BS EN 50441-4:2012

BSI Standards Publication

Cables for indoor residential telecommunication installations

Part 4: Cables up to 1 200 MHz — Grade 3

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National foreword

This British Standard is the UK implementation of EN 50441-4:2012.

The UK participation in its preparation was entrusted to Technical Committee EPL/46, Cables, wires and waveguides, radio frequency connectors and accessories for communication and signalling.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 70379 9

ICS 33.120.10

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2012.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 50441-4

March 2012

ICS 33.120.10

English version

Cables for indoor residential telecommunication installations - Part 4: Cables up to 1 200 MHz - Grade 3

Câbles pour les installations résidentielles de télécommunications en intérieur - Partie 4: Câbles jusqu'à 1 200 MHz - Classe 3

Innenkabel für Telekommunikationseinrichtungen im Wohnbereich - Teil 4: Kabel bis 1 200 MHz - Klasse 3

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 50441-4:2012 E

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Foreword

This document (EN 50441-4:2012) has been prepared by SC 46XC, "Multicore, multipair and quad data communication cables", of CLC/ TC 46X, "Communication cables".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2013-01-23
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2015-01-23

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This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

1 Scope

This European Standard specifies the constructional details and performance requirements for cables for installation in indoor residential cabling systems characterized up to 1 200 MHz. Cables in this European Standard are based on the common design rules specified in EN 50290-2-1 and are specifically intended for supporting ICT and BCT applications (telephone, computer and TV services) as specified in EN 50173-4.

The cables covered in this European Standard are intended to operate with voltages and currents normally encountered in communication systems. These cables are not intended to be used in conjunction with low impedance sources, for example, the electrical power supply of public utility mains.

Cables covered in this European Standard may however be subjected to voltages of not more than 300 V a.c or 450 V d.c and comply with the requirements of the Low Voltage Directive.

The maximum current rating per conductor is 3 A/mm² unless otherwise specified in the relevant detail specification.

2 Normative references

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

EN 50173-1	*Information technology – Generic cabling systems - Part 1: General requirements*
EN 50289-1-2	*Communication cables – Specifications for test methods - Part 1-2: Electrical test methods – DC resistance*
EN 50289-1-3	*Communication cables – Specifications for test methods – Part 1-3: Electrical test methods – Dielectric strength*
EN 50289-1-4	*Communication cables – Specifications for test methods – Part 1-4: Electrical test methods – Insulation resistance*
EN 50289-1-6	*Communication cables – Specifications for test methods – Part 1-6: Electrical test methods – Electromagnetic performance*
EN 50289-1-7	*Communication cables – Specifications for test methods – Part 1-7: Electrical test methods – Velocity of propagation*
EN 50289-1-8	*Communication cables – Specifications for test methods – Part 1-8: Electrical test methods – Attenuation*
EN 50289-1-9	*Communication cables – Specifications for test methods – Part 1-9: Electrical test methods – Unbalance attenuation (longitudinal conversion loss, longitudinal conversion transfer loss)*
EN 50289-1-10	*Communication cables – Specifications for test methods – Part 1-10: Electrical test methods – Crosstalk*
EN 50289-1-11	*Communication cables – Specifications for test methods – Part 1-11: Electrical test methods – Characteristic impedance, input impedance, return loss*
EN 50289-3-7	*Communication cables – Specifications for test methods – Part 3-7: Mechanical test methods – Abrasion resistance of the cable sheath*
EN 50289-3-9	*Communication cables – Specifications for test methods – Part 3-9: Mechanical test methods – Bending tests*
EN 50289-3-17	*Communication cables – Specifications for test methods – Part 3-17: Mechanical test methods – Adhesion of dielectric and sheath*

EN 50290-2-1:2005	*Communication cables – Part 2-1: Common design rules and construction*
EN 50290-2-22	*Communication cables – Part 2-22: Common design rules and construction – PVC sheathing compounds*
EN 50290-2-23	*Communication cables – Part 2-23: Common design rules and construction – PE insulation*
EN 50290-2-27	*Communication cables – Part 2-27: Common design rules and construction – Halogen free flame retardant thermoplastic sheathing compounds*
EN 60332-1-2	*Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame* (IEC 60332-1-2)
EN 60794-1-2	*Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures* (IEC 60794-1-2)
EN 60811-1-1	*Insulating and sheathing materials of electric and optical cables – Common test methods – Part 1-1: General application – Measurement of thickness and overall dimensions – Tests for determining the mechanical properties* (IEC 60811-1-1)
HD 402 S2:1984	*Standard colours for insulation for low-frequency cables and wires* (IEC 60304:1982)

3 Quality control

Not applicable.

