



UL 758

STANDARD FOR SAFETY

Appliance Wiring Material

UL Standard for Safety for Appliance Wiring Material, UL 758

Third Edition, Dated May 2, 2014

Summary of Topics

This revision to ANSI/UL 758 dated July 3, 2024 includes the following changes in requirements:

- Conductor Material Clarification, Revised [Table 5.3](#)***
- Large, Bunch Stranded Conductors, Revised [Table 5.9](#)***
- Dielectric Test on Shielded Constructions, Revised [49.1](#)***
- Addition of Silvered Copper-Beryllium Alloy to [Table 5.3](#)***
- Addition of Silver and Nickel Coated Copper Alloy to [Table 5.3](#)***

Text that has been changed in any manner or impacted by ULSE'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 1, 2023, January 5, 2024, April 19, 2024, and April 26, 2024.

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 ULSE Inc. (ULSE).

ULSE 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 ULSE 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 ULSE or an authorized ULSE representative has been advised of the possibility of such damage. In no event shall ULSE'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 ULSE 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

MAY 2, 2014
(Title Page Reprinted: July 3, 2024)



ANSI/UL 758-2024

1

UL 758

Standard for Appliance Wiring Material

First Edition – July, 2000
Second Edition – April, 2006

Third Edition

May 2, 2014

This ANSI/UL Standard for Safety consists of the Third Edition including revisions through July 3, 2024.

The most recent designation of ANSI/UL 758 as an American National Standard (ANSI) occurred on July 3, 2024. 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 ULSE at any time. Proposals should be submitted via a Proposal Request in the 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.

© 2024 ULSE Inc. All rights reserved.

No Text on This Page

CONTENTS

INTRODUCTION

1	Scope	5
2	General	5
2.1	Components	5
2.2	Units of measurement	6
2.3	Undated references	6

CONSTRUCTION

3	General	7
4	Materials	15
5	Conductor	16
5.1	General	16
5.2	Metal	20
5.3	Size and cross-sectional area	28
5.4	Metal coating	29
5.5	Joints	30
5.6	Resistance	30
5.7	Stranding	31
5.8	Separator	33
5.9	Semi-conductive polymeric layer	34
6	Optical Fiber Member(s)	34
6.1	General	34
6.2	Cable composed of both current-carrying conductors and optical-fiber members	34
6.3	Cable composed entirely of optical-fiber members	34
7	Insulation	34
7.1	General	34
7.2	Materials	35
7.3	Thickness	39
8	Coverings	42
9	Fillers	44
10	Binders	44
11	Shield(s)	44
12	Cable Assembly	44
13	Overall Jacket	45
13.1	General	45
13.2	Materials	46
13.3	Thickness	46

PERFORMANCE

TESTS FOR THERMAL AND CHEMICAL PROPERTIES

14	Physical Properties, Unaged and Air Oven Aged	50
15	Physical Properties, Oil Immersion Aging	52
16	Physical Properties, Gasoline Conditioning	53
17	Physical Properties, Sunlight Resistance	54
18	Conductor Corrosion Test	54
19	Deformation Test (Thermoplastics and Class XL Only)	55
20	Flexibility Test of Nylon Covering	56
21	Flexibility Test	57

22	Heat Shock Test (Thermoplastic Materials Only)	58
23	Cold Bend Test	59
24	Delamination Test.....	60
25	Shrinkback Test – Special Rating TV Wires Only.....	60
26	Ozone Resistance Test – Special Rating TV Use Wires Only	61
27	Durability of Ink-Print Test	62

TESTS FOR MECHANICAL PROPERTIES

28	Crush Resistance Test.....	62
----	----------------------------	----

TESTS FOR ELECTRICAL PROPERTIES

29	Dielectric Test, Method I.....	63
30	Dielectric Test, Method II.....	65
31	Dielectric Test, Method III	66
32	High-Voltage DC Wire Dielectric Voltage-Withstand Test, Method I.....	66
33	High-Voltage DC Wire Dielectric Voltage-Withstand Test, Method II.....	67
34	High-Voltage Cut-Through Test, Special Rated TV Wire Only.....	68
35	Short Term Insulation-Resistance Test in Water at Room Temperature (Wet Rated AWM).....	70
36	Long Term Insulation-Resistance Test in Water at Elevated Temperature (Wet Rated AWM) ...	70
37	Temperature Correction Factor (Wet Rated AWM)	73
38	Capacitance and Relative Permittivity Tests (Wet Rated AWM)	75
39	Stability Factor (Wet Rated AWM).....	76

TESTS FOR FLAME PROPERTIES

40	Horizontal Flame Test for Internal Wiring	76
41	Cable Flame Test	76
42	VW-1 Flame Test.....	76
43	FT1 Flame Test	77
44	FT2 Flame Test	77
45	IEC 60332-1 Flame Test	77
46	IEC 60332-2 Flame Test	77

MANUFACTURING AND PRODUCTION TESTS

47	Test for Continuity of Conductors	78
48	Spark Test	78
	48.1 Appliance wiring material constructed of insulating materials other than laminated films and laminated constructions without uninsulated intervals	78
	48.2 Appliance wiring material constructed of laminated film insulating material with uninsulated intervals	79
48A	Cut-Piece Dielectric Voltage Withstand Test	80
49	Production-Line Dielectric Test	80

MARKINGS

50	Surface Marking of AWM	82
51	Markings on Tag, Reel, or Carton.....	82
52	Multiple Markings	84

INTRODUCTION

1 Scope

1.1 These requirements cover Appliance Wiring Material (AWM) in the form of single insulated conductors, multi-conductor cables, optical fibers, individual insulated conductors, and fiber optic members for use as components in multi-conductor cables.

