



UL 1424

STANDARD FOR SAFETY

Cables for Power-Limited Fire-Alarm Circuits

UL Standard for Safety for Cables for Power-Limited Fire-Alarm Circuits, UL 1424

Fifth Edition, Dated October 8, 2024

Summary of Topics

This revision of ANSI/UL 1424 dated March 19, 2025 includes removing the reference to ANSI/ISA MC96.1 and replace with ASTM E230/E230M in [3.2](#) and [43.1](#).

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 January 24, 2025.

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The most recent designation of ANSI/UL 1424 as an American National Standard (ANSI) occurred on March 19, 2025. 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>.

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INTRODUCTION

1 Scope

1.1 These requirements cover 60 – 250 °C (140 – 482 °F) single- and multiple-conductor cables for use as fixed wiring within buildings (some are also marked for direct burial) principally for power-limited fire-alarm circuits as described in Article 760 and other applicable parts of the National Electrical Code (NEC). Cables covered by these requirements are:

- a) Type FPLP (plenum cable);
- b) Type FPLR (riser cable); and
- c) Type FPL (cable for other than plenum and riser uses in general and in trays).

1.2 The cables covered in these requirements are rated for 300 volts but are not so marked. See [42.1\(h\)](#).

1.3 A cable that contains one or more electromagnetic shields may be surface marked or have a marker tape to indicate that it is "shielded". A cable that contains one or more optical-fiber members has "-OF" supplementing the type letters and is marked in accordance with [43.1\(d\)](#). A cable may consist of or contain one or more coaxial members.

1.4 The overall jacket on a cable that has "sun res" or "sunlight resistant" in a surface marking or on a marker tape complies with a 720-hour sunlight-resistance test.

1.5 A cable that has "dir bur", "direct burial", or "for direct burial" in a surface marking or on a marker tape complies with a 1000-lbf crushing test. Direct-burial cable with wire armor, a metal braid, interlocked metal armor, or a smooth or corrugated metal sheath has a jacket over the metal covering.

1.6 Smoke and fire considerations are as follows for the cables covered in these requirements:

a) TYPE FPLP CABLE – Cable that is intended for installation in accordance with section 722.135 of the National Electrical Code NFPA 70 in a duct, plenum, or other space used to transport environmental air without the cable being enclosed in a raceway in that space is to be tested for smoke and flame characteristics in accordance with the National Fire Protection Association Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces, NFPA 262. A cable that complies exhibits a maximum flame-propagation distance that is not greater than 5 feet, 0 inch (152 cm), a peak optical density of smoke produced of 0.50 or less, and an average optical density of smoke produced of 0.15 or less.

b) TYPE FPLR CABLE – Cable that is intended for use in vertical runs in a shaft, or for installations in which the cable penetrates more than one floor, as specified in section 722.135 of the National Electrical Code NFPA 70. These cables comply with the requirements described in the Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts, UL 1666.

c) TYPE FPL CABLE – Type FPL cable complies with a 70,000 Btu/h (20.5 kW) vertical-tray flame test. The cable manufacturer chooses one of the following tests:

- 1) THE UL TEST REFERENCED IN [23.2.1](#) – These cables comply with the test method described as the UL Flame Exposure (smoke measurements are not applicable) in the Standard Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685 or the Standard for Wire and Cable Test Methods, UL 2556, and are surface marked or designated by a marker tape as "FPL".

2) THE FT4/IEEE 1202 TEST REFERENCED IN [23.3.1](#) – These cables comply with the test method described as the FT4/IEEE 1202 Type of Flame Exposure (smoke measurements are not applicable) in the Standard Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685 or the Standard for Wire and Cable Test Methods, UL 2556. A cable that complies either is not marked or it bears the designation "FT4/IEEE 1202" or "FT4" legible on or through the outer surface or on a marker tape [see marking in [42.1\(i\)](#)].

1.7 These requirements do not cover cables that contain conductors for electric-light, power, or Class 1 circuits. These requirements do not cover cables for Class 3 or Class 2 power-limited circuits (see the Standard for Power-Limited Circuit Cables, UL 13), communications cables (see the Standard for Communications Cables, UL 444), or cables for non-power-limited fire-alarm circuits (NPLF types).

1.8 These requirements do not cover the optical or other performance of any optical-fiber member or group of such members. See [8.4](#).

