



**STANDARD FOR
TELECOMMUNICATIONS CABLE
AIRCORE, POLYOLEFIN INSULATED, COPPER
CONDUCTOR
TECHNICAL REQUIREMENTS**

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INSULATED CABLE ENGINEERS ASSOCIATION, Inc.

STANDARD FOR
TELECOMMUNICATIONS CABLE
AIRCORE, POLYOLEFIN INSULATED, COPPER CONDUCTOR
TECHNICAL REQUIREMENTS

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ACRONYMS, ABBREVIATIONS AND SYMBOLS

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
°C	Degrees of Temperature, Celsius scale, Centigrade
dB	decibel
dc	Direct Current
EIA	Electronic Industries Alliance
ELFEXT	Equal Level Far-End Crosstalk
°F	Degrees of Temperature, Fahrenheit scale
ft	foot or feet
g	gram
ICEA	Insulated Cable Engineers Association
in	inch
ISO	- International Organization for Standardization
kHz	kilohertz
kV	kilovolt
lb	pounds
lbf	pounds of force
MHz	Megahertz
m	meter
mm	millimeter
MPa	megapascal
N	Newton
nF	nanofarad
NEXT	Near-End Crosstalk
NESC	National Electrical Safety Code
ns	nanoseconds
pF	picofarad
PSELFEXT	power sum equal level far end crosstalk
PSNEXT	power sum near end crosstalk
psi	pounds per square inch
rms	root mean square
α	Attenuation

**ICEA STANDARD FOR
AIRCORE, POLYOLEFIN INSULATED, COPPER CONDUCTOR
TELECOMMUNICATIONS CABLE
TECHNICAL REQUIREMENTS**

SECTION 1 GENERAL

- 1.1 **PURPOSE:** The purpose of this Standard is to establish generic technical requirements that may be referenced by individual telecommunications cable specifications covering products intended for normal outside plant use. The parameters covered provide material, construction, and performance requirements that are applicable to aircore, polyolefin insulated and jacketed cables of all pair counts, including a variety of shield and jacket combinations and optional compartmental screening.

Because this Standard does not cover all details of individual cable design, it cannot be used as a single document for procurement of product. It is intended to be used in conjunction with an individual product specification that provides complete design details for the specific cable type and designates the applicable performance requirements. Such individual cable specifications may be prepared either by the user or the manufacturer. The specification designated for procurement is at the option of the user.

- 1.2 **SCOPE:** This Standard covers mechanical and electrical requirements for aircore, polyolefin insulated, copper conductor telecommunications cable. It provides alternative choices for type of insulation, core assembly, color code, sheath design (shielding materials, single or double jackets, and jacket thickness), and screened or non-screened core.
- 1.3 **OPTIONS AND INFORMATION:** These cables are traditional outside plant (OSP) cables having a nominal mutual capacitance at 1 kHz of 52 nF/km (83 nF/mile), with attenuation and crosstalk characterized at discrete frequencies up to 6.3 MHz. For cables characterized above 6.3 MHz, refer to ICEA S-99-688, Broadband Twisted Pair Cable, Aircore, Polyolefin Insulated, Copper Conductors.

This Standard is arranged in Sections. Each covers one specific area of cable requirement and may be referenced as complete Sections or as individual paragraphs.

Sections of this Standard where the user may specify a particular option are listed below:

- 2.1 Conductor Size
- 3.2 Insulation Type
- 4.1.3 Core Layup
- 4.3 Spare Pairs
- 4.5.2 Undulated Core
- 4.5.3 Figure 8 dimensions
- 4.5.4 Reinforced Self-Support
- 4.6 Flooding Compound
- 5.1 Internal Screens
- 6.1 Shielding Systems
- 6.2.2 One or Two Side Coated Aluminum
- 6.2.9 One or Two Side Coated Steel
- 6.3 Shield Application
- 7.1 Inner Jacket
- 7.2.1 Outer Jacket (Material Type)
- 8.8.2 T1-C Applications
- 10.1.2 Length Markings
- 10.4 Pressurization
- 10.5 Optional Requirements

To assist the user in selection of options and to avoid possible misunderstandings between the manufacturer and user, it is suggested that a check-off sheet similar to that shown in Informative Annex A be used.

