" I hereby declare that I have read through this report entitle "Modelling and Analysis an Overcurrent Protection in Power System Network Using PSCAD" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)'

Signature : …….

Supervisor's Name : Dr. Mohd Hendra Bin Hairi…….

Date : 23/06/2016……..

MODELLING AND ANALYSIS AN OVERCURRENT PROTECTION IN A POWER SYSTEM NETWROK USING PSCAD

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A report submitted in partial fulfillment of the requirements for the degree of Electrical Engineering (Industrial Power)

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2016

I declare that this report entitle *"Modelling and Analysis an Overcurrent Protection in Power System Network Using PSCAD"* 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 : ……

Name : Mohamd Hisham Bin Khairul Masri …

Date : 23/06/2016…….

To my beloved mother, father

and my family.

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ABSTRACT

Protection scheme is desperately needed in the power system network. Protection system plays an important role in detecting the presence disorders and may prevent damage caused interference. This can improve the reliability of the system to maintain continuity of supply to the load. Overcurrent protection is among the important and earliest protection scheme in power system. However the interruptions in power system can happen by fault current. Besides, the improper setting or wrong selection and positioned of the power protection devices is among the reason. Therefore, to maintain and improve the performance of the protection system, this thesis presents a model of overcurrent protection scheme in power system. This thesis describes research carried out to investigate the performance of overcurrent relay on relay operation time (ROT) based on several cases. The model of overcurrent protection system and analysis is developed by using PSCAD simulation software. There are several requirement or conditions are set in order to understand and analyze the reaction and performance of protection system model. The various type and location of faults and relays is proposed in this project to see the changes in power system protection performance. Besides, the implementation of different curve characteristic and various standard also performed. Other than that, installation of distributed generator are also determined because it will give a different impact and result to the power system protection when faults are occur in the system. The result will be studied in order to understand the performance of overcurrent relay in protection scheme.

ABSTRAK

Skim perlindungan merupakan perkara yang sangat diperlukan didalam sesebuah rangkaian sistem kuasa. Sistem perlindungan memainkan peranan yang penting dalam mengesan kehadiran gangguan sekaligus mencegah kerosakan yang boleh berlaku akibat daripada gangguan ini. Perkara ini juga dapat meningkatkan tahap keberkesanan sistem dalam memastikan kesinambungan bekalan elektrik kepada beban secara terus. Perlindungan arus lebih adalah antara skim perlindungan yang penting dan terawal dibangunkan didalam sistem kuasa. Walaubagaimanapun, gangguan dalam sistem kuasa boleh berlaku bila-bila masa seperti gangguan arus tinggi. Selain itu, penetapan, kedudukan dan pilihan yang salah terhadap peranti perlindungan juga antara penyebabnya. Oleh hal yang demikian, untuk meningkatkan prestasi sistem perlindungan, tesis ini telah pun dijalankan dengan membina sebuah model skim perlindungan arus lebih. Projek ini mengenai penyiasatan prestasi skim perlindungan arus lebih berdasarkan masa operasi relay terhadap beberapa keadaan yang berbeza. Model skim perlindungan arus lebih dan analisa terhadap model yang dibina dilakukan dengan menggunakan perisian PSCAD. Terdapat beberapa pemboleh ubah yang ditetapkan dalam memahami dan mengkaji tindak balas dan prestasi model yang dibina terhadap pemboleh ubah. Antara pemboleh ubah yang digunakan adalah jenis dan lokasi relay yang digunakan dalam skim perlindungan dan juga jenis-jenis gangguan yang dikenakan. Selain itu juga, jenis graf dan standard relay turut dikaji. Selain itu, penambahan DG kedalam litar juga turut dikaji teutama ketika berlakunya gangguan Keputusan kajian yang didapati daripada simulasi akan difahami dan dikaji berdasarkan prestasi geganti arus dalam skim perlidungan yang dibina.