4 Cable construction

4.1 Conductors

4.1.1 Conductor construction

Conductor construction shall be in accordance with EN 50290-2-1:2005, 4.1.

NOTE Constructions with ‘’Copper Clad’’ conductors do not meet the requirements.

4.1.2 Conductor type

The conductor shall be a solid wire of annealed copper with a minimum diameter of 0,5 mm in accordance with EN 50290-2-1.

NOTE Diameters < 0,5 mm and > 0,65 mm may cause problems with connecting hardware. Diameters larger than 0,8 mm could cause connectorisation problems.

4.2 Insulation

4.2.1 Insulation material

The insulation shall be polyethylene in accordance with EN 50290-2-23. Other materials may be used providing that they do not affect compliance with this European Standard and any local regulations (e.g. Environmental Directives).

4.2.2 Thickness of the insulation

The thickness of the insulation shall be compatible with the electrical requirements as defined in Clause 7.

4.2.3 Colour of the insulated conductor

The colour of insulation shall be a reasonable match to HD 402 S2:1984.

4.3 Cable element

The cable element shall be a pair or a quad.

The lay length shall be in accordance with EN 50290-2-1.

4.4 Screening of the cable element

Not specified but might be required to meet local regulation for EMC performance.

4.5 Cabling

The cables shall have at least 4 pairs or 2 quads. The core of the cable shall comply with the requirements specified in 7.4 and 7.5.

4.6 Spare pairs

Not applicable.

4.7 Colour code

The colour code shall be given in the detail specification; it should take into account the local practices as well as international recognised codes.

The colours shall be easily identifiable.

4.8 Screening and wrapping of the core

4.8.1 Core wrapping

The cable core shall be wrapped with one or more non-hydroscopic synthetic tapes. The synthetic tape shall be applied helically or longitudinally with an overlap of a minimum of 10 %.

4.8.2 Screen

The cable core may be screened, when screened in accordance with EN 50290-2-1.

Where a braid is applied, the minimum coverage (mainly for mechanical reasons) shall be 60 %. Where the screen is a metallised foil and a braid, this minimum coverage shall be 30 %. The method of calculating the coverage is described in EN 50290-2-1.

4.9 Sheath

4.9.1 Sheath material

The sheath shall be of a thermoplastic compound according to EN 50290-2-27 or EN 50290-2-22.

4.9.2 Sheath construction

Unless otherwise specified the colour of the sheath shall be cream. The sheath shall be applied to fit closely to the core of the cable but it shall be possible to strip the cable over 20 cm without removing foils or damaging conductors.

The sheath shall be cylindrical and its external aspect shall not reveal the core profile.

The ovality of the finished cable shall be not greater than 0,16.

4.9.3 Thickness of the sheath

The minimum thickness of the sheath shall be equal to or greater than 0,5 mm when measured in accordance with EN 60811-1-1.

4.10 Ripcord

A ripcord shall be laid under the sheath.

4.11 Overall diameter

For installation practices and connectorisation the recommended outer diameter is given in Table 1.

Table 1 – Recommended outer diameter of the sheath

Number of pairs	Maximal outer diameter mm	Minimum thickness of the sheath mm
4	8,0	0,50

NOTE In case of installation by stapling other diameters may be required (see 5.4.7.3).

4.12 Identification

4.12.1 General

Identification shall be provided either by sheath marking or by identification thread.

4.12.2 Sheath marking

Unless otherwise specified by the customer the cable may be marked as follows.

Sheath marking shall be either by a non-degradable print or embossing and shall contain the following minimum information:

- designation of cable including the numbering of the relevant standard;
- reaction to fire classification (ffs);
- name of supplier;
- metric marking.

