



UL 1277

STANDARD FOR SAFETY

Electrical Power and Control Tray
Cables with Optional Optical-Fiber
Members

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UL Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, UL 1277

Sixth Edition, Dated September 12, 2018

SUMMARY OF TOPICS:

This revision of ANSI/UL 1277 dated November 27, 2023 includes the NEC Related to Copper-Clad Aluminum; [6.1](#)

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 August 4, 2023.

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UL 1277

Standard for Electrical Power and Control Tray Cables with Optional Optical-

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Sixth Edition

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This ANSI/UL Standard for Safety consists of the Sixth Edition including revisions through November 27, 2023.

The most recent designation of ANSI/UL 1277 as an American National Standard (ANSI) occurred on November 27, 2023. 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 electrical power and control cables consisting of either two or more current-carrying copper, aluminum, or copper-clad aluminum circuit conductors, or one or more pairs of thermocouple-extension wires. Thermocouple-extension wires and circuit conductors shall not be mixed in the same cable. These cables are constructed with or without either or both:

- a) One bare or one or more insulated grounding conductor(s), and
- b) One or more individually jacketed optical-fiber members, all under an overall jacket.

These electrical and composite electrical/optical-fiber cables are intended for use (optical and electrical functions associated in the case of a composite cable) in accordance with Article 336 and other applicable parts of the National Electrical Code (NEC), ANSI/NFPA 70 in cable trays, in raceways, and where supported in outdoor locations by a messenger wire.

1.2 The conductors for these cables are described in Sections [9.2](#) (NEC types) and [9.3](#) (other conductors). Cables are surface marked with the conductor type letters and/or with the temperature and “wet”, “dry”, or “wet or dry” ratings applicable to the insulation. Cables for direct burial are so marked on the surface. Cables that have a sunlight-resistant jacket are surface marked “sun res” or “sunlight resistant”. Cables may include one or more optical-fiber member(s) and are surface marked to so indicate. Cables that are surface marked “oil resistant II” have a jacket that is for exposure to oil at temperatures not in excess of 75°C (167°F). Cables that are surface marked “oil resistant I” have a jacket that is for exposure to oil at temperatures not in excess of 60°C (140°F). Each insulated conductor that is oil resistant II, oil resistant I, VW-1, gasoline-resistant, or has another individual conductor use is individually so marked. Cables that are surface marked “-ER” are for use as exposed runs between a cable tray and utilization equipment where the cables are continuously supported and protected against physical damage using mechanical protection such as struts, angles, or channel.

1.3 The overall jacket on these cables is a “gas/vapor-tight continuous sheath” in the sense discussed in Sections 501.15(D) and 501.15(E) of the NEC (see [12.1.1](#)). However, these requirements do not cover investigation of these cables for transmission of gases or vapors through the core so, when these cables are used in a hazardous location, they may need to be sealed as described in the NEC.

1.4 These cables may contain one or more metal shields but do not have a metal sheath or armor. Electrical cables with a metal sheath or armor are covered as Type MC in the Standard for Metal-Clad Cables, UL 1569.

1.5 Connectors and other fittings for these cables are covered in the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

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

2 Units of Measurement

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

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3 References

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 Wherever the designation "UL 1581" is used in this wire 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 2556" is used in this wire standard, reference is to be made to the designated part(s) of the Standard for Wire and Cable Test Methods, UL 2556.

CONSTRUCTION

4 Materials

4.1 Only materials that are acceptable for the particular use shall be employed in a cable.

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

5 General

5.1 Power and control tray cable shall be designated as Type TC and shall comply in all respects with the applicable requirements for construction details, test performance, and markings.

5.2 The electrical insulation in each of the following cables shall be of a material that is acceptable for use in wet locations:

- a) Cable that is marked for direct burial.
- b) Cable that is intended for use in wet locations.

