Volume 2, Issue 5, May – 2017 International Journal of Innovative Science and Research Technology
ISSN No: - 2456 - 2165

Comparison Between Traditional Inverter And Z-Source Inverter

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***Abstract*: The new Z-Source Inverter (ZSI) advantageously utilizes the shoot through state to boost the dc bus voltage by gating on both upper and lower switches of a phase leg and produce a desired output voltage that is greater than the available dc bus voltage. In addition the reliability of the inverter is greatly improved because the shoot-through due to misgating can no longer destroy the circuit. Thus it provides a low-cost, reliable, and high efficiency single stage structure for buck and boost power conversion. The proposed switched qZSI inherits all the advantages of the switched ZSI and features its unique merits. It can realize buck/boost power conversion in a single stage with a wide range of gain that is suited well for application in PV power generation systems. Furthermore, the proposed switched qZSI possesses continuous input current, reduced source stress, and lower component ratings when compared to the traditional ZSI.**

I. INTRODUCTION

Photovoltaic (PV) power generation is becoming more promising since, the introduction of the thin film PV technology due to its lower cost, excellent high temperature performance, low weight, flexibility, and glass free easy installation. However, there are still two primary factors limiting the widespread application of PV power systems. The first is the cost of the solar cell or module and the interface converter system; the second is the variability of the output (diurnal and seasonal) of the PV cells. A PV cell's voltage varies widely with temperature and irradiation, but the traditional Voltage Source Inverter (VSI) cannot deal with this wide range without over-rating of the inverter, because the VSI is a buck converter whose input dc voltage must be greater than the peak ac output voltage. Because of this a transformer and/or a dc/dc converter is usually used in PV applications, in order to cope with the range of the PV voltage , reduce inverter ratings, and produce a desired voltage for the load or connection to the utility. This leads to a higher component count and low efficiency, which opposes the goal of cost reduction.

The Z-Source Inverter (ZSI) has been reported suitable for residential PV system because of the capability of voltage boost and inversion in a single stage. Recently, four new topologies, the quasi-Z-Source Inverters (qZSI), have been derived from the original ZSI. This project analyzes one voltage fed topology of these four in detail and applies it to PV power generation systems. By using the new quasi-Z-Source topology, the inverter draws a constant current from the PV array and is capable of handling a wide input voltage range. It also features lower component ratings and reduced source stress compared to the traditional ZSI. It is demonstrated from the theoretical analysis and simulation results that the proposed qZSI can realize voltage buck or boost and dc-ac inversion in a single stage with high reliability and efficiency, which makes it well suited for PV power systems.

The new Z-Source Inverter (ZSI) advantageously utilizes the shoot through state to boost the dc bus voltage by gating on both upper and lower switches of a phase leg and produce a desired output voltage that is greater than the available dc bus voltage. In addition the reliability of the inverter is greatly improved because the shoot-through due to misgating can no longer destroy the circuit. Thus it provides a low-cost, reliable, and high efficiency single stage structure for buck and boost power conversion. The proposed switched qZSI inherits all the advantages of the switched ZSI and features its unique merits. It can realize buck/boost power conversion in a single stage with a wide range of gain that is suited well for application in PV power generation systems. Furthermore, the proposed switched qZSI possesses continuous input current, reduced source stress, and lower component ratings when compared to the traditional ZSI.

In this project delivered a power extraction of inversion circuit using Switched inductor quasi z source inverter (SL-QZSI) with less number of components and continuous current tracking capability of generation or source. The proposed SLQZSI offers no inrush current using common earthing circuit. Boost ratio and boost power factor is high compared with conventional switched inductor z source inverter. So it's capable of effective extraction of power from solar power generation. Number of passive elements such as inductor and diode count is greatly reduces even at high boosting factors. Simple boost PWM topology is used for verifying about proposed SLQSI and conventional SL-ZSI topology. The simulation performance is analysis using MATLAB/Simulink software and verified circuit is been implemented using PIC16F77 micro-controller.

II. EXISTING TOPOLOGY OF DC-AC INVERTER

Inverter is a power electronic circuit that converts DC power to AC power of desired magnitude and frequency. The inverters find their applications in modern AC motor and uninterruptible power supplies. DC to AC inverters are those devices which are used to produce inversion by converting a direct current into an alternating current. If the output of a circuit is AC then depending on the input i.e. either AC or DC, the devices are called as AC-AC cycloconverters or DC-AC inverters. DC to AC inverters are such devices whose AC output has magnitude and frequency which is either fixed or variable. In case of DC to AC inverters the output AC voltage can be either single phase or three phase. Also, the magnitude of the AC voltage is from the range of 110-380 VAC while the frequencies are either 50Hz, 60Hz or 400Hz.

