INTERNATIONAL STANDARD

ISO/IEC 15018

First edition
2004-06

Information technology – Generic cabling for homes



Reference number
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CONTENTS

Page

FOREWORD 7
Introduction 8
1 Scope 11
2 Normative references 11
3 Definitions and abbreviations 14
3.1 Definitions 14
3.2 Abbreviations 18
4 Conformance 19
5 Structure of the generic cabling system to support ICT and/or BCT applications 20
5.1 General 20
5.2 Functional elements 20
5.3 Cabling subsystems for ICT and BCT 20
5.3.1 General 20
5.3.2 Primary home cabling subsystem 22
5.3.3 Secondary home cabling subsystem 23
5.4 Cabling structure for ICT and BCT applications 23
5.5 Interfaces 24
5.5.1 Equipment interfaces and test interfaces 24
5.5.2 Channel and permanent link 25
5.5.3 Network access cabling 26
5.5.4 External network interface 27
5.6 Accommodation of functional elements 27
5.6.1 Distributors 27
5.6.2 Application outlets 28
5.6.3 Cable pathways 29
5.7 Dimensioning and configuring 29
5.7.1 Distributors 29
5.7.2 Application outlets 30
5.7.3 Equipment cords 31
5.7.4 Building entrance facilities 31
6 Cabling to support CCCB applications 31
6.1 General 31
6.2 Functional elements 31
6.3 Cabling subsystems for CCCB 32
6.3.1 General 32
6.3.2 Area feeder cabling subsystem 32
6.3.3 Coverage area cabling subsystem 33
6.4 Cabling structure for CCCB applications 34
6.5 Interfaces 34
6.5.1 Equipment interfaces and test interfaces 34
6.5.2 Channel and permanent link 35
6.5.3 Network access cabling 36
6.5.4 External network interface 36

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6.6 Accommodation of functional elements 37
6.6.1 Area connection points (ACPs) 37
6.6.2 Control outlets (COs) 37
6.6.3 Cable pathways 37
6.7 Dimensioning and configuring 37
6.7.1 Distributors 37
6.7.2 Control outlet (CO) 37
6.7.3 Cable sharing 38
6.7.4 Equipment cords 38
6.7.5 Building entrance facilities 38
7 Performance 38
7.1 General 38
7.2 ICT channel performance 40
7.3 BCT channel performance 40
7.4 CCCB channel performance 43
8 Reference implementation 45
8.1 General 45
8.2 Cabling assumptions 45
8.2.1 Introduction 45
8.2.2 General 45
8.2.3 Dimensions for ICT and BCT channels 47
8.2.4 Dimensions for CCCB channels 48
9 Cable requirements 49
9.1 General 49
9.2 Cable performance for ICT 49
9.3 Cable performance for BCT 51
9.3.1 Requirements for balanced pairs for BCT 51
9.3.2 Requirements for coaxial cables for BCT 52
9.4 Cable performance for CCCB coverage area 54
10 Connecting hardware 56
10.1 General requirements 56
10.1.1 Applicability 56
10.1.2 Location 56
10.1.3 Design 56
10.1.4 Operating environment 57
10.1.5 Mounting 57
10.1.6 Installation practices 57
10.1.7 Marking and colour coding 57
10.2 Mating interfaces at TO, BO and CO 58
10.2.1 General 58
10.2.2 Mating interface for TO 58
10.2.3 Mating interface for BO 58
10.2.4 Mating interface for CO 59
10.2.5 Minimum performance requirements 59
11 Safety requirements and screening practices 65
11.1 General 65

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11.2 Coexistence with mains 65
11.3 Operational safety 65
11.4 Screening practices 66
11.4.1 General 66
11.4.2 Earthing 66
Annex A (normative) BCT channel levels 67
Annex B (normative) Link performance 68
B.1 General 68
B.2 Performance requirements for ICT permanent links 68
B.3 Performance requirements for BCT permanent links 69
B.4 Performance requirements for CCCB permanent links 71
Annex C (informative) BCT levels: channel and link performance and implementation 72
C.1 General 72
C.2 BCT-H, BCT-M and BCT-L channels 72
C.3 BCT-H, BCT-M and BCT-L links 74
C.4 BCT levels' implementation 76
C.4.1 General 76
C.4.2 Cable specifications 76
C.4.3 Connecting hardware specifications 76
C.4.4 Maximum channel lengths for reference implementations 76
C.4.5 Channel lengths using other coaxial cable specifications 77
C.4.6 Channel lengths using other balanced cable specifications 77
Annex D (informative) Applications and associated cabling 78
Bibliography 81

Figure 1 – Overview of a generic cabling for home 9
Figure 2 – Structure of the generic cabling system 21
Figure 3 – Interconnect and cross-connect models 22
Figure 4 – Hierarchical structure of a generic cabling system in support of ICT and BCT applications 23
Figure 5 – Equipment and test interfaces in support of ICT and BCT applications 24
Figure 6 – Channels and permanent links within the home 26
Figure 7 – Examples of interconnection of home and network access cabling 27
Figure 8 – Interconnection of home cabling subsystems 29
Figure 9 – Structure of the generic cabling system in support of CCCB applications 32
Figure 10 – Hierarchical structure of a generic cabling system in support of CCCB applications 34
Figure 11 – Equipment and test interfaces in support of CCCB applications 35
Figure 12 – Channels and permanent links for CCCB cabling 36
Figure 13 – Reference implementations for ICT and BCT channels (PHD/SHD - TO/BO) 47
Figure 14 – Reference implementations for CCCB channels with PHD or SHD 48
Figure 15 – Reference implementations for CCCB channels with PHD and SHD 49
Figure 16 – Pin grouping assignments for IEC 60603-7 series outlet (front view) 58

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Figure 17 – Pin grouping assignments for 61076-3-104 outlet (front view) 59
Figure 18 – Pin grouping assignments for IEC 60603-7-7 outlet (front view) 59
Figure 19 – Conductor assignment of IEC 61169-2 and IEC 61169-24 (Type F) connector 59

Table 1 – Maximum channel lengths for reference implementations of ICT/BCT channels 30
Table 2 – Different channels and their potential use 39
Table 3 – Minimum performance of BCT-B channels 41
Table 4 – Minimum performance of BCT-C channels 42
Table 5 – Minimum performance of CCCB copper channels for information transfer 44
Table 6 – Minimum performance of CCCB channels for d.c. power feeding 44
Table 7 – Link length equations 46
Table 8 – Mechanical performance requirements for ICT and balanced BCT cables 50
Table 9 – Minimum transmission performance requirements BCT balanced pairs 51
Table 10 – Minimum electrical performance requirements for BCT coaxial cable 52
Table 11 – Mechanical performance requirements for coaxial BCT cables 53
Table 12 – Minimum transmission performance requirements for CCCB coverage area cables 54
Table 13 – Mechanical performance requirements for balanced CCCB coverage area cables 55
Table 14 – Mechanical characteristics of connecting hardware for use with balanced cabling 61
Table 15 – Return loss (*RL*) 62
Table 16 – Insertion loss 63
Table 17 – Near end crosstalk (*NEXT*) 63
Table 18 – Far end crosstalk (*FEXT*) 63
Table 19 – Input to output resistance 64
Table 20 – Current carrying capacity 64
Table 21 – Propagation delay 64
Table 22 – Coupling and screening attenuation 64
Table 23 – Insulation resistance 65
Table 24 – Voltage proof 65

Table A.1 – BCT channels division 67

Table B.1 – Minimum performance of BCT-B permanent links 69
Table B.2 – Minimum performance of BCT-C permanent links 70

Table C.1 – Minimum insertion loss of BCT_B channels for BCT-H, BCT-M and BCT-L 73
Table C.2 – Minimum insertion loss of BCT-C channels for BCT-H, BCT-M and BCT-L 74
Table C.3 – Insertion loss for BCT-B permanent links 75
Table C.4 – Insertion loss for BCT-C permanent links 75
Table C.5 – BCT-L, BCT-M and BCT-H channel implementations 77

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Table D.1 – Grouping of applications and cabling 78
Table D.2 – Characteristics of ICT, BCT & CCCB cabling 80

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INFORMATION TECHNOLOGY – GENERIC CABLING FOR HOMES

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International Standard ISO/IEC 15018 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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Introduction

This standard specifies a generic cabling for three groups of applications in homes:

- Information and Communications Technologies (ICT);
- Broadcast and Communications Technologies (BCT);
- Commands, Controls and Communications in Buildings (CCCB);

as shown in Figure 1, and it is intended to guide installations in new buildings or refurbishments. (Cabling is a part of the infrastructure that supports home systems.)

This standard also applies where cabling is installed to support only one or two of the three application groups listed above.

This standard specifies a generic cabling infrastructure based upon balanced cabling and/or coaxial cabling. ICT channels specified in this standard include optical fibre. The wider use of fibre optical cabling in a home is for further study.

These groups of applications may also be supported by different types of cabling, which may be subject to other standards. For example, ISO/IEC 11801 specifies generic cabling for ICT applications in general for the office environment. While the cabling structure and reference implementations are matched to the home environment in this standard, the channel performances specified for ICT are identical to those specified in ISO/IEC 11801.

This standard specifies a generic cabling for a home that may support ICT, BCT and CCCB application groups. Because it is designed to cover the three major groups, the cabling system may be installed prior to the selection of specific applications. The home may contain one or more buildings (e.g. farm) or may be within a building which contains more than one home (e.g. one home in a multi-dwelling building).

The campus or backbone cabling connecting individual homes is built according to the relevant standard (for instance ISO/IEC 11801 or IEC 60728).

Generic cabling realised according to this standard:

a) allows deployment of a wide range of applications without changes to the fixed cabling infrastructure;

b) provides a platform to support moves, adds and changes of connectivity.

This standard provides:

- users with an application-independent generic cabling for applications run in homes;
- users with a flexible cabling scheme such that changes are both easy and economical;
- building professionals (for example, architects) with guidance for accommodating cabling before specific requirements are known, i.e. in the initial planning either for construction or refurbishment;
- industry and applications standardisation bodies (e.g. ITU-T, ISO/IEC JTC 1/SC 6, ISO/IEC JTC 1/SC 25/WG 1, IEC TC 100) with a cabling system that supports current products and provides a basis for future product development in home electronic systems;
- users, designers and manufacturers of application-specific cabling systems with advice on interfacing to this generic cabling;
- suppliers of cabling components and installers of cabling with relevant requirements;
- service providers with a distribution system for their services.

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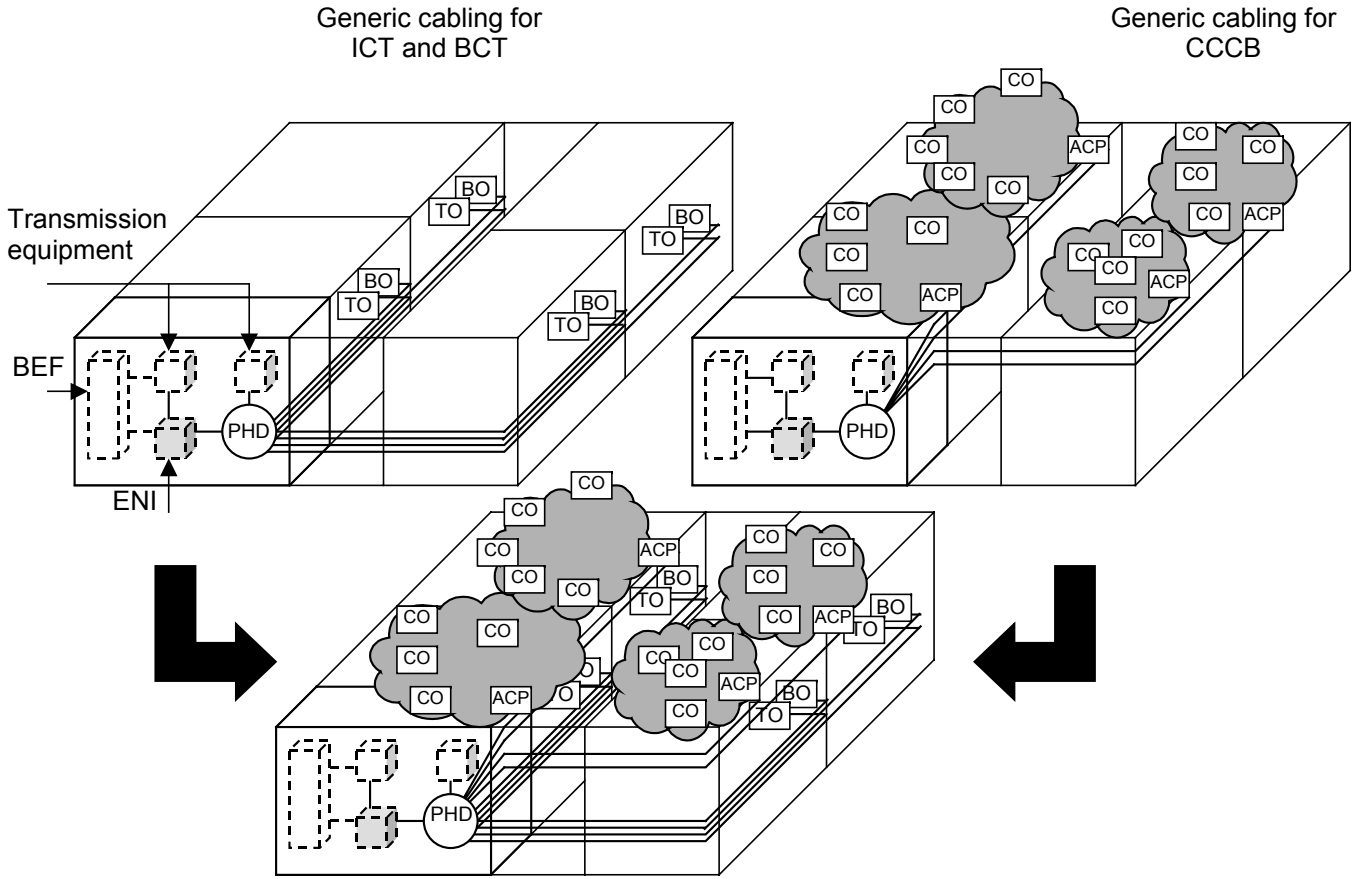


Figure 1 – Overview of a generic cabling for home

A number of ICT, BCT and CCCB applications have been analysed to determine the requirements for a generic cabling (see Table D.2) and to specify the minimum performance of channels given in clause 7. These requirements, together with the logical and physical models described in clauses 5 and 6, have been used to develop the requirements for cabling components and to stipulate their arrangement into generic cabling systems.

Wireless and (unguided) infrared as well as Power Line Communication may also be used for applications mentioned above. Media used for these technologies are not covered in this standard.

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Information technology - Generic cabling for homes

1 Scope

This International Standard specifies generic cabling for homes. A home may contain one or more buildings or may be within a building that contains more than one home.

This standard specifies a generic cabling for three groups of applications:

- Information and Communications Technologies (ICT);
- Broadcast and Communications Technologies (BCT);
- Commands, Controls and Communications in Buildings (CCCB).

It specifies cabling that comprises one or more of the following:

- balanced cabling;
- coaxial cabling;
- optical fibre cabling.

The standard specifies the requirements for the design and configuration of the generic cabling with respect to:

a) structure and topology;
b) minimum configuration;
c) performance requirements for permanent links and channels;
d) density and location of connection points;
e) interfaces to application-specific equipment and external networks;
f) coexistence with other building services.

Although safety (electrical, fire, etc.) and electromagnetic compatibility (EMC) requirements are outside the scope of this International Standard and are covered by other standards and regulations, information given in this International Standard may be of assistance in meeting these requirements.

NOTE 1 National regulations and local codes may preclude carrying certain services on the cabling specified in this standard.

NOTE 2
- Test requirements in this standard are for system designers.
- The installation tests should be decided between supplier and customer or according to the relevant installation guide.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60189-1:1986, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*
Amendment 3 (1992)

IEC 60352-3, *Solderless connections – Part 3: Solderless accessible insulation displacement connections – General requirements, test methods and practical guidance*

IEC 60352-4, *Solderless connections – Part 4: Solderless non-accessible insulation displacement connections – General requirements, test methods and practical guidance*

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IEC 60352-6, *Solderless connections – Part 6: Insulation piercing connections – General requirements, test methods and practical guidance*

IEC 60364-4-41, *Electrical installations of buildings – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60512-2:1985, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 2: General examination, electrical continuity and contact resistance tests, insulation tests and voltage stress tests*

IEC 60512-25-1, *Connectors for electronic equipment – Tests and measurements - Part 25-1: Test 25a – Crosstalk ratio*

IEC 60512-25-2, *Connectors for electronic equipment – Tests and measurements – Part 25-2: Test 25b – Attenuation (insertion loss)*

IEC 60512-25-4, *Connectors for electronic equipment – Tests and measurements – Part 25-4: Test 25d - Propagation delay*

IEC 60512-25-5, *Connectors for electronic equipment – Tests and measurements – Part 25-5: Test 25e – Return loss*[1]

IEC 60512-3, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 3: Current-carrying capacity tests*

IEC 60603-7, *Connectors for frequencies below 3 MHz for use with printed boards – Part 7: Detail specification for connectors, 8-way, including fixed and free connectors with common mating features, with assessed quality*

IEC 60603-7-1:2002, *Connectors for electronic equipment – Part 7-1: Detail specification for 8-way, shielded free and fixed connectors with common mating features, with assessed quality*

IEC 60603-7-2, *Connectors for electronic equipment – Part 7-2: Detail specification for 8-way unshielded free and fixed connectors, for data transmission with frequencies up to 100 MHz*[1]

IEC 60603-7-3, *Connectors for electronic equipment – Part 7-3: Detail specification for 8-way shielded connectors for frequencies up to 100 MHz*[1]

IEC 60603-7-4, *Connectors for electronic equipment – Part 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz (CAT 6, unshielded)*[1]

IEC 60603-7-5, *Connectors for electronic equipment – Part 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz (CAT 6, shielded)*[1]

IEC 60603-7-7:2002, *Connectors for electronic equipment – Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 600 MHz (category 7, shielded)*

IEC 60728 (all parts), *Cabled distribution systems for television and sound signals*

[1] To be published.

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IEC 60966-1, *Radio frequency and coaxial cable assemblies – Part 1: Generic specification – General requirements and test methods*

IEC 60966-2-4, *Radio frequency and coaxial cable assemblies – Part 2-4: Detail specification for cable assemblies for radio and TV receivers – Frequency range 0 to 3 000 MHz, IEC 60169-2 connectors*

IEC 60966-2-5, *Radio frequency and coaxial cable assemblies – Part 2-5: Detail specification for cable assemblies for radio and TV receivers – Frequency range 0 to 1 000 MHz, IEC 61169-2 connectors*

IEC 60966-2-6, *Radio frequency and coaxial cable assemblies – Part 2-6: Detail specification for cable assemblies for radio and TV receivers – Frequency range 0 to 3 000 MHz, IEC 60169-24 connectors*

IEC 61024 series, *Protection of structures against lightning*

IEC 61076-3-104, *Connectors for electronic equipment – Part 3-104: Rectangular connectors – Detail specification for 8 way, shielded free and fixed connectors for data transmissions with frequencies up to 600 MHz minimum*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*

IEC 61156-1, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC 61156-5, *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 600 MHz – Horizontal floor wiring - Sectional specification*

IEC 61156-6, *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 600 MHz – Work area wiring - Sectional specification*

IEC 61156-7, *Multicore and symmetrical pair/quad cables for digital communications – Part 7: Symmetrical pair cables with transmission characteristics up to 1 200 MHz -Sectional specification for digital and analog communication cables*

IEC 61169-1, *Radio-frequency connectors – Part 1: Generic specification – General requirements and measuring methods*

IEC 61169-2, *Radio-frequency connectors – Part 2: Sectional specification - Radio frequency coaxial connectors of type 9,52*

IEC 61169-24, *Radio-frequency connectors – Part 24: Sectional specification – Radio frequency coaxial connectors with screw coupling, typically for use in 75 ohm cable distribution systems (type F)*

IEC 61196 (all parts), *Radio-frequency cables*

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IEC 61935-1:2000, *Generic cabling systems – Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 1: Installed cabling Amendment (2002)*

ISO/IEC 11801:2002, *Information technology – Generic cabling for customer premises*

ISO/IEC 14763-1, *Information technology – Implementation and operation of customer premises cabling – Part 1: Administration*

ISO/IEC TR 14763-2, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*

ITU-T K.31, *Bonding configurations and earthing of telecommunication installations inside a subscriber's building*

EN 50289-1-14*, Communication cables – Specifications for test methods – Part 1-14: Electrical test methods – Coupling attenuation or screening attenuation of connecting hardware*

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1.1
application
system, with its associated transmission method, that is supported by cabling

3.1.2
application outlet
point at which equipment may be connected to the generic cabling in support of ICT and/or BCT application

3.1.3
area connection point (ACP)
point at which coverage area cabling is connected to area feeder cabling

3.1.4
balanced cable
cable consisting of one or more metallic symmetrical cable elements (twisted pairs or quads) [ISO/IEC 11801]

3.1.5
broadcast and communications technologies (BCT)
group of applications including sound radio and TV

NOTE These applications are also called HES class 3 in ISO/IEC TR 15044.

