

Nexans

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Superconductor Fault Current Limiters for MV AC Networks

First cycle fault current limiting solution with near-zero normal state impedance

The Nexans-AMSC superconductor-based fault current limiter (SFCL) solution introduces minimal impedance to the power system under normal conditions and high resistance during faults, limiting short circuit current. The resistive SFCL responds before the first cycle peak and provides an effective means to limit excessive fault currents to more manageable magnitudes without the disadvantages of conventional fault current mitigation methods. Nexans-AMSC SFCLs provide an economic, cost effective solution for protecting transformers, switchgear and other components against excessive short circuit currents in case of faults.

First Cycle Peak Current Limiting

Fault currents above the SFCL's trip current level cause the superconductor element to undergo an almost step-function transition to its high impedance state, ensuring fault current limitation of the first cycle peak.

Near-zero Insertion Impedance

Under normal conditions, the SFCL acts as a near perfect electrical conductor. It is practically invisible in the grid, essentially eliminating steady state losses, voltage drop and other operational limitations of current limiting reactors.

Automatic, Fail-safe

Operation of the SFCL is based upon the physical properties of its superconductor element – no external controls are needed. The current is controlled for a pre-defined interval consistent with the power rating of downstream equipment and to enable fault identification before circuit breaker operation.

Automatic Reinsertion

After a current-limiting operation, the SFCL automatically resets and is ready for the next operation. No external signals are necessary to

reset the device and no elements need to be replaced after a fault.

Continuous Limiting Option

If desired, an interruption-free, current-limited power flow in the grid can be provided by optional parallel-connected inductive or resistive shunts. These provide continuous current limiting while the SFCL is returning to its passive superconducting state.

Minimal Voltage Distortion

Resistive SFCLs produce minimal voltage distortion while limiting fault currents. Only a reduction in current peaks, along with normal voltage waveforms, result from SFCL operation.

Voltage and Current in Phase

Voltage and current remain in phase during current-limiting operation, making it easier for circuit breakers to interrupt the fault current.

Modular Design

The internal modular design of the SFCL allows for customization of the device's ratings, including continuous current, trip current, available fault current, limited fault current and fault duration.



Gridtec Solutions™

- Reduces the system impact of short circuits by limiting the magnitude of high fault currents
- Fast operation limits currents starting with the first cycle peak
- Introduces no steady state impedance to the grid during non-fault conditions
- Automatic operation requires no external controls for operation or reset
- No replacement parts after fault limiting operation
- Modular design allows for selection of critical operating parameters



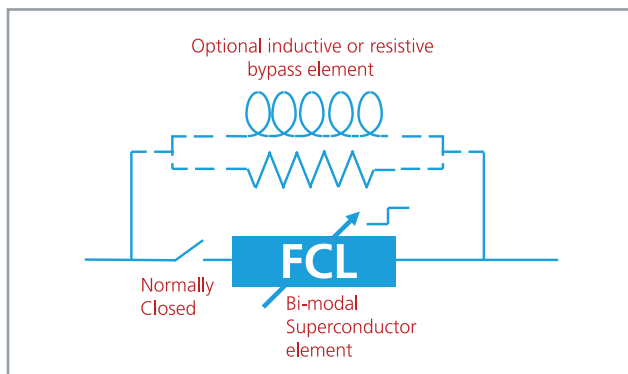


FCL module containing coils of superconductor wire

Method of Operation

The Nexans-AMSC SFCL uses a high temperature superconductor (HTS) element to carry normal load current. The HTS element has near-zero impedance under normal conditions and remains in the circuit when a fault occurs. During the fault, the current magnitude will exceed the HTS material's so-called critical current, causing the HTS material to transition to a very high resistance state.

This transition is immediate and reduces the first cycle and subsequent fault current peaks. In this case, the HTS element acts as what may best be described as a very fast (<2 msec) current-limiting switch. The introduction of resistance by the SFCL also reduces the system X/R ratio at that point, reducing any DC offset in the fault current waveform and further lowering the impact of the fault on downstream devices. A reactor or resistor can be paralleled with the SFCL for extended fault duration operation. See Figure.



Operation of a Stand-Alone Resistive Superconductor Fault Current Limiter

SFCLs are available today for application in the power grid and can serve to reduce fault current magnitudes, eliminate or defer the need to replace circuit breakers, reduce short current forces, and increase system reliability by allowing for tighter grid interconnection.

SFCLs: First cycle peak fault current limiting with near-zero insertion impedance

SPECIFICATIONS

Connection:	Medium Voltage (up to 36 kV L-L)
Frequency:	50 or 60 Hz
SFCL design:	3-phase or 3 x 1-phase as required by SFCL rating
Continuous current rating (I_{rated})	Up to 4000 A
Trip current level (I_{trip})	As required by application
Reponse time	<2msec
Maximum site unlimited fault current (I_p)	As required by application
Limited fault current level (I_{max})	As required by application
Inrush current	As required by application
Fault limitation time (t_d)	≤200msec, or as required by application

Applications

- Bus ties
- Incoming or outgoing feeders
- Interfacing renewable generation to the grid
- Cable protection
- Power plant or industrial facility secondaries

AMSC's Support in Solution Planning

AMSC's Network Planning and Applications group specializes in modeling and analyzing the interaction of SFCLs in power systems. Composed of experienced former utility engineers and backed by the most experienced superconductor wire supplier to the industry, this group will perform all feasibility studies, system design and commissioning studies necessary for the successful specification, construction and installation of an SFCL. This insider background ensures a fully optimized, efficient and reliable solution, based on specific individual needs.

AMSC's comprehensive understanding of utility operations and power networks, coupled with its proficiency with industry standard and proprietary analysis tools, yields sophisticated and customized solutions that can be implemented quickly, reliably and cost effectively.