1.2 The appliance wiring material covered by the requirements of this Standard are solely for use as factory-installed wiring either within the overall enclosure of appliances and other equipment (internal wiring) or as external interconnecting cable for appliances (external wiring), or for further processing as components in multi-conductor cables.

1.3 These requirements do not cover any wire, cable, or cord types that are presently covered in the National Electrical Code (NEC), NFPA 70, and are not intended for installation in buildings or structures in accordance with the NEC except within the scope of the installation instructions of the end-product for which their use is intended.

1.4 These requirements cover appliance wiring material with operating temperatures from a minimum 60°C (140°F) dry temperature rating and voltage ratings from a minimum 30-volt rating. Conductor size ranges from 50 AWG to 2000 kcmil. Appliance wiring material (AWM) composed entirely of optical fiber members or electrical conductors in combination with optical fiber members are also covered by these requirements.

1.5 These requirements do not cover the optical performance of any optical-fiber member or group of such members.

1.6 These requirements do not cover constructions which utilize flat, insulated conductors that are not laid parallel. The requirements for these products are found in the Standard for Flexible Materials Interconnect Constructions, UL 796F.

1.7 The evaluation of the performance of the semi-conductive polymeric layer described in [5.9](#) is not covered by this Standard.

1.8 In addition to these constructions, this Standard establishes guidelines for the evaluation of special constructions that, due to their specific end product use, are not required to meet all of the requirements for general construction AWM.

1.9 The final acceptance of AWM is dependent upon its use in complete equipment that conforms with the standards applicable to such equipment.

2 General

2.1 Components

2.1.1 Except as indicated in [2.1.2](#), a component of a product covered by this Standard shall comply with the requirements for that component.

2.1.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.1.5 Polymeric materials evaluated for its intended use, are not prohibited from being used in the insulation and jacket applications indicated in [Table 2.1](#).

Table 2.1
Polymeric materials for use in wire and cable and associated AWM ratings

AWM rating	Component	Minimum average thickness,		Compound's use or rating
		inch	(mm)	
Sunlight resistant	Insulation	0.030	0.76	Outer PVC or TPE insulation rated for 720 hours sunlight resistance
Sunlight resistant	Jacket	0.030	0.76	Outer PVC or TPE jacket rated for 720 hours sunlight resistance
60°C Wet	Insulation	0.030	0.76	PVC insulation rated for use in Type TW thermoplastic-insulated wire
60°C or 75°C Wet	Insulation	0.030	0.76	PVC insulation rated for use in Types THW or THHW thermoplastic-insulated wire
60°C or 75°C Wet	Insulation	0.015	0.38	PVC insulation rated for use in Type THWN thermoplastic-insulated wire
60°C, 75°C, or 90°C Wet	Insulation	0.015	0.38	PVC insulation rated for use in Type THWN-2 thermoplastic-insulated wire

2.2 Units of measurement

2.2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.2.2 Unless otherwise indicated, all voltage values mentioned in this Standard are root-mean-square (rms).

2.2.3 Equipment calibrated in metric units is to be used when a requirement is applied in metric terms.

2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

2.3.2 Wherever the designation "UL 1581" is used in this Standard, reference is to be made to the designated part(s) of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581. Wherever the designation "UL 62" is used in this Standard, reference is to be made to the designated part(s) of the Standard for Flexible Cords and Cables, UL 62.

CONSTRUCTION

3 General

3.1 The acceptability of an AWM for use in a specific end-product is based on the construction and flame rating of each individual construction.

3.2 [Table 3.1](#) – [Table 3.9](#) serve as indices to requirements for construction details and basic test methods for typical AWM constructions.

3.3 Coiled cables shall comply with the requirements specified in this Standard. All tests and measurements shall be conducted on specimens obtained from the straight ends at each end of the coiled portion of the cable. The straight ends shall have been subjected to the same heat conditioning as the coiled portion during the coiling process. In addition, the minimum average thickness and minimum thickness at any point of insulation and jacket shall be made on the coiled portion and shall meet the requirements specified for an uncoiled construction.

3.4 Wires or cables which have a restricted use are those installed where not subject to movement or mechanical abuse, or where totally enclosed.

3.5 A wire or cable for Class 2 use shall have a voltage rating less than or equal to 150 V AC or DC.

3.6 The high voltage DC wire described in [Table 3.6](#) and [Table 3.6A](#) shall have a minimum voltage rating of 3 kV DC. Wires with DC voltage rating less than 3 kV DC shall be evaluated in accordance with [Table 3.1](#).

