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Speed Control of Single Phase Induction Motor Using Micro-Controller

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ABSTRACT

Single-phase induction motors are widely used in home appliances and Industrial control because of their low cost and rugged construction. Many industrial processes require variable speed drives for various applications. This paper investigates the speed control performance of single-phase induction motor using microcontroller 18F2520. SPWM technique has been employed in this H-BRIDGE inverter to supply the motor with ac voltage. The mct2e optocoupler serves the purpose of isolation between the microcontroller circuit and the H-BRIDGE inverter and supplies the required gate voltage for the conduction of the power MOSFET (IRF840) in the H-BRIDGE inverter The microcontroller senses the speed's feedback signal and consequently provides the pulse width variation signal that sets the voltage and frequency ratio constant, which in turn provides the constant torque for the desired speed. The complete design is modelled and tested using MATLAB simulation and hardware implementation to control the speed of a capacitance start-run single phase induction motor by Sinusoidal pulse width modulation methods using volts/hertz algorithm is carried out.

Keywords - Single phase induction motor (SPIM), Sinusoidal Pulse width modulation (SPWM)

I. INTRODUCTION

Induction motors are widely used in many residential, industrial, commercial, and utility applications. Single-phase induction motors are widely used in home appliances and industrial control. A variable-frequency drive (VFD) is a system for controlling the speed of a rotational or linear alternating current (AC) electric motor by controlling the frequency of the electrical power supplied to the motor. Variable-frequency drives are also known as adjustable-frequency drives (AFD), variable-speed drives (VSD), AC drives, micro drives or inverter drives [2].The multispeed operation and multipurpose operation are provided by controlling the speed of these motors.

In the previous days, the variable speed drives had various limitations such as larger space, poor efficiencies, lower speed and etc. But, the invention of power electronics devices change the situation so now, variable speed drive are constructed in smaller size, high efficiency and high reliability [3].

In this paper, the basic concept of speed control by v/f ratio control, generic topologies, control technique of speed control is discussed. SPIM has been control by frequency And Voltage control method by using SPWM control circuit and H-bridge inverter.

Variable-frequency drives are used in a wide number of applications to control pumps, fans, hoists, conveyors, compressors and other machinery.

II. Speed Control

In Induction motor there are two speed terms synchronous speed and rated speed. Synchronous speed (Ns)is a speed at which a motors magnetic field rotates. Rated speed(N) is motor actual speed.

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

Where, f= frequency in Hz P=Number of Poles

The based speed of the motor is proportional to the supply frequency and inversely proportional to the number of stator poles. So, by changing the supply frequency, the motor speed can be changed. But changing only frequency has limitations. If only frequency reduces then there is possibility of core saturation. Also constant torque capabilities of motor decreases, hence to maintain constant torque voltage-frequency ratio is kept constant**.**

V/f CONTROL

The torque developed by the induction motor is directly proportional to the ratio of the applied voltage and the frequency of supply. By varying the voltage and the frequency, but keeping their ratio constant, the torque developed can be kept constant throughout the speed range.[4]

V = 4.44T Φmf
Stator Voltage (V) ∝ [Stator Flux (Φ)] x
[Angular Velocity (ω)]
V ∝ Φ * 2 Π F
Φ   ∝ V/F

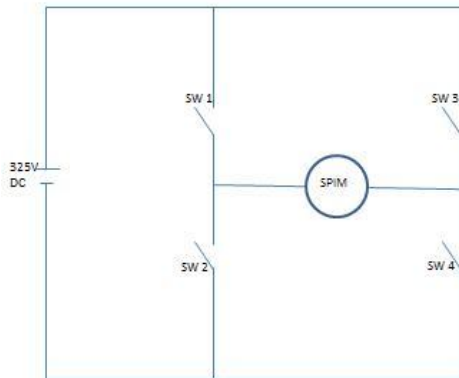## III. AC drive for Single Phase Induction Motor:-

Fig 1.H-bridge inverter driven SPIM

In Fig 1.Mosfets are used as switching device. The operations of this inverter are;

SW1-SW2 ON: Both create short circuits across the DC source and are invalid.

SW3-SW4 ON: Both create short circuits across the DC source and are invalid.

SW1-SW4 ON: Applies positive voltage (Vs.) to the load. The positive current passes through SW1-SW4.

SW2-SW3 ON: Applies negative voltage (-Vs.)across the load.

The negative current(-IL) flows through SW2-SW3and draws energy from the supply. SW1-SW3ON: Applies zero volts across the load.
SW2- SW4ON: Applies zero volts across the Load.
To trigger the switches i.e. Mosfets pulses are required. To generate pulses SPWM technique is used.[3]
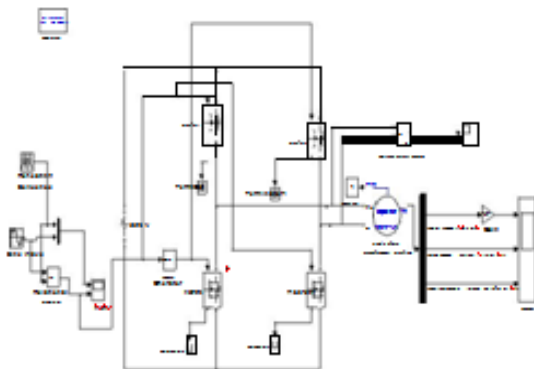
IV. SIMULATION MODEL

Fig.2 Simulation model of Split phase SPIM

Table 1:- Parameters of simulation:-

Sr. No.	Parameters	Values
1	Input DC Voltage	325V
2	Carrier peak amplitude (V_c)	1 pu
3	Reference peak amplitude (V_m)	0.9 pu
4	Capacitor start-run SPIM Motor	0.25 HP,230V 50Hz,2 Pole

