Speed Control of Single Phase Induction Motor Using TRIAC and RPM Measurement by Contactless Tachometer

1.Shubham Bhardwaj
Student MIT, Moradabad
Shubhambhardwaj15@gmail.com

2.Yuvraj Varshney
Student MIT, Moradabad
Yuvraj.mit@gmail.com

3.**Kasav Sharma,** Student
MIT, Moradabad

4.Utkarsh Bhardwaj
Student MIT, Moradabad

ABSTRACT

The main aim of this project is to control the speed of an induction motor by applying varying voltages to the motor by using TRIAC. The project uses zero crossing point of the waveform which is detected by a comparator whose output is then fed to the microcontroller. The microcontroller provides required delayed triggering control to TRIAC through opto isolator interface. Finally the power is applied to the load through a TRIAC. This project uses a microcontroller from 2051 family which is interfaced through two push-button switches for increasing or decreasing the AC power to the load. The varying power shall result in variation in the speed of the motor while the lamp is replaced by the single phase induction motor.IR sensor used for transmitting the signal to white portion on the rotor and photo diode receive the signal then it send to the 8051 microcontroller then LCD display used to display the speed level of Ac load.

1. INTRODUCTION

Definitions of motion control vary widely in industry today. Depending on the application, motion control can refer to simple on/off control or a sequencing of events, controlling the speed of a motor, moving objects from one point to another or precisely constraining the speed, acceleration, and position of a system throughout a move.

Varying interpretations used in the field may confuse engineers working for the first time in some aspect of motion control. Motion control means different things to different sections of industry. As an introduction, this chapter differentiates among motion control techniques. It puts each technique into perspective in terms of where typical applications arise.

In contrast to mechanical speed control technology, which usually employs gearing or belts to change speed, electronic speed control manipulates applied electrical power to control velocity and torque. Electronic speed control in ac motors employ special amplifiers or drives. These generally vary ac motor

speed. Though such electronic controls are more expensive than mechanical speed controls, they provide the advantage of reduced energy costs. Applications for such equipment include fans, blowers, pumps and compressor.

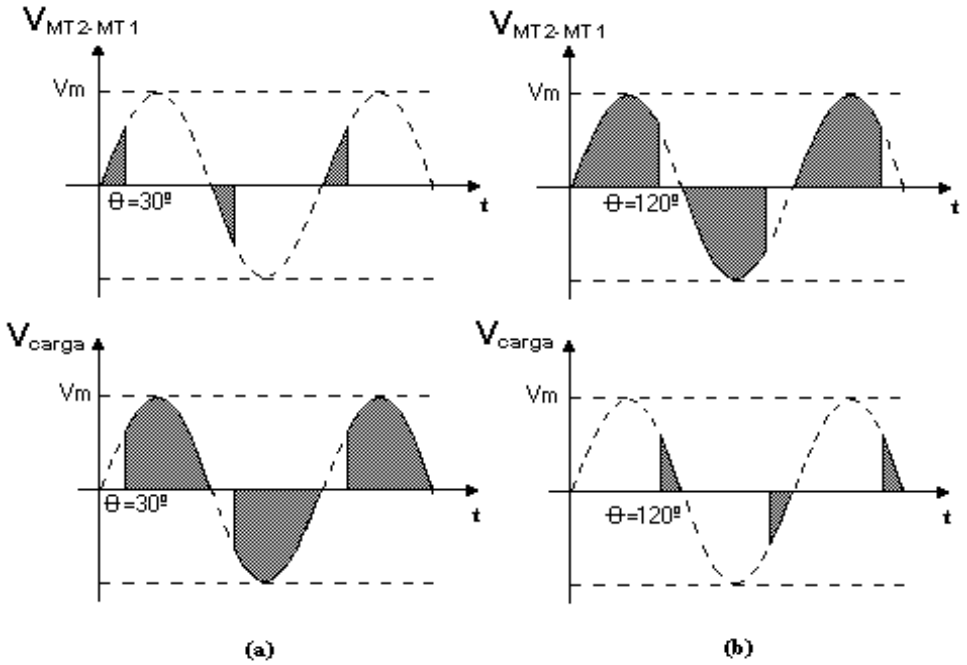

Fig1. Zero crossing of Sinwave

2. HARDWARE DESCRIPTION

i. Zero-Crossing detector

There is a need of a zero-crossing detector that will give us the reference for providing delay for desired firing angle. In above figure 1, for firing angle to be 90' for 220V 50Hz AC signal, we need to have a delay of 2.5 ms (t1=2.5ms) right after each zero crossing. Usually MOC3021 is driven through microcontroller, which gives the firing pulse on the basis of interrupt generated by the zero-crossing detector.

