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SPEED CONTROL OF SINGLE PHASE INDUCTION MOTOR BY USING CYCLOCONVERTER

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Abstract: - *Induction motors have the great advantages of being relatively inexpensive and very reliable. Induction motors in particular are very robust and therefore used in many domestic appliances and used in industries as well. 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 disadvantage. This thesis presents simulation and Implementation of step-down cycloconverter for speed control of single phase induction motor. 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. As the AC supply frequency cannot be changed, so the use of a thyristor controlled cycloconverter which enables the control of speed in steps for an induction motor is solution for this problem. Implementation of the open loop hardware by using the microcontroller and applying gate pulse to thyristor speed of Induction motor is controlled in steps. Cycloconverter gives good direct speed control of induction motor without any intermediate DC stage conversion.*

Keywords:-*Cycloconverter, Pulse Generator, Induction Motor and MATLAB.*

I. INTRODUCTION

AC motors, in general, have superior performance characteristics to their DC counterparts. However, despite these advantages AC motors lack the controllability and simplicity and so DC motors retain a competitive edge where precise control is required. As part from overall project, is to develop an improved cycloconverter control strategy for induction motor. Simulation and modeling techniques have been developed. This contribution describes a method used to simulate an induction motor drive using the SIMULINK toolbox within MATLAB software. The cycloconverter fed induction motor is principally model. Results of the simulation for a given set of induction motor parameters are also presented.

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. But main problem of single phase induction motor is its speed control.

AC-AC conversion using semiconductor switches is done in two different ways: in two stages AC-DC and then DC-AC as in DC link converters or in one stage AC-AC cycloconverter. Cycloconverter is used in high power applications driving induction and synchronous motors. They are usually phase-controlled and they traditionally use thyristor due to their ease of phase commutation. Basic Cycloconverter block is shown in figure 1.

This thesis is about naturally commutated single phase cycloconverter as used to drive electric motors. The aim is to control the speed of single phase induction motor.

Figure 1 CYCLOCONVERTER BLOCK

II. The Single Phase Input Cycloconverter

The circuit of a single phase input to single phase output cycloconverter is shown in Figure 2, It is perhaps the simplest type of cycloconverter and will be used in this thesis as the basis for the investigations into the operation of the cycloconverter and for developing techniques for improving its performance. It is classed as a 2-pulse cycloconverter because there are two phase controlled pulses per mains cycle per output phase. If more than one output phase is needed, the single phase output circuit is just duplicated to create the extra phases. If a neutral return is not required in a multiphase output application, the transformer can be removed to simplify the circuit.

The cycloconverter consists of two thyristor bank of positive and negative as shown in figure 2, which is operating without circulating current; the non-conducting thyristor should always be kept off otherwise the input power supply could be shorted via the positive and negative thyristor half bridges.

