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Three Phase Motor Drive Using Space Vector Pulse Width Modulation Technique

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Abstract: *The main theme of the paper is that we are driving the motor at different speed by PWM technique as by doing that we can easily control the motor speed for different loads.AC loads requires variable voltage and variable frequency. These requirements are fulfilled by a voltage source inverter. A variable output voltage can be achieved by varying the input dc voltage and keeping the gain of the inverter constant. On the other hand, if the dc input voltage is fixed and itis not controllable, a variable output voltage can be achieved by varying the gain of the inverter, which is normally accomplished by pulse-width-modulation control within the inverter. There are number of pulse width modulation techniques but only Space vector technique is a good choice among all techniques to control voltage source inverter. Space vector pulse width modulation (SVPWM) is an advanced and very popular method with several advantages such as its effective DC bus utilization, less harmonic generation in output voltage, less switching losses, wide linear modulation range etc. Owing to these advantages, it is being mostly used to control an inverter.*

Key words: *Pulse width modulation (PWM), Space vector pulse width modulation (SVPWM), Total harmonic distortion (THD), Voltage source inverter (VSI).*

I. INTRODUCTION

A Single-phase system has lower cost features compared to Three-phase system in the power distribution system. Due to the usage of three-phase motors (because of better performance), it necessitates the conversion of Single-phase system to Three-phase system but the problems associated with this conversion system are increased number of components, distortion and irregular distribution of power among the switches of the converter, which may give rise to power quality issues in source side and performance issues in load side. By parallel connection of the rectifier, current processed at the input side reduces and reduction of the output voltage processed by series connection of inverter. Indeed, with the advent of advancement in manufacturing & designing, AC drives super-ceded the DC drives due to their higher performance and better efficiency. The most important advantages of AC drives over DC drives are faster predictable dynamic response, constant and better Power Factor (PF) and 100% continuous torque at zero speed (Applicable to flux vector control technology). AC motors have low cost, less complicated, rugged and easy to maintain or replace, therefore this is also a major cause of shifting of technology from DC drives to AC drives.

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II. LITERATURE SURVEY

[1] José Rodríguez

This paper addressed a switching strategy for multilevel cascade inverters, based on the space-vector theory. The proposed switching strategy generates a voltage vector with very low harmonic distortion and reduced switching frequency. Anandarup Das, et al used a new PWM technique for induction motor drives Space vector modulation (SVM) is an algorithm for the control of pulse width modulation (PWM).[1] It is used for the creation of alternating current (AC) waveforms; most commonly to drive 3 phase AC powered motors at varying speeds from DC using multiple class-D amplifiers. There are variations of SVM that result in different quality and computational requirements. One active area of development is in the reduction of total harmonic distortion (THD) created by the rapid switching inherent to these algorithms.

[2] Robert P. Limanek

The MOSFET is an important element in embedded system design which is used to control the loads as per the requirement. Many of electronic projects developed using MOSFET such as light intensity control, motor control and max generator applications. The MOSFET is a high voltage controlling device provides some key features for circuit designers in terms of their overall performance. This article provides information about different types of MOSFET applications. The MOSFET (Metal Oxide Semiconductor Field Effect Transistor) transistor is a semiconductor device which is widely used for switching and amplifying electronic signals in the electronic devices. The MOSFET is a three terminal device such as source, gate, and drain

[3] Euzeli Cipriano dos Santos

The PIC18F452 is, as with all the other18F series parts, optimized for using C. It has a 31 deep hardware stack and linear memory (rather than banked memory) so we don't have to make adjustments for the hardware when coding in C. This microcontroller is exceptionally powerful and ideal for C programming...but the 18F2550/18F4550 are similar and have a built-in USB interface. The 18F452 has 16k of program memory and 1536 Bytes of RAM and because the RAM is linear, we can declare large arrays which is not possible if we use devices with banked memory (16F series). Note: Banked memory occupies the same memory address space and you switch from one bank to another using some program code (in other devices)

