'TIME AND CURRENT GRADING FOR IDMT RELAY SETTING '

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MAY 2009

"I hereby declared that I have read through this report entitles "Time and Current Grading for IDMT relay Setting and found out that it has comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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This Report Is Submitted In Partial Fulfillment Of Requirement For The Degree of Bachelor In Electrical Engineering (Industrial Power)

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MAY 2009

I declare that this report entitle “Time and Current Grading for IDMT relay Setting” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ....

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Date : 07.05.2009

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Lastly I hope that this technical report can be a reference for anyone who is interest in this project and can get more advantages to anyone who read this technical report. For anyone which is interest in learning this project, they can refer to the second edition report about Final Year Project II which will be complete in session 2009, May.

Thank you.

ABSTRACT

System protection is an important part in the power network systems. The most important part in designing the protection needs to consider such as the type of relays, the size of circuit breaker, the type and size of current transformer, the coordination of relays, and others component to maintain the stability of the system. Then to maintain the stability each relay in the power network must setting in proper technique in term of current and time operation. For this project, the relay that will be study is Inverse Definite minimum time IDMT MK2000 relay .This relay is part of non unit protection where protect the over current and earth fault at the system. This relay formerly is located at the distribution substation and use for back up protection and the major advantage of IDMT MK 2000 relays is their ability to discriminate the time and current. In a radial feeder configuration, supplied from one end only, discrimination of faults can be achieved by incorporating time delays at each relay point. Once the system is set correctly, then discrimination is possible so that the nearest relay to the fault operate to isolate the smallest possible section in the shortest time. This study will be calculate the fault at the system network which is phase to phase fault, phase to earth fault and healthy condition. The simulation using Eracs software will be make for check the power load flow of the system, analysis the location of fault during abnormal condition and compare the value of simulate calculation with the manual calculation. This project also study about the setting and calculating the suitable time, current, plug setting and Time multiplier setting of the IDMT MK2000 relay. In addition, this project will develop the current injector using the toroid magnet. The purpose of develop the current injector is to test the IDMT MK2000 relay that has been setting.

ABSTRAK

Sistem perlindungan adalah komponen yang sangat penting dalam sesuatu sistem talian kuasa. Dalam merekabentuk satu sistem perlindungan kita perlu mengambil kira jenis geganti yang hendak digunakan, saiz pemutus litar, jenis dan saiz pengubah arus dan coordinasi diantara relay dan lain-lain komponen yang terlibat dalam memastikan kestabilan sistem terkawal.Oleh itu, untuk memastikan kestabilan sistem setiap geganti perlu disetkan dengan teknik yang betul terutama untuk arus dan masa kendalianya. Geganti yang di kaji untuk kajian ini adalah jenis *Inverse Definite Minimum Time* (IDMT) relay.Geganti ini dikenali sebagai perlindungan bukan unit yang mana akan beroperasi apabila berlaku lebihan arus dan kerosakkan arus kebumi. Geganti ini biasanya terdapat di pencawang pengagihan utama yang digunakan sebagai perlindungan kedua. Dalam sistem radial,discriminasi untuk kesalahan arus boleh dicapai sekiranya mengabungkan masa pada setiap geganti. Bila sesuatu sistem di set dengan betul dan dengan discriminasi yang sesuai geganti yang terdekat akan berfungsi untuk mengasingkan kesalahan arus rosak yang berlaku dalam masa yang singkat.Kajian ini juga akan mengira kesalahan arus rosak pada kesalahan fasa ke fasa, kesalahan satu fasa ke bumi dan keadaan normal. Simulasi Eracs pula digunakan untuk menentukan kuasa pengaliran beban, kawasan berlakunya kesalahan arus dan membandingkannya dengan pengiraan manual.Kajian ini juga mempelajari cara hendak mengira dan mensetkan masa,arus,pengesetan palam geganti dan berbilang pengesetan masa untuk geganti IDMT.Di tambah lagi,kajian ini akan mereka bentuk suntikan arus pendua dengan mengunakan magnet toroid. Tujuan suntikan arus pendua dibuat adalah untuk menguji geganti yang telah siap di set.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This Project focus on the overcurrent and earth fault protection for substation in power distribution network rated voltage up to 11kV. Protection relay is of the important components used to design the electrical system network. There are many type of protection relay used in the electrical power system for protection such as distance relay, differential relay, pilot wire relay, over current and earth fault relay.For this project, the overcurrent and earth fault relay had been chosed for studies.

