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TIA STANDARD

Generic Telecommunications Cabling for Customer Premises

TIA-568.0-E
(Revision of TIA-568.0-D)

March 2020

TELECOMMUNICATIONS INDUSTRY ASSOCIATION
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Generic Telecommunications Cabling for Customer Premises

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FOREWORD

(This foreword is not considered part of this Standard.)

This Standard was developed by TIA Subcommittee TR-42.1.

Approval of this Standard

This Standard was approved by TIA Subcommittee TR-42.1, TIA Engineering Committee TR-42, and the American National Standards Institute (ANSI).

ANSI/TIA reviews standards every 5 years. At that time, standards are reaffirmed, withdrawn, or revised according to the submitted updates. Updates to be included in the next revision should be sent to the committee chair or to ANSI/TIA.

Contributing organizations

More than 60 organizations within the telecommunications industry (including manufacturers, consultants, end users, and other organizations) contributed their expertise to the development of this Standard.

Documents superseded

This Standard, in part, replaces ANSI/TIA-568.0-D dated September, 2015, and its addendum.

Significant technical changes from the previous edition

- The Cabling Subsystem 1 cabling to coverage areas of ANSI/TIA-862 was added and distinguished from cabling to work area.
- A distinction was made between consolidation points and the connectors contained therein.
- A distinction was made between horizontal connection points and the connectors contained therein.
- The contents of ANSI/TIA-568.0-D-1 (updated references, new media types) were incorporated.
- The formulae for determining cabling lengths for balanced twisted-pair cabling was modified to match the format of ANSI/TIA-568.2.
- Cords with a derating factor of 1.95 were added.
- References were updated to conform with the 2019 edition of the *Telecommunications Industry Association (TIA) Standards Style Guide for Engineering Committees*.

Annexes

There are six annexes to this Standard. Annex A is normative and considered a requirement of this Standard. Annexes B through F are informative and not considered a requirement of this Standard.

Relationship to other TIA standards and documents

The following are related standards regarding various aspects of structured cabling that were developed and are maintained by Engineering Committee TIA TR-42. An illustrative diagram of the ANSI/TIA-568 Series relationship to other relevant TIA standards is given in figure 1.

- ANSI/TIA-568.1, *Commercial Building Telecommunications Infrastructure Standard*
- ANSI/TIA-568.2, *Balanced Twisted-Pair Telecommunications Cabling and Components Standard*
- ANSI/TIA-568.3, *Optical Fiber Cabling and Components Standard*
- ANSI/TIA-568.4, *Broadband Coaxial Cabling and Components Standard*
- ANSI/TIA-569, *Telecommunications Pathways and Spaces*
- ANSI/TIA-570, *Residential Telecommunications Infrastructure Standard*
- ANSI/TIA-606, *Administration Standard for Telecommunications Infrastructure*
- ANSI/TIA-607, *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises*
- ANSI/TIA-758, *Customer-Owned Outside Plant Telecommunications Infrastructure Standard*
- ANSI/TIA-862, *Structured Cabling InfrastructureStandard for Intelligent Building Systems*
- ANSI/TIA-942, *Telecommunications Infrastructure Standard for Data Centers*
- ANSI/TIA-1005, *Telecommunications Infrastructure Standard for Industrial Premises*
- ANSI/TIA-1179, *Healthcare Facility Telecommunications Infrastructure Standard*
- ANSI/TIA-4966, *Telecommunications Infrastructure Standard for Educational Facilities*
- ANSI/TIA-4994, *Standard for Sustainable Information Communications Technology*
- ANSI/TIA-5017, *Telecommunications Physical Network Security Standard*

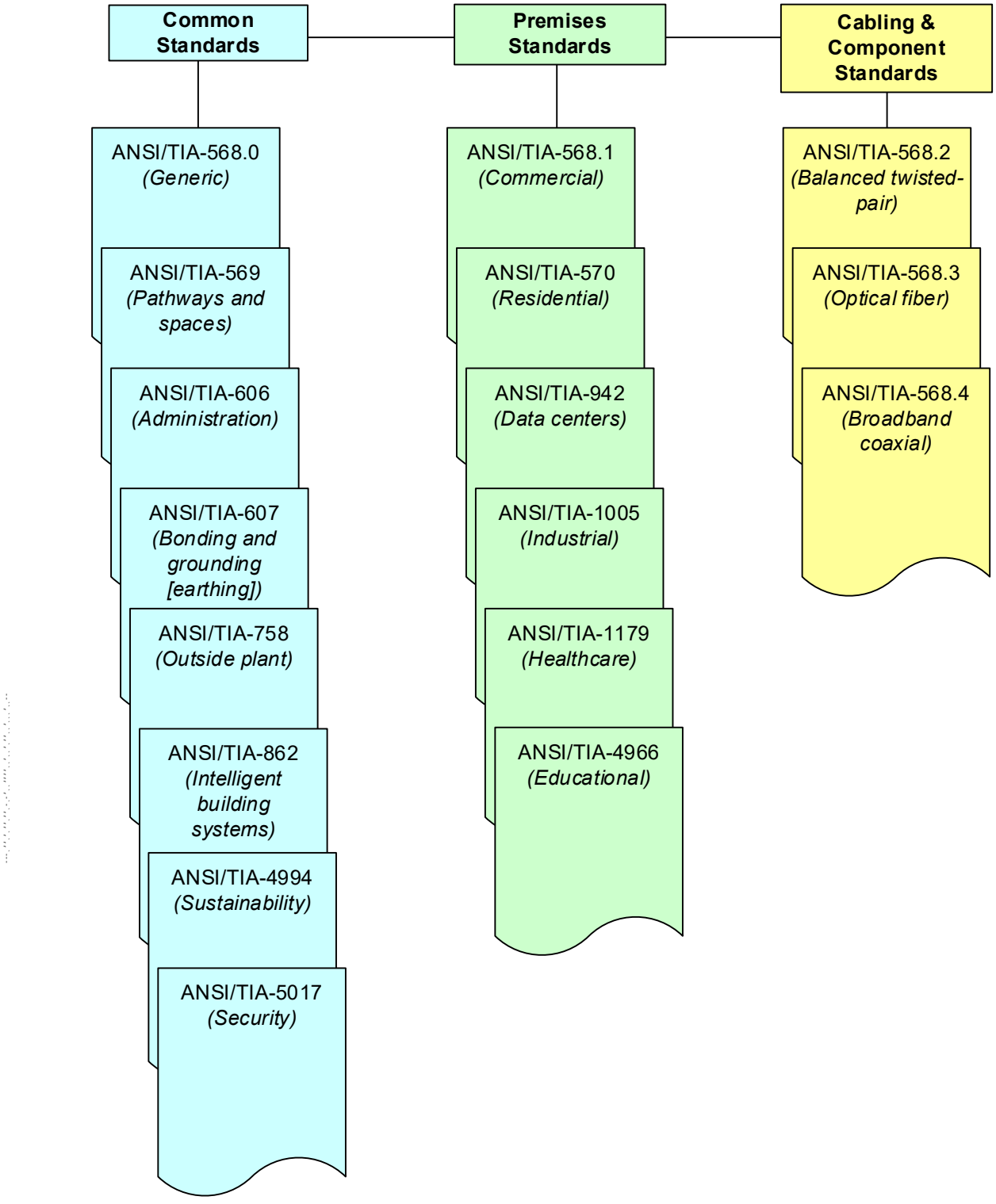


Figure 1 – Relationship between relevant TIA standards

The following documents may be useful to the reader:

- *National Electrical Safety Code*® (NESC®) (IEEE C2)
- *National Electrical Code*® (NEC®) (NFPA 70)

Useful supplements to this Standard are the following BICSI documents: the *Telecommunications Distribution Methods Manual,* the *Outside Plant Design Reference Manual,* and the *Information Technology Systems Installation Methods Manual*. These manuals provide practices and methods by which many of the requirements of this Standard are implemented.

Other references are listed in annex F.

Introduction

This Standard specifies a telecommunications cabling system for buildings that will support a multi-product, multi-vendor environment. It also provides information that may be used for the design of telecommunications products.

Purpose

The purpose of this Standard is to enable the planning and installation of a structured cabling system for all types of customer premises. This Standard specifies a system that will support generic telecommunications cabling in a multi-product, multi-vendor environment.

This Standard is the foundation for premises telecommunications cabling infrastructure. Additional requirements are detailed in standards specific to the type of premises. For example, ANSI/TIA-568.1-E contains additional requirements applicable to commercial building cabling.

Stewardship

Telecommunications infrastructure affects raw material consumption. The infrastructure design and installation methods also influence product life and sustainability of electronic equipment life cycling. These aspects of telecommunications infrastructure impact our environment. Since building life cycles are typically planned for decades, technological electronic equipment upgrades are necessary. The telecommunications infrastructure design and installation process magnifies the need for sustainable infrastructures with respect to building life, electronic equipment life cycling and considerations of effects on environmental waste. Telecommunications designers are encouraged to research local building practices for a sustainable environment and conservation of fossil fuels as part of the design process.

Specification of criteria

Two categories of criteria are specified; mandatory and advisory. The mandatory requirements are designated by the word "shall"; advisory requirements are designated by the words "should", "may", or "desirable" which are used interchangeably in this Standard.

Mandatory criteria generally apply to protection, performance, administration and compatibility; they specify minimally acceptable requirements. Advisory criteria are presented when their attainment may enhance the general performance of the cabling system in all its contemplated applications.

A note in the text, table, or figure is used for emphasis or offering informative suggestions, or providing additional information.

Metric equivalents of US customary units

The dimensions in this Standard are metric or US customary with approximate conversion to the other.

Life of this Standard

This Standard is a living document. The criteria contained in this Standard are subject to revisions and updating as warranted by advances in building construction techniques and telecommunications technology.

1 SCOPE

This Standard specifies requirements for generic telecommunications cabling. It specifies requirements for cabling system structure, topologies and distances, installation, performance, and testing.

> **NOTE –** The diversity of services currently available, coupled with the continual addition of new services, means that there may be cases where limitations to desired performance occur. When applying specific applications to these cabling systems, the user is cautioned to consult application standards, regulations, equipment vendors, and system and service suppliers for applicability, limitations, and ancillary requirements.

2 NORMATIVE REFERENCES

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- ANSI/TIA-568.2, *Balanced Twisted-Pair Telecommunications Cabling and Components Standard*
- ANSI/TIA-568.3, *Optical Fiber Cabling and Components Standard*
- ANSI/TIA-568.4, *Broadband Coaxial Cabling and Components Standard*
- ANSI/TIA-569, *Telecommunications Pathways and Spaces*
- ANSI/TIA-606, *Administration Standard for Telecommunications Infrastructure*
- ANSI/TIA-607, *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises*
- ANSI/TIA-1152, *Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling*
- ANSI/TIA-5017, *Telecommunications Physical Network Security Standard*

3 DEFINITIONS, ACRONYMS AND ABBREVIATIONS, UNITS OF MEASURE

3.1 General

For the purposes of this Standard, the following definitions, acronyms, abbreviations and units of measure apply.

3.2 Definitions

access provider: The operator of any facility that is used to convey telecommunications signals to and from a customer premises.

adapter: A device that enables any or all of the following:

1) different sizes or types of plugs to mate with one another or to fit into a telecommunications outlet,
2) the rearrangement of leads,
3) large cables with numerous wires to fan out into smaller groups of wires, and
4) interconnection between cables.

administration: The method for labeling, identification, documentation and usage needed to implement moves, additions and changes of the telecommunications infrastructure.

alien crosstalk: The unwanted signal coupling from a disturbing pair of a channel, permanent link, or component to a disturbed pair of another channel, permanent link, or component.

attenuation: Reduction in strength of a signal.

backbone: A facility (e.g., pathway, cable or bonding conductor) for Cabling Subsystem 2 and Cabling Subsystem 3.

bonding: The joining of metallic parts to form an electrically conductive path.

cable: An assembly of one or more insulated conductors or optical fibers, within an enveloping sheath.

cable run: A length of installed media, which may include other components along its path.

cable sheath: A covering over the optical fiber or conductor assembly that may include one or more metallic members, strength members, or jackets.

cabling: A combination of all cables, jumpers, cords, and connecting hardware.

Cabling Subsystem 1: Cabling from the equipment outlet to Distributor A, Distributor B, or Distributor C.

Cabling Subsystem 2: Cabling between Distributor A and either Distributor B or Distributor C (if Distributor B is not implemented).

Cabling Subsystem 3: Cabling between Distributor B and Distributor C.

