



UL 1581

STANDARD FOR SAFETY

Reference Standard for Electrical
Wires, Cables, and Flexible Cords

UL Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581
Fourth Edition, Dated October 31, 2001

Summary of Topics:

This revision to ANSI/UL 1581 dated January 25, 2023 includes a correction to the DC resistance test. This correction to [12.3.1](#) from the September 30, 2022 Recirculation bulletin, was inadvertently left out of the revisions dated November 15, 2022.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated September 30, 2022.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

No Text on This Page

OCTOBER 31, 2001
(Title Page Reprinted: January 25, 2023)



1

UL 1581

Reference Standard for Electrical Wires, Cables, and Flexible Cords

First Edition – August, 1983
Second Edition – December, 1991
Third Edition – October, 1997

Fourth Edition

October 31, 2001

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through January 25, 2023.

The most recent designation of ANSI/UL 1581 as an American National Standard (ANSI) occurred on November 15, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

Our Standards for Safety are copyrighted by ULSE Inc. Neither a printed nor electronic copy of a Standard should be altered in any way. All of our Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of ULSE Inc.

COPYRIGHT © 2023 ULSE INC.

No Text on This Page

CONTENTS

INTRODUCTION

1 Scope 9

2 Units of Measurement 9

3 References and Terms.....9

4 thru 9 *Reserved for Future Use* 9

CONDUCTORS

10 Requirements for Aluminum Conductors of an 8000 Series Alloy 9

11 Requirements for Copper-Clad Aluminum Conductors.....10

12 Requirements for Copper-Clad Aluminum Conductors Used in Building Wire 10

 12.1 General.....10

 12.2 Tensile strength and elongation test 11

 12.3 DC resistance test 11

 12.4 Density test 11

 12.5 Diameter measurement.....11

 12.6 Adhesion test 11

 12.7 Cohesion test 11

 12.8 Copper construction.....12

13 thru 19 *Reserved for Future Use*.....13

20 Conductor Diameter and Cross-Sectional Area 13

21 thru 29 *Reserved for Future Use*.....28

30 D-C Conductor Resistance 28

31 thru 39 *Reserved for Future Use*.....48

INSULATION AND JACKET MATERIALS

40 General 48

41 thru 46 *Reserved for Future Use*.....48

47 Index Table 48

48 thru 49 *Reserved for Future Use*.....53

50 Specific Materials 53

51 thru 199 *Reserved for Future Use*.....92

METHODS

CONDUCTOR DIMENSIONS AND RESISTANCE

200 Conductor Diameter 92

201 thru 209 *Reserved for Future Use* 93

210 Conductor Cross-Sectional Area by the Weight Method.....93

211 thru 219 *Reserved for Future Use* 93

220 D-C Conductor Resistance.....93

221 thru 227 *Reserved for Future Use* 94

WIRE BRAID AND SERVING COVERAGE

228 Measurements and Calculations.....94

229 thru 239 *Reserved for Future Use* 94

THICKNESSES OF INSULATION AND JACKET

240	Thicknesses of Insulation on Thermoplastic- and Thermoset-Insulated Wires and Cable	94
241 thru 249	<i>Reserved for Future Use</i>	95
250	Thicknesses of Insulation on Flexible Cord and on Fixture Wire	95
251 thru 259	<i>Reserved for Future Use</i>	96
260	Thicknesses of Jacket on Thermoplastic- and Thermoset-Insulated Wires and Cables	96
261 thru 279	<i>Reserved for Future Use</i>	97
280	Thicknesses of Jacket on Flexible Cord, Fixture Wire, and Elevator Cable	97
281 thru 399	<i>Reserved for Future Use</i>	97

PHYSICAL PROPERTIES TESTS OF INSULATION AND JACKET

400	General	97
401 thru 419	<i>Reserved for Future Use</i>	97
420	Apparatus	97
421 thru 439	<i>Reserved for Future Use</i>	97
440	Preparation of Specimens	97
441 thru 459	<i>Reserved for Future Use</i>	97
460	Recovery	97
461 thru 469	<i>Reserved for Future Use</i>	98
470	Ultimate Elongation and Tensile Strength	98
471 thru 479	<i>Reserved for Future Use</i>	98
480	Accelerated Aging	98
481	Long-Term Aging	99
482 thru 489	<i>Reserved for Future Use</i>	100

COMPOUND ANALYSIS

POLYVINYL CHLORIDE (PVC) COMPOUNDS

490	Infrared Spectroscopy	100
491	Determination of the Ash Content	101
492	Elemental Analysis	102
493	Gel Permeation Chromatography	104

OTHER COMPOUNDS

494	Infrared Spectroscopy	105
495	Pyrolytic Gas Chromatography	105
496	Thermogravimetry	105
497	Differential Scanning Calorimetry	105
498 thru 499	<i>Reserved for Future Use</i>	106

CONDUCTOR CORROSION

500	General	106
501 thru 519	<i>Reserved for Future Use</i>	106

INSULATION FALL-IN

520	Test	106
521 thru 539	<i>Reserved for Future Use</i>	106

HEAT SHOCK

540	Test	106
541 thru 559	<i>Reserved for Future Use</i>	106

DEFORMATION

560	Test	106
561 thru 579	<i>Reserved for Future Use</i>	108

COLD BEND

580	Test	108
581 thru 582	<i>Reserved for Future Use</i>	108

FLEXIBILITY AT LOW TEMPERATURE

583	Test	108
584 thru 592	<i>Reserved for Future Use</i>	110

IMPACT AT ABNORMALLY LOW TEMPERATURE

593	Test	110
594	<i>Reserved for Future Use</i>	111

CRUSHING RESISTANCE

595	Test	111
596 thru 600	<i>Reserved for Future Use</i>	111
601	Crushing-Resistance Test of Round Type NM Cable	111
602 thru 619	<i>Reserved for Future Use</i>	111
620	Crushing-Resistance Test of Types XHHW-2, XHHW, and XHH	111
621 thru 699	<i>Reserved for Future Use</i>	112

DIELECTRIC TESTS

700	Dielectric Breakdown Test of Types XHHW-2, XHHW, and XHH after Glancing Impact	112
701 thru 719	<i>Reserved for Future Use</i>	113
720	Dielectric Breakdown Test of Types XHHW-2, XHHW, and XHH after Scoring	113
721 thru 759	<i>Reserved for Future Use</i>	115
760	Dielectric Voltage-Withstand Test of Straight Foil-Wrapped Specimens.....	115
761 thru 779	<i>Reserved for Future Use</i>	115
780	Dielectric Voltage-Withstand Test of Foil-Wrapped U-Bend Specimens.....	115
781 thru 799	<i>Reserved for Future Use</i>	115
800	Dielectric Voltage-Withstand Test for Cord Conductors	115
801 thru 819	<i>Reserved for Future Use</i>	116
820	Dielectric Voltage-Withstand Test of Coils and Reels in Water	116
821 thru 829	<i>Reserved for Future Use</i>	116
830	Dielectric Voltage-Withstand Tests for Power-Limited Circuit Cable and for Cable for Power-Limited Fire-Alarm Circuits	116
831 thru 899	<i>Reserved for Future Use</i>	117

SPARK TEST

900	Method	117
901 thru 909	<i>Reserved for Future Use</i>	118
910	Spark Tests for Power-Limited Circuit Cable and for Cable for Power-Limited Fire-Alarm Circuits	118
911 thru 918	<i>Reserved for Future Use</i>	120

INSULATION RESISTANCE

919	Test Procedure for Determining the Multiplying-Factor Column for Adjusting Insulation Resistance	120
920	Insulation-Resistance Test in Water	122
921 thru 999	<i>Reserved for Future Use</i>	123

STABILITY FACTOR

1000	Test	123
1001 thru 1019	<i>Reserved for Future Use</i>	123

CAPACITANCE AND RELATIVE PERMITTIVITY

1020	Test	123
1021 thru 1039	<i>Reserved for Future Use</i>	123

MECHANICAL WATER ABSORPTION

1040	Test	123
1041 thru 1042	<i>Reserved for Future Use</i>	125

SWELLING AND BLISTERING IN WATER

1043	Test	125
1044 thru 1059	<i>Reserved for Future Use</i>	125

FLAME TESTS

1060	Vertical Flame and FT1 Tests	125
1061	Cable Flame Test	126
1062 thru 1079	<i>Reserved for Future Use</i>	128
1080	VW-1 (Vertical-Specimen) Flame Test	128
1081 thru 1089	<i>Reserved for Future Use</i>	130
1090	Horizontal-Specimen Appliance-Wire Flame Test	130
1091 thru 1099	<i>Reserved for Future Use</i>	133
1100	Horizontal-Specimen / FT2 Flame Test	133
1101 thru 1159	<i>Reserved for Future Use</i>	134
1160	UL Vertical-Tray Flame Test	134
1161 thru 1163	<i>Reserved for Future Use</i>	134
1164	FT4/IEEE 1202 Vertical-Tray Flame Test	134
1165 thru 1199	<i>Reserved for Future Use</i>	134

SUNLIGHT RESISTANCE

1200	Xenon-Arc Tests	134
------	-----------------------	-----



1201 thru 1249 *Reserved for Future Use* 135

GLASS CONTENT

1250 Test 135
1251 thru 1269 *Reserved for Future Use* 135

TIGHTNESS OF INSULATION

1270 Test for Tightness of Conductor Insulation in Decorative-Lighting Cords and Wire..... 135
1271 thru 1279 *Reserved for Future Use* 136
1280 Test for Tightness of Circuit-Conductor Insulation in Integral Parallel Cord Other Than Tinsel
 Cord 136
1281 thru 1299 *Reserved for Future Use* 136

LEAKAGE

1300 Test of Type TBS for Surface Leakage Resistance 136
1301 thru 1319 *Reserved for Future Use* 136
1320 A-C Leakage-Current Tests of Low-Leakage-Current Service Cords..... 136
1321 thru 1339 *Reserved for Future Use* 138
1340 Test for D-C Resistance of Nonintegral Cord Jacket 138
1341 thru 1399 *Reserved for Future Use* 138

IMPACT RESISTANCE

1400 Test 138
1401 thru 1499 *Reserved for Future Use* 138

ABRASION OF 22 AWG TYPE XTW AND CXTW WIRE AND CORD

1500 Test 138
1501 thru 1509 *Reserved for Future Use* 138

ABRASION

1510 Test 138
1511 thru 1519 *Reserved for Future Use*..... 139

FLEXING OF 22 AWG TYPE XTW AND CXTW WIRE AND CORD

1520 Test 139
1521 thru 1539 *Reserved for Future Use* 140

**CRACKING OF NYLON COVERING ON COAXIAL-CABLE MEMBERS OF ELEVATOR CABLES OR
OF NYLON JACKET ON TYPES TFN, TFFN, AND SPT-1 AND OF INSULATED
CONDUCTORS IN SERVICE CORDS**

1540 Test 140
1541 thru 1559 *Reserved for Future Use* 140

FLEXING OF TYPE SF-1, SF-2, SFF-1, AND SFF-2 FIXTURE WIRES

1560 Test 140

1561 thru 1581 *Reserved for Future Use* 140

FLEXING OF SHIELDED CORDS

1582 Test 140

1583 thru 1589 *Reserved for Future Use* 141

MANDREL TEST OF NYLON JACKET ON TYPE THWN-2, THWN, AND THHN WIRES

1590 Test 141

1591 thru 1599 *Reserved for Future Use* 141

1600 Comparison of Metal Sheaths..... 141

1601 thru 1609 *Reserved for Future Use* 143

MOISTURE ABSORPTION BY FIBROUS COVERINGS OTHER THAN TAPE

1610 Test 143

1611 thru 1629 *Reserved for Future Use*..... 145

FALLING PARTICLES AND DRIPPING FROM FIBROUS-COVERED WIRE AND CABLE

1630 Test 145

1631 thru 1669 *Reserved for Future Use* 146

ARCING OF TYPE HPN CORD

1670 Flame Test 146

1671 thru 1679 *Reserved for Future Use* 146

1680 Broken-Strands Test 146

1681 thru 1689 *Reserved for Future Use* 147

DURABILITY OF INDELIBLE-INK PRINTING

1690 Test 147

INTRODUCTION

1 Scope

1.1 This standard contains specific details of the conductors, of the insulation, of the jackets and other coverings, and of the methods of sample preparation, of specimen selection and conditioning, and of measurement and calculation that are required in wire and cable standards.

