Designation: B470 – 02 (Reapproved 2017)

Standard Specification for Bonded Copper Conductors for Use in Hookup Wires for Electronic Equipment[1]

This standard is issued under the fixed designation B470; 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 stranded uninsulated bare, tin, or tin-lead alloy coated copper conductors in which wires in the strand are metallically bonded together by the application of heat or additional tin, or tin-lead alloy for use in hookup wire for electronic equipment.

1.2 The SI values for density and resistivity are to be regarded as standard. For all other properties, the inch-pound values are to be regarded as the standard and the SI units may be approximate.

1.3 The hazard caveat pertains only to Section 6 of this specification. *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.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 The following documents of the issue in effect at the time of reference form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B3 Specification for Soft or Annealed Copper Wire

B286 Specification for Copper Conductors for Use in Hookup Wire for Electronic Equipment

3. Ordering Information

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

3.1.1 Quantity of each size, material, construction, and type (see 4.1),

3.1.2 Package size (see 8.1),

3.1.3 Special package marking if required (Section 8), and

3.1.4 Place of inspection (Section 7).

4. Conductor Constructions

4.1 Conductor constructions shall conform to the applicable constructions of Specification B286, except that in addition the following bondings may be specified:

4.1.1 *Type I*—Bare copper, stranded, light bonding,

4.1.2 *Type II*—Tin or tin-lead alloy coated copper, stranded, light bonding, or

4.1.3 *Type III*—Tin or tin-lead alloy coated copper, stranded, heavy bonding.

5. General Requirements

5.1 The conductors shall consist of tinned copper conforming to the product description, quality and specification requirements of Specification B286 and bare copper conforming to the product description, quality and specification requirements of Specification B3.

5.2 *Flex Life*—The average of six flex tests specified in 6.1 shall meet the minimum requirements of Table 1for the applicable type and construction.

5.3 *Fraying, Types I and II*—After performing the test in 6.2, no separations of strands shall be visible to the unaided eye (normal spectacles excepted), from the cut end to the point of bend nearest to that cut end.

5.4 *Mandrel Test, Type III Only (see Explanatory* Note 1*)*—After performing the test specified in 6.3 no separation of strands shall be visible to the unaided eye (normal spectacles excepted).

6. Test Methods

6.1 *Flex Life*—The testing equipment shall be designed and set up for operation so that steel mandrels shall be horizontal and so positioned that any vertical movement of the specimen

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[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.

TABLE 1 Flex Life Requirements, Minimum Cycles

Construction	Un-bonded (see Explanatory Note 5)	Type I and II (Light Bonding)	Type III (Heavy Bonding)
7 wire	40	30	20
10 wire	55	40	25
16 wire	85	60	40
19 or more wires	100	70	50

TABLE 2 Conditions for Flex Test

Size, AWG	Nominal Mandrel Diameter (Explanatory Note 4)		Mandrel Spacing		Mass, g
	in.	mm	in.	mm	
16	0.2344	5.954	0.065	1.65	1511
18	0.1875	4.762	0.056	1.42	951
20	0.1562	3.967	0.046	1.17	598
22	0.1250	3.175	0.037	0.94	376
24	0.0937	2.380	0.031	0.79	236
26	0.0625	1.588	0.026	0.66	149

is minimized. The conductor as clamped for test shall pass through the vertical center line between the mandrels.

6.1.1 The conductor shall be bent repeatedly in alternating directions in an arc of 60° on both sides of the vertical center line of the mandrels, at a rate of 24 to 36 cpm, between mandrels of size and spacing specified in Table 2. The mandrels must be so supported that the specified spacing during test is maintained. Mandrel deflection must be avoided. The conductor shall be clamped at a point not less than 1 in. (25.4 mm) above the horizontal center line of the mandrels. A load, as specified in Table 2, shall be applied to the free end of the conductor (Explanatory Note 2) not less than 3 in. (76.2 mm) below the horizontal center line of the mandrels. One cycle occurs when starting from normal the conductor is bent 60° in one direction, reverse bent 120° through the normal position, and then back to normal. Complete rupture of the conductor terminates the test.

6.2 *Fraying*—The conductor, cut square at the end, shall be inserted into a blind hole of the size and depth indicated in Table 3. The edge of the hole shall be broken to no more than 1⁄64 in. (0.40 mm) radius. The conductor shall be bent 90° over the edge of the hole and back to normal.

TABLE 3 Conditions for Fraying and Mandrel Tests

Size, AWG	Fraying Test				Mandrel Test	
	Hole Diameter		Hole Depth		Mandrel Diameter	
	in.	mm	in.	mm	in.	mm
16	0.063	1.60	1⁄4	6.35	3⁄16	4.76
18	0.055	1.40	1⁄4	6.35	1⁄8	3.18
20	0.046	1.17	3⁄16	4.76	5⁄64	1.98
22	0.037	0.94	3⁄16	4.76	3⁄64	1.19
24	0.031	0.79	1⁄8	3.18	1⁄32	0.79
26	0.026	0.66	1⁄8	3.18	1⁄32	0.79

6.3 *Mandrel Test*—The conductor shall be wrapped six close turns over a mandrel as specified in Table 3 and slipped off the end of the mandrel for examination (Explanatory Note 3).

