International Journal of Smart Home
Vol. 10, No. 6 (2016), pp. 277-286
http://dx.doi.org/10.14257/ijsh.2016.10.6.27

Performance of Different Types of DC - DC Converter with P & O Algorithm of MPPT

A.Ambikapathy* [1], Gajendra Singh and Prabhakar Tiwari[3]

[1]*Asst proff, EEE, GCET, Gr.Noida*
[2]*HOD, EEE, SU, Gr.Noida*
[3]*AHOD, EEE, GCET, Gr.Noida*
[1]*ami_ty21@yahoo.com, gajendra.singh3@sharda.ac.in , profptiwari@gmail.com*

Abstract

This comparative study analysis of dc-dc converter for MPPT controller with P and O algorithm of a grid connected system finds the better suitable converter which can give the output with maximum power from the PV module and can have reliability to connect it to the GRID. In this paper the performance of LLC, ZETA and SEPIC converters are designed and simulated then its results are compared to identify the best suitable converter for the grid connected PV with P and O algorithm of MPPT circuit. The performance analysis has been carried out by connecting these converters in the circuit which already simulated for connecting the PV output to the commercial grid. The comparative performance analysis is done at the stage of gird as well as in the stage of output of the converter too.

Keywords: *Solar PV, Grid, Efficiency, MATLAB simulation, resonant converter, zeta converter, sepic converter*

1. Introduction

There are N number of process are involved to satisfy the electricity demand of the customer. The significance of saving one unit of electricity has been discussed in [1] as per that, there is necessity to generate two units of electricity for supplying one unit of electrical energy to the consumer. This is due to the different technical losses from the generating station to the consumer end. Not only technical problem but also the environmental pollution issues also involved in it [1]. Therefore the entire world now days inclined towards the renewable energy generation and started motivating by highlighting the importance of it due its numerous advantages such as fuel free and it require very less maintenance and environmental benefits *etc*. [2]. As we know that even though renewable energy has numerous advantages it has very less energy conversion efficiency for example solar power plant the efficiency of the plant is highly dependent upon the solar radiation, temperature, and load resistance and such kind of parameters are depends on environmental condition which cannot be controlled by human [3]. After generating the electricity again storing of the generated electricity is another challenge
As we know that the storing of all the power which is generated from the solar power plant is impossible so, the remaining power which we get from solar power plant after supplying its own demand where the plant is located can be easily connect it to the commercial grid. [4-6]. Hence in this paper we are going to discuss the various DC- DC converters which are used in PV module which is connected to the commercial grid. Mainly there are three converters topologies which are been discussed in this paper according to their accuracy in power quality, efficiency, and reliability. All these comparisons are done with P and O algorithm of MPPT circuit.

A.Ambikapathy is the corresponding author.

ISSN: 1975-4094 IJSH

2. Maximum Power Point Tracking Technique

The magnitude output power generated by a PV panel is directly proportional to the operating voltage of the PV array. The maximum power point (MPP) corresponding to maximum operating voltage of the PV array depends on solar irradiance and temperature. Hence in order to obtain the maximum operation voltage the maximum power point technique with different algorithm is inserted with the solar system to improve the output and efficiency. The nonlinear V-I and V-P characteristics of solar panel with their MPPT point is shown in Figure (1). [7] In Figure 1 it is shown that the point where the maximum voltage and power can be obtained from the operating characteristics of PV array.

