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2005-06

Low-frequency cables with polyolefin insulation and moisture barrier polyolefin sheath

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-FREQUENCY CABLES WITH POLYOLEFIN INSULATION AND MOISTURE BARRIER POLYOLEFIN SHEATH

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60708 has been prepared by subcommittee 46C: Wires and symmetric cables, of IEC technical committee 46: Cables, wires, waveguides, r.f. connectors, r.f. and microwave passive components and accessories.

IEC 60708 cancels and replaces IEC 60708-1 published in 1981 and amendment 3(1988). This edition constitutes a technical revision.

IEC 60708 has been completely revised technically and structurally. IEC 60708 now comprises only one single standard dealing with general design details and requirements. The old IEC 60708-2(1981), IEC 60708-3(1981) and IEC 60708-4(1983) have already been withdrawn because they are not used anymore. Although IEC 60708 addresses low frequency cables, these cables are often used for digital communications up to 2 Mbit/s or 1 MHz. Therefore a Subclause 7.8 has been added, which provides transmission characteristics for the cable when used for digital communication. Furthermore, Annex H of IEC 60708-1(1981) was deleted: The requirements for filling compounds are not needed anymore since they are covered by the cable performance requirements.

The text of this standard is based on the following documents:

FDIS	Report on voting
46C/713/FDIS	46C/728/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above Table.

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

LOW-FREQUENCY CABLES WITH POLYOLEFIN INSULATION AND MOISTURE BARRIER POLYOLEFIN SHEATH

1 Scope

This standard is intended to define polyolefin-insulated cables for insertion into local outdoor networks.

This standard is applicable to polyolefin insulated and moisture barrier polyolefin sheathed telephone cables, filled or unfilled with copper conductors, and used as:

a) Cables suitable for installation in ducts.

b) Cables suitable for direct burial in the ground.

c) Cables with integral suspension strand for aerial installations.

This standard is in accordance with ITU-T Recommendations.

This standard includes general design details and requirements for dimensions and other constructional details as well as mechanical, electrical and environmental characteristics for all types of low-frequency cables with polyolefin insulation (solid or cellular), filled or unfilled, and moisture barrier polyolefin sheath (with integral suspension strand).

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 60028, *International Standard of Resistance for Copper*

IEC 60189-1, *Low-frequency cables and wires with PVC Insulation and PVC sheath – Part 1: General test and measuring methods*

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

IEC 60811-1-1, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*

IEC 60811-1-2, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Two: Thermal ageing methods*

IEC 60811-1-3, *Insulating and sheathing materials of electric cables – Part 1: General application – Section 3: Methods for determining the density – Water absorption tests – Shrinkage test*

IEC 60811-1-4, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four – Test at low temperature*

IEC 60811-4-1, *Insulating and sheathing materials of electric and optical cables – Common test methods – Part 4-1: Methods specific to polyethylene and polypropylene compounds – Resistance to environmental stress cracking – Measurement of the melt flow index – Carbon black and/or mineral filler content measurement in polyethylene by direct combustion – Measurement of carbon black content by thermogravimetric analysis (TGA) – Assessment of carbon black dispersion in polyethylene using a microscope*

IEC 60811-4-2, *Insulating and sheathing materials of electric and optical cables – Common test methods – Part 4-2: Methods specific to polyethylene and polypropylene compounds – Tensile strength and elongation at break after conditioning at elevated temperature – Wrapping test after conditioning at elevated temperature – Wrapping test after thermal ageing in air – Measurement of mass increase – Long-term stability test – Test method for copper-catalyzed oxidative degradation*

IEC 60811-5-1, *Common test methods for insulating and sheathing materials of electric cables – Part 5-1: Methods specific to filling compounds – Drop point – Separation of oil – Lower temperature brittleness – Total acid number – Absence of corrosive components – Permittivity at 23 °C – DC resistivity at 23 °C and 100 °C*

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

ITU-T L.3, *Armouring of cables*

3 Quality assurance

It is the responsibility of the manufacturer to establish quality assurance by quality control procedures which will ensure that the product will meet the requirements of this standard.

