V/F CONTROL TECHNIQUE FOR THREE PHASE INDUCTION MOTOR DRIVE USING DSP TMS320F2812

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Abstract - *This paper focuses on constant V/F control technique. It also emphasises on the improvement in the performance of motor by the use of DSP TMS320F2812. This method gives the précised output, When a specific load is applied to the induction motor.*

***Key Words*:** Matlab Simulink, constant V/f, DSP, TSM320F2812, Induction motor.

1. INTRODUCTION

Many researches have been accomplished on the advancements of the speed control of Induction motor, which is one of the predominant advantages of motor . Many scientists suggested that the improvement in the system can be done by boosting the lagging voltage[2] ,or stator resistor compensation, also slip frequency compensation, and pole changing methods can also be applied for this purpose[3].But limitations were observed as there were many constraints on which only it gives desired result and also, the motor performance decreases at low frequencies [1]. Again, it is also difficult to determine the boost voltage exactly [2]. The designing of system is quite complicated and many control parameters should be sophisticatedly decided to keep system stable. The slip frequency compensation is complicated [3]. Although, many industries employ D.C. drives where wide range and smooth speed control is required. But with the presence of commutator maintenance of motor increases, which makes it unsuitable for applications requiring high speed. So, preference is always given to adjustable speed induction motor drives because it is cost efficient, robust in construction and having very less operational and maintenance cost. But the induction motor is not essentially a constant speed, as its stable operation is restricted within a narrow range of speed. Therefore, speed control is necessary. Also, another major disadvantage of induction motor is that, it operates at very low power factor. [6]. The chief methods of speed control are: -

a) Variable-Frequency Operation

b) Constant Volts/Hertz Operation

c) Variation of Number of Poles

d) Variation of Motor Resistance e) Variation of Motor Reactance.

2. Study of Constant Volts/Hertz Method

Among all the methods, the easiest and most efficient method is constant v/f control. The V/f control method is, in basically a control method for making the air-gap flux constant, which can be achieved by controlling voltage V of stator and stator frequency f so to keep ratio V/f constant.

3 phase induction motor possessing the synchronous speed Ns is given by following formula:-

$$Ns = \frac{120 * f}{P}$$

Where,

Ns = the synchronous speed in RPM p = the number of poles on the stator f = the supply frequency in Hertz

In a three-phase induction machine, alternating current supplied to the stator windings energizes it to create a rotating magnetic flux.[10] The flux generates a magnetic field in the air gap between the stator and the rotor and induces a voltage which produces current through the rotor bars. The rotor circuit is shorted and current flows in the rotor conductors.[5] The action of the rotating flux and the current produces a force that generates a torque to rotate the rotor. But the rotor never succeeds in attaining same field as of stator. So, the rotor runs slower than the stator field speed. This speed is known as the Base Speed (Nb). The difference of Ns and Nb is called the slip. The slip is directly proportional to load. An increase in load will cause the rotor to reduce its speed or increase slip. A reduction in applied load will cause the rotor to speed up or decreases slip. [7]

$$\%slip = \frac{Ns - Nb}{Ns}$$

Where,
Ns = the synchronous speed in RPM Nb = the base speed in RPM

The motor torque developed varies directly in proportion to the stator magnetic field. But, the stator voltage is directly proportional to the product of angular velocity and stator flux. Therefore, the stator flux proportional to the ratio of voltage applied and supply frequency. By varying the frequency, the motor speed can also be varied. Therefore, varying the voltage and frequency by the same ratio, flux can be controlled and therefore torque can be kept constant throughout the speed range [4][5].

This can be related as follows -

Stator Voltage (V) α [Stator Flux (∅) x [Angular Velocity (ω)]
Therefore, V α ∅ x 2πf

∅ α V/f

Where, ∅ is constant.

3. METHODOLOGY:

This research paper represents the v/f control technique over speed of induction motor with the help of an auxiliary device known as DSP kit TMS320F2812 . It is quite different from the conventional technique and employs the application of micro-electronics to cater the electrical device. Therefore, increasing the efficiency of the process. Also, the simplicity and accessibility of whole system increases. Controlling of device is also facile. DSP (Digital Signal Processor) TMS320F2812 works after the application of load to the system. Hence it changes the speed of the system. The speed which is desired is obtained at the output of the proposed system by comparing the reduced speed with reference speed of the induction motor.

