

## RESIDENTIAL AND LIGHT COMMERCIAL INSTALLATION PRACTICES (TIA-570 COMPLIANCE)

This section covers installations on residential and light commercial premises, which are defined as having four lines or less. The governing standard for such installations is TIA-570. This section does not address multi-family premises. For information on these types of installation, please consult the TIA-570 standard. Note that at the time of this printing, TIA-570 is being revised. However, although new applications or classes of service may be defined in future revisions, guidelines for proper structured cabling installation remain the same.

### 2.1 TELECOMMUNICATIONS WIRING OVERVIEW

It used to be that only employees of the telephone company ('telco' or 'carrier') could install jacks in a premise, using standard plugs and telephone-company-provided jacks. This changed in the mid-1980's when the Federal Communications Commission (FCC) issued wiring Docket 88-57, allowing customers/installers to connect to a carrier's jack or wiring.

The following text describes, in simplified form, the basic two-wire tip and ring circuit with metallic continuity to the telco Central Office (CO). There are many configurations that operate quite differently from the example shown. Party line and nonstandard services often require telco installation and repair only.

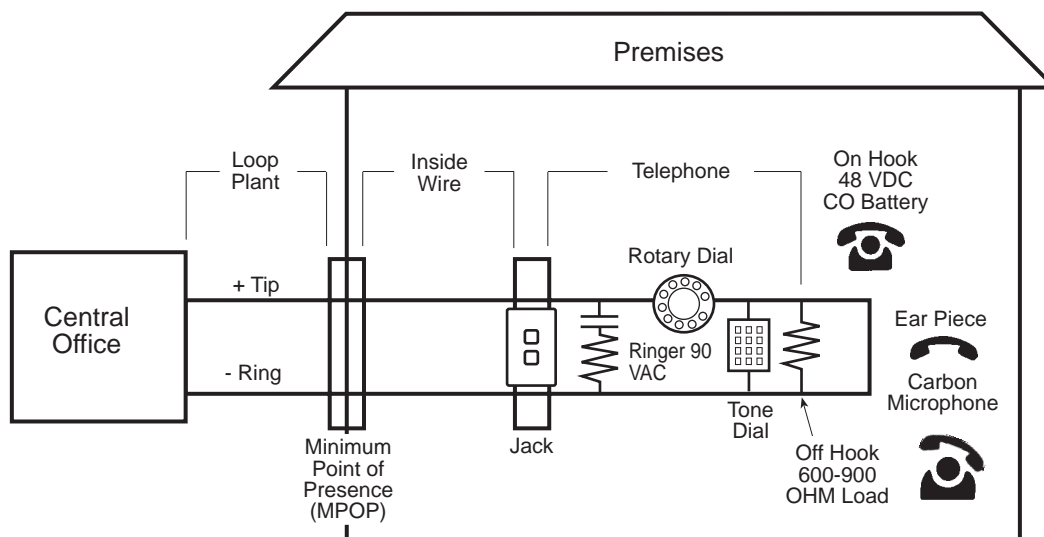
### 2.1.1 BASIC TELECOMMUNICATIONS CIRCUIT

A telco Central Office (CO) provides dialtone to a premise (telephony term for the space occupied by a customer or user in a building). Each premises "line appearance" for dialtone is usually connected to the serving CO with a dedicated pair of wires. This dedicated pair (conductors serving only the customer) is called *CO tip and ring*. (Figure 2-1.)

In the telecommunications circuit, when telephone sets are not in use (handset is "on hook"), there is normally 48 volts DC across tip and ring. This potential, called "CO battery", is highly filtered Direct Current supplied by power sources in the serving central office. When a telephone set goes *off hook* (i.e., the handset is picked up to place or answer a call), a 600-900Ω load is placed across the CO loop. This resistance load reduces the CO battery to 6-12 volts DC, which is called "talk battery." Normal loop current (off hook) is 20-90 milliamps, depending on the distance from the CO, resistance of the loop, and the number and electronic characteristics of the connected phone sets.

Calling signals are sent (numbers dialed) to the CO to place calls by one of two methods. A rotary dial, in series with the loop, makes and breaks the loop current through a contractor at a governed rate. These pulses are translated by the CO equipment to route the call. Tone dialing uses audio signals instead of pulses to transmit digits to the CO. The tone pad draws operating current from the talk battery to operate an internal tone generator

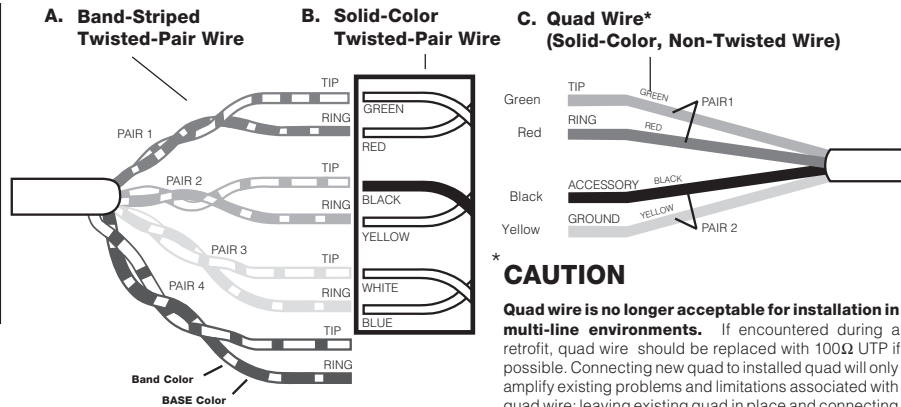
FIG. 2-1. Basic Telecommunications Circuit.



**FIG. 2-2.** Residential Telephone Wire - TIA Color Codes.

Standard 4-Pair UTP Color Codes		
PAIR 1	T	White/Blue
	R	Blue/White
PAIR 2	T	White/Orange
	R	Orange/White
PAIR 3	T	White/Green
	R	Green/White
PAIR 4	T	White/Brown
	R	Brown/White

NOTE: For 6-wire jacks use pair 1, 2 & 3 color codes. For 4-wire jacks, use pair 1 & 2 color codes.