2 Units of Measurement

2.1 In addition to being stated in the inch/pound units that are customary in the USA, each of the requirements is also stated in units that make the requirement conveniently usable in countries employing the various metric systems (practical SI and customary). Equivalent – although not necessarily exactly identical – results are to be expected from applying a requirement in USA or metric terms. Equipment calibrated in metric units is to be used when a requirement is applied in metric terms.

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

3 Referenced Publications

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.

3.2 The following publications are referenced in this Standard:

ANSI Z136, *American National Standard for Safe Use of Lasers*

ASTM B189, *Standard Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes*

ASTM B298, *Standard Specification for Silver-Coated Soft or Annealed Copper Wire*

ASTM B3, *Standard Specification for Soft or Annealed Copper Wire*

ASTM B33, *Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes*

ASTM B355, *Standard Specification for Nickel-Coated Soft or Annealed Copper Wire*

ASTM B869, *Standard Specification for Copper-Clad Steel Electrical Conductor for CATV Drop Wire*

ASTM D5374, *Standard Test Methods for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation*

ASTM D5423, *Standard Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation*

ASTM E230/E230M, *Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

NFPA 262, *National Fire Protection Association Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*

NFPA 70, *National Electrical Code*.

OSHA 29, CFR Part 1910.93a *Occupational Safety and Health Administration (US Department of Labor) Occupational Exposure to Asbestos 29 CFR Part 1910*

OSHA Field Directive, *Occupational Safety and Health Administration Field Operations Manual (FOM)*

UL 13, *Power-Limited Circuit Cables*

UL 1569, *Metal-Clad Cables*

UL 1581, *Electrical Wires, Cables, and Flexible Cords*.

UL 1666, *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shaft*

UL 1685, *Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*

UL 2196, *Tests for Fire Resistive Cables*

UL 2556, *Wire and Cable Test Methods*

UL 444, *Communications Cables*

CONSTRUCTION

4 Materials

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

4.2 The power-limited fire-alarm circuit cables covered in these requirements shall comply in all respects with the applicable requirements for construction details, test performance, and markings.

5 Conductors

5.1 The center conductor of a coaxial member shall be solid or stranded, shall be round, and either shall be of soft-annealed copper or shall be of copper-clad steel having 21 % or higher conductivity in accordance with ASTM B869. All other conductors in a cable shall be of round soft-annealed copper. A solid copper conductor and the individual wires (strands) of a stranded copper conductor shall be round and shall comply with ASTM B3. The wires (strands) of a stranded conductor shall have a right- or left-hand direction of lay. The length of lay of the wires (strands) of a stranded conductor shall not exceed 20 times the calculated diameter over the assembled conductor for 19 – 10 AWG conductors and shall not exceed 30 times the calculated diameter over the assembled conductor for 26 – 20 AWG conductors. The nominal diameters of solid and stranded conductors that are indicated in [Table 5.1](#) are not requirements

but are for use in calculating the dimensions required for various parts of the cable when using [Table 13.1](#), [Table 13.2](#), [Table 14.1](#), [Table 14.2](#) and [Table 19.1](#).

Table 5.1
Conductor Diameters

AWG size of conductor	Solid conductor				Nominal diameter of stranded conductor	
	Nominal diameter		Minimum diameter			
	inch	(mm)	inch	(mm)	inch	(mm)
26 ^b	0.0159	(0.404)	0.0151 ^a	(0.384) ^a	0.0180	(0.457)
25 ^b	0.0179	(0.455)	0.0170 ^a	(0.432) ^a	0.0203	(0.516)
24	0.0201	(0.511)	0.0191 ^a	(0.485) ^a	0.0228	(0.579)
23	0.0226	(0.574)	0.0215 ^a	(0.546) ^a	0.0256	(0.650)
22	0.0253	(0.643)	0.0240 ^a	(0.610) ^a	0.0287	(0.729)
21	0.0285	(0.724)	0.0271 ^a	(0.688) ^a	0.0323	(0.820)
20	0.0320	(0.813)	0.0304 ^a	(0.772) ^a	0.0362	(0.919)
19	0.0359	(0.912)	0.0341 ^a	(0.866) ^a	0.0407	(1.03)
18	0.0403	(1.02)	0.0399	(1.103)	0.0456	(1.16)
17	0.0453	(1.15)	0.0448	(1.138)	0.0513	(1.30)
16	0.0508	(1.29)	0.0503	(1.278)	0.0576	(1.46)
15	0.0571	(1.45)	0.0565	(1.435)	0.0647	(1.64)
14	0.0641	(1.63)	0.0635	(1.613)	0.0727	(1.85)
13	0.0720	(1.83)	0.0713	(1.81)	0.0816	(2.07)
12	0.0808	(2.05)	0.0800	(2.03)	0.0915	(2.32)
11 ^c	0.0907	(2.30)	0.0900	(2.28)	0.103	(2.62)
10 ^c	0.102	(2.59)	0.1010	(2.56)	0.116	(2.95)

