UL 6288

STANDARD FOR SAFETY

Decorative Lighting Cords

UL Standard for Safety for Decorative Lighting Cords, UL 6288

First Edition, Dated March 20, 2024

Summary of Topics

First Edition ANSI/UL 6288, Standard for Decorative Lighting Cords, dated March 20, 2024 applies to thermoplastic insulated wires and jacketed cords intended for use in or with decorative lighting products and are rated 300 V maximum.

The new requirements are substantially in accordance with Proposal(s) on this subject dated September 22, 2023 and January 5, 2024.

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Standard for Decorative Lighting Cords

First Edition

March 20, 2024

This ANSI/UL Standard for Safety consists of the First Edition.

The most recent designation of ANSI/UL 6288 as an American National Standard (ANSI) occurred on March 20, 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.

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INTRODUCTION

1 Scope

1.1 These requirements apply to thermoplastic insulated wires and jacketed cords intended for use in or with decorative lighting products and are rated 300 V maximum.

1.2 The products in this Standard are not oil rated. Products with Type designations ending in "W" are sunlight resistant.

2 Referenced Publications

2.1 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.

2.2 The following publications are referenced in this Standard.

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

ASTM B33, *Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes*

NFPA 70, *National Electrical Code*

UL 588, *Seasonal and Holiday Decorative Products*

UL 2556, *Wire and Cable Test Methods*

3 Glossary

3.1 The following definitions apply in this Standard.

3.2 BUNCH STRANDING – A group of wires twisted together without a predetermined pattern.

3.3 DIAMETER TAPE – A measuring tape that is graduated so that the circumference of a cylindrical object is measured and the reading results in the diameter of the object.

3.4 DIRECTION OF LAY – The longitudinal direction, designated as left-hand (counterclockwise) or right-hand (clockwise), in which the wires of a member or units of a conductor run over the top of the member or conductor as they recede from an observer looking along the axis of the member or conductor.

3.5 GROUNDED CONDUCTOR – A system or circuit conductor that is intentionally grounded.

3.6 GROUNDING CONDUCTOR – A conductor that is defined in the NEC, as "Grounding Conductor, Equipment".

3.7 NEUTRAL CONDUCTOR – A circuit conductor that normally carries current and is connected to ground (earth) at the main electrical panel. The conductor of a 2-wire circuit connected to the supply neutral point and earth ground is referred to as the "neutral".

3.8 NORMAL VISION – Vision without any aid other than the examiner's normal corrective lenses, if any.

3.9 ROOM TEMPERATURE – 25 ±10 °C (77 ±18 °F).

3.10 THERMOPLASTIC – A polymeric-based material that can be repeatedly softened by heating and hardened by cooling, and that in the softened state can be shaped through the application of force.

3.11 Ungrounded Conductor – circuit conductor that is not connected to ground.

4 Units of Measurement

4.1 The values given in SI (metric) units shall be normative. Any other values are for information only and put in parentheses.

CONSTRUCTION

5 General

5.1 Sections 6 – 27 set out specific requirements for these cords (see Table 5.1 – Table 5.3).

Table 5.1
Dimensions of Parallel Cord Types

		Type	
		XTW	DPTW, DPT
Size, mm^2 (AWG)		0.325 (22)	–
		0.519 (20)	0.519 (20)
		0.824 (18)	–
Insulation thickness, mm (mils)	Nominal (not a requirement)	0.76 (30)	1.14 (45)
	Minimum thickness at any point before separation Figure 23.1 (Dimension A)	0.69 (27)	1.02 (40)
	Minimum thickness at any point after separation Figure 23.1 (Dimension B)	0.33 (13)	0.69 (27)
Minimum thickness of web, mm (mils) Figure 23.1 (Dimension C)		1.14 (45)	2.03 (80)

Table 5.2
Round and Integral Parallel Cords

	Type				
	DPT	DPTW	XTW	DJT	DJTW
Temperature ratings, °C	105	105	105	105	105
Maximum voltage, V	300	300	300	300	300
Size of conductors, mm^2 (AWG)	0.519	0.519	0.325, 0.519 and 0.824	0.519	0.519
	(20)	(20)	(22, 20, and 18)	(20)	(20)
Number of conductors	2	2	2 – 6	2 or 3	2 or 3
Grounding conductor	Section 13	Section 13	Section 13	Section 13	Section 13
Conductor:					
Material	Soft, annealed copper (Section 7)				

Table 5.2 Continued on Next Page

Table 5.2 Continued

	Type				
	DPT	DPTW	XTW	DJT	DJTW
Size	Cross-sectional area and DC resistance (8.1)				
Stranding	Size of wires (12.1), lay of wires (12.2)				
General	Joints, coatings, separators (Sections 9, 10, and 11)				
Insulation class	Section 14	Section 14	Section 14	Section 14	Section 14
Circuit conductor, class:					
105 °C	7	7	7	7	7
Grounding conductor:					
105 °C	N/A	N/A	7	7	7
Minimum average thickness, mm (mils)	Table 5.1	Table 5.1	Table 5.1	0.76 (30)	0.76 (30)
Minimum thickness at any point	Table 5.1	Table 5.1	Table 5.1	90 percent of min. avg.	90 percent of min. avg.
Minimum thickness at point of contact	N/A	N/A	N/A	80 percent of min. avg.	80 percent of min. avg.
Covering on individual conductors (optional)	N/A	N/A	N/A	Section 16	Section 16
Assembly	Parallel	Parallel	Parallel	Section 17	Section 17
Jacket class:					
105 °C	N/A	N/A	N/A	1.8	1.8
Minimum average thickness of jacket	N/A	N/A	N/A	0.76 (30)	0.76 (30)
Minimum thickness at any point of jacket	N/A	N/A	N/A	0.61 (24)	0.61 (24)
General	N/A	N/A	N/A	18.1	18.1
Overall braid	N/A	N/A	N/A	Cords with "-B" suffix only, Section 22	
Overall diameter	N/A	N/A	N/A	Section 19	Section 19
Conductor identification	Section 20	Section 20	Section 20	Section 20	Section 20
Tests, Clause:					
Insulation resistance	Section 46	Section 46	Section 46	Section 46	Section 46
Cold bend	Section 32	Section 32	Section 32	Section 32	Section 32
Heat-shock resistance	Section 34	Section 34	Section 34	Section 34	Section 34
Spark	Section 44	Section 44	Section 44	Section 44	Section 44
Dielectric strength	Section 45	Section 45	Section 45	Section 45	Section 45
Continuity	Section 48	Section 48	Section 48	Section 48	Section 48
Mechanical strength	N/A	N/A	N/A	Section 30	Section 30
Jacket resistance	N/A	N/A	N/A	Section 50	Section 50
Durability of ink printing	Section 36	Section 36	Section 36	Section 36	Section 36
Laser printing	Section 43	Section 43	Section 43	Section 43	Section 43
Copper corrosion	Section 49	Section 49	Section 49	Section 49	Section 49
Deformation	29.3	29.3	29.3	29.3	29.3
Tightness of insulation	Section 35	Section 35	Section 35	N/A	N/A

