



ICEA STANDARD FOR
CATEGORY 6 INDIVIDUALLY UNSHIELDED
TWISTED PAIR INDOOR CABLES
(WITH OR WITHOUT AN OVERALL SHIELD)
FOR USE IN COMMUNICATIONS WIRING SYSTEMS
TECHNICAL REQUIREMENTS

Publication ICEA S-102-700-2004

© 2002 by ICEA

INSULATED CABLE ENGINEERS ASSOCIATION, Inc.



Documents

Document Sharing Hub

ICEA STANDARD FOR
CATEGORY 6 INDIVIDUALLY UNSHIELDED TWISTED PAIR INDOOR CABLES (WITH OR
WITHOUT AN OVERALL SHIELD) FOR USE IN LAN COMMUNICATION WIRING SYSTEMS
TECHNICAL REQUIREMENTS

Published By
INSULATED CABLE ENGINEERS ASSOCIATION, INC.

Post Office Box 1568
Carrollton, GA 30112, U.S.A.

Approved June 9, 2004 by
Insulated Cable Engineers Association, Inc.

Copyrighted by the ICEA
Contents may not be reproduced
in any form without permission of the
INSULATED CABLE ENGINEERS ASSOCIATION, INC.

Copies of this publication may be obtained from:
GLOBAL ENGINEERING DOCUMENTS
15 Inverness Way East
Englewood, CO 80113-5776 USA
Telephone: (800) 854-7179
www.global.his.com

FOREWORD

ICEA Standards are published in the public interest and are intended to promote product uniformity and quality throughout the industry. Existence of an ICEA publication does not in any respect preclude the manufacture or use of products not conforming to the Standard.

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.

Questions of interpretation of ICEA Standards can only be accepted in writing, and the reply shall be provided in writing. Suggestions for improvements in this Standard are welcome. Questions and suggestions shall be sent to:

Secretary
Insulated Cable Engineers Association
P.O. Box 1568
Carrollton, GA 30117
United States of America

This Standard was developed by the Telecommunications Wire and Cable Standards Technical Advisory Committee whose membership consisted of technical experts from the manufacturing, user, and general interest segments of the industry. It was approved by ICEA on June 9, 2004. The members of the ICEA Communications Cable Section, Working Group 700, who participated in this project were:

Brian Shuman- Chairman
T. McLaughlin
G. L. Dorna

V. Anyanwu
D. Price
W. Hopkinson

D.K.Baker
M. Silva
T. Rhoads

TELECOMMUNICATIONS WIRE AND CABLE STANDARDS
TECHNICAL ADVISORY COMMITTEE

2003-2004

Committee Chairperson: D. Coleman
Committee Vice-Chairperson: G. Hessler

Individuals who participated in the development of this Standard (manufacturer and user representatives):

R. Allen	Mohawk-CDT
J. Baer	Superior-Essex
J. Baez	CANTV/GTE
D. K. Baker	Superior-Essex
R. Dettmann	Ameritech
T. Carle	Krone Digital Communications, Inc
G. Greer	Norcom/CDT
E. Gurney	Verizon
T. Hardin	Avaya
G. Hessler	USDA/RUSD.
M. Manvela de Faria	CANTV
F. Marquez	Condumex
G. Oriol	General Cable
V. Osornio	Condumex
D. Price	CommScope
B. Pope	Belden Electronics Division
T. Rhoades	Belden Communications Division
C. Rim	General Cable
B. Shuman	Belden Electronics Division
J. Smith	Pirelli
D. Stevens	Berk-Tek
A Turner	Southwire Co.
J.-H. Walling	NORDX/CDT

Associate Members who participated in the development of this Standard:

G. Brown	Union Carbide
E. Brunner	Nova-Borealis
T. Schloemer	Equistar Chemicals
R. Ellis	NEPTCO

1. GENERAL

1.1	Purpose	1
1.2	Scope	1
1.3	Definition of Cable Types	1
1.4	Options and Information	2
1.5	Units and Tolerances	2
1.6	References	2
1.7	Quality Assurance	2
1.8	Safety Considerations	3
1.9	Installation Precautions	3

2. CONDUCTORS

2.1	Solid Conductors for Horizontal and Backbone Cables, and Patch Cordage	3
2.1.1	Solid Conductors	3
2.1.2	Conductor Size	3
2.1.2	Conductor Elongation	3
2.1.4	Factory Joints	3
2.2	Stranded Conductors for Patch Cordage	3
2.2.1	Individual Strands	3
2.2.2	Metallically Bonded Conductors	3
2.2.3	Conductor Size	3
2.2.4	Factory Joints	4

