STANDARDS

SIEMON GUIDELINES TO INDUSTRY STANDARDS

Since the first release of the Commercial Building Telecommunications Cabling Standard (ANSI/TIA/EIA-568 in 1991), the volume of standards information available to the end-user community has increased substantially. As a result, The Siemon Company has focused efforts on educating our customers on the importance of generic, standards-based components and system requirements. The following information has been condensed from a compilation of relevant national and international telecommunications standards and provides a reference to the most commonly used information. Our active involvement in standards development provides us with advance information on emerging standards requirements for both the premises cabling and the applications that the cabling is intended to support. We have also included a preview of pending standards projects.

SECTION CONTENTS

SECTION CONTENTS

AN OVERVIEW OF CABLING STANDARDS

ANSI/TIA/EIA-568-B and ISO/IEC 11801 2nd Edition

The latest edition of the Commercial Building Telecommunications Cabling Standard is ANSI/TIA/EIA-568-B. The Telecommunications Industry Association (TIA) TR42 Technical Committee has broken the standard into a series of documents known as B.1, B.2 and B.3. The B.1 document contains the information needed for designing, installing, and field testing a generic structured cabling system. The B.2 and B.3 documents contain manufacturing and component reliability test specifications for cable, patch cords and connecting hardware. The B.3 document was published in April 2000 dealing with optical fiber. The B.2 document addresses electrical and mechanical requirements of balanced twisted-pair UTP and ScTP. Both B.1 and B.2 are expected for publication Q2 2001.

Also, the International Organization for Standardization (ISO) JTC1 SC 25/WG 3 Working Group on telecommunications cabling continues refinements of the ISO/IEC 11801 standard. January 2000 is the publication date for Edition 1.2 of this standard. The pending second edition of the standard addresses class E and F cabling as well as category 6 and 7 connecting hardware and cables. Items of interest are the work area interface for category 7 and coupling attenuation for copper systems. In optical fiber, the document has standardized on three classes of optical fiber cabling to service existing and future networking applications for channel lengths of 300m, 500m and 2000m. The release of this document is expected Q1 2001.

Following are highlights of the '568-B series standard which has incorporated Telecommunications System Bulletins (TSB's) TSB 67, TSB 72, TSB 75, TSB 95, Addendum's TIA/EIA-568-A-1, 'A-2, 'A-3, 'A-4, and 'A-5 and TIA/EIA/IS-729. For clarity and consistency, '568-B based terminology is used in the following overview with notes on differences in terminology and technical requirements with respect to '11801.

Purpose

- To specify a generic telecommunications cabling system that will support a multi-product, multi-vendor environment.
- To provide direction for the design of telecommunications equipment and cabling products intended to serve commercial enterprises.
- To enable the planning and installation of a structured cabling system for commercial buildings that is capable of supporting the diverse telecommunications needs of building occupants.
- To establish performance and technical criteria for various types of cable and connecting hardware and for cabling system design and installation.

Scope

- Specifications are intended for telecommunications installations that are "office oriented".
- Requirements are for a structured cabling system with a usable life in excess of 10 years.
- Specifications addressed:
  - Recognized Media
  - Cable and Connecting Hardware
  - Performance
  - Topology
  - Cabling Distance
  - Installation Practices
  - User Interfaces
  - Channel Performance

Cabling Elements:

- Horizontal Cabling:
  - Horizontal Cross-connect (HC)
  - Horizontal Cable
  - Transition Point (optional)
  - Consolidation Point (optional)
  - Telecommunications-Outlet/Connector (TO)
- Backbone Cabling:
  - Main Cross-connect (MC)
  - Interbuilding Backbone Cable
  - Intermediate Cross-connect (IC)
  - Intrabuilding Backbone Cable
- Work Area (WA)
- Telecommunications Room (TR)
- Equipment Room (ER)
- Entrance Facility (EF)
- Administration*

**Although administration is addressed to a limited extent, the governing specification on telecommunications administration is ANSI/TIA/EIA-606 and ISO/IEC 14763-1*

ANNEX INFORMATION

B.1

A. Centralized optical fiber cabling (Normative).

B. Shared sheath guidelines for multi-pair UTP cables (Informative).

C. Other cable specifications (Informative)

D. Category 5 cable transmissions (Informative).

E. Optical Fiber applications support information (Informative).

F. Bibliography (Informative).

B.2

A. Reliability testing of connecting hardware used for 100 Ω UTP cabling (Normative).

B. Transmission testing of connecting hardware used for 100 Ω UTP cabling (Normative).

C. Test instruments (Normative).

D. Reference measurements procedures (Normative).

E. 100 Ω Screened twisted-pair (ScTP) cabling (Normative).

F. Derivation of Propagation Delay from insertion loss equation (Normative).

G. 150 Ω Shielded twisted-pair cabling (Informative).

H. Category 5 cabling (Informative).

I. Test Plug qualification procedure (Normative).

J. Modular patch cord test procedure (Normative).

K. Development of channel and component return loss limits (Informative).

L. Bibliography (Informative).

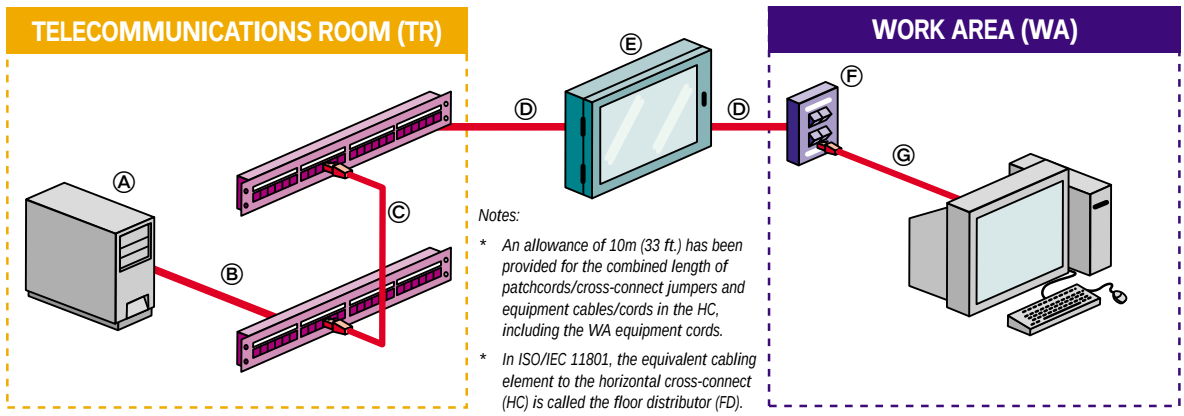
B.3

A. Optical fiber connector performance specifications (Normative).

B. Bibliography and references (Informative).

HORIZONTAL CABLING SYSTEM STRUCTURE

The horizontal cabling system extends from the telecommunications outlet in the work area to the horizontal cross-connect in the telecommunications room. It includes the telecommunications outlet, an optional consolidation point or transition point connector, horizontal cable, and the mechanical terminations and patch cords (or jumpers) that comprise the horizontal cross-connect.



Notes:

* *An allowance of 10m (33 ft.) has been provided for the combined length of patchcords/cross-connect jumpers and equipment cables/cords in the HC, including the WA equipment cords.*

* *In ISO/IEC 11801, the equivalent cabling element to the horizontal cross-connect (HC) is called the floor distributor (FD).*

Ⓐ Customer Premises Equipment

Ⓑ HC Equipment Cord

Ⓒ Patchcords/cross-connect jumpers used in the HC, including equipment cables/cords, should not exceed 5m (16 ft.)

Note: ISO/IEC 11801 specifies a max. patchcord/cross-connect length of 5m (16.4 ft.), which does not include equipment cables/cords.

Ⓓ Horizontal cable 90m (295 ft.) max. total

Ⓔ TP or CP (optional)

Ⓕ Telecommunications outlet/connector (TO)

Ⓖ WA Equipment cord

Note: An allowance is made for WA equipment cords of 5m (16 ft.)

Some points specified for the horizontal cabling subsystem include:

- Recognized Horizontal Cables:

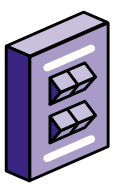
  4-pair 100 Ω unshielded twisted-pair

  2-fiber (duplex) 62.5/125µm or 50/125µm multimode optical fiber

  Note: ISO/IEC 11801 allows 120 Ω unshielded twisted-pair horizontal cabling.

- Multi-unit cables are allowed, provided that they satisfy the hybrid/bundled cable requirements of proposed TIA/EIA-568-B.2.
- Grounding must conform to applicable building codes, as well as ANSI/TIA/EIA-607.
- A minimum of two telecommunications outlets are required for each individual work area.

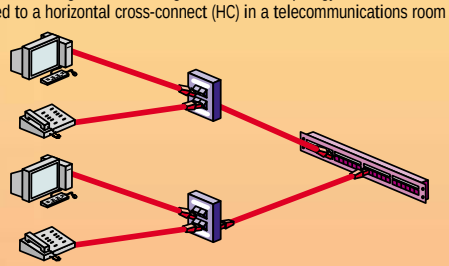
  First outlet: 100 Ω twisted-pair (category 5e is recommended).

  Second outlet: 100 Ω twisted-pair category 5e.

  Two-fiber multimode optical fiber either 62.5/125µm or 50/125µm.
- One transition point (TP) or Consolidation Point (CP) is allowed. The term "transition point" will be removed from the second edition of ISO/IEC 11801. Under carpet cabling will no longer be covered by that standard.
- 150 Ω STP-A cabling is not recommended for new installations.
- Additional outlets may be provided. These outlets are in addition to and may not replace the minimum requirements of the standard.
- Bridged taps and splices are not allowed for copper-based horizontal cabling. (Splices are allowed for fiber.)
- Application specific components shall not be installed as part of the horizontal cabling. When needed, they must be placed external to the telecommunications outlet or horizontal cross-connect (eg. splitters, baluns).
- The proximity of horizontal cabling to sources of electromagnetic interference (EMI) shall be taken into account.

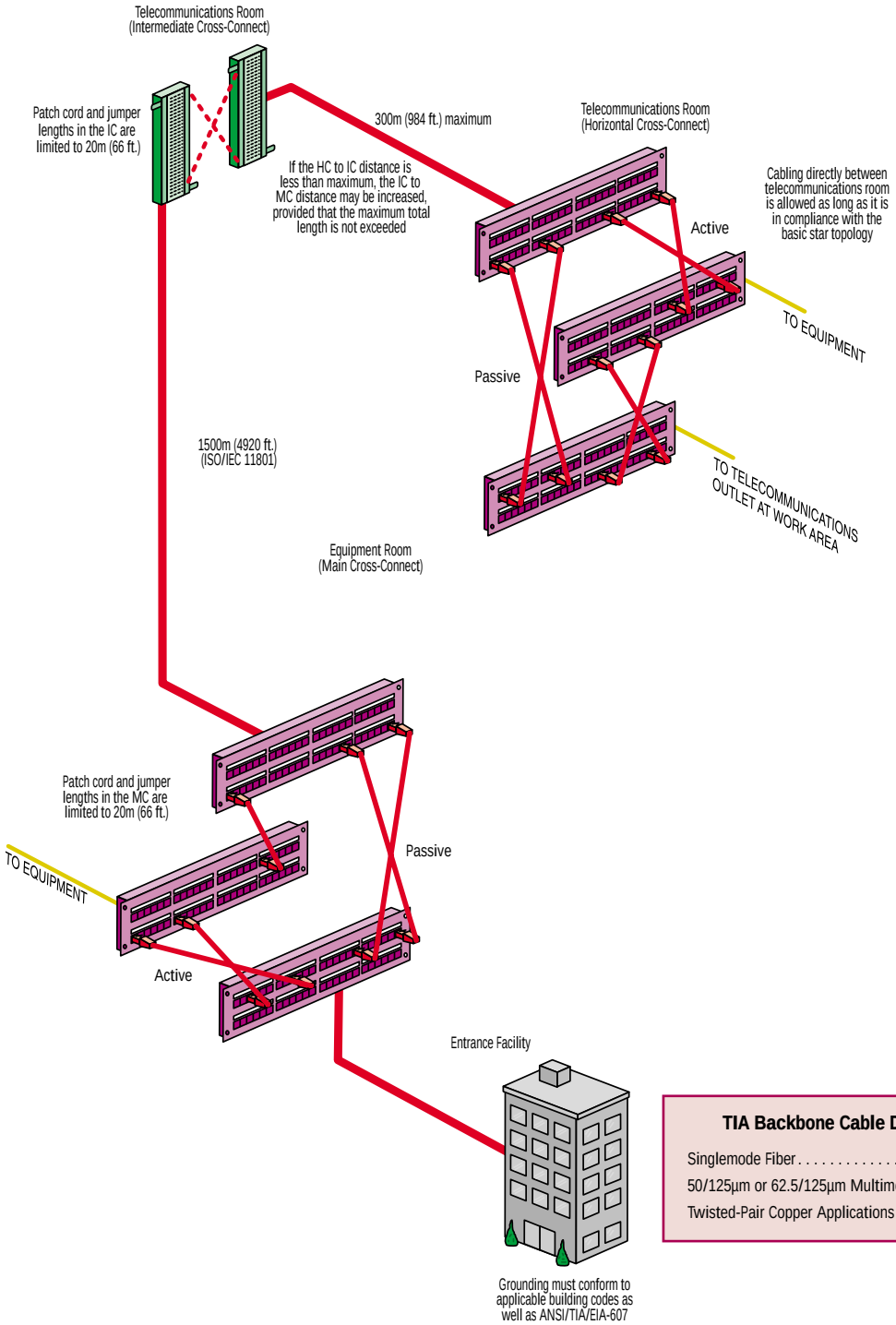
Topology

The horizontal cabling shall be configured in a star topology; each work area outlet is connected to a horizontal cross-connect (HC) in a telecommunications room (TR).



