IOSR Journal of Engineering (IOSRJEN)
e-ISSN: 2250-3021, **p**-ISSN: 2278-8719
Vol. 3, Issue 10 (October. 2013), ||V4|| PP 30-37

Transformer Less Boost DC-DC Converter with Photovoltaic Array

G.Neelakrishnan, M.Kannan, S.Selvaraju, K.Vijayraj, M.Balaji, D.Kalidass
[1]*(AP/EEE, Muthayammal college of Engineering)* [2]*(AP/EEE, Muthayammal college of Engineering)*
[3]*(AP/ECE, Muthayammal college of Engineering)* [4]*(AP/ECE, Muthayammal college of Engineering)*
[5]*(AP/ECE, Muthayammal college of Engineering)* [6]*(AP/EEE, Muthayammal college of Engineering)*

***Abstract:* -** Nowadays, transformer less converters are preferred for higher efficiency, low size and cost. The output voltage of PV arrays is relatively low, requiring a high step-up converter to obtain the DC voltage input of the inverter, the performance and effectiveness of some standard and improved boost converter circuits are discussed and compared in terms of voltage gain, power loss and switch voltage stress requirement. In fact, those performances are examined with deriving formulas and equations of current, voltages, power loss and voltage gain.

***Keywords:* -** *Transformer less, Boost converter, PV Array,; simulation for Transformrer less Boost converter; open loop and closed loop.*

I. INTRODUCTION

The DC to DC or boost converter is the front-end component connected between the PV array and the load. The conventional Isolation Two transistor has additionally, the magnitude if Ringing is not easily predictable during the design stage. The Ringing also increases the voltage stress of primary winding of the Transformer. As a result, the conversion efficiency is degraded and the electromagnetic interference problem becomes severe under this situation. To increase the conversion efficiency, many modified step-up converter topologies have been investigated by several researchers.

The output of the FC or PV cells is typically an unregulated low-level DC voltage that needs to be stepped up to a regulated higher level, for many potential practical applications, and boost converter stages are employed for this purpose. In many applications, the use of a transformer can provide increased output/input voltage gain, as required. However, there are a number of applications where transformer-less power electronic energy converter systems could potentially offer significant advantages, including cost and converter size reduction. the installation of PV generation systems is rapidly growing due to concerns related to environment, global warming, energy security, technology improvements and decreasing costs. PV generation system is considered as a clean and environmentally-friendly source of energy. The main applications of PV systems are in either standalone or grid connected configurations. Standalone PV generation systems are attractive as indispensable electricity source for remote areas. However, PV generation systems have two major problems which are related to low conversion efficiency of about 9% to 12 % especially in low irradiation conditions and the variation of amount of electric power generated by PV arrays continuously with weather conditions. Therefore, research works are carried out to increase the efficiency of the energy produced from the PV arrays.

In fact, this converter uses two inductors of the same inductance level, and the two switches being simultaneously . Similarly to the other converter circuits, the operation of such a converter is subdivided into two modes; the CCM and the DCM.

For an CCM, the switches S1 and S2and are both turned on, and the equivalent circuit of the converter. During this stage, inductors and are charged in parallel from the DC source where as the capacitor releases its energy to the load. Moreover, capacitors and are charged from the DC source.

For an DCM, the switches and are turned off, the inductors L1 and L2 and capacitors C1 and C2 are series connected with the DC source in order to transfer the stored energy to the capacitor and the load.The benefit of choosing the PWM over analog control is increased noise immunity which the PWM is sometimes used for communication. Switching from an analog signal to PWM can increase the length of a communications channel dramatically. At the receiving end, a suitable RC (resistor-capacitor) or LC (inductor capacitor) network can remove the modulating high frequency square wave and return the signal to analog form. So, the filter requirement can be reduced and the overall inverter size can be reduced.

II. CONVENTIONAL ISOLATION ZETA CONVERTER TOPOLOGY

Semiconductor devices is based on the maximum values of the voltage and current stresses withstood by the switches and the diodes. The magnetic and static components are selected as follows. The main drawback of the Isolation Zeta converter circuit is that it requires a high side driver to drive the upper transistor *S*1. However, by utilizing a three-winding gate drive transformer or commercially available high- and low side driver ICs such as IR2110, the complexity of the driving circuit can be minimized. In both cases, only one control signal is required to simultaneously turn on or off *S*1 and *S*2. Experimental current and voltage waveforms of the proposed converter. The value of the total leakage inductance referred to the primary side of the transformer was measured.