Fig-1 Block diagram of scalar V/f control technique for the speed control of induction motor

Above fig.1 represents the block diagram of the whole process. It depicts the outlay and functioning of the system in a simplified manner. Broadly, the system can be viewed as a connection of driver, control and power circuits. DSP320F2812 can be classified under the Driver and control circuits. Power circuit comprises of an Inverter, having a set of IGBTs. Sensors are connected to sense the output, and send the feedback to IPM module.

3.1 SOURCE:

We have use single phase (1ph), 230 Volts AC supply having frequency of 50Hz..

3.2 IPM MODULE (PEC16DSM01):

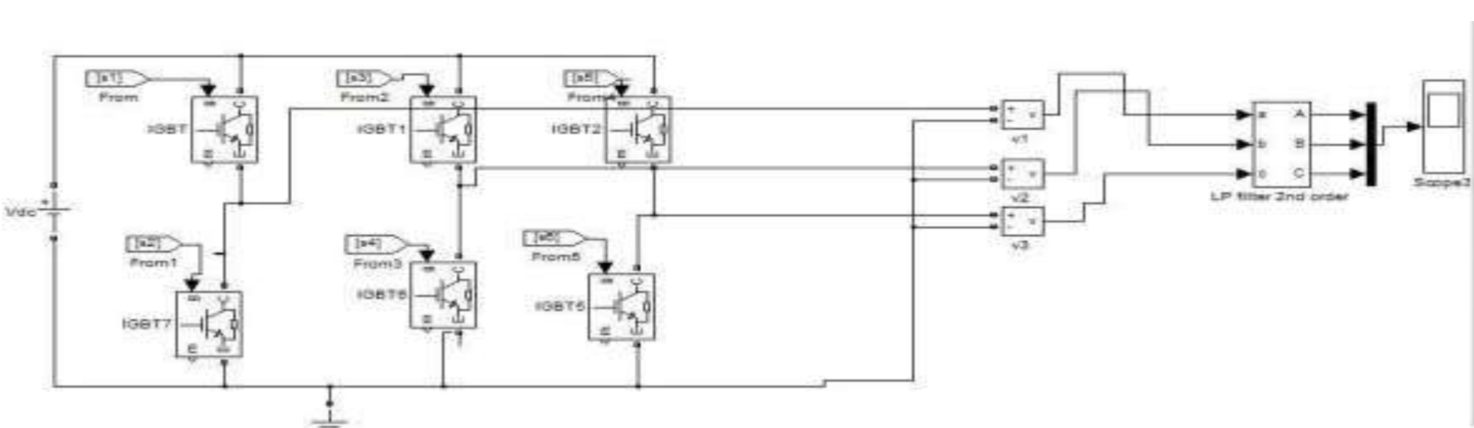

Fig-2 Equivalent inverter circuit

IPM module consists of the 6 IGBTs connected as shown in fig 2. The figure is drawn by Matlab Simulink software. It behaves as 3 phase inverter when driven with the help of gate pulses. For this, gate driver circuit is formed as shown in fig 5.

