Multiple fault protection of pump motor using current sensor

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Abstract—*This paper deals with the protection of Induction type pump motor against possible problems like burn out protection of pump motor using current sensor & check for over current and temperature such as single phasing and over temperature occurs in its operation. It is very important ,because it is used intensively in industry as an actuator. Induction Motors can be protected by using some components such as connectors voltage and current relays. The basic idea or development of the project is to provide safety to the pump motor when any of the phases out of the three phases is missing and also temperature of the motor during operation exceeds the prescribed value it stops immediately*

Keywords— *Pump Motor Protection, Protections against moisture, Earth leakage, current sensor for over current ,single phasing bearing failure.*

I . INTRODUCTION

Every year, more than 20% of electric motors installed burnout around the world. The protective device for the pump is the heart of the total system.. Different kinds of protective relays are available to perform different functions. It is important that a proper protective device is selected for desired function. Protection of a pump motor or lift motor against possible problems, such as single-phasing and over-temperature occurring in the course of its operation is very important. The whole system is supplied with a 3-Phase power i.e., the three transformers are connected to the 3 phases supply. If any of the phase is not available, or the temperature goes high the voltage at positive terminal of the corresponding comparator is more than negative, thus making the output to go high end the transistor conducts making the relay to operate which disconnects the supply to 3CO relay that handles the 3 phases and the motor is disconnected from the supply.

II.NEED FOR PUMP PROTECTION

It is difficult to imagine a pumping system without providing for proper protection against various hazards. Pumps employing 3-phase motors as prime movers are required to be protected from burning. The major causes of motor burn-outs are:
Phase Failure causes burning of motors. Due to fuse failure, loose connections or loss of phase supply, one of the supply lines to the motor becomes dead. However, the motors continue to run on two phases, drawing heavy currents, and burnout.

Reverse Running of pumps and certain machines due to wrong connections or reverse phase sequence endangers the motor and consequently the machine.
Unbalanced Supply generates double frequency currents in the motor windings causing overheating. Unbalanced supply voltage produces heavy negative sequence currents. Overheating of motor winding due to this, is unevenly distributed over the rotor. This leads to insulation breakdown.

Under Voltage overloads the motors in continuous running and is particularly dangerous while starting. Motor draws more currents at reduced voltages, RPM, Torque and Power reduce due to under voltage.

Dry Running is equally dangerous for submersible pumps. Motors of submersible pumps are designed for running under water. They use water as a heat-transfer medium. Due to such dry running the bearing temperature also increases, damaging the bearing and the surrounding portion of the pump.

Over Loading is also one major cause of motor burning. It may occur due to phase failure condition, dry running condition or direct overloading condition of the pump. Overloading causes increase in currents, this in turn results in insulation failure.

Specialized protections like against moisture, earth leakage, bearing failure etc. may also be required for some pumps, In majority cases, however, a bimetal (thermal) overload relay is relied upon for pump protection. When electronic phase failure relay is used for protection, it again generally is a voltage sensing relay.

III.CIRCUIT DIAGRAM PUMP MOTOR MULTIPLE PROTECTION

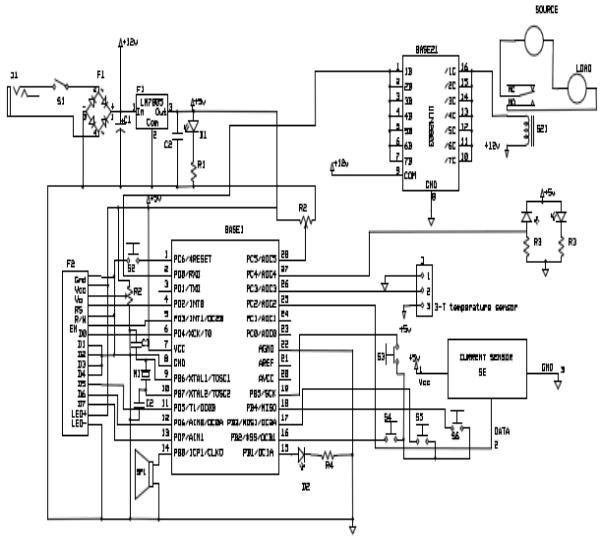

Fig1: Circuit Diagram of Multiple Protections

Above circuit diagram shown in fig1 is base for the hardware implementation of pump motor multiple protection, where each element is arrange according to the requirement.

