OVER/UNDER VOLTAGE PROTECTOR

NAH KIEN WAH

THIS DISSERTATION IS SUBMITTED IN PARTIAL FULFILMENT OF THE BACHELOR DEGREE IN SCIENCE WITH HONOURS

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DECLARATION

I verify that this project is my own work except some materials are taken from the work of others, in which each case has been indicate its source.

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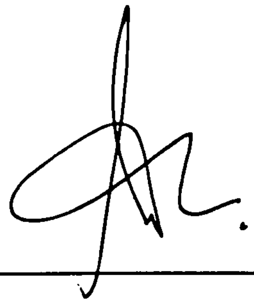

NAH KIEN WAH

HS2005-2652

APPROVAL OF EXAMINERS

APPROVED BY

Signature

1. SUPERVISOR

(Ms. Teh Mee Teng)

5/5/2008

2. EXAMINER 1

(Associate Prof. Dr. Jedol Dayou)

5.5.2008

3. EXAMINER 2

(Mr. Saafie Salleh)

4. DEAN

(Associate Prof. Dr. Shariff A. Kadir Omang)

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ABSTRACT

Over/under voltage protector is designed particularly to overcome the over voltage and under voltage events. It is sensitive enough to disconnect the power supply when the input voltage is out of specific range. Various "over voltage" and "under voltage" is created by using several steps down transformers. Secondary windings of transformers are connected serially, and then its combination voltage measured will be the sum of the output of each transformer. The circuit constructed is connected by the voltage supply which is higher than household power supply (over voltage), hence over voltage range can be determined. While the under voltage range is determined by connecting the voltage supply which is lower than household power supply (under voltage), to the circuit. Operational amplifier IC in the circuit compare its DC voltage with corresponding zener diode, hence control the range of normal power supply permitted in the over/under voltage protector. Over/under voltage protector is built and its range of "voltage permitted" is set to 183.36 V to 262.00 V with uncertainty of 4.61% for over voltage edge and 1.86% for under voltage edge. However, the range of the over voltage and under voltage still can be adjusted using variable resistor VR1 and VR2 respectively.

ABSTRAK

Pelindung voltan tinggi/rendah direka cipta untuk menangani masalah "voltan tinggi" dan "voltan rendah". Alat ini adalah sensitif untuk memutuskan berkalan elektrik daripada peralatan elektrikal, apabila berkalan voltan melebihi atau kurang daripada julat yang ditentukan. Beberapa set "voltan tinggi" dan "voltan rendah" dicipta dengan menggunakan beberapa transformer perendah. Output transformer disambung secara seri, seterusnya voltan gabuangan yang didapati merupakan jumlah setiap output transformer. Litar disambung kepada beberapa "voltan tinggi" yang lebih tinggi daripada voltan perumahan, untuk menentukan had maksimum voltan tinggi yang dibenarkan oleh pelindung voltan tinggi. Begitu juga dengan had minimum voltan rendah, beberapa "voltan rendah" yang rendah daripada voltan perumahan disambung kepada litar. Op-Amp IC dalam litar memainkan peranan dalam membandingkan voltan DC yang melaluinya, seterusnya mengawal julat voltan biasa yang dibenarkan oleh pelindung voltan tinggi/rendah. Pelindung voltan tinggi/rendah dibina dan julat voltan yang dibenarkan ditentukan pada 183.36 V dan 262.00 V, dengan ketidakpastian 4.61 % untuk sempadan voltan tinggi dan 1.86 % untuk sempadan voltan rendah. Bagaimanapun, julat antara sempadan voltan tinggi dan voltan rendah boleh diselaraskan dengan mengunakkan perintang pembolehubah, VR1 dan VR2 masing-masing.

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f_{op}	operating frequency
Hz	Hertz
ω	angular Velocity
A	ampere
V	volt
w	watt
Ω	ohm
TTL	transistor-transistor logic
MOSFET	metal oxide semiconductor field transistor
rms	root mean sq

CHAPTER 1

INTRODUCTION

1.1 Background

Electronic components have been designed to function properly when used within their specified current and voltage ratings. When these ratings are exceeded during operation, or known as over voltage, the component may sustain permanent damage and the equipment may cease to operate. The conditions may be hazardous. Depending on its duration, the over voltage events can be permanent or transient, the latter case also being known as a voltage spike.

