



BS 6004 : 1990

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British Standard Specification for PVC-insulated cables (non-armoured) for electric power and lighting

Conducteurs et câbles (non-armés) isolés au polychlorure de vinyle
(PVC) pour installations — Spécifications

Starkstromleitungen (nicht armierte) mit einer Isolierung aus PVC

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Foreword

This new edition of BS 6004 has been prepared under the direction of the Cables and Insulation Standards Policy Committee, and supersedes BS 6004 : 1984 which is withdrawn.

This edition incorporates amendments 1 and 2 (published February 1988 and January 1989 respectively) and introduces technical changes 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 CENELEC* Harmonization Document HD 21 S2 and includes the special PVC-insulated non-sheathed single-core cable for low temperature installations as specified in HD 21.9 S1.

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 appendix A and guidance to manufacturers on procedures for routine testing in appendix B. This standard and the Harmonization Document 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 : 1984 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)†. 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.

*European Committee for Electrotechnical Standardization.

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

British Standard Specification for PVC-insulated cables (non-armoured) for electric power and lighting

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 1(a), (b) 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 4(a) and (b).	PVC-insulated, PVC-sheathed cable, single-core, flat twin and 3-core	300/500 V;
(e) Table 5(a) and (b).	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 7(a) and (b).	Special PVC-insulated, non-sheathed cable, single-core for installation at low temperatures	450/750 V.

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

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

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 one of the following types:

(a) 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;

(b) plain annealed copper-clad aluminium conductor complying with BS 6360 for the types detailed in tables 1(b), 4(b) and 5(b) only and where the nominal cross-sectional area for circuit conductors is not less than 1.5 mm².

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

4.3 No joints shall be made in the finished solid copper-clad aluminium conductor. Joints shall be permitted in the individual wires of which the copper-clad aluminium stranded conductor is formed but no joint shall be within 300 mm of any other joint within the same layer. Joints shall be cold pressure welded.

5. Insulation

5.1 Types of insulation. The insulation shall be PVC of one of the following types:

- (a) type TI 1 of BS 6746 for the cables detailed in tables 1 to 6 inclusive;
- (b) type TI 4 of BS 6746 for the cable detailed in table 7.

Compliance shall be checked by carrying out the appropriate tests listed in table 9.

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 7, 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 2.1.1 of BS 6469 : 1984.

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 7, as appropriate.

6.3 Harmonized code designations. Harmonized code designations are given in tables 1(a), 1(c), 7(a) and 7(b) 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 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 1(a), 1(c), 7(a) and 7(b) 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. 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 the 'Regulations for Electrical Installations' published by the Institution of Electrical Engineers, any British 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 2.7 of BS 6469 : 1984 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 1 to 6, as appropriate.

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 appendix 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 6746 for type 6 or type TM 1, as given in tables 3 to 7, as appropriate.

Compliance shall be checked by carrying out the appropriate tests given in table 9.

8.2 Application. The sheath shall be applied in a 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 2.1.2 of BS 6469 : 1984.

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. The colour shall be throughout the whole of the sheath or on its surface.

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.

The marking shall be legible and shall be regarded as continuous if the gap between the end of one complete inscription and the beginning of the next does not exceed:

- (1) 500 mm if the marking is on the sheath;
- (2) 200 mm in all other cases.

9.2 CENELEC 'Common Marking'. It shall be permitted for a cable for which a Harmonized Code Designation is given in tables 1 to 7 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 or cord 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 the 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 7 as a national type.

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

9.3 Cables with copper-clad aluminium conductors.

Cables with copper-clad aluminium conductors shall have the legend 'COPPER-CLAD' printed, indented or embossed on the external surface of the cable. The legend shall be compatible with other legends meeting the requirements of 9.1.

9.4 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.

9.5 Cables for installation at low temperature

In addition to the requirements of 9.1, cables given in tables 7(a) and 7(b) 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.

10. Construction and overall dimensions

10.1 Construction. The construction of the cables shall be as given in tables 1 to 7 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 7, as appropriate.

Compliance shall be checked using the method described in 2.1.3 of BS 6469 : 1984.

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.

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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 7, as appropriate, for the mean overall diameter.

Compliance shall be checked using the method described in 2.1.3 of BS 6469 : 1984.

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 insulation resistance shall be not less than the minimum value specified in tables 1 to 7, 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 7 shall comply with BS 4066 : Part 1.

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

Table 1. PVC-insulated, non-sheathed general purpose cable, 450/750 V, single-core

(a) Rigid conductor

NOTE 1. The cables may be suitable for voltages up to 1000 V a.c. or up to 750 V to earth d.c. (see appendix A).

