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since 1976

Structured Cabling Organizations and Standards

Key cabling infrastructure standards

ANSI/TIA ISO/IEC IEEE

Table of Contents

The importance of standards 3
A short history of cabling standards 3
Standards organizations 3
Key standards
- ANSI/TIA/EIA 5
- ISO/IEC 9
- IEEE 10

About Black Box 11

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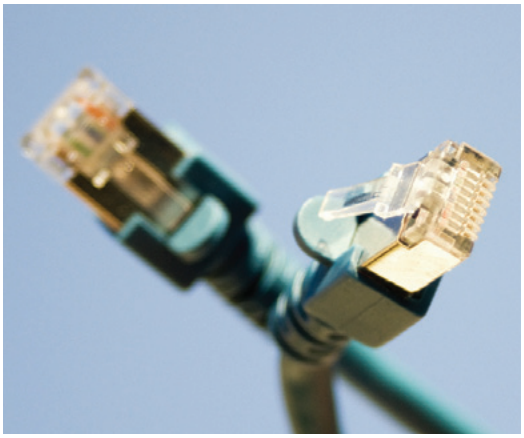
The importance of standards.

Standards are the platform of all telecommunications networks. They establish guidelines and recommend best practices for every aspect of telecommunications cabling systems from network design and installation to cable performance and verification. Standards establish technical criteria and ensure uniformity and compatibility in and between networks, even multivendor networks.



In communications cabling, standards define cabling types, distances, connections, cabling architectures, performance parameters, testing requirements, and more. And because they provide recommended best practices, standards can reduce downtime and installation expenses. They simplify moves, adds, and changes. They maximize system availability, and they extend the usable lifetime of a cabling system. Standards enable you to build structured cabling systems that can easily accommodate existing technologies, equipment, and users, as well as future ones.

Today, there are two primary organizations involved in the development of structured cabling standards. The Telecommunications Industry Association (TIA) standards are usually specified in North America. The International Organization for Standardization standards are more commonly used outside of North America.

A short history of cabling standards.

Before 1985, there were no structured cabling standards. Phone companies used their own cabling. Businesses generally used a vendor's proprietary system. Eventually, the Computer Communications Industry Association (CCIA) approached the Electronics Industries Alliance, formerly Association, (EIA) about developing cabling standards, which they did. Discussions centered around developing standards for voice, data, commercial, and residential cabling systems. (The TIA was formed in April 1988 after a merger of the United States Telecommunications Suppliers Association and the Information and Telecommunications Technologies group of the EIA.)

In 1991, the TIA published its Commercial Building Telecommunications Wiring Standard, ANSI/TIA-568. It was the first standard to define a generic telecommunications system that would support a multiproduct, multivendor environment. It enabled wiring systems to be planned and installed without definite plans for telecommunications equipment installed later. The latest version is TIA-568-C, published in 2009. The standards committees must review standards every five years, although the committees meet frequently. Currently, TIA-42 meets three times a year with interim meetings as needed and issues addendums to update the standards. This guide covers the most relevant standards to commercial buildings today. Specialized buildings and environments, such as data centers, educational institutions, healthcare facilities, industrial environments, etc., are covered by their own standards.

Standards organizations.

Today, there are a number of organizations developing standards related to cabling and communications.

ANSI	**ANSI (American National Standards Institute).** This group coordinates and adopts national standards in the U.S.
Bicsi	**BICSI (Building Industry Consulting Service International, Inc.).** This association supports the information transport systems (ITS) industry with information, education, and knowledge assessment.
CSA	**CSA (Canadian Standards Association).** Electrical and electronic goods in Canada must be CSA approved.
EIA Electronic Industries Alliance	**EIA (Electronics Industries Alliance).** Known for developing cabling standards with the TIA, the EIA ceased operations on February 11, 2011. EIA standards are now managed by the Electronic Components Association (ECA).

TIA (Telecommunications Industry Association). Best known for developing cabling standards with the EIA, the TIA is the leading trade association for the information, communications, and entertainment technology industry.

ISO (International Organization for Standardization). This group is the world's largest developer of standards and includes standards groups from member nations around the world.

IEC (International Electrotechnical Commission). This international standards organization prepares and publishes international standards for all electrical, electronic, and related technologies.

