Analysis and Design Of Zeta Converter

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Abstract: *This paper is based on maintaining constant dc voltage and varying the dc voltage. The main use of zeta converter is to vary the output dc voltage to meet the requirement of dc equipment. The output voltage is measured form open circuit output of the converter. Zeta converter is more beneficial than other types of converters like it has both the properties of buck and boost converter (means it can act as a step up/down converter). It is non inverting polarity type means it gives non inverting output it can be design to achieve low ripple output current and as it has lower settling time, adaptability etc. The output voltage vary by varying the duty cycle by using microcontroller which decide the zeta converter to operate whether in buck or boost converter. We are using ac supply and solar PV panel as a multiple input to our converter. It shows that the converter is multiple input to single output which can be called as a zeta converter. While the design of ZETA Converter is done on MATLAB. Day by day the renewable energy sources are becoming more popular and more importance given to it as it free form pollution, low maintenance cost, etc. So we are including solar PV panel as an input as well as ac supply. The zeta converter is nothing but the DC to DC converter which are widely used as an application in traction motor, e- riksha, power factor correction battery charging, etc. The zeta converter is 90-93% efficient.*

Key Words: *Duty cycle, Zeta Converter, PV (Photovoltaic) cell Module, MOSFET (Metal Oxide Semiconductor Field Effect Transistor, CCM (Continuous Conduction Mode).*

1. INTRODUCTION:

The ZETA converter provides a positive output voltage for input voltage that varies above and below the output voltage. The ZETA converter also needs two inductors and a series capacitor, sometimes called a flying capacitor. The zeta converter is used for to give the gate pulse for MOSFET which is used the driver circuit in our paper we can see that how the gate pulse is given to it, this converter which is configured with a standard boost converter, the ZETA converter is configured from a buck controller that drives a high-side P_{MOSFET}. The ZETA converter is another option regulating an unregulated input-power supply. All non conventional system energy system require particular power converters. seen the power electronic converter is the hart of the entire system , show proper design necessary [7]. ZETA Converter Is mentioned and it is use provide positive output From the input voltage it can be used to increase as well as decrease the voltage. This converter is used for power factor correction applications and short circuit protection [10].

Thus we can use solar photovoltaic cell for the input to the Zeta converter to full fill the requirement of DC input to the converter, as the solar means renewable energy is more popular now a days as the output solar cannot be doubled but due to zeta converter the output of dc voltage can double the output of input voltage and it can be triple by varying Duty cycle. Thus we are using switching techniques for varying the duty cycle. Thus we are using Driver circuit to give the Gate pulse to the ZETA Circuit For the MOSFET to operate in on state.

The Zeta Converter provides Non-inverted output, its ripple less, low voltage diode and Continuous conduction mode. While the load can be use at the output of converter, as the output can be vary we can use large power DC loads.There are many types of converters which can also be use in place of ZETA converter .But however they have certain intrinsic limitation.

BOOST*:* This is not naturally isolated and operates only as a Step-Up voltage. It is not capable of protecting itself against a load and it not able to handle the shortcircuit or overcurrent.

BUCK*:* This Converter is capable of handling inrush current and protecting against the overload. Thus when used in power factor correction application the dc output voltage is reflected to the primary side of the transformer thus blocking the rectifier diode. Thus it indicates that it has no future scope in power factor correction.

BUCK-BOOST*:* We can say that this converter is capable of satisfying all the mentioned specification simultaneously.

CUK and SEPIC*:* This Converter are naturally isolated and it can be operate as step-up and step-down voltage. While it does not protect itself against overload and an additional circuit is needed to limit the inrush current.

Zeta*:*It is similar to the Fly back Converter and in some application it is more advantageous over other DC-DC converter.

2. ZETA CONVERTER:

A zeta converter is a fourth order Nonlinear system being that, with regard to energy input, it can seen as buck-boost-buck converter and with regard to the output, it can be seen as boost-buck-boost converter. The ideal switch based realization of zeta converter is depicted. A non-isolated zeta converter. circuit is shown in the fig.a below. Although several operating modes are possible for this converter depending on inductance value, load resistance and operating frequency, here only continuous inductor current "iL1"analysed using the well known state-space averaging method .The analysis uses the following assumptions.

1. Semiconductors switching devices are considered to be ideal.
2. Converter operating in continuous inductor current mode.
3. Line frequency ripple in the dc voltage is Neglected .

