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Speed Control of Induction Motor Using Single Phase Cycloconverter

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Abstract
In various application of electrical energy especially in industrial areas there are two types of current , Direct Current and Alternating Current are used .Generally fixed voltage, constant frequency single phase or three phase AC is easily available, yet for different applications various type of magnitudes or frequencies are essential. The project is designed to control the speed of a single phase induction motor in three steps by using cycloconverter technique by thyristors. AC motors have the great advantages of being relatively inexpensive and very reliable. Induction motors in particular are very robust and therefore used in various industries like rice mill ,shipping industries ,etc. 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 this project uses a thyristor controlled cyclo-converter which enables the control of speed in steps for an induction motor.
This project is used to contol the speed of induction motor by using SCR based cyclo-converter ,here we used single phase induction motor which is generally applicable in various industries. By using SCR based cyclo-converter we can control the speed of AC motors, by using the V/F control method.

Keywords
Cycloconverter, PIC16F73 micro controller, Induction Motor .

I. Introduction

Speed control of induction motor is necessary in industrial applications.There are several method for the speed control of induction motor. Cycloconverter are use in very large variable frequency drives with ratings from few megawatts upto tens of megawatts. A cycloconverter is a power electronic device used to convert constant voltage constant frequency AC power to adjustable voltage adjustable frequency AC power without DC link, in among all the methods V/F method is simple reliable and economical . the various speed of induction motor can be obtain by varying the supply frequency by using cycloconverter. A cycloconverter is controlled though the timing of its firing pulses ,so that it produces and alternating output voltage. It can also be considered as a static frequency changer and typically contains silicon –controlled rectifiers. The quality of the output waveform improves if more switching devices are used . Induction motor are widely used in many applications due to their energy efficient characteristics . Improvements in its performances means a great saving in electrical energy consumption . thus , a cycloconverter has the facility fot continuous and independent control over both its output frequency and voltage. Cycloconverter eliminates the use of flywheel diode because the presences of flywheel diode in machine increases torsional vibration and fatigue in the component of power transmission system .

II. Cycloconverter

Cycloconverters are used in high power applications driving induction and synchronous motors. They are usually phase-controlled and they traditionally use thyristors due to their ease of phase commutation .cycloconverter. The cycloconverter is a device which converts input AC power at one frequency to output AC power at a different frequency with a one stage conversion. The frequency conversion is achieved using a phase control method. Thus, cycloconverters are capable of providing a variable frequency power supply to AC machines. The cycloconverter also allows power to flow freely in either direction. Over most of its range, the cycloconverter produces a reasonable sine wave output that leads to good output performance, particularly at lower frequencies.

Operating Principle Of Cycloconverter

A. Single-Phase To Single-Phase Cyclo-converter:

This converter comprises of consecutive association of two full-wave rectifier circuits. The input voltage vs, is an ace voltage at a frequency. All the thyristors are fired up at a=0° firing angle, i.e. thyristors acts like diodes. Firing angle for positive converter is meant by αp and for negative converter αn. The frequency of Vo can be altered by shifting the number of cycles, positive and negative converters work. Consider the working of the cycloconverter to accomplish ¼ of the input frequency at the output. For the beginning two cycles of vs, the positive converter acts to giving current to the load. It rectifies the input voltage; thusly, the load found four positive half cycles. In the subsequent two cycles, the negative converter works giving current to the load in the opposite direction.

