

(34.5 kV through 230 kV)

The selector table in this publication lets you compare the features and capabilities of S&C's substation transformer protective devices, so you can select the appropriate device for your application.

The diagram illustrates a power system configuration with three main protective zones defined by dashed lines:

- Protective zone of circuit breaker #1:** This zone is bounded by a dashed line and includes the area between CB1 and the circuit-switcher (C/S). It contains the NC switch, the C/S, and the TC (Thermal Current) relay.
- Protective zone of circuit breaker #2:** This zone is bounded by a dashed line and includes the area between the C/S and CB2. It contains the TC relay, the 86 relay, and the 50/51 relay.
- Protective zone of Circuit-Switcher:** This zone is bounded by a dashed line and includes the C/S, the 50/51 relay, the 86 relay, and the 87 relay.

The system components and their connections are as follows:

- CB1 (Circuit Breaker #1):** Located at the top left, connected to the main bus.
- NC (Normally Closed):** A switch located between CB1 and the C/S.
- C/S (Circuit-Switcher):** A central component that can be opened or closed.
- TC (Thermal Current):** A relay connected to the C/S.
- 86 (Relay):** A relay connected to the TC.
- 50/51 (Relay):** A relay connected to the C/S and the 86 relay.
- 87 (Relay):** A relay connected to the C/S and the 86 relay.
- 63 (Relay):** A relay connected to the C/S.
- Feeder:** A line connecting the C/S to the 86 relay.
- 86 (Relay):** A relay connected to the TC, 50/51, 87, and the Feeder.
- 51 (Relay):** A relay connected to the 86 relay.
- 63 (Relay):** A relay connected to the 86 relay.
- 87 (Relay):** A relay connected to the 86 relay.
- Feeder:** A line connecting the C/S to the 86 relay.
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Overlapping protection from rare high-current primary faults is afforded by the line-terminal circuit breakers and first-zone phase- and ground-fault line-protective relays. Circuit interruption following a high-current primary fault is typically accomplished in 3 cycles. The local primary-side transformer protective device responds to faults

A secondary-side fault current calculator is available at www.sandc.com.

Selection Guide for S&C Substation Transformer Protective Devices

(34.5 kV through 230 kV)

Substation Transformer Protective Device Selector Table

	Trans-Rupter II Transformer Protector, Model EX	Trans-Rupter II Transformer Protector, Model SE	Series 2000 Circuit-Switcher
Voltage Rating, kV	69 through 138	69 through 138 kV	69 through 230 kV
Base Transformer Rating^① (MVA)	69 kV: 30; 115 kV: 36; 138 kV: 43	69 kV: 30; 115 kV: 36; 138 kV: 43	69 kV: 33; 115 kV: 55; 138 kV: 66; 161 kV: 77; 230 kV: 111
Continuous Current Rating, Amperes	420	420	1200, 2000■
Primary-Fault Interrupting Rating	31.5 kA RMS	31.5 kA RMS	69 to 138 kV: 25 kA or 40 kA* RMS; 161 and 230 kV: 20 kA RMS
Secondary-Fault Interrupting Rating	69 kV: 4.2 kA; 115 and 138 kV: 2.6 kA	69 kV: 4.2 kA; 115 and 138 kV: 2.6 kA	4 kA
Three-Phase Fault Interruption?	Yes	Yes	Yes
Available Mounting Configurations	Vertical interrupter	Vertical interrupter	Vertical or horizontal interrupter
Available Phase Spacings and S&C Mounting Pedestal Heights^②	Phase spacings: 48, 84, and 102 inches; Pedestal heights: 96, 120, and 144 inches	Phase spacings: 48, 84, and 102 inches; Pedestal heights: 96, 120, and 144 inches	Phase spacings: 48, 84, 102, and 120 inches; Pedestal heights: 96, 120, 144, 168, 192, 216, and 240 inches■
Integral Disconnect?	Optional vertical-break disconnect	Optional vertical-break disconnect	Model 2010 includes vertical-break disconnect; Model 2020 includes side-break disconnect
Installable on User-Furnished Structure?	Yes	Yes	S&C Mounting Pedestals included as standard. Modifiable for use on user structure
Control Power Source?	User-furnished substation batteries	Self-powered from transformer primary bushing CTs	User-furnished substation batteries
Interrupting Time	3 cycles	5 cycles (including relay power-up time for high-current faults)	5 to 6 cycles
Duty Cycle (O=open, C=closed)	O	O	O or CO
Resetting Method	Manually using tool furnished. Motor operators optionally available for remote "hands-free" resetting	Manually using tool furnished	Motor-operated switch operator furnished
Transformer Magnetizing Current Picked-Up By	User-furnished disconnect or optional S&C-furnished disconnect	User-furnished disconnect or optional S&C-furnished disconnect	Interrupter contacts
Relay Compatible?	Yes	Self-contained overcurrent relays. Compatible with some sudden-pressure relays♦	Yes
Operate/Monitor via SCADA?	Remote open. Remote close with optional motor operators.▼ Contacts available for monitoring pole-unit state	Remote open. Contacts available for monitoring pole-unit state▼	Fully SCADA compatible▲
Scheduled Maintenance	Visual inspection during regular transformer maintenance cycle◀	Visual inspection during regular transformer maintenance cycle◀	Mechanically linked interrupters and disconnect require inspection on approximate 5-year cycle

