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TIA STANDARD

Broadband Coaxial Cabling and Components Standard

TIA-568-C.4 **July 2011**

TELECOMMUNICATIONS INDUSTRY ASSOCIATION
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Broadband Coaxial Cabling and Components Standard

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FOREWORD

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

This Standard was developed by TIA Subcommittee TR-42.7.

Approval of this Standard

This Standard was approved by TIA Subcommittee TR-42.7, TIA Engineering Committee TR-42, and the American National Standards Institute (ANSI).

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 At that time, standards are reaffirmed, withdrawn, or revised according to the submitted updates.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

Contributing organizations

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

Relationship to other TIA standards and documents

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

- *Generic Telecommunications Cabling for Customer Premises* (ANSI/TIA-568-C.0)
- *Commercial Building Telecommunications Cabling Standard* (ANSI/TIA-568-C.1)
- *Balanced Twisted-Pair Telecommunications Cabling and Components Standard* (ANSI/TIA-568-C.2)
- *Optical Fiber Cabling Components Standard* (ANSI/TIA-568-C.3)
- *Commercial Building Standard for Telecommunications Pathways and Spaces* (TIA-569-B)
- *Residential Telecommunications Infrastructure Standard* (ANSI/TIA-570-B)
- *Administration Standard for Commercial Telecommunications Infrastructure* (ANSI/TIA/EIA-606-A)
- *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications* (ANSI-J-STD-607-A)
- *Customer-Owned Outside Plant Telecommunications Infrastructure Standard* (ANSI/TIA-758-A)
- *Building Automation Systems Cabling Standard for Commercial Buildings* (ANSI/TIA/EIA-862)
- *Telecommunications Infrastructure Standard for Data Centers* (ANSI/TIA-942)
- *Telecommunications Infrastructure Standard for Industrial Premises* (ANSI/TIA-1005)

Figure i shows the schematic relationship between the ANSI/TIA-568-C series and other relevant TIA standards.

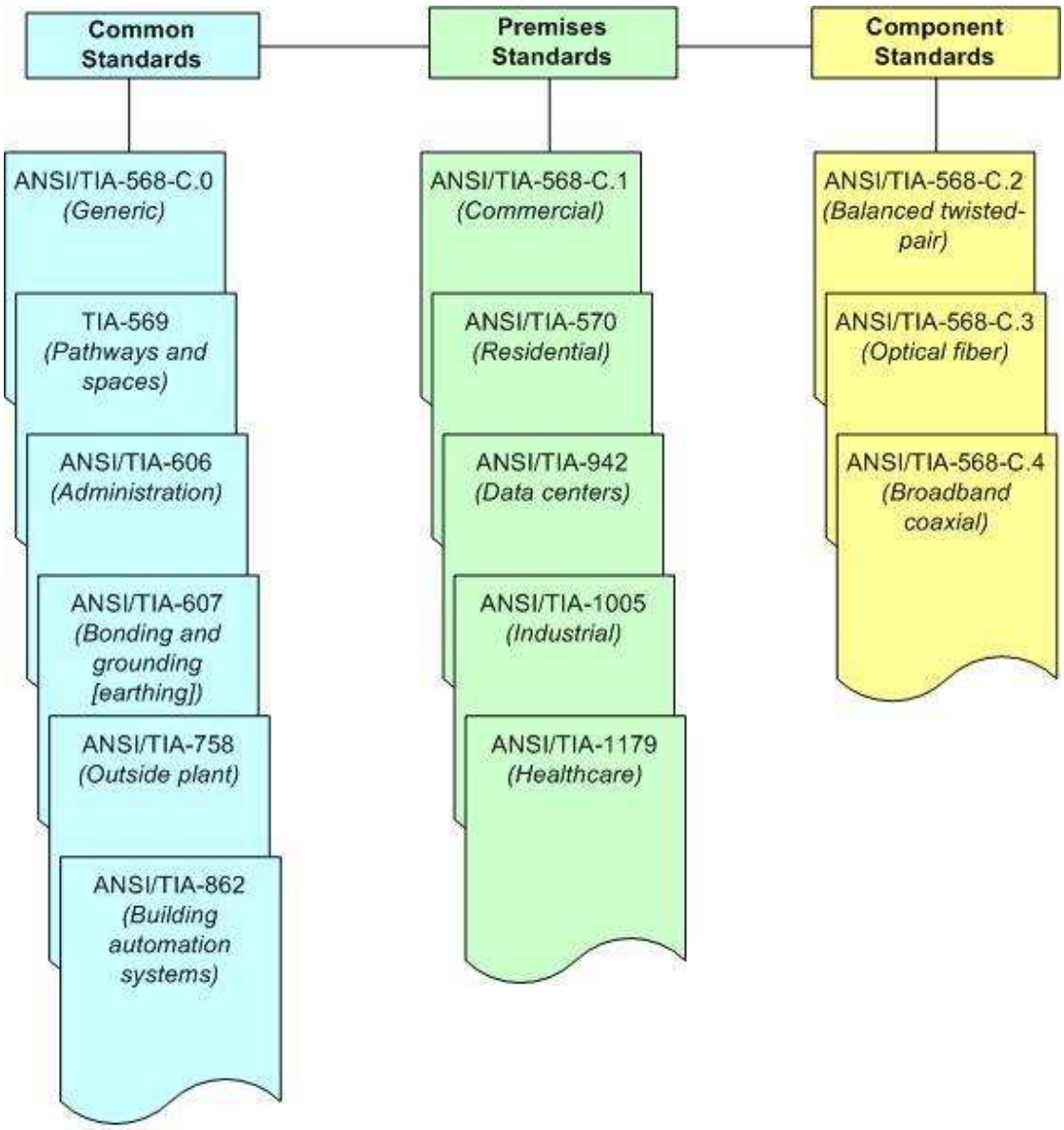

Figure i – Relationship between ANSI/TIA-568-C series and other relevant TIA standards

The following documents may be useful to the reader:

- *National Electrical Safety Code® (NESC®)* (IEEE C2-2007)
- *National Electrical Code® (NEC®)* (NFPA 70-2008)

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

Annexes

Annexes A and B are informative and not considered requirements of this Standard.

Introduction

This Standard specifies requirements and recommendations for 75 Ω broadband coaxial cabling, cables, cords, and connecting hardware to support community antenna television (CATV, commonly referred to as cable television), satellite television, and other applications supported by the telecommunications infrastructure (star topology) defined by ANSI/TIA-568-C.0 and other topologies specified within this Standard.

Stewardship

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

Purpose

This Standard establishes performance and technical criteria for coaxial cabling system configurations for accessing and connecting their respective elements. In order to determine the requirements of a generic coaxial cabling system, performance requirements for various telecommunications services were considered.

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

Specification of criteria

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

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

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

Metric equivalents of US customary units

The dimensions in this Standard are metric or US customary with soft conversion between the two.

Life of this Standard

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

1 SCOPE

This Standard specifies requirements and recommendations for 75 Ω broadband coaxial cabling, cables, cords, and connecting hardware to support community antenna television (CATV, commonly referred to as cable television), satellite television, and other applications supported by the telecommunications infrastructure (star topology) defined by ANSI/TIA-568-C.0 and other topologies specified within this Standard. Included are transmission requirements, mechanical requirements, and requirements related to electromagnetic compatibility (EMC) for cabling, cables and connectors; cabling installation and connector termination procedures; and field testing procedures.