> **NOTE –** See figure 2 for an illustration of the generic cabling topology for **Cabling Subsystem 1, Cabling Subsystem 2, Cabling Subsystem 3, Distributor A, Distributor B, Distributor C**, an optional **consolidation point** or **horizontal connection point**, and the **equipment outlet**. Cabling subsystems do not include equipment cords.

campus: The buildings and grounds having legal contiguous interconnection.

centralized cabling: A cabling configuration using a continuous cable, an interconnect, or a splice from an equipment outlet to a centralized cross-connect in Distributor B or Distributor C.

channel: The end-to-end transmission path between two points at which application-specific equipment is connected.

coaxial cable: A telecommunications cable consisting of a round center conductor surrounded by a dielectric surrounded by a concentric cylindrical conductor (shield) and an optional insulating sheath.

commercial building: A building or portion thereof that is intended for office use.

connecting hardware: A device providing mechanical cable terminations.

connector (plug), duplex; optical fiber: A remateable device that terminates two fibers and mates with a duplex receptacle or adapter.

consolidation point: An assembly of consolidation point connectors.

consolidation point connector: A fixed connection between a distributor and an equipment outlet in a work area.

cord (telecommunications): An assembly of cord cable with a plug on one or both ends.

cord cable: A cable used to construct patch, work area, and equipment cords.

coverage area: The area served by a device.

cross-connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

cross-connection: A connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end.

customer premises: Building(s), grounds and appurtenances (belongings) under the control of the customer.

demarcation point: A point where the operational control or ownership changes.

distributed antenna system: A network of antenna nodes connected to common source(s) that provides wireless service.

Distributor A: Optional connection facility in a hierarchical star topology that is cabled between the equipment outlet and Distributor B or Distributor C.

Distributor B: Optional intermediate connection facility in a hierarchical star topology that is cabled to Distributor C.

Distributor C: Central connection facility in a hierarchical star topology.

distributor room: An enclosed architectural space designed to contain Distributor A, Distributor B or Distributor C.

drop cable: Cable linking a drop terminal (e.g. from a service provider) to a premises terminal.

earth: See **ground**.

earthing: See **grounding**.

electromagnetic compatibility: The ability of electronic systems to operate in their intended electromagnetic environment without suffering performance degradation and without causing performance degradation in other equipment.

electromagnetic interference: Radiated or conducted electromagnetic energy that has an undesirable effect on electronic equipment or signal transmissions.

end user: The owner or user of the premises cabling system.

equipment cord: See **cord**.

equipment outlet: Outermost connection facility in a hierarchical star topology.

equipment outlet assembly: A grouping in one location of several equipment outlets.

equipment outlet space: Space served by an equipment outlet.

fiber optic: See **optical fiber**.

ground: A conducting connection, whether intentional or accidental, between an electrical circuit (e.g., telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

grounding: Connecting to ground or a conductive body that extends the ground connection.

grounding conductor: A conductor used to connect the grounding electrode to the building's main grounding busbar.

horizontal connection point: An assembly of horizontal connection point connectors.

horizontal connection point connector: A fixed connection between a distributor and an equipment outlet or device in a coverage area.

horizontal cross-connect: Distributor A.

identifier: An item of information that links a specific element of the telecommunications infrastructure with its corresponding record.

infrastructure (telecommunications): A collection of those telecommunications components, excluding equipment, that together provide the basic support for the distribution of information within a building or campus.

insertion loss: The power loss resulting from the insertion of a component, link or channel (often referred to as attenuation).

interconnection: A connection scheme that employs connecting hardware for the direct connection of a cable to another cable without a patch cord or jumper, or employs a patch cord or jumper to make a connection between connecting hardware and equipment.

intermediate cross-connect: Distributor B.

jumper: 1) An assembly of twisted-pairs without connectors, used to join telecommunications circuits/links at the cross-connect. 2) An assembly of optical fiber cable with a connector on each end (often referred to as a cord).

link: A transmission path between two points, not including equipment and cords.

main cross-connect: Distributor C.

media (telecommunications): Wire, cable, conductors or fibers used for telecommunications.

mode: A path of light in an optical fiber.

modular jack: A female telecommunications connector that may be keyed or unkeyed and may have 6 or 8 contact positions, but not all the positions need be equipped with jack contacts.

modular plug: A male telecommunications connector for cable or cords that may be keyed or unkeyed and may have 6 or 8 contact positions, but not all the positions need be equipped with contacts.

modular plug cord: A length of cable with a modular plug on both ends.

multimode optical fiber: An optical fiber that carries many paths of light.

multipair cable: A cable having more than four pairs.

multi-user telecommunications outlet assembly: A grouping in one location of several equipment outlets.

optical fiber: Any filament made of dielectric materials that guides light.

optical fiber cable: A cable assembly containing of one or more optical fibers.

outlet/connector (telecommunications): The fixed connector in an equipment outlet.

outside plant: Telecommunications infrastructure designed for installation exterior to buildings.

passive optical network - A fiber optic point to multipoint network that uses a passive optical splitter as a branching or interconnection device.

passive optical splitter: A non-wavelength-selective passive optical branching device with one or two input ports and more than one output port intended to produce optical power at the output ports according to a target split ratio. See: non-wavelength-selective passive optical branching device.

patch cord: A cord used to establish connections on a patch panel.

patch panel: A connecting hardware system that facilitates cable termination and cabling administration using patch cords.

pathway: A facility for the placement of telecommunications cable.

permanent link: The fixed portion of cabling installed between an equipment outlet and its immediate distributor or between two distributors.

plug: A male telecommunications connector.

polarity (optical fiber): A method of positioning optical fibers to ensure connectivity between transmitter(s) and receiver(s).

primary bonding busbar: A busbar placed in a convenient and accessible location and bonded, by means of the telecommunications bonding conductor, to the buildings service equipment (power) ground (formerly known as the telecommunications main grounding busbar).

pull strength: See **pull tension**.

pull tension: The pulling force that can be applied to a cable.

record: A collection of detailed information related to a specific element of the telecommunications infrastructure.

screen: An element of a cable formed by a shield.

secondary bonding busbar: A common point of connection for telecommunications system and equipment bonding to ground, and located in the distributor room (formerly known as the telecommunications grounding busbar).

service provider: The provider of any service that furnishes telecommunications content (transmissions) delivered over access provider facilities.

sheath: See **cable sheath**.

shield: 1) A metallic layer placed around a conductor or group of conductors. 2) The cylindrical outer conductor with the same axis as the center conductor that together form a coaxial transmission line.

single-mode optical fiber: An optical fiber that carries only one path of light.

splice: A joining of conductors, meant to be permanent.

star topology: A topology in which telecommunications cables are distributed from a central point.

telecommunications: The transmission and reception of information by cable, radio, optical or other electromagnetic systems.

telecommunication bonding conductor: A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground (formerly known as the bonding conductor for telecommunications).

telecommunications infrastructure: See **infrastructure (telecommunications)**.

tie cabling: Cabling between distributors at the same hierarchical level.

topology: The physical or logical arrangement of a telecommunications system.

transition point: A connection between round cable and flat undercarpet cable in Cabling Subsystem 1.

wire: An individually insulated solid or stranded metallic conductor.

wireless: The use of radiated electromagnetic energy (e.g., radio frequency and microwave signals, light) traveling through space to transport information.

work area: A building space where the occupants interact with telecommunications terminal equipment.

3.3 Acronyms and abbreviations

ADSL	asymmetrical digital subscriber line
AHJ	authority having jurisdiction
ANSI	American National Standards Institute
ATM	asynchronous transfer mode
BRI	basic rate interface
CATV	community antenna television
CCA	copper coated aluminum
CCS	copper coated steel
CP	consolidation point
DAS	distributed antenna system
EIA	Electronic Industries Alliance
EMI	electromagnetic interference
EO	equipment outlet

FCC	Federal Communications Commission
FDDI	fiber distributed data interface
ffs	for future study
HC	horizontal cross-connect
HCP	horizontal connection point
IC	intermediate cross-connect
IEC	International Electrotechnical Commission
ISDN	integrated services digital network
MC	main cross-connect
MICE	mechanical, ingress, climatic/chemical, electromagnetic
MIMO	multiple input, multiple output
MUTOA	multi-user telecommunications outlet assembly
NCS	National Communications System
NEC®	National Electrical Code®
NESC®	National Electrical Safety Code®
NFPA	National Fire Protection Association
PBB	primary bonding busbar
PON	passive optical network
PRI	primary rate interface
RF	radio frequency
SBB	secondary bonding busbar
TIA	Telecommunications Industry Association
TSB	Telecommunications System Bulletin
US	United States
UTP	unshielded twisted-pair
VDSL	very-high-speed digital subscriber line

3.4 Units of measure

dB	decibel
°C	degrees Celsius
ft	feet, foot
Hz	hertz
in	inch
J	joule
kb/s	kilobit per second

km	kilometer
kV	kilovolt
lb	pound
lbf	pound force
m	meter
Mb/s	megabits per second
MHz	megahertz
mm	millimeter
N	Newton
nm	nanometer
μm	micrometer (micron)
V	volt
V/m	volts per meter
Vrms	volts root mean square
Ω	ohm

4 ENVIRONMENTAL COMPATIBILITY

Telecommunications infrastructure should be designed to be compatible with the worst case environment to which it will be exposed. If required, compatibility with the environment can be achieved with enhanced components or by means of separation or isolation. See Annex D and TIA TSB-185 for information on environmental classifications.

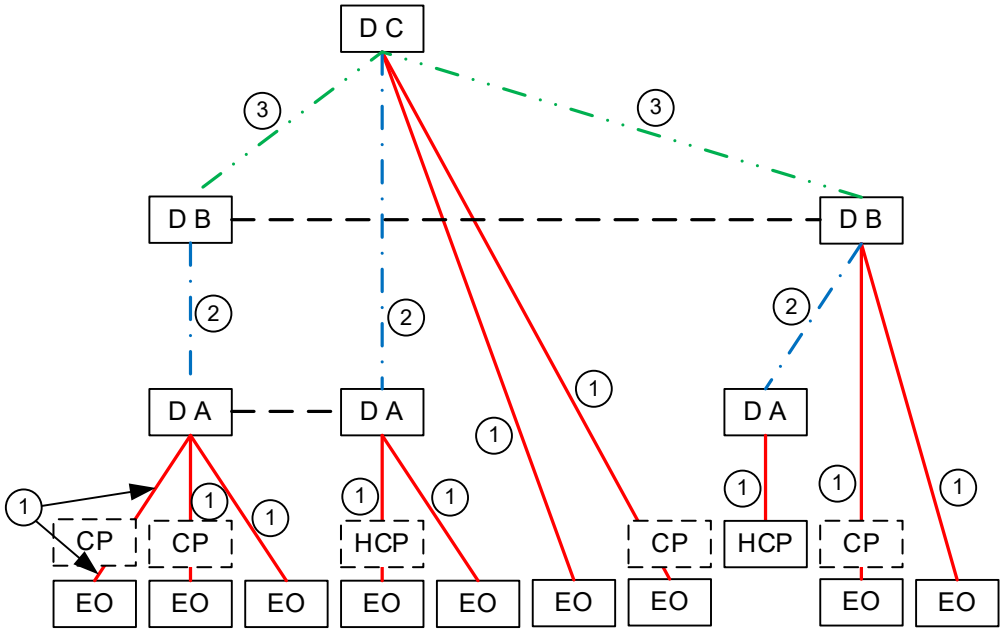
5 TELECOMMUNICATIONS CABLING SYSTEM STRUCTURE

5.1 General

Figure 2 illustrates a representative model of functional elements that comprise a generic cabling system. It depicts the relationship between the elements and how they may be configured to create a total system. The functional elements are “equipment outlets” (EOs), “horizontal connection points” (HCPs), “distributors," and "cabling subsystems", which together comprise a generic telecommunications cabling system.

NOTE – As an example, in a typical commercial building where ANSI/TIA-568.1 applies, Distributor C represents the main cross-connect (MC), Distributor B represents the intermediate cross-connect (IC), Distributor A represents the horizontal cross-connect (HC), and the EO represents the telecommunications outlet/connector.

Figure 3 shows examples of interconnections and cross-connections for Distributor A. Similar configurations may be present for Distributor B and Distributor C.



Legend:

D A	Distributor A	1	Cabling Subsystem 1 cable
D B	Distributor B		
D C	Distributor C	2	Cabling Subsystem 2 cable
EO	Equipment outlet		
HCP	Horizontal connection point connector	3	Cabling Subsystem 3 cable
CP	Optional consolidation point connector		
HCP	Optional horizontal connection point connector		
— — —	Optional tie cabling		

NOTE – All elements shown represent cables and connecting hardware, not spaces or pathways.

