Ain Shams University

Faculty Of Engineering

METHODS OF LOCATING SHORT-CIRCUIT POSITIONS IN ELECTRICAL POWER NETWORKS

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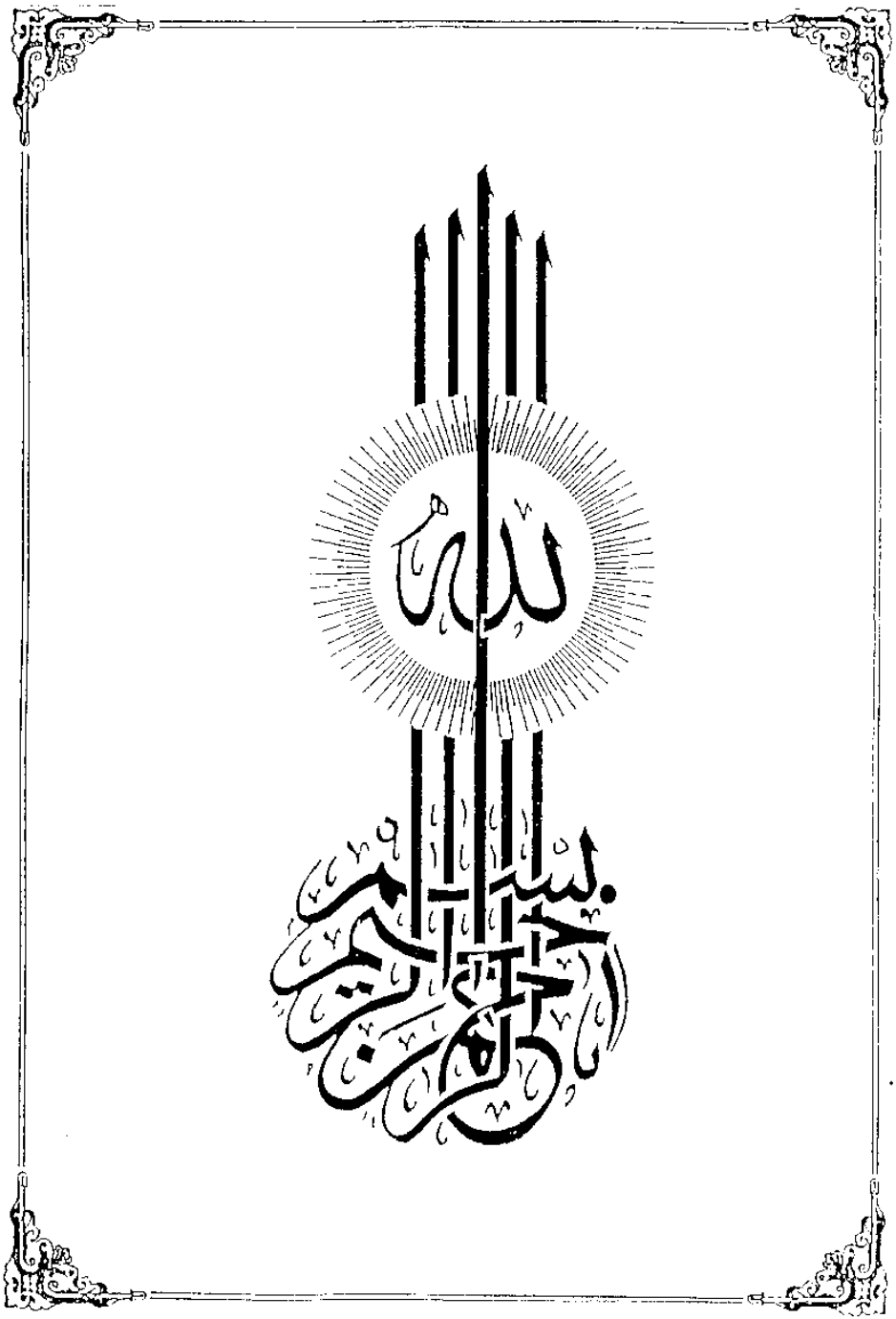

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master in Electrical Engineering.

