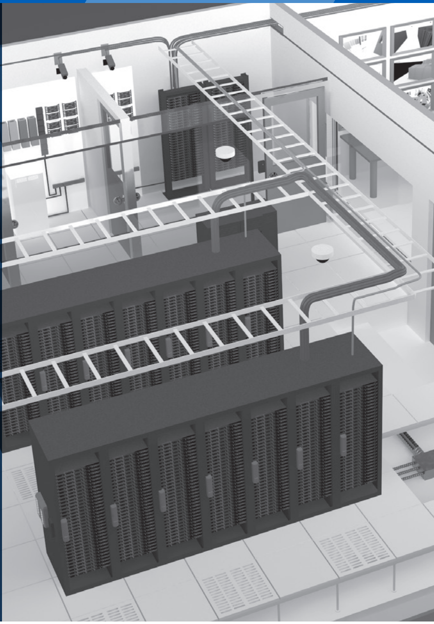
ANSI/TIA-568-C.0
ANSI/TIA-568-C.1
ANSI/TIA-568-C.2
ANSI/TIA-568-C.3
ANSI/TIA-569-C
ANSI/TIA-606-B
ANSI/TIA-607-B
ANSI/TIA-862-A
ANSI/TIA-942-A
ANSI/TIA-1005
ANSI/TIA-1179
ISO/IEC 11801
ISO/IEC 11801 Class E_A
IEEE 802.3af
IEEE 802.3at
IEEE 802.3an
IEEE 802.3ba
IEEE 802.11



STANDARDS REFERENCE GUIDE

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Anixter is a leading global supplier of communications and security products, electrical and electronic wire and cable, fasteners and other small components. We help our customers specify solutions and make informed purchasing decisions around technology, applications and relevant standards. Throughout the world, we provide innovative supply chain management solutions to reduce our customers' total cost of production and implementation.

Purpose of Industry Standards

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Anixter strives to be the industry expert within the data center, security, in-building wireless, industrial communication, wire and cable and fastener industries. Anixter is active within a number of industry associations and participates in committees and organizations around the world and continues to educate customers on updates, announcements and meaningful benefits that are grounded in those standards and best practices.

By adhering to industry standards, organizations can expect to fully experience the benefits of industry standards on overall network performance.

Scope of this Guide

This document is meant as a reference that highlights the key points of the ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, ANSI/TIA-568-C.2, ANSI/TIA-568-C.3, ANSI/TIA-569-C, ANSI/TIA-606-B, ANSI/TIA-607-B, ANSI/TIA-862-A, ANSI/TIA-942-A, ANSI/TIA-1005, ANSI/TIA-1179, ISO/IEC 11801, ISO/IEC 11801 Class E_A, IEEE 802.3af, IEEE 802.3at, IEEE 802.3an, IEEE 802.3ba and IEEE 802.11 standards.

It is not intended as a substitute for the original documents. For further information on any topic in the guide, refer to the actual standard. See the section called "Reference Documents" for instructions on how to order a copy of the standard itself.

Abbreviation References

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CSA	Canadian Standards Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical & Electronics Engineers
ISO	International Organization for Standardization
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
TIA	Telecommunications Industry Association

Table of Contents

Purpose of the ANSI/TIA-568-C.0 Standard

The ANSI/TIA-568-C.0 standard enables the planning and installation of a structured cabling system for all types of customer premises. It specifies a system that will support generic telecommunications cabling in a multiproduct, multimanufacturer environment. By serving as the foundation for premises telecommunications cabling infrastructure, the ANSI/TIA-568-C.0 standard provides additional requirements for other standards specific to the type of premises (e.g., ANSI/TIA-568-C.1 contains additional requirements applicable to commercial building cable).

The standard specifies requirements for generic telecommunications cabling, including:

- Cabling system structures
- Topologies and distances
- Installation, performance and testing
- Optical fiber transmission and test requirements.

This standard replaces ANSI/TIA/EIA-568-B.1 dated April 12, 2001, and its addenda. It incorporates and refines the technical content of ANSI/TIA/EIA-568-B.1-1 Addendum 1, 568-B.1-2 Addendum 2, 568-B.1-3 Addendum 3, 568-B.1-7 Addendum 7, TSB125, TSB140 and TSB153.

Section Contents

ANSI/TIA-568-C.0

Generic Telecommunications Cabling for Customer Premises

Telecommunications Cabling System Structure

General

Figure 1 shows a representative model of the functional elements of a generic cabling system for ANSI/TIA-568-C.0. In a typical commercial building where ANSI/TIA-568-C.1 applies, Distributor C represents the main cross-connect (MC), Distributor B represents the intermediate cross-connect (IC), Distributor A represents the horizontal cross-connect (HC), and the equipment outlet (EO) represents the telecommunications outlet and connector.

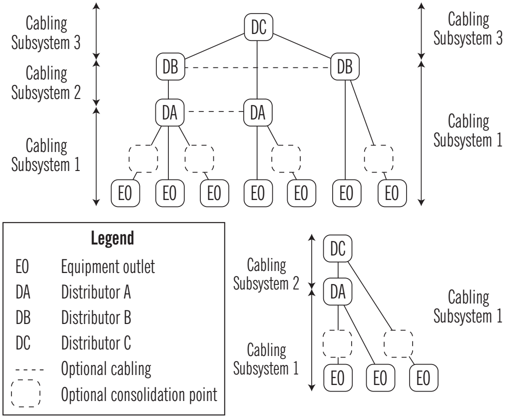


Figure 1 – Elements that comprise a generic cabling system

Topology

- Star topology
- No more than two distributors between Distributor C and an equipment outlet (EO)

Equipment Outlets (EOs)

Also called the work area (WA) in ANSI/TIA-568-C.1, equipment outlets are the outermost location to terminate the cable in a hierarchical star topology.

Distributors

Distributors provide a location for administration, reconfiguration and connection of equipment and testing. They can be either interconnections or cross-connections.

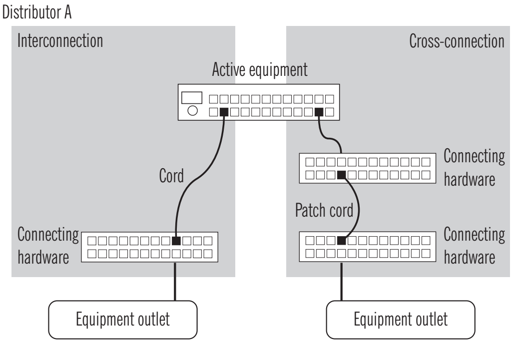


Figure 2 – Interconnections and cross-connections

Cabling Subsystem 1

- Provides a signal path between Distributor A, Distributor B or Distributor C and an EO (see Figure 1)
- Contains no more than one transition point or consolidation point
- Stipulates that splices shall not be installed as part of a balanced twisted-pair cabling subsystem and that splitters shall not be installed as part of optical fiber for Cabling Subsystem 1

Cabling Subsystem 2 and Cabling Subsystem 3

Cabling Subsystem 2 and Cabling Subsystem 3 provide signal paths between distributors (see Figure 1). The use of Distributor B is optional.

Recognized Cabling

The recognized media, which shall be used individually or in combination, are:

- 100-ohm balanced twisted-pair cabling
- Multimode optical fiber cabling
- Single-mode optical fiber cabling.

Cabling media other than those recognized above may be specified by the appropriate premises cabling standards.

Cabling Lengths

Cabling lengths are dependent upon the application and upon the specific media chosen (see following tables).

Cabling lengths

Application	Media	Distance m (ft.)	Comments
Ethernet 10BASE-T	Category 3, 5e, 6, 6A	100 (328)	
Ethernet 100BASE-TX	Category 5e, 6, 6A	100 (328)	
Ethernet 1000BASE-T	Category 5e, 6, 6A	100 (328)	
Ethernet 10GBASE-T	Category 6A	100 (328)	
ASDL	Category 3, 5e, 6, 6A	5,000 (16,404)	1.5 Mbps to 9 Mbps
VDSL	Category 3, 5e, 6, 6A	5,000 (16,404)	1,500 m (4,900 ft.) for 12.9 Mbps; 300 m (1,000 ft.) for 52.8 Mbps
Analog phone	Category 3, 5e, 6, 6A	800 (2,625)	
Fax	Category 3, 5e, 6, 6A	5,000 (16,404)	
ATM 25.6	Category 3, 5e, 6, 6A	100 (328)	
ATM 51.84	Category 3, 5e, 6, 6A	100 (328)	
ATM 155.52	Category 5e, 6, 6A	100 (328)	
ATM 1.2G	Category 6, 6A	100 (328)	
ISDN BRI	Category 3, 5e, 6, 6A	5,000 (16,404)	128 kbps
ISDN PRI	Category 3, 5e, 6, 6A	5,000 (16,404)	1.472 Mbps

Table 1 – Maximum supportable distances for balanced twisted-pair cabling by application, which includes horizontal and backbone cabling (application-specific)

	Parameter	Multimode						Single-mode	
		62.5/125 μm TIA 492AAAA (OM1)		50/125 μm TIA 492AAAB (OM2)		850 nm laser-optimized 50/125 μm TIA 492AAAC (OM3)		TIA 492CAAA (OS1) TIA 492CAAB (OS2)	
Application	**Nominal wavelength (nm)**	**850**	**1300**	**850**	**1300**	**850**	**1300**	**1310**	**1550**
Ethernet 10/100BASE-SX	Channel attenuation (dB)	4.0	–	4.0	–	4.0	–	–	–
	Supportable distance m (ft.)	300 (984)	–	300 (984)	–	300 (984)	–	–	–
Ethernet 100BASE-FX	Channel attenuation (dB)	–	11.0	–	6.0	–	6.0	–	–
	Supportable distance m (ft.)	–	2,000 (6,850)	–	2,000 (6,850)	–	2,000 (6,850)	–	–
Ethernet 1000BASE-SX	Channel attenuation (dB)	2.6	–	3.6	–	4.5	–	–	–
	Supportable distance m (ft.)	275 (900)	–	550 (1,804)	–	800 (2,625)	–	–	–
Ethernet 1000BASE-LX	Channel attenuation (dB)	–	2.3	–	2.3	–	2.3	4.5	–
	Supportable distance m (ft.)	–	550 (1,804)	–	550 (1,804)	–	550 (1,804)	5,000 (16,405)	–
Ethernet 10GBASE-S	Channel attenuation (dB)	2.4	–	2.3	–	2.6	–	–	–
	Supportable distance m (ft.)	33 (108)	–	82 (269)	–	300 (984)	–	–	–
Ethernet 10GBASE-LX4	Channel attenuation (dB)	–	2.5	–	2.0	–	2.0	6.3	–
	Supportable distance m (ft.)	–	300 (984)	–	300 (984)	–	300 (984)	10,000 (32,810)	–
Ethernet 10GBASE-L	Channel attenuation (dB)	–	–	–	–	–	–	6.2	–
	Supportable distance m (ft.)	–	–	–	–	–	–	10,000 (32,810)	–
Ethernet 10GBASE-LRM	Channel attenuation (dB)	–	1.9	–	1.9	–	1.9	–	–
	Supportable distance m (ft.)	–	270 (720)	–	270 (720)	–	270 (720)	–	–
Fibre Channel 100-MX-SN-I (1062 Mbaud)	Channel attenuation (dB)	3.0	–	3.9	–	4.6	–	–	–
	Supportable distance m (ft.)	300 (984)	–	500 (1,640)	–	880 (2,822)	–	–	–

Table 2 – Maximum supportable distances and attenuation for optical fiber applications (more on next table)

	Parameter	Multimode						Single-mode	
		62.5/125 μm TIA 492AAAA (OM1)		50/125 μm TIA 492AAAB (OM2)		850 nm laser-optimized 50/125 μm TIA 492AAAC (OM3)		TIA 492CAAA (OS1) TIA 492CAAB (OS2)	
Application	**Nominal wavelength (nm)**	**850**	**1300**	**850**	**1300**	**850**	**1300**	**1310**	**1550**
Fibre Channel 100-SM-LC-L (1062 Mbaud)	Channel attenuation (dB)	–	–	–	–	–	–	7.8	–
	Supportable distance m (ft.)	–	–	–	–	–	–	10,000 (32,810)	–
Fibre Channel 200-MX-SN-I (2125 Mbaud)	Channel attenuation (dB)	2.1	–	2.6	–	3.3	–	–	–
	Supportable distance m (ft.)	150 (492)	–	300 (984)	–	500 (1,640)	–	–	–
Fibre Channel 200-SM-LC-L (2125 Mbaud)	Channel attenuation (dB)	–	–	–	–	–	–	7.8	–
	Supportable distance m (ft.)	–	–	–	–	–	–	10,000 (32,810)	–
Fibre Channel 400-MX-SN-I (4250 Mbaud)	Channel attenuation (dB)	1.8	–	2.1	–	2.5	–	–	–
	Supportable distance m (ft.)	70 (230)	–	150 (492)	–	270 (886)	–	–	–
Fibre Channel 400-SM-LC-L (4250 Mbaud)	Channel attenuation (dB)	–	–	–	–	–	–	7.8	–
	Supportable distance m (ft.)	–	–	–	–	–	–	10,000 (32,810)	–
Fibre Channel 1200-MX-SN-I (10512 Mbaud)	Channel attenuation (dB)	2.4	–	2.2	–	2.6	–	–	–
	Supportable distance m (ft.)	33 (108)	–	82 (269)	–	300 (984)	–	–	–
Fibre Channel 1200-SM-LL-L (10512 Mbaud)	Channel attenuation (dB)	–	–	–	–	–	–	6.0	–
	Supportable distance m (ft.)	–	–	–	–	–	–	10,000 (32,810)	–
FDDI PMD ANSI X3.166	Channel attenuation (dB)	–	11.0	–	6.0	–	6.0	–	–
	Supportable distance m (ft.)	–	2,000 (6,560)	–	2,000 (6,560)	–	2,000 (6,560)	–	–
FDDI SMF-PMD ANSI X3.184	Channel attenuation (dB)	–	–	–	–	–	–	10.0	–
	Supportable distance m (ft.)	–	–	–	–	–	–	10,000 (32,810)	–

Table 3 – Maximum supportable distances and attenuation for optical fiber applications

Cabling Installation Requirements

- Cabling installations shall comply with the authority having jurisdiction (AHJ) and applicable regulations.
- Cable stress caused by suspended cable runs and tightly cinched bundles should be minimized.
- Cable bindings, which are used to tie multiple cables together, should be irregularly spaced and should be loosely fitted (easily movable).

Balanced Twisted-Pair Cabling

Maximum Pulling Tension

- The pulling tension for a 4-pair balanced twisted-pair cable shall not exceed 110 N (25 pound-force) during installation.
- For multipair cable, manufacturers' pulling tension guidelines shall be followed.

Minimum Bend Radius

Cable

- The minimum inside bend radius, under no-load or load, for a 4-pair balanced twisted-pair cable shall be four times the cable diameter.
- The minimum bend radius, under no-load or load, for a multipair cable shall follow the manufacturer's guidelines.

Cord Cable

- The minimum inside bend radius for a 4-pair balanced twisted-pair cord cable shall be one times the cord cable diameter.

Cable Termination

- Cables should be terminated with connecting hardware of the same performance (Category) or higher.
- The Category of the installed link should be suitably marked and noted in the administrative records.
- The cable geometry shall be maintained as close as possible to the connecting hardware and its cable termination points.
- The maximum pair untwist for the balanced twisted-pair cable termination shall be in accordance with Table 4.

Pair untwist lengths	
Category	**Maximum pair untwist mm (in.)**
3	75 (3)
5e	13 (0.5)
6	13 (0.5)
6A	13 (0.5)

Table 4 – Maximum supportable pair untwist length for Category cable termination

8-Position Modular Jack Pin-Pair Assignments

Pin-pair assignments shall be as shown in Figure 3 or, optionally, per Figure 4 if it is necessary to accommodate certain 8-pin cabling systems. The colors shown are associated with 4-pair cable.

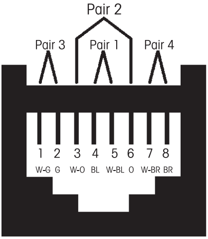


Figure 3 – Front view of 8-position jack pin-pair assignments (T568A)

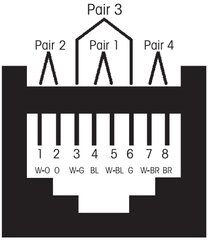


Figure 4 – Front view of optional 8-position jack pin-pair assignment (T568B)

Cords and Jumpers

Cross-connect jumpers and modular plug cords should be of the same Category or higher as the Category of the cabling to which they connect. It is recommended that modular cords be factory manufactured.

Grounding and Bonding Requirements for Screened Cabling

- The screen of screened twisted-pair (ScTP) cables shall be bonded to the telecommunications grounding bus bar (TGB) or telecommunications main grounding bus bar (TMGB).
- A voltage greater than 1 volt rms between the cable screen and the ground of the corresponding electrical outlet used to provide power to the equipment indicates improper grounding.

Optical Fiber Cabling

Minimum Bend Radius and Maximum Pulling Tension

Measured to the inside curvature, the bend radius is the minimum a cable can bend without any risk to kinking it, damaging it or shortening its life. The smaller the bend radius, the greater the material flexibility.

Minimum bend radius and maximum pulling tension			
Cable type and installation details	**Maximum tensile load during installation**	**Minimum bend radii while subjected to maximum tensile load (during installation)**	**No tensile load (after installation)**
Inside plant cable with 2 or 4 fibers installed in Cabling Subsystem 1	220 n (50 lbf)	50 mm (2 in.)	25 mm (1 in.)
Inside plant cable with more than 4 fibers	Per manufacturer	20 times the cable outside diameter	10 times the cable outside diameter
Indoor/outdoor cable with up to 12 fibers	1335 n (300 lbf)	20 times the cable outside diameter	10 times the cable outside diameter
Indoor/outdoor cable with more than 12 fibers	2670 n (600 lbf)	20 times the cable outside diameter	10 times the cable outside diameter
Outside plant cable	2670 n (600 lbf)	20 times the cable outside diameter	10 times the cable outside diameter
Drop cable installed by pulling	1335 n (300 lbf)	20 times the cable outside diameter	10 times the cable outside diameter
Drop cable installed by directly buried, trenched or blown into ducts	440 n (100 lbf)	20 times the cable outside diameter	10 times the cable outside diameter

Table 5 – Maximum and minimum pulling tension and bend radius for different cable types

Polarity

Transmit-to-receive polarity must be maintained throughout the cabling system. (Annex B of the full standard describes methods to do this.)

Purpose of the ANSI/TIA-568-C.1 Standard

The purpose of this standard is to provide guidance on the planning and installation of a structured cabling system for commercial buildings.

Section Contents

ANSI/TIA-568-C.1

Commercial Building Telecommunications Cabling Standard

Entrance Facilities

- Entrance facilities (EFs) contain the cables, network demarcation point(s), connecting hardware, protection devices and other equipment that connects to the access provider (AP) or private network cabling.
- Entrance facilities include connections between outside plant and inside building cabling.

Equipment Rooms (ERs)

- Equipment rooms are considered to be distinct from telecommunications rooms (TRs) and telecommunications enclosures (TEs) because of the nature or complexity of the equipment they contain. An ER may alternatively provide any or all of the functions of a TR or TE.
- The main cross-connect (MC, Distributor C) of a commercial building is located in an ER. Intermediate cross-connects (ICs, Distributor B), horizontal cross-connects (HCs, Distributor A), or both, of a commercial building may also be located in an ER.

Telecommunications Rooms (TRs) and Telecommunications Enclosures (TEs)

- Telecommunications rooms and enclosures provide a common access point for backbone and building pathways (see Figure 5) and cabling used for cross-connection.
- The horizontal cross-connect (HC, Distributor A) of a commercial building is located in a TR or TE. The main cross-connect (MC, Distributor C) and intermediate cross-connects (IC, Distributor B) of a commercial building may also be located in a TR. The TR and any TE should be located on the same floor as the work areas served.
- The telecommunications enclosure (TE) is intended to serve a smaller floor area than a TR and may be used in addition to the “minimum one TR per floor” rule.

