



UL 444

STANDARD FOR SAFETY Communications Cables

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UL Standard for Safety for Communications Cables, UL 444

Fifth Edition, Dated January 20, 2017

Summary of Topics

This revision of ANSI/UL 444 is being issued to incorporate a revision to the Dielectric Strength Test.

As noted in the Commitment for Amendments statement located on the back side of the title page, UL and CSA are committed to updating this harmonized standard jointly.

Text that has been changed in any manner or impacted by UL'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 October 20, 2017.

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Eighth Edition



Underwriters Laboratories Inc.
UL 444
Fifth Edition

Communications Cables

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquires@csagroup.org and include “Proposal for change” in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the Fifth edition including revisions through September 24, 2018.

The most recent designation of ANSI/UL 444 as an American National Standard (ANSI) occurred on September 24, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

The Department of Defense (DoD) has adopted UL 444 on June 12, 1987. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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Preface

This is the harmonized CSA Group and UL standard for Communications Cables. It is the eighth edition of CAN/CSA-C22.2 No. 214, and the fifth edition of UL 444. This harmonized standard has been jointly revised on September 24, 2018. For this purpose, CSA Group and UL are issuing revision pages dated September 24, 2018.

This harmonized standard was prepared by the CSA Group and Underwriters Laboratories Inc. (UL).

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This Standard was reviewed by the CSA Subcommittee on Communication Cable, under the jurisdiction of the Technical Committee on Wiring Products and the Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the Technical Committee.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of Harmonization

This standard uses an IEC format, but is not based on, nor is it to be considered equivalent to, an IEC standard.

This standard is published as an identical standard for CSA Group and UL.

An identical standard is a standard that is exactly the same in technical content except for national differences resulting from conflicts in codes and governmental regulations. Presentation is word for word except for editorial changes.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

Communications Cables

1 Scope

1.1 This standard applies to 60 – 250°C single- or multiple-conductor jacketed or unjacketed, integral or nonintegral cables and single or multiple coaxial cables for telephone and other communication circuits such as voice, data, and audio for on-premise customer systems. These cables may contain one or more optical fibre members. For the purpose of this standard, a coaxial cable or coaxial member conductor is a single conductor with a shield. For the purpose of this standard, a single- or multiple-conductor unjacketed cable is a cross-connect wire.

1.2 This standard applies to communications cables that are intended primarily for installation in accordance with Section 60 of the *Canadian Electrical Code Part I*, and Article 800 of the *National Electrical Code* (NEC), ANSI/NFPA 70. They are rated for 300 V applications, but are not so marked.

Note: See Annex A for a complete list of wire types covered by this Standard and the specific electrical codes for which they are intended.

1.3 This standard does not apply to communications cords.

1.4 In Canada, the Type “-CI” circuit integrity markings are not recognized by the Canadian Electrical Code, Part I.

In the US, Type CMH is not recognized in the NEC.

1.5 If a value for measurement is followed by a value in other units in parenthesis, the second value may be only approximate. The first stated value is the requirement.

2 Reference publications

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.

CSA Group

C22.1–15

Canadian Electrical Code, Part I

CAN/CSA-C22.2 No. 0–10

General Requirements – Canadian Electrical Code, Part II

CSA C22.2 No. 2556–15

Wire and Cable Test Methods

UL (Underwriters Laboratories)

UL 1581

Reference Standard for Electrical Wires, Cables, and Flexible Cords

UL 1666

Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

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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

ANSI (American National Standards Institute)

Z136 Series

Safe Use of Lasers

ANSI/ASTM (American National Standards Institute/American Society for Testing and Materials)

E230/E230M

Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples

ANSI/NFPA (American National Standards Institute/National Fire Protection Association)

NFPA 70

National Electrical Code

ASTM (American Society for Testing and Materials)

B33

Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

B189

Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes

B298

Specification for Silver-Coated Soft or Annealed Copper Wire

B355

Specification for Nickel-Coated Soft or Annealed Copper Wire

B566

Standard Specification for Copper-Clad Aluminum Wire

B869

Specification for Copper-Clad Steel Electrical Conductor for CATV Drop Wire

D5374

Test Methods for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation

D5423

Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation

NFPA (National Fire Protection Association)

NFPA 262

Standard Method of Test for Flame Travel and Smoke of Wire and Cables for Use in Air-Handling Spaces

3 Definitions

3.1 The following definitions apply in this standard:

3.2 **BONDED METAL SHIELD** – A covering over the cable core assembly consisting of a metal tape whose outer surface is adhesively bound to a polymeric jacket over it.

