

Service Note SN002

Guidelines for Handling and Soldering 344 Superconductors

344 superconductors contain an YBCO ceramic thick film deposited on an oxide-buffered Ni-W alloy substrate. The YBCO film is coated with silver and laminated on both sides with a metal strip stabilizer (copper, brass, or stainless steel) utilizing solder having a 179 °C melting point. Figure 1 illustrates the basic structure. While the stabilizer provides some physical protection for the YBCO ceramic, 344 superconductors can still be damaged if improperly handled or subjected to conditions beyond the recommendations provided here.

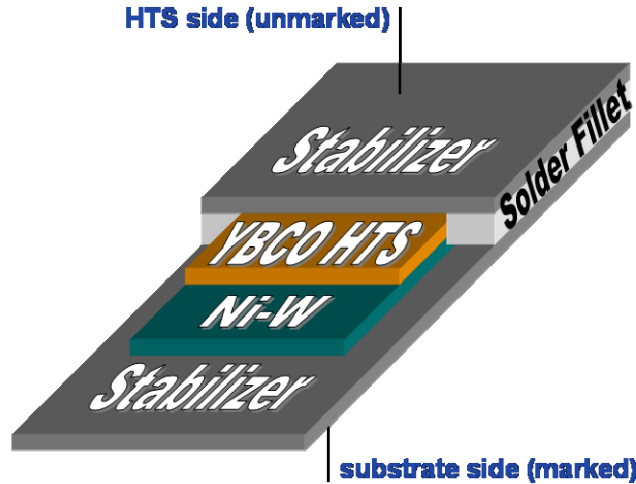


Figure 1. Structure of 344 Superconductors

Markings on 344 Superconductors

The substrate sides of 344 superconductors are marked with printed information indicating the product name, part number, and wire lot information. The marking includes position indicators spaced at one meter intervals. Figure 2 provides an example of the information printed on the substrate side. This information string is repeated every meter.

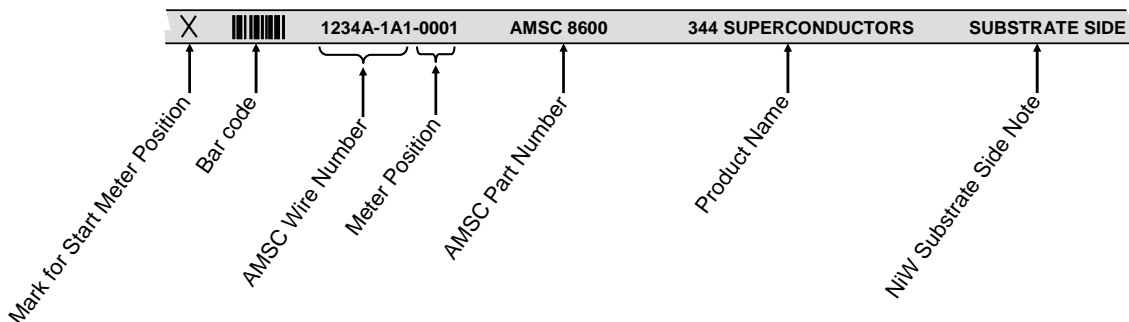


Figure 2. Printed Markings on Substrate Side of 344 Superconductors

The meter markings indicate absolute position on unspliced wires and relative (within sub-wire) position on spliced wires.

Handling 344 Superconductors

To avoid damaging superconductor wire:

- Do not rest heavy objects on the wire.
- Do not pinch, hammer, puncture, scrape, or abrade the surface.
- Avoid sharp bends – this will permanently damage the wire. Bending it back to the original shape will not undo the damage. The recommended minimum bend diameter can found at <http://www.amsc.com/products/htswire/index.cfm>.
- Do not immerse the wire in solder flux or other liquids.
- Do not use uncontrolled heat sources such heat guns or open flames and do not use solder guns with a high tip temperature (see temperature guidelines below).
- Soldered connections should be made directly to the laminated metal stabilizer; do not attempt to remove any of the metal strip.

