Faculty of Electrical and Electronic Engineering Technology

MONITORING AND PROTECTION ON THREE-PHASE MOTOR BY USING GSM MODEM

AFANDI AFHAM BIN ALI

Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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**A project report submitted
in partial fulfillment of the requirements for the degree of
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DEDICATION

My dissertation is dedicated to my family and many friends. A special gratitude to my loving parents ALI BIN MOHAMED & NORLISSHA BINTI SAHALI. Not forget to my friends and my supervisor CHE WAN MOHD FAIZAL BIN CHE WAN MOHD ZALANI for helping me to complete my project report.

ABSTRACT

Because of its ease of use, high durability and high efficiency, the three-phase electrical motor is the most important driver mchinery and widely use in industries. Without a proper maintainence and wrong environment, three-phase electrical motor easily can have problem such as overheating or single-phasing. This project proposes monitoring system for three-phase electrical motor which monitor temperature of the motor and prevent from single-phasing. AT89C51 microcontroller is used in the circuit to receive data from LM35 temperature sensor and send data to buzzer, contactor, and GSM modem.

The temperature sensor's output was first an analog signal and ADC 0804 is used to convert data from temperature sensor into digital signal then send back the data to microcontroller. The intention of this project is to protect three-phase electrical motor from occur abnormal condition such as overheating and single phasing and to develop a system that can monitor motor's condition. The result from this project can contribute to industries in the future.

ABSTRAK

Kerana kemudahan penggunaannya, ketahanan tinggi dan kecekapan tinggi, motor elektrik tiga fasa adalah mesin pemacu yang paling penting dan banyak digunakan dalam industri. Tanpa penyelenggaraan yang betul dan persekitaran yang sesuai, motor elektrik tiga fasa mudah menghadapi masalah seperti terlalu panas atau menjadi fasa tunggal. Projek ini mencadangkan sistem pemantauan untuk motor elektrik tiga fasa yang memantau suhu motor dan mencegah dari menjadi fasa tunggal. Mikrokontroler AT89C51 digunakan dalam litar untuk menerima data dari sensor suhu LM35 dan mengirim data ke buzzer, contactor dan modem GSM.

Output sensor suhu adalah merupakan isyarat analog dan ADC 0804 digunakan untuk menukar data dari sensor suhu menjadi isyarat digital kemudian menghantar kembali data ke mikrokontroler. Tujuan projek ini adalah untuk melindungi motor elektrik tiga fasa daripada keadaan yang tidak normal seperti terlalu panas dan menjadi fasa tunggal dan juga dapat mencipta sistem yang dapat memantau keadaan motor. Hasil akhir dari projek ini dapat menyumbang kepada industri pada masa akan datang.

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δ	-	Voltage angle
ω	-	Omega

LIST OF ABBREVIATIONS

V	-	Voltage
N	-	Revolution Per Minute (RPM)
Tsh or T_L	-	Load
Nm	-	Newton Metre

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CHAPTER 1

INTRODUCTION

1.1 Background

Three-phase electrical motor is the most important driver machinery and widely used in industries because easy to use, high durability and high efficiency. Three-phase electrical motor divided into two which is asynchronous motor and synchronous motor. The main part of the motor is stator, rotor, and the enclosure. Induction motor known as asynchronous motor that operates by using electromagnetic induction principle. According to Alkadhim S.A.S. SSRN Electronic Journal (2020), An A.C. motor is an induction motor (also known as an asynchronous motor). The motor line current flows through the stator windings, creating a flux known as the main flux or stator flux, which passes through the air gap and is cut by the rotor windings' conductors. As a result, an electromotive force is generated in the rotor windings, causing currents to circulate in the rotor windings, resulting in rotor flux.

The interaction of the two fluxes (stator and rotor fluxes) causes the rotating component of the motor to rotate (rotor). The rotor receives electrical power in the same way that an electrical transformer's secondary winding receives power from the primary winding via electrical induction.

