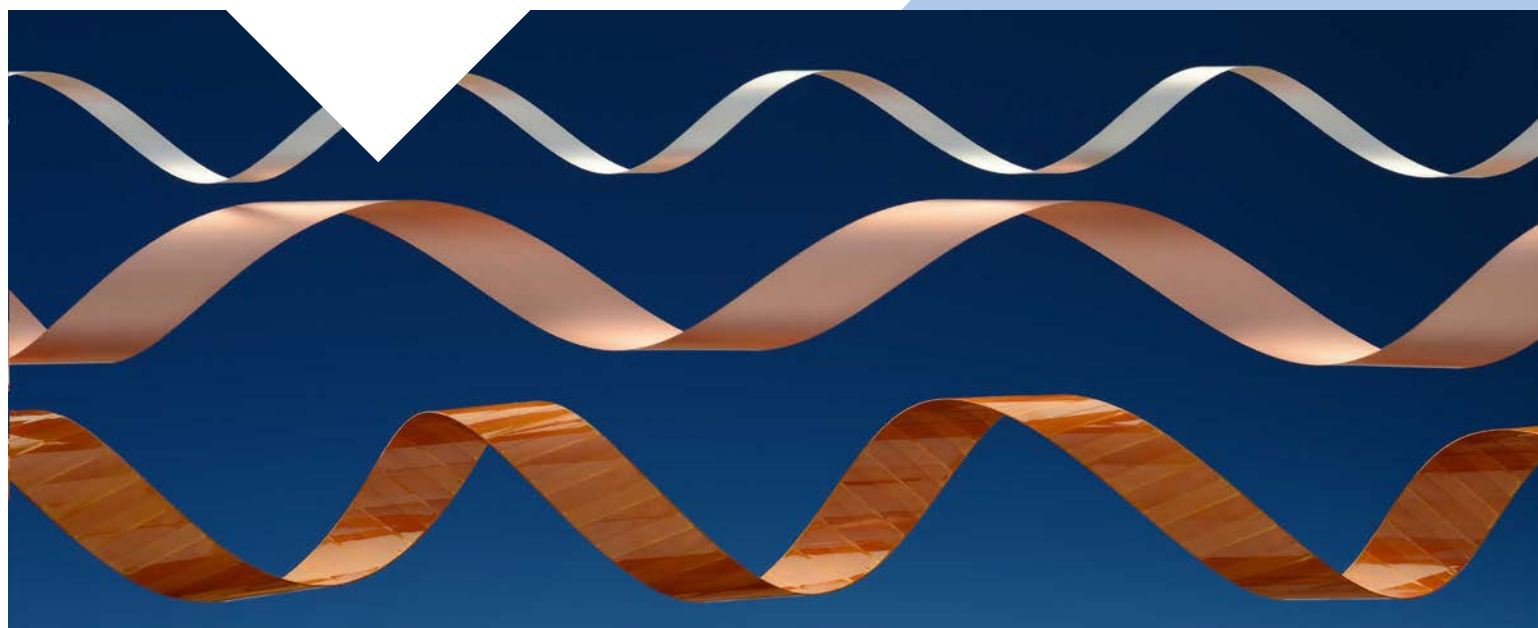


SuperPower® 2G HTS Wire Specifications

Second-Generation (2G) High Temperature Superconductor (HTS) – long, robust lengths with variations in width, substrate thickness, silver and copper stabilizer thickness, and optional insulation

superior performance. powerful technology.



SuperPower® 2G HTS Wire is produced in an automated, continuous process beginning with a high strength metal alloy as the base substrate material then adding buffer layers, ceramic-based superconductor material and protective overlayers.

Once the wire has been slit into device-specific widths, Surround Copper Stabilizer (SCS) is applied to completely encase the wire. Overcurrent capability in SCS wire can be tailored to the specific application. The stabilizer protects the conductor and produces rounded edges that are beneficial for high-voltage applications. Furthermore, the probability of failure in the device due to voltage breakdown is reduced in wire with SCS. SuperPower's SCS has been successfully implemented and tested on continuous lengths of hundreds of meters of wire.



