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Standard Specification for Compressed Round Stranded Aluminum Conductors Using Single Input Wire Construction[1]

This standard is issued under the fixed designation B901; 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 aluminum 1350-H19 (extra hard), 1350-H16 or -H26 (¾ hard), 1350-H14 or -H24 (½ hard), 1350-H142 or -H242 (½ hard), and aluminum alloy 8XXX series as listed in Specification B800 for tempers "O" and H1X or H2X, bare stranded conductors composed of one or more roller shaped or die compressed layers of helically layed wires. The conductors are for general use for electrical purposes (Explanatory Notes 1 and 2).

NOTE 1—For the purposes of this specification, single input wire (SIW) construction is defined as follows: a stranded conductor design methodology that varies the number of wires within a range of conductor sizes in order to permit that range of conductor sizes to be constructed from a single wire size.

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

NOTE 2—Prior to 1975, aluminum 1350 was designated as EC aluminum.

NOTE 3—The aluminum and temper designations conform to ANSI H35.1. Aluminum 1350 corresponds to Unified Numbering System A91350 in accordance with Practice E527. Aluminum alloys in the 8000 series correspond to Unified Numbering System A98XXX in accordance with Practice E527.

NOTE 4—This specification also permits conductors for use as covered or insulated electrical conductors.

NOTE 5—Sealed conductors, which are intended to prevent longitudinal water propagation and are further covered/insulated, are also permitted within the guidelines of this specification.

1.3 *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 the date of material purchase form a part of this specification to the extent referenced herein.

2.2 *ASTM Standards:*[2]

B193 Test Method for Resistivity of Electrical Conductor Materials

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

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

B354 Terminology Relating to Uninsulated Metallic Electrical Conductors

B609/B609M Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes

B800 Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes—Annealed and Intermediate Tempers

B801 Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation

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 *Other Standards:*

ANSI H35.1 American National Standard Alloy and Temper Designation System for Aluminum[3]

NBS Handbook 100 —Copper Wire Tables[4]

3. Classification

3.1 The conductors described in this specification are intended for subsequent insulation or covering. The classification of these conductors is SIW compressed.

[1] This specification is under the jurisdiction of ASTM Committee B01 of 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.

[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 Technical Information Service (NTIS), 5301 Shawnee Rd., Alexandria, VA 22312, http://www.ntis.gov.

