Performance comparison of Quasi-Z-Source inverter with Current Source Switched Boost Quasi Impedance Source Inverter

Shines T.S., S. Ramamoorthy

Abstract: ***This paper present the comparison of quasi impedance source inverter (QZSI) with boost switched based quasi impedance inverter (BSL-QZSI). Mainly this type of inverter is used for interfacing low voltage dc to high voltage ac conversion application for reducing converter stages and components count. The BSL-QZSI has additional switch for controlling the input power flow through inductor. The QZSI does not require control switch for input side. Both inverter circuits are simulated using sine PWM technique. Their performance is compared. The QZSI circuit has better performance compare than BSL-QZSI inverter. Sine PWM method is used to reduce the harmonics and improve the output voltage control.***

Keywords: Quasi impedance source, boost converter, shoot through and harmonic.

I. INTRODUCTION

The boost converter is used to interface between low voltage dc to high voltage dc supply. The additional boost converter increases the cost and size of the system and also reduces the system performance. To avoid boost converter stage some other option also is proposed (z).

Impedance-source (IS) inverters are an emerging technology of single-stage buck-boost electric energy Conversion for renewable energy sources applications. [1]. The quasi-impedance source inverter (qZSI) was derived from basic impedance ZSI by rearrangement of the input side components to achieve lower voltage stress and continuous input current[2],[3]. This inverter provides buck operation by controlling the modulation index and boost operation in the Shoot-through state. The switched-boost inverter (SBI) was presented in [4] as a simpler alternative to the impedance ZSI that contains less components compare than normal ZSI. But this inverter has discontinuous input current and lower dc voltage gain compare than ZSI. In come up energy requirement with wide voltage variation like solar photovoltaic, wind, non-isolated inverters with high dc voltage gain are required for stable operation of grid injection. The boost inverters allow utilization of low voltage level and thus increase the energy level in unfavorable climatic conditions.

DC voltage gain can be improved using the following method such as IS network can be cascaded to enhance dc voltage gain [5], coupled inductors can be used to derive a new IS network with higher dc voltage gain [6]-[11] and switched-inductor and switched-capacitor cells implemented in IS network in [14]. From the all method has some problems such as requires additional passive components, duty cycle loss caused by leakage inductance of a coupled Inductor etc. In this paper QZSI and BSL-QZSI inverter circuit is proposed. The following sections explain the circuit operation and simulation results.

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II. CURRENT SOURCE SWITCHED INDUCTOR BASED BOOST QUASI IMPEDANCE SOURCE INVERTER

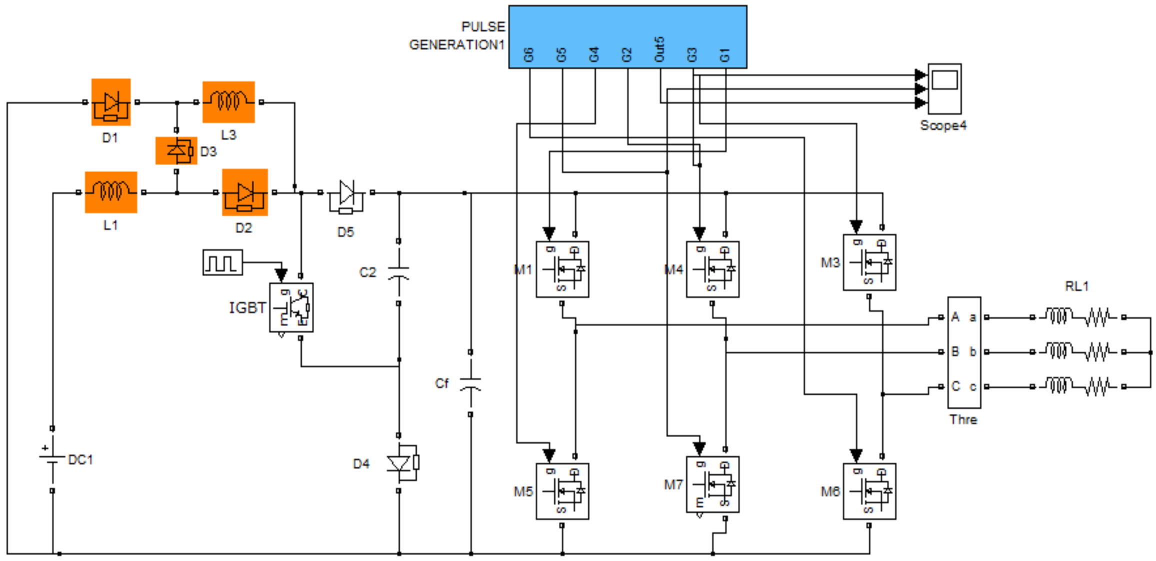

Figure 1. Current source BSL-QZSI

Figure 1 shows the circuit diagram of current source switched inductor based boost quasi impedance source inverter. This inverter has three modes of operation such as one shoot through mode and two active modes.