That is why an induction motor is also known as a revolving transformer, since the primary winding remains stationary while the secondary rotates freely. Usually, these motors are usually placed in different environment and conditions which lead damage to motor parts.

Short circuit on the stator, overheating and single phasing are a few internal parts problems that always happen which can bring damage to the motor.

One of the causes of external problem in a three-phase induction motor is one of the phases disconnect which cause single-phasing disturbances in three-phase induction motor. An electrical motor failure will make production being halted and delay, resulting a lot of losses in financial. In electrical motors, condition monitoring and fault detection described as methods for predicting failure ahead of time such that repair, and maintenance can be done to save motor and keep operation running. To monitor an electrical motor, it must give attention to different types of faults that seem to be normal in these machines.

The Electric Power Research Institute of Canada and the General Electric Company of the United States have conducted an evaluation study to establish how efficient motors are. (Bin Hassan and colleagues.) They put 4797 people through their paces, with 872 failing once or numerous times and 1227 failing altogether on the first try. Furthermore, 335 out of 1227 motors failed on more than one occasion. Failures of the bearings and stator windings are the most common causes of failure, accounting for approximately 80% of all failures. Only 10% of the failures were caused by rotor flaws, with the remaining 90% being caused by other reasons.

1.2 Problem Statement

Usually, all electrical motor failure is cause by lack of monitoring system in electrical motor system as the technician take a long time to identify the problem. Overheating is one of the main problems and defined as rise in a motor’s temperature level beyond a standard limit during its operation. Motor overloading, interference supply voltage, poor cooling capability and unbalanced supply voltages are all the causes of motor overheating. Overheating can contribute such a big problem such as insulation failure, electrical fire and motor lifespan is reduced due to earlier wear and tear of the motor windings. Furthermore, if one of the three phases supplying voltage to a three-phase motor fails, this phenomenon is known as single phasing. Single phasing is when one of a motor's line links is disconnected, resulting in a single-phase motor. A single-phase condition causes an abnormal voltage imbalance in the motor, resulting in high currents and motor heating. According to (Ivana Z. Giceva, Vasilija J. Sarac, Saso A. Gelev, and Vlatko T. Cingoski on 23rd International Scientific-Professional Conference on Information Technology, IT (2018)), If one of the three phases of a three-phase induction motor is disconnected, the motor will run in a physically two-phase mode and will not function. Humming sound was produced as the motor struggled to start in these situations. The continuation of this regime has no physical or operational significance because the motor will not start and can cause minor motor damage in some cases. A start or run capacitor is used in induction motors that are designed to run on a single phase to ensure that the motor starts and runs in the correct direction.3-phase motors depend on the phase sequence of the power supply to ensure that they start and decide their rotation, but with just two lines attached, it's impossible to know whether or not a motor will start and, if it does, in which direction it will rotate. If a single-phasing motor starts, it can be able to run under light loads without tripping simple overload breakers or fuses. When the load on the motor is increased, the current may rise well above the motor's maximum load current, or the rotor may lock up entirely. Both will trip the correct sized motor safety long before the pump reaches the expected output.

1.3 Project Objective

i. To design protection system to protect electrical motor from severe effects such as overheating and single phasing during abnormal conditions.

ii. To develop a system that can easily monitor motor's condition on any occasions.

iii. To evaluate performance of the motor system to reduce risk damage.