The work included in this thesis was carried out by the author in the Department of Electrical Power and Machines, Ain Shams University, from 12 /11 /198 - 1 / 7 /1989 .

No part of this thesis has been submitted for a degree of a qualification at any other University or Institution.

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ABSTRACT

A fault location is used for pinpoint transmission line faults. It allows the reduction of maintenance works and quick system recovery from faults. This work introduces a comparative study for evaluation the performance of two different fault locator sechemes: Lumpd impedance- based fault locator and travelling wave- based fault locator. This Thesis presented survey for many different techniques to estimate the distance to the fault . Also the main characteristics for an efficient fault locator are specified. The main features of Electromagntic Transient Program are described . The theory and capabilities of such a program are presented. The first algorithm which is based on lumped impedance is presented with results obtained and suggested to improve the accuracy. The description of the algorithm which is based on travelling wave technique covered in details Elaboration of the program to suit each type of fault has been introduced to improve the accuracy of the fault locator . The main characteristics of the two algorithms are concluded . The proposed subjects for further study are also given .

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INTRODUCTION

A fault locator is used for pinpointing transmission line faults. It allows the reduction of maintenance works and quick system recovery from faults. During the last few years , a lot of researches has been undertaken in the development of fault location algorithms using measurements of electrical quantities at one or both ends of the line.

This work introduces a comparative study for evaluating the performance of two different fault locator schemes : lumped impedance-based fault locator and travelling wave-based fault locator.

The thesis comprises five chapters followed by three appendices.

In chapter (1) survey for many different techniques , that have been proposed to estimate the distance to the fault , is presented. Also , the main characteristics for an efficient fault locator are specified.

In chapter (2) the main features of the Electromagnetic Transient Program (EMTP), which is used to simulate the transient behavior of any power system , are described . The theory and capabilities of such a program are presented. The specifications of the power system under study is also given in this chapter.

In chapter (3) the details of the first algorithm which is based on lumped impedance is presented with results obtained and suggestions to improve the accuracy.

Chapter (4) covers in details the description of the

applied to single phase and three-phase systems [illegible] the program to suit each type of shunt fault has been introduced to improve the accuracy of the fault locator .

In chapter (5) the main characteristics of the two algorithms are concluded . The proposed subjects for further study are also given .

CHAPTER 1

A REVIEW OF FAULT LOCATION ALGORITHMS

1.1 INTRODUCTION

Transmission lines form a major of a power system . It is also one of the most difficult parts of the power system to maintain and inspect , simply because of its dimension and the environment it is built in . As a results, lines experience more faults than other system components , and so a line protection scheme is essential to any electric power network . The types of line fault are mainly classified as short-circuit and open-circuit . Short-circuit is mainly due to insulation failure , human error , lightning , wind damage and many others . Open circuit may occur for a variety of reasons , including broken conductors and mal-operation of circuit-breakers . The fast and accurate fault location of short-circuited transmission lines is always a prime concern of every power utility from economical and safety considerations . A good protection scheme will enhance the availability of a power system .

Distance relays for transmission line protection provide some indication of the general area where a fault occurred , but they are not designed to pin point the location .

1.2 Purpose For Fault Locators [1],[2]

Fault locators can play an important role where tool patrols are used , particularly on long lines or in rough terrain . Locators can also help where maintenance jurisdiction is divided between different companies or divisions within a company . Also some problems may have disappeared by the time and can not be found with a routine patrol . For example , tree growth could reduce the clearances , resulting breakdown air during sever conductor sagging . By the time the patrol arrives , the conductors have cooled and increased the clearance to the tree . Many other examples , where the appearance of the problem area is difficult , like cranes swinging into the line , damaged insulators and vandalism . Thus , the problem area is not obvious or found .

With knowledge of the fault location , faster repair and restoration of the transmission line can be facilitated . A fault locator is also a useful tool in evaluating transient faults which otherwise could cause weak spots in the transmission system resulting in future problems or faults .

