Designation: B701/B701M – 22

Standard Specification for Concentric-Lay-Stranded Self-Damping Aluminum Conductors, Steel Reinforced (ACSR/SD)[1]

This standard is issued under the fixed designation B701/B701M; 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 concentric-lay-stranded self-damping aluminum conductor, steel-reinforced (ACSR/SD), and its component wires for use as overhead electrical conductors (Explanatory Notes 1 and 2).

1.2 The values stated in inch-pound or SI units are to be regarded separately as standard. Each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the specification. For conductor sizes designated by AWG or kcmil, the requirements in SI units have been numerically converted from corresponding values stated or derived in inch-pound units. For conductor sizes designated by SI units only, the requirements are stated or derived in SI units.

1.2.1 For density, resistivity, and temperature, the values stated in SI units are to be regarded as standard.

NOTE 1—ACSR/SD is designed to control aeolian vibration by integral damping. The conductors consist of a central core of a round steel wire or wires surrounded by two layers of trapezoidal aluminum 1350-H19 wires or two layers of trapezoidal aluminum 1350-H19 wires and one layer of round aluminum 1350-H19 wires (Fig. 1). The trapezoidal-wire layers are separated from each other and from the steel core by two small annular gaps that provide the conductors self-damping characteristics. The round aluminum wires are in tight layer contact between themselves and the underlying trapezoidal wire layer. Different strandings of the same size of conductor are identified by type, which is the approximate ratio of steel area to aluminum area, expressed in percent (Table 1 and Table 2).

NOTE 2—The aluminum and temper designations conform to ANSI Standard H 35.1. Aluminum 1350 corresponds to UNS A91350 in accordance with Practice E527.

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

2.2 *ASTM Standards:*[2]

B230/B230M Specification for Aluminum 1350–H19 Wire for Electrical Purposes

B232/B232M Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)

B263/B263M Test Method for Determination of Cross-Sectional Area of Stranded Conductors

B354 Terminology Relating to Uninsulated Metallic Electrical Conductors

B498/B498M Specification for Zinc-Coated (Galvanized) Steel Core Wire for Use in Overhead Electrical Conductors

B500/B500M Specification for Metallic Coated or Aluminum Clad Stranded Steel Core for Use in Overhead Electrical Conductors

B502/B502M Specification for Aluminum-Clad Steel Core Wire for Use in Overhead Electrical Aluminum Conductors

B549 Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Clad Steel Reinforced for Use in Overhead Electrical Conductors

B606/B606M Specification for High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Aluminum and Aluminum-Alloy Conductors, Steel Reinforced

B802/B802M Specification for Zinc–5 % Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)

B803/B803M Specification for High-Strength Zinc–5 %

[1] This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.07 on Conductors of Light Metals.

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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.

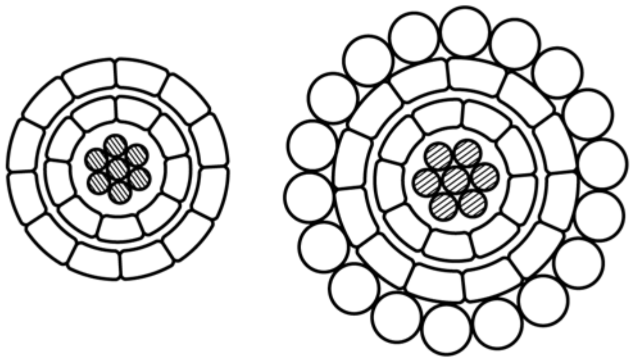

FIG. 1 Illustrations of Typical ACSR/SD Strandings

Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.3 *ANSI Documents:*[3]

ANSI H35.1 American National Standard Alloy and Temper Designation Systems for Aluminum

2.4 *NIST Documents:*[4]

NBS Handbook 100 —*Copper Wire Tables of the National Bureau of Standards*

2.5 *Aluminum Association Documents:*[5]

Publication 50, Code Words for Overhead Aluminum Electrical Conductors

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 ACSR/SD covered by this specification has five types of coated core wire and one type of aluminum-clad core wire which are designated by abbreviations as follows (Explanatory Notes 2 and 9):

3.1.2 *ACSR/SD/AW2*—ACSR/SD using aluminum-clad steel wire (Specification B502/B502M).

3.1.3 *ACSR/SD/GA2*—ACSR/SD using Class A zinc-coated steel wire (Specification B498/B498M).

3.1.4 *ACSR/SD/GC2*—ACSR/SD using Class C zinc-coated steel wire (Specification B498/B498M).