3.3 **CAPABILITY TEST** – A test that is conducted periodically on a cable component, or on a completed cable, intended to be proof of adequate construction and processing, and that is repeated for verification.

3.4 **COAXIAL CABLE** – A cable having one or more coaxial members, each consisting of a conductor centred inside one or more outer conductors consisting of metal tubes or shields, separated from the central conductor by a dielectric material.

3.5 **COVERING** – A jacket, sheath, or armour.

3.6 **CROSS-CONNECT WIRE (CABLE)** – A single- or multiple-conductor construction consisting of insulated conductors without an overall jacket.

3.7 **DIELECTRIC** – An insulating (nonconducting) medium.

3.8 **EQUIVALENT GAUGE** – A round conductor AWG number used to designate a flat conductor that has a cross-sectional area equal to that of the round conductor.

3.9 **GROUND PLANE** – A partially encompassing shield provided to reduce stray electrical fields.

3.10 **INTEGRAL COVERING** – A single extruded layer that serves as both insulation and jacket.

3.11 **JACKET** – A continuous nonmetallic outer covering.

3.12 **MANUFACTURING AND PRODUCTION TEST** – A test performed on a length of wire before further processing and/or on a completed cable before shipment.

3.13 **SEMICONDUCTING** – A material whose resistivity at room temperature is in the range of 10^{-2} – $10^9 \Omega \cdot \text{cm}$.

3.14 **SHIELD** – A conducting layer consisting of tape, braid, wire, or sheath, or a semiconducting layer.

3.15 **THERMOPLASTIC** – An insulation or jacket material that is capable of being repeatedly softened by heating and hardened by cooling through a temperature range characteristic of the material, and which in its softened state is capable of being shaped through the application of force.

Note: Examples of thermoplastic materials are polyethylene (PE), poly (vinyl chloride) (PVC), nylon, and polyethylene terephthalate (PET).

3.16 **THERMOSET** – A cross-linked insulating or jacketing compound that does not soften and flow on subsequent heating.

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4 General Requirements

The requirements of CAN/CSA-C22.2 No. 0, when appropriate, apply to this standard.

5 Construction

5.1 Conductors

5.1.1 The conductors shall be solid or stranded, annealed, bare, or metal-coated copper. The centre conductor of coaxial cables is also permitted to be a smooth or corrugated copper tube. The centre conductor of CMP, CMR, CMG, CM, CMH, and CMX coaxial cables made of copper-clad steel shall have 21 percent or higher conductivity in accordance with ASTM Standard B869.

5.1.2 The centre conductor of CMP, CMR, CMG, CM, and CMX coaxial cables made of copper-clad aluminum shall be in accordance with ASTM Standard B566.

5.1.3 If the insulation adjacent to the copper conductor is of a material that corrodes unprotected copper in the test described in Clause 7.1, the conductor shall be covered with a coating of tin complying with ASTM Standard B33, of lead or lead-alloy complying with ASTM Standard B189, of nickel complying with ASTM Standard B355, of silver complying with ASTM Standard B298, or of another metal or alloy. Evaluation of the effectiveness of these coatings shall be required. Metal-coating a conductor on which the coating is not required for corrosion protection shall be permitted. When this is done, the 100 percent coverage requirement of the relevant ASTM Standard shall be waived.

The maximum temperature rating of cables relative to the diameter and coating of solid copper conductors or copper conductor strands or the thickness and coating of tubular copper conductors shall not be higher than those shown in Table 1.

