Southern States

Title: Southern States 15.5 kV-38 kV *CapSwitcher*® 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 with 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 4,000 feet.

3.01.03 Seismic

The capacitor switcher shall be capable of meeting IEEE 693's high seismic performance level. 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. extreme cold temperature installation, corrosive environment, high altitude installation, etc.) they will be defined in the quotation request.

3.02 Ratings

3.02.01 General Specifications

<table>
<tr><td>Rated Maximum Voltage</td><td>15.5 kV</td><td>27 kV</td><td>38 kV</td></tr>
<tr><td>Rated Power Frequency Withstand Voltage</td><td>50 kV</td><td>60 kV</td><td>80 kV</td></tr>
<tr><td>Rated Lightning Impulse Withstand Voltage (BIL)</td><td>110 kV</td><td>150 kV</td><td>200 kV</td></tr>
<tr><td>Rated Power Frequency</td><td colspan="3">50/60 Hz</td></tr>
<tr><td>Rated Continuous Current</td><td colspan="3">600 A</td></tr>
<tr><td>Short Circuit Making Current</td><td colspan="3">40 kA RMS</td></tr>
<tr><td>Peak Withstand Current</td><td colspan="3">104 kA</td></tr>
<tr><td>Short-Time Symmetrical Withstand</td><td colspan="3">40 kA RMS 2 sec</td></tr>
<tr><td>Rated High-Frequency Transient-Making Current / Transient Inrush Frequency</td><td colspan="3">42 kA peak / 8100 Hz</td></tr>
<tr><td>Rated Short Circuit Interrupting Current</td><td colspan="3">N/A</td></tr>
<tr><td>Rated Duty Cycle</td><td colspan="3">Close Time (ms) – C – 6 cycles – O – 15 sec
<table><tr><th>Voltage</th><th>Close Time (ms)</th><th>Variation (ms)</th></tr><tr><td>120 VAC</td><td>44</td><td>+/- 9</td></tr><tr><td>125 VDC</td><td>44</td><td>+/- 1</td></tr><tr><td>48 VDC</td><td>55</td><td>+/- 3</td></tr></table>(Capacitor bank must be discharged to below 10% before closing is allowed.)</td></tr>
<tr><td colspan="4">CAPACITOR SWITCHING RATINGS (IEEE C37.09a-2005)</td></tr>
<tr><td>Rated Capacitive Switching Current</td><td colspan="3">600 A</td></tr>
<tr><td>Back-to-Back Capacitor Bank Breaking Current</td><td colspan="3">600 A</td></tr>
<tr><td>Rated High-Frequency Transient-Making Current / Transient Inrush Frequency</td><td colspan="3">23 kA peak / 5400 Hz</td></tr>
<tr><td>Capacitive Discharge Withstand</td><td colspan="3">33 kA Peak @ 63 kHz</td></tr>
<tr><td>Resistor Value</td><td colspan="3">See Table in 3.03.01
Pre-insertion time 5-12 ms</td></tr>
</table>

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	125 VDC; 120 VAC, 60 Hz, 1∅
2. Control Voltage	48 VDC; 125 VDC; 120 VAC, 60 Hz, 1∅
3. Auxiliary Voltage	120 VAC, 60 Hz, 1∅

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 SF_6 gas.

3.03.01 Resistor Values and Selection Chart

15.5 kV	**27 kV**	**38 kV**
2 - 6 MVAR 20 Ω	3 - 6 MVAR 30 Ω	3 - 6 MVAR 90 Ω
6.1 - 9 MVAR 10 Ω	6.1 - 16 MVAR 20 Ω	6.1 - 16 MVAR 30 Ω
9.1 - 16 MVAR 6 Ω	16.1 - 27 MVAR 12 Ω	16.1 - 40 MVAR 12 Ω

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 5 ms and 12 ms.