Centralized Optical Fiber Cabling (see Figure 5)

- Centralized optical fiber cabling is designed as an alternative to the optical cross-connect located in the TR or TE in support of installing centralized electronics.
- It provides connections from work areas (WAs) to centralized cross-connects by allowing the use of pull-through cables and the use of an interconnect or splice in the TR or TE.
- The maximum allowed distance for a pull-through cable is 90 m (295 ft.).

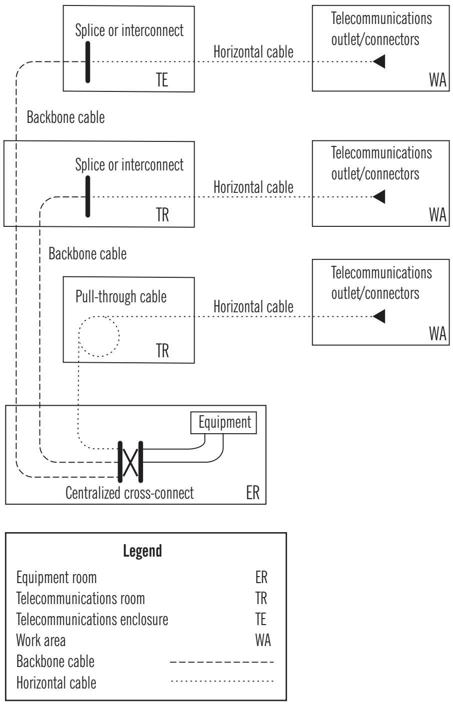


Figure 5 – Centralized optical fiber cabling

Backbone Cabling (Cabling Subsystems 2 and 3)

- Provides interconnections between entrance facilities (EFs), access provider (AP) spaces, service provider (SP) spaces, common equipment rooms (CERs), common telecommunications rooms (CTRs), equipment rooms (ERs), telecommunications rooms (TRs) and telecommunications enclosures (TEs) (see Figure 5)
- Makes sure that the backbone cabling shall meet the requirements of ANSI/TIA-568-C.1 Cabling Subsystem 2 and Cabling Subsystem 3
- Uses a star topology (see Figure 6)
- Allows for no more than two hierarchical levels of cross-connects

Length and Maximum Distances

- Backbone cabling length extends from the termination of the media at the MC to an IC or HC.
- Cabling lengths are dependent on the application and the media chosen. They are found in the previous section covering ANSI/TIA-568-C.0 (see Tables 1, 2 and 3).
- The length of the cross-connect jumpers and patch cords in the MC or IC should not exceed 20 m (66 ft.).
- The length of the cord used to connect telecommunications equipment directly to the MC or IC should not exceed 30 m (98 ft.).

Recognized Cabling

The recognized media, which shall be used individually or in combination, are:

- 100-ohm balanced twisted-pair cabling (Category 3, 5e, 6 or 6A)
- Multimode optical fiber cabling: 850-nm laser-optimized 50/125 μm is recommended; 62.5/125 μm and 50/125 μm are allowed
- Single-mode optical fiber cabling.

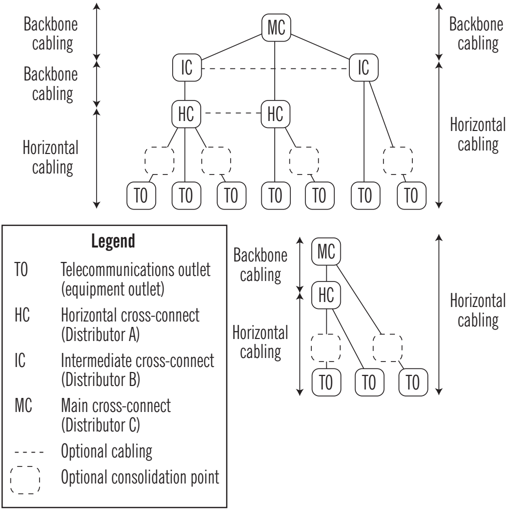


Figure 6 – Commercial building hierarchical star topology

Horizontal Cabling (Cabling Subsystem 1)

- Horizontal cabling (see Figure 7) includes horizontal cable, telecommunications outlets and connectors in the work area (WA); mechanical terminations and patch cords or jumpers located in a telecommunications room (TR) or telecommunications enclosure (TE); and may incorporate multiuser telecommunications outlet assemblies (MUTOAs) and consolidation points (CPs).
- A minimum of two permanent links shall be provided for each work area.
- Each 4-pair cable at the equipment outlet shall be terminated in an 8-position modular jack.
- Optical fibers at the equipment outlet shall be terminated to a duplex optical fiber outlet and connector.
- Horizontal cabling uses a star topology.
- The maximum horizontal cable length shall be 90 m (295 ft.), independent of media type. If a MUTOA is deployed, the maximum horizontal balanced twisted-pair copper cable length shall be reduced in accordance with Table 6 (page 23).
- The length of the cross-connect jumpers and patch cords that connect horizontal cabling with equipment or backbone cabling should not exceed 5 m (16 ft.).
- For each horizontal channel, the total length allowed for cords in the WA, plus patch cords or jumpers and equipment cords in the TR or TE, shall not exceed 10 m (33 ft.) unless a MUTOA is used.

Recognized Cabling

The recognized media, which shall be used individually or in combination, are:

- 4-pair 100-ohm unshielded or shielded twisted-pair cabling (Category 3, 5e, 6 or 6A)
- Multimode optical fiber cabling, 2-fiber (or higher count)
- Single-mode optical fiber cabling, 2-fiber (or higher count).

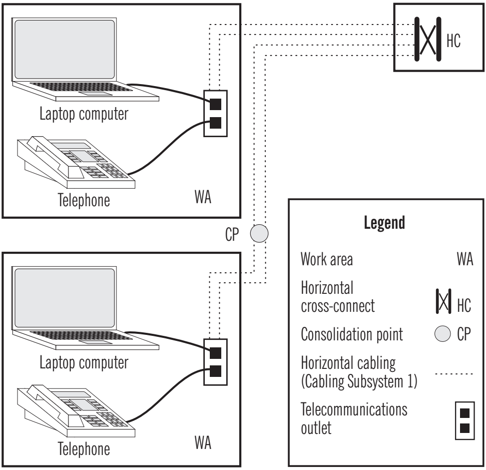


Figure 7 – Typical horizontal and work area cabling using star topology

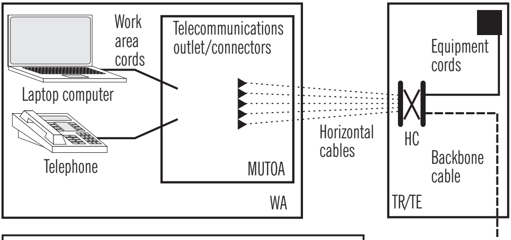
Work Area

- The telecommunications outlet and connector shall meet the requirements of ANSI/TIA-568-C.0.
- The work area (WA) components extend from the telecommunications outlet/connector end of the horizontal cabling system to the WA equipment.
- When application-specific adapters are needed at the WA, they shall be external to the telecommunications outlet and connector.

Open Office Cabling (MUTOA)

Open office design practices use multiuser telecommunications outlet assemblies (MUTOAs), consolidation points (CPs) or both to provide flexible layouts. MUTOAs allow horizontal cabling to remain intact when the open office plan is changed.

- WA cords originating from the MUTOA should be routed through WA pathways (e.g., furniture pathways).
- The WA cables shall be connected directly to workstation equipment without the use of any additional intermediate connections (see Figure 8).
- MUTOAs shall be located in fully accessible, permanent locations, such as building columns and permanent walls. They should not be located in ceiling spaces, obstructed areas or in furniture unless the furniture is secured to the building structure.



Legend

Work area	WA
Telecommunications room	TR
Telecommunications enclosure	TE
Horizontal cross-connect	HC
Multiuser telecommunications outlet assembly	MUTOA

Figure 8 – Multiuser telecommunications outlet assembly (MUTOA) application

Maximum Work Area Cord Lengths

- Balanced twisted-pair WA cables: the maximum cord length used in the context of MUTOAs and open office furniture is as follows in Table 6.
- Optical fiber WA cords: the maximum horizontal cabling length is not affected by the deployment of a MUTOA.

Maximum length of horizontal cables and work area cords				
	24 AWG cords		26 AWG cords	
Length of horizontal cable H m (ft.)	Maximum length of work area cord W m (ft.)	Maximum combined length of work area cord, patch cords and equipment cord C m (ft.)	Maximum length of work area cord W m (ft.)	Maximum combined length of work area cord, patch cords and equipment cord C m (ft.)
90 (295)	5 (16)	10 (33)	4 (13)	8 (26)
85 (279)	9 (30)	14 (46)	7 (23)	11 (35)
80 (262)	13 (44)	18 (59)	11 (35)	15 (49)
75 (246)	17 (57)	22 (72)	14 (46)	18 (59)
70 (230)	22 (72)	27 (89)	17 (56)	21 (70)

Table 6 – Maximum length of work area cord in relation to horizontal cable

Consolidation Point (CP)

The CP is an interconnection point within the horizontal cabling. It differs from the MUTOA in that a CP requires an additional connection for each horizontal cable run. It may be useful when reconfiguration is frequent, but not so frequent as to require the flexibility of a MUTOA (see Figure 9).

- The CP should be located at least 15 m (49 ft.) from the TR or TE.
- Cross-connections shall not be used at a CP.
- Each horizontal cable extending to the WA outlet from the CP shall be terminated to a telecommunications outlet/connector or MUTOA.
- CPs shall be located in fully accessible, permanent locations such as building columns and permanent walls. They should not be located in obstructed areas or in furniture unless the furniture is secured to the building structure.

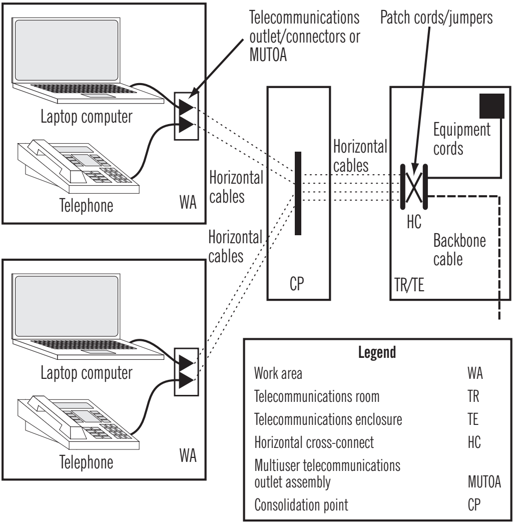


Figure 9 – Application of consolidation point

Purpose of the ANSI/TIA-568-C.2 Standard

This standard includes component and cabling specifications as well as testing requirements for copper cabling, including Category 3, Category 5e, Category 6 and Category 6A. It recommends Category 5e to support 100 MHz applications. By using one laboratory test method to define all categories of connecting hardware, the standard introduces coupling attenuation parameters that are under study for characterizing radiated peak power generated by common-mode currents for screened cables. Balanced twisted-pair channel and permanent performance requirements were moved to this document.

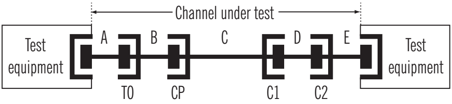
Section Contents

ANSI/TIA-568-C.2

Balanced Twisted-Pair Telecommunications Cabling and Components Standard

Channel and Permanent Link Test Configurations

For the purpose of testing twisted-pair cabling systems, the worst-case cabling channel configuration is assumed to contain a telecommunications outlet and connector, a transition point, 90 meters of twisted-pair cable, a cross-connect consisting of two blocks or panels and a total of 10 meters of patch cords. The figure below shows the relationship of these components.



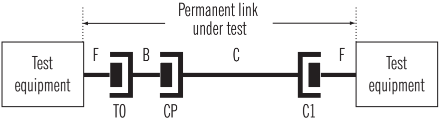
Legend

Cables and cords		**Connecting hardware**	
Work area cord	A	Telecommunications outlet/connector	TO
Optional consolidation point cabling	B	Optional consolidation point connector	CP
Horizontal cabling	C	Horizontal cross-connect or interconnect	C1, C2
Patch cord or jumper cable	D		
Telecommunications room equipment cord	E		

Maximum length	
B + C	90 m (295 ft.)
A + D + E	10 m (32.8 ft.)

Figure 10 – Channel test configuration

The permanent link test configuration includes the horizontal distribution cable, telecommunications outlet and connector or transition point and one horizontal cross-connect component including the mated connections. This is assumed to be the permanent part of a link. The channel is comprised of the permanent link plus cross-connect equipment, user equipment cord and cross-connect patch cable.



Legend

Cables and cords		Connecting hardware	
Test equipment cord	F	Telecommunications outlet/connector	TO
Optional consolidation point cabling	B	Optional consolidation point connector	CP
Horizontal cabling	C	Horizontal cross-connect or interconnect	C1

Maximum length	
B + C	90 m (295 ft.)

Figure 11 – Permanent link test configuration

Definitions of Electrical Parameters

Return loss: A measure of the degree of impedance mismatch between two impedances. It is the ratio, expressed in decibels, of the amplitude of a reflected wave echo to the amplitude of the main wave at the junction of a transmission line and a terminating impedance.

Insertion loss: This term has replaced the term "attenuation" (ATTN). It is a measure of the decrease of signal strength as it travels down the media.

NEXT loss (near-end crosstalk): A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring (nonenergized) pair measured at the near-end.

PSNEXT loss (powersum near-end crosstalk): A computation of the unwanted signal coupling from multiple transmitters at the near-end into a neighboring (nonenergized) pair measured at the near-end.

FEXT loss (far-end crosstalk): A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring pair measured at the far-end.

ACRF (attenuation to crosstalk ratio, far-end) or ELFEXT (equal-level far-end crosstalk): A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring pair measured at the far-end, relative to the received signal level measured on that same pair.

PSFEXT loss (powersum far-end crosstalk): A computation of the unwanted signal coupling from multiple transmitters at the near-end into a neighboring pair measured at the far-end.

PSACRF (powersum attenuation to crosstalk ratio, far-end) or PSELFEXT (powersum equal-level far-end crosstalk): A computation of the unwanted signal coupling from multiple transmitters at the near-end into a neighboring pair measured at the far-end, relative to the received signal level measured on that same pair.

Propagation delay: The time needed for the transmission of signal to travel the length of a single pair.

Propagation delay skew: The difference between the propagation delay of any two pairs within the same cable sheath. Delay skew is caused primarily because twisted-pair cable is designed to have different twists per foot (lay lengths). Delay skew could cause data transmitted over one wire pair to arrive out of sync with data over another wire pair.

ANEXT loss (alien near-end crosstalk): A measure of signal coupling from a near-end disturbing pair into a disturbed pair of a neighboring cable or connector pair or part thereof, measured at the near-end.

PSANEXT loss (powersum alien near-end crosstalk): A computation of signal coupling from multiple near-end disturbing pairs into a disturbed pair of a neighboring channel, cable or connector pair or part thereof, measured at the near-end.

AFEXT loss (alien far-end crosstalk): A measure of signal coupling from a near-end disturbing pair into a disturbed pair of a neighboring cable or connector pair or part thereof, measured at the far-end.

PSAFEXT loss (powersum alien far-end crosstalk): A computation of signal coupling from multiple near-end disturbing channel pairs into a disturbed pair of a neighboring channel or part thereof, measured at the far-end.

PSAACRF (powersum alien attenuation to crosstalk ratio, far-end) or PSAELFEXT (powersum alien equal-level far-end crosstalk): A computation of signal coupling from multiple pairs of disturbing channels to a disturbed pair in another channel measured at the far-end and relative to the received signal level in the disturbed pair at the far-end.

Recognized Categories of Balanced Twisted-Pair Cabling and Components

As data transmission rates have increased, higher performance twisted-pair cabling has become a necessity. In addition, some means of classifying horizontal twisted-pair cables and connecting hardware by performance capability had to be established. These capabilities have been broken down to a series of categories. The following categories are currently recognized.

Category 3: Cables and connecting hardware with transmission parameters characterized up to 16 MHz

Category 5e: Cables and connecting hardware with transmission parameters characterized up to 100 MHz

Category 6: Cables and connecting hardware with transmission parameters characterized up to 250 MHz

Category 6A: Cables and connecting hardware with transmission parameters characterized up to 500 MHz. Additionally, requirements for alien crosstalk are specified in order to support 10GBASE-T transmission systems.

The following tables show the performance limits for channel, permanent link and twisted-pair cable for Category 3, Category 5e, Category 6 and Category 6A.

Channel Transmission Performance

The following tables reflect the various mitigating factors that need to be taken into consideration when calculating a channel's transmission performance.

Channel return loss				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	17.0	19.0	19.0
4.00	-	17.0	19.0	19.0
8.00	-	17.0	19.0	19.0
10.00	-	17.0	19.0	19.0
16.00	-	17.0	18.0	18.0
20.00	-	17.0	17.5	17.5
25.00	-	16.0	17.0	17.0
31.25	-	15.1	16.5	16.5
62.50	-	12.1	14.0	14.0
100.00	-	10.0	12.0	12.0
200.00	-	-	9.0	9.0
250.00	-	-	8.0	8.0
300.00	-	-	-	7.2
400.00	-	-	-	6.0
500.00	-	-	-	6.0

Table 7 – Minimum channel return loss

Channel insertion loss				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	3.0	2.2	2.1	2.3
4.00	6.5	4.5	4.0	4.2
8.00	9.8	6.3	5.7	5.8
10.00	11.2	7.1	6.3	6.5
16.00	14.9	9.1	8.0	8.2
20.00	-	10.2	9.0	9.2
25.00	-	11.4	10.1	10.2
31.25	-	12.9	11.4	11.5
62.50	-	18.6	16.5	16.4
100.00	-	24.0	21.3	20.9
200.00	-	-	31.5	30.1
250.00	-	-	35.9	33.9
300.00	-	-	-	37.4
400.00	-	-	-	43.7
500.00	-	-	-	49.3

Table 8 – Maximum channel insertion loss

Channel NEXT loss (near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	39.1	60.0	65.0	65.0
4.00	29.3	53.5	63.0	63.0
8.00	24.3	48.6	58.2	58.2
10.00	22.7	47.0	56.6	56.6
16.00	19.3	43.6	53.2	53.2
20.00	-	42.0	51.6	51.6
25.00	-	40.3	50.0	50.0
31.25	-	38.7	48.4	48.4
62.50	-	33.6	43.4	43.4
100.00	-	30.1	39.9	39.9
200.00	-	-	34.8	34.8
250.00	-	-	33.1	33.1
300.00	-	-	-	31.7
400.00	-	-	-	28.7
500.00	-	-	-	26.1

Table 9 – Minimum channel NEXT loss

Channel PSNEXT loss (powersum near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	57.0	62.0	62.0
4.00	-	50.5	60.5	60.5
8.00	-	45.6	55.6	55.6
10.00	-	44.0	54.0	54.0
16.00	-	40.6	50.6	50.6
20.00	-	39.0	49.0	49.0
25.00	-	37.3	47.3	47.3
31.25	-	35.7	45.7	45.7
62.50	-	30.6	40.6	40.6
100.00	-	27.1	37.1	37.1
200.00	-	-	31.9	31.9
250.00	-	-	30.2	30.2
300.00	-	-	-	28.8
400.00	-	-	-	25.8
500.00	-	-	-	23.2

Table 10 – Minimum channel PSNEXT loss

Channel ACRF (attenuation to crosstalk ratio, far-end) or elfext (equal-level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	57.4	63.3	63.3
4.00	-	45.4	51.2	51.2
8.00	-	39.3	45.2	45.2
10.00	-	37.4	43.3	43.3
16.00	-	33.3	39.2	39.2
20.00	-	31.4	37.2	37.2
25.00	-	29.4	35.3	35.3
31.25	-	27.5	33.4	33.4
62.50	-	21.5	27.3	27.3
100.00	-	17.4	23.3	23.3
200.00	-	-	17.2	17.2
250.00	-	-	15.3	15.3
300.00	-	-	-	13.7
400.00	-	-	-	11.2
500.00	-	-	-	9.3

Table 11 – Minimum channel ACRF

Channel PSACRF (powersum insertion loss to alien crosstalk ratio far-end) or PSELFEXT (powersum equal-level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	54.4	60.3	60.3
4.00	-	42.4	48.2	48.2
8.00	-	36.3	42.2	42.2
10.00	-	34.4	40.3	40.3
16.00	-	30.3	36.2	36.2
20.00	-	28.4	34.2	34.2
25.00	-	26.4	32.3	32.3
31.25	-	24.5	30.4	30.4
62.50	-	18.5	24.3	24.3
100.00	-	14.4	20.3	20.3
200.00	-	-	14.2	14.2
250.00	-	-	12.3	12.3
300.00	-	-	-	10.7
400.00	-	-	-	8.2
500.00	-	-	-	6.3

Table 12 – Minimum channel PSACRF

Channel Propagation Delay Skew

Channel propagation delay skew shall be less than 50 ns for all frequencies from 1 MHz to the upper frequency limit of the Category. For field-testing channels, it is sufficient to test at 10 MHz only and channel propagation delay skew at 10 MHz shall not exceed 50 ns.

