A Z Source Half Bridge Converter for Electrochemical Power Supply

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Abstract—One LC network is used for obtaining a power supply, which used as electrochemical power supply. Z source is connected in between the source and the load. It can generate various output voltage such as varied positive voltage or the negative voltage and varied time ratio between positive voltage and negative voltage. By using this type of power supply plating should be uniform and reduces the plating time. This converter is derived from the conventional half bridge converter. For getting this type of power supply duty of one switch is fixed as greater than 0.5. It can avoid the shoot through problem. Proposed converter is reduces the size, complexity and cost. It is more efficient than the other converters. Finally, the novel converter is simulated by using MATLAB/Simulink.

Keywords—LC network, shoot through, electro chemical supply, half bridge converter

INTRODUCTION

Conventional converters are voltage source and current source converters. In voltage source converters act as buck converter for dc-ac power conversion and act as boost converter for ac-dc power conversion. So additional boost converter is needed for desired output voltage. Thus system cost is increases and efficiency is reduces. Because of the presence of shoot through problem there is a chance for destroying the devices. In current source converter is act as boost inverter for dc-ac power conversion and act as buck converter for ac-dc power conversion. So additional boost converter is required for required output voltage. This will increases the system cost and reduces the efficiency. Shoot through problem will destroy the devices. The voltage source converter cannot be used as the current source and vice versa. Both the converters are vulnerable to EMI noise in terms of reliability[1],[5].In order to overcome these problems, introducing new topology is called as z source topology. It has unique impedance circuit to couple the converter main circuit to power source and the load. It has X shaped structure consist of two inductors and two capacitors. The shoot through zero state provides buck boost features to the inverter[6],[7].

Half bridge converter is consist of two switches which are connected in series.so there is a chance for shoot through problem which leads to breakdown of the switch. Large ripples making the system unstable. The novel converter is consist of Z source converter is placed in between the supply and the load. The novel converter solve the limited voltage problem and the unbalanced midpoint voltage problem. Conventional electro chemical supply is the dc supply[8]. The main disadvantage of using dc supply is first the electrode should be clean at the starting of plating, for that we have to reverse the supply. In order to get the smooth electroplating product current direction and the density should be varied according to the electroplating technology. Traditionally several cascaded circuit and the complex circuit is used for getting the multi output voltages[2],[8],[9],[10],[11].This increases the cost ,size and instability of the system.

PROPOSED CONVERTER

Proposed converter consisting of half bridge converter is placed in between the source and the load as shown in Fig.1. The source is either AC or DC. If AC supply is using, converted this into DC by an uncontrolled rectifier. The working principle of both is same. The diode D is used for preventing the current from back to the source[12]. The inductor is used in order to avoid strong current when the switches are in the shoot through mode.

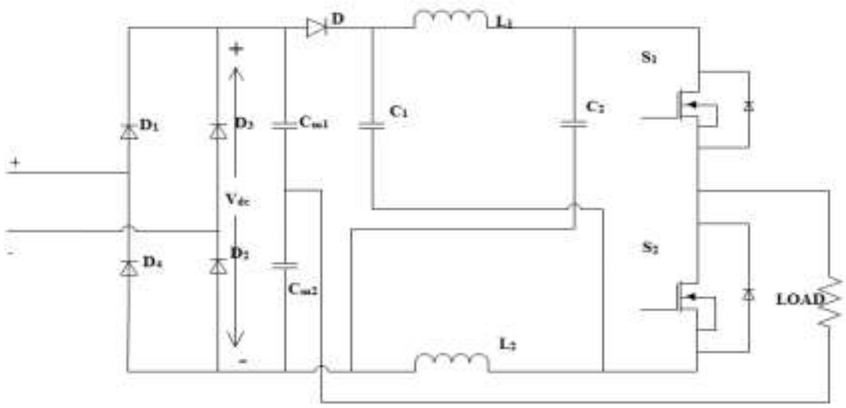

Figure 1. Proposed Converter

Some assumptions are considered for the working of the proposed converter.$L_1=L_2$,$C_1=C_2=C_{m1}=C_{m2}$,All the components are ideal.

Here duties of switches are D_1 and D_2 by switches S_1 and S_2 respectively. D_1 =0.7and D_2=0.5

There are 3 modes of operations[3].

