International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 3 Issue: 11 6287 - 6292

Microcontroller Based Protection and Control of Three-Phase Induction Motor

Prof. Ms. Madhuri Balasaheb Zambre
(Asst. Prof. Department of Electrical Engineering, Modern College of Engineering,Pune)

Mr. Vivek Vitthal Waiphale
M.Tech(Power System)
Assistant Engineer at MSEDCL,Maharashtra

Ms. Bhupali Popat Kumbhar
M.E. (Control System)
Modern College of Engineering, Pune

Abstract:- The fundamental aim of this paper is to distinguish issues of three phase Induction Motor (IM)and control thefaults.The three phase Induction Motor may encounter numerous outer deficiencies because of change in input supply from MSEB, which extremely impacts on three phase Induction Motor.So the protection of motors from such faults is critical. The different faults are under-voltage, single phasing, Over-current and phase reversal and so on. The most essential parameters are Voltage and Current.

Keywords: *IM, under voltage, Single Phasing, Over Current, Phase Reversal*

*****

Introduction

InductionMotors are generally utilized as a part of industry due to their rigidity and speed control flexibility.In this manner, the issue of induction motor protection attracted many researchers.This Project aim is the protection of three phase Induction Motor. There are different techniques for fault identification and protection of Induction motor. Some of fault detection using Artificial Neutral Network, Stator fault checking strategies, Microcontrollers based protection system and Programmable Logic Controller (PLC) based protection system. In this task, the technique utilized is Microcontroller based protection system. The circuit will take the full control of the motor and it will protect the motor from several faults, for example, over voltage and under voltage and the circuit will switch on the motor under safety conditions. This additionally protects induction motor from single phasing which is also a major fault. The circuit is completely controlled by the microcontroller and the microcontroller will consistently monitors the voltages of the three phases and if the voltage goes abnormal then it will switch off the motor until they are typical. With the help of current transformer which senses the current and if it exceeds some particular level then comparator sends this signal to microcontroller to stop the motor. All the conditions are shown by it over the LCD display. In this paper we are utilizing the 8 bit microcontroller AT89C52. It is a 40 pin microcontroller. The protection of induction motor with microcontroller has adaptability to switch off at required time, monitors phase of motor at each time furthermore every motoring activity is known through LCD display. It also protects the motor from single phasing as its maintenance cost is low. Likewise the learning about fault mode behavior of an induction motor drive system is critical from the angle of improved system protection & control.

Literature Review

Various types of ACInduction motors are accessible in the market. Different motors are suitable for different applications. In spite of the fact that AC induction motors are simpler to design than DC motors, the speed and the torque control in different types of ACinductionmotors require a greater understanding of the configuration and the characteristics of these motor. Despite the fact that IMs are solid, they are subjected to some undesirable burdens,causing faults resulting in failure. The electrically related faults, for example, over-voltage, over-current, under-voltage, under-current, over-loadand over-temperature. The over-voltage and over-current can be manmade or natural. Possible causes for over-current incorporate shortcircuits, excessive loads, and inaccurate configuration.Monitorof an IM is a quick developing innovation for the detection of initial faults. It avoids unexpected failure of a 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. A PLC based system which deals with monitoring control system of Induction motor is introduced, in these

systems 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. 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.

As stated above, each fault affects severely on induction motor. Due to Under-voltage motor is not able to run at its full speed and single phasing also causes the problem of under-voltage. The under voltage occurs when a reduced supply voltage with a rated mechanical load on the motor.

Open winding in motor, any open in any phase anywhere between the secondary of the transformer and the motor primary phase open. The effect of single phasing on three phase IM vary with service condition and motor thermal capacities. Large amount of heat will generates due to extra current flowing through winding therefore over-current fault is also dangerous for induction motor.

Due to load in excess of safety rating of motor will cause the over current fault. Therefore large amount of heat generated in the motor which cause the winding failure.The phase reversal occurs when two of the three phases(R Y B)of line reverses .Most of the motors will react very badly to such a situation motor could suddenly begin to turn in the wrong direction, causing major collateral damage.

Types of Motor Failure and Protective Features

There are various components which cause engine disappointment. The most well-known are:

- Overload
- Single staging
- Voltage unbalance
- Voltage too high/low
- Bearing disappointment
- Rapid obligation cycle
- Restricted ventilation
- Moisture and vibration

On the off chance that mechanical disappointments are wiped out, shielding the engine windings from over temperature is the prime function of motor protection.

