



UL 1690

STANDARD FOR SAFETY Data-Processing Cable

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Data-Processing Cable, UL 1690

Fourth Edition, Dated July 7, 2015

Summary of Topics

The Fourth Edition of the Standard for Data-Processing Cable, UL 1690, has been issued to reflect the reaffirmation of the ANSI approval. No changes in requirements have been made.

The revisions are substantially in accordance with Proposal(s) on this subject dated May 8, 2015.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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UL 1690

Standard for Data-Processing Cable

First Edition – December, 1993

Second Edition – April, 1999

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Fourth Edition

July 7, 2015

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The most recent designation of ANSI/UL 1690 as a Reaffirmed American National Standard (ANS) occurred on July 7, 2015. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover electrical cables consisting of one or more current-carrying copper, aluminum, or copper-clad aluminum conductors with or without either or both grounding conductor(s), and one or more 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 hybrid cable) in accordance with Article 645 and other applicable parts of the National Electrical Code (NEC) under the raised floor of a computer room.

Cables complying with these requirements are:

Type DP-1 – Voltage Rating 600 volts, Flame Test: 1.2 (b)

Type DP-1P – Same as Type DP-1 except Flame Test: 1.2 (a)

Type DP-2 – Voltage Rating: 300 volts, Flame Test: 1.2 (b)

Type DP-2P – Same as Type DP-2 except Flame Test: 1.2 (a)

Type DP-3 – Voltage Rating none – for use in signaling circuits meeting the following requirements for maximum available voltage, current and power.

30 volts ac max.

60 volts dc max.

42.4 volts peak max.

100 VA max.

8 amps max.

and/or

other circuits for use in
inherently limited power
sources in accordance with
the requirements in the Standard
for Safety of Information Technology
Equipment – UL 60950

Flame Test: 1.2 (b)

Type DP-3P – Same as Type DP-3 except Flame Test: 1.2 (a)

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

a) TYPE DP-1P, DP-2P and DP-3P CABLES – These cables are 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, ANSI/NFPA 262. A cable that complies exhibits a maximum flame-propagation distance that is not greater than 5 ft, 0 in, or 1.52 m, a peak optical density of smoke produced of 0.5 or less (32 percent light transmission), and an average optical density of smoke produced of 0.15 or less.

b) TYPE DP-1, DP-2, and DP-3 CABLES – Cables comply 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 30.2.1 – This paragraph applies the test method described as the UL Flame Exposure (smoke measurements are not applicable) in the Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685. For compliance, this test damages less than 8 feet (244 cm) of cable.

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2) THE FT4/IEEE 1202 TEST REFERENCED IN 30.3.1 – This paragraph applies the test method described as the FT4/IEEE 1202 Type of Flame Exposure (smoke measurements are not applicable) in the Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685. For compliance, this test damages less than 150 cm (59 inches) of cable.

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 limited (see 14.2) to carrying optical energy that has been ruled not hazardous to the human body. A cable may consist of or contain one or more coaxial members.

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, or Type AC in the Standard for Armored Cable, UL 4.

1.5 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 In addition to being stated in the inch/pound units that are customary in the USA, each of the requirements in this Standard 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.

3 References

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

3.2 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.

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 Data Processing cable shall be designated as Type DP and shall comply in all respects with the applicable requirements for construction details, test performance, and markings.

5 Conductors

5.1 The conductor shall be of soft-annealed copper, high-conductivity copper alloy, copper-clad aluminum, copper-clad steel or an acceptable aluminum alloy. Soft-annealed copper shall comply with ASTM B 3. Copper alloy shall comply with ASTM B 624. A metal coating that is provided on soft-annealed copper, on copper alloy, or on copper-clad aluminum in compliance with Section 8 shall be of tin complying with ASTM B 33, of a tin/lead alloy complying with ASTM B 189, of nickel complying with ASTM B 355, of silver complying with ASTM B 289, or of another metal or alloy (evaluation required). Solid aluminum conductors in size Nos. 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 Section 10 of UL 1581. Copper-clad aluminum conductors shall comply with the requirements in Section 11 of UL 1581.

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

6 Size, Temper, and Assembly

6.1 Conductors shall be of the size, temper, and assembly indicated for the finished wire type in Table 6.1.

Table 6.1
Conductors

Cable type	Sizes of aluminum or copper-clad aluminum conductors	Sizes of soft-annealed copper conductors	Sizes of solid or stranded copper-clad steel or copper alloy conductors
DP-1	12 AWG – 1000 kcmil	18 AWG – 1000 kcmil	None
DP-2	12 – 8 AWG	24 – 8 AWG	None
DP-3	None	30 – 10 AWG ^a	30 – 10 AWG ^a
^a Nos. 11 and 10 AWG copper conductors and No. 10 AWG and smaller copper-clad steel or copper alloy conductors are only for the central conductor in a coaxial member.			

