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Time and current grading for protection relay type MK1000  
& MK2000 / Mohama Naim Mohamad.

**TIME AND CURRENT GRADING FOR  
PROTECTION RELAY  
TYPE MK1000& MK2000**

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**B010410186**

**MAY 2008**

“Saya akui bahawa saya telah membaca karya ini pada pandangan saya karya ini adalah memadai dari skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Elektrik(Kuasa Industri).”

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Tarikh: 6 MEI 2008

**TIME AND CURRENT GRADING FOR PROTECTION RELAY  
TYPE MK1000 & MK2000**


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**This report is submitted in partial fulfillment of the requirements for the  
Bachelor of Electrical Engineering (Industrial Power)**

**Faculty of Electrical Engineering  
Universiti Teknikal Malaysia Melaka**

**May 2008**

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap satunya saya jelaskan sumbernya."

Tandatangan :  .....

Nama : MOHAMAD NAIM MOHAMAD

Tarikh : 7 MEI 2008

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

Signature :  .....

Name : MOHAMAD NAIM MOHAMAD

Date : 7 MEI 2008

**Dedicated especially to my late father  
and my beloved mom**

## ABSTRACT

The main purpose of this project is to investigate the characteristic time grading and current grading using the inverse definite minimum time (IDMT) protection relay type MK1000 and MK2000. Generally, time grading can be define as the minimum time to carry the fault current before nearest protection relay disconnect the supply in circuit. Current grading can be used to obtain the correct discrimination in the circuit where it will be a large different ratio of fault current to rated current in the network. Meanwhile the other objectives of this project are to develop a proper test procedure for the time grading and current grading. Beside that computer simulation can be done by using the ERACS software in order to verify the testing results. This project also develops the current injection set with using the autotransformers and toroidal core as the main element. The main purpose of this current injection to produce secondary current around 100 ampere. At the end this project, this research can help the student to understand the basic operation time grading and current grading in the operation protection relay especially the IDMT operation in the low voltages system.

## ABSTRAK

Tujuan utama projek ini dijalankan adalah untuk mengenal pasti ciri-ciri yang terdapat pada "*current grading*" dan "*time grading*" yang digunakan dalam pemasangan geganti perlindungan didalam sistem elektrik. Secara umumnya "*current grading*" dapat diterangkan dengan masa yang diambil paling singkat yang diambil untuk mengesan arus kegagalan didalam sistem sebelum geganti perlindungan yang paling hampir memutuskan bekalan kuasa didalam sistem. "*Current grading*" pula boleh digunakan untuk mendapatkan diskriminasi betul dalam sistem di mana arus kegagalan dan arus didalam sistem akan menjadi satu nisbah yang besar. Selain daripada itu, objektif lain projek ini adalah menyiapkan kaedah pengujian yang melibatkan "*current grading*" dan "*time grading*". Projek ini juga akan melibatkan penggunaan perisian ERACS dalam membuktikan praktikal dan teori adalah seiring. Selain daripada projek ini juga merekabentuk alat suntikan arus kedua yang akan diguna pakai dalam menjalankan eksperiment nanti. Dalam mereka bentuk alat suntikkan arus kedua, dua komponen utama akan digunakan iaitu "toroidal core" dan pengubah automatik. Diakhir projek ini, diharap kajian yang dilakukan ini dapat membantu pelajar untuk lebih memahami tentang "*current grading*" dan "*time grading*" dalam yang melibatkan sistem perlindungan terutama yang melibatkan geganti jenis IDMT didalam sistem voltan rendah.



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## SHORT FORM

IDMT	Inverse Definite Minimum Time
A	Ampere
$I_{\text{fault}}$	Fault Current
S	Apparent Power
V	Voltage
MVA	Mega-Volt-Ampere
JKR	Jabatan Kerja Raya
TNB	Tenaga Nasional Berhad



# CHAPTER I

## INTRODUCTION

### 1.1 Introduction

The main purpose of this project is to investigate the characteristic time grading and current grading using the inverse definite minimum time (IDMT) protection relay type MK1000 and MK2000. Generally, time grading can be define as the minimum time to carry the fault current before nearest protection relay disconnect the supply in circuit. Current grading can be used to obtain the correct discrimination in the circuit where it will be a large different ratio of fault current to rate current in the network. Meanwhile, the other objectives of this project are to develop a proper test procedure for the time grading and current grading. Beside that computer simulation can be done by using the ERACS software in order to verify the testing results. This project also develops the current injection set with using the autotransformers and toroidal core as the main element. The main target of this current injection set is to produce secondary current around 100 amperes. At the end this project, this project can help the students to understand the basic of operation time grading and current grading in the operation protection relay especially the IDMT operation in the low voltages system.

## 1.2 Project Objective.

The main purposes of this project are:

- Analysis characteristic time grading and current grading
- Simulate the current grading and time grading characteristic for IDMT (inverse definite time minimum) relay type MK1000 & MK2000
- Produce 100 ampere current output in secondary current injection set. By using toroidal core and autotransformers as main element.