BACKBONE CABLING SYSTEM STRUCTURE

The backbone cabling system provides interconnections between telecommunications rooms, equipment rooms, and entrance facilities. It includes backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connections. The backbone also extends between buildings in a campus environment.



TIA Backbone Cable Distances (MC to HC)

Singlemode Fiber	3000m (9840 ft.)
50/125µm or 62.5/125µm Multimode Fiber	2000m (6560 ft.)
Twisted-Pair Copper Applications < 5 MHz	800m (2625 ft.)

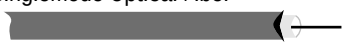
Some points specified for the backbone cabling subsystem include:

- Equipment connections to backbone cabling should be made with cable lengths of 30m (98 ft.) or less.
- The backbone cabling shall be configured in a star topology. Each horizontal cross-connect is connected directly to a main cross-connect or to an intermediate cross-connect, then to a main cross-connect.
- The backbone is limited to no more than two hierarchical levels of cross-connects (main and intermediate). No more than one cross-connect may exist between a main and a horizontal cross-connect and no more than three cross-connects may exist between any two horizontal cross-connects.
- A total maximum backbone distance of 90m (295 ft.) is specified for high bandwidth capability over copper. This distance is for uninterrupted backbone runs. (No intermediate cross-connect).
- The distance between the terminations in the entrance facility and the main cross-connect shall be documented and should be made available to the service provider.
- Recognized media may be used individually or in combination, as required by the installation. Quantity of pairs and fibers needed in individual backbone runs depends on the area served. Recognized backbone cables are:

100 Ω Twisted-Pair

50/125µm or 62.5/125µm Multimode Optical Fiber

Singlemode Optical Fiber



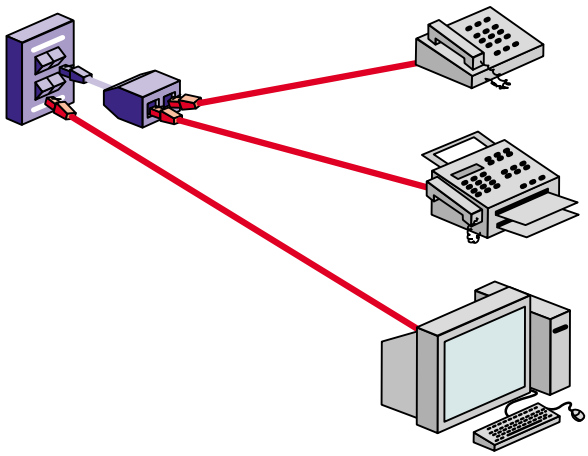
- Multi-pair cable is allowed, provided that it satisfies the power sum crosstalk requirements.
- The proximity of backbone cabling to sources of electromagnetic interference (EMI) shall be taken into account.
- Cross-connects for different cable types must be located in the same facilities.
- Bridged taps and splitters are not allowed.

Notes: In ISO/IEC 11801, the equivalent cabling elements to the main cross-connect (MC) and intermediate cross-connect (IC) are called the campus distributor (CD) and building distributor (BD) respectively.

In addition to those listed, ISO/IEC will allow 120 Ω twisted-pair.

WORK AREA

The telecommunications outlet serves as the work area interface to the cabling system. Work area equipment and cables used to connect to the telecommunications outlet are now included within the scope of proposed '568-B.1 and '11801.



Some specifications related to work area cabling include:

- Equipment cords are assumed to have the same performance as patch cords of the same type and category.
- When used, adapters are assumed to be compatible with the transmission capabilities of the equipment to which they connect.
- Horizontal cable lengths are specified with the assumption that a maximum cable length of 5m (16 ft.) is used for equipment cords in the work area.

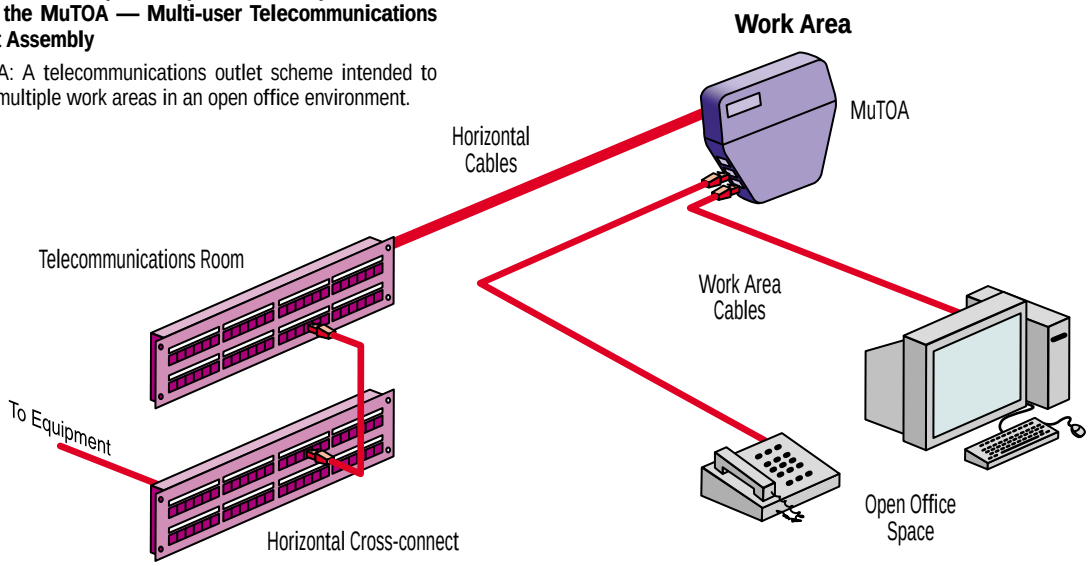
Note: For establishing maximum horizontal link distances, a combined maximum length of 10m (33 ft.) is allowed for patch cables (or jumpers) and for equipment cables in the work area and the telecommunications room.

OPEN OFFICE CABLING

Additional specifications for horizontal cabling in areas with moveable furniture and partitions have been included in proposed TIA/EIA-568-B.1. Horizontal cabling methodologies are specified for "open office" environments by means of multi-user telecommunications outlet assemblies and consolidation points. These methodologies are intended to provide increased flexibility and economy for installations with open office work spaces that require frequent reconfiguration.

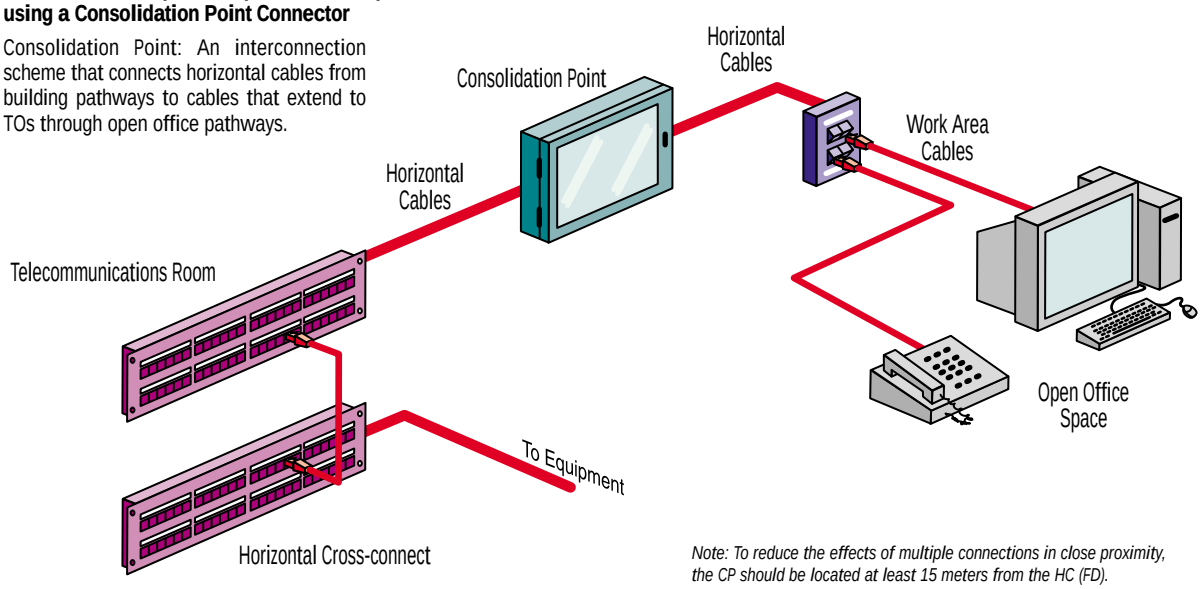
This is an example of Open Office Implementation using the MuTOA — Multi-user Telecommunications Outlet Assembly

MuTOA: A telecommunications outlet scheme intended to serve multiple work areas in an open office environment.



This is an example of Open Office Implementation using a Consolidation Point Connector

Consolidation Point: An interconnection scheme that connects horizontal cables from building pathways to cables that extend to TOs through open office pathways.



Note: To reduce the effects of multiple connections in close proximity, the CP should be located at least 15 meters from the HC (FD).

HORIZONTAL DISTANCES OF COPPER LINKS (OPEN OFFICE)

Copper work area cables connected to a MuTOA, shall meet the requirements of proposed '568-B.1. The maximum length of copper work area cables shall be determined according to:

C = (102 – H) / 1.2*
W = C – 5 ≤ 22m(71 ft.)

Where:

C is the maximum combined length (m) of the work area cable, equipment cable, and patch cord (m).
W is the maximum length (m) of the work area cable.
H is the length (m) of the horizontal cable.

The above equations assume that there is a total of 5m (16 ft.) of patch and equipment cables in the telecommunications room. Table 1 shows the application of these formulae. The length of work area cables shall not exceed 22m (71 ft.). The MuTOA shall be marked with the maximum allowable work area cable length.

Length of Horizontal Cable	Maximum Length of Work Area Cable	Maximum Combined Length of Work Area Cables, Patch Cords, and Equpment Cable
H m (ft.)	W * m (ft.)	C * 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 (71)	27 (89)

Table 1 — Maximum Length of Work Area Cables

Note: The preceding equation and table are based on patch cables having 20% more attenuation than horizontal cables. If higher gauge (e.g. 26 AWG) cables are used that have 50% higher attenuation than solid, as allowed by ISO/IEC 11801, these lengths must be reduced accordingly.

HORIZONTAL DISTANCES OF OPTICAL FIBER LINKS (LONG WORK AREA CABLES)

For optical fiber cables, any length combination of horizontal cables and work area cables is acceptable as long as the total combined length of the horizontal channel does not exceed 100m (328 ft.).

When deploying a centralized fiber cabling topology, the general guidelines of proposed 568-B.1 shall be followed.

Advantages and Features

- It is preferable to use MuTOAs only when the entire length of the work area cord is accessible to facilitate tracing and to prevent erroneous disconnection. Up to 22 meters (71 ft.) of work area cable are allowed.
- MuTOAs are subject to the same interface requirements specified for each media type.
- Consolidation point requirements are performance based. There is no physical interface requirement for the CP except those required to meet functional requirements.
- Implementations using either MuTOAs or CPs are subject to the same end-to-end UTP/ScTP performance requirements.
- Consolidation points have the advantage that they deliver dedicated TOs to individual work areas and do not require provisions for extended cord lengths.

TELECOMMUNICATIONS ROOM

Telecommunications rooms (TR) are generally considered to be floor serving facilities for horizontal cable distribution. They may also be used for intermediate and main cross-connects.