2 NORMATIVE REFERENCES

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

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

ANSI/SCTE 01, *Specification for "F" Port, Female, Outdoor*, 2006

ANSI/SCTE 02, *Specification for "F" Port, Female, Indoor*, 2006

ANSI/SCTE 15, *Specification for Trunk, Feeder and Distribution Coaxial Cable*, 2006

ANSI/SCTE 47, *Test Method for Coaxial Cable Attenuation*, 2007

ANSI/SCTE 60, *Test Method for Interface Moisture Migration Double Ended*, 2004

ANSI/SCTE 71, *Specification for Braided, 75 Ω, Coaxial, Multi-Purpose Cable*, 2008

ANSI/SCTE 74, *Specification for Braided 75 Ω Flexible RF Coaxial Drop Cable*, 2003

ANSI/SCTE 92, *Specification for 5/8-24 Plug (Male), Trunk and Distribution Connectors*, 2007

ANSI/SCTE 117, *Specification for Braided 75 Ω, Mini-Series Broadband Coaxial Cable*, 2006

ANSI/SCTE 123, *Specification for "F" Connector, Male, Feed-Through*, 2006

ANSI/SCTE 124, *Specification for "F" Connector, Male, Pin Type*, 2006

ANSI/SCTE 129, *Drop Passives: Bonding Blocks (without Surge Protection)*, 2007

ANSI/SCTE 146, *Outdoor "F" Female to "F" Female Inline Splice*, 2008

ANSI/SCTE 147, *Specification for 75 Ohm, Inline Attenuators*, 2008

ANSI/SCTE 148, *Specification for Male "F" Terminator, 75 Ohm*, 2008

ANSI/SCTE 151, *Mechanical, Electrical, and Environmental Requirements for RF Traps and Filters*, 2008

ANSI/SCTE 153, *Drop Passives: Splitters, Couplers and Power Inserters*, 2008

ANSI/SCTE 155, *Indoor "F" Female to "F" Female Inline Splice*, 2008

ANSI/SCTE 161, *Drop Amplifiers*, 2009

ANSI/TIA-568-C.0, *Generic Telecommunications Cabling for Customer Premises*, 2009

IEC 61169-8, *Radio Frequency Connectors – Part 8: Sectional Specification – RF Coaxial Connectors with Inner Diameter of Outer Conductor 6,5mm (0,256 in) with Bayonet Lock - Characteristic Impedance 50 Ohms (Type BNC),* 2007

IEC 61196-1-112, *Coaxial Communication Cables – Part 1-112: Electrical Test Methods - Test for Return Loss (Uniformity of Impedance)*, 2006

IEC 62153-4-3, *Metallic Communication Cable Test Methods – Part 4-3: Electro-magnetic Compatibility (EMC) - Surface Transfer Impedance - Triaxial Method*, 2006

IEC 62153-4-4, *Metallic Communication Cable Test Methods – Part 4-4: Electro-magnetic Compatibility (EMC) - Shielded Screening Attenuation, Test Method for Measuring of the Screening Attenuation as Up To and Above 3 GHz*, 2006

ISO/IEC 15018, *Information Technology – Generic Cabling For Homes*, 2004

SBCA Series 6 Recommended Practices, August 20, 2003, *Specification for 75 Ω Flexible RF Coaxial Drop Cable for Direct Broadcast Satellite (DBS) Installations*, 2003

3 DEFINITIONS, ABBREVIATIONS AND ACRONYMS, UNITS OF MEASURE

3.1 General

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

3.2 Definitions of terms

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

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

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

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

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

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

NOTE – See figure 1 for an illustration of the generic cabling topology for Cabling Subsystem 1, Cabling Subsystem 2, Cabling Subsystem 3, Distributor A, Distributor B, Distributor C, an optional consolidation point, and the equipment outlet.

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

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

connecting hardware: A device providing mechanical cable terminations

consolidation point: A connection facility within Cabling Subsystem 1 for interconnection of cables extending from building pathways to the equipment outlet.

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

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

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

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

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

NOTE – See figure 1 for an illustration of the generic cabling topology for Cabling Subsystem 1, Cabling Subsystem 2, Cabling Subsystem 3, Distributor A, Distributor B, Distributor C, an optional consolidation point, and the equipment 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.

equipment cord: See **cord**.

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

NOTE – See figure 1 for an illustration of the generic cabling topology for Cabling Subsystem 1, Cabling Subsystem 2, Cabling Subsystem 3, Distributor A, Distributor B, Distributor C, an optional consolidation point, and the equipment outlet.

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

insertion loss: The signal loss resulting from the insertion of a component, or link, or channel, between a transmitter and receiver (often referred to as attenuation).

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

patch cord: 1) A length of cable with a plug on one or both ends. 2) A length of optical fiber cable with a connector on each end.

pathway: A facility for the placement of telecommunications cable.

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

plug: A male telecommunications connector.

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

return loss: A ratio expressed in dB of the power of the outgoing signal to the power of the reflected signal.

screening attenuation: The ratio, expressed in dB, of the power fed into the cable and the radiated power.

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

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

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 infrastructure: See infrastructure (telecommunications).

transfer impedance: A measure of shielding performance determined by the ratio of the voltage on the conductors enclosed by a shield to the surface currents on the outside of the shield.

3.3 Abbreviations and acronyms

ANSI	American National Standards Institute
AWG	American Wire Gauge
BCT	broadcast and communications technologies
BCT-C	broadcast and communications technologies, coaxial
CATV	community antenna television
CCA	copper coated aluminum
CCS	copper coated steel
CCTV	closed-circuit television
CPE	customer premises equipment
dc	direct current
EMC	electromagnetic compatibility
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
NECA	National Electrical Contractors Association
NFPA	National Fire Protection Association
RF	radio frequency
SBCA	Satellite Broadcasting and Communications Association
SCTE	Society of Cable Telecommunications Engineers
TIA	Telecommunications Industry Association

3.4 Units of measure

dB	decibel
℃	degrees Celsius
℉	degrees Fahrenheit
ft	feet, foot
in	inch
in-lb	inch-pound
lbf	pound-force
m	meter
MHz	megahertz
mm	millimeter
N	newton
N-m	newton-meter
Ω	ohm

4 TOPOLOGY

Broadband coaxial cabling consists of cables, cords, and connecting hardware connected in the generic topology described in ANSI/TIA-568-C.0, with the exception that consolidation points are not used. Cabling Subsystem 1 extends between the equipment outlet and Distributor A, Distributor B, or Distributor C. Cabling Subsystem 2, if present, extends between Distributor A and Distributor B or Distributor C. Cabling Subsystem 3, if present, extends between Distributor B and Distributor C. Figure 1 shows a schematic representation of the elements of a generic cabling topology. Grounding and bonding shall comply with ANSI-J-STD-607-A.