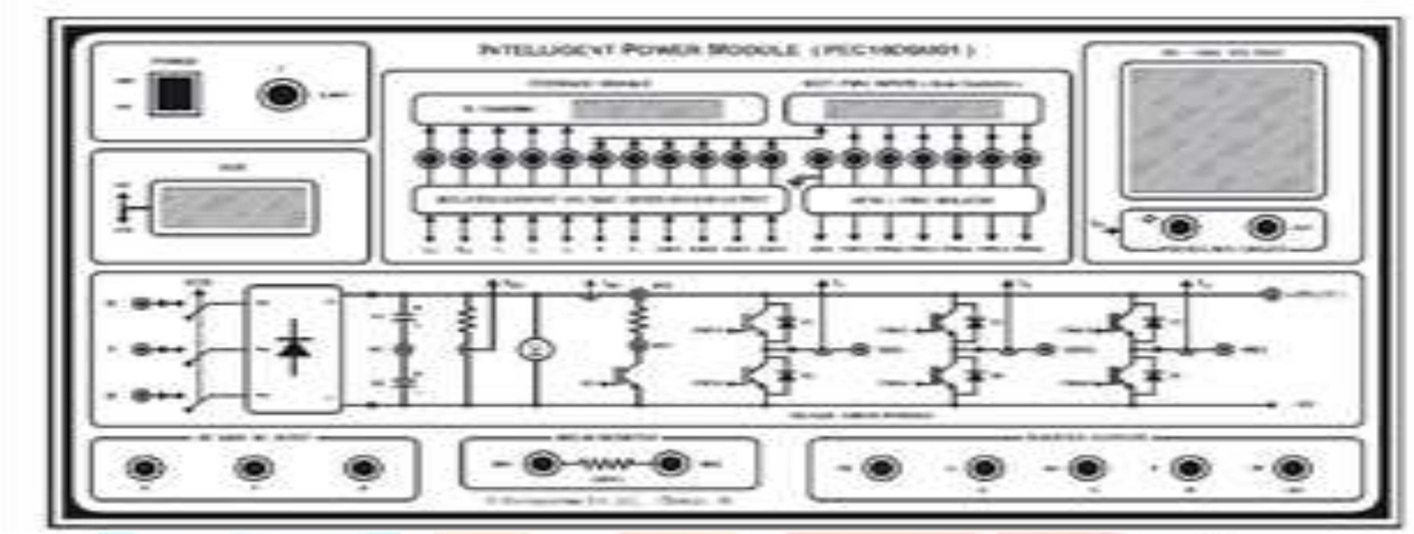

Fig-3 front panel of IPM MODULE

The name is INTELLIGENT POWER MODULE, because this circuit is used for detecting the current rise and temperature in the system. Fig 3 shows clear view of front panel of IPM module.

3.3 INDUCTION MOTOR:

Here, 3ph squirrel cage induction motor is used.

Table -1: Specification of Induction Motor

Motor used	**Squirrel Cage Induction Motor**
Number of phases	3
hp rating	1 hp
Current rating	1.8 A
Rated speed	1400 RPM
Power Factor	0.8

3.4 DSP KIT TMS320LF2812:

Its other name is Testing unit. This unit helps the user to validate the programs that are based on TMS320F2812. The Digital signal processor of TEXAS INSTRUMENT helps to produce the gate signals of the inverter to control IGBTs. So, it can be assumed as a control circuit for IPM module. This kit is compatible with C programming or embedded C. The loading of program can be done by CCSTUDIO Emulator which is connected to interface of DSP kit with the computer.

Fig- 4 DSP TMS320F2812

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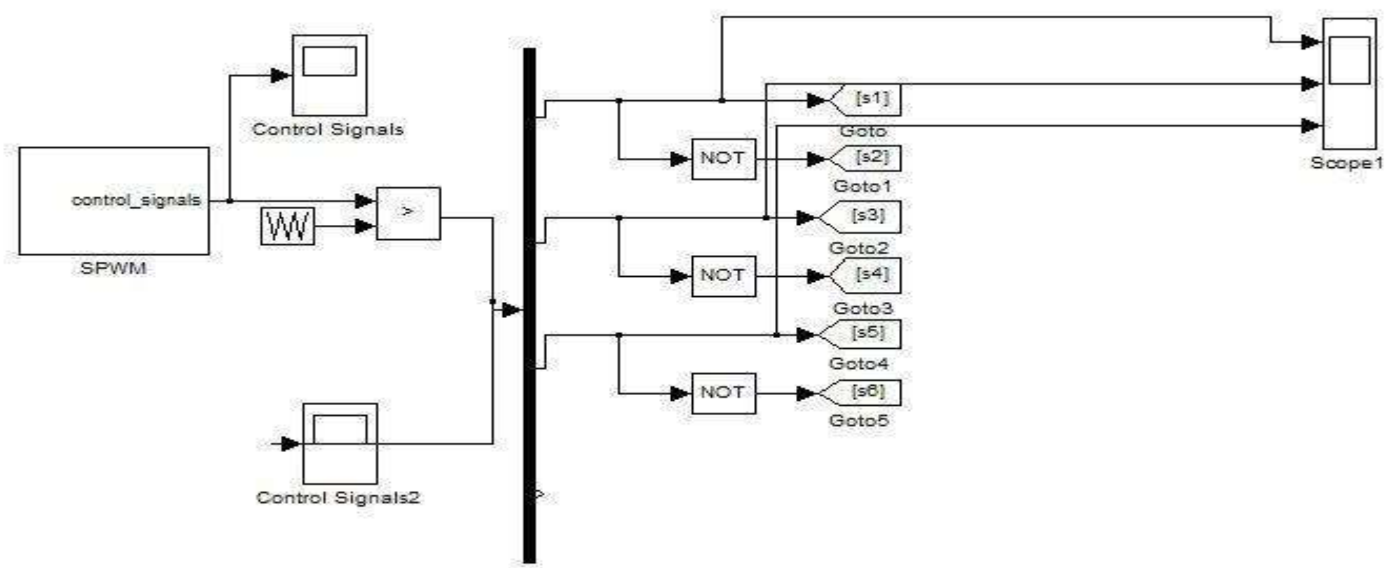

