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

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Abstract - *This paper focuses on scalar control technique which is also known as constant v/f control technique. This paper presents the improvement in the performance by the use of DSP TMS320F2812. This method gives the précised output after the application of load to the induction motor. Matlab simulink software is used for making simulation and the results are obtained by performing the experimental setup.*

Key Words: Scalar control, constant V/f, DSP320F2812, Induction motor.

1. INTRODUCTION

There are number of advancements took place in scalar v/f control technique which is one of the method of speed control of squirrel cage induction motor. Many papers suggests the improvement in the system can be done by boosting the lagging voltage[2],stator resistor compensation, slip frequency compensation, oscillation suppression compensation can also be done for this purpose[3].But limitations were observed as there were constraints on which only it gives required result and also, the motor performance deteriorates at low frequencies [1]. Again, it is difficult to determine the boost voltage [2]. The system is relatively complicated and many control parameters should be designed sophisticatedly to keep system stable. The slip frequency compensation is complicated [3]. In industry, many applications involves the use of D.C. drives where wide range and smooth speed control is required. But presence of commutator leads to continuous maintenance which makes it unsuitable for high speed applications. For these reasons preference is then given to adjustable speed induction motor drives because induction motor is cost efficient, robust in construction and more economical to operate and maintain. But the induction motor is essentially a constant speed, as its stable operation is restricted within a narrow range of speed. Also, another major disadvantage of induction motor is its low operating 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
f)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 which is also called as scalar v/f control. The V/f control method is, in principle a control method for maintaining the air-gap flux constant by controlling voltage V of stator and stator frequency f so to keep ratio V/f constant. 3 phase induction motor having the synchronous speed Ns is given by

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

Where,

Ns = the synchronous speed in RPM

p = the number of poles on the stator

f = the supply frequency in Hertz

When the supply is given to the 3 phase squirrel cage the motor, the alternating voltage is induced which is responsible for the production of magnetic field in rotor. To match the speed, with respect to the stator, the rotor starts moving in the exact same direction as that of the stator flux and tries to catch up the speed with the rotating flux. But the rotor never succeeds in "catching" to the stator field. So, the rotor runs slower than the the stator field speed. This speed is called the Base Speed (Nb). The difference of Ns and Nb is called the slip. The slip varies directly In the proportion 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 decrease slip. [7]

$$\% \text{ slip} = \frac{Ns - Nb}{Ns} * 100$$

Where,

Ns = the synchronous speed in RPM

Nb = the base speed in RPM

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

This can be relate as follows

Stator Voltage (V) α [Stator Flux (K) x [Angular Velocity (T)]

V α K x 2Bf

K α V/f

Where, K is constant.

3. METHODOLOGY:

This paper presents a new modern V/f control technique of induction motor (IM) for precise speed operation. All the compensations used in earlier methods are replaced by the use of DSP KIT TMS320F2812. [1][2][3] and [7]. The system becomes easy to construct and understand. Control operation is simple.DSP kit TMS320F2812 works on the changing speed of the system after application of load to the induction motor. 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. Thus, we can say, this kit is the heart of the proposed system.
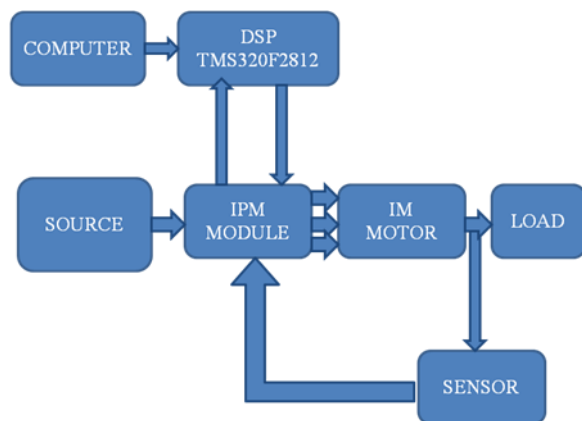

Fig-1 Block diagram of scalar V/f control technique for the speed control of induction motor

Above fig.1 shows the block diagram of V/f control technique using DSP320F2812. The absolute system is constructed with driver, control and power circuits as shown. DSP320F2812 comes under the category of driver and control circuits. Power circuit consist of the inverter circuit which is made by using IGBTs. Sensors are connected to sense the output.
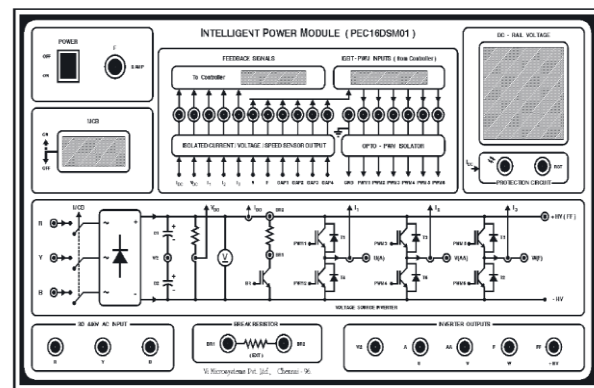
3.1 SOURCE:

1ph, 230V, 50 hertz AC supply is given to the system.

