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NEMA STANDARDS PUBLICATION NO. WC 63.2

PERFORMANCE STANDARD FOR COAXIAL PREMISE DATA COMMUNICATIONS CABLES

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PERFORMANCE STANDARD FOR COAXIAL PREMISE DATA COMMUNICATIONS CABLES

Published by

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Foreword

This standard has been developed by the High Performance Wire and Cable Section of NEMA in close coordination between manufacturers, users, third party certifying agencies and others having specialized experience. The High Performance Wire and Cable Section of NEMA periodically reviews this standard for any revisions necessary to keep it up to date. Proposed revisions or comments should be submitted to:

Vice President, Engineering Department
National Electrical Manufacturers Association
1300 North 17th Street
Rosslyn, Virginia 22209

This standards publication was developed by the Premise Wiring Subcommittee of the High Performance Wire and Cable Section of the National Electrical Manufacturers Association. Section approval of this standard does not necessarily imply that all section members voted for its approval or participated in its development. At the time it was approved, the Premise Wiring Subcommittee had the following members:

Belden Wire & Cable Company—Richmond, IN
Berk-Tek, Inc.—New Holland, PA
BICC Brand-Rex Company—Willimantic, CT
CommScope Network Cable Division—Claremont, NC
Helix/Hi-Temp Cables, Inc.—Franklin, MA
Hitachi Cable Manchester, Inc.—Manchester, NH
Judd Wire Inc.—Turner Falls, MA
Lucent Technologies—Norcross, GA
Mohawk/CDT—Leominster, MA
Montrose/CDT—Auburn, MA
Nodx/CDT (Nortel/Northern Telecom)—Lachine, PQ Canada
Teledyne Thermatics—Elm City, NC

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Section 1
GENERAL

1.1 SCOPE

This standard defines minimum electrical performance characteristics, material and mechanical specifications of premise wiring cables for data applications. Definitions and applicable test methods are included.

The products covered in this Standard shall conform to the requirements of Part 68 of the FCC rules and regulations as well as the applicable article(s) of the National Electrical Code and/or other national and local codes and safety standards.

The performance requirements contained in this document are for cables as manufactured. The installed cable interconnect system may have different characteristics. The performance of the installed cable is outside the scope of this document.

This standard covers 50 ohm coaxial cables for data communication systems.

1.2 REFERENCED STANDARDS

Copies of referenced documents may be obtained from the appropriate sources as follows.

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

ASTM B 3-90	*Soft or Annealed Copper Wire*
ASTM B 8-90	*Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft*
ASTM B 33-91	*Tinned Soft or Annealed Copper Wire for Electrical Purposes*
ASTM B 286-89	*Copper Conductors for Use in Hookup Wire for Electronic Equipment*
ASTM D 1248-84	*Polyethylene Plastics Molding & Extrusion Materials*
ASTM D 2116-91	*FEP-Fluorocarbon Molding & Extrusion Materials*
ASTM D 4566-94	*Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire & Cable*

Federal Communications Commission (FCC)
1919 M Street, N.W.
Washington, D.C. 20554

Code of Federal Regulations, Title 47, Telecommunications, Chapter 1-FCC, Part 68

Institute of Electrical & Electronic Engineers (IEEE)
445 Hoes Lane, IEEE Service Center
P.O. Box 1331
Piscataway, NJ 08855-1331

ANSI/IEEE 802.3	*Carrier Sense Multiple Access with Collision Detection (CSMA/CD)*

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ISO/IEC 8802-3, Fourth Edition, 1993 — *Access Method & Physical Layer Specifications*

National Electrical Manufacturers Association (NEMA)
1300 North 17th Street
Rosslyn, Virginia 22209

NEMA WC 61-*1992* — *Standard for Transfer Impedance Testing*

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

ANSI/NFPA-70-1996 — *National Electrical Code (NEC)*

DODSSP – Customer Service
Standardization Document Order Desk
700 Robbins Avenue
Building 4D
Philadelphia, PA 19111

MIL-C-17G — *Cables, Radio, Frequency, Flexible and Semirigid, General Specification for*

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062

UL 13-90 — *Standard for Power-Limited Circuit Cables*
UL 444-94 — *Standard for Communications Cables*

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Section 2
COAXIAL CABLES

2.1 GENERAL

This section covers the requirements and performance characteristics of coaxial cable to be used in the following baseband local area networks.

a. ISO/IEC 8802-3, 10BASE5
b. ISO/IEC 8802-3, 10BASE2

The NEMA Type designations for coaxial designs are described in Table 2-1.