Figure 2 – Functional elements that comprise a generic cabling system

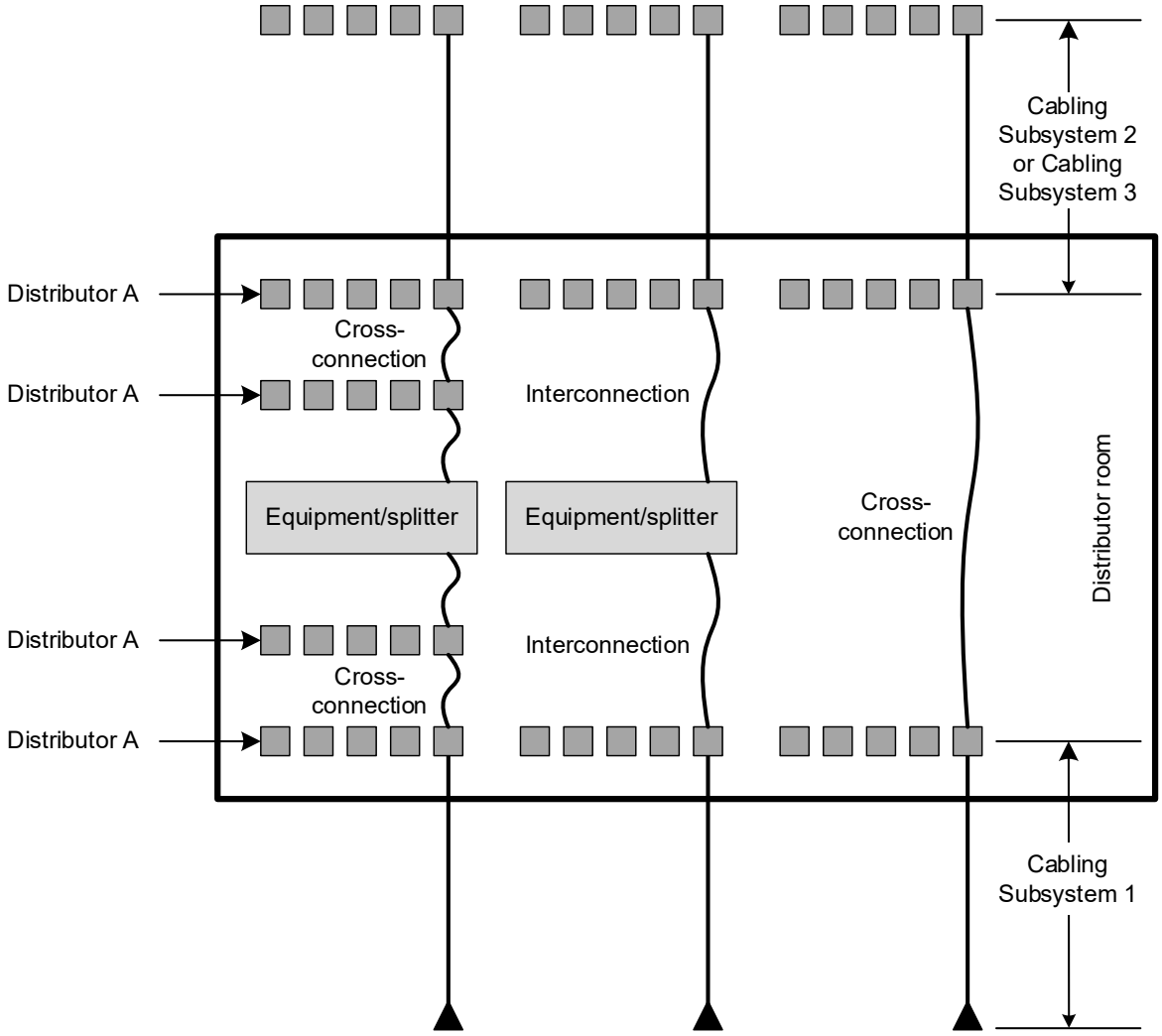


Figure 3 – Examples of interconnections and cross-connections for Distributor A

5.2 Topology

5.2.1 General

Balanced twisted-pair cabling and optical fiber cabling shall be installed in a star topology. Broadband coaxial cabling shall be installed in a star topology or in a bus and star topology, with Cabling Subsystem 2, Cabling Subsystem 3, or both, installed in a bus topology, and with Cabling Subsystem 1 installed in a star topology. See ANSI/TIA-568.4 for information on bus and star topologies.

There shall be no more than two distributors between Distributor C and an EO or HCP connector.

Centralized optical fiber cabling is a hierarchical star topology that extends from Distributor B or Distributor C, through Distributor A (if present) to an EO or HCP connector. See Annex A for additional optical fiber centralized cabling information.

NOTES:

1 – The hierarchical star topology specified by this Standard has been selected because of its acceptance, flexibility and ease of administration.

2 – It may be necessary to divide the facility (e.g., a campus) into smaller areas within the scope of this Standard and then connect these areas together.

5.2.2 Accommodation of non-star configurations

The use of appropriate interconnections, electronics, or adapters can often accommodate systems that are designed for non-star configurations such as ring, bus, or tree.

5.3 Equipment outlets

EOs provide the outermost location to terminate the cable in a hierarchical star topology. They are used for connection of equipment, administration and testing.

5.4 Distributors

Distributors provide a location for administration, reconfiguration, connection of equipment, and for testing. Distributors can be configured as interconnections or cross-connections (see figure 3). The various premises standards (e.g., those listed in the foreword) may contain additional types of implementations at a distributor.

5.5 Cabling Subsystem 1

The function of Cabling Subsystem 1 is to provide a signal path between Distributor A, Distributor B or Distributor C and equipment in the work area or coverage area. A Cabling Subsystem 1 cable run shall contain no more than one transition point, consolidation point (CP) connector, or HCP connector if an EO is present or two HCP connectors if an EO is not present.

Cabling Subsystem 1 for a work area shall terminate in an EO. Cabling Subsystem 1 for a coverage area shall terminate in an EO unless an HCP connector is present, in which case the EO is optional.

Splices shall not be installed as part of balanced twisted-pair Cabling Subsystem 1. Splitters shall not be installed as part of optical fiber Cabling Subsystem 1.

Figure 4 shows examples of Cabling Subsystem 1 cabling to coverage areas and work areas. The coverage area examples show the use of an HCP configured as an interconnection or as a cross-connection as well as cabling without an HCP. Work area examples show cabling with and without a CP.

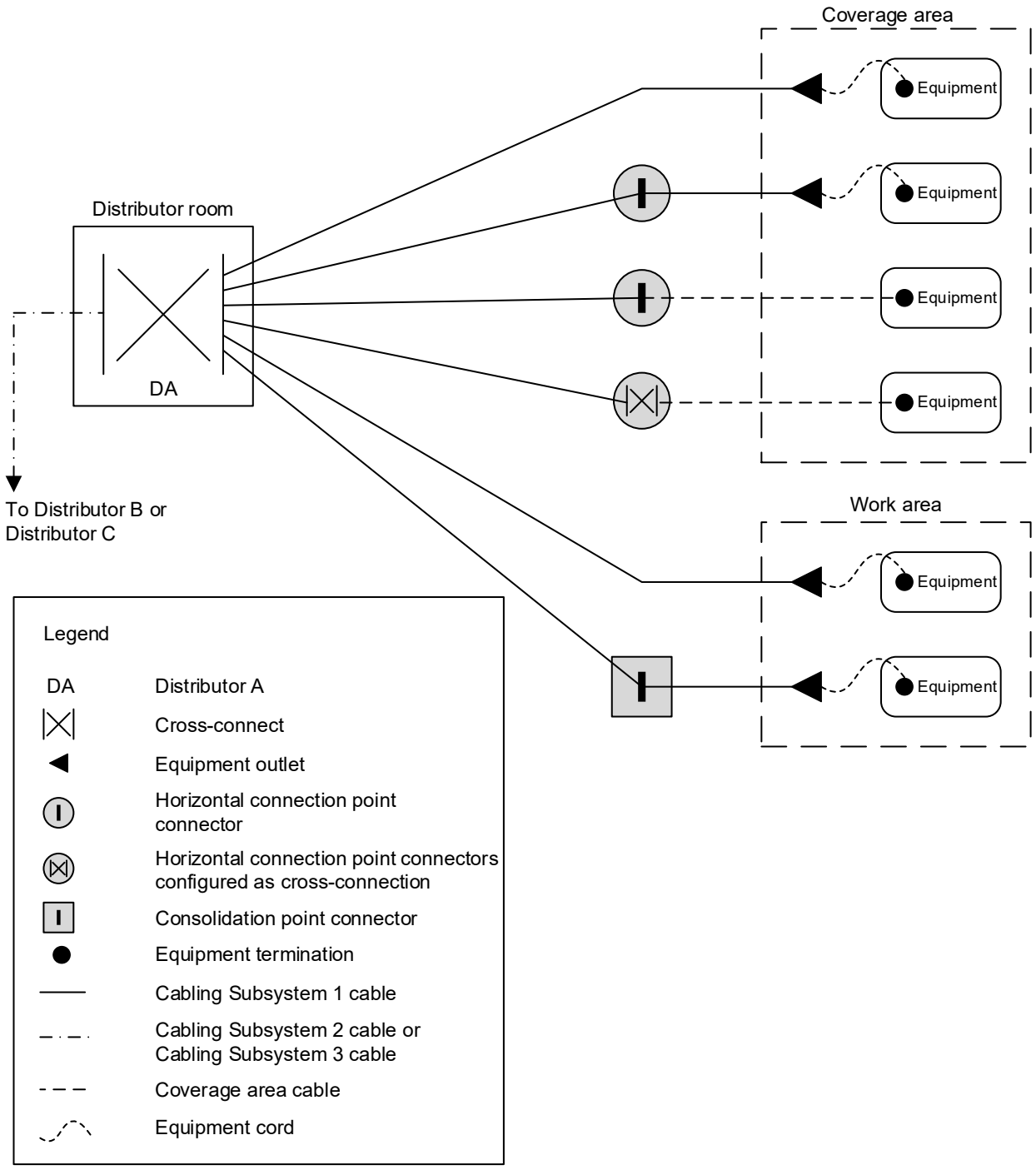


Figure 4 – Examples of Cabling Subsystem 1 cabling

5.6 Cabling Subsystem 2 and Cabling Subsystem 3

Cabling Subsystem 2 and Cabling Subsystem 3 provide signal paths between Distributors (see figure 2). See annex C for information regarding multi-tenant Cabling Subsystem 2 and Cabling Subsystem 3.

NOTE – The use of Distributor B is optional. It may be used, for example, to overcome distance limitations of the application or media. The use of Distributor B may allow a greater selection of media types for Cabling Subsystem 2 and Cabling Subsystem 3.

5.7 Optional tie cabling

Optional tie cabling provides a signal path between distributors at the same hierarchal level and can be used to provide redundancy or to accommodate non-star topologies.

5.8 Recognized cabling

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

a) 100-ohm balanced twisted-pair cabling (ANSI/TIA-568.2), category 5e or higher;

NOTES:

1 – To support a wide range of applications, Category 6A cabling may be required. See Annex C.

2 – Category 8 cabling supports channels with a maximum of 2 connections to a maximum length of 30 m (98 ft).

3 – Category 8 components can be used to construct category 6A 100 m (328 ft) channels. See TIA TSB-184 for power delivery efficiency achievable with category 8 components.

b) multimode optical fiber cabling (ANSI/TIA-568.3) 2-fiber (or higher fiber count);

c) single-mode optical fiber cabling (ANSI/TIA-568.3) 2-fiber (or higher fiber count); and

d) broadband coaxial cabling (ANSI/TIA-568.4).

Recognized cabling components shall meet applicable requirements specified in ANSI/TIA-568.2, ANSI/TIA-568.3, ANSI/TIA-568.4, and, if applicable, the specific premises standard.

5.9 Open space cabling

Open space cabling design practices use multi-user telecommunications outlet assemblies (MUTOAs), EO assemblies, CPs, and HCPs to provide flexible layouts. Such spaces are frequently rearranged to meet changing requirements of the users. The use of CPs and HCPs may allow open spaces to be reconfigured with minimal changes to Cabling Subsystem 1.

5.9.1 Multi-user telecommunications outlet assembly

MUTOAs may be advantageous in open spaces that have equipment that is moved or frequently reconfigured. A MUTOA facilitates the termination of single or multiple Cabling System 1 cables in a common location within a furniture cluster or similar open area. The use of MUTOAs allows Cabling System 1 cabling to remain intact when the open area plan is changed. Equipment cords originating from the MUTOA should be routed through EO space area pathways (e.g., furniture pathways). These equipment cords shall be connected directly to equipment without the use of any additional intermediate connections (see figure 5).

