

Title: Southern States 38 kV-170 kV <b>CapSwitcher<sup>®</sup></b> Vertical Interrupter Style Capacitor Switcher	Product Specification Guide
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## 1.0 SCOPE

This specification covers the design, manufacture, and testing of three pole, gang operated vertical interrupter outdoor capacitor switchers available with or without integrated transient over-voltage control and inrush current mitigation.

## 2.0 STANDARDS

All outdoor capacitor switchers shall be designed, manufactured, assembled, and tested in accordance with the latest applicable ANSI, NEMA, and ASTM standards and guidelines. If there are any conflicts between the ANSI, NEMA, or ASTM standards and this specification the specification shall govern.

## 3.0 DESIGN REQUIREMENTS

### 3.01 Service Conditions

The capacitor switcher shall be suitable for outdoor installation in electric power substations under the following conditions:

#### 3.01.01 Temperature

The capacitor switcher shall perform in an ambient temperature range of -50°C through +50°C.

#### 3.01.02 Altitude

The capacitor switcher shall perform at elevations up to 3,300 feet.

#### 3.01.03 Seismic

The capacitor switcher shall be capable of withstanding seismic loading of 0.2 g ground acceleration in any direction when installed on the manufacturer's furnished support structure and anchor bolts and with flexible connections to the terminal pads. The device shall perform its specified functions during and after the seismic event.

#### 3.01.04 Wind Loading

The capacitor switcher shall be capable of withstanding wind loads up to 90 mph without loss of function.

#### 3.01.05 Additional Requirements

If any site-specific service conditions not covered in sections 3.01.01 through 3.01.04 exist (e.g. corrosive environment, high altitude installation, etc.) they will be defined in the quotation request.

### 3.02 Ratings

#### 3.02.01 General Specifications

Rated Maximum Voltage	38 kV	48.3 kV	72.5 kV	123 kV	145 kV	170 kV *
Rated Power Frequency Withstand Voltage	80 kV	105 kV	160 kV	260 kV	310 kV	365 kV
Rated Lightning Impulse Withstand Voltage (BIL)	200 kV	250 kV	350 kV	550 kV	650 kV	750 kV
Rated Power Frequency	50/60 Hz					
Rated Continuous Current	600 A			650 A		
Peak Withstand Current	130 kA			164 kA		
Short-Time Symmetrical Withstand	50 kA RMS 1 sec			40 kA RMS 1 sec, 63 kA RMS 18 cycles		
Rated Short Circuit Interrupting Current	18 kA (SF <sub>6</sub> / N <sub>2</sub> Gas Mixture)			25 kA (SF <sub>6</sub> / N <sub>2</sub> Gas Mixture)		
Number of Full Fault Operations	10					
Interrupting Speed	5 cycles			3 cycles		
Rated Duty Cycle	CO – 5 min – CO – 5 min – CO (Note: The 5 minutes is to allow the substation capacitor bank to discharge.)					
CAPACITOR SWITCHING RATINGS						
Rated Capacitive Switching Current	600 A			650 A		
Back-To-Back Capacitor Bank Breaking Current	600 A			650 A		
Rated High-Frequency Transient-Making Current / Transient Inrush Frequency	18 kA peak / 4630 Hz			20 kA peak / 4600 Hz		
Resistor Value	See Table in 3.03.01 Pre-insertion time 4-10 ms					

\* Suitable for use on grounded capacitor banks only

### 3.02.02 Additional

The capacitor switcher shall have an endurance life of 10,000 operations.

### 3.02.03 Source Supply Voltages

Purchaser will supply the following sources for the motor, auxiliary, and control circuits:

1. Motor / Control Voltage 48 VDC; 125 VDC; 250 VDC; 120 VAC, 60 Hz, 1Ø; or 240 VAC, 60 Hz, 1Ø
2. Auxiliary Voltage 120 VAC, 60 Hz, 1Ø or 240 VAC, 60 Hz, 1Ø

## 3.03 Resistors

The capacitor switcher shall be constructed with pre-insertion (closing) resistors for damping transients caused by switching capacitor banks. The resistor contacts and the main contacts shall make and break in the SF<sub>6</sub>/N<sub>2</sub> gas mixture.