1) Shoot through state:

Equivalent circuit for this state is shown in Fig. 1a. Both switches are turned on in the same leg. The output of the active impedance network is short-circuited with the switch Sa. The input source voltage and the capacitor C1 are charging inductors L1, L2. In this circuit inductor current IL1 reaches higher value than the current IL2, considering that L1 = L2. The capacitor C1 is discharging with current (IL1+IL2) during this interval. The Switched inductors accumulate energy to be released during the active state. The duration of this interval is DS·T, where DS is the shoot-through duty cycle.

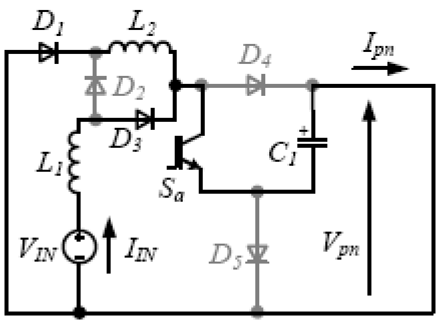

Figure 1a Shoot through state *SS*

2) First active state *A1*

During this time interval the inductors L1 and L2 start to release energy to the load. An equivalent circuit for first active state is shown in Fig. 1b. A process of current equalizing of the Switched Inductors defines this interval, which ends when currents of the SL inductors are equal. The diode D3 is conducting the surplus current (IL1 - IL2). Hence, zero voltage is applied to the inductor L2 and thus its current IL2 is constant, while the current IL1 is decreasing. The Switched inductor supplies the load current and charges the capacitor C1 simultaneously. The duration of this interval is DA1·T.

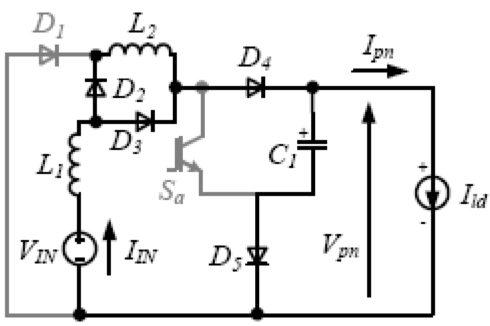

Figure 1(b) first active state *A1*

3) Second active state *A2*

During this time interval the SL inductors continue releasing energy to the load.

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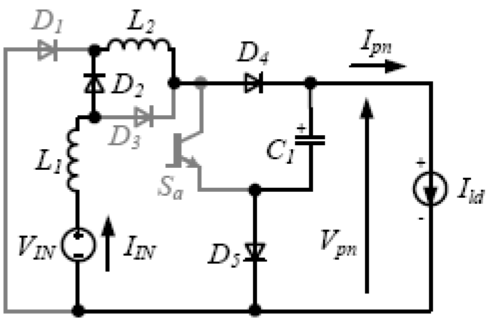
Equivalent circuit for Second active state A2 is shown in Fig. 1c. This interval ends at the end of the period, i. e. DA2 = (1 - DS - DA1). The diode D3 stops conducting because the currents of the SL inductors are equal: IL1 = IL2. These currents are decreasing with the same slope. The switched inductor continues supplying the load current and charging the capacitor C1 simultaneously.



(c) Second active state A2.

III. Quasi impedance source inverter (QZSI)

Fig 2 shows the quasi impedance source inverter circuit diagram. It consists dc source, quasi impedance network, three phase inverter and load. The impedance network is used to boost /buck the voltage as per the shoot through condition. this inverter has two modes of operation.