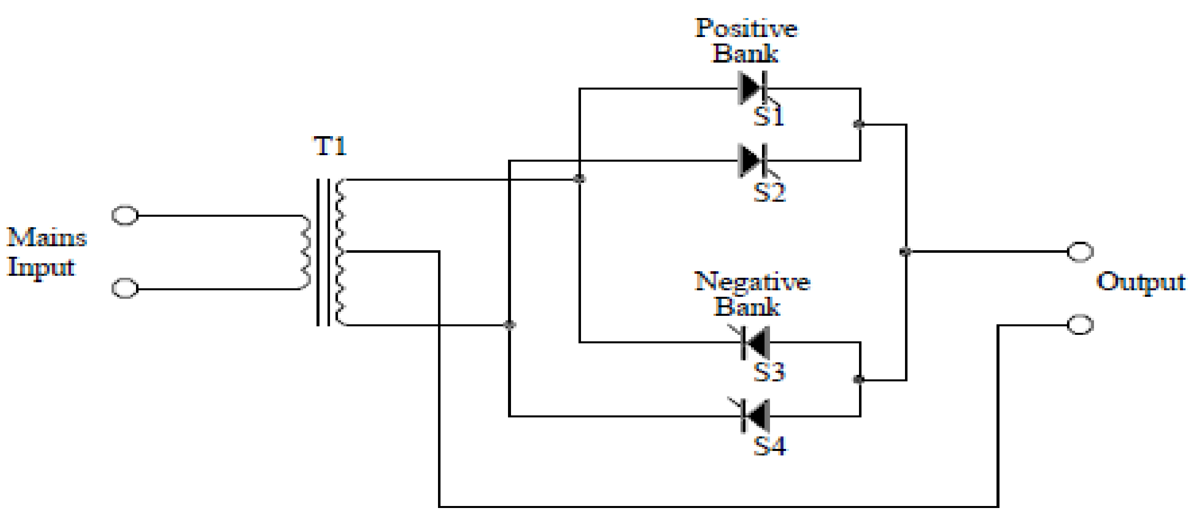

Figure 2 BASIC SINGLE PHASE CYCLOCONVERTER

When the load current is positive, the output voltage is only controlled by phase control of thyristor S1 and S3 whilst the other two negative thyristor S2 and S4 are kept off and vice versa when the load current is negative. When the load current changes its direction at the same time ensuring that two thyristor half bridges are not conducting at the same time.

If the cycloconverter is operating in circulating current mode, both thyristor half bridges are continuously conducting, eliminating the output voltage distortion during load current zero crossing but additional coupled reactors are required between the two thyristor half bridges to limit the circulating current Although the output voltage of the cycloconverter can be improved in circulating current mode, the circulating current reactor tends to be bulky and more expensive and the presence of the circulating current will degrade the input power factor.

III. CYCLOCONVERTER

Which is operating without circulating current; the non-conducting thyristor should always be kept off otherwise the input power supply could be shorted. When the load current is positive, the output voltage is only controlled by phase control of thyristor S1 and S3 at the same time, the other two negative thyristor S2 and S4 are kept off and vice-versa when the load current is negative. When the load current changes its direction at the same time ensuring that the two thyristor half bridges do not conduct at the same time. If the cycloconverter is operating in circulating current mode, both thyristor half bridges are continuously conducting, eliminating the output voltage distortion during load current zero crossing but additional coupled reactors are required between the two thyristor half bridges to limit the circulating current.

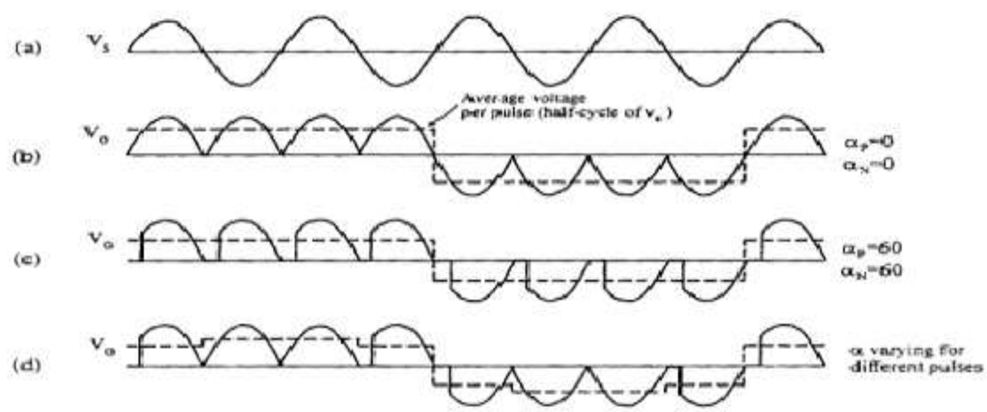

Figure 3 Single Phase Cycloconverter Outputs a) Input voltage b) Output voltage for zero firing angle c) Output voltage for firing angle of 60 degrees d) Output voltage with varying firing angle.

