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# Analysis of the Performance of the Drive of the Z Source Induction Motor Powered by the Converter

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**Abstract -** This paper presents power analysis and simulations of maximum constant boost control with third harmonic injection methods for the Z-well inverter that provide maximum boost for a modulation index. fixed. The Z-Source inverter is a newly invented power conversion concept designed primarily for fuel cell applications in automobiles. The Z-source inverter is very advantageous over traditional inverters and can be used in all AC and DC conversion applications. All conventional PWM techniques can be used to control a Z-source inverter. The maximum constant rise control techniques eliminate low frequency ripples in the inductor current and in the capacitor voltage while maintaining the duty cycle while minimizing the voltage limitations of the switching devices. The maximum gain control method is suitable only for a relatively high output frequency, in the maximum constant gain control method, however, the structure of the Z source network is independent of the output frequency and is determined solely by the determined switching frequency. This article describes the Z parameters of the source inverter such as the boost factor, the output DC link voltage, the capacitor voltage, the output AC voltage, the voltage gain, and so on. are determined experiences. presents performance analysis and simulation of maximum constant boost-control with third harmonic injection methods for the Z-source inverter, which can obtain maximum voltage boost for a fixed modulation index. The Z-source inverter is a recently invented a new power conversion concept mainly developed for fuel cell vehicular applications. The Z-source inverter is very advantageous over traditional inverters and it can be employed in all ac and dc power conversion applications. All traditional PWM methods can be used to control Z-source inverter. Maximum constant boost control methods eliminates the low-frequency ripples in the inductor current and capacitor voltage by maintaining the shoot-through duty cycle constant, and minimize the voltage stresses of switching devices at the same time. The Maximum boost control method is suitable for relatively high output freq uency only, but in the maximum constant boost control method the Z-source network design is independent of the output frequency and determined only by the switching frequency. In this paper Z-source inverter parameters such as boost factor, output dc link voltage, capacitor voltage, output ac voltage, voltage gain etc. are determined for maximum constant boost control method for a fixed modulation index and these results are verified by simulation and experiments.

**Index Terms-** traditional inverters, ZSI- Z-Source Inverter, VSI-Voltage Source Inverter Z-Source Inverter fed Induction Motor, voltage boost, boost factor, PWM, third harmonic injection, voltage gain.

## I. INTRODUCTION

The energy demand is rising worldwide every day. Non-renewable energy sources such as coal, oil and natural gas can not be recovered once the storage of these fuels has been used. The demand for renewable energy sources is increasing worldwide. All renewable energy sources are expected to play an important role in future energy production [1] - [5]. Photovoltaic cells convert solar energy into electrical energy. PV plants can be divided into autonomous plants and plants connected to the network. The photovoltaic system generates low voltage and requires high boosters for its applications. The DC-DC converter, which increases the PV voltage and the VSI, is used to convert the DC voltage into an AC voltage [6].

Traditional VSI and CSI systems have the following limitations and problems: B. Two energy conversion steps are required. VSI can not have an AC output voltage higher than the DC link voltage. VSI and CSI are down or up converters and can not be downboosters. Therefore, you will need a DC-DC converter to increase the DC voltage of the simultaneously lit PV module in the same branch, destroying the devices in the circuit. These disadvantages were solved by the source inverter Z proposed in [7]. ZSI offers a single-stage power conversion with a voltage reduction function. The X-shaped impedance network with L and C components lets ZSI pass. During this time, both switches can be actuated simultaneously in the same phase section, eliminating the dead time and providing amplification capability. A simple constant gain gain control was used to control the shutdown and output voltage of the converter.

Z.J. Zhou et al. Proposal for a new uninterruptible power supply topology using a Z-source inverter that maintains the desired AC voltage with high efficiency, low harmonics, fast response, and good continuous performance [17]. The transient modeling and analysis of PWM-ZSI was developed by P.C. Loh et al. Presented [18]. Modeling and analysis of small alternative ZSI signals in single-line mode in [19]. In [20], a new family of Z-Source Inverters (EZSI) has been proposed to maintain a consistent voltage or current at the DC source without adding an LC filter. Further topologies of asymmetric and symmetric inverted Z-source inverters were presented in [21]. The current-mode technology for the integrated control of ZSI drives for induction motors has been described in [22] by S.Thangaprakash et al. [23] includes source and Z-source inverters with high voltage reversal capability, lower switching device voltage, DC input current, and lower capacitor voltage load. The PI controller and Fuzzy Logic Controller (FLC) were developed and implemented in [24] for H6 single-phase inverters. However, the literature review above does not address the regulation for EZSIIM. This article contains a schematic for EZSIIM with a PI controller and a PID controller. The PI controller and PID controller circuit are designed and simulated using MATLAB / Simulink and the results obtained compared.

