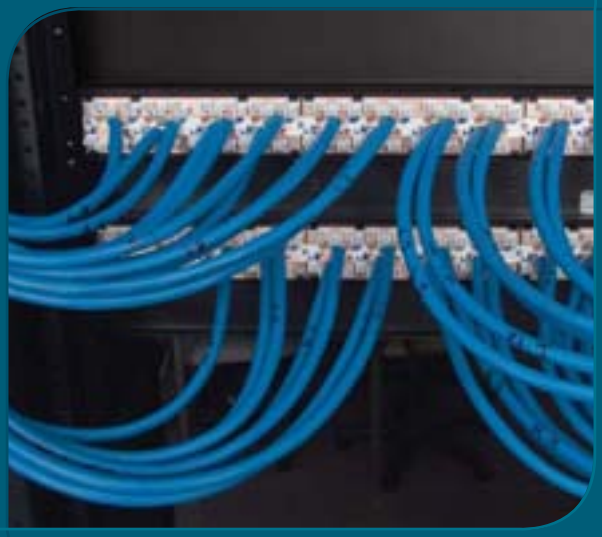
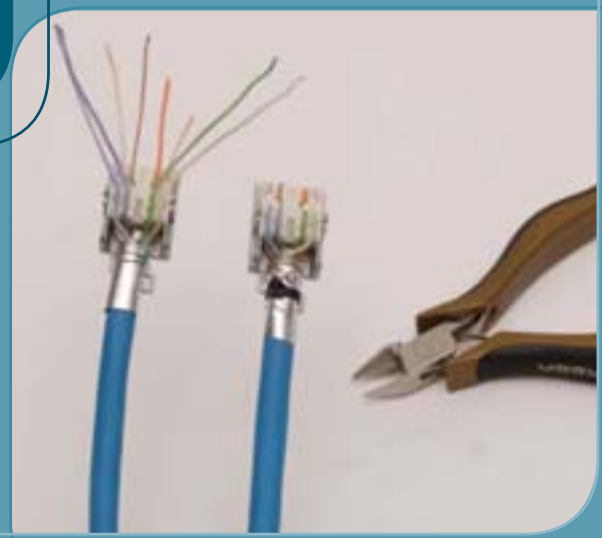
STANDARDS

Structured Cabling Standards and Practices

This section explains the key ANSI/TIA standards and practices required for structured cabling installation and testing. Adherence to standards and codes is required to obtain Hubbell's MISSION CRITICAL® Warranty.





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STRUCTURED CABLING STANDARDS AND PRACTICES•RESIDENTIAL CABLING•FIBER CABLING AND COMPONENT
COPPER CABLING REQUIREMENTS•PATHWAYS AND SPACES•INTERNATIONAL STANDARDS•PERMANENT LINK AN
FIELD TESTING•FIBER INSTALLATION PRACTICES•BUILDING AUTOMATION SYSTEMS•APPLICATION GUIDELINES•S
FOR COMMERCIAL BUILDINGS•GLOSSARY•UTP CABLING COMPONENTS PERFORMANCE•BACKBONE & HORIZ
CABLING STRUCTURE•TELECOMMUNICATIONS PATHWAYS AND SPACES•ADMINISTRATION•RESIDENTIAL CABLIN
TELECOMMUNICATIONS STANDARD•UTP WIRING CONVENTIONS•CABLING STANDARDS•PRODUCT TESTING•G
AND BONDING•INDUSTRIAL ETHERNET APPLICATIONS•WORK AREA•UTP PERMANENT LINK•CHANNEL FIELD TE

Technical Contents

Introduction: Structured Cabling Standards Evolution

Industry standards are published design and performance requirements that are approved by industry ballot among cable and component manufacturers. The objective of cabling standards is to promote global inter-connectivity of equipment from diverse manufacturers. Since the release of IEEE 802.3an 10-Gigabit Ethernet (10GbE) standard in 2006, evolution of ANSI/TIA-568 structured cabling standards has achieved a new level of performance, defined as Category 6A, or Augmented Category 6. The Category 6A cabling performance requirements of Addendum ANSI/TIA-EIA-568-B.2-10 were officially ratified in February 2008.

In addition to the release of Category 6A requirements, the ANSI/TIA-568-B series of standards are being superseded by ANSI/TIA-568-C series. The new '568-C series incorporates all previously published addenda, plus a new section of generic cabling guidelines. 568C.0. These new developments are also presented in this section.

As an active contributor to and leader in cabling standards organizations such as TIA and IEEE, Hubbell manufactures products that exceed all applicable standards. Compliance to industry standards is a long-term commitment by Hubbell Premise Wiring.

Global industry standards offer the following advantages:

- Interoperability of connecting hardware.
- Backward compatibility.
- Open systems architecture.
- Ease of migration to new performance levels.
- Multi-vendor choice to the end-user.

Compliance to standards also applies to **MISSION CRITICAL**® objectives. **MISSION CRITICAL**® is defined as the delivery of long-term, uninterrupted service at stated performance levels.

This is the philosophy of Hubbell's 25-year **MISSION CRITICAL**® warranty. For more information about the Hubbell **MISSION CRITICAL**® training and installer certification, go to:

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Standards

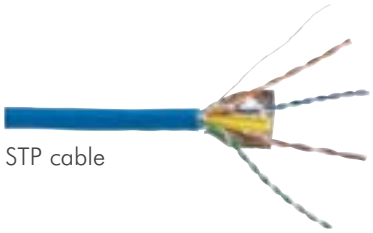
ANSI/TIA-568-C

The ANSI/TIA-568-C series of standards is a family of our individual documents. Note: the 568-C series will replace ANSI/TIA-568-B series in 2008.

- ANSI/TIA-568-C.0: "Generic Telecommunications Cabling for Customer Premises".
- ANSI/TIA-568-C.1: "Commercial Building Telecommunications Cabling Systems Standard".
- ANSI/TIA-568-C.2: "Balanced Twisted Pair Telecommunications Cabling Systems Standard".
- ANSI/TIA-568-C.3: "Optical Fiber Telecommunications Cabling Systems Standard".

UTP cable

Multimode fiber cable



STP cable

ANSI/TIA-568-C.0 defines the overall premises infrastructure for copper and fiber cabling. Detailed requirements for cabling installation and field-testing are also included. TIA-568-C.1 provides detailed design requirements for horizontal and backbone cabling infrastructure and distribution facilities. TIA-568-C.2 and C.3 establish component level testing and prformance requirements for copper and fiber connecting hardware respectively.

ANSI/TIA-568-C.0 and C.1: Horizontal Cabling *(previously 568-B.1)*

The horizontal cabling in a building is a single floor cable distribution from the horizontal cross connect (HC) in the telecommunications room (TR) to the work area (WA) outlet.

Recognized Horizontal Cables

- 4-Pair 100Ω UTP or Screened Twisted Pair (ScTP), Category 3, 5e, 6, and 6A.
  - Minimum 2-Strand Multimode Fiber Optic Cable.
- 150Ω Shielded Twisted Pair (STP).

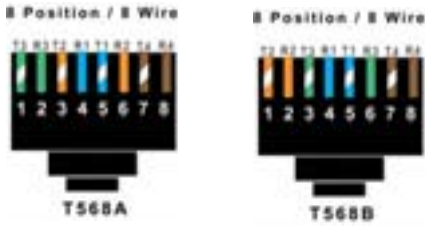
Horizontal Cable Minimum Bend Radius and Pull Force

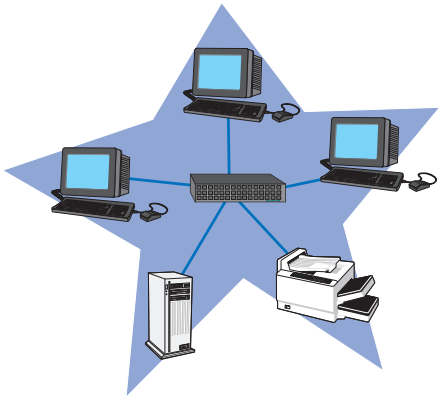
- 4-Pair UTP: 4 times cable diameter.
  - Maximum pull force: 25 lbs.
- Fiber Cable: 10 times cable diameter.
  - See pages N14 and N15 for Pull Forces.

NOTE: See pages N14 and N16 for Installation Practices.

Recognized Connectors

- 8-position modular jack and plug.
  - Pin/pair assignments configured T568A or T568B.
- 568SC and ST-style fiber connectors.
- SFF fiber connectors: LC and MT-RJ.





Horizontal Cabling Topology and Design Notes

Each outlet connection in the work area has an individual cable run (link) from the TR. This represents a star topology shown in the diagram. This arrangement is most convenient for moves, adds and changes (MAC's). Any horizontal cable link is limited to 90 meters in length. Locate the TR centrally on each floor to equalize cable run lengths. As a rule, use 40% max fill for cable pathways. Allow one work area per 100 sq. ft. of floor space for design purposes.

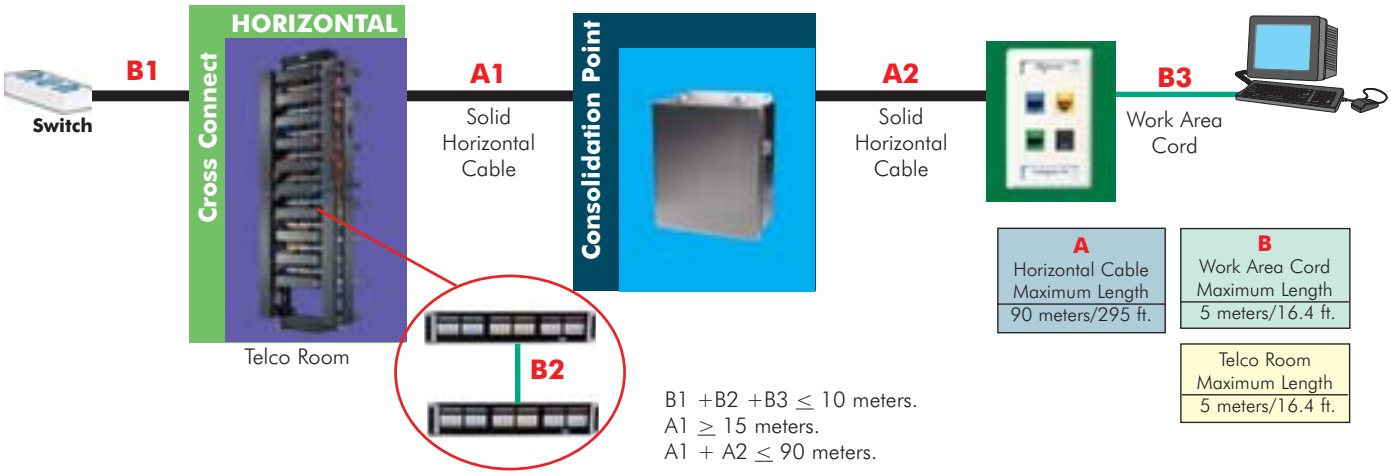
ANSI/TIA-568-C.0 and C.1: Horizontal Cabling Practices (cont'd)

Consolidation Point

The consolidation point is an optional interconnection node that is allowed in the horizontal cabling between the TR and the work area.

- The consolidation point must be mounted to a permanent building structure in an area free from obstructions or furniture.
- Cross connections are not allowed in the consolidation enclosure.
- Due to the effect of NEXT on multiple connections in close proximity, this standard recommends locating all consolidation points at least 15m (49 ft.) away from the TR.
- Consolidation points and transition points cannot be combined in any single horizontal link.
- Each consolidation point should serve a maximum of 12 work areas, with consideration for future growth.
- Administration should follow the guidelines of ANSI/TIA-606-B.

Consolidation Point Solution



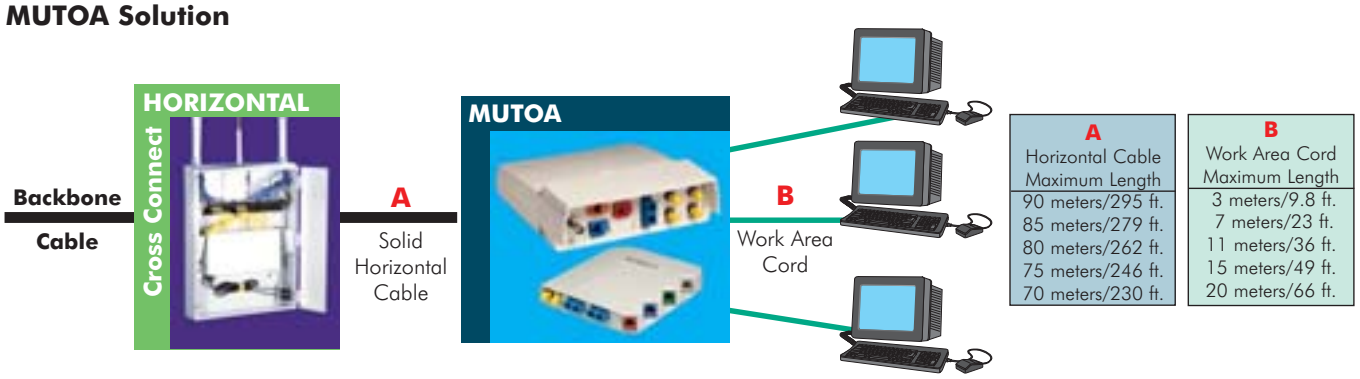
These are maximum channel length configurations - alternate length configuration are allowed, consult the standard.

The Multi-User Telecommunications Outlet Assembly (MUTOA)

The MUTOA contains multiple telecommunications outlet connectors to service a cluster of individual work areas.

- A combination of solid conductor 4-pair UTP cables and fiber optic cables may be run from the TR to the MUTOA.
- The MUTOA is permanently mounted to a building structure that is in close proximity to a cluster of work areas.
- A MUTOA allows horizontal cabling to remain intact when the open-office layout plan is changed.
- Work area cables are either fiber patch cords or stranded conductor copper cords with a modular plug on each end.
- Length of all work area cables from the MUTOA must be labeled on both ends. Maximum length is 20 meters for horizontal runs less than 70 meters.
- Each MUTOA should serve a maximum of 12 work areas.
- Administration should follow the guidelines of ANSI/TIA-606-B.

MUTOA Solution



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ANSI/TIA-568-C.0 and C.1: Optical Fiber Supportable Distances

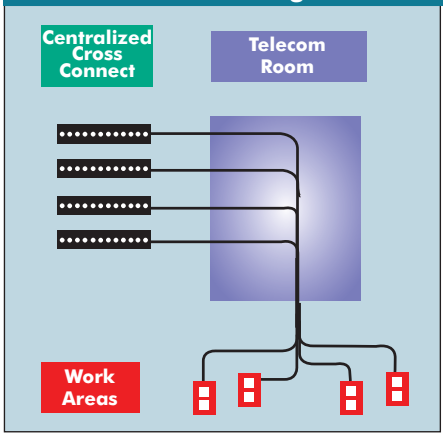
Application	Wave length (nm)	Maximum Supportable Distance (m)				Maximum Channel Attenuation (dB)			
		Multimode			Single-mode	Multimode			Single-mode
		62.5/125	50/125	850 nm Laser Optimized 50/125		62.5/125	50/125	850 mm Laser Optimized 50/125	
10/100BASE-SX	850	300	300	300	NST	4.0	4.0	4.0	NST
Gigabit Ethernet									
1000BASE-SX	850	220	550	N/A	N/A	3.2	3.9	N/A	N/A
1000BASE-LX	1300	550	550	N/A	5000	4.0	3.5	N/A	4.7
10G Ethernet									
10GBASE-S	850	26	82	300	NST	2.6	2.3	2.6	NST
10GBASE-L	1310	NST	NST	NST	10000	NST	NST	NST	6.0
10GBASE-E	1550	NST	NST	NST	40000	NST	NST	NST	11.0
10GBASE-LX4	1300	300	300	300	NST	2.5	2.0	2.0	NST
10GBASE-LX4	1310	N/A	N/A	N/A	10000	N/A	N/A	N/A	6.6

NOTES:
S=Short wavelength; L=Long wavelength; E=Extended wavelength.
NST=Non-standard; N/A=Not applicable.
LX4=Multiplex (4) wavelengths.

