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A Reference Guide To:

ANSI/TIA/EIA-568-B

ANSI/TIA/EIA-568-B.2-1

ANSI/TIA/EIA-568-B.2-Addendum 10

ANSI/TIA/EIA-569-B

ANSI/TIA/EIA-606-A

J-STD-607-A

ANSI/TIA/EIA-942

ANSI/TIA-1005

IEEE 802.3af

IEEE 802.3an

IEEE 802.11

ISO 11801, Class E_A

Standards Reference Guide

ANIXTER®

Anixter: The Cabling System Experts

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 services to reduce our customers' total cost of production and implementation.

Purpose of Industry Standards

By providing guidelines for installation, maintenance and testing to improve availability and reduce expenses associated with downtime, the telecommunications standards define cabling types, distances, connections, cable system architectures, cable termination standards, performance characteristics, installation and testing methods. The standards provide recommended best practices for the design and installation of cabling systems to support a wide variety of existing and future systems to extend the life span of the telecommunications infrastructure. A single common structured cabling system for all communications and security systems simplifies moves, adds and changes, maximizes system availability and extends the usability of a cabling system. By adhering to industry standards, industrial environments can expect to fully experience the benefits of structured cabling on overall performance.

Scope of this Guide

This document is meant as a reference that highlights the key points of the ANSI/TIA/EIA-568-B, 569-B, 606-A, J-STD-607-A, 942, 1005 and IEEE 802.3af, IEEE 802.3an, IEEE 802.11 and ISO 11801 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
EIA	Electronic Industries Alliance
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical & Electronics Engineers
ISO	International Organization for Standardization
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
TIA	Telecommunications Industry Association

Table of Contents

Purpose of the ANSI/TIA/EIA-568-B Standard

The Purpose:

- Establish a generic telecommunications cabling standard that will support a multimanufacturer environment
- Enable the planning and installation of a structured cabling system for commercial buildings
- Establish performance and technical criteria for various cabling system configurations

The Standard Specifies:

- Minimum requirements for telecommunications cabling within an office environment
- Recommended topologies and distances
- Media parameters that determine performance
- Connector and pin assignments to ensure intermateability
- The useful life of telecommunications cabling systems as being in excess of 10 years

Building telecommunications cabling specified by this standard is intended to support a wide range of different commercial building sites and applications (e.g., voice, data, text, video and image). Typically, this range includes sites with a geographical extent from 10,000 to 10,000,000 sq. ft. (3,000–1,000,000 m2) of office space, and with a population of up to 50,000 individual users.

This standard replaces ANSI/TIA/EIA-568-A dated October 6, 1995. This standard also incorporates and refines the technical content of TSB67, TSB72, TSB75, TSB95 and TIA/EIA-568-A-1, A-2, A-3, A-4 and A-5.

ANSI/TIA/EIA-568-B

Commercial Building Telecommunications Cabling Standard
TIA/EIA-568-B.1 General Requirements

TIA/EIA-568-B.1 General Requirements

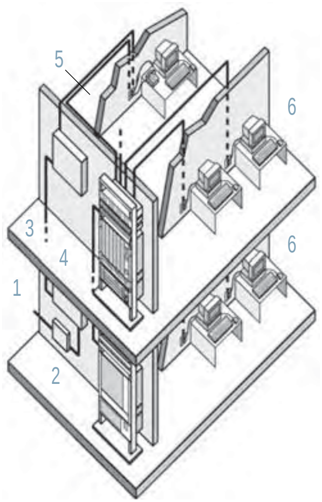

Figure 1 – Six Subsystems of Structured Cabling

The Six Subsystems of a Structured Cabling System

1. Entrance Facilities (EF)

Building entrance facilities (EF) provide the point at which outdoor cabling interfaces with the intrabuilding backbone cabling. The physical requirements of the network interface are defined in the TIA/EIA-569-B standard.

2. Equipment Room (ER)

The design aspects of the equipment room are specified in the TIA/EIA-569-B standard. Equipment rooms usually house equipment of higher complexity than telecommunications rooms. Any or all of the functions of a telecommunications room may be provided by an equipment room.

3. Backbone Cabling

The backbone cabling provides interconnection between telecommunications rooms, equipment rooms and entrance facilities. It consists of the backbone cables, intermediate and main cross-connects, mechanical terminations and patch cords or jumpers used for backbone-to-backbone cross-connection. This includes:

- Vertical connection between floors (risers)
- Cables between an equipment room and building cable entrance facilities
- Cables between buildings (interbuilding).

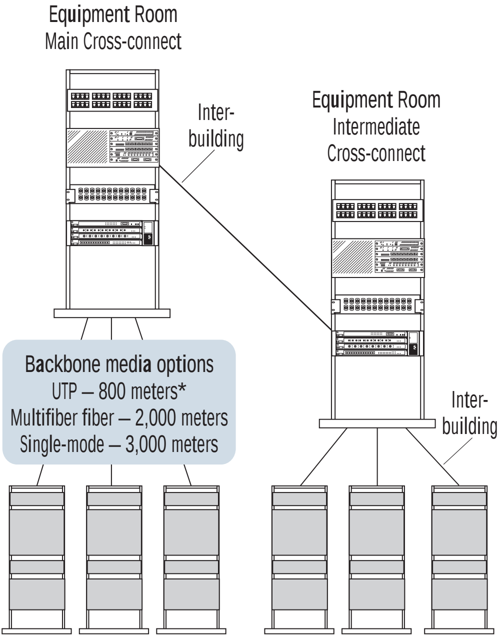

Figure 2 – Specified Backbone Cabling Topology: Star

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Other Design Requirements

- Star topology
- No more than two hierarchical levels of backbone cross-connects
- Bridge taps are not allowed
- Main and intermediate cross-connect jumper or patch cord lengths should not exceed 20 m (66 ft.)
- Avoid installing in areas where sources of high levels of EMI/RFI may exist
- Grounding should meet the requirements as defined in J-STD-607-A

Note: It is recommended that the user consult with equipment manufacturers, application standards and system providers for additional information when planning shared-sheath applications on UTP backbone cables.

Maximum Backbone Distances

Media Type	Main to Horizontal Cross-Connect	Main to Intermediate Cross-Connect	Intermediate to Horizontal Cross-Connect
Copper (Voice*)	800 m (2,624 ft.)	500 m (1,640 ft.)	300 m (984 ft.)
Multimode	2,000 m (6,560 ft.)	1,700 m (5,575 ft.)	300 m (984 ft.)
Single-mode	3,000 m (9,840 ft.)	2,700 m (8,855 ft.)	300 m (984 ft.)

*Note: Backbone distances are application-dependent. The maximum distances specified above are based on voice transmission for UTP and data transmission over fiber. A 90 m distance applies to UTP at spectral bandwidths of 5–16 MHz for Category 3 and 20–100 MHz for Category 5e. Current state-of-the-art distribution facilities usually include a combination of both copper and fiber optic cables in the backbone.

4. Telecommunications Room (TR)

A telecommunications room is the area within a building that houses the telecommunications cabling system equipment. This includes the mechanical terminations and cross-connects for the horizontal and backbone cabling system. Please refer to TIA/EIA-569-B for the design specifications of the telecommunications room.

5. Horizontal Cabling

Specified Horizontal Cabling Topology: Star

The horizontal cabling system extends from the work area telecommunications information outlet to the telecommunications room and consists of the following:

- Horizontal cabling
- Telecommunications outlet
- Cable terminations
- Cross-connections
- Patch cords

Four media types are recognized as options for horizontal cabling, each extending a maximum distance of 90 m:

- 4-pair, 100-ohm UTP/ScTP cable (24 AWG solid conductors)
- 2-fiber, 62.5/125 µm or 50/125 µm optical cable

Maximum Distances for Horizontal Cabling

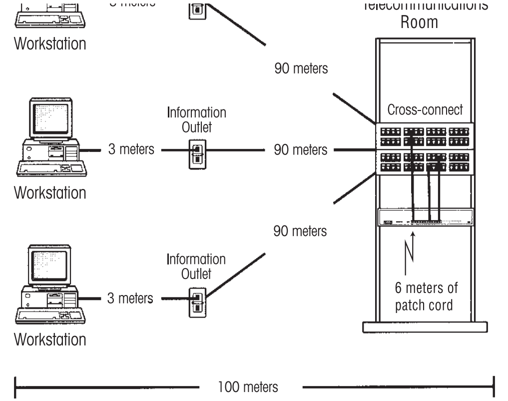

Figure 3 – Maximum Distances for Horizontal Cabling

In addition to the 90 m of horizontal cable, a total of 10 m is allowed for work area and telecommunications room patch and jumper cables.

Multiuser Telecommunications Outlet Assembly

Optional practices for open office environments are specified for any horizontal telecommunications cabling recognized in TIA/EIA 568-B.

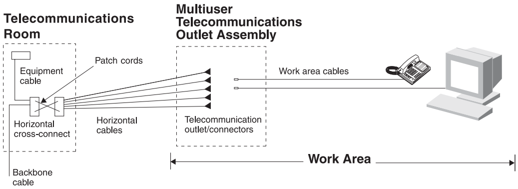

Figure 4 – Six Subsystems of Structured Cabling

A multiuser telecommunications outlet assembly (MUTOA) facilitates the termination of multiple horizontal cables in a common location within a column, wall or permanently secured furniture cluster. Work area cables may then be routed through furniture pathways and directly connected to work area equipment. Each furniture cluster should have one MUTOA that serves a maximum of 12 work areas. Ceiling and access floor mounting is not allowed by TIA/EIA-569-B.

