INTERNATIONAL STANDARD

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Fourth edition
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Low-frequency cables and wires with PVC insulation and PVC sheath –

Part 2: Cables in pairs, triples, quads and quintuples for inside installations

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-FREQUENCY CABLES AND WIRES WITH PVC INSULATION AND PVC SHEATH –

Part 2: Cables in pairs, triples, quads and quintuples for inside installations

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International Standard IEC 60189-2 has been prepared by subcommittee 46C: Wires and symmetrical cables, of IEC technical committee 46: Cables, wires, waveguides, r.f. connectors, r.f. and microwave passive components and accessories.

This fourth edition cancels and replaces the third edition published in 1981, amendment 1 (1989) and amendment 2 (1996). This edition constitutes a technical revision.

This edition includes an update of the technical characteristics.

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

FDIS	Report on voting
46C/821/FDIS	46C829/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 list of all the parts of the IEC 60189 series, under the general title *Low-frequency cables and wires with PVC insulation and PVC sheath*, can be found on the IEC website.

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- withdrawn,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 publication may be issued at a later date.

LOW-FREQUENCY CABLES AND WIRES WITH PVC INSULATION AND PVC SHEATH –

Part 2: Cables in pairs, triples, quads and quintuples for inside installations

1 Scope

This part of IEC 60189 is applicable to cables for inside installations, intended for the interconnection of the following:

– transmission equipment;

– telecommunications equipment;

– equipment for data processing.

NOTE 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 must 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.

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 60189-1:2007, *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 60332-3 (all parts):*Tests on electric cables under fire conditions – Part 3: Test for vertical flame spread*

IEC 60344, *Calculation method of resistance of plain and coated copper conductors of low-frequency cables and wires – Application guide*

3 Terms and definitions

For the purposes of this document, the terms and definitions are given in IEC 60189-1 apply.

4 Cable construction and dimensions

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.

4.1.3 Conductor finish

The conductor may be either plain or tinned.

4.1.4 Conductor dimensions

The conductor is designated by its nominal diameter.

Dimensions are given in Annex C.

4.1.5 Continuity of conductor

Normally the conductor shall be drawn in one piece. In cases of necessity, joints in the conductor are permitted provided that the breaking strength of a joint is not less than 85 % of the breaking strength of the unjointed conductor.

4.2 Insulation

4.2.1 Insulation material

The insulation shall consist of polyvinyl chloride (PVC).

NOTE The term “polyvinyl chloride” denotes a plasticized compound of polyvinyl chloride or vinylchloride vinylacetate copolymers.

4.2.2 Insulation thickness

The insulation shall be continuous having a thickness as uniform as possible, not less than 0,15 mm for a nominal conductor diameter up to and including 0,6 mm, and not less than 0,25 mm for a nominal conductor diameter of 0,8 mm.

The minimum thickness of the insulation shall be measured in accordance with the method specified in 5.2.1.1 of IEC 60189-1.

4.2.3 Application of the insulation

The insulation shall be applied to fit closely to the conductor without adhering to it.

The stripping properties of the insulation shall be checked in accordance with the method specified in 6.4.2 of IEC 60189-1.

It shall be possible to strip the insulation from the conductor easily and without damage to the insulation, to the conductor, or to the tinning, if any.

4.2.4 Colour of insulation

The insulated conductors shall be coloured by one colour or by two different colours.

Colours shall correspond reasonably with the standard colours shown in IEC 60304. When two colours are used, the following conditions shall be fulfilled:

– markings shall be rings or helices: if helices, single helices are preferred, double helices however are allowed;
– markings may be made by helical bicolour extrusion;

– markings printed or painted on the insulation shall adhere satisfactorily;
– markings shall be easily identifiable within any 15 mm length of the insulated conductor;
– the distance of repetition of the markings shall be not less than 4 mm, measured from centre to centre parallel to the axis;
– the width of the rings or helices and the width of their spacing measured parallel to the axis, shall be approximately constant and shall be not less than 1,5 mm;
– the width of the rings or helices need not be the same as that of the spacing.

NOTE For wires identified by ring marking, neither the registration of the two half-bands nor the complete encirclement of the wire is critical.

