PERFORMANCE AND SPEED CONTROL OF CYCLOCONVERTER FED SPLIT PHASE INDUCTION MOTOR

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Abstract - This paper gives comprehensive review of the cycloconverter fed induction motor drive. The cycloconverter converts ac supply of one frequency into ac supply of different frequency without any dc stage in between. Cycloconverter functions by means of phase commutation, without auxiliary forced commutation circuits. The power circuit is more compact, eliminating circuit losses associated with forced commutation. The speed control is achieved by means of step-down cycloconverter because this advantage. The simulation based on MATLAB/ Simulink is shown with performance results for single phase step-down cycloconverter fed induction motor. As the AC supply frequency cannot be changed, this project uses a TRIAC controlled cycloconverter which enables the control of speed in steps for an induction motor. The microcontroller used in this project is AT89S52, switches are provided to select the desired speed range (F, F/2 and F/3) of operation of the induction motor.

Key Words: Speed control, induction motor,TRIAC cycloconverter, simulink, MATLAB.

I.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 [1]. Control of ac motors become very popular because it is possible to obtain the characteristics of dc motors by improving control techniques. Initially, the basic principle of operation used in a cycloconverter is discussed. Then the circuit of a single phase to single cycloconverter of a single-phase to using TRIAC is presented [2]. This is followed by describing the operation of the cycloconverter circuit, along with waveform.

II. OPERATING PRINCIPLE OF SINGLE PHASE CYCLO-CONVERTER

The basic principle of operation of a cycloconverter is explained with reference to an equivalent circuit shown in Fig.1 [3].Each two-quadrant converter is represented as an alternating voltage source, which corresponds to the fundamental voltage component obtained at its output terminals.

The diodes connected in series with each voltage source, show the unidirectional conduction of each converter, whose output voltage can be either positive or negative, being a two-quadrant one, but the direction of current is in the direction as shown in the circuit, as only thyristors unidirectional switching devices, are used in the two converters. Normally, the ripple content in the output voltage is neglected.

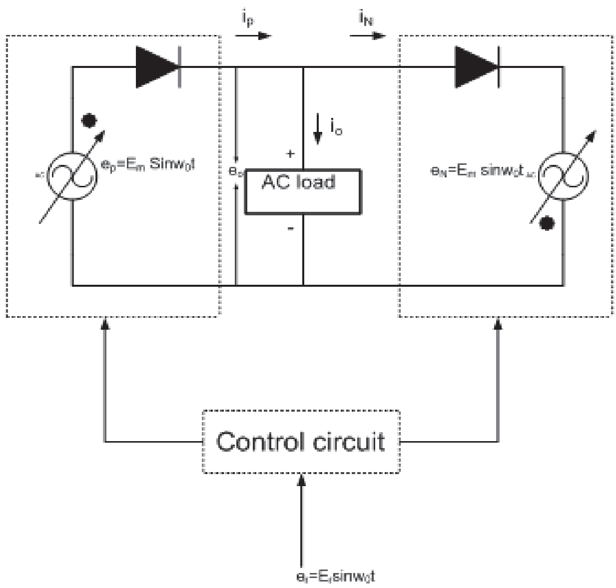

Fig 2.1: Equivalent circuit of cycloconverter

The control principle used in an ideal cycloconverter is to continuously modulate the firing angles of the individual converters, so that each produces the same sinusoidal (ac) voltage at its output terminals. Thus, the voltages of the two generators have the same amplitude, frequency and phase, and the voltage of the cycloconverter is equal to the voltage of either of these generators [4]

The circuit of a single-phase to single-phase cyclo-converter is shown in Fig.2. Two full-wave fully controlled bridge converter circuits, using four thyristors for each bridge, are connected in opposite direction (back to back), with both bridges being fed from ac supply.

Bridge 1 (P – positive) supplies load current in the positive half of the output cycle, while bridge 2 (N – negative) supplies load current in the negative half. The two bridges should not conduct together as this will produce short-circuit at the input. In this case, two thyristors come in series with each voltage source. When the load current is positive, the firing pulses to the thyristors of bridge 2 are inhibited, while the thyristors of bridge 1 are triggered by giving pulses at their gates at that time. Similarly, when the load current is negative, the thyristors of bridge 2 are triggered by giving pulses at their gates, while the firing pulses to the thyristor of bridge 1 are inhibited at that time.

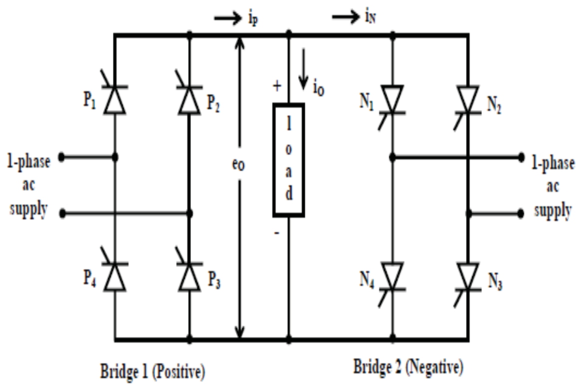

Fig -2.2: Single phase to single phase cycloconverter

This is circulating current free mode of operation. Thus, the firing angle control scheme must be such that only one converter conduct at a time, and the changeover of firing pulses from one converter to the other, should be periodic according to the output frequency [5].

