Circuit Switchers

Southern States

The Power of Ideas

Southern States' Power Switching Division is committed to providing purpose specific devices that solve the most challenging issues facing the transmission and distribution utility markets. The circuit switcher product line, including the **CSV, CSV-CB**, **CSV-DB**, and **CSH**, was created in response to the demand for improved transformer switching and protection at a competitive cost between traditional power fuses and circuit breakers. This bulletin highlights these available designs as well as their applicable ratings.

Southern States

The Quality Name in High Voltage Switching

CATALOG BULLETIN

INTRODUCTION

As utilities continue to face an aging infrastructure as well as rapid commercial and residential growth, many are tasked with replacing and adding new protective equipment to address increased fault level requirements as well as system growth. One of the most critical pieces of equipment a utility should look to develop a thorough understanding of is the protective device located on the primary side of their power transformers. These can help to minimize the risk of costly equipment damage as well as extend customer outage times when interruption of fault currents must take place.

Key factors to consider when selecting a primary-side protection device include overall device reliability, the coordination complexity and requirements of the system, its interruption capability of transformer limited faults, as well as its geographical and environmental footprint. Based on a utility's unique requirements, it may employ power fuses, circuit breakers, or circuit switchers as the primary overcurrent protective device.

This bulletin highlights what primary-side protection devices are available to utilities as well as the considerations to make when making an appropriate selection. In addition, it showcases the Southern States line of circuit switcher products.

Circuit Switchers

Application Specific Devices
For Transformer Switching & Protection

CATALOG BULLETIN

APPLICATION

Selection of Primary Side Transformer Protection

When determining the proper primary-side protection device, utilities should consider the load demands and complexity of their systems. For those system that do not experience high fault levels, the use of **power fuses** may be appropriate. A power fuse is a single-phase device that represents the simplest and least expensive form of an electrical protection device. These are ideally suited for small and medium size transformers (typically < 10 MVA), sized to provide overcurrent protection for faults that occur between the fuse and the nearest secondary protective device. As fault levels and the need to coordinate with upstream and downstream devices grow, however, many utilities must pursue devices with three-phase operation and greater interruption capacity.

Circuit breakers are three phase, *general purpose* devices designed to interrupt and clear an overcurrent fault quickly. This makes them ideally suited for a variety of applications, including power transformer protection where an auxiliary contact is often utilized to increase arc energy and, as a result, gas pressure to quickly interrupt the arc. While this is helpful for interrupting overcurrents quickly, it can present challenges during the interruption of transformer limited faults where fast transient recover voltages (TRVs) occur on the secondary side of the transformer but are interrupted by the primary side protective device. ANSI/IEEE circuit breaker standards do not require assurance testing to this phenomenon, so many manufacturers do not run these costly tests unless specifically requested. It is important that utilities ensure their primary-side protection device is tested to these transformer limited faults, as they account for over 90% of the faults the device will encounter.

In contrast, **circuit switchers** are designed *specifically* for transformer protection and switching applications. This includes testing to ANSI C37.016, which specifically accounts for the high TRV rise times typically experienced during transformer limited fault interruption. Another added benefit of a circuit switcher is its design adaptability, as it can be mounted free standing or on existing structures. Additionally, it can be customized to include an integrated disconnect switch, arrestors, ground switches, and current monitoring devices. Horizontal circuit switchers are also ideal for high voltage mobile trailer applications, where their weight and size, versus a general-purpose breaker, offer substantial value to the user. When deployed, they can be supplied on a racking mechanism that provides the required phase to phase spacing needed for safe operation.

With growing concerns on greenhouse gas emissions, many utilities are also looking to eliminate or reduce their contribution to SF_6 emissions. For systems with high fault potential, where power fuses are not appropriate, the use of SF_6 gas is still the primary arc extinguishing medium used in transformer protective devices. Circuit switchers often require $1/4^{th}$ the SF_6 gas of a circuit breaker, making them a more environmentally friendly option. Vacuum interrupters are also available for some application at 72 kV and below but have limitations in certain applications due to their maximum fault interrupting capabilities and tendency to current chop.

TRANSFORMER PROTECTION OPTIONS

Power Fuses

- For small and medium size transformer protection *(typically less than 10 MVA)*
- Simplest and least expensive in both purchase and installation costs
- Single phase devices which have limited fault current interruption ratings
- At times, difficult to coordinate with upstream and downstream devices

Circuit Breakers

- For protection of 10 MVA and above transformers where higher interrupting ratings are required
- Often employed as a solution in complex bus schemes, protecting the transformer, bus tie schemes, and line
- *General* purpose - designed for a wide variety of applications but not always the most effective choice for *specific* applications
- Not always tested for transient recovery voltages (TRVs) that occur during transformer limited fault interruption

