BS 6231:2006

Incorporating
Corrigendum No. 1

BRITISH STANDARD

Electric cables – Single core PVC insulated flexible cables of rated voltage 600/ 1000 V for switchgear and controlgear wiring

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16677 Corrigendum No. 1	September 2006	Change reference to **8.1** in **10.4** and Table A.1, change temperature to 90 °C in Table 2

Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard was published by BSI and came into effect on 15 July 2006. It was prepared by Subcommittee GEL/20/17, *Low voltage cables*, under the authority of Technical Committee GEL/20, *Electric cables*.

Supersession

This British Standard supersedes BS 6231:1998, which is withdrawn.

Information about this document

This new edition of BS 6231 retains requirements in respect of cable types BK and CK only. Requirements for other types have been withdrawn as they are no longer considered to be market relevant.

The other principal changes introduced in this edition are to call up CENELEC harmonized test methods in place of earlier national methods.

Product certification/inspection/testing

Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this British Standard. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

WARNING. This British Standard calls for the use of procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are presented in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal obligations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies construction and performance requirements, and gives methods of test, for single core, non-sheathed electric cables of rated voltage 600/1000 V that have PVC insulation.

The types of cable specified in this standard are as follows:

Type BK - for a maximum conductor temperature of 70 °C (see Table 1);

Type CK - for a maximum conductor temperature of 90 °C (see Table 2).

These cables are intended for use in the wiring of switch, control, metering, relay and instrument panels of power switchgear, and for such purposes as internal connections in rectifier equipment and its motor starters and controllers. They are intended for use at alternating voltages not exceeding 600 V to earth, and direct voltages not exceeding 1000 V to earth. When installed in the equipment they are suitable for wiring circuits for which the prescribed alternating test voltage does not exceed 4 kV r.m.s. for 1 min.

A summary of the tests applicable to the cables is given in Annex A.

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.

BS 4727-2: Group 08, *Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms — Part 2: Terms particular to power engineering — Group 08: Electric cables.*

BS 5099, *Electric cables — Voltage levels for spark testing.*

BS EN 50356, *Method for spark testing of cables.*

BS EN 50363-3, *Insulating, sheathing and covering materials for low voltage energy cables — Part 3: PVC insulating compounds*

BS EN 50395:2005, *Electrical test methods for low voltage energy cables*

BS EN 50396:2005, *Non-electrical test methods for low voltage energy cables*

BS EN 60228, *Conductors of insulated cables*

BS EN 60332-1-2, *Tests on electric and optical fibre cables under fire conditions — Part 1-2: Test for vertical flame propagation for a single insulated wire or cable — Procedure for 1 kW pre-mixed flame*

BS EN 60811-1-1, *Insulating and sheathing materials of electric cables — Common test methods — Part 1-1: General application — Measurement of thickness and overall dimensions — Tests for determining the mechanical properties.*

3 Terms and definitions

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

3.1 rated voltage U

nominal power-frequency voltage between phase conductors for which the cable is suitable

3.2 rated voltage U_0

nominal power-frequency voltage between conductor(s) and earth for which the cable is suitable

3.3 approximate value

value which is only indicative

NOTE In this standard, values described as "approximate" do not constitute requirements to be checked by measurement.

3.4 nominal value

value by which a quantity is designated

NOTE Nominal values usually give rise to values to be checked by measurements taking into account specified tolerances.

4 Voltage designation

Cables shall be designated by the rated voltages U_0 and U, expressed in the form U_0/U.

NOTE The rated voltage recognized for the purpose of this British Standard is 600/1000 V.

5 Conductors

The conductors shall conform to BS EN 60228, class 5. The insulated conductors shall be circular, plain annealed copper.

6 Insulation

6.1 Types

The insulation shall be type TI 1 as specified in BS EN 50363-3 for cable type BK, and type TI 3 as specified in BS EN 50363-3 for cable type CK.

6.2 Application

The insulation shall be applied closely to the conductor by the extrusion process.