Table 3.1
Single or multiple conductor with extruded insulation

Conductors:		
	Material	See Conductor, Section 5
	Size	See Conductor, Section 5
Insulation:		
	Material	See Insulation, Section 7
	Thickness	See Insulation, Section 7
Covering:		
	Material	See Coverings, Section 8
Markings:		See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel or Carton, Section 51
Basic tests: Physical Properties Unaged and Air Oven Aged, Section 14 . Conductor Corrosion Test, Section 18 Deformation Test (Thermoplastics and Class XL Only), Section 19 . Flexibility Test, Section. 21 . Heat Shock Test (Thermoplastic Materials Only), Section 22 . Cold Bend Test, Section 23 . Durability of Ink-Print Test, Section 27 Crush Resistance Test, Section 28 . Dielectric Test, Method I, Section 29 . Dielectric Test, Method II, Section 30 . Dielectric Test, Method III, Section 31 . Horizontal Flame Test for Internal Wiring, Section 40 . Elective tests/ratings: See Table 3.9		

Table 3.2
Single conductor with other-than-extruded insulation

Conductors:		
	Material	See Conductor, Section 5
	Size	See Conductor, Section 5
Insulation:		
	Material	See Insulation, Section 7
	Thickness	See Insulation, Section 7
Markings:		See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel or Carton, Section 51
Basic tests: Conductor Corrosion Test, Section 18 . Flexibility Test, Section 21 . Cold Bend Test, Section 23 .		

Table 3.2 Continued on Next Page

Table 3.2 Continued

Durability of Ink-Print Test, Section 27 Crush Resistance Test, Section 28 . Dielectric Test, Method I, Section 29 . Dielectric Test, Method II, Section 30 . Horizontal Flame Test for Internal Wiring, Section 40 .	
Elective tests/ratings:	See Table 3.9 .
†Laminated, flat ribbon cable is covered in Table 3.5 .	

Table 3.3
Single and parallel, multi-conductor cable with extruded integral insulation and jacket

Conductors:	Material	See Conductor, Section 5
	Size	See Conductor, Section 5
Integral insulation and jacket:	Material	See Insulation, Section 7 ; Overall Jacket, Section 13
	Thickness	See Insulation, Section 7 ; Overall Jacket, Section 13
Markings:	See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel or Carton, Section 51	
Basic tests: Physical Properties, Unaged and Air Oven Aged, Section 14 . Conductor Corrosion Test, Section 18 . Deformation Test (Thermoplastics and Class XL Only), Section 19 . Flexibility Test, Section 21 . Heat Shock Test (Thermoplastic Materials Only), Section 22 . Cold Bend Test, Section 23 . Durability of Ink-Print Test, Section 27 Dielectric Test, Method I, Section 29 . Dielectric Test, Method II, Section 30 . Dielectric Test, Method III, Section 31 . Horizontal Flame Test for Internal Wiring, Section 40 . Cable Flame Test, Section 41 .		
Elective tests/ratings:		See Table 3.9 .

Table 3.4
Single and multiple-conductor cable using non-integral jacket

Conductors:	Material	See Conductor, Section 5
	Size	See Conductor, Section 5

Table 3.4 Continued on Next Page

Table 3.4 Continued

Insulated conductors:	See Insulation, Section 7 The voltage and temperature rating of the cable shall not exceed the lowest rating of either the insulated conductors or the fiber optic members. Cables rated 60°C, 75°C, and 90°C wet shall use insulated conductors that comply with the applicable wet rating.
Covering:	
Material	See Coverings, Section 8
Shield:	See Shield(s), Section 11
Jacket:	
Material	See Overall Jacket, Section 13
Thickness	See Overall Jacket, Section 13
Markings:	See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel, or Carton, Section 51
Basic tests: Insulated conductors tested in accordance with Table 3.1 , Table 3.2 , Table 3.3 , or Table 3.5 . Physical Properties, Unaged and Air Oven Aged, Section 14 – Test jacket only. Deformation Test (Thermoplastics and Class XL Only), Section 19 . Flexibility Test, Section 21 . Heat Shock Test (Thermoplastic Materials Only), Section 22 . Cold Bend Test, Section 23 . Durability of Ink-Print Test, Section 27 . Horizontal Flame Test for Internal Wiring, Section 40 . Cable Flame Test, Section 41 . Elective tests/ratings: See Table 3.9 .	

Table 3.5
Bonded or laminated flat ribbon cable

Conductors:	
Material	See Conductor, Section 5
Size	See Conductor, Section 5
Insulation:	
Material	See Insulation, Section 7
Thickness	See Insulation, Section 7
Covering:	
Material	See Coverings, Section 8
Markings:	See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel, or Carton, Section 51
Basic tests: Physical Properties, Unaged and Air Oven Aged, Section 14 – Test bonded only. Conductor Corrosion Test, Section 18 . Deformation Test (Thermoplastics and Class XL Only), Section 19 . Flexibility Test, and Jacket, Section 21 .	

Table 3.5 Continued on Next Page

Table 3.5 Continued

Heat Shock Test (Thermoplastic Materials Only), Section [22](#).
Cold Bend Test, Section [23](#).
Durability of Ink-Print Test, Section [27](#).
Delamination Test (Laminated Constructions Only), Section [24](#).
Crush Resistance Test, Section [28](#).
Dielectric Test, Method I, Section [29](#).
Dielectric Test, Method II, Section [30](#).
Dielectric Test, Method III, Section [31](#).
Horizontal Flame Test for Internal Wiring, Section [40](#).

Elective tests/ratings:

See [Table 3.9](#).