**\* CAUTION**

**Quad wire is no longer acceptable for installation in multi-line environments.** If encountered during a retrofit, quad wire should be replaced with 100Ω UTP if possible. Connecting new quad to installed quad will only amplify existing problems and limitations associated with quad wire; leaving existing quad in place and connecting 100Ω UTP to it may also be ineffective, as the quad wire may negate the desired effect of the UTP.

For additional or commercial installation color codes see Table 3-1, page 3-7.

and amplifier that places the precise audio tones on the CO tip and ring. These tones are called DTMF (dual-tone, multi-frequency) signals. Tones are detected and processed by the CO to set up and route the call.

Incoming ringing is delivered to the premises by pulses of 90 VAC at 20-30 Hz sent down the pair from the CO. A capacitor keeps the ringer from operating except when AC ringing is present on the pair.

Note: Some telcos are installing equipment at party line residence locations to electronically convert special party line circuits to standard straight-line wiring methods. This simplifies changes and additions for customer-owned portions of the wiring system within the premises. Be sure to check with the telco on local rules and requirements.

**2.1.2 TELEPHONE WIRE**

Telephone wire carries both voice and data modulation, creating special design requirements. In order to handle these requirements, telephone wire has the following distinct characteristics:

- 1) It is normally 22 or 24 AWG;
- 2) It is always described and connected in pairs;
- 3) The two wires in each pair must be twisted together to preserve signal quality.

**2.1.2.1 The Importance of Maintaining Polarity**

Since telephone systems provide all dialing and voice functions on the polarized tip-and-ring pair with direct

current, polarity must be maintained within each pair. And the individual tip-and-ring conductors must be isolated from other tip-and-ring conductors.

**2.1.2.2 The "Pair" Concept**

Unlike electrical wiring, a telecommunications circuit requires a dedicated pair of wires. Each pair consists of a tip (+) wire and a ring (-) wire. These terms designate how each wire functions in connecting the telephone set with the telephone network.

Most residential systems will require more than a single pair to each telephone location where business lines, faxes, or modems may be in use. Future wiring changes are easier and faster if the multiple pair concept is maintained throughout the installation.

**2.1.2.3 The Reason for Twisted Pairs**

Twisted pair copper wiring is the most prevalent telecommunications media. It is relatively inexpensive, and, when installed correctly, capable of very good performance. Each pair is twisted together to prevent interference (i.e., induction and "crosstalk") from other pairs in the same cable bundle, and from outside sources like power circuits and motors.

Many newer telephones and sophisticated telephone systems will not work properly unless connected to unshielded twisted-pair (UTP) wire. Jacketed, four twisted-pair, color-coded telephone wire is recommended for all inside residential wiring (Figure 2-2).

Quad wire (four-wire, non-twisted telephone station wire) may be encountered in installations that are being expanded or changed, but it is no longer acceptable for multi-line installations. Quad wire can cause noise to be coupled onto the line. This is unacceptable, especially if multi-line use is expected to be required (which is very likely these days). **Any new telephone wire installed should be twisted-pair. If interference already exists on the wires of an installation that is being expanded or changed, it may be necessary to remove any existing quad wire, and replace it with UTP.**

## 2.1.3 TELEPHONE WIRE COLOR CODE

Many twisted pairs can be contained in a telephone cable. These cables are terminated at many different points in a telephone wiring system. Therefore, strict adherence to the color code for each connection is essential to eliminate confusion and wasted time trying to sort out nonstandard wiring.

Two color-coding systems are used to maintain separation of pairs and to indicate polarity. Both solid-color and band-striped codes are in general use.

### 2.1.3.1 Solid-color twisted pair marking

Solid-color marking for inside wiring provides distinct, single-color identification of each wire.

**Pair #1:** Green/Red (tip/ring). **Pair #2:** Black/Yellow (tip/ring). **Pair #3:** White/Blue (tip/ring). (Figure 2-2B.)

### 2.1.3.2 Band-striped twisted pair marking

The other standard telephone color-code system identifies wire with a base color of the insulation, and

a smaller band of color repeated along its length. Within each pair there is one wire that is mostly the base color, with small swatches of the band color; this is the tip wire for that pair. The other wire in the pair is mostly the band color of the first wire with small swatches of the base color; this is the ring wire for that pair (see Figure 2-2A).

Standard four-pair band-striped telephone wiring uses only five colors in distinctive combination (Figure 2-2). The color combination, coupled with the positioning of each color as either the base or the band, identifies the pair number, the tip wire, and the ring wire within the pair. (For 25-pair color coding, please see Appendix C in the back of this guide.)

**Pair #1: White/Blue.**

The tip lead is mostly white (base) with blue bands.

The ring lead of this pair is mostly blue, with white swatches.

**Pair #2: White/Orange.**

Tip mostly white, ring mostly orange.

**Pair #3: White/Green.**

Tip mostly white, ring mostly green.

**Pair #4: White/Brown.**

Tip mostly white, ring mostly brown.

The rate of twist is usually from two to six inches counterclockwise, and may be as tight as one twist in less than half an inch. The tighter the twist, the less likely it will be distorted during installation, and the greater the immunity from interference. (See Book 3, Section 3.2.3.1 for maximum allowable untwisting for each category.) *While the specification for the rate of twist varies with the anticipated data rate carried by the installation, always untwist the least amount of cable necessary to make a connection.*

In a given cable, each pair will have twisting at a different twist rate from other pairs in the same cable (bundle). This is necessary for the same reasons that twisting itself is necessary. A given cable (cable bundle) is thus a manufactured unit with a given number of pairs, not just a random group of pairs bound together in a protective sheath.



**CAUTION: QUAD WIRE IS NO LONGER RECOMMENDED FOR USE IN ANY MULTI-LINE APPLICATION.**

Quad's lack of pair twisting makes it susceptible to interference and should only be used in non-telecommunications applications such as doorbells, HVAC and perhaps security systems.