IEEE (Institute of Electrical and Electronics Engineers, Inc.). IEEE, pronounced "Eye-triple-E", is an international organization and a leading developer of standards in a broad range of disciplines, including electric power, information technology, information assurance, and telecommunications.

NEC (National Electrical Code). The NEC is a document produced by the National Fire Protection Association (NFPA). It is a regionally adoptable standard for the safe installation of electrical wiring and equipment in the United States.

NEMA (National Electrical Manufacturing Association). NEMA is the voice of and forum for the electrical and medical imaging industries serving manufacturer members.

NFPA (National Fire Protection Association). This is the North American organization of fire prevention and an authoritative source on public safety.

Please note, because standards are constantly changing, a document such as this must be considered a guide. To purchase standards or to check the latest versions, please check with the associations below.

Standards Organizations

Organization	Contact	Where to buy
ANSI	www.ansi.org Headquarters: 1899 L Street, NW, 11th Floor Washington, DC, 20036 202-293-8020	http://webstore.ansi.org Customer Service Dept/Document Sales 25 West 43rd Street, 4th floor, New York, NY 10036 212-642-4980 • info@ansi.org
TIA	www.tiaonline.org 1320 N. Courthouse Road, Suite 200 Arlington, VA 22201 701-907-7700	IHS Standards Store • 877-413-5184 customercare@ihs.com • www.global.ihs.com/ 15 Inverness Way East, Englewood, CO 80112 Main office: 800-854-7179
ISO	www.iso.org • central@iso.org ISO Central Secretariat 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland 41 22 749 01 11	sales@iso.org • 41 22 749 08 88 Also ANSI and IHS as listed above.
IEEE	www.ieee.org • 800 701 IEEE (USA and Canada) +1 732 981 0060 (Worldwide)	stds-info@ieee.org www.ieee.org/publications_standards/index.html Also ANSI and IHS as listed above.
IEC	www.iec.ch • inmail@iec.ch Two 3, rue de Varembé, P.O. Box 131 Ch.1211 Geneva 20, Switzerland Phone: +41 22 919 02 11	http://webstore.iec.ch/ Also ANSI and IHS as listed above.

Relationship between TIA-568-C and other relevant TIA standards.

Common Standards	Premises Standards	Component Standards
ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises	**ANSI/TIA-568-C-1:** Commercial Building Telecommunications Cabling Standard	**ANSI/TIA-568-C.2:** Balanced Twisted-Pair Telecommunications Cabling and Components Standard
ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces	**ANSI/TIA-570-C:** Residential Telecommunications Infrastructure Standard	**ANSI/TIA-568-C.3:** Optical Fiber Cabling Components Standard
ANSI/TIA-606-B: Administration Standard for Commercial Telecommunications Infrastructure	**ANSI/TIA-942:** Telecommunications Infrastructure Standard for Data Centers	**ANSI/TIA-568-C.4:** Broadband Coaxial Cabling and Components
ANSI/TIA-607-B: Telecommunications Grounding (Earthing) and Bonding for Customer Premises	**ANSI/TIA-1005:** Telecommunications Infrastructure Standard for Industrial Premises	
ANSI/TIA-758-B: Customer-Owned Outside Plant Telecommunications Infrastructure Standard		
ANSI/TIA-862: Building Automation Systems Cabling Standard for Commercial Buildings		

Key standards.

ANSI/TIA

ANSI/TIA-440-B: *Fiber Optic Terminology. (Under development.)*

ANSI/TIA-568-C.0: *Generic Telecommunications Cabling for Customer Premises (2009).* This document is targeted towards end-users, designers, and installers. This standard is for the planning and installation of structured cabling in all types of customer premises. It specifies minimum requirements for generic telecommunications cabling in a multiproduct, multivendor environment within a commercial building and between buildings in a campus environment. This standard is the foundation for 568-C telecommunications cabling infrastructure design and can be used for generic cabling needs when a specific standard does not exist. It includes:

- Telecommunications cabling system structures
- Topologies and distances
- Installation requirements for twisted pair and fiber
- Fiber performance and testing requirements
- Annex A: Centralized cabling reference
- Annex B: Fiber polarity
- Annex C: Multitenant cabling
- Annex D: Application information
- Annex E: Fiber field test guidelines
- Annex F: Environmental classifications

This standard recognizes CAT6A, and includes fiber link test and performance requirements. It also updates the bend radius for UTP and F/UTP cables to 4x cable O.D. The bend radius for patch cords has been changed to 1x cable O.D.