Storage: Store in a dry environment – keep away from water

Winding Diameter: Please consult the 344 superconductor wire fact sheets, found at: <http://www.amsc.com/products/htswire/index.cfm>

Winding Tension: Please consult the 344 superconductor wire fact sheets, found at: <http://www.amsc.com/products/htswire/index.cfm>

Soldering to 344 Superconductors

General Guidelines for Soldering:

- The surface to be soldered must be smooth, clean, and free from any contamination.
- A non-corrosive solder flux (see recommendations in Table 1 below) should be applied prior to soldering. Do not immerse the wire in flux.
- The HTS wire must be heated to the temperature recommended for the selected solder (see Table 2 below) in a well-controlled manner.
- To safeguard against possible delamination of the wire structure, the maximum recommended temperature for any soldering to 344 superconductors is 165°C. Table 3 below provides time-temperature guidance for soldering AMSC 2G superconductor wires. Where possible, the shortest times at the lowest temperatures should be employed. In no case should the HTS wire be exposed to temperatures exceeding 175 °C.
- Gently contact the wire with the soldering iron until solder flows on the wire surface. Do not apply excessive pressure on the wire with the soldering iron tip.
- After assembly, clean the solder joint to remove any flux residue.

Table 1. Recommended Solder Fluxes

Flux	Activation	Comments
Alpha 260HF Cookson Electronics www.alphametals.com	Organic acid	Halide-free, water based, water soluble
Alpha NR-310-M Cookson Electronics www.alphametals.com	Organic acid	VOC-free, halide-free, rosin/resin-free, no-clean
135 Kester, Inc. www.kester.com	Non-activated rosin	Solvent-based

Table 2. Recommended Solders

Solder	General Description	Composition	Melt Point (°C)
Indalloy 53 Indium Corp. of America (www.indium.com)	Low temperature Sn-free	67% Bi – 33% In Eutectic	109
Indalloy 1E Indium Corp. of America (www.indium.com)	Lower temperature, higher strength	52%In-48%Sn Eutectic	118
Indalloy 4 Indium Corp. of America (www.indium.com)	Higher temperature, lower strength	100% In	157

Table 3. Time and Temperature Guidelines for Soldering to 344 Superconductors

Maximum Time	Temperature Range
3 minutes	165 °C to 175 °C
20 minutes	155 °C to 165 °C
100 minutes	145 °C to 155 °C
3 hours	135 °C to 145 °C
6 hours	125 °C to 135 °C

Attaching Current Leads to 344 Superconductors

The electrical resistance of solder connections to 344 superconductors depends on several factors including solder material, surface cleanliness, contact uniformity, and joint length. Another important factor is the side of the wire used for contact. The construction of 344 superconductors is asymmetrical and the side closest to the YBCO layer provides a lower resistance path to the superconductor core. Contacts made to the opposite side will have higher resistance due to the substrate. To easily identify the two sides, the higher resistance side of the wire is marked as “Substrate Side” as described above (see Figure 1).

For applications in which the wire will *not* be bathed in LN2 or some other cryogenic liquid, it is recommended that all electrical connections be made to the HTS side of the tape. If joint resistance is not critical, electrical connections can be made to either side.

The recommended configuration for attaching current leads to 344 superconductors is shown in Figure 3. For illustrative purposes it is assumed that the current lead is a metal strip of approximately the same thickness and width as the HTS wire. However, the methods described in this Service Note are also applicable to other current lead types.

