An Improved the High Voltage Boost Inversion Ability of Switched Inductor Quasi ZSI by using PWM Technique

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Abstract— This paper presents an improved the high voltage boost inversion ability of switched inductor quasi ZSI by using Boost PWM technique. This presents a comparative analysis of Boost Inversion Ability of Switched Inductor Quasi z-source inverter (SL-QZSI) with conventional z-source Inverter (ZSI). In comparison to conventional ZSI for the same value of voltages in the input and output the proposed SL-QZSI provides the less count on passive component a dc-source with common ground less voltage across the capacitors it gives the continuous input current current shoot through is reduced and also the current stress across the inductor and diodes are reduced. This thesis presents the operating principle boost inversion ability analysis simulation results and comparison of conventional ZSI with SLQZSI The simulation results confirmed the ability of high step up inversion by this proposed SL-QZSI. An extended switched inductor quasi z-source inverter (ESL-QZSI) with high boost voltage inversion ability is presented which combines the SL-QZSI with the traditional boost converter as well as improves the switched-inductor cell. Compared with the classic SL-QZSI topologies the proposed topology reduces the voltage stresses of capacitors power devices and diodes for the same input. The operation principle of the proposed topology is analyzed in detail. In addition, the performance of the proposed topology is verified by simulations and experiments.

Key words: ZSI, SL-QZSI, Boost inversion ability, ESL-QZSI

I. INTRODUCTION

The z-source inverter (ZSI) has elicited much interest recently because of its obvious advantages compared with the classical voltage source inverter. First ZSIs utilize the shoot-through of the inverter bridge to boost voltage and are thus more suitable for application with low input voltages, such as photovoltaic and fuel cells Second no dead time exist b/w the conduction of the upper switch and that of the lower switch thus, the distortion of the output waveform is reduced 3rd boost and inversion of the voltage are realized with single-stage power conversion; efficiency are thus increases Lastly ZSIs exhibit better immunity against EMI noise. However, classic ZSI have obvious disadvantage such as high voltage stresses in the switches and capacitors, huge inrush current, and weak boost ability. The most significant drawback is the discontinuous i/t current, which limits the use of ZSIs and causes lifetime damage to the DC source pulse width modulation (PWM) method such as the maximum boost control method and the constant boost control method, have been developed to overcome these drawbacks and obtain reduced voltage stress and increased boost ability However these PWM method have yet to extend the voltage gain without sacrificing the device cost as well as avoid the discontinous input current the improvement of circuit topology appears to be an opportunity for ZSIs.

An improved ZSI was proposed to reduce the capacitors voltage stress and start up inrush current; however, boost ability remained unchanged and the i/t current was still discontinuous. A novel family of extended boost ZSIs was developed Diode or capacitor assistances was applied to increase the boost ability and make the input current continuous. However these extended boost ZSI have obvious short coming such as small boost effect, complicated structure, and large size. Compared with the classic ZSI QZSI has a lower rating and fewer power devices, continuous input current, and lower current stresses for the DC source a common ground point also exists in QZSI for the DC source and the inverter. The boost ability of QZS Is remains limited.

Switched capacitor (SC), switched inductor (SL), and hybrid SC/SL techniques are commonly used in DC–DC converter to achieve high boost capability with transformerless cascade structures thus size is reduced and power density is increased. ZSI and SL techniques were successfully combine to overcome the boost limitation of the classical ZSI a switched-inductor z-source inverter (SL-ZSI) was presented. Compared with 2 isolated DC sources were embedded into the SL-ZSI topology to make the input current continuous, suppress the voltage stress and improve reliability. The modulation index and shoot through duty ratio are the two independent control variables of the conventional ZSI. By increasing the shoot through duty ratio, voltage boost of the ZSI can be improved while the output ac voltage is keeping up according to the modulation index There is a concession among the shoot through duty ratio and the modulation index: if a high modulation index is used, only a small shoot through duty ratio can be utilized and if a small modulation index is used only a high through duty ratio can be utilized.

It is need to increase the duty ration of shoot through of the inverter bridge voltage from a low voltage dc source, to give a strong boost factor in the conventional ZSI. A small modulation index is utilized for getting large shoot through duty ratio. A small modulation index is reported for reduced the amplitude of the ac output voltage and also decreases ac output performance. Moreover, when a large shoot through duty ratio is applied then a high voltage stress imposed on inverter-bridge and z-source capacitor. Hence the conventional z-source inverter has restriction to give both a high boost factor and a high output voltage simultaneously.