NOTE 2. Cables having conductor sizes smaller than 1.5 mm² are to be found in table 2.

Harmonized code designation

Solid conductor: H07V—U.

Stranded conductor: H07V—R.

Construction

Annealed copper conductor, class 1 solid conductor and class 2 stranded conductor, as shown below.

PVC insulation type TI 1.

Colours for core identification. Green/yellow, blue or other colours (see 6.3).

Nominal cross-sectional area of conductor	Class of conductor	Radial thickness of insulation	Mean overall diameter (upper limit)	Minimum insulation resistance at 70 °C
mm ²		mm	mm	MΩ·km
1.5	1	0.7	3.3	0.011
1.5	2	0.7	3.5	0.010
2.5	1	0.8	3.9	0.010
2.5	2	0.8	4.2	0.009
4	1	0.8	4.4	0.0085
4	2	0.8	4.8	0.0077
6	1	0.8	4.9	0.0070
6	2	0.8	5.4	0.0065
10	1	1.0	6.4	0.0070
10	2	1.0	6.8	0.0065
16	2	1.0	8.0	0.0050
25	2	1.2	9.8	0.0050
35	2	1.2	11.0	0.0040
50	2	1.4	13.0	0.0045
70	2	1.4	15.0	0.0035
95	2	1.6	17.0	0.0035
120	2	1.6	19.0	0.0032
150	2	1.8	21.0	0.0032
185	2	2.0	23.5	0.0032
240	2	2.2	26.5	0.0032
300	2	2.4	29.5	0.0030
400	2	2.6	33.5	0.0028
500*	2	2.8	37.0	0.0028
630*	2	2.8	41.0	0.0025

*National type.

Table 1 (concluded)

(b) Rigid copper-clad aluminium conductor

NOTE. The cables may be suitable for voltages up to 1000 V a.c. or up to 750 V to earth d.c. (see appendix A).

National type**Construction**

Plain annealed copper-clad aluminium conductor, class 1 solid conductor and class 2 stranded conductor as shown below.

PVC-insulated type TI 1.

Colours for core identification. Green/yellow, blue or other colours (see 6.3).

Nominal cross-sectional area of conductor	Class of conductor	Radial thickness of insulation	Mean overall diameter (upper limit)	Minimum insulation resistance at 70 °C
mm ²		mm	mm	MΩ·km
1.5	1	0.7	3.3	0.011
2.5	1	0.8	3.9	0.010
4	2	0.8	4.8	0.0077
6	2	0.8	5.4	0.0065
10	2	1.0	6.8	0.0065
16	2	1.0	8.0	0.0050

(c) Flexible copper conductor

NOTE 1. The cables may be suitable for voltages up to 1000 V a.c. or up to 750 V to earth d.c. (see appendix A).

NOTE 2. Flexible cables smaller than 1.5 mm² are to be found in BS 6500.

Harmonized code designation. H07V—K.

Construction

Annealed copper conductor, class 5 flexible conductor.

PVC-insulation type TI 1.

Colours for core identification. Green/yellow, blue or other colours (see 6.3).

Nominal cross-sectional area of conductor	Radial thickness of insulation	Mean overall diameter (upper limit)	Minimum insulation resistance at 70 °C
mm ²	mm	mm	MΩ·km
1.5	0.7	3.5	0.010
2.5	0.8	4.2	0.009
4	0.8	4.8	0.007
6	0.8	6.4	0.006
10	1.0	7.6	0.0056
16	1.0	8.8	0.0046
25	1.2	11.0	0.0044
35	1.2	12.5	0.0038
50	1.4	14.5	0.0037
70	1.4	17.0	0.0032
95	1.6	19.0	0.0032
120	1.6	21.0	0.0029
150	1.8	23.5	0.0029
185	2.0	26.0	0.0029
240	2.2	29.5	0.0028

Table 2. PVC-insulated, non-sheathed cable for internal wiring, 300/500 V, single-core

NOTE. Flexible conductor versions of the following three sizes of internal wiring cables are specified in BS 6500.

Harmonized code designation. H05V—U.

Construction

Annealed copper conductor, class 1 solid conductor.

PVC-insulation type TI 1.

Colours for core identification. Green/yellow, blue or other colours (see 6.3 for harmonized types).

Nominal cross-sectional area of conductor	Radial thickness of insulation	Mean overall diameter (upper limit)	Minimum insulation resistance at 70 °C
mm ²	mm	mm	MΩ·km
0.5	0.6	2.4	0.015
0.75	0.6	2.6	0.012
1	0.6	2.8	0.011