1.2 The requirements for the particular materials, construction, performance, and marking of an individual type of wire, cable, or flexible cord are stated in the standard covering the finished type. They are not part of this reference standard.

1.3 In each case in which an element of this standard does not apply, the standard covering the finished type so states and specifies what does apply.

2 Units of Measurement

2.1 In addition to being stated in the inch/pound units that are customary in the USA, each numerical requirement in this standard is also stated in units that make the requirement conveniently usable in countries employing the metric system. Equivalent – although not exactly identical – results are to be expected from applying a requirement in inch/pound or metric units. Equipment calibrated in metric units is to be used when a requirement is stated in metric terms.

3 References and Terms

3.1 The term "wire standard" as used in this standard means any standard that covers finished electrical wires, cables, or flexible cords and in which reference is made to this reference standard (UL 1581).

4 thru 9 *Reserved for Future Use*

CONDUCTORS

10 Requirements for Aluminum Conductors of an 8000 Series Alloy

10.1 These requirements cover aluminum wire in annealed and intermediate tempers using 8000 series electrical-conductor-grade aluminum alloys. These alloys are for use in solid conductors in the 6 – 4/0 AWG sizes and in round-strand and compressed- and compact-stranded conductors in the 12 AWG – 2000 kcmil sizes.

10.2 The wire shall be of a registered 8000 series electrical-conductor-grade aluminum alloy complying with ASTM B 800-05. The conductor diameter and cross-sectional area shall comply with Conductor Diameter and Cross-Sectional Area, Section [20](#). The d-c resistance of the conductors shall comply with D-C Conductor Resistance, Section [30](#).

10.3 The temper of the wire of the finished conductor shall be annealed (-0) or intermediate (-H1X) or (-H2X). The tensile strength and elongation (see note b to [Table 10.1](#)) of the finished stranded conductor tested as a unit or of the individual strands removed from the finished conductor or of the finished solid conductor shall comply with [Table 10.1](#) when specimens are tested at a speed of 1 in/min or 25 mm/min using the equipment and procedure described in ASTM B 557-06.

Table 10.1
Mechanical properties^a of solid and stranded conductors of an 8000 series aluminum alloy

Temper	Tensile strength	Elongation ^b in 10 inches or 250 mm
Annealed (-0)	All specimens: 11,250 ±2,750 lbf/in ² or 78 ±19 MPa	Solid conductor: 10.0 percent minimum Stranded conductor: 10.0 percent minimum
Semi-annealed: (-H1X) and (-H2X)	Wires (strands) removed from the finished stranded conductor: 18,675 ±4,425 lbf/in ² or 129 ±30 MPa	Solid conductor: 10.0 percent minimum Stranded conductor: 10.0 percent minimum
	All other specimens: 18,500 ±3,500 lbf/in ² or 128 ±24 MPa	Solid conductor: 10.0 percent minimum Stranded conductor: 10.0 percent minimum
^a For the purpose of determining compliance with the tabulated limits, test results are to be rounded as follows after specimens are tested at a speed of 1 in/min or 25 mm/min using the equipment and procedure described in ASTM B 557-06: 1) Each calculated value of tensile strength is to be rounded to the nearest 100 lbf/in ² or 1 MPa. 2) Each value of elongation is to be rounded to the nearest 0.5 percent as described in the rounding method in ASTM E 29-06b. ^b Compliance with the elongation requirement for stranded conductors is to be determined on wires taken prior to stranding into conductors, on wires taken from a stranded conductor, or on the stranded conductor as a whole.		

11 Requirements for Copper-Clad Aluminum Conductors

11.1 The requirements in this section ([11.1](#)) cover copper-clad aluminum conductors. Copper-clad aluminum conductors shall be drawn from copper-clad aluminum rod. The copper shall be metallurgically bonded to the aluminum core, shall occupy 10 percent or more of the cross section of a solid conductor and of each wire (strand) of a stranded conductor, and shall be concentric with the aluminum. The thickness of the copper shall not be less than 2.56 percent of the diameter of the solid conductor or wire (strand) as determined by microscopic examination of a polished right cross section of the round strand or round solid conductor. The tensile strength of a finished copper-clad aluminum conductor tested as a unit or of the wires (strands) from a finished stranded copper-clad aluminum conductor and of a finished solid copper-clad aluminum conductor shall not exceed 20,000 lbf/in² or 138 MPa when specimens are tested at the speed and using the equipment and procedure indicated in ASTM B 566. The elongation of the same specimens shall not be less than 15 percent in 10 inches or 250 mm.

12 Requirements for Copper-Clad Aluminum Conductors Used in Building Wire

12.1 General

12.1.1 The requirements in this section cover finished, copper-clad aluminum conductors and the individual strands of a finished copper-clad aluminum conductor. Copper-clad aluminum conductors shall be drawn from copper-clad aluminum rod. Copper-clad aluminum strands shall be limited to sizes 0.02257 – 0.2043 in diameter (23 – 4 AWG).

12.1.2 The aluminum core shall be an AA8000 series alloy as described in Section [10](#). The elemental analysis of the aluminum core shall be determined in accordance with ASTM E227. The results of the

elemental analysis on the aluminum core used shall meet the requirements for an AA 8000 series alloy as described in UL 44, Chemical composition of ACM, AA 8000 series aluminum alloy conductor materials.

12.1.3 The copper shall be high-conductivity, oxygen-free copper with an oxygen content not to exceed 0.001% meeting the requirements of ASTM B152. The copper shall be metallurgically bonded to the aluminum core as determined by the methods in [12.6](#) and [12.7](#). The copper shall occupy 10 percent or more by volume of the cross section of a solid conductor and of each wire (strand) of a stranded conductor as determined by the methods in [12.8](#). The thickness of the copper shall not be less than 4.0 percent of the radius of the solid conductor or wire (strand).

12.2 Tensile strength and elongation test

12.2.1 The tensile strength of a finished copper-clad aluminum conductor or of the wires (strands) from a finished stranded copper-clad aluminum conductor and of a finished solid copper-clad aluminum conductor shall not exceed 20,000 lbf/in² or 138 MPa. The elongation of the same specimens shall not be less than 15 percent. The tensile and elongation of a finished conductor or an individual strand shall be tested in accordance with the test, Physical properties of conductors (tensile strength, elongation at break, and ultimate strength) as described in UL 2556. The test shall be conducted at a speed of 12 in/min (305 mm/min), with 10 inches (254 mm) between the benchmarks.

12.3 DC resistance test

12.3.1 The DC resistance of the finished copper-clad aluminum conductor shall not exceed 0.026813 $\Omega \cdot \text{mm}^2/\text{m}$ when tested in accordance with the method, DC Resistance as described in UL 2556.

12.4 Density test

12.4.1 The density of the copper-clad aluminum shall be 3.32 g/cm³ (0.1200 lb/in³) nominal when the conductor material is tested using the method described in Annex B of UL 2556.

12.5 Diameter measurement

12.5.1 The diameter of the solid conductor or any individual strands from a stranded conductor shall meet the requirements in [Table 20.1](#) when measured in accordance with the test Conductor Diameter as described in UL 2556.

12.6 Adhesion test

12.6.1 A specimen of finished copper-clad aluminum conductor shall be fixed in a vice or other securement means. The free end of the conductor shall be flexed back and forth thru 180 degrees using any suitable means until the conductor breaks. The fractured area (not including the clamped area) shall be examined for delamination using magnification of 10X. There shall be no delamination between the copper and the aluminum.

12.7 Cohesion test

12.7.1 A specimen of a single strand of finished copper-clad aluminum conductor shall be selected. The minimum length of the specimen shall be 15 times the diameter of wire under test, plus the length required to secure both ends of the specimen. For example, a 12 AWG solid conductor has a diameter of 0.0808 inches. This would require a length of 1.212 inches (15 X 0.080) between the securement means. The specimen shall be fixed in a clamp or other securement means twisted three complete turns in one direction, untwisted to the original position, twisted three turns in the opposite direction and finally returned to the original position.

If a longer length is needed to facilitate the testing, the number of twists for a given length of wire shall be calculated from the formula:

$$\text{Number of twists} = \frac{\text{Length of wire between securement means, in inches}}{5X \text{ OD of wire, in inches}}$$

In no case shall the number of twists be less than three.

12.7.2 After completion of the twists, the specimen shall be examined for seams or splits in the copper using 10X magnification in the area between the securement means. There shall be no seams or splits in the copper.

12.8 Copper construction

12.8.1 The surface of wire shall be free from pits, slivers, exposed aluminum, or other imperfections when examined under normal vision.

12.8.2 Three specimens of copper-clad aluminum, each specimen located at least 10 feet from the previous specimen, shall be mounted (in a suitable material if needed) so that a polished, right cross section of the conductor can be obtained. The minimum thickness at any point (MinAAP) shall be located and measured. The diameter of the overall conductor (D_c) and the diameter of the aluminum core (D_a) shall be each be measured at three locations and averaged. The three measurement locations shall be at the maximum diameter, the minimum diameter and at a location bisecting the maximum and minimum diameters. The measurements shall be made using a micrometer microscope with a resolution and accuracy of 0.001 mm (0.0001 in).

12.8.3 The ratio of copper with respect to the overall radius, R_{ca} , shall not be less than 4% of the radius of the overall conductor, where

$$R_{ca} = 100 \times \left(\frac{\text{MinAAP}}{D_c / 2} \right)$$

Where:

MinAAP is the minimum thickness of copper at any point when measured as described in [12.8.2](#)

D_c is the average diameter of the overall conductor

12.8.4 The percent copper volume, %Cv shall be calculated using

$$\% C_v = 100 \times \left(\frac{D_c^2 - D_a^2}{D_c^2} \right)$$

Where:

D_c is the average diameter of the overall conductor

D_a is the average diameter of the aluminum core

The copper shall be 10 percent or more by volume of the cross section.

