AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

INVESTIGATION OF NOVEL DIRECTIONAL PROTECTION TECHNIQUES BASED ON CURRENT ONLY MEASUREMENTS

by

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A thesis submitted to the faculty of engineering
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Supervised By

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Statement

This thesis is submitted as partial fulfilment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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ABSTRACT

Directional protection is essential in transmission, sub-transmission and distribution, especially after the impact of high penetration of distributed generators and its integration in the networks that leads to bidirectional in power flow and fault current.

Traditional directional relays have used a voltage signal as a polarizing quantity which may be unreliable in cases of close-in faults and absence of potential transformer in distribution networks.

In this thesis, an investigation of novel directional relaying techniques which require only current measurement from current transformers and eliminate the use of the bulky and costly potential transformers associated with the type of protection in the traditional directional relays is presented.

Novel directional protection algorithms have been investigated, proposed and demonstrated. The new algorithms use only pre-fault and post-fault current signals for determining the fault direction excluding the need for voltage signals. The first method depends on the change in current phase angle before and after fault, the second method utilizes the post-fault current not only as a reference, but also as a polarizing quantity, whereas the third method is based on diagnosing of current waveform slope rise and Lissajous curves for detection of the fault and its direction respectively.

This thesis also presents a comparative performance study of the suggested techniques at different fault conditions.

Further, the investigated techniques are applied to actual data extracted from a digital protection relay, existing in the distribution network of Maadi, Cairo during a forward fault. Furthermore, these techniques are compared with experimental laboratory results for a reverse fault case.

The results of the investigated methods well agree with the actual measurements.

Keywords: Current only directional protection, Phase angle comparator, Pre-fault current, Post fault current

SUMMARY

This thesis demonstrates an investigation and a comparative study between current only directional protection techniques. The thesis is divided into six chapters, it is organized as follows

Chapter 1 is an introduction to the thesis, it provides research objectives and discusses the thesis structure.

Chapter 2 provides a brief overview of the most common applications of directional overcurrent relays. In addition to the theories and principles of different directional protection methods.

Chapter 3 introduces the suggested current only directional techniques including basic equations, diagrams and flowcharts to illustrate these techniques in details.

Chapter 4 shows the performance of the proposed directional algorithms and its corresponding simulation results at different fault scenarios. It has been evaluated and tested using PSCAD / EMTDC and MATLAB tools.

Chapter 5 focuses on the application of the suggested methods to actual data obtained from digital relays to verify the validity of these methods and study their efficiency in a real network in order to confirm theoretical and simulation studies.

Chapter 6 summarizes the advantages of the proposed techniques and it includes a conclusion, as well as a suggestion for future work.

DEDICATION

I wish to thank my family for their patience, love and support during the years of my studies.

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