Channel propagation delay				
Frequency (MHz)	Category 3 (ns)	Category 5e (ns)	Category 6 (ns)	Category 6A (ns)
1.00	580	580	580	580
4.00	562	562	562	562
8.00	557	557	557	557
10.00	555	555	555	555
16.00	553	553	553	553
20.00	-	552	552	552
25.00	-	551	551	551
31.25	-	550	550	550
62.50	-	549	549	549
100.00	-	548	548	548
200.00	-	-	547	547
250.00	-	-	546	546
300.00	-	-	-	546
400.00	-	-	-	546
500.00	-	-	-	546

Table 13 – Maximum channel propagation delay

Channel PSANEXT loss (powersum alien near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	-	-	67.0
4.00	-	-	-	67.0
8.00	-	-	-	67.0
10.00	-	-	-	67.0
16.00	-	-	-	67.0
20.00	-	-	-	67.0
25.00	-	-	-	66.0
31.25	-	-	-	65.1
62.50	-	-	-	62.0
100.00	-	-	-	60.0
200.00	-	-	-	55.5
250.00	-	-	-	54.0
300.00	-	-	-	52.8
400.00	-	-	-	51.0
500.00	-	-	-	49.5

Table 14 – Minimum channel PSANEXT loss

Channel PSAACRF (powersum insertion loss to alien crosstalk ratio far-end) or PSAELFEXT (powersum alien equal level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	-	-	67.0
4.00	-	-	-	65.0
8.00	-	-	-	58.9
10.00	-	-	-	57.0
16.00	-	-	-	52.9
20.00	-	-	-	51.0
25.00	-	-	-	49.0
31.25	-	-	-	47.1
62.50	-	-	-	47.1
100.00	-	-	-	37.0
200.00	-	-	-	31.0
250.00	-	-	-	29.0
300.00	-	-	-	27.5
400.00	-	-	-	25.0
500.00	-	-	-	23.0

Table 15 – Minimum channel PSAACRF loss

Augmented Category 6 Channel Requirements

Note: The requirements for ISO (the International Organization for Standardization) ISO/IEC 11801 Class E_A are more demanding compared to the TIA Augmented Category 6 requirements. Anixter's Infrastructure Solutions Lab tests to the more stringent ISO/IEC 11801 standards.

ISO compared to TIA		
Characteristics 500 MHz (dB)	ISO Class E_A	TIA Augumented Category 6
PSNEXT loss	24.8 dB	23.2 dB
NEXT loss	27.9 dB	26.1 dB
PSANEXT loss	49.5 dB	49.5 dB
Return loss	6.0 dB	6.0 dB
Insertion loss	49.3 dB	49.3 dB
Referred to by IEEE	Yes	No

Table 16 – ISO versus TIA performance comparison

Note: See the IEEE 802.3an and ISO/IEC 11801 Class E_A section of this book for more information on 10 Gigabit cabling and protocol methods.

Permanent Link Transmission Performance

The tables below show the requirements intended for performance validation according to the specific cabling Category.

Permanent link return loss				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	19.0	19.1	19.1
4.00	-	19.0	21.0	21.0
8.00	-	19.0	21.0	21.0
10.00	-	19.0	21.0	21.0
16.00	-	19.0	20.0	20.0
20.00	-	19.0	20.0	20.0
25.00	-	19.0	19.5	19.5
31.25	-	17.1	18.5	18.5
62.50	-	14.1	16.0	16.0
100.00	-	12.0	14.0	14.0
200.00	-	-	11.0	11.0
250.00	-	-	10.0	10.0
300.00	-	-	-	9.2
400.00	-	-	-	8.0
500.00	-	-	-	8.0

Table 17 – Minimum permanent link return loss

Permanent link insertion loss				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	2.6	2.1	1.9	1.9
4.00	5.6	3.9	3.5	3.5
8.00	8.5	5.5	5.0	5.0
10.00	9.7	6.2	5.5	5.5
16.00	13.0	7.9	7.0	7.0
20.00	-	8.9	7.9	7.8
25.00	-	10.0	8.9	8.8
31.25	-	11.2	10.0	9.8
62.50	-	16.2	14.4	14.0
100.00	-	21.0	18.6	18.0
200.00	-	-	27.4	26.1
250.00	-	-	31.1	29.5
300.00	-	-	-	32.7
400.00	-	-	-	38.4
500.00	-	-	-	43.8

Table 18 – Maximum permanent link insertion loss

Permanent link NEXT loss (near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	40.1	60.0	65.0	65.0
4.00	30.7	54.8	64.1	64.1
8.00	25.9	50.0	59.4	59.4
10.00	24.3	48.5	57.8	57.8
16.00	21.0	45.2	54.6	54.6
20.00	-	43.7	53.1	53.1
25.00	-	42.1	51.5	51.5
31.25	-	40.5	50.0	50.0
62.50	-	35.7	45.1	45.1
100.00	-	32.3	41.8	41.8
200.00	-	-	36.9	36.9
250.00	-	-	35.3	35.3
300.00	-	-	-	34.0
400.00	-	-	-	29.9
500.00	-	-	-	26.7

Table 19 – Minimum permanent link NEXT loss

Permanent link PSNEXT loss (powersum near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	57.0	62.0	62.0
4.00	-	51.8	61.8	61.8
8.00	-	47.0	57.0	57.0
10.00	-	45.5	55.5	55.5
16.00	-	42.2	52.2	52.2
20.00	-	40.7	50.7	50.7
25.00	-	39.1	49.1	49.1
31.25	-	37.5	47.5	47.5
62.50	-	32.7	42.7	42.7
100.00	-	29.3	39.3	39.3
200.00	-	-	34.3	34.3
250.00	-	-	32.7	32.7
300.00	-	-	-	31.4
400.00	-	-	-	27.1
500.00	-	-	-	23.8

Table 20 – Minimum permanent link PSNEXT loss

Permanent link ACRF (attenuation to crosstalk ratio, far-end) or ELFEXT (equal-level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	58.6	64.2	64.2
4.00	-	46.6	52.1	52.1
8.00	-	40.6	46.1	46.1
10.00	-	38.6	44.2	44.2
16.00	-	34.5	40.1	40.1
20.00	-	32.6	38.2	38.2
25.00	-	30.7	36.2	36.2
31.25	-	28.7	34.3	34.3
62.50	-	22.7	28.3	28.3
100.00	-	18.6	24.2	24.2
200.00	-	-	18.2	18.2
250.00	-	-	16.2	16.2
300.00	-	-	-	14.6
400.00	-	-	-	12.1
500.00	-	-	-	10.2

Table 21 – Minimum permanent link ACRF

Permanent link PSACRF (powersum insertion loss to alien crosstalk ratio far-end) or PSELFEXT (powersum equal level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	55.6	61.2	61.2
4.00	-	43.6	49.1	49.1
8.00	-	37.5	43.1	43.1
10.00	-	35.6	41.2	41.2
16.00	-	31.5	37.1	37.1
20.00	-	29.6	35.2	35.2
25.00	-	27.7	33.2	33.2
31.25	-	25.7	31.3	31.3
62.50	-	19.7	25.3	25.3
100.00	-	15.6	21.2	21.2
200.00	-	-	15.2	15.2
250.00	-	-	13.2	13.2
300.00	-	-	-	11.6
400.00	-	-	-	9.1
500.00	-	-	-	7.2

Table 22 – Minimum permanent link PSACRF

Permanent link propagation delay				
Frequency (MHz)	Category 3 (ns)	Category 5e (ns)	Category 6 (ns)	Category 6A (ns)
1.00	521	521	521	521
4.00	504	504	504	504
8.00	500	500	500	500
10.00	498	498	498	498
16.00	496	496	496	496
20.00	-	495	495	495
25.00	-	495	495	495
31.25	-	494	494	494
62.50	-	492	492	492
100.00	-	491	491	491
200.00	-	-	490	490
250.00	-	-	490	490
300.00	-	-	-	490
400.00	-	-	-	490
500.00	-	-	-	490

Table 23 – Maximum permanent link propagation delay

Permanent Link Propagation Delay Skew

Permanent link propagation delay skew shall be less than 44 ns for all frequencies from 1 MHz to the upper frequency limit of the Category. For field-testing channels, it is sufficient to test at 10 MHz only and permanent link propagation delay skew at 10 MHz shall not exceed 50 ns.

Permanent link PSANEXT Loss (powersum alien near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	-	-	67.0
4.00	-	-	-	67.0
8.00	-	-	-	67.0
10.00	-	-	-	67.0
16.00	-	-	-	67.0
20.00	-	-	-	67.0
25.00	-	-	-	66.0
31.25	-	-	-	65.1
62.50	-	-	-	62.0
100.00	-	-	-	60.0
200.00	-	-	-	55.5
250.00	-	-	-	54.0
300.00	-	-	-	52.8
400.00	-	-	-	51.0
500.00	-	-	-	49.5

Table 24 – Minimum permanent link PSANEXT loss

Permanent link PSAACRF (powersum insertion loss to alien crosstalk ratio far-end) or PSAELFEXT (powersum alien equal-level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	-	-	67.0
4.00	-	-	-	65.7
8.00	-	-	-	59.6
10.00	-	-	-	57.7
16.00	-	-	-	53.6
20.00	-	-	-	51.7
25.00	-	-	-	49.7
31.25	-	-	-	47.8
62.50	-	-	-	41.8
100.00	-	-	-	37.7
200.00	-	-	-	31.7
250.00	-	-	-	29.7
300.00	-	-	-	28.2
400.00	-	-	-	25.7
500.00	-	-	-	23.7

Table 25 – Minimum permanent link PSAACRF loss

Horizontal Cable Transmission Performance

The following tables show the performance specifications for horizontal cable transmission performance.

Horizontal cable return loss				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	20.0	20.0	20.0
4.00	-	23.0	23.0	23.0
8.00	-	24.5	24.5	24.5
10.00	-	25.0	25.0	25.0
16.00	-	25.0	25.0	25.0
20.00	-	25.0	25.0	25.0
25.00	-	24.3	24.3	24.3
31.25	-	23.6	23.6	23.6
62.50	-	21.5	21.5	21.5
100.00	-	20.1	20.1	20.1
200.00	-	-	18.0	18.0
250.00	-	-	17.3	17.3
300.00	-	-	-	16.8
400.00	-	-	-	15.9
500.00	-	-	-	15.2

Table 26 – Minimum horizontal cable return loss

Horizontal cable insertion loss				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
0.772	2.2	-	-	-
1.00	2.6	2.0	2.0	2.1
4.00	5.6	4.1	3.8	3.8
8.00	8.5	5.8	5.3	5.3
10.00	9.7	6.5	6.0	5.9
16.00	13.1	8.2	7.6	7.5
20.00	-	9.3	8.5	8.4
25.00	-	10.4	9.5	9.4
31.25	-	11.7	10.7	10.5
62.50	-	17.0	15.4	15.0
100.00	-	22.0	19.8	19.1
200.00	-	-	29.0	27.6
250.00	-	-	32.8	31.1
300.00	-	-	-	34.3
400.00	-	-	-	40.1
500.00	-	-	-	45.3

Table 27 – Maximum horizontal cable insertion loss

Horizontal cable NEXT loss (near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
0.772	43.0	-	-	-
1.00	41.3	65.3	74.3	74.3
4.00	32.3	56.3	65.3	65.3
8.00	27.8	51.8	60.8	60.8
10.00	26.3	50.3	59.3	59.3
16.00	23.2	47.2	56.2	56.2
20.00	-	45.8	54.8	54.8
25.00	-	44.3	53.3	53.3
31.25	-	42.9	51.9	51.9
62.50	-	38.4	47.4	47.4
100.00	-	35.3	44.3	44.3
200.00	-	-	39.8	39.8
250.00	-	-	39.3	38.3
300.00	-	-	-	37.1
400.00	-	-	-	35.3
500.00	-	-	-	33.8

Table 28 – Minimum horizontal cable NEXT loss

Horizontal cable PSNEXT loss (powersum near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	62.3	72.3	72.3
4.00	-	53.3	63.3	63.3
8.00	-	48.8	58.8	58.8
10.00	-	47.3	57.3	57.3
16.00	-	44.2	54.2	54.2
20.00	-	42.8	52.8	52.8
25.00	-	41.3	51.3	51.3
31.25	-	39.9	49.9	49.9
62.50	-	35.4	45.4	45.4
100.00	-	32.3	42.3	42.3
200.00	-	-	37.8	37.8
250.00	-	-	36.3	36.3
300.00	-	-	-	35.1
400.00	-	-	-	33.3
500.00	-	-	-	31.8

Table 29 – Minimum horizontal cable PSNEXT loss

Horizontal cable ACRF (attenuation to crosstalk ratio, far-end) or ELFEXT (equal-level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	63.8	67.8	67.8
4.00	-	51.8	55.8	55.8
8.00	-	45.7	49.7	49.7
10.00	-	43.8	47.8	47.8
16.00	-	39.7	43.7	43.7
20.00	-	37.8	41.8	41.8
25.00	-	35.8	39.8	39.8
31.25	-	33.9	37.9	37.9
62.50	-	27.9	31.9	31.9
100.00	-	23.8	27.8	27.8
200.00	-	-	21.8	21.8
250.00	-	-	19.8	19.8
300.00	-	-	-	18.3
400.00	-	-	-	15.8
500.00	-	-	-	13.8

Table 30 – Minimum horizontal cable ACRF

Horizontal cable PSACRF (powersum insertion loss to alien crosstalk ratio far-end) or PSELFEXT (powersum equal-level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	60.8	64.8	64.8
4.00	-	48.8	52.8	52.8
8.00	-	42.7	46.7	46.7
10.00	-	40.8	44.8	44.8
16.00	-	36.7	40.7	40.7
20.00	-	34.8	38.8	38.8
25.00	-	32.8	36.8	36.8
31.25	-	30.9	34.9	34.9
62.50	-	24.9	28.9	28.9
100.00	-	20.8	24.8	24.8
200.00	-	-	18.8	18.8
250.00	-	-	16.8	16.8
300.00	-	-	-	15.3
400.00	-	-	-	12.8
500.00	-	-	-	10.8

Table 31 – Minimum horizontal cable PSACRF

Horizontal Cable Propagation Delay Skew

Horizontal cable propagation delay skew shall be less than 45 ns/100 m for all frequencies from 1 MHz to the upper frequency limit of the Category.

Horizontal cable propagation delay				
Frequency (MHz)	Category 3 (ns/100 m)	Category 5e (ns/100 m)	Category 6 (ns/100 m)	Category 6A (ns/100 m)
1.00	570	570	570	570
4.00	552	552	552	552
8.00	547	547	547	547
10.00	545	545	545	545
16.00	543	543	543	543
20.00	-	542	542	542
25.00	-	541	541	541
31.25	-	540	540	540
62.50	-	539	539	539
100.00	-	538	538	538
200.00	-	-	537	537
250.00	-	-	536	536
300.00	-	-	-	536
400.00	-	-	-	536
500.00	-	-	-	536

Table 32 – Maximum horizontal cable propagation delay

Horizontal cable PSANEXT loss (powersum alien near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	-	-	67.0
4.00	-	-	-	67.0
8.00	-	-	-	67.0
10.00	-	-	-	67.0
16.00	-	-	-	67.0
20.00	-	-	-	67.0
25.00	-	-	-	67.0
31.25	-	-	-	67.0
62.50	-	-	-	65.6
100.00	-	-	-	62.5
200.00	-	-	-	58.0
250.00	-	-	-	56.5
300.00	-	-	-	55.3
400.00	-	-	-	53.5
500.00	-	-	-	52.0

Table 33 – Minimum horizontal cable PSANEXT loss

Horizontal cable PSAACRF (powersum insertion loss to alien crosstalk ratio far-end) or PSAELFEXT (powersum alien equal level far-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	-	-	67.0
4.00	-	-	-	66.2
8.00	-	-	-	60.1
10.00	-	-	-	58.2
16.00	-	-	-	54.1
20.00	-	-	-	52.2
25.00	-	-	-	50.2
31.25	-	-	-	48.3
62.50	-	-	-	42.3
100.00	-	-	-	38.2
200.00	-	-	-	32.2
250.00	-	-	-	30.2
300.00	-	-	-	28.7
400.00	-	-	-	26.2
500.00	-	-	-	24.2

Table 34 – Minimum horizontal cable PSAACRF loss

TIA Category 6 versus Augmented Category 6				
	TIA Category 5e UTP	TIA Category 6 UTP	TIA Augmented Category 6 UTP	ISO Class E_A
Recognized by IEEE 802.3an	No	Yes	Yes	Yes
55-Meter Distance Support	No	Yes	Yes	Yes
100-Meter Distance Support	No	No	Yes	Yes
Extrapolated Test Limits for NEXT and PSNEXT to 500 MHz	No	No	No	Yes

Table 35 – IEEE 10GBASE-T application support

Note: Table 35 compares current TIA Category 6 cabling with new TIA and ISO specifications for 10 Gigabit cabling. This table summarizes the various twisted-pair cabling options and their respective 10 Gigabit performance attributes as defined by the latest standards. Category 5e is not recognized as a viable cabling media to support 10 Gigabit transmission regardless of its installed cabling distance. Category 6 cabling will only support 10 Gigabit Ethernet at a maximum installed distance of 55 meters.

Bundled and Hybrid Cable

Bundled, wrapped or hybrid cables are allowed for use in horizontal cabling, provided that each individual cable type meets the ANSI/TIA-568-C.2 transmission specifications and that the PSNEXT loss created by adjacent jacketed cables is 3 dB better than the normally allowed pair-to-pair NEXT for the cable type being tested. Color codes must follow individual cable standards to distinguish them from multipair twisted-pair backbone cabling.

Patch Cord Transmission Performance

Jumper and patch cord maximum length limitations:

20 m (66 ft.) in main cross-connect

20 m (66 ft.) in intermediate cross-connect

6 m (20 ft.) in telecommunications room

3 m (10 ft.) in the work area

Assembled patch cords: Insertion loss (attenuation): per 100 m (328 ft.) at 20° C = horizontal UTP cable insertion loss + 20 percent (due to stranded conductors) for all performance categories

Matrix of backward compatible mated component performance					
		Category of modular connecting hardware performance			
		Category 3	Category 5e	Category 6	Category 6A
Modular plug and cord performance	**Category 3**	Category 3	Category 3	Category 3	Category 3
	Category 5e	Category 3	Category 5e	Category 5e	Category 5e
	Category 6	Category 3	Category 5e	Category 6	Category 6
	Category 6A	Category 3	Category 5e	Category 6	Category 6A

Table 36 – Matrix of backward compatible mated component performance

Table 36 illustrates that the lowest-rated component determines the rating of the permanent link or channel.

Patch Cord Cable Construction

Stranded conductors for extended flex-life cables used for patch cords and cross-connect jumpers need to be of the same performance Category (or higher) as the horizontal cables they connect.

