INSTALLATION PRACTICES FOR COMMERCIAL BUILDINGS (TIA-568-A COMPLIANCE)

In addition to the installation practices for Residential and Light Commercial buildings in Book 2, the practices in this section should be followed in order for a horizontal cabling installation in Commercial buildings to comply with TIA-568-A.

IMPORTANT: Please read all warnings and cautions on page 1-6.

Scope: This Guide only covers horizontal cabling, not backbone cabling. Backbone cabling for the MDF, IDF, Equipment Room and Telecommunications Closet is beyond the scope of this document. This is due to the fact that backbone cabling in TIA-568-A is very application and building specific, and dependent upon the type of communications, type of building, and many other issues. Thus for backbone and crossconnect design and installation the user is cautioned to refer to the TIA-568-A standard document and if necessary, communications consultants. But in general, the specifications for backbone wiring are:

- **a maximum of two levels**
- **star topology**
- **limited to 90 meters for Category-rated applications; 800 meters for voice applications.**

Horizontal cabling in TIA-568-A, on the other hand, is a generic cabling system. If horizontal cabling is installed according to the practices in the standard, the system will be sufficient for the majority of applications for which it will be used.

For the purposes of this section, horizontal cabling is considered the cabling from the work area to the telecommunications closet. It includes the crossconnects in the telecommunications closet; horizontal cable; and the outlet at the work areas.

Note on Scope Of TIA-568-A: TIA-568-A covers only the building's cabling systems, not the pathways such as conduit or raceways. Commercial building pathways and spaces for telecommunications wiring are covered in a separate standard, TIA-569. Grounding is covered in TIA-607.

3.1 BENEFITS OF TIA-568-A COMPLIANCE

Commercial building horizontal cabling that is installed in accordance with the TIA-568-A standard is like having one type of foundation that can support any type of structure that is built upon it—even if the structure keeps changing. The benefits are that you have one system which will:

a) Simplify ongoing maintenance, relocation, and addition;

b) Accommodate future equipment and service changes;

c) Accommodate a diversity of user applications, including voice, data, LAN, switching, and other building services.

3.1.1 STAR TOPOLOGY

TIA-568-A specifies a star topology: a hierarchical series of distribution levels. In the backbone are the main distribution frame (MDF) and the optional intermediate distribution frame (IDF). Only one IDF is allowed between the MDF and telecommunications closet.

FIG. 3-1. Typical Commercial Building Wiring Topology

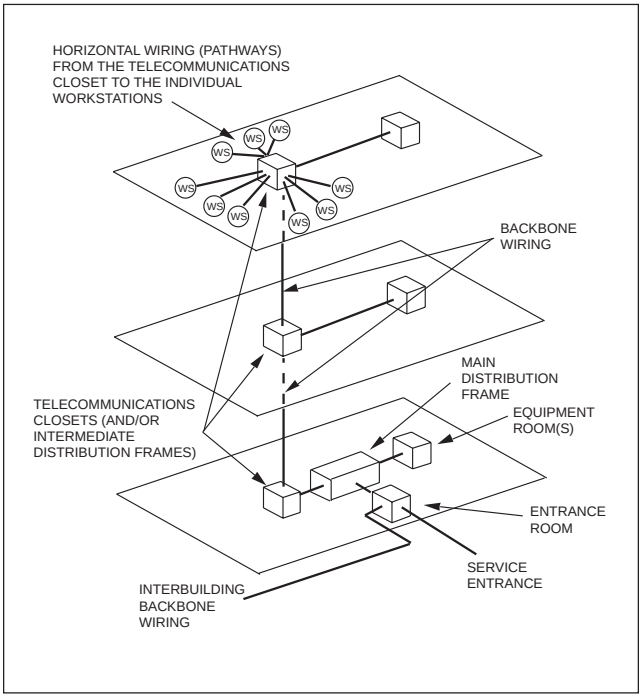
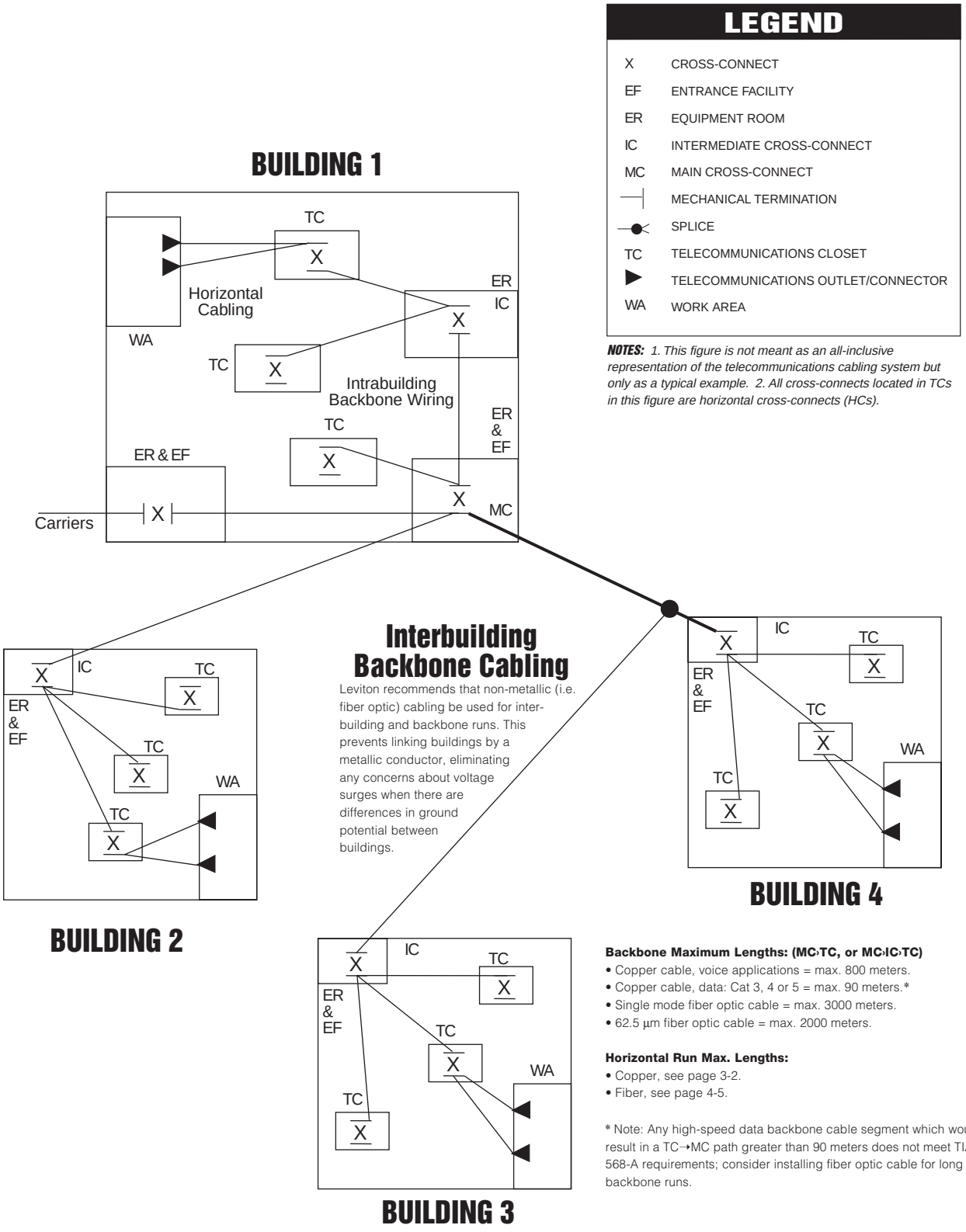


Figure 3-2. Typical Commercial Wiring Topology.