3.1.6
building entrance facility (BEF)
facility that provides all necessary mechanical and electrical services, that complies with all relevant requirements, for the entry of telecommunications cables into a building

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3.1.7
cable element
the smallest construction unit (for example balanced pair, balanced quad, coaxial pair or single optical fibre) in a cable; a cable element may have a screen

3.1.8
cable unit
single assembly of one or more cable elements of the same type or category; the cable unit may have a screen

3.1.9
cabling
system of telecommunications cables, cords, and connecting hardware that can support the connection of information technology and other equipment

3.1.10
channel
end-to-end transmission path connecting any two pieces of application-specific equipment

NOTE 1 Channels specified in this standard are within the boundaries of generic cabling and may only comprise passive components.

NOTE 2 A channel may use one or more pairs, may share a pair with another channel, e.g. power feeding and information may run over the same pair.

3.1.11
coaxial pair
a uniform transmission line consisting of two cylindrical conductors with the same axis [see IEC 60050, term IEV 151-12-39]

3.1.12
commands, controls and communications in buildings (CCCB)
group of applications such as appliance control and building control

NOTE These applications are also called HES class 1 in ISO/IEC TR 15044.

3.1.13
connection
mated device or combination of devices including terminations connecting two cables or cable elements in a not permanent way

3.1.14
connector sharing
ability of a connector to accept multiple plugs in one socket such as 4 one-pair plugs in one 4 pair socket while maintaining the required performance; this may also be achieved by means of an external adapter

3.1.15
coverage area
area within a home covered by any application

3.1.16
cross-connect
apparatus enabling the termination of cable elements and their cross-connection, primarily by means of patch cords or jumpers
[ISO/IEC 11801]

NOTE Incoming and outgoing cables are terminated at fixed points [ISO/IEC 11801]; they are connected with the help of a third cable, a patch cord or a jumper cable.

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3.1.17
distributor
term used for a collection of components (such as patch panels, patch cords) used to connect cables
[ISO/IEC 11801]

3.1.18
equipment cord
cord connecting equipment to a distributor
[ISO/IEC 11801]

3.1.19
equipment interface (EI)
interface at which application specific equipment is connected to the cabling

NOTE An application outlet is an example of an EI.

3.1.20
home
physical structure used as a dwelling place, such as a house or an apartment

NOTE This may be an individual building, part of a larger building or more than one building.

3.1.21
home electronic system (HES)
electronic systems within homes that are interconnected in accordance with ISO/IEC TR 14543

3.1.22
information and communications technologies (ICT)
group of applications using information and communications (telecommunications) technologies

NOTE These applications are also called HES class 2 in ISO/IEC TR 15044.

3.1.23
intercom
communication system for voice and optionally video, internal to the premises often including door opening functions

3.1.24
interconnect
technique enabling equipment cords (or cabling subsystems) to be terminated and connected to the cabling subsystems without using a patch cord or jumper
[ISO/IEC 11801]

NOTE Incoming or outgoing cables are terminated at a fixed point.
[ISO/IEC 11801]

3.1.25
link
transmission path between an outlet or distributor to another outlet or distributor of a generic cabling; it excludes equipment cords

3.1.26
network access cabling
cabling that brings services to the home from a source outside the home (see Figure 7)

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3.1.27
optical fibre cable (or optical cable)
cable comprising one or more optical fibre cable elements
[ISO/IEC 11801]

3.1.28
pathway
facility dedicated to the placement of cable or area reserved for the placement of cable

3.1.29
permanent link
transmission path between two mated interfaces of generic cabling, excluding equipment cords, work area cords and cross-connections, but including the connecting hardware at each end

3.1.30
primary home distributor (PHD)
the primary distributor within a home where cables terminate

3.1.31
remote power feeding
the supply of power different from mains power to application-specific equipment via cabling specified in this standard

3.1.32
requirement to be met by design
requirement which may be met by calculation and selection of appropriate materials and installation techniques, where either there is no test method specified that allows verification or there is no requirement for verification by testing

3.1.33
screened balanced cable
balanced cable with an overall screen and/or screens for the individual elements
[ISO/IEC 11801]

3.1.34
secondary home distributor (SHD)
optional distributor used to provide additional infrastructure flexibility and/or allocate transmission equipment between the primary home distributor and coverage areas (e.g. for homes with multiple floors)

3.1.35
space
area or volume defined by markings or fittings intended for the containment of connecting hardware

3.1.36
terminal equipment
equipment (e.g. telephone handset) that provides user access to an application / service at an outlet

3.1.37
transmission equipment
active equipment used to distribute applications from distributors to other distributors and to outlets

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3.1.38
twisted pair
cable element consisting of two insulated conductors twisted together in a regular fashion to form a balanced transmission line
[ISO/IEC 11801]

3.1.39
unscreened balanced cable
electrically conducting balanced cable without any screen

3.2 Abbreviations

a.c.	alternating current
ACP	Area Connection Point
ACR	Attenuation to Cross-talk Ratio
BCT	Broadcast and Communications Technologies
BCT B	BCT supported by balanced cabling
BCT C	BCT supported by coaxial cabling
BCT-H	BCT high (signal level)
BCT-L	BCT low (signal level)
BCT-M	BCT medium (signal level)
BEF	Building Entrance Facility
BO	Broadcast Outlet
CATV	Community Antenna TV
CC	Cross-Connect
CCCB	Commands, Controls and Communications in Buildings
CCTV	Closed Circuit TV
CO	Control Outlet
d.c.	direct current
EI	Equipment Interface
ELFEXT	Equal Level Far End Cross-talk attenuation (loss)
EMC	Electromagnetic Compatibility
ENI	External Network Interface
EQP	Transmission Equipment
FEXT	Far End Cross-talk
ffs	for further study
HES	Home Electronic System
HVAC	Heating, Ventilating, and Air-Conditioning
ICT	Information and Communications Technology
IEV	International Electrotechnical Vocabulary
ISDN	Integrated Services Digital Network
IL	Insertion Loss
lg	Logarithm with the basis 10
N/A	Not Applicable
NEXT	Near-End cross-talk attenuation (loss)

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OF	Optical Fibre
PELV	Protective Extra Low Voltage
PHD	Primary Home Distributor
PS	Power Source
PS ACR	Power Sum ACR
PS ELFEXT	Power Sum ELFEXT
r.m.s.	root mean square
SELV	Safety Extra Low Voltage
SHD	Secondary Home Distributor
TE	Terminal Equipment
TI	Test Interface
TO	Telecommunications Outlet
TV	Television

4 Conformance

For a cabling installation to conform to this International Standard the following shall apply.

a) The cabling shall support ICT applications.

b) The structure of cabling in support of ICT applications shall conform to the requirements in clause 5.

c) The structure of cabling in support of BCT applications shall conform to the requirements in clause 5.

d) The structure of cabling in support of CCCB applications shall conform to the requirements in clause 6.

e) The interfaces to the cabling at the TO and the BO shall conform to the requirements of clause 10 with respect to mating interfaces and performance.

f) Connecting hardware at other places in the cabling structure shall meet the performance requirements specified in clause 10.

g) All channels and links shall meet the necessary level of performance specified in clause 7 and/or Annex B respectively. This shall be achieved by one of the following:

   1) a channel design and implementation ensuring that the prescribed channel is met;

   2) attachment of appropriate components to a permanent link design meeting the prescribed performance class of Annex B. Channel performance shall be assured where a channel is created by adding more than one cord to either end of a link meeting the requirements of Annex B;

   3) using the reference implementations of clause 8 and compatible cabling components conforming to the requirements of clauses 9 and 10, based upon a statistical approach of performance modelling.

h) System administration shall meet the minimum requirements of ISO/IEC 14763-1.

i) Regulations concerning safety and EMC shall be met as applicable to the location of the installation.

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5 Structure of the generic cabling system to support ICT and/or BCT applications

5.1 General

This clause identifies the functional elements of a generic cabling system to support ICT and/or BCT applications, describes how they are connected together to form subsystems and identifies the interfaces at which application-specific components are connected to the generic cabling infrastructure.

5.2 Functional elements

The functional elements of generic cabling are as follows:

- primary home distributor (PHD);
- primary home cable;
- secondary home distributor (SHD);
- secondary home cable;
- application outlet (TO or BO).

NOTE The SHD and secondary home cable are optional functional elements.

The type and number of functional elements used depends upon the type of premises and the application group(s) served. It is possible to combine multiple functional elements into a single element.

The functional elements used within a given implementation of a generic cabling system are connected together to form cabling subsystems. The connection of equipment at the application outlets and distributors supports applications.

Equipment is not included within the functional elements. The accommodation of functional elements and the facilities for co-location of equipment and functional elements are discussed in 5.7.

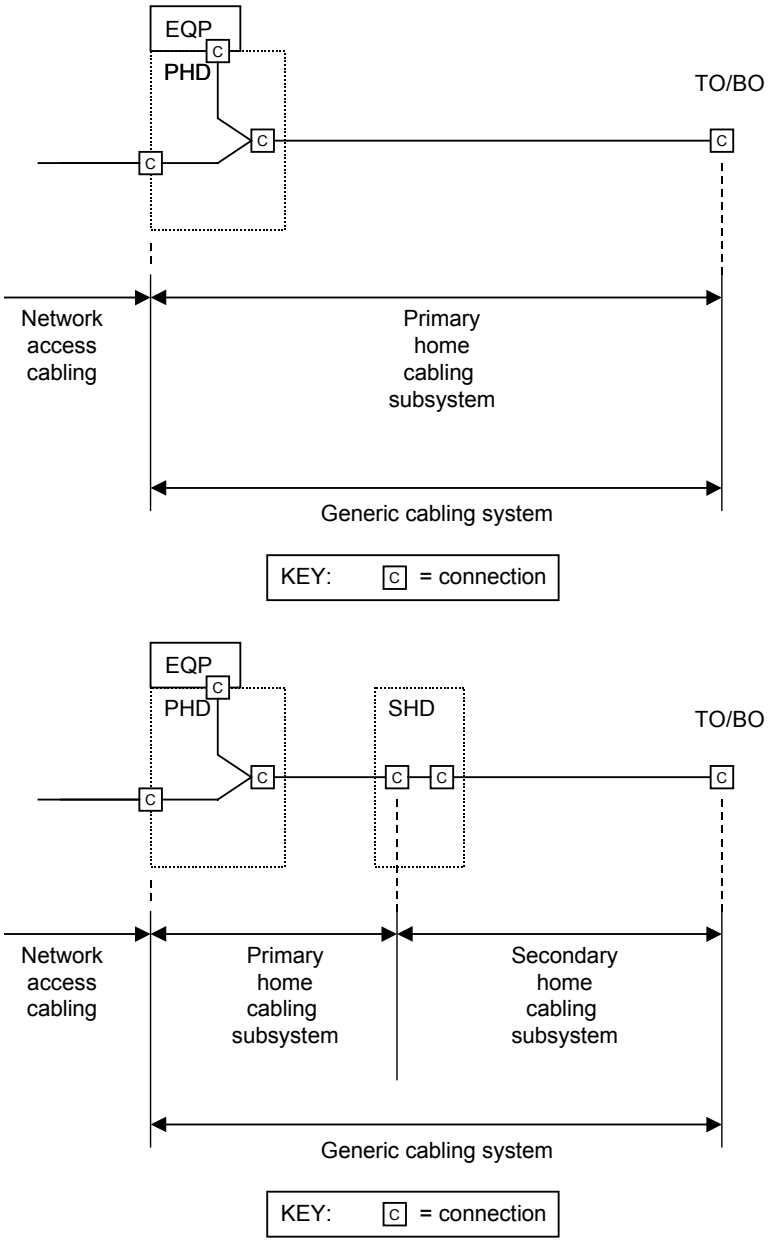
5.3 Cabling subsystems for ICT and BCT

5.3.1 General

Generic cabling schemes to support ICT and/or BCT applications contain a maximum of two cabling subsystems: the primary home cabling subsystem and the secondary home cabling subsystem, as shown in Figure 2.

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NOTE The dotted elements represent the boundaries of functional elements and not the enclosure that contains the functional elements.

Figure 2 – Structure of the generic cabling system

The composition of the subsystems is described in 5.3.2 and 5.3.3. Conformance to this standard does not require the presence of a secondary home cabling subsystem.

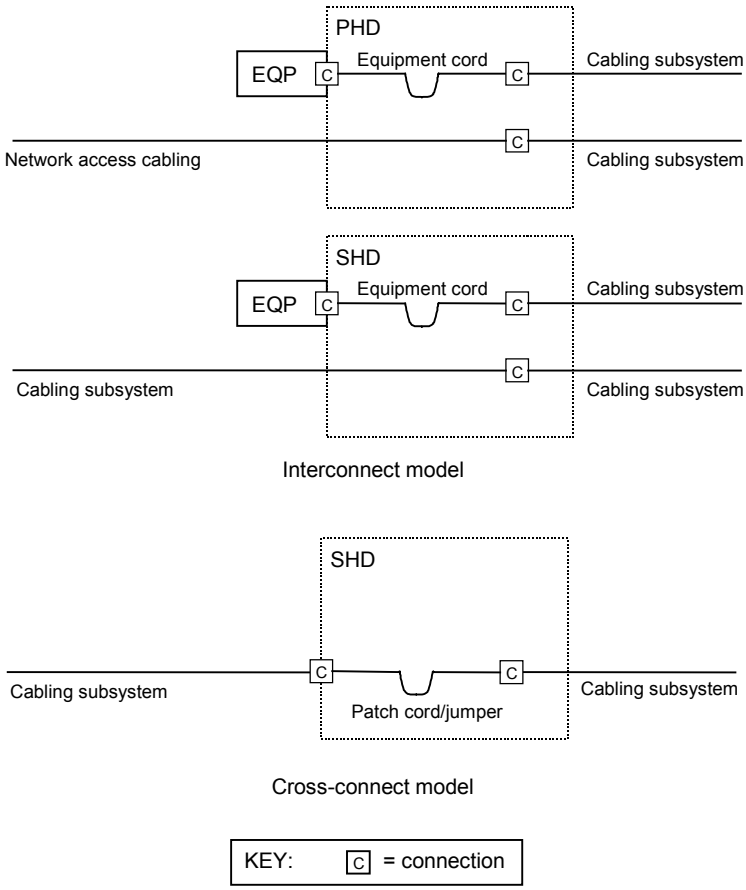
Distributors and application outlets provide the means for configuring the cabling to support topologies in addition to those implemented by the installed cables.

Connections between the cabling subsystems at the SHD are either active, requiring application-specific equipment, or passive using cross-connections by way of either patch cords or jumpers (see Figure 3).

Connection to application-specific equipment at the distributors generally adopts an interconnect approach (see Figure 3).

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Passive connections between the primary home cabling subsystem and the network access cabling at the PHD are generally achieved by using cross-connections.



NOTE The dotted elements represent the boundaries of functional elements and not the enclosure that contains the functional elements.

Figure 3 – Interconnect and cross-connect models

5.3.2 Primary home cabling subsystem

The primary home cabling subsystem extends from the PHD to the application outlet.

When an SHD is used, the primary home cabling subsystem extends from the PHD to the secondary home cabling subsystem.

The subsystem includes:

- the primary home cables;
- the mechanical termination of the primary home cables at the SHD or application outlet as appropriate;
- the mechanical termination of the home cables at the PHD including the connecting hardware, e.g. of the interconnect or cross-connect (see Figure 3);
- any interconnection to application-specific equipment at the PHD;
- any cross-connection to network access cabling at the PHD;
- TO or BO (where a SHD is not used).

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Although equipment cords are used to connect the transmission equipment to the cabling subsystem, they are not considered part of the cabling subsystem because they are application-specific.

The primary home cabling subsystem does not include the interface to the network access cabling at the PHD.

5.3.3 Secondary home cabling subsystem

The secondary home cabling subsystem extends from a SHD to the application outlet.

The subsystem includes:

- the secondary home cables;
- the mechanical termination of the secondary home cables at the TO or BO;
- the mechanical termination of the secondary home cables at the SHD;
- any interconnection to application-specific equipment at the SHD;
- any cross-connection at the SHD;
- TO or BO.

Although equipment cords are used to connect the transmission equipment to the cabling subsystem, they are not considered part of the cabling subsystem because they are application-specific.

5.4 Cabling structure for ICT and BCT applications

For generic cabling to support ICT and/or BCT applications, the functional elements of the cabling subsystems are connected to form a hierarchical structure, as shown in Figure 4.

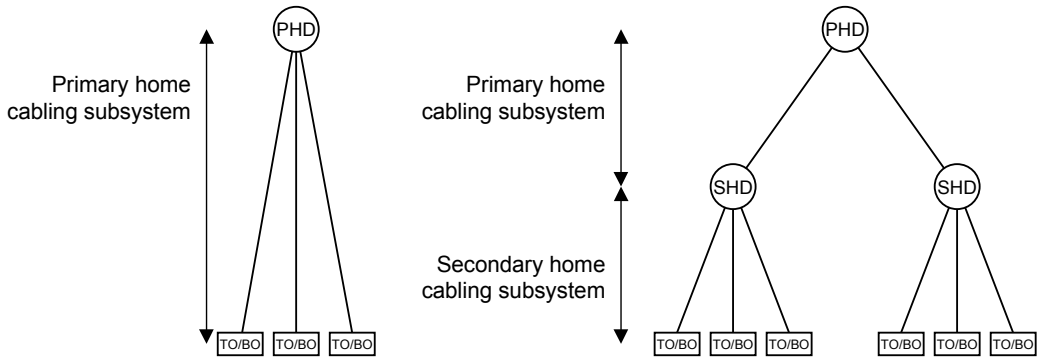


Figure 4 – Hierarchical structure of a generic cabling system in support of ICT and BCT applications

For ICT and BCT applications, the cabling shall have a star topology from the distributors to the application outlet (see Figure 4).

NOTE Buses should be created at the HD or SHD. If cabling is connected to a cabling subsystem to create bus or multi-drop connections this configuration is outside the scope of this standard.

