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Fault Detection of Induction Motor by Using PLC

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Abstract

Protection of induction motor (IM) against likely problems, such as overvoltage, overcurrent, overload, over temperature, and under voltage, occurring in the course of its operation is very important, as it is used in industry as an actuator. IMs can be protected using some components, such as timers, contactors, voltage, and current relays. This method is known as the classical method that is very common and involves mechanical dynamic parts. Computer and programmable integrated circuit (PIC) based protection methods have eliminated many mechanical components. The computer-based protection method requires an analog-to-digital conversion (ADC) card, and the PIC-based protection method does not visualize the electrical parameters measured. In this study, for Induction Motors, a new protection method which is based on a programmable logic controller (PLC) has been introduced. In this method, all contactors, timers, relays, and the conversion card are eliminated. Moreover, the voltages, the cur- rents, the speed, and the temperature values of the motor, and the problems occurred in thesystem, are monitored and alert messages are shown on the computer desktop. Experimental results show that the PLC-based protection method developed costs less, provides higher accuracy as well as riskless and optical environment compared with the classical, the computer, and the PIC-based protection systems.

Keywords: Design automation, fault diagnosis, induction motor protection &programmable control.

Introduction

Induction motors is electro-mechanical devices which is complex used for most industrial application to convert the power from electrical to mechanical form. IMs are used worldwide in industrial applications. These motors are husky used not only for general purposes, but also in hazardous locations and severe environments.

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Although, induction motor is reliable but they are prone to some undesirable stresseswhich causes faults and failure of induction motor. A motor failure that is not identified in an initial stage may become catastrophic and the induction motor may suffer severe damage like, production shutdowns. Such shutdowns are costly in terms of lost production time, maintenance costs, and wasted raw materials. In order to protect the induction motor recent technology is introduced in this study. Due to recent development in Programmable logic control(PLC) it can be used for fault diagnosis of induction motor.

Problem Associated

The alternating current induction motor is frequently referred to as the workhorse of the manufacturing. This is because it offers users simple, rugged construction, easy maintenance and cost-effective pricing. Unexpected failures of IMs can considerably cost for the industrial applications. Following conditions may lead to induction motor failure;

1. Thermal Overload
2. Phase fault
3. High Ambient Conditions (Hot, Blocked Ventilation)
4. Power Supply Issues (Voltage/Current Unbalance, Harmonics)
5. Process caused (Excessive load)
6. Ground Fault
7. Abnormal Operating Conditions

1. 8.Over& Under Voltage
2. 9.Under frequency
3. 10. Voltage and Current Unbalance
4. 11. Load Loss
5. 12. Cogging
6. 13. Jamming
7. 14. Stator fault
8. 15. Bearing fault
9. 16. Rotor fault

PLC

A PLC (Programmable Logic Controllers) is an industrial computer used to monitor inputs, and depending upon their state make decisions based on its program or logic, to control its outputs to automatize a machine or process. The PLC can be used in various applications such as, inautomated system, PLC controller is usually the central part of a process control system and to run more complex processes it is possible to connect more PLC controllers to a central computer.

PLC Based Fault Detection and Protection Technique

Programmable logic controller (PLC) is widely used in industry mainly for automation as well as to improve production rate, quality of product, flexibility to change logic to switch over to different type, reduction in error, reducing breakdown time. The normal function of PLC is to control logical condition as per the program written in it. Related to process condition the various condition of analog and digital deals with logic program. In logic the condition related to motor parameter variations and its nature are not included. Most of a time breakdown occurs with motor and mechanism related to it. It is possible to link the logic related to motor protection to ladder diagram so as to reduce unproductive time.

