TIA-570-B

Residential Telecommunications Infrastructure Standard

Draft 3.0

August 8, 2003

NOTICE:

This contribution has been prepared to assist the TR-42 Engineering Committee. It is offered to the Committee as a basis of discussion and is not a binding proposal on the members of the TR-42.2 Residential Infrastructure Subcommittee. The proposed requirements presented in this document are subject to change in form and technical content after more study. Members of the TR-42.2 Subcommittee specifically reserve the right to add to, or revise, the statements contained herein.

This document is a working draft for review and use by the TR-42.2 Residential Infrastructure Subcommittee members only. It is intended to serve as the basis for discussion and further development of TIA-570-B.

Residential Telecommunications Infrastructure Standard

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Foreword

(This foreword is not part of this Standard)

Approval of this Standard

This Standard was approved by TIA/EIA Subcommittee TR-42.2, TIA/EIA Technical Engineering Committee TR-42, and the American National Standards Institute (ANSI).

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 At that time, standards are reaffirmed, rescinded, or revised according to the submitted updates.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

Contributing organizations

More than 30 organizations within the telecommunications industry contributed their expertise to the development of this Standard (including manufacturers, consultants, end users, and other organizations).

Documents superseded

This Standard replaces ANSI/EIA/TIA-570-A, published September 1999.

This Standard incorporates and refines the technical content of:

- ANSI/TIA/EIA-570—A-1, Residential Telecommunications Cabling Standard; Addendum 1 – Security Cabling for Residences.
- ANSI/TIA/EIA-570—A-2, Residential Telecommunications Cabling Standard; Addendum 2 – Control Cabling for Residences.
- ANSI/TIA/EIA-570—A-3, Residential Telecommunications Cabling Standard; Addendum 3 – Whole-Home Audio Cabling for Residences.

Significant technical changes from the previous edition

- Incorporation of the above mentioned addenda.
- Definitions have been harmonized across all of TIA's telecommunications infrastructure standards. The term "floor serving terminal" has been replaced with the term "multi-dwelling unit-telecommunications room.
- Copper cabling includes recommendations for use of category 6 performance.
- The permanent link has replaced the basic link as a test configuration when testing to characterize full category performance.
- Administration has been added to this Standard.
- Annex B contains an installation guide and Annex C provides an application guide.

Relationship to other documents

A useful supplement to this Standard is the Building Industry Consulting Service International (BICSI) *Residential Network Cabling Manual*. This manual provides practices and methods by which many of the requirements of this Standard are implemented.

The National Electrical Code (ANSI/NFPA 70) contains requirements for telecommunications pathways and cabling within buildings that govern the use of this Standard. The National Electrical Safety Code (ANSI/IEEE C2) also contains requirements for telecommunications pathways and cabling between buildings that govern the use of this Standard.

Other references are listed in Annex D.

This Standard does not replace any code, either partially or wholly. The reader should also be aware of applicable codes that may impact the use of this Standard.

Annexes

Annexes A, B, C and D are informative and not considered as requirements of this Standard.

INTRODUCTION

Purpose

The purpose of this document is to standardize requirements for residential telecommunications infrastructure. These requirements are based on the facilities that are necessary for existing and emerging telecommunications services. Within this Standard, services are correlated to grades of cabling for single-dwelling residences. The cabling infrastructure specifications within this Standard are intended to include support for voice, data, video, home automation systems, environmental control, security, audio, television, sensors, alarms and intercom. This Standard is intended to be implemented for new construction, additions, and remodeled single- and multi-dwelling residential buildings.

Mandatory and advisory terms

In accordance with EIA Engineering Publication, EP-7B, two categories of criteria are specified: mandatory and advisory. Mandatory requirements are designated by the word "shall"; advisory requirements are designated by the words "should, "may", or "desirable", which are used interchangeably throughout this Standard.

Mandatory criterion generally applies to performance and compatibility requirements. Advisory criterions represent:

- A performance or compatibility goal towards which future designs should strive, or
- A recommended method for meeting a performance or compatibility requirement.

Metric equivalents of US customary units

The majority of the metric dimensions in this Standard are soft conversions of US customary units; e.g., 100 mm is the soft conversion of 4 inches.

Conduit dimensions have been replaced by their respective electrical trade size nomenclature. For example, 21 (3/4) trade size conduit refers to a conduit with a metric designator of “21” and an English trade designator of “3/4”. Units (mm, in) are not included with the designator – it is understood that the metric designator is in millimeters and the English designator is in inches.

Life of this Standard

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

1 SCOPE

1.1 Applicability

This Standard applies to telecommunications premises cabling systems and the related pathways and spaces for single- and multi-dwelling residential buildings. It applies to the telecommunications cabling within or between structures and includes the cabling within a living unit and the backbone cabling. It specifies cabling systems intended to support a wide range of telecommunications applications in the residential environment including voice, data, video, security, audio, and control systems.

This Standard is intended to be in conformance with Part 68 of the FCC Rules and Regulations, the National Electrical Code, and the National Electrical Safety Code. Cabling shall comply with applicable local codes and regulations, which shall take precedence over the requirements in this Standard.

1.2 Normative references

The following standards contain provisions that, through reference in this text, constitute provisions of this Standard. At the time of publication of this Standard, the editions were valid. All standards are subject to revision; parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of standards indicated. ANSI and TIA maintain registers of currently valid national standards published by them.

a) ANSI/ICEA S-89-648-2000, *Telecommunications Aerial Service Wire*

b) ANSI/IEEE C2-2002, *National Electrical Safety Code*

c) ANSI/J-STD-607-A-2002, *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications*

d) ANSI/NFPA 70-2002, *National Electrical Code*

e) ANSI/SCTE 01 1996R2001, *"F" Port (Male Feed Thru) Physical Dimensions*

f) ANSI/TIA/EIA-568-B.1-2001, *Commercial Building Telecommunications Cabling Standard; Part 1: General Requirements*

g) ANSI/TIA/EIA-568-B.2-2001, *Commercial Building Telecommunications Cabling Standard; Part 2: Balanced Twisted-Pair Cabling Components*

h) ANSI/TIA/EIA-568-B.3-1999, *Optical Fiber Cabling Components Standard*

i) ANSI/TIA/EIA-569-B-2003, *Commercial Building Standard for Telecommunications Pathways and Spaces*

j) ANSI/TIA/EIA-606-A-2002, *Administration Standard for Commercial Telecommunications Infrastructure*

k) ANSI/TIA/EIA-758-A-2003, *Customer-owned Outside Plant Telecommunications Infrastructure Standard*

l) ANSI/TIA/EIA-968-A-2002 *Telephone Terminal Equipment; Technical Requirements for Connection of Terminal Equipment to the Telephone Network*

m) ATIS, Committee T1, T1.TR.05-1999, *Network and Customer Installation Interface Connector Wiring Configuration Catalog*

n) IEC 60603-7, 1996, *Detail Specification for Connectors, 8-Way, Including Fixed and Free Connectors with Common Mating Features*

o) SCTE, IPS-SP-001, June 13, 1996, *Flexible R.F. Coaxial Drop Cable*

2 DEFINITION OF TERMS, ACRONYMS AND ABBREVIATIONS, UNITS OF MEASURE, SYMBOLS

2.1 General

This clause contains definitions of terms, acronyms, and abbreviations, units of measure, and symbols that have a special meaning or that are unique to the technical content of this Standard. The terms that are used in only one clause may be defined within, and at the beginning of, that clause.

2.2 Definition of terms

The generic definitions in this clause have been formulated for use by the entire family of telecommunications infrastructure standards. Specific requirements are found in the normative clauses of this Standard. For the purposes of this Standard, the following definitions apply.

access line: A telecommunications circuit provided by a service provider at the demarcation point.

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

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

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

(1) different sizes or types of plugs to mate with one another or to fit into a telecommunications outlet,

(2) the rearrangement of leads,

(3) large cables with numerous wires to fan out into smaller groups of wires, and

(4) interconnection between cables.

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

antenna entrance: A pathway facility from the antenna to the associated equipment. (569)

attenuation: The decrease in magnitude of transmission signal strength between points, expressed in dB as the ratio of output to input signal level.

auxiliary disconnect outlet: A device usually located within the tenant or living unit used to terminate the ADO or backbone cable.

auxiliary disconnect outlet cable: In residential applications, the cable from the auxiliary telecommunications disconnect outlet/connector or the distribution device in a customer's premises to the backbone facility or the point of demarcation.

backbone: 1) A facility (e.g., pathway, cable or conductors) between any of the following spaces: telecommunications rooms, telecommunications enclosures, common telecommunications rooms, floor serving terminals, entrance facilities, equipment rooms, and common equipment rooms. 2) in a data center, a facility (e.g. pathway, cable or conductors) between any of the following spaces: entrance rooms or spaces, main distribution areas, horizontal distribution areas, telecommunications rooms.

backbone cable: See **backbone**.

bonding: The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

building automation system: Equipment and telecommunications infrastructure that supports monitoring, control, operation and management of building services.

building backbone: Cabling for interconnecting telecommunications spaces from the telecommunications entrance facility to a horizontal cross-connect within a building.

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

cable run: A length of installed media, which may include other components along its path. (568)

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

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

campus: The buildings and grounds having legal contiguous interconnection.

campus backbone: Cabling for interconnecting telecommunications spaces between buildings.

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

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

conduit: (1) A raceway of circular cross-section. (2) A structure containing one or more ducts.

Editorial note - For the purposes of these Standards the term conduit includes electrical metallic tubing (EMT) or electrical non-metallic tubing (ENT)

connecting hardware: A device providing mechanical cable terminations.

consolidation point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways. (569)

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

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

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

data: Electronically encoded information.

distribution device: A facility located within the dwelling unit for interconnection or cross connection.

distribution device cord: A telecommunications cord that extends between the distribution device and the auxiliary disconnect outlet.

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

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

entrance facility (telecommunications): An entrance to a building for both public and private network service cables (including wireless) including the entrance point of the building and continuing to the entrance room or space. (569)

entrance point (telecommunications): The point of emergence for telecommunications cabling through an exterior wall, a floor, or from a conduit.

entrance room or space (telecommunications): A space in which the joining of inter or intra building telecommunications backbone facilities takes place.

Editorial note - An entrance room may also serve as an equipment room.

equipment cable; cord: A cable or cable assembly used to connect telecommunications equipment to horizontal or backbone cabling.

equipment room (telecommunications): An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect.

fiber optic: See **optical fiber**.

firestop: A fire-rated material, device, or assembly of parts installed in a penetration of a fire-rated barrier.

firestopping: The process of installing listed, fire-rated materials into penetrations in fire-rated barriers to reestablish the fire-resistance rating of the barrier.

fixed devices: Any low-voltage device permanently affixed to a surface for purposes of security, fire detection or other control, data, or entertainment applications.

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

grounding: The act of creating a ground.

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

hard-line trunk: A rigid coaxial cable, typically used for backbone cabling.

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

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

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

link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables.

listed: Equipment included in a list published by an organization, acceptable to the authority having jurisdiction, that maintains periodic inspection of production of listed equipment, and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

main terminal space: The location of the cross-connect point of incoming cables from the telecommunications external network and the premises cable system (See also common equipment room).

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

minimum point of entry: Either the closest practicable point to where the carrier facilities cross the property line or the closest practicable point to where the cabling enters a multi-unit building or buildings.

modular jack: A female telecommunications connector that may be keyed or unkeyed and may have 6 or 8 contact positions, but not all the positions need be equipped with jack contacts. (568)

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

multi-dwelling unit – telecommunications room: See **terminal.**

multimedia: (1) An application that communicates to more than one of the human sensory receptors. (2) Applications that communicate information by more than one means.

network interface device: The point of connection between networks.

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

optical fiber cable: An assembly consisting of one or more optical fibers.

outlet (telecommunications): A designated location containing one or more telecommunications outlet/connectors.

outlet box (telecommunications): A housing used to hold telecommunications outlet/connectors.

outlet cable: A cable placed in a residential unit extending directly between the telecommunications outlet/connector and the distribution device.

outlet/connector (telecommunications): A connecting device in the work area on which horizontal cable or outlet cable terminates.

passive cross-connect: A facility enabling the termination of cable elements and their interconnection or cross-connection by means of jumpers or patch cords.

patch cord: A length of cable with a plug on one or both ends.

pathway: A facility for the placement of telecommunications cable.

permanent link: A test configuration for a link excluding test cords and patch cords.

plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

prewiring: (1) Wiring installed before walls are enclosed or finished. (2) Wiring installed in anticipation of future use or need.

pull strength: See **pull tension**.

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

raceway: Any enclosed channel designed for holding wires or cables.

record: A collection of detailed information related to a specific element of the telecommunications infrastructure. (606)

report: A presentation of a collection of information from the various records.

residential gateway: A device that enables communication among networks in the residence and between residential networks and service providers' networks.

service entrance: See **entrance facility (telecommunications)**.

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

sheath: See **cable sheath**.

singlemode optical fiber: An optical fiber that carries only one path of light. (568)

sleeve: An opening, usually circular, through the wall, ceiling, or floor to allow the passage of cables.

slot: An opening through a wall, floor, or ceiling, usually rectangular, to allow the passage of cables.

space (telecommunications): An area used for housing the installation and termination of telecommunications equipment and cable, e.g., common equipment rooms, equipment rooms, common telecommunications rooms, telecommunications rooms, work areas, and maintenance holes/handholes.

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

splice box: An enclosed space between pathways intended to house a cable splice.

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

telecommunications: Any transmission, emission, and reception of signs, signals, writings, images, and sounds, that is, information of any nature by cable, radio, optical, or other electromagnetic systems.

telecommunications entrance facility: See **entrance facility (telecommunications)**.

telecommunications entrance point: See **entrance point (telecommunications)**.

telecommunications entrance room or space: See **entrance room or space (telecommunications)**.

telecommunications equipment room: See **equipment room (telecommunications)**.

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

telecommunications media: See **media (telecommunications)**.

telecommunications room: An enclosed architectural space for housing telecommunications equipment, cable terminations, and cross-connect cabling.

telecommunications service entrance: See **entrance facility (telecommunications)**.

telecommunications space: See **space (telecommunications)**.

terminal: (1) a point at which information may enter or leave a communications network. (2) The input-output associated equipment. (3) A device by means of which wires may be connected to each other.

termination: This term is outmoded. See **connecting hardware**.

termination hardware: This term is outmoded. See **connecting hardware**.

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

two-level duct: An underfloor raceway system installed with the header raceways and the distribution raceways on two different planes. (569)

wire: An individually insulated solid or stranded metallic conductor.

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

2.3 Acronyms and abbreviations

ac	alternating current
ADA	Americans with Disabilities Act
ADO	auxiliary disconnect outlet
AHJ	authority having jurisdiction
ANSI	American National Standards Institute
AP	access provider
ATIS	Alliance for Telecommunications Solutions
AWG	American Wire Gauge
BICSI	Building Industry Consulting Service International
CATV	community antenna television
CCA	copper coated aluminum
CCS	copper coated steel
CCTV	closed-circuit television
CD	compact disc
CEA	Consumer Electronics Association
DD	distribution device
DIP	dual inline package
DPST	double pole, single throw
DSS	digital satellite system

DVD	digital versatile disc
EIA	Electronic Industries Alliance
EMC	electromagnetic compatibility
FCC	Federal Communications Commission
HVAC	heating, ventilation and air conditioning
IDC	insulation displacement contact
IEC	International Electrotechnical Commission
IEEE	The Institute of Electrical and Electronics Engineers
IR	infrared
MDU-TR	Multi-dwelling unit – telecommunications room
NEC	National Electrical Code
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NID	network interface device
OC	outlet cable
RF	radio frequency
RG	radio grade
RJ	registered jack
SCTE	Society of Cable Telecommunications Engineers
SRL	structural return loss
TIA	Telecommunications Industry Association
UTP	unshielded twisted-pair
UV	ultraviolet
WP	waterproof outlet box

2.4 Units of measure

A	Ampere
dB	decibel
dc	direct current
°C	degrees Celsius
ft	feet, foot
Hz	hertz
in	inch
lbf	pound-force
m	meter
mA	milliampere
MHz	megahertz
mm	millimeter

1	N	Newton
2	sq in	square inch
3	sq mm	square millimeter
4	Vac	volts alternating current
5	μm	micrometer or micron

3 SINGLE-DWELLING RESIDENCE INFRASTRUCTURE

3.1 General

The following sub-clauses describe the infrastructure necessary to support a variety of systems within a single-dwelling residence. Typically these systems include voice, data, video, security, whole-home audio, and control. In many cases, these systems are integrated and the cabling distributed from the distribution device (commonly known as a distribution center) to various locations within the residence. Figure 1 illustrates some of the components of an integrated telecommunications system.

