Ain Shams University
Faculty of Engineering
Electric Power & Machines Department

Fault Location Estimation in Smart Grid

A thesis submitted for partial fulfillment of the requirements for the M.Sc. degree in Electrical Engineering

Submitted by:
Eng. Ahmed Sanad Ahmed Mohamed

Supervised by:
Prof. Dr. Almoataz Youssef Abdelaziz
Faculty of Engineering
Ain Shams University

Dr. Nabil Mohamed Hamed
Faculty of Engineering
Ain Shams University

Dr. Mahmoud Abdallah Attia
Faculty of Engineering
Ain Shams University

Cairo, 2018

EXAMINERS COMMITTEE

Name: Ahmed Sanad Ahmed Mohamed

Thesis title: Fault Location Estimation in Smart Grids

Degree: Submitted in partial fulfillment of the requirements for the M.Sc. degree in Electrical Engineering

Name, Title and Affiliation	Signature

Prof. Dr. Fathy Mabrouk Abo Elenien
Electrical Engineering Department
Faculty of Engineering
Alexandria University

Prof. Dr. Salem Mahmoud Elkhodary
Electrical Power and Machines Department
Faculty of Engineering
Ain Shams University

Prof. Dr. Almoataz Youssef Abdelaziz
Electrical Power and Machines Department
Faculty of Engineering
Ain Shams University

SUPERVISORS COMMITTEE

Name: Ahmed Sanad Ahmed Mohamed

Thesis title: Fault Location Estimation in Smart Grids

Degree: Submitted in partial fulfillment of the requirements for the M.Sc. degree in Electrical Engineering

Name, Title and Affiliation	**Signature**
Prof. Dr. Almoataz Youssef Abdelaziz Electrical Power and Machines Department Faculty of Engineering, Ain Shams University	
Dr. Nabil Mohamed Hamed Electrical Power and Machines Department Faculty of Engineering, Ain Shams University	
Dr. Mahmoud Abdallah Attia Electrical Power and Machines Department Faculty of Engineering, Ain Shams University	

STATEMENT

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements of Master of Science degree in Electrical Engineering.

The included work in this thesis has been carried out by the author at the department of electrical power and machines, Ain Shams University. No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Name: Ahmed Sanad Ahmed Mohamed

Signature: ………………………………………..

Date: / / 2018

ACKNOWLEDGMENT

The author would like to express his sincere thanks to Prof. Dr. Almoataz Youssef Abdelaziz, Dr. Nabil Mohamed Hamed and Dr. Mahmoud Abdallah Attia for their guidance, continuous encouragement and generous help throughout the development of this work.

The helpful discussions with Dr. Mahmoud Abdallah Attia during the course of this thesis are gratefully acknowledged and fully useful helping the author generating this thesis.

The author would also like to express his love, gratitude, and appreciation to his parents, wife Rehab and beautiful lovely daughter and son; Arwa and Marwan for their endless love, encouragement and patience during the course of this work. They were the fuel that makes me move and through the course they represent the motive and the passion for me keeping on and finalizing my course successfully.

Ahmed Sanad Ahmed Mohamed
Cairo, 2018

ABSTRACT

This thesis presents a proposed method for fault location estimation within the transmission grid using different optimization algorithms. An introduction on fault types is presented and illustrated with the concentration on the fault location estimation problem.

Fault location estimation problem is a very crucial one affecting the reliability and continuity of energy supplied to different customers, considering that transmission system is the most exposed system to different types of faults.

Then a literature survey took place mentioning many algorithms used for this purpose and illustrated the theory behind each of them.

The next part shows different case studies and different algorithms were used and compared to reach the best fit from the accuracy and execution time point of view.

The last part shows an illustration of the proposed method of fault location estimation accompanied by the obtained results, curves and graphs when applied to the case study.

Finally, a general conclusion with a recommendation for future work to enhance the presented method, in addition to ways of as well.

Key words:

1- Fault Location. 2- Genetic Algorithm. 3- Harmony Search
4- Casue- Effect. 5- Optimization Technique.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

L-L-L-G: Three-Phase to Ground fault
L-L-L: Three-Phase fault
L-L: Line to Line fault
L-L-G: Double Line to Ground fault
L-G: Single line to ground fault
FLA: Fault Location Algorithms
BCO: Bee Colony Optimization
ABC: Artificial Bee Colony
HCF: Hyper-Cube Framework
PSO: Particle Swarm Optimization
ANN: Artificial Neural Networks
FNN: Feed-forward Neural Network
BPNN: Back-Propagation Neural Network
HMCR: Harmony Memory Considering Rate
PAR: Pitch Adjusting Rate
TLBO: Teaching–Learning-Based Optimization

Chapter 1 INTRODUCTION

1.1 General

Energy reliability is not only considered important but also critical aspects nowadays in energy management. Especially the transmission network that is considered as an essential part of the grid. Using transmission system all customers and end users can get the energy needed for all applications on all voltage levels. So, if a fault occurs within the transmission network, this will lead to outages at customer side affecting all applications such as hospitals, factories, schools, universities & houses.

To keep the transmission system reliability, all types of fault should be detected and located very quickly to clear the fault and restore the energy again after clearing the fault.

This introduces the topic of fault location estimation in the transmission grid, this topic is enhanced and improved nowadays using the available technology. This thesis presents several techniques used to detect fault location using different methodologies and algorithms, comparing them all and the conclusion will be stated at the end.

