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Protection Schemes for Three Phase Induction Motor

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Abstract-This paper contributes for the analysis and the suggested protection against individual phasing of three-phase induction motors. Practice is showing that significant number of three-phase motors is damaged due to individual phasing. At such conditions the current increases considerably and the engine is subjected to burnout. Accordingly, this may cause long production interruptions in the relevant industries. Generally all motors are protected against thermal overloading by bimetal relays, but they are not always capable to ensure protection at individual phasing. As a result of the current research, a reliable electronic protection is proposed that can trip-off any three-phase engine in a case of individual phasing. Such protection is especially priceless when applied to high energy motors. The suggested protection is designed to react instantly whenever anyone of the engine line currents becomes zero. a signal from the protecting circuit switches-off the engine starter in case of failures of anyone of the three phases.

***KeyWords*: overloading , single phasing ,under and over temperature.**

1. INTRODUCTION

Long-term three-phase engine operation depends upon the proper selection of its protection. When one of the stator winding remains without voltage supply the engine continues to operate as a solo-phase gagdet, drawing energy from the remaining two phases. This method of operation is named solo phasing and could occur for instance when one of the fuses the three-phase engine lines "blows" and disconnects one of the stator windings. Surveys in many industries show that the main reasons for three-phase engine failures are the thermal overloading as a result of voltage or load variations, rotor blockages or solo phasing. Thermal overloading and solo phasing cause up to 44% of malfunction cases .

Due to the phenomenon of the solo phasing, the current of the engine increases considerably. If the protection does not operate instantly, the engine overheats and its operation fails, causing downfalls in the particular industry.

In the majority of the applications bimetal over load relays (ORL) are used for the engine protection. These relays are not always effective to preserve the three-phase engine against solo phasing. The objectives of this research are to describe the reaction of the bimetal OLR in cases of solo phasing and to propose an automatic electronic solo phasing protection.

1.1 over temperature

Since the current drawn by the engine is more, heat dissipation in the stator and rotor is increased drastically when the percentage balanced over voltage exceeds 25%. Hence it is recommended to operate the engine within 10% of balance over voltage.

1.2 single phasing

phasing could occur at startup or at running conditions, when the engine is fully loaded, under-loaded or overloaded. The stator windings could be star or delta connected. The reaction of the bimetal over load relay (OLR) is described below assuming that it is set at the rated line engine current. At individual phasing an engine cannot develop starting torque, since an individual-phase individual current produces a pulsating magnetic field with two elements rotating in opposite directions - forward and reversed. Both elements produce equal torques acting in opposite directions and due to this fact the engine cannot begin. This phenomenon can be examined for the two viable engine connections.

2. Overloading

The three-phase engine is overloaded with little currents in the range of I = (1.05 to1.2) IR, where IR is the rated current of the engine. This is due to little load or voltage variations. Under these conditions the engine could operate for a long moment period and should be tripped-out at a moment of about 2 hours, whereby the aging of the insulation will not be affected. The action of the OLR in this case is not very exact, because of the nature of the moment-current characteristic and the significant location of moment-response dissipation. At the same overloading currents one and the same OLR could give very dissimilar moment-responses.

Case 2: The three-phase engine is overloaded with currents in the range of I = (1.2 to 1.5) IR due to light overloading. The tripping moment for a current of 1.5IR should be less than 2 minutes to evade overheating and burnouts.

Case 3: The three-phase engine is overloaded with currents in the range of I = (1.5 to 6) IR due to solo phasing, periodical startups, impeded startups or engine reverses. The normal startup takes a few seconds after which the current declines to its rated value and the engine is not tripped out. In case of impeded startup the OLR should trip out the engine after a moment slightly longer than the normal startup moment.

Typical current curves for dissimilar startups . When the engine starts on no-load the tripping moment should be slightly longer than 2 seconds. Starting period of a fully loaded engine is longer and the tripping should occurs after a period of 5 seconds. At heavy-duty begin the engine should be tripped after a moment period longer than 15 seconds. These moment intervals are selected to allow the engine to speed during the starting period.

3. under and over temperature.

The most critical engine part in honour to thermal overloading is the winding insulation. Depending on the capabilities of the insulating materials to withstand long term operating temperatures the following classes are introduced as shown in Table 1:
higher than normal ambient temperatures. In so doing, you expand the engine's life.

TABLE I

Insulation Class	A	B	F	H
Long term operating temperature, [^oC]	105	130	155	180
Allowable maximum slow rise temperature, [^oC]	140	165	190	215
Allowable maximum fast rise temperature, [^oC]	180	200	225	250

The long term operating (rated) temperature is the limit allowable temperature in a coil, or so named hot-spot temperature. The hot-spot temperature is higher than the average temperature of the coil by up to10 degrees .

