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Integral Analysis of Zeta Converter for Light Load

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ABSTRACT

The conventional Zeta Converter is proposed with bypassing circuit by using basic simple mode of operations. The Zeta converter is a fourth order DC-DC converter which is capable of operating in both Buck and Boost Mode. The proposed Zeta Converter is connecting with resistive Load. For bypassing the conventional method, it consists of diode instead of resistor across the input side inductor. The objective of this paper is to analyze the performance of Zeta converter for light load and to boost the voltage level. The result is verified by effectiveness of model with simulation done in MATLAB Simulink.

KEYWORDS: *Zeta Converter, Resistive load, Diode, Capacitor.*

I. INTRODUCTION

Switching regulators, usually pulse-width modulated converters (PWM converters), are widely used in DC-DC converters or AC-DC converters in which a ripple-free DC voltage or a ripple-free DC current is generated at the output. The efficiency of these switching regulators is mostly very high. However, it is drawback for such converters which require smoothing capacitances at the input and output in order to suppress the ripple. Such smoothing capacitors are bulky, and usually life-limiting, in many cases also unsuitable for temperatures above 100 °C. In order to avoid smoothing capacitors at the output of a switching regulator (PWM converter), a linear regulator can be used instead. The linear regulator supplies the output via an adjustable resistor (controlled transistor) in such a way that the output voltage always remains constant [1], [2]. At the same time, this controller would be very fast (bandwidths up to 1 GHz are known) eliminating the disadvantage of limited dynamics. On the other hand, a linear regulator has the disadvantage that the input voltage must always be greater than the output voltage and has a very poor efficiency, which can be easily below 50% with larger voltage differences between input and output voltage. Therefore very high thermal losses are dissipated in form of heat.

The goal is thus, to take advantage of the switching regulator and the linear regulator at the same time and to avoid their disadvantages in each case. The switching regulators provide steady-state current to the load, while the linear regulator provides higher-frequency transient compensation [3]. Because the linear regulator's transient response compensates the limited transient response of the switching regulator, output capacitance that is commonly required by conventional switching regulators is not needed [4]. Most topologies found in literature regarding linear assisted switching power converters are based on constant voltage outputs. The buck converts the input voltage to the output voltage and supplies power to the load, while a linear regulator supplies current from the input to the output and another linear regulator sinks current from the output of the buck converter to the ground. These solutions may present a high efficiency topology with ripple-free output voltage; however it requires the input voltage to be always larger than the output voltage. As an important solution for the Zeta converter, it can be designed to achieve low-ripple output current and may be employed as a step up/down converter of non- inverting polarity type. This converter has the same buck- boost functionality as the SEPIC, but the output current is continuous, low-ripple output voltage. The zeta converter offers DC isolation between the input and output, which is attractive, when it has risk of short-circuit in the output. This topology can also offer high efficiency, especially if the synchronous switching scheme is used. The synchronous rectification can be easily implemented here, because this topology uses a low-side rectifier.by using this system the voltage level is increased and it perform in boost mode operation. The proposed system consists of zeta merging with diode and capacitor in-between the primary side inductor and the diode.

II. Performance and Analysis of Zeta Converter

The conventional zeta converter consists of two modes of operation and both buck and boost operations. The proposed Zeta converter is also having same modes with boosting voltage level. Here also it consist of two modes of operation with some modifications by adding inductor and diode in the input side inductor for boosting the voltage range and to reduce the ripple content the filter capacitor is used and output current is achieved with low ripple content, the below Fig. 1 shows the proposed zeta converter and the mode of operations and the performance are explained in detail in below operations.

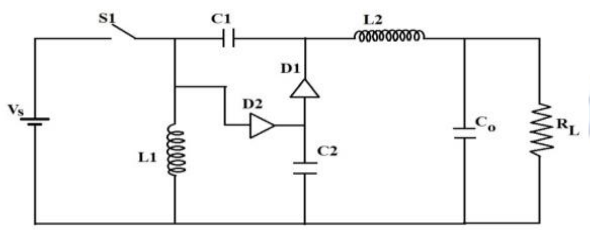

Fig 1 Proposed Zeta Converter circuit diagram

A. Mode 1

Here, the Fig. 2 show the mode 1 operation and the flow of current is from supply VS to S1 (MOSFET switch) and then passed through diode D2 and capacitor C2, inductor L1, C1 capacitor, inductor L2 and filter capacitor CO and resistive load.