When a cycloconverter operates in the non- circulating current mode, the control scheme is complicated, if the load current is discontinuous. The control is somewhat simplified, if some amount of circulating current is allowed to flow between them. In this case, a circulating current limiting reactor is connected between the positive and negative converters, as is the case with dual converter, i.e. two fully controlled bridge converters connected back to back, in circulating-current mode[6]. This circulating current by itself keeps both converters in virtually continuous conduction over the whole control range. This type of operation is termed as the circulating-current mode of operation.

III. HARDWARE IMPLEMENTATION

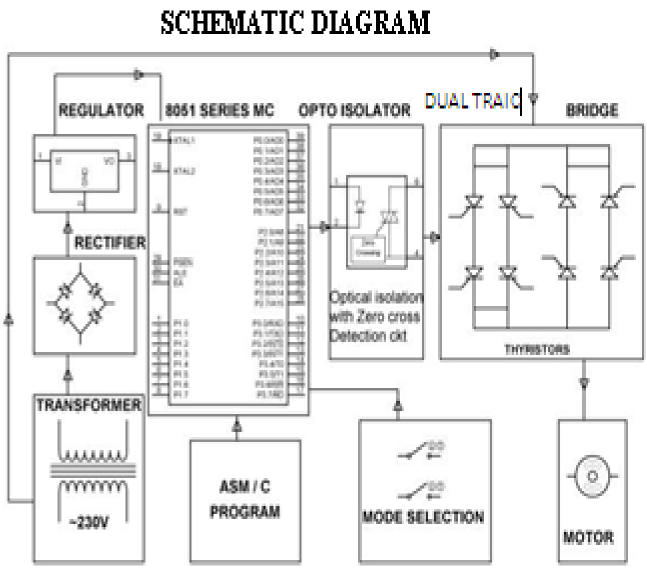

Fig -3.1: Block diagram of cycloconverter using TRIACS

3.1 Description and Working:

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 8051.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 DIACs. The output of the cychloconverter is fed to the induction motor to control the speed at different frequencies.

When the switch 1 is closed SCR gets conducting for 20ms for 1st bridge and next 20ms for 2nd bridge so the total time period of AC cycle is 40ms 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/3 supply we can control the speed of the AC motor

3.2 HARDWARE CIRCUIT

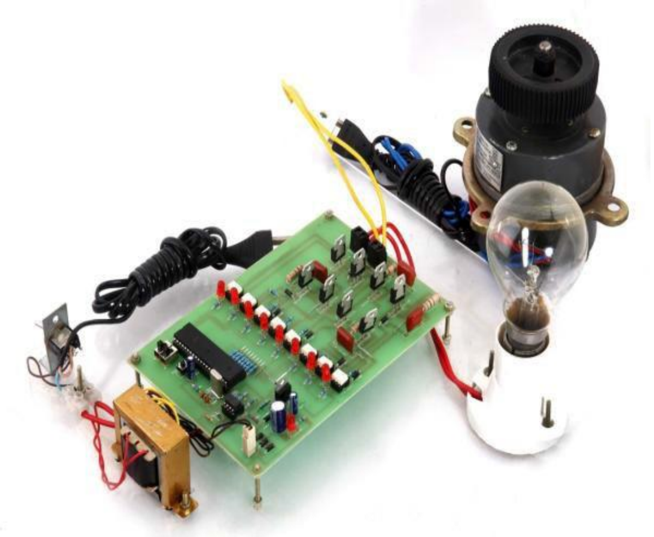

Fig -3.2: Picture of the cycloconverter using traics

IV. SIMULATION OF CYCLOCONVERTER

The objective of this work is to analyses the speed of single phase induction motor performance for various output frequency of the 1-phase cycloconverter [7].

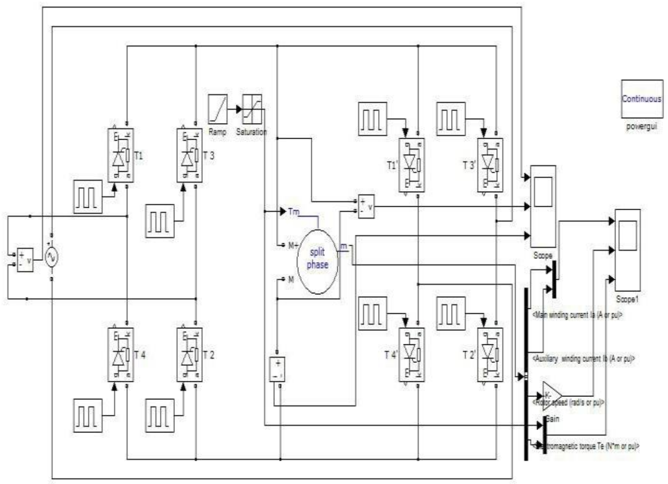

Fig -4.1: Simulation model of single phase to single phase cycloconverte

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 After applying the control strategy