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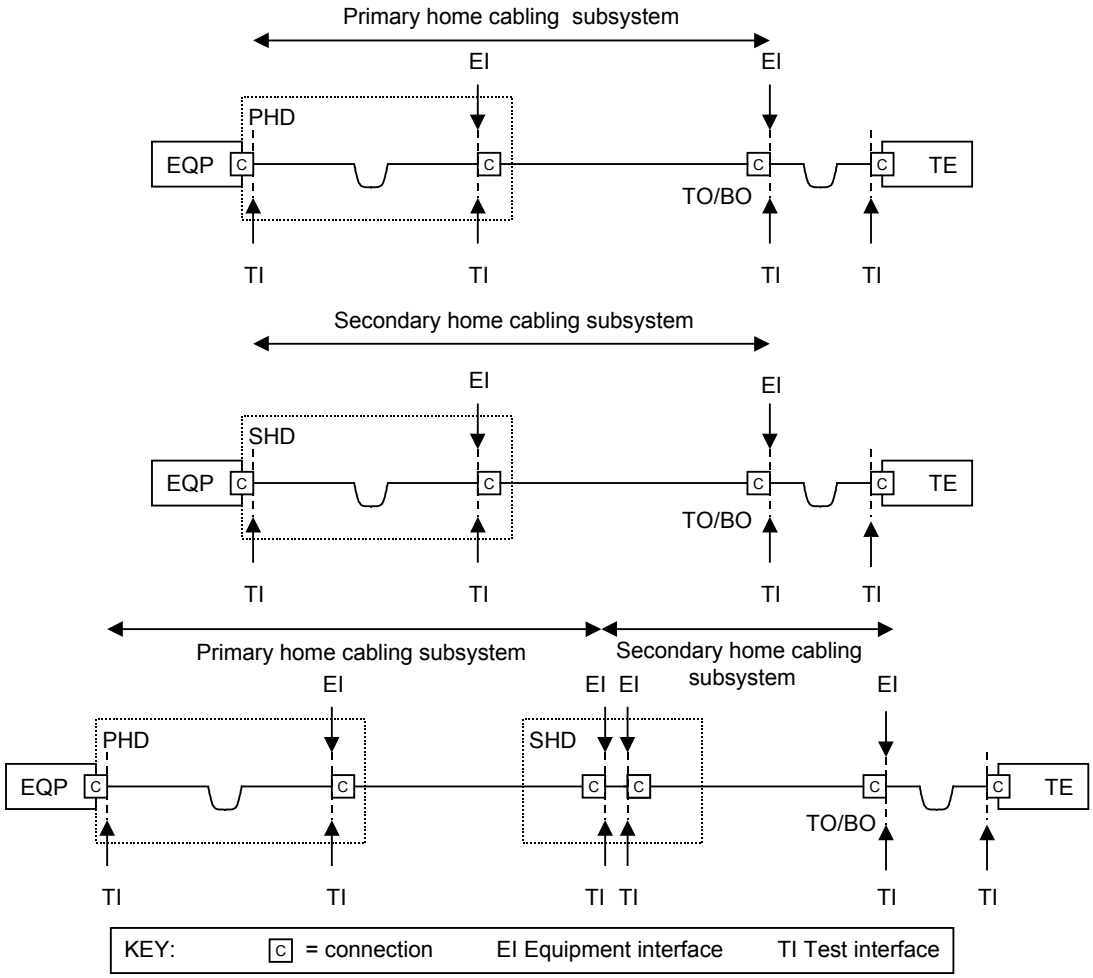
5.5 Interfaces

5.5.1 Equipment interfaces and test interfaces

Equipment interfaces to generic cabling are located at distributors and application outlets. Test interfaces to cabling are located at the ends of each subsystem.

Figure 5 shows the potential equipment interfaces and potential test interfaces within the generic cabling system.

Transmission and terminal equipment are generally connected to the equipment interface using an equipment cord.



NOTE 1 The dotted elements represent the boundaries of functional elements and not the enclosure that contains the functional elements.

NOTE 2 For BCT-C applications (see clause 7) the test interface is defined according to IEC 61169-1.

Figure 5 – Equipment and test interfaces in support of ICT and BCT applications

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5.5.2 Channel and permanent link

5.5.2.1 Channel

The channel is any signal transmission path or power, other than mains, feeding path comprising passive cabling components between:

- connections to the network access cabling and application-specific equipment;
- sender(s) and receiver(s) or between power source and associated load of application-specific equipment.

For cabling to support ICT and/or BCT applications, the channel consists of the home cabling subsystem(s) together with the equipment cord(s), as shown in Figure 6.

It is important that the cabling channel is designed to meet the required class of performance for the applications that are to be run. The performance of the channel excludes the connections at the application-specific equipment.

The transmission performance of channels is detailed in clause 7.

The creation of a channel between two application outlets via a passive cross-connection at the distributors is allowed provided that the relevant channel performance of clause 7 is met.

The maximum channel lengths for each application group are dependent upon the performance of the cable and connecting hardware used (see Table 1 and Table 7 for maximum channel lengths using the reference implementations of clause 8).

Where the performance requirements of an application allow, longer channels may be formed by the passive connection of cabling subsystems together with equipment cords where appropriate.

5.5.2.2 Permanent link

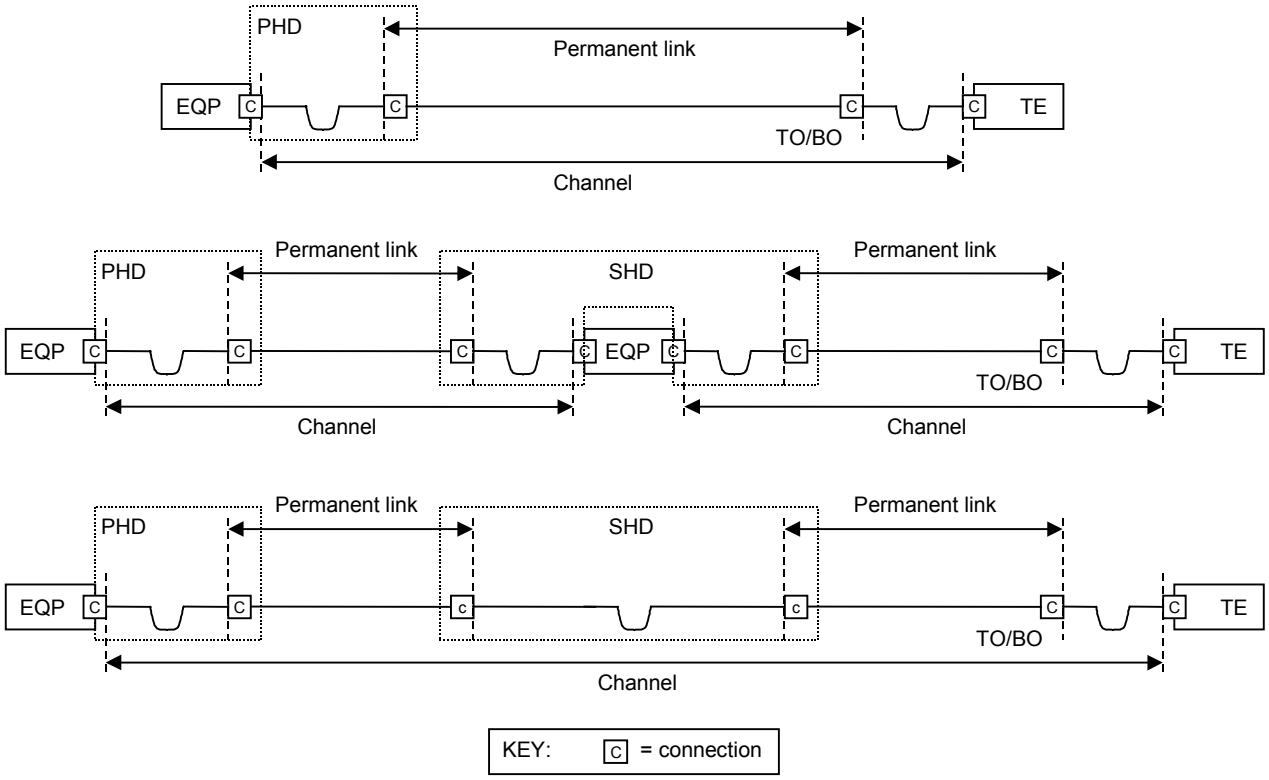
If there is no SHD, the permanent link consists of the primary home cable and the termination of that cable at the application outlet and the PHD, as shown in Figure 6.

If there is an SHD, the permanent link consists of the primary or secondary home cable and the termination of that cable at the SHD and the PHD or the application outlet respectively as shown in Figure 6.

The permanent link includes the connections at the ends of the installed cabling.

The transmission performance of permanent links is detailed in Annex B.

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NOTE The dotted elements represent the boundaries of functional elements and not the enclosure that contains the functional elements.

Figure 6 – Channels and permanent links within the home

5.5.3 Network access cabling

Network access cabling is presented at the PHD as shown in Figure 7.

In premises containing a single home the network access cabling provides the connection between the external network interfaces (public or private) and the PHD.

In premises containing multiple homes the network access cabling may, subject to national or local regulation, also provide the connection between:

- individual homes in the same premises;
- premises external network interfaces (public or private) and the PHD in each home.

When used to provide a direct connection between the generic cabling system and an external network interface in the home, the performance of the network access cabling should be considered as part of the initial design and implementation of customer applications.

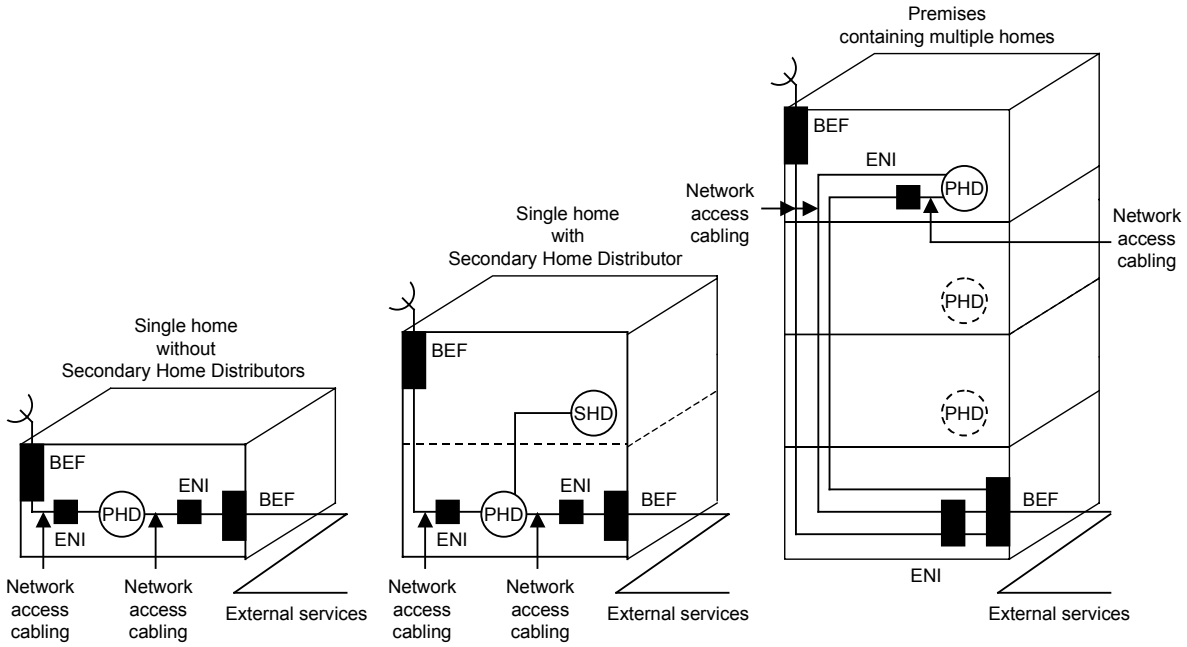
When used to provide a direct connection between the generic cabling system and an external network interface in the same premises (but not within the home served by the home distributor), the network access cabling shall be in accordance with:

- ISO/IEC 11801 for ICT applications;
- IEC 60728 for BCT applications.

The only interfaces to network access cabling within a home shall be those serving that home.

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NOTE Some network access cabling uses bus structure.

Figure 7 – Examples of interconnection of home and network access cabling

5.5.4 External network interface

Connections to external networks for the provision of external telecommunications services are made at external network interfaces. The location of external network interfaces, if present, and the facilities required may be specified by national, regional, and local regulations. The service provider(s) shall be contacted to locate the external network interface(s).

5.6 Accommodation of functional elements

5.6.1 Distributors

5.6.1.1 PHD

Each home shall be served by one PHD. The physical volume of the PHD depends upon the complexity of the infrastructure being served.

The PHD shall be located in a designated area with adequate access and space to house the cabling, the transmission equipment and to enable management of the cabling connections. The PHD shall have access to the mains power required for application-specific equipment.

Other requirements for the accommodation of PHDs should be based upon the general recommendations of ISO/IEC TR 14763-2 for other distributors.

5.6.1.2 SHD

Where used, SHDs shall be located in a designated area with adequate access and space to house the cabling, the transmission equipment and to enable management of the cabling connections. SHDs shall be provided with access to the mains power required for the application-specific equipment.

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Other requirements for the accommodation of SHDs should be based upon the general recommendations of ISO/IEC TR 14763-2 for other distributors.

5.6.2 Application outlets

The number and distribution of application outlets depends upon the size and function of the coverage area.

For ICT and/or BCT applications the coverage area corresponds to a room or to every 10 m^2 within a larger room. Each coverage area should be provided with a minimum of one TO for ICT applications and one BO for BCT applications.

It should be noted that in certain cases an application outlet within a coverage area may be located on the external surface of the building or in a separate building within the premises (see Figure 8).

The cabling provided to a coverage area shall be for ICT and/or BCT channels, as specified in clause 7:

- at least 4 balanced pairs within at least one cable capable of supporting ICT channels in accordance with 7.2. For channels exploiting the maximum length specified in Table 1, the cable shall be either an ICT cable in accordance with 9.2 or a balanced BCT cable in accordance with 9.3.1;

and, in support of BCT channels as specified in clause 7, either

- at least 1 balanced pair within at least one balanced BCT cable capable of supporting BCT channels in accordance with 7.3. For channels exploiting the maximum length specified in Table 1 this cable shall be a balanced cable in accordance with 9.3.1

or

- a least 1 coaxial BCT cable capable of supporting BCT channels in accordance with 7.3. For channels exploiting the maximum length specified in Table 1 this cable shall be a coaxial cable in accordance with 9.3.2.

All cable elements within a coverage area shall be terminated at application outlets. A cable element shall not be terminated at more than one application outlet. (This does not mean impedance matching.)

NOTE 1 Cabling configurations beyond the application outlet that provide such connections (e.g. physical bus) are application-specific and not within the scope of this standard.

NOTE 2 Where the pairs are provided to an application outlet by more than one cable, care shall be exercised to ensure that the channel requirements of clause 7 are met.

Additional balanced cables (for ICT and/or BCT applications) or coaxial cables (for BCT applications) should be provided as defined by the:

- number and mix of applications (e.g. satellite feed, multi-cable feed of CATV, in-house generated video);
- number of application outlets to be served.

NOTE 3 Some applications, such as direct satellite feeds, use frequencies above 1 000 MHz that are only supported by the higher bandwidth BCT-C channels.

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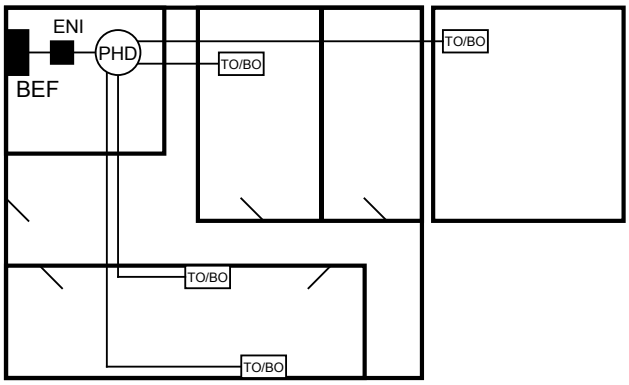


Figure 8 – Interconnection of home cabling subsystems

5.6.3 Cable pathways

Cables are routed using pathways. A variety of cable management systems can be used to support the cables within the pathways including trunking and ducting (see IEC 61084), conduit (IEC 61386) and tray (IEC 61537). Information concerning pathways serving ICT cabling is provided in ISO/IEC 18010.

Pathways shall accommodate the minimum bend radii of the cables to be installed. Where the pathways are to contain more than one cable type, then the largest minimum bend radius shall apply.

Where space available to pathways is limited, the sharing of cables for multiple applications may be considered (see 5.7.2.4).

The pathways used shall match the cabling topology. If not all of the cabling specified in this standard is pre-installed, pathways allowing future installation of cables should be provided for all cabling subsystems. In this case, the pathways shall be sufficient in cross-section and shall provide access to ease the installation of additional cables.

A generic cabling may be located adjacent to mains cabling subject to the requirements of national or local regulations and clause 11.

Where ICT and/or BCT cables are to be installed in the same pathways as mains power cables the requirements of 11.2 shall be observed.

5.7 Dimensioning and configuring

5.7.1 Distributors

The design of distributors should ensure that the lengths of patch cords, jumpers and equipment cords are minimised and administration should ensure that the design lengths are maintained during operation.

Distributors shall be located in such a way that the resulting cable lengths are consistent with the channel performance requirements of clause 7. For the reference implementations described in clause 8, the maximum channel lengths in Table 1 shall be observed subject to the following restrictions:

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- not all applications are supported over the maximum lengths shown in Table 1. Using a single cable type and the support of specific applications over installed channels may require a mix of cabling media and types;
- national, regional, and local regulations or service provider instructions may restrict the maximum channel length between the application outlet and the external network interface.

Table 1 - Maximum channel lengths for reference implementations of ICT/BCT channels

Cabling type		
ICT	**BCT B [a]**	**BCT C [a]**
100	50 [b]	100 [b]

[a] See Annex A and Annex C for performance and length considerations for BCT channels.

[b] BCT channel length is restricted to 50 m when using BCT-B cabling since the BCT balanced cable has higher attenuation than that of BCT coaxial cable.

NOTE Reference implementations are not intended to restrict the use of shorter lengths.

5.7.2 Application outlets

5.7.2.1 Hierarchy

For cabling supporting ICT applications only, the application outlet is termed the TO in accordance with the ISO/IEC 11801. A TO may also be used to support BCT and CCCB applications where appropriate.

For cabling supporting BCT applications, the application outlet is termed the BO and uses connecting hardware specified in 10.2.3. A BO may also be used to support ICT and CCCB applications where appropriate.

5.7.2.2 Telecommunications Outlet (TO)

The TO shall be located in readily accessible locations in the room, depending on the design of the building and subject to the requirements of national and local regulations.

Each TO should be terminated in accordance with 10.2.2 using 4-pairs. 2 pairs per TO may be used as an alternative to 4 pairs. However, this may require pair reassignment and will not support some applications. Care should be taken that the initial pair assignment, and all subsequent changes, are recorded (see ISO/IEC 14763-1 for details of administration requirements). Pair reassignment by means of inserts is allowed.

5.7.2.3 Broadcast Outlet (BO)

The BO shall be located in readily accessible locations in the room, depending on the design of the building and subject to the requirements of national and local regulations.

Each BO using balanced BCT cable should be terminated in accordance with 10.2.3. Fewer than 4 pairs per BO may be terminated; however this may require pair reassignment. Care should be taken that the initial pair assignment, and all subsequent changes, are recorded (see ISO/IEC 14763-1 for details of administration requirements). Pair reassignment by means of inserts is allowed.

Each BO using coaxial BCT cable shall be terminated in accordance with 10.2.3.

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Where balanced cable is used and the BO is intended to also support ICT applications, the number of pairs to be terminated shall take into account the recommendations of 5.7.2.2.

5.7.2.4 Cable sharing

In order to maximise the capacity of cable management systems, it is possible for ICT, BCT and CCCB applications to share cables. However, the sharing of cables by applications with other application groups may require additional performance requirements to be applied. This topic is for further study.

5.7.3 Equipment cords

The performance contribution of the equipment cords, used to connect application-specific equipment to the cabling at distributors and at application outlets, shall be taken into account in the design of the channel. Assumptions have been made concerning the length and the transmission performance of these cords; the assumptions are identified when relevant. The performance contribution of these cords shall be taken into account in the design of the channel. Clause 7 provides guidance on cord length for reference implementations of cabling in accordance with this clause.