^a The diameter (0.95 x nominal) and resistance (1.1 x nominal) requirements for the solid copper 26 – 19 AWG sizes are as established by the communications-cable industry. The diameter (0.99 x nominal) and resistance (1.02 x nominal) requirements for the solid copper 18 – 10 AWG sizes are the same as those established for other cables. The resistance values for stranded copper conductors in all sizes are the same as those established for other cables.

^b 26 and 25 AWG copper conductors are only for either of the following:

 a) In a cable that has a breaking strength shown by test to be at least 25.0 lbf or 111 N or 11.3 kgf in accordance with Section 39. The strength test is not required for cables with four or more conductors.

 b) As the central conductor in a coaxial member.

^c 11 and 10 AWG copper conductors and 10 and smaller AWG copper-clad steel conductors are only for the central conductor in a coaxial member.

5.2 Each conductor shall be continuous throughout the entire length of the finished cable – see test in [17.1](#) and [17.2](#).

5.3 All solid and stranded conductors are to be identified in the cable, tag, reel, and carton size markings as a particular AWG size. The size of the copper conductor shall be verified either by determination of the d-c resistance or, as described in [5.4](#), by determination of the diameter. The size of a stranded conductor shall be verified either by determination of the d-c resistance or by determination of the cross-sectional area as described in [5.4](#). Determination of the conductor size by measurement of the d-c resistance is to be as described in D-C Resistance Test of Copper Conductors, Section [18](#), and is the referee method in all cases.

5.4 In place of complying with the d-c resistance requirement in [18.1](#), at the cable manufacturer's option, a copper conductor may instead comply with the following requirement:

a) **SOLID CONDUCTOR** – The diameter of a solid copper conductor shall not be smaller than the minimum acceptable diameter indicated for the size in [Table 5.1](#) (see [5.3](#)) when the diameter of the conductor is determined from measurements as follows:

1) Measurements of the diameter of a solid copper conductor are to be made over the metal-coated (see [6.1](#) and [6.2](#)) or uncoated copper by optical means or by means of a machinist's micrometer caliper having flat surfaces both on the anvil and on the end of the spindle. In either case, the equipment is to be calibrated to read directly to at least 0.001 inch (0.01 mm), with each division of a width that facilitates estimation of each measurement to 0.0001 inch (0.001 mm). The maximum and minimum diameters at a given point on the solid conductor are each to be recorded to the nearest 0.0001 inch (0.001 mm), added together, and divided by 2 without any rounding off of the sum or resulting average.

2) Each minimum acceptable diameter indicated in [Table 5.1](#) is an absolute minimum. The unrounded average of the two diameter readings is therefore to be compared directly with the minimum in the table for the purpose of determining whether the solid conductor does or does not comply with the diameter requirement.

b) **STRANDED CONDUCTOR** – The cross-sectional area of a stranded copper conductor of a standard (see [5.3](#)) AWG size and having only round strands shall not be smaller than the minimum acceptable area indicated for the size in the 0.98 x nominal column in Table 20.1 of UL 1581. The cross-sectional area of the stranded conductor is to be determined as the sum of the areas of its component round strands.