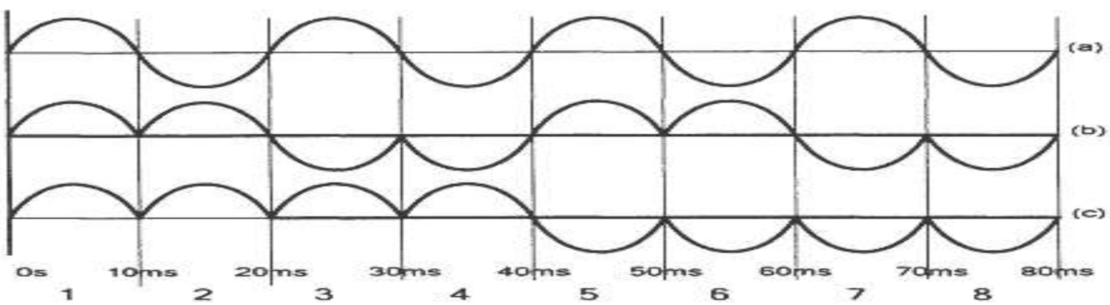

Figure 4 a) Input 50Hz (b) Output 25Hz

Fig.3-a shows the single phase cycloconverter input voltage, firing angle of the thyristor changing over the cycle of the output. This dynamic process produces an output waveform that more closely resembles a sinusoid than the non-dynamic process in Fig.3-b .The single phase cycloconverter sinusoidal waveform (input voltage) is obtaining different improved waveform of the output voltage. From Fig, 3 d show the varying firing angle of the single phase cycloconverter output voltage.

IV. MODELING OF THE SINGLE PHASE INDUCTION MOTOR.

An induction motor or asynchronous motor is a type of alternating current motor where power is supplied to the rotor by means of electromagnetic induction. An electric motor turns because of magnetic force exerted between a stationary electromagnet called the stator and a rotating electromagnet called the rotor. Different types of electric motors are distinguished by how electric current is supplied to the moving rotor.

4.1 Starting of Single Phase Induction Motors.

In a single phase induction motor, it is necessary to provide a starting circuit to start rotation of the rotor. If this is not done, rotation may be commenced by manually giving a slight turn to the rotor. The single phase induction motor may rotate in either direction and it is only the starting circuit which determines rotational direction.

For small motors of a few watts, the start rotation is done by means of one or two single turn of heavy copper wire around one corner of the pole. The current induced in the single turn is out of phase with the supply current and so causes an out-of-phase component in the magnetic field, which imparts to the field sufficient rotational character to start the motor. These poles are known as shaded poles. Starting torque is very low and efficiency is also reduced. Such shaded-pole motors are typically used in low-power applications with low or zero starting torque requirements, such as desk fans and record players. The Single phase induction motor has two windings as shown in figure 5.

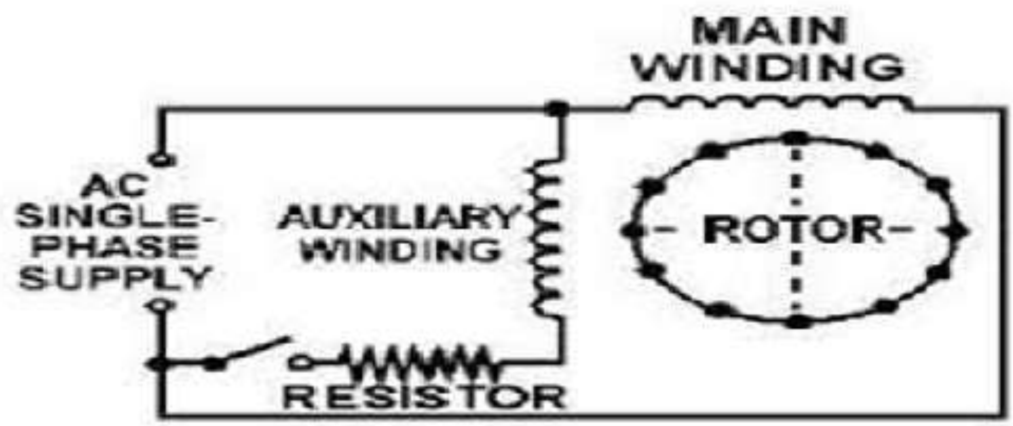

Figure 5 Starting circuit of 1-Ø induction motor

Larger motors are provided with a second stator winding which is fed with an out-of-phase current to create a rotating magnetic field. The out-of-phase current may be derived by feeding the winding through a capacitor or it may derive from the winding having different values of inductance and resistance from the main winding.

In some designs, the second winding is disconnected once the motor is up to speed, usually either by means of a switch operated by centrifugal force acting on weights on the motor shaft or by a positive temperature co-efficient thermistor which, after a few seconds of operation, heats up and increases its resistance to a high value thereby reducing the current through the second winding to an insignificant level. Other designs keep the second winding continuously energized when running, which improves torque.

V. SIMULATION RESULT

Simulation of induction motor speed control is achieved by simply connecting single phase motor to the single phase supply and output can be seen in scope as shown in figure 6.