5.7.4 Building entrance facilities

Building entrance facilities are required whenever network access cables (including cables from antennae) enter buildings and a transition is made to internal cables.

National or local regulations should be consulted to determine any additional requirements where external cables are terminated within the building entrance facility.

6 Cabling to support CCCB applications

6.1 General

This clause identifies functional elements of the generic cabling system to support CCCB applications. Where the functional elements differ from those of clause 5, this clause describes how the functional elements are connected together to form subsystems and identifies the interfaces at which application-specific components are connected to the generic cabling system infrastructure.

6.2 Functional elements

In order to support CCCB applications the following set of functional elements is specified:

- primary home distributor (PHD) (see clause 5);
- primary home cable (see clause 5);
- secondary home distributor (SHD) (see clause 5);
- area feeder cable;
- area connection point (ACP);
- coverage area cable;
- CO.

The type and number of functional elements used depends upon the type of premises. It is possible for the functions of multiple elements to be combined into a single element.

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The functional elements used within a given implementation of a generic cabling system are connected together to form cabling subsystems. Applications are supported by connecting application-specific equipment at the COs and distributors.

The CO may be connecting hardware or may be a termination on the application-specific equipment.

6.3 Cabling subsystems for CCCB

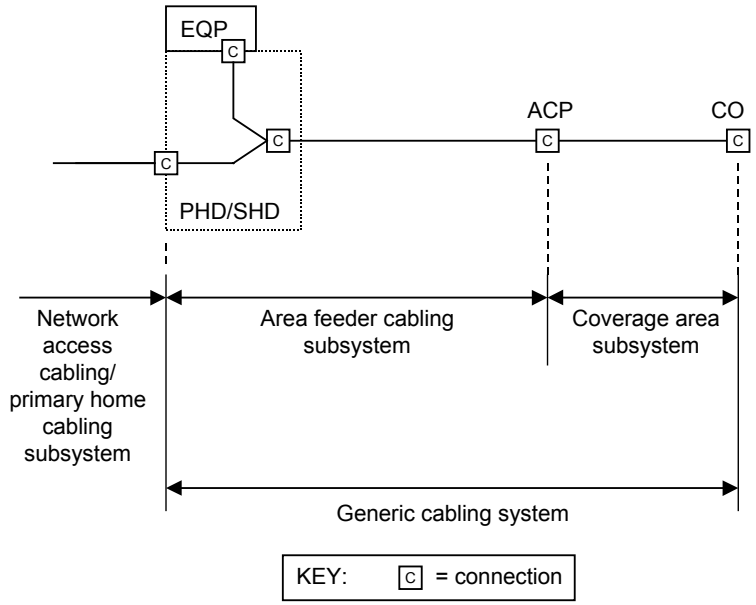
6.3.1 General

Generic cabling systems to support CCCB applications contain a maximum of three cabling subsystems: the primary home cabling subsystem (where a SHD is used) as specified in clause 5, the area feeder cabling subsystem and the coverage area cabling subsystem as shown in Figure 9.

The composition of the subsystems is described in 6.3.2 and 6.3.3.

The distributors and the COs provide the means for configuring the cabling to support topologies in addition to those implemented by the installed cables.

Connections between the cabling subsystems at the ACPs adopts an interconnect approach (see Figure 3).



NOTE The dotted elements represent the boundaries of functional elements and not the enclosure that contains the functional elements.

Figure 9 – Structure of the generic cabling system in support of CCCB applications

6.3.2 Area feeder cabling subsystem

The area feeder cabling subsystem extends from the PHD (or SHD as appropriate) to the ACP. The subsystem includes:

- the area feeder cables;
- the mechanical termination of the area feeder cables at the ACP;
- the mechanical termination of the area feeder cables at the PHD or SHD;

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- any interconnection to application-specific equipment at the PHD or SHD;
- any cross-connection at the PHD or SHD;
- the ACP.

Although equipment cords are included in a channel they are not part of the cabling subsystem because they are application-specific.

6.3.3 Coverage area cabling subsystem

The coverage area cabling subsystem extends from the ACP to the COs. The subsystem includes:

- the coverage area cables;
- the mechanical termination of the coverage area cables at the ACP;
- the mechanical termination of the coverage area cables at the COs;
- the mechanical termination of the coverage area cables to each other at other places within the subsystem;
- the COs.

Although equipment cords are included in a channel they are not part of the cabling subsystem because they are application-specific.

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6.4 Cabling structure for CCCB applications

For generic cabling to support CCCB applications, the functional elements of the cabling subsystems are connected to form a hierarchical structure as shown in Figure 10.

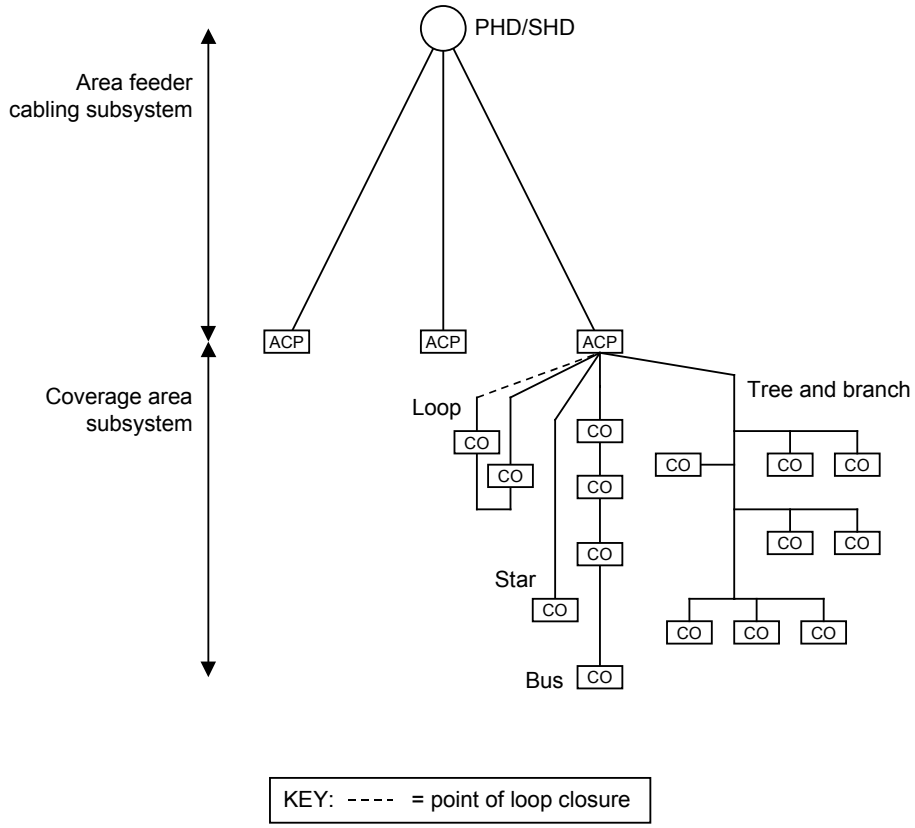


Figure 10 – Hierarchical structure of a generic cabling system in support of CCCB applications

For CCCB applications, the area feeder cabling shall have a star topology from the distributor to the ACP.

The coverage area cabling may be installed in any of the topologies shown in Figure 10. Where permitted by the application, loops shall be closed by a connection only at easily accessible points (e.g. the ACP or at distributors).

6.5 Interfaces

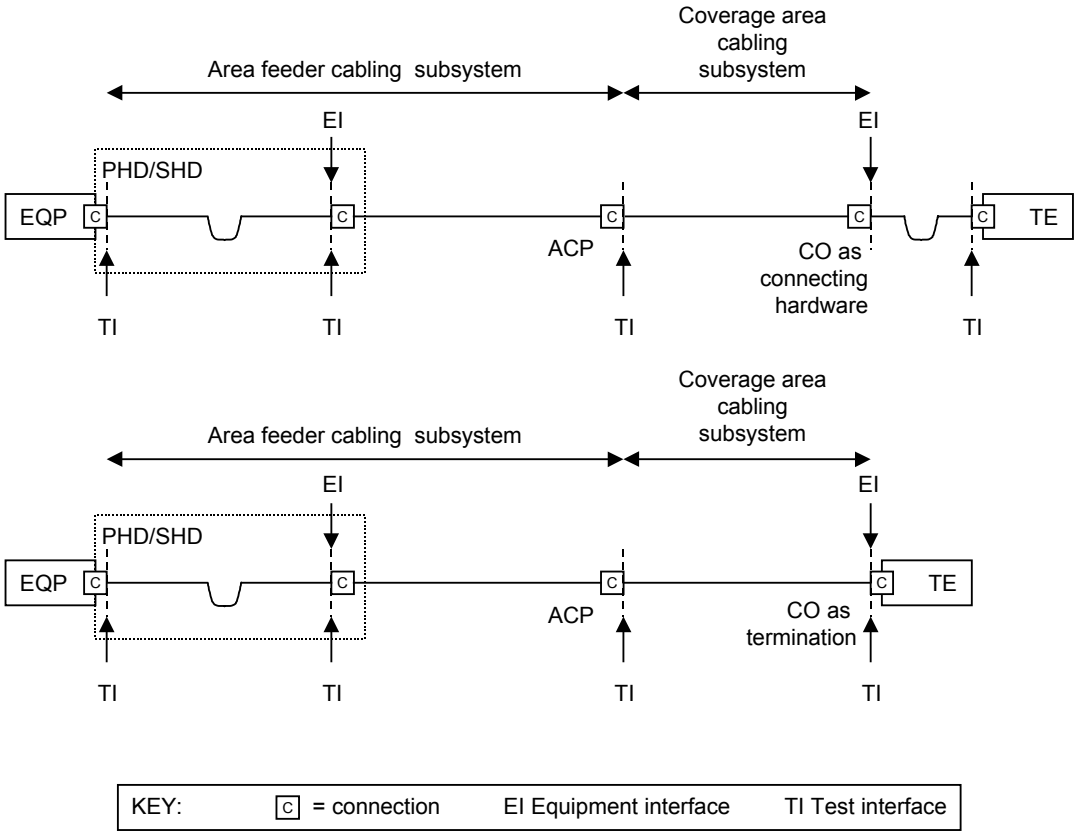
6.5.1 Equipment interfaces and test interfaces

Equipment interfaces to generic cabling are located at distributors and the COs. Test interfaces to cabling are located at the ends of each subsystem.

Figure 11 shows the potential equipment interfaces and potential test interfaces within the generic cabling system.

Transmission equipment at the distributor is generally connected to the equipment interface using an equipment cord. At the CO the equipment interface may be connecting hardware or may be a termination on the application-specific equipment.

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NOTE The dotted elements represent the boundaries of functional elements and not the enclosure that contains the functional elements.

Figure 11 – Equipment and test interfaces in support of CCCB applications

6.5.2 Channel and permanent link

6.5.2.1 Channel

The channel is any signal transmission path or power feeding path comprising passive cabling components between:

- connections to the network access cabling and application-specific equipment;
- sender(s) and receiver(s) or between power source and associated load of application-specific equipment.

For cabling to support CCCB applications, the channel consists of the area feeder cabling subsystem and/or coverage area cabling with the equipment cord(s), as shown in Figure 12.

It is important that the cabling channel be designed to meet the required class of performance for the applications that are to be run. The performance of the channel excludes the connections at the application-specific equipment.

The transmission performance of channels is detailed in clause 7.

The creation of a channel between two COs in different coverage areas via a passive cross-connection at the distributors is allowed provided that the relevant channel performance of clause 7 is met.

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Maximum channel lengths are dependent upon the performance of the cable and connecting hardware used. See 6.7.1 for the maximum cabling lengths using the reference implementations of clause 8.

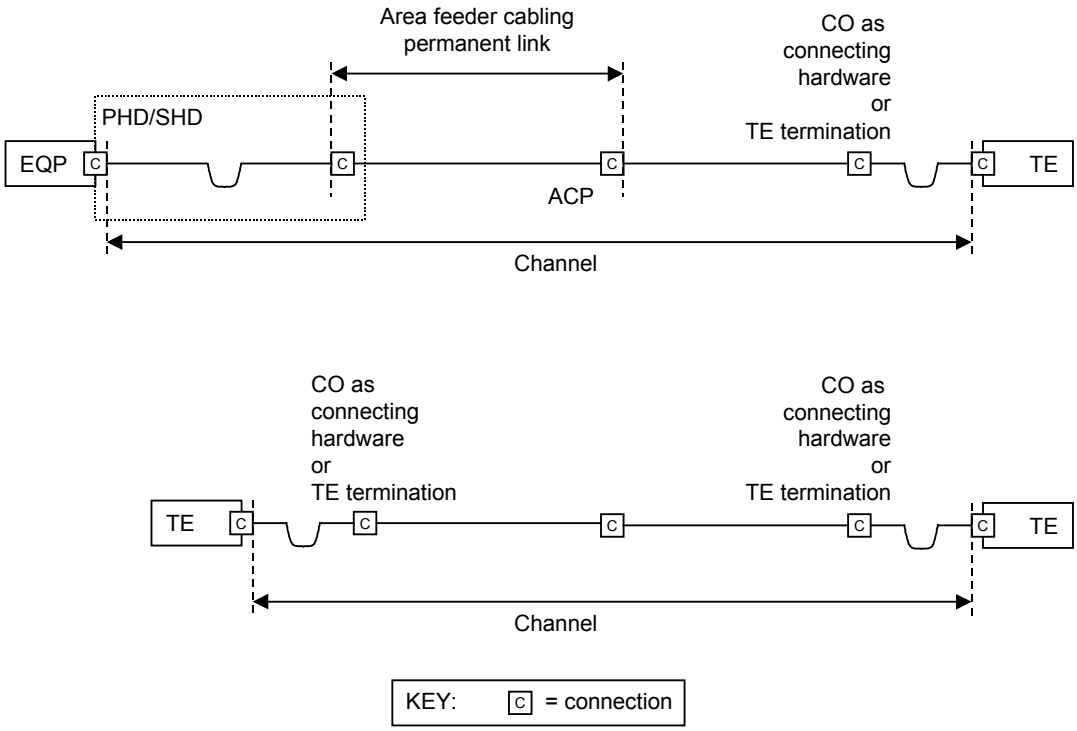
Where the performance requirements of an application allow, longer channels may be formed by the passive connection of cabling subsystems together with equipment cords where appropriate.

6.5.2.2 Area feeder permanent link

The area feeder permanent link consists of the area feeder cable and the termination of that cable at the ACP and the PHD or SHD respectively, as shown in Figure 12.

The permanent link includes the connections at the ends of the installed cabling.

The transmission performance of permanent links is detailed in Annex B.



NOTE The dotted elements represent the boundaries of functional elements and not the enclosure that contains the functional elements.

Figure 12 – Channels and permanent links for CCCB cabling

6.5.3 Network access cabling

See 5.5.3.

6.5.4 External network interface

See 5.5.4.

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6.6 Accommodation of functional elements

6.6.1 Area Connection Points (ACPs)

For CCCB applications the coverage area corresponds to an area of 25 m^2. Each coverage area should be provided with a minimum of one ACP.

CCCB cabling is intended to carry signal and, in many cases, power to the COs. The ACP may provide pair reassignment to allow the conductors within the area feeder cabling to be used in parallel.

Relevant application standards and manufacturers‘ instructions shall be consulted with reference to safety aspects of power feeding. Care shall be taken when using multi-unit or bundled cables due to the possible rise of temperature within the cabling components that may degrade channel performance.

The area feeder cabling to each ACP shall be a 4-pair balanced cable capable of meeting the permanent link performance requirements of Annex B.2, enabling the delivery of ICT applications if appropriate connecting hardware is used at the distributor and the ACP.

6.6.2 Control Outlets (COs)

The number and distribution of COs shall correspond to the size and function of the coverage area.

A CO should be located at, or near, all potential locations of CCCB terminal equipment to facilitate direct termination of CCCB terminal equipment.

It should be noted that in certain cases the terminal equipment connected within a coverage area may be located on the external surface of the building or in a separate building within the premises.

6.6.3 Cable pathways

Where CCCB, ICT and/or BCT cables are to be installed in the same pathways as mains power cables, the requirements of 11.2 shall be observed.

NOTE Based on local regulations or practical considerations, it may be necessary or advisable to have two parallel pathways (one for mains, one for information; or one for mains and CCCB, one for ICT and BCT) even though this standard specifies one.

6.7 Dimensioning and configuring

6.7.1 Distributors

Distributors shall be located such that the resulting cable lengths are consistent with the channel performance requirements of clause 7.

For the reference implementations described in clause 8, the maximum length of the area feeder cabling permanent link shall not exceed 90 m and the total length of coverage cabling shall not exceed 50 m.

National, regional, and local regulations or service provider instructions may restrict the maximum channel length between the COs and the ENI.

6.7.2 Control Outlet (CO)

Where the coverage area cabling is not directly terminated to the CCCB terminal equipment, the CO uses connecting hardware specified in 10.2.4.

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A TO or a BO (see clause 5) may be used to support CCCB applications where appropriate.

A minimum of 1-pair shall be terminated at each CO. The same pair may be terminated at multiple COs within a coverage area.

6.7.3 Cable sharing

CCCB applications may share ICT and BCT cables. However, the sharing of cables by applications with other application groups may require additional performance requirements to be applied and additionally may be subject to national or local regulations. This topic is for further study.

6.7.4 Equipment cords

See 5.7.3.

6.7.5 Building entrance facilities

See 5.7.4.

7 Performance

7.1 General

This clause specifies the minimum performance of a cabling system with channels for three groups of applications: ICT, BCT and CCCB. The minimum channel performances specified in this clause are independent of the length of the channels, are determined by application requirements and shall be met at all intended channel operating temperatures.

Specification of channel performances is based on the minimum performance of the most demanding application of an application group for each transmission characteristic. In general a channel specified for an application group with higher requirements supports applications with lower requirements. Less demanding applications of a higher group may also use channels aimed at a lower group, as shown in Table 2.

NOTE 1 The channel performance specified in this clause is the best performance an application may expect from the worst channel that meets this standard if the design is intended to use any channel that conforms to this standard.

NOTE 2 In case an application exploits a number of channel characteristics that are interrelated, it may not be possible to reach all limits concurrently, as each value is a separate limit. For example, with a current carrying capacity of 175 mA, operating voltage of 72 V and power capacity of 10 W, an application that exploits the full 72 V may not use more than 138 mA, an application that goes to the limit of 175 mA may not use more than 57 V.

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Table 2 – Different channels and their potential use

Channel	Upper frequency of specification MHz	ICT applications supported	BCT applications supported	CCCB applications supported
Balanced CCCB channel	$f = 0{,}1$	ICT applications supported by CCCB channels	BCT applications supported by CCCB channels	all CCCB applications
Balanced ICT channel	$f = 100$	all ICT applications supported by Class D channels as specified in ISO/IEC 11801 [a] up to 100 MHz	BCT applications supported by Class D channel performance as specified in ISO/IEC 11801 [a]	CCCB applications supported by the ICT channel performance [b]
Balanced BCT channel	$f = 1\ 000$	ICT applications supported by the BCT channel performance	all BCT applications supported by balanced cabling	CCCB applications supported by the BCT channel performance [b]
Coaxial BCT channel	$f = 3\ 000$	all ICT applications supported by coaxial cabling that require up to 3 GHz	all BCT applications supported by coaxial cabling that require up to 3 GHz	N/A
	$f = 1\ 000$	all ICT applications supported by coaxial cabling that require up to 1 GHz	all BCT applications supported by coaxial cabling that require up to 1 GHz	N/A
Optical channels	N/A	see ISO/IEC 11801	ffs	ffs

[a] When Class E or F channels are installed to meet the minimum requirements for ICT channels, ICT and BCT applications accommodated by the performance of the respective channels are supported.

[b] The power carrying capacity may limit the applications or the number of COs supported.

