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Designing of Thyristor Based Cycloconverter To Control Induction Motor

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Abstract
In this paper it is shown that how to control the speed of a single phase induction motor by the use of cycloconverter mechanism through thyristors. It becomes difficult to control the speed of induction motors that usually operates at constant speed. The single phase motor finds its application in vacuum cleaners, fans, washing machines, centrifugal pumps, blowers, washing machines, etc. The process is carried out in three steps. The project uses a microcontroller of 8051 family interfaced to a pair of slide switches for selecting the required speed range as F, F/2 and F/3. Thyristor is used for the purpose of controlling speed as the Ac supply frequency to the induction motors cannot be changed. As the switches are set the microcontroller generates the pulses to trigger the SCR's in a dual bridge. This very concept can be further enhanced and implemented to control the speed of a three phase induction motor. It can also be coupled with firing angle control for any desired speed

Keywords: *cycloconverter, thyristors , single phase induction motors*

1. Introduction

In industrial applications Speed control of induction motor is necessary. There are several methods for the speed control of induction motor. Cycloconverter are used in very wide variable frequency drives with ratings from few megawatts up to many tens of megawatts. A cycloconverter (in fig 1) is controlled through the timing of its firing pulses, so that it produces an alternating output voltage. It can also be considered as a constant frequency changer and typically contains silicon-controlled rectifiers. The development of the semiconductor devices has made it possible to control the frequency of the cycloconverter according to the requirement and deliver a large amount of controlled power with the help of semiconductor switching devices like thyristors, in order to get alternating output of variable frequency. The quality of the output waveform improves if more switching devices are used. Splitphase induction motors are widely used in many applications due to their energy efficient characteristics. Improvements in its performance mean a great saving in electrical energy consumption. Thus, a cycloconverter has the facility for continuous and independent control over both its output voltage and frequency[2].

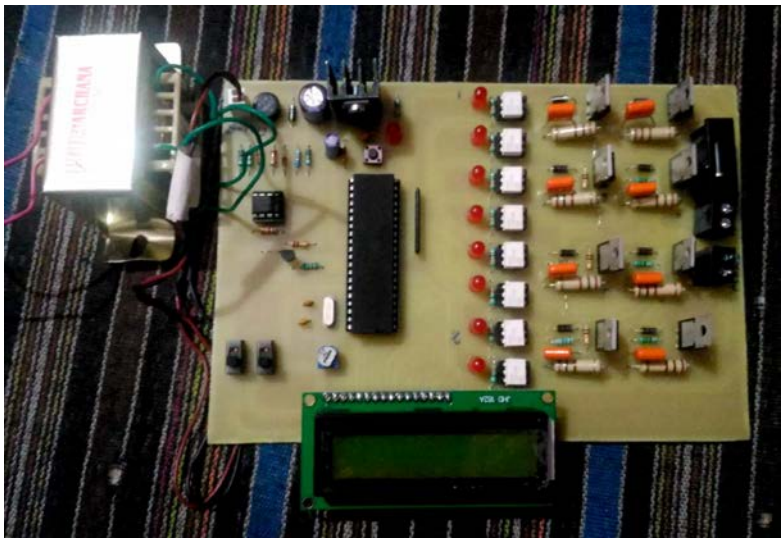

Figure 1 outlook of project

2. Literature Survey

Prasenjit Sontakke[3] described that Induction motors in particular are very robust and therefore used in many domestic appliances such as washing machines, vacuum cleaners, water pumps, and used in industries as well. 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 he used a thyristor controlled cycloconverter which enabled the control of speed in steps for an induction motor.

P R Lole , K D Adahav et al [4] described that the speed control of Induction Motor to be simple and can be made economical by using different methods to control the operation of Cyclo-converter which in turn controls the performance of motor. The speed of the motor can be varied in two ways, one is by changing the number of poles and the second method is by changing the frequency. The speed control through the first method was uneconomical and the number of poles can't be varied under running conditions and the size of the machine also became bulky. These problems were overcome by the second method. In this method, the frequency was varied under running conditions also and there was no change in the size of the motor. In this method, the frequency changing device is Cyclo-converter.

Richa Gajbhiye , Rupali Malghati et al [5] explained that cycloconverter be 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 quality of the output waveform improved when they used more switching devices. Induction motorare widely used in many applications due to their energy efficient characteristics. Improvements in its performances meant a great saving in electrical energy consumption .thus, a cycloconverter has the facility for continuous and independent control over both its output frequency and voltage.

AyebatonyeEpemu et al [6] explained that Induction motor as a constant speed machine when operated from the mains. However it was necessary to vary the speed of the motor in some applications. The speed of a motor basically depends on the supply frequency and number of poles. While the frequency can easily be changed without changing the entire structure of the motor, the same was not said for the number of poles. He examined the use of cycloconverter to vary the speed of single phase induction motors. Cycloconverters work on changing the supply frequency to vary the speed of the motor.