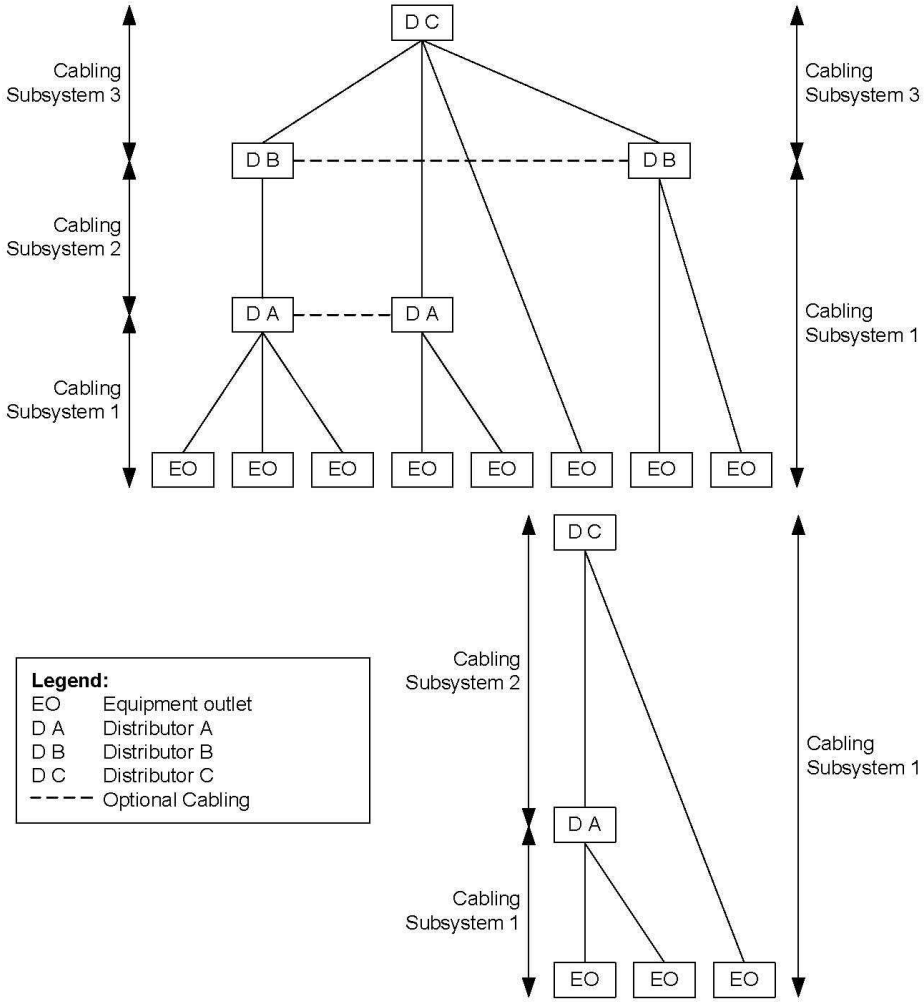

Figure 1 – Elements of generic cabling topology

NOTE – Consolidation points are not specified for broadband coaxial cabling.

The broadband coaxial cabling system topologies are:

a) Physical device connections using a star topology

   1. Star topology as described in ANSI/TIA-568-C.0

   2. Bus topology for Cabling Subsystem 2 and Cabling Subsystem 3 and star topology for Cabling Subsystem 1 (bus and star topology)

b) Physical device connections using multipoint bus

NOTE – Bus and star topology is also known as tree (or trunk) and branch topology.

4.1 Star topology

The star topology for broadband coaxial cabling is that described in ANSI/TIA-568-C.0. Figure 2 is an example of this topology.

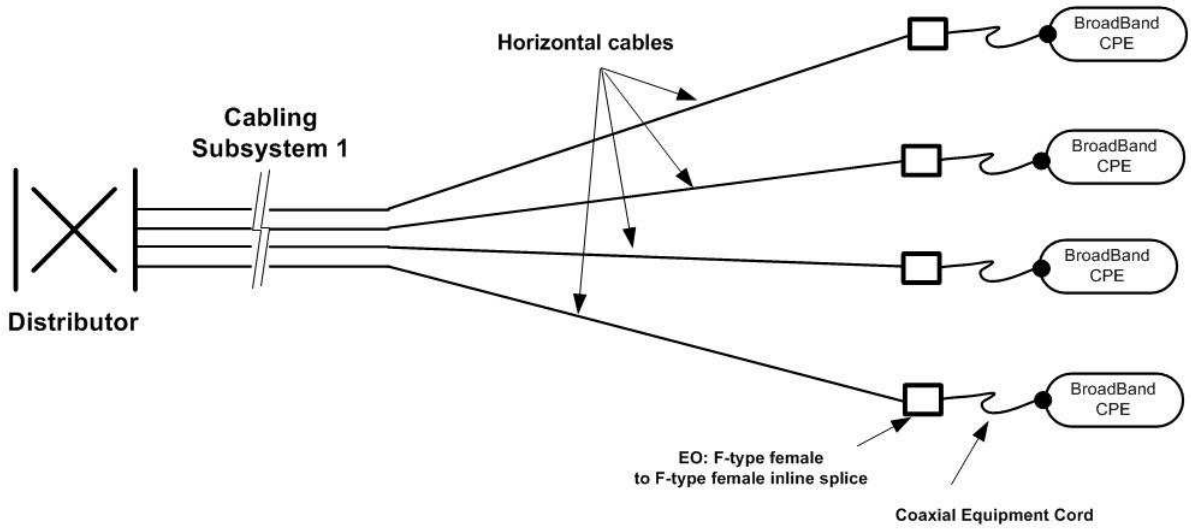

Figure 2 - Example of a star topology

NOTE – In a typical broadband coaxial installation, a splitter could be used as the distributor.

4.2 Bus and star topology

The bus and star topology consists of Cabling Subsystem 2, Cabling Subsystem 3, or both, connected in a bus configuration with Cabling Subsystem 1 connected in a star configuration. The bus configuration allows multiple distributors to be served by a single run of cable. Unless impedance matching is supplied by the last device connected to the bus, the end of the bus shall be terminated with a 75 Ω impedance matching device. Figure 3 shows an example of bus and star topology.