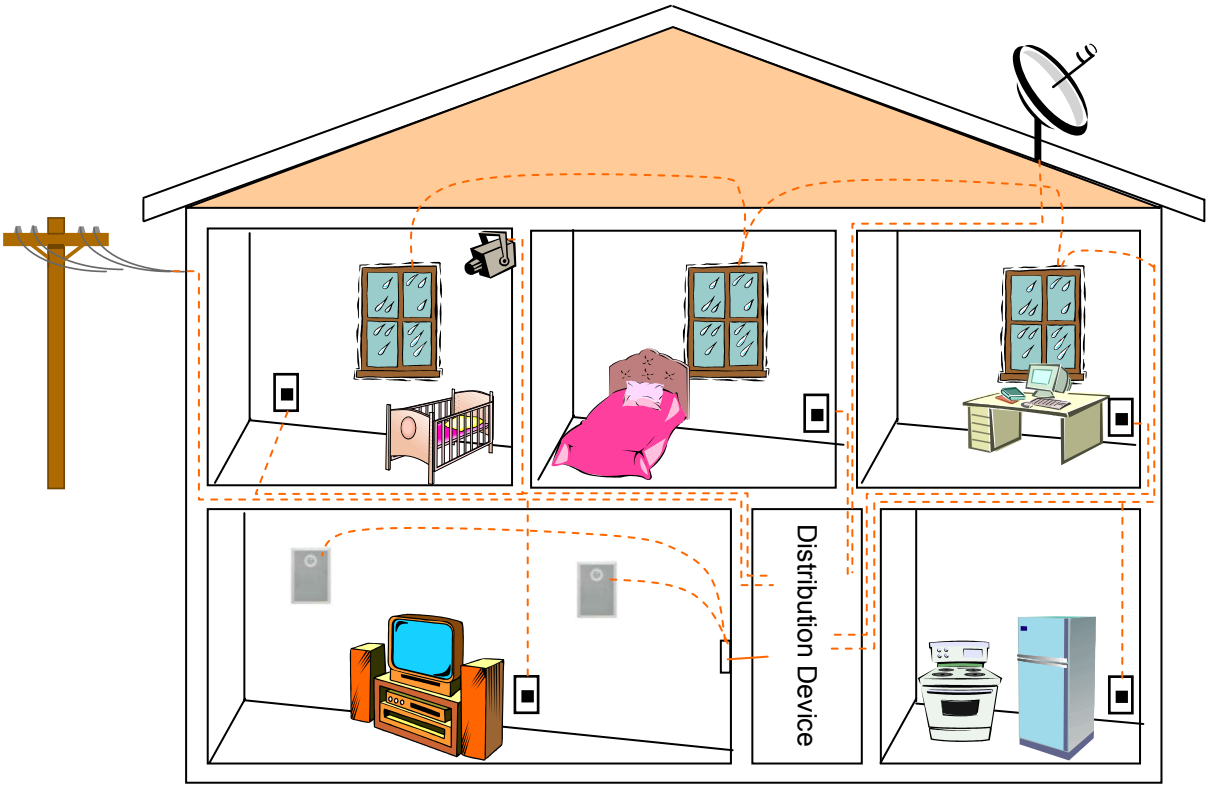
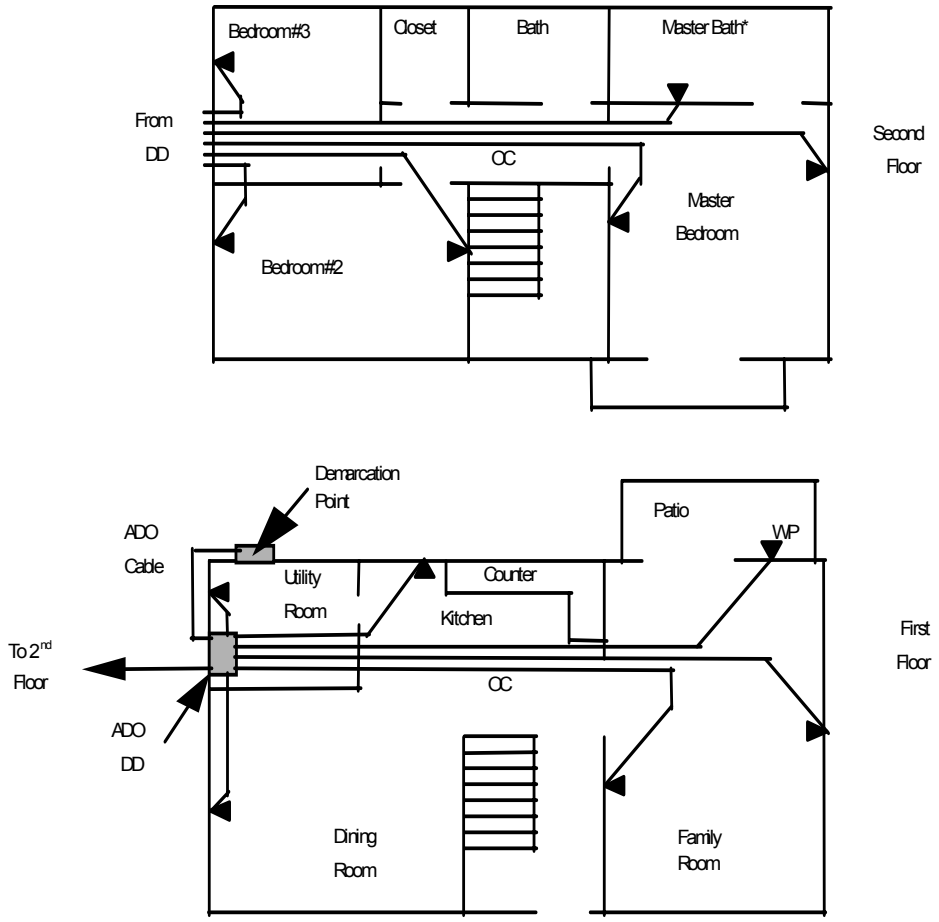


Figure 1 – Illustration of an integrated telecommunications system

3.2 Voice, data and video

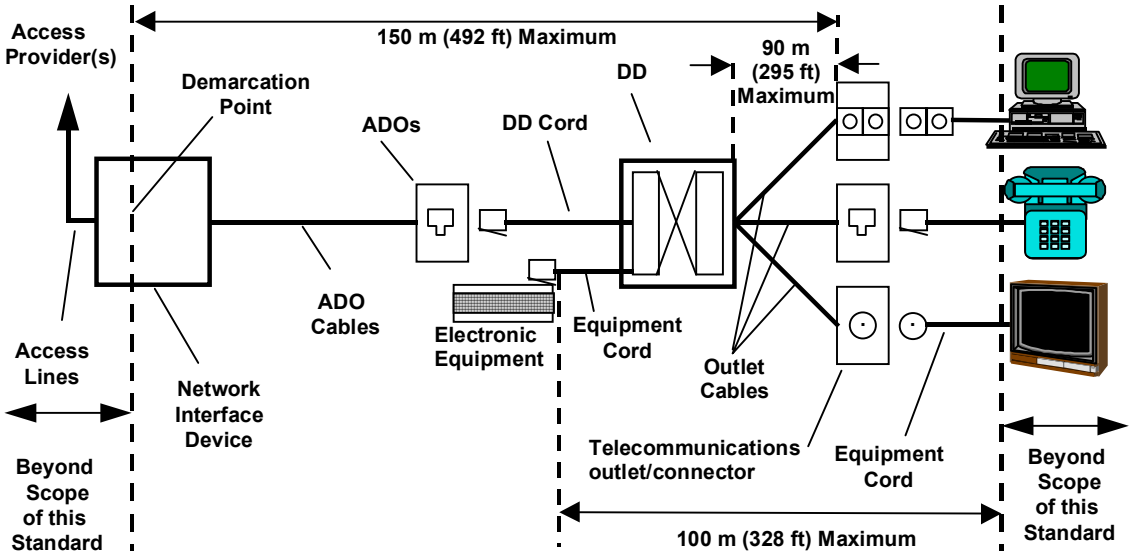
3.2.1 General

The following sub-clauses describe grades of cabling and then sequentially trace the cabling system from the demarcation point to the terminal equipment in a single-dwelling residence (see Figure 2 and Figure 3). Grounding and bonding shall be performed in accordance with applicable electrical codes.



Legend:
► – Telecommunications outlet/connector
ADO – Auxiliary disconnect outlet
DD – Distribution device
OC – Outlet cable
WP – Waterproof outlet box

Figure 2 – Example voice, data, video cabling system for a single-dwelling residence



Legend:
ADO – Auxiliary disconnect outlet
DD – Distribution device

Figure 3 – Typical voice, data, video cabling system components for a single-dwelling residence

3.2.2 Grades of residential cabling

A grading system is established in this Standard based upon voice, data and video services that are expected to be supported within each single-dwelling residence and to assist in the selection of the cabling. Tables 1 and 2 are provided to assist in selecting the appropriate cabling for the residence.

3.2.2.1 Grade 1

For each cabled location, grade 1 provides a generic cabling system that meets the minimum requirements for basic telecommunications services. As an example, this grade provides for telephone, satellite, community antenna television (CATV) and data services. Grade 1 specifies twisted-pair cable and coaxial cable placed in a star topology. Grade 1 cabling minimum requirements consist of one 4-pair UTP cable that meets or exceeds the requirements for category 3, one 75-ohm coaxial cable, and their respective connectors. Installation of category 5e or 6 cabling in place of category 3 cabling is recommended, to facilitate future upgrading to Grade 2.

NOTE – In 1999, the FCC mandated that, after July 2000, telephone cable installed within residences must meet a minimum of category 3 requirements.

3.2.2.2 Grade 2

For each cabled location, grade 2 provides a generic cabling system that meets the requirements for basic and advanced telecommunications services such as high-speed internet and in-home generated video. This grade provides for both current and developing telecommunications services. Grade 2 specifies twisted-pair cable, coaxial cable, and optionally optical fiber cable, all placed in a star topology. Grade 2 cabling minimum requirements consist of two 4-pair UTP cables and associated connectors that meet or exceed the requirements for category 5e cabling; two 75-ohm coaxial and associated connectors; optionally, 2-fiber optical fiber cabling. Installation of category 6 cabling in place of category 5e cabling is recommended.

Table 1 – Recognized residential voice, data, video cabling by grade

Cabling	Grade 1	Grade 2
4-pair UTP	Category 3; Category 5e or 6 recommended	Category 5e; Category 6 recommended
75-ohm coax	X	X
Fiber		X (optional)

3.2.3 Demarcation point

The demarcation point (see Figure 2 and Figure 3) is the point of interface between access provider and customer cabling. The demarcation point may be identified by a network interface device (NID) that is provided and installed by the access provider. For single-dwelling residences, the demarcation point is usually located on the outside of an exterior building wall. The access provider shall be contacted to locate the demarcation point according to applicable regulations.

Where the total length of cabling from the demarcation point to the furthest outlet exceeds 150 m (492 ft), the access provider shall be notified at the design stage to accommodate transmission requirements.

3.2.4 Auxiliary disconnect outlet

An auxiliary disconnect outlet (ADO) provides the means for disconnecting from an access provider. In a single-dwelling residence, an ADO shall be installed where a means of disconnecting is not otherwise provided, or if the location of that disconnection point is not easily accessible. It is desirable to co-locate the ADO with the distribution device (DD). The ADO shall be located indoors and be readily accessible.

3.2.5 Auxiliary disconnect outlet cable

ADO cables extend services from the demarcation point to the ADO. Where a single-dwelling residence is part of a multi-dwelling building, the ADO cables may extend from the multi-dwelling unit - telecommunication room (MDU-TR) to the ADO in the single-dwelling residence space.

3.2.6 Distribution device

A distribution device (DD) shall be provided within each residence. The DD is a facility used for the termination and connection of outlet cables, DD cords, equipment cords and in some cases ADO cables. The DD is used for connection of access providers to the residence and to facilitate moves, adds and changes of the residential premises cabling. Space should be allocated adjacent to or within the DD for the installation of a surge protection device for each conductive cable entering or leaving the building. Access to the building electrical ground shall be provided within 1.5 m (5 ft) of the DD, in accordance with applicable codes.

The DD may consist of a passive cross-connect facility, or an active cross-connect facility, or both. As an example, an active cross-connect facility may be contained within a residential gateway.

3.2.6.1 Location requirements for the distribution device

The DD shall be installed inside the tenant's space in a location that is accessible for cabling maintenance. Where practicable, the location should be centralized within the tenant space to minimize the length of outlet cables. The DD and associated equipment may be mounted on a backboard, or recessed between wall stud spaces.

3.2.6.2 Wall space allocation for a distribution device and associated equipment

Space allocation for the DD is estimated by the grade of service and number of telecommunications outlet/connectors to be installed in the residence. Table 3 provides guidance for planning the wall space that should be allocated for the DD and associated equipment. Telecommunications

equipment should be enclosed within the DD. The manufacturer of the distribution device should be consulted to ensure that voice, data, video, security, whole-home audio, and control systems fit within this space.

Table 2 – Space allocation guidelines for the DD and associated equipment

Number of outlet/connectors	Grade 1	Grade 2
1 to 8	364 mm (14.35 in) wide 254 to 457 mm (10 to 18 in) high	364 mm (14.35 in) wide 18 to 36 in high
9 to 16	364 mm (14.35 in) wide 711 to 914 mm (28 to 36 in) high	364 mm (14.35 in) wide 711 to 1 067 mm (28 to 42 in) high
17 to 24	364 mm (14.35 in) wide 711 to 1 067 mm (28 to 42 in) high	Multiple, interconnected 364 mm (14.35 in) wide 711 to 1 067 mm (28 to 42 in) high
More Than 24	Multiple, interconnected 364 mm (14.35 in) wide 711 to 1 067 mm (28 to 42 in) high	Multiple, interconnected 364 mm (14.35 in) wide 711 to 1 067 mm (28 to 42 in) high

3.2.6.3 Electrical power

Electrical power may be required at the DD. An electrical outlet is recommended for grade 1, and required for grade 2 installations. When required, a 15 A, 120 Vac nominal, non-switchable duplex electrical outlet shall be provided within 1.5 m (5 ft) of the DD. The height of the electrical outlet should be appropriate for the DD and associated equipment being installed.

3.2.7 Cabling

3.2.7.1 Outlet cable

Outlet cable provides the transmission continuity from the DD to the telecommunications outlet/connector. Outlet cable shall be placed in a star topology and may be connected through a consolidation point. The length of each outlet cable shall not exceed 90 m (295 ft). The 90 m (295 ft) length allows an operational length of 100 m (328 ft) including patch cords, jumpers and equipment cords (see Figure 3).

3.2.7.1.1 Recognized cables

Recognized outlet cable includes:

- 4-Pair 100-ohm UTP (category 3, 5e, 6)
- Series 6 coaxial (commonly known as RG6), tri- or quad-shield
- Series 59 coaxial (commonly known as RG59) for baseband CCTV only
- Optical fiber (50/125 μm, 62.5/125 μm multimode; singlemode)

NOTE – Singlemode optical fiber cabling is intended for special case future applications.

3.2.7.1.2 Telecommunications outlet/connector

The telecommunications outlet connector shall be compatible with the media provided at that location (e.g., category 6 cable with a category 6 outlet connector, Series 6 coaxial cable with an F-Type connector).

3.2.7.1.3 Equipment cords, patch cords and jumpers

Equipment cords extend from the telecommunications outlet/connector to the terminal/equipment connector or from the DD to electronic equipment. Patch cords or jumpers may be used for

interconnections or cross-connections at the DD. For each channel, a total of 10 m (33 ft) is allowed for equipment cords and patch cords or jumpers.

3.2.8 Outlet locations

A minimum of one outlet location shall be cabled within each of the following rooms:

- kitchen;
- bedroom;
- family/great room; and,
- den/study.

An outlet location should be provided in each room and additional outlet locations provided within unbroken wall spaces of 3.7 m (12 ft) or more. Additional outlet locations should be provided so that no point along the floor line in any wall space is more than 7.6 m (25 ft), measured horizontally, from an outlet location in that space. An example of outlet locations within a room is illustrated in Figure 4.