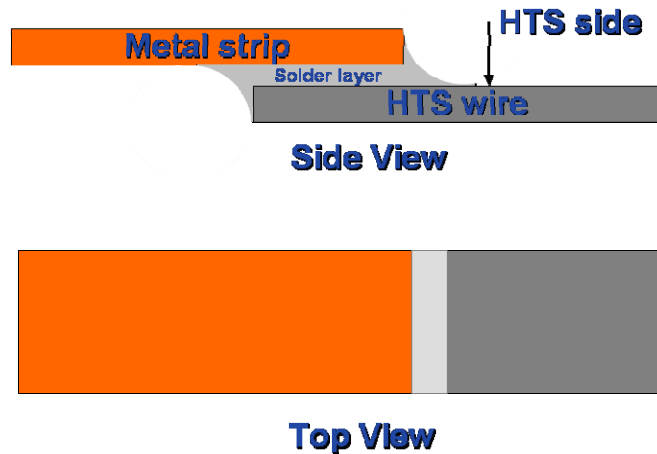


Figure 3. Configuration of a Metal Current Lead Connection

Detailed Instructions for Soldering Leads to 344 Superconductors

Tools/Materials Required:

- Suitable solvent for cleaning (methanol, ethanol, etc.)
- Lint-free cloth or tissue wipes
- Non-corrosive flux
- Solder
- Diagonal wire cutters (recommended tool: Knipex Model No. 7491250)
- Temperature-controlled soldering iron with a spade or chisel tip
- A small wooden dowel or “orange stick” to apply pressure on the joint during assembly
- A heat tolerant work surface, such as a G-10 phenolic plate
- A straight edge, such as a 30 cm long steel rule, to assist with alignment

Step-by-Step Instructions for Current Lead Attachment:

1. Wire Cutting
 - a. Cut clean, straight ends on the HTS wire and the current lead material using the recommended tool. Ends should be free from burrs or sharp protrusions.
2. Wire/Lead Preparation
 - a. Wipe all surfaces to be soldered with solvent
 - b. Apply flux to the low resistance side of the HTS wire
 - c. With the soldering iron set to the appropriate temperature, “tin” the fluxed portion of the wire with a thin coating of solder
 - d. Repeat above steps for the metal current lead
3. Soldered Joint Assembly
 - a. Position the HTS wire and lead together with the desired overlap and tinned surfaces facing each other as shown in Figure 4. A heat-tolerant adhesive tape can be used to secure the tapes during soldering. The tape should be placed at a sufficient distance from the solder joint to avoid exposing it to excessive heat.

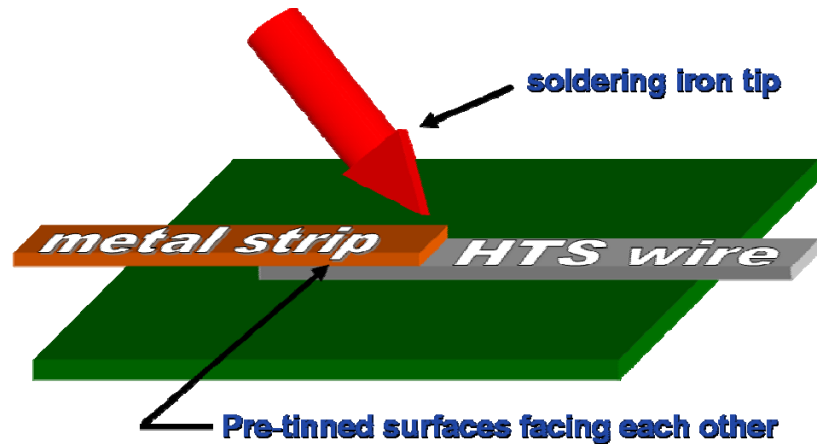


Figure 4. Method of positioning HTS wire and current lead for solder assembly

- b. Ensure good axial alignment of the lead and HTS wire by positioning the two pieces parallel to the straight edge.
 - c. Use the soldering iron to apply heat to the outer surface of the metal current lead until solder reflow at occurs at the joint
 - d. Remove the soldering iron and apply slight pressure on the joint with the wooden dowel. Maintain pressure until the solder has solidified.
4. Finishing/Rework
- a. Remove any excess flux with solvent.
 - b. If excess solder must be removed, use an Xacto® knife or similar sharp instrument to trim the solder.

Splices

Additional factors must be addressed when splicing 344 Superconductors together. For detailed information on splicing, please contact American Superconductor.

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