

IntelliRupter[®] PulseCloser[®] Fault Interrupter



The IntelliRupter fault interrupter's accurate sensing and directional capabilities will help with the increase of distributed energy installations, while PulseClosing[®] Technology solves the problem of stress caused by conventional reclosing.

IntelliRupter PulseCloser Fault Interrupter with PulseClosing Technology – Less Energy, Less Stress, Less Damage

Distribution faults damage equipment, reduce reliability, and adversely affect a utility's bottom line. Some existing fault-management strategies may cause more damage by multiplying the force applied to a system when testing the line for faults after an event.

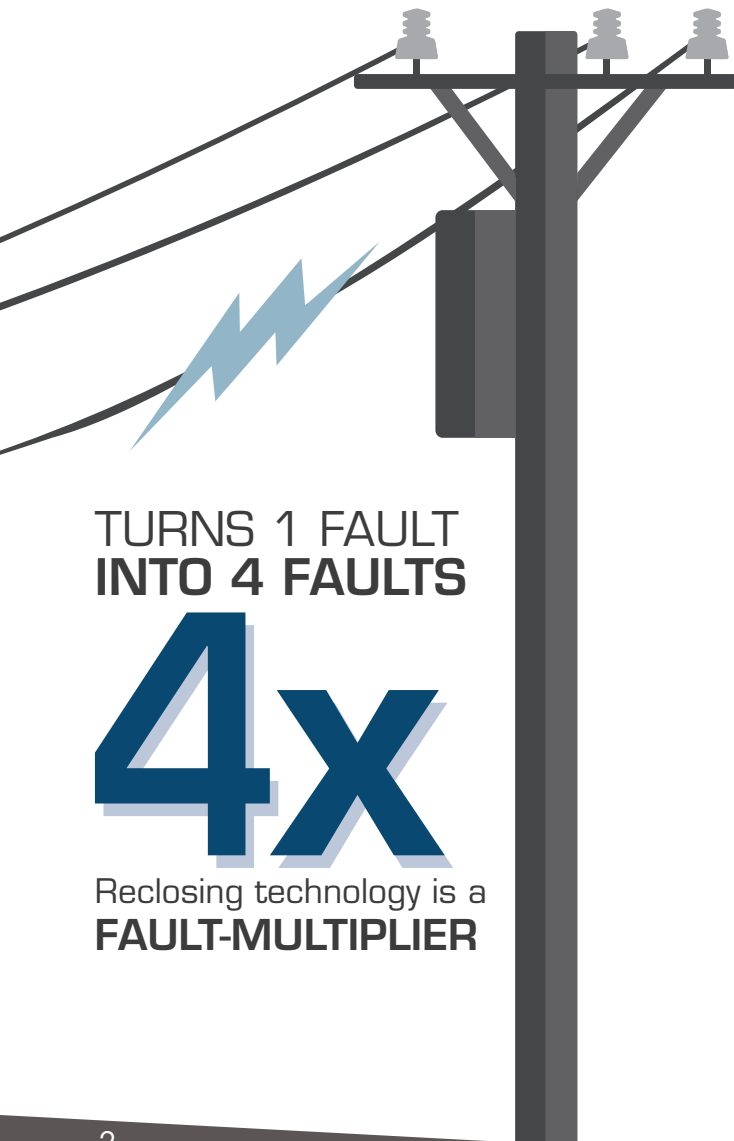
Through its use of PulseClosing Technology, S&C's IntelliRupter PulseCloser Fault Interrupter dramatically reduces the amount of force used to test for faults and significantly lessens momentary outages for customers on the main and adjacent feeders. This strategy improves reliability and reduces costs for both the utility and its customers.

Conventional reclosers stress the circuit with fault current every time they reclose into a fault. But after an IntelliRupter fault interrupter interrupts a fault, it uses 95% less energy through PulseClosing Technology to intelligently test for fault current before closing.

The oscillograms in Figure 1 show the remarkable difference in current versus time during fault-testing with a conventional recloser and with an IntelliRupter fault interrupter.

After clearing a fault, a conventional recloser simply recloses the interrupters to test for the continued presence of the fault. If the fault is still there, the interrupters are tripped again. Then, after a time delay, the interrupters are reclosed. With each reclosing operation, even the fastest recloser feeds a significant amount of energy into the fault, resulting in system-damaging stress and voltage sags that can propagate to adjacent feeders.

Figure 2 shows how a conventional recloser operates in response to a permanent single-phase-to-ground fault. The uncontrolled closing often results in asymmetric fault current, significantly increasing the let-through fault current into the fault.

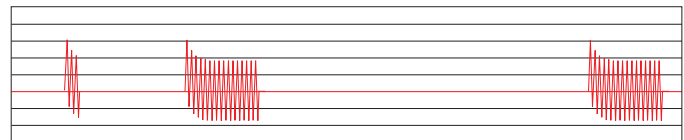


URNS 1 FAULT
INTO 4 FAULTS

4x

Reclosing technology is a
FAULT-MULTIPLIER

Current versus time—conventional recloser—fault from phase wire to grounded neutral



Current versus time—IntelliRupter PulseCloser Fault Interrupter—fault from phase wire to grounded neutral

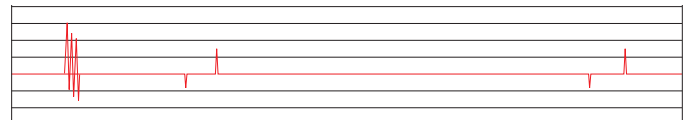


Figure 1. PulseClosing Technology drastically reduces overcurrent stress on the system, as shown here for a permanent phase-wire to grounded-neutral fault.

