

Specification for

**PVC-insulated cables
(non-armoured) for
electric power and
lighting**

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electrotechnical Sector Board to Technical Committee CIL/20, upon which the following bodies were represented:

Association of Consulting Engineers
 Association of Manufacturers of Domestic Electrical Appliances
 BEAMA Electrical Cable and Conductor Accessory Manufacturers' Association
 British Approvals Service for Cables
 British Cable Makers' Confederation
 British Plastics Federation
 British Steel Industry
 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 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 new edition of BS 6004 has been prepared under the direction of the Electrotechnical Sector Board, and supersedes BS 6004 : 1991 which is withdrawn.

This edition includes alterations introduced by Amendment No. 1 to BS 6004 : 1991 (published in September 1993) together with some further technical changes to bring the standard up to date, but it does not reflect a full review or revision of the standard which will be undertaken in due course.

This standard takes into account all those Parts of, and amendments to, CENELEC¹⁾ Harmonization Document HD 21 covered by previous editions. This new edition is aligned also with Amendment 8 to HD 21.1 S2 and Amendment 2 to HD 21.7 S1. It also introduces revised dimensions for the harmonized cable types, calculated in accordance with BS EN 60719 : 1993.

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 CENELEC. Designs shown as National types are not harmonized but are regarded as representing a particular requirement in the United Kingdom which is not reflected in other countries.

Colours for core identification as agreed within CENELEC have been included in the appropriate tables. A guide to the use of PVC-insulated cables is given in annex A and guidance to manufacturers on procedures for routine testing in annex B. This standard and the Harmonization Documents mentioned above are generally in agreement with the technical provisions of the appropriate recommendations issued by the International Electrotechnical Commission (IEC). Differences in the text between this edition and BS 6004 : 1991 are indicated by a vertical 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, MK9 2AF.

Specification

1 Scope

This British Standard specifies requirements and dimensions for non-armoured polyvinyl chloride (PVC) insulated cables for fixed installation and for operation at voltages up to and including 450 V to earth and 750 V a.c. between conductors.

The types of cables included in the standard are:

- | | | |
|--------------------------|---|------------|
| a) Table 1a),
and c). | PVC-insulated,
non-sheathed
general purpose
cable, single-core | 450/750 V; |
| b) Table 2. | PVC-insulated,
non-sheathed cable
for internal wiring,
single-core | 300/500 V; |
| c) Table 3. | PVC-insulated,
PVC-sheathed light
cable, circular twin,
3-core, 4-core and
5-core | 300/500 V; |
| d) Table 4a). | PVC-insulated,
PVC-sheathed cable,
single-core, flat
twin and 3-core | 300/500 V; |
| e) Table 5a). | PVC-insulated,
PVC-sheathed cable
with circuit
protective
conductor,
single-core, flat
twin and 3-core | 300/500 V; |
| f) Table 6. | PVC-insulated,
PVC-sheathed cable
with or without
protective
conductor,
single-core and flat
twin (alternative
conductor versions) | 300/500 V; |
| g) Table 7a)
and b) | Special
PVC-insulated
non-sheathed cable,
single-core for
installation at low
temperatures | 450/750 V; |
| h) Table 8a)
and b). | PVC-insulated,
non-sheathed,
heat-resistant cable,
single-core for
internal wiring | 450/750 V; |
| j) Table 9. | PVC-insulated,
non-sheathed,
heat-resistant cable,
single-core for
internal wiring | 300/500 V. |

A guide to the use of PVC-insulated cables for fixed installation is given in annex A. Guidance to manufacturers for routine testing is given in annex B.

NOTE. The titles of the publications referred to in this standard are listed on page 28.

2 Definitions

For the purposes of this British Standard, the definitions given in BS 4727 apply together with the following.

2.1 rated voltage U_0

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

2.2 rated voltage U

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

3 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. 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 purposes of this standard shall be 300/500 V and 450/750 V.

4 Conductors

4.1 The conductor shall be of annealed copper conductor complying with BS 6360. It shall be permissible for the wires to be tinned except for the types detailed in tables 4, 5 and 6.

4.2 The class of conductor shall be as given in tables 1 to 9, inclusive. Except for conductors with table 1c), 7b) and 8b) constructions, conductors shall be circular solid, circular stranded or compacted circular stranded.

5 Insulation

5.1 Types of insulation

The insulation shall be PVC of one of the following types:

- a) type TI 1 of BS 7655 : Section 3.1 : 1993 for the cables detailed in tables 1 to 6 inclusive;
- b) type TI 4 of BS 7655 : Section 3.1 : 1993 for the cable detailed in table 7;
- c) type TI 3 of BS 7655 : Section 3.1 : 1993 for cables detailed in tables 8 and 9.

Compliance shall be checked by carrying out the appropriate tests listed in table 11.

5.2 Application

The insulation shall be closely applied to the conductor. It shall be possible to remove the insulation 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.

5.3 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 9, 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 using the method 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 to one decimal place 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 Core identification

6.1 General

Each core shall be identified by its colour. The colour shall be either throughout the whole of the insulation or on the surface of the insulation.

6.2 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 9, as appropriate and should be a reasonable match to those given in BS 6746C.