An isolated two-transistor Zeta converter and to present the principle of circuit operation, steady-state analysis, and simplified design procedure of the proposed converter, including the transformer leakage inductance and the transistor output capacitances. The key feature of the proposed converter is that the voltage stresses of the main switches are limited to the dc input voltage VI . the two switches S1 and S2 are n channel power metal–oxide–semiconductor field effect transistors (MOSFETs), output capacitances of which are denoted by CO1 and CO2, respectively. Clamping diodes D1 and D2 are cross-connected across the main switches.

The principle of operation of each stage is explained with the aid of equivalent circuits shown in Fig. 2 and the voltage and current waveforms of the converter shown in Fig. 3.

The analysis of the converter is performed under the following assumptions:

1) the diodes are ideal components;

2) the converter operates in continuous conduction mode (CCM), i.e. ,inductances Lm and L are large enough so that the currents through them are constant;

3) capacitances C and C_f are large enough so that the voltages across them are constant and equal to V_O;

4) the value of the leakage inductance L_l is far lesser than the value of the magnetizing inductance Lm;

5) the time constants of the passive components are much greater than the switching period; and

6) before the beginning of the switching cycle, diode D_3 is conducting and all other switches and diodes are OFF.

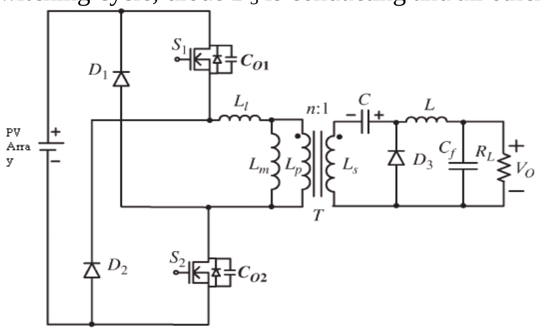

Fig.1 Isolated two-transistor Zeta PWM dc–dc converter

The voltages across Lm and L are $-nV_O$ and $-V_O$, respectively. The current through the switches and L_l is

$$iS_1(t) = iS_2(t) = iL_l(t) = VI + Nvo/L_l(t - t_0) + iL_l(t_0) \quad (1)$$

The current through Lm is

$$iLm(t) = -nV_O/Lm(t - t_0) + iLm(t_0) \quad (2)$$

The current through L is

$$iL(t) = -V_0/L(t - t_0) + iL(t_0) \quad (3)$$

III. PROPOSED TRANSFORMER LESS BOOST CONVERTER TOPOLOGY

A boost (step-up) converter is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

High step up (Boost) converter is used in many applications such as discharge lamp for automobile, fuel cell energy conversion systems, and solar cells. The boost converter can also produce higher voltage to operate cold cathode florescent tube (CFL) in devices such as LCD back light and some flash lights. Moreover, DC-DC converters are building blocks of distributed power supply systems in which a common DC bus voltage is converted to various other voltages according to requirements of particular loads. Such distributed DC systems are common in space stations, ships and airplanes, as well as in computer and telecommunication equipment. It is expected that modern portable wireless communication and signal processing systems will use variable supply voltages to minimize power consumption and to extend battery life. Besides, the boost converter is also used to solve problems invoked with interfacing the output voltage of photo-voltaic (PV) cells to grid.

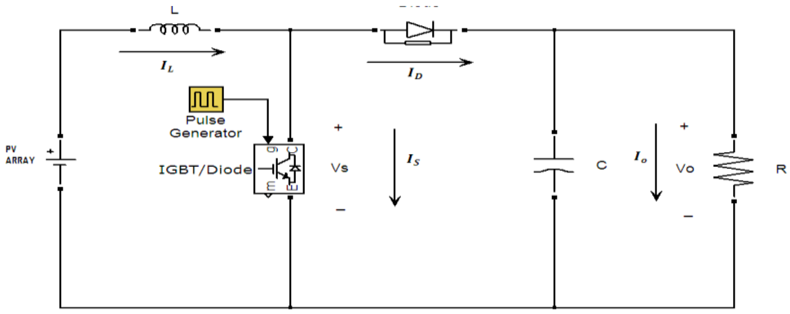

Fig.3.Boost Converter With Pv Array

Boost converter is another popular switched mode power supply (SMPS) circuit that is used for producing isolated and controlled dc voltage from the unregulated dc input supply. As in the case of fly-back converter, the input dc supply is often derived after rectifying (and little filtering) of the utility ac voltage. The forward converter, when compared with the fly-back circuit, is generally more energy efficient and is used for applications requiring little higher power output (in the range of 100 watts to 200 watts).