## 1.3 Problem Statement.

Problem related with the project are:

- Define the best discrimination by using time or current and both
- Discriminate the healthy and faulty equipment or the circuit by current, time and both current and time.
- Define the minimum time interval between time setting of adjacent circuit breaker to prevent the simultaneous operation
- Define the time grading and current grading characteristics.

## 1.4 Scope

Scopes of this project research are:

- This project only related 3 phase and single phase (415 and 240) protection system
- The type protection relay will be use MK1000 and MK2000
- Secondary injection test on protection relay with using 100ADM MK 2

### **1.5 Expected Results**

The expected results from the project are:

- Can be define the characteristic time grading and current grading
- Secondary current injection set can be operate smoothly
- The simulation results are able to verify the hardware operation when the hardware implemented soon.

## **CHAPTER II**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This project research will discuss the principle of coordination protection system in the system. Coordination protection relay can be classified by three types namely discrimination by time, discrimination by current and discrimination current and time or both. The main common aims for the three methods are to give the correct coordinating relay in system. Beside that, the others target of this project research to increase the general knowledge about protection relay such as the circuit breaker, time grading, current grading and utilizing protection relay among the student and fresh engineer especially related with the protection system.

## 2.2 Relay as Protection Devices

Relay has been designed to measure or receive the signal in others word to make it operate or send the signal to another device such as circuit breaker. Protection relay will operate when the abnormal condition occurs in the system and protection relay will provide signal at circuit breaker to trip the circuit. The circuit breaker will open and the fault area will be isolate to minimize fault current. [3]. Nowadays, relay can be classified by three type such as electromechanical, static and microprocessor relay.

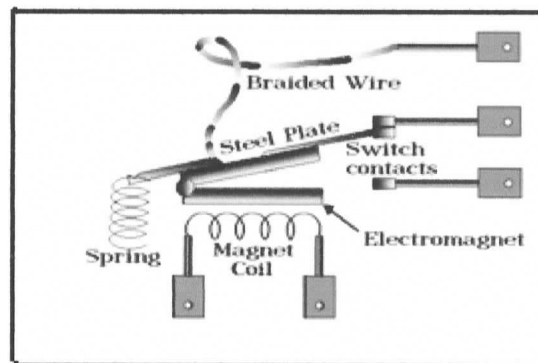


Figure 2.1 Basic Relay

Electromechanical relay can be dividing into two important parts called as “moving” and “static”. When the flow current equal to the setting value, torque will occurs in the moving part and will touch the static part hence the connecter will close and circuit breakers will trip. Electromechanical relay is easy to maintenance and the cost installation is cheaper than others relay.

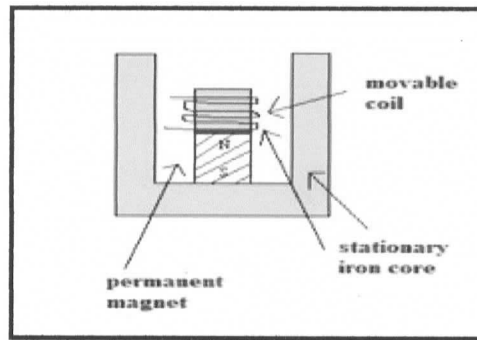


Figure 2.2 Electromechanical Relay

Another relay that based on electromechanically operation is “induction relay”, “attracted-armature relay”, “moving-coil relay”, “thermal relay” and “timing relay”.

Induction relay have been apply to watt-metric relay, KVAR relay, over current relay and over voltages or under voltages relay. Inductions relay construction based on kilowatt meter. Attracted armature relay construction is based on electromagnet element and it used to connect the armature. Induction relay normally use as “all-or-nothing relay” and “measurement relay”. Thermal relay is operated based on the heat. Thermal relay has been used as an overload relay because it has more accuracy and has a long delay time. Timing relay is using in protection system and can be classified into three groups such as short circuit relays, medium-value accurate-time delays and long time relays.

Static relay is usually using in electronic equipment. This relay use electronic circuit as a base circuit to operate. Static relay was used in power protection circuit because it can protect the sensitive equipment from fault current. However this relay is more expensive than electromechanical relay. Beside that, it is easy to maintenance and has the long live time.