Maximum work area cable length is determined by the following table:

Length of Horizontal Cable m (ft.)	Maximum Length of Work Area Cable (24AWG) m (ft.)	Maximum Combined Length of Work Area Cables, Patch Cords and Equipment Cable m (ft.)
90 (295)	5 (16)	10 (33)
85 (279)	9 (30)	14 (46)
80 (262)	13 (44)	18 (59)
75 (246)	17 (57)	22 (72)
70 (230)	22 (72)	27 (89)

Note: No work area cable length may exceed 22 m (72 ft.).

For optical fiber, any combination of horizontal, work area cables, patch cords and equipment cords may not exceed 100 m (328 ft.).

Consolidation Point

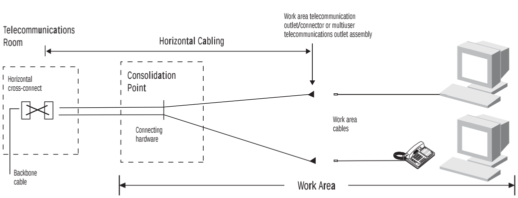

Figure 5 – Consolidation Point

A consolidation point differs from a MUTOA in that it requires an additional connection for each horizontal cable run. Only one consolidation point (an interconnection point in the horizontal cabling) is allowed at a distance of at least 15 m (49 ft.) from the telecommunications room. A transition point (transition from round to flat undercarpet cable) is not allowed. A consolidation point is installed in unobstructed building columns, permanent walls, ceilings or access floors (if accessible).

The multiuser telecommunications outlet and consolidation point methods are intended to be mutually exclusive. Labeling and allowing for spares is required. Moves, adds and changes should be administered in the telecommunications room.

Centralized Optical Fiber Cabling

The ANSI/TIA/EIA-568-B.1 standard offers maximum flexibility for distributed electronics for multitenant buildings by providing for single-tenant users who prefer centralized electronics (e.g., server farms) connected by a fiber horizontal and fiber backbone.

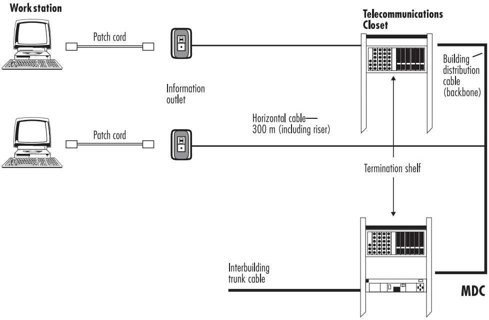

Figure 6 – Centralized Cabling Scheme

To connect fiber from the work area to the equipment room within a single building, the user may use a splice or interconnect in the telecommunications room. The combined distance limitation is 300 m (984 ft.) for horizontal, intrabuilding backbone and patch cords. Alternatively, the user may simply pull cables through the closet. In this last case, the fiber horizontal and backbone consist of one continuous fiber pair, and the pull-through distance limitation is 90 m (295 ft.). Cabling is 62.5/125 µm multimode or 50/125 µm multimode. Sufficient space should be allowed for slack, addition and removal of cables and spares and conversion to a full cross-connect system. Labeling should be in accordance with TIA/EIA-606-A with additional labeling to identify A-B pairs with specific work areas.

6. Work Area (WA)

The work area components extend from the telecommunications (information) outlet to the station equipment. Work area wiring is designed to be relatively simple to interconnect, so moves, adds and changes are easily managed.

Work Area Components

- Station equipment – computers, data terminals, telephones, etc.
- Patch cables – modular cords, PC adapter cables, fiber jumpers, etc.
- Adapters – baluns, etc. (must be external to telecommunications outlet)

Telecommunications Outlet

Each work area should have a minimum of two information outlet ports, one for voice and one for data.

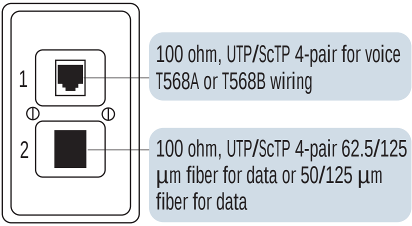

Figure 7 – Information Outlet Standard

8-Position Modular Jack Pair Assignments for UTP

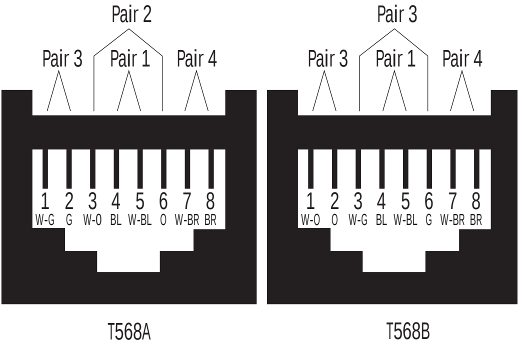

Figure 8 – 8-Position Modular Jack Pair Assignments for UTP

Channel and Permanent Link

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

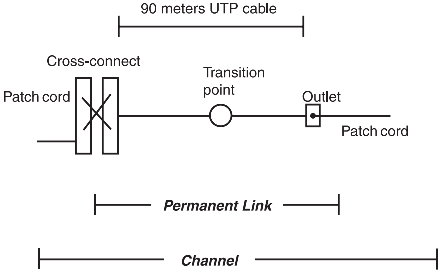

Figure 9 – Horizontal Channel

Two link configurations are defined for testing purposes. The permanent link includes the horizontal distribution cable, telecommunications outlet/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.

Minimum Bend Radius	
Horizontal UTP (4-pair)	4 x diameter
Horizontal ScTP	8 x diameter
Backbone Cable	10 x diameter
Patch Cord	Not determined

Physical requirements of 4-pair UTP:

- Maximum diameter: 1/4 in.
- Breaking strength: 90 lb.
- Maximum pulling tension: 25 lb.

Definitions of Electrical Parameters

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

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

FEXT (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.

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. Referred to as ACR-F (insertion loss to crosstalk ratio far-end) in the TIA/EIA-568-B.2-Addendum 10. (ELFEXT is FEXT adjusted to discount insertion loss.)

PSAACRF (powersum insertion loss to alien crosstalk ratio far-end): 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. Also referred to as powersum alien equal-level far-end crosstalk (PSAELFEXT).

PSANEXT (powersum alien near-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 near-end.

PSAFEXT (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.

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.

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

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.

Tests should also measure each link's physical length, employ wire map to verify pin terminations at each end and identify simple electrical faults.

The following tables show the performance limits for both the permanent links and channel configurations.

Category 3 Permanent Link

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	3.5	40.1
4.0	6.2	30.7
8.0	8.9	25.9
10.0	9.9	24.3
16.0	13.0	21.0

Category 3 Channel

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	4.2	39.1
4.0	7.3	29.3
8.0	10.2	24.3
10.0	11.5	22.7
16.0	14.9	19.3

Category 5e Permanent Link						
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	2.1	>60	>57	58.6	55.6	19.0
4.0	3.9	54.8	51.8	46.6	43.6	19.0
8.0	5.5	50.0	47.0	40.6	37.5	19.0
10.0	6.2	48.5	45.5	38.6	35.6	19.0
16.0	7.9	45.2	42.2	34.5	31.5	19.0
20.0	8.9	43.7	40.7	32.6	29.6	19.0
25.0	10.0	42.1	39.1	30.7	27.7	18.0
31.25	11.2	40.5	37.5	28.7	25.7	17.1
62.5	16.2	35.7	32.7	22.7	19.7	14.1
100.0	21.0	32.3	29.3	18.6	15.6	12.0

Category 5e Permanent Requirements

Maximum link propagation delay: 518 ns at 10 MHz

Maximum link delay skew: 45 ns at 100 MHz

Category 5e Channel						
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	2.2	>60	>57	57.4	54.4	17.0
4.0	4.5	53.5	50.5	45.4	42.4	17.0
8.0	6.3	48.6	45.6	39.3	36.3	17.0
10.0	7.1	47.0	44.0	37.4	34.4	17.0
16.0	9.1	43.6	40.6	33.3	30.3	17.0
20.0	10.2	42.0	39.0	31.4	28.4	17.0
25.0	11.4	40.3	37.3	29.4	26.4	16.0
31.25	12.9	38.7	35.7	27.5	24.5	15.1
62.5	18.6	33.6	30.6	21.5	18.5	12.1
100.0	24.0	30.1	27.1	17.4	14.4	10.0

Category 5e Channel Requirements

Maximum channel propagation delay: 555 ns at 10 MHz

Maximum channel delay skew: 50 ns at 100 MHz

TIA/EIA-568-B.2
Balanced Twisted-Pair Cabling Components

100-ohm Unshielded Twisted-Pair (UTP) Cabling System

Horizontal Cable

As data transmission rates have increased, higher performance UTP cabling has become a necessity. In addition, some means of classifying horizontal UTP 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 3 Horizontal and Backbone Cable (100 meters)			
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)
1.0	2.6	40.3	41
4.0	5.6	32.3	32
8.0	8.5	27.8	28
10.0	9.7	26.3	26
16.0	13.1	23.2	23

Category 3 Horizontal and Backbone Cable

Maximum Category 3 cable propagation delay: 545 ns/100 m at 10 MHz
Maximum Category 3 cable delay skew: 45 ns/100 m at 16 MHz

Category 5e Horizontal and Backbone Cable (100 m)						
Frequency (MHz)	Insertion Loss (dB)	NEXT* (dB)	PSNEXT (dB)	ELFEXT* (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	2.0	65.3	62.3	63.8	60.8	20.0
4.0	4.1	56.3	53.3	51.8	48.8	23.0
8.0	5.8	51.8	48.8	45.7	42.7	24.5
10.0	6.5	50.3	47.3	43.8	40.8	25.0
16.0	8.2	47.2	44.2	39.7	36.7	25.0
20.0	9.3	45.8	42.8	37.8	34.8	25.0
25.0	10.4	44.3	41.3	35.8	32.8	24.3
31.25	11.7	42.9	39.9	33.9	30.9	23.6
62.5	17.0	38.4	35.4	27.9	24.9	21.5
100.0	22.0	35.3	32.3	23.8	20.8	20.1

Category 5e Horizontal and Backbone Cable
* Requirements for 25-pair cable are identical to those for 4-pair cable.

