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PLC BASED INDUCTION MOTOR STARTING AND PROTECTION

[1]Chetan Borse, [2]Akshay Pandhare and [3]Randhir kumar
[1]Department of Electrical Engineering,AISSM's IOIT, Pune
akkshayp22@gmail.com Contact no. 7276707124
[2]Department of Electrical Engineering,AISSM's IOIT, Pune
[3]Department of Electrical Engineering,AISSM's IOIT, Pune

Abstract— The intent of the paper is starting, speed control and protection of induction motor. There bylimitingthe starting current and increase the starting torque and so as to protect the induction motor. There are different methods for starting of the Slip Ring induction Motor. But we have opted the Rotor Resistance Control method forStarting the Induction Motor. Programming is done by using Programmable Logic Controller; control panel isdesigned and programmed according to requirements. The motor will start with high rotor resistance and the rotorresistance is cut off with respective time delay and the motor will run at rated speed. The contactor is used for theswitching of three phase supply to the stator winding. This is how the starting, speed control and protection of induction motor is achieved and the operation is very reliable, sufficiently high efficient. Induction motors arewidely used in many operating areas and industrial applications as they are simple, robust, reliable and have lowproduction costs. The reliability of an induction motor is of great Importance in applications such as commercial,aerospace and military and many industrial applications. In this paper different problems of IM are dealt with asover current, overvoltage, over temperature, over speed, inrush current, vibration monitoring during it's time ofoperation. There are various proposed methods for fault diagnosis and protection of IM. Some of them are Stator fault monitoring techniques, protection system using On-line fault detection, Programmable Logic Controller (PLC)based protection system. In this study, the method which is applied is PLC based protection system of an IM.

Keywords— Induction Motor, Rotor resistance, Protection, Speed control, PLC, Ladder logic, Fault diagnosis

INTRODUCTION

The starting, speed control and protection of Induction motor can achieved easily by using PLC.Three-phase induction motors are widely used in industrial drives because they are rugged, reliable and economical. High Starting torque is a desired feature in some special industrial applications which use 3-Ph Slip Ring Induction motor. An induction motor or asynchronous motor is a 3phase 4pole induction motor. This is a type of alternating current motor where power is supplied to the rotor by means of electromagnetic induction. The 3 phase 4pole induction motor electric motor turns because of magnetic force is exert between the stationary electromagnet called the stator and a rotating. The three-phase induction motors are the most widely used electric motors in industry. They run at essentially constant speed from no-load to full-load .However ,the speed is frequency dependent and consequently these motors are not easily adapted to speed control .We usually prefer d.c. motors when large speed variations are required. Nevertheless, the 3-phase induction motors are simple, rugged, low-priced, easy to maintain and can be manufactured with characteristics to suit most industrial requirements.This3phase 4pole inductions electric motor turns because of magnetic force exert between emotion less electromagnet called the stator and a rotating electromagnet called the rotor. If the slip ring induction motor is started with all the slip rings or the rotor terminals shorted, like a normal induction motor, then it suffers extremely high locked rotor current, ranging upto1400%, accompanied with very low locked rotor torque as low as 60%.So,it is not advised to start a slip ring induction motor with its

OVERVIEWOF BLOCK DIAGRAM

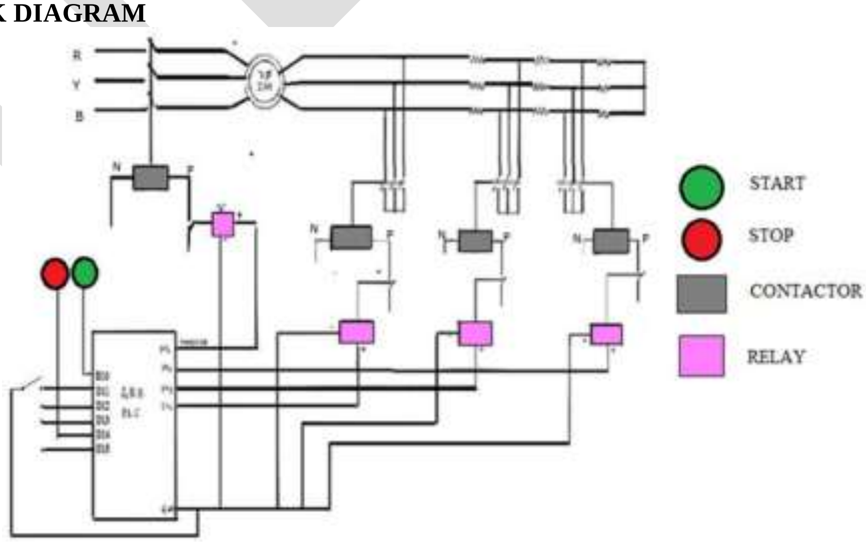


FIG.1 BLOCK DIAGRAM

PROGRAMMABLELOGIC CONTROLLER

A PLC or a programmable controller is a small computer used for automation of real-world processes, such as control of ma- chinery 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 control program is loaded on the PLC memory. The basic structure of the PLC is illustrated in Fig. 2.

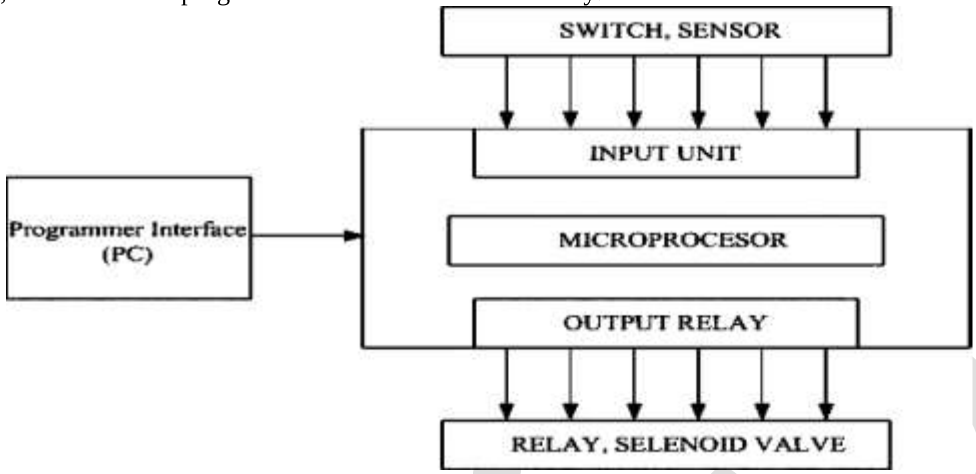


FIG 2PROGRAMMABLE LOGIC CONTROLLER

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. Siemens PLC S7-200 module with 14 digital input/10 digital output addresses with CPU 224 sample (14∗DI 24 V dc/10∗DO 24 V dc) is preferred due to its easy usefulness in experimental application. The PLC programming memory used is composed of 4096 words.

STEP 7—Micro/Win 32 programmer was used as the software. Statement list editor (STL) and ladder diagram (LAD) were used as programming languages. Software of the PLC was prepared on the computer and loaded on the PLC by RS 232-RS 485 PC/planposition

indicator (PPI) cable. While the program prepared is being loaded on the PLC from the computer, the most important point is the baud rate between the PLC and the computer. The baud rate must be appropriate to switch setup on the bound cable in manual.

II) PROTECTION SYSTEM

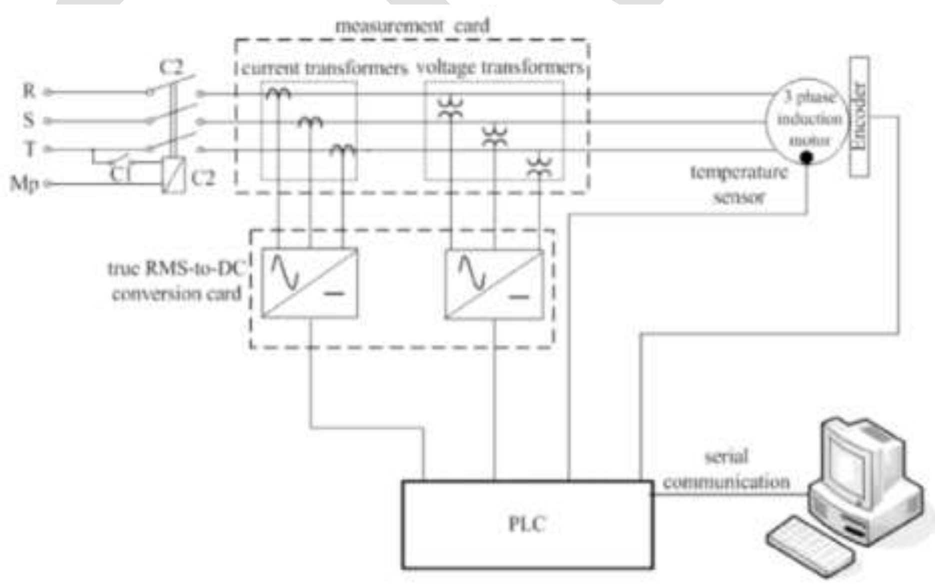


FIG.3.SCHEMATIC DIAGRAM OF THE PROTECTION SYSTEM.

Motor Electrical Protection

- Thermal Overload
- Process Caused (Excessive load)
- High Ambient Conditions (Hot, Blocked Ventilation)
- Power Supply Issues (Voltage/Current Unbalance, Harmonics)
- Phase Fault

• Ground Fault
• Abnormal Operating Conditions
• Over & Under Voltage
• Underfrequency
• Voltage and Current Unbalance
• Load Loss
• Jamming
• Jogging

Overvoltage Protection

The overall result of an overvoltage condition is a decrease in load current and poor power factor.Al though old motors had robust design, new motors are designed close to saturation point for better utilization of core materials and increasing the V/Hz ratio cause saturation of air gap flux leading to motor heating.

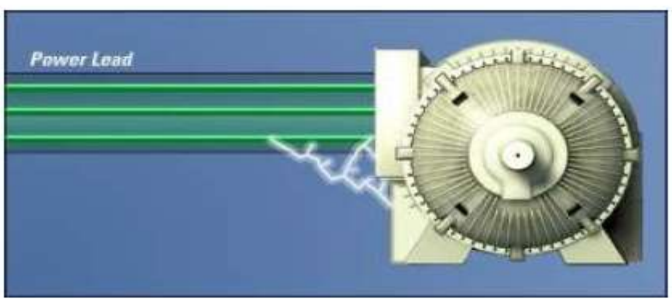
The overvoltage element should be set to 110% of the motors nameplate unless otherwise started in the data sheets.

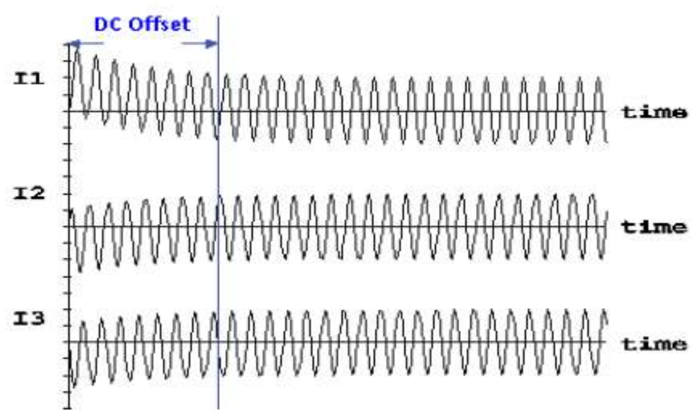
Undervoltage Protection

The overall result of an undervoltage condition is an increase in current and motor heating and a reduction in overall motor performance. The undervoltage protection element can be thought of as backup protection for the thermal overload element. In some cases, if an undervoltage condition exists it may be desirable to trip the motor faster than thermal overload element. The undervoltage trip should be set to 80-90% of nameplate unless otherwise stated on the motor data sheets. Motors that are connected to the same source/bus may experience a temporary undervoltage, when one of motors starts. To override this temporary voltage sags, a time delay set point should be set greater than the motor starting time.

Short Circuit Protection

The short circuit element provides protection for excessively high overcurrent faults Phase-to-phase and phase-to-ground faults are common types of short circuits When a motor starts, the starting current (which is typically 6 times the Full Load Current) has asymmetrical components . These asymmetrical currents may cause one phase to see as much as 1.7 times the RMS starting current. To avoid nuisance tripping during starting, set the the short circuit protection pick up to a value at least 1.7 times the maximum expected symmetrical starting current of motor. The breaker or contactor must have an interrupting capacity equal to or greater then the maximum available fault current or let an upstream protective device interrupt fault current.