ANSI/TIA-568-C.0: Fiber Optic Cabling Guidelines: Centralized Cabling

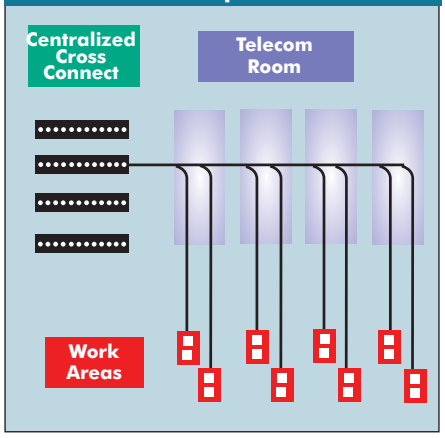
Single tenant users of fiber optic data networks can avoid distributed electronic equipment by using the centralized cabling method. Centralized electronic equipment and cabling reduces cost and complexity, and maximizes transmission performance. Extended distances are permitted using these methods. The interconnect method is most flexible and is the preferred choice.

FIGURE 1 - Pull-through Method



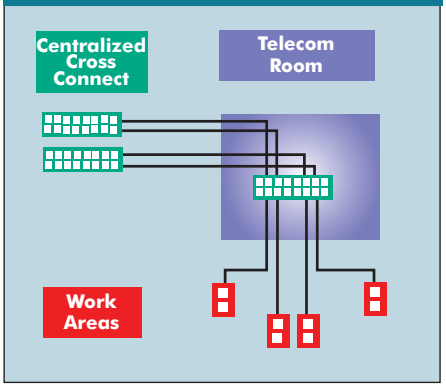
Max Distance: 90m

FIGURE 2 - Splice Method



Max Distance: 300m
(Includes horizontal + backbone + patch cords)

FIGURE 3 - Interconnect Method

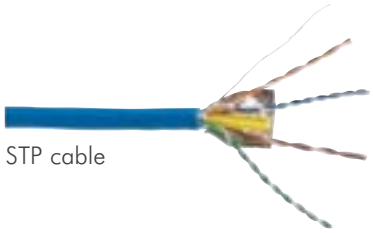


Max Distance: 300m

ANSI/TIA-568-C.1: Backbone Cabling

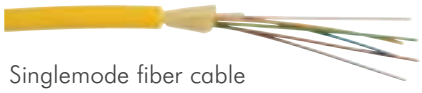
A backbone distribution system is the part of a premises distribution system that provides connection between equipment rooms (ERs), telecommunication rooms (TRs), telecommunication enclosures (TEs), and telecommunication services entrance facilities (EFs).

UTP cable



STP cable

Multimode fiber cable



Singlemode fiber cable

Recognized Backbone Cables

Twisted Pair Copper Cable

- Data: 100Ω solid conductor 24-AWG UTP or Screened Twisted Pair (ScTP) (Cat 6A, Cat 6 or Cat 5e).
- Voice: 100Ω solid conductor 24-AWG UTP (Cat 3 or Cat 5e).
- Multi-pair cable (25-pair, 50-pair).

Multimode Fiber Optic Cable

- 62.5/125µm fiber.
- 50/125µm fiber.
- 50/125µm fiber (laser optimized).

Singlemode Fiber Optic Cable

- 9/125µm fiber.

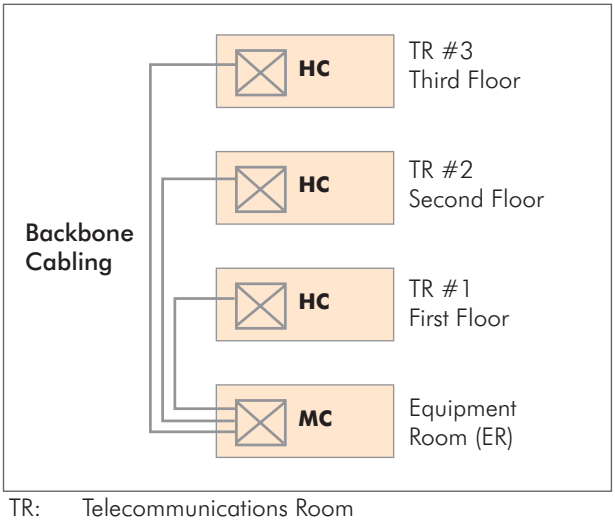
Backbone Cable Minimum Bend Radius

- 4-pair 100Ω UTP: 4x cable diameter.
- Multi-pair (25-50 pair): 10X cable diameter.
- Fiber cable: 15x cable diameter (with load)/10X (no load).
- OSP fiber cable: 20x cable diameter (with load)/10X (no load).

NOTE: See page N14 through N16 for Pull Forces, Minimum Bend Radius, and Installation Practices.

Backbone Cabling Topology and Design Notes

For the simplest design, the HC on each floor receives a home run backbone cable from the MC in the ER. This represents a star topology. Multiple buildings in a campus form a Hierarchical star topology from the central MC facility. Codes require non-fire rated OSP backbone cable to extend no longer than 50 ft into the building without conduit. Firestopping is required for wall or floor penetrations of backbone sleeves or slots. Properly support vertical cables, and do not exceed manufacturer's vertical rise limits. Consider diverse and redundant cable paths for disaster recovery. If possible, vertically align TR's on multiple floors to simplify the backbone pathways.



TR: Telecommunications Room
HC: Horizontal Cross Connect
MC: Main Cross Connect

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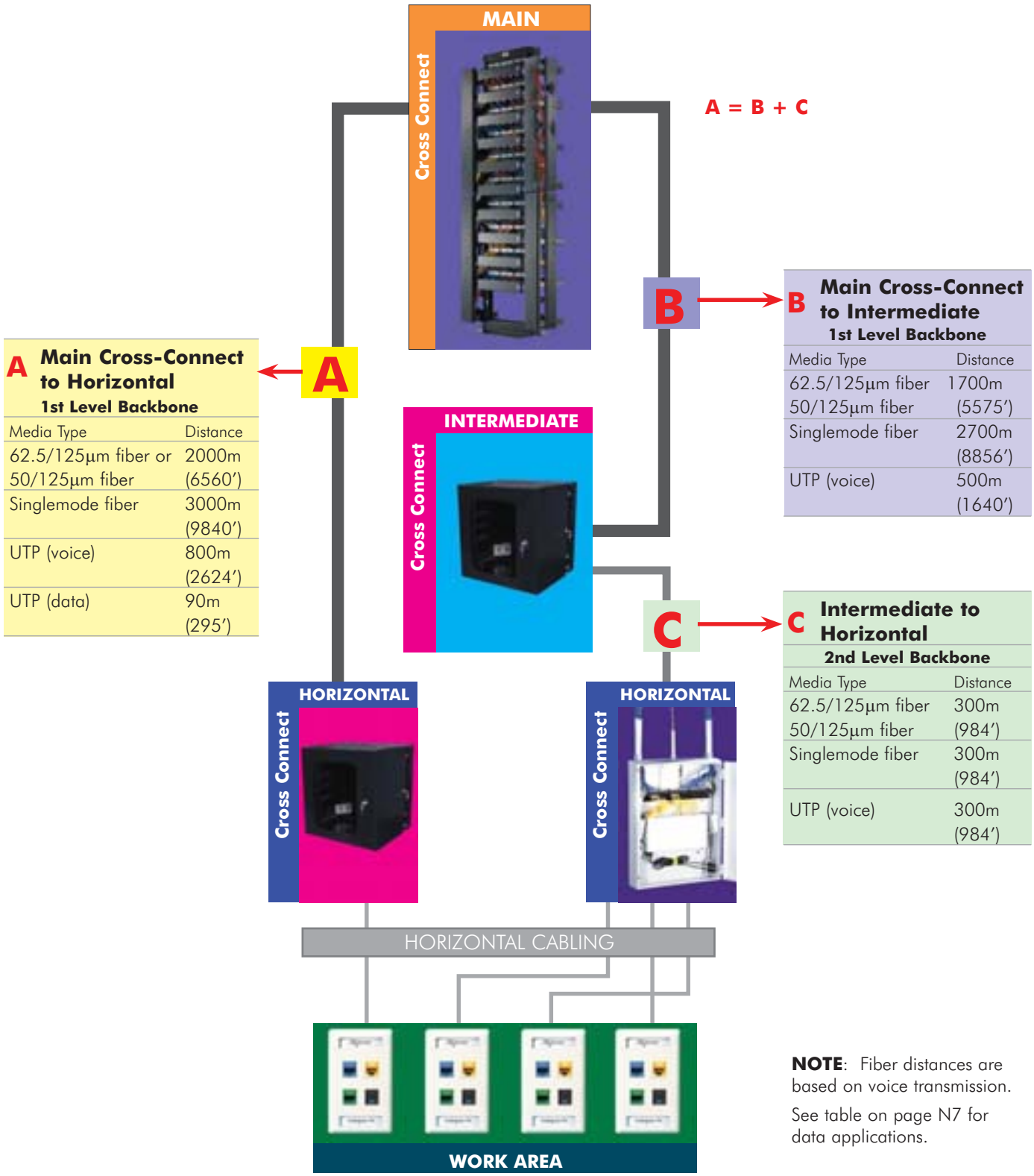
ANSI/TIA-568-C.1: Backbone and Horizontal Cabling Structure

A backbone cabling structure shall have no more than two levels of cross-connections. A two-level backbone and the relationship with horizontal cabling is shown below.

Application Notes

- Backbone distances are application dependent. Maximum distances for UTP are based on voice transmission. A 90-meter maximum distance applies to UTP data transmission at a bandwidth of 5-16 MHz for Category 3, 20-100 MHz for Category 5e, and 1-250 MHz for Category 6.
- For UTP voice applications and fiber, the backbone distances of segment "B" may be increased if "C" is less than the maximum, but the total B + C must not exceed "A".
- Refer to "Optical Fiber Supportable Distances" on page N7.



A Main Cross-Connect to Horizontal
1st Level Backbone

Media Type	Distance
62.5/125µm fiber or 50/125µm fiber	2000m (6560')
Singlemode fiber	3000m (9840')
UTP (voice)	800m (2624')
UTP (data)	90m (295')

B Main Cross-Connect to Intermediate
1st Level Backbone

Media Type	Distance
62.5/125µm fiber 50/125µm fiber	1700m (5575')
Singlemode fiber	2700m (8856')
UTP (voice)	500m (1640')

C Intermediate to Horizontal
2nd Level Backbone

Media Type	Distance
62.5/125µm fiber 50/125µm fiber	300m (984')
Singlemode fiber	300m (984')
UTP (voice)	300m (984')

NOTE: Fiber distances are based on voice transmission.

See table on page N7 for data applications.

ANSI/TIA-568-C.1: Work Area

The work area is the terminal end of the structured cabling network. This is the space for interaction of people with computers, phones, data terminals, and other devices on a local area network (LAN).

- A minimum of two telecommunications outlet connectors are required at each work area:
  - First Outlet (mandatory): 4-pair 100Ω UTP or ScTP cable and connector (Category 5e min. recommended).
  - Second Outlet:
    - 4-pair 100Ω UTP cable and connector (min. Category 5e, Category 6 is recommended).
    - 2-fiber 62.5/125µm or 50/125µm optical fiber cable and connectors: SC, ST-style, or SFF recommended.
- One horizontal transition point or consolidation point is permitted.
- Bridges, taps, or splices are not allowed in copper wiring.
- Additional outlets are allowed. Double gang box is best for service loop storage.
- Equipment cords must have the same performance rating as the patch cords.
- Maximum length for work area cords is 5 meters.
- Splitters are not allowed in optical fibers.
- Separation from electrical wiring and pathways shall be according to ANSI/TIA-569-B.
- Work area telecommunications outlet boxes should be located near an electrical outlet (within 3 feet) and installed at the same height, if appropriate.
- For cable count and pathway capacity, use 1 work area per 100 ft.^{2} of floor space as a general rule. Always factor in future growth for all pathways.

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Telecommunications Room (TR)

The Telecommunications Room (TR) is an enclosed space for management and termination of backbone and horizontal cross connections. The TR typically provides the horizontal cabling to all of the work areas on a single floor of a building. The TR is centrally located, and isolated from EMI (electromagnetic interference), with proper grounding and lighting. The TR may also contain other active equipment, power, or security devices. Backbone cabling feeds each TR in a building from the main cross-connect (MC) in the Equipment Room (ER).

Basic Requirements:

- Minimum (1) TR per floor.
- No carpet or suspended ceilings.
- Minimum (2) walls covered with ¾" A/C plywood.
- Dedicated, unswitched electrical power.
- (1) TR serves up to 10,000 sq. ft. of floor space.
- Temperature and humidity control.

Equipment Room (ER)

The Equipment Room (ER) is a centralized space for housing the core electronic equipment, such as computer servers, routers, hubs, etc. The backbone cabling originates from the ER, which serves the entire building or campus. The ER may function as a TR, and also may contain an entrance facility. Stringent electrical and environmental requirements apply to the design of an ER to provide a suitable operating environment for active network equipment. ERs should be supplied with non-switched, conditioned power with back-up. ERs should not be located near mechanical rooms, electrical distribution panels, or wet/dirty areas.

Basic Requirements:

- Minimum (1) ER per building.
- No carpet, suspended ceiling permitted.
- Dedicated, unswitched electrical power - back-up and surge protection.
- (1) ER serves up to 20,000 sq. ft. of floor space.
- Temperature and humidity control.
- Double doors for entrance.

Entrance Facility (EF)

The Entrance Facility (EF) is located where the access provider and inter-building network cables enter the building. Outside plant cables, typically from underground, are terminated inside the entrance facility. This location is known as the demarcation point – the transition from access provider to customer-owned cable. A combination of electrical, fire, building, municipal, and FCC codes apply to the EF. The EF may share other functions, including fire and security alarms, CCTV, CATV, PBX, etc.

Basic Requirements:

- Dry environment.
- Proper backboarding for equipment.
- Secure location.
- Access to building electrical service ground.
- Circuit protection.

ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling Components

This standard specifies electrical performance requirements for installed UTP cable and connecting hardware for each recognized category. Augmented Category 6 with extended frequency and additional parameters (ANEXT) is included. Performance categories, bandwidth, and field test parameters are listed in the table below. Refer to the glossary for explanation of test parameters.

Table 1: Categories of Transmission Performance and Field Test Parameters

Category	Insertion Loss	NEXT	Length	Wire Map	Delay Skew	ELFEXT	Return Loss	PSACR	PSELFEXT	PSNEXT	ANEXT
Cat 3 (16 MHz)	✓	✓	✓	✓							
Cat 5e (100 MHz)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Cat 6 (250 MHz)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Cat 6A (500 MHz)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components

The tables below incorporate enhanced performance requirements for UTP cables and connecting hardware: Category 3, 5e, 6, and 6A. All Hubbell products exceed these minimum requirements.