3.1.5 *ACSR/SD/GA3*—ACSR/SD using high-strength Class A zinc-coated steel wire (Specification B606/B606M).

3.1.6 *ACSR/SD/MA2*—ACSR/SD using Class A zinc-5 % aluminum-mischmetal alloy-coated steel core wire (Specification B802/B802M).

3.1.7 *ACSR/SD/MC2*—ACSR/SD using Class C zinc-5 % aluminum-mischmetal alloy-coated steel core wire (Specification B802/B802M).

3.1.8 *ACSR/SD/MA3*—ACSR/SD using high-strength Class A zinc-5 % Aluminum-mischmetal alloy-coated steel core wire (Specification B803/B803M).

3.2 For definitions of terms relating to conductors, refer to Terminology Standard B354.

4. Ordering Information

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

4.1.1 Quantity of each size and type (Note 1),

4.1.2 Conductor size: kcmil area,

4.1.3 Conductor type and number of wires, aluminum and steel (Table 1),

4.1.4 Type of steel core wire and if zinc or Zn-5 % Al-MM alloy coated, area density (Classes A and C) of coating (see 5.2),

4.1.5 Special tension test, if required (see 9.2),

4.1.6 Place of inspection (Section 15),

4.1.7 Package size (see 16.1),

4.1.8 Special package marking, if required (Section 17), and

4.1.9 Heavy wood lagging, if required (see 16.3).

5. Requirement For Wires

5.1 Before stranding, the round and trapezoidal aluminum wires shall conform to the requirements of Specification B230/B230M except for shape and diameter tolerance of the trapezoidal wires. The tensile strength and elongation requirements of trapezoidal wires shall be the same as for round wires of equal area. The area tolerances shall be such that the finished conductor conforms to Section 12.

5.2 Before stranding, the steel core wire shall meet the requirements of Specifications B498/B498M, B502/B502M, B606/B606M, B802/B802M, or B803/B803M, whichever is applicable.

6. Joints

6.1 Electric-butt welds, electric-butt, cold-upset welds, or cold-pressure welds may be made in the individual aluminum wires during the stranding process. No weld shall occur within 50 ft. [15 m] of any other weld in the completed conductor (Explanatory Note 3).

6.2 There shall be no joints made in the finished steel wires.

7. Lay

7.1 The nominal lay factors for the trapezoidal aluminum wires are shown in Table 1 (Explanatory Note 1 and Note 4).

7.2 The length of lay for the round aluminum wires shall not be less than 10 nor more than 13 times the outside diameter of that layer.

7.3 In a conductor having multiple layers of aluminum wires, the length of lay of any aluminum layer shall not be less than the length of lay of the aluminum layer immediately beneath it.

7.4 The length of lay of the various layers of steel wires shall conform to the requirements of Specification B500/B500M.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

[5] Available from Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, Arlington, VA 22209, http://www.aluminum.org.

TABLE 1 Construction Requirements of Aluminum Conductors, Self Damping, Concentric-Lay-Stranded, Steel-Reinforced

