Designation: B 694 – 023

Standard Specification for Copper, Copper-Alloy, ~~and~~ Copper-Clad Bronze (CCB), Copper-Clad Stainless Steel (CCS), and Copper-Clad Alloy Steel (CAS) Sheet and Strip for Electrical Cable Shielding[1]

This standard is issued under the fixed designation B 694; 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 establishes the requirements of copper, copper alloy, copper-clad bronze (CCB), copper-clad stainless steel (CCS), and copper-clad alloy steel (CAS) materials, sheet, and strip, in various thicknesses, for use as electrostatic or electromagnetic shielding for insulated power, control, instrumentation, and communication cables.

NOTE 1—See Specification B 736, for related standards for aluminum-based shielding materials.

1.2 The products covered are the following:

Copper or Copper Alloy UNS No.	Type of Products
C11000	copper
C19400	copper-iron alloy
C22000	copper-zinc alloy (commercial bronze)
C23000	copper-zinc alloy (red brass)
C66400	copper-zinc-iron-cobalt alloy
C66410	copper-zinc-iron alloy
C66430	copper-zinc-iron-tin alloy
C71000	cupro-nickel 20 %
...	copper-clad bronze (CCB)
...	copper-clad stainless steel (CCS)
...	copper-clad alloy steel (CAS)

1.3 The values stated in inch-pound units are the standard, except for temperature and grain size which are given in SI units. Values in parentheses are for information only.

1.4 *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:*

A 176 Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
A 505 Specification for Steel, Sheet and Strip, Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
B 152/B 152M Specification for Copper Sheet, Strip, Plate, and Rolled Bar
B 248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar
B 601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast
B 736 Specification for Aluminum, Aluminum Alloy, and Aluminum-Clad Steel Cable Shielding Stock
B 846 Terminology for Copper and Copper Alloys
E 3 Guide for Preparation of Metallographic Specimens
E 8 Test Methods for Tension Testing of Metallic Materials
E 54 Test Methods for Chemical Analysis of Special Brasses and Bronzes
E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)
E 75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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***A Summary of Changes section appears at the end of this standard.**

E 112 Test Methods for Determining Average Grain Size
E 255 Practice for Sampling Copper and Copper Alloys for Determination of Chemical Composition
E 478 Test Methods for Chemical Analysis of Copper Alloys
2.2 *International Standards Organization (ISO) Standards:*
ISO 3110/2 Determination of Aluminum; Flame Atomic Absorption Spectrometric Method (TC/26 Ref. No. N698 E/F)[2]

3. General Requirements

3.1 The following sections of Specification B 248 constitute a part of this specification:
3.1.1 Terminology—Definitions,
3.1.2 Materials and Manufacturing,
3.1.3 Workmanship, Finish, and Appearance,
3.1.4 Sampling—except for chemical analysis,
3.1.5 Number of Tests and Retests,
3.1.6 Specimen Preparation,
3.1.7 Test Methods—except for chemical analysis,
3.1.8 Significance of Numerical Limits,
3.1.9 Inspection,
3.1.10 Rejection and Rehearing,
3.1.11 Certification,
3.1.12 Test Reports (Mill),
3.1.13 Packaging and Package Marking, and
3.1.14 Supplementary Requirements.
3.2 In addition, when a section with a title identical to that referenced in 3.1 appears in this specification, it contains additional requirements, which supplement those appearing in Specification B 248.

4. Terminology

4.1 For definitions of terms relating to copper and copper alloys, refer to Terminology B 846.
4.1.1 *cladding ratio, n*—ratio by percent thickness of the component layers, for example, 16/68/16.

5. Ordering Information

5.1 Orders for material should include the following information:
5.1.1 ASTM designation and year of issue,
5.1.2 Quantity: total for each item, pounds (or kilograms),
5.1.3 Name of material: cable shielding (or "cable wrap"),
5.1.4 Form of material: strip,
5.1.5 Type of material: copper, copper-zinc alloy (commercial bronze), and so forth (see 1.2),
5.1.6 Alloy number when appropriate (see 1.2),
5.1.7 Temper (see Section 8),
5.1.8 Dimensions: thickness and width (see Section 11),
5.1.9 How furnished: coils (rolls), traverse wound on reels or spools, and so forth,
5.1.10 Whether the resistivity test is required for any item (Section 10),
5.1.11 Coil dimension: inner or outer coil diameter limitation, or both, if required,
5.1.12 Weight of coils: coil weights or coil size limitations, if required,
5.1.13 Cladding ratio when appropriate (see 7.5.34),
5.1.14 Certification, if required, (see Section 18),
5.1.15 Mill test report, if required,
5.1.16 Specification designation and year of issue, and
5.1.17 Special tests or exceptions, if any.

