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Performance Comparison between PWM Based Inverter and SVPWM Based Inverter

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ABSTRACT*:* This paper comprehensively analyzes the two famous techniques space-vector modulation (SVPWM) and pulse width modulation (PWM). Space Vector Pulse Width Modulation (SVPWM) is one of the most used techniques to generate sinusoidal voltage and current due to its facility and efficiency with low harmonic distortion. This algorithm is special, used in power electronic applications. This paper describes simulation algorithm of SVPWM & PWM using MATLAB/SIMULINK. The different methods for PWM based Inverter and SVPWM based Inverter are broadly classified to reduce the switching losses and harmonics in the system.

KEYWORDS: Pulse Width Modulation, Space Vector Pulse Width Modulation, MATLAB/SIMULINK, Three Phase Inverter

I. INTRODUCTION

Three phase voltage source inverters are widely used in variable speed AC motor drive applications since they provide variable voltage and variable frequency output through pulse width modulation control. Continuous improvement in terms of cost and high switching frequency of power semiconductor devices and development of machine control algorithms leads to growing interest in more precise PWM techniques.

PULSEWIDTH modulation (PWM) has been studied extensively during the past decades. Many different PWM methods have been developed to achieve the following aims: wide linear modulation range; less switching loss; less total harmonic distortion (THD) in the spectrum of switching waveform; and easy implementation and less computation time.

SPACE VECTOR PULSEWIDTH modulation (SVPWM) is one of the most important PWM methods for three phase inverter; it uses the space vector concept to compute the duty cycle of the switches. It is simply the digital implementation of PWM modulators. The relationship between space vectors and fundamental modulation signals was derived in [2] -[3].

In this paper, first a model for Pulse Width Modulation (PWM) based Inverter and Space vector PWM (SVPWM) based Inverter will be made and simulated using MATLAB/SIMULINK software and then the performance of both the techniques will be compared using MATLAB/SIMULINK.

II. PWM BASED INVERTER

The DC-AC converter, also known as the inverter, converts DC power to AC power at desired output voltage and frequency.[4][5] A complete three phase PWM inverter would consist of three of the single phase inverters with control voltages consisting of sinusoids shifted by 120 degrees between phases. Frequency control in a PWM inverter of this sort is accomplished by changing the frequency of the input control voltage.

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B. Design of PWM based Inverter scheme

The following needs to be defined for the design of the PWM inverter system

- A model that defines different processes of pulses
- Implement zero order hold and relational operator to the sine wave.
- A periodic scalar signal having a waveform that you specify using the Time values and Output values.

Following parameters need to be defined to implement a PWM Inverter

- *Sine Wave* operates in time-based or sample-based mode
- *Repeating Sequence* a periodic scalar signal having a waveform that you specify using the Time values and Output value parameters
- *Zero Order Hold* holds the input for the sample period