6.4 *Resistance*—The conductors after bonding shall meet the requirements of Specification B286.

7. Inspection

7.1 *General*—All test and inspections shall be made at the place of manufacture unless otherwise agreed upon between the manufacturer and the purchaser at the time of the purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification (Explanatory Note 4).

7.1.1 Unless otherwise agreed by the manufacturer and the purchaser, conformance of the wire to the various requirements listed in Section 5 shall be determined on samples taken from each lot of wire presented for acceptance.

7.1.2 The manufacturer shall, if requested prior to inspection, certify that all wire in the lot made under such conditions that the product as a whole conforms to the requirements of this specification as determined by regularly made and recorded tests.

7.2 *Terms Used for Inspection:*

7.2.1 *Lot*—A lot is any amount of wire of one class and size presented for acceptance at one time, such amount, however, not to exceed 10 000 lb (4500 kg).

7.2.2 *Sample*—A sample is a quantity of production units (coils, reels, etc.) selected at random from the lot for the purpose of determining conformance of the lot to the requirements of this specification.

7.2.3 *Specimen*—A specimen is a length of wire removed for test purposes from any individual production unit of the sample.

7.3 *Sample Size*—The number of production units in a sample shall be as follows:

7.3.1 For elongation, resistivity, and mass of coating determinations, the sample shall consist of four production units. For continuity of coating determinations, the sample shall consist of eight production units. From each unit, one test specimen of sufficient length shall be removed for the performance of the required test.

7.3.2 For dimensional measurements and surface finish, the sample shall consist of a quantity of production units shown in Table 4 under the heading “First Sample.”

TABLE 4 Sampling for Dimensional Measurements

Number of Units in Lot	First Sample		Second Sample		Allowable Number of Defects in Both Samples, c_2
	Number of Units in Sample, n_1	Allowable Number of Defects in Sample, c_1	Number of Units in Sample, n_2	$n_1 + n_2$	
1 to 14, incl	all	0	...	...	0
15 to 50, incl	14	0	...	...	0
51 to 100, incl	19	0	23	42	1
101 to 200, incl	24	0	46	70	2
201 to 400, incl	29	0	76	105	3
401 to 800, incl	33	0	112	145	4
Over 800	34	0	116	150	4

7.3.3 For packaging inspection (when specified by the purchaser at the time of placing order), the sample shall consist of a quantity of production units shown in Table 5.

8. Packaging and Package Marking

8.1 The net mass, length (or lengths, and number of lengths, if more than one length is included in the package), size designation, type of conductor, purchase order number, and any other marks required by the purchase order shall be marked on a tag attached to the end of the conductor inside of the package. The same information, together with the manufacturer's serial number (if any) and all shipping marks required by the purchaser, shall appear on the outside of each package.

TABLE 5 Sampling for Surface Finish and Packaging Inspection

Number of Units in Lot	Number of Units in Sample, *n*	Allowable Number of Defective Units, *c*
1 to 30, incl	all	0
31 to 50, incl	30	0
51 to 100, incl	37	0
101 to 200, incl	40	0
201 to 300, incl	70	1
301 to 500, incl	100	2
501 to 800, incl	130	3
Over 800	155	4

8.2 Package sizes for conductors shall be agreed upon between the manufacturer and the purchaser in the placing of individual orders.

8.3 The conductors shall be protected against damage in ordinary handling and shipping.

9. Keywords

9.1 bonded copper conductors; copper conductor for electronic equipment; copper electrical conductor; electrical conductor; electrical conductor—copper

EXPLANATORY NOTES

NOTE 1—Type III will conform to the requirements of the fraying test but performance of the test is not required.

NOTE 2—Test weight is designed to impose a load of 1500 psi (10.3 MPa) calculated for a nominal 7 wire construction.

NOTE 3—Mandrel diameters are to be controlled by the following tolerances which are equivalent to commercial tolerances for drill rod: Up to and including 0.124 in. ± 0.0003 in. (3.150 mm ± 0.0076 mm) 0.125 in. to and including 0.499 in. ± 0.0005 in. (3.175 mm to and including 12.675 mm ± 0.0127 mm).

NOTE 4—Cumulative results secured on the product of a single manufacturer, indicating continued conformance to the criteria, are necessary to ensure an overall product meeting the requirements of this specification. The sample size and conformance criteria given for the various characteristics are applicable only to lots produced under these conditions.

NOTE 5—Unbonded flex life values are given for information only as a basis for comparison to bonded construction. A solid wire of the same AWG number will exhibit a minimum of 10 cycles.