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Protection of Induction Motor from Abnormal Conditions Using PLC

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ABSTRACT: Protection of an induction motor (IM) against possible problems such as over voltage, over current, over temperature and under voltage since it is used intensively in industry as an actuator. IMs can be protected using some components, such as timers, contac-tors, voltage, and current relays. This method is known as the classical method that is very basic and involves mechanical dynamic parts. Computer and programmable logic controller (PLC) based protection methods have eliminated most of the mechanical components. However, the PIC-based protection method requires an analog-to-digital conversion (ADC) card, and this method of protection does not visualize the electrical parameters measured. A new protection method based on a programmable logic con-troller (PLC),for induction motors has been introduced. Thus all contactors, timers, relays, and the conversion card are eliminated. Moreover, the voltages, the currents, the speed, and the temperature values of the motor, and the problems occurred in the system, are monitored and warning messages are shown on the computer screen. Ex-perimental results show that the PLC-based protection method developed costs less, provides higher accuracy as well as safe and visual environment compared with the classical, the computer, and the PLC-based protection systems.

KEYWORDS: Induction Motor, Programmable Logic Controller(PLC) , Relay.

I.INTRODUCTION

Induction motors are perplexing electro-mechanical devices used in most industrial ap-plications for the transformation of power from electrical to mechanical form. Induction Motors are utilized worldwide as the workhorse as a part of mechanical provisions. Such motors are robust machines utilized for general purposes, as well as in risky areas and serious situations. Broadly useful provisions of induction motors incorporate pumps, transports, machine instruments, diffusive machines, presses, lifts, and bundling sup-plies. Then again, requisitions in unsafe areas incorporate petrochemical and common gas plants, while serious environment provisions for induction motors incorporate grain lifts, shredders, and gear for coal plants. Moreover, actuation engines are very depend-able, oblige low support, and have moderately high proficiency.

Induction motors could be energized from consistent frequency sinusoidal power supplies or from adjustable speed AC drives. Be that as it may, induction motors are more susceptible to fault when supplied by AC drives. This is because of the extra voltage stress on the stator windings, the high frequency stator current components, and the induced bearing currents, initiated by AC drives. Furthermore, motor over voltages can happen in light of the length of cable connections between a motor and an AC drive. This last effect is initiated by reflected wave transient voltages. Such electrical hassles may produce stator winding short-circuits and bring about a complete motor failure.

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The solution to the different faults of the induction motor including phase currents, the phase voltages, the speed, and the winding temperatures have been achieved with the using a microcontroller ,but representation of these electrical parameters have not been displayed on a screen. The PLC systems are comprised of special I/O units applicable for direct usage in industrial automation systems. The input components, such as temperature sensors, the level, and the pressure can be directly connected to the input. The driver components such as contactors and solenoid valves of the control circuit can be directly connected to the output. Many industries use PLC in automation processes to reduce the production cost and to increase quality and reliability.