4.3 Cabling element

A cabling element (Figure 1) shall be

– a pair of two insulated conductors twisted together and designated wire a and wire b respectively, or
– a triple of three insulated conductors twisted together and designated wire a, wire b and wire c respectively, or
– a quad (star quad) of four insulated conductors twisted together and designated wire a, wire b, wire c and wire d respectively, or
– a quintuple of five insulated conductors made up in one of the following ways:
  a) five insulated conductors, twisted together and designated wire a, wire b, wire c, wire d and wire e;
  b) four insulated conductors, twisted together and designated wire a, wire b, wire c and wire d and one designated wire e not twisted;
  c) two insulated conductors, twisted together and designated wire a and wire b, combined with two insulated conductors, twisted together and designated wire c and wire d, and one wire designated e.

The maximum length of lay in the finished cable shall be 120 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.

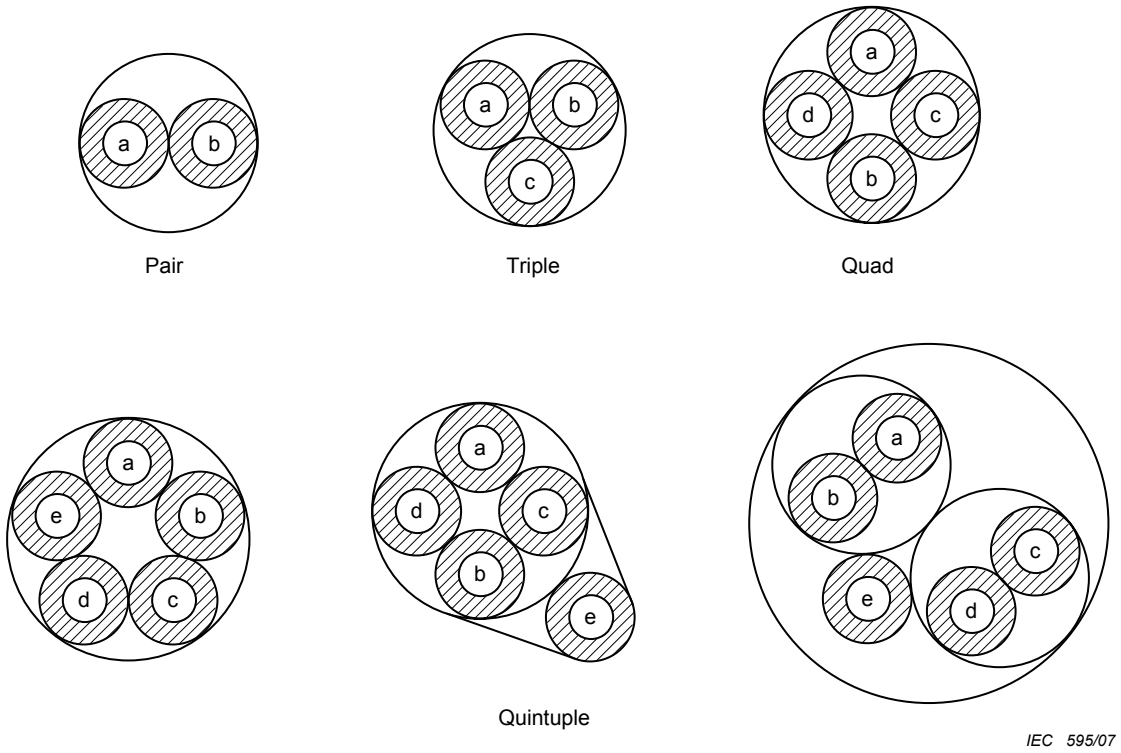

Figure 1 – Cabling elements

4.4 Binding of elements

If a thread or tape is used to bind the cabling elements, it shall consist of non-hygroscopic and non-wicking material.

4.5 Assembling of elements

4.5.1 Concentric layer cables

All the cabling elements shall be stranded in concentric layers.

One single insulated conductor may be added for metering purposes: its diameter shall preferably be the same as that of other conductors and its insulation shall be coloured WHITE-red.

NOTE 1 When necessary, fillers, of non-hygroscopic and non-wicking material, can be used to obtain a round cable core.

NOTE 2 The successive layers of cabling elements may be separated from each other by interlayer binders, of non-hygroscopic and non-wicking material.

4.5.2 Unit cables

The cabling elements shall be bunched together in units of 20 cabling elements, or, if necessary. in sub-units of five or ten cabling elements. In cables for digital exchanges the cabling elements, if necessary, shall be bunched together preferably in units of two, four or eight elements.