Table 5.2 Continued on Next Page

Table 5.2 Continued

	Type				
	DPT	**DPTW**	**XTW**	**DJT**	**DJTW**
Flame (VW-1)	Section 31	Section 31	Section 31	Section 31	Section 31
Physical properties, Table:					
Insulation	Table 29.1 and Table 29.2	Table 29.1 and Table 29.2	Table 29.1 and Table 29.2	Table 29.1 and Table 29.2	Table 29.1 and Table 29.2
Jacket	N/A	N/A	N/A	Table 29.3 and Table 29.4	Table 29.3 and Table 29.4
Additional tests for cords suffixed "-B":					
Flexibility of braid	N/A	N/A	N/A	Section 42	Section 42
Water Absorption	N/A	N/A	N/A	N/A	Section 41
Additional tests for "W" type cords:					
Weather resistance	N/A	Section 33	Section 33	N/A	Section 33
Insulation resistance	N/A	46.1	46.1	N/A	46.1
Permittivity and stability factor	N/A	Section 47	Section 47	N/A	Section 47
Application	Indoor	Outdoor	Outdoor	Indoor	Outdoor

Table 5.3
Insulated Single and Twisted Pair Decorative Cords

	Type						
	CXTW	**CXTW**	**YXTW**	**LXTW**	**LXT**	**LVXT**	**ATXW**
Maximum temperature, °C	105	105	105	60	60	60	60
Maximum voltage, V	300	300	300	300	300	60	60
Size of conductors, mm^2 (AWG)	–	0.162, 0.205, and 0.259 (25, 24, 23)[a]	–	0.162, 0.205, and 0.259 (25, 24, 23)[a]	0.162, 0.205, and 0.259 (25, 24, 23)[a]	–	–
	0.325, 0.519 and 0.824 (22, 20, and 18)	0.325, 0.519 and 0.824 (22, 20, and 18)	0.519 (20) and 0.824 (18)	0.325, 0.519 and 0.824 (22, 20, and 18)	0.325, 0.519 and 0.824 (22, 20, and 18)	0.0507 – 0.205 (30 – 24)	0.0507 – 0.205 (30 – 24)
Number of conductors	2	1	1	1	1	1 or 2[c]	1 – 4[c]
Conductor:							
Material	Soft annealed copper (Section 7)						
Size	Cross-sectional area and DC resistance (8.1)						
Stranding	Size of wires (12.1), lay of wires (12.2)						
General	Joints, coatings, separators (Sections 9, 10, and 11)						
Conductor identification	Section 20	Section 20	N/A	N/A	N/A	N/A	N/A
Maximum lay of conductors	Section 17	Section 17	N/A	N/A	N/A	N/A	N/A
Insulation class	7	7	7	7	7	4	N/A

Table 5.3 Continued on Next Page

Table 5.3 Continued

	Type						
	CXTW	CXTW	YXTW	LXTW	LXT	LVXT	ATXW
Minimum average thickness, mm (mils)	0.76 (30)	0.76 (30)	1.14 (45)	0.76 (30)	0.76 (30)	0.4 (15.8)[e]	0.4 (15.8)[e]
Assembly	Twisted	Single	Single	Single	Single	Single[c]	Single[c]
Tests:							
Physical properties, insulation	29.1	29.1	29.1	29.1	29.1	29.1	29.1[f]
Deformation	29.3	29.3	29.3	29.3	29.3	29.3	N/A
Spark	Section 44	Section 44	Section 44	Section 44	Section 44	Section 44	N/A
Dielectric strength	Section 45	Section 45	Section 45	Section 45	Section 45	Section 45	N/A
Insulation resistance	Section 46	Section 46	Section 46	Section 46	Section 46	Section 46	N/A
Continuity	Section 48	Section 48	Section 48	Section 48	Section 48	Section 48	N/A
Flame VW-1	Section 31	Section 31	Section 31	Section 31	Section 31	Section 31	Section 31 (optional)
Cold bend	Section 32	Section 32	Section 32	Section 32	Section 32	Section 32	N/A
Durability of ink printing	Section 36	Section 36	Section 36	Section 36	Section 36	Section 36	Section 36
Laser printing	Section 43	Section 43	Section 43	Section 43	Section 43	Section 43	Section 43
Heat-shock resistance	Section 34	Section 34	Section 34	Section 34	Section 34	Section 34	N/A
Copper corrosion	Section 49	Section 49	Section 49	Section 49	Section 49	Section 49	N/A
Tightness of insulation	Section 35	Section 35	Section 35	Section 35	Section 35	N/A	N/A
Additional tests for "W" type cords:							
Weather resistance	Section 33	Section 33	Section 33	Section 33	N/A	N/A	Section 33
Insulation resistance	46.1	46.1	46.1	46.1	N/A	N/A	N/A
Permittivity and stability factor	Section 47	Section 47	Section 47	Section 47	N/A	N/A	N/A
Additional tests for cords marked "-S":							
Breaking strength	N/A	Section 40	N/A	N/A	N/A	N/A	N/A
Additional tests for cords marked "-X":							
Breaking strength	N/A	Section 40	N/A	Section 40	Section 40	N/A	N/A
Additional tests for cords marked "-ES" or "-IS"[b], and Type YXTW							
Breaking Strength	N/A	Section 40	N/A	N/A	N/A	N/A	N/A
Abrasion	N/A	Section 38	Section 38	N/A	N/A	N/A	N/A
Flexing	N/A	Section 39	Section 39	N/A	N/A	N/A	N/A
Examination after conditioning	N/A	46.2	N/A	N/A	N/A	N/A	N/A
Application	Outdoor	Outdoor	Outdoor	Outdoor	Indoor	Class 2 or battery[d]	Class 2 or battery[d]

[a] 0.162 mm^2 – 0.259 mm^2 (25 – 23 AWG) for types with "-X" suffix only

[b] Limited to 0.325 mm^2 (22 AWG) only

Table 5.3 Continued on Next Page

Table 5.3 Continued

	Type						
	CXTW	CXTW	YXTW	LXTW	LXT	LVXT	ATXW
[c] Two to four conductors may be bonded in parallel							
[d] As defined in UL 588							
[e] The value indicated is a minimum thickness at any point. The minimum average thickness is not specified.							
[f] Unaged only. The tensile strength and elongation values in Table 29.1 or insulation class 4, before aging, apply.							

6 Conductors

6.1 The conductors shall use flexible stranding. All conductors in a cord shall be the same size.

7 Material

7.1 Conductors shall be of annealed copper in compliance with ASTM B3 or annealed coated copper in compliance with ASTM B33.

