

NEW

CHANCE[®] ELECTRONIC RESETTABLE

— *the smart way to improve distribution system coordination*

SECTIONALIZERS

Optimizing system coordination is a prerequisite for reliable and economic operation of a modern distribution system. Over the past several decades, certain system protection philosophies have evolved utilizing available equipment. While those philosophies have enhanced distribution system coordination, they do not fully address increasingly pressing needs to lower operating costs and raise customer satisfaction. This article reviews current practices and recommends improvements through use of Chance Electronic Resettable Sectionalizers (CRS).

Current practices —

A present-day distribution system typically consists of a feeder (line) originating from a substation. Several laterals are tapped off this feeder. Distribution transformers installed on these laterals supply end users. It is not unusual to see several branch lines tapped off a lateral which, in turn, supply power to several end users.

The challenge for a protection engineer is to keep outages caused by overcurrents confined to a minimum possible section of this complex system. So, the usual practice is to install progressively smaller protective devices (generally fused cutouts) as the circuit moves away from the substation. Were there no other complications, this scheme would provide nearly perfect coordination for the system. However, it is an established fact that most faults on a system are temporary in nature lasting a few cycles to a few seconds. (While some utility records indicate 70 to 80 per cent of all faults are temporary, another study suggests they run as high as 80 to 95 per cent.) Therefore, if the simple scheme suggested above is used, as many as 95 per cent of all system outages could be caused by temporary faults.

The advent of reclosing circuit breakers and automatic circuit reclosers has at

least partially solved this problem. These devices differentiate between temporary and permanent faults with the reclosing device clearing the temporary fault, while protective device immediately down stream from the recloser will operate on permanent faults only.

With these developments, the typical present-day distribution circuit looks like Figure 1. A recloser generally is installed at the start of a feeder, the lateral is fused with a sectionalizing-type cutout and a cutout with an appropriately-sized fuse link is installed at each distribution transformer.

In general, the transformer (or equipment) fuse is sized so that it will operate on all selected overcurrents without causing the recloser to operate. Because the operation of this fuse affects only a limited number of customers, such operations are easily justifiable.

The lateral (sectionalizing) fuse is supposed to coordinate with the recloser in such a way that the recloser fast curve is faster than the fuse minimum-melt time-current characteristic and the recloser slow curve is slower than the maximum-clear time-current characteristic of the fuse. This allows the recloser to clear temporary faults while operating on its fast curve and lets the fuse clear a permanent fault if the recloser transfers

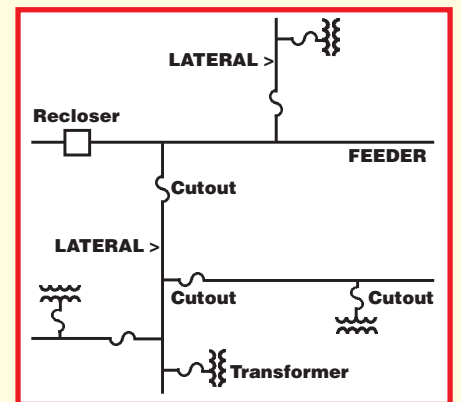


Figure 1
Typical Distribution System

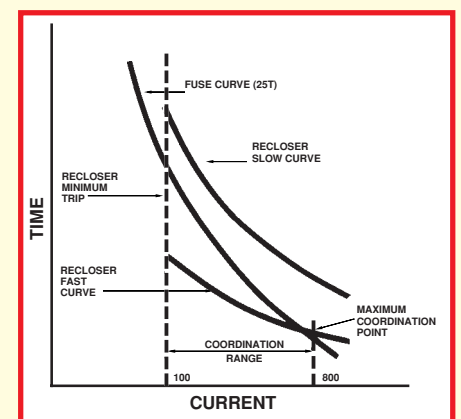


Figure 2
Recloser - Fuse
Coordination

to its slow curve. A typical recloser-fuse coordination scheme is shown in Figure 2.

It is a popular belief that this scheme provides perfect coordination because a recloser prevents fuse operations on temporary faults to eliminate nuisance outages. However, it is not uncommon to find a utility where the engineering department believes that the system is properly coordinated, but operations personnel keep experiencing nuisance fuse blowing for no apparent reason.