Permanent Link Performance

Insertion Loss

Frequency (MHz)	Cat 5e (dB)	Cat 6 (dB)	Cat 6A (dB)
1.0	2.1	1.9	1.9
4.0	3.9	3.5	3.5
8.0	5.5	5.0	5.0
10.0	6.2	5.5	5.5
16.0	7.9	7.0	7.0
20.0	8.9	7.9	7.8
25.0	10.0	8.9	8.8
31.25	11.2	10.0	9.8
62.5	16.2	14.4	14.1
100.0	21.0	18.6	18.0
200.0	-	27.4	26.1
250.0	-	31.1	29.5
300.0	-	-	32.7
400.0	-	-	38.5
500.0	-	-	43.8

Return Loss

Frequency (MHz)	Cat 5e (dB)	Cat 6 (dB)	Cat 6A (dB)
1.0	19.0	19.1	19.1
4.0	19.0	21.0	21.0
8.0	19.0	21.0	21.0
10.0	19.0	21.0	21.0
16.0	19.0	20.0	20.0
20.0	19.0	19.5	19.5
25.0	18.0	19.0	19.0
31.25	17.1	18.5	18.5
62.5	14.1	16.0	16.0
100.0	12.0	14.0	14.0
200.0	-	11.0	11.0
250.0	-	10.0	10.0
300.0	-	-	9.2
400.0	-	-	8.0
500.0	-	-	8.0

NEXT Loss

Frequency (MHz)	Cat 5e (dB)	Cat 6 (dB)	Cat 6A (dB)
1.0	60.0	65.0	65.0
4.0	54.8	64.1	64.1
8.0	50.0	59.4	59.4
10.0	48.5	57.8	57.8
16.0	45.2	54.6	54.6
20.0	43.7	53.1	53.1
25.0	42.1	51.5	51.5
31.25	40.5	50.0	50.0
62.5	35.7	45.1	45.1
100.0	32.3	41.8	41.8
200.0	-	36.9	36.9
250.0	-	35.3	35.3
300.0	-	-	34.0
400.0	-	-	29.9
500.0	-	-	26.7

Channel Performance

Insertion Loss

Frequency (MHz)	Cat 5e (dB)	Cat 6 (dB)	Cat 6A (dB)
1.0	2.2	2.1	2.3
4.0	4.5	4.0	4.2
8.0	6.3	5.7	5.8
10.0	7.1	6.3	6.5
16.0	9.1	8.0	8.2
20.0	10.2	9.0	9.2
25.0	11.4	10.1	10.2
31.25	12.9	11.4	11.5
62.5	18.6	16.5	16.4
100.0	24.0	21.3	20.9
200.0	-	31.5	30.1
250.0	-	35.9	33.9
300.0	-	-	37.4
400.0	-	-	43.7
500.0	-	-	49.3

Return Loss

Frequency (MHz)	Cat 5e (dB)	Cat 6 (dB)	Cat 6A (dB)
1.0	17.0	19.0	19.0
4.0	17.0	19.0	19.0
8.0	17.0	19.0	19.0
10.0	17.0	19.0	19.0
16.0	17.0	18.0	18.0
20.0	17.0	17.5	17.5
25.0	16.0	17.0	17.0
31.25	15.1	16.5	16.5
62.5	12.1	14.0	14.0
100.0	10.0	12.0	12.0
200.0	-	9.0	9.0
250.0	-	8.0	8.0
300.0	-	-	7.2
400.0	-	-	6.0
500.0	-	-	6.0

NEXT Loss

Frequency (MHz)	Cat 5e (dB)	Cat 6 (dB)	Cat 6A (dB)
1.0	60.0	65.0	65.0
4.0	53.5	63.0	63.0
8.0	48.6	58.2	58.2
10.0	47.0	56.6	56.6
16.0	43.6	53.2	53.2
20.0	42.0	51.6	51.6
25.0	40.3	50.0	50.0
31.25	38.7	48.4	48.4
62.5	33.6	43.4	43.4
100.0	30.1	39.9	39.9
200.0	-	34.8	34.8
250.0	-	33.1	33.1
300.0	-	-	31.7
400.0	-	-	28.7
500.0	-	-	26.1

Patch Cord Performance

Return Loss

Frequency (MHz)	Cat 5e (dB)	Cat 6 (dB)	Cat 6A (dB)
1.0	25.0	25.0	20.0
4.0	25.0	25.0	23.0
8.0	25.0	25.0	24.5
10.0	25.0	25.0	25.0
16.0	25.0	25.0	25.0
20.0	24.0	25.0	25.0
31.25	23.1	23.1	23.3
62.5	20.1	20.1	20.7
100.0	18.0	18.0	19.0
200.0	-	15.0	16.4
250.0	-	14.0	15.6
300.0	-	-	14.9
400.0	-	-	13.8
500.0	-	-	13.0

NEXT Loss - Category 6

Frequency (MHz)	Cord Limit (dB) 2m	5m	10m
1.0	65.0	65.0	65.0
4.0	65.0	65.0	65.0
8.0	65.0	65.0	64.8
10.0	65.0	64.5	62.9
16.0	62.0	60.5	59.0
20.0	60.1	58.6	57.2
25.0	58.1	56.8	55.4
31.25	56.2	54.9	53.6
62.5	50.4	49.2	48.1
100.0	46.4	45.3	44.4
125	44.5	43.5	42.7
150	43.0	42.1	41.4
175	41.8	40.9	40.2
200	40.6	39.8	39.3
225	39.7	38.9	38.4
250	38.8	38.1	37.6

NEXT Loss - Category 6A

Frequency (MHz)	Cord Limit (dB) 1m	2m	5m	10m
1.0	65.0	65.0	65.0	65.0
4.0	65.0	65.0	65.0	65.0
8.0	65.0	65.0	65.0	64.8
10.0	65.0	65.0	64.5	62.9
16.0	62.6	62.0	60.5	59.1
20.0	60.7	60.1	58.6	57.2
25.0	58.8	58.2	56.8	55.4
31.25	56.9	56.3	54.9	53.6
62.5	51.0	50.4	49.2	48.1
100.0	47.0	46.4	45.4	44.5
200	41.1	40.7	39.9	39.3
250	39.3	38.9	38.1	37.7
300	36.4	36.2	35.9	35.8
400	31.8	31.9	32.1	32.5
500	28.2	28.4	29.0	29.8

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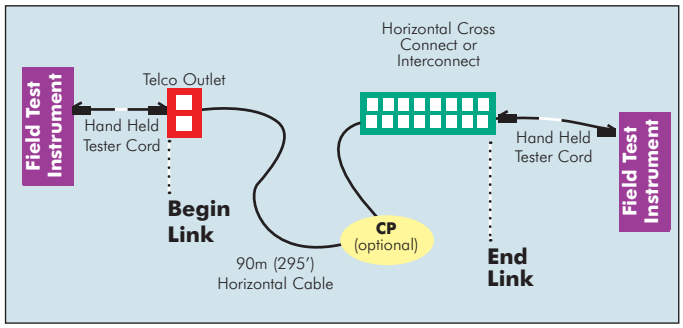
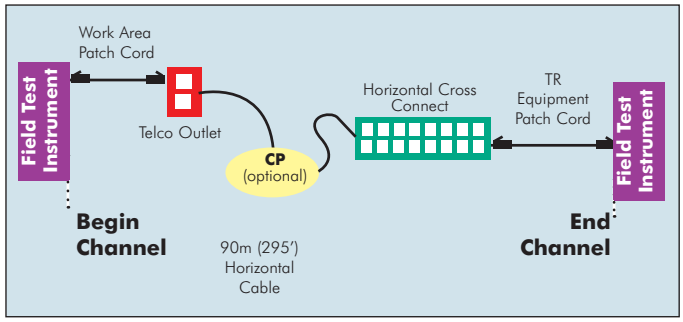
ANSI/TIA-568-C.2: UTP Permanent Link and Channel Field Testing

Permanent Link



The permanent link test configuration includes a length of horizontal cable and one connector attached to each end (see diagram). One optional consolidation point connection is also permitted. The permanent link runs from the cross-connect panel in the TR to the work station outlet. The permanent link overall length must not exceed 90m (295 ft.).

Channel



The channel test configuration includes a length of horizontal cable up to 90 meters, a work area cord, and two patch cord cross connections (see diagram). One optional consolidation point connection is also permitted in the channel. The channel overall length must not exceed 100m (328 ft.).

Hubbell Approved Field Testers for UTP and Optical Fiber Cabling

The Hubbell **MISSION CRITICAL**® warranty program recognizes the field testers and associated test adapters below. These testers function in a bidirectional mode, with automatic data acquisition and storage. All **MISSION CRITICAL**® test parameters are measured and recorded with these testers, for copper or fiber cabling.

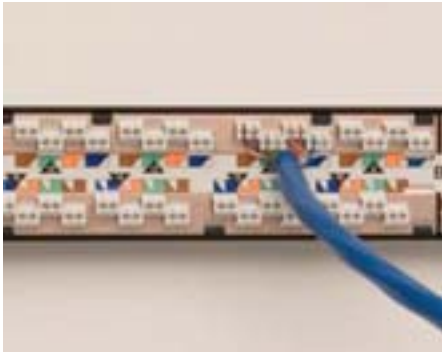
	Field Tester Model		Permanent Link Adapter	Channel Adapter	110 Block T568A Wiring	110 Block T568B Wiring	Cat 6A AXT Test Kit
	Fluke DTX Series 1800 and 1200	Cat 5e/ Cat 6	DTX-PLA001 w/DSP-PM06	DTX-CHA001	DTX-PLA001 w/DSP-PM13A	DTX-PLA001 w/DSP-PM13B	PLA002
		Cat 6A	DTX-PLA0025	DTXCHAOO1AS	N/A	N/A	DTX-10GKIT
	Fluke DSP Series 4000, 4100 and 4300	Cat 5e/ Cat 6A	DSP-LIA101S w/DSP-PM06	DSP-LIA012S	DSP-PM13A	DSP-PM13B	
		Cat 6A	N/A	N/A	N/A	N/A	N/A
	Fluke OMNIScanner and OMNIScanner 2	Cat 5e/ Cat 6	OMNI-LIA101S w/DSP-PM06	8262-42	OMNI-LIA101S w/DSP-PM13A	OMNI-LIA101S w/DSP-PM13B	
		Cat 6A	N/A	N/A	N/A	N/A	N/A
	Agilent Wirescope 350 and FrameScope 350	Cat 5e/ Cat 6	N2604A-101	N2604A-100	N2604A-065	N2604A-066	
	Wirescope Pro	Cat 6A	N2644A-101	N2644A-100	N/A	N/A	N2648A-100
	Ideal Lantek 6 and Lantek 7	Cat 5e/ Cat 6	HPW PCX6Patch Cord	0012-00-0629	1019-00-1112 (Kit)	1019-00-1112 (Kit)	
	Lantek 6A-7G	Cat 6A	HPW PS6 Series atch Cord	Supplied in unit	N/A	N/A	LANTEK 10GBKIT

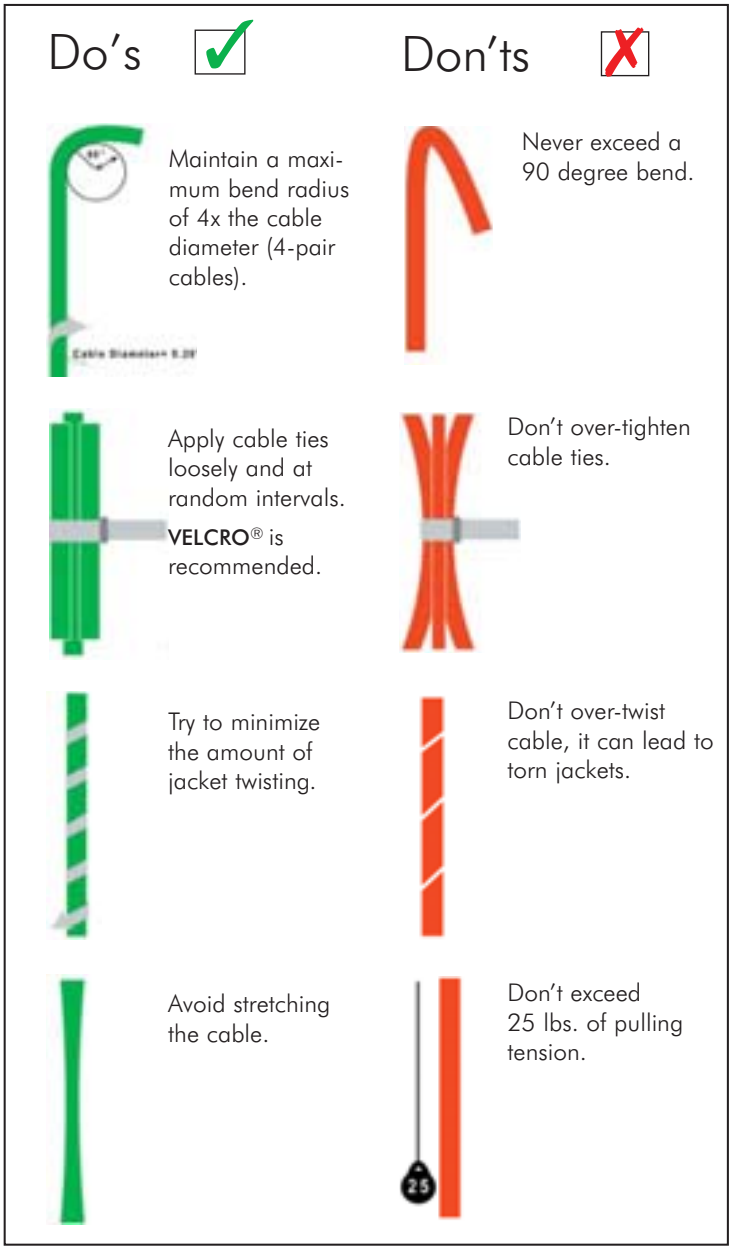
Recommended UTP Installation Practices

- Use the proper strip tool for the cable jacket. Don't cut into the conductor pairs.
- For best results, use the zip cord and peel away the cable jacket.
- Position the stripped cable jacket as close as possible to the termination point to minimize exposure of the twisted pairs.
- Maintain the natural twist of all conductor pairs as close as possible to the termination point. For Category 5e and 6 wiring, the maximum length of untwisted pairs is 0.5". Minimum untwisting optimizes Return Loss performance.
- Never uncoil UTP cable from a stationary spool. Permanent kinks will result from straightening, and NEXT failures may occur. Unwind the cable by rotating the spool with steady speed and tension. Also avoid scraping and kinking when feeding into conduit or raceway.
- Store cable slack for wall outlets above the ceiling for future re-termination.
- Use proper supports and spacing to minimize sag in horizontal runs. Long runs should use cable trays. Do not overload cable supports and trays.
- Don't exceed 40% cable fill ratio in any pathway.
- Avoid EMI by maximizing the separation distance from high voltage circuits, transformers, motors, etc. For shared pathways, use partitioned raceway with 2" minimum separation from power wiring.
- Do not run UTP cables over heater ducts or hot water ducts. High temperatures will degrade performance and deteriorate the cable jacket.
- Centralize TR's to equalize the horizontal cable runs on each floor. Maximum horizontal distance is 90 meters. Very short horizontal runs can increase NEXT.
- Never use staples to position cables.
- Use good cable management practices to maintain proper bend radius.
- For Category 6 cabling, store service loops in a figure "8" pattern to minimize cross-talk and EMI noise pick-up.
- All grounding and bonding shall be according to J-STD-607-A.

Category 6A Installation Practices

- Refer to Hubbell 10GbE Cabling Guidelines.
- NOTE: Larger cable diameters will have an impact on design, pathway fill capacity, and cable deployment.