ADVANCED PINNING (AP) WIRE exhibits superior performance at a range of temperatures from 77K to as low as 4K and well suited for in-magnetic-field applications such as motors, generators and other high-field magnetics.



CABLE FORMULATION (CF) WIRE, utilizes standard wire chemistries that exhibit best performance at around 77K, the liquid nitrogen temperature regime, and in very low magnetic fields for cable and other similar applications.

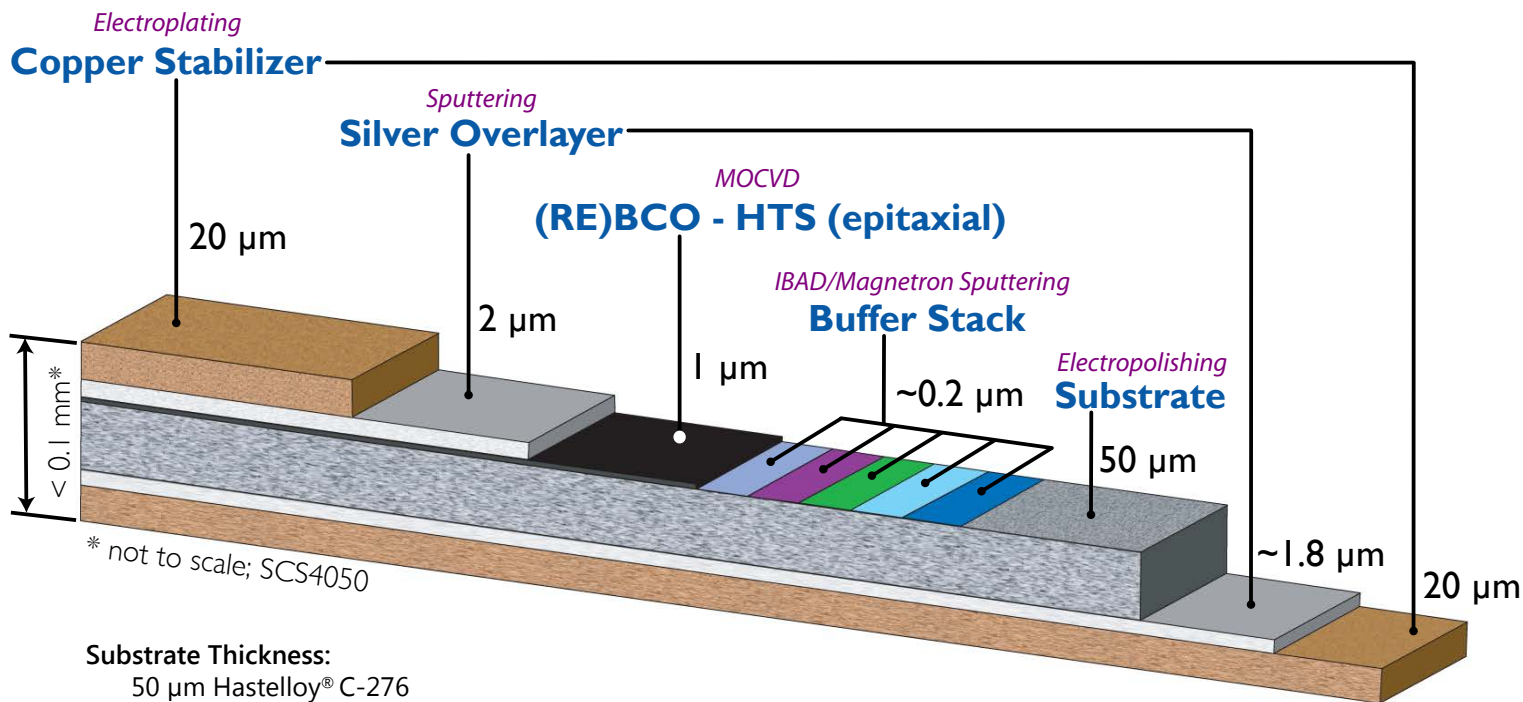


FAULT CURRENT LIMITER (FCL) WIRE utilizes the CF chemistry and begins with a thicker (100 micron), highly resistive Hastelloy® substrate suitable for these grid protection devices. This application, which does not call for any copper stabilizer, can also benefit from the option to vary the thickness of the silver overlayer.