A more common scene of over voltage or over current is the operation of high-power electrical devices such as air conditioners and refrigerators. These high-powered pieces of equipment require a lot of energy to switch on and turn off components like compressors and motors. This switching creates sudden, brief demands for power, which upset the steady voltage flow in the electrical system. While these surges are much less than the intensity of a lightning surge, they can be severe enough to damage components, immediately or gradually, and they occur regularly in most building's electrical systems.

Over voltage of power supply occur when something boosts the electrical charge at some point in the power lines. This causes an increase in the electrical potential energy, which can increase the current flowing to the wall outlet. When the increase lasts three nanoseconds (billionths of a second) or more, it is called a surge. While when it only lasts for one or two nanoseconds, it's called a spike. A number of different things can cause this to happen.

The major source of the over voltage event are lightning strikes. When lightning strikes near a power line, whether it's underground, in a building or running along poles, the electrical energy can boost electrical pressure by millions of volts. This causes an extremely large power surge that will overpower almost any over voltage protector. In a lightning storm, sometime the best protection is to unplug their electrical devices. However, these occurrences are always unexpected.

Other sources of over voltage are power outage, malfunction of electricity supplier, and overload current that will cause the wire to melt, resulting short circuit of electrical appliances.

In normal household and office wiring in our country, the standard voltage is approximately 240 volts. If the voltage rises extremely beyond standard voltage, there is a problem, and the over/under voltage protector helps to prevent that problem from destroying our electrical appliances. Although under voltage condition is more rarely to occur, and the occurrence does not bring any serious damage to the electrical appliances, but once we know the faulty is caused by insufficient of voltage supply, the proper maintenance and checking could be done shortly. Thus, unexpected expense to repair and purchase new set could be avoided, given over/under voltage protector is used.

1.2 Purpose of Project

The purpose of the project is to construct an over/under voltage protector to prevent the electrical appliance from serious damage due to over or under voltage events.

1.3 Objective of Project

The objectives of the project are:

- To develop a circuit that could protect the electrical appliance against over or under voltage events.
- To determine the exact range of normal voltage between over voltage edge and under voltage edge, which is permitted by over/under voltage protector.

1.4 Scope of Project

The scope of the project is to build a circuit that responds to the transient voltage, either exceeds 250 volts or less than 180 volts (approximately), the power supply will disconnect immediately. The power supply will still connected to the appliance if the voltage falls within 180 volts and 250 volts (approximately).

1.5 Hypothesis

The circuit developed is able to detect the over voltage and under voltage, hence disconnect the power supply from the load.

CHAPTER 2

LITERATURE REVIEW

2.1 Electrical Transmission and Distribution

The electrical transmission system is the interconnection of the electric energy produced by power plants with the loads. The operating frequency (f_{op}) is 50 Hz in our country. At the power station, an electrical generator converts mechanical power into a set of alternating electric currents. The currents are sinusoidal functions of time, all at the same frequency but offset in time to give different phases. In a three-phase system, the phases are spaced equally, giving a phase separation of one-third cycle. (Karady, G. G., 2006)

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The three-phase power leaves the generator and enters a transmission substation at the power plant. This substation uses large transformers to convert the generator's voltage (which is at the thousands of volts level) up to extremely high voltages for long-distance transmission on the transmission grid.

For power to be useful in a home or business, it comes off the transmission grid and is stepped-down to the distribution grid. This may happen in several phases. The place where the conversion from "transmission" to "distribution" occurs is in a power substation. A power substation typically does several things:

- It has transformers that step transmission voltages (in the tens or hundreds of thousands of volts range) down to distribution voltages (typically less than 10,000 volts).
- It has a "bus" that can split the distribution power off in multiple directions.
- It often has circuit breakers and switches so that the substation can be disconnected from the transmission grid or separate distribution lines can be disconnected from the substation when necessary.

After that, the power goes from the transformer to the distribution bus. The bus distributes power to two separate sets of distribution lines at two different voltages. The smaller transformers attached to the bus are stepping the power down to standard line voltage (usually 7,200 volts) for one set of lines, while power leaves in the other direction at the higher voltage of the main transformer. The wires at the higher voltage need to be stepped down again, which will often happen at another substation or in small transformers somewhere down the line. (Gonen, T., 1994)

After numerous further conversions in the transmission and distribution network the power is finally transformed to the transformer drum, which is attached to the pole. It reduces the 7,200 volts down to the 240 volts that makes up normal household electrical service. There are two wires running out of the transformer and three wires running to the house.