8 Size

8.1 The conductor size shall be determined by both (a) and (b):

a) The cross-sectional area (stranded conductor) shall not exceed the maximum values given in Table 8.1. The cross-sectional area shall be determined in accordance with the method specified in the test, Cross-sectional area, by diameter method described in UL 2556. The diameter shall be determined in accordance with the method specified in the test, Conductor Diameter, described in UL 2556.

b) The DC resistance of each uncoated copper or tin-coated copper conductor in a finished cord shall be as specified in Table 8.2, Table 8.3, Table 8.4, and Table 8.5. A plus tolerance of 2 percent shall be permitted in the case of a conductor in a twisted multiconductor product having a single layer of conductors. Compliance shall be determined in accordance with the test, DC resistance, in UL 2556. If the results of any measurement in a twisted multiconductor product are not acceptable, the results of referee measurements made by using a straight specimen of the conductor from the cord without the plus tolerance shall be taken as conclusive.

Table 8.1
Cross-Sectional Area of Stranded Conductors

Conductor size		Nominal circular mil area	Maximum cross-sectional area of stranded conductors	
mm^2	(AWG/kcmil)	(circular mils)	mm^2	(circular mils)
0.0507	(30)	(100)	0.053	(102)
0.0647	(29)	(128)	0.067	(131)
0.0804	(28)	(159)	0.083	(162)
0.102	(27)	(202)	0.106	(206)
0.128	(26)	(253)	0.133	(258)
0.162	(25)	(320)	0.168	(326)

Table 8.1 Continued on Next Page

Table 8.1 Continued

Conductor size		Nominal circular mil area	Maximum cross-sectional area of stranded conductors	
mm^2	(AWG/kcmil)	(circular mils)	mm^2	(circular mils)
0.205	(24)	(404)	0.209	(412)
0.259	(23)	(511)	0.264	(521)
0.325	(22)	(640)	0.330	(653)
0.519	(20)	(1 020)	0.525	(1 040)
0.824	(18)	(1 620)	0.836	(1 652)

Table 8.2
Maximum Direct Current Resistance of Stranded Conductors at 20 °C, Ω/km

Conductor size		Bare copper	Coated copper
mm^2	(AWG/kcmil)	Stranded	Stranded
0.0507	(30)	360	379
0.0647	(29)	281	296
0.0804	(28)	226	239
0.102	(27)	179	188
0.128	(26)	143	150.5
0.162	(25)	112.7	118.7
0.205	(24)	89.2	94.0
0.259	(23)	70.6	74.4
0.325	(22)	56.8	59.7
0.519	(20)	35.7	37.6
0.824	(18)	22.4	23.6

Table 8.3
Maximum Direct Current Resistance of Stranded Conductors at 25 °C, Ω/km

Conductor size		Bare copper	Coated copper
mm^2	(AWG/kcmil)	Stranded	Stranded
0.0507	(30)	369	387
0.0647	(29)	289	304
0.0804	(28)	233	244
0.102	(27)	183	192
0.128	(26)	146	153
0.162	(25)	114.5	120.6
0.205	(24)	91.8	97.0
0.259	(23)	71.7	75.9
0.325	(22)	57.9	60.9
0.519	(20)	36.4	38.4
0.824	(18)	22.8	24.1

Table 8.4
Maximum Direct Current Resistance of Stranded Conductors at 20 °C, Ω/1000 ft

Conductor size		Bare copper	Coated copper
mm^2	(AWG/kcmil)	Stranded	Stranded
0.0507	(30)	110	116
0.0647	(29)	86.3	90.6
0.0804	(28)	69.4	72.9
0.102	(27)	54.6	57.4
0.128	(26)	43.5	45.8
0.162	(25)	34.3	36.2
0.205	(24)	27.4	28.9
0.259	(23)	21.5	22.6
0.325	(22)	17.3	18.2
0.519	(20)	10.9	11.5
0.824	(18)	6.83	7.20

Table 8.5
Maximum Direct Current Resistance of Stranded Conductors at 25 °C, Ω/1000 ft

Conductor size		Bare copper	Coated copper
mm^2	(AWG/kcmil)	Stranded	Stranded
0.0507	(30)	112	120
0.0647	(29)	87.8	94.3
0.0804	(28)	70.5	75.9
0.102	(27)	55.5	59.7
0.128	(26)	44.3	47.6
0.162	(25)	34.8	37.5
0.205	(24)	28.1	29.3
0.259	(23)	21.9	23.0
0.325	(22)	17.7	18.6
0.519	(20)	11.1	11.7
0.824	(18)	6.95	7.35

8.2 The individual wires used in a stranded conductor are usually drawn to a specified diameter, which in some cases does not correspond with the diameter of any gauge number. Not all of the individual strands of the completed conductor are required to have the same diameter.

9 Joints

9.1 A joint or splice in one of the individual wires of a stranded conductor shall neither increase the diameter nor decrease the strength of the conductor or the individual wire. A joint or splice shall not be made in a stranded conductor as a whole.

10 Coating

10.1 If the conductor and insulation have been shown to be mutually compatible in accordance with Copper Corrosion, Section 49, omission of the coating shall be permitted. Otherwise, if a separator is not provided over the conductor, all the individual wires of the conductor shall be separately tinned.

11 Separator

11.1 When the conductor is neither coated nor shown to be mutually compatible with the insulation in accordance with Copper Corrosion, Section 49, a separator that is compatible with the insulation as described in 11.3 shall be provided over the conductor.

11.2 A separator shall be permitted on other constructions, but is not required.

11.3 A separator, when provided, is not required to cover the conductor completely unless it is required in order to comply with the copper corrosion test specified in Copper Corrosion, Section 49. It shall be of a color contrasting to that of the conductor, except clear or green or green/yellow shall not be permitted. The separator shall consist of:

a) Close spiraling of fine fibrous yarn or tape;

b) Braid of fine fibrous yarn; or

c) Longitudinally applied tape.

12 Stranding

12.1 General

12.1.1 Flexible conductors shall be bunch-stranded and shall be composed of wires as shown in Table 12.1.

Table 12.1
Stranding

Cord type	Conductor size	Diameter of individual wires			
		Minimum		Maximum	
		mm	(in)	mm	(in)
CXTW-X, LXT-X, LXTW-X	0.162, 0.205, 0.259 mm^2 (25, 24, 23 AWG)	0.079	(0.0031)	0.165	(0.0065)
CXTW, XTW, LXT, LXTW	0.325 mm^2 (22 AWG)	0.079	(0.0031)	0.165	(0.0065)
CXTW, XTW, LXT, LXTW	0.519 mm^2 – 0.824 mm^2 (20 – 18 AWG)	0.125	(0.0049)	0.260	(0.010)
YXTW	0.519 mm^2 (20 AWG) and 0.824 mm^2 (18 AWG)	0.125	(0.0049)	0.260	(0.010)
ATXW, LVXT	0.0507 – 0.0205 mm^2 (30 – 24 AWG)	0.079	(0.0031)	0.165	(0.0065)
DPTW, DPT	0.519 mm^2 (20 AWG)	0.125	(0.0049)	0.165	(0.0065)
DJT, DJTW	0.519 mm^2 (20 AWG)	0.125	(0.0049)	0.260	(0.010)

12.1.2 Fibrous (nonmetallic) thread(s) shall be permitted to be used within the conductor stranding in single conductor cords employing the suffix “-S” or “-X”. When thread(s) are used, the conductor shall meet the requirements of DC resistance in accordance with the test, DC resistance in UL 2556, and shall comply with the requirements in Section 24 or 25, as applicable. Cords employing the suffix "-S" or "-X" shall be marked in accordance with 51.4.1 (c) or (d), respectively. The construction and arrangement of the threads is not specified.