13 thru 19 *Reserved for Future Use*

20 Conductor Diameter and Cross-Sectional Area

Table 20.1
Conductor dimensions

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
									Nominal		Minimum			
	Nominal		Minimum ^c		Maximum ^c		Minimum ^d				0.98 × Nominal ^a		0.97 × Nominal ^b	
	mils mm		mils (0.98 x nominal) mm		mils (1.01 x nominal) mm		mils (0.99 x nominal) mm		cmil mm ²		cmil mm ²		cmil mm ²	
AWG														
56	0.49	0.0124	0.48	0.0122	0.495	0.0126	0.485	0.0123	0.240	0.000122	0.235	0.000119	—	—
55	0.55	0.0140	0.54	0.0137	0.556	0.0141	0.545	0.0138	0.302	0.000153	0.296	0.000150	—	—
54	0.62	0.0157	0.61	0.0154	0.63	0.0159	0.614	0.0156	0.384	0.000195	0.376	0.000191	—	—
53	0.70	0.0178	0.69	0.0174	0.71	0.0180	0.69	0.0176	0.490	0.000248	0.480	0.000243	—	—
52	0.78	0.0198	0.76	0.0194	0.79	0.0200	0.77	0.0196	0.608	0.000308	0.596	0.000302	—	—
51	0.88	0.0224	0.86	0.0219	0.89	0.0226	0.87	0.0221	0.774	0.000392	0.759	0.000384	—	—
50	0.99	0.0251	0.97	0.0246	1.00	0.0254	0.98	0.0249	0.980	0.000497	0.960	0.000487	—	—
49	1.11	0.0282	1.09	0.0276	1.12	0.0285	1.10	0.0279	1.23	0.000624	1.21	0.000611	—	—
48	1.24	0.0315	1.22	0.0309	1.25	0.0318	1.23	0.0312	1.54	0.000779	1.51	0.000765	—	—
47	1.40	0.0356	1.37	0.0348	1.41	0.0359	1.39	0.0352	1.96	0.000993	1.92	0.000973	—	—
46	1.57	0.0399	1.54	0.0391	1.59	0.0403	1.55	0.0395	2.46	0.00125	2.41	0.00122	—	—
45	1.76	0.0447	1.73	0.0438	1.78	0.0452	1.74	0.0443	3.10	0.00157	3.04	0.00154	—	—
44	2.0	0.051	1.96	0.050	2.02	0.0513	1.98	0.050	4.00	0.00203	3.92	0.00199	—	—
43	2.2	0.056	2.16	0.055	2.22	0.0564	2.18	0.055	4.84	0.00245	4.74	0.00240	—	—
42	2.5	0.064	2.45	0.062	2.53	0.0641	2.48	0.063	6.25	0.00317	6.13	0.00310	—	—
AWG														
41	2.8	0.071	2.7	0.070	2.83	0.072	2.77	0.070	7.84	0.00397	7.68	0.00389	—	—
40	3.1	0.079	3.0	0.077	3.13	0.080	3.07	0.078	9.61	0.00487	9.42	0.00477	—	—
39	3.5	0.089	3.4	0.087	3.54	0.090	3.47	0.088	12.2	0.00621	12.0	0.00606	—	—

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
									Nominal		Minimum			
	Nominal		0.98 × Nominal ^a		0.97 × Nominal ^b									
	mils	mm	mils (0.98 x nominal)	mm	mils (1.01 x nominal)	mm	mils (0.99 x nominal)	mm	cmil	mm ²	cmil	mm ²	cmil	mm ²
38	4.0	0.102	3.9	0.100	4.04	0.103	3.96	0.101	16.0	0.00811	15.7	0.00795	—	—
37	4.5	0.144	4.4	0.112	4.55	0.115	4.46	0.113	20.2	0.0103	19.8	0.0100	—	—
36	5.0	0.127	4.9	0.125	5.05	0.128	4.95	0.126	25.0	0.0127	24.5	0.0124	—	—
35	5.6	0.142	5.5	0.139	5.7	0.144	5.5	0.141	31.4	0.0159	30.8	0.0156	—	—
34	6.3	0.160	6.2	0.157	6.4	0.162	6.2	0.158	39.7	0.0201	38.9	0.0197	—	—
33	7.1	0.180	7.0	0.177	7.2	0.182	7.0	0.179	50.4	0.0255	49.4	0.0250	—	—
32	8.0	0.203	7.8	0.199	8.1	0.205	7.9	0.201	64.0	0.0324	62.7	0.0318	—	—
31	8.9	0.226	8.7	0.222	9.0	0.228	8.8	0.224	79.2	0.0401	77.6	0.0393	—	—
30	10.0	0.254	9.8	0.249	10.1	0.257	9.9	0.251	100	0.0507	98	0.0497	—	—
29	11.3	0.287	11.1	0.282	11.4	0.290	11.2	0.284	128	0.0647	125	0.0633	—	—
28	12.6	0.320	12.3	0.312	12.7	0.323	12.5	0.318	159	0.0804	156	0.0790	—	—
27	14.2	0.361	13.9	0.353	14.3	0.363	14.1	0.358	202	0.102	198	0.100	—	—
26	15.9	0.404	15.6	0.396	16.1	0.409	15.7	0.399	253	0.128	248	0.126	—	—
25	17.9	0.455	17.5	0.444	18.1	0.460	17.7	0.450	320	0.162	314	0.159	—	—
24	20.1	0.511	19.7	0.500	20.3	0.516	19.9	0.506	404	0.205	396	0.201	392	0.199
23	22.6	0.574	22.1	0.561	22.8	0.579	22.4	0.568	511	0.259	501	0.254	496	0.251
22	25.3	0.643	24.8	0.630	25.6	0.650	25.0	0.635	640	0.324	627	0.318	621	0.314
21	28.5	0.724	27.9	0.709	28.8	0.732	28.2	0.717	812	0.412	796	0.404	788	0.400
20	32.0	0.813	31.4	0.798	32.3	0.820	31.7	0.805	1020	0.519	1000	0.509	989	0.503
19	35.9	0.912	35.2	0.894	36.3	0.922	35.5	0.902	1290	0.653	1264	0.641	1251	0.633

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
									Nominal		Minimum			
	Nominal		Minimum ^c		Maximum ^c		Minimum ^d				0.98 × Nominal ^a		0.97 × Nominal ^b	
	mils	mm	mils (0.98 x nominal)	mm	mils (1.01 x nominal)	mm	mils (0.99 x nominal)	mm	cmil	mm ²	cmil	mm ²	cmil	mm ²
18	40.3	1.02	39.5	1.00	40.7	1.03	39.9	1.01	1620	0.823	1588	0.807	1571	0.798
17	45.3	1.15	44.4	1.13	45.8	1.16	44.8	1.14	2050	1.04	2009	1.02	1989	1.01
16	50.8	1.29	49.8	1.26	51.3	1.30	50.3	1.28	2580	1.31	2528	1.28	2503	1.27
15	57.1	1.45	56.0	1.42	57.7	1.47	56.5	1.44	3260	1.65	3195	1.62	3162	1.60
14	64.1	1.63	62.8	1.60	64.7	1.64	63.5	1.61	4110	2.08	4028	2.04	3987	2.02
13	72.0	1.83	70.6	1.79	72.7	1.85	71.3	1.81	5180	2.63	5076	2.58	5025	2.55
12	80.8	2.05	79.2	2.01	81.6	2.07	80.0	2.03	6530	3.31	6399	3.24	6334	3.21
11	90.7	2.30	88.9	2.26	91.6	2.33	89.8	2.28	8230	4.17	8065	4.09	7983	4.04
AWG														
10	101.9	2.588	99.9	2.537	102.9	2.614	100.9	2.563	10380	5.261	10172	5.16	10069	5.103
9	114.4	2.906	112.1	2.847	115.5	2.934	113.3	2.878	13090	6.631	12828	6.50	—	—
8	128.5	3.264	125.9	3.198	129.8	3.297	127.2	3.231	16510	8.367	16180	8.20	—	—
7	144.3	3.665	141.4	3.592	145.7	3.701	142.9	3.630	20820	10.55	20404	10.34	—	—
6	162.0	4.115	158.8	4.034	163.6	4.155	160.4	4.074	26240	13.30	25715	13.03	—	—
5	181.9	4.620	178.3	4.529	183.7	4.666	180.1	4.575	33090	16.77	32428	16.43	—	—
4	204.3	5.189	200.2	5.085	206.3	5.240	202.3	5.138	41740	21.15	40905	20.73	—	—
3	229.4	5.827	224.8	5.710	231.7	5.885	227.1	5.768	52620	26.67	51568	26.14	—	—
2	257.6	6.543	252.4	6.411	260.2	6.609	255.0	6.477	66360	33.62	65033	32.95	—	—
1	289.3	7.348	283.5	7.201	292.2	7.422	286.4	7.275	83690	42.41	82016	41.56	—	—
1/0	324.9	8.252	318.4	8.087	328.1	8.334	321.7	8.171	105600	53.49	103488	52.42	—	—
2/0	364.8	9.266	357.5	9.080	368.4	9.357	361.2	9.174	133100	67.43	130438	66.08	—	—

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
									Nominal		Minimum			
	Nominal		0.98 × Nominal ^a		0.97 × Nominal ^b									
	Nominal		Minimum ^c		Maximum ^c		Minimum ^d		Nominal		0.98 × Nominal ^a		0.97 × Nominal ^b	
			mils (0.98 x nominal)		mils (1.01 x nominal)		mils (0.99 x nominal)							
	mils	mm		mm		mm		mm	cmil	mm ²	cmil	mm ²	cmil	mm ²
3/0	409.6	10.40	401.4	10.20	413.7	10.51	405.5	10.30	167800	85.01	164444	83.31	—	—
4/0	460.0	11.68	450.8	11.45	464.6	11.80	455.4	11.57	211600	107.2	207368	105.1	—	—
kcmil									kcmil		kcmil			
250	—	—	—	—	—	—	—	—	250	127	245	124.1	—	—
300	—	—	—	—	—	—	—	—	300	152	294	149.0	—	—
350	—	—	—	—	—	—	—	—	350	177	343	173.8	—	—
400	—	—	—	—	—	—	—	—	400	203	392	198.6	—	—
450	—	—	—	—	—	—	—	—	450	228	441	223.5	—	—
500	—	—	—	—	—	—	—	—	500	253	490	248.3	—	—
550	—	—	—	—	—	—	—	—	550	279	539	273.1	—	—
600	—	—	—	—	—	—	—	—	600	304	588	297.9	—	—
650	—	—	—	—	—	—	—	—	650	329	637	322.8	—	—
700	—	—	—	—	—	—	—	—	700	355	686	347.6	—	—
750	—	—	—	—	—	—	—	—	750	380	735	372.4	—	—
800	—	—	—	—	—	—	—	—	800	405	784	397.2	—	—
900	—	—	—	—	—	—	—	—	900	456	882	446.9	—	—
1000	—	—	—	—	—	—	—	—	1000	507	980	496.6	—	—
1100	—	—	—	—	—	—	—	—	1100	557	1078	546.2	—	—
1200	—	—	—	—	—	—	—	—	1200	608	1176	595.9	—	—
kcmil									kcmil		kcmil			
1250	—	—	—	—	—	—	—	—	1250	633	1225	620.7	—	—
1300	—	—	—	—	—	—	—	—	1300	659	1274	645.5	—	—

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
									Nominal		Minimum			
	0.98 × Nominal ^a		0.97 × Nominal ^b											
	mils	mm	mils (0.98 x nominal)	mm	mils (1.01 x nominal)	mm	mils (0.99 x nominal)	mm			cmil	mm ²	cmil	mm ²
1400	—	—	—	—	—	—	—	—	1400	709	1372	695.2	—	—
1500	—	—	—	—	—	—	—	—	1500	760	1470	744.9	—	—
1600	—	—	—	—	—	—	—	—	1600	811	1568	794.5	—	—
1700	—	—	—	—	—	—	—	—	1700	861	1666	844.2	—	—
1750	—	—	—	—	—	—	—	—	1750	887	1715	869.0	—	—
1800	—	—	—	—	—	—	—	—	1800	912	1764	893.8	—	—
1900	—	—	—	—	—	—	—	—	1900	963	1862	943.5	—	—
2000	—	—	—	—	—	—	—	—	2000	1013	1960	993.1	—	—

^a The minimums in this column apply to flexible cord and fixture wire conductors composed of 29 – 20 AWG strands. Except where specified otherwise in the wire standard, the minimums in this column also apply to solid and stranded wires and cables (regardless of strand size).