4. Ordering Information

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

4.1.1 Quantity,

4.1.2 Conductor size: circular-mil area of AWG (see Section 8 and Table 1),

4.1.3 Alloy designation,

4.1.4 Class (see 3.1),

4.1.5 Temper (see 5.1 and 5.3),

4.1.6 Details of special-purpose lays, when required (see 7.2 and 7.3),

4.1.7 When tension tests are required on the completed conductor (see Section 15),

4.1.8 Package size (see 19.1),

4.1.9 Special package marking, if required (see Section 20),

4.1.10 Heavy wood lagging, if required (see 19.2), and

TABLE 1 Construction Requirements of Compressed Round SIW Stranded

Aluminum Conductors												
Conductor Size			Hard Drawn Copper Equivalent			Minimum Number of Wires	Nominal Diameter of SIW Compressed Conductor in.	Nominal Diameter of SIW Compressed Conductor mm	Mass		DC Resistance at 20°C	
cmils	AWG	mm^2	cmils	AWG	mm^2				lb/1000ft	kg/km	Ω/1000ft	Ω/km
4 000 000		2027	2 520 000		1277	217	2.168	55.07	3823	5688	0.00442	0.0145
3 500 000		1773	2 200 000		1115	169	2.028	51.51	3345	4977	0.00505	0.0166
3 000 000		1520	1 890 000		957.7	169	1.878	47.69	2839	4225	0.00584	0.0192
2 500 000		1267	1 570 000		795.5	127	1.714	43.54	2366	3521	0.00701	0.0230
2 000 000		1013	1 260 000		638.5	127	1.533	38.94	1875	2789	0.00867	0.0284
1 900 000		962.7	1 195 000		605.5	127	1.494	37.95	1781	2650	0.00913	0.0300
1 800 000		912.1	1 132 000		573.6	127	1.454	36.93	1687	2510	0.00963	0.0316
1 750 000		886.7	1 101 000		557.9	127	1.434	36.42	1640	2441	0.0099	0.0325
1 700 000		861.4	1 069 000		541.7	127	1.413	35.89	1593	2371	0.0102	0.0335
1 600 000		810.7	1 006 000		509.7	127	1.371	34.82	1500	2232	0.0109	0.0358
1 500 000		760.1	943 000		477.8	90	1.327	33.71	1406	2092	0.0116	0.0381
1 400 000		709.4	880 000		445.9	90	1.282	32.56	1312	1953	0.0124	0.0407
1 300 000		658.7	818 000		414.5	90	1.236	31.39	1218	1813	0.0133	0.0436
1 250 000		633.4	786 000		398.3	90	1.212	30.78	1172	1743	0.0138	0.0453
1 200 000		608.0	755 000		382.6	90	1.187	30.15	1125	1674	0.0144	0.0472
1 100 000		557.4	692 000		350.6	90	1.137	28.88	1030	1533	0.0158	0.0518
1 000 000		506.7	629 000		318.7	53	1.084	27.53	937	1395	0.0173	0.0568
900 000		456.0	566 000		286.8	53	1.028	26.11	844	1255	0.0193	0.0633
800 000		405.4	503 000		254.9	53	0.969	24.61	750	1116	0.0217	0.0712
750 000		380.0	472 000		239.2	53	0.939	23.85	703	1046	0.0231	0.0758
700 000		354.7	440 000		223.0	34	0.907	23.04	656	976	0.0248	0.0814
650 000		329.4	409 000		207.2	34	0.874	22.20	609	907	0.0267	0.0876
636 000		322.3	400 000		202.7	34	0.865	21.96	596	887	0.0273	0.0896
600 000		304.0	377 000		191.0	34	0.840	21.34	562	837	0.0289	0.0948
550 000		278.7	346 000		175.3	34	0.804	20.42	516	767	0.0315	0.103
500 000		253.4	314 000		159.1	30	0.766	19.46	469	697	0.0347	0.114
477 000		241.7	300 000		152.0	30	0.747	18.96	447	665	0.0364	0.119
450 000		228.0	283 000		143.4	30	0.727	18.47	422	628	0.0385	0.126
400 000		202.7	252 000		127.7	24	0.685	17.40	375	558	0.0434	0.142
350 000		177.3	220 000		111.5	24	0.641	16.28	328	488	0.0495	0.162
336 400		170.5	211 600	0000	107.2	18	0.629	15.96	315	469	0.0516	0.169
300 000		152.0	188 700		95.62	18	0.594	15.09	281	418	0.0578	0.190
266 800		135.2	167 800	000	85.03	18	0.560	14.22	250	372	0.0650	0.213
250 000		126.7	157 200		79.65	18	0.542	13.77	234	349	0.0694	0.228
211 600	0000	107.2	133 100	00	67.44	17	0.498	12.65	198	295	0.082	0.269
167 800	000	85.03	105 600	0	53.51	15	0.443	11.25	157	234	0.103	0.338
133 100	00	67.44	83 690	1	42.41	11	0.395	10.03	125	186	0.130	0.426
105 600	0	53.51	66 360	2	33.63	7	0.352	8.94	99.0	147	0.164	0.538
83 690	1	42.41	52 620	3	26.66	7	0.313	7.95	78.4	117	0.207	0.679
66 360	2	33.63	41 740	4	21.15	6	0.283	7.19	62.2	92.6	0.261	0.856
52 620	3	26.66	33 090	5	16.77	6	0.252	6.40	49.3	73.4	0.330	1.08
41 740	4	21.15	26 240	6	13.30	6	0.225	5.72	39.1	58.2	0.416	1.36
33 090	5	16.77	20 820	7	10.55	6	0.200	5.08	31.0	46.2	0.523	1.72
26 240	6	13.30	16 510	8	8.366	6	0.178	4.52	24.6	36.6	0.661	2.17
20 820	7	10.55	13 090	9	6.633	6	0.159	4.04	19.5	29.0	0.834	2.74
16 510	8	8.366	10 380	10	5.260	6	0.142	3.61	15.5	23.0	1.05	3.44
13 090	9	6.633	8 234	11	4.172	6	0.126	3.20	12.3	18.3	1.32	4.33
10 380	10	5.260	6 530	12	3.309	6	0.113	2.87	9.73	14.5	1.67	5.48
6 530	12	3.309	4 110	14	2.083	6	0.089	2.26	6.12	9.11	2.67	8.76
4 110	14	2.083	2 580	16	1.307	6	0.071	1.80	3.85	5.73	4.22	13.8
2 580	16	1.307	1620	18	0.8209	6	0.054	1.37	2.42	3.60	6.71	22.0
1 620	18	0.8209	1020	20	0.5168	6	0.043	1.09	1.52	2.26	10.7	35.1
1 020	20	0.5168	642	22	0.3253	6	0.034	0.86	0.96	1.42	16.9	55.4

4.1.11 Place of inspection (see Section 18).

5. Requirements for Wires

5.1 The purchaser shall designate the temper of conductors of SIW compressed or SIW conductor.

5.1.1 For conductor tempers other than H19, the manufacturer shall have the following options on manufacturing method:

5.1.1.1 Strand the conductor from wires drawn to final temper;

5.1.1.2 Strand the conductor from wires drawn to H19 temper and annealed to final temper prior to stranding; or

5.1.1.3 Strand the conductor from H19 wires and anneal the stranded conductor to final temper.

5.2 Before stranding, the aluminum wire used shall meet the requirements of Specifications B230/B230M, B609/B609M, or B800, whichever is applicable.