5.5 A joint in a solid conductor or in one of the individual wires of a stranded conductor shall be made in a workmanlike manner, shall be smooth, and shall not have any sharp projections. A joint in a stranded conductor is to be made by separately joining each individual wire, or is to be made by machine brazing or welding of the conductor as a whole provided that the resulting solid section of the stranded conductor is not longer than 1/2 inch (13 mm), there are no sharp points, and the distance between brazes or welds in a single conductor does not average less than 3000 feet (915 m) in any reel length of insulated single conductor. A joint made before insulation is applied to a conductor shall not increase the diameter of the solid conductor or individual wire (strand). A joint made after insulating shall not increase the diameter of the solid conductor or individual wire (strand) by more than 20 %. Joints made after insulating shall be made prior to further processing and shall be insulated by heat-shrinkable tubing or by applying the original or investigated comparable insulation by means of a bonded patch or molding, and shall comply with the requirements in this Standard. A jacket that is damaged to the point that the underlying assembly is exposed or that is opened for the purpose of repairing a conductor either:

- a) Shall be stripped and replaced in its entirety; or
- b) A second duplicate jacket shall be applied over the first for the entire length of the cable.

5.6 The total jacket thickness shall not exceed any limitation determined for a particular cable in an applicable flame or smoke-and-flame test or other test specified in this Standard.

6 Metal Coating

6.1 If the insulation adjacent to a solid copper conductor or a conventional (not bunch-tinned) stranded copper conductor is of a material that corrodes unprotected copper in the test Copper Corrosion described in UL 2556, the solid conductor or the individual wires (strands) of the stranded conductor that is not bonded shall be individually covered with a coating of tin complying with ASTM B33, of a tin/lead alloy complying with ASTM B189, of nickel complying with ASTM B355, of silver complying with ASTM B298, or of another metal or alloy (evaluation required).

6.2 It is acceptable to metal-coat a solid conductor or the individual wires (strands) of a stranded conductor on which a coating is not needed for corrosion protection.

6.3 The maximum temperature rating of the cable is not specified relative to the diameter of copper wires used in the serving, wrap, or braid shielding described in [10.2\(c\)](#). Otherwise, copper strands and solid copper conductors shall not be used in a cable with a temperature rating higher than indicated in [Table 6.1](#).

Table 6.1
Maximum Temperature Rating of Cable Relative to Diameter and Coating of Solid Copper Conductors or of Copper Conductor Strands

Metal coating of copper strands or of solid copper conductor	Diameter of each strand or of the solid conductor	
	Smaller than 0.015 inch (0.38 mm)	At least 0.015 inch (0.38 mm)
Uncoated or coated with tin or a tin/lead alloy	150 °C (302 °F)	200 °C (392 °F)
Coated with silver	200 °C (392 °F)	200 °C (392 °F)
Coated with nickel	over 200 °C (392 °F)	over 200 °C (392 °F)

7 Insulation Material and Application

7.1 General

7.1.1 Each conductor shall be insulated for its entire length with one or more of the insulation materials indicated in [Table 16.1](#) or referenced in note a to [Table 16.1](#). The insulation shall be solid or, in the cases indicated in the second column of [Table 16.1](#), may be expanded (foamed). In any case, a solid dielectric skin (a thin, solid, extruded layer that may or may not be separable) of the same or other material from [Table 16.1](#) may be applied over the solid insulation or over the foam. The material insulation in an air-gap coaxial member shall consist of a solid tube over a solid spacer (thread) that has a nominally circular cross section and is applied to the conductor helically in a continuous length (length of lay is not specified). Otherwise, the insulation shall be applied directly to the conductor, shall have a circular cross section, and shall fit tightly to the conductor but shall not adhere excessively (no test). The insulation shall be uniform and shall not have any defects (bubbles, open spots, rips, tears, cuts, or foreign material) that are visible with normal or corrected vision without magnification.

7.1.2 Either of the following materials that the manufacturer wishes to use as insulation or a jacket shall be evaluated for the requested temperature rating as described in the test Dry Temperature Rating of New materials (Long Term Aging Test) in UL 2556:

- a) Material generically different from any insulation or jacket material that is named in [Table 16.1](#) for the construction (new material).
- b) Material that is named in [Table 16.1](#) yet does not comply with the short-term tests specified for the material in Specific Materials, Section 50 of UL 1581.

7.1.3 The temperature rating of materials (a) and (b) shall be the temperature rating for the cable determined as specified in [13.1](#). The thicknesses of insulation and/or jacket using materials (a) and/or (b) shall be as required for the specific cable type. Investigation of the electrical, mechanical, and physical characteristics of the cable using material (a) and/or (b) shall show the material(s) to be comparable in performance to an insulation or jacket material named in [Table 16.1](#) for the required temperature rating. The investigation shall include tests such as crushing, impact, abrasion, deformation, heat shock, insulation resistance, and dielectric voltage-withstand.