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LIST OF ABBREVIATIONS

UTEM	Universiti Teknikal Malaysia Melaka
FKE	Fakulti Kejuruteraan Elektrik
TNB	Tenaga Nasional Berhad
IDMT	Inverse Definite Minimum Time
SLG	Single-Line-to-Ground
DLG	Double-Line-to-Ground
TPG	Three-Phase-to-Ground
IEEE	Institute of Electrical and Electronic Engineer
IEC	International Electrotechnical Commission
SI	Standard Inverse
VI	Very Inverse
EI	Extremely Inverse
TDS	Time Dial Setting
MV	Mega Volt
MVA	Mega Volt Ampere
PMU	Pencawang Masuk Utama
PPU	Pencawang Pembahagian Utama

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CHAPTER 1

INTRODUCTION

1.1 Background

Power system protection is one of the branch in electrical power engineering. The protection term give a significant meaning in the electrical power engineering, where it is a division in electrical power engineering that concerned with the detection and isolations of fault and other type of unusual situation in power system. These fault often occur at the worst possible time and cause the maximum amount of inconvenient to the customer utility [11]. Thus the protection system is needed in providing the quick isolation of fault and faulty area from the service. This is to allow the largest possible part of the power system to continue in service.

There are several types of protection system that have been applied in the power system distribution by the utility company. The common protection system in distribution power system including distance protection, overcurrent protection and differential protection. This project focused on overcurrent protection scheme which is widely used in power system distribution for many years. Overcurrent protection system is use to detect the current magnitude which exceeds the specified adjustable current magnitude. This type of protection system is used with the overcurrent relay as the measuring instrument which it is respond to the current magnitude of the input current [1].

This project has been carried out to compare and analyze the effect on performance of the overcurrent protection model towards relay operation time based on the IDMT, overcurrent relay characteristic's curve, different type of faults different type of curve standard and DG installation in power system. This is to make sure that, the protection system is isolate the fault and faulty area only while leaving the largest possible area of the

system in service. Besides, the impact of installation distributed generation (DG) into power system to the protection scheme also studied.

1.2 Problem Statement

Protection is one of the important element in the power system. A power system must not only capable of meeting the present load but also requires the flexibility to meet. The system must be kept in operation continuously without major breakdown [1]. A good protection scheme must achieve the basic features of protection system such as selectivity, stability, speed and sensitivity [4]. However, sometimes the relay that should be operated due to the fault does not work properly- delay in operation or does not function at all. It might be due to the problems from the setting of the relay or several condition. So, related to the problem, the study will be focused to performance of overcurrent relay based on relay operation time. Several cases were performed in order to investigate and study the relationship between relay operation times with the condition or event happened. The PSCAD is used as the platform to performed and demonstrate performance of the proposed overcurrent protection scheme under various scenarios [8].

1.3 Objectives

The objectives of this project are:

a) To model an overcurrent protection circuit in the power system network.
b) To analyze the relay operation time of overcurrent protection for the power system network based on type of relay characteristic curve, type of fault and their location.
c) To study the effect of installation distributed generation (DG) on relay operation time.

1.4 Scope of research

This project totally focused on the overcurrent protection in distribution system. The circuit design involved five or less bus-bars and the power rating for the distributed generation is up to 10MW or less. The scopes for this research are specifically detailed as follows:

a) To analyze the effect of IDMT characteristic curve on relay operation time based on IEC 60255 and IEEE C37.112 standard.
b) Fault applied are three-phase-to-ground, double-phase-to-ground and single-phase to the ground.
c) To compare relay operating time between circuit without DG and circuit with DG installation.
d) The circuit modeled for distribution system of 132/33kV and 33/11kV.
e) Analysis using PSCAD software.

1.5 Thesis Outline.

This thesis consists of five chapters which are introduction, literature review, methodology, result and conclusion. The first chapter had reviewed the objective and scope of this project with background of the study. Follow by chapter 2 which focused more on the theory and literature review of past research that relevant to the project, topic on overcurrent relay, IDMT relay curve characteristic and protection components have been focused in this chapter.