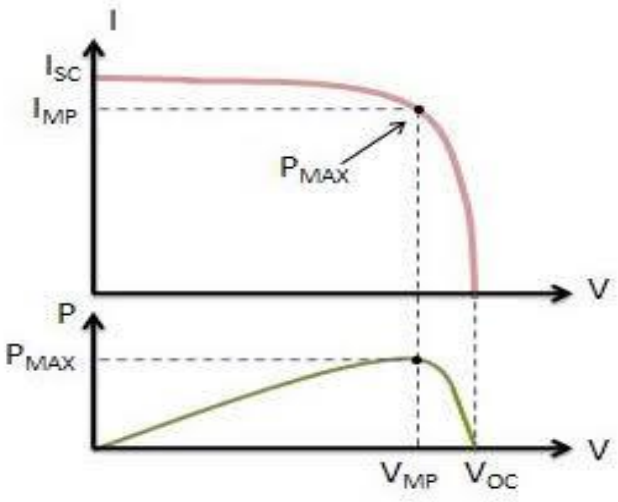

Figure 1. V-I and Power Characteristics of PV Panel with Maximum Power Point

2.1 P and O of MPPT Technique

The P&O algorithm is made to track the maximum power point from the PV panel. The tracking algorithm of this technique calculates the output voltage; current and power of the output of PV array and change the value of duty cycle of DC-DC converter according to the maximum power point. Once the perturb action is taken place again the output of PV array will be compared and calculated to see whether the duty cycle value has been increased or decreased. For example once it is being observed that duty cycle value was increased then the same action is carried out for the further operation otherwise the action can be reversed to get the desired output [8]. The algorithm of this method has been made in flow chart of Figure (2). For an increment in the power, the perturbation action should be kept in the same direction and for a decrement power then the perturbation action will be in the opposite direction. By keeping this as a concept of operation of MPPT, the algorithm of P and O algorithm is implemented [9]. The process of shifting the point is repeated until the obtaining of the maximum power point is being achieved. From the Figure .2 it is understood that the maximum point is fixed and till the point is being shifted to the desired point and the process is finally give the signal to PWM generator in order to change the duty cycle of the DC – DC converter [10]. This process is carried out to achieve the maximum power point region which is shown in Figure 1 the point may not be exactly in the maximum point but at least in the region it should lie. Once the maximum power point changes the duty cycle of the DC- DC converter then it is inverted to get the AC output using multi-level inverter [11].

The detailed algorithm of P and O is given in appendix 1. This algorithm is programmed inside the MPPT block of Figure(3) of simulation of PV connected to Grid.

3. Realization and Simulation Models of PV Connected to Grid

In this part we are going to see the block diagram and circuit model of the PV connected to the grid. After realizing the general simulation model the DC-DC converter topology is being changed by different topology to compare the best topology among the topologies which is mentioned in the Abstract. The block diagram and simulation realization circuit are given in Figure (3) and (4). In the above Figure 3 it is shown the process of connecting the output of Solar PV into commercial grid. As we know the output of the PV panel is DC hence to connect it to the grid we need to convert it into AC with the parameters which are capable of connecting to the existing commercial grid. So we to make the output of PV panel to compatible to the commercial grid it has to be sent to the MPPT to make sure that the maximum power has been observed from the PV panel without much deviation and again it has to be boosted using DC-DC converter with the help of PI controller the DC-DC converter is being operated because the duty cycle of the converter is being decided by the PI controller according to the desired output.

