Z CONVERTER CONTROL OF A V/F INDUCTION MOTOR DRIVE USING SINE PWM

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ABSTRACT

In this paper author has implemented speed control of an induction motor fed by sine pulse width modulation (PWM) on Psim software. Z source inverter (ZSI); is used to convert DC to AC supply and the control loop V/F control strategy. API controller is used inherently for controlling the shoot through time interval from the z source capacitor voltage error. The various parameters are plotted using PSIM simulation software and results are demonstrated on the 1.8KW induction motor connected from ZSI from 5Hz to 75Hz. The various simulation results are plotted during startup, input voltage change and load disturbance are plotted.

KEYWORDS: Z-Source inverter, Voltage boost, Pulse Width Modulation, Space Vector Modulation

INTRODUCTION:

As the conventional voltage source inverter and current source inverter has many limitations, so author has proposed the z source inverter (ZSI). The ZSI inverter has many advantages which are lacking in conventional inverter some of them are listed as follows. The Z source inverter is self boost type of converter used for DC – AC power rectification and at the output desired AC voltage can be obtained which is always greater than the source line voltages.

1. In ZSI short circuit between any legs is permissible so dead is not necessary to be attribute.
2. ZSI uses a second order filters which are more effective than the capacitor used in traditional PWM inverter.
3. As ZSI uses an inductor inrush current and harmonics are restricted.
4. During sag condition in the grid network ride through voltage is provided with ZSI without usage on any energy storage elements.

The general z source converter structure, which consists of inductors and capacitors L1, L2 and C1, C2 respecting connected in cross shape enables the inverter connection to DC voltage source which can be battery, DC generator, fuel cell etc is shown in fig.1.

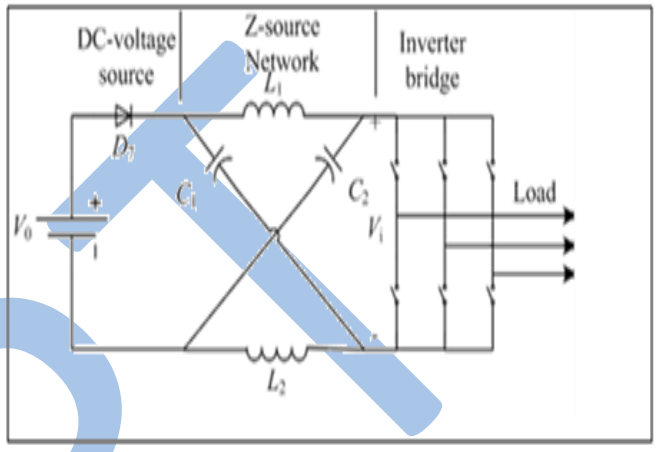

Fig.1. Z source inverter

The utilization of the z source inverter is mainly done to boost the DC link voltage to desired level which can be greater than or equal to DC voltage. During sag condition voltage boost is necessary condition may be DC side itself or load connected may demand the higher voltage than provided by the DC link. A zero state is been produced when three lower or upper switches are ON at same instant which shorts the load terminals. During zero state terminals, the so called shoot through times can be introduced when two transistors from one, two or three are conducting simultaneously.

CLOSED LOOP V/F CONTROLLED INDUCTION MOTOR DRIVE

A V/F control diagram for induction motor is shown in fig.2. The closed loop control is designed in a way that slip regulation of inverter and induction machine will improve the dynamic performance. The error in speed loop will generate the slip command by using proportional integral (PI) controller and limiter. The addition of slip enables to send feedback of speed and then observer signal will generate the frequency command. The frequency command will generate the voltage command by using volts/hertz generator. The volts/hertz closed loop speed control simulation model is shown in fig. 3.

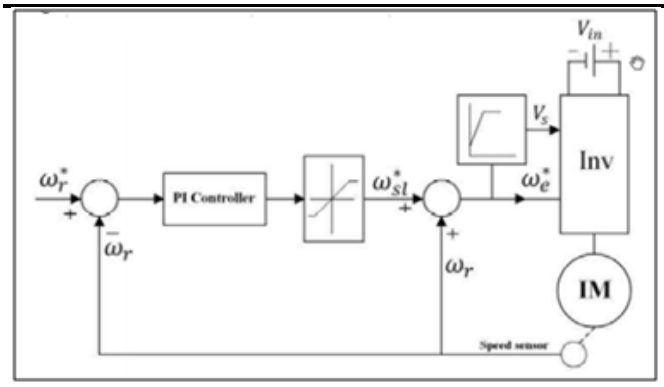

Fig.2. General Volts/Hertz based closed loop speed control scheme of induction motor.

