

BS EN 50173-1:2011



BSI Standards Publication

Information technology — Generic cabling systems

Part 1: General requirements

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee TCT/7, Telecommunications - Installation requirements.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Date	Text affected
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English version

**Information technology -
Generic cabling systems -
Part 1: General requirements**

Technologies de l'information -
Systèmes de câblage générique -
Partie 1: Exigences générales

Informationstechnik -
Anwendungsneutrale
Kommunikationskabelanlagen -
Teil 1: Allgemeine Anforderungen

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 215, *Electrotechnical aspects of telecommunication equipment*. This 3rd edition of EN 50173-1 replaces the text of EN 50173-1:2007, EN 50173-1:2007/A1:2009 and consolidates these two standards with the text of EN 50173-1:2007/FprAB:2010 for the convenience of the user of the standard.

The text of draft amendment EN 50173-1:2007/FprAB was submitted to the Formal Vote and was approved by CENELEC to amend EN 50173-1:2007 on 2011-04-01.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2012-04-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2014-04-01 |

The previous editions of European Standards EN 50173:1995 and EN 50173-1:2002 have been developed to enable the application-independent cabling to support ICT applications in office premises. Their basic principles, however, are applicable to other types of applications and in other types of premises.

TC 215 has decided to establish relevant European Standards which address the specific requirements of these premises. In order to point out the commonalities of these cabling design standards, these ENs are published as individual parts of the series EN 50173, thus also acknowledging that standards users recognize the designation “EN 50173” as a synonym for generic cabling design.

At the time of publication of this European Standard, series EN 50173 comprises the following standards:

- | | |
|--------------|---|
| – EN 50173-1 | Information technology – Generic cabling systems – Part 1: General requirements |
| – EN 50173-2 | Information technology – Generic cabling systems – Part 2: Office premises |
| – EN 50173-3 | Information technology – Generic cabling systems – Part 3: Industrial premises |
| – EN 50173-4 | Information technology – Generic cabling systems – Part 4: Homes |
| – EN 50173-5 | Information technology – Generic cabling systems – Part 5: Data centres |

This edition of EN 50173-1:

- a) contains a change of electromagnetic parameters in the MICE classification (Table 3);
- b) introduces new component Categories 6_A and 7_A in accordance with the channel Classes E_A and F_A defined in EN 50173-1:2007/A1:2009;
- c) modifies insertion loss requirements for coaxial channels;
- d) modifies optical fibre Class OF-100 media and defines a new cabled optical fibre Category OM4;
- e) amends and modifies connecting hardware requirements, defines both a new interface for 2 optical fibres and for 12 and 24 fibres;
- f) introduces limits for additional parameters in Annexes A, B and D.2;
- g) revises D.3 regarding test requirements for mechanical and environmental performance of connecting hardware;
- h) updates Annex F “Supported applications”;

- i) introduces a new normative Annex I “Test procedures to assess conformance with EN 50173 standards”;
- j) amends various other subclauses, tables and figures.

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Introduction

This European Standard contains general requirements in support of the other standards in the EN 50173 series.

It should be noted that generic cabling is a passive system and cannot be tested for EMC compliance individually. Application-specific equipment, designed for one or more cabling media, is required to meet relevant EMC standards on those media. Care should be taken that the installation of any of those media in a cabling system does not degrade the characteristics of the system. The installation methods of EN 50174 series should be used to minimise the effect of electromagnetic disturbances. For EMC requirements of BCT cabling see EN 50083-8.

Series EN 50174 and EN 50310 specify requirements for earthing and equipotential bonding.

Figure 1 and Table 1 show the schematic and contextual relationships between the standards produced by TC 215 for information technology cabling, namely:

- 1) this and other parts of the EN 50173 series;
- 2) application dependent cabling design (e.g. EN 50098 series);
- 3) installation (EN 50174 series);
- 4) testing of installed cabling (EN 50346);
- 5) equipotential bonding requirements (EN 50310).

In addition, a number of Technical Reports have been developed to support or extend the application of these standards, including:

- CLC/TR 50173-99-1, *Cabling guidelines in support of 10 GBASE-T*;
- CLC/TR 50173-99-2, *Information technology – Implementation of BCT applications using cabling in accordance with EN 50173-4*.

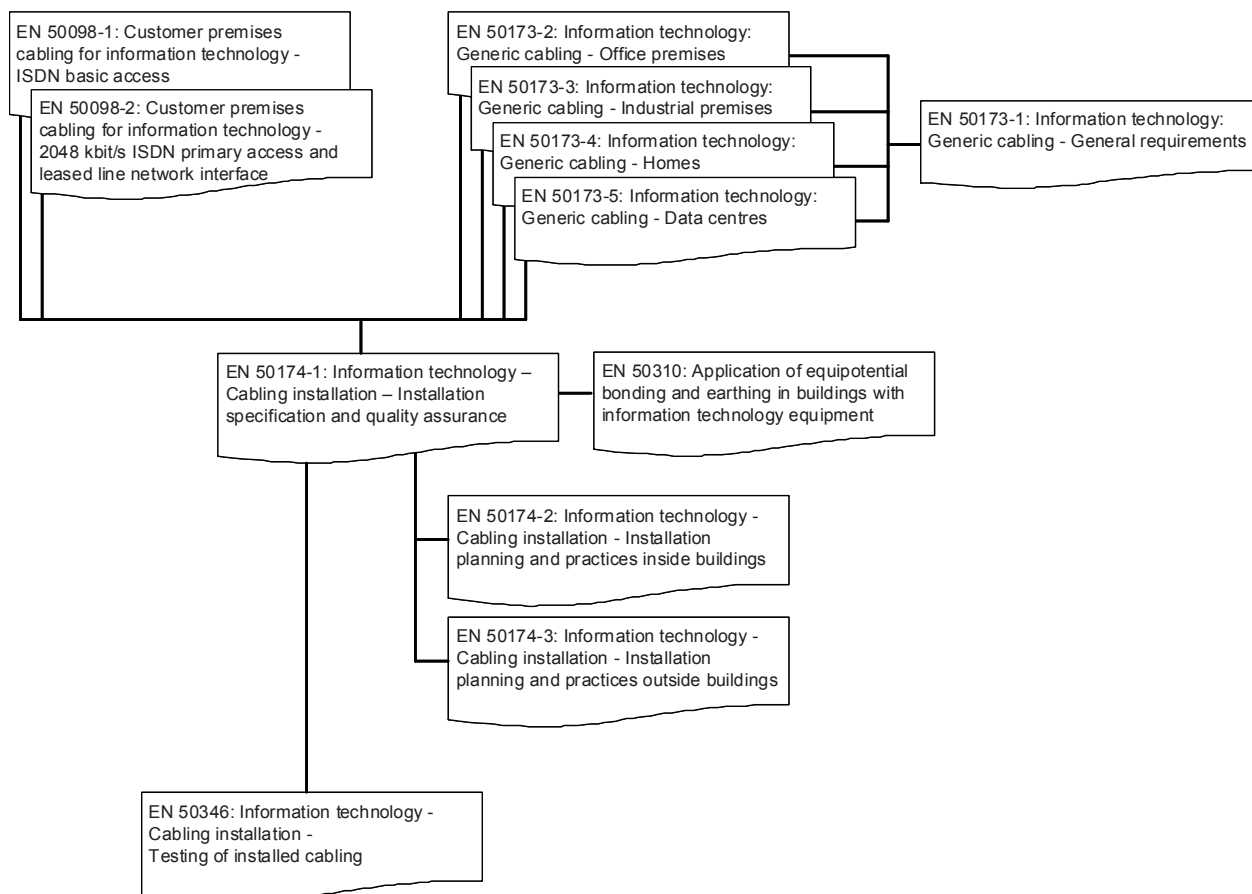


Figure 1 – Schematic relationship between the EN 50173 series and other relevant standards

Table 1 – Contextual relationship between EN 50173 series and other standards relevant for information technology cabling systems

Building design phase	Generic cabling design phase	Specification phase	Installation phase	Operation phase
EN 50310 6. Bonding networks	EN 50173 series except EN 50173-4 4: Structure 5: Channel performance 7: Cable requirements 8: Connecting hardware requirements 9: Requirements for cords and jumpers A: Link performance limits	EN 50174-1 4 Requirements for specifying installations of information technology cabling 5: Requirements for installers of information technology cabling		EN 50174-1 4: Requirements for specifying installations of information technology cabling
		Planning phase		
	and EN 50173-4 4 and 5: Structure 6: Channel performance 8: Cable requirements 9: Connecting hardware requirements 10: Requirements for cords and jumpers A: Link performance limits	EN 50174-2 4: Requirements for planning installations of information technology cabling 6: Segregation of metallic information technology cabling and power supply cabling 7: Electricity distribution systems and lightning protection and EN 50174-3 and (for equipotential bonding) EN 50310	EN 50174-2 5: Requirements for the installation of information technology cabling 6: Segregation of metallic information technology cabling and power supply cabling 8: Office (commercial) premises 9: Industrial premises 10: Homes 11: Data centres and EN 50174-3 and (for equipotential bonding) EN 50310 and EN 50346 4: General requirements 5: Test parameters for balanced cabling 6: Test parameters for optical fibre cabling	

1 Scope and conformance

1.1 Scope

This European Standard specifies:

- a) the structure and configuration of the backbone cabling subsystems of generic cabling systems within the types of premises defined by the other standards in the EN 50173 series;
- b) channel performance requirements in support of the standards in the EN 50173 series;
- c) link performance requirements in support of the standards in the EN 50173 series;
- d) backbone cabling reference implementations in support of the standards in the EN 50173 series;
- e) component performance requirements in support of the standards in the EN 50173 series.

