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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, Siemon 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.

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AN OVERVIEW OF CABLING STANDARDS

ANSI/TIA/EIA-568-B AND ISO/IEC 11801:2002 2ND ED. 2002-09, IEC 61156-5, -6

The latest edition of the Commercial Building Telecommunications Cabling Standard is ANSI/TIA/EIA-568-B. The Telecommunications Industry Association (TIA) TR-42 Technical Committee has broken the standard into a series of documents known as B.1, B.2 and B.3. The '568-B.1 document contains the information needed for designing, installing, and field testing a generic structured cabling system. The '568-B.2 and '568-B.3 documents contain manufacturing and component reliability test specifications for cable, patch cords and connecting hardware. The '568-B.3 document was published in April 2000 and is applicable to optical fiber components. The '568-B.2 document specifies the electrical and mechanical requirements of unshielded (UTP) and screened (F/UTP) balanced twisted-pair components. The standard addresses requirements for category 3 and 5e cabling and component requirements. Both '568-B.1 and '568-B.2 were published in June 2001.

Also, the International Organization for Standardization (ISO) JTC1 SC 25/WG 3 Working Group on telecommunications cabling has published the second edition of the ISO/IEC 11801 standard. The standard addresses class E and F cabling and category 6 and 7 connecting hardware and cables. Items of interest unique to the '11801 standard 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.

For component requirements, '11801:2002 references the IEC cable specifications for horizontal (IEC 61156-5) and work area (IEC 61156-6). With a few exceptions detail in the cable clause of '11801:2002, all requirements for cable can be found in these two specifications. '11801:2002 references the IEC 60603-7-X series (x = 1, 2, . . . 7) for the RJ-45 style outlets and IEC 61076-3-104 for the new RJ-45 outlets (TERA® type connectors).

ISO/IEC 15018 edition 1, cabling for the home references the same IEC cables and connectors as '11801:2002 for information and communication technology (ICT) applications. For broadcast communications technology, it references the IEC 1200 MHz cable specifications, IEC 61196-7 and for the primary outlet IEC 61076-3-104.

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 '11801:2002.

ADDENDA TO THE '568B STANDARD

TIA/EIA-568-B.1-1 (Addendum 1) — Minimum 4-pair UTP and 4-pair ScTP patch cable bend radius

TIA/EIA-568-B.1-2 (Addendum 2) — Grounding and bonding specifications for screened balanced twisted-pair horizontal cabling

TIA/EIA-568-B.1-3 (Addendum 3) — Supportable distances and channel attenuation for optical fiber applications by fiber type

TIA/EIA-568-B.1-4 (Addendum 4) — Recognition of category 6 and 850 nm laser-optimized 50/125µm multimode optical fiber cabling

TIA/EIA-568-B.1-5 (Addendum 5) — Telecommunications cabling for telecommunications enclosures

TIA/EIA-568-B.2-1 (Addendum 1) — Transmission performance specifications for 4-pair 100 Ω category 6 cabling

TIA/EIA-568-B.2-2 (Addendum 2) — The purpose of this addendum is to release sub-clauses 4.3.4.8, 4.4.4.4.1, 4.4.4.9 and 5.4.3 of TIA/EIA-568-B.2

TIA/EIA-568-B.2-3 (Addendum 3) — Additional considerations for insertion loss and return loss pass/fail determination

TIA/EIA-568-B.2-4 (Addendum 4) — Solderless connection reliability requirements for copper connecting hardware (Addendum 4)

TIA/EIA-568-B.2-5 (Addendum 5) — Corrections to TIA/EIA-568-B.2

TIA/EIA-568-B.2-6 (Addendum 6) — Category 6 related component test procedures TIA/EIA-568-B.2 The purpose of this addendum is to revise sub-clauses 4.3-4.8, 4.4-4.4.1, 4.4.4.9 and 5.4.3 of TIA/EIA-568-B.2

TIA/EIA-568-B.3-1 (Addendum 1) — Additional transmission testing performance specifications for 50/125µm optics fiber cables.

ANSI/TIA/EIA-568-B ANNEX CONTENT 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 cabling transmissions (Informative).
E. Optical fiber applications support information (Informative).
F. Bibliography (Informative).

B.2

A. Reliability testing of connecting hardware used for 100 Ω balanced twisted-pair cabling (Normative).
B. Test equipment overview (Normative).
C. Testing of cable (Normative).
D. Testing of connecting hardware (Normative).
E. Testing of cabling (Normative).
F. Testing of patch cords (Normative).
G. Multi-port measurement considerations (Normative).
H. Measurement accuracy (Informative).
I. Test instruments (Normative).
J. Comparison measure procedures (Normative).
K. 100 Ω screened twisted-pair (F/UTP) cabling (Normative).
L. Derivation of propagation delay from insertion loss equation (Informative).
M. 150 Ω shielded twisted-pair cabling (Normative).
N. Category 5 cabling (Informative).
O. Development of channel and component return loss limits (Informative).
P. Bibliography (Informative).

B.3

A. Optical fiber connector performance specifications (Normative).
B. Bibliography and references (Informative).

SIEMON'S PREFERRED CABLE TERMINOLOGY

Siemon UTP (Categories 3, 5e, and 6):

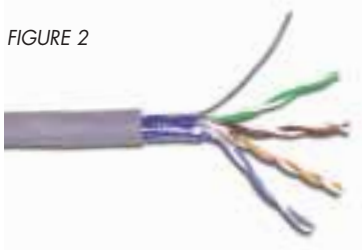
UTP cable constructions feature unshielded twisted-pairs enclosed within an overall thermoplastic jacket as shown in figure 1. UTP cables are compatible with Siemon MAX®, CT®, HD®, S210®, S110®, and S66™ product lines.

FIGURE 1

Siemon F/UTP (Categories 5e and 6):

F/UTP cable constructions feature unshielded twisted-pairs surrounded by an overall conductive mylar-backed aluminum foil shield and enclosed within an overall thermoplastic jacket as shown in figure 2. F/UTP cables are compatible with Siemon screened MAX® and screened HD5® product lines. TIA and legacy Siemon materials referred to this cable type as "ScTP" or "FTP".

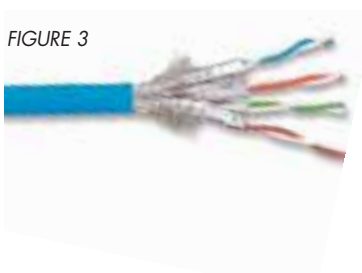
FIGURE 2



Siemon S/FTP (Categories 6 and 7):

S/FTP cable constructions feature individually foil-shielded twisted-pairs surrounded by an overall braid and enclosed within an overall thermoplastic jacket as shown in figure 3. S/FTP cables are compatible with Siemon TERA® and screened MAX® product lines. Legacy Siemon materials referred to this cable type as "PiMF", "STP", or "SSTP".

FIGURE 3



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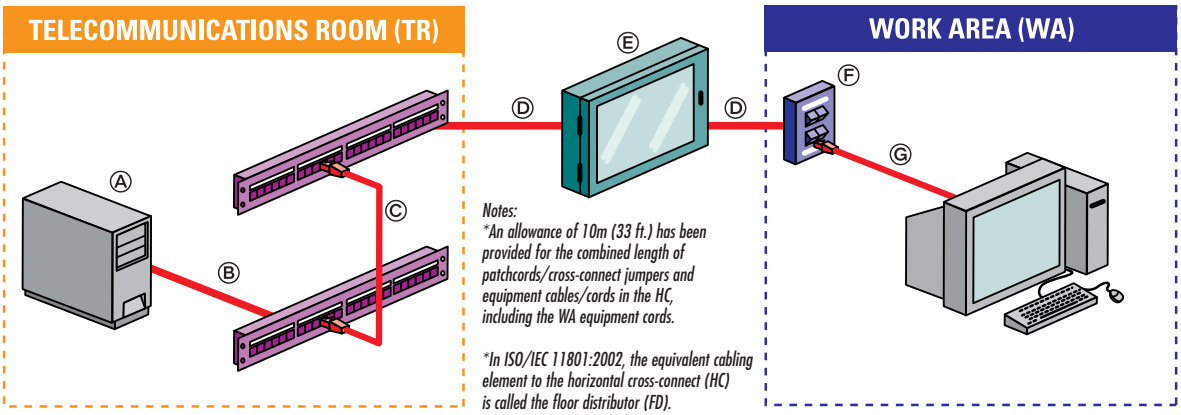
HORIZONTAL CABLING SYSTEM STRUCTURE

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.



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

Note: ISO/IEC 11801:2002 specifies a max. patchcord/cross-connect length of 5m (16.4 ft.), which does not include equipment cables/cords.

D Horizontal cable 90m (295 ft.) max. total
E TP or CP (optional)
F Telecommunications outlet/connector (TO)
G 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 (UTP) or screened twisted-pair (F/UTP).

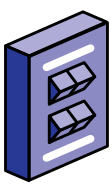
  

  4-pair 100 Ω fully shielded twisted-pair (S/FTP) (ISO/IEC 11801:2002 only).

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

- Multi-unit cables are allowed, provided that they satisfy the hybrid/bundled cable requirements of TIA/EIA-568-B.2, ISO/IEC 11801:2002.
- Grounding shall conform to applicable building codes and the requirements of ANSI-J-STD-607-A.
- A minimum of two telecommunications outlets are required for each individual work area.

