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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-ad10

ANSI/TIA/EIA-569-B

ANSI/TIA/EIA-606-A

J-STD-607-A

ANSI/TIA/EIA-942

IEEE 802.3af

IEEE 802.3an

IEEE 802.11

ISO Class E_A

ISO 11801

ISO 18010

EN50173

EN50174

EN50310

European Standards Reference Guide

ANIXTER

Anixter: The Cabling Systems Experts

Anixter is the world's leading supplier of communications products used to connect voice, video, data and security systems. Anixter is also the leading provider of electrical and electronic wire and cable, fasteners, and other small components to build, repair and maintain a variety of systems and equipment. We bundle our products with our innovative Supply Chain Services to cut costs out of our customers' business processes and ensure they get the right product, the first time.

You can look to Anixter when you need any type of communication infrastructure. Whether you're looking for data, voice or video networks, wired or wireless, in an office, campus or factory, Anixter is the company to turn to. We are the one distributor with both the technical expertise to help you determine the right products for your application and the unparalleled global distribution capabilities to get you that product, when and where you need it. In an effort to continually support you, we have pulled together some valuable information from ANSI/TIA/EIA, ISO, CENELEC and IEEE.

The information contained within this reference guide covers the key aspects of the ANSI/TIA/EIA-568-B, 568-B.2-1, 568-B.2-ad10, 569-B, 606-A, 607-A, 942, IEEE 802.3af, IEEE 802.3an, IEEE 802.11, ISO Class E_A, ISO 11801, EN50173, EN50174 and EN50310 standards. We hope you find the guide informative and useful.

Scope of this Handbook

This document is meant as a reference that highlights the key points of the ANSI/TIA/EIA-568-B, 569-B, 606-A, 607-A and IEEE 802.3af, IEEE 802.3an, IEEE 802.11, ISO Class E_A, ISO 11801, EN50173, EN50174 and EN50310 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
EN CENELEC	European Committee for Electrotechnical Standardisation
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical & Electronic Engineers
ISO	International Organisation for Standardisation
NEC	National Electric Code (USA)
NEMA	National Electrical Manufacturers Association (USA)
NFPA	National Fire Protection Association (USA)
TIA	Telecommunications Industry Association

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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 that modifications are both easy and economical
- Building professionals (for example, architects) guidance on the accommodation of cabling at the initial stages of development

The international standard specifies a multi-vendor cabling system which 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 which take into account 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 and D meeting the requirements of standardised 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.

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

The Purpose:

- Establish a generic telecommunications cabling standard that will support a multi-vendor 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:

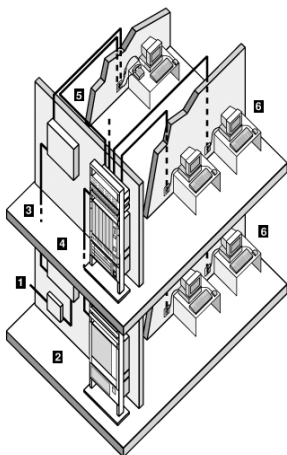
- Minimum requirements for telecommunications cabling within an office environment
- Recommended topology and distances
- Media parameters which determine performance
- Connector and pin assignments to ensure interconnectability
- The useful life of telecommunications cabling systems as being in excess 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 3,000 to 1,000,000m² (10,000 – 10,000,000 square feet) 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.

ISO 11801:2002 and TIA/EIA-568-B.1 General Requirements



The Subsystems of a Structured Cabling System

Campus Distributor (CD)/Building Entrance (BEF)

Building entrance facilities 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. For Europe refer to EN50174-1 and TIA-568-B for USA specifications.

Building Distributor (BD)/Equipment Room Facility (ER)

The design aspects of the BD/ER room are specified in the TIA/EIA-569-B and EN 50174-1 standard. This room usually houses equipment of higher complexity that serve the entire building such as servers and telecoms switches. Any or all of the functions of a floor distributor/telecommunications room may be provided by this room.

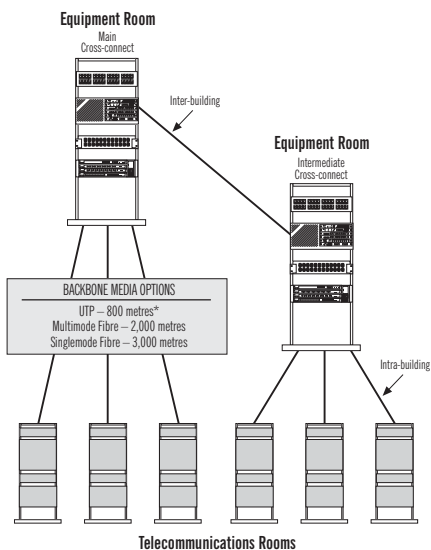
Backbone Cabling

The backbone cabling provides interconnection between floor distributor/telecommunications rooms, building distributor/equipment rooms and campus distributor/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 a BD/ER and building cable entrance facilities or campus distributor
- Cables between buildings (interbuilding)



Specified Backbone Cabling Topology: Star

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 20m (66ft)
- Avoid installing in areas where sources of high levels of EMI/RFI may exist
- Grounding should meet the requirements as defined in EN50310 and J-STD-607-A.

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

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

ISO 11801 Performance of Optical Fibre Cable

Class OF-300 channels up to 300m

Class OF-500 channels up to 500m

Class OF-2000 channels up to 2000m

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

Floor Distributor (FD)/Telecommunications Room (TR)

A FD/TR room is the area within a building that houses the telecommunications cabling system equipment. This includes the mechanical terminations and/or cross-connects for the horizontal and backbone cabling system.

Please refer to ISO 11801 and TIA/EIA-569-B for the design specifications of the FD/TR room.

Horizontal Cabling

Specified Horizontal Cabling Topology: Star

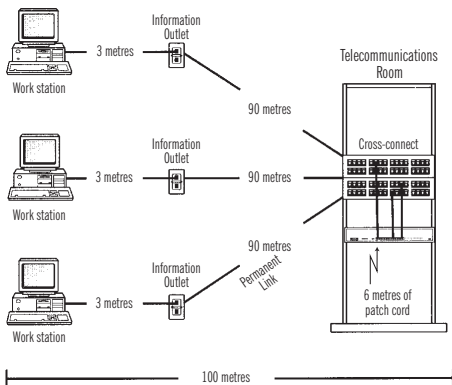
The horizontal cabling system extends from the work area telecommunications information outlet to the FD or TR room and consists of the following:

- Horizontal Cabling
- Telecommunications Outlet
- Cable Terminations
- Cross-Connections
- Patch Cords

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

- 4pair, 100ohm UTP/ScTP cable (22–24 AWG solid conductors)
- 2fibre, 62.5/125 μ m or 50/125 μ m optical cable

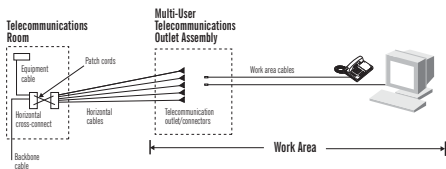
Maximum Distances for Horizontal Cabling



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

Multi-User Telecommunications Outlet Assembly (ISO MUTO)

Optional practices for open office environments are specified for any horizontal telecommunications cabling recognised in ISO 11801 and TIA/EIA-568-B.



A multi-user telecommunications outlet assembly (MUTOA or MUTO) 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 MUTO which serves a maximum of 12 work areas. Ceiling and access floor mounting is not allowed by ISO 11801 and TIA/EIA-569-B.