Clauses 9 and 10 provide the minimum performance that components need to provide when used to implement channels following the channel models shown in clauses 5 and 6 for the reference implementations of clause 8.

The component performance for other lengths and operating temperatures may be calculated based on the channel performance specified in this clause and the channel models from clauses 5 and 6.

While cabling channels for ICT and CCCB within the home presently are provided via balanced cables only, channels for BCT may be provided via balanced cable or coaxial cable. The CCCB channel specified in this clause assumes power feeding and information transfer on the same pair(s). The CCCB channel is specified with a current carrying capacity of 0,7 A. This requirement may be met with one pair of CCCB cable or 4 pairs of ICT cable connected together. All channels specified in this clause assume bi-directional transmission.

The majority of BCT channels use one balanced pair or one coaxial cable. ICT applications use one, two or four pairs. The requirements for pair-to-pair characteristics are specified in this standard also to cover the case where a channel contains multiple transmission paths (pairs). The power feeding, where applicable, is covered in the specification of the channel. The channel for power feeding may start at other points than that for information transfer.

NOTE Multiple pair requirements are only applicable to cables having more than one pair.

Cables and connecting hardware may support multiple channels, provided the safety and electrical characteristics of the channels are not degraded.

This standard includes the option where the same resource, e.g. cable or connecting hardware, may serve more than one channel. If this option is exploited, the additional

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requirements for sharing of such resources specified in this clause shall be met. Where only a cable is shared, the additional requirements for the cable are specified in clause 9.

The minimum performance specified in this clause shall be met by appropriate design of the channels, selection of adequate material and their proper installation.

The term “attenuation” is widely used in the cable industry to characterise cables. However, due to impedance mismatches in cabling systems, especially at higher frequencies, the behaviour of a cable that constitutes part of a system is better described as “insertion loss”. In this standard, the term “insertion loss” is adopted throughout, to describe the signal attenuation over the length of channels, links and short components. However, it should be clearly understood that insertion loss is not a length specific characteristic. The term “attenuation” is used for cables and for the following parameters:

- attenuation to crosstalk ratio (*ACR*);
- unbalance attenuation;
- coupling attenuation;
- screening attenuation.

For the calculation of *ACR*, *PS ACR*, *ELFEXT* and *PS ELFEXT*, the corresponding insertion loss is used.

7.2 ICT channel performance

The cabling channels from PHD and SHD respectively to TOs as shown in Figure 6, shall meet the minimum transmission performances as specified up to 100 MHz in clause 6 of ISO/IEC 11801:2002 for Class D channels over the whole temperature range the cabling is intended to work. Installation of Class E channels is strongly recommended.

In case more than one Class D channel uses the same cabling components (cables and connecting hardware), each channel shall meet the requirements as specified in ISO/IEC 11801:2002 for Class E channels.

The cables installed as part of such channels shall provide the transmission characteristics needed to meet the minimum channel performance chosen (class D, class E, or even class F) and in addition they shall meet the mechanical characteristics specified in Table 8. The minimum performance of cables used to implement channels exploiting the maximum distance specified in Table 1 shall meet the minimum performance specified in clause 9.

7.3 BCT channel performance

Cabling channels for BCT may be provided via balanced or coaxial cables.

BCT-C channels shall meet the minimum transmission performances as specified in Table 3, together with those specified for Class F channels in ISO/IEC 11801:2002, over the whole temperature range in which the cabling is intended to operate.

BCT-B channels shall meet the minimum transmission performances as specified in Table 4 over the whole temperature range in which the cabling is intended to operate.

In addition, balanced cables used for BCT channels shall meet the mechanical requirements specified in Table 8, coaxial cables used shall meet the mechanical requirements specified in Table 11.

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In order to avoid unnecessary amplification and attenuation of BCT applications at the distributors and BOs respectively, two additional BCT channel levels have been specified, as shown in Annex A.

In order to maintain the channel performance equipment cords that meet IEC 60966-2-4, IEC 60966-2-5 and IEC 60966-2-6 respectively shall be used.

Table 3 – Minimum performance of BCT-B channels

Channel characteristics				Cabling channel performance	Test method
No	**Electrical characteristics**	**Units**	**Frequency** MHz	**Balanced channel**	
1	Nominal impedance	Ω		100	to be met by design
2	Minimum return loss (*RL*) at each cabling Interface [a]	dB	$4 \le f < 40$	$24 - 5\lg(f)$, 19 dB min	4.9 of IEC 61935-1
			$40 \le f \le 1\,000$	$32 - 10\lg(f)$, 8 dB min	
	Informative values		$f = 100$	12	
			$f = 1\,000$	8	
3	Maximum insertion loss (*IL*)	dB	$1 \le f \le 1\,000$	$49{,}5 \times \left(1{,}645\sqrt{f} + 0{,}01 \times f + 0{,}25/\sqrt{f}\right)/100 + 2 \times 0{,}02\sqrt{f}$ 2 dB min	
	Informative values		$f = 1$	2,0	4.4 of IEC 61935-1
			$f = 4$	2,0	
			$f = 10$	2,8	
			$f = 100$	9,1	
			$f = 200$	13,1	
			$f = 600$	23,9	
			$f = 1\,000$	32,0	
4	Minimum coupling attenuation – Connected to cable TV or CATV	dB			to be met by design
			$30 \le f < 300$	85	
			$300 \le f < 470$	80	
			$470 \le f \le 1\,000$	75	
	Connected to individual antenna		$30 \le f \le 470$	75	
			$470 \le f \le 1\,000$	65	
5	Transfer impedance	mΩ		Choose appropriate material to meet local regulations.	

[a] The return loss requirements shall be met at both ends of the cabling. Return loss (*RL*) values at frequencies where the insertion loss (*IL*) is below 3,0 dB are for information only.

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Table 4 – Minimum performance of BCT-C channels

Channel characteristics				Cabling channel performance		Test method
No	**Electrical characteristics**	**Units**	**Frequency** MHz	**Coaxial channel**		
				1 GHz channel	**3 GHz channel**	
1	Nominal impedance	Ω		75		to be met by design
2	Minimum return loss (*RL*) at each cabling interface	dB	$5 \le f < 470$	18		IEC 60966-1
			$470 \le f < 1\,000$	16		
			$1\,000 \le f \le 3\,000$	N/A	10	
3	Maximum insertion loss (*IL*) (attenuation)	dB	$1 \le f \le 3\,000$	$103{,}5 \times \left(0{,}835\sqrt{f} + 0{,}002\,5f\right) / 100 + 2 \times 0{,}02\sqrt{f}$ 2 dB min		ffs
	Informative values		$f = 5$	2,0		
			$f = 10$	2,9		
			$f = 100$	9,3		
			$f = 200$	13,3		
			$f = 600$	23,7		
			$f = 1\,000$	31,2		
			$f = 2\,400$	N/A	50,5	
			$f = 3\,000$	N/A	57,3	
5	Maximum (d.c.) loop resistance	Ω	d.c.	ffs	10	IEC 60966-1
6	Current carrying capacity	mA	d.c.	ffs	500	to be met by design
7	Operating voltage	V	d.c.	ffs	72 [a, b]	
8	Power capacity	W	d.c.	ffs		
9	Maximum propagation delay	ns	$f = 100$	548		to be met by design
10	Minimum screening attenuation – Connected to cable TV or CATV	dB	$30 \le f < 300$	85		to be met by design
			$300 \le f < 470$	80		
			$470 \le f \le 1\,000$	75		
			$1\,000 \le f \le 3\,000$	N/A	55	
	Connected to individual antenna		$30 \le f \le 470$	75		
			$470 \le f \le 1\,000$	65		
			$1\,000 \le f \le 3\,000$	N/A	50	

[a] TV networks presently use 24 V a.c. and 34 V d.c.

[b] In countries that limit applications to a lower voltage, the minimum operating voltage for the cabling may be lowered to the highest voltage allowed.

NOTE 1 Where requirement for transmission of more than 1 GHz are specifically excluded for the lifetime of an installation the column for 1 GHz applies, otherwise the 3 GHz channel specification shall apply.

NOTE 2 The performance of network access cabling channels for BCT are for further study by relevant bodies.

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7.4 CCCB channel performance

Specifications for HES, like ISO/IEC TR 14543, support the connection of a number of addressable devices to a shared channel. Such devices are often powered via the same conductors that are also used for information transfer. Therefore the performance of CCCB channels that may be installed prior to the selection of a specific application is determined by:

- the maximum number of devices supported on a single channel by the majority of HES specifications;
- the maximum feeding distance of the most power-demanding devices;
- the minimum transmission characteristics of the most bandwidth-demanding device.

Based on these considerations cabling channels for information transfer and for power feeding may start at different locations even when they share the same pair. The nature of the CCCB cabling within the coverage area (shown as a cloud in Figure 14 and Figure 15 and in more detail in Figure 10) requires that transmission performance is specified in two ways. The first specifies the individual transmission paths between any two connection points for application specific equipment. The second specifies the characteristics of all the cabling within the coverage area together with its area feeder cabling. The electrical characteristics of the latter may be measured.

CCCB channels shall meet the minimum performance for transmission characteristics and for power feeding specified in Table 5 and Table 6 respectively, over the whole temperature range at which the cabling is intended to work.

The area feeder cables shall meet the mechanical characteristics specified in Table 8. The area feeder cabling shall be capable of class D link performance, as specified in ISO/IEC 11801:2002. Verification of this requirement would require termination with connecting hardware specified for the TO.

The cables installed in the coverage area as part of such channels shall provide the transmission characteristics needed to meet, together with the area feeder cable, the channel performances as specified in Table 5 and Table 6. In addition, they shall meet the mechanical characteristics specified in Table 13.

The minimum transmission performance of cables used to implement channels exploiting the maximum distance specified in Table 1 are specified in 9.4.

Connection points where CCCB applications may be connected shall provide a minimum of one channel for information transfer and for power feeding consisting of, and sharing one balanced pair.

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Table 5 – Minimum performance of CCCB copper channels for information transfer

	Channel characteristics		Channel performance		Test method
	Electrical characteristics	**Units**	**Frequency** kHz		
1a	Minimum mutual capacitance of pair [a]	nF	f = 1	2 ffs	3.2.5 of IEC 61156-1
1b	Maximum mutual capacitance of pair [a]	nF	f = 1	20	3.2.5 of IEC 61156-1
2	Maximum d.c. loop resistance	Ω	d.c.	8	3.2.1 of IEC 61156-1
3	Maximum (d.c.) resistance unbalance	% of loop resistance	d.c.	3	3.2.2 of IEC 61156-1
4	Maximum attenuation	dB	f = 100	4	3.2.2 of IEC 61156-1
5	Capacitance unbalance between pairs [a, b]	pF	f = 1	75	3.2.6 of IEC 61156-1
6	Maximum propagation delay	ns	f = 100	1 000	to be met by design
7	Maximum unbalance attenuation	dB	f = 100	20	to be met by design
8	Capacitance unbalance to earth [a]	pF	f = 1	450	3.2.6 of IEC 61156-1
NOTE As the same pair may be used for power feeding and information transfer the requirements specified in Table 6 shall also be met.					
[a] This characterises the behaviour of the area access cable plus the complete area cabling. [b] Multiple pair requirements are only applicable to cables having more than one pair.					

Table 6 – Minimum performance of CCCB channels for d.c. power feeding

	Channel characteristics			Channel performance with current capacity	Test method
	Electrical characteristics at all operating temperatures	**Units**	**Frequency** kHz		
1	Maximum d.c. loop resistance from distributor housing the power source to any CO	Ω	d.c.	10	5.1 of IEC 60189-1
2	Maximum d.c. resistance unbalance	% of loop resistance	d.c.	1,5	3.2.2 of IEC 61156-1
3	Current carrying capacity	A	d.c.	0,7	to be met by design
4	Operating voltage	V	d.c.	72	
5	Power capacity	W	d.c.	15	
6	Fault current carrying capacity	A	d.c.	1 [a]	
NOTE As the same pair may be used for power feeding and information transfer the requirements specified in Table 5 shall also be met.					
[a] In case the power is fed by parallel conductors or thicker conductors, the fault current carrying capacity may be 3 A.					

The CCCB channel model specified in clause 6 supports the implementation of CCCB and/or of Class D channels with utilisation of appropriate coverage area cabling.

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8 Reference Implementation

8.1 General

This clause describes implementations of a generic cabling infrastructure that utilises components that meet the minimum requirements specified in clauses 9 and 10. These reference implementations meet the requirements of clause 7 when installed in accordance with the applicable installation procedures and in compliance with the maximum channel lengths specified in Table 1.

8.2 Cabling assumptions

8.2.1 Introduction

In the reference implementation of this clause, the components used in each cabling channel shall meet the following requirements:

- a specific balanced copper cabling channel shall use components all of which having the same nominal impedance;
- optical fibre channels for ICT in the primary home subsystem shall be in compliance with ISO/IEC 11801;
- coaxial cabling channels shall use components that meet the requirements as specified in 9.3.2 and 10.2.

The reference implementations will meet the channel performance specified in clause 7 over the maximum distances specified in Table 1 with components meeting the performance requirements at 20 °C. When the channels are intended to operate at a higher temperature, they shall meet the minimum performance at that temperature, either by shortening the channel, taking into account the effect of temperature on the performance of cables, as shown in Table 7, or by using cables that provide the performance needed at the higher temperature.

8.2.2 General

The generic cabling provides the transmission paths from the PHD to TOs, BOs, and COs. With cables and connecting hardware meeting the minimum performance specified in clauses 9 and 10 respectively, it is possible to create channels of lengths up to 100 m for all ICT and coaxial BCT channels. For balanced BCT channels using these components it is also possible to create channels of lengths of up to 50 m. For CCCB the combined length of the area feeder permanent link and the total cable length installed in the coverage area shall not exceed 140 m.

In order to avoid unnecessary amplification and attenuation of BCT applications at the distributors and BOs respectively, two additional BCT channel levels have been specified, as shown in Annex A.

Table 7 gives an overview of the maximum length achievable for the different channels when the components used just meet the minimum performance specified in clauses 9 and 10.

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Table 7 – Link length equations

			Implementation equation for lengths using		
Model	**Figure**	**Maximum length** m	**BCT balanced components**	**BCT coaxial components**	**CCCB components**
CCCB area feeder cabling	Figure 14 Figure 15	90	90	N/A	N/A
CCCB coverage area cabling	Figure 14 Figure 15	50	50	N/A	50
ICT (2 connections)	Figure 13 A	100	H = 135-FX	N/A	N/A
ICT (4 connections)	Figure 13 B	100	H = 133-FX	N/A	N/A
BCT (2 connections)	Figure 13 A	100 coaxial 50 balanced	H = 50-FX	H = 104-FX	N/A

Legend for equations

H the maximum length of the fixed cable (m);

F combined length of patch cords, jumpers and equipment cords;

X the ratio of flexible cable attenuation (dB/m) to fixed cable attenuation (dB/m)
for ICT cable (balanced), 1,5 is used as default value;
for BCT cable (coaxial and balanced), 1,35 is used as default value.

NOTE

For operating temperatures above 20 °C, H should be reduced by:

a) 0,2 % per °C for balanced screened cables,

b) 0,4 % per °C for unscreened balanced cables up to 40 °C,

c) 0,6 % per °C for unscreened balanced cables between 40 °C and 60 °C,

d) 0,2 % for coaxial cables.

These are default values and should be used where the actual characteristic of the cable is not known.

If the cable is specified to meet the attenuation requirements of clause 8 at a “base” temperature above 20 °C then the calculation shall only apply to planned temperatures above the “base” temperature.

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8.2.3 Dimensions for ICT and BCT channels

Figure 13 shows the models used to correlate home cabling dimensions specified in this clause with the ICT and BCT channel specifications in clause 7.

Figure 13 shows the channel configurations from the distributors to the TOs and BOs. The channels shown contain a maximum of four connections.



Figure 13 A – Model with two connections

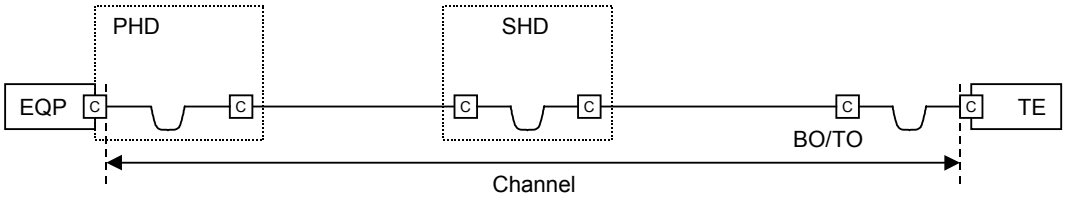


Figure 13 B – Model with four connections

KEY: C = connection

Figure 13 – Reference implementations for ICT and BCT channels (PHD/SHD - TO/BO)

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8.2.4 Dimensions for CCCB channels

There is considerable design freedom for CCCB channels. Figure 14 and Figure 15 show some of the most common designs.

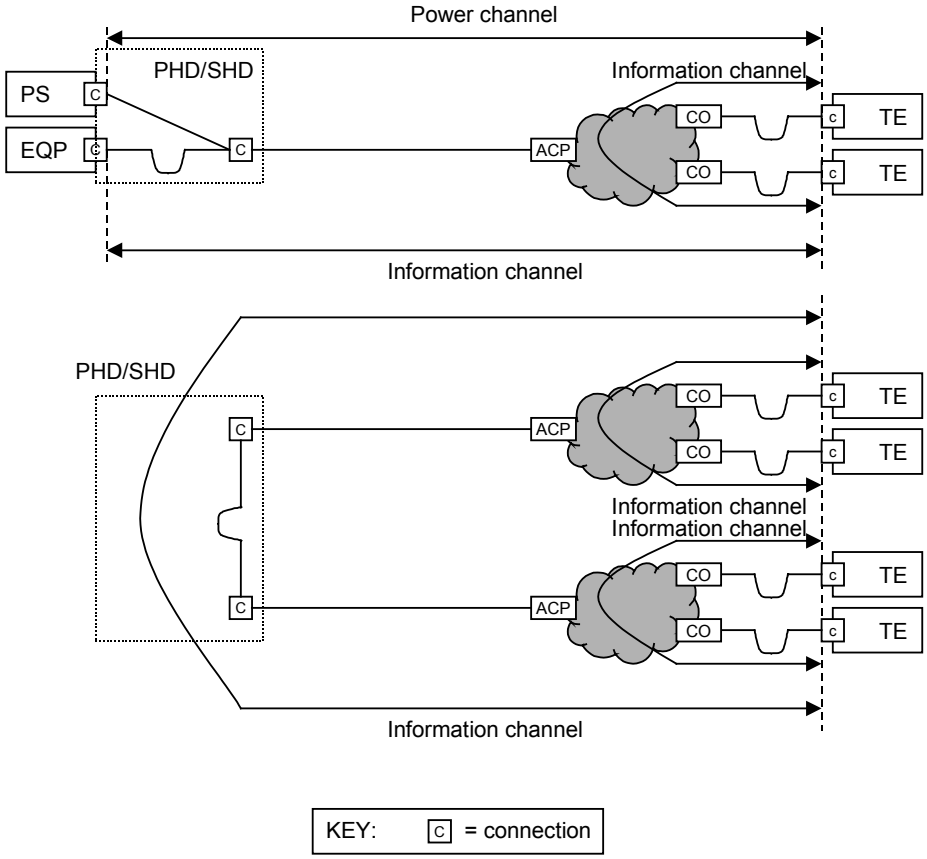


Figure 14 – Reference implementations for CCCB channels with PHD or SHD

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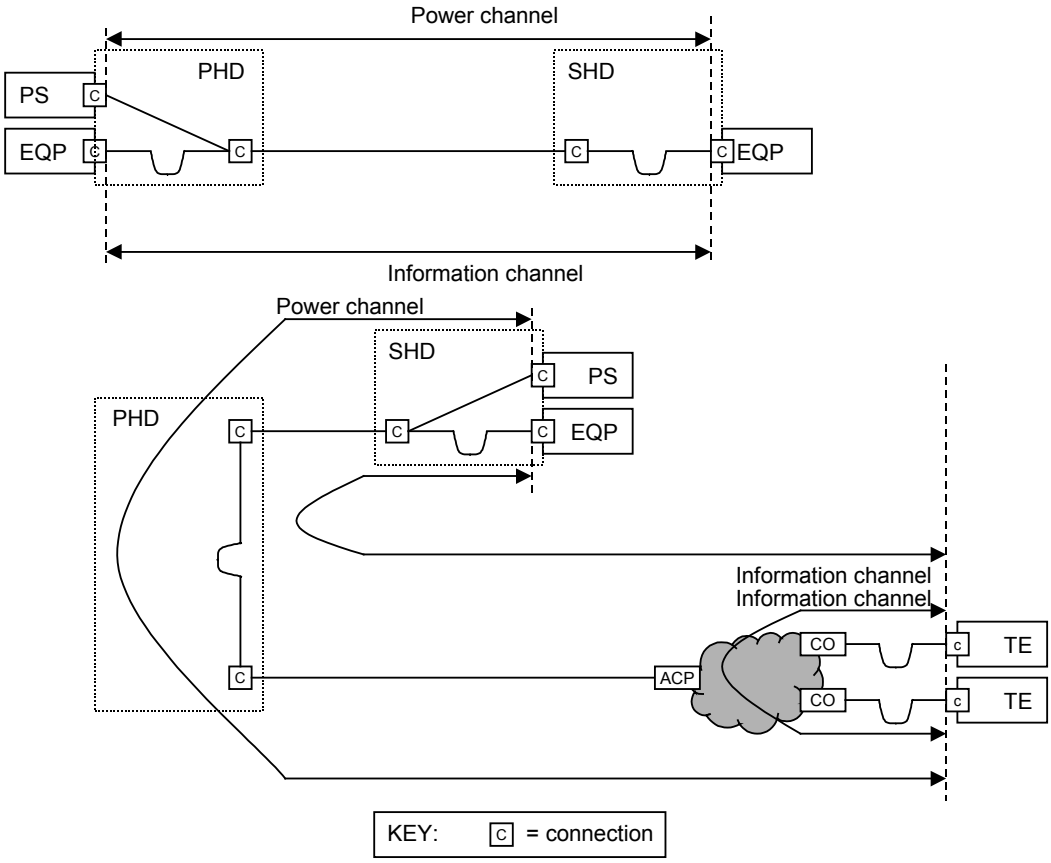


Figure 15 – Reference implementations for CCCB channels with PHD and SHD

9 Cable requirements

9.1 General

This clause specifies the minimum requirements for cables as parts of links and channels of the reference implementation of clause 8.

