DESIGN A REMOTE TERMINAL UNIT (RTU) FAULT DETECTION SENSOR TO DETECT VOLTAGE IN RANGE OF UNDER VOLTAGE AND OVERVOLTAGE FAULT.

Muhammad Tarmizi Bin Rosli

Bachelor of Electrical Engineering
(Control, Instrumentation & Automation)

June 2014

"I hereby declare that I have read through this report entitle "**Design a Remote Terminal Unit (RTU) Fault Detection Sensor to Detect Voltage in Range of Under Voltage and Overvoltage Fault"** and found that it has complied the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation & Automation) with honors"

Signature : ……

Supervisor Name : ……

Date : ……

DESIGN A REMOTE TERMINAL UNIT (RTU) FAULT DETECTION SENSOR TO DETECT VOLTAGE IN RANGE OF UNDER VOLTAGE AND OVERVOLTAGE FAULT.

Submitted By:

MUHAMMAD TARMIZI BIN ROSLI

B011010197

A progress report submitted in partial fulfilment of the requirement for the degree of

Bachelor of Electrical Engineering

(Control, Instrumentation & Automation) with Honours

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

(UTeM)

2014

I declare that this report entitle "**Design a Remote Terminal Unit (RTU) Fault Detection Sensor to Detect Voltage in Range of Under Voltage and Overvoltage Fault"** is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidate of any other degree.

Signature : ……

Name : MUHAMMAD TARMIZI BIN ROSLI

Date : …….

Dedicated, in thankful appreciation for support, encouragement and understandings

To:

My supervisor Datuk Prof Dr Mohd Ruddin Ab Ghani

My beloved father and mother Rosli Bin Dollah and Norhayati Binti Hassan

My family members and all friends

ACKNOWLEDGEMENT

First of all, I would like to praise ALLAH S.W.T. for His blessing. He gave me physical and mental strength to carry on my final year project I (FYP1) up to completion.

I also would like to express gratitude and thanks to my supervisor, Datuk Prof Dr Mohd Ruddin Ab Ghani for support, encouragement, guidance, advice and unfailing patience through the duration of the project. His encouragement and guidance are truly appreciated. Not to forget master student Wan Nor Shela Ezwane Wan Jusoh, Siti Hajar Raman and Wan Ahmas Redhauddin Wan Hassan who also encouraged me to complete this project. Otherwise, this project has not been possible to achieve the objective.

Hence, I am also would like to thank to my father and mother and all the family members for their encouragement and never ending support. Their support and lovely companionship are another important source of strength for me.

Finally, I would like to offer thanks and deepest gratitude from the bottom of my heart for all the supports, encouragements and inspiration I obtained through the duration of this project.

ABSTRACT

Remote Terminal Unit (RTU) is a data acquisition device that implements in the Distribution Automation System (DAS). The primary function of the RTU is to monitor electrical parameter data, such as voltage from line distribution before transmit to consumers. The data sensed by RTU system will be analyzed and transmit commands to a central computer to take action automatically based on the fault occur. The design of this project will be focused on designing fault detection sensor to emphasis on any value differences in voltage by using microcontroller board (SK40C). The system is developed for single phase faults and the types of faults detect is under voltage and overvoltage. The main heart of this project is voltage sensor and a PIC microcontroller. The microchip will be programmed to a specific voltage for the condition under voltage and over voltage when voltage sensor detects input voltage. Then, at the end of this project, fault detection sensor will be able to detect under voltage and overvoltage faults and ready to interface with complete Remote Terminal Unit project.

ABSTRAK

Remote Terminal Unit (RTU) adalah pengambilalihan peranti data yang dilaksanakan dalam Sistem Automasi Pengagihan (DAS). Fungsi utama RTU adalah untuk memantau parameter data elektrik seperti voltan daripada pengagihan talian sebelum menghantar kepada pengguna. Data yang dikesan oleh sistem RTU akan dianalisis dan menghantar arahan kepada unit kawalan untuk mengambil tindakan secara automatik berdasarkan perubahan voltan yang berlaku. Projek ini tertumpu kepada menghasilkan alat pengesan perbezaan voltan untuk mengesan perbezaan nilai dalam voltan dengan menggunakan litar mikropengawal. Sistem ini dicipta untuk mengesan perubahan satu fasa voltan (230V) sama ada nilai voltan yang diterima rendah atau tinggi dari nilai yang sebenar. Komponen utama projek ini adalah sensor voltan dan PIC mikrocip. Mikrocip akan diprogram dengan bacaan nilai voltan tertentu bagi mengesan keadaan voltan. Kemudian, di akhir projek ini , Remote Terminal Unit (RTU) akan pengesanan perubahan pada voltan dan boleh bersiap sedia untuk di pasankan dengan projek Remote Terminal Unit.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

CHAPTER 1

INTRODUCTION

1.1 Project Background

Remote terminal unit (RTU) is an electronic control device that interfaces with distributed control system, such as SCADA (supervisory control and data acquisition) to analyze the electrical parameter at the distribution station. The data are collected from process equipment at remote locations and transfer back to a central unit to define data condition [1]. The data read by remote terminal unit can be in three conditions such as analog input, digital (status input) and digital (control outputs). The data read in an electrical parameter such as RMS value of voltage and current, frequency, power etc.