**Current standards require Category 3 UTP as the minimum grade of cable for all twisted pair residential applications,** to ensure minimum performance for home computer use and compatibility with future multimedia services. Consider installing at least Category 5.

## 2.2 GENERAL TELECOMMUNICATIONS WIRING INSTALLATION PRACTICES

It is important that the premises telecommunications wiring system be installed using the proper wiring devices and techniques. This section describes the generally

preferred methods for roughing-in and installing telecommunications wiring and information outlets.

**NOTE: The UTP installation practices in this section are basic procedures and considerations for Residential applications only. Additional UTP installation requirements for Commercial premises in compliance with TIA-568-A and Category requirements are in Book 3 of this Guide.**

## 2.2.1 TIA PREFERRED WIRING METHOD FOR RESIDENTIAL/LIGHT COMMERCIAL

The wiring method preferred by the Telecommunication Industry Association (TIA) for residential/light commercial premises is the star method (also called home run).

With star wiring, each telecommunications outlet is directly wired to the distribution device. The distribution device is a common point for terminating all distribution wire runs and for originating all inside wire runs. It provides for the connection of inside wire to distribution wire, and may also provide for the connection of control equipment in system applications. (“Inside” wire refers to four-pair UTP wire.)

The star wiring method offers many advantages. For example, if a wire is damaged during construction, the loss is confined only to that run instead of all jacks beyond the damage. Since the damaged run can be isolated, the fault can be easily located with test equipment. And if the customer wants to add additional telephone lines, the connections can be easily made at the distribution device, so there is no need to remove, rewire, and replace jacks.

Fixed devices such as intercoms, security systems, sensors and smoke detectors may be wired in a star, loop or daisy chain configuration.

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.

## 2.2.2 ROUGHING-IN CORRECTLY

The following are general rules for running cable, whether residential, light industrial or commercial:

- **Always make a quick check for shorts, opens, and ground when the rough-in is completed.**

Lightweight telephone wiring is much easier to damage than other cable types. The jacket can be caught on sharp edges or nail points and inside conductors grounded, shorted, or broken. It will take just a few minutes to ensure that no connections were forgotten and that no wiring was damaged as it was pulled in or secured during rough-in.

- **Do not splice wires on the cable runs.** Pull a new wire if things go wrong.
- **Do not exert more than 25 pounds of pulling tension on 4-pair cables.** Larger capacity cables should be pulled as per the manufacturer’s directions.
- **Do not run cables in parallel with power wiring.** See Table 2-1 for minimum separation of telecommunications cable from interference sources.
- **Do not bend cable sharply** or nick the protective sheath over the insulated wires.
- **Maintain polarity** (i.e., carefully match wire colors) of the Tip (+) and Ring (-) pairs from the demarcation point to the outlets. Polarity reversal causes problems with some telephones and most data devices.
- **To provide compatibility with two-line telephones, wire up the two inner pairs of a jack.** If using the recommended 4-pair jack with industry standard wiring, this is automatically included.
- **Use plastic non-metallic-type staples** to support wire, and leave the wire loose inside the staples—do not drive staples all the way in. Driving staples in tightly may crimp wire and damage the insulation or wire, impairing its ability to carry voice/data.
- **If conduit is installed, always leave a pull cord in** to facilitate running new wire.
- **Never run power in the same conduit with telecommunications cable.** Only low-voltage monitor and control lines may share conduit with telecommunications.
- **Avoid undercarpet runs if possible,** as they are inherently more susceptible to damage, particularly in residences. If they must be installed, follow the manufacturer’s directions carefully, and remember that only one transition from one type of cabling to another is standard in a single room. Avoid installing undercarpet runs in damp areas. Note that undercarpet power cables are not allowed in residential installations.
- **Where possible, use inner walls for runs to avoid conflict with firebreaks and insulation.** Inner-wall wiring also makes it a lot easier to replace wires if necessary, or to add wires. Nonetheless, wiring

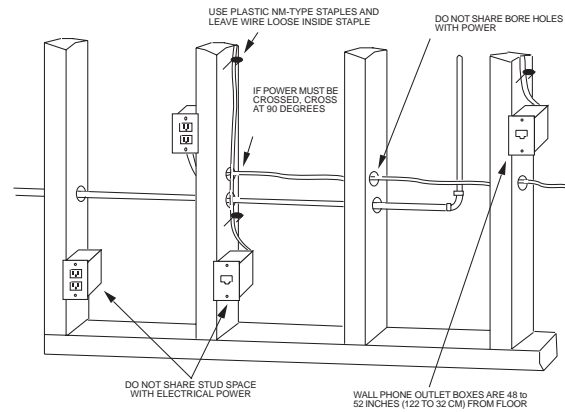
through external walls is not always avoidable, so installation handling should be the same as for electrical wire.

- **Do not run telecommunications wire parallel to power wiring without adequate separation. Instead, cross them at 90° angles, and do not share bore holes with power wires** (see Fig. 2-3 & Table 2-1).
- **Keep wire away from sources of heat**, like hot water pipes and heater ducts, and glass walls subject to direct sunlight.
- **Avoid running external wires**—they are not desirable, both for appearance and safety reasons. Wires on the outside of a building may be allowed under local code for additions, but should be avoided for initial installations.
- **Leave 18 inches of spare wire at outlets and connection points** for connections and changes.

**TABLE 2-1.** Minimum Separations Between Residential & Light Commercial Telecommunications Wiring and Other Wiring.

Purpose	Type of Wire Involved	Minimum Separation
Electric Supply	Bare light or power of any voltage.	5 feet
	Open wiring not over 300 volts.	2 inches
	Wires in conduit, or in armored or non-metallic sheath cable/power ground wires.	None
Radio & TV	Antenna lead & ground wires without grounded shield.	4 inches
Signal/Control Wire	Open wiring not over 300 volts.	None
CATV Cables	Community television systems coaxial cables with grounded shield.	None
Telephone Service Drop Wire	Aerial or buried.	2 inches
Sign	Neon signs and associated wiring from transformer.	6 inches
Fluorescent Lighting	Fluorescent lighting wire.	5 inches
Lightning System	Lightning rods and wires.	6 feet

**FIG. 2-3.** Interstud Wiring.



- **Firestopping, bonding, and grounding must be performed according to fire, building, and electrical codes that apply.** This document does not cover those issues, but a resource list for such documents is provided in Appendix E of this Guide.