Table 3.6
High voltage* DC wire with extruded insulation

Conductors:	Material	See Conductor, Section 5
	Size	See Conductor, Section 5
Insulation:	Material	See Insulation, Section 7 (solid insulation only)
	Thickness	See Insulation, Section 7
Covering:	Material	See Coverings, Section 8
Jacket:	Material	See Overall Jacket, Section 13
	Thickness	See Overall Jacket, Section 13
Markings:		See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel, or Carton, Section 51
Basic tests:		
Physical Properties, Unaged and Air Oven Aged, Section 14 .		
Conductor Corrosion Test, Section 18 .		
Deformation Test (Thermoplastics and Class XL Only), Section 19 .		
Flexibility Test, Section 21 .		
Heat Shock Test (Thermoplastic Materials Only), Section 22 .		
Shrinkback Test – Special Rating TV Wires Only, Section 25 .		
Ozone Resistance Test – Special Rating TV Use Wires Only, Section 26 .		
Durability of Ink-Print Test, Section 27 .		
Crush Resistance Test, Section 28 .		
High-Voltage DC Wire Dielectric Voltage-Withstand Test, Method I, Section 32 .		
High-Voltage DC Wire Dielectric Voltage-Withstand Test, Method II, Section 33 .		
High-Voltage Cut-Through Test, Special Rated TV Wire Only, Section 34 .		
Horizontal Flame Test for Internal Wiring, Section 40 .		
VW-1 Flame Test (required for TV wire), Section 41 .		
Elective tests/ratings:		See Table 3.9 .
*High voltage indicates wires rated 3kV DC or higher.		

Table 3.6A
High voltage* DC wire with other-than-extruded insulation

Conductors:		
	Material	See Conductor, Section 5
	Size	See Conductor, Section 5
Insulation:		
	Material	See Insulation, Section 7
	Thickness	See Insulation, Section 7

Table 3.6A Continued on Next Page

Table 3.6A Continued

Covering:	Material	See Coverings, Section 8
Jacket:	Material	See Overall Jacket, Section 13
	Thickness	See Overall Jacket, Section 13
Markings:		See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel, or Carton, Section 51
Basic tests:		
Conductor Corrosion Test, Section 18 .		
Flexibility Test, Section 21 .		
Shrinkback Test – Special Rating TV Wires Only, Section 25 .		
Ozone Resistance Test – Special Rating TV Use Wires Only, Section 26 .		
Durability of Ink-Print Test, Section 27 .		
Crush Resistance Test, Section 28 .		
High-Voltage DC Wire Dielectric Voltage-Withstand Test, Method I, Section 32 .		
High-Voltage DC Wire Dielectric Voltage-Withstand Test, Method II, Section 33 .		
High-Voltage Cut-Through Test, Special Rated TV Wire Only, Section 34 .		
Horizontal Flame Test for Internal Wiring, Section 40 .		
VW-1 Flame Test (required for TV wire), Section 41 .		
Elective tests/ratings:		See Table 3.9 .
*High voltage indicates wires rated 3kV DC or higher.		

Table 3.7
Fiber optic cables*

Optical fiber:	See Cable composed entirely of optical-fiber members, 6.3
Buffer:	
Material	See Cable composed entirely of optical-fiber members, 6.3
Thickness	See Cable composed entirely of optical-fiber members, 6.3
Covering:	
Material	See Coverings, Section 8
Jacket:	
Material	See Overall Jacket, Section 13
Thickness	See Overall Jacket, Section 13
Markings	See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel, or Carton, Section 51
Basic tests: Physical Properties, Unaged and Air Oven Aged, Section 14 . Deformation Test (Thermoplastics and Class XL Only), Section 19 . Flexibility Test, Section 21 . Heat Shock Test (Thermoplastic materials only), Section 22 . Cold Bend Test, Section 23 . Durability of Ink- Print Test, Section 27 . Horizontal Flame Test for Internal Wiring, Section 40 . VW-1 Flame Test (required for external use), Section 42 .	
*Cables covered by this table contain no current-carrying parts.	

Table 3.8
Single- and multiple-conductor cable employing a non-extruded covering as the outermost layer^s

Conductors:	
Material	See Conductor, Section 5
Size	See Conductor, Section 5
Insulated conductors:	
Material	See Insulation, Section 7
Thickness	See Insulation, Section 7
Shield:	See Shield(s), Section 11
Covering:	
Material	See Coverings, Section 8
Markings:	See Surface Marking of AWM, Section 50 , and Markings on Tag, Reel, or Carton, Section 51
Basic tests: Insulated conductors tested in accordance with Table 3.1 , Table 3.2 , Table 3.3 , or Table 3.5 . Flexibility Test, Section 21 .	

Table 3.8 Continued on Next Page

Table 3.8 Continued

Cold Bend Test, Section 23 .	
Durability of Ink-Print Test, Section 27 .	
Horizontal Flame Test for Internal Wiring, Section 40 .	
Elective tests/ratings:	See Table 3.9 .
^s Laminated flat ribbon cable is covered in Table 3.5 .	

