

Performance Analysis of Modified Two Source Switched Inductor Quasi ZSI

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Abstract

This paper present a high boost voltage inverter called switched inductor quasi Z-source inverter (SL-qZSI) powered by two dc sources. The proposed model suppresses the in-rush current at start-up and thereby, protects the device. To control the output of the proposed model, a type of PWM technique, which is simple boost PWM technique is used. This technique introduces shoot through states in the inverter. The model is tested with different load conditions and corresponding simulation results are also plotted.

Key Words: Z-source inverter (ZSI), simple boost PWM technique, Switched inductor quasi ZSI.

1 Introduction

To convert power from to other form (i.e., AC or DC), we use electronic converters. These converters are used in power system, where conversion of power is needed, for example, (i) when we need

to transfer power over long distances, HVDC is desirable, so the existing AC power is converted to DC power, (ii)uninterrupted power supplies take AC power, store it after converting it to DC and later convert it to AC and supply when needed, (iii) in FACTS devices like STATCOM, DVR, etc.

So, for this purpose of power conversion, we have voltage source converters (VSC) and current source converters (CSC). But, they have certain limitations like, VSC can be used as buck converter alone and CSC can be used as a boost converter alone. So, in utilities where to have both buck and boost feature of a converter, we cannot use either of them. So, usage of Z-source inverter (ZSI) has been started, which has this buck boost facility. ZSI was initially proposed and developed by F.Z.Peng[1] in 2003.

ZSI reduces the number of power conversion stages, but its size is a disadvantage due to presence of passive elements, which are inductor and capacitor. Due to the presence of these, the cost of the device also increases [2]. ZSI has large inrush currents at time of start-up, which is a disadvantage. So, to overcome this disadvantage, Quasi ZSI (qZSI) came into picture. This also reduces the ratings of inductors and capacitors and also improvement in the input profiles can be seen. A combination of switched inductor with conventional ZSI (SL-ZSI) was also implemented earlier which gives strong step up inversion and thereby overcomes boost limitation of conventional ZSI.

2 Proposed technique

In this paper, a new model, which is, modified two source switched inductor quasi ZSI (Modified two source SL-qZSI) is proposed [3].

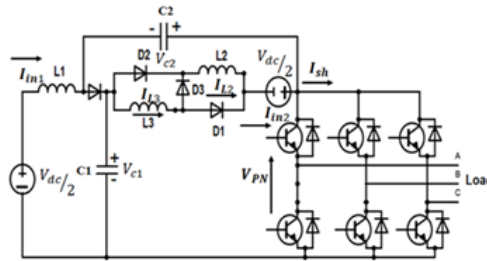


Fig. 1. Modified two source switched inductor qZSI

When compared to SL-ZSI, the proposed model improves gives an improvement in current, reduces the count of passive components and also reliability is improved. For a given input and output voltages, the shoot through current, voltage stress on capacitors, current stress on inductors and diodes in the proposed modified two source SL-qZSI are lower than those of SL-ZSI. The proposed model also reduces the inrush current during start-up, due to which the device gets damaged.

3 ANALYSIS OF MODIFIED TWO SOURCE SL-QZSI

The circuit analysis of the proposed model of Modified two source switched inductor quasi ZSI is shown below. In non-shoot through state, as shown in Fig.2(a), we have,

$$V_{L1} = V_{C1} - \frac{V_{dc}}{2} \quad (1)$$

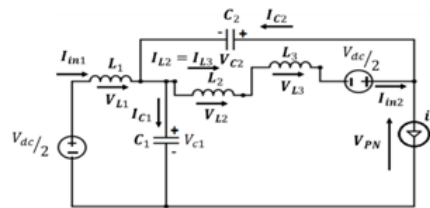
$$V_{L2} + V_{L3} = V_{C2} - \frac{V_{dc}}{2} \quad (2)$$

$$V_{PN} = V_{C1} + V_{C2} \quad (3)$$

$$I_{C1} = I_{in1} - i_i \quad (4)$$

$$I_{C2} = I_{L2} - i_i = I_{L3} - i_i \quad (5)$$

$$I_{in2} = I_{L2} \quad (6)$$



(a)

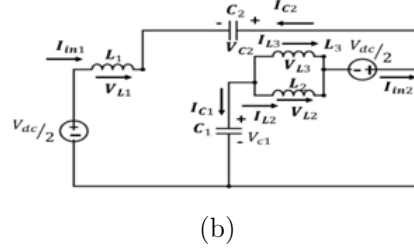


Fig.2.Equivalent circuit of Modified two source SL-qZSI.
(a)Non-shoot through state, (b) shoot through state.