ii. Opto-Coupler for TRIAC driver

MOC3021 is an opto Triac (product of Motorola) that is used for isolation between power and driving circuitry. Note that when C828 on the base is applied voltage>0.7V, Triac gets triggered. As the triac gets triggered now, the positive or negative voltage (whatever maybe) get pass through the gate of BT136 (thyristors) and hence triggered it. It should be noted here that by using above arrangement we can control the RMS voltage in both directions. What needs to be taken care of, is the triggering time or firing angle.

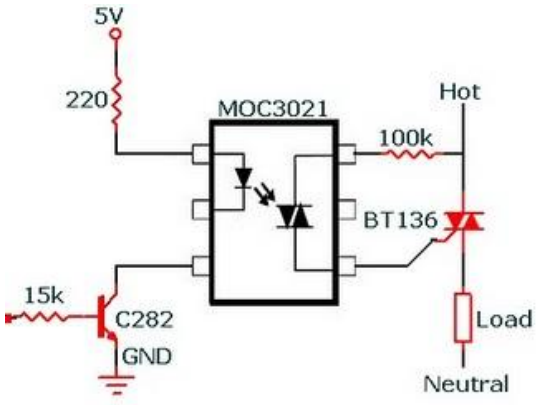

Fig 2 : An opto-coupler

iii. Voltage Regulator

The LM78XX/LM78XXA series of three-terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a Wide range of applications. Each type employs internal current limiting, thermal shutdown and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output Current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

iv. 8051 Micro Controller

The 8051 developed and launched in the early 80`s, is one of the most popular micro controller in use today. It has a reasonably large amount of built in ROM and RAM. In addition it has the ability to access external memory.

The generic term `8x51` is used to define the device. The value of x defining the kind of ROM, i.e. x=0, indicates none, x=3, indicates mask ROM, x=7,indicates EPROM and x=9 indicates EEPROM or Flash.

v. TRIAC

Triac is a power electronic component that conducts in both directions when triggered through gate. .As it can be seen that at time t1, angle of sinusoid is 45' which means that if we triggered Triac at this angle i-e at 45', only shaded blue area will pass through the Triac and hence through the load. Observe that shaded blue are has RMS Voltage less than the pure sinusoid. This is the basic principle by which RMS Voltage control is accomplished. Firing needs a small pulse at gate that can be give through microcontroller also. Similarly at firing angle 90' (*firing angle is an angle with reference zero crossing at which the Triac is triggered using gate pulse*) , only red part of sinusoid will pass through the Triac giving us the RMS 110V for 220V.