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

1.2 Conformance

This European Standard does not contain specific conformance requirements. The other standards in the EN 50173 series incorporate the requirements of this standard as part of their individual conformance requirements.

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.

EN 50083 (series), *Cable networks for television signals, sound signals and interactive services*

NOTE EN 50083 series is gradually replaced by EN 60728 series.

EN 50117-1, *Coaxial cables – Part 1: Generic specification*

EN 50117-4-1, *Coaxial cables – Part 4-1: Sectional specification for cables for BCT cabling in accordance with EN 50173 – Indoor drop cables for systems operating at 5 MHz – 3 000 MHz*

EN 50174-1:2009, *Information technology – Cabling installation – Part 1: Installation specification and quality assurance*

EN 50174-2, *Information technology – Cabling installation – Part 2: Installation planning and practices inside buildings*

EN 50174-3, *Information technology – Cabling installation – Part 3: Installation planning and practices outside buildings*

EN 50288-1, *Multi-element metallic cables used in analogue and digital communication and control – Part 1: Generic specification*

EN 50288-2-1, *Multi-element metallic cables used in analogue and digital communication and control – Part 2-1: Sectional specification for screened cables characterized up to 100 MHz – Horizontal and building backbone cables*

EN 50288-2-2, *Multi-element metallic cables used in analogue and digital communication and control – Part 2-2: Sectional specification for screened cables characterized up to 100 MHz – Work area and patch cord cables*

EN 50288-3-1, *Multi-element metallic cables used in analogue and digital communication and control – Part 3-1: Sectional specification for unscreened cables characterized up to 100 MHz – Horizontal and building backbone cables*

EN 50288-3-2, *Multi-element metallic cables used in analogue and digital communication and control – Part 3-2: Sectional specification for unscreened cables characterized up to 100 MHz – Work area and patch cord cables*

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3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document and the other standards in the EN 50173 series, the following terms and definitions apply.

3.1.1

administration

methodology defining the documentation requirements of a cabling system and its containment, the labelling of functional elements and the process by which moves, additions and changes are recorded

3.1.2**alien (exogenous) crosstalk**

signal coupling from a disturbing pair of a channel to a disturbed pair of another channel

NOTE This also applies to the signal coupling from a disturbing pair within a permanent link or component, used to create a channel, to a disturbed pair within a permanent link or component, used to create another channel.

3.1.3**alien (exogenous) far-end crosstalk loss (AFEXT)**

signal isolation between a disturbing pair of a channel and a disturbed pair of another channel, measured at the far-end

NOTE This also applies to the measurement of the signal isolation between a disturbing pair within a permanent link or component, used to create a channel, and a disturbed pair within a permanent link or component, used to create another channel.

3.1.4**alien (exogenous) near-end crosstalk loss (ANEXT)**

signal isolation between a disturbing pair of a channel and a disturbed pair of another channel, measured at the near-end

NOTE This also applies to the measurement of the signal isolation between a disturbing pair within a permanent link or component, used to create a channel, and a disturbed pair within a permanent link or component, used to create another channel.

3.1.5**application**

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

3.1.6**attenuation to alien (exogenous) crosstalk ratio at the far-end (AACR-F)**

difference, in dB, between the alien far-end crosstalk loss from a disturbing pair of a channel and the insertion loss of a disturbed pair in another channel

NOTE This also applies to the calculation using the alien far-end crosstalk loss from a disturbing pair within a permanent link or component, used to create a channel, and the insertion loss of a disturbed pair within a permanent link or component, used to create another channel.

3.1.7**attenuation to alien (exogenous) crosstalk ratio at the near-end (AACR-N)**

difference, in dB, between the alien near-end crosstalk loss from a disturbing pair of a channel and the insertion loss of a disturbed pair in another channel

NOTE This also applies to the calculation using the alien near-end crosstalk loss from a disturbing pair within a permanent link or component, used to create a channel, and the insertion loss of a disturbed pair within a permanent link or component, used to create another channel.

3.1.8**attenuation to crosstalk ratio at the far-end (ACR-F)**

difference, in dB, between the far-end crosstalk loss from a disturbing pair of a channel and the insertion loss of a disturbed pair of the same channel

NOTE This also applies to the calculation using the far-end crosstalk loss from a disturbing pair within a permanent link or component, used to create a channel, and the insertion loss of a disturbed pair within the permanent link or component, of the same channel.

3.1.9**attenuation to crosstalk ratio at the near-end (ACR-N)**

difference, in dB, between the near-end crosstalk loss from a disturbing pair of a channel and the insertion loss of a disturbed pair of the same channel

NOTE This also applies to the calculation using the near-end crosstalk loss from a disturbing pair within a permanent link or component, used to create a channel, and the insertion loss of a disturbed pair within the permanent link or component, of the same channel.

3.1.10**average alien (exogenous) near-end crosstalk loss**

calculated average of the alien near-end crosstalk loss of the pairs of a disturbed channel

NOTE This also applies to the calculation using the pairs within a permanent link, used to create a channel.

3.1.11

average power sum alien (exogenous) near-end crosstalk loss

calculated average of the power sum alien near-end crosstalk loss of the pairs of a disturbed channel

NOTE This also applies to the calculation using the pairs within a permanent link used to create a channel.

3.1.12

average power sum attenuation to alien (exogenous) crosstalk ratio far-end

calculated average of the power sum attenuation to alien crosstalk ratio at the far-end of the pairs of a disturbed channel

NOTE This also applies to the calculation using the pairs within a permanent link used to create a channel.

3.1.13

balanced cable

cable consisting of one or more symmetrical metallic cable elements (twisted pairs or quads)

3.1.14

broadcast and communication technologies

group of applications using the HF band (3 MHz to 30 MHz), the VHF band (30 MHz to 300 MHz) and the UHF band (300 MHz to 3 000 MHz) for transmission of sound radio, TV and two-way data services, as well as for in-home inter-networking

3.1.15

building backbone cable

cable that connects the building distributor to a floor distributor

NOTE Building backbone cables may also connect floor distributors in the same building.

3.1.16

building distributor

distributor in which the building backbone cable(s) terminate(s) and at which connections to the campus backbone cable(s) may be made

3.1.17

building entrance facility

facility that provides all necessary mechanical and electrical services for the entry of telecommunications cables into a building and which may allow for transition from external to internal cable

3.1.18

cable

assembly of one or more cable units of the same type and Category in an overall sheath

NOTE It may include an overall screen.

3.1.19

cabled optical fibre Category

system of defining requirements for the cabled optical fibre performance within optical fibre channels and links (also referred to as performance codes in those standards developed by IEC SC 86A to support premises cabling)

3.1.20

cable element

smallest construction unit in a cable

NOTE 1 A cable element may have a screen.

NOTE 2 A pair, a quad, a single isolated lead with coaxial screen and a single optical fibre are examples of a cable element.

3.1.21**cable unit**

single assembly of one or more cable elements usually of the same type or Category

NOTE A cable unit may have a screen.

3.1.22**cabling**

system of telecommunications cables, cords and connecting hardware that supports the operation of information technology equipment

3.1.23**campus**

premises containing one or more buildings

3.1.24**campus backbone cable**

cable that connects the campus distributor to the building distributor(s)

NOTE Campus backbone cables may also interconnect building distributors.

3.1.25**campus distributor**

distributor from which the campus backbone cabling emanates

3.1.26**channel**

any transmission path comprising passive cabling components between application-specific equipment or between application-specific equipment and an external network interface

NOTE Differing definitions of the term “channel” as given in other standards (such as series EN 50083) are not applicable in series EN 50173.