In fact, this converter uses two inductors of the same inductance level, and the two switches being simultaneously. Similarly to the other converter circuits, the operation of such a converter is subdivided into two modes; the CCM and the DCM. The following subsections address the performance and steady state analysis of this converter.

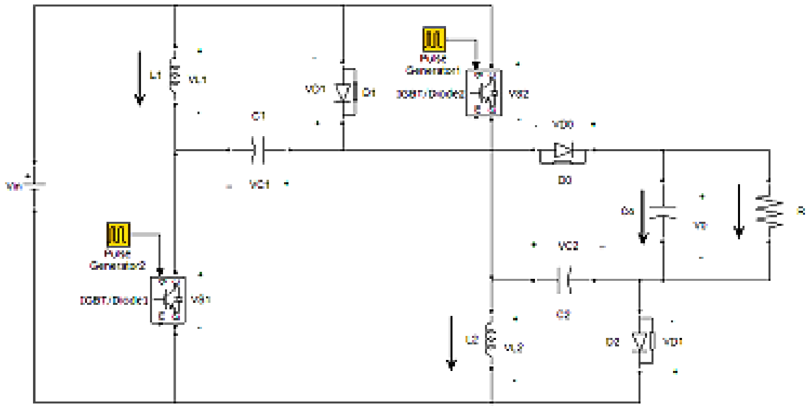

Fig.3 Transformer less boost converter

This mode of operation can be further divided into two stages:
Stage 1: This stage extends from to as sown in Figure 3. In this interval, switches and are both turned on, and the equivalent circuit of the converter will be as shown in Figure 4.During this stage, inductors L1 and L2 are charged in parallel from the DC source where as the capacitor releases its energy to the load. Moreover, capacitors C1 and C2 are charged from the DC source.

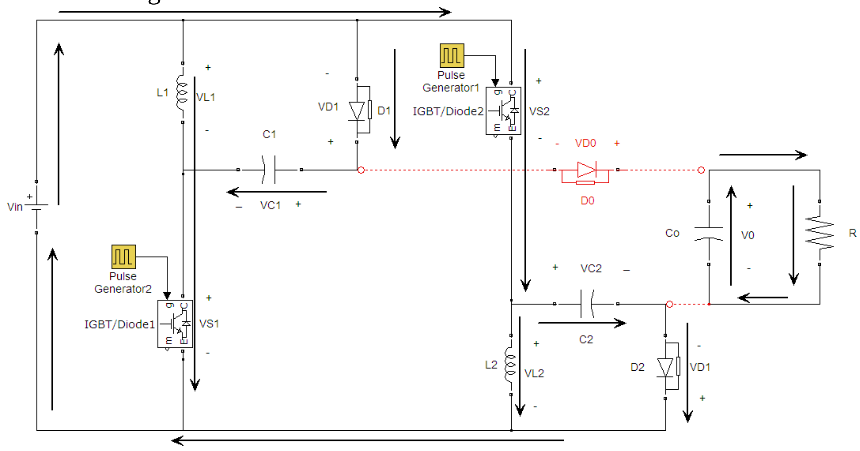

Fig.4 Continuous Conduction Mode(S_1 and S_2 ON) Considering the circuit of Figure 4. the voltages across L_1,L_2,C_1 and C_2 are given by:

$$V_{L1}=V_{L2}=V_{in}=V_{C1}=V_{C2} \quad (4)$$

Stage 2: which extends from to appearing in Figure 5.During this time interval, and are switched off as shown as below. Besides,L1,L2,C1 and C2 , and are connected in series .