SuperPower® 2G HTS Wire Specifications

	Minimum I_c measured by continuous direct current	Width	Total Wire Thickness	Critical Axial Tensile Strain at 77K	Critical Bend Diameter in Tension (40 μ m) @ room temp	Critical Bend Diameter in Compression (40 μ m) @ room temp
SF = Stabilizer Free (standard 2 μ m of silver)						
SF2050	50 amp	2 mm	0.055 mm	0.45%	11 mm	11 mm
SF3050	75 amp	3 mm	0.055 mm	0.45%	11 mm	11 mm
SF4050	100 amp	4 mm	0.055 mm	0.45%	11 mm	11 mm
SF6050	150 amp	6 mm	0.055 mm	0.45%	11 mm	11 mm
SF12050	300 amp	12 mm	0.055 mm	0.45%	11 mm	11 mm
SF12100*	300 amp	12 mm	0.105 mm	0.40%	25 mm	25 mm
SCS = Surround Copper Stabilizer (standard 2 μ m of silver and 40 μ m of copper; critical tensile stress of >550MPa at 77K)						
SCS2050	50 amp	2 mm	0.1 mm	0.45%	11 mm	11 mm
SCS3050	75 amp	3 mm	0.1 mm	0.45%	11 mm	11 mm
SCS4050	100 amp	4 mm	0.1 mm	0.45%	11 mm	11 mm
SCS6050	150 amp	6 mm	0.1 mm	0.45%	11 mm	11 mm
SCS12050	300 amp	12 mm	0.1 mm	0.45%	11 mm	11 mm

* 2G HTS wire type SF12100 with highly resistive substrate, flexibility in wire stabilization options and very tight current uniformity is suitable for fault current limiter (FCL) applications. First peak limitation demonstrated with fast response time, low quench current, and rapid recovery.



Substrate Thickness:

50 μ m Hastelloy® C-276
[or 100 μ m for SF12100]

Substrate Yield Strength:

1,200 MPa at 77K

Substrate Resistivity:

125 $\mu\Omega$ -cm – higher resistivity leads to lower eddy current ac loss

Magnetic Properties:

non-magnetic, leads to lower ferromagnetic ac loss

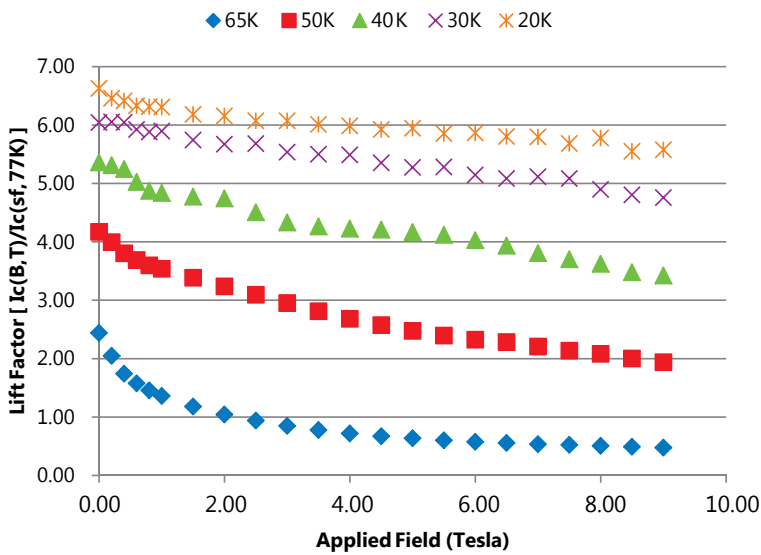
SuperPower'd

Ic vs. Field Data (Lift Factor Measurement):

