HIGH SPEED COMMUNICATIONS PLENUM CABLE

CATEGORY 5e

LIMITED COMBUSTIBLE, PVC-FREE

UNSHIELDED TWISTED PAIR (UTP)

This specification complies with the electrical requirements of ANSI/TIA/EIA-568-B.2, Addendum 1. The specification also complies with the primary requirement for limited combustible and smoke-developed cables installed in ceiling cavity and raised floor plenums in accordance with the Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A. This cable also complies with, and exceeds, the flame and smoke requirements for cable installed in ducts, plenums and other spaces used for environmental air in accordance with Articles 725,760,770, 800, 825 and 830 of the National Electrical Code (NEC), NFPA 70.

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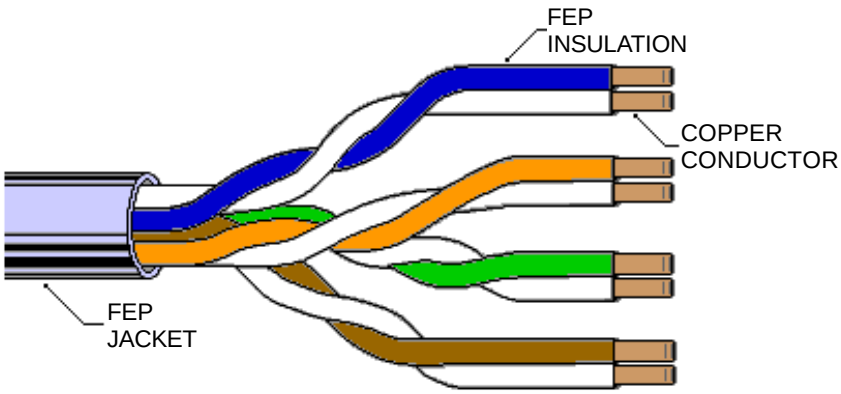
Category 5e Limited Combustible, PVC-Free



SCOPE

This specification defines the requirements for commercially available, high-performance Category 5e limited combustible, CMP plenum-rated LAN communications cable.

CABLE CONSTRUCTION	
Conductor	24 AWG solid annealed copper.
Insulation	FEP fluoropolymer resin on each pair.
Jacket	FEP fluoropolymer.

2.0 Introduction

This specification assures a cable that demonstrates both outstanding fire safety and high speed electrical transmission performance, based on approved industry consensus codes, standards and testing methods. New emphasis and research into cable fire safety peformance and the environmental hazards associated with legacy CMP communications cables containing PVC, have resulted in new cable designs that significantly reduce smoke damage from fire and, at the same time, eliminate the widely recognized environmental and disposal hazards from cables containing lead and other materials used in PVC compounds. These new cable designs, which are commercially available from several major manufacturers, represent the cable industry's "best available technology" have been incorporated into this specification.

A similar specification, which complies with ANSI/TIA/EIA-568-B 2, Addendum 1 is also available where even higher electrical performance is desired. See specification: Ultra High Speed Communications Plenum Cable, Category 6 CMP, Limited Combustible, PVC-free, Unshielded Twisted Pair.

3.0 Scope

This specification defines the requirements for commercially available, high-performance Category 5e limited combustible, CMP plenum-rated LAN communications cable.

3.1 Electrical Transmission

The cable design described herein complies with the electrical requirements of ANSI/TIA/EIA-568-B.2 and is the minimum recommended for Gigabit Ethernet applications. This specification also includes material requirements for conductor insulation and cable jacketing to provide superior long-term temperature and humidity stability and to meet the performance requirements described in Section 6.0 of this specification.

3.2 Fire Safety

The cable design described herein complies with the primary requirement for limited combustible and smoke-developed cables installed in ceiling cavity and raised floor plenums in accordance with the Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A. This cable also complies with, and exceeds, the flame and smoke requirements for cable installed in ducts, plenums and other spaces used for environmental air in accordance with Articles 725,760,770, 800, 825 and 830 of the 2002 National Electrical Code (NEC), NFPA 70

This cable demonstrates:

- Extremely low smoke compared to the requirements of the 2002 NEC
- Very low flame spread
- Very low fuel load

3.3 Environmental Sustainability

The cable design described herein is lead and PVC-free, and conforms to the worldwide movement to eliminate the hazards from products containing lead and other materials used in PVC compounds. This cable is environmentally friendly and may be recycled with no adverse or toxic effects.