In addition, it specifies those cable requirements that provide compatibility with connecting hardware of clause 10, where required, as well as other cable requirements important for the implementation of generic cabling systems.

This clause does not provide the full set of cable characteristics, which is provided in cable specifications such as in the IEC 61156 series.

9.2 Cable performance for ICT

The minimum requirements are met with cables as specified in IEC 61156-5 and meeting the Category 5 requirements in ISO/IEC 11801:2002. If a cable is shared by two or more ICT applications additional requirements should be taken into account, which may be fulfilled by Category 6 and Category 7 cables as specified in IEC 61156-5 and IEC 61156-6 respectively, as well as meeting the requirements in ISO/IEC 11801:2002.

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Cables used to implement ICT channels shall meet the minimum requirements for mechanical characteristics specified in Table 8. Cables that meet Category 5 requirements in ISO/IEC 11801:2002 meet Table 8.

Table 8 – Mechanical performance requirements for ICT and balanced BCT cables

	Cable characteristics	Units	Value
1	Diameter of conductor	mm	0,4 to 0,8 [a]
2	Diameter over insulated conductor	mm	≤1,6 [b]
3	Number of conductors in a cable element	per pair / per quad	2 / 4
4	Screen around cable element [c]		Optional
5	Number of cable	pairs	≥4
	Elements in a unit	quads	≥2
6	Screen around cable unit [c]		Optional
7	Screen around cable [c]		Optional
8	Outer diameter of cable [d]	mm	≤90
9	Temperature range [e]	°C	installation: 0 to +50 operation: -20 to +60
10	Minimum bending radius for pulling during installation		8 times outer cable diameter
11	Minimum bending radius installed		4 times outer cable diameter
12	Fire rating		According to 3.5.9 of IEC 61156-1, or in accordance with national or local regulations
13	Colour coding		as required by local regulations or customer, preferred IEC 60708-1
14	Cable marking		as required by customer

[a] Conductor diameters below 0,5 mm and above 0,65 mm may not be compatible with all connecting hardware.

[b] Diameters over the insulated conductor up to 1,7 mm may be used if they meet all other performance requirements. These cables may not be compatible with all connecting hardware.

[c] See 11.4.

[d] Should be minimised to make best use of duct and cross-connect capacity. In case of under carpet cable the value is not applicable.

[e] For certain applications (e.g. precabling buildings in a cold climate) a cable with a lower temperature bending performance of –30 °C may be required.

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9.3 Cable performance for BCT

9.3.1 Requirements for balanced pairs for BCT

Balanced cables used to implement BCT channels exploiting the maximum distances specified in Table 1 shall meet the minimum requirements specified in Table 9 together with the category 7 requirements in 9.2 of ISO/IEC 11801:2002, and together with 3.3.2 (attenuation) for 1 MHz ≤ *f* ≤ 1 000 MHz and a minimum of 4 dB, as well as 3.3.7 (return loss) of IEC 61156-7:2003-05 for 600 MHz < *f* ≤ 1 000 MHz

See IEC 61156-7 for specifications of cables that meet these requirements.

Table 9 – Minimum transmission performance requirements BCT balanced pairs

No	Electrical characteristics		Units	Frequency MHz	Requirement
3	Minimum coupling attenuation		dB		
		Connected to cable TV or CATV		$30 \leq f < 300$	85
				$300 \leq f < 470$	80
				$470 \leq f \leq 1\ 000$	75
		Connected to individual antenna		$30 \leq f < 470$	75
				$470 \leq f \leq 1\ 000$	75

Any cable used to implement BCT channels shall meet the minimum mechanical requirements specified in Table 8.

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9.3.2 Requirements for coaxial cables for BCT

Coaxial cables used to implement BCT channels exploiting the maximum distances specified in Table 1 shall meet the minimum requirements of Table 10. See IEC 61196 series for specifications of cables that meet these requirements.

Table 10 – Minimum electrical performance requirements for BCT coaxial cable

No	Electrical characteristics		Units	Frequency MHz	Requirements
1	Mean characteristic impedance		Ω	100	75 ± 3
2	Minimum return loss (*RL*) on 100 m cable		dB	$5 \leq f < 470$	20
				$470 \leq f < 1\,000$	18
				$1\,000 \leq f \leq 3\,000$	12 ffs
3	Maximum attenuation		dB/100 m	$1 \leq f \leq 3\,000$	$0{,}835 \times \sqrt{f} + 0{,}002\,5\,f$
	Informative values at key frequencies			$f = 5$	4,0
				$f = 10$	4,0
				$f = 100$	8,6
				$f = 200$	12,3
				$f = 600$	22,0
				$f = 1\,000$	28,9
				$f = 2\,400$	46,9
				$f = 3\,000$	53,2
4	Maximum (d.c.) loop resistance		Ω/100 m	d.c.	9
5	d.c. current carrying capacity		A	d.c.	0,5
6	Operating voltage		V	d.c.	72
7	Power capacity		W	d.c.	ffs
8	Velocity ratio		%		>66
9	Minimum screening attenuation		dB		
		Connected to cable TV or CATV		$30 \leq f < 300$	85
				$300 \leq f < 470$	85
				$470 \leq f \leq 1\,000$	85
				$1\,000 < f \leq 3\,000$	ffs
		Connected to individual antenna		$30 \leq f < 470$	75
				$470 \leq f \leq 1\,000$	75
				$1\,000 < f \leq 3\,000$	ffs
10	Maximum transfer impedance		mΩ/m	$f = 5$	7
				$f = 30$	1,2

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Any coaxial cable used to implement BCT channels shall meet the minimum requirements for mechanical characteristics specified in Table 11 for compatibility with connectors specified in clause 10.

Table 11 – Mechanical performance requirements for coaxial BCT cables

	Cable characteristics	Units	Value
1	Diameter of inner conductor [a]	mm	0,6 to 1,2
2	Diameter over dielectric [a]	mm	3 to 6
3	Outer diameter of outer conductor	mm	3,5 to 6,5
4	Number of coaxial cable elements in a cable	pairs	≥1
5	Outer diameter of cable [b]	mm	≤11
6	Temperature range [c]	°C	installation: 0 to +50 operation: -20 to +60
7	Minimum bending radius for pulling during installation		10 times outer cable diameter
8	Minimum bending radius installed		4 times outer cable diameter
9	Cable marking		as required

[a] Conductor diameters below 0,6 mm and above 1,2 mm may not be compatible with all connecting hardware.
The two measured values using the IEC method shall be averaged and then compared to the limit for compliance verification.

[b] Should be minimised to make best use of duct and cross-connect capacity. In case of under carpet cable the value is not applicable.

[c] For certain applications (e.g. precabling buildings in a cold climate) a cable with a lower temperature bending performance of –30 °C may be required.

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9.4 Cable performance for CCCB coverage area

Cables used to implement CCCB coverage area, assuming a maximum length of 50 m of installed cable including all spurs, shall meet the minimum requirements for installed cables specified in Table 12.

Table 12 – Minimum transmission performance requirements for CCCB coverage area cables

	Cable characteristics			Cable performance		Test Method
	Electrical characteristics at all operating temperatures	**Units**	**Frequency** kHz	**Power feeding**	**Information transfer including cable sharing**	
1	Mutual capacitance	nF/km max	$f = 1$	N/A	90	3.2.5 of IEC 61156-1
2	Maximum d.c. loop resistance	Ω/km	d.c.	75	150	3.2.1 of IEC 61156-1
3	Maximum d.c. resistance unbalance	%	d.c.	1,5	1,5	3.2.2 of IEC 61156-1
4	Current carrying capacity per conductor	A	d.c.	0,75	N/A	To be met by design
5	Operating voltage	V	d.c.	72	72	
6	Maximum attenuation	dB/100 m	$f = 100$	N/A	2	3.3.2 of IEC 61156-1
7	Capacitance unbalance between pairs	pF/km	$f = 1$	N/A	500	3.2.6 of IEC 61156-1,
8	Capacitance unbalance to earth	pF/km	$f = 1$	N/A	3 000	3.2.6 of IEC 61156-1
9	Maximum group delay	μs/km	$f = 100$	N/A	5,5	3.3.1 of IEC 61156-1
10	Minimum near end unbalance attenuation	dB	$f = 100$	N/A	40	3.3.3 of IEC 61156-1

NOTE 1 The same pair may be used for power feeding and information transfer.

NOTE 2 Operating temperatures normally are in the range of –20 °C to +60 °C.

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Any cable used to implement CCCB channels shall meet the minimum requirements for mechanical characteristics specified in Table 13.

Table 13 – Mechanical performance requirements for balanced CCCB coverage area cables

	Cable characteristics	Units	Cable performance	Test method
1	Diameter of conductor	mm	0,65 to 1,0 [a]	3.4.1 of IEC 61156-1
2	Diameter over insulated conductor [b]	mm	≤1,6	3.4.1 of IEC 61156-1
3	Number of conductors in a cable element	per pair / per quad	2/4	Visual
4	Screen around cable element [c]		Optional	Visual
5	Number of cable elements in a unit	Pairs	≥1	Visual
		Quads	≥1	Visual
6	Screen around cable unit [c]		Optional	Visual
7	Number of cable units in a cable		≥1	Visual
8	Screen around cable core [c]		Optional	Visual
9	Outer diameter of cable [d, e]	mm	≤20	3.4.1 of IEC 61156-1
10	Temperature range [f]	°C	Installation: 0 to +50 Operation: –20 to +60	To be met by design
11	Minimum bending radius for pulling during installation		8 times outer cable diameter	3.4.8 of IEC 61156-1
12	Minimum bending radius installed		4 times outer cable diameter	To be met by design
13	Fire rating		According to 3.5.9 of IEC 61156-1 unless otherwise, in accordance with national or local regulations	As applicable
14	Colour coding [g]		As required by local regulations or customer, preferably IEC 60708-1	To be met by design
15	Cable marking		As required by local regulations or national specifications	To be met by design

[a] Conductor diameters above 0,8 mm may not be compatible with all connecting hardware.

[b] Diameters of the insulated conductor up to 1,6 mm may be used if they meet all other performance requirements. These cables may not be compatible with all connecting hardware.

[c] If it is intended to use cables with screening, care shall be taken that the connecting hardware is properly designed to terminate the screen.

[d] Should be minimised to make best use of duct and cross-connect capacity.

[e] In case of under carpet cable the value is not applicable.

[f] For certain applications (e.g. precabling buildings in a cold climate) a cable with a lower temperature bending performance of –30 °C may be required.

[g] For cables with fewer cable elements than those specified in IEC 60708, pair colours should be consistent with all pairs or quads specified starting from 1 up to the number of elements in the cable.

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10 Connecting hardware

10.1 General requirements

10.1.1 Applicability

This clause provides guidelines and requirements for connecting hardware used in a generic cabling. For the purpose of this clause, a connector is a component normally attached to a cable or mounted on a piece of apparatus (excluding an adapter) for electrically or optically joining separable parts of a cabling system. Unless otherwise specified, only the performance of connections is specified. For connectors used at TOs, BOs, COs, mating interfaces and minimum performance are specified. For connectors at all other places only the minimum performance is specified.

These requirements apply to individual connectors, which include TOs, BOs, COs, patch panels, splices and cross-connects. All requirements for these components are applicable for the temperature range of –10 ºC to +60 ºC. Performance requirements do not include the effects of cross-connect jumpers or patch cords. Requirements for cords for ICT cabling are provided in clause 13 of ISO/IEC 11801:2002.

In the following tables, requirements are provided for a range of frequencies. Performance values at discrete frequencies are provided for reference only. The requirements listed for ICT are an excerpt from ISO/IEC 11801.

NOTE This clause does not address requirements for devices with passive or active electronic circuitry, including those whose main purpose is to serve a specific application or to provide compliance with other rules and regulations. Examples include media adapters, impedance matching transformers, terminating resistors, LAN equipment, filters and protection apparatus. Such devices are considered to be outside the scope of a generic cabling and may have significant detrimental effects on network performance. Therefore, it is important that their compatibility with the cabling system and equipment be considered before use.

10.1.2 Location

Connecting hardware is installed:

a) in a home distributor (PHD/SHD) providing the cross-connections between cabling subsystems and interconnections to application-specific equipment;

b) at the ACPs;

c) at the TOs, BOs and COs.

10.1.3 Design

In addition to its primary purpose, connecting hardware should be designed to provide:

a) a means to identify cabling for installation and administration, as described in ISO/IEC 14763-1;

b) a means to permit orderly cable management;

c) a means of access to monitor or test cabling and equipment;

d) protection against physical damage and ingress of contaminants;

e) a termination density that is space efficient, but that also provides ease of cable management and ongoing administration of the cabling system;

f) a means to accommodate screening and bonding requirements, when applicable.

Any connections used at distributors shall meet the same performance requirements as those specified in this clause.

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10.1.4 Operating environment

Performance of the connecting hardware shall be maintained over temperatures ranging from –10 °C to +60 °C. Connecting hardware should be protected from physical damage and from direct exposure to moisture and other corrosive effects. This protection may be accomplished by installation in an appropriate enclosure for the environment according to the relevant IEC standard.

10.1.5 Mounting

Connecting hardware should be designed to provide flexibility for mounting, either directly or by means of an adapter plate or enclosure (e.g. on walls, in walls, in racks, or on other types of distribution frames and mounting fixtures).

10.1.6 Installation practices

The manner and care with which the cabling is implemented are significant factors in the performance and ease of administration of installed cabling systems. Installation and cable management precautions should include the elimination of cable stress as caused by tension, sharp bends, and tightly bunched cables.

The connecting hardware shall be installed to permit:

a) minimal signal impairment and maximum screen effectiveness (where screened cabling is used) by proper cable preparation, termination practices (in accordance with manufacturer's guidelines) and well organised cable management;

b) room for mounting equipment associated with the cabling system. Racks should have adequate clearances for access and cable dressing space.

In cabling pathways and in areas occupied by connecting hardware, cable bend radius requirements in clause 9 shall be observed.

The connecting hardware shall be identified according to the requirements of ISO/IEC 14763-1. Planning and installation of connecting hardware for ICT cabling should be carried out in accordance with ISO/IEC TR 14763-2.

NOTE 1 Some connections perform a crossover function between cable elements to meet the transmit/receive circuit demands of the equipment attached to the cabling.

NOTE 2 Besides signal degradation, improper termination practices of balanced cable elements, screens or both may also create loop antenna effects resulting in levels of signal emissions that may exceed regulatory requirements.

10.1.7 Marking and colour coding

In order to maintain consistent and correct point-to-point connections, provision shall be made to ensure that terminations are properly located with respect to connector positions and their corresponding cable elements. Such provisions may include the use of colours, alphanumeric identifiers or other means designed to ensure that cables are connected in a consistent manner throughout the system.

When two physically similar cable types are used in the same subsystem, they shall be marked in such a way as to allow each cable type to be clearly identified. For example, different performance categories, different nominal impedance and different optical fibre core diameters should carry unique markings or colours to facilitate visual identification.

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10.2 Mating interfaces at TO, BO and CO

10.2.1 General

Mating interfaces used for ICT channels shall comply with ISO/IEC 11801:2002.

Any connecting hardware used shall ensure that the channel requirements specified in clause 7 are met.

When connectors are used at TOs, BOs, and COs the mating interfaces shall meet the following specifications.

10.2.2 Mating interface for TO

TOs for ICT: ICT connector: IEC 60603-7 series (including IEC 60603-7-1 for screened/unscreened connectors, IEC 60603-7-2 for unscreened connectors, IEC 60603-7-3 for screened connectors, IEC 60603-7-4, IEC 60603-7-5 and IEC 60603-7-7 for screened connectors.)

NOTE Some local codes or regulation may require a specific connector for a telephone outlet, especially for homes.

Pin and Pair Assignments for the IEC 60603-7 series connectors for ICT applications are specified in Figure 16.

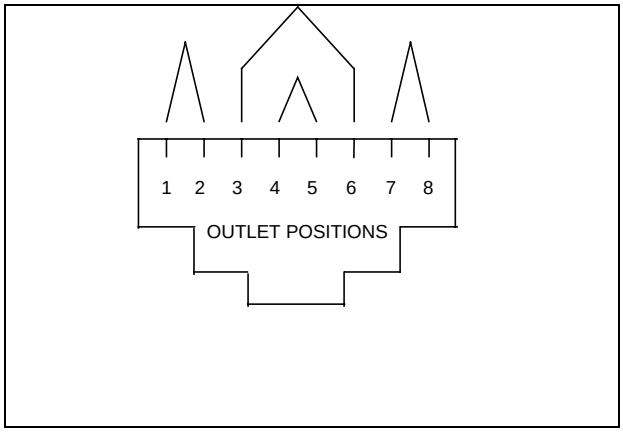


Figure 16 – Pin grouping assignments for IEC 60603-7 series outlet (front view)

10.2.3 Mating interface for BO

The interface at the BO shall be one of the following,

- IEC 61076-3-104: Balanced rectangular connector for Balanced channels.
- IEC 61169-2: Coaxial connector of Type 9,52 for coaxial channels.
- IEC 61169-24: Coaxial connector (Type F) for coaxial channels.

NOTE National or local regulations may require another mating interface for BCT applications and may take precedence over the specifications in this standard.