6. Materials and Manufacture

6.1 *Material*—The material shall be of such quality that it conforms to the properties and characteristics prescribed in the specification.
6.2 *Manufacture*— Cladding metals as appropriate may be bonded to the specified base metal by any method that will produce a clad material that will conform to this specification.

Annual Book of ASTM
[2] Available from American National Standards, Vol 01.03. Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

7. Chemical Composition

7.1 Homogeneous copper and copper-alloy materials shall conform to the requirements prescribed in Table 1 for the particular material.

7.2 Copper cladding shall be, unless otherwise specified, a copper conforming in chemical composition to that covered by Specification B 152/B 152M. The grade provided shall be one of the following coppers, such that the final strip meets the conductivity and mechanical properties of this specification. These are:

C10920
C11000
C11020
C12000

7.3 These specification limits do not preclude the possible presence of other unnamed elements. Limits may be established and determination required for unnamed elements by agreement between the manufacturer and the purchaser.

7.4 Except for copper C11000, copper may be taken as the difference between all the elements analyzed and 100 %.

7.4.1 *Alloys C19400, C22000, and C23000*— When all elements specified in Table 1 are determined, the sum of the results shall be 99.8 % min.

7.4.2 *Alloys C66400, C66410, C66430, C64785, and C71000* —When all elements specified in Table 1 are determined, the sum of the results shall be 99.5 % min.

7.5 *Clad Metal*:

7.5.1 For stainless steel clad cores, the stainless steel shall conform in chemical composition to one covered by Specification A 176. Unless otherwise specified, stainless steel in accordance with UNS No. S43000 (Type 430) shall be supplied.

7.5.2 For alloy steel clad cores, the steel shall conform in chemical composition to one covered by Specification A 505. Unless otherwise specified, alloy steel UNS No. G41300 shall be supplied.

7.5.3 For bronze clad cores, the bronze shall conform in chemical composition to the requirements of UNS No. C64785 listed in Table 1.

7.5.4 Unless otherwise stated (see 5.1.13), the cladding ratio shall be one of the standard ratios listed in Table 2 and Table 3, and shall be expressed as XX/XX/XX, copper/bronze/copper, copper/stainless steel/copper, or copper/alloy steel/copper as appropriate.

TABLE 1 Chemical Requirements

Element	Composition, %								
	Copper or Copper Alloy UNS No.								
	C11000	C19400	C22000	C23000	C66400	C66410	C66430	C71000	C64785 core of Copper-Clad Bronze
~~Copper (incl silver)~~	~~99.90 min~~	~~97.0 min~~	~~89.00–91.0~~	~~84.0–86.0~~	~~remainder~~	~~remainder~~	~~remainder~~	~~remainder~~	
Copper (incl silver)	99.90 min	97.0 min	89.00–91.0	84.0–86.0	remainder	remainder	remainder	remainder	remainder
~~Iron~~	~~...~~	~~2.1–2.6~~	~~0.05 max~~	~~0.05 max~~	~~1.3–1.7~~	~~1.8–2.3~~	~~0.6–0.9~~	~~1.0 max~~	
Iron	...	2.1–2.6	0.05 max	0.05 max	1.3–1.7	1.8–2.3	0.6–0.9	1.0 max	0.02 max
~~Lead, max~~	~~...~~	~~0.03~~	~~0.05~~	~~0.05~~	~~0.015~~	~~0.015~~	~~0.05~~	~~0.05~~	
Lead, max	...	0.03	0.05	0.05	0.015	0.015	0.05	0.05	0.015
~~Tin~~	~~...~~	~~...~~	~~...~~	~~...~~	~~0.05 max~~	~~0.05 max~~	~~0.6–0.9~~	~~...~~	
Tin	...	...	...	...	0.05 max	0.05 max	0.6–0.9	...	0.5–2.0
~~Zinc~~	~~...~~	~~0.05–0.20~~	~~remainder~~	~~remainder~~	~~11.0–12.0~~	~~11.0–12.0~~	~~13.0–15.0~~	~~1.0 max~~	
Zinc	...	0.05–0.20	remainder	remainder	11.0–12.0	11.0–12.0	13.0–15.0	1.0 max	3.0–6.0
~~Nickel (incl cobalt)~~	~~...~~	~~...~~	~~...~~	~~...~~	~~...~~	~~...~~	~~...~~	~~19.0–23.0~~	
Nickel (incl cobalt)	...	...	...	...	...	...	...	19.0–23.0	0.4–1.6
~~Manganese~~	~~...~~	~~...~~	~~...~~	~~...~~	~~...~~	~~...~~	~~...~~	~~1.0 max~~	
Manganese	...	...	...	...	...	...	...	1.0 max	0.2–1.0
~~Phosphorus~~	~~...~~	~~0.015–0.15~~	~~...~~	~~...~~	~~...~~	~~...~~	~~0.10 max~~	~~...~~	
Phosphorus	...	0.015–0.15	...	...	...	...	0.10 max	...	0.015 max
~~Cobalt~~	~~...~~	~~...~~	~~...~~	~~...~~	~~0.30–0.7~~	~~...~~	~~...~~	~~...~~	
Cobalt	...	...	...	...	0.30–0.7	...	...	...	...
Iron and cobalt	...	...	...	...	1.8–2.3	...	...	...	...
Silicon	...	...	...	...	...	...	...	...	0.15 max
Aluminum	...	...	...	...	...	...	...	...	3.0–6.0