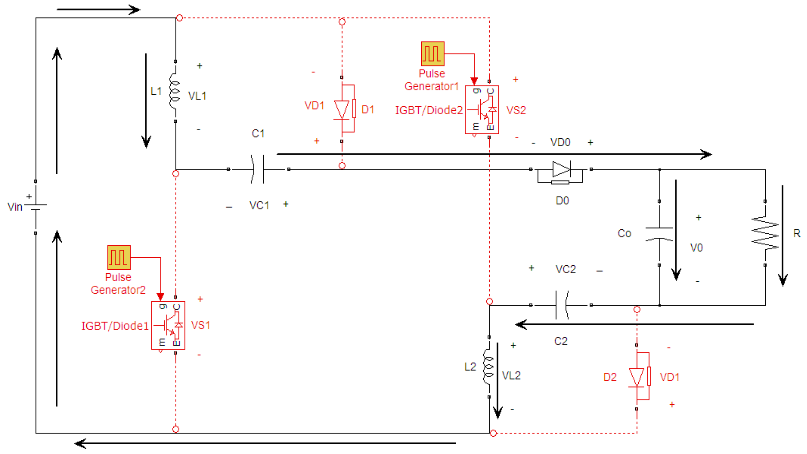

Fig.5 Continuous Conduction Mode(S$_1$ and S$_2$ OFF)

The DC source in order to transfer the stored energy to and the load. So, the voltages across and are derived as:

$$V_{L1}=V_{L2}=V_{in}+V_{C1}+V_{C2}-Vo/2 \quad (5)$$

$$V_{L1}=V_{L2}=3V_{in}-Vo/2 \quad (6)$$

The DCM is also subdivided into three distinct stages:

Stage1: This takes place to and t1 between and appearing in Figure 6. The status of the converter is the same as that of stage 1 in the CCM.

The voltage gain can be evaluated.

$$\int DT_s \ \ Vin\ dt+\int T_sDT_s\ 2V_{in}-V_o/2\ dt=0$$

$$V_o/V_{in}=2/1-D \quad (7)$$

, where, D is the duty cycle. The voltage of the switches S1and S2 is given by

$$Vs_1=Vs_2=V_{D1}=V0/2$$

Stage 2: This extends from to appearing in Figure 6. In this time interval, the switches and are turned off, the inductors and capacitors and are series connected with the DC source.

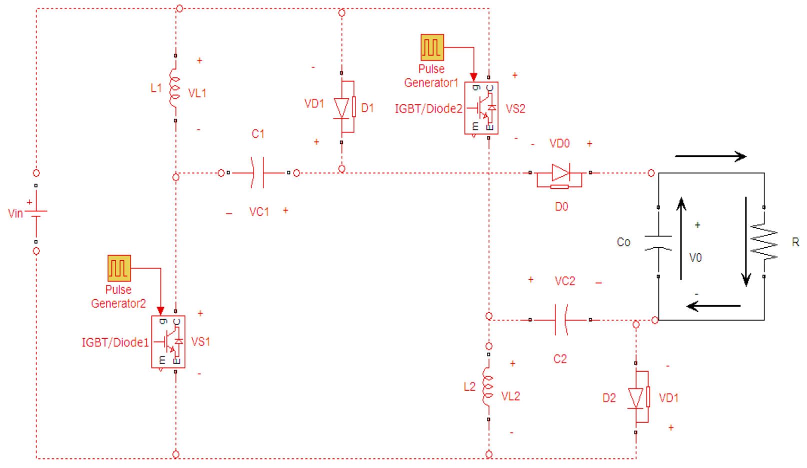

Fig.6 Discontinuous Mode(S1 and S2 OFF)

In order to transfer the stored energy to the capacitor and the load, so the converter has the equivalent circuit shown in Figure 6.The inductor currents and start decreasing to zero .

IV. SIMULATION

Simulation is done using Matlab and the results are presented. The Simulink model of an improved DC to DC boost converter for solar installation system . Simulation of the improved boost converter was carried out with the following parameters. *Vin* = 12 V to 17V, *V*0=60V, *L*=5 mH, *C*=2000 μF & 30 mF, Duty cycle ratio = 65% and *RL*=10 Ω. *Vin* is applied as input voltage in normal condition . *Vin* of 17 volts is applied as input while assuming external disturbance in the PV panel. The driving pulse of the MOSFET is shown as below. The duty cycle ratio of the pulse is 65%. The output current which is 6 A. The steady state value of output voltage is 60 V.