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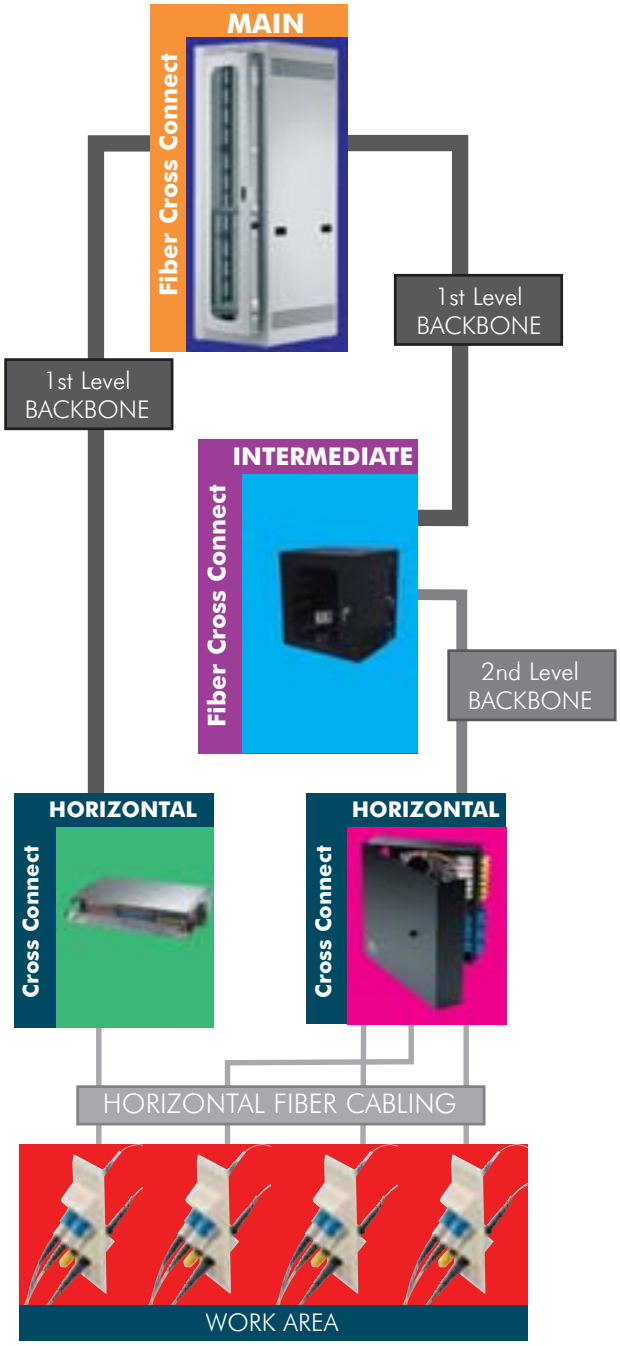
ANSI/TIA-568-C.0 and C.3: Optical Fiber Cabling and Components

Optical Fiber Cable Transmission Performance Parameters

Optical fiber cable type	Wavelength (nm)	Max. Attenuation (dB/km)	Bandwidth (MHz-Km)
50/125µm Multimode	850	3.5	500
	1300	1.5	500
50/125µm Laser Optimized	850	3.5	2000
	1300	1.5	500
62.5/125µm Multimode	850	3.5	160
	1300	1.5	500
Singlemode Inside Plant	1310	1	N/A
	1550	1	N/A
Singlemode Outside Plant	1310	0.5	N/A
	1550	0.5	N/A

Backbone and Horizontal Fiber Cabling Structure



This standard incorporates optical, mechanical, and environmental performance requirements for installed fiber optic cables and connectors.

- The optical fiber cable construction shall consist of 50/125µm, 62.5/125µm multimode fibers, or 9/125µm singlemode optical fibers.
- Installed optical fiber cabling and connection hardware shall meet the requirements of ANSI/TIA-568-C.3, and applicable sections of ANSI/TIA-568-C.1.

Performance Specifications for Multimode and Singlemode Fiber Optic Connectors

- Maximum insertion loss is 0.75dB for mated pair connectors of all types. Maximum splice loss is 0.3dB.
- Maximum return loss is 20dB for multimode and 26dB for singlemode fiber.
- All fiber links are tested individually.

Minimum Bend Radius and Maximum Pulling Tension

- 2 and 4 fiber cables for horizontal cabling shall not exceed a minimum of 25mm (1") bend radius with no applied load.
- 2 and 4 fiber cables for horizontal cabling shall not exceed a minimum of 50mm (2") bend radius with a maximum applied load of 222N (50Lbf).
- All other indoor fiber cables shall not exceed a minimum bend radius of 10 times the cable outside diameter (O.D.) with no applied load, and 15 times the cable O.D. with the rated load applied.
- Outside plant fiber cables shall not exceed a minimum bend radius of 10 times the cable O.D. with no applied load, and 20 times the cable O.D. with the rated load applied.
- Outside plant cables shall have a minimum pull strength of 2670N (600Lbf).
- Drop cables shall have a minimum pull strength of 1335N (300 Lbf).
- Workstation (patch cord) cables shall have a minimum pull strength of 50N (11Lbf).

568SC Standard Fiber Connector

- Most widely recognized connector for multimode and singlemode applications.
- Each channel in a duplex SC interconnect are referred to as Position 'A' and Position 'B'.
- A 62.5/125 multimode SC connector housing or adapter shall be beige.
- A 50/125 multimode SC connector housing or adapter shall all be aqua.
- A singlemode SC connector or adapter shall be blue.

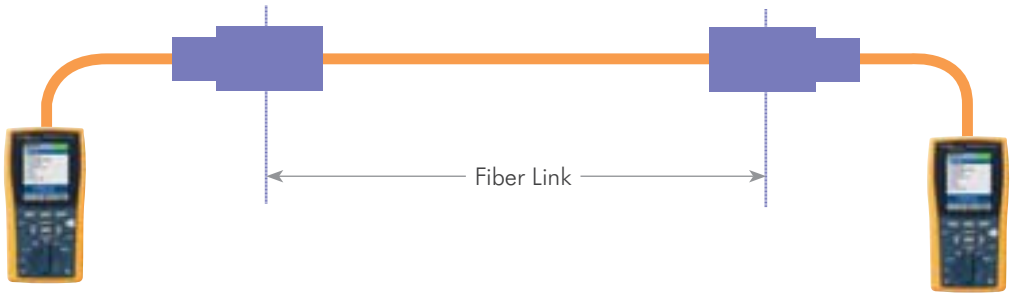
Small Form Factor Connectors (SFF)

- Approved for use in main cross connects, horizontal and backbone cabling, consolidation points, and the work area. Use for high-density applications.
- SFF connector type 'LC' is recommended most.

ANSI/TIA-568-C.0 and C.3: Optical Fiber Cabling and Components

Fiber Link Testing

An optical fiber link test configuration includes a length of passive horizontal or backbone cable with a connector attached to each end. Consolidation point connections are permitted within the system loss budget. Each individual link segment in a fiber backbone or horizontal run must be tested. The total link insertion loss is the sum of the individual link segment losses.



NOTE: Advanced testers will measure insertion loss in both directions at multiple wavelengths through (2) channels.

Recommended Optical Fiber Installation Practices

Cable Runs

- Use inner duct through conduit and sleeves to protect cables from abrasion.
- Conduit fill rules apply: 40% maximum fill and no more than (2) 90° bends in a single run. A 50% conduit fill is permitted for a single cable.
- Maintain proper bend radius in all locations. Use a bend radius drum for strain relief and support.
- Vertical cables must be supported by the internal strength member.
- Do not use clamps or staples to support cables.
- Use the proper pulling method, and do not exceed the cable tensile load rating. Consult the cable manufacturer.

Stripping and Cable Prep

- Use the proper cable strip tools to avoid damage to fibers.
- Use the ripcord to remove cable jacket.
- Never use a utility knife for scoring the cable or sheath.
- Establish all break-out locations before connectorization.

Connectorization

- Use recognized methods, such as epoxy, anaerobic, crimp, or pre-polish type.
- Terminate and test in small batches.
- Relieve all cable weight from the installed connectors.
- Always clean and inspect connector end face before mating into the adapter.
- Check several channels with an OTDR to verify cable installation is free of micro-bends.

Service Loops

- Leave several large coils of main run cable at each end of the run.
- Leave approximately 2-3 meters of buffered fiber coiled in fiber enclosures.
- Leave 1 meter of buffered fiber coiled behind wall outlets.

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ANSI/TIA-568-C.2: Category 6A UTP Cabling

Augmented Category 6, or Category 6A unshielded twisted pair (UTP) cable is designed to support 10GBASE-T (10 Gigabit Ethernet) transmission in accordance with IEEE802.3an requirements. IEEE802.3an was officially ratified in June 2006. The 568B.2-10 standard for Category 6A was officially ratified in February 2008.

- Category 6A permanent link and channel performance are defined to 500 MHz.
- Alien Cross Talk (AXT) parameters are defined to 500 MHz.
- AXT is a measure of signal coupling from energized pairs in a disturber cable or component into disturbed pairs within surrounding cables or components.
- Category 6A AXT parameters are summarized below (see Glossary also):
  - ANEXT (Alien Near End Crosstalk).
  - PSANEXT (Power Sum Alien Near-End Crosstalk).
  - AACRF (Attenuation to Alien Crosstalk Ratio, Far End). NOTE: Previously referred to as AFEXT.
  - PSAACRF (Power Sum Attenuation to Alien Crosstalk ratio, Far-End). NOTE: Previously referred to as PSAFEXT.

To mitigate the effects of AXT, the cable design shall meet the “worst case” 6-around-1 AXT requirements as shown below. Larger wire size, tighter twisting and thicker cable jacket are key design parameters. As a result, the cable diameter is larger, and will have an impact on installation practices. Refer to Hubbell’s “10 GbE Cabling Guidelines for more details.

- Field-testing of AXT in installed links or channels is optional per 568B-2-10.
- AXT field testing equipment is identified in the table on page N13.
- Link and channel components must also be designed to mitigate AXT.

"Worst Case" 6 around 1 AXT Test Configuration.

TIA/TSB-155: Field AXT Mitigation for Installed Category 6 Cabling

Telecommunications Systems Bulletin TSB-155, released in March 2007, was developed to qualify installed Category 6 cabling for operation at 500 MHz to support 10GbE transmission. Category 6 cabling used for 10GbE applications is restricted to the performance level of the cable and the AXT environment.

- Defines field AXT test parameters for installed Category 6 cabling links.
- Establishes length restrictions for installed Category 6 cabling.
- Standard Category 6 cabling: 37 meters maximum (no testing).
- Standard Category 6 cabling: 37 to 55 meters maximum (AXT testing recommended, mitigation not likely).
- Enhanced Category 6 cabling: > 55 meters (Mitigation and AXT testing highly recommended, , mitigation expected).
- NOTE: The primary limitation with 10GbE operation is ANEXT. Individual Cat 6 links with no EMI should be able to support 10GbE up to 100m. Multiple links in parallel become a concern with ANEXT.

The mitigation procedure suggested by TSB-155 is outlined below. Each mitigation step requires field AXT testing to 500 MHz for verification.

- Unbundle cables and patch cords.
- Substitute ScTP patch cords and equipment cords.
- Substitute Category 6A jacks.
- Substitute Category 6A panels.

ANSI/TIA-569-B: Telecommunications Pathways and Spaces

The applications below are supported by this standard. The 569B standard incorporates all previous addenda to the 569A version.

569B: Surface (Perimeter) Raceway Systems

- May contain work area outlets at desired locations.
- Include the base channel, cover, fittings and outlet accessories.
- May be either single channel or multi-channel with dividers.
- Are designed to maintain 25mm (1 in.) minimum cable bend radius.
- Can be installed as baseboard, chair rail, or ceiling runs with vertical feeders.
- Support single or multiple room distribution.
- Should be sized at 40% max cable fill to accommodate future expansion.

NOTE: Metallic raceway systems shall be properly bonded to ground per J-STD-607-A.
Never combine power and data cabling within a single raceway channel.

569B: Furniture Pathways and Spaces

- Separation requirements apply for power and data cabling.
- Furniture pathways shall have a minimum cross section area of 9.5 cm^2 (1.5 in^2).
- This specification is based on a work area cluster serving four persons with three outlet connections each.

NOTE: The usable cross sectional area may be reduced by bend radius limits of the installed cables.

569B: Access Floor Pathways and Spaces

- Standard access floors shall have a minimum of 150mm (6in.) finished floor height.
- A floor height of 200mm (8in.) is the recommended clearance for cable trays.
- The free space above any cable tray or raceway under an access floor must allow for easy removal of covers.
- Connecting hardware is prohibited below the access floor, however a consolidation point is permitted as an exception.
- Locate penetration points and floor outlets away from office traffic.
- All standards apply for separation of power and data cables.

569B: Poke-Thru Fittings

- A poke-thru device is used for penetration of building cabling through above-grade structural floors. Typically available in flush or raised configurations.
- Maintain fire rating of the floor after installation.
- Provide power and/or data service ports in limited capacity.

NOTE: Contact a Structural Engineer before penetrating load-bearing floors

Hubbell SystemOne AV FRPT

Large Capacity, FRPT

Flush, FRPT

569B: In-Floor Systems

- Typically specifies embedded ducting in concrete or cellular floor configurations.
- Design of these systems applies to new building constructions.

569B: Multi-Tenant Pathways and Spaces

- Specifies common equipment and telecommunications rooms.
- Also includes provisions for shared access and service provider spaces.

569B: Cable Trays and Wireways

- Describes various pre-fabricated structures for supporting and routing cables.