Maximum Work Area Cable Length is Determined by the Following Table:

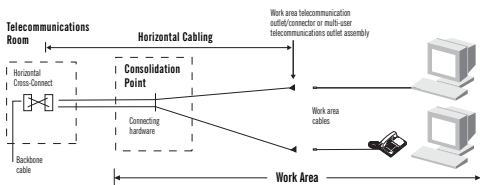
Length of horizontal cable m (ft)	Maximum length of work area cable (24AWG) m (ft)	Maximum combined length of work area cables, patch cords and equipment cable m (ft)
90 (295)	5 (16)	10 (33)
85 (279)	9 (30)	14 (46)
80 (262)	13 (44)	18 (59)
75 (246)	17 (57)	22 (72)
70 (230)	22 (72)	27 (89)

For ISO figures please refer to Table 21 of the ISO 11801 standard

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

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

Consolidation Point

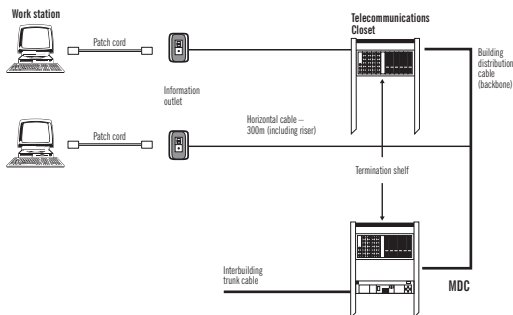


A consolidation point differs from a MUTOA in that it requires an additional connection for each horizontal cable run. Only one consolidation point (an interconnection point in the horizontal cabling) is allowed, at a distance of at least 15m (49ft) from the FD/TR room. A transition point (transition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

The multi-user telecommunications outlet and consolidation point methods are intended to be mutually exclusive. Labelling and allowance for spares is required. Moves, adds and changes should be administered in the telecom room.

Centralised Optical Fibre Cabling

The ISO 11801 and ANSI/TIA/EIA-568-B-1 standards offer maximum flexibility for distributed electronics for multi-tenant buildings by providing for single-tenant users who prefer centralised electronics (i.e., server farms) connected by a fibre horizontal and fibre backbone.



Centralised Cabling Scheme

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

Work Area

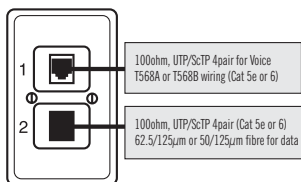
The work area components extend from the telecommunications (information) outlet to the station equipment. Work area wiring is designed to be relatively simple to interconnect so that moves, adds and changes are easily managed.

Work Area Components

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

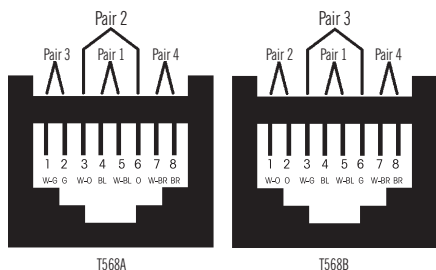
Telecommunications Outlet

Each work area should have a minimum of two information outlet ports, one for voice and one for data. The cabling choices are indicated in the following diagram.



Telecommunications Outlet

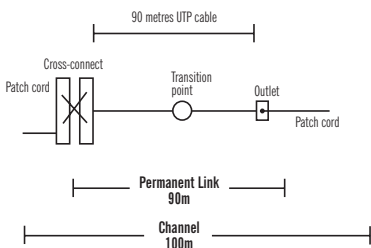
8-Position Modular Jack Pair Assignments for Twisted Pair



T568B is the most commonly used configuration. Care should be taken to select one cabling scheme throughout the installation to ensure error free wiring.

Channel and Permanent Link

For the purposes of testing UTP/ScTP cabling systems, the horizontal channel is assumed to contain a telecommunications outlet/connector, a transition point, 90m of UTP or ScTP Category 5e/Class D or 6/Class E cable, a cross-connect consisting of two blocks or panels and a total of 10m of patch cords. The figure below shows the relationship of these components.



Two link configurations are defined for testing purposes. The permanent link includes the horizontal distribution cable, telecommunications outlet/connector or consolidation 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 hardware, user equipment cord and cross-connect patch cable.

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

Physical requirements of 4pair UTP/ScTP:

Maximum diameter: 6.35mm

Breaking strength: 40kgs.

Maximum pulling tension: 11kgs.

ISO Minimum Bend Radius	
Horizontal UTP/ScTP	25mm for 4pair cables up to 6mm diameter
Horizontal UTP/ScTP	50mm for 4pair cables over 6mm diameter

Physical requirements of 4pair cable	
Diameter of conductors	0.4 – 0.8mm
Diameter of insulation conductors	≤ 1.6mm
Outer diameter of backbone cable	≤ 90mm
Temperature range	Installation: 0 to 50°C Operation: -20 to 60°C

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 neighbouring (non-energised) 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 neighbouring (non-energised) 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 neighbouring 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 neighbouring pair measured at the far-end, relative to the received signal level measured on that same pair. (ELFEXT is FEXT adjusted to discount attenuation.)

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

PSANEXT (powersum alien near-end crosstalk): A computation of signal coupling from multiple near end disturbing channel pairs into a disturbed pair of a neighbouring 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 neighbouring 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 pairs are designed to have different twists per metre (lay lengths). Delay skew could cause data transmitted over one channel to arrive out of sync with data over another channel.

The following tables show the limitations for both the permanent links and channel.

Tests should also measure physical length of each link, and employ wire map to verify pin terminations at each end and identify simple electrical faults. Level IIe field test equipment accuracy is defined.

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 Permanent Link Requirements

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 3 Channel Requirements

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 Link Requirements

Maximum link propagation delay: 518 ns @ 10 MHz

Maximum link delay skew: 45 ns @ 100 MHz

ISO Class D Permanent Link Informative Values

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	4.0	60.0	57.0	58.6	55.6	19.0
16.0	7.7	45.2	42.2	34.5	31.5	19.0
100.0	20.4	32.3	29.3	18.6	15.6	12.0

Class D Permanent Link Requirements**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 @ 10 MHz

Maximum channel delay skew: 50 ns @ 100 MHz

ISO Class D Channel Informative Values

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	4.0	60.0	57.0	57.4	54.4	17.0
16.0	9.1	43.6	40.6	33.3	30.3	17.0
100.0	24.0	30.1	27.1	17.4	14.4	10.0

Class D Channel Requirements**Class E/Category 6 Permanent Link**

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	1.9/4.0*	65.0	62.0	64.2	61.2	19.1/21.0*
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	7.0/7.1*	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	18.6/18.5*	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	31.1/30.7*	35.3	32.7	16.2	13.2	10.0

*ISO Requirements informative other figures identical to TIA Cat 6

Category 6 Permanent Link Requirements

Maximum Cat 6 permanent link propagation delay: less than 498 ns @ 10 MHz

Maximum Cat 6 permanent link delay skew: less than 44 ns/100 m @ 10 MHz

Category 6 Channel

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)
1.0	2.1/4.0*	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	8.0/8.3*	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	21.3/21.7*	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

*ISO Requirements informative other figures identical to TIA Cat 6

Category 6 Channel Requirements

Maximum Cat 6 channel propagation delay: less than 555 ns @ 10 MHz

Maximum Cat 6 channel delay skew: less than 50 ns/100m @ 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/Class E _A				
	TIA Category 5e UTP	TIA Category 6 UTP	TIA Augmented Category 6 UTP	ISO Class E _A
Recognised by IEEE 802.3an	No	Yes	Yes	Yes
55 Metre Distance Support	No	Yes	Yes	Yes
100 Metre Distance Support	No	No	Yes	Yes
Extrapolated Test Limits for NEXT and PSNEXT to 500MHz	No	No	No	Yes

Note: This table compares current TIA Category 6 cabling with new TIA and ISO specs for 10 Gigabit cabling.