3.1.27**coaxial cable**

cable the transmission line of which is in the form of two coaxial conductors (unbalanced cable)

3.1.28**connection**

mated device or combination of devices including terminations used to connect cables or cable elements to other cables, cable elements or application specific equipment

3.1.29**commands, controls and communications in buildings**

group of applications such as appliance control and building control

3.1.30**cord**

cable unit or element with a minimum of one termination

3.1.31**cross-connect**

method of connecting a cabling subsystem to equipment (or another cabling subsystem) by the use of a patch cord or jumper

3.1.32**distributor**

term used for the functions of a collection of components (for example, patch panels, patch cords) used to connect cables

3.1.33**equipment cord**

cord connecting equipment to a distributor

3.1.34**equipment interface**

point at which application-specific equipment can be connected to the generic cabling or network access cabling

3.1.35**equipment room**

room dedicated for housing distributors and application-specific equipment

3.1.36**equipotential bonding**

provision of electric connections between conductive parts, intended to achieve equipotentiality [195-01-10 of IEC 60050-195:1998]

3.1.37**external network interface**

termination point providing external network demarcation

3.1.38**floor distributor**

distributor used to make connections between the building backbone cabling subsystem, cabling subsystems specified in other standards in the EN 50173 series and active equipment

NOTE See telecommunications room.

3.1.39**functional performance**

level of transmission performance able to support an intended Class of applications

3.1.40**generic cabling**

structured telecommunications cabling system, capable of supporting a wide range of applications

NOTE 1 Application-specific hardware is not a part of generic cabling.

NOTE 2 Generic cabling can be installed without prior knowledge of the required applications.

3.1.41**hybrid cable**

assembly of two or more different types or Categories of cables or cable units covered by an overall sheath

NOTE It may be covered by an overall screen.

3.1.42**information and communication technologies**

group of applications using information and communications (telecommunications) technologies

3.1.43**information technology**

telecommunications

branch of technology concerned with the transmission, emission and reception of signs, signals, writing, images and sounds; that is, information of any nature by cable, radio, optical or other electromagnetic systems

NOTE The term telecommunications has no legal meaning when used in this document.

3.1.44**interconnect**

method of connecting a cabling subsystem to equipment (or another cabling subsystem) without the use of a patch cord or jumper

3.1.45**jumper**

cable, cable unit or cable element without connectors used to make a connection on a cross-connect

3.1.46**keying**

mechanical feature of a connector system that guarantees correct orientation of a connection or prevents the connection to a jack or optical fibre adapter of the same type intended for another purpose

3.1.47**link**

transmission path between two specified test interfaces of generic cabling

3.1.48**MICE classification**

classification system that describes the environment conditions that are local to a channel based upon the following factors: mechanical (M), ingress (I), climatic and chemical (C) and electromagnetic (E)

3.1.49**multi-unit cable**

balanced cable containing more than four pairs

3.1.50**network access cable**

cable connecting the external network interfaces to a generic cabling distributor

3.1.51**operating temperature**

temperature of the cabling, once a steady state has been reached, combining ambient temperature with any increase due to the application being supported

3.1.52**optical fibre cable (or optical cable)**

cable comprising one or more optical fibre cable elements

3.1.53**optical fibre duplex adapter**

mechanical device designed to align and join two optical fibre duplex connectors

3.1.54**optical fibre duplex connector**

mechanical termination device designed to transfer optical power between two pairs of optical fibres

3.1.55**pair**

twisted pair or one side circuit (two diametrically facing conductors) in a star quad

3.1.56**patch cord**

cord used to establish connections on a patch panel

3.1.57**patch panel**

cross-connect designed to accommodate the use of patch cords

NOTE It facilitates administration for moves and changes.

3.1.58**permanent link**

transmission path between any two test interfaces within a cabling subsystem link including the connecting hardware at each end

NOTE Premises-specific definitions are found in other standards in the EN 50173 series.

3.1.59**power sum alien (exogenous) far-end crosstalk loss (PSAFEXT)**

power sum of the signal isolation between multiple disturbing pairs of one or more channels and a disturbed pair of another channel, measured at the far-end

NOTE This also applies to the calculation using the multiple disturbing pairs within one or more permanent links or components and a disturbed pair within a permanent link or component, used to create another channel.

3.1.60**power sum alien (exogenous) near-end crosstalk loss (PSANEXT)**

power sum of the signal isolation between multiple disturbing pairs of one or more channels and a disturbed pair of another channel, measured at the near-end

NOTE This also applies to the calculation using the multiple disturbing pairs within one or more permanent links or components and a disturbed pair within a permanent link or component, used to create another channel.

3.1.61**power sum attenuation to alien (exogenous) crosstalk ratio at the far-end (PSAACR-F)**

difference, in dB, between the power sum alien far-end crosstalk loss from multiple disturbing pairs of one or more channels and the insertion loss of a disturbed pair in another channel

NOTE This also applies to the calculation using the multiple disturbing pairs within one or more permanent links or components and the insertion loss of a disturbed pair within a permanent link or component, used to create another channel.

3.1.62**power sum attenuation to alien (exogenous) crosstalk ratio at the near-end (PSAACR-N)**

difference, in dB, between the power sum alien near-end crosstalk loss from multiple disturbing pairs of one or more channels and the insertion loss of a disturbed pair in another channel

NOTE This also applies to the calculation using the multiple disturbing pairs within one or more permanent links or components and the insertion loss of a disturbed pair within a permanent link or component, used to create another channel.

3.1.63**power sum attenuation to crosstalk ratio at the far-end (PSACR-F)**

difference, in dB, between the power sum far-end crosstalk loss from multiple disturbing pairs of a channel and the insertion loss of a disturbed pair in the same channel

NOTE This also applies to the calculation using the multiple disturbing pairs within one or more permanent links or components, used to create a channel, and the insertion loss of a disturbed pair within a permanent link or component, of the same channel.

3.1.64**power sum attenuation to crosstalk ratio at the near-end (PSACR-N)**

difference, in dB, between the power sum near-end crosstalk loss from multiple disturbing pairs of a channel and the insertion loss of a disturbed pair in the same channel

NOTE This also applies to the calculation using the multiple disturbing pairs within one or more permanent links or components, used to create a channel, and the insertion loss of a disturbed pair within a permanent link or component, of the same channel.

3.1.65**requirement met by design**

requirement that does not require testing and where conformance may be achieved either by selection of appropriate components and their installation techniques or by conformance of a related parameter

3.1.66**screened cable**

assembly of two or more balanced twisted pair cable elements or one or more quad cable elements where each element is individually screened and/or the elements are contained within an overall screen

3.1.67**screened cabling**

system of telecommunications cables, cords and connecting hardware each of which contains screens and within which the screens are interconnected

3.1.68**small form factor connector**

optical fibre connector designed to accommodate two or more optical fibres with at least the same mounting density as balanced cabling interfaces in accordance with EN 60603-7 series

3.1.69**splice**

joining of conductors or fibres, generally from separate cables

3.1.70**star quad**

cable element which comprises four insulated conductors twisted together

NOTE 1 Two diametrically facing conductors form a transmission pair.

NOTE 2 Cables containing star quads can be used interchangeably with cables consisting of pairs, provided the electrical characteristics meet the same specifications.

NOTE 3 Often, the term quad is used instead of star quad.

3.1.71**telecommunications room**

enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling

3.1.72**test interface**

point at which test equipment can be connected to the generic cabling

3.1.73**twisted pair**

cable element that consists of two insulated conductors twisted together in a determined fashion to form a balanced transmission line

3.1.74**unscreened cable**

balanced cable without any screens

3.2 Abbreviations

For the purposes of this document and the other standards in the EN 50173 series, the following abbreviations apply.