Regardless of the installation type, proper wiring requires good planning and careful work to avoid damaging cables and to make good connections.

### 2.2.3 RESIDENTIAL TELECOMMUNICATIONS OUTLETS

For residential applications, the 8-position jack, wired to T568A pin/pair assignment is recommended. It must accept 6-position plugs.

- **When installing outlet boxes on wooden studs, it is important to maintain proper separation of communications and power cables** (see Table 2-1). These two types of cables should not share drill holes or stud spaces. Desk telephone jacks should be located at the same distance from the floor as electrical outlets. (See Figure 2-3.)
- **Any data outlet should, at minimum, be served by one 100Ω UTP cable in addition to any voice cabling at the same outlet.**
- **Consider the potential layout of furniture in a room when positioning outlets.** The standard for line cords is 10 feet or less and that should be taken into account. In offices it is desirable to place outlets on opposing walls in the event furniture is rearranged.

BOOK

# 2

RESIDENTIAL AND LIGHT COMMERCIAL APPLICATIONS

EIA/TIA 570

Compliant Installation

### 2.2.3.1 Recommended Cabling Systems

Standards Proposal 3490-A is a proposed modification of TIA-570. It proposes different grades of residential cabling depending on the services supported within a residence. Typical services available cover a broad range including telephone, data, video, multi-media, home automation systems, environmental control, security, audio, television, sensors, alarms and paging.

**Grade 1** Cabling supports telephone, CATV and data applications. Minimum cable requirements are a four-pair 100 ohm UTP that meet or exceed Category 3 transmission requirements and 75 ohm coaxial cables.

**Grade 2** Cabling supports all that Grade 1 supports, as well as multimedia applications including fiber optic wiring. Minimum cable requirements consist of four-pair 100 ohm UTP cables that meet or exceed requirements for Category 5 cable and 75 ohm coaxial cables. Two strand 62.5/125 $\mu$ m optical fiber cable is an optional cable for Grade 2 installations.

For full compliance, jacks must be wired to the T568A or T568B pin/pair assignment, and all four pairs being terminated.

### 2.2.3.2 Recommendations for Distribution Device Areas

The size and spacing of residential distribution devices is determined by the grade of service and number of outlets. (see Table 2-2). All distribution devices should either be mounted on 3/4" plywood backboard or within a recessed stud space.

Electric power at the distribution device is required by both Grades 1 and 2.

**TABLE 2-2.** Minimum Space for Distribution Device.

Number of Outlets	Grade 1	Grade 2
1 to 8	41 cm (16") wide 61 cm (24") high	81 cm (32") wide 153 cm (60") high
9 to 16	81 cm (32") wide 92 cm (36") high	81 cm (32") wide 153 cm (60") high
17 to 24	81 cm (32") wide 107 cm (42") high	92 cm (36") wide 153 cm (60") high
More than 24	81 cm (32") wide 153 cm (60") high	92 cm (36") wide 153 cm (60") high

## 2.2.4 CONNECTOR TERMINATIONS

There are two basic types of technology used for connection of individual wires to telecommunications information outlets: binding post or insulation displacement (IDC).

### 2.2.4.1 Binding Post Connections

Binding post (screw terminal) connections (Fig. 2-4) are the most common method for terminating residential wiring to an outlet. A screw and washer are used to secure the individual stripped wire leads. They are usually used where only a few terminations are necessary because they are time-consuming to install.

- **Be careful not to nick the inner copper conductors when stripping wire.** As with standard electrical screw terminal connections, copper conductors should be wrapped clockwise between two washers.
- **Be sure the wire does not get caught in the screw threads,** as it may break. It may then appear to be connected only because the insulated portion is trapped by the washers. Many "opens" appearing after device installation can be traced to broken inside copper conductors in connections that appeared sound because the plastic insulation was secured between washers. Overtightening can also break the conductor.
- **Trim off any excess exposed bare wire.** Spade lugs should be connected between the head of the screw and the first (top) washer. Binding posts are not designed to accept more than two or three wires under a single screw.

**FIG. 2-4.** Binding Post Connection.



- **Avoid sloppy device termination, which often causes wire faults such as crosses and shorts.** Stripping too much wire and failing to inspect the connections carefully can lead to these faults. Often the fault does not appear until after the plate has been secured by screws and the wad of wire in the box pushes against the rear of the device.
- **Always leave plenty of spare wire at each point** to permit remaking damaged or faulted connections later. Carefully "dress" your connections so that spare conductors will remain clear of terminated connections and will not become grounded or crossed when attaching the device or straps with screws.

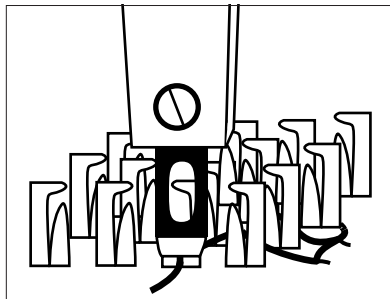
- **Do not tighten binding posts with more than 7 pounds of torque** because the threads may strip and make the post useless.

### 2.2.4.2 Insulation Displacement Connectors

The insulation displacement connector (IDC) method is generally perceived to be faster and more reliable than binding post connections. The conductor is not stripped but forced into a terminal strip containing sharp inside edges that pierce the insulation and make a solid electrical and mechanical connection. The wire is held tightly between two metal contacts, forming a gas-tight seal. Most insulation displacement systems require special tools for punch-down (see Fig. 2-5).

