

PulseFinding™ Fault Location Technique

S&C's PulseFinding Fault Location Technique helps users overcome protection-coordination limitations when installing multiple series feeder fault interrupters downstream of a substation breaker. Often, feeder characteristics, such as available fault current and load levels, can make coordinating more than two or three fault interrupters challenging. The PulseFinding technique enables multiple IntelliRupter® PulseCloser® Fault Interrupters to overcome these limitations by sharing the same coordination characteristics.

IntelliRupter® fault interrupters can easily be installed downstream of an existing recloser by using the PulseFinding technique and having the two devices share the same curve to operate the PulseFinding technique. Furthermore, the PulseFinding technique helps distribution engineers inexperienced with configuring protection coordination simplify the task of coordinating fault interrupters by eliminating the need to change substation-breaker or recloser-protection settings.

Protection settings of IntelliRupter fault interrupters downstream of a breaker or recloser can be identically configured to the breaker or recloser. By using the PulseFinding Fault Location Technique, an unlimited number of series IntelliRupter fault interrupters can be installed by enabling them to all have the same overcurrent-protection settings. Although all IntelliRupter fault interrupters upstream of a fault and configured with the same protection settings will initially trip, the PulseFinding technique recovers from this intentional initial overtripping.

Note: Overtripping occurs when miscoordination or phase-to-phase contact (conductor-slap) causes more unintended trips after an initial fault. This can cause more devices to trip and could cause protection schemes to fail, resulting in blown fuses and persistent faults.

Note: Recovery from intentional overtripping is accomplished by enabling the PulseFinding technique and always using PulseClosing® Technology before closing after tripping. PulseClosing Technology allows several tests without the undesired effects of conventional reclosing (voltage sags, component stress, etc.).

Referring to **Figure 1**, all IntelliRupter fault interrupters configured to the same time-current characteristic (TCC) curve and upstream of a fault (f) will trip to isolate the fault (Step #2). Beginning with the IntelliRupter fault interrupter closest to the substation breaker (IR-1), IR-1 detects one side is still energized. An operation using a pulse to test the line (Step #3) successfully closes it (Step #4) because the downstream IntelliRupter fault interrupters (IR-2 and IR-3) are open.

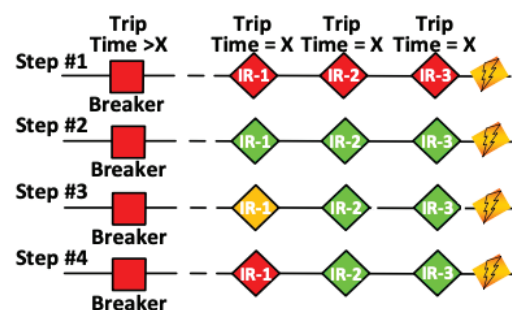


Figure 1. Multiple IntelliRupter fault interrupters in series are set up for use of the PulseFinding technique, and all trip because of the fault.

As illustrated in **Figure 2**, the test using a pulse and the closing sequence continues (Steps #5 and #6) until the IntelliRupter fault interrupter closest to the fault (IR-3) uses PulseClosing Technology to close. When the IntelliRupter fault interrupter closest to the fault (IR-3) uses PulseClosing Technology to close (Step #7) and the fault is still present, the pulse current produced doesn't activate the overcurrent protection of the upstream devices (IR-1 and IR-2). Because the IntelliRupter closest to the fault (IR-3) uses PulseClosing Technology and detects the downstream fault, it never closes (Step #8), overtripping never recurs and, if the fault is persistent, it eventually locks out.

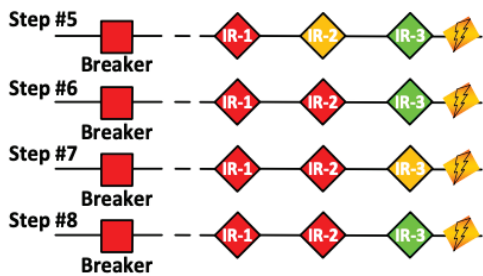


Figure 2. The PulseFinding technique enables multiple series IntelliRupter fault interrupters to isolate the fault.

