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Fault Detection and Correction of 3-phase Induction Motor

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Abstract: **The main aim of this project is to detect faults of three phase IM and control the faults. This project deals with speed control of Induction Motor. The three phase induction motor may experience many incipient faults due to various reasons. So the protection of these motors from such faults is very important. The various faults are over-voltage/current, under-voltage/current, overload, single phasing, speed variation, over-temperature etc. The most important parameters are voltage, current, speed and temperature. The voltage, current and speed can be controlled using three phase PWM inverter. The frequency and duty cycle of the PWM is controllable and by controlling them we can control the output voltage, frequency and current of inverter. If the voltage of the motor is less than the rated voltage then the duty cycle of PWM is increased, if the voltage is more than rated then the duty cycle is reduced. The frequency of PWM is kept constant since the speed of motor depends on the supply voltage frequency. Here we keep the v/f ratio constant for speed control. The heart of this project is microcontroller PIC18f4431.**

***Keywords*: Microcontroller PIC18F4431, Pulse Width Modulation (PWM), IM (Induction Motor)**

I. INTRODUCTION

A large number of motors are being used for general purposes in our surrounding from house- hold equipment to machine tools in industrial facilities. The electric motor is now a necessary and indispensable source of power in many industries. The function and performance required for these motor are wide-ranging. IM are the most widely used motor for appliances, induction control, and automation; hence they are roust, reliable and durable. When power is supplied to an IM at the recommended specifications, it runs at rated speed. However, many applications need variable speed operations.

Various type of AC induction motors are available in the market. Different motors are suitable for different application. Although AC induction motors are easier to design than DC motors, the speed and the torque control in various type of AC induction motors require a greater understanding of the design and the character of these motor. Although IMs are reliable, they are subjected to some undesirable stresses, causing faults resulting in failure. The electrically related faults such as over-voltage, over-current, under-voltage, under-current, overload, and over-temperature. The sources of over-voltage and over-current can be manmade or natural. Possible causes for over-current include short circuits, excessive load, and incorrect design. Monitoring of an IM is a fast emerging technology for the detection of initial faults. It avoids unexpected failure of an industrial process. In spite of their robustness they do occasionally fail and their resulting unplanned downtime can prove very costly. Therefore, condition monitoring of electrical machines has received considerable attention in recent years. The control of the parameters such as voltage, current, speed, load and temperature is also become very important for the health of the induction motor. Due to the faults in such parameters there can be damage to the motor.

Classical monitoring techniques for three-phase Induction motors are generally provided by some combination of mechanical and electrical devices such as timers, contactors, voltage relays, current relays and earth fault relay etc. these techniques are very basic and involve some mechanical dynamic parts of the equipment can cause problem in the course of operation and can reduce the life and

efficiency of system. A computer based protection system also has been introduced, measurements of the various faults of phase voltages, phase current, temperature and speed were achieved and transferred to computer for final protection decision but this system requires separate analog to digital conversion cards which increases cost and size of the system[2]. A PlC based system which deals with monitoring control system of Induction motor is introduced, in these system the parameters are sensed with the help of analog modules, processed and displayed on PC. The ladder programming and SCADA software is used to monitor the parameters on the PC, In case faults are detected the alarms are blown and the motor is stopped. But it requires separate PLC module, analog modules and software which are costly[3]. And these systems do not find the tolerable limit values of motor parameters. Microprocessor based protection systems are developed but they do not provide control action, they only display information on screen and blow alarm[4].

II. THE SYSTEM STRUCTURE

A. Overall System Architecture

The design aims are detecting the faults then monitoring and controlling the motor from these faults. First find out tolerable limit values of voltage, current, speed, temperature. Then these parameters are measured and are compared to these tolerable limit value. The three phase inverter is used to convert DC voltage obtained from rectifier into AC .The gating signals for MOSFET are generated using microcontroller PIC18f4431. When parameters are out of range by using microcontroller programming and PWM inverter we protect the motor from faults. Here we use CT for current measurement. LM35 for temperature measurement and IR sensor for speed measurement.

