Electrical Power and Energy Systems 33 (2011) 1049–1053

Contents lists available at ScienceDirect

Electrical Power and Energy Systems

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

A transient current based busbar protection scheme using Wavelet Transforms

Shaik Abdul Gafoor [a,*], Pulipaka V Ramana Rao [b]

[a] Electrical and Electronics Engineering Department, Bapatla Engineering College, Bapatla 522101, India
[b] Electrical and Electronics Engineering Department, College of Engineering and Technology, ANU, Guntur 522510, India

ARTICLE INFO

Article history:
Received 16 November 2007
Accepted 1 January 2011
Available online 24 February 2011

Keywords:
Wavelet Transforms
Fault index
Busbar protection

ABSTRACT

This paper deals with application of Wavelet Transform for detection of busbar faults and to discriminate them from external faults. The fault indexes of differential current and that of a source CT current are obtained over narrow moving windows based on their respective detail coefficients. The fault indexes of both current signals obtained are compared with their respective threshold values to detect the internal faults. The time shift of differential current detail coefficients compared to those of source current due to saturation of CT is used to discriminate the external faults from internal faults. The scheme is tested successfully for different types of external and internal faults.

1. Introduction

Busbar is one of the most important elements of a power system connecting a variety of elements like generators, transmission lines and loads. A fault on busbar leads to loss of all the elements connected to it. The protection scheme of busbar should be fast, reliable and stable. A simple current differential scheme works satisfactorily for busbar protection. But this scheme is likely to maloperate due to CT errors, ratio-mismatches and saturation of one of the CTs in the event of external fault. A percentage biased differential scheme can restrain from false tripping but it reduces the sensitivity of the relay [1]. Failure to trip for an internal fault or false tripping due to external faults can both have disastrous effects on the stability of power system and may even cause a complete blackout [2]. Introduction of numerical techniques provides new solutions for busbar protection, thereby improving the operation and stability of power system [3]. Feser et al., proposed such a numerical based technique which makes use of ANN for recovering the original signal from saturated CT current signal thereby avoiding the false tripping in case of external faults [4]. However the CT error and ratio-mismatch can still cause the mal-operation of the scheme proposed.

The Wavelet Transforms (WT) has been proposed for busbar protection, which has feature extraction capabilities due to their Multi Resolution Analysis [5]. Various WT based techniques have been proposed in literature for tackling the problems associated with the busbar protection namely CT error, CT saturation and ratio-mismatch. A Continuous Wavelet Transforms (CWT) based method, making use of operating and restraining signals similar to percentage biased differential protection scheme was proposed in [6]. Mohammed has proposed a scheme in [7], which makes use of Wavelet Packet Transforms (WPT). However there is always a need to develop innovative and efficient method for busbar protection.

This paper presents a WT based busbar protection scheme that utilizes detail decomposition of differential current to detect internal faults. The time shift in transients between the differential and source currents is used to discriminate external faults from internal faults. The details of the proposed scheme are described in the following sections.

2. Wavelet analysis

Wavelet Transform (WT) is an efficient means of analyzing transient currents and voltages. Unlike DFT, WT not only analyzes the signal in frequency bands but also provides non-uniform division of frequency domain, i.e. WT uses short window at high frequencies and long window at low frequencies. This helps to analyze the signal in both frequency and time domains effectively. A set of basis functions called wavelets, are used to decompose the signal in various frequency bands, which are obtained from a mother wavelet by dilation and translation. Hence the amplitude and incidence of each frequency can be found precisely.

Wavelet Transform is defined as a sequence of a function $\{h(n)\}$(low pass filter) and $\{g(n)\}$(high pass filter). The scaling function $\varphi(t)$ and wavelet $\psi(t)$ are defined by the following equations

$$\varphi(t) = \sqrt{2}\sum h(n)\ \varphi(2t-n)$$
$$\psi(t) = \sqrt{2}\sum g(n)\ \varphi(2t-n)$$

where $g(n) = (-1)^n\ h(1-n)$.

* Corresponding author. Tel./fax: +91 8643224246.
E-mail addresses: saadgafoor@gmail.com (S. Abdul Gafoor), pvr_eee@yahoo.co.in (P.V Ramana Rao).

0142-0615/$ - see front matter
doi:10.1016/j.ijepes.2011.01.022