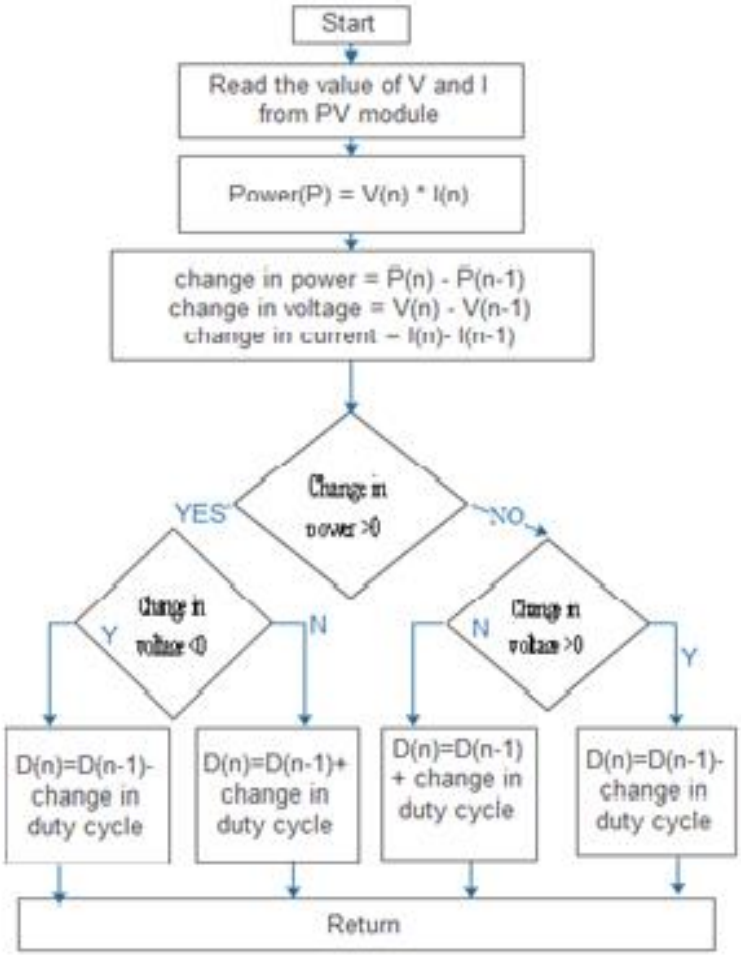

Figure 2. Flow Chart of P and O Algorithm

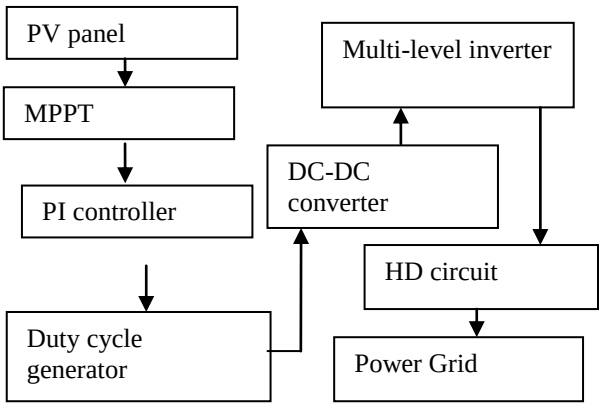

Figure 3. Block Diagram of PV Connected to Grid

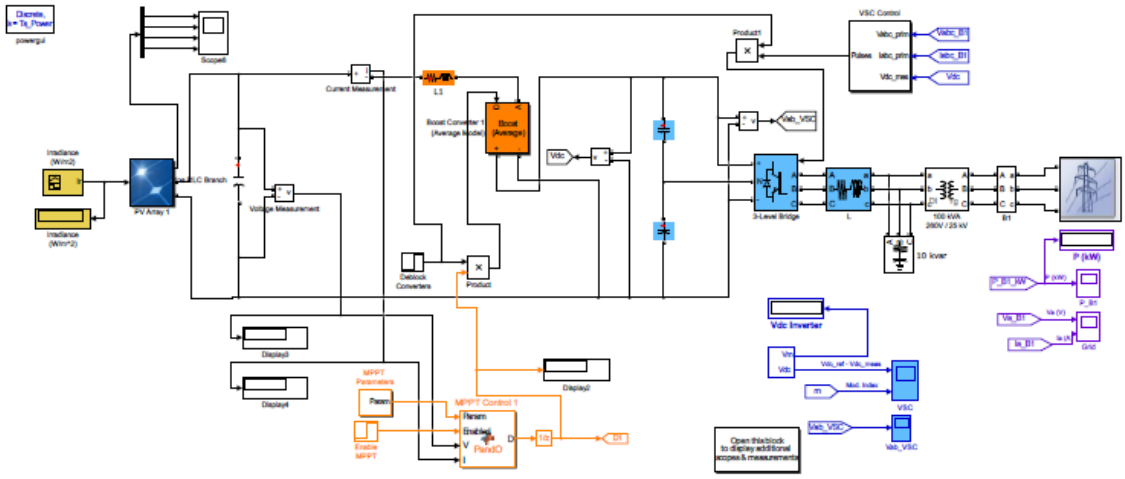

Figure 4. MATLAB Simulation of PV Connected to Grid

3.1 Simulation Result at Grid with LLC Converter

In Figure 4 in the place of DC-DC converter, the different converters are replaced and its performance is captured. The first attempt was done with the LLC resonant converter whose circuit diagram is given in Figure 5. And after applying this converter the power output at the stage of Grid has been captured and displayed here to compare and to find the better converter according to their performance in terms of its power quality. This LLC resonant converter can operate in different modes such as series mode, parallel mode *etc*. [12-13]. The circuit diagram which is shown in Figure 4 has been realized in MATLAB simulation and this block has been added to the MATLAB simulation of Figure 4 and its results are observed for the comparison.