TABLE 2 Tensile Strength Requirements and Approximate Hardness Values for Shielding Materials in Commonly Ordered Tempers

Description		Temper Designation		Tensile Strength, ksi[A] (Mpa[B])		Approximate Rockwell Hardness[C]	
Copper or Copper Alloy UNS No.	Type of Material	Standard	Former	Min	Max	Other Scales Thicknesses >0.020 in.	Superficial 30T Thicknesses >0.012 in.
			Cold-Rolled Tempers:				
C11000	Copper	H00	eighth hard	32 (220)	40 (275)	F 54–82	up to 49
		H01	quarter hard	34 (235)	42 (290)	F 60–84	18–51
		H02	half hard	37 (255)	46 (315)	F 77–89	43–57
			Annealed Tempers:				
		O61	annealed	...	34 (235)	...	...
			Annealed Tempers:				
C19400	Copper-iron alloy	O61	annealed[D]	45 (310)	55 (380)	...	...
		O50	light annealed[D]	50 (345)	60 (415)	...	...
			Cold-Rolled Tempers:				
		H02	half hard	53 (365)	63 (435)	B 49–69	52–63
			Cold-Rolled Tempers:				
C22000	Commercial bronze	H01	quarter hard	40 (275)	50 (345)	B 27–52	38–53
		H02	half hard	47 (325)	57 (395)	B 50–63	52–61
			Annealed Tempers:				
		O81	quarter hard	39 (270)	46 (315)	...	...
			Cold-Rolled Tempers:				
C23000	Red brass	H01	quarter hard	44 (305)	54 (375)	B 33–58	45–60
		H02	half hard	51 (350)	61 (420)	B 56–68	58–66
			Annealed Tempers:				
		O81	quarter hard	44 (305)	54 (375)	...	...
			Annealed Tempers:				
C66400	Copper-zinc-iron-cobalt alloy	O60	soft[D]	53 (365)	60 (415)	...	...
C66410	Copper-zinc-iron alloy	O60	soft[D]	53 (365)	60 (415)	...	...
C66430	Copper-zinc-iron-tin alloy	O60	soft[D]	59 (405)	69 (475)	...	59–69
			Cold-Rolled Tempers:				
C71000	Cupro-nickel 20 %	H01	quarter hard	47 (325)	63 (435)	B 45–72	46–65
		H02	half hard	56 (385)	70 (485)	B 64–78	59–69
			Annealed Tempers:				
		OS035	0.025–0.050 mm	52 (355)	...	B 18–35	28–40
		OS015	0.010–0.020 mm	53 (365)	...	B 35–88	40–58
Copper-Clad Stainless (CCS) and Copper-Clad Alloy Steel (CAS)							
Cladding Ratio	Total Thickness						
	in. (mm)		Annealed Tempers				
16/68/16	0.005 (0.13)	O61	annealed[D]	55 (380)	68 (470)	15T 89 max	...
33.3/33.3/33.3	0.006 (0.15)	O61	annealed[D]	44 (305)		15T 89 max	...
Copper-Clad Bronze (CCB)							
Cladding Ratio	Total Thickness						
	in. (mm)		Annealed Tempers				
12.5/75/12.5	[E]	O61	annealed[D]	55 (380)	68 (470)	15T 89 max	...
		O81	annealed to temper—quarter hard	62 (425)	75 (515)	15T 92 max	...
16/68/16	[E]	O61	annealed[D]	55 (380)	68 (470)	15T 89 max	...
		O81	annealed to temper—quarter hard	62 (425)	75 (515)	15T 92 max	...