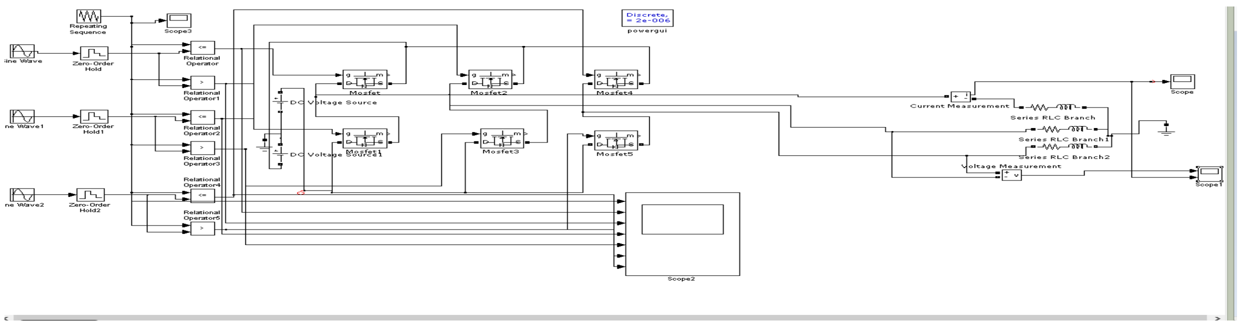
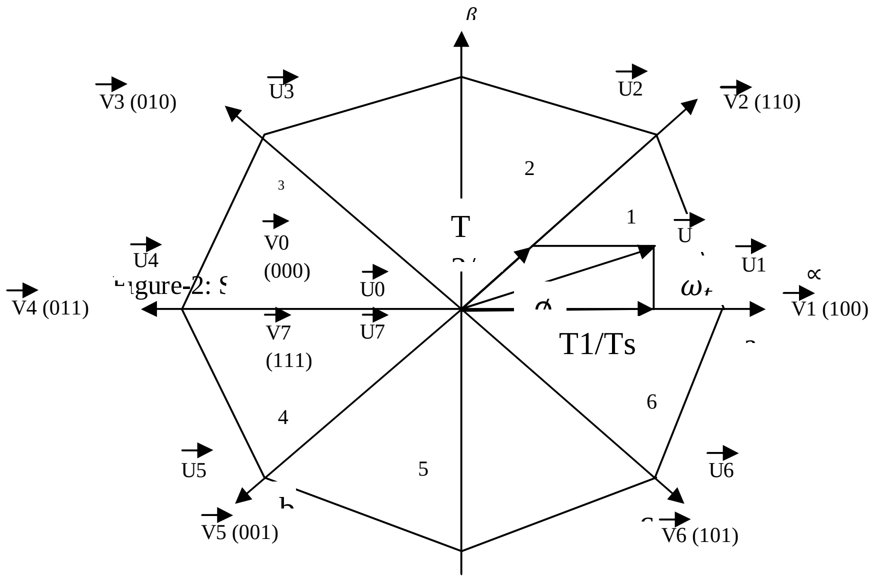


Figure-1: PWM Inverter

Space Vector Pulse Width Modulation (SVPWM) was originally developed as a vector approach to Pulse Width Modulation (PWM) for three phase inverter, Space Vector Pulse Width Modulation (SVPWM) method is an advanced; computation intensive PWM method and possibly the best techniques for Induction Motor Drive application.We use this method for less switching losses, hence less total harmonic distortion & this is the advantage of SVPWM



Principle of Space Vector PWM

The main idea behind SVPWM is to divide the 2D-plane into six equal areas, each of them is called a sector. As shown in Fig.1. Each sector is determined by four vectors via, Vi+1 where I ∈{1..5} these vectors are called active vectors

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because when these vectors are applied to the power module the output voltage of the power module, will be greater than zero i.e. one of the switches will not be off. The other two vectors V0 and V7 are called inactive vector, because all switches will be off or on. These two vectors allocate in the center of the circle C of Fig. 1. Vref vector will scan all sectors with the time.For every sample time we can determine the sector containing Vref and calculate the time period for each vector of the determined sector. [6]