When the application is tested by removing the insulation from the conductor, there shall be no damage to the insulation itself or the conductor.

6.3 Thickness

The radial thickness of the insulation, when determined by taking the average of a number of measurements in accordance with Annex B, shall be not less than the appropriate value given in Table 1 or Table 2, and the smallest of the measured values shall not fall below the value given in Table 1 or Table 2 by more than 10 % + 0.1 mm.

6.4 Spark test

When tested at the manufacturer's works in accordance with BS EN 50356, using either the a.c. or the d.c. method and the test voltages specified in BS 5099, there shall be no breakdown of the insulation.

7 Identification

All cables shall be identified by colour in accordance with Tables 1 and 2. The colour shall be either throughout the insulation or on its external surface.

Where the bi-colour combination green-and-yellow is used, 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.

Conformity shall be checked by measurement.

NOTE 1 In cases of dispute regarding the green-and-yellow combination and where appropriate to the method of colour marking of the insulation, a suitable test method for checking conformity is given in BS EN 50396:2005, clause ***5.2****.*

NOTE 2 Attention is drawn to the fact that, according to the use to which cables are put, they could be subject to core colour requirements specified in BS 7671, in other British Standards or in other standards, or in regulations or statutory instruments.

NOTE 3 In accordance with BS EN 60446, the single colours green and yellow are only permitted where a confusion with the colouring of the protective conductor is not likely to occur.

The colour used for core identification shall be clearly identifiable. When the core is lightly rubbed ten times with a piece of cotton wool soaked in water, there shall be no degradation of the colour.

8 Cable marking

The cable shall be marked with the number of this British Standard, i.e. BS 6231[1)], on the outer surface by printing, indenting or embossing.

Type CK cables shall additionally be marked with the legend:

HEAT RESISTING 90

NOTE This additional marking may be combined with the marking of the indication of origin.

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

The marking of the manufacturer's name or trademark shall be by printing, indenting or embossing on the sheath.

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1) Marking BS 6231 or BS 6231:2006 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

Any marking shall be legible and regarded as continuous if the gap between the end of one complete inscription and the beginning of the next does not exceed 275 mm.

Any marking by printing shall be durable. Conformity shall be checked by rubbing the marking lightly ten times with a piece of cotton wool or cloth soaked in water.

9 Routine tests for finished cables

9.1 General

Routine tests shall be performed as identified in Table A.1.

NOTE 1 The schedule of tests given in Annex A shows the category of each test parameter, and gives cross-references to the appropriate requirements and test methods.

*NOTE 2 Routine tests for components are covered in Clauses **5** to **7** and are identified in Table A.1.*

10 Sample tests for finished cables

10.1 General

Sample tests shall be performed as identified in Table A.1.

The tests specified in this clause shall be performed under the test conditions specified in Annex C unless otherwise specified in the details for the particular test.

NOTE 1 The schedule of tests given in Annex A shows the category of each test parameter, and gives cross-references to the appropriate requirements and test methods.

*NOTE 2 Sample tests for components are covered in Clauses **5** to **7** and are identified in Table A.1.*

10.2 Conductor resistance

When measured in accordance with BS EN 60228 and corrected to 20 °C, on a sample of cable not less than 1 m in length, the d.c. resistance of each conductor shall conform to the requirements specified in BS EN 60228.

10.3 Voltage withstand of completed cable

When a sample of completed cable is tested in accordance with Annex D, no breakdown of the insulation shall occur.

10.4 Insulation resistance

When the cable is tested in accordance with BS EN 50395:2005, **8.1**, the insulation resistance shall be not less than the minimum value specified in the appropriate construction table.

10.5 Mean overall dimensions

The mean overall diameter of the cable shall be within the limits specified in the appropriate construction table.

Conformity shall be checked by the method described in BS EN 60811-1-1:1995, **8.3**.

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

For diameters not exceeding 25 mm, take the mean of six measurements as the mean overall diameter.

For diameters exceeding 25 mm, take the mean of three measurements as the mean overall diameter.