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Pin and pair assignments for IEC 61076-3-104 and IEC 60603-7-7 style connectors for ICT and BCT applications using a balanced BO are specified in Figure 17 and Figure 18.

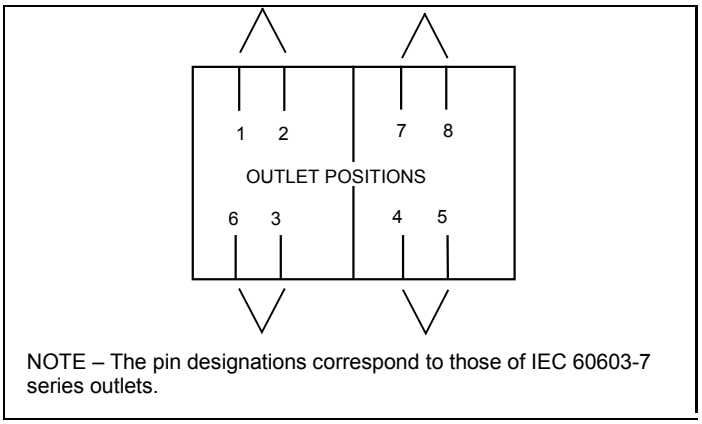


Figure 17 – Pin grouping assignments for 61076-3-104 outlet (front view)

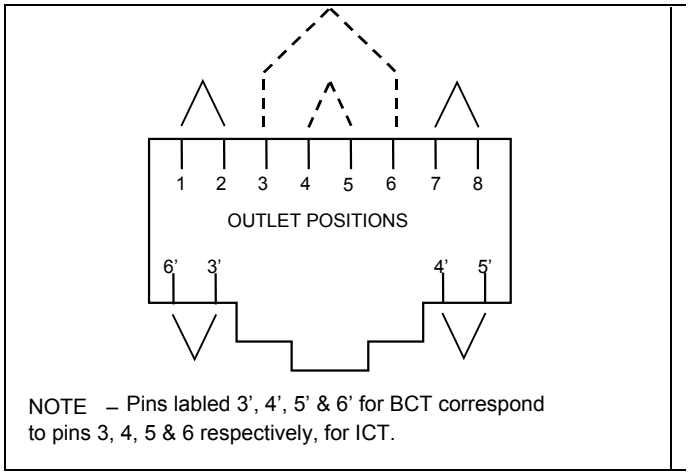


Figure 18 – Pin grouping assignments for IEC 60603-7-7 outlet (front view)

Figure 19 shows the conductor assignment for mating interfaces of coaxial BOs.

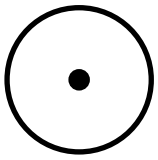


Figure 19 – Conductor assignment of IEC 61169-2 and IEC 61169-24 (Type F) connector

10.2.4 Mating interface for CO

COs for CCCB: CCCB connector interface is not specified in this standard.

10.2.5 Minimum performance requirements

10.2.5.1 General

Connecting hardware for use in distributors, TOs, BOs and COs shall meet the corresponding performance requirements specified in the following tables.

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For connecting devices that provide cross-connections without patch cords or jumpers, electrical performance shall not be worse than the equivalent of two connectors and 5 m of patch cord of the same application group. Applicable parameters include insertion loss, input to output resistance, input to output resistance unbalance, propagation delay, delay skew and transfer impedance. In addition, crosstalk loss, return loss and unbalance insertion loss of such devices are permitted to be worse than the minimum values specified in the following tables but not more than 6 dB.

10.2.5.2 Mechanical characteristics

Connecting hardware intended for use with balanced cabling shall meet the requirements specified in Table 14.

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Table 14 – Mechanical characteristics of connecting hardware for use with balanced cabling

Mechanical characteristics			Requirement	Component or test standard
a)	Physical dimensions **(only at TO, BO or CO)**	ICT	Mating dimensions and gauging IEC 60603-7-2, IEC 60603-7-3 [a]	IEC 60603-7-2, IEC 60603-7-3 [a]
		BCT-B	Mating dimensions and gauging IEC 61076-3-104 [b]	IEC 61076-3-104 [b]
		BCT-C	Mating dimensions and gauging IEC 61169-24, IEC 61169-2	IEC 61169-24, IEC 61169-2
		CCCB	Mating dimensions and gauging ffs	ffs
b)	Termination compatibility for balanced cables			
	Nominal conductor diameter - mm	ICT and BCT	0,5 to 0,65 [c]	-
		CCCB	0,65 to 1,0	
	Cable type	Patching [d]	Stranded conductors	-
		Jumpers	Stranded or solid conductors	-
		Other	Solid conductors	-
	Nominal diameter of insulated conductor mm	ICT and BCT	0,7 to 1,4 [e, f]	-
		CCCB	0,7 to 1,6	
	Number of conductors	TO	8	Visual inspection
		Other	≥2*n (n = 1,2,3, ...)	
	Cable outer diameter mm	Outlet	≤20	-
		Plug	≤9 [g]	
	Means to connect screen [h]		-	Annex B and 11.4
c)	Mechanical operation (durability)			
	Cable termination (cycles)	Non-reusable IDC	1	IEC 60352-4
		Reusable IDC	≥20	IEC 60352-3
		Non-reusable IPC (plug)	≥1	IEC 60352-6
	Jumper termination (cycles)		≥200 [i]	IEC 60352-3
	Two pieces interface (cycles) (e.g. modular plug and socket)		≥750	IEC 60603-7, IEC 61076-3-104, level P1

[a] For higher frequency performance the applicable IEC 60603-7 detail specification applies.

[b] In installations where other factors, such as interoperability with 60603-7 series take preference over the connector sharing offered in IEC 61076-3-104, also the interface specified in IEC 60603-7-7 may be used.

[c] It is not required that connecting hardware be compatible with cables outside of this range. However, when cables with conductor diameters as low as 0,4 mm or as high as 0,8 mm are used, special care shall be taken to ensure compatibility with connecting hardware to which they connect.

[d] Connectors used in work area cords and equipment cords shall also be compatible with stranded conductors.

[e] Use of connectors having an interface as specified in IEC 60603-7 are often limited to cables having insulated conductor diameters in the range of 0,8 mm to 1,0 mm.

[f] It is not required that connecting hardware be compatible with cables outside of this range. However, when cables with insulated conductor diameters as high as 1,6 mm are used, special care shall be taken to ensure compatibility with connecting hardware to which they connect.

[g] Applicable only to individual units.

[h] If it is intended to use screened cabling, care should be taken that the connector is designed to terminate the screen. Note that there may be a difference between connectors designed to terminate balanced cables with overall screens only, as opposed to cables having both individually screened elements and an overall screen.

[i] This durability requirement is only applicable to connections designed to administer cabling system changes (i.e., at a distributor).

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10.2.5.3 Electrical characteristics

Connecting hardware intended for use with balanced cabling shall meet the following performance requirements. Connecting hardware shall be tested with terminations and test leads that match the nominal characteristic impedance of the type of cables (i.e. 100 Ω or 120 Ω) they are intended to support.

Connectors used for ICT applications shall at minimum comply with category 5 requirements defined in ISO/IEC 11801:2002. Connectors used for BCT applications shall comply with the requirements listed in Table 15, Table 16 and Table 22 together with the category 7 requirements defined in ISO/IEC 11801:2002. Connectors used for CCCB applications shall comply with the requirements listed in Table 15 to Table 24.

Table 15 – Return loss (*RL*)

Electrical characteristics	Frequency MHz	Requirement			Test standard
		BCT B	BCT C	CCCB	
Minimum return loss (*RL*) dB	$f = 0{,}1$	N/A	N/A	30,0	IEC 60512-25-5 (balanced, draft)
	$1 \leq f \leq 100$	-	-	N/A	IEC 61169-2
	$1 \leq f \leq 1\,000$	68 – 20lg(*f*)	23,0	N/A	IEC 61169-24
	$1000 \leq f \leq 2\,000$	N/A	23,0	N/A	
	$2\,000 \leq f \leq 3\,000$	N/A	23 – 73lg(*f*/2000)	N/A	
Minimum return loss (*RL*) values at selected frequencies (reference only) [a] dB	$f = 0{,}1$	30,0	N/A	30,0	
	$f = 1$	30,0	23,0	N/A	
	$f = 100$	28,0	23,0	N/A	
	$f = 1\,000$	10,0	23,0	N/A	
	$f = 3\,000$	N/A	10,0	N/A	

[a] Return loss (*RL*) at frequencies that correspond to calculated values of greater than 30,0 dB shall revert to a minimum requirement of 30,0 dB.

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Table 16 – Insertion loss

Electrical characteristics	Frequency MHz	Requirement			Test standard
		BCT B	BCT C	CCCB	
Maximum insertion loss (*IL*) [a] dB	$f = 0{,}1$	0,10	N/A	0,10	IEC 60512-25-2 IEC 61169-1 (coaxial)
	$1 \leq f \leq 100$	N/A	0,1	N/A	
	$1 \leq f \leq 1\,000$	$0{,}02\sqrt{f}$	0,1	N/A	
	$1 \leq f \leq 3\,000$	N/A	$0{,}02\sqrt{f}$	N/A	
Maximum insertion loss (*IL*) values at selected frequencies (informative) dB	$f = 0{,}1$	0,10	0,10	0,10	
	$f = 1$	0,10	0,10	N/A	
	$f = 100$	0,20	0,20	N/A	
	$f = 600$	0,49	0,49	N/A	
	$f = 1\,000$	0,63	0,63	N/A	
	$f = 2\,400$	N/A	0,98	N/A	
	$f = 3\,000$	N/A	1,10	N/A	

[a] Insertion loss at frequencies that correspond to calculated values of less than 0,1 dB shall revert to a requirement of 0,1 dB maximum.

Table 17 – Near end crosstalk (*NEXT*)

Electrical characteristics	Frequency MHz	Requirement	Test standard
		CCCB	
Minimum *NEXT* dB	$f = 0{,}1$	80,0	IEC 60512-25-1 (balanced)
Minimum *NEXT* values at selected frequencies (informative) dB	$f = 0{,}1$	80,0	

Table 18 – Far end crosstalk (*FEXT*)

Electrical characteristics	Frequency MHz	Requirement	Test standard
		CCCB	
Minimum *FEXT* dB	$f = 0{,}1$	65,0	IEC 60512-25-1
Minimum *FEXT* loss values at selected frequencies (informative) dB	$f = 0{,}1$	65,0	

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Table 19 – Input to output resistance

Electrical characteristics	Frequency MHz	Requirements	Test standard
		CCCB	
Maximum input to output resistance [a] mΩ	d.c.	100	IEC 60512-2 Test 2a
[a] Input to output resistance is a separate measurement from the contact resistance measurements required in IEC 60603-7. Input to output resistance is measured to determine the connector's ability to transmit direct current and low frequency signals. Contact resistance measurements are used to determine the reliability and stability of individual electrical connections. These requirements are applicable to each conductor and to the screen, when present.			

Table 20 – Current carrying capacity

Electrical characteristics	Frequency MHz	Requirement	Test standard
		CCCB	
Minimum current carrying capacity [a, b, c] A	d.c.	0,7	IEC 60512-3 Test 5b (balanced); IEC 61169-1 (coaxial)
[a] Applicable for an ambient temperature of 60 °C. [b] Applicable to each conductor. [c] Sample preparation shall be as specified in the applicable document.			

Table 21 – Propagation delay

Electrical characteristics	Frequency MHz	Requirement	Test standard
		CCCB	
Maximum propagation delay ns	$f = 0{,}1$	1,0	IEC 60512-25-4

Table 22 – Coupling and screening attenuation

Electrical characteristics		Frequency MHz	Requirement			Test standard
			BCT-B	BCT-C	CCCB	
Minimum coupling attenuation / Screening effectiveness		$f = 0{,}1$	N/A	N/A	ffs	EN 50289-1-14
dB	Individual antenna	$30 \leq f < 470$	75	75	N/A	
		$470 \leq f \leq 1\,000$	65	65	N/A	
	Connected to cable TV or CATV	$30 \leq f < 300$	85	85	N/A	
		$300 \leq f < 470$	80	80	N/A	
		$470 \leq f \leq 1\,000$	75	75	N/A	
		$1000 \leq f \leq 3\,000$	N/A	55	N/A	

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Table 23 – Insulation resistance

Electrical characteristics	Frequency MHz	Requirement	Test standard
		CCCB	
Minimum insulation resistance MΩ	d.c.	100	IEC 60512-2 Test 3a, Method C – 500 V d.c.

Table 24 – Voltage proof

Electrical characteristics		Frequency MHz	Requirement	Test standard
			CCCB	
Minimum voltage proof		d.c.		IEC 60512-2 Test 4a
V	Conductor to conductor		1 000	
	Conductor to test panel		1 500	

11 Safety requirements and screening practices

11.1 General

In order to achieve most reliable safety and EM performances the international standards referenced in this clause shall be considered. However, applicable national and local regulations shall take precedence.

11.2 Coexistence with mains

Where CCCB, ICT or BCT cable share the same pathways as mains power cables:

- special measures regarding dielectric strength between cables and cable elements have to be taken into account;
- a barrier, a partition or physical separation in accordance with applicable rules and regulations and performance requirements may be required.

11.3 Operational safety

The cabling system specified in this standard and the equipment connected to it, shall ensure safe operation and protection against electric shock during normal operation as well as under specified fault conditions such as short circuits in the cabling or the attached equipment.

Care shall be taken that no part of the cabling system comes into contact with higher voltages than SELV during or after the installation. This implies that the cabling system complies with the following electrical safety requirements.

To achieve the required protection against electric shock, SELV or PELV as defined in IEC 60364-4-41 shall be used as the protective measure for the HES cabling.

NOTE 1 Some countries do not accept the use of PELV according to IEC 60364-4-41.

If for functional reasons a connection between SELV circuits and earth is required, this connection shall comply with the requirements for protective impedance as described in IEC 61140.

NOTE 2 Some countries do not accept connections via protective impedance.

Where a lightning protection is required, IEC 61024 applies.

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If a lightning protection system exists, the cabling system shall be integrated into this protection system.

11.4 Screening practices

11.4.1 General

This clause applies when screened cables or cables with screened elements or units are used. Only basic guidance is provided. The procedures necessary to provide adequate earthing for both electrical safety and electromagnetic performance are subject to national and local regulations, are dependent on proper workmanship, and are at times only accomplished with installation-specific engineering. Note that a proper handling of screens in accordance with suppliers' instructions will increase performance and safety.

11.4.2 Earthing

IEC TR 61000-5-2 should be considered. All screens of the cables shall be terminated at each distributor. Normally, the screens are connected to the equipment racks, which are, in turn, bonded to building earth.

NOTE 1 High working frequencies are best served with a meshed system.

The bond shall be designed to ensure that

a) the path to earth shall be permanent and of low impedance. It is recommended that each equipment rack is individually bonded, in order to assure the continuity of the earth path.

b) the cable screens provide a continuous earth path to all parts of a cabling system that are interconnected by it.

c) this bonding directs currents induced within the generic cabling to earth for the purpose of reducing interference from power lines and other sources of disturbances. All earthing electrodes of different systems in the building shall be bonded together in accordance with local regulations to reduce effects of differences in earth potential.

NOTE 2 ITU-T K.31 should be taken into account.

The building’s earthing system should not exceed the earth potential difference limits of 1 V r.m.s. between any two earths on the network.

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Annex A
(normative)

BCT channel levels

Cabling channels for BCT may be provided via balanced or coaxial cables.

Homes of different sizes may be subject to different signal levels delivered to the PHD. This signal level may depend upon the distance to an antenna or an ENI of a cable TV system. To support this variation in home sizes economically, two additional BCT channels with lower insertion loss are specified as shown in Table A.1.

Table A.1 – BCT channels division

Name	Units	BCT-H	BCT-M	BCT-L
Input signal level		high	medium	low
Insertion loss level		high	medium	low
Insertion loss value at 1 GHz	dB	32	16,5	9
Max. reference length with coaxial cable	m	100	50	25
Max. reference length with balanced cable	m	50	25	12,5

This takes into account that a number of BCT applications supported by the generic cabling specified in this standard use analogue technology, where signals are amplified rather than regenerated and therefore can handle less of a difference in channel insertion loss than digital transmission.

See Annex C for details about these channels.

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Annex B
(normative)

Link performance

B.1 General

This Annex contains performance requirements for installed cabling between test interfaces for permanent links which do not constitute the entire channel.

This Annex specifies the minimum performance requirements for three permanent links: ICT, BCT and CCCB (only the part served by the area feeder cable). For channel models, see clause 5.

The possible test interfaces are specified in Figure 5 and Figure 11.

NOTE For the division of BCT links in BCT-H, BCT-M and BCT-L, see Annex C.

B.2 Performance requirements for ICT permanent links

Permanent links for ICT shall meet the transmission performances specified in ISO/IEC 11801:2002 for Class D permanent links over the whole temperature range over which the cabling is intended to work. Where multiple Class D applications are to be supported over a common cabling link (i.e. using the same cables and connecting hardware), the link shall meet the Class E link requirements as specified in ISO/IEC 11801:2002. For cable sharing, see also 9.3 of ISO/IEC 11801:2002.

The cables installed as part of such links shall provide the transmission characteristics needed to meet this performance requirement. In addition, they shall meet the mechanical characteristics specified in Table 8.

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B.3 Performance requirements for BCT permanent links

Permanent links for BCT may be provided via balanced or coaxial cables.

BCT-B permanent links shall meet the minimum transmission performances as specified in Table B.1 together with those specified for Class F links in ISO/IEC 11801:2002 over the whole temperature range in which the cabling is intended to work.

BCT-C permanent links shall meet the minimum transmission performances as specified in Table B.2 over the whole temperature range in which the cabling is intended to work.

In addition, balanced cables used to implement BCT permanent links shall meet the mechanical requirements as specified in Table 8, coaxial cables shall meet the mechanical requirements as specified in Table 11.

Table B.1 – Minimum performance of BCT-B permanent links

Permanent link characteristics				Permanent link performance	Test method
No	**Electrical characteristics**	**Units**	**Frequency** MHz		
1	Nominal impedance	Ω		100 [a]	to be met by design
2	Minimum return loss (*RL*) at each cabling Interface [b]	dB	$4 \le f < 40$	$24 - 5\lg(f)$, 19 dB min	4.9 of IEC 61935-1
			$40 \le f \le 1\,000$	$32 - 10\lg(f)$, 8 dB min	
3	Maximum insertion loss (*IL*) (attenuation)	dB	$1 \le f \le 1\,000$	$44{,}1 \times \left(1{,}645\sqrt{f} + 0{,}01 \times f + 0{,}25 \Big/ \sqrt{f}\right) / 100 + 2 \times 0{,}02 \times \sqrt{f}$ 2 dB min	4.4 of IEC 61935-1
	Informative values		$f = 1$	2,0	
			$f = 4$	2,0	
			$f = 10$	2,5	
			$f = 100$	8,1	
			$f = 200$	11,7	
			$f = 600$	21,4	
			$f = 1\,000$	28,6	
4	Minimum coupling - attenuation - Connected to cable TV or CATV	dB	$30 \le f < 300$	85	to be met by design
			$300 \le f < 470$	80	
			$470 \le f \le 1\,000$	75	
	Individual antenna		$30 \le f < 470$	75	
			$470 \le f \le 1\,000$	65	

[a] This value is achieved by suitable design, and appropriate choice of cabling components (irrespective of their nominal impedance), see ISO/IEC 11801.

[b] The return loss requirements shall be met at both ends of the cabling. Return loss (*RL*) values at frequencies where the insertion loss (*IL*) is below 3,0 dB are for information only.

