

BRITISH STANDARD

BS 6007 : 1993

Specification for

Rubber-insulated cables for electric power and lighting

Conducteurs et câbles isolés au caoutchouc
pour installations

Starkstromleitungen mit einer Isolierung aus
Gummi

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Cables and Insulation Standards Policy Committee (CIL/-) to Technical Committee CIL/20, upon which the following bodies were represented:

Association of Consulting Engineers
Association of Manufacturers of Domestic Electrical Appliances
BECCAMA (Beama Electrical Cable Connector and Accessories Manufacturers' Association)
British Approvals Service for Cables
British Cable Makers Confederation
British Plastics Federation
British Steel Industry
Department of the Environment (Property Services Agency)
Department of Trade and Industry (Consumer Safety Unit, CA Division)
Electricity Association
Engineering Equipment and Materials Users' Association
Institution of Electrical Engineers
London Regional Transport

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
British Electrical Systems Association (BEAMA Ltd.)
British Non-Ferrous Metals Federation
British Steel plc
Chartered Institution of Building Services Engineers
ERA Technology Ltd.
Electrical Installation Equipment Manufacturers' Association (BEAMA Ltd.)
Engineering Industries Association
GAMBICA (BEAMA Ltd.)
Institution of Incorporated Executive Engineers
Lighting Industry Federation Ltd.
London Underground Ltd.
National Association of Lift Makers
Portable Electric Tool Manufacturers' Association
Transmission and Distribution Association (BEAMA Ltd.)

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Foreword

This edition of BS 6007 has been prepared under the direction of the Cables and Insulation Standards Policy Committee and it supersedes BS 6007 : 1991 which is withdrawn.

This edition includes alterations introduced by Amendment No. 1 to BS 6007 : 1991 (published in May 1993) together with some further technical changes to bring the standard up to date but it does not reflect a full review of the standard which will be undertaken in due course.

This new edition is aligned with Amendments 8, 9, 10 and 11 to HD 22.1 S2, Amendment 3 to HD 22.2 S2 and Amendment 5 to HD 22.4 S2.

Where Harmonized Code Designations are given, the requirements are in conformity with those of all countries which accept the basic principles of harmonization in accordance with the requirements of CENELEC¹⁾. Designs shown as recognized national types are not harmonized but are regarded as representing a particular requirement in the UK which is not reflected in other countries.

Colours for core identification as agreed with CENELEC have been included in tables 1 to 8, as appropriate.

Differences in the text between this edition and BS 6007 : 1991 are indicated by a line in the margin.

Certification. Attention is drawn to the certification services (see inside back cover) of the British Approvals Service for Cables (BASEC)²⁾. These services include licensing manufacturers to use BASEC certification trade marks as independent assurance that cables or cords have been designed and manufactured to appropriate British Standards. BASEC is a subscriber to an agreement in CENELEC whereby cables or cords coming within Harmonized Code Designations and manufactured under a BASEC licence, can carry marks acceptable to other signatory countries (CENELEC 'Common Marking').

Compliance with a British Standard does not of itself confer immunity from legal obligations

¹⁾ European Committee for Electrotechnical Standardization.

²⁾ British Approvals Service for Cables, Silbury Court, 360 Silbury Boulevard, Milton Keynes, Buckinghamshire MK9 2AF.

Specification

1 Scope

This British Standard specifies requirements for the construction, electrical properties, mechanical properties and dimensions of non-armoured rubber-insulated cables and flexible cables for operation at voltages up to and including 450 V a.c. to earth and 750 V a.c. between conductors.

