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Methodology for testing a parameter-free fault locator for transmission lines

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ABSTRACT

This paper presents a comparison between two different approaches to fault location both with and without utilising transmission line parameters. Firstly, an impedance-based parameter-dependent algorithm, derived by using modal transformation theory and fast Fourier transform is presented. The methodology is able to locate the fault whether it is on an overhead line or on an underground power cable. The second algorithm is a parameter-free fault location method that uses time synchronised data. Here, the unknown fault location is determined from voltage and current phasors, synchronously measured at both line terminals. This approach to fault location avoids the requirement for prior knowledge of line parameters, which is advantageous as line parameters are not always known precisely. This paper presents the results of algorithm testing through the use of ATPDraw simulations and MATLAB. The results were validated through laboratory experiments. The results of the line parameter-free model are compared with those from the parameter-dependent model. Both algorithms were tested for single line to ground faults.

1. Introduction

Electric power is generated by diverse and dispersed sources, which are often remote from load centres. Transmission lines are essential for transporting the generated power to load centres, and their routes can be very long and through inhospitable terrain. Should a fault occur that cannot be cleared through auto-reclosure, then service crews must be sent to repair the fault; knowledge of where exactly the fault has occurred expedites this process and helps to improve the security and quality of the energy supply [1]. Thus, fault location algorithms have become a very important part of transmission line protection schemes [2–4].

FLAs are a means to accurately determining the distance to a fault on a transmission line from a set reference point, which is usually one of the line terminals.

Whilst there are very many different methods of fault location discussed in the literature, FLAs can be broadly classified into two main types [3]:

- methods based upon travelling wave technology [5–7];
- methods based upon the transmission line impedance and voltage and current measurements [8–11].

Impedance-based FLAs measure take voltage and current measurements from one or both ends of the transmission line and utilise suitable circuit analysis techniques to calculate the distance to the fault from the reference point as a function of the transmission line parameters (resistance R, inductance L, and capacitance C per unit length) [12]. However, these parameters may not be known precisely and they can change with different line loading and weather conditions, which may adversely impact the accuracy of the fault location calculations. In recent years, several papers have been published in which methods of eliminating the negative impact of the line parameters on fault location calculations have

Abbreviations: OHL, overhead line; EMTP, Electro Magnetic Transients Programme; ATP, Alternate Transients Programme; FLA, fault location algorithm; SMT, synchronized measurement technology; PMU, phasor measurement units; SLG, single line to ground.

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