Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 4, Issue. 6, June 2015, pg.278 – 286

RESEARCH ARTICLE

Study Locus Comparison on "PAM, PWM, PPM With Space Vector PWM using a Simulink Model"

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Abstract – This paper analyzes the locus comparison of PAM, PWM, PPM with SVPWM. Using the MATLAB/SIMULINK model. SVPWM is more in use because of easier digital realization, reduced harmonics, reduced switching losses and better dc bus utilization. Comparison of PPM, PAM, PWM, SVPWM conclude that SVPWM can produce about 15% higher output voltage as it utilizes dc bus voltage more efficiently and also it produce less harmonic distortion than others.

***Keywords*: - PAM, PPM, PWM, SVPWM, SVM, THD, FFT**

1. INTRODUCTION

Inverters are used to convert dc power to ac power. This AC/DC converters are mostly used in various application like DC motor drives, adjustable speed ac drives, SMPS, UPS, household electric appliances etc. Changing the duty ratio of switches changes the speed of motor. Fixed dc input voltage is fed as input to the inverter. Now on adjusting the on and off period of inverter components we may obtain controlled ac output voltage. There are several techniques used for controlling semiconductor converter. PAM, PPM, PWM and SVPWM technique are used. PWM is an advance technique position of the pulse gets controlled. SVPWM is the most efficient technique using now a days. SVPWM is the most efficient technology used among all. Comparing all the four technique this one is having less harmonic distortion in a three phase voltage source rectifier. Harmonics have a negative effect on power factor also. The addition of harmonic current to the fundamental current increases the total rms current by which power factor of the circuit will get affect. The output voltage of space vector pulse width modulation technique is 1.155 times more than sinusoidal pulse width modulation. SVPWM has a fast dynamic response and easy digital implementation. Digital implementation is the notable feature of space vector modulation which can be easily implemented in digital signal processor.

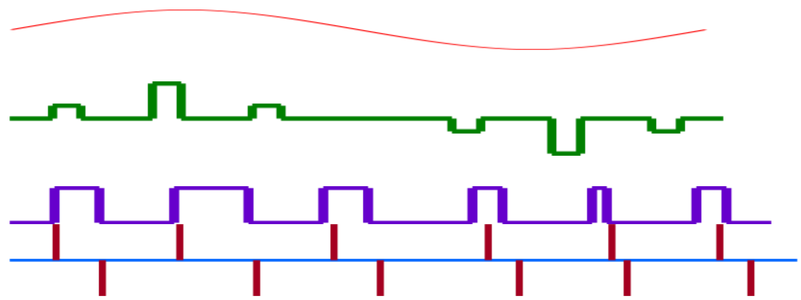


Figure.1: Represent the sinusoidal analog signal with amplitude modulated pulse, width modulated pulse, position modulated pulse whose locus comparison is done using simulink model.

2. Problem in Previous Technique

While analyzing sinusoidal pulse width modulation following problems encountered :

- Harmonic distortion is more.
- Low output peak voltage.
- Efficiency is low.

To overcome this problems we are comparing the locus of PAM,PWM,PPM with SVPWM so that we get high efficiency with less harmonic distortion. Till now the comparison between PWM and SVPWM is done by which we get the result that SVPWM is more efficient than PWM as shown in figure:

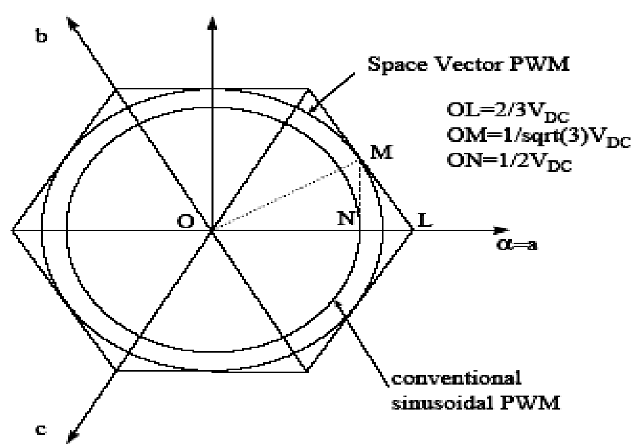


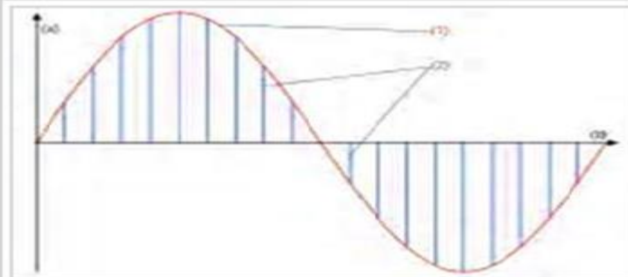
Figure.2: Represents simulink model of PWM and SVPWM.