Table 2-1
NEMA TYPE DESIGNATIONS FOR COAXIAL DESIGNS

NEMA Type	Application	10Base5 Description
10B5/1	10Base5	50 ohm coax, foam core, 0.405 inch OD, listed for NEC non-plenum installations
10B5P/1	10Base5	50 ohm coax, foam core, 0.375 inch OD, listed for NEC plenum installations
		10Base2 Description
10B2/1	10Base2	50 ohm coax, solid core, tinned copper braid shield, 0.195 inch OD, listed for NEC non- plenum installations
10B2/2	10Base2	50 ohm coax, foam core, aluminum foil/tinned copper braid shield, 0.185 inch OD, listed for NEC non-plenum installations
10B2P/1	10Base2	50 ohm coax, solid core, tinned copper braid shield, 0.189 inch OD, listed for NEC plenum installations
10B2P/2	10Base2	50 ohm coax, foam core, aluminum foil/tinned copper braid shield, 0.168 inch OD, listed for NEC plenum installations

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2.2 MATERIALS

Materials for the cable shall be as specified herein. All dimensions for materials are nominal unless otherwise specified. When a material is not specified, a material shall be used that will enable the finished product to meet its performance requirements. Additionally, the manufacturer shall ensure that the product conforms with the applicable article(s) of the *National Electrical Code* and/or other national and local codes and safety standards.

2.2.1 Conductors

Center conductors and braid wires shall be as specified below.

2.2.1.1 Bare Copper Wire

Bare copper wire shall conform to soft or annealed wire in accordance with ASTM B 3.

2.2.1.2 Tin-Coated Copper Wire

Tin-coated copper wire shall conform to soft or annealed copper wire in accordance with ASTM B 33.

2.2.1.3 Stranded Inner Conductors

Stranded inner conductors shall be in accordance with ASTM B 8 or ASTM B 286. Tensile strength and elongation of conductors shall be tested prior to stranding. Conductors shall not be coated after stranding (no overcoating). Individual wires, before stranding, shall meet all the requirements of the basic wires.

2.2.2 Insulations

Materials for dielectric cores shall be as specified below

2.2.2.1 Polyethylene

Polyethylenes shall conform to applicable requirements of ASTM D 1248.

2.2.2.2 Fluorinated Ethylene Propylene (FEP)

FEPs shall conform to applicable requirements of ASTM D 2116.

2.2.3 Jackets

Materials for jackets shall conform to the requirements of the applicable *National Electrical Code* cable type.

2.3 ISO/IEC 8802-3 10BASE5

2.3.1 10B5/1 Components/Construction Details

2.3.1.1 Inner Conductor

Solid uncoated copper wire
Diameter: 0.0855 ± 0.0005 inch (2.17± 0.013 mm)

2.3.1.2 Dielectric Core

Foamed polyethylene
Diameter: 0.247 ± 0.005 inch (6.27 ± 0.13 mm)
Eccentricity of the insulated conductor shall be 10% maximum. The conductor shall show no residue of foam when stripped.

The adhesion of conductor shall be 20.0 lb_f (89.0 N) minimum on a 6 inch (152.4 mm) sample.

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2.3.1.3 Shield (4 Layers of Braid and Foil)

Reading outward from the dielectric core:

Foil Layer: 0.001 inch (0.025 mm) adhesive/
0.002 inch (0.051 mm) aluminum/
0.00092 inch (0.024 mm) polyester/
0.00035 inch (0.009 mm) aluminum
Tape to be applied longitudinally to core with minimum 0.125 inch (3.18 mm) overlap, adhesive side facing core.