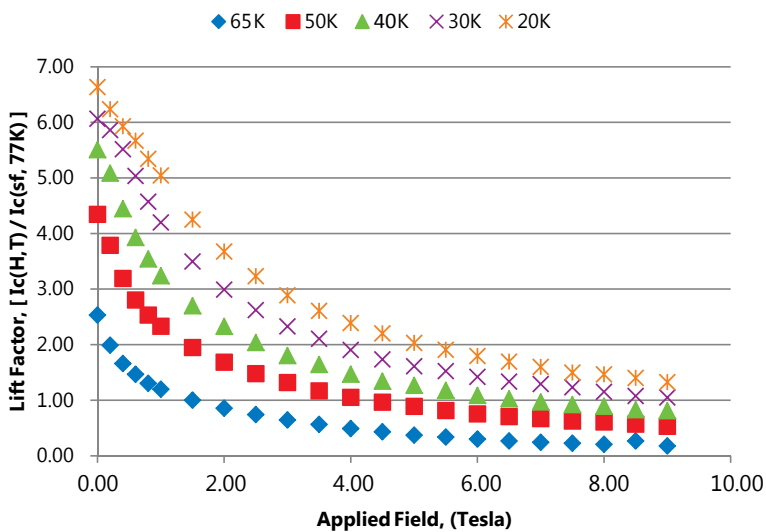
SP Wire Id M3-909-3

measurements performed at the University of Houston

M3-909-3 Lift Factor, H//a,b



M3-909-3 Lift Factor, H//c



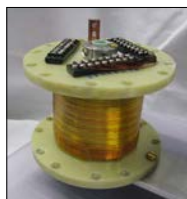
SuperPower'd™ for superior performance

SuperPower® 2G HTS Wire and coil application:

• **2011:** A new world-record magnetic field of 35.4 Tesla inside a superconducting coil has been reached using a single piece of about 100 m of REBCO conductor wound in layers and nested in a 31 Tesla background magnet



• **2009:** A high field magnet coil fabricated by SuperPower with its 2G HTS wire and tested at NHMFL again breaks world records when achieving a magnetic field of 27.4 Tesla at 4.2K in 19.89 Tesla background field



We are ready TODAY to discuss your SuperPower® 2G HTS Wire needs for your specific application.

- Standardized testing provided with all wire deliveries
- I_c uniformity in long lengths of 2G HTS wire: STDEV < 10%
- Insulated wire is available (see back page for details)
- I_c values range from 80 up to 150 A at 77K, 0T in 4 mm widths
- Engineering Current Density at 77K, 0T
 - Standard Wire (J_e) = 250 A/mm²
 - Premium Wire (J_e) = 275 to 325 A/mm²

Other custom configurations are available.

Please visit us at www.superpower-inc.com or by email at sales@superpower-inc.com, with your specifications, including:

- Wire length, width and thickness requirements
- Performance characteristics (critical current, stress, etc.)
- Surround copper stabilizer [SCS] (10-115 μ m), silver overlayer [SF] (2-5 μ m), or silver/gold stabilizer preference
- Other physical or performance characteristics and the application
- Delivery timeframe

Other applications:

• **2013:** The ECCOFLOW SFCL was designed, built and tested by a team of fifteen European organizations that include five European utility companies. SuperPower's unique SFCL wire was meticulously tested and evaluated and found to be the only wire capable of meeting all of the device requirements. In fact, the high performance level of the wire supplied allowed a reduction in the amount of wire needed for the device to operate as designed.

