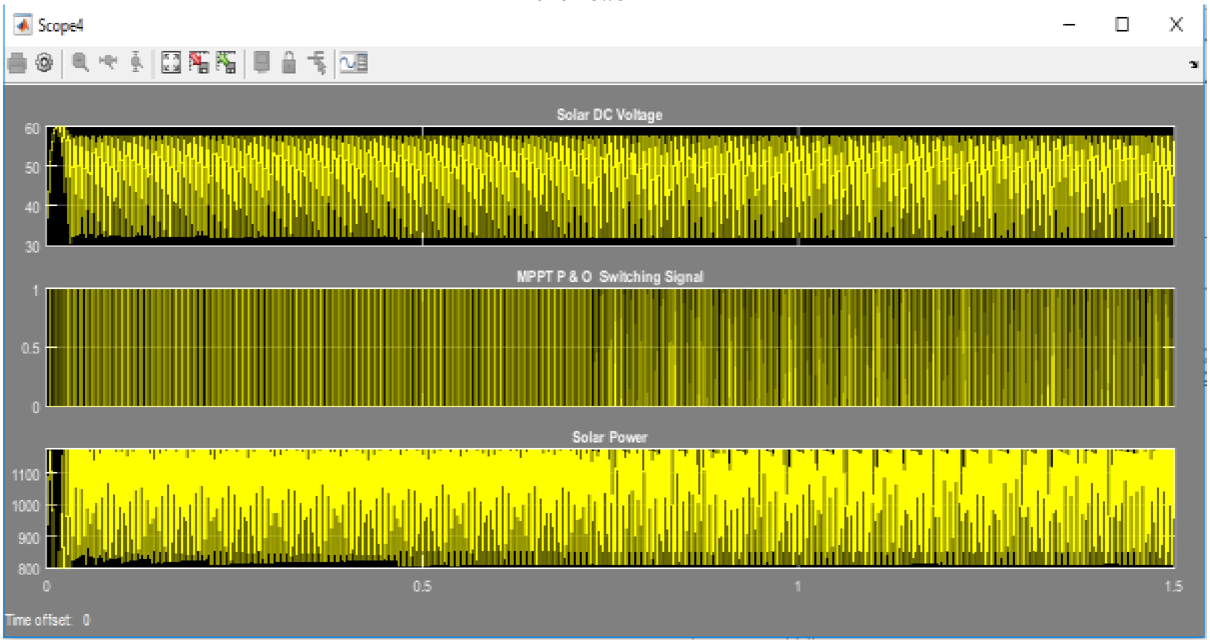
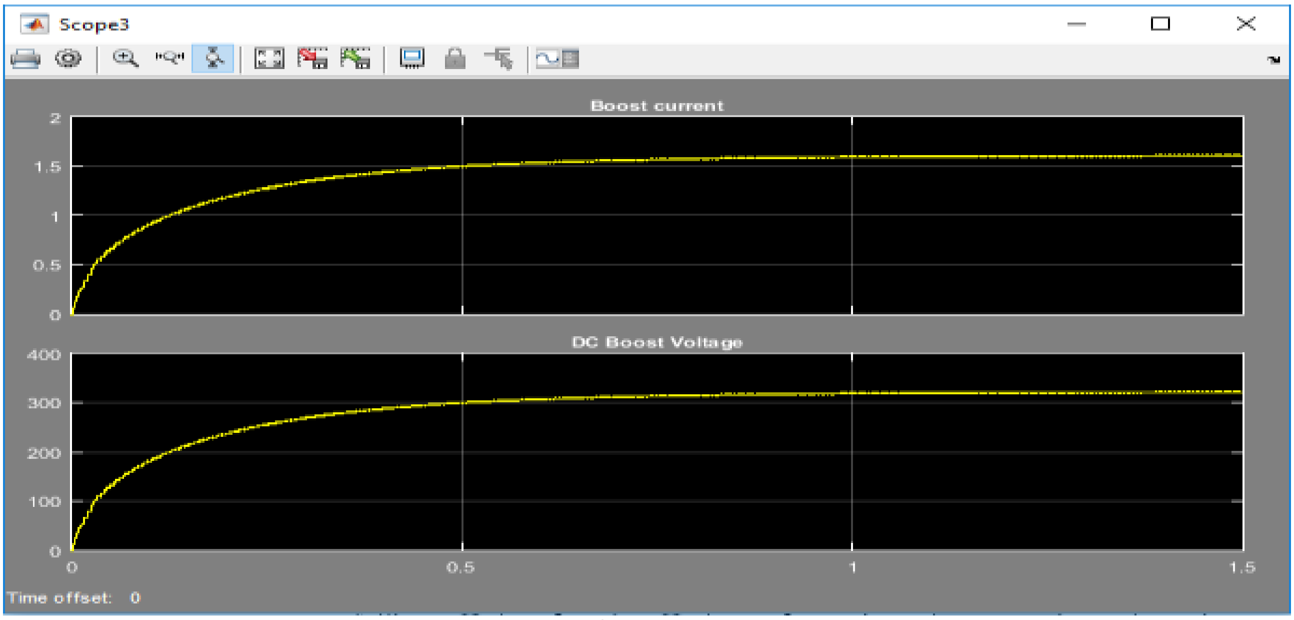