^b For conductors in flexible cords and fixture wires in which the conductors are composed of 36 – 30 AWG strands, the minimums in this column apply.

^c The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.

^d The values in this column apply where the wire standard specifies only a minimum diameter for the conductor.

Table 20.2
Diameters over round compact-stranded conductors

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inch	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
12 AWG	0.085	2.16	0.083	2.11	0.086	2.18
11	0.095	2.41	0.093	2.36	0.096	2.44
10	0.107	2.72	0.105	2.67	0.108	2.74
9	0.120	3.05	0.118	3.00	0.121	3.07
8	0.134	3.40	0.131	3.23	0.135	3.43
7	0.152	3.86	0.149	3.78	0.154	3.91
6	0.169	4.29	0.166	4.22	0.171	4.34
5	0.191	4.85	0.187	4.75	0.193	4.90
4	0.213	5.41	0.209	5.31	0.215	5.46
3 AWG	0.238	6.02	0.233	5.92	0.240	6.10
2	0.268	6.81	0.263	6.68	0.271	6.88
1	0.299	7.59	0.293	7.44	0.302	7.67
1/0	0.336	8.53	0.329	8.36	0.339	8.61
2/0	0.376	9.55	0.368	9.35	0.380	9.65
3/0	0.423	10.74	0.415	10.54	0.427	10.85
4/0	0.475	12.07	0.466	11.84	0.480	12.19
250 kcmil	0.520	13.21	0.510	12.95	0.525	13.34
300	0.570	14.48	0.559	14.20	0.576	14.63
350	0.616	15.65	0.604	15.34	0.622	15.80
400	0.659	16.74	0.646	16.41	0.666	16.92
450	0.700	17.78	0.686	17.42	0.707	17.96
500	0.736	18.69	0.721	18.31	0.743	18.87
550	0.775	19.69	0.760	19.30	0.783	19.89
600	0.813	20.65	0.797	20.24	0.821	20.85
650	0.845	21.46	0.828	21.03	0.853	21.67
700	0.877	22.28	0.859	21.82	0.886	22.50
750	0.908	23.06	0.890	22.61	0.917	23.29
800	0.938	23.83	0.919	23.34	0.947	24.05
900	0.999	25.37	0.979	24.87	1.009	25.63
1000	1.060	26.92	1.039	26.39	1.071	27.20

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.

Table 20.3
Diameters over round compressed concentric-lay-stranded ASTM Classes B, C, and D aluminum,
uncoated copper, and coated copper conductors

Conductor size	Nominal ^b		Minimum ^c		Maximum ^c	
	inch	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
14 AWG	0.071 ^a	1.80 ^a	0.070	1.79	0.072	1.83
13	0.080 ^a	2.03 ^a	0.078	1.98	0.081	2.06
12	0.089	2.26	0.087	2.21	0.090	2.29
11	0.100	2.54	0.098	2.49	0.101	2.57
10	0.113	2.87	0.111	2.82	0.114	2.90
9	0.126	3.20	0.123	3.12	0.127	3.23
8	0.142	3.61	0.139	3.53	0.143	3.63
7	0.159	4.04	0.156	3.96	0.161	4.09
6	0.178	4.52	0.174	4.42	0.180	4.57
5	0.200	5.08	0.196	4.98	0.202	5.13
4	0.225	5.72	0.221	5.61	0.227	5.77
3	0.252	6.40	0.247	6.27	0.255	6.48
2	0.283	7.19	0.277	7.04	0.286	7.26
1	0.322	8.18	0.316	8.03	0.325	8.26
1/0	0.362	9.19	0.355	9.02	0.366	9.30
2/0	0.405	10.3	0.397	10.08	0.409	10.39
3/0	0.456	11.6	0.447	11.35	0.461	11.71
4/0	0.512	13.0	0.502	12.75	0.517	13.13
250 kcmil	0.558	14.2	0.547	13.89	0.564	14.33
300	0.611	15.5	0.599	15.21	0.617	15.67
350	0.661	16.8	0.648	16.46	0.668	16.97
400	0.706	17.9	0.692	17.58	0.713	18.11
450	0.749	19.0	0.734	18.64	0.756	19.20
500	0.789	20.0	0.773	19.63	0.797	20.24
550	0.829	21.1	0.812	20.62	0.837	21.26
600	0.866	22.0	0.849	21.56	0.875	22.23
650	0.901	22.9	0.883	22.43	0.910	23.11
700	0.935	23.7	0.916	23.27	0.944	23.98
750	0.968	24.6	0.949	24.10	0.978	24.84
800	1.000	25.4	0.980	24.89	1.010	25.65
900	1.060	26.9	1.039	26.39	1.071	27.20

Table 20.3 Continued on Next Page

Table 20.3 Continued

Conductor size	Nominal ^b		Minimum ^c		Maximum ^c	
	inch	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
1000	1.117	28.4	1.095	27.81	1.128	28.65
1100	1.173	29.8	1.150	29.21	1.185	30.10
1200 kcmil	1.225	31.1	1.200	30.48	1.237	31.42
1250	1.250	31.8	1.225	31.12	1.262	32.05
1300	1.275	32.4	1.250	31.75	1.288	32.72
1400	1.323	33.6	1.297	32.94	1.336	33.93
1500	1.370	34.8	1.343	34.11	1.384	35.15
1600	1.415	35.9	1.387	35.23	1.429	36.30
1700	1.459	37.1	1.430	36.32	1.474	37.44
1750	1.480	37.6	1.450	36.83	1.495	37.97
1800	1.502	38.2	1.472	37.39	1.517	38.53
1900	1.542	39.2	1.511	38.38	1.557	39.55
2000	1.583	40.2	1.551	39.40	1.599	40.61

^a Aluminum is for use in the 12 AWG – 2000 kcmil sizes, not in the 14 and 13 AWG sizes.

^b In no case is the diameter of a compressed-stranded conductor to be more than 3 percent smaller than the diameter of the conductor determined after the conductor is assembled and before it is compressed.

^c The values in these two columns apply where the wire standard (power principally) specifies maximum and minimum diameters for the conductor.

Table 20.3.1
Diameters over round compressed unilay-stranded ASTM Class B aluminum, uncoated copper, and coated copper conductors

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
1 AWG	0.313	7.95	0.307	7.80	0.316	8.03
1/0	0.352	8.94	0.345	8.76	0.356	9.04
2/0	0.395	10.03	0.387	9.83	0.399	10.13
3/0	0.443	11.25	0.434	11.02	0.447	11.35
4/0	0.498	12.65	0.488	12.40	0.503	12.78
250 kcmil	0.542	13.77	0.531	13.49	0.547	13.89
300	0.594	15.09	0.582	14.78	0.600	15.24
350	0.641	16.28	0.628	15.95	0.647	16.43
400	0.685	17.40	0.671	17.04	0.692	17.58
450	0.727	18.47	0.712	18.08	0.734	18.64

Table 20.3.1 Continued on Next Page

Table 20.3.1 Continued

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
500	0.766	19.46	0.751	19.08	0.774	19.66
550	0.804	20.42	0.788	20.02	0.812	20.62
600	0.840	21.34	0.823	20.90	0.848	21.54
650 kcmil	0.874	22.20	0.857	21.77	0.883	22.43
700	0.907	23.04	0.889	22.58	0.916	23.27
750	0.939	23.85	0.920	23.37	0.948	24.08
800	0.969	24.61	0.950	24.13	0.979	24.87
900	1.028	26.11	1.007	25.58	1.038	26.37
1000	1.084	27.53	1.062	26.97	1.095	27.81
1100	1.137	28.88	1.114	28.30	1.148	29.16
1200	1.187	30.15	1.163	29.54	1.199	30.45
1250	1.212	30.78	1.188	30.18	1.224	31.09
1300	1.236	31.39	1.211	30.76	1.248	31.70
1400	1.282	32.56	1.256	31.90	1.295	32.89
1500	1.327	33.71	1.300	33.02	1.340	34.04
1600	1.371	34.82	1.344	34.14	1.385	35.18
1700	1.413	35.89	1.385	35.18	1.427	36.25
1750	1.434	36.42	1.405	35.69	1.448	36.78
1800	1.454	36.93	1.425	36.20	1.469	37.31
1900	1.494	37.95	1.464	37.19	1.509	38.33
2000	1.533	38.94	1.502	38.15	1.548	39.32

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor. Otherwise, in no case is the diameter of a compressed-stranded conductor to be more than 3 percent smaller than the diameter of the conductor determined after the conductor is assembled and before it is compressed.

Table 20.4
Diameters over ASTM Class B round concentric-lay-stranded conductors

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
30 AWG	0.0113	0.287	0.0111	0.282	0.0114	0.290
29	0.0128	0.325	0.0125	0.318	0.0129	0.328
28	0.0143	0.363	0.0140	0.356	0.0144	0.356
27	0.0161	0.409	0.0158	0.401	0.0163	0.414
26	0.0180	0.457	0.0176	0.447	0.0182	0.462
25	0.0203	0.516	0.0199	0.505	0.0205	0.521
24	0.0228	0.579	0.0223	0.566	0.0230	0.584
23	0.0256	0.650	0.0251	0.638	0.0259	0.658
22 AWG	0.0287	0.729	0.0281	0.714	0.0290	0.737
21	0.0323	0.820	0.0317	0.805	0.0326	0.828
20	0.0362	0.919	0.0355	0.902	0.0366	0.930
19	0.0407	1.03	0.0399	1.013	0.0411	1.044
18	0.0456	1.16	0.0447	1.135	0.0461	1.171
17	0.0513	1.30	0.0502	1.275	0.0518	1.315
16	0.0576	1.46	0.0564	1.433	0.0582	1.478
15	0.0647	1.64	0.0635	1.613	0.0653	1.659
14	0.0727	1.85	0.0712	1.81	0.0734	1.86
13	0.0816	2.07	0.0800	2.03	0.0824	2.09
12	0.0915	2.32	0.0897	2.28	0.0924	2.35
11	0.103	2.62	0.101	2.57	0.104	2.64
10	0.116	2.95	0.114	2.90	0.117	2.97
9	0.130	3.30	0.127	3.23	0.131	3.33
8	0.146	3.71	0.143	3.63	0.147	3.73
7	0.164	4.17	0.161	4.09	0.166	4.22
6	0.184	4.67	0.180	4.57	0.186	4.72
5	0.206	5.23	0.201	5.11	0.208	5.28
4	0.232	5.89	0.227	5.77	0.234	5.94
3	0.260	6.60	0.255	6.48	0.263	6.68
2	0.292	7.42	0.286	7.26	0.295	7.49
1	0.332	8.43	0.325	8.26	0.335	8.51
1/0	0.372	9.45	0.365	9.27	0.376	9.55
2/0	0.418	10.62	0.410	10.41	0.422	10.72