Conductor Size		Stranding Number of Wires and Diameter, in.[A]				Nominal Aluminum Lay Factor	Mass per 1000 ft, lb	Rated Strength, kip[A,B]	Nominal Outside Diameter, in.
			Aluminum		Steel[C]				
kcmil	Type[D]	Code Word[E]	Round	Trapezoidal[F]	Round				
2156	8	Bluebird		10 × 0.2179	19 × 0.0961	14.5	2504	60.7	1.716
				15 × 0.2184		12.1			
			21 × 0.2145			11.0			
1780	8	Chukar		9 × 0.2041	19 × 0.0874	14.5	2068	51.1	1.565
				13 × 0.2150		12.0			
			21 × 0.1957			11.0			
1780	5	Smew		8 × 0.2171	7 × 0.1144	16.0	1921	43.6	1.531
				14 × 0.2128		12.5			
			21 × 0.1914			11.5			
1590	13	Falcon		10 × 0.1891	19 × 0.1030	13.5	2039	55.1	1.521
				14 × 0.1977		11.7			
			24 × 0.1690			11.5			
1590	7	Lapwing		8 × 0.2059	7 × 0.1253	15.9	1791	42.6	1.468
				12 × 0.2130		12.8			
			21 × 0.1835			11.5			
1590	5	Ratite		8 × 0.2095	7 × 0.1083	15.4	1715	39.1	1.447
				13 × 0.2143		12.5			
			23 × 0.1669			11.5			
1431	13	Plover		10 × 0.1792	19 × 0.0977	13.5	1835	49.6	1.448
				14 × 0.1868		11.7			
			24 × 0.1609			11.5			
1431	7	Bobolink		8 × 0.1946	7 × 0.1189	15.1	1612	38.9	1.398
				12 × 0.2015		12.2			
			21 × 0.1747			11.5			
1431	5	Popinjay		8 × 0.1936	7 × 0.1025	16.0	1544	35.3	1.381
				13 × 0.1972		12.5			
			21 × 0.1726			11.5			
1351.5	13	Martin		11 × 0.1604	19 × 0.0949	14.7	1733	46.8	1.417
				15 × 0.1652		12.8			
			21 × 0.1772			11.5			
1351.5	10	Frigate		9 × 0.1786	7 × 0.1377	14.5	1629	41.7	1.389
				14 × 0.1757		12.2			
			21 × 0.1735			11.0			
1351.5	7	Dipper		8 × 0.1890	7 × 0.1155	15.2	1522	36.7	1.361
				12 × 0.1954		12.2			
			21 × 0.1701			11.0			
1351.5	5	Ringdove		8 × 0.1946	7 × 0.0997	16.0	1458	33.4	1.344
				12 × 0.1949		12.8			
			21 × 0.1680			11.5			
1272	13	Pheasant		11 × 0.1552	19 × 0.0921	14.7	1631	44.1	1.378
				15 × 0.1599		12.8			
			21 × 0.1723			11.5			
1272	7	Bittern		8 × 0.1829	7 × 0.1121	14.5	1433	34.6	1.323
				12 × 0.1894		12.3			
			21 × 0.1653			11.5			
1272	5	Scissortail		7 × 0.1929	7 × 0.0967	15.7	1372	31.4	1.305
				11 × 0.2029		12.3			
			21 × 0.1631			11.5			
1192.5	13	Grackle		10 × 0.2147	19 × 0.0892	14.2	1526	41.9	1.274
				16 × 0.2138		11.5			
1192.5	7	Bunting		8 × 0.1768	7 × 0.1085	15.1	1343	32.4	1.284
				12 × 0.1831		12.2			
			21 × 0.1604			11.5			
1192.5	5	Oxbird		7 × 0.1868	7 × 0.0936	15.7	1286	29.5	1.266
				11 × 0.1960		12.3			
			21 × 0.1582			11.5			
1113	13	Finch		9 × 0.2188	19 × 0.0862	14.2	1424	39.1	1.233
				15 × 0.2133		11.5			
1113	7	Bluejay		8 × 0.1705	7 × 0.1049	15.9	1254	30.3	1.242
				12 × 0.1765		12.8			
			21 × 0.1553			11.5			
1113	5	Avocet		7 × 0.1818	7 × 0.0904	16.0	1200	27.5	1.226
				12 × 0.1798		12.4			
			21 × 0.1533			11.5			
1033.5	13	Curlew		9 × 0.2106	7 × 0.1383	14.2	1329	36.3	1.191
				14 × 0.2129		11.5			
1033.5	7	Ortolan		8 × 0.2168	7 × 0.1010	15.2	1161	28.1	1.145
				14 × 0.2167		11.5			