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Table B.2 – Minimum performance of BCT-C permanent links

Permanent link characteristics				Permanent link performance		Test Method
No	**Electrical Characteristics**	**Units**	**Frequency** MHz	**Coaxial link**		
				1 GHz link	**3 GHz link**	
1	Nominal impedance	Ω		75		to be met by design
2	Minimum return loss (*RL*) at each cabling interface	dB	$5 \le f < 470$	18		
			$470 \le f < 1\,000$	16		
			$1\,000 \le f \le 3\,000$	N/A	10	
3	Maximum insertion loss (*IL*) (attenuation) [a]	dB	$1 \le f \le 3\,000$	$90 \times \left(0{,}835\sqrt{f} + 0{,}002\,5f\right) / 100 + 2 \times 0{,}02\sqrt{f}$ 2 dB min.		
	Informative values		$f = 5$	2,0		
			$f = 10$	2,5		
			$f = 100$	8,1		
			$f = 200$	11,6		
			$f = 600$	20,7		
			$f = 1\,000$	27,3		
			$f = 2\,400$	N/A	44,2	
			$f = 3\,000$	N/A	50,1	
4	Minimum *NEXT* coaxial to coaxial	dB	$f = 100$	100		to be met by design
5	Maximum (d.c.) loop resistance	Ω	d.c.	9		5.1 of IEC 60189-1
6	(d.c.) current carrying capacity	mA	d.c.	500		to be met by design
7	Operating voltage	V	d.c.	72		
8	Power capacity	W	d.c.	ffs		
9	Maximum propagation delay	ns	$f = 100$	490		to be met by design
10	Minimum screening attenuation – Connected to cable TV or CATV	dB	$30 \le f < 300$	85		to be met by design
			$300 \le f < 450$	80		
			$450 \le f \le 1\,000$	75		
			$1\,000 \le f \le 3\,000$	N/A	55	
	Individual antenna		$30 \le f < 470$	75		
			$470 \le f \le 1\,000$	65		
			$1\,000 \le f \le 3\,000$	N/A	50	

NOTE Where requirement for transmission of more than 1 GHz are specifically excluded for the lifetime of an installation the column for 1 GHz applies.

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B.4 Performance requirements for CCCB permanent links

The permanent link construed by the area feeder cable shall meet the minimum performance specified for Class D links in ISO/IEC 11801:2002. The permanent link construed by area feeder cable and coverage area cabling used for CCCB information transfer shall meet the performance requirements for transmission characteristics specified in Table 5 over the whole temperature range the cabling is intended to work. The permanent links used for power feeding shall meet the minimum performance specified Table 6 over the whole temperature range the cabling is intended to work.

The cables installed as part of permanent links shall provide the transmission characteristics needed to meet these performance requirements. In addition they shall meet the mechanical characteristics specified in Table 8 for the area feeder cable and in Table 13 for the coverage area cable.

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Annex C
(informative)

BCT levels: channel and link performance and implementation

C.1 General

All three BCT channel levels support the same applications. They provide the means to exploit the actual distances in a specific installation in order to minimise the need for amplification and attenuation of the signal at distributors and BOs.

In cases were the BCT channels in a specific premise belong to different performance levels, the level of performance should be identified for each channel installed. Channels that have a higher attenuation than the maximum attenuation specified for BCT-M should be marked as BCT-H, channels that have a higher attenuation than the maximum attenuation specified for BCT-L but a lower than the maximum attenuation for BCT-M should be marked as BCT-M, and channels below the maximum attenuation for BCT-L should be marked as BCT-L.

C.2 BCT-H, BCT-M and BCT-L channels

Cabling channels for BCT-H, BCT-M and BCT-L implemented on balanced cable should meet the minimum transmission performance for Class F channels as specified in ISO/IEC 11801:2002 together with the return loss (*RL*), coupling attenuation and transfer impedance specified in Table 3, in addition they should meet the insertion loss (*IL*) specified in Table C.1 over the whole temperature range the cabling is intended to operate at. The cables used should also meet the mechanical requirements specified in Table 8.

NOTE The performance of network access cabling channels for BCT are for further study by relevant bodies.

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Table C.1 – Minimum insertion loss of BCT_B channels for BCT-H, BCT-M and BCT-L

Channel Characteristics			Cabling Channel performance			Test Method
Electrical Characteristics	**Units**	**Frequency** MHz	**Balanced channel**			
Nominal impedance	Ω		100			to be met by design
			BCT-H	**BCT-M**	**BCT-L**	
Maximum insertion loss (*IL*)	dB	$1 \le f \le 1\,000$	$\left(LPL + x \times LEC\right) \times \left(1{,}645\sqrt{f} + 0{,}01 \times f + 0{,}25/\sqrt{f}\right) / 100 + 2 \times 0{,}02\sqrt{f}$ 2 dB min [a]			
Informative values for length factor in m [b]			49,5	24,5	12,5	4.4 of IEC 61935-1
	dB	$f = 1$	*2*	2	2	
		$f = 4$	*2*	2	2	
		$f = 10$	*2,8*	2	2	
		$f = 100$	*9,1*	4,7	2	
		$f = 200$	*13,1*	6,8	3,7	
		$f = 600$	*23,9*	12,3	6,8	
		$f = 1\,000$	*32,0*	16,5	9,0	
NOTE *For ease of use the BCT values from* Table 3 *are copied in italics as BCT-H.*						

[a] L_{PL} = permanent link length, and L_{EC} = total equipment cord length x is the insertion loss (*IL*) premium for the cords.

[b] length factor = L_{PL} +1,35 x L_{EC}

Cabling channels for BCT implemented on coaxial cable should meet the minimum transmission performances specified in Table 4, in addition they should meet the insertion loss (*IL*) specified in Table C.2 over the whole temperature range the cabling is intended to operate at. The cables used shall also meet the mechanical requirements specified in Table 11.

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Table C.2 – Minimum insertion loss of BCT-C channels for BCT-H, BCT-M and BCT-L

Channel Characteristics			Cabling Channel performance			Test Method
Electrical Characteristics	**Units**	**Frequency** MHz	**Coaxial channel**			
Nominal impedance	Ω		75			to be met by design
			BCT-H	**BCT-M**	**BCT-L**	
Maximum insertion loss (*IL*) (attenuation)	dB	$1 \le f \le 1\,000$ $1\,000 = f \le 3\,000$ [a]	$\left(LPL + x \times LEC\right) \times \left(0{,}835\sqrt{f} + 0{,}002\,5f\right) / 100 + 2 \times 0{,}02\sqrt{f}$ 2 dB min [b]			ffs
Informative values for a length factor in m [c]			103,5	51,4	26,4	
	dB	$f = 5$	*2*	2	2	
		$f = 10$	*2,9*	2	2	
		$f = 100$	*9,3*	4,8	2,7	
		$f = 200$	*13,3*	6,9	3,8	
		$f = 600$	*23,7*	12,3	6,8	
		$f = 1\,000$	*31,2*	16,1	8,9	
		$f = 2\,400$	*50,5* [a]	26,1 [a]	14,3 [a]	
		$f = 3\,000$	*57,3* [a]	29,6 [a]	16,2 [a]	

NOTE *For ease of use the BCT values from* Table 4 *are copied in italics as BCT-H.*

[a] Not applicable when the requirement for transmission of more than 1 GHz is specifically excluded for the lifetime of an installation.

[b] L_{PL} = permanent link length, and L_{EC} = total equipment cord length x is the insertion loss (*IL*) premium for the cords.

[c] length factor = L_{PL} +1,35 x L_{EC}

C.3 BCT-H, BCT-M and BCT-L links

Permanent links for BCT implemented on balanced cable should meet the minimum transmission performances for links as specified in Table B.1 together with those specified for class F links in ISO/IEC 11801:2002 over the whole temperature range the cabling is intended to work, together with the insertion loss specified in Table C. 3. In addition the cables used should meet the mechanical requirements as specified in Table 8.

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Table C. 3 – Insertion loss for BCT-B permanent links

Permanent link characteristics			Permanent link performance			Test Method
Electrical Characteristics	**Units**	**Frequency** MHz	**balanced BCT-H**	**balanced BCT-M**	**balanced BCT-L**	
Maximum insertion loss (*IL*) (attenuation)	dB	$1 \leq f \leq 1\,000$	$LPL \times \left(1{,}645\sqrt{f} + 0{,}01 \times f + 0{,}25/\sqrt{f}\right) / 100 + 2 \times 0{,}02 \times \sqrt{f}$ 2 dB min			
Informative values for L_{PL} in m			44,1	19,1	7,1	
	dB	$f = 1$	2,0	2,0	2,0	4.4 of IEC 61935-1
		$f = 4$	2,0	2,0	2,0	
		$f = 10$	2,5	2,0	2,0	
		$f = 100$	8,1	3,7	2,0	
		$f = 200$	11,7	5,4	2,4	
		$f = 600$	21,4	9,8	4,3	
		$f = 1\,000$	28,6	13,1	5,7	
NOTE This value is achieved by suitable design, and appropriate choice of cabling components (irrespective of their nominal impedance), see ISO/IEC 11801.						

Permanent links for BCT implemented on coaxial cable should meet the minimum transmission performances for channels as specified in Table B.2 over the whole temperature range the cabling is intended to work, together with the insertion loss specified in Table C. 4. In addition the cables used should meet the mechanical requirements as specified in Table 11.

Table C. 4 – Insertion loss for BCT-C permanent links

Permanent link characteristics			Permanent link performance			Test Method
Electrical Characteristics	**Units**	**Frequency** MHz	**Coax link BCT-L**	**Coax link BCT-M**	**Coax link BCT-H**	
Maximum insertion loss (*IL*) (attenuation)	dB	$1 \leq f \leq 1\,000$ $1\,000 = f \leq 3\,000$ [a]	$LPL \times \left(0{,}835\sqrt{f} + 0{,}002\,5f\right) / 100 + 2 \times 0{,}02\sqrt{f}$ 2 dB min.			
Informative values for L_{PL} in m			90	46	21	
	dB	$f = 5$	2,0	2,0	2,0	
		$f = 10$	2,5	2,0	2,0	
		$f = 100$	8,1	4,4	2,2	
		$f = 200$	11,6	6,2	3,2	
		$f = 600$	20,7	11,1	5,6	
		$f = 1\,000$	27,3	14,6	7,3	
		$f = 2\,400$ [a]	44,2	23,5	11,8	
		$f = 3\,000$ [a]	50,1	26,7	13,4	
[a] not applicable when the link is not intended to support 3 GHz channels.						

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C.4 BCT levels' implementation

C.4.1 General

This subclause provides details of the methodology used to develop the requirements for the BCT insertion loss levels introduced in Annex A and their interrelation with the cabling components of clauses 9 and 10 that produces the maximum reference implementation channel lengths of clause 8.

C.4.2 Cable specifications

Two coaxial cable specifications have been developed by IEC (and CENELEC). These have equation based attenuation requirements as follows (in dB/100m) (*f* in MHz):

- $ATTENUATION_{\text{cable A}} = 0{,}6 \times \sqrt{f} + 0{,}002\,5 \times f$ (E.1)
- $ATTENUATION_{\text{cable B}} = 0{,}835 \times \sqrt{f} + 0{,}002\,5 \times f$ (E.2)

A balanced cable with performance characteristics at frequencies up to and above 1 GHz is specified in IEC 61156-7. This cable has a formula based attenuation as follows (in dB/100m):

$$1{,}645 \times \sqrt{f} + 0{,}01 \times f + \frac{0{,}25}{\sqrt{f}} \quad \text{(E.3)}$$

This cable meets the requirements as specified for BCT B cables in 9.3.1.

C.4.3 Connecting hardware specifications

In this international standard both the balanced and coaxial connecting hardware have an attenuation of 0,02*$\sqrt{f}$ (in dB).

For this reason the insertion loss levels are characterised in terms of their channel attenuation requirements. Requirements for channel attenuation at 1 GHz of 32, dB, 16,5 dB and 9 dB were allocated to BCT-H, BCT-M and BCT-L respectively.

C.4.4 Maximum channel lengths for reference implementations

The maximum channel lengths in the reference implementations are based upon a channel attenuation at 1 000 MHz of 32 dB (BCT-H), 16,5 dB (BCT-M), and 9 dB (BCT-L) corresponding to an approx. channel attenuation at 400 MHz of 19 dB, 10 dB and 6 dB. This relates to coaxial channel lengths of 100 m, 50 m and 25 m and balanced channel lengths of 48 m, 23 m and 11 m for application levels BCT-H, BCT-M and BCT-L respectively.

A common model is used for both balanced and coaxial channels. The assumptions are listed below:

- a two connections model;
- for channels in excess of 50 m (indicating a large home), it is assumed that the total equipment cordage will be 10 m;
- for channels of 50 m and below it is assumed that the total cordage will be 4 m.

The BCT-C cable used, is the cable B discussed above. The equipment cords have a stranded construction having 35 % attenuation premium (X = 1,35).

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The balanced cable mentioned in C.4.2 will meet the requirements for BCT-B cables. The equipment cords are assumed to be of a stranded construction with a 35 % attenuation premium (X = 1,35).

The equations for channel insertion loss/attenuation are therefore:

- coaxial: $\left(L_{PT} + 1{,}35 \times L_{EC}\right) \times \frac{0{,}835\sqrt{f} + 0{,}002\,5f}{100} + 0{,}04\sqrt{f}$ (E.4)

- balanced: $\left(L_{PT} + 1{,}35 \times L_{EC}\right) \times \frac{1{,}645\sqrt{f} + 0{,}01f + \frac{0{,}25}{\sqrt{f}}}{100} + 0{,}04\sqrt{f}$ (E.5)

where L_{PL} = permanent link length and L_{EC} = total equipment cord length.

Table C.5 shows the resulting channel lengths and their associated insertion loss/attenuation values.

Table C.5 – BCT-L, BCT-M and BCT-H channel implementations

Channel level	Channel type	Permanent link length m	Equipment cord length m	Channel length m	Insertion loss dB	
					at 400 MHz	at 1 000 MHz
BCT-H	BCT B	44,1	4	48,1	19,1	32,0
BCT-H	BCT C	90	10	100	19,1	31,2
BCT-M	BCT B	19,1	4	23,1	9,8	16,5
BCT-M	BCT C	46	4	50	9,9	16,1
BCT-L	BCT B	7,1	4	11,1	5,4	9,0
BCT-L	BCT C	21	4	25	5,5	8,9

C.4.5 Channel lengths using other coaxial cable specifications

Installing cable A within the permanent link and using cable B as equipment cords creates a channel insertion loss/attenuation equation

- coaxial: $\left(L_{PT} + 1{,}35 \times L_{EC}\right) \times \frac{0{,}6\sqrt{f} + 0{,}002\,5f}{100} + 0{,}04\sqrt{f}$ (E.6)

The channel lengths achieved will significantly exceed those defined for cable B and may be necessary for larger homes.

C.4.6 Channel lengths using other balanced cable specifications

Installing cables that meet the requirements of Category 7 as specified in ISO/IEC 11801 creates a channel insertion loss/attenuation equation

- balanced: $\left(L_{PT} + 1{,}5 \times L_{EC}\right) \times \frac{1{,}8\sqrt{f} + 0{,}01f + \frac{0{,}2}{\sqrt{f}}}{100} + 0{,}04\sqrt{f}$ (E.7)

The channel lengths achieved will be lower than for the BCT-B cables specified in this standard. However, the reduced cable diameter may be advantageous and such cables may be applicable to smaller homes.

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Annex D
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Applications and associated cabling

Cabling is an infrastructure for applications. The requirements of applications on the media used are, above all, related to the bandwidth needed, and the topology (logical and physical implementation) used. Previously at least six kinds of cabling have been found in residential and commercial buildings that support groups of applications as listed in Table D.1. In addition, cabling specific to a single application may be used, for example, between a PC and a printer, and between a hi-fi amplifier and speakers.

A multitude of topologies and materials are replaced by a clear cabling structure. Therefore, this standard simplifies and improves home networks with a future-proof approach.

Table D.1 – Grouping of applications and cabling

Application field		**As supported by legacy present cabling topology / cable type**							**As supported by application groups in this standard**
Line No	**Name**	**Mains**	**Phone**	**TV**	**Intercom**	**Security**	**Control**	**Other**	
1	Mains supply	O/p							mains supply
2	Lighting control	O/p					O/h, p, t		**CCCB**
3	Building control	O/p					O/h, p, t		**CCCB**
4	Appliance control	O/p					O/h, p, t		**CCCB**
5	Demand management via circuit breakers	O/p							
6	Burglar alarm					B/t			**CCCB**
7	Fire alarm					B/t			**CCCB**
8	Intercom				B/t		O/h, t		**ICT**
9	Telephone		E/t						**ICT**
10	ISDN		E/t						**ICT**
11	HiFi							S/l	**BCT**
12	Computing		B/d, S/t		B/d, S/t	B/d, S/t	B/d, S/t, d	O/d	**ICT**
13	CCTV			B/c, S/c	B, S			B/c	**BCT**
14	Radio and TV			B, S/c				B/c	**BCT**
Column No	1	2	3	4	5	6	7	8	9

B: Bus, loop through
c: coaxial cable
d: data cable
E: extended star
h: home control system cable
l: loudspeaker cable
O: open topology. For mains distribution based on local regulations, this may include loops.
p: power distribution cable
S: star
t: simple “telephone” cable

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The difference in cabling is caused by electrical codes, requirements concerning the electrical characteristics of the channel, the topology required or permitted by the applications, and traditions in installation profession. Variations may be found in the number of outlets supported by a specific transmission technology used for / by the application, e. g., point to point or bus. In some commercial buildings, separate networks for security and/or telephone may be required for administrative purposes or to meet contractual requirements e. g. with a specific insurance company.

With changing technology, regulations and electrical codes, it is feasible to have a generic cabling infrastructure that serves all purposes other than for mains distribution, and comprising only three groups of applications conveying information as shown in Table D.1, column 9: CCCB, ICT and BCT, since the electrical characteristics of the channels and the topologies required by these different applications are similar enough to allow few cable types and two topologies to serve all applications.

Taking into account

- the transmission characteristics of the channels required by different groups of application; and
- the differences in technique and demand situation for low and high performance balanced cables;

a generic cabling infrastructure serving all purposes other than mains presently consists of three channel levels as outlined in Table D.2. This table summarises the most obvious characteristics, which are described in detail in the relevant clauses.

NOTE In some cases local rules and regulations may limit the degree of integration allowed in a specific implementation.

Compared to ICT and BCT cabling, the requirements of CCCB cabling can be more demanding with respect to power load and may require a higher insulation. It is however, less demanding with respect to transmission performance.

ICT cabling generally uses balanced cabling, as specified in ISO/IEC 11801:2002.

BCT may use coaxial and balanced cables. Therefore for pre-cabling both cable constructions are specified.

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Table D.2 – Characteristics of ICT, BCT & CCCB Cabling

	ICT Cabling	BCT Cabling	CCCB Cabling
Topology	(Hierarchical) star see Figure 4	(Hierarchical) star, see Figure 4	Bus, tree, star , see Figure 10
Type of media	Balanced cables, optical fibres	Balanced cables, coaxial cables	Balanced cables
Typical frequency range	Up to 100 MHz	Up to 3 GHz [a]	Up to 100 kHz
Channel classes according to ISO/IEC 11801:2002	Class D [b]	N/A	N/A
Power distributed on network	Occasionally	Occasionally	Frequently
Device Mobility or frequent Relocation	YES	YES	NO for sensors, switches YES for specific appliances
Interface at device	Balanced connector: IEC 60603-7 [c], Optical fibre connectors: IEC 60874-14, IEC 60874-19, SC type	Coaxial connectors: IEC 61169-2 or IEC 61169-24 (“F type”) Balanced connector: IEC 61076-3-104 [d]	Fixed connection, CCCB connector(s)

NOTE Vicinity to mains depends on installation preferences and local regulation.

[a] On balanced cabling up to 1 GHz

[b] This definition is from ISO/IEC 11801:2002.

[c] IEC 60603-7 is also known as RJ45 in the market place.

[d] In installations where other factors, such as interoperability with IEC 60603-7 series take preference over the connector sharing offered with IEC 61076-3-104, also the interface specified in IEC 60603-7-7 may be used.

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