A gas-tight IDC termination eliminates the chance for bi-

**FIG. 2-5.** Punched-Down IDC Connections (shown on a 66-clip block).



metal corrosion which exists with screw terminal devices where a bare copper conductor and a screw of a different material (usually zinc plated) are connected in the presence of oxygen from the surrounding air.

There are several styles of IDC's, each using different methods of operation. The most common IDC types are 66 clip and 110. There are also several other types on the market, but regardless of type, all use similar methods of insulation displacement connection using various punchdown tools. The wire is forced between two surfaces (usually with a special punchdown tool) and the insulation is pierced, cut or displaced.

All IDC types are designed for relatively permanent connection; if changes have to be made, the wire must be removed and the connector cleaned of all metal and insulation material before the wire can be cut off and reinstalled. Assure that the type used is appropriate for the application in size (capacity) and rating; **IDC termination is specified for compliance with TIA-568-A Category 3, 4 or 5 (see Book 3).**

#### 2.2.4.2.1 66 Clip Connecting Blocks

These industry-standard blocks (Fig. 2-6) can be used as a distribution device or in equipment rooms to connect voice and data network wiring to customer premise

**FIG. 2-6.** 66-Clip Connecting Block.



equipment. They are also used in remote and intermediate wiring closets throughout larger installations as common connecting points for nearby equipment. Some products employ IDC blocks at the station as well.

#### 2.2.4.2.2 110 Connector Blocks

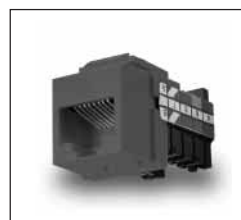
**FIG. 2-7.** 110 Connecting Block.



Another form of insulation displacement connection is the 110 connector block (Fig. 2-7). These blocks can be used as a distribution device or in wiring closets and equipment rooms. Each 110 IDC unit contains double-ended insulation displacement quick clips that terminate 22-26 gauge solid wire. These clips provide gas-tight connections and are fully enclosed in non-conductive plastic to eliminate the possibility of accidental contacts or "hits" on sensitive circuits. A 110 punchdown tool is required for proper installation.

#### 2.2.4.2.3 Category-Compliant Jacks with 110 IDC Connectors

**FIG. 2-8.** 110 IDC-Terminated Jack.



These individually housed jacks (Fig. 2-8) are installed in voice and data information outlets, providing a direct termination between the station wiring and the jack contacts. Using a jack with 110-type insulation displacement connectors eliminates the need for an

intermediate block connection, and ensures solid, undisturbed terminations. IDC termination is specified for compliance with TIA-568-A.

### 2.2.5 JACKS

A jack is a receptacle for standard telephone equipment to plug into. Jacks can be wired in a variety of ways to satisfy individual requirements of a particular application. (Note: connectors for fiber optic cable are covered in Book 4.)

### 2.2.5.1 Wiring Jacks For Residential Applications

The EIA/TIA-570 standard, when revised, will recommend the use of 8-conductor jacks only. However, the use of 4-conductor and 6-conductor jacks is still widespread in residential applications. Leviton strongly recommends that at least Category 5 wiring and devices be used for all residential and light commercial telecommunications wiring. This Category of cable will allow the building occupants great future flexibility for the usage of the telecommunications wiring.

While the recommended standard is to follow the TIA wiring scheme, there are (and will continue to be) telecommunications equipment (i.e., phones, fax machines, etc.) that utilize different wiring schemes. While a T568A/B wiring pattern is recommended for current and future installations, the use of USOC codes does continue today. Information on USOC codes is provided in Appendix D should you run across them in your work.

In general, residential applications are wired with one or sometimes two jacks per room. Older, more traditional style residential jacks are wired with screw terminals, but some of the newer style modular jacks are wired with insulation displacement systems. Typically, for small jacks, a special termination tool is provided that has limited life. Be sure to follow the manufacturer's directions for termination, and use the proper tool.

**Note: For terminating a jack with IDCs, a screwdriver blade will NOT do the job properly—in fact, it will cause more problems.** Also, if things go wrong or changes need to be made, you need to remove the wire and any shreds of insulation material and re-terminate.

### 2.2.5.2 Wiring Jacks For Light Commercial Applications

Light commercial applications typically use eight-position jacks, and are wired for at least two jacks at every workstation. Commercial applications are wired this way also; see Book 3 for TIA-568-A compliant installation practices.

- **In general, all light commercial jacks should be wired to the TIA-568-A standard wiring pattern 'T568A' or 'T568B'** (unless specific circumstances dictate that other wiring schemes be used). These will accommodate both six-position USOC plugs and ISDN applications, as well as most common commercial applications. (See Fig. 2-9.)

**Note On USOC Codes:** Be aware that with regard to wiring 8-conductor jacks, there are two separate industry wiring standards often called USOC. Basically, two USOC codes have evolved: the original USOC code developed before the FCC issued a code, and the USOC code RJ61X later registered by the FCC. The only difference between the two is that the pair consisting of pins 1 and 8 is reversed. A mix-up can cause a system to work improperly, and require additional labor for troubleshooting and re-wiring.

Since the two wiring patterns are often called by the same general name 'USOC', it is important to verify the pin-outs of the required wiring configuration where a USOC code is required, and use the more specific term RJ61X where that wiring pattern is desired.

USOC (Generic)			RJ61X		
Pin Desig.	Jack Pin #	Wire Color	Pin Desig.	Jack Pin #	Wire Color
T1	5	Wht/Blue	T1	5	Wht/Blue
R1	4	Blue	R1	4	Blue
T2	3	Wht/Orange	T2	3	Wht/Orange
R2	6	Orange	R2	6	Orange
T3	2	Wht/Green	T3	2	Wht/Green
R3	7	Green	R3	7	Green
T4	8	Wht/Brown	T4	1	Wht/Brown
R4	1	Brown	R4	8	Brown

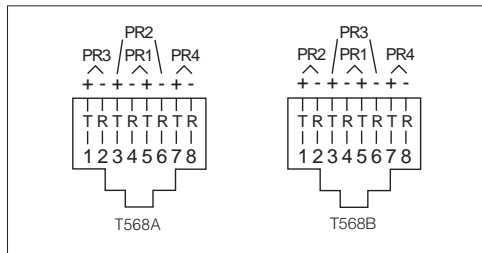
Both T568A and T568B wiring will accommodate standard telephone sets, ISDN, and most data line phones.

