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SINGLE PHASING PREVENTER FOR THE PROTECTION OF THREE PHASE FAULTS

K.Vishnu[1]
Assistant professor,
Department of Electrical and Electronics Engineering,
Vignan institute of technology and science, Telangana.

Y.ALEKHYA[2]*,A. JAGAN*[3] *,K. SOWMYA*[4] *,Md.WASEEMUDDIN*[5]
U.G.Student,
Department of Electrical and Electronics Engineering,
Vignan institute of technology and science,Telangana.

Abstract

This paper proposes a protection scheme for three phase induction motors against single- phasing faults. Dynamic model of the induction motor in the stationary reference frame was adopted and modified to reflect single-phasing fault. A simulation algorithm was proposed, which can help determine the impact of single-phasing on any three-phase induction motor. A case study simulation was carried-out with sudden single-phasing using MATLAB/SIMULINK software. A single-phasing protection by means of contactors was reviewed before an enhanced single-phasing protection was designed. A prototype of the enhanced protection method was implemented by the use of ac to dc converter, PIC16F877A and DC relays. The latter, in additional to offering protection against single- phasing, also protects the motor from under-voltage, over-voltage and voltage unbalance. Index Term- -- Single-phasing, Three-phase induction motor, PIC16F877A, ADC, contactor. It is to protect an induction motor from single phasing and over temperature. Providing a protection system is very important in industries, using lot of motors such that production is not hampered owing to failure of any motor. The basic idea for the development of this topic is to provide safety to the industrial motor/pump/lift Motor etc. If any of the phases, out of the 3 phases is missing or if the temperature of the motor during operation exceeds the threshold value, motor stops immediately. If any of the phases is not available the corresponding transformer stops supplying power to the circuit. This leads to one of the four relays getting switched OFF. The main relay which is powered through a set of four relays gets disconnected because of one relay not being powered. Thus, the main relay that delivers 3 phase supplies to the motor gets disconnected. Three phase induction motor generally suffers from overheating, single phasing and phase reversal problems. The rise in temperature level of a motor during its operation beyond a permissible limit is known as overheating. The causes of motor overheating are motor overloading, distortion in the supply voltage, impaired cooling capability, unbalanced supply voltages etc. Because of overheating, we can face the problems such as Electrical fire, Insulation failure, Decrease in life time of motor due to earlier wear and tear of the motor windings etc.

1. Introduction

Single-phasing is the condition that results when one phase of a three-phase motor is suddenly open-circuited during operation. Single-phasing can occur as a result of blown fuse, loose connection and partial failure of switch gears; this is a fault condition. One potential threat of a single-phased induction motor is overheating, which consequently leads to insulation damage. When a three-phase induction motor in operation is suddenly single-phased, it continues to operate but draws excessive current in the other two remaining phases. A single-phased induction motor, by itself, does not have a starting torque, thus when an attempt is made to power it on from rest, it will only produce a humming sound. Leading standard organizations have concluded that 30 percent of motor failures are attributed to insulation failure and 60 percent of these are caused by overheating. It is also known that thermal overloading and single-phasing make up to 44% of malfunction case [3, 4]. Maintenance experts agree that excessive heat causes rapid deterioration of motor winding insulation. The common rule is that insulation life is reduced by half for every 10°C of additional heat to the windings. Several studies have been done on protection against single phasing, under voltage, over voltage and voltage unbalance.

2. Existing System

A novel protecting method for induction motor against faults due to voltage unbalance and single phasing this paper proposes a protection scheme for three phase induction motors against single phasing faults. Dynamic model of the induction motor in the stationary reference frame was adopted and modified to reflect single-phasing fault. A simulation algorithm was proposed, which can help determine the impact of single phasing on any three- phase induction motor. A case study simulation was carried-out with sudden single-phasing using MATLAB/SIMULINK software. A single-phasing protection by means of contactors was reviewed before an enhanced single-phasing protection was designed. A prototype of the enhanced protection method was implemented by the use of ac to dc converter, PIC16F877A and DC relays. The latter, in additional to offering protection against single phasing, also protects the motor from under-voltage, over-voltage and voltage unbalance. Suggested Citation C. U. Ogbuka and O. Bassey, ‘‘Protection Method against Induction Motor Single-Phasing Fault.

