IEEE Guide for Protective Relay Applications to Power System Buses

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IEEE Power & Energy Society

Sponsored by the
Power System Relaying Committee

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Abstract: Concepts of power bus protection are discussed in this guide. Consideration is given to availability and location of breakers, current transformers, and disconnectors as well as bus-switching scenarios, and their impact on the selection and application of bus protection. A number of bus protection schemes are presented; their adequacy, complexity, strengths, and limitations with respect to a variety of bus arrangements are discussed; specific application guidelines are provided. Breaker failure protection is discussed as pertaining to bus protection. Means of securing bus protection schemes against corrupted relay input signals are also included.
Keywords: breaker-and-a-half, breaker failure (BF) protection, breaker substitution, buses, check zone, CT saturation, current transformers, differential bus protection, double-bus double-breaker, double-bus single-breaker, dynamic bus replica, electric power substations, high-impedance differential, main bus, partial differential, percentage differential, protective relaying, ring bus, single-bus single-breaker, stub bus, transfer bus, voltage trip supervision, zone-interlocked bus protection

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Introduction

This introduction is not part of IEEE Std C37.234-2009, IEEE Guide for Protective Relay Applications to Power System Buses.

Electric power system buses are points of common connection for source and load circuits. As such buses are essential in maintaining power system integrity. Unnecessary isolation of a power bus by its protection system can considerably alter topology of the power grid and, even without other contingencies, can lead to system stability problems. Therefore the security of bus protection schemes is of paramount importance.

At the same time the close proximity and connection of various power apparatus within the perimeter of a substation and its exposure to secondary effects of a short circuit require fast isolation of all bus faults.

This document provides application guidelines for selecting and engineering bus protection schemes for a variety of bus configurations using several different protection philosophies to meet the requirements of security, dependability, and speed of operation.

The guide reviews many typical bus configurations and explains typical switching operations and their impact on the bus protection systems. This includes reconfigurable buses, such as double-bus single-breaker configuration, breaker substitution, main and transfer bus, etc., where the zones of protection change as the bus is switched, thus requiring the bus protection system to adapt accordingly for optimum selectivity.

The document reviews the most common bus protection schemes and presents their relative advantages given specific bus configuration and switching flexibility, as well as performance requirements for the protection system. This includes schemes ranging from differentially connected overcurrent relays to microprocessor-based differential schemes with dynamic zone selection.

After reviewing relay input sources—current transformers (CTs) , voltage transformers (VTs), and position sensing schemes for breakers and disconnect switches—the guide elaborates on each bus protection method in more detail by examining the operating principle, providing general setting guidelines and listing general requirements for CTs.

The document also discusses specific related bus protection application issues including, but not limited to, partial differential protection, applications with paralleled CTs, CT column ground fault protection, voltage trip supervision, dynamic bus selection for double-bus single-breaker buses, bus protection under a breaker substitution configuration, stub bus configuration or configuration with paralleled buses, breaker failure (BF) application for reconfigurable buses, and treatment of in-zone out-of-service elements that provide a ground path for short-circuit currents.

A setting calculation example for a high-impedance bus differential scheme is given in Annex A.

A protection logic design example is provided in Annex B to illustrate concepts of dynamic zone selection, dynamic BF trip selection, protection during a breaker substitution configuration, or circuit transfer leading to paralleling multiple buses via disconnect switches, voltage trip supervision, and the check zone. The example has been developed for a double-bus single-breaker configuration, but these advanced bus protection concepts are applicable to any reconfigurable bus.

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