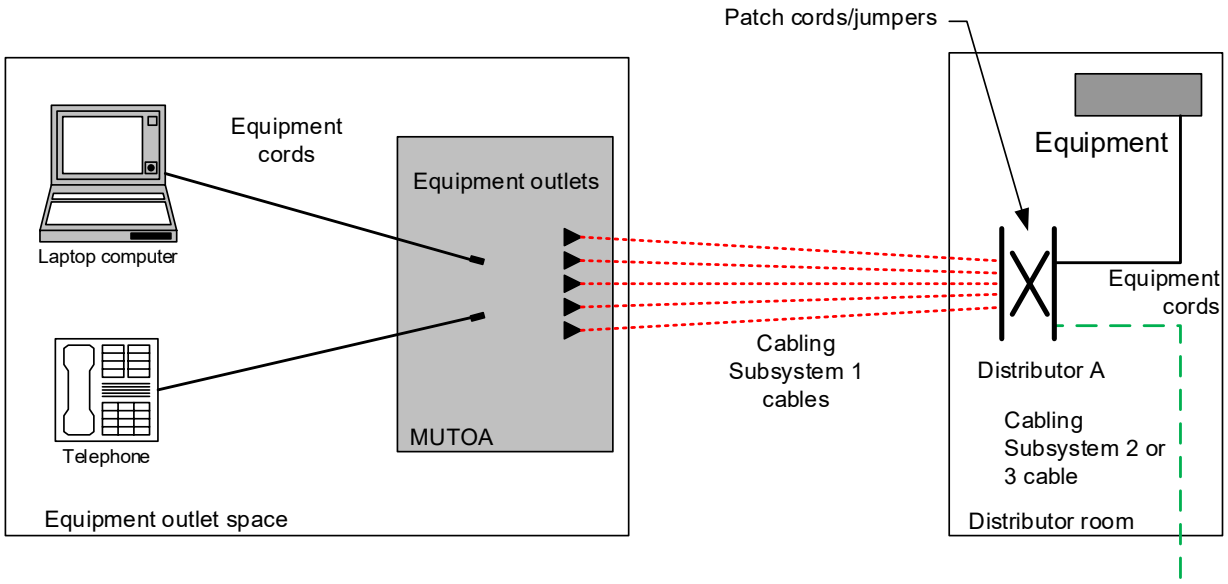


Figure 5 – Example of the use of a MUTOA

5.9.1.1 Design considerations

MUTOAs should be located in an open area so that clusters of EO spaces are served by at least one MUTOA. The MUTOA should be limited to serving a maximum of 12 EO spaces. Maximum cord length requirements (see 5.9.1.4) shall also be taken into account. Spare capacity should also be considered when sizing the MUTOA.

5.9.1.2 Installation practices

MUTOAs shall be located in fully accessible, permanent locations, such as building columns, and permanent walls. MUTOAs shall not be located in ceiling spaces, or any obstructed area. MUTOAs shall not be installed in furniture unless that unit of furniture is permanently secured to the building structure.

5.9.1.3 Administration

In addition to the requirements of ANSI/TIA-606, the cords connecting the MUTOA to the equipment shall be labeled on both ends with a unique cord identifier. The end of the cords at the MUTOA shall be labeled with the equipment it serves, and the end at the equipment shall be labeled with the MUTOA identifier and a port identifier. MUTOAs used with balanced twisted-pair cabling shall be marked with the maximum allowable cord length.

5.9.1.4 Maximum cord lengths

5.9.1.4.1 Balanced twisted-pair cabling

Balanced twisted-pair cords used in the context of MUTOAs and open space areas shall meet the requirements of ANSI/TIA-568.2. The maximum length in meters shall be determined according to 5.10.2.

5.9.1.4.2 Optical fiber cabling

Optical fiber cords used in the context of MUTOAs and open space areas shall meet the requirements of ANSI/TIA-568.3. The maximum cabling length is not affected by the deployment of a MUTOA.

5.9.2 Consolidation point

The CP connector is an optional fixed connector within Cabling Subsystem 1 serving a work area (i.e., the space where occupants interact with telecommunications terminal equipment). A CP is an assembly of CP connectors and each Cabling Subsystem 1 link containing a CP connector shall also contain a MUTOA or EO. Device connections shall not be made directly to the CP connector. Cross-connections shall not be used at a CP. No more than one CP connector shall be used within the same Cabling Subsystem 1 cable run. A transition point and a CP connector shall not be used in the same Cabling Subsystem 1 link. A HCP connector and a CP connector shall not be used in the same Cabling Subsystem 1 link. The cables and connections used at a CP shall meet the requirements of ANSI/TIA-568.2 or ANSI/TIA-568.3 and be installed in accordance with the requirements of clause 5 (see figure 6).

For balanced twisted-pair cabling, in order to reduce the effect of multiple connections in close proximity on near-end cross-talk (NEXT) loss and return loss, the CP should be located at least 15 m (49 ft) from the distributor.

A CP may be useful when reconfiguration is frequent, but not so frequent as to require the flexibility of the MUTOA.

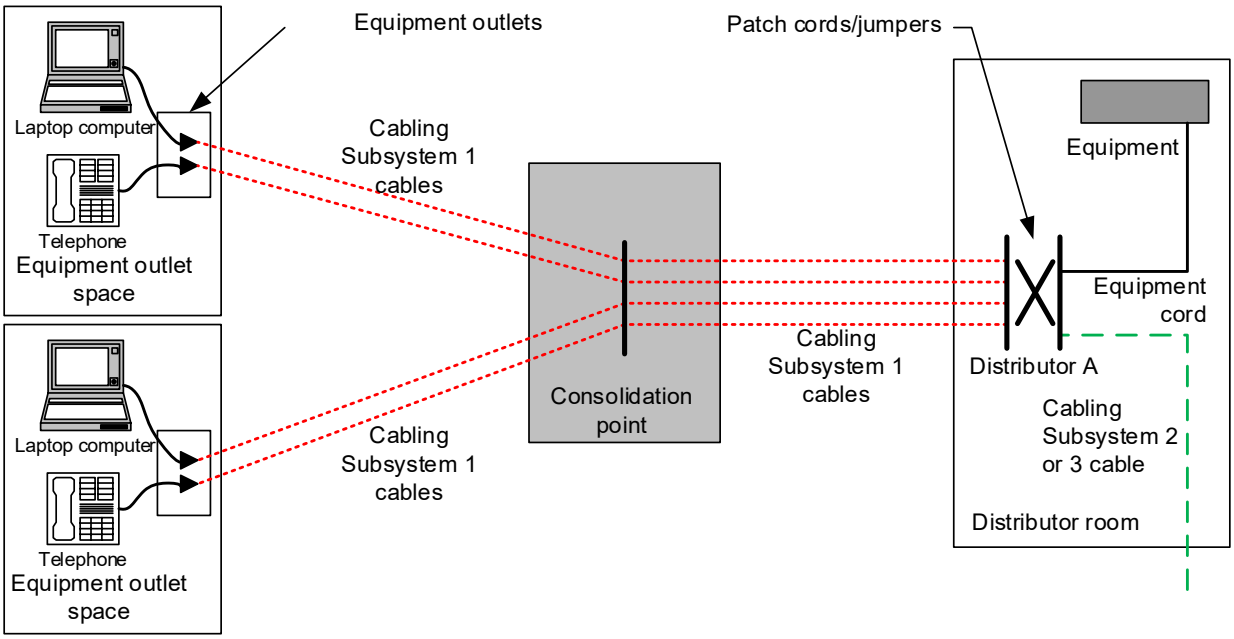


Figure 6 – Example of the use of a consolidation point

5.9.2.1 Design considerations

A CP connector may be used as an interconnection point between the distributor EO in a work area. Clusters of EOs in work area spaces may be served by one or more CPs. Each CP should be limited to a maximum grouping of 24 CP connectors. Spare capacity should be considered when sizing the CP.

5.9.2.2 Installation practices

CPs shall be located in fully accessible, permanent locations such as building columns, and permanent walls. CPs shall not be located in any obstructed area. CPs shall not be installed in furniture unless that unit of furniture is secured to the building structure. CPs shall not be used for direct connection to active equipment.

5.9.3 Horizontal connection point

5.9.3.1 General

An HCP allows coverage area connections to be reconfigured. A maximum of two HCP connectors shall be used in a single Cabling Subsystem 1 link if an EO is not present. No more than one HCP connector shall be used in a single Cabling Subsystem 1 link if an EO is present. Each cable extending from the HCP shall be terminated to an EO (see 4.5) or directly to a device (see ANSI/TIA-862).

When an EO is used, the HCP connector is optional. In this case the HCP connector is to the cabling supporting intelligent building systems what the CP connector is to commercial building and generic telecommunications cabling.

Cross-connections are allowed in the HCP. When cross-connections are used at the HCP, an EO shall not be installed as part of Cabling Subsystem 1. This requirement ensures that the Cabling Subsystem 1 channel contains no more than 4 connections.

NOTE: A cross-connection may be used at the HCP in cases where there is no EO to facilitate moves, adds and changes without the need to re-terminate the cabling.

HCPs shall be administered in the same manner as telecommunications cabling, hardware, pathways and spaces as specified in ANSI/TIA-606-C.

For balanced twisted-pair cabling, in order to reduce the effect of multiple connections in close proximity on NEXT loss and return loss, the HCP should be located at least 15 m (49 ft) from the distributor located in the distributor room or distributor enclosure.

The functions of a CP and an HCP can be combined within the same zone enclosure. Refer to ANSI/TIA-862 for information on zone enclosures.

NOTE – This configuration may be referred to as zone cabling.

The number of devices served by an HCP will depend on the number of coverage areas served and should be limited to a maximum of 96. Refer to ANSI//TIA-862 for coverage area planning.

A minimum of 50% of the HCP connectors should be reserved for future expansion.

5.9.3.2 Location

HCPs shall be located in fully accessible, permanent locations, such as building columns and permanent walls. HCP design, including location, should be developed in accordance with the security and architectural plans of the building. For more details on security, see ANSI/TIA-5017. HCPs shall not be installed in furniture systems unless that unit of furniture is permanently secured to the building structure. The use of suspended ceiling space or access floor space for HCPs may be acceptable, provided that the space is accessible without moving building fixtures and it is reasonable to assume such space will continue to be in an open space such as a corridor or hallway. In all cases, the use of HCPs in plenum spaces used for environmental air shall conform to applicable building codes.

5.10 Cabling lengths

5.10.1 General

Cabling lengths are dependent upon the application and upon the specific media chosen (see annex C). The length includes the cords and jumpers used for cross-connections, interconnections, and connections at the EO. Specific premises standards (e.g., those listed in the foreword) may specify additional cabling length limitations.

5.10.2 Balanced twisted-pair cabling

5.10.2.1 General

The maximum supportable distances for 4-pair balanced twisted-pair cabling applications shown in table 1 assume a total of 10 m (33 ft) of cords and jumpers (for cross-connections, interconnections, and connections at the EO) with an insertion loss de-rating factor of 0.2. This assumption results in an effective maximum supportable distance which is 2 m greater than the actual maximum supportable distance. Maximum supportable distances for longer cord (or jumper) lengths or for different de-rating factors can be calculated in meters as follows:

$$L_{\max\_effective} = L_{\max} + 2\,\text{m} \quad (1)$$

$$L_{cords} \le \frac{L_{\max\_effective} - L_{link}}{D} = \frac{L_{\max} + 2 - L_{link}}{D}\,\text{m} \quad (2)$$

where:

D is the insertion loss de-rating factor for the cord (or jumper) type (see ANSI/TIA-568.2) with the following values:

1.0 (22/23 AWG),
1.2 (24 AWG),
1.5 (26 AWG),
1.95 (28 AWG;

L_{cords} is the combined length of all the cords and jumpers in the channel;

L_{link} is the length of Cabling Subsystem 1, Cabling Subsystem 2 or Cabling Subsystem 3;

$L_{\max}$ is the maximum supportable distance for the application; and

$L_{max\_effective}$ is the effective maximum supportable distance.

NOTES:

1. These calculations assume all cords and jumpers have the same insertion loss de-rating factor.
2. The de-rating factors given above are repeated from ANSI/TIA-568.2 for convenience.

In all cases with cords with a derating factor of 1.95, the maximum cord length shall be 15 m (49 ft) per ANSI/TIA-568.2.

5.10.2.2 100 m channel

Many applications for balanced twisted-pair cabling have a maximum supportable distance of 100 m (328 ft) assuming a 90 m (296 ft) permanent link length and 10 m (33 ft) of cords with an insertion loss de-rating factor of 1.2. The calculations for a channel to support these applications using different cord lengths, insertion loss de-rating factors, or both, are as follows:

$$L_{cords} \le \frac{102 - L_{link}}{D}\,\text{m} \quad (3)$$

Table 1 illustrates the results of the above formulae for a 100 m channel. The maximum cord length for cords with a de-rating factor of 1.95 shall be 15 m (49 ft).

