Simulation and Analysis of Space Vector PWM Inverter Fed Three Phase Induction Motor Drive

[1]Reena Soni, [2] Deepti Jain

[1]Master's scholar, [2]Assistant professor,
Department of Electrical Engineering
SAMRAT ASHOK TECHNOLOGICAL INSTITUTE, VIDISHA, MADHYA PRADESH

***Abstract*- Space vector Pulse Width Modulation changeable speed drives are increasingly applied in many new industrial applications that require better performance. In recent times, developments in power electronics and semiconductor technology have lead advance in power electronic systems. Therefore, dissimilar circuit configurations namely multilevel inverters have become popular and extensive interest by investigator are given on them. Variable voltage and frequency supply to a.c drives is constantly obtained from a three-phase voltage source inverter. A number of Pulse width modulation (PWM) schemes are used to obtain changeable voltage and frequency supply. Here is used three-phase voltage source inverters which is carrier-based sinusoidal PWM and space vector PWM (SVPWM). There is an increasing trend of using space vector PWM because of their easier digital understanding and superior dc bus consumption. This project focuses on gradually development SVPWM implement on an Induction motor. The model of a three-phase a voltage source inverter is discus based on space vector theory. Simulation results are obtained by means of MATLAB/Simulink environment for effectiveness of the study. At this time open loop & close loop simulation and analysis of SVPWM Inverter fed Induction motor is carried out. This thesis analysis the theoretical and modulation form of control strategy and simulation are obtainable by the different switching conditions.**

***Key words*: SVPWM Inverter, PI Controller, IGBT, Induction Motor Drive, MATLAB/SIMULINK.**

I. INTRODUCTION

To control Induction motor drives, PWM inverters is very popular. Using VSI possible to control both frequency and importance of the voltage and current functional to Induction motor drive. As a result, PWM inverter-fed IM motor drives are more changeable, reliable and offer a wide range speed. Also it gives better efficiency and higher performance when compared to fixed frequency Induction motor drives. The energy, which is delivered by the PWM inverter to the IM motor, is controlled by PWM signals practical to the gates of the power switches of Inverter at different times for changing durations to manufacture the desired output voltage waveform. A number of Pulse width modulation (PWM) scheme are used to obtain variable electrical energy and frequency from a Inverter to control IM drives But most widely used PWM techniques for three-phase VSI a space vector PWM (SVPWM). But to reduce harmonic content & increase magnitude of voltage space vector PWM (SVPWM) is improved than SPWM. moreover space vector PWM technique (SVPWM) instead of sine PWM performance (SPWM) is utilized 10% more DC link voltage. So using SVPWM techniques for 3 phase inverter switches & Output of inverter is fed to speed control of IM drives. Simulation is done in a MATLAB/ SIMULINK Software & present.
Induction motors, predominantly squirrel- cage are rugged, cheaper, lighter, Smaller, efficient, require low maintenance and can operate in dirty and explosive environment. They are used in application such as fans, blowers, mill run-out tables, cranes, conveyers, toehold and all that [4]. Simulation results are obtained by means of MATLAB/Simulink atmosphere for effectiveness of the study. Open loop and Close loop of three phase space vector pulse width modulated voltage source inverter fed Induction Motor Drive has simulate and analyze here.