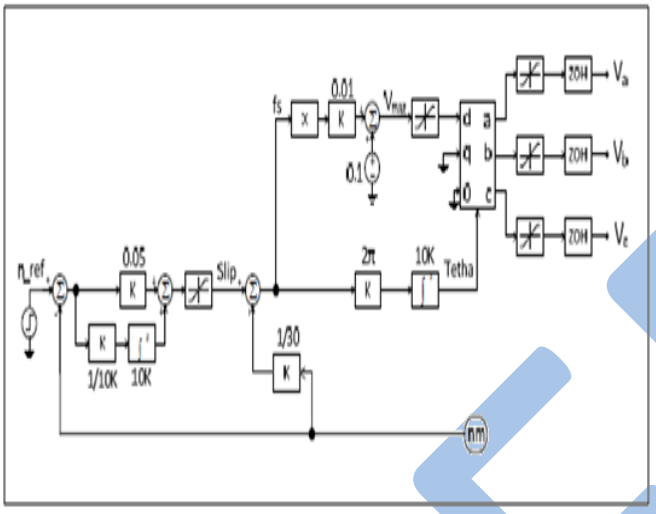

Fig. 3. Volts/Hertz closed loop speed control

SINE PWM TECHNIQUE

There are various techniques available under sinusoidal pulse width modulation (SPWM). Small modifications in SPWM techniques will provide shoot through pulses to Z source inverter. Various PWM methods used to control ZSI are as follows:

1. SBC with sine carrier PWM
2. Simple Boost Control (SBC) with triangular carrier PWM
3. Maximum boost control and Maximum boost control with third harmonic injection
4. Traditional space vector PWM (SVPWM) control
5. Constant boost control and Maximum constant boost control

When using sine PWM inverter the width of voltage for output cycle varies in sinusoidal fashion. To understand this scheme which involves a comparison of a high frequency triangular voltage is compared with sinusoidal modulating signal which shows the specific fundamental component of the pole voltage waveform. The maximum amplitude of the modulating signal must be restricted to the maximum amplitude of the carrier signal.

EXPERIMENTAL WORK:

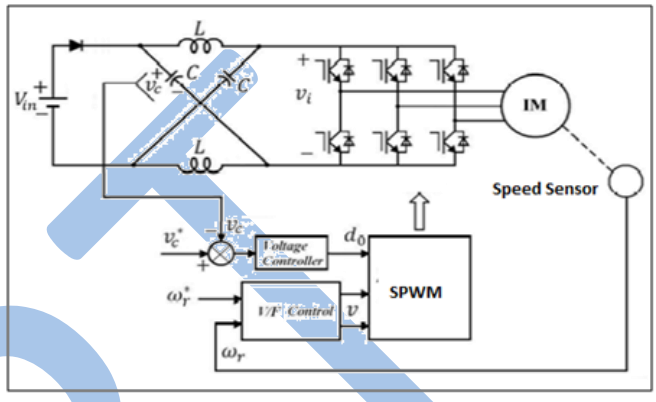

Fig.4. Closed loop speed control of three phase induction motor fed by Sine PWM Z-source inverter.

Table 1. Parameters of Induction Motors

Parameter	Value
Output power	1.8KW
Line voltage	400V
Input frequency	50Hz
Poles	4
Rotor resistance	1.97 Ohm
Stator resistance	2.56 Ohm
Stator inductance	0.014 H
Rotor Inductance	0.011 H
Moment of Inertia	0.0120 KM Sq M
Rated DC input voltage	500V

