UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF SMART UNDER AND OVER VOLTAGE PROTECTION SYSTEM FOR DOMESTIC APPLICATION USING MICROCONTROLLER

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Industrial Power) (Hons.)

by

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TAJUK: **Development of Smart Under and Over Voltage Protection System for Domestic Application Using Microcontroller**

SESI PENGAJIAN: **2015/16 Semester 2**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

……

(Associate Professor Mohd Ariff bin Mat Hanafiah)

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ABSTRAK

Kejatuhan dan kenaikan voltan yang melampau merupakan salah satu daripada masalah voltan yang mana ia memberi keruncingan kepada kualiti kuasa. Masalah ini boleh terjadi di mana-mana peringkat system kuasa sama ada di peringkat janakuasa, penghantaran mahupun pengagihan. Memfokuskan kepada kawasan domestik, permasalahan ini boleh memudaratkan pengguna juga merosakkkan peralatan rumah atau domestik. Sewaktu berlakunya kejatuhan dan kenaikan voltan secara melampau, suis utama di dalam kotak agihan utama akan terputus bekalan kesan daripada arus tinggi yang terhasil. Ketidaknormalan voltan ini akan mengganggu operasi peralatan elektrik di rumah sekaligus merencatkan aktiviti-aktiviti yang melibatkan voltan bekalan. Pengguna perlu menghidupkan semula suis utama secara manual. Ia membahayakan pengguna kerana mereka tidak tahu keadaan voltan bekalan pada masa tersebut. Kajian ini dilaksanakan bertujuan memberi nilai tambah keselamatan kepada pengguna memandangkan ia menghidup dan mematikan bekalan kuasa secara automatik melalui kawalan oleh pengawal mikro. Kajian ini dijalankan melalui simulasi litar menggunakan perisian Proteus dan MicroC. Kemudian, perkakasan dibina untuk tujuan pelaksanaan litar. Pengetahuan berkenaan litar elektronik, litar elektrik dan juga pengaturcaraan diperlukan bagi menjayakan kajian ini, selain daripada itu, pengetahuan mengenai penyelesaian masalah ketidakfungsian litar dan keselamatan perlu diambil kira sebagai pengetahuan yang perlu dimiliki dan diaplikasikan sepanjang proses kajian ini.

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ABSTRACT

Under and over voltage is one of the voltage abnormalities which give crucial power quality. It can happen at any stage of power system either in generation, transmission or distribution. Focusing to domestic area, these irregularities can harm the user as well as damage the domestic or home appliances. Whenever under and over voltage happens, main switch in the distribution board will turns off due to high current produced by the main power supply. It will disrupt the operations of domestic appliances as well as activities involving supply voltage. User needs to turn on the main switch manually. It is dangerous to the user since they do not know the condition of the main power supply. This research is done purposely to add safety to the user since it turns on and off main power supply automatically through the control done by the microcontroller. This research is done through simulation of the circuit using Proteus and MicroC software. Next, the hardware is constructed for the execution of the circuit. Knowledge of electronic circuit, electric circuit as well as programming is used in this research. Apart from that, knowledge of troubleshooting and safety must be considered as important knowledge needed through the research process.

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DEDICATION

To my beloved husband

Nabil Fikri bin Aziz

Son and baby

Daniyal Haziq bin Nabil Fikri

Mother

Masyati binti Mail and Jamelah binti Baba

Father

Mokhtar bin Saad

Siblings

Siti Masiah ‘Awatif binti Mokhtar

Siti Musliha Ajmal binti Mokhtar

Siti Mashanis Aliya binti Mokhtar

Iza Nuriza binti Aziz

For the love, support, encouragement, help and du’a. Thank you very much.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

µC	-	Microcontroller
µF	-	micro Farad
AC	-	Alternating Current
ADC	-	Analogue to Digital Converter
AVS	-	Automatic Voltage Switch
BCD	-	Binary-Coded Decimal
CBEMA	-	Computer Business Equipment Manufacturers Association
DC	-	Direct Current
DVD	-	Digital Versatile Disc
EU	-	European Union
F	-	Farad
GSM	-	Global System for Mobile
IC	-	Integrated Circuit
IEEE	-	Institute of Electrical and Electronics Engineers
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
mA	-	mili Ampere
MOV	-	Metal Oxide Varistor
MΩ	-	Mega Ohm
V	-	Voltage
VAC	-	Alternating Current Voltage
VDC	-	Direct Current Voltage
W	-	Watt
Ω	-	Ohm

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CHAPTER 1
INTRODUCTION

1.0 Background of Project

Voltage abnormalities happen at any stages of power electrical system such as generation, transmission, distribution as well as end user due to various causes respectively. These irregularities such as under voltage, over voltage, sags, swells, short-term voltage fluctuations, voltage imbalance and intermittent supply failures produce different level of effects depend on scale of the faults. They can cause danger not only to human life such as burn, permanent disability and death but also damage to the equipment which lead to loss of property and money.