This project involved designing fault detection sensor voltage for remote terminal unit (RTU) where it is suitable to use in power system distribution. The process design must study information from other circuit in order to get the best design for voltage sensor. Then, the voltage sensor design will be effective to sense the different voltage values in the system. Voltage fault detection can be described into three states which is under voltage fault, overvoltage fault and stable.

In industry application, the RTU will determine the fault status and operate corresponding switching, isolates faults and restore power supply [2]. The distribution station protection device is very important to protect residential areas from fault condition. Moreover, the used current system is imported from another country technologies and used in our local distribution. Since it used imported product then the price must be higher

included the maintenance fee. So from this situation decision has been made that local student must study how to develop our protection product.

Since the increasing population and unavoidable demands, it leads to the high increase demands on electrical power. With this increase in demand of power, then the existing system may not fully support for demanding requirements. From the analysis of fault condition, the problem can be reduced by knowing the factor of fault occur.

The main objective of this project is to develop fault detection sensor and it focus for monitoring process only, the protection and controlling part are not covered in this project. The fault detection sensor can only sense the fault condition and display the fault value.

1.2 Problem Statement

At the distribution station, the voltage may drop and rise from its rated value due to lack of electrical equipment's functional abilities. There are many types of fault occur in process distribution voltage to consumers. The fault occurs can be categorized into two types which is balanced and unbalanced faults. The balanced fault normally has less than 5% fault, while the unbalanced fault has single-line to ground fault (60-75% fault), double-line to ground fault (15-25% fault) and line-to-line faults (5-15% fault).

Normally, the voltage consumes to consumer may drop from the distribution line supplying to a specific load whereby the load could be any consumer which cause the consumer voltage drop from its rated value. For example, in the current industry, the voltage may rise or drop from its rated value due to improper operation of the voltage regulating equipment such as transformers or capacitor.

Apart from this problem, this final year project will be a case study to develop and design the fault detection sensor to detect and monitor fault at the substation. This project will provide a fault detection sensor to detect voltage in the range of under voltage, normal voltage and overvoltage.

1.3 Objective

The objective of this project can be described as below:

- To design fault detection sensor to detect fault voltage input.

- Ensure that the design will be able to monitor and display the fault voltage in the range of under voltage and overvoltage.

1.4 Scope of Project

The scope for this project is to design the fault detection sensor on input voltage to detect under voltage and overvoltage. Range of voltage need to be considered is a single phase system (0 to 260V). This fault detection circuit is based on the variable transformer which will supply the AC voltage to the designed voltage sensor circuit. After that, immediately a fault detected process by microcontroller board (SK40C) and display the fault condition on the LCD screen.

Furthermore, the limitation of the entire project is divided into two. First part of the project is to design and build the hardware of the sensor voltage. Its components included variable transformer as input, voltage sensor circuit, microcontroller circuit and LCD display. The voltage sensor will design for 0 to 300V input supply and the output will in the range of 0 to 5V. Then, the output voltage will supply as input to the PORTA of SK40C microcontroller board and the output will be at PORTB and connected to the LCD display

The second part is the development of a C language using Micro C programming that will read the output voltage from designed circuit to determine the range of under voltage and overvoltage condition and display on LCD. The under voltage fault will determine when the input voltage less than 200V and the normal voltage set in between of 200V and 250V. Lastly the overvoltage voltage will be in condition fault when voltage exceeds more than 250V

Finally, after complete these two parts of the project, then the design voltage was ready to use as a voltage sensor to complete Remote Terminal Unit circuit.

1.5 Project Contribution

This project is expected to improve power management and system fault at distribution station. The specific range voltage can be easily described through programming in PIC microchip after detecting by voltage sensor. From that, the system will be able to easily describe the type of fault voltage range, better accuracy and improve the efficiency of power distribution system. The prototype of the voltage sensor design will be used in real Remote Terminal Unit prototype project.

Apart from this final year project, the further development of this project has been determined. The reliability of the system can be improved by setting up the time and date of fault condition when the system detects a fault. Hence, the fault detection sensor does not only record voltage fault, but the time and date also recorded together. After that the analysis of fault can be easily made by knowing what time voltage fault often occurred.

Lastly, this project is not only to design fault detection sensor, but it also includes two studies the importance of fault protection device in the power distribution system. Since the distribution system involved transmitted of high voltage range, then the system must be secured and restrict to harm consumers. Hence, student able gain knowledge by knowing and studies the factor that leads to overvoltage and under voltage fault.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Literature Review

This chapter explains the theory and basic concept of designing voltage sensor and application of Remote Terminal Unit (RTU). The principle idea is created before the design process of voltage sensor is conducted. This chapter also covers all instrument parts that's connected to a remote terminal unit (RTU) e.g. voltage sensor, c language programming, microcontroller board, etc. This will provide a clear understanding of the system and the design.