TABLE 1 *Continued*

Conductor Size		Stranding Number of Wires and Diameter, in.[A]				Nominal Aluminum Lay Factor	Mass per 1000 ft, lb	Rated Strength, kip[A,B]	Nominal Outside Diameter, in.
			Aluminum		Steel[C]				
kcmil	Type[D]	Code Word[E]	Round	Trapezoidal[F]	Round				
1033.5	5	Snowbird		7 × 0.1746	7 × 0.871	16.0	1115	25.9	1.185
				12 × 0.1731		12.4			
			21 × 0.1481			11.5			
954	13	Cardinal		8 × 0.2147	7 × 0.1329	14.2	1227	33.5	1.147
				13 × 0.2122		11.5			
954	7	Rail		8 × 0.2080	7 × 0.0971	15.2	1073	26.1	1.103
				13 × 0.2163		11.5			
954	5	Phoenix		7 × 0.2196	7 × 0.0836	15.6	1027	23.7	1.088
				13 × 0.2178		11.5			
795	16	Drake		9 × 0.1865	7 × 0.1360	13.9	1093	31.8	1.077
				13 × 0.1926		11.5			
795	13	Condor		8 × 0.1957	7 × 0.1213	14.2	1023	28.2	1.055
				12 × 0.2018		11.5			
795	10	Puffin		7 × 0.2067	7 × 0.1056	14.7	956	25.1	1.034
				12 × 0.2033		11.5			
795	7	Tern		7 × 0.2034	7 × 0.0886	15.2	893	21.9	1.013
				11 × 0.2144		11.5			
795	5	Macaw		6 × 0.2167	7 × 0.0764	15.6	856	19.8	0.999
				11 × 0.2160		11.5			
636	16	Grosbeak		9 × 0.1666	7 × 0.1216	13.9	874	25.4	0.975
				13 × 0.1723		11.5			
636	13	Rook		8 × 0.1749	7 × 0.1085	14.3	818	22.9	0.955
				12 × 0.1806		11.5			
636	10	Goldfinch		7 × 0.1848	7 × 0.0945	14.7	765	20.1	0.935
				12 × 0.1819		11.5			
636	7	Killdeer		7 × 0.1815	7 × 0.0793	15.2	715	17.7	0.917
				12 × 0.1838		11.5			
636	5	Pipit		6 × 0.1938	7 × 0.0684	15.8	684	16.1	0.903
				11 × 0.1932		11.5			
556.5	16	Dove		9 × 0.1557	7 × 0.1138	14.0	765	22.6	0.919
				13 × 0.1613		11.5			
556.5	13	Parakeet		8 × 0.1637	7 × 0.1015	14.3	716	20.0	0.901
				13 × 0.1662		11.5			
556.5	10	Sapsucker		7 × 0.1728	7 × 0.0884	14.7	669	17.8	0.882
				12 × 0.1702		11.5			
556.5	7	Sunbird		7 × 0.1707	7 × 0.0741	15.2	625	15.5	0.863
				11 × 0.1790		11.5			
556.5	5	Blackbird		6 × 0.1820	1 × 0.1692	15.8	599	13.6	0.843
				10 × 0.1892		11.5			
477	16	Hawk		9 × 0.1438	7 × 0.1053	14.0	655.8	19.5	0.860
				13 × 0.1496		11.5			
477	13	Flicker		8 × 0.1515	7 × 0.0940	14.4	613.5	17.2	0.843
				13 × 0.1502		11.5			
477	10	Toucan		7 × 0.1599	7 × 0.0818	14.8	573.4	15.3	0.824
				12 × 0.1576		11.5			
477	7	Jackdaw		7 × 0.1577	7 × 0.0686	15.2	535.8	13.3	0.808
				12 × 0.1589		11.5			
477	5	Kestrel		6 × 0.1656	1 × 0.1566	16.0	513.3	11.7	0.787
				10 × 0.1768		11.5			
397.5	16	Ibis		9 × 0.1278	7 × 0.0961	14.2	546.5	16.4	0.771
				14 × 0.1338		11.5			
397.5	10	Stork		7 × 0.1424	7 × 0.0747	15.0	477.9	12.9	0.750
				12 × 0.1459		11.5			
397.5	7	Longspur		6 × 0.1501	1 × 0.1657	15.8	446.1	10.6	0.725
				11 × 0.1544		11.5			
397.5	5	Erne		6 × 0.1558	1 × 0.1430	15.6	427.7	9.74	0.717
				10 × 0.1587		11.5			
336.4	16	Linnet		10 × 0.1041	7 × 0.0884	14.7	462.4	14.3	0.716
				16 × 0.1194		11.5			
336.4	10	Woodcock		8 × 0.1215	7 × 0.0687	15.1	404.5	11.0	0.688
				14 × 0.1249		11.5			
336.4	7	Hummingbird		6 × 0.1406	1 × 0.1525	15.6	377.7	9.13	0.664
				11 × 0.1407		11.5			
336.4	5	Cowbird		6 × 0.1416	1 × 0.1315	15.9	361.9	8.5	0.667
				10 × 0.1470		11.5			
266.8	16	Partridge		10 × 0.0881	7 × 0.0788	15.0	367.0	11.35	0.645
				12 × 0.1256		11.5			
266.8	10	Spoonbill		8 × 0.0978	1 × 0.1619	16.0	320.0	8.45	0.610
				11 × 0.1315		11.3			
266.8	7	Eider		7 × 0.1080	1 × 0.1358	16.0	299.4	7.61	0.601
				13 × 0.1193		11.2			

TABLE 1 *Continued*

Conductor Size		Stranding Number of Wires and Diameter, in.[A]				Nominal Aluminum Lay Factor	Mass per 1000 ft, lb	Rated Strength, kip[A,B]	Nominal Outside Diameter, in.
			Aluminum		Steel[C]				
kcmil	Type[D]	Code Word[E]	Round	Trapezoidal[F]	Round				
266.8	5	Titmouse		6 × 0.1183 12 × 0.1234	1 × 0.1171	16.0 11.1	286.9	6.92	0.593

