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A Basic DSP Processor-Based Sector-Independent Space Vector Modulation

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Abstract*: This document demonstrates the process of building a sector-independent Space Vector Modulation (SVPWM) system using a DSP processor in fundamental motor drive systems. The implementation of traditional space vector modulation proves complex because it includes extensive calculations. Before moving forward, it is essential to determine the magnitude of voltage vectors according to speed specifications and Volts/Hz data in software and hardware domains. Computing the phase angle and quadrant and sector determination enables the calculation of switching time segments based on decomposition matrices.*

This proposed algorithm dissipates all computational requirements that exist in traditional approaches. The closed loop control system achieves precise switching period control through fixed compare register values which it implements using the Volts/Hz principle. Through its built-in Space Vector Pulse Width Modulation hardware module, the TI TMS320LF2407A generates PWM pulses that include four switching states within one PWM period. The performance evaluation of the 4-hp induction motor supplied by IGBT-based inverter modules generated through DSP processor control pulses showed promising results.

Keywords*: PWM Volts/Hz concept, Space vector, DSP processor, and Closed loop control*

I. Introduction

The wide acceptance of PWM inverter-fed adjustable speed AC motor drives results from their superior performance combined with higher operational efficiency when compared to standard motor drives. The PWM inverter controls the supply voltage and current to motors by adjusting frequency together with magnitude for sustained flux operation. Two types of pulse-width modulation exist namely space vector PWM and trapezoidal PWM along with sinusoidal PWM and hysteresis PWM. The various motors including the switched reluctance, BLDC and AC induction receive their PWM-based controls through these methods. The popularity of Space Vector PWM technology continues to rise because it delivers higher fundamental output and produces fewer output harmonics.

Current developments in high-speed DSP technology enable researchers to execute complex control algorithms. The development utilizes the Texas Instruments TMS320LF2407A DSP controller which includes practical accessories to fulfill work requirements. There are two separate methods which generate SVPWM waveforms [2]. This software-based method depends exclusively on the standard comparison features of the digital processor. The comparison registers receive data that was calculated as switching time intervals during this phase. The PWM channels require dual toggling states to form six distinct switching conditions inside one PWM cycle. The PWM pulses are created through the hardware module of the DSP LF2407A in hardware-implemented topologies.

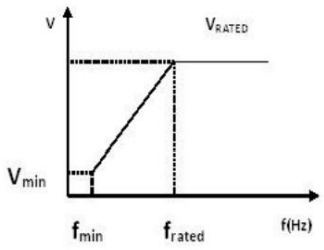

Fig 1: Volts/Hz profile

II. Control Methodology

A combination of switching states which match the basic space vectors constructs the SVPWM method [4] for approximating motor voltage vector. During short sampling intervals defined by the program the average inverter voltage output needs to match the average outgoing reference voltage. The fundamental Space Vector orientations can be found in Figure 2.

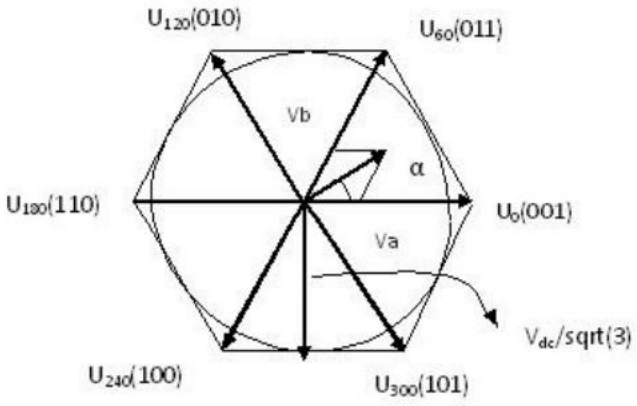

Fig 2: Space Vector Diagram

During speed variations the automatic output voltage regulation happens because the software maintains constant Volts/Hz ratios through its fixed T1 and T2 values. The closed loop control technique can be visually represented through Figure 3.