The types of cables included in the standard are:

- (a) Table 1. Rubber-insulated, textile-braided and compound cable, single core 450/750 V;
- (b) Table 2. Rubber-insulated and sheathed cable, flat twin 300/500 V;
- (c) Table 3. Rubber-insulated and sheathed flexible cable, 3-core and 4-core 300/500 V;
- (d) Table 4. Rubber-insulated and sheathed flexible cable, single core, circular twin, 3-core, 4-core and 5-core 450/750 V;
- (d1) Table 4A. Rubber-insulated and sheathed flexible cable, having more than 5-core (multicore cables) 450/750 V;
- (e) Table 5. Rubber-insulated, HOFR-sheathed flexible cable, single core, circular twin, 3-core, 4-core and 5-core 450/750 V;
- (f) Table 6. Rubber-insulated, braided, heat-resistant flexible cable, single core and twisted twin 300/500 V;
- (g) Table 7. Heat-resistant, rubber-insulated, single core cables for internal wiring 450/750 V;
- (g1) Table 7A. Heat-resistant, rubber-insulated, single core cables for internal wiring 300/500 V
- (h) Table 8. Unbraided, silicone-rubber-insulated cables for internal wiring 300/500 V.

A guide to the use of rubber-insulated cables is given in appendix A. Guidance to manufacturers on procedures for routine testing is given in appendix B.

2 References

2.1 Normative references

This British Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed on page 28. For dated references, subsequent amendments to or revisions of any of these publications apply to this British Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publications referred to applies.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard, the definitions given in BS 4727 : Part 2 : Group 08 apply together with the following.

3.1 rated voltage U_0

The power-frequency voltage to earth for which the cable is designed.

3.2 rated voltage U

The power-frequency voltage between conductors for which the cable is designed.

4 Voltage designation

The rated voltage of a cable is the reference voltage for which the cable is designed and which serves to define the electrical tests and shall be expressed, in volts, by the following expression:

$$U_0/U$$

where

U_0 is the r.m.s. value between any insulated conductor and earth, i.e. the metal covering of the cable or the surrounding medium;

U is the r.m.s. value between any two phase-conductors of a multicore cable or of a system of single-core cables.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended and this applies both to the value U_0 and to the value U .

In a direct current system, the nominal voltage of the system shall be not higher than 1.5 times the rated voltage of the cable.

NOTE. The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %. A cable can be used at 10 % higher operating voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.

The rated voltages recognized for the purpose of this standard shall be 300/500 V and 450/750 V.

5 Conductors

5.1 Construction

The conductors shall be annealed copper conductors complying with BS 6360. Unless otherwise given in tables 1 to 8, as appropriate, the individual wires of conductors shall be plain or covered with an effective layer of commercial tin.



For cables specified in table 7, where the wires are plain, a separator tape made of suitable material shall be placed between the conductor and the insulation.

NOTE. For cables specified in tables other than tables 7 and 7A, a separator tape made of suitable material may be applied around each conductor. The application of a separator is left to the discretion of the manufacturer.

The solderability of plain conductors, except for the cables whose properties are given in table 6, shall be tested as described in appendix C. The part of the conductor that has been immersed in the solder bath shall be adequately tinned.

5.2 Class

The class of the conductor shall be as given in tables 1 to 8, inclusive.

6 Insulation

6.1 Type of insulation

The insulation shall be one of the following types, as given in tables 1 to 8, as appropriate:

- (a) type GP 1 rubber insulation complying with BS 6899;
- (b) types EI 2, EI 3 and EI 4 rubber insulation complying with BS 7655 : Section 1.1.

Compliance shall be checked by carrying out the appropriate tests listed in table 10.

6.2 Application

The insulation shall be closely applied to the conductor or separator as follows:

- (a) types EI 3 and GP 1: unless applied by the extrusion process, the insulation shall consist of at least two layers;
- (b) types EI 2 and EI 4: the insulation shall be extruded in a single layer.

It shall be possible to remove the insulation easily, without damage to the insulation itself, the conductor or the tin coating, if any.

Compliance shall be checked by examination and by a manual test.