II.INVERTER BASIC

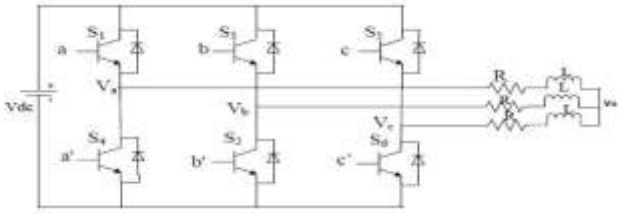

Figure 1. Three phase Inverter bridge

III. COMPONENT USED IN MODEL

A.SVPWM

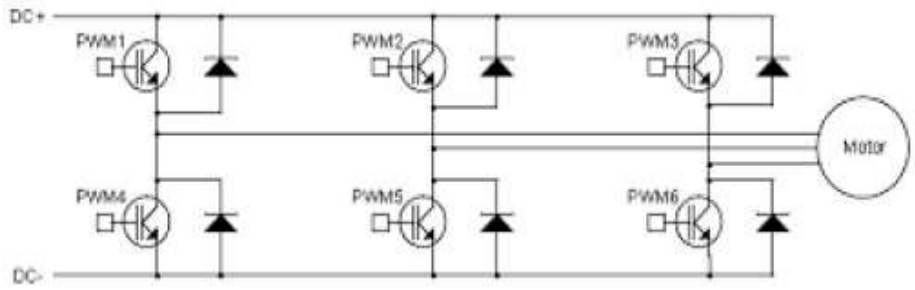

Fig. 2 Circuit of SVPWM

The Principle of SVPWM using a 3 -phase inverter is presented on the mainly of space vector technique in Fig 1. S1 to S6 are the six power switches that from the output, which are controlled by mean the switching variables a ,a', b, b' and c, c'. When an top transistor is switched on, i.e., the corresponding a', b' or c' is zero. Consequently , the on and off states of the upper switches S1, S3, S5 may be used to determine the SPACE VECTOR PWM refers to a special switching sequence of the upper power switches of a 3-phase power inverter. It has been shown to generate low harmonic distortion within the output voltages and /or currents carried out to the phases of a power system and to provide more efficient use of supply voltage comparison with other modulation technique. To implement Space vector PWM, the voltage equations within the abc reference frame may be transformed into the stationary reference frame that include the horizontal (d) and vertical (q) axes as depicted in Fig.

The SVPWM technique is more popular than conventional technique because of its exceptional features.

- More efficient use of DC supply voltage
- more output voltage then traditional modulation
- Lower Total Harmonic Distortion (THD)
- less commutation losses

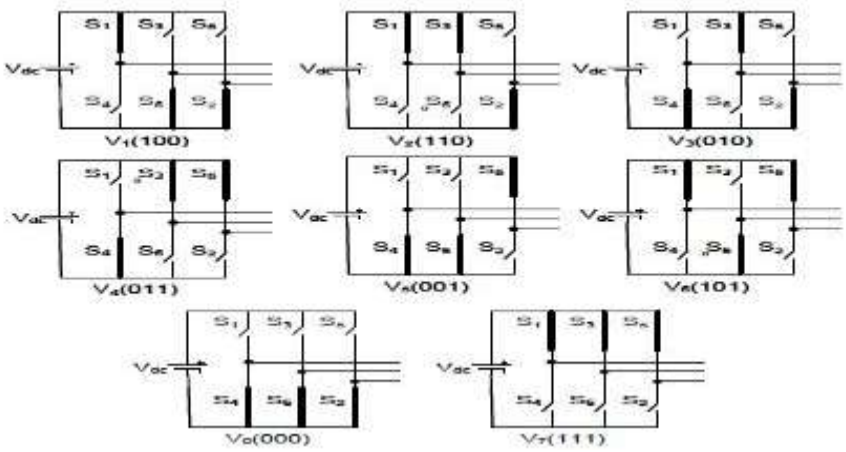

Fig 3 Eight Switching States of voltage source inverter

B. SVPWM IPLEMENTATION

The space vector PWM can be implemented by the following steps:

Step1. Determine Vd, Vq, Vref, and angle (á)

