International Journal of Research in Engineering, Science and Management
Volume-2, Issue-6, June-2019
www.ijresm.com | ISSN (Online): 2581-5792

Fault Detection and Protection of Induction Motor by using PLC

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***Abstract*: Induction motor is rotating type of electro-mechanical device. Induction motor convert electrical energy into mechanical energy. Induction motor is highly reliable, require less maintenance and have high efficiency. Induction motor are wide in range of operation and it used in many application because its construction is simple and robust. In past induction motor can be protected by manual operation of component such as timer, contactor, electromagnetic switch, voltage and current transformer. Protection of an induction motor against problem such as short circuit, temperature rise, single phasing and motor vibration occurring in the operation is very important. Manual operation of protection system are very slow and is not accurate. Looking to this issues, in this paper PLC based protection method is used. Which operated automatically, provide higher accuracy and quick response.**

***Keywords*: PLC, 3 Phase Induction Motor, fault analysis and detection, Economical, Reliable.**

1. Introduction

Induction motor work on the principle of electro-magnetic induction. In which electromagnetic field induced into the rotor when rotating magnetic field of stator cut the stationary rotor. Induction motor is the most modest electrical machine from construction point of view. Induction motor are highly reliable, require low maintenance and have high efficiency [1]. The motor fault is due to mechanical and electrical stress. Mechanical stress is caused by overload and suddenly load change, which can produce vibration in motor [4]. Electrical stress is caused by Short circuit, temperature rise and some other fault like speed, single phasing. Hence the failure occurs in the motor, such failure is costly, increase maintenance cost and wasted raw material. To overcome above problem, the fault detection and protection of induction motor by using PLC (Programmable Logic Controller) method can be used.

Fig. 1, shows the block diagram in which, CT (current transformer) & PT (potential transformer) are used for current and voltage measurement, LM 35 for measuring temperature and vibration by using piezoelectric sensor. The output of these sensor are given to PLC.

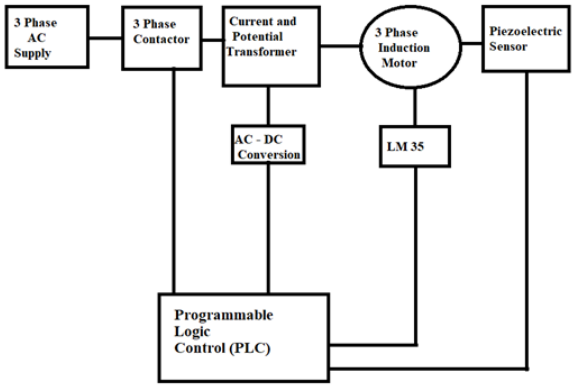

Fig. 1. Block diagram of fault detection and protection of induction motor by using PLC

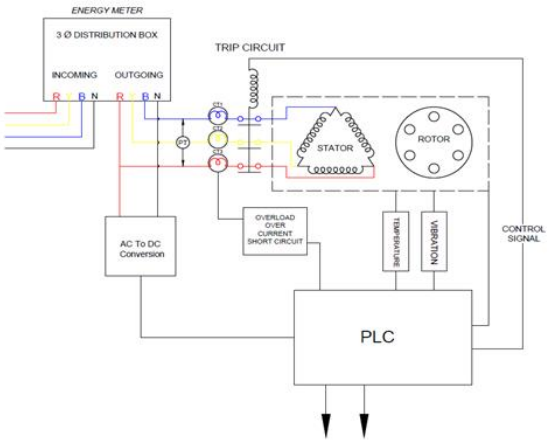

Fig. 2. Circuit Diagram for fault detection and protection of induction motor by using PLC

In above circuit diagram the three phase supply is given to motor through trip coil. The phase voltage, phase current, temperature and vibration are monitored using PLC. This monitored value are continuously compared with their rated value stored in PLC. If any fault occur, the program automatically stop motor immediately. The motor is shut down by the control signal sent from PLC. When motor turn off indication is shown.

2. Components specification

A. *Programmable logic controller*

Fig. 3. PLC- 8D1, DIGIX-1-230 V

- Output Rating- 5A, 230V AC,24V DC
- Code memory- 112 KB
- Digital input- 8, Digital output-5
- Communication Interface- RS485 Based MODBUS RTU Protocol
- Supply Voltage- 180-270 VAC, 50/60 HZ, 18-20V DC

B. *Potential transformer*

PT Ratio – 230:5V

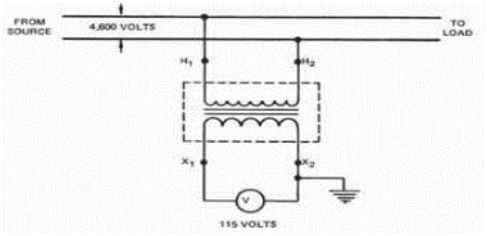

Fig. 4. Potential Transformer

C. *Hall effect based linear ac current sensor*

- Operating current- 3.3 mA
- Sensitivity- 525 mV/A
- Voltage range- 3-12 volt
- Internal conductor resistance- 8.3 mohm
- Bandwidth- 13KHz

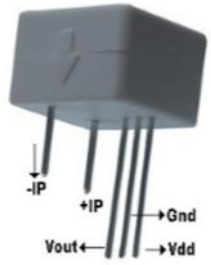

Fig. 5. Hall effect based linear ac current sensor

D. *Temperature Sensor (LM35)*

- Calibrated directly in ° Celsius
- Linear + 10 mV/°C Scale Factor
- 0.5°C Ensured Accuracy (at +25°C)
- Rated for Full −55°C to +150°C Range
- Operates from 4 to 30 V DC

E. *Piezoelectric Sensor*

- Dynamic Range- 0.1Hz-180 Hz
- Impedance- <500 ohm
- Voltage- > 30 volt
- Operating temperature- 20 deg. Cel.

F. *Induction Motor*

- Rated Speed – 1400 RPM
- Rated Current – 4.7 Amp.
- Voltage – 415V
- HP – 3
- Insulation Type – Class

3. Simulation result

A. *Partial Hardware*

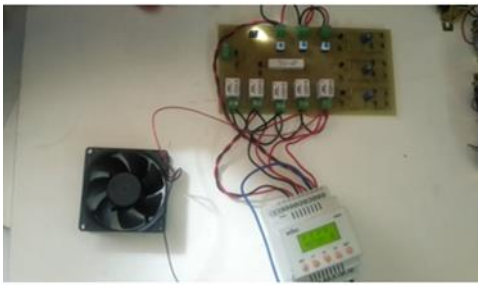

Fig. 6. Partial Hardware of Project

The voltage and current measurement is done using a voltage transformer and current transformer respectively. Bridge rectifier are connected with both the voltage and current transformer to convert the AC to DC. The piezoelectric sensor is used where the voltage produced is proportional to the vibration from the motor and this voltage is given to the analog input of the PLC.

B. *Ladder logics for PLC*

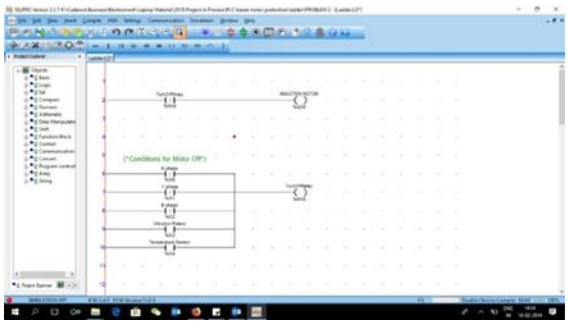

Fig. 7. Ladder Diagram

For select PLC SELPRO version 5.3.7, software is used for design the ladder logic for PLC. Once the ladder logic program prepared on the computer, it is loaded into the PLC using a RS-232 cable. Generally, separate software's are needed for various types of PLCs.

4. Conclusion

In the project the automated protection system for three phase Induction motor are designed. This will be implemented successfully. If any fault is observed during online operation of the motor, warning message appear and then the motor is stopped. It provides a visual environment, which makes the system more friendly and faster than other techniques.

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