As under and over voltage also occur in distribution system, it exposed hazard to the consumer also to the domestic appliances. Most of the domestic applications are electronic-based thus, they are more sensitive to abnormal condition. Apart from that, it give losses to the consumer due to disruption of domestic appliances operation or destruction of the circuit as well as the domestic appliances itself. Hence, a protection from under and over voltage is need to be installed with the end circuit.

Microcontroller is the paramount component in this project which act as the brain of the project. It senses, gives instructions and decides what to be done by the system. It switched on and off main power supply according to the status of the project. The microcontroller is called as a smart component where connect and disconnect the main power supply from the load automatically.

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1.1 Problem Statement

Under voltage and over voltage are the main power quality issues nowadays. It might happens at any stage of power system including at the distribution area including at consumer's house. The sudden over and under voltage results in decline power quality and damage to the equipment and domestic appliance(Manish et al. 2014). Consumers lost their moneys and properties due to under and over voltage problem. Chapman (2001), estimated that cost of loss about €10 billion per annum were faced by the industry and commerce in EU due to power quality problems.

In domestic area, whenever under and over voltage occur, it will face the power supply failure where the main switch at distribution board will turn off permanently and cause damage to the domestic appliances since there is no protection circuit or device towards under and over voltage problem. Turning the main switch without safety verification will cause hazard to the user. Thus, the user needs to call electricity utility to come and fix the problem. It costs of time while daily activities which consume mostly electricity are interrupted. If the power failure happens while the consumers are not in home or they do not aware to this problem, it will disrupt the operation of electrical home appliances such as refrigerator and safety devices like security camera and automated gate. Thus, this project is proposed to provide additional protection to the end circuit due to under and over voltage difficulties.

1.2 Objectives of Project

The specific objectives for this project are to:

- Design a system to read single phase AC voltage by using microcontroller 16F877A
- Design a control system for under and over voltage system by using microcontroller PIC16F877A.
- Simulate, testing and execute prototype of the project.

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1.3 Scopes of Project

This assessment will be focusing in domestic area particularly at home distribution board. The project is divided into two parts, which are simulation of the software and development of the hardware.