7.2 Thicknesses

7.2.1 General

7.2.1.1 The dimensions of the spacer (thread) portion of the material insulation in an air-gap coaxial member are not specified. The average thickness and the minimum thickness at any point of the tube portion of an air-gap coaxial member shall not be less than indicated in [Table 7.2](#). The thicknesses of the integral insulation (solid) and jacket on a flat, parallel cable shall not be less than indicated in [Table 7.1](#). The average thickness and the minimum thickness at any point of solid insulation (including any skin) on single-conductor cable shall not be less than indicated in [Table 7.3](#). The average thickness and the minimum thickness at any point of solid insulation (including any skin) in a coaxial member and on every other conductor, including each conductor in nonintegral flat cable, shall not be less than indicated in [Table 7.2](#). The thicknesses of foamed insulation (including any skin) shall be evaluated based on the performance of the finished cable when tested in accordance with this standard. In any case, the thicknesses of solid and foamed insulations (including any skin) are to be determined by means of measurements made as described in the test Thickness in UL 2556, with the following modifications for stranded conductors that leave one or more strand impressions in the insulation that are too small to accommodate a pin of 1 mm (0.04 inch) in diameter:

- a) The 0.003-inch (3-mil) or 0.08-mm thickness-reduction allowance mentioned in UL 2556 is applicable to both average and minimum at any point measurements, and is to be applied only to insulation that is from a stranded conductor as mentioned above and has an average thickness (including any skin) of at least 0.015 inch (0.38 mm) where the measurements are made using a micrometer microscope.
- b) Only an optical method as applicable from [7.2.1.2](#) and [7.2.1.3](#) is to be used for thickness measurements of insulation that is from a stranded conductor as mentioned above and has an average thickness (including any skin) less than 0.015 inch (0.38 mm).

7.2.1.2 Thickness measurements of a nylon or similar covering (see note a to [Table 7.2](#) and note a to [Table 7.3](#)) of insulation having an average thickness or minimum thickness at any point of not more than 0.0060 inch (0.152 mm) (including any skin) are to be made by means of a micrometer microscope or other optical instrument that is calibrated to read directly to at least 0.0001 inch (0.1 mil) or 0.001 mm. Each of these measurements is to be recorded to the nearest 0.0001 inch (0.001 mm). Otherwise, under [7.2.1.1\(b\)](#), a simply manipulated optical device that is accurate to 0.001 inch (1 mil) or 0.01 mm may be used for insulation, with each measurement recorded to the nearest 0.001 inch (0.01 mm).

7.2.1.3 For [7.2.1.1\(b\)](#), the conductor and any covering over the insulation or skin are to be removed from the finished insulated conductor. A thin slice of the insulation plus any skin is then to be cut perpendicular to the longitudinal axis of the resulting hollow tube. Measurements are to be taken of the maximum and minimum wall thicknesses of the slice. The recorded maximum and minimum thicknesses are to be added together and divided by 2 without any rounding off of the sum but with the resulting average rounded off (see [7.2.2](#) – [7.2.5](#)) to the same degree as stated in for the recorded measurements. The average thickness so determined and the recorded minimum thickness are to be taken as the average and minimum-at-any-point thicknesses that are to be compared with [Table 7.2](#) or with whatever lesser thicknesses are established for the construction as the result of the insulation-crushing test described in Crushing Resistance Test of Insulation, Section [30](#).

Table 7.1
Thicknesses of Integral Insulation (Solid) and Jacket on 2-, 3-, or 4-Conductor Flat, Parallel Cable
and Distance Between Conductors