The possible detection methods to identify the motor faults by using PLC are listed as follows:

1. Voltage measurement –by PT
2. Current measurement –by CT
3. Speed measurement –proximity sensor
4. Temperature measurement –LM35

Voltage Measurement by PT

Voltage transformers (VT), also called potential transformers (PT), are a parallel connected type of instrument transformer. They are designed to present minimum load to the supply being measured and have an exact voltage ratio and phase relationship to enable exact secondary connected metering.The PT is ordinarily described by its voltage ratio from primary to secondary. A 230:5 PT will provide an output voltage of 5 volts when 230 volts are applied across its primary winding. Standard secondary voltage ratings are 120 volts and 70 volts, can be matched with standard measuring instruments. Hence, when supply voltage increases gradually the voltage across secondary will be high this is when the PLC will detect the fault and disconnect the motor from supply.

Current Measurement by CT

Current transformers (CT) are series connected type of instrument transformer. They are designed to present minimum load to the supply being calculated and have an exact current ratio and phase relationship to enable accurate secondary connected metering. Primary current ranges from 1A to 1,000A & secondary current range from 5mA, 10mA, 30mA, 100mA, and 0.33A. The perfect value of secondary current becomes less important ant i.e. one can choose 5mA/30mA secondary current instead of 100mA, 350mA etc. We have selected CT according to requirement of our project is 1A:10V (i.e. when primary current is 1Amp then voltage at secondary side is 10 volt). The resistance of secondary winding is 22Ω. Hence, when supply current increases gradually the current across secondary will be high this is when the PLC will detect the fault and disconnect the motor from supply.

Proximity Sensors

A proximity sensor is a sensor which detects the presence of nearby objects without any physical contact. A proximity sensor frequently emits an electromagnetic field or a beam of electromagnetic radiation, and looks for changes in the field or return signal. The object being sensed is frequently referred to the proximity sensors target. Different proximity sensor targets require different sensors. For example, a capacitive or photoelectric sensor can be suitable for a plastic target; an inductive proximity sensor always requires a metal target.

Temperature Measurement

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly related to the Centigrade temperature. Thus the LM35 has a merit over linear temperature sensors calibrated in °Kelvin. . The LM35 doesn't require any external calibration or trimming to provide typical exactness. Low cost is secured by trimming and calibration at the wafer level the low output impedance, linear output, and precise inherent calibration of the LM35 make interfacing to control circuitry especially easy. The LM35 is used with single power supplies, or with plus and minus supplies. As the LM35 draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. So when the temperature of the motor increases the system gets disconnected from the supply.

Hardware and Instrumentation of System

The test rig used in the present study consists of a 3 HP/1440 rpm three-phase IM, three voltage transformers with transformation ratio of 230/2V connectedto eachphase of IM, a current transformer (control CT) connected to any one phase of IM, a temperature sensor with transformation ratio of 10 mV for each 1 °C increasing temperature, a inductive proximity sensor used for measuring the rotor speed, true RMS to DC conversion circuit,three phase contactor, WPLsoft-2.30 Controller.