6.3 Thickness

The mean value of the thickness of the insulation shall be not less than the value given for each type and cross section of cable in tables 1 to 8, as appropriate. However, it shall be permissible for the thickness at any place to be less than the value specified provided that the difference does not exceed $0.1 \text{ mm} + 10\%$ of the value specified.

Compliance shall be checked by the measurements described in 8.1 of BS 6469 : Section 1.1 : 1992.

From each core to be tested, one sample of core shall be taken from each of three places separated by at least 1 m.

The mean of all the values obtained on the three pieces of insulation shall be calculated to two decimal places and then rounded off to obtain the mean value of insulation thickness. If the calculation gives 5 or more for the second decimal figure, the first figure shall be raised to the next number: thus, for example, 1.75 shall be rounded to 1.8 and 1.74 to 1.7.

The smallest of all the values obtained shall be taken as the minimum thickness of insulation at any place.

6.4 Addition of tape

Where stated in tables 1 to 8, it shall be permissible for a proofed textile tape to be applied over the insulation. The tape shall be applied helically with a minimum overlap of 1 mm. In the completed cable, it shall be possible to remove the proofed tape without damage to the insulation.

7 Core identification

7.1 General

NOTE. The methods of core identification depend on the number of cores, as shown in 7.1.1 and 7.1.2.

7.1.1 Cables having 1 to 5 cores

Each core shall be identified by its colour. The colour shall be either throughout the whole of the insulation or on its surface, or, where it is given in tables 1 to 8 that it is permitted, on a proofed tape or textile braid which may be applied over the insulation. In the latter case, the identifying colour shall be visible on the external surface.

7.1.2 Multicore cables (having more than 5 cores)

Multicore cables (having more than 5 cores) shall be identified in accordance with the requirements of table 4A.

If the cores are identified by inscription, this shall be in accordance with the method stated in appendix F.

7.2 Colours

The colours of the cores according to the number of cores in the cable and also the sequence of these colours shall be as given in tables 1 to 8, as appropriate.

7.3 Harmonized code designations

Harmonized code designations are given in tables 6, 7, 7A and 8 for single core non-sheathed cables. These cables shall be permitted to bear the Common Marking in accordance with 11.2, provided the colours comply with the following:

- (a) the colours available shall include the combination green/yellow and the colour blue;
- (b) combinations of colours other than green/yellow shall not be considered harmonized.

Single-core non-sheathed cables complying with the properties given in tables 1 to 8 where harmonized



code designations are given, but having core colours not in accordance with the requirements of this subclause, are not harmonized types and shall not bear the Common Marking.

NOTE 1. Attention is drawn to the fact that, according to the use to which the cables are put, it may be necessary to comply with core colour requirements specified in BS 7671, any other British or other standard applicable, or any appropriate regulations or statutory requirements.

NOTE 2. In addition to the combination green/yellow, and the mono-colour blue, the following other mono-colours are recognized as harmonized: black, brown, grey, orange, pink, red, turquoise, violet and white.

7.4 Bi-colour combination

On the core marked with the bi-colour combination green/yellow, the distribution of these colours shall be such that for every 15 mm length of core, one of these colours shall cover at least 30 % and at most 70 % of the surface of the core, while the other colour covers the remainder of the surface.

NOTE 1. In case of dispute and where appropriate to the method of colour marking of the insulation, see clause 8 of BS 6469 : Section 99.1 : 1992 for a test method to check compliance.

NOTE 2. *Information on the use of the colours green/yellow and blue.* It is understood that the colours green and yellow when they are combined as specified above are recognized exclusively as a means of identification of the core intended for use as earth connection or similar protection and that the colour blue is intended for the identification of the core intended to be connected to neutral. If, however, there is no neutral, blue can be used to identify any core except for earthing or protective conductor.

7.5 Clarity and durability

The colours shall be clearly identifiable and durable.

Compliance shall be checked by trying to remove the colour of the cores by rubbing the core 10 times with a piece of cotton wool or cloth soaked in water.

