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A Case Study of Fault Detection and Protection of Three-Phase Induction Motor

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Abstract-Induction motors are used in many industrial applications as they have simple constructed and have low production costs. Induction motors are used more due to their certain advantages such as versatility, dependability and economy, good self-starting capability, offers users simple, easy maintenance, low cost and reliability. The reliability of an induction motor is of great importance in industrial as well as commercial, aerospace and military applications. In this paper different problem such as overvoltage, over temperature, over current, single phasing, vibration monitoring which are being faced by IM's during its course of operation. There are various methods for fault detection and protection of IM. Some methods involving are MCSA technique, Programmable Logic Controller (PLC) and Microcontroller based protection system. In the microcontroller based system the circuit will take the full control of the motor and it will protect the motor from several faults. In this paper we are studying the different technique for detection and protection of various faults of the three phase induction motor such as MCSA, PLC, and MICROCONTROLLER etc. 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.

Index Terms- : Induction motor, Microcontroller, PLC, MCSA

1. INTRODUCTION

Various types of AC Induction 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 AC induction motors 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 burden, causing faults resulting in failure. The electrically related faults, for example, over-voltage, over-current, under-voltage, single phasing, over temperature. Classical monitoring techniques for three-phase Induction motors are generally provided by some combination of mechanical and electrical devices such as contactors, voltage 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 [7]**.** The MCSA method can detect these faults at an early stage and thus avoid secondary damage and complete failure of the motor. In this paper we discuss three techniques. The MCSA technique is discuss, the PLC based protection is also better solution to protect the IM against the various faults, by using several sensors we can sense or detect The fault and give information to PLC about the abnormal criteria after that according to program PLC protect motor from such abnormal condition. The third technique is based upon microcontroller, as we know microcontroller is flexible, fast operation and easily available with low cost, by installing program into it we use it, hence this technique is very suitable for fault detection and protection of IM.

2. TECHNIQUES FOR FAULT DETECTION

2.1. *Motor current signature analysis*

Motor Current Signature Analysis (MCSA) is a system used for analyzing or trending dynamic, energized systems [4]. This system prepared to be used in industrial applications to diagnose and isolate the faulty motors immediately at their incipient stage, and to avoid any damage occur for the motors, or for their supply system**.**

The difficulty with this detection is the sensitivity of the measured fault parameters to machine specific details such as size, power, construction type and loading [8]. Thus for a reliable fault detection classification is generally required.

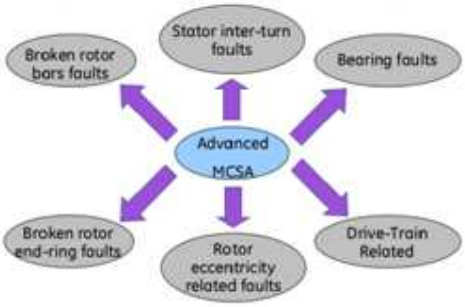

Fig.1. Motor current signature analysis

Consider the following most popular type.

2.1.1. *Fuzzy logic*

This involves making decisions based on classifying signals into a series of fuzzy values rather than simply as healthy or faulty based on a single threshold. For instance, based on the broken bar side band amplitude, a motor could be classified as healthy, marginal or faulty. Fuzzy logic allows combining fuzzy information from different signals together to make a more accurate judgment regarding the health of the motor. Therefore, it has been observed that the MCSA technique can be used in the fault diagnosis of induction machine in the Transient conditions with wavelet transform. But, with the wavelet transform only some complicated work has been carried out. It has been observed that the wavelet transform diagnoses many faults, successfully in the transient conditions. Therefore, now researchers will have to face the challenges to diagnose induction motor faults in these conditions also.

2.2. *PLC*

Due to the recent development in the Programmable Logic Controller (PLC) technology, it is widely used in most industrial applications and utility plant. One possible application is to use the PLC for fault diagnosis of IM. Researchers have studied a variety of machine faults and have come to conclusion that machine failures include mechanical and insulation faults. There are various other types of insulation system faults and mechanical faults. The PLC systems are equipped with special I/O units appropriate for direct usage in industrial automation systems [5]. The input components, such as the pressure, the level, and the temperature sensors, can be directly connected to the input. The driver components of the control circuit such as contactors and solenoid valves can directly be connected to the output.

A PLC can be programmed to sense, activate, and control industrial equipment. Therefore, a PLC incorporates a number of I/O points, which allow electrical signals to be interfaced [5].