Circuit Switchers

- For protection of 10 MVA and above transformers where higher interrupting ratings are required
- Designed and tested *specifically* for transformer protection and switching (ANSI C37.016 standard) - includes testing to ensure interruption of TRV faults
- Available up to 40 kA primary-fault interruption
- Smaller footprint, less SF_6 use than traditional circuit breakers
- Ideal weight and size for mobile substation applications

SSLLC VERTICAL CIRCUIT SWITCHERS

CSV 38 kV - 72.5 kV

RATINGS								
Maximum Voltage Rating (kV)	**27**	**38**	**38**	**48.3**	**72.5**	**38**	**48.3**	**72.5**
Interrupter/Blade BIL (kV)	150	200	200	250	350	200	250	350
Continuous Current	1200 A & 1600 A		1200 A			1200 A, 1600 A, 2000 A, 2500 A		
Primary Fault Interrupting	25 kA		25 kA (31 kA*)			40 kA		
Secondary Thru-Fault Interrupting	4 kA		4 kA			4 kA		
Interrupting Time	3 cycles		5 cycles			3 cycles		
Power Frequency	50/60 Hz		60 Hz			60 Hz		
Short-Time Withstand	25 kA (3 sec)		40 kA (3 sec)			40 kA (3 sec)		
Peak Withstand	62.5 kA		104 kA			104 kA		
Short-Circuit Making	25 kA		40 kA			40 kA		
Insulator Design	Porcelain		Composite			Porcelain		
Ambient Temp. Rating	-40°C to +50°C		-40°C to +50°C *(-50°C to +50°C optional)***			-30°C to +50°C		

* Product can be rated for 31.5 kA interrupting (3 operations)
** -50°C rating is 18 kA (SF_6 / N_2)

CSV 48.3 kV - 170 kV

RATINGS					
Maximum Voltage Rating (kV)	**48.3**	**72.5**	**123**	**145**	**170**
Interrupter/Blade BIL (kV)	250	350	550	650	750
Continuous Current	1200 A, 1600 A, 2000 A, 3000 A, 4000 A*				
Primary Fault Interrupting	25 kA, 31.5 kA, 40 kA				
Secondary Thru-Fault Interrupting	4 kA				
Interrupting Time	3 cycles				
Power Frequency	60 Hz				
Short-Time Withstand	50 kA (3 sec)				
Peak Withstand	130 kA				
Short-Circuit Making	50 kA				
Insulator Design	Porcelain				
Ambient Temperature Rating	-40°C to +50°C standard *(-50°C to +50°C optional)*				

* Consult factory for 4000A ratings

CATALOG BULLETIN

SSLLC VERTICAL CIRCUIT SWITCHERS

CSV 242 kV

RATINGS	
Maximum Voltage Rating	**242 kV**
Interrupter/Blade BIL	900 kV
Continuous Current	1200 A
Primary Fault Interrupting	20 kA
Secondary Thru-Fault Interrupting	4 kA
Interrupting Time	6 cycles
Power Frequency	60 Hz
Short-Time Withstand	40 kA (3 sec)
Peak Withstand	104 kA
Short-Circuit Making	40 kA
Insulator Design	Porcelain
Ambient Temperature Rating	-30°C to +50°C

CSV-DB & CSV-CB 72.5 kV - 170 kV

VERTICAL INTERRUPTER CIRCUIT SWITCHER WITH INTEGRAL DISCONNECT SWITCH

RATINGS				
Maximum Voltage Rating (kV)	**38**	**48.3**	**72.5**	**170**
Interrupter/Blade BIL (kV)	200	250	350	750
Continuous Current	2000 A, 3000 A, 4000 A*			
Power Frequency	60 Hz			
Short-Time Withstand	50 kA (3 sec)			
Peak Withstand	130 kA			
Insulator Design	Porcelain			
Ambient Temperature Rating	-40°C to +50°C standard *(-50°C to +50°C optional)*			
CIRCUIT SWITCHER RATINGS:				
Primary Fault Interrupting	25 kA, 31.5 kA, 40 kA			
Secondary Thru-Fault Interrupting	4 kA			
Interrupting Time	3 cycles			
Short-Circuit Making	50 kA			

* Consult factory for 4000A ratings

SSLLC HORIZONTAL CIRCUIT SWITCHERS

CSH & CSH-B 38 kV - 170 kV

BLADE BIL (CSH-B)	
Max Voltage	**Blade BIL**
38 kV	200 kV
48.3 kV	250 kV
72.5 kV	300 kV
123 kV	550 kV
145 kV	650 kV
170 kV	750 kV

550 kV BIL INTERRUPTER RATINGS [1]			
	Temp Range	**≤ 72.5 kV**	**123 kV**
PBF 100s	-30°C to +50°C		20 kA
	-40°C to +50°C	25 kA	
	-50°C to +40°C	15 kA [3]	12 kA [3]
TLF	-40°C to +50°C	4 kA	2.9 kA [2]
	-50°C to +40°C	2.5 kA [3]	1.7 kA [3]