Figure 3 Shoot through mode

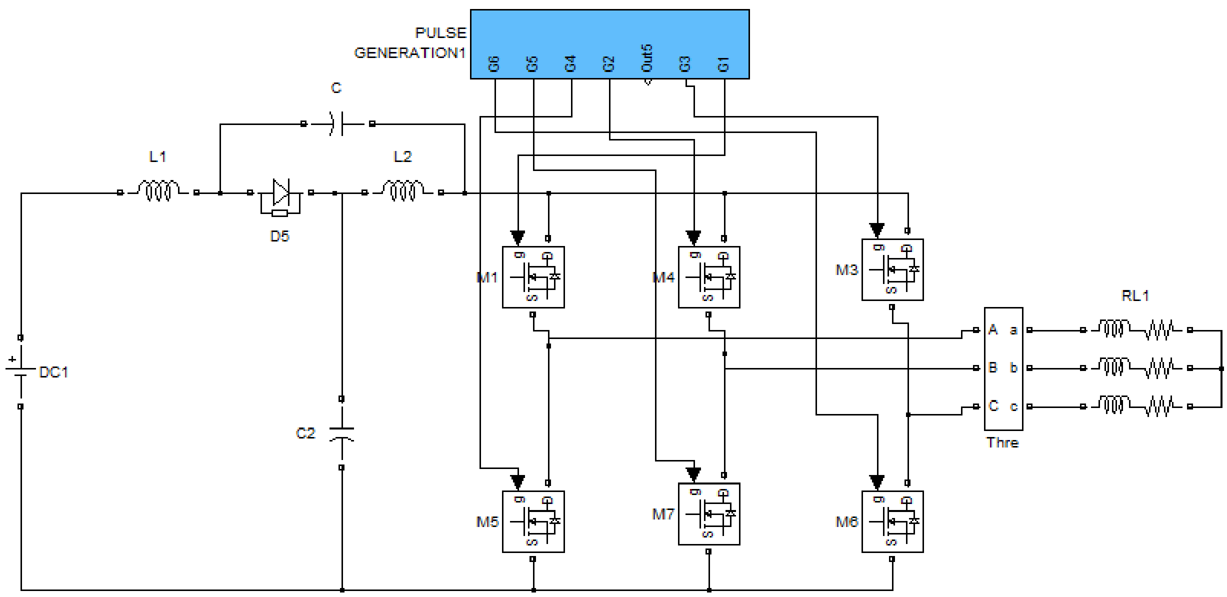


Figure 2 Quasi impedance source inverter circuit diagram

3.1 Shoot through mode

At the shoot-through state shown in Fig. 3, during this interval the one leg switch is shorted with short duration. At that time the current flow through inductor as shown in Fig 3.the capacitors transfer their electrostatic energy to magnetic energy stored in the inductors.

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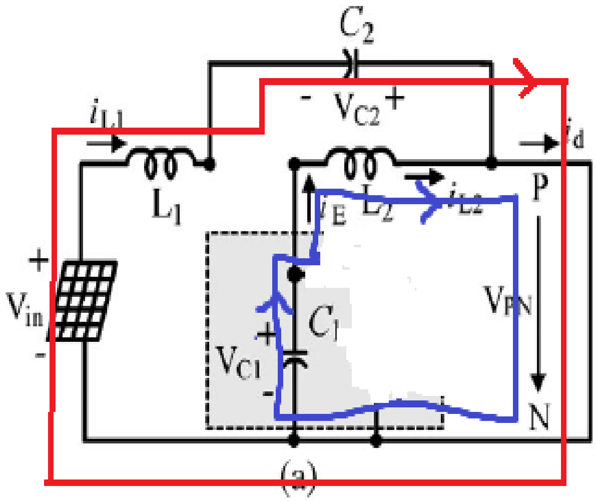

Figure 3

3.2 Non Shoot through mode:

At the non-shoot-through states shown in Fig. 4 the dc power source, as well as the inductors, charges the capacitors and powers the external ac load, boosting the dc voltage across the inverter bridge

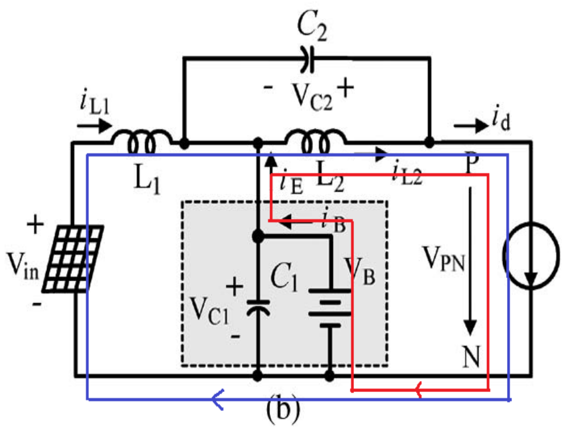

Figure 4 Non Shoot through mode

3.3 Control Technique:

Three phase ac volatge is taken as reference this reference signal is compared with triangular carrier signal. This control method is called as Sine PWM technique. During normal operation of the inverter, at any instant two device in same leg do not conduct. But proposed Z source inverter this operation is possible. This operation is called as shoot through mode. This pulse pattern as shown in the figure 5 and fig 6.