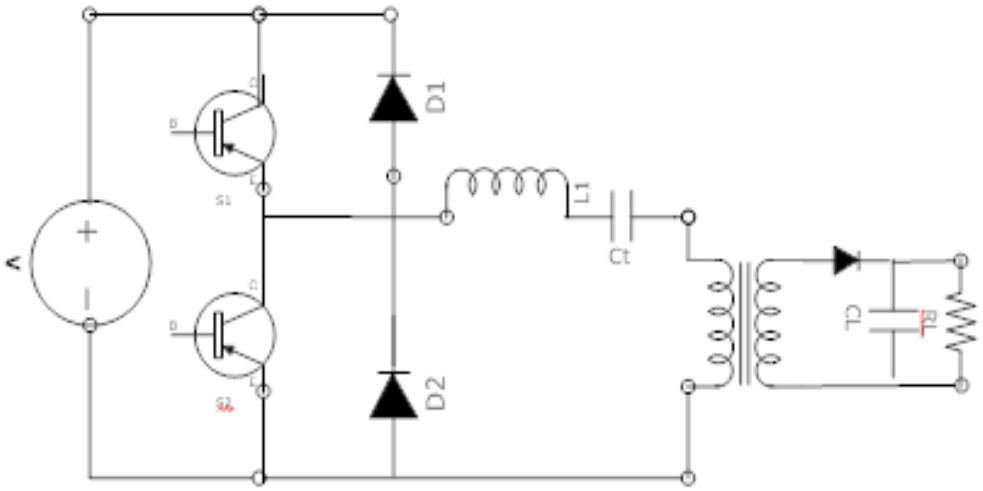

Figure 5. Circuit Diagram of LLC Resonant Converter

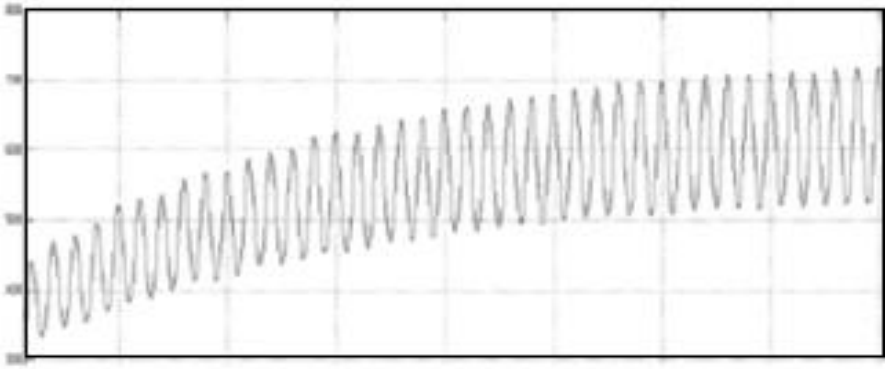

Figure 6. Simulation Graph of Power at the Stage of Grid with LLC Resonant Converter of 100KW

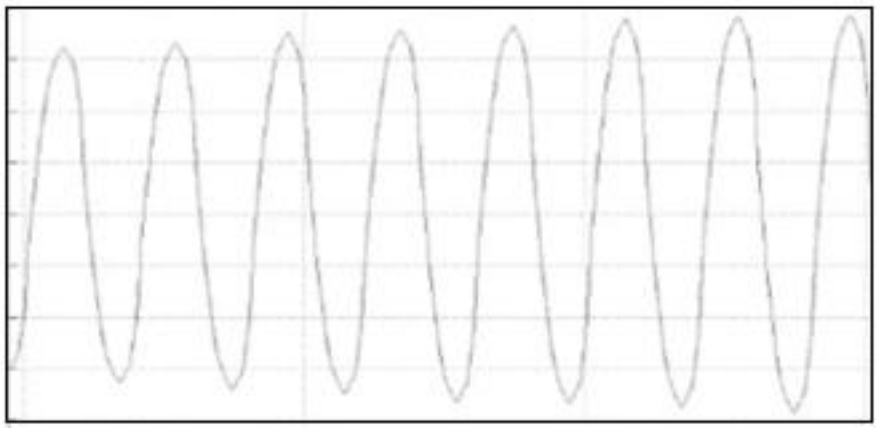

Figure 7. Simulation Graph of Voltage at the Stage of Grid with LLC Resonant Converter of 100KW