The units and sub-units, if any, shall be stranded together.

One single insulated conductor may be added for metering purposes; its diameter shall preferably be the same as that of the other conductors and its insulation shall be coloured WHITE-red.

4.6 Sequence of elements

4.6.1 Concentric layer cables

The numbering sequence of the cabling elements shall be from the centre of the cable to the outside layer.

The direction of counting shall be the same in each layer (clockwise or counter-clockwise).

4.6.2 Unit cables

The numbering sequence of the cabling elements in each unit or subunit shall be from the centre to the outside.

NOTE Some techniques of stranding may allow changes in the relative positions of cabling elements in the units and subunits.

When subunits of five elements are used, they shall consist exclusively, and in the following sequence, of elements 1 to 5, 6 to 10, 11 to 15 and 16 to 20. When subunits of ten elements are used, they shall consist exclusively, and in the following sequence, of elements 1 to 10 and 11 to 20.

4.7 Total number of elements

When the units of 20 cabling elements or the subunits of five or ten cabling elements are used, the preferred total number of cabling elements shall be a multiple of five elements for cables comprising a total of up to 30 elements; a multiple of ten elements for cables comprising a total of more than 30 but not more than 60 elements; and a multiple of 20 elements for cables comprising a total of more than 60 elements. When the units of two, four or eight cabling elements are used, the preferred total number of cabling elements shall be a multiple of four elements for cables comprising a total of up to 24 elements and a multiple of eight elements for cables comprising a total of more than 24 elements.

The single insulated conductor for metering does not count as an element.

All elements assembled together form the core of the cable.

4.8 Identification of the cabling elements and of the insulated conductors

Identification of the cabling elements and of the insulated conductors in a cable with concentric stranding or in each unit of a cable with unit stranding shall be based on a code of colours.

All cabling elements shall be identified by the a and b wires only, the c, d and e wires each having a distinctive identification colour which shall be the same in all cabling elements.

The code is given in Annex A. For cables with unit stranding of 20 cabling elements or with subunits of five or ten cabling elements, the full colour code, or counting block No. 1 only may be used. For cables with unit stranding of two, four or eight cabling elements, the colour code is the same given in Annex A, with the exclusion of the colours corresponding to the cabling elements 5, 10, 15, 20, etc.

NOTE For cables using single coloured conductors only, every wire in the cable may be individually identified at the request of the purchaser.

In such cases, this can be done by adding a tracer to the standard colour given in Annex A. The tracer does not replace the colour code, but is an optional addition to be specified by the purchaser who requires it.

4.9 Sequence and identification of the units

The numbering sequence of the units in the cable shall be from the centre of the cable.

If the counting block No. 1 only is used, each unit of the cable shall be identified by an open helical lapping, of non-hygroscopic and non-wicking material of distinctive colour.

The preferred colour code for unit identification lappings is given in Annex B.

Alternatively, a tape, on which the number of the unit is printed, may be used. The height of the printed number shall be not less than 3 mm and the spacing measured from centre to centre of the printing, shall be not more than 20 mm.

In cables comprising more than 20 cabling elements and using counting block No. 1 only, sub-units shall carry the identification tape corresponding to the unit of which they form part.

4.10 Wrapping

The core of the cable may be wrapped with a protective layer of non-hygroscopic and non-wicking material (for example, a helical or longitudinal lapping of one or more tapes with overlap or a thin continuous sheath).

If a screen is provided, the protective layer shall be mandatory.

4.11 Screening

The core of the cable may be provided with a screen. It shall consist of copper or aluminium tape of 0,04 mm minimum thickness, or of a thin tape of the same materials, of 0,008 mm minimum thickness, laminated to a plastic tape.

The tape shall be wound helically or applied longitudinally round the wrapped core with an overlap of at least 20 % or 6 mm, whichever is less.

One or more tinned copper wires shall be included in the cable in continuous contact with the surface of the metal tape. The wires may be of circular section or flat: the total cross-section shall be not less than 0,125 mm^2.

The screen may be provided with an outer protective layer of non-hygroscopic and non-wicking material (for example, a longitudinal or helical wrapping of one or more tapes with overlap).

4.12 Rip cord

A non-hygroscopic and non-wicking non-metallic rip cord may be provided.

4.13 Sheath

4.13.1 Sheath material

The sheath shall consist of polyvinyl chloride.