Patch cord return loss				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	19.8	19.8	19.8
4.00	-	21.6	21.6	21.6
8.00	-	22.5	22.5	22.5
10.00	-	22.8	22.8	22.8
16.00	-	23.4	23.4	23.4
20.00	-	23.7	23.7	23.7
25.00	-	24.0	24.0	24.0
31.25	-	23.0	23.0	23.0
62.50	-	20.0	20.0	20.0
100.00	-	18.0	18.0	18.0
200.00	-	-	15.0	15.0
250.00	-	-	14.0	14.0
300.00	-	-	-	12.8
400.00	-	-	-	10.9
500.00	-	-	-	9.5

Table 37 – Minimum patch cord return loss

2-Meter patch cord NEXT loss (near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	65.0	65.0	65.0
4.00	-	65.0	65.0	65.0
8.00	-	60.6	65.0	65.0
10.00	-	58.7	65.0	65.0
16.00	-	54.7	62.0	62.0
20.00	-	52.8	60.1	60.1
25.00	-	50.9	58.1	58.2
31.25	-	49.0	56.2	56.3
62.50	-	43.2	50.4	50.4
100.00	-	39.3	46.4	46.4
200.00	-	-	40.6	40.7
250.00	-	-	38.8	38.9
300.00	-	-	-	36.2
400.00	-	-	-	31.9
500.00	-	-	-	28.4

Table 38 – Minimum 2-meter patch cord NEXT loss

5-Meter patch cord NEXT loss (near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	65.0	65.0	65.0
4.00	-	64.5	65.0	65.0
8.00	-	58.6	65.0	65.0
10.00	-	56.7	64.5	64.5
16.00	-	52.8	60.5	60.5
20.00	-	50.9	58.6	58.7
25.00	-	49.1	56.8	56.8
31.25	-	47.2	54.9	54.9
62.50	-	41.6	49.2	49.2
100.00	-	37.8	45.3	45.4
200.00	-	-	39.8	39.9
250.00	-	-	38.1	38.1
300.00	-	-	-	35.9
400.00	-	-	-	32.1
500.00	-	-	-	29.0

Table 39 – Minimum 5-meter patch cord NEXT loss

10-Meter patch cord NEXT loss (near-end crosstalk)				
Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1.00	-	65.0	65.0	65.0
4.00	-	62.5	65.0	65.0
8.00	-	56.7	64.8	64.8
10.00	-	54.9	62.9	63.0
16.00	-	51.0	59.0	59.1
20.00	-	49.2	57.2	57.3
25.00	-	47.4	55.4	55.4
31.25	-	45.6	53.6	53.6
62.50	-	40.2	48.1	48.1
100.00	-	36.7	44.4	44.5
200.00	-	-	39.3	39.3
250.00	-	-	37.6	37.7
300.00	-	-	-	35.8
400.00	-	-	-	32.5
500.00	-	-	-	29.8

Table 40 – Minimum 10-meter patch cord NEXT loss

Purpose of the ANSI/TIA-568-C.3 Standard

The purpose of the ANSI/TIA-568-C.3 standard is to specify cable and component transmission performance requirements for premises optical fiber cabling. Although this standard is primarily intended to be used by manufacturers of optical cabling solutions, other groups such as end-users, designers and installers may also find it useful.

Section Contents

ANSI/TIA-568-C.3

Optical Fiber Cabling Components

ANSI/TIA-568-C.3 Optical Fiber Cabling Components

Optical fiber cabling systems				
Optical fiber and cable type[2]	**Wavelength (nm)**	**Maximum attenuation (dB/km)**	**Minimum overfilled modal bandwidth-length product (MHz • km)**[1]	**Minimum effective modal bandwidth-length product (MHz • km)**[1]
62.5/125 μm Multimode TIA 492AAAA (OM1)	850 1300	3.5 1.5	200 500	Not required Not required
50/125 μm Multimode TIA 492AAAB (OM2)	850 1300	3.5 1.5	500 500	Not required Not required
850-nm Laser-optimized 50/125 μm multimode TIA 492AAAC (OM3)	850 1300	3.5 1.5	1,500 500	2,000 Not required
Single-mode indoor-outdoor TIA 492CAAA (OS1) TIA 492CAAB (OS2)[3]	1310 1550	0.5 0.5	- -	- -
Single-mode inside plant TIA 492CAAA (OS1) TIA 492CAAB (OS2)[3]	1310 1550	1.0 1.0	- -	- -
Single-mode outside plant TIA 492CAAA (OS1) TIA 492CAAB (OS2)[3]	1310 1550	0.5 0.5	- -	- -
NOTES				
1 – The bandwidth-length product, as measured by the fiber manufacturer, can be used to demonstrate compliance with this requirement.				
2 – The fiber designation (OM1, OM2, OM3, OS1 and OS2) corresponds to the designation of ISO/IEC 11801 or ISO/IEC 24702.				
3 – OS2 is commonly referred to as "low water peak" single-mode fiber and is characterized by having a low attenuation coefficient in the vicinity of 1383 nm.				

Table 41 – Optical fiber cable transmission performance parameters

Optical fiber bend radius	
Fiber type	**Bend radius**
Small Inside Plant Cable (2–4 fibers)	1 in. (no load)
	2 in. (with load)
All Other Inside Plant Cable	10 x diameter (no load)
	15 x diameter (with load)
Outside Plant Cable	10 x diameter (no load)
	20 x diameter (with load)

Table 42 – Optical fiber bend radius

Outside plant cable must be water-blocked and have a minimum pull strength of 600 lb. (drop cable pull strength may be 300 lb.).

Optical Fiber Connector

No specified connector: 568 "SC" and other duplex designs may be used in addition to the MPO or MTP array connectors.

Color Identification

Unless color coding is used for some other purpose, the connector strain relief and adapter housing should be identifiable by the following colors:

a) 850-nm laser-optimized 50/125 μm fiber – aqua
b) 50/125 μm fiber – black
c) 62.5/125 μm fiber – beige
d) Single-mode fiber – blue
e) Angled contact ferrule single-mode connectors – green

In addition, unless color coding is used for some other purpose, the connector plug body should be generically identified by the following colors, where possible:

a) Multimode – beige, black or aqua
b) Single-mode – blue
c) Angled contact ferrule single-mode connectors – green

Optical Fiber Telecommunications Outlet Required Features

- Capability to terminate minimum of two fibers into 568 "SC" couplings or other duplex connection
- Means of securing fiber and maintaining minimum bend radius of 25 mm (1 in.)

Optical Fiber Splices, Fusion or Mechanical

Maximum insertion loss 0.3 dB

- Minimum return loss:
  – Multimode: 20 dB
  – Single-mode: 26 dB
  – Single-mode: 55 dB (analog CATV)

Optical Fiber Connector (mated pair)

- Maximum insertion loss 0.75 dB

Patch Cords

- Shall be dual fiber of the same type as the horizontal and backbone fiber
- Polarity shall be keyed duplex

Purpose of the ANSI/TIA-569-C Standard

Telecommunications systems have an impact on almost every area within and between buildings. The complexity of telecommunications has increased and now includes voice, data, video, access control, fire and security, audio, environmental and other intelligent building controls over media that includes, copper data cabling, fiber optics and various forms of wireless transmission. This standard recognizes that buildings have a long life cycle and must be designed to support dynamically changing telecommunications systems and media over the life of the building. This document standardizes specific pathway and space design and construction practices in order to support telecommunications media and equipment within buildings. It does not standardize on the media or equipment. It provides useful information on the industry standard design alternatives available for telecommunications pathways and spaces. It is up to the telecommunications designer to properly select among the alternatives based upon the applications being employed and the various constraints imposed.

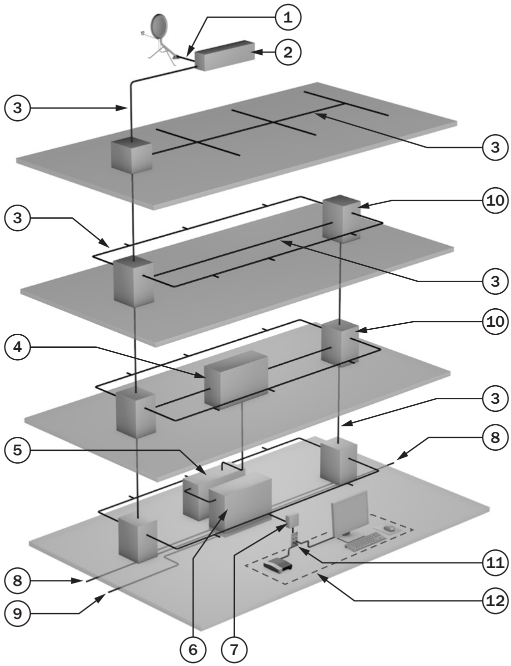
This is a summary document that highlights portions of the key provisions of the standard.

Section Contents

ANSI/TIA-569-C

Telecommunications Pathways and Spaces

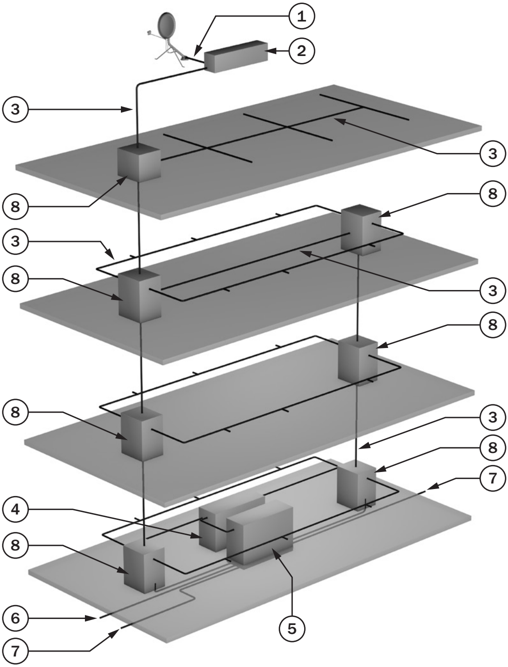
CONTINUES >



Description

1. Wireless service entrance pathway
2. Entrance room
3. Building pathways
4. Distributor room
5. Access provider space, service provider space
6. Entrance room
7. Distributor enclosure
8. Service entrance pathway
9. Diversity of entrance routes
10. Distributor room
11. Equipment outlet
12. Equipment outlet location

Figure 12 – Example of pathways and spaces in a single-tenant building



Description

1. Wireless service entrance pathway
2. Entrance room
3. Common building
4. Access provider space, service provider space
5. Entrance room
6. Service entrance pathway
7. Diversity of entrance routes
8. Common distributor room

Figure 13 – Example of common pathways and spaces in a multi-tenant building

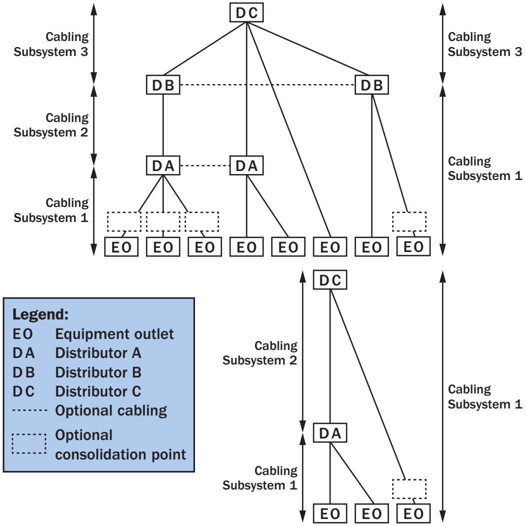


Figure 14 – Elements of generic cabling topology

Figure 14 is a representative model of the functional elements that comprise a generic cabling system in a variety of environments, including offices, industrial areas, etc. In a typical commercial office building where ANSI/TIA-568-C.1 applies, Distributor C represents the main cross-connect (MC), Distributor B represents the intermediate cross-connect (IC), Distributor A represents the horizontal cross-connect (HC) and the equipment outlet (EO) represents the telecommunications outlet/connector.

Design Considerations
Building Spaces
Temperature and Humidity Requirements

ASHRAE Class	SPACE	Environmental Requirements
Class A1 A2 A3 A4	See note 1	• Temperature: 18-27º C (64-81º F) dry bulb – High altitude: reduce maximum dry-bulb temperature 1º C (1.8º F) for every 300 m (1,000 ft.) above 1,800 m (5,900 ft.) altitude. • Maximum relative humidity (RH): 60% • Maximum dew point: 15º C (59º F) • Minimum dew point (lower moisture limit): 5.5º C (42º F)[2] • Maximum rate of temperature change: 5º C (9º F) per hour
Class B	Distributor room Distributor enclosure Entrance room or space Access provider space Service provider space Common distributor room	• Temperature: 5-35º C (41-95º F) dry bulb – High altitude: reduce maximum dry-bulb temperature 1º C (1.8º F) for every 300 m (1,000 ft.) above 900 m (3,000 ft.) altitude. – Diskettes: minimum temperature with diskette in a drive is 10º C (50º F). • Relative humidity (RH): 8-80% • Maximum dew point: 28º C (82º F)
Class C	See note 1	• Temperature: 5-40º C (41-104º F) dry bulb – High altitude: reduce maximum dry-bulb temperature 1º C (1.8º F) for every 300 m (1,000 ft.) above 900 m (3,000 ft.) altitude. – Diskettes: minimum temperature with diskette in a drive is 10º C (50º F). • Relative humidity (RH): 8-80% • Maximum dew point: 28º C (82º F)

Note: 1. Class A1, Class A2, Class A3, Class A4 and Class C are not referenced by this Standard. They are included for reference by specific premises standards.

2. Dew point of 5.5º C (42º F) corresponds to approximately 44% RH at 18º C (64º F) and 25% RH at 27º C (81º F).

Table 43 – Temperature and humidity requirements for telecommunications spaces

Common Requirements for Rooms

The requirements of this section apply to the following telecommunications spaces: distributor room; common distributor room; entrance room or space; access provider space; and service provider space.

General and Architectural

- Avoid selecting locations that are restricted by building components that limit expansion such as elevators, core, outside walls or other fixed building walls.
- There should be accessibility for delivery of large equipment. A minimum of one wall shall be covered with 19 mm (3/4 in.) plywood covered with two coats of fire-retardant paint.
- The backboard shall be 1.2 m (4 ft.) x 2.4 m (8 ft.) sheets, mounted vertically with bottom of plywood mounted 150 mm (6 in.) above the finished floor.
- Minimum ceiling height shall be 2.4 m (8 ft.) without obstructions. The height between the finished floor and the lowest point of the ceiling should be a minimum of 3 m (10 ft.) to accommodate taller frames and overhead pathways.
- Floor loading shall be sufficient to bear all the installed loads in the building and a structural engineer consulted to do the design.
- Lighting shall be a minimum of 500 lux in the horizontal plane and 200 lux in the vertical plane measured 1 m (3 ft.) above the finished floor.
- The door shall be a minimum of 0.9 m (36 in.) wide and 2 m (80 in.) high with no doorsill, hinged to open outward (code permitting). A double door 1.8 m (72 in.) wide by 2.3 m (90 in.) high is recommended if large equipment delivery is anticipated.
- There should be no exterior windows.
- Temperature and humidity shall meet the requirements for ASHRAE Class B in Table 43.
- Environmental control such as power distribution and conditioner systems, and UPS systems, up to 100 kVA, dedicated for use by telecommunications systems in the room are permitted to be installed in the space. UPS larger than 100 kVA must be located in a separate room.

- Fire protection shall be provided per code.

- Telecom spaces shall not be located below water level, unless preventative measures are employed to prevent water infiltration. The space shall be free of water or drain pipes not directly required to support equipment in the room.

Racks and Cabinets

- A minimum of 1 m (3 ft.) of clearance in front of racks and cabinets shall be provided but a 1.2 m (4 ft.) clearance is preferred. A minimum of 0.6 m (2 ft.) of rear clearance shall be provided but a clearance of 1 m (3 ft.) is preferred.

- Cabinets shall be selected and configured to provide adequate cooling for the equipment they contain. There are many cooling methods available.

- The maximum cabinet and rack height shall be 2.4 m (8 ft.). It is preferable that they be no taller than 2.1 m (7 ft.) for easier access to equipment installed at the top.

- Cabinets should be of adequate depth to accommodate the planned equipment to be installed, including cabling and the front and rear, power cords, cable management hardware and power strips. Consideration should be given to using cabinets that are at least 150 mm (6 in.) deeper or wider than the largest installed equipment.

- Cabinets should have adjustable front and rear rails, which should provide 42 or more rack mount units of space. If patch panels are installed on the front or rear of cabinets, the front or rear rails should be recessed at least 100 mm (4 in.) to allow for cable management.

- Power strips should be used with cabinets and racks that contain active electronics. Power circuits should have dedicated neutral and ground conductors. Power strips should have a locking plug but not have an on/off switch or breaker reset button to minimize accidental shut-off.

- A vertical cable manager shall be installed between each pair of racks and at both ends of every row of racks.

Distributor Room (Equipment Room/Telecommunications Room)

The distributor room is a common access point for cabling subsystems and building pathways. It may contain telecommunications equipment, cable terminations, and associated cross-connect cabling. The distributor room may also contain information technology equipment and building automation systems (BAS) equipment and cabling. The distributor room shall be dedicated to the telecommunications function and should not be shared with electrical installations other than those used for telecommunications or related equipment. Equipment not related to the support of the distributor room (piping, ductwork, pneumatic tubing etc.) shall not be installed in or pass through this room.

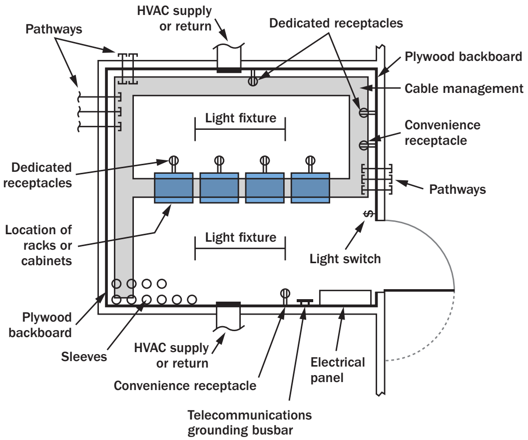


Figure 15 – Typical distributor room

Architectural and Environmental

- Locate the distributor room as close as possible to the center of the area served.
- If multiple distributor rooms are on the same floor they should be interconnected with a minimum of one trade size 3 conduit or equivalent.
- Size: Minimum floor space shall be based on the number of (Distributor A) equipment outlets served directly as shown in Table 44. The minimum dimension is 3 m (10 ft.) long by 3 m (10 ft.). wide. A distributor room containing Distributor B should be a minimum of 10 m^2 (100 $ft.^2$). A distributor room containing Distributor C should be a minimum of 12 m^2 (120 $ft.^2$) for buildings with a gross area of up to 50,000 m^2 (500,000 $ft.^2$).
- There shall be a minimum of one distributor room per floor.
- There shall be a minimum of two dedicated 120 V AC, nonswitched, AC duplex receptacles provided, each on a separate 20 A dedicated branch circuit.

Equipment Outlets Served	Minimum Floor Space m^2 ($ft.^2$)	Typical Dimensions m (ft.)
Up to 200	15 (150)	3 x 5 (10 x 15)
201 to 800	36 (400)	6 x 6 (20 x 20)
801 to 1,600	72 (800)	6 x 12 (20 x 40)
1,601 to 2,400	108 (1,200)	9 x 12 (30 x 40)

Table 44 – Floor space

Entrance Room or Space

The entrance room is a space in which the joining of inter- or intrabuilding telecommunications facilities takes place. It is an entrance point for outside plant cabling and may contain incoming service provider cables, protectors and building cables. An entrance room may also serve as a distributor room.

- Must meet the Common Requirements for Rooms (page 60).
- Shall be located in a dry area not subject to flooding and as close as possible to the building entrance point.
- Sized to meet the present and future requirements of Distributor C.
- May be an open area or room. For buildings exceeding 2,000 m^2 (20,000 $ft.^2$), an enclosed room should be provided. In buildings up to 10,000 m^2 (100,000 $ft.^2$), it may be suitable to use wall-mounted termination hardware. A larger floor area may require the use of free-standing frames for terminating cables.