ANSI/TIA-568-C.1: *Commercial Building Telecommunications Cabling Standard (February 2009).* This premises standard replaces ANSI/TIA-568-B.1. This standard is for the planning and installation of structured cabling in all types of premises. It specifies minimum requirements for telecommunications cabling within a commercial building and between buildings in a campus environment with a geographic reach of 3000 square meters to 1,000,000 square meters. It defines terms, specifies cabling topologies, types, and distances as well as outlet and connector configurations. It supports a wide range of commercial applications including voice, data, text, video, and images. It includes:

- Entrance facilities
- Equipment rooms
- Telecommunications rooms and enclosures
- Backbone cabling
- Horizontal cabling
- The work area
- Administration
- Consolidation points

This standard is aimed at end-users, designers, and installers. It adds CAT6 and CAT6A cabling, 850-nm laser-optimized 50-micron cabling, and telecommunications enclosures. It deletes CAT5, 150-ohm STP, and 50-ohm and 75-ohm coax cable. It also moves the copper channel and permanent link requirements to 568-C.2.

ANSI/TIA-568-C.2: *Balanced Twisted-Pair Telecommunications Cabling and Components Standard (August 2011).* This component-level standard incorporates 568-B addendums, such as ANSI/TIA-568-B.2-10 from 2008, and is targeted towards manufacturers of twisted-pair cabling systems and components.

It specifies permanent link, channel performance, and test procedures for CAT3, CAT5e, CAT6, and CAT6A systems. It also recommends CAT5e to support 100-MHz applications. It introduces coupling attenuation and information on modeling configurations. One test method is specified for all categories of connecting hardware. Field tester requirements have been removed and moved to ANSI/TIA-1152. It specifies:

- Mechanical and transmission requirements for channels, permanent links, cords and connectors
- Annex A: Connector reliability
- Annex B: Measurement requirements
- Annex C: Cabling and component test procedures
- Annex D: Connector transfer impedance test method
- Annex E: Connector test fixtures
- Annex F: Multiport measurement considerations
- Annex G: High-temperature environment installations
- Annex H: Propagation delay derivations
- Annex I: Channel and component return loss limits
- Annex J: Modeling configurations
- Annex K: NEXT loss limits
- Annex L: PS-AACRF and AFEXT loss normalization
- Annex M: CAT5 channel parameters

TR-42.7 is currently developing ANSI/TIA-568-C.2-1: Specifications for Category 8 (100-Ohm Next Generation Cabling), a new category of cabling to support future applications beyond 10GBASE-T. Publication is expected in 2014. This is for a 2-GHz standard with alien crosstalk requirements that are more stringent than ISO/IEC 11801 Class F_A. The connector requirements are based on an RJ-45 connector and will be backward compatible. The standard will include specifications for shielded as well as unshielded twisted-pair cabling. It is highly unlikely, though, due to the stringent draft alien crosstalk requirements, that UTP cabling will satisfy the performance requirements of the standard.

ANSI/TIA-568-C.3: *Optical Fiber Cabling Components Standard (July 2008).* This standard replaces ANSI/TIA-568-B.3. and defines multimode and single-mode fiber cable types and performance levels. It is written for manufacturers of optical fiber cabling systems and components. It adds ISO nomenclatures for OM1, OM2, OM3, OS1, and OS2 optical fiber cable to transmission performance tables. It recommends connector strain relief, housing, and adapter color coding. The minimum OFL bandwidth for 62.5-micron fiber has been increased from 160-MHz/km to 200 MHz/km at 850 nm. The standard includes:

- Fiber cable types, wavelength specification, attenuation, and bandwidth
- Connecting hardware and adapters
- Patch cords and fiber transitions
- Annex A: Connector performance specifications

ANSI/TIA-568-C.3-1 Addendum 1: *Addition of OM4 Cabled Optical Fiber and Array Connectivity (December 2011)* adds new specifications for 50/125-µm laser-optimized OM4 fiber cable and components.