- **Install jacks at the same height as electrical outlets.** Wall-mount phone jacks should be 48 to 52 inches from the floor.
- **Cover unused wallboxes with a blank wall plate** to protect and mark their location.

## 2.3 GENERAL TIPS ON INSTALLING MODULAR CABLES & JACKS

- **Six-position modular cables from the wall to the telephone or other equipment are typically "frogged" or "mirror image" on each end**—and that is OK because the equipment expects that.
- **The jack (and plug) of the handset of the phone is usually smaller than the one that goes from the wall to the phone; typically a four position plug.**
- **"Tinsel" and stranded wiring is used between the wall and most phones and other devices because it is more flexible than solid wire.** Stranded wire is used for extension cords, distribution cords and patch cords.

**FIG. 2-9.** T568A and T568B Compliant Wiring Configurations



- **Wire each jack to be standard T568A or T568B unless good reason exists to do otherwise** (for example, the jack has only six conductors, or the equipment requires a different wiring scheme to operate). External adapters are preferred for odd requirements, like splitting out a line for two pieces of equipment (phone and answering machine, for example). Standard wiring is easier to troubleshoot and less likely to result in confusion later.

**IMPORTANT:** For your protection, please read and understand all installation warnings and cautions on page 1-6.

**NOTE:** Information on compliance with TIA-606, the Wiring Administration standard, can be found in Book 3.

## 2.4 GENERAL TIPS ON QUALITY INSTALLATIONS

- **Every connection degrades system performance, so use the minimum necessary.**
- **Better to provide excess capacity in terms of cable and outlets than not enough.** Later additions are costly and time consuming.
- **Wire to the highest anticipated data rate (speed) or greater—never less.**
- **Never install components of unknown/questionable origin or quality.** At the very best, the system will transmit signals to the level of its weakest component. Every element and connection is important.
- **Document all connections carefully, and keep installations neat and tidy.** This will save time and hassle when modifying or troubleshooting the system later.
- **Test everything.**

## 2.5 RESIDENTIAL WIRING DIAGRAMS

The following illustrations are provided as a basic guideline for various residential wiring systems.

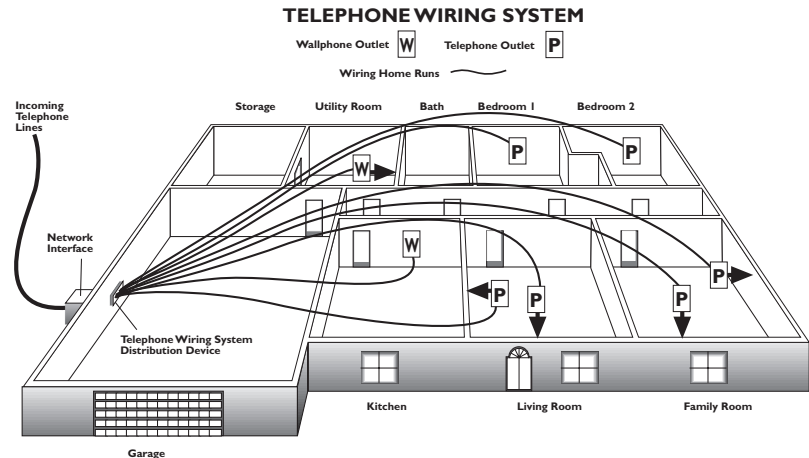
Each illustration shows a simple residence with a single wiring system depicted. For each wiring system, the following topics are addressed: *cable type*, *terminations*, *wiring topology*, *connectivity* (i.e. how devices are attached to the wiring) and *other considerations*.

Of course, each installation will call for its own special wiring requirements. Use these diagrams as a starting point while planning each wiring system for a particular job.

The distribution devices mentioned for each system are typically co-located in a garage or other utility area of the home. For a discussion of the size requirements for distribution device backboard, see Table 2-2. Other considerations for the distribution device location include access to electrical power, surge protection and access to electrical ground (<1.5 meters or 5 feet).

For new construction, it is recommended that cable be run in concealed pathways. Consider using conduit for cable pathways to allow for pulling additional wiring in the future. For retrofits of an existing structure, conceal the wiring in attics or crawl spaces wherever possible. For exposed retrofit cabling, enclose the cables in protective surface-mount raceway.

Finally, consider installing wire in areas such as attics, basements, bathrooms, etc. Requirements for wiring in unusual areas will be dictated by different factors for each job.



### TELEPHONE WIRING SYSTEM

**Cable Type:** 4 pair 100 Ohm UTP—Category 3 minimum, for Grade 1 installations; Category 5 for Grade 2 installations.

#### Terminations:

**Outlet End:** 8 position Category 5 jack with T568A wiring (or may use T568B). Minimum of one voice jack per outlet. Other outlets in same room must be separate home runs.

**Distribution End:** Bridged or unbridged termination modules, or punch-down block for a more versatile system.

**Topology:** Home run (star wired) from common distribution point.

**Connectivity:** Phones plug in at the outlet, incoming dial tone pairs punch down and are routed at distribution device.

**Other Considerations:** Consider flexible assignment of dial tone sources to various rooms. Consider breaking out individual pairs at outlets using external breakout box. Consider additional requirements for key telephone system, etc. Install a wall phone jack in kitchen and at least one voice outlet in each bedroom. Consider extra outlets in larger rooms, or in rooms where furniture arrangements may dictate requirements for outlets on two or more walls.