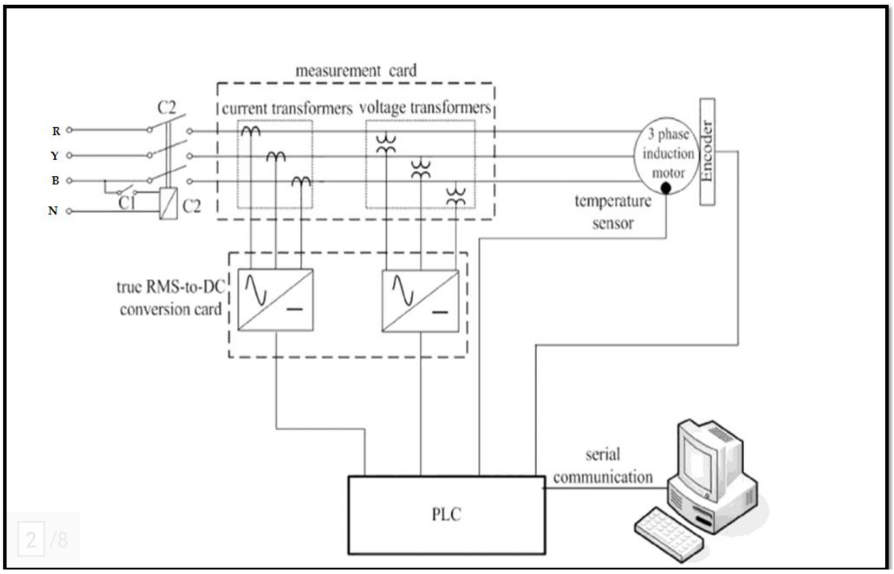

Fig.1. Schematic diagram

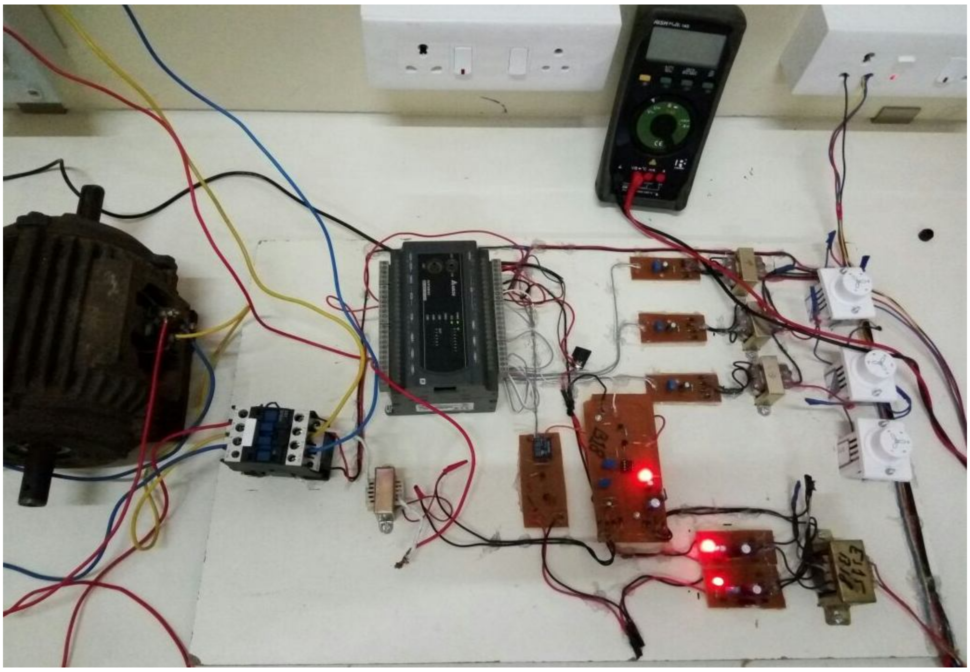

Fig.2. General View of proposed system implemented

Flowchart and Block Diagram of Software Developed

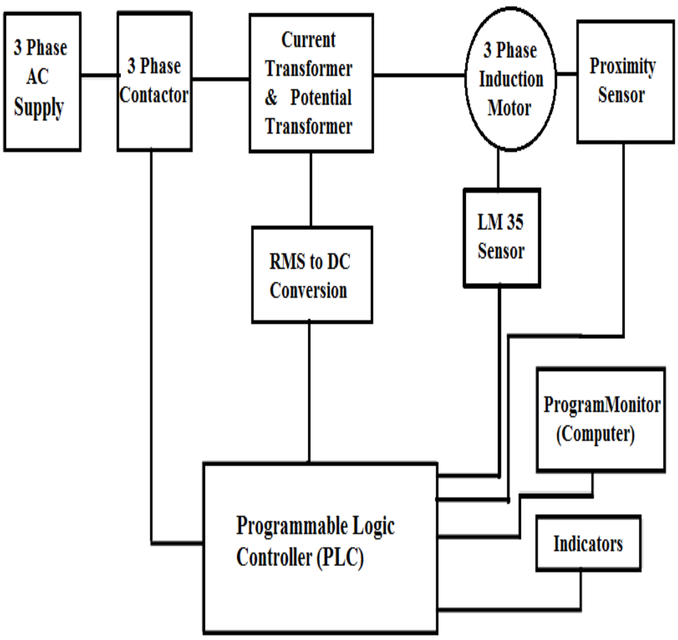

Fig.3 Block diagram of proposed system

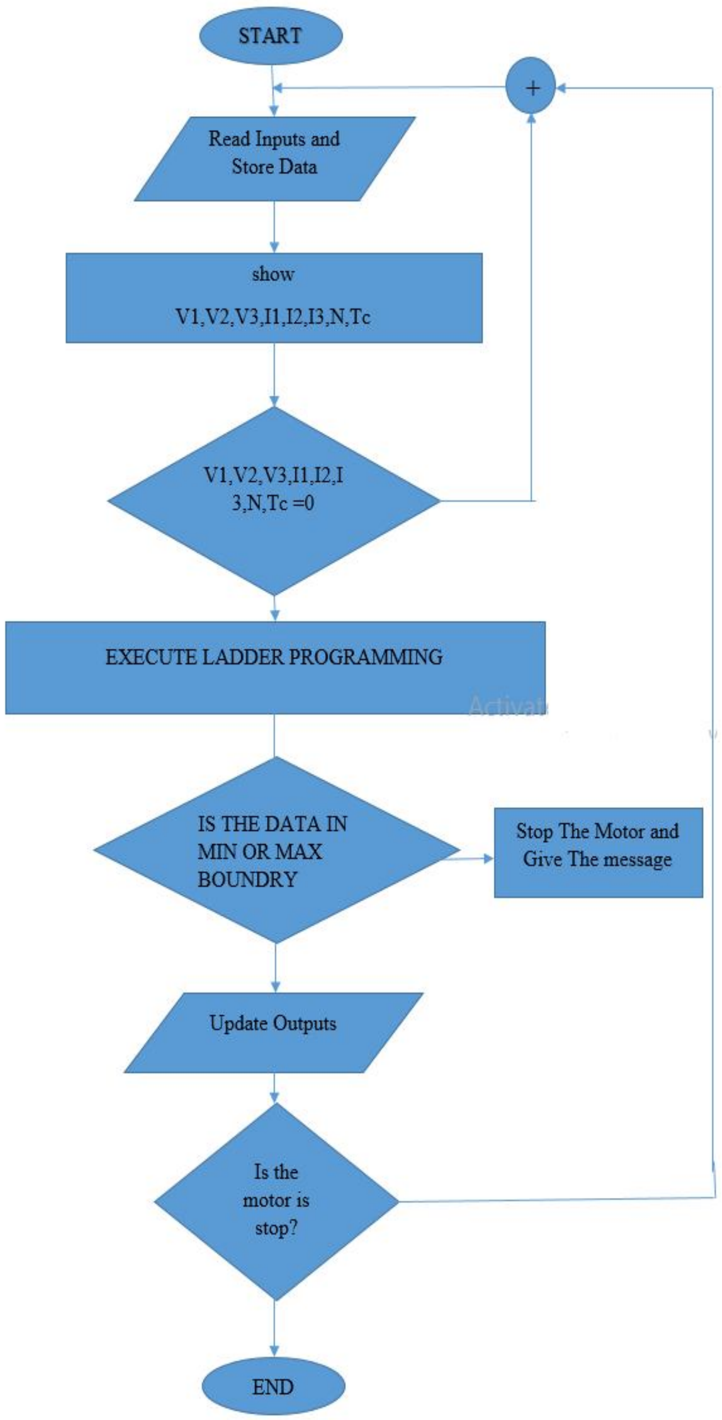

Fig.4. Flowchart for proposed system

Conclusion

The results showed that a reliable PLC-based protection system including all variables of three phases IM"s and operators has been developed. The total length of the PLC software is about 500 lines. Therefore, PLC software developed is scanned at every 185 microns-sec. the detection of the possible faults was also achieved about 5000 times in a second through the related sensors.
Thus it is expected that protection of motor can be more efficient and faster than other techniques such as classical technique because of use of electronic devices instead of mechanical equipment.This protection system can be applied to various ac motors just by adopting small modification in both hardware and software.

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