# PRIMARY INJECTION -EVALUATION OF A CURRENT TRANSFORMER SATURATION AND THE EFFECT TO THE RELAY PERFORMANCE

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2008/2009

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for forwarding the Degree of Bachelor in Electrical Engineering. (Control, Instrumentation & Automation)"

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**This Report Is Submitted In Partial Fulfillment of Requirement for the Degree of Bachelor's in Electrical Engineering**
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"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. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree"

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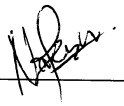
| Signature | : |  |
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To my beloved mother and father

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# ABSTRACT

The project entitled 'Primary Injection – Evaluation of a Current Transformer Saturation and the Effect to the Relay Performance' is proposed to have better understanding on the protection devices used in power system. This paper will concentrate on the evaluation of current transformer saturation and the effect of the saturation to the relay performance. In order to evaluate current transformer saturation, this project will involve few testing on the current transformer. At beginning of the current transformer testing, insulation resistance test will be performed to check the integrity of the winding. The test then followed by DC resistance test to ensure that current transformer have almost same resistance on its secondary so that there will be almost same erratum recorded in next testing. Then the magnetization test will takes place. The purpose of this test is to observe the magnetization curve drawn from the experiment. This test then followed by ratio check test. In this project, 50/5 and 100/5 current transformer ratio will be used. From the result, the saturation value shown by both current transformer and its effect towards relay performance analyzed

# ABSTRAK

Projek Sarjana Muda yang bertajuk "Suntikan Primer- Menilai ketepuan arus transformer dan kesan kepada pelaksanaan geganti" dicadangkan untuk menambah kefahaman dalam alatan perlindungan yang digunakan dalam sistem kuasa. Kertas kerja ini memfokuskan tentang hubungan antara nilai ketepuan arus transformer dan kesan ketepuan ke atas sesebuah sistem. Didalam menilai ketepuan arus transformer, projek ini akan melibatkan beberapa ujian ke atas transformer. Pada permulaan ujian ke atas arus transformer, ujian penebatan akan dilakukan untuk menilai kekuatan transformer. Ujian ke atas transformer diteruskan dengan ujian rintangan arus terus untuk memastikan arus transformer mempunyai nilai rintangan yang hampir sama pada litar sekundernya supaya semua arus transformer mengalami nilai peratusan kesilapan yang hampir sama. Kemudian ujian diteruskan dengan ujian lengkung kemagnetan. Tujuan ujian ini adalah untuk melihat bentuk lengkung yang diperoleh dari ujian ini. Ujian arus transformer seterusnya adlah ujian nisbah. Dalam projek ini, arus transformer yang bernisbah 50/5 dan 100/5 akan digunakan. Daripada keputusan ketepuan yang diperoleh dari kedua-dua nisbah arus transformer yang berbeza ini dan kesannya terhadap geganti dianalisa.

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# CHAPTER 1

# PROJECT BACKGROUND

## 1.1 BACKGROUND

Electrical power system is part where other types of energy is converted into electrical energy and delivering this energy to the consumer. As the energy is not convenient to be stored, this energy must generally be used as it is being produced. In producing and transmitting electrical energy to the consumer, the safety at the plant or transmission part must be considered by the power producer and Tenaga Nasional Berhad as the largest electricity utility in Malaysia.

In generating station, current transformer is used to isolate protection and measuring equipment from power system to ensure the personnel working with the relays and meters working in safer environment. Current transformer used to transform high primary current in the circuit to a small secondary current in order to have an accurate measurement since the range has been scaled down. Current transformer is also economic device as it is provide lower input for relays.

## 1.2 PROBLEM STATEMENT

In order to have safe environment when we are dealing with power station, existence of high voltage and large current, protection is the most important thing that we have to consider. Protection equipment must be installed where it is necessary and it must be efficient and operate appropriately when is needed. Nowadays there is lots of protection devices used in power system. Current transformer is designed to provide current in its secondary proportional to the current flows in its primary side.

First problem in this project is to find excitation current and voltage. Current transformer is commonly used in metering protective relaying. For the protection used, the CT is installed with the relay. When the fault current; few times larger than normal current, flows in the primary side, it will cause the secondary side to saturate. This excitation current and excitation voltage that built up when the current injected to the secondary side of CT is needed to draw the magnetization graph.

