SMART PROTECTION SYSTEM FOR INDUSTRY AND DOMESTIC DISTRIBUTION BOARD (SPeeeDo)

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Bachelor of Electrical Engineering (Industrial Power)

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Supervisor Endorsement

"I hereby declare that I have read through this report entitle *"Smart Protection System for Industry and Domestic Distribution Board (SPeeeDO)"* and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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A report is submitted in partial fulfillment of the requirements for the degree of

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Student Declaration

I declare that this report entitle *"Smart Protection System for Industry and Domestic Distribution Board (SPeeeDO)"* is the result of my own research except as cited in the reference. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : …….

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ABSTRACT

The Earth Leakage Circuit Breaker (ELCB) is a device that is used to protect a system from tripping or shut down caused by short circuited or unbalanced current between the phase connection and the neutral connection. Thus, ELCB is designed to overcome such this condition as fast as it could in order to reduce the harm caused by the shock. When the system is tripped, the ELCB cannot turn on back automatically and also cannot give any signal or indicator to the consumer when it is tripping. Furthermore, the location of the distribution board is far from the consumer and it will caused the wasting of time of the consumer to turn on back the system manually to back the normal. Thus, the Smart Protection System for Industry and Domestic Distribution Board (SPeeeDo) is developed and designed to study and applied the applications of the auto reclose on distribution board that is suitable for the industry and domestic users. Other than that, SPeeeDo system is developed with the combination of Global System for Mobile (GSM) and emergency indicators such lamp and bell. In this system, the GSM will be integrating with the Programmable Integrated Circuit (PIC) and liquid crystal display (LCD) to produce an output of the system. Hence, this GSM will send a message to the consumers in order to mention that the system is tripped while the LCD will display the status of the system either it is in normal condition or tripped condition. In addition, the bell is installed together in order to mention that the system has permanent fault. This bell will be functioned at the last of tripping only.

ABSTRAK

Pemutus Litar Bocor ke Bumi adalah peranti yang digunakan untuk melindungi sistem daripada terputus atau ditutup disebabkan oleh berlakunya litar pintas ataupun ketidakseimbangan fasa antara fasa mahupun sambungan antara neutral. Oleh yang demikian, pemutus litar bocor ke bumi direka untuk mengatasi masalah ini daripada berlaku bagi mengurangkan berlakunya bahaya akibat daripada kejutan elektrik. Apabila peranti ini terputus, ianya tidak dapat memberikan semula bekalan kepada sistem secara automatik dan tidak menunjukkan sebarang reaksi terhadap pengguna bahawa litar tersebut telah terputus bekalannya. Tambhana pula, kedudukan papan pengagihan yang terletak di dalam industri mahupun rumah adalah jauh daripada kedudukan pengguna tersebut. Hal ini menyebabkan pengguna terpaksa menaikkan semula peranti tersebut kepada keadaan asal secara manual supaya bekalan tersambung kembali dan ia mengakibatkan berlakunya pembaziran masa semata-mata untuk menghidupkan semula bekalan. Oleh itu, Sistem Perlindungan Pintar untuk Papan Pengagihan di Industri dan Domestik (SPeeeDo) direka bentuk untuk mengkaji aplikasi sistem pemutus litar automatik beserta dengan gabungan sistem bumi untuk telefon (GSM) dan juga lampu dan loceng untuk dijadikan sebagai petunjuk kecemasan. Dalam sistem ini, GSM tersebut akan berinteraksi dengan Litar Aturcara Bersepadu (PIC) dan paparan cecair kristal (LCD) untuk mengeluarkan keluaran sistem. GSM tersebut akan menghantar pesanan kepada pengguna untuk memberitahu bekalan telah terputus dan skrin akan memaparkan keadaan sistem pada ketika itu. Loceng akan berfungsi buat kali terakhir apabila sistem tidak boleh memberikan bekalan secara automatik lagi.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AR	Auto Re-closer
ARD	Auto Reclose Device
CB	Circuit Breaker
CMOS	Complementary Metal Oxide Semiconductor
DG	Distributed Generation
EHV	Extra High Voltage
ELCB	Earth Leakage Circuit Breaker
ELR	Earth Leakage Relay
GSM	Global system for Mobile
HV	High Voltage
IC	Integrated Circuit
IDMT	Inverse Definite Minimum Time
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MV	Medium Voltage
OTP	One Time Programmable
PCB	Printed Circuit Board
PIC	Programmable Integrated Circuit
ROM	Read Only Memory
SAC	Second Arc Current
SMS	Short Message Service
TCC	Time Current Characteristic
TTL	Transistor – Transistor Logic

