

FAULT LOCATION ON OVERHEAD TRANSMISSION LINE USING PHASOR
MEASUREMENT UNIT

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Dedication to my beloved mother, Fatimah Pandak Leman and my father Idris Mohd Bakir, my wife Fairuz Fadhilah and my sons, who support me physically, mentally and emotionally, throughout the course of my Master's.

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ABSTRACT

“Fault location on overhead transmission line using phasor measurement unit” is a study for obtaining the accurate location of fault occurred in power transmission. The fault location studies have attracted interest among researchers since 2000 due to the increase in awareness of the importance of providing a reliable and effective utilities services. This study chooses impedance-based, travelling wave and phasor as fault location methods since they are well developed and recognized for providing accurate and reliable results. The power system network is modeled using ATP-EMTP and Power World software, and the outputs are manipulated into calculation based on algorithm. According to the results, the most accurate method is travelling wave, followed by phasor and impedance-based method. This study also discusses factors that affect the results to each of the methods. The advantages of these methods to the power industry include providing improvement in the aspects of reducing down-time, minimising damage, saving utilities cost, etc.

ABSTRAK

"Menganalisis lokasi kerosakan pada penghantaran kuasa talian atas menggunakan unit pengukuran pemfasa" adalah satu kajian untuk mendapatkan lokasi yang tepat kerosakan yang berlaku dalam talian penghantaran kuasa. Kajian lokasi kerosakan telah menarik minat di kalangan para penyelidik yang bermula sejak tahun 2000 kerana kesedaran telah meningkat tentang kepentingan kebolehpercayaan dan keberkesanan perkhidmatan utiliti. Kajian ini memilih berasaskan impedans, gelombang perjalanan dan pemfasa sebagai kaedah lokasi kerosakan kerana ia dimajukan dengan baik dan diiktiraf sebagai kaedah yang tepat dan boleh dipercayai. Rangkaian sistem kuasa dimodelkan menggunakan ATP-EMTP dan Kuasa Dunia perisian dan output dimanipulasi ke dalam pengiraan berdasarkan algoritma. Berdasarkan kepada keputusan, kaedah yang paling tepat adalah perjalanan gelombang, diikuti oleh pemfasa dan kaedah berasaskan impedans. Kajian ini juga membincangkan faktor-faktor yang mempengaruhi keputusan kepada setiap kaedah. Implikasi ke arah industri tenaga adalah ia boleh memberi peningkatan dalam aspek mengurangkan masa kerosakan, mengurangkan kerosakan, menjimatkan kos utiliti dan sebagainya.

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LIST OF ABBREVIATIONS

ATP	–	Alternative Transient Program
EMTP	–	Electromagnetic Transient Program
DFT	–	Discrete Fourier Transformation
HVDC	–	High Voltage Direct Current

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CHAPTER 1

INTRODUCTION

1.1 Preamble

Faults are the disturbance in power system that cause equipment malfunction for certain period of time. There is a need to improve power system protection fault detection way to achieve the standard requirement set up by regulatory body. It is necessary and crucial for requiring fast data gathering in fault analysis through computing technique. In the power protection system's point of view it is consider to be a failure to protect for the overall system when the clearance time is beyond the standard requirement [1]. There are many types of faults, such as single line to ground, double line, double line to ground and three phase faults. Based on Tenaga Nasional Berhad tripping statistic in 2006, the most frequent fault on transmission line, which takes 93.56% of line tripping, was a single phase to ground fault [2]. The common causes for tripping are lighting strikes, tree encroachment, cable failure due to aging, etc.

1.2 Problem Background

The fault affects the performance of the overall system and if it is not managed properly, it could be costly for the company in terms of the ability to provide better services. The fault will not only affect the transmission line, but also the equipment, load and generator in unbalanced situation. The task to immediately clear the faults in transmission network is one of the most important tasks for the power operation engineer and planner. On top of conventional practice, impedance-based methods are used extensively. These are several relevant reasons for carrying out studies on fault location using phasor measurement method.

The study is expected to find ways of reducing time in identifying fault location during fault occurrence in the network. The focus of the study is comparing the result between these methods.

1.3 Problem Statement

The conventional method for detecting fault location is by searching along the overhead line using the fault location equipment, which can be time consuming. The established impedance method becomes a reference to the result. However, this method has been amended several times due to the interest of research community in the past and present. The reactance algorithm is one of the earliest impedance-based algorithms for fault locations. The interest parameter required for homogeneous line is the impedance between the sending and receiving terminals.

The proposed impedance method uses single voltage and current from one end and the relation with residual current. Less equipment means simplicity and good range of estimation in impedance method are the advantage. It is also believed that accuracy on the estimation can be achieved by using travelling wave method and phasor method, instead of conventional impedance method. The proposed algorithm uses voltage and current from both ends in order to estimate the ratio of distance at fault, compared with total length of line. Availability of measurement of voltage and current at both ends allows the calculation algorithm to be manipulated in such a way that the three-phase system can become a one-phase system. This report will make the comparison on the performance of each introduced method. The results of fault location finding in each method depict the overall performance.

1.4 Objective

A number of objectives have been identified in this study:

- a) To study on fault location methods on high voltage transmission line;
- b) To develop relevance power network modelling and simulation by using the ATP-EMTP software;
- c) To compare the performance of these methods.

1.5 Project Scope

This study will reflect the estimation of fault location based on phasor measurement technique for overhead transmission line. The scope of this study is as shown:

- a) The fault location techniques are applied to the offline disturbance between different methods;
- b) The synchronous output is used with one- and two-end terminals power network model;
- c) The overall performance is studied in the area of accuracy, availability and practicality each method via a common type of fault to the high voltage network.

The network model, as depicted in Figure 1.1, shows a study of a fault place that occurs in transmission line between two generators. The same network model will be considered to compare and utilise the related software tool in fault calculation. These generators can be replaced with similar model since not all transmission lines are connected to the generator. This is especially related to transmission lines located in remote areas.

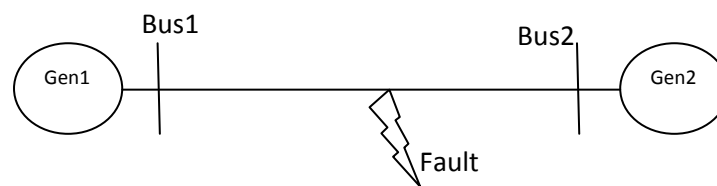


Figure 1.1: Network model for fault occurrence in a transmission line

1.6 Significance of Project

There is an increase of awareness in the importance of reliability, safety and economic factors of maintaining power system network, which have raised the concerns of the ability to detect fault locations within a short period of time. The methods tested in this study will determine the best outcome in estimation fault location in transmission lines. The accuracy of fault location calculation is compared with using three different methods while duplicating the best network similar to that with the real system.

1.7 Organisation of Report

The report consists of five chapters. Chapter 1 presents the introduction of the study, problem statement, objectives and project scope. Chapter 2 gives literature reviews on the methods. The algorithm derivation for devising methods and obtaining comparison fault location results is discussed in Chapter 3 and Chapter 4, which also include discussions on the methodology of the implementation process. The conclusion and suggestions for future works are explained in Chapter 5.

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