International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

MATLAB Based Simulation on Boost Converter with P&O Technique to Supply Utility Grid

Mr. Dasharath Moyade[1], Asst. Professor Dr. Ramsha Karamapuri[2], Asst. Prof. S.S. Thakur[3], Asso. Prof. C.S. Sharma[4]

[1] *M. Tech. Scholar Dept. of Electrical Engg. Samrat Ashok Technological Institute, Vidisha (M.P.)*
[2] *Asst. Professor, VNIT Nagpur , Maharashtra, India*
[3] *Asst.Professor in Electrical Engg. Samrat Ashok Technological Institute, Vidisha ,(M.P.), INDIA*
[4] *Asso.Professor and H.O.D. in Electrical Engg. Samrat Ashok Technological Institute, Vidisha ,(M.P.)*

Abstract:-In this paper the boost converter is DC-DC topologies are the foremost powerful methodologies of power converters. A boost converter is the most popular prototype of DC-DC converters practiced in different power electronics applications.We have made MATLAB model which has four parts, first part is solar panel which makes direct current, second part gives solar panel supply to boost converter and boost converter is connected to MPPT P&O technique which takes maximum power from solar panel to boost converter gives to. The third part is the inverter which converts the output direct current of the boost converter to AC and the fourth part passes the supply from the inverter to the utility grid. We have done simulations on a MATLAB model whose results are shown in simulation result section in this paper and the boost converter results are input voltage of the boost converter is 296.9 V and the output voltage of the boost converter is 499.7 V. the performance of BOOST converter is Excellent by using a MPPT P&O Technique.

Key words: DC-DC boost converter; Maximum Power Point Tracking (MPPT), P&O method.

1 Introduction:-

DC-DC switching converter can be divided into two types, non-isolated and isolated. Non-isolated converters are the simplest, including Buck Converter, Boost Converter, Buck-Boost Converter, Cook Converter, Sepic Converter, Zeta Converter, etc. They have similar topologies consisting of two switches, inductors, capacitors and loads. By connecting these components in different ways, different voltage conversion functions can be achieved. Buck converter convert an enter voltage to a lesser output voltage. A boost converter converts an input voltage to a higher output voltage. Buck converter, boost converter, cook converter, sepic converter and zeta converter can provide an output voltage that is both high and low compared to the input voltage, combining the functions of a buck converter and boost converter in one circuit.

A boost converter is a power converter whose output DC voltage is greater than its input DC voltage. It is a type of Switch Mode Power Supply (SMPS) that consists of at least two semiconductor switches (a diode and a transistor) and at least one energy storage element. A boost converter is sometimes called a boost converter because it "boosts" the source voltage. Since energy must be conserved (P = VI), the output current is less than the source current. The boost converter has the same components as the buck converter, but it produces a higher output voltage than the converter source. Boost converters begin their voltage conversion with current flowing through the inductor (the switch is closed). Then they close the switch without letting the current go through a path other than the diode (it acts as a one-way valve) then the current wants to incident really fast and the only way to do this is to lower its voltage is to amplify (similar to inrush) at the end that connects to the diode and the switch. If the voltage is high enough, it opens the diode, and through a diode, current cannot flow back. This is the very basic concept of a boost converter.

Circuit analysis of the boost converter begins by making these assumptions:

- The circuit is operating in the steady state.
- The capacitor is very large, and the output voltage is held constant at voltage Vo. This restriction will be relaxed later to show the effects of finite capacitance.
- The switching period is T, the switch is closed for time DT and open for time (1-D)T
- The components are ideal.

2 BOOST Converter:-

A boost converter or boost switch mode power supply may also be called a switch mode regulator. Increase the input voltage to generate a higher output voltage. The popularity of the switch mode regulator is due to its high efficiency, compact size and low cost.

In a boost converter, the output voltage is greater than the input voltage, hence the name "boost". Below is a Matlab simulation model of a boost converter using a power MOSFET.

