A Non-Linear Control Technique for Single Phase qZSI

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Abstract:
Quasi-Z-source inverters, or qZSIs, are a common type of inverter used in transformer-less systems because they can boost or buck input voltage without a requirement for a DC- DC converter. A transformer is not necessary for the qZSI's single-stage conversion to operate as a grid-tie converter. In transformer-less designs common mode current is the major problem, though, because there is no galvanic isolation. To reduce the common mode current, this article offers controlling the qZSI using a modified pulse width modulation (PWM) approach two additional semiconductor switches. The developed methodology provides a practical means of integrating solar photovoltaic systems into the grid. what the recommended topology's attributes should be:
1)It uses the phase-leg shoot through to boost the direct current and voltage to required level by eliminating the need for a second dc-dc converter.
2) Freewheeling is achieved while removing PWM deadtime by employing extra linked switches.

Keywords: Photovoltaic, input-output feedback linearization, zero dynamics, non-linear control, quasi-Z-source inverter.

1 Introduction

Because of the depletion of fossil fuels, growing environmental concerns, and rising global energy consumption, it is essential to use clean energy sources. There are a number of alternatives being created, one of which is solar photovoltaic (PV), it the most promising sources of Renewable energy(RE). Solar Photo Voltaic systems can be used in grid-interactive mode to supply electricity to a utility grid or in standalone mode to supply load directly. In order to feed an AC load in standalone mode or to feed the utility grid at a specific voltage(V) and frequency(F), solar PV systems inevitably need an interface inverter.

1.1 Preface

Transformers of some kind are usually used in grid-connected solar PV inverter circuits to connect to the grid, avoid Direct Current injection, and reduce or it eliminate the leakage losses common mode. These transformers are significant, costly, and have a lower overall system efficiency since they are line frequency rated. It is one among the fastest-growing Renewable energy sources; therefore, to reduce the volume and expense, a high frequency transformer is used on the Direct Current side. A solar photovoltaic system operating in standalone mode can provide power to a load directly. It can provide electricity to a utility grid when in grid interactive mode. When using a solar photovoltaic system, an interface inverter is always required, either to supply an AC load in independent mode or to supply a particular voltage and frequency to the electric grid.

1.2 Objective

The information from the literature review is sufficient to pursue the following objectives in order to answer the problem statement that is mentioned in this section.

An improved voltage boost: Because many applications call for high voltage levels, the qZSI's ability to enhance output voltage is a useful feature. For applications requiring high voltage boosts, the qZSI is a desirable alternative since it can produce higher voltage gains than conventional Z-source inverters.

1. **Improved efficiency:** When compared to other kinds of inverters, the qZSI can offer enhanced efficiency because it is made to minimize losses that happen during energy conversion. This is achieved by reducing switching losses and raising the system's power factor.
2. **Increased dependability:** Compared to other inverter types, the qZSI has a simpler topology, which increases its reliability and ease of maintenance. Furthermore, it is cheaper to produce and implement because to the simpler topology.
3. **Improved power quality:** The qZSI can provide better power quality than other types of inverters, which is important in applications where a stable and reliable power supply is required. The qZSI can reduce the harmonic distortion in the output waveform, resulting in cleaner power.

The overall goal of the qZSI's research is to provide a power converter that, when combined with a high voltage boost and enhanced power quality, is more reliable, effective, and affordable than other kinds of inverters.

2 Existing System

This Fig.1 addresses the block diagram paradigm, functionality, benefits, and drawbacks of the current system.

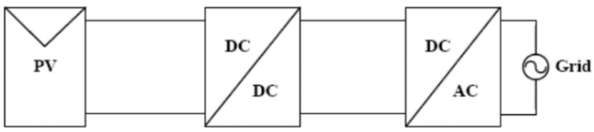

Fig. 1. Block Diagram of Existing System.

There is more work to be done on the application of Z-source networks in DC- DC power conversion, as the majority of studies on these networks now concentrate on dc-ac power conversion. The current study extends Z source networks to DC- DC converters with boost capabilities by offering a range of hybrid Z source boost DC- DC converters that are created by varyingly combining regular Z-source/qZ-source network. As a result, the Z-source/qZ-source networks are merged, preserving all the benefits of the conventional Z-source/qZ-source networks while improving the boost capabilities of the hybrid Z-source networks. The aforementioned benefits render the suggested converters ideal for photovoltaic power systems, whereby a high step-up capacity dc-dc converter is typically required. It is possible to use the proposed hybrid Z-source networks for DC- AC, AC- AC, and AC- DC networks like conventional Z-source network.