3. CONDUCTOR INSULATION

3.1	Insulation Material	4
3.2	Insulation Dimensions, Colors, and Splices	4
3.2.1	Dimensions, Horizontal and Backbone Cables	4
3.2.2	Colors	4
3.2.3	Color Systems	4
3.2.4	Splices	4
3.3	Insulation Physical Requirements	4
3.3.1	Adhesion, Solid Conductors	5
3.3.2	Elongation	5
3.3.3	Compression, Solid Conductors	5
3.3.4	Cold Bend	5
3.3.5	Shrinkback	5
3.3.6	Heat Exposure (Aging)	5
3.3.7	Aged Flexibility	5

3.4	Twist Length and Color Coding	5
3.4.1	Pairs	5
3.4.2	Horizontal and Backbone Cables	6
3.4.3	Patch Cordage	6
3.4.4	Tight Twist Pairs	6
4.	CORE CONSTRUCTION	
4.1	Binders	7
4.2	Core Wrap	7
4.3	Ripcord	7
5.	SHIELDS	
5.1	Shielding System	7
5.2	Shielding Materials	7
5.2.1	Aluminum Tape	7
5.2.2	Copper Tape	7
5.2.3	Laminated Tape	7
5.2.4	Copper Braid	7
5.2.5	Laminated Tapes/Braid	7
5.3	Metal Tape Shield Application	7
5.4	Metal Tape Shield Splices	7
6.	JACKET	
6.1	Jacket Material	8
6.2	Jacket Thickness	8
6.3	Completed Cable Jacket Requirements	8
6.3.1	Tensile Strength	8
6.3.2	Elongation	8
6.3.3	Heat exposure (Aging)	8
6.4	Jacket Color	8
7.	ELECTRICAL REQUIREMENTS	
7.1	General	9
7.2	Measurement Precaution	9
7.3	DC Resistance	9
7.4	DC Resistance Unbalance	9
7.5	Mutual Capacitance	9
7.6	Pair-To-Ground Capacitance Unbalance	9
7.7	Attenuation	9
7.7.1	Horizontal and Backbone Cables	10
7.7.1.1	Attenuation	10
7.7.1.2	Elevated Temperature Test	11
7.7.2	Patch Cables	11

7.8	Crosstalk	11
7.8.1	Near End Crosstalk.....	11
7.8.2	Power Sum Near End Crosstalk	12
7.8.3	Equal Level Far End Crosstalk	13
7.8.4	Power Sum Equal Level Far End Crosstalk	14
7.9	Characteristic Impedance.....	15
7.10	Return Loss	15
7.11	Phase Delay	16
7.12	Phase Delay Skew	17
7.12.1	Delay Skew.....	17
7.12.2	Environmental Effects	17
7.13	Insulation Resistance	17
7.14	Conductor-To-Conductor DC Proof Test	17
7.15	Core-To-Shield DC Proof Test.....	17
7.16	AC Leakage Test.....	17
7.17	Continuity of Metallic Cable Elements	17
7.18	Transfer Impedance	17
8.	MECHANICAL REQUIREMENTS	
8.1	Cable Cold Wrap Test	17
8.2	Flex Test	18
8.3	Sheath Adherence.....	18
8.4	Cable Pulling Tension.....	18
8.5	Flammability	18
8.6	Limited Smoke.....	19
8.7	Halogen Content	19
8.8	National Electrical Code	19
9.	GENERAL REQUIREMENTS	
9.1	Identification and Marking.....	20
9.1.1	Method of Identification.....	20
9.1.2	Length Marking	20
9.2	Jacket Ink Marking Durability.....	20
9.3	Packaging	20

TABLES

Table 3-1:	Insulation Color	4
Table 3-2:	Pair Color Code	6
Table 3-3:	Pair Color Code for Patch Cordage	6
Table 7-1:	Maximum DCR	9
Table 7-2:	Maximum Attenuation	10
Table 7-3:	Minimum Worst Pair NEXT	12
Table 7-4:	Minimum Worst Pair Power Sum NEXT	13
Table 7-5:	Minimum Worst Pair ELFEXT	14
Table 7-6:	Minimum Worst Pair Power Sum ELFEXT	15
Table 7-7:	Minimum Return Loss Requirements	15
Table 7-8:	Minimum Return Loss	16
Table 7-9:	Maximum Phase Delay	16
Table 7-10:	Maximum Transfer Impedance	17
Table I:	Specifications Referenced in this Standard	21

APPENDICES

Appendix A:	Test Procedures for Wicking and Hygroscopicity	25
Appendix B:	Cable Ripcord Test	27
Appendix C:	Metallic Tape Splice Breaking Strength, Percent Retention	28
Appendix D:	Durability Test of Ink Marking	29

ANNEX

Annex A:	Cable Performance at Elevated Temperatures	30
Annex B:	Product Guide	33
Annex C:	ICEA Standards	35