AACR-F	Attenuation to alien (exogenous) crosstalk ratio at the far-end
AC	Alternating current
ACR-N	Attenuation to crosstalk ratio at the near-end
ACR-F	Attenuation to crosstalk ratio at the far-end

AFEXT	Alien (exogenous) far-end crosstalk loss
ANEXT	Alien (exogenous) near-end crosstalk loss
APC	Angled physical contact
ATM	Asynchronous transfer mode
α	Insertion loss
α_{avg}	Average insertion loss
BCT	Broadcast and Communications Technologies
BD	Building distributor
c	Velocity of propagation in free space
C	Connection
CCCB	Controls, Commands and Communications in Buildings
CD	Campus distributor
CSMA/CD	Carrier sense multiple access with collision detection
DAB	Digital Audio Broadcast
DVB	Digital Video Broadcast
DVB-C	Digital Video Broadcast, cabled
DVB-S	Digital Video Broadcast, satellite
DVB-T	Digital Video Broadcast, terrestrial
d.c., DC	Direct current
EI	Equipment interface
ELTCTL	Equal level transverse conversion transfer loss
EMC	Electromagnetic compatibility
EQP	Transmission equipment
FC	Fibre Channel
FD	Floor distributor
FDDI	Fibre distributed data interface
FEXT	Far-end crosstalk loss
ffs	For further study
FOIRL	Fibre optic inter-repeater link
HF	High frequency
ICT	Information and Communication Technologies
IDC	Insulation displacement connection
IPC	Insulation piercing connection
ISDN	Integrated services digital network
LAN	Local area network
MICE	Mechanical, Ingress, Climatic and chemical, Environmental
N/A	Not applicable
NEXT	Near-end crosstalk loss
PBX	Private branch exchange
PC	Physical contact
PMD	Physical Layer Medium Dependent
PP	Patch panel
PSACR-N	Power sum attenuation to crosstalk ratio at the near-end

PSAACR-F	Power sum attenuation to alien (exogenous) crosstalk ratio at the far-end
PSAACR-F _{avg}	Average power sum attenuation to alien (exogenous) crosstalk ratio at the far-end
PSACR-F	Power sum attenuation to crosstalk ratio at the far-end
PSAFEXT	Power sum alien (exogenous) far-end crosstalk loss
PSAFEXT _{norm}	Normalised power sum alien (exogenous) far-end crosstalk loss
PSANEXT	Power sum alien (exogenous) near-end crosstalk loss
PSANEXT _{avg}	Average power sum alien (exogenous) near-end crosstalk loss
PSFEXT	Power sum far-end crosstalk loss
PSNEXT	Power sum near-end crosstalk loss
SC	Subscriber connector
TCL	Transverse conversion loss
TI	Test interface
TP	Twisted pair
TV	Television
UHF	Ultra high frequency
VHF	Very high frequency

4 Structure of generic cabling

4.1 General

This clause identifies the backbone functional elements of generic cabling, independent of the type of premises within which the cabling is installed, describes how they are connected together to form backbone cabling subsystems and identifies the interfaces at which application-specific components are connected by the generic cabling. Channels, created by connecting application-specific cabling components to the generic cabling, are used to support applications. Applications listed in Annex F are supported by connecting active equipment at the telecommunications outlets and the distributors.

Each type of premises contains additional functional elements.

4.2 Backbone functional elements

The backbone functional elements of generic cabling to support ICT applications are as follows:

- a) campus distributor (CD);
- b) campus backbone cable;
- c) building distributor (BD);
- d) building backbone cable;
- e) floor distributor (FD).

Groups of these functional elements are connected together to form backbone cabling subsystems (see 4.3).

4.3 General structure and hierarchy of backbone cabling subsystems

Generic cabling systems contain up to two types of backbone cabling subsystems: campus backbone and building backbone. The cabling subsystems are connected together to create a generic cabling system with a structure as shown in Figure 2. The composition of the subsystems is described in 4.4.1 and 4.4.2. The functional elements of the cabling subsystems are interconnected to form a basic hierarchical topology as shown in Figure 3. Where the functions of distributors are combined the cabling subsystems linking them are not required.

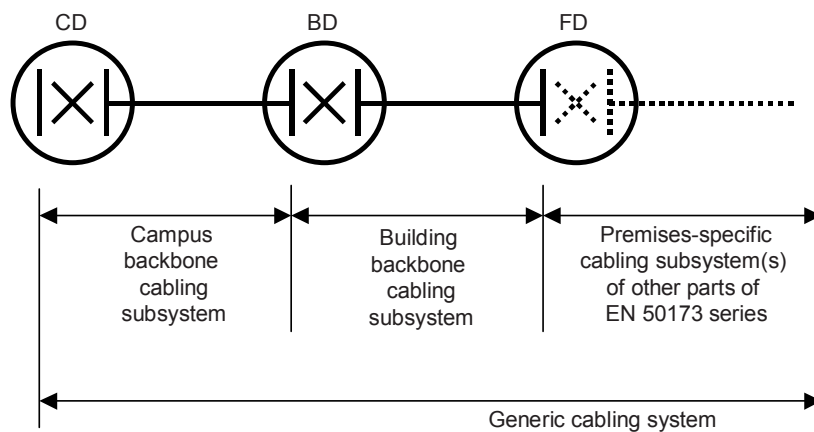
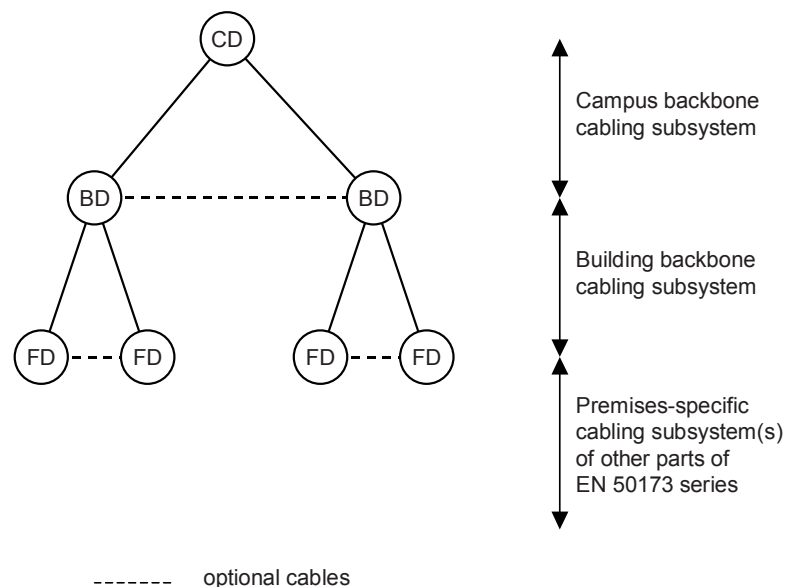


Figure 2 – Structure of generic cabling



NOTE Data centre cabling in accordance with EN 50173-5 may be connected to any of the distributors.

Figure 3 – Hierarchical structure of generic cabling

Connections between cabling subsystems are either active, requiring application-specific equipment, or passive. Connection to application-specific equipment adopts either an interconnect or a cross-connect approach (see Figure 4). Passive connections between cabling subsystems adopt either a cross-connect approach, by way of either patch cords or jumpers, or an interconnect approach.

4.4 Cabling subsystems

4.4.1 Campus backbone cabling subsystem

The campus backbone cabling subsystem extends from the campus distributor to the building distributor(s) connected to it usually located in separate buildings. When present, the subsystem includes:

- the campus backbone cables including any cabling components within the building entrance facilities;
- the mechanical termination of the campus backbone cables at both the campus and building distributors together with associated patch cords and/or jumpers at the CD.

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 campus backbone cabling may provide direct connection between building distributors. When provided this cabling shall be in addition to that required for the basic hierarchical topology.

4.4.2 Building backbone cabling subsystem

The building backbone cabling subsystem extends from building distributor to the floor distributors connected to it. When present, the subsystem includes:

- a) the building backbone cables;
- b) the mechanical termination of the building backbone cables at both the building and floor distributors together with associated patch cords and/or jumpers at the BD.

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 building backbone cabling may provide direct connection between floor distributors. When provided this cabling shall be for redundancy and in addition to those required for the basic hierarchical topology.

4.4.3 Design objectives

It is generally not possible or economically viable to install backbone cabling for the entire life of the generic cabling system. Instead, the design may be based on current or foreseeable application requirements. Such short-term selection criteria are often appropriate for building backbone cabling where there is good physical access to pathways for future changes.

The selection of campus backbone cabling may require a longer term approach than that adopted for the building backbone, particularly if access to pathways is more limited.

4.5 Accommodation of functional elements

4.5.1 Distributors in the EN 50173 series of standards

The requirements for the accommodation of distributors are specified in EN 50174-2.

4.5.2 Campus, building and floor distributors

Campus, building and floor distributors are typically located in equipment rooms or telecommunications rooms.

A telecommunications room should provide all the facilities (space, power, environmental control etc.) for passive components, active devices, and external network interfaces housed within it. Each telecommunications room should have direct access to the backbone.

An equipment room is an area within a building where telecommunications equipment is housed and may or may not contain distributors. Equipment rooms are treated differently from telecommunications rooms because of the nature or complexity of the equipment (e.g. PBXs or extensive computer installations). More than one distributor may be located in an equipment room. If a telecommunications space houses more than one distributor it should be considered an equipment room.

4.5.3 Cables

Backbone cables are routed using pathways. A variety of cable management systems can be used to support the cables within the pathways including ducts, conduits and tray. Requirements for the pathways and the cable management systems within them are provided in the EN 50174 series of standards.