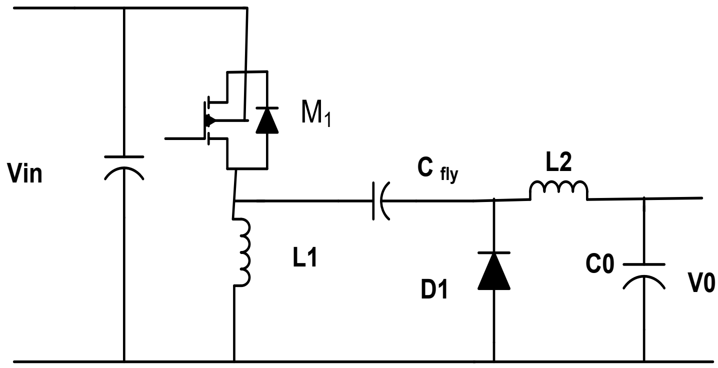


Fig a. Proposed Structure of Basic Zeta converter

3. PRINCIPLE OF OPERATION:

When analysing Zeta converter it waveform shows the equilibrium, L_1 average current equals$I_{IN}$and L_2 average current equals I_{out} since there is no DC current through the flying capacitor C_{FLY}. Also thereStage-1[M_1ON]

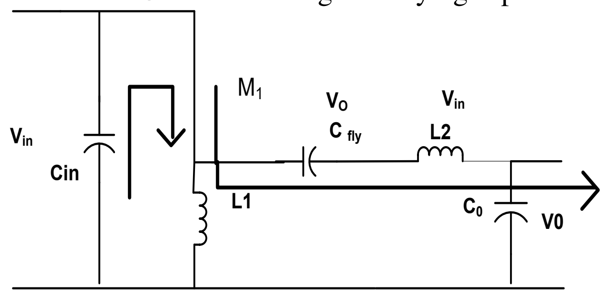


Fig b. Zeta converter during MOSFET ON time

The switch M_1 is in ON state, so voltages VL_1 andVL_2 are equal to Vin . In this time interval diode D1 is OFF with a reverse voltage equal to - (V_{in} + V_O). Inductor L_1 and L_2 get energy from the voltage source, and their respective currents IL_1 and IL_2 are increased linearly by ratio V_{in}/L_1 and V_{in}/L_2respectively. Consequently, the switch current $IM1=IL_1+IL_2$ is increased linearly by a ratio V_{in}/L, where $L=L_1.L_2/(L_1+L_2)$. At this moment, discharging of capacitor C_{fly} and charging of capacitor C_0 take place.

Stage-2 [M_1 OFF]

Is no DC voltage across either inductor. Therefore, C_{FLY} ground potential at its left side and V_{OUT} at its right side, resulting the DC voltage across C_{FLY} is equal to VOUT.

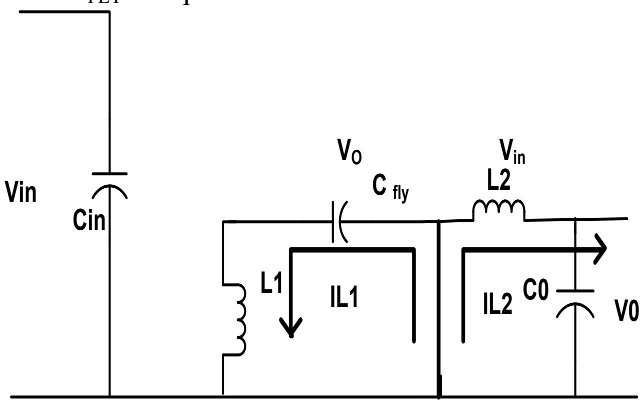


Fig c.Zeta converter during MOSFET OFF time

In this stage, the switch M_1 turns OFF and the diode D_1 is forward biased starting to conduct. The voltage across L_1 and L_2 become equal to $-V_o$ and inductors L_1 and L_2 transfer energy to capacitor C_{fly} and load respectively. The current of L1 and L2 decreases linearly now by a ratio $-V_0/L1$ and $-V_0/L2$, respectively. The current in the diode $ID_1=IL_1+IL_2$also decreases linearly by ratio –V0/L. At this moment, the voltage across switch M_1 is $V_M= V_{in} + V_0$. Figure 4 shows the main waveforms of the ZETA converter, for one cycle of operation in the steady state continues mode.

4. CALCULATION OF LOAD RESISTANCE AND DUTY:

In This Paper We can analysis of various converter methodology components i.e., power, input voltage, output voltage, output current and load resistance .So output voltage and input voltage we can control the duty cycle.

