Ind. J. Sci. Res. and Tech. 2013 1(1):1-3/Deb ISSN:-2321-9262 (Online)
Online Available at: http://www.indjsrt.com
Research Article

CONTROL OF VOLTAGE SOURCE INVERTER FOR ADJUSTABLE SPEED DRIVE- A STUDY REPORT

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ABSTRACT
A voltage source inverter (VSI) is commonly used to supply a three-phase induction motor with variable frequency and variable voltage for variable speed applications. Pulse Width Modulation (PWM) Control technique is an excellent control strategy to control various parameters in an induction motor. A number of Pulse width modulation (PWM) schemes are used to obtain variable voltage and frequency supply. The most widely used PWM schemes for three-phase voltage source inverters are carrier-based sinusoidal PWM and space vector PWM (SVPWM). In PWM, three phase reference modulating signals are compared against a common triangular carrier to generate the PWM signals for the three phases. In SVPWM methods, a revolving reference voltage vector is provided as voltage reference instead of three phase modulating waves. There is an increasing trend of using space vector PWM (SVPWM) because of their easier digital realization and better dc bus utilization. The Space Vector Pulse Width Modulation of a three level inverter provides the additional advantage of superior harmonic quality and larger under-modulation range that extends the modulation factor to 90.7% from the traditional value of 78.5% in Sinusoidal Pulse Width Modulation.

Key Words: PWM, SVPWM, Voltage Source Inverter (VSI) and Induction Motor

INTRODUCTION
The main objective of static power converters is to produce an ac output waveform from a dc power supply. According to the type of ac output waveform, the topologies can be considered as voltage source inverters (VSIs), where the independently controlled ac output is a voltage waveform (Gupta & Kumar, 2012). Though there are four types of voltage source inverter viz. single phase, half bridge, full bridge and three phase VSI, are available, but three phase VSI are superior in comparison with others by virtue of their medium to high power applications (Holtz, 1994). The growth applications for three-phase voltage source inverters lead to a requirement for a highly flexible algorithm for inverter modulation control. The process of control in which a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components is termed as Pulse-Width Modulation (PWM) control (Bimbhra, 2003). Space vector modulation (SVM) is an algorithm for the control of pulse width modulation (PWM) which 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. The objective of our present study is to compare between PWM and SVPWM for control of voltage source inverter for adjustable speed drive. Adjustable speed drive (ASD) or variable-speed drive (VSD) describes equipment used to control the speed of machinery. It is capable of adjusting both speed and torque from an induction or synchronous motor. An adjustable speed drive might consist of an electric motor and controller that is used to adjust the motor's operating speed. The combination of a constant-speed motor and a continuously adjustable mechanical speed-changing device might also be called an adjustable speed drive.
The benefits provided by the adjustable speed drives are as follows:
Smoother operation; Acceleration control; Different operating speed for each process recipe; Compensate for changing process variables; Allow slow operation for setup purposes; Adjust the rate of production; Allow accurate positioning; Control torque or tension.

MATERIALS AND METHODS
Adjustable speed drive (ASD)
An ASD can be regarded as a frequency converter rectifying ac voltages from the mains supply into dc, and then modifies this into an ac voltage with variable amplitude and frequency. The motor is thus supplied with variable voltage and frequency, which enables infinitely variable speed regulation of three-phase, asynchronous standard induction motor.

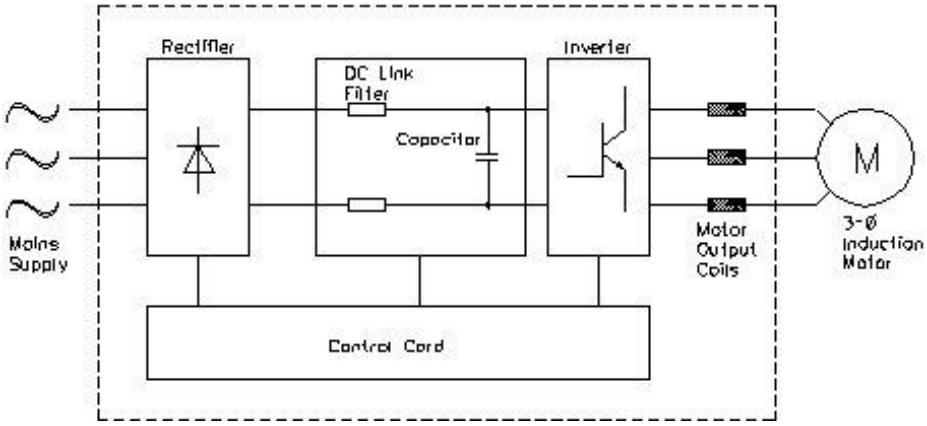

Figure 1: Model of an ASD

Voltage source inverters (VSI)