After an IntelliRupter fault interrupter clears a fault, it tests for the continued presence of the fault using S&C's advanced magnetic actuator design, coupled with unique PulseClosing Technology. IntelliRupter fault interrupters intelligently close at a precise point on the voltage wave, resulting in a short pulse that's less than half the symmetrical fault current.

Figure 3 shows how IntelliRupter fault interrupters operate in response to a permanent single-phase-to-phase fault, with a typical current pulse of just 5 milliseconds.

With IntelliRupter fault interrupters, your system only experiences overcurrent stress from the initial fault—not from every reclosing operation typically associated with reclosing. Component life is extended, eliminating costly replacement. PulseClosing Technology also dramatically reduces through-faults, which are a leading cause of premature aging of substation transformers. Moreover, power quality is improved because use of PulseClosing Technology doesn't disturb source-side customers with irritating voltage sags and blinks.

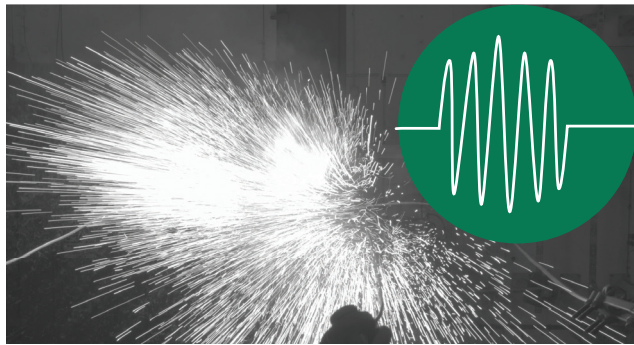


Figure 2. Conventional reclosing in response to a permanent fault.



Figure 3. Response to a permanent fault with PulseClosing Technology.

Greater Segmentation reduces the number of customers without power when there is a sustained outage. IntelliRupter fault interrupter's accurate sensor and precision actuators result in a total tolerance on the coordination curves of just $\pm 2\%$. Traditional reclosers do not provide this level of accuracy limiting the number of reclosers that can be coordinated. With the addition of IntelliRupter fault interrupters it is now possible to increase the number of devices that can be coordinated increasing segmentation and reducing the number of customers per segment resulting in fewer customers without power when a sustained outage occurs.

Prepare for the Grid of the Future

The grid of the future will see an increase of renewable energy resources and microgrid installations that will change the way power flows. Unidirectional power flow will no longer be the norm, requiring a protection device to be able to recognize changes to power direction. Weaker sources will result in instabilities that will require protection devices to recognize and respond to sudden changes in frequency. IntelliRupter fault interrupters recognize changes to power direction and frequency. An increase in weaker sources also means that using traditional reclosing will increase the probability of creating system instabilities making PulseClosing Technology essential for distributed power applications. Using IntelliRupter fault interrupters today prepares you for the grid of tomorrow.

For more information on IntelliRupter fault interrupters, visit sandc.com/intellirupter.

Application Overview

Universal Protection for Overhead, Underground, or Hybrid Circuits

S&C's IntelliRupter PulseCloser Fault Interrupter is a breakthrough in overhead and underground distribution system protection. This unitized package of fault-interrupting and control components can operate as a stand-alone fault interrupter or, with appropriate options, can be integrated into a SCADA system, a Demand Management System (DMS), and/or an S&C IntelliTeam® SG Automatic Restoration System. See Figure 4.

Overhead System Applications

IntelliRupter fault interrupters provide outstanding protection on overhead systems through 38 kV. They are available in upright-crossarm (see Figure 5 on page 5 and Figure 6 on page 6) and compact-crossarm (see Figure 7 on page 7) mounting configuration models, with or without an integrated, hook-stick-operated disconnect for visible air-gap isolation of switched-open circuits.

IntelliRupter fault interrupters provide full live-switching performance under all ice conditions; circuit-making, circuit-breaking, and advanced fault interrupting are accomplished within the interrupters meeting all the requirements of IEEE Standard C37.60 for automatic circuit reclosers and fault interrupters. There are no external moving parts.

On disconnect-equipped models, the disconnect is interlocked with the interrupters to ensure they are open prior to opening or closing the disconnect. The interrupting devices may be operated with the disconnect in either position. A status point is provided for remote monitoring of disconnect position.

Underground System and Hybrid System Applications

Pad-Mounted Style IntelliRupter fault interrupters provide full live-switching performance on underground systems through 27 kV. See Figure 8 on page 8. Circuit-making, circuit-breaking, and use of a pulse of current to detect the presence of a fault are accomplished within the interrupters. The low energy of the PulseClosing Technology makes the Pad-Mounted Style IntelliRupter fault interrupter ideal for hybrid systems comprised of both overhead and underground circuits, meaning the same overhead fault-location techniques can be applied to the underground part of the circuit. The factory-assembled, freestanding, self-supporting enclosure meets the requirements of ANSI C57.12.28 for enclosure integrity and includes provisions for cable entrance and exit through the bottom.

