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Four Switch Three Phase Inverter fed Induction Motor

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ABSTRACT: This project presents the four switch three phase inverter fed induction motor with PWM method gives a simple way to select a three or four vectors, that gives the output voltage as desired in the presence of voltage oscillations across the two dc links capacitor , this method is called space vector modulation. over this pulse width modulator the wye effect and delta designed motor windings are also considered. Finally that three phase four switch inverter is evaluated. Then the simulation results are produced through MATLAB/SIMULINK.

KEYWORDS: FSTPI- four switch three phase inverter, IM-induction motor, PWM-pulse width modulation.

I.INTRODUCTION

Three phase variable speed drives for asynchronous motors have been used more and more, especially in energy saving drive applications. In many cases, the cost reduction is an important target for the drive. Hence, a reduced number of inverter switches is a promising solution. The speed of the induction motor can be controlled by varying its input AC voltage and frequency. Several inverter schemes with reduced number of switches have been proposed. Among them the four switch three phase inverter (B4) was introduced with four IGBT switches instead of six (B6) in a conventional three phase inverters. The 4S3P inverter, which uses only four switches to produce three phase output voltages, is the suggested topology with a low cost. The modulation strategies have been developed based on space vectors. Compared with the SPWM method, the space vector PWM (SVPWM) method has been shown to generate less total harmonic distortion in output voltages and currents, less switching loss and a wide linear modulation region.

II. PROPOSED SYSTEM

This paper presents a general method to generate pulse width modulated (PWM) signals for control of four-switch, three phase voltage source inverters, even when there are voltage oscillations across the two dc-link capacitors. The method is based on the so called space vector modulation, and includes the scalar version. The proposed method provides a simple way to select four vectors to synthesize the desired output voltage during the switching period. In the proposed approach, the selection of four vectors is parameterized by a single variable. SVPWM methods are implemented on the formation of the reference vector on the plan αβ which is divided into four sectors. The active vectors and their duration in one sampling interval are selected and calculated on the basis of the required location respective for these sectors. SVPWM method is based on the principle of similarity of the one for B6 inverters, where plan αβ is divided into 6 sectors and the formation of $_{Vref}$ is done similarly as for B6. This facilitates the calculation for B4 and some issues for B6 can be applied for B4. The simulation and experimental results verify the advantages of the proposed inverter.

III.CIRCUIT DIAGRAM

The circuit consists of 4-switches q_1, q_2, q_3 and q_4 and split capacitors VC_1 and VC_2. The 3-phase AC input, which is of fixed frequency, is rectified by the rectifier switches. The power circuit is the three-phase four-switch inverter.

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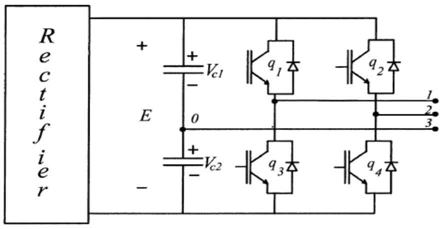

Fig 1 AC drive system configuration

Two phases ‘a’ and ‘b’ are connected to the two legs of the inverter, while the third phase ‘c’ is connected to the center point of the dc-link capacitors, VC_1 and VC_2 . The 4 power switches are denoted by the binary variables q_1 to q_4, where the binary ‘1’ corresponds to an ON state and the binary ‘0’ corresponds to an OFF state. The states of the upper switches (q_1, q_2) and lower switches (3 S, 4 S) of a leg are complementary that is $q_3 = 1 - q_1$ and $q_4 = 1 - q_2$. Also it will be assumed that a stiff voltage is available across the two dc-link capacitors, and Vc1=Vc2= (E/2), where E corresponds to a stiff dc-link voltage. Phase to common point voltage depends on the turning off signal for the switch .Combinations of switching S1-S4 result in 4 general space vectors, components αβ of the voltage vectors are gained from abc voltages by using Clark’s transformation .In order to form the required voltage space vector V_{ref} , we can use 3 or 4 vectors in one sampling interval Ts. The constant value 0 (zero) vectors can be formed by dividing to (duration of zero vector) among 2 opposite vectors.