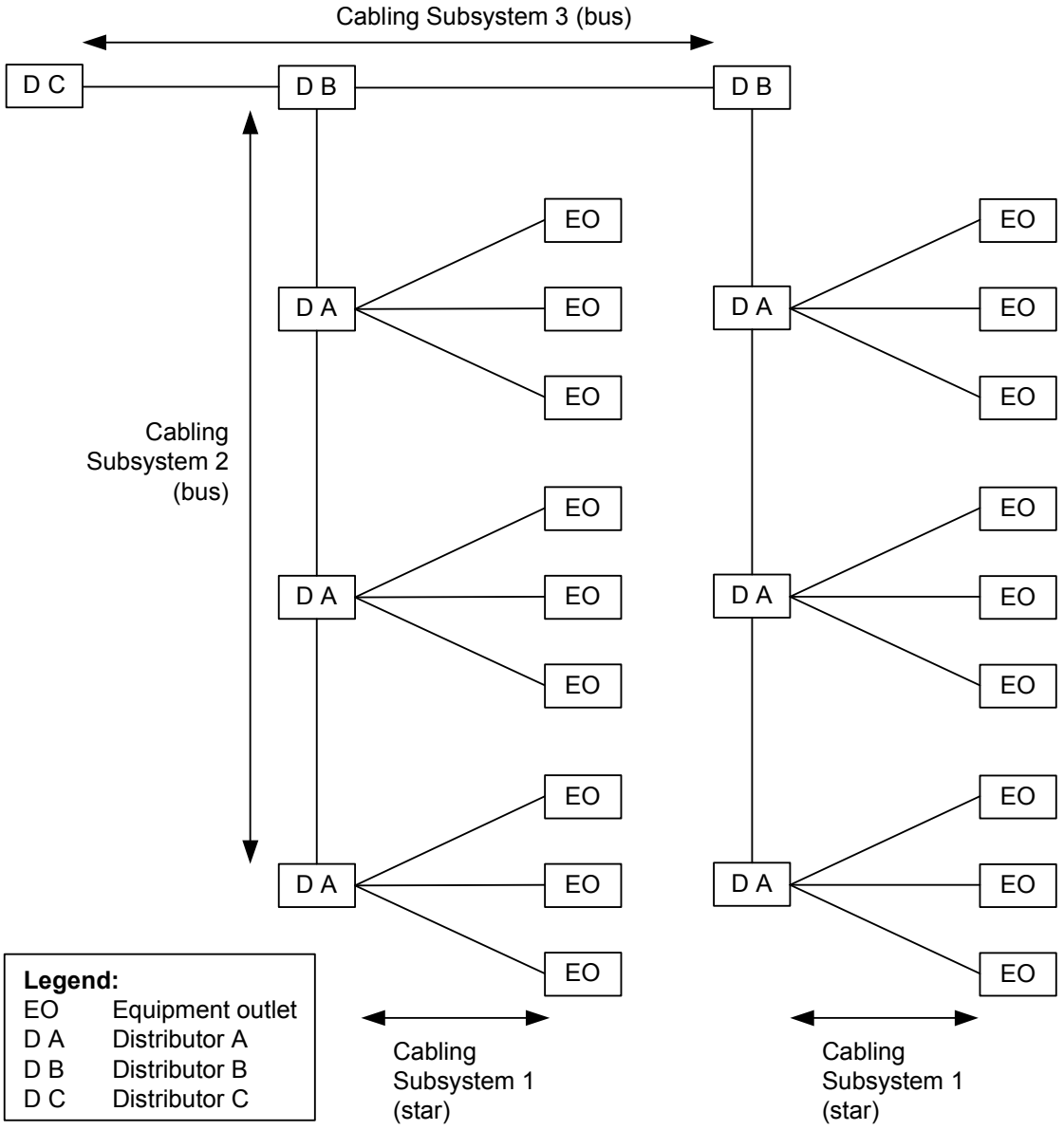

Figure 3 - Example of bus and star topology

4.3 Multipoint bus

The bus configuration is a multipoint interconnection of devices supporting broadband applications. In this configuration, multiple devices are daisy-chained to the EO connection. The connection of these devices is outside the scope of this Standard and this clause is provided for information only. The bus may be terminated with an end-of-line-device (e.g., resistor).

When used, the multipoint bus connection allows multiple broadband CPEs to be connected to the same Cabling Subsystem 1 link. The number of broadband CPEs in a multipoint bus is application dependent. Figure 4 shows an example of a multipoint bus.

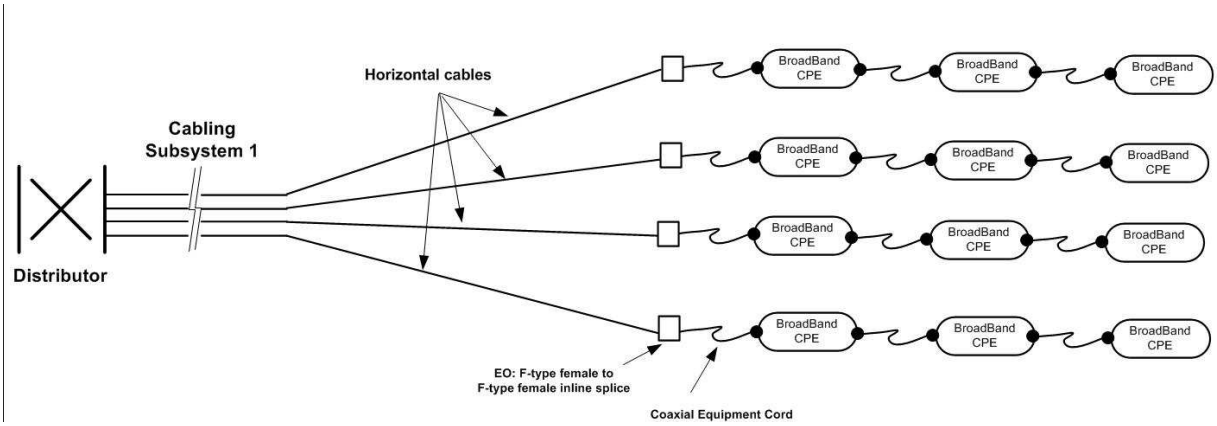

Figure 4 - Example of multipoint bus

5 CABLING SUBSYSTEM 1

5.1 Recognized cables

The recognized 75 Ω coaxial cables for Cabling Subsystem 1 are:

a) Series 6 dual-, tri- or quad-shield and
b) Series 11 dual-, tri- or quad-shield

NOTE - Dual-shield cable construction is commonly referred to as single tape and braid.

5.2 Maximum cable length

The length of each link in Cabling Subsystem 1 shall not exceed 90 m (295 ft). The length of links constructed with Series 6 cable should not exceed 46 m (150 ft). Cabling Subsystem 1 links in excess of 46 m (150 ft) should be constructed using Series 11 cable.

5.3 Equipment outlet

The equipment outlet shall be the F-type male connector as specified in clause 8.3.1 mated to an F-type female feed-through connector as specified in clause 8.3.1 and as shown in figure 5. Connectors for outdoor environments shall be sealed (see ANSI/SCTE 60).

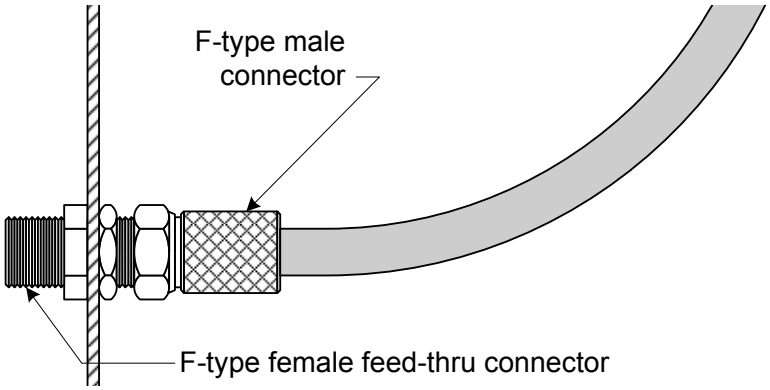

Figure 5 - Coaxial equipment outlet

5.4 Cable termination at Distributor A, Distributor B or Distributor C

At Distributor A, Distributor B, or Distributor C each cable shall be terminated with an F-type male connector as specified in clause 8.3.1.

6 CABLING SUBSYSTEM 2 AND CABLING SUBSYSTEM 3

6.1 Recognized cables

The recognized 75 Ω coaxial cables for Cabling Subsystem 2 and Cabling Subsystem 3 are:

a) Series 6 dual-, tri- or quad-shield;
b) Series 11 dual-, tri- or quad-shield;
c) Trunk, feeder, and distribution cable (refer to ANSI/SCTE 15 for examples of these types of cables); and
d) Braided multipurpose cable (refer to ANSI/SCTE 74 for an example of this type of cable).

NOTE - Dual-shield cable construction is commonly referred to as single tape and braid.

6.2 Maximum cable length

The length of links constructed with Series 6 cable should not exceed 46 m (150 ft). The length of links constructed with Series 11 cable should not exceed 100 m (328 ft). Links in excess of 100 m (328 ft) should be constructed using trunk, feeder, or distribution cable or braided multipurpose cable.

NOTE – If the insertion loss of the combined cabling for Cabling Subsystem 1, Cabling Subsystem 2, and Cabling Subsystem 3 exceeds the service provider's allowance, amplification may be required.

6.3 Cable termination

Each series 6 or Series 11 cable shall be terminated with an F-type male connector as specified in clause 8.3.1. Each trunk, feeder and distribution cable shall be terminated with a 5/8-24 male connector as specified in clause 8.3.2. Each braided multipurpose cable should be terminated with a 5/8-24 male connector as specified in clause 8.3.2.

7 SERIES 6 AND SERIES 11 LINK PERFORMANCE

7.1 General

The transmission requirements specified in clause 7 are for non-plenum Series 6 and Series 11 coaxial cables. For links using other types of cables, the transmission performance, materials of construction and dimensions may vary from those specified in the referenced documents. Consult the manufacturer for additional information on these types of cables.

