Designation: B624 – 07 (Reapproved 2012)

Standard Specification for High-Strength, High-Conductivity Copper-Alloy Wire for Electronic Application[1]

This standard is issued under the fixed designation B624; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers high-strength, high-conductivity round copper-alloy wire 0.00099 to 0.0720 in. [0.025 to 1.829 mm] in diameter, used for electronic hookup wire. The tensile strength of the wire is 60 ksi [414 MPa] minimum and the electrical conductivity at 20°C is 85 % IACS minimum.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B193 Test Method for Resistivity of Electrical Conductor Materials

E8 Test Methods for Tension Testing of Metallic Materials

3. Ordering Information

3.1 Orders for wire furnished to this specification shall include the following information:

3.1.1 Quantity (pounds or kilograms),

3.1.2 Wire size (Table 1),

3.1.3 Place of inspection (Section 7),

3.1.4 Package size (Section 9), and

3.1.5 Special marking, if required (Section 9).

4. Materials and Manufacture

4.1 The wire shall be copper alloy of such quality and purity that the finished product shall have the properties and characteristics prescribed in this specification. Chemical analysis of a specific alloy is not a requirement of this specification unless definite agreement is reached between the manufacturer and the purchaser in the placing of individual orders.

5. General Requirements

5.1 *Tensile Properties*—The minimum breaking strength and elongation of the conductor shall be as prescribed in Table 1. Breaking strengths of intermediate sizes may be calculated in accordance with Explanatory Note 1.

5.2 *Electrical Resistance*—The electrical resistance of the wire at a temperature of 20°C shall not exceed the values in Table 1. Resistances of intermediate sizes may be calculated in accordance with Explanatory Note 2.

5.3 *Diameter*—The wire size shall be expressed as the diameter of the wire in decimal fractions of an inch to the nearest 0.0001 in. [0.003 mm]. For diameters under 0.0100 in. [0.254 mm], the wire shall not vary from the specified diameter by more than ±0.0001 in. [0.003 mm]. For diameters 0.0100 in. [0.254 mm] and over, the wire shall not vary from the specified diameter by more than ±1 %, expressed to the nearest 0.0001 in. [0.003 mm].

5.4 *Joints*—Joints necessary to processing shall be of such quality that all requirements of this specification are met.

5.5 *Finish*—The finished material shall be free of defects that detract from the normal end use or longevity of the product. The material shall be smooth, bright, clean, and free of laps, slivers, seams, scratches, and other imperfections not consistent with good commercial practice.

6. Test Method

6.1 *Breaking Strength and Elongation* —Conduct tension and elongation tests in accordance with Test Methods E8 and with a rate of loading not to exceed 10 in./min [250 mm/min]. The breaking strength shall equal or exceed the value specified in Table 1.

[1] This specification 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.

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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 Tensile Properties and Resistance

Nominal Diameter		Breaking Strength, min		Elongation, min, % in 10 in. or 250 mm	Resistance, max, at 20°C	
in.	mm	lbf	N		Ω/1000 ft	Ω/km
0.0720	1.829	239	1065	9	2.40	7.88
0.0641	1.628	190	844	9	3.03	9.94
0.0571	1.450	151	670	9	3.82	12.5
0.0508	1.290	119	530	9	4.82	15.8
0.0453	1.151	94.8	422	9	6.08	19.9
0.0403	1.024	75.0	334	9	7.66	25.1
0.0359	0.912	59.5	265	9	9.68	31.7
0.0320	0.813	47.3	210	9	12.1	39.9
0.0285	0.724	37.5	167	9	15.3	50.2
0.0253	0.643	29.6	132	9	19.5	63.7
0.0226	0.574	23.6	105	9	24.3	80.0
0.0201	0.511	18.7	83.1	9	30.8	101
0.0179	0.455	14.8	65.8	9	38.9	128
0.0159	0.404	11.7	52.0	9	49.5	161
0.0142	0.361	9.31	41.4	9	61.4	202
0.0126	0.320	7.33	32.6	9	78.1	257
0.0113	0.287	5.90	26.2	9	97.3	320
0.0100	0.254	4.62	20.6	8	124	408
0.0089	0.226	3.65	16.2	8	158	517
0.0080	0.203	2.94	13.1	8	195	643
0.0071	0.180	2.31	10.3	8	249	820
0.0063	0.160	1.81	8.1	8	317	1040
0.0056	0.142	1.43	6.3	8	403	1330
0.0050	0.127	1.13	5.0	7	508	1670
0.0045	0.114	0.91	4.0	7	630	2080
0.0040	0.102	0.72	3.2	7	802	2610
0.0035	0.089	0.54	2.4	7	1060	3450
0.0031	0.079	0.42	1.9	7	1360	4410
0.0028	0.071	0.34	1.5	6	1670	5490
0.0025	0.064	0.27	1.2	6	2120	6950
0.0022	0.056	0.21	0.9	6	2770	9080
0.0020	0.051	0.17	0.8	6	3380	11 100
0.00176[A]	0.045	0.22	1.0	...	4430	14 500
0.00157[A]	0.040	0.17	0.8	...	5650	18 500
0.00140[A]	0.036	0.13	0.6	...	7220	23 700
0.00124[A]	0.031	0.10	0.5	...	9390	30 800
0.00111[A]	0.028	0.08	0.4	...	12 000	39 200
0.00099[A]	0.025	0.06	0.3	...	15 400	50 500

[A] These single ends will be hard temper.

