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AUTOMATIC PHASE SEQUENCE AND OVERLOAD PROTECTION USING PIC MICROCONTROLLER

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ABSTRACT

In case of three phase AC operation, most widely used motor is Three phase induction motorwhich is widely used inindustrial,commercial and agricultural applications.Thusanalysis of the motor is much essential to find out utilization index of the motor for better performance.The objective of this project is to provide automatic protection system for the three phase induction motor using PIC microcontroller.Here we use PIC microcontroller to monitor the conditions of the motor and control the motor operation whenever abnormal conditions such as undervoltage,overload and phase reversal occur.The control of the motor operation happens in such a way that the protection circuit switches off the motor during undervoltage and overload conditions and corrects the phase sequence during phase reversal conditions.

I. INTRODUCTION

Three phase Induction Motors are generally utilized in agriculture purpose and industry due to their rigidity and low maintenance .In this manner, the issue of induction motor protection attracted many researchers.This Project aim is the protection of three phase Induction Motor. There are different techniques for fault identification and protection of Induction motor. Some fault detection techniques are Artificial Neutral Network, Stator fault checking strategies, Microcontrollers based protection system and Programmable Logic Controller (PLC) based protection system.In this task, the technique utilized is Microcontroller based protection system. The circuit will take the full control of the motor and it will protect the motor from several faults, for example, under voltage and overcurrent and the circuit will switch on the motor under safety conditions. This additionally protects induction motor from phase reversal which is also a major fault. The circuit is completely controlled by the microcontroller and the microcontroller will consistently monitors the voltages of the three phases and if the voltage goes abnormal condition then it will switch off the motor until they are typical. All the conditions are shown by the microcontroller over the LCD display. In this project we are utilizing the 8 bit microcontroller PIC16F877A.It is a 40 pin microcontroller. The protection of induction motor with microcontroller has adaptability to switch off at required time, monitors phase of motor at each time furthermore every motoring activity is known through LCD display.

II. INDUCTION MOTOR AND ITS FAULTS

An electrical motor is such an electromechanical device which converts electrical energy into a mechanical energy. In case of three phase AC operation, most widely used motor is Three phase induction motor as this type of motor does not require any starting device or we can say they are self-starting induction motors.It is self-starting,less armature reaction and brush sparking because of the absence of commutators and brushes that may cause sparks,robust in construction,economical and easier to maintain.Thus these motors are widely used in industrial and commercial applications and also in agricultural fields.Squirrel cage motors are widely used due to their rugged construction and simple design. Slip ring motors require external resistors to have high starting torque.

The most common motor faults are under voltage, over voltage, single phasing, overload and phase reversal among which we have dealt with under voltage, overload and phase reversal faults in this project.

Each fault affects severely on induction motor. Due to Under-voltage motor is not able to run at its full speed and single phasing also causes the problem of under-voltage. The under voltage occurs when a reduced supply voltage with a rated mechanical load is applied on the motor.

Due to load in excess of safety rating of motor will cause the over current fault. Therefore large amount of heat generated in the motor which cause the winding failure.The phase reversal occurs when two of the three phases(R Y B) of line reverses. Most of the motors will react badlyto such a situation in such a way the motor could suddenly begin to turn in the wrong direction, causing major collateral damage.

The Name plate details of the three phase induction motor for which we have developed the automatic protection system is

S.No.	Parameters	Rating
1	Line Voltage	400 V
2	Current	4.3 A
3	Speed	1440 rpm
4	Phase	3 PH
5	Type	Squirrel cage

Table 1 Name plate details of 3PH IM

III. BLOCK DIAGRAM

The main block diagram of the automatic protection system of three phase induction motor using pic microcontroller is