① Based on 7%-impedance transformer. Base transformer rating can vary at temperatures lower than -35°C. See product specification bulletin for details.

② Special modifications to the standard phase spacings and pedestal heights are available. Contact your nearest S&C Sales Office for details.

▼ Remote gas-density indicator optionally available.

◀ Silicone-polymer insulation and electrically linked pole-units require no regular maintenance. Periodic testing of the protective relay circuit is recommended.

♦ Compatible with user-furnished relays and monitoring equipment that do not draw power from the control circuit. Contact your nearest S&C Sales Office for details.

■ 69 kV-138 kV Series 2000 Circuit-Switchers available in 2000 A continuous are not available with 40 kA primary-fault interrupting ratings.

* 69 kV-138 kV Series 2000 Circuit-Switchers available in 40 kA primary-fault interrupting capability are not available in 2000 A continuous.

■ Series 2000 Circuit-Switchers are furnished with 96-inch height mounting pedestals as standard. Taller pedestal heights are available.

▲ Remote gas-density monitor optionally available.



	Mark V Circuit-Switcher	Mark VI Circuit-Switcher	Type SMD Power Fuses
	34.5 through 230 kV	69 through 138 kV	34.5 through 138 kV
	69 kV: 33; 115 kV: 55■; 138 kV: 66; 161 kV: 77; 230 kV: 111	69 kV: 30; 115 kV: 36; 138 kV: 43	34.5 kV: 12; 46 kV: 15; 69 kV: 18; 115 kV: 25; 138 kV: 30
	1200	420	250E and 300E
	7 or 8 kA RMS	31.5 kA RMS	34.5 kV: 33.5 kA; 46 kV: 31.5 kA; 69 kV: 17.5 or 25.0 kA; 115 kV: 10.5 kA; 138 kV: 8.75 kA RMS
	4 kA	69 kV: 4.2 kA ; 115 and 138 kV: 2.6 kA	Depends on unit ampere rating and speed selected
	Yes	Yes	No, single phase
	Horizontal interrupter	Vertical interrupter	Vertical, vertical-offset, upright, inverted, and right-angle
	Phase spacings: 41, 51, 96, 108, and 123 inches★; Pedestal heights: 8, 9, 10, 11, and 12 feet	Phase spacings: 51, 84, and 102 inches; Pedestal heights: 96, 120, and 144 inches	Phase spacings vary according to mounting arrangement and voltage rating
	Vertical-break or center-break disconnect	Vertical-break disconnect	Not applicable
	Yes●★	Yes●	Yes
	User-furnished substation batteries	User-furnished substation batteries	Not required
	8 cycles with shunt-trip option; 30 cycles without shunt-trip option	3 cycles	1 cycle. Depends on fuse unit ampere rating and speed selected, and level of fault current
	O or CO	O or CO	O (Fuse will operate if fault current is present when circuit is energized)
	CS-1A Switch Operator available separately. Manual operating handle available at some voltages	Disconnect operated by CS-1A Switch Operator furnished. Interrupters reset by motor operators furnishedⓈ	Manually following fuse unit replacement
	Integral high-speed disconnect▲	Integral high-speed disconnect	User-furnished disconnect
	Yes	Yes	Not applicable
	Fully SCADA compatible	Fully SCADA compatible△	Not applicable
	Mechanically linked interrupters and disconnect require inspection on approximate 5-year cycle	Mechanically linked disconnect requires inspection on approximate 5-year cycle	Visual inspection during regular transformer maintenance cycle. Refinishing of fuse units if necessary◆

