

Protection Scheme of Three Phase Equipment

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Abstract: The induction motors are predominant in industrial applications. The motor runs on three phase supply and an acceptable temperature maintain the loads at desired conditions. But if any phase goes missing or there is increase in the temperature of the windings it damages the motor. Therefore, this project helps to provide protection to the industrial motors by removing the power to the motor immediately if any of the phases misses out of the three phases, or if the temperature of the motor exceeds the threshold value. Thus, this project is to develop an induction motor protection system for protecting the motor from any damages occurring from single phasing and over temperature conditions.

Keywords: single-phasing, over temperature, op-amp, comparator.

I. INTRODUCTION

The project is designed to protect an induction motor from single phasing and over temperature. In industries where a lot of motors are used, it is recommended to provide a protection scheme for continuity of production. The basic idea for the development of this project is to provide safety to the industrial motor/pump/lift Motor etc. If any of the phases, out of the 3 phases is missing or if the temperature of the motor during operation exceeds the threshold value, motor stops immediately. The system uses a 3-Phase power supply where three single phase transformers are connected to it. If any of the phases is not available the corresponding transformer stops supplying power to the circuit. This leads to one of the four relays getting switched OFF. The main relay which is powered through a set of four relays gets disconnected because of one relay not being powered. Thus the main relay that delivers 3 phase supply to the motor gets disconnected. A thermistor is connected to the motor body to sense the temperature. If the temperature increases then supply to the fourth relay is disconnected.

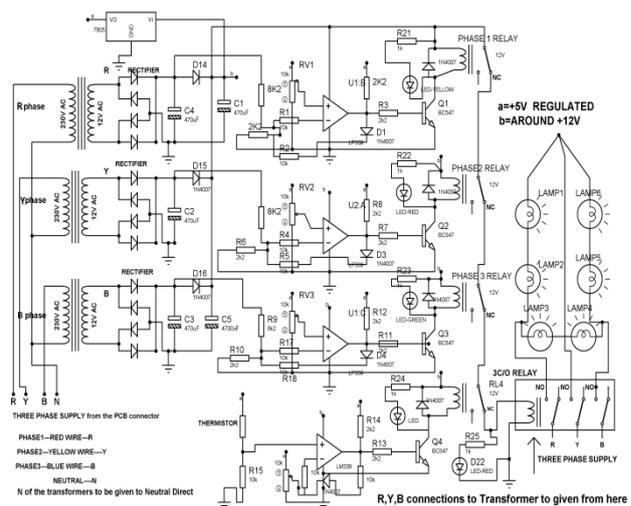


Fig: 2 Circuit Diagram of the Project

II. DESCRIPTION AND WORKING

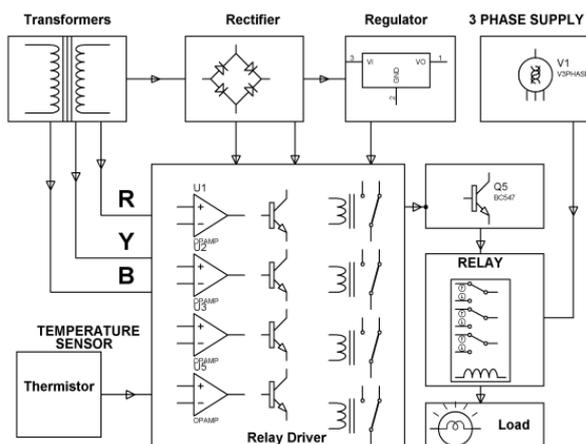


Fig: 1 Block Diagram of the Project

A. Description

Three numbers step-down transformers from 230v to 12v are used with their primary connected in star and secondary are individually fed to three bridge rectifiers with filter capacitors C2, C3 & C4 from where the DC voltage is fed to a quad Op-amp used as comparator LP339/LM339 to the respective inverting inputs after passing through potential divider. The non-inverting inputs of first three comparators are given pre-settable DC voltage by RV1, RV2 & RV3. Another Op-amp is used to with its inverting input by a pre-settable voltage while its non-inverting input is given to a series connected thermistor resistor arrangement across the 5v supply. The output of all the 4 comparators is given to drive Q1, Q2, Q3, and Q4 that operate respective relays. All the common NC contacts of the relays are connected in series and are fed from a DC supply to another 3 CO relay coil with the other point of that connected to GND. Three diodes D14, D15 & D16 are used respectively from each secondary generated DC and finally filtered by C1. Reason behind

this is to ensure un-interrupted DC supply for the circuit operation in the event of failure of any one phase. A regulator IC 7805 is used for providing steady voltage reference to RV1, RV2, RV3 and RV4.

B. Working

In normal operations pre-sets RV1, RV2, RV3 & RV4 are so set that the output of the comparators is held low resulting in 4 relays phase1 relay, phase2 relay, phase3 relay, temperature relay number4 all are in deactivated condition so the 12v dc flows through NC contacts of the those relays to the coil of the 3CO relay forcing it be in active operation so that 3 phase supply is available to the load through the NO contact of the 3CO relay. The project uses lamps instead of the motor. In the event of failure of any phase the corresponding comparator output goes high that switches ON the respective relay, the contact of which opens to discontinue the 12V DC supply to the 3CO relay coil. As the 3 CO relay now is deactivated the 3 phase motor connected in series with the NO contacts open to stop the motor. Similarly while the temperature goes high on the body of the motor, the mounted thermistor resistance falls to develop logic high for Q4 to operate relay4 & disconnect the DC voltage to the 3CO relay coil. Thus in the process the motor is protected against any phase failure or high body temperature.

III.OBSERVATION

The setup is connected to a 3-phase induction motor of rating 1kW and 440V AC 3-phase. During discontinuity of any one phase of the motor, the set up shuts down the entire power flow from the mains to the motor. Also when a temperature rise occurs in the motor windings, the thermistor in the set up senses it and if the rise is more than the permissible limit of the motor. In this project, the induction motor used is having Class B insulation, so the temperature limit is around $120^{\circ}\text{C} \pm 10\%$.

IV.NEED OF THIS SYSTEM

Three-phase induction motors are accountable for 85 per cent of the installed capacity of the industrial driving systems. Therefore, the protection of these motors is necessary for reliable operation of loads. Motor failures are mainly divided into three groups: electrical, mechanical and environmental. Mechanical stresses cause overheating resulting in the rotor bearings wear and tear thus further results in increasing temperatures. Electrical failures are caused by various faults like Phase-to-phase and phase-to-ground faults, single phasing, over and under voltage, voltage and current unbalance, under frequency, etc. If single phasing occurs then other two phases develop negative sequence current in rotor bars, increase motor noise, decrease its speed, rotor bars and stator windings are over heated. For over and under voltage fault as the name implies if phase voltage is beyond and below 220V respectively. Similarly over temperature occurs when temperature of the motor exceeds its normal temperature.

These faults will damage the motor or reduce its lifetime. In this project we design a circuit which provides protection from some of the above electrical faults such as single phasing, over and under voltage and over temperature.

V. CONCLUSION

The basic idea for the development of this project is to provide safety to the industrial motor/pump/lift Motor etc. If any of the phases, out of the 3 phases is missing or if the temperature of the motor during operation exceeds the threshold value, motor stops immediately. Further the project can be enhanced by using current sensors for over load protection and phase sequence sensor for protecting the motor from applying wrong phase sequence.

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