The second problem is to determine the CT magnetization curve shape and its saturation point. The current transformer is consists of magnetic element, thus, the graph plotted should obey the B-H curve shape. The CT must be saturated when the current is 10 to 20 times larger than its rated current.

The last problem is to determine when the relay will trip if the 50/5 ratio of current transformer is used when the relay sets at two condition; first at 5 A which is the current transformer secondary rated current and secondly at 100 A which is 20 times of secondary rated current.

## 1.3 PROJECT OBJECTIVE

In this paper, the aim of the project entitled Primary Injection - Evaluation of a Current Transformer Saturation and the Effect to the Relay Performance are as follow:

- To be familiar with electrical equipment used in testing field.
- To gain knowledge and experience in testing electrical equipment.
- To determine current transformer saturation point.
- To observe current transformer saturation for different ratio of CT.
- To analyze the effect of the current transformer saturation and to the relay performance.

## 1.4 PROJECT SCOPE

This final year project entitled Primary Injection – Evaluation of a Current Transformer Saturation and the Effect to the Relay Performance will be conducted on seventh and eighth semester of the faculty's undergraduate program.

The emphasis of this project is on analyzing the behavior of CT saturation graph. This analysis will be based on the result obtained from the test conducted at the faculty's lab and guided by the data collected from the industrial company that involve in power station testing and commissioning.

The testing is using current transformer with ratio 50/5 and 100/5 in order to analyze the current transformer saturation value for different ratio of CT. The current transformer then connected to the relay, the current transformer then is injected at the primary side to observe the relay performance. Combined overcurrent and earth-fault relay, MK2000 will be used in this project.

However, main limitation of this project is the analysis will only involve the CT with small ratio as the current injector provided in faculty's lab can only injected up to 100A. So it is not efficient to test CT with larger ratio.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 MULTIMETER

This FLUKE multimeter is used to measure voltage on the secondary side of the magnetization curve testing.


**FIGURE 2.1.1 FLUKE MULTIMETER**

## 2.2 CLAMP METER

Model 2017 Kyoritsu clamp meter designed as tear drop shape so that it is easier for user to deal with cable in compact places and tight cable areas. This clamp meter has three units which is AC current, AC voltage and resistance. Resistance range also can be used to check continuity because it is equipped with audible continuity test. This clamp meter is able response frequency ranged 40Hz to 1kHz on AC current and voltage.

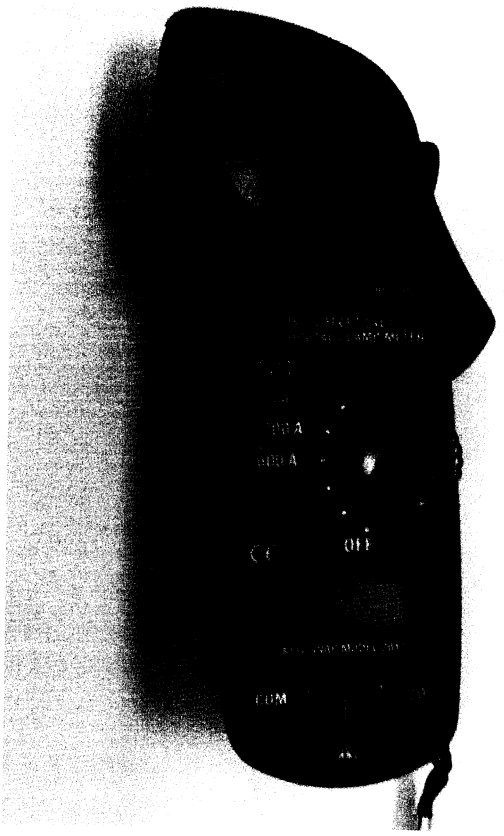

**FIGURE 2.2.1 CLAMP METER MODEL 2017**

## 2.3 INSULATION TESTER

Kyoritsu 3166 insulation tester can injected up to 1000VDC test voltage. The maximum measurement range is 2000 Mega ohms and the mid scale value is 50 mega ohms. The accuracy is about three percent of full scale value.