- 1.4 **UNITS AND TOLERANCES:** SI units (see NIST-SP 811) are specified throughout this Standard except for conductor size. Approximate US equivalents and Fahrenheit temperatures are provided for information only. The rounding-off method of ASTM E 29 shall be used for determining conformance with requirements.
- 1.5 **REFERENCES:** All documents referenced herein shall be as listed in Table 1 with issues or dates as indicated. When a specific date or issue number is not indicated, the latest issue shall be used.
- 1.6 **QUALITY ASSURANCE:** It is the responsibility of the manufacturer to establish a quality assurance system consistent with TL-9000, or an alternate system acceptable to the user. When the user wishes to require a specific quality assurance program or special testing procedures, agreement between the user and the manufacturer should be reached before the order is placed.

Requirements provided in this Standard are of two types, qualification and product performance. Qualification requirements are intended to be proof of adequate design and processing and shall be repeated as needed for verification. Product performance requirements are those that shall be met by every length of delivered cable as assured by quality control methods. The following tests shall be performed on all completed cables. The term "completed cable" refers to a continuous length of finished cable resulting from the last jacketing operation.

Properties that shall be tested on 100 percent of the cable lengths produced are listed below by paragraph number:

1. Jacket Thickness per Paragraph 7.1.2 and Paragraph 7.2.2
2. Average Mutual Capacitance per Paragraph 8.3
3. Conductor-to-Conductor DC Proof Test per Paragraph 8.10
4. Core-to-Shield DC Proof Test per Paragraph 8.11
5. Core-to-Screen DC Proof Test per Paragraph 8.12
6. Continuity of Metallic Cable Elements per Paragraph 8.14

Unless otherwise specified, all tests shall be performed at $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($73^{\circ}\text{F} \pm 5^{\circ}\text{F}$).

- 1.7 **SAFETY CONSIDERATIONS:** Materials in the cable shall present no dermal or environmental hazards as defined by current industry standards or applicable federal or state laws and regulations.

The user of this Standard is cautioned to observe any applicable health or safety regulations and rules relative to the manufacture and use of cable made in conformity with this Standard. This Standard hereafter assumes that manufacture, testing, installation, and maintenance of cables defined by this Standard will be performed only by properly trained personnel using suitable equipment and employing appropriate safety precautions.

SECTION 2 CONDUCTORS

- 2.1 **REQUIREMENTS:** Each conductor shall be a solid wire of commercially pure annealed copper and shall meet the quality requirements of ASTM B 3 except that requirements for "Dimensions and Permissible Variations" are not applicable and elongation requirements are superseded by this Standard. The conductor sizes shall be 16, 19, 22, 24, 26 and 28 American Wire Gauge (AWG) per ASTM B 258. The nominal diameters stated in Table 2-1 are for reference only:

Table 2-1
CONDUCTOR DIAMETER

Conductor Size (AWG)	Nominal Diameter	
	Inch	(mm)
16	0.0508	(1.290)
19	0.0359	(0.912)
22	0.0253	(0.643)
24	0.0201	(0.511)
26	0.0159	(0.404)
28	0.0126	(0.320)

When tested in accordance with ASTM E 8, the minimum conductor elongation in the completed cable shall not be less than shown in Table 2-2:

Table 2-2
CONDUCTOR ELONGATION

Conductor Size (AWG)	Minimum Elongation (%)
16	24
19	22
22	20
24	16
26	12
28	8

- 2.2 **FACTORY JOINTS:** Prior to insulating, factory joints in conductors are allowed. Joints in uninsulated conductors shall be free from lumps and sharp projections. Splices in the insulated conductors shall be reinsulated with a nonhygroscopic, dielectric material. There shall be no exposed conductor at the splice. Insulated splices in finished cable shall be capable of meeting all applicable electrical requirements of this Standard.