5.3 All wires in the conductor shall be of the same temper.

6. Joints

6.1 Only cold-pressure joints or electric-butt, cold-upset joints may be made in the wires of SIW compressed or SIW conductor.

6.2 The minimum distance between joints in the wires of the completed conductor shall be no less than 1 ft (0.3 m).

7. Lay

7.1 For SIW compressed stranded conductors manufactured for subsequent covering or insulating, the average lay length of the wires shall be not less than 8 nor more than 16 times the outer diameter of the finished conductor. For conductors of 37 wires or more, this requirement shall apply to the wires in the outer two layers only, unless otherwise agreed upon.

7.2 Other lays for special purposes shall be furnished by special agreement between the manufacturer and the purchaser (Explanatory Note 3).

7.3 For conductors manufactured for subsequent covering or insulating, the direction of lay of the outer layer shall be left hand and may be reversed or unidirectional/unilay in successive layers, unless otherwise specified by the purchaser.

8. Construction

8.1 The areas of cross section, the minimum number of wires, and diameters of the finished strand shall conform to the requirements prescribed in Table 1.

9. Rated Strength of Conductor

9.1 The rated strength of 1350-H19 conductors shall be taken as the percent, indicated in Table 2, of the sum of the strengths of the component wires, calculated using the nominal wire diameters and the specified minimum average tensile strength given in Specification B230/B230M for 1350-H19 wire.

9.2 The rated strengths of 8000 series conductors shall be taken as the percent, indicated in Specification B801, of the sum of strengths of the component wires, calculated using the nominal wire diameters and the specified minimum average tensile strength given in Specification B800 for 8000 series wire.

TABLE 2 Rating Factors[A]

Number of Layers	Rating Factor, %
1	96
2	93
3	91
4	90
5 and above	89

[A] This relates to 1350 alloy only. Refer to the Rating Factors Table in Specification B801 for values for 8000 series alloys.

9.3 Calculations for rated strengths of 1350-H16, -H26, -H14, -H24, -H142, and -H242 conductors shall be made on the basis of the strengths of the component wires, using the nominal wire diameters and the specified maximum and minimum tensile strengths for the appropriate temper of the respective component wires given in Specification B609/B609M. The minimum rated strengths of the conductors shall be taken as the sum of the calculated minimum strengths of the component wires multiplied by the rating factor given in Table 2. The maximum rated strength of the conductors shall be taken as the sum of the calculated maximum strength of the component wires multiplied by the rating factors given in Table 2.

9.4 Calculations for rated strengths of 8000 series "O" temper H1X and H2X conductors shall be made on the basis of the strengths of the component wires, using the nominal wire diameter for the noncompacted construction and the specified maximum and minimum tensile strengths of the appropriate temper of the respective component wires given in Specification B800. The minimum rated strengths of the conductors shall be taken as the sum of the calculated minimum strengths of the component wires multiplied by the rating factor given in Specification B801. The maximum rated strength of the conductors shall be taken as the sum of the calculated maximum strengths of the component wires.

9.5 Rated-strength and breaking-strength values shall be rounded to three significant figures, in the final value only, in accordance with the rounding method of Practice E29.

10. Density

10.1 For the purpose of calculating mass, cross sections, and so forth, the density of aluminum 1350 shall be taken as 0.0975 lb/in.^{3} (2705 kg/m^3) at 20°C. The density of 8000 series aluminum alloys shall be taken as 0.098 lb/in.^{3} (2.710 g/cm^3) at 20°C.

11. Mass and Electrical Resistance

11.1 The mass and electrical resistance of a unit length of a stranded conductor are a function of the length of lay. The approximate mass and electrical resistance may be determined using the standard increments shown in Table 3. When greater accuracy is desired, the increment based on the specific lay of the conductor may be calculated (Explanatory Note 6).