7 Conductor Diameter and Cross-Sectional Area

7.1 The nominal, maximum ($1.01 \times$ nominal), and minimum ($0.98 \times$ nominal) diameters of solid and stranded conductors are shown in Tables 20.1, 20.2, 20.3, 20.3.1, 20.4, and 20.6 of UL 1581. Conductor diameter is to be measured using the method shown in Section 200 of UL 1581. The sizes of the various types of wire are indicated in Table 6.1.

7.2 Compressed unilay copper conductors that are smaller in diameter than the requirement ($0.98 \times$ nominal in Table 20.1 of UL 1581) for compressed concentric lay conductors shall be marked the same as compact conductors in accordance with 38.1.

7.3 The nominal cross-sectional area of a conductor is indicated in Table 20.1 of UL 1581 (not a requirement).

8 Metal Coating

8.1 If the insulation adjacent to a copper, copper alloy, copper-clad aluminum, or copper-clad steel conductor is of a material that corrodes unprotected copper in the test in 500.1 of UL 1581, and if a protective separator is not provided, the solid conductor and each of the individual strands of a stranded conductor shall be separately covered with a metal or alloy coating complying with 5.1 as applicable to the finished wire type.

8.2 In the case of a stranded conductor on which a coating is not needed for corrosion protection but is solely to keep the insulation from adhering to copper, it is acceptable to coat only the wires of the outer layer.

8.3 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 item (b) of 15.5.2. Otherwise, copper strands and solid copper conductors shall not be used in a cable with a temperature rating higher than indicated in Table 8.1. Aluminum or copper-clad aluminum conductors shall not be used in a cable with a temperature rating higher than 90°C (194°F).

Table 8.1
Maximum temperature rating of cable relative to diameter and coating of solid copper conductor 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 or 0.38 mm	At least 0.015 inch or 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)	200°C (392°F)

9 Separator

9.1 A separator is acceptable between the conductor and the insulation of a solid or stranded wire or cable, but is not required. A separator shall be insulating but shall not be considered to be part of the required insulation.

9.2 A separator used between a conductor and insulation shall be colored or shall be opaque to make the separator clearly distinguishable from the conductor once the insulation is removed. The color shall be other than green or green and yellow and may be solid, striped, or in some other pattern.

10 Joints

10.1 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 essentially smooth, and shall not have any sharp projections. A joint in a stranded conductor may be made by:

- a) Separately joining each individual wire, or
- b) For Type DP-3 only 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 in or 13 mm, there are no sharp points, and the distance between brazes or welds in a single conductor does not average less than 3000 ft or 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). For Type DP-3 only, a joint made after insulating shall not increase the diameter of the solid conductor or individual wire (strand) by more than 20 percent. The insulation applied to joints after insulating shall be equivalent to that removed and shall comply with the requirements in this standard. Heat-shrinkable tubing, bonded patch, and molding is accepted for Type DP-3 but taping is not. A joint in a compact- or compressed-stranded conductor shall not be made before compacting or compressing.

10.2 In a rope-lay stranded conductor, which consists of a central core surrounded by one or more layers of stranded members (primary groups), each member may be considered equivalent to a solid wire and, as such, is acceptable spliced as a unit. These joints are not to be any closer together than two lay lengths.

11 Resistance

11.1 The direct-current resistance of any length of conductor shall not be higher than the maximum acceptable (nominal $\times 1.02$) indicated in the applicable one of the eleven Tables 30.1 – 30.11 of UL 1581 at 20°C (68°F) or at 25°C (77°F) or in Table 11.1 of this Standard when measured as described in 220.1 – 220.9 of UL 1581.