Voltage source inverters are used to regulate the speed of three-phase squirrel cage motors by changes the frequency. It consists of input rectifier, DC link and output converter. There are four types of voltage source inverter viz. single phase, half bridge, full bridge and three faze VSI. Here we used the three phase VSI.

Speed control of induction motor using SVPWM

In Fig. 2 shows the model of speed control of an induction motor using SVPWM. Here we use Mat Lab (2009 version) simulink software. A 3-phase squirrel-cage motor rated 3 HP, 220 V, 60 Hz, 1725 rpm is fed by a 3-phase MOSFET inverter connected to a DC voltage source of 325 V.

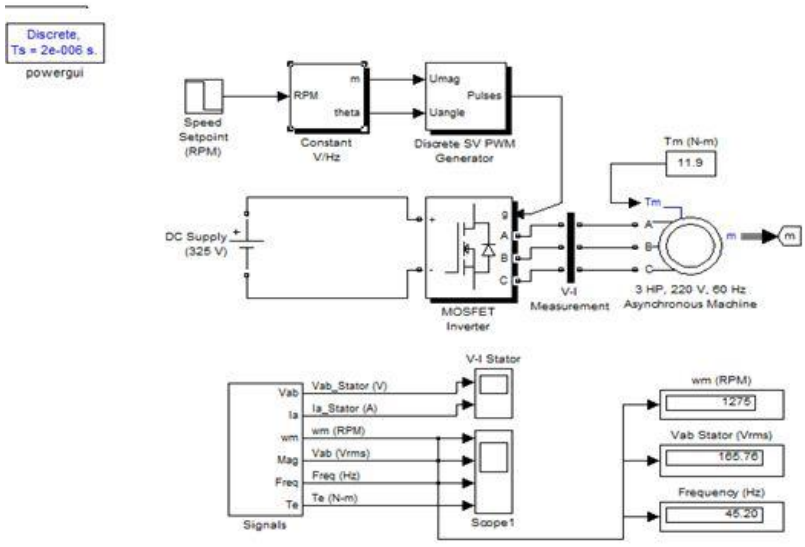

Figure 2: Speed control of an induction motor using SVPWM Inverter

The load torque applied to the machine's shaft is constant and set to its nominal value of 11.9 N.m. The firing pulses to the inverter are generated by the "Space-Vector PWM modulator" block. The longer the pulses, the more time gate will be ON and shorter the pulses, the less time the gate will be ON. Speed control of the motor is performed by the "Constant V/Hz" block. The magnitude and frequency of the stator voltages are set based on the speed set point.

RESULTS AND DISCUSSION

In Fig. 3 a sine wave voltage has been obtained. The input which we applied was dc supply and the output we obtained was ac waveform. In figure 4.the initial motor speed was at 1720 RPM and the rms value of the stator voltages was 220V@60Hz. At 0.1s, the speed set point was changed from 1725 to 1300 RPM. When the motor reached a constant speed of 1275 RPM, the stator voltage rms value was down to 165.8V and the frequency was 45.2 Hz (Fig. 4).