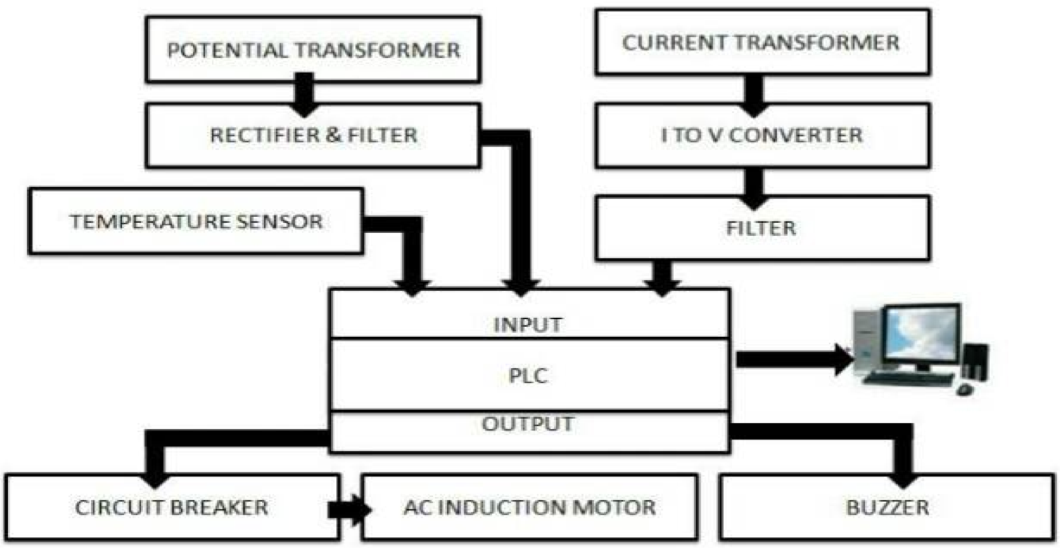
II.RELATED WORKS

Sujith John Mathew, B Hemalatha[1] designed an alternative method to prevent the failures that happen in induction motors using a Programmable Logic Controller (PLC) and sensors to measure the different parameters related to induction motors such as current, voltage, temperature, speed, and vibration. All these parameters are constantly monitored with the help of SCADA during the operation of the motor and if any faults were to occur, there will be change in one or more parameters by which we can take the necessary precautions thus preventing damage to the induction motor. The voltage and current measurement is done using a voltage transformer and a cur-rent transformer respectively. These analog values are now sent to the analog inputs of the PLC. For temperature measurement, a LM35 sensor is used to send the analog input of the PLC.A protection system has been designed for safeguarding induction motors against all possible faults. If any fault occurs, a cautioning message shows up on computer and afterward the motor is halted.

Avinash Kumar, SK Biradar, Dipti Roy[2] suggested that a PLC can be associated for motor protection and de-rating indication and control apart from regular automation function so as to have overall control of process and keeping healthy condition to reduce breakdown time. Any number of motors can be monitored for unbalance, low or high voltage along with current and respective temperature which are used in process. The voltage and current will be sensed by line sensor i.e. CT / PT and given to interface card. The interface card contains the operational amplifier based circuit which converts it to compatible signal level for A/D converter module or card of PLC as per industry standard. It will then interpreted by PLC to take appropriate action as per ladder program.

III.PROPOSED METHODOLOGY

The figure 3.1 shows the block diagram for the protection of induction motor. The major components are programmable logic controller (PLC), potential transformer, temperature sensor, relay and buzzer. Potential transformer is used to measure the supply voltage. Current is measured using current transformer. Rectifier and filter circuit is used with both potential and current transformer to convert ac to dc. PLC receives signals from all the sensors connected to its input module and output is produced according to the program burned in it. The protection can be visualized using a personal computer connected to the PLC.



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PROGRAMMABLE LOGIC CONTROLLER (PLC)

A PLC or a small computer used for automation of real world processes, such as control of machinery on factory assembly lines. 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. Input and output components of the processes are connected to the PLC; and the program is loaded on the PLC memory.

INDUCTION MOTOR

An induction motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor's rotor can be either wound type or squirrel-cage type. The AC power supplied to the motor's stator creates a magnetic field that rotates in time with the AC oscillations. The induction motor stator's magnetic field is therefore changing or rotating relative to the rotor. This induces an opposing current in the induction motor's rotor, in effect the motor's secondary winding, when the latter is short-circuited or closed through an external impedance. The rotating magnetic flux induces currents in the windings of the rotor. The currents in the rotor windings in turn create magnetic fields in the rotor that react against the stator field. Due to Lenz's Law, the direction of the magnetic field created will be such as to oppose the change in current through the rotor windings. The cause of induced current in the rotor windings is the rotating stator magnetic field, so to oppose the change in rotor-winding currents the rotor will start to rotate in the direction of the rotating stator magnetic field. The rotor accelerates until the magnitude of induced rotor current and torque balances the applied load.