Using the PulseFinding Technique Applications with Existing Assets

Although the PulseFinding Fault Location Technique is frequently applied to series IntelliRupter fault interrupters to improve reliability, it can also be applied when adding IntelliRupter fault interrupters to feeders having existing reclosers, as shown in **Figure 3**. This is accomplished by configuring the protection settings of IR-3 to match those of RC-2, IR-2 to those of RC-1, and IR-1 to those of the breaker. The PulseFinding technique enables an existing feeder to have better reliability and protection without having to set up coordination or adding additional complexity to the system.

Using the PulseFinding Technique to Enable Reliability Improvements

The PulseFinding Fault Location Technique improves feeder reliability by working with existing assets for feeder segmentation. In the case of a feeder with existing assets, the IntelliRupter fault interrupters' protection settings are configured the same as an existing upstream recloser or breaker. When these

devices trip (they are configured with the same TCC curve), the PulseFinding technique will begin to look for the fault and restore service to the segments not affected by the fault, resulting in SAIFI (outage-frequency) and SAIDI (outage-duration) improvements for persistent faults. See **Figure 4**.

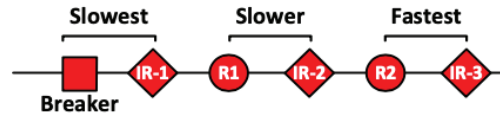


Figure 3. The PulseFinding technique used with IntelliRupter fault interrupters and existing assets.

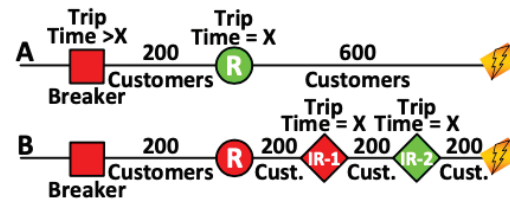


Figure 4. The PulseFinding technique enables multiple series IntelliRupter fault interrupters to isolate the fault.

Benefits of using the PulseFinding technique with automated loop restoration or the IntelliTeam® SG Automatic Restoration System

When the IntelliTeam SG Automatic Restoration System is used with the PulseFinding Fault Location Technique, it enables the system to automatically recover from intended or unintended miscoordination. In loop restoration, the PulseFinding technique overcomes coordination limitations reconfigured in recloser feeders.

(See Technical Paper 766-T113 for more on automated loop restoration or use of the IntelliTeam SG system with the PulseFinding technique.)

PulseClosing Advantage

Reclosers configured with the same protection settings are incapable of replicating the benefits of the PulseFinding Fault Location Technique. See **Table 1**.

Table 1. Competitor Comparison Table

<i>Device</i>	<i>PulseFinding Technique</i>	<i>Voltage Sag Avoidance</i>	<i>Limitless Number of Devices</i>	<i>Overtipping Avoidance</i>
<i>IntelliRupter fault interrupter</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Reclosers</i>	<i>No</i>	<i>No</i>	<i>No</i>	<i>No</i>

Presuming the IntelliRupter fault interrupters in Figures 1 and 2 are replaced with conventional reclosers, they won't use PulseClosing Technology before reclosing; they will all trip. See Figure 5, Step # 2. However, if Step #7 in **Figure 5** is a reclosing operation (instead of one using PulseClosing Technology), the overtipping in Step #2 recurs every time R3 recloses, eventually resulting in R1 and R2 locking out with no improvement in SAIFI and SAIDI.

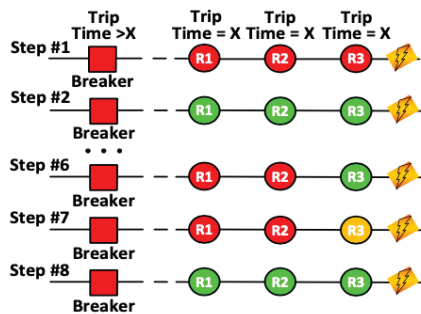


Figure 5. Multiple series conventional reclosers reacting to a permanent fault.