Table 20.4 Continued on Next Page

Table 20.4 Continued

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
3/0	0.470	11.94	0.461	11.71	0.475	12.07
4/0	0.528	13.41	0.517	13.13	0.533	13.54
250 kcmil	0.575	14.61	0.564	14.33	0.581	14.76
300	0.630	16.00	0.617	15.67	0.636	16.15
350	0.681	17.30	0.667	16.94	0.688	17.48
400	0.728	18.49	0.713	18.11	0.735	18.67
450	0.772	19.61	0.757	19.23	0.780	19.81
500	0.813	20.65	0.797	20.24	0.821	20.85
550	0.855	21.72	0.838	21.29	0.864	21.95
600	0.893	22.68	0.875	22.23	0.902	22.91
650 kcmil	0.929	23.60	0.910	22.86	0.938	23.83
700	0.964	24.49	0.945	24.00	0.974	24.74
750	0.998	25.35	0.978	24.84	1.008	25.60
800	1.030	26.16	1.009	25.63	1.040	26.42
900	1.094	27.79	1.072	27.23	1.105	28.07
1000	1.152	29.26	1.129	28.68	1.164	29.57
1100	1.209	30.71	1.185	30.10	1.221	31.01
1200	1.263	32.08	1.238	31.45	1.276	32.41
1250	1.289	32.74	1.263	32.08	1.302	33.07
1300	1.314	33.38	1.288	32.72	1.327	33.71
1400	1.365	34.67	1.338	33.99	1.379	35.03
1500	1.412	35.86	1.384	35.15	1.426	36.22
1600	1.459	37.06	1.430	36.32	1.474	37.44
1700	1.504	38.20	1.474	37.44	1.519	38.58
1750	1.526	38.76	1.495	37.97	1.541	39.14
1800	1.548	39.32	1.517	38.53	1.563	39.70
1900	1.590	40.39	1.558	39.57	1.606	40.79
2000	1.632	41.45	1.599	40.61	1.648	41.86

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.

Table 20.4.1
Diameters over ASTM Class C round concentric-lay-stranded conductors

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	Inches	mm	Inches (0.98 x nominal)	mm	Inches (1.01 x nominal)	mm
30 AWG	0.0115	0.292	0.0113	0.338	0.0116	0.295
29	0.0130	0.330	0.0127	0.323	0.0131	0.333
28	0.0145	0.368	0.0142	0.361	0.0146	0.371
27	0.0163	0.414	0.0160	0.406	0.0165	0.419
26	0.0182	0.465	0.0178	0.452	0.0184	0.467
25	0.0205	0.521	0.0201	0.511	0.0207	0.526
24	0.0230	0.584	0.0225	0.572	0.0232	0.589
23	0.0259	0.658	0.0254	0.645	0.0262	0.665
22	0.0290	0.737	0.0284	0.721	0.0293	0.744
21 AWG	0.0327	0.830	0.0320	0.813	0.0330	0.838
20	0.0365	0.927	0.0358	0.909	0.0369	0.937
19	0.0412	1.046	0.0404	1.026	0.0416	1.057
18	0.0460	1.168	0.0451	1.146	0.0465	1.181
17	0.0519	1.318	0.0509	1.293	0.0524	1.331
16	0.0585	1.486	0.0573	1.455	0.0591	1.501
15	0.0655	1.664	0.0642	1.631	0.0662	1.681
14	0.0735	1.867	0.0720	1.829	0.0743	1.887
13	0.0825	2.096	0.0850	2.159	0.0833	2.116
12	0.0925	2.350	0.0907	2.304	0.0934	2.372
11 AWG – 2000 kcmil	b	b	b	b	b	b

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.
^b Use [Table 20.4](#).

Table 20.5
Nominal dimensions of round strands

AWG size of strand	Diameter		Cross-sectional area	
	Mils	mm	cmil	mm ²
40	3.1	0.079	9.61	0.00487
39	3.5	0.089	12.2	0.00621
38	4.0	0.102	16.0	0.00811
37	4.5	0.144	20.2	0.0103
36	5.0	0.127	25.0	0.0127

Table 20.5 Continued on Next Page

Table 20.5 Continued

AWG size of strand	Diameter		Cross-sectional area	
	Mils	mm	cmil	mm ²
35	5.6	0.142	31.4	0.0159
34	6.3	0.160	39.7	0.0201
33	7.1	0.180	50.4	0.0255
32	8.0	0.203	64.0	0.0324
31	8.9	0.226	79.2	0.0401
30	10.0	0.254	100	0.0507
29	11.3	0.287	128	0.0647
28	12.6	0.320	159	0.0804
27	14.2	0.361	202	0.102
26	15.9	0.404	253	0.128
25	17.9	0.455	320	0.162
24	20.1	0.511	404	0.205
23	22.6	0.574	511	0.259
22	25.3	0.643	640	0.324
21	28.5	0.724	812	0.412
20	32.0	0.813	1020	0.519

Table 20.6
Nominal strand and conductor dimensions for 19-wire combination round-wire unilay-stranded copper or aluminum conductors

AWG conduc tor size	Nominal strand dimensions								Conductor diameter					
	Large strand				Small strand				E = 3A + 2C Nominal		F = 0.98 x E Minimum ^a		G = 1.01 x E Maximum ^a	
	A Diameter		B Cross-sectional area		C Diameter		D Cross-sectional area							
	inch	mm	cmil	mm ²	inch	mm	cmil	mm ²	inch	mm	inch	mm	inch	mm
14	0.0159	0.4	253	0.128	0.0117	0.3	137	0.069	0.071	1.80	0.70	1.78	0.72	1.83
12	0.0201	0.5	404	0.205	0.0147	0.4	216	0.109	0.090	2.29	0.88	2.24	0.091	2.31
10	0.0253	0.6	640	0.324	0.0185	0.5	342	0.173	0.113	2.87	1.11	2.87	0.114	2.90
9	0.0284	0.7	807	0.408	0.0208	0.5	433	0.219	0.127	3.23	0.127	3.14	0.128	3.25
8	0.0319	0.8	1018	0.515	0.0234	0.6	548	0.277	0.143	3.63	1.40	3.56	0.144	3.66
7	0.0358	0.9	1282	0.649	0.0262	0.67	686	0.347	0.160	4.06	0.157	3.99	0.162	4.11
6	0.0402	1.0	1616	0.818	0.0294	0.7	864	0.437	0.179	4.55	0.175	4.45	0.181	4.60
5	0.0452	1.1	2043	1.034	0.0331	0.8	1096	0.555	0.202	5.13	0.198	5.03	0.204	5.18
4	0.0507	1.3	2570	1.301	0.0371	0.9	1376	0.696	0.226	5.74	0.221	5.61	0.228	5.79
3	0.0570	1.4	3249	1.644	0.0417	1.1	1739	0.880	0.254	6.45	0.249	6.32	0.257	6.53
2	0.0640	1.6	4096	2.073	0.0468	1.2	2190	1.108	0.286	7.26	0.280	7.11	0.289	7.34
1	0.0718	1.8	5155	2.609	0.0526	1.3	2767	1.400	0.321	8.15	0.316	8.03	0.324	8.23
1/0	0.0807	2.1	6512	3.296	0.0591	1.5	3493	1.768	0.360	9.14	0.353	8.97	0.364	9.25
2/0	0.0906	2.3	8208	4.154	0.0663	1.7	4396	2.225	0.404	10.26	0.396	10.06	0.408	10.36
3/0	0.1017	2.6	10343	5.234	0.0745	1.9	5550	2.809	0.454	11.53	0.445	11.30	0.459	11.66
4/0	0.1142	2.9	13042	6.600	0.0836	2.1	6989	3.537	0.510	12.95	0.500	12.70	0.515	13.08

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.

21 thru 29 *Reserved for Future Use*

30 D-C Conductor Resistance

30.1 The specifications for this test are located in the DC Resistance Test in the Standard for Wire and Cable Test Methods, UL 2556.

30.2 The requirements for the various materials and constructions are found in [Table 30.1](#) – [Table 30.11](#).

30.3 For conductor material not defined in [Table 30.1](#) – [Table 30.11](#) having 100 percent conductivity, the maximum resistance shall be the same as the uncoated copper.

Table 30.1
Maximum direct-current resistance of solid conductors of aluminum, copper-clad aluminum, and uncoated copper

AWG size of conductor	20°C				25°C			
	Aluminum and copper-clad aluminum		Uncoated copper		Aluminum and copper-clad aluminum		Uncoated copper	
	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m
56	–	–	44064	144574	–	–	44880	147251
55	–	–	34986	114789	–	–	35700	117132
54	–	–	27540	90359	–	–	28050	92032
53	–	–	21624	70948	–	–	22032	72287
52	–	–	17340	56893	–	–	17748	58231
51	–	–	13668	44845	–	–	13974	45849
50	–	–	10812	35474	–	–	11016	36144
49	–	–	8588	28179	–	–	8752	28714
48	–	–	6885	22500	–	–	7018	23025
47	–	–	5396	17704	–	–	5508	18072
46	–	–	4294	14089	–	–	4376	14357
45	–	–	3417	11211	–	–	3478	11412
44	–	–	2642	8668	–	–	2693	8835
43	–	–	2183	7162	–	–	2224	7296
42	–	–	1693	5555	–	–	1724	5656
41	–	–	1346	4418	–	–	1377	4518
40	–	–	1102	3614	–	–	1122	3681
39	–	–	864	2835	–	–	880	2888
38	–	–	661	2169	–	–	674	2212
37	–	–	522	1713	–	–	532	1747
36	–	–	423	1389	–	–	431	1416

Table 30.1 Continued on Next Page

Table 30.1 Continued

AWG size of conductor	20°C				25°C			
	Aluminum and copper-clad aluminum		Uncoated copper		Aluminum and copper-clad aluminum		Uncoated copper	
	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m
35	—	—	338	1108	—	—	344	1128
34	—	—	266	873	—	—	271	890
33	—	—	210	689	—	—	214	703
32	—	—	165	542	—	—	168	552
31	—	—	134	438	—	—	137	448
30	—	—	106	347	—	—	108	354
29	—	—	82.8	271	—	—	84.5	277
28	109	358	66.6	218	111	364	67.9	223
27	85.9	282	52.4	172	87.6	287	53.4	175
26	68.6	225	41.8	138	70.0	230	42.6	140
25	54.1	178	33.0	108	55.3	181	33.7	110
24	43.0	141	26.2	85.9	43.8	144	26.7	87.6
23	33.9	111	20.7	67.9	34.6	114	21.1	69.3
22	27.1	88.9	16.5	54.3	27.6	90.6	16.8	55.3
21	21.5	70.5	13.1	42.7	21.8	71.5	13.3	43.6
20	16.9	55.4	10.3	33.9	17.2	56.6	10.5	34.6
19	13.5	44.2	8.21	26.9	13.7	45.0	8.37	27.4
18	10.7	35.1	6.52	21.4	10.9	35.7	6.64	21.8
17	8.45	27.7	5.15	16.9	8.61	28.2	5.25	17.2
16	6.72	22.0	4.10	13.5	6.85	22.5	4.18	13.7
15	5.31	17.4	3.24	10.6	5.41	17.8	3.30	10.8
14	4.21	13.8	2.57	8.45	4.30	14.1	2.62	8.61
13	3.35	11.0	2.04	6.69	3.41	11.2	2.08	6.82
12	2.65	8.71	1.62	5.31	2.71	8.89	1.65	5.42
11	2.11	6.92	1.29	4.22	2.15	7.06	1.32	4.30
10	1.670	5.479	1.019	3.343	1.703	5.590	1.038	3.408
9	1.325	4.347	0.8084	2.652	1.352	4.435	0.8242	2.704
8	1.051	3.446	0.6407	2.102	1.071	3.515	0.6532	2.143
7	0.8328	2.733	0.5081	1.667	0.8497	2.788	0.5181	1.699
6	0.6609	2.168	0.4031	1.323	0.6741	2.211	0.4110	1.348
5	0.5242	1.720	0.3197	1.049	0.5361	1.754	0.3260	1.070
4	0.4155	1.363	0.2535	0.8315	0.4239	1.390	0.2585	0.8478