P=VI
100=48*I
I=2.083 Ampere (Output Current)
48=24*D/1-D
D=67%

V=IR
48=2.083*R
R=23.043≈25 Ω (Load Resistance)

Where , D= duty Cycle
The Output voltage of zeta converter is given by,

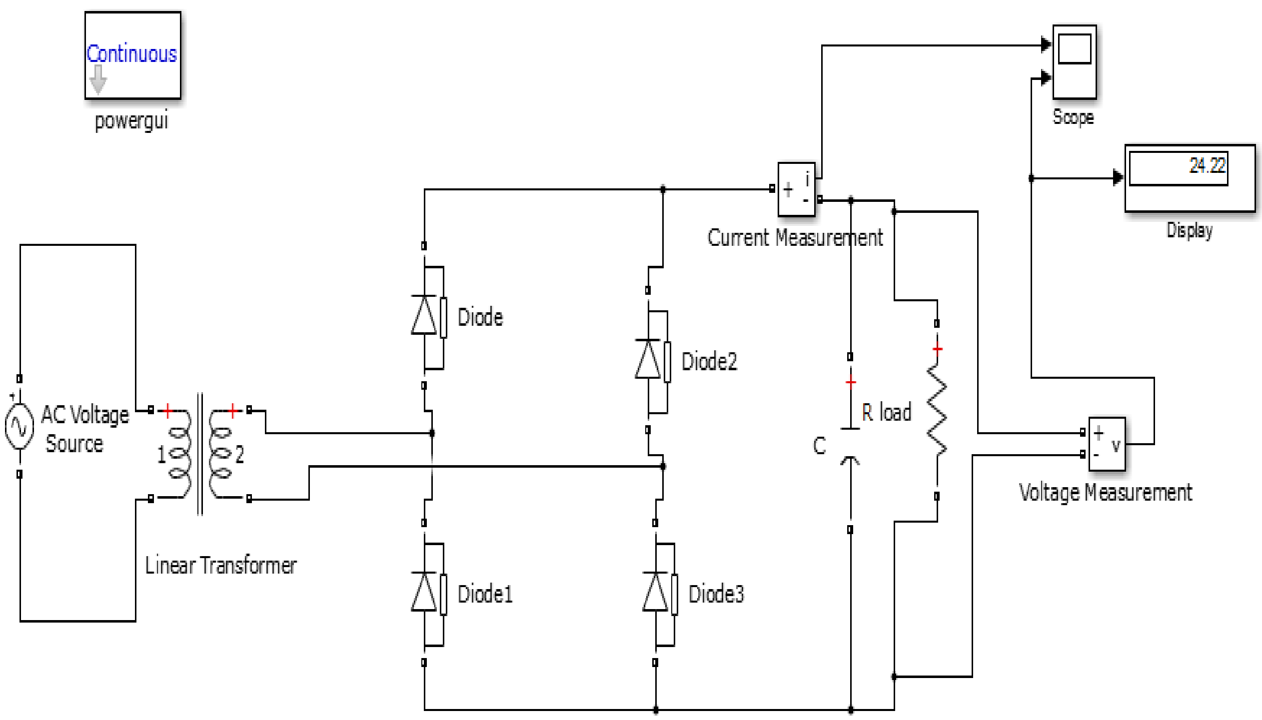
$$Vo = \frac{D}{1-D}Vin$$

Where,
Input voltage (Vi) = 24
Power (P) = 100W
Output voltage (Vo) = 48
Output current (Io) =2.083Amper