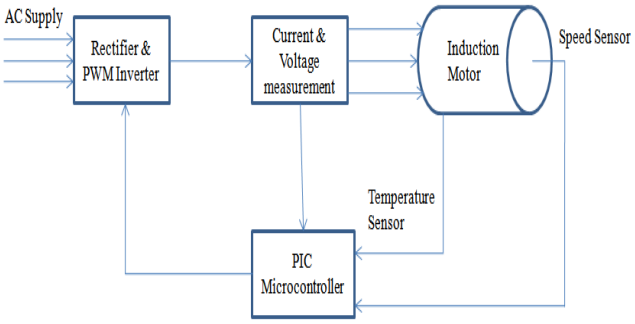

Figure 1. System architecture

Fig.1 shows system architecture of whole project. The whole system can be divided into three parts. The first part concerned with rectifier and inverter .The rectifier can be three phase. The inverter is its driver. The second part is concerned with the parameters measurement of the motor like voltage, current, temperature and speed. The third part concerned with the heart of the system i.e. PIC microcontroller. The analog parameter are converted into digital using PIC microcontroller which consist of inbuilt 10 bit ADC. The PIC 18f4431 has 8 power control modules to generate the 8 PWM simultaneously.

III. THE HARDWARE DESIGN

A. Three Phase Motor Driver Circuit

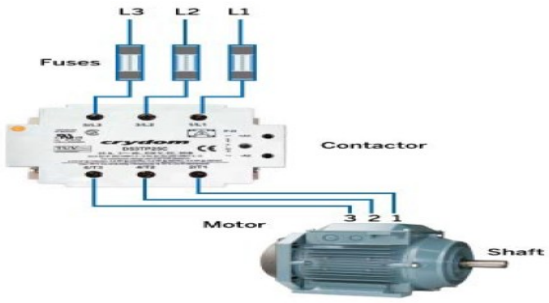

Figure 2. Solid State Relay

In Fig.2. SSR is used as three phase motor driver circuit. In that AC to AC conversion is present so separate rectifier and separate invertor is not used. Coming series AC supply control the firing angel, internal thyristor circuit and width of PWM. So we can control voltage, current, speed, and load ripple.

B. Pulse Width Modulation Inverter

To achieve voltage control within the inverter and to reduce the harmonic contents in the output voltage, PWM inverters are used. In PWM inverters, Width of the output are modulated to achieve the voltage control.

Here we can generate PWM by using proteus and controlling action done by controller PC18f4431. CRO is connected pin 17 of controller. And for controlling we use microc programming.

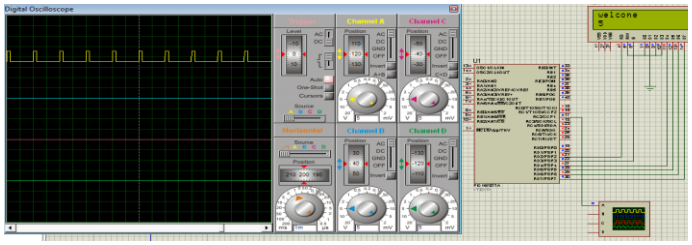

Figure 3. Three Phase Inverter

C. Temperature Sensor LM35

Fig.4 shows Temperature sensor LM35. LM35 is a precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 does not require any external calibration to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Lm35 has + 10.0 mV/°C scale factor and 0.5°C accuracy. It is suitable for remote application. It operates from 4 to 30 volts. Less than 60 µA current drain. Lm35 sensor sense temperature and send it to display on Web page of Internet through LPC2148.

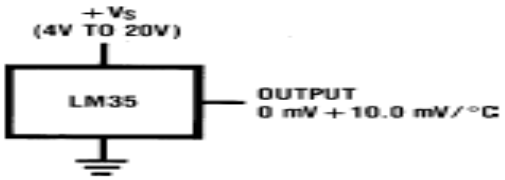

Figure 4. Temperature sensor LM3

D. Voltage Protection System

In voltage measurement we get two faults first is over-voltage and second is under voltage. Over voltage is voltage grater than limit voltage and under voltage is voltage lees than limit voltage. When supply voltage is grater than 250 volt we get over-voltage fault then with help of controller we stop the motor and we control the over-voltage. Also if we get supply voltage is less than 150 volt, we get under voltage fault then we stop the motor and control the under-voltage, by using PIC microcontroller programming we increases and decreases duty cycle of PWM inverter when voltage is varying between 250volt to 150volt. Here we can increase or decrease the voltage of induction motor by using dimer. How much voltage is given to motor is given is displays on LCD.