Step2. Determine time duration T1, T2, T0

Step3. Determine the switching time of each switches

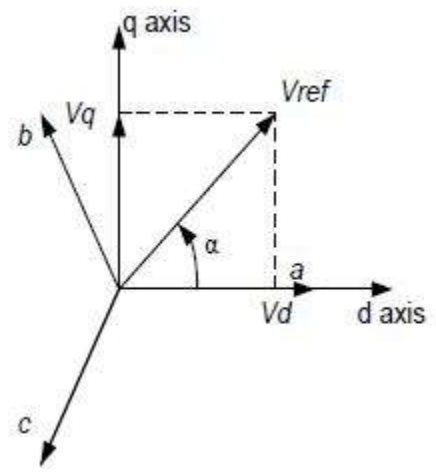

Fig 4 Voltage Space Vector and its d, q axis

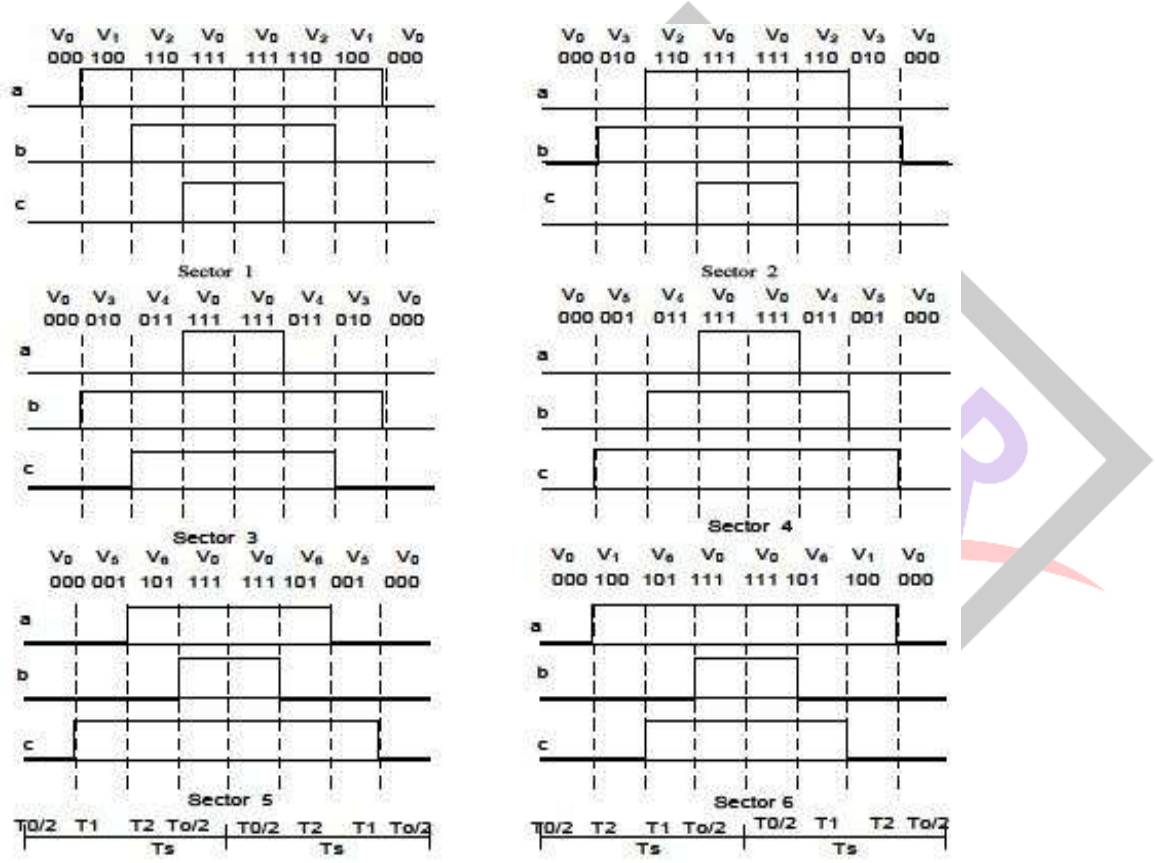

Fig 5 SVPWM switching patterns at each sector.

C. PI Controller

Correction factor is also used in pi controller for improving accuracy of the system. Stability of PI Controller is done by Ziegler Nichols method. It is used to increase the speed response & also remove steady state error .Other advantage of the PI Controller is that the organize of the system is increases , damping improved , reduced maximum overshoot, decrease bandwidth and increased the rise time.

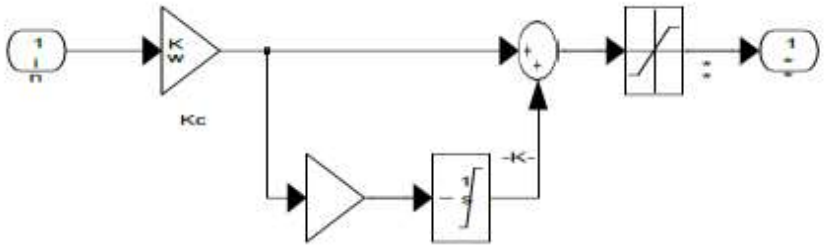

Fig. 6 Circuit of PI Controller

III. Simulation and Result Discussion

The SIMULINK Models has been developed for SVPWM in MATLAB.13/SIMULINK.
The Block Diagram of SVPWM inverter fed Induction Motor is shown in Figure
The simulation parameters used:
Fundamental frequency =50 Hz
Switching frequency =1 kHz
DC voltage =450Volt
Modulation Index (MI) = 0.8
Asynchronous Machine = 3HP, 220V, 50Hz