Table 11.1
Maximum acceptable direct-current resistance of solid copper conductors

AWG size of conductor	Uncoated				Coated			
	20°C		25°C		20°C		25°C	
	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer
30	114	374	117	384	119	390	121	397
29	89.3	293	91.1	299	92.9	305	94.7	311
28	71.8	236	73.3	240	74.7	245	76.2	250
27	56.5	185	57.6	189	58.8	193	59.9	197
26	45.1	148	46.0	151	46.9	154	47.8	157
25	35.6	117	36.3	119	37.0	121	37.7	124
24	28.6	93.8	29.2	95.8	31.5	103	32.1	105
23	22.3	73.2	22.7	74.5	23.2	76.1	23.7	77.8
22 DP2	16.5	54.1	16.8	55.1	17.2	56.4	17.5	57.4
22 DP3	18.0	59.1	18.4	60.4	19.8	65.0	20.2	66.3
21 DP2	13.1	43.0	13.3	43.6	13.6	44.6	13.8	45.3
21 DP3	14.1	46.3	14.4	47.2	14.7	48.2	15.0	49.2

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Table 11.1 Continued on Next Page

Table 11.1 Continued

AWG size of conductor	Uncoated				Coated			
	20°C		25°C		20°C		25°C	
	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer
20 DP2	10.3	33.8	10.5	34.5	10.7	35.1	10.9	35.8
20 DP3	11.1	36.4	11.3	37.1	11.6	38.1	11.8	38.7
19 DP2	8.21	26.9	8.37	27.4	8.54	28.0	8.70	28.5
19 DP3	8.86	29.1	9.04	29.7	9.21	30.2	9.39	30.8
18	6.52	21.4	6.65	21.8	6.78	22.2	6.91	22.7
17	5.15	16.9	5.25	17.2	5.36	17.6	5.47	17.9
16	4.10	13.5	4.18	13.7	4.26	14.0	4.35	14.3
15	3.24	10.6	3.30	10.8	3.37	11.1	3.43	11.3

12 Stranding

12.1 A stranded wire or cable shall have the number of strands indicated in Table 12.1. Copper strands smaller than No. 36 AWG shall not be used on 24 AWG and larger conductors. Aluminum or copper-clad aluminum strands smaller than No. 22 AWG shall not be used. A compact-stranded conductor shall not be segmented.

Table 12.1
Conductor stranding

Size of wire	Number of strands in combination unilay	Minimum number of strands	
		Compact stranded	All others
30 – 13 AWG	—	—	7
14 and 13	19 (copper only)	—	7
12 – 9	19 (copper only)	7	7
7 – 2	19	7	7
1 – 4/0	19	18	19
213 – 500 kcmil	—	35	37
501 – 1000	—	58	61

12.2 The individual wires used in making up a stranded conductor are usually drawn to a specified mil diameter which may or may not be the diameter of any AWG or other standard gauge number. The individual wires of a concentric-lay-stranded conductor are not necessarily all of the same diameter.

12.3 A 19-wire combination round-wire unilay-stranded soft-annealed copper or aluminum conductor shall be round and shall consist of a straight central wire, an inner layer of six wires of the same diameter as the central wire with the six wires having identical lengths of lay, and an outer layer consisting of six wires of the same diameter as the central wire alternated with six smaller wires having a diameter of 0.732 times the diameter of the central wire and with all twelve wires of the outer layer having the same length of lay and direction of lay as the six wires of the inner layer. No particular assembly of the individual wires of any other stranded conductor is required, but simple bunching (untwisted strands) shall not be used for the entire conductor or any part thereof. The length of lay of the strands in a single-bunch bunch-stranded conductor shall not be greater than indicated in Table 12.2. The direction of lay of the strands in a single-bunch bunch-stranded conductor shall be left-hand. Any type of stranding in Table 210.2 of UL 1581 other than compact stranding or single-bunch-stranding shall comply with the applicable 12.4, 12.5, or 12.6. The direction of lay of the outer layer shall be left-hand in all cases.

Table 12.2
Length of lay of strands in a single-bunch bunch-stranded conductor^a

AWG size of conductor	Maximum acceptable length of lay	
	inch	mm
18	1	25
16	1-1/4	32
14	1-5/8	41
13	1-5/8	41
12	2	51
11	2	51
10	2-1/2	64
9	2-1/2	64
8	2-3/4	70
7	3	76
6	3-3/8	86
larger than 6	16 times the conductor diameter	

^a Includes the constructions in note ^a to Table 210.2 of UL 1581.

12.4 A compact-stranded conductor shall be a round aluminum conductor consisting of a central core wire surrounded by one or more layers of helically laid wires with all layers having the same direction of lay (left-hand unidirectional) and with each layer rolled, drawn, or otherwise compressively formed to distort the originally round or partially preshaped strands to various close fitting shapes that achieve almost complete filling of the spaces originally present between the strands. Each layer shall be compacted before the next layer is applied, and each compacted layer – including the outermost layer – shall have an essentially smooth, round outer surface. The overall diameter of the finished, compacted conductor shall not be larger than indicated in column C or D of Table 20.2 of UL 1581. The length of lay of the strands in the outer layer of a No. 1 AWG – 4/0 AWG conductor shall be 8 – 16 times the overall diameter of that layer. The length of lay of the strands in the outer layer of a No. 12 – 2 AWG conductor shall be 8.0 – 17.5 times the overall diameter of that layer.