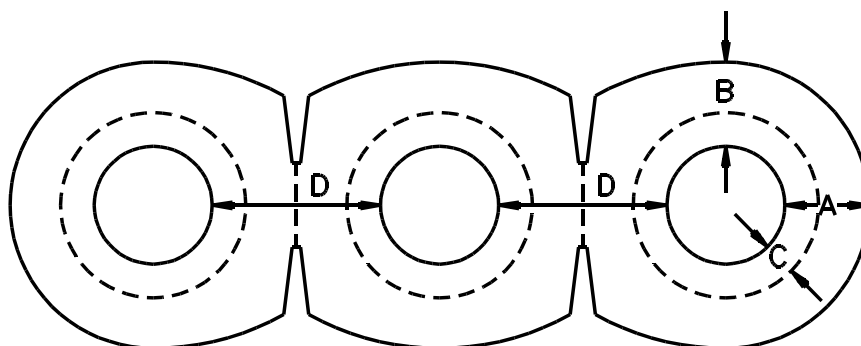
Size of conductors AWG	Nominal thickness away from tear area(s) (vertical dashed line through web or webs in Figure 7.1) and outside Point P or X (defined in Figure 7.2)		Minimum thickness at any point before separation measured outside Point P or X (defined in Figure 7.2)		Minimum thickness at any point after separation		Minimum distance between copper conductors	
	A ^a (Information only – not a requirement)		B ^a		C ^a		D ^a	
	Inch	(mm)	Inch	(mm)	Inch	(mm)	inch	(mm)
22 – 12	0.020	(0.51)	0.018	(0.46)	0.010	(0.25)	0.030	(0.76)

^a Dimensions A – D are illustrated in [Figure 7.1](#).

Figure 7.1

Integral Flat Cable

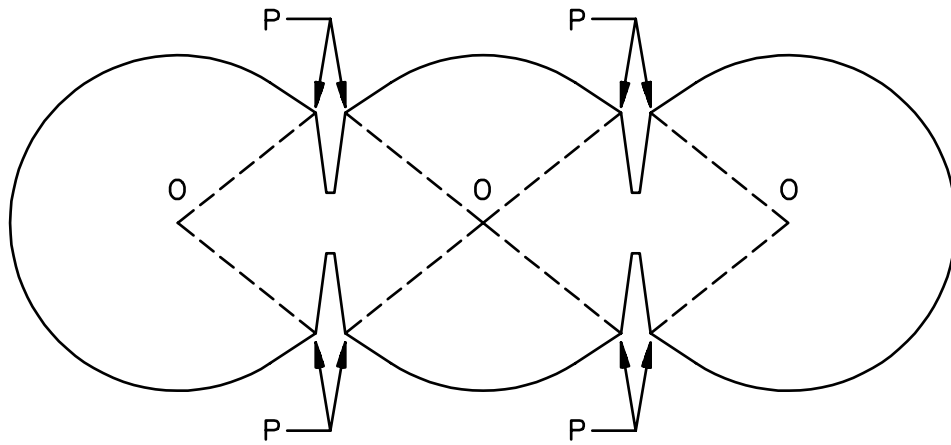
See [Table 7.1](#) for Dimensions A – D



SB0636–2

Figure 7.2

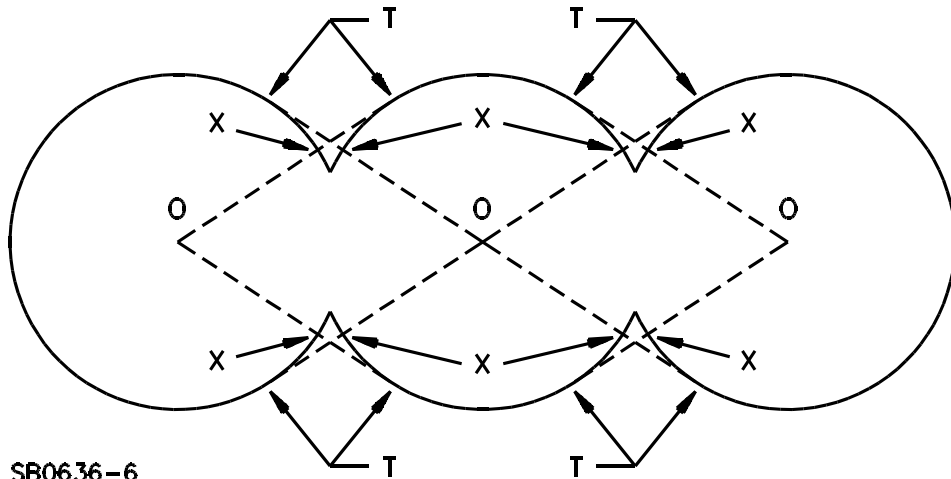
Definition of Regions of Valley Slopes on which Thickness Measurements are Not to be Made in Integral Flat Cables



SB0636-5

Constructions with a Cross Section Having a Definite Point P at the Outer End of Each Valley Slope

OP in each case is a straight line from the center O of a conductor to P on the same segment of the cross section. Thickness measurements are not to be made on any valley slope.