In shoot through state, as shown in Fig.2(b), we have

$$V_{L1} = -V_{C2} - \quad (7)$$

$$V_{L2} = V_{L3} = -V_{C1} - \frac{V_{dc}}{2} \quad (8)$$

$$I_{C1} = -I_{in2} = -I_{L2} - I_{L3} \quad (9)$$

$$I_{C2} = -I_{in1} \quad (10)$$

State-space averaging of equations from (1) to (10), we have

$$V_{C1} = \frac{1 + D^2}{1 - 2D - D^2} \frac{V_{dc}}{2} \quad (11)$$

$$V_{C2} = \frac{1 + 2D - D^2}{1 - 2D - D^2} \frac{V_{dc}}{2} \quad (12)$$

$$V_{PN} = V_{C1} + V_{C2} = \frac{1 + D}{1 - 2D - D^2} V_{dc} = BV_{dc} \quad (13)$$

$$\hat{v}_{ph} = \frac{MV_{PN}}{2} = \frac{MBV_{dc}}{2} \quad (14)$$

$$I_{in1} = I_{in2} = (1 + D)I_{L2} \quad (15)$$

$$I_{L2} = I_{L3} = (1 - D)/(1 - 2D - D^2)i_i \quad (16)$$

4 PWM TECHNIQUE

To obtain the control over the proposed model, we are using simple boost sinusoidal pulse width modulation technique (SPWM). In traditionally existing sinusoidal pulse width modulation technique, we cannot produce shoot through states. So, to insert shoot through

states we are now using simple boost SPWM. In the traditional technique, we have to wave, which are triangular carrier wave and a reference wave which is normally a sinusoidal wave. The pulses are generated by comparing the carrier wave with reference wave. The devices are switched ON only when the sinusoidal wave is greater than the triangular wave. In the modified technique [4], we take two reference lines additionally. One is upper reference line and the other is lower reference line. Upper reference line is taken equal to or above the upper envelope of reference waves and the lower reference line is taken equal to or lower than the lower envelope of the reference line. Whenever the triangular wave crosses these references lines, then all devices are given pulses to switch them ON, even if they are in OFF/ ON condition. So, this produces shoot through states by turning all the devices ON. This is explained using the below figure.

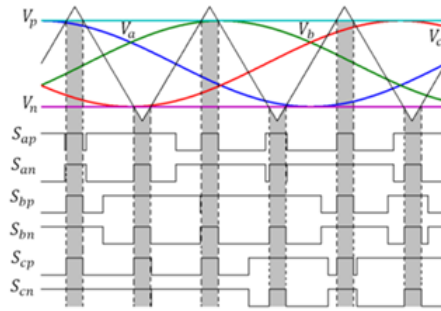


Fig. 3. Simple boost PWM technique

Simple boost method of PWM technique is used because this improves the output voltage of the inverter when compared to maximum boost PWM technique.

5 RESULTS

A. Three phase series RLC load

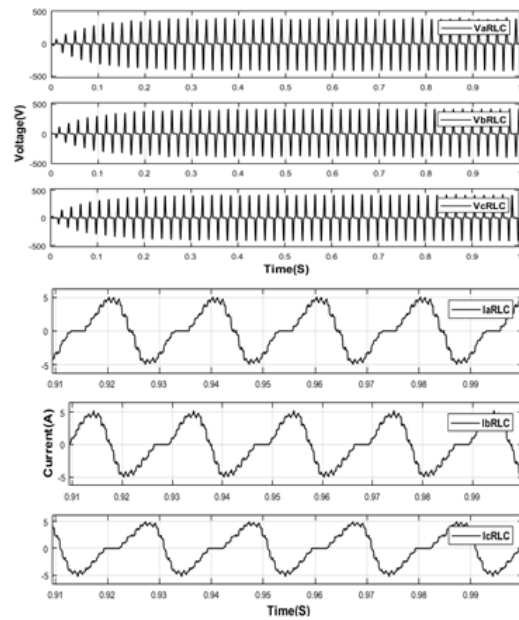


Fig. 4. Simulation results for three phase load voltages and currents respectively, voltage is 406V and current is 5.03A.