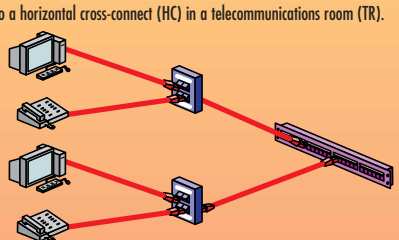
  

  First outlet: 100 Ω twisted-pair (category 6 is recommended).

  Second outlet: 100 Ω twisted-pair or 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" was removed from the second edition of ISO/IEC 11801:2002. Under carpet cabling is no longer recognized by that standard.
- 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).



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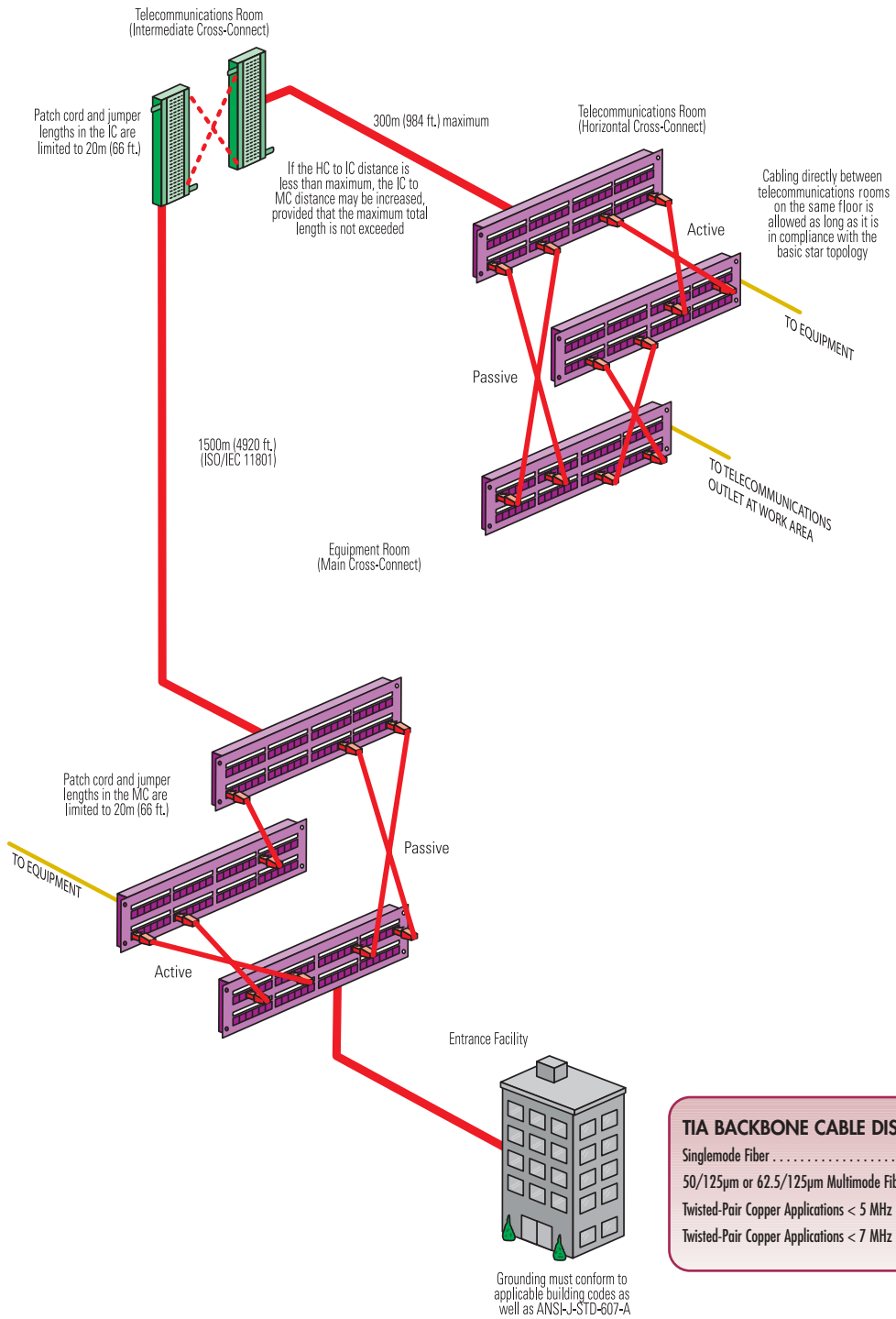
BACKBONE CABLING SYSTEM STRUCTURE

The backbone cabling system provides interconnections between telecommunications rooms, equipment rooms, main terminal space, 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.)
Twisted-Pair Copper Applications < 7 MHz	100m (328 ft.)

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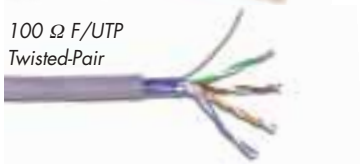
SOME POINTS SPECIFIED FOR THE BACKBONE CABLING SUBSYSTEM INCLUDE:

- 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:

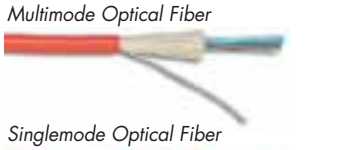
100 Ω UTP Twisted-Pair

100 Ω F/UTP Twisted-Pair

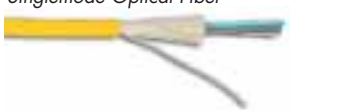


100 Ω S/FTP Twisted-Pair

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



Singlemode Optical Fiber

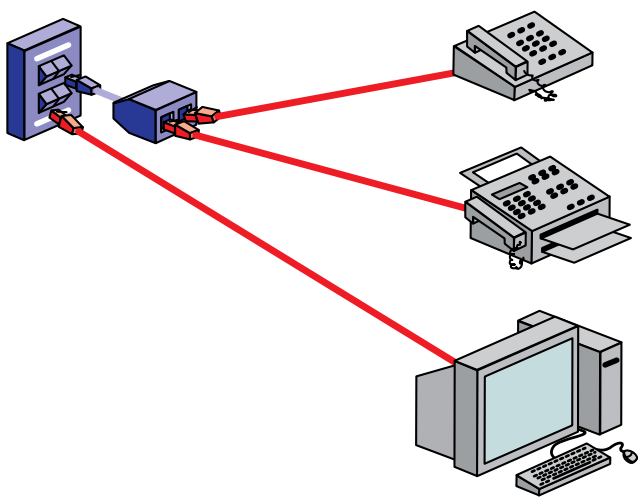


- Multi-pair cable is allowed, provided that it satisfies the power sum crosstalk requirements.
- The proximity of backbone cabling to sources of electromagnetic interference (EMI) shall be taken into account.
- Cross-connects for different cable types shall be located in the same facilities.
- Bridged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

Notes: In ISO/IEC 11801:2002, 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.

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 '568-B.1 and '11801:2002.



SOME SPECIFICATIONS RELATED TO WORK AREA CABLING INCLUDE:

- Equipment cords are assumed to have the same performance category as the horizontal cable to which they connect.
- When used, adapters are assumed to be compatible with the transmission capabilities of the equipment to which they connect.
- ISO/IEC 11801:2002 allows for any cord to be longer if the horizontal is shorter. See open office cabling.

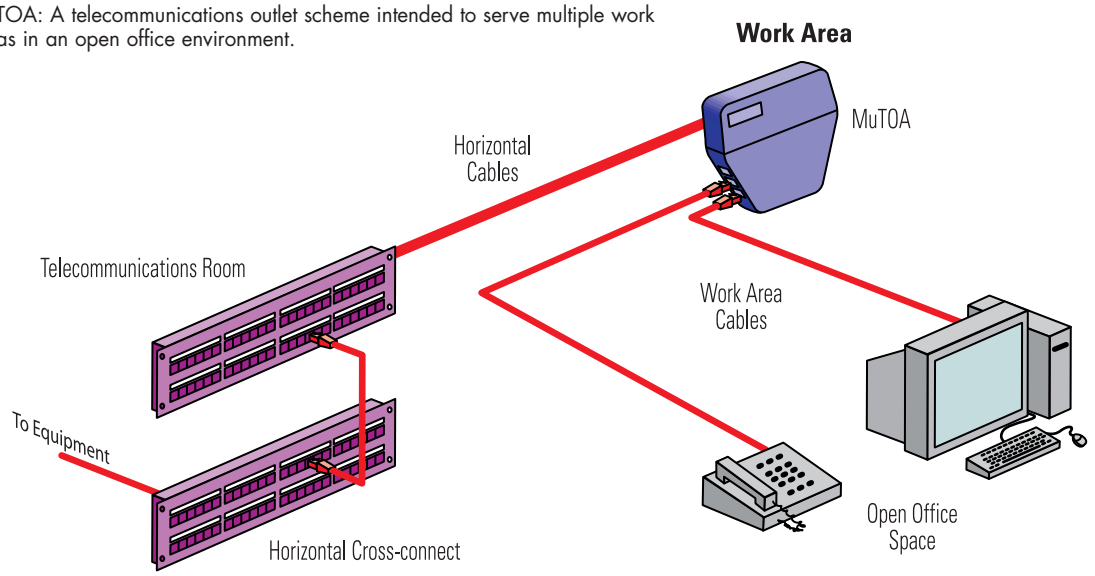
Note: For establishing maximum horizontal link distances, a combined maximum length of 10m (33 ft.) is allowed for patch cables (or jumpers) and for equipment cables in the work area and the telecommunications room.