It is not intended that a complete testing programme shall be carried out on every length of conductor and cable. When the purchaser wishes to specify acceptance tests or other quality procedures, it is essential that agreement be reached between the purchaser and the manufacturer by the time of ordering.

4 Cable construction

4.1 Conductor

4.1.1 Conductor material

The conductor shall consist of annealed copper, uniform in quality and free from defects. The properties of the copper shall be in accordance with IEC 60028.

4.1.2 Type of conductor

The conductor shall consist of a single strand circular in section. The nominal diameter shall be at least 0,4 mm.

4.1.3 Conductor-finish

The conductor shall be plain.

4.1.4 Continuity of conductor

Joints in the conductor are permitted provided that the tensile strength of a joint is not less than 90 % of the tensile strength of the unjointed conductor.

4.2 Insulation

4.2.1 Insulation material

The conductor shall be covered with solid or cellular polyolefin insulation or any combination thereof.

For cellular insulation, the cells produced by the expanding process shall be uniformly distributed circumferentially and should be substantially non-intercommunicating.

The material for the insulation shall be a virgin thermoplastic compound suitably stabilized. Examples of suitable materials are:

– Polyethylene.
– Polypropylene.

4.2.2 Insulation thickness

The insulation shall be continuous and shall have a thickness such that the completed cable will meet the electrical requirements specified.

4.2.3 Colour of insulated conductor

The insulated conductors shall be coloured. Colours shall be readily identifiable and shall correspond reasonably with the standard colours shown in IEC 60304.

4.3 Cabling element

A cabling element (Figure 1) shall be:

- a pair of two insulated conductors twisted together and designated wire a and b respectively,

or

- a quad of four insulated conductors twisted together and designated wire a, wire c, wire b, and wire d respectively.

The maximum length of lay in the finished cable shall not exceed 150 mm.

NOTE Forming the element with a variable lay can lead to the infrequent but acceptable occurrence of the maximum lay being longer than specified.

4.4 Stranding

The cable elements shall be formed into a number of sub-units or units which can be stranded into a regular make up to produce the required number of pairs.

4.5 Colour code

4.5.1 General

Three different colour schemes for identifying pair or quad counts are defined. One with 10 pair or 5 quad sub-units, one for 25 pair colour groups and a third for 25 quad colour groups.

4.5.2 Sub-units, units and cables up to and including 100 pairs or 100 quads

4.5.2.1 10 pair or 5 quad count

The pairs or quads shall be identified by each insulated conductor having a single colour in accordance with the colour scheme given in Annex A.

Sub-units of 10 pairs or 5 quads shall be identified by coloured bindings of tape or threads according to the colour scheme given in Annex B for assembly into units of 50 pairs (25 quads) or 100 pairs (50 quads).

4.5.2.2 25 pair count

The pairs shall be identified by each insulated conductor having a single colour in accordance with the colour scheme given in Annex C.

Sub-units shall be identified by coloured bindings of tape or threads. Each group of sub-units making up a 25 pair count shall be identified by a common colour of bindings. For 50 and 100 pair cables the colours of the bindings are given in Annex D.

4.5.2.3 25 quad count

The quads shall be identified by each insulated conductor having a single colour in accordance with the colour scheme given in Annex E.

Sub-units shall be identified by coloured bindings of tape or threads. Each group of sub-units making up a 25 quad count shall be identified by a common colour of bindings. For 50 quad (100 pair) and 100 quad (200 pair) cables the colours of the bindings are given in Annex D.

4.5.3 Cables of more than 100 pairs or 100 quads

Cables shall be assembled in concentric layers of units. The units shall be identified by coloured bindings of tape or threads.

4.5.3.1 Marker / reference identification system

In each layer, the marker unit shall be identified by red coloured bindings, the reference unit shall be identified by green coloured bindings and the other units shall be identified by bindings of a contrasting or natural colour.

The marker and reference units shall be adjacent and the counting of units in each layer of the cable shall be in the same direction.

4.5.3.2 Marker identification system

In each layer, the marker unit shall be identified by red coloured bindings and the other units shall be identified by bindings of a contrasting or natural colour.