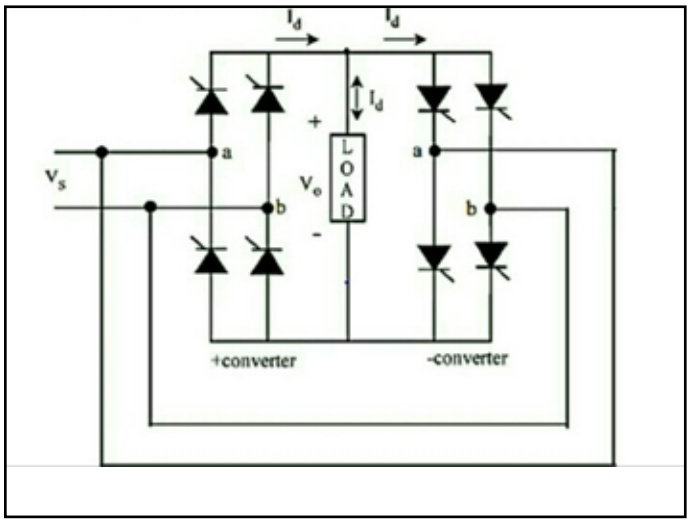

Fig. : (a) Cycloconverter, Single-phase to single-phase

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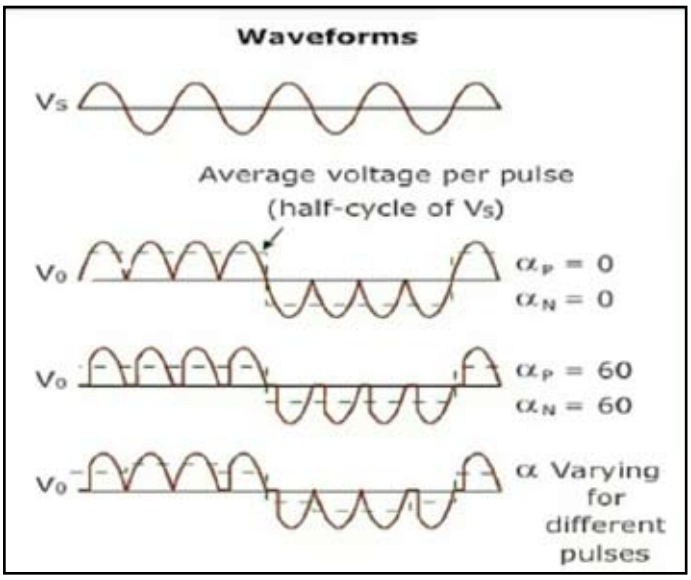

Fig. : shows cycloconverter waveforms of Single-phase to single-phase

1) Input voltage
2) Output voltage for zero firing angle
3) Output voltage with firing angle p/3 rad
4) Output voltage with varying firing angle

Due to the frequency of the output, Vo in fig.3b is one fourth of the input voltage, i.e. fo/fi=1/4 that's why it is step down cycloconverter. Instead of it, if the cycloconverter frequency has correlation like this fo/fi>1, it's known as step-up cycloconverters.

III. PIC 16F76 MICRO-CONTROLLER

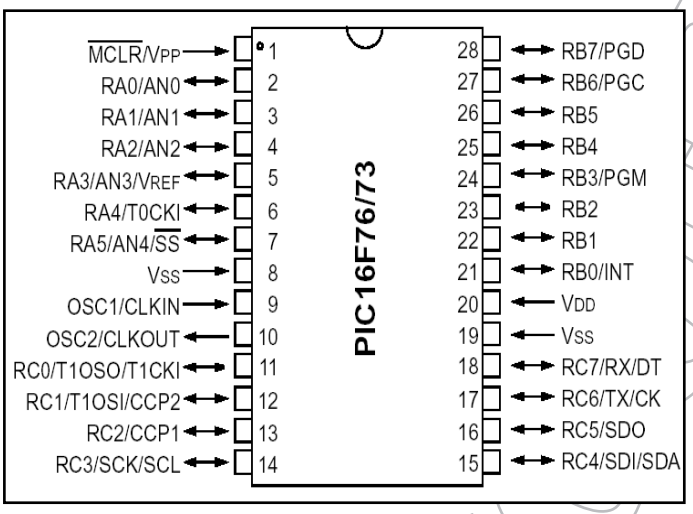

Fig: Pin diagram of PIC16F76 microcontroller.

PIC16F76 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. PIC16F73 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. PIC16F73 perfectly fits many uses, from automotive industries and controller home appliances to industrial instruments and safety device .

IV. 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.

V. Block Diagram

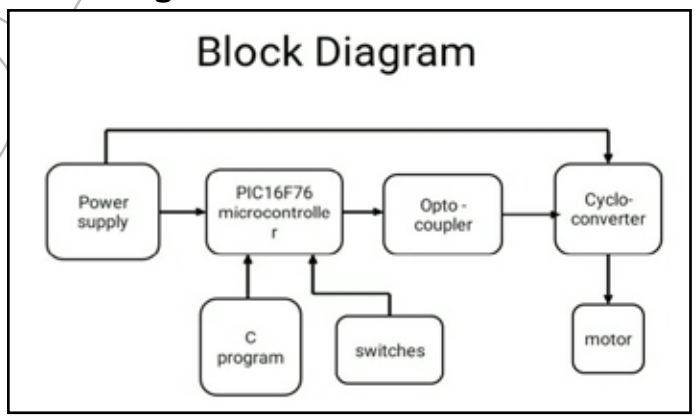

Fig : Block diagram of speed control of induction motor using single phase cycloconverter.

Description:
single phase 230 V Power supply is given the transformer for step down the voltage from 230v AC to 12V AC. The 12v AC is then fed to the bridge rectifier . The rectifier converts 12V ac to 12VDC . output of the rectifier is fed to the Voltage regulator 7805 it gives the output of 5V DC. The 5V DC is given to Vcc of the micro

controller PIC16F76.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.

VI. Conclusion

A cycloconverter is a device use to convert a constant voltage constant frequency AC power to variable voltage variable frequency without any intermediate DC link. In this paper presented a speed control of single phase induction motor by using single phase cycloconverter. There are several techniques use for conversion but order to have maximum converter utilization, special cycloconverter techniques have to be used.

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