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Comparative Characteristics of Iron-Core Current Transformers and Rogowski Coils for Applications for Protective Relaying Purposes

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Abstract

Iron-core current transformers (CTs) have traditionally been used for protection and measurement applications in part because of their ability to produce the high-power output required by electromechanical equipment. Microprocessor-based devices consume less power than traditional electromechanical equipment; thereby, making high-power current sensors unnecessary. However, despite low-power requirements, microprocessor-based relays have been designed to accept signals from conventional CTs by internally transforming the CT secondary currents to low-level voltages and replicating conventional relay schemes. This occurred because low-power sensors were not available and/or customers were not ready to accept a paradigm change in relay protection practices and operations.

When conventional CTs are used with new microprocessor-based relays, commonly recognized CT problems such as saturation and remanence can affect the relay performance in the same way as with traditional schemes. Other CT disadvantages include large size and weight.

Rogowski Coil current sensors have performance characteristics that are favorable when compared to conventional CTs. These include high measurement accuracy and a wide operating range allowing the use of the same device for both metering and protection. In addition, Rogowski Coils make protection schemes possible that were not achievable by conventional CTs because of saturation, size, weight, and/or difficulty encountered when attempting to install current transformers around conductors that cannot be opened. High short-circuit currents can cause extreme CT saturation, resulting in substantial CT secondary current distortion. Differential protection systems must reliably operate under these conditions, since the impact on the power system can be serious in both cases: if the differential protection operates due to CT saturation for an Out-Of-Zone fault (lack of security) or if it does not operate for an In-Zone fault (lack of dependability). Special algorithms and solutions must be applied on conventional schemes to satisfy these requirements, which, in many cases, cannot easily be achieved. Rogowski Coil-based relay protection provides superior solutions. The schemes are also simple, user friendly, and require less wiring and space than conventional designs.

This paper is organized into three sections. Section 1 presents designs and characteristics of high-precision Rogowski Coils. Section 2 compares Rogowski Coil and conventional iron-core current transformer performances. Section 3 describes novel protection solutions for power transformers, generators, and busbars.