This table summarises the various Twisted Pair cabling options and their respective 10 Gigabit performance attributes as defined by the latest draft standards. Category 5e is not recognised as a viable cabling media to support 10 Gigabit transmission regardless of its installed cabling distance. Category 6/Class E cabling will only support 10 Gigabit at a maximum installed distance of 55 metres subject to further study.

Augmented Category 6 and ISO 11801 Class E_A Definitions in addition to EIA/TIA-568-B and ISO 11801:2002

alien (exogenous) crosstalk: Signal coupling from pairs of a disturbing channel or part thereof, to a disturbed pair of another channel.

AFEXT (alien (exogenous) far-end crosstalk): Signal coupling from a pair of a disturbing channel to a disturbed pair of another channel, measured at the far-end.

ANEXT (alien exogenous near-end crosstalk): Signal coupling from pairs of a disturbing channel or part thereof, to a disturbed pair of another channel or part thereof, measured at the near-end.

AACR-F (attenuation to alien (exogenous) crosstalk ratio at the far-end): A computation of the signal coupling of a pair of disturbing channel, 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.

AACR-N (attenuation to alien (exogenous) crosstalk ratio at the near-end): A computation of the signal coupling of a pair of a disturbing channel, to a disturbed pair in another channel, measured at the near-end, and relative to the received signal level in the disturbed pair at the near-end.

ACR-F (attenuation to crosstalk ratio at the far-end): A computation of the signal coupling from a disturbing pair, to a disturbed pair within the same channel, measured at the far-end, and relative to the received signal level in the disturbed pair at the far-end.

ACR-N (attenuation to crosstalk ratio at the near-end): A computation of the signal coupling from a disturbing pair, to a disturbed pair within the same channel, measured at the near-end, and relative to the received signal level in the disturbed pair at the near-end.

The addition of these definitions is in relation to the extended requirements as specified in the IEEE802.3an 10 Gigabit Ethernet standard on twisted pair copper. These requirements are needed due to the worst case influence of 6 x 4 pair cables transmitting data around one 4 pair cable. And how these can affect the 10 Gigabit Ethernet signals. The Augmented Category 6/Class E_A are both still in draft format at the time of publication.

ISO Class E_A Standard

The draft requirements for ISO (The International Organisation for Standardisation) Class E_A are more demanding compared to TIA/EIA Augmented Cat 6 draft requirements. Anixter's Infrastructure Solutions Lab tests to the more stringent ISO draft standards.

ISO Compared to TIA Channel		
Characteristics 500MHz (dB)	ISO Class E _A	TIA Augmented Cat 6 Draft
PSNEXT Loss	24.8dB	23.2dB
NEXT Loss	27.9dB	26.1dB
PSANEXT Loss	49.5dB	49.5dB
Return Loss	6.0dB	6.0dB
Insertion Loss	49.3dB	49.3dB
Referred to by IEEE	Yes	No

The table below compares current TIA Category 6 cabling with new TIA and ISO specs for 10 Gigabit cabling.

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
Recognised by IEEE 802.3an	No	Yes	Yes	Yes
55 Metre Distance Support	No	Yes	Yes	Yes
100 Metre Distance Support	No	No	Yes	Yes
Extrapolated Test Limits for NEXT and PSNEXT to 500MHz	No	No	No	Yes

This table summarises the various UTP cabling options and their respective 10 Gigabit performance attributes as defined by the latest draft standards. Category 5e is not recognised 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 metres. Today, the only options for operating 10 Gigabit at 100 metres are the TIA Augmented Category 6 and ISO Class E_A standards. ISO's Class E_A system has superior return loss, NEXT and PSNEXT performance values when compared with the current TIA Augmented Category 6 draft proposals.

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 characterised up to 500 MHz. (Please note: this addendum is in draft form at the time of this publication. This information does not reflect the final published standard).

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)	PSAACR-F (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 Requirements

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ACR-F (dB)	PSACR-F (dB)	Return Loss (dB)	PSANEXT (dB)	PSAACR-F (dB)
1.0	2.2	65.0	62.0	63.3	60.3	19.0	67.0	77.0
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 draft requirements for ISO (The International Organisation for Standardisation) Class E_A are more demanding compared to TIA/EIA Augmented Cat 6 draft requirements. Anixter's Infrastructure Solutions Lab tests to the more stringent ISO draft standards.

ISO Class E_A Channel Requirements

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)	ACR-F (dB)	PSACR-F (dB)	Return Loss (dB)	PSANEXT (dB)	PSAACR-F (dB)
1	4.0	65.0	62.0	65.0	62.0	19.0	67.0	67.0
100	20.8	39.9	37.1	25.5	22.5	12.0	60.0	37.0
250	33.8	33.1	30.2	17.5	14.5	8.0	54.0	29.0
500	49.3	27.9	24.8	11.5	8.5	8.0	49.5	23.0

Informative information only taken from the ISO/IEC 11801 Draft for Class E_A and is subject to change without notice.

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

Balanced Twisted Pair Cabling Components

100ohm Unshielded and Shielded Twisted Pair

Horizontal Cable

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

Category 3

Cables/connecting hardware with transmission parameters characterised up to 16 MHz.

Category 5e/Class D

Cables/connecting hardware with transmission parameters characterised up to 100 MHz.

Category 3 Horizontal and Backbone Cable (100 metres)			
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PSNEXT (dB)
0.772	2.2	43.0	43
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 Cat 3 cable propagation delay: 545 ns/100m @ 10 MHz

Maximum Cat 3 cable delay skew: 45 ns/100m @ 16 MHz

Category 5e Horizontal and Backbone Cable (100m)

Frequency (MHz)	Insertion Loss (dB)	NEXT* (dB)	PSNEXT (dB)	ELFEXT* (dB)	PSELFEXT (dB)	Return Loss (dB)
0.772	1.8	67.0	64.0			19.4
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

Maximum Cat 5e cable propagation delay: 538 ns/100m @ 100 MHz

Maximum Cat 5e cable delay skew: 45 ns/100m @ 100 MHz

Characteristic impedance of horizontal cabling = 100ohms \pm 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 and ISO 11801:2002 specifications, and that powersum NEXT loss created by adjacent jacketed cables be 3dB better than the normally allowed pair-to-pair NEXT for the cable type being tested. Colour codes must follow individual cable standards to distinguish them from multipair backbone cabling.

TIA UTP/ScTP Patch Cords**Jumper/Patch Cord Maximum Length Limitations:**

- 20m (66ft) in main cross-connect
- 20m (66ft) in intermediate cross-connect
- 6m (20ft) in telecom room
- 3m (10ft) in the work area

ISO UTP/ScTP Patch Cords Maximum Lengths:

- When MUTO used work area cord should not exceed 20 metres
- Refer to Table 12 of the ISO 11801 standard for equations of cord lengths

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. Lastly, UTP/ScTP 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)	2m Cord NEXT (dB)	5m Cord NEXT (dB)	10m 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

Attenuation: per 100 metres (328 feet) @ 20 °C = horizontal UTP cable attenuation + 20% (due to stranded conductors)

Note: ISO do not specify information on patch cords. These are referenced in the relevant IEC test standard for components.

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 characterised up to 250 MHz.