[A] ksi = 1000 psi.
[B] See Appendix X3.
[C] Rockwell values normally apply as follows: The B and F scales apply to metal 0.020 to 0.036 in. (0.5 to 0.91 mm) in thickness. The Superficial 30-T scale applies to metal 0.012 to 0.028 in. (0.30 to 0.71 mm) in thickness.
[D] There is no grain size requirement but all annealed metal shall be fully recrystallized.
[E] See Appendix X2, Table X2.1.

8. Temper

8.1 As described in Classification B 601, tempers furnished to this specification shall be:
8.1.1 Copper C11000—H00, H01, H02, and O61.
8.1.2 Copper alloy C19400—H02, O61, and O50.
8.1.3 Copper alloy C22000—H01, H02, and O81.
8.1.4 Copper alloy C23000—H01, H02, and O81.
8.1.5 Copper alloy C66400, C66410, and C66430—O60.
8.1.6 Copper alloy C71000—H01, H02, OS035, and OS015.
8.1.7 Copper-Clad Steel—O61.
8.1.8 Copper-Clad Bronze—O61 and O81.

TABLE 3 Preferred Cladding Ratios—Copper-Clad S Materials

Clad Material	Nominal Total Thickness of Strip		Cladding Ratio, CCS or CAS	Nominal Thickness, in. (mm)			Conductivity, % IACS	
	in.	mm		Copper	StCoreel	Copper	Nominal	Minimum
	0.005	0.13	16/68/16	0.0008 (0.02)	0.0034 (0.09)	0.0008 (0.02)	30	28
CCS or CAS	0.005	0.13	16/68/16	0.0008 (0.02)	0.0034 (0.09)	0.0008 (0.02)	30	28
	0.006	0.15	33.3/33.3/33.3	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	61	60
CCS or CAS	0.006	0.15	33.3/33.3/33.3	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	61	60
CCB	0.005	0.13	16/68/16	0.0008 (0.02)	0.0034 (0.09)	0.0008 (0.02)	32	30
CCB	0.005	0.13	12.5/75/12.5	0.0006 (0.016)	0.0038 (0.1)	0.0006 (0.016)	30	28

9. Mechanical Property Requirements

9.1 *Grain Size*:

9.1.1 There are no minimum or maximum grain size requirements for product in annealed tempers O50, O61, and O81; however, the metal shall be fully recrystallized.

9.1.2 When tested in accordance with Test Methods E 112, copper alloy UNS No. C71000 in annealed tempers OS035 and OS015 shall conform to the grain size requirements prescribed in Table 2.

9.2 *Hardness*:

9.2.1 *Rockwell Hardness*—The hardness test is a quick and convenient method for estimating tensile strength and grain size. Approximate hardness values are given in Table 2. For copper-clad materials, copper is etched off with a suitable reagent before testing the steel. This test is not required and shall not be used as a basis of rejection.

9.3 *Tensile Strength*—The finished product shall conform to the requirements prescribed in Table 2 for the particular material and temper.

10. Physical Property Requirements

10.1 Annealed material shall conform to the requirements of Table 4.

11. Dimensions, Mass, and Permissible Variations

11.1 *General*—For the purpose of determining conformance with the dimensional requirements prescribed in this specification, any measured value outside the specified limiting values for any dimension may be cause for rejection.

11.2 *Thickness*—The standard method of specifying thickness shall be in decimal fractions of an inch. For material 0.021 in. (0.53 mm) and under in thickness, it is recommended that the nominal thickness be stated not closer than the nearest half-thousandth. (For example, specify 0.006 or 0.0065 in. (0.15 or 0.165 mm), but not 0.0063 in. (0.160 mm).) A list of preferred thicknesses is shown in Appendix X2. The thickness tolerance shall be those shown in Table 5 and Table 6.