But even bearing failures can result in motor winding failure if not detected in time.There are a number of ways that motors can be protected with respect to the needs of plant management. Table 1 below classifies these functions. There is no substitute for the proper application of motors or proper maintenance. However, protective devices can help you to use the motor to its optimum limits.

Table.2.1 Breakdown causes, effects and possible motor damage

Causes	Effect	Possible damage
Thermal overload: Extreme starting condition Locked rotor High overload Under-voltage Intermittent operation	over-current and thus unacceptable heating-up of windings	soldered joint damage rotor cage burnt windings stator windings
Cooling problems: Restricted cooling Ambient temperature too high	unacceptable heating-up	burnt windings stator windings
Electrical causes: Single phase condition Unbalanced voltage Earth fault Shorted turns Winding short circuit	unbalance over-current of windings heating-up depending on motor size and bearing damage load	individual windings or parts burnt
Mechanical causes: Imbalance Mis-alignment Improperly installed drive(e.g. bearing load of V-belts too high)	uneven wear of bearings	bearing damage

Necessity for motor protection:

It could be accepted that legitimately arranged, dimensioned, introduced, worked and kept up drives ought not to separate. In actuality, be that as it may, these conditions are barely ever perfect. The recurrence of diverse engine harm varies since it relies on upon distinctive particular working conditions. Measurements demonstrate that yearly down times of 0.5...4% must be normal. Most breakdowns are brought on by an over-burden. Protection shortcomings prompting earth issues, swing to-turn or twisting short-circuits are brought on by overabundance voltage or pollution by sogginess, oil, oil, dust or chemicals.

The approximate percentages of by these individual faults are:

• Overload 30%
• Insulation damage 20%
• Phase failure 14%
• Bearing damage 13%
• Ageing 10%
• Rotor damage 5%
• Others 8%

Thusly, the going with centers must be seen to guarantee issue free operation of an electrical drive:

• Correct design: a suitable engine must be decided for each application.
• Professional operation: proficient establishment and customary support are preconditions for shortcoming free operation.
• Good engine protection: this needs to cover all possible issue zones.
- It must not be stumbled before the engine is put at danger.
- If the engine is put at danger, the insurance gadget needs to work before any harm happens.
- If harm can't be kept, the security gadget needs to work rapidly with a specific end goal to limit the degree of the harm.

Block Diagram:

The main block diagram of automatic voltage control of Induction motor using microcontroller is shown in fig:

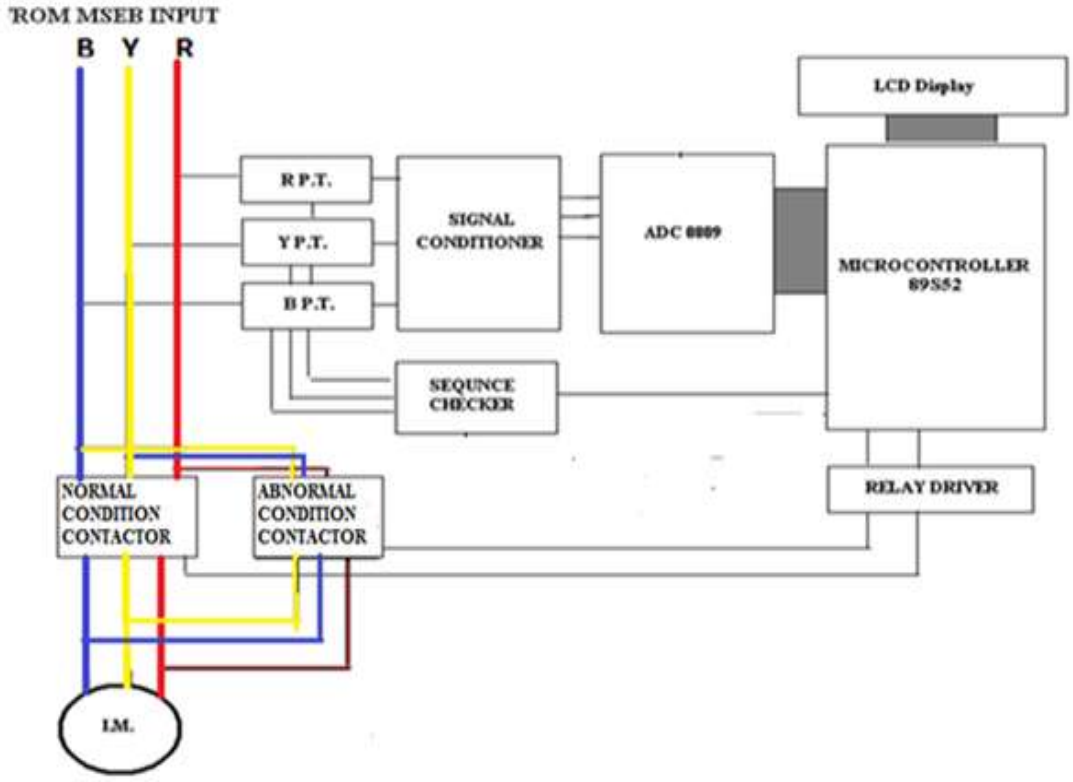

Fig 1 Block diagram of three-phase IM using microcontroller

Description:

In under voltage protection of 3 phase induction motor protects the motor from the under voltage. When supply system has low voltage than the rated of induction motor then under voltage protection section of protection supply is provided to motor. It has same concept as overvoltage it also has comparator which compare two voltage one form supply and another from the voltage drop across the variable résistance. When voltage drop across the variable resistance is lower than specified value, this signal sends to microcontroller through ADC. If the input voltage becomes over then automatically both contactors will be trips. The contactors are connected through relay driver & relay circuit. Relay driver is used for to increasing the current handling capacity of incoming signals from microcontroller unit and microcontroller stop the operation of motor in the case of running and fails to operate in case of starting.

In single phasing protection for 3 phase induction motor system, if any one of the phases is faulted then automatically trips both the contactors. Generally in single phase supply voltage is lower value than specified value. On this value of voltage motor is unable to start. Comparator which compares single phasing supply voltage and rated specified voltage, and single sends to microcontroller and microcontroller generates single and contactor will be trip through relay drive which stop the motor if motor is running

and does not allow to motor start in case of standstill. Single phasing occurs as a result of several possibilities. As a loose wire, a bad connection, bad starter contacts, overload relay problems, a bad breaker, a blown fuse etc.

Phase reversal problem occurs in motor when the supply phase is reversed due to wrong connection (except than RYB) due to phase reversal motor starts running in anticlockwise (opposite direction from normal) would cause operation and safety problem. Most of three phases motor run opposite phases. Abnormal contactor operates when any one the phase changes in input side so as to motor will rotates with regular rotation. Also two contactors trips when any fault occur in input line voltage. This type of protection is used in application like elevators where it would be damaging or dangerous for the motor to run in reverse. Generally when motor is connected with the important application then type of protection being much more important .When the load is connected with motor then reversal of phase means Direction of rotation is changed. It could cause serious problem therefore much more care is required to protect the motor form such type of fault. The overheating protection system is placed to turn the motor off when the excess heat is generated within the motor. This protection system will rest the motor until it cools to safe operating temperature.

Over-current protection of motor means protect the motor, if load is exceed than specified value. This over-current in motor is generally caused by overloading of motor, bearing seizes up something locked the motor shaft from turning. Each phase current is sensed by using current transformer and if current level exceeds its rated value then comparator sends signal to microcontroller to stop the motor.

And one of latest provision is implemented in our project is that it corrects the phase sequence so to run the motor in proper direction with change in R,Y,B sequence this is done by phase checker circuit. LCD is used for display of all LCD faults and message to user.

Results

1. Hardware System:

Fig.2 shows the complete hardware system

Fig.2 shows the complete hardware system which consist of three phase supply, dimmer, three phase Induction Motor, Microcontroller, Voltage circuit, Current circuit.

2. Results OnLCD:

- **Under-voltage :**

If supply voltage of motor is less than 180 degree then fault under voltage is detected and motor stop running.

Figure 3: Under voltage display on LCD

- **Phase Reversal :**

when the supply phase is reversed due to wrong connection (except than RYB) due to phase reversal motor starts running in anticlockwise (opposite direction from normal) is detected and motor starts running in clockwise.