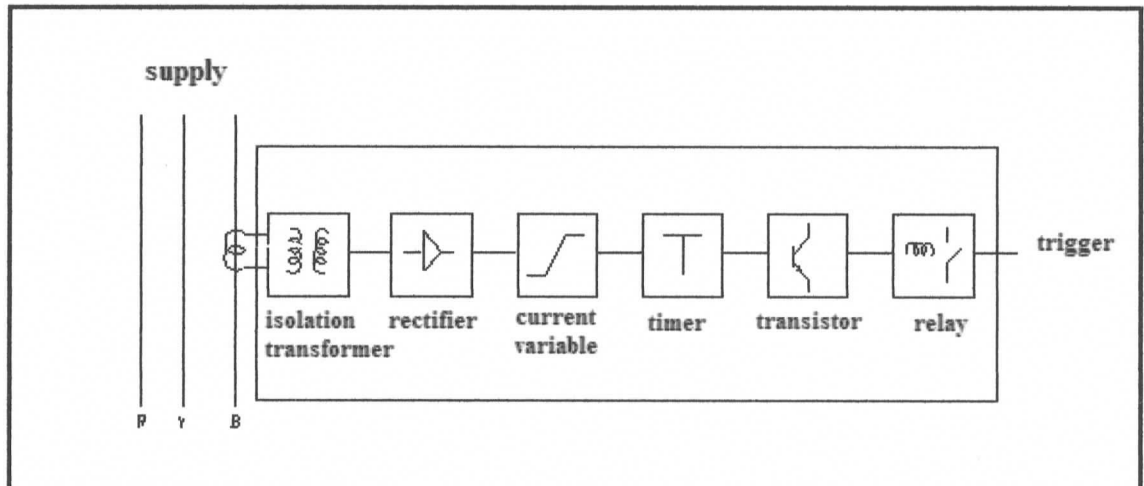


Figure 2.3 Block Diagram Static Relay [4]

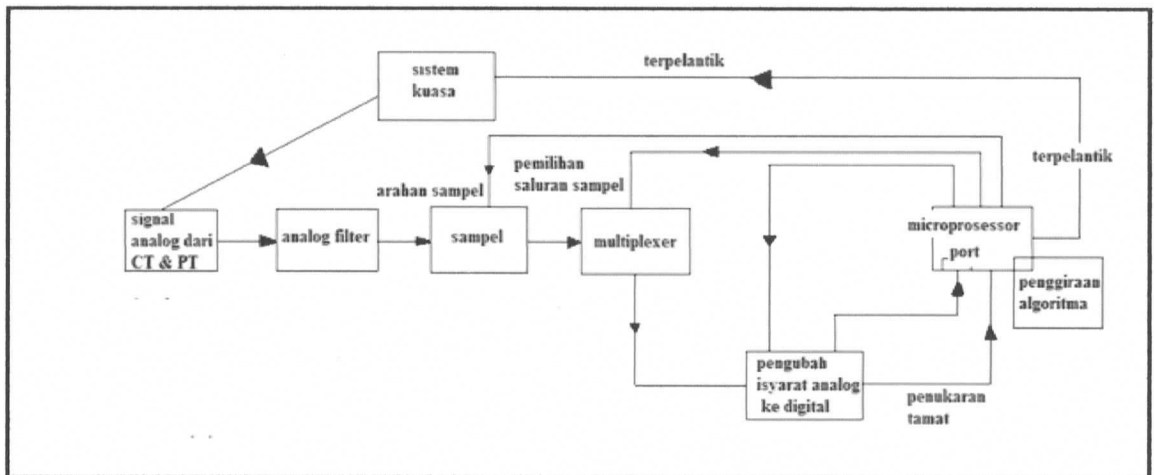


Figure 2.4 Block Diagram Microprocessor Relay [5]

Relay based on microprocessor is a relay where using the software and operate based on binary code. The different of this relay is programming has been used and the basic concept from the conventional relay has been changed for comparison and the binary code. Relay type microprocessor can store the fault of data that already happened previously.

### **2.3 Protection System with using Single Processor for Low Voltages**

Single Processor is use the network of communication system. This network functions to analyze data from equipment by separate. All data will send to main computer. In this network, main computer will send the signal to the devices and finally the signal has been prescribed by protocol. System communication type Ethernet include protocol collision-detection multiple-access (CSMA/DA) has been used in this system. [4]. This concept was operating by sending data from the device to main processor. The sending data include the voltage, current and devices status. In the network, microprocessors will used to analyze data and make the decision related to the system. The advantage of this system is the processor can detect all information related to the system. Protection system and controller was design depend on electrical signal like current magnitude and phase angle. As a conclusion this system has a lot of advantages on protection system where the extra protection to feeder device through the main device on current executioner without affects the system.

### **2.4 Discrimination by Time**

Discrimination by time is the basic idea to add time lag features to control the relays of the number circuit breaker in the protection system. Discrimination by time can be defined as the nearest circuit breaker to the fault will operate first. The minimum time interval between time settings of adjacent circuit will be considering before setting the time to prevent the simultaneous operation [1]. The minimum time interval is required to the breaker to clear the fault in the system. Besides, the minimum time interval setting must be match with the relay and the current transformers (CT) [1]. Discrimination by time has a big problem where the problem occurred from discrimination by time will increase in time fault clearance. The time will be increase if the fault occurs closed at the power source especially when MVA rating value is highest. [2]