PERFORMANCE IMPROVEMENT OF THREE PHASE INDUCTION MOTOR BY CONTROLLING THD USING SIMULINK

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Abstract- **Three phase induction motors are reliable, rugged and highly durable and of-course need less maintenance. Today many advanced semiconductor devices are available in power electronics market like BJT, IGBT, MOSFET etc. for control of electric drives. In our work MOSFET is used as a semiconductor device. simulink is utilized with matlab to get a reliable and flexible simulation. PWM technique is good method of controlling the speed of induction motor. In AC motor drives, SVPWM (space vector pulse width modulation) inverter makes it possible to control both magnitude and frequency of the voltage and current applied to a motor. This work represents the model, scheme and performance improvement of three phase induction motor using simulink by controlling THD.**

Key words**: Space vector PWM Inverter, MOSFET, Induction Motor Drive, MATLAB/SIMULINK.**

I. INTRODUCTION

The induction machine is an important motor of electric machines.For any industrial control and automation applications, three phase induction motor are mostly used. There is necessary to control the output voltage of inverter for the constant voltage/frequency control of an induction motor. PWM (pulse width modulation) technique provides better constant V/F control of an induction motor. Away from the various PWM techniques, the sinusoidal PWM is good and most popular method. Be it domestic application, motion control is required everywhere. The systems that are used for this purpose are called drives. Such a system, if makes use of electric motor is known as an electrical drive. In industrial drives, use of various control algorithms and sensors is done to control the speed of the motor using proper speed control methods.

The basic block diagram of an electrical drive is shown below-

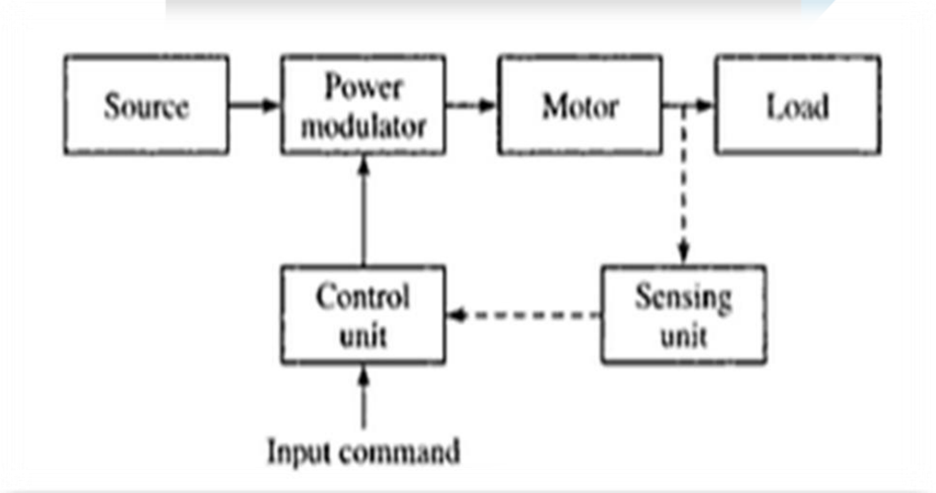

Fig 1. Block diagram of electrical drive

An electrical drive is defined as a form of machine equipment designed to convert electrical energy into mechanical energy.In the above block diagram of an electrical drive system, electric motor, power modulator, control unit, sensors and the load are shown as the major components included in the drive.

The electric motor is the core element of an electrical drive that converts electrical energy into mechanical energy. The motor can be DC motor or AC motor depends on the type of load.

Power modulator is also known as power processor which is mainly a power electronic converter and is dependable for controlling the power flow to the motor so as to achieve variable speed, reverse and brake operation of the motor. The power electronic converter include AC-AC, AC-DC, DC-AC and DC-DC converters.

The control unit tells the power modulator, how much power it has to generate by providing the reference signal to it after taking into account the input command and sensor inputs. The control unit could be a microcontroller, microprocessor or a digital signal processor.

A variable speed drive is used to run DC motors are known as DC drives and the variable speed drives used to control the AC motors are known as AC drives.AC drives are used to drive the AC motor especially three phase induction motor because these are predominant over other motors in most of the industries. In industrial terms, AC drive is also known as variable frequency drive (VFD), variable speed drive (VSD) or adjustable speed drive (ASD).

Though there are various types of VFDs (or AC drives), all of them are work on same principle that converting fixed incoming voltage and frequency into variable voltage and variable frequency output. The frequency of the drive determines the how rapid motor should run while the combination of voltage & frequency decides the amount of torque that motor to generate. Adjustable and variable speed drives may be purely electromechanical, mechanical, hydraulic or electronic.

