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**MODELING AND ANALYSIS OF AN OVERCURRENT PROTECTION AND
COORDINATION IN POWER SYSTEM NETWORK USING PSCAD SOFTWARE**

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

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016

I declare that this report entitled “Modeling and Analysis of an Overcurrent Protection and Coordination in Power System Network using PSCAD Software” 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 the candidate of any other degree.

Signature :
Name :
Date :

DEDICATION

To my beloved father
MUSLIM BIN NGADI

To my lovely mother
RAFEAH BINTI JAJURI

Relatives and Siblings

Classmates and Friends

ACKNOWLEDGEMENT

In the name of Allah S.W.T, the most gracious and merciful, praise to Allah the lord of universe and may blessing and peace of Allah be upon his messenger Muhammad S.A.W. First of all I would like to thank Allah for granting me the courage and health for the completion of this project report.

I would like to thank my supervisor Dr. Mohd Hendra Bin Hairi who taught me how to become a researcher. His professional behavior and excellent guidance in this project makes all the difficulties an easy one.

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During these 22 years of being a student, I have had many teachers who worked hard to educate me. I am aware of the great influence they have had on my life. I say thanks to all my teachers.

Being far from my family for nearly 4 years, I can understand better how precious they are. I believed my parents did a magnificent job on educating their kids even though they had very little resources available. Thanks to my father and my mother for their parental advice.

ABSTRACT

The case study in this project to analysis of an overcurrent protection and coordination in power system which is represent by using software of Power System Computer Aided Design (PSCAD). Protection against overcurrent by using coordination system benefits to protect the power system against any fault in order to limit the amount of duration during any interruption between breakers. To maintain high integrity of power system, this system could be minimizing damage in the system and components. Actually, faults may occur due to several reasons and they cannot be avoided such as lightning or other mechanical and natural causes.

Since the commencement of modern electrical system, coordination assignments were performed to guarantee that protection system would work with the necessary reliability and security. The tools to perform such task have developed from the utilization of a glass table with light and log-log curve sheets into computer base projects with GUI. Meanwhile, protective devices have likewise experienced progressions from the electromechanical gadgets to the multifunctional, numerical devices. All through the changes in coordination tools and protective devices setups, a great number of protection coordination standards will stay. In expansion, new systems are created to help us with the utilization of protection systems to reduce fault in basic to protection system functions. The advancements in the coordination projects and present day multifunctional numerical devices utilized as a part of distribution and industrial systems.

ABSTRAK

Kajian dalam projek ini adalah untuk menganalisis sistem perlindungan lebih arus dan koordinasi dalam sistem kuasa dengan menggunakan perisian Reka Bentuk Berbantuan Sistem Kuasa Komputer (perisian PSCAD). Perlindungan terhadap arus lebih manfaat dengan menggunakan sistem koordinasi untuk melindungi sistem kuasa terhadap apa-apa gangguan dan menghadkan jumlah tempoh masa gangguan antara pemutus. Untuk mengekalkan integriti yang tinggi sistem kuasa, sistem ini boleh mengurangkan kerosakan dalam sistem dan komponen. Sebenarnya, kesilapan boleh berlaku kerana beberapa sebab dan tidak boleh dielakkan seperti kilat atau sebab-sebab mekanikal dan semula jadi lain.

Sejak bermulanya sistem elektrik moden, tugas penyelarasan telah dilakukan untuk menjamin bahawa sistem perlindungan akan bekerjasama dengan kebolehpercayaan dan keselamatan yang diperlukan. Alat untuk melaksanakan tugas itu telah dibangunkan daripada penggunaan meja kaca dengan cahaya dan log-log graf lengkung ke dalam projek-projek asas komputer dengan GUI. Sementara itu, peranti perlindungan telah juga mengalami janjang dari alat elektromekanik untuk pelbagai fungsi, peranti berangka. Semua melalui perubahan dalam alat penyelarasan dan peranti perlindungan, sejumlah besar standard penyelarasan perlindungan akan kekal. Dalam pengembangan, sistem baru yang dicipta untuk membantu kami dengan penggunaan sistem perlindungan untuk mengurangkan masalah dalam asas kepada fungsi sistem perlindungan. Kemajuan dalam projek-projek penyelarasan dan masa kini peranti berangka pelbagai fungsi digunakan sebagai sebahagian daripada pengedaran sistem dan sistem perindustrian.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	ACKNOWLEDGEMENT	i
	ABSTRACT	ii
	ABSTRAK	iii
	TABLE OF CONTENTS	iv
	LIST OF FIGURE	viii
	LIST OF TABLE	xi
	LIST OF GRAPH	xii
1	INTRODUCTION	1
	1.1 Introduction	1
	1.2 Project Background	2
	1.3 Problem Statement	3
	1.4 Project Objectives	3
	1.5 Scope	4
	1.6 Expected Project Outcome	4
	1.7 Significant of Project	5