The first level, the MDF, links to other levels via the backbone cabling. The MDF may link to the third and final level, the telecommunications closet (TC) directly, or in large installations it may link to some TCs via an optional second level, the intermediate distribution frame (IDF). The TC terminates the backbone cable and cross-connects to the horizontal cabling. The horizontal cabling terminates in the work area at the workstation (WS). The TC and work area must be on the same floor. (See Fig. 3-1.)

The EIA/TIA-568-A wiring system is based upon a star wiring topology. In a star topology, all phones or workstations are wired directly to a central location. The star topology accommodates direct connection applications (10Base-T, 100Base-T), bus applications (Ethernet with some restrictions), and daisy chain applications (IBM Token Ring and 5250). Most applications can operate on any of the three designated cabling systems, but some applications will require low-cost external devices called baluns to interface coaxial applications hardware to UTP wiring systems.

The EIA/TIA standards are designed to be generic to allow multiple vendors' components of the same Category rating to be used successfully in the same system. As another benefit, a TIA standard-compliant cabling system can accommodate future equipment and service changes to simplify ongoing maintenance and relocation.

In the star topology for commercial installations, each piece of user's equipment (such as a phone or terminal) connects directly to the common equipment in the telecommunications closet or equipment room. A minimum of two cables are run to each user's work area, usually one for voice and one for data.

3.1.1.1 COMMERCIAL TELECOMMUNICATIONS OUTLETS

The telecommunications outlet must be an 8-position jack wired to T568A or T568B pin/pair assignment.

3.1.1.2 ALLOWED CABLING SYSTEMS

Voice cable and connections (i.e. jacks) are four-pair 100 ohm UTP. For full compliance, jacks must be wired to one of the two TIA-specified pin/pair assignment, called T568A or T568B and all four pairs must be terminated.

Data cable and connections can be any of the following: four-pair 100 ohm UTP, commonly used for 10Base-T; 150 ohm STP, commonly used for token ring or 62.5/125 um optical fiber, commonly used for fiber distributed data interface (FDDI). Each cable type was chosen for its large installed base, multiple vendors and applications, and low cost. In the backbone are the main distribution frame (MDF) and the optional intermediate distribution frame (IDF). (See Figure 3-1.) Only one IDF is allowed between the MDF and telecommunications closet.

3.1.1.3 Equipment Locations

- **Communications equipment (phones, fax machines, computers, etc.) may be located in any space**—work areas, TCs, distribution frames, or a separate space called an equipment room.

3.1.1.4 Non-Star Topologies

- **Bus, tree and ring topologies are implemented in the telecommunications closet or other crossconnects rather than directly between work areas. Application distance limitations must be checked.**

3.1.2 MAXIMUM HORIZONTAL DISTANCES

- **Horizontal closet-to-workstation run: Maximum cable length from the mechanical termination of the media in the TC to the telecommunications outlet is 90 meters** (295 feet), **independent of media type.**
- **Splices and bridged taps are not allowed** as part of the horizontal cabling, (except as noted in transition point and consolidation point below.)
- **Only one transition point is allowed** between flat undercarpet cables and one of the recognized horizontal cables.
- **MUTO and Consolidation Points are covered in TSB-75.**

  MUTO-(Multi-User Telecommunications) Outlet is the same as a standard outlet, except it services more than one workstation area (longer patch cords are allowed).

  Consolidation Point-This is a splice point for wiring going to an open office area. No patching is allowed in a consolidation point and no transition point is allowed where a consolidation point is used. The consolidation point must be attached to a permanent building structure (outside wall, load-bearing wall, ceiling beam, etc.)
- **Length of work area equipment cable: It is suggested that the maximum equipment cable length**

from the telecommunications outlet to the work area equipment be limited to 3 meters (10 feet).

- In addition, it is suggested that the **maximum cable length for jumpers and patch cords in the telecommunications closets be limited to 7 meters (23 feet)**, with no single cord exceeding 6 meters; see Figure 3-3. A maximum of 2 patch cords is allowed per horizontal run.
- **It is suggested that equipment cables meet or exceed patch cable performance requirements.**

3.1.3 HORIZONTAL CABLING SYSTEMS

- **There must be a minimum of two cabling runs from the telecommunications closet to each individual work area.** The requirement of having two cabling runs is due to the importance of both voice and data telecommunications in a commercial building, and to allow implementation of bus and ring topologies. **TIA-568-A realizes that most work areas will require both voice and data telecommunications within the lifetime of the cabling system, and so requires that all work areas be wired with a minimum of two outlets.**
- **The required two horizontal cabling runs to each work area shall be as follows:**

  1) One shall be a four-pair 100Ω UTP.

  2) The other/second shall be one of:

  a) Four-pair 24 AWG 100Ω UTP, or

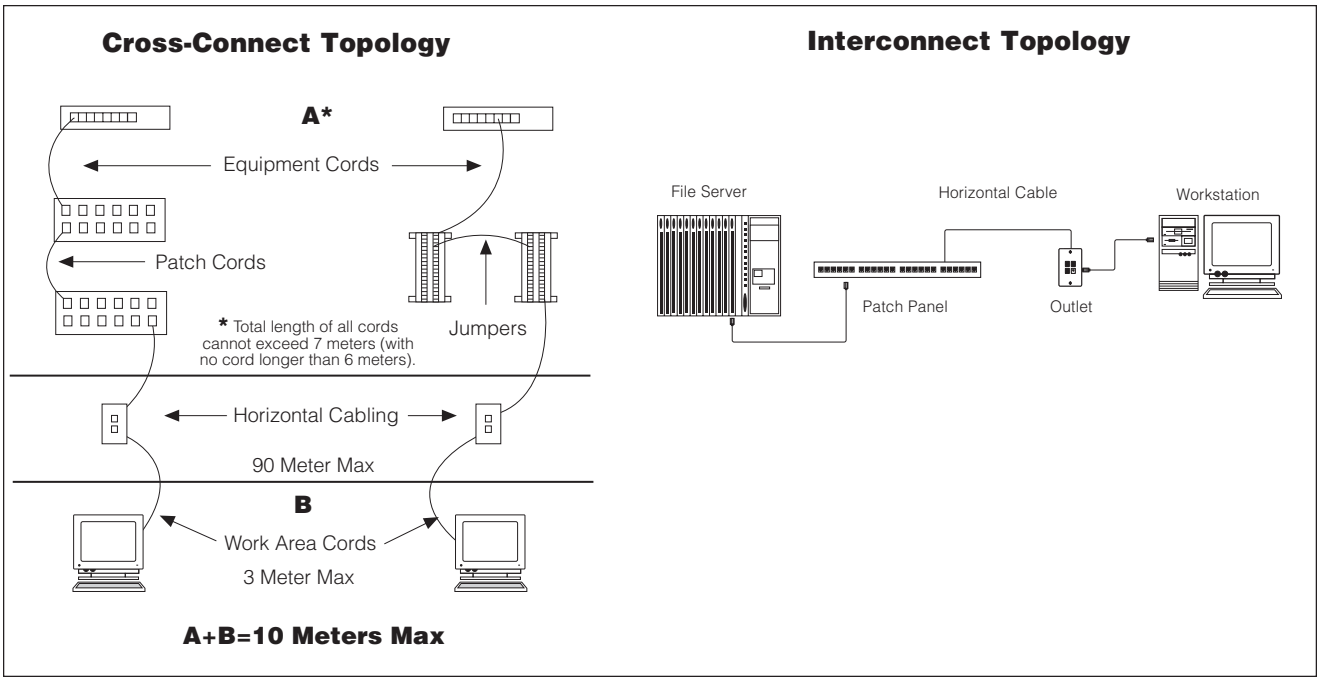
  b) Two-pair 150Ω STP, or

  c) Two-strand, 62.5/125 μm optical fiber.
- **Hybrid cables (consisting of more than one of the above recognized cables under a common sheath) may be used in the horizontal cabling provided that they meet the hybrid cable requirements in TIA-568-A.**
- **Coaxial cable (allowed, but not part of a compliant system).**

3.1.3.1 Horizontal Cabling System Selection

There are three types of cable recognized for standard-compliant installation: 100Ω UTP, 150Ω STP and 62.5/125μm fiber optic cable.