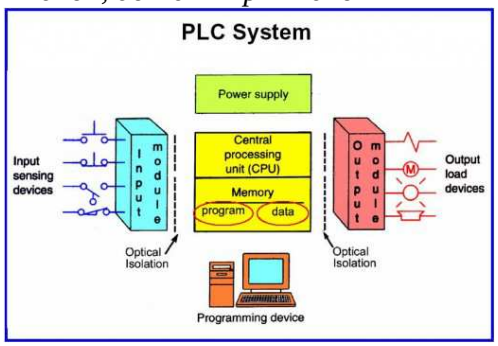

Fig 2 Basic Structure of PLC

Input and output components of the processes are connected to the PLC; and the control program is loaded on the PLC memory. The basic structure of the PLC is illustrated in Fig.

In this study, the PLC measures the current, the voltage, the temperature, and the speed of an induction motor through analog inputs. In addition, it continuously monitors the inputs and activates the outputs according to the program

2.2.1 Fault detection methods in PLC

a) Use of Multiple Sensor Types

The majority of present research has been carried out by a single sensor signal with a particular signal processing technique to detect a given fault. In the future work we can use multiple sensor signals with processing techniques. As a result, accuracy of fault detection will be improved.

b) Detection Multiple Faults

There has been little work carried out on the identification of multiple faults in machines. This may be complicated by the inter-dependencies of the fault signals if there is more than one fault. The use of multiple sensors types and processing techniques may also be helpful for this work.

c) Detection Based on Varying Load

Many researchers have usually worked in the detection of faults only for under full load conditions. Though, in practice it has been seen that for actual load when machine is tested may not be controllable. Partial load operation can significantly changes the fault signals. For instance, it has been shown that the broken bar sidebands of the current spectrum are sensitive to the machine loading.

2.3. *Microcontroller*

This technique is developed to protect the three phase [7] induction motor from single phasing, under voltage, over voltage, over current etc. microcontroller protects and controlled the whole system.

Special features of Microcontroller based Protection system

1) Protection of personnel from shock hazards due to winding shorts or earth leakage current from moisture.
2) Complete protection is provided using both voltage and current measurements. Thus allowing maximum motor
Utilization with minimum down time for all AC motors.
3) Fault prediction and protection is combined together.

2.3.1 Fault Detection methods in Microcontroller

a) Use of Sensors

The functioning has been carried out by a single sensor signal with a particular signal processing technique to detect a given fault. In the future work we can use multiple sensor signals with processing techniques. As a result, accuracy of fault detection will be improved. Various signals processing techniques can be applied to these sensors signals to extract particular features which are sensitive to the presence of faults. Finally, in the fault detection stage, a decision needs to be made as to whether a fault exists or not.

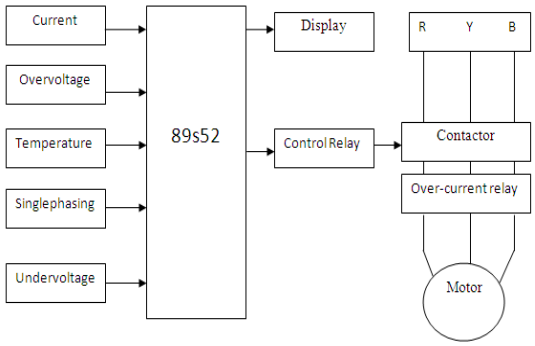

Fig 3 microcontroller based fault detection

This system is based on low cost electronic device that can acquire and pre-process current, voltages and temperatures, and transmit processed key-information related to the motor operation condition using ZIGBEE wireless technology.

3. CONCLUSION

In the present paper, a comprehensive review of induction motor faults and their detection techniques have been carried out. The accurate health monitoring technique of the induction motor can improve the reliability and reduce the Maintenance costs. If any fault is observed during online operation of the motor, a warning message appears on computer and then the motor is stopped these happens in case PLC protection system. The test has been found successful in detecting the faults and in recovering them. In case of Microcontroller the dissertation is based on the protection of three phase Induction Motor implemented using microcontroller, current transformers and protective relays. The system is very cheap as compared to present protective devices available. The techniques which are used in protection system are easily available in the market and can be also used to large protection system. The results showed that a reliable Microcontroller-based protection system including all variables of IM and operators have been developed and better than the MCSA and PLC technique. The use of Microcontroller has greatly reduced the cost of implementing new control circuits on the plant floor and has reduced the time needed to make various changes to the relay circuit as demanded by a given process.

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