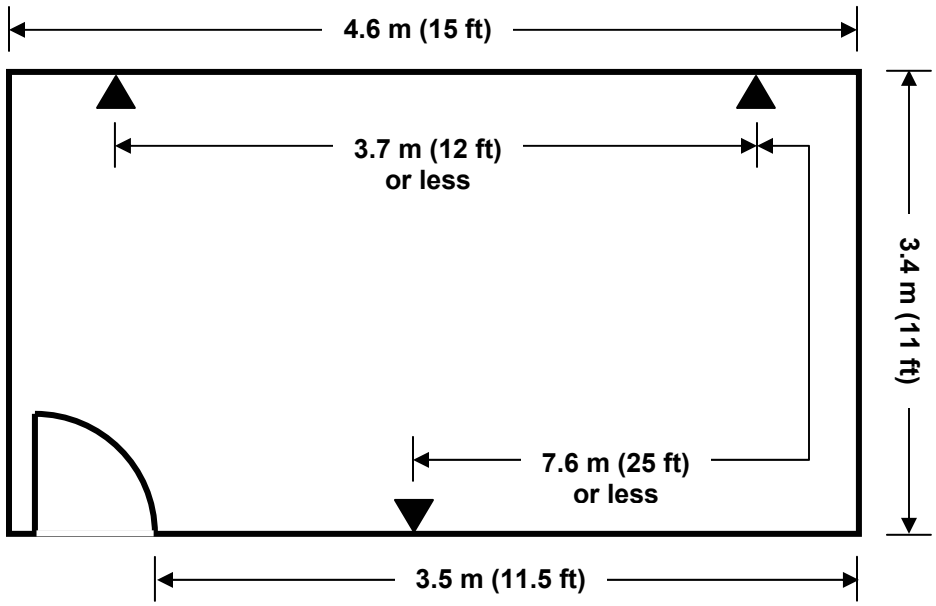


Figure 4 – Example illustration of outlet locations within a room

3.2.9 Outlet cable pathways

For new construction, pathways that conceal the cable shall be used as a means for placing outlet cable between a DD and the telecommunications outlet box or mounting bracket. Pathways that conceal the cable are recommended for remodeling construction. Typically, “pre-wire” cabling is accomplished by placing the cables through holes in wall studs and ceiling joists before the walls and ceilings are sheathed.

3.3 Security systems

3.3.1 General

Security systems require appropriate cabling to support attributes such as alarm and video surveillance. Alarm systems are not only used for intrusion detection, but also fire detection. Video surveillance may be used with intrusion detection systems or to monitor conditions throughout the residence.

Security systems denote a security or a combination of systems consisting of components such as a control panel, user keypads for arming and disarming the system, sensors and alerting devices (e.g., siren, strobe light). The sensor array comprise of magnetic contacts on exterior doors and either contacts or shock/glass-break detectors on externally accessible windows, interior motion detectors

and pressure sensing mats. An alerting device, such as a high output bell or siren to warn occupants of an intruder or life safety situation, is frequently provided. Optionally, an off-premises connection from the panel to a central monitoring station may also be provided. Combination systems may also include life safety features such as panic buttons, smoke and carbon monoxide detectors. Electronic door latches and window shutter operators, environmental and lighting control systems may also be integrated into the system. A security system may incorporate a video surveillance camera system, two-way audio prompting and listen-in for central monitoring station alarm verification and various types of critical alarm sensors to warn of equipment outage, moisture and freezing temperatures.

Fire alarm denotes a fire alarm system consisting of strategically placed initiating devices (e.g., smoke and heat detectors, manually actuated devices) and alerting devices (e.g., sirens and strobe lights) that are connected to an alarm panel. Optionally, this system may provide an off-premises connection to a central monitoring station to report alarm conditions. For the purpose of clarification, fire alarm requirements for a multi-dwelling building are typically the same requirements as for a commercial structure that may include pull-boxes and other means of directly notifying the fire department. In a single-dwelling residence, the alarm generated from smoke or heat sensors is generally relayed first to a monitoring service through the security panel dial-up connection and the monitoring service then verifies the alarm prior to summoning the fire department.

3.3.2 Device location

The location of sensors and cabling devices shall meet the requirements of NFPA 70, NFPA 72, and local regulations. The security/alarm system designer should consult the owner regarding special alarm and security requirements such as for occupants with impaired sight, hearing, mobility and health needs. The designer should also consider the building design and the anticipated traffic patterns of the occupants as this will influence the program setting of arming and disarming delays, the positioning of sensors/detectors and surveillance cameras, and the provisioning of zones of protection. As a minimum guide for fire protection, a smoke detector should be installed outside of each sleeping area, and on each additional floor of a multi-floor dwelling, including basements. Heat detectors should be installed in kitchens, attics, and garages.

3.3.3 Cabling

3.3.3.1 General

Security cabling should be run in a star topology from each detector or sensor to the security/alarm panel. Except for smoke detectors, daisy-chaining of devices is not recommended. A daisy-chain system may not easily identify a location within the zone being penetrated and makes trouble-shooting difficult (e.g., a malfunctioning sensor).

3.3.3.2 Fire alarm systems

Article 760 of the NEC specifies the minimum requirements for fire alarm multi-conductor cables. In general, single-dwelling residences rely on either stand-alone single station smoke detectors or combination security systems where fire detection and central alarm notification is a feature available in the security system.

A full fire alarm and evacuation system typically is only required in commercial and institutional buildings. Most Authorities Having Jurisdiction (AHJ) have requirements for installer training and certification for installation of fire alarm systems.

3.3.3.3 Security and combination systems

Article 725 of the NEC specifies the minimum requirements for security multi-conductor cables. Security systems are typically cabled with two (2) or four (4) conductor cables of either 16- or 18-AWG stranded or 22-AWG solid wires depending on the length of the cable and current draw (see Table 8). Single-dwelling residential security systems are generally installed with cables having solid 22-AWG wire except for high current circuits such as user interfaces and alerting devices (e.g., siren, strobe light). Category 3, 5e or 6 cable may be used where acceptable to the manufacturer of the security/alarm panel.

3.3.3.3.1 Sensors (initiating devices) to control panel

Passive sensors require two (2) conductors in a cable while active sensors require four (4) conductors. For most active sensors, two conductors supply power and two conductors initiate the signal. All security sensors should be supervised by installing one or more resistors at the sensor end of the cable so that the alarm panel can differentiate between a closed or open contact and a cable fault. The panel manufacturer may provide resistor values and configurations.

3.3.3.3.2 Keypads and user interface

Keypads and user interfaces generally require four conductors and are frequently designed to be connected in a bus topology. Wire gauge is determined on the basis of a 5-percent voltage drop over the length of the circuit. Any voice-input circuits shall use a minimum of category 3 cables; output circuits should use wire gauges depending upon the length of cable run and current draw (see Table 8).

3.3.3.3.3 Alerting devices

Sirens, bells and other audible and visual enunciators are generally termed as alerting devices. These system peripherals are generally powered from the control panel with 2 or 4 conductors. Some notification devices such as those used outdoors may require up to 3 A of current or more. Alerting devices used outdoors may require additional conductors for tamper-proof contacts.

3.3.3.3.4 Video

Articles 820 and 725 of the NEC specify the minimum requirements for community antenna television (CATV) and closed circuit television (CCTV) coaxial cable, respectively. Baseband video systems (e.g., CCTV), commonly use coaxial cables with a 95-percent copper braid to properly shield the baseband signal and a bare copper center conductor typically surrounded by an expanded foam dielectric. Broadband video systems (e.g., CATV), requires Series 6 coaxial cable with aluminum foil and aluminum braid shields to properly shield the broadband signals and a copper-clad steel center conductor or bare copper center conductor surrounded by expanded foam. Using a modulator, baseband video signals can also be carried over a broadband system by modulating the baseband video signal to an unused television channel.

With the use of suitable baluns, both baseband and broadband video signals may be transmitted over category 5e or 6 cables. Video surveillance systems typically require additional cabling for power and pan and tilt functions or they may use the coaxial conductors for this purpose.

3.3.3.3.5 Device connections

Connections to devices for security systems are typically made with screw lugs. However, some devices, such as sensors for doors need to be spliced. In these cases an insulation displacement connector (IDC) should be used. If there is not sufficient space to accommodate an IDC, then such connections shall be mechanically spliced, soldered and insulated.

3.3.4 System power

Residential security and combination burglar alarm/fire alarm systems are centrally powered from the control panel and generally operate on 12 to 16.5 Vac (power-limited) for security applications. Integral battery back-up is provided to power the system for a specified number of hours in the event of a power outage. The electrical input is provided by a low-voltage current-limited transformer (i.e., Class 2 listed per NEC) that plugs in to a 110 Vac, 15 A convenience outlet or by direct connection to an electrical supply. When a convenience electrical outlet is used, it shall be non-switchable and mounted in a secure location within 1.5 m (5 ft) of the panel with the transformer affixed to the outlet to prevent disconnection. The gauge of the wire between the control unit and the transformer should be selected from the wire tables to ensure there is no more than 5% voltage drop for the maximum current load (see Table 8).

3.4 Whole-home audio cabling

3.4.1 General

Whole-home audio systems (digital and analog) use sources such as radio, satellite, CD, DVD and streaming internet signaling that are distributed to speakers in multiple rooms, commonly referred to as “zones”. The audio to each zone is typically controlled by either a volume control or keypad. A

keypad generally has more functionality than that of a volume control such as having the ability to select an individual source.

3.4.2 Device locations.

Proper location of speakers and volume control/keypad devices is critical to assure the best audio and control performance. Manufacturer's recommendations should be followed for optimum mounting locations.

3.4.3 Cabling

3.4.3.1 General

There are three distinct areas where cabling is placed between devices when installing an audio system (see Figure 5). In each of these areas where cabling is placed, multi-conductor speaker cables and category 5e or 6 cables shall be installed. The three areas where cabling is placed include:

- Audio/video headend to distribution device
- Distribution device or audio/video headend to volume control/keypad
- Volume control/keypad to speakers

3.4.3.1.1 Audio/video headend to distribution device

From the audio/video headend to the distribution device, six conductors of speaker wire and one category 5e or 6 cable shall be installed. Four of the speaker wire conductors will deliver left and right speaker signal to the distribution device, the remaining two speaker wires may be used to deliver control voltage. The category 5e or 6 cable may be used for communication (e.g., digital audio, connection to internet, IR).

3.4.3.1.2 Distribution device or audio/video headend to volume control/keypad

From the distribution device or audio/video headend to each volume control location, four conductors of speaker wire and one category 5e cable shall be installed. Volume controls/keypads are typically large devices and may not fit well into a single-gang electrical box. Low-voltage brackets may be used as allowed by code.

3.4.3.1.3 Volume control/keypad to speakers

From the volume control/keypad location to one speaker in its zone (or a stereo speaker), four conductors of speaker wire and one category 5e or 6 cable shall be installed. Additionally, from the same volume control/keypad location to the other speaker in its zone, two conductors of speaker wire shall be installed.

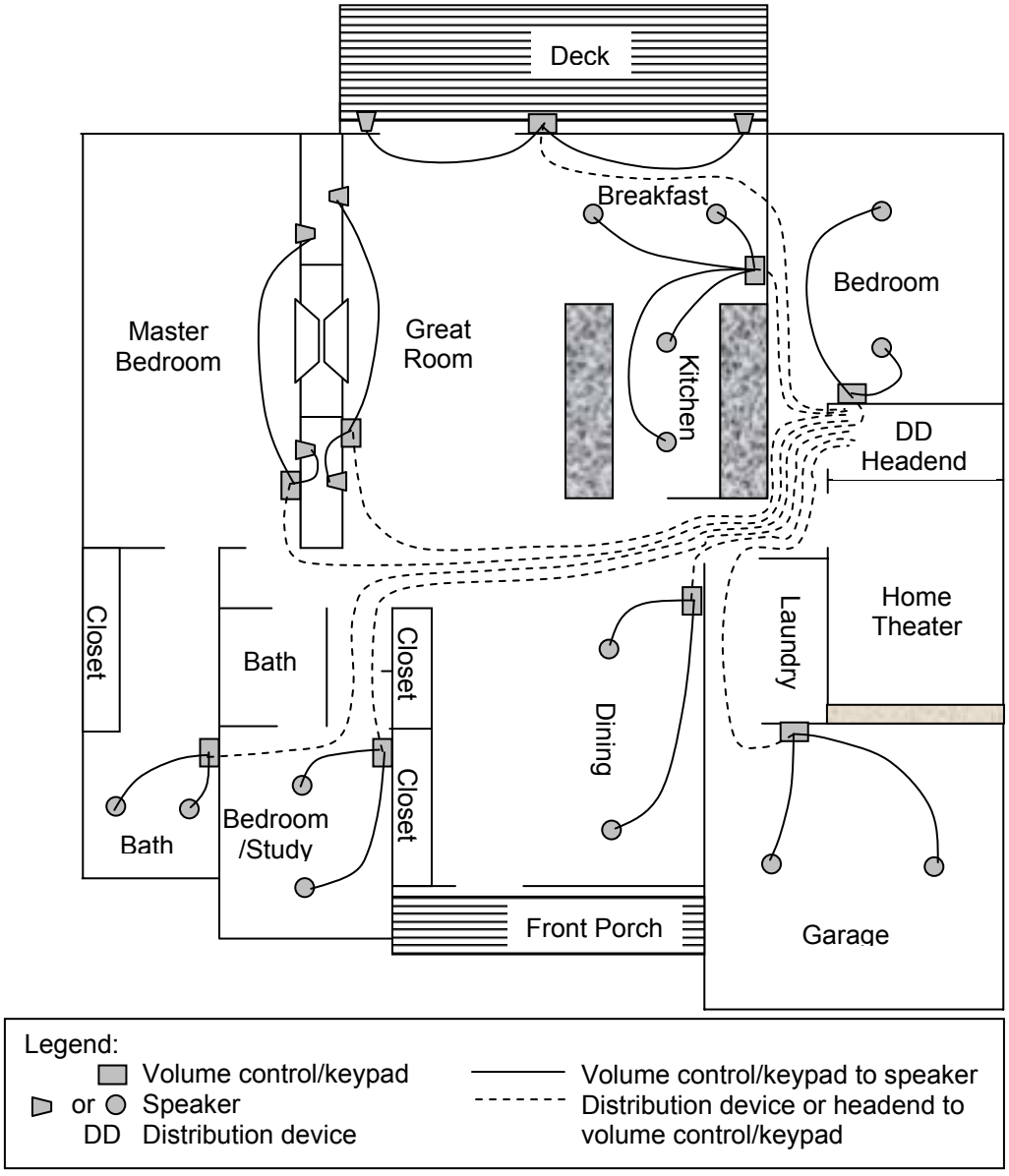


Figure 5 – Example illustration of a whole-home audio system

3.5 Control systems

3.5.1 General

Control systems cabling is used for climate control, lighting control and home automation. Information on established rating levels for lighting control, climate control, and whole home automation may be found in documents published by the Consumer Electronics Association (CEA).

3.5.2 Climate control systems

Regulating the climate in two or more areas of the residence requires a zoned climate control system. Based on the information received from each zone, the dampers adjust to provide the amount of heated or cooled air into the area.

Generally, each zone is installed with a communicating thermostat that sends signals to a microprocessor based control unit that controls motorized dampers and possibly multiple heating and cooling units. Temperature sensing devices may also be used to monitor the climate and relay its information to the communicating thermostats. Alternatively, temperature sensing devices may

communicate with the control unit directly thereby negating the need for communicating thermostats. Climate control systems may be integrated with security, alarm or home automation systems.

In zoned HVAC systems, additional cabling will be required for damper control and monitoring of the heating and cooling equipment. Each zone will require a dedicated thermostat. Installing a multi-conductor (thermostat) cable (5 to 8 solid conductors of 18-AWG) and a category 5e or 6 cable from the distribution system to the HVAC unit will accommodate a large variety of climate control options.

3.5.3 Lighting control systems

There are generally two types of wired lighting control systems – single room systems and whole house systems. Single room systems, for example, may turn on, off or dim various lights in the room by employing microprocessor based switch touch-plates programmed to various lighting sequences or scenes. A whole house system, on the other hand, would incorporate a central control unit programmed to control both inside and outside lighting devices. This programming would be set for various lighting functions, levels or scenes. In many instances the lighting control system, whether simple or sophisticated, will interface with the security and alarm system.

Lighting control systems that incorporate wall-box mounted dimmers and switches require cabling from each switch to a central controller. Many of these systems use category 5e or 6 cable for control, but local codes in some jurisdictions may require multi-conductor cable rated for higher voltages. The system manufacture of the lighting control system shall be consulted to determine the type of cable.

3.5.4 Home automation systems

Cabling for home automation systems may include voice, data and video cabling, security cabling, lighting and climate control cabling and audio cabling. Additional cabling may be required for motorized drapes, television lifts, door intercoms, irrigation sprinklers, pool/spa controls and other systems. These systems may use Category 5e or 6 cabling for communication between devices using control, data or Internet protocols. The manufacture of the lighting control system shall be consulted to determine the type of cable.