Pad-Mounted Style IntelliRupter fault interrupters are available with or without an integrated disconnect for visible air-gap isolation of switched-open circuits. The interrupters may be operated with the disconnect in either position.

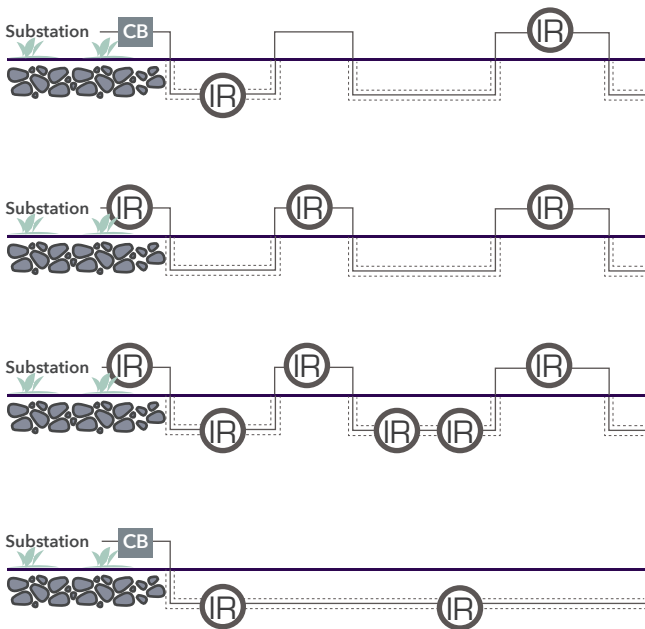


Figure 4. Hybrid system applications.

Units can be deployed on overhead and underground circuits with similar protection. You no longer need to compromise protection and reliability. All temporary faults are cleared and service is automatically restored.

For existing circuits where adding pad-mounted gear would be difficult, units can be deployed on overhead sections with full test sequences. Also, usage in the substation optimizes protection on the first cable section and reduces stress on substation transformers.

PulseClosing Technology allows for an unlimited number of units in series, meaning better segmentation on overhead and underground circuits than ever before.

This technology can also be used on all-underground circuits and can be added without affecting existing equipment (which is there to distribute power). A key point is that service is automatically restored for any temporary or self-clearing cable faults, and the control center is notified of the incident for planning cable inspections.

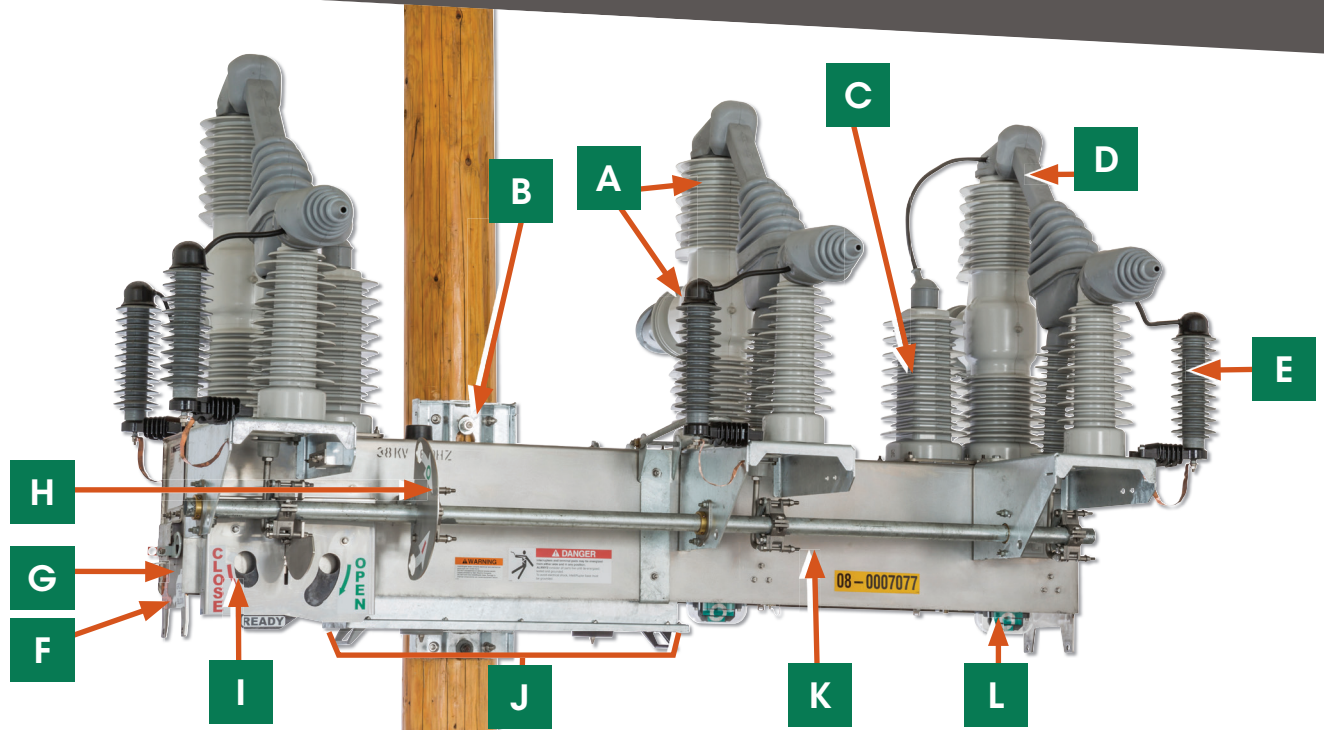


Figure 5. A Disconnect-Style IntelliRupter fault interrupter in an upright-crossarm mounting configuration, rated 38 kV maximum.

