

Design and Implementation of Z-Source Inverter for Voltage Boost Application

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Abstract: The z-source inverter is a unique impedance network in which at input side dc source is given through the rectification using Isolation Transformer & Bridge Rectifier. Z-Source Inverter overcomes the limitations of traditional VSI & CSI and provides a conversion, by controlling the shoot through duty cycle. In this project, the hardware design of three phase induction Motor of 0.25HP connect as load to Z-Source inverter, fed form rectifier as input . The hardware is divided into two parts: Main circuit, Control circuit. The main circuit consists of Isolation Transformer, Bridge rectifier & Filter, Z-source network, Inverter Bridge (using MOSFET'S as switches) & Induction motor. The control circuit consists of Supply to microcontroller, Generation of isolated power supplies & Isolation and gate driver circuit.

Keywords: Z-Source Inverter, MOSFET, Bridge Rectifier, Microcontroller, Isolation Transformer.

1. Introduction

Inverter is a power electronic circuit whose function is to convert dc input voltage to a symmetrical ac output voltage of desired magnitude and frequency. They are widely used in Industrial applications such as variable speed ac motor drives, induction heating, standby power supplies, and uninterruptible power supplies. Inverters can also be used for power factor improvement (FACTS). The input to the inverter may be from a battery, fuel cell, solar cell, or other dc source. The traditional inverters that are commonly used are VSI & CSI. The V-source converter is a buck (step-down) inverter for dc- to-ac power conversion and the V-source converter is a boost (step-up) rectifier (or boost converter) for ac-to-dc power conversion. On the other hand the I-source inverter is a boost inverter for dc-to-ac power conversion and the I-source converter is a buck rectifier (or buck converter) for ac-to-dc power conversion. Both the converters are either a boost or a buck converter and cannot be a buck-boost converter and are vulnerable to EMI noise in terms of reliability. This is overcome by using a Z-Source Inverter which employs two inductors and two capacitors. By selecting the suitable values of Inductors and capacitors it can be used as VSI or CSI. Therefore without changing the circuit it can work as both Buck/Boost Inverter.

In this paper the voltage of the inverter can be controlled by controlling the on period of the switch and the frequency can be varied by varying the time period.

2. Problem statement

There are two parameter to be changed in order get the desired output AC voltage in it are the modulation index which is also present in traditional voltage source inverters and the boosting factor which depends on the shoot-through time. These two parameter are consider while designing of single phase Z-source inverter and their control strategies.

3. Objective

The purpose of the paper is to control the speed of induction motor with help of two parameters i.e. the modulation index & the boosting factor.

4. Methodology

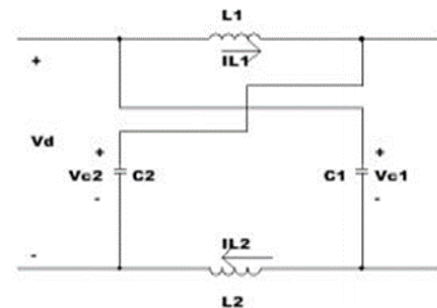


Fig. 1. Basic diagram of Z-Source Inverter

The Impedance Source Network is a combination of two inductors and two capacitors. It is the energy storage or filtering element working as the second order filter for the Impedance Source inverter. It is more effective to suppress voltage and current ripples. The Inductor and capacitor requirement should be smaller compared to traditional inverters.

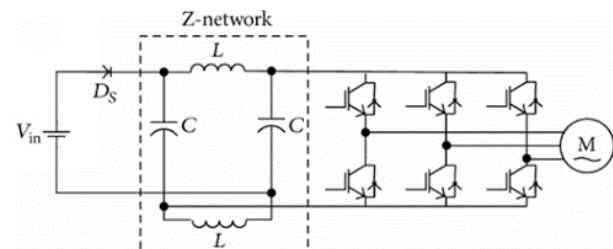


Fig. 2. Circuit diagram

The equivalent circuit of the Impedance source inverter is shown in Fig. 2. The inverter bridge is equivalent to a short circuit when the inverter bridge is in the shoot through zero state. The equivalent switching frequency from the Impedance source network is six times the switching frequency of the main inverter, which greatly reduces the required inductance of the Impedance source network.

The Impedance Source Inverter Bridge has one extra zero state. When the load terminals are shorted through both upper and lower devices of any one phase leg or all three phase legs. This shoot through zero state is forbidden in the VSI, because it would cause a shoot-through. This network makes the shoot through zero state possible. This state provides the unique boost feature to the inverter.

5. Components

- Z-source Inverter
- MOSFETs
- Bridge Rectifier
- Microcontroller
- 3-phase Induction Motor

6. Advantages

- The source can be either a voltage source or current source. The DC source of a ZSI can either be a battery, a diode rectifier or a thyristor converter, a fuel cell

stack or a combination of these.

- The main circuit of a ZSI can either be the traditional VSI or the traditional CSI.
- Works as a buck-boost inverter.
- The load of ZSC can either be inductive or capacitive or another Z-source network.

7. Conclusion

This paper presents the idea of speed control of induction motor using Z-Source inverter.

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