2.1 Existing Systems Technique

1. Push- Pull Inverter Topology
2. Integrated dual output converter
3. High frequency transformer
4. Controlling a PEM fuel cell battery system that is linked to the grid in only one cycle.

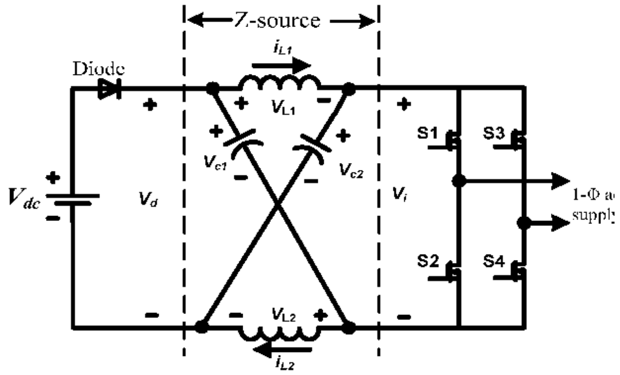

Fig. 2. Circuit Diagram of Existing System.

3 Proposed System

The block diagram and model are covered in the section on the suggested system.

The Z-source inverter is not harmed by large variations in the input DC voltage. A single stage PEC called the ZSI may boost an input dc voltage by up to 200%. In solar PV systems that support output voltage fluctuations, this type of inverter is common. This inverter design's main benefit is its capacity to do simultaneous inversion and boosting without overtaxing the inverter. Because there are fewer components in the system's architecture, it is more reliable, more efficient, and costs lower. With a quasi-circuit architecture and constant input current, the quasi ZSI variant

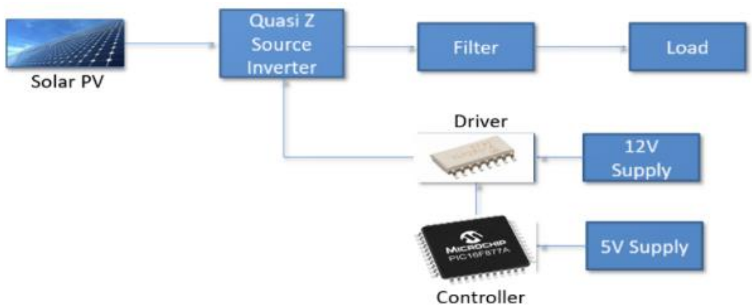

Fig. 3. Block Diagram of Proposed System.

The suggested quasi-topology in Figure 3 is not isolated. One diode, two wires, and two capacitors make up the source side. Partially divided, the source side conductor is evenly linked to the forward (L1) and return (L2) routes. Assumed to be equivalent capacitors are C1 and C2. The typical quasi is composed of these components. The ground, both positive and negative PV terminals, and both combine to generate two stray capacitors (Cp v) with a half-life of nanoseconds. The diodes D5 and D6 are accompanied by two more switches, Q5 and Q6. The two little wires, L01 and L02, that link the grid to the inverter are there for filtering purposes. Q5 and Q6, additional switches, are commutative at the grid frequency. Moreover, the extra switches offer decoupling between the PV array and the grid in addition to maintaining the fixed potential of half of the boosted voltage at terminals A and B. It should be mentioned that the additional switches have very little—if any—switching losses when they are used since they operate at grid frequency. The HB switches function at the switching frequency, while the additional switches run at the grid frequency (50 Hz).

3.1 Quasi Z Source Inverter's Working Principle

The recommended inverters have output voltage capabilities that are equivalent to a full bridge inverter

(+V in to V in). If S1's duty cycle is set to (00.5), the inverter may produce a positive output voltage; if S1's duty cycle is set to (0.52/3), the o/p voltage(V) may be negative. When the duty cycle is equal to 0.5, the quasi-Z-source inverters could output 0 V. The induction current and capacitor voltage reference directions are shown in the illustration for the following steady state equation.

3.2 Quasi Z Source Inverter Modulation

Generalizing the appropriate conduction time of each switch of 2phase legs is possible using two sinusoidal voltage references, vA* and vB*. Compare these references to a triangular carrier voltage and you will see a 180 degree phase change. To extend the shoot-through zero state, two straight lines, vP* and vN*, are employed. In the conventional Z source inverter, the shoot through duty cycle may be changed to provide a different voltage boost..

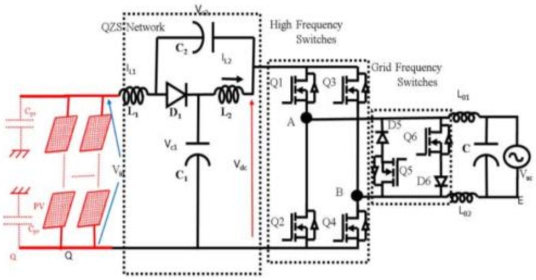

Fig. 4. Circuit Diagram of Proposed System.