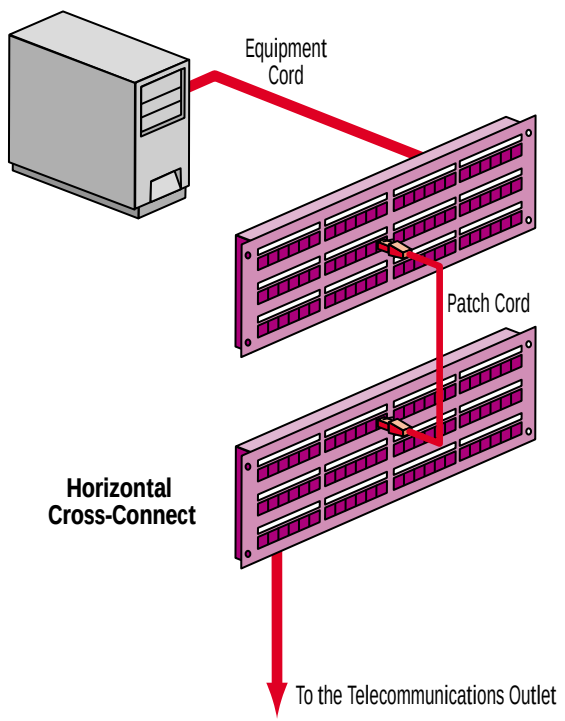
Some specifications related to the telecommunications room:

- (TR's) shall be designed and equipped in accordance with ANSI/TIA/EIA-569-A.
- Cable stress from tight bends, cable ties, staples, and tension should be avoided by well-designed cable management.
- Only standards-compliant connecting hardware shall be used.
- Application-specific electrical components shall not be installed as part of the horizontal cabling.
- Horizontal cable terminations shall not be used to administer cabling system changes. Instead, jumpers patch cords, or equipment cords are required for re-configuring cabling connections.

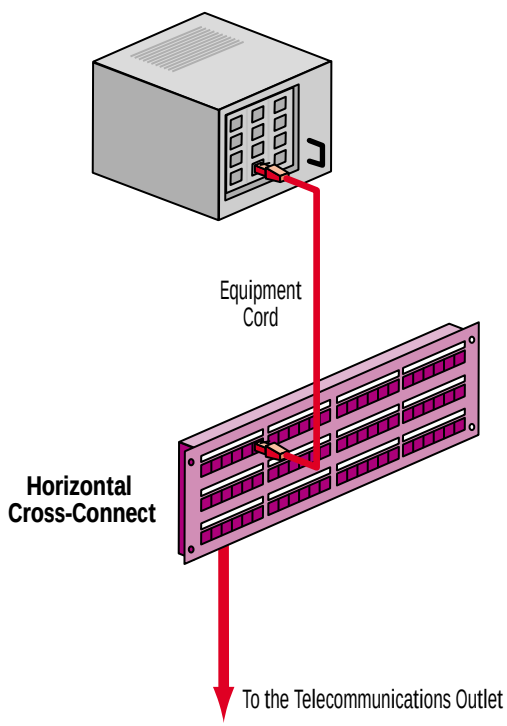
The two types of schemes used to connect cabling subsystems to each other and to equipment are known as interconnections and cross-connections.

Note: A "cross-connect" (a.k.a. distributor) is a facility, whereas a "cross-connection" is a connection scheme. Cross-connections are typically used to provide a means of configuring individual port connections between the cabling and equipment with multiport outputs (i.e., 25-pair connectors). Interconnections may be used with equipment that has individual output ports. A cross-connect facility (a.k.a. distributor) may house interconnections, cross-connections, or both.

CROSS-CONNECTION:
A connection scheme using patch cords or jumpers that attach to connecting hardware on each end.



INTERCONNECTION:
A connection scheme that provides for direct connections to building cabling from equipment without a patch cord.



TWISTED-PAIR (BALANCED) CABLING

The categories of transmission performance specified by Siemon for cables, connecting hardware links and channels are:

Designation	Transmission Characteristics	Description
	Transmission characteristics are specified up to 16 MHz.	Meets applicable category 3 and class C requirements of ISO/IEC 11801 2000, ANSI/TIA/EIA-568-B.1 & B.2. Requirements are specified to an upper frequency limit of 16 MHz.
	Transmission characteristics are specified up to 100 MHz.	Performs to category 5e of '568-B.1 & B.2 and additional class D requirements of ISO/IEC 11801. Requirements are specified to an upper frequency limit of 100 MHz. This classification is a superset of category 5 and class D.
	Transmission characteristics will be specified up to 250 MHz.	Performs to category 6* and class E requirements under development by ISO/IEC and TIA. Requirements are expected to be specified to an upper frequency limit of at least 250 MHz. This classification is a superset of  .
	Transmission characteristics will be specified up to 600 MHz.	Performs to category 7* and class F requirements under development by ISO/IEC. Requirements are expected to be specified to an upper frequency limit of at least 600 MHz. This classification is an electrical superset of  .

Category 4 and 5 are no longer recognized by TIA or ISO/IEC for new installations

** Category 6 and 7 industry standards are currently under development. Current drafts at date of publication are TIA PN-3737 draft 7 and ISO/IEC JTC 1/SC 25 N 655.*

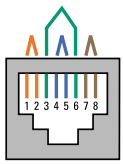
Notes:

Terminology and classifications specified in ISO/IEC 11801 for cabling links differ slightly from TIA categories (See page 12.20 in this catalog). UTP categories 1, 2 and 4 are not specified.

Components and installation practices are subject to all applicable building and safety codes that may be in effect

UTP TELECOMMUNICATIONS OUTLET/CONNECTOR

- 8-position modular jack per IEC 60603-7 (proposed '568-B.1 states that all 4 pairs must be connected).
- Pin/pair assignment: T568A (US federal government publication NCS, FTR 1090-1997 recognizes designation T568A only).
- Optional assignment to accommodate certain systems: T568B.
- Durability rating 750 mating cycles minimum.
- Backward compatibility and interoperability is required.

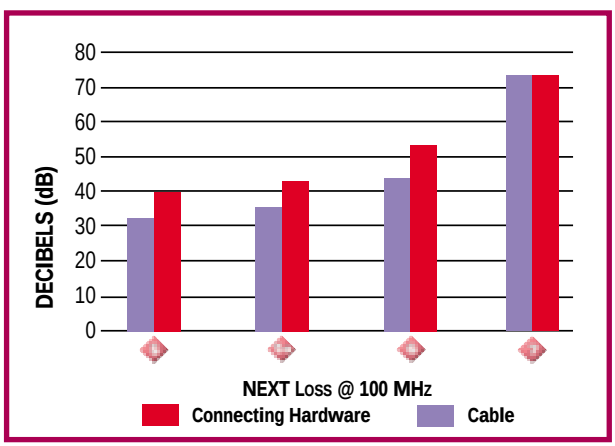


FULLY SHIELDED TELECOMMUNICATIONS OUTLET/CONNECTOR

- Entirely new interface design to support class F cabling.
- Will require a new wiring pin/pair assignment.
- Transmission measurement methods for category 7 are under study.
- Durability rating 1000 mating cycles minimum.

UTP CONNECTING HARDWARE VS CABLE NEXT PERFORMANCE

- Specifications cover all types of connectors used in the cabling system including the telecommunications outlet/connector.
- Does not cover work area adapters, baluns, protection, MAUs, filters, or other application-specific devices.
- Temperature range - 10°C (14°F) to 60°C (140°F).
- Outlets shall be securely mounted. Outlet boxes with unterminated cables must be covered and marked.
- Transmission requirements are much more severe than cable of a corresponding category. (See graph)
- Performance markings should be provided to show the applicable transmission category and should be visible during installation (for example ◆) in addition to safety markings.
- Installed connectors shall be protected from physical damage and moisture.



UTP LINK PERFORMANCE MARKING AND IDENTIFICATION

- Link category marking should be clearly visible on both ends (component markings are not sufficient).
- Labeling, markings, and color-coding shall be provided in accordance with ANSI/TIA/EIA-606.

SCREENED CABLING (ScTP)

As a result of the release of TIA/EIA/IS-729 and the maturity of the '568-B and '11801 standards, telecommunications groups recognize the presence of an overall shield over four twisted-pairs; a media termed Screened Twisted-Pair or ScTP cabling.

ScTP Cable:

- Color-coding:
  - Pair 1 = White/Blue – Blue
  - Pair 2 = White/Orange – Orange
  - Pair 3 = White/Green – Green
  - Pair 4 = White Brown – Brown
- 0.51mm (24 AWG) 100 Ω 4-pair enclosed by a foil shield.
- A copper conductor drain wire of .040mm (26 AWG) or larger shall be provided.
- Should be marked "100 Ω ScTP", in addition to any safety markings required by local or national codes.
- Same mechanical and transmission requirements apply to backbone and horizontal cables.
- Additional performance requirements, including surface transfer impedance, is specified in the IS-729 standard entitled, "Technical Specifications for 100 Ω Screened Twisted-Pair Cabling".

ScTP Connectors:

- Interface and pair assignments same as IEC 60603-7 (Proposed '568-B.1 states that all 4 pairs must be connected).
- Additional transfer impedance and shield mating interface requirements specified in the IS-729 standard entitled, "Technical Specifications for 100 Ω Screened Twisted-Pair Cabling".

ScTP Patch Cords:

- Specifications call for 26 AWG (7 strands @ 0.15mm) or 24 AWG (7 strands @ 0.20mm) stranded conductors.
- Allows for an overall shield.
- Allows for 50% more attenuation than horizontal cable.

ScTP Installation Practices:

- Shield shall be bonded at both ends at the "Telecommunication Grounding Busbar".
- The difference between the two grounds shall be no more than 1.0 V RMS.

FULLY SHIELDED CABLING (SSTP)

Fully shielded cabling requirements are under development by ISO. Cable and connector specification will extend to at least 600 MHz and are intended to support the pending class F cabling requirements. .

Fully Shielded Cable:

- Color-coding:
  - Pair 1 = White/Blue – Blue
  - Pair 2 = White/Orange – Orange
  - Pair 3 = White/Green – Green
  - Pair 4 = White/Brown – Brown
- Four 0.51mm (24 AWG) or larger 100 Ω twisted-pairs each enclosed by an individual foil shield with an overall shield provided over the four-pairs.
- Mechanical and transmission requirements are under development by ISO.

Fully Shielded Connectors:

- Interface and pair assignments are under development by ISO.
- Mechanical and transmission requirements are under development by IEC SC 46 A.

Fully Shielded Patch Cables:

- Mechanical and transmission requirements are under development by IEC SC 48 B..

Fully Shielded Installation Practices:

- Installation Practices are under development by ISO/IEC.

TRANSMISSION PERFORMANCE SPECIFICATIONS FOR FIELD TESTING OF BALANCED CABLING SYSTEMS

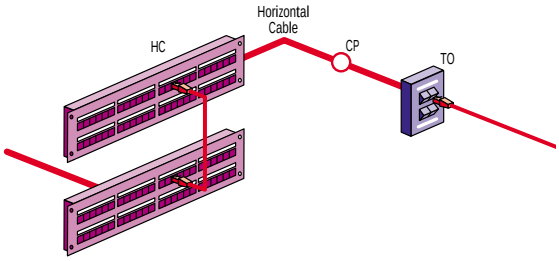
This document provides users with the opportunity to use comprehensive test methods to validate the transmission performance characteristics of installed category 5e and lower grade twisted-pair cabling systems. The categories of balanced cabling systems in this bulletin correspond with the balanced cabling categories of ANSI/TIA/EIA-568-B.1 and pending drafts for category 6/class E and category 7/class F.

Horizontal Channel

Performance Specified in:

Proposed TIA/EIA-568-B.1 (category 5e) and PN-3727 d7

Proposed ISO/IEC 11801 2nd edition (SC25 N655)



Transmission Performance Comparison @ 100 MHz

Cabling Type	Channel Insertion Loss (dB)	Channel NEXT (dB)	Channel ELFEXT (dB)	Channel Return Loss (dB)	Channel *ACR (dB)
Category 5e/Class D (@ 100 MHz)	24.0	30.1	17.4	10.0	6.1
Category 6 Class E (@ 100 MHz)	21.7	39.9	23.3	12.0	18.2
Class 7/Class F (@ 100 MHz)	20.8	62.9	44.4	12.0	42.1

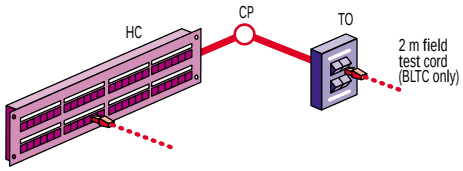
**Not specified by TIA*
Numbers in parenthesis are calculated based on using 5 meters of additional flexible cables that meet Class D ISO/IEC 11801.