Matrix of Backward Compatible Mated Component Performance

	Class C/Cat 3	Class D/Cat 5e	Class E/Cat 6	Class F/Cat 7
Class C/Cat 3	Class C/Cat 3	Class C/Cat 3	Class C/Cat 3	Class C/Cat 3
Class D/Cat 5e	Class C/Cat 3	Class D/Cat 5e	Class D/Cat 5e	Class D/Cat 5e
Class E/Cat 6	Class C/Cat 3	Class D/Cat 5e	Class E/Cat 6	Class E/Cat 6
Class F/Cat 7	Class C/Cat 3	Class D/Cat 5e	Class E/Cat 6	Class F/Cat 7

Matrix of Backward Compatible Mated Component Performance

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

ISO 11801 AND TIA/EIA-568-B.3 Optical Fibre Cabling Components

Optical Fibre Cabling Systems

Optical Fibre Cabling Media

- Horizontal – 62.5/125 or 50/125 μ m multimode optical fibre (minimum of two fibres)
- Backbone – 62.5/125 or 50/125 μ m multimode or singlemode optical fibre

Cable Transmission Performance Parameters Multimode (Horizontal & Backbone)

Wavelength (nm)	Maximum Attenuation (dB/km)	62.5 μ m	50 μ m	50 μ m
		Minimum Bandwidth (MHz/km)	Minimum Bandwidth (MHz/km)	Laser Optimised (MHz/km)
850	3.5	160/200*	500	1500/2000
1300	1.5	500	500	500
*ISO Classification		OM1	OM2	OM3

OM1, OM2 and the lower bandwidth of 1500MHz/km OM3 are over filled launch bandwidths (LED). 2000MHz/km OM3 is designed for VCSEL laser launch.

Laser optimised fibres are designed to support legacy equipment as well as 300 metres for 10 Gigabit Ethernet using VCSEL Laser technology.

Cable Transmission Performance Parameters Singlemode (Backbone)

Wavelength (nm)	Inside Plant	Outside Plant
	Maximum Attenuation (dB/km)	Maximum Attenuation (dB/km)
1310	1.0	0.5
1550	1.0	0.5
ISO Classification OS1		

Optical Fibre Bend Radius

Fibre Type	Bend Radius
Small Inside Plant Cable (2–4 fibres)	25mm (no load)
	50mm (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 260 kilograms. (Drop cable pull strength may be 130 kilograms)

Note: Cable pulling strengths are dependent on the manufacturers recommendations not necessarily those stated.

Optical Fibre Connector

No specified connector: 568SC and other duplex designs may be used.

Colour Identification

- Beige or Black — multimode connector/coupling
- Blue — PC singlemode connector/coupling (SM APC Green)

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

Optical Fibre Telecommunications Outlet

Required Features

- Capability to terminate minimum of two fibres into 568SC couplings or other duplex connection. High density cross connects may use small form factor (SFF) connectors that meet the standards requirements
- Means of securing fibre and maintaining minimum bend radius of 25mm (1")

Optical Fibre Splices, Fusion or Mechanical

- Maximum attenuation 0.3dB
- Minimum return loss:
 - Multimode: 20dB
 - Singlemode: 26dB
 - Singlemode: 55dB (analogue CATV)

Optical Fibre Connector (mated pair)

- Maximum insertion loss 0.75dB

Patch Cords

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

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

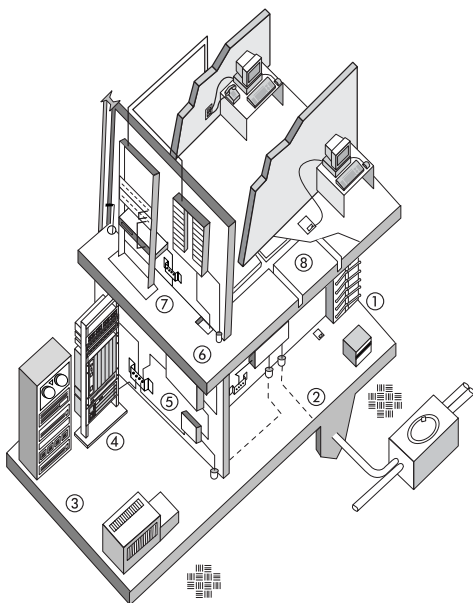
As the complexity of voice and data telecommunications has increased, standards have been established to ensure the operability, flexibility, manageability and longevity of these critical commercial support systems. Telecommunications now encompasses voice, data and video transmission of business information,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

A multi-tenant commercial building has a life expectancy of at least 50 years. Software, hardware and communications equipment have a far shorter lifespan of between one and five years. Moreover, in a multi-tenant environment, continuous moves, adds and changes are inevitable. It is the purpose of standards to guide design and ease future changes by planning for the future now. These standards are intended to provide for 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 metre

Pathways and Spaces



1. Electrical Entrance

2. Telco Entrance

3. Telecom Equipment Room

4. Data

5. Voice

6. Telecom Room

7. Grounding and Bonding

8. Under Floor System

TIA/EIA-569-B Design Considerations

Service Entrance Pathways

For underground facilities, use a minimum 10cm (4 inch) conduit or duct constructed of PVC, multiple plastic duct, galvanised steel, fibre glass.

With appropriate encasement. No more than two 90° manufactured bends are allowed (10 times the diameter). Drain slope should not be less than 30cm (12 inches) per 30m (100ft). Recommended conduit fill varies but should not exceed 40% for more than two cables.

Maintenance holes 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.

Entrance Facilities

Entrance facilities include the pathways for outside carrier services, interbuilding backbone, alternate entrance and antennae entrance pathways. 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 15m (50ft) of building penetration and to provide primary voltage protection.

In buildings larger than 2,000sq m (20,000sq ft) usable space, a locked, dedicated, enclosed room is recommended. Beyond 7,000sq m (70,000sq ft), a locked, dedicated room is required, with a plywood termination field provided on two walls.

In buildings up to 10,000sq m (100,000sq ft), a wall-mounted termination field may serve as the entrance facility, using 19mm (3/4-inch) plywood, 2.4m (8ft) high. Beyond 10,000sq m (100,000sq ft), rack-mounted and free-standing frames may also be required.

Minimum space requirements are given as follows:

Gross Building Floor Space sq m (sq ft)	Plywood Field m (ft) x m (inches)	Room Dimension m (ft)
1000 (10,000)	2.44m (8ft) high x 1m (39")	
2000 (20,000)	2.44m (8ft) high x 1.07m (42")	(A room recommended)
4000 (40,000)	2.44m (8ft) high x 1.727m (68")	beyond this level)
5000 (50,000)	2.44m (8ft) high x 2.28m (90")	
6000 (60,000)	2.44m (8ft) high x 2.44m (96")	(A dedicated room required)
8000 (80,000)	2.44m (8ft) high x 3.048m (120")	3.66m (12ft) x 1.9m (6.3ft)
10000 (100,000)	2.44m (8ft) high x 2 walls	3.66m (12ft) x 1.9m (6.3ft)
20000 (200,000)	2.44m (8ft) high x 2 walls	3.66m (12ft) x 2.74m (9ft)
40000 (400,000)	2.44m (8ft) high x 2 walls	3.66m (12ft) x 3.96m (13ft)
50000 (500,000)	2.44m (8ft) high x 2 walls	3.66m (12ft) x 4.72m (15.6ft)
60000 (600,000)	2.44m (8ft) high x 2 walls	3.66m (12ft) x 5.56m (18.3ft)
80000 (800,000)	2.44m (8ft) high x 2 walls	3.66m (12ft) x 6.78m (22.3ft)
100000 (1,000,000)	2.44m (8ft) high x 2 walls	3.66m (12ft) x 8.40m (27.7ft)

Rule of thumb: Allow 0.1sq m (1sq ft) of plywood wall mount for each 20sq m (200 sq ft) 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 sq m (sq ft)
1–100	14 (150)
101–400	37 (400)
401–800	74 (800)
801–1,200	111 (1,200)

Rule of thumb: Provide 0.07sq m (0.75sq ft) of equipment room floor space for every 10sq m (100sq ft) 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 1m x 2.44m (36" x 80") lockable doors, with no door sills.