**Table 3.9
Elective tests and ratings**

Flame tests:	VW-1 Flame Test, Section 42 . FT1 Flame Test, Section 43 . FT2 Flame Test, Section 44 . IEC 60332-1 Flame Test, Section 45 . IEC 60332-2 Flame Test, Section 46 .
Mechanical test:	Crush Resistance Test, Section 28 .
Sunlight resistance test:	Physical Properties, Sunlight Resistance, Section 17 .
Oil and gasoline resistance tests:	Physical Properties, Oil Immersion Aging, Section 15 . Physical Properties, Gasoline Conditioning, Section 16 .
Wet ratings tests:	Temperature Correction Factor (Wet Rated AWM), Section 37 . Capacitance and Relative Permittivity Tests (Wet Rated AWM), Section 38 . Stability Factor (Wet Rated AWM) Section 39 . Short Term Insulation-Resistance Test in Water at Room Temperature (Wet Rated AWM), Section 35 , required for all wet rated wires. Long Term Insulation-Resistance Test in Water at Elevated Temperature (Wet Rated AWM), Section 36 , at 50°C required for wires rated 60°C wet. Long Term Insulation-Resistance Test in Water at Elevated Temperature (Wet Rated AWM), Section 36 , at 75°C required for wires rated 75°C wet. Long Term Insulation-Resistance Test in Water at Elevated Temperature (Wet Rated AWM), Section 36 , at 90°C required for wires rated 90°C wet. Long Term Insulation-Resistance Test in Water at Elevated Temperature (Wet Rated AWM), Section 36 , at 100°C required for wires rated 100°C wet.

4 Materials

4.1 Each material used in AWM shall be compatible with all of the other materials used in the wire or cable.

4.2 Due to possible incompatibility, TPE materials of the styrenic type may not be suitable for use in cords whereby direct contact with PVC may occur. A separator is one acceptable means of avoiding direct contact. Other combinations of materials which could be incompatible, if any, are as yet undetected.

4.3 Due to possible incompatibility, uncoated copper, copper alloy, copper-clad aluminum, copper-clad steel, or other components with uncoated copper on the outer surface shall not be used in wire or cable whereby direct contact with aluminum may occur. A separator is one acceptable means of avoiding direct contact, or the copper components shall be metal-coated.

5 Conductor

5.1 General

5.1.1 A conductor consisting of a single wire is designated as a solid conductor, while one consisting of a number of individual wires is designated as a stranded conductor. The American Wire Gauge (AWG) numbers, the kcmil (thousands of circular mils) sizes, and the square-millimeter sizes each signify a definite nominal total cross-sectional area (see [Table 5.1](#) or [Table 5.2](#)) independent of the conductor material. The individual wires used in making up a stranded conductor are not required to correspond to any particular AWG or other standard gauge size. A tinsel conductor consists of a number of strands, twisted together, a portion of, or all strands being composed of one or more flattened wires of copper or copper alloy, helically wound on a fibrous polymeric thread. A conductor with a tubular cross-section and uniform wall thickness shall be of copper, and may be metal coated. A bus bar conductor consists of a single bar, or two or more bars stacked to form two or more layers, with each bar of solid rectangular cross-section with two plane, parallel surfaces and round or other simple regularly shaped edges. Fibrous yarns impregnated or coated with metal or other conductive materials may be used as a conductor, or may be assembled with other types of conductor strands to form a conductor. A carbon fiber filament conductor consists of a number of carbon fibers twisted together to form the conductor and the carbon fibers may be metal coated. A resistance wire is a conductor material used in products primarily as the source of heat based on a designed resistance per finished unit length. A magnet wire conductor shall consist of an enameled single conductor or an assembly of individually enameled wires which may be assembled or twisted together with an overall covering of film fiber, tape, or extruded compound to form a Litz wire. The magnet wire conductor shall have a minimum temperature rating of the AWM and be evaluated in accordance with the requirements in the Standard for Systems of Insulation Materials – General, UL 1446. The size of a conductor composed of or containing conductive fibrous yarns and resistance wires including carbon fiber filament conductors, a conductor of a tubular shape, or a bus bar conductor, and a magnet wire conductor shall be determined by conductor resistance described in [5.6.1](#). The circular mil area (CMA) of a rectangular conductor shall be determined from the formula:

$$\text{average width (mils)} \times \text{average thickness (mils)} \times 1.273$$

The AWG size can then be determined using [Table 5.1](#).

Table 5.1
Conductor dimensions

Size of conductor, AWG	Diameter of solid conductor				Cross-sectional area of stranded conductor			
	Nominal,		Minimum,		Nominal,		Minimum,	
	Mils	(mm)	Mils	(mm)	Cmils	(mm ²)	Cmils	(mm ²)
50	0.99	0.0251	0.98	0.025	0.980	0.000497	0.960	0.000486
49	1.11	0.0282	1.10	0.028	1.23	0.000624	1.21	0.000613
48	1.24	0.0315	1.23	0.031	1.54	0.000768	1.51	0.000765
47	1.40	0.0356	1.39	0.035	1.96	0.000993	1.92	0.000973
46	1.57	0.0399	1.55	0.039	2.46	0.00125	2.41	0.00122
45	1.76	0.0447	1.74	0.044	3.10	0.00157	3.04	0.00154
44	2.0	0.051	1.98	0.050	4.00	0.00203	3.92	0.00198
43	2.2	0.056	2.18	0.055	4.84	0.00245	4.74	0.00240
42	2.5	0.064	2.48	0.063	6.25	0.00317	6.13	0.003115
41	2.8	0.071	2.77	0.070	7.84	0.00397	7.68	0.00389