ACRONYMS, ABBREVIATIONS AND SYMBOLS

ACR	Attenuation-to-Crosstalk Ratio
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ASQC	American Society for Quality Control
AWG	American Wire Gauge
Centigrade	Degrees of Temperature, Celsius scale
cm	centimeter(s)
CM	UL Listing designation for General Purpose Communication Cable
CMG	UL Listing designation for General Purpose Communication Cable
CMR	UL Listing designation for Riser Communication Cable
CMP	UL Listing designation for Plenum Communication Cable
CMX	UL Listing designation for Limited Use Communication Cable
DC	Direct Current
dB	decibel(s)
ELFEXT	Equal Level Far End Crosstalk
FEXT	Far End Crosstalk

ACRONYMS, ABBREVIATIONS AND SYMBOLS (continued)

f	Frequency in Megahertz
Fahrenheit	Degrees of Temperature, Fahrenheit scale
ft	foot or feet
FTP	Overall shielded Twisted Pair Cable
gm(s)	gram(s)
ICEA	Insulated Cable Engineers Association
in	inch(es)
IO FEXT	Input/Output Far End Crosstalk
kHz	kilohertz
kg	kilogram
lbf	pound(s) of force
LS	limited smoke
MHz	Megahertz
m	meter(s)
mA	milliamp(s)
mm	millimeter(s)
MPa	Megapascal
N	Newton
nF	nanofarad
NEC	National Electrical Code
NEXT	Near End Crosstalk
ns	nanoseconds
oz	ounce(s)
PSACR	Power Sum Attenuation-to-Crosstalk Ratio
PSELFEXT	Power Sum Equal Level Far End Crosstalk
PSNEXT	Power Sum Near End Crosstalk
pF	picofarad
psi	pounds per square inch
RL	Return Loss
Sec	Second(s)
SI	International System of Units
T	Temperature
UL	Underwriters Laboratories
UTP	Unshielded Twisted Pair Cable
°	degrees symbol, temperature or angle
α	Attenuation
μ S	microSiemen

CATEGORY 6, INDIVIDUALLY UNSHIELDED TWISTED PAIR INDOOR CABLES (WITH OR WITHOUT AN OVERALL SHIELD) FOR USE IN LAN COMMUNICATION WIRING SYSTEMS,

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 indoor premises use in the wiring systems of communications users. The parameters covered provide material, construction, and performance requirements.

Because this Standard does not cover all details of individual cable design, it cannot be used as a single document for procurement of product. This Standard is intended for use 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, electrical and flammability requirements for thermoplastic insulated and jacketed, copper conductor, individually unshielded twisted pair indoor cables, with or without an overall shield, intended for use as horizontal cables, backbone cables, or in the manufacture of patch cords. Depending upon the application and system requirements, this Standard provides choices for materials and flammability ratings.

Category cables are intended for voice, text, data, video and image transmission and are categorized by electrical transmission characteristics based on existing system requirements and projected application needs.

This Standard covers the minimum performance requirements for Category 6 cables up to four pairs, with enhanced transmission characteristics specified up to 250 MHz.

For additional Categories, see companion ICEA Standards S-80-576 for Categories 1 and 2 and S-90-661 for Categories 3, 5, and 5e. Additional associated Standards and other ICEA standards are listed in Annex C.

- 1.3 DEFINITION OF CABLE TYPES:**

Horizontal cables are normally used in that portion of the telecommunications cabling system between the telecommunications closet and the work area telecommunications outlet. The conductors are solid.

Backbone cables are normally used in that portion of the telecommunications cabling system between telecommunications closets, equipment rooms, and entrance facilities within a building. The conductors are solid.

Patch cordage is a length of cable used in the manufacture of patch cords where it is combined with connectors on one or both ends to join telecommunication circuits/links at the cross-connect and to connect workstations to the wall outlet. The conductors may be solid or stranded.

1.4 OPTIONS AND INFORMATION:

This Standard is arranged in Sections covering specific areas of cable requirements and may be referenced as complete Sections or as individual paragraphs.

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

2.1, 2.2	Conductor
3.4.3	Color Code for Patch Cordage
4.3	Ripcord
5.1	Shielding System
6.4	Jacket Color
8.5	Flammability
8.6	Limited Smoke
8.7	Halogen Content
9.1.2	Length Marking
9.3	Packaging

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 B be utilized.

1.5 **UNITS AND TOLERANCES:** Throughout this Standard, the primary unit of measure is indicated first and these values must be used for determination of product conformance. Parenthetical conversions are approximate and are provided for information only. Unless otherwise specified, the rounding-off method of ASTM E 29 shall be used for determining measurement tolerances.

1.6 **REFERENCES:** All documents referenced herein shall be as listed in Table I with issues and/or dates as indicated.

1.7 **QUALITY ASSURANCE:** It is the responsibility of the manufacturer to establish a quality assurance system consistent with ANSI/ASQC Q9000-1, Q9004-1, TL-9000, or an alternate system acceptable to the user. When the user requires a specific quality assurance program and/or special testing procedures, agreement between the user and the manufacturer should be reached before the order is placed.

