MODELING DISTANCE PROTECTION

Azlan Bin Abu Samah

4 BEKP 2

MAY 2009

MODELING DISTANCE PROTECTION

AZLAN BIN ABU SAMAH

This Report Is Submitted In Partial Fulfillment of Requirements for the Degree of Bachelor in Electrical Engineering (Industrial Power)

Fakulti Kejuruteraan Elektrik
Universiti Teknikal Malaysia Melaka

MAY 2009

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of the Bachelor of Electrical Engineering (Industrial Power)"

Signature : ....

Supervisor's Name : ....Mohd Hendra Hairi...........

Date : ....11/5/09...........

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references."

Signature : ....

Name : AZLAN BIN ABU SAMAH

Date : 11/5/2009

ACKNOWLEDGEMENTS

Firstly, I would like to express my deep and sincere gratitude to ALLAH S.W.T for giving me the strength and ability to complete this project. I am deeply grateful to my supervisor, En. Mohd Hendra Bin Hairi for his detailed and constructive comments, and for his important support throughout this project research. I owe my loving thanks to my parents and family. Without their encouragement and understanding it would have been impossible for me to finish this FYP 1 report. . Besides, I would like to thank En. Fuad and En. Firdaus for their assistance in conducting the lab testing such as equipment setup, lab schedule and lab equipment document for the purpose of this project

Finally, I would like to thank to all my friends for their unwavering support in completion of this project. Without the support of those mentioned above, this completion would not have happened.

ABSTRACT

The purpose of this project is to design and modeling the distance protection for to understand the distance protection operation. Other than that, this project is suitable for student to learn about the system and the operation of distance protection in interactive way. The distance protection is some of system protection to power system protection especially at transmission line. The purpose of power system is to detect power system abnormal conditions and fault. It is also protect the system with method to selectively isolate the affected faulty equipment of the plant from the rest of the power system.

Protection system is very important to minimize further damage to equipment and to minimize the danger to people and property. It also maintains the integrity and stability of the power system by minimizing the effect of the faults. Furthermore, power system must have a system protection because it can minimize the time of supply interruption and minimize the stress on other equipment.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CT	Current Transformer
PT	Potential Transformer
VT	Voltage Transformer
EMT	Electromagnet
V	Voltage
A	Ampere
CB (A1 & C1)	Circuit breaker
21Z	Distance relay
Sub	Substation
BF	Breaker failure

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Project Background

Distance protection protects primary equipment through the line. A transmission on line posses its own impedance which is made up of resistance and reactance (mainly inductance).The impedance of the line is directly proportional to its length. On the occurrence of a fault, the distance relay measures the impedance of the line up to the faulty point if Z less than the relay set value it will operate.

For this project, this protection system intends to design the distance protection relay using the balance beam type. The type must have input current and voltage to operate the system.

Current and voltage are needed to operate the project. This project use balance beam type and operate when the current and voltage exist. When there is input form current transformer, CT (current) and potential transformer (voltage), the induction will induce the parts of the beam so the beam will meet the contact then trip the circuit. Balance beam type uses electromagnetic theory to operate the trip based on the input given from the CT and the potential transformer. This balance beam uses electromagnet theory and beam setting to operate. The beam of the relay can be set to get a better performance of protection. This project in addition needs some alteration in the setting to produce a better and effective protection system.

1.2 Problem Statement

The problem for this project, the operation of distance protection can't show the real operation at transmission system. Distance protection doesn't give clear vision how it is operating. Furthermore, distance protection used at transmission line which the line bring high voltage (33kV ~500kV) lie at Figure 1.1. So, it is dangerous from someone to know the operation clearly. The equipment use is too expensive to buy merely for studying the operation. After completing this project, anyone can learn the operation in easy and interactive way. This simple operation is shown in Figure 1.2