POTENTIAL TRANSFORMER

The potential transformer works along the same principle of other transformers. It converts voltages from high to low. It will take the thousands of volts behind power transmission systems and step the voltage down to something that meters can handle. These transformers work for single and three phase systems, and are attached at a point where it is convenient to measure the voltage.

CURRENT TRANSFORMER

Current transformer (CT) is used for measurement of electric currents. Current trans-formers, together with voltage transformers (VT) (potential transformers (PT), are known as instrument transformers. When current in a circuit is too high to directly apply to measuring instruments, a current transformer produces a reduced current accurately connected to measuring and recording instruments. A current transformer also isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are used in metering and protective relays in the power industry.

TEMPERATURE SENSOR

These sensors use a solid-state technique to determine the temperature. That is to say, they don't use mercury (like old thermometers), bimetallic strips (like in some home thermometers or stoves), nor do they use thermistors (temperature sensitive resistors). Instead, they use the fact as temperature increases, the voltage across a diode increases at a known rate. (Technically, this is actually the voltage drop between the base and emitter - the Vbe - of a transistor. By precisely amplifying the voltage change, it is easy to generate an analog signal that is directly proportional to temperature. There have been some improvements on the technique but, essentially that is how temperature is measured.

RELAY

A relay is an electromechanical device having electrical, magnetic and mechanical components. The relays control the electric circuit by opening or closing the contacts of that circuit. An electromechanical relay consists of three terminals namely common (COM), normally closed(NC) and normally opened(NO) contacts. These can either get opened or closed when the relay is in operation. These relays can work on both AC and DC supply sources. The construction is somewhat different for AC and DC relays, but both work on the same principle of electromagnetic induction.

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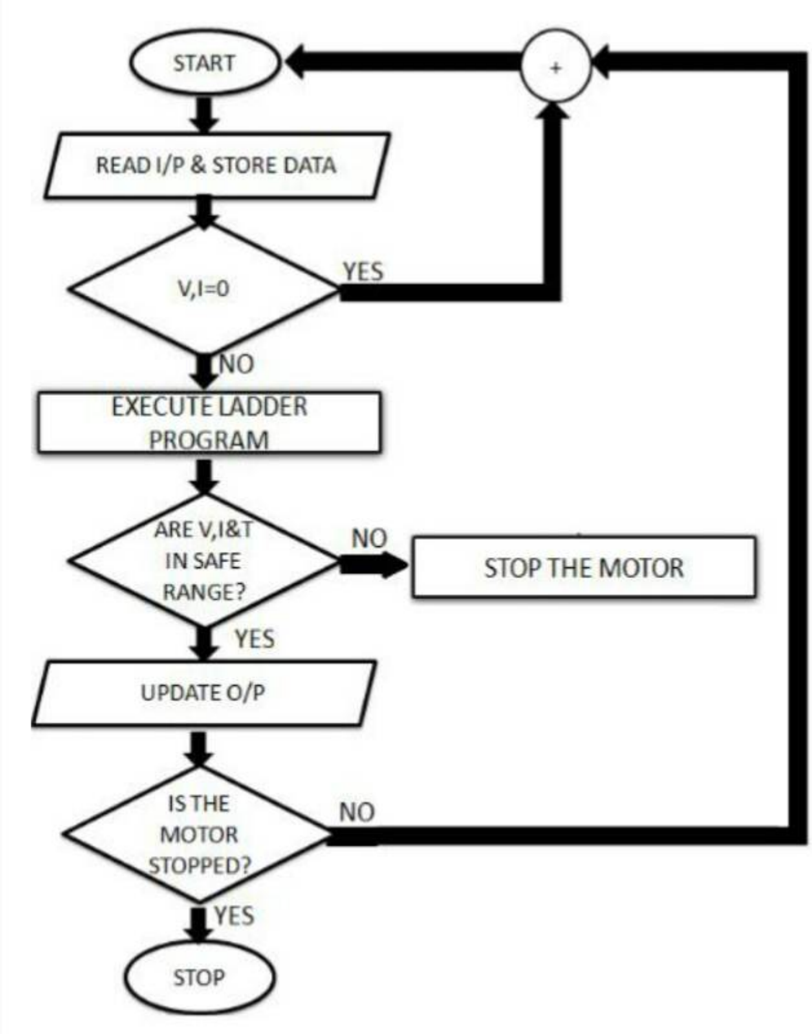
IV. EXPERIMENTAL SETUP & RESULT