ANSI/TIA-568-C.4: *Broadband Coaxial Cabling and Components (July 2011).* This standard consolidates information from the Residential (RG-6 & RG-59) and Data Center (Type 734 & 735) Standards. This standard defines:

- Topology
- Cabling subsystems 1, 2, and 3
- Series 6 and Series 11 link performance
- Coaxial cable, cords, and connecting hardware
- Installation requirements
- Field test requirements
- Annex on background information for coaxial cabling requirements

ANSI/TIA/-569-C: *Commercial Building Standard for Telecommunications Pathways and Spaces. (February 2012).* TIA-569-B addressed commercial buildings. This latest version includes the addition of HVAC requirements based on 2008 ASHRAE recommended practices for temperature and humidity, power/data separation guidelines, and lighting requirements. It also includes the removal of conduit fill requirements (40% is no longer compliant) and the removal of outdated floor loading information.

- Environmental compatibility
- Telecommunications facilities
- Building spaces
- Access provider and service provider spaces
- Multitenant building spaces
- Building pathways
- Annex on firestopping and electromagnetic noise-reduction guidelines

ANSI/TIA-570-C: *Residential Telecommunications Infrastructure Standard.*

ANSI/TIA-606-B: *Administration Standard for Commercial Telecommunications Infrastructure (June 2012).* The administration of a cabling plant is increasingly important as a building can have many tenants and networking applications over its serviceable lifespan. This standard specifies four classes of administration based upon the complexity of the cabling plant being administered. It also includes the Data Center addendum and additional technical information.

ANSI/TIA-607-B: *Telecommunications Grounding (Earthing) and Bonding for Customer Premises (August 2012).* This standard specifies uniform telecommunications grounding and bonding for commercial buildings.

ANSI/TIA-758-B: *Customer-Owned Outside Plant Telecommunications Infrastructure.*

ANSI/TIA-862-A: *Building Automation Systems Cabling Standard for Commercial Buildings (March 2011).* This standard has been reopened, and the name will possibly change to Intelligent Building instead of Building Automation. Also the standard will go to a B version. The standard specifics generic cabling for building automation systems in commercial buildings.

ANSI/TIA-942-A: *Telecommunications Infrastructure Standard for Data Centers (August 2012).* This standard provides requirements and guidelines for the design and installation of single- and multitenant data centers. The latest version recommends CAT6A copper and OM4 fiber as the minimum for data center cabling. It also approves the MPO connector for multistrand fiber, and LC as the preferred connector for two-strand fiber. It also removes CAT3 and CAT5 horizontal cabling (voice backbone only). The guidelines also incorporate more coaxial cabling specifications, a 3-level lighting protocol, and revised temperature/humidity limits. It also moved some specifications, such as grounding and bonding, and administration labeling to other standards. This standard specifies:

- Data center design
- Cabling systems and infrastructure
- Spaces and related topologies
- Pathways
- Redundancy
- Annexes include: Cabling design considerations, Access provider information, Coordination of equipment plans with other engineers, Data center site selection and building design considerations, Data center infrastructure tiers, and Data center design examples

ANSI/TIA-1005-A: *Telecommunications Infrastructure Standard for Industrial Premises (November 2011).* This standard addresses the specific needs of telecommunications within and between industrial buildings. It defines infrastructure, distance, outlets, and topology specifically for cabling in harsh, industrial environments. The standard includes:

- Industrial areas
- Spaces
- Pathways
- Firestopping
- Backbone and horizontal cabling
- Work area
- Grounding and bonding
- Performance
- Annexes address other requirements.

ANSI/TIA-1152: *Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling (September 2009).* This standard provides requirements for copper field test instruments. It also addresses ways to compare field test results with laboratory test results.

ANSI/TIA-1179: *Healthcare Facility Telecommunications Infrastructure Standard (July 2010).* This standard specifies cabling and infrastructure for healthcare facilities. It also address specific requirements in clinical and non-clinical areas.

ANSI/TIA-1183: *Measurement Methods and Test Fixtures for Balun-less Measurements of Balanced Components and Systems (August, 2012).* This Standard is intended to be used as an independent testing reference and describes methods and fixtures that support laboratory measurement of all differential mode, mixed mode, and common mode transmission parameters up to 1 GHz.

