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A novel approach to adaptive single phase auto-reclosing scheme for EHV transmission lines

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ABSTRACT

In modern interconnected power systems, nearly 80% of faults in high voltage transmission lines are intrinsically transient. The necessity of rapid fault clearing has resulted in fast development of protection equipments. Moreover, need for reliable supply of loads has led to improvements in single phase auto-reclosing equipments. In this paper, a novel and efficient method is proposed that leading to improved performance and efficiency of single phase auto-reclosing. In the case of occurrence of permanent faults, the proposed yardstick is accurate and authentic to diagnose fault type (transient or permanent). To validate accuracy and authenticity of the proposed method, a 400 kV transmission system is simulated using EMTP software and results are presented.

1. Introduction

Nearly 80% of faults in high voltage transmission lines are intrinsically transient [1]. The most prevalent potential of transient faults is lightning, transmission lines switching and jiff contact by external objects. This transient faults can be cleared by temporary opening of the faulty phase. Hence, these faults are allowed to be self-cleared. For this type of faults, the transmission system can be energized by a Single Phase Auto-Reclosing (SPAR). This strategy improves reliability and stability of power systems [2]. These types of faults include permanent faults which are not clearable by SPAR. Conventional auto-reclosing is not recommended especially in transmission lines located near generators [3–6]. Therefore, locking of SPAR equipment is attended in last decade.

This paper presents Adaptive Single Phase Auto-Reclosing (ASPAR) for high voltage transmission line by providing the opportunity of simply controlling auto-reclosing using a computer in the station.

Correct discrimination between transient and permanent faults is necessary to solve this problem. Different solutions are proposed for this case [7–10], most of which are based on the analysis of voltage waveform at the sending or receiving end of the transmission line in the fault happening period (dead time). In [7], an online ASPAR is presented. Type of fault (transient or permanent) is detected by wavelet transform and by processing transient voltage waveform. In [8], another ASPAR algorithm is introduced which is based on monitoring the fundamental component of the zero sequence instantaneous power to detect the instant of secondary arc quenching. Design of a reclosing relay based on the method proposed in [8] is sophisticated because of the complexity of this approach. Another algorithm is presented in [9] to lock the reclosing equipment on permanent fault. This algorithm is essentially based on fundamental and third components of the voltage and current waveforms. Also, detection of fault location in a 110 kV power system is considered. In [10], by processing the input terminal voltage and using total harmonic distortion (THD) criterion, appropriate transient or permanent protective action is carried out.

To optimize the ASPAR of transmission lines, in this paper, a novel approach which is simple, accurate and reliable is presented.

2. ADALINE neural network architecture

ADAptive LInear NEuron (ADALINE) was first proposed by Widrow and Hoff from Standford University [11–14]. An ADALINE, as shown in Fig. 1, is a multi-input, single output, single layer linear neural element, and its characteristics are:

(a) trained on-line based on the changing inputs and the target response;
(b) self adaptive algorithm can be applied to the weights training; and
(c) simple structure makes it easy to implement on hardware.

An ADALINE can be used for on-line following of harmonic content of a signal. To illustrate the problem, a signal which has some harmonics is considered as:

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