7.2 Test link

The test link for broadband coaxial cabling consists of the cable with mated connectors at both ends. Figure 6 shows the test link for Cabling Subsystem 1. Figure 7 shows the test link for Cabling Subsystem 2 and Cabling Subsystem 3.

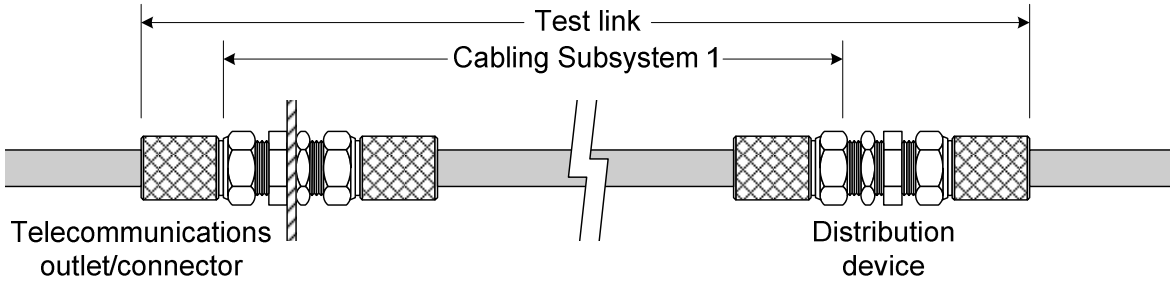

Figure 6 - Test link for Cabling Subsystem 1

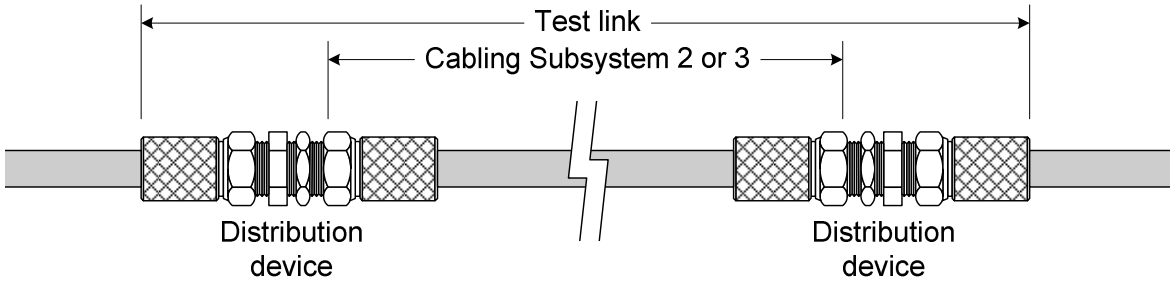

Figure 7 - Test link for Cabling Subsystem 2 and Cabling Subsystem 3

7.3 Insertion loss

Coaxial cabling insertion loss limits are calculated by adding the insertion loss of the cable at 20 ºC (68 ºF) to the insertion loss of two connections as shown in equation (1).

$$InsertionLoss_{cabling} = InsertionLoss_{cable} + 2 \cdot InsertionLoss_{conn} \ dB \quad (1)$$

Coaxial cabling insertion loss should be measured in accordance with ANSI/SCTE 47. Coaxial cable insertion loss shall meet or be less than the values determined using the equations shown in Table 1 for all frequencies from 5 MHz to 1002 MHz (or 5 MHz to 3000 MHz for cable intended for satellite television systems) at 20 ºC (68 ºF). For the purposes of field measurements, calculated limits that result in insertion loss values less than 3 dB revert to a requirement of 3 dB maximum.

Table 1 - Coaxial cabling insertion loss

	Insertion loss (dB)
Series 6 **Cabling Subsystem 1** **Cabling Subsystem 2** **Cabling Subsystem 3** **(46 m/150 ft)**	$\frac{46}{100}\left(0.694\sqrt{f} - 0.0003 \cdot f + \frac{0.89}{\sqrt{f}}\right) + 2 \times 0.02\sqrt{f}$
Series 11 **Cabling Subsystem 1** **(90 m/295 ft)**	$\frac{90}{100}\left(0.4\sqrt{f} + 0.00168 \cdot f + \frac{0.77}{\sqrt{f}}\right) + 2 \times 0.02\sqrt{f}$
Series 11 **Cabling Subsystem 2** **Cabling Subsystem 3** **(100 m/328 ft)**	$0.4\sqrt{f} + 0.00168 \cdot f + \frac{0.77}{\sqrt{f}} + 2 \times 0.02\sqrt{f}$

The coaxial cable insertion loss values in Table 2 are provided for information only.

Table 2 - Maximum insertion loss of coaxial cabling

Frequency (MHz)	Series 6	Series 11	
	Cabling Subsystem 1 Cabling Subsystem 2 Cabling Subsystem 3 (46 m/150 ft) (dB)	Cabling Subsystem 1 (90 m/295 ft) (dB)	Cabling Subsystem 2 Cabling Subsystem 3 (100 m/328 ft) (dB)
5	1.0	1.2	1.3
55	2.7	3.1	3.5
211	5.2	6.2	6.8
250	5.7	6.7	7.4
270	5.9	7.0	7.7
300	6.2	7.4	8.2
330	6.5	7.8	8.6
350	6.7	8.0	8.9
400	7.2	8.6	9.5
450	7.6	9.2	10.1
500	8.0	9.7	10.7
550	8.4	10.2	11.3
600	8.7	10.7	11.8
750	9.7	12.1	13.3
870	10.5	13.1	14.5
950	11.0	13.8	15.2
1002	11.2	14.2	15.6
1450	13.5	17.4	19.2
1750	14.8	19.4	21.4
2050	16.0	21.2	23.4
2250	16.7	22.4	24.7
3000	19.3	26.5	29.2
NOTE – Insertion loss values for frequencies above 1002 MHz are for cabling intended for satellite television systems only.			

7.4 Return loss

Coaxial cabling return loss should be measured in accordance with IEC 61196-1-112. Coaxial cabling return loss shall meet or exceed the values shown in table 3 for all specified frequencies. Requirements for frequencies above 1002 MHz are for cabling intended for satellite television systems only.

Table 3 - Return loss of coaxial cabling

Frequency (MHz)	Return loss (dB)
$5 \le f \le 1002$	20
$1002 < f \le 3000$ (satellite TV)	15

7.5 Screening attenuation

Based upon the use of compliant components (clause 8) and specified installation practices (see clause 9), the screening attenuation of coaxial cabling links is expected to meet or exceed the levels in table 4. Field testing is not required. Values for frequencies above 1002 MHz are for cabling intended for satellite television systems only.

Table 4 - Screening attenuation of coaxial cabling

Frequency (MHz)	Screening attenuation (dB)	
	Dual-shield	Tri-, quad-shield
$30 \le f \le 1002$	70	75
$1002 < f \le 2000$ (satellite TV)	65	65
$2000 < f \le 3000$ (satellite TV)	55	55

8 COAXIAL CABLE, CORDS, AND CONNECTING HARDWARE

8.1 Coaxial cable

8.1.1 General

The requirements in clause 8.1 are for non-plenum Series 6 and Series 11 cables only. For plenum cables, transmission performance, materials of construction and dimensions may vary from those specified in the referenced documents. Consult the manufacturer for requirements for plenum cables in those jurisdictions where plenum cables are required and for requirements for other cable types.

Series 6 coaxial cables shall meet the requirements of ANSI/SCTE 74 or the SBCA Series 6 Recommended Practices.

NOTE – The cables specified in the SBCA Series 6 Recommended Practices have extended frequency performance and lower dc resistance requirements which may be required for satellite television systems.