OPEN OFFICE CABLING

Additional specifications for horizontal cabling in areas with moveable furniture and partitions have been included in 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.

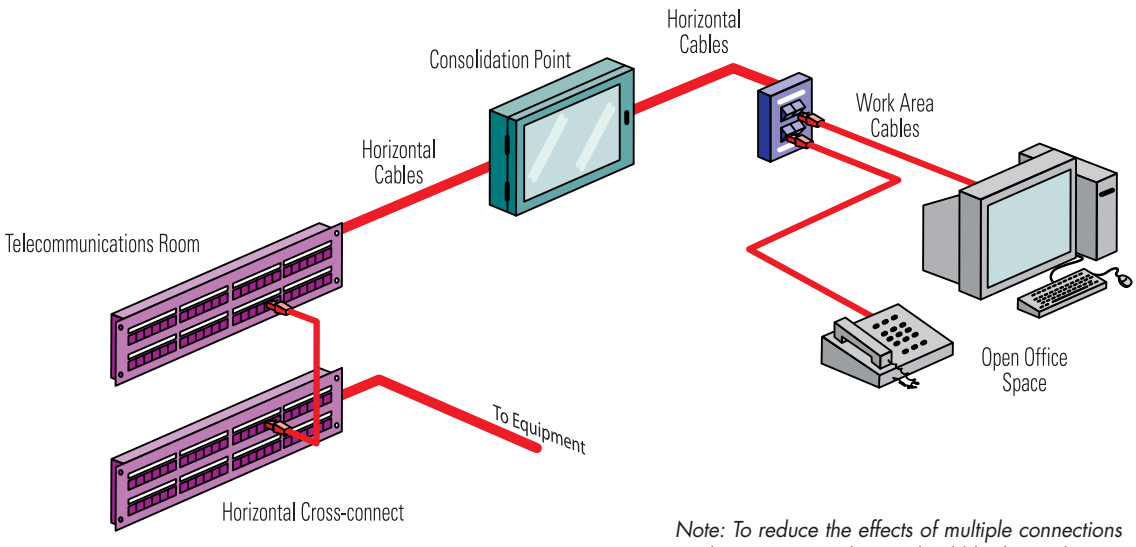
THIS IS AN EXAMPLE OF OPEN OFFICE IMPLEMENTATION USING THE MuTOA — MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY

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 15m (50 ft.) from the HC (FD).

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HORIZONTAL DISTANCES OF COPPER LINKS (OPEN OFFICE)

The table entries 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 assuming the use of 24 AWG cable. The length of work area cables shall not exceed 22m (72 ft.) per TIA/EIA 568-B, 20m (66 ft.) per ISO/IEC 11801:2002. The MuTOA shall be marked with the maximum allowable work area cable length.

LENGTH OF HORIZONTAL CABLE	MAXIMUM LENGTH OF WORK AREA CABLE 24 AWG (20%)	MAXIMUM LENGTH OF WORK AREA CABLE 26 AWG (50%)
H m (ft.)	W m (ft.)	W m (ft.)
90 (295)	5 (16)	4 (13)
85 (279)	9 (30)	7 (23)
80 (262)	13 (44)	11 (35)
75 (246)	17 (57)	14 (46)
70 (230)	22 (72)	17 (56)

TABLE 1 — MAXIMUM LENGTH OF WORK AREA CABLE

**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 11801:2002, 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 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 22m (72 ft.) of work area cable is 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 performance requirements.
- Consolidation points have advantage in 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 TIA-569-B.
- 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.

TR42.1.1 NETWORK DISTRIBUTION NODES

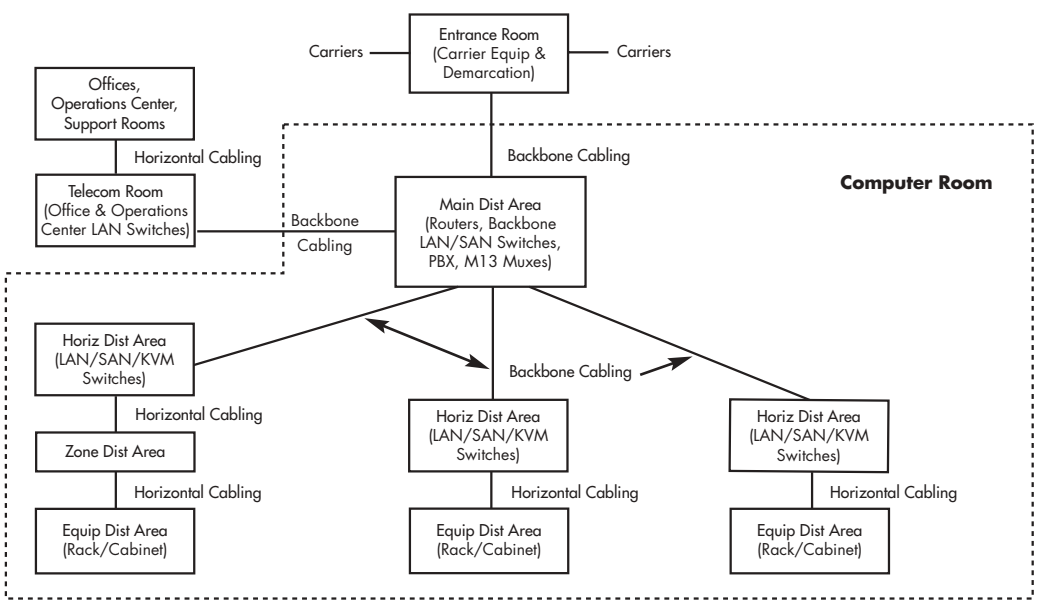
TR-42.1.1 was tasked to create a new standard for Application Spaces such as Internet Data Centers, Service Distribution Nodes, and Storage Area Networks. The scope of the group was to develop cabling topology, recognized media types, cabling requirements, and requirements for pathways & spaces for the above application spaces and inter/intra-node connections.

TIA-TR-42.1.1 is expected to release the standard in June 2005. Draft 5 SP-3-0092 was released June 17, 2004, including considerations for telecommunication infrastructure, spaces, pathways, redundancy and new terminology.

The standard will address infrastructure standards for data centers and computer rooms of all types and sizes, including small server rooms within an office building to large multi-floor data centers. The standard will be constructed so that the topology described will be adaptable to any size data center.

The standard will recognize two categories of data centers. The private domain ("enterprise") consists of private corporations, government agencies, or the establishment of other intranets or extranets, while public domain ("internet") consists of traditional telephone service providers, unregulated competitive service providers and related commercial operators.

FIGURE: GENERIC DATA CENTER TOPOLOGY



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TWISTED-PAIR (BALANCED) CABLING

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

DESIGNATION	TRANSMISSION CHARACTERISTICS	DESCRIPTION
3	Transmission characteristics are specified up to 16 MHz.	Meets applicable category 3 and class C requirements of ISO/IEC 11801:2002, ANSI/TIA/EIA-568-B.1 & B.2. Requirements are specified to an upper frequency limit of 16 MHz.
5e	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 11801:2002. Requirements are specified to an upper frequency limit of 100 MHz.
6	Transmission characteristics are specified up to 250 MHz.	Performs to category 6 of '568-B.2-1 TIA-TSB-155 draft, and class E requirements of ISO/IEC 11801:2002. Requirements are specified to an upper frequency limit of 250 MHz. This classification is a superset of 5e.
6a	Transmission characteristics are specified up to 500 MHz.	Performs to category 6 of '568-B.2-1 and '568-B.2-10 and class E of ISO/IEC 11801:2002 and amendment NBS 1 to ISO/IEC 11801. Requirements are specified to an upper frequency limit of 500 MHz. This classification is specified with the additional requirements of TSB-155 to support the operation of 10GBASE-T over 4-connector channel to typologies over distances from at least 55m up to 100m. *Note: Augmented category 6 draft requirements are still in development and are intended to be published before 2006.*
7	Transmission characteristics are specified up to 1.0 GHz.	Performs to category 7 and class F requirements of ISO/IEC 11801:2002. Requirements are specified to an upper frequency limit of 600 MHz. This classification is an electrical superset of 6a. Supports all parameters to 1.0 GHz for compliance to ISO/IEC 15018 and ISO/IEC 11801 Ed. 2, Amd. 1st draft.

Terminology and classifications specified in ISO/IEC 11801:2002 for cabling links differ slightly from TIA categories (see page 13.22). Components and installation practices are subject to all applicable building and safety codes that may be in effect.

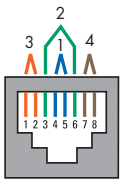
INDUSTRIAL ETHERNET CONNECTIVITY AND APPLICATIONS

There are several standards bodies around the world currently working towards Industrial premise cabling standards. Some of the more prominent committees are the TIA (Telecommunications Industry Association), IEC (International Electrotechnical Commission), and the ODVA (Open DeviceNet Vendor Association).