Requirements shall be met on every length of completed cable as assured by quality control methods or by 100% testing. The term "completed cable" refers to a continuous length of finished cable resulting from the last jacketing operation.

Properties that shall be tested on every length of completed cable, prior to shipment, are listed below by paragraph number.

7.14	Conductor - To - Conductor DC Proof Test
7.15	Core - To - Shield DC Proof Test
7.17	Continuity of Metallic Cable Elements

As an exception to these requirements for products packaged in-line, these tests may be performed at the last assembly operation prior to jacketing.

- 1.8 **SAFETY CONSIDERATIONS:** Materials in the cable shall present no dermal, environmental, or other safety hazards as defined by current industry standards or applicable federal, state, or local 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, test, 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.

- 1.9 **Installation Precautions:** As with all transmission media, if recommended cabling precautions and installation methods are not observed, specified transmission capabilities may not be achieved.

SECTION 2 CONDUCTORS

2.1 **SOLID CONDUCTORS FOR HORIZONTAL AND BACKBONE CABLES, AND PATCH CORDAGE**

- 2.1.1 **Solid Conductors:** Solid conductors shall consist of commercially pure, annealed, copper and shall meet the requirements of ASTM B 3 for annealed, bare copper wire or ASTM B 33 for annealed, tin coated copper wire except that requirements for "Dimensions and Permissible Variations" are not applicable and elongation requirements are superseded by this Standard.

- 2.1.2 **Conductor Size:** In a completed cable, the minimum conductor diameter shall be 0.0191 inches (0.485 mm). The conductor diameter shall be sized to meet the transmission and electrical parameters of Section 7.

- 2.1.3 **Conductor Elongation:** When tested in accordance with ASTM E 8, the minimum elongation of any conductor removed from the completed cable shall not be less than 8%.

- 2.1.4 **Factory Joints:** Prior to insulating, factory joints in conductors may be either butt brazed, using a silver alloy solder and nonacid flux, or butt welded. Joints in uninsulated conductors shall be free from lumps and sharp projections and shall not increase the diameter. Subsequent to insulating, solder sleeves may also be used. The breaking 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.

2.2 **STRANDED CONDUCTORS FOR PATCH CORDAGE**

- 2.2.1 **Individual Strands:** The individual wires for stranded conductors shall consist of commercially pure, annealed, copper and shall meet the requirements of ASTM B 3 for annealed, bare copper wire or ASTM B 33 for annealed, tin coated copper wire.

- 2.2.2 **Metallically Bonded Conductors:** Stranded conductors metallically bonded together shall meet the requirements of ASTM B 470.

- 2.2.3 **Conductor Size:** Stranded conductors shall comply with ASTM B 8 or ASTM B 286 except that the requirements for "Dimensions and Permissible Variations" are not applicable.

- 2.2.4 **Factory Joints:** Prior to insulating, joints in the individual wires of a stranded conductor may be made by silver soldering, brazing or butt-welding. There shall be no sharp points, and the distance between joints in a single conductor should not average less than 3000 feet (915 m) in any reel length of insulated single conductor. The breaking 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 suitable thermoplastic material(s) (solid, foam, or any combination thereof) meeting the completed cable requirements of this Standard. Examples of suitable materials are:

polyolefins
fluoropolymers
nonhalogen materials

- 3.2 **INSULATION DIMENSIONS, COLORS, AND SPLICES:** The insulation shall be as uniform and smooth as is consistent with good commercial practice.

- 3.2.1 **Dimensions:** The diameter over insulation shall not exceed 0.048 inch (1.22 mm).

- 3.2.2 **Colors:** The insulation shall be uniformly colored as shown in Table 3-1:

Table 3-1

INSULATION COLORS	
Blue (Bl)	White(W)
Orange (O)	Red (R)
Green (G)	Black (Bk)
Brown (Br)	Yellow (Y)
Slate (S)	

- 3.2.3 **Color Systems:** Insulation colors are specified in terms of the Munsell Color System of ASTM D 1535 and should comply with ANSI/EIA 359-A, "EIA Standard Colors for Color Identification and Coding." Deviations from the color limits are allowed, but colors shall be as close to the required color centroid as possible, following good commercial practice. All colors shall be readily identifiable and distinguishable from each other.
- 3.2.4 **Splices:** Splices in the insulated conductors shall be insulated with a non-hygroscopic, dielectric material. There shall be no exposed conductor at the splice. Insulated conductors with insulated splices in completed cable shall be capable of meeting all applicable electrical requirements of this Standard.
- 3.3 **INSULATION PHYSICAL REQUIREMENTS:** Each type of insulation from conductors of completed cable shall meet the applicable requirements listed under this Section.