Fig-5 gate driving signal generation

3.5 SENSORS:

We have used QEP sensor (QUADRATURE ENCODER PULSE) to detect the speed of motor. It has white band , which helps in measuring speed. When white band reaches to same position after 1 minute, it helps to calculate the RPM of motor. Fig 6 shows the QEP sensor.

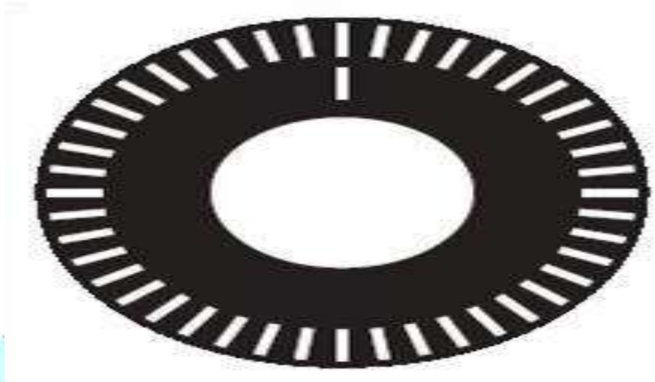

Fig-6 QEP sensor

4. WORKING:

On turning on the supply voltage, the system voltage (V_{dc}) is set to 300V. DSP kit sends the gate pulses to IGBTs and its output is again fed to 3 phase squirrel cage induction moto of 0.75kW and motor starts running with its base speed. But, on application of certain amount of load, the speed of motor decreases, and thst decrease in speed is detected by QEP sensor, and it sends signals back to DSP kit. Now, DSP kit executes the program and gives the signal to IPM module, and hence voltage increases, so speed also increases and becomes equal to base speed. Thus, speed control is obtained in a smooth manner.

5. RESULTS:

Table -2: CLOSED LOOP V/F CONTROL OF INDUCTION MOTOR

Vdc Volt	*f1* Hz	*f2* Hz	Spee D RPM Ns1	Speed RPM Ns2	V/*f* Ratio 1	V/*f* Ratio2
300	33. 33	33. 33	1000	999	9.0	9.00
	26.	26.				

300	66	56	800	797	11.25	11.29
300	23. 33	23. 3	700	699	12.85	12.87

6.CONCLUSION:

We have used QEP sensor (QUADRATURE ENCODER PULSE) to detect the speed of motor. It has white band, which helps in measuring speed. When white band reaches to same position after 1 minute, it helps to calculate the RPM of motor. Fig 6 shows the QEP sensor. The control system having DSP kit TMS 320F2812 has the several advantages. DSP TMS 320F2812 is fast processing device allows high sampling pulses. Above table is proof of speed is kept nearly constant i.e Ns1 and Ns2 .V/f1 and V/f2 are the values calculated for respective synchronous speed . It is observed that the V/f ratios for the synchronous speeds NS1 and Ns2 are almost same. So, it can be concluded that this method is capable of keeping the speed constant during the loaded condition by using V/f control technique by using DSP kit TMS320F2812. This high precision control system allows the fast production of signals for the IPM module which enhances the system performance. Wide range of control is obtained which reduces the harm to the system under loaded condition. Thus, it ensures reliability of proposed system.

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