4 MULTI-DWELLING/CAMPUS INFRASTRUCTURE

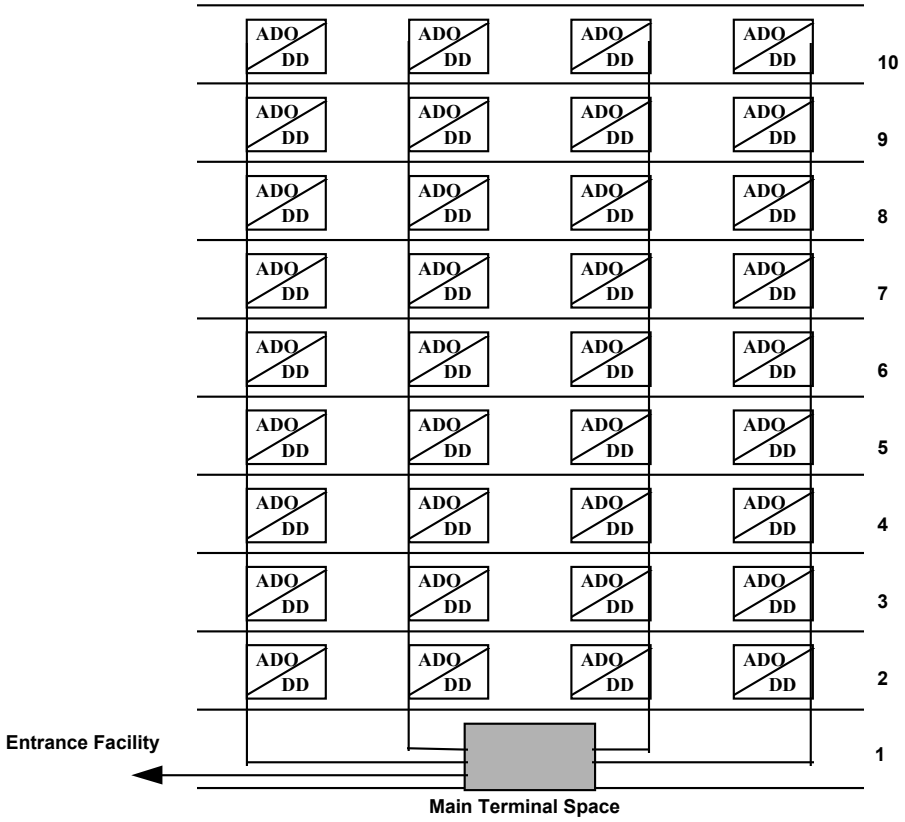
4.1 Voice, data and video

4.1.1 General

The following sub-clauses sequentially trace the multi-dwelling/campus infrastructure from the demarcation point to the MDU-TR (see Figure 6, Figure 7, Figure 8, and Figure 9).

In multi- dwelling residences, the demarcation point may be located at a minimum point of entry or it may be located in the individual tenant space. Access to shared-use space shall be controlled by the building owner or agent. Where the total length of cabling from the demarcation point to the furthest outlet exceeds 150 m (492 ft), the access provider shall be notified at the design stage to accommodate transmission requirements.

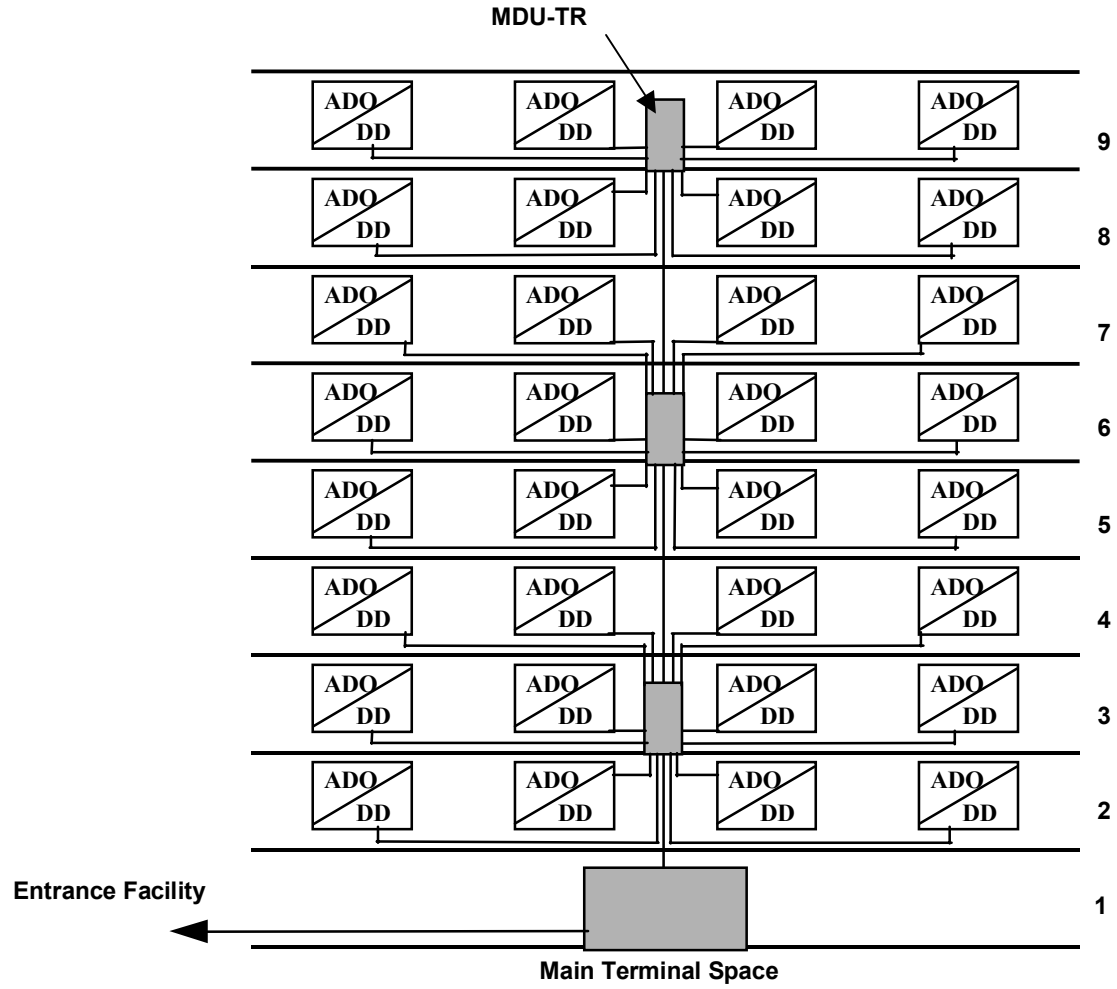
Grounding and bonding shall be performed in accordance with applicable electrical codes. For multi-dwelling buildings, ANSI-J-STD-607-A provides additional bonding and grounding information.



Legend:
ADO– Auxiliary Disconnect Outlet
DD – Distribution Device

NOTE – All residential units are of similar design and stacked one above the other.

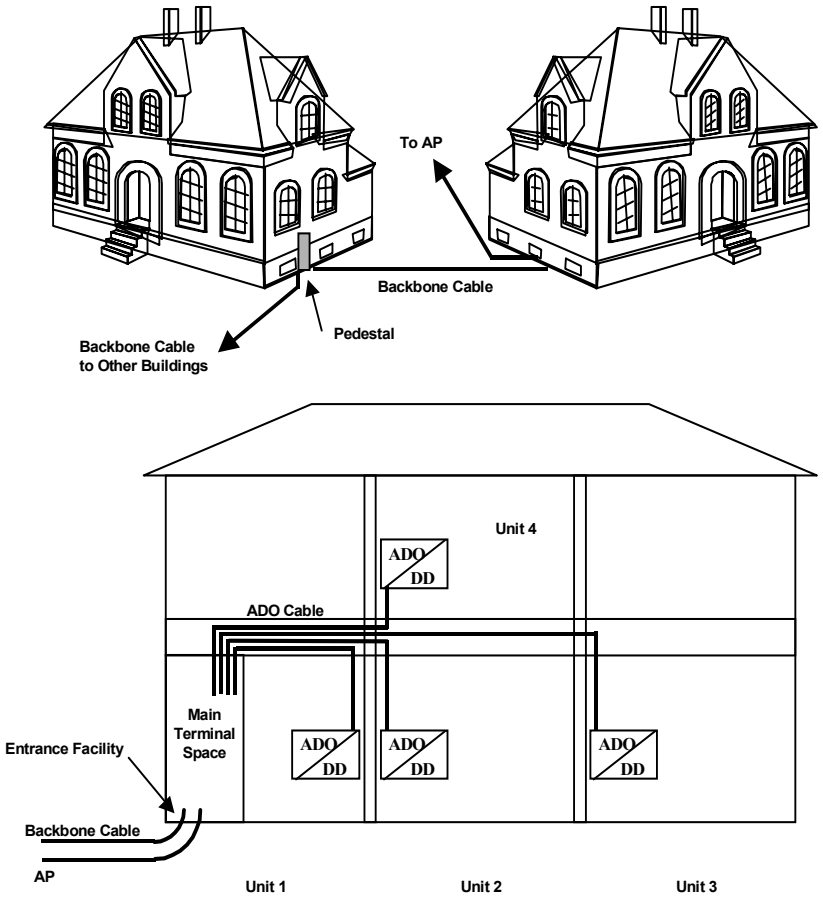
Figure 6 – Typical backbone cabling for a multi-floor multi-dwelling building (Stacked)



Legend:
ADO – Auxiliary disconnect outlet
DD – Distribution device
MDU-TR – Multi-dwelling unit – telecommunications room

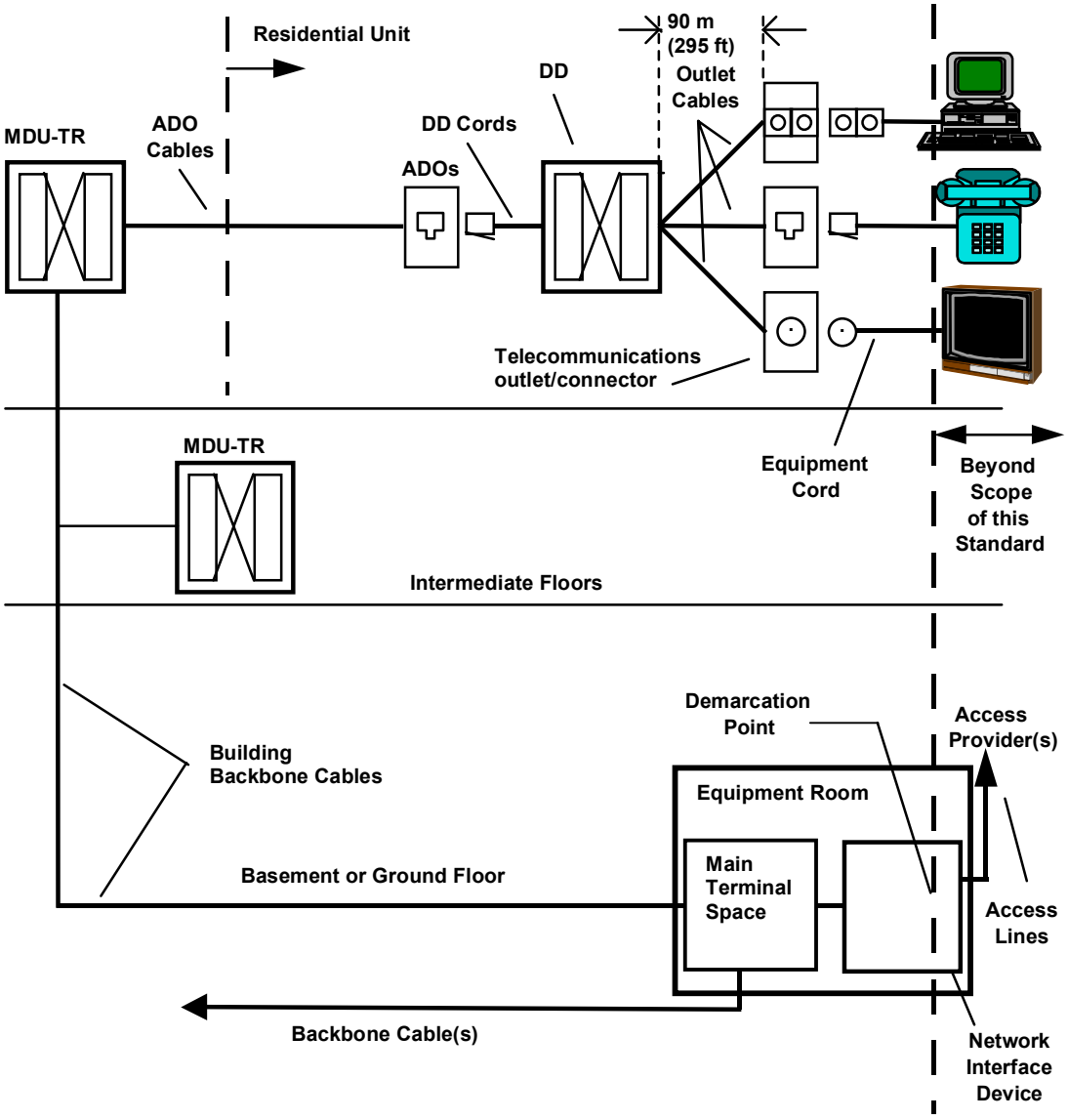
NOTE – Residential units are not similar in design and are not stacked one above the other.

Figure 7 – Typical backbone cabling for a multi-floor multi-dwelling building (Using MDU-TRs)



Legend:
ADO – Auxiliary Disconnect Outlet
DD – Distribution Device
AP – Access Provider(s)

Figure 8 – Typical backbone cabling system for a multi-dwelling building or campus environment



Legend:
ADO – Auxiliary disconnect outlet
DD – Distribution device
MDU-TR – Multi-dwelling unit – telecommunications room

Figure 9 – Typical cabling system components of a multi-dwelling or campus environment

4.1.2 Entrance facility

The entrance facility (see Figure 6, Figure 7, and Figure 8) consists of the telecommunications service entrance to the building, including the entrance point through the building wall and continuing to the main terminal space or equipment room. The entrance facility may contain the backbone pathways that link to other buildings in campus situations. Antenna entrances may also constitute part of the entrance facility. All access providers shall be contacted to establish their requirements. For further information about entrance facilities, see ANSI/TIA/EIA-569-B.

Consult the applicable codes to determine if primary protection is required. Provisions should be made for the installation of a surge protection device for each conductive cable entering or leaving the entrance facility. Access to the building electrical ground shall be provided within 1.5 m (5 ft) of the conductive cable terminations in the entrance facility in accordance with applicable codes.

4.1.3 Main terminal space

The main terminal space may be co-located with the entrance facility. It may also be used to house active equipment. The main terminal space may house the demarcation point, ADO cable, and backbone cable. The associated pathways, protection devices, and any other equipment needed to provide a connection from the access providers' access lines may also be located in the main terminal space.

4.1.4 Equipment room

An equipment room may house the entrance facility, the main terminal space, and an MDU-TR. An equipment room typically houses more equipment than an MDU-TR and it has different space requirements. An equipment room requires other support facilities such as power, and heating, ventilation, and air conditioning (HVAC). For more information on equipment rooms, see ANSI/TIA/EIA-569-B.

4.1.5 Multi-dwelling unit – telecommunications room (MDU-TR)

The MDU-TR is the space where backbone and ADO cables terminate. A MDU-TR should be located on each floor, or every third floor, thus serving the floor it is on and the floors above and below.

An MDU-TR should be in a common area and easily accessible. The minimum size of the space should be in accordance with Table 3. The MDU-TR may be required to be expanded in size to accommodate additional hardware.

Table 3 – Minimum space for an MDU-TR

	Grade 1	Grade 2
Minimum space for first five tenant units	370 mm (14.5 in) wide 610 mm (24 in) high	775 mm (30.5 in) wide 610 mm (24 in) high
Minimum additional space per tenant unit	32 270 sq mm (50 sq in)	64 540 sq mm (100 sq in)

If active equipment is placed within the MDU-TR, a dedicated, un-switched 15 A, 120 Vac nominal outlet shall be provided within 1.5 m (5 ft) of the MDU-TR. The height of the electrical outlet should be appropriate for the MDU-TR being installed and shall be in compliance with applicable codes.

4.1.6 Backbone pathways

4.1.7 General

Within buildings, consideration should be given to establishing spare pathway capacity (e.g., conduit) for future media additions or modifications.