■ 40 MVA for 115-kV single-gap Mark V Circuit-Switchers.

★ Phase spacing of Integer Style Circuit-Switchers is fixed by the dimensions of the mounting frame. For Circuit-Switchers rated 34.5 kV and 46 kV: 41 inches; for Circuit-Switchers rated 69 kV: 51 inches.

● An as-built drawing of the user-furnished structure is required at the time of order.

▲ CS-1A Switch Operator is required to obtain high-speed disconnect operation.

Ⓢ Two-minute interrupter resetting time is required between opening operations.

◆ User must stock spare fuse units. Fuse unit end fittings are reusable.



Selection Guide for S&C Substation Transformer Protective Devices

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Transformer Protective Device Overview

S&C Series 2000, Mark V, and Mark VI Circuit-Switchers use stored-energy operating mechanisms to drive the interrupters open, and have trip-free operating capability. In the event the Circuit-Switcher is closed into a fault, it will open immediately to interrupt the fault. Mark V and Mark VI Circuit-Switchers, as well as some styles of Series 2000 Circuit-Switchers, are equipped with an integral disconnect which provides visual indication of the device's state in addition to working clearance for transformer maintenance or repair.

Circuit-Switchers are available in ratings from 34.5 through 230 kV, with primary-fault interrupting ratings up to 31.5 kA, secondary-fault interrupting ratings up to 4200 amperes, and interrupting times as low as 3 cycles.

Additional information on Series 2000 Circuit-Switchers is available in S&C Publications 716-30 and 716-31. Information on Mark V Circuit-Switcher is available in S&C Specification Bulletin 711-31. Information on the Mark VI Circuit-Switcher is available in S&C Specification Bulletin 712-31.

S&C Trans-Rupter II Transformer Protector, Models EX and Model SE feature puffer-type interrupters similar to those used in Series 2000 Circuit-Switchers. These interrupters provide a 31.5-kA fault interrupting rating and 3-cycle interrupting time. Trans-Rupter II has

been tested to confirm its ability to interrupt fast TRVs and has been assigned a secondary-fault interrupting rating similar to Circuit-Switchers. Each pole-unit has its own operating mechanism; the pole-units are filled with SF₆ and sealed.

Model EX is tripped by user-furnished relaying; it requires an external power source. Model SE features a self-contained overcurrent protection relay system and needs no external power source. Additional information on Trans-Rupter II Transformer Protector is available in S&C Publications 731-30 and 731-31.

S&C Type SMD Power Fuses provide reliable, economical protection of small-to-medium-sized transformers. The savings can be considerable because power fuses are less costly than other types of protective equipment. They also require no costly auxiliary equipment such as station batteries, motor-driven switch operators, or protective relays.

S&C Power Fuses are included in the selector table to help contrast their capabilities with those of S&C Circuit-Switchers and Trans-Rupter II Transformer Protector. Detailed information on the application of S&C Power Fuses for transformer protection can be found in S&C Data Bulletin 210-110.

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