Adjustable speed drive (ASD) or variable speed drive (VSD) describes apparatus used to control the speed of machine. Many industrial processes such as assembly lines must drive at different speeds for different products. Where speeds may be choose from several different pre-set ranges, generally the drive is said to be adjustable speed. If the output speed can be altered without steps over a range, the drive is typically referred to as variable speed.

II. INVERTER BASIC

The circuit model of a typical three-phase voltage source bridge inverter is shown in Figure, S1 to S6 are the six power switches that shape the output, which are controlled by the switching variables a, a‟, b, b‟, c and c‟. When an upper switches is switched on, i.e., when a, b or c is 1, the corresponding lower switches is switched off, i.e., the corresponding a‟, „b or c‟ is 0.Therefore, the on and off states of the upper transistors S1, S3 and S5 can be used to determine the output voltage.

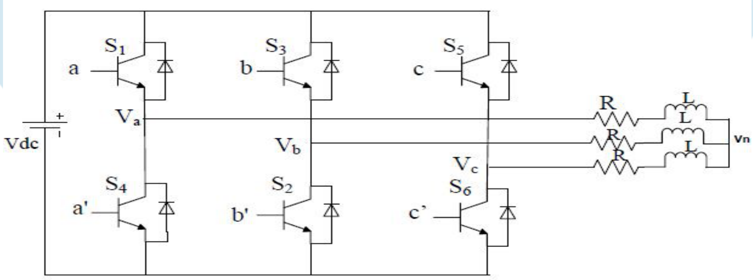

Fig 2. 3-φ Inverter bridge

III. COMPONENT USED IN MODEL

A.SVPWM

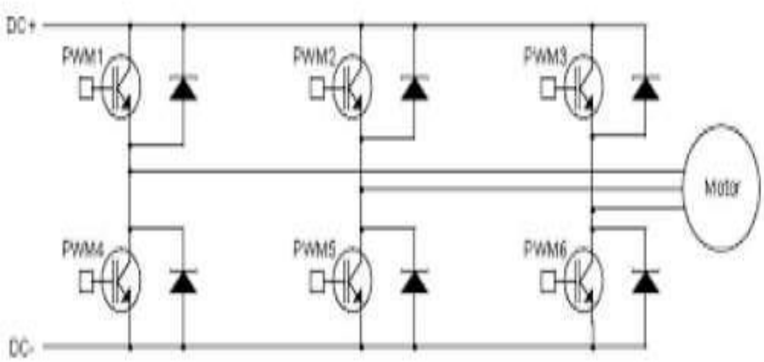

Fig 3. Circuit of SVPWM

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

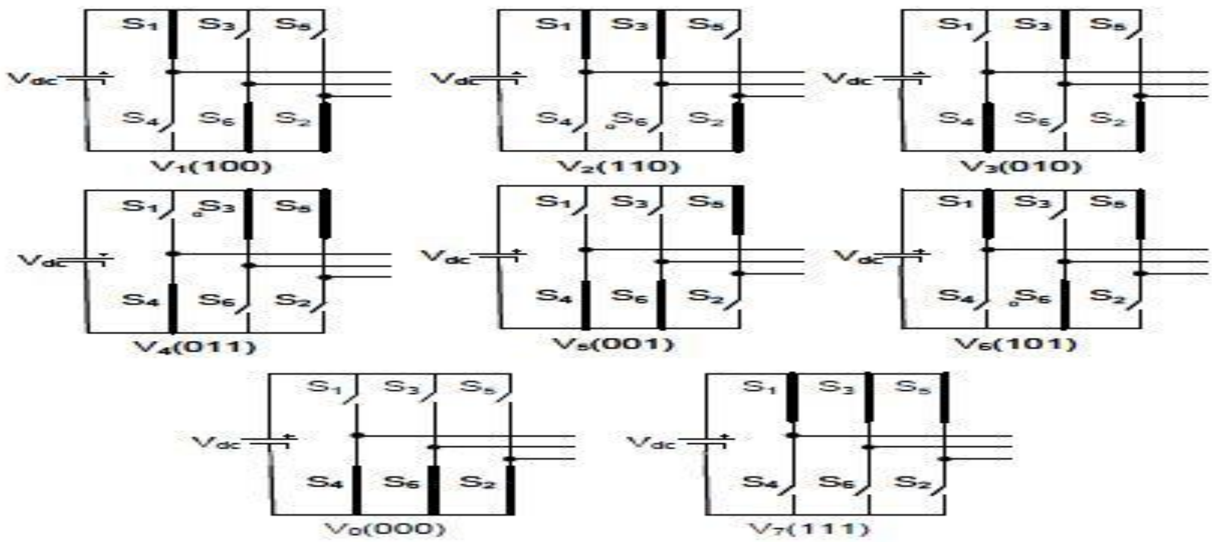

Fig 4. Eight Switching States of voltage source inverter

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

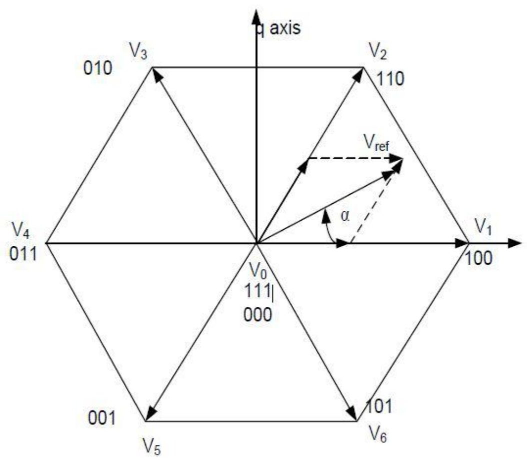

Fig 5. Space vector diagram

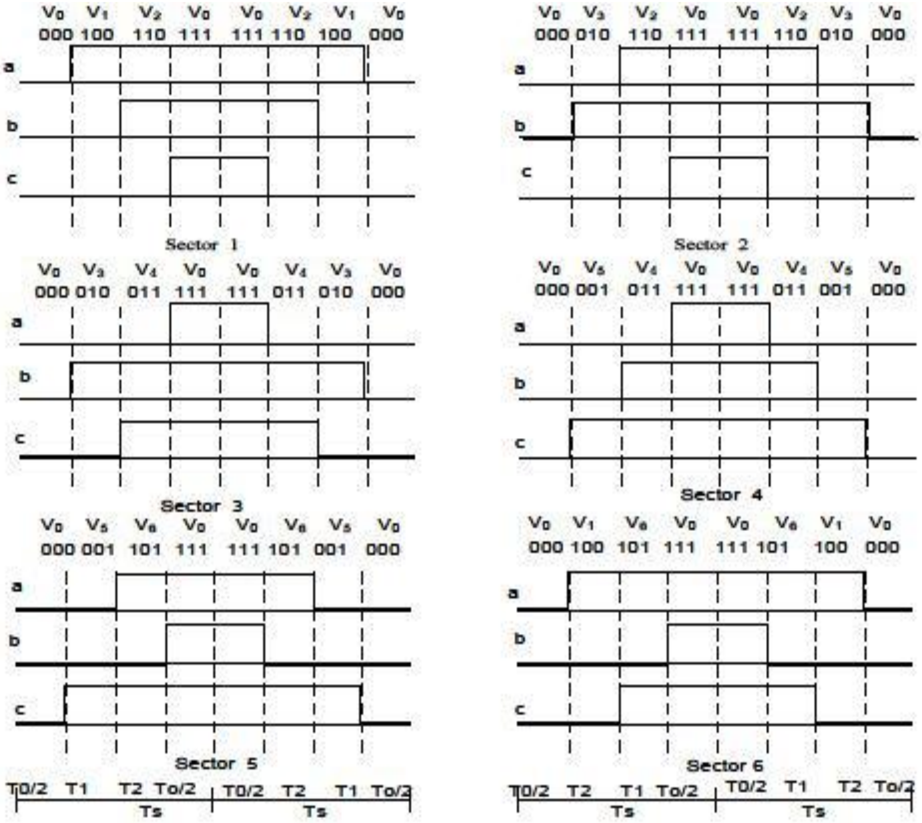

Fig 6. SVPWM switching patterns at each sector

IV. SIMULATION AND RESULT DISCUSSION

The SIMULINK Models has been developed for SVPWM in MATLAB. 9/SIMULINK.
The Block Diagram of SVPWM inverter fed Induction Motor is shown in Figure
The simulation parameters used:
Fundamental frequency = 50 Hz
Carrier frequency = 2000Hz
DC voltage = 440Volt
Modulation Index (MI) = 1
Asynchronous Machine = 3HP, 220V, 50Hz