Mode 1:It is a shoot through state as shown in Fig.2. The capacitor C_1 and C_2 discharges the energy to the inductor. The diode D became reverse biased. According to the loop C_2-Load-C_{m2} the output voltage of the converter is taken as

$$V_0 = V_{c2} - V_{cm2} \qquad (1)$$

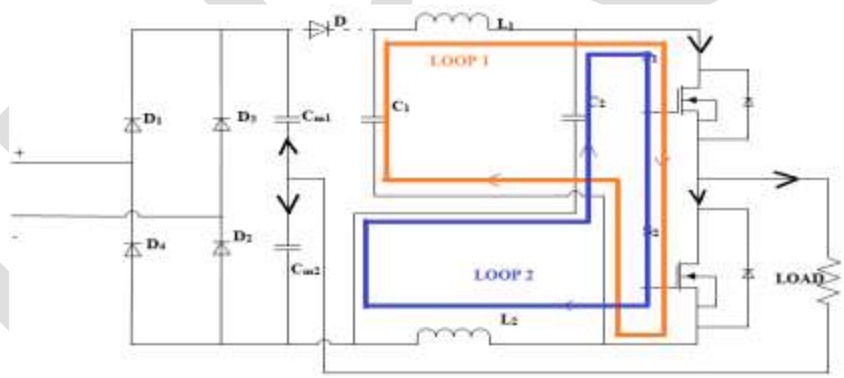

Figure 2. mode 1:S_1 and S_2 is ON

Mode 2:In loop 1,L_1 discharges the energy to C_2.

$$V_{L1} = V_{dc} - V_{c2} \qquad (2)$$

In loop 2 L_2 discharges the energy to C_1 as shown in Fig.3.

$$V_0 = V_{c2} - V_{cm2} \qquad (3)$$

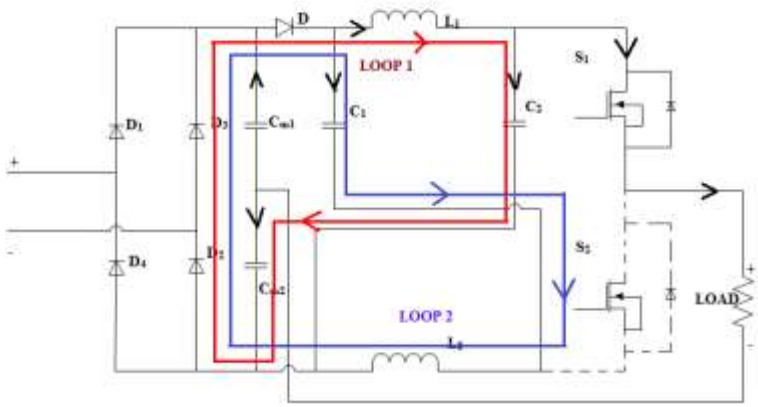

Figure 3. mode 2: S_1 ON and S_2 OFF

Mode 3:voltage across the C_2 is increases because L_1 discharges the energy to the C_2. voltage across the C_1 is increases because L_2 discharges the energy to the C_1.From the loop V_{in}-D-C_1-Load-C_{cm2},the output voltage is