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## II. FUNCTIONAL PRINCIPLES OF THE Z-SOURCE INVERTER

Figures 2.1 and 2.2 show the equivalent circuits of the Z source network in the smart and non-smart states. The output voltage and the output current of the Z source network, as well as the reference directions of the voltages and currents are shown in FIG. 2.1. Due to the Z-source symmetric network, voltages and currents are the same

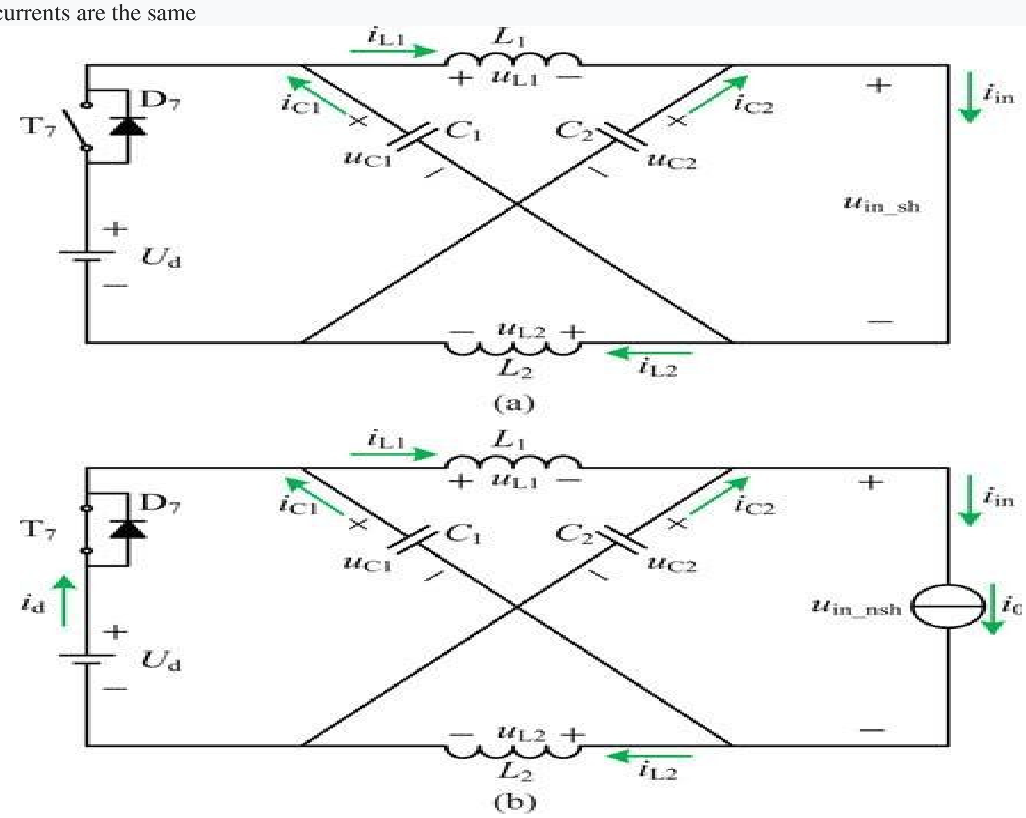


**Fig. 2.1. Equivalent circuits of Z-source network. 2.2 Shoot-through state. (b) Nonshoot-through state.**

***Active state:*** The inverter is operated in one of its six active states. Diode D is polarized in the forward direction. The load and inverter bridge are replaced by the power source, as shown in Figures 2.1 and 2.2.

(The switches Sx ≠ Sx', x = A, B, or C; D = ON. For time interval T1)

$$V_L = V_{dc}/2 - V_C \qquad V_i = V_C + V_L = 2V_C \qquad V_d = V_D = 0 \qquad (1)$$

$$i_{dc} = i_L + i_C \qquad i_i = i_L - i_C \qquad i_{dc} \neq 0 \qquad (2)$$

***Nonshoot-Through zero state:*** The inverter bridge operates in one of two zero states that are not assigned to it. The bridge can be considered an open circuit. The DC input voltage appears between the inductor and the capacitor. However, in the load, no output current from the inverter flows.
In inactive zero mode, the switches Sx x Sx ', x = A, B or C switch; D = ON.