Table 30.1 Continued on Next Page

Table 30.1 Continued

AWG size of conductor	20°C				25°C			
	Aluminum and copper-clad aluminum		Uncoated copper		Aluminum and copper-clad aluminum		Uncoated copper	
	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m
3	0.3296	1.081	0.2010	0.6595	0.3362	1.103	0.2050	0.6725
2	0.2613	0.8574	0.1594	0.5231	0.2666	0.8747	0.1626	0.5333
1	0.2073	0.6798	0.1264	0.4146	0.2113	0.6935	0.1289	0.4228
1/0	0.1643	0.5390	0.1002	0.3287	0.1676	0.5499	0.1022	0.3353
2/0	0.1304	0.4275	0.07949	0.2608	0.1329	0.4362	0.08105	0.2659
3/0	0.1033	0.3392	0.06306	0.2069	0.1055	0.3460	0.06429	0.2109
4/0	0.08196	0.2689	0.04999	0.1640	0.08361	0.2743	0.05098	0.1673

Table 30.2

Maximum direct-current resistance of solid copper conductors coated with tin or a tin/lead alloy

AWG Size of Conductor	20°C		25°C	
	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m
56	45792	150244	46640	153026
55	36358	119291	37100	121725
54	28620	93902	29150	95641
53	22472	73731	22896	75122
52	18020	59124	18444	60515
51	19504	63993	14522	47747
50	11236	36865	11448	37561
49	8925	29284	9095	29840
48	7155	23476	7293	23928
47	5607	18398	5724	18780
46	4468	14642	4547	14920
45	3551	11651	3615	11860
44	2745	9008	2798	9182
43	2268	7443	2311	7582
42	1760	5773	1791	5878
41	1399	4591	1431	4695
40	1145	3756	1166	3826
39	898	2946	915	3001
38	687	2254	701	2299
37	543	1781	553	1815

Table 30.2 Continued on Next Page



Documents

Document Sharing Hub

Table 30.2 Continued

AWG Size of Conductor	20°C		25°C	
	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m
36	440	1443	448	1471
35	351	1151	357	1172
34	277	908	282	925
33	218	716	223	730
32	172	563	175	574
31	139	456	142	466
30	110	361	112	368
29	86.1	282	87.8	289
28	69.3	227	70.6	232
27	54.5	179	55.6	182
26	43.5	143	44.3	145
25	34.4	112	35.0	115
24	27.3	89.3	27.8	91.1
23	21.5	70.6	22.0	72.0
22	17.2	56.4	17.5	57.5
21	13.6	44.4	13.8	45.3
20	10.7	35.2	10.9	36.0
19	8.54	28.0	8.70	28.6
18	6.77	22.2	6.91	22.7
17	5.37	17.6	5.47	17.9
16	4.26	14.0	4.35	14.2
15	3.38	11.1	3.44	11.2
14	2.68	8.78	2.72	8.96
13	2.12	6.97	2.16	7.10
12	1.68	5.53	1.71	5.64
11	1.34	4.39	1.37	4.48
10	1.060	3.476	1.080	3.545
9	0.8319	2.730	0.8483	2.784
8	0.6594	2.163	0.6724	2.206
7	0.5229	1.716	0.5332	1.749
6	0.4148	1.361	0.4230	1.388
5	0.3291	1.079	0.3356	1.101
4	0.2608	0.8559	0.2660	0.8727

Table 30.2 Continued on Next Page



Documents
Document Sharing Hub

Table 30.2 Continued

AWG Size of Conductor	20°C		25°C	
	Ohms per 1000 ft	Ohms per 1000 m	Ohms per 1000 ft	Ohms per 1000 m
3	0.2069	0.6788	0.2109	0.6922
2	0.1641	0.5384	0.1673	0.5489
1	0.1300	0.4268	0.1326	0.4352
1/0	0.1026	0.3367	0.1047	0.3433
2/0	0.08140	0.2670	0.08300	0.2723
3/0	0.06457	0.2119	0.06583	0.2160
4/0	0.05119	0.1680	0.05219	0.1713

Table 30.3

Maximum direct-current resistance of aluminum, copper-clad aluminum, and compact-stranded aluminum conductors and uncoated copper conductors: concentric-stranded ASTM Classes B, C, and D, compact-stranded, and compressed-stranded

Size of conductor	20°C				25°C			
	Aluminum and copper-clad aluminum		Uncoated copper		Aluminum and copper-clad aluminum		Uncoated copper	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
30 AWG	—	—	108	354	—	—	110	361
29	—	—	84.3	277	—	—	86.0	282
28	111	364	67.9	223	113	371	69.2	227
27	87.6	287	53.4	175	89.4	293	54.5	179
26	70.0	230	42.7	140	71.3	234	43.5	143
25	55.3	181	33.7	111	56.4	185	34.4	113
24	43.8	144	26.7	87.6	44.6	146	27.2	89.2
23	34.6	114	21.1	69.2	35.3	116	21.5	70.5
22	27.7	90.9	16.9	55.4	28.2	92.5	17.2	56.4
21	21.8	71.5	13.3	43.6	22.1	72.5	13.5	44.3
20	17.4	57.1	10.6	34.6	17.7	58.1	10.8	35.3
19	13.7	44.9	8.36	27.4	14.0	45.9	8.53	28.0
18	10.9	35.8	6.66	21.8	11.1	36.4	6.79	22.2
17	8.68	28.5	5.27	17.3	8.86	29.1	5.37	17.6
16	6.87	22.5	4.18	13.7	7.00	23.0	4.26	14.0
15	5.41	17.8	3.31	10.9	5.53	18.1	3.37	11.1
14	4.30	14.1	2.62	8.62	4.38	14.4	2.68	8.78
13	3.41	11.2	2.08	6.82	3.48	11.4	2.12	6.97
12	2.71	8.88	1.65	5.43	2.76	9.07	1.68	5.53

Table 30.3 Continued on Next Page

Table 30.3 Continued

Size of conductor	20°C				25°C			
	Aluminum and copper-clad aluminum		Uncoated copper		Aluminum and copper-clad aluminum		Uncoated copper	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
11	2.15	7.07	1.32	4.30	2.19	7.20	1.34	4.39
10	1.70	5.589	1.039	3.409	1.738	5.702	1.060	3.476
9 AWG	1.35	4.434	0.8245	2.705	1.379	4.524	0.8407	2.758
8	1.07	3.515	0.6535	2.144	1.092	3.585	0.6663	2.186
7	0.8495	2.787	0.5182	1.700	0.8666	2.844	0.5284	1.734
6	0.6740	2.211	0.4112	1.348	0.6876	2.256	0.4192	1.375
5	0.5346	1.754	0.3261	1.070	0.5454	1.789	0.3325	1.091
4	0.4238	1.390	0.2585	0.8481	0.4324	1.419	0.2636	0.8649
3	0.3361	1.103	0.2050	0.6727	0.3429	1.125	0.2091	0.6860
2	0.2665	0.8745	0.1626	0.5335	0.2719	0.8922	0.1659	0.5440
1	0.2113	0.6934	0.1289	0.4230	0.2156	0.7074	0.1315	0.4313
1/0	0.1676	0.5498	0.1022	0.3354	0.1710	0.5609	0.1042	0.3419
2/0	0.1329	0.4361	0.08108	0.2660	0.1356	0.4450	0.08267	0.2712
3/0	0.1055	0.3459	0.06431	0.2110	0.1075	0.3529	0.06558	0.2151
4/0	0.08360	0.2743	0.05099	0.1673	0.08528	0.2798	0.05200	0.1705
250 kcmil	0.07076	0.2322	0.04316	0.1416	0.07219	0.2368	0.04401	0.1444
300	0.05897	0.1935	0.03597	0.1180	0.06015	0.1974	0.03667	0.1204
350	0.05054	0.1659	0.03082	0.1011	0.05156	0.1691	0.03144	0.1031
400	0.04423	0.1450	0.02698	0.08851	0.04511	0.1480	0.02751	0.09024
450	0.03931	0.1289	0.02398	0.07867	0.04010	0.1316	0.02445	0.08021
500	0.03537	0.1161	0.02158	0.07080	0.03609	0.1184	0.02200	0.07220
550	0.03216	0.1055	0.01961	0.06436	0.03281	0.1076	0.02000	0.06563
600	0.02948	0.09673	0.01798	0.05900	0.03008	0.09867	0.01834	0.06016
650	0.02721	0.08928	0.01660	0.05447	0.02776	0.09109	0.01692	0.05553
700	0.02527	0.08291	0.01541	0.05057	0.02578	0.08458	0.01572	0.05157
750	0.02358	0.07738	0.01438	0.04721	0.02406	0.07894	0.01467	0.04812
800	0.02211	0.07254	0.01348	0.04425	0.02255	0.07400	0.01375	0.04512
900	0.01966	0.06448	0.01199	0.03933	0.02005	0.06578	0.01222	0.04011
1000	0.01769	0.05804	0.01079	0.03540	0.01804	0.05920	0.01101	0.03610
1100	0.01609	0.05275	0.009809	0.03218	0.01640	0.05383	0.01000	0.03281
1200	0.01474	0.04836	0.008992	0.02950	0.01503	0.04934	0.009169	0.03008
1250	0.01415	0.04643	0.008632	0.02833	0.01443	0.04736	0.008802	0.02888

Table 30.3 Continued on Next Page



Documents
Document Sharing Hub

Table 30.3 Continued

Size of conductor	20°C				25°C			
	Aluminum and copper-clad aluminum		Uncoated copper		Aluminum and copper-clad aluminum		Uncoated copper	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
1300	0.01357	0.04465	0.008230	0.02723	0.01388	0.04554	0.008463	0.02776
1400	0.01264	0.04145	0.007707	0.02529	0.01289	0.04229	0.007859	0.02579
1500	0.01179	0.03869	0.007193	0.02360	0.01203	0.03947	0.007335	0.02406
1600	0.01106	0.03627	0.006744	0.02212	0.01128	0.03701	0.006877	0.02256
1700 kcmil	0.01040	0.03414	0.006347	0.02083	0.01062	0.03482	0.006472	0.02124
1750	0.01011	0.03316	0.006166	0.02023	0.01031	0.03383	0.006287	0.02062
1800	0.009827	0.03224	0.005995	0.01967	0.01003	0.03290	0.006112	0.02005
1900	0.009310	0.03055	0.005679	0.01864	0.009497	0.03116	0.005791	0.01900
2000	0.008844	0.02902	0.005395	0.01770	0.009023	0.02960	0.005501	0.01804