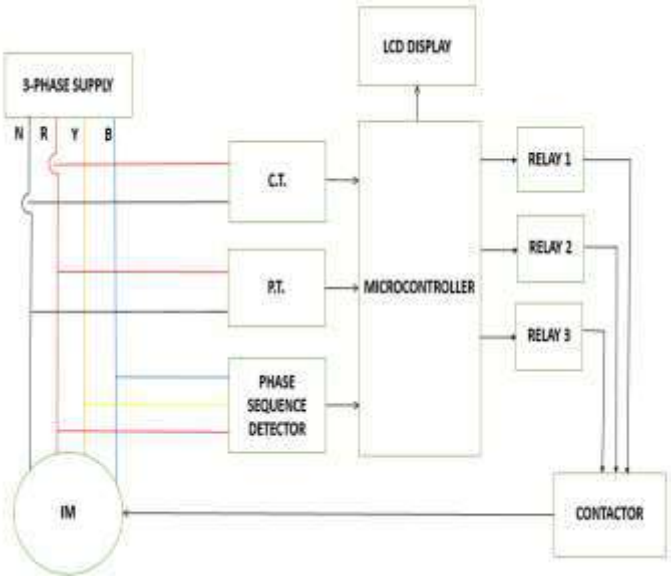


Fig 1 Block diagram of protection system

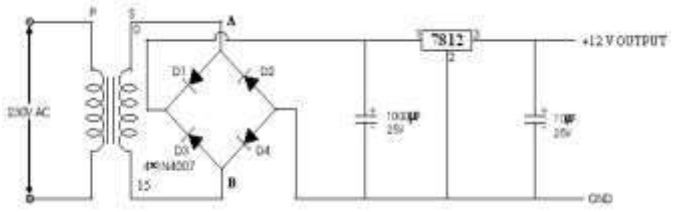
Description :

The main components of the system are PIC 16F877A, Current Transformer(10A/5V), Potential Transformer(230V/6V), 16*2 Liquid Crystal Display, Relay(12V) and Contactor. Here single phase is taken from three phase supply is taken for voltage and current measurement. Three phase supply is given as input to phase sequence detector module to check the phase sequence. Then the measured voltage, current and checked phase sequence is given to ADC pins of PIC 16F877A. Using the C-program dumped in PIC 16F877A, it compares the measured parameters with the predefined ranges used in the program and displays voltage and current values in the LCD as well as sends the signal to relay according to the results of comparison of the measured parameters.

The relay then switches on or off the motor through the contactor. With the help of the output voltage of the phase sequence detector module, phase reversal is detected by the PIC 16F877A and sends the signal to the relays which then correct the negative sequence and send the positive sequence to the motor through the contactor.

IV CIRCUIT DESCRIPTION

The protection system consists of four modules namely Power Supply, Voltage measrement, Current measurement, Phase sequence detector and Relay modules.



Power Supply Module

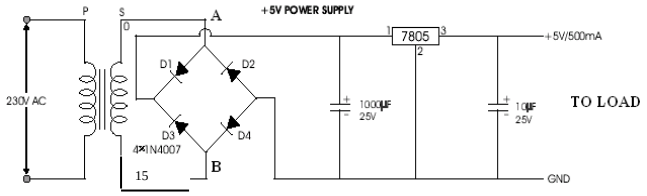


Fig 2 Schematic diagram of Power Supply

230V ac is stepped down into 15V ac by 230V/15V ac step down potential tansformer.15V ac is then converted into 15V dc by bridge rectifier.The dc voltage is filtered by capacitors and regulated into 12V and 5V using 7812 and 7805 voltage regulators respectively.The 12Vdc and 5Vdc are supplied to relays and PIC 16F877A respectively.