1.3 Fault Locating Techniques

During the last few years , a lot of researches has been undertaken in development of fault location algorithms using measurements of electrical quantities at one or both ends of the line . The fault location algorithms may broadly classified in two categories :

i) Lumped parameter model - based fault locator .

ii) Distributed parameter model - based fault locator .

This section reviews some of the previously published 'fault' distance measurement methods .

1.3.1 Lumped parameter model-based fault locator

A) General description

The approach , often used in transmission line protection is based on representing the lines by lumped impedance .The objective is to find the complex impedance of the system in the direction of the fault as seen from the measurement site , either one-end or two ends . Using the calculated value of this complex impedance the fault distance may be deduced . The complex impedance concept refers only to the power frequency voltages and currents which are extracted by using filters , Fourier analysis or other means , to remove high frequency components and occasionally dc offset from the recorded fault voltage and current wave.

B) Classical fault locator at one - end

i) T.Takgi , R.Kondow [3],[4] developed the algorithm that measures the distance to the fault point by using the one-terminal voltage and current data . This method is based on the following equations that express a fault point voltage (V_f) and current (I_f) :

$$V_f = V_S \hat{} \cosh \gamma x - Z_S \hat{} I_S \sinh \gamma x$$

$$I''_{Sf} = (V''_S / Z_S) \hat{} \sinh \gamma x - I''_S \cosh \gamma x$$

Then , the distance x is obtained as :

$$x = \frac{Imj\ (V_S \hat{}\ I''^{*}_S)}{Imj\ (Z \hat{}\ I_S \hat{}\ I''^{*}_S)}$$

Where :-

x : distance to the fault point .

V_S : voltage of s-terminal .

I_S : current of s-terminal .

I_f , V_f : current and voltage of fault point .

I''_S , V''_S : current ,voltage difference between pre-fault and after fault current and voltage respectively .

I''_{Sf} : fault current difference between pre-fault and during fault current from s-terminal .

I''_{RF} : fault current difference between pre-fault and during fault current from R terminal .

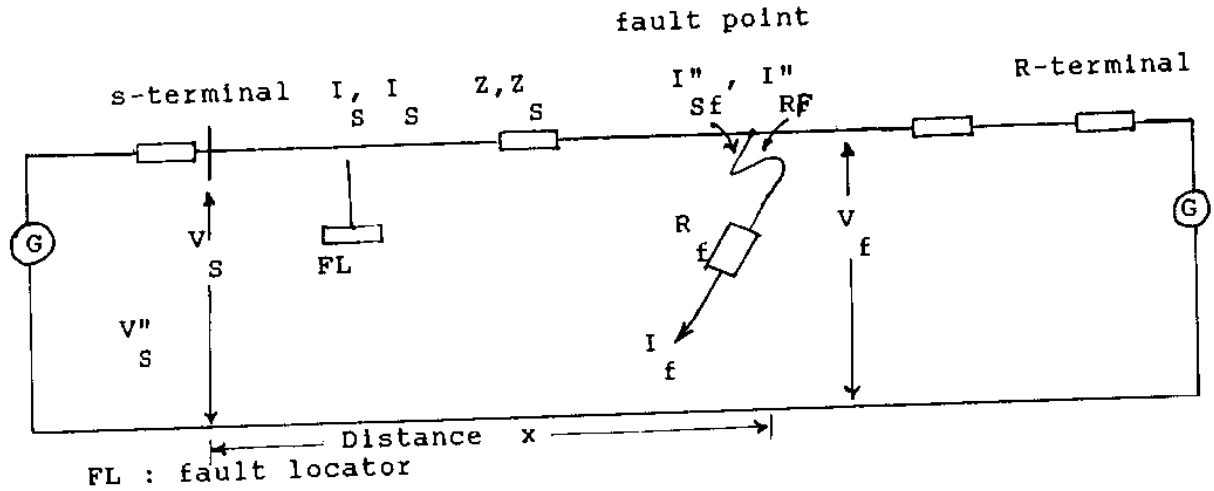
Z_S : surge impedance .

Z : transmission line impedance per unit length .

γ : propagation constant .

Imj : Imaginary component .

* : conjugate component .



FL : fault locator

Fig. 1.1 Fault in a single phase circuit