When an Transformer less boost converter has an input voltage of 12V , through this voltage up to output voltage that is 60v is given to output of boost converter circuit and output of this circuit is 60V and output current is 6 Amps. Simulation circuit for Boost converter are shown in Figure.7

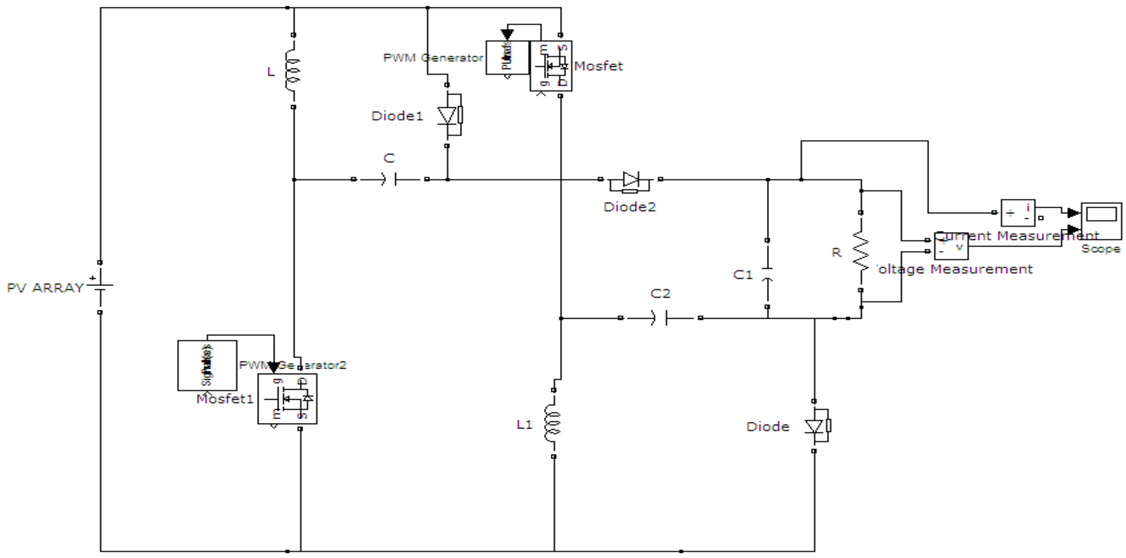

Fig.7 Simulation circuit of Transformer less Boost converter.

When an Boost converter has an input voltage of 12V , is given to input of boost converter circuit and output of this circuit is 60V. simulation circuit for buck-buck converter are shown in Figure.8

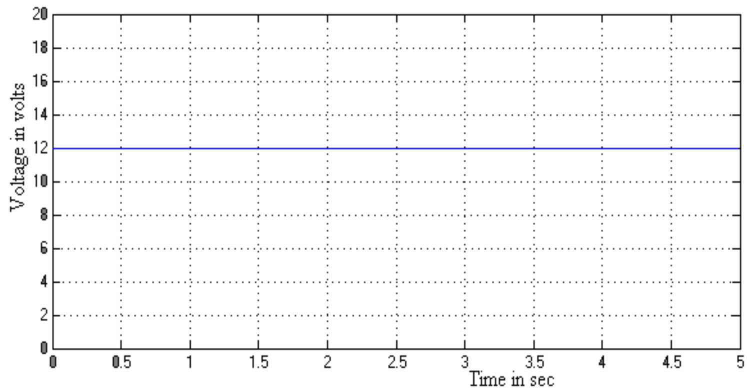

Fig.8 Input voltage

When an output current from the boost converter has an 6.5 A, which is DC current are shown in figure.9

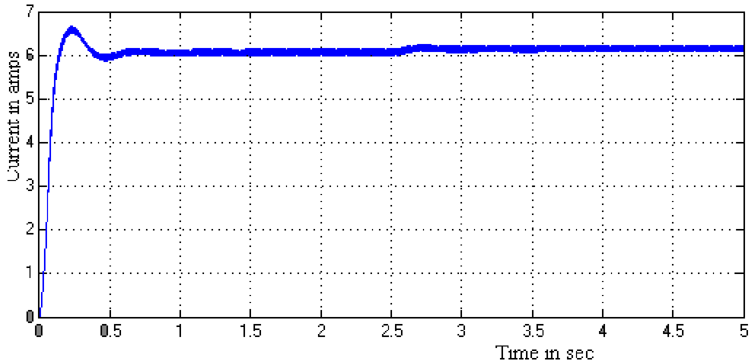

Fig.9 Output current

When an output voltage from the boost converter has an 60 V, which is DC voltage are shown in figure.10

