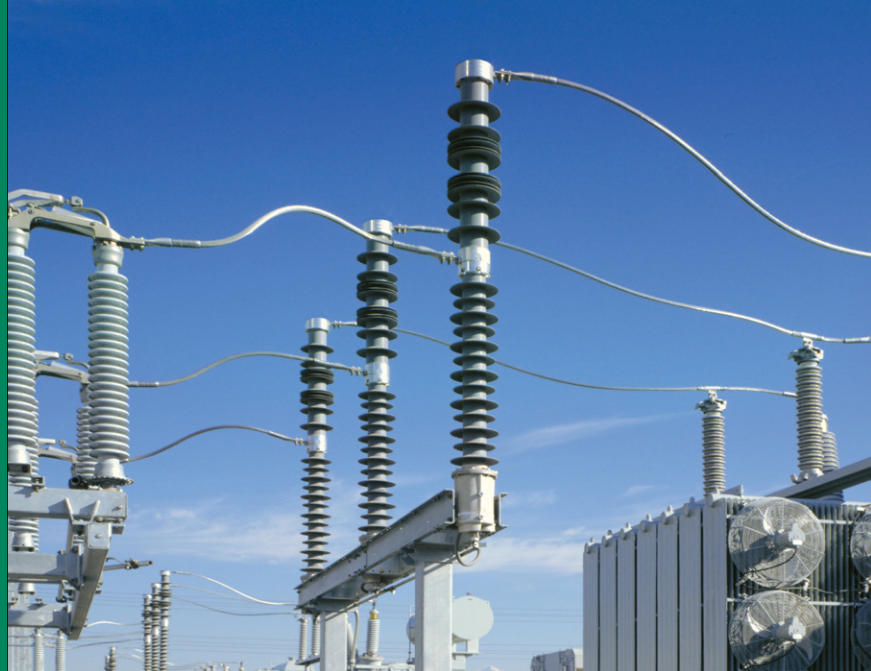


TRANS-RUPTER II[®] TRANSFORMER PROTECTOR

AFFORDABLE SOPHISTICATED
TRANSFORMER PROTECTION



The Low-Cost Solution for Sophisticated Transformer Protection.

CONTENTS

Introduction	1
A Design Specifically Tailored to Transformer Protection	3
Superior Operating Mechanism	5
Model EX for Use with User-Furnished Control System	5
Model SE with Self-Powered Overcurrent Protection System	7
How It Works	9
S&C Mounting Pedestals	11
Accessories	11
Ratings	12

Introduction

- ◆ Are you spending more than you want for transformer protection? Are you buying circuit breakers with expensive features you don't need?
- ◆ Do you want a device that's economical and easy to install, such as power fuses, but with three-phase tripping and the ability to coordinate with downstream protective devices, such as a circuit-switcher or circuit breaker?
- ◆ Is increasing system capacity challenging the fault-interrupting capability of your existing protective devices?
- ◆ Are you building a compact or mobile substation and need a device with flexible mounting arrangements?
- ◆ Are you planning a new substation or an upgrade of an existing substation and want to keep costs down?



Introduction (continued)

Utilities are looking to improve reliability and reduce costs by replacing aging transformer-protective devices. Customers understand the importance of transformer protection but may not be aware that there are alternatives to using devices with limited functions such as power fuses or expensive circuit breakers with features that are not needed.

The Trans-Rupter II Transformer Protector is a low-cost and low-maintenance solution that does not merely change transformer protection practices, it revolutionizes them! The Trans-Rupter II Transformer Protector is designed strictly for transformer protection (it is not for other switching duties, such as line and capacitor switching). This means the customer only pays for the features it needs while enjoying the same

protective benefits offered by circuit-switchers and breakers. See **Table 1**.

The Trans-Rupter II Transformer Protector is designed exclusively for primary-side application on distribution substation transformers, where operation is infrequent and continuous-current requirements are modest. It provides all the features needed for reliable transformer protection and eliminates the cost of those that aren't.

