Designation: ~~B786/B786M – 08 (Reapproved 2013)ε1~~ B786/B786M – 08 (Reapproved 2018)

Standard Specification for 19 Wire Combination Unilay-Stranded Aluminum Conductors for Subsequent Insulation[1]

This standard is issued under the fixed designation B786/B786M; 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.

~~ε[1] NOTE—Designation was corrected editorially in October 2013.~~

1. Scope

1.1 This specification covers bare combination unilay-stranded conductors made from round wires of aluminum 1350 and 8000 series of aluminum alloys, for insulated conductors for electrical purposes. Aluminum 1350 wires in tempers -H19 (extra hard), -H16 or -H26 (¾ hard), -H14 or -H24 (½ hard), and -H142 or -H242 (½ hard) and 8000 series aluminum alloys wires in tempers "0" and H1X or H2X are permitted. These conductors shall be constructed with a central core wire surrounded by two layers of helically laid wires, resulting in an outer diameter equal to the compressed-stranded equivalent conductors.

NOTE 1—For the purpose of this specification, combination unilay conductor is defined as follows: a central core wire surrounded by a layer of six helically laid wires of the same diameter as the core wire with a helically laid outer layer containing six smaller wires alternated between six wires of the same diameter as the wires in the layer underneath. Both layers have a common length and direction of lay (see Fig. 1).

1.1.1 For the purpose of this specification, normal conductor classification (Class AA, A, B, C) is not applicable, as these conductors are intended for subsequent insulation. The descriptive term combination unilay-stranded shall be used in place of conductor classification (Note 2 and Note 3).

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

NOTE 3—The aluminum and temper designations conform to ANSI Standard H35.1. Aluminum 1350 corresponds to Unified Numbering System A91350 in accordance with Practice E527. Unified Numbering System alloy designations for 8000 Series aluminum alloys in accordance with Practice E527 are listed in Table number 1 of Specification B800.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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 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

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

[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.

Current edition approved ~~April 1, 2013~~March 1, 2018. Published ~~April 2013~~March 2018. Originally approved in 1988. Last previous edition approved in ~~2008~~2013 as ~~B786 – 08~~.B786/B786M – 13ε1. DOI: ~~10.1520/B0786_B0786M-08R13E01.~~10.1520/B0786_B0786M-08R18.

[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~~standard's Document Summary page on the ASTM website.

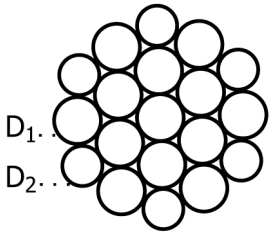

FIG. 1 Cross Section of Conductor

TABLE 1 Construction Requirements for 19-Wire Combination Unilay Stranded Aluminum Conductors

Area of Cross-Section, cmil	Size, American (or Brown and Sharpe) Wire Gage	Wire D_1[A] Diameter		Wire D_2[B] Diameter	
		mils	mm	mils	mm
556 500		185.3	4.71	135.6	3.44
500 000		175.6	4.46	128.5	3.26
477 000		171.5	4.36	125.5	3.19
450 000		166.6	4.23	121.9	3.10
397 500		156.6	3.98	114.6	2.91
350 000		146.9	3.73	107.5	2.73
336 400		144.0	3.66	105.4	2.68
300 000		136.0	3.45	99.6	2.53
266 800		128.3	3.26	93.9	2.38
250 000		124.2	3.15	90.9	2.31
211 600	0000	114.2	2.90	83.6	2.12
167 800	000	101.7	2.58	74.5	1.89
133 100	00	90.6	2.30	66.3	1.68
105 600	0	80.7	2.05	59.1	1.50
83 690	1	71.8	1.82	52.6	1.34
66 360	2	64.0	1.63	46.8	1.19
52 620	3	57.0	1.45	41.7	1.06
41 740	4	50.7	1.29	37.1	0.94
33 090	5	45.2	1.15	33.1	0.84
26 240	6	40.2	1.02	29.4	0.75
20 820	7	35.8	0.91	26.2	0.67
16 510	8	31.9	0.81	23.4	0.59
13 090	9	28.4	0.72	20.8	0.53
10 380	10	25.3	0.64	18.5	0.47
6 530	12	20.1	0.51	14.7	0.37

[A] Equation to calculate D_1:

$$D_1 = \sqrt{\frac{\text{Cross} - \text{Sectional Area}}{16.2149}}$$

[B] Equation to calculate D_2:

$$D_2 = D_1 \times 0.732.$$

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 Standard:*[3]

ANSI H35.1/H35.1(M) Alloy and Temper Designation Systems for Aluminum

2.4 *NIST Standard:*

[4]

NBS Handbook 100 — ~~*NBS Handbook 100*~~*Copper Wire Tables*

3. Ordering Information

3.1 Orders for materials under this specification shall include the following information:

3.1.1 Conductor alloy,

3.1.2 Quantity of each size,

3.1.3 Conductor size: Circular-mil area or American Wire Gage, AWG (Section 6 and Table 1),

3.1.4 Stranding (see Explanatory Note 1),

[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.