6 All Conductors

6.1 Except for the thermocouple alloy for thermocouple-extension cables, only copper, copper-clad aluminum, or an acceptable aluminum alloy shall be used for the conductors in a cable. Soft-annealed copper shall comply with ASTM B 3. Solid aluminum conductors in sizes 12 – 8 AWG shall comply with the requirements for aluminum-wire stock (aluminum-alloy conductor material). All other aluminum conductors shall comply with the requirements for semi-annealed 8000 series aluminum conductors in Requirements for Aluminum Conductors of an 8000 Series Alloy, Section 10, of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581. Copper-Clad aluminum conductors shall comply with the requirements in Requirements for Copper-Clad Aluminum Conductors Used in Building Wire, Section 12 of UL 1581.

6.2 A copper conductor shall not be smaller than 18 AWG and shall not be larger than 1000 kcmil. An aluminum or copper-clad aluminum conductor shall not be smaller than 12 AWG and shall not be larger than 1000 kcmil.

6.3 Each 6 – 4/0 AWG and 250 – 1000 kcmil conductor shall be stranded. An 18 or 16 AWG copper conductors shall comply with the requirements for fixture wire conductors in the Standard for Fixture Wire, UL 66. A 14 AWG or larger copper, or 12 AWG or larger aluminum conductor shall comply with the requirements in the Standard for Thermoset-Insulated Wires and Cables, UL 44, or in the Standard for Thermoplastic-Insulated Wires and Cables, UL 83, except as modified in this section.

6.4 Any joint in a conductor shall comply with the applicable standard indicated in [9.2](#), except that a splice is acceptable in an 18 – 10 AWG stranded conductor as a whole if the splice (butt splice) is made by

machine brazing or welding such that the resulting solid section of the stranded conductor is not longer than 1/2 inch or 13 mm, the splice does not increase the diameter of the conductor, there are no sharp points, and the distance between splices in a single conductor does not average less than 3000 ft or 915 m in any reel length of that single insulated conductor. A butt splice shall be made before insulating or after insulating and prior to further processing. Butt splices of stranded conductors made after insulating and splices of insulated solid conductors made with other than the original insulation shall be the subject of an investigation that includes tests to determine that all electrical, physical, and mechanical properties of the original system of insulation and any jacket on the conductor have been restored at the point of each splice. All finished, insulated stranded conductors containing a butt splice or splice made with other than the original insulation shall not be marked as an NEC type but, for polarity identification, color coding and/or surface printing of hash marks, numbers, color names, or the like are acceptable.

7 Compact-Stranded, Sector Conductors

7.1 Compact-stranded, sector conductors shall be shaped as a 120° segment of a circle.

7.2 Compact-stranded, sector conductors shall comply with all of the requirements specified for All Conductors, Section 6, with the following exceptions:

- a) Sector conductors shall be limited to sizes 1/0 AWG – 750 kcmil.
- b) The conductor size shall be determined by the test, DC resistance in UL 2556.
- c) For purposes of calculating lay length, the effective diameter of the conductor shall be determined by adding the lengths of the conductor's major and minor axes and dividing by 2. The major axis is defined as the distance from top of the arc to bottom tip, and the minor axis is defined as the distance from left tip to right tip.
- d) Sector conductors are limited to copper only.

8 Grounding Conductors

8.1 The cable may contain one or more grounding conductors. Each grounding conductor that is provided shall be of copper, aluminum, or copper-clad aluminum and shall not be smaller than indicated in the applicable [Table 8.1](#) (90°C or 194°F conductors), [Table 8.2](#) (75°C or 167°F conductors), or [Table 8.3](#) (60°C or 140°F conductors). See [11.4.2\(b\)](#) (shield as grounding conductor).

8.2 One grounding conductor (bare or insulated) in a flat cable (see [11.1.6](#) for round cable) may be in one location or in several sections (see size limits in [8.3](#)) or may be distributed helically (concentric – see size limits in [8.4](#)) over all of the conductors in the cable. Every other grounding conductor in a flat cable shall not be sectioned or distributed helically.

8.3 A grounding conductor smaller than 14 AWG shall not be sectioned. A sectioned grounding conductor shall not have any part (section) smaller than 18 AWG. See [6.2](#).

8.4 A copper grounding conductor smaller than 14 AWG shall not be distributed helically (concentric). A helically distributed grounding conductor shall not have any of its wires smaller than 26 AWG (15.9 mils or 0.404 mm in diameter) if of copper or 22 AWG (25.3 mils or 0.643 mm in diameter) if of aluminum.