$$V_0 = V_{in} - V_{c1} - V_{cm2} \qquad (4)$$

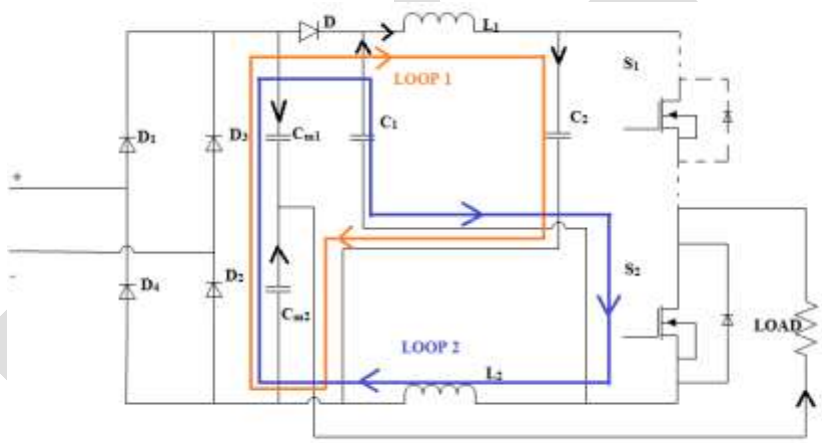

Figure 4. mode 3:S_1 OFF and S_2 ON

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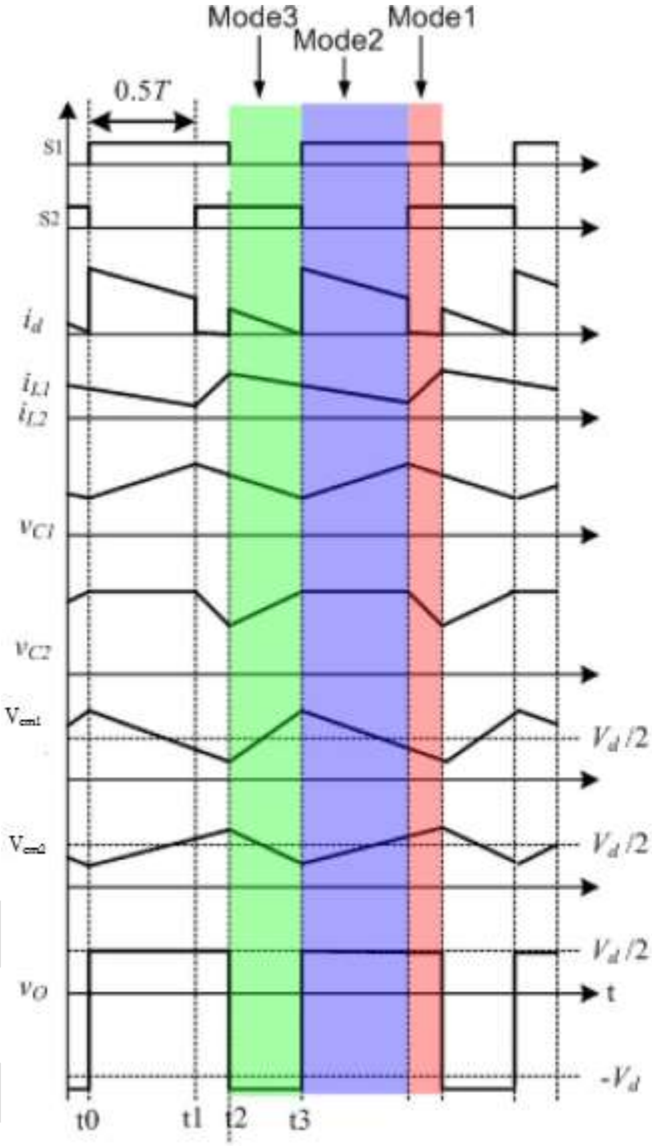

Figure 5. Waveforms of z source half bridge converter

PARAMETER DESIGN

In this section designing the inductance and the capacitance.

In the design section input is taken as the dc (V_{dc}) supply.

A. Design of the capacitor

Determine the voltage second characteristics of L_1,

$V_{c1}=V_{c2}=(2 - D_1 - D_2)V_d/(3 - (D=1 + D_2))$ (6)

$V_{cd2}= (2V_{c2}- V_d)D_1 - V_{c2} + V_d.$ (7)

Positive output voltage of the converter is obtained from the equation (3).

$V_p=\{(1 - D_1)V_d \}/\{3- 2(D_1 + D_2)\}$ (8)

Negative output voltage of the converter is

$V_n=- \{D_1V_d\}/\{3\text{-}2(D_1+D_2)\}$ (9)

From (6),(8) and (9)

When S_1 is on $V_{c2}=\{2-D_1-D_2\}V_0/\{1-D_1\}$ (10)

When S_2 is on and S_1 is off $V_{c2}=\{2-D_1-D_2\}V_0/\{-D_1\}$ (11)

The current through the I_{c2} and I_{L2} is $I_0/2$
Differential equation of the capacitor is

$$C_2=I_{c2}dt/dvc_2 \quad (12)$$

$$dt=\{D_1+D_2-1\}T \quad (13)$$

$$dvC2 = x_c\%V_{c2M} \quad (14)$$

X_c% is the permitted fluctuation range. V_{c2M} is the maximum rated voltage of C_2.