The figureshows a circuit showing DC-AC inverter along with filters which are used to reduce the effect of harmonics to provide distortion free output ac signal. The front part of the circuit consists of AC to DC converters. If he output ac voltage is more distorted as compared to the reference ac voltage then filter circuits are used again to produce the desired clean sinusoidal AC voltage.

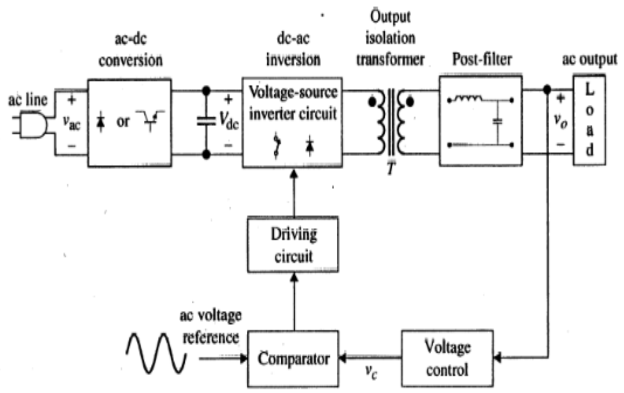


Fig 1 Power Electronic Circuit with DC-AC inverter

A. Current Source Inverter

The way each of the drive building blocks operates defines the type of drive topology. The first topology that will be investigated is the current source inverter (CSI). The converter section uses silicon-controlled rectifiers (SCRs), gate commutated thyristors (GCTs), or symmetrical gate commutated thyristors (SGCTs). This converter is known as an active rectifier or active front end (AFE). The DC link uses inductors to regulate current ripple and to store energy for the motor. The inverter section comprises gate turn-off thyristor (GTO) or symmetrical gate commutated thyristor (SGCT) semiconductor switches. These switches are turned on and off to create a pulse width modulated (PWM) output regulating the output frequency.

The design in Figure 7 implements cascaded SGCT devices to achieve a 4160V system rating. A gate driver is required for each of the switching devices to control the device switch timing.

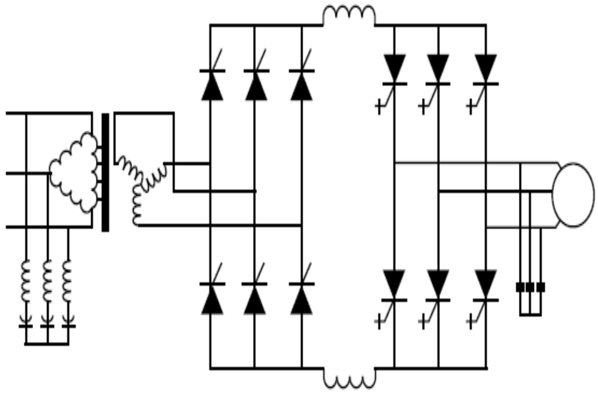


Fig 2 Current source inverter configuration

The CSI design requires input and output filters due to high harmonic content. The input (Figure 7) is similar to a low voltage (LV) drive six-pulse input. At higher horsepower, a six-pulse active front end (AFE) input creates harmonics in the power system and poor power factor. To mitigate this issue, drive manufacturers combine either input transformers or reactors and harmonic filters to reduce the detrimental effects of the drive on the power system at the point of common coupling (PCC).

B. Voltage Source Inverter

The inverter is composed of insulated gate bipolar transistor (IGBT) semiconductor switches. There are other alternatives to the IGBT: insulated gate commutated thyristors (IGCTs) and injection enhanced gate transistors (IEGTs). This paper will focus on the IGBT as it is used extensively in the MV VSI drives market. The IGBT switches create a PWM voltage output that regulates the voltage and frequency to the motor. The design in Figure 8 shows a neutral point clamped (NPC) three-level inverter topology. The IGBT switching devices are cascaded to achieve a 4160V system rating.