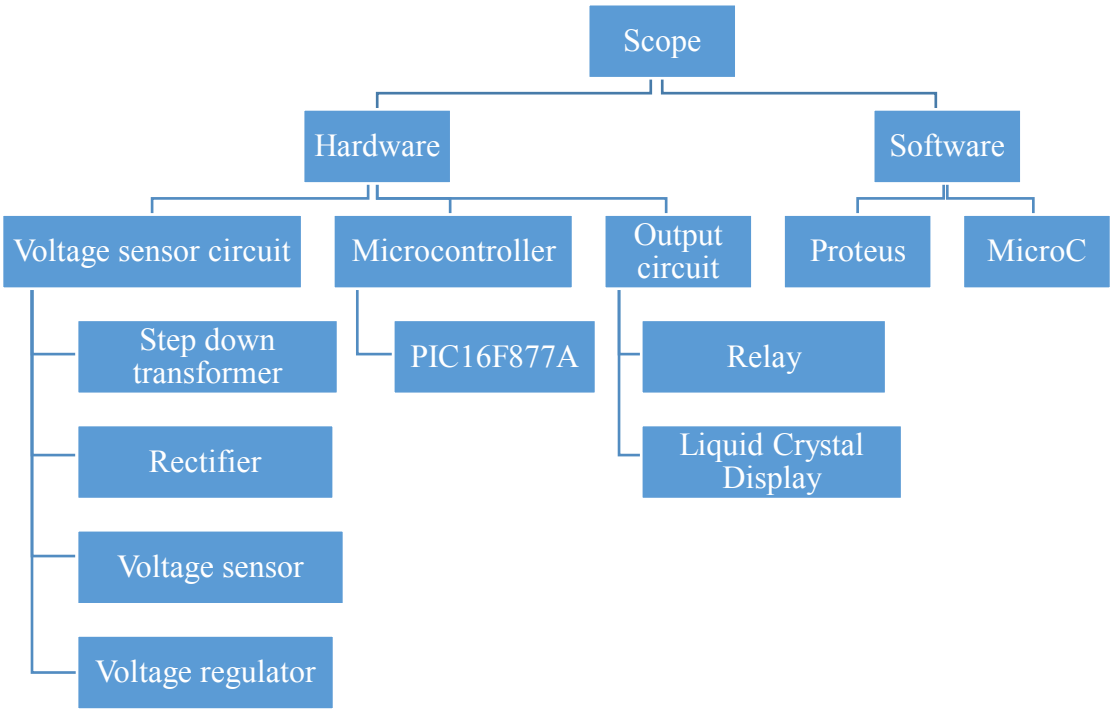

Figure 1.3: Division of Work Scope

1.4 Organization of Report

This report consists of five chapters begin with report introduction and end with conclusion. The remainder chapters are literature review, methodology and results as well as discussions. Literature review covers overview and method to provide protection from under and over voltage. Meanwhile, methodology shows sequence of works in order to develop this project. Results of implementation of this project will be written in chapter four along with its discussion. Chapter five will delivers conclusion and recommendation for future planning. However, results with discussion and conclusion will be continued in Bachelor Degree Project II.

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1.5 Summary

This chapter covers the background of the project and the problem statement which encouraged this project to be conducted. The goals of this report also deliberated in this chapter. Furthermore, the scope of this report also discussed to make sure this report was conducted systematically and guided according to its objectives.

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CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter elaborates the overview of under and over voltage; how these abnormalities happened continue with the literature review on under and over voltage protections. The information gained from this research will be used throughout the project assessment.

2.1 Theory: Overview of Under and Over Voltage

2.1.1 Definition of Under and Over Voltage

According to IEEE Std. (1995) whenever the voltage lags 10 to 20 percent from the nominal voltage for duration more than 60 seconds, it is defined as under voltage while voltage that exceed 10 to 20 percent of the nominal voltage for more than 60 seconds, it is defined as over voltage. Figure 2 and 3 shows under and over voltage waveform respectively.

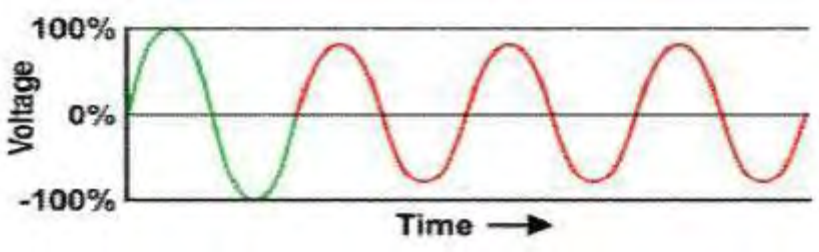

Figure 2.1.1: Under Voltage Waveform (Kapoor et al. 2014)

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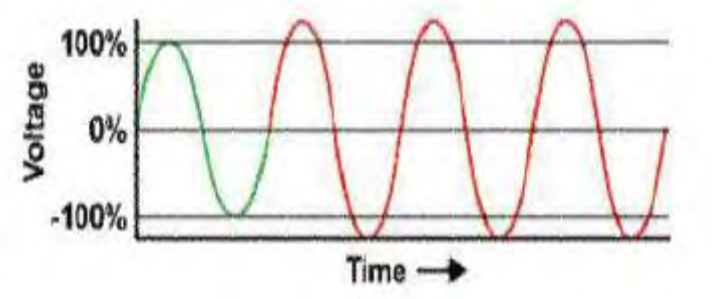

Figure 2.1.1a: Over Voltage Waveform (Kapoor et al. 2014)

Both of these circumstances that operate outside the acceptable power envelop are shown at CBEMA Curve in Figure 2.1.1b.

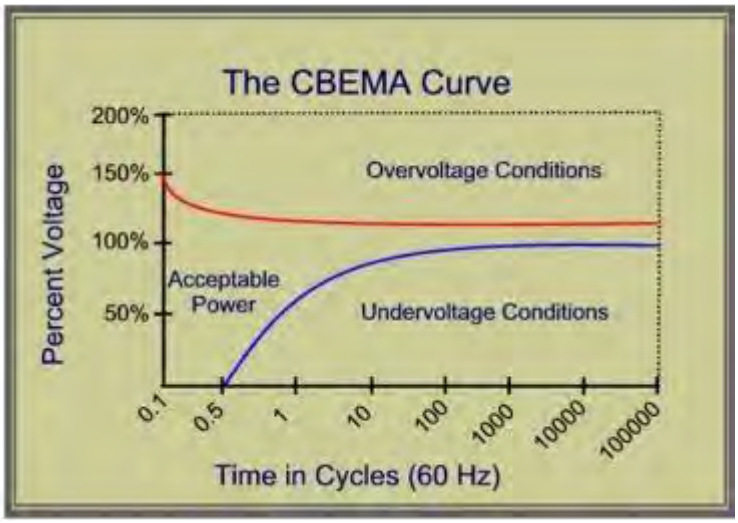

Figure 2.1.1b: CBEMA Curve
(Source: http://www.hersheyenergy.com/voltage_irregularitires.html n.d.)