UHV	Ultra High Voltage
USB	Universal Serial Bus
VoLL	Value of Lost Load
ZCT	Zero Current Transformer

CHAPTER 1

INTRODUCTION

1.1 Overview

Earth Leakage Circuit Breaker (ELCB) is a device that used directly to detect current that flow directly from live part of the installation to the earth that cause the power system should be cut off. It was mainly used in TT earthing systems of design distribution. The device can detect the presence of faults or leakage current and at the same time will be as a protective device to consumer from electrical shock when occurred to the consumer's equipment.

The ELCB is designed consists of a mechanical switch, zero current transformer (ZCT), high level transistors and reset buttons. The current flowing in the ELCB will be limited by the high level transistor when the current flowing through its line when reset buttons is pushed.

ZCT is used to detect unbalanced current in the system to protect the system from damage. Once the fault occurred over the current setting on it, the system will be tripped by mechanical switch.

1.2 Problem Statements

ELCB is one of the electrical equipment that used as a protective device. The main purpose of the ELCB is to trip or turn off the power supply when faults or disturbances occurred in the system [1]. However, when the system is tripped, users should turn on back the ELCB to the normal operation to get back the power supply.

The other problem is when the system is tripped or blackout, the device cannot give any signal to the consumer. In addition, most of the current conventional ELCB does not have an alarm indicator placed on the distribution board.

Moreover, the distribution board is placed far from the consumer. Thus, when the tripping occurred, the consumer should go to the distribution board to turn it back manually into the normal condition. Hence, this problem can caused the wasting of working time of the consumer.

1.3 Project Objectives

The objectives of this project are:

i) To study on the function of an auto re-closer system applied for distribution board.

ii) To design a smart protection system for earth leakage circuit breaker for industry and domestic distribution board.

iii) To develop an auto re-closer system with GSM integration and emergency indicators.

1.4 Scope of Project

The scope of this project is to study on the application of an auto re-closer system applied for distribution board. In this project, Proteus software is used to design the circuit of PIC microcontroller and GSM system. Then, the distribution board is design with an auto re-closer system and the PIC and GSM system will connect together with the distribution board. The circuit of PIC microcontroller will communicate with LCD and GSM modem to show the status of the tripping system. After this, the emergency lamp will light on and GSM system will send a text message in term of short message service (SMS) to user's mobile phone in order to alert the user that the system has been tripped. At the end of tripping system, the bells will ringing to mention that the system has permanent fault that should be considered.

1.5 Layout of the Research Work

This report consists of five main chapters. Chapter 1 discusses about the introduction and overview of the project, objectives of the project, scopes and problems statements of the project.

Chapter 2 explains more on the literature review of the project. It is a fact-finding research on the previous project and concept that had been used.

In Chapter 3, research methodology of the project will explained detailed. Every stage in the flow chart of the research methodology is elaborate. The stage of developing hardware equipment will be explained too.

Then, the results obtained from the observation of the project will discuss and analyze in the Chapter 4. The results of hardware development are observed in term of the output graph of current and voltage by using oscilloscope and Fluke meter while in software

implementation of the project the result is observed based on the simulation using Proteus software.

Finally, conclusion and recommendation of the project will present in Chapter 5. The discussion of the results is accompanied in this chapter and conclusion has been made related to the objective that should be achieved.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will review on the application of auto reclosing ELCB unit of power system network. Similarly, auto reclosing unit is one of the widely used application in transmission lines and distribution networks of power network. Section 2.2 will discuss detailed about the application of auto reclosing ELCB on transmission lines that focused on fault differentiate and the method of solving problems on auto reclosing unit. Meanwhile, application on distribution networks will review on placement of auto reclosing on distribution networks and the method used to solve problems on auto reclosing in distribution networks that has been discussed in Section 2.3.

Furthermore, Section 2.4 until Section 2.7 will be the review on the main components that has been used in the software implementation. It consists of PIC Microcontroller, GSM modem and LCD that should be installed in SPeeeDo system. The uses of all the application are to make the SPeeeDo system more valuable and friendly user for domestic and industry user.