IV.SPACE VECTOR DESIGN ANALYSIS

The Pole voltages V_{10}, V_{20}, and V_{30} depend on the states of the power switches. They can be expressed in terms of the binary variables q_1 and q_2 and the dc-link voltage as follows,

$$v_{10} = (2q_1 - 1)\frac{\bar{E}}{2}$$

$$v_{20} = (2q_2 - 1)\frac{\bar{E}}{2}$$

$$v_{30} = 0$$

Space vector modulation and the problem of selecting the appropriate switching sequence are better understood, if the three phase quantities are transformed into αβ quantities.

A.WYE CONNECTION

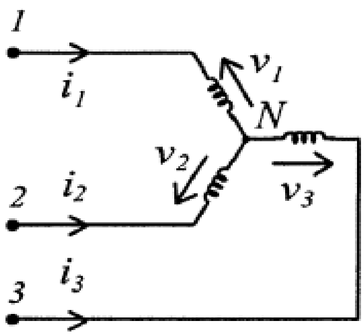

Fig 2 Three phase induction motor stator winding wye connection

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In this case the line-to-neutral voltages are, V1=V10-VN_0, V2=V20-Vn0, V3=-Vn0, and VN_0 is the voltage between the neutral (N) and the dc bus mid-point (0). The induction motor is assumed to be symmetric, with its neutral wire disconnected.

The αβ voltage components are given by,

$$v_\alpha = \sqrt{\frac{2}{3}}\left(q_1\bar{E} - q_2\frac{\bar{E}}{2} - \frac{\bar{E}}{4}\right)$$

$$v_\beta = \sqrt{\frac{2}{3}}\left(q_2\frac{\sqrt{3}}{2}\bar{E} - \frac{\sqrt{3}}{4}\bar{E}\right)$$

B.DELTA CONNECTION

In this case,V_1= V_{10}-V_{20},V_2= V_{20}-V_{30} and V_3=V_{30}-V_{10} and, consequently, the αβ voltage components.The combination of the states of the switches as given in Table 2 account for four different vectors in the αβ plane. Their amplitude is a factor root three times either, than the vectors of the Wye connection.

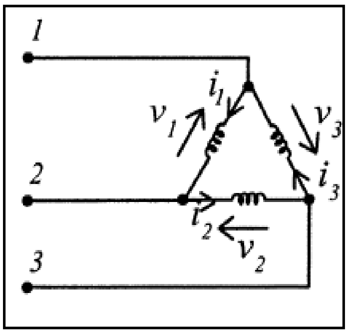

Fig 3 Three phase induction motor stator winding delta connection

V.SPACE VECTOR MODULATION

Space vector modulation (SVM) is an algorithm for the control of pulse width modulation (PWM).For the induction motor drive, the three phase voltage references in a balanced set are given by equation,

$$V_{as}^* = V_m \cos \omega tn$$
$$V_{bs}^* = V_m \cos\left(wt - \frac{2\pi}{3}\right)$$
$$V_{cs}^* = V_m \cos\left(wt + \frac{2\pi}{3}\right)$$

The scalar modulation uses the phase voltages in calculating the switching time. Since the two phases of the induction motor are connected to the inverter legs and the third phase is connected to the neutral point of the dc link, the line-to-line voltage can be used for the PWM instead of the phase voltage. The c phase is connected to the neutral point.