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 2.4m, the height between finished floor and lowest point should be 3m to accommodate tall racks and overhead raceways. False ceilings should not be installed.

HVAC: 24 hours a day, 365 days a year, 18°C to 24°C, 30 to 55% humidity, positive pressure.

Lighting: Typically, 2.56m high, providing 500lux (50ft candles) at 1.0m above floor. With independent power from telecommunications equipment.

Electrical: Typically, a minimum of two dedicated 20 A, 230 V AC duplex outlets on separate circuits is required. Convenience duplex outlets shall be placed at 2m intervals around the perimeter. Emergency power should be considered and supplied if available.

Bonding and Grounding: Access shall be made available to the bonding and grounding as specified in J-STD-607-A or EN50310.

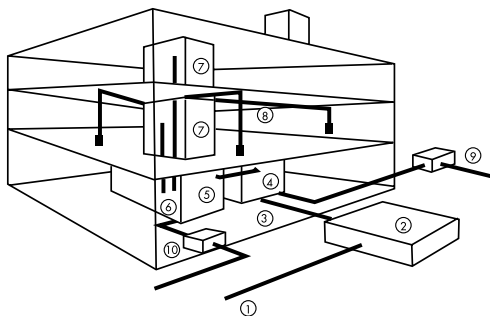
Dust: Less than 100 micrograms/cubic metre/24 hour period.

Floor loading: Rooms shall be located on floor areas designed with a minimum floor loading of 4.8 kPa. This will depend on localised heavy loads and if unusually heavy equipment is anticipated this will need to be increased.

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 telecom rooms.

Backbone Pathways

Within a building, the intrabuilding backbone pathways extend between the entrance facilities, equipment room and telecommunications rooms. Telecom rooms should be stacked vertically above each other on each floor, and provided with a minimum of three 10cm (4") sleeves (a stub of conduit through the floor) for less than 5000sq m (50,000 sq ft) served. An equivalent 10cm x 30cm (4" x 12") slot may be used in lieu of three sleeves. Fire stopping is required. If rooms are not vertically aligned, then 10cm (4") 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% for any run greater than two cables.



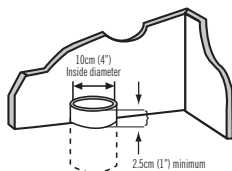
Backbone and Horizontal Pathways

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

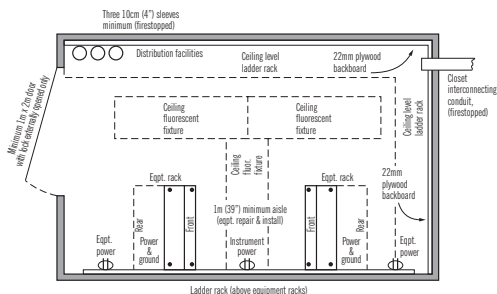
Telecommunications Room

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 telecom room per floor is required if distance to a work area exceeds 90m, or if floor area served exceeds 1000sq m (10,000sq ft). Recommended room sizing is 3m x 3.3m (10' x 11') for each 1000sq m (10,000sq ft) area served.

Power, lighting, air conditioning and limited access are typical. See requirements for equipment room. There are a minimum of three 10cm (4") fire stopped 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.



Riser Sleeve



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 run from the telecom room along J-hooks suspended above a plenum ceiling, which fan out once a work zone is reached. They then drop through interior walls or 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 embedded in greater than 6.4cm concrete flooring.

Flushduct

Single-level rectangular duct embedded flush in greater than 2.5cm concrete flooring.

Multi-channel Raceway

Cellular raceway ducts capable of routing telecom and power cabling separately in greater than 7.6cm (3") reinforced concrete.

Cellular Floor

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

Trenchduct

A wide, solid tray, sometimes containing compartments, and fitted with a flat top (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/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 low and flexibility (future changes) are not required.

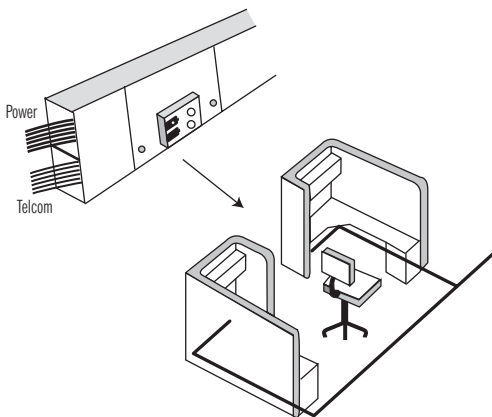
Cable Trays

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

Perimeter Pathways

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

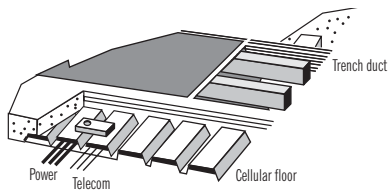
Rule of thumb: Typically, size horizontal pathways by providing 2.5cm^2 (1sq in) of cross-section area for every 10sq m (100sq ft) of workspace area being served.



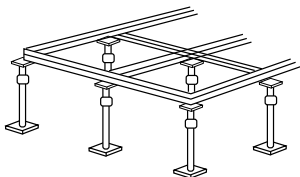
Perimeter Pathway and Modular Office Path

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 30m.

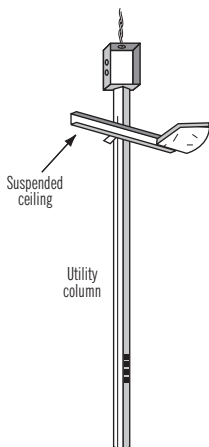
A Variety of Horizontal Pathways



Access Floor



Access Floor



Ceiling Utility Pole

Consolidation Points and MUTOs

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 multi-user telecommunication outlet assembly (MUTO) is another methodology to reduce cabling moves, adds and changes in modular furniture settings. The user cord is directly connected to the MUTO. A MUTO 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 MUTOs, see ANSI/TIA/EIA-568-B.1.

Electromagnetic Interference

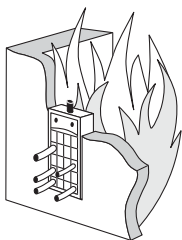
Voice and data telecommunications cabling should not be run adjacent and parallel to power cabling — even along short distances — unless one or both cable types are shielded and grounded. For low voltage communication cables, a minimum 127cm distance is required from any fluorescent lighting fixture or power line over 2 kVA and up to 60cm from any power line over 5 kVA*.

In general, telecommunications cabling is routed separately, or 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.

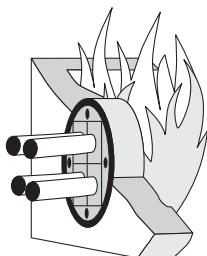
***Note:** Distance recommendations from (1990) TIA/EIA-569 are reproduced here by popular request. For current recommendations, refer to country specific requirements.

Firestopping

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 briefly discusses passive mechanical systems and non-mechanical systems such as putty, caulk, cements, intumescent sheets and strips, silicone foams and pre-manufactured pillows. The most common method is stuffing all apertures with ceramic/mineral wool and caulking both sides with fire-resistant putty. The information refers the designer to check manufacturer specifications and UL ratings against EN1366-3, DIN 4102-9 and BS 476-3.