4.12.3 Identification thread

Where a cable is not identified by sheath marking there shall be an alternative means of identification (e.g. identification thread laid under the sheath, identification tape, printing on the core wrapping, etc.).

Identification shall contain the following minimum information:

- designation of cable including the numbering of the relevant standard;
- reaction to fire classification;
- name of supplier.

4.13 Delivery length

4.13.1 Labelling

Unless otherwise specified in the detail specification drums or coils shall be provided with a label with a non-degradable print containing the following minimum information:

- designation of cable including the numbering of the relevant standard;
- reaction to fire classification;
- name of supplier;
- batch part number;
- length of cable.

EXAMPLE EN 50XXX – £££ – 03/00 – 543 m.

4.13.2 End caps

The ends of the delivery length of cable shall be adequately capped to avoid water ingress.

5 Mechanical requirements

5.1 Conductor

The conductor shall be in accordance with EN 50290-2-1.

5.2 Insulation

The insulation shall be in accordance with EN 50290-2-1.

5.3 Sheath

The sheath shall be in accordance with EN 50290-2-27 or EN 50290-2-22.

5.4 Finished cable

5.4.1 Sheath integrity

Sheath integrity shall be checked during manufacturing by spark test in accordance with EN 50289-1-3.

5.4.2 Static bending radius

The purpose of this test is to demonstrate the ability of the cable to be installed with permanent bending. The test is performed at 2 m from the free end of a 100 m sample.

The test method is given in EN 50289-3-9.

The radius of the mandrel shall be five times the nominal outer diameter. The number of turns shall be one. The number of cycles shall be five.

During and after the test, the cable shall not show any visible mechanical defect. The return loss, transfer impedance (only after the test) and the NEXT shall be within the limits given in Clause 7.

5.4.3 Abrasion resistance of the sheath

Abrasion resistance shall be tested and verified in accordance with EN 50289-3-7.

The number of cycles shall be specified in the detail specification.

5.4.4 Kink test

A test shall be performed on five samples with a loop diameter of four times the outer diameter in accordance with EN 50289-3-9. Only one kink on only one sample is allowed.

5.4.5 Cut-through test

A test shall be performed at five different locations on a 50 m length of cable, with a spacing of 3 m, and with a maximum force of 15 N in accordance with Method E12 of EN 60794-1-2.

The size of the needle should correspond reasonably to the dimensions of the staples to be used in installation.

After the test the cable shall not show any visible mechanical defect. The return loss measured after the test shall be within the limits given in Clause 7.

5.4.6 Adhesion of the sheath

A test shall be performed in accordance with EN 50289-3-17.

The purpose of this test is to evaluate the capability of removing the sheath without damaging the screened un-covered core.

The stripping length shall be 200 mm.

The rate of stripping shall be 100 mm/min.

The stripping force shall be greater than 8 N but not more than 40 N.

5.4.7 Installation capability

5.4.7.1 General

These cables may be installed in ducts, in raceways, directly buried in plaster, surface mounted by gluing or stapling.

Additional tests may be undertaken where agreed between customer and manufacturer to establish the compatibility between the cable sheath and the glue or the plaster, or to establish the stapling ability.

5.4.7.2 Adhesion

Additional tests may be undertaken where agreed between customer and manufacturer to establish the compatibility between the cable sheath and the adhesive.

The test should

a) demonstrate the ability of the glued cable to provide the specified adhesion strength after ageing,

b) ensure that there is no chemical reaction on the sheath after ageing.

5.4.7.3 Stapling

The following additional test shall be undertaken where agreed between customer and manufacturer to establish the stapling capability. The test is aimed to demonstrate that stapling at regular intervals does not affect the return loss of the installed cable.

The following test shall be carried out over an overall length of cable of 100 m. The test fixture (Figure 1) is intended to simulate installation around a door or a window as well as obstacles using staples.

Size of staples shall be according to customer/manufacturer agreement.

Staples shall be applied according to the state of the art. The interval between staples shall be equal to the length of stapler's base or 20 cm ± 2 cm.