Table 1 – Maximum cord and link length, 100 m 4-pair channel

L_{link} m (ft)	Maximum combined length of cords m (ft)			
	***D* = 1.0**	***D* = 1.2**	***D* = 1.5**	***D* = 1.95**
90 (296)	12 (39)	10 (33)	8 (26)	6 (20)
85 (279)	17 (56)	14 (46)	11 (36)	9 (30)
80 (262)	22 (72)	18 (59)	15 (49)	11 (36)
75 (246)	27 (89)	22 (72)	18 (59)	14 (46)
70 (230)	32 (105)	27 (89)	21 (69)	15 (49)
65 (213)	37 (121)	31 (102)	25 (82)	15 (49)
60 (197)	42 (138)	35 (115)	28 (92)	15 (49)
55 (180)	47 (154)	39 (128)	31 (102)	15 (49)
50 (164)	52 (171)	43 (141)	35 (115)	15 (49)
45 (148)	57 (187)	47 (154)	38 (125)	15 (49)
40 (131)	62 (203)	52 (171)	41 (135)	15 (49)
35 (115)	67 (220)	56 (184)	45 (148)	15 (49)
30 (98)	72 (236)	60 (197)	48 (157)	15 (49)
25 (82)	77 (253)	64 (210)	51 (167)	15 (49)
20 (66)	82 (269)	68 (223)	55 (180)	15 (49)
15 (49)	87 (285)	72 (236)	58 (190)	15 (49)
10 (33)	92 (302)	77 (253)	61 (200)	15 (49)
5 (16)	97 (318)	81 (266)	65 (213)	15 (49)
0 (0)	102 (335)	85 (279)	68 (223)	15 (49)

5.10.3 Demarcation point

The cabling length between the demarcation point and Distributor C shall be included in the total distance calculations. The length and type of media (including gauge size for balanced twisted-pair cabling) shall be recorded in administration documentation. For more details on administration see ANSI/TIA-606.

6 CABLING INSTALLATION REQUIREMENTS

6.1 General

Cabling and its installation shall comply with the requirements of the authority having jurisdiction (AHJ) and applicable regulations.

Cable stress, such as that caused by tension in suspended cable runs and tightly cinched bundles, should be minimized. Cable bindings, if used to tie multiple cables together, should be irregularly spaced and should be loosely fitted (easily moveable).

The cable shall not be subjected to pulling tension exceeding the pulling strength rating of the cable. The cable bend radius shall be greater than or equal to the minimum bend radius requirement during and after installation.

6.2 Balanced twisted-pair cabling

6.2.1 Maximum pulling tension

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

6.2.2 Minimum inside bend radius

6.2.2.1 Cable

The minimum inside bend radius, under no-load or load, for 4-pair balanced twisted-pair cable shall be four times the cable diameter. For example, a cable diameter of 9 mm (0.354 in) requires a minimum bend radius of 36 mm (1.5 in).

The minimum inside bend radius, under no-load or load, for multipair cable shall follow the manufacturer's guidelines.

6.2.2.2 Cord cable

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

6.2.3 Cable termination

6.2.3.1 General

Cables should be terminated with connecting hardware of the same performance category or higher. The installed transmission performance of cabling where components of different performance category requirements are used shall be classified by the least-performing component. The category of the installed link should be suitably marked and noted in the administration records.

It is essential to maintain the design performance of connecting hardware when terminated to a balanced twisted-pair cable, and this shall be achieved by terminating the appropriate connecting hardware for that balanced twisted-pair cable in accordance with the connecting hardware manufacturer's instructions. Where no connecting hardware manufacturer instructions exist, cable geometry shall be maintained as close as possible to the connecting hardware and its cable termination points, and the maximum pair un-twist shall be in accordance with table 2.

Table 2 – Maximum pair un-twist for category cable termination

Category	Maximum pair un-twist mm (in)
3	75 (3)
5e	13 (0.5)
6	13 (0.5)
6A	13 (0.5)
8	13 (0.5)

NOTE – Information on category 3 cabling retained to support existing installations.

6.2.3.2 Eight-position modular jack pin-pair assignments

Pin-pair assignments shall be as shown in figure 7 or figure 8. The colors shown are associated with 4-pair cable. It is recommended that pin-pair assignments be uniform throughout.

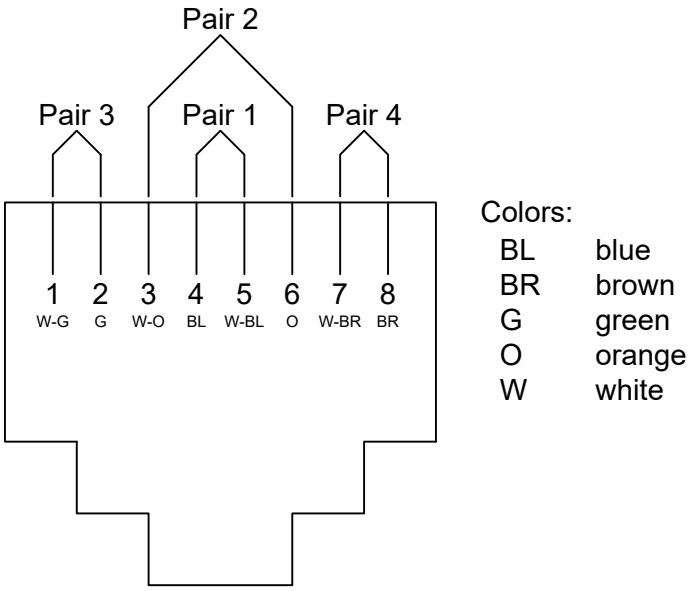


Figure 7 – Front view of eight position jack pin-pair assignments (T568A)

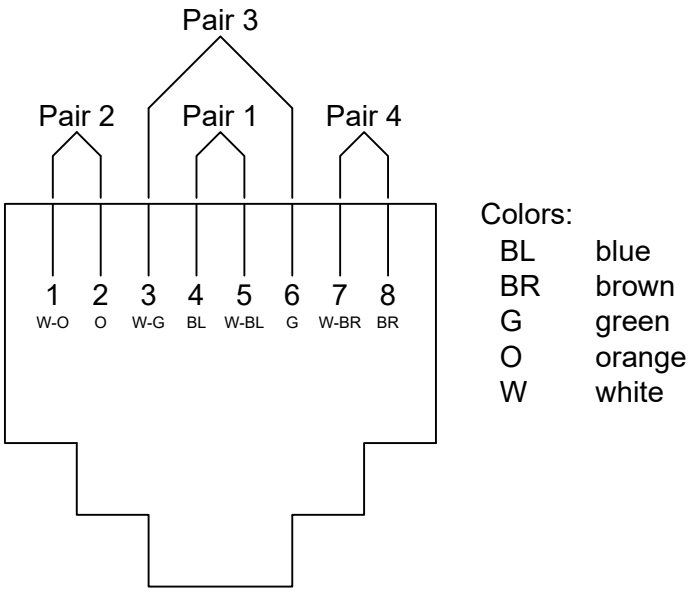


Figure 8 – Front view of eight-position jack pin-pair assignment (T568B)

6.2.4 Cords and jumpers

Cross-connect jumpers and modular plug cords should be of the same category or higher as the category of the cabling to which they connect. Due to performance and testing requirements, it is recommended that modular plug cords be factory manufactured.

6.2.5 Telecommunications bonding requirements for screened cabling

Grounding and bonding of the screen and associated connecting hardware shall meet the requirements of this Standard and the manufacturer installation instructions.

The screen of screened twisted-pair cables shall be bonded to the primary bonding busbar (PBB) or the secondary bonding busbar (SBB). This is generally accomplished by terminating the cable shield to the connector following manufacturer's instructions. The connecter is then bonded to the frame of the metallic panel which is bonded per ANSI/TIA-607. To extend the screen of Cabling Subsystem 1 at the EO to the equipment, use a screened twisted-pair cord. Voltage of greater than 1.0 Vrms between the screen of Cabling Subsystem 1 at the EO and the ground wire of the corresponding electrical outlet expected to provide power to the equipment indicates improper grounding and is not recommended. The bonding and grounding infrastructure should be modified so that this voltage is less than 1.0 Vrms.

6.2.6 Separation of power and telecommunications cables

Refer to ANSI/TIA-569 for pathway separation from electromagnetic interference (EMI) sources guidelines and the specific premises standard (e.g., those listed in the foreword) for additional performance considerations.

6.2.7 Electrostatic discharge

Electrostatic charges are generated when different materials come into contact and are then separated. This charging effect is made even greater by friction such as the rubbing of two materials together. A good conducting path will allow this stored charge to dissipate rapidly.

Cables can acquire an electrostatic charge during installation when they are unreeled from a cable reel or dragged across a floor. Before connecting equipment to installed cabling, discharge the electrostatic charges to ground.

See TIA TSB-153 for more information on electrostatic discharge.

6.2.8 Guidelines for supporting power delivery over balanced twisted-pair cabling

Balanced twisted-pair cabling may be used to provide remote power to a wide variety of devices. When planning new installations delivering remote power, category 6A or higher 4-pair balanced twisted-pair cabling as specified in ANSI/TIA-568.2 is recommended. Refer to TIA TSB-162 and TIA TSB-184 for additional information.

6.3 Optical fiber cabling

6.3.1 Minimum inside bend radius and maximum pulling tension

See Table 3 for maximum tensile loads and minimum inside bend radii. For non-circular cables the minimum bend radius should be calculated using the minor axis of the cable.

Table 3 – Maximum tensile load and minimum inside bend radius

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

6.3.2 Cords

Optical fiber cords shall have the same fiber type as the optical fiber cabling and meet the requirements of ANSI/TIA-568.3-D. The minimum inside bend radius for optical fiber cord cable shall be 25 mm (1 in) unless a smaller minimum bend radius is specified by the cord manufacturer.

6.3.3 Polarity

To support communication systems that use separate optical fibers in each direction, the cabling system shall provide means to maintain correct signal polarity so that the transmitter on one end of the channel will connect to the receiver on the other end of the channel. Maintaining the correct transmit-to-receive polarity throughout the cabling system is crucial for system operation. ANSI/TIA-568.3 illustrates some methods for maintaining polarity for these systems.

6.4 Broadband coaxial cabling

6.4.1 Bend radius

The minimum inside bend radius for coaxial cable shall not be less than that recommended by the manufacturer. If no recommendation is provided, the minimum inside bend radius shall be ten times the cable outside diameter under no-load conditions and twenty times the cable outside diameter when the cable is under a tensile load.

6.4.2 Pull tension

The maximum pull tension of coaxial cable is dependent on the size and material of the center conductor. Copper-coated steel (CCS) is stronger than bare copper or copper-coated aluminum (CCA). Pull tension for coaxial cables with CCS or copper center conductors shall not exceed the maximum values in table 4. Pull tension for coaxial cables with CCA center conductors shall not exceed the manufacturer's recommended maximum. When pulling a combination of different types of cable, pull tension shall not exceed the maximum value for the minimum strength cable.

Table 4 – Maximum pull tension for coaxial cable

Center conductor	Maximum pulling tension N (lbf)	
	Series 6	Series 11
CCS	334 (75)	667 (150)
Copper	178 (40)	356 (80)

6.4.3 F-type mating torque

F-type male connectors mated to F-type female connectors should be tightened to a torque between 0.6 N-m (5 in-lb) and 3.5 N-m (30 in-lb), depending on the equipment and the application that the connector interfaces to. Generally, connectors for indoor applications should be tightened to a torque of 0.6 N-m (5 in-lb) to 1.8 N-m (15 in-lb) and connectors for outdoor applications should be tightened to a torque of 3.5 N-m (30 in-lb).

6.4.4 Termination of unused ports and cables

Each energized but unused coaxial connector that is part of the connecting block, splitter, amplifier or other similar cabling component shall be terminated with a 75 Ω impedance matching

termination device. In addition, each energized unused coaxial cable shall be terminated with a 75 Ω impedance matching termination device. See ANSI/TIA-568.4 for requirements for impedance matching termination devices.

6.4.5 Other installation guidelines

A minimum of 200 mm (8 in) of excess cable should be stored at each outlet, adhering to the minimum bend radius specified in 6.4.1. Spacing of cable supports, such as attachments made to wall studs, should be made at varying intervals no greater than 1.5 m (5 ft) to avoid degrading electrical performance.

7 CABLING TRANSMISSION PERFORMANCE AND TEST REQUIREMENTS

7.1 General

Transmission performance depends on cable characteristics, length, connecting hardware, cords, cross-connections, the total number of connections, and the care with which they are installed and maintained. This clause addresses field-test specifications for post-installation performance measurements of cabling.

7.2 Field-test instrument calibration

The test instrument documentation shall include certification of calibration according to the manufacturer's requirements. Additionally, the test instrument shall report the date and time of its current calibration.

7.3 Balanced twisted-pair cabling transmission performance and test requirements

Transmission performance requirements for balanced twisted-pair cabling are specified in ANSI/TIA-568.2. See ANSI/TIA-1152 for associated field test equipment requirements.

7.4 Optical fiber cabling transmission performance and test requirements

Transmission performance and test requirements for optical fiber cabling are specified in ANSI/TIA-568.3.