Now, we are comparing it with PAM and PPM also and determine which one is more efficient among all.

3. Basics Of PAM, PWM, PPM, and SVPWM

3.1. BASICS OF PAM

Pulse amplitude technique is widely used in many engineering application. Pulse amplitude modulation is a form of signal modulation where the message information is encoded in amplitude of series of signal pulses. It is an analog pulse modulation scheme in which amplitude of a train of carrier pulse are varied according to the sample value of message signal. After that demodulation is performed by detecting the amplitude level of carrier at every symbol period. This technique is commonly used in communication field for transmission of analog data. It is used in TV transmission and commercial radio technique also.



Principle of PAM: (1) original signal, (2) PAM signal, (a) amplitude of signal, (b) time

Figure.3: Represents sampilng of original signal

3.2 BASICS OF PWM

In sine triangle PWM, the modulating signal is compared with the triangular carrier signal to generate pulse width modulation signal. A very high carrier frequency is applied and is compared with the triangular wave. This frequency of reference signal is used to control the modulation index of signal. The number of pulses per half cycle is depend upon the carrier frequency. This triangular wave is also used to control the speed at which the switches are turned off and turned on. Pulse width modulation is a simple and linear technique which gives a six step voltage values between 0% and 78.5%. PWM is the most popular method which used to control the output voltage without any additional component. Lower order harmonics can be removed or minimized along with the output voltage control. For small values of modulation index, the carrier signal and the modulating signal should be synchronized; if this is not the case then the sub harmonics will be present. For larger value of modulation index, the sub harmonics will be negligible. In over modulation region, some intersection between the carrier and the modulating signal are missed which leads to the generation of lower order harmonics but a higher fundamental a.c. output voltage is obtained. This diagram represents the fundamental a.c. component of the output voltage.

3.3. BASICS OF SVPWM

SPACE VECTOR PULSE WIDTH MODULATION is the intensive and the best pulse width modulation technique for three phase voltage source inverter. SVPWM having special switching sequence and less harmonic distortion in output voltage and current. SVPWM is more efficiently used than any other technique as it uses the supply voltage efficiently. Using SVPWM control on switching pulses is also possible. In it the thermal harmonic distortion get decrease with increase in modulation index. In SVPWM pulses get controlled at every 60 degree. Using the MATLAB/SIMULINK tools SPWM and SVPWM performance are analyzed and observed as it give a better fundamental performance with reduced thermal harmonic distortion. SVPWM utilizes the d.c. bus voltage more efficiently and it offers a flexible control of output voltage as well as frequency and thus improving the overall power factor of the system. SVPWM are used in UPS, computer, variable frequency driver application, vector control for induction motor and synchronous as vector approach to PWM for three phase inverter. It is a sophisticated technique for generating sine wave that provide high voltage to motor with lower total harmonic distortion. The main aim of any modulation technique is to obtain variable output having a maximum fundamental component with minimum harmonics. In it also a reference sine wave is compared with triangular wave. The frequency of modulating wave is used to determine the output voltage. The peak amplitude of modulating wave determine the modulation index and in turn control the rms value of output voltage. The rms value of output voltage can be varied by changing the modulation index. This technique improve the distortion factor as it eliminates all the harmonics equal to 2p-1. Where p is defined as the number of pulse per half cycle. It is clear that peak output voltage of an inverter using spwm depend on the modulation index. Higher output voltage can be obtained by increasing the modulation index towards one because of the width of the pulse that are near the peak of sinewave do not vary significantly with modulation index. SPWM technique is modified so that carrier wave is applied at first and last sixty degree of one half cycle. Thus SPWM increases the utilization of d.c. bus voltage, reduces the number of switching of power devices and improve the harmonics characteristics of output voltage.