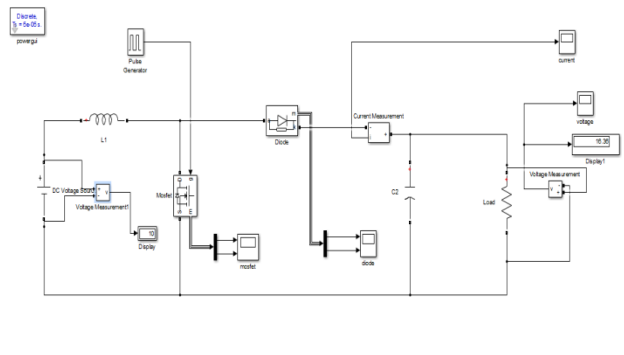


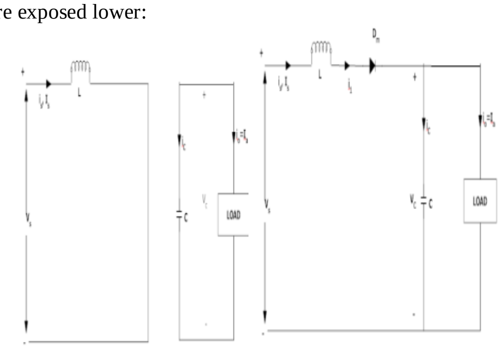
Fig. 1 Boost converter MATLAB simulation model

The boost converter function can be divided into two modes, Mode 1 and Mode 2.

Mode 1 starts when MOSFET M1 is turned on at time t = 0. The inrush current increases and flows through the inductor L and MOSFET M1.

Mode 2 starts when MOSFET M1 is turned off at time t=t1. The inductor current drops to the next cycle. The power accumulated in the inductor L flows during the load.

The circuit for the two modes of process are exposed lower:



(a) (b)

Fig. 2 Circuit operation (a) Mode 1 (b) Mode 2

The waveforms for the voltages and currents are shown below

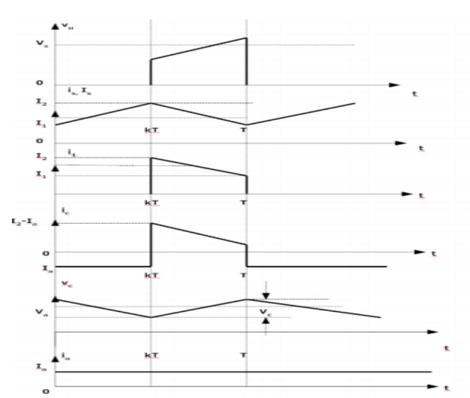


Fig 3Waveform for Boost Converter

The voltage-current relative for the inductor L is:

$$i = \frac{1}{L}\int_0^t V dt + i_0 \qquad (1)$$

Or

$$V = L\frac{di}{dt}$$

For a constant rectangular pulse:

$$i = \frac{Vt}{L} + i_o \qquad (2)$$

When the MOSFET M1 is switched

$$i_{pk} = \frac{(V_{in} - V_{Trans})T_{on}}{L} + i_o \qquad (3)$$

Or

$$\Delta i = \frac{(V_{in} - V_{Trans})T_{on}}{L}$$

And while the transistor is switched off the current is:

$$i_o = i_{pk} - \frac{(V_{out} - V_{in} + V_D)T_{off}}{L} \qquad (4)$$

Or

$$\Delta i = \frac{(V_{out} - V_{in} + V_D)T_{off}}{L} \qquad (5)$$

By equate from side to side delta i, we can solve for V_{out}:

$$\frac{(V_{in} - V_{Trans})T_{on}}{L} = \frac{(V_{out} - V_{in} + V_D)T_{off}}{L} \qquad (6)$$

$$V_{in} - V_{Trans} D = (V_{out} + V_D)(1 - D) \qquad (7)$$

$$V_{out} = \frac{(V_{in} - V_{Trans})D}{1-D} - V_D \qquad (8)$$

Abandon the voltage drops transversely the diode and the transistor:

$$V_{out} = \frac{V_{in}}{1-D} \qquad (9)$$

The main challenge when designing a converter is the type of inductor used. From the above equations, it can be seen that the inductance is inversely proportional to the wave current. So a larger inductor must be used to reduce the ripple.