12.2 Lay of strands

12.2.1 The maximum acceptable length of lay of strands for all cords other than 0.325 mm^2 (22 AWG) Types CXTW and XTW shall not exceed 32 mm (1.25 in) when tested in accordance with the test, Length of Lay (uncovered components), in UL 2556. The direction of lay is not specified.

12.2.2 The maximum acceptable length of lay of strands of a 0.325 mm^2 (22 AWG) conductor shall not exceed 32 mm (1.25 in) when tested in accordance with the test, Length of Lay (uncovered components), in UL 2556, or shall be based on the performance of the finished type in the abrasion and flexing test described in Section 38 and Section 39, respectively.

13 Grounding (Bonding) and Grounded (Neutral) Conductors

13.1 When a grounding conductor is incorporated into a cord, it shall be insulated.

14 Insulation

14.1 The classes of insulation materials covered in this standard are shown in Table 14.1. The classes, thicknesses, and required testing of insulation to be used on a particular type are shown in Table 5.1 – Table 5.3. The insulation shall be applied directly over the conductor or the separator if one is used. The insulation shall be applied concentrically about the conductor, except for cord Types DPT, DPTW, and XTW.

Table 14.1
Insulations

Class no.	Material type	Material description	Temperature rating, maximum, °C	
			Dry	Wet
4	Thermoplastic	PVC	60	60
7	Thermoplastic	PVC	105	60
Legend: PVC – Polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate				

15 New Materials

15.1 Thermoplastic insulation materials that are generically different from those named in the index tables shown in Table 14.1 shall be evaluated for the requested temperature rating as described in Section 37. Investigation of the electrical, mechanical, and physical characteristics of the construction using the new material shall show the new material to be comparable in performance to the materials currently specified for the application.

16 Covering

16.1 Tape shall be permitted as an inner covering over the insulation of individual conductors of jacketed cords, but shall not be used as an outer covering.

17 Conductor Assembly

17.1 Lay of conductors

17.1.1 Types DJT and DJTW shall have the individual conductors twisted together with a length of lay not greater than 51 mm (2.00 in) for a two-conductor cord or 57 mm (2.25 in) for a three-conductor cord. For two-conductor type CXTW, the lay shall not be more than 30 times the overall diameter of the insulated conductor.

17.1.2 Length of lay shall be determined in accordance with the test, Length of Lay (covered components), in UL 2556.

17.2 Fillers

17.2.1 Fillers shall be permitted in types DJT and DJTW. If fillers are used, they shall be of suitable material and shall be twisted with the individual conductors to form a compact assembly having an essentially circular cross-section.

17.3 Binder

17.3.1 The application of a binder, consisting of a braid, tape, or wrap of suitable material over the conductor assembly, shall be permitted in types DJT and DJTW.

18 Jackets

18.1 General

18.1.1 If a jacket is required, the conductor assembly of the cord shall be covered by and properly centered within the jacket. The jacket shall be applied directly to the conductor assembly or binder, if one is used, and shall fill all the spaces, if any, around the conductor assembly.

18.1.2 All jackets shall provide an essentially circular cross-section for the finished cord. The classes of jacket provided in this Standard are shown in Table 18.1. The classes, thicknesses, and required testing of jackets used on a particular cord shall be as shown in Table 5.2.

Table 18.1
Jackets

Class no.	Material type	Material description	Temperature ratings maximum, °C Dry
1.5	Thermoplastic	PVC	60
1.8	Thermoplastic	PVC	105
Legend: PVC – Polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate			

18.2 New materials

18.2.1 Thermoplastic jacket materials that are generically different from those named in the index tables shown in Table 18.1, if selected for use, shall be evaluated for the requested temperature rating as described-in 37.1.1. Investigation of the electrical, mechanical, and physical characteristics of the construction using the new material shall show the new material to be comparable in performance to the materials indicated for the application.

19 Overall Dimensions

19.1 When the diameter of a round cord is greater than 6.35 mm (0.25 in), diameter measurements may be made using a diameter tape accurate to 0.25 mm (0.01 in). The tape shall be wrapped tightly around the specimen, but not so tight that the specimen is compressed. To determine whether or not a cord complies with the requirement within Table 19.1, measurements of overall diameter shall be made under the overall braid (if present, see Section 22) at five points, at intervals of approximately 150 mm (6 in) on a 1 m (3 ft) length of finished cord. An arithmetic average of the readings shall be used as the specimen diameter.

Table 19.1
Overall Diameter of Round Service and Heater Cords

Type of cord	Range of overall diameters, mm (in)		
	Size of conductors mm^2 (AWG)	Two-conductor	Three-conductor
DJT, DJTW	0.519 (20)	6.50 – 7.39 (0.256 – 0.291)	6.88 – 7.77 (0.271 – 0.306)

NOTES:

1 – When a metal support member in accordance with 21.3 is included, the maximum diameters in this table do not apply.

2 – The above tabulated diameters do not apply to a cord that is intended for application in which

a) A fitting is molded on each end of the cord; or

b) A fitting is molded onto one end of the cord and a means of strain relief is molded on towards the other end of the cord.

3 – Cord types with the suffix "-B" shall be measured under the braid.

19.2 When there are questions regarding compliance with this standard or when the cord diameter is 6.35 mm (0.25 in) or less, measurements shall be made with dial micrometer or calipers having a resolution of 0.013 mm (0.0005 in) and accurate to 0.025 mm (0.001 in). At any given cross-section, the maximum diameter, minimum diameter, and two additional diameters that bisect the two angles formed by the maximum and minimum diameters shall be measured. The diameter for the cord at that point shall be the average of the four values.

20 Method of Distinguishing Conductors

20.1 Conductors shall be distinguished as follows:

a) Grounded (neutral) conductors shall be distinguished by one of the following methods, and these colors shall be restricted to such use:

1) White or grey colored braid;

2) White or grey colored insulation;

3) White or grey colored separator in integral constructions only;

4) Tinned conductor on integral constructions only; or

5) One or more grooves, ridges, or white stripes on the exterior of integral constructions only.

b) Grounding conductors shall be distinguished by the color green or a combination of the colors green and yellow. On a grounding conductor colored green, one or more yellow stripes that cover no less than 5 percent and not more than 70 percent of the calculated circumference of the finished conductor insulation shall be permitted.

20.2 The use of a thin, non-separable colored coating of a suitable material that is compatible with the insulation over the surface of the insulation on the individual conductors, in lieu of colored insulation, shall be permitted.