5.1.4 For stranded conductors, the length of lay of the strands shall not exceed 20 times the calculated diameter over the assembled conductor for 19 – 6 AWG conductor, or 30 times for 30 – 20 AWG conductor. The direction of lay of the strands may be right- or left-hand.

5.1.5 The conductors shall be continuous when tested in accordance with Clause 6.2.

5.1.6 The size of the copper conductor shall be determined either by means of the resistance shown in Tables 2 and 3, or by means of the dimensions shown in Table 5. In case of dispute, the resistance method shall be the referee method. The size of copper-clad steel or copper-clad aluminum conductor shall be determined by means of the dimensions shown in Table 5. Applications for various AWG sizes and conductor compositions are shown in Table 4.

5.1.7 Resistance shall be determined in accordance with Clause 7.16.

5.1.8 Dimensions shall be determined in accordance with Clause 7.17.

5.1.9 A joint in a solid conductor or in one of the individual wires of a stranded conductor shall be made in a skillful 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) Machine brazing or welding of the conductor as a whole.

In either case, the resulting solid section of the stranded conductor shall be not longer than 13 mm (1/2 in), there shall be no sharp points, and the distance between brazes or welds in a single conductor shall not average less than 915 m (3000 ft) 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 percent.

The insulation applied to joints after insulating shall be equivalent to that removed (means of insulation such as heat-shrinkable tubing, bonded patch, and molding have been found acceptable, but taping has not) and shall comply with the requirements in this Standard.

5.1.10 Any section of a conductor that includes a factory joint shall have a breaking strength that is not less than 85 percent of the breaking strength of an adjacent section of the conductor without a joint.

5.1.11 "CMX Outdoor" cables shall be smaller in diameter than 6.35 mm (0.25 in).

5.1.12 "CMX Outdoor – CMR" shall also comply with the requirements for CMR cables. These cables may have an overall diameter greater than 6.35 mm (0.25 in).

5.1.13 "CMX Outdoor – CMG" shall also comply with the requirements for CMG cables. These cables may have an overall diameter greater than 6.35 mm (0.25 in).

5.1.14 "CMX Outdoor – CM" shall also comply with the requirements for CM cables. These cables may have an overall diameter greater than 6.35 mm (0.25 in).

5.2 Insulation

5.2.1 Each conductor shall be insulated with one or more continuous layers of solid and/or expanded material. The insulation shall be uniform and shall not have any defects (bubbles, open spots, rips, tears, cuts, or foreign material) that are visible without magnification to normal or corrected-to-normal vision. The average thickness of the insulation and the minimum thickness at any point of the insulation are not specified. The average thickness of insulation used, including the average thickness of the tube portion of an air-gap coaxial member, shall be determined by means of an optical device. The method for measuring the thickness of insulation and for rounding off the results shall be as described in Clause 7.15.

5.2.2 The insulation in an air-gap coaxial member shall consist of a solid or foam tube over a solid or foam spacer.

5.2.3 Each conductor, including the centre conductor for a coaxial member, shall meet the dc or ac spark test as described in Clause 6.1 after being insulated and before any subsequent operation. One hundred percent of product shall be tested by the manufacturer at the factory.

5.2.4 The thickness of insulation at any point in a cable with a separable jacket (non-integral construction) shall be sufficient to meet the applicable manufacturing and production tests of Section 6 and the capability tests of Section 7. The thicknesses of the integral insulation (solid) and jacket in 2-, 3-, or 4-conductor flat, parallel cable shall be not less than as indicated in Table 6.

5.2.5 The insulated conductors shall be distinctly identified.

5.2.6 The insulated conductors shall be suitable for indoor use where normal conditions are such that cables may be subjected to maximum operating conditions from 60 – 250°C, inclusive. See Clause 7.3 for temperature rating requirements.

5.3 Optical fibre members

5.3.1 One or more glass fibres that are individually coated and buffered, jacketed either singly in a tight jacket, or in a group in a loose tube, or enclosed in a nonmetallic tape, wrap, or braid that provides complete coverage may be included along with the copper conductors.