A . Simulation Model

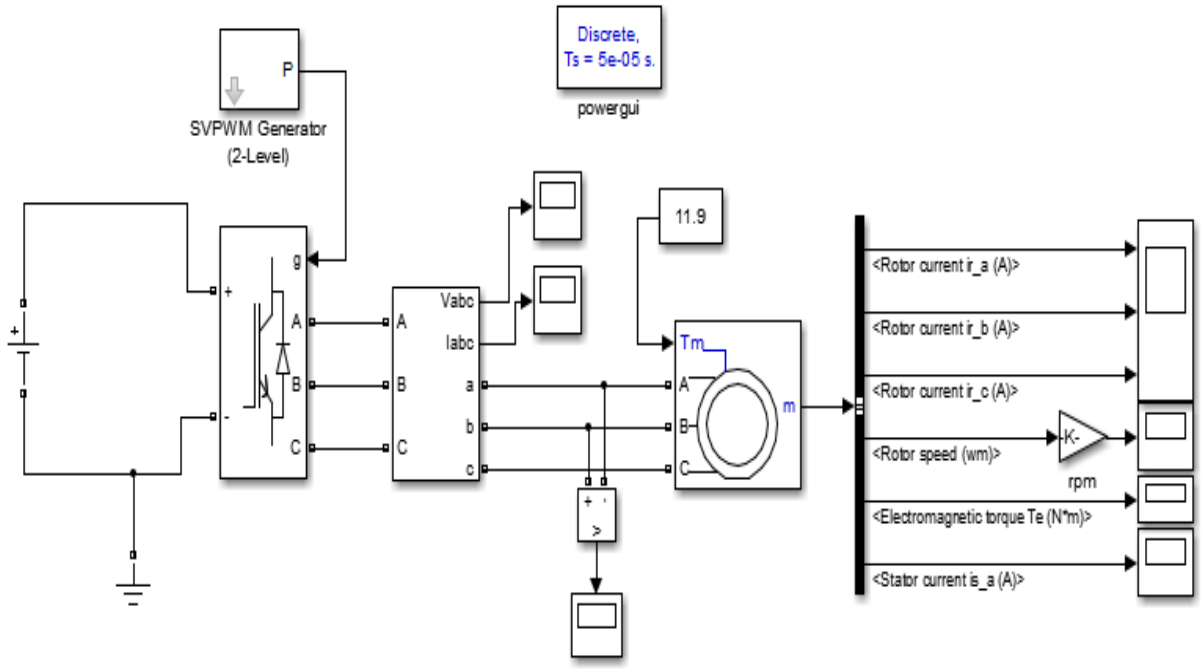

Fig 7 Simulation model of Open loop

B. Simulation result

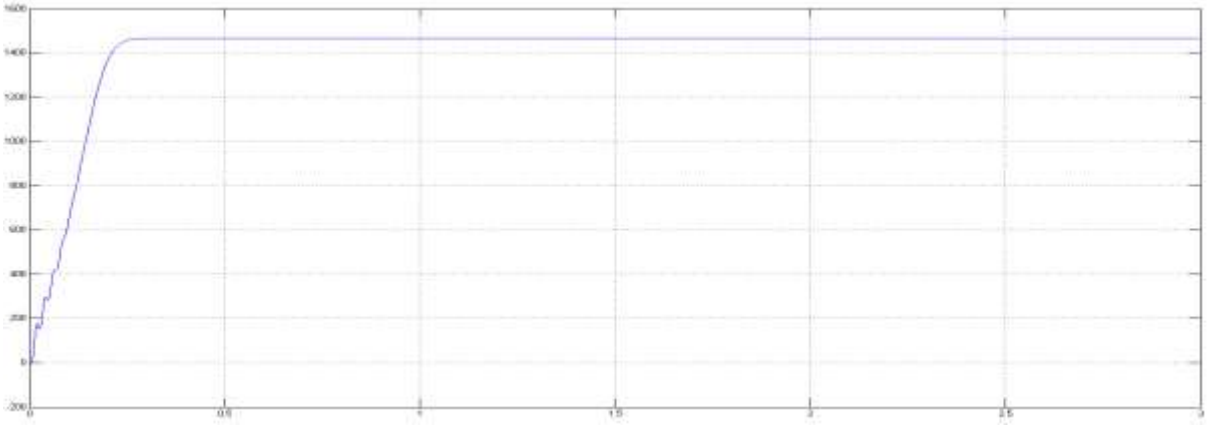

Fig.8 Open loop speed versus time

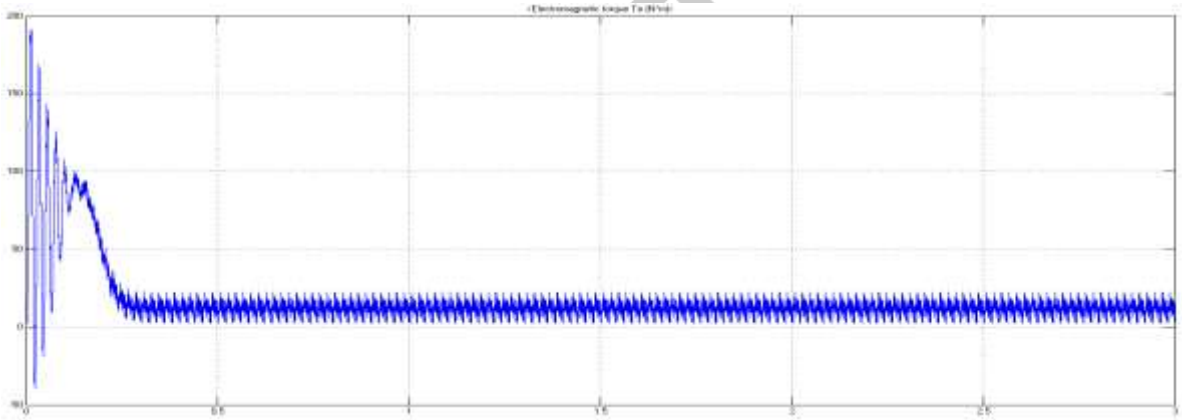

Fig 9 Open loop electromagnetic torque versus time

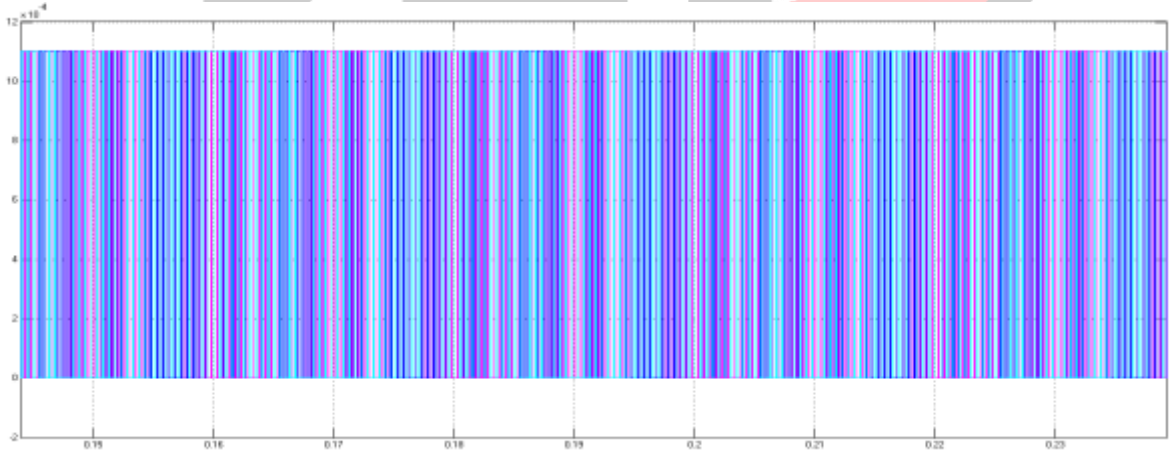

Fig 10 Open loop phase voltages versus time graph

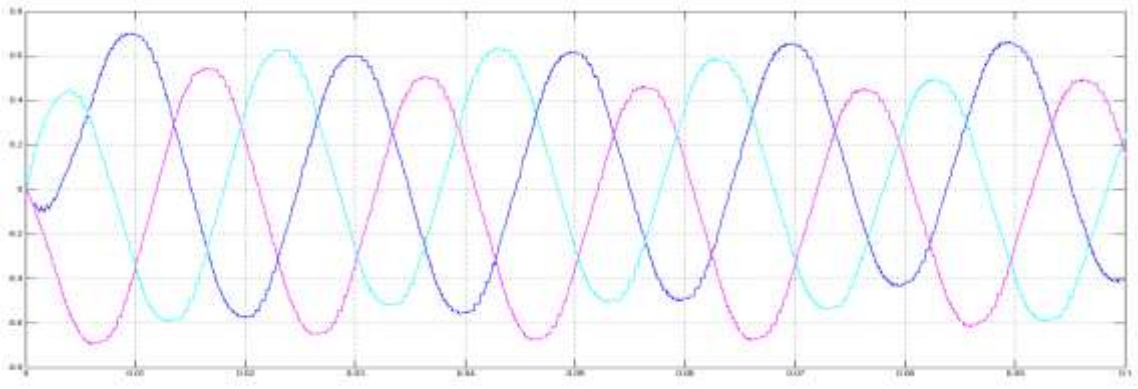

Fig 11 Open loop phase currents versus time graph

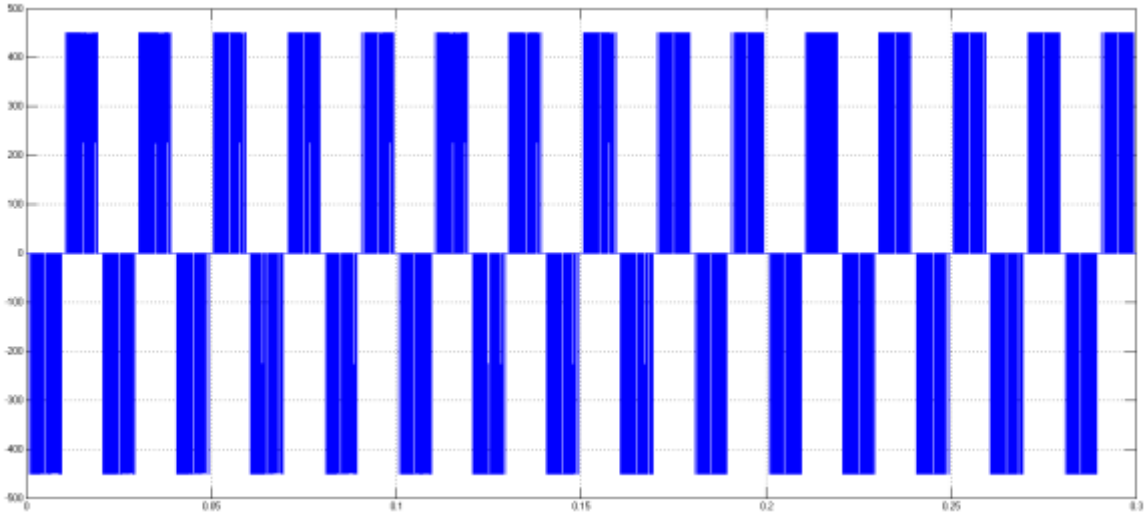

Fig 12 Open loop load voltage versus time graph time