6.2 *Resistance*—Measure resistance in accordance with Test Method B193.

6.3 *Diameter*—Make diameter measurements with a micrometer or equivalent caliper equipped with a vernier graduated in 0.0001 in. or 0.003 mm. Gage each coil in three places, one near each end and one near the center. From each spool, unreel approximately 12 ft [4 m] and gage the wire in six places between the second and twelfth foot from the end. The average of the measurements obtained shall be considered the wire size specified in 5.3.

7. Inspection

7.1 *General*—All tests and inspections shall be made at the place of manufacture unless otherwise agreed upon between the manufacturer and the purchaser at the time of 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 3).

7.1.1 Unless otherwise agreed upon between 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, when requested before inspection, shall certify that all wire in the lot was 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 *Description of Inspection Terms :*

7.2.1 *Lot*—An inspection lot shall consist of an identifiable quantity of wire subjected to inspection at one time. Each lot shall consist of units of wire of the same size and temper, manufactured under essentially the same conditions at essentially the same time. The amount in any case shall not exceed 100 production units.

7.2.2 *Sample*—A sample is a quantity of production units (coils, reels, and so forth) 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 breaking strength, elongation, electrical resistance, and diameter measurements, the sample shall consist of a quantity of production units shown in Table 2 under heading "First Sample." From each unit, one test specimen of sufficient length shall be removed for the performance of the required tests.

7.3.2 For surface finish and packaging inspection, when specified by the purchaser at the time of placing the order, the sample shall consist of a quantity of production units as shown in Table 3.

TABLE 3 Sample for Surface Finish and Packaging

Number of Units in Lot	Number of Units in Sample, *n*	Allowable Number of Defects in Sample to Accept Lot, *c*
1 to 3	All	0
4 to 8	4	0
9 to 15	9	0
16 to 25	14	0
26 to 40	20	0
41 to 65	30	0
66 to 100	42	0

8. Conformance Criteria

8.1 Any lot of wire, the samples of which comply with conformance criteria of this section, shall be considered as complying with the requirements of Section 5. Individual production units that fail to meet one or more of the requirements shall be rejected. Failure of a sample group from a lot to meet one or more of the following criteria shall constitute cause for rejection of the lot. The conformance criteria for each of the prescribed properties given in Section 5 are as follows:

8.1.1 For breaking strength, elongation, resistance, and diameter measurements, the sample shall consist of a quantity of production units shown in Table 2 under heading "First Sample." If there are no defects, the lot shall be considered as conforming to these requirements. If there are defects, but the number of these do not exceed the allowable defect number c_2 (Table 2) for the respective number of units in the sample, a second sample equal to n_2 shall be taken and the total defects of the $n_1 + n_2$ units shall not exceed the allowable defect number c_2. Failure to meet this requirement shall constitute failure to meet the conformance criteria (Explanatory Note 4).

8.1.1.1 *Breaking Strength and Elongation* —The breaking strength and elongation of each of the specimens shall conform to the requirements of 5.1 and Table 1.

8.1.1.2 *Electrical Resistance*—The electrical resistance shall conform to the requirements of 5.2 and Table 1.

8.1.1.3 *Diameter*—The diameter of each of the specimens shall conform to the requirements of 5.3.

8.1.2 For surface finish and packaging, when specified by the purchaser at the time of placing the order, the sample shall consist of a quantity of production units as shown in Table 3. The number of units in the sample showing nonconformance to the requirements shall not exceed the allowable defect number *c* in Table 3. Failure to meet the requirements shall constitute failure to meet the conformance criteria.

9. Packaging and Package Marking

9.1 Package sizes and marking shall be agreed to between the manufacturer and the purchaser in the placing of individual orders.

9.2 The wire shall be packaged so that it is protected against damage or degradation in ordinary handling and shipping.

TABLE 2 Sampling for Mechanical and Electrical Tests

Number of Units	First Sample		Second Sample		
	Number of Units in Sample, n_1	Allowable Number of Defects in Sample to Accept Lot, c_1	Number of Units in Sample, n_2	$n_1 + n_2$	Allowable Number of Defects in Both Samples to Accept Lot, c_2
1 to 3	all	0	...	...	0
4 to 8	4	0	...	...	0
9 to 15	4	0	5	9	1
16 to 25	5	0	9	14	1
26 to 40	8	0	12	20	1
41 to 65	12	0	18	30	1
66 to 100	19	0	23	42	1

EXPLANATORY NOTES

NOTE 1—The minimum breaking strength for any single strand conductor shall be calculated as follows:

$$\text{Breaking strength, min, lb} = 47\,120 \times (\text{mindiameter, in.})^2$$

or

$$\text{Breaking strength, min, N} = 324.9 \times (\text{mindiameter, mm})^2$$

NOTE 2—The maximum electrical resistance for any single strand conductor shall be calculated as follows:

$$\text{Resistance, max}(\Omega/1000\ \text{ft}) = \frac{0.01220}{(\text{mindiameter, in.})^2}$$

or

$$\text{Resistance, max, } (\Omega/\text{km}) = \frac{25.83}{(\text{mindiameter, mm})^2}$$

NOTE 3—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 sizes and conformance criteria given for the various characteristics are applicable only to lots produced under these conditions.

NOTE 4—A defect should be taken as the failure of the individual requirements (breaking strength, elongation, resistance, and diameter) specified in 8.1.1. For example, a defect of two individual requirements would be considered one defect of each requirement and not two defects of the sample.