8.5 One grounding conductor may be bare. All others shall be insulated. Grounding-conductor insulation and any individual covering over that insulation shall comply with Circuit Conductors, Section 9, as if the insulated grounding conductor were a circuit conductor and shall comply with [11.1.2](#) (insulation ratings) and [11.1.3](#) (assembly limits). See [11.1.4](#) (placement in a flat cable), [11.1.6](#) (placement in a round cable), [27.1](#) (color), and Insulated Equipment-Grounding Conductors, Section 33 and Isolated-Grounding Conductors, Section 34, (differentiation).

8.6 Any or all insulated grounding conductors may be designated as isolated-grounding conductors, with the outer surface of each such conductor marked as indicated in Isolated-Grounding Conductors, Section 34. See 11.1.4, 11.1.6 (cabling), 27.1 (color), and 31.1(l) (tag marking).

8.7 Cables marked "-ER" as indicated in 30.1 and 31.1 shall contain one or more grounding conductors, except that a grounding conductor is not required in a cable with three or more circuit conductors and no conductor larger than 6 AWG.

Table 8.1
Smallest grounding conductor in cable containing 90°C (194°F) circuit conductors

Size of largest ungrounded circuit conductor in cable		Grounding conductor		Maximum D-C resistance of sectioned or concentric grounding conductor			
		Copper	Aluminum or copper-clad aluminum				
Copper	Aluminum or copper-clad aluminum	Smallest AWG size of unsectioned grounding conductor	Smallest AWG size of unsectioned grounding conductor	20°C (68°F)		25°C (77°F)	
				Ohms based on 1000 feet	Ohms based on 1000 meters	Ohms based on 1000 feet	Ohms based on 1000 meters
18 AWG	—	18	—	7.06	23.2	7.19	23.6
17	—	17	—	5.59	18.3	5.70	18.7
16	—	16	—	4.45	14.6	4.53	14.9
15	—	15	—	3.44	11.3	3.51	11.5
14	12 AWG	14	12	2.73	8.96	2.78	9.14
13	11	13	11	2.16	7.10	2.20	7.24
12	10	12	10	1.72	5.64	1.75	5.75
11	9	11	9	1.37	4.48	1.39	4.56
10 – 8	8 – 6	10	8	1.080	3.546	1.102	3.615
7 – 4	5 – 2	8	6	0.6795	2.230	0.6929	2.274
3 – 2/0	1 – 3/0	6	4	0.4276	1.403	0.4359	1.430
3/0 AWG – 250 kcmil	4/0 AWG – 350 kcmil	4	2	0.2689	0.8820	0.2742	0.8993
300 – 400	400 – 600	3	1	0.2132	0.6996	0.2175	0.7133
450 – 650	700 – 1000	2	1/0	0.1691	0.5548	0.1724	0.5657
700 – 900	—	1	2/0	0.1340	0.4398	0.1367	0.4485
1000	—	1/0	3/0	0.1063	0.3487	0.1084	0.3556

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Table 8.2
Smallest grounding conductor in cable containing 75°C (167°F) circuit conductors

Size of largest ungrounded circuit conductor in cable		Grounding conductor		Maximum D-C resistance of sectioned or concentric grounding conductor			
		Copper	Aluminum or copper-clad aluminum				
Copper	Aluminum or copper-clad aluminum	Smallest AWG size of unsectioned grounding conductor	Smallest AWG size of unsectioned grounding conductor	20°C (68°F)		25°C (77°F)	
				Ohms based on 1000 feet	Ohms based on 1000 meters	Ohms based on 1000 feet	Ohms based on 1000 meters
18 AWG	—	18	—	7.06	23.2	7.19	23.6
17	—	17	—	5.59	18.3	5.70	18.7
16	—	16	—	4.45	14.6	4.53	14.9
15	—	15	—	3.44	11.3	3.51	11.5
14	12 AWG	14	12	2.73	8.96	2.78	9.14
13	11	13	11	2.16	7.10	2.20	7.24
12	10	12	10	1.72	5.64	1.75	5.75
11	9	11	9	1.37	4.48	1.39	4.56
10 – 7	8 – 5	10	8	1.080	3.546	1.102	3.615
6 – 3	4 – 1	8	6	0.6795	2.230	0.6929	2.274
2 – 3/0	1/0 – 4/0	6	4	0.4276	1.403	0.4359	1.430
4/0 AWG – 300 kcmil	250 – 450 kcmil	4	2	0.2689	0.8820	0.2742	0.8893
350 – 550	500 – 800	3	1	0.2132	0.6996	0.2175	0.7133
600 – 800	900 – 1000	2	1/0	0.1691	0.5548	0.1724	0.5657
900 – 1000	—	1	2/0	0.1340	0.4398	0.1367	0.4485