4.5.3.3 Full colour code system for 25 pair count

Each 25 pair count group shall be identified by bindings coloured in accordance with Annex F.

4.5.3.4 Full colour code system for 10 pair or 5 quad count or 25 quad count

Each group of sub-units making up a 100 pair (50 quad) count group shall be identified by a common colour of bindings in accordance with Annex G.

4.6 Spare pairs or quads

Spare pairs or quads may be provided individually or as a spare pair unit and shall be placed in the interstices of the cable core.

4.7 Filling

For filled cables, the interstices of the cable core shall be filled continuously with a compound suitable to prevent water penetration within the cable.

The filling compound shall be compatible with the other relevant cable elements. The suitability shall be tested by the use of the following test methods:

– the amount of oil separation from the filling compound shall meet the requirements of Clause 5 of IEC 60811-5-1.

– The drop point shall be less than 70 °C. The determination of the drop point shall be in accordance with Clause 4 of IEC 60811-5-1.

– The filling compound shall be tested for the presence of corrosive components in accordance with Clause 8 of IEC 60811-5-1.

4.8 Core protection

The core of the cable may have a protective layer (e.g. a helical or longitudinal lapping of one or more tapes).

4.9 Sheath

4.9.1 General

A moisture barrier aluminium laminated polyethylene sheath construction is specified for both underground and aerial cables. This type of sheath will also provide screening.

For aerial cables a figure "8" construction is specified.

Circular sheath cables can also be used as aerial cables.

4.9.2 Sheath material

4.9.2.1 Polyethylene

The polyethylene shall have a minimum carbon black content of 2,0 %.

4.9.2.2 Aluminium tape

The aluminium tape shall be coated on at least one side with a polymer film. The aluminium tape without the polymer layer shall have a nominal thickness of at least 0,15 mm.

4.9.3 Application of the sheath

4.9.3.1 Sheath

The aluminium tape shall be applied longitudinally with a minimum overlap of not less than 6 mm or 20 % of the circumference of the core protection, whichever is the smaller.

The polyethylene part of the sheath shall adhere to the polymer coating of the aluminium tape and the sheath shall be applied to fit closely to the protected core of the cable.

4.9.3.2 Sheath with an integral suspension strand

The polyethylene part of the sheath, complying with 4.9.3.1, shall cover the suspension strand and cable core to form a figure "8" construction in which the suspension strand is parallel with but separate from the cable core.

NOTE The web dimensions should be compatible with the clamping hardware.

The minimum tensile strength of strand is specified in Table 1.

Table 1 –Tensile strength of strand

Maximum overall diameter of the sheathed cable core D_{max} mm	**Minimum tensile strength of strand** kN
D_{max} <10	6,0
10 ≤ D_{max} <20	12,5
20 ≤ D_{max} <30	16,0
30 ≤ D_{max} <40	22,5

4.10 Cable protection

According to ITU-T Recommendation L.3, armouring can be applied over the sheath to improve the strength of the cable against mechanical damage, rodents and insect attack and/or to improve the screening efficiency against electromagnetic interference and lightning discharges. The armouring may be made by metallic tape (or tapes) or wires with a protective layer.

4.11 Finished cable

4.11.1 Overall diameter

To obtain nominal values, the user may ask the supplier to quote his values.

The overall diameter of the cable shall be measured in accordance with the method specified in 2.2.2 of IEC 60189-1.

4.11.2 Sheath marking

The sheath may be marked. Common methods of marking are embossing, sintering, imprinting, hot foil and surface printing.

Marking may be provided as a single or double line of marking. A single line of marking shall be provided by marking longitudinally along the length of the cable. A double line of marking shall be provided with the two lines diametrically opposite each other, longitudinally along the length of the cable.

The abrasion resistance of the sheath markings shall be demonstrated in accordance with IEC 60794-1-2, method E2B.

For a double line of marking, the abrasion resistance test needs only be carried out on one line of marking.

4.11.3 Sealing of ends

The ends of the finished cable shall be adequately sealed to prevent the ingress of moisture.

4.12 Delivery

Delivery shall be made on drums with suitable protection.