Rectangular



Round

The TIA/EIA-569-B standard is an in-depth document covering all aspects of the pathways and spaces within a building. These extracts are designed to give an idea as to the content and have many similar chapters to the TIA/EIA-569-A standard that is now superseded. Within Europe the ISO/IEC18010:2002 should be consulted.

Introduction to ISO/IEC18010:2002 Pathways and Spaces for Customer Premises Cabling

The TIA-569-B standard is widely accepted within the data communications market and referenced extensively around the world. An international standard is also available. The following information has been extracted from the ISO/IEC 18010 standard.

Building Telecommunications Spaces

Work Area (WA)

- A minimum of two separate outlet locations should be provided in the initial design located to offer maximum flexibility within the work area

Telecommunications Room (TR) or Floor Distributor (FD)

- Should contain telecommunications equipment, cable, terminations and associated cross-connect cables
- Located as close as possible to the centre of the area to be served. Horizontal pathways should terminate in this location
- The TR should not be shared with electrical installations other than those for telecommunications
- A minimum of two electrical outlets from separate supplies shall be provided. Additional outlets shall be placed around the room at regular intervals
- Environmental requirements apply only to cabling based on ISO/IEC 11801. HVAC should be included in the design to maintain a temperature the same as the adjacent office area

Equipment Room (ER) or Building Distributor (BD)

- Any or all of the functions of a TR or building entrance facility may alternatively be provided by an equipment room
- Considerations
 - Floor loading
 - Access for heavy equipment
 - Located above water levels
 - HVAC to be supplied
 - Locate away from sources of EMI/RFI interference

Access Floor

- In new constructions the access floor should be depressed.
This depth shall be the same as the finished access floor.
- Where this is not possible then suitable ramps or steps shall be installed.
- Care should be taken to ensure there is sufficient clearance below the access floor surface.
- Considerations should be given to the following:
 - Quantity of cables, especially in areas with restricted access
 - Secondary pathway system, if any
 - Crossing of cableruns
 - Bend radius limitations of the cable to enable cable exit
 - Sufficient space for access
 - Other services

Cable Trunking systems (Conform to IEC 61084)

- Types include:
 - Wall and ceiling cable trunking systems
 - Floor cable trunking systems
 - Service poles made from cable trunking
 - Cable tray and ladder
 - Conduit systems
 - Furniture pathways
 - In wall cabling
 - Service poles

Campus pathways and related spaces

- These include:
 - Direct buried pathways
 - Underground pathways
 - Tunnels
 - Aerial
 - Building entrance facilities
 - Maintenance holes
 - Handholes

For full details please refer to the full ISO/IEC 18010 standard.

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

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

TIA/EIA-606-A Administration Standard

Administration Concepts

The typical administration system includes records, reports, drawings and work orders.

Identifiers

Each space, pathway, cable termination point and ground is assigned a unique identifier – a number that can be simply encoded to provide supplemental information.

Telecommunication Records

Minimum required records for each cable, space, pathway, ground, termination hardware and position are maintained. These records are required to be linked (cross-referenced) to all related records.

Optional Linkages

Optional linkages may be made to other records. Such records might include blueprints, PBX records, equipment inventories (phones, PCs, software, LAN, furniture) and user codes (extension, account billing number, passwords).

It is desirable that reports can be generated from one or more sets of interlinked records in a variety of formats.

Drawings

Drawings, both conceptual and as-built, include floor plans, cable schematics and rack layouts.

Work Orders

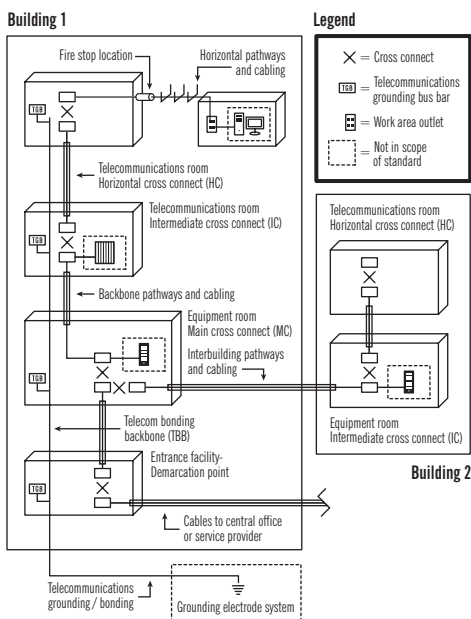
Work orders may involve spaces, pathways, cables, splices, terminations or grounding, individually or in combination. The work order should list those responsible for physical changes, as well as those updating the documentation to ensure future accuracy.

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/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.



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 labelling. An administration system can be managed using a paper-based system, general-purpose spreadsheet software, or special-purpose cable management software.

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 2 Administration

Class 2 addresses the administration of infrastructure with one or more Telecommunications Spaces (TSs) 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 fibre identifier
- Firestopping location identifier

Class 2 administration may additionally include pathway identifiers.

Class 3 Administration

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

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

- Identifiers required in Class 2 administration
- Building identifier
- Campus backbone cable identifier
- Campus backbone pair or optical fibre 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 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
- Inter-campus element identifier

Additional identifiers may be added if desired.

The following table summarises the required identifiers for each class of administration:

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
fs₁/fs₂-n	Building Backbone Cabling		R	R	R
fs₁/fs₂-n.d	Building Backbone Pair or Optical Fibre		R	R	R
f-FSLn(h)	Firestop Location		R	R	R
[b₁.fs₁]/[b₂.fs₂]-n	Campus Backbone Cable			R	R
[b₁.fs₁]/[b₂.fs₂]-n/d	Campus Backbone or Optical Fibre			R	R
b	Building			R	R
c	Campus or Site				R
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 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 4pair 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 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 other end of the backbone cable			
	n =	one or two alpha-numeric 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 fibre			
	FSL =	an identifier referring to a firestopping location			
	h =	one numeric character specifying the hour rating of a firestopping system			
	[b ₁ .fs ₁]/[b ₂ .fs ₂]-n =	Campus Backbone Identifier			
Class 3 Identifiers	d =	two to four numeric characters identifying a single copper pair or a single optical fibre			
	b =	one or more alpha-numeric characters identifying a single building			
Class 4 Identifiers	c =	one or more alpha-numeric characters identifying a campus or a site			

Identification Formats

A unique alphanumeric identification code is created for every location, pathway, cable and termination point. Suggestions in the standard include:

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

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 the organisation and updating of multiple records by the use of powerful relational database (three-dimensional spreadsheet) programmes.

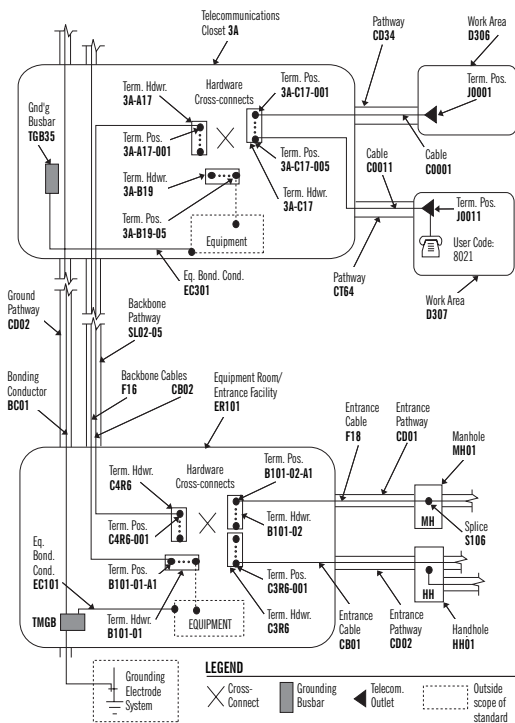
Identification Example

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 Labelling 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.