- A** Integrated voltage sensors on both sides of IntelliRupter fault interrupter provide highly accurate sensing across entire temperature range. Integrated current sensors provide extremely flat response, from low-level load currents through fault current levels, ensuring reliable measurements critical for system analysis. Sensors are molded into interrupter housings for all-weather durability. See below for more details.
- B** Integrated pole-mounting bracket is designed for easy installation; prevents tilting.
- C** The integral power module is fed from one side of an IntelliRupter fault interrupter or, optionally, two integral power modules are fed from a different phase on both sides to maximize availability of control power. This eliminates the cost and complexity of separately mounted control power transformers.
- D** The integrated disconnect provides visible air-gap isolation for dead-line work and facilitates operational testing. Mechanically interlocked with interrupters.
- E** Optional factory-installed and -wired surge arresters are on both sides of an IntelliRupter fault interrupter, simplifying installation.
- F** The HOT-LINE TAG lever disables circuit testing and allows for faster interrupting times when the downstream circuit is being serviced.
- G** The GROUND-TRIP BLOCK lever allows the ground elements to be turned off to avoid nuisance tripping due to unbalances caused by single-phase switching.
- H** The disconnect OPEN/CLOSE lever provides a visible gap, allowing line crews to visually verify isolation when required by your operating practices.
- I** The interrupter OPEN/CLOSE/READY lever allows line crews to perform manual **Open** and **Close** operations with a utility hookstick and for the unit to be locked open for service or opened in the complete absence of control power.
- J** The control group features a hookstick-removable protection and control module and communication module. A multi-function status light indicates the control group is operating normally. A hot-line tag light indicates a "set" tag.
- K** A stainless steel base provides outstanding corrosion-resistance, even in the harshest environments.
- L** Interrupter OPEN/CLOSED indicator directly linked to the magnetic actuator to provide a reliable indication of the interrupter position.

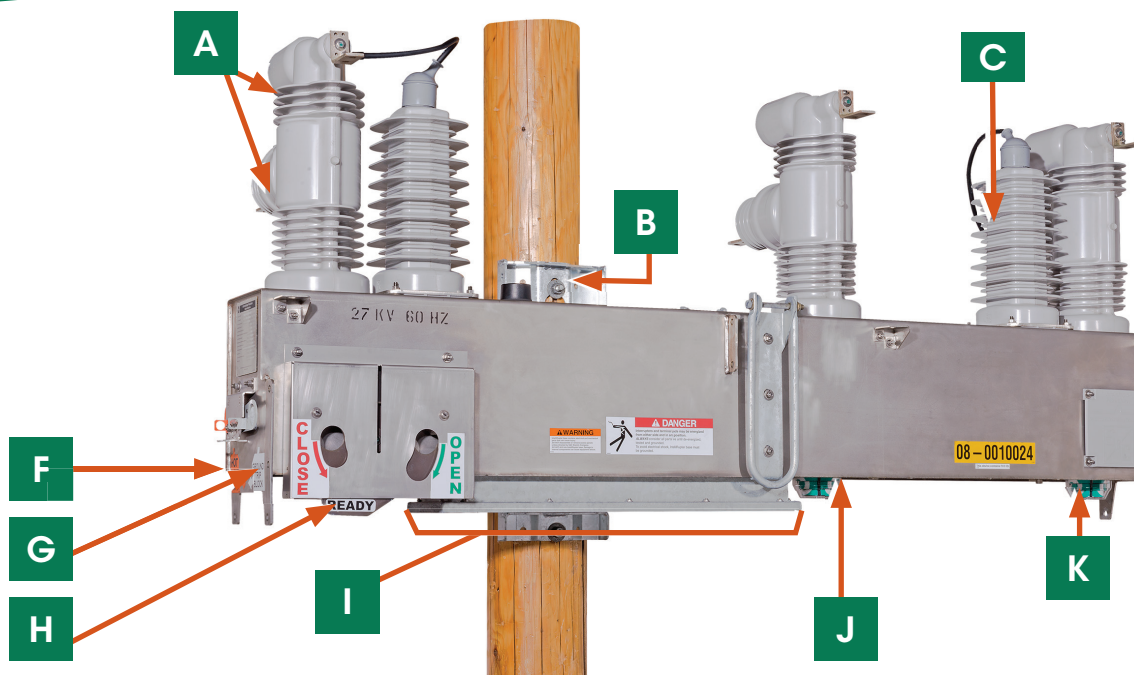


Figure 6. A Non-Disconnect Style IntelliRupter fault interrupter in an upright-crossarm mounting configuration, rated 15.5 kV maximum.