4.0 Physical

In addition to the applicable requirements of ANSI/ICEA S-90-661, ANSI/TIA/EIA 568-B.2 and UL 444, the physical design of the cable shall meet sections 4.1 to 4.8 inclusive.

4.1 Solid Conductors

Solid conductors shall consist of commercially pure, annealed bare copper and shall meet the reqirements of ASTM B 3 except that requirements for "Dimensions and Permissible Variations" are not applicable.

4.2 Conductor Size

The conductors shall be per ASTM B 258 except for dimensions. In a completed cable, the minimum conductor diameter shall be 0.0191 inches (0.485 mm) (24 AWG). The diameter of the insulated conductor shall be 0.048 in. (1.22 mm) maximum.

4.3 Conductor Insulation

Each copper conductor shall be insulated 100% with FEP fluoropolymer resin, but may include FEP concentrate color additives. There shall be no splices of the insulated conductor.

4.4 Pair Assembly

Cable shall consist of 4 insulated conductor pairs. The pair twist length shall be selected by the manufacturer to assure compliance with the transmission requirements of Section 6.0.

4.5 Outer Jacket

The core, consisting of 4 insulated conductor pairs, shall be protected with an overall thermoplastic covering generally referred to as an "outer jacket." The jacket be 100% FEP fluoropolymer resin, but may include FEP concentrate color additives, and shall meet and maintain the physical, mechanical and electrical requirements of ASTM D4565 for the expected life of the cable.

4.6 Color Codes

The color code shall be as shown in Table 4.6.

Table 4.6
Color Codes for Horizontal 100 Ω UTP Cable

Conductor Identification	Color Code	Abbreviation
Pair 1	White-Blue Blue	W-BL BL
Pair 2	White-Orange Orange	W-O O
Pair 3	White-Green Green	W-G G
Pair 4	White-Brown Brown	W-BR BR

Note: The conductor insulation is white, and a colored marking is added for identification. For cables with tightly twisted pairs (all less than 38mm [1.5 in.] per twist) the mate conductor may serve as the marking for the white conductor. A white marking is optional.

4.7 Cable Marking and Identification

The cable jacket shall be legibly marked at least every 24 in. by surface printing throughout the entire length of the cable. The cable shall be UL or ETL verified and labeled with the following words placed immediately before the the CMP cable Type designation: "Limited Combustible FHC 25/50"

Other cable markings shall include:

— Manufacturer's Identification

— Type of Cable Construction

— Cable Footage Marker

4.8 Tag, Reel or Carton Label

The following information shall also be included on the tag, reel or carton:

A) " Limited Combustible FHC 25/50" placed immediately before the CMP Type designation

B) For cables installed in ceiling cavity plenums and raised floor plenums; "This cable meets the limited combustible and smoke developed requirements in the Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A".

5.0 Mechanical

5.1 Conductor Elongation

Minimum elongation of conductors from a finished cable shall be in accordance with ICEA S-90-661.

5.2 Cable Breaking Strength

Finished cable shall have a minimum breaking strength of 400 N (90 lbf), measured in accordance with ASTM D 4565.

5.3 Cable Bend Radius

Twisted pair cables shall withstand a bend radius of 25.4 mm (1 in.) at a temperature of –20°C ±1°C without jacket or insulation cracking when tested in accordance with ASTM D4565, Wire Bending Test.

5.4 Temperature Rating

The cable shall be rated 200°C in accordance with UL-444.

6.0 Electrical Transmission

Transmission requirements shall conform to all applicable sections of ANSI/TIA/EIA 568-B.2 Category 5e and the reference values expressed for measured electrical parameters.

6.1 General

DC resistance; DC resistance unbalance; Mutual capacitance; and Capacitance Unbalance pair to ground shall be in accordance with ANSI/TIA/EIA-568-B.2

6.2 Return Loss

Return loss is a measure of the reflected energy caused by impedance variations in the cable and is especially important for applications that use simultaneous bi-directional transmission. Return loss is expressed in dB relative to the reflected signal level. For all frequencies from 1 MHz to 100 MHz, category 5e horizontal cable return loss shall meet or exceed the values specified in Table 6.2.