1.8	Report outline	5
2	LITERATURE REVIEW	6
2.1	Literature Review Overview	6
2.2	What Is Power System Protection	6
2.3	What Is Protection And Coordination	7
2.4	PSCAD Software	11
2.4.1	What Is PSCAD Software	11
2.4.2	Application of PSCAD Software	11
2.4.3	PSCAD Master Library	12
2.5	Faults Analysis Studies	13
2.6	Relay	15
2.6.1	Characteristics of Relay	16
2.6.2	Relay Speed	18
3	METHODOLOGY	23
3.1	Literature review	23
3.2	Collecting data	23
3.3	Design the simulation	24
3.3.1	Construct single line diagram	24
3.3.2	Transformer	26
3.3.3	RMS meter	27
3.3.4	Relay setting	28
3.3.5	Fault finding	31

3.4	Troubleshoot the simulation	33
3.5	Relay setting problem	33
3.6	Methodology flowchart	37
4	RESULT AND DISCUSSION	39
4.1	Introduction	39
4.2	Result and discussion	39
4.3	1 st CASES	40
4.3.1	Time margin for protection coordination	40
4.3.2	Overcome supply interruption	44
4.3.3	Relay signal in different type of fault	45
4.4	2 nd CASES	46
4.4.1	Time margin for protection coordination	46
4.4.2	Overcome supply interruption	50
4.4.3	Relay signal in different type of fault	51
4.5	3 rd CASES	52
4.5.1	Time margin for protection coordination	52
4.5.2	Overcome supply interruption	56
4.5.3	Relay signal in different type of fault	57
4.6	4 th CASES	58
4.6.1	Time margin for protection coordination	58
4.6.2	Overcome supply interruption	62
4.6.3	Relay signal in different type of fault	63

4.7	5 th CASES	64
4.7.1	Time margin for protection coordination	64
4.7.2	Overcome supply interruption	68
4.7.3	Relay signal in different type of fault	69
4.8	6 th CASES	70
4.8.1	Time margin for protection coordination	70
4.8.2	Overcome supply interruption	74
4.8.3	Relay signal in different type of fault	75
5	CONCLUSION AND RECOMMENDATION	76
5.1	Introduction	76
5.2	Conclusion	76
5.3	Future Recommendations	78
	REFERENCE	79
	APPENDICES	81
	Appendices A: Inverse Definite Minimum Time (IDMT)	82
	Appendices B: Letter Of Confirmation From Tenaga Nasional Berhad	82

LIST OF FIGURE

FIGURE	TITLE	PAGE
1.2.1	Coordination for Radial System	2
2.3.1	Time Versus Current Fuse to Fuse Coordination	8
2.3.2	Time Versus Current Auto-Recloser to Fuse Coordination	9
2.3.3	Time Versus Current Circuit Breaker to Fuse Coordination	9
2.3.4	Time Versus Current Circuit Breaker to Fuse Coordination	10
2.3.5	Time Versus Current Circuit Breaker to Auto Recloser Coordination	10
2.4.1	Power System Computer Aided Design	11
2.4.2	Master Library in PSCAD	13
2.5.1	Example of Short Circuit	14
2.5.2	Unbalanced Fault	15
2.6.1	Three-Layer Structure of Power System	15
2.6.2	Reliability of Protection System	16
2.6.3	Closed and Open Zones Protection	17