### 3.03.01 Resistor Values and Selection Chart

Applied Voltage (kV)	Bank Size (MVAR)	Closing Resistor Size
38	3 to 5	90 Ω
	5.1 to 9	60 Ω
	9.1 to 15	30 Ω
	15.1 to 25	20 Ω
	25.1 to 40	12 Ω
48.3	4 to 18	40 Ω
	18.1 to 48	20 Ω
72.5	5 to 20	80 Ω
	20.1 to 72	40 Ω
123	15 to 40	150 Ω
	40.1 to 75	75 Ω
	75.1 to 130	37.5 Ω
145	10 to 25	150 Ω
	25.1 to 60	150 Ω
	60.1 to 120	75 Ω
	120.1 to 155	37.5 Ω
175	18 to 30	300 Ω
	30.1 to 75	150 Ω
	75.1 to 181	75 Ω

#### Notes:

- 1) If you have a capacitor bank size not shown in the table above for one of these kV ratings, please contact Southern States for closing resistor values and provide the bank size in MVAR and the kV rating of the installation.

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- 2) Additionally, if desired, Southern States can analyze a customer's specific installation and recommend a resistor size based upon that installation specific requirements (i.e. kV rating of the installation, single bank switching or back-to-back switching, bank size, sequence in which banks are added – for back to back applications, etc.

The resistor must be able to withstand closing into a fault and continue to perform its specified function without damage. Resistor insertion time shall be between 4 ms and 10 ms. Resistors shall be optional for systems that do not require transient over-voltage control or inrush current mitigation. The quotation request will specify if resistors are to be supplied and their required ohm rating.

The resistor and interrupter must be contained in a common housing. The interrupter must directly activate the resistor. Designs using separate housings for the interrupter and resistor (or other transient suppression device) are not acceptable. Designs that insert the transient suppression device in air are not acceptable.

#### 3.04 Interrupter

The capacitor switcher shall use SF<sub>6</sub> single gap puffer interrupters. Each interrupter shall be housed in an insulator that is ANSI 70 gray. Arc assist type interrupters are not acceptable. Each interrupter shall be provided with an overpressure relief device and shall be field refillable. Hermetically sealed interrupters are not acceptable.

#### 3.05 SF<sub>6</sub>/N<sub>2</sub> Gas System

The capacitor switcher shall have a common gas system constructed of copper tubing that allows all of the interrupters to be pressurized through one fill port accessible from the mechanism housing/control cabinet.

The gas system shall include the insulators, a color-coded, temperature compensated gas density gauge that is visible from the ground and has low-pressure alarm and lockout contacts. The density switch must be at ground potential. Battery powered gas density monitors are not acceptable.

The system shall be constructed such that the density gauge can be isolated from the interrupters to allow the low-pressure alarm and lockout contact set points to be verified. A means for refilling the system in the field without disassembling the capacitor switcher must be provided. The capacitor switcher shall have a leak rate of less than 0.5% per year.

#### 3.06 Terminal Pads

Terminal pads shall be unplated aluminum with 4 hole NEMA drilling pattern for use with purchaser furnished terminal connectors. The terminal pads shall be reversible for mounting at the top, bottom, or either side of the interrupter.

### 3.07 Operating Mechanism

#### 3.07.01 Spring Operating Mechanism

Each capacitor switcher shall be provided with a spring open-spring close mechanism with a rated duty cycle of CO – 5 min – CO – 5 min – CO. The spring shall be charged via an electric motor in 15 seconds or less. Pneumatic, hydraulic, or combination pneumatic/hydraulic mechanisms are not acceptable. Devices utilizing multiple mechanisms are not acceptable.

