Designation: B 961 – 08

# Standard Specification for Silver Coated Copper and Copper Alloy Stranded Conductors for Electronic Space Application[1]

This standard is issued under the fixed designation B 961; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers uninsulated silver-coated soft or annealed copper and copper alloy stranded conductors for use in electronic space application.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* This precautionary caveat pertains only to Section 9.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

NOTE 1—The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein.

B 193 Test Method for Resistivity of Electrical Conductor Materials

B 258 Specification for Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors

B 298 Specification for Silver-Coated Soft or Annealed Copper Wire

B 286 Specification for Copper Conductors for Use in Hookup Wire for Electronic Equipment

B 624 Specification for High-Strength, High-Conductivity Copper-Alloy Wire for Electronic Application

E 3 Guide for Preparation of Metallographic Specimens

2.2 *European Space Agency (ESA):*[3]

ESA/SCC 3901 Generic Specification No. 3901

2.3 *European Cooperation for Space Standardization (ECSS):*[3]

ECSS-Q-70-20A Determination of the Susceptibility of Silver Plated Copper wire and Cable to "Red Plague" Corrosion

## 3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Quantity of each size.

3.1.2 Customer specification requirements including conductor size, designation, and construction.

3.1.3 Whether silver-coated copper or silver-coated copper-alloy.

3.1.4 Package size (Section 12).

3.1.5 Special package marking if required (Section 11), and

3.1.6 Place of inspection (Section 10).

## 4. Coating of Wires

4.1 *Coating Thickness*—The silver coating of wires composing stranded conductors shall be uniform such that no area around the strand circumference is covered by less than 80 micro-inches of silver. Uniform silver coating shall be verified by micro-sectioning as outlined in section 9.1.

4.1.1 Single points caused by eccentric strands or minute scratches shall not be less than 60 micro-inches minimum or exceed 3 points in number around the micro-sectioned strand circumference.

4.2 The silver coating of wires composing stranded conductors (before and after stranding) shall conform to the polysulfide test in accordance with Specification B 298.

4.3 The average silver coating thickness of wires composing stranded conductors shall be verified by electronic determination (Method A) in accordance with Specification B 298.

[1] This test method is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.04 on Conductors of Copper and Copper Alloys.

Current edition approved Sept. 1, 2008. Published October 2008.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] ESA Publications Division, ESTEC, P.O. Box 299, 2200 AG Noordwijk, The Netherlands (ESA/SCC 3901 download available from www.escies.org).

4.4 *Red Plague Corrosion Test*—Representative samples of the silver coated conductors shall conform to codes 0 – 3 of the accelerated corrosion test for un-insulated silver-plated conductors as outlined in section 9.2 (Explanatory Note 1).

## 5. General Requirements

5.1 *Temper*—Unless otherwise specified, all coated conductors shall be furnished in the annealed temper.

5.2 *Elongation*—The elongation of stranded conductors shall be permitted to vary from the requirements of the applicable Specifications B 298 and B 624 by the following amounts:

5.2.1 For stranded silver coated copper conductors 22 AWG and smaller, the test shall be performed on the whole conductor and the elongation measured when the first strand of the conductor breaks. The minimum average elongation shall not be less than 10 % with no individual specimen less than 5 %.

5.2.2 For stranded silver coated copper conductors larger than 22 AWG, strands shall be carefully removed from the conductor and tested for elongation. The minimum average elongation shall not be less than 10 % with no individual strand less than 5 %.

5.2.3 For stranded silver coated copper alloy conductors, the test shall be performed on the whole conductor only and the elongation measured when the first strand of the conductor breaks. The minimum elongation shall not be less than 6 %.

## 6. Lay of Stranded Conductors

6.1 The direction of lay of the outside layer of stranded conductors shall be left-hand.

6.2 The direction of lay of the other layers shall be reversed in successive layers, unless otherwise agreed upon between the manufacturer and the purchaser.

6.3 The length of lay of the individual wires composing the outside layer of the stranded conductor shall not be less than 8 nor more than 16 times the outside diameter of that layer.