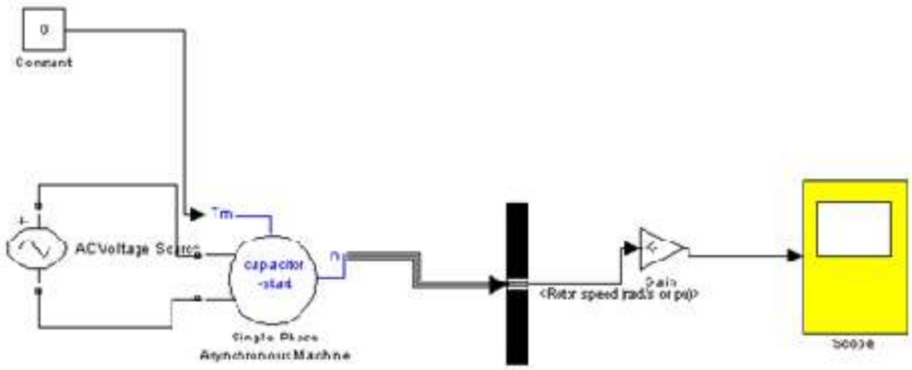

Figure 6 SIMULINK model of a Single phase Induction motor model

The simulation starts with the generation of 50 Hz reference sine wave. It should be noted that all the simulations were made for Zero Load Torque, and firing angle □=60°.