Dynamic modeling and boost control methods pulse width modulation methods and other z-source network topologies are analyzed QZSI is developed to overcome the drawbacks in conventional ZSI is analyzed. Compared with conventional ZSI QZSI have ability to provide improving

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input profiles reducing passive component ratings and but there is no improvement on voltage boost ability.

The proposed SL-QZSI is based on the well-known QZSI topology and adds only one inductor and three diodes. This topology is studied under the assumption that all components are ideal. The switched inductor quasi z-source inverter (SL-QZSI) in not only has fewer passive components but also produces lower stress on the capacitors, inductors, and diodes. The typical switched inductors are replaced by a bootstrap capacitor and boost inductors derived from without increasing the complexity of the circuit.

II. Z-SOURCE INVERTER

The traditional voltage and current inverters have been seriously restrict due to their narrow obtainable output voltage range short through problem causes by misgating and some other theoretical difficulties due to their bridge type structure. The topology of the z-source inverter was proposed to overcome the problems in the traditional inverters in which the function of the traditional dc-dc boost converter has been successfully introduced into the inverter by a unique x-shape impedance network z-source inverters are recent inverter topology that can perform both buck and boost functions as a single unit A unique feature of z-source inverter is the shoot through states by which 2 semiconductor switches of the same phase leg can be turn ON simultaneously Therefore no dead time is need and o/p distortion is greatly reduced and thus reliability is greatly improve This feature is not available in the voltage source and current source inverters.

z-source inverter are mainly applied for load that demand a high voltage gain such as motor drives and as a power conditioning unit for renewable sources like solar fuel cells etc to match the input source voltage differences The development in z-source inverter topology provides a consecutive enhancement in voltage gain and output waveforms. A trade off between the boost capability and component count is always a major concern to keep the cost stable.

It is to be noted that increase in the component with suitable modification can improve the performance of these types of inverters The topology growth has been in terms of addition or reduction of passive component inclusion of extra semiconductor switches alteration two or inclusion of dc sources and also changes of modulation schemes etc. Voltage buck inversion ability is also provided for those application that need low ac voltages.

The z-source concept is applicable on all direct current to alternating current, ac-to-dc, ac-to-ac and dc-to-dc power conversion.

The configuration of a ZSI consists of the following components:

- Two Inductors
- Two Capacitors
- DC source
- Inverter or Converter
- Load or Converter

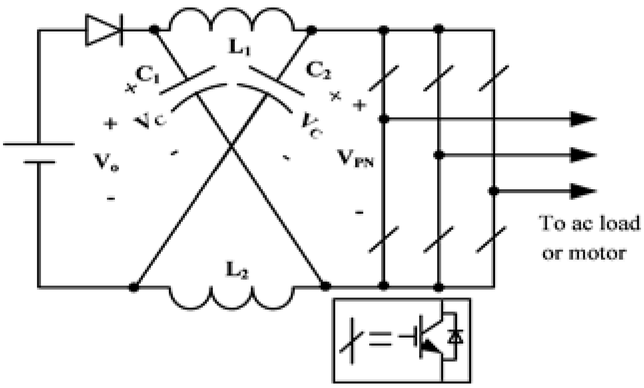

Fig. 1: Z-source Inverter

A ZSI structure use the series combinations of IGBT and diode It overcomes all the theoretical barriers and limitations of the VSI and CSI and give rise to power conversion concept Figure depicts a two-port network that consists of two split inductors L1 L2 and capacitors C1 C2 connected in X shape to provide an impedance source (z-source) coupling the converters to the dc source load or another converters. The dc source or load may be either a voltage or a current source or load Hence the dc sources can be a batteries diode rectifier thyristor converter fuel cell an inductors a capacitors or any combinations of these Series combinations of IGBTs and diode are used as switches in the converter circuits The inductances can be provided by a split inductors or two separate inductors.

A. *The classical ZSI has some limitations:*

1) In some applications, the current taken from the dc input source is intermittent.
2) DC source and converter does not share the common ground.
3) It needs a dc link coupling capacitor is connected across the energy source to protect unwanted discontinuity of current.