Link Test Configuration

Performance Specified in:

Proposed TIA/EIA-568-B.1 (category 5e) and PN-3727 d7

Proposed ISO/IEC 11801 2nd edition (SC25 N655)



Transmission Performance Comparison @ 100 MHz

Cabling Type	Permanent Link Insertion Loss (dB)	Permanent Link NEXT (dB)	Permanent Link ELFEXT (dB)	Permanent Link Return Loss (dB)	Permanent Link *ACR (dB)
Category 5e/Class D (@ 100 MHz)	20.4	32.3	18.6	12.0	11.9
Category 6 Class E (@ 100 MHz)	18.5	41.8	24.2	14.0	23.3
Class 7/Class F (@ 100 MHz)	17.1	65.0	46.0	14.0	48.7

**Not specified by TIA*
Class D attenuation values are calculated based on 90 meters horizontal cable plus two connectors (no flexible cord contribution) that meet ISO/IEC 11801. Class D NEXT values are based on voltage summation of the near-end connector and horizontal cable.

Some points specified for transmission field testing for twisted-pair cabling systems

- Twisted-Pair cabling systems are comprised of cables and connecting hardware specified in TIA/EIA-568-B.2.
- Required test parameters include wire-map, length, insertion loss, and pair-to-pair NEXT loss, powersum NEXT loss, ELFEXT, powersum. ELFEXT, return loss, propagation delay, and delay skew.
- Two levels of pass or fail are indicated, depending on measured margin compared to minimum specifications. Testing of NEXT loss is required in both directions.
- Requirements are intended for performance validation and are provided in addition to '568-B.1 & B.2 requirements on components and installation practices.

OPTICAL FIBER CABLING

The '568-B.3 specification on optical fiber cabling consists of one recognized cable type for horizontal subsystems and two cable types for backbone subsystems:

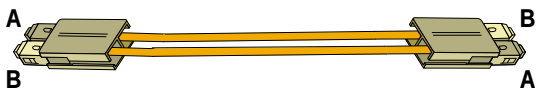
Horizontal – 50/125µm or 62.5/125µm multimode (two fibers per outlet).

Backbone – 50/125µm or 62.5/125µm multimode or singlemode.

All optical fiber components and installation practices shall meet applicable building and safety codes.

Optical Fiber Patch Cords:

- Shall be a two-fiber (duplex) cable of the same type as the cables to which they connect.
- Shall be configured so that "A" connects to "B" and "B" connects to "A".



Installation of Optical Fiber Connecting Hardware:

- Connectors shall be protected from physical damage and moisture.
- Optical fiber cable connecting hardware should incorporate high-density termination to conserve space and provide for ease of optical fiber cable and patch cord management upon installation.
- Optical fiber cable connecting hardware should be designed to provide flexibility for mounting on walls, in racks, or on other types of distribution frames and standard mounting hardware.

Optical Fiber Cabling Installation:

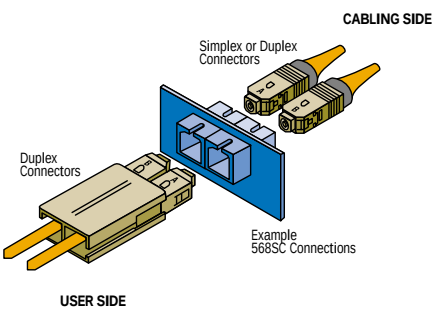
- The Siemon Company recommends that a minimum of 1m (3.28 ft.) of two-fiber cable (or two buffered fibers) be accessible for termination purposes.
- Testing is recommended to assure correct polarity and acceptable link performance. Clause II of "568 B.1 provides recommended optical fiber link performance testing criteria.

Optical Fiber Connections:

- Connector designs shall meet the requirements of the corresponding TIA FOCIS documents
- Telecommunications outlet/connector boxes shall be securely mounted at planned locations.
- The telecommunications outlet/connector box shall have:
  - Cable management means to assure a minimum bend radius of 25mm (1.00 in.) and should have slack storage capability.
  - Provisions for terminating and housing a minimum of two optical fibers.
- Identification of fiber types:
  - Multimode connectors or a visible portion of it and adapters shall be identified with the color beige.
  - Singlemode connectors or a visible portion of it and adapters shall be identified with the color blue.
- The two positions in a duplex connector are referred to as "position A" and "position B".

Small Form Factor (SFF) Connectors:

- Qualified SFF duplex and multi-fiber connector designs may be used in the main cross-connect, intermediate cross-connect, horizontal cross-connect, consolidation points and work area.
- A TIA Fiber Optic Connect Intermateability Standard (FOCIS) shall describe each SFF design.
- The SFF design shall satisfy the requirements specified in Annex A of the '568-B.3 standard.
- Some advantages of SFF connectors include compact size, modular compatibility with the eight position modular copper interface, and adaptability to high-density network electronics.

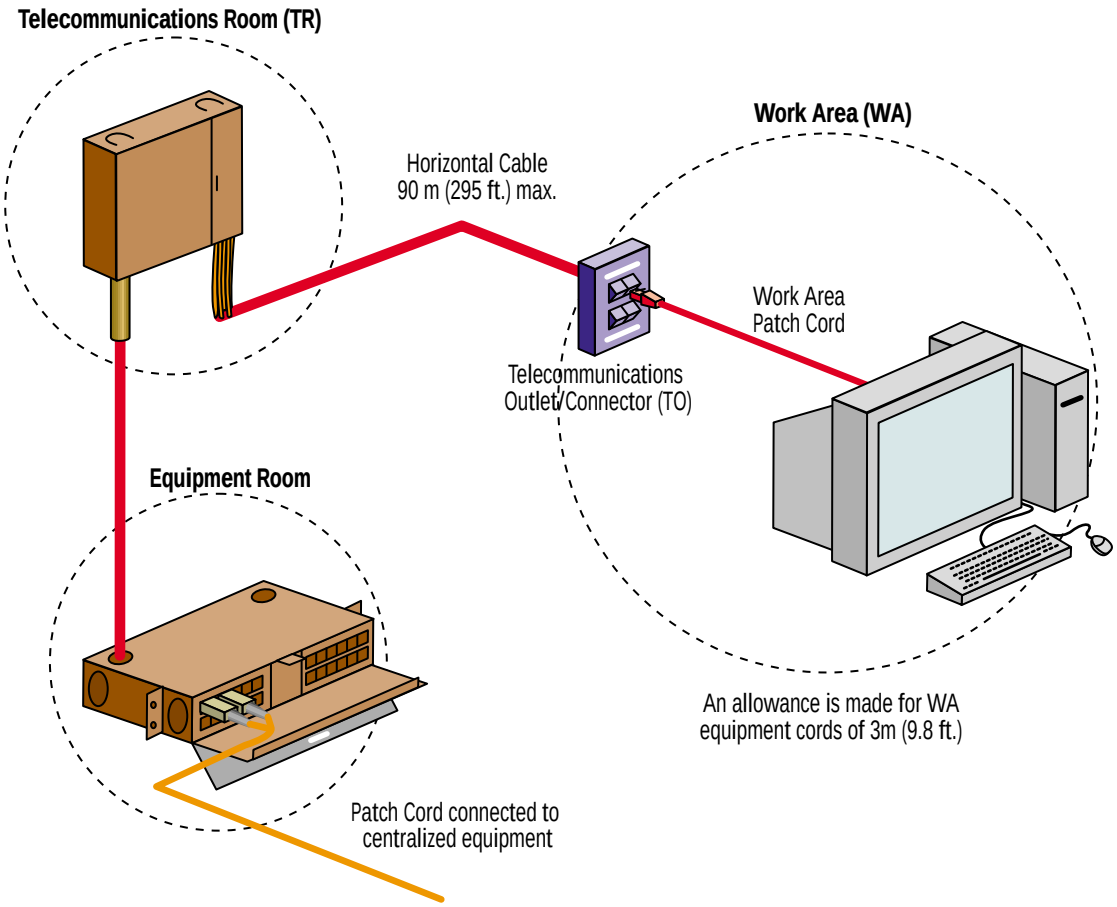


568-B.1

Annex A Centralized Optical Fiber Cabling Guidelines

Centralized optical fiber cabling provides the user with the flexibility of designing an optical fiber cabling system for centralized electronics typically in single tenant buildings. It contains information and guidelines for design and installation requirements.

Typical schematic for centralized optical fiber cabling using an interconnection.



Some points specified in B.1 for a centralized optical fiber cabling system include:

- Intended for single-tenant users who desire centralized vs. distributed electronics.
- Implementation allows cables to be spliced or interconnected at the telecommunications room such that cables can be routed to a centralized distributor for total cable lengths of 300m (984 ft.) or less, including patch cords or jumpers.
- Allows for migration from an interconnection or splice to a cross-connection scheme that can also support distributed electronics.
- Pull-through implementations are allowed when total length between the telecommunications outlet/connector and centralized cross-connect is 90m (295 ft.) or less.
- Connecting hardware required to:
  - join fibers by re-mateable connectors or splices,
  - provide for simplex or duplex connection of optical fibers,
  - provide means of circuit identification,
  - allow for addition and removal of optical fibers.

Note: Some multimode fiber implementations may be limited to an operating range of 220m to support 1000BASE-SX.

PROPAGATION DELAY AND DELAY SKEW

Propagation delay and delay skew requirements for all compliant 4-pair 100 Ω cables have been added for testing category 5e cable. Propagation delay and delay skew requirements of multipair cables are subject to additional study.

Propagation delay is equivalent to the amount of time that passes between when a signal is transmitted and when it is received at the other end of a cabling channel. Delay skew is the difference between the pair with the least delay and the pair with the most delay. Transmission errors that are associated with excessive delay and delay skew include increased jitter and bit error rates.

The maximum propagation delay skew requirement for 4-pair 100 Ω cables is frequency dependent and is specified by the following equation:

Cable delay skew shall not exceed 45 ns/100m between 1 MHz and the highest referenced frequency for a given category.

It is anticipated that the requirements of propagation delay and delay skew will also be applicable to pending category 6 cable specifications while more stringent performance criteria will be specified for pending category 7 cables.

ADDITIONS TO TIA/EIA-568-B.1, B.2, AND B.3

1. TIA/EIA TSB72 centralized optical fiber cabling is incorporated as an alternative to the optical cross-connection located in the telecommunications room when deploying 62.5/125µm and 50/215µm optical fiber cable in the horizontal.

2. ANSI/ICEA S-90-661-1994 for specifying the physical and mechanical requirements of recognized cables was updated.

3. The 568SC optical fiber connector axial pull off strength requirement was decreased to 19.4 N (4.4 lb*f*).

4. Globally, the word “polarization” was replaced with “polarity”.

5. A provision for common mode terminations for testing connecting hardware was incorporated. This revision accommodates telecommunications networking implementations that may employ common mode terminations in the active equipment.

HYBRID AND BUNDLED CABLES

As a result of the demand for open office architecture and the need to support multiple telecommunications applications in a shared sheath, performance specifications for hybrid cables have been revised. A new term called “bundled cables” has been introduced to describe 4-pair cable assemblies that are not covered by an overall sheath (as specified for hybrid cables), but by any generic binding method such as “speed-wrap” or “cable-ties”

The new hybrid and bundled cable requirements state that power sum NEXT loss between all non-fiber cable types within the cable shall be 3 dB better than the specified pair-to-pair NEXT loss for each cable type. See figure 1.

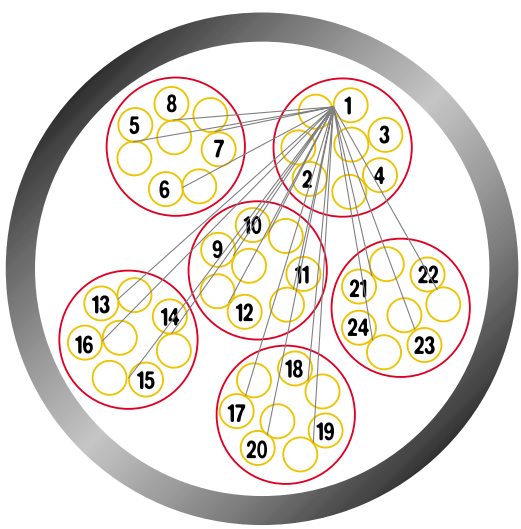
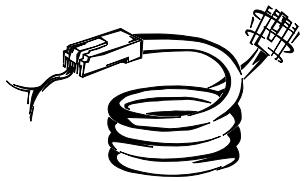


Figure 1: Pair-to-Pair measurements required to calculate power sum NEXT for pair 1 of a 24-pair cable.