In chapter 3, the methodology of the project such as the circuit diagram design and implementation has been summarized in this chapter. The result and discussion are presented in Chapter 4 while recommendation and suggestion for future research are outlined in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Electric power is generated and transmitted to the consumer through the large grid connection. The generation of electric power started from the power plant or generator, then the voltage will be step up before transmitting the electric power to the consumer. This practice is applied in order to minimize the losses of electric power through the transmission. The power is then transmitted to the commercial or residential consumers.

The main objective of all power system is to maintain and reliable power supply to the end user. In the normal condition, the power system will be works accordingly to the design. The current is distributed and flow in the pre-design value which suitable to the electrical power elements ratings. However, in some undesired condition the fault can be occurred. This conditions occur due to the natural event or human error such as weather, lightning, wind damage, human vandalism, insulation deterioration, falling tree and etc. This circumstances will lead to the unwanted situation where connection between phase conductor of transmission line and phase conductor to the ground happened.

The needs of protection scheme in the power system is important to ensure that the investment is made on existing equipment will get the maximum returns back, which goes to makeup the power system and to make sure the customer satisfied with the reliable service which the operation of the system must be kept in service where the system must continuously in process without major breakdown.

2.2 Fault type and effects

Fault is a failure or unusual condition that experience by the power system where it comes from several condition including lightning and etc. Fault can be divided into two main areas, which are ‘Active’ and ‘Passive’ fault. [1]

The ‘Active’ fault happening when the actual current flow from one phase of conductor to the other phase of conductor which also known as phase-to-phase fault, or the flowing of current from one phase of conductor to the ground known as phase-to-ground. The active fault also can be divided into two other type of faults which are ‘solid’ fault and ‘incipient’ fault [1].

The ‘solid’ fault is happened as the result of immediate complete breakdown of insulation happen when the pick struck of cable or cable was dug up by bulldozer and etc [1]. These circumstances will lead to the very high of fault current where it can resulting to the explosion. Besides, the ‘incipient’ fault is a fault that start in a small way before it changes into catastrophic failure afterwards [1].

While for the ‘passive’ faults is actually not a real fault where it is a condition that are stressing the system beyond its design capacity. The typical example of passive fault such as over voltage, power swing, and under frequency. But this type of fault can ultimately change to active fault.

Furthermore, there are several type of faults that can occur in a three-phase A.C. system where the power distribution system is globally a three-phase. The following figure shows the condition of faults that can occur in the three phase system.

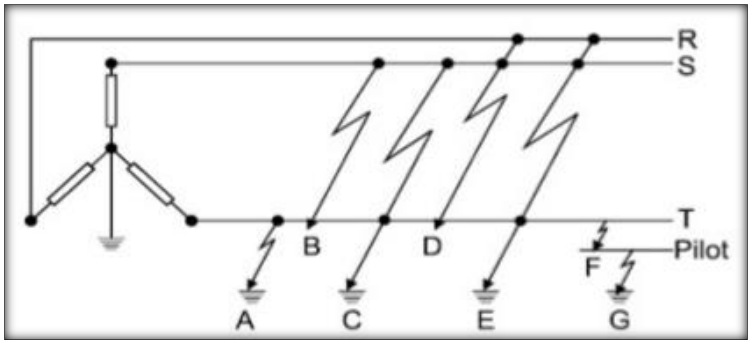

Figure 2.1: The condition of faults in three phase system.

(A) Phase-to-ground fault
(B) Phase-to-phase fault
(C) Phase-to-phase-to-ground fault
(D) Three-phase fault
(E) Three-phase-to-ground fault
(F) Phase-to-pilot fault
(G) Pilot-to-ground fault

2.3 Overcurrent

Based on the *National Electrical Code*, the overcurrent is a phenomenon when the current of conductor or equipment is larger or excess than the equipment rating or the ampacity of a conductor. This situation may result from short circuit, ground fault or overload. [2]

Heat is always produce from the flowing of current in a conductor. The higher the current, the more the heat produced. Heat produced from the conductor can damage the electrical components if it is too high, which cause by the excessive current flow. For that reason, conductors have a rated continuous current carrying capacity or ampacity [2]. To protect the conductor from the excessive flow of current, the overcurrent protection devices are used. The protective devices are used to protect the circuit conductors from overheating by allow certain level of current to flow through it where it is should not higher than the rated current [2].