Table 6.2
Return loss @ 20°C ± 3°C (68° F ± 5.5°F), worst pair for a length of 100 m (328 ft)

Frequency, MHz	Category 6, dB
$1 \le f \le 10$	$20 + 5 \log (f)$
$10 \le f \le 20$	25
$20 \le f \le 250$	$25 - 7 \log (f/20)$

6.3 Insertion Loss

Insertion loss is a measure of the signal loss resulting from the insertion of a cable length between a transmitter and receiver. It is often referred to as attenuation. Insertion loss is expressed in dB relative to the received signal level. Insertion loss shall be measured for all cable pairs in accordance with ASTM D4566 at 20 ± 3°C or corrected to a temperature of 20°C using a 0.4 %/°C correction factor for Category 5e cables for the measured insertion loss.

Table 6.3
Insertion loss @ 20°C ± 3°C (68°F ± 5.5°F), worst pair for a length of 100 m (328 ft)

Frequency, MHz	Category 5e, dB
0.772	1.8
1.0	2.0
4.0	4.1
8.0	5.8
10.0	6.5
16.0	8.2
20.0	9.3
25.0	10.4
31.25	11.7
62.5	17.0
100.0	22.0

6.4 Near-End Crosstalk (NEXT) Loss

NEXT loss is a measure of the unwanted signal coupling from a transmitter at the near-end into neighboring pairs measured at the near-end. NEXT loss is expressed in dB relative to the launched signal level. NEXT loss shall be measured for all cable pair combinations in accordance with ASTM D4566 NEXT loss measurement procedure.

Table 6.4
Horizontal cable NEXT loss @ 20°C ± 3°C (68°F ± 5.5°F), worst pair-to-pair, for a length of 100 m (328 ft)

Frequency, MHz	Category 5e, dB
0.772	67.0
1.0	65.3
4.0	56.3
8.0	51.8
10.0	50.3
16.0	47.2
20.0	45.8
25.0	44.3
31.25	42.9
62.5	38.4
100.0	35.3

6.5 Power Sum Near-End Crosstalk (PSNEXT) Loss

Since each duplex channel can be disturbed by more than one duplex channel, PSNEXT loss is specified for horizontal cables. PSNEXT loss takes into account the combined crosstalk (statistical) on a receive pair from all near-end disturbers operating simultaneously. The PSNEXT loss is calculated in accordance in accordance with ASTM D4566 as a power sum on a selected pair from all other pairs.

Table 6.5
PSNEXT loss @ 20°C ± 3°C (68°F ± 5.5°F), for a length of 100 m (328 ft)

Frequency, MHz	Category 5e, dB
0.150	74.7
0.772	64.0
1.0	62.3
4.0	53.3
8.0	48.8
10.0	47.3
16.0	44.2
20.0	42.8
25.0	41.3
31.25	39.9
62.5	35.4
100.0	32.3

6.6 Equal Level Far-End Crosstalk (ELFEXT)

FEXT loss is a measure of the unwanted signal coupling from a transmitter at the far-end into neighboring pairs measured at the near-end. ELFEXT is expressed in dB as the difference between the measured FEXT loss and the insertion loss of the distributed pair. FEXT loss shall be measured and ELFEXT calculated for all cable pair combinations in accordance with ASTM D4566 FEXT measurement procedure.

Table 6.6
ELFEXT @ 20°C ± 3°C (68°F ± 5.5°F), worst pair-to-pair for a length of 100 m (328 ft)

Frequency, MHz	Category 5e, dB
1.0	63.8
4.0	51.8
8.0	45.7
10.0	43.8
16.0	39.7
20.0	37.8
25.0	35.8
31.25	33.9
62.5	27.9
100.0	23.8

6.7 Power Sum Equal Level Far-End Crosstalk (PSELFEXT)

Since each duplex channel can be distributed by more than one duplex channel, equal level far-end crosstalk (ELFEXT) is specified for horizontal cables. Power sum equal level far-end crosstalk loss takes into account the combined crosstalk (statistical) on a receive pair from all far-end disturbers operating simultaneously. The power sum equal level far-end crosstalk (PSELFEXT) is calculated in accordance with ASTM D4566 as a power sum on a selected pair from all other pairs.