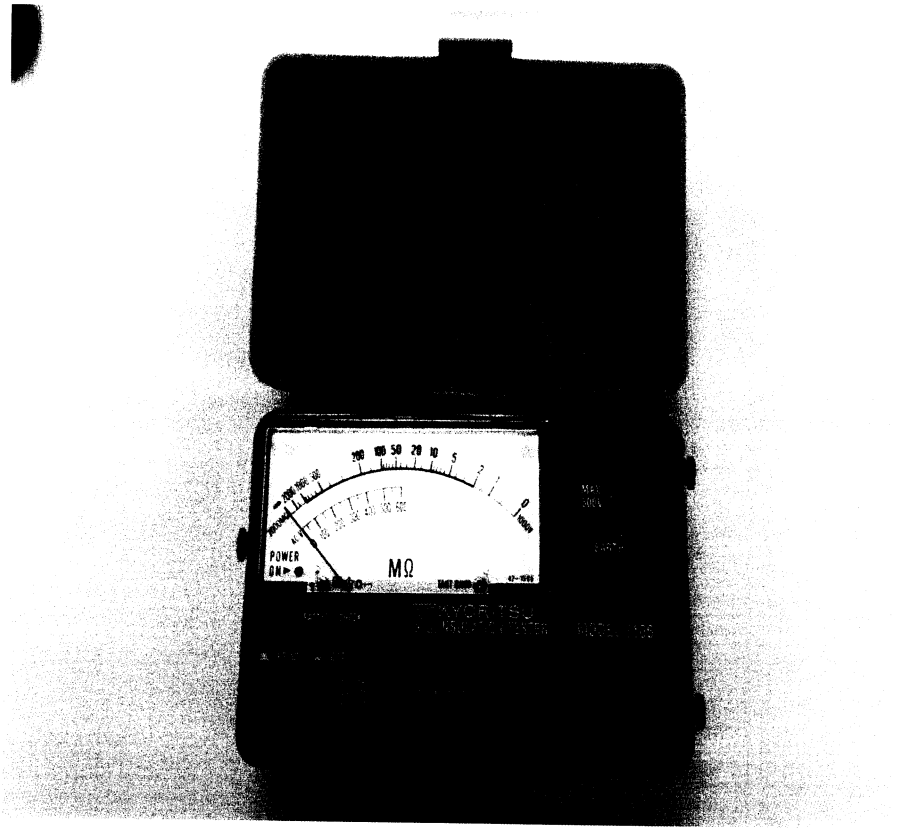


**FIGURE 2.3.1 KYORITSU 3166**

## 2.4 CURRENT TRANSFORMER

Current transformer is a device that steps down the current in its secondary proportional to the current flowing in its primary side. Normally current transformer is used in metering or protective relay. Measuring current transformer has to be accurate from 10% to 120% of their rated current and the protection current transformer has to be accurate for currents at least ten times of its rated current. MCQ A SES wound primary current has 50/5 rated current complete with busbar. This class one low ration transformer has dual frequency of 50Hz and 60Hz.