IV.BLOCK DIAGRAM

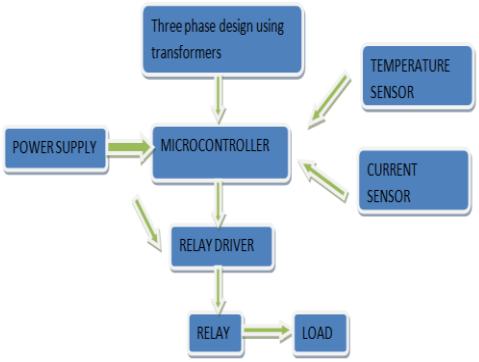

Fig2:Block diagram of Multiple Protection

Basic block diagram is shown in fig 2 where every step and process is shown as a separate block.

Three Phase Design: Consists of step down transformers and other unit for three phase supply monitoring.

Microcontroller: This is the brain of the system which takes the input and generates the proper output

Sensor Block: This consist temperature sensor for temperature monitoring current sensor for over load monitoring.

Relay Driver: The driver is basically used to provide sufficient voltage and current to the relay

Relay: Act as an electro mechanical automatic switch.

V. PCB DESIGNING

A printed circuit board, or PCB, is used to mechanically support and electrically connect the electronic components using conductive pathways, tracks or. Signal traces etched from copper sheets lamented onto a non-conductive substrate

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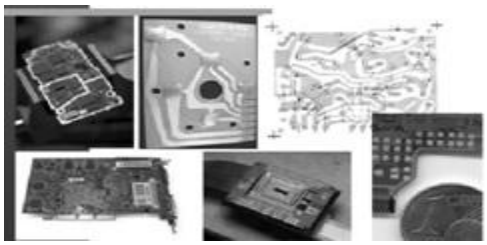

Fig3: PCB Designing

VI.POWER SUPPLY DESIGNING

The input is 230V AC which is step down using the transformer (12-0-12) .The 12V ac input is fed to the bridge diode to gives 12V pulsating DC. This DC voltage is filtered through the capacitor to remove the ripples. The filtered DC is fed to 7805 regulator to fetch +5v regulated output. This regulated voltage is given to all the components to function properly.

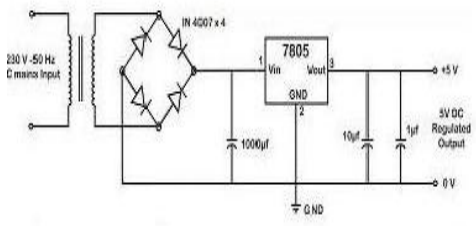

Fig4: Power Supply Designing

VII.WORKING OF HARDWARE

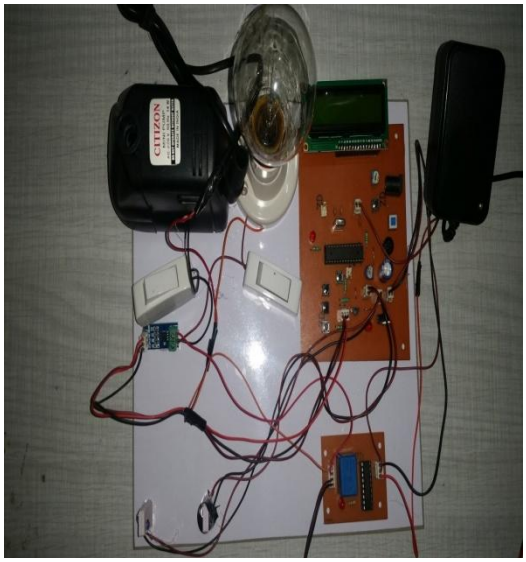

Fig5: Hardware arrangement of Multiple Protection

The main objective of the project is designing a monitoring unit for the pump motor to monitor the temperature, voltage, current, dry run and single phasing. The system will automatically monitor the all the parameters and display it on LCD(S or US means stable or unstable or OK and fault).