5 Mechanical requirements

5.1 Conductor

Elongation at break of the bare conductor shall be not less than:

- 10 % for conductor of 0,4 mm diameter;
- 15 % for conductor over 0,4 mm diameter.

Compliance shall be checked by measuring the elongation at break in accordance with the method specified in 3.3 of IEC 60189-1.

5.2 Insulation

The elongation at break shall be measured on tubular samples in accordance with the method specified in 9.1 of IEC 60811-1-1.

The measured values of elongation at break shall be not less than 300 %.

5.3 Sheath

5.3.1 Tensile strength and elongation

Compliance shall be checked on samples of sheath after removing the aluminium tape by measuring the tensile strength and elongation at break in accordance with the method specified in 9.2 of IEC 60811-1-1.

The measured values of tensile strength shall be not less than:

- 10 MPa for low or medium density polyethylene;
- 16,5 MPa for high density polyethylene.

The median of the measured values of elongation at break shall be not less than 300 %.

5.3.2 Adhesion of aluminium tape to the polyethylene

The force required to peel the aluminium tape from the polyethylene shall be not less than 0,8 N per millimetre width when tested as follows:

Rectangular test pieces about 150 mm long and 15 mm wide shall be cut longitudinally from the cable sheath in one operation using a sharp punch. The test piece shall not include the overlap of the aluminium tape.

About 50 mm of the aluminium tape shall be separated from one end of the test piece. The aluminium tape shall be inserted in the upper grip of a suitable tensile testing machine and the separated end of sheath of the test piece in the lower grip.

The grips of the tensile machine shall be separated at a rate of 100 ± 50 mm/min and the average force required to separate the aluminium tape and the polyethylene sheath shall be noted.

The mean of three determinations shall be recorded as the force required to peel the aluminium tape from the cable sheath.

5.3.3 Adhesion of aluminium tape at the overlap

The force required to peel the aluminium tape at the overlap shall be not less than 0,8 N per millimeter.

5.4 Finished cable

5.4.1 Sheath integrity

5.4.1.1 The sheath shall withstand a spark test voltage of at least 8 kV r.m.s. or 12 kV d.c.

5.4.1.2 For unfilled cables, the sheath shall withstand without leakage an internal gas pressure of 50 kPa to 100 kPa for 2 h after equalization of pressure throughout the cable length.

NOTE It is not necessary to carry out this test if the sheath is tested in accordance with 5.4.1.1.

5.4.2 Resistance to water penetration

For filled cables, the interstices of the cable core shall be filled continuously with compound to prevent the water penetration within the cable.

Compliance shall be checked on samples of filled cable according to IEC 60794-1-2, method F5B.

5.4.3 Cable drip

The cable shall pass the compound flow test of IEC 60794-1-2, method E14. The test temperature shall be 70 °C.

6 Thermal stability and environmental requirements

6.1 Insulation

6.1.1 Thermal oxidative stability (OIT-test)

A 30 cm length of cable, with its ends sealed, shall be conditioned in an oven for 14 days at 70 °C. At the end of the conditioning period, one sample of each colour of insulation shall be removed from the cable, any filling compound present removed by wiping with a dry towel, and the measurement of OIT of the insulation carried out at 200 °C in accordance with Annex B of IEC 60811-4-2.

The insulation shall be removed from the conductor prior to testing.

The minimum oxidative induction time of any pair/quad in the finished cable shall not be less than 40 min for solid insulation and 60 min for cellular insulation.

6.1.2 Shrinkage

The shrinkage of the insulation shall be not more than 5 % when measured on a 200 mm long sample (L) in accordance with Clause 10 of IEC 60811-1-3.

The heating time shall be 1 h and the test temperature shall be 115 ± 1 °C.

6.1.3 Wrapping test of insulation after thermal aging

The insulation of filled cables after thermal ageing shall comply with the wrapping test specified in Clause 9 of IEC 60811-4-2.

6.1.4 Bending test at low temperature

The insulation shall comply with the bending test at –40 °C specified in 8.1 of IEC 60811-1-4.