The locus of the reference vector is the inside of a circle with a radius of 1/2Vdc.In the SV modulation it can be shown that the length of each of the six vectors is 2/3Vdc .In steady state the reference vector magnitude might be constant. This fact makes the SV modulation reference vector locus smaller than the hexagon described above. This locus narrows itself to the circle inscribed within the hexagon, thus having a radius of $1/\sqrt{3}$ Vdc. In figure below the different reference vector loci are presented.

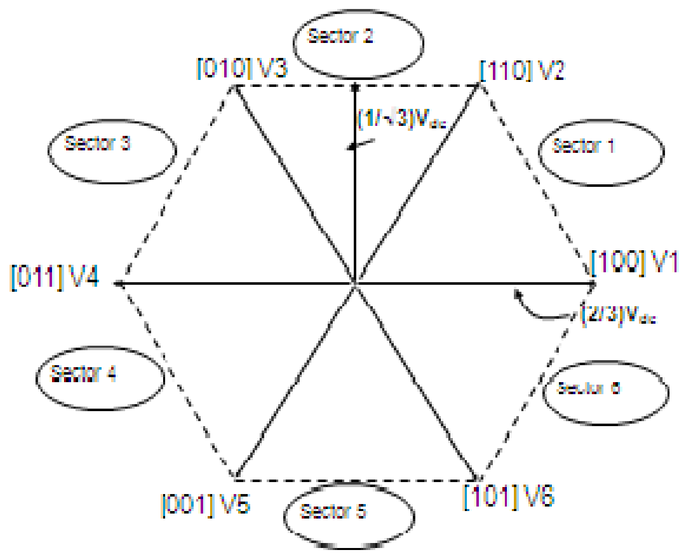


Figure.4 Represents locus of space vector modulation daigram

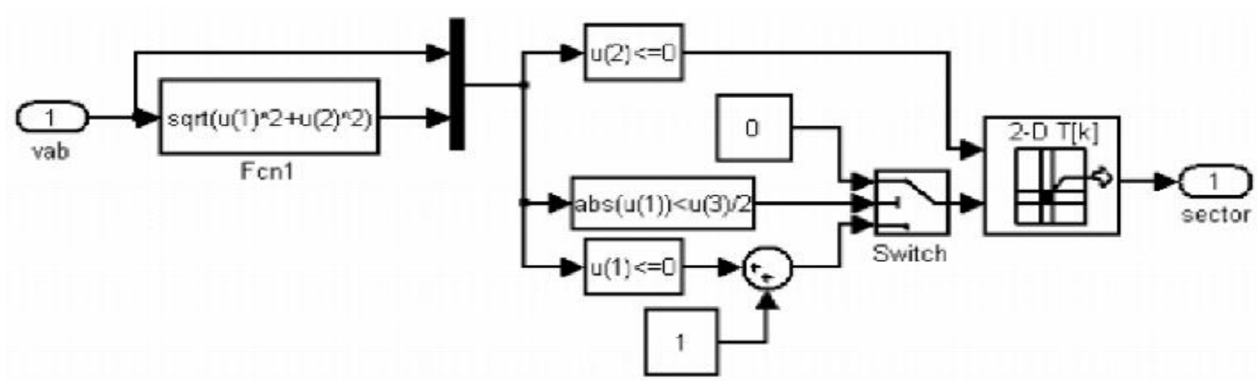


Figure.6 Represents sector selection algorithm

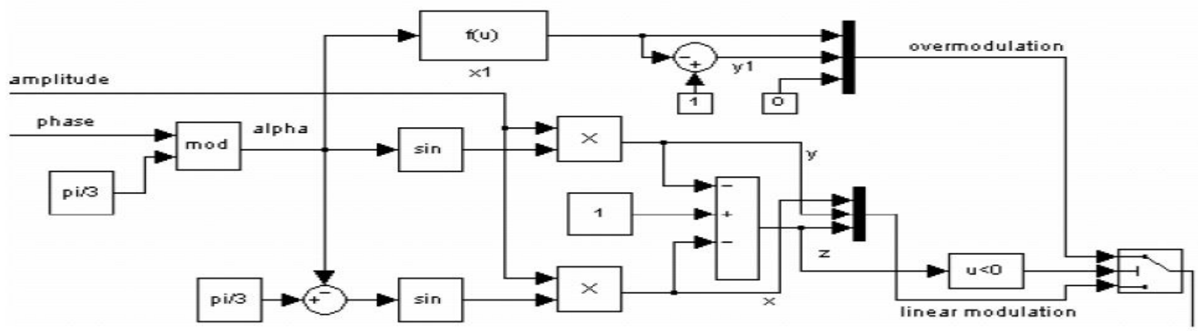


Fig.7 Deriving the weight of adjacent non-zero basic vector

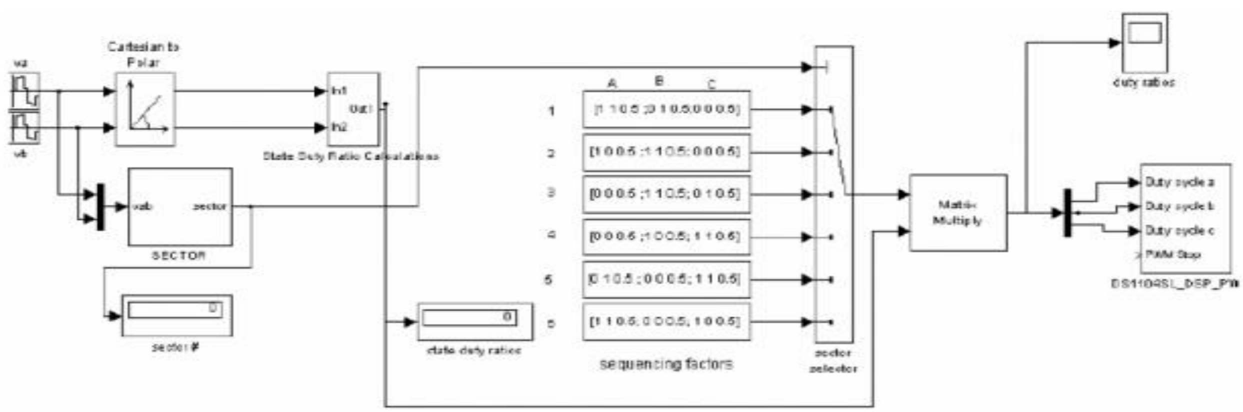


Figure.8 Represents space vector modulation simulink model.

3.4. BASICS OF PPM

Pulse position modulation is a technique to produce a signal in which position of carrier signal is varied according to the message signal. To achieve the goal like noise performance, constant bandwidth, power efficiency, simple transistor and receiver circuit and constant transmitter power PPM technique is achieved. Unlike PWM the pulse position is kept constant to achieve constant transmitter power. In PPM the modulation is done by changing the position of pulse from mean position according to the variation of modulating signal. PPM can be easily generated from the PWM waveform. When PWM is modulated according to the input signal waveform PPM generated. This technique is used to generate a small pulse of constant width at the end of duty time of each and every PWM pulse.