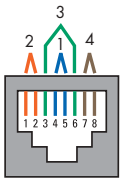
These committees are establishing the standards for both connectivity requirements that are needed within harsh industrial environments, as well as the applications that will need to be supported. The TIA and the ODVA are recommending an Ethernet platform for easier integration of information into the office environment. The IEC has released a Publicly Available Specification (IEC/PAS 61076-3-111 Ed.1) covering connectors to 250 MHz in the Industrial environment. The Siemon Industrial MAX® plug and outlet are specified as connector variant 1 in the standard and the IEC 61076-3-106 draft industrial connector specification.

UTP AND SCREENED TELECOMMUNICATIONS OUTLET/CONNECTOR

- 8-position modular jack per IEC 60603-7 ('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.



T568A



T568B


Example UTP Outlet


Example Screened Outlet

FULLY SHIELDED TELECOMMUNICATIONS OUTLET/CONNECTOR

- Entirely new interface design to support class F cabling per IEC 61076-3-104.
- Transmission measurement methods for category 7 and class F specified by ISO/IEC 11801:2002 and 1.0 GHz per ISO/IEC 15018 and ISO/IEC 11801 Ed.2, Amd. 1st draft.
- Durability rating 750 mating cycles minimum.

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-A.

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SCREENED CABLING (F/UTP)

As a result of the release of TIA/EIA/IS-729 and the maturity of the '568-B and '11801:2002 standards, telecommunications groups recognize the presence of an overall shield over four twisted-pairs; a media termed Screened Twisted-Pair. This cabling type is recognized as F/UTP, which stands for a foil applied over unshielded twisted-pairs.

F/UTP 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" or "100 Ω F/UTP", 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 TIA/EIA-568-B.2 and ISO/IEC 11801:2002.

SCREENED CONNECTORS:

- Interface and pair assignments same as IEC 60603-7 ('568-B.1 states that all 4 pairs must be connected).
- Additional transfer impedance and shield mating interface requirements specified in IEC 60603-7-3 and IEC 60603-7-5.

F/UTP 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.

F/UTP 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 (S/FTP)

Fully shielded cabling requirements have been developed by ISO and IEC. Cable and connector specifications extend to 600 MHz and support class F cabling requirements. (An ISO/IEC project has been started to create amendment 1 of Ed. 2 of ISO/IEC 11801, which extends class F to 1.0 GHz). This cabling type is recognized as S/FTP, which stands for a foil and braided overall shield applied over individually foil shielded twisted-pairs.

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 developed by ISO and IEC.

FULLY SHIELDED CONNECTORS:

- Cabling interface and pair assignments specified by ISO/IEC 11801:2002.
- Mechanical and transmission requirements specified in IEC 60603-7-7 and IEC/PAS 61076-3-104.

FULLY SHIELDED PATCH CABLES:

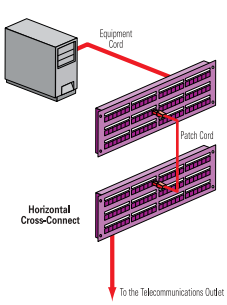
- Mechanical and transmission requirements are specified in IEC 61156-5 and IEC 61156-6.

FULLY SHIELDED INSTALLATION PRACTICES:

- Installation Practices developed by ISO/IEC.

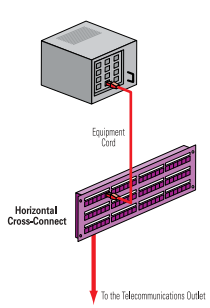
CROSS-CONNECT

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



INTERCONNECT

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



TRANSMISSION PERFORMANCE SPECIFICATIONS FOR FIELD TESTING OF BALANCED CABLING SYSTEMS

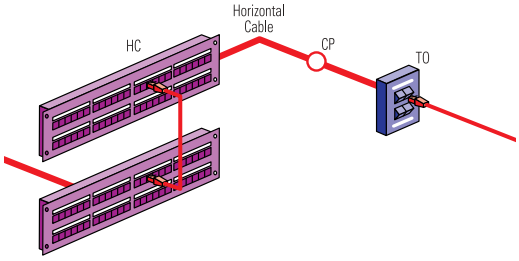
This document provides users with the opportunity to use comprehensive test methods to validate the transmission performance characteristics of installed category 7, 6, 5e and lower grade twisted-pair cabling systems. The categories of balanced cabling systems in this bulletin correspond with the balanced cabling categories of ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2-1, and ISO/IEC 11801:2002.

HORIZONTAL CHANNEL (COPPER)

Performance Specified in:

TIA/EIA-568-B.1 (category 5e), TIA/EIA-568-B.2-1 (category 6), and proposed TIA/EIA-568-B.2-10 (augmented category 6)

ISO/IEC 11801:2002 2nd Edition (classes D, E and F) and proposed amendment 1 to ISO/IEC 11801:2002



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

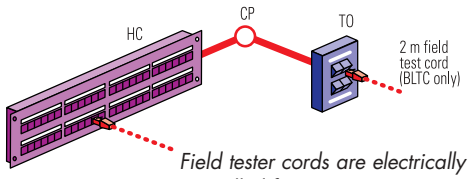
**Not specified by TIA*

LINK TEST CONFIGURATION

Performance Specified in:

TIA/EIA-568-B.1 (category 5e), TIA/EIA-568-B.2-1 (category 6), and proposed TIA/EIA-568-B.2-10 (augmented category 6)

ISO/IEC 11801:2002 2nd Edition (classes D, E and F) and proposed amendment to ISO/IEC 11801'2002



Field tester cords are electrically cancelled from test

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)	17.7	65.0	46.0	14.0	47.3

**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 11801:2002. 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 and ISO/IEC 11801:2002.
- 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. Level III field test accuracy required for category 6/class E.

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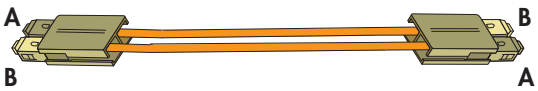
OPTICAL FIBER CABLING

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:

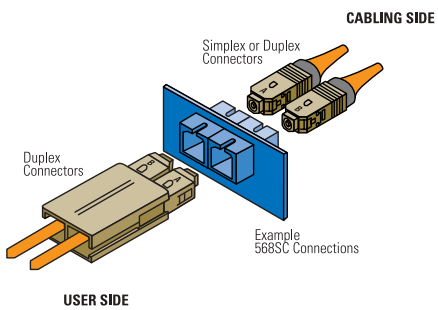
- Siemon recommends that a minimum of 1m (3.28 ft.) of two-fiber cable (or two buffered fibers) be accessible for termination purposes.
- Testing is recommended to assure correct polarity and acceptable link performance. Clause 11 of '568-B.1 provides recommended optical fiber link performance testing 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 in.) and should have slack storage capability.
  - Provisions for terminating and housing a minimum of two optical fibers.
- Identification of fiber types:
  - Multimode connector or a visible portion of it and adapters shall be identified with the color beige.
  - Singlemode connector 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.



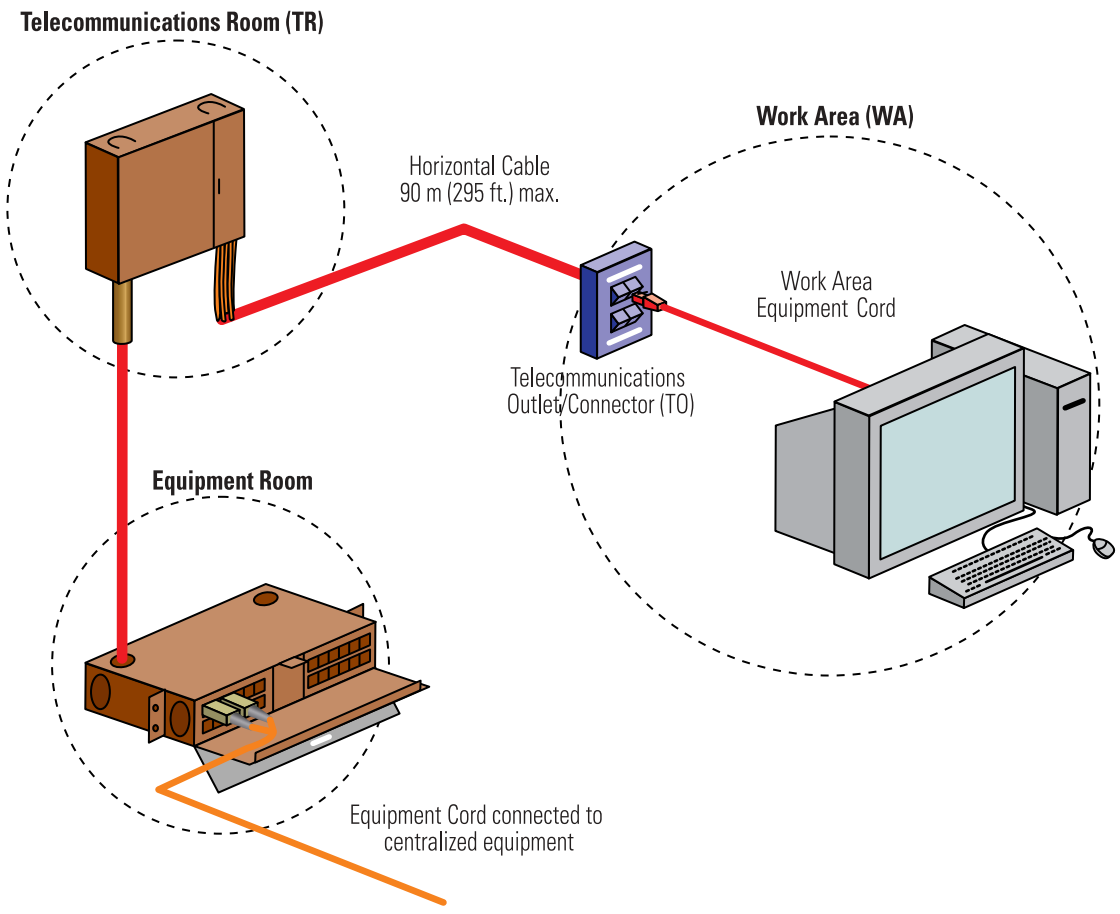
See page 13.20 for information on optical fiber cabling classes OF-300, OF-500 and OF-2000, as specified in ISO/IEC 11801:2002.