6.2 Sheath

6.2.1 Elongation at break after ageing

The mechanical characteristics of the sheath shall remain sufficiently constant during normal use. This is checked by determining the elongation at break according to 9.2 of IEC 60811-1-1 after an ageing test at 100 ± 2 °C for 10 × 24 h according to 8.1 of IEC 60811-1-2. The median of the values of elongation at break shall be not less than 300 %.

6.2.2 Resistance to weathering

The polyethylene sheath shall contain 2,5 ± 0,5 % carbon black, well dispersed. The carbon black content of the polyethylene sheath shall be measured in accordance with the method specified in Clause 11 of IEC 60811-4-1.

6.2.3 Resistance to environmental stress cracking

The resistance to environmental stress cracking shall comply with the requirements specified in Clause 8 of IEC 60811-4-1. Procedure B shall be applied.

7 Electrical requirements

7.1 General

Values of statistical requirements of the parameters specified below shall relate to a significant distribution of measurements carried out on cable lengths considered for inspection.

7.2 Electrical resistance of conductor

The electrical resistance of the conductor at a temperature of 20 °C shall not exceed the values given in Table 2.

Table 2 – Conductor resistance

Conductor nominal diameter mm	Individual value Ω/km	Average Ω/km
0,4	150	144
0,5	96,0	92,1
0,6	66,6	63,9
0,8	36,8	35,3

The resistance shall be measured in accordance with the method specified in 5.1 of IEC 60189-1.

NOTE The maximum individual values are in accordance with IEC 60344, using k4 value for a cabling lay factor greater than 16. The maximum average values are 96 % of the maximum individual values.

7.3 Electrical resistance unbalance

The electrical resistance unbalance between conductors in the same pair shall not exceed 2 %.

It is defined as:

$$\frac{R_{\text{max}} - R_{\text{min}}}{R_{\text{max}} + R_{\text{min}}} \times 100$$

where

R_{max} = resistance, in ohms, for the conductor with the higher resistance value

R_{min} = resistance, in ohms, for the conductor with the lower resistance value

The measurement shall be carried out on the finished cable by means of a device capable of measuring to within 0,5 % of the value of the conductor resistance.

7.4 Dielectric strength

The dielectric strength of the insulation shall be checked on the finished cable. The insulation shall withstand the application of a d.c. test voltage. The test voltages for alternative durations are given in Table 3.

Table 3 – Dielectric strength

Type of insulation	Conductor to conductor		Conductor to screen	
	Duration of test		Duration of test	
	3 s	60 s	3 s	60 s
Solid	2 kV	1 kV	6 kV	3 kV
Cellular	1 kV	0,5 kV	2 kV	1 kV

NOTE An a.c. test voltage of $V_{\text{d.c.}}/\sqrt{2}$ may be used.

7.5 Insulation resistance

The insulation resistance at a temperature of 20 °C shall be not less than:

- for filled cables 1 500 MΩ·km
- or unfilled cables 5 000 MΩ·km

The insulation resistance shall be measured in accordance with the method specified in 5.3 of IEC 60189-1.

7.6 Mutual capacitance

The mutual capacitance shall not exceed the values given in Table 4.

Table 4 – Mutual capacitance

Capacitance level of cables and number of pairs or quads in cable	Maximum average nF/km	Maximum individual nF/km
High capacitance level:		
1) 20 pairs or 10 quads or more	55	64
2) less than 20 pairs or 10 quads	-	64
Low capacitance level:		
1) 20 pairs or 10 quads or more	42	49
2) less than 20 pairs or 10 quads	-	49

The capacitance shall be measured in accordance with the method specified in 5.4 of IEC 60189- 1.

7.7 Capacitance unbalance

The capacitance unbalance shall not exceed the values given in Table 5 per 500 m length of cable:

Table 5 – Capacitance unbalance

	Individual value pF		95 % values pF	
	0,4, 0,5 and 0,6 mm	0,8 mm	0,4, 0,5 and 0,6 mm	0,8 mm
Pair-to-pair	250	160	150	100
Side-to-side	800	500	500	300
Pair-to-earth		1 700		1 000
Side-to-earth		1 700		1 000

The capacitance unbalance shall be measured in accordance with the method specified in 5.5 of IEC 60189-1. If the tested cable has a length L other than 500 m the measured value shall be corrected as follows:

– for pair-to-pair and side-to-side: the measured value shall be divided by:

$$0{,}5 \times (L/500 + \sqrt{L}/500)$$

– for pair-to-earth and side-to earth- the measured value shall be divided by:

$$L/500$$

In all cases, lengths of less than 100 m shall be considered as equal to 100 m.