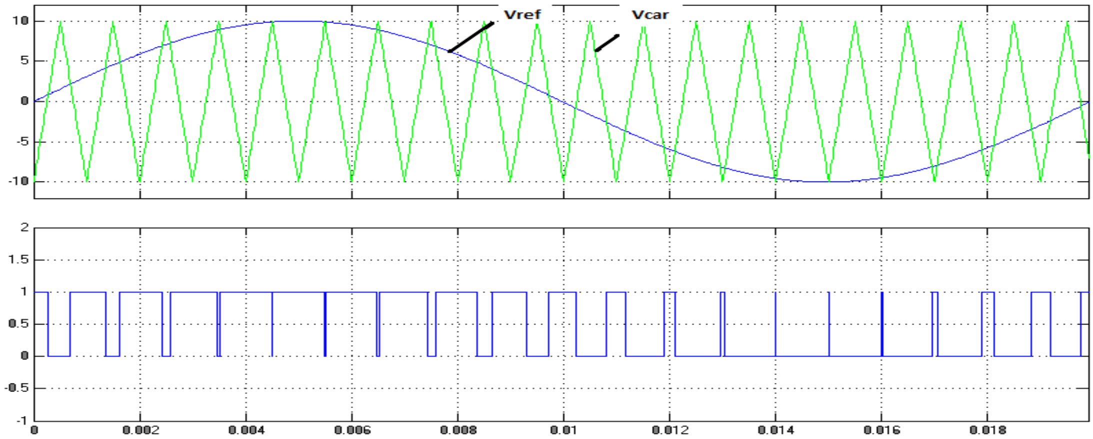

Figure 5 sine pwm generation method and pulse pattern

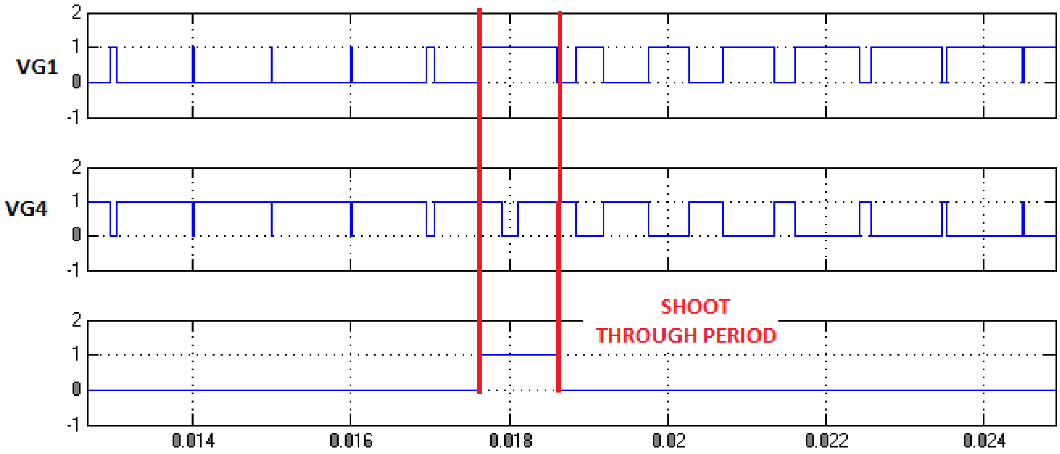

Figure 6, shoot through pulse pattern for switch s1 and s4

IV. SIMULATION RESULT

Fig 7 shows the Current source BSL-QZSI inverter circuit diagram. It consists of DC supply, impedance network, three phase inverter and load. The impedance network is used to boost the voltage as well as to protect the circuit during short circuit condition. The boost converter is used to regulate the dc link voltage is constant. Fig 8 shows the DC supply output voltage. Fig 9 shows the inverter output voltage. Fig 10 shows the inverter output current. Fig 11 shows the FFT analysis for current waveform. From this result the current has THD 29.72%.