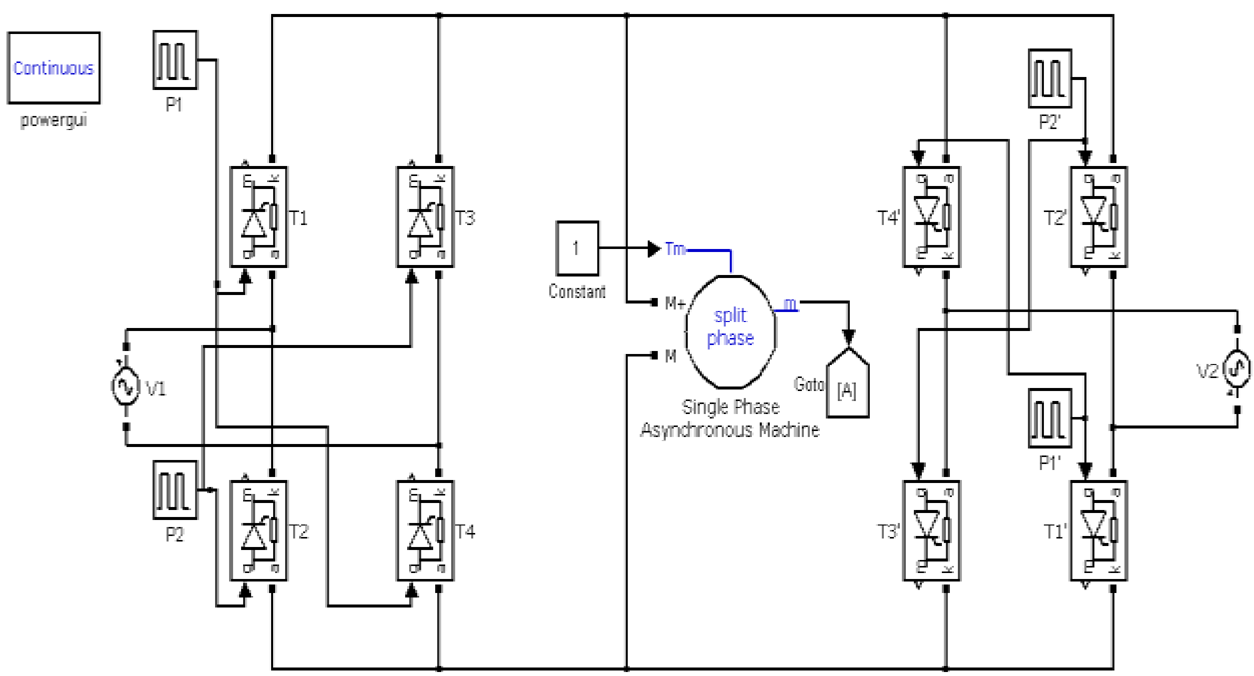

Figure 7 single phase cycloconverter model with single phase induction motor

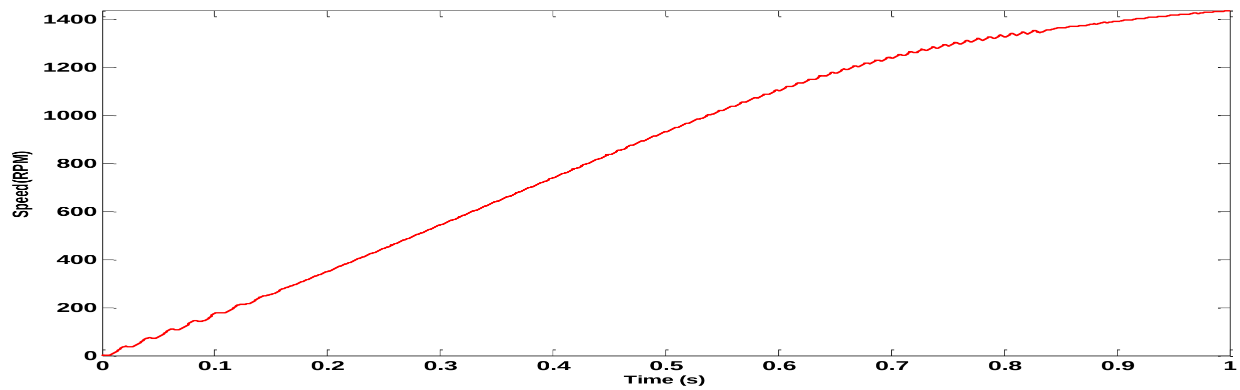

Figure 8 Speed Vs Time output of single phase induction motor at f=50 Hz

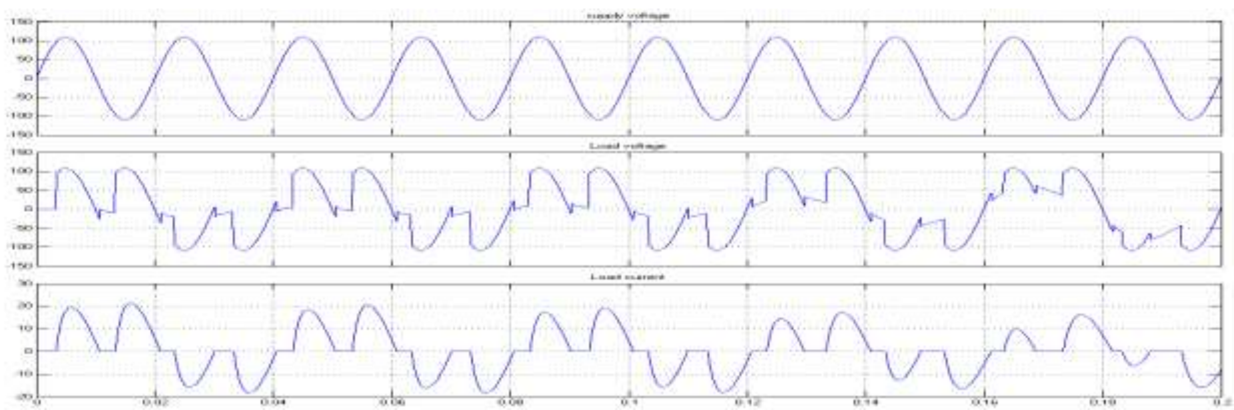

Figure 9 Waveform for the input frequency 2 times the output frequency

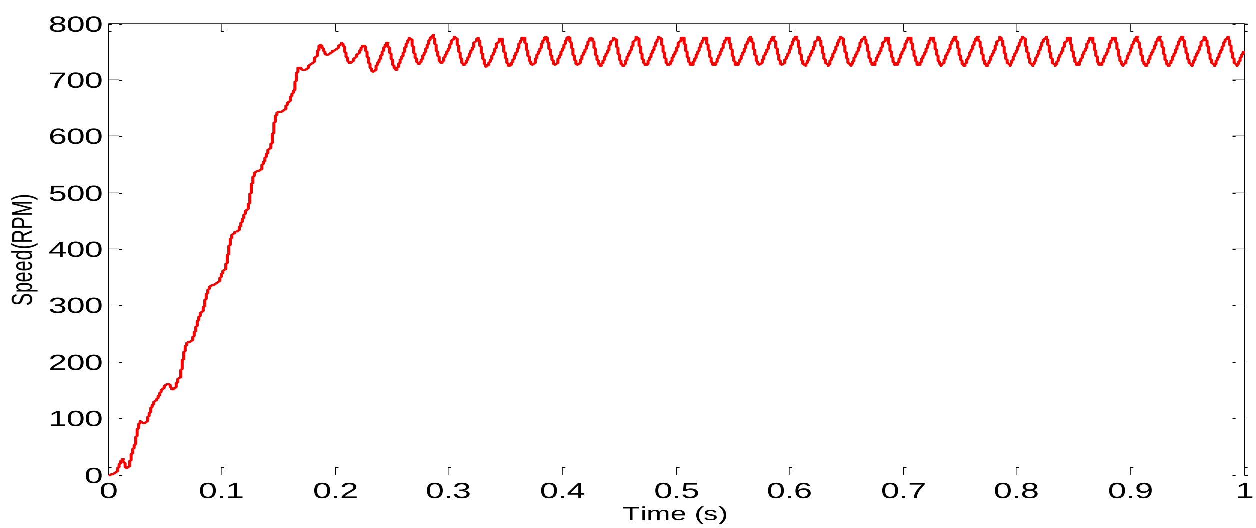

Figure 10 Speed Vs time output of single phase induction motor at f=25 Hz

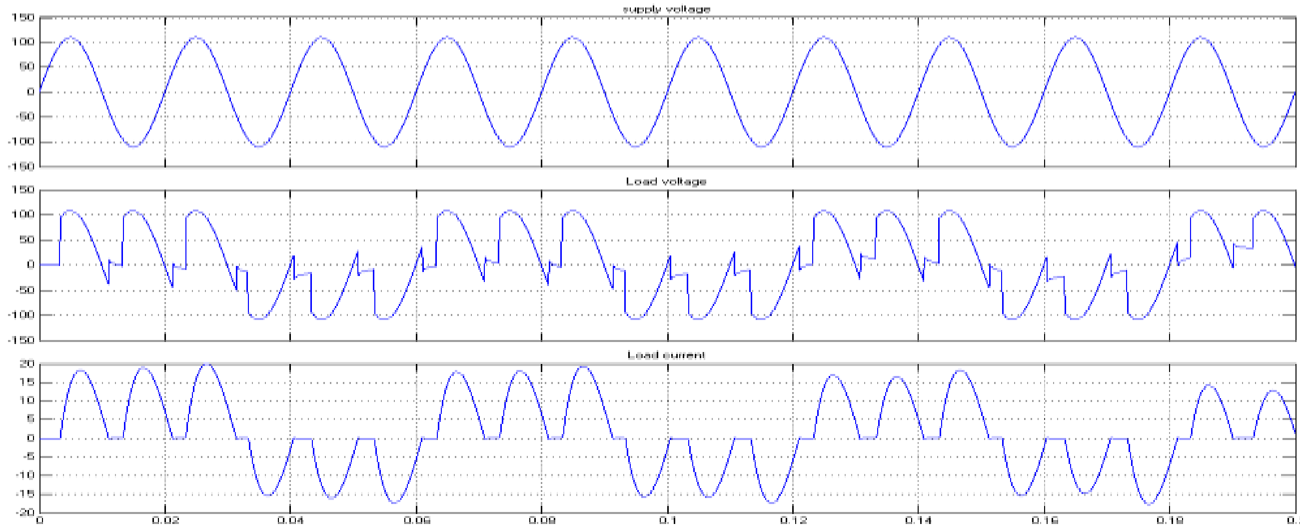

Figure 11 Waveform shows the input frequency is 3 times the output frequency

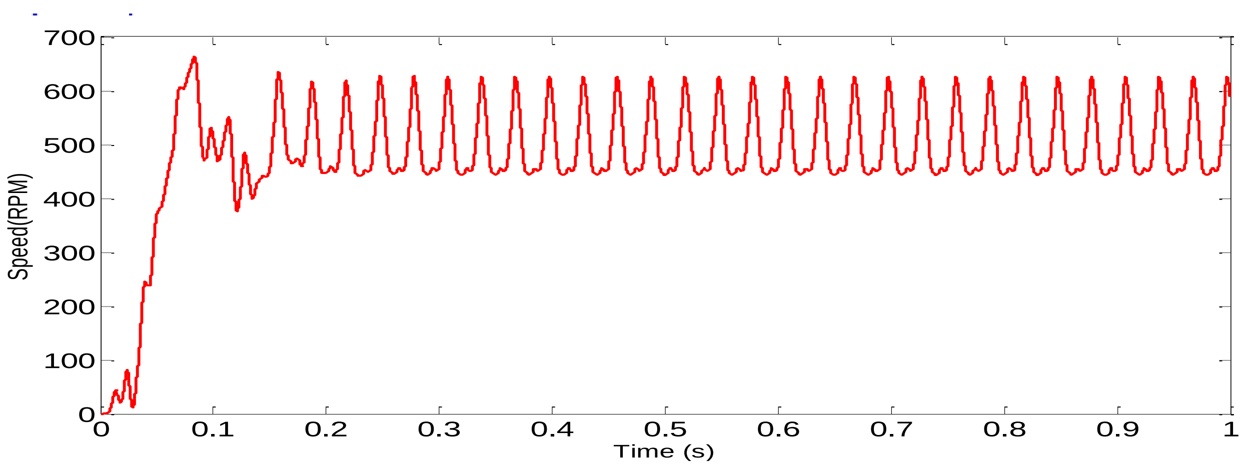