Series 11 coaxial cables shall meet the requirements of ANSI/SCTE 74.

Trunk, feeder, and distribution cables shall meet the requirements of ANSI/SCTE 15.

Braided multipurpose cables shall meet the requirements of ANSI/SCTE 71.

8.1.2 Insertion loss

Coaxial cable insertion loss shall be measured in accordance with ANSI/SCTE 47. Coaxial cable insertion loss shall meet or be less than the values determined using the equations shown in table 5 for all frequencies from 5 MHz to 1002 MHz (or 5 MHz to 3000 MHz for cable intended for satellite television systems) at 20°(68ºF).

Table 5 - Coaxial cable insertion loss, for a length of 100m (328 ft)

	Insertion loss (dB)
Series 6	$0.694\sqrt{f} - 0.0003 \cdot f + \frac{0.89}{\sqrt{f}}$
Series 11	$0.4\sqrt{f} + 0.00168 \cdot f + \frac{0.77}{\sqrt{f}}$

The coaxial cable insertion loss values in table 6 are provided for information only.

Table 6 - Maximum coaxial cable insertion loss, for a length of 100m (328 ft)

Frequency (MHz)	Series 6 (dB)	Series 11 (dB)
5	1.95	1.25
55	5.25	3.16
211	10.08	6.22
250	10.95	6.79
270	11.38	7.07
300	11.98	7.48
330	12.56	7.86
350	12.93	8.11
400	13.80	8.71
450	14.63	9.28
500	15.41	9.82
550	16.15	10.34
600	16.86	10.84
750	18.81	12.24
870	20.24	13.29
950	21.13	13.95
1002	21.70	14.37
1450	26.02	17.69
1750	28.53	19.69
2050	30.83	21.57
2250	32.26	22.77
3000	37.13	26.96
NOTE – Insertion loss values for frequencies above 1002 MHz are for cable intended for satellite television systems only.		

8.1.3 Return loss

Coaxial cable return loss should be measured in accordance with IEC 61196-1-112. Coaxial cable return loss shall meet or exceed the requirements shown in table 7 for all specified frequencies. Requirements for frequencies above 1002 MHz are for cable for satellite television systems only.

Table 7 - Return loss of coaxial cable

Frequency (MHz)	Return loss (dB)
$5 \le f \le 1002$	20
$1002 < f \le 3000$ (satellite TV)	15

8.1.4 Screening attenuation

Coaxial cable screening attenuation shall be measured in accordance with IEC 62153-4-4. Coaxial cable screening attenuation shall meet or be less than the requirements shown in table 8 for all specified frequencies. Requirements for frequencies above 1002 MHz are for cable for satellite television systems only.

Table 8 - Screening attenuation of coaxial cable

Frequency (MHz)	Screening attenuation (dB)	
	Dual-shield	Tri-, quad-shield
$30 \le f \le 1002$	70	75
$1002 < f \le 2000$ (satellite TV)	65	65
$2000 < f \le 3000$ (satellite TV)	55	55

8.1.5 Transfer impedance

Coaxial cable transfer impedance shall be measured in accordance with IEC 62153-4-3. Coaxial cable transfer impedance shall meet or be less than the requirements shown in table 9 from 5 MHz to 30 MHz.

Table 9 - Transfer impedance of coaxial cable

Media	Transfer impedance (mΩ/m)
Dual-shield	50
Tri-shield	15
Quad-shield	15

8.2 Coaxial equipment and patch cords

Series 59 cable is commonly used for equipment and patch cords. Miniature coaxial cable meeting the requirements of ANSI/SCTE 117 may be utilized for this purpose. Inside an enclosure, miniature coaxial cable using a center conductor no smaller than 26 AWG may be used. Miniature or flexible coaxial cable transmission performance shall comply with the requirements specified for Series 6 coaxial cable (see clause 8.1), with the exception that the insertion loss shall not exceed 1.35 times the insertion loss of Series 6 coaxial cable (see clause 8.1.2). For lengths longer than 3 m (10 ft), Series 6 cable should be used. Other types of cords that have better performance than Series 6 cords may be used to connect equipment to the EO or the DA if required by the equipment interface.

Cords shall be constructed using F-type male connectors as specified in clause 8.3.1. Factory terminated cords are recommended.

8.3 Coaxial connecting hardware

8.3.1 F-type connector

8.3.1.1 Physical

8.3.1.1.1 Male

F-type male connectors for Series 6 cable shall meet the physical requirements of ANSI/SCTE 123. F-type male connectors for Series 11 cable and for miniature coaxial cable shall meet the physical requirements of ANSI/SCTE 124. The use of compression type male connectors is recommended.

> NOTE – Because the F-type male connector for Series 6 cable uses the center conductor of the cable as a connector contact, SCTE refers to it as a “feed-through” connector. This should not be confused with the F-type female feed-through connector described below.

8.3.1.1.2 Female

F-type female feed-through connectors for indoor environments shall meet the physical requirements of ANSI/SCTE 02. F-type female feed-through connectors for outdoor environments shall meet the physical requirements of ANSI/SCTE 01.

8.3.1.2 Electrical

F-type mated connectors shall meet the performance requirements of ISO/IEC 15018 for type BCT-C connectors for CATV, with the exception that the connecting hardware insertion loss shall be less than or equal to the values determined using in equation (2). Calculations that result in insertion loss values less than 0.1 dB shall revert to a requirement of 0.1 dB maximum.

$$IL_{ConnectingHardware} \leq 0.02 \cdot \sqrt{f} \ \ dB \qquad (2)$$

8.3.2 5/8-24 connector

5/8-24 male connectors shall meet the physical requirements of ANSI/SCTE 92.

8.3.3 75-ohm BNC connector

A 75-Ohm BNC connector may be used when a quick connect and disconnect capability is needed. 75-ohm BNC connectors shall comply with annex A of IEC 61169-8.

8.4 Signal splitters

Signal splitting devices are commonly used to divide the signal in coaxial cabling systems. See ANSI/SCTE 153 for information on insertion loss and port-to-port isolation of these devices.

8.5 Filters and traps

Filters and traps are commonly used to control the frequency response of coaxial cabling systems. See ANSI/SCTE 151 for information on coaxial filters.

8.6 Inline splices

The appropriate inline splices shall be used for indoor or outdoor applications. Outdoor inline splices shall conform to ANSI/SCTE 146. Indoor splices shall conform to ANSI/SCTE 155.

8.7 Ground blocks

Ground blocks for coaxial cabling systems shall comply with ANSI/SCTE 129.

8.8 Inline attenuators

Inline attenuators are commonly used to adjust the signal delivered to customer premises equipment. See ANSI/SCTE 147 for information on these devices.

8.9 Signal amplifiers

Signal amplifiers are commonly used to increase the signal delivered to customer premises equipment. See ANSI/SCTE 161 for information on these devices.

8.10 Impedance matching termination devices

Impedance matching termination devices shall comply with ANSI/SCTE 148.

9 INSTALLATION REQUIREMENTS

9.1 Installation temperature

Coaxial cabling shall be installed within the temperature range specified by the manufacturer.

9.2 Bend radius

The minimum bend radius for coaxial cable shall not be less than that 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.

9.3 Pull tension

The maximum pull tension of coaxial cable is dependant on the size and material of the center conductor. Copper-clad steel (CCS) is stronger than bare copper or copper-clad aluminum (CCA). Pull tension for coaxial cables with CCS or copper center conductors shall not exceed the maximum values in table 10. Pull tension for coaxial cables with CCA center conductors shall not exceed the manufacturer's recommended maximum. When pulling a combination of different types of cable, pull tension shall not exceed the maximum value for the minimum strength cable.