11.2 The maximum electrical resistance of a unit length of stranded conductor shall not exceed 2 % over the nominal dc

TABLE 3 Standard Increments Due to Stranding

Size of Conductor, All Classes, cmils[A]	Increment (Increase) of Mass and Electrical Resistance, %
4 000 000 to 3 000 001, incl	4
3 000 000 to 2 000 001, incl	3
2 000 000 and under	2

[A] Conversion Factors: 1 cmil = 5.067 E-04 mm^2, 1 mil = 2.54 E-02 mm, 1 lb/1000 ft = 1.488 E+00 kg/km, 1 ft = 3.048 E-01 m, 1 lb = 4.536 E-01 kg, 1 lbf 4.448 E-03 kN.

resistance shown in Table 1 (Explanatory Note 8). When dc resistance is measured at other than 20°C, it is to be corrected by using the multiplying factor given in Table 4.

11.3 For conductors to be used in covered or insulated wires or cables, dc resistance measurement may be used to determine compliance with this specification in lieu of the method outlined in Section 13; however, the reference method shall be the same as that outlined in Section 12.

12. Variation in Area

12.1 The area of cross section of the completed conductor shall be not less than 98 % of the area of cross section of the conductor size listed in column 1 of Table 1. The manufacturer may have the option of determining the cross-sectional area by the following method.

12.1.1 The area of cross section of a conductor may be determined by Test Method B263. In applying that test method, the increment in mass resulting from stranding may be the applicable value specified in 11.1 or may be calculated from the measured component dimensions of the sample under test. In case of question regarding area compliance, the actual mass increment due to stranding shall be calculated.

13. Finish

13.1 The conductor shall be free of all imperfections not consistent with good commercial practice.

TABLE 4 Temperature Correction Factors for Conductor Resistance

Temperature, °C	Multiplying Factor for Conversion to 20°C
0	1.088
5	1.064
10	1.042
15	1.020
20	1.000
25	0.980
30	0.961
35	0.943
40	0.925
45	0.908
50	0.892
55	0.876
60	0.861
65	0.846
70	0.832
75	0.818
80	0.805
85	0.792
90	0.780

14. Variation in Diameter

14.1 The average diameter of the conductor shall vary by not more than +1 to –2 % from the nominal diameter specified in Table 1.

15. Mechanical and Electrical Tests of Conductors NOT Annealed After Stranding

15.1 For 8000 series alloys, refer to the Mechanical and Electrical Tests of Conductors in 8000 Series Alloys in "O" Temper, H1X or H2X Wire and Not Annealed After stranding in Specification B801. For the 1350 alloys covered in this specification, the requirements are as stated in the subsequent sections.

15.2 Wires composing the conductors shall be tested prior to stranding in accordance with the applicable specification (see 5.2), and tests on the completed conductor are not required. However, when requested by the purchaser and agreed to by the manufacturer at the time of ordering, the tension tests of wires before stranding may be waived and the completed conductor tested in accordance with 15.3, or wires removed from the completed conductor tested in accordance with 15.4.

15.3 When the completed conductor is tested as a unit, the breaking strength shall be not less than the rated strength of 1350-H19 conductors or the minimum rated strength of 1350-H16, -H26, -H14, -H24, -H142, and -H242 conductors if failure occurs in the free length at least 1 in. (25 mm) beyond the end of either gripping device, or shall be not less than 95 % of the rated or minimum rated strength if failure occurs inside, or within 1 in. of the end of either gripping device. The breaking strength of 1350-H16, -H26, -H14, -H24, -H142, and -H242 conductors shall be not greater than their maximum rated strengths. The free length between grips of the test specimen shall be not less than 24 in. (610 mm), and care shall be taken to ensure that the wires in the conductor are evenly gripped during the test (Explanatory Note 4).

15.4 Routine production testing of the aluminum wires after stranding is not required. However, when such tests are requested by the purchaser and agreed upon by the manufacturer at the time of ordering (or made for other reasons), the 1350-H19 wires removed from the completed conductor shall have tensile strengths of not less than 95 % of the minimum tensile strengths prescribed for individual tests in Table 1 of Specification B230/B230M. 1350-H16, -H26, -H14, -H24, -H142, and -H242 wires shall have tensile strengths of not less than 95 % of the minimum tensile strengths nor more than 105 % of the maximum tensile strength prescribed in Specification B609/B609M, as applicable (Explanatory Note 5). The electrical resistivity shall meet the minimum resistivity specified for the wire before stranding. Elongation tests may be made for information purposes only, and no minimum values are assigned (Explanatory Note 5). The frequency of these tests shall be decided upon between the purchaser and the manufacturer.

15.5 All wires composing the conductors shall be capable of meeting the bending properties stated in Specification B230/B230M after stranding.