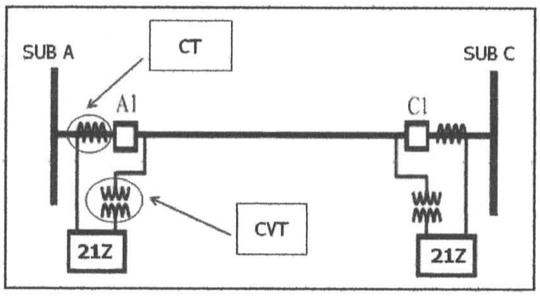

Figure 1.1: Simple circuit at transmission side

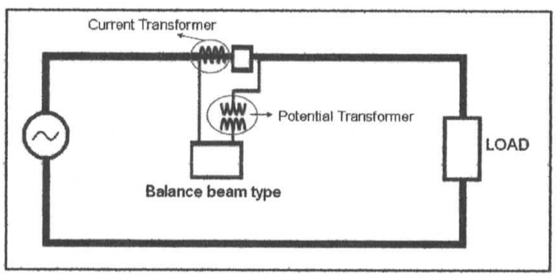

Figure 1.2: Simple circuit at small scale

1.3 Project Objective

Objectives of this project are:-

i. design a model for distance protection
ii. to design the distance protection relay using the balance beam type
iii. to show function of current transformer & potential transformer for the system

1.4 Project Scope

The scopes of this project are:

i. Design the operation of balance beam relay
ii. Apply the theory of electromagnet to operate the beam
iii. Setting the beam of the relay to get a better performance of protection

CHAPTER 2

LITERATURE REVEW

2.1 Introduction

The principle of operation of the distance relay is very much like that of the current restraint relay in which the restraining is carried out by voltage. In such a relay, the greater the current and lower the voltage, the greater torque the final control element of the relay will have, but current increase and voltage decrease in the circuit, according to ohm's law, lead to a decrease of resistance of the circuit.

It turns out that such a relay picks up as the resistance of the controlled circuit decrease to a certain threshold. This is what actually called a resistance relay. In facts the resistance relay is the one that respond to the ratio of one input quantity (voltage) to another one (current); that is it compares voltage and current.

These so called "balance beam relay" of the simplest type provided comparison of voltage and current only by value and did not take into account the angle between them, which was an essential disadvantage of this type of relay. This principle will be explained more in chapter 3.

2.2 Electromagnet

An electromagnet is a magnet that runs on electricity. Unlike a permanent magnet, the strength of an electromagnet can easily be changed by changing the amount of electric current that flows through it. The poles of an electromagnet can even be reversed by reversing the flow of electricity.

The movement of electric charges creates a magnetic field an electromagnet works because an electric current produces a magnetic field. The magnetic field produced by an electric current forms circle around the electric current, as shown in the diagram below:

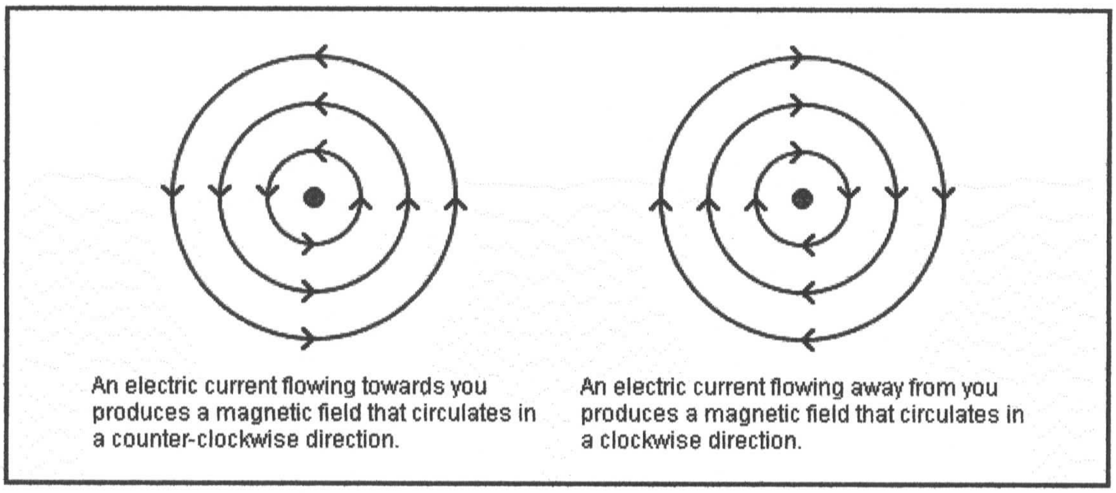

Figure 2.1: Magnetic field diagram

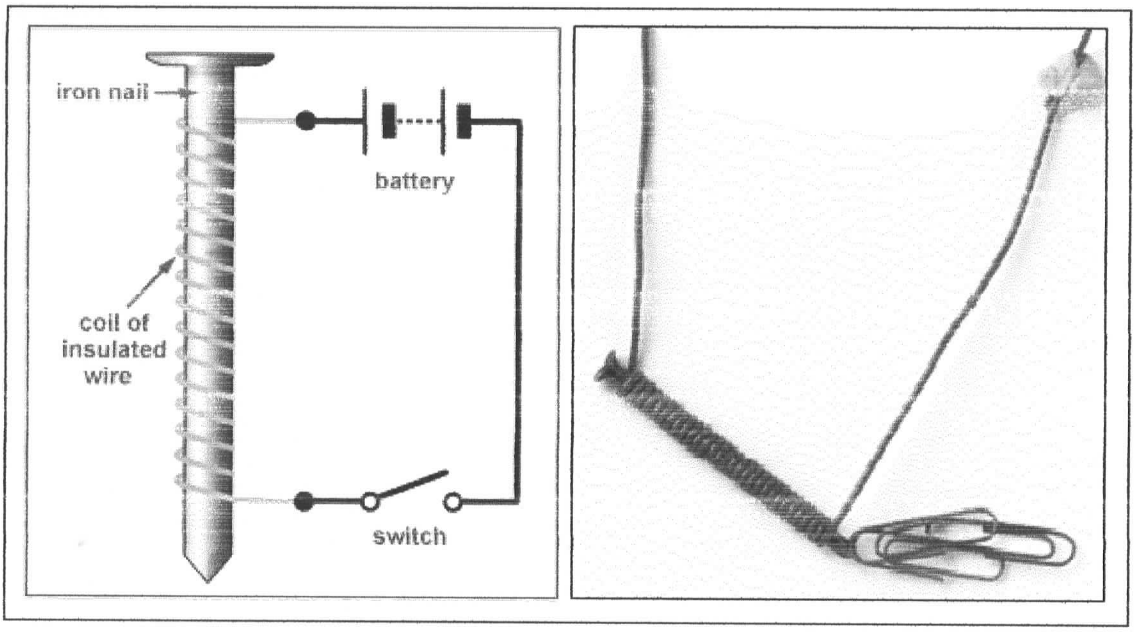

Figure 2.2: Example of between electricity and electromagnet

Electromagnet can be introduced as in Figure 2.2. If a wire carrying an electric current is formed into a series of loops, the magnetic field can be concentrated within the loops. The magnetic field can be strengthened even more by wrapping the wire around a core. The atoms of certain materials, such as iron, nickel and cobalt, each behave like tiny magnets. Normally, the atoms in something like a lump of iron point in random directions and the individual magnetic fields tend to cancel each other out. However, the magnetic field produced by the wire wrapped around the core can force some of the atoms within the core to point in one direction. All of their little magnetic fields add together, creating a stronger magnetic field.

As the current flowing around the core increases, the number of aligned atoms increases and the stronger the magnetic field becomes. At least, up to a point. Sooner or later, all of the atoms that can be aligned will be aligned. At this point, the magnet is said to be saturated and increasing the electric current flowing around the core no longer affects the magnetization of the core itself.

2.3 Electromagnetic System of Relay

2.3.1 Electromagnetic Relay

Electromagnetic relay is a relay whose operation depends upon the electromagnetic effects of current flowing in an energizing winding.

There are two basic types of electromagnet relays:

i. Attraction relay
ii. Induction relay

Electromagnetic attraction relay operates by virtue of a plunger being drawn into a solenoid, or an armature being attracted to the poles of an electromagnet. Such relays may be actuated by DC or AC quantities (current, voltage, power).

Electromagnetic induction relay uses the principle of the induction motor whereby torque is developed by induction in a rotor; this operating principle applies only to relays actuated by alternating current, and in dealing with those relays that shall call it simply "induction-type".

2.3.2 Relay Construction

Relays are amazingly simple devices. There are four parts in every relay:

i. Electromagnet
ii. Armature that can be attracted by the electromagnet
iii. Spring
iv. Set of electrical contacts

Figure 2.3 shows that a relay consists of two separate and completely independent circuits. The first is at the bottom and drives the electromagnet. In this circuit, a switch is controlling power to the electromagnet.