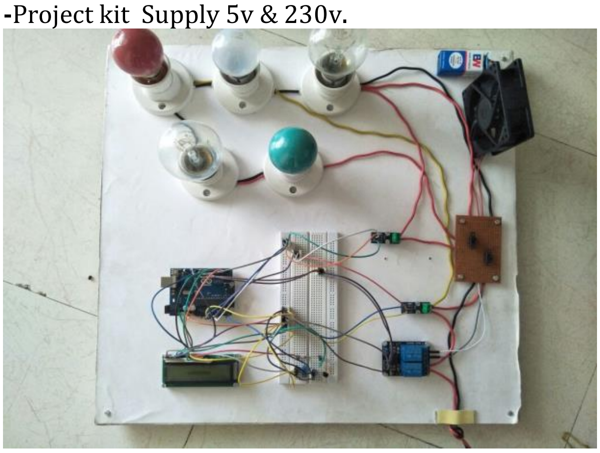
The life expectancy of the insulation and of the engine depends mainly upon the hot-spot temperature. If the three-phase engine operates continuously at its rated temperature the life expectancy could be more than 10 years. If the same engine operates continuously at a temperature 10oC higher than the rated, its life will be halved according to Montsinger rule . It follows that the ideal protection should trip out the engine whenever the hot spot temperature is exceeded. However this is not worth in honour to the continuity of the industrial process involving induction motors. This process must continue uninterrupted as long as feasible and switching-off should be avoided.

For short periods of moment, like at startup, higher temperatures are allowed since they do not affect the aging of the engine insulation. It is accepted that the coil temperature, measured after startup by the resistance mode, could be higher than the long-term temperature as shown in Table I. sedate rise temperatures are typical for long but little overloading whereby the engine and the bimetal temperatures are equal and change in exactly the same path. For class B this temperature is 165oC.

swift rise temperatures are due to big but short term overloading like short-circuit or individual phasing currents, or sudden blockage of the rotor. In such cases the coil temperature increases and the bimetal temperature differs significantly from that of the coil. swift rise temperatures are very critical and if exceeded they guide to immediate insulation destruction like cracking, breakdowns, melting or burnouts. swift rise temperature for class B materials is 200oC.

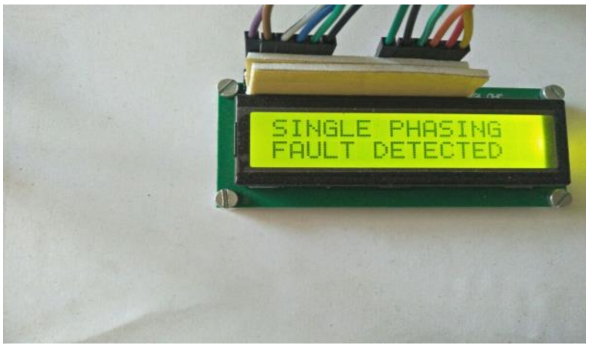
4) Faults and detection of fault on display screen

-Project kit Supply 5v & 230v.



1) Single phasing fault detection

- Display of type of fault occurred after fault detected,single phasing fault detected and displayed.



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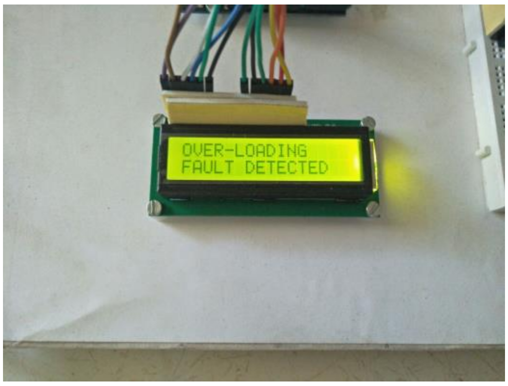
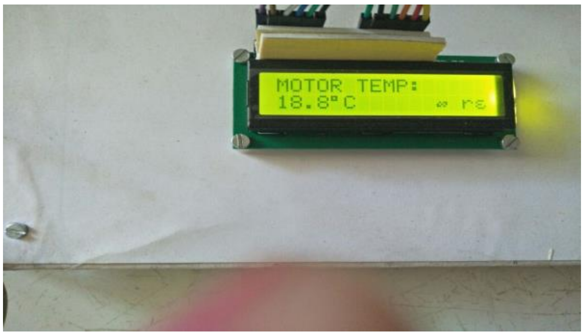
2) overloading fault

- Display of type of fault occurred after fault detected,overloading fault,



3) Under and over temperature

-Above temp. 20*c motor fan cooling starts &
Above 30*c whole system shutdown for protection purposes.



5. CONCLUSIONS

The tree-phase induction motors are widely used in the industry and they have to be properly protected to prevent damages due to thermal overloading and solo phasing. There are engine applications where the solo phasing and the impossibility of engine restart are unsafe for the driven mechanism. Due to these circumstances the engine should be tripped-off.

To make induction engine run efficiently and to safeguard it from various faults, sensing circuits have been designed. These sensing circuit sense the faults occur in an induction engine. These faults are monitored by the protection system and if any fault occurs the engine automatically turned off.

Hence this prototype version of microcontroller based protection system is very easy in design, reliable, highly versatile, and cost effective and gives quick response.

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