The Trans-Rupter II Transformer Protector doesn't just provide a low purchased cost. With its simple installation procedure and no periodic maintenance needs, it provides low installed and operating costs, too. The Trans-Rupter II Transformer Protector's lightweight, compact design allows it to be mounted on many substation structures, or even directly on the transformer or disconnect switch.

TABLE 1. A Comparison of Today's Alternatives for Transformer Protection

Feature	Power Fuses	Circuit-Switchers	Circuit Breakers	Trans-Rupter II Transformer Protector Model EX	Trans-Rupter II Transformer Protector Model SE
Three-Phase Tripping	No	Yes	Yes	Yes	Yes
Activated by Relays	No	Yes	Yes	Yes	Yes
Resettable	No	Yes	Yes	Yes	Yes
High Interrupting Ratings	No	Yes	Yes	Yes	Yes
SCADA Compatibility	No	Yes	Yes	Yes	Yes
No Substation Batteries	Yes	No	No	No	Yes
Mounting Flexibility	Yes	No	No	Yes	Yes
Low Installed Cost	Yes	No	No	Yes	Yes

The Model EX is perfect for substations where control power and relays are already in place. It's especially suited for retrofitting overdutied circuit breakers or circuit-switchers or for updating transfer-trip, flash-bus, or high-speed grounding switch transformer-protection schemes.

The Model SE features a self-powered overcurrent-protection system activated by the current transformers on the primary bushings

of the transformer. The Model SE is ideal for retrofitting power fuse installations and for new substation construction, saving the cost of substation batteries, relays, and even the control house!

The Trans-Rupter II Transformer Protector is an economical and technological breakthrough in transformer protection.

A Design Specifically Tailored to Transformer Protection

The Trans-Rupter II Transformer Protector features individual hermetically sealed, SF₆ gas-filled pole-units, each with its own electrically tripped operating mechanism. There's no mechanical interphase linkage to install, adjust, or maintain. The reliable single-gap puffer-type interrupters interrupt the circuit in three cycles and maintain dielectric ratings when open. The Trans-Rupter II Transformer Protector has a 31.5-kA fault-interrupting rating, more than enough for most applications.

The pole-units are extremely lightweight: 69-kV pole-units weigh just 175 lbs. (79 kg), 115-kV pole-units weigh 210 lbs. (95 kg), and 138-kV pole-units weigh 217 lbs. (98 kg). The pole-units feature durable composite-polymer silicone insulation that is lightweight and shatterproof.

The insulation system exhibits no sensitivity to ultraviolet radiation and it's hydrophobic.

Water beads on the surface instead of forming a film. This property prevents the formation of leakage paths that can cause tracking and flashover. The insulation also maintains its hydrophobic properties regardless of the amount or type of contaminants on its surface, so there's no need to power-wash pole-units, even in coastal regions or areas with heavy industrial pollution.

The pole-units meet the criteria of IEC Standard 815 for medium insulation. The unique skirt arrangement provides a leakage distance of 58 inches (147 cm) line to ground and 59 inches (150 cm) across the interrupter at 69 kV. At 115 kV, the leakage distance is 101 inches (257 cm) line to ground and 115 inches (292 cm) across the interrupter. And at 138 kV, the leakage distance is 118 inches (300 cm) line to ground and 115 inches (292 cm) across the interrupter.

A Design Specifically Tailored to Transformer Protection (continued)

The unique sealing process draws on S&C's 60+ years of expertise in designing circuit-switchers and ensures a zero leakage rate at temperatures from -35°C to +40°C. (-31°F to +104°F). The pole-units are factory-filled to full pressure under controlled conditions and then permanently sealed. Field-filling is never needed, eliminating the risk of contaminating the interrupting medium. All pole-units undergo thorough leak tests before shipping using an ultra-sensitive "sniffer" capable of detecting minute traces of SF₆ gas, thus ensuring superior reliability in the field. See **Figure 1** and **Figure 2**.

FIGURE 1. Pole-unit base detail.