FIG. 3-3. Cross-Connect topology with Maximum Horizontal Distances vs. Interconnect topology.



100Ω UTP is the most universal cabling system and generally the least expensive. It covers almost all applications up to 100 MHz with a minimum of cost. The user must decide which category of 100Ω UTP cabling system is needed for the application. For voice cabling systems, Category 3 is sufficient; for data cabling systems, Category 5 is highly recommended.

150Ω STP is usually installed as a hybrid system, consisting of one 150Ω STP data cabling system and one 100Ω UTP Category 3 voice cabling system under one sheath. 150Ω STP is usually used for token ring applications, but the extended bandwidth 150Ω STP has application hardware for broadband video up to 300 MHz and 155 Mbps ATM.

Optical fiber is typically the most expensive cabling system to install, but it has the widest bandwidth (in excess of 1 GHz). While optical fiber is not practical for voice and other low bandwidth applications in the horizontal, optical fiber should be the cabling system choice for high bandwidth applications such as FDDI, ATM, broadband video and multiplexed signals.

For specific cabling system requirements, see Sections 3.2 (100Ω UTP), 3.3 (150Ω STP) and Book 4 (optical fiber).

3.1.3.2 Cabling System Components

Each cabling system is composed of four main components:

1) Telecommunications outlet

2) Horizontal cable

3) Crossconnect hardware

4) Patch cables, equipment cables and jumpers

The telecommunications outlet is in the work area and provides access to the building tele communications cabling system.

Horizontal cables connect the work area outlet to the crossconnect system in the telecommunications closet.

Crossconnect hardware terminates the horizontal cable, backbone cable, and equipment in the telecommunications closet.

Patch cables and jumpers connect crossconnect hardware in the telecommunications closets.

Equipment cables connect telecommunications equipment to the outlet in the work area or to the cross connects in the telecommunications closet (see Section 3.4 for more information on TC crossconnects).

- **Per the National Electrical Code®, each component must be listed for the purpose.** Look for the UL or ETL listing for each component (CSA in Canada).
- **All components must comply with FCC Part 68** (CS-03 in Canada). Look for the compliance statement on the component or the component packaging. Wire and cable are listed with the FCC.

Each cabling system, along with its components, is described in the sections to follow.

3.1.3.3 Other Cabling Systems

- **If you need to include other cabling systems but still wish to have a TIA-568-A compliant installation, other cabling systems may be included to the work area , as long as they are in addition to the two TIA-568-A required cabling systems.** Examples of additional cabling systems are IBM 3270 on RG-62U or 100Ω UTP with baluns; video on RG59, Category 5 100Ω UTP or 150Ω STP, LonWorks; and voice on 25 pair 100Ω UTP.

3.1.4 GROUNDING & BONDING CONSIDERATIONS

Grounding and bonding systems are normally an integral part of the specific application or telecommunications cabling system that they protect. They protect personnel and equipment from hazardous voltages, and reduce the effect of electromagnetic interference (EMI) to and from the telecommunications cabling system. **Improper grounding and bonding can induce voltages which disrupt telecommunications circuits.**

- **Grounding and bonding shall meet the National Electrical Code (NEC) requirements and practices,** except where other authorities or codes impose a more stringent requirement or practice.
- **Additionally, grounding and bonding shall conform with TIA-607 requirements** for telecommunications infrastructure.
- **Grounding and bonding instructions and requirements of the equipment manufacturer should also be followed**. Grounding and bonding requirements of specific data and telecommunications networks could possibly exceed the grounding and bonding requirements of the national or local requirements or practices.

3.2 100Ω UTP CABLING SYSTEMS

100Ω UTP cabling systems currently are the most versatile and often the most cost effective. They cover almost all applications up to 100 MHz with a minimum of cost.

100Ω UTP cabling system components have been categorized into performance groups. Each performance group characterizes the performance of the components up to a specific frequency:

Category 3: up to 16 MHz (10 Mbps)

Category 4: up to 20 MHz (16 Mbps)

Category 5**:** up to 100 MHz (100 Mbps)

For category selection for a specific application, refer to Section 1. A general rule of thumb is to use Category 3 for voice cabling systems, and Category 5 for data cabling systems.

- **As a minimum for any category-rated installation, make sure all components are at least of the minimum category required.** Just as a chain is no stronger than its weakest link, the lowest category-rated component in a system reduces the entire cabling system to that category.

3.2.1 100Ω UTP WORK AREA OUTLETS

- **Generally, screw terminations for cable outlets limit an outlet to Category 3 performance.**
- **Category 4 outlets usually terminate on an insulation displacement connector (IDC)** such as 110, and internal leads are twisted and are often limited to less than 8" in length.
- **Category 5 outlets always use an IDC for cable terminations,** and have internal compensation to meet the transmission requirements.

3.2.1.1 100Ω UTP Work Area Outlet Installation

- **Each four-pair cable shall have all pairs terminated on an eight-position jack.**
- **Pin/pair assignments shall be as per T568A, or T568B** (Figure 3-4). T568A is the new pin-out scheme and is generally used for analog voice applications using 2 lines. T568B is the more common pin-out scheme, and is generally used for multi-line electronic key systems and most data applications. Either will comply with most voice and data applications including ISDN, 10BASE-T, 16 Mbps token ring and ATM.
- **Maintain the twists of the cable as close to the termination on the outlet as possible, to maintain the transmission characteristics of the category. Category specifications require that pair twisting be maintained to within the following distances from the outlet termination:**

  Category 3 max. allowed untwisting: **3"**

  Category 4 max. allowed untwisting: **1"**

  Category 5 max. allowed untwisting: **1/2"**

  Above Category 5 allowed untwisting: **<1/2"**

Note: TIA-568-A does not specify the maximum allowable untwisting for Category 3 UTP, but 3" is suggested as the maximum distance for standard practice.

- **Leave a sufficient service loop of the horizontal cable for future adds, moves and changes.** Usually $^1/_3$ to 1 meter (1 to 3 feet).
- **Each telecommunications outlet must comply with pair color codes or have a conversion chart shipped with each outlet.** Pair color codes are as shown in Table 3-1.
- **The bend radius of the cable must be no tighter than four times (4x) the cable's outside diameter, at any point in the horizontal channel** (such as pathway corners, and station outlet entrances and service loops). For four-pair UTP plenum cable, this translates to about a 1" bend radius.
- **For multi-pair cable (>4 pairs; typically 25-pair), the minimum allowed bend radius is 10x the outside diameter.**

Fig. 3-4 EIA/TIA-568-A Compliant Wiring Configurations.

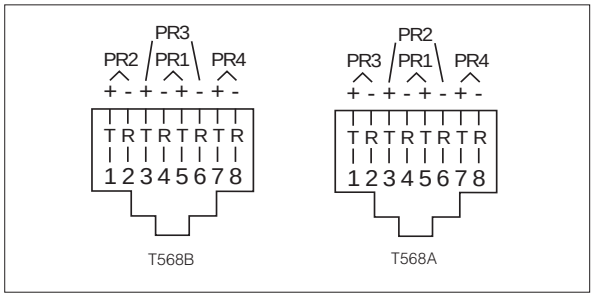


TABLE 3-1. Telecommunications Wiring Color Codes.