1.4 Scope of Project

In this study, a hardware circuit is design to avoid three phase motor from overheat and single phasing whenever one of the two happens, the motor from the supply is disconnect. LCD screen is used to monitor status of the motor by showing current temperature and the phases currently present are indicated by bulbs. During irregular conditions happens, the user is notified by an alarm and SMS was sent to the user's mobile phone. AT89C51 microcontroller use in this circuit sense abnormal conditions. The 4-pole contactor de-energize which disconnects the motor from the supply, by sounding a buzzer and sending SMS to the user's mobile phone via a GSM modem. Three single phase transformers are used and connect with star connection which primary is connected to the 3-phase supply. The secondary ends of the 6V are connected in parallel resulting in a net output voltage of 0V when all phases are present and nearly 6V when one of the phases fails. To sense the motor's temperature, LM35 temperature sensor is use in this circuit. The temperature sensor's output is an analogue signal. As a result, it is converted to a digital signal and send the data to microcontroller via an Analog/Digital converter ADC0804 and send to microcontroller. The current motor temperature can be continuously tracked in the LCD screen. The microcontroller buzzes an alarm, sends an SMS, and disconnects the supply from the load if the motor temperature reaches the hot spot or critical temperature.

1.5 Thesis Outline

On the first chapter in bachelor’s degree Project is introduction. In introduction consists of project background, problem statement, objectives, and scope of study. In Chapter 2, the literature review will be discussed. On this chapter, some related journal articles and previous research papers were study to gain a better understanding to relate and how current projects are developed as well as to identify gaps and similarities in previous similar research. The project's system and method of data for the guide to continue bachelor’s degree Project, equipment used, and applications will be discussed more in chapter 3. Finally, in final chapter for the bachelor’s degree Project will clarify the findings that will be raised to assess the project's success.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Electric motors are such an integral part of our daily lives that we rarely think about them. Induction motors are one of the most well-known forms of electric motors. Because of their robust design and ease of operation, induction motors are used to drive loads in textile mills, agriculture, and almost all manufacturing industries. An induction motor consists of two parts which are stator and rotor. The stator is made up of different stampings with slots for three-phase windings to pass through. It's bound to fit a certain number of poles. The windings are separated by 120 degrees symmetrically. Induction motors use two types of rotors: squirrel cage rotors and wound rotors. The system does not need any DC field current to operate.

The rotor is the electromagnetic circuit's rotating part. The squirrel cage rotor is the most common type of rotor. A cylindrical laminated core with axially spaced parallel slots for holding the conductors makes up the rotor. A copper, aluminum, or alloy bar is placed in each slot. In three-phase induction motors, the rotor is often used as an anchor. The anchor shape of the rotors used in early electrical devices is the inspiration for this name. The anchor's winding is caused by the magnetic field in electrical equipment, but in three-phase induction motors, the rotor takes this role.

Rather than being physically bound by wires, rotor voltage is induced in the rotor windings. The magnitude of the force varies directly with the strength of the magnetic field and the volume of current flowing in the conductor, according to the basic theory of the induction motor. The operation of a three-phase induction motor is not always reliable;

certain issues occur because of failing to prepare ahead of time. Irregular maintenance, constant use of a three-phase induction motor, lack of a three-phase induction motor control system, overcurrent, and overload, causing the motor to overheat and a variety of other issues may occur.

Heat is produced on the motor windings when a three-phase induction motor is used as a drive. According to (JAREE-Journal on Advance Research in Electrical Engineering Volume3, Number 2, October 2019), This energy is not only transformed into motion energy, but it also dissipates into heat at a rate of 10-20%, which is referred as motor losses. The industrial process may be interrupted that cause from motor not full operated in 100% condition.

2.2 Single-Phasing on Three-Phase Induction Motor

Three-phase induction motor could not start if one of the motor's phases is disconnected, causing the motor to run in a two-phase mode. Humming sound could appear in such situations, and the motor would fail to start. Since the motor will not function, and in some cases, minor motor damage will occur, continuing to operate such a device has no physical or operational benefit. A loaded induction motor with rated or less than rated load loses one of its phases for various reasons such as a blown fuse, a broken power supply line, or a bad terminal link, can cause the motor to work only with the remaining two phases.

If any safety steps are not taken in a timely manner, this so-called single phasing operation mode could cause many operational problems for induction motors, which could very likely result in rapid deterioration of motor parameters and burnout. Depending on whether the input supply is single-phase AC or three-phase AC, there are two types of induction motors: single-phase induction motors and three-phase induction motors.