When measuring pair-to-earth capacitance unbalance, all pairs except the pair under test shall be connected to the aluminium tape and earth.

When measuring side-to-earth capacitance unbalance, all quads except the quad under test shall be connected to the aluminium tape and earth. The other two wires of the quad shall be connected to the mid-point of the bridge.

7.8 Transmission characteristics (when used for digital communication)

7.8.1 Attenuation

Attenuation values depend on cable design und should be given by the manufacturer.

Measurement method according to IEC 61156-1, 3.3.2.

7.8.2 Near End Crosstalk (NEXT)

NEXT values are given in Table 6.

Measurement method according to IEC 61156-1, 3.3.3.

7.8.3 Equal Level Far-end Crosstalk (ELFEXT)

ELFEXT values are given in Table 6.

Measurement method according to IEC 61156-1, 3.3.5.

7.8.4 Power sum (PS) of crosstalk loss

Power sum values of near-end and equal-level far-end crosstalk loss are given in Table 6.

Measurement method according to IEC 61156-1

Table 6 – Transmission characteristics

Frequency kHz	**Minimum** **NEXT** dB	**Minimum** **ELFEXT** dB at 1 km	**Minimum** **PS NEXT** dB	**Minimum** **PS ELFEXT** dB at 1 km
150	52	58	49	54
300	48	52	45	48
1 000	40	42	37	38

7.8.5 Characteristic impedance

The nominal value of characteristic impedance Z_0 of the cable shall be in the range from 80 Ω to 130 Ω at 1 MHz, depending on the design. The maximum deviation from the nominal characteristic impedance shall be within ±15 %.

Measurement method according to IEC 61156-1, 3.3.6.

7.8.6 Velocity of propagation

The velocity of propagation shall be >60 % at 1 MHz.

Measurement method according to IEC 61156-1, 3.3.1.

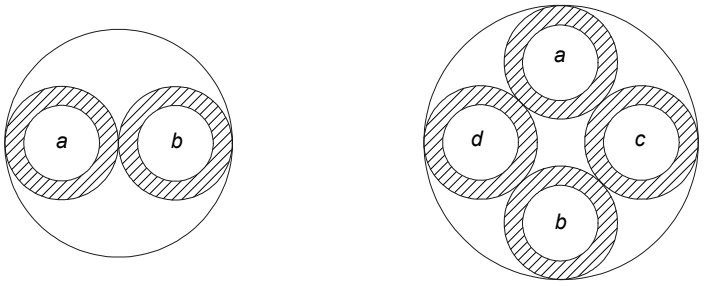

Figure 1 – Cabling elements

Annex A
(normative)

Colour code: 10 pair or 5 quad count

See Tables A.1 and A.2.

Table A.1 – 10 pair count

Cable element	Colour of insulation a-wire	b-wire
1	white	blue
2	“	orange
3	“	green
4	“	brown
5	“	grey
6	red	blue
7	“	orange
8	“	green
9	“	brown
10	“	grey

Table A.2 – 5 quad count

	Colour of insulation			
Cable element	**a-wire**	**b-wire**	**c-wire**	**d-wire**
1	White	Blue	Turquoise	Violet
2	“	Orange	“	“
3	“	Green	“	“
4	“	Brown	“	“
5	“	grey	“	“

Annex B
(normative)

Colour code: sub-unit identification for 50 pair (25 quad) and 100 pair (50 quad) cables or units, using 10 pair or 5 quad count

B.1 Full colour code system

See Table B.1.

Table B.1 – Full colour code system

Sub-unit number	Colour of bindings
1	Blue
2	Orange
3	Green
4	Brown
5	grey
6	White
7	Red
8	Black
9	Yellow
10	violet

B.2 Marker/reference identification system

In each layer, the marker sub-unit shall be identified by red coloured bindings, the reference sub-unit shall be identified by green coloured bindings and the other sub-units shall be identified by bindings of a contrasting or natural colour.