Table I Design specification of zeta converter

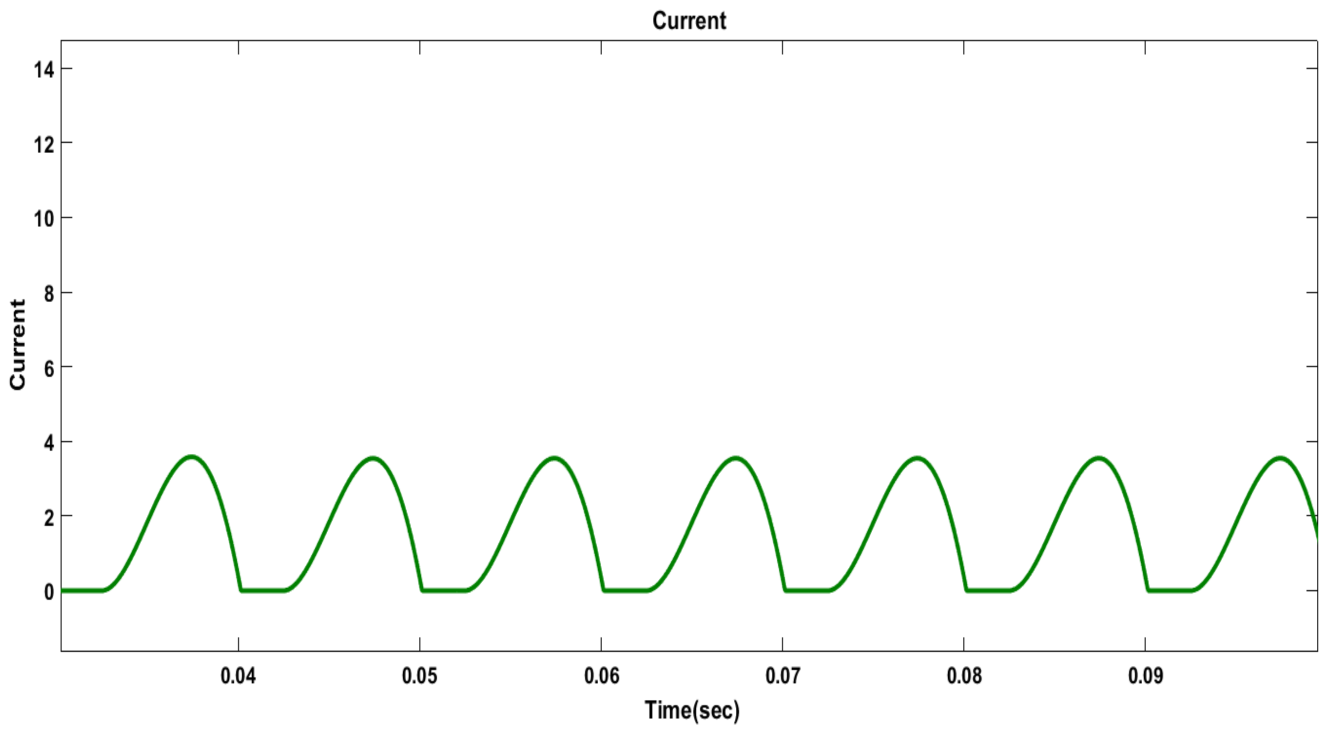
Sr. No.	COMPONENT	Values
1	Input voltage	24V
2	Output voltage	48V
3	Power	100W
4	Output current	2.83AMP
5	Switching frequency	50khz
6	Resistance	9ohm
7	Pulse generator	67%
8	Capacitor and inductor	300uf, 1MHs

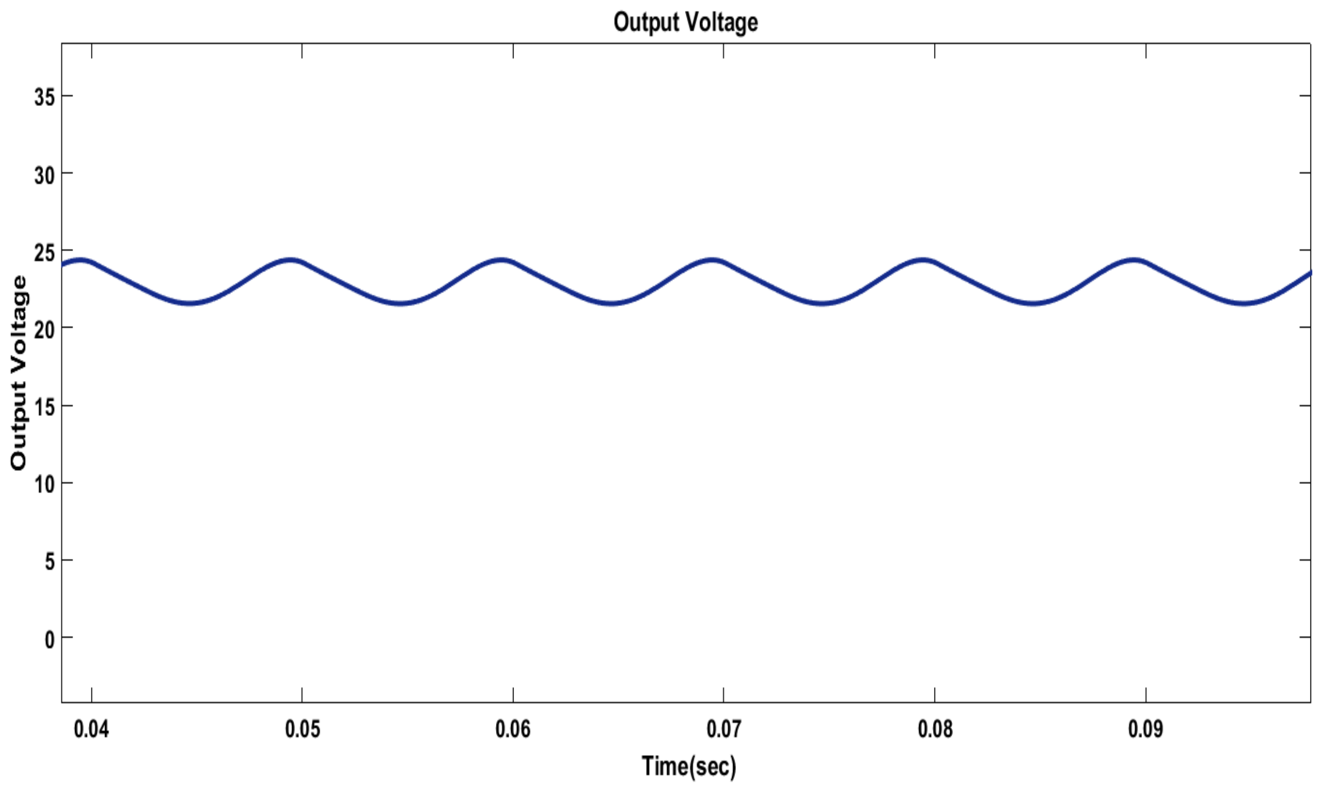
5.SIMULATION OF BRIDGE RECTIFIER:



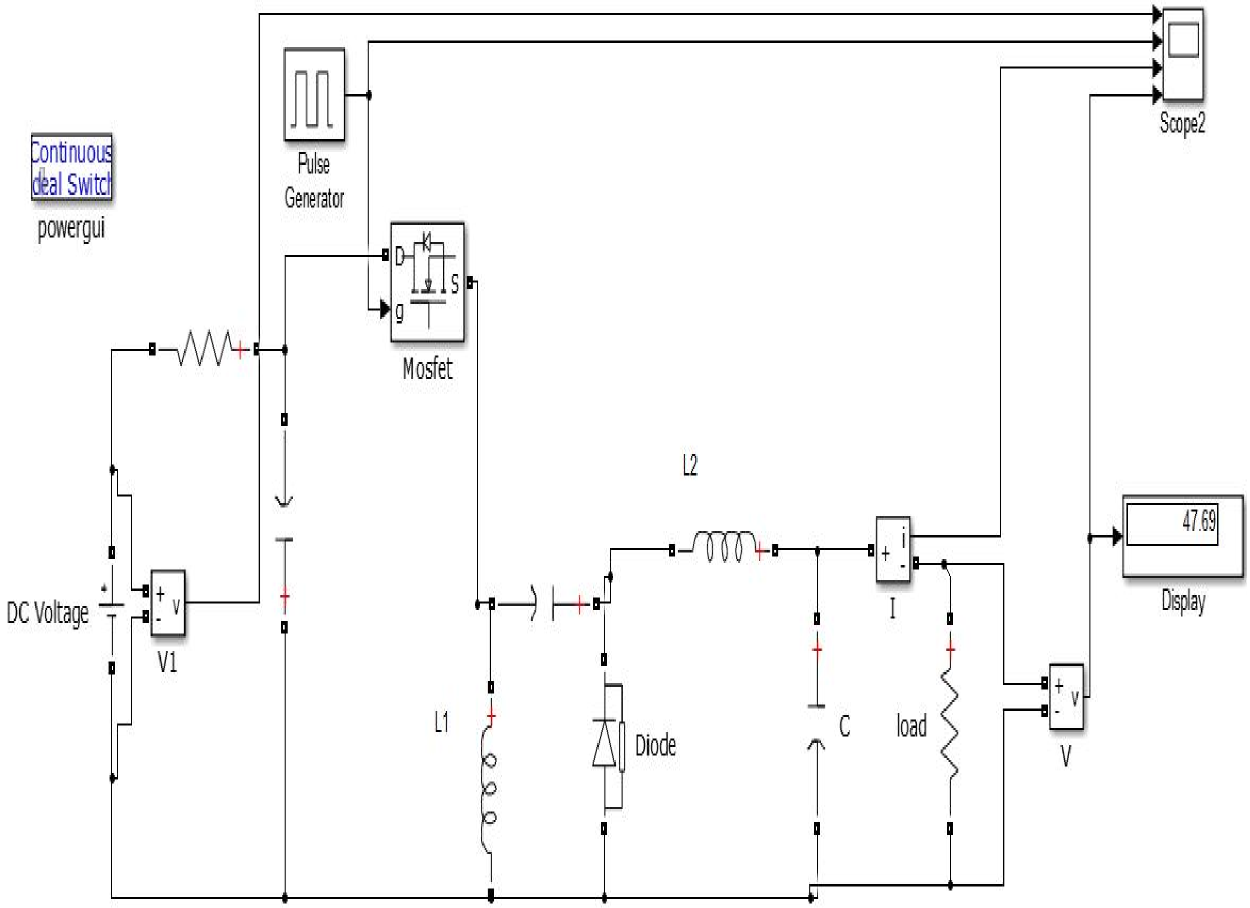
We are Simulating the ZETA Converter in MATLAB , so we are performing BridgeRectifier circuit firstly in MATLAB. We are using 230 V AC Supply as an input to rectifier circuit, capacitor and resistance as load which act as a filter circuit and a linear transformer of 230 by 24 V so we get the 24 V at the output side of filter circuit of Rectifier. Thus the output Scope shown below which shows the output current and output voltage Graph of Bridge Rectifier Circuit. The Graph is shown in between Current Vs time and Output Voltage Vs time. Thus this output voltage is applied to ZETA converter circuit where it can be step up or step down by varying the the duty cycle.