3.1.5 Temper (see Section 11),
3.1.6 Details of special-purpose lays, if required (see 5.2),
3.1.7 When physical tests shall be made (see Sections 7 and 8),
3.1.8 Package size (see 16.1),
3.1.9 Heavy wood lagging, if required (see 17.2),
3.1.10 Special package marking, if required (Section 17), and
3.1.11 Place of inspection (Section 15).

4. Joints

4.1 Electric-butt welds, cold pressure welds, or electric-butt cold-upset welds may be made in the finished individual wires composing the conductor but shall not be closer together than 1 ft (Explanatory Note 2).

5. Lay

5.1 For combination unilay conductors the lay of a layer of wires shall be not less than 8 nor more than 16 times the outside diameter of the outer layer.

5.2 Other lays for special purposes shall be furnished by special agreement between the manufacturer and the purchaser.

NOTE 4—Certain types of insulation conductors may require shorter lay than other conductors. It is expected that special requirements regarding length of lay will be specified by the purchaser in such instances.

5.3 The direction of lay shall be left-hand unless the direction of lay is specified otherwise by the purchaser.

6. Construction (Explanatory Note 1)

6.1 The areas of cross section, numbers, and diameters of wires in the various conductors shall conform to the requirements prescribed in Table 1 (Note 3) (see Fig. 1).

6.2 The diameters of the wires listed in Table 2 are nominal. In order to produce an essentially round 19-wire construction, the outer 12-wire layer in the combination unilay product is comprised of 6 wires of the same diameter as the wires in the 7-wire core, and 6 wires approximately 25 % smaller. The 2-wire sizes are alternated around the 7-wire core.

7. Mechanical and Electrical Tests of Conductors not Annealed after Stranding

7.1 Wires composing the conductors shall be tested prior to stranding in accordance with the applicable specification (see 11.1.2), and tests on the completed conductor are not required. However, when requested by the purchaser and agreed to by the

TABLE 2 Diameters, Areas and Mass of 19-Wire Combination Unilay Stranded Aluminum Conductor[A]

Size of Conductor, cmil or AWG	Nominal Conductor Diameter[B]		Nominal Area		Mass		Direct Current Resistance at 20°C	
	in.	mm	in.^{2}	mm^2	lb/1000 ft	kg/km	Ω/1000/1000 ft	Ω/km/km
556 500	0.827	21.0	0.4371	282	521	775	0.0312	0.1024
500 000	0.784	19.9	0.3927	253	468	697	0.0347	0.1139
477 000	0.766	19.5	0.3746	242	447	665	0.0364	0.1194
450 000	0.744	18.9	0.3534	228	421	627	0.0385	0.1263
397 500	0.699	17.8	0.3122	201	372	554	0.0436	0.1431
350 000	0.656	16.7	0.2749	177	328	488	0.0495	0.1624
336 400	0.643	16.3	0.2642	170	315	469	0.0516	0.1693
300 000	0.607	15.4	0.2356	152	281	418	0.0578	0.1896
266 800	0.573	14.6	0.2095	135	250	372	0.0650	0.2133
250 000	0.554	14.1	0.1963	127	234	348	0.0694	0.2277
0000	0.510	13.0	0.1662	107	198	295	0.0820	0.2690
000	0.454	11.5	0.1318	85.0	157	234	0.103	0.3389
00	0.404	10.3	0.1045	67.4	125	185	0.130	0.4275
0	0.360	9.14	0.08291	53.5	98.9	147	0.164	0.5387
1	0.321	8.15	0.06573	42.4	78.4	117	0.207	0.6798
2	0.286	7.26	0.05212	33.6	62.1	92.4	0.261	0.8573
3	0.254	6.45	0.04133	26.7	49.3	73.4	0.330	1.0814
4	0.226	5.74	0.03278	21.1	39.1	58.2	0.416	1.3633
5	0.202	5.13	0.02599	16.8	31.0	46.1	0.523	1.72
6	0.179	4.55	0.02061	13.3	24.6	36.6	0.661	2.1684
7	0.160	4.06	0.01635	10.5	19.5	29.0	0.834	2.7362
8	0.143	3.63	0.01297	8.37	15.5	23.1	1.05	3.4464
9	0.127	3.23	0.01028	6.63	12.3	18.3	1.32	4.3307
10	0.113	2.87	0.00816	5.26	9.73	14.5	1.67	5.4790
12	0.090	2.29	0.00513	3.31	6.12	9.11	2.67	8.7598

