by John J. Shea

Digital Protective Relays

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ISBN 978-1-4398-3785-6
www.crcpress.com
431 pp., $129.95 (Hardcover), 2011

The digital protective relay, or numeric relay, uses a microprocessor to analyze power system voltages and currents for the purpose of detection of faults in an electric power system. It generally measures analog voltage and current signals and converts them to digital. The microprocessor analyzes the magnitude, phase, and harmonic content of the digital signals, among other quantities. The relay is capable of applying advanced logic, e.g., deciding whether the relay should trip, based on current and/or voltage magnitudes (and angle in some applications) set by the user, relay contact inputs, and sometimes the timing and order of event sequences.

There is an abundant literature describing the benefits, applications, operation, and uses of digital protective relays. However, the author contends that there is little information on their limitations and drawbacks. He offers a unique focus on the associated problems and disadvantages, delving into the inner workings of the devices to help readers evaluate manufacturers' product claims. The book focuses on practical solutions and explains how to select a relay for an intended application and avoid the many problems that can arise. It describes the construction of the functional modules of existing relays, details potential problems and solutions, assesses the dangers of intentional electromagnetic pulses, and discusses alternative non-microprocessor-based protective relays.

This is not a book on how to set and adjust relays. It is not an in-depth review of digital protective relay fundamentals, although some of the basics are covered. Rather, it delves into the finer details of component behavior for many relay types. The underlying theme of the book seems to be that digital protective relays are becoming less reliable with the addition of sophisticated electronics, and consequently the electric power grid could be vulnerable to their failure either during normal operation or from an electromagnetic pulse attack.

This is an interesting book because of the unbiased, insightful, and practical material it presents. The reader will learn about some of the basic operation of digital protective relays but also about the issues facing the manufacturers. This type of information, not normally found in academic books on a subject, really helps one select relays and decide what to look for in relay design and reliability. The topics covered include basic protective relay design, logic inputs, power supplies, testing, and nondigital analog alternatives. The potential reliability problems associated with digital relays, e.g., component failures, microprocessor glitches, and power supply failures, are reviewed, along with failure statistics. The author also discusses some of the potential failures from lightning-induced damage and transient overvoltages, and protection methods. These are serious threats that digital relays must be able to handle. The book also contains information on various types of electromechanical relays, mainly those used in the output of the digital protective relays, and subminiature gas-insulated electromechanical types. Relay operation and problems due to unequal contact erosion are discussed. It is claimed that, in some cases, electromechanical relays without microprocessors would be more reliable and more immune to electromagnetic interferences, and data are presented to support that claim.

This book would be of interest to engineers who design or specify digital protective relays. It is filled with information on their failure modes and reliability.