Table 10 - Maximum pull tension for coaxial cable

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

9.4 F-type mating torque

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

9.5 Termination of unused ports and cables

Each energized but unused coaxial connector that is part of the connecting block, splitter, amplifier or other similar cabling component shall be terminated with a 75 Ω impedance matching termination device. In addition, each energized unused coaxial cable shall be terminated with a 75 Ω impedance matching termination device as specified in clause 8.10.

9.6 Other installation guidelines

A minimum of 200 mm (8 in) of excess cable should be stored at each outlet, adhering to the minimum bend radius specified in clause 9.2. Spacing of cable supports, such as attachments made to wall studs, should be made at varying intervals no greater than 1.5m (5 ft) to avoid degrading electrical performance.

10 FIELD TEST REQUIREMENTS

10.1 General

Coaxial cable can be damaged during the construction phases of rough-in, wall sheathing installation, and even during the siding of the exterior. Many of these damaging faults result from causes such as nails and staples penetrating 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. In addition, coaxial cabling is particularly susceptible to poor connector installation practices. For these reasons, coaxial cabling shall be acceptance tested to ensure compliance with this Standard. Acceptance testing for coaxial cabling includes:

1) a visual inspection of all cabling;
2) verification of all cabling; and
3) either:
   a) qualification; or
   b) performance characterization.

10.2 Visual inspection

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

1) obvious damage to cable;
2) separation from EMI sources;
3) incorrect bend radii;
4) excessive cable length;
5) improperly terminated, loose or damaged connectors; and
6) improperly installed bonding and grounding conductors at the demarcation point.

10.3 Verification

Verification testing of coaxial cabling identifies opens or shorts and shall be performed during rough-in, prior to the installation of insulation and wall sheathing, to ensure proper end-to-end connectivity.

10.4 Qualification and performance characterization

Qualification or performance characterization shall be performed during the “trim-out” stage of cabling. Performance characterization is recommended.

10.4.1 Qualification

Qualification tests the ability of the coaxial cabling to carry the appropriate signal (e.g., CATV, satellite television). If done, qualification shall be performed using actual signals and equipment appropriate to the application, or by the use of a qualification test instrument. For example, CATV cabling could be qualified by visual verification of acceptable television reception or by measuring received signal levels using a power meter.

10.4.2 Performance characterization

Performance characterization tests the cabling to the electrical performance criteria in clause 7.

Annex A (informative) Background information for coaxial cabling requirements

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

A.1 General

This annex provides background information on the determination of insertion loss, return loss, screening attenuation and transfer impedance requirements for coaxial cable and connecting hardware in clause 8 and for coaxial cabling in clause 7.

A.2 Coaxial cable

Most requirements for Series 6 and 11 coaxial cables are specified in clause 8.1 by reference to ANSI/SCTE 74 or the SBCA Series 6 Recommended Practices. To facilitate derivation of cabling requirements, more comprehensive insertion loss requirements and new return loss, screening attenuation and transfer impedance requirements were added.

A.2.1 Insertion loss

Various industry standards specify insertion loss at discrete frequencies (refer to table 11). These requirements are also provided in table 6 for information only.

Linear regression was used to generate equations fit to these discrete values. The equations were then adjusted manually so that they were not significantly more stringent than the requirements in the referenced documents. The new insertion loss requirements are given in table 5. Note that these new requirements do not replace the discrete requirements in the referenced standards. Both sets of requirements apply.

Figure A.1 compares the linear requirements of the Series 6 cable insertion loss requirements in table 5 with the discrete values in the SCTE and SBCA standards. Figure A.2 compares the linear requirements of the Series 11 cable insertion loss requirements in table with the discrete values in the SCTE standard.

A.2.2 Return loss

The coaxial cable return loss requirements given in clause 8.1.3 are more stringent than those of ISO/IEC 15018, but were selected to reflect the performance of commonly available cables. Note that the structural return loss requirements in the SCTE and SBCA standards still apply.

A.2.3 Screening attenuation

The screening attenuation requirements given in clause 8.1.4 are less stringent than those of ISO/IEC 15018, but were selected to reflect the performance of commonly available cables.

A.2.4 Transfer impedance

Transfer impedance requirements were added in clause 8.1.5 to limit RF emissions at frequencies up to 30 MHz.

Table 11 - Maximum coaxial cable insertion loss (for information only)

Frequency (MHz)	Insertion loss (dB/100 m) at 20 ºC (68 ºF)		
	Series 6		Series 11
	SBCA	SCTE	SCTE
5	1.87	1.90	1.25
55	5.25	5.25	3.15
211	9.43	10.00	6.23
250	10.24	10.82	6.72
270	10.63	11.04	7.00
300	11.25	11.64	7.38
330	11.84	12.26	7.71
350	12.20	12.63	7.94
400	13.12	13.61	8.53
450	14.04	14.43	9.02
500	14.80	15.29	9.51
550	15.62	16.08	9.97
600	16.34	16.73	10.43
750	18.44	18.54	11.97
870	19.99	20.04	13.31
950	21.33		
1000	21.46	21.49	14.27
1450	26.25		
1750	28.67		
2050	31.04		
2250	32.81		

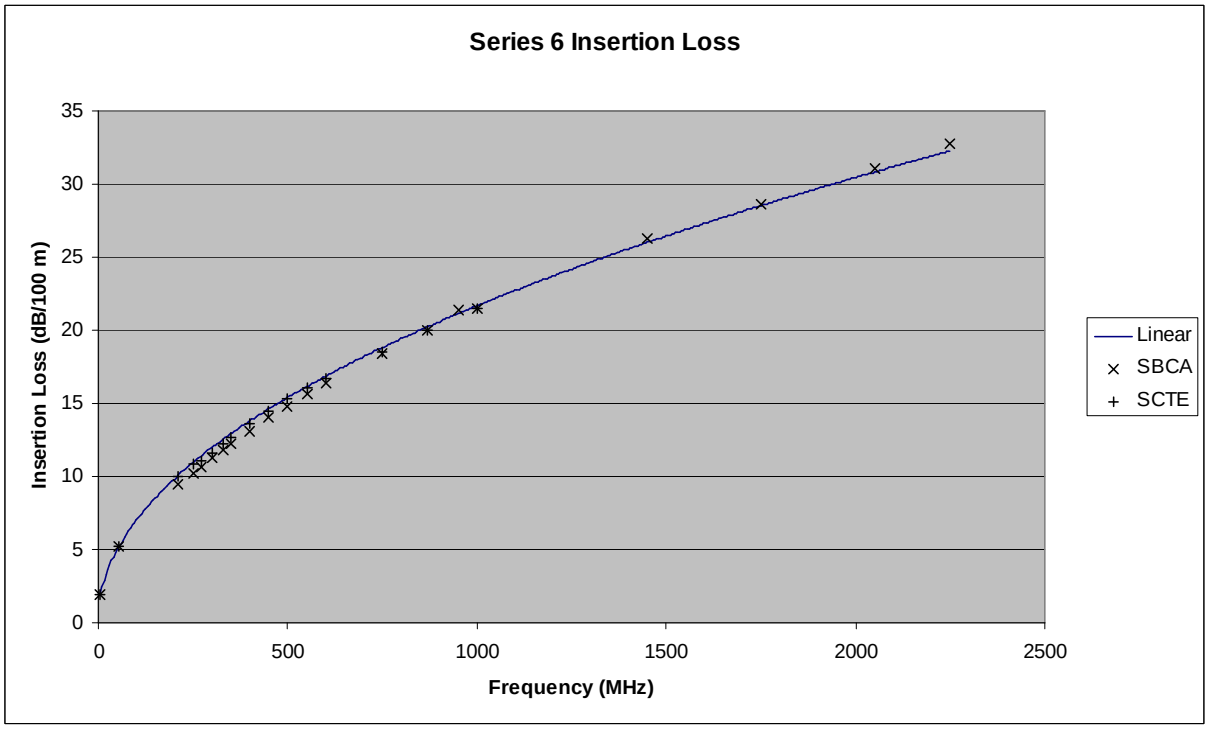

Figure A.1 - Comparison of linear versus discrete insertion loss values, Series 6 cable