3.3 Quasi Z Source Inverter Operation Modes

We develop a unique PWM approach and propose a modified switching signal generation for the control of the qZSI as demonstrated. Three different switching states are generated: powering, FW, and ST. When PV sources are feeding energy into the grid, they are operating in "powering" mode. In order to raise the dc source voltage, this kind of switching—known as ST state—involves shorting the inverter legs. During the ST phase, the grid's additional switches and source side capacitors are crossed by circulating current while the inverter remains disconnected.

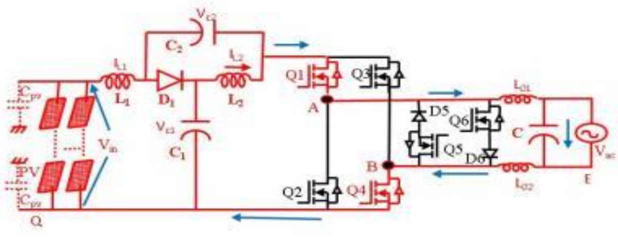

Fig. 5. Powering Mode of qZSI.

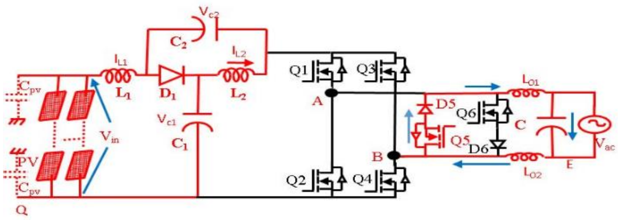

Fig. 6. Freewheeling Mode of qZSI.

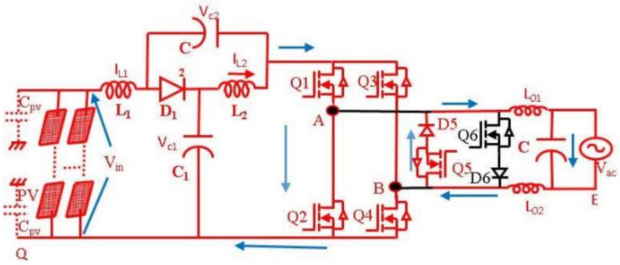

Fig. 7. Shoot through Mode of qZSI.

4 Simulation

The regulation of energy flow between RES (such solar or wind power) and the power grid is accomplished through the employment of non-linear control strategies for 1Φ qZS grid-connected inverter. One kind of power converter that is appropriate for use in RES is the qZSI, which may increase or decrease the voltage of a DC power source. This kind of inverter's non-linear control technique uses a feedback loop to modify the output voltage(V) and current(I) in the inverter response to variations the input power(P) and grid settings.