PRODUCTION MODULAR CORD NEXT LOSS TEST METHOD AND REQUIREMENTS FOR UNSHIELDED TWISTED PAIR CABLING

TIA/EIA-568-B-2 defines a generic and non-destructive methodology for NEXT loss testing of modular plug cords. NEXT loss performance requirements for category 5e modular plug cords, when measured with the particular test head specified in the Standard, are provided. Note that, although the methodology may be used as the basis for determining the minimum NEXT loss performance requirements of other categories of modular plug cords, at present. The methodology described in the Standard contains the detailed NEXT loss calculations (which are based upon patch cable NEXT loss, test head NEXT loss, and cable and connector attenuation contributions) for the determination of the NEXT loss limits for any category patch cord and suitably designed test head.



TRANSMISSION PERFORMANCE SPECIFICATIONS FOR 4-PAIR 100 Ω ENHANCED CATEGORY 5e CABLING

'568-B.1 & B.2 specifies enhanced category 5 (category 5e) performance requirements. Category 5e has become become the de facto minimum standard for cabling. These documents addresses the minimum equal level far-end crosstalk (ELFEXT) and return loss requirements necessary to support developments in applications technology and defines the minimum performance needed for a worst case four-connector channel to support applications that utilize full-duplex transmission schemes, such as Gigabit Ethernet. To ensure additional crosstalk headroom for robust applications support, this document also specifies power sum performance requirements for category 5e cables and cabling.

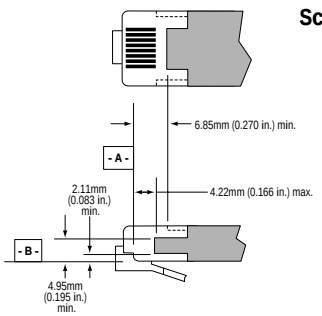
ADDITIONAL TRANSMISSION PERFORMANCE GUIDELINES FOR 4-PAIR 100 Ω CATEGORY 5 CABLING

Annex "D" of TIA/EIA-568-B.1 outlines minimum recommendations for the new channel parameters of return loss and equal level far-end crosstalk (ELFEXT). These return loss and ELFEXT recommendations are specified to ensure the support of Gigabit Ethernet over installed or "legacy" category 5 cabling and were derived from worst case performance of channels with only two connection points. The two-connector channel topology is consistent with the IEEE committee's assumption that cabling used to support Gigabit Ethernet systems will most likely utilize an interconnect instead of a cross-connect field and will not include a consolidation or transition point connection. Existing installed category 5 cabling should be verified to ensure that performance meets the minimum recommendations of this document. Channel configurations with three or four connectors that meet the specified ELFEXT and return loss recommendations will also support Gigabit Ethernet. The specifications of this Annex are applicable for the qualification of existing installed cabling only.

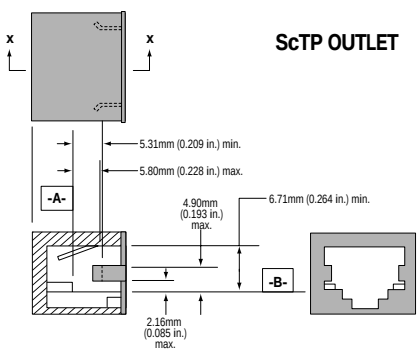
TECHNICAL SPECIFICATIONS FOR 100 Ω SCREENED TWISTED PAIR CABLING INCLUDED IN B.1 AND B.2

Screened twisted-pair cabling specifications have additional technical requirements on the outlet interface, shield effectiveness, installation practices, and performance relative to ScTP links and components.

ScTP PLUG



ScTP OUTLET



ISO/IEC 11801:2000 EDITION 1.2

Amendment 2 to ISO/IEC 11801

The performance specifications in ISO amendment 2 provide new requirements for return loss and ELFEXT loss to compliment the existing ISO class D requirements. The new specified return loss and ELFEXT loss requirements are in harmony with the values proposed in '568-B.1 & B.2. Edition 1.2 also includes propagation delay and delay skew requirements for channels and permanent links that are in harmony with the requirements of TIA/EIA-568-B.1.

The requirements of Edition 1.2 to ISO/IEC 11801 are normative and this document has become the governing international standard for new Class D cabling installations.

ISO/IEC 11801:2000.1.2

Now that ANSI/TIA/EIA-568-B and ISO/IEC 11801 2nd Edition are reaching maturity, cabling standards groups are focusing their efforts on the development of next generation cabling specifications and the fulfillment of technical issues that have surfaced as a result of their ongoing developmental efforts. Some of the draft specifications and guidelines that are being investigated by national or international standards groups for future publications or next editions of '568-B and '11801 are outlined below.

CATEGORY 6/CLASS E

Proposed category 6/class E standards describe a new performance range for unshielded and screened twisted-pair cabling. Category 6/class E is intended to specify the best performance that UTP and ScTP cabling solutions can be designed to deliver based on current technology. Category 6/class E will be specified in the frequency range of at least 1-250 MHz. For category 6/class E, the 8-position modular jack interface will be mandatory at the work area. Category 6/class E will be backward compatible meaning that applications running on lower categories/classes will also be supported. If different category/class components are to be mixed with category 6/class E components, the combination shall meet the transmission requirements of the lowest performing category/class component.

TIA, ISO, CENELEC, and others are collaborating closely on the development of category 6 and class E standards and their proposed requirements are well harmonized.

2nd quarter 2001

CATEGORY 7/CLASS F

Proposed category 7/class F describes a new performance range for fully shielded (i.e., overall shield and individually shielded pairs) twisted-pair cabling. It is anticipated that category 7/class F will be specified in the frequency range of 1-600 MHz. Even though these requirements will be supported by a new interface design, category 7/class F will be backward compatible meaning that applications running on lower categories/classes will also be supported.

TIA is not actively developing a standard for category 7.

2nd quarter 2001

COMPARISON OF '568-B SERIES VERSUS PROPOSED '11801 2ND EDITION FIBER CABLING PERFORMANCE SPECIFICATIONS

'568-B Series	Proposed '11801 2nd Edition

Optical Fiber Cabling and Component Specifications

'568-B Series	Proposed '11801 2nd Edition
Horizontal $Link_{Insertion\ Loss} \leq 2.0$ dB at 850nm or 1300nm	<table><tr><th colspan="5">Channel attenuation dB</th></tr><tr><th>Channel</th><th colspan="2">Multimode</th><th colspan="2">Singlemode</th></tr><tr><th></th><th>850nm</th><th>1 300nm</th><th>1 310nm</th><th>1 550nm</th></tr><tr><td>OF-300</td><td>2.55</td><td>1.95</td><td>1.80</td><td>1.80</td></tr><tr><td>OF-500</td><td>3.25</td><td>2.25</td><td>2.00</td><td>2.00</td></tr><tr><td>OF-2000</td><td>8.50</td><td>4.50</td><td>3.50</td><td>3.50</td></tr></table>
Horizontal $Link_{Insertion\ Loss}$ With/CP ≤ 2.75dB @ 850nm or 1300nm	
Centralized $Link_{Insertion\ Loss} \leq 3.3$ dB @ 850nm or 1300nm based on three connector pairs	
Centralized Plus Open Office CP $Link_{Insertion\ Loss} \leq 4.1$ dB @ 850 or 1300nm based on three connector pairs	
Backbone $Link_{Insertion\ Loss} = Cable_{Atten} + Connector_{Insertion\ Loss} + Splice_{Insertion\ Loss}$	
$Connector_{Insertion\ Loss} \leq 0.75$ dB	$Connector_{Atten} \leq 0.75$ dB
$Splice_{Insertion\ Loss} \leq 0.3$ dB	$Splice_{Atten} \leq 0.3$ dB
$Cable_{Atten} \leq 3.5$ dB/km at 850nm for 62.5/125µm and 50/125µm	$Cable_{Atten} \leq 3.5$ dB/km at 850nm for 62.5/125µm and 50/125µm
$Cable_{Atten} \leq 1.5$ dB/km at 1300nm for 62.5/125µm and 50/125µm	$Cable_{Atten} \leq 1.5$ dB/km at 1300nm for 62.5/125µm and 50/125µm
$Cable_{Atten} \leq 0.5$ dB/km for singlemode outside plant cable	$Cable_{Atten} \leq 1.0$ dB/km for singlemode (no differentiation between inside and outside plant cables)
$Cable_{Atten} \leq 1.0$ dB/km for singlemode inside plant cable	

Multimode Optical Fiber Modal Bandwidth (Overfilled Launch)

Bandwidth ≥ 160 MHz-km at 850nm for 62.5/125µm	Bandwidth ≥ 200 MHz-km at 850nm for 62.5/125µm and 50/125µm (OM1)
Bandwidth ≥ 500 MHz-km at 850nm for 50/125µm	Backbone ≥ 500 MHz-km @ 850nm for 62.5/125µm and 50/125µm (OM2 and OM3)
Bandwidth ≥ 500 MHz-km at 1300nm for 62.5/125µm and 50/125µm	Bandwidth ≥ 500 MHz-km at 1300nm for 62.5/125µm and 50/125µm (OM1, OM2 and OM 3)

Note: Fiber type OM3 to be specified in ISO/IEC 11801 second edition, same as OM2 plus laser bandwidth of 2000 MHz-km (ffs) at 850nm.

CABLING SPECIFICATIONS CROSS-REFERENCE CHART (ANSI/TIA/EIA-568-B SERIES AND ISO/IEC 11801) 2ND EDITION

ANSI/TIA/EIA-568-B Series **Commercial Building Telecommunications Cabling Standard**	**ISO/IEC 11801 2nd Edition** **Generic Cabling for Customer Premises**
Terminology	
Cross-connect (a facility enabling the termination of cable elements and their connection by patch cord or jumper).	*Distributor (a facility enabling the termination of cable elements and their connection by patch cord or jumper).*
MC (Main Cross-connect)	*CD (Campus Distributor)*
IC (Intermediate Cross-connect)	*BD (Building Distributor)*
HC (Horizontal Cross-connect)	*FD (Floor Distributor)*
TO (Telecommunications Outlet/connector)	*TO (Telecommunications Outlet)*
CP (Consolidation Point) An interconnection scheme that connects horizontal cables that extend from building pathways to horizontal cables that extend into work area pathways.	*Consolidation Point, a location in the horizontal cabling where a cable may end, which is not subject to moves and changes, and another cable starts leading to the TO which adapts to changes* *- or-* *a location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways*
Interbuilding Backbone	*Campus Backbone*
Intrabuilding Backbone	*Building Backbone*
Horizontal Media Choices	
4-pair 100 Ω unshielded twisted-pair/ScTP	**4-pair (or 2-pair) *100 Ω (or 120 Ω) balanced cable*
Two fiber, 50/125µm or 62.5/125µm optical fiber	**62.5/125µm (or 50/125µm) optical fiber*
	**indicates preferred media choices.*
Backbone Media Choices	
100 Ω unshielded twisted-pair/ScTP	*100 Ω (or 120 Ω) balanced cable*
50/125µm or 62.5/125µm optical fiber	*62.5/125µm or 50/125µm optical fiber*
Singlemode optical fiber	*Singlemode optical fiber*
	150 Ω shielded twisted-pair
Bend Radius	
Horizontal ≥ 4 times cable O.D. no load, For UTP 8 times cable OD load, For ScTP no load *Backbone ≥ 10 times cable O.D.*	*Horizontal ≥ 4 times cable O.D.* *Backbone ≥ 6 times cable O.D.* *≥ 8 times cable O.D. while pulling cables*

ANSI/TIA/EIA-568-B Series Commercial Building Telecommunications Cabling Standard	ISO/IEC 11801 2nd Edition Generic Cabling for Customer Premises
Engineering Approach	
Not applicable. Field testing for verification only.	*Link performance determines compliance.*
Design Approach	
Design constraints, component specifications, and installation methods determine compliance.	*Design constraints, component specifications, and installation methods determine compliance.*
Connector Termination	
All pairs shall be terminated at the outlet.	*Partial termination at the 100 Ω or 120 Ω outlet is permitted.*
Pair untwist shall not exceed 13mm (0.5 in) for category 5 or higher cables. Pair-untwist for category 3 shall be within 75mm (3 in.) from the point of termination	*Pair untwist should not exceed 13mm (0.5 in.) for category 5 cables*
Categories of Cabling Performance	
Category 3 is specified to 16 MHz.	*Class C is specified to 16 MHz.*
Category 5 and 5e is specified to 100 MHz.	*Class D is specified to 100 MHz.* *An Optical Class is also specified.*
Category 6 to be specified to 250 MHz.	*Class E to be specified to 250 MHz.*
Category 7 to be specified to 600 MHz.	*Class F to be specified to 600 MHz.*

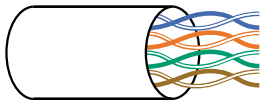
Note: For TIA standards, the term "category" is used to specify both components and cabling performance. For ISO/IEC and CENELEC standards, the term "category" is used to describe component performance (i.e., cable and connecting hardware). The term "class" is used to describe cabling (i.e., link and channel performance).