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VI. SIMULATION RESULTS

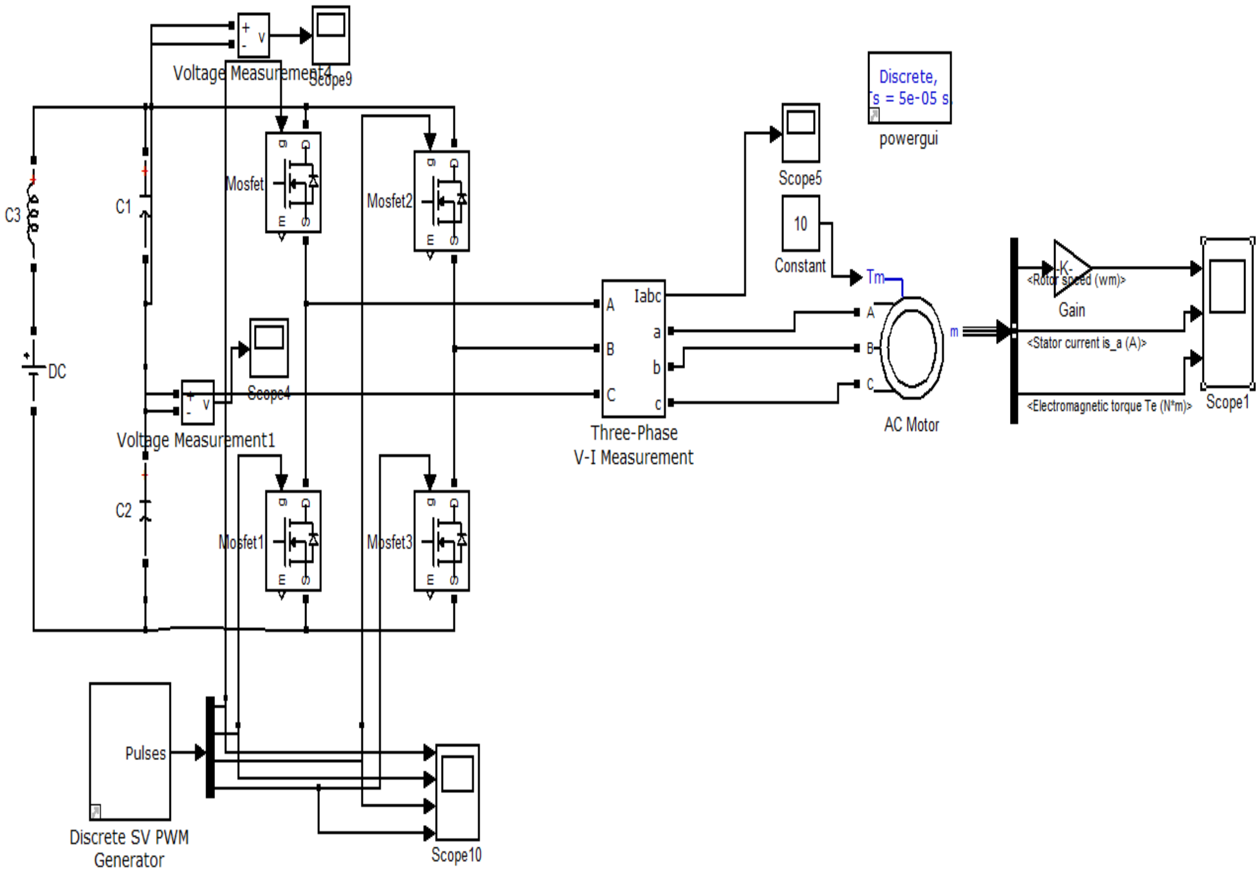
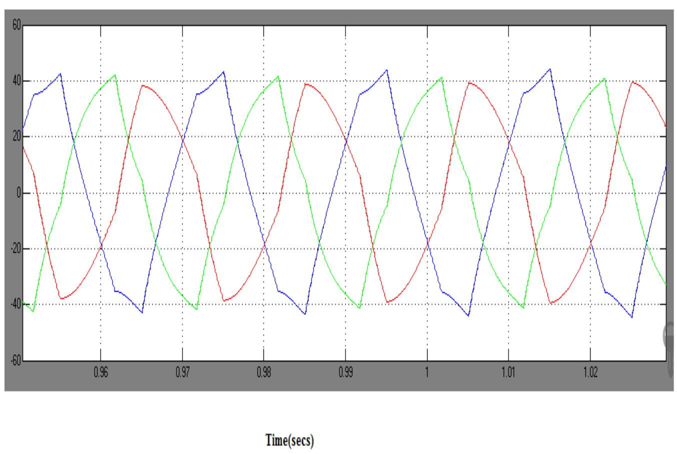