$$V_L = V_{dc}/2 - V_C \qquad V_i - 2V_C \qquad V_d - V_D = 0 \qquad (3)$$

$$i_{dc} = i_L + i_C \qquad i_i = 0 \qquad i_{dc} \neq 0 \qquad (4)$$

***Shoot-through zero state:*** Zeroing is possible in seven different ways. Without disturbing the active states, each phase in the total time zero is assigned the intercommunication state. The front diode D is biased in the reverse direction. The inverter is considered by its DC link as a short circuit. There is no voltage at the load, but the capacitor voltage is increased depending on the duty cycle.
(The switches Sx = Sx '= ON, x = A, B or C, D = OFF for the time interval (T0)

$$V_L = V_C \qquad V_i = 0 \qquad V_d = V_D = -2V_C \qquad (5)$$

$$i_L = -i_C \qquad i_i = i_L - i_C \qquad i_C = 0 \qquad (6)$$

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Intermediate circuit voltage and peak AC voltage can be expressed by executing the results of the state space mean

$$= M\frac{V_i}{2} = \frac{MV_{dc}}{2(1-2T_0/T)} = B\left(\frac{MV_{dc}}{2}\right) \quad (7)$$

EZSI provides the same voltage gain as ZSI with inherent filter capability. Built-in sources help maintain the required voltage level in the impedance network with a lower voltage across the capacitor [11].This document proposes an EZSIIM system based on closed-loop photovoltaic systems using a PI controller and a PID controller to drive the induction motor at the required speed.

## III.SIMULATION RESULTS

The simulation is performed with MATLAB / SIMULINK software. Simulink library files include built-in models of many electrical and electronic components and devices such as diodes, MOSFETs, capacitors, inductors, motors, and power supplies. The simulation is performed with the MATLAB / SIMULINK software. Simulink library files include integrated models of many electrical and electronic components and devices such as diodes, MOSFETs, capacitors, inductors, motors, and power supplies.

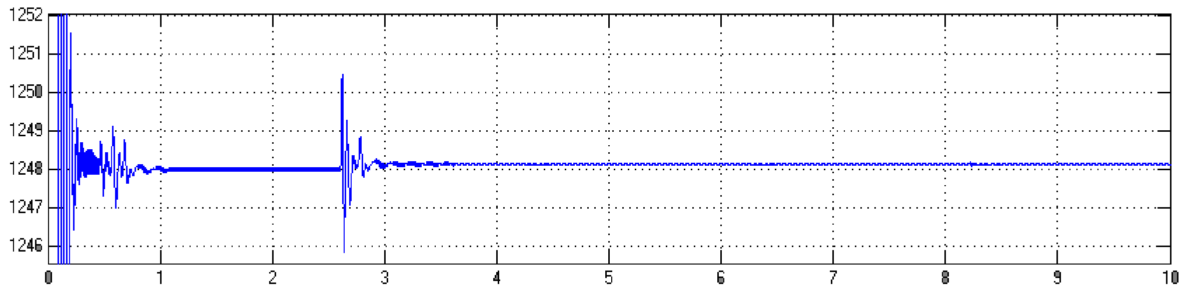

Fig.3.2. Speed of the Three phase induction motor with PI controller

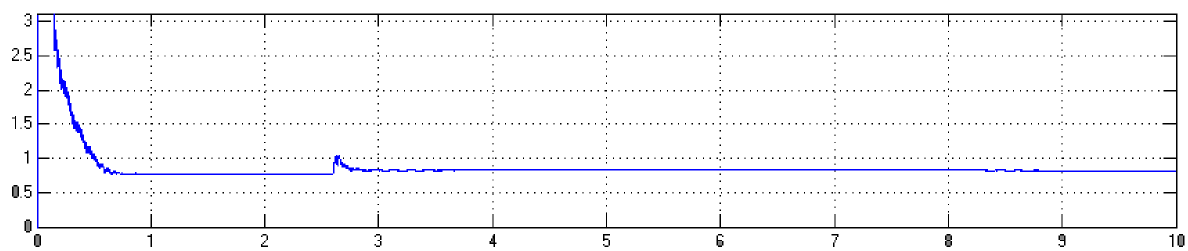

Fig.3.3. Torque of the Three phase induction motor with PI controller

Different PWM techniques and their comparison are presented. The Maximum Constant Boost control method is the most advantageous PWM control method among other PWM control methods. Maximum Constant Augmentation with Third Harmonic Injection The PWM control method increases the output voltage while minimizing the voltage between the switching devices. It allows over-modulation, where the modulation index can vary from 0.57 to 1.154.