Table 2. Z Source network parameters

Parameter	Value
Capcitors	750 Micro Farad
Inductors	450 Micro Farad

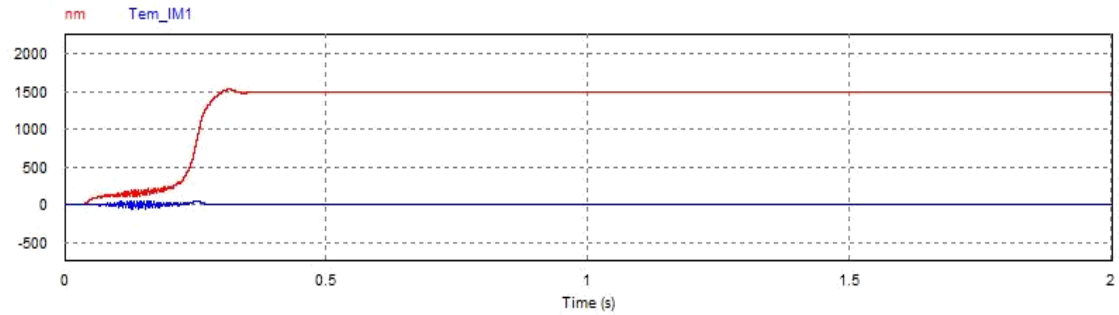

Fig. 5. Speed torque waveform of ZSI fed drive

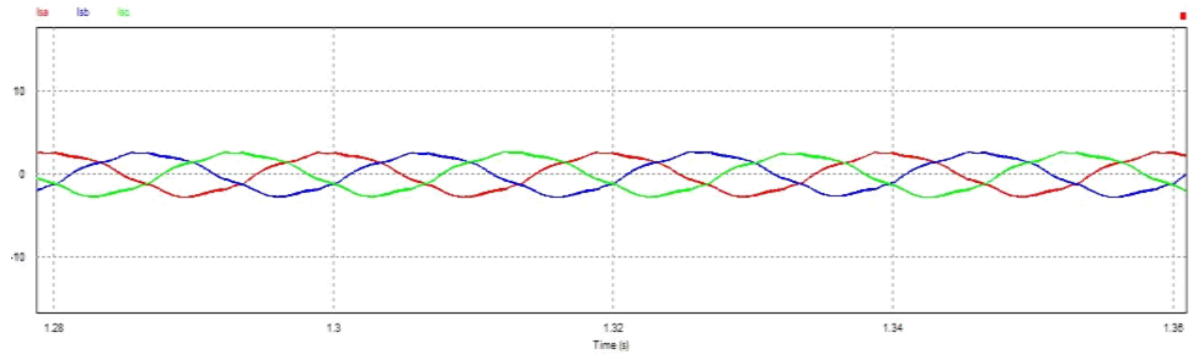

Fig. 6. Three phase current waveform of ZSI fed drive

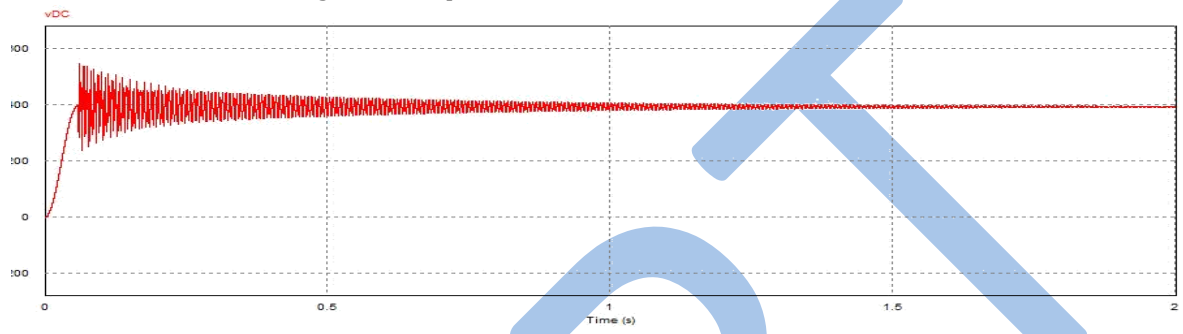

Fig. 7. DC link voltage of Z-source inverter

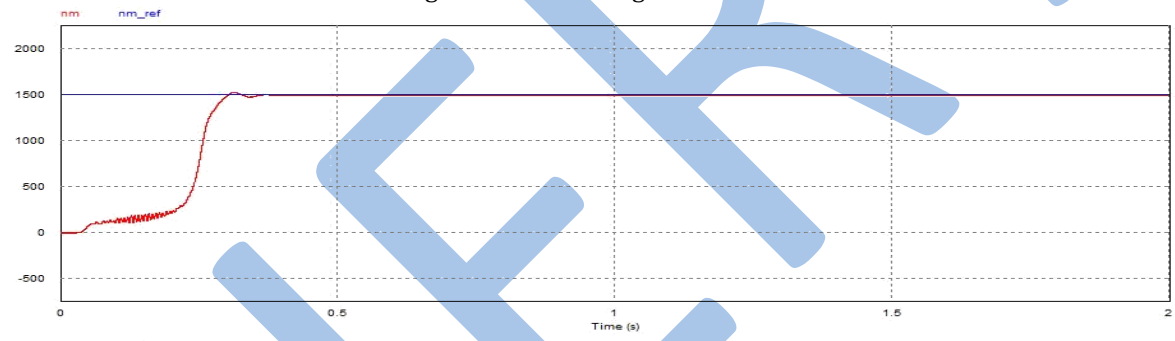

Fig. 8. Reference speed and actual speed plot of ZSI drive

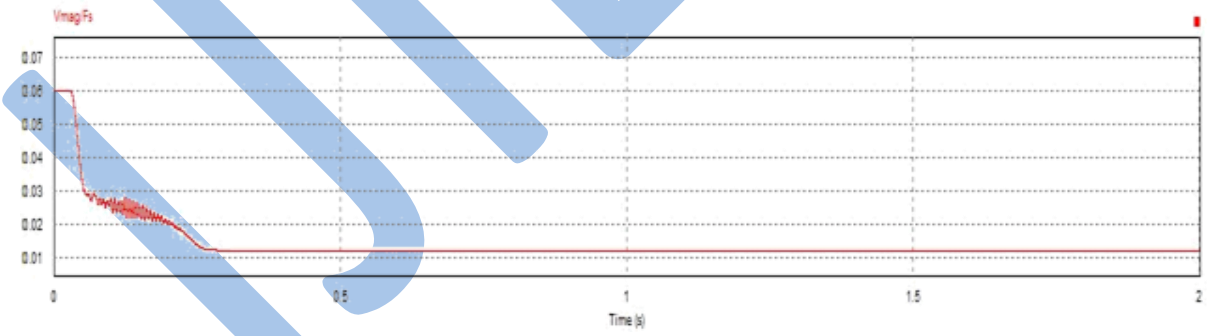

Fig. 9. V/F ratio waveform of ZSI fed drive

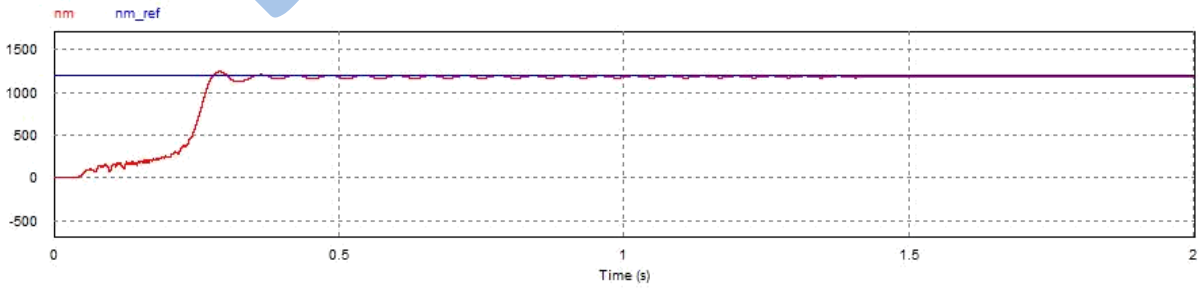

Fig. 10. Speed Response of V/F control for ZSI fed IM Drive (1200RPM)

For verifying the close loop control and different voltage strategies simulations are carried out in voltage control strategies on PSIM software. This simulation are carried out on 1.8KW induction motor fed from a z source inverter and various parameters of induction motor and z source network parameters are listed in Table I and Table II respectively. For calculation of modulation index reference of V/F method is used. In fig. 4. Closed loop speed control of 3 phase induction motor fed by sine PWM inverter is shown and same is implemented on PSIM software. The machine starts to 50Hz with a load torque of 0.7. as shown in fig.7. a capacitor voltage is boosted to 790V and stays there after settling time. The induction motor is capable of handling ± 50% step load with few damped oscillations in capacitor voltage and induction current. A sag of around 50% can be handled smoothly is steady as output voltage of capacitor voltage. Motor smoothly operates even at 5HZ as capacitor voltage is very high and steady. The gradual decrease in capacitor voltage with motor frequency improves drive performance.

CONCLUSION

In this paper closed loop speed control of sine pulse width modulation fed induction motor with z source inverter based close loop V/F control strategy is demonstrated in great detail. The system is implemented on PSIM simulation software for ease of use and better results with good accuracy. The DC link voltage is governed by the closed loop voltage controller, control by the sine PWM. The simulation carried out shows the validity of the proposed method.

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