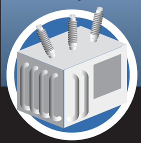
STI
SUPERCONDUCTOR TECHNOLOGIES INC.

Conversion
Fault Current Limiters
&
Transformers



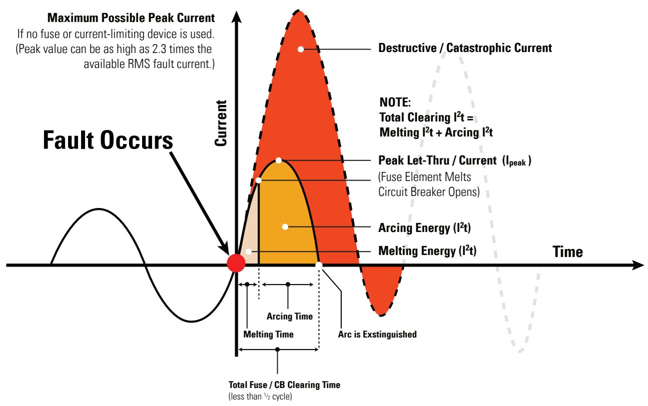
Superconducting Fault Current Limiters

With power demand on the rise and new power generation sources being added, the grid has become overcrowded and vulnerable to catastrophic faults. Faults are abnormal flows of electrical current like a short circuit. As the grid is stressed, faults and power blackouts increase in frequency and severity. SFCLs are powerful surge protectors that act as circuit breakers or fuses to prevent harmful faults from taking down substation equipment by reducing the fault current to a safer level (20 – 50% reduction), so that the existing switchgear can still protect the grid.

Catastrophic transformer failure

Currently, electrical-utilities use massive 80kA circuit breakers, oversized transformers and fuses to prevent faults from damaging their equipment and protecting against surges. Once a circuit breaker has suffered a catastrophic failure, grid equipment, such as costly transformers, is exposed and vulnerable. Smart grid and embedded generation enhancements will increase the need for SCFLs.

Superconducting Fault Current Limiters have numerous and immediate benefits to the power grid. SFCLs protect against damaging fault currents and blackouts while enhancing system safety, stability, and efficiency. SFCLs do not fail or suffer destructive failure during a power surge.

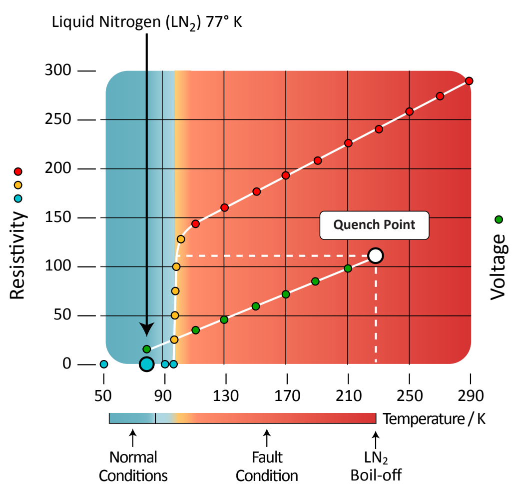


Fault current example voltage/current waves

During a high power surge an incredible amount of current is passed through the superconductor coil. In most cases this causes the liquid nitrogen coolant to boil off and the wire to become non-superconducting. A typical SFCL will take around an hour to cool down and return to steady state. This recovery time is far superior to conventional solutions. A critical benefit for new utility build-outs is the improved system reliability when renewables, like solar and wind, are added. When compared to a complete substation upgrade, SFCLs are a significantly lower CAPEX investment.

Benefits of Superconducting Fault Current Limiters:

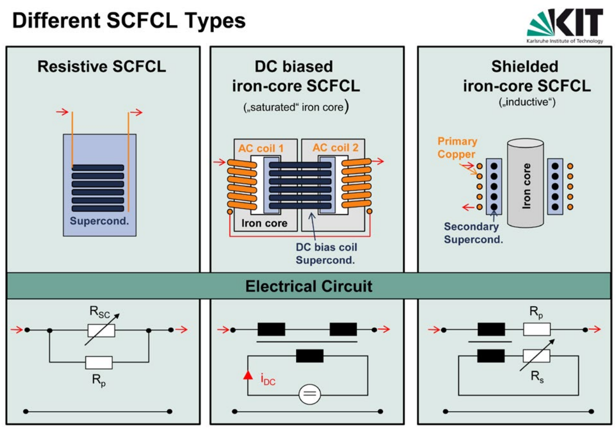
- *Protects against damaging fault currents and blackouts.*
- *Enhanced system safety, stability, and efficiency.*
- *Improved system reliability when renewables are added.*
- *Significantly lower CapEx than a sub-station upgrade.*



SFCL over-current quench point

Superconducting Fault Current Limiters (cont.)

There are three primary types of SCFLs under development: Inductive, Resistive and Saturable Core. Many developers have chosen to use resistive type superconducting limiters due to their compact size, weight and lower cost. This design leverages the innate resistive properties of HTS wire to eliminate faults. Development is underway to scale from medium (35 kV) to high (138 kV) voltages and operate at higher temperatures (77 K).



SFCL configurations - Karlsruhe Institute of Technology

Resistive SFCLs making headway:

- *Compact in size and weight while designed to utilize the resistive properties of HTS wire to eliminate fault.*
- *Scale from medium (35 kV) to high (138 kV) voltages and operate at higher temperatures (77 K).*
- *An estimated 15 to 30 kilometers of 2G HTS wire is required per three phase device.*

It is estimated that 15 to 30 kilometers of 2G HTS wire is required per three phase device.
United States DOE estimates the market size for SFCLs at several billion dollars over the next 15 years. While approximately 250,000 power substations exist worldwide, the additional of renewables to the Smart grid and embedded generation enhancements will increase the need for power safety and security with SCFLs. STI is engaged with a number of SFCL manufacturers, working towards aligning customer requirements for qualification with our product development.

HTS Transformers

Grid operators face a major challenge in moving power safely and efficiently, from generators to consumers, through several stages of voltage transformation step downs and step ups. At each stage, valuable energy is lost in the form of waste heat. Moreover, while demands are continually rising, space for transformers and substations - especially in dense urban areas - is severely limited.

Conventional oil-cooled transformers pose a fire and environmental hazard. Compact, efficient HTS transformers, by contrast, are cooled by safe, abundant and environmentally benign liquid nitrogen. As an additional benefit, these actively-cooled devices will offer the capability of operating in overload, to twice the nameplate rating, without any loss of life to meet occasional utility peak load demands.