Once stapled, the cable shall not show any visible mechanical defect. The return loss and the NEXT shall be in accordance with the limits given in Clause 7.

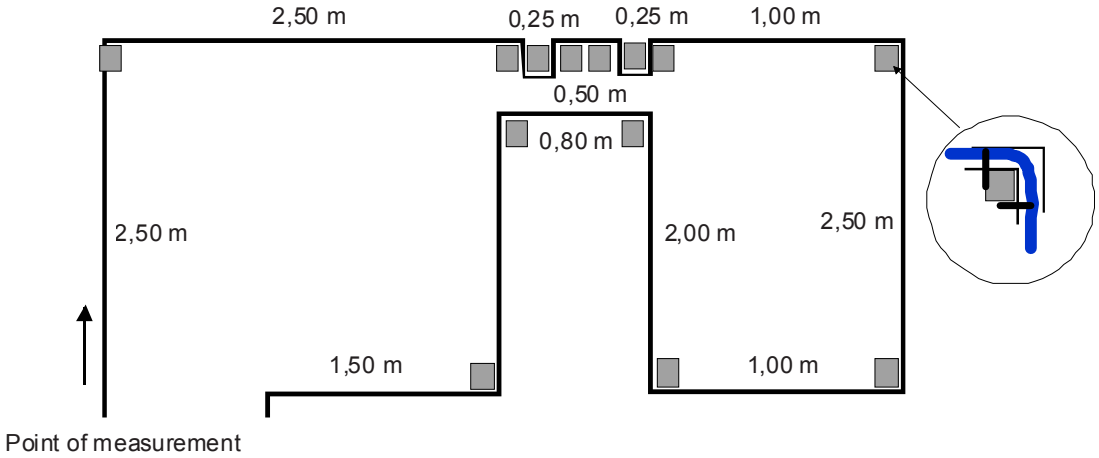

Figure 1 – Test fixture

5.4.7.4 In duct laying

Using a pulling force that shall be below the maximum allowable pulling strength of the cable under test, a sample of 50 m shall be pulled through an installation tube system (see Figure 2). The maximum allowable pulling force can be found in the relevant detail specification of the cable.

The installation tube system shall consist of four 90° bends with a radius of 60 mm each. These four bends will be connected with tube pieces with a length of 800 mm. The maximum inner diameter of the tubes is three times the cable diameter. Tubes shall be selected to represent the installation material of the local market.

The pulling force needed to pull the cable through the tube system shall be monitored. Return loss and coupling attenuation shall be checked on the sample after having performed the installation test. For return loss the complete 50 m sample shall be tested from both ends. For coupling attenuation a random sample out of the 50 m shall be tested.

Return loss and coupling attenuation shall comply with the specification (for RL see 7.5.3 and for coupling attenuation see 7.5.4).