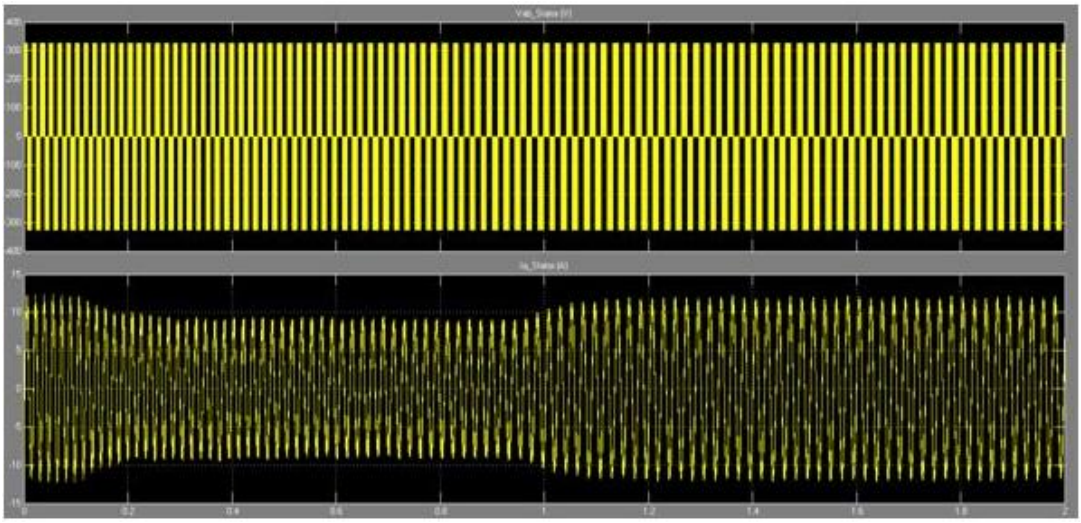

Figure 3: Response of stator voltage Vab and stator current Ia versus time

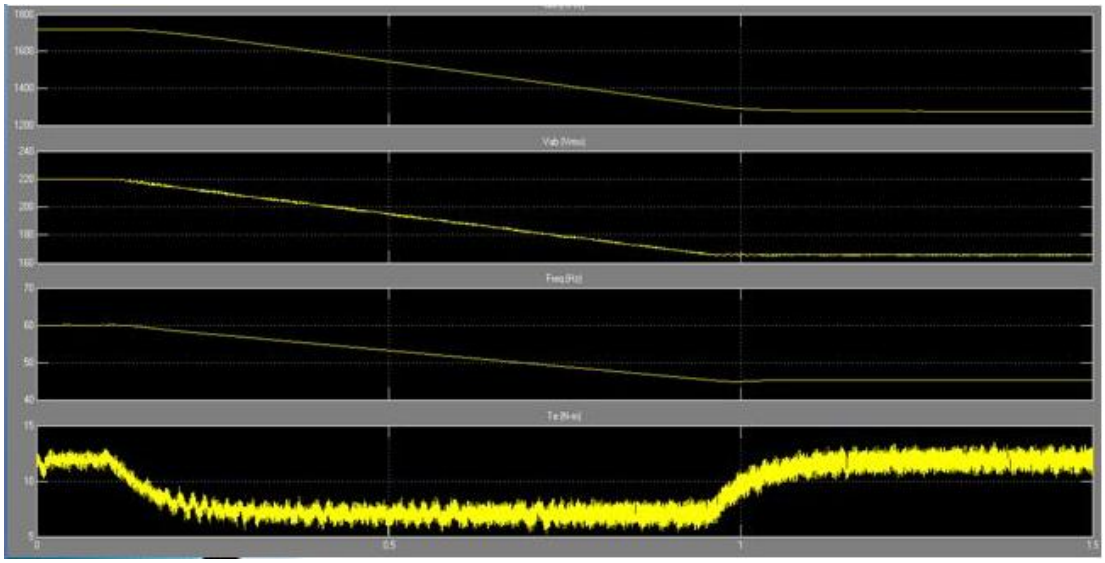

Figure 4: Response of speed (in rpm) of rotor, stator voltage (Vab), frequency & torque of an induction motor

As seen from the above discussion Space Vector PWM is superior as compared to Sinusoidal pulse width modulation in many aspects like :

The Modulation Index is higher for SVPWM as compared to SPWM.

The output voltage is about 15% more in case of SVPWM as compared to SPWM.

The current and torque harmonics produced are much less in case of SVPWM.

However despite all the above mentioned advantages that SVPWM enjoys over SPWM, SVPWM algorithm used in three-level inverters is more complex because of large number of inverter switching states.

Hence we see that there is a certain trade off that exists while using SVPWM for inverters for Adjustable speed Drive Operations. Due to this we have to choose carefully as to which of the two techniques to use weighing the pros and cons of each method.

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