6. SIMULATION OUTPUT OF BRIDGE RECTIFIER:





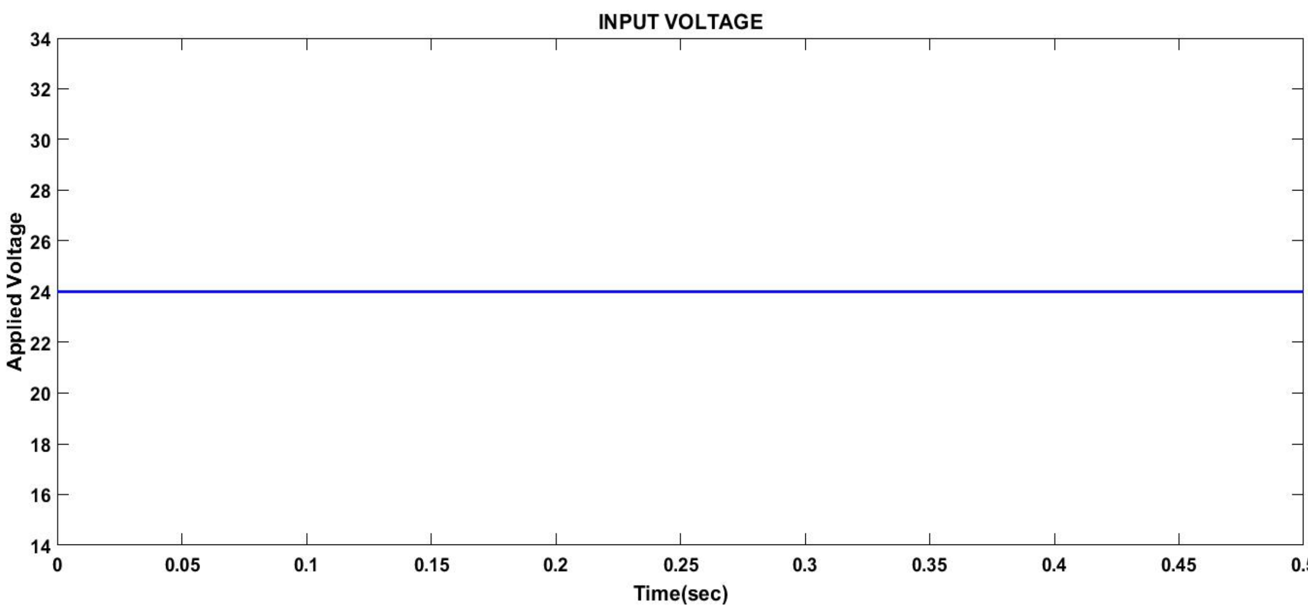
7.SIMULATION OF ZETA CONVERTER

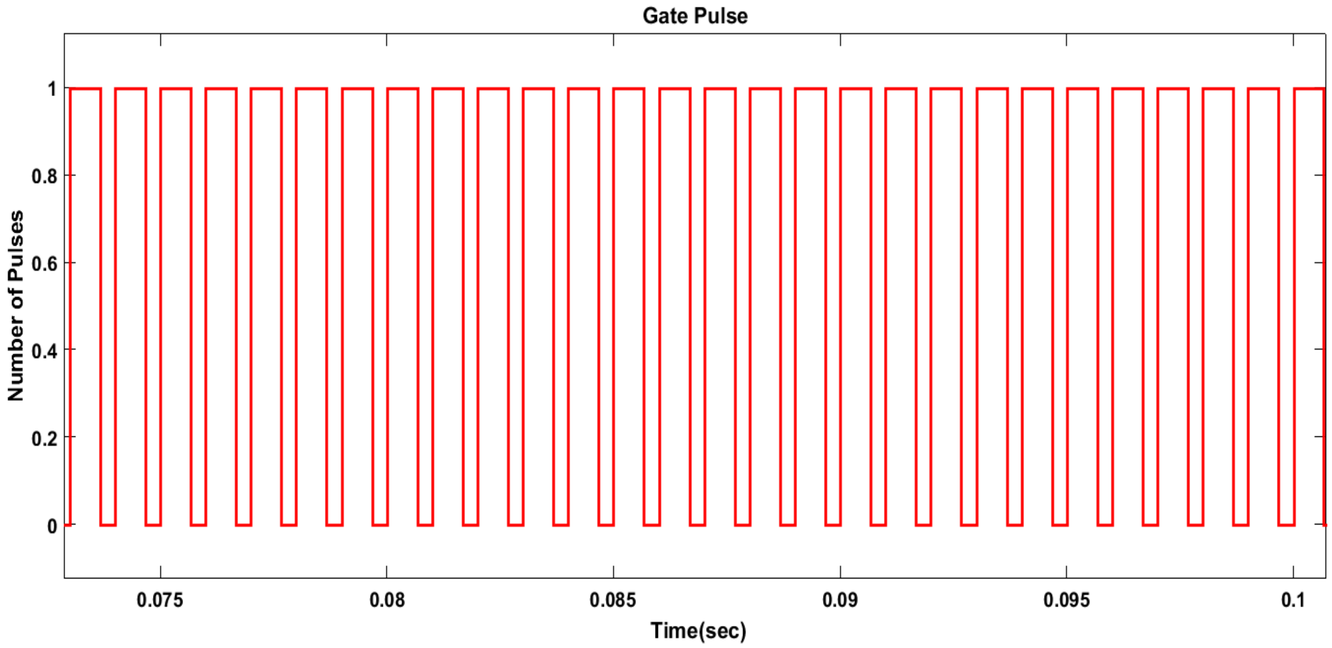


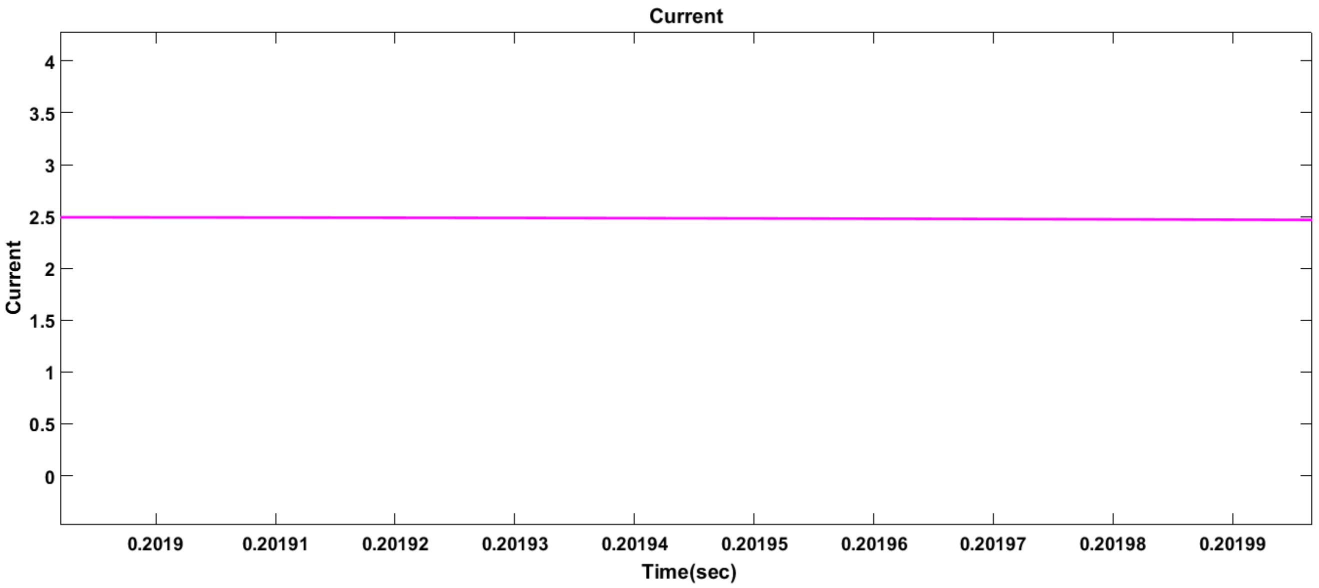
In this Zeta Simulation the final output of the project is analysed by the output of ZETA converter. But in this circuit as usual the basic zeta circuit is design in MATLAB where the output of bridge rectifier is given to zeta converter kit and we are a switching diode for fast switching of charge flowing through it as the load resistance is connected to compensate the output. So by varying the duty cycle in pulse generator the output is varied to double the input as the duty cycle is 67% for double output at the zeta converter.