#### 3.07.02 Mechanism Housing and Control Components

An ANSI 70 gray painted steel mechanism housing shall be furnished and shall be provided with the following accessories:

1. Electric spring charging motor
2. Color coded, temperature compensated gas density gauge with low-pressure alarm contact and low-pressure lockout contact
3. Trip-close pistol grip switch
4. Close coil
5. Trip coil
6. Anti-pump relay
7. Time delay relay
8. Local-remote selector switch
9. 10 spare non-adjustable auxiliary switch contacts factory set as 5 normally open (NO) and 5 normally closed (NC) contacts (for 38 kV-72.5 kV units) or 12 spare non-adjustable auxiliary switch contacts factory set as 6 normally open (NO) and 6 normally closed (NC) contacts (for 123 kV-170 kV units)
10. Thermostatically controlled cabinet heater
11. Molded case circuit breakers for protection of motor circuit, control circuit, and heater circuit
12. Spring charged-discharged indicator
13. Manual closing spring charging handle
14. Open-Close position indicator
15. Manual trip and close lever
16. Operations counter
17. 120 VAC cabinet light with door actuated switch
18. 120 VAC duplex receptacle with GFCI
19. View window in cabinet door
20. Hinged cabinet door with 3 point latch, open position door stop, and padlocking provisions

### 3.08 Ground Pads

Two NEMA 2 hole ground pads shall be supplied for grounding the structure to the station ground grid.

#### 4.0 MANUFACTURING REQUIREMENTS

##### 4.01 Wiring

Wiring shall be:

1. Point-to-point without splices or tee connections.
2. Bundled using cable ties.
3. Clearly identified with permanently affixed markers.
4. Sized per NFPA-70 except being No. 14 AWG.

##### 4.02 Base Frame

Each capacitor switcher shall be provided with a manufacturer furnished base frame which houses the gas piping that forms the common gas system while also housing the interpole linkage that connects the three interrupters to the spring operating mechanism. The base frame shall be ANSI 70 gray painted steel with phase spacing as shown in the following table.

Maximum kV Rating	Phase Spacing (inches)
38, 48.3, or 72.5	48
123, 145, or 170	84

##### 4.03 Support Structure

Each 38 kV through 72.5 kV capacitor switcher shall be provided with a manufacturer supplied support structure consisting of one hot dipped galvanized tubular steel 12" x 8" vertical column (mounting pedestal) 46-¾" tall with a 1" thick base plate measuring 24" x 24" with a 4 hole bolt pattern on 20" x 20" centers and furnished for use with 1" x 2'-9" "J" type anchor bolts.

Each 123 kV through 170 kV capacitor switcher shall be provided with a manufacturer supplied support structure consisting of two hot dipped galvanized tubular steel 12" X 8" vertical columns (mounting pedestals) 83-¼" tall with a 1" thick base plate measuring 24" x 24" with a 4 hole bolt pattern on 20" x 20" centers and furnished for use with 1" x 2'-9" "J" type anchor bolts.

Unless otherwise specified in the quotation request anchor bolts will be provided by the purchaser. All anchor bolts shall be sized as required for the operational loads generated by the capacitor switcher. The manufacturer shall determine anchor bolt sizing and anchor bolt plan details when providing the anchor bolts.

#### 5.0 DESIGN TESTS

The capacitor switcher shall be design tested in accordance with ANSI C37.09-2001. The testing shall include a dielectric test, a power test, a continuous current test, and a mechanical endurance test. The dielectric test shall include 60 Hz power frequency, lighting impulse withstand, and visual corona. The power test shall include short circuit

interrupting, fault closing, short time withstand, resistor fault closing, and shunt capacitor bank switching.

## 6.0 PRODUCTION TESTS

Each capacitor switcher shall be fully assembled as a three-phase unit at the factory, adjusted, tested, and timed per ANSI C37.09 section 5. The tests shall include:

### 6.01 Mechanical Operation Tests

There shall be at least 50 mechanical operations performed at the factory. Timing tests, opening and closing operations at minimum and maximum operating voltage, and spring recharge time shall be recorded.