Table 5.1 Continued on Next Page

Table 5.1 Continued

Size of conductor, AWG	Diameter of solid conductor				Cross-sectional area of stranded conductor			
	Nominal,		Minimum,		Nominal,		Minimum,	
	Mils	(mm)	Mils	(mm)	Cmils	(mm ²)	Cmils	(mm ²)
40	3.1	0.079	3.07	0.078	9.61	0.00487	9.42	0.00477
39	3.5	0.089	3.47	0.088	12.2	0.00621	11.9	0.00603
38	4.0	0.102	3.96	0.101	16.0	0.00811	15.7	0.00796
37	4.5	0.114	4.46	0.113	20.2	0.0103	19.8	0.0100
36	5.0	0.127	4.95	0.126	25.0	0.0127	24.5	0.0124
35	5.6	0.142	5.54	0.141	31.4	0.0159	30.8	0.0156
34	6.3	0.160	6.24	0.158	39.7	0.020	38.9	0.0197
33	7.1	0.180	7.03	0.179	50.4	0.0255	49.4	0.0250
32	8.0	0.203	7.92	0.201	64.0	0.0324	62.7	0.0318
31	8.9	0.226	8.81	0.224	79.2	0.0401	77.6	0.0393
30	10.0	0.254	9.9	0.251	100	0.0507	98	0.0497
29	11.3	0.287	11.2	0.284	128	0.0647	125	0.0633
28	12.6	0.320	12.5	0.318	159	0.0804	156	0.0790
27	14.2	0.361	14.1	0.358	202	0.102	198	0.100
26	15.9	0.404	15.7	0.399	253	0.128	248	0.126
25	17.9	0.455	17.7	0.450	320	0.162	314	0.159
24	20.1	0.511	19.9	0.506	404	0.205	396	0.201
23	22.6	0.574	22.4	0.569	511	0.259	501	0.254
22	25.3	0.643	25.0	0.635	640	0.324	627	0.318
21	28.5	0.724	28.2	0.716	812	0.412	796	0.404
20	32.0	0.813	31.7	0.805	1020	0.519	1000	0.509
19	35.9	0.912	35.6	0.904	1290	0.653	1264	0.641
18	40.3	1.02	40.0	1.016	1620	0.823	1588	0.807
17	45.3	1.15	44.9	1.140	2050	1.04	2009	1.02
16	50.8	1.29	50.3	1.278	2580	1.31	2528	1.28
15	57.1	1.45	56.5	1.435	3260	1.65	3195	1.62
14	64.1	1.63	63.5	1.613	4110	2.08	4028	2.04
13	72.0	1.83	71	1.80	5180	2.63	5076	2.58
12	80.8	2.05	80	2.03	6530	3.31	6399	3.24
11	90.7	2.30	90	2.29	8230	4.17	8065	4.09
10	101.9	2.588	101	2.57	10380	5.261	10172	5.16
9	114.4	2.906	113	2.87	13090	6.631	12828	6.50
8	128.5	3.264	127	3.23	16510	8.367	16180	8.20
7	144.3	3.665	143	3.63	20820	10.55	20404	10.34
6	162.0	4.115	160	4.06	26240	13.30	25715	13.03
5	181.9	4.620	180	4.57	33090	16.77	32428	16.43
4	204.3	5.189	202	5.13	41740	21.15	40905	20.73
3	229.4	5.827	227	5.77	52620	26.67	51568	26.14

Table 5.1 Continued on Next Page

Table 5.1 Continued

Size of conductor, AWG	Diameter of solid conductor				Cross-sectional area of stranded conductor			
	Nominal,		Minimum,		Nominal,		Minimum,	
	Mils	(mm)	Mils	(mm)	Cmils	(mm ²)	Cmils	(mm ²)
2	257.6	6.543	255	6.48	66360	33.62	65033	32.95
1	289.3	7.348	286	7.26	83690	42.41	82016	41.56
1/0	324.9	8.252	322	8.18	105600	53.49	103488	52.42
2/0	364.8	9.226	361	9.17	133100	67.43	130438	66.08
3/0	409.6	10.40	406	10.31	167800	85.01	164444	83.31
4/0	460.0	11.68	455	11.56	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
1250	—	—	—	—	1250	633	1225	620.7
1300	—	—	—	—	1300	659	1274	645.5
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	1010	1960	993.1

Table 5.2
Conductor dimensions in metric sizes

Nominal cross-sectional area of conductor, mm ²	Minimum cross-sectional area of conductor, mm ²
0.01	0.0098
0.05	0.049
0.1	0.098
0.5	0.490
0.75	0.735
1.0	0.98
1.5	1.47
2.5	2.45
4	3.92
6	5.88
10	9.80
16	15.68
25	24.50
35	34.30
50	49.00
70	68.60
95	93.10
120	117.6
150	147.0
185	181.3
240	235.2
300	294.0
400	392.0
500	490.0
630	617.4
800	784.0
1000	980
1200	1176
1400	1372
1600	1568
1800	1764
2000	1960
2500	2450

5.1.2 A fibrous thread used within the conductor stranding and used as a reinforcing member to improve breaking strength is not prohibited from being used. The construction and arrangement of the threads is not specified.

5.1.3 *Deleted*

5.2 Metal

5.2.1 A solid or stranded conductor shall not be used where subjected to any temperature that exceeds that shown for the metal as indicated in the third column of [Table 5.3](#). The metal shall comply with the applicable ASTM specification, when specified, as indicated in [Table 5.3](#).