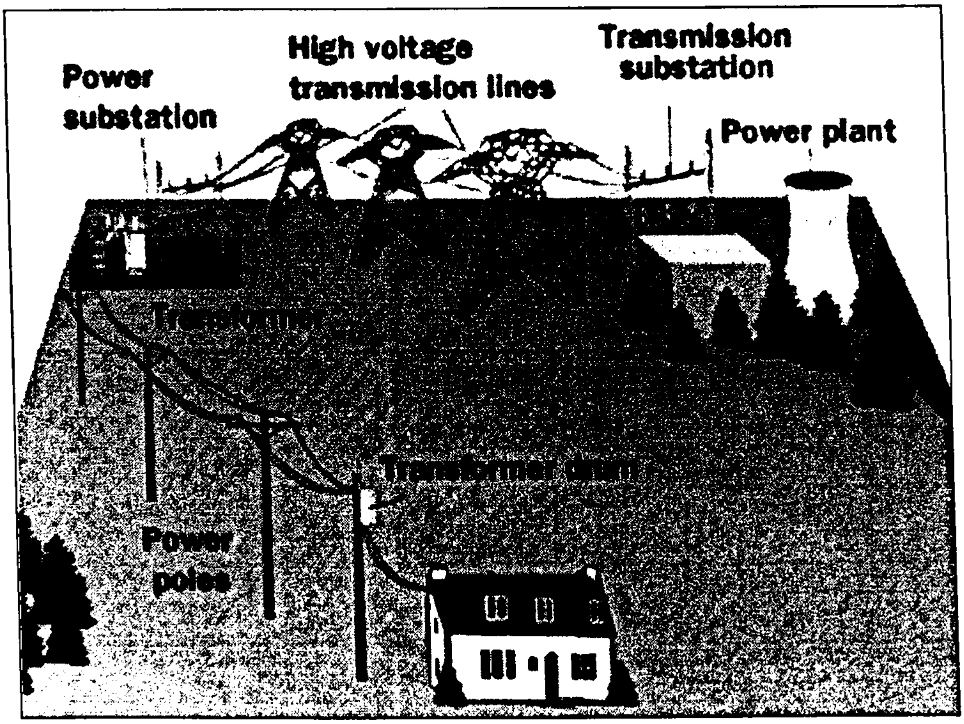

Figure 2.1 Electrical Power Transmissions and Distribution (Karady, G. G., 2006)

The two from the transformer are insulated, and the third one is bare. The bare wire is the ground wire. The two insulated wires each carry 120 volts, but they are 180 degrees out of phase so the difference between them is 240 volts. The transformer is wired in this sort of configuration (www.howstuffwork.com):

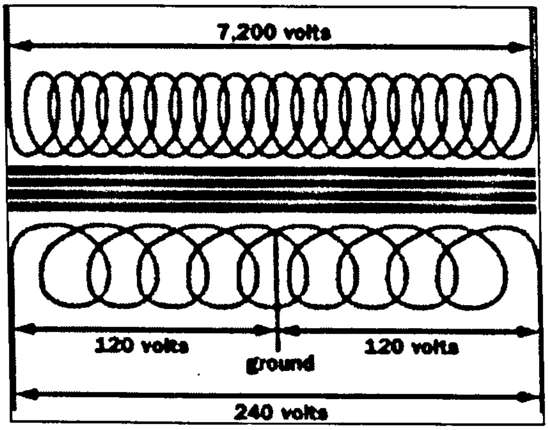

Figure 2.2 Wiring of Transformer to Household Power Supply (Gonen, T., 1994)

2.1.1 Grounding System

In electricity supply systems, a grounding system defines the electrical potential of the conductors relative to that of the Earth's conductive surface. Grounding system has implications for the safety and electromagnetic compatibility of the power supply.

The grounding wire is directly or indirectly connected to one or more earth electrodes. These may be located locally, be far away in the suppliers network or in many cases both. This grounding wire is usually but not always connected to the neutral wire at some point and they may even share a cable for part of the system under some conditions. The ground wire is also usually bonded to pipe work to keep it at the same potential as the electrical ground during a fault. Water supply pipes often used to be used as ground electrodes.

A power ground serves to provide a return path for fault currents and therefore allows the fuse or breaker to disconnect the circuit. The power ground is also often bonded to the house's incoming pipe work, and pipes and cables entering the

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