International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 21 Issue 3 – APRIL 2016.

DESIGN AND IMPLEMENTATON OF IMPROVED Z-SOURCE INVERTER FED INDUCTION MOTOR FOR WIND APPLICATIONS

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***Abstract*— This paper presents the simulation and implementation of Z-source inverter fed induction motor using PWM technique.The Z – source inverter employs a unique impedance network couple with inverter main circuit. Z-source inverter is used to reduce the line current harmonic, improves the input power factor, high reliability and extends output voltage range. Pulse Width Modulation variable speed drives are increasingly applied in many new industrial applications that require superior performance.PWM technique is used to control the frequency and voltage. It is also used to reduce the line current harmonics. The circuit will be simulated using MATLAB and implemented using embedded controller. Both simulation and hardware results will be verified.**

***Index Terms*— Z-source inverter, pulse-width modulation (PWM)**

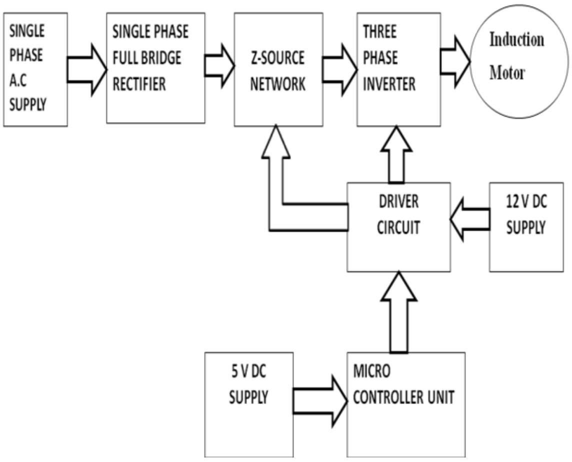


Fig 1 Block diagram

I. Introduction

This project deals with Impedance Source Inverter for induction motor drives. Impedance Source Inverter can be applied to the entire spectrum of power conversion. It is used as Boost-Buck conversion where a capacitor and inductor are used. In this thesis, the Impedance Source Inverter is considered in place of Voltage Source Inverter and Current Source Inverter. By using this Impedance Source Inverter the problems mentioned are rectified and then we can get higher efficiency.

Traditionally there are two inverters namely Voltage Source Inverter and Current Source Inverter. Each inverter has six switches in the main circuit. These switches are power switches with anti-parallel diodes. These diodes provide bi-directional current flow and voltage blocking capability. Traditional source inverters have following problems,

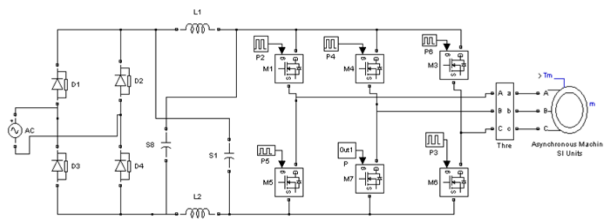
There can be either a boost or a buck inverter operation and cannot be a buck-boost inverter operation.

- Input voltage.

Their main circuits cannot be interchangeable. In other words; neither the voltage source inverter can be used for the current source inverter, or vice-versa.

They are vulnerable to EMI noise in terms of reliability.

Three phase a.c. supply is fed to the rectifier, which will convert three phase A.C. supply to D.C. The rectified D.C. supply is now given to an inverter through an impedance network. The impedance inverter output is now fed to the induction motor as input. The process is explained using the circuit diagram



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Bridge rectifier is commonly used in high power applications. The impedance network is a two port network. A two port network has input terminals and output terminals. This network also called as lattice network. This lattice network consists of split inductors (L_1 phase AC supply is given to the rectifier unit; rectification is a process of converting alternating current or voltage into a direct current or voltage. The three phase and L_2) and capacitors (C_1 and C_2) The Impedance Source Inverter consists of voltage source from rectifier supply, impedance network, three phase inverter and with AC motor load. This network is coupled with inverter main circuit and source. This impedance network is a second order filter, and also this network is energy storage or filtering element for the Impedance Source

Inverter. DC to AC converters is known as inverter. The function of an inverter is to change a DC input voltage to AC output voltage of desired magnitude and frequency. Three phase inverters are normally used for high power applications. We choose 1200 conduction for proper and reliable operation of inverter. MOSFET have chosen for three-phase inverter. There are three modes of operation of operation in one half cycles for Y-connected load.