Maximum Category 5e cable propagation delay: 538 ns/100 m at 100 MHz
Maximum Category 5e cable delay skew: 45 ns/100 m at 100 MHz

Characteristic impedance of horizontal cabling = 100 ohms ± 15 percent from 1 MHz to the highest referenced frequency (16 or 100 MHz) of a particular category.

Bundled and Hybrid Cable

Bundled, wrapped or hybrid cables are allowed for use in horizontal cabling, provided that each individual cable type meets TIA/EIA-568-B.2 specifications and that powersum NEXT 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 UTP backbone cabling.

UTP Connecting Hardware

To ensure that installed connecting hardware (telecommunications outlets, patch cords and panels, connectors, cross-connect blocks, etc.) will have minimal effect on overall cabling system performance, the characteristics and performance parameters presented in this section must be met.

Category 3 Connecting Hardware		
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	0.1	58.0
4.0	0.2	46.0
8.0	0.3	39.9
10.0	0.3	38.0
16.0	0.4	33.9

Category 3 Connecting Hardware

Category 5e Connecting Hardware				
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	FEXT (dB)	Return Loss (dB)
1.0	0.1	65.0	65.0	30.0
4.0	0.1	65.0	63.1	30.0
8.0	0.1	64.9	57.0	30.0
10.0	0.1	63.0	55.1	30.0
20.0	0.2	57.0	49.1	30.0
25.0	0.2	55.0	47.1	30.0
31.25	0.2	53.1	45.2	30.0
62.5	0.3	47.1	39.2	24.1
100.0	0.4	43.0	35.1	20.0

Category 5e Connecting Hardware

The preferred termination method for all UTP connecting hardware includes the insulation displacement contact (IDC). To ensure overall system integrity, horizontal cables need to be terminated with connecting hardware of the same category or higher.

The following requirements apply only to wire and cable used for patch cords and cross-connect jumpers.

UTP Patch Cords

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

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.
- UTP cabling systems are not Category 3 or 5e compliant unless all components of the system satisfy their respective category requirements.

Category 5e Assembled Patch Cords

Frequency (MHz)	2 m Cord NEXT (dB)	5 m Cord NEXT (dB)	10 m Cord NEXT (dB)	Return Loss (dB)
1.0	65.0	65.0	65.0	19.8
4.0	62.3	61.5	60.4	21.6
8.0	56.4	55.6	54.7	22.5
10.0	54.5	53.7	52.8	22.8
16.0	50.4	49.8	48.9	23.4
20.0	48.6	47.9	47.1	23.7
25.0	46.7	46.0	45.3	24.0
31.25	44.8	44.2	43.6	23.0
62.5	39.0	38.5	38.1	20.0
100.0	35.1	34.8	34.6	18.0

Category 5e 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)

TIA/EIA-568-B.2-1
Balanced Twisted-Pair Cabling Components

Category 6 Transmission Performance

This addendum describes Category 6 cables, patch cords, connecting hardware, permanent link and channel transmission parameters characterized up to 250 MHz.

Matrix of Backward Compatible Mated Component Performance				
	Category 3	Category 5	Category 5e	Category 6
Category 3	Category 3	Category 3	Category 3	Category 3
Category 5	Category 3	Category 5	Category 5	Category 5
Category 5e	Category 3	Category 5	Category 5e	Category 5e
Category 6	Category 3	Category 5	Category 5e	Category 6

Matrix of Backward Compatible Mated Component Performance

The lowest rated component determines the rating of the link or channel.

Category 6 Solid Horizontal and Backbone Cable						
Frequency (MHz)	Insertion Loss (dB)	NEXT* (dB)	PSNEXT (dB)	ELFEXT* (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	2.0	74.3	72.3	67.8	64.8	20.0
4.0	3.8	65.3	63.3	55.8	52.8	23.0
8.0	5.3	60.8	58.8	49.7	46.7	24.5
10.0	6.0	59.3	57.3	47.8	44.8	25.0
16.0	7.6	56.2	54.2	43.7	40.7	25.0
20.0	8.5	54.8	52.8	41.8	38.8	25.0
25.0	9.5	53.3	51.3	39.8	36.8	24.3
31.25	10.7	51.9	49.9	37.9	34.9	23.6
62.5	15.4	47.4	45.4	31.9	28.9	21.5
100.0	19.8	44.3	42.3	27.8	24.8	20.1
200.0	29.0	39.8	37.8	21.8	18.8	18.0
250.0	32.8	38.3	36.3	19.8	16.8	17.3

Category 6 Solid Horizontal and Backbone Cable (100 m)*

*Horizontal and backbone cables are defined only as identical 4-pair cables.

Maximum Category 6 cable propagation delay: 538 ns/100 m at 100 MHz (536 at 250 MHz)

Maximum Category 6 cable delay skew: 45 ns/100 m at all frequencies

The PSNEXT performance of bundled or hybrid cables must be 1.2 dB greater than shown above.

Category 6 Connecting Hardware				
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	FEXT (dB)	Return Loss (dB)
1.0	0.10	75.0	75.0	30.0
4.0	0.10	75.0	71.1	30.0
8.0	0.10	75.0	65.0	30.0
10.0	0.10	74.0	63.1	30.0
16.0	0.10	69.9	59.0	30.0
20.0	0.10	68.0	57.1	30.0
25.0	0.10	66.0	55.1	30.0
31.25	0.11	64.1	53.2	30.0
62.5	0.16	58.1	47.2	28.1
100.0	0.20	54.0	43.1	24.0
200.0	0.28	48.0	37.1	18.0
250.0	0.32	46.0	35.1	16.0

Category 6 Connecting Hardware

Category 6 Assembled Patch Cords				
Frequency (MHz)	2 m Cord NEXT (dB)	5 m Cord NEXT (dB)	10 m Cord NEXT (dB)	Return Loss (dB)
1.0	65.0	65.0	65.0	19.8
4.0	65.0	65.0	65.0	21.6
8.0	65.0	65.0	64.8	22.5
10.0	65.0	64.5	62.9	22.8
16.0	62.0	60.5	59.0	23.4
20.0	60.1	59.6	57.2	23.7
25.0	58.1	56.8	55.4	24.0
31.25	56.2	54-9	53.6	23.0
62.5	50.4	49.2	48.1	20.0
100.0	46.4	45.3	44.4	18.0
125.0	44.5	43.5	42.7	17.0
150.0	43.0	42.1	41.4	16.2
175.0	41.8	40.9	40.2	15.6
200.0	40.6	39.8	39.3	15.0
225.0	39.7	38.9	38.4	14.5
250.0	38.8	38.1	37.6	14.0

Category 6 Assembled Patch Cords

Insertion loss (attenuation) per 100 m (328 ft.) at 20°C is defined as equal to UTP solid cable insertion loss plus 20 percent.

(The increased insertion loss allowance is due to stranded conductors.)

Category 6 Permanent Link						
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	1.9	65.0	62.0	64.2	61.2	19.1
4.0	3.5	64.1	61.8	52.1	49.1	21.0
8.0	5.0	59.4	57.0	46.1	43.1	21.0
10.0	5.5	57.8	55.5	44.2	41.2	21.0
16.0	7.0	54.6	52.2	40.1	37.1	20.0
20.0	7.9	53.1	50.7	38.2	35.2	19.5
25.0	8.9	51.5	49.1	36.2	33.2	19.0
31.25	10.0	50.0	47.5	34.3	31.3	18.5
62.5	14.4	45.1	42.7	28.3	25.3	16.0
100.0	18.6	41.8	39.3	24.2	21.2	14.0
200.0	27.4	36.9	34.3	18.2	15.2	11.0
250.0	31.1	35.3	32.7	16.2	13.2	10.0

Category 6 Permanent Link

Maximum Category 6 permanent link propagation delay: less than 498 ns at 10 MHz
Maximum Category 6 permanent link delay skew: less than 44 ns/100 m at 10 MHz

Category 6 Channel						
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	2.1	65.0	62.0	63.3	60.3	19.0
4.0	4.0	63.0	60.5	51.2	48.2	19.0
8.0	5.7	58.2	55.6	45.2	42.2	19.0
10.0	6.3	56.6	54.0	43.3	40.3	19.0
16.0	8.0	53.2	50.6	39.2	36.2	18.0
20.0	9.0	51.6	49.0	37.2	34.2	17.5
25.0	10.1	50.0	47.3	35.3	32.3	17.0
31.25	11.4	48.4	45.7	33.4	30.4	16.5
62.5	16.5	43.4	40.6	27.3	24.3	14.0
100.0	21.3	39.9	37.1	23.3	20.3	12.0
200.0	31.5	34.8	31.9	17.2	14.2	9.0
250.0	35.9	33.1	30.2	15.3	12.3	8.0

Category 6 Channel

Maximum Category 6 channel propagation delay: less than 555 ns at 10 MHz
Maximum Category 6 channel delay skew: less than 50 ns/100m at 10 MHz

Category 6 Longitudinal Conversion Loss (LCL)		
Frequency (MHz)	Cable LCL (dB)	Connector LCL (dB)
1.0	40.0	40.0
4.0	40.0	40.0
8.0	40.0	40.0
10.0	40.0	40.0
16.0	38.0	40.0
20.0	37.0	40.0
25.0	36.0	40.0
31.25	35.1	38.1
62.5	32.0	32.1
100.0	30.0	28.0
200.0	27.0	22.0
250.0	26.0	20.0

Category 6 Longitudinal Conversion Loss (LCL)

Longitudinal Conversion Transfer Loss (LCTL) is not yet defined.