Substituting equation (13) and (14) into (12)

$$C_2 =\{Io(D_1 + D_2 - 1)T\}/\{2X_c\%V_{c2M}\}$$

B. Design of the inductor

C. Differential equation of the inductance is

$$V_{L2}=V_{L2}dt_L/di_{L2} \quad (15)$$

$$di_{L2}=X_L\%I_{L2} \quad (16)$$

$$V_{L2M}=V_{c2M} \quad (17)$$

Substituting (13),(16) and (17) into (15) leads to
$L_2=\{_{2Vc2M}(D_1 + D_2 - 1)T\}/\{X_L\%I_0\}$

SIMULATION RESULT

Simulation parameters for the proposed converter and its values are given in the table 1.

Table 1. Simulation parameters and values

Parameters	**Values**
V_{in}	0.24
D_1,D_2	0.7T,0.5T

L_1,L_2	100µH
C_1,C_2,C_{m1},C_{m2}	470µF

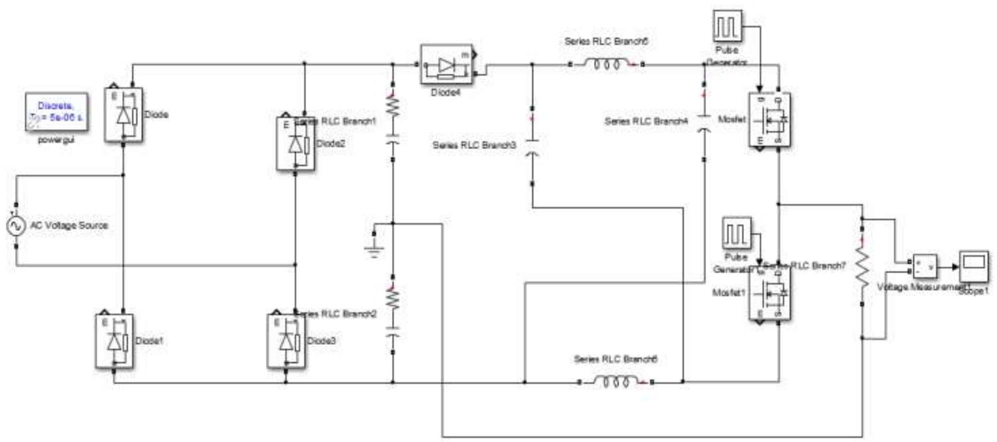

Figure 6. Simulation diagram of proposed converter

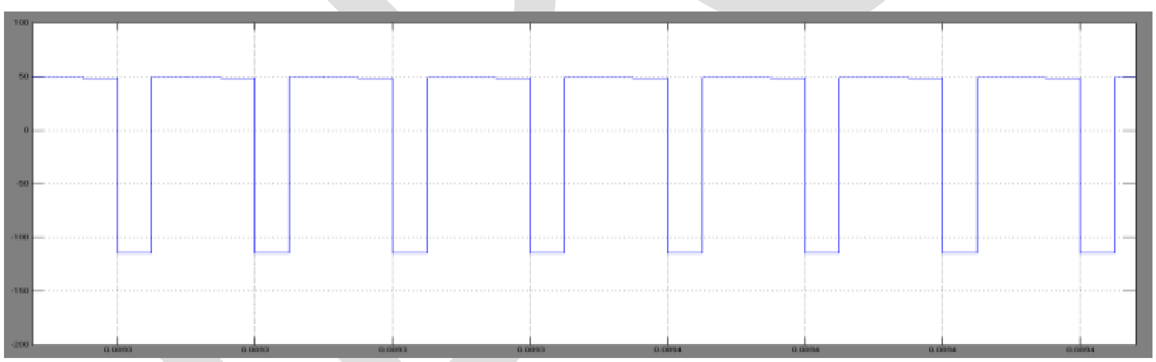

Figure 7. output waveform

CONCLUSION

The z source half bridge converter can be used for electrochemical supply when the duty of the switch S_1 is greater than 0.5T.Either dc or ac supply can be used as the input supply. By using this supply, get smooth electroplating product and plating time can be reduced. Novel converter is remove the all the drawbacks of conventional electrochemical supply. Efficiency and stability of the system is greater as compared to conventional one. The proposed converter is reduces the cost as the traditional one. Novel converter can solve the limited voltage problem.

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