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PROTECTION AND MONITORING OF THREE PHASE INDUCTION MOTOR FROM OVER VOLTAGE, UNDER VOLTAGE, SINGLE PHASING, PHASE REVERSAL, AND OVERHEATING REVIEW

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Abstract - *This paper describes protection of three phases Induction Motor from single phasing phase reversal, over voltage, and under voltage. Due to this electrical fault the winding of motor get burned which produce insulation damage and thus mitigate the life time of Motor. This fault is inducing in Induction Motor due to variation in Induction Motor parameters. When three phase Induction Motor works regularly, it is compulsory to protect the motor from these unlikely faults. Three phase Induction Motor directly connected through the supply, if the supply voltage has sag and swell due to damage the performance of Motor is affected and in some cases winding is heated .When phase sequence is reversed due to wrong connection then motor begin to rotate in another direction, if supply system has only one phase and other phase is disconnected then it is single phasing problem. Online condition monitoring of the Induction Motor has been widely used in the detection of fault.*

Keywords: Microcontroller, Monitoring technique, Overheating, over voltage, Phase reversal, Single phasing, Three phase induction motor, Under voltage etc

1. INTRODUCTION

Induction motor is the backbone for every industry. However like any other machine, they will eventually fail because of heavy duty cycle, poor grounding environment, installation and manufacturing factors etc. With escalating demand for reliability and efficiency, the field of fault diagnosis in induction motor is gaining importance .If the fault are not devine, it may result in large revenue losses as well as pose threat to reliability and safety of operation. Three phase induction motor generally suffers from under voltage, over voltage, overheating, single phasing and phase reversal problems. When the three phase induction motor supply with higher voltage than is rated value then induction motor starts overheated. In paper, a variable resistance is used when supply voltage is less than voltage drop beyond the resistance is more than it protects the motor from this fault. When supply voltage is only one phase, this is single phasing issue and supply voltage take down the rated and once again motor fails to begin. In the case of motor heating a LM sensor is used which sense the temperature of winding if it is out run than specified limit then once again motor fails to start. It is highly desired that three phase induction motor works adrift from these all types of fault. Details description of all types of fault is discuss below.

2. PROTECTION OF OVER VOLTAGE

In over voltage protection system of three phase induction motor protects the motor from over voltage, the voltage which is more than rated voltage. In circuit diagram of overvoltage protection, it consist the comparator which compare two voltages one is supply and other is drop across the variable resistance. When the voltage drop across the variable resistance is higher than certain limit then comparator generates signal. This signal is fed to microcontroller and microcontroller takes the suitable action as shown in below:

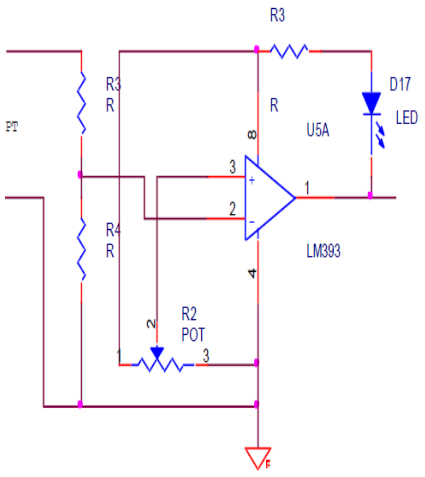

Fig.1: Circuit Diagram of Overvoltage Protection.

3. PROTECTION OF UNDER VOLTAGE

In under voltage protection of three phase induction motor feeds the protection from the under voltage. When supply system has low voltage than the certain rated of induction motor then under voltage protection section of

protection supply is provided to motor. Single phasing works. It has similar concept as over voltage it also has comparator which compare two voltage one from supply and other from the voltage drop .Across the variable resistance. When voltage drop across the variable resistance is less than certain limit, this signal sends to microcontroller and microcontroller stop the working of motor in the case of running and fails to work in case of starting. Preset is used to set the certain value as shown in fig.2. This circuit concern with same fashion as overvoltage protection works only the different is that value set by preset. In this case set value is minimum but in overvoltage case set values by preset resister. When suitable voltage drop across the Resister exceeds from the set values of preset the signal sends to microcontroller.

