Microcontroller Based detection and protection of induction motor

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Abstract **- The fundamental aim of this project is to trip the relay if the faultis occurring in three phase induction motor. A low cost and reliable protection scheme have been designed which monitors the parameter of induction motor such as current, temperature and speed of motor. Circuit measures this parameter by CT, Tachometer, Temperature sensor and then the collected data will feed to the microcontroller. LCD will display the measured value if the measured value crosses the specified limited then GSM will send the measured value to the registered mobile number and relay will operate and supply is to be cut off and motor will stop. This type of protection takes fraction of second.**

I.INTRODUCTION

Because the induction motor is rugged in construction and its operation is easy, it is employed in most manufacturing industries to drive loads. But the three-phase induction motor generally suffers from under voltage, overvoltage, overheating, single phasing and phase reversal problems. The life of the motor may be reduced by 50% if it is allowed to reach and operate at a temperature above its maximum rating [1]. The life of electric motor is considered to be about 20 years.

There are wide range of AC motor and motor characteristics because of all the numerous duties for these they are used. Induction motor is generally utilized as a part of industry due to their rigidity and speed control flexibility. Due to some power quality issues like overvoltage and under voltage and due to variation in current, fault is occur in induction motor. To overcome such type of fault we use some circuitry to protect the motor. In our project we use microcontroller PIC18F452 as a main part of our circuit. We use5 input ports of microcontroller to interface tachometer, three CT's, and temperature sensor LM35. By using tachometer, CT's and temperature sensor we continuously collect data of speed, current and temperature respectively. By collecting these data microcontroller send these data to the mobile phone of the person who work on that motor. If current or temperature exceed the predetermine limit, then this will sense by sensors and data will be displayed on the LCD and the emergency message will be send to the mobile phone through GSM model. And to protect the motor from over-current and over-temperature relay will trip and motor will stop. These all process of tripping the relay will take fraction of seconds. Our main objective of the project is to make cheap and reliable protection system for 3 phase induction motor.

II. PRINCIPLE OF OPERATION OF THREE PHASE

INDUCTION MOTOR An induction motor consists of two parts: the stator and the rotor. The stator core is built of sheet-steel laminations that are supported in a frame [5]. The windings are placed in the stator slots 120 electrical degrees apart. Windings may be connected in "star" (or wye) or delta configuration [5]. A Cutaway of a typical 3 phase AC motor is shown in Fig.1.

The rotor of the induction motor is made of a laminated core with conductors placed parallel to the shaft The rotor conductors are embedded in the surface of the core, and are insulated from the core, because rotor currents follow the "least resistance" path. The rotor conductors are shorted by end rings at both ends [1].

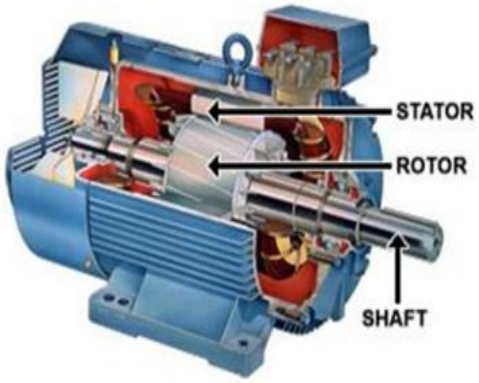

Fig.1. Cut way of a Typical 3-Phase AC Motor

Rotor of a Squirrel Cage Motor is shown Fig.2.

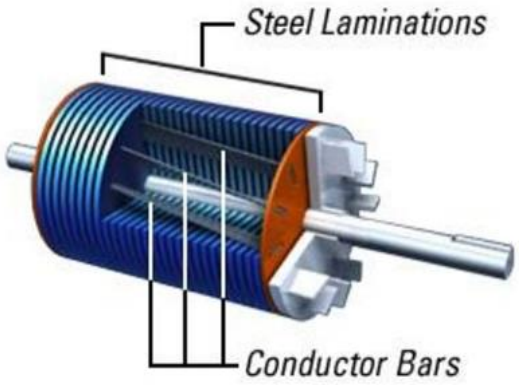

Fig.2. Rotor of a Squirrel Cage Motor

When the stator windings of an induction are connected to a three-phase power, a rotating magnetic field ensues as a result of current through it coils in a speed that corresponds to the frequency of the supply voltage connected to the stator. If the rotating magnetic field creates a pair of poles (N, S) on the stator surface, this corresponds to one cycle of the alternative current AC.

III. CAUSES OF DAMAGING THE INDUCTION MOTO

Over-current: Over-current or exceed current is a situation where a larger than intended electric current exist through conduction, leading to excessive generation of heat, and the risk of fire or damage to induction motor.

Causes of Over-current: Miswiring can cause over-current in motors. If the wiring is incorrect on a motor, it can lead to shorts and other problems. If the phase-to-phase insulation breaks down, this can cause over-current. This insulation is intended to prevent the current from finding a circuit in an unintended place. Most electrical devices with complex wiring come with circuit breakers and fuses. These are intended to protect the devices from over-current. Circuit breakers generally must be bought to match the motor or device you are looking to regulate but fuses are almost universal, so that any fuses can be placed in any device. If either of these preventative devices breaks down, over-current can become a problem.

Overvoltage: An overvoltage is an increase in the rms value of AC voltage greater than 110 percent or 0.11p.u. at the power frequency for a duration longer than 1 min. over voltages are usually the result of load switching (e.g., switching off a large load or energizing a capacitor bank). The over voltages result because either the system is too weak for the desired voltage regulation or voltage controls are inadequate. Incorrect tap settings on transformers can also result in system over voltage.