20.3 For integral constructions, one conductor shall be distinguishable by physical or visual means (e.g., ridges, grooves, ink printing, insulation color).

21 Support Members

21.1 The incorporation of a supporting member in the center of Type DJT or DJTW shall be permitted. Supporting members of steel, nonmetallic material, fibrous material, or other suitable material shall be permitted.

21.2 When metal is used, the support member shall consist of a flexible, stranded metal that is insulated with the same grade and thickness of insulation as used on a circuit conductor of the same size as the strength member.

21.3 The overall jacket shall be marked to show that a metal support member is present [see 51.4.1(a)].

22 Overall Fibrous Braid on Cords With "-B" Suffix

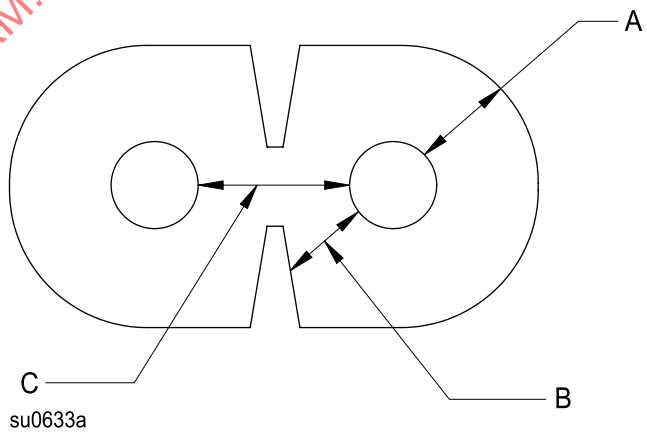
22.1 An overall nonmetallic, fibrous braid may be applied over Type DJT or DJTW. When a braid is applied the product shall be printed or have a marker tape under the braid in accordance with 51.4.1(b).

23 Integral Constructions

23.1 Types DPT, DPTW, and two-conductor XTW, shall be of an integral construction and shall be such that the two insulated conductors can be separated readily for any distance after removal of the overall braid (if present) only when slit at the end and intentionally torn apart (see Figure 23.1).

Figure 23.1

Two-Conductor Types DPTW, DPT, and XTW



23.2 Three- to six-conductor Type XTW shall consist of the integral construction (see Figure 23.2). The construction of the cord shall be such that the insulated (circuit) conductors can be separated readily for

any desired distance after removal of the overall braid (if present) when slit at the end and intentionally torn apart.

Figure 23.2

Three- to six-circuit conductor Type XTW without grounding conductors

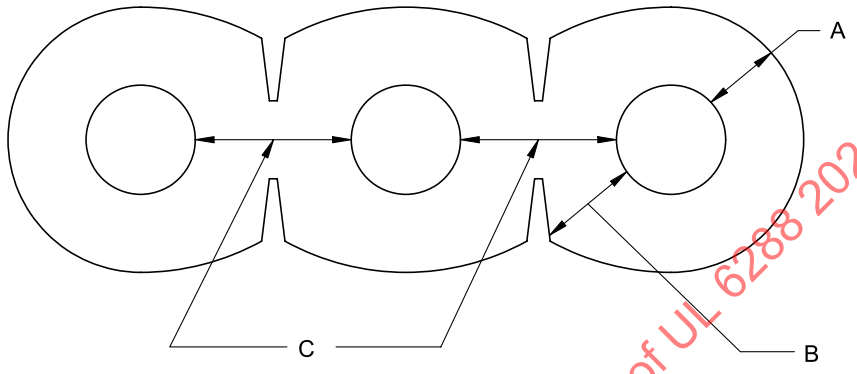


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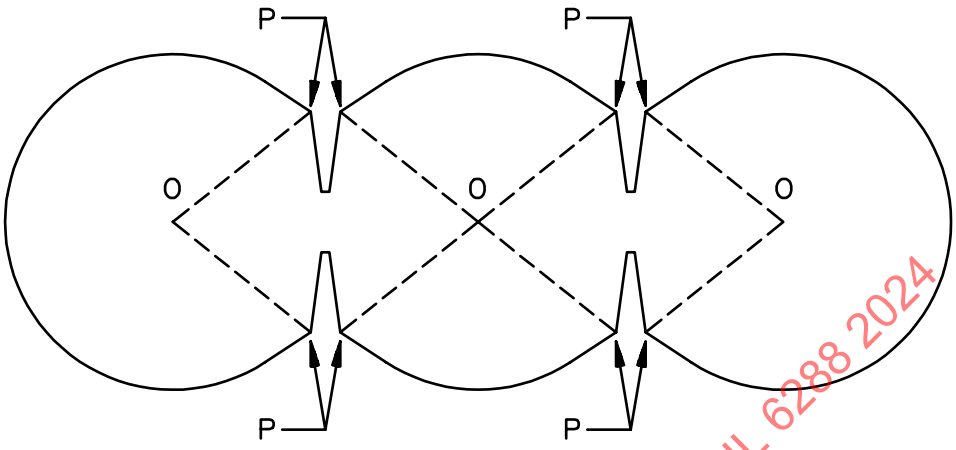
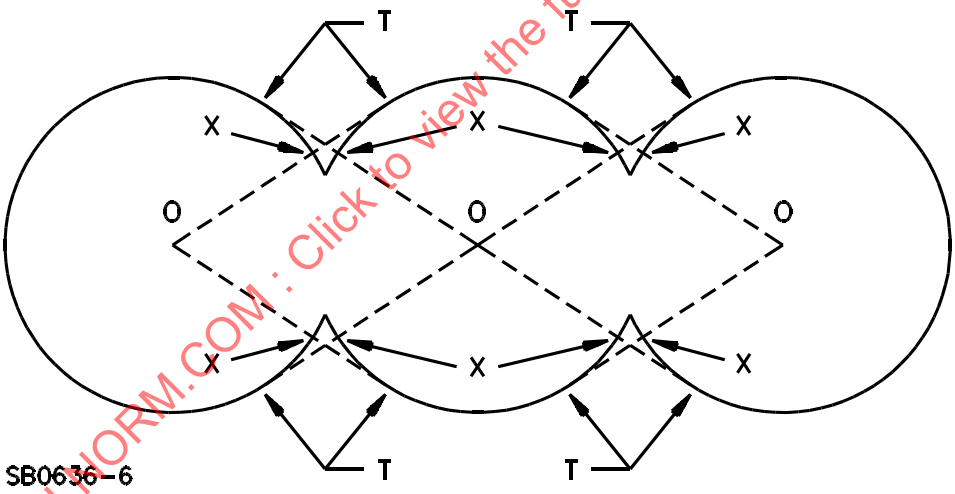
Figure 23.3

Definition of Regions of Valley Slopes on Which Thickness Measurements Before Separation Shall Not Be Made in Integral Parallel Cords



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 before separation shall not be made on any valley slope.



Constructions with a cross-section having a definite point to mark the outer end of each valley slope.