Figure 12 Speed Vs time output of single phase induction motor at f=16.66 Hz

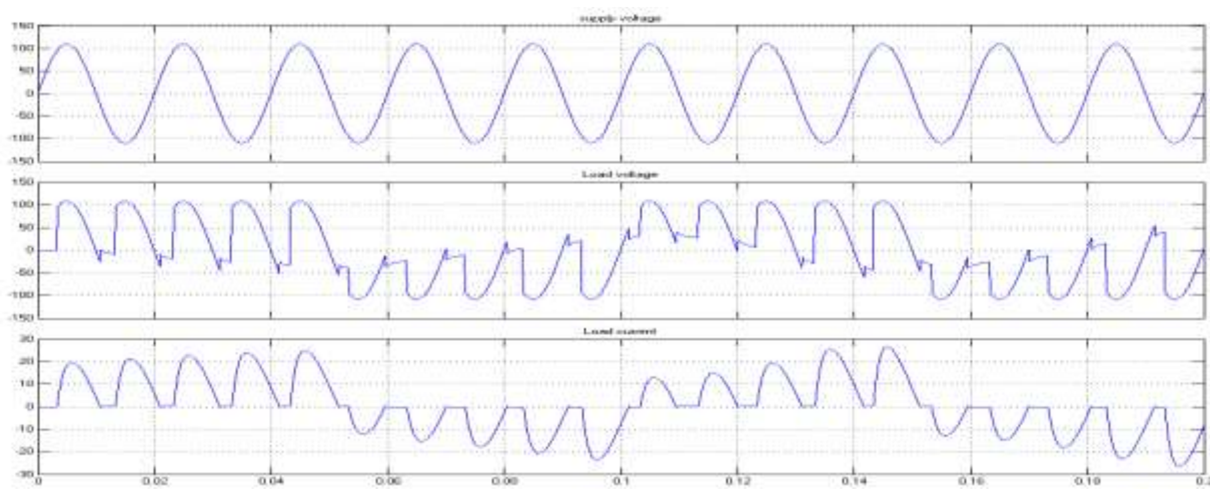

Figure 13 Waveform shows the input frequency is 5 times the output frequency

VI. Conclusion

The cycloconverter circuit is simulated and finally desired results are obtained for different frequency. So by changing the supply frequency speed variation of induction motor can be obtained. The hardware Implementation of power supply and microcontroller circuit is completed. Gate pulse for bridge 1of positive cycle and bridge 2 of negative cycle can be obtained from microcontroller by programming for 50 Hz, 25Hz and 16.66Hz frequency. The prototype model is connected with single phase induction motor load. Speed varies with change in frequency. Thus required results are obtained with this prototype model and speed of induction motor is controlled.

This is a prototype model design actual working model according to requirement of application can be design in future. Also this is single phase cycloconverter one can develop three phase cycloconverter circuit accordingly. Also, the harmonic analysis of system having cycloconverter can be done.

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