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_6 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_6 Gas System

Each phase of the capacitor switcher shall have a color-coded, temperature-compensated density gauge. The fill pressure shall be 52 psig nominal and 32 psig minimum. 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

The capacitor switcher shall be provided with a spring open-spring close mechanism with a mechanism duty cycle of 4 cycles – C – 6 cycles – O – 15 seconds. When issued a close command, the close coil releases the closing spring allowing the mechanism to close the device in 4 cycles. After a close operation has occurred, an open command will actuate the trip coil which releases the opening spring allowing the mechanism to open the device in 6 cycles. When a close operation and open operation have occurred and both springs are discharged, the charging motor energizes both the closing spring and the opening spring (in 15 seconds or less) and prepares the mechanism to operate the device. Pneumatic, hydraulic, or combination pneumatic/hydraulic mechanisms are not acceptable. Devices utilizing multiple mechanisms are not acceptable.

3.07.02 Mechanism Components

1. Electric spring charging motor
2. Trip coil
3. Close coil
4. 6 spare non-adjustable auxiliary switch contacts factory set as 3 normally open (NO) and 3 normally closed (NC) contacts
5. Open-Close position indicator
6. Manual trip capability
7. Mechanical operations counter
8. Thermostatically controlled heater

3.08 Ground Connections

Two grounding connections which accept #8 solid to #2/0 stranded connectors shall be supplied for grounding the mechanism to the station ground grid.

4.0 MANUFACTURING REQUIREMENTS

4.01 Mechanism Housing

Each capacitor switcher shall be provided with a housing that connects the three interrupters to the spring operating mechanism at 24 inch phase spacing for 15.5 kV, 27 kV, and 38 kV.

4.02 Support Structure

The capacitor switcher is designed to be mounted on a capacitor bank platform or structure provided by customer. Mounting details of the capacitor bank platform or structure must be defined in the quotation request.

5.0 DESIGN TESTS

The capacitor switcher shall be design tested in accordance with IEEE C37.66-2005, Standard Requirements for Capacitor Switches for AC systems (1 kV to 38 kV), unless otherwise noted in section 3.02.01. 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, lightning impulse withstand, and visual corona. The power test shall include fault closing, short time withstand, resistor fault closing, and shunt capacitor bank switching. The capacitor switcher shall also be design tested in accordance with IEEE C37.09a in demonstration of the ability of the capacitor switcher to switch capacitive current multiple times as in a back-to-back capacitor bank switching application.

6.0 PRODUCTION TESTS

Each capacitor switcher shall be fully assembled as a three-phase unit at the factory, adjusted, tested, and timed. 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_6 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 and Coil Resistance Tests
The resistance of each heater and coil 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 Drawings
The manufacturer shall furnish drawings of the capacitor switcher in AutoCAD .DWG format or Adobe Acrobat .PDF format via e-mail. The purchase order will designate the name and e-mail address of the individual to whom the drawings should be forwarded.

8.02 Instruction Books
The manufacturer shall furnish an electronic copy of the instruction book via e-mail, transmitted to the same individual that the final drawings are to be sent to unless purchaser otherwise instructs manufacturer at time of purchase order placement.

8.03 Additional Documentation
One complete set of drawings and one copy of the instruction book shall be shipped in a weatherproof envelope with each capacitor switcher.

9.0 SHIPPING AND DELIVERY

All capacitor switchers shall be shipped completely assembled and fully pressurized, ready for quick and easy field installation.

10.0 WARRANTY

All capacitor switchers and their accessories furnished under this specification shall be covered by a five-year warranty from date of shipment or 10,000 operations; whichever comes first; against failure due to design or to defects in workmanship or material.

11.0 SPECIFIC QUOTE REQUIREMENTS

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

1. Rated Maximum Voltage
2. Closing Resistor Value
3. Motor / Control Voltage (48 VDC, 125 VDC, or 120 VAC, 60 Hz, 1∅)
4. Additional requirements, if applicable (see section 3.01.05 and section 4.02)
5. If the optional ratings shown in table 3.02.01 for peak fault-making, symmetrical fault-making, and short-time symmetrical withstand should be furnished in lieu of the standard ratings for these performance characteristics

12.0 ACCEPTABLE CAPACITOR SWITCHER

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