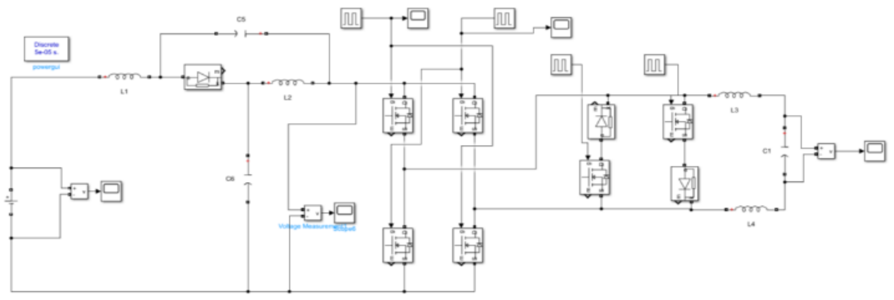

Fig. 8. Simulation Model of Z-Source Inverter

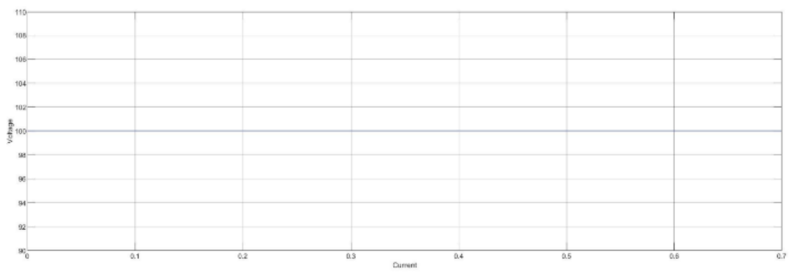

Fig. 9. DC Input Voltage

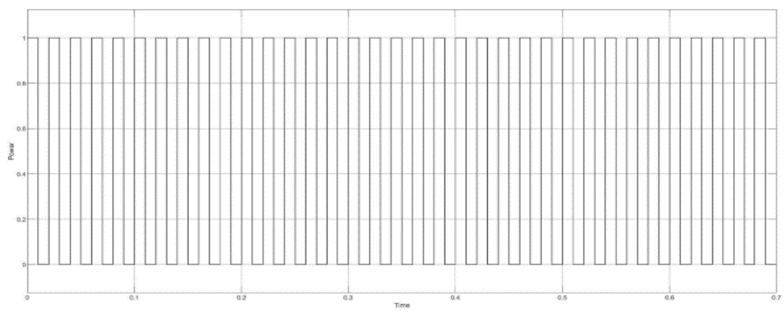

Fig. 10. Pulses for Switch S1

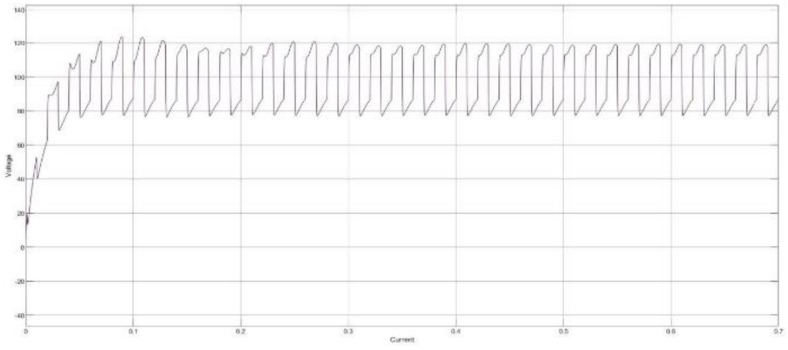

Fig. 11. AC Link Output Voltage

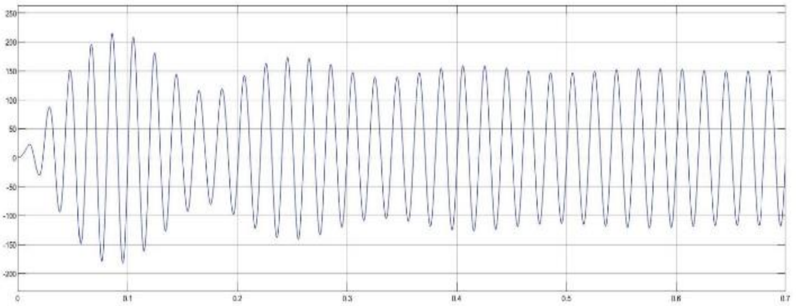

Fig.12. AC Output Voltage

5 Hardware Implementation

5.1 Introduction

A PIC micro-controller is used in the hardware system of the suggested converter. The PIC controller's pulse coding scheme is designed using software systems like as Proteus, Mplab, and Micropro. The PIC and driver circuit are designed by the power supply circuit to drive the pulses to the MOSFET.

5.2 Hardware Components

Table 1. Hardware Components.

Hardware Components	Rating
Transformer	230V/12V
Capacitor	1. 2.2µF,450V 2. 1000µF,5V, 3. 33 AEO, 4. 47µF,63V
Driver - TLP 250	7-10 mA
MOSFET (7)	IRF 840
Micro Controller-PIC16F877	
Diode IN 007 (9)	-
Transistor l7805CV	5V
Crystal Oscillator	4MHz
Resistor (8)	470 Ohms
Capacitor	1. 2.2µF,450V 2. 1000µF,5V,

	3. 33 AEO, 4. 47µF,63V
Driver - TLP 250	7-10 mA
MOSFET (7)	IRF 840
Micro Controller-PIC16F877	1000 Ohms
IC FAN7392 N (2)	20 ns 3A
LED (2)	-
Inductor DIP	2 Amps
Heatsink (7)	-

