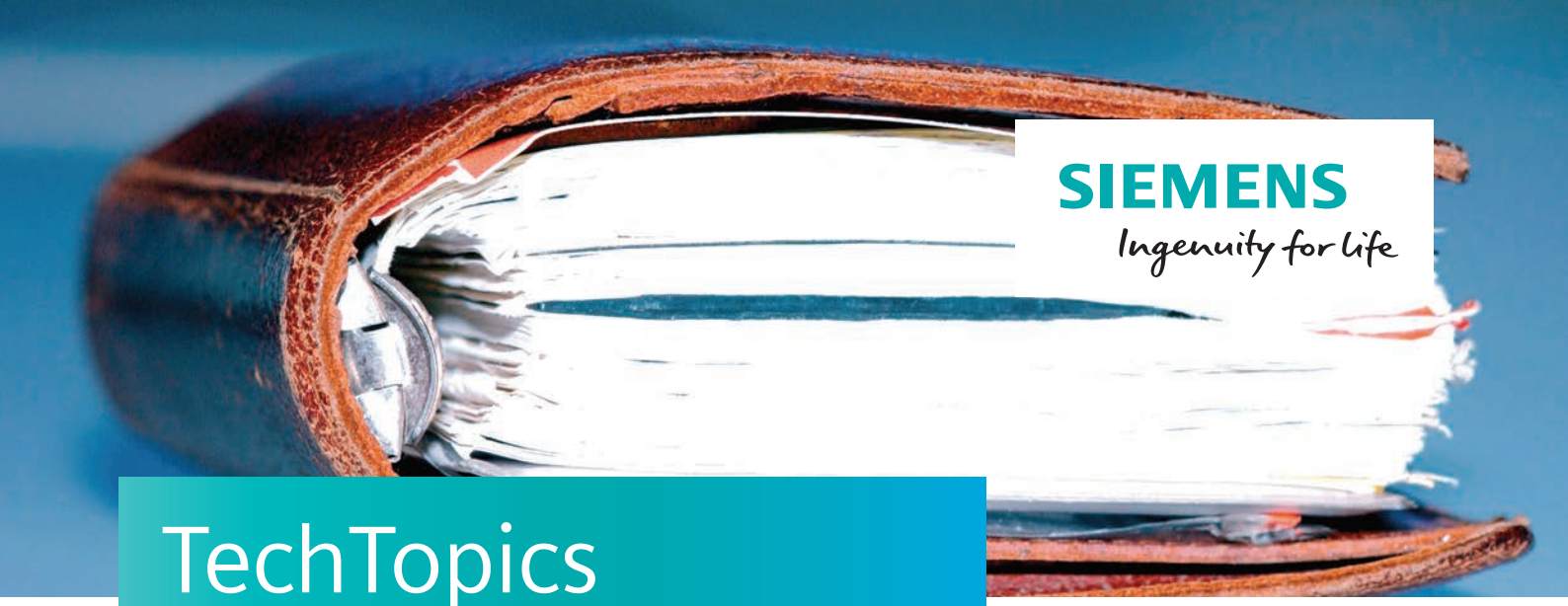

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TechTopics No. 130

Reclosers or circuit breakers?

Siemens often fields questions from users about the differences between a recloser and a high-voltage circuit breaker, and particularly about the appropriate applications for each of them.

Reclosers and high-voltage circuit breakers serve much the same function in distribution systems, but differ in their capabilities. A recloser may be thought of as a light-duty circuit breaker (even though it is not a circuit breaker). Conversely, equipped with the appropriate protective relays, a high-voltage circuit breaker can serve in a reclosing role as well.

In this issue of TechTopics, products rated for use in 15 kV, 27 kV, and 38 kV distribution systems will be discussed.

First, some definitions.

Recloser

A recloser (more formally, an automatic circuit recloser) is defined by IEEE (and IEC) as a "self-controlled device for making, carrying, and automatically interrupting and reclosing an alternating-current circuit, with a predetermined sequence of opening and reclosing followed by resetting, hold-closed, or lockout operation. It includes an assembly of control elements required to detect overcurrents and control the recloser operation." (IEEE/IEC C37.60 (62271-111)).

Circuit breaker

A circuit breaker is defined by IEEE as "a mechanical switching device, capable of making, carrying, and breaking currents under normal circuit conditions and also, making and carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short circuit." (IEEE C37.100).

A recloser is distinguished by having a mandatory automatic control and protective device, but this is not significant as most high-voltage circuit breakers used in utility distribution systems have protective relays with similar (or even identical) functionality.

Beyond the definitions, how do reclosers and high-voltage circuit breakers compare?

Standards

The standard for a recloser is a dual-logo IEEE/IEC standard, designated as IEEE/IEC C37.60 (62271-111).

For high-voltage circuit breakers, there are a number of IEEE standards and guides, amongst which are:

- C37.04, Rating Structure for AC High-Voltage Circuit Breakers
- C37.06, AC High-Voltage Circuit Breakers - Preferred Ratings
- C37.09, Test Procedures for AC High-Voltage Circuit Breakers
- C37.010 Application Guide for AC High-Voltage Circuit Breakers

There are also several additional guides, such as for capacitance-current switching, transient-recovery voltage, and reactor switching. IEEE C37.06 will be withdrawn in the near future, as the revisions in process now will move the preferred ratings into the basic C37.04 standard.

Continuous current

Reclosers are typically available in current ratings of 630 A or 800 A, with some vendors offering other ratings such as 400 A and 1,200 A. Circuit breakers are typically available with ratings of 1,200 A, 2,000 A, and 2,500 A or 3,000 A. Circuit breakers are most often used in distribution substations, whereas reclosers are most often used beyond the substation, out on the overhead distribution lines.

Short-circuit current

Reclosers are typically available with symmetrical short-circuit ratings of 12.5 kA or 16 kA, with some offerings at lower or higher currents. Circuit breakers are commonly available with symmetrical short-circuit ratings of 20 kA, 25 kA, 31.5 kA, or 40 kA.

The higher short-circuit current ratings are appropriate for use at the distribution substation, where the short-circuit current is higher than it is out on the distribution lines.

Size

Reclosers are small and light (on the order of 200-300 pounds without mounting structure), as they are most commonly installed on power poles out on the overhead distribution system. They may, less frequently, be installed in a small distribution substation on a substation frame structure as shown on page 1. A high-voltage circuit breaker, being intended primarily for use in a distribution substation, is frame mounted and installed on a concrete pad or pilings. The weight of a circuit breaker ranges from about 1,800 pounds to over 3,000 pounds, depending on voltage class, continuous current, and accessories.

Seismic withstand

Reclosers typically do not have a seismic rating, since their seismic capability is largely dependent on the support pole, and thus not under the control of the manufacturer. Circuit breakers are installed on a ground level foundation, and are available with seismic qualification to the highest levels seen in North America.

Endurance

Endurance is substantially the same for reclosers and circuit breakers. Standards for reclosers require a mechanical (no load) endurance of 2,000 operations, but most (not all) of the suppliers of reclosers publish endurance capabilities of 10,000 operations. A similar situation prevails for outdoor (class S2) high-voltage circuit breakers, with the IEEE C37.06 standard requiring 2,000 mechanical (no load) operations, but with most vendors publishing endurance capabilities of 10,000 operations.

For perspective, an endurance of 2,000 operations translates into 50 operations per year over a 40-year life. While many of these products stay in service for 40 years, very few of them ever see 50 operations per year.

The electrical endurance of reclosers and circuit breakers are different.

For reclosers, the electrical endurance at rated continuous current is not specified in the standard. Instead, the test duty specified for reclosers with interrupting capacity of at least 8 kA includes 116 operations, of which 16 are at full fault rating, 56 at half fault rating, and 44 at 15-20 percent of fault rating. After this standard operating duty, it is estimated that the contacts will have reached their half life (reference IEEE/IEC 62271-111-2012, table 12). For the most part, vendors do not state the endurance capability of reclosers switching rated continuous current, but it is likely that they are capable of 10,000 operations at rated continuous current. Based on the standard operating duty in IEEE 62271-111, the estimated number of full fault interruptions possible is about 100. For the Siemens reclosers, the number of full-fault interruptions is up to 250.