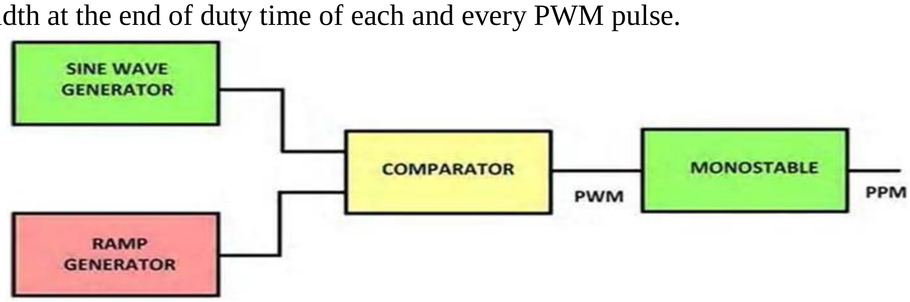


Figure.9 Represents generation of PPM from PWM

4. Implementation of simulink model

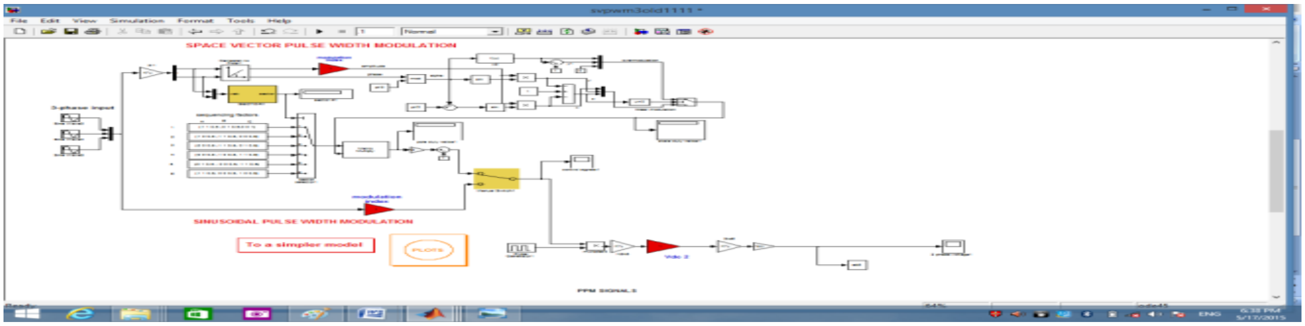


Figure.10 Simulink model of pwm and svpwm

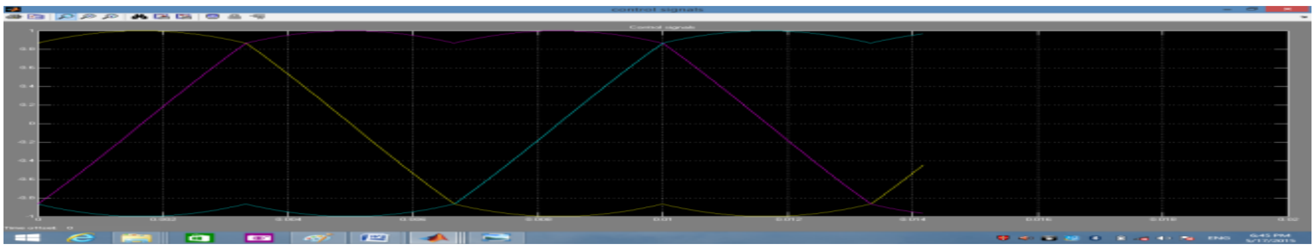


Figure.11 Represent control signal of pwm and svpwm

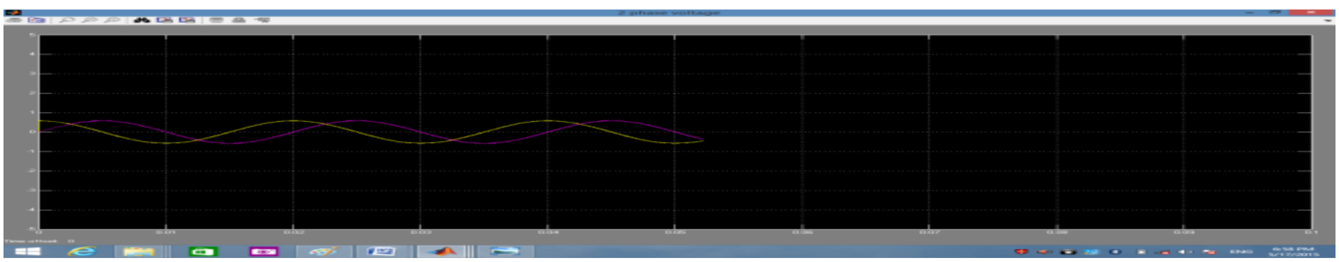


Figure.12 Represent 2 phase voltage of pwm and svpwm

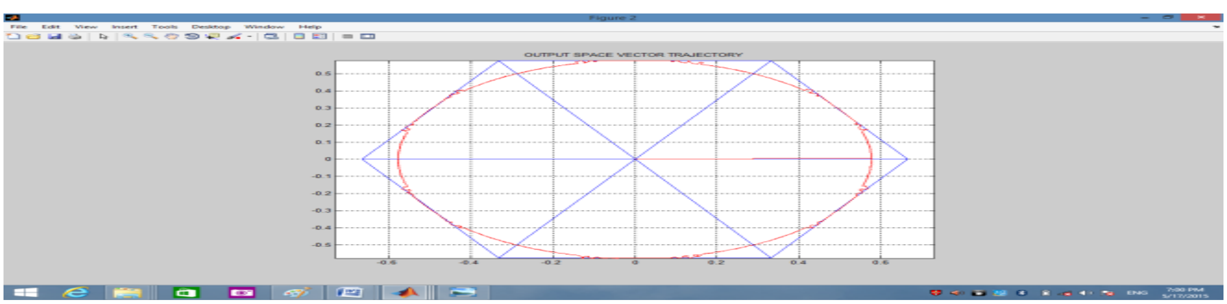


Figure.13 Represent locus comparison of pwm and svpwm.