Table 5.3
Conductor – metal specifications

Conductor metal	ASTM reference for the metal	Temperature limit for the metal, °C (°F)	Other limits
Copper, uncoated, diameter of each strand or thickness of rectangular or tubular conductor less than 0.015 inch (0.38 mm)	ANSI/ASTM B 3	150 (302)	Uncoated conductor smaller than 0.0031 inch (0.079 mm) meet the elongation requirements as defined for conductors with a diameter of 0.0031 inch (0.079 mm) as shown in ASTM B 3)
Copper, uncoated, diameter of each strand or thickness of rectangular or tubular conductor at least 0.015 inch (0.38 mm)	ANSI/ASTM B 3	200 (392)	Uncoated conductor smaller than 0.0031 inch (0.079 mm) meet the elongation requirements as defined for conductors with a diameter of 0.0031 inch (0.079 mm) as shown in ASTM B 3.
Copper, tin-coated, diameter of each strand or thickness of rectangular or tubular conductor less than 0.015 inch (0.38 mm)	ANSI/ASTM B 33	150 (302)	Tin-coated conductor smaller than 0.0031 inch (0.079 mm) meet the elongation requirements as defined for conductors with a diameter of 0.0031 inch (0.079 mm) as shown in ASTM B33.
Copper, tin-coated, diameter of each strand or thickness of rectangular or tubular conductor at least 0.015 inch (0.38 mm)	ANSI/ASTM B 33	200 (392)	Tin-coated conductor smaller than 0.0031 inch (0.079 mm) meet the elongation requirements as defined for conductors with a diameter of 0.0031 inch (0.079 mm) as shown in ASTM B 33.
Copper, hard-drawn, uncoated, each strand less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 1	150 (302)	
Copper, hard-drawn, uncoated, each strand at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 1	200 (392)	
Copper, medium-hard-drawn, uncoated, each strand less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 2	150 (302)	
Copper, medium-hard-drawn, uncoated, each strand at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 2	200 (392)	
Copper, hard-drawn or medium-hard-drawn, tin coated, each strand less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 246	150 (302)	
Copper, hard-drawn or medium-hard-drawn, tin	ANSI/ASTM B 246	200 (392)	

Table 5.3 Continued on Next Page

Table 5.3 Continued

Conductor metal	ASTM reference for the metal	Temperature limit for the metal, °C (°F)	Other limits
coated, each strand at least 0.015 inch (0.38 mm) in diameter			
Copper, lead-base-alloy coated, diameter of each strand or thickness of rectangular or tubular conductor less than 0.015 inch (0.38 mm)	ANSI/ASTM B 189	150 (302)	
Copper, lead-base alloy coated, diameter of each strand or thickness of rectangular or tubular conductor at least 0.015 inch (0.38 mm)	ANSI/ASTM B 189	200 (392)	
Copper, uncoated or tin coated, each strand less than 0.015 inch (0.38 mm) in diameter, metallurgically bonded	ANSI/ASTM B 286, B 470	150 (302)	For use where flexibility is not a concern. Metallurgically bonded via heat or the addition of tin (topcoated, over coated)
Copper, uncoated or tin coated, each strand at least 0.015 inch (0.38 mm) in diameter, metallurgically bonded	ANSI/ASTM B 286, B 470	200 (392)	For use where flexibility is not a concern. Metallurgically bonded via heat or the addition of tin (topcoated, over coated)
Copper, silver-coated	ANSI/ASTM B 298	200 (392)	
Copper, nickel-coated	ANSI/ASTM B 355	250 (482)	
Copper, nickel-coated, Class 10	ANSI/ASTM B 355	350 (662)	
Copper, nickel-coated, Type A, 27 percent minimum nickel coated copper	ANSI/ASTM B 355	550 (1022)	
Copper, gold coated	Per the requirements in the 'other limits' column	200 (392)	Copper per ASTM B 3 Gold coating per ANSI/ASTM B 488
Copper, oxygen free, each strand less than 0.015 inch (0.38) in diameter	ANSI/ASTM B 170	150 (302)	
Copper, oxygen free, each strand at least 0.015 inch (0.38) in diameter	ANSI/ASTM B 170	200 (392)	
Copper-nickel-zinc (nickel-silver)	ANSI/ASTM B 206	150 (302)	
Copper, bus bars, uncoated	ANSI/ASTM B 187	105 (221)	
Copper, bus bars, tin coated	ANSI/ASTM B 187	105 (221)	
Copper alloy, hard-drawn, diameter of each strand or thickness of rectangular or tubular conductor less than 0.015 inch (0.38 mm)	ANSI/ASTM B 105	150 (302)	May be uncoated or provided with a tin, or lead-base-alloy coating. Uncoated or tin-coated conductors smaller than 0.032 inch (0.813 mm) meet the tensile strength and elongation requirements as defined for conductors with a diameter of