568-B.1 AND ISO/IEC 11801:2002

CENTRALIZED OPTICAL FIBER CABLING:

Centralized optical fiber cabling provides the user with the flexibility of designing an optical fiber cabling system for centralized electronics 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 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 channel 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. The use of laser optimized 50 micon multimode fiber is required to support 300m of 10GBASE-SX.

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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.*

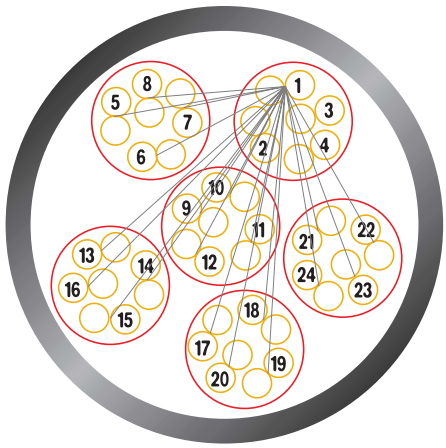
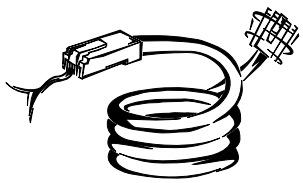


FIGURE 1:
Pair-to-Pair measurements required to calculate power sum NEXT loss for pair 1 of a 24-pair hybrid cable.

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

TIA/EIA-568-B.2 and TIA/EIA-568-B.2-1 defines a generic and non-destructive methodology for NEXT loss testing of modular plug cords respectively. 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 5e (TIA/EIA-588-B.2) or category 6 (TIA/EIA-568-B.2-1) patch cord and suitably designed test head.



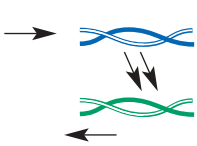
CROSSTALK NOISE

NEXT — Near-end Crosstalk — Signal coupling between pairs in the same cable when the disturbing signal is sent from the same end as the receiver.

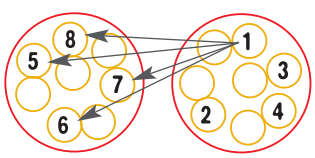
FEXT — Far-end Crosstalk — Signal coupling between pairs in the same cable when the disturbing signal is sent from the opposite end as the receiver.

Alien Crosstalk — A measure of the unwanted signal coupling between pairs in adjacent cabling.

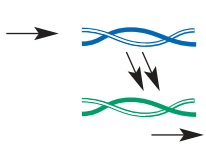
Power Sum Alien Crosstalk — A combination of the unwanted signal cabling between all pairs in adjacent cabling.



Near-end Crosstalk



Alien Crosstalk



Far-end Crosstalk

NEXT GENERATION CABLING

CATEGORY 6/CLASS E ('568-B.2-1 AND '11801:2002)

Category 6/class E standards describe a new performance range for unshielded and screened twisted-pair cabling. Category 6/class E specifies the best performance that UTP and F/UTP (screened) cabling solutions can be designed to deliver based on current technology. Category 6/class E is 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 is 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 have collaborated closely on the development of category 6 and class E standards and their requirements are well harmonized.

Augmented category 6/Class E, Edition 2.1 (proposed TIA/EIA 568-B.2-10) and amendments 1 to ISO/IEC 11801 2002. This standard will document the additional requirements necessary to support the operation of 10GBASE-T over 100-meter, 4-connector augmented category 6 and class E, edition 2.1 cabling.

Note: Augmented category 6 draft requirements are still in development and are intended to be published in 2006.

CATEGORY 7/CLASS F ('11801:2002)

Category 7/class F describes a new performance range for fully shielded (i.e., overall shield and individually shielded pairs) twisted-pair cabling. Category 7/class F is specified in the frequency range of 1-600 MHz. Even though these requirements are 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.

IEC 60603-7-7 and IEC/PAS 61076-3-104 specify two compliant interface designs. TIA is not actively developing a standard for category 7/class F.

ISO/IEC 11801:2002 2ND EDITION

The performance specifications in ISO/IEC11801:2002 2nd Edition provide new requirements for return loss and ELFEXT loss to complement the existing ISO class D requirements. The new specified return loss and ELFEXT loss requirements are in harmony with the values in '568-B.1 & B.2. The 2nd Edition of '11801 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 the 2nd Edition to ISO/IEC 11801 are normative and this document has become the governing international standard for cabling installations.

The first amendment to ISO/IEC 11801:2002 is being drafted and includes increasing class F/category 7 frequency range to 1.0 GHz. The first amendment to IEC 61076-3-104 is also being drafted and will be increased to 1.0 GHz to support the ISO/IEC 11801 amendment.

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STANDARDS UPDATE

ISO/IEC 15108 INFORMATION TECHNOLOGY — GENERIC CABLING FOR HOMES

This Standard recognizes the Siemon TERA® connector as an approved balanced cabling interface for all referenced home cabling communication applications. The specific home applications referenced in the Standard are:

Information and communications technology (ICT),
Broadcast communications technologies (BCT), and
Commands, controls and communication in buildings (CCCB).

The technical requirements of the Standard address cabling structure and topology, minimum configuration, link and channel performance, interfaces, and coexistence with other services. A summary of key media and interface criteria is shown in the table below:

	ICT CABLING	BCT CABLING	CCCB CABLING
Type of media:	Balanced cables, optical fibers	Balanced cables, coaxial cables	Balanced cables
Typical frequency range	Up to 100 MHz	Up to 3 GHz	Up to 100 kHz
Channel classes according to ISO/IEC 11801:2002:	Class D	N/A	N/A
Interface at device:	Balanced or optical fiber connectors per ISO/IEC 11801 Ed. 2.0	Balanced connector per IEC 61076-3-104 (Siemon TERA) or coaxial connectors: IEC 61169-2 or IEC 61169-24 ("F type") or	Fixed connection, CCCB connector(s) including balanced or optical fiber connectors per ISO/IEC 11801 Ed. 2.0

While the IEC 61076-3-104 Siemon TERA interface is recognized for use in all three home cabling applications, it is important to note that the TERA interface is the primary balanced twisted-pair cabling interface recognized to support BCT cabling applications. This connector is the most recognized commercially available interface for ISO/IEC category 7/class F applications.

ISO/IEC TR 24704 INFORMATION TECHNOLOGY CUSTOMER PREMISES CABLING FOR WIRELESS ACCESS POINTS

This Technical Report addresses planning considerations for future connection to wireless access points that supplement the existing copper and fiber optic premises cabling system infrastructure specifications of ISO/IEC11801 Ed. 2.0. Specified infrastructure guidelines are intended to support an array of coverage areas that form a wireless network grid within a building. The Report specifies ISO/IEC 11801 compliant horizontal cabling design considerations and guidelines for wireless access planning in the following areas:

- minimum configuration, structure and topology,
- performance requirements for permanent links and channels,
- coverage and location of telecommunications outlets,
- interfaces to wireless access points, and
- power delivery over balanced cabling.

It is important to note that information and guidance related to the placement and security of wireless access points are not addressed in the content of this Report, although recommendations related to the placement of telecommunications outlets (TOs) are provided to support flexible deployment of wireless services.

IEC 61076-3-104 DETAIL SPECIFICATION FOR 8-WAY, SHIELDED FREE AND FIXED CONNECTORS FOR DATA TRANSMISSIONS WITH FREQUENCIES UP TO 600 MHZ MINIMUM

The IEC 61076-3-104 standard describes requirements for a non-RJ 45 category 7 telecommunications connecting hardware interface that is based on the TERA plug/outlet interface developed by Siemon. This represents the first time in history that a non-RJ style connector interface has been internationally standardized for four-pair connections in a structured cabling system.

During the interface selection process conducted by ISO/IEC, an independent panel was asked to judge six different non-RJ-style connector proposals. Based on forty-eight separate criteria, including size, complexity, manufacturability, user-friendliness and transmission performance, the TERA interface was ranked the best overall choice for delivering the demanding bandwidth specified in the Standard. This new interface Standard was endorsed by eighteen countries and represents a significant achievement for structured cabling. The international support for approval of the TERA interface and its associated Standard confirms its status as a non-proprietary solution.

