Electric Power Systems Research 80 (2010) 907–914

Contents lists available at ScienceDirect

Electric Power Systems Research

journal homepage: www.elsevier.com/locate/epsr

Real time evaluation of DWT-based high impedance fault detection in EHV transmission

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ARTICLE INFO

Article history:
Received 15 May 2008
Received in revised form
12 November 2009
Accepted 31 December 2009
Available online 4 February 2010

Keywords:
High impedance fault (HIF)
Wavelet transform
Real time testing

ABSTRACT

It is possible to capture the required travelling wave information contained in fault transients using wavelet transform. This paper presents practical real time testing for the high impedance fault (HIF) detection algorithm based on real time accidents data. The proposed scheme is implemented for HIF detection in extra high voltage transmission lines. The classifier is based on an algorithm that uses recursive method to sum the absolute values of the high frequency signal generated over one cycle and shifting one sample. Characteristics of this scheme are analyzed by extensive real time studies that clearly reveal that this technique can accurately detect HIFs in the EHV transmission lines within only half a cycle from the instant of fault occurrence. The reliability of this scheme is not affected by different fault conditions such as fault distance and fault inception angle.

1. Introduction

High impedance faults (HIFs) are difficult to be detected through conventional protection relays such as distance relays. When a conductor makes a contact with a poor conductive surface, the resulting level of fault current is usually lower than the nominal current of the system at that fault location. Therefore, conventional relay system will not be able to detect and trip HIFs. The failure of HIF detection may lead to potential hazards to human beings and fires [1].

HIFs on electrical transmission and distribution networks involve arcing and/or nonlinear characteristics of fault impedance, which cause cyclical pattern and distortion. Therefore, the objective of most detection schemes is to evaluate the special features in patterns of the voltages and currents in HIFs.

Several researchers in recent years have presented many techniques aimed for detecting HIF more effectively. These techniques include discrete wavelet transform with other different methods [1–3], down-conductor fault detection and location via a voltage based method [4], and development of a fuzzy inference system based on genetic algorithm [5].

This paper describes a fault detection technique for HIF in transmission line. This technique involves capturing voltage signals generated in transmission lines under different HIFs via coupling capacitive voltage transformer. The detection process is performed through signal decomposition, thresholding the absolute sum values of the wavelet transform coefficients for one cycle in a moving window scheme against a real time estimated threshold value.

2. Fault detection algorithm based on wavelet transform

This algorithm is based on using the high frequency information from the wavelet analysis by using DWT to discriminate between HIF and non-fault transients such as line switching, load sudden rejection, etc. The algorithm uses the Daubechie4 coefficient wavelet family (DB4) [6].

The sampling rate employed is 200 kHz (i.e., 4000 samples /cycle at 50 Hz). Fig. 1 shows the fault detection procedure of this technique, where *Va*, *Vb*, and *Vc* are the three phase voltages for which useful information through discrete wavelet transform realization under HIF is achieved. *Sa*, *Sb*, and *Sc* are the sum values of the first detailed output (d1 component) for a 1-cycle period and are presented in absolute values. Fault criterion (*Sth*) is the magnitude threshold for tripping condition. The whole process is based on a moving window approach where the 1-cycle window is moved continuously by one sample [7].

The criteria for the protective relay to initiate a trip signal is such that the absolute values of these operating (*Sa*–*Sb*), (*Sb*–*Sc*), or (*Sc*–*Sa*) must stay above the threshold level *Sth*. The symbol "*F*" is a counter that signifies the sample number (and, therefore, the time period), the value of "*F*" is incremented and as soon as it attains the level "D". So, the trip signal is initiated.

Sum special cases are difficult to be discriminated; such case occurred when the normal power system switching opera-

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doi:10.1016/j.epsr.2009.12.019