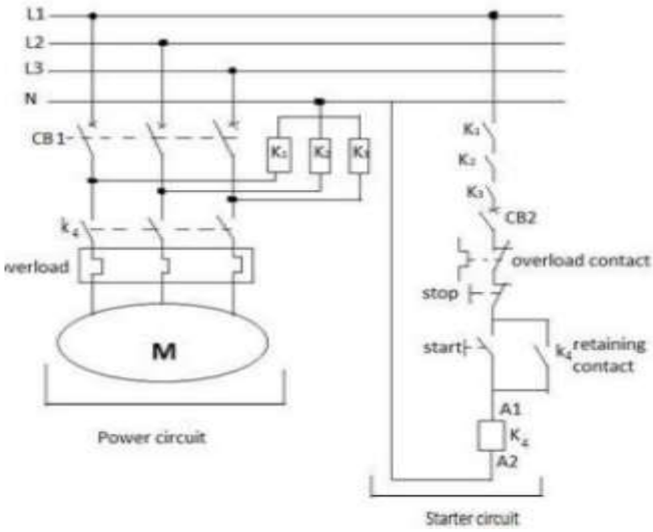
3. Proposed System

Single phasing preventer is used to protect the induction motor from single phasing fault. Single phasing is very dangerous fault to the electrical motor and which damages the motor stator winding rapidly. Generally single phasing is nothing but a motor runs when one of the supplies is disconnected due to open circuit or improper contact in switch or other electrical equipment failure. Normally, the motor runs with the three-phase supply and which takes balance current in each phase winding. Consider one of the fuses has blown. But the motor still in a rotating position which tries to rotates at the same speed. At that same time, the absence phase current will be shifted to the remaining live phases. Therefore, the current in the other phases increases up to 3 times its normal value instantly. This is called a single phasing fault.

4. METHODOLOGY

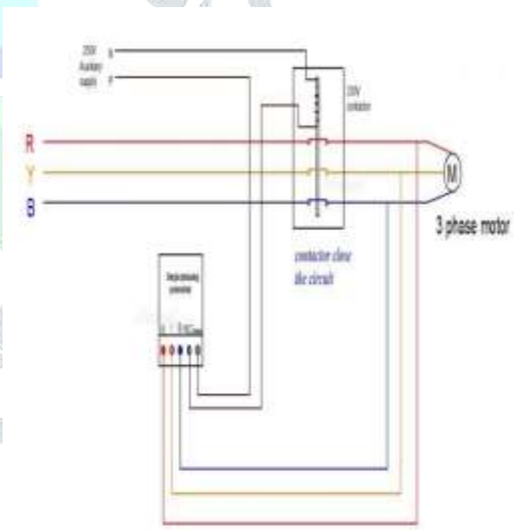
CONVENTIONAL PROTECTION AGAINST SINGLE-PHASING

Most protective circuits against single-phasing are electronic in nature and may not easily be available to lab and workshop supervisor. The figure below shows a simple protective circuit which can easily be implemented and added to most motor starters, but for simplicity, we incorporated it to DOL. It involves the use of three contactors (K1, K2 and K3) whose coils are connected to each of the motor phase supply. The contacts of these contactors are placed in series at the starter circuit to realize a logical AND, such that any phase that fails will automatically disconnect the motor from the supply. In order to simplify analysis and ensure good connections, electric motor connection circuits are usually divided into two circuits – the power circuit and the control or starter circuit. At first, the motor is OFF because the contactor contacts k4 are normally open and not yet been energized. When the start button is pressed (the start button is a normally opened push button or mono stable button), line 1 (L1) gets to the coil of the contactor and it becomes energized and closes the contactor contacts; but the push button moves back to its open state. In order to ensure that the contactor remains energized after the first push, one of the contactor contacts is connected in parallel with the start button, and this contact retains its connection by ensuring that the coil is still energized after the operator pressed the push button; that is why this parallel connection is called retaining contact. If the operator presses the stop button or power is interrupted, it de-energizes the coil of the contactor and there is no way it will get energized again because the retaining contact gets disconnected when the coil was de-energized. The advantage of this is that the motor does not suddenly start once power is restored.