4.13.2 Sheath thickness

The sheath shall be continuous having a thickness as uniform as possible and not less than the value specified in Annex D for cables with unit stranding of 20 cabling elements or with subunits of five or ten cabling elements and in Annex E for cables with unit stranding of four or eight cabling elements.

The minimum thickness of the sheath shall be determined in accordance with the method specified in 5.2.1.2. of IEC 60189-1.

4.13.3 Application of the sheath

The sheath shall be applied to fit closely to the core of the cable.

The sheath shall not adhere to the insulation of the conductors, nor to the screen or protective layer, if provided.

NOTE Adhesion of the sheath to a screen consisting of a metal tape laminated to a plastic tape is permissible.

4.13.4 Colour of sheath

The colour of the sheath shall be preferably grey.

NOTE An alternative sheath colour may be specified by the purchaser who requires it.

4.14 Finished cable

4.14.1 Diameter of cable over sheath

The diameter over the sheath of the finished cable shall not exceed the value given in Annexes D and E.

The diameter over the sheath of the finished cable shall be measured in accordance with the method specified in 5.2.3 of IEC 60189-1.

4.14.2 Sealing of ends

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

Sealing shall be carried out immediately after inspection and acceptance tests.

4.15 Delivery

Delivery shall be made on reels or in coils protected in a suitable manner.

5 Mechanical requirements

5.1 Conductor

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

10 % for solid conductor of 0,4 mm in diameter;

15 % for solid conductor of over 0,4 mm in diameter.

Compliance shall be checked by measuring the elongation at break in accordance with the method specified in 6.3 of IEC 60189-1.

If the conductor is tinned, the amount of tin per unit area shall be adequate for soldering the conductor to the terminals without difficulty.

Compliance shall be checked by means of the solder test on samples of the conductors in accordance with the method specified in 7.7 of IEC 60189-1.

Good tinning shall be evidenced by free flowing of the solder with wetting of the conductor ends.

5.2 Insulation

The insulation shall have adequate mechanical strength and elasticity. These properties shall remain sufficiently constant during normal use.

Compliance shall be checked before and after accelerated ageing by measuring the tensile strength and the elongation at break at samples of the insulation in accordance with the method specified in 6.3 of IEC 60189-1.

The accelerated ageing conditioning is specified in 7.1 of IEC 60189-1.

The median of the measured values of tensile strength shall be not less than 12,5 N/mm^2 (12,5 MPa).

The median of the measured values of elongation at break shall be not less than 100 %.

Moreover, the difference between the median values for tensile strength and elongation obtained before and after accelerated ageing shall not exceed 20 % of the median values before accelerated ageing.

NOTE 1 The values specified for tensile strength and for elongation at break are independent and non-concomitant minima. An insulation with one characteristic of near-minimum value should present a value well above the minimum for the other characteristic.

NOTE 2 The median value is the middle value if an odd number of values is obtained or the average of the two middle values if an even number of values is obtained.

The test results should have been arranged in sequence of increasing values.

5.3 Sheath

The sheath shall have adequate mechanical strength and elasticity. These properties shall stay sufficiently constant during normal use.

Compliance shall be checked before and after accelerated ageing by measuring the tensile strength and the elongation at break on samples of the sheath in accordance with the method specified in 6.3 of IEC 60189-1.

The median of the measured values of tensile strength shall be not less than 12,5 N/mm^2 (12,5 MPa).

The median of the measured values of elongation at break shall be not less than 125 %.

Moreover, the difference between the median values for tensile strength and elongation obtained before and after accelerated ageing shall not exceed 20 % of the median values before ageing.

6 Thermal stability and climatic requirements

6.1 Insulation

6.1.1 Measurement of insulation shrinkage after overheating of conductor

The measured shrinkage shall be not more than 4 % when tested according to 7.6 of IEC 60189-1.

6.1.2 Cold bend test

The insulation shall show no cracks when tested according to 7.4.1 of IEC 60189-1.

6.1.3 Heat shock test

The insulation shall show no cracks when tested according to 7.5.1 of IEC 60189-1.

6.2 Sheath

6.2.1 Pressure test

Compliance shall be checked in accordance with the test specified in 7.2 of IEC 60189-1.

6.2.2 Cold bend test

The sheath shall show no cracks when tested according to 7.5.2 of IEC 60189-1.

6.2.3 Heat shock test

The sheath shall show no cracks when tested according to 7.5.2 of IEC 60189-1.