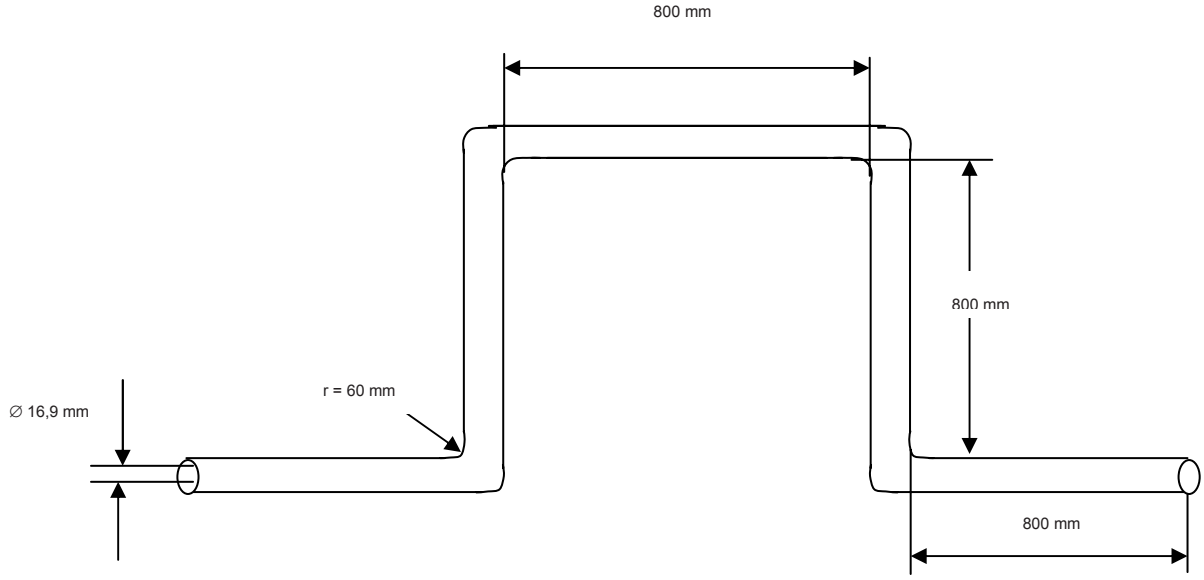

Figure 2 – Installation test system

5.4.7.5 Installation practices

Cables shall be installed in accordance with EN 50173-1.

The installation temperature range without mechanical degradation shall be 0 °C to 50 °C.

During handling and laying the dynamic bending radius shall be greater than eight times the OD. This shall be tested according to EN 50289-3-9.

6 Environmental and climatic requirements

6.1 Insulation

The insulation shall be in accordance with EN 50290-2-1.

6.2 Sheath

The sheath shall be in accordance with EN 50290-2-1.

The sheath material shall meet the general requirements specified in EN 50290-2-22 or EN 50290-2-27.

6.3 Fire behaviour

Unless otherwise required the cable shall meet the requirement of EN 60332-1-2 as a minimum.

7 Electrical requirements

7.1 General

The values given in the tables are for information only. When tested in accordance with EN 50289-1-4 the specified formulas shall be used to determine compliance with figures rounded to one decimal place.

7.2 Conductor resistance

The d.c. resistance of conductors shall not exceed 17,0 Ω/100 m when tested in accordance with EN 50289-1-2.

The conductor resistance unbalance shall not exceed 2,0 %.

7.3 Dielectric strength and capacitance

The cable shall withstand a voltage of 1 kV d.c. for 1 min or 0,7 kV a.c. for 1 min or 2,5 kV d.c. for 2 s or 1,7 kV a.c. for 2 s when tested according to EN 50289-1-3. The test shall be performed between conductors.

There is no requirement specified for the mutual capacitance of the pairs; however, the capacitance unbalance shall not exceed 1 200 pF/km.

7.4 Insulation resistance

Insulation resistance shall be greater than 5 000 Ω.km.

7.5 High frequency characteristics

7.5.1 General

The transmission measurements should be performed on cable samples of 100 m laid out without stress. Other sample configurations that satisfy the performance recommendations of 7.5.2 to 7.5.6 and 7.6 will be deemed to be acceptable provided correlation to the reference method has been verified. In case of conflict, the first method (100 m, off-reel) should be used.

NOTE In the case of box packaged cables, the performance requirements apply after storing the sample for three days after removing the cable from the box.

7.5.2 Impedance

The mean characteristic impedance shall be measured in accordance with EN 50289-1-11 and applies at 100 MHz.

Table 2 – Cable impedance

Nominal characteristic impedance	100 Ω
Mean characteristic impedance	(100 ± 5) Ω

7.5.3 Return loss

The return loss shall be measured in accordance with EN 50289-1-11. For the measurement of return loss a test sample having a round trip loss ≥ 40 dB at any measured frequency should be used.

Table 3 – Return loss measurement

4	8	10	16	20	31,25	62,5	100	250	600	1 200	MHz
23,1	24,5	25,0	25,0	25,0	23,6	21,5	20,1	17,3	17,3	14,3	dB
≥ 20 + 5 log (*f*), 4 MHz ≤ *f* < 10 MHz; ≥ 25 dB, 10 MHz ≤ *f* < 20 MHz; ≥ 25 - 7 log (*f*/20), 20 MHz ≤ *f* ≤ 250 MHz ≥ 17,3 dB, 250 MHz ≤ *f* ≤ 600 MHz ≥ 17,3 - 10 log (*f*/600), 600 MHz ≤ *f* ≤ 1 200 MHz											

7.5.4 Attenuation

The attenuation shall be measured in accordance with EN 50289-1-8. The maximum values are given in Table 4.