4.1 Motor Protection Against Single-Phasing

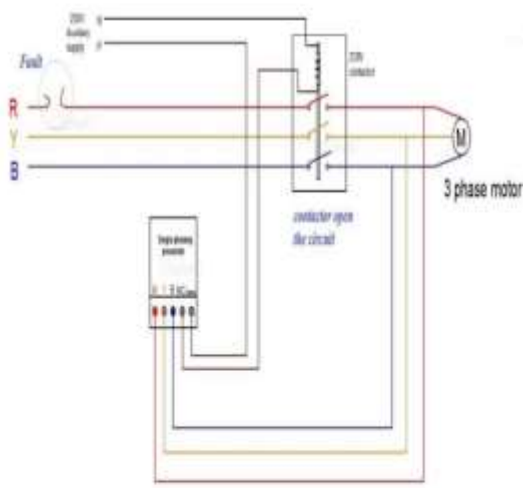
The Single Phasing Preventer which is shown in figures has five terminals, three terminals red, yellow, and blue for three phase supply which are to be connected before the motor and after the contactor. The remaining two gray terminals are the ‘Common terminal’ of the relay and ‘Normally closed (NC) terminal’ of the relay. As you see in the below connection diagrams the contactor having the rating 230v. So, an auxiliary supply of 230v is given to the contactor through the two terminals of the single phasing preventer



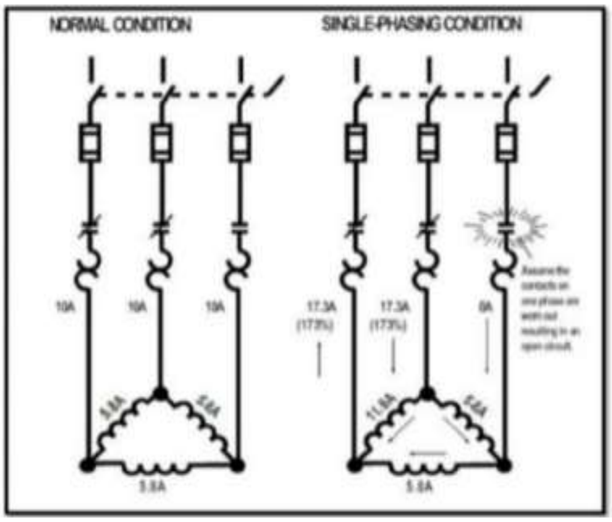
4.1.1 Under Normal Condition

4.1 Under Fault Condition

When the ‘R’ phase gets disconnected or single phasing occurred the preventer sends the fault and acts as an opened switch therefore the contactor does not get supply and it breaks the circuits so the motor will be stopped.



4.1.2 Under Fault Condition



5. General Faults in Induction Motor

There are various faults occurring in 3 phase induction motor, but in our project, we have protected the induction motor from the following faults only i.e.

- Single phasing
- Over speeding
- Over heating

5.1 SINGLE PHASING

It is well known that a three-phase induction motor will continue to operate when disturbance of some sort causes the voltages supplied to the motor to become single- phase. The single phasing can occur as a result of a fuse blowing or protective device opening on one phase of the motor. Other possibilities include feeder or step- down transformer fuses blowing. Even though the motor will continue to operate in this condition, the motor will heat up very quickly and it is essential that the motor be removed from service by the opening of a motor circuit breaker or some other type of protective device. This paper will describe three different ways in which an induction motor will operate ina single-phase condition. For purposes of this paper "single-phase “will include any condition in which the three line-to- line voltage phases appear on the same line.