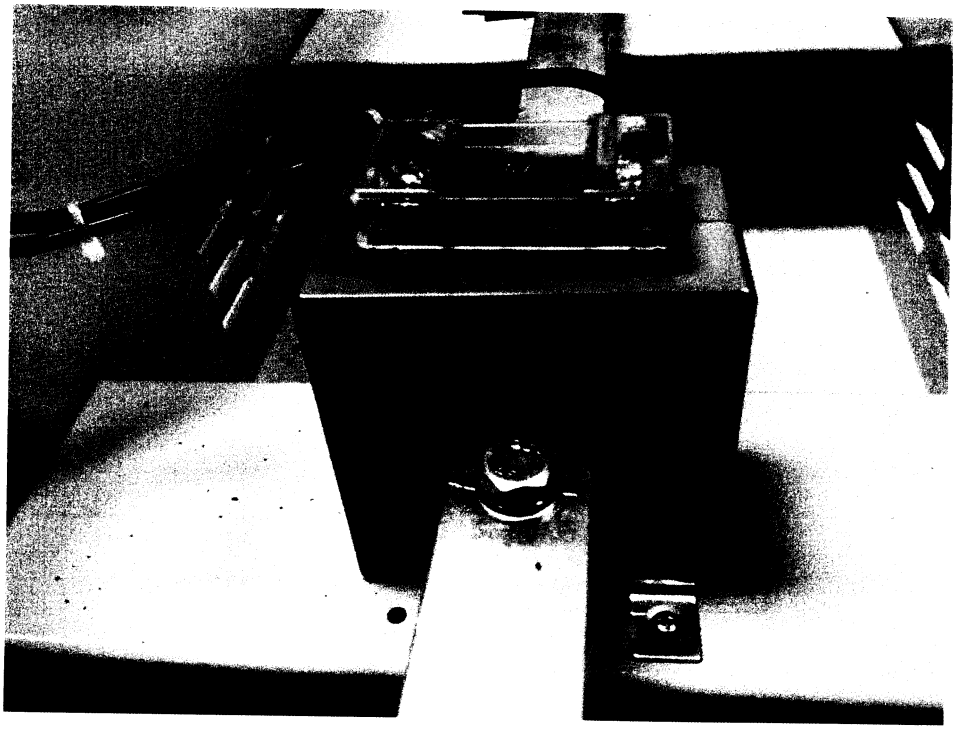

**FIGURE 2.4.1 50/5 SES CURRENT TRANSFORMER**

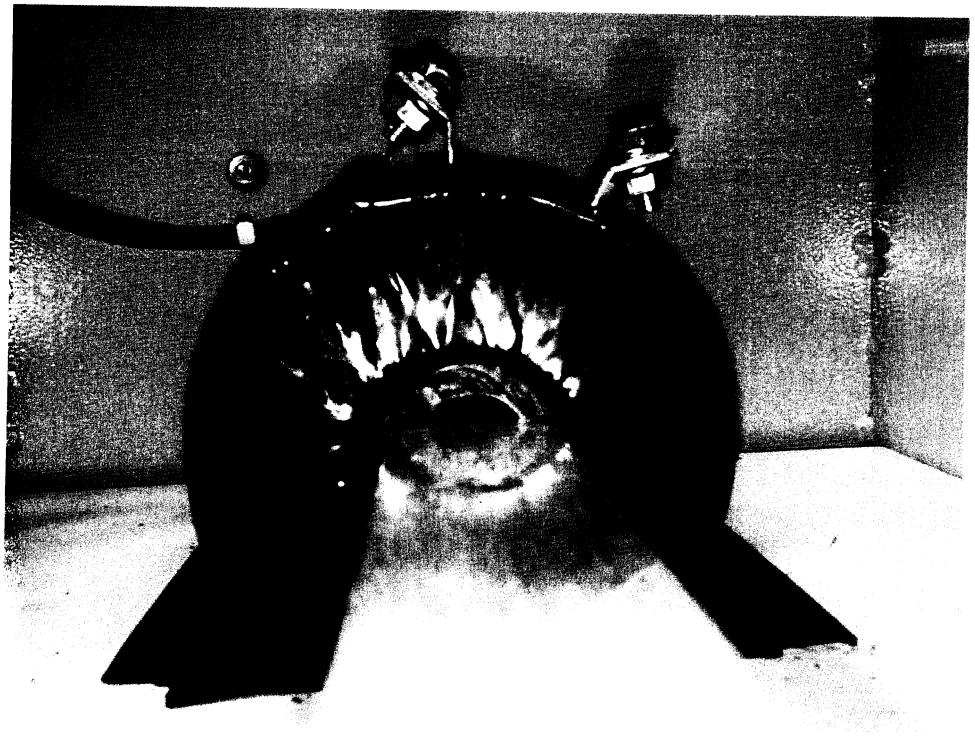

**FIGURE 2.4.2 100/5 SES CURRENT TRANSFORMER**

## 2.5 MIKRO RELAY

MK 2000 is a digital microprocessor based relay is combination of current and earth fault relay. It provides three independent phase current element and one non-directional earth-fault elements. These elements then connected to the current transformer to be protected.