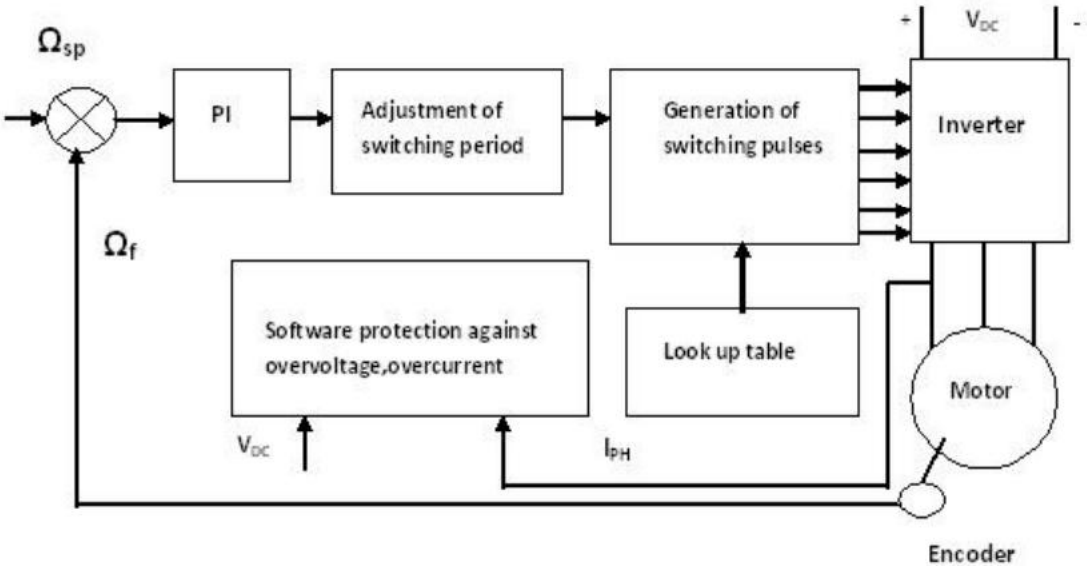

Fig 3: Block diagram of control scheme

III. Experimental Results

The hardware schematic which was implemented appears in Figure 5. According to performance tests the motor achieved satisfactory results when it operated at rated speed while carrying loads and without loads. The hardware used a 300V DC link voltage combined with 5.88kHz as its maximum switching frequency limit. The terminal voltage output of the motor decreases according to Figure 6 during 500 rpm operation without applying a

load. The output voltage waveform appears in Figure 7 after a low pass filter (cutoff at 50 Hz) performs filtering operations. The depicted phase current waveform (scaled down) appears in Figure 8 under all operating conditions.

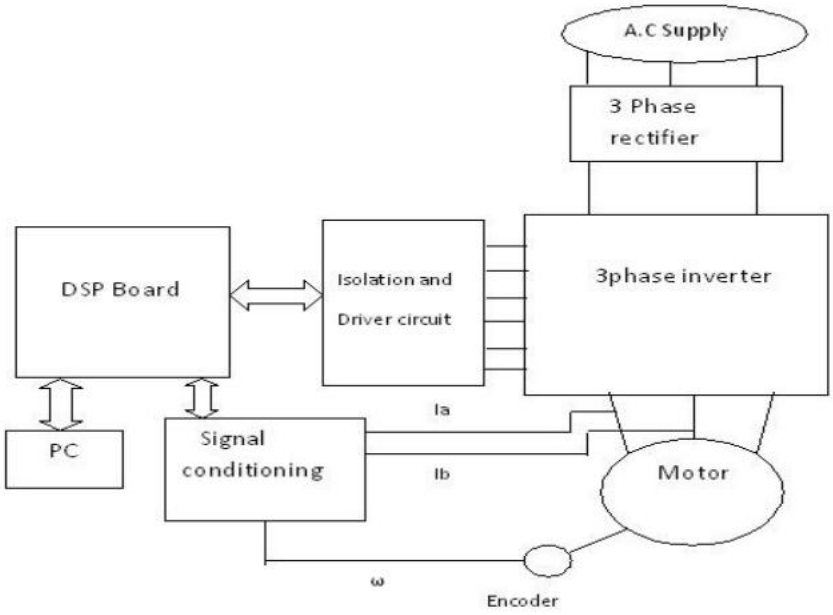

Fig 4: Experimental Set up

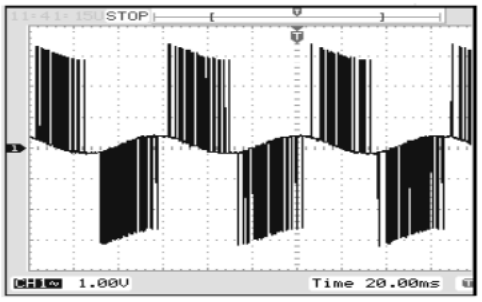

Fig 5: Unfiltered output voltage

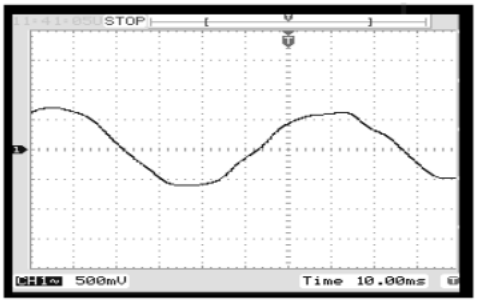

Fig 6: Filtered output voltage

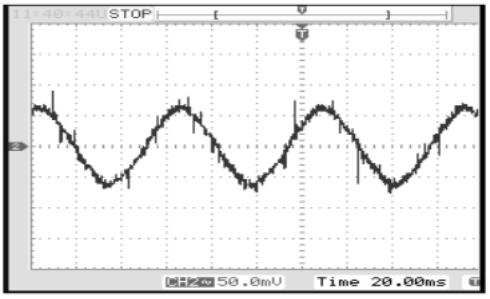

Fig 7: Phase current

IV. Conclusion

The research introduces an unburdened approach for space vector modulation implementation in basic motor control functions. The approach functions effectively with either closed-loop and open-loop systems. The DSP processor's quick computing power enables automated step angle adjustments that improve drive performance across different operating situations. The extension of fin remains possible when Space Vector Modulation appears in alternative application systems.

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