OT 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 before separation shall not be made on any valley slope other than X, which is the intersection of the line OT with the valley slope. Thickness measurements before separation shall be made on each slope segment TX.

23.3 The thickness of the insulation on integral cords, before and after separation of the conductors, and the other dimensions of these cords shall be in accordance with Table 5.1 and Table 5.2.

24 Decorative Cord Types CXTW With Suffix "-S"

24.1 Decorative cord Type CXTW marked with the suffix "-S" as indicated in 51.4.1(c) shall comply with the requirements specified for Type CXTW and to those specified in 12.1.2. The suffix "-S" is limited for use on single conductor CXTW cord in 0.325 mm^2 (22 AWG) or larger size.

25 Decorative Cord Types CXTW, LXT, and LXTW with Suffix "-X"

25.1 Decorative cord types CXTW, LXT, and LXTW marked with the suffix "-X" as indicated in 51.4.1(d) shall comply with the requirements specified for type CXTW, LXT, and LXTW, respectively, and to those specified in 12.1.2. The suffix "-X" is limited for use on only CXTW, LXT, and LXTW cord in sizes 0.162, 0.205, and 0.259 mm^2 (25, 24, and 23 AWG).

26 Decorative Cord Type CXTW With Suffix "-IS"

26.1 Decorative cord type CXTW marked with the suffix "-IS" as indicated in 51.4.1(e) shall comply with the requirements specified for type CXTW and to those specified in 26.2. The suffix "-IS" is limited for use on single conductor CXTW cord in 0.325 mm^2 (22 AWG) size.

26.2 Fibrous (nonmetallic) thread(s) may be embedded within the insulation of a single conductor CXTW cord. When the threads are embedded in the insulation, the finished wire shall be designated CXTW-IS and shall be marked in accordance with 51.4.1(e). The overall insulation thickness including the threads shall comply with the requirements for CXTW. The minimum thickness at any point of insulation over the fibrous threads shall not be less than 0.381 mm (15 mils).

27 Decorative Cord Type CXTW with Suffix "-ES"

27.1 Decorative cord type CXTW marked with the suffix "-ES" as indicated in 51.4.1(f) shall comply with the requirements specified for type CXTW and to those specified in 27.2. The suffix "-ES" is limited for use on only CXTW cord in 0.325 mm^2 (22 AWG) size.

27.2 Fibrous (nonmetallic) thread(s) may be run along the outside of the CXTW insulation and shall be covered with the same material as the CXTW insulation. The thickness of material over the thread(s) is not specified. When the strength member is applied in this manner, the finished wire shall be designated CXTW-ES and shall be marked in accordance with 51.4.1(f).

PERFORMANCE

28 Thickness of Insulation and Jacket

28.1 Insulation

28.1.1 The minimum average and minimum thickness at any point of the insulation, and the thickness of the insulation on integral cords, before and after separation of the conductors, shall be determined in accordance with the test, Thickness, in UL 2556.

28.2 Jacket

28.2.1 The average and minimum thickness at any point of the jacket shall be determined in accordance with the test, Thickness, in UL 2556.

29 Physical properties

29.1 Insulation

29.1.1 The physical properties of the various classes of insulation, when tested before and after accelerated aging, shall comply with the applicable requirements given in Table 29.1 and Table 29.2. Compliance shall be determined in accordance with the test, Physical Properties (ultimate elongation and tensile strength), in UL 2556.

Table 29.1
Physical Properties – Insulation (Before Aging)

Class no.	Temperature rating, maximum, °C		Material type	Before aging	
	Dry	Wet		Minimum elongation, percent	Tensile strength, MPa (lbf/in2)
4	60	60	Thermoplastic	100	10.3 (1500)
7	105	60	Thermoplastic	100	10.3 (1500)

Table 29.2
Physical Properties – Insulation (After Aging)

Class no.	Air oven test			
	Oven temp. °C ±2	Time days	Minimum percentage of unaged value	
			Elongation, percent	Tensile strength, percent
4	100	7	65	85
7	136	7	65	85

29.2 Jackets

29.2.1 The physical properties of the various classes of jackets, when tested before and after accelerated aging, shall comply with the applicable requirements given in Table 29.3 and Table 29.4. Compliance shall be determined in accordance with the test, Physical Properties (ultimate elongation and tensile strength), in UL 2556 on die-cut samples.

Table 29.3
Physical properties – Jackets (Before Aging)

Class no.	Temperature rating, maximum, °C	Material type	Before aging	
	Dry		Minimum elongation percent	Tensile strength MPa (lbf/in^2)
1.5	60	Thermoplastic	100	10.3 (1500)
1.8	105	Thermoplastic	100	10.3 (1500)

Table 29.4
Physical Properties – Jackets (After Aging)

Class no.	Air oven test			
	Oven temp. °C ±2	Time days	Minimum percentage of unaged value	
			Elongation, percent	Tensile strength, percent
1.5	100	7	45	85
1.8	136	7	45	85

29.3 Deformation

29.3.1 Insulation

29.3.1.1 The insulation on single-conductor wires, and on the individual conductors from a multi-conductor cord (separated, in the case of parallel cords), shall not decrease by more than 50 percent in thickness when subjected to a force caused by a mass as shown in Table 29.5, and while maintained at a temperature of 121 °C ±2 °C for 1 hour.

Table 29.5
Deformation Test

Size of conductor mm^2 (AWG)	Mass on insulation specimen g
0.0507 – 0.325 (30 – 22)	200
0.519, 0.824 (20, 18)	300

29.3.2 Jacket

29.3.2.1 Specimens of jackets from finished cords shall not decrease by more than 50 percent in thickness when subjected to a force caused by a mass of 2000 g (4.4 lbs), and while maintained at the temperature shown in Table 29.5 for 1 hour.

29.3.3 Method

29.3.3.1 Compliance with 29.3.1 and 29.3.2 shall be determined in accordance with the test, Deformation, in UL 2556. The overall braid, if present, shall be removed.

30 Mechanical Strength

30.1 General

30.1.1 The mechanical strength of finished Types DJT and DJTW, after removal from the overall braid (if present) shall be such that no conductor will break when the overall cord is subjected to a force caused by a mass of 68 kg (150 lbs) for 1 minute.

30.2 Method

30.2.1 Compliance shall be determined in accordance with the test, Mechanical Strength, in UL 2556. In case of dispute, the weight method shall be considered the referee method.

31 Vertical Flame Test – VW-1

31.1 When the finished cord and the finished individual insulated conductors within a cord are tested separately, they shall not convey flame, drop flaming particles that ignite cotton, or continue to burn for more than 60 seconds after any of five 15 seconds applications of a standard test flame. Compliance shall be determined in accordance with the test, FV-2/VW-1, in UL 2556. A specimen shall be considered to have conveyed flame if more than 25 percent of the extended portion of the indicator is burned. In parallel construction, the major diameter shall face the burner.