MODULATION INDEX	THD OF CURRENT (%)	THE OF VOLTAGE (%)
0.6	3.11	33.33
0.8	2.11	25.40
1	1.94	21.21

Table 1 modulation index affects THD of current and voltage in open loop

C. Simulation model of close loop

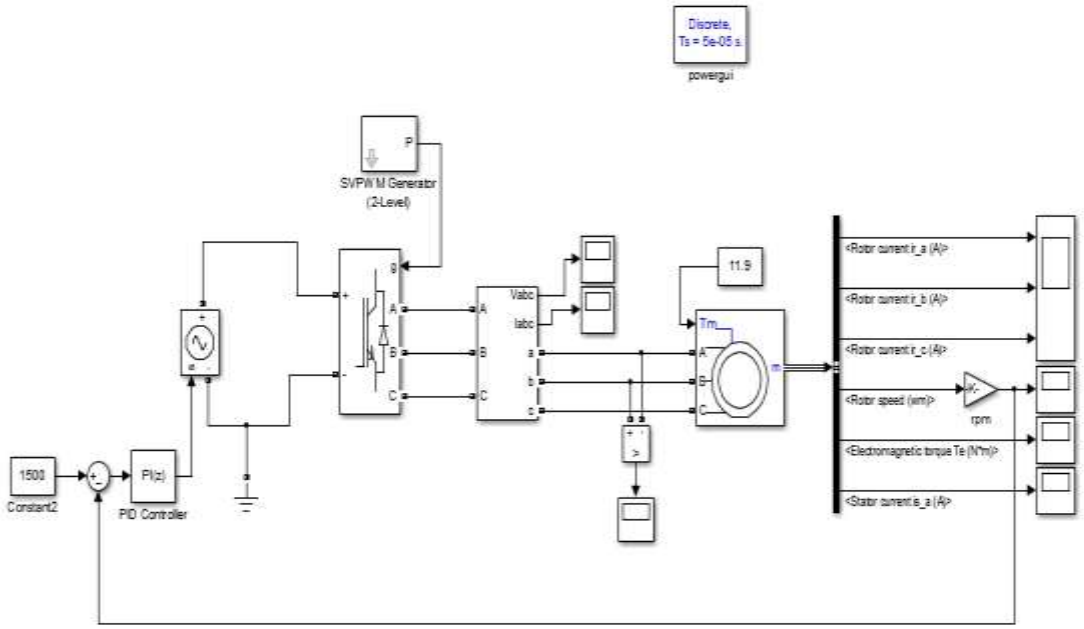

Fig 13 Simulation Model of close loop

D. Simulation Results Of Close loop

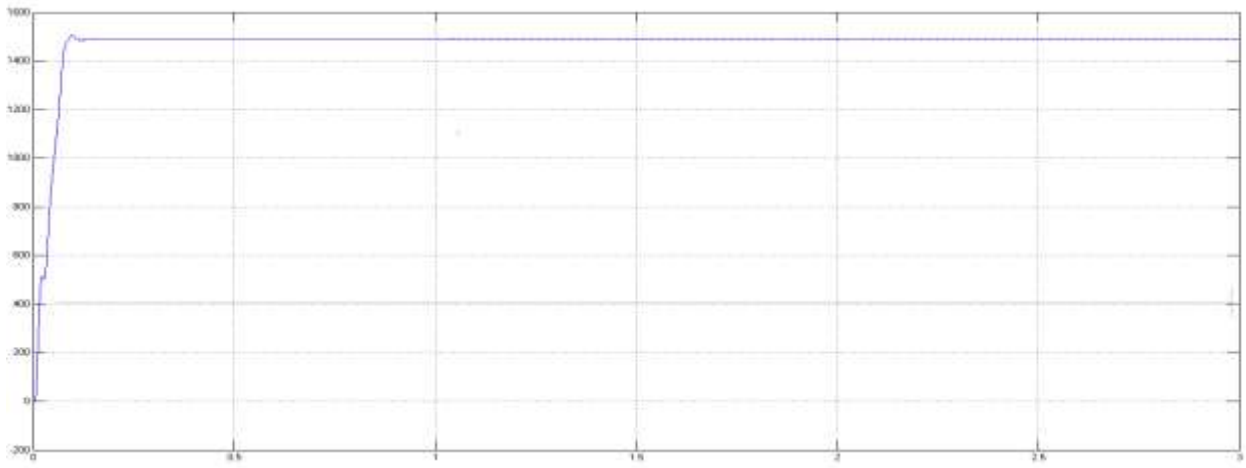

Fig 14 Scope showing rotor speed versus time graph

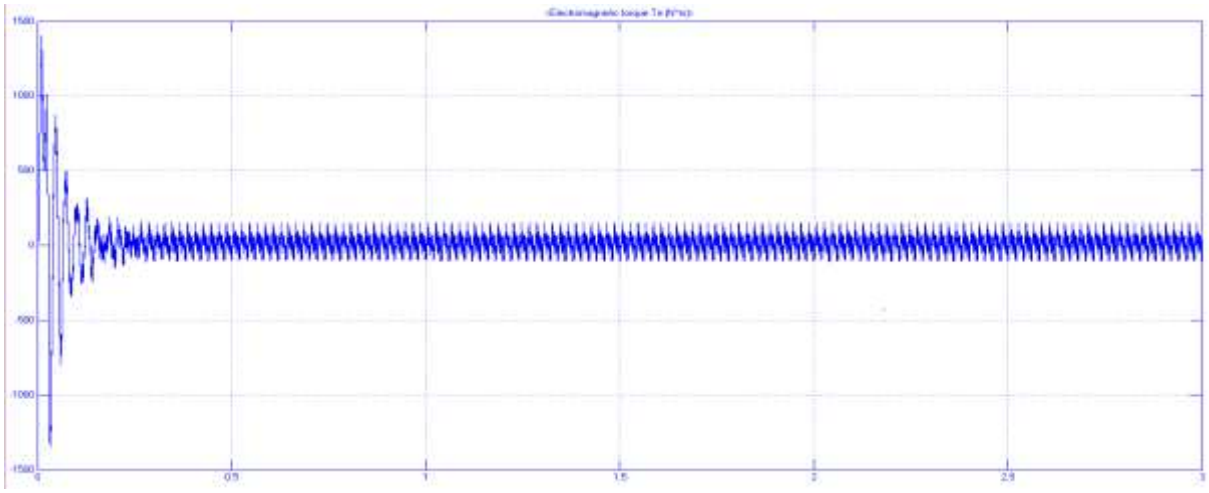

Fig 15 Close loop electromagnetic torque versus time graph

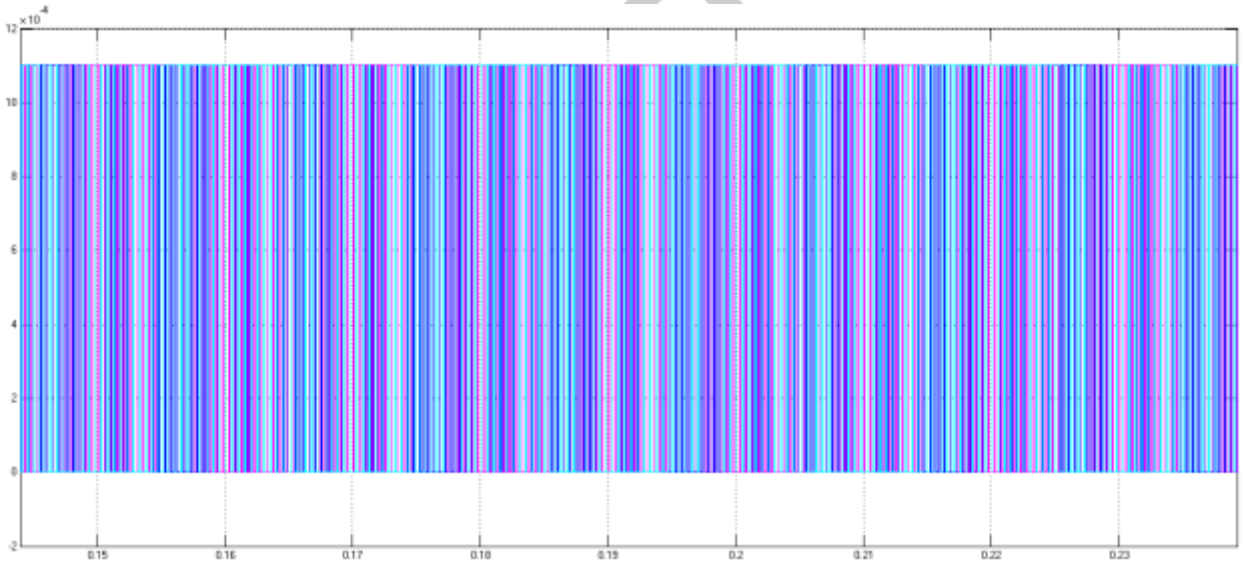