[A] *Conversion Factors:*
1 kcmil = 0.5067 mm^2; 1 in. = 25.4 mm; 1 kip = 1000 lbf = 4.448 kN.
[B] Rated strengths of complete conductors are calculated in accordance with 9.1 and with Class A zinc-coated steel core wire in accordance with Specification B498/B498M.
[C] Lay factors for steel core are the same as for equivalent stranding of conventional ACSR.
[D] The type number is the approximate ratio of the steel to aluminum area in percent.
[E] Code words shown in this column are obtained from, "Publication 50, Code Words for Overhead Aluminum Electrical Conductors," by the Aluminum Association. They are provided here for information only.
[F] Wire size indicates equal area round wire diameter.

TABLE 2 Comparison of ACSR/SD with Equivalent Stranding of ACSR[A]

ACSR/SD Type Number[B]	Conventional ACSR Stranding[C]
5	42/7
7	45/7
8	84/19
10	22/7
13	54/7
13	54/19
13	24/7
16	26/7

[A] The equivalent stranding is that stranding of conventional ACSR that has the same area of aluminum and steel as a given ACSR/SD type.
[B] ACSR/SD type number is the approximate ratio of the steel area to the aluminum area in %.
[C] See Specifications B232/B232M and B549.

7.5 The direction of lay of the outside layer of aluminum wires shall be right-hand.

7.6 The direction of lay of the aluminum and steel wires shall be reversed in successive layers.

7.7 For the purpose of this specification the lay factor is the ratio of the length of lay to the external diameter of the corresponding layer of wires or members in the stranded conductor.

8. Construction

8.1 The nominal aluminum cross-sectional area, type, stranding, and equivalent wire diameters shall be as shown in Table 1 (Explanatory Note 1).

8.2 The smaller sizes of ACSR/SD consist of a steel core, an inner gap surrounded by a layer of trapezoidal aluminum wires (called the inner layer), and an outer gap surrounded by a second layer of trapezoidal aluminum wire (called the outer layer). The larger sizes of ACSR/SD consist of a steel core, an inner gap surrounded by a layer of trapezoidal aluminum wires (called the inner layer), an outer gap surrounded by a layer of trapezoidal aluminum wires (called the middle layer), and a layer of round aluminum wires (called the outer layer) fitting tightly over the middle layer. The diameter and number of steel core wires, the number and equivalent round wire diameters of the trapezoidal aluminum wires, and the number and diameter of the round aluminum wires shall be as shown in Table 1.

8.3 All conductor gaps shall be measured radially. The nominal thickness of the gap is 0.030 in. [0.75 mm]. The tolerance of both the inner and outer gaps shall be plus 0.000 in. [0.00 mm] and minus 0.010 in. [0.25 mm].

8.4 Tests to determine the actual diameter of the conductor are not required by this specification but shall be made if agreed upon between the manufacturer and purchaser at the time of placing the order. When measurements of the diameter are made, these shall be made in the manufacturer's premises during fabrication and at the central point between the final closing die of the strander and the capstan when the conductor is under tension. When so measured the maximum difference in mean diameter from the nominal diameter shall be 1 % (measured in the transverse plane), and the maximum difference in diameter at any transverse section shall be not greater than 3 %.

9. Strength of Conductor

9.1 The rated strength of a complete conductor, as shown in Table 1, shall be taken as the aggregate strength of the aluminum and steel components calculated as follows. The strength contribution of the aluminum 1350-H19 wires shall be taken as the percentage indicated in Table 3, in accordance with the number of aluminum layers, of the sum of the wire strengths calculated from the specified diameter of the round wires and from the diameters of round wires having the same area as the trapezoidal wires shown in Table 1, and the appropriate minimum average tensile strength given in Specification B230/B230M. The strength contribution of the steel core wires shall be taken as the percentage, indicated in Table

TABLE 3 Rating Factors

Number of Layers			No. of Steel Wires	Rating Factor, %	
Aluminum		Steel			
Round	Trapezoidal	Round		Aluminum	Steel
...	2	[A]	1	95	96
...	2	1	7	95	96
...	2	2	19	95	93
1	2	1	7	93	96
1	2	2	19	93	93

[A] Central steel wire only; the 96 % rating factor is applied to the single steel wire core as a factor of safety in the event the steel wire contains a weld (made prior to drawing).