Wire Pair # and Lead Functions	Banded Colors	Semi-Solid Colors	Cat 5 Solid Colors (tightly twisted together)	8-Position T568A Jack Pin #	8-Position T568B Jack Pin #	6-Position Jack Solid Colors*	6-Position RJ25 USOC Jack Pin *
1 Tip	White-Blue	White-Blue	White	5	5	Green	4
1 Ring	Blue-White	Blue	Blue	4	4	Red	3
2 Tip	White-Orange	White-Orange	White	3	1	Black	2
2 Ring	Orange-White	Orange	Orange	6	2	Yellow	5
3 Tip	White-Green	White-Green	White	1	3	White	1
3 Ring	Green-White	Green	Green	2	6	Blue	6
4 Tip	White-Brown	White-Brown	White	7	7		
4 Ring	Brown-White	Brown	Brown	8	8		

*Note: The wire insulation is white, and a colored marking is added for identification (see Book 2, Section 2.1.1 on band-striped color marking). For cables with tightly twisted pairs (all less than 38.1mm [1.5 inches]) the mate conductor may serve as the marking for the white conductor. A white marking is optional. *Added for informational purposes only; does not comply with EIA/TIA-568-A.*

3.2.1.2 Installing Outlets for Cabling Systems in Addition to the Minimum TIA-568-A Cabling System

Any 100Ω UTP modular jack or adapter may be *added* to the minimum cabling system outlet, as long as the minimum cabling system for TIA-568-A is met. Baluns, 6 position USOC, 8 position USOC or MMJ outlets may be added to the work area telecommunications outlet as required by the specific site.

3.2.2 100Ω UTP CABLING SYSTEMS

- **The unshielded inside cable used in the horizontal cabling system is 24 AWG** thermoplastic insulated conductors formed into four individually twisted pairs and enclosed by a thermoplastic jacket.
- **Four-pair 22 AWG cables may be used if they meet the physical transmission requirements of the desired Category.**
- **Four-pair screened twisted pair (100Ω STP) cables may be used if they meet the physical and transmission requirements of the desired Category.**
- **Undercarpet cables may be used for certain applications, but only one transition point from round cable to flat undercarpet cable is permitted on any horizontal run. Undercarpet cables shall meet ANSI/IPC-FC-21 and must be listed for that purpose.**

3.2.2.1 100Ω UTP Cable Installation

- **For TIA-568-A compliant installations, do not exceed 25 lbs. of pulling tension on the cable** (4-pair, 24 gauge).
- **Do not chafe or damage the outer jacket of the cable.** Watch out for sharp corners, screws, nails, or excess flashing that may cut or chafe the jacket.
- **Installation in colder climates may require cables with special jackets.** PVC and other jacket materials may require treatment to remain flexible in the colder regions.
- **The wire color code shall be as shown in Table 3-1.**

☞ **See "Do/Don't" Installation Guide beginning on page 3-15.**

3.2.3 100Ω UTP CABLING SYSTEM TELECOMMUNICATIONS CLOSET CONNECTING HARDWARE

The telecommunications closet is where connecting hardware for 100Ω UTP cable is installed as a means of connecting the horizontal cabling to the backbone cabling or equipment.

Two types of crossconnects are common: patch panels and crossconnect blocks.

Patch panels often have the backbone cable, horizontal cable, or electronic equipment cord directly terminated on the cable terminations. Crossconnecting is achieved by patch cords.

Crossconnect blocks are usually IDC connections with the electronic equipment cords, horizontal cables and backbone cables terminated on one side. The crossconnect jumpers terminate to the other side of the block, and between blocks to complete the crossconnect.

- **It is desirable that hardware used to terminate cables be of the insulation displacement connector (IDC) type.** Screw terminals are not recommended except as required for specific applications. See Table 3-2.

TABLE 3-2. Termination Hardware for Category-Rated Cabling Systems.

Termination Hardware	Category 3	Category 5	Beyond Category 5
Screw terminals	(1)	-	-
25 pair connector	(2)	(2)	-
66-clip	Yes	(2)	-
110	Yes	Yes	Yes

Note (1): If the application specifically requires it.
Note (2): Some versions comply; check with the manufacturer.

3.2.3.1 100Ω UTP Connecting Hardware Installation

- **Install connecting hardware in a neat, well organized manner**, using wire management and mechanical termination practices in accordance with manufacturer's guidelines.
- **Connecting hardware must be organized into connecting fields for ease of administration**; see Section 3.4, Telecommunications Closet.
- **Document the installation, and use color coding and labeling;** see Section 3.5, Administration.
- **Preserve wire pair twists as closely as possible to the point of mechanical termination, in order to minimize signal impairment.** This will maintain the transmission characteristics of the category. Category specifications require that twisting be maintained to within the following distances from the outlet termination:

  Category 3 UTP = 3" max. untwisting*

  Category 4 UTP = 1" max. untwisting

  Category 5 UTP = 1/2" max. untwisting

  Above Category 5 UTP = <1/2. untwisting

  **NOTE: TIA-568-A does not specify allowed untwisting for Category 3, but 3" is suggested as the maximum distance.*

3.2.4 100Ω UTP CROSSCONNECT JUMPERS, PATCH CORDS AND EQUIPMENT CORDS

- **The summed lengths of the jumpers, patch cords and equipment cords should not exceed 23 feet (7 meters) in length in the telecommunications closet.**
- **It is preferable to buy pre-manufactured patch and equipment cords made to the required lengths** since in-the-field installation of modular plugs on equipment and patch cord cable can be difficult for category compliance.
- **The twists of the individual pairs must be maintained up to and into the plug. This is especially crucial for Category 5 applications.** For Category 5, the twist must be maintained to within .5" of the front of the plug. See Table 3-3 for correct wiring of Category 5 patch cords.
- **Modular plugs for solid wire provide the best connection on TIA compliant patch cord cable.**
- **Use only the modular plug crimping tool recommended by the plug manufacturer.**
- **Patch cord cable must be Category compliant. Tinsel cordage ("silver satin") is not acceptable.**

3.2.4.1 100Ω UTP Crossconnect Jumpers

- **TIA-568-A requires that all jumper cables comply with Category transmission requirements.** These jumpers may be 1 through 4 pairs.

For technical information, call 1 (800) 722-2082 • For product information, call 1 (800) 922-6229 • website: www.levitontelcom.com • e-mail: info@levitontelcom.com

TABLE 3-3. Patch Cord Wire Color Codes.

Conductor Identification (1)	Wire Color
Pair 1 + Pair 1 -	White (2) Blue (3)
Pair 2 + Pair 2 -	White (2) Orange (3)
Pair 3 + Pair 3 -	White (2) Green (3)
Pair 4 + Pair 4 -	White (2) Brown (3)

Notes: (1) + = Tip, - = Ring
(2) Mostly white wire may have the associate color as a band or stripe.
(3) Mostly colored wire may have white as a band or stripe.

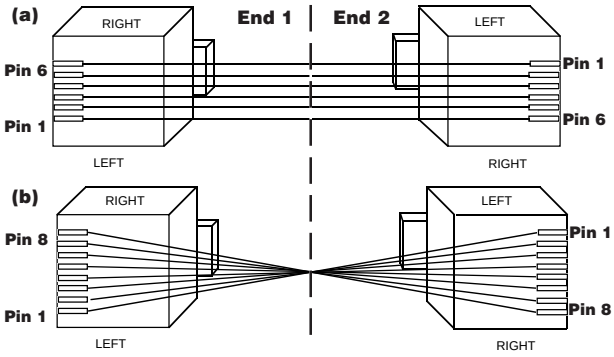
3.2.4.2 100Ω UTP PATCH CORDS

- **TIA-568-A requires all patch cords to comply with category transmission requirements. However, patch cords are allowed additional attenuation so that a more "lossy" (less stringent attenuation characteristics) flexible cable may be used.**
- **It is recommended that stranded, twisted conductor patch cords be used. Flat, silver satin patch cords do not comply with any Category.** Both solid or stranded conductors can be used. The trade-off is that while the solid conductors may provide superior electrical performance, the stranded cords provide better flex life.
- **Patch cords do not reverse the wires with the plugs.** Pin 1 of end 1 connects to pin 1 of end 2. (See Fig. 3-5b.)