SB0636-6

Constructions with a Cross Section not Having a Definite Point to Mark the Outer End of Each Valley Slope

OP in each case is a straight line from the center O of a conductor to T, the point of tangency, on the adjacent segment of the cross section. Thickness measurements are not to be made deeper on a valley slope than point X, which is the intersection of the line OT with the valley slope. Thickness measurements are to be made on each slope segment TX.

Table 7.2
Thicknesses of Solid Insulation (Including any Skin) in Jacketed Ribbon Cable and in Nonintegral Round and Flat Multiple-Conductor Cable

Size of conductor	Insulation whose unaged tensile strength is less than 2000 lbf/in ² or 13.79 MN/m ² or 1379 N/cm ² or 1.41 kgf/mm ²						PVC (1) with an unaged tensile strength of at least 2000 lbf/in ² or 13.79 MN/m ² or 1379 N/cm ² or 1.41 kgf/mm ² , and (2) with or without a covering ^a of nylon, PBT, or similar thermoplastic material or ECTFE, ETFE, FEP, HDPE, PFA, PTFE (TFE), PVDF, PVDF Copolymer, TFE, Semirigid PVC, PP, or XLPO	
	CP or silicone rubber		LDPE, PVC, or TPE (all without a nylon or similar covering)		PVC with a covering ^a of nylon, PBT, or similar thermoplastics material or TPE with a covering ^a of Nylon or XL (without a nylon or similar covering)			
	A		B		C		D	
	Minimum average thickness	Minimum thickness at any point	Minimum average thickness	Minimum thickness at any point	Minimum average thickness	Minimum thickness at any point	Minimum average thickness	Minimum thickness at any point
AWG	Inch							
26 – 20	0.015	0.013	0.012	0.010	0.009	0.008	0.0060	0.0050
19 – 15	0.015	0.013	0.015	0.013	0.009	0.008	0.009	0.008
14 – 10 ^b	0.020	0.018	0.020	0.018	0.012	0.010	0.012	0.010
AWG	mm							
26 – 20	0.38	0.33	0.30	0.25	0.23	0.20	0.152	0.127
19 – 15	0.38	0.33	0.38	0.33	0.23	0.20	0.23	0.20
14 – 10 ^b	0.51	0.46	0.51	0.46	0.30	0.25	0.30	0.25
NOTE: Solid insulation for a given size range indicated in column 1 is for average and point thicknesses thinner than indicated in this table where the insulation on the smallest conductor in the indicated size range complies with the insulation crushing test described in Crushing Resistance Test of Insulation, Section 30.								
^a Measured by means of the micrometer microscope described in 7.2.1.2, the minimum thickness at any point of the nylon covering shall not be less than 0.0020 inch (2.0 mils) or 0.050 mm.								
A covering of a material other than nylon is to be evaluated. The investigation is to demonstrate that the other material thickness, temperature rating, flexibility, flammability, and other characteristics critical to the application provide the particular construction with a comparable covering. Investigation of the mechanical-abuse characteristics is to include at least the crushing, impact, and abrasion comparison tests that are described in the tests Crush Resistance, Impact Resistance and Abrasion Resistance in UL 2556.								
^b 11 and 10 AWG copper conductors and 10 AWG and small copper-clad steel conductors are only for the central conductor in a coaxial member. Copper-clad steel conductors shall have 30 % or higher conductivity in accordance with ASTM B452								

Table 7.3
Thicknesses of Solid Insulation (Including any Skin) on 18 – 12 AWG Conductors in Single or Multiple-Conductor Non-Jacketed Cable

Insulation material		Minimum average thickness of insulation		Minimum thickness at any point of insulation	
		inch	(mm)	inch	(mm)
CP, HDFRPE, LDFRPE, HDPE, LDPE, PP, PVC, SRPVC, TPE, XL, or XLPO	Without a nylon or similar covering	0.020	(0.51)	0.018	(0.46)
	With a covering ^a of nylon, PBT, or similar thermoplastic material	0.015	(0.38)	0.010	(0.25)
ECTFE, ETFE, FEP, PA, PTFE (TFE), PVDF, or PVDF copolymer		0.015	(0.38)	0.013	(0.33)
NOTE: Thinner solid insulation is to be evaluated.					
^a Measured by means of the micrometer microscope described in 7.2.1.2 , the minimum thickness at any point of the nylon or similar covering shall not be less than 0.0040 in (4.0 mils) or 0.102 mm. See the second paragraph of note a to Table 7.2					