6.3 Resistance to flame propagation

Resistance to flame propagation shall be checked in accordance with the test specified in 7.3.2 of IEC 60189-1. Performance of fire non-propagation in accordance with IEC 60332-3 may be required.

7 Electrical requirements

7.1 Electrical resistance of conductor

The electrical resistance of the conductor measured at, or corrected to, a temperature of 20 °C shall not exceed the values specified in Annex C.

Calculation of these resistance values is based on IEC 60344, using the k_1 value for tinned conductors and k_3 and k_4 for twisting and cabling lay factors greater than 16.

If the twisting and cabling lay factors are 16 or less, IEC 60344 shall be applied with the corresponding values of k_3 and k_4.

The same resistance values apply also to plain conductors.

The method for measuring the resistance and also for correcting the measured values for length and temperature are specified in 8.1 of IEC 60189-1.

7.2 Dielectric strength

The insulation shall withstand the application for 1 min without breakdown of the voltage specified in Annex C.

The method for checking the dielectric strength is specified in 8.2 of IEC 60189-1.

7.3 Insulation resistance

Insulation resistance measured at a temperature of 20 °C shall be not less than the value specified in Annex C.

The method for measurement of insulation resistance is specified in 8.3 of IEC 60189-1.

7.4 Mutual capacitance

The mutual capacitance of any pair of conductors shall not exceed 120 nF/km.

The method for measurement of mutual capacitance is specified in 8.4 of IEC 60189-1.

NOTE Measurement of mutual capacitance is optional.

7.5 Capacitance unbalance

The capacitance unbalance between any two pairs of different cabling elements shall not exceed 400 pF per 500 m length of cable.

The method for measurement of capacitance unbalance is specified in 8.5 of IEC 60189-1.

NOTE Measurement of capacitance unbalance is optional.

Annex A
(normative)

Colour code

Counting block	Colour block	Cabling element	Colour of insulation	
			a-wire	*b*-wire
1	1	1	white	blue
		2	white	orange
		3	white	green
		4	white	brown
		5	white	grey
	2	6	red	blue
		7	red	orange
		8	red	green
		9	red	brown
		10	red	grey
	3	11	black	blue
		12	black	orange
		13	black	green
		14	black	brown
		15	black	grey
	4	16	yellow	blue
		17	yellow	orange
		18	yellow	green
		19	yellow	brown
		20	yellow	grey
2	5	21	WHITE-blue	blue
		22	WHITE-blue	orange
		23	WHITE-blue	green
		24	WHITE-blue	brown
		25	WHITE-blue	grey
	6	26	RED-blue	blue
		27	RED-blue	orange
		28	RED-blue	green
		29	RED-blue	brown
		30	RED-blue	grey
	7	31	BLACK-blue	blue
		32	BLACK-blue	orange
		33	BLACK-blue	green
		34	BLACK-blue	brown
		35	BLACK-blue	grey
	8	36	YELLOW-blue	blue
		37	YELLOW-blue	orange
		38	YELLOW-blue	green
		39	YELLOW-blue	brown
		40	YELLOW-blue	grey
3	9	41	WHITE-orange	blue
		42	WHITE-orange	orange
		43	WHITE-orange	green
		44	WHITE-orange	brown
		45	WHITE-orange	grey
	10	46	red-ORANGE	blue
		47	red-ORANGE	orange
		48	red-ORANGE	green
		49	red-ORANGE	brown
		50	red-ORANGE	grey
	11	51	black-ORANGE	blue
		52	black-ORANGE	orange
		53	black-ORANGE	green
		54	black-ORANGE	brown
		55	black-ORANGE	grey
	12	56	YELLOW-orange	blue
		57	YELLOW-orange	orange
		58	YELLOW-orange	green
		59	YELLOW-orange	brown
		60	YELLOW-orange	grey