11.3 *Width*—The width tolerances shall be those required by Specification B 248, unless otherwise stated in the purchase order.

11.4 *Straightness*—The straightness tolerances shall be those required by Specification B 248, unless otherwise stated in the purchase order.

TABLE 4 Electrical Resistivity and Conductivity

UNS Alloy No.	Mass Resistivity, $\Omega \cdot g/m^2$	Conductivity %, IACS
A. Copper Alloy Materials		
C11000	0.153 28	100.00
C19400	0.256 03	60
C22000	0.379 30	40
C23000	0.407 73	37
C66400	0.504 01	30
C66410	0.504 01	30
C66430	0.540 63	28
C71000	2.568 91	6

B. Copper-Clad St Bronzeel Material

Total Thickness, in.	Cladding Ratio	Mass Resistivity, $Ohm \cdot g/m^2$	Conductivity %, IACS
all	12.5/75/12.5	...	28 min
all	16/68/16	...	30 min

C. Copper-Clad Steel Material

Total Thickness, in.	Cladding Ratio	Mass Resistivity, $Ohm \cdot g/m^2$	Conductivity %, IACS
0.005	16/68/16	...	28
0.006	33.3/33.3/33.3	...	60

TABLE 5 Thickness Tolerances

Material	Thickness, in. (mm)	Tolerance, Plus and Minus in. (mm)	
		12 in. (305 mm) and Under in Width	Over 12 in. (305 mm)
Copper and copper alloys	0.004 (0.102) and under	0.0003 (0.0076)	0.0006 (0.015)
	Over 0.004 to 0.005 (0.127), incl	0.0004 (0.010)	0.0008 (0.020)
	Over 0.005 to 0.009 (0.229), incl	0.0005 (0.013)	0.001 (0.025)
	Over 0.009 to 0.013 (0.330), incl	0.0008 (0.020)	0.0015 (0.038)
Copper-clad bronze (CCB)	0.004 (0.102) and under	0.0003 (0.0076)	0.0006 (0.015)
	Over 0.004 to 0.005 (0.127), incl	0.0004 (0.010)	0.0008 (0.020)
	Over 0.005 to 0.009 (0.229), incl	0.0005 (0.013)	0.001 (0.025)
	Over 0.009 to 0.013 (0.330), incl	0.0008 (0.020)	0.0015 (0.038)
Copper-clad stainless steel (CCS)	Over 0.004 to 0.005 (0.127), incl	0.0005 (0.013)	...
	Over 0.005 to 0.009 (0.229), incl	0.0006 (0.015)	...
Copper-clad alloy steel (CAS)	Over 0.004 to 0.005 (0.127), incl	0.0005 (0.013)	...
	Over 0.005 to 0.009 (0.229), incl	0.0006 (0.015)	...

TABLE 6 Width Tolerances for Slit Metal and Slit Metal with Rolled Edges (applicable to all materials listed in 1.2)

Width, in. (mm)	Width Tolerances,[A] Plus and Minus For All Thicknesses	
	in.	(mm)
2 (50.8) and under	0.005	(0.13)
Over 2 to 12 (50.8 to 305), incl	0.008	(0.20)
Over 12 to 24 (305 to 610), incl	0.015	(0.38)

[A] If tolerances are specified as all plus or all minus, double the values given.

11.5 *Cladding Ratio*—Cladding ratios shall be within ±10 % of nominal; test method shall be metallurgical microsection of at least three samples per lot.

12. Workmanship, Finish, and Appearance

12.1 All material shall be uniform in quality and condition, sound and free of internal and external defects of a nature that interferes with normal fabrication or the performance of the cable shielding. It shall be well cleaned and free of dirt. A superficial film of residual light lubricant is permissible, unless otherwise specified.

12.2 Copper-clad material shall be free of defects including unbond or delamination of a nature that interferes with normal commercial operations.

13. Sampling

13.1 *Chemical Composition for Copper and Copper Alloys*:

13.1.1 Instead of sampling in accordance with Practice E 255, the manufacturer shall have the option of sampling at the time castings are poured or from the semifinished or finished product.