The voltage gain of the inverter obtained in the above analysis is 2.075. As the time span (T0) increases, so does the amplification factor and thus the voltage gain of the inverter. Thus the gain and the voltage gain of the inverter are depends on the shoot-through time. The simulation results with the same input voltage and carrier frequency are shown in the following figures, which is in good agreement with the analysis and the theoretical results. For a conventional inverter, it is undesirable to obtain an output voltage of 230 Vrms with a modulation index of 0.8 and a DC voltage of 486 V since an additional reserve circuit is required. FIG. 10 shows that the DC input voltage applied to the source inverter Z is 188V. The capacitor voltage is the average DC link voltage that remains nearly constant at about 337V, as shown in FIG. Thus, the input voltage (188 V) is increased (337 V) and applied as an intermediate circuit voltage. The peak value of this DC link voltage appears as input voltage in the main inverter circuit.

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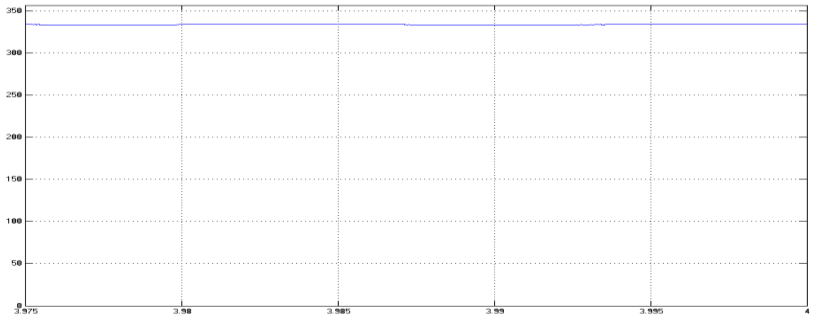

Fig. 3.4. Capacitor voltage = 337V

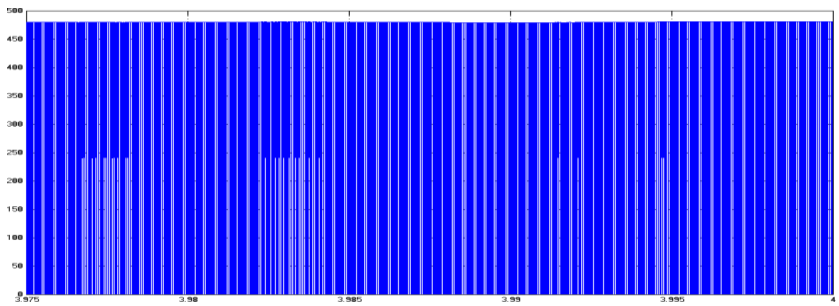

Fig.3.5. Peak dc Link voltage across inverter Bridge = 480V

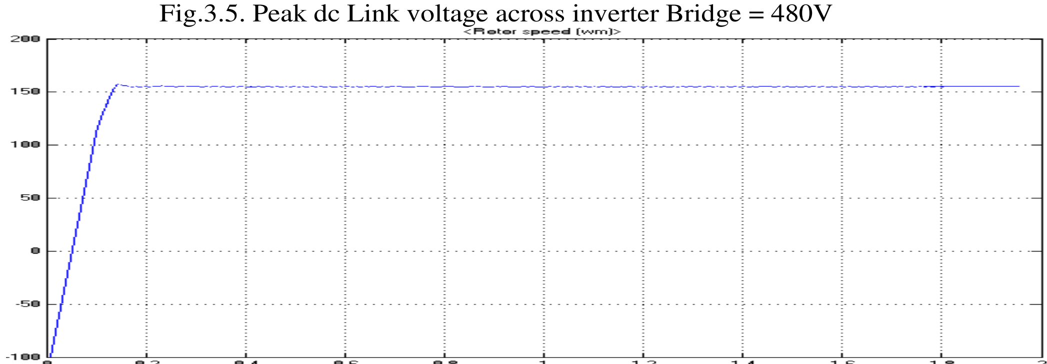


Fig.3.6. Speed Variation

The simulation result for the speed change of the induction motor is shown in Figure 16. Initially, the speed of the induction motor ramps up linearly, and at that point the motor gets more power to maintain the torque. In the steady state, a maximum speed of the induction motor of about 157rad / s is maintained. In terms of speed, the maximum speed is 1500 rpm.

## IV.CONCLUSION

The Z-Source converter eliminates the conceptual and theoretical barriers and limitations of the conventional voltage source converter and power source converter and offers an advanced energy conversion concept. The Z-source inverter system can generate an output voltage greater than the DC input voltage by controlling the punch ratio, which is not possible for conventional ASD systems. In this work, the operating principle has been described, the circuit properties analyzed and their concept and superiority demonstrated.

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