3. Methodology

Cycloconverter is a frequency converter from one level to another, that can change AC power from one frequency to AC power at another frequency. Here, an AC to AC conversion process is done with a frequency change. Hence it is also referred as frequency changer.[7] Normally, the output frequency is less than the input frequency. The implementation of the control circuit is complicated due to the huge number of SCRs. The Microcontroller or DSP or microprocessor is used in control circuits.A cyclo-converter can achieve frequency conversion in one stage and ensures that voltage and the frequencies are controllable. In addition, the need to use commutation circuits is not necessary because it utilizes natural commutation. Power transfer within a Cycloconverter occurs in two directions. It is designed to control the speed of a single phase induction motor in three steps by using a Cycloconverter technique by Thyristors. The Cycloconverter has four Thyristors divided into two Thyristor banks as shown in Fig 2, i.e, a positive bank and a negative bank of each. When the positive current flows in the load, the output voltage is controlled by phase control of the two positive array Thyristors whereas, the negative array Thyristors are kept off and vice versa when negative current flows in the load[8]. A major control problem of the cyclo-converter is how to swap between banks in the shortest possible time to avoid distortion while ensuring the two banks do not conduct at the same time. A common addition to the power circuit that removes the requirement to keep one bank off is to place a center tapped inductor called a circulating current inductor between the outputs of the two banks. Both banks can now conduct together without shorting the mains. Also, the circulating current in the inductor keeps both banks operating all the time, resulting in improved output waveforms.[9]

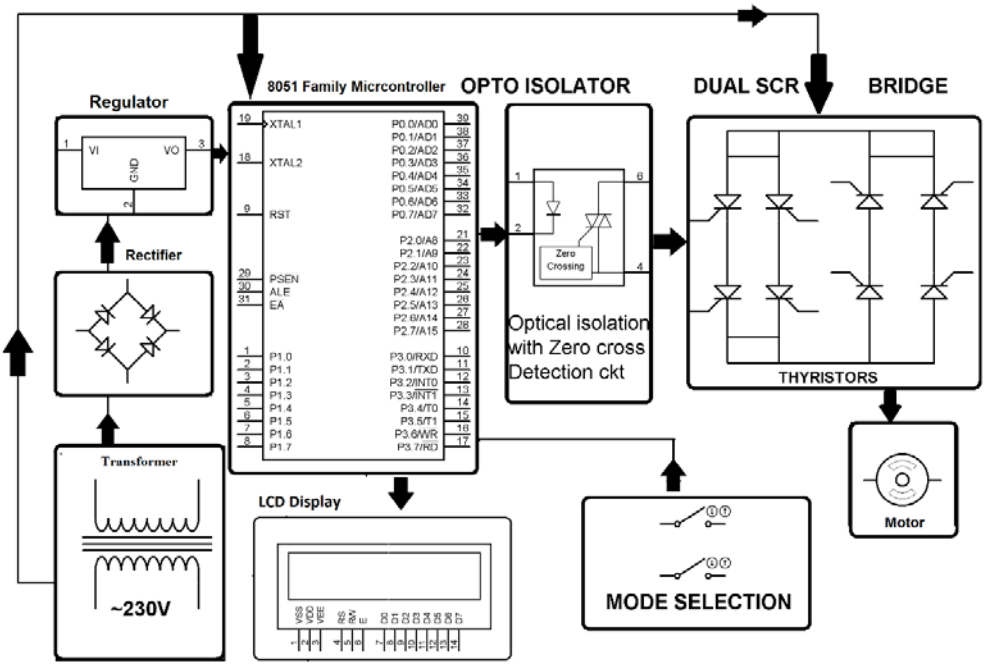

Fig 2.block Diagram

4. Operation

Cycloconverter consists of two single phase full bridge circuits bridge1 and bridge 2, load is connected in between these two bridge circuits as shown in figure. Each bridge consists of four thyristors. From these upper group thyristors are positive and lower group are negative group thyristors. These thyristors gate pulses are controlled by zero crossing detector and microcontroller. The firing angle control consists of eight MOC 3021 opto-isolators. MOC 3021 contains a LED and a light sensitive TRIAC. When the LED s switched on then the TRIACs in MOC3021 gets the input and they turn on. The opto-isolators (MOC 3021) isolate the high frequency modulated driver control circuit with low frequency cycloconverter circuit. At time t=0+ the thyristors on the 1st bridge to switch on for predefined time period t, during this time period to other bridge is kept off position[10]. To control the speed of the induction motor frequency control of the output voltage by turn-On and turn-Off time periods of the thyristors. When the switch 1 is closed SCR gets conducting for 20 ms for first bridge and next 20ms for second bridge so the total time period of AC cycle is 40 ms, so it gives the frequency 25Hz i.e. F/2. When the switch 2 closed the time period of conduction for the 1st bridge takes place for 30ms and then other bridge for 30ms,so the total time period of AC cycle is 60ms 16.66 Hz i.e. F/3. This supply is given to the motor by using F/2 and F/3supply we can control the speed of the AC motor.[11]

5. Conclusions

In manufacturing and process industries, the variable frequency is required for driving various electrical machineries. The cycloconverter or variable frequency generator plays a significant role in driving those electrical machineries. The study mainly focuses on the design and construction of the single phase cycloconverter. The commercially designed single phase cycloconverter circuit may use different design pattern than this one. This single phase cycloconverter circuit can be extended further for three phase application. In case of the three phase cycloconverter, each of the positive and negative converter group operates for half the period of the output frequency.[12]

6. Future Scope

From this work and result analysis, it is observed that speed of an induction motor can be efficiently controlled by using Cycloconverter. The role of Cycloconverter in speed control of induction motor is to vary the supply frequency which in turn, changes the speed of motor. In the present work, the Simulation of speed control of motor at different frequencies by using Cycloconverter is simulated and waveforms are discussed which will be of great prospect in future.[13]

7. Acknowledgement

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