13.1.1.1 When sampled at the time castings are poured, at least one sample shall be taken for each group of castings poured simultaneously from the same source of molten metal.

13.1.1.2 When sampled from a semifinished or finished product, at least one sample representative of the product of each cast bar from a single melt charge continuously processed with heat identity maintained shall be taken.

13.1.1.3 When sampled from semifinished or finished product when heat identity has not been maintained, a single sample representative of each 10 000-lb lot, or fraction thereof, shall be taken. When the product piece is greater than 10 000 lb, one sample to be representative of the product piece shall be taken.

13.2 *Clad Metal*:

13.2.1 When materials of fabrication have been certified to meet the requirements of the specification to which they were ordered, sampling by the fabrication is not required unless specified otherwise in the contract or purchase order.

13.2.2 When sampling of the fabricating materials is specified in the contract or purchase order, sampling shall be as prescribed in the specification to which the material was ordered.

14. Number of Tests and Retests

14.1 *Tests*:

14.1.1 *Chemical Composition*—Determine as the average of at least two replicate determinations for each specified element in Table 1.

14.1.2 *Grain Size and Tensile Strength*— Determine as the average of results from two test specimens.

14.2 *Retests*:

14.2.1 *Chemical Composition*—Should one or more of the determinations fail to conform with the requirements of Table 1, a retest may be made on a new composite made up from the pieces originally selected.

14.2.2 *Grain Size and Tensile Strength*— Should the test results fail to conform with the requirements, a retest shall be permitted on two specimens made up from the pieces originally selected.

15. Specimen Preparation

15.1 *Chemical Composition*—Preparation of the analytical specimens shall be the responsibility of the reporting laboratory.

15.2 *Grain Size*—In case of disagreement, test specimens shall be prepared in accordance with Guide E 3.

15.3 *Tensile Strength*—In case of disagreement, test specimens shall be prepared in accordance with Test Methods E 8.

16. Test Methods

16.1 Test methods for quality control shall be discretionary.

16.2 *Chemical Composition*—In case of disagreement, determination shall be as follows:

Element	Test Method
Aluminum	ISO 3110 (AA)
Cobalt	E 75
Copper	E 478
Iron	E 478
High iron	E 54
Lead	E 478 (AA)
Manganese	E 62
Nickel	E 478 (photometric)
Phosphorus	E 62
Silicon	E 62
Silver	E 478
Tin	E 478 (photometric)
Zinc	E 478 (titrimetric)

17. Rejection and Rehearing

17.1 *Rejection*:

17.1.1 Product that fails to conform to the specification requirements when inspected or tested by the purchaser, or purchaser's agent, are subject to rejection.

17.1.2 Rejection shall be reported to the manufacturer, or supplier, promptly and in writing.

17.1.3 In case of dissatisfaction with results of the test upon which rejection is based, the manufacturer, or supplier, may make claim for a rehearing.

17.2 *Rehearing*—As a result of product rejection, the manufacturer or supplier may make claim for a retest to be conducted by the manufacturer, or supplier, and the purchaser. Samples of the rejected product shall be taken in accordance with the product specification and subjected to test by both parties using the test method(s) specified in the product specification, or alternatively, upon agreement of both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

18. Certification

18.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

19. Packaging and Package Marking

19.1 *Packaging*—The product shall be separated by size, composition, and temper, and prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation and to afford protection from the normal hazards of transportation.

19.2 *Package Marking*— Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, shape, gross and net weight, and name of supplier. The specification number shall be shown, when specified.

20. Keywords

20.1 bimetallic; cladding ratio; copper; copper alloy; copper-clad bronze; copper-clad alloy steel; copper-clad stainless steel; electric cable shielding; electrical conductivity; grain size; Rockwell Hardness; sheet; strip; tensile; UNS No. C11000; UNS No. C19400; UNS No. C22000; UNS No. C23000; UNS No. C64785; UNS No. C66400; UNS No. C66410; UNS No. C66430; UNS No. C71000; UNS No. G41300; UNS No. S43000

APPENDIXES

(Nonmandatory Information)

X1. EXPLANATORY NOTE—CABLE SHIELDING

X1.1 Cable shielding or "cable wrap" is normally used by manufacturers of electrical insulated wire and cable in strips of various widths. The material is wrapped around an insulated wire or group of wires, and may be applied over an intervening layer of wrapping material or over a jacket. The material may be applied in various configurations depending upon the requirements of the finished cable:

X1.1.1 *Helical wrap*— overlapped, butted, or gapped.