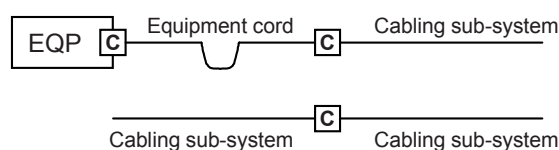
4.6 Equipment Interfaces and test interfaces for backbone cabling

Equipment interfaces to generic cabling are located at the ends of each backbone cabling subsystem.

Campus, building and floor distributors may have an equipment interface to an external service at any port, and may use either interconnects or cross-connects (see Figure 4). Figure 5 shows the potential equipment interfaces to the backbone cabling subsystems.

Test interfaces to generic cabling are located at the ends of each backbone cabling subsystem. Figure 5 shows the potential test interfaces to the backbone cabling subsystems.

a) interconnect model



b) crossconnect model

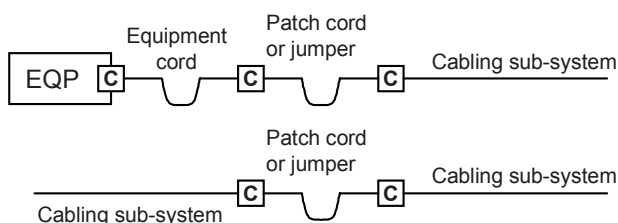


Figure 4 – Interconnect and cross-connect models



Figure 5 – Test and equipment interfaces for backbone cabling

4.7 Dimensioning and configuring

4.7.1 External network interface

Connections to external networks for the provision of services (e.g. public telecommunications) are made at external network interfaces. The location of external network interfaces, if present, and the facilities which shall be provided may be regulated by national, regional, and local regulations. If the external network interface is not connected directly to a generic cabling interface the performance of the network access cabling should be taken into account and should be considered as part of the initial design and implementation of customer applications. The type of cross-connect and the network access cable may be governed by national regulations, in which case they shall be taken account of in the design of the generic cabling.

4.7.2 Building entrance facilities

Building entrance facilities are required whenever campus backbone, public and private network cables (including antennae) enter buildings and a transition is made to internal cables. It comprises an entrance point at a building wall and the pathway leading to the campus or building distributor. Local regulations may require special facilities where the external cables are terminated. At this termination point, a change from external to internal cable can take place.

5 Channel performance

5.1 Environmental performance

5.1.1 General

The environmental performance specifications of channels are classified to cover the different conditions under which channels are required to operate in the types of premises defined in the other standards of the EN 50173 series.

The local conditions, to which the cabling components within the channel are exposed, shall be used to determine the applicable environmental classification(s) of this clause. With regard to temperature the local environment is considered to be the operating temperature of the cabling.

The environmental classifications described in this clause shall be used for the selection of:

- a) components and/or protection afforded to them;
- b) installation techniques to be applied to the channel in order to provide protection against extreme environments.

It is possible for the different locations within a channel to be subject to different environmental conditions. The local environment along the channel shall be classified accordingly. For each M, I, C, or E group, the classification of a given environment shall be determined by the most demanding parameter within the M, I, C or E group. However, the selection of components shall be based on the specific demands of each of the parameters within the M, I, C, or E group, which may be less demanding than the overall classification of the group.

5.1.2 Environmental classifications

Table 2 lists the environmental classifications for channels. The details of the environmental classifications are set out in Table 3.

Generally, it is possible to classify a channel environment by using any combination of the MICE designations, e.g. M₂I₁C₃E₁. However, certain environments (e.g. nuclear, chemical, fire, explosive, damage risk from animals, salt mist) demand additional requirements beyond those of this clause. Further details on specific environments are shown in Annex G.

Table 2 – Channel environments

Parameter	Environmental class		
	1	2	3
Mechanical rating	M ₁	M ₂	M ₃
Ingress rating	I ₁	I ₂	I ₃
Climatic and chemical rating	C ₁	C ₂	C ₃
Electromagnetic rating	E ₁	E ₂	E ₃

The requirements of a given classification cover the requirements of a lower classification, i.e. channels designed to operate under environmental conditions defined by M_2 shall continue to operate under environmental conditions defined by M_1 .

The parameters of the environmental classifications are defined in Table 3.

Table 3 – Details of Environmental Classification

Mechanical	M ₁	M ₂	M ₃
Shock/bump ^a			
Peak acceleration	40 m/s ²	100 m/s ²	250 m/s ²
Vibration			
Displacement amplitude (2 Hz to 9 Hz)	1,5 mm	7,0 mm	15,0 mm
Acceleration amplitude (9 Hz to 500 Hz)	5 m/s ²	20 m/s ²	50 m/s ²
Tensile force	See Note 1	See Note 1	See Note 1
Crush	45 N over 25 mm (linear) min.	1 100 N over 150 mm (linear) min.	2 200 N over 150 mm (linear) min.
Impact	1 J	10 J	30 J
Bending, flexing and torsion	See Note 1	See Note 1	See Note 1
Ingress	I ₁	I ₂	I ₃
Particulate ingress (max. diameter)	12,5 mm	0,05 mm	0,05 mm
Immersion	None	Intermittent liquid jet ≤ 12,5 l/min ≥ 6,3 mm jet > 2,5 m distance	Intermittent liquid jet ≤ 12,5 l/min ≥ 6,3 mm jet > 2,5 m distance and immersion (≤1 m for ≤ 30 min)
Climatic and chemical	C ₁	C ₂	C ₃
Ambient temperature	- 10 °C to + 60 °C	- 25 °C to + 70 °C	- 40 °C to + 70 °C
Rate of change of temperature	0,1 °C/min	1,0 °C/min	3,0 °C/min
Humidity	5 % to 85 % (non-condensing)	5 % to 95 % (condensing)	5 % to 95 % (condensing)
Solar radiation	700 W/m ²	1 120 W/m ²	1 120 W/m ²
Liquid pollution	Concentration x 10 ⁻⁶	Concentration x 10 ⁻⁶	Concentration x 10 ⁻⁶
Contaminants			
Sodium chloride (salt/sea water)	0	< 0,3	< 0,3
Oil (dry-air concentration)	0	< 0,005	< 0,5
Sodium stearate (soap)	None	> 5 × 10 ⁴ aqueous non-gelling	> 5 × 10 ⁴ aqueous gelling
Detergent	None	ffs	ffs
Conductive materials in solution	None	Temporary	Present
Gaseous pollution	Mean/Peak (Concentration × 10 ⁻⁶)	Mean/Peak (Concentration × 10 ⁻⁶)	Mean/Peak (Concentration × 10 ⁻⁶)
Contaminants			
Hydrogen sulphide	< 0,003 / < 0,01	< 0,05 / < 0,5	< 10 / < 50
Sulphur dioxide	< 0,01 / < 0,03	< 0,1 / < 0,3	< 5 / < 15
Sulphur trioxide (ffs)	< 0,01 / < 0,03	< 0,1 / < 0,3	< 5 / < 15
Chlorine wet (>50% humidity)	< 0,000 5 / < 0,001	< 0,005 / < 0,03	< 0,05 / < 0,3
Chlorine dry (<50% humidity)	< 0,002 / < 0,01	< 0,02 / < 0,1	< 0,2 / < 1,0
Hydrogen chloride	- / < 0,06	< 0,06 / < 0,3	< 0,6 / 3,0
Hydrogen fluoride	< 0,001 / < 0,005	< 0,01 / < 0,05	< 0,1 / < 1,0
Ammonia	< 1 / < 5	< 10 / < 50	< 50 / < 250
Oxides of Nitrogen	< 0,05 / < 0,1	< 0,5 / < 1	< 5 / < 10
Ozone	< 0,002 / < 0,005	< 0,025 / < 0,05	< 0,1 / < 1

Table 3 – Details of Environmental Classification (*continued*)

Electromagnetic	E₁	E₂	E₃
Electrostatic discharge – Contact (0,667 µC)	4 kV	4 kV	4 kV
Electrostatic discharge – Air (0,132 µC)	8 kV	8 kV	8 kV
Radiated radio frequency, amplitude modulated (RF – AM)	3 V/m at (80 to 1 000) MHz 3 V/m at (1 400 to 2 000) MHz 1 V/m at (2 000 to 2 700) MHz	3 V/m at (80 to 1 000) MHz 3 V/m at (1 400 to 2 000) MHz 1 V/m at (2 000 to 2 700) MHz	10 V/m at (80 to 1 000) MHz 3 V/m at (1 400 to 2 000) MHz 1 V/m at (2 000 to 2 700) MHz
Conducted radio frequency (RF)	3 V at 150 kHz to 80 MHz	3 V at 150 kHz to 80 MHz	10 V at 150 kHz to 80 MHz
Electrical fast transient/Burst (EFT/B) AC mains power including the protective earth	1 000 V	1 000 V	2 000 V
Electrical fast transient/Burst (EFT/B) I/O (signal/data/control)	500 V	500 V	1 000 V
Surge (transient ground potential difference) - signal, line to earth	500 V	1 000 V	1 000 V
Magnetic Field (50/60 Hz)	1 A/m	3 A/m	30 A/m
Magnetic Field (60 Hz to 20 000 Hz)	ffs	ffs	ffs
^a The repetitive nature of the shock experienced by the channel shall be taken into account.			
NOTE 1 This aspect of environmental classification is installation-specific and should be considered in association with EN 50174-2 and the appropriate component specification.			