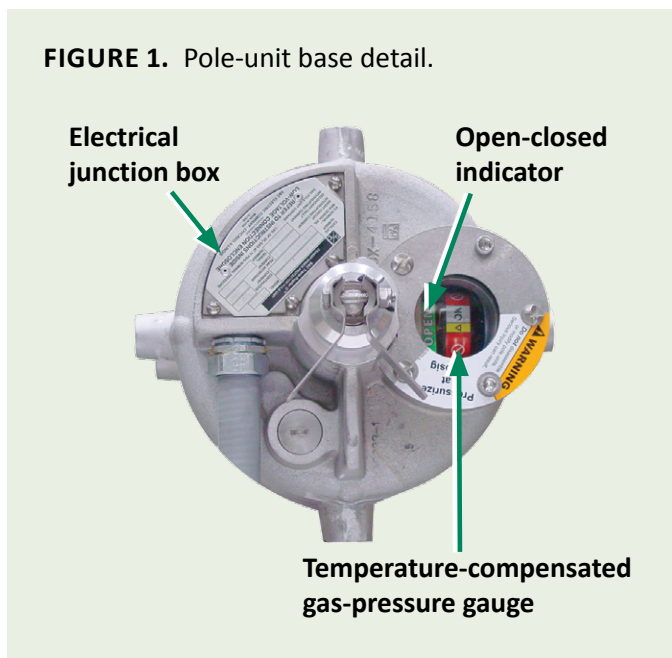
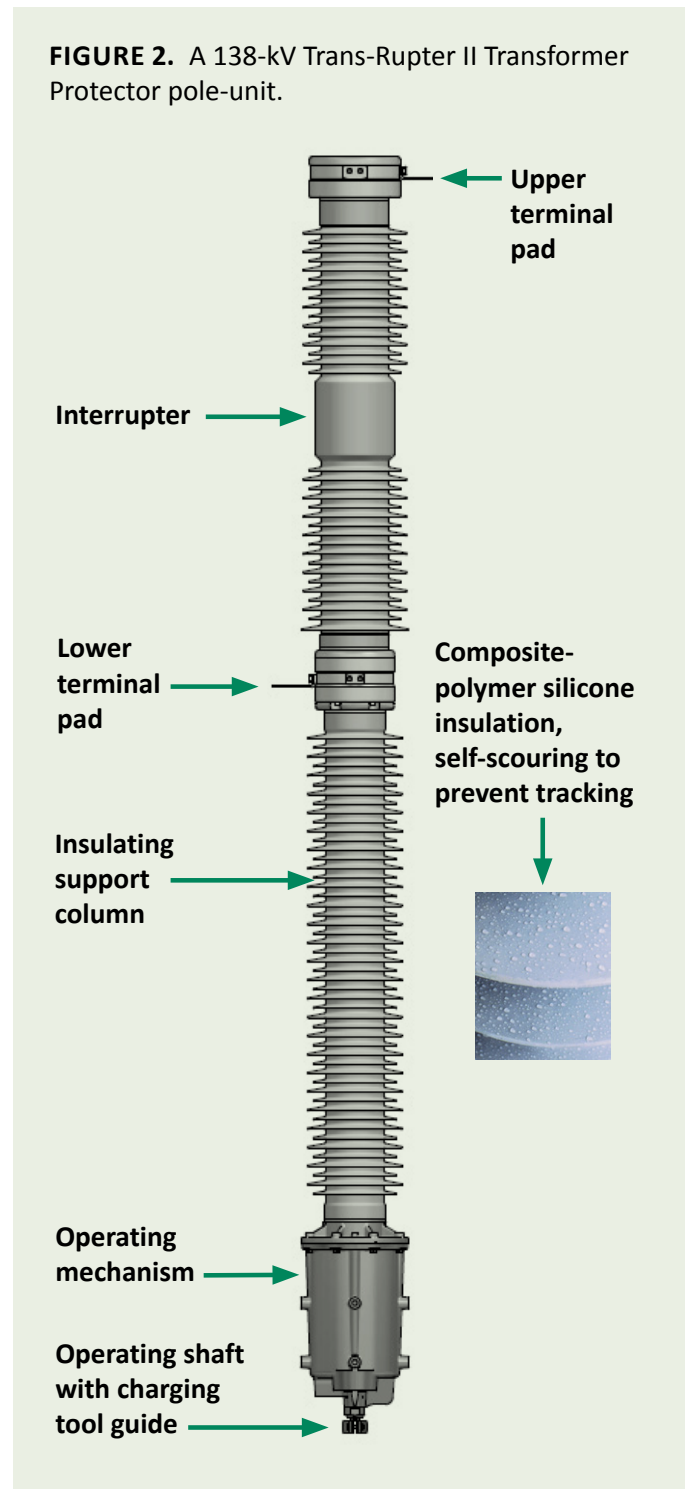


