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A REVIEW OF CYCLOCONVERTER TYPE VOLTAGE AND FREQUENCY VARIATIONS FOR HIGH FREQUENCY APPLICATIONS

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Abstract : This paper presents a technique to control the speed of single phase induction motor by using IGBT. Induction motor is a constant speed machine when operated from the mains. However it is necessary to vary the speed of the motor in some applications. The speed of a motor basically depends on the supply frequency and supply voltage. This paper examines the use of Cycloconverters to vary the speed of single phase induction motors. Cycloconverters work on changing the supply frequency to vary the speed of the motor. With the aid of three push buttons connected to the microcontroller and the program written on it, the speed of the motor was varied in three steps, at F, F/2 & F/3. This method is suitable for such application where the load varies approximately as square of speed, such as centrifugal pumps drives, fan load, refrigerator, blower etc

***Key words*- Induction Motor, Speed control, Cycloconverter, Microcontroller, Variable frequency drives.**

1. Introduction

In this paper cycloconverter is introduced as a type of power controller, where an alternating voltage at supply frequency is converted directly to an alternating voltage at load frequency (normally lower), without any intermediate dc stage. These new approaches need a simple method of control for ac motors. The cycloconverter is device that converts ac supply of one frequency into ac supply of different frequency without any dc stage in between. It can be also consider as a static frequency changer and typically contains silicon-controlled rectifiers. A.C. motors have the great advantages of being relatively inexpensive and very reliable. The induction motor is known as a constant-speed machine, the difficulty of varying its speed by a cost effective device is one of its main disadvantages. As the AC supply frequency cannot be changed, so the use of a TRIAC controlled cycloconverter which enables the control of speed in steps for an induction motor is solution for this problem. In this paper cycloconverter is introduced as a type of power controller, where an alternating voltage at supply frequency is converted directly to an alternating voltage at load frequency (normally lower), without any intermediate dc stage. These new approaches need a simple method of control for ac motors

2. Project Description

The Cycloconvereter have several important features, cycloconveter frequency can be varied by conduction period for each IGBT. However, control of induction motor is challenging task, many authors have suggested different techniques for speed control of induction of induction motor. For speed-sensorless operation, as both the initial rotational direction and speed is unknown, it would be difficult to achieve smooth and fast resumption of normal operation if the starting scheme is not deliberately designed. A method based on variable frequency control (V/F) is proposed to address this problem. The variable frequency has important usage in the industrial world. The electricity produced from the generating station are normally 50Hz and these frequency is not applicable for most of the application.

3. Block Diagram of Proposed System

The block diagram of proposed system is shown in figure 1.1. This design proposes the open loop control topologies of a induction motor using cyclonverter. The system is powered by 230VAC 50Hz supply that is rectified to 12V DC and then regulated to 5V DC. The cycloconverter has two bridges, bridge 1 (positive cycle) and bridge 2 (negative cycle). The motor is connected between the bridges. Each bridge is made up of four thyristors. Each thyristor is connected through an optoisolator to the microcontroller. The microcontroller contains the program codes that control the operation of the cycloconverter. A cycloconverter is input frequency fi and output frequency fo. A cycloconverter is a type of power controller in which an alternating voltage supply frequency is converted directly to an alternating voltage at load frequency without any intermediate DC stage. The cyclonverter is connected as shown in fig. The operation of cycloconverter is, the singlephase to single-phase cycloconverter should be studied first. This converter consists of back-to-back connection of two full-wave rectifier circuits.

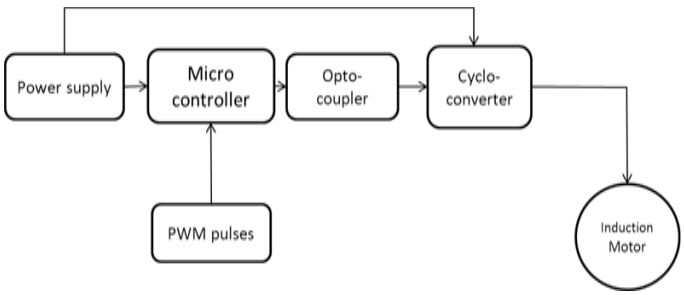

Fig-1.1 Block diagram of proposed system

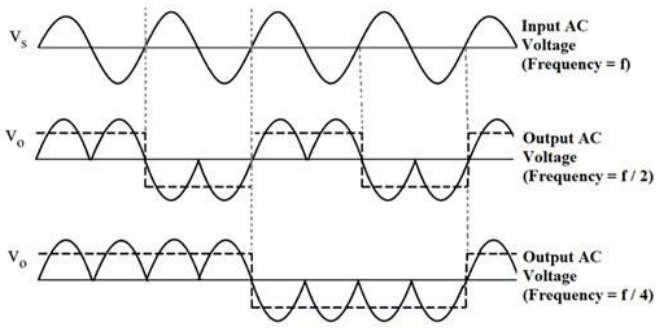

Fig-1.2 Waveform cycloconverter

4. Mathematical Modeling

THREE PHASE INDUCTION MOTOR SPEED:

$$n_{slip} = n_{sync} - n_m$$

THE SLIP:

$$s = \frac{n_{sync} - n_m}{n_{sync}}$$

ROTOR FREQUENCY:

$$f_r = \frac{p.n_{slip}}{120}$$

OUTPUT VOLTAGE RMS:

$$V_{0(rms)} = \sqrt{\frac{Vm^2}{2\pi}\left[\int_a^{2\pi} Vm^2 \sin^2 \omega t \, d(wt)\right]}$$

$$V_{0(rms)} = \sqrt{\frac{Vm^2}{2\pi}\left[\int_a^{2\pi}\left(\frac{1-\cos 2\omega t}{2}\right) d(wt)\right]}$$

Output load voltage:

$$V_o = V_l = 0; \qquad for\ \omega t = 0\ to\ \alpha$$

$$V_o = V_l = V_m \sin \omega t; \qquad for\ \omega t = \alpha\ to\ 2\pi$$

5. Induction Motor

AC motor have the great advantages of being relatively inexpensive and very reliable. The induction motor may be regarded as practically a constant speed machine , the difficulty of varying its speed economically constitutes one of its main problem. These problem can be overcome by using a thyristor controlled cycloconverter that enable the speed to be lowered in steps by microcontroller triggering a SCR bank of 8 nos in F, F/2 and F/3.The load is used as a single phase induction motor in which the speed of induction motor can be control by using various method, out of which basically we used V/F control method in which single phase cycloconverter used to control the speed.The base speed of induction motor is directly proportional to the supply frequency and the no. of poles of the motor. Since the no. of poles are fixed by design, the best way to vary the speed of induction motor is by varying the supply frequency. By varying the voltage and the frequency. but keeping their ratio constant , throughout speed range. This exactly what v/f control tries to achieve. The starting current requirement is lower. The stable operating region of the motor is increase. Instead of simply running at its best rated speed, the motor can be typically from 5% of the synchronous speed up to the base speed. At the base speed , the voltage and frequency reach the rated values. We can drives the motor beyond the base speed by increasing the frequency further. However the applied voltage cannot be increase beyond the rated voltage. The acceralation and deceleration of the motor can be controlled by controlling the change supply frequency of the motor with respect to time . When the load is increased , while at based speed the speed drop and slip increases. By varying the frequency the speed of the motor can be varied. Therefore by varying the voltage and frequency by the same ratio, flux can be kept constant throughout the speed range .This makes constant v/f most common speed control of the induction motor