Counting block	Colour block	Cabling element	Colour of insulation	
			a-wire	*b*-wire
4	13	61	WHITE-green	blue
		62	WHITE-green	orange
		63	WHITE-green	green
		64	WHITE-green	brown
		65	WHITE-green	grey
	14	66	red-GREEN	blue
		67	red-GREEN	orange
		68	red-GREEN	green
		69	red-GREEN	brown
		70	red-GREEN	grey
	15	71	black-GREEN	blue
		72	black-GREEN	orange
		73	black-GREEN	green
		74	black-GREEN	brown
		75	black-GREEN	grey
	16	76	YELLOW-green	blue
		77	YELLOW-green	orange
		78	YELLOW-green	green
		79	YELLOW-green	brown
		80	YELLOW-green	grey
5	17	81	WHITE-brown	blue
		82	WHITE-brown	orange
		83	WHITE-brown	green
		84	WHITE-brown	brown
		85	WHITE-brown	grey
	18	86	RED-brown	blue
		87	RED-brown	orange
		88	RED-brown	green
		89	RED-brown	brown
		90	RED-brown	grey
	19	91	black-BROWN	blue
		92	black-BROWN	orange
		93	black-BROWN	green
		94	black-BROWN	brown
		95	black-BROWN	grey
	20	96	YELLOW-brown	blue
		97	YELLOW-brown	orange
		98	YELLOW-brown	green
		99	YELLOW-brown	brown
		100	YELLOW-brown	grey
6	21	101	WHITE-grey	blue
		102	WHITE-grey	orange
		103	WHITE-grey	green
		104	WHITE-grey	brown
		105	WHITE-grey	grey
	22	106	red-GREY	blue
		107	red-GREY	orange
		108	red-GREY	green
		109	red-GREY	brown
		110	red-GREY	grey
	23	111	black-GREY	blue
		112	black-GREY	orange
		113	black-GREY	green
		114	black-GREY	brown
		115	black-GREY	grey
	24	116	YELLOW-grey	blue
		117	YELLOW-grey	orange
		118	YELLOW-grey	green
		119	YELLOW-grey	brown
		120	YELLOW-grey	grey

The c, d and e wires, if any, shall be identically coloured in all elements: c = turquoise; d = violet; e = ORANGE-green.

Except in the case of bicolour extrusion, the colour printed in capitals shall be known as the “base colour”; it shall be:
a = the extruded colour;
h = the colour presenting the greater area of exposure on the finished wire.

Annex B
(normative)

Unit identification

No.	1	2	3	4	4
Colour	blue	orange	green	brown	grey
No.	6	7	8	9	10
Colour	white	red	black	yellow	violet

Annex C
(normative)

Electrical requirements of insulated conductors

Conductor		Test requirements	
Nominal diameter mm	**Maximum resistance** Ω/km	**Dielectric strength test voltage** V	**Minimum Insulation resistance** MΩ.km
0,4	153	1 000 a.c.	500
0,5	97,8	or	
0,6	67,9	1 500 d.c.	
0,8	37,5	1 500 a.c.	
		or	
		2 250 d.c	

Annex D
(normative)

Cables in pairs, triples, quads, and quintuples for inside installations (with screening)