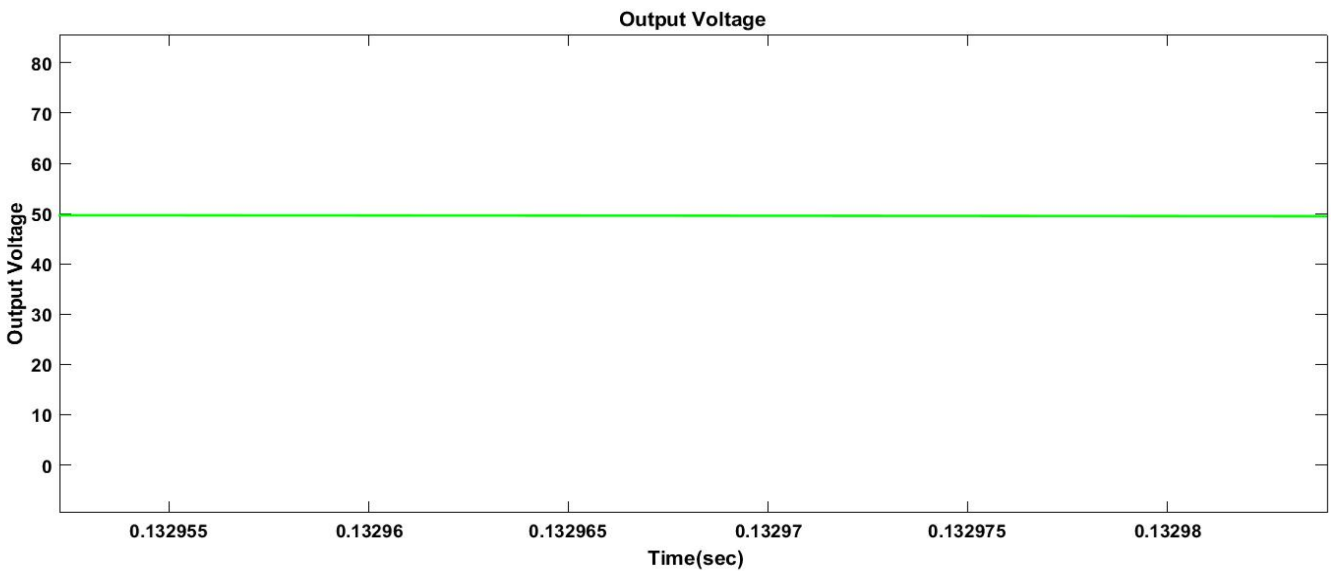
So the Scope below shows the simulation output of zeta converter of input voltage, Pulse Generator, Output Current and Output voltage and the analysis of output is done with respect to input voltage. Thus the Performance of Zeta Converter is done on MATLAB and Same the Analysis Is Done With Respect to Input voltage, low resistances, zero voltage diode, while it runs continuous conduction mode and at the output side it shows less ripple then the other type of DC-DC Converter. So the Output Efficiency leads to 90-93%.

7..SIMULATION OUTPUT OF ZETA CONVERTER:




Gate Pulse
Number of Pulses
1
0.8
0.6
0.4
0.2
0
0.075
0.08
0.085
0.09
0.095
0.1
Time(sec)


Current
Current
4
3.5
3
2.5
2
1.5
1
0.5
0
0.2019
0.20191
0.20192
0.20193
0.20194
0.20195
0.20196
0.20197
0.20198
0.20199
Time(sec)


Output Voltage
Output Voltage
80
70
60
50
40
30
20
10
0
0.132955
0.13296
0.132965
0.13297
0.132975
0.13298
Time(sec)

8. CONCLUSION:

In this paper we have concluded that how The ZETA converter is works on another converter topology to provide a regulated output voltage from an input voltage that varies above and below the output voltage. we can calculated the values of zeta converter considering the wattage i.e. 100w and we are get the values of output current, load resistance ,and also calculate the value of duty cycle so we can varythe duty cycle and The benefits of the ZETA converter include lower output-voltage ripple and easier compensation.Thus the efficiency of ZETA converter is comparatively higher than other types of DC-DC converter.

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