HARDWARE IMPLEMENTATION FOR EMBEDDED Z (EZ)-SOURCE FEED BASED ADJUSTABLE SPEED DRIVE SYSTEM

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ABSTRACT

This paper represents the topology and hardware design of Embedded-Z (EZ) source feed induction motor. Conventionally there are two converters used for ASD systems i.e. Voltage Source Inverter (VSI) and Current Source Inverter (CSI), but they have a limited output voltage range. Conventional VSI and CSI support only either buck or boost DC-AC power conversion and need a relatively complex modulator. The problems in traditional source converters can be overcome by Z source inverter. In this LC impedance are employed for fast power conversion. Due to requirement of additional LC filter the cost of operation also increases. Therefore, instead of using an external LC filter in Z-source inverters, this paper gives an alternative family of Z-source inverters i.e. EZ-source inverter. In which input DC source has embedding between LC impedance, which perform the current and voltage filtering operation in current type and voltage type EZ source inverter. This paper illustrate the hardware design of EZ source inverter fed induction motor which overcome problems of conventional VSI and CSI inverters. And it gives the smooth speed control of induction motor.

Keyword: - *EZ-source inverters-source inverters, Z-Source inverter Pulse Width Modulation, Adjustable Speed Drive System, PIC Controller.*

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1. INTRODUCTION

Due to the recent advancements in the fields of powerconversion and energy storage, it is essential to design an new topology of inverter which can operate efficiently with variable voltage sources. In particular, the converter may need to provide voltage enhancing capability in renewable energy (e.g. fuel cell and solar energy) applications due to unbalanced output voltage from the electrical sources, which are unnecessarily affected by their output current and the ambient condition. So an alternative solution for this is Z-source inverter, which has an unique passive elements structure which provide voltage buck-boost capability but Z-source source inverter has some deficiencies which overcome by advanced family of Z-source inverter i.e. Embedded Z-source inverter. An EZ-source inverter provides inherent features for ASD system. As we know, we have two conventional converters i.e. VSI and CSI where they have operate only in either voltage buck operation or boost operation at a time.

2. EXISTING SYSTEM

Inverters are used to dc to ac power conversion where the input is dc supply either voltage or current is converted in to variable output ac voltage. The output of inverter can be controlled by controlling input dc supply or by varying gain of the inverter. Nowadays there are two types of conventional inverter are using in industries for adjustable speed drive system. They are:-

1) Voltage source Inverter
2) Current source Inverter.

In conventional voltage source inverter (VSI), the DC input voltage source connected across a large capacitor. The voltage produced by this dc link is feed to main network. The input dc supply may be a battery or fuel cell or diode

rectifier, or capacitors. The inverter circuit consists of six switches; each is consist of antiparallel combination of power transistors and diode which gives bidirectional flow of current and blocking capability reverse voltage.
In conventional current-source inverter (CSI), the large DC inductor are connected to form a DC current source and connected in series with input dc supply such as a battery or fuel-cell or diode rectifier or converter etc. Like VSI network CSI also consist of six switches each consist of antiparallel combination of power transistors and diode which gives bidirectional flow of current and blocking capability reverse voltage. The control voltage pulse width modulation(PWM) technique used for voltage source inverter and current source inverter the on/off time the switching devices is controlled by applying (PWM) to the control terminal i.e. gate of the device.

2.1 DISADVANTAGES OF EXISTNG SYSTEM

The VSI based system has the following theoretical barriers and limitations-

- They are only either a buck or a boost converter.
- For VSI main bridge inverter circuits cannot be interchangeable. In other words the voltage-source inverter main circuit cannot be used for the current source inverter or vice versa.
- The AC output voltage is limited below and cannot exceed the DC bus voltage.
- The upper and lower devices of each phase leg cannot be switched on simultaneously.
- There is problem of electromagnetic interference (EMI), which reduces reliability of inverter.
- The upper and lower electronic devices of each phase leg cannot be switched on simultaneously.
- An additional LC filter is provided for AC sinusoidal voltage.

The CSI based system has the following theoretical barriers and limitations-

- At least one of the upper devices and one of the lower devices have to be gated on and maintained on at any time. Otherwise, an open circuit of the DC inductor would occur and destroy the circuit component.
- Overlap time for safe current commutation is needed in the current source converter, which also causes waveform distortion, etc.

So, to overcome these effects and to achieve buck-boost operation in a single stage converter, a new technique is implemented i.e. Z-source inverter. The network is shown in fig.1.