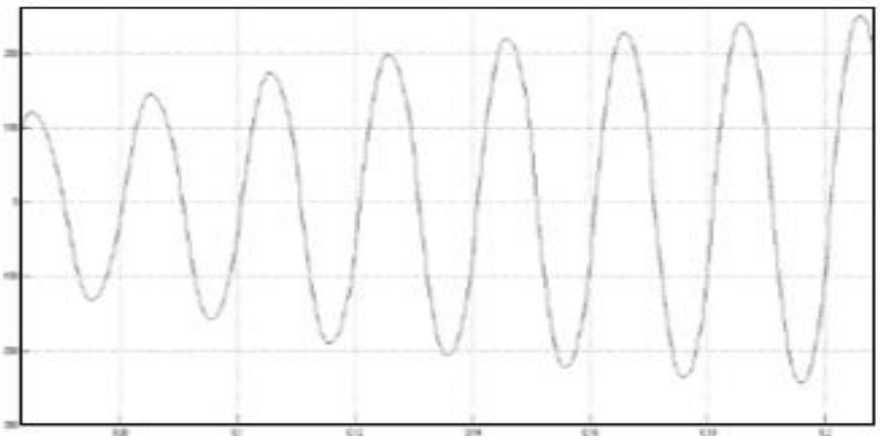

Figure 8. Simulation Graph of Current at the Stage of Grid with LLC Resonant Converter of 100KW

The Figures 6, 7 and 8 are shows the voltage, current and power output at the stage of grid with LLC resonant converter. These results will be further compared with the other converters results for concluding the better converter.

3.2 Simulation Result at Grid with ZETA Converter

In Figure 4 in the place of DC-DC converter, the ZETA converter is being replaced whose circuit diagram is given in Figure.9. And after applying this converter the power output at the stage of Grid has been captured and displayed here to compare and to find the better converter according to their performance in terms of its power quality[14 -17]. The circuit diagram which is shown in Figure 9 has been realized in MATLAB simulation and this block has been added to the MATLAB simulation of Figure 4 and its results are observed for the comparison. When the above diagram is being realized in MATLAB and replaced in place of LLC resonant converter it gives the result better than the previous converter which is shown in Figures 10, 11 and 12

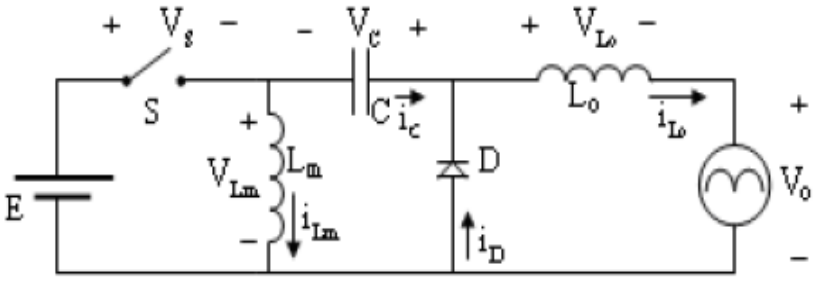

Figure 9. Circuit Diagram of ZETA Converter

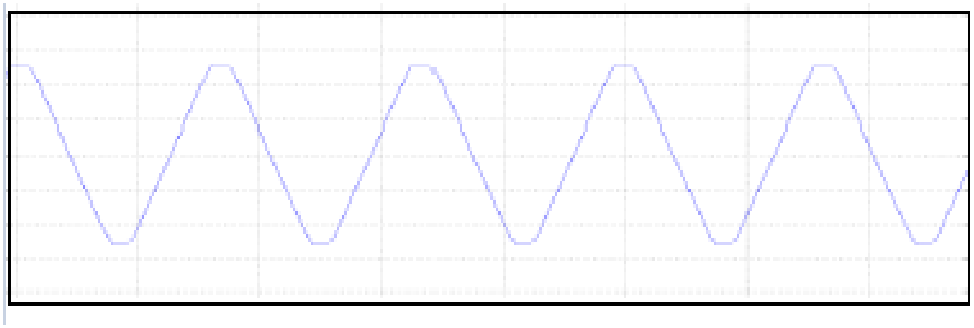

Figure 10. Simulation Graph of Voltage at the Stage of Grid with Zeta Converter of 100 KW

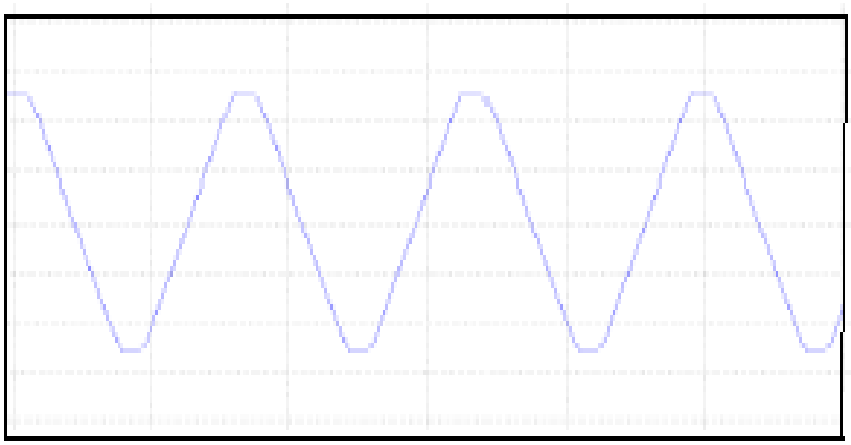

Figure 11. Simulation Graph of Current at the Stage of Grid with ZETA Converter of 100KW