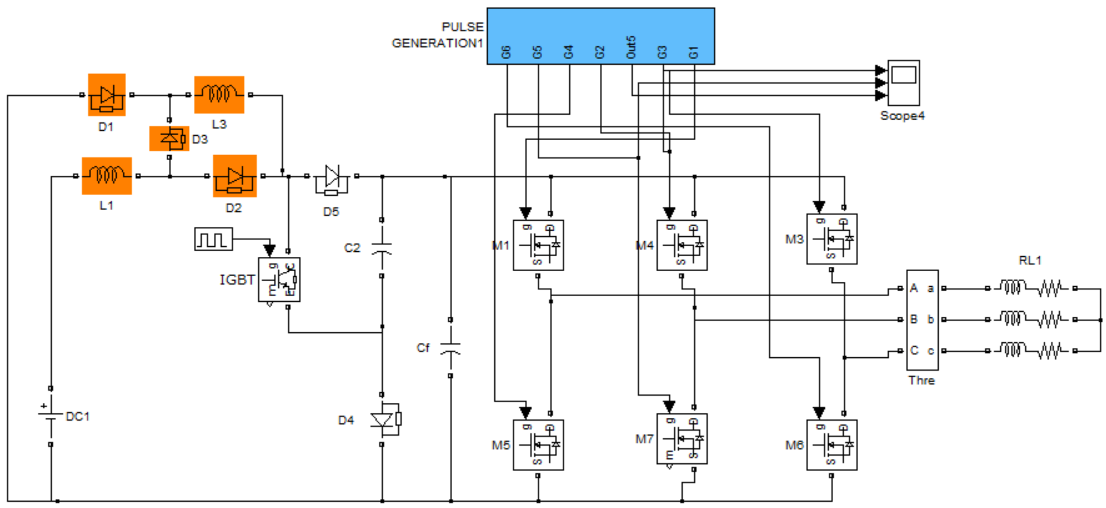

Fig 7 Current source BSL-QZSI inverter

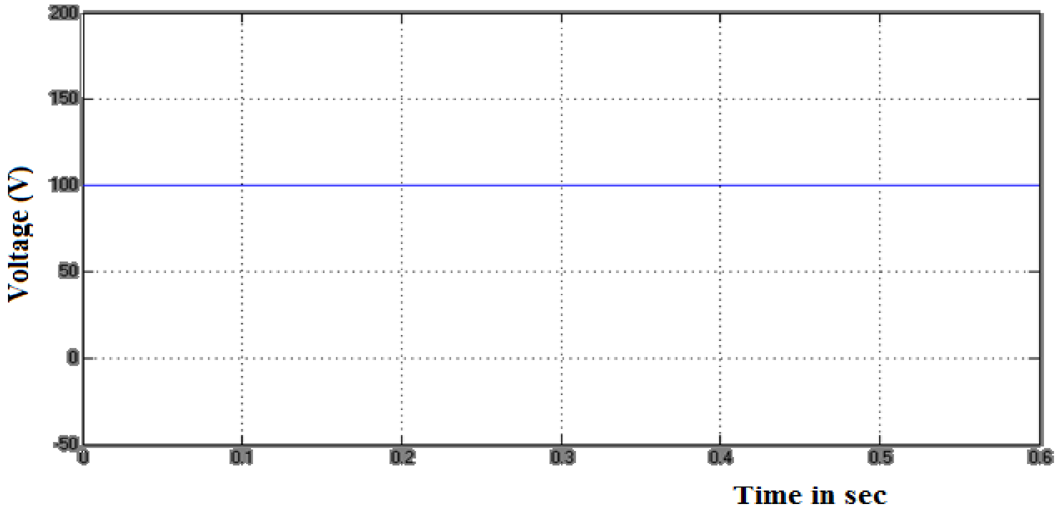

Fig 8 PV cell output voltage

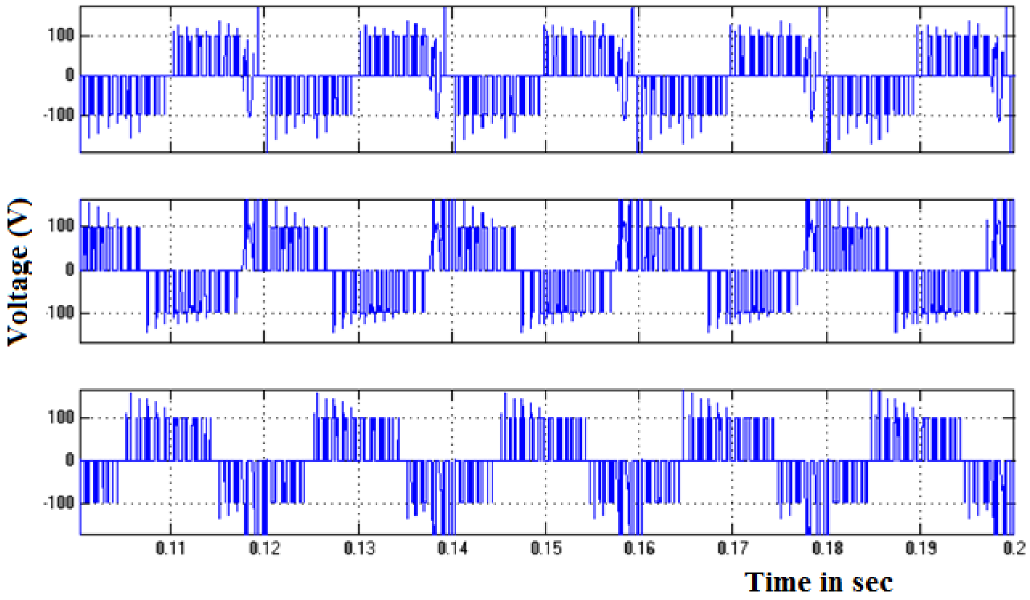

Fig 9 Inverter Line voltage

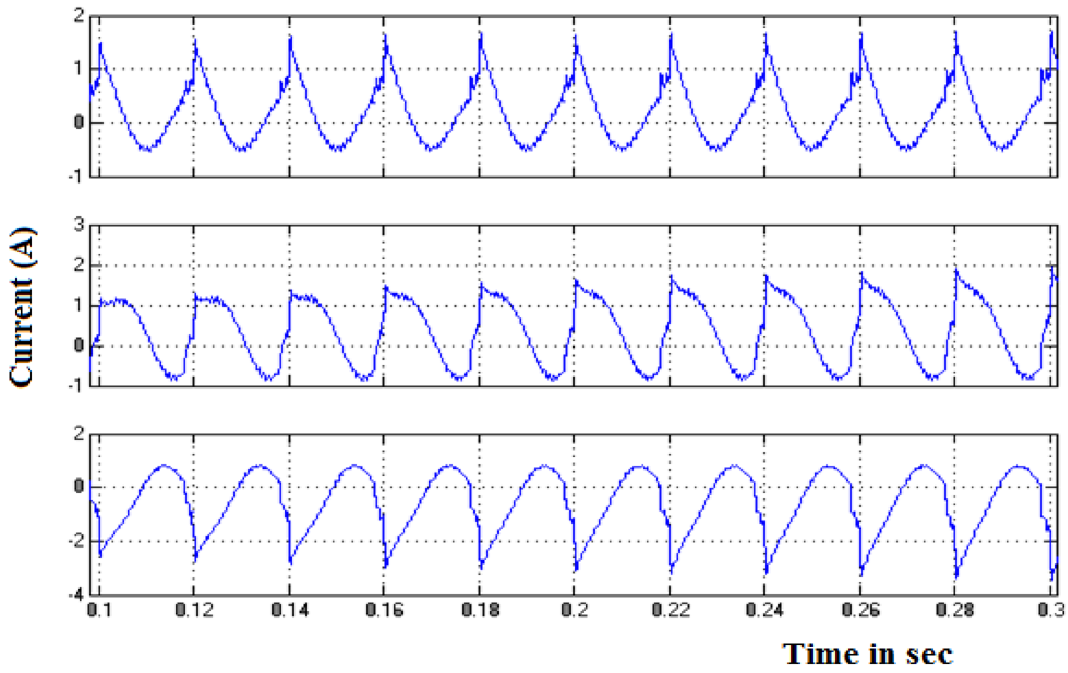

Fig 10 Inverter output current

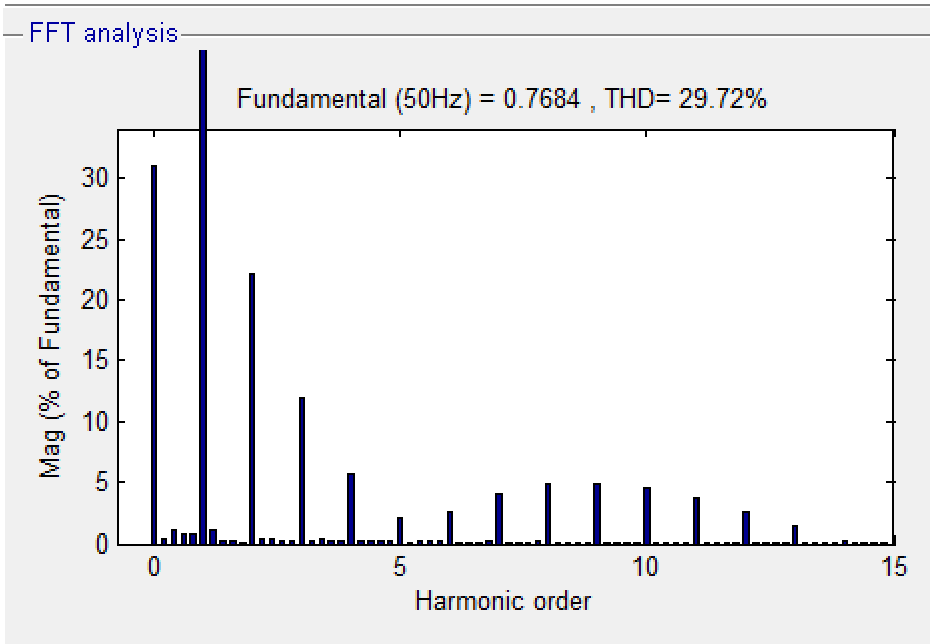

Fig 11 FFT ANALYSIS for output current

Fig 12 shows the proposed quasi z-source inverter circuit diagram. It consists of dc supply, impedance network, three phase inverter and load. The impedance network is used to boost the voltage as well as to protect the circuit during short circuit condition. Fig 13 shows the inverter output voltage. Fig 14 shows the inverter output current. Fig 15 shows the FFT analysis for current waveform. From this result the current has THD 8.64%.