For the Tenaga Nasional Berhad (TNB) substation, most of the protection relay is located at each feeder of the distribution system network. Protection relay for model IDMT MK2000 relays normally suitable for main switch board (MSB) at the building. This relay formerly is located at the distribution substation and use as the backup protection. The major advantage of IDMT MK 2000 relays is their ability to discriminate the time and current. In a radial feeder configuration, the supplied from one end only. The discrimination of faults can be achieved by incorporating time delays at each relay point. This enables the nearest relay to trip and isolate the faulty circuit without affecting the other non-faulty circuits. By proper setting of the relays only the attracted parts of the network will lost the supply, thus the smallest portion of the system will be affected.

1.2 Objective

The main objective for this project are:

- To analyze the load flows, fault analysis and coordination of the relay power at system network by using simulation software Cape.
- To develop proper setting technique for over current and earth fault using the IDMT MK 2000 relay.
- To analyze the performance of the time and current grading method designed for power system network based on IDMT relay.
- To develop low cost 100A current injector using autotransformer and toriodial.

1.3 Problem Statemant

Some interruptions in power supply were due to the improper setting or wrong selection of the power protection devices. As a result, it had caused inherent tripping, inadequate over current protection and inactivated earth fault. This knowledge of design power system protection play very important rules to ensure that is no interruption of power supply. Its cover the load flow analysis, fault analysis, proper setting and technique of relay setting.

1.4 Scope of the Project

The scope of this project are:

- Focus on overcurrent and earth fault relay operation, the relay setting current and time and the relay characteristic.
- The characteristic curve that has been used for analies is standard inverse characteristic.
- Determine the components and parameters that is use in the network system such as calculate the fault, fault MVA, time multiple setting (TMS), and time operating of the relay.
- To analyze the load flows, fault analysis and coordination of the relay at power system network using simulation software Cape.
- The secondary test of relay using the current injector vanguard RFD-200.
- The fault analysis that will be study only for over current, short circuit and earth fault.

1.5 Expected results

This project should be:

- Successful in setting the IDMT MK2000 relay for over current protection in the system.
- Successful in coordinating and implementing the IDMT MK2000 relay in the selected power network system.
- Successful in developing current injector design to produce 100A output by using toroid magnet.

CHAPTER 2

LITERATURE REVIEW

2.1 Component of Protection

2.1.1 Current Transformer (CT)

Current transformer is one of the important parts in the electrical protection system. Current transformer is use to step down current for metering purpose and protection purpose (relay). It's also can separate the protection circuit (secondary) from the main circuit (primary). The primary winding connected in series with the conductor carrying the current which to be measured or controlled. The secondary winding is thus isolated from the high voltage and then can be connected to low-voltage metering circuits. The secondary output from the Current Transformer is the information used by the relays to determine the conditions exist in the plant being protected. Current transformer comes with two shapes, which are ring shape and wound shape .Ring shape is use for high ratio current transformer and the wound shape is use for the low ratio current transformer. Current transformer also been classified into few class. For the metering purpose, it was classified into class 1, class 2, class 3, class 0.1, class 0.2, and class 0.5 meanwhile for the protection purpose it has class 5P, class 10P and class X. Every class has different ratio and different application [11].

2.1.2 Fuses

A fuse is one of the oldest overcurrent protection devices. It essential component is a metal wire or strip that melts when too much current flows. It breaks the circuit in which it is connected, thus protecting the circuit other components from damage due to excessive current. Fuses are an essential part of a power distribution system to prevent fire or damage. When too much current flows through a wire, it may overheat and be damaged or even start a fire. Fuses are selected to allow passage of normal currents, but to quickly interrupt a short circuit or overload condition. There are several aspects must be consider before choosing the fuse likes the current factor, fuses element, rated current. The fuses factor will determine the classification of the fuses either it delicate class or rough class.The fuse factor is the ratio between of the fuse current and the rated fuse current.If the fuse factor below of the value of 1.2, it is consider for delicate class, while if the value is 1.5 and upper it is clasify for rough class [11].

2.1.3 Circuit Breaker

A circuit breaker is an automatically-operated electrical switch which is designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset either manually or automatically to resume normal operation. Circuit breakers are made in varying sizes, from small devices which protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city. During an overload, the solenoid pulls the core through the fluid to close the magnetic circuit, which then provides sufficient force to release the latch. The delay permits brief current surges beyond normal running current for motor starting and energizing equipment. Short circuit currents provide sufficient solenoid force to release the latch regardless of core position thus bypassing the delay feature. Ambient temperature affects the time delay but does not affect the current rating of a magnetic breaker.