2.2 Transmission Lines

In transmission lines power network, the auto re-closer unit is used to protect the overhead system from losses or faults during transmit the electricity. The auto-reclose is widely use on transmission lines to make the fault line re-run after the temporary fault elimination. As information, Malaysia has a high isokeraunic level of about 180 thunder day per year [2]. This condition will suffer a high transient fault that will be affects the reliability and quality of supply to the consumers [2]. In conjunction, different types of an auto re-closer are used at different lines of voltages.

For example, a single and three poles auto re-closer is used on the 275kV whilst on 132kV lines three pole auto re-closer is used. Similarly, percentage of transient is higher on lower voltages such as 132kV and 66kV while lower percentage of transient on higher voltages 275kV due to its insulation level. In this condition, the auto re-closer is employed to carry out the duty to maintain continuity of supply. In the other hand, the uses of auto re-closing on 275kV can help the systems stability and synchronism in maintenance that making the better performance of auto re-closing [2].

2.2.1 Fault Differentiate

Usually, auto re-closing widely installed on overhead lines of voltages levels from 132kV up to 500kV. It is because, during transmission, it may cause fault or overload of electricity. When fault or short circuited occurred during transmitting, the auto re-closer will recover these problems as well as saving energy and time of workers to recovered the problems. There are two types of tripping that occur in transmission system which are the System Fault and Non-system Fault [2].

The System Fault is defined as an electrical fault which involves the failure of primary electrical apparatus that resulted from the deviation of electrical parameters from their normal operation values and requires the disconnection by tripping of the relevant breakers [2].

Non-system Fault is defined as any incorrect operation of circuit breaker in which affected a cause other than system fault. If permanent fault had occurred, for the first time the auto re-closer relay should attempt to close the circuit breaker until the fault is cleared. Once the fault still uncleared, the breaker will trip for the second time and will issue a lockout signal to the circuit breaker [2].

Moreover, auto re-closing has been used in Extra High Voltage (EHV) or Ultra High Voltage (UHV) transmission lines to discriminate faults between the line charging inrush current and the current resulting on the transmission lines. Even though auto re-closer is widely uses in transmission lines, but every installation and clearing faulted by tripping of the circuit breaker at transmission lines will produces high negative sequence current in nearby the generators [3]. The effects of this should be considered to make the system stability and reliability. Usually, to reduce these negative sequences current, the capacitance grounding had been connected together between the ground and neutral point of star winding of a transformer at transmission lines that will make the net zero sequence reactance become zero.

Then, by refer to [3], the maximum faults in EHV transmission lines are not permanent faults and occurred between single phases to ground (LG) that caused mainly due to lightning and over voltages that had been created on the line by switching and others. The poles of circuit breaker (CB) of the faulted phase at each end of transmission lines are opened to cleared faults. Therefore, heating is one of the problems that associated when installing single pole auto reclosing nearby the generators due to negative sequence current produced during the period of unbalanced. The unbalanced occurred due to opening of one phase in a three phase system. The problem become worse when dead time of auto re-closure is high because of the larger angular swing of the remote generator is produced. Even though the re-closure is successful, the duration of high amplitude power oscillations is still long.

2.2.2 The Method of Solving Problems on Auto Reclosing Unit

There are several movement should be taken to prevent these problems. The negative sequence current should be reduce to make the transient stability limit can be improved during single pole auto re-closing. Other than that, the sudden change of generator output at the instant of reclosing should be eliminating. Then, the solution of these problems is by inserting a grounding capacitor between ground and star winding neutral point of a transformer connected to the remote generator. The grounding capacitor is inserted when one phase remains open circuited before auto re-closure and make the power transfer during this period of time delay remains equal to the pre-fault power beside it also makes the current on the transmission line increase to $\sqrt{3}$ times of the pre-fault value. So, the transient stability limit can be improved too. Indirectly, magnitude of angular swing associated with auto reclosing becomes very low and the sudden changed of generator output power at the instant of reclosing is almost eliminated [3].

Figure 2.1 describes about the zero, positive and negative sequence network connection that zero sequence does not allow current to flow through the generators in star-delta connection of transformer at both ends. It is circulates through the transformer grounding, transmission line and ground.