8 Filler

8.1 Material

Unless otherwise specified, the filler shall be composed of one of the following or of any combination of the following:

- (a) a compound of rubber or equivalent synthetic elastomers, vulcanized or unvulcanized; or
- (b) natural or synthetic textiles; or
- (c) paper.

There shall be no harmful interactions between the constituents of the filler and the insulation and/or the sheath.

8.2 Application

Whether the cable includes fillers or whether the sheath may penetrate between the cores thus forming a filling, shall be as given in tables 1 to 8, as appropriate, for each type of cable. The fillers, if any, shall fill the spaces between the cores, giving the assembly a

practically circular shape, and shall not adhere to the cores.

NOTE. The assembly of cores and fillers may be held together by a film or tape.

A centre filler, if used, shall comply with 8.1.

9 Braid

9.1 Fibre

The yarns forming the braid shall be one of the following:

- (a) based on natural material, e.g. cotton or treated cotton;
- (b) based on synthetic material, e.g. rayon or polyamide;
- (c) fibre made of glass or equivalent material.

9.2 Construction

The braid shall have a uniform texture, without knots or gaps. Braids made of glass fibres shall be treated with a suitable substance in order to resist fraying.

10 Sheath

10.1 Type of sheath

The sheath shall be one of the following types complying with BS 7655 : Section 2.1 or Section 2.3 as given in tables 1 to 8, as appropriate:

- (a) type EM 1 ordinary duty rubber sheath for inner sheath only;
- (b) type EM 3 ordinary duty rubber sheath;
- (c) type EM 2 ordinary duty oil-resisting and flame-retardant sheath;
- (d) type RS 4 heavy duty oil-resisting and flame-retardant sheath.

Compliance shall be checked by carrying out the appropriate tests given in table 10.

10.2 Construction

10.2.1 General

The protective sheath shall be extruded and shall consist of a single layer or of two layers, as given in tables 1 to 8, as appropriate, complying with 10.2.2 or 10.2.3.

10.2.2 Single layer

The sheath shall be applied as an homogeneous layer

- (a) to the core, in single-core cables;
- (b) to the assembly of cores and any filler, in multicore cables.

The sheath shall be capable of being removed without damage to the cores. Where taped cores are employed, some transfer of proofing from the tape to the sheath shall be permissible.

NOTE. A tape or film may be applied under the sheath.





Where given in tables 1 to 8, the sheath shall penetrate into the space between the cores, thus forming a filler.

10.2.3 *Sheath in two separate homogeneous layers*

The two layers shall be as follows.

(a) *Inner layer.* The inner sheath shall be applied as specified in 10.2.2.

NOTE. A proofed tape or equivalent separator may be applied over the inner layer.

If the tape or separator, if any, adheres to the inner sheath, it shall be permitted for its thickness for values not exceeding 0.5 mm to be included in the measurement of thickness of the inner sheath.



(b) *Outer layer.* The outer layer of the sheath shall be applied over the inner layer, or over the tape or separator if any. The outer layer shall be applied as an homogeneous layer.

NOTE. The outer sheath may or may not be bonded to the inner layer or to the tape or separator.

If the outer layer is bonded to the inner layer, it shall be visibly distinguishable from the inner layer; if it is not bonded, it shall be easily separable from the inner layer.

10.3 Thickness

The mean value of the sheath thickness shall be not less than the value given for each type and cross section of cable in tables 2, 3, 4 and 5, as appropriate. However, it shall be permissible for the thickness at any place to be less than the value specified, provided that the difference does not exceed 0.1 mm + 15 % of the value specified.

Compliance shall be checked by the measurements described in 8.2 of BS 6469 : Section 1.1 : 1992.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

The mean of all the values obtained on the three pieces of sheath shall be calculated to two decimal places and rounded off as detailed in 6.3 to obtain the mean value of sheath thickness.

The smallest of all the values obtained shall be taken as the minimum thickness of sheath at any place.