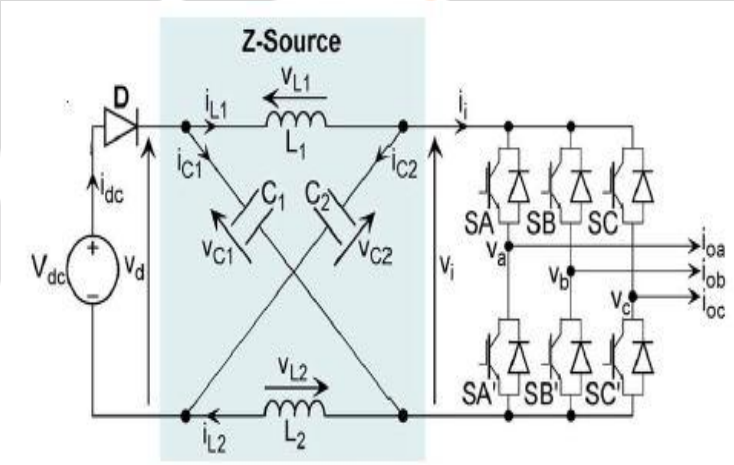

Fig-1: Traditional Z-source Inverter

Z-Source is the X –Shaped structure consists of L1, L2, C1, and C2 in which we can obtain both buck-boost operations in single stage conversion. In this DC Source is placed at far-left in series with diode. So, by this, chopping is occurred in the source current which is caused by the commutation of diode D, so in this condition to smoothen the source current an additional LC filter is required which would rise over all cost of the system and construction of the system by this additional LC filter is complex.
So to overcome the above drawbacks, a new technique is proposed i.e. embedded source inverter shown in fig.2.

3. PROPOSED EMBEDDED Z-SOURCE INVERTER

The proposed Embedded EZ-Source Inverter. It has DC sources embedded within the X shaped LC impedance network with its inductive elements L1 and L2 used for filtering the currents in voltage type EZ-source inverters and its capacitive elements C1 and C2 for voltage filtering in current be utilized where source filtering is significant EZ-Source inverter, smoothens the source current without any additional LC filter but the gain of the Z-Source and EZ-Source is same but only source filtering is achieved without any additional LC filter. The voltage stress experienced by C 1 and C 2 is lower than the original network but in this EZ-Source inverter requires two voltage sources which are cost effective. So to reduce stress across the capacitor and its rating, to achieve lower harmonics, to obtain low switching losses and to make system compact in size, a new technique is implemented i.e. partially parallel EZ-Source inverter With reduced switches. In this paper, induction motor is taken as a load.

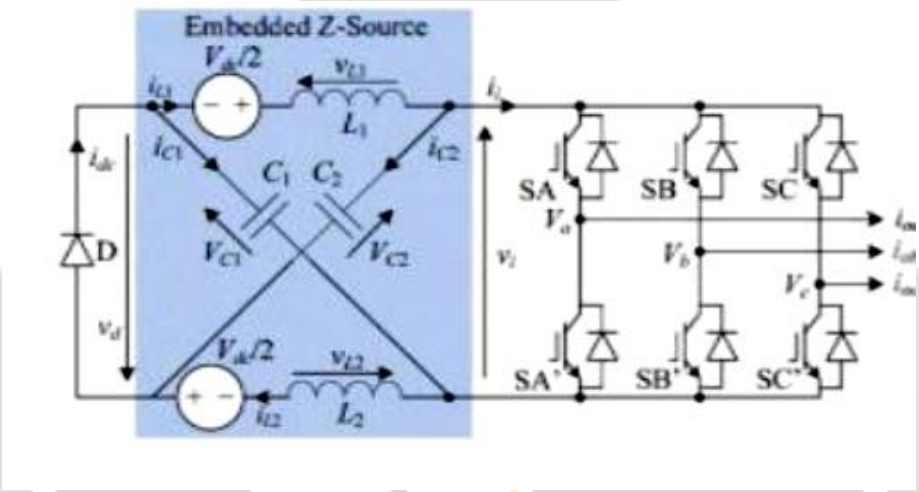

Fig -2: Proposed Embedded Z-source Inverter

4. BLOCK DIAGRAM OF HARDWARE DESIGN

The block diagram of single phase E-Z-source inverter using pic controller for speed control of induction motor is shown in fig.3. It contains following main section EZ-source inverter, pic controller, driver section, triggering circuit, speed control circuit.

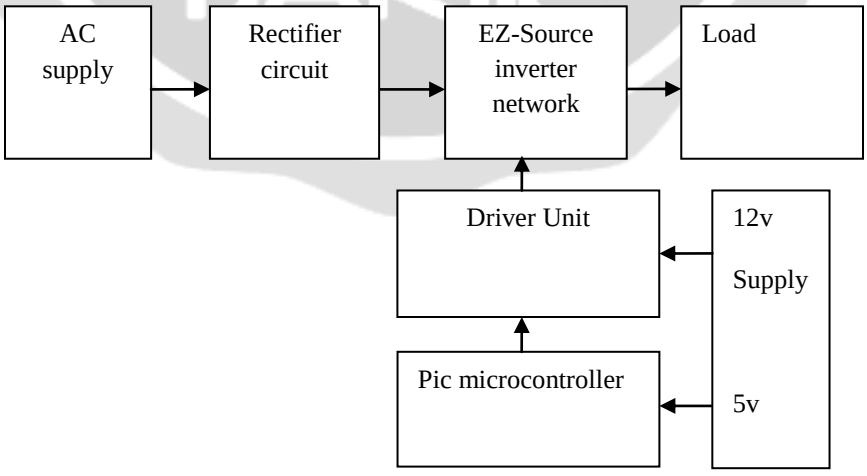

Fig-3: Block Diagram of Hardware Implementation.