5.2 Transmission performance

5.2.1 General

The required transmission performance Class of this clause shall be met for all environmental classifications specified for the channel.

5.2.2 Balanced cabling channel performance

5.2.2.1 General

This standard specifies the following classes for balanced cabling:

- a) Class A: specified up to 0,1 MHz;
- b) Class B: specified up to 1 MHz;
- c) Class C: specified up to 16 MHz;
- d) Class D: specified up to 100 MHz;
- e) Class E: specified up to 250 MHz;
- f) Class E_A: specified up to 500 MHz;
- g) Class F: specified up to 600 MHz;
- h) Class F_A: specified up to 1 000 MHz.

A Class A channel is specified so that it will provide the minimum transmission performance to support Class A applications. Similarly, Class B, C, D, E, E_A, F and F_A channels provide the transmission performance to support Class B, C, D, E, E_A, F and F_A applications respectively. Channels of a given class will support all applications of a lower class. Class A is regarded as the lowest class.

This standard specifies the following additional Classes for balanced cabling in support of specific types of transmission system described in other standards in the EN 50173 series:

- i) Class CCCB: specified up to 0,1 MHz;
- j) Class BCT-B specified up to 1 000 MHz.

The channels specified in 5.2.2 are not guaranteed to support the simultaneous transmission of different applications, of the same or different application Classes of Annex F, within a cable or at an interface to the generic cabling. The sharing of components by applications (to, for example, maximise the capacity of cable management systems) may require additional performance requirements to be applied. These requirements are not included in this standard.

The insertion loss performance of BCT-B cabling is further subdivided into three sub-Classes, L, M and H. These sub-Classes have identical performance requirements for all other transmission parameters.

The parameters specified in this subclause apply to channels with screened or unscreened cable elements, with or without an overall screen, unless explicitly stated otherwise.

The nominal impedance of channels is 100 Ω . This is achieved by suitable design, and appropriate choice of cabling components (irrespective of their nominal impedance).

5.2.2.2 Return loss

The variation of the input impedance of a channel is characterised by the return loss. The return loss parameter is applicable to Classes C, D, E, E_A, F, F_A and BCT-B only. The return loss for each pair of a channel shall meet the limits computed, to one decimal place, using the formulae of Table 4. The limits shown in Table 5 are derived from the formulae at key frequencies only.

When required, the return loss shall be measured according to EN 50346. Terminations of 100 Ω shall be connected to the cabling elements under test at the remote end of the channel. The return loss requirements shall be met at both ends of the cabling.

Table 4 – Formulae for return loss limits for a channel

Class	Frequency MHz	Minimum return loss dB
C	$1 \leq f \leq 16$	15,0
D	$1 \leq f < 20$	17,0
	$20 \leq f \leq 100$	$30 - 10 \times \lg f$
E	$1 \leq f < 10$	19,0
	$10 \leq f < 40$	$24 - 5 \times \lg f$
	$40 \leq f \leq 250$	$32 - 10 \times \lg f$
E _A	$1 \leq f < 10$	19,0
	$10 \leq f < 40$	$24 - 5 \times \lg f$
	$40 \leq f < 398,1$	$32 - 10 \times \lg f$
	$398,1 \leq f \leq 500$	6,0
F	$1 \leq f < 10$	19,0
	$10 \leq f < 40$	$24 - 5 \times \lg f$
	$40 \leq f < 251,2$	$32 - 10 \times \lg f$
	$251,2 \leq f \leq 600$	8,0
F _A	$1 \leq f < 10$	19,0
	$10 \leq f < 40$	$24 - 5 \times \lg f$
	$40 \leq f < 251,2$	$32 - 10 \times \lg f$
	$251,2 \leq f < 631$	8,0
	$631 \leq f \leq 1\,000$	$36 - 10 \times \lg f$
BCT-B	$4 \leq f < 10$	19,0
	$10 \leq f < 100$	$24 - 5 \times \lg f$
	$100 \leq f < 251,2$	$29 - 7,5 \times \lg f$
	$251,2 \leq f < 600$	$17,2 - 2,6 \times \lg f$
	$600 \leq f \leq 1\,000$	$35 - 9 \times \lg f$

Table 5 – Return loss limits for a channel at key frequencies

Frequency MHz	Minimum return loss dB							
	0,1	1,0	16,0	100,0	250,0	500,0	600,0	1 000,0
Class C	N/A	15,0	15,0	N/A	N/A	N/A	N/A	N/A
Class D	N/A	17,0	17,0	10,0	N/A	N/A	N/A	N/A
Class E	N/A	19,0	18,0	12,0	8,0	N/A	N/A	N/A
Class E _A	N/A	19,0	18,0	12,0	8,0	6,0	N/A	N/A
Class F	N/A	19,0	18,0	12,0	8,0	8,0	8,0	N/A
Class F _A	N/A	19,0	18,0	12,0	8,0	8,0	8,0	6,0
Class BCT-B	N/A	19,0	18,0	14,0	11,0	10,2	10,0	8,0

Values of return loss at frequencies for which the measured channel insertion loss is below 3,0 dB are for information only.

5.2.2.3 Insertion loss

The insertion loss α for each pair of a channel shall meet the limits computed, to one decimal place, using the formulae of Table 6. The limits shown in Table 7 are derived from the formulae at key frequencies only.

When required, the insertion loss of the channel shall be measured according to EN 50346.

Table 6 – Formulae for insertion loss limits for a channel

Class	Frequency MHz	Maximum insertion loss dB
A	$f = 0,1$	16,0
B	$f = 0,1$	5,5
	$f = 1$	5,8
C	$1 \leq f \leq 16$	$1,05 \times (3,23 \times \sqrt{f}) + 4 \times 0,2$
D	$1 \leq f \leq 100$	$1,05 \times (1,910 \times \sqrt{f} + 0,022 \times f + 0,2/\sqrt{f}) + 4 \times 0,04 \times \sqrt{f}, 4,0 \text{ min.}$
E	$1 \leq f \leq 250$	$1,05 \times (1,82 \times \sqrt{f} + 0,016 \times f + 0,25/\sqrt{f}) + 4 \times 0,02 \times \sqrt{f}, 4,0 \text{ min.}$
E _A	$1 \leq f \leq 500$	$1,05 \times (1,82 \times \sqrt{f} + 0,009 \times f + 0,25/\sqrt{f}) + 4 \times 0,02 \times \sqrt{f}, 4,0 \text{ min.}$
F	$1 \leq f \leq 600$	$1,05 \times (1,8 \times \sqrt{f} + 0,01 \times f + 0,2/\sqrt{f}) + 4 \times 0,02 \times \sqrt{f}, 4,0 \text{ min.}$
F _A	$1 \leq f \leq 1\,000$	$1,05 \times (1,8 \times \sqrt{f} + 0,005 \times f + 0,25/\sqrt{f}) + 4 \times 0,02 \times \sqrt{f}, 4,0 \text{ min.}$
CCCB	$f = 0,1$	4,0
BCT-B-L	$1 \leq f \leq 1\,000$	$0,132 \times (1,645 \times \sqrt{f} + 0,01 \times f + 0,25/\sqrt{f}) + 2 \times 0,02 \times \sqrt{f}, 2,0 \text{ min.}$
BCT-B-M	$1 \leq f \leq 1\,000$	$0,264 \times (1,645 \times \sqrt{f} + 0,01 \times f + 0,25/\sqrt{f}) + 2 \times 0,02 \times \sqrt{f}, 2,0 \text{ min.}$
BCT-B-H	$1 \leq f \leq 1\,000$	$0,514 \times (1,645 \times \sqrt{f} + 0,01 \times f + 0,25/\sqrt{f}) + 2 \times 0,02 \times \sqrt{f}, 2,0 \text{ min.}$
NOTE The slope (difference in attenuation) between 47 MHz and 862 MHz is critical for BCT- B applications. See F.1 for additional information regarding supported applications.		