- A** Integrated voltage sensors on both sides of IntelliRupter fault interrupter provide highly accurate sensing across entire temperature range. Integrated current sensors provide extremely flat response, from low-level load currents through fault current levels, ensuring reliable measurements critical for system analysis. Sensors are molded into interrupter housings for all-weather durability.
- B** Integrated pole-mounting bracket is designed for easy installation; prevents tilting.
- C** The integral power module is fed from one side of an IntelliRupter fault interrupter or, optionally, two integral power modules are fed from a different phase on both sides to maximize availability of control power. This eliminates the cost and complexity of separately mounted control power transformers.
- F** The HOT-LINE TAG lever disables circuit testing and allows for faster interrupting times when the downstream circuit is being serviced.
- G** The GROUND-TRIP BLOCK lever allows the ground elements to be turned off to avoid nuisance tripping due to unbalances caused by single-phase switching.
- H** The interrupter OPEN/CLOSE/READY lever allows line crews to perform manual **Open** and **Close** operations with a utility hookstick and for the unit to be locked open for service or opened in the complete absence of control power.
- I** The control group features a hookstick-removable protection and control module and communication module. A multi-function status light indicates the control group is operating normally. A hot-line tag light indicates a "set" tag.
- J** A stainless steel base provides outstanding corrosion-resistance, even in the harshest environments.
- K** Interrupter OPEN/CLOSED indicator directly linked to the magnetic actuator to provide a reliable indication of the interrupter position.

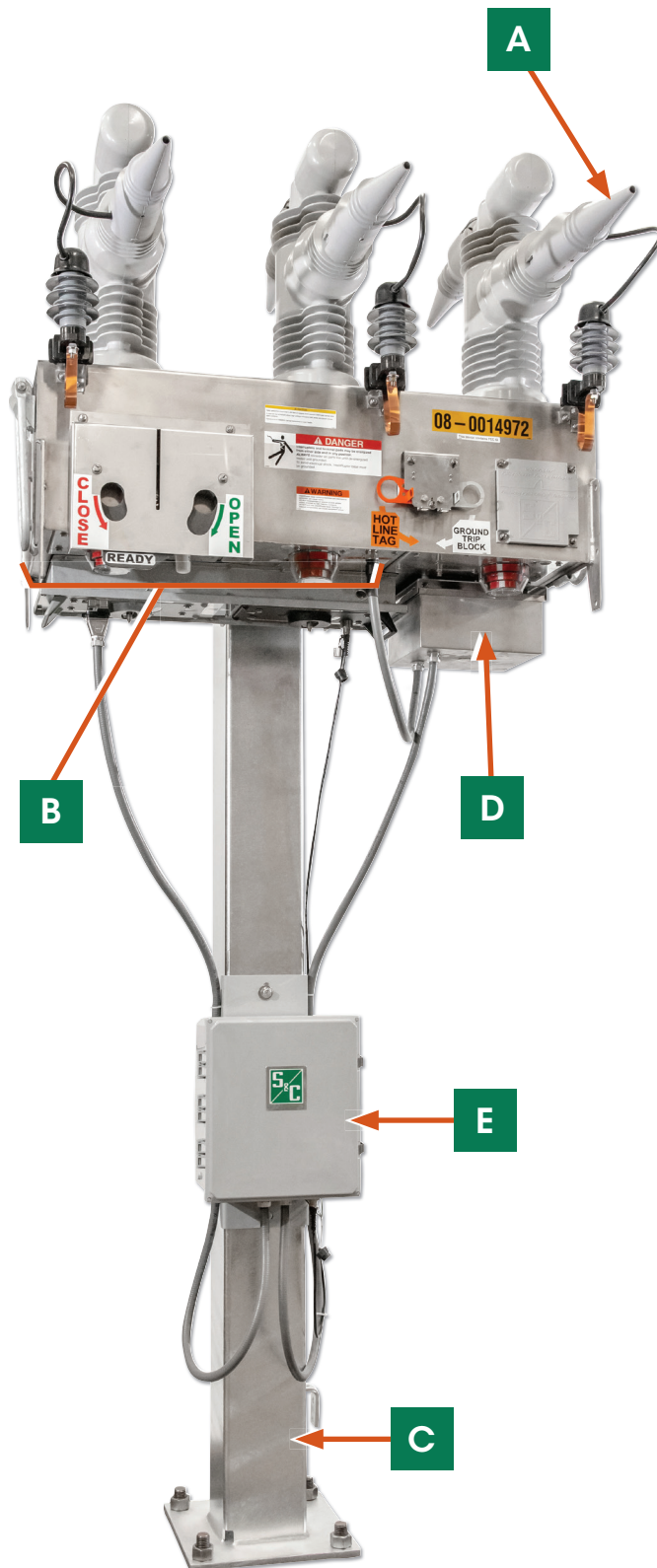


Figure 7. A Non-Disconnect Style IntelliRupter fault interrupter in a compact crossarm mounting configuration, rated 27 kV maximum. Furnished with features suitable for substation application.

- A** Wildlife protection helps to reduce outages caused when wildlife comes in contact with energized parts. The IntelliRupter fault interrupter wildlife protection is specifically designed to provide the best fit and highest degree of protection possible.
- B** The control group is furnished with a factory installed and wired fiber-optic modem. Fiber-optic connectivity provides fast, reliable communications with a much higher degree of noise immunity that is ideal for substation applications.
- C** The mounting pedestal is ideal for substation applications, allowing the IntelliRupter fault interrupter to fit nicely under the substation bus.
- D** The external power supply interface box has inputs for ac and dc, allowing it to be powered from a pole-top transformer or substation battery.
- E** The external trip interface allows hardwired connections to substation protection schemes such as bus differential, transformer differential, and back up overcurrent relays.