2.7.1	Time-Current Characteristics Of Definite Time (DT) And Inverse Definite Minimum Time (IDMT) Relay	19
2.7.2	Effect of Changing Plug Setting (PS)	21
2.7.3	Effects of Changing Time Multiplier Setting (TMS)	22
3.3.1	Single Line Diagram of Distribution System	25
3.3.2	Three Phase Two Winding Transformer	26
3.3.3	Transformer 1, T1	26
3.3.4	Multi-meter	27
3.3.5	Inverse Time of Overcurrent Relay for 3L5 and AR4003A	28
3.3.6	Inverse Time of Overcurrent Relay for 4L5 and AR4001A	29
3.3.7	Inverse Time of Overcurrent Relay for AR4001A and ARJ100	29
3.3.8	Inverse Time of Overcurrent Relay for ARJ100 and ARJ1001	30
3.3.9	Inverse Time of Overcurrent Relay for ARJ101 and ARJ104	30
3.3.10	Inverse Time of Overcurrent Relay for AR J101 and AR 331	31
3.3.11	Three Phase Fault	31
3.3.12	Line-to-Ground	31
3.3.13	Double Line-to-Ground	31
3.3.14	Timed Fault Logic	32
3.3.15	Type of Fault	32
3.4.1	Relay setting for 3L5 and AR4003B	33

3.4.2	Relay setting for 4L5 and AR4001A	34
3.4.3	Relay setting for AR J100 and AR4001A	34
3.4.4	Relay setting for AR J101 AND AR J100	35
3.4.5	Relay setting for AR J104 and AR J101	35
3.4.6	Relay setting for AR 331 AND AR J101	36
3.5.1	Methodology Flowchart	38
4.3.1	Operation of Relay at AR4003B and 3L5	40
4.3.2	Case 1 Backup Supply Interruption	44
4.4.1	Operation of Relay at AR4001A and 4L5	46
4.4.2	Case 2 Backup Supply Interruptions	50
4.5.1	Operation of Relay at ARJ100 and AR4001A	52
4.5.2	Case 3 Backup Supply Interruptions	56
4.6.1	Operation of Relay at ARJ101and ARJ100	58
4.6.2	Case 4 Backup Supply Interruptions	62
4.7.1	Operation of Relay at ARJ104 and ARJ101	64
4.7.2	Case 5 Backup Supply Interruptions	68
4.8.1	Operation of Relay at AR331 and ARJ101	70
4.8.2	Case 6 Backup Supply Interruptions	74

LIST OF TABLE

TABLE	TITLE	PAGE
2.7.1	Relay Characteristics to IEC 60255	20
4.3.1	Time Operation of Relay at AR4003B and 3L5	45
4.4.1	Time Operation of Relay at AR4001A and 4L5	51
4.5.1	Time Operation of Relay at ARJ100 and AR4001A	57
4.6.1	Time Operation of Relay at ARJ101 and ARJ100	63
4.7.1	Time Operation of Relay ARJ104 and ARJ101	69
4.8.1	Time Operation of Relay at AR331 and ARJ101	75

LIST OF FIGURE

GRAPH	TITLE	PAGE
4.3.1	Fault current AR4003B and 3L5	41
4.3.2	Relay Operation Time Tripping for AR4003B	41
4.3.3	Relay Operation Time Tripping for 3L5	42
4.4.1	Fault current for AR4001A and 4L5	47
4.4.2	Relay Operation Time Tripping for AR4001A	47
4.4.3	Relay Operation Time Tripping for 4L5	48
4.5.1	Fault current for ARJ100 and AR4001A	53
4.5.2	Relay Operation Time Tripping for ARJ100	53
4.5.3	Relay Operation Time Tripping for AR4001A	54
4.6.1	Fault current for ARJ101 and ARJ100	59
4.6.2	Relay Operation Time Tripping for ARJ101	59
4.6.3	Relay Operation Time Tripping for ARJ100	60
4.7.1	Fault current for ARJ104 and ARJ101	65
4.7.2	Relay Operation Time Tripping for ARJ104	65
4.7.3	Relay Operation Time Tripping for ARJ101	66

4.8.1	Fault current for AR331 and ARJ101	71
4.8.2	Relay Operation Time Tripping for AR331	71
4.8.3	Relay Operation Time Tripping for ARJ101	72

CHAPTER 1

INTRODUCTION

1.1 Introduction

Major electrical power systems are generation, transmission, and distribution. From the generation of electricity, power supply will distribute through the transmission line. The transmission line will reach the distribution system to separate the power supply. In distribution system, there are including primary and secondary distribution system. This system runs the power supply from the substations going to the customer.