Voltage Measurement Module

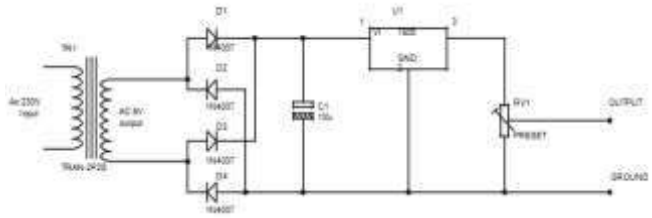


Fig 3 Schematic diagram of Voltage Measurement

Voltage measurement is used to measure the ac supply voltage to be given as input to the PIC 16F877A, which then displays the voltage value in LCD and to detect the undervoltage conditions whenever some voltage unbalance occurs.

Here phase voltage(230V)of three phase supply is measured for voltage measurement. The ac 230V is stepped down into 6Vac using step down potential transformer and 6V ac is converted into 6V dc using bridge rectifier.The 7805 IC regulator is used to produce constant 5V dc in order to provide input to ADC pin of pic microcontroller.ThusPIC identifies the voltage using ADC equivalent of the voltage.With the help of voltage setting used in the program, whenever the undervoltage occurs the PIC identifies it and produces signal to stop the motor through the relay and contactor.

Current Measurement Module

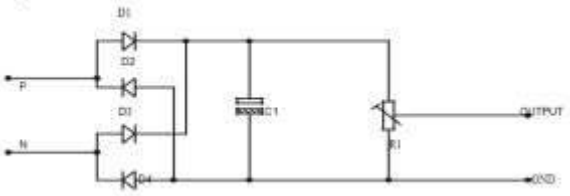


Fig 4 Schematic diagram of Current Measurement

Current measurement is used to measure the supply current to be given as input to the PIC,which then displays the current value in LCD and to detect the overcurrent whenever overload conditions occur.

The C.T produces 5V ac equivalent for 10A current.The bridge rectifier used converts the ac value into dc value in order to provide the voltage as ADC input.Then the PIC identifies the current value using ADC equivalent of the voltage.Withthe help of current setting used in the program, whenever the overload occurs the PIC identifies it and produces signal to stop the induction motor through the relay and contactor.

Phase sequence detector Module

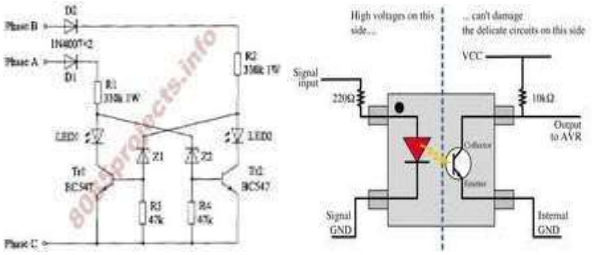


Fig 5 Schematic diagram of Phase sequence detector Module

The motor rotates in the forward direction when the positive sequence RYB occurs and rotates in negative direction when the negative sequence occurs for example,RBY(Y and B gets interchanged) due to voltage unbalance conditions.

The circuit is designed such that phase sequence detection and correction occur whenever phase B and phase C are interchanged while R phase is constant always.Whenever sequence doesn't change LED 1 glows and thus optocoupler produces 0V.Whenever phase B and phase C interchanges LED 1 glows and thus optocoupler produces 0.6V.The output of optocoupler is given as input to pic microcontroller and using the program pic sends the signal to relay1 and relay 2 in order to send the positive sequence or correct the negative sequence by switching between them.

Relay Module

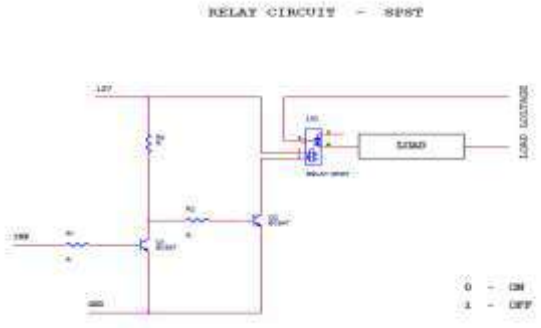


Fig 6 Schematic diagram of Relay Module

This circuit is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay. The relay ON and OFF is controlled by the pair of switching transistors (BC 547). The relay is connected in the Q2 transistor collector terminal. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and Normally open (NO).