3.2 IPM MODULE (PEC16DSM01):
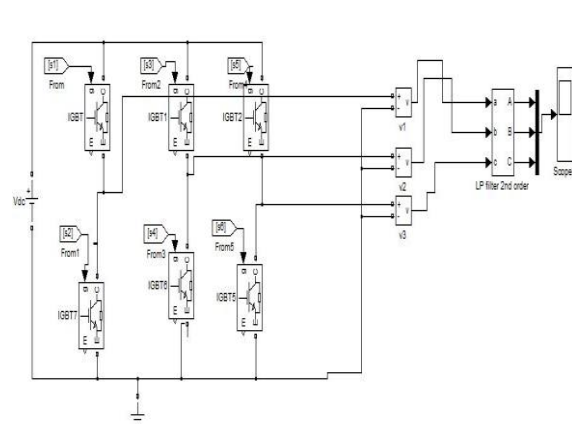
Fig-2 Equivalent inverter circuit

IPM module consists of the 6 IGBTs connected as shown in fig 2. It acts as 3 ph inverter when given the gate pulses. For this, gate driver circuit is formed as shown in fig 5.

Fig-3 front panel of IPM MODULE

The circuits are built in for detecting current rise and temperature of the system. so, this is called as INTELLIGENT POWER MODULE.fig 3 shows the 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	1415 RPM
Power Factor	0.8

3.4 DSP KIT TMS320LF2812:

This kit is also known as testing unit. This featured unit enables the user to verify programs based on TMS320F2812. The Digital Signal Processor TMS320F2812 of TEXAS Instrument is used for the production of gate driver signals of the inverter. So this is the control circuit for the IPM Module.

Fig- 4 DSP TMS320F2812

In this kit, programming can be done by C programming or embedded C. program can be loaded by CCSTUDIO. Emulator which is connected to interface DSP kit with the computer.
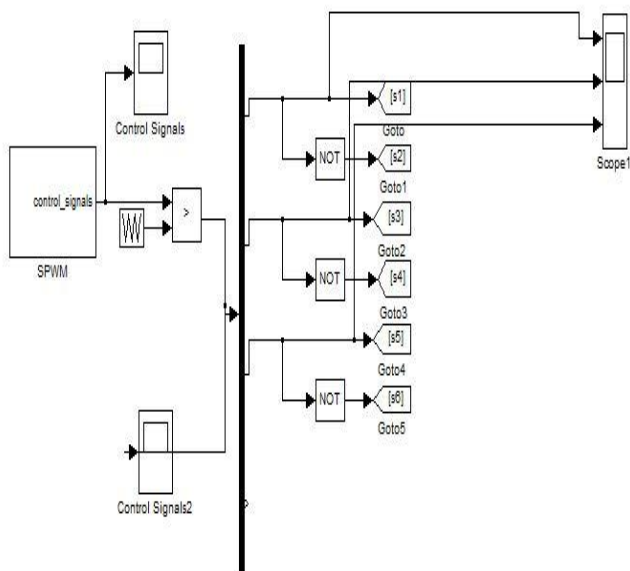

Fig-5 gate driving signal generation

3.5 SENSORS:

The eQEP sensor (QUADRATURE ENCODER PULSE) is used for detecting the speed of motor. It have white band as shown in fig6. It measures the speed by just measuring the white band which reaches to the same position after 1 min so we get RPM value of motor under any condition.
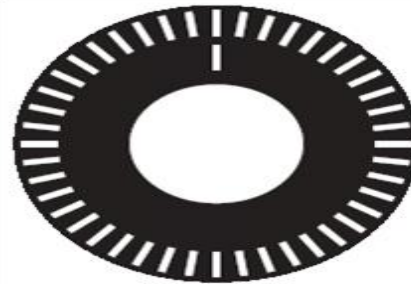

Fig-6 QEP sensor

4. WORKING:

When supply is turned ON, the system voltage Vdc is adjusted to 300V. IGBT gates gets pulses from the DSP kit, and gives the output which is applied to the 3 ph to squirrel cage induction motor of 0.75KW and motor starts running with its base speed. But when it is loaded, its speed decreases. So that decrease in speed is detected by QEP sensor and it is given to DSP kit. Now DSP TMS320F2812 performs the program and gives the signal of IPM module which leads to increase in voltage which will be required to maintain the base speed. In this way the speed of motor continues the base speed after the load is applied. Thus, speed control of induction motor is obtained.

5. RESULTS:

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

Vdc Volt	$f1$ Hz	$f2$ Hz	Speed RPM Ns1	Speed RPM Ns2	V/f Ratio 1	V/f Ratio2
300	33.33	33.33	1000	999	9.0	9.00
300	26.66	26.56	800	797	11.25	11.29
300	23.33	23.3	700	699	12.85	12.87

6.CONCLUSION:

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 ie Ns1 and Ns2 .V/f1 and V/f2 are the values calculated for respective synchronous speeds

ie.Ns1 and Ns2.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 the proposed system.

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