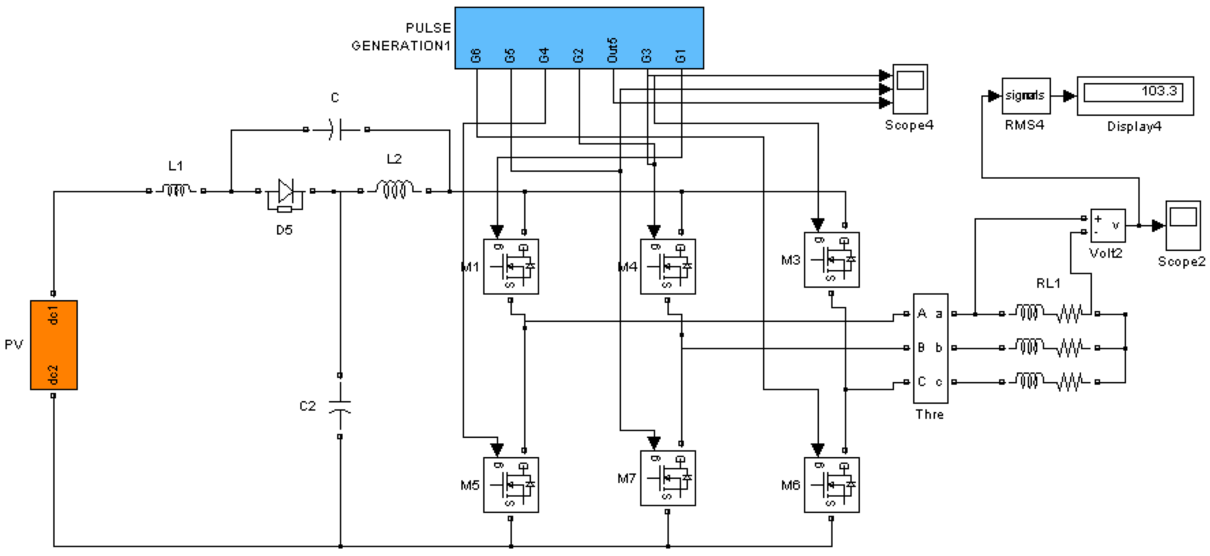

Fig 12 conventional Zsource inverter

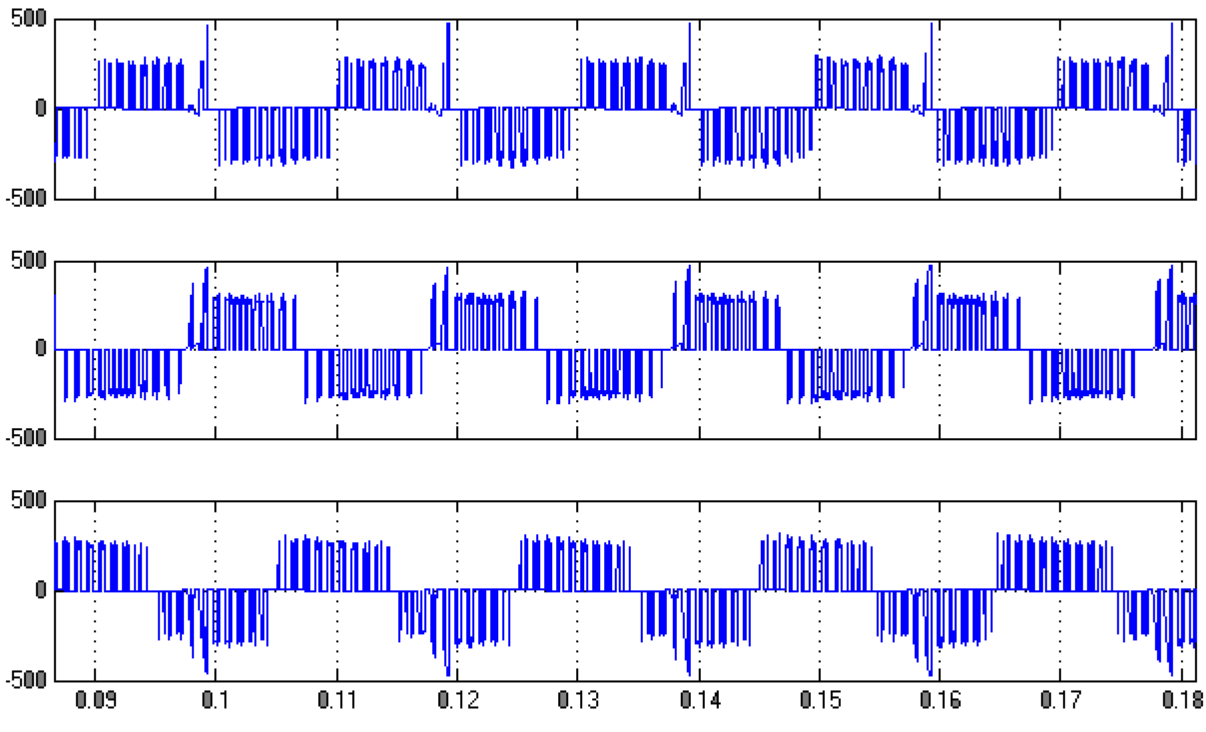

Fig 13 Inverter Line voltage

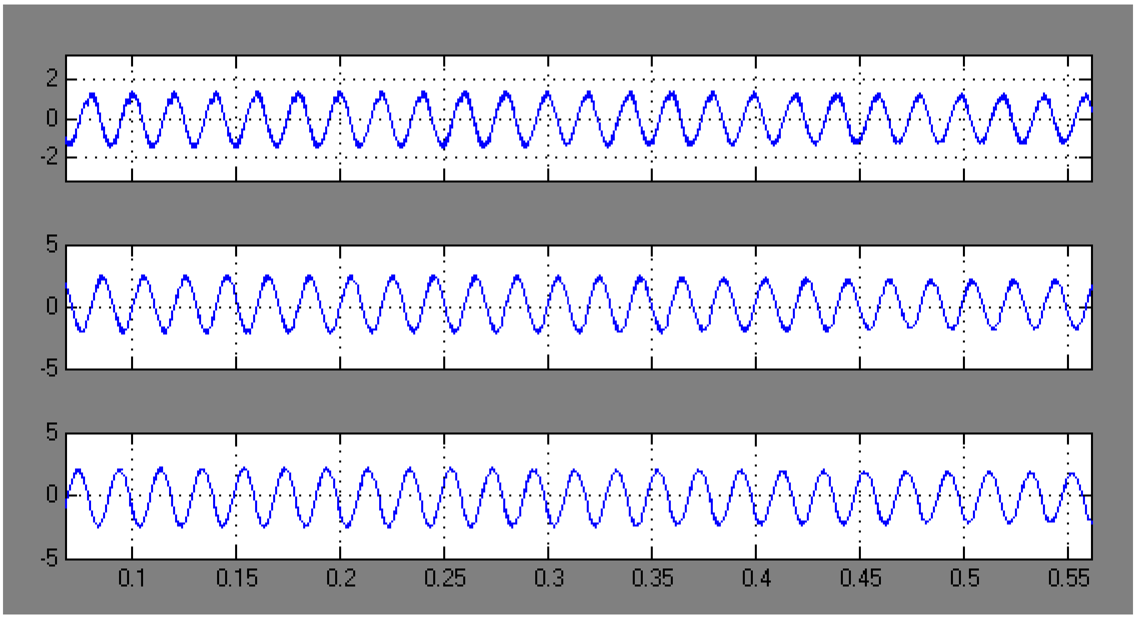

Fig 14 Inverter output current

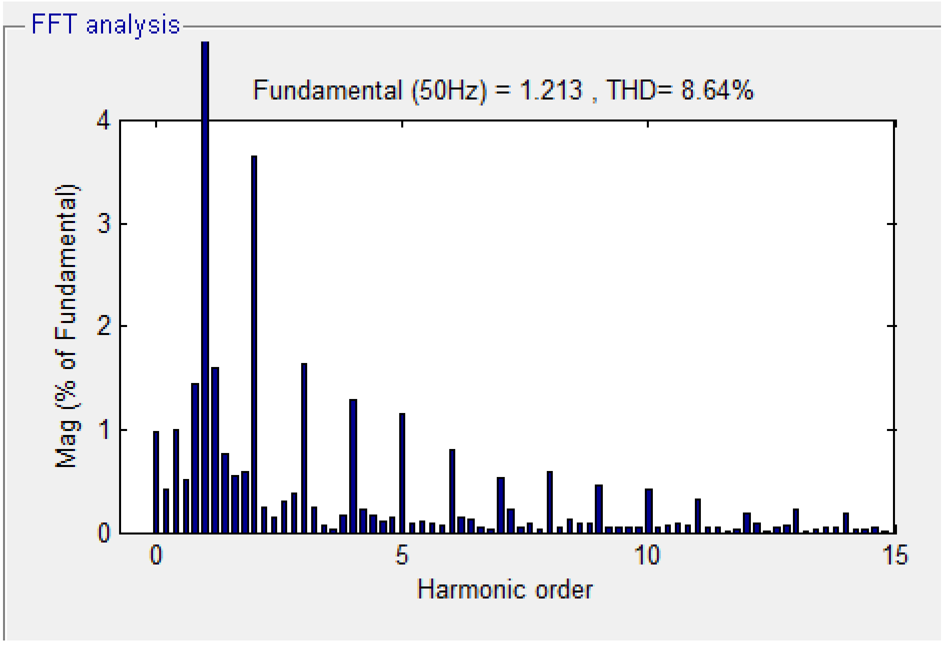

Fig 15 FFT ANALYSIS for output current

Comparative analysis

The circuit performances are analyzed based on simulation results. The input voltage, shoot through period, switching frequency and load values are taken common for both circuits. The **QZSI** has better voltage gain comparable than **SL-QSBI**. It is shown from table 1. The **QZSI** has less harmonic 8.64% comparable than **SL-QSBI** 29.72%.

Table(1)

Parameters	QZSI	SL-QSBI
Input dc voltage	100V	100V
Impedance network output voltage	216V	195V

Output current(RMS)	0.801A	0.62A
Phase voltage(RMS)	65	57
Line voltage(RMS)	119	71
THD%	8.64	29.72
Inductor	0.5mH	0.5mH
Capacitor	1000uf	1000uf

VI. CONCLUSION

The **QZSI** inverter and **SL-QSBI inverter** are simulated using Sine PWM technique in this paper. The **QZSI** has better voltage gain comparable than **SL-QSBI**. It is verified from simulation results. The **QZSI** inverter has less harmonic 8.64% compare than **SL-QSBI** 29.72%. The work extended further for implementation in hardware.

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