TIA/EIA-862 BUILDING AUTOMATION SYSTEMS CABLING STANDARD FOR COMMERCIAL BUILDINGS

Building automation encompasses control systems such as security and monitoring (i.e. CCTV), safety systems such as fire alarm, environmental conditioning systems such as heating, ventilation, and air conditioning (HVAC), and energy management systems such as internal and external lighting. The TIA/EIA-862 Standard specifies generic cabling

topology, architecture, design, installation practices, test procedures, and coverage areas to support building automation systems (BAS) used in commercial buildings. Since, historically, providers of these building automation services specified their own proprietary equipment, cables, interface connections, and topology, this new Standard offers the distinct advantage of being able to support multi-product and multi-vendor environments using one generic structured cabling system.

It is important to note that other "low voltage systems" (e.g., audio/video paging, service/equipment alarms, non-voice/data communications, wireless access points) are also supported by the telecommunications cabling infrastructure requirements of this Standard.

IEEE 802.3AF POWER OVER ETHERNET

This Standard was approved for publication in June of 2003 and describes means to economically provide power over a twisted-pair link segment to a single Ethernet device by specifying the voltage and minimum and maximum current and wattage necessary to provide power concurrently with 10BASE-T, 100BASE-TX, and 1000BASE-T signaling. Although the Standard specifies compatibility with category 3 and category-5e structured cabling, supplying power over Ethernet is recognized to also be compatible with category 6 and category 7 cabling. The specified methodology is compatible and interoperable with compliant RJ- 45 MDI (media-dependent interface) Ethernet devices including switch-to-switch connections (both supplying power), cross-over cables, and common mode termination implementations. The following applications directly benefit from power application over MDIs:

- IP Telephony
- Web Cameras
- Wireless Access Points
- Industrial Automation
- Home Automation
- Security Access Control and Monitoring Systems
- Point of Sale Terminals
- Lighting Control
- Gaming and Entertainment Equipment
- Building Management

There are two locations where power can be introduced: endpoint or mid-span. Endpoint power (a.k.a. phantom power) is introduced via the active equipment as shown in figure 1 below.

Mid-span power is introduced in the Telecommunications Room (TR) between the patch panel and switch as shown in figure 2 below.

Power may be applied over the pairs in one of three possible schemes as shown in table below.

Conductor	Alternative A (MDI-X)	Alternative A (MDI)	Alternative B (All)
1	– VPort	+ VPort	
2	– VPort	+ VPort	
3	+ VPort	– VPort	
4			+ VPort
5			+ VPort
6	+ VPort	– VPort	
7			– VPort
8			– VPort

IEEE 802.3af Powering Options

Endpoint power can be applied using alternatives A, B or both. It is important to note that, while active equipment may be capable of both alternatives A and B, they are not to operate both alternative A and alternative B on the same link segment simultaneously. Mid-span power application is limited to alternative B and 10/100 applications only. Refer to the Siemon Q&A entitled, "Powered Ethernet" for additional information.

Recent developmental work within the IEEE committee supports expansion of the original scope of this Standard to evaluate proposals that will result in increased power carrying capability over the cabling infrastructure.

PROPOSED IEEE 802.3AN 10GBASE-T

This pending applications standard is anticipated to publish in July of 2006. Based upon the IEEE 802.3 Ethernet frame format, this new high-speed data application will support a full-duplex transmission rate of 10 Gb/s over 4-pair structured cabling (2.5 Gb/s throughput per pair). Installed, legacy category 6 cabling is anticipated to support the 10GBASE-T application over 4-connector structured topologies up to at least 55 meters in length. The pending augmented category 6 (proposed TIA/EIA-568-B.2-10) cabling requirements will be specified to support the 10GBASE-T application over 4-connector, 100 meter structured topologies.

ISO/IEC 14165-114: INFORMATION TECHNOLOGY — FIBRE CHANNEL — PART 114: 100 MBIT/S COPPER PHYSICAL INTERFACE (FC-100-DF).

This application Standard defines a 1 Gigabit per second signaling protocol using a 2-pair transmission scheme. The Standard specifies one pair to transmit and one pair to receive and is intended only for operation over 100 meter, 4-connector category 7/class F cabling topologies. With the publication of this application standard, Siemon's TERA® solution becomes the world's first and only cabling system capable of supporting two simultaneous Gigabit per second data applications over one 4-pair channel.

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COMPARISON OF '568-B SERIES VERSUS '11801:2002 2ND EDITION FIBER CABLING PERFORMANCE SPECIFICATIONS

OPTICAL FIBER CABLING AND COMPONENT SPECIFICATIONS:

'568-B Series

Horizontal Link Insertion Loss ≤ 2.0 dB at 850nm or 1300nm

Horizontal Link With CP Insertion Loss ≤ 2.75dB @ 850nm or 1300nm

Centralized Link Insertion Loss ≤ 3.3 dB @ 850nm or 1300nm based on three connector pairs

Centralized Plus Open Office CP Link Insertion Loss ≤ 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 ≤ 0.75 dB

Splice Insertion Loss ≤ 0.3 dB

Cable Atten ≤ 3.5 dB/km at 850nm for 62.5/125µm and 50/125µm

Cable Atten ≤ 1.5 dB/km at 1300nm for 62.5/125µm and 50/125µm

Cable Atten ≤ 0.5 dB/km for singlemode outside plant cable

Cable Atten ≤ 1.0 dB/km for singlemode inside plant cable

'11801:2002 2nd Edition

CHANNEL ATTENUATION dB

Channel	Multimode		Singlemode	
	850nm	1300nm	1310nm	1550nm
OF-300	2.55	1.95	1.80	1.80
OF-500	3.25	2.25	2.00	2.00
OF-2000	8.50	4.50	3.50	3.50

Connector Atten ≤ 0.75 dB

Splice Atten ≤ 0.3 dB

Cable Atten ≤ 3.5 dB/km at 850nm for 62.5/125µm and 50/125µm

Cable Atten ≤ 1.5 dB/km at 1300nm for 62.5/125µm and 50/125µm

Cable Atten ≤ 1.0 dB/km for singlemode (no differentiation between inside and outside plant cables)

MULTIMODE OPTICAL FIBER MODAL BANDWIDTH (OVERFILLED LAUNCH):

'568-B Series

Bandwidth ≥ 160 MHz-km at 850nm for 62.5/125µm

Bandwidth ≥ 500 MHz-km at 850nm for 50/125µm

Bandwidth ≥ 500 MHz-km at 1300nm for 62.5/125µm and 50/125µm

Note: Additional performance specifications for 50/125µm cables are provided in ANSI/TIA/EIA-568-B.3-1. These requirements are harmonized with fiber type 'OM3' as specified in ISO/IEC 11801:2002 2nd Edition.

'11801:2002 2nd Edition

Bandwidth ≥ 200 MHz-km at 850nm for 62.5/125µm and 50/125µm (OM1)

Bandwidth ≥ 500 MHz-km @ 850nm for 62.5/125µm and 50/125µm (OM2)

Bandwidth ≥ 1500 MHz-km @ 850nm for 62.5/125µm and 50/125µm (OM3)

Bandwidth ≥ 500 MHz-km at 1300nm for 62.5/125µm and 50/125µm (OM1, OM2 and OM3)

Note: Fiber type OM3 specified in ISO/IEC 11801:2002 2nd Edition, requires laser launch bandwidth of 2000 MHz-km at 850nm. This requirement is assured by testing differential modal delay (DMD).

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

ANSI/TIA/EIA-568-B SERIES	ISO/IEC 11801:2002 2ND EDITION
COMMERCIAL BUILDING TELECOMMUNICATIONS CABLING STANDARD	**GENERIC CABLING FOR CUSTOMER PREMISES**
TERMINOLOGY	**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
Intrabuilding Backbone	Campus Backbone
Interbuilding Backbone	Building Backbone
HORIZONTAL MEDIA CHOICES	**HORIZONTAL MEDIA CHOICES**
4-pair 100 Ω unshielded twisted-pair (UTP or F/UTP)	4-pair 100 Ω balanced cable (UTP or F/UTP)
Two fiber, 50/125µm or 62.5/125µm optical fiber	Optical fiber (50µm, 62.5µm or singlemode permitted)
BACKBONE MEDIA CHOICES	**BACKBONE MEDIA CHOICES**
100 Ω balanced twisted-pair (UTP or F/UTP)	100 Ω balanced twisted-pair (UTP or F/UTP)
50/125µm or 62.5/125µm optical fiber	62.5/125µm or 50/125µm optical fiber
Singlemode optical fiber	Singlemode optical fiber
BEND RADIUS	**BEND RADIUS**
Horizontal ≥ 4 times cable O.D. no load for UTP, 8 times cable O.D. 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