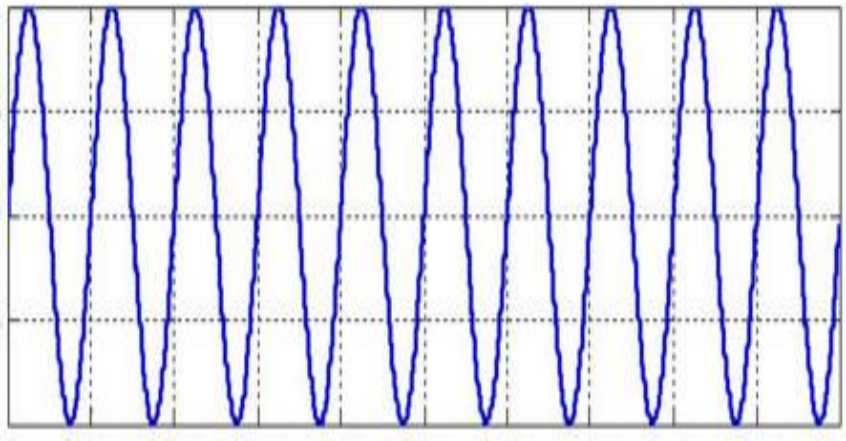

Figure 12. Simulation Graph of Current at the Stage of Grid with ZETA Converter of 100KW

3.3. Simulation Result at Grid with SEPIC Converter

In Figure 4 in the place of DC-DC converter, the SEPIC converter is being replaced whose circuit diagram is given in Figure 13. And after applying this converter the power output at the stage of Grid has been captured and displayed here to compare and to find the better converter according to their performance in terms of its power quality[18 -20].

The circuit diagram which is shown in Figure 13 has been realized in MATLAB simulation and this block has been added to the MATLAB simulation of Figure 4 and its results are observed for the comparison. When the above diagram is being realized in MATLAB and replaced in place of ZETA converter it gives the result not much better than the ZETA converter which is shown in Figures 14, 15 and 16. The Figures 14, 15 and 16 are shows the voltage, current and power output at the stage of grid with SEPIC converter. These results will be further compared with the other converters results for concluding which will be the better converter and compatible with the grid so as to produce the AC output with less harmonic distortion (HDC).the different DC-DC converter topology has been replaced one by one and the graph is captured