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ANSI/TIA-570-B: Residential Telecommunications Cabling Standard

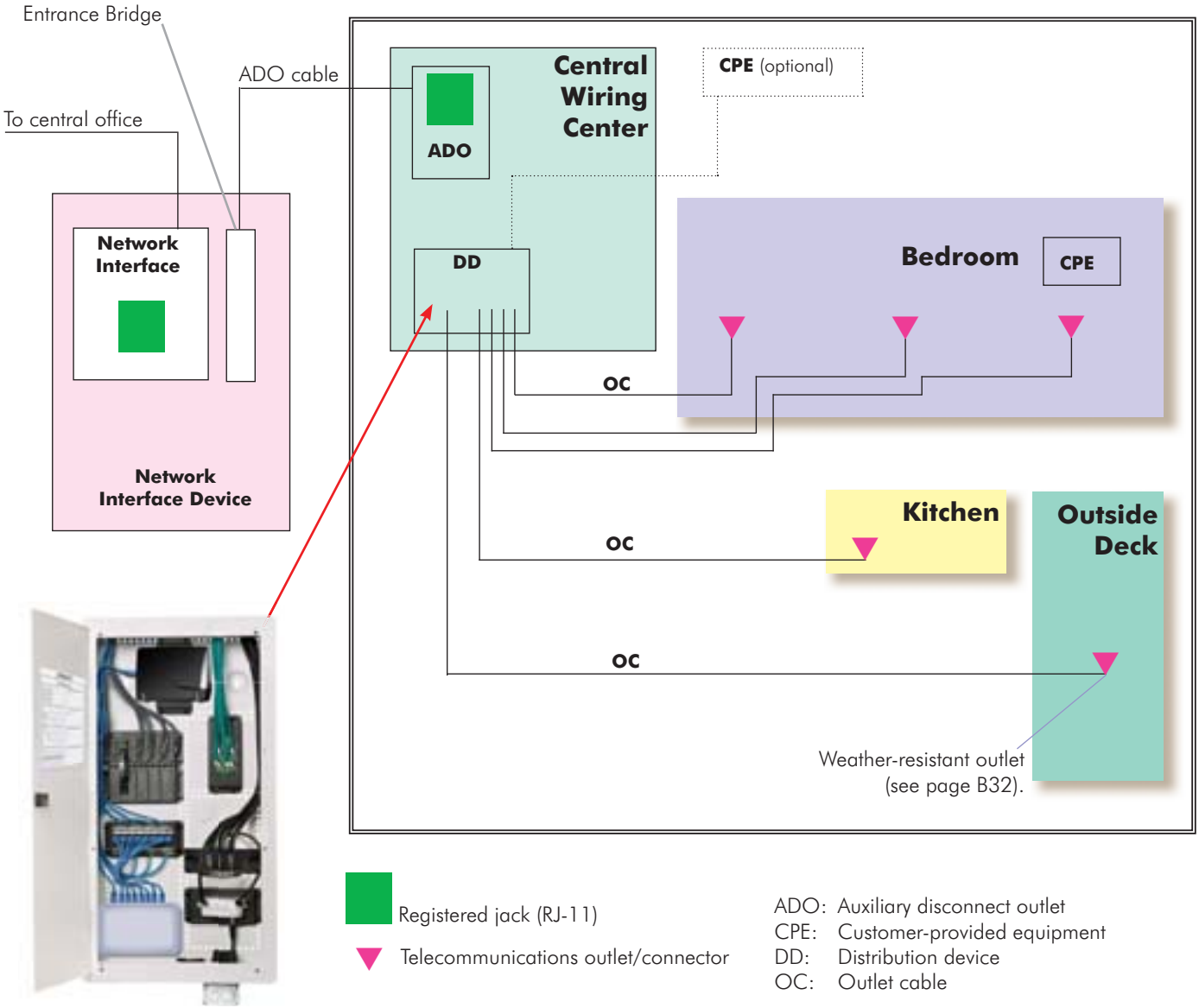
This standard specifies cabling infrastructure for distribution of telecommunications services in single or multi-tenant dwellings. Residential cabling begins at the interface with the Access Provider, known as the Demarcation Point. The in-house cable distribution follows a star topology. Cabling for audio, security, and home controls have been added to this standard in the addenda listed below.

There are two grades of Residential Cabling:

- Grade 1: Minimum Requirement.
  - One 4-pair UTP Category 3 minimum cable and connecting hardware.
  - One 75Ω series 6 coaxial cable and connecting hardware.
- Grade 2: Advanced Multimedia (Recommended).
  - Two 4-pair UTP Category 5e minimum cable and connecting hardware.
  - Two 75Ω coaxial cables and connecting hardware.
  - One pair of cabled multimode optical fibers (optional).

ANSI/TIA-570-A Addenda

- 570A-1: "Security Cabling for Residences".
- 570A-2: "Control Cabling for Residences".
- 570A-3: "Whole Home Audio Cabling for Residences".



Registered jack (RJ-11)

Telecommunications outlet/connector

ADO: Auxiliary disconnect outlet
CPE: Customer-provided equipment
DD: Distribution device
OC: Outlet cable

ANSI/TIA-606-B: Administration Standard for Commercial Telecommunications Infrastructure

This standard establishes basic guidelines for identification, labeling, and record keeping. These practices are essential for continued operation and maintenance of a cabled network. The advantages of identifying and documenting all elements of the cabling infrastructure are:

- Improved traceability of the network connections, paths, and locations.
- Moves, adds and changes (MAC's) are easily implemented.
- Maintenance and troubleshooting is simplified.

Key Elements of the Network that Require Identifier Labels and Records:

- Connecting hardware and splices.
- Cables.
- Telecommunications pathways (conduit, firestops, etc.).
- Telecommunications spaces (EF, ER, TR, WA).
- Grounding and bonding locations (TMGB, TGB, TBB).
- Equipment.
- Building.
- Outside plant (OSP) cables and pathways.

Four Classes of System Administration:

- Class 1: Single Building, 1 TR.
- Class 2: Single Building, multiple TR's.
- Class 3: Campus with OSP.
- Class 4: Multi-Campus/Multi OSP.

Requirements for Identifiers

- Identifiers should have a logical alphanumeric code.
- The code number should link to detailed permanent records.
- Standard 606-B color codes should be used for all cross-connect fields.

Requirements for Records

- Drawings and documents must be backed-up and secured by the building administration.
- Moves, add's and changes (MAC's) must be documented with a change order.
- MAC's must be updated in the permanent records.
- All identifier information must be cross-referenced in the permanent records.

Requirements for Labels

- All labels must use a traceable, permanent identifier.
- Each cable and pathway must be labeled on both ends.
- All labels shall meet UL969 legibility, defacement and adhesion requirements.
- Station connections may be labeled on the face plate.
- All jack, connector and block hardware can be labeled on the outlet or panel.

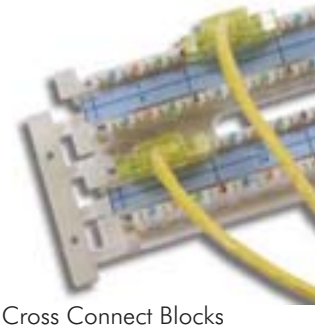
606-B Color Coding

Orange	Demarcation point (Pantone 150C) - Central Office
Green	Network connections on customer's side (Pantone 353C)
Purple	Common equipment (Pantone 246C) - PVBX, LANs
White	1st level backbone - Main to Intermediate
Gray	2nd level backbone (Pantone 422C) - Intermediate to Telecom
Blue	Horizontal cabling (closet end only) (Pantone 291C) - Work Area
Brown	Inter-building backbone (Pantone 465C)- Campus Environment
Yellow	Auxiliary circuits (Pantone 101C) - Alarm, Security, etc.
Red	Key telephone systems (Pantone 184C)


Patch Cords


Patch Panels


Fiber Panels


Cross Connect Blocks

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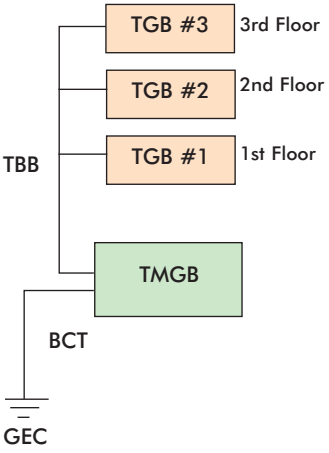
J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications

Grounding Bar
Cat No. **MCCGBAR**

This standard specifies grounding and bonding design and distribution methods for commercial buildings. Proper earth grounding of the building structure and wiring is a requirement of the National Electric Code (NEC). Bonding all electrical and telecommunications equipment to the primary grounding electrode conductor (GEC) is essential for maximizing performance and safety. *Bonding to water pipes is now a code violation.

Bonding telecommunications equipment, facilities, and cabling to the primary grounding electrode is accomplished using the following major elements:



- Grounding Electrode Conductor (GEC).
- Bonding Conductor (BC).
- Telecommunications Main Grounding Busbar (TMGB).
- Telecommunications Bonding Backbone (TBB).
- Telecommunications Grounding Busbar (TGB).

J-STD-607-A specifies the TMGB and TGB as a pre-drilled solid copper bar that extends the GEC for connecting the TBB. The TBB is typically a 6AWG stranded copper conductor that joins the copper TGB's on each floor of the building. A TGB is located in every TR and ER in the building. J-STD-607A also recommends surge protection devices for active telecommunications equipment.

* The GEC is the largest grounding conductor and extends into the earth to a specified depth.

- The TBB should be continuous with no splices.
- Connections to the TBB must use listed compression fittings.

ANSI/TIA-862: Building Automation Systems Cabling Standard for Commercial Buildings

This standard establishes guidelines for structured cabling of low-voltage building automation systems (BAS). BAS wiring and control systems are converging with telecommunications infrastructures. NEC allows power-limited BAS systems to share the pathways and spaces with telecommunications infrastructure. LAN cabling is therefore not limited to voice and data transmission, and BAS applications present a new opportunity. Converging BAS with telecommunications are driving new industry standards. Designers must consider BAS cabling when sizing pathways and spaces in a building.

The key advantages of converging BAS and Telecom cabling are:

- Project responsibility is reduced to a single team.
- The building design and system administration is simplified.
- Consolidation of service, equipment, and cabling facilities is achieved.
- Common pathways and bonding points create a centralized infrastructure.
- Cabling installation and practices of ANSI/TIA-568-C can be utilized.

Basic Cabling Requirements for BAS:

- The horizontal cabling, installation, and BAS outlet connector shall meet ANSI/TIA-568-C.1.
- A distributed or centralized star topology should be used.
- Recognized cables for BAS horizontal and backbone:
  - 100 Ohm balanced UTP cable (ANSI/TIA-568-C.2).
  - Multimode or singlemode optical fiber (ANSI/TIA-568-C.3).
- The BAS outlet may be connected from an HC or an optional CP.
- Shared pathways of BAS/Telecom cables must be code and capacity compliant.
- For use with balanced UTP cable, the BAS device operating voltage and current are limited per ANSI/TIA-862, Annex 'A'.
- Separation of services is recommended in ANSI/TIA-862, Annex 'B'.
  - Shared cable sheath of BAS and telecommunications wiring is not recommended.

ANSI/TIA-942: Telecommunications Infrastructure Standards for Data Centers

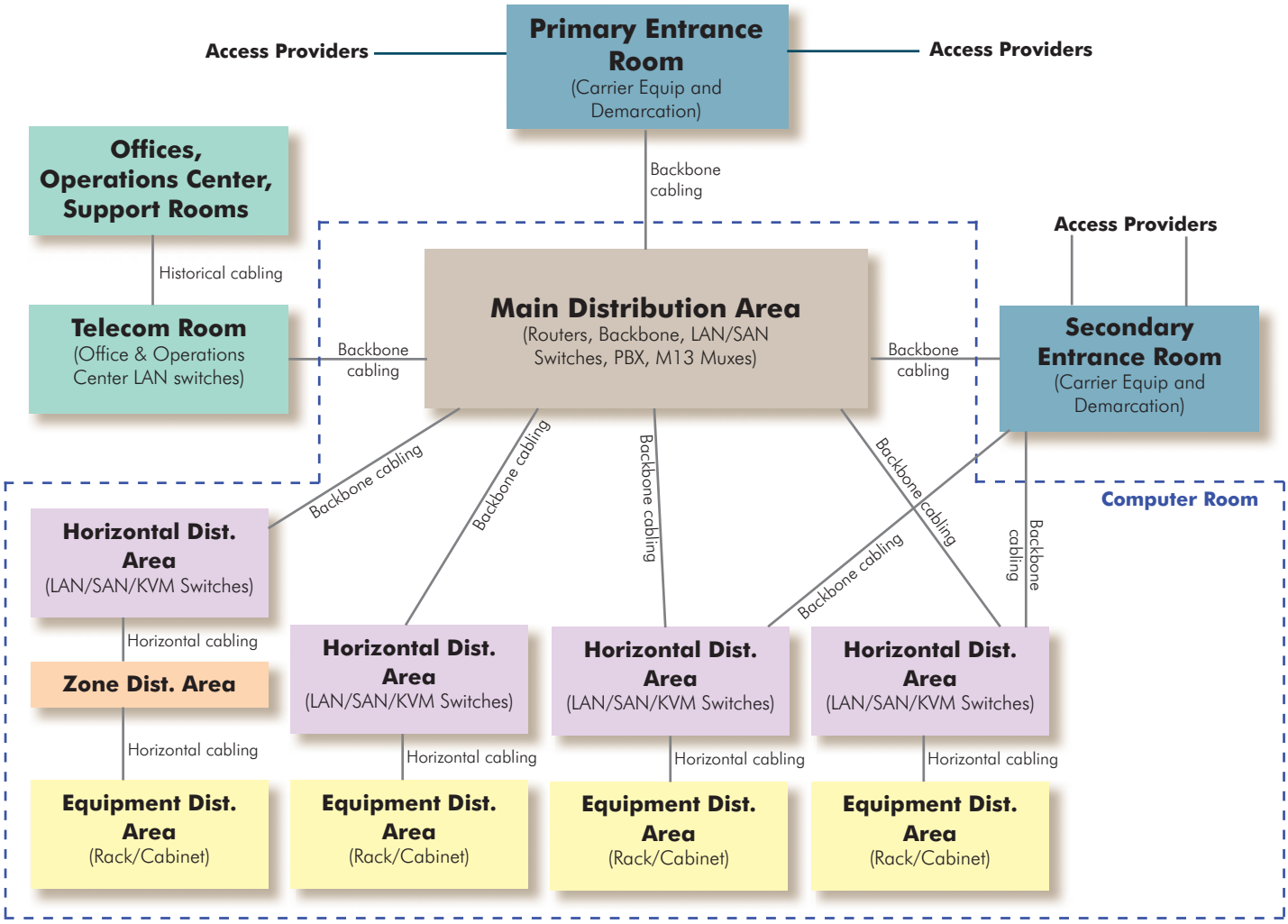
TIA-942 defines a data center as a building or portion of a building dedicated to housing large scale computer rooms and support facilities. Data centers are highly protected facilities that typically serve large private institutions or public service providers. Engineering design considerations for data centers include: architectural layout, space allocation, power, cooling, security, floor loading, telecommunications cabling distribution, and disaster avoidance/recovery.

Data centers have a high level of fault tolerance, with (4) tiers of redundancy for all critical systems and support functions. Higher tiers are inclusive of lower tiers of redundancy, and provide increased levels of protection from service interruptions caused by specific events, such as fire or earthquakes. A Tier 4 facility provides maximum service availability, and is also the most costly construction.

A typical Data Center includes:

- Entrance Room (ER).
- Telecommunications Room(s) (TR).
- Main Distribution Area (MDA).
- Horizontal Distribution Areas.
- Equipment Distribution Area (EDA).

A schematic layout of a data center is illustrated below.



ANSI/TIA-942 Addenda

- ANSI/TIA-942-1: "Data Center Coaxial Cabling Specifications and Application Distances".
- ANSI/TIA-942-2: "Additional Media and Guidelines for Data Centers".

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ANSI/TIA-1005: Industrial Telecommunication Infrastructure

The official standard is developed by the TIA/TR-4.9 Industrial Telecommunications Infrastructure Subcommittee. This standard defines the requirements for cabling, connectors, pathways, and spaces designed to operate in harsh environments.

For the Industrial Ethernet application, the basic performance and reliability sections of ANSI/TIA-568-C apply. Additional requirements are being defined in TIA-1005 to incorporate harsh environments.

TR-42.9 has established four conditions (MICE) that define the industrial environment:

- Mechanical (shock, vibration, impact, etc.).
- Ingress (contamination influx).
- Climate (temperature, humidity, UV exposure, etc.).
- Electromagnetic (conducted and radiated interference).

Industrial Ethernet components are rated to withstand these conditions under specific levels of severity. The level of severity is determined by the application.

Ingress Protection (IP) codes are a two-digit code with the following criteria:

- First Digit: degree of protection from human contact with hazardous elements inside an enclosure, or from influx of foreign matter.
- Second Digit: degree of protection of equipment inside enclosures from the influx of water.

Example: **IP67 (6 = first digit, 7 = second digit)**
The higher the number, the higher the degree of protection from human contact and influx of water.