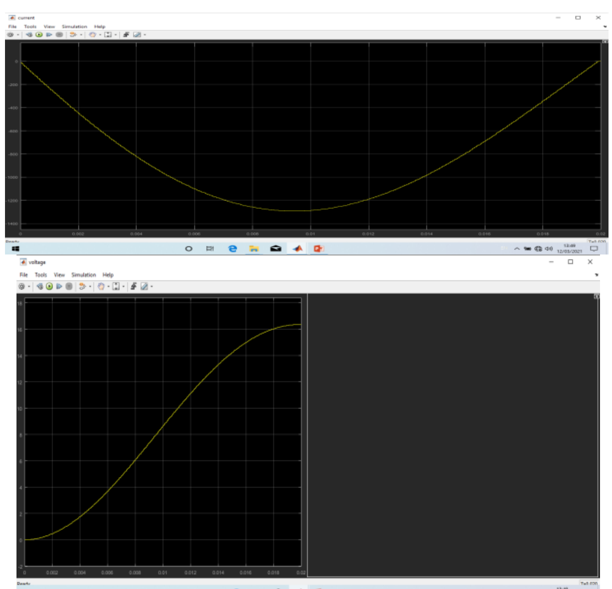


Fig.4 Boost Converter Voltage and Current Simulation Result

3 MPPT Solar Charge Controller

Integrated MPPT solar charge controller with MPPT algorithm to maximize the amount of current entering the DC-DC converters from the PV module. MPPT is a DC to DC converter that works by taking the DC input from the PV module, converting it to AC, and converting it to a varying DC voltage and current to match the PV module exactly.Block diagram of MPPT Tracking control system is shown in fig.

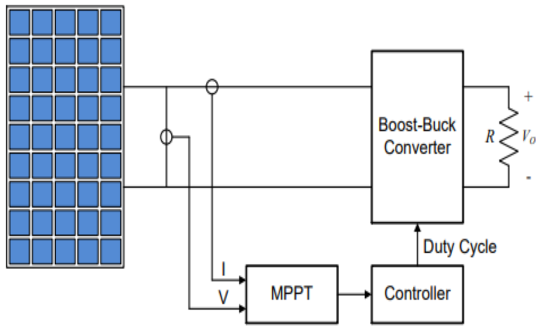


Fig.5 MPP Tracking Control Block Diagram

Maximum Power Point Tracking (MPPT) is used to get maximum power from these systems. Applications from MPPT such as powering the grid, charging a battery or powering an electric motor. In these applications, the load may demand more energy than the photovoltaic system. In this case, an energy conversion system is used to maximize the energy of the photovoltaic system.

4 P&O method Principle

In the P&O method, the MPPT algorithm is based on computing the power change by sampling both the PV output power and the PV current and voltage. The tracker operates by increasing or decreasing the solar panel voltage periodically. If a given disturbance causes an increase (decrease) in the PV output power, the subsequent disturbance is produced in the same (opposite) direction. Therefore, the duty cycle of the DC chopper is changed and the process is repeated until the point of maximum power is reached. In fact, the system revolves around the MPP.

Perturb and inspection is the most widely used MPPT method due to its ease of implementation. The operating point of the photovoltaic module varies as the load conditions vary. The maximum power point can be achieved by selecting the appropriate load. The maximum power of the photovoltaic module can be achieved by incorporating an intelligent mechanism to change the load resistance observed by the photovoltaic module. In a boost-buck converter, the input voltage is controlled by the appropriate charge ratio settings to power the converter MOSFETs.

5 Boost Converter Simulation Results

The Boost Converterusing P&O method circuit simulated using MATLAB Simulink and the output waveform is obtained. The Boost converter simulation model is shown in the fig. (6).The Boost Converter determine component values that are constant across all switching frequencies, duty cycles, and load resistance. The DC/DC Boost converter design has larger application by use of constant components.Boost converters are considered indirect energy transfer converters. The converter transfers energy by use of an energy storing phase and an energy discharging phase.The charging phase of the boost converter occurs when the switch is in the open state. If the switch has been open for a long period of time, the voltage drop of the diode will reduce to a negative value and the capacitor will have a charge that is equal to the input voltage of the converter. Once the switch is closed, the input voltage passes through the inductor at a linear rate in DC/DC operation.The Boost converter MATLAB/Simulink based results are presented and validate the advantages of the MPPT controller in terms of the tracking speed and tracking accuracy are shown in the fig. (7-10).

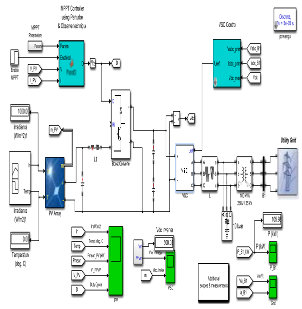


Fig. 6 MATLAB Simulation Model for BOOST Converter using P&O method

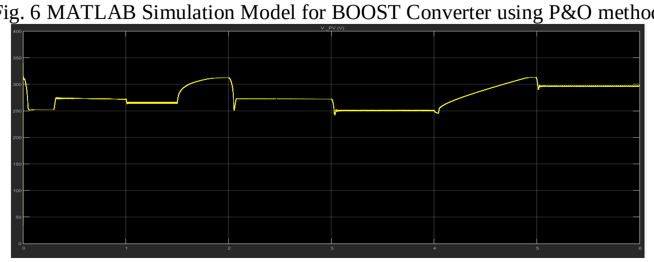


Fig.7 MATLAB Simulation Result for BOOST converter Solar Panel Voltage (Volt)