Table 4 – Maximum cable attenuation

Frequency MHz	**Attenuation** dB/100 m
1	1,9
4	3,5
10	5,4
16	6,8
20	7,6
31,25	9,6
62,5	13,7
100	17,5
250	28,5
300	31,5
600	46,3
1 200	69,0
NOTE These values are derived from the following equation: $\alpha \leq 1{,}645\sqrt{f} + 0{,}01f + 0{,}25/\sqrt{f}$, 4 MHz ≤ *f* ≤ 1 200 MHz Values below 4 MHz are for information only. The attenuation should meet values adjusted for temperature up to 60 °C with a temperature coefficient of 0,2 % per degree rise above 20 °C.	

7.5.5 Crosstalk

7.5.5.1 General

The crosstalk shall be measured in accordance with EN 50289-1-10.

7.5.5.2 PSNEXT

The minimum PSNEXT value shall comply with the equation 103 - 15 log (*f*/MHz) (for 4 ≤ *f* ≤ 1 200 MHz) as given for typical frequencies in Table 5. For those frequencies where the calculated value of PSNEXT is greater than 75 dB the requirement shall be 75 dB.

Table 5 – Minimum PSNEXT

Frequency MHz	PSNEXT dB
4	≥ 75
62,5	≥ 75
100	≥ 73
250	≥ 67
300	≥ 66
600	≥ 61
1 000	≥ 58
1 200	≥ 57

7.5.5.3 PSELFEXT

The values are to be referenced to 100 m. The minimum PSELFEXT value shall comply with the equation 91 - 20 log (*f*/MHz) (for $4 \le f \le 1\,200$ MHz) as given for typical frequencies in Table 6. For those frequencies where the calculated value of PSELFEXT is greater than 75 dB the requirement shall be 75 dB.

Table 6 – Minimum PSELFEXT

Frequency MHz	PSELFEXT dB
4	≥ 75
10	≥ 71
62,5	≥ 55
100	≥ 51
250	≥ 43
300	≥ 41
600	≥ 35
1 000	≥ 31
1 200	≥ 29

7.5.6 Delay and skew

The phase delay, when measured in accordance with EN 50289-1-7, shall not exceed $534 + 36/\sqrt{f}$ ns/100 m, 1 MHz $\le f \le$ 1 200 MHz.

The propagation delay difference between any combinations of the pairs shall not exceed 25,0 ns/100 m in the frequency range from 4 MHz to 1 200 MHz when the delay is measured at (-20 ± 2) °C, (20 ± 3) °C and (60 ± 1) °C.

7.6 Electromagnetic behaviour

7.6.1 Transfer impedance

The transfer impedance (Z_t) shall be measured in accordance with EN 50289-1-6. The following requirements shall be achieved:

≤ 10 mΩ/m at 1 MHz and 10 MHz;
≤ 30 mΩ/m at 30 MHz;
≤ 60 mΩ/m at 100 MHz.

7.6.2 Coupling attenuation

The coupling attenuation shall be measured in accordance with EN 50289-1-6 and shall be greater than 85 dB between 30 MHz and 100 MHz and 85 - 20 log (f/100 MHz) dB from 100 MHz to 1,2 GHz.

7.6.3 Screening attenuation

The screening attenuation shall be measured in accordance with EN 50289-1-6 and shall be greater than 60 dB between 30 MHz and 1 200 MHz.

7.7 Unbalance attenuation

The near-end unbalance attenuation shall be measured in accordance with EN 50289-1-9. The maximum values are given defined by the equation 40 - 10 log (f/MHz) dB, 1 MHz ≤ f ≤ 200 MHz.

7.8 Environmental and safety aspects

The cable shall comply with local environmental and safety requirements as implemented in the relevant standards and directives.

Bibliography

EN 50173-4 *Information technology – Generic cabling systems – Part 4: Homes*

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