FIGURE 2. A 138-kV Trans-Rupter II Transformer Protector pole-unit.



Superior Operating Mechanism

The operating mechanism is a spring-charged, stored-energy device. It uses minimal parts for heightened reliability. The operating mechanism is sealed in SF₆ gas for excellent protection from the environment. No heaters are necessary. Unlike many other transformer-protective devices, the Trans-Rupter II Transformer Protector's operating mechanism doesn't require periodic maintenance.

An indicator on the underside of each pole-unit base shows whether the pole-unit is "closed and

charged" or "open and discharged." Each pole-unit includes contacts for remote indication of pole-unit state, which can be monitored via SCADA. A temperature-compensated gas-pressure gauge on the underside of each pole-unit base provides local visibility of gas density and two-level leak indication. A remote gas-density indicator is optionally available.

Model EX for Use with User-Furnished Control System

Model EX is tripped by an external signal from a user-furnished differential, sudden-pressure, overcurrent, or other relay. Model EX requires a user-furnished 48-Vdc or 125-Vdc control power source.

A low-voltage connection enclosure is provided for connecting the user-furnished relays and control-power source. No heaters are required.

Each pole-unit has three contacts that can be used to monitor pole-unit state remotely. If specified, two extra contacts for the remote gas-density indicator can be included.

One use case of the Model EX is it can help protect a wind-generation substation transformer. See **Figure 3**. In dusty mesa environments, its non-tracking composite-polymer silicone insulation that provides superior dielectric performance.

FIGURE 3. A Model EX protecting a wind-generation substation.

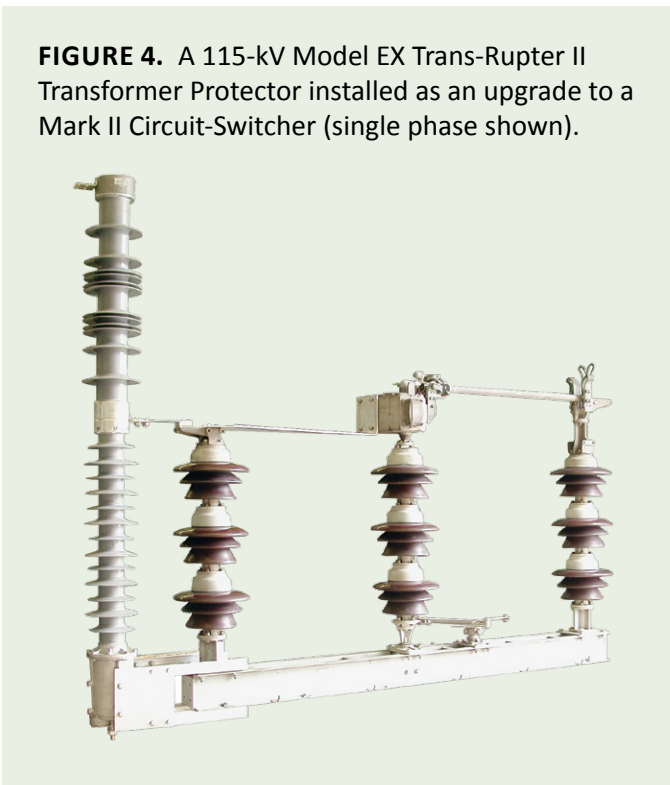


Model EX for Use with User-Furnished Control System *(continued)*

The Trans-Rupter II Transformer Protector's 31.5-kA fault-interrupting rating is more than sufficient to handle future increases in available fault current ... a possibility if generating capacity at the wind facility ever increases.