The tensile strength of any conductor containing a joint shall not be less than 90 % of the strength of an adjacent length of conductor outside the joint area.

SECTION 3 CONDUCTOR INSULATION

- 3.1 **INSULATION MATERIAL:** The conductor shall be insulated with a suitable polyolefin material meeting the completed cable requirements of this Standard. The polyolefin shall consist of 100 % virgin material as defined in ASTM D 883. The insulation shall contain a stabilization system sufficient to pass the Thermal Oxidative Stability Test of Paragraph 3.4.6.
- 3.2 **INSULATION TYPE:** Type of conductor insulation shall be either solid, foam, or foam-skin as defined under Paragraphs 3.2.1, 3.2.2, or 3.2.3. Specific type of insulation required for any product may be designated by the individual product specification that provides cable construction details.
- 3.2.1 **Solid.** Insulation shall be colored solid polyolefin material
- 3.2.2 **Foam.** Insulation shall be colored cellular polyolefin material. Cable designs employing the use of foam insulation on 28 AWG conductors are specifically excluded from this Standard
- 3.2.3 **Foam-Skin.** Insulation shall consist of an inner layer of natural polyolefin foam material covered by a continuous outer layer of colored solid polyolefin insulation. Cable designs employing the use of foam-skin insulation on 28 AWG conductors are specifically excluded from this Standard

- 3.3 **INSULATION DIMENSIONS, COLORS, AND SPLICES:** The insulation shall be as uniform and smooth as is consistent with good commercial practice. The nominal diameter of the insulation shall be such that all applicable requirements of this Standard are met.

The insulation shall be uniformly colored as specified under type requirements of Paragraph 3.2 using the ten colors shown in Table 3-1:

Table 3-1
INSULATION COLORS

RING	TIP
Blue (BL)	White (W)
Orange (O)	Red (R)
Green (G)	Black (BK)
Brown (BR)	Yellow (Y)
Slate (S)	Violet (V)

Colors of the insulation are specified in terms of the Munsell Color System of ASTM D 1535 and shall comply with ANSI/EIA-359-A, "EIA Standard Colors for Color Identification and Coding".

- 3.4 **INSULATION PHYSICAL REQUIREMENTS:** Unless otherwise specified, insulation taken from each gauge size of completed cable shall meet the applicable requirements listed under this Section.

- 3.4.1 **Insulation Adhesion.** When tested in accordance with ASTM D 4565 at a rate of travel of 51 mm $\pm$ 25 mm (2 in $\pm$ 1 in) per minute, the adhesion shall not exceed the values in Table 3-2.

Table 3-2
CONDUCTOR ADHESION

Conductor Size (AWG)	Maximum Adhesion	
	N	(lbf)
16	27	(6)
19	22	(5)
22	18	(4)
24	13	(3)
26	11	(2.5)
28	9	(2)

- 3.4.2 **Elongation.** When tested in accordance with ASTM D 4565, elongation of the insulation removed from the conductor shall not be less than 150 %. The minimum length of unclamped specimen shall be 51 mm (2.0 in). The minimum speed of jaw separation shall be 25 mm (1.0 in) per minute per 25 mm (1.0 in) of unclamped specimen.

- 3.4.3 **Compression.** When tested in accordance with ASTM D 4565, foam and foam-skin insulated conductors, shall withstand the compression requirements specified in Table 3-3 using a rate of approach not to exceed 0.51 mm (0.02 in) per minute.