7.5 Broadband coaxial cabling transmission performance and test requirements

Transmission performance and test requirements for broadband coaxial cabling are specified in ANSI/TIA-568.4.

8 GROUNDING AND BONDING

Telecommunications grounding and bonding shall meet the requirements of ANSI/TIA-607.

9 PATHWAYS AND SPACES

Pathways and spaces shall meet the requirements on ANSI/TIA-569.

10 FIRESTOPPING

Firestopping shall meet the requirements of ANSI/TIA-569.

11 ADMINISTRATION

Administration shall meet the requirements of ANSI/TIA-606.

12 CABLING FOR WIRELESS ACCESS POINTS

Cabling for wireless access points should follow the guidelines of TIA TSB-162.

It is recommended to install two category 6A or higher cabling runs to each wireless access point.

13 PHYSICAL NETWORK SECURITY

Physical network security shall meet the requirements of ANSI/TIA-5017.

Annex A (normative) Centralized optical fiber cabling

This annex is normative and is considered part of this Standard.

A.1 General

Centralized optical fiber cabling is intended for users who desire to deploy centralized electronics. Centralized cabling provides connections from the EO to centralized cross-connects by allowing the use of pull-through cables (continuous sheath cables), an interonnect, or a splice (see figure 9).

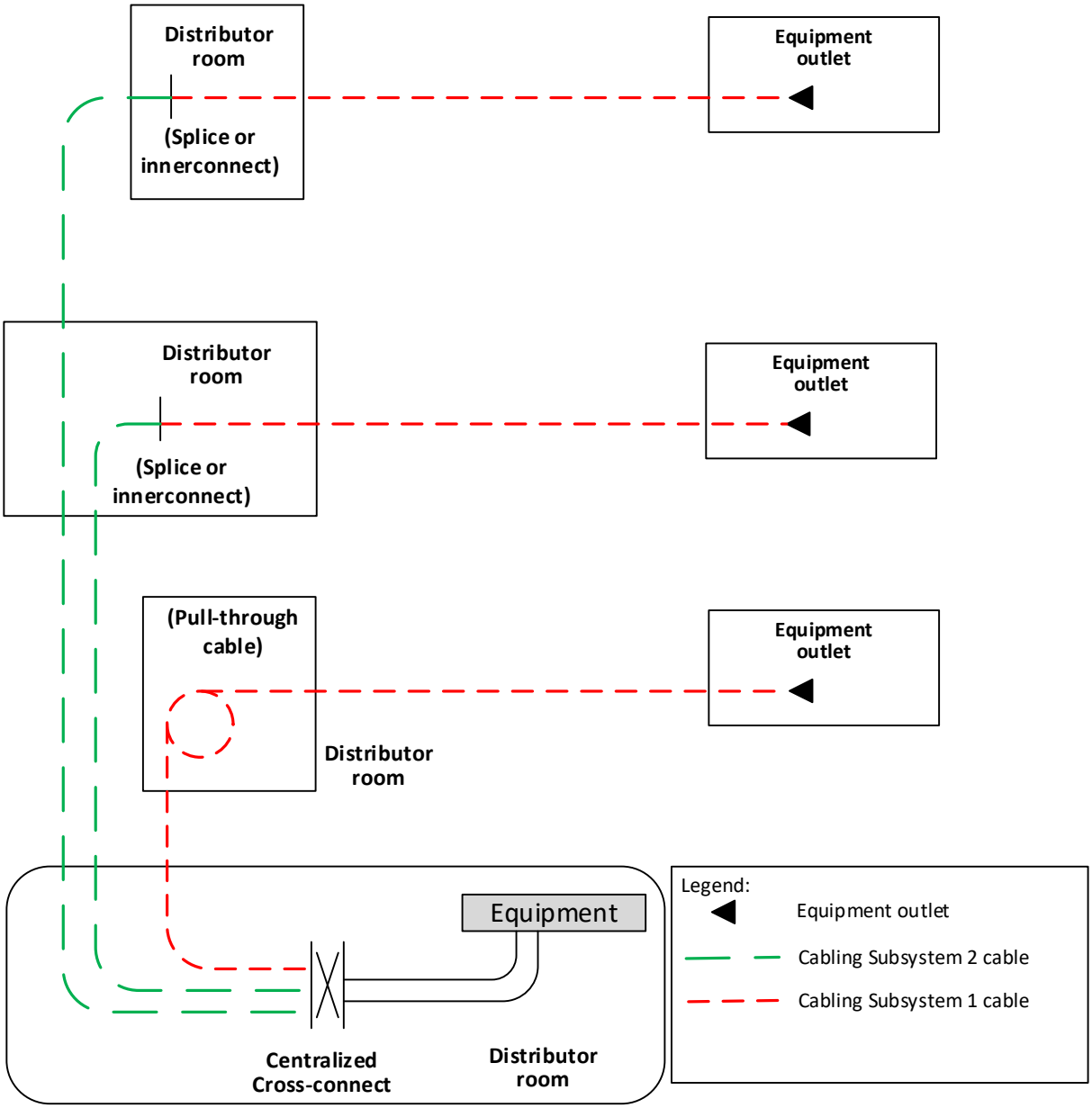


Figure 9 – Illustration of centralized optical fiber cabling

A.2 Implementation

Implementation of centralized cabling shall be within the same building as the areas served.

Centralized cabling design shall allow for migration (in part or in total) of the pull-through, interconnect, or splice implementation to a cross-connection, interconnection or equipment connection. The design shall allow sufficient length (service loop) to facilitate this migration. Service loops may be stored as cable or unjacketed fiber (buffered or coated). Service loop storage shall provide bend radius control so that cable and fiber bend radius limitations are not violated.

Administration of moves and changes shall be performed at the centralized cross-connect.

Annex B (informative) Multi-tenant Cabling Subsystem 2 and Cabling Subsystem 3

This annex is informative and not part of this Standard.

Ownership of new multi-tenant Cabling Subsystem 2, Cabling Subsystem 3, or both is determined at the time that the decision is made to build, and may be constrained by regulatory conditions.

When the decision is made to deploy a multi-tenant Cabling Subsystem 2, Cabling Subsystem 3, or both, the selection of media type should be based on the following criteria:

- User type (e.g., residential, commercial) – initial and forecast
- Frequency of tenant changes
- Applications supported – initial and forecast
- Design
- Cabling distances

The deployment of an appropriate range of media types is recommended.

New multi-tenant Cabling Subsystem 2, Cabling Subsystem 3, or both, should be designed to serve tenant needs for many years. They should be sized to accommodate anticipated growth in user demand, and in a configuration that supports the limitations and requirements of the anticipated medium.

See Annex C for application support information regarding media types.

Annex C (informative) Application support information

This annex is informative and not part of this Standard.

C.1 General

This clause provides information regarding applications support for many of the available applications across media types recognized in this Standard. This compilation allows the user to easily access enough basic information to make informed decisions about media choices and system design. With a predetermined knowledge of the required distances, the anticipated applications, and the cabling system design, the user can determine the most appropriate media for their needs. Still, this information is not intended to constitute a design guideline. Application standards and cabling system manufacturers should be consulted to establish complete requirements and capabilities of specific cabling alternatives.

> **NOTE –** Premises standards may impose distance limitations shorter than those listed.

C.2 Balanced twisted-pair cabling supportable distances

Table 5 lists maximum supportable distances for applications using balanced twisted-pair cabling. The table is based on the minimum performance requirements of specific balanced twisted-pair cabling established by ANSI/TIA-568.2. Applications are identified using both industry standard and common names.

Table 5 – Maximum supportable distances for balanced twisted-pair cabling applications

Application	Media	Distance m (ft)	Comments
Ethernet 10BASE-T	category 3, 5e, 6, 6A[1], 8	100 (328)	
Ethernet 100BASE-TX	category 5e, 6, 6A[1], 8	100 (328)	
Ethernet 1000BASE-T	category 5e, 6, 6A[1], 8	100 (328)	
Ethernet 2.5GBASE-T	category 6A[1,2], 8	100 (328)	
Ethernet 5GBASE-T	category 6A[1,2], 8	100 (328)	
Ethernet 10GBASE-T	category 6A[1,3], 8	100 (328)	
Ethernet 25GBASE-T	category 8	30 (98)	
Ethernet 40GBASE-T	category 8	30 (98)	
IEEE Std 802.3™ Type 1 PoE	category 5e, 6, 6A[1], 8	100 (328)	
IEEE Std 802.3™ Type 2 PoE	category 5e, 6, 6A[1], 8	100 (328)	
IEEE Std 802.3bt™ Type 3 PoE	category 5e, 6, 6A[1], 8	100 (328)	
IEEE Std 802.3bt™ Type 4 PoE	category 5e, 6, 6A[1], 8	100 (328)	
HDBaseT	category 6A[1], 8	100 (328)	
ADSL	category 3, 5e, 6, 6A, 8	5000 (16 000)	1.5 Mb/s to 9 Mb/s
VDSL	category 3, 5e, 6, 6A, 8	5000 (16 000)	1500 m (4900 ft) for 12.9 Mb/s; 300 m (1000 ft) for 52.8 Mb/s
Analog Phone	category 3, 5e, 6, 6A, 8	800 (2625)	
FAX	category 3, 5e, 6, 6A, 8	5000 (16 000)	
ATM 25.6	category 3, 5e, 6, 6A[1], 8	100 (328)	
ATM 51.84	category 3, 5e, 6, 6A[1], 8	100 (328)	
ATM 155.52	category 5e, 6, 6A[1], 8	100 (328)	
ATM 1.2G	category 6, 6A[1], 8	100 (328)	
ISDN BRI	category 3, 5e, 6, 6A, 8	5000 (16 000)	128 kb/s
ISDN PRI	category 3, 5e, 6, 6A, 8	5000 (16 000)	1.472 Mb/s

NOTES

1 – Category 8 components can be used to construct category 6A 100 m (328 ft) channels. See TIA TSB-184 for power delivery efficiency achievable with category 8 components.

2 – Installed category 5e and category 6 cabling qualified in accordance with TIA TSB-5021 can support 2.5GBASE-T and 5GBASE-T.

3 – Installed category 6 cabling qualified in accordance with TIA TSB-155 can support 10GBASE-T for maximum distances between 37 m (121 ft) and 55 m (180 ft) depending on the alien crosstalk environment.

C.3 Optical fiber cabling supportable distances

The Ethernet, Fibre Channel and FDDI applications listed in table 6 and table 7 require two optical fibers to support bi-directional communications, with the exceptions of 40GBASE-SR4 that requires eight fibers and 100GBASE-SR10 that requires 20 fibers. The PON applications listed in table 8 require one fiber to support bidirectional communications.

Table 6 lists maximum supportable distances and maximum channel attenuation for applications using multimode optical fiber cabling. The table is based on the minimum performance requirements of 62.5/125 μm (OM1), 50/125 μm (OM2), 850 nm laser-optimized 50/125 μm (OM3, OM4 and OM5), fiber established by ANSI/TIA-568.3. Applications are identified using industry standard nomenclature.

NOTE – OM1 and OM2 are no longer recognized media. Information is included for maintenance of legacy installations.