The Model EX is an economical way to upgrade S&C Mark II through Mark V Circuit-Switchers in transformer-protection applications. See **Figure 4** Trans-Rupter II Transformer Protector pole-units mount directly to the circuit-switcher bases and provide enhanced 31.5-kA fault-interrupting protection and three-cycle operating time. The blade assemblies of the circuit-switcher are retained as a source-side series disconnect; their fault-closing capability is maintained. The Trans-Rupter II Transformer Protector uses the existing relays, structure, and foundation, minimizing installation time and cost.

FIGURE 4. A 115-kV Model EX Trans-Rupter II Transformer Protector installed as an upgrade to a Mark II Circuit-Switcher (single phase shown).

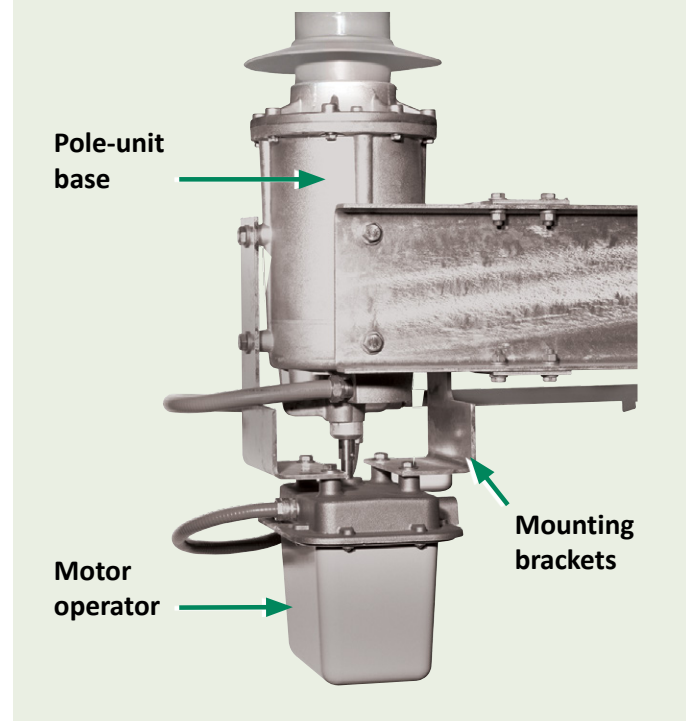


Model EX is perfect for new substations and for retrofitting outdated circuit breakers, transfer-trip schemes, or high-speed grounding switches.

Motor operators are optionally available for Model EX and provide remote resetting capability. See **Figure 5**. The operators mount under the Trans-Rupter II Transformer Protector pole-units. They're easy to install and are removable for manual closing and charging should control power is lost. No heaters are required.

The motor operators eliminate the need to manually close the interrupters. Their operation may be coordinated with that of a motor operated disconnect used to pick up the transformer.

FIGURE 5. A motor operator mounted to a pole-unit.