HARSH-e

Hubbell Application Rating System for Harsh Environments

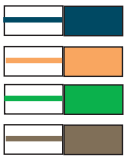
	e3 Application Severe	e2 Application Harsh	e1 Application Tough
Dust	Enclosures: **NEMA 4X** Connectors: **IP67** and **IP66** Totally protected against dust (Dust-tight)	Enclosures: **NEMA 4/12/13** Connectors: **IP67** and **IP66** Protected against dust, Objects greater than 1 mm	Enclosures: **NEMA 3R** Connectors: **IP43** Objects greater than 1 mm i.e., tools, wires, small wires
Water	Enclosures: **NEMA 4X** Connectors: **IP67** and **IP66** Immersion and strong pressure jets	Enclosures: **NEMA 4/12/13** Connectors: **IP67** and **IP66** Protected against strong and low pressure jets	Enclosures: **NEMA 3R** Connectors: **IP43** Protected against sprays of water to 60° from vertical
Corrosion	Enclosures: **NEMA 4X** Stainless Steel: Dust, water and corrosive liquids Connectors: PBT Common oils, chemicals and cleaning agents	Enclosures: **NEMA 4/12/13** Ice, dust, water, non-corrosive liquids Connectors: PBT Common oils	Enclosures: **NEMA 3R** Falling rain, sleet Connectors: N/A
Impact	Enclosures: 14 ga., 304 SS Connector Housing: PBT	Enclosures: 14 ga., steel Connector Housing: PBT	Enclosures: 14 ga., steel Connectors: Thermoplastic
Tamper	Enclosures: Protected, secured and locked	Enclosures: Protected, and optional locked	Enclosures: Protected, but not secured
Temperature	TIA-568-C.2 TIA/TR 42.9 pending	TIA-568-C.2	TIA-568-C.2
Vibration	TIA/TR 42.9 10-500Hz 5g Acceleration	TIA/TR 42.9 10-500Hz 2g Acceleration	TIA/TR 42.9 10-500Hz 0.7g Acceleration
Ultra-Violet	Protected	Protected	Not Protected

Standard UTP Wiring Conventions

Horizontal UTP Cable and Patch Cords

- Solid copper 4-pair 24 AWG UTP is specified for distribution cabling. Stranded UTP is specified for patch cords for flexibility. Shielded cable is not commonly used in the U.S. Splices bridge taps are not permitted.
- Cable, connectors and patch cords shall be marked with the performance category. Always match performance categories of cables and components throughout the infrastructure.
- All cable, cords and connecting hardware shall meet performance requirements of ANSI/TIA-568-C.2. Hubbell assures this compliance with all products and cable partners.

COLOR CODING:



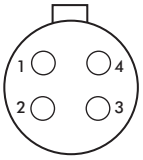
white-blue/blue
white-orange/orange
white-green/green
white-brown/brown

Backbone UTP Cable

- Solid copper 4-pair and 25-pair UTP is specified. An overall shield is optional.
- Performance category markings and compliance to ANSI/TIA-568-C.1 and 568-C.2 is required.
- Circuits with incompatible signals should be partitioned in separate binder groups. Prior to making shared sheath circuit assignments, consult the equipment manufacturer for signal characteristics (i.e., frequency, amplitude, voltage, etc.).
- Tip conductor insulation colors are matched to the binder group. Ring conductor insulation colors correspond the pair.

Recognized Connector and Wiring Configurations

- 8-position modular jack/plug.
- 8-position modular panel/plug.
- T568A wiring or T568B wiring options.
- Cat 5e, Cat 6 or Cat 6A recommended.
- Type M4 - 4-pin recognized for industrial automation.



Type M4
(Male)

RJ-45 ANSI/TIA-568 Wiring Conventions

Two wiring standards were adopted. Both configurations are based on maximum transmission performance.

T568A
1: Green/White
2: Green
3: Orange/White
4: Blue
5: Blue/White
6: Orange
7: Brown/White
8: Brown

- Preferred method.
- Directly compatible with 2-pair voice and Token Ring systems utilizing 6-position connectors.

T568B
1: Orange/White
2: Orange
3: Green/White
4: Blue
5: Blue/White
6: Green
7: Brown/White
8: Brown

- Optional method.
- AT&T's standard.
- Directly compatible with AT&T phone systems.

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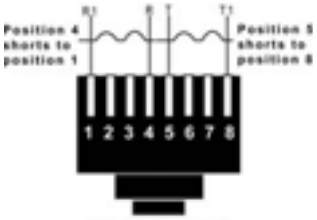
Standard UTP Wiring Conventions

USOC Conventions

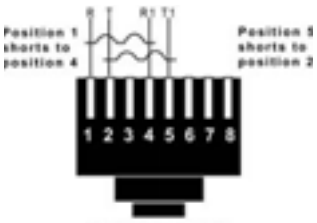
Universal Service Ordering Codes (USOC) are a series of Registered Jack (RJ) wiring configurations developed by the Bell System for connection of customer premises equipment to the network. FCC regulations govern these configurations.

USOC RJ61

USOC RJ25



USOC RJ31X

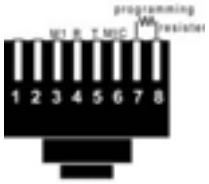


USOC RJ48X

USOC RJ14

USOC RJ11

USOC RJ48S



USOC RJ45S

Color Coding

TIP		RING	
Pair 1	T1 - White/Blue	Pair 1	R1 - Blue
Pair 2	T2 - White/Orange	Pair 2	R2 - Orange
Pair 3	T3 - White/Green	Pair 3	R3 - Green
Pair 4	T4 - White/Brown	Pair 4	R4 - Brown

LAN Wiring Conventions

Local Area Network standards designed to operate over UTP specify pin/pair assignments on modular connectors for various signal transmission protocols. While ANSI/TIA-568A and 568B conventions support all these designations, there are some cases where the user chooses to cable only the number of pairs required to support these applications.

10/100BASE-T

- 10 Mbps Ethernet over UTP.
- Uses only two pairs.
- 100 Mbps Ethernet.

Token Ring

- 4/16 Mbps Token Ring over copper.
- Uses only two pairs.

TP-PMD

- 100 Mbps FDDI over copper.
- Uses only two pairs.

1000BASE-T (TS68A)

- 1000 Mbps Ethernet over UTP.
- Uses all four pairs.

Standard UTP Wiring Conventions

Block Wiring

Standard color codes for 25-Pair UTP cable are specified in the chart below.

Wire/Color Code	Tip and Ring	Pair Number	50 Pin Positions	66 or 110 Block Positions
white/blue blue/white	Tip 1 Ring 1	Pair 1	26 1	1 2
white/orange orange/white	Tip 2 Ring 2	Pair 2	27 2	3 4
white/green green/white	Tip 3 Ring 3	Pair 3	28 3	5 6
white/brown brown/white	Tip 4 Ring 4	Pair 4	29 4	7 8
white/slate slate/white	Tip 5 Ring 5	Pair 5	30 5	9 10
red/blue blue/red	Tip 6 Ring 6	Pair 6	31 6	11 12
red/orange orange/red	Tip 7 Ring 7	Pair 7	32 7	13 14
red/green green/red	Tip 8 Ring 8	Pair 8	33 8	15 16
red/brown brown/red	Tip 9 Ring 9	Pair 9	34 9	17 18
red/slate slate/red	Tip 10 Ring 10	Pair 10	35 10	19 20
black/blue blue/black	Tip 11 Ring 11	Pair 11	36 11	21 22
black/orange orange/black	Tip 12 Ring 12	Pair 12	37 12	23 24
black/green green/black	Tip 13 Ring 13	Pair 13	38 13	25 26
black/brown brown/black	Tip 14 Ring 14	Pair 14	39 14	27 28
black/slate slate/black	Tip 15 Ring 15	Pair 15	40 15	29 30
yellow/blue blue/yellow	Tip 16 Ring 16	Pair 16	41 16	31 32
yellow/orange orange/yellow	Tip 17 Ring 17	Pair 17	42 17	33 34
yellow/green green/yellow	Tip 18 Ring 18	Pair 18	43 18	35 36
yellow/brown brown/yellow	Tip 19 Ring 19	Pair 19	44 19	37 38
yellow/slate slate/yellow	Tip 20 Ring 20	Pair 20	45 20	39 40
violet/blue blue/violet	Tip 21 Ring 21	Pair 21	46 21	41 42
violet/orange orange/violet	Tip 22 Ring 22	Pair 22	47 22	43 44
violet/green green/violet	Tip 23 Ring 23	Pair 23	48 23	45 46
violet/brown brown/violet	Tip 24 Ring 24	Pair 24	49 24	47 48
violet/slate slate/violet	Tip 25 Ring 25	Pair 25	50 25	49 50

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Audio Video Cabling

AV signal-level cabling and connectors are an integral part of structured horizontal cabling. Low voltage AV cabling may share the same pathways and wall outlet boxes with twisted pair or fiber data cabling. However, according to NEC 2005 Article 725.56(F), Class 1 audio power cables are prohibited from sharing the same pathway with any other Class 2 or Class 3 low voltage control wiring or network cables.

Common AV Media Interface Connectors

Types of AV Cable Media

- Co-axial: RG6, RG59.
- Fire Wire.
- 15-wire: VGA/HDMI.
- 2-wire audio: 26 to 14 AWG.
- 4-pair balanced UTP or FTP.
- USB.
- HDMI.

Two Basic Forms of Audio Signal

- Analog Audio: sound waves are modulated into a continuous electrical signal.
- Digital Audio: analog audio signal is encoded into digital bits.

Two Basic Forms of Video Signal

- Composite Video (low resolution).
  - Three color components delivered by one single cable, no audio content.
  - Max resolution: 480i.
- Component Video (high resolution)
  - Red/Green/Blue (RGB) color components delivered by three separate cables, with audio content.
  - Resolution up to 1080i.

AV Cable Distance Limits and Other Considerations

Total channel distances are limited for specific applications. USB channel lengths should not exceed 5.0 meters. Fire wire channel lengths should not exceed 4.5 meters. Horizontal cabling installations should allow for proper bend radius inside outlet boxes and behind walls.

Shared pathways with other communications or low voltage cabling should be analyzed for any potential signal interference issues.

Installation Tips

- Don't exceed cable minimum bend radius when installing connectors. Contact cable manufacturer for bend radius specifications.
- Soldering: Use the proper wire and solder temperature. NOTE: A "cold solder" will cause termination failures.
- Screw terminal: Strip wire insulation to proper length. Capture all strands neatly during insertion.

HPW Product Compatibility Chart	Port Configurations						
Product	1	2	3	4	6	9	12
iSTATION™ Module, 1U Flat	✓	✓	-	-	-	-	-
iSTATION™ Module, 1.5U Angled	✓	✓	-	-	-	-	-
iSTATION™ Module, 1.5U Recessed, Angled	✓	✓	-	-	-	-	-
IFP Plates, 1-Gang	✓	✓	✓	✓	✓	-	-
IFP Plates, 2-Gang	-	-	-	-	✓	✓	✓
Tamper-Proof Plates	-	-	-	✓	-	-	-
Stainless Steel Plates, 1-Gang	✓	✓	✓	✓	✓	-	-
Stainless Steel Plates, 2-Gang	-	-	-	-	✓	✓	✓
ISM Surface Mount Housings	✓	✓	-	✓	✓	-	✓
ISF Outlet Frames	-	✓	✓	✓	✓	-	-
Quad 106 Outlet Frames	-	✓	-	✓	-	-	-
Furniture Plates	-	✓	-	✓	-	-	-
OFPPL Multimedia Plate	-	-	-	✓	-	-	-
AMO Multimedia Housing	✓	✓	✓	✓	✓	✓	✓
UDX Jack Panels, 1U, 24-port	✓	✓	✓	✓	✓	✓	✓
UDX Jack Panels, 1U, 36-port	✓	✓	✓	✓	✓	✓	✓

International Standards

ISO/IEC 11801 2nd Edition: Information Technology - Generic Cabling for Customer Premises

The Joint Technical Committee (JTC1) of the International Organization for Standardization (ISO) and IEC released the second edition of ISO/IEC 11801 in 2002. This document is closely aligned with the ANSI/TIA-568-C series of U.S. standards. The recognized backbone and horizontal cables are identical to 568-C, with additional allowance for 120Ω ScTP voice cable, and Category 7 applications. Category 7 cable and components are fully shielded and are used primarily in Europe. Channel lengths and cable performance parameters may vary slightly between ISO/IEC and U.S, standards. Refer to the tables below for comparison.

CENELEC EN 50173: Information Technology – Generic Cabling Systems

The European Committee for Electrotechnical Standardization (CENELEC) produces standards that are also closely aligned with ANSI/TIA and ISO/IEC. British, Canadian and Australian standards also align with CENELEC and ISO/IEC. Refer to the tables below for comparison.

Supported Media - International

Designation	ANSI/TIA-568-C	ISO/IEC 11801 2nd Ed. 2002	CENELEC EN-50173-1: 2002
Category 3 (16 MHz)	Supported	Supported: Class C	Supported: Class C
120Ω Category 3 (16 MHz)	Not Supported	Supported: Class C	Supported: Class C
Category 5e (100 MHz)	Supported	Supported: Class D	Supported: Class D
Category 6 (250 MHz)	Supported	Supported: Class E	Supported: Class E
Category 6A (500 MHz)	Supported	Supported: Class EA*	Supported: Class EA*
Category 7 (600 MHz)	Not Recognized	Supported: Class F	Supported: Class F
50/125 - 62.5/125 Multimode	Supported	Supported	Supported
Singlemode Fiber	Supported	Supported	Supported
Singlemode Fiber to the Work Area	Not Supported	Supported	Supported
Work Area Outlet Configuration	4 Pairs T568A or B	4 Pairs T568A Only	4 Pairs T568A Only
Stranded Patch Cord Attenuation	120% of Horiz. Cable	150% of Horiz. Cable	150% of Horiz. Cable

Common International Standards

Common Standards	ANSI/TIA	ISO/IEC	CENELEC	Australia/New Zealand
Premise Cabling: General Requirements	568-C	11801 2nd Edition	50173	AS/NZS 3080
Pathways/Spaces	569-B	18010	50174-2	AS/NZS 3084
Residential	570-B		50173-3	AS/NZS 3086
Administration	606-B	14763-1	50174-2	AS/NZS 3085
Grounding/Bonding	J-STD-607A		50310	

* ***NOTE***: *Category 6A requirements will be incorporated into ISO/IEC 11801 and CENELEC EN-50173 after the release of the ANSI/TIA-568-C Standards Series.*

Applications Guide: Cabling Channel Solutions

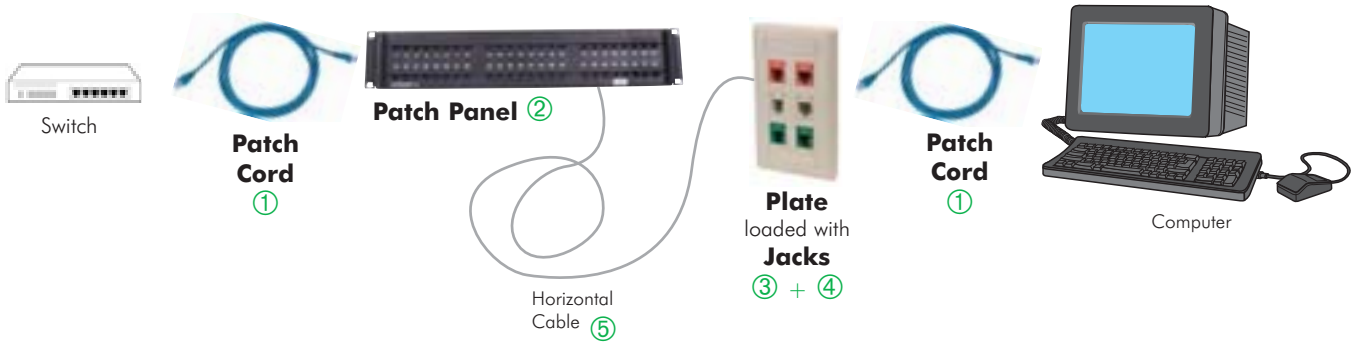
Category 5e/6/6A Solution (without Consolidation Point)