Table 6 – Maximum supportable distances and channel attenuation for multimode optical fiber applications

	Fiber Type	62.5/125 µm		50/125 µm		850 nm laser-optimized 50/125 µm			
	Fiber Standard	TIA-492AAAA (OM1)		TIA-492AAAB (OM2)		TIA-492AAAC (OM3)		TIA-492AAAD (OM4) and TIA-492AAE (OM5)	
	Nominal wavelength (nm)	850	1300	850	1300	850	1300	850	1300
Application	**Parameter**								
Ethernet 10/100BASE-SX	Channel attenuation (dB)	4.0	-	4.0	-	4.0	-	4.0	-
	Supportable distance m (ft)	300 (984)	-	300 (984)	-	300 (984)	-	300 (984)	-
Ethernet 100BASE-FX	Channel attenuation (dB)	-	11.0	-	6.0	-	6.0	-	6.0
	Supportable distance m (ft)	-	2000 (6560)	-	2000 (6560)	-	2000 (6560)	-	2000 (6560)
Ethernet 1000BASE-SX	Channel attenuation (dB)	2.6	-	3.6	-	-	-	-	-
	Supportable distance m (ft)	275 (900)	-	550 (1804)	-	Note 1	-	Note 1	-
Ethernet 1000BASE-LX	Channel attenuation (dB)	-	2.3	-	2.3	-	2.3	-	2.3
	Supportable distance m (ft)	-	550 (1804)	-	550 (1804)	-	550 (1804)	-	550 (1804)
Ethernet 10GBASE-S	Channel attenuation (dB)	2.4	-	2.3	-	2.6	-	2.9	-
	Supportable distance m (ft)	33 (108)	-	82 (269)	-	300 (984)	-	400 (1312)	-
Ethernet 10GBASE-LX4	Channel attenuation (dB)	-	2.5	-	2.0	-	2.0	-	2.0
	Supportable distance m (ft)	-	300 (984)	-	300 (984)	-	300 (984)	-	300 (984)
Ethernet 10GBASE-LRM	Channel attenuation (dB)	-	1.9	-	1.9	-	1.9	-	1.9
	Supportable distance m (ft)	-	220 (720)	-	220 (720)	-	220 (720)	-	220 (720)
Ethernet 25GBASE-SR	Channel attenuation (dB)	-	-	-	-	1.8	-	1.9	-
	Supportable distance m (ft)	-	-	-	-	70 (230)	-	100 (328)	-
Ethernet 40GBASE-SR4	Channel attenuation (dB)	-	-	-	-	1.9	-	1.5 [2]	-
	Supportable distance m (ft)	-	-	-	-	100 (328)	-	150 (492)	-
Ethernet 100GBASE-SR4	Channel attenuation (dB)	-	-	-	-	1.8	-	1.9	-
	Supportable distance m (ft)	-	-	-	-	70 (230)	-	100 (328)	-
Ethernet 100GBASE-SR10	Channel attenuation (dB)	-	-	-	-	1.9	-	1.5 [2]	-

Table 6 (Concluded)

	Fiber Type	62.5/125 µm		50/125 µm		850 nm laser-optimized 50/125 µm			
	Fiber Standard	TIA-492AAAA (OM1)		TIA-492AAAB (OM2)		TIA-492AAAC (OM3)		TIA-492AAAD (OM4) and TIA-492AAE (OM5)	
	Nominal wavelength (nm)	850	1300	850	1300	850	1300	850	1300
Application	**Parameter**								
1G Fibre Channel 100-MX-SN-I	Channel attenuation (dB)	3.0	-	3.9	-	4.6	-	4.6	-
	Supportable distance m (ft)	300 (984)	-	500 (1640)	-	860 (2822)	-	860 (2822)	-
2G Fibre Channel 200-MX-SN-I	Channel attenuation (dB)	2.1	-	2.6	-	3.3	-	3.3	-
	Supportable distance m (ft)	150 (492)	-	300 (984)	-	500 (1640)	-	500 (1640)	-
4G Fibre Channel 400-MX-SN	Channel attenuation (dB)	1.8	-	2.1	-	2.9	-	3.0	-
	Supportable distance m (ft)	70 (230)	-	150 (492)	-	380 (1247)	-	400 (1312)	-
8G Fibre Channel 800-MX-SN	Channel attenuation (dB)	1.6	-	1.7	-	2.0	-	2.2	-
	Supportable distance m (ft)	21 (69)	-	50 (164)	-	150 (492)	-	190 (624)	-
8G Fibre Channel 800-MX-SA	Channel attenuation (dB)	1.6	-	1.9	-	2.6	-	2.2	-
	Supportable distance m (ft)	40 (131)	-	100 (328)	-	300 (984)	-	300 (984)	-
10G Fibre Channel 1200-MX-SN-I	Channel attenuation (dB)	2.4	-	2.2	-	2.6	-	2.9	-
	Supportable distance m (ft)	33 (108)	-	82 (269)	-	300 (984)	-	400 (1312)	-
16G Fibre Channel 1600-MX-SN	Channel attenuation (dB)	-	-	1.6	-	1.9	-	2.0	-
	Supportable distance m (ft)	-	-	35 (115)	-	100 (328)	-	125 (410)	-
32G Fibre Channel 3200-MX-SN-S 3200-MX-SN-I	Channel attenuation (dB)	-	-	2.0	-	1.9	-	1.9	-
	Supportable distance m (ft)	-	-	20 (66)	-	70 (230)	-	100 (328)	-
FDDI PMD ANSI X3.166	Channel attenuation (dB)	-	11.0	-	6.0	-	6.0	-	6.0
	Supportable distance m (ft)	-	2000 (6560)	-	2000 (6560)	-	2000 (6560)	-	2000 (6560)

NOTES

1 – At the time 1000BASE-SX was developed, OM3 and OM4 had not been standardized. See entries for 1G Fibre Channel 100-MX-SN-I for guidance.

2 –1.0 dB total connection and splice loss allowance per IEEE 802.3.

Table 7 lists maximum supportable distances and maximum channel attenuation for applications using single-mode optical fiber cabling. The table is based on the minimum performance requirements of single-mode fiber established by ANSI/TIA-568.3. Applications are identified using industry standard nomenclature.

NOTE – OS1 is no longer recognized media. Information is included for maintenance of legacy installations

Table 7 – Maximum supportable distances and channel attenuation for single-mode optical fiber applications

	Fiber Type	**Dispersion unshifted single mode and low-water-peak**	
	Fiber Standard	**TIA 492CAAA (OS1) and TIA 492CAAB (OS2)[1]**	
	Nominal wavelength (nm)	**1310**	**1550**
Application	**Parameter**		
Ethernet 1000BASE-LX	Channel attenuation (dB)	4.5	-
	Supportable distance m (ft)	5000 (16405)	-
Ethernet 10GBASE-LX4	Channel attenuation (dB)	6.3	-
	Supportable distance m (ft)	10000 (32810)	-
Ethernet 10GBASE-E	Channel attenuation (dB)	-	11.0
	Supportable distance m (ft)	-	40000 (131230)
Ethernet 10GBASE-L	Channel attenuation (dB)	6.2	-
	Supportable distance m (ft)	10000 (32810)	-
Ethernet 40GBASE-LR4	Channel attenuation (dB)	6.7	-
	Supportable distance m (ft)	10000 (32810)	-
Ethernet 40GBASE-FR	Channel attenuation (dB)	4.0	-
	Supportable distance m (ft)	2000 (6562)	-
Ethernet 100GBASE-LR4	Channel attenuation (dB)	6.3	-
	Supportable distance m (ft)	10000 (32810)	-
1G Fibre Channel 100-SM-LC-L	Channel attenuation (dB)	7.8	-
	Supportable distance m (ft)	10000 (32810)	-
2G Fibre Channel	Channel attenuation (dB)	7.8	-

200-SM-LC-L	Supportable distance m (ft)	10000 (32810)	-

Table 7 (Concluded)

	Fiber Type	Dispersion unshifted single mode and low-water-peak	
	Fiber Standard	TIA-492CAAA (OS1) and TIA-492CAAB (OS2)[1]	
	Nominal wavelength (nm)	1310	1550
Application	**Parameter**		
2G Fibre Channel 200-SM-LC-L	Channel attenuation (dB)	7.8	-
	Supportable distance m (ft)	10000 (32810)	-
4G Fibre Channel 400-SM-LC-M	Channel attenuation (dB)	4.8	-
	Supportable distance m (ft)	4000 (13124)	-
4G Fibre Channel 400-SM-LC-L	Channel attenuation (dB)	7.8	-
	Supportable distance m (ft)	10000 (32810)	-
8G Fibre Channel 800-SM-LC-I	Channel attenuation (dB)	2.6	-
	Supportable distance m (ft)	1400 (4593)	-
8G Fibre Channel 800-SM-LC-L	Channel attenuation (dB)	6.4	-
	Supportable distance m (ft)	10000 (32810)	-
10G Fibre Channel 1200-SM-LL-L	Channel attenuation (dB)	6.0	-
	Supportable distance m (ft)	10000 (32810)	-
16G Fibre Channel 1600-SM-LC-L	Channel attenuation (dB)	6.4	-
	Supportable distance m (ft)	10000 (32810)	-
32G Fibre Channel 3200-SM-LC-L	Channel attenuation (dB)	6.3	-
	Supportable distance m (ft)	10000 (32810)	-
FDDI SMF-PMD ANSI X3.184	Channel attenuation (dB)	10.0	-
	Supportable distance m (ft)	10000 (32810)	-

NOTES:
1 – For the purposes of this table single-mode indoor/outdoor and single-mode inside plant cables (TIA 492CAAB) are considered equivalent to OS2.

Table 8 lists maximum supportable distances, and minimum and maximum channel attenuation including the attenuation of couplers and splitters for Passive Optical Networks (PON) applications using single-mode optical fiber cabling. The table is based on the minimum performance requirements of single-mode fiber established by ANSI/TIA-568.3. Applications are identified using industry standard nomenclature.

Table 8 – Maximum supportable distances and minimum and maximum channel attenuation for single-mode fiber passive optical network (PON) applications

Application	Fiber Type	Dispersion unshifted single-mode and low-water-peak			
	Fiber Standard	TIA-492CAAA (OS1) and TIA-492CAAB (OS2)[4]			
	Parameter	Nominal wavelength (nm), wavelength range (nm) and direction			
		1270	1310	1490	1577
		1260..1280	1260..1360	1480..1500	1575..1580
		Upstream		Downstream	
1000BASE-PX10 EPON (IEEE 802.3)	Min channel attenuation, dB		5	5	
	Max channel attenuation, dB		20	19.5	
	Max supportable distance, m (ft)	10000 (32810)			
10GBASE-PRX10 10G-EPON (IEEE 802.3av)	Min channel attenuation, dB		5		5
	Max channel attenuation, dB		20		20
	Max supportable distance, m (ft)	10000 (32810)			
10GBASE-PR10 10G-EPON (IEEE 802.3av)	Min channel attenuation, dB	5			5
	Max channel attenuation, dB	20			20
	Max supportable distance, m (ft)	10000 (32810)			
1000BASE-PX20 EPON (IEEE 802.3)	Min channel attenuation, dB		10	10	
	Max channel attenuation, dB		24	24	
	Max supportable distance, m (ft)	20000 (65620)			
GPON Class B (ITU-T G.984)	Min channel attenuation, dB		10	10	
	Max channel attenuation, dB		25	25	
	Max supportable distance, m (ft)	20000 (65620)			
10GBASE-PRX20 10G-EPON (IEEE 802.3av)	Min channel attenuation, dB		10		10
	Max channel attenuation, dB		24		24
	Max supportable distance, m (ft)	20000 (65620)			
	Max channel attenuation, dB		24		24
	Max supportable distance, m (ft)	20000 (65620)			

Table 8 (Concluded)

10GBASE-PR20 10G-EPON (IEEE 802.3av)	Min channel attenuation, dB	10			10
	Max channel attenuation, dB	24			24
	Max supportable distance, m (ft)	20000 (65620)			
10GBASE-PRX30 10G-EPON (IEEE 802.3av)	Min channel attenuation, dB		15		15
	Max channel attenuation, dB		29		29
	Max supportable distance, m (ft)	20000 (65620)			
10GBASE-PR30 10G-EPON (IEEE 802.3av)	Min channel attenuation, dB	15			15
	Max channel attenuation, dB	29			29
	Max supportable distance, m (ft)	20000 (65620)			
GPON Class C (ITU-T G.984)	Min channel attenuation, dB		15	15	
	Max channel attenuation, dB		30	30	
	Max supportable distance, m (ft)	20000 (65620)			
GPON Class B+ (ITU-T G.984)	Min channel attenuation, dB		13	13	
	Max channel attenuation, dB		28	28	
	Max supportable distance, m (ft)	20000 (65620)			
GPON Class C+ (ITU-T G.984)	Min channel attenuation, dB		17	17	
	Max channel attenuation, dB		32	32	
	Max supportable distance, m (ft)	60000 (196850) [2]			
Class N1 XG-PON (ITU-T G.987)	Min channel attenuation, dB	14			14
	Max channel attenuation, dB	29			29
	Max supportable distance, m (ft)	40000 (131230) [3]			
Class N2 XG-PON (ITU-T G.987)	Min channel attenuation, dB	16			16
	Max channel attenuation, dB	31			31
	Max supportable distance, m (ft)	40000 (131230) [3]			

NOTES

1 – The channel attenuation is the sum of all link attenuations and attenuation values for all passive components including splitters (see 5.5), couplers and jumpers.

2 – Subject to 20km differential fiber distance limit for conventional ITU-T G.984 GPON systems, and subject to 40 km differential fiber distance limit for the ITU-T G.984.7-compliant systems.

3 – Supportable fiber distance can be increased up to 60 km, subject to 40km differential distance limit.

4 – For the purposes of this table single-mode indoor/outdoor and single-mode inside plant cables (TIA-492CAAB) are considered equivalent to OS2.

C.4 Broadband coaxial cabling supportable distances

Table 9 lists maximum supportable distances for applications using broadband coaxial cabling. The table is based on the minimum performance requirements of specific balanced coaxial cabling established by ANSI/TIA 568.4.

Table 9 – Maximum supportable distances for broadband coaxial cabling applications

Application	Media	Distance m (ft)
CATV	series 6	56 (184)
	series 11	100 (328)
Satellite TV	series 6	56 (184)
	series 11	100 (328)

Annex D (informative) Environmental classifications

This annex is informative and not part of this Standard.