B. Three phase series RL load

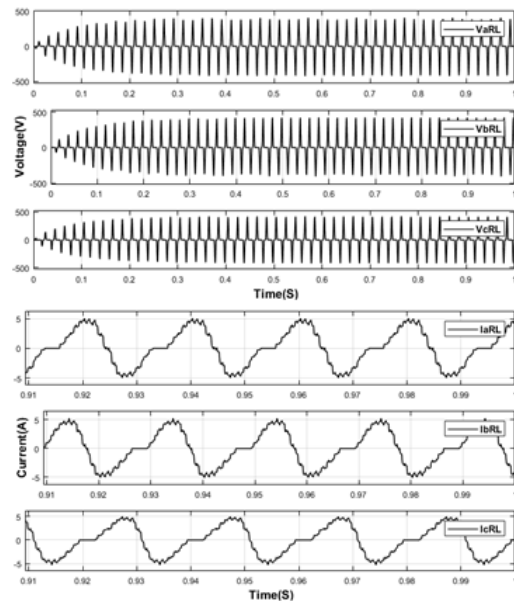


Fig. 5. Simulation results for three phase load voltages and currents respectively, voltage is 425V and current is 5A.

C. Three phase series RC load

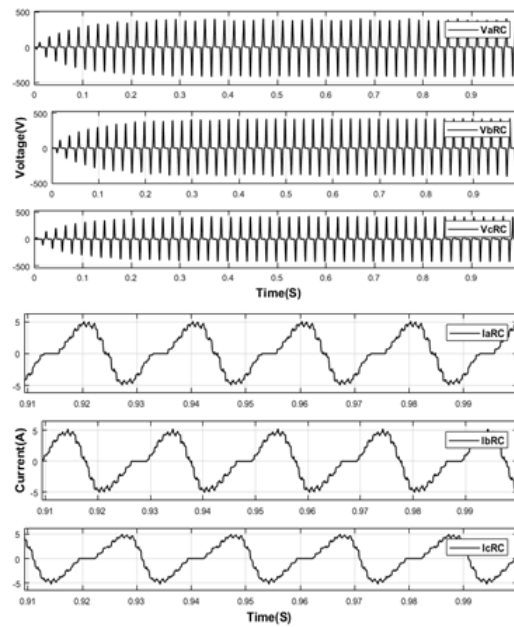


Fig. 6. Simulation results for three phase load voltages and currents respectively, voltage is 424.6V and current is 5.2A.

D. Three phase series LC load

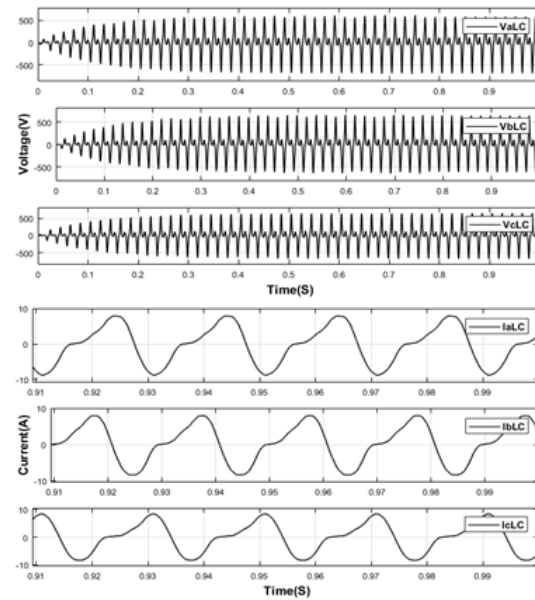


Fig. 7. Simulation results of three Phase voltages and currents respectively and the output voltage is 533.6V and output current is 7.9 A