V. Sinusoidal Pulse width modulation:

The waveforms of Sinusoidal PWM are shown in the fig. 3. In this modulation the triangular waveform (V_c) is Compared with sinusoidal waveform (V_m). The inputs to the comparator are V_c and V_m. The output of the comparator is high when the magnitude of the sinusoidal voltage is greater than the magnitude of triangular voltage. It can be seen that the output voltage has a train of pulses of unequal width. The width is maximum for the centre pulse and it decreases on either side. The width of the pulse varies sinusoidal. This is called asymmetric. In SPWM since the width of the pulses are unequal. The harmonics of this voltage waveform will be less than PWM waveform. [9]

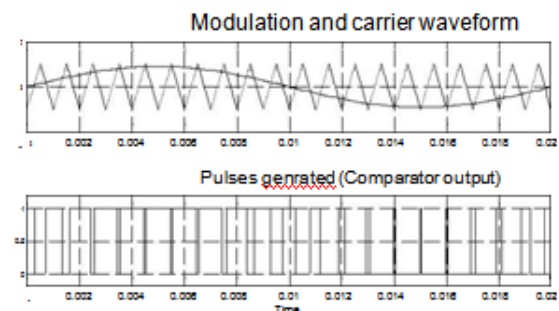## VI. Output Waveform of SPWM:-

Fig.3 Simulation of SPWM

We can vary the Frequency by changing the frequency of the modulating signal i.e. sinusoidal signal. We can vary voltage at output by the varying value of MODULATING INDEX (m). Where;

$$m = \frac{Vm}{Vc}$$

V_m= Reference sinusoidal signal. V_c=Carrier signal

The magnitude of modulation index is limited below one (i.e., $0<m\leq1$) to avoid over modulation.
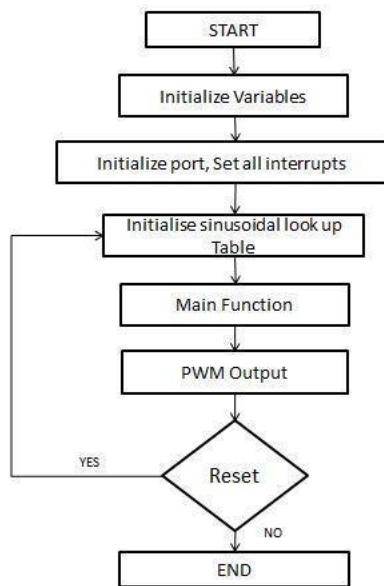
## VII. ALGORITHM OF SPWM PULSES

Fig.4 Flow chart of PIC18F2520 programming

Fig.4 shows Flow chart of PIC18f2520 Micro-controller programing. To trigger Mosfets pulses are required and these pulses are generated using Micro-controller. In microcontroller programing is to be done so as to get desired pulses to triggered Mosfets. Reference Sinusoidal signal and Carrier signal is formed inside Micro-controller using lookup table. These signals are compared to get pulses for Mosfet switching [10].
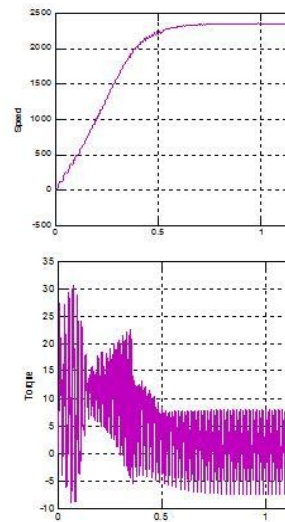
VIII. RESULTS

Keeping V/f ratio constant for different values of voltage and frequency, MATLAB simulation is obtained. Torque-speed characteristics is observed and compared.
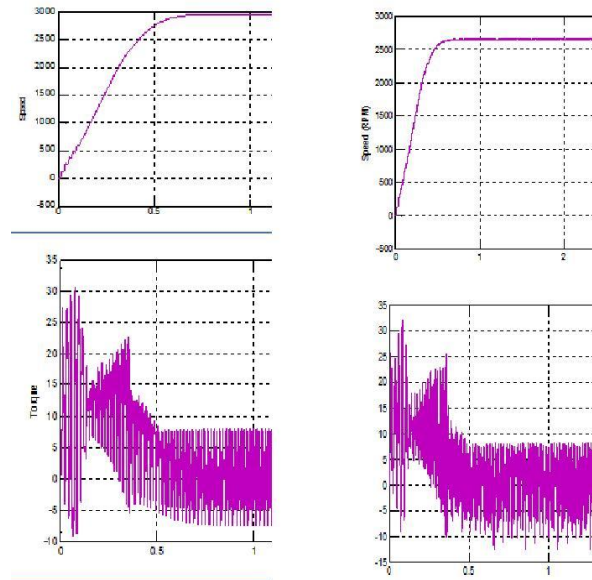
Fig(a)   Fig(b)

Fig(c)

Fig (a), Fig (b) and Fig(c) shows speed-torque characteristics. We can observe that speed changes in all the three cases but torque remain constant. We can conclude that, as the speed changes Torque remain constant.

IX. CONCLUSION

The use of a Variable Speed Drive for a speed control application usually offers an energy efficient and economic solution . Simple and straight forward VSD's, such as the PWM inverter drives, are available for applications where the speed control accuracy is required. This compact inverter had its hardware reduced to a minimum

through the use of H-bridge inverter. The variable speed drive with variable frequency and voltage control method will offer new, low-cost solutions for light commercial and consumer applications. From Matlab Simulation conclusion can be made that we can vary frequency from 16 Hz to 50 Hz at for changing the speed of induction motor. It is observed that speed can be change from 500 RPM to rated speed in case of 2-pole single phase capacitor start-run induction motor.

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