Table 7 – Insertion loss limits for a channel at key frequencies

Frequency MHz	Maximum insertion loss dB							
	0,1	1,0	16,0	100,0	250,0	500,0	600,0	1 000,0
Class A	16,0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Class B	5,5	5,8	N/A	N/A	N/A	N/A	N/A	N/A
Class C	N/A	4,2	14,4	N/A	N/A	N/A	N/A	N/A
Class D	N/A	4,0	9,1	24,0	N/A	N/A	N/A	N/A
Class E	N/A	4,0	8,3	21,7	35,9	N/A	N/A	N/A
Class E _A	N/A	4,0	8,2	20,9	33,9	49,3	N/A	N/A
Class F	N/A	4,0	8,1	20,8	33,8	49,3	54,6	N/A
Class F _A	N/A	4,0	8,0	20,3	32,5	46,7	51,4	67,6
Class CCCB	4,0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Class BCT-B-L	N/A	2,0	2,0	2,7	4,4	6,4	7,1	9,5
Class BCT-B-M	N/A	2,0	2,0	5,0	8,2	11,9	13,2	17,6
Class BCT-B-H	N/A	2,0	3,7	9,4	15,3	22,4	24,8	33,2

5.2.2.4 Near-end crosstalk loss (NEXT)**5.2.2.4.1 Pair-to-pair NEXT (NEXT)**

The pair-to-pair NEXT parameter is applicable to Classes A to F_A. The pair-to-pair NEXT α_{NEXT} for each pair combination of a channel shall meet the limits computed, to one decimal place, using the formulae of Table 8. The limits shown in Table 9 are derived from the formulae at key frequencies only.

When required, the NEXT shall be measured according to EN 50346. The NEXT requirements shall be met at both ends of the cabling.

Table 8 – Formulae for NEXT limits for a channel

Class	Frequency MHz	Minimum NEXT dB
A	$f = 0,1$	27,0
B	$0,1 \leq f \leq 1$	$25 - 15 \times \lg f$
C	$1 \leq f \leq 16$	$39,1 - 16,4 \times \lg f$
D	$1 \leq f \leq 100$	$-20 \times \lg \left(10^{\frac{65,3 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{83 - 20 \times \lg f}{-20}} \right), 65,0 \text{ max.}$
E	$1 \leq f \leq 250$	$-20 \times \lg \left(10^{\frac{74,3 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{94 - 20 \times \lg f}{-20}} \right), 65,0 \text{ max.}$
E _A ^{a, c}	$1 \leq f \leq 500$	$-20 \times \lg \left(10^{\frac{74,3 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{94 - 20 \times \lg f}{-20}} \right), 65,0 \text{ max.}$
F	$1 \leq f \leq 600$	$-20 \times \lg \left(10^{\frac{102,4 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{102,4 - 15 \times \lg f}{-20}} \right), 65,0 \text{ max.}$
F _A ^{b, c}	$1 \leq f \leq 1\,000$	$-20 \times \lg \left(10^{\frac{105,4 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{116,3 - 20 \times \lg f}{-20}} \right), 65,0 \text{ max.}$
a Where the channel insertion loss at 450 MHz is less than 12 dB, the requirement is reduced by $1,4((f - 450)/50)$ for $f \geq 450$ MHz. b Where the channel insertion loss at 900 MHz is less than 17 dB, the requirement is reduced by $2,8((f - 900)/100)$ for $f \geq 900$ MHz. c The terms in the formulae are not intended to imply component performance.		

Table 9 – NEXT limits for a channel at key frequencies

Frequency MHz	Minimum NEXT dB							
	0,1	1,0	16,0	100,0	250,0	500,0	600,0	1 000,0
Class A	27,0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Class B	40,0	25,0	N/A	N/A	N/A	N/A	N/A	N/A
Class C	N/A	39,1	19,4	N/A	N/A	N/A	N/A	N/A
Class D	N/A	63,3	43,6	30,1	N/A	N/A	N/A	N/A
Class E	N/A	65,0	53,2	39,9	33,1	N/A	N/A	N/A
Class E _A	N/A	65,0	53,2	39,9	33,1	27,9	N/A	N/A
Class F	N/A	65,0	65,0	62,9	56,9	52,4	51,2	N/A
Class F _A	N/A	65,0	65,0	65,0	59,1	53,6	52,1	47,9

Values of NEXT at frequencies for which the measured channel insertion loss is below 4,0 dB are for information only.

5.2.2.4.2 Power Sum NEXT (PSNEXT)

The PSNEXT parameter is applicable to Classes D, E, E_A, F and F_A only. The PSNEXT α_{PSNEXT} for each pair of a channel shall meet the limits computed, to one decimal place, using the formulae of Table 10. The limits shown in Table 11 are derived from the formulae at key frequencies only.

The PSNEXT requirements shall be met at both ends of the cabling.

PSNEXT of pair k , $\alpha_{PSNEXT}(k)$, is computed from pair-to-pair NEXT $\alpha_{NEXT}(i,k)$ of the adjacent pairs i , $i = 1 \dots n$, as follows:

$$\alpha_{PSNEXT}(k) = -10 \times \lg \sum_{i=1, i \neq k}^n 10^{-0,1 \times \alpha_{NEXT}(i,k)} \quad (1)$$

where $\alpha_{NEXT}(i,k)$ is the pair-to-pair NEXT of pair k to adjacent pair i in dB.

Table 10 – Formulae for PSNEXT limits for a channel

Class	Frequency MHz	Minimum PSNEXT dB
D	$1 \leq f \leq 100$	$-20 \times \lg \left(10^{\frac{62,3 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{80 - 20 \times \lg f}{-20}} \right), 62,0 \text{ max.}$
E	$1 \leq f \leq 250$	$-20 \times \lg \left(10^{\frac{72,3 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{90 - 20 \times \lg f}{-20}} \right), 62,0 \text{ max.}$
E _A ^{a, c}	$1 \leq f \leq 500$	$-20 \times \lg \left(10^{\frac{72,3 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{90 - 20 \times \lg f}{-20}} \right), 62,0 \text{ max.}$
F	$1 \leq f \leq 600$	$-20 \times \lg \left(10^{\frac{99,4 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{99,4 - 15 \times \lg f}{-20}} \right), 62,0 \text{ max.}$
F _A ^{b, c}	$1 \leq f \leq 1\,000$	$-20 \times \lg \left(10^{\frac{102,4 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{113,3 - 20 \times \lg f}{-20}} \right), 62,0 \text{ max.}$
^a Where the channel insertion loss at 450 MHz is less than 12 dB, the requirement is reduced by $1,4((f - 450)/50)$ for $f \geq 450$ MHz. ^b Where the channel insertion loss at 900 MHz is less than 17 dB, the requirement is reduced by $2,8((f - 900)/100)$ for $f \geq 900$ MHz. ^c The terms in the formulae are not intended to imply component performance.		

Table 11 – PSNEXT limits for a channel at key frequencies

Frequency MHz	Minimum PSNEXT dB							
	0,1	1,0	16,0	100,0	250,0	500,0	600,0	1 000,0
Class D	N/A	60,3	40,6	27,1	N/A	N/A	N/A	N/A
Class E	N/A	62,0	50,6	37,1	30,2	N/A	N/A	N/A
Class E _A	N/A	62,0	50,6	37,1	30,2	24,8	N/A	N/A
Class F	N/A	62,0	62,0	59,9	53,9	49,4	48,2	N/A
Class F _A	N/A	62,0	62,0	62,0	56,1	50,6	49,1	44,1

Values of PSNEXT at frequencies for which the measured channel insertion loss is below 4,0 dB are for information only.

5.2.2.5 Attenuation to crosstalk ratio at the near-end (ACR-N)

NOTE ACR-N replaces, and is equivalent to, ACR of previous editions of this standard.

5.2.2.5.1 Pair-to-pair ACR-N

ACR-N of pairs i and k , $\alpha_{ACR-N}(i,k)$, is computed from pair-to-pair NEXT $\alpha_{NEXT}(i,k)$ and insertion loss $\alpha(i)$ of pair i as follows:

$$\alpha_{ACR-N}(i,k) = \alpha_{NEXT}(i,k) - \alpha(i) \quad (2)$$

where

i is the number of the disturbing pair;

k is the number of the disturbed pair;

$\alpha_{NEXT}(i,k)$ is the pair-to-pair NEXT of pair k to adjacent pair i , in dB. The NEXT shall be measured according to EN 50346 in dB;

$\alpha(i)$ is the insertion loss of pair i , when measured according to EN 50346, in dB.