**See ANSI/TIA/EIA-568-B.1-1 for specifications on patch cable band radius.*

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

ANSI/TIA/EIA-568-B SERIES	ISO/IEC 11801:2002 2ND EDITION
COMMERCIAL BUILDING TELECOMMUNICATIONS CABLING STANDARD	**GENERIC CABLING FOR CUSTOMER PREMISES**
ENGINEERING APPROACH	**ENGINEERING APPROACH**
Not applicable. Field testing for verification only.	Link performance determines compliance.
DESIGN APPROACH	**DESIGN APPROACH**
Design constraints, component specifications, and installation methods determine compliance.	Design constraints, component specifications, and installation methods determine an alternate means of compliance.
CONNECTOR TERMINATION	**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 5e or higher cables. Pair-untwist for category 3 shall be within 75mm (3 in.) from the point of termination.	In accordance with manufacturer's guidelines.
CATEGORIES OF CABLING PERFORMANCE	**CATEGORIES OF CABLING PERFORMANCE**
Category 3 is specified to 16 MHz	Class C is specified to 16 MHz
Category 5e is specified to 100 MHz	Class D is specified to 100 MHz An Optical Class is also specified.
Category 6 is specified to 250 MHz	Class E is specified to 250 MHz
Augmented category 6 will be specified to 500 MHz	Class E, edition 2.1 will be specified to 500 MHz Class F is specified to 600 MHz

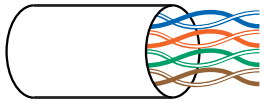
Note: For TIA standards, the term "category" is used to specify both components and cabling performance. For ISO/IEC, CENELEC and other cabling standards outside of the U.S. and Canada, the term "category" is used to describe component performance (i.e., cable and connecting hardware). The term "class"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

PERFORMANCE SPECIFICATION	PERFORMANCE SPECIFICATION
Stranded Cable Attenuation = 20% worse than solid requirements for UTP, 50% worse for F/UTP.	Stranded Cable Attenuation = 50% worse than solid requirements for both UTP and F/UTP.
Hybrid requirements call for power sum NEXT loss margin + 3dB over pair-to-pair NEXT loss limit.	Hybrid requirements call for 6 dB better PSNEXT loss between cable units than the PSNEXT loss specified for the cable.

HORIZONTAL TWISTED-PAIR CABLE

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

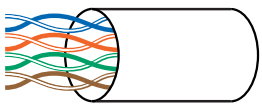
- Color-coding:
  white/blue – blue
  white/orange – orange
  white/green – green
  white/brown – brown



TWISTED-PAIR PATCH CORDS AND CROSS-CONNECT JUMPERS

- Patch cords should use stranded cable for adequate flex-life.
- Stranded cables must meet the minimum performance requirements for horizontal cable except that 20 percent more attenuation for UTP is allowed by '568-B.2 and 50 percent more attenuation is allowed by '11801:2002 for UTP and F/UTP.
- 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 '568-B.2.
- Color Codes for Stranded, 100 Ω 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.

MULTI-PAIR CABLE

- 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 hybrid requirements apply when multiple cable units are contained within 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

Insulation Marking

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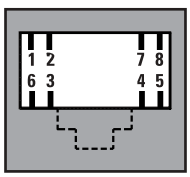
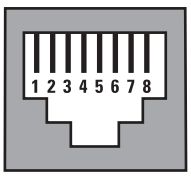
MODULAR WIRING REFERENCE

MODULAR JACK STYLES:

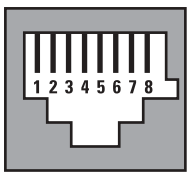
There are four basic modular jack styles. The 8-position modular outlets are commonly and incorrectly referred to as "RJ45". The 6-position modular jack is commonly referred to as an RJ11. Using these terms can sometimes lead to confusion since the RJ designations actually refer to very specific wiring 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.



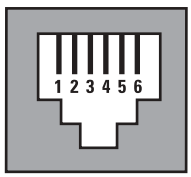
8-position class F



8-position



8-position keyed

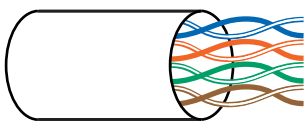


6-position

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

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.


UTP Horizontal Cable (solid 24 AWG)

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

8-position T568A/T568B

8-position USOC

6-position USOC

STRAIGHT-THROUGH OR REVERSED?

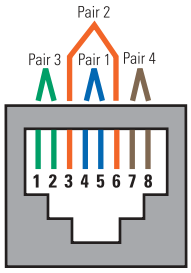
Modular cords are used for two basic applications. One application uses them for patching between modular patch panels. When used in this manner modular cords should always be wired "straight-through" (pin 1 to pin 1, pin 2 to pin 2, pin 3 to pin 3, etc.). The second major application uses modular cords 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".

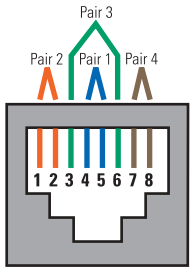
COMMON OUTLET CONFIGURATIONS

Two wiring schemes have been adopted by the '568-B.1 and '11801:2002 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, 5e, and 6 are only applicable to this type of pair grouping.



T568A

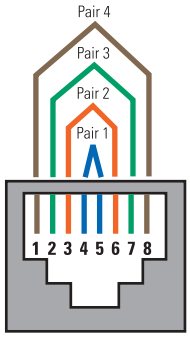
Pair ID	PIN #
T1	5
R1	4
T2	3
R2	6
T3	1
R3	2
T4	7
R4	8



T568B

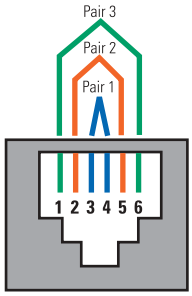
Pair ID	PIN #
T1	5
R1	4
T2	1
R2	2
T3	3
R3	6
T4	7
R4	8

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

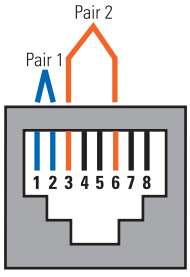
Pair ID	PIN #
T1	5
R1	4
T2	3
R2	6
T3	2
R3	7
T4	1
R4	8



USOC 1-, 2- or 3-pair

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

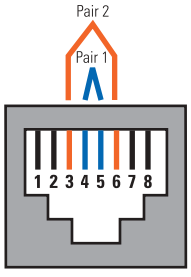
10BASE-T and 100BASE-TX wiring specifies an 8-position jack but uses only two pairs. These are pairs two and three of T568A and T568B schemes.



10/100BASE-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.

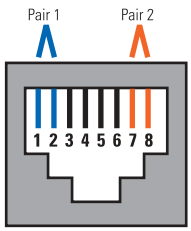


Token Ring (802.5)

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

1000BASE-T and 10GBASE-T wiring specifies an 8-position jack. Can be either the T568A or T568B configuration.
(See above)

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

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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.
- ✔ Use hook and loop tie wraps.

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 higher 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

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
10GBASE-T (802.3an)	Bi	Bi	Bi	Bi
1000BASE-T (802.3ab)	Bi	Bi	Bi	Bi
1000BASE-TX (TIA/EIA 854)	TX	RX	TX	RX
100BASE-VG (802.12)	Bi	Bi	Bi	Bi
100BASE-T4 (802.3u)	TX	RX	Bi	Bi
100BASE-TX (802.3u)	TX	RX	—	—
1000BASE-TX2/4	TX	RX	—	—

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

[1]*Optional terminations may be required by some manufacturers' active implementations.*

RECOMMENDED COLOR-CODING SCHEME

SIEMON COLOR #	COLOR CODE	
02	white □	1st Level Backbone (MC/IC or MC/TC Terminations)
03	red ■	Key Telephone Systems
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 lb*f*) 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 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.

TIA-569-B*

COMMERCIAL BUILDING STANDARD FOR TELECOMMUNICATIONS PATHWAYS AND SPACES

The TIA TR42.3 Working Group on Telecommunications Pathways & Spaces published the TIA-569-B ('569-B) Standard in 2004.

FOLLOWING ARE HIGHLIGHTS OF THE '569-B STANDARD:

PURPOSE:

- Standardize design and construction practices for telecommunications pathways and spaces.
- 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, including wireless.
- Telecommunications pathways and spaces within and between buildings.
- Commercial building design for both single and multi-tenant buildings.