3.2.4.3 100Ω UTP Equipment Cords

- **Although equipment cords are supplied by the equipment vendor, TIA-568-A does require that they meet the same performance criteria as patch cords, and comply with Category transmission requirements.** The one exception is equipment cord for analog telephones, such as "500" sets. Ordinary flat, silver satin equipment cords may be used for analog telephones.
- **Maximum length for work area equipment cords is 10 feet (3 meters).**
- **In the telecommunications closet, the summed lengths of the equipment and patch cables and jumpers together should not exceed 7 meters** (23 feet) **total.**
- **Equipment cords for data applications usually do not reverse the wires with the plugs;** pin 1 of end 1 connects to pin 1 of end 2. (Fig. 3-5b.)
- **Equipment cords for analog telephones usually reverse the wires with the plugs;** (i.e., pin 1 of end 1 connects to pin 6 of end 2. See Fig. 3-5a.)

FIG. 3-5. (a) Reversed and (b) Straight-Through Pin-Outs.



3.3 150Ω STP CABLING SYSTEMS

Two 150Ω STP cabling systems exist today. The initial (and unnamed) version is characterized to 20 MHz and is applicable for token ring applications up to 16 Mbps. The new version is the "Extended" 150Ω STP, sometimes called "1A" (in reference to the extended version designator for the new Type 1 cable).

The Extended 150Ω system is characterized to 300 MHz and is not only applicable for token ring applications up to 100 Mbps, but is also being suggested for broadband video. TSB-53 defines the extended 150Ω STP. In TIA-568-A, the extended cabling system replaces the initial version.

Extended components will be designated either by an "A" following the type designation on the cables, or an "E" or the word "EXTENDED" on the cable and connector.

Upgrading existing 150Ω STP cabling systems to the Extended 150Ω cabling system will not usually require replacing the cable. Contact the cable vendor to see if the existing cable meets the Extended requirements, which most existing cables exceeded. However, the connector will still have to be replaced, as the initial connector falls short of meeting requirements for Extended systems.

3.3.1 150Ω STP OUTLET

- **The telecommunications connector to be used for terminating the l50Ω STP cable shall be that specified by ANSI/IEEE 802.5 for the media interface connector.** This connector is hermaphroditic in design (having both male and female connector elements) so that the two identical units will mate when oriented 180° with respect to each other.
- **The new extended version (specified in TSB-53) will be matable with the old version. It is recommended that the extended version be used in all new installations.**

3.3.1.1 150Ω STP Outlet Installation

This connector generally is installed directly on the horizontal cable at the work area, or in the telecommunications closet.

- **It is suggested that a 1 to 3 foot (1/3 to 1 meter) service loop be added at both locations for adds, moves and changes.** Keep in mind that this may be difficult with the cable, due to its large size.

3.3.2 150Ω STP CABLE

- **150Ω STP cable must meet the requirements of EIA Interim Standard Omnibus Specification, NQ-EIA/IS-43, and the Detail Specifications listed in the standard.**

3.3.2.1 150Ω STP Cable Installation

In addition to the cable installation practices in Book 2:

- **Do not exceed the manufacturer's recommendations for pulling tension.**
- **Do not chafe or damage the outer jacket of the cable.** Watch for sharp corners, screws, nails or excess flashing that may cut or chafe the jacket.
- **Installation in colder climates may require cables with special jackets.** PVC and other jacket materials may require treatment to remain flexible in colder regions.

3.3.3 150Ω STP TELECOMMUNICATIONS CLOSET CONNECTING HARDWARE

Patch panels and passive or electronic hubs are the usual crossconnect hardware. Crossconnect blocks are rarely used and are not recommended. Termination of the backbone and horizontal cables is usually to either a 150Ω STP media interface connector, or to an IDC on the patch panel.

3.3.3.1 150Ω STP Crossconnect Panels

Patch panels are generally one of two types: an open panel with a hole for the 150Ω STP media interface connector to snap into, or a panel with IDCs for termination of the building cables.

- **In either case, follow the manufacturer's recommendations for termination.**
- **Allow 1 to 3 feet (1/3 to 1 meter) of service loop for future adds, moved and changes.**
- **For 19-inch (483-mm) rack-mounted cross-connect panel installations,** allow room on the rack for possible telecommunications equipment associated with the 150Ω STP cable.
- **Racks should have at least the following clearances for access and cable dressing space:**
  - ***30 inches*** (762 mm) in the rear
  - ***36 inches*** (915 mm) in the front
  - ***14 inches*** (356 mm) on the side

3.3.3.2 150Ω STP Hubs

Passive or active hubs usually are connected via the 150Ω STP media interface connectors and patch cords to the horizontal cabling. Backbone cables may be optical fiber or 150Ω STP cables, and are usually connectorized and connected directly to the hub to minimize connections. **In either case, follow the recommendations for 150Ω STP patch panels.**

3.3.3.3 150Ω STP Patch Cords and Equipment Cords

3.3.3.3.1 150Ω STP Patch Cords

150Ω STP patch cords are usually purchased items and are not normally constructed in the field.

- **If field construction is required, follow the patch panel or hub vendor's recommendations.**

- **Patch cord length should be limited to 23 feet (7 meters).**

3.3.3.3.2 150Ω STP Equipment Cords

The 150Ω STP equipment cords are usually provided by the equipment vendor and are not normally constructed in the field. If field construction is required, follow the equipment vendor's recommendations.

- **Equipment cord length should be limited to 10 feet (3 meters).**

3.4 THE TELECOMMUNICATIONS CLOSET

The Telecommunications closet (TC) is the hub of the horizontal cabling system and is the key to a well organized horizontal cabling system. Since all telecommunication transmissions to and from the work area end up in the TC, the organization of the TC is critical for future adds, moves and changes. See Figure 3-6 for general closet layout.

First, the telecommunications closet must be sufficient in size to handle the crossconnect field, the associated electronic equipment, the backbone and horizontal cables, and the pathways (conduits, etc.) for the cables—and still have enough room for a craftsperson to work, without disrupting services. **The following specifications are from the Pathways Standard, TIA-569.**

There should be one TC per floor, dedicated to telecommunications. If there are multiple TCs on a floor, they shall be interconnected by a minimum one trade size 3 conduit.

- **The TC serving an office area should be of a specific minimum size to accommodate the current and future services in the area served (see Table 3-4).** These sizes may seem a little large, but the TC needs to have enough room to allow electronic equipment to be added for voice, data, video, security, etc.
- **Lighting shall be adequate** (minimum of 50 footcandles) so that craftspersons can distinguish small lettering and work with the small wires.
- **Enough electrical service and outlets** to provide power for the installed electronic equipment and the craftsperson's equipment.
- **Clean and free of clutter.**
- **Dedicated to telecommunications.** The TC should not be a storage room.
- **Climate controlled.** Most electronic equipment designed for telecommunications closets requires a limited temperature environment. Separately controlled heating and air conditioning for the TC are almost always required.
- **Secure.** Businesses rely heavily on their communications systems, so access to the TC must be limited to authorized personnel. The door should be lockable.

FIG. 3-6. Typical Telecommunications Closet.