Boost factor B can be expressed as conversion relation between dc-link voltage across the inverter bridge Vdc and the input source voltage Vin.

$$B = \frac{V_{pn}}{V_{dc}} = \frac{1}{1-2(T_o-T)} = \frac{1}{1-2D}$$

Where To is the interval of shoot through zero state during a switching cycle T and D is duty ratio of each cycle D=To/T

From equation , it is observed that D should be limited to minimum value zero to 0.5 the maximum value In this range the impedance network can achieve step up dc-dc conversion from Vdc to VPN But the large value of D needs to be taken for a low voltage dc energy source to provide a very high boost factor. Hence z-source converter should be operated for a long interval of shoot through zero state.

III. SL-QZSI TOPOLOGY

The proposed inverter consists of three inductors (L1, L2 and L3), two capacitors (C1 and C2) and four diodes (Din D1 D2 and D3). The combination of L2-L3-D1-D2-D3 acts as a switched inductor cell The proposed topology provide in rush current suppression however the inductors and capacitors in proposed inverter still resonate. Compared with a conventional QZSI the proposed inverter adds only

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three diodes and one inductor. Like the classical ZSI the proposed SL-QZSI has extra shoot through zero states besides the traditional six active and two zero states as in classic ZSI Thus the operating principle is same to classic ZSI For the purpose of analysis the operating state are classified into shoot through and non shoot through state.

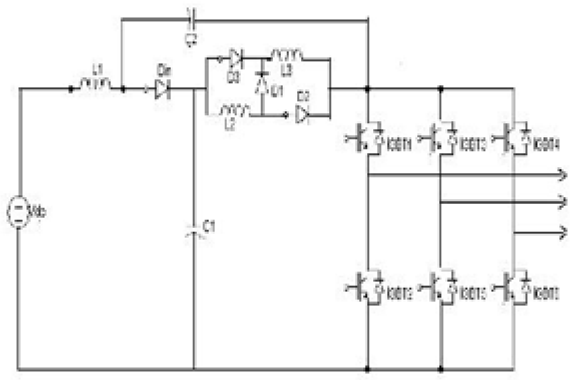

Fig. 2: SL-QZSI circuit

IV. EXTENDED SWITCHED INDUCTOR QUASI Z-SOURCE INVERTER

The general structure of ESL-QZSI, which consists of four inductors (L1, L2, L3, L4), three capacitors (C1 C2 C3) five diodes (D1 D2 D3 D4 D5) and one switch (S). The proposed topology combines it with a typical boost circuit and one inductor is replaced by an improved switched inductor cell. Compared with SL-QZSI, one inductor, one capacitor & 1 switch are added Further more the proposed topology uses only one more capacitor & one more switch As seen only a few components are added in ESLQZSI The proposed topology possesses much higher boost ability with the same shoot through duty ratio than the other topology to improve the output voltage profile For the same input.

V. SIMULATION RESULTS

The PWM of ZSI circuit is shown in fig.3.

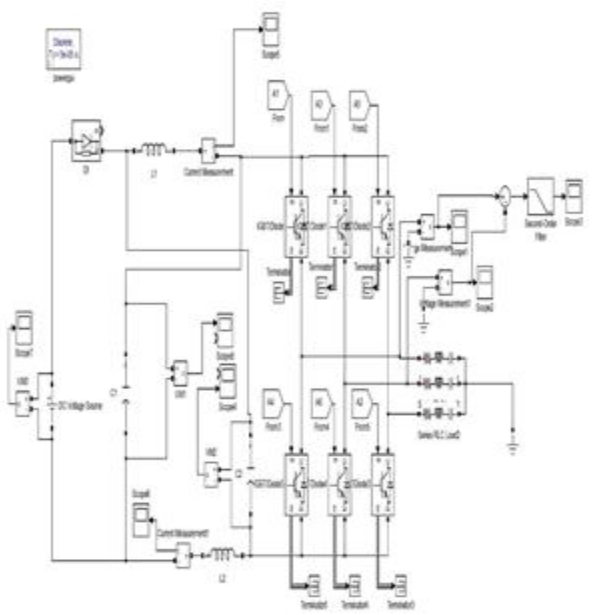

Fig. 3: ZSI

To verify the improved boost ability of proposed technology, The initial voltage is assumed to 0 volt in the capacitor C1 and C2 of the both inverter. The 50hz assigned the switching frequency (fs). The input dc source voltage is 48Vdc The line to line voltage and the Pulse Width Modulation (PWM) control was used here in this simulation and all components are ideal.