4.1.7.1 Building backbone pathways

Building pathways typically employ conduits, sleeves, slots, or cable trays as a means for placing backbone cable. A minimum of one 100 (4) trade size conduit or sleeve shall be provided for each backbone pathway where backbone cable extends from the main terminal space to an MDU-TR. Where cable bundles with an equivalent diameter of 25 mm (1 in) or less extend through each residence, a minimum of one 40 (1-1/2) trade size conduit or sleeve shall be provided for the backbone pathways. For more information on building backbone pathways, see ANSI/TIA/EIA-569-B.

4.1.7.2 Campus telecommunications backbone pathways

Campus telecommunications backbone pathways provide a means of interconnecting separate buildings and consist of underground, buried, aerial, and tunnel pathways. For more information on campus telecommunications backbone pathways, see ANSI/TIA/EIA-758-A.

4.1.8 Backbone cabling

4.1.8.1 Recognized cables

Recognized backbone cables include:

- Multi-pair 100-ohm UTP
- Series 6 and 11 coaxial (commonly known as RG6 tri- or quad-shield and RG11, respectively)
- Series 59 coaxial (commonly known as RG59) for baseband CCTV only
- Hard-line coaxial
- Multi-conductor (copper)
- Optical fiber (50/125 μm, 62.5/125 μm multimode; singlemode)

4.1.8.2 Topology

A star topology should be implemented for twisted-pair and optical fiber backbone cabling. Coaxial backbone cable may be implemented using a star or bus topology.

4.1.8.3 Campus cabling protection

When buildings are connected with campus cabling, applicable fusing and voltage protection codes shall be followed.

4.2 Security

In most jurisdictions, multi-dwelling buildings must meet commercial fire alarm system requirements, which are outside the scope of this document. These installations must be designed and installed by licensed commercial fire alarm system contractors, in accordance with NFPA 72.

For multi-dwelling residences, suitable controlled access needs to be provided to common areas for tenants and their authorized visitors. Access is normally gained via an entry telephone with the aid of a surveillance camera mounted in the entryway and modulated to an unused television channel for viewing.

Additional access control systems may include key fobs, card readers, proximity readers and video intercom systems. Additional cabling may be required for electric locksets, door strikes and motorized gates. Any access control that limits egress, or access by emergency personnel may be subject to local code restrictions.

4.3 Control systems

For backbone cabling of control systems, see ANSI/TIA/EIA-862, manufacturer recommendations, and the NEC.

5 CABLE AND CONNECTING HARDWARE

5.1 General

Cable and associated components shall be suitable for use in the environment to which they are exposed (e.g., ultra-violet [UV] resistant cable, listed cable).

5.2 Unshielded twisted-pair (UTP) cabling

5.2.1 Cable

UTP cable shall meet the requirements of ANSI/TIA/EIA-568-B.2.

5.2.1.1 Aerial service drop cable

Aerial service drop cable is typically a small diameter, low pair-count cable with limited unsupported span distances. It is used to feed a small number of pairs from a higher pair-count cable into a single location. The maximum span length shall not exceed 60 m (195 ft). Aerial service drop cable shall meet the requirements of ANSI/ICEA S-89-648.

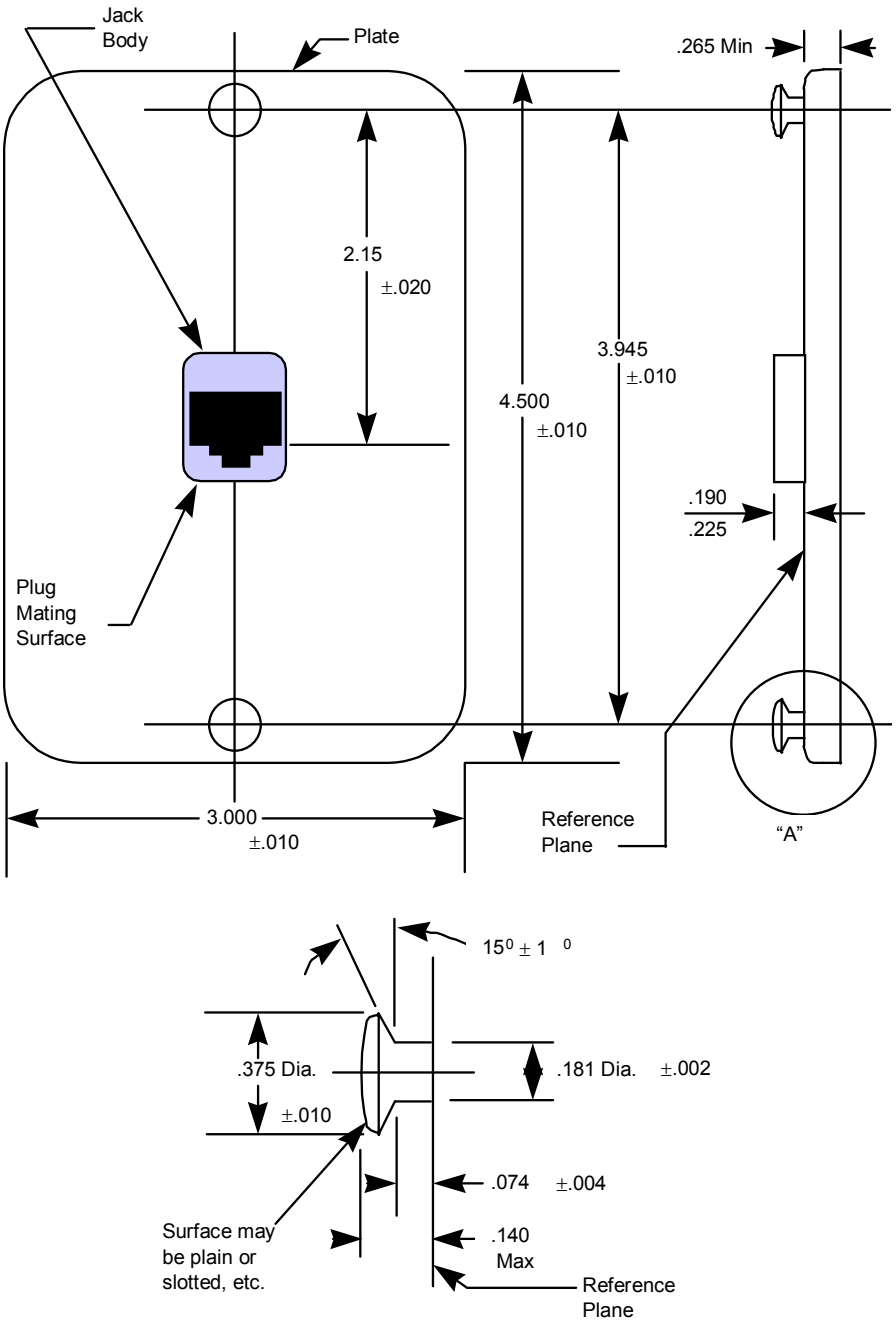
5.2.2 Equipment and patch cords

Equipment and patch cords, other than device specific cords, shall meet the requirements of ANSI/TIA/EIA-568-B.2.

5.2.3 Connecting hardware

5.2.3.1 General

All connecting hardware used with UTP cable shall meet the transmission and reliability requirements of ANSI/TIA/EIA-568-B.2. At outlet locations, UTP cable shall be terminated on an eight-position T568A telecommunications outlet/connector. Flush or surface-mount outlets designed for mounting of wall telephones shall use the dimensions of the mounting plate shown in Figure 10.



NOTE – Measurements are in inches.

Figure 10 – Telecommunications wall outlet mounting plate

5.2.3.2 Eight-position telecommunications outlet/connector

The eight-position telecommunications outlet/connector shall meet the modular interface requirements of IEC 60603-7. The pin-pair assignment configuration of the eight-position telecommunications outlet/connector shall comply with T568A as specified in ANSI/TIA/EIA-568-B.2 (see Figure 11).

The eight-position modular outlet/connector shall satisfy the contact resistance requirements of ANSI/TIA/EIA-568-B.2 when mated to an eight position plug per IEC 60603-7 after being subjected to 200 insertions of a six-position plug that meets the dimensional requirements of TIA/EIA-968-A.

The latching surface in the outlet/connector shall be set back from the face of the outlet/connector no more than 5.46 mm (0.215 in) so that the outlet/connector will not "capture" the plug clip.

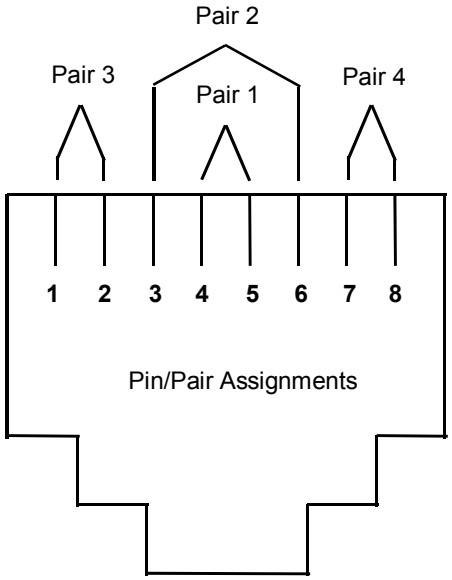


Figure 11 – Eight-position pin-pair assignment (designation T568A)

5.2.3.3 Six-position telecommunications connector (plug)

To prevent damage of the eight-position outlet/connector when mating to a six-position plug, the tab width for a six-position plug shall be 6 mm (0.238 in) to 6.2 mm (0.243 in).

5.3 75-ohm coaxial cabling

5.3.1 General

Coaxial cable is used for satellite, CATV and CCTV systems. Satellite and CATV systems shall use Series 6 outlet cable. Coaxial backbone cable shall be Series 6, 11, or hard-line trunk. Series 59 cable may only be used for baseband CCTV systems and for patch and equipment cords. Series 6, 11 and hard-line trunk cable are specified within this clause.

5.3.2 Electrical specifications

Coaxial cables shall meet the requirements of SCTE IPS-SP-001 as specified up to a bandwidth of 1000 MHz for CATV or 2200 MHz for satellite.

5.3.2.1 Attenuation

Coaxial cable shall meet the attenuation requirements of Table 4 however, listed plenum coaxial cables are allowed a 20-percent degradation to these requirements.

Table 4 – Coaxial cable attenuation

Series	6	11
Frequency (MHz)	Maximum (dB/100 ft) dB/100m	
5	(0.81) 2.66	(0.38) 1.25
55	(1.60) 5.25	(1.03) 3.38
211	(3.08) 10.10	(2.01) 6.59
250	(3.36) 11.02	(2.20) 7.22
270	(3.50) 11.48	(2.30) 7.55
300	(3.70) 12.14	(2.43) 7.97
330	(3.89) 12.76	(2.55) 8.37
350	(4.01) 13.15	(2.64) 8.66
400	(4.30) 14.11	(2.83) 9.28
450	(4.58) 15.03	(3.02) 9.91
500	(4.84) 15.88	(3.19) 10.46
550	(5.09) 16.70	(3.36) 11.02
600	(5.34) 17.52	(3.54) 11.61
750	(6.00) 19.69	(3.99) 13.09
870	(6.50) 21.33	(4.33) 14.21
1000	(7.00) 22.97	(4.67) 15.32
1200	(7.70) 25.26	(5.13) 16.83
1450	(8.60) 28.21	(5.61) 18.40
1800	(9.65) 31.65	(6.19) 20.30
2200	(10.70) 35.10	(6.78) 22.24

5.3.2.2 Structural return loss (SRL)

Coaxial cable uses structural return loss (SRL) measurements to characterize reflections due to impedance roughness as opposed to return loss (RL) that is used for twisted-pair measurements. SRL measures reflections relative to the characteristic impedance of the cable compared to RL that uses the design impedance of the cable as the reference impedance.

Coaxial cable requires a minimum 20 dB SRL from 5 to 1000 MHz and a minimum 15 dB SRL from 1000 to 2200 MHz.

5.3.2.3 Characteristic impedance

Characteristic Impedance shall be 75 +/- 3 ohms.

5.3.3 Physical and dimensional requirements

5.3.3.1 Center conductor

The center conductor shall be copper, copper coated steel (CCS) or copper coated aluminum (CCA). Bare copper may be required for baseband or applications requiring DC powering of devices. CCS is the most commonly used material. CCA is typically used for semi rigid distribution cables and larger flexible coaxial designs. The center conductor shall meet the requirements of Table 5.

Table 5 – Coaxial cable center conductor diameter

Series		6	11
(inches)	(min)	0.0399	0.0634
	(max)	0.0418	0.0647
(mm)	(min)	1.01	1.61
	(max)	1.06	1.64

5.3.3.2 Dielectric core

The core surrounding the center conductor shall consist of a continuous layer of polymeric material.

5.3.3.3 Shielding

The shielding layer shall consist minimally of a laminated foil tape and a 60-percent metallic braid. The tape shall be applied longitudinally with an overlap and be continuous. In some areas it may be desirable to use additional shielding layers to minimize signal ingress and egress. Tri-shield or quad-shield cables provide additional shielding. The local access provider should be consulted for the appropriate shield to be used for the installation.

5.3.3.4 Jacket

The cable jacket shall be a continuous layer of a polymeric material and meet NEC requirements (e.g., riser, plenum). The dimensional requirements listed in Table 6 and Table 7 shall be used to specify the proper connecting hardware.

Table 6 – Coaxial cable jacket diameter non-plenum

	Series	6	11
Standard	(inches)	0.272 + 0.008	0.395 + 0.008
	(mm)	6.91 + 0.200	10.04 + 0.200
Tri-Shield	(inches)	0.278 + 0.008	0.395 + 0.008
	(mm)	7.06 + 0.200	10.04 + 0.200
Quad-Shield	(inches)	0.300 + 0.008	0.405 + 0.010
	(mm)	7.62 + 0.200	10.29 + 0.250

Table 7 – Coaxial cable jacket diameter plenum

	Series	6	11
Standard	(inches)	0.239 + 0.006	0.351 + 0.008
	(mm)	6.07 + 0.150	8.92 + 0.200
Tri-Shield	(inches)	0.248 + 0.006	N/A
	(mm)	6.30 + 0.150	N/A
Quad-Shield	(inches)	0.260 + 0.006	0.372 + 0.008
	(mm)	6.61 + 0.150	9.45 + 0.200

5.3.3.5 Environmental

Series 6 and 11 cable should be capable of being installed at temperatures ranging from –20 °C to +60 °C. Certain plenum cables have a lower temperature limit of 0 °C. Cables placed in areas with an above 60 °C continuous environment should indicate the appropriate temperature rating.

5.3.4 Equipment and patch cords

Series 59 cable is commonly used for equipment and patch cords. Miniature coaxial cable using a center conductor no smaller than 24-AWG may be utilized for this purpose. For lengths longer than 3.05 m (10 ft), Series 6 cable should be used. Factory terminated cords are recommended.

5.3.5 Coaxial connecting hardware

5.3.5.1 Coaxial cable connector

Series 6 and 11 cables shall be connectorized with compression or non-hexagonal crimp-on F-Type connectors that meet the requirements of ANSI/SCTE 01 1996R2001. Hard-line cable shall be connectorized with an N-Type connector. F-Type or N-Type connectors for outdoor environments shall be sealed.

5.3.5.2 Termination

Each energized but unused coaxial connector that is part of the connecting block, splitter, amplifier or other similar electronic element shall be terminated with a 75-ohm impedance matching termination device. In addition, each energized unused coaxial cable shall be terminated with a 75-ohm impedance matching termination device.

5.4 Optical fiber cabling

5.4.1 Cable

Optical fiber cable shall meet the requirements of ANSI/TIA/EIA-568-B.3.

5.4.1.1 Aerial service drop cable

Drop cables are typically small diameter, low fiber count cables with limited unsupported span distances. They are used to feed a small number of fibers from a higher fiber count cable into a single location. Drop cable shall have a minimum pull strength of 1335 N (300 lbf).

5.4.2 Equipment and patch cords

Equipment and patch cords, other than device specific cords, shall meet the requirements of ANSI/TIA/EIA-568-B.3.

5.4.3 Connecting hardware

Optical fiber connecting hardware shall meet the requirements of ANSI/TIA/EIA-568-B.3.

5.5 Multi-conductor cabling

5.5.1 Security cable

Fire alarm cable shall be listed in accordance with Article 760 of the NEC. Security cable shall be listed in accordance with Article 725 of the NEC.

Typical alarm cable color code is black, red, green and yellow and the security cable color code is black, red, white and green. In a DC powered system, red shall denote the positive conductor. Ground wire shall be a minimum of 14-AWG and jacketed in green.

In the fire and security industry, panel manufacturers typically specify the number of conductors and wire gauge required for connections using their panels. Some general guidelines for wire selection, based on distance and current draw, are shown in Table 8.