7.2.2 Rounding off to the nearest 0.0001 inch

7.2.2.1 A figure in the fourth decimal place is to remain unchanged:

- a) If the figure in the fifth decimal place is 0 – 4 and the figure in the fourth decimal place is odd or even; or
- b) If the figure in the fifth decimal place is 5 and the figure in the fourth decimal place is even (0, 2, 4, and so forth).

A figure in the fourth decimal place is to be increased by 1:

- c) If the figure in the fifth decimal place is 6 – 9 and the figure in the fourth decimal place is odd or even; or
- d) If the figure in the fifth decimal place is 5 and the figure in the fourth decimal place is odd (1, 3, 5, and so forth).

7.2.3 Rounding off to the nearest 0.001 inch

7.2.3.1 A figure in the third decimal place is to remain unchanged:

- a) If the figure in the fourth decimal place is 0 – 4 and the figure in the third decimal place is odd or even; or
- b) If the figure in the fourth decimal place is 5 and the figure in the third decimal place is even (0, 2, 4, and so forth).

A figure in the third decimal place is to be increased by 1:

- c) If the figure in the fourth decimal place is 6 – 9 and the figure in the third decimal place is odd or even; or
- d) If the figure in the fourth decimal place is 5 and the figure in the third decimal place is odd (1, 3, 5, and so forth).

7.2.4 Rounding off to the nearest 0.001 mm

7.2.4.1 A figure in the third decimal place is to remain unchanged:

- a) If the figure in the fourth decimal place is 0 – 4 and the figure in the third decimal place is odd or even; or
- b) If the figure in the fourth decimal place is 5 and the figure in the third decimal place is even (0, 2, 4 and so forth).

A figure in the third decimal place is to be increased by 1:

- c) If the figure in the fourth decimal place is 6 – 9 and the figure in the third decimal place is odd or even, or
- d) If the figure in the fourth decimal place is 5 and the figure in the third decimal place is odd (1, 3, 5, and so forth).

7.2.5 Rounding off to the nearest 0.01 mm

7.2.5.1 A figure in the second decimal place is to remain unchanged:

- a) If the figure in the third decimal place is 0 – 4 and the figure in the second decimal place is odd or even; or
- b) If the figure in the third decimal place is 5 and the figure in the second decimal place is even (0, 2, 4, and so forth).

A figure in the second decimal place is to be increased by 1:

- c) If the figure in the third decimal place is 6 – 9 and the figure in the second decimal place is odd or even; or
- d) If the figure in the third decimal place is 5 and the figure in the second decimal place is odd (1, 3, 5, and so forth).

8 Coaxial and Optical-Fiber Members

8.1 Each coaxial member shall consist of a single central conductor covered in turn with solid or foamed insulation (with or without a skin) complying (including thicknesses) with Insulation, Section 7, or the air-gap construction complying with 7.1.1; a shield(s) (outer conductor) complying with Section 10; and a jacket, which is optional on a member used inside the cable (see Table 9.1) but is required on a member whose outer surface is the outer surface of the cable (see Table 12.1). The jacket on a coaxial member used within a cable shall comply with Table 9.1. The jacket on a coaxial member shall comply with Section 13 if the jacket on the member constitutes the overall cable jacket.

8.2 An optical-fiber member shall consist of the following:

- a) One or more glass fibers that are individually coated and tight buffered and then are jacketed in any thickness with one of the insulation materials named in Table 16.1 or referenced in note a to Table 16.1, or are enclosed in a nonmetallic tape, wrap, or braid that provides complete coverage and is electrically nonconductive.
- b) One or more glass fibers that are individually coated, optionally tight buffered, and then are enclosed in a loose buffer tube. A loose buffer tube:
 - 1) Shall be of any thickness of one of the insulations named or referenced in Table 16.1; or
 - 2) Shall be enclosed in a jacket of one of the insulations named or referenced in Table 16.1;or