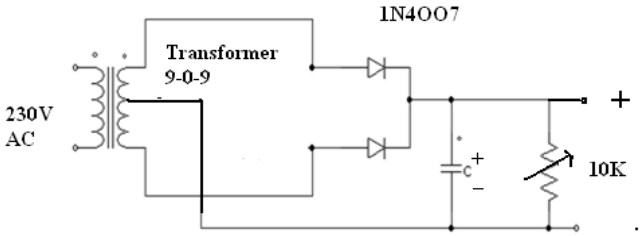

Figure 5. Voltage Protection Circuit

E. Current Protection Circuit

A current transformer (CT) is used for measurement of electric current when current is too high to directly apply to measuring instrument, to the current in

circuit, which can be conveniently connected to measuring and recording instruments. A Current Transformer also isolates them easuring instruments from what may be very high voltage in the monitored circuit. CT is commonly used in metering and protective relays in the electrical power industry. The phase current is measured for detecting the fault of over-current. We design measurement circuit with current transformer. It step down the current to low level. The current is then converted into voltage using current to voltage transformer and rectified to get the output voltage.

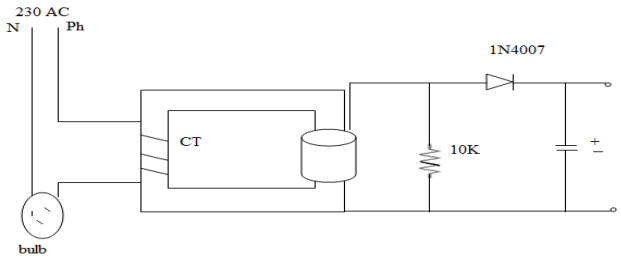

Figure 6. Current Protection Circuit

F. Speed Sensor

In our project we put that sensor in front of motor fan, which count motor revolution. Actual speed of induction motor is 1400rpm. 1400rpm is dividing by 60 and we get center point of pulses are 25. This point is given to controller, when motor start running if pulses are grater than 25 pulse motor minimize the speed and if less the 25 it increase the speed. Finally motor try to achieve center point that is 25. Vitiation of speed displays on LCD.

Figure 7. Speed Sensor

G. Flow Diagram of System

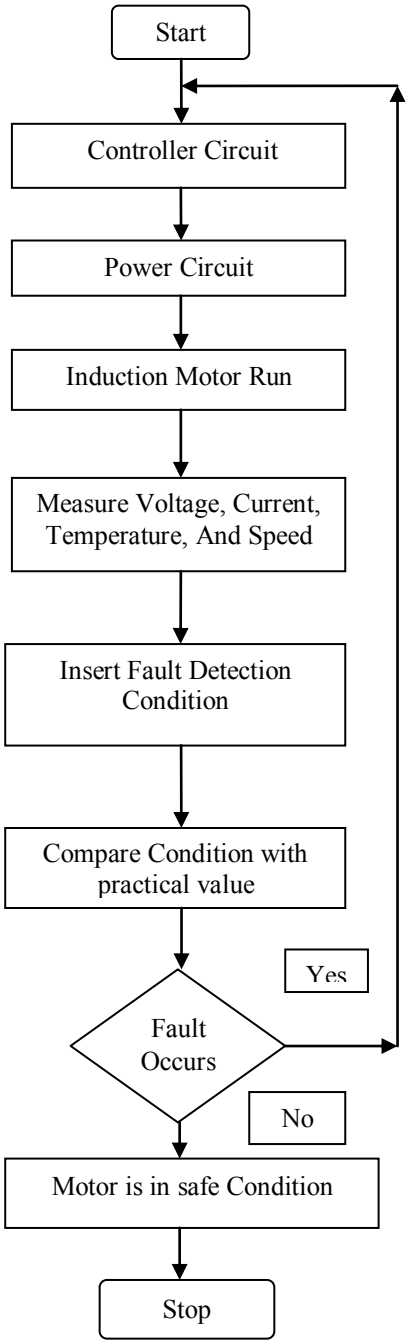

Figure 8. Flow Diagram of System

III. SOFTWARE RESULTES

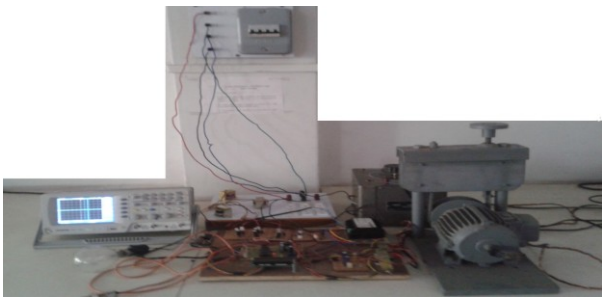

Figure 9. Complete Hardware System

The Fig.9 shows the complete hardware system which consist of three phase supply, SSR, dimer, three phase Induction Motor, Microcontroller, Voltage circuit, Current circuit, temperature sensor, Speed sensor, CRO

Results On LCD

A. Temperature

If temperature of Induction Motor is garter than 45 degree then fault over temperature is detected and motor stop running (PWM stop).