The system will turn off if there is any fault. This project consists of control switches interfaced to the controller one to put on/off the motor manually. Once the motor is on all the parameters are started monitoring.

There are 3 more control switches interfaced to the controller and all are active low which are used to show the availability or non availability of phase.

There is also system monitor the dry run of the motor. To monitor this we can implant an IR sensor in the flow line pipe. If the flow of water is there the receiver will receive less intensity of IR transmitted from the IR transmitter led else IR received will be higher than a threshold. However dry run will be monitored only when motor is in on state.

To monitor the voltage we a supplied the voltage through a preset so that we can vary the voltage to so voltage variation. To monitor the temperature we have used a DS18B20 temperature sensor (digital sensor based on one –wire communication). In this project there is system monitor the current across the load.

To monitor this we can implant a current sensor in series with the load. If the load increase that is the current increases this notify the overload condition else normal run.

The output in the project is LCD interface and relay driving unit. There is 16x2 LCD interface also to display the activities like the parameters. The LCD is interfaced to the microcontroller through its 6 pins .Proper display on LCD is managed through programming (refer programming section).

The next output of the microcontroller is given to ULN2803 relay driver. The relay finally selects the operation and type of operation by enabling the system. The operations are controlled as per the programming.

Relays are electromagnetic switches that are triggered to enable desired supply to the load here cooling or heating device .The relays which are used hear are 12V relay.

VII.COMPONENT USED

Adapters

The adapters are the device that has inbuilt circuitry for converting the 230V AC in to desired DC like +5V adapter, +12V adapter, +9V adapter and many more. This consists of inbuilt circuit for HIGH AC to low voltage DC conversion.

Berge Strip

Berge strip is also type of connector. It is of two types male or female. This is also used for making electrical connections to mount some components. The come in different packages and dimensions. Depending upon the need they can be purchased. These are used for mounting certain modules, LCD etc. Male connector: These have metallic rods for the connection.

C.Capacitors

The function of capacitors is to store electricity, or electrical energy. The capacitor also functions as filter, passing AC, and blocking DC. The capacitor is constructed with two electrode plates separated by insulator. They are also used itiming circuits because it takes time for a capacitor to fill with charge. They can be used to smooth varying DC supplies by acting as reservoir of charge.

D.Connectors

Connectors are wire connection and interface to connect two different points.

It has different configuration like
2- pin connector,
3 -pin connector,
4- pin connector and many more

E.Crystal Oscillators

A crystal oscillator is an electronic circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. There are many types of crystal oscillators. One of them is a crystal oscillator employing an inverting amplifier including a CMOS (complementary metal oxide semiconductor) circuit, and used, for example, as a reference signal source of a PLL (phase-pocked poop) circuit of a mobile phone.

F.LCD Interface

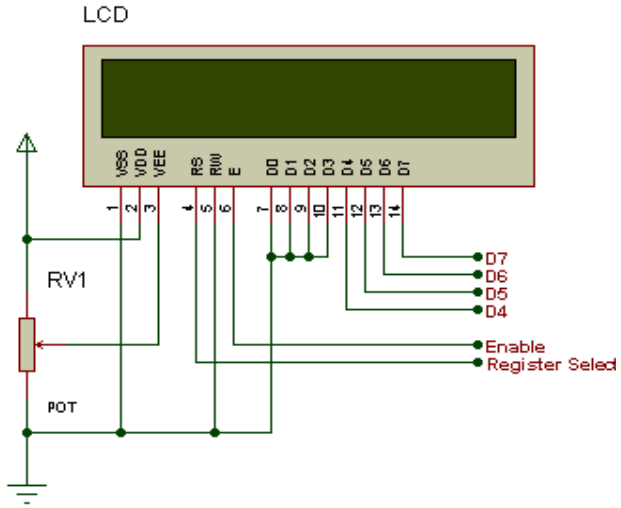

Fig5:LCD Interface

Above is the connection diagram of LCD in 4-bit mode, where we only need 6 pins to interface an LCD. D4-D7 is the data pins connection and Enable and Register select are for LCD control pins.