X1.1.2 *Longitudinal application*—corrugated or smooth, overlapped, butted, gapped, or welded/soldered.

X1.2 The selection of the particular material and of the thickness of the material to be used is dependent largely upon the specification requirements for the finished wire or cable. Military and Federal Specifications, Rural ~~Electrification Administration (REA)~~ Utilities Services (RUS) specifications, ICEA (Insulated Cable Engineers Association) specifications, among others, typically apply.

X1.3 Electrical conductivity of the material is an important characteristic considered in the selection process and is affected by the material, its thickness, and the method of application. Corrosion resistance is important for various environments. Physical strength requirements may include such features as resistance to tensile stress, resistance to bending stress (including repeated bending), resistance to gopher attack, and so forth.

X2. PREFERRED THICKNESSES

X2.1 It is recommended that whenever possible, material purchased to this specification be ordered in a thickness as listed in Table X2.1.

TABLE X2.1 Preferred Thickness, Nominal

Material or UNS No.	Thickness, in. (mm)
C11000	0.005 (0.13)
	0.010 (0.25)
C19400	0.006 (0.15)
	0.007 (0.18)
C22000 and C23000	0.005 (0.13)
	0.007 (0.18)
	0.010 (0.25)
C66400	0.0055 (0.14)
C66410	0.0055 (0.14)
C66430	0.005 (0.13)
	0.007 (0.18)
	0.010 (0.25)
C71000	0.005 (0.13)
Copper-clad bronze (CCB)	0.0048 (0.122)[A]
	0.005 (0.13)[A]
	0.0055 (0.14)[A]
	0.006 (0.15)[A]
	0.007 (0.18)[A]
	0.010 (0.25)[A]
Copper-clad stainless steel (CCS)	0.005 (0.13)[A]
	0.006 (0.15)[A]
Copper-clad alloy steel (CAS)	0.005 (0.13)[A]
	0.006 (0.15)[A]

[A] Total thickness of strip.

X3. METRIC EQUIVALENTS

X3.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ($N = kg \cdot m/s^2$). The derived SI unit for pressure or stress is the newton per square metre (N/m^2), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6 894 757 Pa, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2.—

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B 694 – 02) that may impact the use of this standard. (Approved Oct. 1, 2003.)

(*1*) Added Copper-Clad Bronze (CCB) to the title of this specification.
(*2*) Added copper-clad bronze (CCB) to paragraphs 1.1 and 1.2.
(*3*) Added 7.5.3 for chemical composition requirements of the UNS No. C64785 core of the copper-clad bronze.
(*4*) Added 8.1.8 for copper-clad bronze.
(*5*) Added copper-clad bronze and UNS No. C64785 to Section 20, Keywords.
(*6*) Added chemical requirements for the Bronze core (C64785) of Copper-Clad Bronze to Table 1.
(*7*) Added Tensile Strength requirements for Copper-Clad Bronze to Table 2.
(*8*) Added Preferred Cladding Ratios for Copper-Clad Bronze to Table 3.
(*9*) Added Electrical Conductivity requirements for Copper-Clad Bronze to Table 4.
(*10*) Added Thickness Tolerances for Copper-Clad Bronze to Table 5.
(*11*) Added Preferred Thickness for Copper-Clad Bronze to Table X2.1.
(*12*) Changed Rural Electrification Administration (REA) to Rural Utilities Services (RUS) in X1.2.

Committee B05 has identified the location of selected changes to this standard since the last issue (B 694 – 01) that may impact the use of this standard. (Approved Oct. 10, 2002.)

(*1*) Added UNS Alloy No. C66430 to this specification.
(*2*) Revised section on chemical composition and added UNS Alloy No. C66430.
(*3*) Added UNS Alloy No. C66430 to Table 2 and Section 8 (Temper).
(*4*) Added Mass Resistivity and Conductivity to Table 4 for the following UNS Alloy Nos.: C19400, C22000, C23000, C66400, C66410, C66430, and C71000.
(*5*) Added Chemical Test Method for Tin to 16.2.
(*6*) Added UNS Nos. to Keywords.
(*7*) Added to Table X2.1 Preferred Thickness, Nominal for UNS Alloy Nos. C23000 and C66430 to Table X2.1