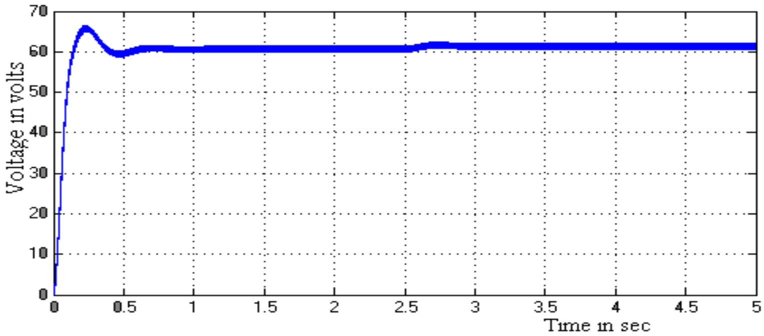

Fig.10 Output voltage

When an open loop Transformer less boost converter DC-DC Converter as an disturbance through an substation are shown as in figure. 11

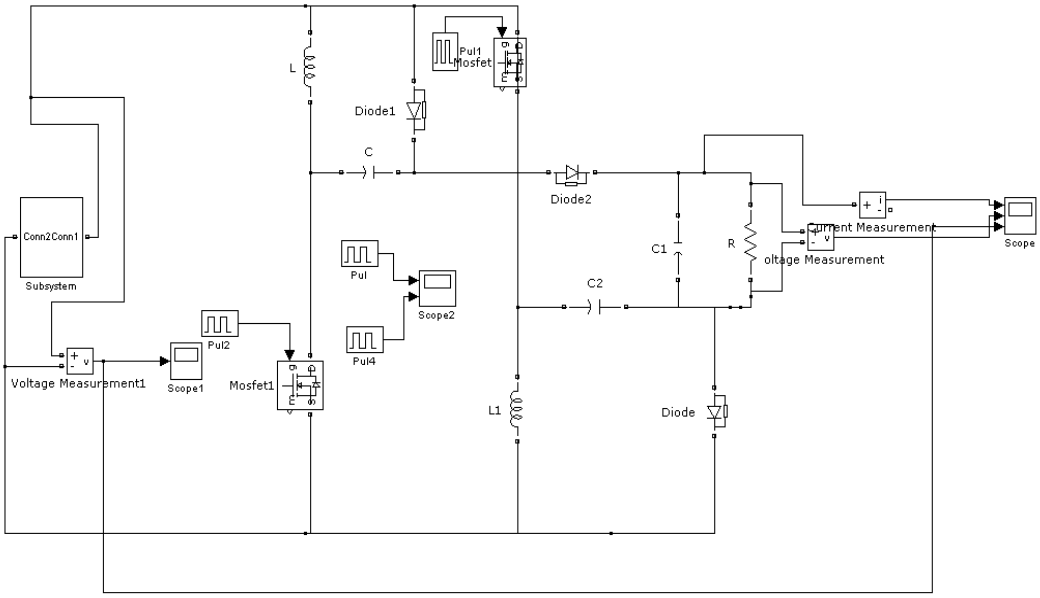

Fig.11 open loop simulation circuit for Transformer less boost converter

The voltage Boost to 60V and this simulation circuit of Transformer less Boost converter are shown in figure .11

When an Boost converter has an 12V AC as an input voltage are shown as in figure.12

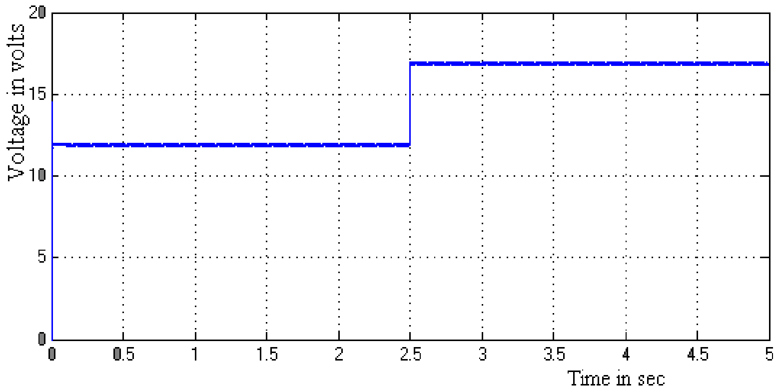

Fig.12 Input voltage

When an 12V AC input voltage is given to an switching device and it converter into pulsating DC as 62V are shown as in figure.12