In fact, there are two major problems with present coordination schemes. One involves recloser/sectionalizing-fuse coordination and the other, sectionalizing-fuse/equipment-fuse coordination.

Recloser/sectionalizing-fuse coordination

Because the recloser is a mechanical device, it requires a specific time to operate. This time is generally on the order of 3 to 4 cycles. Consequently, the recloser fast curve (while inverse time in nature for lower levels of current) tends to become asymptotic at 3 to 4 cycles. A fuse link, on the other hand, is a fusible element and, depending on the current level, can melt in as little as 10 milliseconds. Therefore, as shown in Figure 2, beyond a level of current known as the maximum-coordination point, the fuse will operate before the recloser has a chance to clear a temporary fault. This obviously will result in a nuisance outage. The maximum-coordination point typically occurs at 6 to 8 times the minimum-trip (pickup) setting of the recloser. As Figure 2 shows, with the minimum trip of the recloser set at 100 amps, a 25T link ceases to coordinate beyond 800 amps. Most likely, short-circuit currents will exceed the 800-amp level, especially near substations. Indeed, with higher

trip settings and higher-rated fuse links, the coordination range could be significantly extended. However, system overload considerations generally will limit such an extension. Such extension will rarely extend the coordination to available short circuit current level.

Fuse/fuse coordination

Most distribution circuits have at least two fuses in series. An essential requirement for coordinating two or more fuse links in series is that the maximum-clearing time of the downstream fuse link (protecting fuse link) shall not exceed 75 per cent of the minimum-melting time of the upstream fuse link (protected fuse link). Because both the minimum-melting and maximum-clear times are based on the level of fault current, there is a level beyond which a particular fuse link will stop coordinating with another link as shown in Figure 3. This may result in both the upstream and downstream fuse links operating at the same time. In the example above, a 25T fuse link was used at the start of the lateral. From Figure 3, it is apparent that a 25T link will not coordinate beyond 1,500 amps with the smallest of the fuse links (1T).

Therefore, it may be concluded that:

- a) Beyond the maximum-coordination point, the recloser will not coordinate with the sectionalizing (lateral) fuse link.
- b) Beyond a certain level, the recloser, sectionalizing fuse link and the equipment fuse link will not coordinate with each other.

The noteworthy common denominator in these conclusions is the sectionalizing fuse link. So, if it could be either eliminated or replaced by a device to extend the coordination range to the system's maximum available short-circuit current, system coordination would be greatly enhanced.

This can be easily achieved by using a sectionalizer in place of the fuse link at the start of a lateral. A sectionalizer is a protective device which has no time-current characteristic and does not interrupt a fault. When subjected to an overcurrent followed by a current below its minimum threshold, it merely counts backup recloser operations. After a predetermined number of such operations, it isolates the circuit while the backup recloser is in the open position. The recloser is then allowed to close, restoring service to unaffected sections of the system. If the fault is temporary and is cleared

Protecting Type T Fuse Link Ampere Rating	Protected Type T Fuse Link Ampere Rating														
	6	8	10	12	15	20	25	30	40	50	65	80	100	140	200
	<i>Maximum Currents (rms amperes) for safe coordination</i>														
1	280	390	510	690	920	1150	1500	1900	2490	3000	3900	4800	6200	9500	15000
2	280	390	510	690	920	1150	1500	1900	2490	3000	3900	4800	6200	9500	15000
3	280	390	510	690	920	1150	1500	1900	2490	3000	3900	4800	6200	9500	15000
6			340	690	920	1150	1500	1900	2490	3000	3900	4800	6200	9500	15000
8				400	850	1150	1500	1900	2490	3000	3900	4800	6200	9500	15000
10					480	990	1500	1900	2490	3000	3900	4800	6200	9500	15000
12						550	1190	1900	2490	3000	3900	4800	6200	9500	15000
15							670	1500	2490	3000	3900	4800	6200	9500	15000
20								890	2000	3000	3900	4800	6200	9500	15000
25									1100	2250	3900	4800	6200	9500	15000
30										1250	3000	4800	6200	9500	15000
40											1700	3700	6200	9500	15000
50												2100	5000	9500	15000
65													2700	9500	15000
80														6600	15000
100														3900	15000
140															5200
200															

Figure 3
Coordination Chart for T Links
Source: Chance Fuse Link Application Guide, Bull. 10-7701