Distributor Enclosure (Formerly Telecom Enclosure)

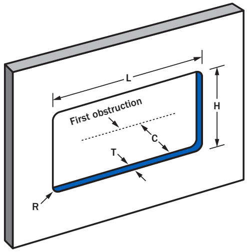
A distributor enclosure is a case or housing that is designed to contain Distributor A, Distributor B or Distributor C. It is a common access point for cabling subsystems and pathways.

- It shall be located as close as possible to the center of the area served.
- It must have CEA-310E-compliant mounting holes installed or equipped with a plywood backboard to facilitate hardware mounting.
- There should be a minimum of 500 lux of light within the enclosure.
- A minimum of one dedicated 120 V/20 A nonswitched, duplex electrical outlet shall be provided.

Equipment Outlet (EO)

An equipment outlet is the outermost connection facility in a hierarchical star topology. The type of equipment outlet hardware is based on the service area it serves and the environment. In an office area, it can be a telecom outlet or a MUTOA while in a data center the equipment outlet can be a patch panel or other connecting hardware.

- A minimum of one equipment outlet space shall be provided per area serviced. Two separate equipment outlets should be provided in areas where it may be difficult to add outlets at a later date.
- Bend radius requirements should not be violated in the space behind equipment outlets
- Outlet boxes, if used, should be no smaller than 50 mm (2 in.) wide, 75 mm (3 in.) high, and 64 mm (2.5 in.) deep.
- If furniture is used, there are two standard sizes of openings specified:
  – Equivalent to NEMA OS 1, WD 6 openings with a minimum depth of 30.5 mm (1.2 in.)
  – Alternative furniture opening as specified in Figure 16 below:



	Dimensions		Tolerance	
	mm	(in.)	mm	(in.)
L	68.8	(2.71)	1.02	(0.040)
H	35.1	(1.38)	0.90	(0.035)
T	1.4	(0.055)	0.64	(0.025)
R	4.06	(0.16) max.	–	–
C	30.5	(1.2) min.	–	–

Figure 16 – Dimensions for furniture equipment outlet opening

Other Spaces Covered in the Standard
(Not summarized in this document)

Access Provider Spaces and Service Provider Spaces
These spaces are used for the provider's transmission, reception and support equipment.

Multi-Tenant Building Spaces
These spaces include distributor rooms, pathways and other spaces that serve multiple tenants in a multi-tenant building.

Building Pathways

Types of Pathways

Areas Above Ceilings
May be used as pathways as well as spaces for connecting hardware.

Access Floor Systems
Consist of modular floor panels supported by pedestals and stringers.

Cable Support Systems
Cable trays and runways can be located below or above the ceiling or within an access floor system.

Underfloor Duct Systems
Pathways consisting of distribution and feeder ducts embedded in concrete containing cables for telecommunications and power services.

Cellular Floor

Generally used in steel-frame buildings in floors above grade, the steel or concrete cell sections act as the concrete floor form and later, with header ducts, act as the distribution raceways.

Perimeter Raceways

Surface-mounted pathways may contain equipment outlets and are often installed at baseboard, chair-rail or ceiling height.

Utility Columns

Extending from the ceiling to the service area, these columns provide pathways for wire and cable.

Pathway Separation from EMI Sources

Separation Between Telecommunications and Power Cables

- The requirements of the National Electric Code (NFPA 70) shall apply.
- Zero separation distance is permitted when either the electrically conductive telecommunications cables, the power cables or both are enclosed in metallic pathways that meet the following conditions:
  - Metallic pathway(s) completely enclose the cables and are continuous.
  - Metallic pathway(s) are properly grounded and bonded per ANSI/TIA-607-B.
  - Walls of the pathway(s) have a minimum thickness of 1 mm (0.04 in.) nominal if made of steel or 1.5 mm (0.06 in.) nominal if made of aluminum.
  - No separation is required between telecommunications and power cables crossing at right angles.
- Table 45 (page 68) covers the guidelines for separation between balanced twisted-pair cables and adjacent power wiring. The separation distances in Table 45 may be halved if the data and power cables are installed in separate solid metallic or wire mesh cable trays.

Power Circuit Type (Sinusoidal)	Number of Radial Power Circuits	Minimum Recommended Separation, mm (in.) [1]				
		E1 (EFT/B = 500 V)		E2 (EFT/B = 500 V), E3 (EFT/B = 1,000 V)		
		Unscreened Power Cables	Armored or Screened Power Cables [2]	Unscreened Power Cables		Armored or Screened Power Cables [2]
				Unshielded Cable	Shielded Cable	
120/230 V AC, 20 A 1-phase	1	0 (0)	0 (0)	50 (2)	1 (0.04) [3]	0 (0)
	2	0 (0)	0 (0)	50 (2)	5 (0.2) [3]	2.5 (0.1)
	3	0 (0)	0 (0)	50 (2)	10 (0.4) [3]	5 (0.2)
	4	0 (0)	0 (0)	50 (2)	12 (0.5) [3]	6 (0.2)
	5–15	0 (0) [3]	0 (0)	50 (2)	50 (2)	25 (1)
	16–30	100 (4)	50 (2)	100 (4)	100 (4)	50 (2)
	31–60	200 (8)	100 (4)	200 (8)	200 (8)	100 (4)
	61–90	300 (12)	150 (6)	300 (12)	300 (12)	150 (6)
	≥ 91	600 (24)	300 (12)	600 (24)	600 (24)	300 (12)
120/230 V AC, 32 A 1-phase	1	10 (0.4) [3]	5 (0.2)	50 (2)	10 (0.4) [3]	5 (0.2)
	2	20 (0.8) [3]	10 (0.4)	50 (2)	20 (0.8) [3]	10 (0.4)
	3	30 (1) [3]	15 (0.6)	50 (2)	30 (1) [3]	15 (0.6)
	4–5	50 (2)	25 (1)	50 (2)	50 (2)	25 (1)
	6–9	100 (4)	50 (2)	100 (4)	100 (4)	50 (2)
	10–19	200 (8)	100 (4)	200 (8)	200 (8)	100 (4)
	20–28	300 (12)	150 (6)	300 (12)	300 (12)	150 (6)
	≥ 29	600 (24)	300 (12)	600 (24)	600 (24)	300 (12)
120/230 V AC, 63 A 1-phase	1	50 (2)	25 (1)	50 (2)	50 (2)	25 (1)
	2–3	100 (4)	50 (2)	100 (4)	100 (4)	50 (2)
	4–8	200 (8)	100 (4)	200 (8)	200 (8)	100 (4)
	9–14	300 (12)	150 (6)	300 (12)	300 (12)	150 (6)
	≥ 15	600 (24)	300 (12)	600 (24)	600 (24)	300 (12)
120/230 V AC, 100 A 1-phase	1	100 (4)	50 (2)	100 (4)	100 (4)	50 (2)
	2	200 (8)	100 (4)	200 (8)	200 (8)	100 (4)
	3	300 (12)	150 (6)	300 (12)	300 (12)	150 (6)
	≥ 4	600 (24)	300 (12)	600 (24)	600 (24)	300 (12)
480 V AC, 100 A 3-phase	1	300 (12)	300 (12)	300 (12)	300 (12)	300 (12)
	≥ 2	600 (24)	600 (24)	600 (24)	600 (24)	600 (24)

Note: 1. Separation distances may be halved if the power cables and data cables are installed in separate metallic pathways (see above).

2. Armoring or screening must completely surround the cable (except at the socket) and be properly bonded and grounded (earthed).

3. 50 mm (2 in.) if loose (individual) power conductors are used and not bundled or maintained close together.

Table 45 – Recommended separation from power wiring for balanced twisted-pair cabling

Separation from Lighting

Twisted-pair cabling should be separated from fluorescent lamps and fixtures by a minimum of 125 mm (5 in.).

Cable Tray and Cable Runway

Cable trays shall be planned with an initial fill ratio of 25 percent. The maximum fill ratio of any cable tray shall be 50 percent. It should be noted that a fill ratio of 50 percent for four-pair and similar size cables will physically fill the entire tray due to spaces between cables and random placement. The maximum depth of any cable tray shall be 150 mm (6 in.).

Noncontinuous pathway supports shall be located at intervals not to exceed 1.5 m (5 ft.). Cable shall not be laid directly on ceiling tiles or rails. Wires or rods that are already used for other functions, such as suspended ceiling grid support, shall not be used as attachment points for noncontinuous supports.

Conduit

No section of conduit shall be longer than 30 m (100 ft.) between pull points. No section of conduit should have more than two 90 degree bends. The inside bend radius of a conduit 50 mm (2 in.) or less shall be at least six times the internal diameter. For conduits with an internal diameter more than 50 mm (2 in.), the inside bend radius shall be at least 10 times the internal diameter. Pull boxes should be readily accessible and should be installed in straight sections of conduit and not used in place of a bend.

Vertical Pathway – Sleeves or Conduits, Slots

Sleeves: A minimum of five metric designator 103 (trade size 4) conduits or sleeves should be provided to service up to 4,000 m^2 (40,000 $ft.^2$) of usable floor space. One additional conduit or sleeve should be provided for each additional 4,000 m^2 (40,000 $ft.^2$) of usable floor space.

Slots: Slots are typically located flush against the wall within a space and should be designed at a depth (the dimension perpendicular to the wall) of 150–600 mm (6–24 in.) or narrower depths wherever possible. The size of the pathway using slots should be one slot sized at 0.04 m^2 (60 $in.^2$) for up to 4,000 m^2 (40,000 $ft.^2$) of usable floor space served. The slot area should be increased by 0.04 m^2 (60 $in.^2$) with each 4,000 m^2 (40,000 $ft.^2$) increase in usable floor space served.

A structural design engineer must approve the location and configuration of sleeves and slots.

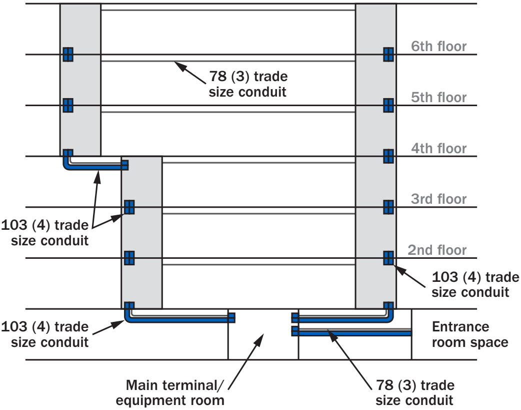


Figure 17 – Typical office building pathway layout

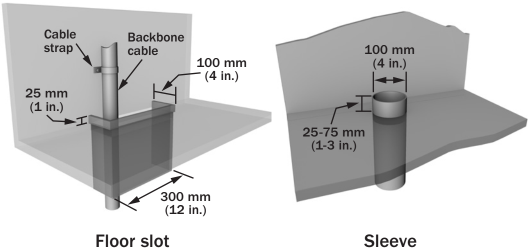


Figure 18 – Typical sleeve and slot installations

Annex A – Firestopping

This is a normative annex and considered part of the standard. It provides guidelines and requirements as well as methods, materials and other considerations for reestablishing the integrity of fire-rated structures such as walls, floors and ceilings when these structures are penetrated by components.

There are two broad categories of firestops:

1. Mechanical: Premanufactured elastomeric components shaped to fit around standard cables, tubes and conduits.

2. Nonmechanical: These come in a variety of forms that have the benefit of adapting to irregular openings and off-center penetrating items (e.g., putties, caulks, cementitious materials, intumescent sheets, intumescent wrap strips, silicone foam and premanufactured pillows).

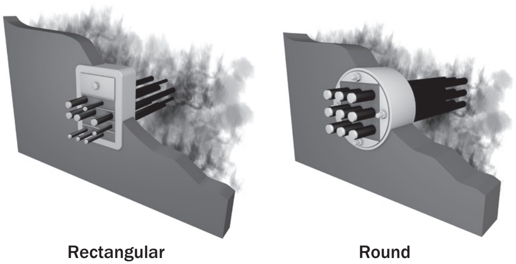


Figure 19 – Mechanical firestops

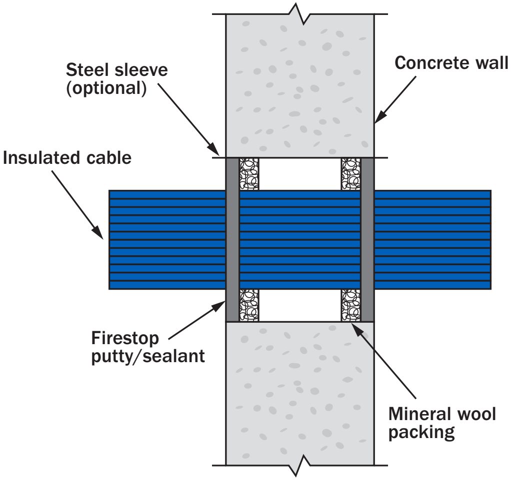


Figure 20 – Cross-section of through-wall firestop

Purpose of the ANSI/TIA-606-B Standard

This standard defines the “Classes of Administration” needed to properly label and administer a telecommunications infrastructure. It specifies administration for a generic telecommunications cabling system that will support a multiproduct, multimanufacturer environment.

This standard provides uniform guidelines for an administration methodology that is independent of the applications that may change over the life of the telecommunications infrastructure.

The intention of this standard is to increase the value of the infrastructure investment by reducing system maintenance expenses, extending the useful life of the system and providing effective service to users.

This standard specifies two identifier formats, one fully backward compatible with legacy TIA-606-A identifiers and one based on TIA-606-A, but modified to be compatible with the ISO/IEC TR 14763-2-1 identifiers. New administration systems should use the identifier format compatible with the ISO/IEC TR 14763-2-1.

Section Contents

ANSI/TIA-606-B

Administration Standard for Telecommunications Infrastructure

Elements of an Administration System

- Cabling Subsystem 1 pathways and cabling
- Cabling Subsystem 2 and 3 pathways and cabling
- Telecommunications grounding and bonding
- Spaces (e.g., entrance facility, telecommunications room, equipment room)
- Firestopping

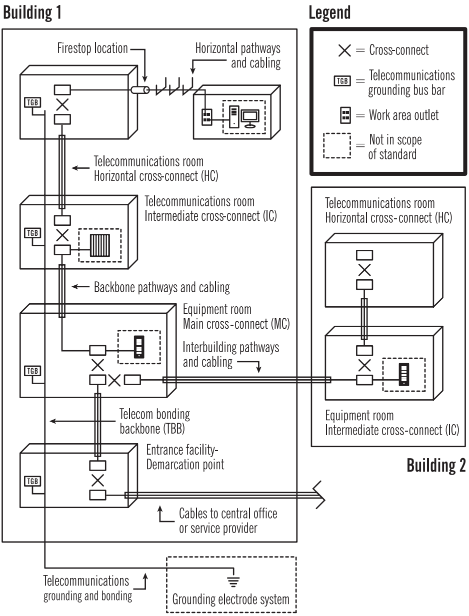


Figure 21 – A typical model for the infrastructure elements used in an administration system

Scope

This standard:

- Assigns identifiers to components in the infrastructure
- Specifies elements of information that make up records for each identifier
- Specifies relationships between records to access information they contain
- Specifies reports providing information on groups of records
- Specifies graphical and symbolic requirements.

Classes of Administration

Four classes of administration are specified in this standard to accommodate diverse degrees of complexity present in telecommunications infrastructure. Each class defines the administration requirements for identifiers, records and labeling. An administration system can be managed using a paper-based system, general-purpose spreadsheet, software specialized software or automated infrastructure management (AIM) systems.

The most relevant factors in determining the minimum class of administration are the size and complexity of the infrastructure. The number of telecommunications spaces (TS), such as equipment room (ER), telecommunications room (TR), access provider spaces, service provider spaces, common distributor room, and entrance facility (EF) spaces, is one indicator of complexity.

Compatible Formats for ANSI/TIA-606-A and ISO/IEC TR 14763-2-1

Two formats are specified for identifiers:

1. A format that is backward compatible with ANSI/TIA-606-A
2. A format that is compatible as specified in ISO/IEC TR 14763-2-1

Note: The following two tables (Table 46 and Table 47) show the identifiers grouped by their "class" for both the ANSI/TIA-606-A and the ISO/IEC TR 14763-2-1 standards. It does not provide all the individual identifier codes and formats or the specific clauses concerning each identifier that are found in the table in the master standard document. Providing such detailed information would require a voluminous amount of space and is outside the scope of this summarized Anixter Standards Reference Guide. For more in-depth information, please refer to the actual ANSI/TIA-606-B document.

Identifiers Grouped by Class – ANSI/TIA-606-A Compatible

Description of Identifier	Class of Administration			
	1	2	3	4
Telecommunications space (TS)	R	R	R	R
Cabinet, rack, enclosure, wall segment	R	R	R	R
Patch panel or termination block	R	R	R	R
Port on patch panel or termination on termination block	R	R	R	R
Cabling Subsystem 2 or 3 (backbone) cable or cable between cabinets, racks, enclosures, or wall segments	O	R	R	R
Port within Cabling Subsystem 2 or 3 cable or cable within distributor telecommunications room, equipment room, or computer room	O	R	R	R
Cabling Subsystem 1 (horizontal) link	R	R	R	R
Equipment outlet or telecommunications outlet	O	O	O	O
Consolidation point	O	O	O	O
Port in ZDA in a data center	O	O	O	O
Space in Cabling Subsystem 1 link	O	O	O	O
TMGB - Telecommunications main grounding bus bar	R	R	R	R

Table 46 – Identifiers grouped by class – ANSI/TIA-606-A compatible

Description of Identifier	Class of Administration			
	1	2	3	4
TGB - Telecommunications grounding bus bar	R	R	R	R
RGB - Rack grounding bus bar	O	O	O	O
mesh-BN - Mesh bonding network	O	O	O	O
BCT - Bonding conductor for telecommunications	R	R	R	R
TBB - Telecommunications bonding backbone	O	R	R	R
GE - Grounding equalizer	O	R	R	R
Bonding conductor from object to TMGB	R	R	R	R
Bonding conductor from object to TGB	R	R	R	R
Bonding conductor from object to mesh-BN	O	O	O	O
Bonding conductor from object to RGB	O	O	O	O
Building Cabling Subsystem 2 or 3 (backbone) cable	O	R	R	R
Building Cabling Subsystem 2 or 3 pair/port	O	R	R	R
Building Cabling Subsystem 2 or 3 cable space	O	O	O	O
Firestop location	O	R	R	R
Campus or site	O	O	O	R
Building	O	O	R	R
Interbuilding cable	O	O	R	R
Interbuilding cable pair/port	O	O	R	R
Interbuilding cable space	O	O	O	O
Outdoor telecommunications space (e.g., maintenance holes, handholes, pedestals, outdoor cabinets)	O	O	O	O
Intraspace pathway	O	O	O	O
Building pathway	O	O	O	O
Building entrance pathway	O	O	O	O

Table 46 – Continued

Description of Identifier	Class of Administration			
	1	2	3	4
Outside plant pathway	O	O	O	O
Campus entrance pathway	O	O	O	O
Path cord	O	O	O	O
Equipment cord	O	O	O	O
Direct cable between equipment	O	O	O	O

Table 46 – Continued

Notes:

R = required identifier for class, when corresponding element is present
O = optional identifier for class

Identifiers Grouped by Class – ISO/IEC TR 14763-2-1 Compatible

Description of Identifier	Class of Administration			
	1	2	3	4
Telecommunications space (TS)	R	R	R	R
Cabinet, rack, enclosure, wall segment	R	R	R	R
Patch panel or termination block	R	R	R	R
Port on patch panel or termination on termination block	R	R	R	R
Cabling Subsystem 2 or 3 (backbone) cable or cable between cabinets, racks, enclosures or wall segments	O	R	R	R
Port within Cabling Subsystem 2 or 3 cable or cable within distributor, telecommunications room, equipment room or computer room	O	R	R	R
Cabling Subsystem (horizontal) link	R	R	R	R
Equipment outlet or telecommunications outlet	O	O	O	O
Consolidation point	O	O	O	O
Port in ZDA in a data center	O	O	O	O
Space in Cabling Subsystem 1 link	O	O	O	O
TMGB - Telecommunications main grounding bus bar	R	R	R	R
TGB - Telecommunications grounding bus bar	R	R	R	R
RGB - Rack grounding bus bar	O	O	O	O
mesh-BN - Mesh bonding network	O	O	O	O
BCT - Bonding conductor for telecommunications	R	R	R	R
TBB - Telecommunications bonding backbone	O	R	R	R
GE - Grounding equalizer	O	R	R	R
Bonding conductor from object to TMGB	O	O	O	O
Bonding conductor from object to TGB	O	O	O	O
Bonding conductor from object to mesh-BN	O	O	O	O
Bonding conductor from object to RGB	O	O	O	O
Building Cabling Subsystem 2 or 3 (backbone) cable	O	R	R	R
Building Cabling Subsystem 2 or 3 pair/port	O	R	R	R
Building Cabling Subsystem 2 or 3 cable space	O	O	O	O
Firestop location	O	R	R	R

Table 47 – Identifiers grouped by class – ISO/IEC TR 14763-2-1 compatible

Description of Identifier	Class of Administration			
	1	2	3	4
Campus or site	O	O	O	R
Building	O	O	R	R
Interbuilding cable	O	O	R	R
Interbuilding cable pair/port	O	O	R	R
Interbuilding cable space	O	O	O	O
Outdoor telecommunications space (e.g. maintenance holes, handholes, pedestals, outdoor cabinets)	O	O	O	O
Intra-space pathway	O	O	O	O
Building pathway	O	O	O	O
Building entrance pathway	O	O	O	O
Outside plant pathway	O	O	O	O
Campus entrance pathway	O	O	O	O
Path cord	O	O	O	O
Equipment cord	O	O	O	O
Direct cable between equipment	O	O	O	O

Table 47 – Continued

Notes:

R = required identifier for class, when corresponding element is present

O = optional identifier for class

Note: Table 46 and Table 47 show the identifiers grouped by their "class" for both the ANSI/TIA-606-A and the ISO/IEC TR 14763-2-1 standards. It does not provide all the individual identifier codes and formats or the specific clauses concerning each identifier that are found in the table in the master standard document. Providing such detailed information would require a voluminous amount of space and is outside the scope of this summarized Anixter Standards Reference Guide. For more in-depth information, please refer to the actual ANSI/TIA-606-B document.