Figure8 Solar DC Voltage MPPT O Switching Signal and Solar Power



Figur9 Simulation Curve of Boost current and DC Boost Voltage

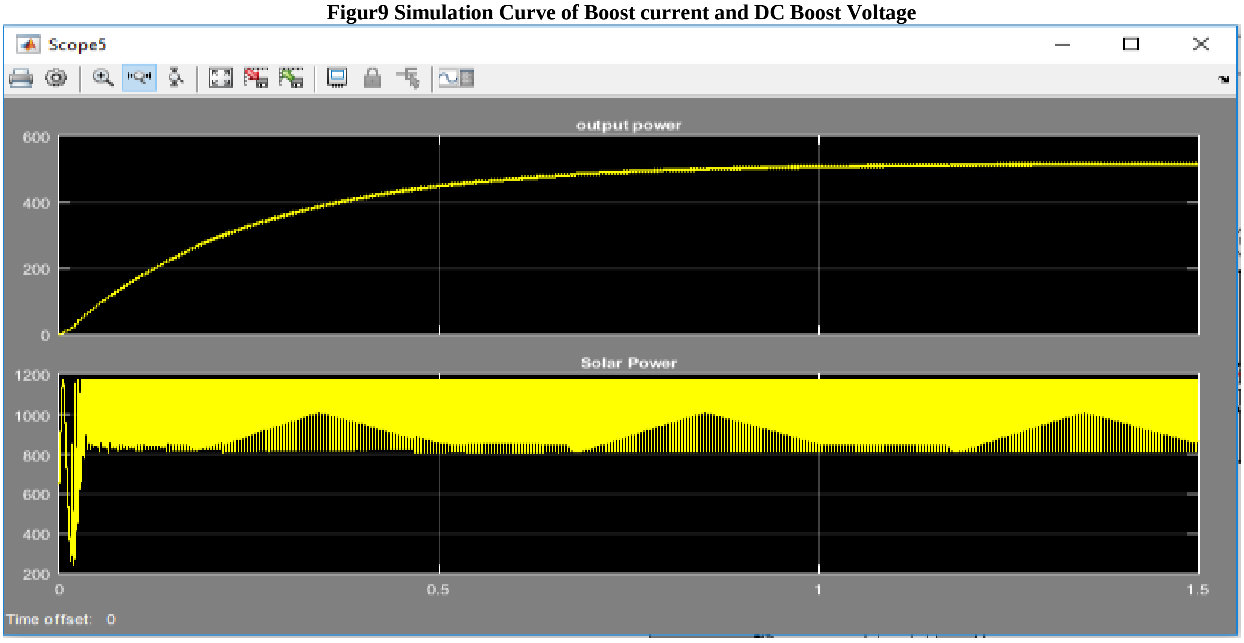


Figure10 Solar Power curve

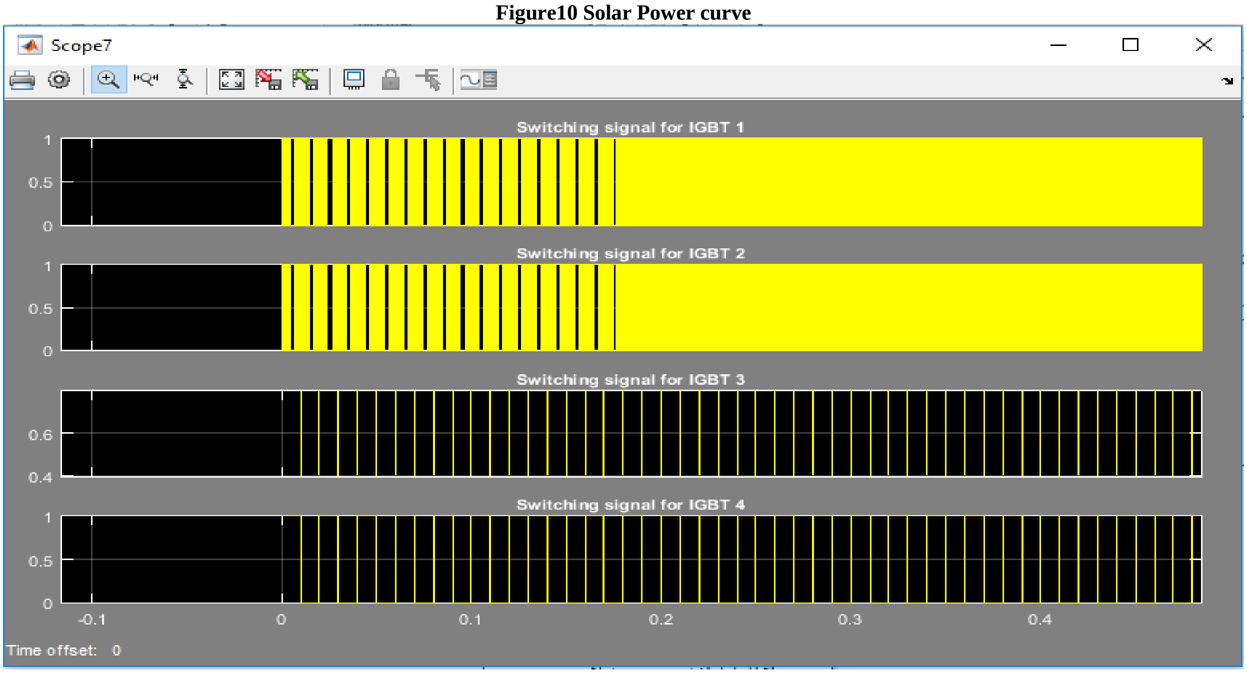


Figure11 Different Switching signal for IGBT

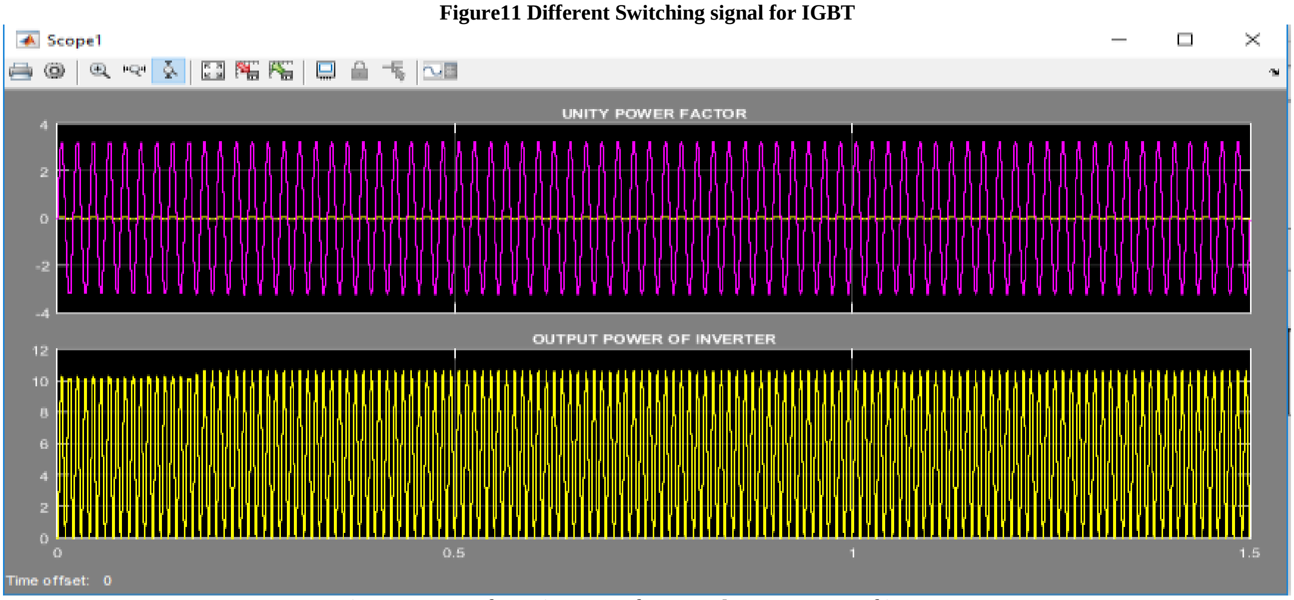


Figure12 Curve for unity power factor and output power of inverter

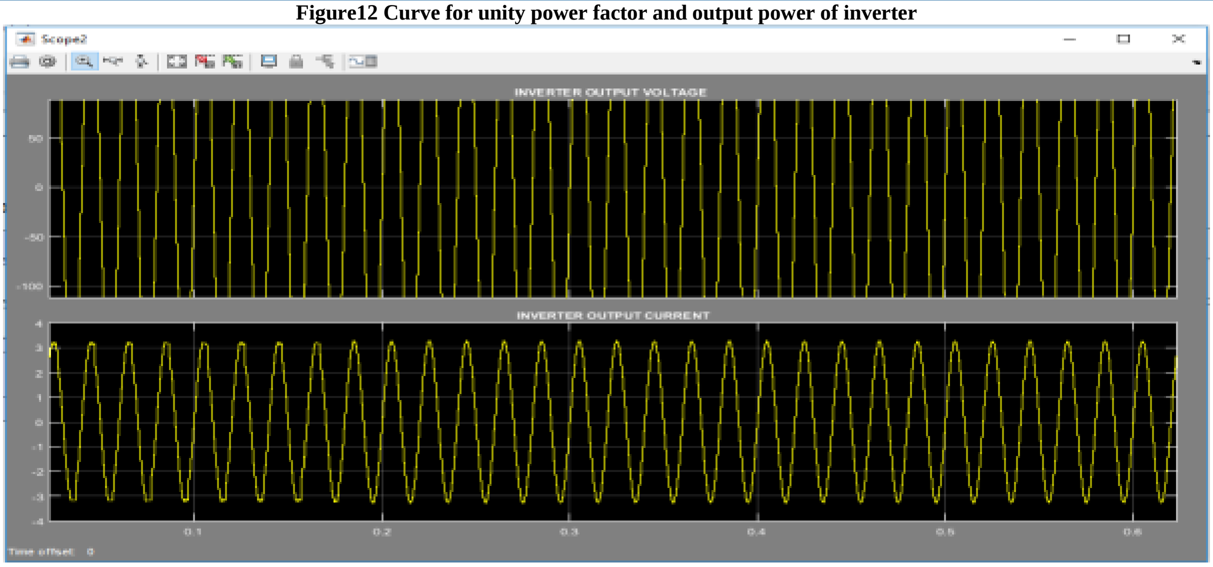


Figure13 Inverter output voltage and output current

CONCLUSION

The review has covered a few different inverter topologies for photovoltaic applications. The task for such an inverter is to amplify the photovoltaic low voltage up to the higher-level voltage of the grid and to convert it from DC into AC. In our research work polycrystalline solar PV module is utilized and after that, with help of boost converter, we increased DC power received from solar to the desired level using IGBT circuitry and also utilizes various scope to analyze the simulation of the circuit. We also used PI (Proportional Integration) controller to limit voltage and current. Our main focus is to reduce THD which must be under 5% as per IEEE standard and finally in our research work we are able to achieve THD below 5%. There are various techniques to reduce THD and always odd harmonics are reduced as our fundamental frequency is 50Hz so therefore odd harmonics occurred at 150Hz, 250Hz, and 350Hz and so on. Further, we can look for to boost more voltage as compared to our research work and also total harmonic distortion will also be reduced with effective design and advanced concept.THD can be reduced using S Transform technique which is basically in frequency domain and in it DFT and FFT concept is used

REFERENCES

[1.] Hcoman Dehbonei, Chem Nayar. Lawrence Borle. “A Combined Voltage Controlled and Current Controlled ‘Dual Converter for a Weak Grid Connected Photovoltaic System with Battery Energy Storage". IEEE Conference 011 Power Electronics Specialists. Vol. 3. pp: 1495-1500. 2002.