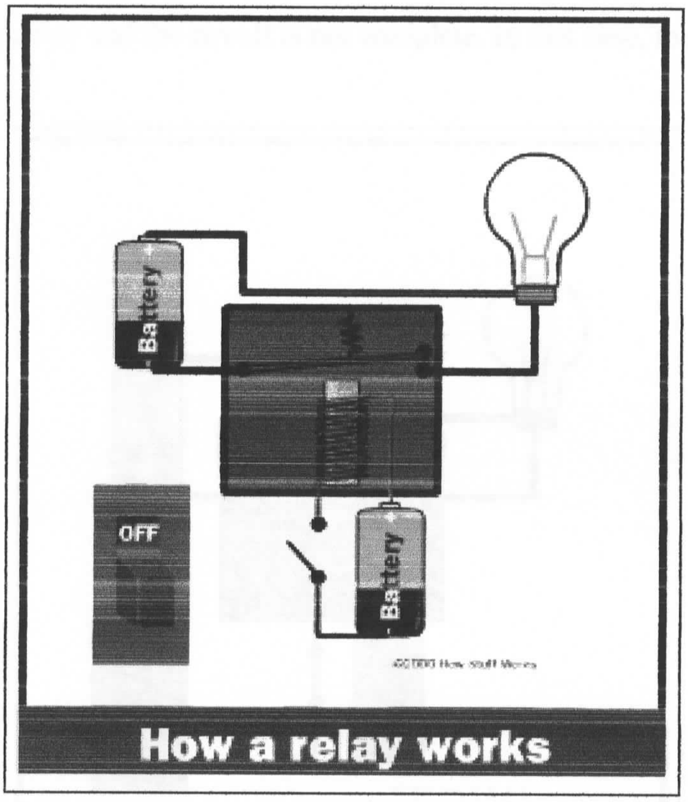

Figure 2.3: Relay operation (switch open)

2.4 Potential Transformer @ Voltage Transformer

Transformers can also be used in electrical instrumentation systems. Due to transformers' ability to step up or step down voltage and current, and the electrical isolation they provide, they can serve as a way of connecting electrical instrumentation to high-voltage, high current power systems.

Designing, installing, and maintaining a voltmeter capable of directly measuring 13,800 volts AC would be no easy task. The safety hazard alone of bringing 13.8 kV conductors into an instrument panel would be severe, not to mention the design of the voltmeter itself. However, by using a precision step-down transformer, we can reduce the 13.8 kV down to a safe level of voltage at a constant ratio, and isolate it from the instrument connections, adding an additional level of safety to the metering system. It shown in Figure 2.5.