Table 3-3
INSULATION COMPRESSION

Conductor Size (AWG)	Minimum Compressive Strength for 51-mm (2-in) Sample	
	N	(lbf)
16	712	(160)
19	712	(160)
22	467	(105)
24	311	(70)
26	200	(45)

- 3.4.4 **Cold Bend.** When tested in accordance with ASTM D 4565, insulated conductors shall show no cracks when observed with normal or corrected-to-normal vision. The test temperature shall be $-40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($-40\text{ }^{\circ}\text{F} \pm 4\text{ }^{\circ}\text{F}$) with a mandrel diameter of three times the outside diameter of the insulated conductor.
- 3.4.5 **Shrinkback.** When tested in accordance with ASTM D 4565 at $115\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($239\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$), insulation shrinkback shall not exceed 10 mm (3/8 in). All changes in insulation length, which occur from the time the samples are cut, shall be included.
- 3.4.6 **Thermal Oxidative Stability.** Insulation of the completed cable shall be capable of meeting the following requirement:

A sample length of cable shall be preconditioned in a forced air circulating oven, conforming to ASTM D 5423, Type II, for 14 days at $70\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($158\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$). When tested in accordance with ASTM D 4565, insulation specimens removed from the sample shall meet a minimum oxidative induction time of 20 minutes for solid, and 60 minutes for foam or foam-skin. Test temperature shall be $200\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($392\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$). The copper conductors shall be removed from the insulation before testing. Pan material for the tests shall be aluminum.

Alternately, the foam and foam-skin insulation may be tested at $210\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($410\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$) and shall meet a minimum oxidative induction time of 25 minutes. In case of dispute, the $200\text{ }^{\circ}\text{C}$ test shall be used as the referee method.

NOTE: The above requirement is based upon a stabilization system utilizing compounds identified by the Chemical Abstract Service as CAS #6683-19-8 and CAS #32687-78-8. If a different stabilization system is employed, then a suitable qualification program should be initiated to predict long term performance with subsequent modification of the oxidation induction time requirements as appropriate.

- 3.5 **TWIST LENGTH AND COLOR CODING:** Insulated conductors shall be formed into pairs using twist lengths that will ensure that the finished cables shall be capable of meeting the electrical requirements of this Standard. The average twist length of any pair in the finished cable shall not exceed 165 mm (6.5 in).

Insulated conductors shall be formed into pairs in accordance with Table 3-4:

Table 3-4
PAIR DESIGNATION AND COLOR CODE

Pair Number	Conductor		Pair Number	Conductor	
	Ring	Tip		Ring	Tip
1	Blue	White	14	Brown	Black
2	Orange	White	15	Slate	Black
3	Green	White	16	Blue	Yellow
4	Brown	White	17	Orange	Yellow
5	Slate	White	18	Green	Yellow
6	Blue	Red	19	Brown	Yellow
7	Orange	Red	20	Slate	Yellow
8	Green	Red	21	Blue	Violet
9	Brown	Red	22	Orange	Violet
10	Slate	Red	23	Green	Violet
11	Blue	Black	24	Brown	Violet
12	Orange	Black	25	Slate	Violet
13	Green	Black			

- 3.5.1 In cables having more than 25 pairs, the pair color code of 3.5 above shall be repeated and each group of 25 pairs shall be distinguished by colored binders in accordance with Paragraph 4.2.2.

SECTION 4 CORE CONSTRUCTIONS

- 4.1 **CORE ASSEMBLY:** Unless otherwise specified by the manufacturer, or the individual cable product specification referencing this Standard, core assembly shall be as follows:
- 4.1.1 In cables having 25 pairs or less, the twisted pairs shall be assembled in layers to form a substantially cylindrical core. Adjacent layers may be cabled in the same direction or in opposite directions. Cables having 25 pairs or less may also be composed of subgroups in lieu of the concentric layer construction.
- 4.1.2 In cables having more than 25 pairs, the twisted pairs shall be grouped, each group being bound by threads or tape. Each group shall contain no more than 25 pairs, excluding spare or service pairs. When desired for lay-up reasons, the basic 25-pair groups may be divided into two or more subgroups called units. Each unit in a particular 25-pair group shall be bound with binder threads or binder tapes of the colors indicated in Table 4-1 for its particular 25-pair group. The pair count shall be consecutive from 1 to 25 as given in Paragraph 3.5 through the units in a group.