Braid Layer: Tinned copper
Strand diameter: 0.0063 inch (0.16 mm) nominal
Picks/inch(mm): 9.7 (0.38) ± 10%
Ends: 7
Carriers: 24
Percent coverage: 94% minimum

Foil Layer: 0.00035 inch (0.009 mm) aluminum/
0.00092 inch (0.025 mm) polyester/
0.00035 inch (0.009 mm) aluminum
Tape to be applied longitudinally to core with minimum 0.125 inch (3.18 mm) overlap.
Diameter: 0.288 inch (7.32 mm)

Braid Layer: Tinned copper
Strand diameter: 0.0063 inch (0.16 mm) nominal
Picks/inch(mm): 5.0 (0.20) ± 10%
Ends: 8
Carriers: 24
Percent coverage: 90% minimum
Diameter: 0.326 ± 0.007 inch (8.28 ± 0.178)

2.3.1.4 Jacket

Polyvinyl Chloride
Diameter: 0.405 ± 0.007 inch (10.3 ± 0.18 mm)
Color: Yellow
Jacket band marking shall be required (see 2.3.4).

2.3.2 10B5P/1 Components/Construction Details

2.3.2.1 Inner Conductor

Solid uncoated copper wire
Diameter: 0.085 ± 0.0005 inch (2.17 ± 0.013 mm)

2.3.2.2 Dielectric Core

Foamed FEP
Diameter: 0.247 ± 0.005 inch (6.27 ± 0.13 mm)
Eccentricity of the insulated conductor shall be 10% maximum. The conductor shall show no residue of foam when stripped.
The adhesion of conductor shall be 20.0 lb_f (89.0 N) minimum on a 6 inch (150 mm) sample.

2.3.2.3 Shield (4 Layers of Braid and Foil)

Reading outward from the dielectric core:

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Foil Layer: 0.001 inch (0.025 mm) adhesive/
0.002 inch (0.051 mm) aluminum/
0.001 inch (0.025 mm) polyester/
0.00035 inch (0.009 mm) aluminum
Tape to be applied longitudinally to core with minimum 0.125 inch (3.18 mm) overlap, adhesive side facing core.

Braid Layer: Tinned copper
Strand diameter: 0.0071 inch (0.18 mm) nominal
Picks/inch (mm): 9.7 (0.38) ± 10%
Ends: 7
Carriers: 24
Percent coverage: 94% minimum
Diameter: 0.293 inch (7.44 mm)

Foil Layer: 0.00035 inch (0.009 mm) aluminum/
0.001 inch (0.025 mm) polyester/
0.00035 inch (0.009 mm) aluminum
Tape to be applied longitudinally to core with minimum 0.125 inch (3.18 mm) overlap.

Braid Layer: Tinned Copper
Strand diameter: 0.0071 inch (0.18 mm) nominal
Picks/inch (mm): 4.2 (0.165) ± 10%
Ends: 8
Carriers: 24
Percent coverage: 90% minimum
Diameter: 0.326 ± 0.007 inch (8.28 ± 0.178 mm)

2.3.2.4 Jacket

Fluoropolymer or equvalent
Diameter: 0.375 ± 0.010 inch (9.53 ± 0.25 mm)
Color: Orange
Jacket band marking is required: (see 2.3.4)

2.3.3 Electrical Requirements and Characteristics

The sum of the center conductor resistance plus the shield resistance shall not exceed 3.05 ohms/1000 ft (0.010 ohms/meter) at or corrected to 20°C.

The velocity of propagation shall not be less than 77% of the speed of light.

The average characteristic impedance shall be 50 ± 2 ohms when measured in accordance with the methods of MIL-C-17 Time Domain Reflectometer (TDR) method. Periodic variations in impedance along a single piece of cable may be up to ± 3 ohms sinusoidal centered around the measured average value, with a period less than 6.56 ft (2 m).

The attenuation shall not exceed 3.66 dB/1000 ft (1.20 dB/100 m) at 5 MHz and 5.18 dB/1000 ft. (1.70 dB/100 m) at 10 MHz.

The transfer impedance of the cable shall not exceed the value shown in Figure 2-1 as a function of frequency.

The nominal capacitance is 26 pF/ft (85 pF/m).