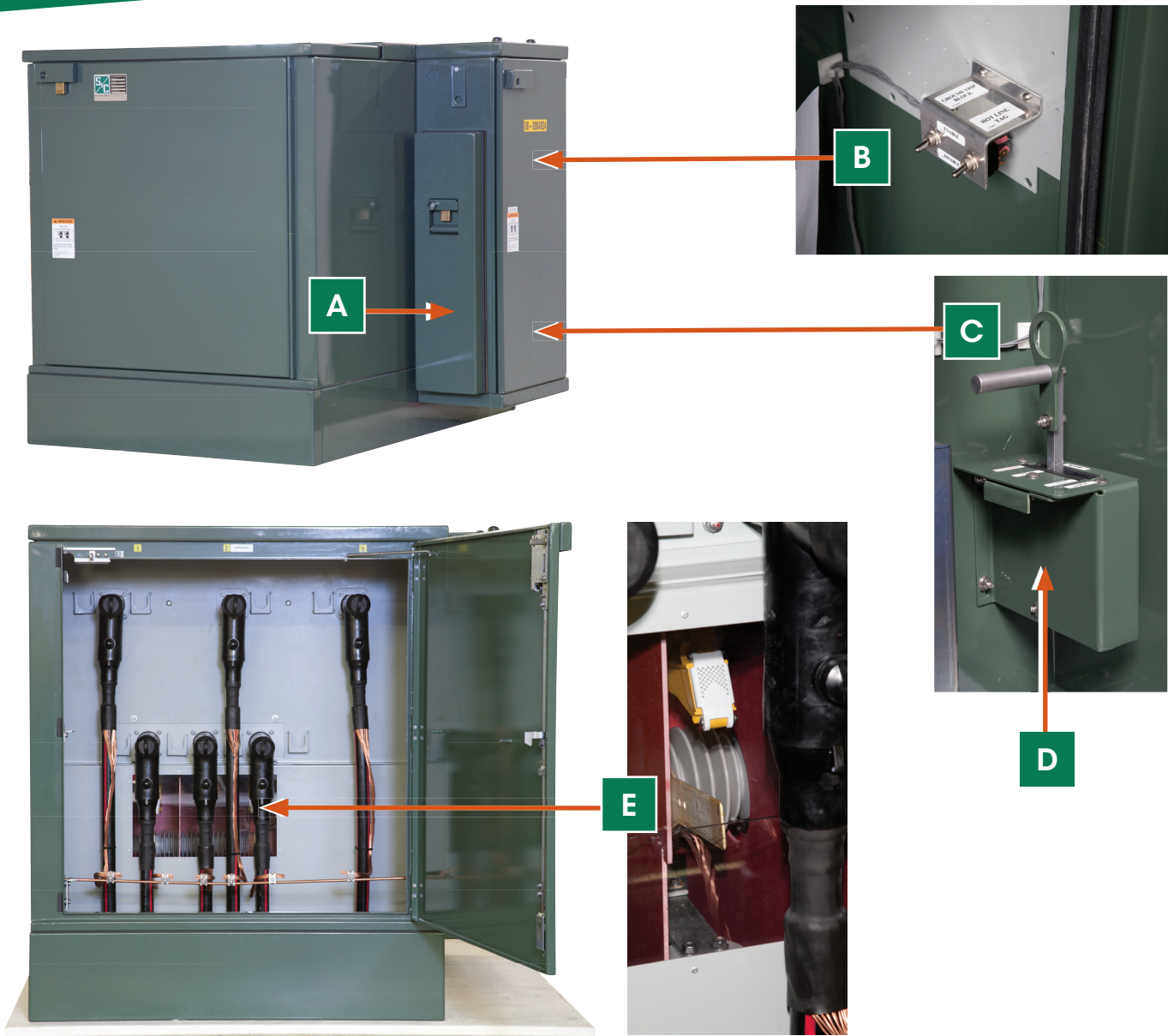


Figure 9. IntelliRupter fault interrupter accessories.

- A** The protection and control module and communication module provide excellent immunity to surges and noise. Located in the low-voltage compartment.
- B** The Hot-Line Tag disables circuit testing and allows for faster interrupting times when the downstream circuit is being serviced. When applied, the **Ground Trip Block** feature allows the ground elements to be turned off to avoid nuisance tripping due to unbalances caused by single-phase switching. Located in the low-voltage compartment.

- C** The interrupter OPEN/CLOSE/READY lever allows line crews to perform manual **Open** and **Close** operations with a utility hookstick and allows the IntelliRupter fault interrupter to be opened in the complete absence of control power. Located in the low-voltage compartment.
- D** The interlock lever bar provides a means to lock interrupters in the **Open** position for service work.
- E** A visible load-break disconnect provides a visible gap, allowing line crews to visually verify isolation when required by their operating practices.

New Concept in Controls

IntelliRupter fault interrupters are available with several kinds of control groups. Each offers easy configuration and operation—and examination of waveforms and events—using secure wireless communication to a nearby laptop computer. Each control group includes a protection and control module and a communication module. This flexible, low-maintenance arrangement offers excellent immunity to surges and noise induced by normal power-line events, such as faults and lightning strikes, and—in the case of IntelliRupter fault interrupters for overhead system applications—eliminates control boxes and the associated cables avoiding unnecessary clutter on the pole.