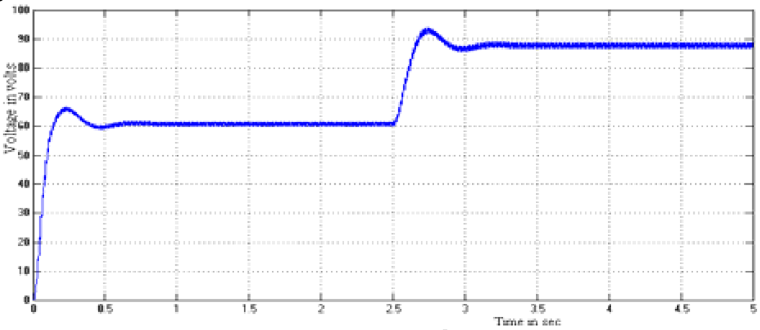

Fig.13 output voltage

When a disturbance is given time at a 25 sec and given error voltage of 6v on this input section with the help of substation. When an output voltage of 90v with this error voltage of 30v in this output side are shown as in figure 13

When an closed loop Transformer less boost converter DC-DC Converter as an disturbance through an substation are shown as in figure 11

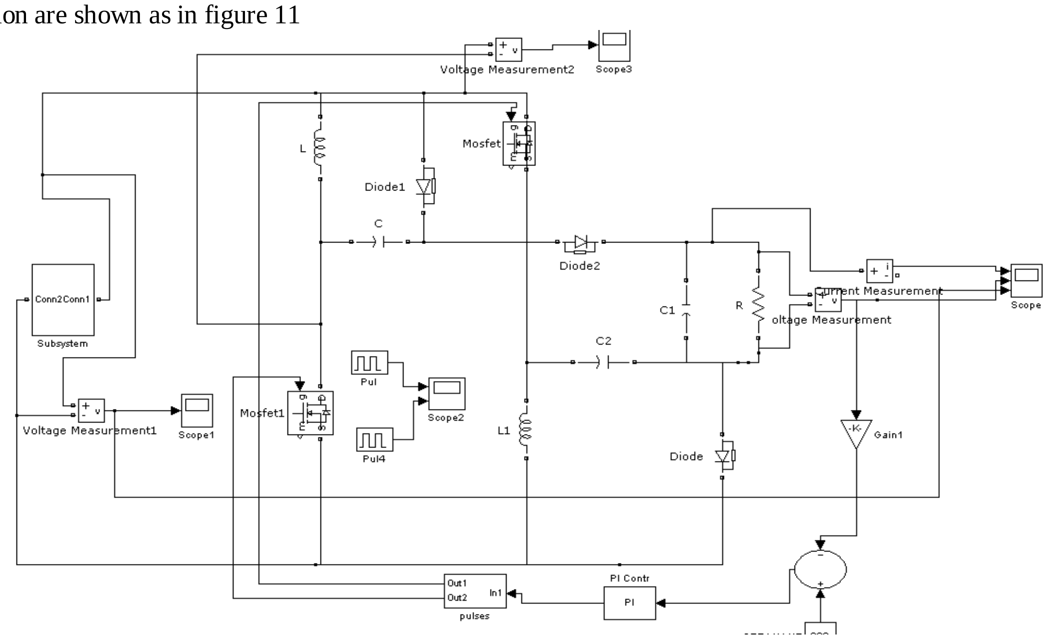

Fig.14 closed loop simulation circuit for Transformer less boost converter

When a disturbance is given time at a 25 sec and given error voltage of 6v on this input section with the help of substation. When an output voltage of 90v with this error voltage of 30v in this output side.