6.3 Harmonized code designations

Harmonized code designations are given in tables 1a), 1c), 2, 7a), 7b), 8a), 8b) and 9 for single-core non-sheathed cables; these cables are harmonized types, except where explicitly shown as national types, and shall be permitted to bear the Common Marking in accordance with 9.2, provided the colours comply with the following:

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

Single-core non-sheathed cables complying with the properties given in tables 1a), 1c), 2, 7a), 7b), 8a), 8b) and 9 where harmonized code designations are given, but having core colours not in accordance with the above requirements, are not harmonized types and shall not bear the Common Marking.

NOTE 1. 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.

NOTE 2. 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 : 1992 or other standard applicable, or any appropriate regulations or statutory requirements.

6.4 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 not more than 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 at 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.

6.5 Clarity and durability

The colours shall be clearly identifiable and durable.

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

7 Fillers and extruded inner covering

7.1 Fillers

When separate fillers are used they shall be composed of one of the following a) and b) or a combination of the two:

- a) an extruded compound based on unvulcanized rubber or plastics;
- b) natural or synthetic textile fibres.

A centre filler shall not be used in multicore cables unless specifically permitted in tables 3 to 6, as appropriate.

7.2 Extruded inner covering

7.2.1 An inner covering shall consist of an extruded compound based on unvulcanized rubber or plastic.

7.2.2 Inner coverings composed of unvulcanized rubber shall be compatible with PVC cores. Compliance shall be checked using the non-contamination test given in annex C and compatibility confirmed if the median values after ageing comply with the following.

Compatibility of TI 1 insulation

a) <i>Tensile strength</i>		
Minimum value (N/mm ²)	12.5	
Maximum variation (%)	20	
b) <i>Elongation at break</i>		
Minimum value (%)	125	
Maximum variation (%)	20	

NOTE. Variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

8 Sheath

8.1 Type of sheath

The sheath shall be PVC complying with BS 7655 : Section 4.1 or Section 4.2 for type 6 or type TM 1, as given in tables 3 to 6, as appropriate.

Compliance shall be checked by carrying out the appropriate tests given in table 11.

8.2 Application

The sheath shall be extruded as an homogeneous layer:

- a) to the core, in the single-core cables;
- b) to the assembly of cores and inner covering (if any) in other cables.

The sheath shall be capable of being removed without damage to the cores.

NOTE. A separator consisting of a tape or film may be placed under the sheath.

8.3 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 3 to 6, 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.

Where the sheath fills the interstices between the cores of flat cables the specified thickness shall apply at the place where the thickness of the sheath is at its minimum.

Compliance shall be checked using the method 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 to one decimal place as described in 5.3 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.

8.4 Colour

The colour of the sheath is specified only for cables whose properties are given in tables 4 to 6; for these cables the colour of the sheath shall be as given in the appropriate table and, where indicated, shall be a reasonable match to BS 6746C. The colour shall be throughout the whole of the sheath 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.

9 Marking

9.1 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 trade mark.

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 trade mark, 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 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 the unsheathed cable;
 - ii) on the insulation of the sheathed cable;
 - iii) on a tape within a sheathed cable.

NOTE. A 'specified mark' is any mandatory mark covered by this standard or the optional CENELEC common marking as specified in 9.2.

9.2 CENELEC 'Common Marking'

It shall be permitted for a cable for which a Harmonized Code Designation is given in tables 1 to 9 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 < HAR > applied by one of the three alternative methods specified in 9.1.
- 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 sections 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 9 as a national type.

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

9.3 Durability

Any marking by printing shall be durable.

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

9.4 Cables for installation at low temperature

In addition to the requirements of 9.1, cables given in tables 7a) and 7b) shall have a continuous marking applied, using the symbol 'V3' (indicating suitability for installation at low temperature), by printing, indenting or embossing on the insulation.

9.5 Cables with type TI 3 insulation

In addition to the requirements of 9.1, cables given in tables 8a), 8b), and 9 shall have a continuous marking applied, using the symbol 'V2' (indicating heat-resistant insulation), by printing, indenting or embossing on the insulation.

10 Construction and overall dimensions

10.1 Construction

The construction of the cables shall be as given in tables 1 to 9, as appropriate.

Compliance shall be checked by examination and measurement.

10.2 Mean overall dimensions

The mean overall dimensions of the cables shall be within the limits given in tables 1 to 9, as appropriate.

Compliance shall be checked using the method 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.

10.3 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 9, as appropriate, for the mean overall diameter.

Compliance shall be checked using the method 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.

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

11 Electrical requirements

11.1 Conductor resistance

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

11.2 Voltage test on complete cable

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

11.3 Voltage test on cores

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

11.4 Insulation resistance

When the cable is tested as described in **D.1** and **D.4**, the resistance shall be not less than the minimum value specified in tables 1 to 9, as appropriate.

11.5 Long term resistance of insulation to d.c.

When the cable is tested as described in **D.1** and **D.5**, the exterior of the insulation shall show no damage.

NOTE. Discolouration of the insulation should be ignored.

11.6 Test to check the absence of faults on insulation

When the cable is tested as described in **D.1** and **D.6**, it shall withstand the applied voltage without failure of the insulation.

12 Test under fire conditions

The cables whose properties are given in tables 1 to 9 shall comply with BS 4066 : Part 1.

The test shall be carried out on a sample of the complete cable.