Model SE with Self-Powered Overcurrent Protection System

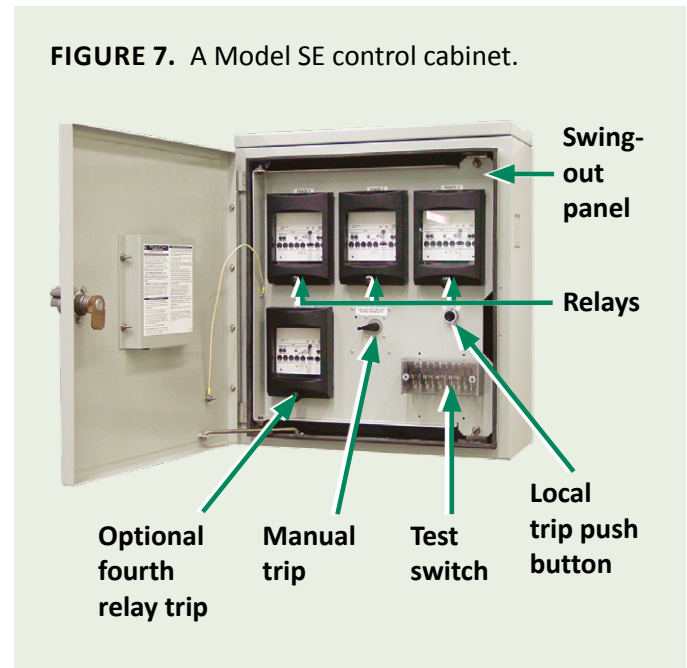
Model SE is ideal for new installations and for retrofitting overdutied power fuse installations where there's no control house or control power source. The Model SE is great for mobile substations, too, and remote substations where constructing a control house is impracticable. See Figure **Figure 6**. Because no batteries are required, there's no battery maintenance to contend with and no control house necessary. And no batteries can significantly lower initial purchase cost as well as lifetime costs.

FIGURE 6. A 138-kV Model SE Trans-Rupter II Transformer Protector mounted to transformer at a temporary installation on railroad ties.



The three microprocessor-based, self-powered overcurrent relays and the trip-energy supply are housed in a weatherproof control cabinet that mounts easily on most substation structures. See Figure **Figure 7**. The relays provide both time-overcurrent and instantaneous-overcurrent protection and are field-settable with adjustable time delays.

FIGURE 7. A Model SE control cabinet.



Model SE with Self-Powered Overcurrent Protection System (continued)

The Model SE relays are mounted on a swing-out panel that provides easy access to the terminals for making the wiring connections to the pole-units and the transformer's primary-side current transformers. The draw-out style relays may be tested in place or removed for setting and testing at a testing bench. Both the relays and the Model SE's trip-energy supply can be tested without taking the Trans-Rupter II Transformer Protector out of service.

The overcurrent relays feature a variety of industry standard time-current characteristics. A fourth overcurrent relay is optionally available to monitor neutral current and provide enhanced ground-fault sensing. Relay power-up time is two cycles. Combined with the Trans-Rupter II Transformer Protector's three-cycle interrupting time, Model SE can provide a total fault-clearing time of five cycles.

Sensing for the overcurrent relays and power for the relays and the trip-energy supply, is provided by primary-side current transformers. A pushbutton is furnished in the control cabinet to initiate local trip operation; a manual trip device provides the energy to trip the pole-units during installation before the transformer is energized and should control power be lost. An optional test switch is available to test the trip circuit without opening the pole-units.

FIGURE 8. A 69-kV Model SE Trans- Rupter II Transformer Protector on an S&C Mounting Pedestal.



TRIPPING

The Trans-Rupter II Transformer Protector features three-phase tripping of the electrically linked pole-units using the following process:

- Step 1.** Each pole-unit operating mechanism receives a trip signal from the user-furnished protective relay (on Model EX) or the self-powered overcurrent relay system (on Model SE). See Figure **Figure 9**.
- Step 2.** The trip solenoid is energized. The solenoid armature drops down on the trip latch, releasing the latch. See Figure **Figure 10**.
- Step 3.** Stored energy from the trip springs pulls the operating rod downward, opening the interrupter. See Figure **Figure 11**.
- Step 4.** The source-side disconnect is open to isolate transformer (not shown).

FIGURE 9. The interrupter closed.

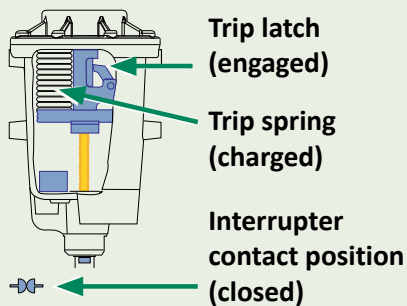


FIGURE 10. The trip solenoid energized, and the trip latch released.

