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Control and Monitoring of 3 – Phase Induction Motor Using PLC

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ABSTRACT: Induction motors are widely used in various industrial fields due to their simple, robust and reliable operation. Hence, to get the proper output and efficiency continuous monitoring and controlling is necessary [1]. In this paper, various aspects of three phase induction motor such as speed; temperature, voltage and current are monitored and controlled using the PLC. As sometimes the condition like over voltage, under voltage, overloading, overheating, over speed etc. may give rises to unwanted conditions for the motors [4][5]. Therefore as soon as such condition arises the motor should be turned off automatically. There are various methods for controlling the induction motor such as online fault detection, stator monitoring techniques, systems based upon microcontrollers or PICs. In this paper the method adopted is with the help of PLC (Programmable Logic Controllers). Here the various factors are monitored using sensors and PLC [3]. And if any harmful condition arises motor is turned off automatically.

KEYWORDS: Three Phase Induction Motor, PLC, Speed, Temperature, Voltage, Current, Protection.

I. INTRODUCTION

Induction motors are electro-mechanical devices used in most industrial applications for the transformation of power from electrical to mechanical form. Induction Motors are utilized all over the world as the workhorse as a part of mechanical provisions due to their simple, robust, reliable behaviour. But sometimes they undergo undesirable stress, causing faults and also its failure. Therefore faults are needed to be detected as soon as it occurs to prevent it from damage. Hence, the continuous monitoring of the induction motor is required ie. Whether it is working in the specified limits or not and as soon as it goes out of the required limits motor should be turned off automatically. The method used in this paper is by using the PLC. The main advantage of using PLC is its real time approach as instantaneous values of various components such as phase voltage, phase current; power, power factor, speed, temperature etc. will be displayed on the screen in real time [2]. Various sensors such as thermocouple, encoder are used to measure the temperature and rotor speed of the induction motor. Other perimeters such as voltage, current, power, power factor etc. are also displayed on the screen as well as on the energy meter that is another input source for the plc. PLC used is 24V 12- input 8-output and the software used is twidosoft (version 3.5).

II. PROGRAMMABLE LOGIC CONTROLLER

A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. A PLC is an example of a real time system since output results must be produced in

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response to input conditions within a bounded time, otherwise unintended operation will result. A PLC monitors inputs, makes decisions based on its program, and controls outputs to automate a process or machine [2]. Functional block diagram of PLC is shown in figure 1 in this four block namely CPU, Memory, Inputs and Outputs. The CPU is the central processing unit like a computer which operates as per the program conditions. Memory unit store the program condition in any of the form like ladder logic. Input unit provide the input to the CPU by sensing through the sensors present in the system network and Output unit provide or give the signal to the units/ machines to be operate as per the input conditions.

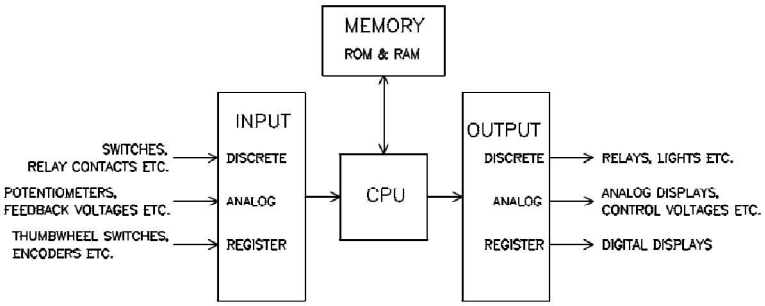

Figure 1: Block Diagram of PLC

The Central Processing Unit (CPU) is the control portion of the PLC. It interprets the program commands retrieved from memory and acts on those commands. Programs are generally written in the PLC in the form of a ladder diagram consisting of vertical rails and horizontal rungs and the program is stored in the memory of the PLC. It can take various types of inputs and generate outputs along with it. In this study voltage, current, speed, temperature etc are taken as inputs and output of PLC is connected to the contractor which is further connected to the motor.

III. METHODOLOGY

In this section methodology taken for the project is discussed and as can be seen in the block diagram in figure 2 below

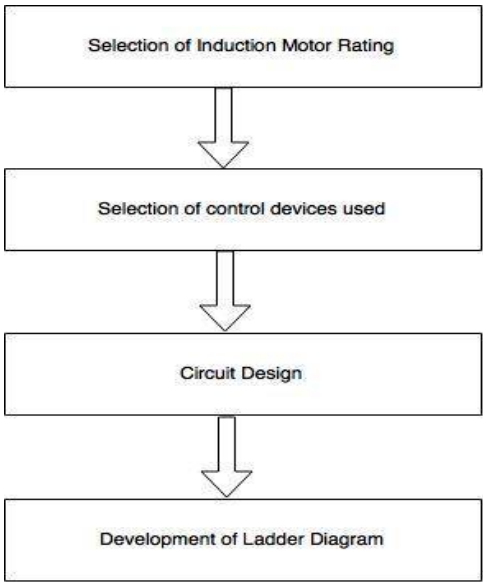

Figure 2: Methodology followed

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the first and the basic step is to select the rating of the induction motor for the project and according to it control devices are selected and the circuit is designed accordingly and finally the programming is done in the PLC according to inputs applied and the outputs required in the operation of the induction motor.

Software used for this work is twidosoft (version 3.5) in which the ladder programming is done considering the methodology required to be followed. A simple flow chart is shown in figure 3 below describing the programming steps that were executed in the program.

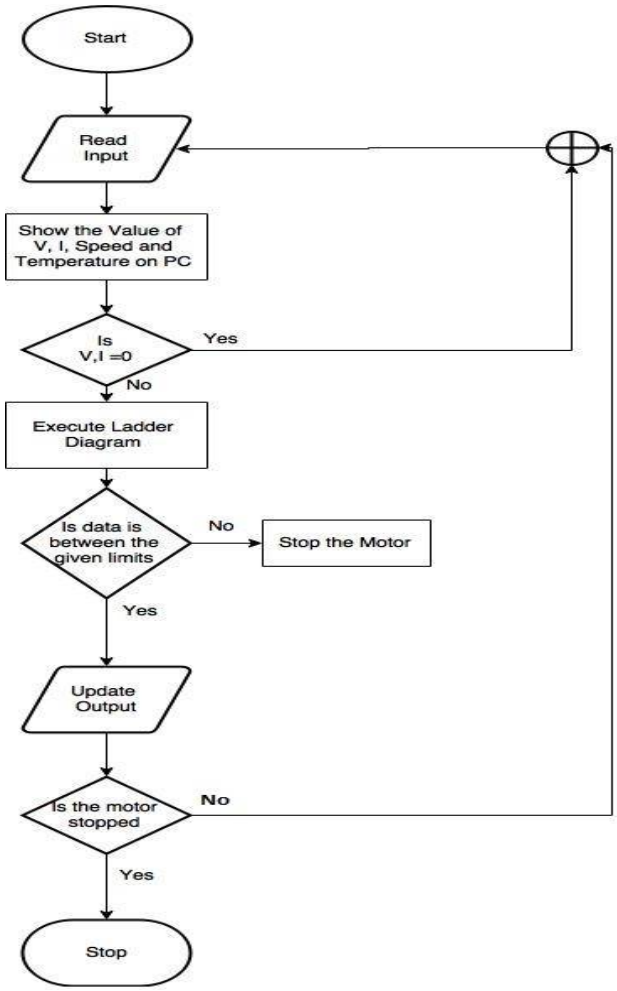

Figure 3: Flow chart of the Program

IV. CONTROL OF INDUCTION MOTOR

Induction motor connection diagram is shown in the figure 4. Inputs are given to the PLC from energy meter, thermocouple and encoder. Motor will only run if the inputs stays in the required limits and as soon as the inputs to the PLC goes beyond the specified values PLC sends the signal to the contractor which cuts off the supply for the motor and motor shuts down.

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Here in this project work specified limits for the voltage are between 350 to 390 Volts and if the voltage comes below 350V or goes above 390V the motor will shut down. Similarly the maximum limits for the current, temperature, speed are set to 6 Amp, 50^0C, 850 RPM respectively

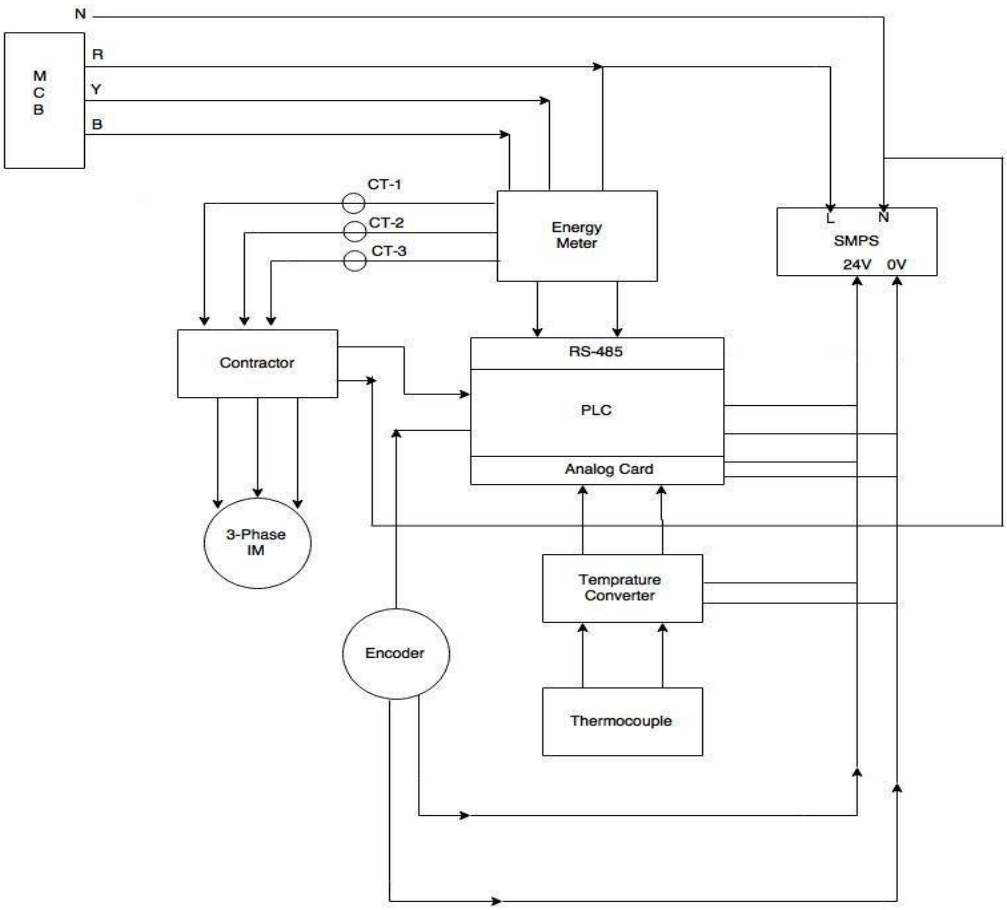

Figure 4: Connection diagram of Induction Motor Protection and Control

V. HARDWARE AND INSTRUMENTATION

Hardware consists of Motor, PLC and other components like energy meter, encoder, thermocouple analog card, temperature transmitter, control transformer, contractor etc. Hardware connections can be seen below in figure 5. In this project Thermocouple is used as a temperature sensing device which converts the temperature sensed into the voltage. This voltage is as low as in millivolts which converted by the temperature transmitter in the voltage range in between 1 to 10 volts. Output of temperature transmitter is send to the analog card which converts the analog input from the thermocouple to the digital form and given to the PLC as input. Encoder is connected to the PLC directly Encoder consists of Optical sensor which senses the rotor speed in the form of pulse trains. Instantaneous values voltage and current (via CT) are measured with the help of energy meter.

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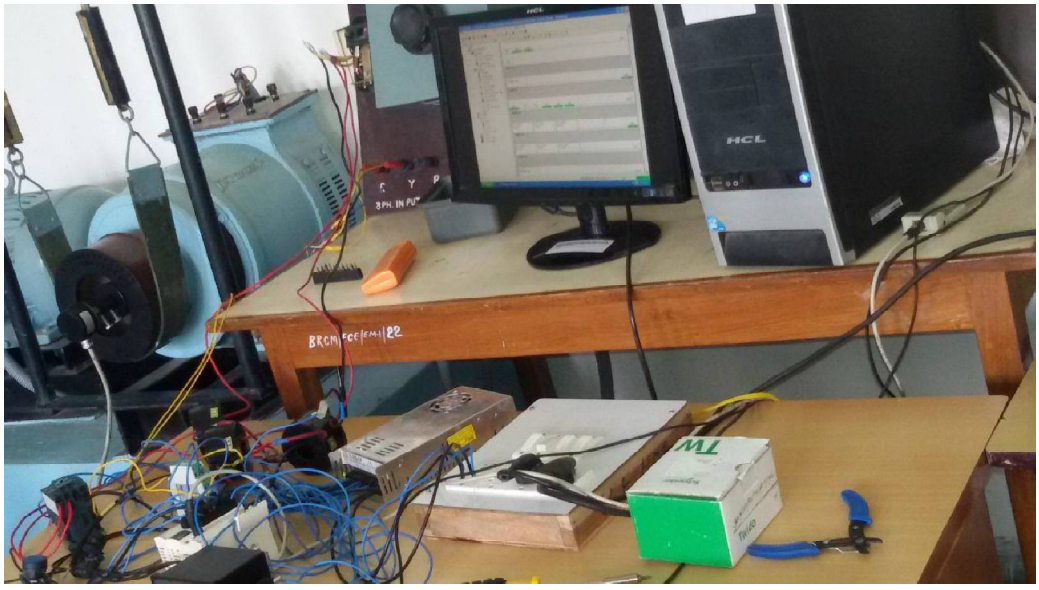

Figure 5: Hardware Connection of the Induction Motor Protection

VI. CONCLUSION AND FUTURE RECOMMENDATION

A three-phase induction motor has been connected to the monitoring and control system with the help of various measuring components. The plc controlled system deals with the most important types of failures of an IM such as over and under voltage, over current, over temperature, over speed etc. If any fault appears during the operation of motor then the motor stops immediately [5]. The test has been found successful in monitoring and controlling the induction motor.

Similar kind of work can be done with the help of SCADA, DCS etc. and further corrective measures can also be taken care off while designing such systems. Other types of faults can also be considered such power factor problems ground faults etc.

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