Table 6.7
PSELFEXT @ 20°C ± 3°C (68°F ± 5.5°F) for a length of 100 m (328 ft)

Frequency, MHz	Category 5e, dB
1.0	60.8
4.0	48.8
8.0	42.7
10.0	40.8
16.0	36.7
20.0	34.8
25.0	32.8
31.25	30.9
62.5	24.9
100.0	20.8

6.8 Propagation Delay

Propagation delay is the time it takes for a signal to propagate from one end to the other. Propagation delay is expressed in nanoseconds (ns). Propagation delay shall be measured for all cable pairs in accordance with ASTM D4566.

Table 6.8
Propagation delay, velocity of propagation and propagation delay skew for 4-pair horizontal cables @ 20°C ± 3°C (68°F ± 5.5°F)

Frequency, MHz	Maximum Propagation Delay, ns/100 m	Minimum Velocity of Propagation, %	Propagation Delay Skew, ns/100 m
1	570	58.5%	45
10	545	61.1%	45
100	538	62.0%	45

6.9 Propagation Delay Skew

Propagation delay skew is a calculation of the signaling delay difference from the fastest pair to the slowest. Propagation delay skew is expressed in nanoseconds (ns). Propagation delay skew shall be measured for all cable pairs in accordance with ASTM D4566.

For all frequencies between 1 MHz and the highest referenced frequency in MHz, propagation delay skew shall not exceed 45 ns/100 m at 20°C, 40°C and 60°C. In addition, the propagation delay skew between all pairs shall not vary more than ± 10 ns from the measure value at 20°C when measured at 40°C and 60°C. Compliance shall be determined using a minimum 100 m of cable.

7.0 Fire Safety Performance

7.1 Low Fuel Load

Fuel load shall be determined by potential heat value. Potential heat value shall not exceed 3,500 Btu/lb (8.141 mJ/kg) when tested according to NFPA 259.

7.2 Flame Spread and Smoke

Flame Spread Index and Smoke Developed Index (SDI) shall be determined in accordance with NFPA 255, and shall not exceed the following values.

Table 7.2
NFPA 255 Flame and Smoke Indexed Against Red Oak

Flame Spread Index	≤ 25
Smoke Developed Index	≤ 50

8.0 Environmental

8.1 Harmful Materials

The finished cable shall be free of PVC and contain neither lead, cadmium or other heavy metals nor pthalate plasticizers.

8.2 Recyclability and Disposal

The finished cable shall be fully recyclable or, if disposed, present no environmental hazard or pollutant.

9.0 Approved Cable Manufacturers and Part Numbers

- Belden
- Berk Tek/NEXANS
- Mohawk/CDT
- Avaya

Neither substitute cable, insulating and jacketing materials, nor manufacturers shall be permitted.

10.0 Reference Documentation

American National Standards Institute (ANSI)
11 W 42nd St.
13th Floor
New York, NY 10036

American Society for Testing and Materials (ASTM)
100 Barr Harbor Dr.
West Conshohocken, PA 19428-2959

ASTM B 3-90	Soft or Annealed Copper Wire
ASTM 4565	Cold Bend Test
ASTM D4566-94	Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire & Cable
ASTM 4565	Physical and Environmental Properties of Insulation and Jackets for Telecommunications Wire and Cable

Intertek Testing Services (ETL/SEMCO)
3933 U.S. Route 11
Cortland, NY 13045

Insulated Cable Engineers Association
PO Box 1568
Carrollton, GA 30117

ANSI/ICEA S-90-661 Category 3,5,5e	Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) For Use In General Purpose and LAN Communications

National Fire Protection Association (NFPA)
Batterymarch Park
Quincy, MA 02269

ANSI/NFPA 70	2002 National Electrical Code (NEC)
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems

Telecommunications Industries Association (TIA)
2500 Wilson Blvd., Suite 300
Arlington, VA

ANSI/TIA/EIA568B.2	Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted Pair Cabling Components Addendum 1 Category 6

Underwriters Laboratories, Inc.
333 Pfingsten Rd.
Northbrook, IL 60062

UL 444	Standards for Communications Cable Listing Program Subject 2424