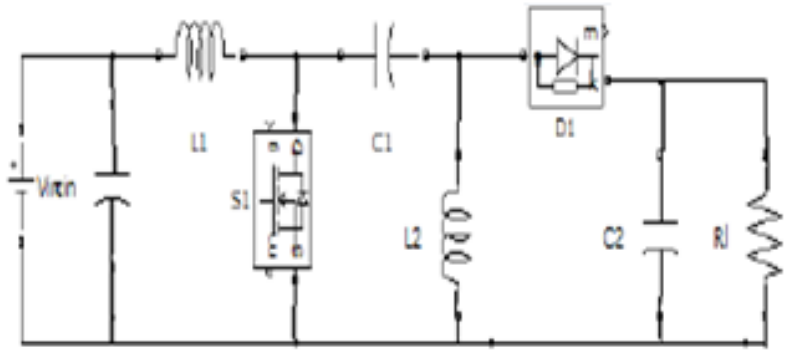

Figure 13. Circuit Diagram of SEPIC Converter

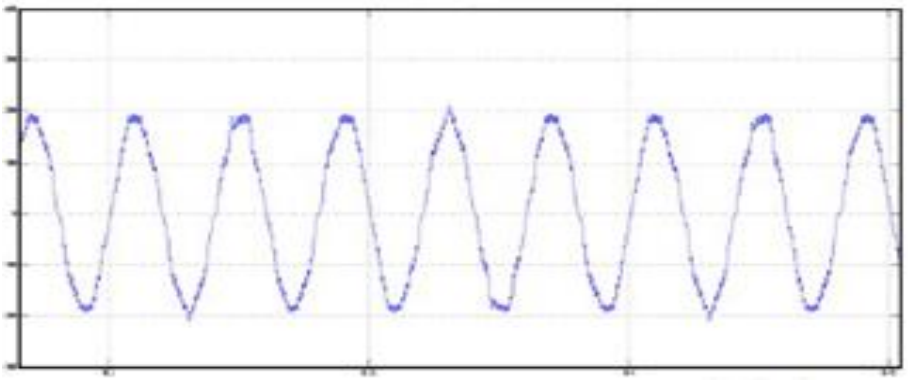

Figure 14. Simulation Graph of Power at the Stage of Grid with SEPIC Converter of 100KW

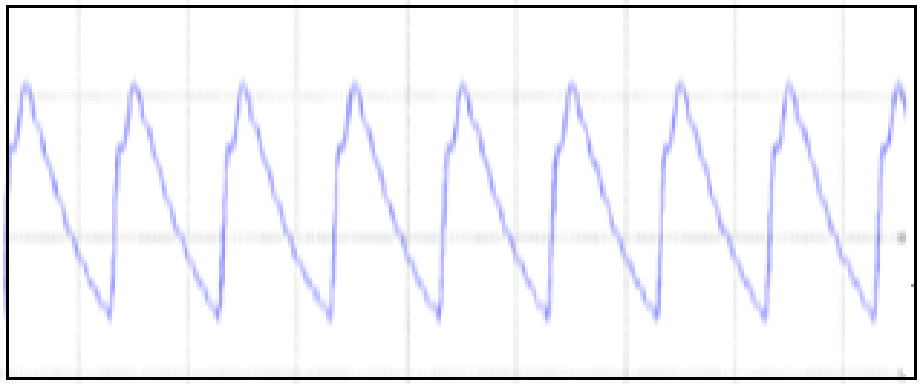

Figure 15. Simulation Graph of Current at the Stage of Grid with SEPIC Converter of 100KW

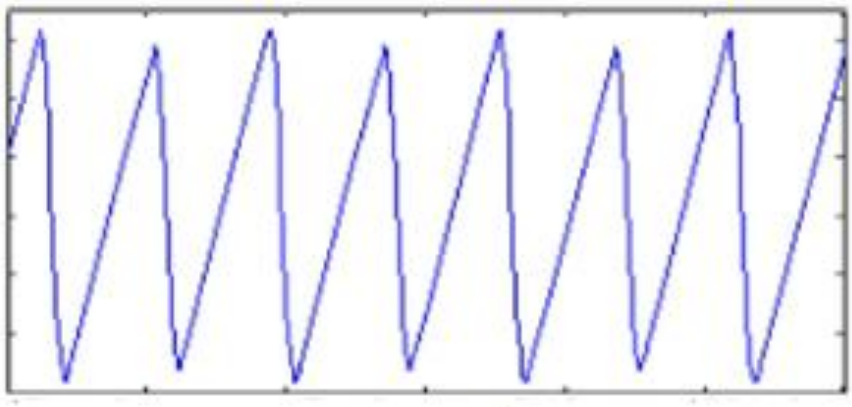

Figure 16. Simulation Graph of Voltage at the Stage of Grid with SEPIC Converter of 100KW

4. Conclusion

This paper presented one of the most important requirements of Photovoltaic system connected to the commercial grid. The basic traditional principle of Maximum Power Point Tracking system of P and O algorithm is being combined with different Dc-Dc converter and the simulation in MATLAB is carried out and then its results are compared in terms of purity in sine wave of voltage, current and power. From the Figures 6,7,8,10,11,12,14,15 and 16 it is obvious that the ZETA DC-DC converter gives the best output which is compatible with the commercial grid. The implementation of proposed MPPT method is done on Boost converter topology and the simulation result is displayed. In future this ZETA converter is being combined with two different technologies such as predictive control and soft switching will be carried out and its results will be compared with other topology

References

[1] A.Ambikapathy. Gajendra Singh, Prabhakar Tiwari, "Significance of saving one unit of Electricity", 1st UPCON-ICEEE2015, 26-28th March, l2015, IEEE explore, pp1-6.
[2] Z.peng, W.yang, X.Weidong, and L.Wenyuan "Reliability evaluation of grid connected photovoltaic power system" IEEE Transaction on sustainable energy.vol.3. pp 379-389. 2012.
[3] M.Kasper, D.Bortis, T.Friedi and J.W.Kolar, " Classification and comparative evaluation of PV panel intergrated dc-dc converter concepts" in IEEE power electronics and motion control conference (EPE/PEMC), 2012,pp-LS1e4-LS1e.4-8.