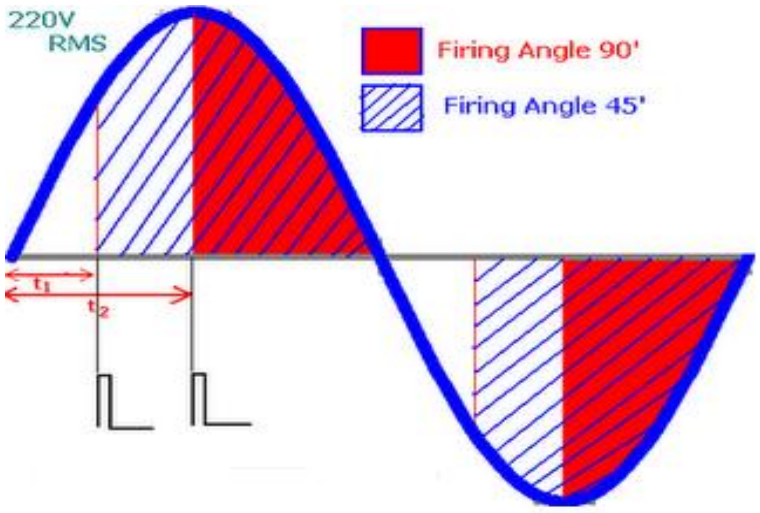

Fig.3 Representation of firing Angle of TRIAC

3. Circuit Diagram:

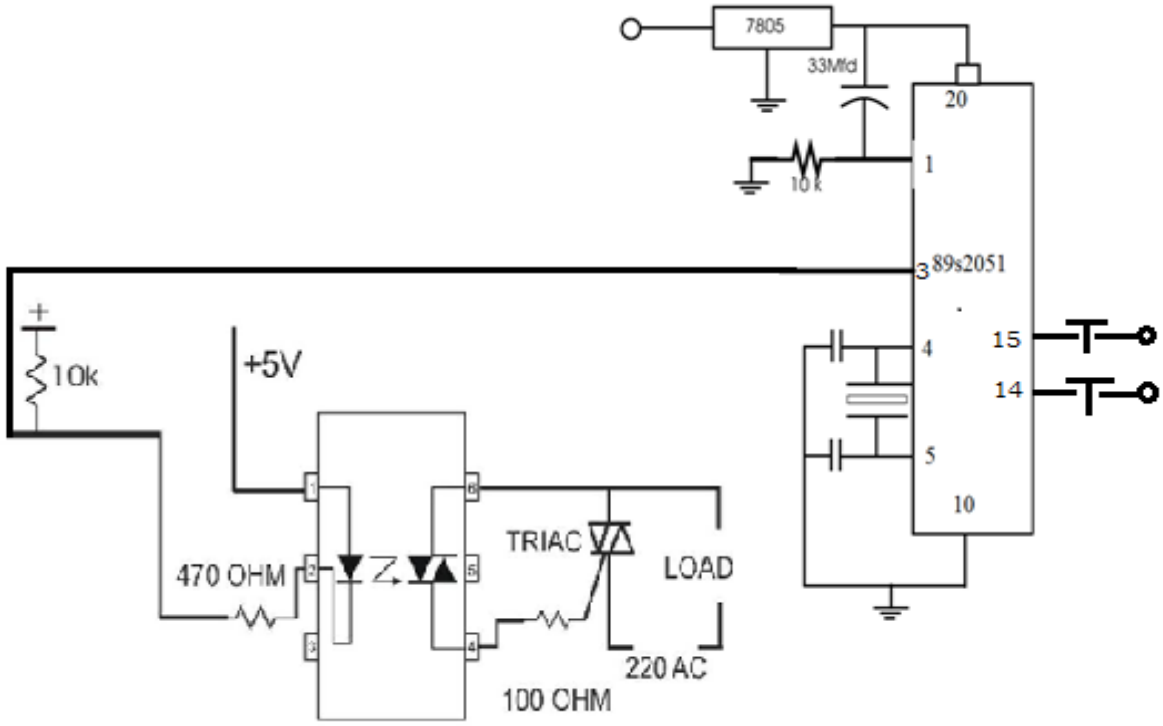

Fig. 4 Circuit of Speed controlling

We use two microcontrollers 8051 and 2051.In case of speed measurement circuit we use 8051 microcontroller and for speed controlling we use 2051.In 8051Pin no 40 is connected to the positive supply. Crystal is connected to the pin no 18 and 19. Complete circuit is work on 5 volt regulated power supply. For this purpose we use one step down transformer, two diode and on capacitor circuit. After capacitor we use one 5 volt regulator circuit. Output of the regulator is connected to the 8051 regulator circuit.

In 2051 microcontroller one ac signal is also provided to the pin no p3.3 to give zero crossing action. For this purpose we use one full wave rectifier and this pulsating dc is provided to the optocoupler. Optocupler convert this signal into opposite direction and the same time give a optical isolation to this pin. Optocoupler is a combination of one infra red transmitter and one phototransistor. Output of the phototransistor is connected to the external interrupt no 1. There is a two external interrupt in this microcontroller. In this microcontroller one is connected to the infra red eye and second is connected to the zero crossing ac voltage.

Output pins of the microcontroller is connected to the port p1. Note that output of the microcontroller is active low, so to drive the transistor and relay coil we use one inverter ic. There is a four output for the four on/off signal.

Firstly we on the switch when the microcontroller send the fan on signal then p1.6 p1.7 pins and low and output led is also on. Note that led is connected in reverse bias on this pin. This opto triac is a very special triac. By this triac we control the firing angle of the triac. Pin no 4 and 6 are connected to the triac through load.

We control the brightness of the triac through the pulse train of the pulse width modulation. As we as we press the up or down key. New pulse width is available on the output. By this output we compare

with the zero crossing action and by the result we control the brightness of the lamp or speed of the fan. Pulse width modulation is the most important part of this project to control the speed of the fan or control the brightness of the lamp.