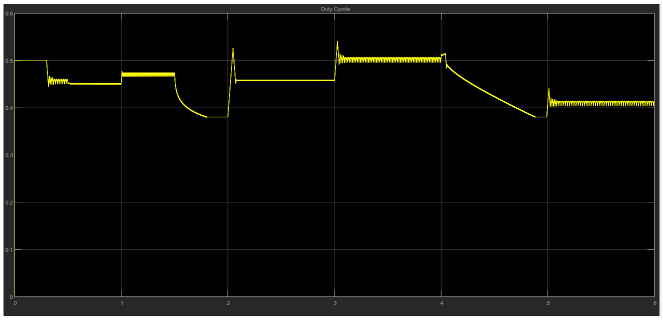


Fig. 8 MATLAB Simulation Result for BOOST converter Duty Cycle from P&O controller

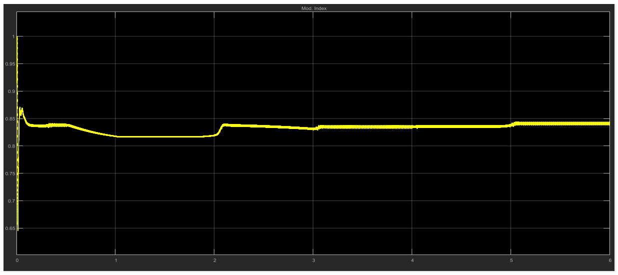


Fig. 9 MATLAB Simulation Result for BOOST Converter modulation Index

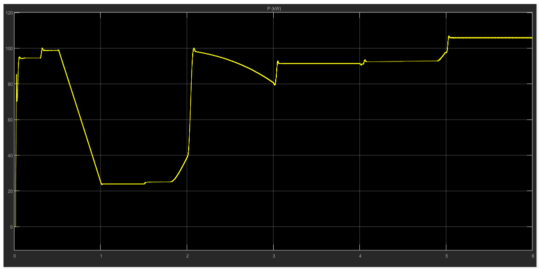


Fig 10 MATLAB Simulation Result for BOOST converter maximum Power output (KW)

6 Simulation Result:-

The results will be separated into two categories: Simulated and measured. These results will be based off the modules from the target specifications to be as close to real PV modules that exist in the world today. Using these PV modules as the input, in addition to the components calculated earlier, the boost converter will be simulated using software and then measured using a printed circuit board (PCB) with real components. The converter will be simulated and measured using three different modes of operation. The first scenario will be with a 36-cell low voltage high current PV module that will test the lower limits of converter in boost mode. The next scenario will be with a 96-cell high voltage low current PV module that will test the upper limits of the converter in buck mode.

Table 1 :- BOOST Converter details

BOOST Converter			
Solar irradiation (W/m^2)	1000		
Temperature (Deg. C)	50	PV Voltage (volt) max	3.392e+02
Output Voltage from Solar Penal/ Input voltage of boost converter(Volt)	296.9	PV Voltage (volt) mean	2.771e+02
output voltage of boost converter(Volt)	499.7	PV Voltage (volt) RMS	2.778e+02
Pmean_PV(kW) max	1.075e+02	Duty Cycle(max)	5.405e-01
Pmean_PV(kW) mean	8.160e+01	Duty Cycle(mean)	4.500e-01
Pmean_PV(kW) RMS	8.645e+01	Duty Cycle(RMS)	4.517e-01
Inverter DC input (Volt)	500.05		

Table 2:- Solar PV Detail

Solar PV Detail		
Parallel String	66	
Series connected modules per string	5	
Maximum Power (W)	305.226	
Open Circuit voltage Voc (V)	64.2	
Voltage at Maximum power Point Vmp(V)	54.7	
Temperature Coefficient of Voc(%/deg. C)	-0.27269	
Cell per module	96	
Short circuit current Isc (A)	5.96	
Current at maximum power point Imp (A)	5.58	
Temperature Coefficient of Isc(%/deg. C)	0.061745	
Light Generated current IL(A)	6.0092	
Diode Saturation current I0(A)	6.3014e-12	
Diode ideality factor	0.94504	
Shunt resistance Rsh (ohms)	269.5934	
Series Resistance Rs (ohms)	0.37152	

Table 3:- VSC Controller details

VSC Controller	
Nominal power (VA)	100e3
Frequency	50
Nominal DC Bus Voltage	500
Total transformer leakage impedance resistance	0.002
Total transformer leakage impedance inductance	0.06
Nominal primary voltages	25e3
Nominal secondary voltages	260
RL branch Resistance	500e-6*377/50/2
RL Branch inductance	500e-6/2

7 Conclusion :-

in this paper the simulation result shown a boost converter performance is excellent and the solar irradiation between 250-1000W/m2 and the temp. varies between 20-50 Deg. C. the voltage at maximum power point Vmp is 54.7 volt, and current at maximum power point Imp is 5.58 per penal. The duty cycle of the boost converter is 5.405e-01.