The EZ-source inverter is utilized to realize inversion and boost function. A two port impedance network looks like symmetrical lattice network most commonly used in filter and attenuator circuit. The microcontroller has been programmed to the PWM signal of the inverter and converts it to ac power to feed the motor under control. Fig.3 shows the hardware circuit implementation for this work

4. HARDWARE IMPLEMENTATION

4.1 DC Regulated Power Supply

The regulated power supply required to operation of driver circuit and PIC controller for the generation of gate signal required for operation of semiconductor switching devices which are integrated in Embedded Z-source inverter. DC regulated power supply of 12 V for driver circuit and 5 V for PIC controller is provided through following devices.

- Step down transformer
- Diode Bridge Rectifier:
- Filtering Unit
- Voltage Regulator

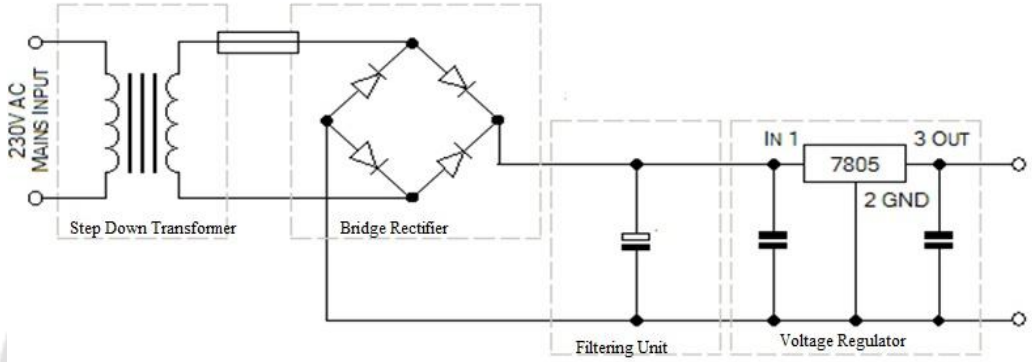

Fig-3: DC Regulated Power Supply

4.2 Peripheral interfacing controller(PIC)

Peripheral Interface Controllers (PIC) is one of the advanced microcontrollers developed by microchip technologies. These microcontrollers are widely used in modern electronics applications. A PIC controller integrates all type of advanced interfacing ports and memory modules. These controllers are more advanced than normal microcontroller like INTEL 8051. As like normal microcontroller, the PIC chip also combines a microprocessor unit called CPU and is integrated with various types of memory modules (RAM, ROM, EEPROM, etc.), I/O ports, timers/counters, communication ports, etc.

8-bit PIC16F877A microcontroller was chosen to obtain the pulses for the FSTPI to drive the Induction Motor. This Microcontroller has a 25 MHz processor, 33 input/output (I/O) pins, interrupts, counters, timers, I/O ports, RAM, and ROM/EPROM. The peripheral interface controllers (PICs) are the integrated circuits based on CMOS technology. The main components of a PIC are RAM, EPROM, EEPROM, and Peripheral Interface Adaptor (PIA). These components are inserted in the same integrated circuit to reduce the size, the cost of the system and make design of the system easier. The address bus, the data bus and the control bus connecting the components are placed in the PIC circuit by the manufacturer. Because of these advantages, PICs have been preferred devices in practical control applications. PIC16F877A used in this work operates at 20 MHz clock frequency and runs each instruction as fast as200 ns.

Flash Program Memory is up to 8K×14 words. Data memory is partitioned into four banks which contain the General Purpose Registers and the Special Function Registers. Bits RP1 and RP0 are the bank select bits. Each bank extends up to 7Fh (128 bytes). It contains 1 K EEPROM as a program memory, 15 special hardware registers, 36 general purpose registers and 64 byte EEPROM as a data memory. PICs have been preferred control devices because of their low cost, less energy consumption and small volume. The microcontroller has been programmed to

vary the frequency of the PWM signal that controls the frequency of the voltage applied at the gate drives, and as a result of this the switching frequency of the inverter is controlled.

4.3 Driver circuit:

The driver circuit is supplied using a step down transformer 230V/12V AC .In this project the driver circuit is mainly used to amplify the pulse output coming from the microcontroller circuit. The driver circuit containing following devices-

- Buffer IC (CD4050)
- Transistor (CK100, 2N2222)
- Optocoupler (MCT2 OR MCT2E)

4.4 Induction motor

Induction motors have many advantages compared to DC motors and synchronous motors in many aspects, such as size, efficiency, cost, life span and maintainability. Low cost and ease of manufacturing have made the induction motors a good choice for electric and hybrid vehicles. In our project prototype motor is used. It is 3phae induction of 0.25 HP rating.

5. CONCLUSION

This paper presents a hardware design of new topology for ASD system based on the EZ-source inverter. This design can be implementing in very low cost. The EZ-source inverter employs a unique LC impedance network couple to the inverter main circuit and thus it providing unique features that are

1. Can produce any desired output ac voltage, even greater than the line voltage,

2. Provides ride-through during voltage sags without any additional circuits and energy storage, minimizes the motor ratings to deliver a required power, and

3. reduces in-rush and harmonic current.

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