10.4 Colour

10.4.1 *General*

The colour of the sheath is specified only for the cable the properties of which are given in table 5, and shall be as given in table 5.



10.4.2 *Black sheaths*

For cables specified in table 5, or where a black sheath is applied to a cable where colour is not specified, the colour shall be throughout the whole of the sheath (or the whole of the outer layer in a two layer construction).

10.4.3 *Other coloured sheaths*

For all coloured sheaths other than those specified in 10.4.2, the colour shall be throughout the whole of the sheath (or the whole of the outer layer in two layer construction) or on its surface. Where surface colouring is applied, the surface colour shall be of essentially the same material as the underlying material and shall be applied as part of the extrusion process. The surface colour shall not be separable from the underlying material and shall be durable.

11 Marking

11.1 Indication of origin

All cables shall be provided with an indication of origin consisting either of an identification thread or threads or the continuous marking of the manufacturer's name or trademark.

If coloured threads are used, the colours shall comply with those registered in PD 2379, where applicable. The colours shall be easy to recognize or shall become

recognizable by cleaning with petrol or other suitable solvent, if necessary.

The marking of the manufacturer's name or trademark, if used, shall be by one of the three following alternative methods:

- (a) printed tape within the cable;
- (b) printing, indenting or embossing on the insulation of at least one core, the core coloured blue, if any;
- (c) printing, indenting or embossing on the sheath, if any.

Each specified mark shall be legible and regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed:

- (1) 550 mm if the marking is on the outer sheath of the cable;
- (2) 275 mm if the marking is:
 - (i) on the insulation of an unsheathed cable;
 - (ii) on the insulation of a sheathed cable;
 - (iii) on a tape within a sheathed cable.

NOTE. A 'specified mark' is a mandatory mark covered by this standard, or the optional CENELEC common marking as specified in 11.2.

11.2 CENELEC 'Common Marking'

It shall be permitted for a cable for which a Harmonized Code Designation is given in tables 1 to 8 to carry an indication that it has been manufactured under a licence issued by one of the Approvals organizations subscribing to the CENELEC Agreement on the use of a commonly agreed marking for cables and cords. If it does carry such an indication, this shall be one of the following.

(a) The mark of the Approvals Organization, followed by the Common Marking $\triangleleft$ HAR $\triangleright$ applied by one of the three alternative methods specified in 11.1.

(b) An identification thread extending throughout the length of the cable indicating the Approvals Organization. The base colour shall be yellow and this shall be serially dyed or printed red and black. The lengths of the coloured section shall comply with dimensions laid down by CENELEC for that Approvals Organization (see PD 2379).

Neither of these indications shall be used for a cable shown in tables 1 to 8 as a national type.

The name CENELEC, in full or abbreviated, shall not be directly marked on, or in, the cable.

11.3 Heat-resisting cables

Cables having type GP 1 rubber insulation shall be identified throughout their length by the legend 'HEAT RESISTING 85', either printed on a tape within the cable or printed on the core, or printed, indented or embossed on the external surface of the cable. The gap between the end of one legend and the beginning of the next shall be not greater than 300 mm.

11.4 Outer marking

Type EM 2 sheathed cables, whose properties are given in table 4 and table 4A, shall be distinguished by means of the marking 'RN' printed or embossed on or indented into the sheath.

Type EI 3 insulated cables, whose properties are given in tables 7 and 7A, shall be distinguished by means of the marking 'G' printed or embossed on or indented into the insulation.

The marking shall be continuous as specified in 11.1.

11.5 Durability

Any marking by printing shall be durable.

Compliance shall be checked by lightly rubbing the marking 10 times with a piece of cotton wool or cloth soaked in water.



Two measurements shall be taken at the same cross section of the cable covering the maximum and minimum values.

12 Construction and overall dimensions

12.1 Construction

The construction of the cables shall be as given in tables 1 to 8, as appropriate.

Compliance shall be checked by examination and measurement.

