



Designation: F96 – 77 (Reapproved 2020)

Standard Specification for Electronic Grade Alloys of Copper and Nickel in Wrought Forms¹

This standard is issued under the fixed designation F96; 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 alloys of copper and nickel in a variety of wrought shapes suitable for external and internal use in electron devices.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 The following safety hazards caveat applies to Test Methods Section 8 only: *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, health, and environmental 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 *ASTM Standards:*²

[A342/A342M Test Methods for Permeability of Weakly Magnetic Materials](#)

[B122/B122M Specification for Copper-Nickel-Tin Alloy, Copper-Nickel-Zinc Alloy \(Nickel Silver\), and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar](#)

[B127 Specification for Nickel-Copper Alloy Plate, Sheet, and Strip](#)

[B164 Specification for Nickel-Copper Alloy Rod, Bar, and Wire](#)

[B165 Specification for Nickel-Copper Alloy Seamless Pipe and Tube](#)

[E75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys \(Withdrawn 2010\)](#)³

3. Ordering Information

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

3.1.1 Alloy (see 9.1),

3.1.2 Shape,

3.1.3 Condition (cold-rolled, hot-rolled, etc.),

3.1.4 Dimensions,

3.1.5 Weight,

3.1.6 Packaging (see 10.2), and

3.1.7 Special requirements (see 11.1).

4. Manufacture and Workmanship

4.1 The material shall be handled in such a manner that oxide contamination and foreign material such as metal chips and dirt shall be minimized on the surfaces.

4.2 Sheet and strip intended for deep drawing shall be substantially free from directional properties which can cause excessive tearing in the deep drawn product.

5. Chemical Composition

5.1 This material shall conform to the chemical composition shown in Table 1.

5.2 When specifically requested, a certificate of chemical analysis shall be supplied by the manufacturer. Sample for chemical analysis is to be taken from a ladle sample at the time the melt is cast. Each sample shall be individually analyzed to the requirements of 5.1 and the numerical results of analysis reported in the certification.

5.3 In case of disagreement, the analysis shall be made in accordance with Test Method E75 for the respective materials when such methods of analysis are available. When ASTM methods are not available, the analytical procedures shall be agreed upon by the manufacturer and the purchaser.

¹ This specification is under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.03 on Metallic Materials, Wire Bonding, and Flip Chip.

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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.

³ The last approved version of this historical standard is referenced on www.astm.org.

TABLE 1 Chemical Requirements ^A

Alloy	1	2	3	4	5
Nominal Composition, %	70 Cu-30 Ni	70 Cu-30 Ni	90 Cu-10 Ni	55 Ni-45 Cu	65 Ni-35 Cu
UNS Alloy Number	C71580	C71590	C70690	N04404	N04400
Nickel, %	29–33	29–33	9.0–11.0	52–57	62 min
Cobalt, %	^B	0.05 max	0.02 max	^B	^B
Iron, max, %	0.5	0.005	0.005	0.5	2.5
Zinc, max, %	0.05 ^C	0.001	0.001	0.02 ^C	0.02 ^C
Manganese, max, %	0.3	0.001	0.001	0.1	2.0
Lead, max, %	0.05 ^C	0.001	0.001	0.01 ^C	0.01 ^C
Carbon, max, %	0.07	0.03	0.03	0.15	0.2
Silicon, max, %	0.15	0.02	0.02	0.1	0.5
Sulfur, max, %	0.024	0.003	0.003	0.015	0.015
Aluminum, max, %	0.05	0.002	0.002	0.05	—
Phosphorus, max, %	0.03	0.001	0.001	0.03 ^C	0.02 ^C
Copper, %	65 min	67 ^D min	89.0 ^D min	balance	28.0–34.0

^A By agreement between purchaser and seller, analysis may be required and limits established for elements or compounds not specified in this table.

^B Cobalt counting as nickel. (For these alloys the percentage given for nickel includes any cobalt present, and no separate value is given for cobalt.)

^C Need not be routinely determined and reported unless specifically requested by agreement between purchaser and seller.

^D The following additional requirements shall apply to Alloys 2 and 3; bismuth, arsenic, titanium, tin, and antimony – 10 ppm each max; mercury – 5 ppm max.

6. Physical Properties

6.1 *Alloy 1*—The properties shall be as shown in the applicable basic product specification referenced in 5.1 except for grain size which shall conform to the requirements in Table 2.

6.2 *Alloys 2 and 3*— The mechanical properties shall be as agreed upon between manufacturer and purchaser. The grain size shall conform to the requirements in Table 2.

6.3 *Alloy 4*:

6.3.1 The mechanical properties shall be as agreed upon between manufacturer and purchaser.

6.3.2 Grain size and hardness for deep drawing quality sheet and strip shall conform to the requirements shown in Specification B127.

6.3.3 The magnetic permeability shall not exceed 1.1 when tested at – 3°C and a field strength of 39.8 A/m.

6.3.3.1 Testing shall be performed in accordance with Method 5 of Test Methods A342/A342M, or by an equivalent procedure. In case of disagreement, Method 5 of Test Methods A342/A342M shall be used as the referee method.

6.3.3.2 Testing shall be performed on a one per heat basis.

6.4 *Alloy 5*—The properties shall be as shown in the applicable basic product specifications referenced in 5.1.

7. General Condition

7.1 *Macroscopical*— Edges shall be free from seams, laps, folds, and cracks which would be detrimental to its end use.

7.2 *Microscopical*— The material shall be free of nonmetallic inclusions or discontinuities which would be detrimental to its end use when examined in accordance with 8.1.2.

8. Test Methods

8.1 For Alloys 1 and 2, the properties enumerated in this specification shall be determined on specimens prepared in accordance with the following procedures.

8.1.1 *Macroscopical*:

8.1.1.1 For this examination, usually performed on heat-treated or unheat-treated specimens of large diameter wire, rod, tube, and shaped extrusions, specimens shall be machined to a 63 rms surface finish or smoother on the transverse section and degreased.

8.1.1.2 Prepare a fresh 1 + 1 aqueous solution of commercial nitric acid to which has been added 5 g of copper per litre of solution before use. The solution shall be kept free from dirt and maintained during use at a temperature 24 ± 3°C.

8.1.1.3 Etch the specimens for 3 to 5 min by lowering into the solution and agitating slowly. Remove periodically to determine whether the etching is sufficient. If the specimens tend to stain, adding 25 mL of hydrochloric acid to each litre of solution will minimize the staining. After etching, wash and dry the specimen before examination.

8.1.1.4 Examine at 10× magnification.

8.1.2 *Microscopical*:

8.1.2.1 Cut and degrease longitudinal specimens from the finished material. Heat to 850 ± 25°C for 30 min in an atmosphere containing not less than 10 % hydrogen and rapidly cool but do not necessarily quench.

8.1.2.2 Polish the specimens and etch for microscopical examination in a solution consisting of:

Water	800 mL
Sodium dichromate	16 g
Sulfuric acid (concentrated)	64 mL
Sodium chloride	12 g

8.1.2.3 Examine at 100× magnification.

TABLE 2 Grain Size of Annealed Tempers of Alloys 1, 2, and 3

Temper	Average Grain Size, mm					
	Sheet and Strip			Rod and Bar		
	nominal	min	max	nominal	min	max
Soft anneal	0.035	0.025	0.050	0.035	0.025	0.050
Light anneal	0.015	^A	0.025	0.015	^A	0.030

^A Although no minimum grain size is required, this material shall be fully recrystallized.