32 Cold Bend – All Types

32.1 The insulation and jacket (if applicable) shall show no cracks when a specimen of the finished cord is conditioned at the temperature specified in Table 32.1 for 4 hours and, while still at the specified temperature, wound the required number of turns around the mandrel having a diameter as specified in Table 32.2. Compliance shall be determined in accordance with the test, Cold Bend, in UL 2556.

Table 32.1
Temperature for Cold Bend Test

Type of cord	Test temperature
Any "W" cord not marked or marked minus 40 °C	minus 40 °C
Any "W" cord marked minus 50 °C	minus 50 °C
Any "W" cord marked minus 60 °C	minus 60 °C
Any "W" cord marked minus 70 °C	minus 70 °C
Any other type of cord	minus 20 °C

Table 32.2
Mandrel diameter for cold bend test

Minor diameter of flat cord or overall diameter of round finished cord mm (in)	Diameter of mandrel mm (in)	Number of turns around mandrel[a]
0 – 3.18 (0 – 0.125)	6.5 (0.25)	6
3.19 – 6.35 (0.126 – 0.250)	12.7 (0.50)	6
6.36 – 9.52 (0.251 – 0.375)	19.0 (0.75)	6
9.53 – 12.70 (0.376 – 0.500)	25.4 (1.00)	6
12.71 – 15.88 (0.501 – 0.625)	31.8 (1.25)	6
Greater than 15.88 (0.625)	2 X cord diameter	1

[a] The specimen shall be wound six close turns around the mandrel.

33 Weather Resistance – All "W" Cords

33.1 After conditioning for 720 hours in a xenon arc weatherometer as described in the test, Weather (sunlight) resistance, in UL 2556, the outermost extruded layer of Type "W" cords shall:

a) Show no cracks when wound one complete turn around a mandrel having a diameter as shown in Table 32.2 while at a temperature of minus 30 °C ±1 °C for a period of 1 hour. During the bending, the conditioned surface shall be opposite the surface contacting the mandrel. The specimen shall be allowed to rest 16 hours to 96 hours at room temperature before conducting the cold bend test; and

b) Retain an average tensile strength and elongation of not less than 80 percent. Conditioned and unaged sets (five specimens each) shall be allowed to rest 16 hours to 96 hours at room temperature, followed by physical properties testing. Conditioned surfaces required to be die-cut shall not be buffed or skived away.

34 Heat-Shock Resistance

34.1 The insulation shall show no cracks when specimens of finished unjacketed cords, specimens of the individual conductors from jacketed cords, and specimens of single-conductor and twisted pair cords, are exposed to a temperature of 121 °C ±2 °C for all temperature ratings of PVC for 1 hour while wound six close turns around a mandrel having a diameter as shown in Table 34.1. The specimen shall show no cracks when unwound from the mandrel after cooling to room temperature.

Table 34.1
Mandrel Diameter for Heat-Shock Resistance Test on Insulation

	Diameter of mandrel, mm (in)				
Size of conductor mm^2 (AWG)	Individual conductor of DJT and DJTW	Types XTW, CXTW[a], LXT[b], LXTW[b]	Type LVXT	Type YXTW	Types DPTW, DPT
0.0507 (30)	–	–	2.4 (0.094)	–	–
0.0647 (29)	–	–	2.4 (0.094)	–	–
0.0804 (28)	–	–	2.4 (0.094)	–	–
0.100 (27)	–	–	2.4 (0.094)	–	–
0.128 (26)	–	–	2.4 (0.094)	–	–
0.162 (25)	–	2.4 (0.094)	2.4 (0.094)	–	–
0.205 (24)	–	2.4 (0.094)	2.4 (0.094)	–	–
0.259 (23)	–	2.4 (0.094)	–	–	–
0.325 (22)	–	2.4 (0.094)	–	–	–
0.519 (20)	2.4 (0.094)	2.4 (0.094)	–	4.0 (0.16)	4.0 (0.16)
0.824 (18)	–	2.4 (0.094)	–	4.0 (0.16)	–

[a] Also applicable to cords with "-S", "-ES", "-IS", or "-X" suffix.

[b] Also applicable to cords with "-X" suffix.

34.2 The overall braid for a cord with "-B" suffix, jacket, and insulation on specimens of the finished cords shall show no cracks after being subjected to a temperature of 121 °C ±2 °C for all temperature ratings of PVC for 1 hour while wound around a mandrel having a diameter as shown in Table 34.2. The overall braid, jacket, and insulation shall show no cracks when unwound from the mandrel after cooling to room temperature.

Table 34.2
Mandrel Diameter for Heat-Shock Resistance Test on Jackets

Overall diameter of finished cord or minor dimension of flat cords mm (in)	Diameter of mandrel mm (in)
0.0 – 6.35 (0 – 0.250)	12.7 (0.50)
6.36 – 7.92 (0.251 – 0.312)	20.6 (0.81)

Table 34.2 Continued on Next Page

Table 34.2 Continued

Overall diameter of finished cord or minor dimension of flat cords mm (in)	Diameter of mandrel mm (in)
7.93 – 9.52 (0.313 – 0.375)	28.6 (1.13)
9.53 – 11.1 (0.376 – 0.437)	34.9 (1.37)
11.2 – 12.7 (0.438 – 0.500)	42.8 (1.69)
12.8 – 14.3 (0.501 – 0.563)	50.8 (2.00)
14.4 – 15.9 (0.564 – 0.625)	54.0 (2.13)
NOTE – For round cords having an overall diameter less than 19 mm (0.748 in), the specimen shall be wound six close turns around the mandrel.	

34.3 Compliance with 34.1 and 34.2 shall be determined in accordance with the test, Heat shock resistance, in UL 2556.

35 Tightness of Insulation Test

35.1 The insulation of single-conductor and twisted pair cords shall be applied tightly to reduce slipping of the conductor in the insulation when each conductor is subjected to the procedure outlined in 35.2. The insulation on parallel cords shall be applied tightly to reduce slipping of the insulation when subjected to the procedure outlined in 35.3.

35.2 Following the method described in 35.4 and with the 1.81 kg (4 lbs) weight and specimen thus suspended for a period of 30 seconds, slipping of the conductor, separator, or combination thereof shall not exceed 3 mm (0.11 in). Measurement shall be made at the top of the specimen at the point at which the bare conductor enters the insulation.

35.3 Following the method described in 35.4 and with the 3.63 kg (8 lbs) weight and specimen thus suspended for a period of 30 seconds, slipping of any conductor, separator, or combination thereof shall not exceed 3 mm (0.11 in). Measurement shall be determined from the point where the conductor is cut off even with the insulation.

35.4 Compliance with 35.2 and 35.3 shall be determined in accordance with the test, Tightness of insulation, in UL 2556.

36 Durability of Ink Printing

36.1 Surface-printed markings shall be complete and legible after two samples have been tested in accordance with the test, Durability of ink printing, in UL 2556. One sample shall be conditioned at the rated temperature of the sample for 24 hours.