12.5 A compressed-stranded conductor shall be a round conductor consisting of a central core wire surrounded by one or more layers of helically laid wires with, for the No. 6 AWG – 1000 kcmil sizes, the direction of lay reversed in successive layers. The direction of lay of the outer layer shall be left-hand in all cases. The strands of one or more layers are to be slightly compressed by rolling, drawing, or other means to change the originally round strands to various shapes that achieve filling of some of the spaces originally present between the strands. A finished compressed-stranded ASTM Class B, C, or D conductor shall not be larger or smaller in overall diameter than indicated in Table 20.3 of UL 1581.

12.6 Every stranded conductor covered in Table 210.2 of UL 1581 other than a compact-stranded conductor or a single-bunch bunch-stranded conductor shall comply with the following:

- a) The direction of lay of the strands, members, or ropes in a No. 6 AWG – 1000 kcmil conductor other than a combination unilay or compressed-unidirectional-lay conductor shall be reversed in successive layers. Rope-lay conductors with bunch-stranded or concentric-stranded members shall be either unidirectional or reversed. All unidirectional lays and the outer layer of reversed lays shall be in the left-hand direction.

- b) For a bunch-stranded member of a rope-lay-stranded conductor in which the members are formed into rope-stranded components that are then cabled into the final conductor, the length of lay of the individual members within each component shall not be more than 30 times the outside diameter of one of those members.
- c) For a concentric-stranded member of a rope lay-stranded conductor, the length of lay of the individual strands in a member shall be 8 – 16 times the outside diameter of that layer. The direction of lay of the strands in each member shall be reversed in successive layers of the member.
- d) The length of lay of the strands in both layers of a 19-wire combination round-wire unilay-stranded conductor shall be 8 – 16 times the outside diameter of the completed conductor. Otherwise, the length of lay of the strands in every layer of a concentric-lay-stranded or compressed-stranded conductor consisting of fewer than 37 strands shall be 8 – 16 times the outside diameter of that conductor.
- e) The length of lay of the strands in the outer two layers of a concentric-lay-stranded conductor consisting of 37 or more strands shall be 8 – 16 times the outside diameter of the conductor.
- f) The length of lay of the members or ropes in the outer layer of a rope-lay-stranded conductor shall be 8 – 16 times the outside diameter of that layer.

13 Insulation

13.1 Material and Application

13.1.1 Each conductor shall be insulated for its entire length with one or more of the insulation materials indicated in Table 13.1 or referenced in note ^a to Table 13.1. The insulation shall be solid or, in the cases indicated in the second column of Table 13.1, may be expanded or 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 13.1 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. 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. The use of foamed or expanded insulation or an air-gap construction is limited to Type DP-3 series cables.

13.1.2 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 Long-Term Aging, Section 481 of UL 1581:

- a) Material generically different from any insulation or jacket material that is named in Table 13.1 or 16.1 (new material).

b) Material that is named in Table 13.1 or 16.1 yet does not comply with the short-term tests specified for the material.

The temperature rating of materials (a) and (b) shall be as required for the specific data-processing cable type. The thicknesses of insulation and/or jacket using materials (a) and/or (b) shall be as required for the 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 13.1 or 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.

Table 13.1
Index to insulations

Material(s) ^a	Temperature rating of insulation	Applicable table of physical properties in UL 1581 (see 13.2)
CP	90°C (194°F) solid	50.1
	75°C (167°F) solid	50.1
ECTFE ETFE	150°C (302°F) solid	50.63
	foamed	—
FEP	200°C (392°F) ^b solid	50.70
	foamed	—
HDFRPE LDFRPE	75°C (167°F) solid	50.133
	foamed	—
HDPE	75°C (167°F) solid	50.136
	foamed	—
LDPE	75°C (167°F) solid	50.136
	foamed	—
PFA or MFA	200°C (392°F) ^b solid	50.137
	foamed	—
	250°C (482°F) ^b	50.137
Polypropylene: PP, FRPP (DP-3 series only)	75°C (167°F) solid	50.139
	foamed	—
	60°C (140°F) solid	50.139
	foamed	—