Figure 4: Phase Change display on LCD

- **Single Phasing**

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

Figure 5: R phase abnormal display on LCD

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

Figure 6: Y phase abnormal display on LCD

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

Figure 7: B phase abnormal display on LCD

- **Over-Current:**

If load is increased, then over-current problem is detected and motor stop to running.

Figure 8: over-current display on LCD

Conclusion and Future Work

Protection of three phase induction motor from under voltage, single phasing, over current and phase reversal provide the smooth running of motor improves its lifetime and efficiency. Generally these faults generated when supply system is violating its rating. In three phase induction motor when running at rated voltage, current and load these faults are not generated. For smooth running of motor generally concentration on supply voltage under the prescribe limit and load which is driven by the motor should also be under the specified limit.

There are certain features that can be added in this system. Following are some of the features are:

Incorporate RTC chipDS1307 which can be used to show the time, and we can soft different readings of rpm in timely manner.We can use serial memory chip AT74c04 and can store these records in the system and we can upload this data to the PC by the serial communication using MAX 232 IC.Therefore the efficiency of motor can be controlled using this system.Instead of microcontroller we can use CPLD chip since the CPLD chip incorporates many more features than microcontroller. VLSI/VHDL can be used for CPLD programming. Real time clock can be added so that ON time & OFF time of the motor can be entered & also the system will switch ON & OFF at the predetermined time.

References :

[1] Maria G. Ioannidis [Vol. 19, NO. 3, SEPTEMBER 2004] *"Design and Implementation of PLC-Based Monitoring Control System for Induction Motor*" IEEE Transactions on Energy Conversion.

[2] RamazanBayindir, Ibrahim Sefa,,IlhamiColak, and AskinBektas [Vol. 23 NO.3 SEPTEMBER 2008.] "*Fault Detection and Protection of Induction motor using sensor*" IEEE Transactions on Energy Conversion,

[3] ElSayed M. Tag Eldin, Hassan R. Emara, Essam M. Aboul-Zahab, Shady S. Refaat [2007 IEEE.]"*Monitoring and Diagnosis of External Faults in Three Phase Induction Motors Using Artificial Neural Network*"

[4] RajasekarThota, Sreerami Reddy, RoopTejaNeeluru M [Vol 04, Special Issue 01, 2013.]" *A Microcontroller Based Protection And Control Of A Low Voltage Motors By Using Zigbee Technology*" International Journal of Motorering Sciences Research-IJESR.

[5] International Journal of Scientific Research and Management Studies (IJSRMS) Devesh Kumar, Piyush Kumar Verma, Brijesh Kumar Singh, Ravindra Singh, Vishal Singh Assistant Professor, Pursuing B-Tech MIT Moradabad, India'' *Single Phasing, Phase Reversal, Overvoltage, Under Voltage and Overheating Protection of Three Phase Induction Motor''*

[6] Ms. PatilSmitaJaywant ,Mr. PatilSachinSambhaji , Ms.PatilPragati Deepak [Volume 3, Issue 8, August 2014] " *Fault Detection and Correction of 3-phase Induction Motor*". In International Journal of Advanced Research in Electronics and Communication Motorering (IJARECE).

[7] I.J Nagrath& D. P Kothari. The McGraw-Hill.

[8] The 8051 Microcontroller and Embedded Systems by – Muhammadh Ali Mazidi, Janice GillispeiMazidi.

[9] M. C¸ unkas¸, R. Akkaya, and A. O¨ ztu¨rk, [Nicosia, Cyprus, vol. 3, pp. 1093–1096.
[2000] "Protection of ac motors by means of microcontrollers," in *Proc. 10thMediterranean ElectrotechnicalConf.,Melecon* .

[10] A. M. Graham and M. Etezadi-Amoli,[vol. 4, 2000, pp. 2475–2480.] Design implementation and simulation of PLC based speed controller using fuzzy logic," in *Proc.IEEE Power Eng. Soc. Summer Meeting*.

[11] M. Benbouzid, M. Vieira, and C. Theys,[vol. 14, no. 1, pp. 14–22, Jan. 1999] ―Induction motor's fault detection and localization using stator current advanced signal processing techniques,‖ *IEEE Trans. Power Electron.*

[12] Cristianini, N., &Shawe, J. [2000]. *An Introduction to Support Vector Machines and Other Kernel-based Learning Methods.* UK: University Press Cambridge