II MATHEMATICAL ANALYSIS OF IMPEDANCE NETWORK

Assume the inductors (L_1&L_2) and capacitors (C_1 &C_2) have the same inductance and capacitance values respectively.

L_1 and L_2 – series arm inductors; V_1 is input voltage;

C_1 and C_2 – parallel arm capacitors; V_2 is output voltage;

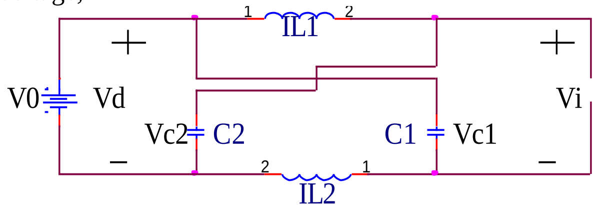


Figure 1.1 equivalent circuit of impedance source

From the Figure.1.1, equivalent circuit of the model is derived in equations 3.1 to 3.12.

$Vc_1 = Vc_2 = V_C$ …3.1

$V_{L1} = V_{L2} = V_L$ …3. 2

$V_L = V_C$

$V_D = 2Vc$

$V_I = 0$

During the switching cycle T

$V_L = V_O - V_C$ …3.3

$V_D = V_O$

$V_I = V_C – V_{L} = 2 V_C - Vo)$

$V_I = 2V_c – V_O$ …3.4

Where V_o is the dc source voltage and $T = T_o + T_1$ …3.5

The average voltage of the inductors over one switching period (T) should be zero in steady state

$V_L = V_L = T_o .V_c + T_1 (V_o - V_c) / T = 0$

$V_L = (T_o .V_c + V_o.T_1 - V_c.T_1) / T = 0$

$V_L = (To - T_1) V_C / T + (T_1.Vo) / T$

$Vc/Vo = T_1 / (T_1 - T_0)$ …3.6

Similarly the average dc link voltage across the inverter bridge can be found as follows from equation (3.4)

$V_I = V_I = (To.0 + T_1). (2Vc - Vo) / T$ …3.7

$V_I = (2V_c. T_1/T) - (T_1 Vo/T)$

$2V_c = V_o$

From equation (3.6)

$T_1.V_o / (T_1 - To) = 2V_c.T_1 / (T_1 - T_o)$

$V_C = V_o.T_1 / (T_1 - T_o)$

The peak dc-link voltage across the inverter bridge is

$V_I = V_C - V_L = 2 V_C - V_O$

$= T / (T_1 - To).V_o = B.V_o$ Where $B = T / (T_1 - T_o)$ i.e ≥ 1 …3.8

B is a boost factor

The output peak phase voltage from the inverter

$V_{ac} = M.V_i/2$, where M is modulation index. …3.9

In this source $V_{ac} = M.B.V_o /2$ …3.10

In the traditional sources,

$V_{ac} = M.V_o/2$

For Z-Source,

$V_{ac} = M.B.V_o / 2$

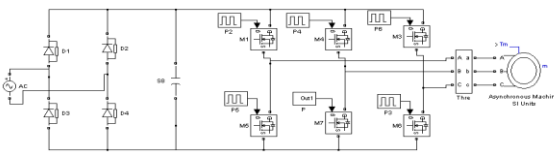
The output voltage can be stepped up and down by choosing an appropriate buck –