III. DESIGN METHODOLOGY

Working

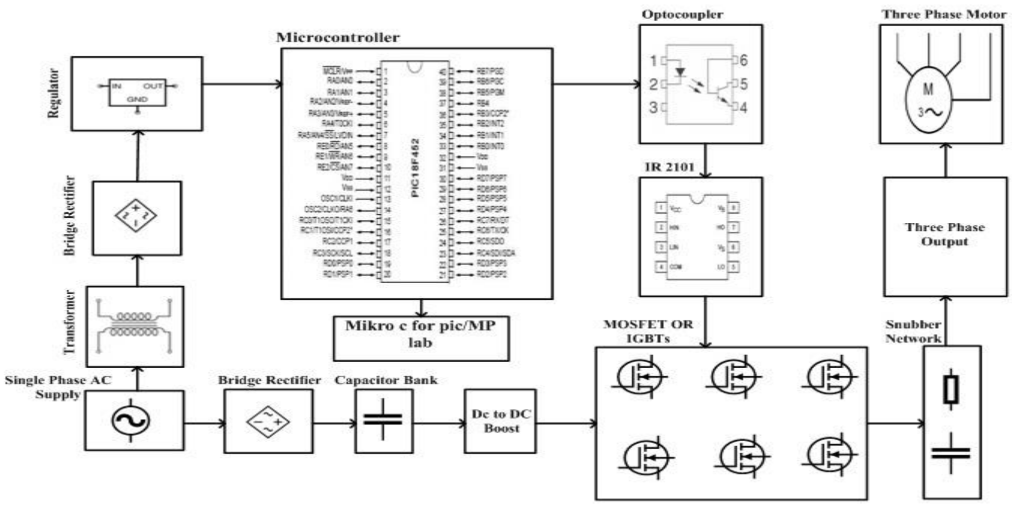

Figure 1: Block Diagram of three-phase motor drive using SVPWM technique

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When the three-phase motor drive is connected to the power supply of 220 V ac then these ac voltages are converted into dc through bridge rectifier but these are not pure dc voltage these are basically the pulsating dc voltage. The capacitor bank is connected at the output of bridge rectifier, which removes the ac contents and provide pure dc voltages to the voltage source inverter. The voltage source inverter, which is basically the three phase H bridge consists of semiconductor switches. When these switches are operated through the vector space pulse width modulation technique, which is provide by the microcontroller, then these switches invert the dc voltage in to three phase ac voltage. These three phase ac voltages are used for operating the three-phase ac motor. We can change speed of motor by changing the frequency of vector space pulse width modulation through microcontroller.

MATHEMATICAL FORMULA FOR DESIGNING

1) $Vb + Vc = \sqrt{[(\frac{1}{3}Vdc)^2 + (\frac{1}{3}Vdc)^2 + 2*\frac{1}{3}Vdc * \frac{1}{3}Vdc * \cos(120)]}$

2) $Vb+Vc=\frac{1}{3}Vdc$

3) $Va+Vb+Vc=\frac{2}{3}Vdc + \frac{1}{3}Vdc$ =Vdc=Resultant

Here Va, Vb, Vc are the three space vectors to which the gate pulses are given simultaneously
And Vdc is the resultant of the three space vectors.

The goal of SVPWM is to produce a "mean vector" during the PWM period (T_{PWM}) that is equal to the desired voltage vector (V_{out}).

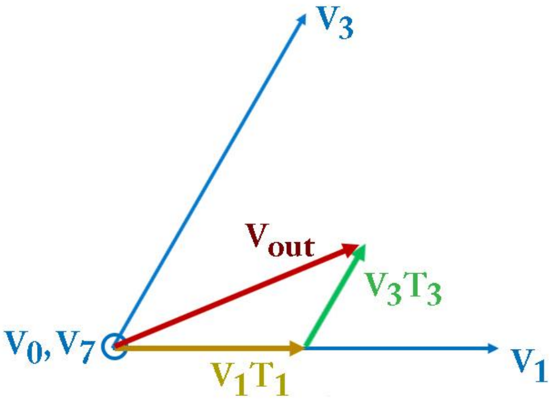

Figure 2: Vector addition of two vectors

The location of V_{out} is determined on the star diagram, and the base vectors that constrain that sector (V_1 and V_3, for example), along with one of the null vectors, are used to synthesize the desired voltage. This is done by applying V_1 for a specified time (T_1), V_3 for a specified time (T_3), and the null vector for the amount of time necessary (T_0) to provide a resultant vector equal to V_{out}.

Here,
V_1= Voltage vector (say when switching pattern is 100)
V_3= Voltage vector (say when switching pattern is 110)
T_1= Time for which switching pattern corresponding to V_1
T_3= Time for which switching pattern corresponding to V_3
T_0=Time duration for which inverter switching pattern is (000) or (111)

The values of T1, T3, and T_0 can be determined with the following equations:

$$T_1 = |\frac{Vout}{V1}| . T_{PWM} \quad \ldots 1$$

$$T_3 = |\frac{Vout}{V3}| . T_{PWM} \quad \ldots 2$$

$$T_0 = T_{PWM} - (T_1 + T_3) \quad \ldots 3$$

The simulation of V_{out} can then be expressed as:

$$V_{out} = V_1T_1 + V_3T_3 + V_0T_0$$

IV RESULTS

Table 1. Switching vectors, phase voltage and output line to line voltage

Voltage vectors	Switching vectors			Line to neutral voltage			Line to line voltage		
	A	B	C	V_{an}	V_{bn}	V_{cn}	V_{ab}	V_{bc}	V_0
V_0	0	0	0	0	0	0	0	0	0
V_1	1	0	0	2/3	-1/3	-1/3	1	0	-1
V_2	1	1	0	1/3	1/3	-2/3	0	1	-1
V_3	0	1	0	-1/3	2/3	-1/3	-1	1	0
V_4	0	1	1	-2/3	1/3	1/3	-1	0	1
V_5	0	0	1	-1/3	1/3	2/3	0	-1	1
V_6	1	0	1	1/3	-2/3	1/3	1	-1	0
V_7	1	1	1	0	0	0	0	0	0