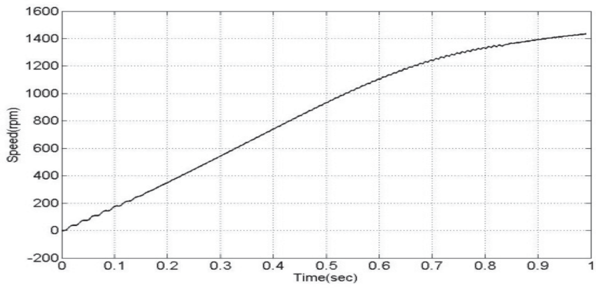

Fig-4.2: Speed Vs time output of single phase induction motor at f=50 HZ

In order to get a better understanding of the control system and to verify the control techniques, Fig 3.4, Fig 4.4 shows output waveform of cycloconverter for input

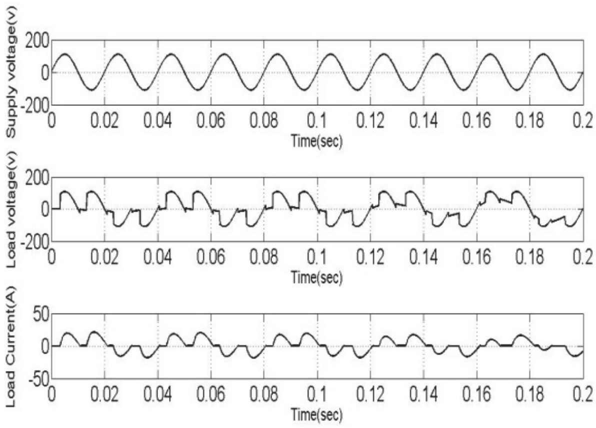

Fig-4.3: Waveform shows the input frequency is 2 times the output frequency

The input and output waveforms are shown in above figure. It is clearly indicates that the input frequency 50 Hz is reduced to 25 Hz (1/2) at the output.

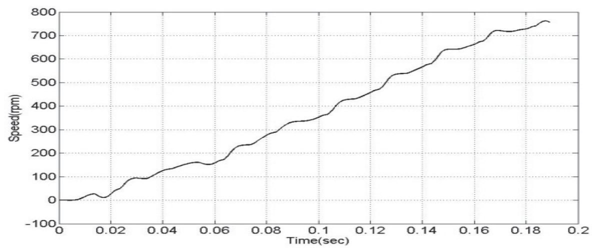

Fig-4.4 : Speed Vs time output of single phase induction motor at f=25 Hz (fi/2)

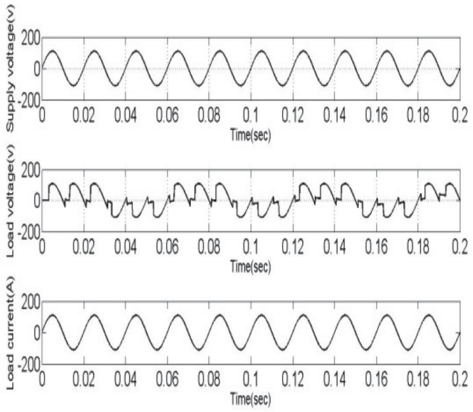

Fig- 4.5: Waveform shows the input frequency is 3 times the output frequency

The input and output waveforms are shown in above figure. It is clearly indicates that the input frequency 50 Hz is reduced to 16.66 Hz (1/3) at the output.

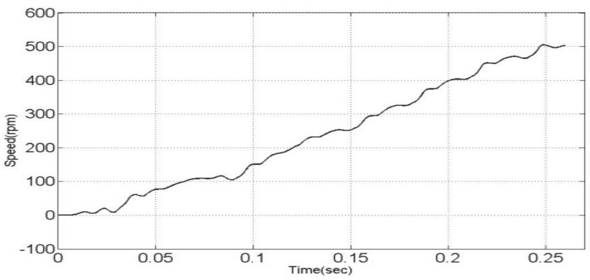

Fig-4.5: Speed V/S time output of single phase induction motor at f=16.66 Hz (fi/3)

4.1 SIMULATION RESULTS

The result obtained using MATLAB for single phase cycloconverter coupled induction motor as follows

TABLE :1 SIMULATION DATA

Supply frequency (Hz)	**Output Frequency (Hz)**	**Speed of induction motor (rpm)**
50	50	1434
50	25	762
50	16.66	500

V.CONCLUSION

The cycloconverter circuit is simulated and desired results obtained. The single phase cycloconverter used for control of speed of single phase induction motor by supplying desired variable frequency. This single phase cycloconverter circuit can be extended further for three phase application.

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