Boost factor B_B $B_B = B._M$ (it varies from 0 to α) …3.11

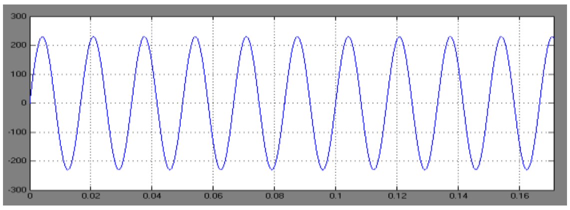
The capacitor voltage can be expressed as

$V_{c1} = V_{c2} = V_C = (1 - T_o / T).V_o / (1 - 2T_o / T)$ …3.12

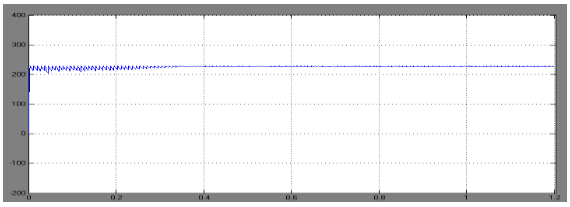
The buck- boost factor B_B is determined by the modulation index M and the Boost factor B. The boost factor B can be controlled by duty cycle of the shoot through zero state over the non-shoot through states of the PWM inverter. The shoot through zero state does not affect PWM control of the inverter, since it equivalently produces the same zero voltage to the load terminal. The available shoot through period is limited by the zero state periods that are determined by the modulation index.



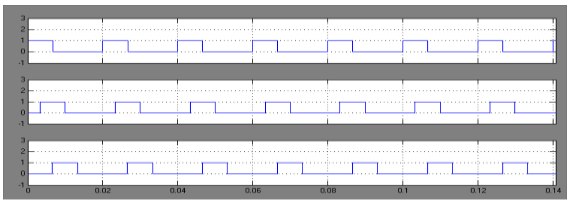
(fig.2) Voltage source inverter with R load