750 kV BIL INTERRUPTER RATINGS [1]					
	Temp Range	**≤ 72.5 kV**	**123 kV**	**145 kV [2]**	**170 kV [4]**
PBF 100s	-40°C to +50°C	25 kA	20 kA [5]		
	-50°C to +40°C	15 kA [3]	12 kA [3]		
TLF	-40°C to +50°C	4 kA	2.9 kA [2]	2.3 kA [2]	2.7 kA [2]
	-50°C to +40°C	2.5 kA [3]	1.7 kA [3]	1.4 kA [3]	1.6 kA [3]

1) Ratings shown are for 1200A (*for 1600A, top temperature is +40°C*).
Ratings **do not** apply to 2000A.
Ratings apply to both porcelain and composite interrupter housings.
2) Nameplate will include note "**TLF = 4 kA @ 7.6 kV/µs TRV"**
3) SF_6 / N_2 Gas Mixture
4) 170 kV ratings are for Grounded Systems (1.3 k_{pp}) - All other ratings are suitable for Ungrounded Systems (1.5 k_{pp})
5) For existing installations, the 123 kV can also be rated 25 kA for -30°C to + 50°C. If 25 kA is specified for a new installation, the CSH2 design should be utilized.

CSH2 & CSH2-B 38 kV - 145 kV

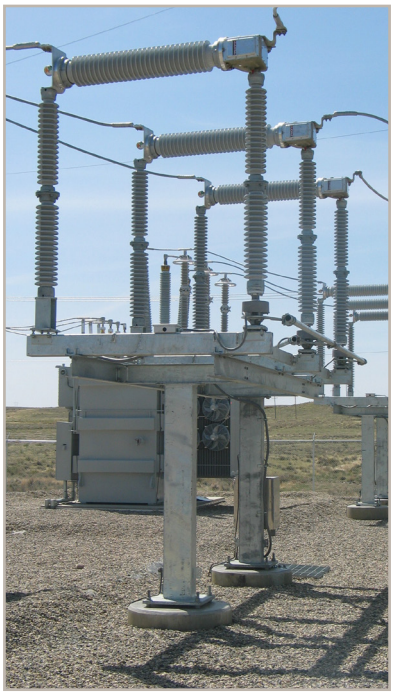
BLADE BIL (FOR CSH2-B)					
Maximum Voltage Rating	**38 kV**	**48.3 kV**	**72.5 kV**	**123 kV**	**145 kV**
Blade BIL	200 kV	250 kV	350 kV	550 kV	650 kV

650 kV BIL INTERRUPTER RATINGS [1]					
	Temp Range	**≤ 72.5 kV**	**123 kV**	**145 kV [2]**	**Interrupter Housing**
PBF 100s	-30°C to +50°C	40 kA			Composite
	-40°C to +50°C	31.5 kA			
TLF [2]	-40°C to +50°C	4 kA			

1) Ratings shown are for 1200A. For 1600A, top temperature is +40°C
2) 145 kV ratings are for Grounded Systems (1.3 k_{pp})
3) There is not a 2000A rating available
4) The CSH2 is currently not offered at temperatures below -40°C

SSLLC HORIZONTAL CIRCUIT SWITCHERS

CSH & CSH-B 245 kV



RATINGS	
Maximum Voltage Rating	**245 kV** [1]
Interrupter/Blade BIL	900 kV
Continuous Current	1200 A & 1600 A for all kV ratings [2]
Primary Bus Fault Interrupting	20 kA (12 kA for -50°C)
Transformer Limited Fault	4 kA
Interrupting Time	6 cycles
Power Frequency	60 Hz
Short-Time Withstand	40 kA / 3 sec
Peak Withstand	108 kA
Short-Circuit Making	40 kA
Ambient Temperature Range	-30°C to +50°C standard (-50°C to +50°C optional [3])

1) The 245 kV rating is suitable for Grounded Systems.
2) Consult factory for higher current ratings.
3) Only available as CSH-B

SSLLC MOTOR OPERATORS

CM-4AE *Motor Operator for Circuit Switcher Operation*

SPECIFICATIONS	
OUTPUT TORQUE	OPERATING TIME (SECONDS)
32,000 in - lbs	8

VOLTAGE		
VDC	Inrush (Locked Rotor)	Running
48	75	15
125	33	7.5
250	*	*

* Contact Southern States

Southern States increases utility systems reliability by delivering next generation switching, automation and protection solutions built on a century of service and customer care.

Southern States

30 Georgia Avenue, Hampton, GA 30228
P 770.946.4562 F 770.946.8106
sales@southernstatesllc.com www.southernstatesllc.com
24/7 emergency support line: 770.946.4565

Publication Number CB800-Circuit Switcher Bulletin R2 11182020 Printed in USA November 2020