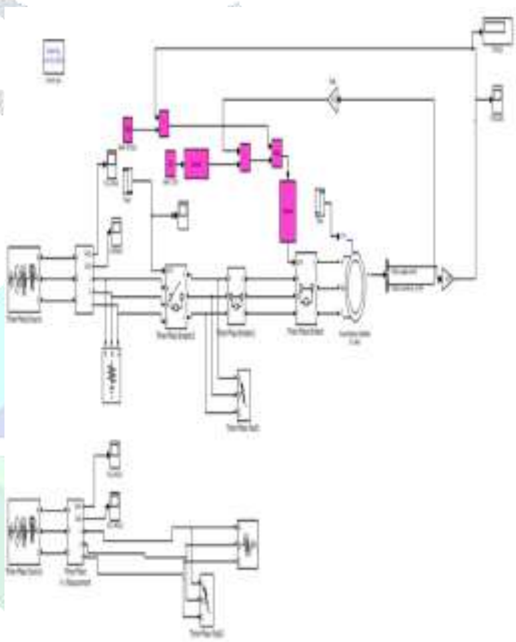
5.2 OVER SPEEDING

Significant frequency changes never take place on a large distribution system during a major disturbance. The most important effect of frequency change is the resulting change in motor speed. For example, if the frequency drops by 20% (Ns=120f/P). This change in motor speed may be unacceptable in many applications.

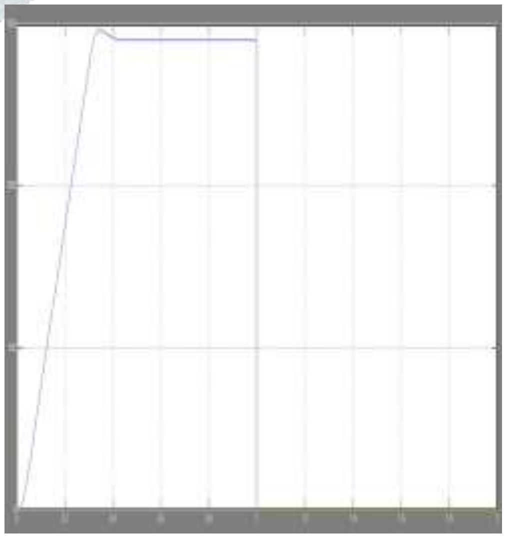
5.3 OVER HEATING

Although standard induction motors can develop twice their rated power for short periods, they should not be allowed to run continuously beyond their rated capacity. Overloads cause overheating which deteriorates the insulation and reduces its useful life. In practice, thermal overload relays are provided in motor circuit.

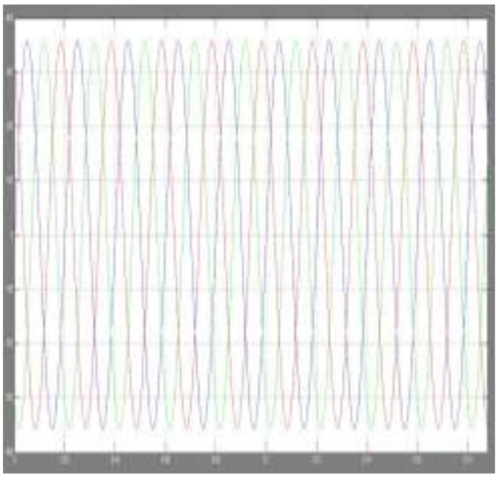
6. Results



6.1 Simulation Circuit



6.2 Open Circuit



6.3 Closed circuit

7. CONCLUSION

The circuit was fully controlled by the micro controller and the micro controllers will continuously monitors all the three parameters that are three phases, speed, temperature and if the parameter goes abnormal then it will switch off the motor until they are normal. It's not only protecting motor from transient voltages; it also switches on the motor automatically without manual requirement. The manual monitoring of this motor is difficult so automatic protection of induction motor has such an importance. Also, with the use of GSM the project can be made useful in remote places where maintenance is the major problem.

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