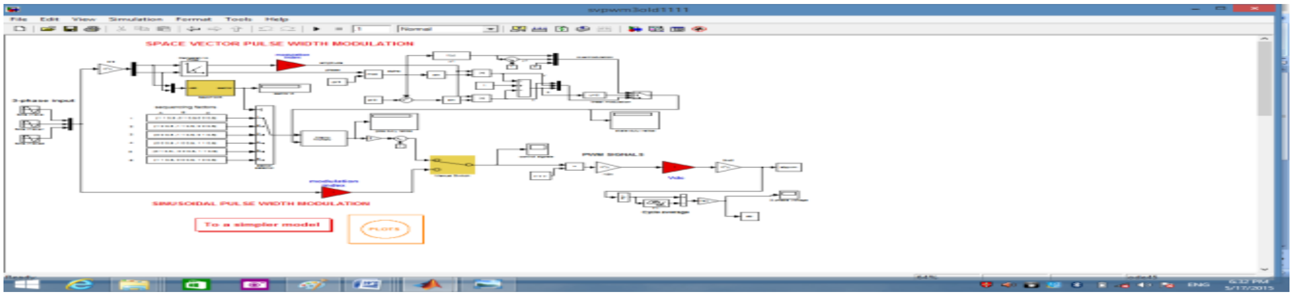


Figure.14 Represent simulink model of ppm and svpwm

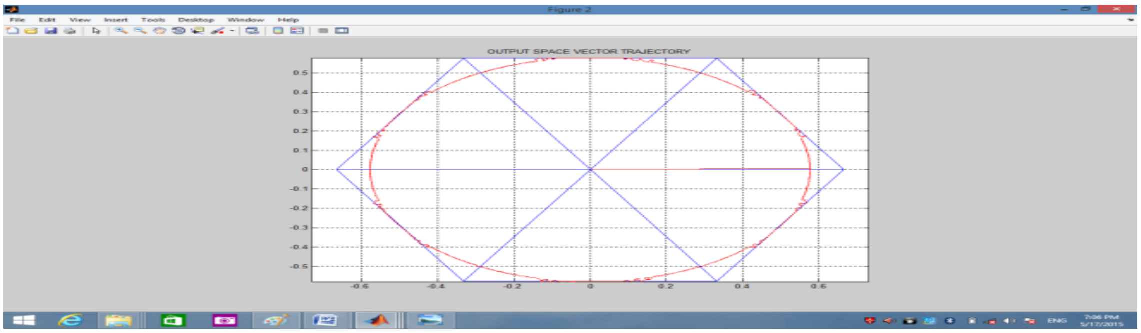


Figure.15 Represent locus comparison of ppm and svpwm

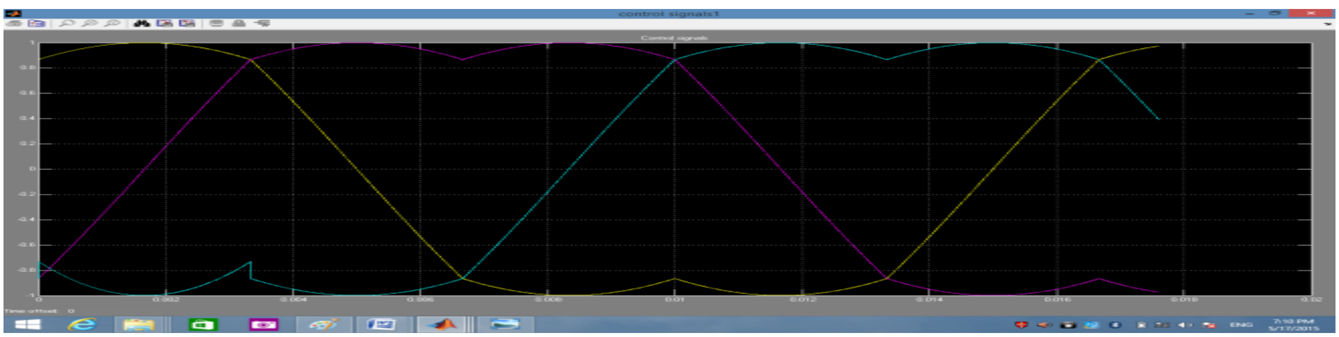


Figure.16 Represent control signal of ppm and svpwm

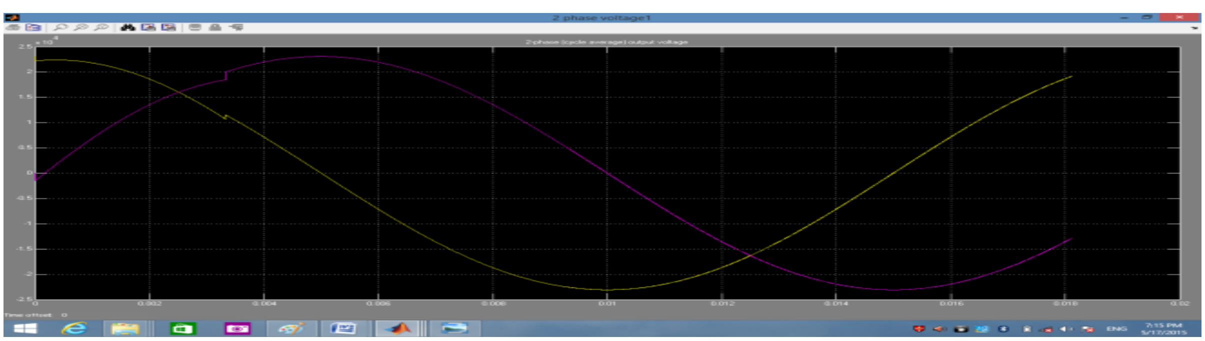


Figure.17 Represent 2 phase voltage of ppm and svpwm