The simulation results showed that the proposed control technology managed to improve the system responsiveness to a wide range of operating conditions, and the MPPT P&O technology is much better than the traditional technique.

REFERENCE

[1] R. J. Wai, C. Y. Lin, C. Y. Lin, R. Y. Duan, and Y. R. Chang, “High efficiency power conversion system for kilowatt-level stand-alone generation unit with low input voltage,” IEEE Trans. Ind. Electron., vol. 55, no. 10, pp. 3702–3714, Oct. 2008.

[2] A. Oi, M. Anwari, and M. Taufik, "Modeling and simulation of photovoltaic water pumping system," in Modelling & Simulation, 2009. AMS'09. Third Asia International Conference on, 2009, pp. 497-502: IEEE.

[3] B. Nayak, A. Mohapatra, and K. B. Mohanty, "Selection criteria of dc-dc converter and control variable for MPPT of PV system utilized in heating and cooking applications," Cogent Engineering, vol. 4, no. 1, p. 1363357, 2017.

[4] H. Rezk and A. M. Eltamaly, "A comprehensive comparison of different MPPT techniques for photovoltaic systems," Solar energy, vol. 112, pp. 1-11, 2015.

[5] J. Ahmed and Z. Salam, "A critical evaluation on maximum power point tracking methods for partial shading in PV systems," Renewable and Sustainable Energy Reviews, vol. 47, pp. 933-953, 2015.

[6] T. Esram and P. L. Chapman, "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques," Energy Conversion, IEEE Transactions on, vol. 22, no. 2, pp. 439-449, 2007.

[7] R. Faranda, S. Leva, and V. Maugeri, "MPPT techniques for PV Systems: Energetic and cost comparison," in Power and Energy Society General Meeting - Conversion and Delivery of Electrical Energy in the 21st Century, 2008 IEEE, 2008, pp. 1-6.

[8] D. Hohm and M. E. Ropp, "Comparative study of maximum power point tracking algorithms," Progress in photovoltaics: Research and Applications, vol. 11, no. 1, pp. 47-62, 2003.

[9] K. Ishaque and Z. Salam, "A review of maximum power point tracking techniques of PV system for uniform insolation and partial shading condition," Renewable and Sustainable Energy Reviews, vol. 19, no. 0, pp. 475-488, 3// 2013.

[10] K. Ishaque, Z. Salam, and G. Lauss, "The performance of perturb and observe and incremental conductance maximum power point tracking method under dynamic weather conditions," Applied Energy, vol. 119, pp. 228-236, 2014.

[11] J. P. Ram, T. S. Babu, and N. Rajasekar, "A comprehensive review on solar PV maximum power point tracking techniques," Renewable and Sustainable Energy Reviews, vol. 67, pp. 826-847, 2017.

[12] M. Tajuddin, M. Arif, S. Ayob, and Z. Salam, "Perturbative methods for maximum power point tracking (MPPT) of photovoltaic (PV) systems: a review," International Journal of Energy Research, vol. 39, no. 9, pp. 1153-1178, 2015.

[13] J. Ahmed and Z. Salam, "An improved perturb and observe (P&O) maximum power point tracking (MPPT) algorithm for higher efficiency," Applied Energy, vol. 150, pp. 97-108, 2015.

[14] J. Ahmed and Z. Salam, "A modified P&O maximum power point tracking method with reduced steady-state oscillation and improved tracking efficiency," IEEE Transactions on Sustainable Energy, vol. 7, no. 4, pp. 1506- 1515, 2016.

[15] J. Ahmed and Z. Salam, "An Enhanced Adaptive P&O MPPT for Fast and Efficient Tracking Under Varying Environmental Conditions," IEEE Transactions on Sustainable Energy, 2018.

[16] R. H. Ashique, Z. Salam, and J. Ahmed, "An adaptive P&O MPPT using a sectionalized piece-wise linear PV curve," in Energy Conversion (CENCON), 2015 IEEE Conference on, 2015, pp. 474-479: IEEE.