E. Three phase series R load

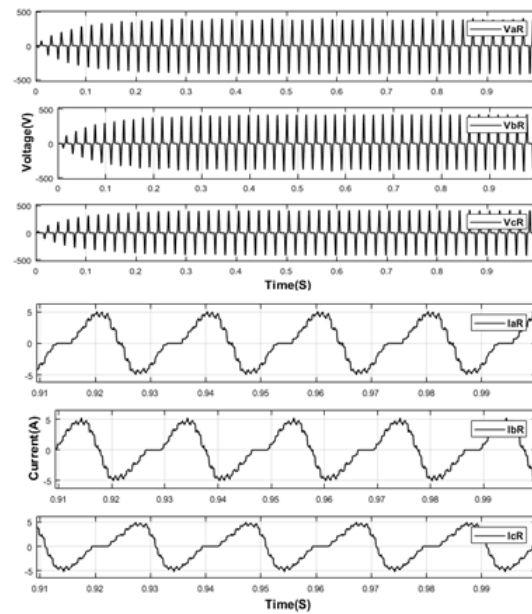


Fig. 8. Simulation results of three Phase voltages and currents respectively and the output voltage is 420.7V and output current is 5.2 A

F. Three phase series L load

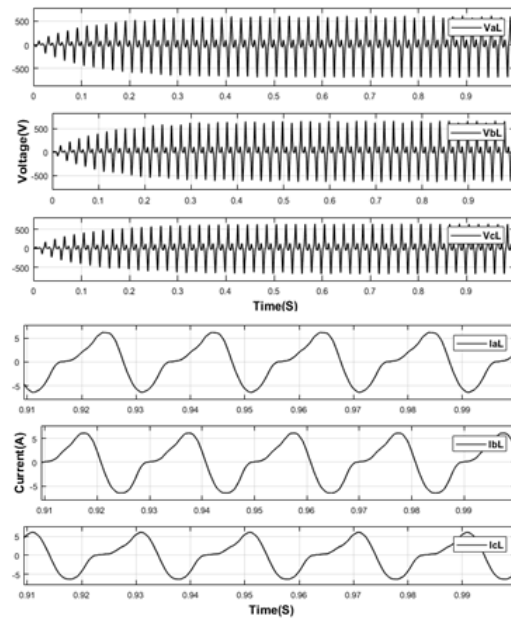


Fig. 9. Simulation results of three Phase voltages and currents respectively and the output voltage is 546V and output current is 6.1A

G. Three phase series C load

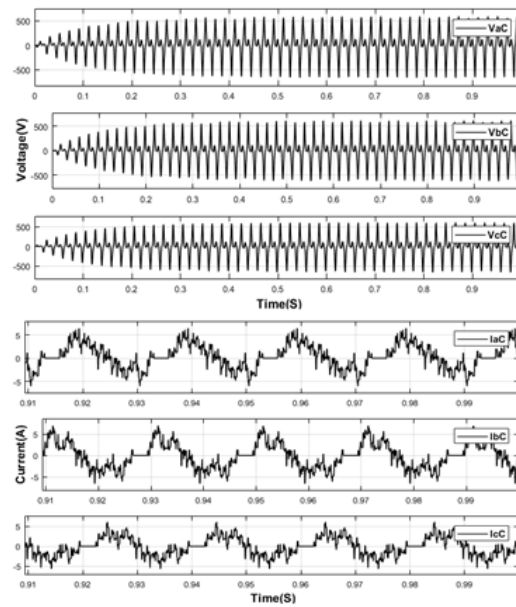


Fig. 10. Simulation results of three Phase voltages and currents respectively and the output voltage is 577V and output current is 6.3 A