Fault is detected in power system by any abnormal current flow. For instance, in short circuit faults the currents bypass the load. While in open circuit faults circuit is interrupted by failure while stops the current from passing. A fault may involve any case of the following: L-L-L-G, L-L-L, L-L, L-L-G or L-G. In the power grid, protection equipment detects the fault and operates the circuit breakers and/or other devices in order to isolate the faulted area. The fault can be symmetrical, which means that the fault is affecting all phases equally [1]. If some phases were affected, the fault became very complicated for the analysis because some major assumptions will not be valid, at this case the fault is called asymmetrical fault. Most of transmission line faults are asymmetric. Most of the transmission lines faults are caused by overvoltage because of lightning strokes and any event of switching surges or by another conducting object falling on transmission line such as birds or trees.

The most common type of faults is line-ground faults (L-G) where one of the conductors is connected to the ground. This can also occur due to a fallen tree due to a winter storm.

Figures 1.1-1.4 show some common fault types that may occur along the transmission line.

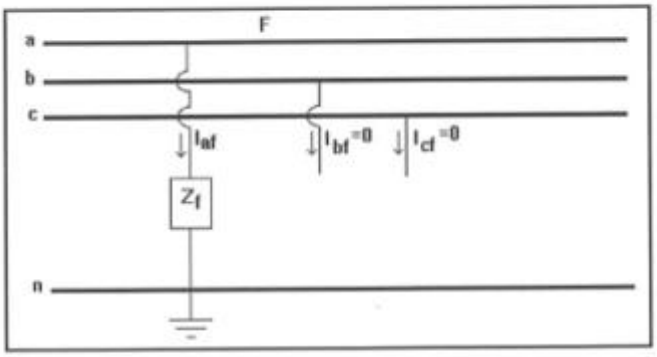

Figure 1.1 Single Phase to Ground Fault

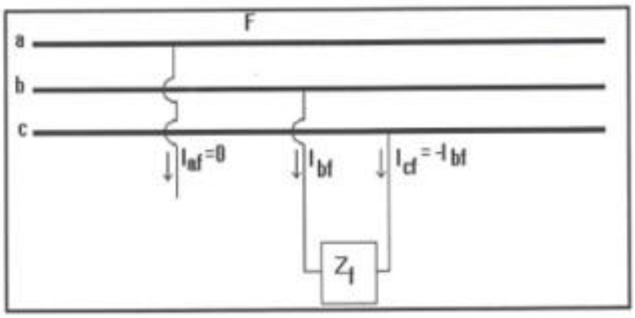

Figure 1.2 Phase to Phase Fault

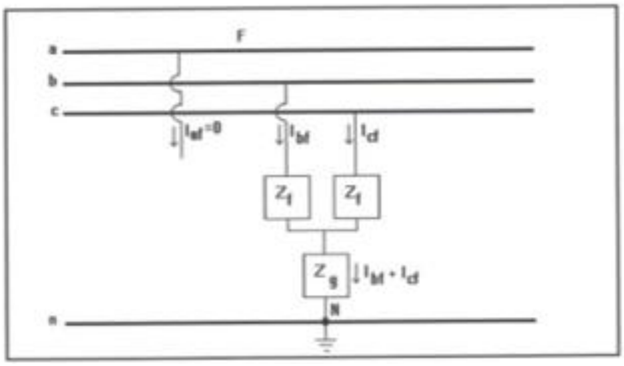

Figure 1.3 Double Phase to Ground Fault

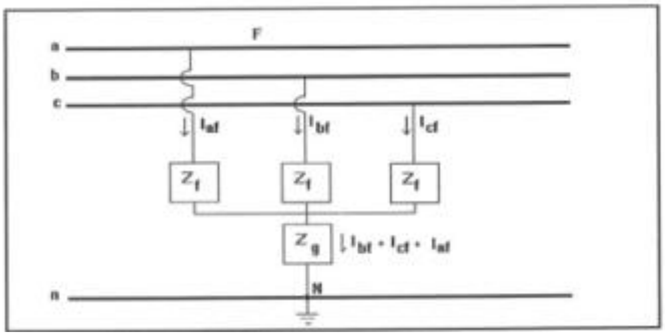

Figure 1.4 Three Phase Fault

1.2 Series Faults

a) One-line open.
b) Two-line open.

Series faults occur due to unbalanced series impedance. For instance, when a fuse or any device that doesn't disconnect all three-phases, operate. Also, if a resistance is inserted in one phase or two phases. Such faults can occur when only one or two phases are open, while the other is closed.

When a fault occurs, currents of high value pass through the line towards the fault, which causes overheating that can damage the line.

1.3 Shunt Faults

a- Single line to ground faults. Figure 1.5-1.6

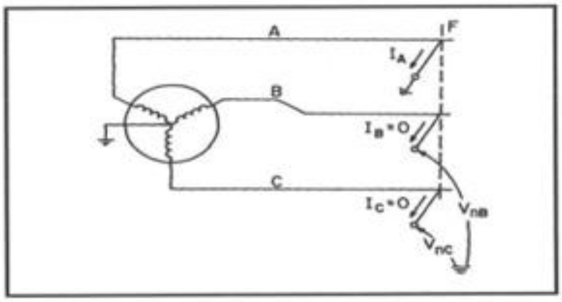

Figure 1.5 Single Phase to Ground Fault schematic

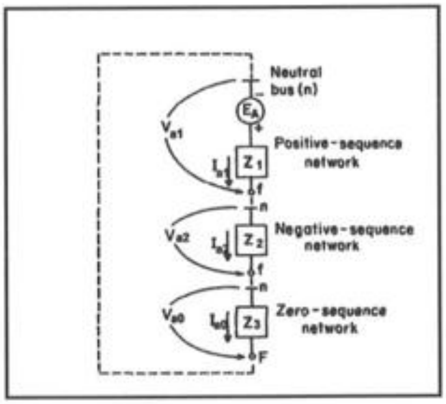

Figure 1.6 Equivalent Circuit for Single Phase to Ground Fault

b- Double line to ground faults. Figure 1.7-1.8