ANSI/TIA-4966: *Telecommunications Infrastructure for Educational Buildings and Spaces.* (In development. TR-42.1)

TIA-492AAAD: *Detail Specification for 850-nm Laser-Optimized, 50-µm Core Diameter/125-µm Cladding Diameter Class IA Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber.*

TIA-598: *Cable Color Coding.* (Not yet published.)

TR-42.10: *STEPS (Sustainable Technology Environments Program).*

TSB-140: *Additional Guidelines for Field-Testing Length, Loss, and Polarity of Optical Fiber Cabling Systems.*

TSB-155-A: *Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T.*

TSB-162-A: *Telecommunications Cabling Guidelines for Wireless Access Points.*

TSB-184: *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling.*

TSB-190: *Guidelines on Shared Pathways and Shared Sheaths.*

TSB-1005: *Telecommunications Infrastructure Standard for Industrial Premises.*

ISO/IEC (International Organization for Standardization/International Electrotechnical Commission)

ISO/IEC 11801 Edition 2.2: *Customer Premises (June 2011).* This standard specifies channel and link classes for balanced copper (Classes A, B, C, D, E, EA, F, and FA) and fiber (OM1, OM2, OM3, OM4, OS1, and OS2) cabling systems. It is directed at the general office environment. This standard specifies generic cabling, channel, link, and component performance requirements, implementation, conformance and verification. It specifies:

- Conformance
- Structure of the generic cabling system
- Balanced cabling
- Reference implementations for balanced cabling
- Performance of optical fiber cabling
- Cable requirements
- Connecting hardware requirements
- Screening practices
- Administration
- Balanced cords
- Annexes address performance, test, link, and other issues.

Under development within IS0/IEC 11801 are standards for generic cabling for customer premises, industrial premises, homes, and data centers.

ISO/IEC 15018 Edition 1.0: *Generic Cabling for Homes (June 2004).*

ISO/IEC 24702 Edition 1.0: *Industrial Premises (October 2006).* This standard addresses structure, cabling, performance, connecting requirements, cords, and more.

ISO/IEC 14763-3 Edition 1.1: *Testing of Optical Fiber Cabling (February 2011).*

ISO/IEC 24764 Edition 1.0: *Generic Cabling Systems for Data Centers (April 2010).* This standard addresses conformance and the structure of the generic cabling system in the data center.

ISO/IEC 14763-2 Edition 1.0: *Planning and Installation (February 2012).*

IEEE

IEEE-802.3-2012: Standard for Ethernet. In July 2012, the IEEE officially approved the IEEE 802.3-2012 Standard for Ethernet, which defines wired connectivity for Ethernet local area, access, and metropolitan area networks. The IEEE 802.3 revision incorporates various technical updates and enhancements and consolidates a host of amendments to the base standard that were approved since IEEE 802.3's last full revision, in 2008. Amendments addressing 10 Gbit/s Ethernet Passive Optical Networks (EPONs), energy efficiency, extension to 40 Gbit/s and 100 Gbit/s speeds while maintaining compatibility with previously installed IEEE 802.3 interfaces, enhanced support for loss-sensitive applications and time synchronization are among those that have been incorporated into IEEE 802.3-2012. Previous standards incorporated into this standard include:

- IEEE Std 802.3-2008/Cor1-2009 (Pause reaction delay corrigendum)
- IEEE Std 802.3at-2009 (DTE power enhancements)
- IEEE Std 802.3av-2009 (10Gb/s PHY for EPON)
- IEEE Std 802.3az-2010 (Energy-efficient Ethernet)
- IEEE Std 802.3ba-2010 (40-Gbps and 100-Gbps Ethernet)
- IEEE Std 802.3bc-2009 (Ethernet organizationally specific type, length, values [TLVs])
- IEEE Std 802.3bf-2011 (Ethernet support for the IEEE P802.1AS time synchronization protocol)
- IEEE Std 802.3bg-2011 (40-Gbps Ethernet single-mode fiber PMD)

Popular IEEE Standards

IEEE 802.11aa-2012: *Wireless Networking. (Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: MAC Enhancements for Robust Audio V)*