2.2 Power Distribution Station

Distribution station is the final station that received voltage from power plant before distribute electricity to consumers. The distribution system can be divided into two types, overhead distribution and underground distribution. The overhead distribution is where the electricity distributed through line on wood or electrical pillar. Meanwhile, underground distribution is to be free of electric wires and poles. In addition, when underground distribution system is called hybrid underground/overhead, then it has line voltage on the underground and the transformers and medium voltage line are overhead. But when the system is entirely underground, the medium line voltage is buried and the transformers are mounted on ground level pads [7].

2.3 Distribution Automation

Distribution automation is the system that allowed computers to control automatic the utility distribution facilities with no human intervention [3]. In details, it provides the ability to automatically monitor, coordinate and remotely operate distribution devices, such as relays and sectionalizing switches.

The primary function of distribution automation is to increase efficiency of power supply when there are fault occur. When a fault occurs, several actions are taken by substation operator to determine the reason of fault and this process normally take an amount of time depending on the fault situation. However, with designing distribution automation, the action will be taken by computer-based system and computerized controller can monitor the system and decide on proper actions instantly.

2.4 Remote Terminal Unit (RTU)

The objective of remote terminal unit (RTU) is developed to acquire electrical parameters, data e.g. voltage and current from the line input to transmit commands and instruction to system control data, supervisory control and data acquisition SCADA. The primary function of the RTU is to detect faults, fault location, diagnosis, fault, and switching control to maintain power supply system to load when a fault occurs [2]. The other function of remote terminal unit can be described as below [4] [6]:

- Acquisition other parameters information such as measured values, signals, meter reading, etc.
- Deliver commands or instructions, set points, the control variable, etc. including their monitoring as a function of time.
- Identify the changes in signal input with time data allocation and sequencing recording of status by the central computer.
- Processing of information transmitted to and from telecommunication equipments.
- Communicate with the central computer.

The structure of the RTU is shown in Figure 2.1 (below).

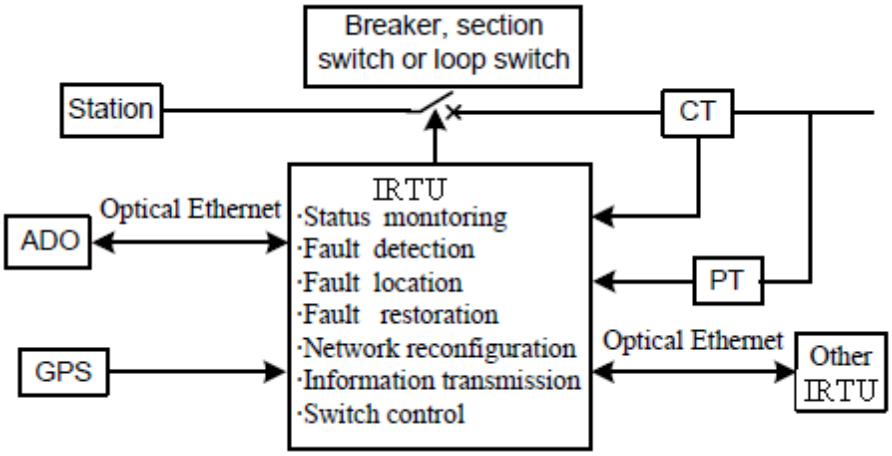

Figure 2.1: Structure of RTU [2].

2.5 Under Voltage

Under voltage is the situation where the value of voltage is lower than the desired value. This problem may occur from the load which is not suitable to use in circuit or lack of electrical equipments to functioning. So, this problem can cause other instruments in the distribution system to operate under normal condition. Then the consumers will receive unrated voltage when this fault occurs.

There are two types of common losses occur in a distribution power system which is the power lines and transformers. The type of losses is referred to core losses and copper losses. Core losses can be divided into two losses which is hysteresis loss and eddy current. Both depend on magnetic properties of core the transformer and the losses is directly fixed and do not depend on the load current. While the copper loss depends on the current in both primary and secondary coils. As the current depend on the load of transformer (P=I^2R), then the copper loss is varying with the load. If the load is increased then more losses form in the transformer windings.

Hence, the increased resistance will convert electrical energy into heat and imposes additional loads on the distribution station. Besides that, poor connections or inadequate sizes also cause to under voltage fault and result in excessive energy losses. Poor connection includes loose cable terminal, corroded terminal, poor crimps and worn/poorly adjusted between contacts.

2.6 Overvoltage

Overvoltage is a situation where the value of voltage increases over 100% from rated voltage. Overvoltage can cause a sudden reduction in loads, failure of electrical control instrument such as voltage regulators, cause insulation failure, etc. Overvoltage in power system can be classified into two main types such as external overvoltage and internal overvoltage.

External overvoltage is a situation generated by atmospheric disturbance and lightning is the most common and the most severe. While internal overvoltage is generated by changes in the operating conditions of the network. Internal overvoltage can be divided into two types, switching overvoltage and temporary overvoltage.

The increasing in transmission voltages needed to fulfil by power substation, switching surges have become the governing factor in the design of insulation for the high voltage power system. In the meantime, lightning overvoltage come as a secondary factor in these networks.