Number of cabling	0 4 mm diameter conductor								0,5 mm diameter conductor								0,6 mm diameter conductor								0,8 mm diameter conductor							
	Minimum sheath thickness mm				Maximum overall diameter of cable mm[a]				Minimum sheath thickness mm				Maximum overall diameter of cable mm[a]				Minimum sheath thickness mm				Maximum overall diameter of cable mm[a]				Minimum sheath thickness mm				Maximum overall diameter of cable mm[a]			
	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples
5	0,6	0,6	0,7	0,7	6,5	7,0	8,5	9,0	0,6	0,6	0,7	0,7	7,0	8,0	9,0	10,0	0,6	0,7	0,7	0,8	7,5	8,5	9,5	11,0	0,7	0,8	0,9	0,9	10,0	11,5	13,5	14,5
10	0,7	0,7	0,8	0,8	8,5	9,5	11,0	12,0	0,7	0,7	0,8	0,9	9,0	10,5	12,0	13,5	0,7	0,8	0,8	0,9	10,0	11,5	13,0	14,5	0,9	0,9	0,9	1,0	13,5	15,5	17,5	19,5
15	0,7	0,8	0,8	0,9	9,5	11,0	12,5	14,0	0,7	0,8	0,9	0,9	10,5	12,0	14,0	15,5	0,8	0,8	0,9	0,9	11,5	13,0	15,0	16,5	0,9	0,9	1,0	1,0	15,5	17,5	20,5	23,0
20	0,8	0,8	0,9	0,9	11,0	12,0	14,0	15,5	0,8	0,9	0,9	0,9	12,0	13,5	15,5	17,5	0,8	0,9	0,9	1,0	13,0	14,5	17,0	19,0	0,9	1,0	1,0	1,15	17,5	19,5	23,0	26,5
25	0,8	0,9	0,9	0,9	12,0	13,5	15,5	16,5	0,8	0,9	0,9	1,0	13,0	14,5	17,0	19,0	0,9	0,9	0,9	1,0	14,5	16,0	18,5	21,0	1,0	1,0	1,0	1,15	19,5	20,0	25,5	29,0
30	0,8	0,9	0,9	0,9	12,5	14,5	16,5	18,5	0,9	0,9	0,9	1,0	14,0	15,5	18,0	20,5	0,9	0,9	1,0	1,0	15,5	17,0	20,0	22,5	1,0	1,0	1,15	1,35	21,0	21,5	27,5	31,5
40	0,9	0,9	0,9	1,0	14,5	16,0	18,5	21,0	0,9	0,9	1,0	1,0	15,5	17,5	20,5	23,0	0,9	1,0	1,0	1,15	17,0	19,5	22,5	26,0	1,0	1,15	1,15	1,35	23,5	23,5	32,0	36,0
50	0,9	0,9	1,0	1,0	15,5	17,5	20,5	23,0	0,9	1,0	1,0	1,15	17,0	19,5	22,5	26,0	0,9	1,0	1,15	1,15	18,5	21,0	25,0	28,5	1,15	1,15	1,35	1,6	26,0	27,0	35,0	40,0
60	0,9	1,0	1,0	1,15	17,0	19,0	22,0	25,5	0,9	1,0	1,0	1,15	18,5	21,0	24,5	28,0	1,0	1,0	1,15	1,35	20,5	23,0	27,0	31,0	1,15	1,35	1,6	1,6	28,5	29,5	38,5	43,5
80	1,0	1,0	1,15	1,15	19,0	21,5	22,5	28,5	1,0	1,10	1,15	1,35	21,0	23,5	28,0	32,0	1,0	1,15	1,35	1,35	23,0	26,5	31,0	35,0	1,35	1,6	1,6	1,6	32,5	32,5	44,0	49,5
100	1,0	1,0	1,15	1,35	21,0	23,5	28,0	32,0	1,0	1,15	1,35	1,35	23,0	26,5	31,5	35,5	1,15	1,15	1,35	1,6	25,5	29,0	34,5	39,5	1,35	1,6	1,6	1,6	35,5	41,0	48,5	55,0
120	1,0	1,15	1,15	1,35	22,5	26,0	30,0	34,5	1,15	1,15	1,35	1,6	25,5	28,5	34,0	39,0	1,15	1,35	1,6	1,6	27,5	32,0	38,0	42,5	1,6	1,6	1,6	1,6	39,5	44,5	52,5	59,5
140	1,0	1,15	1,35	1,6	24,0	27,5	33,0	37,5	1,15	1,35	1,35	1,6	27,0	31,0	36,5	41,5	1,15	1,35	1,6	1,6	29,5	34,0	40,5	45,5	1,6	1,6	1,6	1,6	42,0	47,5	56,0	64,0
160	1,15	1,15	1,35	1,6	26,0	29,0	34,5	40,0	1,15	1,35	1,6	1,6	28,5	33,0	39,0	44,0	1,35	1,35	1,6	1,6	32,0	36,0	43,0	48,5	1,6	1,6	1,6	1,6	44,5	59,5	59,5	68,0

[a] For engineering calculation purposes.

NOTE For unscreened cables, the maximum outer diameter must be reduced by 0,5 mm.

Annex E
(normative)

Cables in pairs for digital exchanges (with screening)

Number of cabling elements	0,4 mm diameter conductor		0,5 mm diameter conductor	
	Minimum sheath thickness	Maximum overall diameter of cable	Minimum sheath thickness	Maximum overall diameter of cable
	mm	mm[a]	mm	mm[a]
	Pairs	Pairs	Pairs	Pairs
2	0,4	5	0,4	5,5
4	0,4	6	0,6	6,5
8	0,4	7	0,7	8,5
12	0,6	8,5	0,7	9,5
16	0,6	9,5	0,7	10,5
24	0,7	11,5	0,8	12,5
32	0,7	12,5	0,9	14,5
48	0,7	14,5	–	–
64	–	–	0,9	19
128	0,9	22,5	–	–

[a] For engineering calculation purposes.

NOTE For unscreened cables, the maximum outer diameter must be reduced by 0,5 mm.

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