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

Note: This table compares current TIA Category 6 cabling with new TIA and ISO specifications for 10 Gigabit cabling. This table summarizes the various UTP 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.

TIA/EIA-568-B.2-Addendum 10 Balanced Twisted-Pair Cabling Components (Augmented Category 6)

Augmented Category 6 Transmission Performance

This addendum describes Augmented Category 6 cables, patch cords, connecting hardware, permanent link and channel transmission parameters characterized up to 500 MHz.

Augmented Category 6 Permanent Link Requirements

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ACR-F (dB)	PSACR-F (dB)	Return Loss (dB)	PSANEXT (dB)	PSAACRF (dB)
1.0	1.9	65.0	62.0	64.2	61.2	19.1	67.0	67.0
4.0	3.5	64.1	61.8	52.1	49.1	21.0	67.0	65.7
8.0	4.9	59.4	57.0	46.1	43.1	21.0	67.0	59.6
10.0	5.5	57.8	55.5	44.2	41.2	21.0	67.0	57.7
16.0	6.9	54.6	52.2	40.1	37.1	20.0	67.0	53.6
20.0	7.7	53.1	50.7	38.2	35.2	19.5	67.0	51.7
25.0	8.7	51.5	49.1	36.2	33.2	19.0	67.0	49.7
31.25	9.7	50.0	47.5	34.3	31.3	18.5	66.2	47.8
62.50	13.9	45.1	42.7	28.3	25.3	16.0	63.1	41.8
100.0	17.9	41.8	39.3	24.2	21.2	14.0	61.1	37.8
200.0	26.0	36.9	34.3	18.2	15.2	11.0	56.6	31.8
250.0	29.4	35.3	32.7	16.2	13.2	10.0	55.5	29.8
300.0	32.6	34.0	31.4	14.6	11.6	9.2	53.9	28.2
400.0	38.4	29.9	27.1	12.1	9.1	8.0	52.1	25.7
500.0	43.8	26.7	23.8	10.2	7.2	8.0	50.6	23.7

Augmented Category 6 Permanent Link Requirements

Augmented Category 6 Channel Requirement								
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ACR-F (dB)	PSACR-F (dB)	Return Loss (dB)	PSANEXT (dB)	PSAACRF (dB)
1.0	2.2	65.0	62.0	63.3	60.3	19.0	67.0	67.0
4.0	4.1	63.0	60.5	51.2	48.2	19.0	67.0	65.0
8.0	5.7	58.2	55.6	45.2	42.2	19.0	67.0	58.9
10.0	6.4	56.6	54.0	43.3	40.3	19.0	67.0	57.0
16.0	8.1	53.2	50.6	39.2	36.2	18.0	67.0	52.9
20.0	9.1	51.6	49.0	37.2	34.2	17.5	67.0	51.0
25.0	10.2	50.0	47.3	35.3	32.3	17.0	66.0	49.0
31.25	11.4	48.4	45.7	33.4	30.4	16.5	65.1	47.1
62.50	16.3	43.4	40.6	27.3	24.3	14.0	62.0	41.1
100.0	20.8	39.9	37.1	23.3	20.3	12.0	60.0	37.0
200.0	30.0	34.8	31.9	17.2	14.2	9.0	55.5	31.0
250.0	33.8	33.1	30.2	15.3	12.3	8.0	54.0	29.0
300.0	37.3	31.7	28.8	13.7	10.7	7.2	52.8	27.5
400.0	43.6	28.7	25.8	11.2	8.2	6.0	51.0	25.0
500.0	49.3	26.1	23.2	9.3	6.3	6.0	49.5	23.0

Augmented Category 6 Channel Requirements

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

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

TIA/EIA-568-B.3
Optical Fiber Cabling Components

Optical Fiber Cabling Systems

Optical Fiber Cabling Systems

Optical Fiber Cabling Media

- Horizontal – 62.5/125 or 50/125 µm multimode optical fiber (minimum of two fibers)
- Backbone – 62.5/125 or 50/125 µm multimode or single-mode optical fiber

Cable Transmission Performance Parameters Multimode (Horizontal and Backbone)

Wavelength (nm)	Maximum Attenuation (dB/km)	Laser Optimized 50 µm Minimum Bandwidth (MHz • km)	50 µm Minimum Bandwidth (MHz • km)	62.5 µm Minimum Bandwidth (MHz • km)
850	3.5	1,500/2,000*	500	160
1,300	1.5	500	500	500

* 2,000 MHz • km laser optimized 50µm fiber is designed for VCSEL laser launch.

Cable Transmission Performance Parameters Single-Mode (Backbone)

Wavelength (nm)	Inside Plant Maximum Attenuation (dB/km)	Outside Plant Maximum Attenuation (dB/km)
1,310	1.0	0.5
1,550	1.0	0.5

Optical Fiber Bend Radius

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)

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: 568SC and other duplex designs may be used.

Color Identification

- Beige – multimode connector/coupling
- Blue – single-mode connector/coupling

Note: The ISO/IEC standard now specifies the 568SC-type fiber connector in the work area.

Optical Fiber Telecommunications Outlet

Required Features

- Capability to terminate minimum of two fibers into 568SC 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

For more information on Fibre Channel, order Anixter's Data Center Resource Guide at anixter.com/datacenterguide.

Purpose of the ANSI/TIA/EIA-569-B Standard

As the complexity of voice and data telecommunications has increased, standards have been established to ensure the operability, flexibility, manageability and longevity of these critical commercial support systems. Telecommunications systems now encompass voice, data and video transmission of business information, fire and security, audio, environmental and other intelligent building controls over media that include fiber optics, specialized copper data cabling, microwave and radio wave. This section concisely describes the architectural design elements of cabling pathways and dedicated rooms for telecommunications equipment.

A multitenant commercial building has a life expectancy of at least 50 years. Software, hardware and communications gear have a far shorter life span of one to five years. Moreover, in a multitenant environment, continuous moves, adds and changes are inevitable. Standards help to guide the design of current systems to ease future changes. By planning for the future, these standards intend to provide a generic structured cabling plant capable of running any voice or data application foreseeable in the next 10 to 15 years.

Abbreviations:

AWG	American Wire Gauge
V	Volts
A	Amps
kVA	Kilovolt ampere
V/m	Volts per meter

ANSI/TIA/EIA-569-B

Commercial Building Standard for Telecommunications Pathways and Spaces

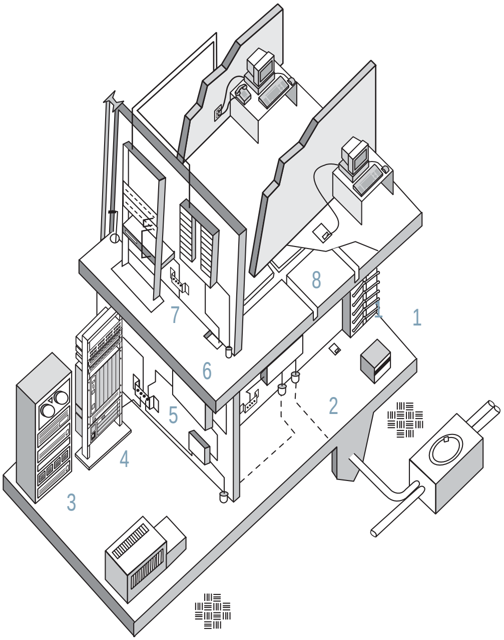

Figure 10 – Commercial Building

1 Electric Entrance
2 Telco Entrance
3 Telecommunications Equipment Room
4 Data Equipment
5 Voice Equipment
6 Telecommunications Room
7 Grounding and Bonding
8 Underfloor System

TIA/EIA-569-B Design Considerations

Entrance Facilities

Entrance facilities include the pathways for outside carrier services, interbuilding backbones, alternate entrances and antennae entrances. The entrance facilities consist of a termination field interfacing any outside cabling to the intrabuilding backbone cabling. The local telephone carrier is typically required to terminate cabling within 50 ft. of building penetration and to provide primary voltage protection.

In buildings larger than 20,000 usable sq. ft., a locked, dedicated, enclosed room is recommended. Beyond 70,000 sq. ft., a locked, dedicated room is required, with a plywood termination field provided on two walls.

In buildings up to 100,000 usable sq. ft., a wall-mounted termination field may serve as the entrance facility, using 3/4-in. plywood, 8-ft. high. Beyond 100,000 sq. ft., rack-mounted and free-standing frames may also be required. Minimum space requirements are given as follows:

Service Entrance Pathways

For underground facilities, use a minimum 4-in. conduit or duct constructed of PVC type B, C or D, multiple plastic duct, galvanized steel or fiber glass with appropriate encasement. No more than two 90° manufactured bends are allowed (10 times the diameter). Drain slope should not be less than 12 in. per 100 ft. Recommended conduit fill varies but should not exceed 40 percent for more than two cables.

Maintenance holes (typically 3,500 lb./sq. in., concrete) must be equipped with sump, corrosion-protected pulling iron, cable racks, grounded ladder and only such power and light conductors as required for telecommunications support per NEC requirements.