Applications Supported

- **10BASE-T**
- **100BASE-T**
- **1000BASE-T**
- **10GBASE-T**
- **ISDN**
- **Token Ring**
- **ATM 155**
- **TP PMD**
- **VoIP**

Hubbell Solutions

Product	Cat 6A Solution	Cat 6 Solution	Cat 5e Solution
① Patch Cord	PC6A Series	PCX6 Series	PCX5E Series
② Patch Panel	HP6A Series	P6E or PXJ Series	P5E Series
③ Plates	IFP or IMF Series	IFP or IMF Series	IFP or IMF Series
④ Jack(s)	HJ6A	HXJ6	HXJ5E
⑤ Cable	C6A Series	C6 Series	C5E Series



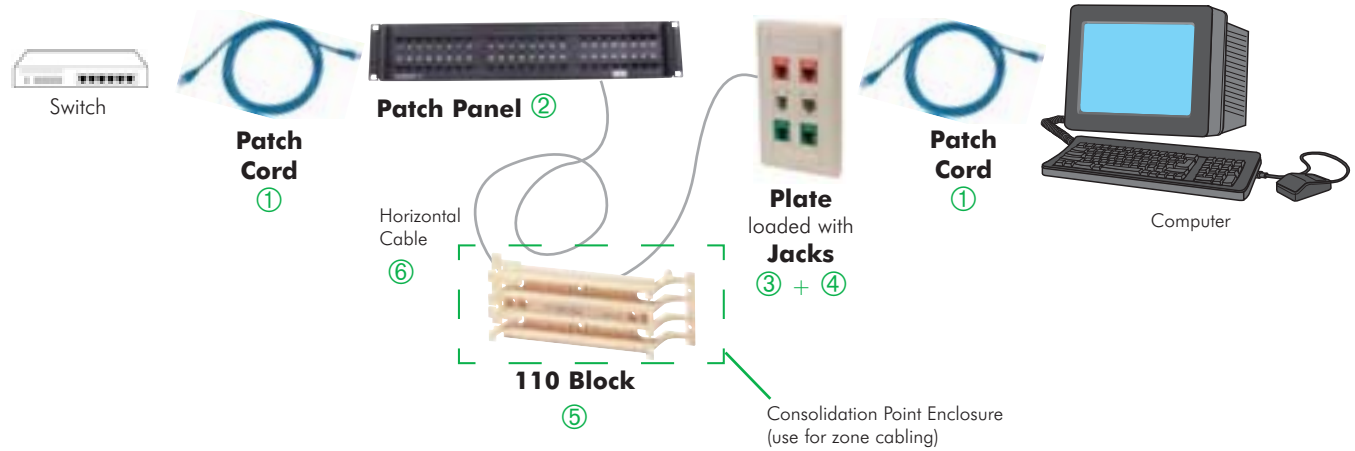
Category 5e/6 Solution (with Consolidation Point)

Applications Supported

- **10BASE-T**
- **100BASE-T**
- **1000BASE-T**
- **ISDN**
- **Token Ring**
- **ATM 155**
- **TP PMD**
- **VoIP**

Hubbell Solutions

Product	Cat 6 Solution	Cat 5e Solution
① Patch Cord	PCX6 Series	PCX5E Series
② Patch Panel	P6E or PXJ Series	P5E Series
③ Plates	IFP or IMF Series	IFP or IMF Series
④ Jack(s)	HXJ6	HXJ5E
⑤ or 110 Block	6110 Series	110BLK Series
⑥ Cable	C6 Series	C5E Series



Applications Guide: Cabling Channel Solutions

25-Pair UTP

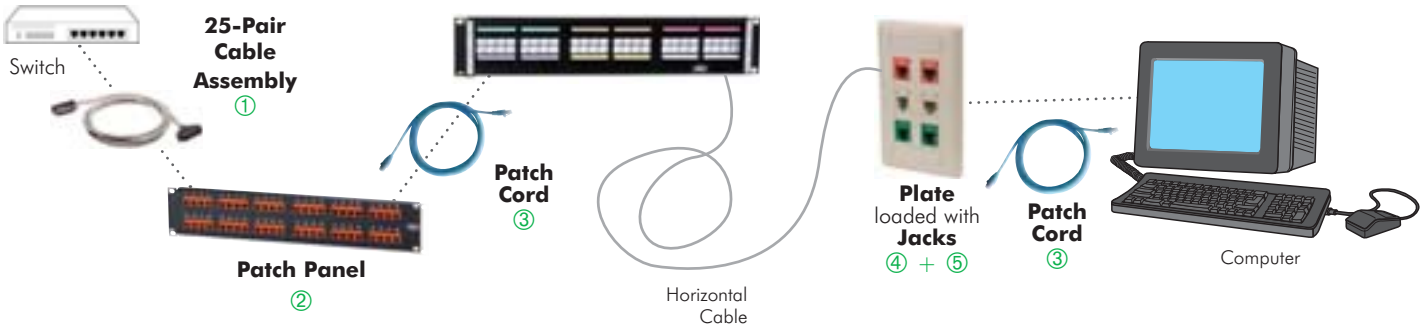
Applications Supported

- **10BASE-T**
- **100BASE-T**

Hubbell Solutions

Product		100BASE-T	10BASE-T
①	25-Pair Cable Assembly	525PS Series	Customer Supplied
②	Patch Panel	MCC**XX**100BT19*	
③	Patch Cord	PCX6 Series	PCX5E Series
④	Plate	IFP or IMF Series	IFP or IMF Series
⑤	Jack(s)	HXJ6 Series	HXJ5E Series

* **XX** changes with port capacity, length or style, depending on the product.



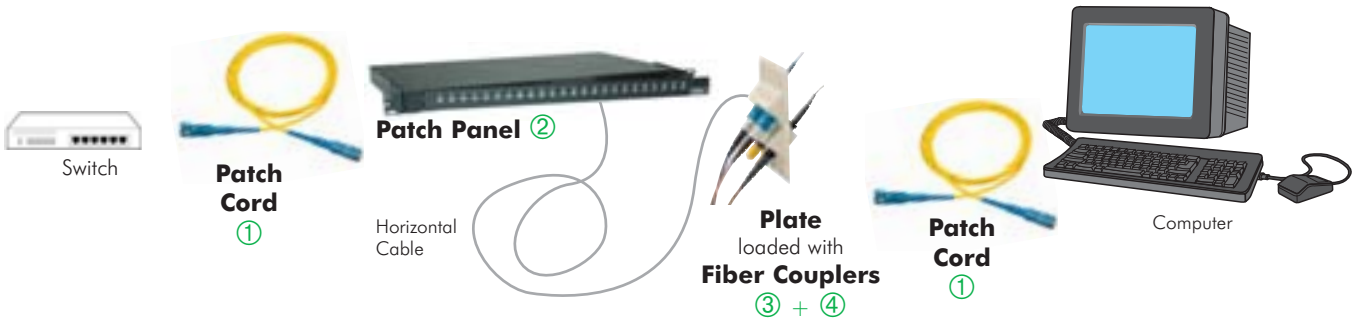
Fiber Solutions

Applications Supported

- **1000BASE-SX/LX**
- **ATM (Fiber)**
- **10GBASE-SX/LX**

Hubbell Multimode Solutions

Product		Fiber Solution
①	Patch Cord	DFPSC Series
②	Patch Panel	FPR/FCR Series
③	Plates	IFP, IMF or AFP Series
④	Fiber connector	**OPTICHANNEL**™ OR **2CLICK**® Series



Fiber Application Notes:
- *For 10GBASE-SX, use laser-optimized 50/125µm multimode cable, cords and connectors.*
- *For 10GBASE-LX, use singlemode cabling and components.*

Fiber Supportable Distances:
- *See table on page N7.*

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Glossary

10GBASE-T
IEEE 10-Gigabit Ethernet data transmission.

100BASE-T
IEEE Fast Ethernet standard baseband (single channel) data transmission at 100 Mbps over twisted pair copper wiring.

1000BASE-T
IEEE Gigabit Ethernet standard baseband (single channel) data transmission at 1000 Mbps over twisted pair wiring.

1000BASE-LX
IEEE Gigabit Ethernet standard baseband (single channel) data transmission at 1000 Mbps over fiber optic cable using long wavelength lasers, typically 1300nm.

1000BASE-SX
IEEE Gigabit Ethernet standard baseband (single channel) data transmission at 1000 Mbps over fiber optic cable using short wavelength lasers, typically 850nm.

AACRF (Attenuation to Alien Crosstalk Ratio, Far End)
The difference in dB between the AFEXT from a disturber pair and the insertion loss of a disturbed pair within a surrounding link or channel.

ACR (Attenuation-to-Crosstalk Ratio)
A cable performance parameter computed by subtracting the insertion loss (attenuation) of a pair from the near end crosstalk value. See NEXT.

Adapter
An interconnect device through joins similar or dissimilar connectors.

AFEXT (Alien Far End Crosstalk)
Signal coupling from energized pairs in a disturber cable or components into pairs within surrounding cables or components, measured at the far end.

Alien Cross-talk (ANEXT)
Unwanted signal induced into pairs within a cable from surrounding cables.

Anaerobic Adhesive
An adhesive that cures in the absence of air.

ANEXT (Alien Near End Crosstalk)
Signal coupling from energized pairs in a disturber cable or component into pairs within surrounding cables or components, measured at the near end.

Attenuation
The reduction in strength of an electrical or optical signal through a medium or interconnect. Expressed in decibels (dB) relative to a reference signal. Also known as insertion loss.

AWG (American Wire Gauge)
A wire sizing convention based on the number of draw steps. The larger the AWG number, the smaller the wire diameter.

AXT (Alien Crosstalk)
A measure of signal coupling from energized pairs in a disturber cable or component into disturbed pairs within surrounding cables or components.

Backbone Cabling
The permanent cabling structure that originates from the main cross connect in the equipment room. The backbone cabling links telecommunications rooms and other buildings in a campus to the main cross connect. Also referred to as vertical cabling.

Balance
A condition where all complex electromagnetic fields are perfectly equal and opposite.

Bandwidth
The permissible range of transmission frequencies of a communications system. Expressed in Hertz (cycles per second).

BER (Bit Error Rate)
The fraction of total bits transmitted that are erroneous. Caused by EMI or crosstalk.

BNC Connector
A bayonet (push and turn) style coax cable connector.

Bonding
The permanent joining of conductors to the building grounding infrastructure.

Building Automation System (BAS)
An intelligent network of devices, cabling, and equipment that provides automated control of building services such as lighting, climate, and fire detection.

Building Entrance
The physical location where outside plant (OSP) cables penetrate the building.

Campus
In terms of networking, a campus refers to multiple buildings interconnected together.

Category 5e
Balanced twisted-pair cabling specifications characterized from 1 MHz to 100 MHz frequency range. Replaces Cat 5 with new parameters such as PSNEXT, RL, ELFEXT, and more stringent NEXT performance.

Category 6
Balanced twisted-pair cabling specifications characterized from 1MHz to 250 MHz frequency range.

Category 6A
Balanced twisted-pair cabling specifications for Augmented Category 6 performance, characterized from 1MHz to 500MHz frequency range.

CATV (Community Antenna Television)
A local cable TV network that receives signal from a master antenna.

CCTV (Closed Circuit Television)

A private TV system in which signal is transmitted to a limited number of receivers.

Central Office
A common carrier switching center that serves a region of subscribers in a local loop.

Channel
The end-to-end transmission path, which includes the horizontal permanent link, equipment cord and cross connect cord. See Permanent Link.

Characteristic Impedance
The impedance of a transmission line, which when terminated at the near end, would make the line appear infinitely long. A line terminated at its characteristic impedance would have no standing waves or reflections, and a constant ratio of voltage to current at any frequency along the line.

Chrominance
The color portion of a video signal. See also Luminance.

Cladding
The glass layer surrounding the core of an optical fiber, having a different index of refraction than the core. The cladding permits total internal reflection within the core.

Cleave
A flat 90° break separation of an optical fiber, initiated by crack propagation.

Collision Detection
The ability of an Ethernet network to detect simultaneous (colliding) signal traffic.

Component Video
Baseband analog (video) signal comprised of three discrete RGB colors (red, green, blue). Each color is delivered through a separate cable to produce a high resolution RGB signal.

Composite Video
Baseband analog (video) signal from a single channel containing color but no audio signal.

Consolidation Point
An interconnection point in the horizontal cabling between the horizontal cross connect and the work station. See Interconnection.

Core
The central region of an optical fiber through which light transmits.

Cross Connection
A connection point where distribution cables are joined to equipment cables or to other cables using patch cords.

Crosstalk
Unwanted signal induced between separate conductors or cables. See also Alien Crosstalk.

Data Terminal Equipment (DTE)
Office equipment such as phones and modems that are powered by DC voltage.

Decibel (dB)
A standard measure of gain or loss of signal power relative to a reference value.

Delay Skew
The difference in propagation delay between any two pairs within a cable.

Demarcation Point
The connection interface between the service provider cabling and the customer cabling.

Dielectric
A non-metallic, non-conductive material used for wire or coax cable insulation.

Digital Signal
An electronic signal that changes rapidly from one state to another in discrete steps.

Distribution Frame
A structure through which backbone interconnections or cross-connections are made. Main and intermediate distribution frames are known as MDF and IDF respectively.

Duplex
Simultaneous transmission in both directions.

Glossary

Earth Ground
An electrical connection to earth ground by a grounding electrode system.

EMI (Electromagnetic Interference)
Radiated or conducted electromagnetic energy that has an undesirable affect on equipment or signal transmissions. Also referred to as noise, which increases bit error rate (BER).

Entrance Facility (EF)
A code-compliant room or enclosed space that supports the entry of outside public and private network service cabling.

Equipment Room (ER)
An environmentally controlled room or space dedicated to housing telecommunications equipment and main cross connect hardware.

Ethernet
A LAN protocol using a logical bus structure and carrier sense multiple access with collision detection (CSMA/CD). Governed by the IEEE-802.3 series of standards.

F Connector
A 75 ohm coax connector typically used for television and video equipment.

Ferrule
A cylindrical element of a fiber optic connector that provides central alignment of the fiber.

FEXT (Far End Crosstalk)
A measure of unwanted signal coupling from a pair energized by a transmitter at the near end, into surrounding pairs at the far end relative to the transmitter signal level.

Fiber Optics
The technology of light transmission through glass optical fiber by means of total internal reflection.

Fire-Rated Poke-Through
A cable outlet or distribution device suitable for penetration through fire-rated floors.

Firestopping
The process of installing fire-rated materials into wall or floor penetrations to re-establish the fire rating of the barrier.

Full Duplex
Simultaneous bi-directional signal transmission through a media. See half duplex.

Fusion Splice
The process of joining glass optical fibers together using a controlled electric arc.

GHz (GigaHertz)
A unit of frequency equal to 1 billion hertz, or 1 million megahertz.

Grounding Electrode (GE)
A copper clad steel rod or plate secured underground to provide a common low impedance conductive path to the soil. The GE is the primary grounding point for all electrical and telecommunications equipment.

Grounding Electrode Conductor (GEC)
A conductor that is bonded to the grounding electrode that provides a common ground connection for equipment and distributed grounding backbones. See also TMGB, TBB.