Class 1 Administration

Class 1 addresses the administration needs when only one equipment room (ER) is administered. This ER is the only telecommunications space (TS) administered and neither TRs, Cabling Subsystem 2 or 3 (backbone) cabling, or outside plant cabling is administered.

The following infrastructure identifiers shall be required in Class 1 Administration when the corresponding elements are present:

- TS (telecommunications space) identifier
- Cabinet, rack, enclosure, wall segment identifier
- Patch panel or termination block identifier
- Patch panel port and termination block position identifiers
- Identifiers for cables between cabinets, racks, enclosures, or walls in the same space
- Cabling Subsystem 1 (horizontal) link identifier
- Telecommunications main grounding busbar (TMGB) identifier
- Telecommunications grounding busbar (TGB) identifier

Refer to Tables 46 and 47 for Class 1 identifiers.

Class 2 Administration

Class 2 addresses the administration of infrastructure with one or more telecommunications spaces (TS) in a single building.

The following infrastructure identifiers shall be required in Class 2 Administration when the corresponding elements are present:

- Identifiers required in Class 1 Administration
- Building Cabling Subsystem 2 and 3 (backbone) cable identifiers
- Building Cabling Subsystem 2 and 3 port identifiers
- Firestopping location identifiers

Class 2 Administration may also include pathway identifiers.

Refer to Tables 46 and 47 for Class 2 identifiers.

Class 3 Administration

Class 3 Administration addresses infrastructure with multiple buildings at a single site.

The following infrastructure identifiers shall be required in Class 3 Administration:

- Identifiers required in Class 2 Administration
- Building identifier
- Campus cable identifier
- Campus cable pair or fiber identifier

The following infrastructure identifiers are optional in Class 3 Administration:

- Identifiers optional in Class 2 Administration
- Outside plant pathway element identifier
- Campus pathway or element identifier

Additional identifiers may be added if desired.

Refer to Tables 46 and 47 for Class 3 identifiers.

Class 4 Administration

Class 4 Administration addresses infrastructure with multiple sites or campuses.

The following infrastructure identifiers shall be required in Class 4 Administration:

- Identifiers required in Class 3 Administration
- Campus or site identifier

The following infrastructure identifiers are optional in Class 4 Administration:

- Identifiers optional in Class 3 Administration
- Intercampus element identifier

Additional identifiers may be added if desired.

Refer to Tables 46 and 47 for Class 4 identifiers.

Some Common Generalized Administration Labeling Guidelines

- Each telecommunications space (TS) shall be labeled with the TS identifier inside the room to be visible to someone working in the room.
- Each cabinet and rack shall be labeled with its identifier on the front and rear in plain view.
- Text on labels shall be machine printed.
- Patch panels should be labeled with their identifier and with the identifier of the patch panel at the far end.
- A unique campus or site identifier shall be assigned to each campus or site.
- A unique building identifier shall be assigned to each building.
- All ports on patch panels and all positions on terminal blocks shall be labeled.
- Cables terminated on patch panels or termination blocks shall be identified by the identifiers of the ports/terminations on both ends of the cable.
- Each intrabuilding and interbuilding cable shall be assigned with a unique identifier.
- Equipment outlets and their associated ports shall be labeled.
- The TMGB and TGB shall be labeled with their identifiers.
- All grounding conductors should be labeled with their identifiers.
- A firestopping location identifier shall identify each installation of firestopping material.
- Detailed records of all administration elements will be maintained as defined in the standard.

Color-Coding Identification

Color coding of cables, connectors, cords, jumpers, termination fields, labels, pathways, and other components may be used to identify the type, application, function, or position of a component within the infrastructure.

Termination Type	Color	Pantone#	Typical Application
Demarcation Point	Orange	150C	Central office connection
Network Connection	Green	353C	User side of central office connection
Common Equipment	Purple	264C	Connection to PBX, mainframe computer, LAN, multiplexer
Cabling Subsytem 3	White		Terminations of building Cabling Subsytem 3 cable connecting MC to ICs
Cabling Subsytem 2	Gray	422C	Terminations of building Cabling Subsytem 2 cable connecting IC to HCs
Campus Cabling	Brown	465C	Termination of campus cable between buildings
Cabling Subsytem 1	Blue	291C	Terminations of Cabling Subsytem 1 cable in TSs
Miscellaneous	Yellow	101C	Alarms, security or energy management

Table 48 – Example of termination field color coding

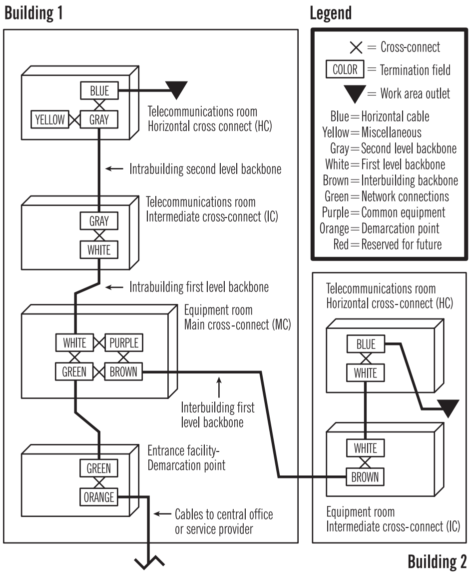


Figure 22 – Example of color-coding of termination fields

Permanent Labels

- The size, color and contrast of all labels should be selected to make sure that the identifiers are easily read.
- Labels should be visible during normal maintenance of the infrastructure.
- Labels should be resistant to environmental conditions (such as moisture, heat or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
- The text on labels shall be machine generated.

Administration Systems Using Records, Linkages and Reports

Administration may be accomplished using traditional paper-based methods, spreadsheets, databases or specialized software. In addition to these systems, the functions of automated infrastructure management systems may be suitable for more complex installations, where staffing attributes make the use of automated systems more effective and efficient, and to meet regulatory compliance requirements. Generally, these systems maintain a database of all infrastructure records and may also include linkages to related records that can be used to generate reports, provide tracing functions and reduce duplication of information.

Specialized software, if used, may include standard databases and a variety of detection mechanisms to improve the accuracy and efficiency of telecommunications infrastructure administration. It may include technology to detect infrastructure changes and update records. It should be capable of generating labels or exporting the data to a device or program that will print them.

Automated Infrastructure Management Systems

Automated infrastructure management systems may be used. If used, they should:

- Automatically document the infrastructure elements as described in this standard
- Provide a comprehensive record of all the connected equipment
- Facilitate easy troubleshooting
- Provide an automated method of discovering and documenting configuration of LAN and SAN switches
- Automatically discover and document end devices that connect to the network
- Be fault tolerant (e.g., retention of information after a power outage)
- Include the capability of automatically monitoring patch connections between connections with automated management, and of generating alerts and updating documentation when any of these patch connections are changed
- Be capable of automatically generating reports about the telecommunications infrastructure.

Purpose of the ANSI/TIA-607-B Standard

This standard specifies a uniform telecommunications grounding and bonding infrastructure that shall be followed within commercial buildings. Following the AT&T divestiture of 1984, the end-user became responsible for all premises cabling for voice and data. Advancements in voice communications and the convergence of voice and data communications led to increasingly complex interactive systems owned and maintained by the end-user. These systems require a reliable electrical ground-reference potential. Grounding by attachment to the nearest piece of iron pipe is no longer satisfactory to provide ground-reference for sophisticated active electronics systems.

Section Contents

ANSI/TIA-607-B

Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

Design Considerations

Solid copper grounding bus bars (1/4 in. thick x 4 in. high x variable length) are installed with insulated standoffs in entrance facilities and the equipment room, as well as each telecommunications room (1/4 in. thick x 2 in. high x variable length is sufficient here). Each bus bar is drilled with rows of holes according to NEMA standards for attachment of bolted compression fittings.

Telecommunications equipment, frames, cabinets and voltage protectors are typically grounded to these bus bars. Bus bars are connected by a backbone of insulated, solid copper cable between all closets and rooms (minimum 6 AWG, 3/0 AWG recommended). This backbone is connected to a main grounding bus bar in the telecommunications entrance facility, to an earth ground in the electrical entrance facility and to structural steel on each floor. Bonding conductor cabling must be colored green or labeled appropriately.

Abbreviations

- Telecommunications main grounding bus bar (TMGB)
- Telecommunications bonding backbone (TBB)
- Telecommunications grounding bus bar (TGB)
- Telecommunications bonding backbone interconnecting bonding conductor (TBBIBC)

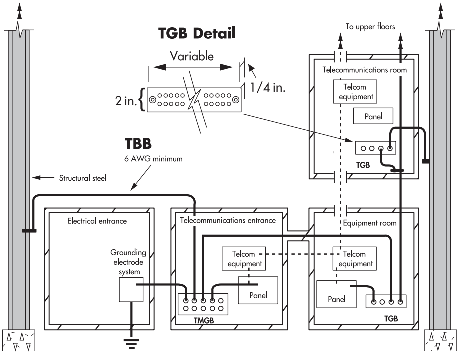


Figure 23 – Schematic of grounding/bonding network

Purpose of the ANSI/TIA-862-A Standard

This standard specifies the minimum requirements for a building automation system (BAS) cabling system, including the topology, architecture, design and installation practices, test procedures and components. The standard specifies cabling that is intended to support building management-related applications in a wide range of premises.

Section Contents

ANSI/TIA-862-A

Building Automation Systems Cabling Standard

For Commercial Buildings

Building automation encompasses control systems such as security and monitoring (e.g., video surveillance), safety systems (e.g., fire alarms), environmental conditioning systems (e.g., heating, ventilation and air conditioning), and energy management systems (e.g., internal and external lighting). The ANSI/TIA-862-A standard specifies generic cabling topology, architecture, design, installation practices, test procedures, and coverage areas to support building automation systems used in commercial buildings. Because providers of these building automation services traditionally specify their own proprietary equipment, cables, interface connections and topology, this standard offers the distinct advantage of being able to support multiproduct and multimanufacturer environments by using one generic structured cabling system.

It is important to note that this standard also supports the telecommunications cabling infrastructure for other low-voltage systems (e.g., audio and video paging, service and equipment alarms, nonvoice and data communications, and wireless access points).

The standard specifies:

- Horizontal cabling
- Backbone cabling
- Coverage area
- Spaces
- Pathways
- Administration

Telecommunications Cabling System Structure

This standard establishes a structure for building automation system (BAS) cabling based on the generic cabling system structure in ANSI/TIA-568-C.0. Figure 24 shows a typical building layout that uses a hierarchical star-wired cabling topology to support various BAS devices.

The elements of a BAS cabling system structure are listed below.

- Cabling Subsystem 1, Cabling Subsystem 2 and Cabling Subsystem 3 coverage area (space containing equipment outlets)
- Telecommunications room (TR) or common telecommunications room (CTR) (space containing Distributor A, Distributor B or Distributor C)
- Equipment room (ER) or common equipment room (CER) (space containing Distributor A, Distributor B or Distributor C)
- Mechanical room (MR)
- Entrance facilities (EF)
- Recognized horizontal and backbone cabling media meeting the requirements of ANSI/TIA-568-C.2 and ANSI/TIA-568-C.3
- Administration

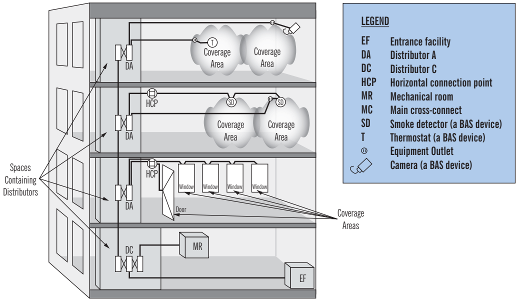


Figure 24 – ANSI/TIA-862-A star-wired cabling topology

Cabling Subsystem 1

This cabling subsystem is intended to provide a structured wiring framework for the integration of common services, the diversity of BAS systems and products, redundancy, and physical security requirements such as closed-circuit television (CCTV) and IP-based video. The elements of Cabling Subsystem 1 include Distributor A, Distributor B or Distributor C, the cable, horizontal connection point (HCP) and the equipment outlet as shown in Figure 25.

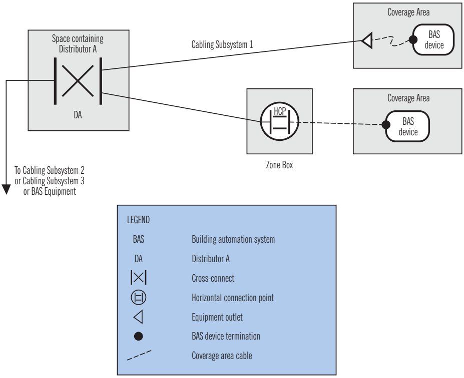


Figure 25 – Example for Cabling Subsystem 1

When planning the cabling infrastructure, the Cabling Subsystem 1 should accommodate the coverage areas specified by the standard as defined in Table 49.

Cabling Subsystem 2 and Subsystem 3

Cabling Subsystem 2 and Cabling Subsystem 3 provide interconnections between the spaces that contain Distributor A, Distributor B or Distributor C, MR, terminal space and EFs that span a campus' buildings.

The estimates for the Cabling Subsystem 2 and Cabling Subsystem 3 (balanced twisted-pair and optical fiber) requirements should be based on:

- The requirements of ANSI/TIA-568-C.0
- The BAS applications projected over the life expectancy of the cabling system
- The maximum number of BAS devices and electronic controllers projected over the life expectancy of the cabling system.

Coverage Area

The coverage area refers to the space that is covered by a single BAS device. The size of the coverage area is typically determined by the density of people and devices in a given area, but other factors such as physical security and BAS equipment requirements should be considered when allocating the coverage area within a building.

Usage of Floor Space	Coverage Area (m^2)
Office	25
Indoor parking	50
Retail	25
Factory	50
Hotel	25
Classroom	25
Hospital	25
Mechanical room	5

Table 49 – Typical coverage area for BAS devices

In order to accommodate moves, adds and changes as well as conserve space in TRs and ERs, consider zone cabling as shown in Figure 25. A single zone box can serve both BAS and telecommunications cabling; additional zone boxes can be provisioned based on:

- Accessibility
- Security
- Administration
- Special requirements.

Section Contents

ANSI/TIA-942-A

Telecommunications Infrastructure Standard for Data Centers

Data Center Cabling Infrastructure

The basic elements of a data center cabling system include the following:

- Horizontal cabling
- Backbone cabling
- Cross-connect in the entrance room or main distribution area
- Main cross-connect (MC) in the main distribution area
- Horizontal cross-connect (HC) in the telecommunications room, horizontal distribution area or main distribution area
- Zone outlet or consolidation point in the zone distribution area
- Outlet in the equipment distribution area

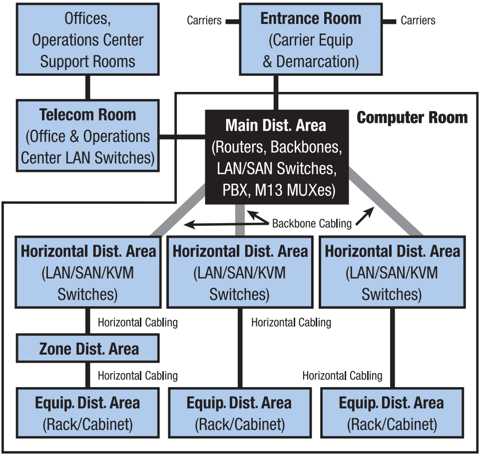


Figure 26 – Example of basic data center topology

Energy-Efficient Design

Data centers consume a disproportionate amount of energy on a square-foot basis compared to other areas of a building. The increased energy consumption is largely due to the density of computing hardware and associated power and cooling systems needed to support data center operations. Therefore, it's recommended that sustainable design practices be incorporated into the data center's design to improve power and cooling efficiency.

The following systems should be optimized to make sure that energy efficiency is achieved.

- Telecommunications cabling: Overhead telecommunications cabling can improve airflow in data centers by removing potential obstructions that could be present in underfloor pathways. Otherwise, cable pathways must be designed to accommodate cables that could potentially disrupt airflow and static pressure within a raised-floor environment.
- Lighting: It's recommended that a three-level lighting protocol be used in data centers, depending on human occupancy.

  Level 1: Data center unoccupied

  Level 2: Initial entry into the data center

  Level 3: Occupied space

  Optional override: Lighting in all zones at level 3

Hot and Cold Aisles

Cabinets and racks shall be arranged in an alternating pattern with the fronts of cabinets and racks facing each other in a row to create hot and cold aisles. Cold aisles are in front of racks and cabinets. If there is an access floor, power distribution cables should be installed here under the access floor on the slab. Hot aisles are behind racks and cabinets. If there is an access floor, cable trays for telecommunications cabling should be located under the access floor in the hot aisles.

A minimum of 1 m (3.28 ft.) of front clearance shall be provided for installation of equipment. A front clearance of 1.2 m (4 ft.) is preferable to accommodate deeper equipment. A minimum of 0.6 m (2 ft.) of rear clearance shall be provided for service access at the rear of racks and cabinets. A rear clearance of 1 m (3.28 ft.) is preferable. Some equipment may require service clearances of greater than 1 m (3.28 ft.).

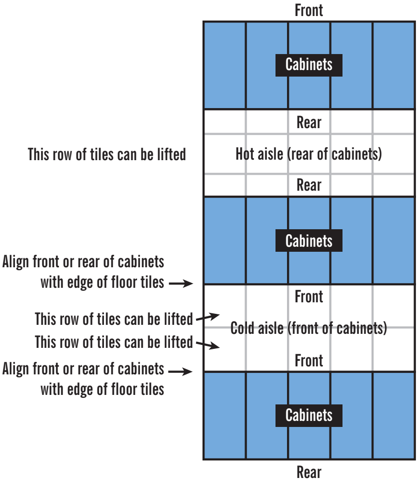


Figure 27 – Hot and cold aisles

Horizontal Cabling

The horizontal cabling is the portion of the telecommunications cabling system that extends from the mechanical termination in the equipment distribution area to either the horizontal cross-connect in the horizontal distribution area or the main cross-connect in the main distribution area. The horizontal cabling includes horizontal cables, mechanical terminations, and patch cords or jumpers. It may also include a zone outlet or a consolidation point in the zone distribution area.