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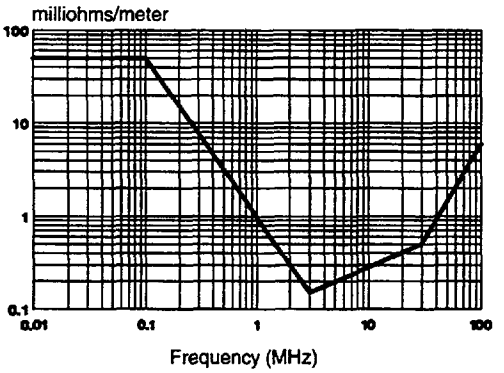

FIGURE 2-1
10BASE5

2.3.4 Ring Band Markings

The cable shall be marked with annular rings in a color contrasting with the background color of the jacket. The rings shall be regularly spaced at 98.4 ± 1.97 inches (2.5 m ± 5 cm) along the entire length of the cable. These annular rings are to be 0.250 to 0.375 inches (6.35 to 9.53 mm) wide and should look solid from a 12 inch (304.8 mm) distance. It is permissible to cover characters of other specified markings where they coincide.

2.4 ISO/IEC 8802-3 10BASE2

2.4.1 10B2/1 Components/Construction Details

2.4.1.1 Inner Conductor

19 strands of tinned copper wire;
Diameter: 0.0071 inch (0.18 mm)
Overall diameter: 0.035 ± 0.002 inch (0.89 ± 0.05 mm)

2.4.1.2 Dielectric Core

Solid polyethylene
Diameter: 0.116 ± 0.006 inch (2.95 ± 0.15 mm)
Eccentricity of the insulated center conductor shall be 10% maximum

2.4.1.3 Shield

Single braid of tinned copper wire
Strand diameter: 0.005 inch (0.127 mm)
Picks/inch (mm): 10.2 (0.40) ± 10%
Ends: 7
Carriers: 16
Percent coverage: 95% nominal

2.4.1.4 Jacket

Polyvinyl chloride
Diameter: 0.193 ± 0.012 inch (4.90 ± 0.30 mm)
color: gray

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2.4.2 10B2P/1 Components/Construction Details

2.4.2.1 Inner Conductor

19 strands of tinned copper wire
Diameter: 0.0071 inch (0.18 mm) nominal
Overall diameter: 0.035 ± 0.002 inch (0.89 ± 0.05 mm)

2.4.2.2 Dielectric Core

Solid FEP
Diameter: 0.116 ± 0.006 inch (2.95 ± 0.15 mm)
Eccentricity of insulated center conductor shall be 10% maximum

2.4.2.3 Shield

Single braid of tinned copper wire
Strand diameter: 0.005 inch (0.127 mm) nominal
Picks/inch (mm): 10.2 (0.40) ± 10%
Ends: 7
Carriers: 16
Percent coverage: 95% minimum

2.4.2.4 Jacket

Fluoropolymer or equivalent
Diameter: 0.189 ± 0.012 inch (4.80 ± 0.30 mm)
color: gray

2.4.3 10B2/2 Components/Construction Details

2.4.3.1 inner conductor

19 strands of tinned copper wire
Diameter: 0.0079 inch (0.20 mm) nominal
Overall diameter: 0.037 ± 0.0003 inch (0.94 ± 0.008 mm)

2.4.3.2 Dielectric Core

Foam polyethylene
Diameter: 0.099 ± 0.007 inch (2.51 ± 0.178 mm)
Eccentricity of insulated center conductor shall be 10% maximum.

2.4.3.3 Shield

Foil Layer: 0.0001 inch (0.0025 mm) adhesive/
0.002 inch (0.051 mm) aluminum/
0.00092 inch (0.025 mm) polyester/
0.00035 inch (0.009 mm) aluminum
Tape to be applied longitudinally with minimum 0.125 inch (3.18 mm) overlap, adhesive side facing core.