LADDER LOGIC FOR STARTING OF MOTOR

DIFFERENT PROGRAMMING LANGUAGES

1. LADDER DIAGRAM
2. FUNCTIONAL BLOCK DIAGRAM LANGUAGE
3. SEQUENTIAL FUNCTION CHART LANGUAGE
4. INSTRUCTION LIST LANGUAGE

HERE WE ARE USED LADDER LOGIC FOR STARTING AND PROTECTION PURPOSE

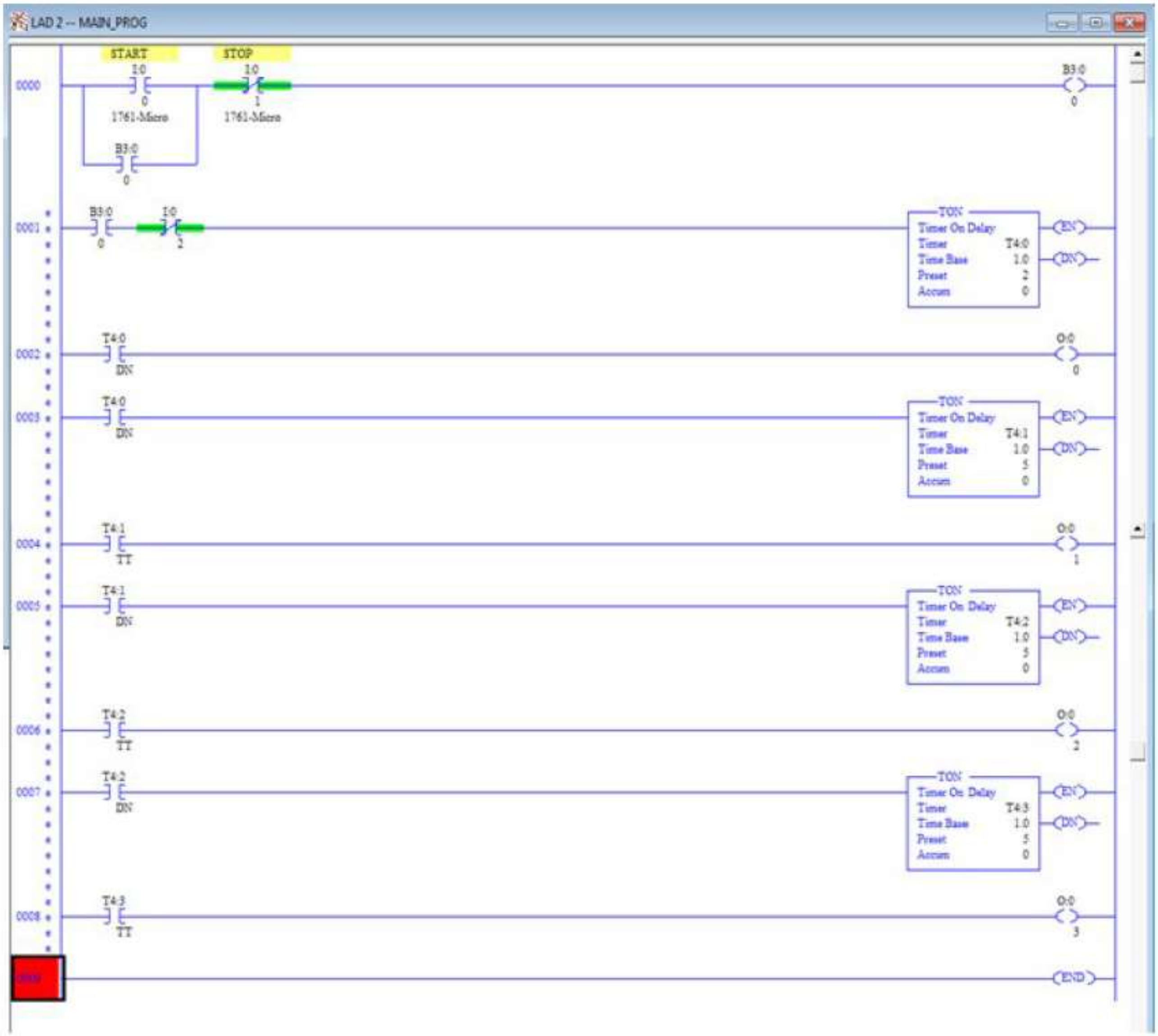


fig.4.ladder logic for starting of motor

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CONCLUSION

Speed control and protection of induction motor is achieved and the operation is very reliable, sufficiently high efficient. Without changing in any hardware connection just by simply changing the program in the PLC; the motor can be made to run in for any duration of time. This system also used for one of the starting method of three phase slip ring Induction motor this system not only reduces the starting current to a limit, but also develops High starting torque which is required in many of the induction motor applications. This can be applicable to run the lift, by changing the logic in a program and it can also be used for any industrial applications. This PLC based system requires less hardware compared to any microcontroller or microprocessor based system. Programmable Logic Controllers (PLC) are widely used in industrial control because they are inexpensive, easy to install and very flexible in applications. A PLC interacts with the external world through its inputs and outputs.

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