G.Microcontroller:Atmega168

However with advancement of the microcontroller systems various features have been included in the controllers but there three main building blocks which a system at-least should have to perform any task. They are:

- A processing unit (CPU)
- I/O PORTS for interaction with user
- Memory elements (RAM/ROM/Flash/EEPROM)

The Atmel ATmega48/88/168 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48/88/168 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing All relays operate using the same basic principle. The e.g. will use a commonly used 4-pin relay. Relays have two circuits: A control circuit (shown in GREEN) and a load circuit (shown in RED).The control circuit has small control coil while the load circuit has a switch. The coil controls the operation of the switch.

H.Relays

Relay energized (ON): Current flowing through the control circuit coil (pins1 & 3)creates a small magnetic field which causes the switch to close, pins 2 & 4. The switch, which is a part of the load circuit, is used to control an electrical circuit that may connect to it. Current now flows through pins 2 & 4 shown in Red, when the relay in energized.

Relay De-energized (OFF**):**When current stops flowing through the control circuit, pins 1 & 3, the relay becomes de-energized. Without the magnetic field, the switch opens and current is prevented from flowing through pins 2 & 4. The relay is now off.

Relay operation-2:When no voltage is applied to pin1, there is no current flow through the coil. No

current means no magnetic field is developed, and the switch is open. When voltage is supplied to pin 1, current flow through the coil creates the magnetic field needed to close the switch allowing continuity between pins 2

I. Current Sensors

This current sensor gives precise current measurement for both AC and DC signals. These are good sensors for metering and measuring overall power consumption of systems. The current sensing technique based on a shunt resistor . The Allegro ACS712 current sensor is based on the principle of Hall-effect,

J. Switches

In electrical engineering, a **switch** is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another.The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts, which are connected to external circuits. Each set of contacts can be in one of two states: either "closed" meaning the contacts are touching and electricity can flow between them, or "open", meaning the contacts are separated and the switch is non-conducting. Switches may be operated by process variables such as pressure, temperature, flow, current, voltage, and force, acting as sensors in a process and used to automatically control a system.

K.. Embedded System

Embedded Systems are components integrating software and hardware jointly and specifically designed to provide given functionalities. A combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a dedicated function. An embedded system is an application that contains at least one programmable computer (typically in the form of a microcontroller, a microprocessor or digital signal processor chip) and which is used by individuals who are, in the main, unaware that the system is computer-based. Embedded systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks.

VIII. CONCLUSION

By the current sensor and temperature monitoring we can know that when the motor is going to burn so we can stop it or take measure to protect it from damaging which is a better strategy that can be applied in large pumping and small pumping too. Protection of three phase induction motor from over voltage, under voltage, single phasing, and overheating and phase reversal provide the smooth running of motor improves its lifetime and efficiency. Generally these faults generated when supply system is violating its rating. In three phase induction motor when running at rated voltage, current and load these faults are not generated. For smooth running of motor generally concentration on supply voltage under the prescribe limit and load which is driven by the motor should also be under the specified limit.

In future the motor can be enhanced and we can increase the efficiency of the motor by reducing the power consumption and making it in a a large scale Beside this we can implement it in the refineries to pump the oils and also be used as a major motor or large scale pumping motor.

REFERENCES:

[1] Electric Machines by I.J Nagrath & D. P Kothari. The McGraw-Hill.

[2] Electric Machinery by P.S Bhimbra (Khanna Publishers)

[3] I. Colak, H. Celik, ˙I. Sefa, and S. Demirbas, ―On line protection system for induction motors, Energy Convers. Manage. vol. 46, no. 17, pp.2773–2786, 2005.

[4] www.marineinsight.com/ tech/ marine electrical

[5] F. Filippetti, G. Franceschini, C. Tassoni, and P. Vas, ―AI techniques in induction machines diagnosis including the speed ripple effect,‖ IEEE Trans. Ind. Appl., vol. 34, no. 1, pp. 98–108, Jan./Feb. 1998.

[6]. Slemon, GR and A Stravghen, electrical machine