The relay common pin is connected to supply voltage. The normally open (NO) pin connected to load. When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the Q2 transistor. So the relay is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and relay is turned ON. Hence the common terminal and NO terminal of relay are shorted. Now load gets the supply voltage through relay.

Voltage signal from PIC microcontroller	Transistor Q1	Transistor Q2	Relay
1	On	Off	Off
0	Off	On	On

Table 2 Relay operation

V. HARDWARE RESULT

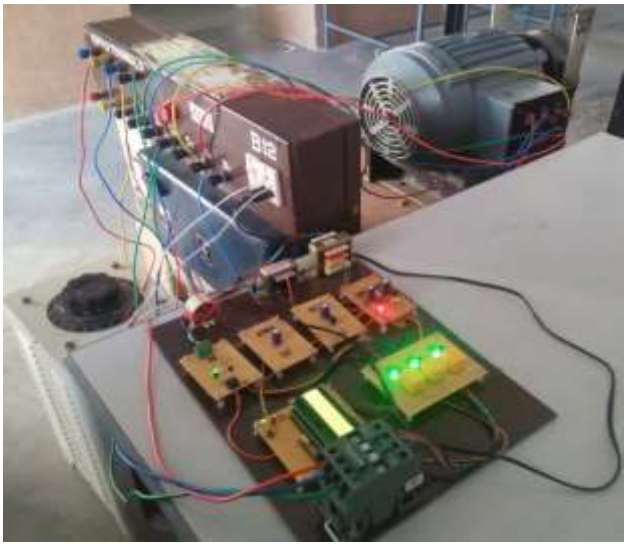


Fig 7 Laboratory setup of the protection system

Fig 8 Undervoltage condition

The rated supply voltage for the three phase induction motor used in our laboratory is 400V whose phase voltage is 230V.Here phase voltage is taken for voltage measurement.Whenever supply voltage goes below 200V it is considered as undervoltage condition and the circuit detects and displays the voltage in LCD as in Fig 7 and also switches off the motor immediately.

Fig 9 Overload condition

The rated current for the three phase induction motor used in our laboratory is 4.3A. Here single phase is taken for current measurement.Whenever the load goes above 4.3A it is considered as overload condition and the circuit detects and displays the overcurrent in LCD as in Fig 8 and also switches off the motor immediately.

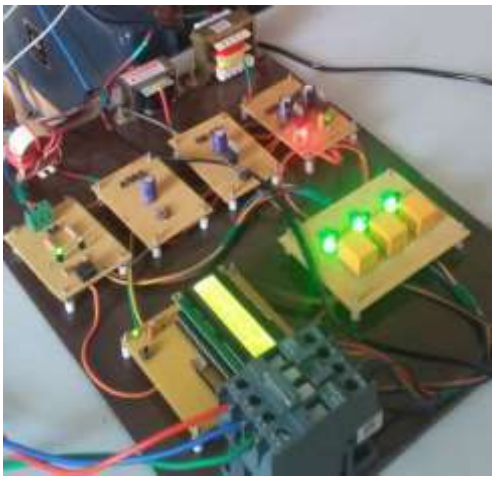


Fig 10 Phase reversal condition

In Fig 9 the LED 2 in the phase sequence detection module glows indicating that phase sequence has been reversed i.e. RBY occurs.In this condition the relay 1 and 2 switches between the Y and B phase and sends the positive sequence to the motor through the contactor such that the motor always rotates in the forward direction.

VI. CONCLUSION

This protection system using PIC Microcontroller is an improved method because it is a very low cost device as compared to other protective devices. The system is tested in the laboratory for many times on Three phase induction motor under faulty condition and it gives desirable results. The system is reliable and rugged. This is a prototype for the

protection of motor for under voltage, over current and phase reversal.

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