Table 8 – Cable distance based on current draw of conductors

Wire Size AWG	Current Draw							
	50 mA m (ft)	100 mA m (ft)	300 mA m (ft)	500 mA m (ft)	600 mA m (ft)	1 A m (ft)	2 A m (ft)	3 A m (ft)
22	152 (500)	76 (250)	25 (83)	15 (50)	13 (41)	8 (25)	4 (12)	3 (8)
20	213t (700)	107 (350)	36 (116)	21 (70)	18 (58)	11 (35)	5 (17)	4 (11)
18	396 (1300)	198 (650)	66 (216)	40 (130)	33 (108)	20 (65)	10 (32)	7 (21)
16	457 (1500)	229 (750)	76 (250)	46 (150)	38 (125)	23 (75)	11 (37)	8 (25)
14	975 (3200)	488 (1600)	163 (533)	98 (320)	81 (266)	49 (160)	24 (80)	16 (53)
12	1554 (5100)	777 (2550)	259 (850)	155 (510)	130 (425)	78 (255)	39 (127)	26 (85)

NOTE – 1 to 3 A ratings are intended for alerting devices (e.g., sirens, strobe lights).

5.5.2 Control cable

Control systems may require cable containing 16- to 22-AWG wire. However, cable recognized in ANSI/TIA/EIA-568-B.2 may be sufficient for use in control cabling and should be verified with the equipment manufacturer. In multi-dwelling buildings, a building automation system may be cabled in accordance with ANSI/TIA/EIA-862.

5.5.3 Whole home audio cable

Speaker cable shall be constructed of multiple stranded copper conductors, each conductor sized at a minimum cross-sectional area of 16-AWG. Bundled cables consisting of speaker cable and category 5e or 6 cable may be used. Category 5e or 6 cable shall meet the requirements of ANSI/TIA/EIA-568-B.2.

5.5.3.1 Speaker wire (conductor) gauge selection

The resistance of the cable connecting the speakers to the amplifier becomes relevant in determining how much power reaches the speaker. For example, a 30 m (100 ft) cable run of 16-AWG speaker wire will have a loop resistance of 0.8-ohms. If this is used with a 4-ohm speaker, approximately 17-percent of the power will be lost to the cable, resulting in only 83-percent of the power reaching the speaker. Larger gauge wire will reduce power loss. Typically, 16-AWG or 14-AWG speaker wire connections are provided on electronic devices for whole-home audio systems. See Table 9.

Table 9 – Speaker impedance with power loss according to wire gauge and length

Speaker Impedance	Loss (dB)	Power Loss (percent)	16-AWG Run m (ft)	14-AWG Run m (ft)
4	0.5	11	18 (60)	30 (100)
4	1	21	40(130)	64 (210)
4	2	37	88 (290)	140 (460)
4	3	50	152 (500)	241 (790)
8	0.5	11	37 (120)	58 (190)
8	1	21	79 (260)	125 (410)
8	2	37	177 (580)	283 (930)
8	3	50	302 (990)	482(1 580)

6 INSTALLATION REQUIREMENTS

6.1 General

To protect the public network and active equipment, premises cabling should be disconnected at the demarcation point or ADO during cabling maintenance. Other electrical sources (e.g., a low voltage transformer) shall also be disconnected.

6.1.1 Cable placement

For optimum performance of the cabling system, care should be taken to provide physically well-ordered placement of cable and components, followed by a visual inspection. A well-organized cable placement directly affects visual identification and correction of faults as well as simplifying moves, adds, and changes.

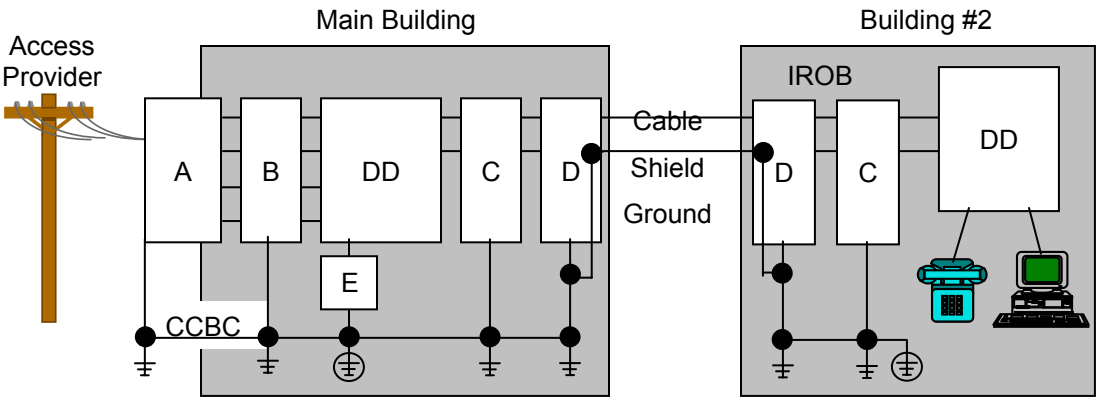
Precautions should be taken to eliminate cable stress such as that caused by tension in suspended cable runs, tightly cinched bundled cables, and exceeding the minimum bend radius requirements of the cable. Cable placement should not deform the cable's outer jacket.

6.1.2 Firestopping

All pathways shall be suitably firestopped as per applicable building codes. For more information on firestopping, see ANSI/TIA/EIA-569-B.

6.1.3 Secondary protection

When a secondary protector is installed, it shall be installed in series with the indoor telecommunications cabling between the primary protector and the distribution device (see Figure 12). Secondary protectors shall be listed for the purpose and shall be compatible with the primary protector.



Protection Locations

A – Access line primary
B – Access line secondary
C – Backbone secondary
D – Backbone primary
DD – Distribution device
E – Power line

Power Company Multi Grounded Neutral (MGN)

Bonding Points

IROB – In Range Out of Building
CCBC – Closely Coupled Bonding Conductor

Figure 12 – Typical protection components for residential cabling

6.1.4 Electromagnetic compatibility

6.1.4.1 UTP cable for voice, data and video

6.1.4.1.1 Separation distance from electrical power

Separation between UTP cable for voice data and video and electrical power conductors shall meet applicable electrical codes. Additionally, when UTP cable is placed alongside ac electrical power

cable inside wall space or ceiling space, it shall have a minimum separation of 50.4 mm (2 in). Where UTP cable for voice, data and video crosses power cable, it should cross at a right angle.

6.1.4.2 Security systems

6.1.4.2.1 Separation distance from electrical power

Parallel runs of security cable and ac electrical power cable shall be separated by a minimum of 150 mm (6 in) to minimize induced electrical interference problems. Where security system cabling crosses power cable, it should cross at a right angle.

6.1.4.2.2 Separation from other telecommunications cables

Cabling for security keypads and other active devices often emits electrical (RF and EMI) interference, or may be affected by it. These cables shall be separated by a minimum of 150 mm (6 in) from any other telecommunications cabling. Where security cable crosses other telecommunications cable, it should cross at a right angle.

6.1.4.3 Whole-home audio systems

6.1.4.3.1 Separation distance from electrical power

Parallel runs of audio cable and ac electrical power cable shall be separated by a minimum of 305 mm (12 in) to minimize induced electrical interference problems. Where audio system cabling crosses power cable, it should cross at a right angle.

6.1.4.3.2 Separation from other telecommunications cables

Audio system cables running parallel to other telecommunications cables should be separated by at least 305 mm (12 in) to minimize induced electrical interference problems. Where audio system cabling crosses other telecommunications cabling, it should cross at a right angle.

6.1.4.4 Reducing noise coupling

In order to further reduce noise coupling from electrical power wiring and motors or transformers, the following installation practices for metallic telecommunications cable should be considered:

- Increased physical separation.
- Electrical branch circuit line, neutral, and grounding conductors should be maintained close together (e.g., twisted, sheathed, taped, or bundled together) for minimizing inductive coupling into telecommunications cabling.
- If telecommunications cable comes within close proximity of electrical power wiring, it is recommended that they cross at 90-degree angles.
- Use of surge protectors in branch circuits that can further limit the propagation of electrical surges.
- Use of fully enclosed, grounded metallic raceway or grounded conduit.

6.2 100-Ohm UTP cabling

6.2.1 Bend radius

In spaces with UTP terminations, cable bend radii shall not be less than four times the cable diameter for outlet cable.

6.2.2 Pulling tension

The maximum pulling tension for a 4-pair 24-AWG UTP cable should not exceed 110 N (25 lbf).

6.2.3 Connecting hardware

Cables should be terminated with connecting hardware of the same category or higher. Installed transmission performance of components that meet requirements of different performance categories shall be classified by the least performing component in the link (e.g., cables, connectors, and patch cords that are not rated for the same transmission capability). This performance category should be marked on the connecting hardware or noted in the administration records.

Only remove as much cable jacket as required to terminate connecting hardware in order to maintain cable the geometry. When terminating connecting hardware, preserve pair-twist as close as possible

to the point of mechanical termination. For category 5e and category 6 cables, the amount of pair untwisting as a result of termination to connecting hardware shall be no greater than 13 mm (0.5 in). For category 3 cables, the untwisting shall be no greater than 75 mm (3 in). . A minimum of 200 mm (8 in) of excess cable should be stored at each outlet.

6.2.4 Cross-connect jumpers and patch cords

Cross-connect jumpers and cables used for patch cords should be of the same category or higher as the outlet cables to which they connect. Due to the variety of cable types, connecting hardware types, tooling and testing required, field termination of patch cords is not recommended.

6.3 75-Ohm coaxial cabling

6.3.1 Bend radius

The minimum bend radius for coaxial cable shall not be less than recommended by the manufacturer. If no recommendation is provided, the minimum bend radius shall be 10 times the cable outside diameter under no-load conditions and 20 times the cable outside diameter when the cable is under a tensile load.

6.3.2 Pulling tension

The maximum pulling tension of coaxial is dependant on the size and material of the center conductor. Copper-coated steel (CCS) is stronger than bare copper. Pulling tension should not exceed the guidelines in Table 10.

Table 10 – Pulling tension guidelines for coaxial cables

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

NOTE – When pulling a combination of different types of cable, limit the pulling tension to that of the minimum strength cable.

6.3.3 Coaxial outlet and distribution device connector

Each coaxial cable at the outlet and the DD shall be connectorized with a female F-Type connector. Table 11 provides the requirements of the type of cable and connector combinations that are compatible.

Table 11 – Coaxial cable and connector type use

Cable Type	Backbone Cable	Outlet Cable	Connector Type	Patch/Equipment Cord
Series 59	No	No	F	Yes
Series 6	Yes	Yes	F	Yes
Series 11	Yes	Yes	F	No
Hard-line	Yes	No	F or N	No

6.3.4 Other installation guidelines

A minimum of 200 mm (8 in) of excess cable should be stored at each outlet. Spacing of cable supports, such as attachments made to wall studs, should be made at varying intervals to avoid degrading SRL performance.

6.4 Optical fiber cabling

6.4.1 Outlet and building cable

Outlet and building optical fiber cables shall not be subjected to a bend radius smaller than the manufacturer's recommended minimum bend radius for the cable. 2- and 4-fiber cables intended for outlet or building cabling shall not be installed with a bend radius less than 25.4 mm (1 in) under no-

load conditions. 2- and 4-fiber cables intended to be pulled through pathways during installation shall not be installed with a bend radius less than 50.8 mm (2 in) under a minimum pull load of 222 N (50 lbf).

Building backbone optical fiber cables shall not exceed the bend radius recommendation provided by the cable manufacturer. If a recommendation is not provided or known, then the cable bend radius shall not exceed 15 times the cable outside diameter when subjected to tensile loading up to the cable rated limit, or 10 times the cable outside diameter when not subjected to a tensile load.

Campus backbone optical fiber cables shall not exceed the bend radius recommendation provided by the cable manufacturer. If a recommendation is not provided or known, then the cable bend radius shall not exceed 20 times the cable outside diameter when subjected to tensile loading up to the cable rated limit, or 10 times the cable outside diameter when not subjected to a tensile load.

6.4.2 Connecting hardware

6.4.2.1 General

The outlet end of an optical fiber outlet cable run should be contained in a telecommunications outlet box or mounting bracket. A minimum of 1 m (3.3 ft) of two-strand optical fiber cable, or two buffered optical fibers should be accessible for termination purposes.

6.4.2.2 Connecting hardware

To ensure a connection will maintain the correct polarity throughout the cabling system, the correct adapter orientation and optical fiber cabling shall be followed. Once the system is installed, and correct polarity is verified, the optical fiber cabling system will maintain the correct polarity of transmit and receive fibers and will not be a concern for the end user.

Optical fiber cabling shall be installed so as to pair an odd numbered fiber with the next consecutive even numbered fiber (i.e., fiber 1 with 2, 3 with 4, and so forth) to form two fiber transmission paths. Each cabling segment shall be installed in a pair-wise cross-over orientation such that odd numbered fibers are Position A at one end and Position B at the other end while the even numbered fibers are Position B at one end and Position A at the other end.

The cross-over shall be achieved by using consecutive fiber numbering (i.e., 1,2,3,4...) on both ends of an optical fiber link, but the adapters shall be installed in opposite manners on each end (i.e., A-B, A-B... on one end and B-A, B-A... on the other). This approach is illustrated in Figure 13 and Figure 14.