5.3.2 An optical fibre member, or group of members, may include one or more metallic or nonmetallic strength members.

5.3.3 The construction of the glass fibre, the coatings, and the fibre jacket is not specified. The construction of nonmetallic tape, wrap, or braid is not specified. The construction of nonmetallic or non-current-carrying metal strength members is not specified.

5.3.4 Non-current-carrying metallic members included in optical fibre member(s) shall be electrically continuous, and shall meet the requirements of Clause 6.2.

5.4 Core assembly

5.4.1 A communications cable shall be essentially round or flat.

5.4.2 Two or more insulated conductors with or without one or more coaxial or optical fibre members shall be assembled to form a cable core. A cable may also consist of one or more coaxial member with or without optical fibre members. A round cable core consisting of 12 or fewer pairs, or 2, 3, or 4 single insulated conductors, may have the pairs or insulated conductors laid straight, but otherwise all conductors, groups of conductors, members, and groups of members shall not be laid straight. In any case, the length of lay is not specified. The direction of lay may be right- or left-hand and may be changed at intervals throughout the length of the cable. The use of fillers is optional. Different conductors and coaxial members may be insulated with different materials if the materials comply with Clause 5.2 on conductor insulation. The conductors in the cable may be of any mixture of sizes and stranding.

5.4.3 When optical fibre member(s) are assembled with other electrical conductors in a common layer, they shall be cabled with the same direction and length of lay as the electrical conductors; otherwise the direction and the length of lay is not specified.

Optical fibre members may include one or more non-current-carrying, electrically conductive members such as a metal strength element or a metal vapour barrier. The construction of these parts is not specified.

5.5 Defective pairs

5.5.1 The cable is not acceptable if the applicable factory dielectric strength test described in Clause 6.3 shows any defective pair having a breakdown of the insulation of either conductor to a shield.

5.5.2 A defective pair shall be any pair in which the following discontinuity and/or dielectric faults are revealed in testing by the cable manufacturer at the cable factory:

- a) Discontinuity in either conductor of the pair determined by means of the test described in Clause 6.2; and
- b) One or more of the following dielectric breakdowns of the insulation determined by means of the applicable dielectric strength test described in Clause 6.3:
 - i) Conductor to conductor within the pair;
 - ii) Either conductor of the pair to any conductor outside the pair.

5.5.3 Cables that contain 200 or more pairs may contain acceptable defective pairs in a quantity that shall not exceed 0.5 percent of the number of pairs marked on the tag, reel, or carton for the cable. Both ends of a cable in which there are one or more acceptable defective pairs shall be marked to warn of the presence of the defective pair(s). A notice such as a defective-pair tag shall be attached to each end of a cable in which there are factory-located defects. The notices shall identify the factory counting system (establish a direction for counting multiunits) and shall also identify each of the factory-found acceptable defective pairs according to layer (if pertinent to the counting system), multiunit number, unit colors, and pair color.

5.6 Spare pairs

Cables that contain 400 or more pairs may also contain spare pairs to make certain that the number of usable pairs equals or exceeds the number of pairs marked on the tag, reel, or carton. The quantity and position of the spare pairs are not specified. The colors of each spare pair shall be derived from the standard colors and shall be in unique combinations, and it shall not be possible to confuse them with the colors of the regular cable pairs.

5.7 Core binders

The core, any group of conductors, or several groups within the core may be bound by a nonmetallic binder. No other details of the core binders are specified.

5.8 Core wrap

The core, any group of conductors, or several groups within the core may be enclosed in a nonmetallic core wrap consisting of a serving, wrap, tape, or other construction. A metal shield as described in Clause 5.9.1 may serve as a core wrap. No other details of the core wrap are specified.

5.9 Shields

5.9.1 An electromagnetic shield is optional other than as the outer conductor in a coaxial member. One or more shields may be used in a given cable.