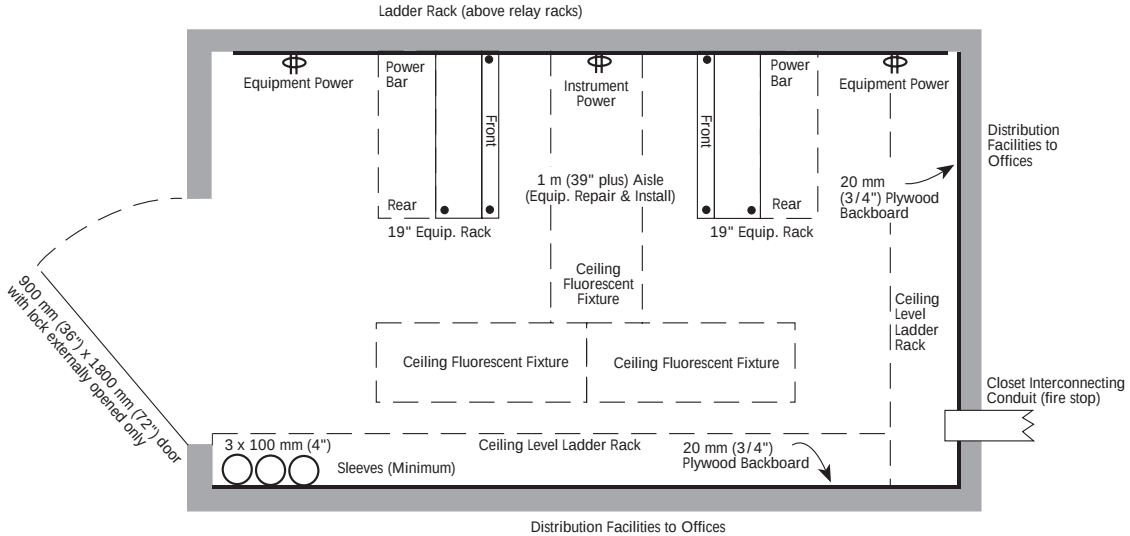


TABLE 3-4. Minimum Recommended TC Sizes.

Serving Area: ft2	(m2)	Closet Size: ft. x ft.	(m x m)
10,000	(1000)	10 x 11	(3 x 3.4)
8,000	(800)	10 x 9	(3 x 2.8)
5,000	(500)	10 x 7	(3 x 2.2)

- **Located in a room other than the power distribution or mechanical equipment** (heating, ventilation and air conditioning).
- **Door width shall be 36";** it should be lockable and open outward.
- **The TC shall be firestopped** - sleeves, slots, penetration, etc.

3.4.1 TC CROSSCONNECT FIELDS

TC crossconnect fields must be well organized to facilitate installation and changes, as this is the key to an easy-to-administer system.

- **Crossconnects are usually mounted on a plywood backboard mounted to the walls of the TC (see Fig. 3-7). The crossconnects are usually organized first by cable type (backbone, horizontal, equipment). Then they are often color-coded and organized into cabling system types and services due to the crossconnects required:**
  - Category 3 IDCs for voice (Category 3 100Ω UTP)
  - Category 5 IDCs or patch panels for applications using Category 5 100Ω UTP
  - Extended 150Ω STP patch panels for 100 MHz token ring
  - Optical fiber patch panels for FDDI
- **EIA/TIA-606 suggests that TC crossconnects be organized into color coded fields.** Most crossconnect devices can have colored labels or markers added for identification (Table 3-5).
- **Sufficient space and hardware must be provided to handle the size and weight of the backbone cables, horizontal cables, patch cords and jumper cables.**
- **Provide a service loop at each termination for future adds, moves and changes.**
- **For 100Ω UTP and 150Ω STP, only use jumper cables, patch cords, and crossconnect devices that comply with the Category or extended requirements of the cabling system.** Use of lower performance components will cause performance degradation, poor quality signals, and possible data loss.

3.4.2 TC ELECTRONIC EQUIPMENT

With increasing use of communications by each person in a commercial environment, the TCs are being equipped

FIG. 3-7. Voice & Data Backboards in the TC.

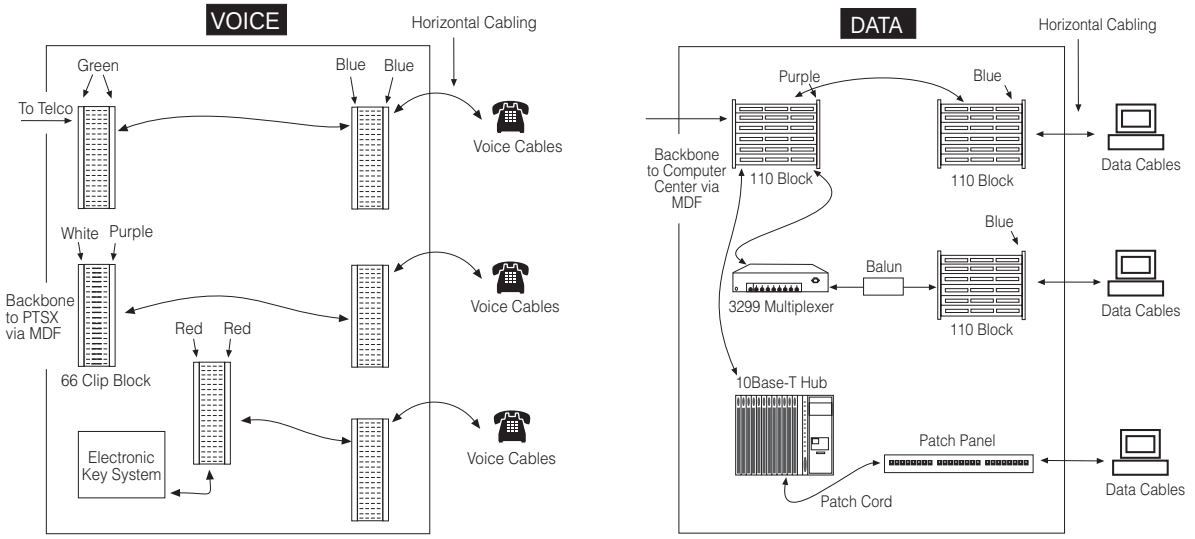


TABLE 3-5. Crossconnect Field Color Codes.

Crossconnect Field	Color
Backbone cable from main crossconnect	White
Backbone cable from intermediate crossconnect	Grey
Customer side of demarcation point	Green
Common equipment (PBXs, LANs)	Purple
Horizontal cable	Blue
Auxiliary circuits (alarms, etc.)	Yellow
Key Telephone	Red
Central Office Cable	Orange
Campus Cable	Brown

with more electronic equipment. Thus it is important to maintain sufficient space for cooling and heating, servicing, and cable management.

The following electronic equipment is often housed in the TC:

1) Key system
2) Small PBX
3) Multiplexer or hub
4) Security system
5) File or print servers

3.4.3 TC PATHWAYS

- **The TC will have conduits or raceways entering the TC for backbone and horizontal cables.**

3.5 CABLING SYSTEM ADMINISTRATION (COMPLIANCE WITH TIA-606)

To facilitate ongoing wiring system management and changes, wiring installations should be documented per the requirements of TIA-606. Proper wiring administration is a requirement of TIA-568-A.

Wiring administration involves both the planning and documentation of each installation. Over time, changes to even the most well-laid-out installation can (and often do) degrade into an installation that is almost impossible to administer. The accumulation of 'quick fixes', leftover disconnected equipment, and nonstandard installation changes often accumulate in closets, with the result that even simple changes are more difficult and time-consuming to make.

Good administration is every bit as important as making good connections to wires. The following is a basic checklist of administration practices. If local practices have been established, these should be discussed with the building owner or manager, and adhered to carefully.