Table 8.3
Smallest grounding conductor in cable containing 60°C (140°F) circuit conductors

Size of largest ungrounded circuit conductor in cable		Grounding conductor		Maximum D-C resistance of sectioned or concentric grounding conductor			
		Copper	Aluminum or copper-clad aluminum				
Copper	Aluminum or copper-clad aluminum	Smallest AWG size of unsectioned grounding conductor	Smallest AWG size of unsectioned grounding conductor	20°C (68°F)		25°C (77°F)	
				Ohms based on 1000 feet	Ohms based on 1000 meters	Ohms based on 1000 feet	Ohms based on 1000 meters
18 AWG	—	18	—	7.06	23.2	7.19	23.6
17	—	17	—	5.59	18.3	5.70	18.7
16	—	16	—	4.45	14.6	4.53	14.9
15	—	15	—	3.44	11.3	3.51	11.5
14	12 AWG	14	12	2.73	8.96	2.78	9.14

Table 8.3 Continued on Next Page



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Table 8.3 Continued

Size of largest ungrounded circuit conductor in cable		Grounding conductor		Maximum D-C resistance of sectioned or concentric grounding conductor			
		Copper	Aluminum or copper-clad aluminum				
Copper	Aluminum or copper-clad aluminum	Smallest AWG size of unsectioned grounding conductor	Smallest AWG size of unsectioned grounding conductor	20°C (68°F)		25°C (77°F)	
				Ohms based on 1000 feet	Ohms based on 1000 meters	Ohms based on 1000 feet	Ohms based on 1000 meters
13	11	13	11	2.16	7.10	2.20	7.24
12	10	12	10	1.72	5.64	1.75	5.75
11	9	11	9	1.37	4.48	1.39	4.56
10 – 6	8 – 4	10	8	1.080	3.546	1.102	3.615
4 – 2	3 – 1/0	8	6	0.6795	2.230	0.6929	2.274
1 – 4/0	2/0 AWG – 300 kcmil	6	4	0.4276	1.403	0.4359	1.430
250 – 400 kcmil	350 – 600	4	2	0.2689	0.8820	0.2742	0.8993
500 – 750	700 – 800	3	1	0.2132	0.6996	0.2175	0.7133
800 – 1000	900 – 1000	2	1/0	0.1691	0.5548	0.1724	0.5657

9 Circuit Conductors

9.1 General

9.1.1 Each power and control circuit conductor shall be insulated.

9.2 NEC types

9.2.1 Each power and control circuit conductor that is available as a National Electrical Code type shall comply with this standard and shall be of one of the following types:

- a) 14 – 4/0 AWG and 250 – 1000 kcmil branch-circuit types complying with the Standard for Thermoset-Insulated Wires and Cables, UL 44, the Standard for Thermoplastic-Insulated Wires and Cables, UL 83, or the Standard for Fluoropolymer Insulated Wire, UL 83A:

Type(s)	Ratings for Type TC application	Standard
FEP and FEPB	200°C (392°F) dry 600 V special applications or 90°C (194°F) dry 600 V	83A
RHH	90°C (194°F) dry 600 V, 1000 V or 2 kV	44
SA	200°C (392°F) dry 600 V, 1000 V special applications or 90°C (194°F) dry 600 V, 1000 V	44
RHW-2	90°C (194°F) wet or dry 600 V, 1000 V or 2 kV	44

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