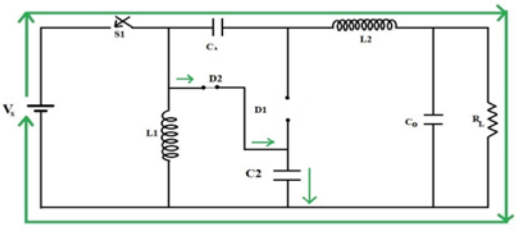

Fig. 2 Mode 1 operation for the proposed converter

B. Mode 2

In Fig. 3 diagram show the mode 2 operation and the flow of current through the diode D1 by discharging the inductor current L2 and capacitor CO. This operation takes place in the mode 2,

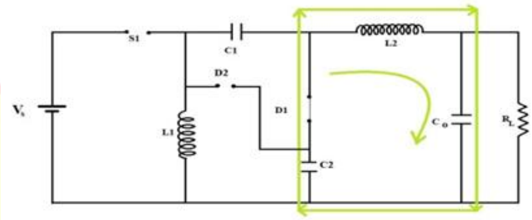

Fig. 3 Mode 2 operation for proposed converter

III. SYSTEM MODELLING FOR PROPOSED SYSTEM

Whereas inductor L=L1=L2 in switch ON condition,So, the duty cycle is

$$D = \frac{V_O}{V_O + V_{in}}, \quad \text{----- (1)}$$

Where for proposed zeta converter, the output voltage equation is

$$V_o = \frac{D}{1-D} V_{in} \quad \text{----- (2)}$$

The power equation is shown in the (3) equation,

$$P = VI \quad \text{----- (3)}$$

The output voltage equation derived from the equation (2),

$$V_{out} = V_{in} \frac{D}{1-D} \quad \text{----- (4)}$$

For designing capacitor and inductor parameters,

$$L = L1 = L2 = \frac{DV_{in}}{F\Delta L} \quad \text{------ (5)}$$

$$C1 = \frac{DV_O}{F*R*\Delta V} \quad \text{------ (6)}$$

$$C2 = \frac{DV_{in}}{8F^2 L2 \Delta V} \quad \text{------ (7)}$$

IV. RESULTS FOR SIMULATION

The simulations are takes place using the tool of Simulink MATLAB tool and the inductor current and capacitive voltage are shown below, the Fig. 4 shows the MATLAB simulation diagram. Input given to the proposed Zeta converter is DC and then output is also DC by boosting the voltage levels. So it is a DC-DC Zeta boost operation converter. The duty cycle is calculated by Ton and Toff time. The resistive load is given to this proposed Zeta converter.The parameters used in the simulation are shown in the below table. 1,