Environmental classifications have been developed for the purpose of describing areas in which cabling is placed. The specifications of MICE include: M - mechanical; I - ingress; C - climatic; and E - electromagnetic. Compatibility with the environment can be achieved with enhanced cabling components or through protection, separation or isolation. Table 10 provides thresholds for environmental conditions. MICE 1 ($M_1I_1C_1E_1$) generally relates to environmentally controlled areas such as commercial building offices, MICE 2 ($M_2I_2C_2E_2$) generally relates to a light industrial environment and MICE 3 ($M_3I_3C_3E_3$) generally relates to an industrial environment. The classification for areas with mixed environments may be described by including the classification level for each variable as a subscript (e.g., $M_1I_2C_3E_1$). If a cabling system component crosses an environmental boundary, the component or mitigation technique should be selected to be compatible with the worst-case environment to which it is exposed.

The MICE tables should not be used as performance requirements individually or in combination for components, links, or channels.

Refer to TIA TSB-185 for a tutorial on environmental classifications.

Table 10 – MICE environmental conditions

Mechanical	**M_1**	**M_2**	**M_3**
Shock/bump (see note 1)			
Peak acceleration	40 m/s^{-2}	100 m/s^{-2}	250 m/s^{-2}
Vibration			
Displacement amplitude (2 Hz to 9 Hz)	1.5 mm	7.0 mm	15.0 mm
Acceleration amplitude (9 Hz to 500 Hz)	5 m/s^{-2}	20 m/s^{-2}	50 m/s^{-2}
Tensile force	See b)	See b)	See b)
Crush	45 N over 25 mm (linear) min.	1 100 N over 150 mm (linear) min.	2 200 N over 150 mm (linear) min.
Impact	1 J	10 J	30 J
Bending, flexing and torsion	See b)	See b)	See b)

Ingress	**I_1**	**I_2**	**I_3**
Particulate ingress (dia. max)	12.5 mm	50 µm	50 µm
Immersion	None	Intermittent liquid jet ≤ 12.5 l/min ≥ 6.3 mm jet > 2.5 m distance	Intermittent liquid jet ≤ 12.5 l/min ≥ 6.3 mm jet > 2.5 m distance and immersion (≤1 m for <=30 minutes)

Table 10 (Continued)

Climatic and chemical	C_1	C_2	C_3
Ambient temperature	-10 °C to +60 °C	-25 °C to +70 °C	-40 °C to +70 °C
Rate of change of temperature	0.1 °C per minute	1.0 °C per minute	3.0 °C per minute
Humidity	5 % to 85 % (non-condensing)	5 % to 95 % (condensing)	5 % to 95 % (condensing)
Solar radiation	700 Wm^{-2}	1 120 Wm^{-2}	1 120 Wm^{-2}
Liquid pollution (see note 3) Contaminants	Concentration x 10^{-6}	Concentration x 10^{-6}	Concentration x 10^{-6}
Sodium chloride (salt/sea water)	0	<0.3	<0.3
Oil (dry-air concentration) (for oil types see note 2)	0	<0.005	<0.5
Sodium stearate (soap)	0	>5 x 10^4 aqueous non-gelling	>5 x 10^4 aqueous gelling
Detergent	0	ffs	ffs
Conductive materials	0	Temporary	Present
Gaseous pollution (see Note 3) Contaminants	Mean/Peak (Concentration x 10^{-6})	Mean/Peak (Concentration x 10^{-6})	Mean/Peak (Concentration x 10^{-6})
Hydrogen sulphide	<0.003/<0.01	<0.05/<0.5	<10/<50
Sulphur dioxide	<0.01/<0.03	<0.1/<0,3	<5/<15
Sulphur trioxide (ffs)	<0.01/<0.03	<0.1/<0.3	<5/<15
Chlorine wet (>50 % humidity)	<0.000 5/<0.001	<0.005/<0.03	<0.05/<0.3
Chlorine dry (<50 % humidity)	<0.002/<0.01	<0.02/<0.1	<0.2/<1.0
Hydrogen chloride	-/<0.06	<0.06/<0.3	<0.6/3.0
Hydrogen fluoride	<0.001/<0.005	<0.01/<0.05	<0.1/<1.0
Ammonia	<1/<5	<10/<50	<50/<250
Oxides of Nitrogen	<0.05/<0.1	<0.5/<1	<5/<10
Ozone	<0.002/<0.005	<0.025/<0.05	<0.1/<1

Table 10 (Concluded)

Electromagnetic	E_1	E_2	E_3
Electrostatic discharge – Contact (0,667 µC)	4 kV	4 kV	4 kV
Electrostatic discharge – Air (0,132 µC)	8 kV	8 kV	8 kV
Radiated RF - AM	3 V/m at (80 to 1 000 MHz) 3 V/m at (1 400 to 2 000 MHz) 1 V/m at (2 000 to 2 700 MHz)	3 V/m at (80 to 1 000 MHz) 3 V/m at (1 400 to 2 000 MHz) 1 V/m at (2 000 to 2 700 MHz)	10 V/m at (80 to 1 000 MHz) 3 V/m at (1 400 to 2 000 MHz) 1 V/m at (2 000 to 2 700 MHz)
Conducted RF	3 V at 150kHz to 80MHz	3 V at 150kHz to 80MHz	10 V at 150kHz to 80MHz
EFT/B (comms)	500 V	500 V	1 kV
Surge (transient ground potential difference) - signal, line to earth	500 V	1 kV	1 kV
Magnetic Field (50/60 Hz)	1 Am^{-1}	3 Am^{-1}	30 Am^{-1}
Magnetic Field (60 Hz to 20 000 Hz)	ffs	ffs	ffs

NOTES

1 – Bump: the repetitive nature of the shock experienced by the channel shall be taken into account.

2 – This aspect of environmental classification is installation-specific and should be considered in association with IEC 61918 and the appropriate component specification.

3 – A single dimensional characteristic, i.e. Concentration x 10^{-6}, was chosen to unify limits from different standards.

Annex E (informative) Guidelines on shared sheaths and shared pathways for balanced twisted-pair cabling

This annex is informative and not part of this Standard.

E.1 General

This annex provides guidance related to:

a) multiple applications running within the same sheath;
b) multiple applications operating over different cable categories or constructions sharing the same pathways;
c) alien crosstalk interference between category 6A UTP cables manufactured by different manufacturers; and
d) alien crosstalk interference between category 6A UTP cables and other category cables.

See TIA TSB-190 for additional information.

E.2 Multiple applications operating under the same cable sheath

This clause provides information and guidance related to the operation of multiple applications under the same cable sheath.

E.2.1 General

The shared sheath guidelines described in this clause are typical and do not cover every combination of applications. It is recommended that the user consult with equipment manufacturers, applications standards, and system providers for additional information.

E.2.2 Guidelines for shared-sheath implementations

There are many issues to consider when deciding which applications and how many systems can operate under the same cable sheath or share a common 25 pair binder group in a multipair cable. Some of the most important transceiver considerations are:

a) transmit amplitudes;
b) signal;
c) robustness of protocols; and
d) receiver sensitivity.

Applications operating in different frequency ranges typically do not interfere with each other. The main concern occurs when systems with a common bandwidth operate under the same cable sheath or share a common binder group in a multipair cable. From a knowledge of the type of transmission, appropriate guidelines regulating distances and the number of systems operating under the same cable sheath or in a multipair binder group can be determined. One example of sheath sharing is the 10BASE T standard that accounted for all of the effects listed herein and determined that 12 systems could share a common 25-pair binder group of category 3 multipair cabling. In addition, 6 systems of the 1000BASE-T application or 12 systems of the 100BASE-TX application can share a common 25-pair binder group of category 5e or higher category of multipair cabling.

Shared sheath performance using category 5e or higher category of multipair cabling is considerably better than category 3 for applications with data rates up to 10 Mb/s.

Some examples of shared sheath restrictions for specific applications using category 3 binder groups are:

a) TIA-232 and ISDN applications should be on separate binder groups;
b) 3270 type signals converted to 100 ohm balanced twisted-pair should not share the same binder group as 10BASE T. (Some 3270 baluns may have poor rejection capabilities at higher frequencies.);
c) Signals from hosts with multiple controllers should not share the same binder group (signals from the same controller can share a binder group); and
d) Signals with significantly different power levels should not share the same binder group.

E.3 Multiple applications operating over different cabling categories or constructions

Category 5e, category 6, and category 6A cabling supporting non-10GBASE-T applications (e.g. 100BASE-TX, 1000BASE-T) may be placed unbundled or in adjacent bundles within the same pathway with category 6A and TIA TSB-155 compatible category 6 cabling supporting the 10GBASE-T application without adversely affecting application performance. Category 6A cabling should be used for all new installations intended to support the 10GBASE-T application.

In addition, balanced twisted-pair cabling can share the same pathways as series 6 or series 11 coaxial cabling and optical fiber cabling.

E.4 Category 6A UTP cables from different manufacturers

Compliant category 6A UTP cables from different manufacturers may be placed bundled, unbundled, or in adjacent bundles (see figure 10) within the same pathway. Alien crosstalk requirements will inherently be met by compliance with ANSI/TIA-568.2.

Figure 10 – Example of adjacent bundles of category 6A cables from different manufacturers

E.5 Category 6A UTP cables and other category cables

Compliant category 6A UTP cables and other category cables may be placed bundled (see figure 11), unbundled, or in adjacent bundles within the same pathway without exceeding the alien crosstalk limits specified in ANSI/TIA 568.2.

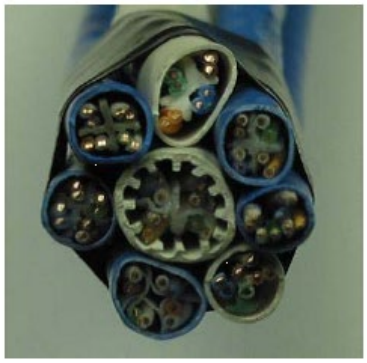


Figure 11 – Example bundle configuration with seven category 6 cables around one category 6A cable

Annex F (informative) Bibliography

This annex is informative and not part of this Standard.

The following documents are referenced in this Standard

- ANSI/TIA-862, *Structured Cabling Infrastructure Standard for Intelligent Building Systems*
- TIA TSB-153, *Static Discharge Between LAN and Data Terminal Equipment*
- TIA TSB-155, *Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T*
- TIA TSB-162, *Telecommunications Cabling Guidelines for Wireless Access Points*
- TIA TSB-184, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling*
- TIA TSB-185, *Environmental Classification (MICE) Tutorial*
- TIA TSB-190, *Guidelines on Shared Pathways and Shared Sheaths*
- TIA TSB-5021, *Guidelines for the Assessment and Mitigation of Installed Cabling to Support 2.5GBASE-T and 5GBASE-T*

The following is a list of some generally applicable basic standards and guides that are relevant to the requirements of this Standard:

- FCC 47CFR Part 68, *Connection of Terminal Equipment to the Telephone Network*
- Federal Telecommunications Recommendation 1090-1997, *Commercial Building Telecommunications Cabling Standard*, 11 August 1997, by National Communications System (NCS).
- IEEE C2, *National Electrical Safety Code*® (NESC®)
- IEEE Std 802.3™, *IEEE Standard for Ethernet*
- NFPA 70, *National Electrical Code® (NEC®)*
- TIA TSB-31, *Telecommunications – Telephone Terminal Equipment Rationale and Measurement Guidelines for US Network Protection*

The organizations listed below can be contacted to obtain reference information.

ANSI
American National Standards Institute (ANSI)
11 W 42 St.
New York, NY 10032
USA
(212) 642-4900
www.ansi.org

BICSI
8610 Hidden River Parkway
Tampa, FL 33637-1000
USA
(800) 242-7405
www.bicsi.org

FCC
Federal Communications Commission (FCC)
445 12th St SW
Washington, DC 20554
USA
(301) 725-1585
www.fcc.org

Federal and Military Specifications
National Communications System (NCS)
Technology and Standards Division
701 South Court House Road
Arlington, VA 22204-2198
USA
(703) 607-6200
www.ncs.gov

IEC
International Electrotechnical Commission (IEC)
Sales Department
PO Box 131
3 rue de Varembé
CH-1211 Geneva 20
Switzerland
+41 22 919 02 11
www.iec.ch

IEEE
IEEE Service Center
445 Hoes Ln., PO Box 1331
Piscataway, NJ 08855-1331
USA
(732) 981-0060
www.ieee.org

NFPA
National Fire Protection Association (NFPA)
Batterymarch Park
Quincy, MA 02269-9101
USA
(617) 770-3000
www.nfpa.org

TIA
Telecommunications Industry Association (TIA)
1320 N Courthouse Rd #200
Arlington, VA 22201
USA
(703) 907-7700
www.tiaonline.org

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