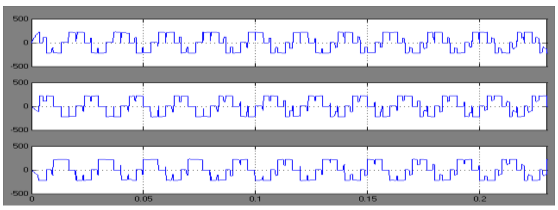
(fig.2.1) AC input voltage



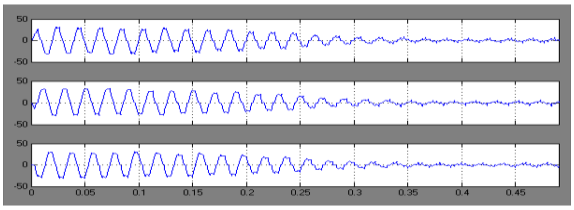
(fig.2.2) Rectifier output voltage



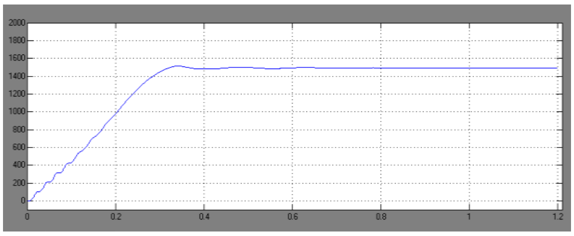
(fig.2.3) Driving pulse output



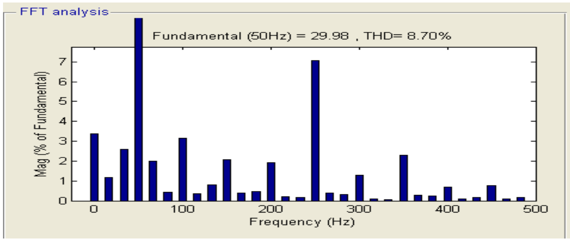
(fig.2.4) Phase to phase voltage



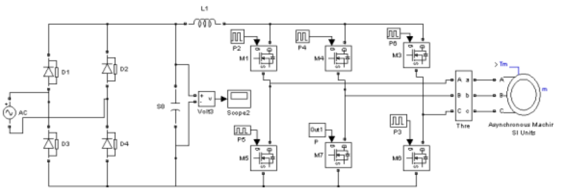
(fig.2.5) Inverter output phase current



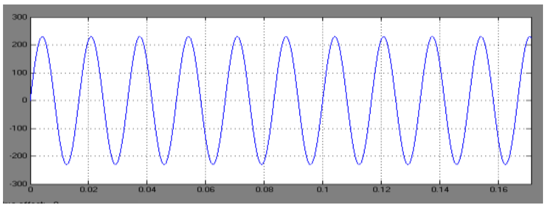
(fig.2.6) Rotor Speed



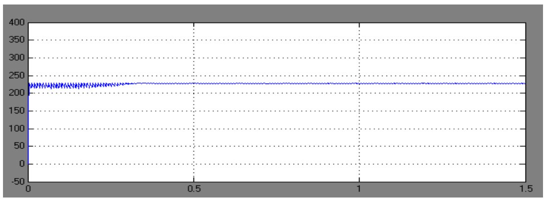
(fig.2.7) FFT Analysis



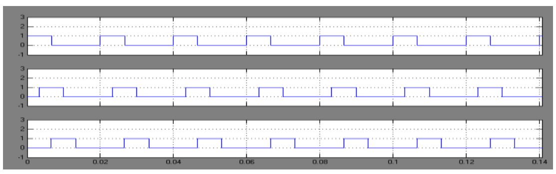
(fig.3) Current source inverter with R load