The following partial listing of common services and systems should be considered when designing the horizontal cabling:

- Voice, modem and facsimile telecommunications service
- Premises switching equipment
- Computer and telecommunications management connections
- Keyboard/video/mouse (KVM) connections
- Data communications
- Wide area networks (WAN)
- Local area networks (LAN)
- Storage area networks (SAN)
- Other building signaling systems (building automation systems such as fire, security, power, HVAC, etc.)

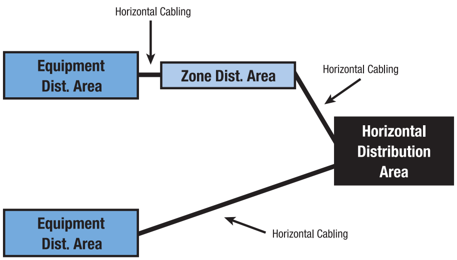


Figure 28 – Horizontal cabling using star topology

Maximum Equipment Area Cord Length				
	24 AWG UTP/24 ScTP patch cords		26 AWG ScTP patch cords	
Length of horizontal cable (H) m (ft.)	Maximum length of zone area cable (Z) m (ft.)	Maximum combined length of zone area cables, patch cords and equipment (C) m (ft.)	Maximum length of zone area cable (Z) m (ft.)	Maximum combined length of zone area cables, patch cords and equipment cable (C) m (ft.)
90 (295)	5 (16)	10 (33)	4 (13)	8 (26)
85 (279)	9 (30)	14 (46)	7 (23)	11 (35)
80 (262)	13 (44)	18 (59)	11 (35)	15 (49)
75 (246)	17 (57)	22 (72)	14 (46)	18 (59)
70 (230)	22 (72)	27 (89)	17 (56)	21 (70)

Table 50 – Maximum length horizontal and equipment area cables

Backbone Cabling

The function of the backbone cabling is to provide connections between the main distribution area, the horizontal distribution area and entrance facilities in the data center cabling system. Backbone cabling consists of the backbone cables, main cross-connects, horizontal cross-connects, mechanical terminations and patch cord or jumpers used for backbone-to-backbone cross-connections.

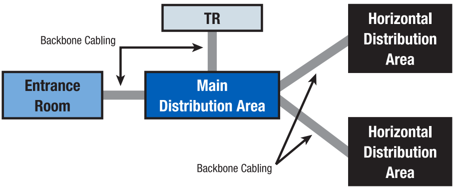


Figure 29 – Backbone cabling using star topology

Recognized Cabling Media for Horizontal and Backbone Applications

Recognized cables, associated connecting hardware, jumpers, patch cords, equipment cords and zone area cords shall meet all applicable requirements specified in ANSI/TIA-568-C.2 and ANSI/TIA-568-C.3.

- 4-pair 100-ohm twisted-pair cable (ANSI/TIA-568-C.2), Category 6 or Category 6A, with Category 6A recommended
- 50/125 μm 850-nm laser-optimized multimode fiber cable OM3 or OM4 (ANSI/TIA-568-C.3) with OM4 recommended
- Single-mode optical fiber cable
- Recognized coaxial media: 75-ohm (734 and 735 type) coaxial cable (Telcordia Technologies GR-139-CORE) and coaxial connector (ANSI T1.404)

Redundancy

Data centers that are equipped with diverse telecommunications facilities may be able to continue their function under catastrophic conditions that would otherwise interrupt the data center's telecommunications service. This standard includes four tiers relating to various levels of availability of the data center facility infrastructure. The tiers are related to research conducted by the Uptime Institute, which defines four tiers of performance as shown in the following table.

In addition to the base redundancy requirements specified by the Uptime Institute tier framework, the ANSI/TIA-942-A also recommends tier levels for architectural, electrical, mechanical and telecommunications.

From a telecommunications infrastructure redundancy perspective, providing redundant cross-connect areas and pathways that are physically separated can increase the reliability of the communications infrastructure. It is common for data centers to have multiple access providers that supply services, redundant routers, redundant core distribution and edge switches. Although this network topology provides a certain level of redundancy, the duplication in services and hardware alone does not make sure that single points of failure have been eliminated.

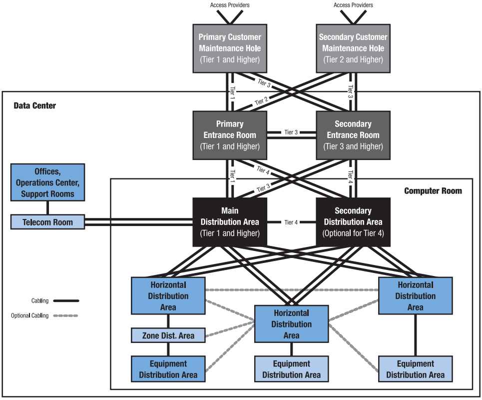


Figure 30 – Uptime Institute Tier references

Purpose of the ANSI/TIA-1005 Standard Telecommunications Infrastructure for Industrial Premises

This standard helps to enable the planning and installation of telecommunications cabling infrastructure within and between industrial buildings. In contrast to the ANSI/TIA-568-C series of wiring standards, which addresses commercial buildings, the central concept of this standard is the potential exposure to hostile environments in the industrial space. A prime design principle of this document is the special cabling system requirements for industrial operations.

Section Contents

ANSI/TIA-1005

Expected Usefulness:

- This standard is useful for those responsible for designing a telecommunications infrastructure to meet the requirements of an industrial environment.
- A working knowledge of this standard may prove beneficial in understanding problems associated with the unique aspects of industrial environments and applications.

The Standard's Specifics:

- Definition of structured cabling for commercial networks
- Definition of structured cabling for industrial networks
- The ANSI/TIA-1005 standard structure
- Industrial area concepts
- Recognized cables
- Recognized connectivity
- The automation outlet
- 2-pair cabling
- Multiconnect or Ethernet channels
- MICE

Terminology

- **Automation island:** Area in proximity to the industrial machines
- **Automation outlet:** Where the generic telecommunications cabling ends and the automation-specific cabling begins
- **Device area:** Where system I/O interacts with control equipment
- **Industrial segment:** A point-to-point connection between two active industrial communications devices
- **MICE:** Mechanical, ingress, climate/chemical, electromechanical conditions

Increasing severity

	Classes		
Mechanical	M_1	M_2	M_3
Ingress rating	I_1	I_2	I_3
Climatic	C_1	C_2	C_3
Electromagnetic	E_1	E_2	E_3

The MICE matrix defines environmental classes in three levels and four parameters.

Legend

$M_1I_1C_1E_1$ describes a worst-case environment according to ISO/IEC 11801

$M_2I_2C_2E_2$ describes a worst-case light-industrial environment

$M_3I_3C_3E_3$ describes a worst-case industrial environment

Figure 31 – MICE matrix

Industrial Areas

Industrial premises cabling may traverse from the front office through the factory floor. The factory floor (see Figure 32) may include work areas and automation islands. Typically, industrial premises encompass environments that are much harsher when compared to commercial office environments. As such, additional performance requirements for industrial-premises telecommunications components must be considered.

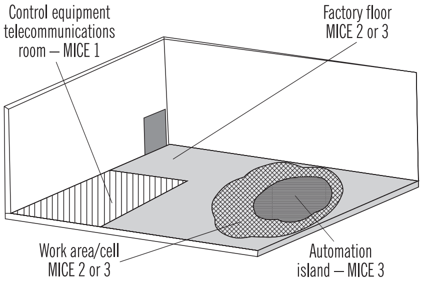


Figure 32 – Typical industrial environment

Control Equipment/Telecommunications Room

This area is equivalent to the MDC or IDC as defined in the ANSI/TIA-568-C.1. It is usually enclosed and protected from the factory environment and is located where the primary network interface equipment for the factory is housed.

Factory Floor Area

The factory floor is the space beyond the office in the manufacturing facility where the machines and work areas exist. These are typically high-traffic areas that require special consideration for the protection and placement of communications equipment. The factory floor environment is generally classified MICE 1 or higher.

Work Area

On a factory floor, the work area is where personnel interact with the telecommunications devices and industrial machines. Work areas often have more severe environments than the factory floor. It is important that the work area be properly designed for both occupants and control devices. The environment of the work area is generally classified MICE 1 or higher.

Automation Island Area

The automation island is the space on the factory floor in immediate proximity to or on the industrial machines and usually accompanies a work area. It is usually the most environmentally harsh area within the industrial premise. Accordingly, the automation island can often be identified as an area where humans are generally not present during machine cycling. In some cases, the automation island may extend into the work area. Components selected to be installed need to be compatible with the environment near the components. The industrial machines require connectivity to machine-control devices such as machine sensors, vision and general telecommunications devices. The environment of the automation island is generally classified MICE 3.

Purpose of the ANSI/TIA-1179 Healthcare Facility Telecommunications Infrastructure Standard

- Enables the planning and installation of a structured cabling system for healthcare facilities and buildings
- Establishes performance and technical criteria for various cabling system configurations for accessing and connecting their respective elements.

Healthcare organizations have a diversity of services available to them and are constantly adding new services. When applying specific applications to these cabling systems, consult application standards, regulations, equipment manufacturers, system suppliers and service suppliers for applicability, limitations and ancillary requirements.

Section Contents

ANSI/TIA-1179

Note to the reader: This standard duplicates many, but not all, sections of the ANSI/TIA-568-C.0, C.1, C.2 and C.3 standards that are already covered in this Anixter Standards Reference Guide booklet. In the interest of conserving space and avoiding unnecessary duplication, this summary guide will focus on highlighting the unique aspects of the ANSI/TIA-1179 standard that are not covered in other standards. It will reference those other standards when necessary.

Telecommunications Cabling System Structure

This standard establishes a cabling system structure based on the generic cabling system structure in ANSI/TIA-568-C.0 (see Figure 6 on page 19 in the Anixter Standards Reference Guide for ANSI/TIA-568-C.1). Even though ANSI/TIA-1179 has elements that share the same name as those in ANSI/TIA-568-C.1, they are not necessarily the same physical elements for the healthcare facility telecommunications system.

Scope

This standard specifies:

- The telecommunications infrastructure for healthcare facilities (e.g., hospitals and clinics)
- Cabling, cabling topologies and cabling distances
- Pathways and spaces (e.g., size and location)
- Ancillary requirements.

In addition to telecommunications systems, this standard specifies cabling that is intended to support a wide range of clinical and nonclinical systems, including:

- RFID (radio frequency identification systems)
- BAS (building automation systems)
- Nurse calls
- Security
- Access control
- Pharmaceutical inventory.

Entrance Facilities

The entrance facilities (EF) shall be designed and installed in accordance with the requirements of ANSI/TIA-569-B.

The EF shall:

- Be designed with multiple entrance points and route diversity
- Be sized to accommodate other systems (e.g., building automation systems, nurse calls, security, CATV, biomedical systems) when necessary.

If the EF room size is not large enough to accommodate these other systems, they shall be installed in the equipment room (ER) or in another ER dedicated for such applications.

Functions of Entrance Facilities

- The network demarcation point between the access providers (APs) and customer premises cabling may be part of the EF. The location of this point may be determined by federal or local regulations.
- Electrical protection devices for campus backbone cables and in some cases for antennas and AP cabling may be located in the EF. Electrical codes apply for electrical protection.
- Connections between building cabling and outside plant cables via splice or other means may be included in the EF.

Equipment Rooms

- Equipment rooms shall be designed and provisioned according to the requirements in ANSI/TIA-569-B.
- In many cases, an equipment room is combined with the EF and contains AP service and other premise terminations.
- Equipment rooms shall provide a minimum of two diverse pathways between the ER and EF for critical-care areas that would be severely impacted by a loss of telecommunications services. These diverse pathways shall require a route-separation distance as great as practical.

Telecommunications Rooms and Telecommunications Enclosures

- Telecommunications rooms and enclosures shall be designed in accordance with ANSI/TIA-569-B.
- TRs should not have nontelecommunications services (e.g., medical gases, fluids) routed within them.
- The TR should be larger than that suitable for an office-oriented commercial building due to the numerous telecommunications services present in healthcare facilities (e.g., nurse call, patient tracking). A TR size should be 12 m^2 (130 $ft.^2$) or larger.

Cross-Connections and Interconnections

Horizontal and backbone building cables shall be terminated on connecting hardware that meets the requirements of ANSI/TIA-568-C.2 (for balanced twisted-pair cable) or ANSI/TIA-568-C.3 (for optical fiber cable).

Centralized Optical Fiber Cabling

Centralized cabling shall meet the requirements of ANSI/TIA-568-C.0. (See Figure 5 on page 17.)

Backbone Cabling (Cabling Subsystem 2 and Cabling Subsystem 3)

- The backbone cabling shall meet the requirements of ANSI/TIA-568-C.0 (Cabling Subsystems 2 and 3).
- It should be planned to accommodate future equipment needs, diverse user applications, ongoing maintenance, service changes, sustainability, flexibility and relocation.
- A minimum of two diverse-route backbone pathways and cables shall be provided to each TR or TE that serves critical care areas that may be severely impacted by a loss of access-provider services. Placing cable between HCs, as shown in Figure 6 on page 19, is one option that can be used to accomplish this.
- Diverse pathways should entail a route separation as great as practical.

Star Topology

Backbone cabling shall meet the hierarchical star-topology requirements of ANSI/TIA-568-C.0.

- There shall be no more than two hierarchical levels of cross-connects in the backbone cabling.

Centralized Optical Fiber Cabling

Centralized optical cabling is designed as an alternative to the optical cross-connect located in the TR or TE when deploying recognized optical fiber cabling to the work area (WA) from a centralized cross-connect. (See Figure 5 on page 17 in the Anixter Standards Reference Guide for ANSI/TIA-568-C.1.)

Length

Cabling lengths are dependent upon the application and upon the specific media chosen (see ANSI/TIA-568-C.0 and the specific application standard).

Recognized Cabling

The transmission media, which shall be used individually or in combination in backbone cabling, are as follows:

- Use 100-ohm balanced twisted-pair cabling (ANSI/TIA-568-C.2); Category 6 or higher is recommended.
  - Category 6A is recommended for new installations.
  - For backbone cabling, Category 3 cabling should be limited to analog voice applications.
- Use multimode optical fiber cabling (ANSI/TIA-568-C.3); 850-nm laser-optimized 50/125 μm is recommended.
- Use single-mode optical fiber cabling (ANSI/TIA-568-C.3).

Horizontal Cabling (Cabling Subsystem 1)

General

Horizontal cabling (See Figure 7 in the Anixter Standards Reference Guide for ANSI/TIA-568-C.1) includes horizontal cable, telecommunications outlet/connectors in the work area (WA), mechanical terminations and patch cords or jumpers located in a telecommunications room (TR) or telecommunications enclosure (TE), and may incorporate multiuser telecommunications outlet assemblies (MUTOAs).

- The pathways and spaces to support horizontal cabling shall be designed ... and installed in accordance with the requirements of ANSI/TIA-569-B.

- Application-specific electrical components, such as impedance-matching devices required by some networks or services, shall not be installed as part of the horizontal cabling. When needed they will be placed external to the telecommunications outlet/connector.

For healthcare applications, the meaning of the term "work area" must be expanded to include all the connectivity required by the various applications used in a healthcare environment to provide the appropriate level of services. After the initial installation, adding or changing horizontal cabling could result in a net decrease in the quality of care being provided, which jeopardizes infection control measures or compromises life safety measures. Due to the cost and impact of making changes after the initial installation, designers need to reduce or eliminate the probability of requiring changes to the horizontal cabling as the user's requirements evolve (e.g., by installing cabling in pathways placed between areas so the cabling is easily accessed by maintenance personnel).

- The minimum number of permanent links shall be the number required to provide the needed cabling for each type of work area. (See "Work Area" in the next section.)
- Each balanced twisted-pair cable shall be terminated in an 8-position modular jack at the equipment outlet.
- The telecommunications outlet and connector for 100-ohm balanced twisted pair cable shall meet the requirements of ANSI/TIA-568-C.0.
- Optical fibers at the equipment outlet shall be terminated to a duplex optical fiber outlet and connector meeting the requirements of ANSI/TIA-568-C.3.

Topology

- The horizontal cabling shall be a star topology that meets the requirements of ANSI/TIA-568-C.0.
- Each WA outlet connector shall be connected to the horizontal cross-connect (HC).

Length

The horizontal cable length extends from the termination of the media at the HC in the TR or, when used, the TE to the telecommunications outlet/connector in the work area.

The maximum length should be:

- 90 m (295 ft.) for balanced twisted-pair horizontal cabling
- 90 m (295 ft.) for optical fiber backbone cabling except for some cases where the length may be increased according to the application and upon the specific media chosen (see annex D of ANSI/TIA-568-C.0)
- 5 m (16 ft.) for cross-connect jumpers and patch cords in cross-connect facilities.

For each horizontal channel, the total length allowed for cords in the WA, plus patch cords or jumpers and equipment cords, in the TR or TE shall not exceed 10 m (33 ft.) unless a MUTOA is used.

Recognized Cabling

Three types of media are recognized and recommended for use in the horizontal cabling system:

- 100-ohm balanced twisted-pair cabling: Category 5e or higher (ANSI/TIA-568-C.2); Category 6 or higher is recommended. Category 6A is recommended for new installations.
- Multimode optical fiber cabling (ANSI/TIA-568-C.3), 2-fiber or higher fiber count; 850 nm laser-optimized 50/125 μm is recommended.
- Single-mode optical fiber cabling (ANSI/TIA-568-C.3), 2-fiber or higher fiber count is recommended.

Work Area

General

The work area (WA) components extend from the telecommunications outlet and connector end of the horizontal cabling system to the WA equipment (e.g., phone, computer, wireless access point). The telecommunications outlet and connector shall meet the requirements of ANSI/TIA-568-C.0.

In healthcare applications, the work area takes on a broader scope as it is located in a multitude of application-specific areas and spaces within the healthcare facility. These areas are divided into the following classifications:

- Patient services
- Surgery, procedure and operating rooms
- Emergency
- Ambulatory care
- Women's health
- Diagnosis and treatment
- Caregiver
- Service and support
- Facilities
- Operations
- Critical care

Work Area Density

Table 51 shows the recommended telecommunications outlet and connector densities based on the classifications above and the function at that location. This table shows a representative list of application-specific areas found in healthcare facilities. The names and functions of the areas are not standards-based, so they may vary by facility. Each area classification is listed with representative related spaces and each space is listed with its associated "cabling services." The letters L, M or H refer to the relative cabling density of that work area location. If no other guidance is provided, the cabling designer should select a number between the midpoint and upper end of the range to determine the number of outlets in a particular work area location.