Power systems are concerned about the generation, transmission, distribution and utilization. Actually, power system utility is probably the largest and most fully used in the world in each country. Interruption or fault could be happen in anytime and anyplace in the power system. Fault can happen either in external interruption or internal interruption caused by lightning or switch surges, to insulation disturbance, or other mechanical and natural causes. System protection and coordination was design to conserve minimum damage when interruption occurs. The limitation of time during interruption controlled to make sure the interruption not damaging the equipment of electrical devices. Information of protection and coordination to protect any generation or, transmission line or, distribution power system to get course of system operation.

Protective relay is one of the components that very important in protection and coordination. These components give an advantage to reduce harmful damage to both electrical equipment and public when there have any interruption fault occur. The characteristics of relay design to get action as fast as possible when the fault current happens.

1.2 Project Background

The simple design of power system network should describe the real situation of power system flow. The value of power, voltage and current is given to fulfill the relation. The design also include fault to operate the function of circuit breaker. Three phase fault was applied because it was the worst fault and high current. The function of protection and coordination is to limit the duration during interruption or fault. This is because when fault happen, the transient of fault will cause damage of electrical equipment. To overcome this problem, time dial of relay must be small and probably fast action to trip.

In electrical power system, fault happen when there have an abnormal current condition. For example, short circuits happen when the accidentals low resistance connection or current bypass through the normal load. There some interruption or failures that can cause the open-circuit fault happen. In three phase systems, fault can happen during phase or ground fault. There is only happen either phase fault or ground fault or both phase and ground fault. In power system, protective device was design to stop the faults when occur and protect the device from damage(Chen et al., 2012).



Figure 1.2.1 Coordination for Radial System

1.3 Problem Statement

Power system is the flow of power to supply electricity to customer. To give full of power supply to customer, there might be not have any disturbance or interruption in power transportation. Protection system is one of the most necessary ways to protect the transportation of power supply. During the transportation of power supply, there has much electrical equipment that influence in the system. The electrical components that influence in the system are transformer, buss bar, transmission line and etc. When an interruption occurs, the overcurrent will interrupt the electrical component. Each of the components has the limitation to support the overcurrent fault. Time is the most factors that can attach damage to the electrical element. The exposing of equipment to the interruption longer than usual time will take the equipment to damage.

In Overcurrent Protection and Coordination, there have many circuit breaker that will take action in one circuit which is „protective“ circuit breaker and „protecting“ circuit breaker. Protecting circuit breaker will take action first when fault happen. If protecting circuit breaker fail to isolate the fault, so it will affected the second circuit breaker. Now the damage taken during fault increasing to two damage circuit breaker. During this interruption, the disadvantage will effect to the customer. Customer will don't have any power supply until the maintenance complete by worker. Therefore, the maintenance cost will increase compare the damage of one circuit breaker than two circuit breaker that get damage.

1.4 Project Objectives

The objectives of this project are stated below:

1. Modeling a simulation of overcurrent protection and coordination power system network.
2. Reduce exposure and isolate problem.
3. Put the limitation of duration during an interruption.
4. Minimizing the damage during interruption.

1.5 Scope

In this project, there are some limitations are made:

- Using Power System Computer Aided Protection (PSCAD) to design the power network.
- Only use current transformer and Inverse Time Over Current (itoc51) as relay.
- Overcurrent protection and coordination in distribution system.
- Faults apply in three phase, double phase and single phase. Three phase fault is used as the worst fault.
- The distribution system will discover in 132kV-33kV distribution system in Behrang.

There are some limitations during this project. First is to find the true information about generation, transmission line, distribution and circuit breaker. To get the trusted information, journal and IEEE standard is taken from the library and revision book. Next, this project will do only in a design by using PSCAD. There is no outside observation has been done. To analyze the correction of data inserted, calculation has been done to confirm the data input.