Gross Building Floor Space (ft.^{2}/ m^2)	Plywood Field		Room Dimension	
5,000/465	8' high x 39" wide	(3 m x 99 cm)		
10,000/1,000	8' high x 39" wide	(3 m x 99 cm)		
20,000/2,000	8' high x 42" wide	(3 m x 107 cm)	(A room recommended	
40,000/4,000	8' high x 68" wide	(3 m x 173 cm)	beyond this level)	
50,000/5,000	8' high x 90" wide	(3 m x 229 cm)		
60,000/6,000	8' high x 96" wide	(3 m x 244 cm)	(A dedicated room required)	
80,000/8,000	8' high x 120" wide	(3 m x 305 cm)	12' x 6.3'	(4 m x 2 m)
100,000/10,000	8' high x 2 walls	(3 m x 2 walls)	12' x 6.3'	(4 m x 2 m)
200,000/20,000	8' high x 2 walls	(3 m x 2 walls)	12' x 9'	(4 m x 3 m)
400,000/40,000	8' high x 2 walls	(3 m x 2 walls)	12' x 13'	(4 m x 4 m)
500,000/50,000	8' high x 2 walls	(3 m x 2 walls)	12' x 15.6'	(4 m x 5 m)
600,000/60,000	8' high x 2 walls	(3 m x 2 walls)	12' x 18.3'	(4 m x 6 m)
800,000/80,000	8' high x 2 walls	(3 m x 2 walls)	12' x 22.3'	(4 m x 7 m)
1,000,000/100,000	8' high x 2 walls	(3 m x 2 walls)	12' x 27.7'	(4 m x 9 m)

Rule of thumb: Allow 1 sq. ft. (929 cm^2) of plywood wall mount for each 200 sq. ft. (19 m^2) area of floor space.

Equipment Room

An equipment room is essentially a large telecommunications room that may house the main distribution frame, PBXs, secondary voltage protection, etc. The equipment room is often appended to the entrance facilities or a computer room to allow shared air conditioning, security, fire control, lighting and limited access.

Number of Workstations	Equipment Room Floor Space (ft.^{2})	
1–100	150	(14 m^2)
101–400	400	(38 m^2)
401–800	800	(74 m^2)
801–1,200	1,200	(111 m^2)

Rule of thumb: Provide 0.75 sq. ft. (697 cm^2) of equipment room floor space for every 100 sq. ft. (9 m^2) of user workstation area.

Location

Typically, rooms should be located away from sources of electromagnetic interference (transformers, motors, X-ray, induction heaters, arc welders, radio and radar).

Perimeters

Typically, no false ceiling; all surfaces treated to reduce dust; walls and ceiling painted white or pastel to improve visibility.

Limited Access

Typically, single or double 36 in. x 80 in. lockable doors with no doorsills.

Other

Typically, no piping, ductwork, mechanical equipment or power cabling should be allowed to pass through the equipment room. No unrelated storage.

Ceiling Height

Minimum clear height in room shall be 8 ft. (2.4 m); the height between the finished floor and the lowest point should be 10 ft. (3 m) to accommodate tall racks and overhead raceways. False ceilings should not be installed.

HVAC

24 hours a day, 365 days a year, 64° to 75°F, 30 to 55 percent humidity, positive pressure, with independent power from telecommunications equipment.

Lighting

Typically, 8.5-ft. high, providing 50 foot-candle at 3 ft. above floor.

Electrical

Typically, a minimum of two dedicated 15 A, 110 V AC duplex outlets on separate circuits is required. Convenience duplex outlets shall be placed at 6-ft. intervals around the perimeter. Emergency power should be considered and supplied if available.

Bonding and Grounding

Access shall be available to the bonding and grounding as specified in J-STD-607-A.

Dust

Less than 100 micrograms/cubic meter per 24 hour period.

Note: The term "typically" is applied here to indicate, where applicable, that these requirements also apply to other elements of the cabling system spaces. Lighting requirements, for instance, are largely identical for entrance facilities, equipment rooms and telecommunications rooms.

Intrabuilding Backbone Pathways

Within a building, the intrabuilding backbone pathways extend between the entrance facilities, equipment room and telecommunications rooms. Telecommunications rooms should be stacked vertically above each other on each floor and be provided with a minimum of three 4-in. sleeves (a stub of conduit through the floor) for less than 50,000 sq. ft. served. An equivalent 4-in. x 12-in. slot may be used in lieu of three sleeves. Firestopping is required. If rooms are not vertically aligned, then 4-in. horizontal conduit runs are required. Include no more than two 90° bends between pull points. Pulling iron or eyes embedded in the concrete for cable pulling is recommended. Fill should not exceed 40 percent for any run greater than two cables.

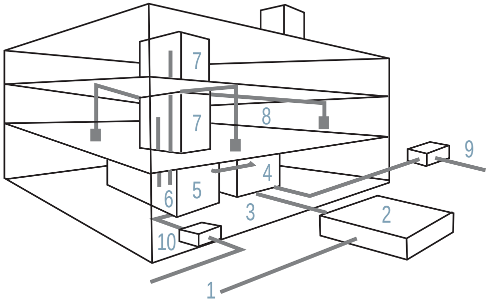

Figure 11 – Backbone and Horizontal Pathways

1	Telco Conduit
2	Telco Manhole
3	Entrance Conduit
4	Telco Entrance Facility
5	Telecommunications Equipment Room
6	Vertical Backbone
7	Telecommunications Room
8	Horizontal Cabling
9	Interbuilding Backbone
10	Electrical Entrance Facility

Telecommunications Room

The telecommunications room on each floor is the junction between backbone and horizontal pathways. It contains active voice and data telecommunications equipment, termination fields and cross-connect wiring. More than one telecommunications room per floor is required if the distance to a work area exceeds 300 ft. or if the floor area served exceeds 10,000 sq. ft.. Recommended room sizing is 10 ft. x 11 ft. for each 10,000 sq. ft. area served. Power, lighting, air conditioning and limited access are typical. See requirements for equipment room. There are a minimum of three 4-in. firestopped backbone sleeves in the floor at the left side of a plywood termination field, which are ideally located near the door. A fire extinguisher is recommended.

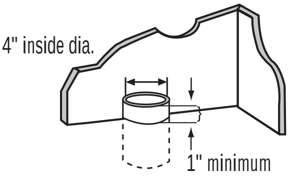

Figure 12 – Riser Sleeve

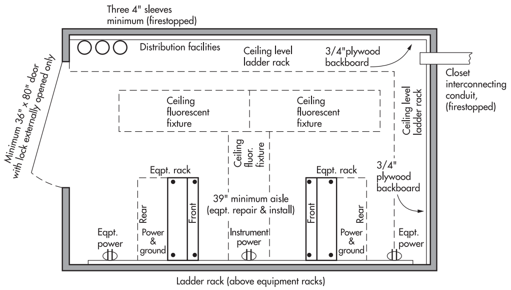

Figure 13 – Typical Telecommunications Room

Horizontal Pathways

Horizontal pathways extend between the telecommunications room and the work area. A variety of generic pathway options are described. Choice of pathway(s) is left to the discretion of the designer. The most commonly employed pathway consists of cable bundles that run from the telecommunications room along J-hooks suspended above a plenum ceiling, which fan out once a work zone is reached. They then drop through interior walls, support columns or raceways and terminate at an information outlet (I/O).

Other options include the following:

Underfloor Duct

Single- or dual-level rectangular ducts imbedded in greater than 2.5-in. (7 cm) concrete flooring.

Flushduct

Single-level rectangular duct imbedded flush in greater than 1-in. (3 cm) concrete flooring.

Multichannel Raceway

Cellular raceway ducts capable of routing telecommunications and power cabling separately in greater than 3-in. (8 cm) reinforced concrete.

Cellular Floor

Preformed hollows or steel-lined cells are provided in concrete with header ducts from the telecommunications room arranged at right angles to the cells.

Trenchduct

A wide, solid tray, sometimes containing compartments and fitted with a flattop (with gaskets) along its entire length. It is embedded flush with the concrete finish.

Access Floor

Modular floor panels supported by pedestals, used in computer rooms and equipment rooms.

Plenum and Ceiling

Bundled cables, suspended above a false ceiling, fan out to drop through walls, power poles or along support columns to baseboard level.

Conduit

To be considered only when outlet locations are permanent, device density is low and flexibility (future changes) is not required.

Cable Trays

Options include channel tray, ladder tray, solid bottom, ventilated and wireway.

Perimeter Pathways

Options include surface raceway, recessed, molding and multichannel (to carry separate power and lighting circuits).

Rule of thumb: Typically, size horizontal pathways by providing 1 sq. in. of cross-section area for every 100 sq. ft. of workspace area being served.

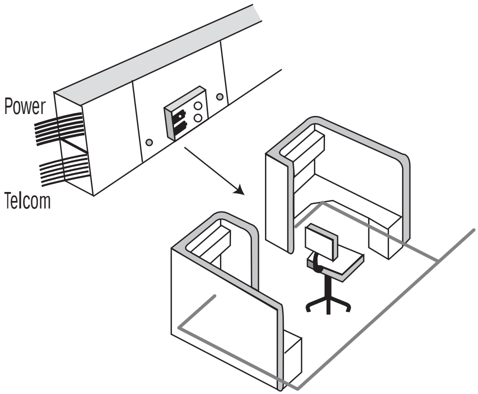

Figure 14 – Perimeter Pathway and Modular Office Path

Note: Typically, a pull box, splice box or pulling point is required for any constrained pathway where there are more than two 90° bends, a 180° reverse bend or length more than 100 ft.

A Variety of Horizontal Pathways

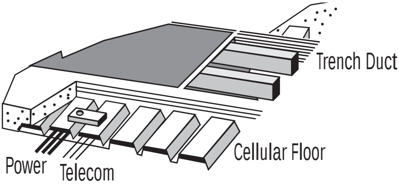

Figure 15 – Access Floor

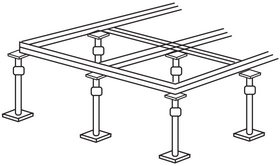

Figure 16 – Access Floor

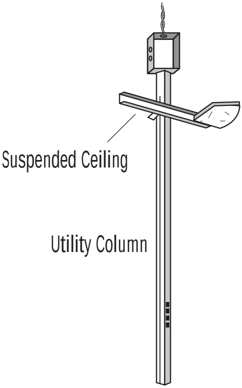

Figure 17 – Ceiling Utility Pole

Consolidation Points and MUTOAs

Consolidation points provide limited area connection access. Typically, a permanent flush wall, ceiling or support column-mounted panel serves modular furniture work areas. The panels must be unobstructed and fully accessible without moving fixtures, equipment or heavy furniture.