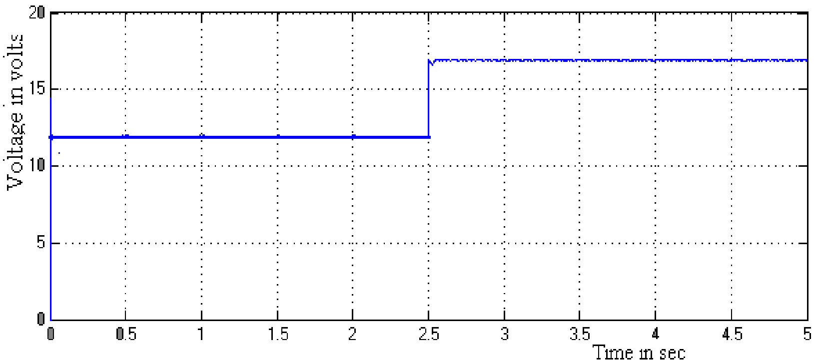

Fig.15 Input voltage

When an Input voltage of Transformer less converter is given with disturbance of 6v through substation and its output voltage are shown as in below Fig.16

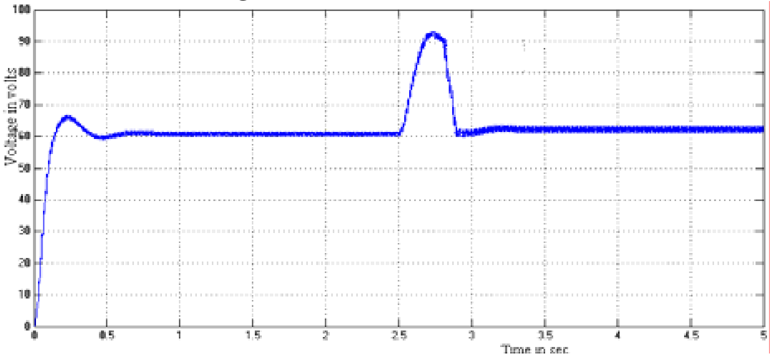

Fig.16 output voltage

V. CONCLUSION

A Renewable Energy resource is mostly used for Small Industrial and big consumer. In that we use a Photovoltaic Cell are used for a Source, which is not enough to drive the requirement. So, to increase the generated the source voltage foe that purpose mostly used a transformer. In that we have a more losses due to the Iron and copper present in the transformer. To avoid such a losses used a switching device, which is used to increase the voltage level

REFERENCES

[1] Y Blaabjerg F, Chen Z, Kjaer SB. Power electronics as efficient interface in dispersed power generation systems. *IEEE Trans. Power Electronics, 2004; 19(5):1184-1194.*

[2] F. H. Khan and L. M. Tolbert, "A multilevel modular capacitor-clamped dc–dc converter," *Eur. Conf. Power Electron. Appl.*, pp. 1–10.*Nov./Dec. 2007.*

[3] S. Lee, S. Choi, and G. Moon, "High-efficiency active-clamp forward converter with transient current build-up (TCB) ZVS technique, *Prog. Photovolt, Res. Appl., vol. 15, no. 7, pp. 629–650, 2007.*

[4] Y. Lo and J. Lin, "Active-clamping ZVS flyback converter employing two transformers," *Proc. ISIE*, pp. 2390–2395Nov. 2007.

[5] J. P. Rodrigues, I. Barbi, and A. J. Perin, "Buck converter with ZVS three level boost clamping," *Proc. Eur. Conf. Power Electron. Appl.*, pp. 110.2007.

[6] J. P. Rodrigues, I. Barbi, and A. J. Perin, "Three level forward converter with ZVS boost clamping," IEEE Trans. Ind. Electron., vol.53, no. 4, pp. 1003.

[7] H. Mao, O. A. Rahman, and I. Batarseh, "Zero-voltage-switching dc–dc converters with synchronous rectifiers," IEEE Trans. Ind. Electron., vol.53, no. 4, pp. 1002– 1016.

[8] T. Qian and B. Lehman, "Dual interleaved active-clamp forward with automatic charge balance regulation for high input voltage application,"*IEEE transactions on power electronics*, Vol.20, No.1, January 2005.

[9] C. Torres, J. Pacheco, M. Pacheco, F. Ramos, A. Cruz, M. Dur´an, and M.Hidalgo, "Toxic wastes treatment using different configurations of plasma torches," *European Journal of Scientific Research*, ISSN 1450-216X Vol.7

[10] J. P. Rodrigues, I. Barbi, and A. J. Perin, "Buck converter with ZVS threelevel buck clamping," *IEEE transactions on industrial electronics*, Vol. 56, No. 8, August 2009.