H. Three phase parallel RLC load

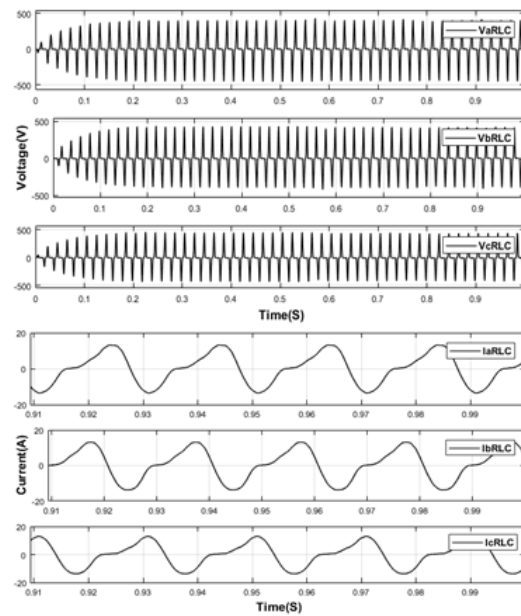


Fig. 11. Simulation results of three Phase voltages and currents respectively and the output voltage is 406V and output current is 13.6 A

I. Three phase parallel RL load

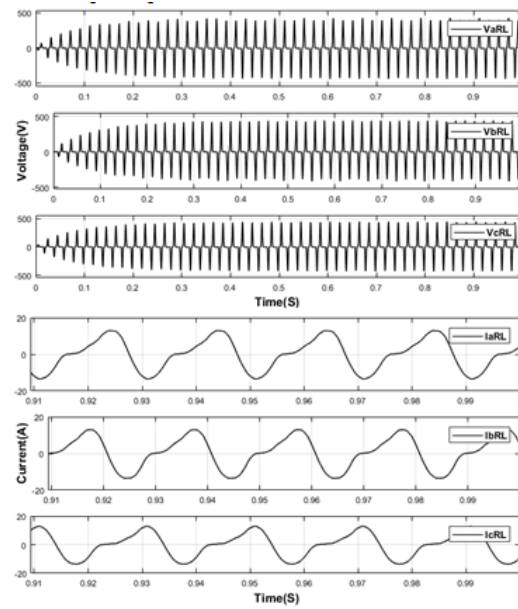


Fig. 12. Simulation results of three Phase voltages and currents respectively and the output voltage is 441.6V and output current is 12.8 A

J. Three phase parallel RC load

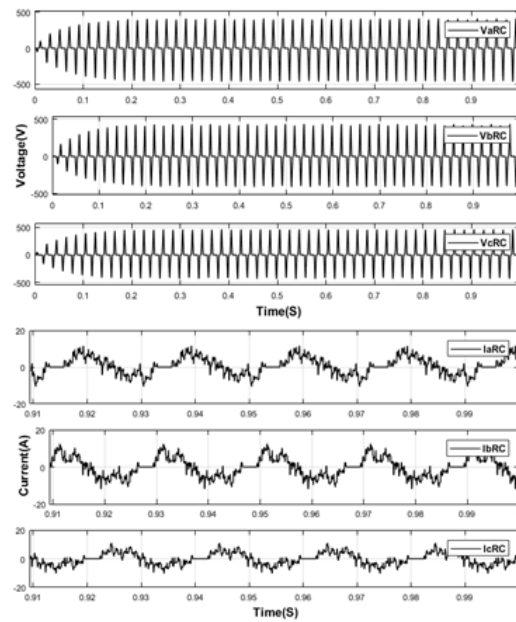


Fig. 13. Simulation results of three Phase voltages and currents respectively and the output voltage is 437V and output current is 12.42 A

K. Three phase parallel LC load

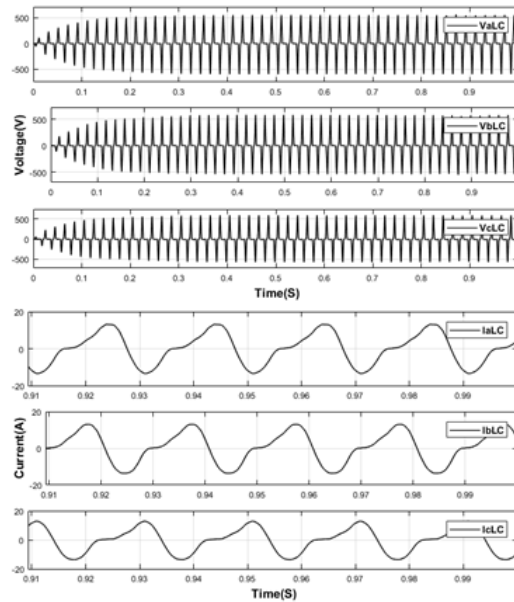


Fig. 14. Simulation results of three Phase voltages and currents respectively and the output voltage is 522V and output current is 13.8 A