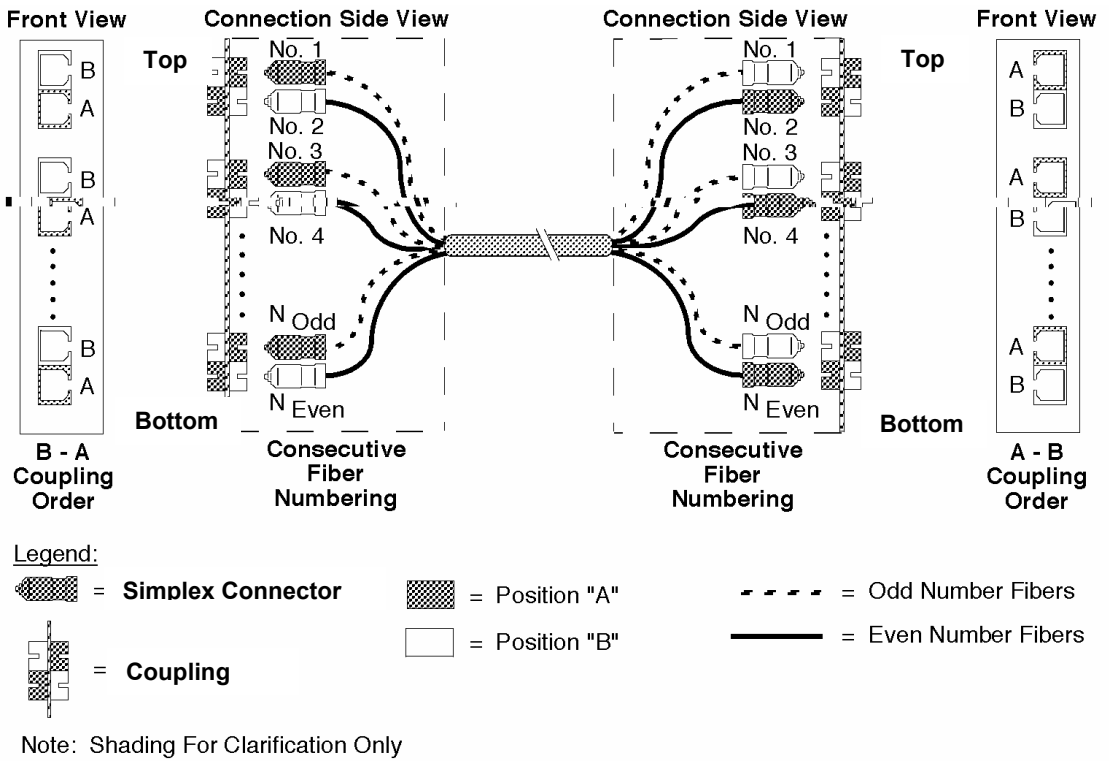


Figure 13 – Example of polarity for optical fiber cabling

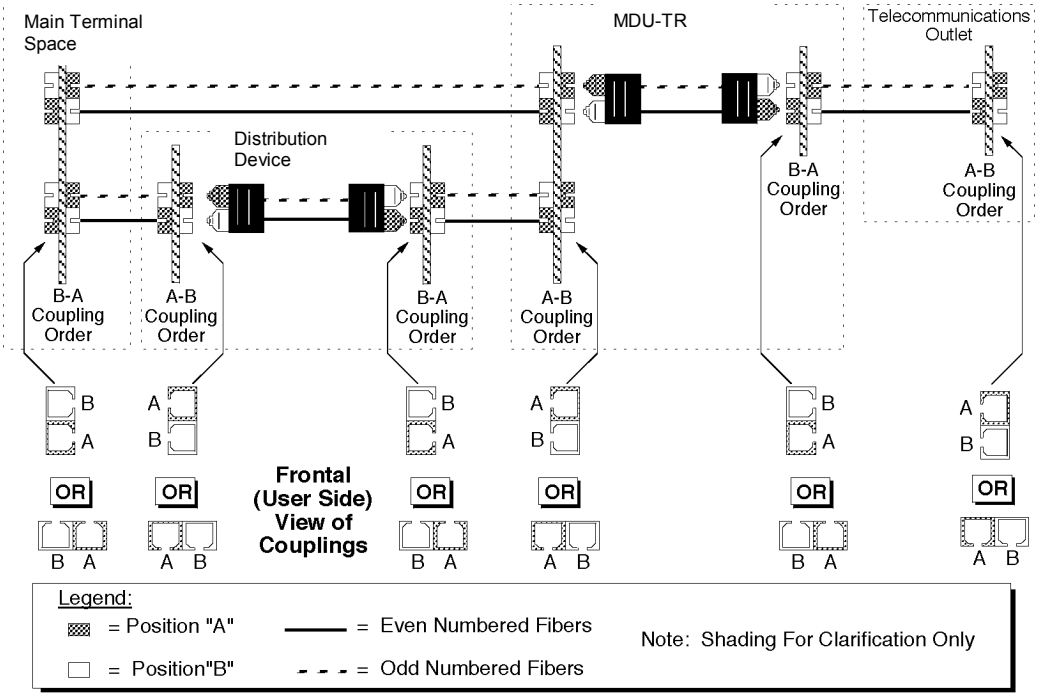


Figure 14 – Example of optical fiber cabling polarity for residential buildings

6.5 Security cabling

6.5.1 Device locations

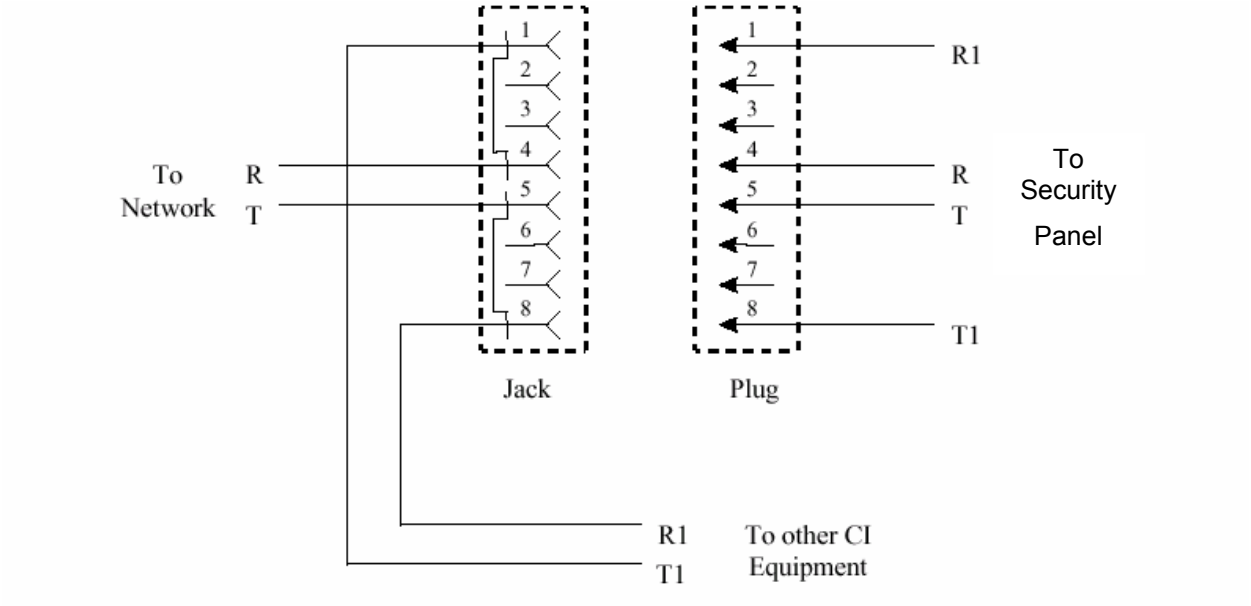
Proper location of sensors and devices is critical to assure best response or capture performance and to minimize potential false alarms. Manufacturers recommendations should be followed on optimum mounting locations. Installed cabling end-point locations should be marked for all sensors and detectors that will be installed after the trim-out phase of building construction. Cables for video surveillance cameras should be terminated in a junction box to facilitate later installation of the cameras.

6.5.2 Security panel

All cabling shall terminate in an alarm or security panel that shall be properly grounded to earth ground. The panel shall be connected either directly to the ac electrical power supply or to a low voltage source of power using a Class 2 Listed plug-in transformer. A standby battery and associated trickle charger are normally provided within the control panel so that the system can continue to function during periods of utility power outage.

A dial-up telephone line provides a central monitoring station connection for monitoring the security/alarm system. An RJ-31X interface (specified in ATIS, Committee T1 Technical Report No. 5) shall be used that gives transmission priority to the security system. Figure 15 illustrates the connections to an RJ-31X interface.

NOTE – Some manufacturers have substituted a double pole, single throw (DPST) dual inline package (DIP) switch wired across a standard eight-position modular jack for the RJ-31X. These must be connected to the telephone line ahead of any other distribution devices.



NOTES

1 – This connector is presently listed in Part 68 of the FCC's rules and regulations but because of the Commission's deregulation of premises wiring, this configuration is no longer used as a network interface but is still used by customers on the customer side of the network interface.

2 – The short between pins 1 & 4 and pins 5 & 8 are removed when a plug is inserted into the jack.

Figure 15 – Illustration of connections associated with an RJ-31X registered jack

6.6 Control cabling

Control device locations should be carefully considered by consulting applicable codes and regulations. Each of these locations should be marked to identify the positions of thermostats and sensors for installation during the “trim-out” phase of construction. Detailed installation instructions provided by equipment manufacturers should be followed.

6.7 Whole-home audio cabling

6.7.1 General

Installing audio cabling after wall stud construction and electrical power cable installation allows speaker and control locations to be lined up and coordinated with other room features such as light fixtures or walls.

6.7.1.1 Wire color code

All speaker cable should be color coded, or distinctively marked to ensure proper polarity.

Color-coded cables generally have a red and a black conductor. The red conductor should be used for the positive terminals, and the black conductor for the negative terminals.

Four conductor-unpaired cables generally have red, black, white and green conductors. Red and black should be positive and negative for the right speaker in each zone. White is positive and green is negative for the left speaker. Other colors may be used, but all connections must be consistent. If a different color code is used, the color code should be labeled near the amplifier terminals.

6.7.1.2 Polarity

Correct polarity of the wire to the speaker is critical to proper sound reproduction. All speakers should have the positive connection plus sign (+) or red terminal connected to the positive (+ or red) terminal on the amplifier, and the negative (– or black) terminal connected to the negative amplifier terminal.

Amplifier terminals should not be “commoned” (connected to each other), unless specifically allowed by the amplifier manufacturer for a specific purpose, such as bridging an amplifier for higher power output.

7 FIELD TEST REQUIREMENTS

7.1 General

Telecommunications cabling (voice, data, video, security, audio, control) can be damaged during the construction phases of rough-in, drywall installation, and even siding of the exterior. Many of these damaging faults result from causes such as nail and staple holes in the cable, severe kinks in the cable where the cable was pulled through a drilled hole in a stud or joist, or a cable tear where the cable sheath and conductors are damaged from the pull. For these reasons, telecommunications cabling shall be acceptance tested to ensure compliance with this standard. Acceptance testing includes:

1. a visual examination of all cabling;
2. verification of all cabling, and;
3. either:
   a) qualification of copper cabling for data cabling or;
   b) performance characterization of copper or optical fiber cabling for data cabling.

NOTE – Data cabling uses either 4-pair UTP copper or optical fiber cable with a connector on each end of the cable.

7.2 Visual examination

Visual inspection of each cable run shall be made after the cable has been installed prior to installation of insulation and gypsum board. Visual inspection may include but is not limited to:

a) obvious damage to cable;
b) separation from EMC sources;
c) incorrect bend radii, and;
d) excessive cable length.

7.3 Verification Testing

Verification testing is generally performed in two steps: 1) prior to the installation of insulation and gypsum board, and; 2) during the “trim-out” stage of the cabling after painting.

NOTE – Performing either a qualification test or a performance characterization test of data cable will generally negate the need for verification testing during the “trim-out” stage.

Verification testing of the cabling shall be performed to ensure proper end-to-end connectivity. Optical fiber shall be tested as specified in subclause 7.5.2. Coaxial cable shall be verified to ensure connectivity to the remote end with an absence of shorts. Twisted-pair cabling test shall include:

a) Wiremap;
b) Length;
c) Continuity to the remote end;
d) Shorts between any two or more conductors;
e) Crossed pairs;
f) Reversed pairs;
g) Split pairs; and,
h) Any other mis-wiring.

Verification testing shall be performed on all category 3 or higher telecommunications cabling that is bridged or not terminated with an 8-pin modular jack on both ends. Additionally, verification testing shall be performed on other than category 3 or higher telecommunications cables and cabling. Examples of category 3 or higher cables and cabling where it may not be terminated at both ends with an 8-position modular jack are:

a) ADO cable;
b) cable used for powering video cameras, IR targets or IR emitters;

c) cable for telephones that terminate on bridging modules in the DD;
d) audio cable for speakers and volume controls, and;
e) cable for control systems.

Examples of cabling other than category 3 or higher are:

a) ADO cable (e.g., coaxial, optical fiber);
b) audio cable for speakers and volume controls, and;
c) Series 6 cable for radio frequency (RF) Broadband, digital satellite system (DSS), and CCTV.

7.4 Cable qualification

Cable qualification of data cabling is preferred over verification testing during the "trim-out" stage of cabling. Cable qualification tests the cabling to determine that certain network technologies (e.g., 100BASE-T, FireWire) will perform on the cabling system. Cable qualification shall be performed using network equipment installed on the cabling, or by use of a qualification test instrument.

7.5 Performance characterization

7.5.1 Copper cabling

Performance characterization may be used in lieu of verification testing or cable qualification testing of data cabling during the "trim-out" stage of cabling. Performance characterization tests the cabling to all performance criteria of a category of cable specified by ANSI/TIA/EIA-568-B.2. Performance characterization testing shall use either a permanent link (see Figure 16) or a channel (see Figure 17) measurement in accordance with ANSI/TIA/EIA-568-B.1 clause 11. The permanent link refers to the permanent part of the cabling installed (cable up to 295 ft. from the central distribution center to the outlet and the connectors) without patch cords installed on each end of the cable. A channel refers to the permanent part of the cabling plus the patch cords (328 ft.) that will be left on the ends and later connected to equipment (in a channel test the end user patch cords stay plugged into the jacks).

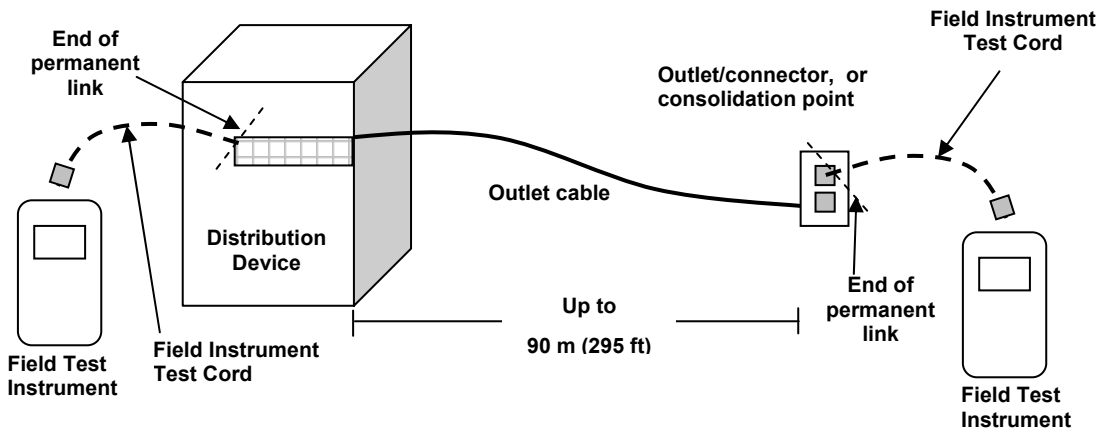


Figure 16 – Permanent link test configuration

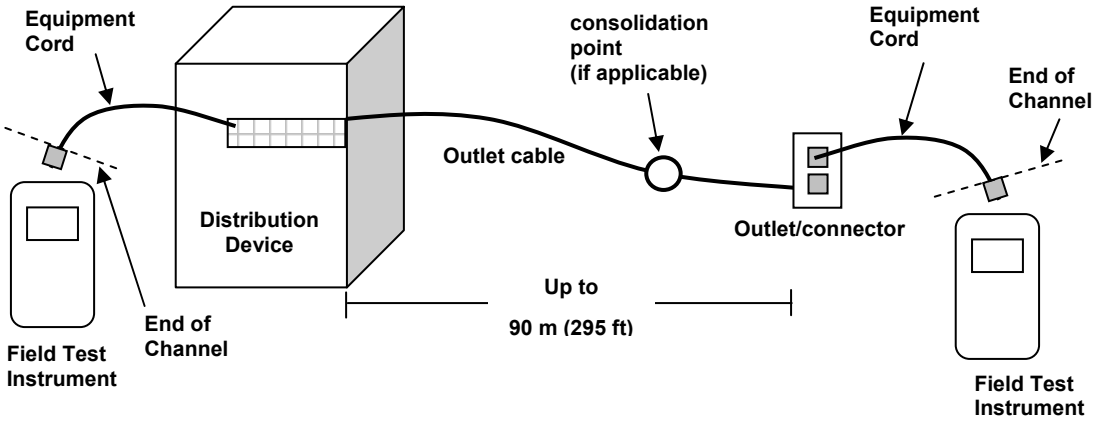


Figure 17 – Channel test configuration

7.5.2 Optical fiber cabling

Optical fiber cabling shall be tested by following the requirements of ANSI/TIA/EIA-568-B.1.

8 ADMINISTRATION

8.1 General

Administration, including labeling, identification, and documentation, shall be performed for the telecommunications infrastructure. Labels should be mechanically printed.

8.2 Single-dwelling residence

Administration for single-dwelling residences can range from a simple label affixed to the inside of the distribution device identifying each cabling run, to blueprints indicating outlet locations and identifying cable runs.

8.2.1 Cable identification

Cable runs from the distribution device to the outlet shall be labeled on each end of the cable. This may be accomplished by affixing suitable identification tags or labels.

8.2.2 Outlet identification

Outlet labeling is desired but not a requirement due to aesthetic considerations in the living space. Icons or labels may be mounted on the faceplate of each outlet, which denote the intended application for each outlet cable.

8.2.3 Distribution device Identification

At a minimum, a label shall be provided within the distribution device denoting each cable run. Each cable run should be identified by room and wall locations. For example, B1-N could denote an outlet on the north wall of bedroom one.

8.3 Multi-dwelling building(s)

Multi-dwelling residences (e.g., apartment buildings, condominiums) are cabled and shall be administered in the same manner as commercial buildings. The choice selection of Class 1, 2, 3 or 4 is based on the number of residential units in a building and the number of buildings in a development.

For multi-dwelling residential telecommunications infrastructure administration requirements, refer to ANSI/TIA/EIA-606-A.

Annex A (informative) Cabling residential buildings

This annex is informative and is not considered a part of this Standard.

A.1 General

A.1.1 Construction

Residential construction has traditionally differed from commercial construction. Commercial buildings evolved to incorporate cabling systems to address networking capabilities, while most single- and multi-dwelling residential construction had cabling installed to primarily support telephone and television. However, beyond being just living spaces with limited telecommunications needs, residences have become the home offices, are incorporating sophisticated automation, and are used with bandwidth intensive applications. Preparing residences for these services with the proper grade of telecommunications cabling is the focus of this annex.

A.1.2 Cabling infrastructure

Certain steps must be followed to ensure a well-performing telecommunications cabling system in single- and multi-dwelling residential construction. The cabling system must be planned to incorporate cabling pathways, spaces, and proper installation.