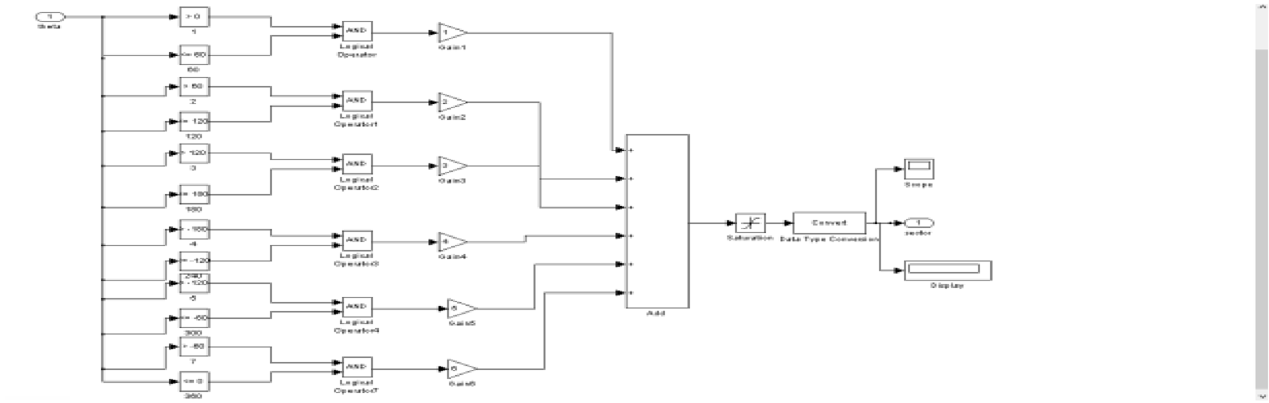

Figure-3(a): Sector Selection

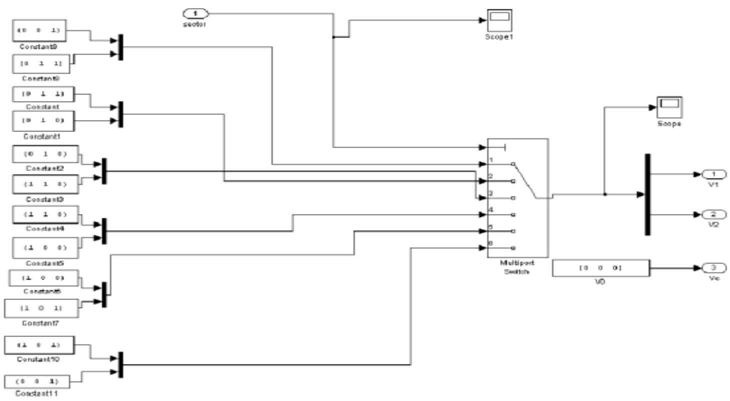

Figure-3 (b): Vector Selection

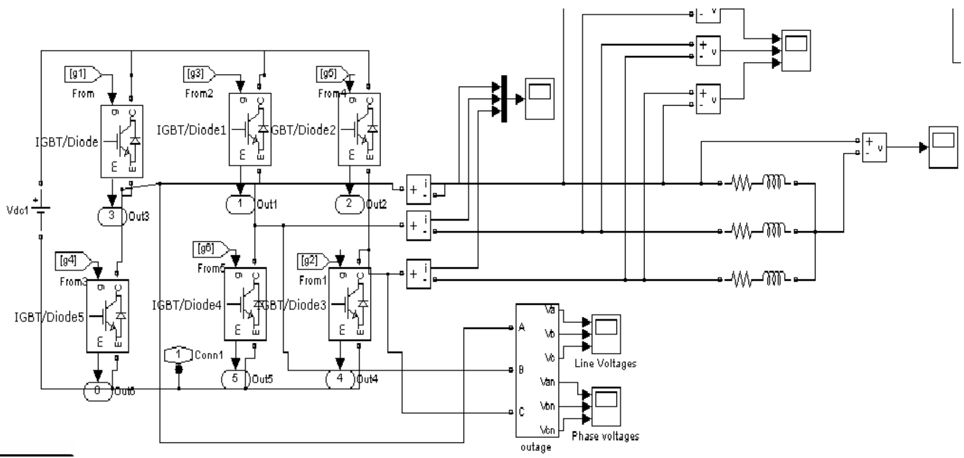

Figure-3 (c): SVPWM Inverter

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III. SIMULATION RESULTS FOR PWM BASED INVERTER

In the below figure 4 the current waveform has been shown when we draw trhe model using PWM inverter whose MATLAB block diagram shown above. Figure 5 shows the waveform of voltage waveform.