When embossing in accordance with Clause **8** is used, the points at which measurements are made shall not coincide with the embossing.

10.6 Flame propagation on single cable

Cables shall be tested in accordance with BS EN 60332-1-2. The test shall be carried out on a sample of completed cable. After the test, the cable shall conform to the performance criteria recommended in BS EN 60332-1-2:2004, Annex A.

11 Type tests for finished cables

11.1 General

Type tests shall be performed as identified in Table A.1.

The tests specified in clauses shall be performed under the test conditions specified in Annex C unless otherwise specified in the details for the particular test.

NOTE 1 The schedule of tests given in Annex A shows the category of each test parameter, and gives cross-references to the appropriate requirements and test methods.

*NOTE 2 Type tests for components are covered in Clauses **5** to **7** and are identified in Table A.1.*

11.2 Long-term resistance of PVC insulation to d.c.

When the cable is tested in accordance with BS EN 50395:2005, Clause **9**, the insulation shall meet the requirements given in that clause.

Table 1 **PVC insulated flexible cable – Type BK**

Construction:

Conductor: — class 5 copper, plain annealed

Insulation: — PVC type TI 1.

Colours for identification:

Single colours: Any colour is permitted subject to the notes in Clause **7**

Bi-colour: Green-and-yellow (for earthing or similar protection, see Clause **7**, notes 2 and 3)

Nominal cross-sectional area of conductor	**Mean radial thickness of insulation**	**Mean overall diameter**		**Minimum insulation resistance at 70 °C**
		Lower limit	**Upper limit**	
mm^2	mm	mm	mm	MΩ·km
0.5	0.8	2.4	3.0	0.0161
0.75	0.8	2.6	3.1	0.0141
1.0	0.8	2.7	3.3	0.0128
1.5	0.8	3.0	3.6	0.0111
2.5	0.8	3.4	4.1	0.0094
4	0.8	3.9	4.8	0.0077
6	0.8	4.4	5.3	0.0059
10	1.0	5.7	7.2	0.0058
16	1.0	6.7	9.0	0.0048
25	1.2	8.4	11.5	0.0047
35	1.2	9.7	12.5	0.0040
50	1.4	11.5	15.4	0.0039
70	1.4	13.2	17.5	0.0033
95	1.6	15.1	19.2	0.0032
120	1.6	16.7	21.2	0.0029
150	1.8	18.6	23.9	0.0029
185	2.0	20.6	25.9	0.0029
240	2.2	23.5	28.9	0.0028

Table 2 **PVC insulated flexible cable – Type CK**

Construction:

Conductor: — class 5 copper, plain annealed

Insulation: — PVC type TI 3

Colours for identification:

Single colours: Any colour is permitted subject to the notes in Clause **7**

Bi-colour: Green-and-yellow (for earthing or similar protection, see Clause **7**, notes 2 and 3)

Nominal cross-sectional area of conductor	**Mean radial thickness of insulation**	**Mean overall diameter**		**Minimum insulation resistance at 90 °C**
		Lower limit	**Upper limit**	
mm^2	mm	mm	mm	MΩ·km
0.5	0.8	2.4	3.0	0.0161
0.75	0.8	2.6	3.1	0.0141
1.0	0.8	2.7	3.3	0.0128
1.5	0.8	3.0	3.6	0.0111
2.5	0.8	3.4	4.1	0.0094
4	0.8	3.9	4.8	0.0077
6	0.8	4.4	5.3	0.0059
10	1.0	5.7	7.2	0.0058
16	1.0	6.7	9.0	0.0048
25	1.2	8.4	11.5	0.0047
35	1.2	9.7	12.5	0.0040
50	1.4	11.5	15.4	0.0039
70	1.4	13.2	17.5	0.0033
95	1.6	15.1	19.2	0.0032
120	1.6	16.7	21.2	0.0029
150	1.8	18.6	23.9	0.0029
185	2.0	20.6	25.9	0.0029
240	2.2	23.5	28.9	0.0028

Annex A (normative) Schedule of tests

Table A.1 lists the range of tests applicable to the cables covered by this British Standard and gives cross-references to the requirements and test methods. The last column shows the category of each test, i.e. T, S or R.