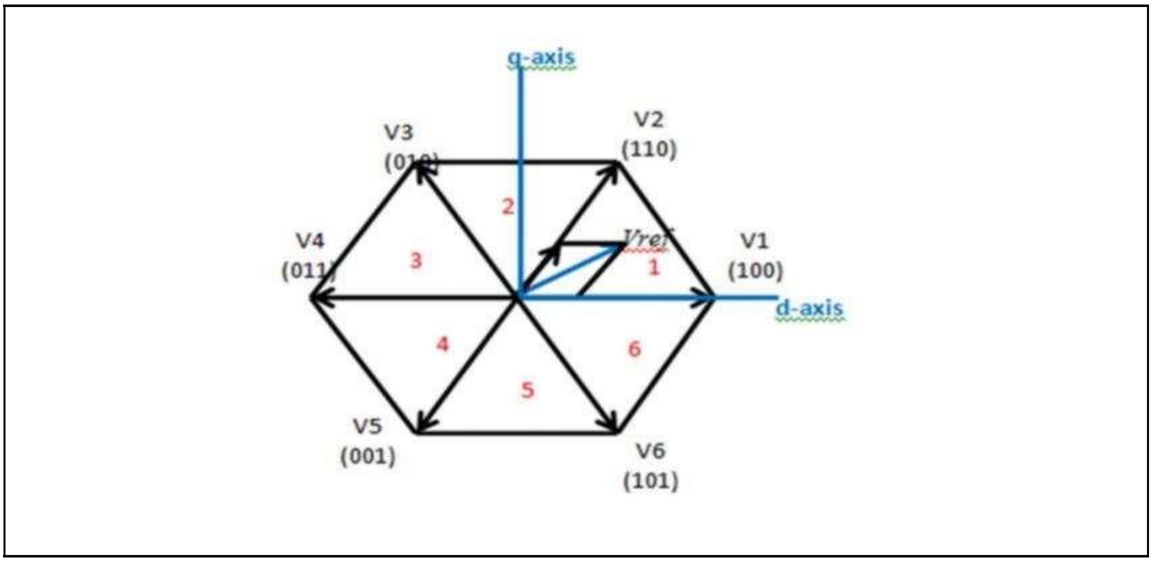

Figure 3: Basic sector and vector diagram

V CONCLUSION

After the comparative evaluation of Space Vector PWM with existing SPWM for Inverter fed IM it can be said that SVPWM has better control approach. The simulation outcomes with THD obtained from the FFT analysis of the output signal were contrasted in the previous segment. After careful study of FFT graphs, it can be seen that SVPWM offers 14.4% improved output. Also, SVPWM method overcomes the major drawback of conventional SPWM in order to control an induction motor is that it has high-harmonic distortion owing to irregular nature of the PWM switching characteristics. In our result it can also be seen that MOSFET provides faster switching speed than IGBT and reduce the cost of the design for medium voltage input devices. SVPWM offers better end result at the inverter output in terms of lesser THD in voltage, current, and electromagnetic torque compared to SPWM. Hence, SVPWM provides a better fundamental output voltage.

REFERENCES

[1]Abdelfatah Kolli, Student Member, IEEE, Olivier Béthoux, Member, IEEE, Alexandre De Bernardinis, Member, IEEE, Eric Labouré, and Gérard Coquery "Space-Vector PWM Control Synthesis for an H-Bridge Drive in Electric Vehicles" *IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 62, NO. 6, JULY 2013.*

[2] Euzeli Cipriano dos Santos, Nady Rocha, and Cursino Brandao Jacobina "Suitable SinglePhase to Three-Phase AC–DC–AC Power Conversion System" *IEEE Advancement in microcontroller pic family ,Transaction on Power Electronics, vol.30, no. 2, pp.860-870, Feb 2015.*

[3]Robert P. Limanek, and J. Pou, "Analysis and control of DC-capacitor-voltage-drift phenomenon of a passive front-end five-level converter," *IEEE Transactions on Industrial Electronics, vol. 54, no. 6, pp. 3255-3266, 2007.*

[4]Keliang Zhou and Danwei Wang, Member, IEEE "Relationship Between Space-Vector Modulation and Three-Phase Carrier-Based PWM: A Comprehensive Analysis" *IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 49, NO. 1, FEBRUARY 2002.*

[5]Relationship between Space-Vector Modulation and Three- Phase Car rier-Based PWM: A Comprehensive Analysis Keliang Zhou and Danwei Wang, Member, *IEEE.*

[6] Simulation and comparision of SPWM and SVPWM control for three phase Inverter. K. Vinoth Kumar, Prawin Angel Michael, Joseph P. John and Dr. S. Suresh Kumar *School of Electrical Sciences, Karunya University, Coimbatore, Tamilnadu, India.*

[7] Analysis, Simulation and Implementation of Space Vector Pulse Width Modulation Inverter E. Hendawi, F. Khater and A. Shaltout *Electronics Research Institute,Cairo University, GIZA EGYPT.*

[8] Bose, B. K., "*Modern Power Electronics and AC Drives*," Prentice Hall PTR, 2002.

[9] Rashid, M. H., "*Power Electronics Handbook*," Academic Press, 2001.

[10] Mohan, N., "*First Course on Power Electronics and Drives*," MNPERE, 2003.