GENERAL TIPS ON WIRING ADMINISTRATION

- **Plan for change.** Allow sufficient space in closets and elsewhere to make the changes that are both inevitable and, in many cases, unforeseeable. Logically plan the points at which the system will be cross-connected such that each individual case can be efficiently dealt with, but unnecessary connections (which would degrade system performance) are not added. (This is particularly important for Category compliance.)
- **Avoid quick fixes.** Use standard wiring practices so that all connections can be easily found and identified. Cross-connections made in ceilings, for example, are not standard, and so will inevitably be forgotten and difficult to administer.
- **Use a consistent plan for documenting all wiring.** The plan may be simple or complex depending on the installation, but it must be complete, orderly, scrupulously maintained, and readily accessible. Finally, it should be decipherable by other installers.
- **Neatness is essential.** All wiring should be laid out neatly and consistently. Closets should be kept clean, with adequate room to work.

  Do not let old equipment, leftover materials, and miscellaneous items accumulate and impede full access to wiring and equipment in use.
- **Assure that all connections have adequate service loop for minor changes.**
- **Use a worksheet to document the installation** and indicate the length of cable runs to each room, the location of primary and secondary outlets (identified as such and in which order

they were run from the primary), the station numbers (phone numbers) of each access line (if known), and the wire color combinations for each line and the relationship between wire colors where colors have been converted at the distribution device, etcetera. Note any special circumstances, and leave a copy of the document near the distribution device for future reference.

- **Clearly label** all station wire at each end, and clearly indicate the marking scheme on the worksheet.
- **Maintain the relationship of pairs and lines** at the distribution device, and label the lines clearly if the distribution device does not have a clear marking scheme.

☛ **Continue to Book 4 for Fiber Optic Cabling System installation practices in compliance with TIA-568-A (Commercial Building Installations).**

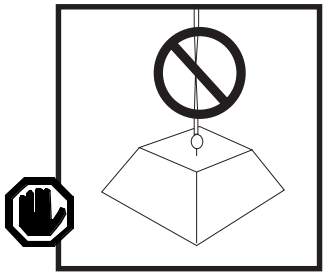
CATEGORY 5 UTP INSTALLATION—DO'S AND DON'TS GUIDE

In order for unshielded twisted-pair (UTP) cable (including Cat 5, Cat 5e and more advanced systems) to deliver high-speed performance, it is manufactured to very tight specifications. In order to maintain UTP cabling system performance after manufacture, proper handling is essential.

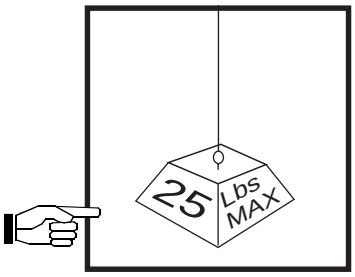
Damaging cable can greatly affect its ability to carry data at higher rates—and once damaged, is not always readily 'fixable'. Many common occurrences, like over-stretching or over-bending, can permanently stretch the conductors or alter the insulation, thus affecting the transmission properties of the cable. For example, cable that has been kinked cannot just be straightened out and expected to provide the intended level of performance.

Thus proper installation is one of the most important keys to cabling system performance. By heeding the following installation tips, and avoiding common handling mistakes, there is much greater assurance that the cabling system will perform as planned.

CABLE TENSION

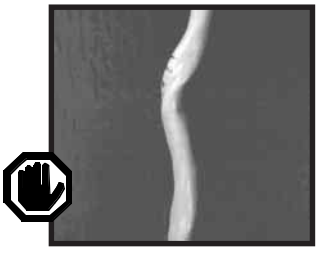


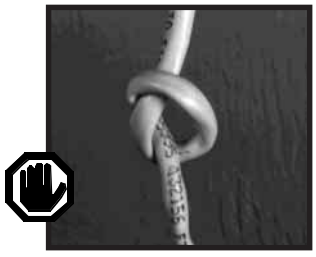
***DON'T** pull cable with excessive force, as this will alter the cable's insulation and transmission properties.*



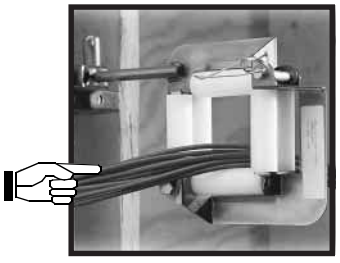
***DO** pull cable using less than 25 pounds of pull-force.*

UNROLLING CABLE





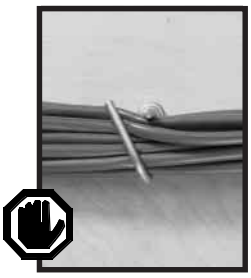
***DON'T** allow the cable to kink, knot or snag while pulling it off the spool or out of the box; deforming the pair-twist will alter the performance of the cable.*



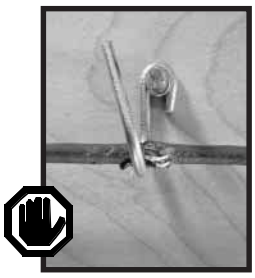
***DO** use a cable pulling accessory.*

CATEGORY 5 UTP INSTALLATION—DO'S AND DON'TS GUIDE

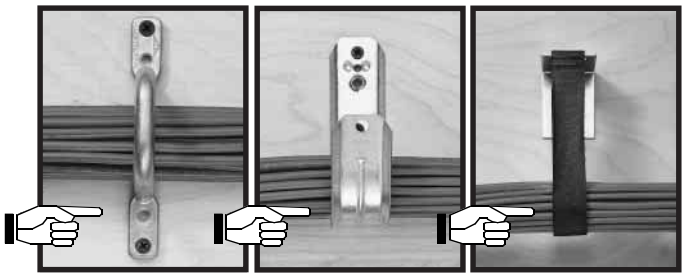
RUNNING & SUPPORTING CABLE



DON'T *overstress cables by overloading...*



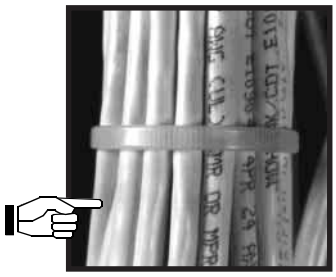
...and ***DON'T*** *allow the cable hook to rip or fray the cable.*



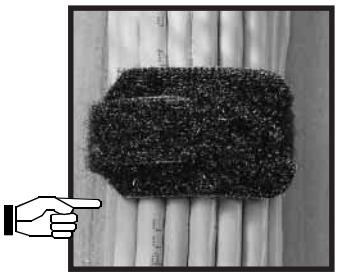
DO *use j-hooks or similar devices designed to support cables.*

RUNNING & SECURING CABLE

DON'T *overstress cables by overtightening cable ties, especially to the point where crush-stress is visible.*

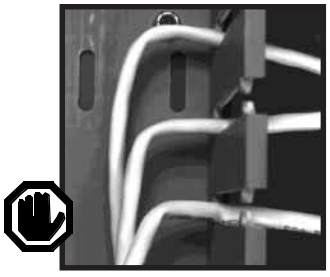


DO *use tie wraps loosely on large bundles. (see also 'Using Tie-wraps')*

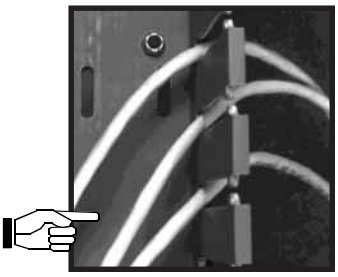


DO *use Velcro® tie wraps to secure large bundles.*

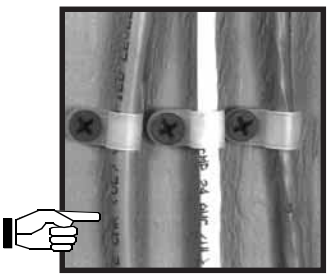
USING WIRE CHANNELS



DON'T *allow the cable to form right angles or sharp bends.*



DO *use sweeping bends.*



DO *use cable clamps on individual runs.*

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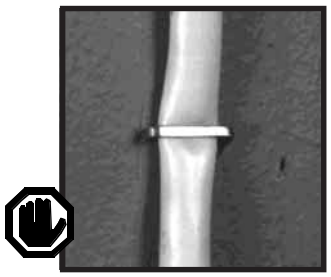
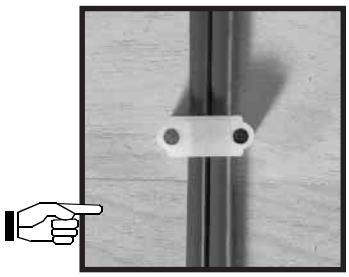
CATEGORY 5 UTP INSTALLATION—DO'S AND DON'TS GUIDE