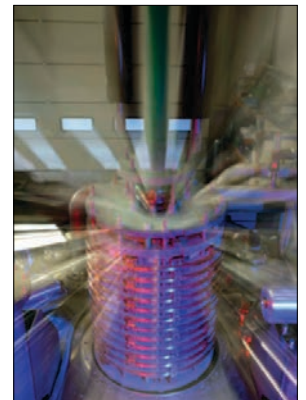
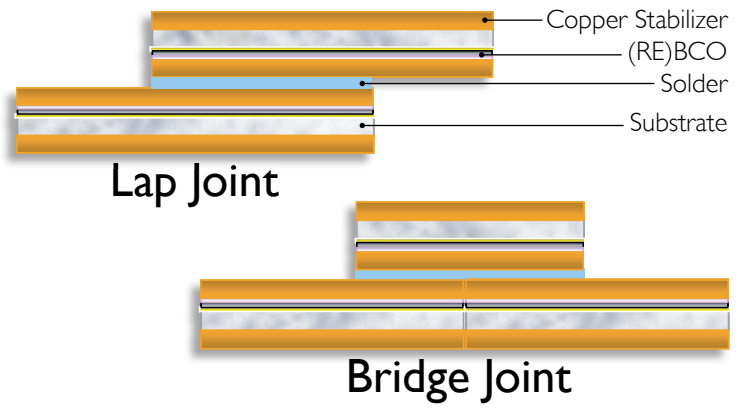


Image courtesy of Nexans SuperConductors GmbH: A module of the ECCOFLOW SFCL incorporating SuperPower® 2G HTS wire.

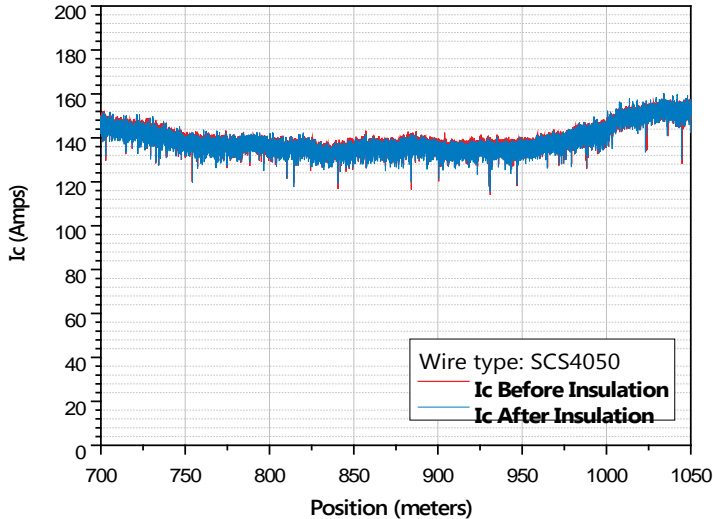


Insulated 2G HTS Wire

SuperPower offers in-house insulation for a variety of applications. Available configurations include 4, 3, 6 and 12 mm wire widths.

Wire is insulated with 0.0125 mm or 0.025 mm thick polyimide, both with a ~ 0.0125 mm silicone adhesive. Wrapping styles are butt wrapped (no overlap) or an adjustable overlap of 0 to 30% (standard overlap).

After insulation, the wire is not accessible for transport current measurements at every 5 m in the reel-to-reel test system. Therefore, a non-contact I_c technique is used to re-confirm the wire quality after insulation.



High Quality Joints

Despite these long lengths, it is often necessary to splice wire segments together. Our low resistance, high quality joints and splices have a minimal effect on the superior performance of our wire.

- Base tape thickness = 0.1 mm
- Thickness at joint or splice = 0.22 mm (*about two times thinner than splices with 1G or other 2G wires!*)
- Joint length = 25 to 200 mm, or per customer specifications
- Temperature limit on solder up to 240°C (much higher than with other 2G HTS wires)

Joints between 2G HTS wires show excellent electrical and thermo-mechanical properties.

- No degradation in I_c ($1 \mu\text{V}/\text{cm}$) over the joint or splice
- No decrease in I_c and no increase in joint resistivity when bent over a diameter of 25.4 mm
- Minimum bend diameter at joint = 25 mm
- Typical joint resistance < 20 n Ω , 100 mm over lap