IntelliRupter fault interrupters are powered from the distribution line through the integral power module(s) or the external power supply, if furnished.

The protection and control module provides point-on-wave closing to minimize asymmetric fault current and inrush current. It features a complete set of protection and control functions, including:

- Simultaneous independent directional phase ground, negative-sequence, sensitive-earth time-overcurrent, instantaneous-overcurrent, and definite-time elements
- Directional blocking of overcurrent elements
- Over/under voltage elements
- Over/under frequency elements
- Phase unbalance detection
- Synchronization check
- Cold-load pickup modifier

Comprehensive diagnostics are included, too. A 20-channel GPS chip set provides 1-ms accurate time-stamping of events to speed post-event analysis, as well as IntelliRupter fault interrupter location data for your graphical information system.

Hook-stick operation levers for **Open, Close, Hot Line Tag,** and **Ground Trip Block** operations make transitioning from reclosers to IntelliRupter fault interrupters is easy for line workers.

IntelliRupter fault interrupters are factory-assembled on a stainless steel base and include:

Three-pole vacuum interrupters rated 630● amperes continuous on 15-kV and 27-kV disconnect models and all 38-kV models, 800 amperes continuous on 15-kV and 27-kV non-disconnect and compact models, 16,000 amperes interrupting at 15 kV, and 12,500 amperes interrupting at 27 kV and 38 kV

Unique magnetic latching actuators for the interrupters, providing single-phase tripping/single-phase lockout, single-phase tripping/three-phase lockout, or three-phase tripping/three-phase lockout (The interrupters can be manually tripped by means of a manual lever. Operable from the ground with an extendostick (overhead models), or they can be manually tripped by means of a manual OPEN/CLOSE/READY lever (pad mount models).)

High-accuracy sensors, for three-phase monitoring of line current and three-phase monitoring of line voltage on both sides of the interrupters (Sensing accuracy is $\pm 0.5\%$ for both voltage and current. Total system accuracy for fault detection, including sensing, control, and interrupting time, is $\pm 2\%$.)

External power supply connector, permitting pre-installation uploading and downloading of configuration settings, plus radio programming and battery charging, as applicable, indoors in your service center or lab

Unique multi-function status indicator, which shows that the control group is operating normally (The blink rate changes when a Wi-Fi connection is made, control power is lost, or the position of the OPEN/CLOSE/READY lever is changed. A separate HOT LINE TAG indicator shows a “set” tag.)

Integrated Global Positioning System, providing 1-ms accurate time-stamping of events to speed post-event analysis as well as IntelliRupter fault interrupter location data for entry into your graphical information system

For Overhead Upright-Crossarm Models Only: Provisions for three surge arresters on each side of the IntelliRupter fault interrupter (Factory-installed and -wired MacLean Power Systems Zforce™ Type ZHP (Heavy Duty) polymer-housed metal-oxide surge arresters are optionally available.)

Single-point lifting means, for convenient rigging and hoisting during installation

● A continuous current rating of 800 amperes applies with a 2 ft./sec. wind, similar to conductor ratings for the models rated to 630 amperes continuous.

For Pad Mount Models Only:

Controlled access to enclosure compartments (S&C's Penta-Latch® Mechanism provides automatic door latching and permits padlocking only when the door is securely latched. Doors can only be opened with a pentahead socket wrench or tool.)

Long-lasting enclosure protection (The enclosure is protected from corrosion by S&C's Ultradur® Finishing System. The roof is undercoated with an insulating "no-drip" compound. A resilient closed-cell gasket on the enclosure bottom flange protects the finish from being scratched during installation and isolates it from the alkalinity of a concrete foundation.)

Terminals equipped with 600-ampere bushings (with studs) (Bushing interfaces are in accordance with ANSI/IEEE Standard 386 and accept all standard separable insulated connectors. Parking stands are provided adjacent to each

bushing. Grounding provisions, suitable for use with separable insulated connectors and related accessories, are located in the termination compartment.)

Hinged roof section over the cable-termination compartment, allowing easy cable pulling during installation (The cable-termination compartment accommodates either single 600-ampere deadbreak connectors equipped with elbow-style surge arresters or two stacked 600-ampere deadbreak connectors without elbow-style surge arresters. Elbow-style surge arresters are required on both sides of Pad-Mounted Style IntelliRupter fault interrupters when installed on a feeder to protect it from surges beyond its ratings. When installed in a substation or at the base of a riser/dip pole, surge arresters are only required on the load side of Pad-Mounted Style IntelliRupter fault interrupters.)

Options

IntelliTeam® SG Automatic Restoration System

IntelliRupter fault interrupters are fully compatible with the IntelliTeam SG Automatic Restoration System.

IntelliRupter fault interrupters can take full advantage of S&C's field-proven IntelliTeam SG Automatic Restoration System. Its **Rapid Self-Healing** feature accomplishes restoration in seconds.

The IntelliTeam SG system includes a setup tool—IntelliTeam® Designer—which greatly simplifies configuration and deployment.

The IntelliTeam SG system uses all available alternate sources to restore unfaulted line segments, without overloading any part of the system. The system minimizes the number of customers experiencing an extended power interruption, tremendously improving your system.