12.2 Mean overall dimensions

The mean overall dimensions of the cables shall not exceed the upper limits given in tables 1 to 8.

NOTE. The lower limit, where given, is an indicative value only and not a requirement for compliance with this specification.

Compliance shall be checked by the measurements described in 8.3 of BS 6469 : Section 1.1 : 1992.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

For flat cable the mean of the three determinations of each of the major and minor axes shall be taken as the mean overall dimensions.

For other cable, the mean of the six values obtained shall be taken as the mean overall diameter.

12.3 Ovality

The difference between any two values of the overall diameter of circular sheathed cables at the same cross section (ovality) shall not exceed 15 % of the upper limit given in tables 1 to 8, as appropriate, for the mean overall diameter.

Compliance shall be checked by the measurements described in 8.3 of BS 6469 : Section 1.1 : 1992.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

13 Electrical requirements

13.1 Conductor resistance

When the d.c. resistance of each conductor is measured on a sample of cable at least 1 m in length it shall comply with BS 6360.

13.2 Voltage test on complete cable

When the cable is tested as described in D.1 and D.2 no breakdown of insulation shall occur.

13.3 Voltage test on core

When the core is tested as described in D.1 and D.3 no breakdown of insulation shall occur.

13.4 Test to check the absence of faults in insulation

When cable is tested as described in D.1 and D.4 no failure of insulation shall occur.

13.5 Surface resistance of sheath

When cable is tested as described in D.1 and D.5 the surface resistance of the sheath shall be not less than $1 \times 10^9 \Omega$.

13.6 Insulation resistance test for cables or cores having maximum admissible conductor temperature above 90 °C

When cable or core is tested as described in D.6 the minimum insulation resistance value shall not be below the appropriate value given in tables 7 and 7A.



14 Test under fire conditions

The cables whose properties are given in tables 4, 4A and 5 shall comply with BS 4066 : Part 1. The test shall be carried out on a sample of the complete cable.

15 Flexing test

Unless cables have more than 18 cores laid up in more than two concentric layers, flexible cables having 4 mm² conductors or less, whose properties are given in tables 3, 4, 4A and 5 shall comply with the flexing test in BS 6500 under the conditions of test given in tables 1(a) and 2 of that standard.

Flexible cables having conductors with a nominal cross section exceeding 4 mm² shall not be subjected to the flexing test.

Table 1. Rubber-insulated, textile-braided and compound cable, 450/750 V single core**National type****Construction**

Tinned annealed copper conductor. Class 1 solid conductor and class 2 stranded conductor, as shown in the table.

Optional tape separator.

Rubber insulation type GP 1.

Optional proofed tape.

Textile braid.

Preservative compound.

Colours for core identification. Black, red or other colours (see clause 7).

Nominal cross-sectional area of conductor	Class of conductor	Radial thickness of insulation	Mean overall diameter (upper limit)
mm ²		mm	mm
1	1	0.8	4.3
1.5	1 or 2	0.8	4.6
2.5	1 or 2	0.8	5.0
4	2	1.0	6.4
6	2	1.0	7.0
10	2	1.2	8.6
16	2	1.2	9.6
25	2	1.4	11.5
35	2	1.4	13.0
50	2	1.6	14.5
70	2	1.6	16.5
95	2	1.8	19.0

Table 2. Rubber-insulated and sheathed cable, 300/500 V flat twin**National type****Construction**

Tinned annealed copper conductor. Class 2 stranded conductor.

Rubber insulation type EI 4.

Two cores laid parallel and sheathed with type EM 2.

Colours for core identification. Black and red.

Colour of sheath. Not specified.

Nominal cross-sectional area of conductor	Radial thickness of insulation	Radial thickness of sheath	Mean overall dimensions	
			Lower limit	Upper limit
mm ²	mm	mm	mm	mm
2.5	0.8	1.1	5.4×8.8	6.8×11.0