The ACR-N parameter is applicable to Classes D, E, E_A, F and F_A only. The ACR-N for each pair combination of a channel shall meet the limits computed according to Equation (2), to one decimal place, using the relevant formulae of Table 6 and Table 8. The limits shown in Table 12 are derived with Equation (2) at key frequencies only.

The ACR-N requirements shall be met at both ends of the cabling.

Table 12 – ACR-N limits for a channel at key frequencies

Frequency MHz	Minimum ACR-N dB							
	0,1	1,0	16,0	100,0	250,0	500,0	600,0	1 000,0
Class D	N/A	59,3	34,5	6,1	N/A	N/A	N/A	N/A
Class E	N/A	61,0	44,9	18,2	-2,8	N/A	N/A	N/A
Class E _A	N/A	61,0	45,0	19,0	-0,8	-21,4	N/A	N/A
Class F	N/A	61,0	56,9	42,1	23,1	3,1	-3,4	N/A
Class F _A	N/A	61,0	57,0	44,7	23,1	6,9	0,7	-19,6

5.2.2.5.2 Power sum ACR-N (PSACR-N)

PSACR-N of pair k , $\alpha_{PSACR-N}(k)$, is computed from PSNEXT $\alpha_{PSNEXT}(k)$ and insertion loss $\alpha(k)$ of pair k as follows:

$$\alpha_{PSACR-N}(k) = \alpha_{PSNEXT}(k) - \alpha(k) \quad (3)$$

where

k is the number of disturbed pair;

$\alpha_{PSNEXT}(k)$ is the PSNEXT of pair k in dB;

$\alpha(k)$ is the insertion loss of pair k in dB when measured according to EN 50346

The PSACR-N parameter is applicable to Classes D, E, E_A, F and F_A. The PSACR-N for each pair of a channel shall meet the limits computed according to Equation (3), to one decimal place, using the relevant formulae of Table 6 and Table 10. The limits shown in Table 13 are derived with Equation (3) at key frequencies only.

The PSACR-N requirements shall be met at both ends of the cabling.

Table 13 – PSACR-N limits for a channel at key frequencies

Frequency MHz	Minimum PSACR-N dB							
	0,1	1,0	16,0	100,0	250,0	500,0	600,0	1 000,0
Class D	N/A	56,3	31,5	3,1	N/A	N/A	N/A	N/A
Class E	N/A	58,0	42,3	15,4	– 5,8	N/A	N/A	N/A
Class E _A	N/A	58,0	42,4	16,2	– 3,7	– 24,5	N/A	N/A
Class F	N/A	58,0	53,9	39,1	20,1	0,1	– 6,4	N/A
Class F _A	N/A	58,0	54,0	41,7	23,7	3,9	– 2,3	– 22,6

5.2.2.6 Attenuation to crosstalk ratio at the far-end (ACR-F)

NOTE ACR-F replaces, and differs from, ELFEXT of previous editions of this standard.

5.2.2.6.1 Pair-to-pair ACR-F

The ACR-F parameter is applicable to Classes D, E, E_A, F and F_A only.

ACR-F_{*i,k*} of pairs *i* and *k*, $\alpha_{ACR-F}(i,k)$, is computed as follows:

$$\alpha_{ACR-F}(i,k) = \alpha_{FEXT}(i,k) - \alpha(k) \text{ [dB]} \quad (4)$$

where

i is the number of the disturbing pair;

k is the number of the disturbed pair;

$\alpha_{FEXT}(i,k)$ is the far-end crosstalk loss coupled from disturbing pair *i* into disturbed pair *k*. When required, it shall be measured according to EN 50346;

$\alpha(k)$ is the insertion loss of pair *k*. When required, it shall be measured according to EN 50346.

The ACR-F for each pair combination of a channel shall meet the limits computed, to one decimal place, using the equations of Table 14. The limits shown in Table 15 are derived from the equations at key frequencies.

Table 14 – Formulae for ACR-F limits for a channel

Class	Frequency MHz	Minimum ACR-F dB
D	$1 \leq f \leq 100$	$-20 \times \lg \left(10^{\frac{63,8 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{75,1 - 20 \times \lg f}{-20}} \right)$
E	$1 \leq f \leq 250$	$-20 \times \lg \left(10^{\frac{67,8 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{83,1 - 20 \times \lg f}{-20}} \right)$
E _A	$1 \leq f \leq 500$	$-20 \times \lg \left(10^{\frac{67,8 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{83,1 - 20 \times \lg f}{-20}} \right)$
F	$1 \leq f \leq 600$	$-20 \times \lg \left(10^{\frac{94 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{90 - 15 \times \lg f}{-20}} \right), 65,0 \text{ max.}$
F _A	$1 \leq f \leq 1\,000$	$-20 \times \lg \left(10^{\frac{95,3 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{103,9 - 20 \times \lg f}{-20}} \right), 65,0 \text{ max.}$
NOTE ACR-F values at frequencies that correspond to measured FEXT values of greater than 70,0 dB are for information only.		

Table 15 – ACR-F limits for a channel at key frequencies

Frequency MHz	Minimum ACR-F dB							
	0,1	1,0	16,0	100,0	250,0	500,0	600,0	1 000,0
Class D	N/A	57,4	33,3	17,4	N/A	N/A	N/A	N/A
Class E	N/A	63,3	39,2	23,3	15,3	N/A	N/A	N/A
Class E _A	N/A	63,3	39,2	23,3	15,3	9,3	N/A	N/A
Class F	N/A	65,0	57,5	44,4	37,8	32,6	31,3	N/A
Class F _A	N/A	65,0	63,3	47,4	39,4	33,4	31,8	27,4

5.2.2.6.2 Power sum ACR-F (PSACR-F)

The PSACR-F parameter is applicable to Classes D, E, E_A, F and F_A only.

PSACR-F of pair k , $\alpha_{PSACR-F}(k)$, is computed as follows:

$$\alpha_{PSACR-F}(k) = -10 \times \lg \left[\sum_{i=1, i \neq k}^n 10^{\frac{-\alpha_{FEXT}(i,k)}{10}} \right] - \alpha(k) \text{ [dB]} \quad (5)$$

where

i is the number of the disturbing pair;

k is the number of the disturbed pair;

n is the total number of pairs;

$\alpha_{FEXT}(i,k)$ is the far-end crosstalk loss coupled from disturbing pair i into disturbed pair k . When required, it shall be measured according to EN 50346;

$\alpha(k)$ is the insertion loss of pair k . When required, it shall be measured according to EN 50346.

The PSACR-F for each pair of a channel shall meet the limits computed, to one decimal place, using the formulae of Table 16. The limits shown in Table 17 are derived from the formulae at key frequencies.

Table 16 – Formulae for PSACR-F limits for a channel

Class	Frequency MHz	Minimum PSACR-F dB
D	$1 \leq f \leq 100$	$-20 \times \lg \left(10^{\frac{60,8 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{72,1 - 20 \times \lg f}{-20}} \right)$
E	$1 \leq f \leq 250$	$-20 \times \lg \left(10^{\frac{64,8 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{80,1 - 20 \times \lg f}{-20}} \right)$
E _A	$1 \leq f \leq 500$	$-20 \times \lg \left(10^{\frac{64,8 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{80,1 - 20 \times \lg f}{-20}} \right)$
F	$1 \leq f \leq 600$	$-20 \times \lg \left(10^{\frac{91 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{87 - 15 \times \lg f}{-20}} \right), 62,0 \text{ max.}$
F _A	$1 \leq f \leq 1\,000$	$-20 \times \lg \left(10^{\frac{92,3 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{100,9 - 20 \times \lg f}{-20}} \right) 62,0 \text{ max.}$
NOTE PSACR-F values at frequencies that correspond to measured FEXT values of greater than 70,0 dB are for information only.		

Table 17 – PSACR-F limits for a channel at key frequencies

Frequency MHz	Minimum PSACR-F dB							
	0,1	1,0	16,0	100,0	250,0	500,0	600,0	1 000,0
Class D	N/A	54,4	30,3	14,4	N/A	N/A	N/A	N/A
Class E	N/A	60,3	36,2	20,3	12,3	N/A	N/A	N/A
Class E _A	N/A	60,3	36,2	20,3	12,3	6,3	N/A	N/A
Class F	N/A	62,0	54,5	41,4	34,8	29,6	28,3	N/A
Class F _A	N/A	62,0	60,3	44,4	36,4	30,4	28,8	24,4

5.2.2.7 Direct current (d.c.) loop resistance

The d.c. loop resistance for each pair of a channel shall meet the limits given in Table 18. When required, the d.c. loop resistance shall be measured according to EN 50346.