[2.] J. S. Siva Prasad and B. G. Femandes_. “Active Commutated Thyristors CS1 for Grid Connected Photovoltaic Applications". The 4m International Conference on Power Electronics and Motion Control. Vol. 3, pp: 1767-1771. 2004.

[3.] Anastasios Ch. Kyritsis. Nikolaos P. Papanikolaou. “Design and control of a current source fly-back inverter for decentralized grid connected photovoltaic systems." European Conference on Power Electronics and Applications. pp: p.1-p.10, 2005.

[4.] Qingrong Zeng. Liuchen Chang. “Novel SVPWM Based Predictive Current Controller' for Single-phase Grid Connected Inverters". Canadian Conference on Electrical and Computer Engineering. pp: 1262-1265. 2005.
[5.] Juan Jose Negroni. Carlos Meza. Domingo Biel. “Control of a Buck Inverter for Grid- Connected PV Systems: a Digital and Sliding Mode Control Approach ".IEEE International Symposium on Industrial Electronic. Vol. 2. pp: 739-744. 2005.
[6.] Yi Huang, Miaosen Slien, and Iin Wang. “Z-Source Inverter for Residential Photovoltaic Systems". IEEE Transaction on Power Electronics. Vol.21. No. 6, pp: 1176-1782,2006
[7.] Yang Chen, Keyue Smedley, “A Cost-effective Single-phase Grid-connected Inverter with Maximum Power Point Tracking". IEEE Conference on Industrial Applications (41st IAS annual meeting). Vol.2. pp: 995-1000. 2006.
[8.] Hoorman Dehhonei and C.V. Nayar, "A Grid-Connected Photovoltaic System with Direct Coupled Power Quality Control". 32nd IEEE Annual Conference on Industrial Electronics. pp: 5203-5208, 2006.
[9.] Bahak Parhang. Shahnokh Farhangi, "Comparison of Z-Source and Boost-Buck Inverter Topologies as a Single Phase Transformer-less Photovoltaic Grid-Connected Power Conditioner". 37th IEEE Conference on Power Electronics Specialists. pp: 1-6. 2006
[10.] Pedro Gonies Barbosa, Henrique Antonio Carvallio Braga, "Boost Current Multilevel Inverter and Its Application on Single-Phase Grid-Connected Photovoltaic Systems". IEEE Transactions on Power Electronics. vol. 21, Issue no.: 4, pp: 1116-1124, 2006.
[11.] Hirotaka Koizuimi, Norio Goshima, and Kosuke Kurokava. “A Novel Microcontroller for Grid-Connected Photovoltaic Systems". IEEE Transactions on Industrial Electronics. Vol. S3, Issue no.: 6, pp: ISS9-1897. 2006.
[12.] Mi Dong, An Luo, Lisha Bai. Jian Yang, “An Integrative Control Scheme for Boost-buck Inverter in Grid Connected Photovoltaic Systems." IEEE Conference on Applied Power Electronics. pp: 524-528. 2007
[13.] J. B. Wang, Joe Chen, Ronald Li, “A Grid Connected Photovoltaic System with Irradiation Injected Current Control“. IEEE The 7th International Conference on Power Electronics. pp: 43-435, 2007.
[14.] G. Brando, A. Dannier. “A Sensor-less Control of H-bridge Multilevel Convener for Maximum Power Point Tracking in Grid Connected Photovoltaic Systems". International Conference on Clean Electrical Power. pp: 789-794. 2007.
[15.] Gabriele Grandi, Daiko Ostojic. Claudio Rossi, “Dual Inverter Configuration for Grid-Connected Photovoltaic Generation Systems". 29th International Conference on Telecommunications Energy. pp: 88O-885, 2007.
[16.] T. Shamhi and N. Ammasai Gormden, “Power Electronic Interface for Grid Connected PV array using Boost Converter and Line-Commutated Inverter with MPPT". International Conference on Intelligent and Advanced Systems. pp: 882-886, 2007.
[17.] Ulrich Boeke and Heinz van der Broeck. "Transformer-less Converter Concept for a Grid Connection of Thin-film Photovoltaic Modules". IEEE Industry Applications Society Annual Meeting. pp: 1-8, 2008.
[18.] Mateus F. Sclionardie and Denizar C. Martins, “Single-Phase Grid-Connected Photovoltaic System with Active and Reactive Power Control Using dq0 Transformation". IEEE Conference on Power Electronics Specialists. pp: 1202-1203. 2008.