- L = Low: Two to six outlets in each area
- M = Medium: Six to 14 outlets in each area
- H = High: > 14 outlets in each area

A) Patient services							
Administration	Registration	Patient room	Family lounge	Waiting room	Nurses stations	Library	Consultation
M	M	H	L	L	H	M	L

B) Surgery/procedure/operating rooms							
Patient prep	Patient holding	Patient recovery	Sterile Zone	Substerile zone	Intensive care rooms	Operating room	Anesthesia offices
M	M	M	L	L	H	H	M

C) Emergency				
Ambulance bay	Evaluation	Observation	Exam rooms	Procedure rooms
L	M	H	M	H

D) Ambulatory care						
Procedure rooms	Out-patient surgery rooms	Mammography	Biopsy	Exam rooms	X-ray	Patient holding
M	H	M	L	M	L	L

E) Women's health				
Ultrasound	Lactation	Labor/delivery room	Infant bays	Nursery
M	H	M	L	M

Table 51 – Recommended work area outlet densities

F) Diagnostic and treatment					
Magnetic resonance imaging (MRI) & control room	Simulator & control room	Linear accelerator & control room	CT scanner & control room	Procedure rooms	Operating rooms
H	H	H	H	H	H
Fluoroscopy	Radiograph	X-ray	Radiation processing	Lab	
L	L	L	L	H	

G) Caregiver				
Exam room	Clean utility	Soiled utility	Nourishment	Charting
M	M	M	L	L
Nurse station	Workroom	Galley	Read room	
H	M	L	M	

H) Service/support		
Blood bank area	Pharmacy area	Anesthesia area
M	M	H

I) Facilities				
Janitor closet	Electrical rooms	Communication/ technology rooms	Building utility rooms	Elevator machine rooms
L	L	L	L	L
Mechanical rooms	Security office command center	Fire command	Specialty storage (e.g. batteries, chemicals)	
L	H	M	L	

J) Operations					
Administration	General storage	Cafeteria	Food service	Locker rooms/ showers	Laundry
M	L	L	M	L	L
Central sterile	Lounge	On-call suite	Retail areas	Conference rooms	General office areas
M	L	L	L	M	L

K) Critical Care		
ICU	Neonatal ICU	Recovery
H	H	H

Table 51 – Continued

Work Area (WA) Cords

- Cords used in the WA shall meet the performance requirements of ANSI/TIA-568-C.2 or ANSI/TIA-568-C.3.

Multiuser Telecommunications Outlet Assemblies (MUTOAs)

MUTOAs can be used to provide flexible layouts for spaces that are frequently rearranged to meet changing requirements of the end-user.

- MUTOAs must meet the requirements of ANSI/TIA-568-C.1.
- See the Section "Open Office Cabling [MUTOA]" and Figure 8 in the Anixter Standards Reference Guide for ANSI/TIA-568-C.1.

Maximum Work Area Cord Lengths for MUTOAs

- Balanced twisted-pair cables used in the context of MUTOAs shall meet the requirements of ANSI/TIA-568-C.2.
- The maximum cord length of balanced twisted-pair WA cables used in the context of MUTOAs is as shown in Table 6 in the Anixter Standards Reference Guide for ANSI/TIA-568-C.1.
- Optical fiber work area cords used in the context of MUTOAs shall meet the requirements of ANSI/TIA-568-C.3. The maximum horizontal cabling length is not affected by the deployment of a MUTOA.

Cabling Installation Requirements

- Installation requirements of ANSI/TIA-568-C.0 in addition to this standard shall be followed.
- Some locations in healthcare facilities may be sensitive to atmospheric contamination. Cabling products with specific attributes (e.g., filled or blocked cable, minimal off-gassing) may be required in these locations.
- Infection control requirements (ICR) could have a serious impact on the times and conditions for cabling installation, moves, adds and changes as well as restrictions on removing ceiling tiles, wall penetrations and access to unoccupied spaces. Prior to installation or modifications in any occupied area, the facility ICR should be consulted. Telecommunications spaces that are subject to ICR should be labeled to indicate that ICR measures may be necessary prior to entry.
- Certain cabling products from some areas of healthcare facilities may require specific and regulated means of disposal. Reusing or relocating cabling products (e.g., patch cords) from certain areas may be restricted due to infection control measures or related concerns.
- Some areas of healthcare facilities may involve high levels of electromagnetic interference (EMI). wSome cable assemblies that support data transmission in these areas may require appropriate components, isolation or mitigation to comply with electromagnetic environments.
- Cabling in healthcare facilities may be exposed to high magnetic fields, radiation, high temperature, chemicals, etc. The design, installation methods and products selected should be compatible with the environment and support adequate performance during operation. The location of cabling and spaces should be selected to minimize these effects.
- Healthcare facilities make use of a number of wireless applications. It is recommended that the wireless environment be characterized and understood prior to the design, selection and installation of cabling to make sure of satisfactory operation.

Grounding and Bonding

Grounding and bonding shall meet the requirements of ANSI/TIA-568-C.0. Additional information can be found in IEEE 602: "Recommended Practice for Electrical Systems in Healthcare Facilities."

Cabling Transmission Performance and Test Requirements

The transmission performance and test requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.2 and ANSI/TIA-1152 shall be met.

Purpose of the ISO/IEC 11801 Standard
Generic Cabling for Customer Premises

This international standard provides users with an application-independent generic cabling system capable of supporting a wide range of applications. It provides users with a flexible cabling scheme, so modifications are both easy and economical. Building professionals (architects, for example) are given guidance on the accommodation of cabling at the initial stages of development.

Section Contents

ISO/IEC 11801

The International Standard

The International Standard specifies a multimanufacturer cabling system that may be implemented with material from single and multiple sources and is related to:

- International standards for cabling components developed by committees in the IEC
- Standards for the installation and operation of information technology cabling as well as for testing of installed cabling
- Applications developed by technical committees of the IEC
- Planning and installation guides that take into account the needs of specific applications.

Generic cabling defined within The International Standard:

- Specifies a cabling structure supporting a wide variety of applications
- Specifies channel and link classes A, B, C, D and E, meeting the requirements of standardized applications
- Specifies channel and link classes E and F based on higher performance components to support future applications
- Specifies optical channel and link classes OF-300, OF-500 and OF-2000
- Involves component requirements and specifies cabling implementations that make sure performance of permanent links and channels meet or exceed the requirements for cabling classes
- Specifies a cabling system that is anticipated to have a useful life in excess of 10 years.

Class E_A are more demanding compared to the ANSI/TIA Augmented Category 6 requirements. Anixter's Infrastructure Solutions Lab tests to the more stringent ISO standards.

ISO compared to TIA		
Characteristics 500 MHz (dB)	ISO Class E_A	TIA Augmented Category 6
PSNEXT loss	24.8 dB	23.2 dB
NEXT loss	27.9 dB	26.1 dB
PSANEXT loss	49.5 dB	49.5 dB
Return loss	6.0 dB	6.0 dB
Insertion loss	49.3 dB	49.3 dB
Referred to by IEEE	Yes	No

Table 52 – ISO/IEC Class E_A and TIA Category 6 performance comparison

TIA Category 6 versus Augmented Category 6 versus ISO Class E_A				
	TIA Category 5e	TIA Category 6	TIA Augmented 6	ISO Class E_A
Recognized by IEEE 802.3an	No	Yes	Yes	Yes
55-Meter distance support	No	Yes	Yes	Yes
100-Meter distance support	No	No	Yes	Yes
Extrapolated test limits for NEXT and PSNEXT to 500 MHz	No	No	No	Yes

Table 53 – ISO and TIA 10GBASE-T media types

Table 53 summarizes the various UTP cabling options and their respective 10 Gigabit performance attributes as defined by the latest draft standards. Category 5e is not recognized as a viable cabling media to support 10 Gigabit transmission regardless of its installed cabling distance. Category 6 cabling will only support 10 Gigabit at a maximum installed distance of 55 meters.

Today, the only options for operating 10 Gigabit at 100 meters using RJ45 connectivity are the TIA Augmented Category 6 and ISO/IEC Class E_A standards. The ISO/IEC Class E_A system has superior NEXT and PSNEXT performance values when compared with the current TIA Augmented Category 6 standard.

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Purpose of the IEEE 802 Standards

This family of standards covers networking standards and recommended practices for wired and wireless, local, metropolitan and other area networks.

Section Contents

IEEE 802 Standards

IEEE 802.3af
Power over Ethernet (PoE) Standard

The IEEE 802.3af specification calls for power source equipment (PSE) that operates at 48 volts of direct current. This guarantees 12.95 watts of power over unshielded twisted-pair cable to data terminal equipment (DTE) 100 meters away (the maximum distance supported by Ethernet). That's enough power to support IP phones, WLAN access points and many other DTE devices. Two PSE types are supported including Ethernet switches equipped with power supply modules called endspan devices and a special patch panel called a midspan device that sits between a legacy switch and powered equipment, injecting power to each connection.

IEEE 802.3at
Power over Ethernet+ (Plus) Standard

The IEEE 802.3at Power over Ethernet Plus amendment to the IEEE 802.3af standard offers improved power-management features and increases the amount of power to end devices. The amendment allows for the powering devices through standard Category 5e, 6 and 6A cabling. It allows many more devices, such as access control and video surveillance, to receive power over a twisted-pair cabling infrastructure.

The standard defines the technology for powering a wide range of devices up to 25 watts over existing Category 5e and above cables. The 802.3at standard states that 30 watts at a minimum are allocated at the port, so 24.6 watts are provided at the end-device connector 100 meters away. It also allows for gigabit pass-through. PoE Plus represents a considerable upgrade over the existing PoE standard.

IEEE 802.3an
Physical Layer and Management Parameters for 10 Gbps Operation Type 10GBASE-T

Describes the physical layer (PHY) for 10 Gigabit Ethernet transmission over twisted-pair copper cable.

IEEE 802.3an standard		
Standard	**Media**	**Distance**
ISO Class F (individual shields)	S/FTP	100 m
ISO Class E_A	UTP	100 m
TIA Augmented Category 6	UTP	100 m
Shielded Category 6 (overall shield)	F/UTP, ScTP, STP	100 m
TIA Standard Category 6/ISO Class E	UTP	<55 m

Table 54 – Maximum 10GBASE-T cabling distances

ANSI/TIA-568-C.2 (Augmented Category 6) and ISO/IEC 11801 Class E_A cable specifications are based on IEEE cabling models. 100 meters over UTP is only guaranteed when using Augmented Category 6 or ISO/IEC Class E_A-compliant cabling systems.

IEEE 802.3ba

Media Access Control Parameters, Physical Layers and Management Parameters for 40 Gbps and 100 Gbps Operation

The 802.3ba amendment to the IEEE 802.3-2008 standard defines media access control (MAC) parameters, physical layer specifications and management parameters for the transfer of 802.3 frames at 40 Gbps and 100 Gbps. The amendment facilitates the migration of 10 Gigabit Ethernet from the network core to the network edge by providing 40 Gbps and 100 Gbps data rates for backbone and backhaul applications to effectively remove the bandwidth bottleneck that exists in many corporate networks today.

The following media types and distances are approved as part of the 802.3ba amendment:

40 Gigabit Ethernet		
Protocol	**Media**	**Distance**
40GBASE-CR4	Twinax	10 m
40GBASE-SR4	OM3 MMF	100 m
40GBASE-SR4	OM4 MMF	150 m
40GBASE-LR4	SMF	10 km

100 Gigabit Ethernet		
Protocol	**Media**	**Distance**
100GBASE-CR10	Twinax	10 m
100GBASE-SR10	OM3 MMF	100 m
100GBASE-SR10	OM4 MMF	150 m
100GBASE-LR4	SMF	10 km
100GBASE-ER4	SMF	40 km

Table 55 – 40 Gbps and 100 Gbps approved media types and distances

IEEE 802.11 Wireless Standard

IEEE 802.11, the Wi-Fi standard, denotes a set of wireless LAN/WLAN standards developed by Working Group 11 of the IEEE LAN/MAN standards committee (IEEE 802). The term 802.11x is also used to denote this set of standards and is not to be mistaken for any one of its elements. There is no single 802.11x standard.

802.11 details a wireless interface between devices to manage packet traffic (to avoid collisions, etc.). Some common specifications and their distinctive attributes include the following:

802.11a – Operates in the 5 GHz frequency range (5.125 to 5.85 GHz) with a maximum 54 Mbps signaling rate. The 5 GHz frequency band isn't as crowded as the 2.4 GHz frequency because it offers significantly more radio channels than the 802.11b and is used by fewer applications. It has a shorter range than 802.11g, is actually newer than 802.11b and is not compatible with 802.11b.

802.11b – Operates in the 2.4 GHz Industrial, Scientific and Medical (ISM) band (2.4 to 2.4835 GHz) and provides signaling rates of up to 11 Mbps. This is a commonly used frequency. Microwave ovens, cordless phones, medical and scientific equipment, as well as Bluetooth devices, all work within the 2.4 GHz ISM band.

802.11e – Ratified by the IEEE in late September 2005, the 802.11e quality-of-service specification is designed to guarantee the quality of voice and video traffic. It will be particularly important for companies interested in using Wi-Fi phones.

802.11g – Similar to 802.11b, this standard supports signaling rates of up to 54 Mbps. It also operates in the heavily used 2.4 GHz ISM band but uses a different radio technology to boost overall throughput. Compatible with older 802.11b.

802.11i – Also sometimes called Wi-Fi Protected Access 2 (WPA 2), 802.11i was ratified in June 2004. WPA 2 supports the 128-bit-and-above Advanced Encryption Standard, along with 802.1x authentication and key management features.

802.11k – Passed in June 2008, the 802.11k Radio Resource Management Standard will provide measurement information for access points and switches to make wireless LANs run more efficiently. It may, for example, better distribute traffic loads across access points or allow dynamic adjustments of transmission power to minimize interference.

802.11n – Ratified in September 2009, 802.11n is a set of standards for wireless local area network (WLAN) communications, developed by the IEEE LAN/WAN Standards Committee (IEEE 802) in the 5 GHz and 2.4 GHz public spectrum bands. The proposed amendment improves upon the previous 802.11 standards by adding multiple-input multiple-output (MIMO) and many other newer features.

The Anixter Infrastructure Solutions Lab℠

Anixter's Infrastructure Solutions Lab℠ actively demonstrates the best practical technology solutions from best-in-class manufacturers in the area of enterprise cabling, video security and access control and industrial automation for our customers. Our mission for The Lab is simple—educate, demonstrate and evaluate.

- **Educate** customers on the latest industry standards and technologies
- **Demonstrate** the latest infrastructure and security product solutions available from our manufacturer partners
- **Evaluate** our network infrastructure and security solutions to make sure that our customers are selecting the right products for their specific needs

We are continually testing products in The Lab to establish that:

- Quality products are recommended and delivered to our customers
- Performance across product lines and within systems is consistent
- Products and systems recommended to customers can be integrated and follow the trend toward convergence.

Networking and security product testing at The Lab includes:

- Random performance testing of Anixter's inventory to make sure products comply to standards
- Network throughput and interoperability testing
- Copper and fiber cabling compliance verification (ANSI/TIA, ISO/IEC, IEEE)
- Customer proof of concept
- Power over Ethernet (PoE)
- Application testing
- 10 Gig Ethernet cabling testing
- Video over IP, video quality and bandwidth utilization
- Power over Ethernet capability and verification
- Digital compression image quality vs. analog technology testing
- Evaluation of analog and IP cameras, video management software evaluation, DVR, NDVR and NVR products.

Register for a Lab visit: anixter.com/lab

THE LAB℠
ANIXTER'S INFRASTRUCTURE SOLUTIONS LAB

Anixter's Infrastructure Solutions Lab In Action

Challenge: Leading Pennsylvania University Explores Campuswide Rewiring Project

Anixter Infrastructure Solutions Lab Resolution: The Anixter Infrastructure Solutions Lab was called upon to help this university determine which copper cabling system would best meet its current and future information technology needs. The university had a variety of different copper cabling products installed in its network infrastructure: Category 3, Category 5 and some Category 5e. The Anixter Infrastructure Solutions Lab deployed computer applications that the university typically carried over its cabling infrastructure, including Lotus Notes, SAP and streaming video. Testing found that its current infrastructure was consistently dropping information, causing the network to operate slowly and inefficiently. This same traffic was sent over a Category 6 infrastructure with no degradation to the data. Armed with testing from the Anixter Infrastructure Solutions Lab, university IT professionals wrote cabling infrastructure specifications around a higher-performing Category 6 system that better met the university's network performance needs.

Challenge: Major Railway Company Needs Video Surveillance to Monitor Switchyard

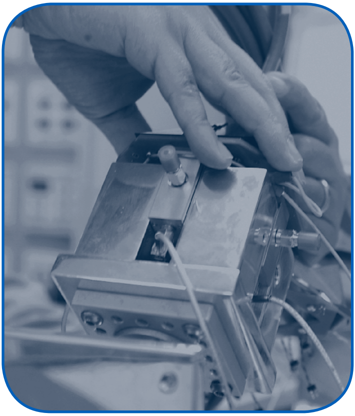
Anixter Infrastructure Solutions Lab Resolution: A railroad company wanted to use video surveillance to monitor yards as it assembled unit trains, but it had a big cabling challenge. Installing traditional cabling in the switchyard would have entailed major disruptions and expense for them. Instead, Anixter's Infrastructure Solutions Lab recommended a sophisticated wireless Internet video surveillance system that did not require cabling. Anixter was able to simulate the wireless Internet video surveillance solution in the Infrastructure Solutions Lab for the customer. The Infrastructure Solutions Lab also provided this customer with test results illustrating how much bandwidth the video solution would absorb on the customer's network as well as the video quality the customer could expect from the recommended system.

Challenge: National Insurance Company with Data Center Cabling Choice

Anixter Infrastructure Solutions Lab Resolution: The Anixter Infrastructure Solutions Lab assessed backbone cabling requirements based on the current and future bandwidth needs for this insurance provider. The Anixter Infrastructure Solutions Lab ran representative network traffic over 62.5-micron, 50-micron and laser-optimized 50-micron fiber (OM3) to ascertain which would best meet the company's needs. These tests were key in determining that the OM3 was the customer's best choice.

Anixter's 10 Gigabit Ethernet Cabling Testing

Anixter's Infrastructure Solutions Lab is the only UL Certified lab to conduct rigorous, independent third-party testing of emerging 10 Gigabit cabling solutions. Anixter's 10 Gigabit cabling testing examines electrical characteristics such as insertion loss, return loss and crosstalk, but also looks at alien crosstalk (which is part of the Augmented Category 6 spec). To make sure the 10 Gigabit cabling solutions we sell meet the highest levels of performance and reliability, the Anixter Infrastructure Solutions Lab tests the toughest performance parameter, alien crosstalk, in the "worst case" scenario. Customers can rest assured that the cabling solutions Anixter sells will provide the network performance they require.




THE LAB

Reference Documents for Further Information on Cabling Standards

ANSI/TIA-568-C.0 (2009)

Generic Telecommunications Cabling for Customer Premises

ANSI/TIA-568-C.1 (2009)

Commercial Building Telecommunications Standard

ANSI/TIA-568-C.2 (2009)

Balanced Twisted-Pair Telecommunications Cabling and Components Standard

ANSI/TIA-568-C.3 (2009)

Optical Fiber Cabling Components

ANSI/TIA-569-C (2012)

Telecommunications Pathways and Spaces

ANSI/TIA-606-B (2012)

Administration Standard for Commercial Telecommunications Infrastructure

ANSI/TIA-607-B (2011)

Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

ANSI/TIA-862-A (2011)

Building Automation Systems Cabling Standard

ANSI/TIA-942-A (2012)

Telecommunications Infrastructure Standard for Data Centers

ANSI/TIA-1005 (2009)

Telecommunications Infrastructure for Industrial Premises

ANSI/TIA-1179 (2010)

Healthcare Facility Telecommunications Infrastructure Standard

ISO/IEC 11801 (2002)

Generic Cabling for Customer Premises

ISO/IEC 11801 Class E_A (2010)

IEEE 802.3af (2003)

Power over Ethernet (PoE) Standard

IEEE 802.3at (2009)

Power over Ethernet + (Plus)

IEEE 802.3an (2006)

Physical Layer and Management Parameters for 10 Gbps Operation Type 10GBASE-T

IEEE 802.3ba (2010)

Media Access Control Parameters, Physical Layers and Management Parameters for 40 Gbps and 100 Gbps Operation

IEEE 802.11

Wireless Standard

802.11n (2009)

802.11k (2008)

802.11e (2005)

802.11i (2004)

802.11a (2003)

802.11b (2003)

802.11g (2003)

Obtaining Standards Documents

ANSI/TIA documents may be purchased through the IHS Standards Store (Global Engineering Documents) at 877.413.5184 or global.ihs.com. IEEE documents may be purchased through IEEE, P.O. Box 1331, Piscataway, NJ 08855 or ieee.org. CSA documents may be purchased through the Canadian Standards Association at csa.ca or by calling 416.747.4000.

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