Larger circuit breakers such as those used in electrical power distribution may use vacuum, an inert gas such as sulfur hexafluoride or have contacts immersed in oil to suppress the arc. There are many different technologies used in circuit breakers. Types that is common in domestic, commercial and light industrial applications at low voltage (less than 1000 V). *Miniature Circuit Breaker* (MCB) is rated current not more than 100 A. The trip characteristics are normally not adjustable. It is thermal or thermal-magnetic operation. *Moulded Case Circuit Breaker* (MCCB) rated current up to 1000 A. Thermal or thermal-magnetic operation. Trip current may be adjustable. Electric power systems require the breaking of higher currents at higher voltages. *Vacuum circuit breaker* (VCB) with rated current up to 3000 A, these breakers interrupts the current by creating and extinguishing the arc in a vacuum container. These can only be practically applied for voltages up to about 35,000 V, which corresponds roughly to the medium-voltage range of power systems. Vacuum circuit breakers tend to have longer life expectancies between overhaul than do air circuit breakers. *Air circuit breaker* (ACB) rated current up to 10,000 A [5].Trip characteristics often fully adjustable including configurable trip thresholds and delays. Usually the electronically controlled, though some models are microprocessor controlled. There is often used for main power distribution in large industrial plant, where the breakers are arranged in draw-out enclosures for ease of maintenance [5].

2.1.4 Protection Relays

The protective relay is a device that constantly monitors the condition of a particular section of the circuit or network to determine whether there is a need to open a circuit breaker to isolate any abnormality in the system. It makes decisions by comparing the measured quantities to the pre-determined values or sequence during healthy condition of the system. In other words, it performs typical protection device operation. An abnormal condition can occur due to commonly large variation in load and fault .The main purpose of protective relay is to establish on most power system as a performance of a protection scheme. There are two main groups of relays. The first group belongs to relays designed to detect and measure abnormal conditions. The second group is auxiliary relays, designed to be connected in the auxiliary circuits controlled by the measuring relay contacts, and to close or open further contacts usually in much heavier circuits. This project used Inverse Definite Minimum Time (IDMT) MK 2000 Overcurrent and Earth fault relay

2.2 Overcurrent and Earth fault relay

Overcurrent protection is a protective relay which responds to a rise in current flowing through the protected element over a pre-determined value. Overcurrent relays are classified under code 5x (for example are 50, 51) in ANSI relay code. The main purpose of overcurent relay are exactly is the name suggested to operate based on the overcurent flowing into a system and prevent such scenario from taking place. Overcurrent relay can also be constructed as IDMT and instantaneous relay. Example of overcurrent relays are GE IAC50 Time Overcurrent Relay (electromechanical) and MIC 8050 N 011 G 00C Microprocessor multifunction relay [12].

2.2.1 ***Inverse Difinite Minimum Time*** **(IDMT) relay protection**

Inverse Difinite Minimum Time is the relay with an inverse current or time characteristic.The time delays are reduced for higher currents and time delay are long for low currents flow.These relay are known as IDMT relays.A minimum time of operation is incorporated to ensure co-ordination between the relays when the fault level does not vary along the feeder.

2.2.2 *Standart Inverse Difinite Minimum Time* (IDMT) Overcurrent relay

The current and time tripping characteristics of IDMT relays may need to be varied according to the tripping time required and the characteristics of other protection devices used in the network. For these purposes, IEC 60255 defines a number of standard characteristics as show in the table above:

Table 2.1: Standard Characteristic Equation [3]

Relay Characteristic	Equation (IEC 60255)
Standard Inverse (SI)	$t = TMSx\frac{0.14}{I_r^{0.02}-1}$
Very Inverse (VI)	$t = TMSx\frac{13.5}{I_r-1}$
Extremely Inverse (EI)	$t = TMSx\frac{80}{I_r^2-1}$
Long time standard earth fault	$t = TMSx\frac{120}{I_r-1}$

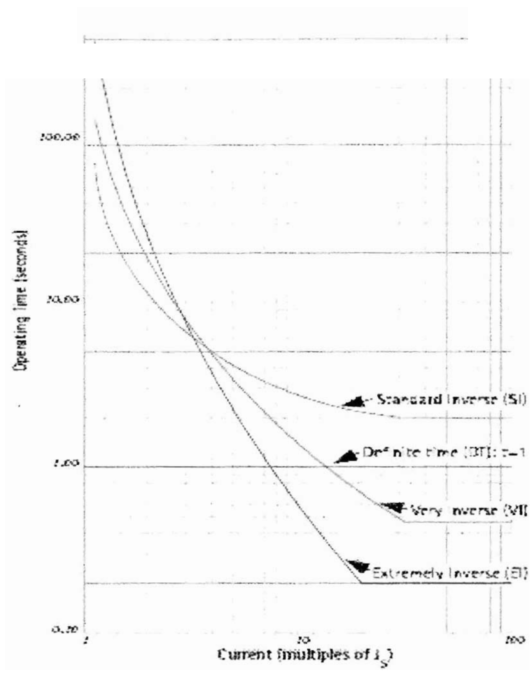

Figure 2.1:IDMT relay Characteristic curve [3]

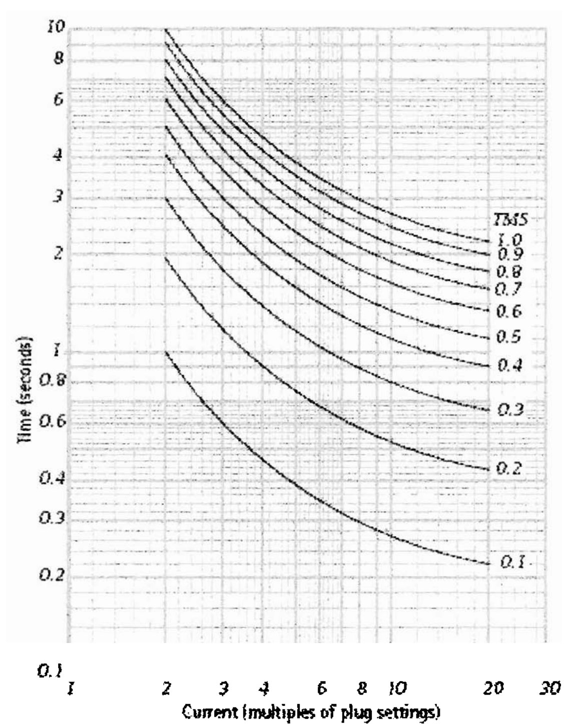

Figure 2.2 :Typical time and current characteristic of standard IDMT relay [3]

The mathematical description of the curve are given in table 2.1, and the curves based on a common setting current and time multiplier setting of 1 second are shown in figure 2.1.The tripping characteristic for different settings using the standard inverse curve are illustrated in figure 2.2.Normaly the standard inverse curve is use, but if satisfactory grading cannot be achieved the very inverse or extreme inverse curve is used to resolve the problem.

2.2.3 Instantaneous Overcurrent Relays

The instantaneous can be used where the source is small in comparison with the protected circuit impedance. This makes a reduction in the tripping time at high fault levels possible. It also improves the overall system grading by allowing the discriminating curve behind the high set instantaneous element to be lowered.

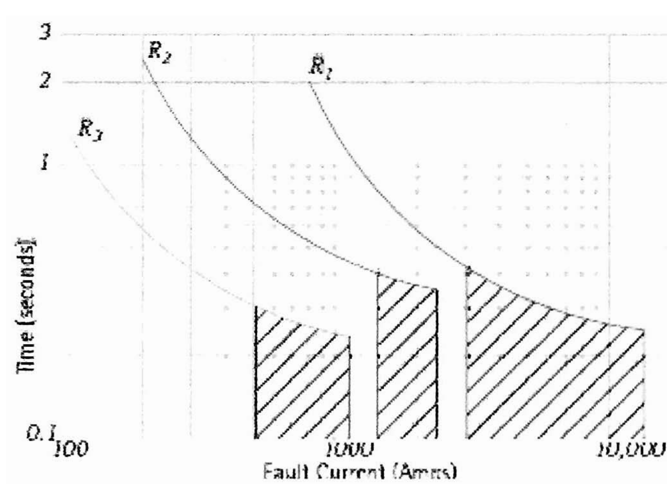

Figure 2.3: Characteristic of combined IDMT and high-set instantaneous relay [3]

As shown in figure 2.3 above, one of the advantages of the high set instantaneous elements is to reduce the operating time of the circuit protection by shade area below the discriminating curve. If the source impedance remains constant, it is then possible to achieve high speed protection over large section of the protected circuit. For example relay R2 is graded with relay R3 at 500A and not 1100A ,allowing relay R2 to be set with a TMS of 0.15 instead of 0.2 while maintaining a grading margin between relays of 0.4s.Relay 1 also is graded with R2 at 1400A and instead of at 2300A.

2.2.4 Very Inverse Overcurrent Relays

Very inverse over current relays are particularly suitable if there is a substantial reduction of fault current. It as the distance from the power source increases, there will increase in fault impedance too. For very inverse, the operating time is approximately double for reduction in current from 7 to 4 times of the relay current setting. This permits the use of the same tome multiplier setting for several relays in series.

2.2.5 Extremely Inverse Overcurrent Relays

With this characteristic, the operation time is approximately inverse proportional to the square of the applied current. This makes it suitable for the protection of distribution feeder circuit in which the feeder is subjected to peak current of on switching. The extreme inverse characteristic that has been used gives the satisfactory grading margin,but use of the standard inverse and very inverse characteristic at the same setting does not effect the system.

2.2.6 Definite Time Overcurrent Relays

Definite time characteristic is also called the time-delayed over current relays. The various time delays can be adjusted to suit different requirements. The time relay has lower