For circuit breakers, IEEE C37.06 specifies 100 operations at rated continuous current. However, most vendors publish a capability of 10,000 operations at rated continuous current.

One issue relative to electrical endurance is that of contact wear in the vacuum interrupters. With most (if not all) reclosers, direct determination of the amount of contact wear is not possible, as the vacuum interrupter is located inside an epoxy-molded housing and inaccessible for measuring contact wear. Contact wear can be estimated based on the accumulated current (or accumulated current squared) interrupted, depending on the recloser controller device used. Since the vacuum interrupter is integrated into the molded housing, replacement of the vacuum interrupter is generally not possible.

For circuit breakers, if the vacuum interrupter is not encased in a molded housing, the contact wear can be measured directly, and if necessary, the vacuum interrupters can be replaced. While it is unlikely that a vacuum interrupter will have to be replaced over the service life of the circuit breaker, it is comforting to know that it can be replaced if necessary.

Circuit breakers are designed to allow maintenance, whether of the operating mechanism itself, or for replacement of vacuum interrupters. Reclosers, generally, are not designed to allow maintenance by the user, and require return to the manufacturer if any internal maintenance is needed. Circuit breakers are mounted near the ground level, making maintenance relatively convenient. Reclosers are usually mounted high on the power pole, so that any possible maintenance requires a boom truck and special procedures due to proximity to high voltages.

Application

Reclosers are available as three-phase units, as single-phase units, and even in a form known as a triple-single (three single-phase units in one assembly). Reclosers are often applied on single-phase overhead distribution lines, so the single-phase unit is appropriate. High-voltage circuit breakers, being commonly installed at the distribution substation, are always three-phase designs.

Reclosers have current sensors incorporated in the molded housing, and it is not possible to add additional current transformers directly to the recloser assembly. Additional current transformers, if needed, would have to be added separate from the recloser, increasing the cost of the total installation. Also, the recloser control cabinet is of fixed size, so there is likely no room to bring the secondary leads from additional current transformers into the recloser controller cabinet.

Therefore, reclosers are not readily adaptable to addition of metering or additional relays (e.g., for transformer differential or other protection).

Circuit breakers, on the other hand, typically have the capability for up to four current transformers inside the enclosure, so that complex differential schemes, dedicated sophisticated metering equipment, and similar options are easily accommodated. In addition, the circuit breaker enclosure has a large compartment for secondary devices, meters, relays, transducers, and similar items, so the circuit breaker can be configured to meet the user's desires.

Reclosers are designed for use with an automatic-reclosing function, typically allowing up to three reclose operations in an operating sequence before the controller puts the recloser in lockout. This is expressed typically as O- t – CO – t – CO – t – CO, where O = open operation, CO = close-open operation, and the time delays (t) are adjustable. The time intervals for a recloser can be as short as a few seconds, but longer times are generally desirable to allow the ionized gases at the fault location to dissipate before the circuit is re-energized.

Circuit breakers can be configured in an equivalent manner, depending on the capabilities of the protective relay specified. The first close operation should be no shorter than 0.3 s after the first interruption, and subsequent reclose operations should be at intervals no less than about 10-12 s to allow time for the circuit breaker operating mechanism (whether stored-energy or magnetic-actuator) to recharge.

Economics

Years ago, circuit breakers were more expensive to purchase than reclosers, especially archaic hydraulic-oil circuit reclosers. However, in today's utility environment, communications technologies have become a necessity, and old style reclosers do not adapt well to communications devices. As a result, reclosers have become significantly more costly, at the same time that circuit breaker purchase costs have been more steady, or have even declined. Depending on the options required, today's circuit breakers may be available at little or no premium over reclosers.

Typical recloser controller cabinet compartment door open

Typical SDV7 distribution circuit breaker with high-voltage door and relay compartment doors open

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