## DATA WIRING SYSTEM

**Cable Type:** 4 pair 100 Ohm UTP— Category 3 minimum for Grade 1 installations, Category 5 for Grade 2 installations.

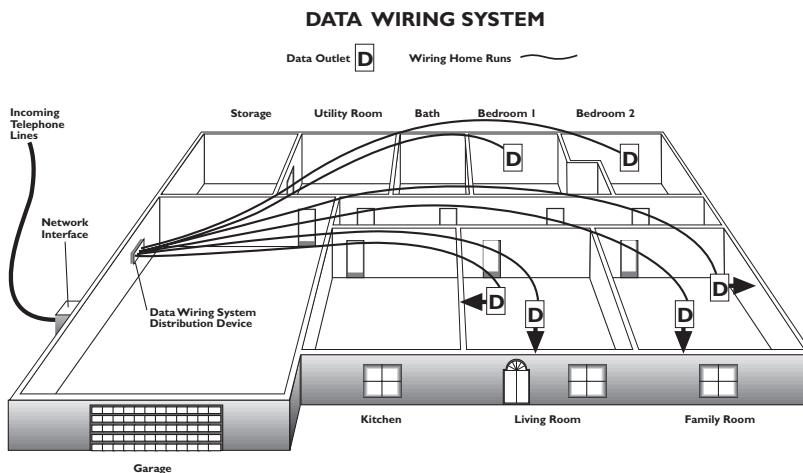
**Terminations:**

**Outlet End:** 8 position Category 5 jack with T568A wiring (or may use T568B). Minimum of one data jack per outlet. Other outlets in same room must be separate home runs.

**Distribution End:** Unbridged module, Category 5 patch block (or Category 5 patch panel) or individual Category 5 jacks mounted in a housing, bracket or panel T568A wiring (or T568B may be used). Wiring must match the wiring at the outlet.

**Topology:** Home run to common distribution point (usually same area as telephone wiring system distribution point)

**Connectivity:** Patch cords from hub to panel/block/etc. at distribution end; patch cords from outlet to data terminal network connection (i.e. the NIC card jack).



**Other Considerations:** Local Area Network data hub mounts on wall near distribution device. Install a data jack in each bedroom. Consider extra outlets in larger

rooms, in home office areas, or in rooms where furniture arrangements may dictate requirements for outlets on two or more walls.

## AUDIO/VIDEO (BASEBAND) SYSTEM WIRING

**Cable Type:** 2 or 4 conductor stranded, low-inductance audio wire per speaker—for high power applications. For low power applications, shielded, line level cables of various types for audio/video signals.

**Terminations:**

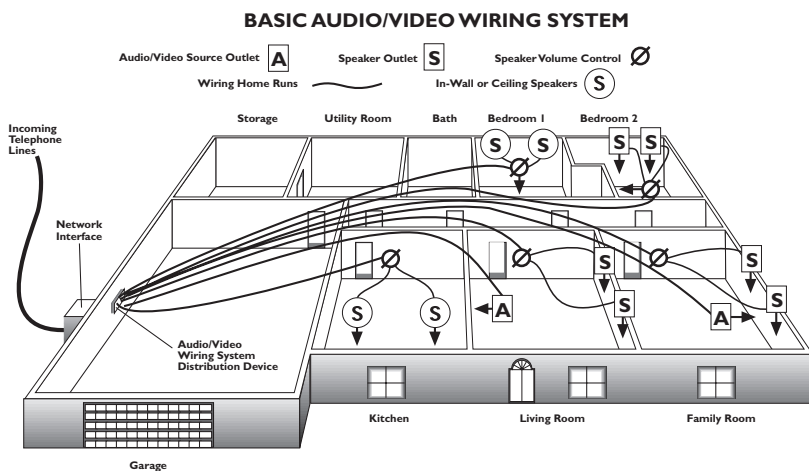
**Outlet End:** Binding posts, banana jacks, RCAs or push/insert type connectors in wallplates.

**Distribution End:** Varies depending on audio/video distribution unit.

**Topology:** Home runs from potential entertainment system locations to audio/video distribution unit. Home runs from in-wall speakers, ceiling speakers, or audio/video outlets via speaker volume controls to audio distribution unit. Audio/video wiring distribution point may be co-located with voice/data/video distribution devices, or may be near the entertainment center location, or other convenient location as a sub-system.

**Connectivity:** Jumper cables from outlets to free-standing speakers and/or patch cords and cables to audio/video components. Wires terminate directly into audio/video distribution unit at distribution end.

**Other Considerations:** The audio/video distribution unit may be an electronic device which allows flexible assignment of multiple sets of speakers to one or more audio/video sources.



BOOK

# 2

RESIDENTIAL AND LIGHT COMMERCIAL APPLICATIONS

EIA/TIA 570 Compliant Installation

## VIDEO (BROADBAND) SYSTEM WIRING

**Cable Type:** RG6 Quad shield 75 Ohm coaxial cable recommended. Two runs of coax to each TV outlet location recommended (single run to front door camera location and other like locations; two runs to attic or roof for satellite). Also see "Other Considerations" below.

**Terminations:** Male F-type connector at both ends of cable. Threaded F-type fittings are recommended to reduce noise. Push-on type F-fittings are not recommended (except special high-quality push-ons.)