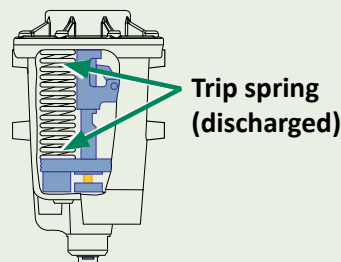
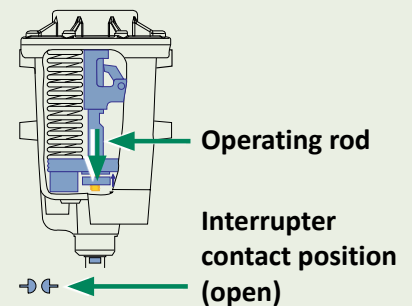


FIGURE 11. The interrupter open.



How It Works (continued)

CLOSING AND CHARGING

The Trans-Rupter II Transformer Protector's pole-units are manually closed and charged on a single-phase basis. This simple procedure typically takes less than five minutes to complete for all three phases. The Trans-Rupter II Transformer Protector is furnished with an easy-to-use ergonomic manual charging tool. This tool is held captive during the following charging process and cannot be removed until the pole-unit is fully closed:

- Step 1.** Hook the charging tool to the operating shaft under the pole-unit base. See Figure **Figure 12**.
- Step 2.** Turn the tool counterclockwise. The spring resetting plate is driven upward, charging the trip springs and resetting the trip solenoid, trip latch, and closing latch. A torque limiter in the handle of the charging tool prevents overcharging. See Figure **Figure 13**.
- Step 3.** To complete the process, crank the tool clockwise. The spring resetting plate returns to the mechanism base, ready for another trip operation. See Figure **Figure 14**.
- Step 4.** When the tool reaches its definite stop, the tool can be removed. See Figure **Figure 15**.
- Step 5.** Close the source-side disconnect to pick up the transformer magnetizing current and energize the transformer (Not shown).

FIGURE 12. Attaching the manual charging tool.

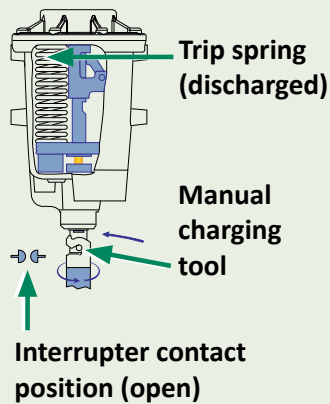


FIGURE 13. Turning the tool counterclockwise to charge the trip spring and engage the trip latch.

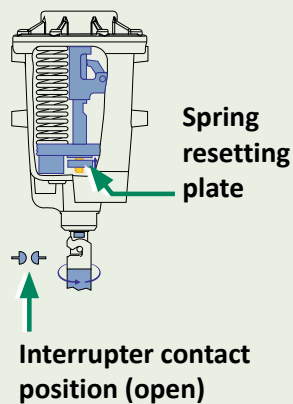


FIGURE 14. Turning the tool clockwise to reset the spring resetting plate.

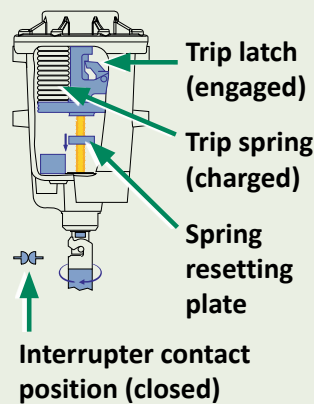
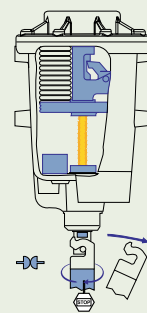


FIGURE 15. Remove manual charging tool.