1.6 Expected Project Outcome

The expectation to this project is the duration time between two operating relay might be $\pm 0.4s$. The overcurrent fault was applied to certain zone to see the action of relay during the interruption. There have two characteristics in overcurrent protection and coordination which is main protection circuit breaker and backup protection circuit breaker. The situation when the faults occur, the main circuit breaker will isolate the fault first and if it is not, so the backup circuit breaker will take action and isolate fault. The duration to second circuit breaker will take action is ± 0.4 sec which is normally use in TNB Sdn. Bhd. Protection system.

1.7 Significant of project

The research of signal in relay operation of overcurrent protection and coordination, there has a time margin between two signals of operation relay. The relay will operate when fault occur. To improving the protection coordination, the main system of tripping needs a backup system to flow the power supply through the customer.

1.8 Report outline

The main focus of this report was to discuss about the overcurrent protection and coordination system in distribution system. Modeling the simulation of protection coordination by using Power System Computer Aided Design (PSCAD) was used as a simulator in this report. This report will divide into five parts which are introduction, literature review, research methodology, results and conclusion.

The first part is introduction which discuss about overall of the research. The part of this chapter such as project background, problem statement, objectives, scope of the project, expected project outcome, significant of the project and report outline will be discussed in this project. In chapter 2, this section was fully discussed about the literature review. The basic components that have been used in this project was discussed and explained. The main theory of the project was taken as a reference to do this project. All the rated got from the journal was used to make the simulation. The main sources of this section actually come from the journals, reference books, articles and internet sources. Next section is methodology of the running project. In this section was discussed the way to complete this project. The procedure to complete the simulation until getting the result was discussed. The result and discussion was clearly discussed in chapter 4. The result outcome from the simulation was clearly explained and discussed. Chapter 5 is the final chapter for this report where the chapter will discuss on the conclusion of the project. Conclusion is the project final statement whether all the process and result is achieved the objectives stated or not.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature review overview

This part discuss about the reviews and information data about protection and coordination. The information data must be understood to complete the project. Every data and standard was collect from revision book, journals and world web.

2.2 What is Power System Protection?

Protection can be define as “the science, skill, and art of applying and settings relays or fuses to provide maximum sensitivity to faults and undesirable conditions, but to avoid their operation on all permissible or tolerable condition”-*Blackburn*(Durand, 2010). [1]

Power systems are subjected to various types of fault. Generally fault currents are high since fault impedances are normally low. Breaking of conductors creates numerous faults, while failure of insulation creates a shunt type of fault. In power system, faults may occur due to several reasons and they cannot be avoided. This will result in an increase of current and reduction of voltage. Hence, system stability and reliability are also affected. Therefore, to protect the various parts of power system and the system as a whole, power system protection is necessary.

Power system protection is used to protect power system against any fault in order to:

- i. Prevent danger and accident to public.
- ii. Minimize damage to equipment.
- iii. Minimize supply disruption.
- iv. Maintain high integrity of power system quality.

Power system protection works through detection of fault and subsequent isolation of the fault using relay combination with circuit breaker or fuse. With correct setting of relay and selection of fuse rating, proper fault isolation can be achieved.

Main function of protection system in electrical power system is to ensure the continuity of the electrical power supply. To fulfill this condition, protection device must be able to detect the abnormal current condition in electrical equipment or circuit. It does also can detect the location where the faults occur. To execute the isolate zone, protective device must have true decision to take action. Protection also can protect the other equipment from taking damage and can flow current depend on rating(Homburg, Power, Engineer, & Services, 2011). [2]

2.3 What is Protection and Coordination?

Protection and coordination is a protective device that can manage the best timing of tripping when interruption occurs. The main advantage is to minimize the total damage of electrical component(IEEE, 1997)[4]. Besides, it can increase the lifespan of the electrical component.

Actually, protection coordination is a design of protective devices that can divide the power system into a protective zone. When a fault is happen in certain zone, the protective actions will take actions to isolate the zone from the entire system. Overlapped regions are created by two sets of instrument transformer and relays for each circuit breaker. This system designed to eliminate unprotected areas of redundancy(Fecime, 2008). [3]