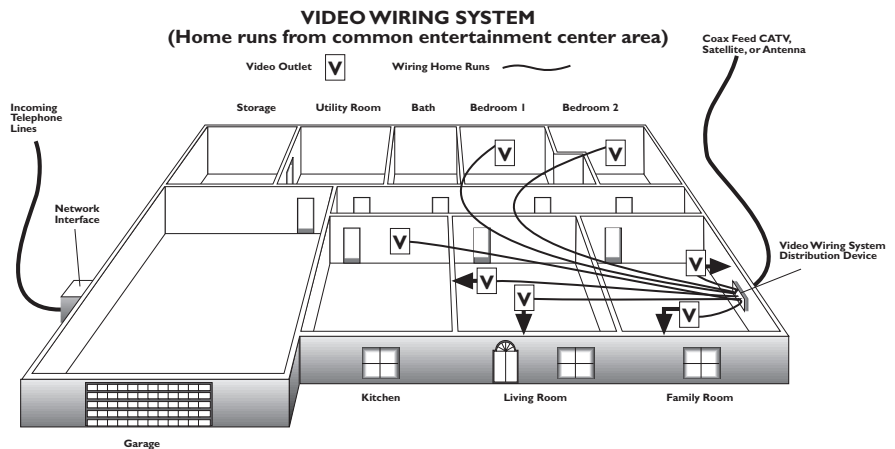
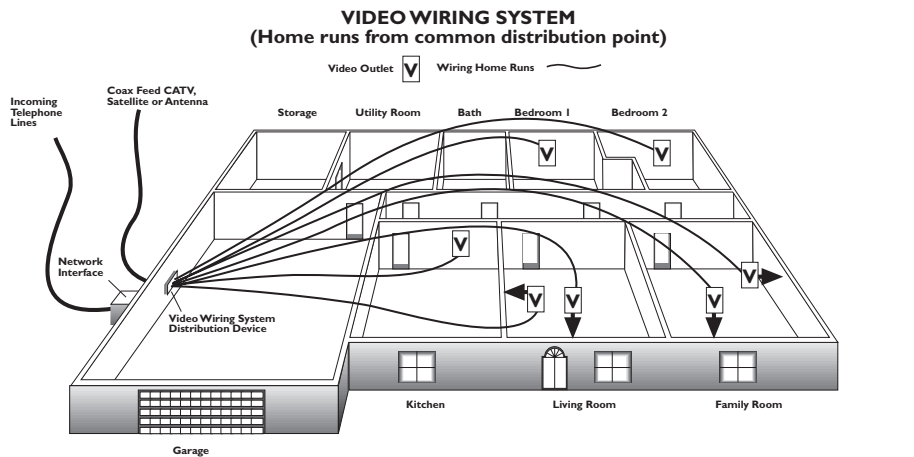
**Outlet End:** Attached to the rear side of the outlet (which contains a female-female F-type coupler).

**Distribution End:** Male F-type Connector.

**Topology:** Home run to common distribution point. This distribution point may be same area as voice/data wiring system distribution point or may be the entertainment center location (home theater room or family room, etc.)

**Connectivity:** At outlet end, coaxial 75 ohm patch cords extend from outlet to video device (TV, VCR, etc.) At distribution end, male F-type connectors plug directly into video service unit, splitters, etc.

**Other Considerations:** A video service unit, splitter(s), and/or amplifiers may be located at the video wiring system distribution point. Utilize 75 ohm termination caps at idle outlets. In lieu of RG6 coaxial cable, high-quality 100 ohm Category 5 UTP cable may be used for video distribution with suitable adaptive devices. (Coax-to-UTP



converters may be required at both ends of each cable run.) Install a video outlet in each bedroom. Consider extra outlets in larger rooms, or in rooms where video equipment may have several location options. Two runs of RG6 allow for video distribution from any video source as well as distribution to a TV at each outlet location, and RG6 coax

may become a medium for data application. Another possibility is that fiber optic cable may eventually become a medium of choice for some audio/video applications.

## FIBER OPTIC WIRING SYSTEM

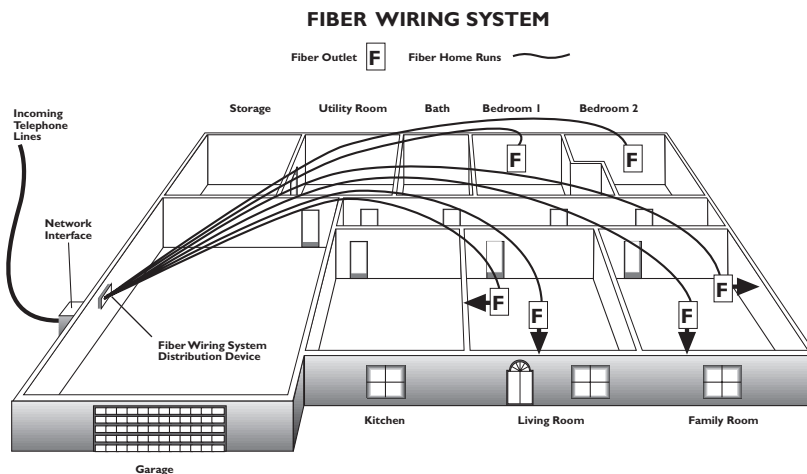
**Cable Type:** 2-strand, 62.5/125mm multimode fiber optic cable.

**Terminations:** Two individual ST-type connectors (male) at each end of cable or two individual SC-type connectors (male) at each end of cable. These plug into wallplate-mounted couplings (2 STs or duplex SC) at the outlet end, and plug into panel mounted couplings at the distribution end.

**Topology:** Home run (star-wired) from common distribution point (co-located at the data distribution point).

**Connectivity:** Fiber optic patch cords at both ends.

**Other Considerations:** Fiber optic applications are not currently in common use in the residential



market. Cabling with fiber, however, gives the user a versatile, high-bandwidth, cabling system that may provide much future capability. As a cost savings, fiber optic cable is often left unterminated. "Service loops" may be stored behind the

outlet wallplate, and at the fiber optic wiring system distribution device. The fiber optic cable may be terminated and mounted in wallplates and at the distribution device when needed.

BOOK

# 2

RESIDENTIAL AND LIGHT COMMERCIAL APPLICATIONS

EIA/TIA 570 Compliant Installation

## BASIC SECURITY WIRING SYSTEM

**Cable Type:** Any copper communication cable

**Terminations:** Loops terminate on connections in alarm panel. Alarm panel wires to an RJ31X jack for incoming/outgoing security line connections.

**Topology:** Daisy chain security loops intercept all windows, external doors, motion detectors and smoke detectors.

**Connectivity:** Connections to sensors, detectors, etc. are permanent connections and will be dependent upon the type of device implemented.

**Other Considerations:** A touch pad, mounted in a convenient location is used to turn alarm system on/off or to set user

programmable options. Note: This diagram/description is provided as an example only. Please refer to security system manufacturers' recommendations for cabling requirements.