5.3 Hardware Setup

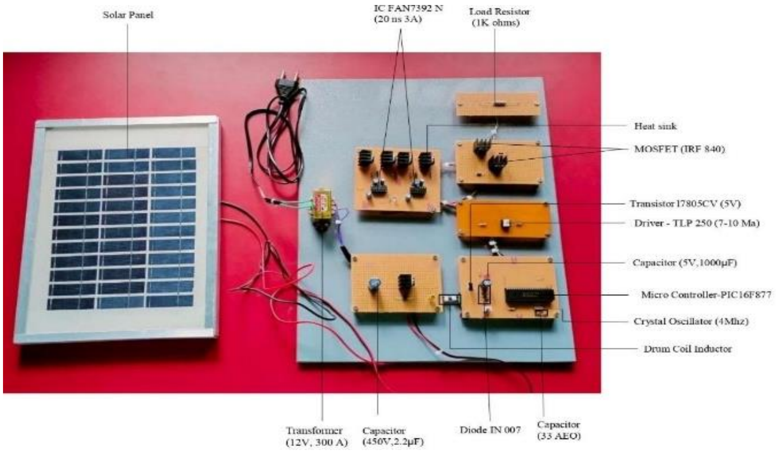

Fig. 13. Hardware Model of Quasi Z-Source Inverter

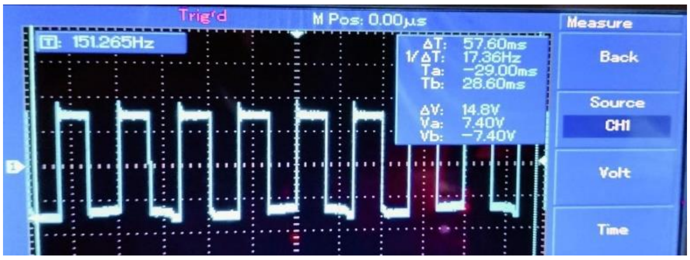

Fig. 14. Pulses Switch1 Waveform

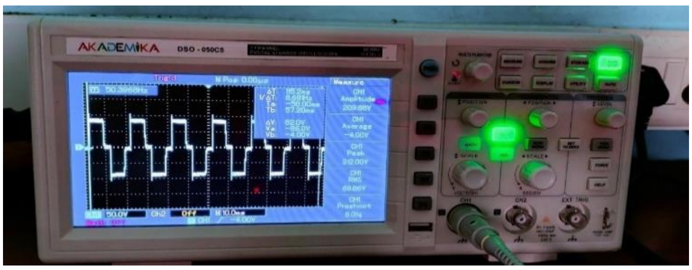

Fig. 15. Waveform of AC Output Voltage

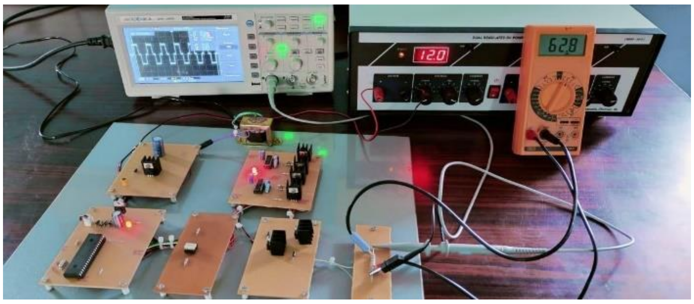

Fig. 16. Multimeter Reading of AC Output Voltage

5.4 Discussion

A transformer is a passive electrical component that moves electrical energy between one or more electrical circuits. This step-down transformer, model 12-0-12 12V 2A, is used. It outputs 12V, 0V, ground, or both 12V and 0V. Step-down functionality in this transformer lowers 230V AC to 12V AC. The power rating for this transformer is 2A.

A driver is a circuit that controls another electronic device, such as a high-power transistor, a liquid crystal display (LCD), or any number of other electronic devices. In order to regulate power switches in quasi conductor devices, driver circuits are most frequently employed to enhance signals from controllers or microcontrollers.

The MOSFET is one type of FET that is often created by carefully regulating silicon oxidation. The conductivity of the gadget is controlled by the voltage of its isolated gate. This material's ability to alter conductivity in response to applied voltage can be used to switch or amplify electronic signals.

6 Conclusion

Numerous non-isolated, single-phase, single-stage qZSI are proposed in this paper. It is a low-cost micro inverter that is especially useful for grid-connected low-voltage applications involving photovoltaic (PV) panels. A quasi-Z-source inverter employs complimentary control over its two switches, but a standard 1Φ Z-source inverter adds an additional shoot through zero state to give the boost function. The leakage current from the PV panel is virtually eliminated because the input DC source and the output AC voltage share the same ground. After summarizing the topology expansions, other inverter topologies based on the same notion may be developed. To demonstrate the distinct characteristics and validate the accuracy of the suggested circuit, a prototype of a 1Φ qZSI has been built and evaluated. A 200 W prototype with a 110V o/p Voltage (V) is also being developed for low voltage grid connection applications; more results from modeling and experiments will be included in a later article. Z-source inverters are similar to power inverters, which are circuits that convert DC- AC. It functions as a buck-boost inverter without the need of a DC- DC converter bridge because of its unique design.

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