A Combined Directional and Faulted Phase Selector Element Based on Incremental Quantities

Benmouyal, G.; Mahseredjian, J.

Author Affiliation: Schweitzer Engineering Laboratories, Inc.; Hydro-Quebec

Abstract: In this paper differential incremental or superimposed voltage and current quantities are used in order to determine directionality of a fault in a network. It is shown that this can be accomplished by performing three scalar products between three voltage and current phasor pairs. The relative levels of these same three scalar products can be furthermore used to identify the faulted phases. While, in ultra-high-speed directional comparison relays, superimposed voltage and current had to be treated in the time domain in order to get speed, in this paper all computations are done in the frequency domain.

Keywords: Digital relaying, directional element, single pole tripping, protective relays.

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A Current-Based Solution for Transformer Differential Protection. Part I: Problem Statement

Guzman, A.; Zochol, S.; Benmouyal, G.; Altuve, H.

Author Affiliation: Schweitzer Engineering Laboratories; Universidad Autonomade Nuevo Leon

Abstract: This paper analyzes the problem of transformer differential protection. First, we review the concept of transformer differential protection. We then analyze magnetizing inrush, overexcitation, and current transformer (CT) saturation phenomena as possible causes of relay misoperation. Finally, we summarize the existing methods for discriminating internal faults from inrush and overexcitation conditions. In Part II of the paper we propose a new approach for transformer differential protection and describe the relay that is based on this approach.

Keywords: Protective relaying, power transformer protection, differential protection.

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A Short-Circuit Current Study for the Power Supply System of Taiwan Railway

Huang, S.; Chen, B.; Kuo, Y.; Lu, K.; Huang, M.

Author Affiliation: Feng Chia University

Abstract: The western Taiwan railway transportation system consists mainly on a mountain route and ocean route. Taiwan Railway Administration (TRA) has conducted a series of experiments on the ocean route in recent years to identify the possible causes of unknown events that cause the trolley contact wires to melt down frequently. The conducted tests include the short-circuit fault test within the power supply zone of the Ho Long Substation (Zhu Nan to Tong Xiao) that had the highest probability for the melt down events. Those test results, based on the actual measured maximum short-circuit current, provide a valuable reference for TRA when comparing against the said events.

The Le Blanc transformer is the main transformer of the Taiwan railway electrification system. The Le Blanc transformer mainly transforms the Taiwan Power Company (TPC) generated three-phase alternating power supply system (69kV, 60Hz) into two single-phase alternating power distribution systems (M phase and T phase) (26kV, 60Hz) needed for the trolley traction. As a unique winding connection transformer, the conventional software for fault analysis will not be able to simulate its internal current and phase difference between each phase current. Therefore, besides extracts of the short-circuit test results, this work presents an EMTP model based on the Taiwan Railway Substation equivalent circuit model with a Le Blanc transformer. The proposed circuit model can simulate the same short-circuit test to verify the actual fault current and accuracy of the equivalent circuit model.

Moreover, the maximum short-circuit current is further evaluated with reference to the proposed equivalent circuit. Preliminary inspection of the trolley contact wire reveals the possible causes of meltdown events based on the simulation results.

Keywords: Railway electrification system, trolley contact wire.

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A New Transmission Line Fault-Locating System

Adu, T.

Author Affiliation: Mehta Tech, Inc.

Abstract: The paper describes a new fault-locating system that has been developed at Mehta Tech, Inc. (MTI). The distance-calculating technique of the system is based on the reactance method of fault distance estimation using data from one terminal of a transmission line. The technique compensates for errors caused by factors such as load flow and fault resistance. The system has been in commercial use by some reputable electric utilities, both local and international, for over three years. The paper also presents some field results that have been obtained from some of these electric utilities that are using the new fault-locating system.

Keywords: Fault location/fault distance, phasor, fault classification, faulted feeder selection, single-ended, reactance.

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Fast Fault Section Estimation in Distribution Substations Using Matrix-Based Cause-Effect Networks

Chen, W.H., Liu, C.W., Tsai, M.S.

Author Affiliation: National Taiwan University, Taiwan; Chinese Culture University

Abstract: A new method for estimating fault sections in power substations is proposed. In this paper, the knowledge representation and inference procedures based on the cause-effect networks (CE-Nets) and rule matrix transformation techniques are presented. The matrix-based inference procedures are proposed to estimate the possible fault sections through simple matrix operations by transforming the established CE-Nets into matrix forms. The method is superior to existing production systems in the inference speed and the process of implementation. By testing on a typical Taiwan Power Company's (Taipower) secondary substation, the experimental results show the effectiveness of the proposed method even for the fault domains involving multiple faults and failure operations of protective devices. Moreover, it is easy to implement and transplant into different substations.

Keywords: Fault diagnosis, cause-effect network, rule matrix.

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Surge Protective Devices

Development of Advanced Built-In Surge Arresters for Distribution Systems with New Zinc-Oxide Elements

Hama, M.; Ishizaka, H.; Shimizu, J.; Nishiki, S.; Kaku, I.

Author Affiliation: Mitsubishi Electric Corp., Amagasaki, Japan

Abstract: New zinc-oxide elements with a varistor voltage about twice that of conventional ones have been developed by reducing the ZnO grain size with a new additive, which enables to halve the series number of elements in metal oxide surge arresters. Using these elements, we have developed advanced built-in surge arresters enclosed in 6.6 kV pole transformers and switchgear. The advanced arresters have