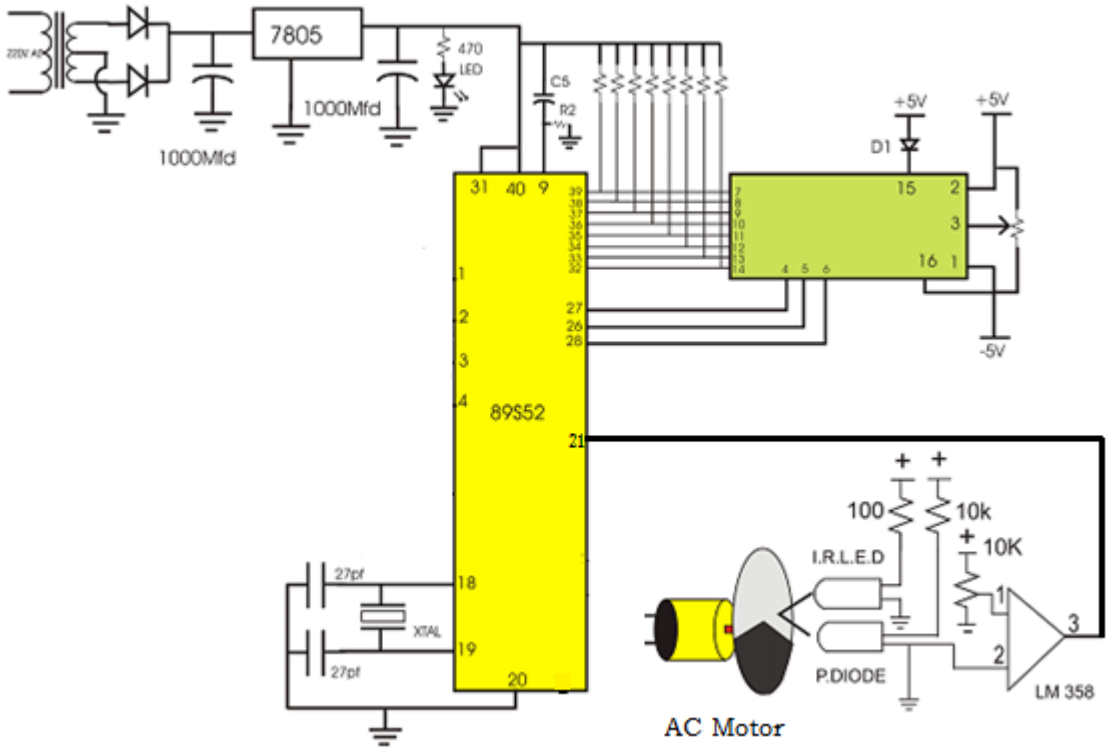

Fig. 5 Circuit of Speed measurement

4. OPERATION

The project uses zero crossing point of the waveform which is detected by a comparator whose output is then fed to the microcontroller. The microcontroller provides required delayed triggering control to theTriac through opto isolator interface. Finally the power is applied to the load through Triac in series. This project uses two microcontrollers from 8051 family which is interfaced through a push-button switch for increasing or decreasing the AC power to the load. The varying power shall result in variation in the speed of the motor while the lamp is replaced by the single phase induction motor of 1Hp.

In case of tachometer we are using a photo diode and IR sensor mounted on a single PCB. From IR sensor infra-red rays are emitted all times and photo diode can detect the rays. We have marked the white portion on the rotor of the motor and when IR sensor is come front of rotor the rays are reflected by white portion and absorbed by the photo diode. Thus a signal is given to the LM 358 amplifier. LED glows at every cycle when sensor detect the white portion then RPM are measured and displayed on the LCD.

5. CONCLUSION

Adjustable Speed Drives are used in any application in which there is mechanical equipment powered by motors. The drives provide extremely precise electrical motor control, so that motor speeds can be ramped up and down, and maintained, at speeds required and at the same time speed can also be measured by the tachometer. Thus in this project we show that how we provide a complete automation with the help of switches on the induction motor.

REFERENCES

- Ashfaq Husain, 'Electric Machines' ,DhanpatRai& Co.
- Dr. P. S. Bimbhra, 'Power Electronics', Khanna publication
- John Crisp, 'Introduction of Microprocessor and Microcontroller', Newnos publication
- S. Bhattacharya and S. Chatterjee, 'Industrial electronics and Control', McGrraw Hill Education(India) Pvt. Ltd.
- B. k. Bose,2002, Modern Power electronics and AC Drives. Prentice Hall of India, New Delhi