Table 5.3 Continued on Next Page

Table 5.3 Continued

Conductor metal	ASTM reference for the metal	Temperature limit for the metal, °C (°F)	Other limits
Copper alloy, hard-drawn, silver coated, diameter of each strand less than 0.032 inch (0.81 mm)	—	200 (392)	0.032 inch (0.813 mm) as shown in ASTM B 105. May contain no more than 0.7% silver. Conductors smaller than 0.032 inch (0.81 mm) meet the tensile strength and elongation requirements for 0.032 inch (0.81 mm) conductors shown in ASTM B 105. Minimum 80% IACS.
Copper alloy, hard-drawn, silver coated	ANSI/ASTM B 105	200 (392)	Must be silver coated. Minimum 80% IACS.
Copper alloy, hard-drawn, diameter of each strand or thickness of rectangular or tubular conductor at least 0.015 inch (0.38 mm)	ANSI/ASTM B 105	200 (392)	May be uncoated or provided with a tin, lead-base-alloy, silver, or nickel coating
High strength copper alloy, annealed, diameter of each strand or thickness of rectangular or tubular conductor less than 0.015 inch (0.38 mm)	ANSI/ASTM B 624	150 (302)	May be uncoated or provided with a tin, or lead based alloy coating. Copper alloy employing 0.05 – 0.127 mm (1.969 – 5.0 mils) may be minimum 70 percent IACS and meets the same requirements as conductors meeting ASTM B624 except that the minimum tensile strength shall not be less than 294 MPa.
High strength copper alloy, annealed, diameter of each strand or thickness of rectangular or tubular conductor at least 0.015 inch (0.38 mm)	ANSI/ASTM B 624	200 (392)	May be uncoated or provided with a tin, or lead based alloy coating
Copper or copper alloy silver-coated	ANSI/ASTM B 961	200 (392)	
Copper alloy, hard-drawn or high strength nickel-coated	—	250 (482)	
Copper-zirconium alloy, less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 747	150 (302)	
Copper-zirconium alloy, less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 747	200 (392)	Shall be silver coated
Copper-zirconium alloy, at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 747	200 (392)	
Phosphor-bronze alloy, less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 159	150 (302)	
Phosphor-bronze alloy, at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 159	200 (392)	
Copper-clad aluminum, annealed, 6530 circular mils or 3.31 mm ² (12 AWG) and larger	ASTM B 566	90 (194)	Class 10A

Table 5.3 Continued on Next Page

Table 5.3 Continued

Conductor metal	ASTM reference for the metal	Temperature limit for the metal, °C (°F)	Other limits
Copper-clad aluminum, hard-drawn, 6530 circular mils or 3.31 mm ² (12 AWG) and larger	ASTM B 566	90 (194)	Class 10H
Copper-clad steel, diameter of each strand or thickness of rectangular or tubular conductor less than 0.015 inch (0.38 mm)	ANSI/ASTM B 452	150 (302)	Minimum conductivity of 30 percent IACS ^a
Copper-clad steel, diameter of each strand or thickness of rectangular or tubular conductor at least 0.015 inch (0.38 mm)	ANSI/ASTM B 452	200 (392)	Minimum conductivity of 30 percent IACS ^a
Copper-clad steel, silver-coated	ANSI/ASTM B 501	200 (392)	Minimum conductivity of 30 percent IACS ^a
Aluminum, 6,530 – 16,510 circular mils or 3.31 – 8.367 mm ² (12 – 4/0 AWG), solid or stranded	ANSI/ASTM B 800	90 (194)	Tensile-strength 15,000 – 22,000 psi or 103 – 152 MN/m ² or 10.3 – 15.2 kN/cm ² or 10.5 – 15.5 kgf/mm ² , elongation 10 percent or more with 10-inch or 250-mm gauge length – component aluminum wire stock (conductor material), formerly "aluminum conductor material (ACM)"
Aluminum, 3/4 hard, 6530 – 16510 circular mils or 3.31 – 8.367 mm ² (12 – 4/0 AWG), solid or stranded	ANSI/ASTM B 609	90 (194)	Tensile strength 17,000 – 22,000 psi or 117 – 152 MN/m ² or 11.7 – 15.2 kN/cm ² or 12 – 15.5 kgf/mm ²
Aluminum, 1/2 hard, 6530 – 16510 circular mils or 3.31 – 8.367 mm ² (12 – 4/0 AWG), solid or stranded	ANSI/ASTM B 609	90 (194)	Tensile strength 15,000 – 20,000 psi or 103 – 138 MN/m ² or 10.3 – 13.8 kN/cm ² or 10.5 – 14.9 kgf/mm ²
Aluminum, hard, 6530 – 16510 circular mils or 3.31 – 8.367 mm ² (12 – 4/0 AWG), solid or stranded	ANSI/ASTM B 609	90 (194)	
Aluminum 1100, H12 alloy 6530 – 16510 circular mils or 3.31 – 8.367 mm ² (12 – 4/0 AWG), solid or stranded	ANSI/ASTM B 211	105	
Stainless steel alloys	ANSI/ASTM A 580 or A 555	250 (482)	
Nickel-coated iron	–	250 (482)	
Nickel, nickel alloy	ANSI/ASTM B 160 or B 473, or per the requirements in the 'other limits' column	550 (1022)	Minimum tensile strength 45,000 psi or 31.6 kgf/mm ² elongation at least 10 percent, nominal volume resistivity 45 ohm circular mil/foot at 20°C (68°F)
Nickel-chromium-alloy	ANSI/ASTM B 344 or B 267, or B 166	550 (1022)	
Nickel-copper-iron alloy	ANSI/ASTM B 164	250 (482)	
Iron	ASTM E230/E230M	320 (608)	Thermocouple conductor, Type J

Table 5.3 Continued on Next Page