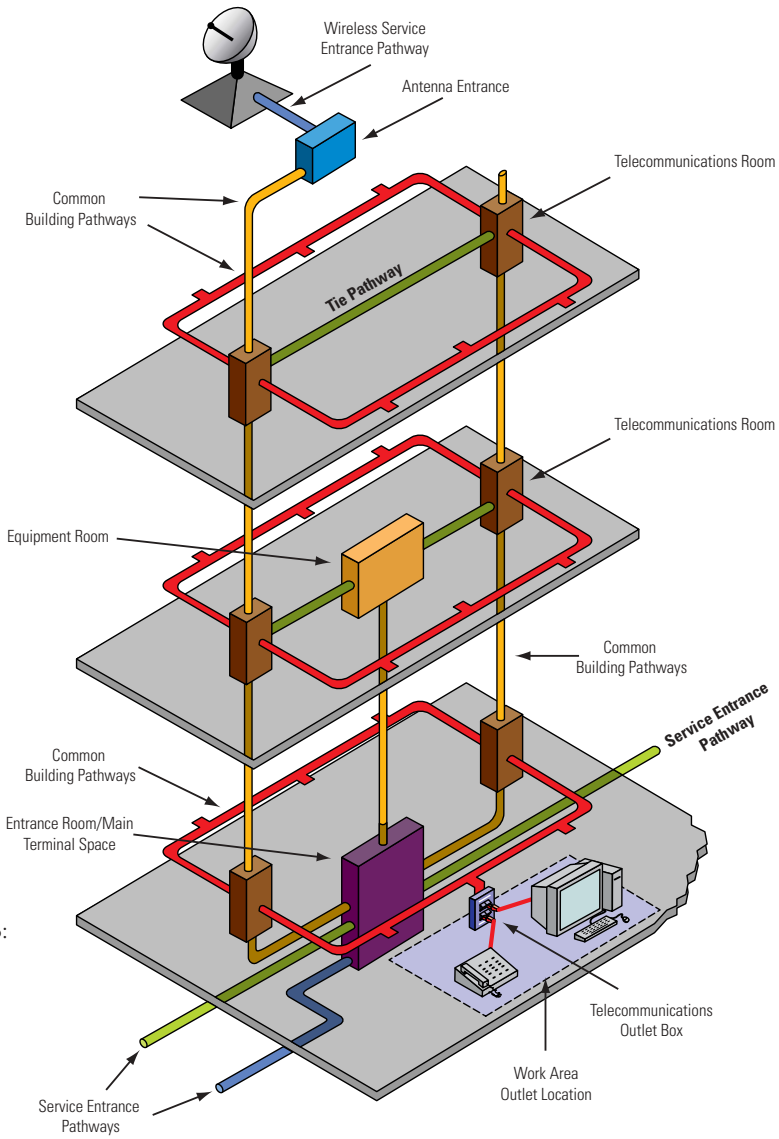
ELEMENTS:

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

ANNEX INFORMATION:

The following normative and informative annexes are provided in TIA-569-B:

A. Firestopping (Normative)
B. Additional section information (Informative)
C. Noise reduction guidelines (Informative)
D. Bibliography and references (Informative)



**ANSI approval pending.*

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BUILDING AND BACKBONE INCLUDES:

PATHWAY TYPES:

- **CEILING —** Open environment above accessible ceiling tiles and frame work.
- **ACCESS FLOOR —** Raised modular floor tile supported by pedestals, with or without lateral bracing or stringers.
- **TRAY & RUNWAY —** Prefabricated rigid structures for pulling or placing cable.
- **CONDUIT —** Metallic and nonmetallic tubing of rigid or flexible construction permitted by applicable electrical code.
- **FURNITURE —** Modular systems of furniture containing pathways/raceways for concealing cable and terminating outlets.
- **IN-FLOOR —** Network of raceways embedded in concrete consisting of distribution and header ducts, trenches, and cellular systems.
- **PERIMETER —** Surface, recessed, molding, and multi-channel raceway systems for wall mounting around rooms or along hallways.
- **VERTICAL PATHWAYS —** Sleeve or conduit and slot penetrations for access to other floors.
- **UTILITY COLUMNS —** Vertical channel for cable access to work area locations.
- **PARTITION CABLING —** Where demountable partitions are used to conceal cables.
- **IN-WALL CABLING —** Where cables pass through stud openings.

SPACE TYPES:

- **ENTRANCE FACILITIES —** Telecommunications service entrance to the building including entrance through the wall.
- **ACCESS PROVIDER/SERVICE PROVIDE —** Spaces location of transmission, reception and support equipment.
- **MULTI-TENANT BUILDING SPACES —** Includes common Equipment Room and column Telecommunications Room.
- **BUILDING SPACES —**
  - Outlet box/bracket/poke-thru
  - Multi-user telecommunications outlet assembly
  - Consolidation Point
  - Splice box/zone box
  - Telecommunications Enclosure
  - Telecommunications Room
  - Equipment Room
  - Entrance Room

DESIGN CONSIDERATIONS:

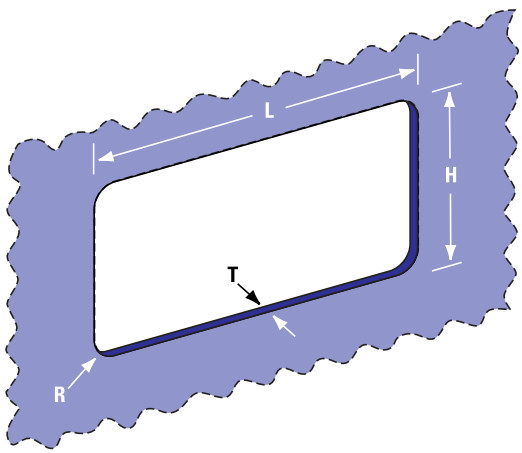
- Grounded per code and ANSI-J-STD-607-A ('607-A)
- Designed to handle recognized media as specified in ANSI/TIA/EIA-568-B series
- Not allowed in elevator shafts
- Accommodate seismic zone requirements
- Installed in dry locations

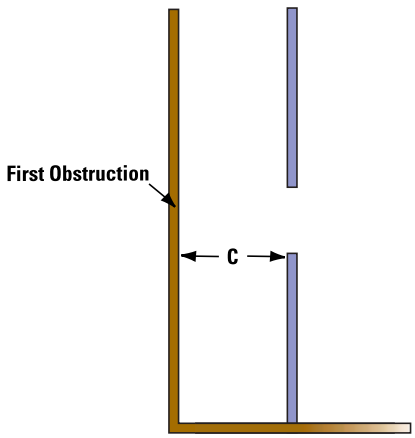
WORK AREA

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. Height coordinated power outlet.
- 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, WD-6)
- 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 are governed by applicable electrical code for safety. Minimum separation requirements of Article 800-52 of ANSI/NFPA 70 (National Electric Code) shall be applied.

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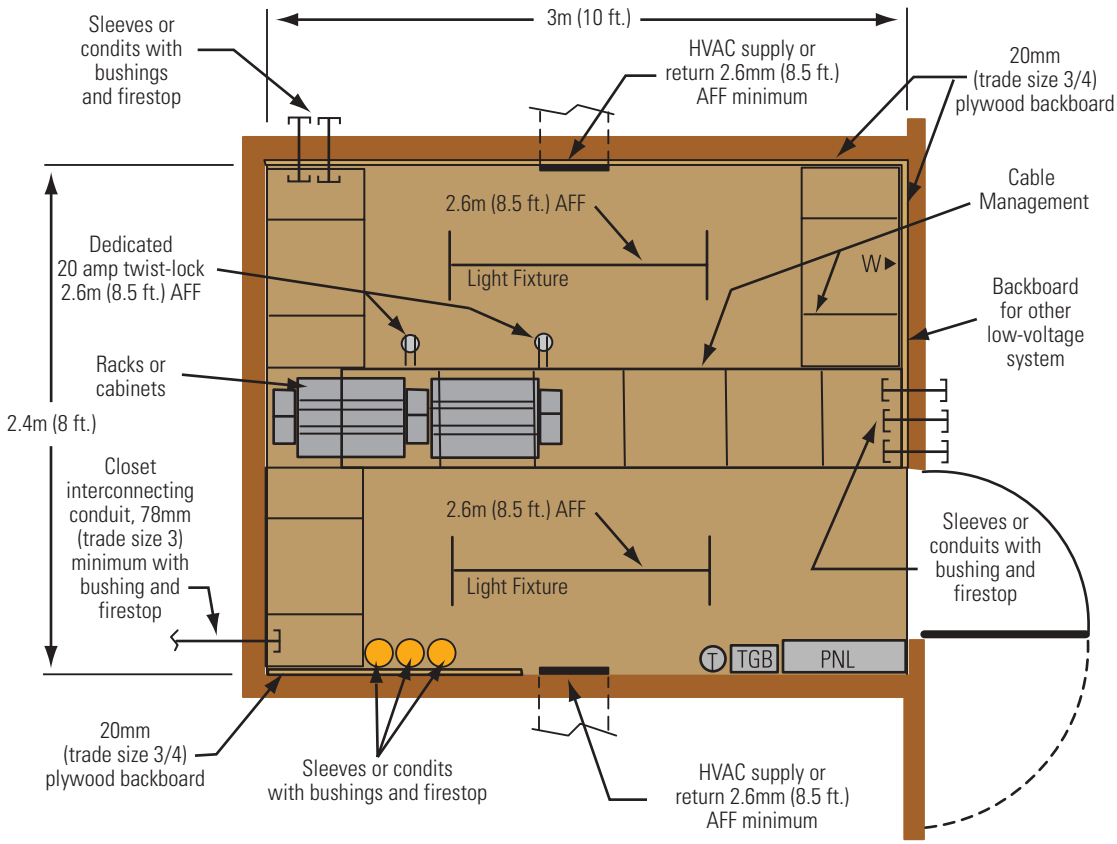
TELECOMMUNICATIONS ROOM

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/ft^2).

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.
- One wall 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) at 1m (3 ft.) above finished floor (AFF).
- 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 nominal non-switched duplex electrical outlet receptacles or equivalent, 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-J-STD-607-A.
- 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.
- One wall should have 20mm (0.75 in.) A-C plywood 2.4m (8 ft.) high.
- Minimum door same as telecommunications room. Double doors without center post or sill is recommended.
- Access to ground per ANSI-J-STD-607-A.

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.
- Wireless transmission/reception shall be located close to wireless field.

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 21mm (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

Note: Common equipment rooms & telecommunications rooms are made available in multi tenant environments and controlled by building owner or agent.

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