L. Three phase parallel R load

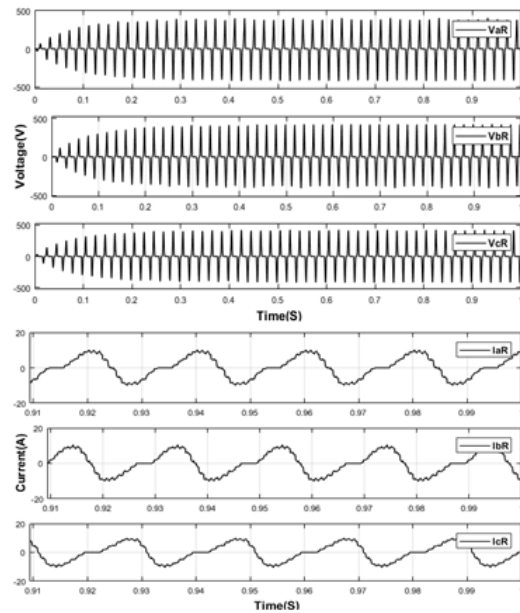


Fig. 15. Simulation results of three Phase voltages and currents respectively and the output voltage is 428V and output current is 11 A

M. Three phase parallel L load

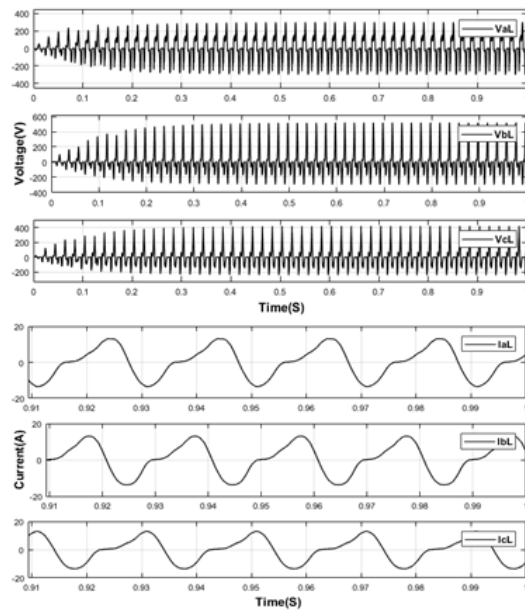


Fig. 16. Simulation results of three Phase voltages and currents respectively and the output voltage is 480V and output current is 13.2 A

N. Three phase parallel C load

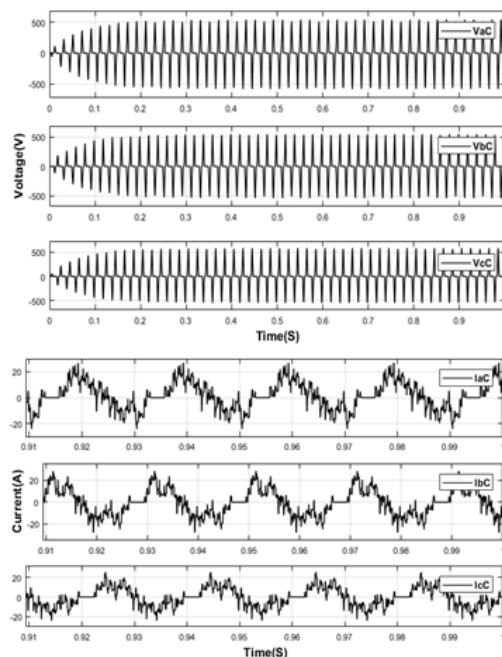


Fig. 17. Simulation results of three Phase voltages and currents respectively and the output voltage is 533V and output current is 26 A

6 Conclusion

Modified two source switched inductor quasi ZSI(SL-qZSI) is tested with different loads in both series and parallel combination and the obtained results are plotted. Simple boost PWM is used to insert shoot through states and to control the output. The proposed model is observed to give better results when this control technique is used.

References

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