The marker and reference sub-units shall be adjacent and the counting of sub-units in each layer of the cable shall be in the same direction.

B.3 Marker/identification system

In each layer, the marker sub-unit shall be identified by red coloured bindings and the other sub-units shall be identified by bindings of a contrasting or natural colour.

Annex C
(normative)

Colour code: 25 pair count

See Table C.1.

Table C.1 – Colour of insulation

Pair	a-wire	b-wire
1	White	Blue
2	“	Orange
3	“	Green
4	“	Brown
5	“	Grey
6	red	Blue
7	“	Orange
8	“	Green
9	“	Brown
10	“	Grey
11	black	Blue
12	“	Orange
13	“	Green
14	“	Brown
15	“	Grey
16	yellow	Blue
17	“	Orange
18	“	Green
19	“	Brown
20	“	Grey
21	violet	Blue
22	“	Orange
23	“	Green
24	“	Brown
25	“	Grey

Annex D
(normative)

Colour code: unit identification for 50 pair or quad and 100 pair or quad cables or units, using 25 pair or quad count

See Table D.1.

Table D.1 – Colour of insulation

25 pair or quad count group number	1	2	3	4
Colour of bindings	Blue	orange	green	brown
NOTE 1 White may be included with each of the four colours.				
NOTE 2 Multiple units of 50 or 100 pairs or quads may be used.				

Annex E
(normative)

Colour code: 25 quad count

See Table E.1.

Table E.1 – Colour of insulation

Quad	a-wire	b-wire	c-wire	d-wire
1	White	Blue	Turquoise	Violet
2	“	Orange	“	“
3	“	Green	“	“
4	“	Brown	“	“
5	“	Grey	“	“
6	red	Blue	turquoise	violet
7	“	Orange	“	“
8	“	Green	“	“
9	“	Brown	“	“
10	“	Grey	“	“
11	black	Blue	turquoise	violet
12	“	Orange	“	“
13	“	Green	“	“
14	“	Brown	“	“
15	“	Grey	“	“
16	yellow	Blue	turquoise	violet
17	“	Orange	“	“
18	“	Green	“	“
19	“	Brown	“	“
20	“	Grey	“	“
21	pink	Blue	turquoise	violet
22	“	Orange	“	“
23	“	Green	“	“
24	“	Brown	“	“
25	“	Grey	“	“

Annex F
(normative)

Colour code: unit identification for cables with more than 100 pairs, 25 pair count

See Table F.1.

Table F.1 – Colour of bindings

25 pair count group number	Colour of bindings
1	White – blue
2	White – orange
3	White – green
4	White – brown
5	White – grey
6	Red – blue
7	Red – orange
8	Red – green
9	Red – brown
10	Red – grey
11	Black – blue
12	Black – orange
13	Black – green
14	Black – brown
15	Black – grey
16	Yellow – blue
17	Yellow – orange
18	Yellow – green
19	Yellow – brown
20	Yellow – grey
21	Violet – blue
22	Violet – orange
23	Violet – green
24	Violet – brown
25	Violet – grey
NOTE Multiple units of 50 or 100 pairs may be used.	

For cables of more than 600 pairs, the binding over each multiple unit shall be coloured as given in Table F.2.

Table F.2 – Colour of bindings of multiple units

Multiple units of	Colour
First 24 groups	White
Second 24 groups	Red
Third 24 groups	Black
Fourth 24 groups	Yellow

Annex G
(normative)

Colour code: unit identification for cables with more than 100 pairs or 50 quads, using 10 pair or 5 quad count or 25 quad count

See Table G.1.

Table G.1 – Colour of bindings

100 pair (50 quad) count group number	Colour of bindings
1	Blue
2	Orange
3	Green
4	Brown
5	Grey
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	White – blue
12	White – orange
13	White – green
14	White – brown
15	White – grey
16	Red – blue
17	Red – orange
18	Red – green
19	Red – brown
20	Red – grey

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