S&C Mounting Pedestals

The Trans-Rupter II Transformer Protector can be furnished with optional easy-to-install S&C Mounting Pedestals. See Figure **Figure 8** on page 8. Pedestals are available at 48- through 102-inch (122- through 259-cm) phase spacings at standard heights of 8, 10, and 12 feet (244, 305, and 366 cm). All pedestals are of an 8-inch (20-cm) square galvanized-steel tube construction and come with pre-wired conduit and all of the hardware necessary for installation.

The Trans-Rupter II Transformer Protector is also available with an integral manually operated source-side disconnect for when a complete transformer protection package is required. The disconnect can be power-operated by an S&C Type LS-1 Switch Operator, which can be coordinated with the optional motor operators on Model EX for complete remote operation capability.

Accessories

The following accessories are available for the Trans-Rupter II Transformer Protector. Other accessories are available. Consult the nearest S&C Sales Office for details.

- A Motor operators, 48-Vdc (applicable to Model EX switches)
- B Motor operators, 125-Vdc (applicable to Model EX switches)
- C2 Pole-unit quick-connect control cable (applicable to Trans-Rupter II Transformer Protectors furnished with S&C Mounting Pedestals)
- C3 Complete quick-connect control cable for connecting pole-unit charging motors and the low-voltage connection enclosure (applicable to Model EX furnished with S&C Mounting Pedestals)
- F Bypass accessory (applicable on 69-kV through 115-kV Models only)
- L Tool key interlock
- P Remote gas-density indicator

Ratings

TABLE 2. Trans-Rupter II Transformer Protector Ratings¹

kV Nom.	kV Max	kV BIL	Cont. Amp., RMS	4-Hr. Amp., RMS	Peak With- stand Amp., RMS	1-Sec. Amp., RMS	Duty-Cycle Fault-Inter- rupting, Sym. ² 3-time ³ Amp., RMS	Duty-Cycle Fault-Inter- rupting, Sym. ² 5-time Amp., RMS	Duty-Cycle Fault-Inter- rupting, Sym. ² 10-time Amp., RMS	Duty-Cycle Fault-Inter- rupting, Sym. ² 30-time Amp., RMS	Second- ary Faults ⁴ Amp., RMS
69	72.5	350	420	630	81 900	31 500	31 500	18 900	9 450	3 150	4 200
115	123	550	420	630	81 900	31 500	31 500	18 900	9 450	3 150	2 600
138	145	650	420	630	81 900	31 500	31 500	18 900	9 450	3 150	2 600

- Ratings for applications between -35°C to +45°C (-31°F to +113°F). A cold-temperature version of the transformer protector is available for application at -50°C (-58°F) with reduced interrupting ratings. Call the nearest S&C Sales Office for details.
- Rating is based on transient recovery-voltage parameters defined in the following tables of IEC Standard 60056, Edition 4.0: 1987:
For Trans-Rupter II Transformer Protector models rated 69 kV: Tables IIa, XVa, and XVIa.
For Trans-Rupter II Transformer Protector models rated 115 kV and 138 kV: Tables IIc, XVc, XVIc, and XVII.
- Trans-Rupter II Transformer Protectors cannot be applied on systems with short-circuit currents in excess of this value.
- The Trans-Rupter II Transformer Protector is suitable for transformer-primary applications where the inherent secondary-fault current—the secondary-side fault current as reflected on the primary side of the transformer, assuming an infinite (zero-impedance) source—does not exceed this value for a fault external to the transformer. The Trans-Rupter II Transformer Protector secondary-fault current may be calculated as follows:

$$I = \frac{57.8P}{(\%Z)E}$$

- where
- I = Inherent secondary-fault current, amperes
 - P = Transformer self-cooled three-phase rating, kVA
 - E = Primary-side system phase-to-phase voltage, kV
 - %Z = Percent transformer primary-to-secondary impedance, referred to transformer self-cooled three-phase kVA rating (example: enter 7% as 7.0)

$$57.8P = \left(\frac{1}{1.73} \right) * 100 \left\{ \text{where } 1.73 = \sqrt{3} \right.$$



CONTACT YOUR S&C SALES REPRESENTATIVE FOR MORE INFORMATION

sandc.com