Table 30.4
Maximum direct-current resistance of copper conductors, concentric-stranded ASTM Class B with each strand coated with tin or a tin/lead alloy and compressed-stranded ASTM Class B with each strand coated

Size of Conductor	20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
30 AWG	116	381	118	387
29	90.5	297	92.3	303
28	72.8	239	74.3	244
27	57.3	188	58.5	192
26	45.8	150	46.7	153
25	36.2	119	36.9	121
24	28.7	94.2	29.2	95.8
23	22.7	74.5	23.1	75.8
22	18.1	59.4	18.5	60.7
21	14.3	46.9	14.5	47.6
20	11.2	36.7	11.4	37.4
19	8.88	29.1	9.06	29.7
18	7.06	23.2	7.19	23.6
17	5.59	18.3	5.70	18.7
16	4.45	14.6	4.53	14.9
15	3.44	11.3	3.51	11.5
14	2.73	8.96	2.78	9.14

Table 30.4 Continued on Next Page

Table 30.4 Continued

Size of Conductor	20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
13	2.16	7.10	2.20	7.24
12	1.72	5.64	1.75	5.75
11	1.37	4.48	1.39	4.56
10	1.080	3.546	1.102	3.615
9	0.8574	2.813	0.8742	2.868
8 AWG	0.6795	2.230	0.6929	2.274
7	0.5389	1.768	0.5495	1.802
6	0.4276	1.403	0.4359	1.430
5	0.3392	1.113	0.3458	1.134
4	0.2689	0.8820	0.2742	0.8993
3	0.2132	0.6996	0.2175	0.7133
2	0.1691	0.5548	0.1724	0.5657
1	0.1340	0.4398	0.1367	0.4485
1/0	0.1063	0.3487	0.1084	0.3556
2/0	0.08432	0.2766	0.08598	0.2820
3/0	0.06688	0.2194	0.06820	0.2238
4/0	0.05248	0.1722	0.05352	0.1755
250 kcmil	0.04488	0.1473	0.04577	0.1501
300	0.03740	0.1227	0.03814	0.1252
350	0.03206	0.1052	0.03270	0.1072
400	0.02776	0.09109	0.02831	0.09288
450	0.02467	0.08097	0.02516	0.08256
500	0.02222	0.07287	0.02264	0.07431
550	0.02040	0.06693	0.02080	0.06825
600	0.01871	0.06135	0.01907	0.06257
650	0.01709	0.05606	0.01742	0.05715
700	0.01586	0.05205	0.01618	0.05307
750	0.01481	0.04858	0.01510	0.04953
800	0.01388	0.04554	0.01416	0.04644
900	0.01234	0.04048	0.01259	0.04128
1000	0.01111	0.03643	0.01132	0.03715
1100	0.01010	0.03312	0.01029	0.03377
1200	0.009254	0.03037	0.009436	0.03096

Table 30.4 Continued on Next Page



Documents
Document Sharing Hub

Table 30.4 Continued

Size of Conductor	20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
1250	0.008884	0.02915	0.009059	0.02972
1300	0.008543	0.02803	0.008711	0.02858
1400 kcmil	0.007933	0.02602	0.008089	0.02654
1500	0.007403	0.02429	0.007549	0.02477
1600	0.006941	0.02278	0.007078	0.02322
1700	0.006533	0.02143	0.006661	0.02186
1750	0.006346	0.02082	0.006471	0.02123
1800	0.006171	0.02024	0.006291	0.02063
1900	0.005845	0.01918	0.005960	0.01955
2000	0.005552	0.01822	0.005662	0.01857

Table 30.5

Maximum direct-current resistance of copper conductors, concentric-stranded ASTM Classes C and D with each strand coated with tin or a tin/lead alloy and compressed-stranded ASTM Classes C and D with each strand coated

Size of conductor	Class C				Class D			
	20°C		25°C		20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
30 AWG	116	381	118	387	116	381	118	387
29	90.5	297	92.3	303	90.5	297	92.3	303
28	72.8	239	74.3	244	72.8	239	74.3	244
27	57.3	188	58.5	192	57.3	188	58.5	192
26	45.8	150	46.7	153	45.8	150	46.7	153
25	36.2	119	36.9	121	36.2	119	36.9	121
24	28.7	94.2	29.2	95.8	28.7	94.2	29.2	95.8
23	22.7	74.5	23.1	75.8	22.7	74.5	23.1	75.8
22	18.1	59.4	18.5	60.7	18.1	59.4	18.5	60.7
21	14.3	46.9	14.5	47.6	14.3	46.9	14.5	47.6
20	11.4	37.4	11.6	38.1	11.4	37.4	11.6	38.1
19	8.98	29.5	9.16	30.1	8.98	29.5	9.16	30.1
18	7.15	23.5	7.29	23.9	7.15	23.5	7.29	23.9
17	5.65	18.5	5.76	18.9	5.65	18.5	5.76	18.9
16	4.44	14.6	4.53	14.9	4.49	14.7	4.58	15.0
15	3.52	11.5	3.58	11.7	3.55	11.6	3.62	11.9
14	2.78	9.15	2.85	9.32	2.82	9.25	2.89	9.42

Table 30.5 Continued on Next Page



Documents

Document Sharing Hub

Table 30.5 Continued

Size of conductor	Class C				Class D			
	20°C		25°C		20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
13	2.21	7.26	2.25	7.41	2.21	7.26	2.25	7.41
12	1.75	5.75	1.78	5.88	1.75	5.75	1.78	5.88
11	1.37	4.48	1.39	4.56	1.40	4.57	1.42	4.66
10 AWG	1.08	3.55	1.10	3.62	1.10	3.62	1.12	3.69
9	0.857	2.82	0.874	2.87	0.875	2.88	0.892	2.93
8	0.679	2.23	0.692	2.27	0.679	2.23	0.693	2.27
7	0.539	1.76	0.550	1.81	0.539	1.76	0.550	1.81
6	0.427	1.41	0.436	1.43	0.427	1.41	0.436	1.43
5	0.339	1.11	0.346	1.13	0.339	1.11	0.346	1.13
4	0.269	0.882	0.274	0.900	0.269	0.882	0.274	0.900
3	0.213	0.700	0.217	0.713	0.213	0.700	0.217	0.713
2	0.169	0.555	0.172	0.566	0.169	0.555	0.172	0.566
1	0.134	0.440	0.137	0.449	0.134	0.440	0.137	0.449
1/0	0.106	0.349	0.108	0.355	0.106	0.349	0.108	0.355
2/0	0.0844	0.276	0.0860	0.282	0.0844	0.276	0.0860	0.282
3/0	0.0669	0.219	0.0681	0.223	0.0669	0.219	0.0681	0.223
4/0	0.0530	0.174	0.0541	0.177	0.0530	0.174	0.0541	0.177
250 kcmil	0.0449	0.147	0.0458	0.150	0.0449	0.147	0.0458	0.150
300	0.0374	0.122	0.0381	0.125	0.0374	0.122	0.0381	0.125
350	0.0320	0.105	0.0326	0.107	0.0320	0.105	0.0326	0.107
400	0.0280	0.0920	0.0286	0.0938	0.0280	0.0920	0.0286	0.0938
450	0.0249	0.0818	0.0254	0.0834	0.0249	0.0818	0.0254	0.0834
500	0.0224	0.0736	0.0228	0.0751	0.0224	0.0736	0.0228	0.0751
550	0.0204	0.0669	0.0208	0.0682	0.0204	0.0669	0.0208	0.0682
600	0.0187	0.0614	0.0191	0.0625	0.0187	0.0614	0.0191	0.0625
650	0.0172	0.0566	0.0176	0.0577	0.0172	0.0566	0.0176	0.0577
700	0.0160	0.0526	0.0163	0.0537	0.0160	0.0526	0.0163	0.0537
750	0.0150	0.0491	0.0153	0.0501	0.0150	0.0491	0.0153	0.0501
800	0.0141	0.0460	0.0143	0.0469	0.0141	0.0460	0.0143	0.0469
900	0.0124	0.0409	0.0128	0.0417	0.0124	0.0409	0.0128	0.0417
1000	0.0111	0.0364	0.0113	0.0371	0.0112	0.0368	0.0114	0.0375
1100	0.0102	0.0335	0.0104	0.0342	0.0102	0.0335	0.0104	0.0342

Table 30.5 Continued on Next Page

Table 30.5 Continued

Size of conductor	Class C				Class D			
	20°C		25°C		20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
1200	0.00935	0.0307	0.00954	0.0313	0.00935	0.0307	0.00954	0.0313
1250	0.00898	0.0295	0.00915	0.0300	0.00898	0.0295	0.00915	0.0300
1300	0.00863	0.0284	0.00880	0.0289	0.00863	0.0284	0.00880	0.0289
1400	0.00794	0.0260	0.00809	0.0265	0.00802	0.0263	0.00817	0.0268
1500	0.00741	0.0243	0.00755	0.0248	0.00748	0.0246	0.00763	0.0250
1600 kcmil	0.00702	0.0231	0.00715	0.0235	0.00702	0.0231	0.00715	0.0235
1700	0.00660	0.0216	0.00673	0.0220	0.00660	0.0216	0.00673	0.0220
1750	0.00642	0.0210	0.00654	0.0214	0.00642	0.0210	0.00654	0.0214
1800	0.00617	0.0202	0.00629	0.0206	0.00623	0.0205	0.00635	0.0208
1900	0.00584	0.0192	0.00596	0.0196	0.00591	0.0194	0.00602	0.0198
2000	0.00555	0.0183	0.00566	0.0186	0.00561	0.0184	0.00572	0.0188

Table 30.6
Maximum direct-current resistance of 19-wire combination round-wire unilay-stranded copper conductors

Metal coating of strands	AWG size of conductors	20°C		25°C	
		Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
Each	14	2.78	9.15	2.85	9.32
	13	2.21	7.26	2.25	7.41
	12	1.75	5.75	1.78	5.88
	11	1.37	4.48	1.39	4.56
	10	1.08	3.55	1.10	3.62
Strand	9	0.857	2.82	0.874	2.87
	8	0.679	2.23	0.692	2.27
	7	0.539	1.76	0.550	1.81
	6	0.427	1.41	0.436	1.43
	5	0.339	1.11	0.346	1.13
Coated	4	0.269	0.882	0.274	0.900
	3	0.213	0.700	0.217	0.713
	2	0.169	0.555	0.172	0.566
	1	0.1340	0.4398	0.1367	0.4485
	1/0	0.1063	0.3487	0.1084	0.3556
	2/0	0.08432	0.2766	0.08598	0.2820