6. PIC 16F877A Microcontroller

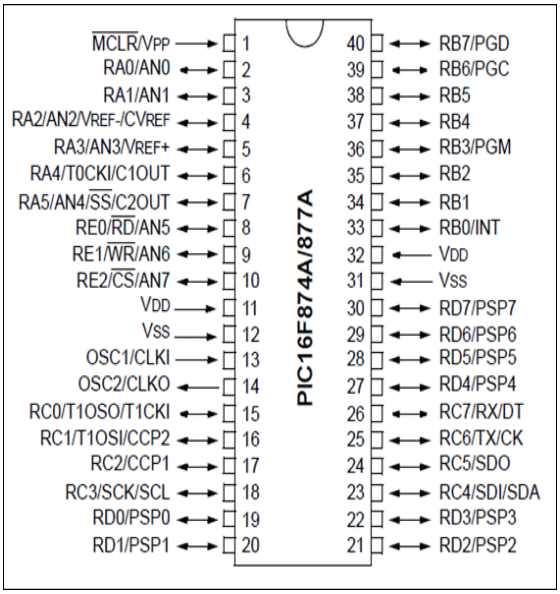

Fig-2.1 Pin configuration of PIC 16f877a

PIC16F877A is a peripheral interface controller is a microcontroller developed by microchip, PIC microcontroller is fast and easy to implement program.It is a microcontroller which supports the protocols like CAN,SPI,UART for interfacing with other peripherals. PIC16F877A uses 14 bits for instructions which allows for all instructions to be one word instructions. The crystal oscillator speed that can be connected to the PIC microcontroller range from DC to 20 MHz . Using the C compiler normally 20 MHz oscillator will be used and the price is very cheap. The 20 MHz crystal oscillator should be connected with about 22pF capacitor PIC16F877A perfectly fits many uses, from automotive industries controller PIC16F877A.The micro controller has been programmed i.e. ASM/C program to give output to optical isolation with zero cross detection circuit. It compares two signals in order to get zero crossing whenever the zero crossing occurs it gives an output. . A microcontroller programme is developed to control the firing pulses of gate driving circuit, these firing pulses are controlled by SCR. The output of the cycloconverter is fed to the induction motor to control the speed at different frequencies

7. Hardware Results

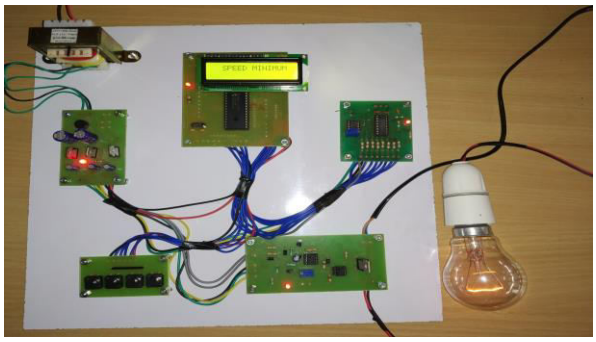

Fig-3.1 Operation of Load at Minimum Speed

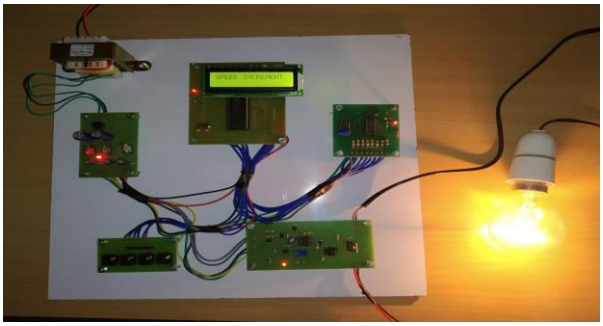

Fig-3.2 Operation of Load at Maximum Speed

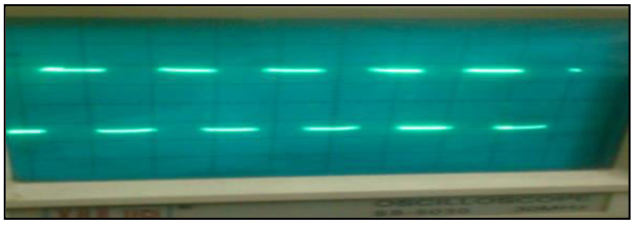

Fig-3.3- Input signal of 10KHz

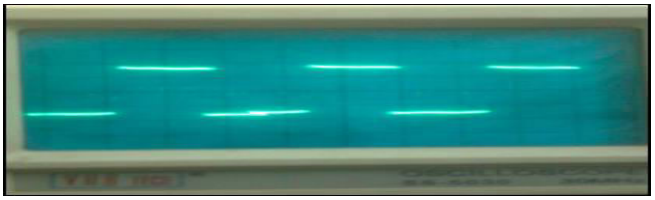

Fig-3.4- Output signal of 500Hz

8. Conclusion

In this work, the model of Cycloconverter operation using MATLAB/Simulink software has been carried out. Simulation result is feasible to realize the designed cycloconverter in various basic AC-AC converter as a step-up frequency changer. In this work the total harmonic distortion is reduced as 0.15% by changing the softswitches in cycloconverter design. The cyclo-converter circuit has designed for variable frequency drives, the main aim of this paper is to attain variable speed for various applications and also for induction motor for adjustable frequency. Single phase Cyclo-converter used to change the speed of induction motor with the help of microcontroller, different desired frequency is obtained to equalize the desired speed. This different frequency of cyclo-converter is obtaind in the manner of adjustable speed to F, F/2 & F/3. Furthermore, it provides means for limiting the slip and consequently the motor current, also high voltage circuit from affecting the system receving the signal can be prevent with the help of opto-coupler. This means a reduction in the Cyclo-converter rating and better efficiency.

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