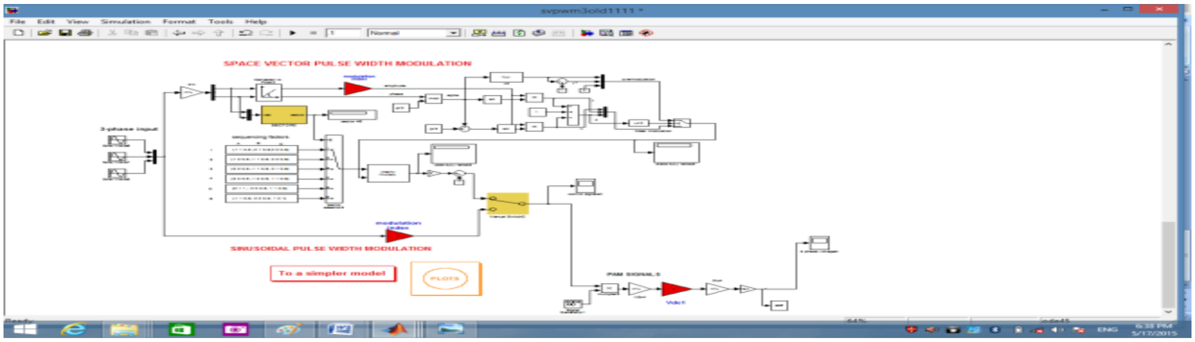


Figure.18 Represent simulink model of pam and svpwm

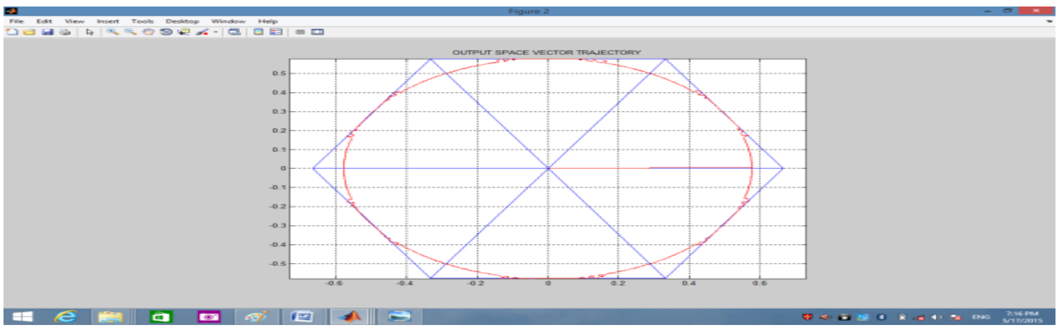


Figure.19 Represent locus comparison of pam and svpwm

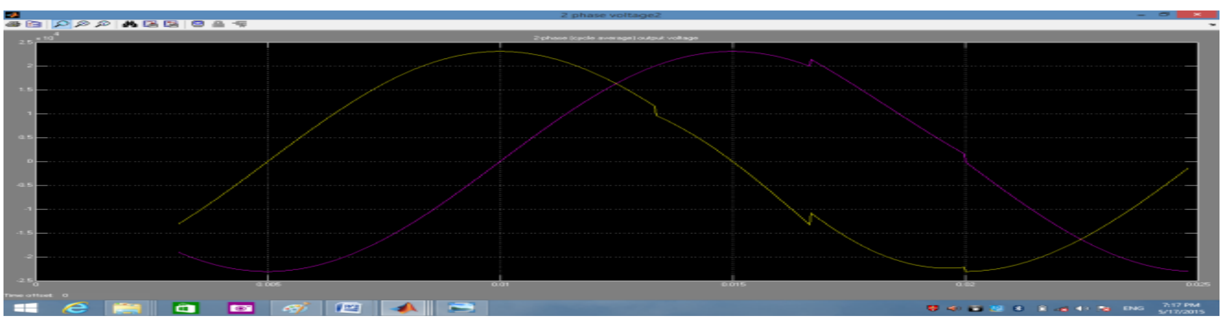


Figure.20 Represent 2 phase voltage

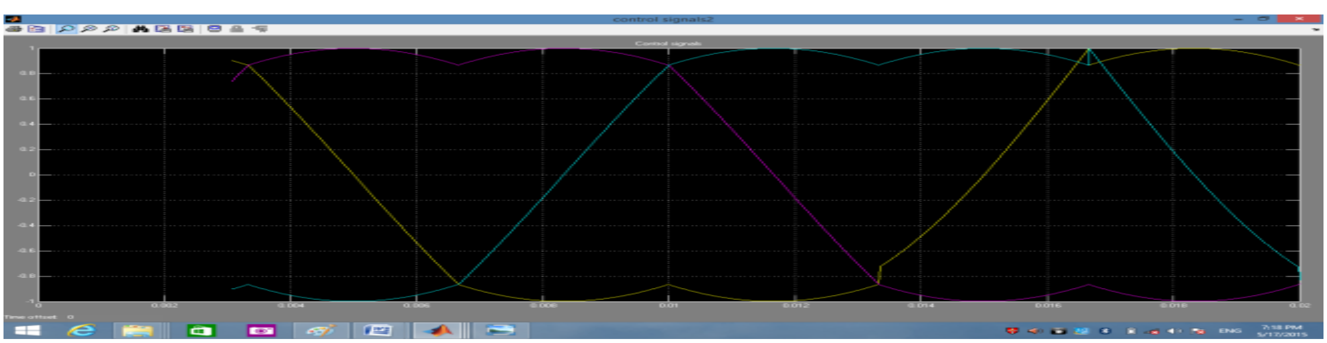


Figure.21 Represent control signal of pam and svpwm

5. STIMULATION RESULT

For one complete cycle the locus is generated for pam, pwm, svpwm. Among all we had analyze that SVPWM is more efficient than PAM, PWM, PPM as SVPWM cover much larger area than other using MATLAB(SIMULINK) model.

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SAURABH MITRA H.O.D in Dr. C.V. RAMAN UNIVERSITY, KARGI ROAD, KOTA BILASPUR, C.G. INDIA. Guide of the project of LOCUS COMPARISON OF PAM, PWM, PPM WITH SVPWM.

