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PLC Based Slip Ring Induction Motor Starting and Protection

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ABSTRACT

The intent of the paper is starting, speed control and protection of induction motor. There bylimitingthe starting currentand increase the starting torque and so as to protect the induction motor. There are different methods for starting of the Slip Ringinduction Motor. But we have opted the Rotor Resistance Control method forStarting the Induction Motor. Programming is done byusing Programmable Logic Controller; control panel isdesigned and programmed according to requirements. The motor will start withhigh rotor resistance and the rotorresistance is cut off with respective time delay and the motor will run at rated speed. The contactor isused for theswitching of three phase supply to the stator winding. This is how the starting, speed control and protection of inductionmotor is achieved and the operation is very reliable, sufficiently high efficient. Induction motors arewidely used in many operatingareas and industrial applications as they are simple, robust, reliable and have lowproduction costs. The reliability of an inductionmotor is of great Importance in applications such as commercial,aerospace and military and many industrial applications.

In this paperdifferent problems of IM are dealt with asover current, overvoltage, over temperature, over speed, inrush current, vibration monitoringduring it's time ofoperation. There are various proposed methods for fault diagnosis and protection of IM. Some of them are Statorfault monitoring techniques, protection system using On-line fault detection, Programmable Logic Controller (PLC)based protectionsystem. 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*

1. INTRODUCTION

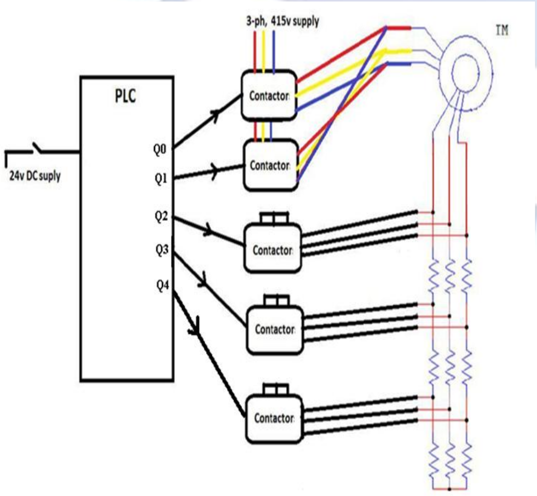
Three phase induction motors are the heart of industries. Every industrial process is associated with induction machines either directly or indirectly. Its robustness and simple construction has led to vast industrial applications. When we see importance of induction motors in industries the question of its protection and monitoring arises. Industrial induction motors are used in different processes due to which they may exhibit abnormal conditions like over voltage, over current, over temperature and many others. If these faults are not controlled in the defined time span, it can completely destroy the induction motor. The conventional methods of protection of induction motors uses mechanical relays and microcontroller and other discrete components that led to time delay and other processing problems which could result in damage to the costly industrial motors. Thus when it comes to huge industrial control units the modern method of protection plays an important role.

There are various different techniques which have been used to cope with different mechanical and electrical faults in Induction. This includes modern protection methodology where complete protection is done through the programmable logic controller (PLC). In this method of protection, the online monitoring of induction motor is done and all the necessary electrical parameters – voltage, current and temperature are monitored. If the parameters are bounded which mean all the parameters are within their normal operating range, the PLC will continuously be allowing the induction motor to be connected with the three phase supply. However, if there is any disturbance found, PLC will trip the induction motor by giving a tripping-signal to magnetic contactor and relay as per the programmed conditions.

The protection scheme using solid state relays coupled with PLC and magnetic contactors. Hence the drawbacks associated with mechanical relays are eradicated.

Three-phase induction motors arewidely used in industrial drives because they are rugged, reliable and economical. High Starting torque is a desired feature in somespecial industrial applications which use 3-Ph Slip Ring Induction motor. They run at essentially constant speed from no-load to full-load.If the slip ring induction motor is started with all the sliprings or the rotor terminals shorted, like a normal induction motor, then it suffers extremely high locked rotor current, rangingupto1400%, accompanied with very low locked rotor torque as low as 60%.So,it is not advised to start a slip ring induction motor withits rotor terminal shorted.

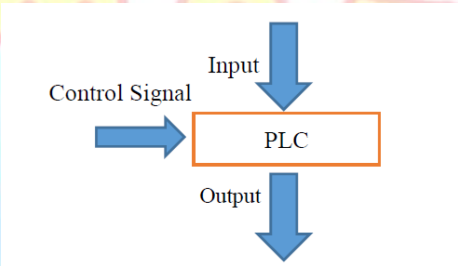
II . SYSTEM DESIGN



At the instant of starting, the contactors of eachstage resistance is set to 'OFF' position. This inserts maximum resistance in series with each phase of the rotor circuit. This reduces the starting current and at the same time starting torque is increased due to external rotor resistance.

As the motor accelerates, the external resistance is gradually removed from the rotor circuit with the given time delay as per program. When the motor attains rated speed, last contactor will removes the whole external resistance from the rotor circuit.

Slip Ring induction motors are mainly used for driving high inertia loads or the loads which require a starting torque across a full speed range. Hence, by correctly selecting the starting resistors inserted into the rotor circuit, the maximum torque can be obtained from the motor at a relatively low starting current. Thus, the magnitude of starting torque is controlled by the value of starting resistance.



Programmable Logic Controllers are essentially a computing device. The PLC monitors input signal, processes the data received and then makes decisions based on the stored program ladder logic.

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. Although old motors hadrobust design, new motors are designed close to saturation point for better utilization of core materials and increasing the V/Hzratio 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 motorperformance. The undervoltage protection element can be thought of as backup protection for the thermal overload element. In somecases, if an undervoltage condition exists it may be desirable to trip the motor faster than thermal overload element. The undervoltagetrip should be set to 80-90% of nameplate unless otherwise stated on the motor data sheets. Motors that are connected to the samesource/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 arecommon types of short circuits When a motor starts, the starting current (which is typically 6 times the Full Load Current) hasasymmetrical 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 maximumexpected symmetrical starting current of motor. The breaker or contactor must have an interrupting capacity equal to or greater thenthe maximum available fault current or let an upstream protective device interrupt fault current.

PLC measures the current, the voltage, the temperature, speed and many others factors of an induction motor through analog inputs.

In addition, it continuously monitors the inputs and activates the outputs according to the program.

2. CONCLUSION

The aim of this paper is to develop a system to 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 As discussed it is possible to use PLC for motor protection as well as for indication by visual or audible alarm by assigning digital output This is possible using analog input card for PLC Another advantage is the parameters can be recorded to get details of parameter trends also The trends are available using SCADA software and are useful for future analysis and production planning.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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