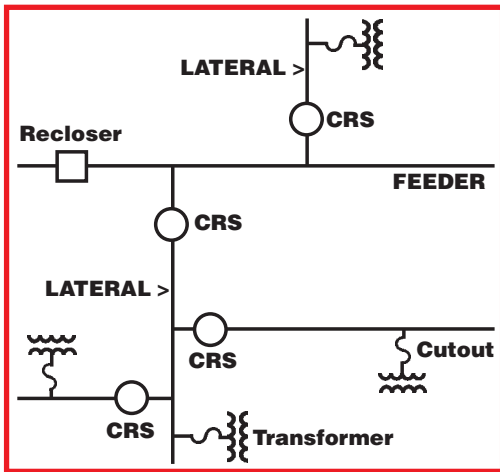


Figure 4
Distribution system with sectionalizers

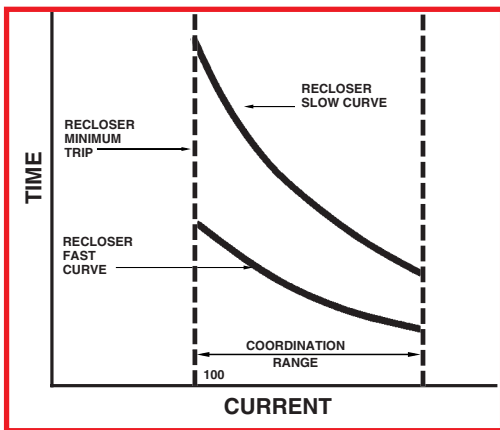


Figure 5
Recloser coordination with sectionalizer



Figure 6
Resetting Chance Type CRS Sectionalizer

before the sectionalizer count reaches the predetermined number, the sectionalizer remains closed and resets to its original state after a predetermined time.

If this new approach is adopted, the system shown in Figure 1 becomes the one shown in Figure 4 with the sectionalizer denoted as CRS. Because the sectionalizer has no time-current characteristic, the net effect is that the recloser coordination scheme shown in Figure 2 is greatly simplified, as shown in Figure 5. With no fuse curve to intersect recloser time-current characteristics, the coordination range is extended to the system's maximum-available short-circuit current. As an added benefit, the transformer fuse link becomes an independent entity.

Based on the foregoing analysis, an optimum coordination of a distribution system can be achieved by using reclosers on the feeders, sectionalizers on the lateral and fuses to protect such equipment as transformers.

The Chance Electronic Resettable Sectionalizer (CRS)

The previous section established that replacing a fuse with a sectionalizer at the start of a lateral greatly enhances system coordination. Although the sectionalizer has been available for many years, a lack of understanding about its application and less than satisfactory performance by some early designs have severely restricted its use on distribution systems. The CRS offers excellent performance and gives protection engineers the opportunity to markedly enhance system coordination.

Construction —

Shown in Figure 6, CRS consists of an electronic-logic circuit mounted outside a copper tube. The logic receives signals from two current transformers also mounted on the tube. The tube is fitted with top and bottom contacts and a trunnion similar to those on a single-vent open-type cutout and a spring loaded mechanism for the drop out action of the sectionalizer. This entire assembly fits in a standard Chance Type C cutout mount.

Earlier versions of Chance Electronic Sectionalizers (Type CES) required replacement of the actuators after each operation. Users generally carried an inventory of and equipped each line truck with the actuators. The new Chance Electronic Resettable Sectionalizer (Type CRS) uses the spring loaded mechanism to actuate the drop out action of the sectionalizer. The mechanism can then be reset with help of an adjustable wrench as shown in Figure 6. This eliminates the need to inventory the actuator and the line crews can have one less item on their trucks.

Operation —

Operational characteristics of the CRS are: Minimum-actuating current, number of counts and reset time. The operational logic of a two-count sectionalizer can be summarized with reference to Figure 7, which illustrates the responses to a transient fault and a permanent fault.