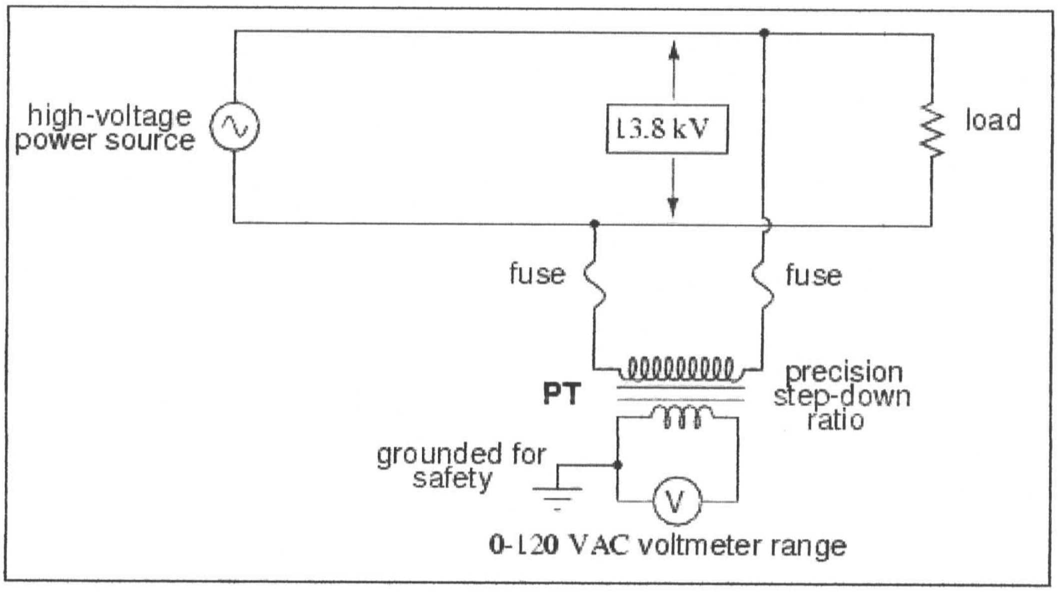

Figure 2.5: Instrumentation application of PT

Now the voltmeter reads a precise fraction, or ratio, of the actual system voltage, its scale set to read as though it were measuring the voltage directly. The transformer keeps the instrument voltage at a safe level and electrically isolates it from the power system, so there is no direct connection between the power lines and the instrument or instrument wiring. When used in this capacity, the transformer is called a Potential Transformer, or simply PT.

Potential transformers are designed to provide as accurate a voltage step-down ratio as possible. To aid in precise voltage regulation, loading is kept to a minimum: the voltmeter is made to have high input impedance so as to draw as little current from the PT as possible. A fuse has been connected in series with the PT's primary winding, for safety and ease of disconnecting the PT from the circuit.

A standard secondary voltage for a PT is 120 volts AC, for full-rated power line voltage. The standard voltmeter range to accompany a PT is 150 volts, full-scale. PTs with custom winding ratios can be manufactured to suit any application. This lends itself well to industry standardization of the actual voltmeter instruments themselves, since the PT will be sized to step the system voltage down to this standard instrument level.

2.5 Current Transformer

Following the same line of thinking, we can use a transformer to step down current through a power line so that we are able to safely and easily measure high system currents with inexpensive ammeters. Of course, such a transformer would be connected in series with the power line, like Figure 2.6.

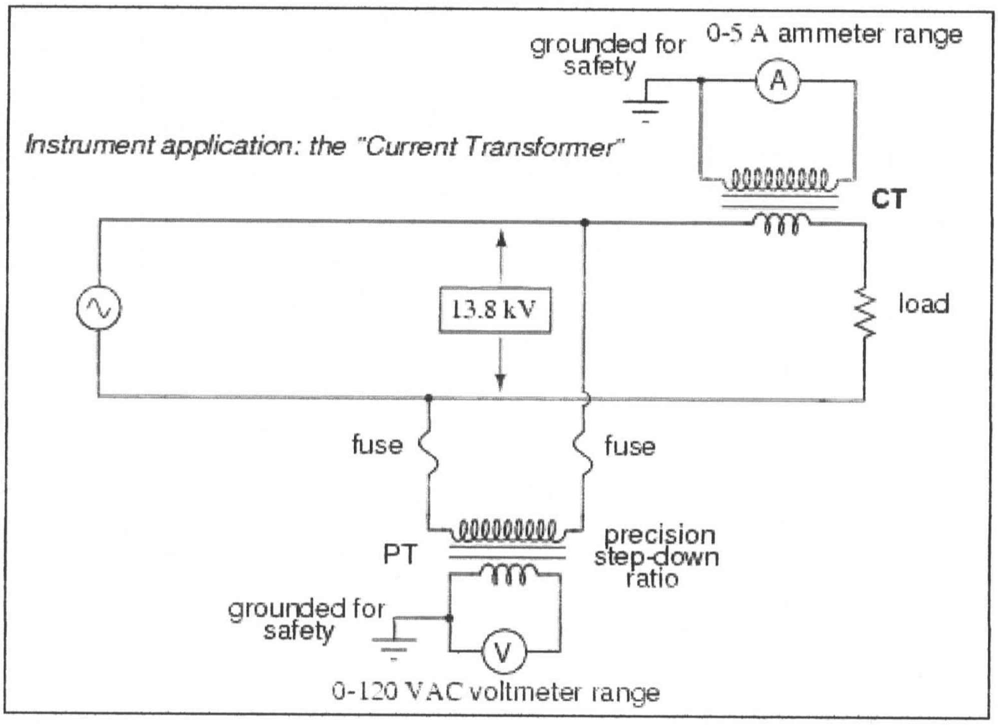

Figure 2.6: Instrumentation application of CT

Note that while the PT is a step-down device, the Current Transformer (or CT) is a step-up device (with respect to voltage), which is what is needed to step *down* the power line current. Quite often, CT's are built as donut-shaped devices, through which the power line conductor is run, the power line itself acting as a single-turn primary winding like Figure 2.9.