Performance Specification	
Stranded Cable Attenuation = 20% margin over solid requirements.	*Stranded Cable Attenuation = 50% margin over solid requirements.*
Curve fit evaluation of impedance performance allowed.	*Curve fit evaluation of impedance performance not allowed.*
Hybrid requirements are applicable to the total number of (non-fiber) units within a cable. (Power sum margin + 3dB over pair-to-pair limit.)	*Hybrid requirements based upon adjacent non-fiber units within a cable.*

HORIZONTAL TWISTED-PAIR CABLE

- Solid 4-pair 0.51mm (24 AWG) specified [0.64mm (22 AWG) solid also allowed]. An overall shield (ScTP) is optional.
- Performance marking should be provided to show the applicable performance category. These markings do not replace safety markings.

- Color-coding:
  white/blue – blue
  white/orange – orange
  white/green – green
  white/brown – brown



HYBRID AND BUNDLED CABLES

Hybrid/Bundled Cables:

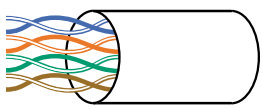
- Hybrid/bundled cables that contain multiple units of recognized horizontal copper cables are subject to additional NEXT loss requirements between cable units. These requirements assure a minimum of 3 dB additional power sum crosstalk isolation between applications that may operate on adjacent binder groups.
- All detailed specifications for the individual cable units used in the hybrid assembly still apply.
- Hybrid bundled cables shall meet the transmission requirements specified in TIA/EIA-B.2.

TWISTED-PAIR PATCH CORDS AND CROSS-CONNECT JUMPERS

- Patch cords must use stranded cable for adequate flex-life.
- Stranded cables must meet the minimum performance requirements for horizontal cable except that 20 percent more attenuation is allowed by '568-B.2 and 50 percent more attenuation is allowed by '11801.
- Color-code for cross-connect jumpers: One conductor white, the other a visibly distinct color such as red or blue.
- Performance markings should be provided to show the applicable transmission category in addition to safety markings.
- Insulated O.D. of stranded wires should be 0.8mm (0.032 in.) to 1mm (0.039 in.) to fit into a modular plug.
- Production performance specifications for plug cord assemblies are addressed in B.2.
- Color Codes for Stranded, 100 Ω UTP Patch Cord:

OPTION 1		OPTION 2
white/blue–blue	**PAIR 1**	green–red
white/orange–orange	**PAIR 2**	black–yellow
white/green–green	**PAIR 3**	blue–orange
white/brown–brown	**PAIR 4**	brown–slate

Note: Because of their identical pair groupings, patch cords terminated with either T568A or T568B pair assignments may be used interchangeably, provided that both ends are terminated with the same pin/pair scheme.



TWISTED-PAIR PATCH CORDS AND CROSS-CONNECT JUMPERS

- Performance markings should be provided to show the applicable performance category. These markings do not replace safety markings.
- Services with incompatible signal levels should be partitioned into separate binder groups. Guidelines for shared sheaths are provided in Annex B of '568-B.1.
- Transmission requirements are equivalent to horizontal cables except that NEXT loss performance is based on power-sum rather than worst-pair characterization to allow for multiple disturbing signals (of the same type) in the same sheath.
- Note: Tip conductors have colored insulation that corresponds to that of the binder group. Ring conductors have colored insulation that corresponds to that of the pair.
- Backbone twisted-pair cables consist of solid 0.51mm (24 AWG) cables that contain more than four pairs (typically multiples of 25-pairs are used). An overall shield is optional.
- Color-coding (specified by reference to ICEA: see chart to right).

Color-coding (specified by reference to ICEA)

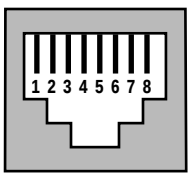
TIP		RING
white/blue	pair 1	blue/white
white/orange	pair 2	orange/white
white/green	pair 3	green/white
white/brown	pair 4	brown/white
white/slate	pair 5	slate/white
red/blue	pair 6	blue/red
red/orange	pair 7	orange/red
red/green	pair 8	green/red
red/brown	pair 9	brown/red
red/slate	pair 10	slate/red
black/blue	pair 11	blue/black
black/orange	pair 12	orange/black
black/green	pair 13	green/black
black/brown	pair 14	brown/black
black/slate	pair 15	slate/black
yellow/blue	pair 16	blue/yellow
yellow/orange	pair 17	orange/yellow
yellow/green	pair 18	green/yellow
yellow/brown	pair 19	brown/yellow
yellow/slate	pair 20	slate/yellow
violet/blue	pair 21	blue/violet
violet/orange	pair 22	orange/violet
violet/green	pair 23	green/violet
violet/brown	pair 24	brown/violet
violet/slate	pair 25	slate/violet

MODULAR WIRING REFERENCE

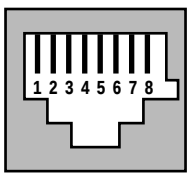
Modular Jack Styles:

There are four basic modular jack styles. The 8-position modular outlets are commonly and incorrectly referred to as "RJ45". The 6-position modular jack is commonly referred to as an RJ11. Using these terms can sometimes lead to confusion since the RJ designations actually refer to very specific wiring configurations called Universal Service Order Code (USOC). The designation 'RJ' means Registered Jack. Each of these basic jack styles can be wired for different RJ configurations. For example, the 6-position jack can be wired as an RJ11C (1-pair), RJ14C (2-pair), or RJ25C (3-pair) configuration. An 8-position jack can be wired for configurations such as RJ61C (4-pair) and RJ48C. The keyed 8-position jack can be wired for RJ45S, RJ46S, and RJ47S. The fourth modular jack style is a modified version of the 6-position jack (modified modular jack or MMJ). It was designed by Digital Equipment Corporation® (DEC) along with the modified modular plug (MMP) to eliminate the possibility of connecting DEC data equipment to voice lines and vice versa.

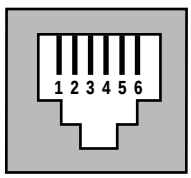
Note: The Siemon Company has developed a guide to modular hardware pin/pair assignments. Contact our sales office for a free copy.



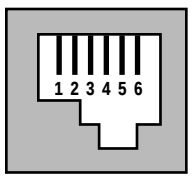
8-position



8-position keyed



6-position

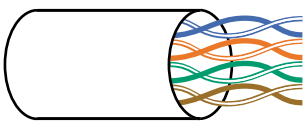


6-position modified

MODULAR PLUG PAIR CONFIGURATIONS

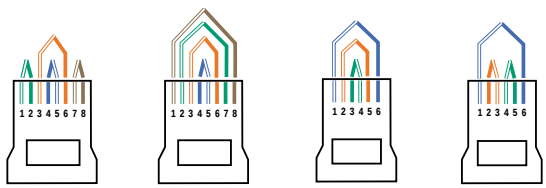
It is important that the pairing of wires in the modular plug match the pairs in the modular jack as well as the horizontal and backbone wiring. If they do not, the data being transmitted may be paired with incompatible signals.

Modular cords wired to the T568A color scheme on both ends are compatible with T568B systems and vice versa.



white/blue–blue
white/orange–orange
white/green–green
white/brown–brown

UTP Horizontal Cable (solid 24 AWG)



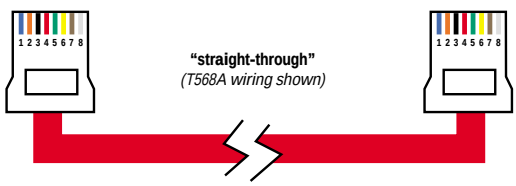
8-position T568A/T568B
8-position USOC
6-position USOC
6-position DEC

STRAIGHT-THROUGH OR REVERSED?

Modular cords are used for two basic applications. One application uses them for patching between modular patch panels. When used in this manner modular cords should always be wired "straight-through" (pin 1 to pin 1, pin 2 to pin 2, pin 3 to pin 3, etc.). The second major application uses modular cords to connect the workstation equipment (PC, phone, FAX, etc.) to the modular outlet. These modular cords may either be wired "straight-through" or "reversed" (pin 1 to pin 6, pin 2 to pin 5, pin 3 to pin 4, etc.) depending on the system manufacturer's specifications. This "reversed" wiring is typically used for voice systems. The following is a guide to determine what type of modular cord you have.

HOW TO READ A MODULAR CORD

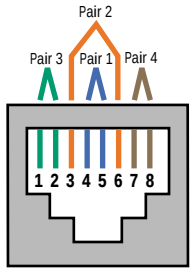
Align the plugs side-by-side with the contacts facing you and compare the wire colors from left to right. If the colors appear in the same order on both plugs, the cord is wired "straight-through". If the colors appear reversed on the second plug (from right to left), the cord is wired "reversed".



"straight-through"
(T568A wiring shown)

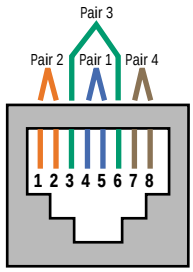
COMMON OUTLET CONFIGURATIONS

Two wiring schemes have been adopted by the '568-B.1 and '11801 standards. They are nearly identical except that pairs two and three are reversed. T568A is the preferred scheme because it is compatible with 1 or 2-pair USOC systems. Either configuration can be used for Integrated Services Digital Network (ISDN) and high speed data applications. Transmission categories 3, 5, 5e, and 6 are only applicable to this type of pair grouping.



T568A

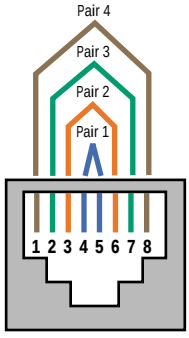
Pair ID	PIN #
T1	5
R1	4
T2	3
R2	6
T3	1
R3	2
T4	7
R4	8



T568B

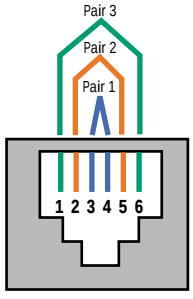
Pair ID	PIN #
T1	5
R1	4
T2	1
R2	2
T3	3
R3	6
T4	7
R4	8

USOC wiring is available for 1-, 2-, 3-, or 4-pair systems. Pair 1 occupies the center conductors, pair 2 occupies the next two contacts out, etc. One advantage to this scheme is that a 6-position plug configured with 1, 2, or 3 pairs can be inserted into an 8-position jack and still maintain pair continuity. A note of warning though, pins 1 and 8 on the jack may become damaged from this practice. A disadvantage is the poor transmission performance associated with this type of pair sequence. None of these pair schemes is cabling standard compliant.



USOC 4-pair

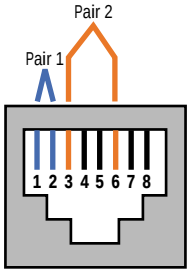
Pair ID	PIN #
T1	5
R1	4
T2	3
R2	6
T3	2
R3	7
T4	1
R4	8



USOC 1-, 2- or 3-pair

Pair ID	PIN #
T1	4
R1	3
T2	2
R2	5
T3	1
R3	6

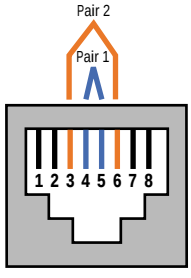
10BASE-T wiring specifies an 8-position jack but uses only two pairs. These are pairs two and three of T568A and T568B schemes.



10BASE-T (802.3)

Pair ID	PIN #
T1	1
R1	2
T2	3
R2	6

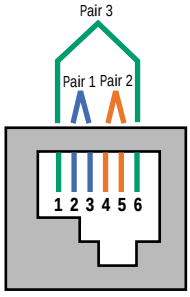
Token Ring wiring uses either an 8-position or 6-position jack. The 8-position format is compatible with T568A, T568B, and USOC wiring schemes. The 6-position is compatible with 1- or 2-pair USOC wiring.



Token Ring (802.5)

Pair ID	PIN #
T1	5
R1	4
T2	3
R2	6

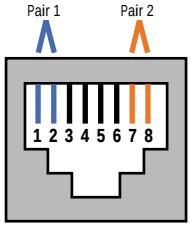
The MMJ is a unique wiring scheme for DEC® equipment.



3-Pair MMJ

Pair ID	PIN #
T1	3
R1	2
T2	4
R2	5
T3	1
R3	6

ANSI X3T9.5 TP-PMD uses the two outer pairs of an 8-position jack. These positions are designated as pair 3 and pair 4 of the T568A wiring scheme. This wiring scheme is also used for ATM.



TP-PMD (X3T9.5) **and ATM**

Pair ID	PIN #
T1	1
R1	2
T2	7
R2	8

RECOMMENDED CABLING PRACTICES

Do's:

- ✔ Terminate each horizontal cable on a dedicated telecommunications outlet.
- ✔ Locate the main cross-connect near the center of the building to limit cable distances.
- ✔ Maintain the twist of horizontal and backbone cable pairs up to the point of termination.
- ✔ Tie and dress horizontal cables neatly and with a minimum bend radius of 4 times the cable diameter.