Fig. 2: Preset To Set Value

4. PROTECTION OF SINGLE PHASING

In single phasing protection to three induction motor, if other two phases is faulted and only one protection of motor section begins functioning. Generally in single phase supply voltage is less than certain value .on this value of voltage motor is unable to begin. Comparator which compares single phasing supply voltage and rated specified voltage, and sends to microcontroller and microcontroller generates signal which halt the motor, if motor is continuous and does not allow to motor start in case of standstill. Sometime single phasing protection looking much motor important when the motor is scar which important function like furnishing ,pump driving, and crane driving etc this fig.3 shows the extremely single phasing condition in three phase induction motor. Where one phase breakdown and motor is simply supplied by remaining phases which is similar to single phasing condition .Single phasing occurs other things can cause this subversive condition conspicuous taken are a louder than usual humming from the motor and for a shaft that vibrates somewhat that rotating. As a result of several possibilities. An unbowed wire, a bad breaker a blown fuse, and other things can cause this subversive condition conspicuous taken are a louder than usual humming from the motor and for a shaft that vibrates somewhat that rotating.

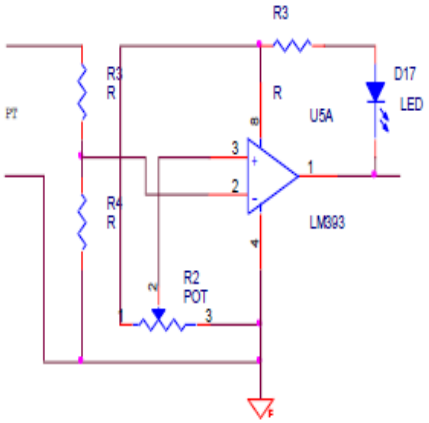

Fig.3: Single Phasing

5. PROTECTION OF PHASE REVERSAL

Overheating protection of motor means protect the motor from overheating of its winding. This overheating in motor is specifically caused by overloading of motor, bearing seizes up something locked the motor shaft from inflection motor merely fails to start properly, a failure to start of motor may cause by faulty start in winding in motor. For sensing the heat LM35 sensor is provide for this purpose. This sensor is connected to comparator inputs. With the assist of sensor which sense the temperature of winding and its temperature outrun to some particular level then comparator sends this signal to microcontroller as shown in fig. 4

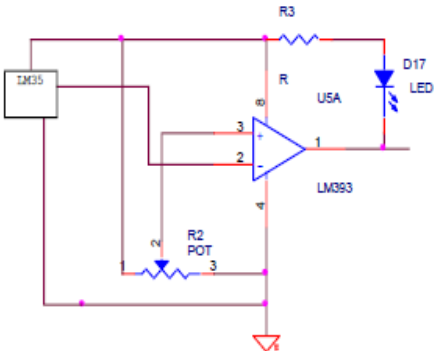

Fig. 4: Diagram of Phase Reversal

6. BLOCK DIAGRAM

The block diagram is shown below in fig.5. Microcontroller is AT89552 is used with programming code which drives the whole system in conformity with their characteristic. One relay drive is used which drive the relay function. All the five unit of controlling warring as input for microcontroller and a

power supply is also used which supply the power to microcontroller. As the input provided by the distinct section of protection according to that microcontroller works.

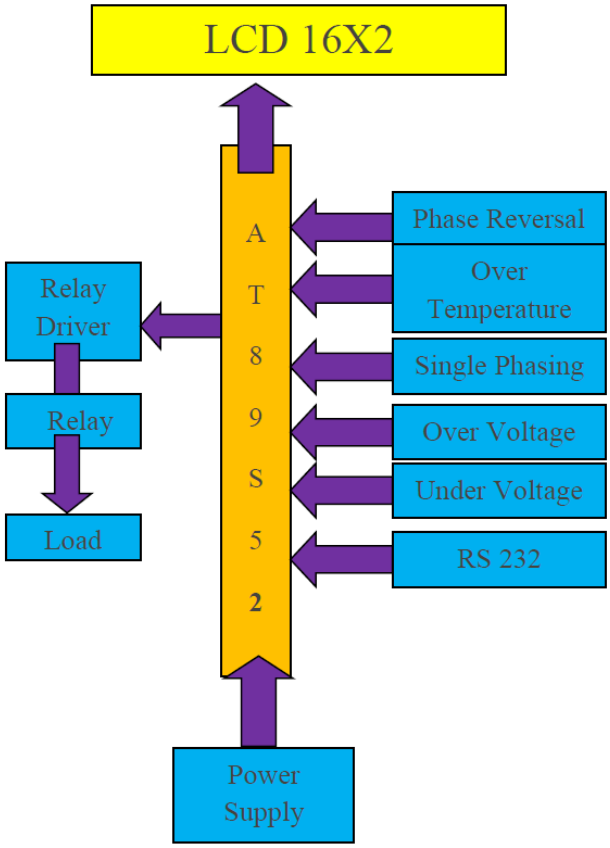

Fig. 5: Block Diagram of System

7. HEALTH MONITORING TECHNIQUES

There are a lot of methods which have already been used in the last four decades for health monitoring of the machine
But most commonly used techniques are described below:

i) THERMAL MONITORING

The thermal monitoring of electrical machines can be completed by measuring local temperature of the motor or by the estimation of the parameter. Due to the shorted turns in the stator winding the value of stator current will be very high and hence it produces excessive heat if proper action would not be taken and results into the destruction of the motor.
So, some researchers have introduced thermal model of electric motor. Basically this model is classified into two parts:

a) Finite element analysis(FEA) based model

b) Lumped parameter based mode

ii) MAGNETIC FLUX MONITORING

Abnormal harmonics which appear in the stator current are functions of a number of variables due to magneto motive force (MMF) distribution and permeance-wave representation of the air-gap. Hence any distortion in the air-gap flux density due to stator defect sets up an axial flux in the shaft. The axial magnetic leakage flux of an induction motor is readily measured using a circular search coil which is placed on the non-drive (rear) end of the machine, concentric with the shaft. The search coil produces an output voltage which is proportional to the rate of change of the axial leakage flux. This signal contains many of the same frequency components which are present in the stator current. it is particularly useful for estimating the speed as it contains a strong component at the slip frequency.

iii) PARTIAL DISCHARGE MONITORING

This method is used for detecting stator insulation faults in higher voltage motors. It consists of detecting the low amplitude, ultrafast pulses(ns) produced by electric discharges in small voids in the insulation. Partial discharge occur even in healthy machines. However an increase in the amount of partial discharge activity can be associated with insulation degradation.

iv) AIR GAP TORQUE MONITORING

The air gap torque is produced by the flux linkage and the currents of a rotating machine. It is very sensitive to any unbalance created due to defects as well as by the unbalanced voltages. Since, all types of motor faults produce the side bands at special frequencies in the air gap torque. Since, it is not possible to measure air gap torque directly. The difference between the estimated torques from the model gives an indication of the existence of broken bars. From the input terminals, the instantaneous power includes the charging and discharging energy in the windings. Therefore, the instantaneous power can not represent the instantaneous torque. From the output terminals, the rotor shaft and mechanical load of a rotating machine constitute a tensional spring system that has its own natural frequency. The attenuates of the components of air gap torque transmitted through the tensional spring system are different for different harmonic orders of torque components. But by using this method it is not easy to diagnose all faults.

v) NOISE MONITORING

By measuring and analyzing the acoustic noise spectrum we are able to do noise monitoring. Due to the air gap eccentricity the noise is produced. This noise is used for fault detection in induction motor. However it is not the

accurate way to detect the fault by noise monitoring because of the noisy background from the other machines. Ventilation noise is associated with air turbulence, which is produced by periodic disturbances in the air pressure due to rotating parts. The noise is due to the Maxwell's stresses that act on the iron surfaces. These forces are responsible for producing the noise in the stator structure.

vi) STATOR VOLTAGE MONITORING

This can be safely measured using high frequency differential voltage probe or isolation amplifier. It has been used to calculate the instantaneous power, instantaneous torque and negative sequence impedance.

vii) STATOR CURRENT MONITORING

The stator current is usually measured using a clip-on hall-effect current probe. It contains frequency components which can be related to a variety of faults such as mechanical and magnetic asymmetries, broken rotor bars and shorted turns in the stator windings. Most of the published research work in recent years has examined the use of the stator current for health monitoring. Particularly using frequency analysis.

8. CONCLUSION

Protection and monitoring of three phase induction motor from over voltage, single phasing and overheating and phase reversal provide the non committal running of motor. Civilize its lifetime and efficiency. Specifically these faults induce when supply system is violating its rating. In three phase induction motor when running at rated voltage, current and load these fault are not generated .For smooth running of motor specifically concentration on supply voltage under the prescribe restriction and load which is driven by the motor should also be under certain limit.

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