A.2 Telecommunications planning

A.2.1 Cable system planning

Initially, the designer of the system must understand the tenants' immediate needs and desires, and attempt to provide a cabling system that will be used to migrate with future systems. From this information, the telecommunications cabling system should be planned with one of the two grades of residential cabling for voice, data and video applications. Additionally, planning should include considerations of security, control and whole-home audio cabling.

A.2.2 Architectural planning

A.2.2.1 Single-dwelling residence

An indoor space should be provided to house the distribution device (DD). This space should be in a centrally located, accessible area that is provided with adequate power, lighting, and ventilation. In some situations, additional termination spaces may be required.

Floor outlets or conduits in poured slab floors must be planned in advance. Wherever possible, telecommunications pathways should be designed into the structure to facilitate cable installation and growth.

A sufficient number of telecommunications outlets should be planned to prevent the need for extended cords. Mounting heights should be in compliance with the Americans with Disabilities Act (ADA). An outlet should be installed in each unbroken wall space of 3.7 m (12 ft) or more. Additional outlets should be installed so that no point along the floor line in any wall space is more than 7.6 m (25 ft), measured horizontally, from an outlet in that space.

A.2.2.2 Multi-dwelling residential buildings

The architectural telecommunications cabling plan of the multi-dwelling residential complex is usually comprised of the following types of distribution:

- Buildings that may have the entrance facility located on the exterior of a building(s).
- Buildings with multiple backbone pathways through typical residential units.
- Buildings with multi-dwelling unit – telecommunications rooms (MDU-TR's).
- Campus backbones.

A.2.3 Construction planning

The building construction and sequence of events must be followed closely for the telecommunications cabling to be installed properly and to perform to expectations. The telecommunications cabling should be planned as early as possible in the building project. Usually, the builder contacts access providers early in the design phase to determine right-of-way, and entrance facility requirements. However, due to the nature of housing sales, the planning of the individual residence's telecommunications cabling may not be accomplished until very late in the construction stages. The designer, builder, owner, and tenant must collaborate early on to determine specific telecommunications needs and to ensure timely installation of the required cabling infrastructure. When the building is to be pre-wired, the rough-in of telecommunications cabling should be installed prior to wall and ceiling insulating or closing of the wall cavity. Coordination with other trades prior to this stage of construction is imperative to ensure a timely and effective telecommunications cabling installation.

A.2.4 Documentation

A.2.4.1 Components

The telecommunications cabling components should be documented on construction plans prior to the rough-in stage of the electrical power cabling. The components of a single-dwelling residential cabling system that need to be designed into the cabling plan include the ADO cable, the ADO, the DD, the outlet cabling, fixed device locations (e.g., intercom, security keypad, sensors, speakers), and outlet locations. For multi-dwelling backbones, the cabling components that need to be designed into the documentation include the ADO cabling, the backbone cabling, the associated backbone spaces, and facility requirements (e.g., electrical, HVAC). Construction plans should indicate:

- the location and type of telecommunications outlets and fixed devices;
- the type of cabling and pathways;
- the space designated for the backbone facilities, the DD, the ADO, and for electronic telecommunications equipment;
- the demarcation point; and,
- the entrance facility to the building, or residence.

A.3 Telecommunications spaces

A.3.1 General

Telecommunications spaces include the areas used to house telecommunications equipment and connecting hardware. Consider using a flush mounted DD where aesthetic are a concern or space is limited.

A.3.2 Space planning

Space planning for telecommunications cabling will be affected by the choice of the grade of cabling, the size of the residence, and the number of cables being distributed on the premises. Where outlet cable lengths extend beyond 90 m (295 ft), additional telecommunications spaces should be incorporated into the design that will be interconnected with backbone pathways. At the DD, additional space may be required for equipment or other subsystems that interconnect with the DD (e.g., audio systems, security systems, home automation, local area network switches, etc.). Consideration should be given to future expansion, upgrades, and the addition of other subsystems.

A.3.3 Construction guidelines

Construction guidelines for telecommunications spaces will vary according to the grade of cabling planned to be installed, environmental needs of equipment, and aesthetics desired by the consumer. In-wall cabinets or surface-mount space may be used for the DD. A shelf or wall-mount support structure should be considered at the DD for electronic equipment.

A.4 Telecommunications pathways

A.4.1 General

Telecommunications pathways provide the means of extending outlet, backbone, and ADO cabling between telecommunications spaces. Backbone pathways may extend between buildings, or between termination points within a building.

A.4.2 Pathways planning

Cabling pathways should be planned to meet applicable code requirements. In addition to code requirements, the pathways should be planned such that installed cabling performance will not be impeded. For example, an excessive bend in the pathway at a perpendicular wall junction or use of exterior walls or attic space, that may get extremely hot, can impede performance. When planning pathways, keep in mind that, in most instances, cabling will be a placed in a star topology.

A.4.3 Construction guidelines

A.4.3.1 Single-dwelling residence

Constructing pathways in single-dwelling residences may be as simple as drilling holes in studs and joists to create a cabling pathway. Still, there are other situations that may require conduit, flexible tubing or other raceways to be installed. Where metal studs are used, a protective pathway such as conduit or bushings should be installed to minimize cable abrasion during installation, or due to building vibrations. The interior unit walls and ceilings should be used for pathways. Exterior wall pathways may jeopardize cable installation by the nailing of siding through the sheathing, or the effects of heat during summer months in certain areas. Alternatively, surface raceway can be used in applications where cable pathways within the wall are not preferred.

A.4.3.2 Multi-dwelling residential building

Typically, conduit, sleeves, cable tray, or flexible tubing are installed for backbone and ADO cabling within and between structures. However, some backbone pathways in multi-dwelling low-rise residences may be as simple as drilling holes in studs and joists to create a cabling pathway. Where metal studs are used, a protective pathway such as conduit or bushings should be installed to minimize cable abrasion during installation or due to building vibrations.

A.5 Telecommunications cabling (finish)

A.5.1 General

The outlet cabling point-to-point distribution is usually installed from the telecommunications DD to outlets.

A.5.2 Construction guidelines

Finishing-out the telecommunications cabling system involves terminating cable to the connecting hardware and installing the appropriate sensors, speakers and faceplates. This part of the project not only provides the means for connecting the telecommunications devices, but may also provide for a neat appearance at the conclusion of the job. An electrical power outlet should be provided that is convenient to each telecommunications outlet in the residence. Where fixed devices are cabled, the manufacturer's instructions should be followed for mounting and termination.

A.6 Security of backbone

Where access is needed for multiple tenants, appropriate security measures should be taken. The building owner or agent should control access to shared-use space.

Annex B (informative) Installation guide

This annex is informative and is not considered a part of this Standard.

B.1 Introduction

The focus of this section is on cable installation. There are six basic steps that need to be followed in installing the cabling include:

- design of the cabling system;
- preparation a bill of materials (BOM);
- accomplish the pre-wire;
- trim-out installation;
- test the system; and,
- provide documentation.

B.2 Cabling system design

In consultation with the builder or homeowner determine type and location of outlets in the home. Plans should be marked up to designate all Grade 1 or Grade 2 outlet locations for voice. data, video, and cabling for security, control and whole-home audio.

A minimum of one information outlet is recommended in the kitchen, each of the bedrooms and any unbroken 3.7 m (12 ft) wall section. Two information outlets are recommended in the master bedroom, den/study and family room.

Determine the location of distribution device, which should be centrally located within the climate-controlled living space to minimize cable run lengths. It should be in close proximity of voice, video and data entry points and within 1.5 m (5 ft) of a 15 A dedicated duplex electrical outlet.

Plan cable run routes for the various cables between the distribution device and information outlets and other end points. The maximum allowable distance between the distribution device and an information outlet is 90 m (295 ft).

B.3 Bill of materials

Prepare a bill of materials as per the system design (e.g., information outlets, distribution device, modules, cable). Determine the average cable run length to determine the number of 150 m (500 ft) or 300 m (1 000 ft) spools/boxes of each cable type that are needed.

Determine, based on the parameters of the installation, if individual cables, siamese cables, or multimedia cables will be installed. Select other cables that may be needed for whole-home audio, home automation, home security and other applications.

Inventory installation tools and test equipment to make ensure of their availability throughout the project.

B.4 Pre-wire

Pull cables as required between the distribution device and information outlets and other end points. Cables must be extended in a star topology and splices are not allowed. It is recommended to maintain a 305 mm (12 in) separation from power cables and if these need to be crossed, do so at right angles. In addition, maintain a 305 mm (12 in) separation from speaker-level audio cables and if these need to be crossed, do so at right angles.

In pulling cables do not exceed 110 N (25 lbf) for category 3, 5e or 6 twisted-pair cable, 178 N (40 lbf) for the Series 6 (RG6) coaxial cable and follow manufacturer recommendations for the optical fiber cable. Leave a minimum of 1 m (3 ft) of slack at the distribution device and 0.25 m (8 in) at the information outlet.

During installation make sure that the 25 mm (1 in) minimum bend radius for twisted-pair cable and the 75 mm (3 in) minimum bend radius for the Series 6 (RG6) coaxial cable are not exceeded. Bending these cables tighter than the specified minimum bend radius will degrade electrical performance parameters.

Label cable ends to facilitate connections in distribution device. A rough-in distribution device may be installed at this time. Installation of the distribution device should be at approximately eye level.

B.5 Trim-out

Install 8-position modular plugs or jacks as required on the twisted-pair cables or punch-down on connecting blocks. Install F-Type connectors on both ends of each coaxial cable run. Terminate optical fiber cables per manufacturer recommendations. Complete information outlet assembly and install faceplate.

Install modules per manufacturer recommendations in distribution device and connect the appropriate cables. Make sure that all cable ends are permanently marked to facilitate testing, future trouble-shooting and making adds, moves and changes.

Connect external services to distribution device. This includes telephone lines, CATV service, DSL lines, cable modems and may also include satellite dishes, digital radio receivers and various rooftop antennas. There may be additional connections for energy and security monitoring.

Ensure that a proper ground exists at the distribution device and security panel. Consider utilization of lighting arresters, surge suppressors and uninterruptible power supplies in the system to provide circuit protection.

B.6 Testing

Test each cable run in accordance with clause 7. Visually inspect and verification test each of the cable runs prior to the installation of insulation and gypsum board to ensure there are no continuity problems. During the trim-out stage of the project, all cables with exception of those used for data transmission are to be verification tested once again. This will ensure the integrity of the cables (e.g., cables were not damaged during insulation and gypsum board installation, exterior sheathing or siding installation). For data cabling, each cable run should be qualification tested to ensure application services will be supported, or full performance characterization to ANSI/TIA/EIA-568-B-2.

B.7 Documentation

Affix to the distribution device a list of the cable runs and their locations. Provide a copy of the test results on each of the cable runs as well as any warranty information to the owner. Additionally, copies of all instruction sheets for modules mounted in distribution device should be provided to the owner. A label with the installer name and phone number should be affixed to the distribution device for future reference of the owner should they require additional work.

Annex C (informative) Typical applications that interface to residential cabling

This annex is informative and is not considered a part of this Standard.

C.1 General

This annex is informative guide to describe typical, applications that interface to residential cabling. See Table 12.

Table 12 – Common applications that interface to residential cabling

Application	Media	User/Device Interface	Distance from service provider (m)	Comments
Analog Phone	Category 3, 5e, 6	IEC-60603-7	5,000	
ISDN BRI	Category 3, 5e, 6	IEC-60603-7	5,000	128 Kb/s
ISDN PRI	Category 3, 5e, 6	IEC-60603-7	5,000	1.472 Mb/s
ADSL	Category 3, 5e, 6	IEC-60603-7	5,000	1.5 Mb/s to 9 Mb/s
Cable Modem	RG-6 coax	SCTE IPS-SP-401	5,000	
CCTV	RG-6 coax	SCTE IPS-SP-401		“F” Type connector
CATV	RG-6 coax	SCTE IPS-SP-401		“F” Type connector
HDTV	RG-6 coax	SCTE IPS-SP-401		Satellite, broadcast, or cable
FAX	Category 3, 5e, 6	IEC-60603-7	5,000	
ATM	Category 3, 5e, 6	IEC-60603-7		
VDSL	Category 3, 5e, 6	IEC-60603-7	5,000	4500 ft for 12.9 Mb/s and 1000 ft for 52.8 Mb/s total distance
SONET	Single mode			Up to OC-192 (10G/s)
IEEE 802.3 Ethernet First Mile	Category 3, MM fiber, SM fiber	Various	Up to 40,000	Under development
10GBASE-S	50/125 μm, 1500/500 MHz•km		300	
10GBASE-L	Single-mode		10000	
10GBASE-E	Single-mode		40000	
1000BASE-SX	62.5/125 μm, 160/500 MHz•km		220	
1000BASE-SX	50/125 μm, 500/500 MHz•km		550	
1000BASE-SX	50/125 μm, 1500/500 MHz•km		550	
1000BASE-LX	62.5/125 μm, 160/500 MHz•km		550	
1000BASE-LX	50/125 μm, 500/500 MHz•km		550	
1000BASE-LX	50/125 μm, 1500/500 MHz•km		550	
1000BASE-LX	Single-mode		5000	

100BASE-SX	62.5/125 μm, 160/500 MHz•km		300	
100BASE-SX	50/125 μm, 500/500 MHz•km		300	
100BASE-F	62.5/125 μm, 160/500 MHz•km		2000	
100BASE-F	50/125 μm, 500/500 MHz•km		2000	
100BASE-F	50/125 μm, 500/500 MHz•km		2000	
10BASE-F	62.5/125 μm, 160/500 MHz•km		2000	
10BASE-F	50/125 μm, 500/500 MHz•km		2000	
10BASE-F	50/125 μm, 1500/500 MHz•km		2000	

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ANNEX D (informative) Bibliography and References

This annex is informative only and is not part of this Standard.

This annex contains information on the documents that are related to or have been referenced in this document. Many of the documents are in print and are distributed and maintained by national or international standards organizations. These documents can be obtained through contact with the associated standards body or designated representatives. The applicable electrical code in the United States is the *National Electrical Code*®.

- ANSI/TIA/EIA-526-7-1998, *Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant*
- ANSI/TIA/EIA-526-14-A-1998, *Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant*
- TIA/EIA TSB-31-B, FCC 47 CFR 68, Rationale and Measurement Guidelines
- Federal Communications Commission (FCC) Washington D.C., *The Code of Federal Regulations, FCC 47 CFR 68*
- NEMA-250-1985, *Enclosures for Electrical Equipment (1000 Volts Maximum)*
- UL 444-90, *UL Standard for Safety Communications Cables*

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

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

ASTM
American Society for Testing and Materials (ASTM)
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
USA
(610) 832-9500
www.astm.org

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

CSA
Canadian Standards Association International (CSA)
178 Rexdale Blvd.
Etobicoke, (Toronto), Ontario
Canada M9W 1R3
(416) 747-4000
www.csa-international.org

EIA
Electronic Industries Alliance (EIA)
2500 Wilson Blvd., Suite 400
Arlington, VA 22201-3836
USA
(703) 907-7500
www.eia.org

FCC
Federal Communications Commission (FCC)
Washington, DC 20554
USA
(301) 725-1585
www.fcc.org

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

ICEA
Insulated Cable Engineers Association, Inc. (ICEA)
PO Box 440
South Yarmouth, MA 02664
USA
(508) 394-4424
www.icea.net

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

IEEE
The Institute of Electrical and Electronic Engineers, Inc (IEEE)
IEEE Service Center
445 Hoes Ln., PO Box 1331
Piscataway, NJ 08855-1331
USA
(732) 981-0060
www.ieee.org

IPC
The Institute for Interconnecting and Packaging Electronic Circuits
2215 Sanders Rd.
Northbrook, IL 60062-6135
USA
(847) 509-9700
www.ipc.org

ISO
International Organization for Standardization (ISO)
1, Rue de Varembe
Case Postale 56
CH-1211 Geneva 20
Switzerland
+41 22 74 901 11
www.iso.ch

NEMA
National Electrical Manufacturers Association (NEMA)
1300 N. 17th Street, Suite 1847
Rosslyn, VA 22209
USA
(703) 841-3200
www.nema.org

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

SCTE
Society of Cable Telecommunications Engineers (SCTE)
140 Philips Rd.
Exton, PA 19341-1318
USA
(800) 542-5040
www.scte.org

Telcordia Technologies (formerly; Bellcore)
Telcordia Technologies Customer Service
8 Corporate Place Room 3C-183
Piscataway, NJ 08854-4157
USA
(800) 521-2673
www.telcordia.com

TIA
Telecommunications Industry Association (TIA)
2500 Wilson Blvd., Suite 300
Arlington, VA 22201-3836
USA
(703) 907-7700
www.tiaonline.org

UL
Underwriters Laboratories, Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096
USA
(847) 272-8800
www.ul.com