2.1.2 Causes of Over Voltage

Over voltages on power systems are due to various causes. Over voltage emerging on a power system can be commonly classified into two main categories (Ram & Vishwakarma 2011) which are external over voltages and internal over voltages.

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2.1.2.1 External Over Voltage

Atmospheric disturbances notably lighting is the main cause of these over voltages. These over voltages take form of a unidirectional impulse whose the highest possible amplitude has no direct relationship with the operating voltage of the system (Ram & Vishwakarma, 2011, pg592).

There are several factors that create the external voltages.

(a) Direct lightning strokes.

(b) Lightning discharge that occur close to the line will electromagnetically induced over voltage (usually known as side stroke).

(c) Atmospheric condition that evolving along the line length will induced voltages.

(d) Charged cloud which presence nearby will electrostatically induced over voltages.

(e) Over voltages that induced electrostatically due to fractional impacts of little particles like dry snow or dust.

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Figure 2.1.2.1 to 2.1.2.1b shows factors that creates external over voltage.

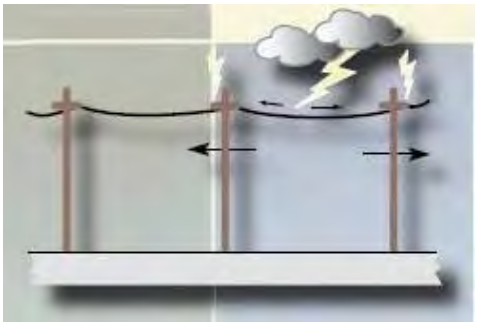

Figure 2.1.2.1: Over Voltage due to Direct Lightning Stroke
(Source: http://electrical-engineering-portal.com/overvoltages-caused-by-lightning 26/04/13)

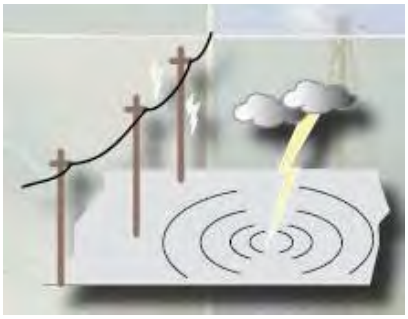

Figure 2.1.2.1a: Over Voltage due to Lightning Discharge that Occur Close to the Line
(Source: http://electrical-engineering-portal.com/overvoltages-caused-by-lightning 26/04/13)

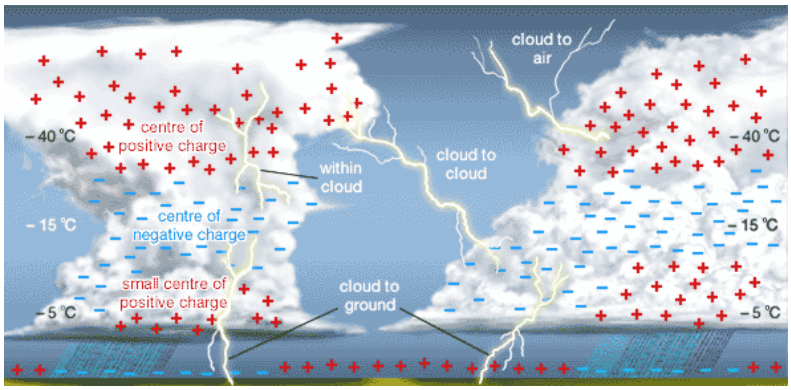

Figure 2.1.2.1b: Over Voltage due to Presence of Charged Cloud
(Source: http://kids.britannica.com/comptons/art-139631/When-the-electrical-charge-becomes-sufficiently-separated-in-a-thundercloud 1999)

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2.1.2.2 Causes of Over Voltage: Internal Over Voltage

These over voltage are created by changes in the working conditions of the electrical system. According to Ram & Vishwakarma (2011) these internal over voltages are caused by either switching over voltages (transient over voltages of high frequency) or temporary over voltages (steady state over voltages of power frequency).

Transient over voltages happen when there is changed of network state by a switching operation or fault condition. They are generally oscillatory and in the form of damped sinusoid. Their frequencies may differ between several hundred Hz to several kHz and it is control by the immanent inductances and capacitance in the circuit. As an example, switching on or off equipment like switching a high rectors and a transformer while no load connected will render over voltages of transient nature.

Temporary over voltages are the steady state voltages of power frequency that can be result of disconnection of load, especially in the case of long transmission line. It is also usually happen at the areas where transformers tap setting were set incorrectly for supplying energy and reduction of the loads executed (Seymour 2012). During seasonal regions, the transformers were set to supply high output but it were not set back to normal output even though the seasonal regions were over. Hence, reduction of power usage during off-season causes the over voltage since the demand and supply is not balance.

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