Over-temperature: Motor temperature is one of the factors which we should monitor and make sure that it should be in normal range. The Temperature of the motor is closely related with the winding temperature. If temperature exceeds the predetermined values, then the winding insulation may become damage or weak. From that damage it will make the internal short circuit between winding phase and cause a serious damage to the induction motor.

Causes of Over-temperature: High ambient temperature of motor • Bearing jammed • Under sizing motor capacity • Not suitable voltage rated running in overload.

Crawling: It has been observed that squirrel cage type induction motor has a tendency to run at very low speed compared to its synchronous speed, this phenomenon is known as crawling. The resultant speed is nearly 1/7th of its synchronous speed.

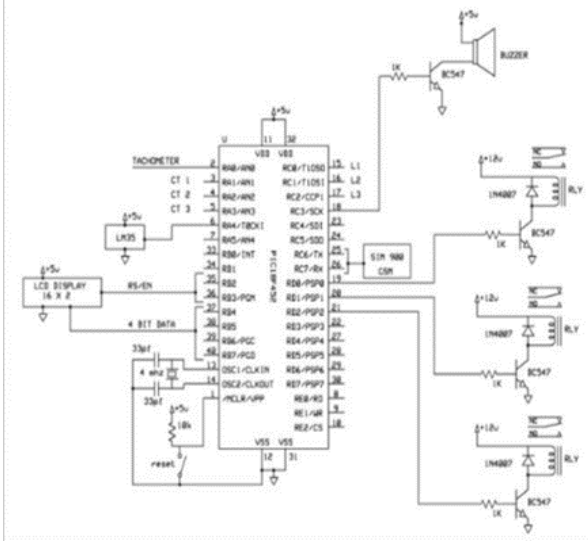

Fig2: Circuit diagram of detection and protection circuitry

Main Component Used in Circuit

- Microcontroller PIC18F452
- Bridge rectifier
- Induction Motor
- Temperature sensor LM35
- Tachometer IC-LM2917 (Frequency to voltage IC)
- Relay 12V ICO
- GSM 900
- LCD Display (16×2)
- Three Current Transformer
- Transformer

IV. DESCRIPTION OF ABOVE COMPONENT

Microcontroller PIC18F45

Microcontroller receives data from temperature sensor, Tachometer and CT then convert it from Analog to Digital LCD.

Features:

- 5V DC
- 10bit ADC
- 40pin IC
- Flash Memory 32k
- On-chip RAM - 1536 bytes
- EEPROM - 256 bytes
- 4 Timers

Bridge rectifier

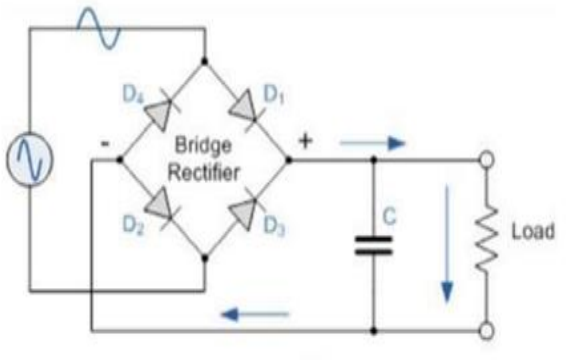

Fig 3: Bridge Wave Rectifier

We use bridge rectifier to get pure DC signal. Bridge rectifier is highly efficient than others. It consists of 4 diodes D1, D2, D3 and D4. When we give AC supply to the circuit in positive half cycle D1 and D2 become forward biased, and it will start conduction at the same time D3 and D4 are reverse biased hence it does not conduct. In negative half cycle D3 and D4 become forward biased and start conduction and D1, D2 become reverse biased and stop conduction.

Induction Motor:

An electrical motor is such an electromechanical device which converts electrical energy into mechanical energy. Specification: 3phase squirrel cage induction motor, 415V, 0.5HP,50Hz, 4Pole, speed up to 1500rpm, Insulation class E or B (Hindustan Manufacturer).

Tachometer:

IC-LM2917 frequency to voltage converter. The Lm2917 series are monolithic frequency to voltage converter with a high gain op-amp/comparator designed to operate a relay, lamp or other load when input frequency reaches or exceeds the selected rate.

$Vout=FIn\times Vcc\times R1\times C1$

Temperature Sensor:

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

Relay:

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where itis

necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

LCD display:
Liquid Crystal Display is used for display the measured readings and if fault occur it also show on LCD. 16×2 LCD is used in circuit. It has 16 character and 2 rows.

GSM 900:
GSM is a cellular network, which means that cell phones connect to it by searching for cells in the immediate vicinity. There are five different cell sizes in a GSM network—macro, micro, pico, femto, and umbrella cells.

V.WORKING

230V 50Hz supply is given to the step-down transformer it converts 230 volts in 12-0-12V AC. 12V directly given to relay because our relay work on 12V AC remaining 12V AC is given to bridge circuit. Bridge circuit convert that 12VAC into 12V DC. As our all component like microcontroller, LCD display is work on 5V AC. The 5V Ac supply given through IC to the other component. Once the circuit is energized tachometer continuously take the readings of speed, CT gives reading of current and LM35 take the readings of temperature. All these data fed to microcontroller and microcontroller continuously compare the measured value with predetermine values if the measured value cross the specified limit, then microcontroller gives command to the relay to trip immediately and through GSM the message send to the person who work on it. It will take fraction of second and motor will be completely isolate from faulty section immediately.

VI.CONCLUSION

This paper presented a reliable, fast, and efficient for induction motor protection. In industries due to over-voltage, Under-voltage, Overcurrent, and over-temperature motor may get damage hence this paper has successfully present reliable, fast and efficient system for induction motor protection this system can be implemented in any industries where the protection of motor is essential requirement. The thesis is based on protection of3phase induction motor under faulty condition and itis implemented using PIC microcontroller, relay driver circuit and CT's.

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