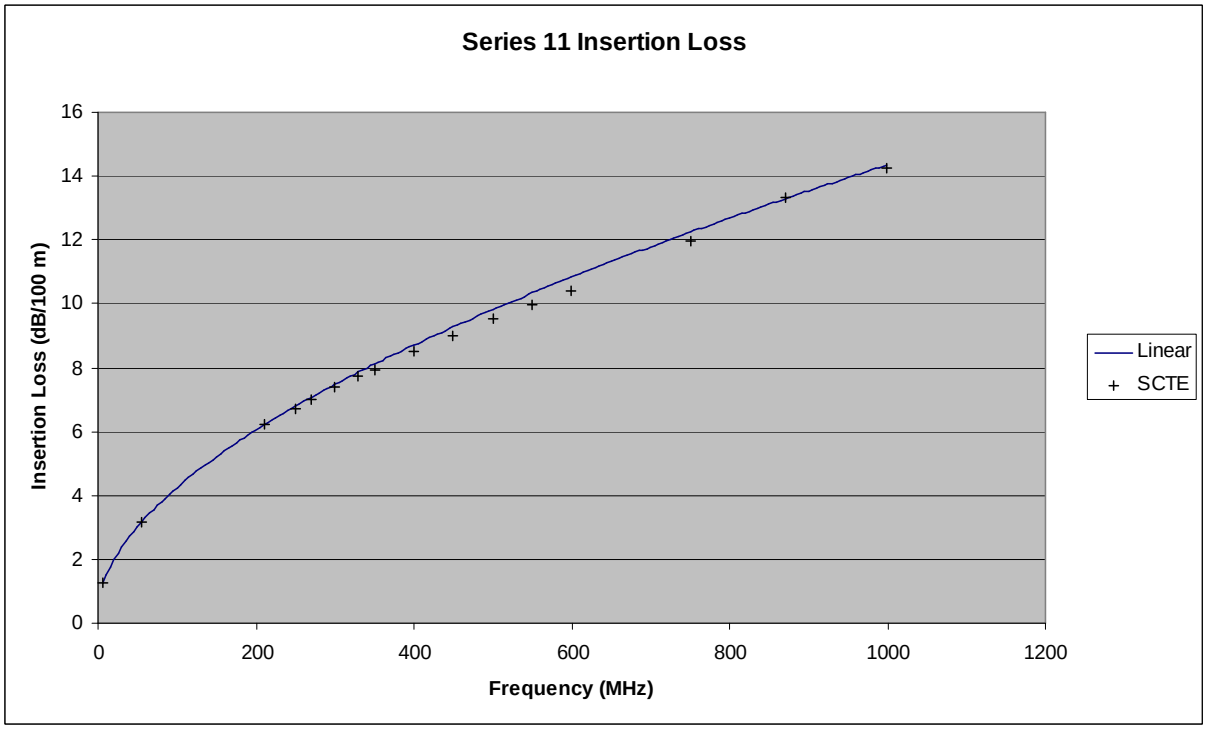

Figure A.2 - Comparison of linear versus discrete insertion loss values, Series 11 cable

A.3 Connecting hardware

Clause 8.3.1.2 specifies connecting hardware electrical requirements by reference to ISO/IEC 15018. The requirements are summarized below for information only.

A.3.1 Insertion loss

Maximum coaxial connecting hardware insertion loss is given by equation (A-1). When the value determined by the equation is less than 0.1 dB, the maximum insertion loss reverts to 0.1 dB.

$$IL_{ConnectingHardware} \leq 0.02\sqrt{f} \ \ dB \qquad \text{(A-1)}$$

A.3.2 Return loss

Minimum connecting hardware return loss is shown in table A.1.

Table A.1 - Minimum connecting hardware return loss

Frequency (MHz)	Return loss (dB)
$1 \leq f \leq 2000$	23
$2000 < f \leq 3000$	$23 - 73\log(f/2000)$

A.3.3 Screening attenuation

Minimum connecting hardware screening attenuation is shown in table A.2.

Table A.2 - Minimum connecting hardware screening attenuation

Frequency MHz	Screening attenuation (dB)
$30 \leq f \leq 300$	85
$300 < f \leq 470$	80
$470 < f \leq 1000$	75
$1000 < f \leq 3000$	55

A.4 Coaxial cabling

A.4.1 Insertion loss

Maximum coaxial cabling insertion loss specified in equations 1, 2 and 3 of clause 7.3 is the sum of the maximum insertion loss of the maximum allowed length of cable plus the maximum insertion loss of two mated connections. The 0.1 dB floor on connecting hardware insertion loss does not apply when determining maximum cabling insertion loss. Equation (A-2) shows how the maximum cabling insertion loss was determined.

$$IL_{Cabling} \leq \frac{L_{\max}}{100} \cdot IL_{Cable,100m} + 2 \cdot IL_{ConnectingHardware} \ \ dB \qquad \text{(A-2)}$$

A.4.2 Return loss

The cabling return loss requirements in clause 7.4 are more stringent than those of ISO/IEC 15018, but were selected to reflect the performance attained when commonly available cables are used.

A.4.3 Screening attenuation

The screening attenuation requirements given in clause 7.5 are less stringent than those of ISO/IEC 15018, but were selected to reflect the performance attained when commonly available cables are used.

Annex B (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. In addition to those documents referenced in clause 2, the following documents may be useful to the reader:

ANSI/NECA/BICSI-568, *Installing Commercial Building Telecommunications Cabling*, 2006

BICSI *Information Transport Systems Installation Methods Manual (ITSIMM),* 5th edition, 2008

BICSI *Outside Plant Design Reference Manual (OSPDRM),* 4th edition, 2007

BICSI *Telecommunications Distribution Methods Manual (TDMM),* 12th edition, 2009

IEEE C2, *National Electrical Safety Code® (NESC®)*, 2007

NFPA 70, *National Electrical Code® (NEC®)*, 2008

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

ANSI
American National Standards Institute (ANSI)
25 W 43 St
New York, NY 10036
USA
(212) 642-4900
www.ansi.org

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

IEC
International Electrotechnical Commission (IEC)
3, rue de Varembé
1211 Geneva 20
Switzerland
+41 22 919 02 11
www.iec.ch

IEEE
IEEE
10662 Los Vaqueros Circle
PO Box 3014
Los Alamitos, CA 90720-1264
USA
(800) 272-6657
www.ieee.org

ISO
International Organization for Standardization (ISO)
1, ch. de la Voie-Creuse
Case postale 56
CH-1211 Geneva 20
Switzerland
+41 22 749 01 11
www.iso.org

NECA
National Electrical Contractors Association (NECA)
3 Bethesda Metro Center
Suite 1100
Bethesda, MD 20814
(301) 657-3110
www.necanet.org

NFPA
National Fire Protection Association (NFPA)
1 Batterymarch Park
Quincy, MA 02169-7471
USA
(617) 770-3000
www.nfpa.org

SBCA
Satellite Broadcasting and Communications Association (SBCA)
1730 M St NW, Suite 600
Washington, DC 20036
USA
(800) 541-5981
www.sbca.com

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

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

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