To produce the required L-L voltage of 190volts (Vrms) from the dc input source with maximum boost control for the main power circuit of SL-QZSI, we get Vc1=94V Vc2=93V.

Fig. shows the proposed simulation diagram of SL-QZSI circuit and the simulation results is shown in the Fig. with maximum boost control the C1 and C2 voltages are boosted to 95V and 90V in steady sate respectively peak VPN is boosted to 190V. Due to the resonance created in the quasi impedance-source inductors and capacitors inrush current in the proposed SLQZSI appears. However, the less inrush current is obtained in this SL-QZSI then the conventional ZSI. Fig. is shows the simulation diagram of conventional ZSI topology to obtained 125 volts of Vrms in the output L-L voltage from the same 48 volts input dc source with high boost control instead of the conventional ZSI, Fig. shows the simulation results for the conventional ZSI.Even though the proposed SL-QZSI needs more inductors and diodes than the conventional one total inductance used in the proposed SL-QZSI is equal or lower than that of one inductor in the conventional ZSI. Thus volume and cost of the proposed system are almost same as those of the conventional one.

Fig. are shows that, to produce same output L-L voltage of 190 volts (Vrms) from 48 volt of input dc voltage develops low voltage stress across the capacitors higher peak dc link voltage (Vpn), peak shoot through current is low in the proposed circuit of SL-QZSI instead of conventional ZSI.

Fig. shows the components voltage stress on z-source capacitor versus voltage gain G of the proposed SL-QZSI and the conventional ZSI Fig. shows the voltage stress on inverter-bridge versus voltage gain G and from the under the same voltage gain G, the voltage stress on the z-source capacitor and the inverter bridge of the proposed SLQZSI are much lesser than that of the conventional one.

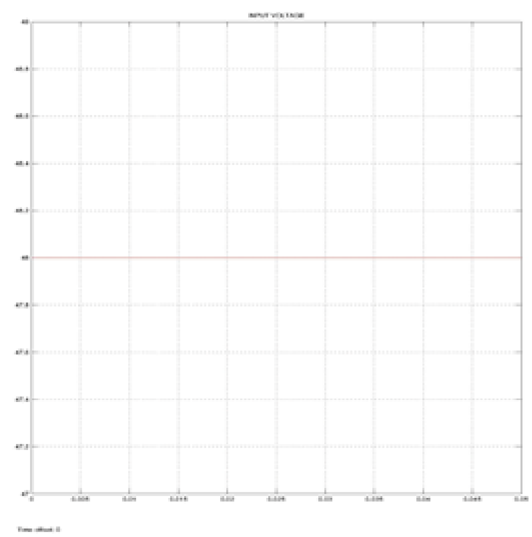

Fig. 4: Input voltage

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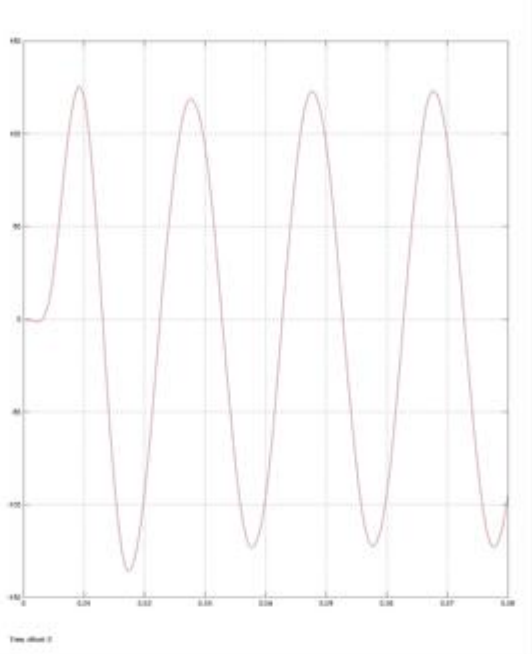