Fig 16 Close loop phase voltages versus time graph

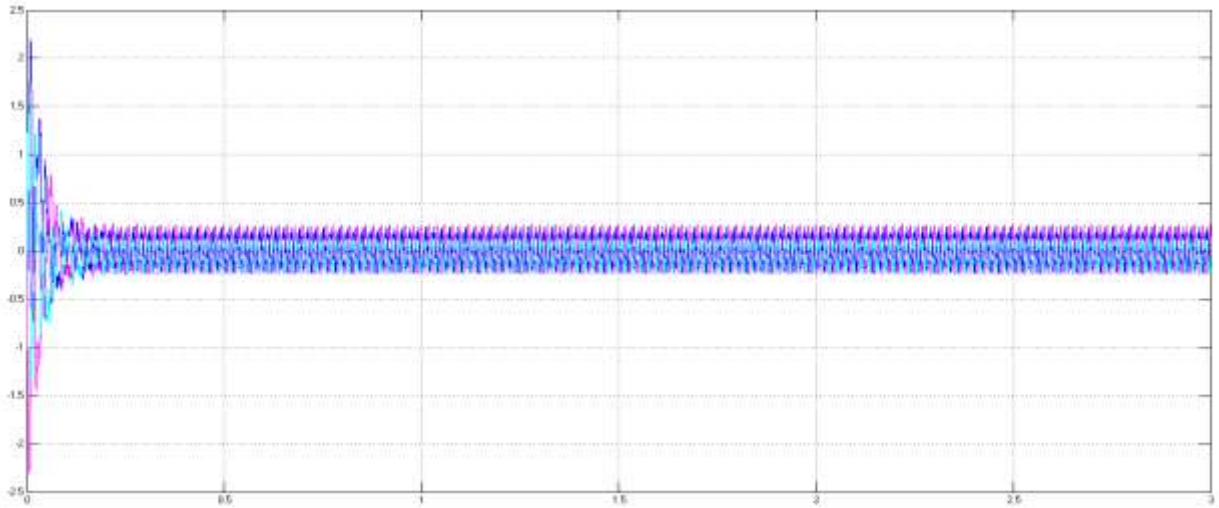

Fig 17 Close loop phase current versus time graph

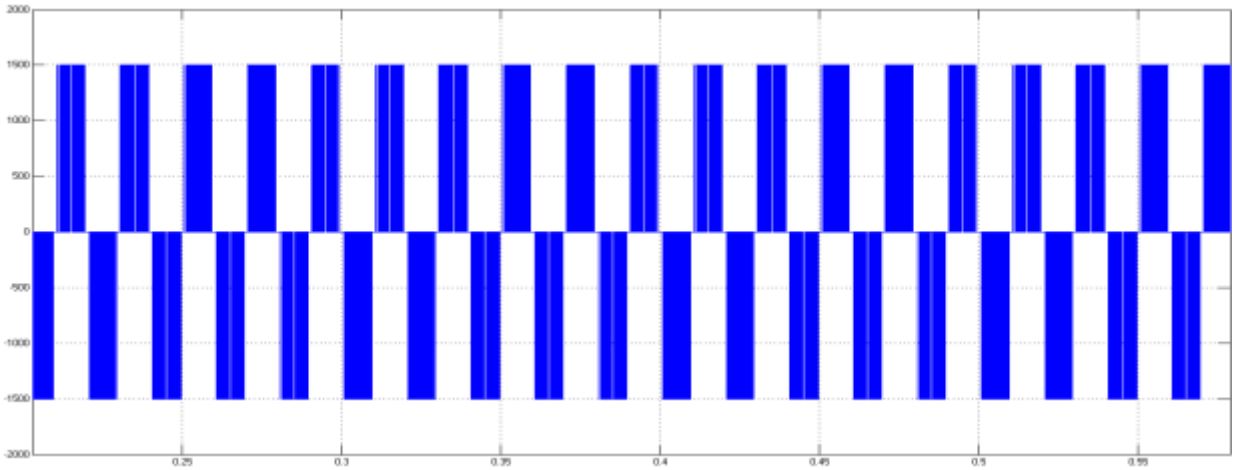

Fig 18 Close loop load voltage versus time graph

MODULATION INDEX	THD OF CURRENT (%)	THD OF VOLTAGE (%)
0.4	4.13	13.44
0.6	3.69	11.21
1	1.30	10.65

Table 2 modulation index affects THD of current and voltage in close loop system

IV. Conclusion

In this paper work Simulation and analysis of Space Vector PWM inverter fed three phase induction motor drive has been done in open loop and colse loop system.This work is carried out in MATLAB/SIMULINK invironment. The switching devices used are the power IBGTs. For generation of switching pulse the SVPWM technique has been used which produced three phase balanced output. Three phase balanced output is then used to operate an induction motor. The total harmonic distortion (THD) has been calculated for phase current and phase voltage of open loop and close loop. The modulation index varies between 0.1 to 1.0. I have fulfilled my aim to great extend. Means it has been evidently shown through results that by varying modulation index from low to high value we can reduce the THD of phase currents and phase voltages. The variations in modulation index also effect the speed of induction motor drive. There are fluctuations in the preliminary of rotor currents, electromagnetic torque but this is absent the speed. This is because of machine's inertia. This is evidently observable in scope. In open loop system steady state situation is reached at time t= 5 but in close loop system steady state situation is reached at time t=0.15. This is clearly visible in respective scopes.

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