Administrative Labelling Map

Here is a combination schematic/elevation view of a structured telecommunications cabling system, detailing a TIA/EIA-606-A compliant labelling scheme. The example records in this guide follow the labelling shown below.



Summary of Record Elements

This table outlines the minimum required information and required linkages. Further information is optional. A multi-dimensional 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	
Splice	Cable Pair/Condition #s	Space Records	
	Splice Identification #	Cable Records	
Grounding	TMGB	Splice Type	Space Records
		TMGB Identification #	Bonding Conductor Records
		Busbar Type	Space Records
		Grounding Conductor #s	
		Resistance to Earth	
		Date of Measurement	
	Bonding	Bonding Conductor ID#	Grounding Busbar Records
		Conductor Type	Pathway Records
	Conductor	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/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 coloured green or labelled appropriately with an alphanumeric identifier and warning label. Grounding records are similar to cable record format.

Grounding/Bonding Terms (with acronyms):

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

Label Colour Coding

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

Termination Type	Colour	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	Grey	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 J-STD-607-A

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.

Design Considerations

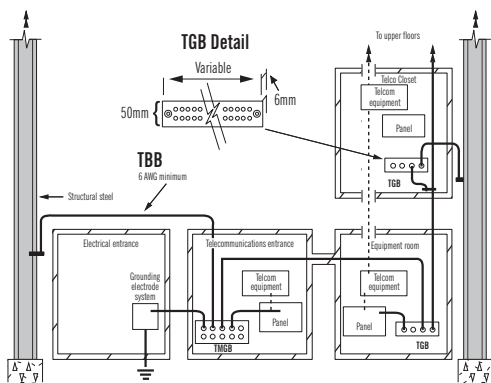
Solid copper grounding busbars 6mm x 10cm x variable length (1/4" thick x 4" high x variable length) are installed with insulated standoffs in entrance facilities and the equipment room, as well as each telecom room (6mm thick x 50mm high x variable length is sufficient here). Each busbar is drilled 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 16mm², 95mm² 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 coloured green or labelled appropriately.

Terms

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

(See schematic of grounding/bonding opposite.)



Schematic of Grounding/Bonding Network

EN 50310 Application of equipotential bonding and earthing in buildings with information technology equipment.

The EN 50310 standard should be referenced in Europe. EN 50310 should be applied at least in the case of newly constructed buildings and whenever possible in existing buildings.

The Purpose of ANSI/TIA-942-2005 Telecommunications Infrastructure Standard for Data Centers

- 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 vendors, and system service suppliers for applicability, limitations, and ancillary requirements. Consider consolidating standardised and proprietary cabling into a single structured cabling system.

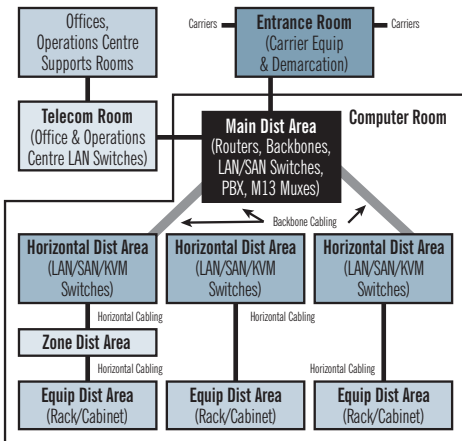
The Standard Specifies:

- Cabling Design
- Network Design
- Facilities Design
- Informative Annexes containing “Best Practices” and availability requirements
- Spaces
- Pathways
- Racks/Cabinets

Data Center Cabling Infrastructure

The basic elements of the data center cabling system structure are 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

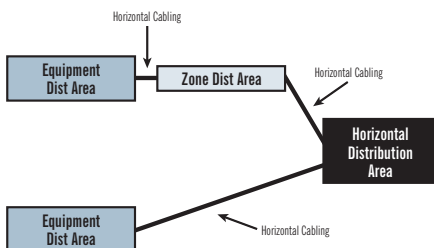


Horizontal Cabling

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 the horizontal cabling is designed:

- 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 signalling systems (building automation systems such as fire, security, power, HVAC, Building Automation Systems, etc.).

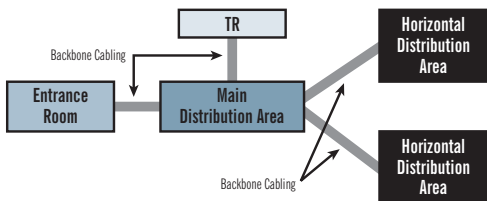


Horizontal Cabling Using Star Topology

Length of Horizontal Cable (H)	24 AWG UTP/24 AWG ScTP Patch Cords		26 AWG ScTP Patch Cords	
	Maximum Length of Zone Area Cable (Z)	Maximum Combined Length of Zone Area Cables, Patch Cords and Equipment (C)	Maximum Length of Zone Area Cable (Z)	Maximum Combined Length of Zone Area Cables, Patch Cords and Equipment Cable (C)
m (ft)	m (ft)	m (ft)	m (ft)	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.



Backbone Cabling Using Star Topology

Recognised Cabling Media for Horizontal and Backbone Applications

Recognised 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.

- 100ohm twisted pair cable (ANSI/TIA/EIA-568-B.2), Category 6 recommended (ANSI/TIA/EIA-568-B.2-1)
- Multimode optical fibre cable, either 62.5/125 micron or 50/125 micron (ANSI/TIA/EIA-568-B.3), 50/125 micron 850 nm laser optimised multimode fibre is recommended (ANSI/TIA-568-B.3-1)
- Singlemode optical fibre cable (ANSI/TIA/EIA-568-B.3)
- The recognised coaxial media are 75ohm (734 and 735 type) coaxial cable (Telcordia Technologies GR-139-CORE) and coaxial connector (ANSI T1.404).

Within Europe the following cables would be recognised for use in the Data Center.

- 100ohm twisted pair cable (ISO 11801:2002) Class E recommended
- Multimode optical fibre cable, either OM2, OM3 overfilled or laser optimised
- OS1 singlemode optical fibre
- Coaxial as above

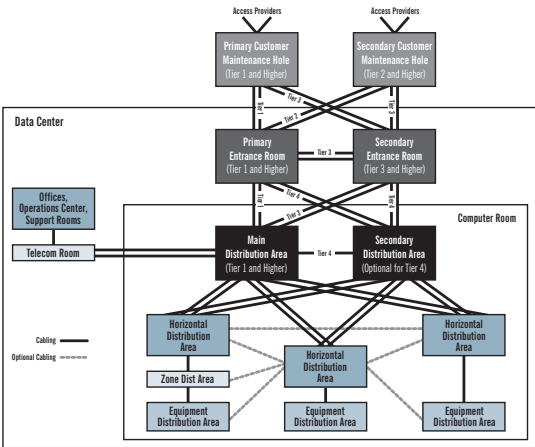
Redundancy

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 define four tiers of performance as shown in the following table.