Fig. 5: Output voltage

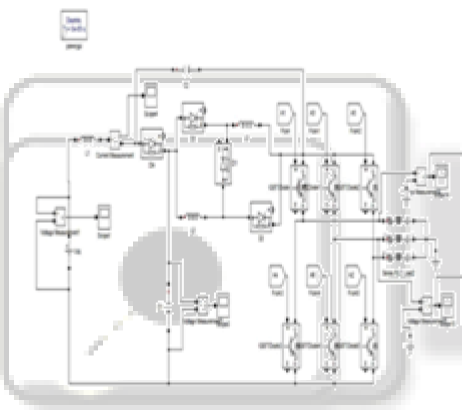

Fig. 6: Circuit of proposed slqzsi

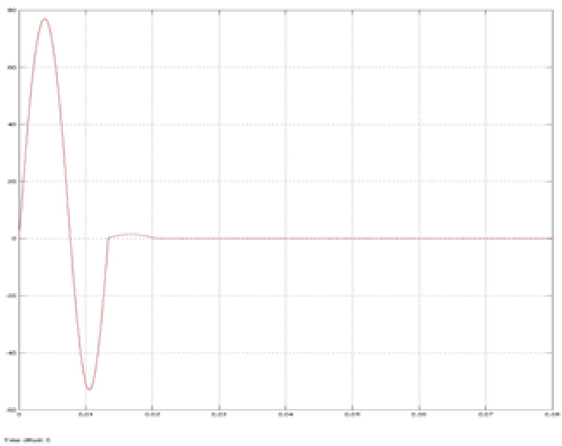

Fig. 7: Inductor current

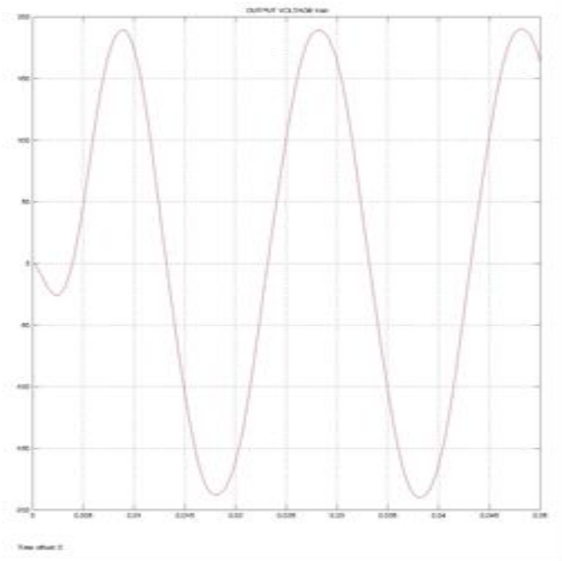

Fig. 8: Output voltage

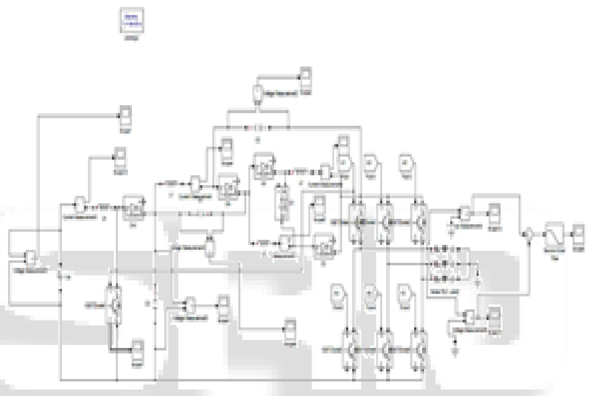

Fig. 9: Extended SL-QZSI

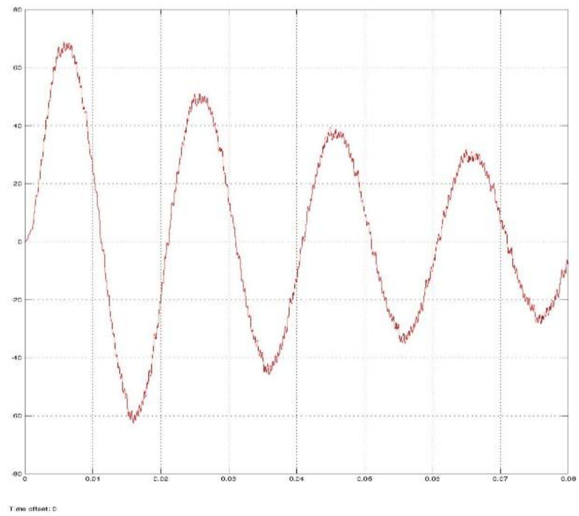

Fig. 10: Inductor current

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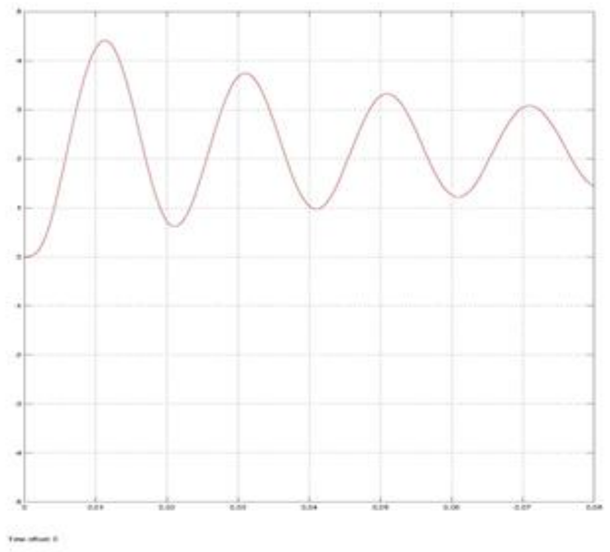

Fig. 11: Capacitor Current

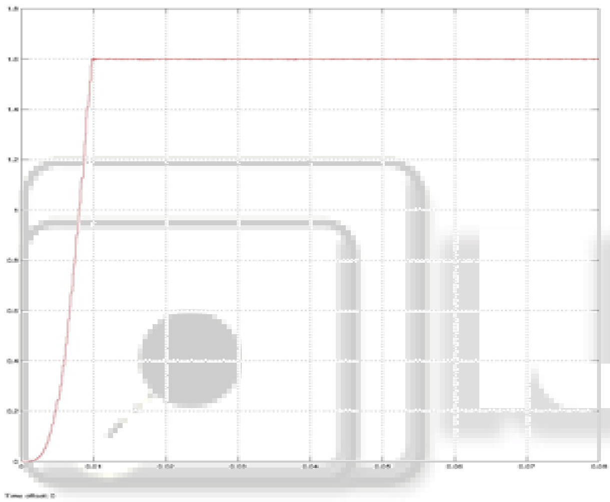

Fig. 12: Capacitor Current

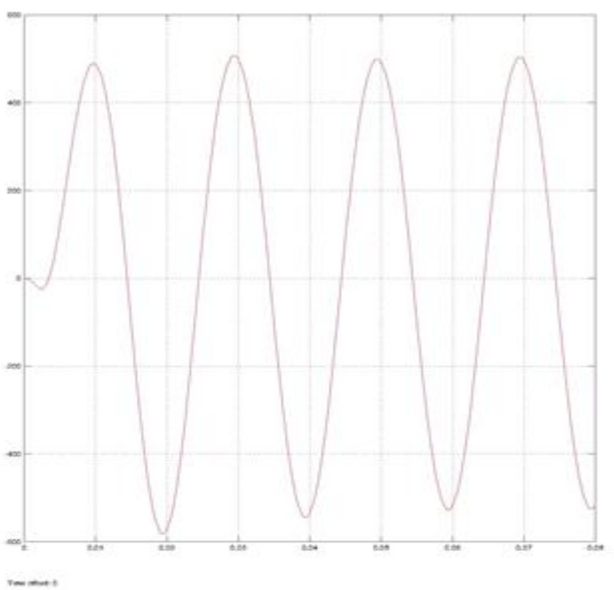

Fig. 13: Output Voltage.

VI. CONCLUSION

An improved ZSI topology called switched inductor quasi z-source inverter achieves the high boost voltage inversion ability. It shares the dc common ground with continuous input current and the Maximum boost control method is used to obtain maximum voltage gain.

This method maximize the shoot-through period and maximum output voltage without disturbing the active states by turning all zero states into the shoot-through zero state for a given modulation index.

The SL-QZSI is analyzed theoretically and experimental modeling is performed in MATLAB/simulink and the improved performances are compared with those of the conventional ZSI. The proposed topology has a higher voltage boost ratio and a lower voltage stress across the z-source capacitors an inverter bridge compared to the conventional topology The relationship between voltage stress of the switches and the voltage gain shows that the proposed SL-QZSI topology has superior than the conventional ZSI Implementation with adding some inductor, capacitor and diode in switched inductor z-source inverter for more better result is known as an extended switched inductor quasi z-source inverter with the high voltage gain and boost inversion ability.

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