Don'ts:

- ✘ Do not use connecting hardware that is of a lower category than the cable being used.
- ✘ Do not create multiple appearances of the same cable at several distribution points (called bridged taps).
- ✘ Do not over-tighten cable ties, use staples, or make sharp bends with cables.
- ✘ Do not place cable near equipment that may generate high levels of electromagnetic interference.

TWISTED-PAIR CONNECTOR TERMINATIONS

- Pair twists shall be maintained as close as possible to the point of termination.
- Untwisting shall not exceed 75mm (3.0 in) for category 3 links and 13mm (0.5 in) for category 5e, and category 6 links.
- Connecting hardware shall be installed to provide well-organized installation with cable management and in accordance with manufacturer's guidelines.
- Strip back only as much jacket as is required to terminate individual pairs.

APPLICATION-SPECIFIC PAIR ASSIGNMENTS FOR THE 100 OHM CABLING, ISO/IEC 8802

Application	Pins 1-2	Pins 3-6	Pins 4-5	Pins 7-8
ISDN	Power	TX	RX	Power
Analog Voice	—	—	TX/RX	—
802-3 (10BASE-T)	TX	RX	—	—
802-5 (Token Ring)	—	TX	RX	—
FDDI (TP-PMD)	TX	Optional[1]	Optional[1]	RX
ATM User Device	TX	Optional[1]	Optional[1]	RX
ATM Network Equip.	RX	Optional[1]	Optional[1]	TX
1000BASE-T (802.3ab)	Bi[2]	Bi[2]	Bi[2],	Bi[2]
100BASE-VG (802.12)	Bi	Bi	Bi	Bi
100BASE-T4 (802.3u)	TX	RX	Bi	Bi
100BASE-TX (802.3u)	TX	RX	—	—

**Bi = bi-directional TX = Transmit RX = Receive*

[1]Optional terminations may be required by some manufacturers' active implementations. *[2]Under development by IEEE802.3ab*

RECOMMENDED COLOR-CODING SCHEME

Siemon Color #	Color Code	
02	white	1st Level Backbone (MC/IC or MC/TC Terminations)
03	red	Reserved for future use (formerly Key Telephone Sys.)
04	gray	Second Level Backbone (IC/TC Terminations)
05	yellow	Miscellaneous (Auxiliary, Security, Alarms, etc.)
06	blue	Horizontal Cable Terminations (a.k.a. Station Cable)
07	green	Network Connections (customer side of demarc)
08	purple	Common Equipment (PBX, Host, LANs, Muxes)
09	orange	Demarcation Point (Central Office Terminations)
60	brown	Interbuilding Backbone (Campus Cable Terminations)

TWISTED-PAIR CABLING INSTALLATION PRACTICES

- To avoid stretching, pulling tension should not exceed 110N (25 lbf) for 4-pair cables.
- Installed bend radii shall not exceed:
  - 4 times the cable diameter for horizontal UTP cables under no load conditions.
  - 8 times the cable diameter for horizontal UTP cables under load conditions
  - 8 times the cable diameter for horizontal ScTP cables.
  - 10 times the cable diameter for multi-pair backbone twisted-pair cables under no load conditions.
- Horizontal cables should be used with connecting hardware and patch cords (or jumpers) of the same performance category or higher.
- Avoid cable stress, as caused by:
  - cable twist during pulling or installation
  - tension in suspended cable runs
  - tightly cinched cable ties or staples
  - tight bend radii
- Important Note: Installed twisted-pair cabling shall be classified by the least performing component in the link.

ANSI/TIA/EIA-569-A

Commercial Building Standard for Telecommunications Pathways and Spaces

The TIA TR42.3 (formerly TR41.8.3) Working Group on Telecommunications Pathways & Spaces published the ANSI/TIA/EIA-569-A ('569-A) Standard in 1998.

Following are highlights of the '569-A Standard:

Purpose

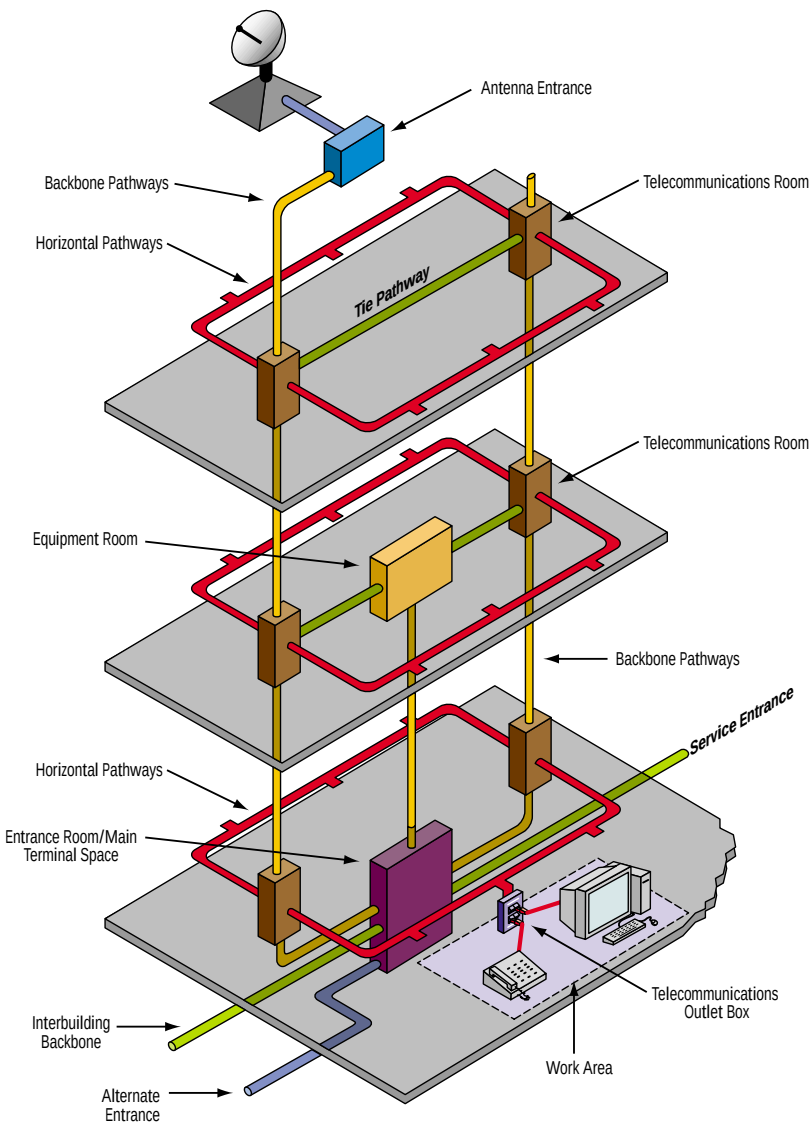
- Standardize design and construction practices.
- Provides a telecommunications support system that is adaptable to change during the life of the facility.

Scope

- Pathways and spaces in which telecommunications media are placed and terminated.
- Telecommunications pathways and spaces within and between buildings.
- Commercial building design for both single and multi-tenant buildings.

Elements

- Horizontal
- Backbone
- Work Area
- Telecommunications Room
- Equipment Room
- Main Terminal Space
- Entrance Facility



Annex Information

The following normative and informative annexes are provided in ANSI/TIA/EIA-569-A:

A. Firestopping (Normative)

B. Additional section information (Informative)

C. Interbuilding Backbone Pathways and Related Spaces (Normative)

D. References (Informative)

HORIZONTAL

Pathways from telecommunications room to work area.

Includes:

Pathway Types:

- Underfloor — Network of raceways embedded in concrete consisting of distribution and header ducts, trenches, and cellular systems.
- Access Floor — Raised modular floor tile supported by pedestals, with or without lateral bracing or stringers.
- Conduit — Metallic and nonmetallic tubing of rigid or flexible construction permitted by applicable electrical code.
- Tray & Wireway — Prefabricated rigid structures for pulling or placing cable.
- Ceiling — Open environment above accessible ceiling tiles and frame work.
- Perimeter- Surface, recessed, molding, and multi-channel raceway systems for wall mounting around rooms or along hallways.

Space Types:

- Pull Boxes — Used in conjunction with conduit pathway systems to assist in the fishing and pulling of cable.
- Splice Boxes — A box, located in a pathway run, intended to hold a cable splice.
- Outlet Boxes — Device for mounting faceplates, housing terminated outlet/connectors, or transition devices.

Design Considerations:

- Grounded per code and ANSI/TIA/EIA-607 ('607)
- Designed to handle recognized media as specified in ANSI/TIA/EIA-568-B series
- Not allowed in elevator shafts
- Accommodate seismic zone requirements
- Installed in dry locations

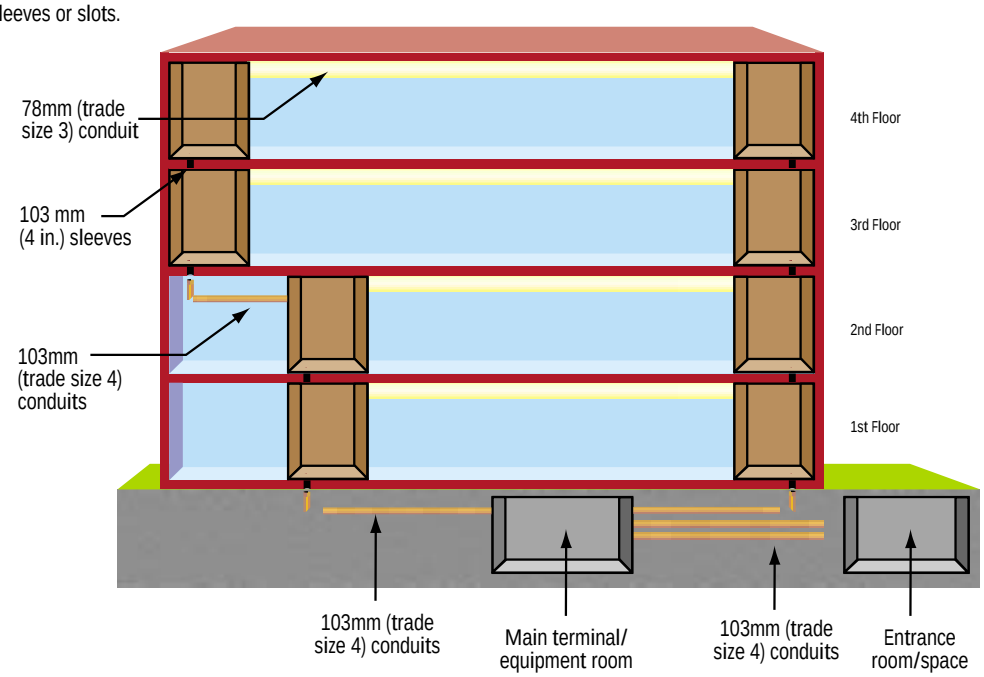
BACKBONE

Pathways routed from closet-to-closet.

Building Backbone Types:

- Ceiling
- Conduit
- Sleeves — An opening, usually circular, through the wall, ceiling, or floor.
- Slots — An opening, usually rectangular, through the wall, ceiling, or floor.
- Trays

Typically the most convenient and cost effective backbone pathway design in multi-story buildings, is to have stacked closets located one above the other, connected by sleeves or slots.



Design Considerations:

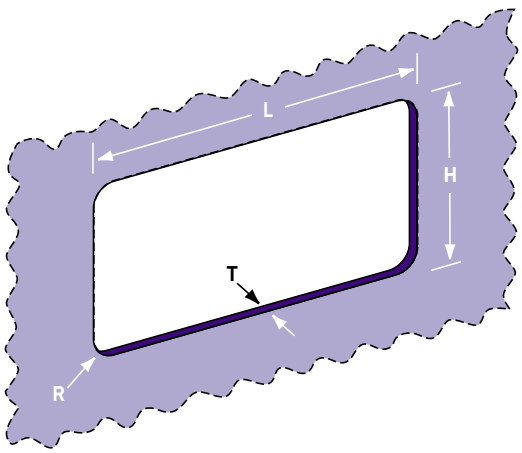
- Grounded per code and '607
- Accommodate seismic zone requirements
- Water should not penetrate the pathway system
- Tray, conduits, sleeves, slots penetrate closets minimum 25mm (1 in.)
- Designed to handle all recognized media (as specified in '568-A)
- Integrity of all fire stop assemblies shall be maintained

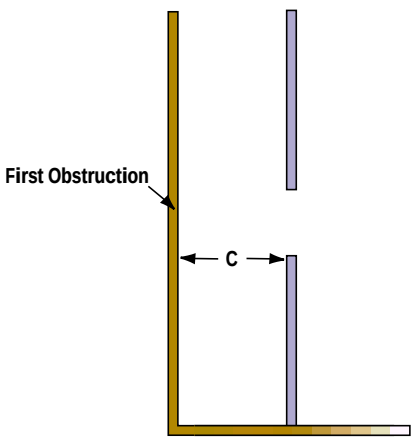
WORK AREA

Primary location where the building occupants interact with dedicated telecommunications equipment.