External Trip Interface

The optional external trip interface allows hardwire connections from the substation equipment to be decoded and sent to the control through an optical connection, providing complete electrical isolation between the substation control voltages and the IntelliRupter fault interrupter control system. Integrating the IntelliRupter fault interrupter into the substations allows S&C's PulseClosing Technology to directly protect substation transformers. This feature will allow connections to backup relays, transformer and bus differential protection relays, control house indicators, switches, and other substation protection, allowing it to be tripped at protection speeds for these applications. It has been designed to work with S&C's IntelliTeam SG Automatic Restoration System, allowing the substation protection to integrate seamlessly with the industry's fastest self-healing system.

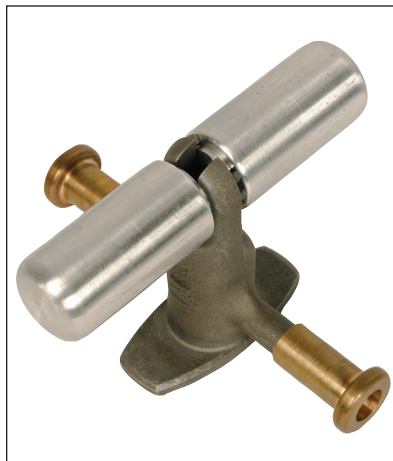
In addition to the substation application, this new feature also opens opportunities for integrating with distributed energy resources by providing an interface for tripping and monitoring.

The **External Trip** feature provides six inputs and five outputs. Go to sandc.com and see S&C Instruction Sheet 766-514 for more details. The customer interface will accept dc voltages ranging from 19 Vdc to 180 Vdc, allowing it to operate with 24-V, 48-V, and 125-V substation batteries. It can also operate from 102 Vac to 208 Vac.



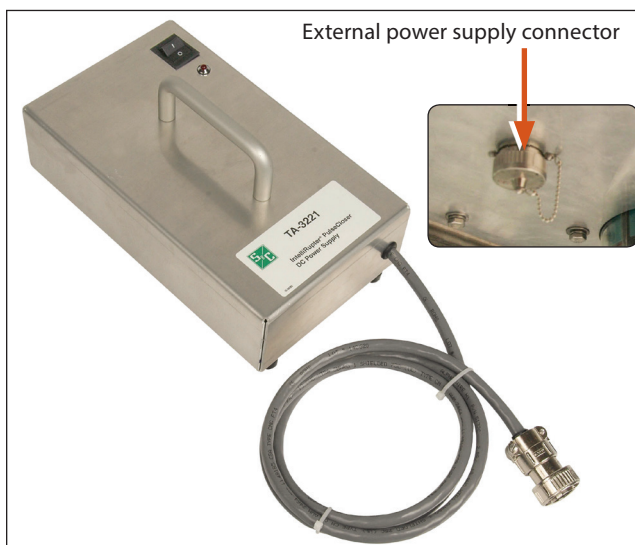
Module handle fitting.

Attaches to the hookstick with universal fitting. Permits field installation and removal of protection and communication module. Includes prong for operating IntelliRupter fault interrupter levers.



Module stub handle.

Permits installation and removal of the protection and communication module—in your service center or lab. When permitted by utility operating practice, can be used by a gloved individual to install and remove modules in the field.



External power supply connector

Power supply. Powers the protection and control module and communication module, installed in the base or low-voltage compartment—in your service center or lab. Permits Open, Close, and Pulsing operations, pre-installation uploading and downloading of configuration settings, programming of radio, and charging of radio batteries, as applicable. For indoor use only.

Other Accessories:

- Spare 12-Vdc, 8-ampere-hour battery pack for communication module
- Battery charger output harness, for connecting battery pack to an 800-mA, current-limited 12-Vdc lead-acid battery charger
- Detailed instruction manual that includes printed copies of all IntelliRupter fault interrupter instruction sheets, erection drawings, and reference drawings

Figure 9. IntelliRupter fault interrupter accessories.

Table 1. Disconnect Styles^①

kV		Amperes, RMS	
Maximum	BIL	Continuous	Interrupting, Symmetrical
15.5	110	630/800●	16 000
27	125		12 500
38	170		12 500

① Each IntelliRupter fault interrupter includes as standard an integrated power module fed from one phase on one side of the switch. An integrated power module fed from one phase on each side of the switch is optionally available.

- 630 amperes per IEC; 800 amperes with a minimum wind velocity of 2 ft/sec.

Table 2. Compact and Non-Disconnect Styles^①

kV		Amperes, RMS	
Maximum	BIL	Continuous	Interrupting, Symmetrical
15.5	95	800	16 000
27	125		12 500

① Each IntelliRupter fault interrupter includes as standard a choice of one integrated power module that derives necessary control power from one phase on one side of the switch, or an external power supply for use when user-provided control power is available. See S&C Instruction Sheet 766-510 for available input ranges. An integrated power module fed from one phase on each side of the switch is optionally available.

Table 3. Non-Disconnect Styles^①

kV		Amperes, RMS	
Maximum	BIL	Continuous	Interrupting, Symmetrical
15.5	110	800	16 000
27	125	800	12 500
38	170	630/800●	12 500

① Each IntelliRupter fault interrupter includes as standard an integrated power module fed from one phase on one side of the switch. An integrated power module fed from one phase on each side of the switch is optionally available.

- 630 amperes per IEC; 800 amperes with a minimum wind velocity of 2 ft/sec.