Braid Layer: Tinned copper
Strand diameter: 0.005 inch (0.127 mm) nominal
Picks/inch (mm): 12.5 (0.492) ± 10%
Ends: 6
Carriers: 16
Percent coverage: 93% minimum
Diameter: 0.135 inch (3.43 mm) nominal

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2.4.3.4 Jacket

Polyvinyl chloride
Diameter: 0.185 ± 0.004 inch (4.70 ± 0.010 mm)
Color: gray

2.4.4 10B2P/2 Components/Construction Details

2.4.4.1 Inner Conductor

19 strands of tinned copper wire
Diameter: 0.0079 inch (0.20 mm) nominal
Overall diameter: 0.037 ± 0.0003 inch (0.94 ± 0.008 mm)

2.4.4.2 Dielectric Core

Foam FEP
Diameter: 0.099 ± 0.007 inch (2.51 ± 0.178 mm)
Eccentricity of center conductor shall be 10% maximum

2.4.4.3 Shield

Foil Layer: 0.001 inch (0.025 mm) adhesive/
0.002 inch (0.051 mm) aluminum/
0.00092 inch (0.025 mm) polyester/
0.00035 inch (0.009 mm) aluminum
Tape to be applied longitudinally with minimum 0.125 inch (3.18 mm) overlap, adhesive side facing core.

Braid Layer: Tinned copper
Strand diameter: 0.005 inch (0.127 mm) nominal
Picks/inch(mm): 12.5 (0.492) ± 10%
Ends: 6
Carriers: 16
Percent coverage: 93% minimum
Diameter: 0.135 inch (3.43 mm) nominal

2.4.4.4 Jacket

Fluoropolymer or equivalent
Diameter: 0.165 ± 0.007 inch (4.19 ± 0.178 mm)
Color: gray

2.4.5 Electrical Requirements and Characteristics

The sum of the center conductor resistance plus the shield resistance shall not exceed 15.24 ohms/1000 ft (0.050 ohms/meter) at or corrected to 20°C.

The velocity of propagation shall not be less than 65% of the speed of light.
The average characteristic impedance shall be 50 ± 2 ohms when measured in accordance with the methods of MIL-C-17 (TDR method). Periodic variations in impedance along a single piece of cable may be up to ± 3 ohms sinusoidal centered around the measured average value, with a period less than 6.56 ft (2 m).

The attenuation shall not exceed 9.88 dB/1000 ft (3.24 dB/100 m) at 5 MHz and 14.0 dB/1000 ft (4.59 dB/100 m) at 10 MHz.

The transfer impedance of the cable shall not exceed the value shown in Figure 2-2 as a function of frequency. The nominal capacitance is 26 pF/ft (85 pF/m).

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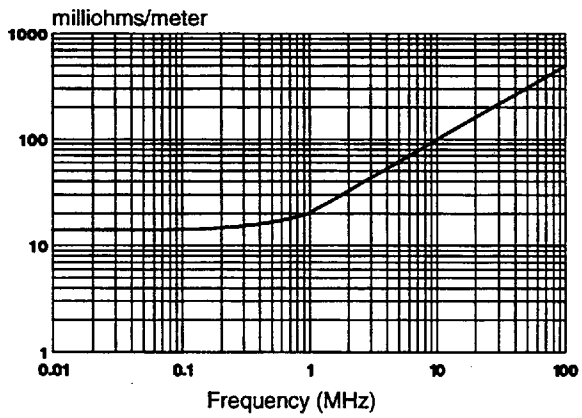

FIGURE 2-2
10BASE2

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NEMA STANDARDIZATION BACKGROUND

The purpose of NEMA standards, their classification, and status are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following; nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 1)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.

(Standardization Policies and Procedures, p. 6)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes, which have received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative:

NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture.

Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development.

Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, p. 5)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data or other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative.

(Standardization Policies and Procedures, p. 5)

Identification of Status

Standards in NEMA Standards Publications are identified as "NEMA Standard," "Suggested Standard for Future Design," or "Adoptive Standard." These indicate the status of the standard. A statement incorporating the auxiliary verb "shall" indicates that compliance with a requirement is mandatory for compliance with the standard. These classes of standards are identified in the foreword or throughout the text.

The material identified as "Authorized Engineering Information" is designated similarly. Statements incorporating other auxiliary verbs such as "should," "may," etc. refer to the authorized engineering information and not to procedures required for compliance with the standard.

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