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Universal Protection System for Ac Industrial Motors

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Abstract: *The purpose of designing this project is to protect alternating current motors from various faults such as over-voltage, over-current, under voltage, unbalanced current & over heating etc. Protection system for motors plays a vital role in industries such that production is not slow down owing to failure of any motor. The main idea for the development of this project is to offer safety to the AC industrial motors, pumps and very high speed motors. If any of the given phase gets damaged (due to fault) or if any over current or over voltage fault occurs motor stops immediately. If any of the phases is not available the respective transformer will stop supplying power to the circuit. Further the project can be expanded by using current sensors for over load protection and phase sequence sensor for protecting the motor from wrong phase sequence. We are using microcontroller which will compare the current data with the predefined data and if found faulty then it will command relay to trip and will protect the ac motors.*

Keywords: *AC Motors, Protection, Microcontroller, Relay, Contactors*

I. Introduction

Nowadays, due to the Modern power systems, the system requires high degree of reliability. A system during its operation may develop some trouble or may produce some abnormal condition of operation, which may cause damage to the equipment's. Among them some of the situations are unavoidable and beyond human control. Therefore, to detect such fault conditions and react quickly in order to minimize adverse impact, a real-time algorithm is required [1]. This monitoring function is efficiently managed by a smart electronic device, known as the protection relay, which continuously observes the grid parameters (such as voltages & currents) and switches the appropriate devices in faulty conditions. Most of the data processing happens in the digital system. So, these devices are called as Numerical or Digital Protection Relays.

Electric motors are very important for any industrial plant, and often run critical processes. The motors which have ratings below 3.3kV are known as Low Tension (LT) Motors and those whose are ranging from 3.3kV to 11kV are called as High Tension (HT) Motors. Motors which are used in manufacturing sector like oil, gas and mining industries consumes electricity of around 90%. Thus, motors are a remarkable investment. But if we analyse the statistics, we can say that despite of having reliability of operation and simplicity of construction, annually the motor failure rate is around 3.5-5%. Downtime in a factory can be expensive and, can also exceed the cost of motor replacement.

Hence, a proper motor protection is required to minimize the motor failure rate, prevent damage to equipment associated and to ensure production targets along with personnel safety [2].In industries many faults in motors occurs such as,

- Over Current
- Unbalanced current
- Over voltage
- Under voltage
- Symmetrical faults
- Single phasing
- Over load
- Temperature rise etc.

So to avoid effects of such problems we will make universal protection system for ac motors which will protect our motor from above problems. And it will be user defined as per the ratings of motors (up to 25 amps). The basic idea for the development of this project is to provide safety to the industrial motor, pumps and very high speed motors i.e. spindle motor, Induction motors etc. In this system three single phase transformer are connected to three phase power supply.

II. Literature Survey

Over a hundred years ago, since the beginning of system protection, the protective relaying in industrial and utility power systems has tremendously evolved. Electromechanical relays were the defective protection devices without the use of microcontrollers. These were more preferable for simple protective functions of individual loads, but not preferable for complex system [c][d]. Around 1970s, solid-state static relays replaced the EM relays with a slight change in protection scheme. The design consisted of analog circuits for detection of current/voltage value, instead of coils and magnets. After the detection of input signal, a comparator circuit determined the overload condition. But, for designing the statics relay there were certain problem which were arising adding to its limitations [c][d]. The first generation microprocessor based numerical relays then brought innovations in developing new algorithms and the beginning of combining several protection functions in one multifunction relay package. Major difference in analog circuits here was the use of analog to digital converter [3][4].

These relays have built-in test routines, it is also called as a "watchdog", that signals an alarm output, & the operators know when the relay fails. A report on "Large Motor Reliability Survey of Industrial and Commercial Installations", published by the IEEE Motor Reliability Working Group gives results of IEEE surveys on motor reliability and major causes of motor failure[5]. A summary of these results is shown in Table 1:-

Table 1

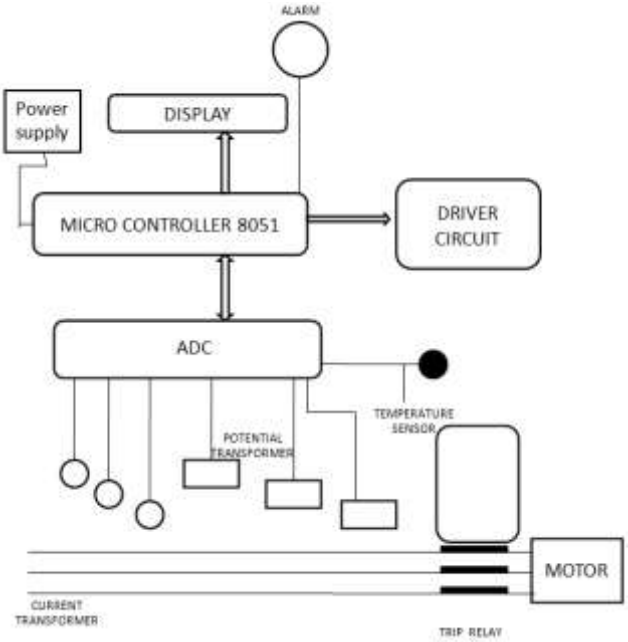
Failure Contributor	Percentage
Overload	30%
Insulation damage	20%
Phase failure	14%
Bearing damage	13%
Ageing	10%
Rotor damage	5%
Others	8%

The various limitations found in presently available relays are [6]:

- Error in Phase angle while detection.
- Analog input range is not accurate.
- Noise problems while operating.
- Capability of communication is very less.
- Low precision in calculation of analog inputs.
- Response time is slow.
- Data storage is constant.
- Less facility of disturbance record.

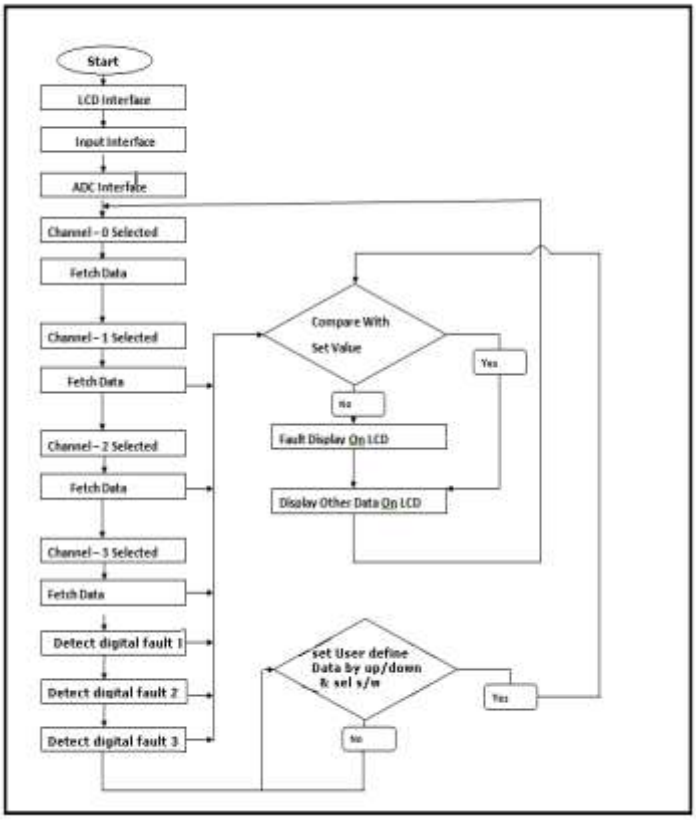
III. Block Diagram

Fig 1 shows the block diagram of the protection system. Here the three single phase transformer are connected to three phase supply. Three CT,s and three PT,s are connected to three phase supply. AC supply is converted to DC supply using converter circuit and it is fed to ADC. Further, the digital pulses are given to microcontroller from ADC. 5v external supply is to be given to operate microcontroller where display is given so that we can continuously check parameters such as voltage, current, temp, etc. Microcontroller will not directly drive the relay when fault occurs, so we require relay driver circuit. We are using ULN 2003 relay driver IC which can drive total 8 relay from the range of 5v to 12v. We are also using the contractor for tripping the circuit. Basically contactor is an electrically controlled switch used for switching an electrical power circuit

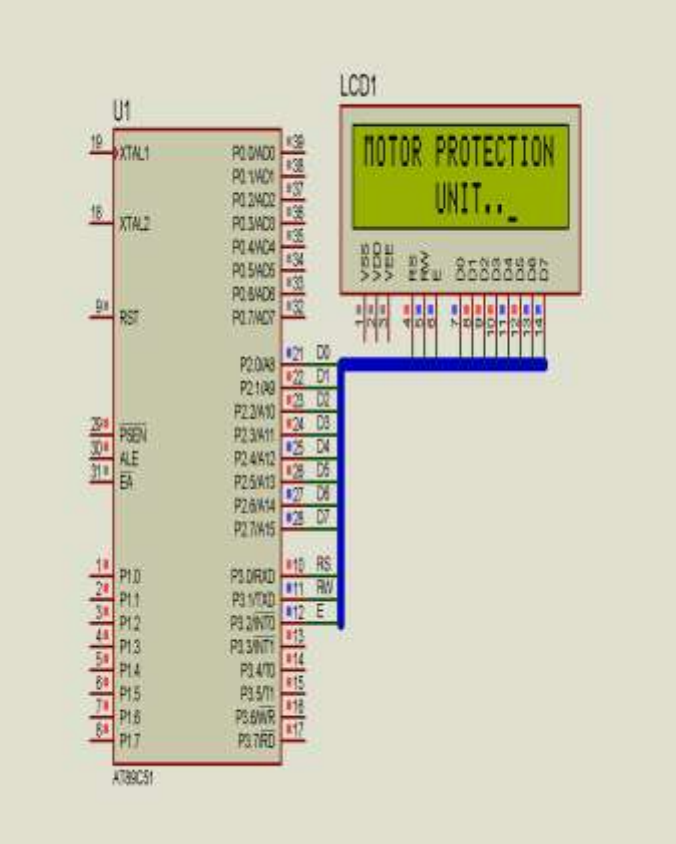


IV. Flow Chart

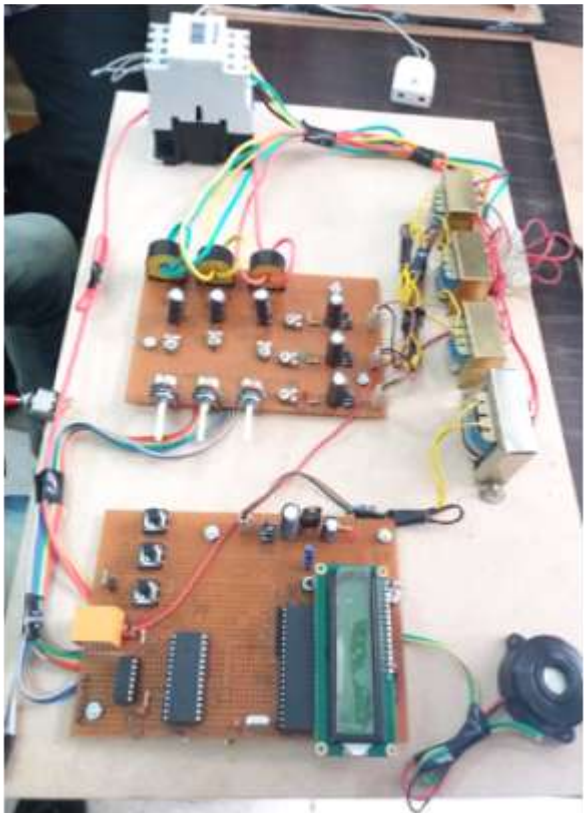
In the starting our system will show our system's name "MOTOR PROTECTION UNIT" then it will start showing normal operating data of voltages, currents and temperature of every single phase. Now it will compare this data of every phase step by step with pre-set values. And this information will be sent to microcontroller. Now when error or fault is found or detected at that time fault will be displayed on LCD and again loop will be restarted. We can set our data as per the rating of the motor at every restart.



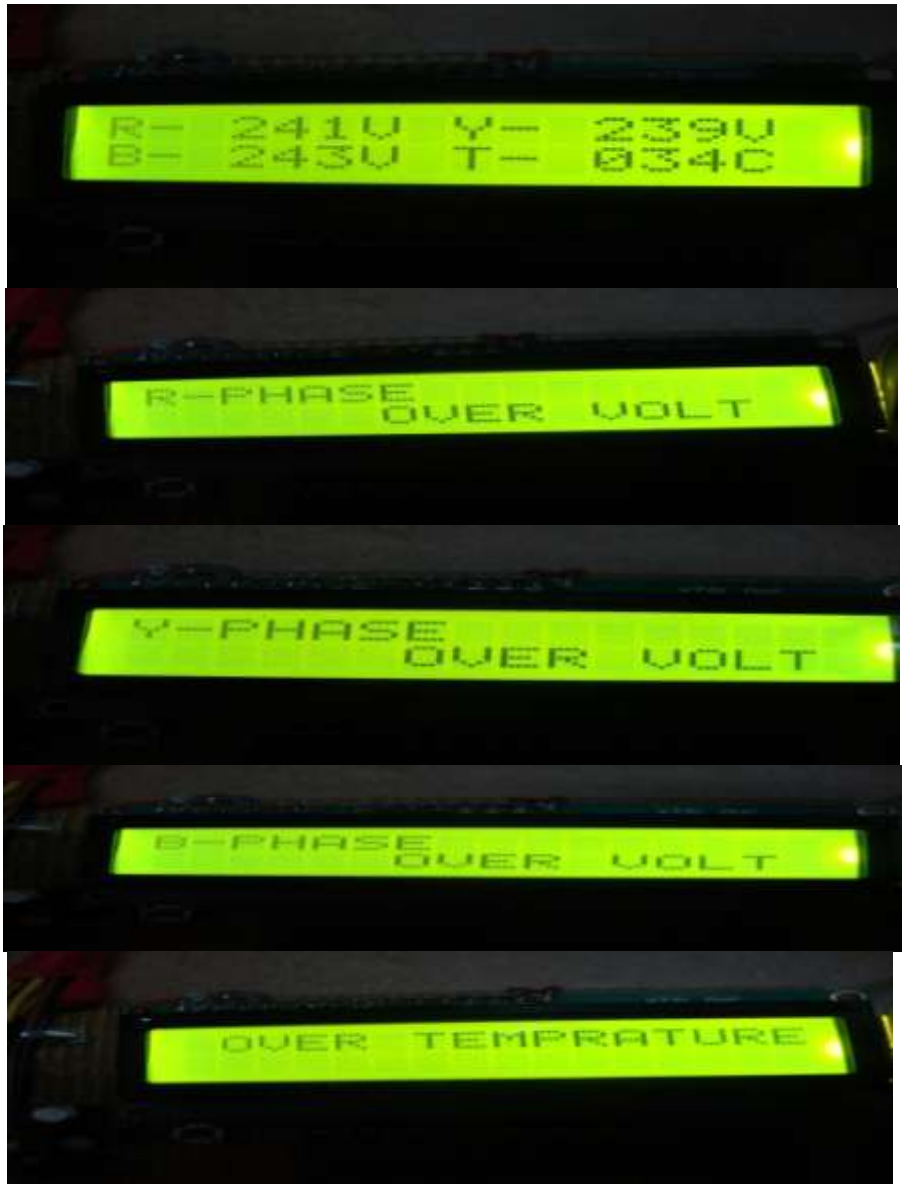
V. Simulation Results



VI. Hardware Circuit



VII. Results & Discussions



We have manually made faults on every phase and made the system to trip the circuit. When R phase's voltage become more than rated value, our system identified the fault and tripped the circuit. And at that time LCD was showing R PHASE OVER VOLTAGE.

We have manually made faults on every phase and made the system to trip the circuit. When Y phase's voltage become more than rated value, our system identified the fault and tripped the circuit. And at that time LCD was showing Y PHASE OVER VOLTAGE.

We have manually made faults on every phase and made the system to trip the circuit. When R phase's voltage become more than rated value, our system identified the fault and tripped the circuit. And at that time LCD was showing B PHASE OVER VOLTAGE.

We have manually made faults on every phase and made the system to trip the circuit. When phase's current become more than rated value, our system identified the fault and tripped the circuit. And at that time LCD was showing OVER CURRENT.

We have set the temperature limit to 40^0 C and we have continuously ran the motor at full load until temperature increased beyond 40^0 C and when system's temperature is above critical limit circuit will trip and system will show "OVER TEMP" on LCD screen.

VIII. Acknowledgement

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IX. Conclusion

Providing protection using digital relay techniques is a critical aspect is field of power system. These relays should employ high-speed and high-accuracy electronics in order to avoid catastrophic failures. Motor protection system requires different techniques and input or output capabilities. Based on this systematic study we have design this protection system that can protect motor from as many faults as it can cover. Our system is capable of applying logic and comparing and then analyzing whether the relay will trip or not based on values of current, voltage & temperature.

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