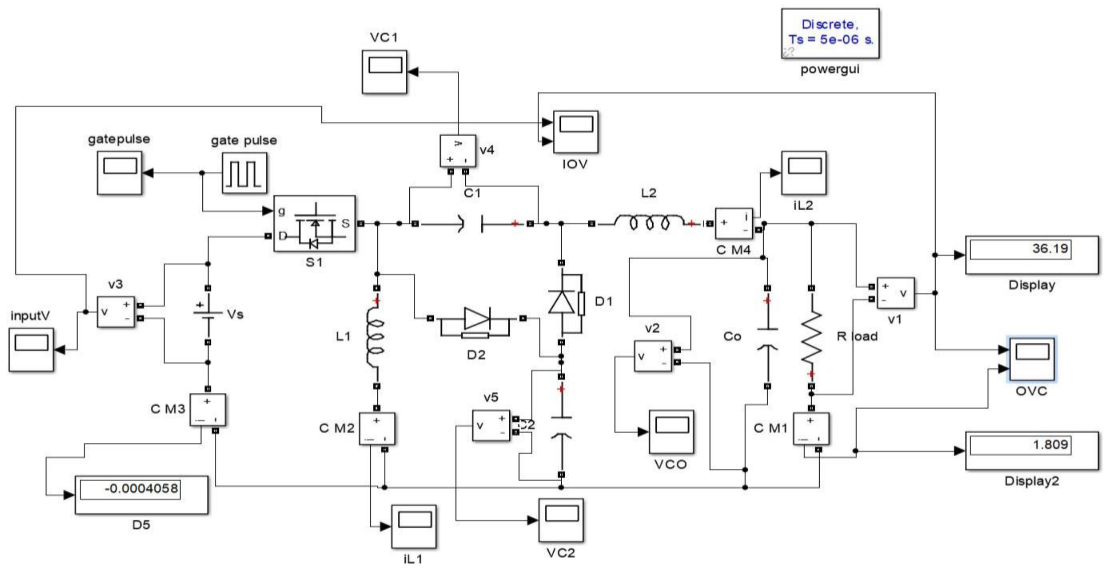

Fig. 4 Simulation diagram of proposed Zeta converter

Table. 1 Simulated parameters value

PARAMETER	VALUES
Input voltage	20V
Frequency	20K
Duty cycle	45%
Inductor L1,L2	25e-3 H
Capacitor C1,C2,Co	42e-6 F
Output voltage	36V
Output current	2A

The waveform which is obtained for the 20V dc input voltage source, by gaining the output voltage nearly 36V with 2A current. The inductor current andcomparison of the input and output voltage are s hown below,

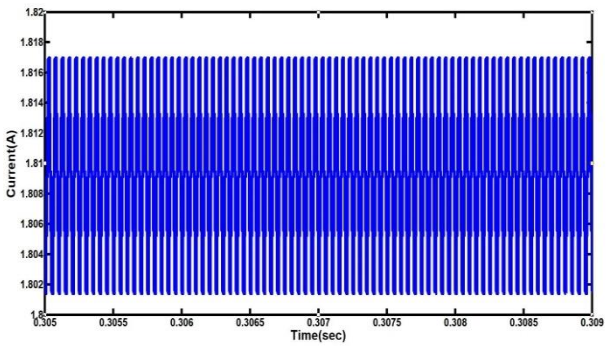

Fig. 5 Inductor current (L1) Vs Time (sec)

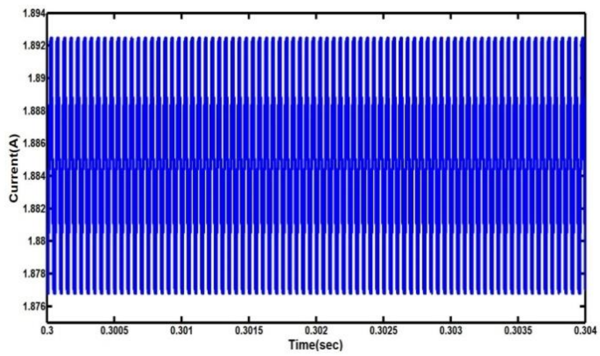

Fig. 6 Inductor current (L2) Vs Time (sec)

In Fig. 7 the output voltage and the input voltage are compared and the simulation results are shown, these simulations are simulated in MATLAB Simulink software. The ripple content is reduced and then voltage level is boosted in this proposed Zeta boost converter are shown below.

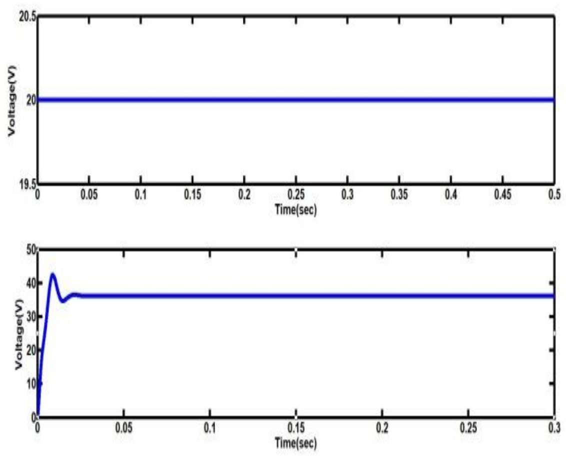

Fig. 7 Comparison of Input voltage Vs Output voltage

V. CONCLUSION

The main goal of this paper is to highlight how zeta converter can be used as efficient converter and for useful electrical energy conversion, which can be primarily used as a electric charge storage purpose and as well as alternative for electrical energy. Focusing on automobile industries in particular, zeta converter can be used to charge the automotive batteries. Thus, if every one of us started using more and more renewable energy powered devices with efficient transfer of energy, the energy crisis can be minimized at a greater level. In this proposed zeta converter it is merging with bypassing unit so the voltage increased and it is shown in simulation using the MATLAB Simulink tool.

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