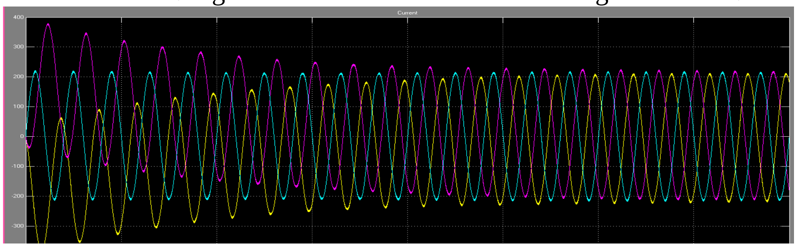

Figure-4: Current Waveform

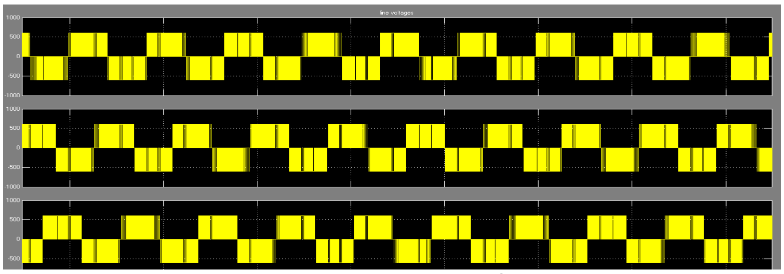

Figure-5: Voltage Waveform

IV. SIMULATION RESULTS FOR SVPWM BASED INVERTER

In the below figure 6 the current waveform has been shown when we draw trhe model using SVPWM inverter whose MATLAB block diagram shown above. Figure 7 shows the waveform of voltage waveform.

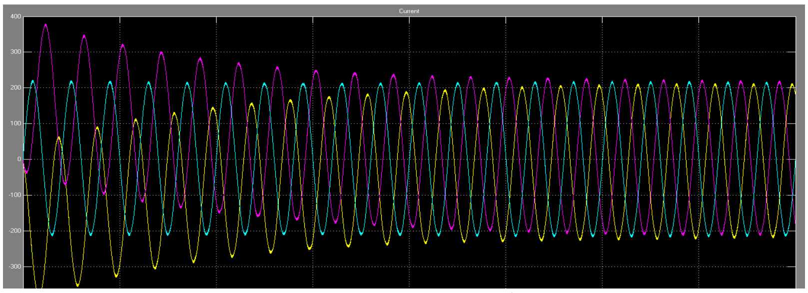

Figure-6: Current Waveform

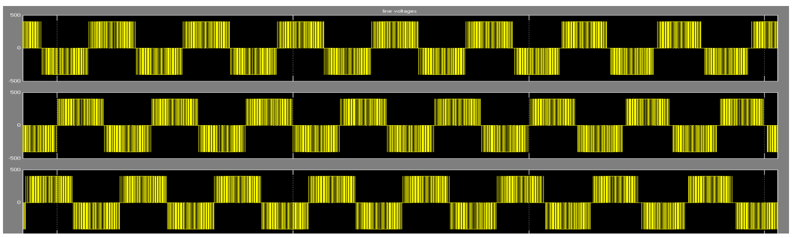

Figure-7: Voltage Waveform

Result Analysis Of PWM & SVPWM Inverter With Mathematical Model

The total harmonic distortion (THD) of Line Voltage of PWM & SVPWM based inverter is 68.72% & 67.18%, respectively, THD of Phase Voltage of PWM and SVPWM based inverter is 68.77% & 67.48% respectively and THD of Current of PWM & SVPWM based inverter is 19.21% & 4.10% respectively.

(i) Table for Result Analysis of PWM & SVPWM Inverter

Serial no.	Total Harmonic Distortion	PWM	SVPWM
1	Line voltage	68.72%	67.18%
2	Phase voltage	68.77%	67..48%
3	Current	13.21%	4.10%

V. CONCLUSION

In this paper simulation studies have been carried to show the comparison of operation of PWM and SVPWM based Inverter, Firstly model of PWM inverter is discussed and simulation model of PWM inverter is obtained using MATLAB/SIMULINK is introduced and it is observed that harmonics are present in the simulation result. Hence, for improving the result; we use Space Vector Pulse Width Modulation Technique in our project to improve the harmonics present in current and voltage. Hence Simulation studies indicate that harmonics is reduced in SVPWM based inverter model in comparison to PWM based inverter model and THD of Line Voltage of PWM & SVPWM is 68.72% & 67.18%, respectively, THD of Phase Voltage of PWM and SVPWM is 68.77% & 67.48% respectively and THD of Current of PWM & SVPWM is 19.21% & 4.10% respectively.

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