Protection of Induction motor is done by continuous monitoring of voltage, current, temperature of the motor. The various steps involved in the execution of the program is shown by using the flow chart.



The dc supply required is produced by a circuit consisting of a step down transformer, a bridge rectifier and a capacitor. The output obtained is 9V. This 9V is given to a voltage regulator and the output is 5V dc. The potential transformer is connected parallel to the supply and current transformer is connected in series with motor. A relay is also connected in series with motor for automatic stopping of motor when fault is detected. The temperature sensor is fitted on the body of the motor. The sensed values from potential and current transformer are fed to PLC through a rectifier and filter unit. The output of temperature sensor is directly fed to PLC. Output from the PLC is given to relay through a transistor to control the motor during abnormal conditions. The output from the PLC is also given to a buzzer which issues a warning sound.

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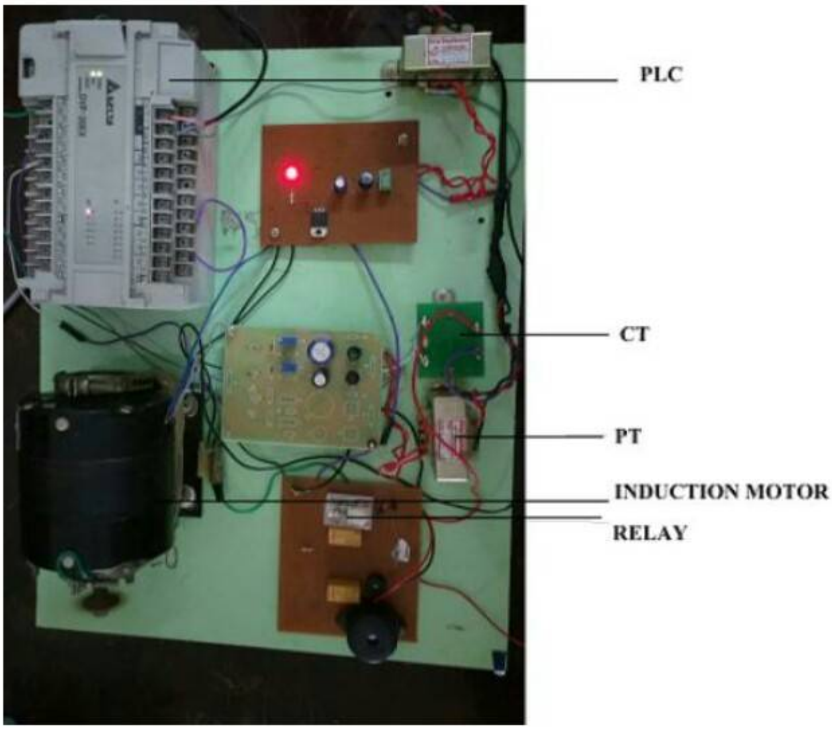

V.CONCLUSION

System for protection of System for protection of induction motor from abnormal conditions using PLC is built and tested. PLCs can be used even in unclean circumstances and environments of high temperatures, humidity and chemicals and thus suitable in an industry than any other logic devices. They have direct interoperability to other industrial devices such as relays, valves, actuators, transmitters, motor starters etc. Simplicity in programming of PLC makes the system more popular. The project can be modified by implementing supervisory control and data acquisition (SCADA), which provides real time monitoring of various parameters of the motor on a computer screen. Further, the protection can be implemented with large three phase motors used in industries.

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