2.4 Overcurrent Protection

Overcurrent protection is one of the most important and earliest protection principle that developed. The overcurrent protection is a scheme that protecting the devices or components in the power system from damage due to excessive of current flow. The protection system detects the fault based on the fact that the fault current is obviously larger

than the usual load current after the fault occurs. The overcurrent is divided into two subtypes which are instantaneous overcurrent and inverse-time overcurrent. The instantaneous overcurrent will operates instantaneously if the input current is larger than the setting value. For the inverse-time overcurrent it is operates in the way which the operating time is inversely with the input current [4].

2.5 Principles of Relay Operation

There are a lot of different type of relays used in protective scheme. However, they are follow the same logic pattern. Figure 2.3 shows the protective scheme logic chart. There are inputs, measurement, determination and output. The input will represent current, voltage, frequency or perhaps other value that exist in protective circuit at any instant in time. The relay measures this values and then determines the circuit operating condition whether within in a normal parameters. Under normal operating condition output is zero which it is set to open or close contact at rest. However, in any intolerable fault level, the relay will imposes operating signal value under control circuit usually in terms of DC volt. This tripping signals is then fed into one or more circuit breaker to cause them to open, so as to isolate the faulty part from the rest of unfaulty power system.

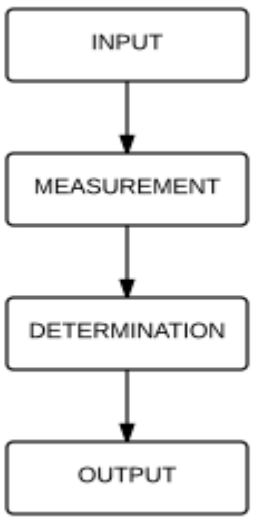

Figure 2.3: The protective scheme logic operation.

2.6 Overcurrent Relay

An overcurrent relay provides protection against over currents. This type of relay uses current input from the CT and compare with the preset current. Figure 2.4 shows the logical representation of this type of relay. If the input current is exceeds the value of preset current the relay detects an overcurrent and send the trip signal to the circuit breaker which open its contact to disconnect the protected equipment [12]. When relay detects a fault, the condition is called fault pickup. In case the relay is instantaneous overcurrent relay the relay will issuing the trip signal to the breaker instantaneously after picking up the fault or it can delay for a specific time before send a trip signal to the breaker in case of time-overcurrent relay. This time delay is also known as the operation of the relay, and is computed by the relay on the basis of the protection algorithm incorporated in the microprocessor [19].

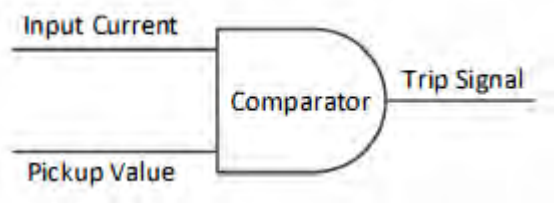

Figure 2.4: Logical representation of Over-Current Relay.

The overcurrent relay usually combine both instantaneous and time overcurrent units. Instantaneous response provided by moving armature units which functioning to operate on a very large currents. Time response is provided by the inverse induction disk unit and it is set to operate at a lower noise current.

Induction disc unit operates on the same principle as a motor. As in the figure 2.5, metal plate attached to the shaft can rotate freely. The coil current is specified. The eddy current is induced in the metal disc by magnetic field that generated by current. Then, the magnetic field of stationary coil interacts with the magnetic field of eddy current which generates a torque on the disc.

The torque produced rotates the shaft and metal disc which at the same time bring and position the moving contact to the fixed contact in the closed position. When the flow falls below the preset value, the contact disc will move and return to the open position by