A multiuser telecommunications outlet assembly (MUTOA) is another methodology to reduce cabling moves, adds and changes in modular furniture settings. The user cord is directly connected to the MUTOA. A MUTOA location must be accessible and permanent and may not be mounted in ceiling spaces or under access flooring. Similarly, it cannot be mounted in furniture unless that furniture is permanently secured to the building structure.

For more descriptive information on distance limitations and purposes of consolidation points and MUTOAs, see ANSI/TIA/EIA-568-B.1.

Electromagnetic Interference

Voice and data telecommunications cabling should not be run adjacent and parallel to power cabling – even along short distances – unless one or both cable types are shielded and grounded. For low-voltage communication cables, a minimum 5-in. distance is required from any fluorescent lighting fixture or power line over 2 kVA and up to 24 in. from any power line over 5 kVA*. In general, telecommunications cabling is routed separately several feet away from power cabling. Similarly, telecommunications cabling is routed away from large motors, generators, induction heaters, arc welders, X-ray equipment and radio frequency, microwave or radar sources.

*Note: Distance recommendations from (1990) TIA/EIA-569 are reproduced here by popular request. For current recommendations, refer to NEC/NFPA 70, Article 800-52.

Firestops

Annex A of the standard discusses various types of packing used to re-establish the integrity of fire-rated structures when these barriers have been penetrated by cable. This section of the standard briefly discusses passive mechanical systems and non-mechanical systems such as putty, caulk, cements, intumescent sheets and strips, silicone foams and premanufactured pillows. The most common method is stuffing all apertures with ceramic or mineral wool and caulking both sides with fire-resistant putty. The information refers the designer to check manufacturer specifications and UL ratings against NFPA, ASTM and NEC codes.

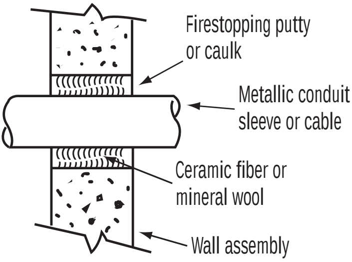

Figure 18 – Cross-Section of Typical Firestop

Purpose of the ANSI/TIA/EIA-606-A Standard

Modern buildings require an effective telecommunications infrastructure to support the wide variety of services that rely on the electronic transport of information. Administration includes basic documentation and timely updating of drawings, labels and records. Administration should be synergistic with voice, data and video telecommunications, as well as with other building signal systems, including security, audio, alarms and energy management.

Administration can be accomplished with paper records, but in today's increasingly complex telecommunications environment, effective administration is enhanced by the use of computer-based systems.

A multitenant commercial building has a life expectancy of at least 50 years. Moreover, in a multitenant environment, continuous moves, adds and changes are inevitable.

Administrative record keeping plays an increasingly necessary role in the flexibility and management of frequent moves, adds and changes. This standard concisely describes the administrative record keeping elements of a modern structured cabling system.

Section Contents

TIA/EIA-606-A

Administration Standard for Commercial Telecommunications Infrastructure

TIA/EIA-606-A

Administration Standard for Commercial Telecommunications Infrastructure

Elements of an Administration System:

- Horizontal pathways and cabling
- Backbone pathways and cabling
- Telecommunications grounding and bonding
- Spaces (e.g., entrance facility, telecommunications room, equipment room)
- Firestopping

The figure below illustrates a typical model for the infrastructure elements used in an administration system.

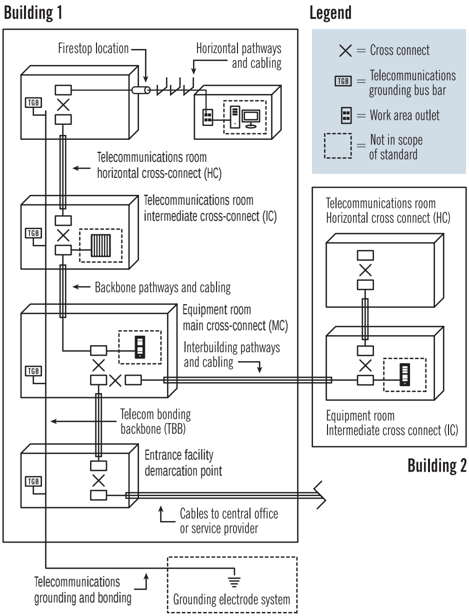

Figure 19 – Administration System

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 or special-purpose cable management software.

Identifier	Description of Identifier	Class of Administration 1	2	3	4
fs	Telecommunications space (TS)	R	R	R	R
fs-an	Horizontal link	R	R	R	R
fs-TGMB	Telecommunications main grounding busbar (TMGB)	R	R	R	R
fs-TGB	Telecommunications grounding busbar (TGB)	R	R	R	R
fs_1/fs_2-n	Building backbone cabling		R	R	R
fs_1/fs_2-n.d	Building backbone pair or optical fiber		R	R	R
f-FSLn(h)	Firestop location		R	R	R
[b_1-fs_1]/[b_2-fs_2]-n	Campus backbone cable			R	R
[b_1-fs_1]/[b_2-fs_2]-n/d	Campus backbone or optical fiber			R	R
b	Building			R	R
c	Campus or site				R

Class 1 Administration

Class 1 addresses the administration requirements for a building or premise that is served by a single equipment room (ER).

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

- Telecommunications space (TS) identifier
- Horizontal link identifier
- Telecommunications main grounding busbar (TMGB)
- Telecommunications grounding busbar (TGB)

Class 1 Identifiers		
f	=	numeric character(s) identifying the floor of the building occupied by the TS
s	=	alpha character(s) uniquely identifying the TS on floor f, or the building area in which the space is located
fs	=	the TS identifier
a	=	one or two alpha characters uniquely identifying a single patch panel, a group of patch panels with sequentially numbered ports, or an IDC connector (punch-down block), or a group of IDC connectors, serving as part of the horizontal cross-connect
n	=	two to four numeric characters designating the port on a patch panel, or the section of an IDC connector on which a four-pair horizontal cable is terminated in the TS
TMGB	=	portion of an identifier designating a telecommunications main grounding busbar
TGB	=	portion of an identifier designating a telecommunications grounding busbar

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 backbone cable identifier
- Building backbone pair or optical fiber identifier
- Firestopping location identifier

Class 2 Administration may additionally include pathway identifiers.

Class 2 Identifiers		
fs_1	=	TS identifier for the space containing the termination of one end of the backbone cable
fs_2	=	TS identifier for the space containing the termination of the other end of the backbone cable
n	=	one or two alphanumeric characters identifying a single cable with one end terminated in the TS designated fs_1 and the other end terminated in the TS designated FS_2
fs_1/fs_2-n	=	a building backbone cable identifier
d	=	two to four numeric characters identifying a single copper pair or a single optical fiber
FSL	=	an identifier referring to a firestopping location
h	=	one numeric character specifying the hour rating of a firestopping system

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 backbone cable identifier
- Campus backbone pair or optical 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.

Class 3 Identifiers		
$[b_1\text{-}fs_1]/[b_2\text{-}fs_2]\text{-}n$	=	campus backbone identifier
d	=	two to four numeric characters identifying a single copper pair or a single optical fiber
b	=	one or more alphanumeric characters identifying a single building

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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.

Class 4 Identifiers
c = one or more alphanumeric characters identifying a campus or a site

Identification Formats

A unique alphanumeric identification code is created for every location, pathway, cable and termination point. The standard includes these suggestions:

Identification Format Example

The actual format in the preceding chart is not mandated by the standard. However, the chosen format must be consistent and provide a unique identifier number for each system element. This method lends itself to organizing and updating multiple records by the use of powerful relational database (three-dimensional spreadsheet) programs.

Alphanumeric Identification Code			
BCxxx	bonding conductor	HHxxx	handhole
BCDxxx	backbone conduit	ICxxx	intermediate cross-connect
Cxxx	cable	Jxxx	jack
CBxxx	backbone cable	MCxxx	main cross-connect
CDxxx	conduit	MHxxx	manhole or maintenance hole
CTxxx	cable tray	PBxxx	pull box
ECxxx	equipment (bonding) conductor	Sxxx	splice
EFxxx	entrance facility	SExxx	service entrance
ERxxx	equipment room	SLxxx	sleeve
Fxxx	fiber	TCxxx	telecommunications closet
GBxxx	grounding busbar	TGBxxx	telecommunications grounding busbar
GCxxx	grounding conductor	TMGB	telecommunications main grounding busbar
		WAxxx	work area

Identification Example

J0001	Label for an information outlet jack
D306	Designation for a work area
3A-C17-005	Termination in closet 3A, column C, row 17, block position 005

Examples like those above (taken from the TIA/EIA 606-A text and administrative labeling map) indicate the flexibility of conventions that can be established for purposes of naming. Logical naming conventions can also convey considerable additional information about other linkages. Further examples are included in the complete standard.

Summary of Record Elements

This table outlines the minimum required information and required linkages. Further information is optional. A multidimensional database or spreadsheet is helpful.