## 7. Joints

7.1 No joints shall be made at the final draw prior to stranding. No joints shall be made in the individual strands or in the completed conductor during the stranding process. Necessary joints made in the wire and rods prior to final drawing shall be in accordance with the best workmanship practice.

## 8. Physical and Electrical Test

8.1 Tests to determine conformance of the coating to the requirements prescribed in Section 4 shall be performed before insulating.

8.2 Tests to determine conformance to the elongation requirements prescribed in section 5.2 shall be made before insulating.

8.3 Tests to determine conformance to electrical resistance requirements prescribed in 3.1.2 shall be made on the uninsulated conductor in accordance with Test Method B 193.

## 9. Test Methods

9.1 *Micro-Sectioning of Strands*:

9.1.1 The silver coating shall be evaluated for uniform coating requirements using the following procedure for micro-sectioning of strands. Section 9.1 shall be performed according to best commercial metallographic practice. Guide E 3 would provide a good background reference for metallographic examination and preparation of samples.

9.1.2 The test specimen shall consist of untwisted strands from the completed conductor. The test specimen shall be electroplated with a copper or nickel coating, which is not less than 25 µm. The copper or nickel coating will provide protection of the specimen edges for follow-up grinding and polishing preparation.

9.1.3 Mount the test specimen in a low exotherm (heat) casting resin encapsulating the specimen for metallographic preparation and cross-sectioning.

9.1.4 The specimen should be ground and polished using appropriate grinding disk pads and diamond paste. The diamond paste should go down to at least 0.25 µm.

9.1.5 Etch the polished specimen in a new solution of ammonia (commercially pure), which contains two drops of 37 % hydrogen peroxide.

9.1.6 Use a metallographic microscope to examine the etched cross-section with at least 400× magnification. The specimen shall meet the requirements of section 4.1.

9.2 *Red Plague Corrosion Test*:

9.2.1 *Apparatus*:

(See Appendix X1 and Fig. 2).

9.2.2 *Preparation of Sample*:

9.2.2.1 The conductor to be used in test shall be taken from the test spool with a minimum of handling. Handling of the conductor must be done using powder free gloves.