[4] B.Farhangi and S. Farahangi " Comparison of z source and Boost Buck inverter topologies as a single phase transformerless photovoltaic grid connected power conditioner" in IEEE Power Electronics specialist conference (PESC), 2006, pp 1-6.
[5] H.Behjati and A Davoudi "A multiple input multiple output DC – DC converter" IEEE Transaction on Industry Application vol.49. pp-1464-1479, 2013.
[6] H.Keyhani abd H.A. Toliyat " A New generation of buck-boost resonant AC-Link Dc-DC converter" in IEEE Applied Power Electronics Conference and Exposition(APEO) 2013, pp 1383-1390.
[7] Tae Yeop Kim, *et al*. A Novel based Maximum Power Point Tracking Controller of Photovoltaic Power System Rapidly Changing Solar Radiation [J]. IEEE International Symposium on Industrial Electronics, 2002, 2:1011-1014
[8] Roberto Francisco Coelho* and Denizar Cruz Martins "An Optimized Maximum Power Point Tracking Method Based on PV Surface Temperature Measurement" book on sustainable energy -recent studies, INTECH publication, oct 2012.
[9] Marin-leonard FLOREA and adrian BLTTANU, Modeling photovoltaic arrays with MPPT Perturb & observe algorithm in Proc. IEEE Advanced Trends in Electrical Engineering Conference.,pp.1-4, 2013.
[10] Ahmed m Atallah, Almoataz Y Abdelaziz, Raihan S Jumaah "Article on Implementation of Perturb and observe MPPT of Pv system with direct control method using buck and buck boost converters" An International Journal of Emerging Trends in Electrical and Electronics and Instrumentation Engineering. Vol.1 feb 2014
[11] Vedasangamithra, N Selvarani"Design and analysis of MPPT algorithms for CHBMLI " International Journal of Advanced Research in Electrical, Electronics and Instrumentation Energy. Vol 2. Feb 2012.
[12] Sreereshmi T O and lekshmi Mohan "Resonant converter for photot voltaic system" international Conference on Advanced trends in engineering and technology – 2014. (FORSCHUNG) PP 176-181
[13] Shivaraja L " Modulation and Simulation of LLC Resonant converter for photovoltaic system" International journal of emerging technology and innovation engineering. Vol 1, issue 4, april 2015, pp 175 -181.
[14] Neeraj priyadarshi, Dr.Vinod Kumar, Dr.R.R.Joshi" Zeta converted integrated inverter for grid connected PV system with optimal power point track" International journal of innovation research in science engineering and technology vol4, issue 2, Feb 2015 pp 427-423.
[15] Yanbo CHE, Wen zhang, Weili " The design of MPPT control in photovoltaic system" Key lab of smart grid ministry of education , Tianjin university, Tianjin, china. Pp 71-73.
[16] HenriqueF.Lepez, Cesar Zollmann, Rean Viero e Fernando S. Dos reis " photovoltaic panels grid – tied by a Zeta converter" IEEE Explore Power electronics conference sep 2009 COBEP'09, Brazilian. Pp 182-188
[17] A.Ambikapathy, Gajendra Singh, Ashish Srivastav"Soft swirching ZETA converter with predictive controltechnique for grid connected PV, International journal of applied engineering research, vol 10, 2015 pp 226- 231.
[18] Ajmal K A, K punnagai selvi, Nileena P subhash " integration of two sepic converters and a single phase bidirectional inverter using MPPT algoritms" IJIRSET, Vol 3, Special issue 1, feb 2014 pp 743-748
[19] Adeline sneha, K Kumar, V Bens Joie victor, J Aran Glenn " Photovoltaic based Dc-DC Multiport converter with distributed generation" International journal of innovative research in electrical, electronics, Instrumentation and control engineering, vol2 , issue 8, Augest 2014, pp 1894-1899
[20] T.Ajith Bosco Raj, R Ramesh, J R Maglin, M vaigunda moorthi, I willim christopher, C gopinath, C Yashuvanth " Grid connected Solar PV system with SEPIC converter compared with parallel boost converter based MPPT" Research article on Hindawi publishing corporation, International journal of photo energy, vol 2014, 12 pages