	Record	Required Information	Required Linkages
Pathways & Spaces	Pathway	Pathway Identification #	Cable Records
		Pathway Type	Space Records
		Pathway Fill	Pathway Records
		Pathway Load	Grounding Records
	Space	Space Identification #	Pathway Records
		Space Type	Cable Records
			Grounding Records
Wiring	Cable	Cable Identification #	Termination Records
		Cable Type	Splice Records
		Unterminated Pair #s	Pathway Records
		Damaged Pair #s	Grounding Records
		Available Pair #s	
	Termination Hardware	Termination Hardware #s	Termination Position Records
		Termination Hardware Type	Space Records
		Damaged Position #s	Grounding Records
	Termination Position	Termination Position #	Cable Records
		Termination Position Type	Other Termination Records
		User Code	Termination Hardware Records
		Cable Pair/Condition #s	Space Records
	Splice	Splice Identification #	Cable Records
		Splice Type	Space Records
Grounding	TMGB	TMGB Identification #	Bonding Conductor Records
		Busbar Type	Space Records
		Grounding Conductor #s	
		Resistance to Earth	
		Date of Measurement	
	Bonding Conductor	Bonding Conductor ID#	Grounding Busbar Records
		Conductor Type	Pathway Records
		Busbar Identification #	
	TGB	Busbar Identification #	Bonding Conductor Records
		Busbar Type	Space Records

Grounding and Bonding Administration

Telecommunications systems require a reliable electrical ground reference potential, provided by a dedicated grounding and bonding conductor network.

> **WARNING**
>
> IF THIS CLAMP OR CABLE
> IS LOOSE OR MUST BE REMOVED,
> PLEASE CALL THE BUILDING
> TELECOMMUNICATIONS MANAGER

Bonding conductor cabling shall be colored green or labeled appropriately with an alphanumeric identifier and warning label. Grounding records are similar to cable record format.

Grounding and Bonding Terms (with abbreviations):

TMGB	Telecommunications Main Grounding Busbar
TBB	Telecommunications Bonding Backbone
TGB	Telecommunications Grounding Busbar
TBBIBC	Telecommunications Bonding Backbone Interconnecting Bonding Conductor

Label Color Coding

Shown here are the color codes used for termination field labels.

Termination Type	Color	Comments
Demarcation Point	Orange	CO terminations
Network Connections	Green	Also aux. circuit terms.
Common Equipment	Purple	PBX, host, LANs, Mux
First-Level Backbone	White	MC-IC terminations
Second-Level Backbone	Gray	IC-TC terminations
Station	Blue	Horizontal cable terms.
Interbuilding Backbone	Brown	Campus cable terms.
Miscellaneous	Yellow	Aux., maint., security
Key Telephone Systems	Red	

The abbreviation “terms.” is used in this example (for space considerations) to mean “terminations.”

The Purpose of the J-STD-607-A 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

J-STD-607-A
Commercial Building Grounding and Bonding Requirements for Telecommunications

Design Considerations

Solid copper grounding busbars (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 busbar 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 busbars. Busbars 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 busbar 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.

Terms

- Telecommunications Main Grounding Busbar (TMGB)
- Telecommunications Bonding Backbone (TBB)
- Telecommunications Grounding Busbar (TGB)
- Telecommunications Bonding Backbone Interconnecting Bonding Conductor (TBBIBC)

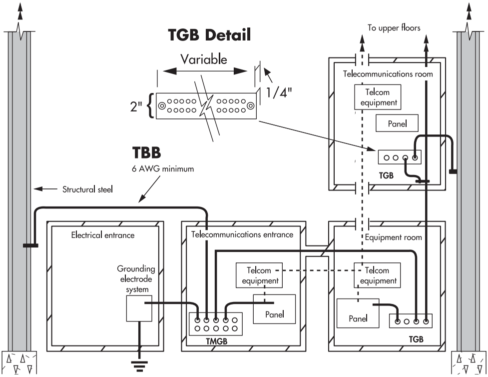

Figure 20 – Schematic of Grounding/Bonding Network

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The Purpose of the ANSI/TIA/EIA-942 Standard

- The purpose of this standard is to provide requirements and guidelines for the design and installation of a data center or computer room.
- It is intended for designers who need a comprehensive understanding of the data center design including the facility planning, the cabling system and the network design.
- It facilitates the planning for data centers to occur earlier in the building development process (architectural, facilities and IT).

Data centers support a wide range of transmission protocols. Some of these protocols impose distance restrictions that are shorter than those imposed by this standard. When applying specific transmission protocols, consult standards, regulations, equipment manufacturers and system service suppliers for applicability, limitations and ancillary requirements. Consider consolidating standardized and proprietary cabling into a single structured cabling system.

The Standard Specifies:

- Cabling design
- Network design
- Facilities design
- Informative annexes containing best practices and availability requirements
- Spaces
- Pathways
- Racks and cabinets.

Section Contents

ANSI/TIA/EIA-942

Telecommunications Infrastructure Standard for Data Centers

Data Center Cabling Infrastructure

The basic elements of the data center's 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

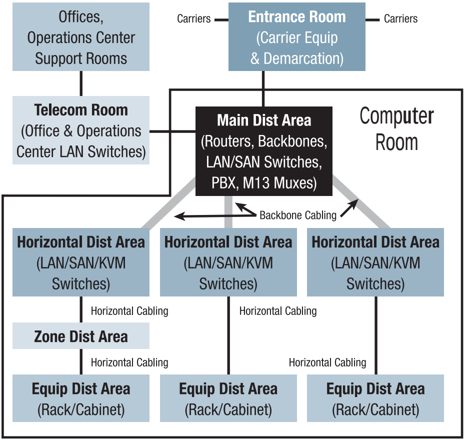

Figure 21 – Data Center Cabling Infrastructure

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 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 ft.) is preferable. Some equipment may require service clearances of greater than 1 m (3 ft.).

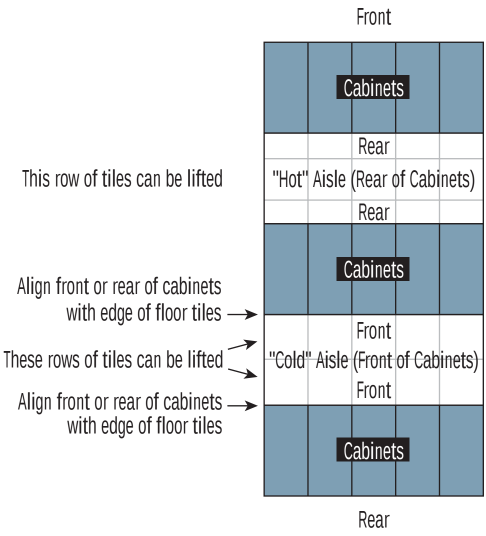

Figure 22 – Hot and Cold Aisles

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, and may 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.)

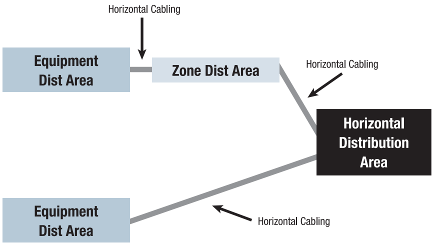

Figure 23 – Horizontal Cabling Using Star Topology

	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)

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-connection.

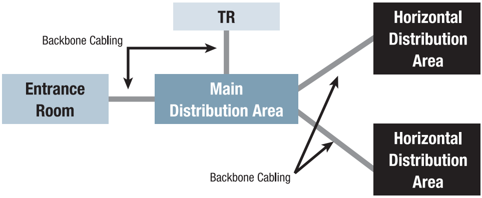

Figure 24 – Backbone Cabling Using Star Topology

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/EIA-568-B.2 and ANSI/TIA/EIA-568-B.3.

- 100-ohm twisted-pair cable (ANSI/TIA/EIA-568-B.2), Category 6 recommended (ANSI/TIA/EIA-568-B.2-1)
- Multimode optical fiber cable, either 62.5/125 µ or 50/125 µ (ANSI/TIA/EIA-568-B.3), 50/125 µ 850 nm laser-optimized multimode fiber is recommended (ANSI/TIA-568-B.3-1)
- Single-mode optical fiber cable (ANSI/TIA/EIA-568-B.3)
- The recognized coaxial media are 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.

	Tier I: Basic	Tier II: Redundant Components	Tier III: Concurrently Maintainable	Tier IV: Fault Tolerant
Number of Delivery paths	Only 1	Only 1	1 Active, 1 Passive	2 Active
Redundant Components	N	N+1	N+1	2 (N+1) S+S
Support Space to Raised Floor Ratio	20%	30%	80-90%	100%
Initial Watts/ft.	20-30	40-50	40-60	50-80
Ultimate Watts/ft.	20-30	40-50	100-150	150+
Raised Floor Height	12 in.	18 in.	30-36 in.	30-36 in.
Floor Loading Pounds/ft.	85	100	150	150+
Utility Voltage	208, 480	208, 480	12-15kV	12-15kV
Months to Implement	3	3 to 6	15 to 20	15 to 20
Year First Deployed	1965	1970	1985	1995
Construction $/ft. Raised Floor	$450	$600	$900	$1,100+
Annual IT Downtime Due to Site	28.8 hrs.	22.0 hrs.	1.6 hrs.	0.4 hrs.
Site Availability	99.671%	99.749%	99.982%	99.995%

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 supplying 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 ensure that single points of failure have been eliminated.

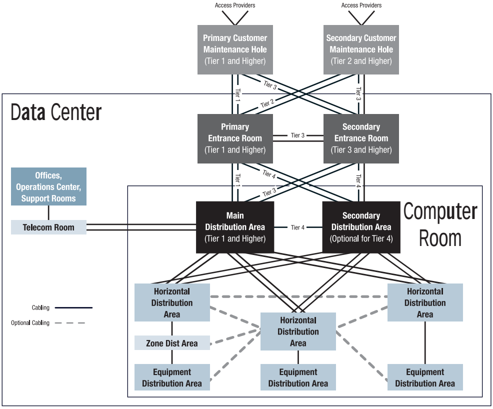

Figure 25 – Backbone Cabling Using Star Topology

Purpose of the ANSI/TIA-1005 Standard

The Purpose:

- This standard helps to enable the planning and installation of telecommunications cabling infrastructure within and between industrial buildings.
- In contrast to the ANSI/TIA/EIA-568, 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.