Figure 10. Temperature display on LCD

B. Voltage

If supply voltage of motor is less than 150 degree then fault under voltage is detected and motor stop running (PWM stop).

Figure 11. Under voltage display on LCD

If supply voltage of motor is garter than 250 degree then fault under voltage is detected and motor stop running (PWM stop).

Figure 12. Over voltage display on LCD

C. Current

Supply current display on LCD

Figure 13. Current display on LCD

D. Phase

If all phases are in proper condition then Motor run properly and display phase ok LCD.

Figure 14. All phases are ok

If R phase of Induction Motor is open Then signal phase problem is detected and motor stop running.

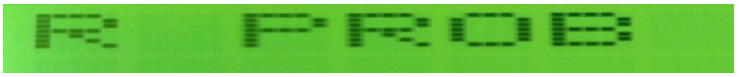

Figure 15. R phase display on LCD

If Y phase of Induction Motor is open then single phase problem is detected and motor stop to running.

Figure 16. Y phase display on LCD

If B phase of Induction Motor is open then single phase problem is detected and motor stop to running.

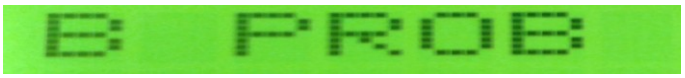

Figure 17. B phase display on LCD

Results On Graph

Fig 18 shows three phase power supply given to three phase Induction motor

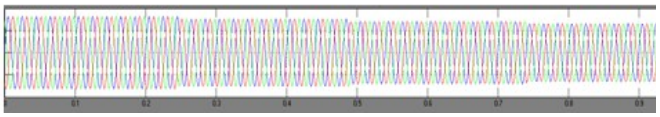

Figure 18. Three Phase Supply

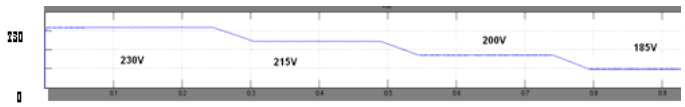

Figure 19. Under Voltage

Fig. 19 shows graph of under voltage in three phase Induction motor.

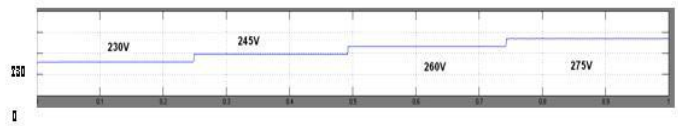

Figure 20. Over Voltage

Fig. 20 shows graph of under voltage in three phase Induction motor.

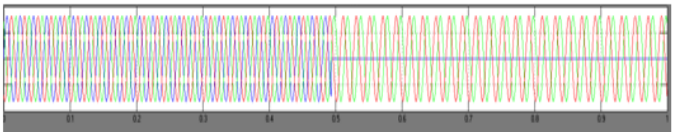

Figure 21. Single Phasz

Fig. 21 shows graph of single phasing When any one phase of pwer supply is open then single phasing is arrive.

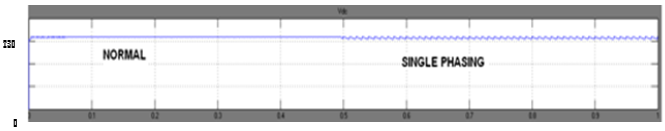

Figure 22. Voltage at Single Phase

Fig. 22 shows graph of voltage at single phasing. Initially when three phase supply is given to three phase Induction Motor supply voltage is in normal condition. But when single phase problem occur then noise is present in supply voltage shown in figure.

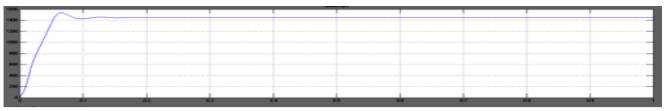

Figure 23. Speed of Three phase Induction Motor

Fig 23 shows graph of speed of induction motor at controlling action.

V. CONCLUSION

From the above system we can detect and control the faults(over-voltage/current, under-voltage/current, over-temperature, single phasing, Speed variation) of Induction motor. To achieve above purpose we use PWM inverter and PIC18f4431 which is hart of project.

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helped me to complete the work up to this stage and hope will continue in further research.

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