5.9.2 Where used, the shield(s) shall be electrically continuous and shall comply with the test requirements of Clause 6.2. To facilitate electrical bonding to ground of the shield(s), a continuous uninsulated, uncoated or metal coated, solid or stranded, copper conductor (drain wire) when used shall be placed in contact with the shield(s). Uncoated copper drain wires shall not be used when aluminum-faced tape is used as a shield.

5.10 Jackets

5.10.1 A jacket consisting of a continuous nonmetallic outer covering consisting of a material complying with the requirements of Clauses 5.10.2 – 5.10.8 shall be applied over the cable construction.

5.10.2 The jacket shall be uniform and shall not have any defects (bubbles, open spots, rips, tears, cuts, or foreign material) that are visible without magnification to normal or corrected-to-normal vision.

5.10.3 All cables except those with an overall core wrap as described in Clause 5.8 or an overall bonded or unbonded metal shield as described in Clause 5.9 shall comply with the peel test requirements of Clause 7.11.

5.10.4 Minimum point and minimum average jacket thickness shall be in accordance with requirements specified in Table 7 for jacket materials other than fluoropolymers, and Table 8 for fluoropolymer jacket materials. Maximum average thickness requirements shall be determined from the submitted sample.

For reference purposes, measurements shall be made by means of an optical instrument that is calibrated to read to at least 0.001 mm (0.0001 in).

5.10.5 Jackets with thicknesses other than indicated in Tables 7 and 8 are acceptable if the finished cable complies with the requirements of the tests described in this Standard. Evaluation of thinner jackets shall include, but not be limited to, crush, impact, and abrasion tests.

5.10.6 Cables on which a jacket thicker than as indicated in Table 7 or 8 is necessary to enable the cable to comply with any applicable flame or other test described in these requirements shall be made with whatever greater thickness of jacket may be needed for this purpose. In this case, the minimum thickness at any point of the thicker jacket shall be not less than 80 percent of the average thickness of the heavier jacket.

5.10.7 Jackets shall be capable of meeting the unaged and heat-aged requirements in accordance with Clause 7.8.

5.10.8 Tensile strength values of jacket materials, as specified in Tables 9 and 10 shall be determined in accordance with the test, Insulation and Jacket Physical Properties in CSA C22.2 No. 2556 or UL 2556.

5.10.9 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 shall either be stripped and replaced in its entirety or have a second jacket applied over the first.

5.11 Metallic covering

An electrically continuous metal sheath or braid may be applied over the jacketed cable (see Note to Table 11).

5.12 Metallic messenger

5.12.1 A metallic messenger may be joined to the outermost jacket by the means of a web. The jacket thickness over the messenger and between the messenger and the cable core is not specified, provided that the required jacket thickness over the conductors is not reduced.

6 Manufacturing and Production Tests

6.1 Spark test after insulating

6.1.1 No insulated conductor shall show more than an average of one fault per 915 m (3000 ft) in any reel length of single insulated conductor when spark tested as described in the test, Spark, of CSA C22.2 No. 2556 or UL 2556.

6.1.2 A dc or ac spark tester shall include a voltage source, an electrode, a voltmeter, a system for detecting, counting, and signalling faults, and the necessary electrical connections. The ability of the equipment to comply with the requirements in Clause 6.1.3 shall be certified at least annually by an accredited independent calibration service or its investigated equivalent such as by checking the test potential with an applicable voltmeter whose calibration is traceable to a nationally recognized standard.

6.1.3 The voltage source of a dc or ac spark tester shall maintain the following test voltage under all normal conditions of leakage current:

- a) An essentially sinusoidal rms potential of 1750 V for an ac test;
- b) 2500 V for a dc test. The current output of which the dc power supply is capable shall not exceed 5 mA. Any ripple shall not exceed 1 percent. After a fault, the dc test voltage shall recover to the full test voltage in 5 ms or less, unless 610 mm (2 ft) or less of the product travels through the electrode in the time that it takes for the full voltage recovery;
- c) For conductor gauge sizes 22 – 30 AWG which are to be used in cables without coaxial members, but with foam or foam skin insulation and protected by bonded metal shields, the following spark test voltage may be used: