DISCRIMINATION OF OVERCURRENT AND EARTH FAULT OF A LOW VOLTAGE SYSTEM

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DISCRIMINATION OF OVERCURRENT & EARTH FAULT OF A LOW VOLTAGE NETWORK

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This Report Is Submitted In Partial Fulfillment of Requirement for the Degree of Bachelor's in Electrical Engineering (Control, Instrumentation & Automation)

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“I hereby declared that I have read through this report entitle “Discrimination of Overcurrent & Earth Fault of A Low Voltage Network” 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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"I hereby declared that this report entitle " Discrimination of Overcurrent & Earth Fault of A Low Voltage Network" is a result of my own work except for the excerpts that have been cited clearly in the references."

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Specially dedicated to

My beloved father and mother…
Mr. Mohd Ghazali b. Sulong & Mrs. Wan Hafsah bt. Hj Wan Ahmad

My inspirational motivator…

En.Mohd Hendra b. Hairi

All my friends,

Thank you for everything…

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ABSTRACT

This project is to analyze how the discrimination of overcurrent and earth fault happen to the relay. This project is divided into two parts as FYP I and FYP II which are conducted throughout Semester I and Semester II 2008/2009. The project is based on the fault happen and selectivity of the relay to trip. The function of the relay is to protect the instrument that situated in an electrical system. In that case the relay will create a save zone to work and will protect the entire instrument so it will remain in a good condition. The analysis will focus on the testing of the relay operation time and current to discriminate the fault and focus on relay setting so it can operate within the minimum current operation. The discrimination is achieved when the relay nearest fault operates rather than other relay upstream on it. This ensures that a fault will be disconnected with minimal disruption to any other circuit in the system. Therefore, the setting of relay which is near the equipment must be nominal value and trip first to protect the equipment. So the analysis will ensure that the relay and protection system can operate under certain fault. This analysis can be design a low voltage network.

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ABSTRAK

Projek ini dijalankan untuk menganalisis bagaimana geganti lebihan arus dan kerosakkan bumi dipilih. Projek ini dibahagi kepada dua bahagian iaitu PSM I dan PSM II yang mana setiap bahagian dijalankan dalam tempoh masa Semester I dan Semester II 2008/2009. Projek ini adalah berdasarkan kepada kegagalan dan pemilihan geganti untuk beroperasi. Geganti ini bertujuan untuk melindungi alatan-alatan yang terdapat dalam sistem dari kerosakan. Untuk kes ini, geganti akan membina satu zon selamat dan akan melindungi alatan tertentu supaya alatan itu tidak rosak dan berada salam keadaan yang baik. Analisis ini akan tertumpu kepada ujikaji terhadap operasi geganti bagi masa dan arus untuk memilih kegagalan arus supaya geganti itu boleh beroperasi dengan arus operasi yang minimum. Yang telah ditetapkan nilai arusnya. Pemilihan geganti akan tercapai apabila geganti yang paling hampir dengan kegagalan akan beroperasi dahulu berbanding dengan geganti yang lain yang bervoltan bahagian utama. Ini memastikan kegagalan itu terputus daripada litar yang lain di dalam sistem. Oleh sebab itu, geganti dengan nilai yang ditetapkan yang mana berdekatan dengan kegagalan perlulah ditetapkan dengan nilai yang nominal untuk ia beroperasi dahulu untuk melindungi alatan-alatan lain. Oleh itu, analisis akan memastikan geganti beroperasi dalam kegagalan tertentu dan dari analisis ini juga dapatlah dibina satu sistem voltan rendah.

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CHAPTER 1

INTRODUCTION

Protection of overcurrent and earth fault is important in high and low voltage system. In power distribution this protection is a must in all voltage line. This system will provide the protection for the transmission line and all the electrical equipment that involved in the distribution system.

In this project, the overcurrent and earth fault protection will be studied and test. But the project is not only take a focus in overcurrent and earth fault protection but the discrimination of the overcurrent and earth fault relay in low voltage system.

1.1 Project Objectives

This project will be a suitable baseline to understand the fundamental of overcurrent and earth fault relay protection. This protection relay is an important part in voltage system. There are many type of relay already used in power industry. The studies of testing this device are difficult to be found. It also not so clearly teaches in any education lesson. No specific book or subject can be found related to this testing. With this project it can help student understand about the fundamental and the testing that carried out to test the protection relay.

The overcurrent that we choose to give a suitable protection is IDMT relay. This relay provides a better protection by the choice of the suitable TMS that can give the faster respond with the high operated current.

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Testing to the relay will be made in order to accomplish the suitable setting that followed the TNB regulation. They will be a secondary injection take part to test the relay operation. This testing is an important part for this project. The testing will consist of the operating current and trip time.

The discrimination is mostly operated like distance relay. The same fundamental will be applied such as the location of the fault and the nearest protection device location. During this project, testing will be conducted to prove that the discrimination will take part in term of clearing the fault.

The IDMT setting will be applied to the protection relay in order to get the appropriate clearance time and ideal protection within the TNB regulation. This regulation is important in order to comply at all TNB substations. The regulation already been applied at all TNB distribution line prove to meet the satisfaction.

Overall, the project will be included the study and understand the fundamental of overcurrent and earth fault protection. After the fundamental done there will be the technical part involve where testing and analysis of the result take part. This is the most important and key to achieve the discrimination success.

1.2 Problem Statement

Protection of overcurrent and earth fault is an important in high and low voltage system. Hence, the overcurrent and earth fault studies are performed to evaluate the efficient protection of the power distribution.

In power distribution, this protection is a must in all voltage line. With this system it will provide the protection for the transmission line and all the electrical equipment that involved in the distribution system.

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The project will focus in selecting the suitable setting that can be applied to the low voltage system according to the setting that been complied with TNB. The setting has been use by TNB in all the substation and power station.

Other main problem is to choose the correct relay to discriminate according to the fault happen. The discrimination is the ability of the system to choose and protect the equipment according to the location of the fault. The system will separate the fault and only one location will be stop and the others will operate normally. This system will give a better operation in distribution system where only the nearest equipment to the fault that trip and separate but the others are operate normally.

With overcurrent and earth fault protection, there is some curve selection that must be made in order to give a suitable discrimination to the system. The curve will consist the time selection and current selection. The IDMT relay is the suitable relay that can give a suitable discrimination throughout the system. IDMT (Inverse Definite Minimum Time) is a relay that has a time multiplier setting (TMS) and plug setting (PS) that can give a time and current operated value. With this value the suitable setting selection will be made.

TMS is a series of curve that been use in order to discriminate fault. With TMS a suitable time can be automatically selected if the fault current increase. This is because the fault current is different according to the system such as switchgear or motor. It is important for the relay to have the ability to operate automatically to clear the fault from the system.

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1.3 Project Scope

This PSM project entitled „Discrimination of an Overcurrent and Earth Fault of a Low Voltage Network" is basically divided into two parts which are PSM I and PSM II. This project will be conducted throughout the final year of the undergraduate program with PSM I and PSM II conducted throughout the first and second semester respectively.

Basically, this project will focus on overcurrent and earth fault in term of time and current discrimination. Voltage of 415V which is used in the system will involved this project. At this voltage, protection of fault widely used because fault always happen at this condition. Incomer and feeder is consisting in the circuit as a complete system.

The analysis is based on the data collected from the TNB. The analysis would involve theoretical and practical analysis. For the theoretical analysis, the calculation of relay setting will be calculated. The calculation consist of plug setting (PS) and time multiplier setting (TMS) that is use then to set the relay to trigger for tripping. While practical analysis consist of relay testing and system test. For the testing, first testing is focus on test of each relay then analysis the characteristic relay. Second testing is test the system and then analysis the characteristic.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

First step after project title selection is doing the literature review. The purpose of this research is to gain more knowledge about the project. The source of the project is from reference books and internet surfing.

2.2 Overcurrent Protection

Overcurrent relays and fuses are the most commonly applied form of distribution power system protection. Relays are activated from current transformer secondary with typical secondary ratings of 1A or 5A. These relays were originally electromechanical devices but modern versions are microprocessor based and incorporate many features and refinements to increase versatility and improve coordination between relays and fuses on the same feeder.

The generic term relay is used for a collection of elements that are associated with phase or ground fault protection supplied from current transformers to provide instantaneous or inverse-time phase and ground fault protection, with or without time delay characteristics. These elements are programmable to produce characteristics that can replicate fuse curves or multi-function curves composed of definite-time, inverse time and instantaneous components. Inverse-time elements are available with inverse, moderately inverse, very inverse, and extremely inverse characteristics specified by IEEE or IEC standards [1]. Settings suitable for phase or ground fault protection are available, sometimes along with breaker fail backup protection.

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A common feature for both phase and ground fault elements is selection between definite-time and inverse-time characteristics for different current operating levels commonly defined as high set and low set. High set elements provide fast operation to clear high fault current levels thus minimizing plant damage. In most cases, coordination with downstream protection is not an issue. Low set elements are required to properly coordinate with upstream and downstream protection and ensure adequate time margins between operating characteristics over the range of feeder fault current levels. A range of independently set timing elements provides a great deal of flexibility in dealing with the requirements to provide these margins.

Relay element settings are described generically in time and multiples of primary current or relay rated current. These in turn, can be translated into time multipliers and relay tap settings by reference to the manufacturer"s literature. In practice, most utilities employ a limited number of device types which are:

- Instantaneous
- Definite time
- Inverse time (Very Inverse and Extremely Inverse)
- Inverse Definite Minimum Time (IDMT)

2.2.1 Instantaneous

Instantaneous elements are simple devices that operate at a given level of current. In practice, the higher the fault current above the current setting the faster the operation. There is a minimum time of operation dictated by the rate at which the fault current rises. The operating current related to the element setting is not particularly accurate since the elements are intended for backup protection purposes or to achieve fast fault clearance where accuracy is not an issue.

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A particular form of instantaneous element is designed to increase the setting accuracy by filtering out the dc component of fault current and is used where improved accuracy is an issue in ensuring correct discrimination between protective devices.

2.2.2 Definite Time

Definite time overcurrent elements are simply instantaneous overcurrent elements assigned a given current setting and controlled by a timer set to operate at a designated time.

2.2.3 Inverse Time

Inverse time elements are designed to operate according to the inverse time curve. They have a definite minimum operating current, determined by the current setting, and a definite minimum time of operation, determined by the time setting. The curve is asymptotic to both the time and current axes. The shape of the curve is chosen according to whether an inverse-time, a very inverse-time, or an extremely inverse-time characteristic is desired.

Inverse time elements have a range of current settings that determine the currents, defined in amps, supplied by the current transformer at which the element is designed to just operate. For example, a 1 amp rated phase fault element usually has tap settings of 0.5, 0.75, 1.0, 1.25, 1.5, 1.75, 2.0 amps, being the nominal currents at which the relay operates [1]. In practice, a 1.0 amp setting requires typically 1.1 amps or more to operate the element in a finite time. The companion ground fault element is likely to have a setting range of 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 amps.

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2.2.4 Inverse Definite Minimum Time

IDMT or Inverse Definite Minimum Time is the characteristic if the core is made to saturate at a later stage obtained. The time-current characteristic is inverse over some range and then after saturation assumes the definite time form. In order to ensure selectivity, it is essential that the time of operation of the relays should be dependent on the severity of the fault in such a way that more severe the fault, the less is the time to operate, this being called the inverse-time characteristic. This will also ensure that a relay shall not operate under normal overload conditions of short duration.

It is essential also that there shall be a definite minimum time of operation, which can be adjusted to suit the requirements of the particular installation. At low values of operating current the shape of the curve is determined by the effect of the restraining force of the control spring, while at high values the effect of saturation predominates. Different time settings can be obtained by moving a knurled clamping screw along a calibrated scale graduated from 0.1 to 1.0 in steps of 0.05 [2]. This arrangement is called Time Multiplier Setting (TMS) and will vary the travel of the disc required to close the contacts. This will shift the time-current characteristics of the relay parallel to itself.

The plug setting (PS) of the relay changes the number of turns in the exciting coil. The winding of the coil is provided with seven taps which are brought to the front panel and the required tap is selected by a push-in plug. With the plug in the first position (0.5), the whole of the coil is utilized, and the relay is most sensitive. In the seventh position (2.0), only a quarter of the coil is utilized and hence four times more current is required to operate the relay. The seven plug positions are marked 0.5, 0.75, 1, 1.25, 1.5, 1.75 and 2.0 (or 50%, 75%, 100% etc). Should the plug be removed altogether, the relay automatically defaults to the 2.0 or 200% setting.

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2.3 Earth Fault Protection

An earth fault is the most frequent fault occurring on rotating machines. These result from machine insulation damage, which allows a fault current to flow from the windings to earth via stator laminations. The magnitude of this earth fault current depends on the network earthing arrangement. As in the case of phase-phase faults, a fast fault clearing time is required in order to reduce damage and repair cost [4].

Earth fault relay is a protection component that protects the system from ground fault. This relay is operating when the fault current is more than current setting [3]. On 1909, the earth faults relay starting to be use. This is causes of a high development and electricity is widely used. Therefore, to avoid fault happen and to protect the equipment, a protection device is needed.

To provide earth fault protection, the core balance CT solution whatever type of network earthing is used. This method is allows for the detection of small resistive values of earth fault current.

Furthermore, an earth fault unit supplied from the residual connection of three line CTs carries the risk of maloperation during starting. In order to obtain stability, the pick up must be set between 0.15 to 0.2 In of the CTs, which is often too high compared to the maximum earth fault current [4].

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2.4 Project Equipment

This project will be successful because of the important equipments that will use for the testing. Some of equipments are current injector, IDMT relay and current transformer.

2.4.1 Current Injector

The current injector that will use in this project is the Model RFD-200 S2 Test Unit. This test set is manufactured by Vanguard Instruments Company. The current injector is shown in Figure 2.1.

Figure 2.1: Model RFD-200 S2 Test Unit

This test set is a second generation, microprocessor-based, single-phase relay tester. This model was designed specifically to test electromechanical, electronic and microprocessor based current or voltage relays.

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An AC current source with 3 outputs (10A, 40A and 100A) provides test current to the relays but can also be used as a stand alone current source. One 0-250Vac voltage source and one 0-300Vdc voltage source are available for testing relays or can be used as stand alone voltage sources.

The RFD-200 S2 has built-in timer with independent start and stop trigger inputs designed to measure the time between event transitions. The elapsed time is delayed in milliseconds and cycles.

2.4.2 Current Transformer

Current transformer is a type of instrument transformer that is designed to provide a current in its secondary which is accurately proportional to the current flowing in its primary.

Current transformers are designed to produce either an alternating current or alternating voltage proportional to the current being measured. The current transformers used with the Wattnode Tranducers produced a 333mV alternating voltage when the rated current is measured (either 30A or 50A) [11].

The current transformers measure power flow and provide electrical inputs to power transformers and instruments. There are two basic types of current transformers which are wound and torodial. Wound CTs consist of an integral primary winding that is inserted in series with the conductor that caries the measured current. The example of current transformer is shown in Figure 2.2.

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