[A] Mass and electrical resistance are based on aluminum 1350.
[B] To calculate the diameter, multiply the large wire diameter in Table 1 times 3 and add two times the small wire diameter.
Example: AWG 4/0 diameter = [3(114.2) + 2(83.6)] = 509.8

manufacturer at time of ordering, the tension tests of wires before stranding may be waived and the completed conductor tested in accordance with 7.2, or wires removed from the completed conductor tested in accordance with 7.5.

7.2 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. The strength 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. (600 mm) and care shall be taken to ensure that the wires in the conductor are evenly gripped during the test (Explanatory Note 3).

7.3 The rated strength of 1350-H19 conductors and the minimum rated strength of 1350-H16, -H26, -H14, -H24, -H142, and -H242 conductors shall be taken as 93 % of the sum of the specified minimum average tensile strengths of the component wires for 1350-H19 conductors, as prescribed in Table 1, Tensile Requirements, of Specification B230/B230M, and of the sum of the specified minimum tensile strengths of the component wires for 1350-H16, -H26, -H14, -H24, -H142, and -H242 conductors, as prescribed in Specification B609/B609M, as applicable. The maximum rated strength of the 1350-H16, -H26, -H14, -H24, -H142 and -H242 conductors shall be taken as the sum of the specified maximum strengths of the component wires, as prescribed in Specification B609/B609M, as applicable. The rated strengths shall be calculated using specified nominal wire diameters.

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

7.5 When wires are removed from the completed conductor and tested, 1350-H19 wires shall have minimum tensile strengths not less than 95 % of the tensile strengths prescribed for individual tests in Table 1, Tensile Requirements, of Specification B230/B230M. 1350-H16, -H26, -H14, -H24, -H142, and -H242 wires shall have tensile strengths not less than 95 % of the minimum tensile strength nor more than 105 % of the maximum tensile strength prescribed in Specification B609/B609M, as applicable (Explanatory Note 4).

7.6 All wires composing the conductors shall be capable of meeting the bending properties stated in Specification B230/B230M after stranding. Routine production testing after stranding is not required.

7.7 Mechanical and electrical tests of conductors in 8000 series aluminum alloys in “0” temper, H1X or H2X wire and not annealed after stranding shall be in accordance with Section 9 of Specification B801.

8. Mechanical and Electrical Tests of Conductors Annealed after Stranding

8.1 Tensile properties and electrical resistivity shall be determined on samples taken from 10 % of the reels or coils of conductor, but from not less than five (or all if the lot is less than five) reels or coils. Resistivity shall be determined as prescribed in the Resistivity section of Specification B230/B230M on one wire from each conductor sample except this test is not required if performed previously on the 1350-H19 wire. At the manufacturer’s option, tension tests shall be made either on one of the inner seven wires and one wire from each additional layer of each conductor sample to determine conformance with 8.2 or on the conductor as a unit to determine conformation with 8.3.

8.2 When wires removed from the completed conductor are tested, 1350-H26, -H24, and -H242 wires shall have tensile strengths not less than 95 % of the minimum tensile strength nor more than 105 % of the maximum tensile strength prescribed in Specification B609/B609M, as applicable (Explanatory Note 4).

8.3 When the completed conductor is tested as a unit, the breaking strengths of 1350-H26, -H24, and -H242 conductors shall conform with 7.2, 7.3, and 7.4.

8.4 All wires composing the conductors shall be capable of meeting the bending properties stated in Specification B230/B230M after stranding. Routine production testing after stranding is not required.

8.5 Mechanical and electrical tests of conductors of 8000 series aluminum alloys fabricated from wires other than H2X and annealed after stranding to meet “0” temper or H2X requirements shall be in accordance with Section 10 of Specification B801.

9. Mass and Resistance

9.1 The mass and electrical resistance of a unit length of stranded conductor are a function of the length of lay. The approximate mass and electrical resistance may be determined using the standard increment of 2 %. When greater accuracy is desired, the increment based on the specific lay of the conductor may be calculated (Explanatory Note 1).

9.2 The maximum electrical resistance of a unit length of stranded conductor shall not exceed 2 % over the nominal d-c resistance shown in Table 2 (Explanatory Note 6). When the d-c resistance is measured at other than 20°C, it is to be corrected by using the multiplying factor given in Table 3.