The categories and corresponding designations, as defined in IEC/CENELEC standards for cables, are as follows.

a) *Type tests (T)*: tests required to be made before supplying, on a general commercial basis, a type of cable covered by this British Standard, in order to demonstrate satisfactory performance characteristics to meet the intended application. These tests are of such a nature that after they have been made, they need not be repeated unless changes are made in the cable material, design or type of manufacturing process which might change the performance characteristics.

b) *Sample tests (S)*: tests made on samples of completed cable, or components taken from a completed cable, adequate to verify that the product meets the design requirements.

c) *Routine test (R)*: tests made on all production cable lengths to demonstrate their integrity.

Table A.1 **Schedule of tests**

Parameter	Requirement given in clause:	Test method	Test category
Tests on components			
Conductor construction	**5**	BS EN 60228	S
Insulation:			
— type	**6.1**	BS EN 50363-3	T
— application	**6.2**	Visual examination and manual test	S
— thickness	**6.3**	Annex B and BS EN 60811	S
— spark test	**6.4**	BS EN 50356 and BS 5099	R
Cores:			
— identification and durability of colour	**7**	Visual examination and manual test	S
Tests on completed cables			
Cable marking	**8**	Visual examination and measurement	R
Durability of marking	**8**	Manual test	S
Conductor resistance	**10.2**	BS EN 60228	S
Voltage withstand of completed cable	**10.3**	Annex D	S
Insulation resistance - at 70 °C (BK types) - at 90 °C (CK types)	**10.4**	BS EN 50395:2005, **8.2**	S
Long term resistance to d.c.	**11.2**	BS EN 50395:2005, **9**	T
Mean overall diameter	**10.5**	BS EN 60811-1-1:1995, **8.1**	S
Performance under fire conditions:			
— flame propagation on single cable	**10.6**	BS EN 60332-1-2	S

NOTE 1 Tests classified as sample (S) and routine (R) may be required as part of a type approval scheme.
NOTE 2 The order of the tests in this schedule does not imply a sequence of testing.

Annex B (normative) Measurement of insulation thickness

B.1 Sampling

The measurement of thickness of insulation shall be made on samples of cable taken from three different places, separated by at least 1 m.

B.2 Procedure

The measurement shall be made in accordance with BS EN 60811-1-1. Six thickness measurements shall be made on each sample

B.3 Expression of results

The average of all the 18 values obtained shall be calculated to two decimal places and then rounded to obtain the mean value for the insulation thickness. Round the calculated mean value to one decimal place, 0.05 being rounded upwards.

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

Annex C (normative) Test conditions

WARNING. This British Standard calls for the use of procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

C.1 Ambient temperature

Tests shall be made at an ambient temperature of (20 ± 10) °C unless otherwise specified in the details for the particular test.

C.2 Frequency and waveform of power frequency test voltages

Unless otherwise specified in the particular test, the frequency of the alternating test voltages shall be in the range 49 Hz to 61 Hz. The waveform shall be substantially sinusoidal. The ratio peak value/r.m.s. value shall be equal to $\sqrt{2}$ with a tolerance of ± 7%.

Annex D (normative) Method of test for voltage withstand

Immerse a sample of completed cable, between 10 m and 20 m long, in water at a temperature of (20 ± 5) °C for a period of not less than 1 h. Earth the water.

With the cable still immersed apply a test voltage between the conductor and the water. Raise the test voltage gradually to 3 500 V a.c. and maintain it at that value for 5 min.

Bibliography

BS 7671:1992, *Requirements for Electrical Installations. IEE Wiring Regulations. Sixteenth edition.*

BS EN 60446, *Basic and safety principles for the man-machine interface, marking and identification. Identification of conductors by colours or numerals.*

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