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 proposed ANSI/TIA-1005 draft standard structure
- Industrial area concepts
- Recognized cables
- Recognized connectivity
- The automation outlet
- 2-pair cabling
- Multiconnect or Ethernet channels
- MICE

Terms not part of ANSI/TIA/EIA-568-B:

- 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

The MICE concept is based on the assumption that cabling, even under the worst conditions of an environmental class, is still protected and helps to guarantee reliable network operation.

Section Contents

ANSI/TIA-1005

Telecommunications Standard for Industrial Premises

Industrial Areas

Industrial premises cabling may traverse from the front office through the factory floor. The factory floor (see Figure 26) 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.

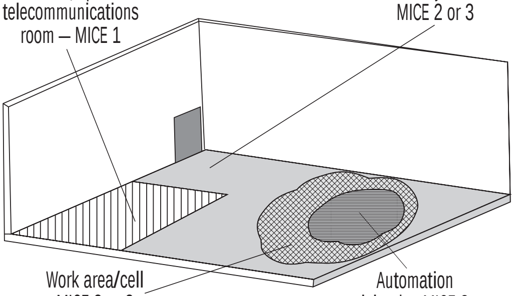

Figure 26 – Typical Industrial Environment

Control Equipment/Telecommunications Room

This area is equivalent to the MDC or IDC as defined in the ANSI/TIA/EIA-568-B. 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 local to 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.

Anixter Standards Reference Guide

Telecommunications Infrastructure for Industrial Premises

Anixter's Standards Reference Guide for Telecommunications Infrastructure for Industrial Premises is an invaluable tool to help you plan and install telecommunications cabling infrastructure within and between industrial buildings. The ANSI/TIA-1005 standard addresses the potential exposure to hostile environments in the industrial space. In addition to the special cabling system requirements for industrial operations, including 2-pair cabling systems, the standard provides definitions for areas in the industrial space including automation islands, outlets and cables.

To order a copy go to
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for Anixter Part No. 252181.

Purpose of the ISO 11801:2002 Standard

The International Standard provides:

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

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 account for the needs of specific applications.

Generic cabling defined within this 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 ensure performance of permanent links and channels that meet or exceed the requirements for cabling classes

The International Standard specifies a generic cabling system that is anticipated to have a usable life in excess of 10 years.

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ISO 11801 Class E_A Standard

The requirements for ISO (the International Organization for Standardization) Class E_A are more demanding compared to the TIA/EIA 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

TIA Category 6 versus Augmented Category 6 versus ISO Class E_A

	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

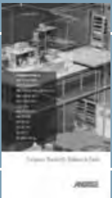
This table summarizes the various UTP cabling options and their respective 10 Gigabit performance attributes as defined by the latest draft standards. Category 5e is not recognized as a viable cabling media to support 10 Gigabit transmission regardless of its installed cabling distance. Category 6 cabling 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 Class E_A standards. ISO's Class E_A system has superior NEXT and PSNEXT performance values when compared with the current TIA Augmented Category 6 standard.

The Anixter European Standards Reference Guide

The Anixter European Standards Reference Guide is an invaluable industry tool to help you stay informed of recent developments in standards for structured cabling systems. The guide includes an up-to-date summary of the ANSI/TIA/EIA, ISO, CENELEC and IEEE standards featuring European standards ISO 11801, ISO 18010, EN50173, EN50174, EN50310.

To order a copy, go to www.anixter.com/literature.



IEEE's 802.3af Power over Ethernet (PoE) Standard

The IEEE's 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.

More commonly referred to as the PoE+ standard, the 802.3at working group is developing a higher power PoE standard (24 watts minimum) than what is available on the current 802.3af PoE specification (12.95 watts maximum). The standard is currently in draft form with an anticipated completion date by the end of 2009.

IEEE's 802.3at – DTE enhancements – More commonly referred to as PoE+ Task Force. This working group is developing a higher power PoE standard (24 watts minimum) than what is available on token ring 802.3af PoE specifications (12.9 watts maximum). The standard is currently in draft 3.3 with an anticipated completion date of mid-2009.

IEEE's 802.11 Wireless Standards

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 very 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 – 802.11n is a set of standards for wireless local area network (WLAN) computer communications developed by the IEEE LAN/MAN 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 working group is not expected to finalize the amendment until December 2009.

IEEE 802.3an Standard

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

ANSI/EIA/TIA-568-B.2-ad10 (Augmented Category 6) and ISO 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 Class E_A compliant cabling systems.

TIA-568-B.2-ad10 Augmented Category 6 or ISO 11801 Class E_A cables.

10 Gigabit Ethernet Channel Applications			
Application	10GBASE Fiber (802.3ae)	10GBASE-T	10GBASE-CX4 (802.3ak)
Data Center (Server Clustering)	Yes	Yes	Yes (< 15 m)
Horizontal (In Building)	No	Yes	No
Vertical (Risers)	Yes	No	No
Campus/Metro	Yes	No	No

In the chart above, the recommended application roadmaps for 10 Gigabit Ethernet cabling and protocol types have been provided. The choice of which media to use will revolve around three variables:

- Circuit distances
- Cost
- Active equipment interfaces (connectors)

10GBASE fiber will maintain traditional application in backbones and risers and also in the data center for server clustering.

10GBASE-T copper will remain in the traditional areas of application (in horizontal building cabling but also in the data center between servers and clusters).

10GBASE-CX4 defines a multiconductor copper solution primarily designed to connect servers and switches over short distances.

802.3ba – 40 Gbps and 100 Gbps Ethernet – The purpose of this project is to extend the 802.3 protocol to operating speeds of 40 Gbps and 100 Gbps in order to provide a significant increase in bandwidth while maintaining compatibility with the installed base of 802.3 interfaces, previous investment in research and development, and principles of network operation and management. Anticipated completed date for all working groups is 2011.

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 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 product solutions available from our manufacturer partners
- Evaluate our network infrastructure and security solutions to ensure that our customers are selecting the right products for their specific needs

We are continually testing products in our Lab to ensure:

- Quality products are recommended and delivered to our customers
- Consistency of performance across product lines and within systems
- Interoperability of products and systems to ensure customers can integrate systems and follow the trend toward convergence.

THE LAB
ANIXTER'S INFRASTRUCTURE SOLUTIONS LAB

Networking and Security Product Testing at Our Lab Includes:

- Random performance testing of Anixter inventory to ensure quality of standards compliance
- Network throughput and interoperability testing
- Copper and fiber cabling compliance verification (TIA/EIA, 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.

Anixter's Infrastructure Solutions Lab In Action

Problem: 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.

Problem: Major Railway Company Needs Video Surveillance To Monitor Switchyard

Anixter Infrastructure Solutions Lab Resolution: A railroad company wanted to use video surveillance to monitor its yards as workers assembled unit trains, but it had a big cabling challenge. Installing traditional cabling in the switchyard would have entailed major disruptions and expense for the customer. 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.

Problem: 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 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 ensure that the 10 Gigabit cabling solutions we sell meet the highest levels of performance and reliability for our customers, the Anixter Infrastructure Solutions Lab tests the toughest performance parameter, alien crosstalk, in a "worst case" scenario. Customers can rest assured that the cabling solutions Anixter sells will provide the network performance they require.

Products. Technology. Services. Delivered Globally.

Reference Documents for Further Information on Cabling Standards

TIA/EIA-568-B.1 (2001)
Commercial Building Telecommunications Cabling Standard Part 1: General Requirements

TIA/EIA-568-B.2 (2001)
Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components

TIA/EIA-568-B.2-1 (2002)
Transmission Performance Specifications for 4-pair 100Ω Augmented Category 6 Cabling

TIA/EIA-568-B.2-ad10 (2008)
Transmission Performance Specifications for 4-pair 100Ω Augmented Category 6 Cabling

TIA/EIA-568-B.3 (2000)
Optical Fiber Cabling Components Standard

TIA/EIA-569-B (2004) (CSA T530)*
Commercial Building Standard for Telecommunications Pathways and Spaces

TIA/EIA-570-A (1999) (CSA T525)*
Residential and Light Commercial Telecommunication Wiring Standard

TIA/EIA-606-A (2002) (CSA T528)*
Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

J-STD-607-A (2002) (CSA T527)*
Commercial Building Grounding/Bonding Requirements for Telecommunications

*Canadian Standards Association equivalent document

TIA/EIA-758 (1999)
Customer-Owned Outside Plant Telecommunications Cabling Standard

TIA/EIA-942 (2005)
Telecommunications Infrastructure Standard for Data Centers

ANSI/TIA-1005 (Draft)
Telecommunications Infrastructure for Industrial Premises

ISO/IEC 11801 (2002)
Generic Cabling for Customer Premises

IEEE 802.3-1998 (1998)
Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specification (also known as ANSI/IEEE Std 802.3-1998 or ISO 8802-3: 1990 (E))

IEEE 802.3an (2006)
Physical Layer and Management Parameters for 10 Gbps Operation, Type 10GBASE-T

IEEE 802.5-1998 (1998)
Token Ring Access Method and Physical Layer Specifications (also known as ANSI/IEEE Std 802.5-1998)

Obtaining Standards Documents

TIA/EIA documents may be purchased through Global Engineering Documents at (800) 854-7179 or www.global.ihs.com. IEEE documents may be purchased through IEEE, P.O. Box 1331, Piscataway, NJ 08855 or www.ieee.org. CSA documents may be purchased through the Canadian Standards Association at www.csa.ca or by calling (416) 747-4000.

For further assistance or more information, contact your local Anixter sales office or 1.800.ANIXTER. Some material in this publication is reproduced from standards publications, which are copyrighted by the Telecommunications Industry Association.

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