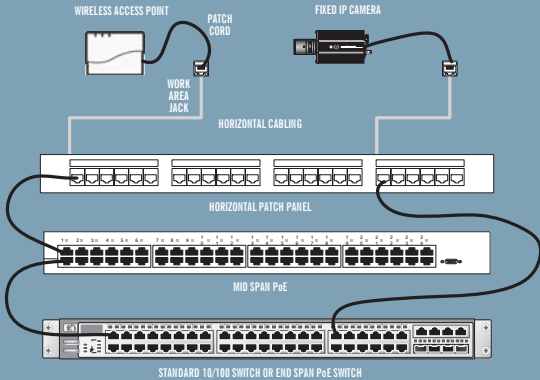
	Tier I: Basic Components	Tier II: Redundant Maintainable	Tier III: Concurrently Tolerant	Tier IV: Fault Tolerant
Number of Delivery paths	Only 1	Only 1	1 Active, 1 Passive	2 Active
Redundant Components	N	N + 1	N + 1	2 (N + 1) S+S
Support Space to Raised Floor Ratio	20%	30%	80-90%	100%
Initial Watts/m ²	60-90	120-150	120-180	150-240
Ultimate Watts/m ²	60-90	120-150	300-450	450+
Raised Floor Height	30cm	45cm	80-90cm	80-90cm
Floor Loading Kilograms/m ²	415	488	732	732+
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
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 providing 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.



IEEE-802.3af Power over Ethernet (PoE) Standard

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



IEEE 802.3an 10GBASE-T Standard

The IEEE 802.3an 10 Gigabit Ethernet standard has been created to support 10GBASE-T transmission over twisted pair cabling. The cabling standards are in draft format at time of going to press. See TIA/EIA-568-B addendum 10 for Augmented Cat 6 and ISO 11801 draft for Class E_A within this guide.

IEEE 802.3an Standard			
IEEE Model	Standard	Media	Distance
1	ISO Class F (individual shields)	STP	100m
	ISO Class E _A	UTP	100m
	TIA Augment Cat 6	UTP	100m
2,3,4	Shielded Cat 6 (overall shield)	FTP	100m
	TIA Standard Cat 6/ ISO Class E*	UTP	< 55m

* Mitigation guidelines are available for testing a Category 6/Class E installation. Please refer to TIA TSB-155, ISO/IEC-24750 or CENELEC EN 50173-99-1.

Cabling types and distances		
Cabling	Supported link segment distances	Cabling references
Class E/Category 6	35 to 100m**	ISO/IEC TR-24750 or TIA/EIA TSB-155
Class E/Category 6: unshielded	35m	ISO/IEC TR-24750 or TIA/EIA TSB-155
Class E/Category 6: screened	100m	ISO/IEC TR-24750 or TIA/EIA TSB-155
Class F	100m	ISO/IEC TR-24750
New Class E _A /Augmented Category 6	100m	ISO/IEC 11801 Ed 2.1 or TIA/EIA-568-B.2-10

** Supported link segments up to 100m shall meet the alien crosstalk to insertion loss requirements specified in 55.7.3.1.2 and 55.7.3.2.2

ANSI/EIA/TIA-568-B.2-ad10 (Augmented Category 6) and ISO Class E_A cable specifications are based on IEEE models. Both TIA and ISO standards are in draft format at the time of going to print.

The IEEE created four models, which specify distance limitations based on media types.

100 metres over UTP is only guaranteed when using the ANSI/EIA/TIA-568-B.2-ad10 Augmented Cat 6 or ISO Class E_A cables and components.

10 Gigabit Ethernet Channel Applications

Application	10GBase Fibre (802.3ae)	10GBase-T	10GBase-CX4 (802.3ak)
Data Center (Server Clustering)	Yes	Yes	Yes (<15m)
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 fibre 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 multi-conductor copper solution primarily designed to connect servers and switches over short distances.

IEEE-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 54Mbit/sec. signalling 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 isn't 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 signalling rates of up to 11Mbit/sec. 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 of 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, but this standard supports signalling rates of up to 54Mbit/sec. 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 — Predicted for ratification in mid-2007, 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 minimise interference.

802.11n — The Standard for Enhancements for Higher Throughput is designed to raise effective WLAN throughput to more than 100Mbit/sec. Final ratification is expected in 2007.

The Anixter Infrastructure Solutions Lab

Anixter's Infrastructure Solutions Lab allows us to actively demonstrate the best practical technology solutions from best in class manufacturers in the area of enterprise cabling solutions, video security and access control systems 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 network infrastructure and security 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 towards convergence

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 fibre 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 utilisation
- Power over Ethernet capability and verification
- Digital compression image quality vs. analogue technology testing
- Evaluation of analogue and IP cameras, video management software evaluation, DVR, NDVR and NVR products

Business Drivers Affecting the Purchase of Enterprise Cabling Products:

- New applications
- Higher bandwidth requirements
- Convergence
- Maintain competitive edge
- Cost of Moves, Adds and Changes (MACs)
- Business process efficiencies

Business Drivers Affecting the Purchase of Security Products:

- Convergence of IT and Security
- Analogue to digital technology shift
- Loss prevention
- Systems integration
- Preventative security precautions
- Asset protection

Anixter's Infrastructure Solutions Lab In Action

Problem: Leading Pennsylvania University Explores Campus-Wide Rewiring Project

The Anixter Infrastructure Solutions Lab was called upon to help this university determine which copper cabling system would best meet their current and future information technology needs. The university had a variety of different copper cabling products installed in their network infrastructure — Category 3, Category 5 and some Category 5e. The Anixter Infrastructure Solutions Lab deployed computer applications that the university typically carried over their cabling infrastructure including Lotus Notes, SAP and streaming video. Testing found that their 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 Cat 6 system that better met the university's network performance needs.

Problem: Major Railway Company Needs Video Surveillance To Monitor Switchyard

This railroad wanted to use video surveillance to monitor yards as they assembled unit trains, but had a big cabling challenge in front of them. Installing traditional cabling in the switchyard would have entailed major disruptions and expense for the customer. The Anixter Infrastructure Solutions Lab recommended a sophisticated wireless internet video surveillance system that didn't 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

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, 50-micron, and laser- optimised 50-micron fibre (LOMF) to ascertain which would best meet their needs. These tests were key in determining that the LOMF was the customer's best choice.

Anixter's 10 Gigabit Ethernet Cabling Testing

The Anixter Infrastructure Solutions Lab is the only UL-certified lab to conduct rigorous, independent 3rd party testing of the emerging 10 Gigabit cabling solutions. Anixter's 10 Gigabit cabling testing examines electrical characteristics such as attenuation, return loss, and crosstalk, but also looks at alien crosstalk (which is part of the Augmented Cat 6 draft 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 the "worst case" scenario. You can rest assured that the cabling solutions Anixter sells will provide the network performance you require.



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-ad10 (Draft)

Balanced Twisted Pair Cabling Components

TIA/EIA-568-B.3 (2000)

Optical Fibre Cabling Components Standard

TIA/EIA-569-B (1998) (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

TIA/EIA-758 (1999)

Customer-owned Outside Plant Telecommunications Cabling Standard

TIA/EIA-942 (2005)

Telecommunications Infrastructure Standard for Data Centers

ISO/IEC 11801 (2002)

Generic Cabling for Customer Premises

*Canadian Standards Association equivalent document

ISO/IEC 18010 (2002)

Pathways and spaces for customer premises cabling

EN 50173-1:2002

Part 1: General requirements and office areas

EN 50174-1:2001

Part 1: Specification and quality assurance

EN 50174-2:2001

Part 2: Installation planning and practices inside buildings

EN 50174-3:2003

Part 3: Installation planning and practices outside buildings

EN 50310:2006

Application of equipotential bonding and earthing in buildings with information technology equipment

IEEE 802.3 REVISION 5

Carrier sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specification

IEEE 802.3an (2006)

Physical Layer and Management Parameters for 10 Gb/s 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

ISO/IEC and TIA/EIA documents may be purchased through Global Engineering Documents on www.global.ihs.com. IEEE documents may be purchased on www.ieee.org. CSA documents may be purchased through the Canadian Standards Association at www.csa.ca. ISO documents may be purchased on www.iso.org. CENELEC documents may be purchased on www.cenelec.org.

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