Fig 4 Simulation diagram

A.OUTPUT WAVEFORM OF THREE PHASE CUREENT



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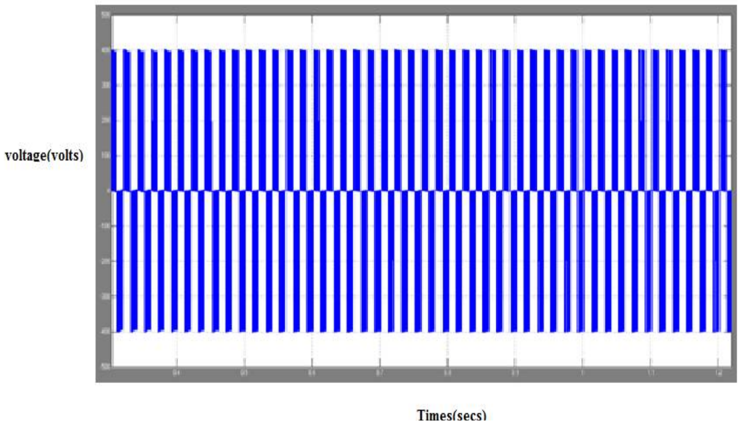
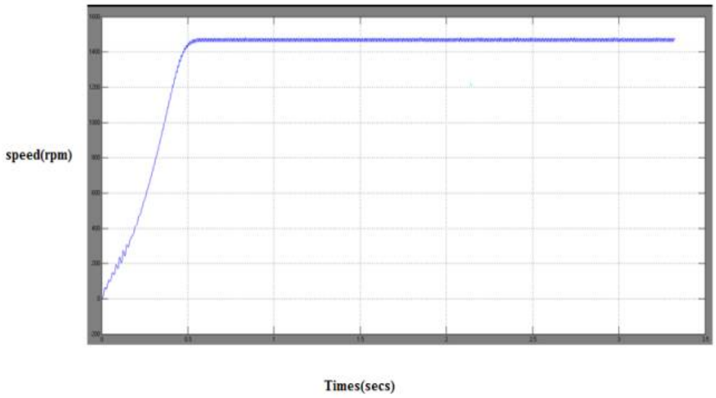
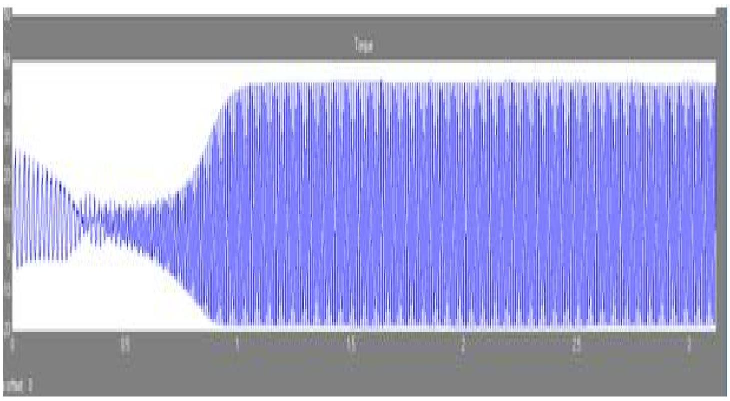
B.OUTPUT WAVEFORM OF THREE PHASE VOLTAGE



C. OUTPUT WAVEFORM OF MOTOR SPEED



D.OUTPUT WAVEFORM OF ELECTROMAGNETIC TORQUE



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VII.CONCLUSION

A cost effective FSTP inverter fed AC Motor drive has been simulated and successfully implemented. This project presents a complete development and analysis for four switch three phase inverter fed asynchronous motor drive. The design and development of this project has been implemented by using in Matlab / Simulink. A comparison of performances for the proposed FSTP inverter fed AC Motor drive with conventional SSTP inverter fed drive has also been made in terms of speed response, torque response, and three phase currents under identical operating conditions. The drive also shows good performance in speed operation under the effect of load disturbances. The proposed control scheme with low cost implementation is suitable for commercial applications.

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