Design Considerations:

- At least one telecommunication outlet box location shall be planned for each work area.
- This location should be coordinated with the furniture plan. A power outlet should be nearby.
- Control center, attendant, and reception areas shall have direct and independent pathways to the serving telecommunications room.
- Furniture System Design:
  - Cable access via walls, columns, ceilings, or floors. Fittings that transition between building and furniture pathways require special planning.
  - Furniture pathway fill capacity is effectively reduced by furniture corners, and connectors mounted within the furniture pathway systems.
  - Furniture pathways bend radius shall not force the installed cable to a bend radius of less than 25mm (1 in.).
  - Furniture spaces designed to house slack storage, consolidation points, or multi-user telecommunications outlet assemblies shall provide space for strain relieving, terminating, and storing slack for the horizontal cables.
  - Slack storage and furniture pathway fill, shall not affect the bend radius and termination of the cable to the connector.
  - Furniture pathway openings shall comply with either of two sizes:
    - Standard NEMA opening (NEMA OS 1 [Ref D.14], WD-6 [Ref D.15])
    - Alternate opening:



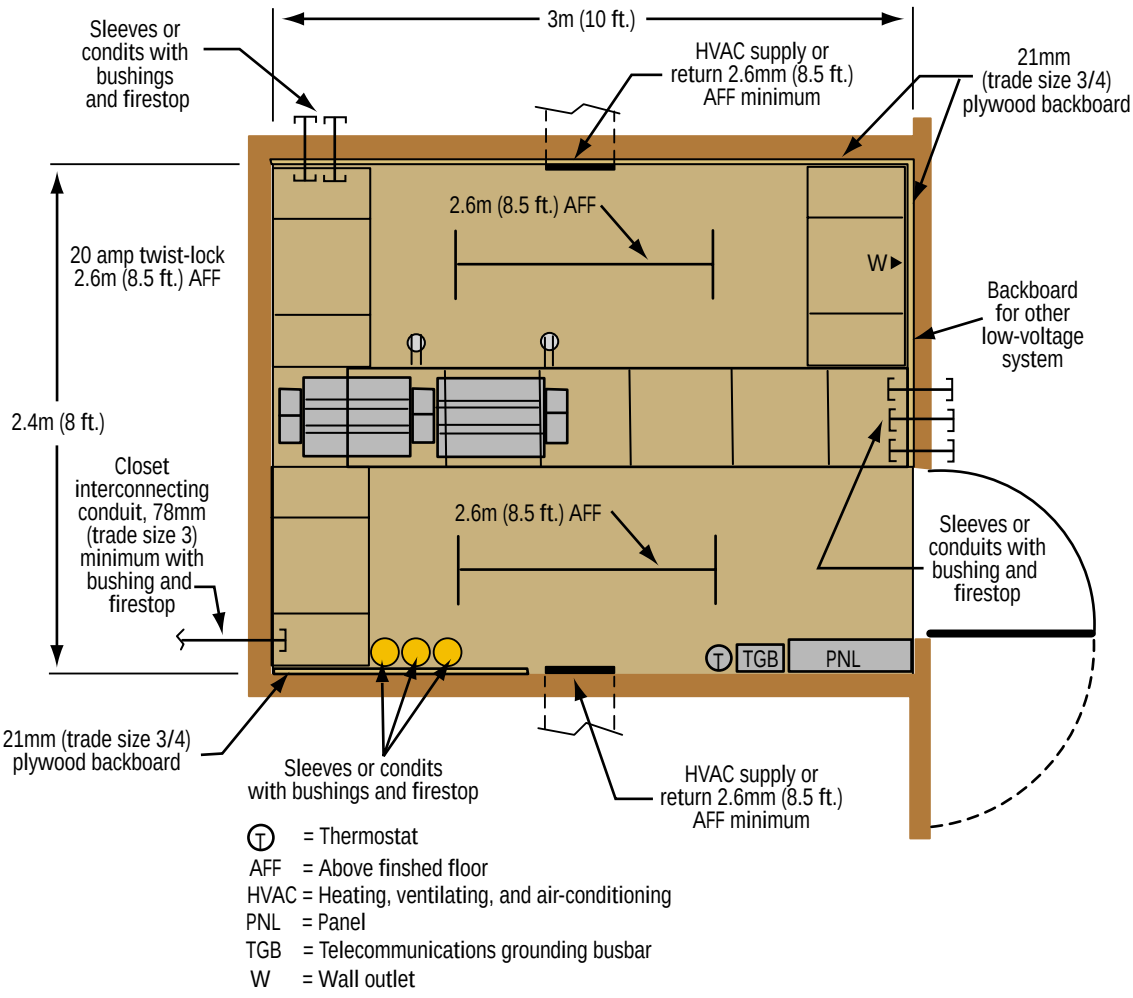


	Dimension	Tolerance
L (length)	68.8mm (2.71 in.)	1.02mm (0.040 in.)
H (height)	35.1mm (1.38 in.)	0.90mm (0.035 in.)
T (depth)	1.40mm (0.055 in.)	0.64mm (0.025 in.)
R (corner radius)	4.06mm (0.160 in.) max.	—
C (distance to 1st obstruction)	30.5mm (1.2 in.) min.	—

  - Power/telecommunication separation requirements is governed by applicable electrical code for safety. Minimum separation requirements of Article 800-52 of ANSI/NFPA 70 (National Electric Code) shall be applied.

TELECOMMUNICATIONS ROOM

Recognized location of the common access point for backbone and horizontal pathways.



T = Thermostat
AFF = Above finshed floor
HVAC = Heating, ventilating, and air-conditioning
PNL = Panel
TGB = Telecommunications grounding busbar
W = Wall outlet

Design:

- Dedicated to telecommunications function.
- Equipment not related to telecommunications shall not be installed, pass through or enter the telecommunications room.
- Multiple closets on the same floor shall be interconnected by a minimum of one (78mm (trade size 3) conduit, or equivalent pathway.
- Minimum floor loading 2.4 kPA (50 lbf/ft2).

Design Considerations:

- Minimum one closet per floor to house telecommunications equipment/cable terminations and associated cross-connect cable and wire.
- Located near the center of the area being served.
- Horizontal pathways shall terminate in the telecommunications room on the same floor as the area served.
- Accommodate seismic zone requirements.
- Two walls should have 20mm (0.75 in.) A-C plywood 2.4m (8 ft.) high.
- Lighting shall be a minimum of 500 lx (50 foot candles) and mounted 2.6m (8.5 ft.) above floor.
- False ceilings shall not be provided.
- Minimum door size 910mm (36 in.) wide and 2000mm (80 in.) high without sill, hinged to open outwards, or slide side-to-side or removable, and fitted with a lock.
- Minimum of two dedicated 120V 20A nominal, non-switched, AC duplex electrical outlet receptacles, each on separate branch circuits.
- Additional convenience duplex outlets placed at 1.8m (6 ft.) intervals around perimeter, 150mm (6 in.) above floor.
- Access to the telecommunications grounding system as specified by ANSI/TIA/EIA-607.
- HVAC requirements to maintain temperature the same as adjacent office area. A positive pressure shall be maintained with a minimum of one air change per hour or per code.

EQUIPMENT ROOM

A centralized space for telecommunications equipment that serves specific occupants of the building.

Any or all of the functions of a telecommunications room or entrance facility may alternately be provided by an equipment room.

Location

- Site locations should allow for expansion.
- Accessible to the delivery of large equipment.
- Not located below water level.
- Away from sources of EMI.
- Safeguards against excessive vibration.
- Sizing shall include projected future as well as present requirement.
- Equipment not related to the support of the equipment room shall not be installed in, pass through, or enter the equipment room.

Design Considerations

- Minimum clear height of 2.4m (8 ft.) without obstruction.
- Protected from contaminants and pollutants.
- Access to backbone pathways.
- HVAC provided on a 24 hours-per-day, 365 days-per-year basis.
- Temperature and humidity controlled range 18° C (64° F) to 24°C (75° F) with 30% to 55% relative humidity measured 1.5m (5 ft.) above floor level.
- Separate power supply circuit shall be provided and terminated in its own electrical panel.
- Minimum lighting 500 lx (50 foot candles). Switch location shall be near entrance door to room.
- Minimum door same as telecommunications room. Double doors without center post or sill is recommended.
- Access to ground per ANSI/TIA/EIA-607.

MAIN TERMINAL SPACE

Centralized space that houses the main cross-connect. Commonly used as a separate space in multi-tenant buildings to serve all tenants.

- Location considerations are as specified for equipment room.
- Provisioning area as specified for telecommunications closets except power is reduced to convenience receptacles.

ENTRANCE FACILITY

Consists of the telecommunications service entrance to the building and backbone pathways between buildings.

Location

- Providers of all telecommunications services shall be contacted to establish requirements.
- Location of other utilities shall be considered in locating the entrance facility.
- Alternate entrance facility should be provided where security, continuity or other special needs exist.
- Equipment not related to the support of the entrance facility should not be installed in, pass through, or enter the telecommunications entrance facility.
- Dry location not subject to flooding and close as practicable to building entrance point and electrical service room.

Design Considerations

- Accommodate the applicable seismic zone requirements.
- A service entrance pathway shall be provided via one of the following entrance types: Underground, Buried, Aerial, Tunnel.
- Minimum one wall should be covered with rigidly fixed 20mm (0.75 in.) A-C plywood.
- Minimum lighting same as telecommunication room.
- False ceilings shall not be provided.
- Minimum door same as telecommunications room.
- Electrical power same as telecommunications room. No convenience receptacles mentioned.
- Grounding same as telecommunications room.

MISCELLANEOUS

- Fire stopping per applicable code
- Horizontal pathway separation from Electromagnetic interference (EMI) sources:
  - Separation between telecommunications and power cables (Article 800.52 of ANSI/NFPA 70)
  - Building protected from lightning (ANSI/NFPA 780 (Ref D.4)
  - Surge protection (Article 280 of ANSI/NFPA 70 and 9.11 of ANSI/IEEE 1100 [Ref D.1])
  - Grounding (ANSI/TIA/EIA-607)
  - Corrected faulty wiring (Section 7.5 of ANSI/IEEE 1100)
- Reducing noise coupling:
  - Increase separation from noise sources
  - Electrical branch circuit line, neutral, and grounding conductors should be maintained close together
  - Use of surge protectors in branch circuits
  - Use fully enclosed grounded metallic raceway or locate cabling near grounded metallic surface

TIA/EIA-569-A-1

Perimeter Pathway Addendum

This addendum deals with the constriction, applications, premises design and installation of perimeter pathways also known as surface raceway systems.

It describes both single and multi channel systems mounted on walls at a variety of heights and directions. The sizing of such pathways are based on 40% fill for initial installations but allows up to 60% fill for moves adds or changes to the installed cabling system during its life cycle. Fittings for Perimeter raceway systems must allow for the band radius requirements of the installed cable.

TIA/EIA-569-A-2

Furniture Pathway Fill Addendum

The sizing of such pathways are based on 40% fill for initial installations but allows for up to 60% fill for moves, adds and changes to the installed cabling system during its life cycle. Furniture fittings such as outlets and connectors used to terminate the installed cables need to be considered when determining the percentage of fill. Fish and pull techniques may result in reduced capacity of the pathway as compared to furniture manufacturers which allow placing cables into the pathways.

TIA/EIA-569-A-3

Revision to subclause 4.3, "Access Floor", of TIA/EIA-569-A

Introduces low profile floors as compared to standard height floors. Low profile floors are 6" or lower while standard height floors are 6" or greater. This revision describes the use of access floors as it refers to guidelines and installation.

TIA/EIA-569-A-4

Addendum 4 to ANSI/TIA/EIA-569-A Poke-Thru Devices

A poke-thru is a device for routing cables through a floor while maintaining the fire-rating integrity of the floor. These devices are an option for routing horizontal cables when other pathway types are not practical. Types include flush floor mount and those that rise up above floor level, also known as pedestal, raised, tombstone or monument.

TIA/EIA-A-5

Addendum 5 to ANSI/TIA/EIA-569-A

This addendum revisists underfloor systems including cells, treches, and ducts to replace subclause 4 of the ANSI/TIA/EIA-569-A standard.