A . SIMULATION MODEL

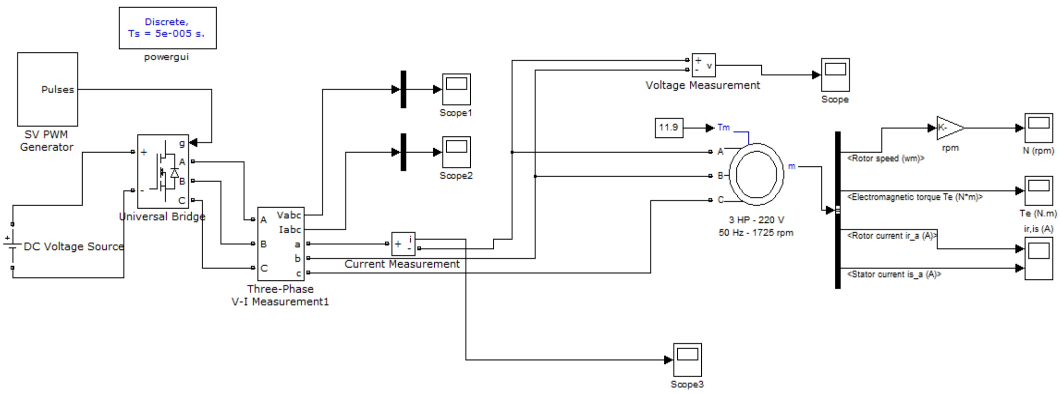

Fig 7. Simulation model

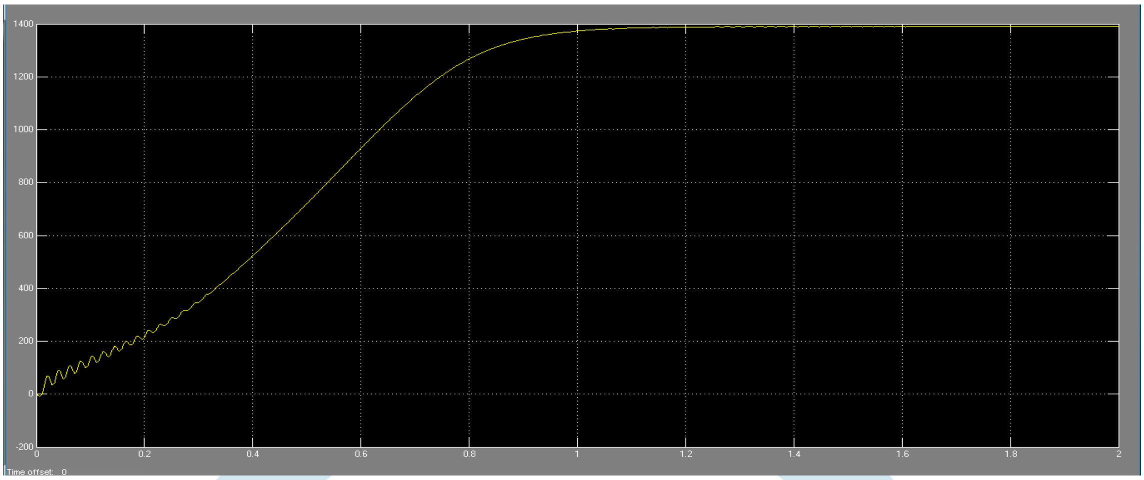

Fig 8. Motor speed v/s time

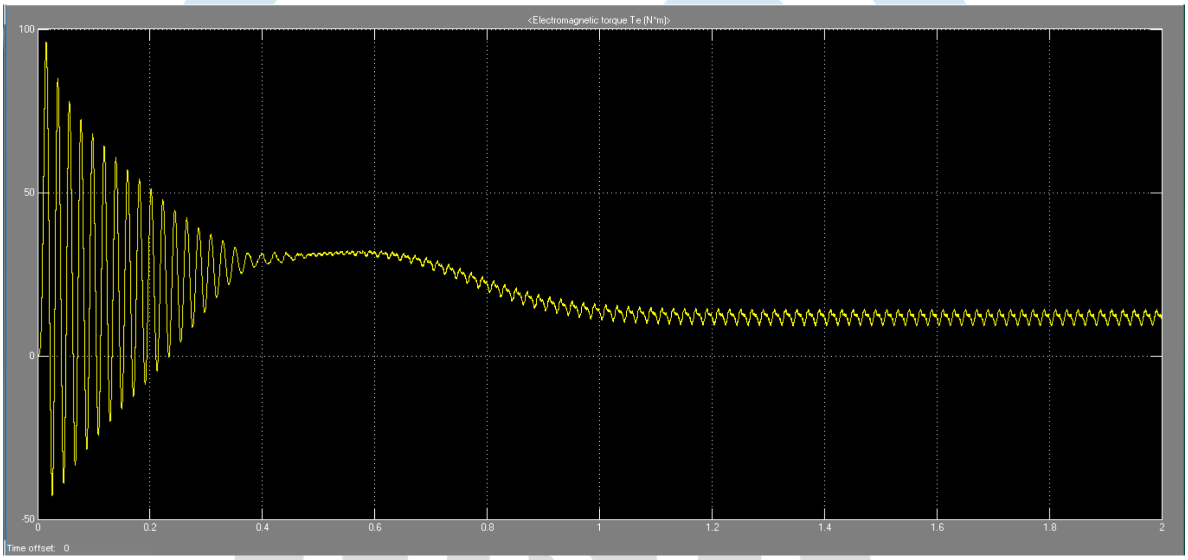

Fig 9. Electromagnetic torque v/s time

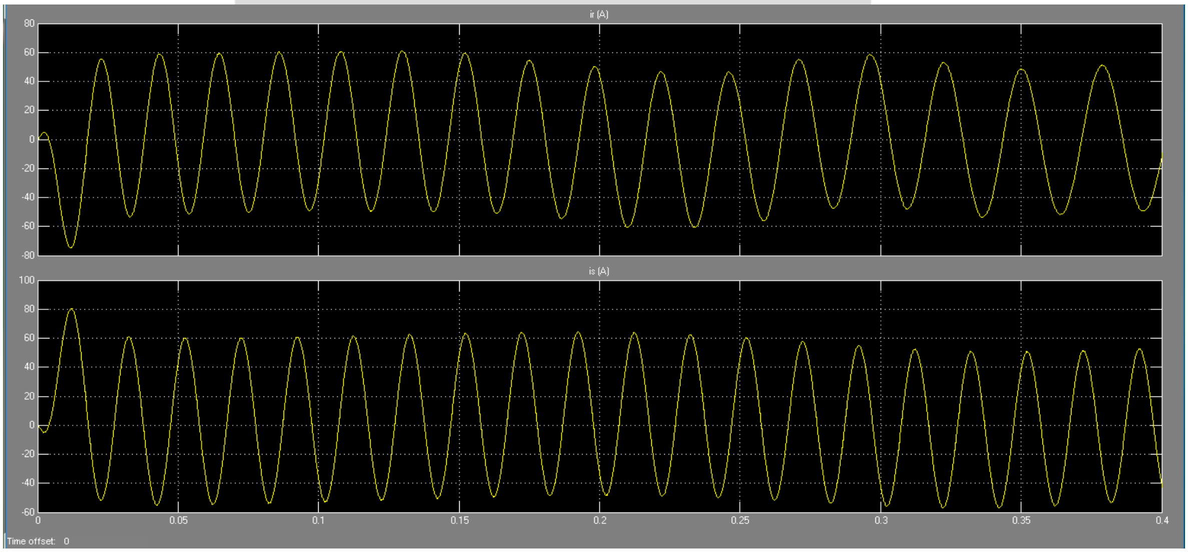

Fig 10. Rotor and stator current v/s time

RESULT DISCUSSION

The simulation is done at different modulation index and the THD% of current and voltage is given by following table.

TABLE FOR THD %

MODULATION INDEX	THD FOR CURRENT(%)	THD OF VOLTAGE(%)
0.4	3.03	111.50
0.6	2.88	104.04
0.8	1.46	38.08
1	0.63	10.41

Table 1: THD% for current and voltage

As clearly shown by the table content that at modulation index 1, the THD% of current and voltage is less as compare to other modulation index. We can say that if we increase the value of modulation index from low to high, the THD% of current and voltage waveform is reduced from higher to lower value.

V. CONCLUSION

The main objective of any modulation technique is to obtain variable output having maximum fundamental component with minimum harmonics. The aim of pulse width modulation method is improvement of fundamental output voltage and reduced of harmonic content in three phase voltage source inverter.

In this thesis, the space vector pulse width modulation technique is used for controlling the THD. Simulation work is carried in matlab 2009/simulink.

The simulation study reveals that space vector pulse width modulation gives inhanced fundamental output with better quality. The SVPWM utilize a changing carrier frequency to spread the harmonics simultaneously to a wideband area so that the peak harmonics are reduced greatly. And the performance can be further improved by changing modulation index from low to high value.

The simulation model is simulate at different modulation index 0.4 , 0.6 , 0.8 & 1 and we can observe that at modulation index 1 gives better fundamental output as compare to other modulation index value.

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