IEEE 802.11 a/b/g/n: *Wireless LAN (WLAN) and Mesh (Wi-Fi certification). IEEE 802.11 ac (draft).*

IEEE 802.16.1b-2012: *Wireless MAN-Advanced Air Interface for Broadband Wireless Access Systems - Amendment: Enhancements to Support Machine-to-Machine Applications.*

IEEE 802.3af: *Power over Ethernet. (PoE).*

IEEE 802.3at: *Power over Ethernet Plus (PoE Plus).*

Other IEEE 802 Standards

IEEE 802.1: *Bridging (Networking) and Network Management*

IEEE 802.2: *Logical Link Control (Upper Part of Data Link Layer)*

IEEE 802.3: *Ethernet (CSMA/CD)*

IEEE 802.4: *Token Bus (Disbanded)*

IEEE 802.5: *Defines the MAC Layer for a Token Ring (Inactive)*

IEEE 802.6: *Metropolitan Area Networks (Disbanded)*

IEEE 802.7: *Broadband LAN using Coaxial Cable (Disbanded)*

IEEE 802.8: *Fiber Optic TAG (Disbanded)*

IEEE 802.9: *Integrated Services LAN (Disbanded)*

IEEE 802.10: *Interoperable LAN Security (Disbanded)*

IEEE 802.11: *Wireless LAN & Mesh (Wi-Fi Certification)*

IEEE 802.12: *Demand Priority (Disbanded)*

IEEE 802.13: *Not Used*

IEEE 802.14: *Cable Modems (Disbanded)*

IEEE 802.15: *Wireless PAN*

IEEE 802.15.1: *(Bluetooth Certification)*

IEEE 802.15.4: *(ZigBee Certification)*

IEEE 802.16: *Broadband Wireless Access (WiMAX certification)*

IEEE 802.16e: *(Mobile) Broadband Wireless Access*

IEEE 802.17: *Resilient Packet Ring*

IEEE 802.18: *Radio Regulatory TAG*

IEEE 802.19: *Coexistence TAG*

IEEE 802.20: *Mobile Broadband Wireless Access*

IEEE 802.21: *Media-Independent Handoff*

IEEE 802.22: *Wireless Regional Area Network*

IEEE 802.23: *Emergency Services Working Group*

IEEE 802.24: *Smart Grid TAG New (November, 2012)*

IEEE 802.25: *Omni-Range Area Network (Not Yet Ratified)*

Current IEEE Task Forces*

IEEE 802.3ba 40-Gbps and 100-Gbps Ethernet

IEEE P802.3.1 (IEEE 802.3.1a) Revision to IEEE Std 802.3.1-2011 Ethernet MIBs Task Force

IEEE 802.3bf Ethernet Support for IEEE P802.1AS Time Synchronization Protocol

IEEE 802.3bg 40-Gbps Ethernet Single-mode Fiber PMD

IEEE P802.3bj 100 Gb/s Backplane and Copper Cable Task Force

IEEE P802.3bk Extended EPON Task Force

IEEE 802.3bm Next Generation 40-Gbps and 100-Gbps Optical Ethernet Task Force

IEEE P802.3bn EPON Protocol over Coax (EPoC) Task Force

IEEE P802.3bp Reduced Twisted Pair Gigabit Ethernet PHY Task Force

IEEE 802.3: Next Generation BASE-T Study Group

IEEE 802.3: Distinguished Minimum Latency Traffic in a Converged Traffic Environment Study Group

100-Gbps Backplane and Copper Cable Task Force

Extended EPON

EPON Protocol over a Coax (EPoC) PHY Study Group

Reduced Twisted-Pair Gigabit Ethernet (TRPGE) PHY Study Group

**Note: These task forces are continually changing.*

About Black Box

Black Box Network Services is a leading provider of copper and fiber cabling and infrastructure products, serving 175,000 clients in 150 countries with 200 offices throughout the world. Find what you need to build and expand your structured cabling system at **blackbox.com**. From the data center to the desktop, you'll find everything you need for your communications infrastructure, including CAT7, CAT6A, CAT6, and CAT5e cable; fiber optics; connecting hardware; cable management; data center enclosures, cooling solutions, and power protection; and testers and tools. Learn more at **blackbox.com/go/Cables**.

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