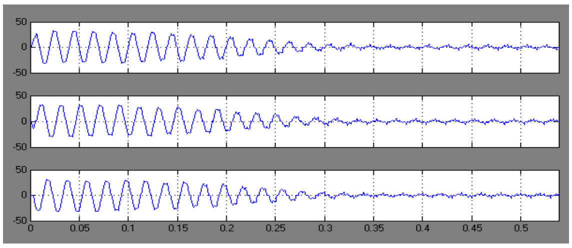
(fig.3.1) AC input voltage



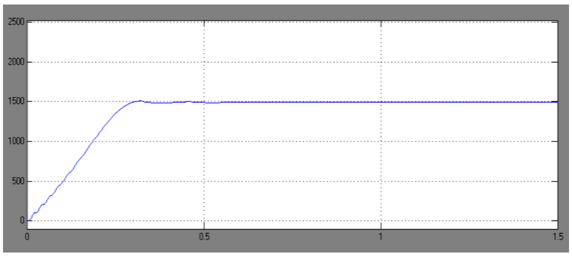
(fig.3.2) Rectifier output voltage



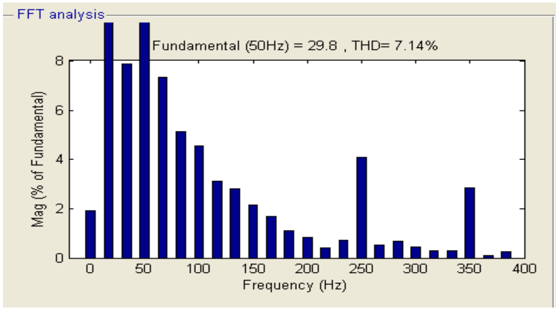
(fig.3.3) Driving pulse output



(fig.3.4) Inverter output phase current



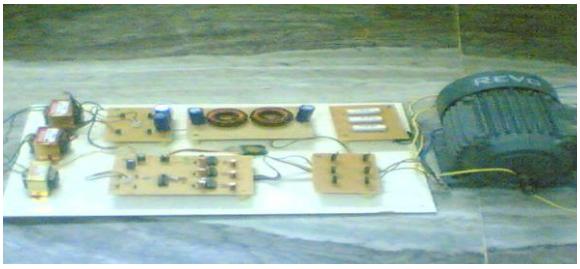
(fig.3.5) Rotor speed



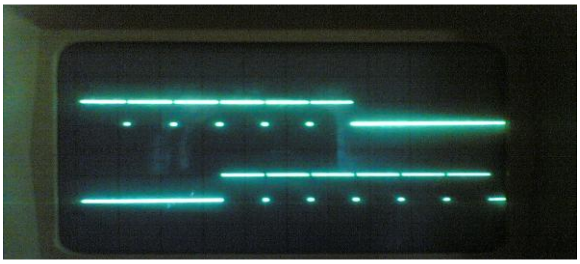
II. COMPARISION

1. In CSI as inductor is used in the dc link, the source impedance is high. It acts as a constant current source.In VSI as capacitor is used in the dc link; it acts as a low impedance voltage source.In ZSI as capacitor and inductor is used in the dc link, it acts as a constant high impedance voltage source.
2. A CSI can capable of withstanding short circuit across any two of its output terminals. Hence momentary short circuit on load and misfiring of switches are acceptable .A VSI cannot accept the mis-firing of switches In ZSI mis-firing of the switches sometimes is also acceptable.
3. CSI is used in only buck or boost operation of inverter. VSI is used in only a buck or boost operation of inverter. ZSI is used in both buck and boost operation of inverter.
4.In CSI and in VSI the main circuit cannot be interchangeable.But in ZSI the main circuits are interchangeable.
5. CSI and VSI are affected by the EMI noise. In ZSI main circuit is less affected by the interchangeable EMI noise.

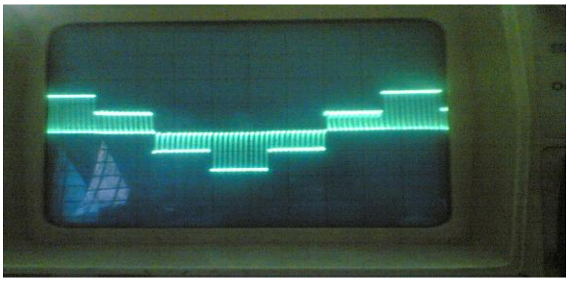
IV.EXPERIMENTAL RESULTS



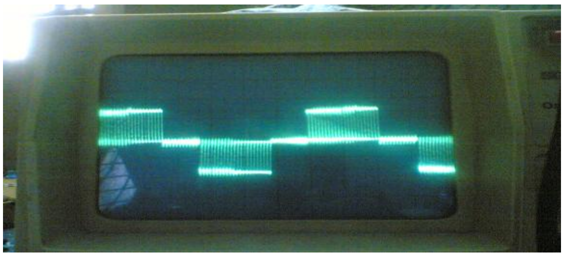
Hardware proto type photos



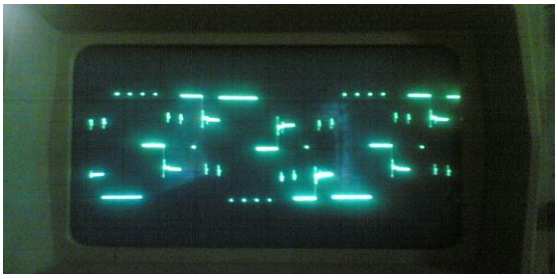
PWM pulses



Line voltage with motor load



Line voltage with R load



Phase voltage with R load

V. CONCLUSION

In this project, the operating principles, switching techniques and modes of operation of impedance source inverter for induction motor drive studied and discussed. Using PSPICE software the impedance source circuit is simulated. To the best of the authors knowledge impedance source inverter for induction motor drive have not been explored previously. It has better a.c. out put voltage output power than the traditional source inverter.

The power supply unit circuit, control circuit and impedance source inverter have been implemented using PIC microcontroler. The output waveforms in this project, impedance source inverter for induction motor drive circuit have been proposed to improve the stability of the output voltage.

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