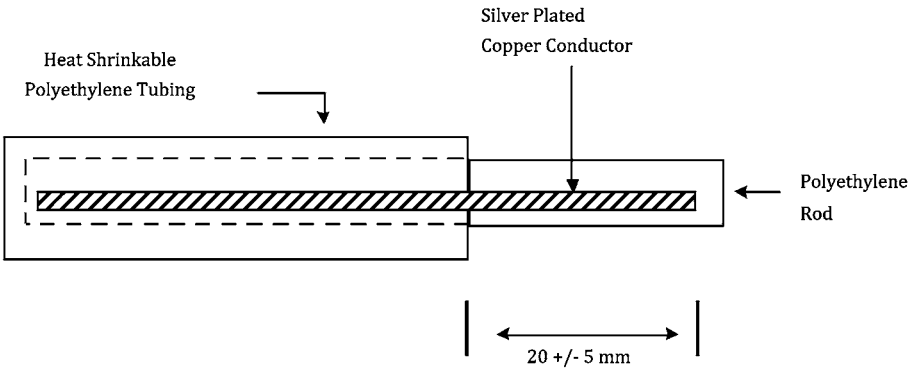


**FIG. 1 Prepared Test Sample**

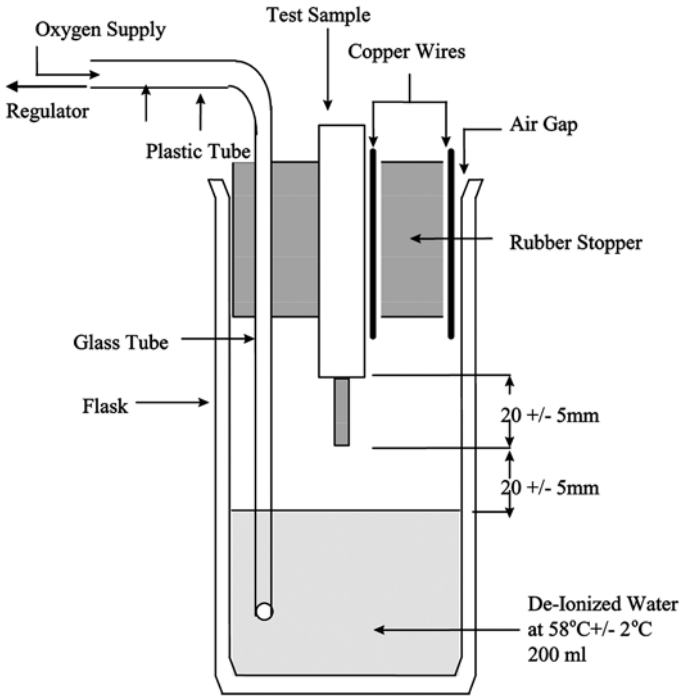


**FIG. 2 Diagram of Test Equipment for Red Plague Corrosion Test**

9.2.2.2 The test samples shall be 8 to 16 in. in length and attached to the polyethylene rod.

9.2.2.3 The rod sample shall then be encapsulated in the heat shrinkable polyethylene tubing with one end having 20 +/– 5 mm of conductor exposed. (Fig. 1).

9.2.3 *Preparation of Test Equipment*:

9.2.3.1 Temperature controlled bath shall be filled with de-ionized water and allowed sufficient time for bath to reach testing temperature. (58°C +/– 2°C).

9.2.3.2 Fill glass flask with 200 ml of de-ionized water and place in temperature controlled bath to allow it to reach an equilibrium temperature.

9.2.3.3 The test sample shall be inserted in a hole in the rubber stopper. Insert copper wire between glass flask and rubber stopper to allow for air gap.

9.2.3.4 The glass tube shall be inserted into the rubber stopper and the rubber stopper then fitted into the glass flask.

9.2.3.5 Adjust glass tube height until it is immersed in the de-ionized water. Adjust sample height until it is 20 +/– 5 mm above the height of the de-ionized water in the flask (Fig. 2).

9.2.3.6 Adjust oxygen (industrial oxygen with 99.2 % or greater purity) supply to a flow rate of 50 +/– 10 bubbles per min.

9.2.3.7 Water level evaporation in the temperature controlled bath should be prevented by a covering of any suitable material, e.g., Hollow Ball Bath Covers.

9.2.4 *Test*:

9.2.4.1 Test sample shall be exposed to controlled environment for 240 h.

9.2.4.2 After 240 h, the sample shall be removed from controlled environment.

9.2.5 *Evaluation*:

9.2.5.1 Remove the clear polyethylene jacket immediately using an appropriate cutting tool that does not damage the conductor.

9.2.5.2 The test sample shall be evaluated within 3 h after removal from controlled environment.

9.2.5.3 Inspect the sample using 20× magnification for corrosion sites. The corrosion site will appear as red/black cuprous oxide showing evidence of galvanic corrosion.

9.2.5.4 The following criteria shall be used for the evaluation of the results for 7-strand conductors:

CODE 0 NONE, no corrosion points.

CODE 1 ONE POINT, on one or two adjacent strands in one location along the length of the sample.

CODE 2 SLIGHT, on two to three adjacent strands in one location along the length of the sample.

CODE 3 MODERATE, on two to three strands in two to three locations along the length of the sample.

CODE 4 MODERATE, on more than four adjacent strands in four or more locations along length of the sample.

CODE 5 SEVERE CORROSION, affecting more than 50 % of the total strands from the conductor in any one location.

9.2.5.5 The following criteria shall be used for the evaluation of the results for 19-strand conductors:

CODE 0 NONE, no corrosion points.

CODE 1 ONE POINT, on one or two adjacent strands in one location along the length of the sample.

CODE 2 SLIGHT, on two to eight adjacent strands in one location along the length of the sample.

CODE 3 MODERATE, on two to eight strands in two to three locations along the length of the sample.

CODE 4 MODERATE, on two to ten strands in four or more locations along the length of the sample.