Table 30.6 Continued on Next Page

Table 30.6 Continued

Metal coating of strands	AWG size of conductors	20°C		25°C	
		Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
Each	3/0	0.06688	0.2194	0.06820	0.2238
	4/0	0.05248	0.1722	0.05352	0.1755
	14	2.62	8.62	2.68	8.78
	13	2.08	6.82	2.12	6.97
	12	1.65	5.43	1.68	5.53
	11	1.32	4.30	1.34	4.39
	10	1.039	3.409	1.060	3.476
	9	0.8245	2.705	0.8407	2.758
	8	0.6535	2.144	0.6663	2.186
	7	0.5182	1.700	0.5284	1.734
	6	0.4122	1.348	0.4192	1.375
	5	0.3261	1.070	0.3225	1.091
	4	0.2585	0.8481	0.2636	0.8649
	3	0.2050	0.6727	0.2091	0.6860
	2	0.1626	0.5335	0.1659	0.5440
	1	0.1289	0.4230	0.1315	0.4313
Uncoated	1/0	0.1022	0.3354	0.1042	0.3419
	2/0	0.08108	0.2660	0.08267	0.2712
	3/0	0.06431	0.2110	0.06558	0.2151
	4/0	0.05099	0.1673	0.05200	0.1705

Table 30.6A
Maximum direct-current resistance of 19-wire combination round-wire unilay-stranded aluminum conductors

AWG size of conductor	20°C		25°	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
6	0.6716	2.204	0.6852	2.248
5	0.5326	1.748	0.5436	1.784
4	0.4224	1.386	0.4309	1.414
3	0.3351	1.100	0.3418	1.121
2	0.2656	0.8714	0.2710	0.8892
1	0.2107	0.6913	0.2149	0.7051
1/0	0.1671	0.5483	0.1705	0.5594
2/0	0.1325	0.4347	0.1351	0.4433
3/0	0.1051	0.3448	0.1072	0.3517
4/0	0.08332	0.2734	0.08501	0.2789

Table 30.7
Maximum direct-current resistance of ASTM Class G stranded conductors

Size of Conductor	Uncoated copper				Coated copper (each strand coated with tin or a tin/lead alloy)				Aluminum			
	20°C		25°C		20°C		25°C		20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
14 AWG	2.65	8.70	2.70	8.86	2.82	9.24	2.87	9.41	—	—	—	—
13	2.10	6.90	2.14	7.03	2.23	7.33	2.28	7.47	—	—	—	—
12	1.67	5.48	1.70	5.58	1.77	5.81	1.81	5.93	—	—	—	—
11	1.32	4.35	1.35	4.42	1.40	4.61	1.43	4.70	—	—	—	—
10	1.05	3.45	1.07	3.51	1.11	3.66	1.13	3.73	—	—	—	—
9	0.832	2.73	0.849	2.78	0.884	2.90	0.902	2.96	—	—	—	—
8	0.660	2.16	0.673	2.20	0.701	2.30	0.715	2.35	—	—	—	—
7	0.523	1.71	0.533	1.75	0.545	1.79	0.555	1.82	0.858	2.82	0.875	2.88
6	0.415	1.37	0.423	1.39	0.431	1.42	0.441	1.45	0.680	2.23	0.695	2.27
5	0.329	1.08	0.336	1.10	0.343	1.12	0.349	1.14	0.540	1.77	0.551	1.81
4	0.261	0.857	0.266	0.873	0.271	0.890	0.276	0.908	0.428	1.41	0.437	1.43
3	0.207	0.679	0.211	0.693	0.215	0.707	0.219	0.720	0.340	1.11	0.347	1.13
2	0.164	0.539	0.167	0.550	0.170	0.560	0.174	0.571	0.369	0.883	0.274	0.901
1	0.132	0.431	0.134	0.440	0.137	0.449	0.140	0.457	0.215	0.707	0.220	0.721
1/0	0.104	0.342	0.106	0.349	0.108	0.355	0.110	0.362	0.170	0.560	0.174	0.571
2/0	0.0826	0.271	0.0843	0.276	0.0860	0.282	0.0876	0.288	0.136	0.445	0.139	0.454
3/0	0.0656	0.215	0.0668	0.219	0.0681	0.223	0.0696	0.228	0.107	0.353	0.109	0.360
4/0	0.0520	0.170	0.0530	0.174	0.0541	0.177	0.0552	0.181	0.0853	0.279	0.0869	0.286
250 kcmil	0.0443	0.145	0.0451	0.148	0.0460	0.151	0.0469	0.154	0.0725	0.238	0.0740	0.243
300	0.0368	0.121	0.0375	0.123	0.0384	0.125	0.0391	0.129	0.0604	0.198	0.0616	0.202
350	0.0316	0.104	0.0322	0.106	0.0328	0.108	0.0335	0.110	0.0518	0.170	0.0528	0.173

Table 30.7 Continued on Next Page

Table 30.7 Continued

Size of Conductor	Uncoated copper				Coated copper (each strand coated with tin or a tin/lead alloy)				Aluminum			
	20°C		25°C		20°C		25°C		20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
400	0.0276	0.0917	0.0282	0.0924	0.0288	0.0942	0.0293	0.0962	0.0453	0.149	0.0462	0.152
450	0.0246	0.0806	0.0251	0.0822	0.0255	0.0838	0.0260	0.0855	0.0403	0.132	0.0411	0.135
500	0.0221	0.0725	0.0225	0.0704	0.0230	0.0755	0.0235	0.0769	0.0362	0.119	0.0370	0.121
550 kcmil	0.0202	0.0663	0.0206	0.0675	0.0210	0.0690	0.0214	0.0703	0.0332	0.108	0.0338	0.111
600	0.0186	0.0607	0.0189	0.0619	0.0193	0.0631	0.0196	0.0644	0.0304	0.0996	0.0310	0.102
650	0.0171	0.0561	0.0174	0.0571	0.0177	0.0583	0.0182	0.0595	0.0280	0.0919	0.0286	0.0937
700	0.0159	0.0520	0.0162	0.0530	0.0165	0.0542	0.0168	0.0552	0.0260	0.0834	0.0265	0.0871
750	0.0148	0.0486	0.0151	0.0496	0.0154	0.0505	0.0157	0.0515	0.0243	0.0797	0.0248	0.0813
800	0.0139	0.0456	0.0142	0.0464	0.0145	0.0473	0.0147	0.0483	0.0227	0.0747	0.0233	0.0762
900	0.0123	0.0405	0.0125	0.0413	0.0129	0.0421	0.0131	0.0429	0.0202	0.0664	0.0206	0.0677
1000	0.0111	0.0364	0.0113	0.0371	0.0115	0.0379	0.0117	0.0387	0.0183	0.0598	0.0186	0.0610
1100	0.0101	0.0332	0.0103	0.0338	0.0105	0.0345	0.0107	0.0351	0.0165	0.0543	0.0169	0.0554
1200	0.00926	0.0304	0.00944	0.0310	0.00963	0.0316	0.00981	0.0322	0.0152	0.0498	0.0155	0.0508
1250	0.00888	0.0292	0.00906	0.0297	0.00924	0.0303	0.00942	0.0309	0.0146	0.0478	0.0149	0.0488
1300	0.00855	0.0280	0.00871	0.0286	0.00888	0.0292	0.00906	0.0297	0.0140	0.0460	0.0143	0.0469
1400	0.00794	0.0260	0.00809	0.0265	0.00825	0.0270	0.00842	0.0276	0.0131	0.0426	0.0133	0.0436
1500	0.00741	0.0243	0.00755	0.0248	0.00770	0.0253	0.00785	0.0258	0.0121	0.0398	0.0123	0.0406
1600	0.00701	0.0230	0.00715	0.0235	0.00729	0.0239	0.00744	0.0244	0.0115	0.0377	0.0117	0.0385
1700	0.00660	0.0216	0.00672	0.0220	0.00686	0.0225	0.00700	0.0230	0.0108	0.0355	0.0110	0.0362
1750	0.00641	0.0210	0.00654	0.0214	0.00666	0.0218	0.00679	0.0223	0.0105	0.0345	0.0107	0.0352
1800	0.00623	0.0204	0.00635	0.0208	0.00648	0.0212	0.00661	0.0216	0.0102	0.0335	0.0104	0.0342
1900	0.00591	0.0194	0.00602	0.0198	0.00614	0.0201	0.00626	0.0205	0.00968	0.0310	0.00987	0.0323
2000	0.00561	0.0184	0.00572	0.0188	0.00583	0.0192	0.00595	0.0195	0.00919	0.0302	0.00937	0.0308

Table 30.8
Maximum direct-current resistance of ASTM Class H stranded conductors

Size of Conductor	Uncoated copper				Coated copper (each strand coated with tin or a tin/lead alloy)				Aluminum			
	20°C		25°C		20°C		25°C		20°C		25°C	
	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m	Ohms per 1000 feet	Ohms per 1000 m
8 AWG	0.666	2.18	0.679	2.23	0.708	2.33	0.722	2.37	—	—	—	—
7	0.528	1.73	0.539	1.76	0.561	1.85	0.572	1.88	—	—	—	—
6	0.419	1.38	0.427	1.41	0.446	1.46	0.454	1.49	—	—	—	—
5	0.333	1.09	0.339	1.11	0.353	1.16	0.360	1.18	—	—	—	—
4	0.263	0.865	0.268	0.881	0.279	0.918	0.286	0.936	—	—	—	—
(wires)												
3	0.209	0.686	0.213	0.700	0.222	0.728	0.226	0.743	—	—	—	—
2 (133)	0.166	0.544	0.169	0.555	0.172	0.566	0.175	0.576	0.271	0.891	0.277	0.910
2 (259)	0.166	0.547	0.170	0.557	0.176	0.580	0.181	0.592	—	—	—	—
1	0.133	0.434	0.135	0.442	0.141	0.460	0.143	0.469	—	—	—	—
1/0	0.105	0.344	0.107	0.350	0.109	0.357	0.111	0.364	0.171	0.563	0.175	0.574
2/0	0.0830	0.272	0.0847	0.277	0.0864	0.284	0.0880	0.289	0.136	0.447	0.139	0.456
3/0 (259)	0.0659	0.216	0.0672	0.220	0.0685	0.224	0.0699	0.230	0.108	0.354	0.110	0.361
3/0 (427)	0.0662	0.217	0.0675	0.221	0.0703	0.231	0.0717	0.236	—	—	—	—
4/0 (259)	0.0522	0.171	0.0532	0.174	0.0544	0.179	0.0554	0.182	0.0857	0.280	0.0874	0.287
4/0 (427)	0.0525	0.172	0.0536	0.175	0.0546	0.180	0.0557	0.183	0.0861	0.283	0.0878	0.288
250 kcmil	0.0445	0.146	0.0453	0.149	0.0462	0.152	0.0471	0.155	0.0728	0.239	0.0743	0.244
300	0.0370	0.121	0.0377	0.123	0.0386	0.126	0.0393	0.129	0.0607	0.199	0.0619	0.203
350	0.0317	0.104	0.0323	0.106	0.0330	0.108	0.0337	0.110	0.0520	0.170	0.0530	0.174
400	0.0277	0.0911	0.0284	0.0929	0.0289	0.0948	0.0295	0.0966	0.0455	0.149	0.0464	0.152
450	0.0247	0.0810	0.0252	0.0826	0.0257	0.0843	0.0262	0.0859	0.0405	0.133	0.0413	0.136
500	0.0222	0.0729	0.0226	0.0744	0.0232	0.0758	0.0236	0.0773	0.0364	0.119	0.0371	0.122

Table 30.8 Continued on Next Page