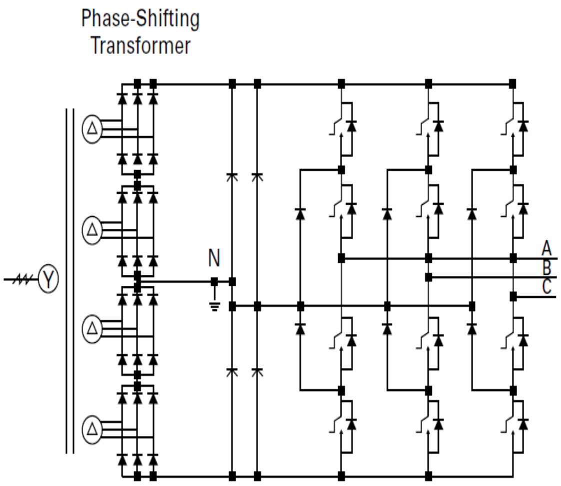
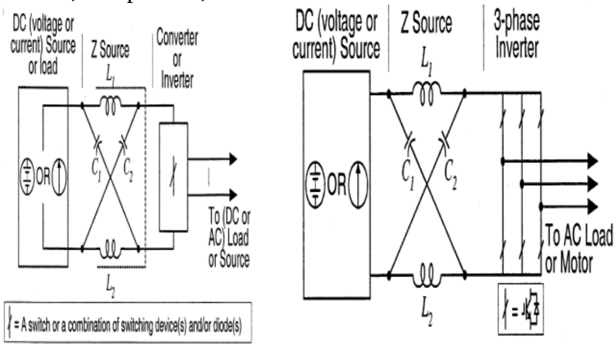


Fig 3 Voltage source inverter configuration

III. Z SOURCE INVERTER DESCRIPTION AND OPERATING PRINCIPLES

To overcome the above problems of the traditional V-source and I-source converters, this paper presents an impedance-source (or impedance-fed) power converter (abbreviated as Z-source converter) and its control method for implementing dc-to-ac, ac-to-dc, ac-to-ac, and dc-to-dc power conversion. Fig shows the general Z-source converter structure proposed. It employs a unique impedance network (or circuit) to couple the converter main circuit to the power source, load, or another converter, for providing unique features that cannot be observed in the traditional V- and I-source converters where a capacitor and inductor are used, respectively.

The Z-source converter overcomes the above-mentioned conceptual and theoretical barriers and limitations of the traditional V-source converter and I-source converter and provides a novel power conversion concept. In Fig.3.1 (a), a two-port network that consists of a split-inductor and and capacitors and connected in X shape is employed to provide an impedance source (Z-source) coupling the converter (or inverter) to the dc source, load, or another converter. The dc source/or load can be either a voltage or a current source/or load. Therefore, the dc source can be a battery, diode rectifier, thyristor converter, fuel cell, an inductor, a capacitor, or a combination of those.



(a) **(b)**

Fig 4 Z source configuration (a) general z source (b) anti parallel switch combination of z Source

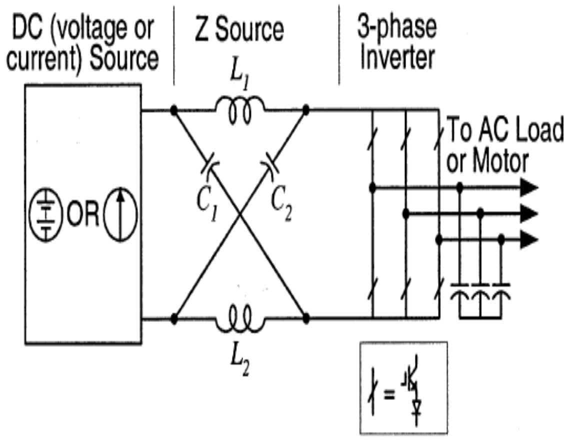


Fig 5 Series combination switches with z source circuit

IV. EQUIVALENT CIRCUIT, OPERATING PRINCIPLE, AND CONTROL

The unique feature of the Z-source inverter is that the output ac voltage can be any value between zero and infinity regardless of the fuel-cell voltage. That is, the Z-source inverter is a buck–boost inverter that has a wide range of obtainable voltage.The traditional three-phase V-source inverter has six active vectors when the dc voltage is impressed across the load and two zero vectors when the load terminals are shorted through either the lower or upper three devices, respectively.

Therefore, Fig shows the equivalent circuit of the Z-source inverter viewed from the dc link when the inverter bridge is in one of the eight nonshoot-through switching states. All the traditional pulsewidth-modulation (PWM) schemes can be used to control the Z-source inverter and their theoretical input–output relationships still hold.