37 Dry Temperature Rating of New Materials (Long-Term Aging Test)

37.1 Scope

37.1.1 This test verifies the dry temperature rating of new materials and establishes short-term air-oven aging parameters and requirements.

NOTE 1: The long-term aging test evaluates a material for its dry temperature rating only. Other properties are evaluated based on requirements in the applicable wire and cable standard.

NOTE 2: For the product standard, after sufficient experience with a new material has been compiled, the material will be submitted for inclusion in the standard in a timely manner.

37.2 Test method

37.2.1 Compliance shall be determined in accordance with the test, Dry temperature rating of new material (Long-term aging test), in UL 2556.

38 Abrasion Test for Types XTW, CXTW, CXTW-ES, CXTW-IS, and YXTW

38.1 General

38.1.1 When required by 12.2, the insulation on the 0.325 mm^2 (22 AWG) size of Types XTW and CXTW cord and of the straightened individual conductors from finished Type CXTW cord shall not wear through to expose the conductor or conductors in 400 or fewer cycles on any of the specimens. Additionally, Types CXTW-ES or CXTW-IS cord shall not wear through to expose the strength member or the conductor in 400 or fewer cycles on any of the specimens, and the insulation on a YXTW cord shall not wear through to expose the conductor in 600 or fewer cycles on any specimens.

38.2 Method

38.2.1 The apparatus, specimens, and procedure shall be in accordance with the test, Abrasion resistance, in UL 2556, with a weight that exerts 1.1 ±0.1 N (4.0 ±0.5 ozf).

38.3 Examination

38.3.1 Following the completion of the abrasion cycles, the weights shall be removed from the specimens. The cord shall be examined for exposure of conductors. The CXTW-ES or CXTW-IS cord shall also be examined for exposure of strength members.

39 Flexing Test for Types XTW, CXTW, CXTW-ES, CXTW-IS, and YXTW

39.1 General

39.1.1 No more than half the strands in any conductor in the 0.325 mm^2 (22 AWG) size of Types XTW, CXTW, CXTW-ES, and CXTW-IS cord shall be broken by 6000 cycles of the flexing.

39.1.2 In addition, for types CXTW-ES and CXTW-IS, as a result of the 6000 cycles of flexing, the strength member shall not be damaged and the strength member within the insulation shall not damage the insulation. Damage of the insulation includes but is not limited to exposure of the conductor or splitting of the insulation.

39.1.3 No more than half the strands in any conductor of a Type YXTW cord shall be broken by 9000 cycles of the flexing.

39.2 Apparatus

39.2.1 The apparatus and the specimens shall be in thermal equilibrium with the surrounding air at a temperature of 23.0 ±8.0 °C (73.4 ±14.4 °F) throughout the test.

39.2.2 The apparatus shall consist of:

a) Weight exerting 0.210 ±0.003 N (0.75 ±0.01 ozf);

b) Fixed round rods 12.7 mm (0.50 in) in diameter; and

c) A movable rod capable of a simple harmonic motion at a rate of 12 cycles per minute in a semi-circular path.

39.3 Specimen preparation

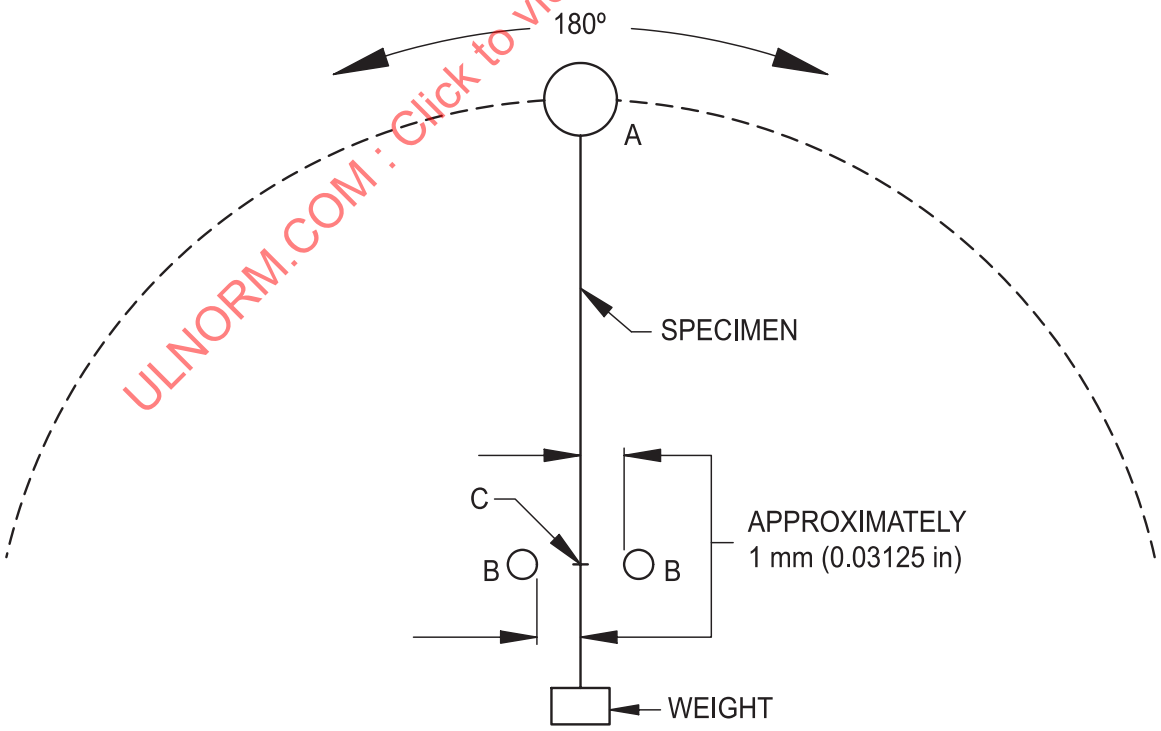
39.3.1 Six specimens shall be cut from a sample length of the finished wire or cord and shall be tested without any conditioning.

39.4 Procedure

39.4.1 Each specimen shall be bent into the form of a flat-bottomed square-cornered U with the legs of the U straight and of equal length. The bottom of the U in each case shall be taped to the underside of a movable round horizontal rod (A in Figure 39.1) with the axis of the conductor or conductors parallel to the longitudinal axis of the movable rod and the legs of the U extending vertically downward between a pair of fixed round rods (B in Figure 39.1) that are 12.7 mm (0.50 in) in diameter. A weight exerting 0.210 ±0.003 N (0.75 ±0.01 ozf) shall be attached to the free end of each leg. The conductors of the specimens shall be connected in series. The longitudinal axes of the two fixed rods shall be in a horizontal plane and shall be parallel to one another and to the longitudinal axis of the movable rod to which the specimens are taped. The distance between the two rods shall be adjusted to result in the specimens hanging midway between the rods, with a space from specimen to rod of near 1 mm (0.04 in) on each side. A current of 1.5 A shall be passed through the conductor(s).

Figure 39.1

Fixture for Flex Test



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