### 6.02 Leak Test

An SF<sub>6</sub> leak test shall be performed to confirm the leak rate is less than 0.5% per year.

### 6.03 Resistance Tests

#### 6.03.01 Current Path Resistance Tests

A terminal-to-terminal micro-ohm resistance check shall be performed on each interrupter using a 100 A DC source and the values shall be recorded.

#### 6.03.02 Heater, Coil, and Relay Resistance Tests

The resistance of each heater, coil, and relay shall be confirmed to be within specifications and the value(s) shall be recorded.

#### 6.03.03 Closing Resistor Value Tests

The value of the resistor in each interrupter shall be confirmed to be within specifications and shall be recorded.

### 6.04 Dielectric Tests

#### 6.04.01 Control Circuit Dielectric Test

The completely assembled and wired operator control circuit shall pass a dielectric test of 1500 V for 1 minute.

#### 6.04.02 Interrupter Dielectric Test

Each interrupter shall pass a power frequency withstand test at 60 Hz for one minute. The required test value shall be at least three times rated line-to-ground voltage.



## 7.0 SPARE PARTS

No spare parts shall be required to be purchased at the time of capacitor switcher purchase. Stock shall be maintained at the manufacturer available for rush shipment in the event of an emergency need.

## 8.0 DOCUMENTATION REQUIREMENTS

### 8.01 Approval Drawings

The manufacturer shall furnish approval drawings in AutoCAD .DWG format via e-mail. The purchase order will designate the name and e-mail address of the individual where the drawings should be forwarded. If there are no comments to the approval drawings purchaser will respond via e-mail that drawings are approved as submitted with no changes. If comments are required then one copy of the drawings will be returned to the manufacturer within 10 days from the date of transmittal marked “approved with comments as noted”.

### 8.02 Final Drawings

The manufacturer shall furnish final drawings in AutoCAD .DWG format via e-mail. Unless otherwise specified in the purchase order, the final drawings will be forwarded to the same individual that the approval drawings were sent to.

### 8.03 Instruction Books

The manufacturer shall furnish an electronic copy of each applicable instruction book in Adobe Acrobat .PDF format via e-mail. Unless otherwise specified in the purchase order, the instruction book(s) will be forwarded to the same individual that the approval drawings were sent to.

### 8.04 Additional Documentation

One complete set of final drawings and one copy of each applicable instruction book shall be shipped in a weatherproof envelope with each capacitor switcher.

## 9.0 SHIPPING and DELIVERY

The capacitor switcher shall be match-marked and disassembled as necessary to accommodate shipping dimensional clearance restrictions. The interrupters shall be shipped with a positive pressure of 5 – 10 psi of SF<sub>6</sub>, eliminating the need to pull a vacuum on them in the field. An SF<sub>6</sub> fill kit and an N<sub>2</sub> fill kit shall be provided to fill the common gas system to rated pressure during installation.

## 10.0 SPECIFIC QUOTE REQUIREMENTS

Information furnished by purchaser at time of quote request will include:

1. kV rating
2. Closing resistor value
3. Motor / Control voltage (48 VDC; 125 VDC; 250 VDC; 120 VAC, 60 Hz, 1Ø; or 240 VAC, 60 Hz, 1Ø)
4. Heater voltage (120 VAC, 60 Hz, 1Ø or 240 VAC, 60 Hz, 1Ø)
5. If manufacturer is to supply anchor bolts
6. Additional requirements, if applicable (see section 3.01.05)

#### 11.0 ACCEPTABLE CAPACITOR SWITCHER

Supply Southern States type **CapSwitcher**<sup>®</sup> or acceptable equal. Any equal proposed must meet or exceed this specification.

**CapSwitcher**<sup>®</sup> is a registered trademark of Southern States, LLC.