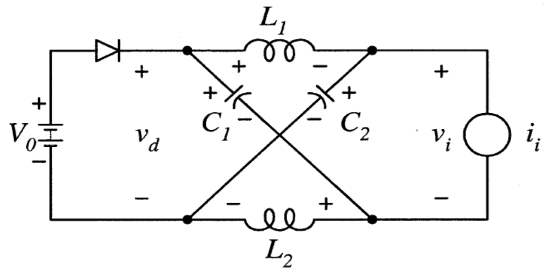


Fig 6 Equivalent circuit of the Z-source inverter viewed from the dc link

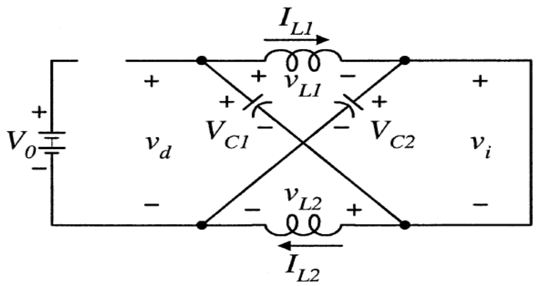


Fig 7 Equivalent circuit of the Z-source inverter viewed from the dc link

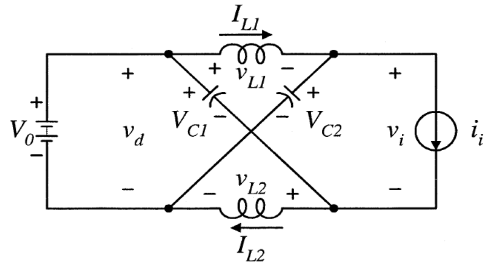


Fig 8 Equivalent circuit of the Z-source inverter viewed from the dc link

V. PROPOSED SWITCHED QUASI Z SOURCE INVERTER

The switched quasi-Z-source inverter (QZSI) is similar to the switched ZSI presented in fig. above, but has several advantages including in some combination; lower component ratings, reduced source stress, reduced component count, and simplified control strategies. a PV system with the topology of the switched QZSI is described.

The operation of SQZSI can be broken down into two states; the active state and the shoot through state. During the active state, the inverter is operated by the same manner as a standard voltage source inverter (VSI). But, the shoot through state occurs when both switches in at least one phase conduction. The voltage across the inverter, V_{pn} , during this state is zero. When the inverter is in the shoot-through state for the interval of To during a switching cycle of T_0 , the following voltage equations can be described from (3.1)

$$V_{c1} = V_{L1}, \quad V_{c2} + V_{in} = V_{L2}, \quad V_{L} = 0$$

When the inverter is in the active state for an interval of T1 , during a switching cycle of T . From the Fig we have,

$$V_{L1} = V_{c1} - \hat{V}_{out} = v_{c2}$$

$$V_{L2} = V_{in} - V_{c1} = V_{in} - \hat{V}_{out} + V_{c2}$$

The average voltage of the inductors, vL1, over one switching period of T should be zero in steady state, and from (2) and (3), we have

$$V_{L1} = \vec{V}_{L1} = \frac{T_0 V_{c1} + T_1(-Vc1)}{T} = \frac{T_0 V_{c1} + T_1(V_{c1} - \hat{V}_{out})V_{c1}}{T} = 0$$

$$T_0(V_{c1}) = T_1 {}^* V_{c2},$$

$$V_{c2} = \frac{T_1}{T}\hat{V}_{out}$$

$$V_{c2} = \frac{T_0}{T}\hat{V}_{out}, \quad \hat{V}_{out} = V_{c1} + V_{c2}$$

Switching period of T should be zero in steady state, from (1), (2) and (3), we also have

$$V_{L2} = \vec{V}_{L2} = \frac{T_0(V_{C2} + V_{in}) + T_1(V_{in} - V_{c1})}{T}$$

$$\frac{T_0(V_{c2} + V_{in}) + T_1(V_{in} - \hat{V}_{out} + V_{c2})}{T}$$

$$V_{out} = \frac{T}{T_1 - T_0} V_{in}, V_{in} = V_{c1} + V_{c2}$$

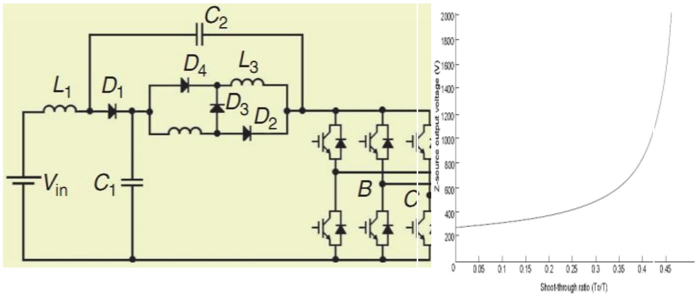
Similarly, the average dc-link voltage across the inverter bridge can be found as follows:

$$V_{out} = \frac{T_1(V_{c1} + V_{c2})}{T} = V_{c1}$$

By solving 5, 6 and 7 is given by

$$V_{out} = V_{c1}\frac{T_1}{T_1 - T_0}V_{in}$$

From last equation , it is well defined that the input voltage of SLQZSI can be boosted by using the shoot-through ratio. Figure 17 shows the relationship between the Z-source output voltage and the shoot-through ration.



(a) (b)

Fig 9 Configuration of SLQZSI (b) Boosted voltage by shoot-through time

If this shoot-through ratio is not controlled well, the system can be affected by this. During the shoot-through state, in case of SLZSI, the input current is zero due to the blocking diode. But this current is the output current of PV array and so, it should be continuous for the MPPT control. In case of the SLQZSI, the input current is continuous. The output voltage of SLZSI and SLQZSI is zero during the shoot-through time interval.

VI. SIMULATION RESULTS

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

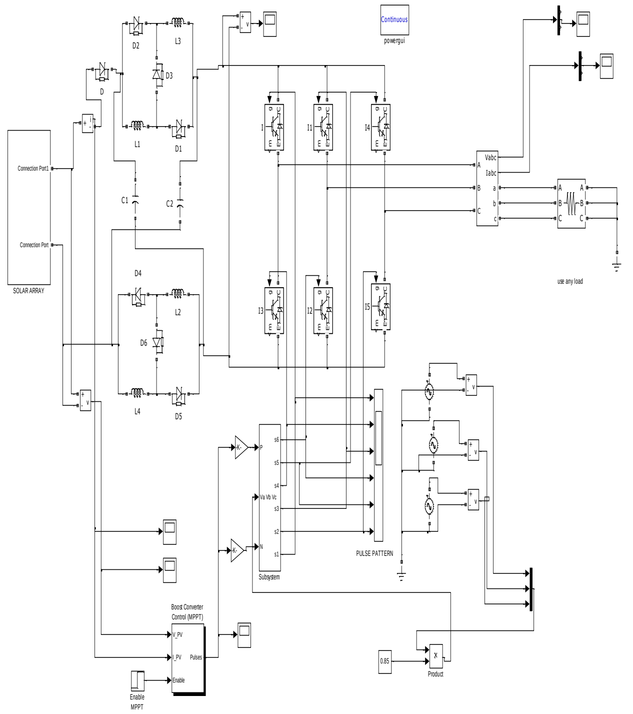


Fig 10 Implementation circuit of Zsource inverter

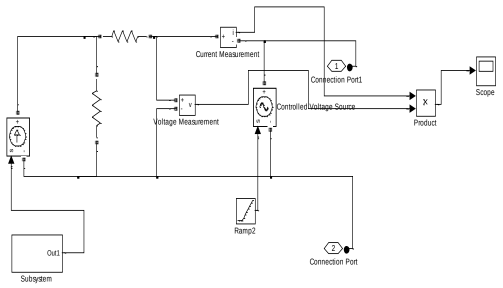


Fig 11 Photovoltaic circuit

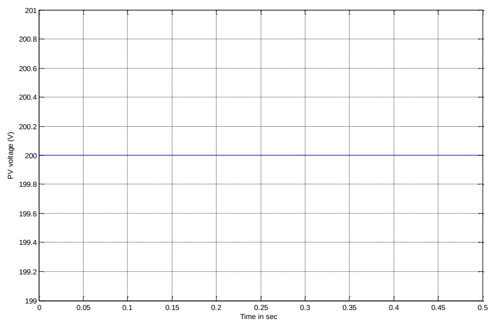


Fig 11 Input voltage performance

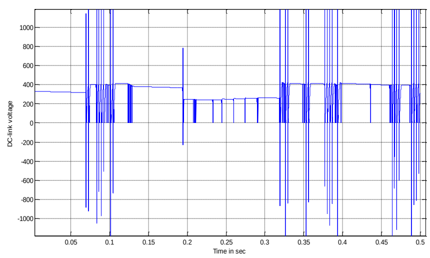


Fig 12 DC-link voltage

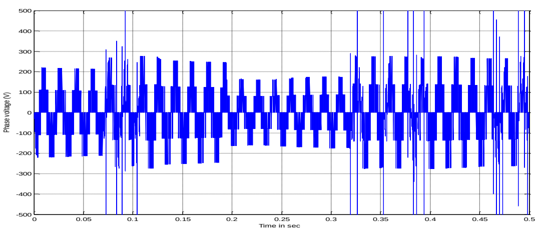


Fig 12 SLZSI -Phase voltage

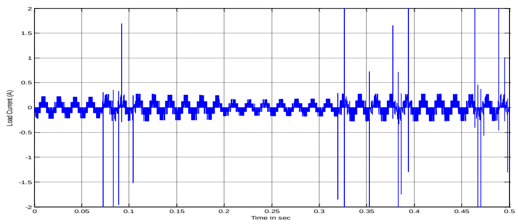


Fig 13 SLZSI -Phase current

A. Proposed switched quasi z source inverter implementation and results

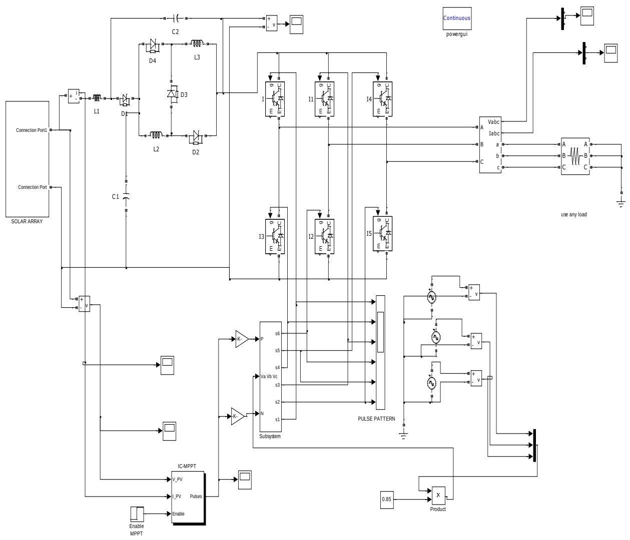