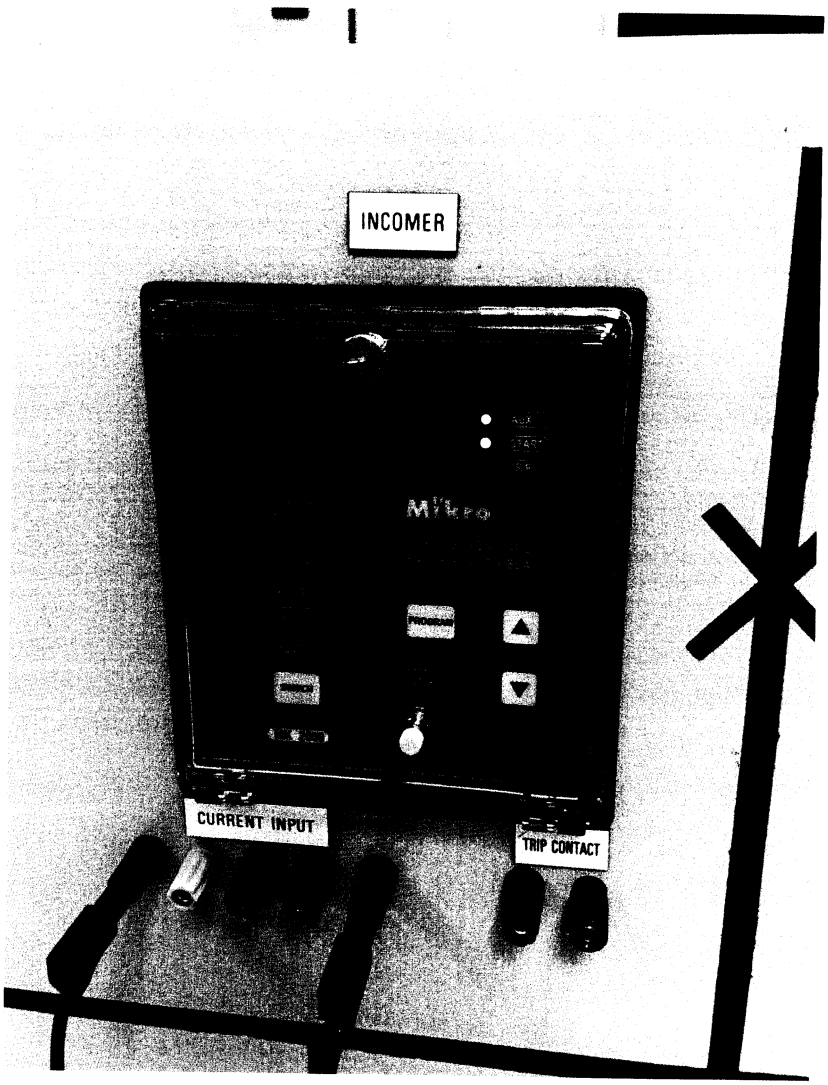


**FIGURE 2.5.1 MK2000**

## 2.6 PORTABLE RELAY TEST SET

Model RFD-200 Series 2 is microprocessor-based single phase relay tester designed to test electronic, electromechanical and microprocessor-based current or voltage relays. Besides that, RFD-200 S2 provides three outputs current source; 10A, 40A and 100A test current to the relay that also can be used as stand alone current source. RFD-200 S2 has one isolated 0-250 VAC voltage source for relay testing or used as stand alone voltage sources. The relay test set also equipped with built-in timer with independent start and stop trigger inputs designed to measure the time between event transitions.

AC voltage source can supply up to 260 volt during no-load and 240 on-load voltage. Both current and voltage sources are controlled by the output control knob. Both current and voltage sources are controlled with up and down switches located beside the output control knob. When the 'ON' switch selected, LED light will lit, the current and voltage source are turned on. The output control knob then used to set desired value of current and voltage. This source remains on until 'OFF' switch selected. The value of output current source is displayed on the RFD-200 S2 four lines by 20 character back-lit LCD.


**FIGURE 2.6.1 VANGUARD PORTABLE RELAY TEST SET**

# CHAPTER 3

# PROJECT METHODOLOGY

## 3.1 INTRODUCTION

In order to accomplish, this project involving few steps of testing sequence before the final testing in the system takes place. The complete processes and steps in this project are shown in the figure 1.