Grounding Equalizer (GE)
A 6AWG conductor that connects multiple telecommunications bonding backbones (TBB's) in a multistory building. The GE reduces potential differences between TBB's.

Ground Loop
Ground current induced by voltage differences between grounding points. A ground loop represents poor grounding practice and can cause interference in a LAN.

Headroom
A measure in decibels of the amount in which a communications system exceeds the specified performance limits.

Home Run
A pathway or cable without any splices or intermediate termination points.

Horizontal Cabling
The cabling from the horizontal cross connect in the TR to the work area outlet.

Horizontal Cross Connect (HC)
A connection point in the TR where the horizontal cabling joins to the backbone cabling using patch cords.

Hybrid Cable
A single sheath cable containing any combination of UTP, fiber or coax.

Impedance
The total opposition to flow of alternating current by resistive, capacitive, and inductive elements, expressed in ohms.

Innerduct
A non-metallic flexible round conduit that is installed within larger pathways.

Insertion Loss
The decibel reduction (attenuation) in received signal power through a mated connector pair or cable link.

Interconnection
The direct connection between horizontal distribution cables, typically by punch-down, without using patch cords. Interconnections are used mostly in consolidation points.

Intermediate Cross Connect (IC)
A cross connect between the first and second level backbone cabling.

Internet Protocol (IP)
Software in the network layer that tracks device address, routes outgoing messages, and recognizes incoming messages. See TCP/IP and OSI Model.

Interoperability
The ability of equipment from several vendors to function seamlessly together using a common set of protocols.

ISDN (Integrated Services Digital Network)
A digital communications facility that provides end-to-end voice/data and video/audio over a public switched telephone network (PSTN).

Jack
The female connector of a plug/jack mated pair. A jack is used in the work area outlet.

Jumper
A twisted pair cable segment without connectors. Contrast with Patch Cord.

LAN (Local Area Network)
A non-public data communications network confined to a limited geographic area, with customer-owned servers and peripherals.

LC Connector
A single channel fiber small form factor connector (SFF) with a 1.25mm diameter ferrule.

LED (Light Emitting Diode)
A semiconductor diode that transforms an electronic input signal to an incoherent photonic output. LED's are use for multimode systems.

Luminance
The measurable intensity, or brightness information portion of a video signal. See also Chrominance.

Main Cross Connect (MC)
The primary cross connection point between core network equipment cables, first level backbone and entrance cables.

Metropolitan Area Network (MAN)
A data communications network spanning a geographical area the size of a large city. See also Wide Area Network (WAN).

Microbend
A microscopic bend in an optical fiber that causes optical signal loss and distortion. A microbend can cause fiber breakage over time.

Micron (mm)
One micron is equal to one millionth of a meter. Optical fiber is measured in microns.

Microwave
Electromagnetic waves in the range of 1 to 30 GHz, used for wireless voice, data and video transmission in a linear path through the atmosphere, or hard-wired through coaxial cable.

Mission Critical
With regard to a data network, Mission Critical is the reliable delivery of long-term uninterrupted service, at stated performance levels, to assure continuous operation of the enterprise critical functions.

MHz (Mega Hertz)
A unit of frequency equal to one million Hertz.

Modal Dispersion
The effect of multimode light pulses traveling in different paths through an optical fiber. High order modes, which travel in the outer core are delayed relative to low order modes that travel faster through the inner core. See Differential Mode Delay.

Mode
A bundle of light rays that travel in one direction. See Multimode and Singlemode.

Multimode Fiber
A large core optical fiber, typically 50 or 62.5 microns, which transmits light in randomly varying internal paths. Contrast with singlemode optical fiber.

MUTOA
Multi-User Telecommunications Outlet Assembly. A multi-port horizontal cabling outlet that serves a group of individual work areas.

Nanometer (nm)
A unit of length equal to one billionth of a meter, typically describing fiber operating wavelengths.

NEXT (Near End Crosstalk)
A measure of unwanted signal coupling from a single pair energized by a transmitter at the near end, into surrounding pairs at the near end relative to transmitter signal level.

Node
A common connection point in a network, such as a Hub.

Nominal Velocity of Propagation (NVP)
The ratio of actual signal speed to the velocity of light in a vacuum.

Ohm (Ω)
A measure of electrical resistance, or impedance such as 75Ω coax cable.

Open Architecture
Computer or network hardware and software that is interoperable across multiple vendors and flexible to permit customization.

Open Office
An open-air floor space of multiple offices (cubicles) separated by moveable partitions.

Open Systems Interconnection (OSI) Reference Model
A seven-layer gateway architecture developed by ISO. The seven layers are: Physical, Data Link, Network, Transport, Session, Presentation, and Application.

Optical Fiber
A continuous round glass medium, typically 125 microns outside diameter, having a core and cladding layer of specific indices of refraction that permit transmission of light waves. See Core, Cladding Multimode Fiber and Singlemode Fiber.

OTDR (Optical Time Domain Reflectometer)
An instrument that transmits signal and measures back-reflected signal to characterize faults along an optical fiber, such as splices, mated pairs, microbends or fiber breaks.

Outlet (Telecommunications)
A connecting device, typically in a wall or partition, that provides a connection point between the work area cord and the horizontal cabling.

Outside Plant (OSP)
Telecommunications cabling and equipment from the Local Exchange Carrier (LEC) or interbuilding backbone cabling that is physically located outside, either underground, aerial, or wireless towers.

Packet
A bundle of data in binary form, organized for transmission. A packet consists of: 1) a header for control and address information, 2) Text (or payload), and 3) a trailer for error correction and detection.

Patch Panel
A multi-port cross connect field of connectors that facilitates administration, and moves, adds, or changes (MAC's).

Patch Cord
A length of cable with a plug connector on each end. Contrast with Jumper.

Pathway
An open or closed channel, such as a conduit or wire tray, which is used for routing, distribution, and protection of telecommunications cables.

Permanent Link
An installed segment of horizontal or backbone cable having connecting hardware on each end.

Physical Layer
The lowest level in the OSI model, that which includes the mechanical connection of devices to the transmission medium to gain physical access to the LAN.

Plenum Cable
A cable with low smoke insulation that is suitable for placement in air handling spaces.

Plug
The male version of a cable connector, typically mounted to a patch cord or fiber backbone behind the patch panel.

Port
A physical connection node to a network, either in the equipment or in the LAN cabling.

Poke Through System
See Fire-Rated Poke-Through.

Polarity
The designation of positive and negative in electrical terms, or the distinction between transmit (Tx) or receive (Rx) in telecommunications. Polarity is typically color coded or marked on the hardware.

Power Budget
The difference between optical transmitter power and receiver sensitivity in dB.

Private Branch Exchange (PBX)
A customer-owned premises telephone switching console for internal routing of phone calls received from one or more outside lines.

Propagation Delay
The elapsed time it takes for a signal to travel from the transmitter to the receiver. Expressed as a fraction of the speed of light in a vacuum. See Delay Skew.

PSAACRF (Power Sum Attenuation to Alien Crosstalk ratio, Far-End)
The difference in dB between the PSAFEXT from multiple disturbing pairs and the insertion loss of a disturbed pair within a surrounding link or channel.

PSACR (Power Sum Attenuation to Crosstalk Ratio)
A computation by subtracting pair insertion loss (attenuation) from the power sum near end crosstalk value. See PSNEXT.

PSAFEXT (Power Sum Alien Far-End Crosstalk)
The power sum signal coupling from multiple disturbing pairs to a disturbed pair within a surrounding link or channel, measured at the far end.

PSANEXT (Power Sum Alien Near-End Crosstalk)
The power sum signal coupling from multiple disturbing pairs to a disturbed pair within a surrounding link or channel, measured at the near end.

PSNEXT (Power Sum Near End Crosstalk)
A measure of unwanted signal coupling into a single pair at the near end from all other surrounding pairs energized by transmitters at the near end. See NEXT.

PSELFEXT (Power Sum Equal Level Far End Crosstalk)
A measure of unwanted signal coupling into a single pair at the far end from all other surrounding pairs energized by transmitters at the near end, normalized by the insertion loss of the pair.

Pull Box
An in-line conduit or raceway box with an access cover to facilitate cable feed through corners and bends.

Rack Unit (RU)
An increment of vertical rack space. 1 RU is equal to 1.75 inches.

Raised Floor
A modular floor constructed over a concrete base having posts, stringers and removable plates for access to the space below. Also referred to as an access floor.

RCDD
Registered Communications Distribution Designer. A professional certification granted by BICSI that is base on experience, credentials, and passing an exam.

Refractive Index
The ratio of velocity of light in a medium to the velocity of light in a vacuum. A property of the core and cladding of an optical fiber. Also referred to as index of refraction.

Return Loss
The measure of back-reflected signal intensity in copper or fiber transmission line.

RFI (Radio Frequency Interference)
Electromagnetic interference at radio frequencies, typically between 500 kHz and 30 GHz. See EMI.

RGB (Red-Green-Blue)
The three primary colors used in component video signal processing.

Riser Cable
Cable that is rated for vertical applications, such as high strength backbone.

Router
An intelligent, multi-protocol, central network switching device that monitors, processes, and directs data traffic among multiple LANs, MANs or WANs. Contrast with Hub, which is a non-intelligent device.

SC Connector
A single channel push-pull type fiber connector with a 2.5mm diameter ferrule. Also referred to as 568SC or subscriber channel connector. Duplexing needs a separate clip.

Shielded Twisted Pair Cable (STP and ScTP)
A balanced twisted pair cable with an overall metal shield for EMI/RFI immunity. STP uses a foil shield , and ScTP uses a perforated metal screen shield.

Server
A high-capacity client-shared computer that functions as the central core of a network. The server holds the network operating system, e-mail, shared files, and programs.

Service Entrance
The location where the service provider's cabling enters the building. See Entrance Facility.

Glossary

Service Loop
Excess cable supplied in a channel that is stored in a coil for future needs

Signal-to-Noise Ratio (SNR)
The ratio of signal power to noise power level in dB. See Noise.

Simplex
Transmission in one direction through a single channel.

Singlemode Optical Fiber
A 8-9 micron core optical fiber which transmits light only in a single axial direction, achieving very high bandwidth over 20 GHz.

Sleeve/Slot
Large circular or rectangular openings through walls, ceilings, or floors to allow passage of cables, conduit, and innerduct.

Splitter
A passive device used to divide a signal into two or more output signals.

ST Connector
A single channel, "straight tip" fiber connector, developed by AT&T, with a bayonet style coupling nut, having a 2.5mm ferrule diameter.

Star Topology
A network configuration where all workstations are cabled individually from a horizontal cross-connect (HC), and all HC's are cabled individually from the main cross-connect (MC), thus forming a star pattern. This is practice is recommended by BICSI and TIA.

Surface Raceway
A visible enclosed cable pathway that typically runs along exposed walls or ceilings.

Surge Suppression
The isolation and diversion of transient voltage surges, which are harmful to electronic equipment.

T1 Line
A digital transmission line operating at a rate of 1.544 Mbps (24 voice channels). This is the DS1 level in the TDM digital hierarchy. See also DS0, DS1, and TDM.

Tap
An electrical connection into a bus or trunk line, such as a drop cable to a workstation.

TBB (Telecommunications Bonding Backbone)
A distributed infrastructure 6AWG or larger copper conductor that interconnects all TGB's to the TMGB in a building. See TGB and TMGB.

TCP/IP
Transmission Control Protocol/Internet Protocol. A standard client-server network connectivity protocol that is supported by most LAN/WAN operating systems.

TDR (Time Domain Reflectometer)
An instrument that transmits a signal and measures back-reflected signal to characterize faults along a transmission line. See also OTDR.

Telecommunications Room (TR)
An enclosed building space for housing telecommunications equipment, cable terminations, and cross-connect cabling. A TR serves a single floor in a building.

TGB (Telecommunications Grounding Busbar)
A pre-drilled solid copper bar that is bonded to the TBB, and serves as the common grounding point for electronic equipment and cabling hardware within a TR or ER.

TIA (Telecommunications Industry Association)
An organization of telecommunications industry professionals that publishes standards jointly with ANSI and EIA, through an industry-wide balloting process.

Tight Buffer Cable
An indoor multi-fiber cable with each individual fiber having a 900 micron jacket applied tightly over the acrylate coating.

Tip and Ring
An old telephony term synonymous to "plus and minus". Derived from switchboard cord plugs, where the tip wire is positive and ring wire is negative.

Terminal
An access node through which Date Terminal equipment (DTE) is connected, allowing data to flow into or out of a telecommunications network.

TMGB (Telecommunications Main Grounding Busbar)
A pre-drilled solid copper bar that is bonded to the primary grounding electrode conductor in the electrical service entrance facility. The TBB connects to the TMGB.

Token
A specific combination of bits to be used in a LAN to grant transmit privileges through a ring network. The token circulates continuously through the ring.

Token Ring Topology
A closed loop daisy chain network configuration where data traffic must flow through adjacent equipment in either direction to reach the server.

Topology
The physical or logical arrangement or mapping of a telecommunications network, such as a bus, star, or ring topology.

Transmitter
An active device that emits a pulsed electronic or optical signal into a transmission media.

TSB (Telecommunications System Bulletin)
An interim standards document published by the TIA, which describes new specifications and procedures to be incorporated in the next revision of the affected standard.

Twisted Pair Cable
See Balanced UTP Cable.

USOC (Universal Service Ordering Code)
An FCC-governed series of registered jack (RJ) wiring configurations that connect the customer premises equipment to the public network.

UTP (Unshielded Twisted Pair)
See Balanced UTP cable.

VCSEL (Vertical Cavity Surface Emitting Laser)
A small laser that emits a coherent beam of optical power at 850nm in a vertical direction from the active surface. VCSEL's are used for Gigabit Ethernet over multimode fiber.

VLAN (Virtual LAN)
The logical grouping of network devices into sub-networks using switching technology, to improve data traffic flow or security.

Video Signal
Transmission of moving frames of pictures in a frequency range of 1 to 6 MHz.

Video Compression
The conversion of analog video to a digital format, which can be transmitted as a T1 signal at 1.544 Mbps. Higher compression can transmit at lower bit rates down to 128 Kbps.

Visual Fault Locator
A fiber optic light source that emits high power red light at 650nm. Used to illuminate fibers in a cable. A broken fiber will emit a red glow through the buffer layer.

Voice Over Internet Protocol (VOIP)
The technology of processing and combining voice signals with packet transmission using TCP/IP. Analog voice signals are converted to packets and merged with internet traffic.

WAN (Wide Area Network)
A telecommunications network that extends beyond the metropolitan area, and may span international distances via satellite or undersea cabling.

WDM (Wavelength Division Multiplexing)
The combining of multiple optical channels at different wavelengths into a single multiwavelength channel. WDM increases the capacity of a single fiber channel.

WiFi (Wireless Fidelity)
Synonymous to HiFi, describing audio equipment. WiFi is another term to describe a wireless LAN, operating under the IEEE 802.11 standard at 2.4 GHz.

WLAN (Wireless Local Area Network)
A LAN with no wire infrastructure that operates on RF transceivers. Typically used for rapid deployment in temporary situations. WLAN transmission is not as fast as wired networks, and is affected by obstructions and interference.

Wire Map Test
A measure of continuity of all pin/pair combinations in a cabled link or channel.

Work Area (Work station)
The building space where the user interacts with telecommunications terminal equipment, which is connected to the work area outlet.

Zone Cabling
A cable distribution from the horizontal cross connect to an open office area (zone) utilizing a consolidation point or MUTOA.