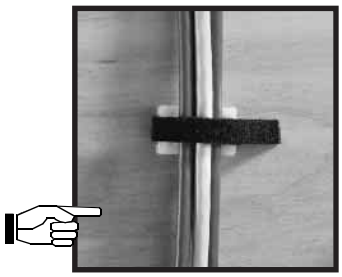
STAPLING CABLE



DON'T *squish cables when securing them.*

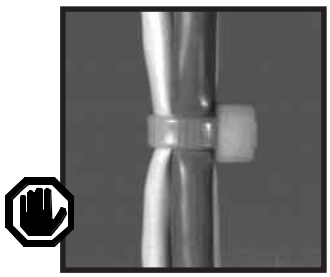


DO *staple by hand, or use staplers with depth stops.*

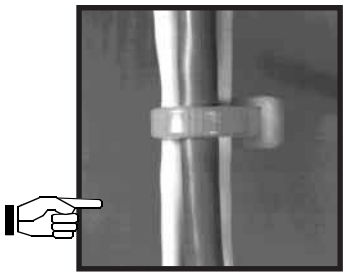


DO *use Velcro® to keep cables from becoming over-cinched.*

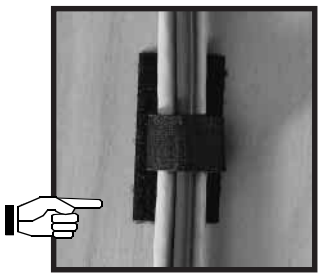
USING TIE-WRAPS



DON'T *cinch the cables tightly, especially to the point where crush-stress is visible.*

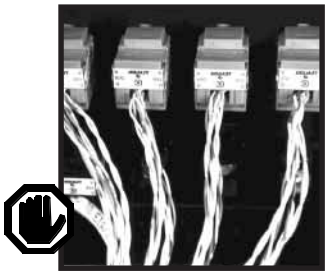


DO *tie-wrap the bundle loosely.*

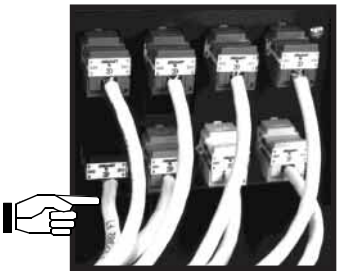


DO *use Velcro® as a flexible and reusable alternative to plastic tie-wraps to keep bundles from cinching.*

REMOVING CABLE JACKET



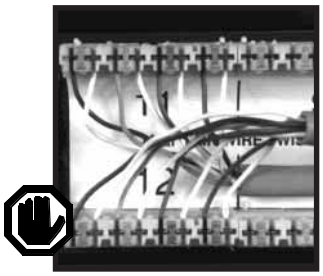
DON'T *remove too much cable jacket.*



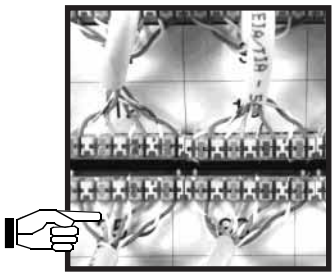
DO *retain cable jacket as close to the termination point as possible.*

CATEGORY 5 UTP INSTALLATION—DO'S AND DON'TS GUIDE

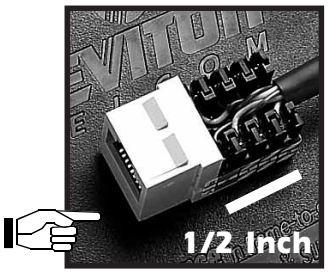
MAINTAINING PAIR TWISTS DURING TERMINATION



DON'T *untwist the cable pairs more than 1/2 inch and* ***DON'T*** *strip cable jacket back any more than you need to.*

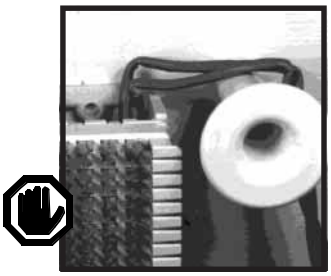


DO *maintain pair twists to within 1/2 inch of the termination point, and the cable jacket is maintained as close to the terminations as possible.*

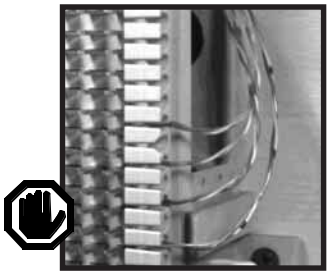


1/2 Inch Guide: *The 110 Termination Deck on Leviton jacks is 1/2" long, making it easy to assure compliance with the TIA-568-A 1/2 inch maximum untwisting rule for Category 5 cable and less than 1/2 inch maximum for Category 5e and 6. Also, the center channel helps bring the wire right up to the terminations.*

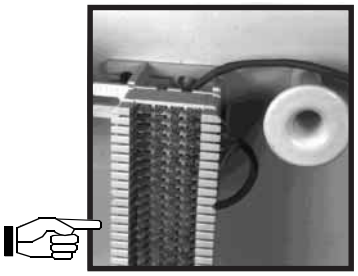
TERMINATING ONTO 66 BLOCKS



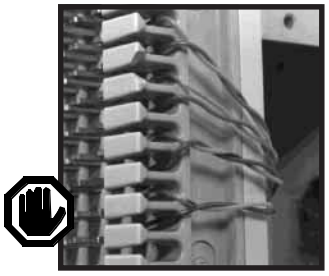
DON'T *kink or twist cables sharply.*



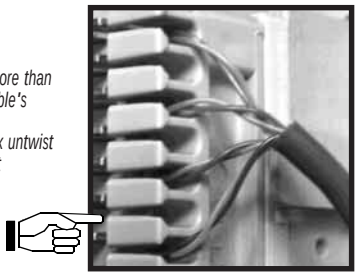
DON'T *unstrip too much cable jacket.*



DO *use cable management to avoid twisting or kinking.*

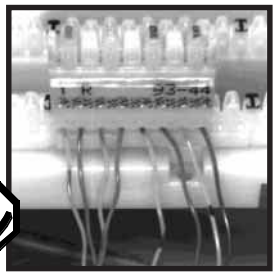


DON'T *allow pairs to untwist more than the maximum allowed for the cable's Category rating:*
Above Category 5: <1/2" max untwist
Category 5: 1/2" max. untwist
Category 4: 1" max. untwist
Category 3: 3" max. untwist

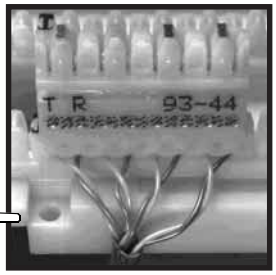


DO *maintain pair twisting close to the termination point. Route individual pairs as shown to maximize pair twisting. (Also note that the cable jacket is maintained as close to the terminations as possible.)*

TERMINATING ONTO 110 BLOCKS



DON'T *allow pairs to untwist more than the maximum allowed for the cable's Category rating:*
Above Category 5: <1/2" max untwist
Category 5:1/2" max. untwist
Category 4:1" max. untwist
Category 3:3" max. untwist



DO *maintain pair twisting close to the termination point. (Also note that the cable jacket is maintained as close to the terminations as possible.)*

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