Fig 14 Implementation circuit for switched quasi z source inverter

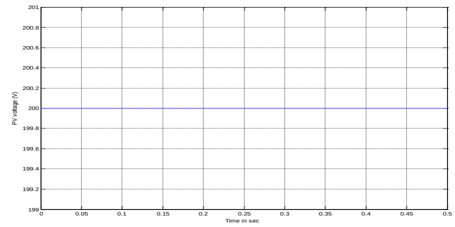


Fig 15 Input voltage performance

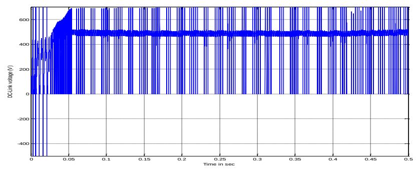


Fig 16 DC-link voltage

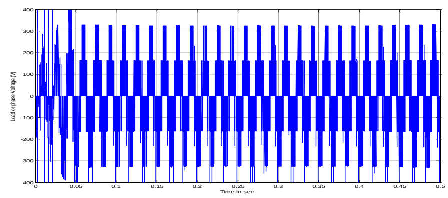


Fig 17 SL-QZSI -Phase voltage

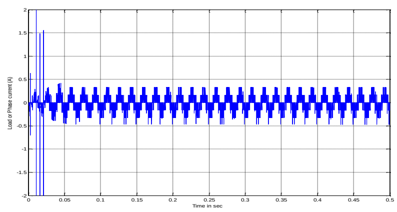


Fig 18 SL-QZSI -Phase current

VII. SIMULATION RESULT INPUT PARAMETERS

Parameter	Range
PV	400W/200V
Inductor (L)	1mH
Capacitor (C)	800uF
Switching frequency (Hz)	500Hz
System power (Load)	162
Load voltage	325
Utility grid frequency(Hz)	50

Table. System parameters

VIII. CONCLUSION

This paper is analysing and design of switched quasi z source inverter fed photovoltaic power source for grid connection system using simple boost PWM controller. Incremental conductance algorithm is presented in maximum power point tracking to extract and improve the efficiency of photovoltaic source or generation. The adequate interfacing or matching of boosted power was obtained using switched quasi z source inverter network for utility grid or AC load application. The performance of switched quasi network was obtained using desired simple boost PWM approach and enough control of power is obtained using proposed MPPT topology. The simulation result is proved that proposed configuration enough to meet utility demand and high efficiency performance in generation of PV over classical switched z source inverter circuit.

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