For the transient fault, fault current exceeded the CRS actuating current, and subsequently was reduced to less than the hold-off threshold by tripping the upstream reclosing device. These first steps in the operational logic set the sectionalizer to a count of one (1). But because the fault was

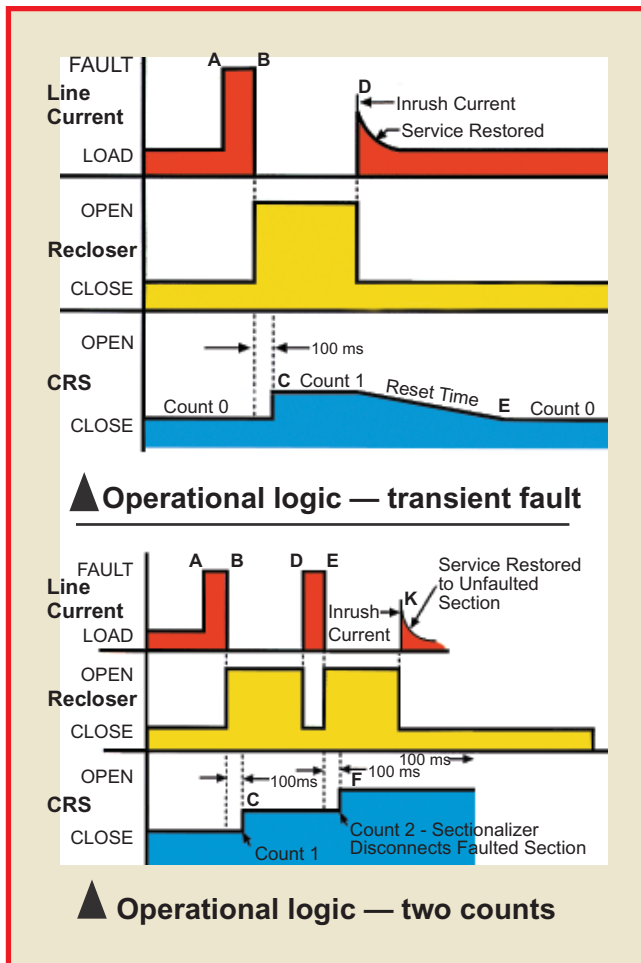


Figure 7

transient, the load current upon reclosing stays below the CRS actuating current so its operational logic proceeds no further. In fact, at the end of the reset time, the CRS count resets to zero (0).

In the case of the permanent fault, the first two logic steps are identical to the transient fault, but this time the fault current once again exceeded the actuating current and subsequently was reduced to less than the hold-off threshold by a second tripping of the upstream reclosing device. These final two steps in the operational logic are what cause the sectionalizer to proceed to a count of two (2). At this time, the logic circuit sends an electrical signal to the actuator, causing the trunnion to unlatch and rotate the sectionalizer electronic module which swings down to its open position during the open time of the recloser. ■

The Chance Electronic Resettable Sectionalizer (CRS)

Features and benefits —

1. Resettable Design

CRS is a resettable design. There is no need to replace the actuator after each operation of the sectionalizer.

2. Low threshold for dead-line detection (0.3 amp)

This ensures that a return to normal load current following a temporary fault will not result in an erroneous count by the sectionalizer.

3. Immunity to inrush current

The logic circuit is programmed to recognize an overcurrent only if both the negative and positive half cycles of an overcurrent exceed the CRS minimum actuating current level. Because magnetic inrush is invariably unidirectional, they are ignored by the logic circuit.

4. Immunity to temperature variations

The electronic logic circuit provides accurate, consistent operation across a wide range of ambient temperatures.

5. Self powered

Power required to drive the logic circuit and the actuator is supplied by two current transformers mounted on the copper tube. Therefore no external power source is required.

6. Protects against cold-load pickup

The low threshold for dead-line detection protects against an erroneous count from a temporary current rise above the actuating-current level due to cold-load pickup.

7. Surge and EMI protection

CRS electronic circuitry is qualified against electromagnetic interference, radio frequency interference and surge current.

8. Reliable dropout action

CRS hardware provides more positive and rapid dropout operating action.

9. Interchangeability

CRS hardware is designed with the user in mind. It fits the Chance Type C cutout mounts and the S&C Electric Type XS cutout mounts, simplifying installation and retrofitting.

10. Increased reliability at reduced costs

Because CRS virtually eliminates nuisance outages (and up to 80 per cent of all outages are termed nuisance), using CRS can significantly reduce system operating costs.

NOTE: Because Hubbell has a policy of continuous product improvement, we reserve the right to change design and specifications without notice.



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