BRITISH STANDARD

BS 7870 : Section 3.2 : 1996

LV and MV polymeric insulated cables for use by distribution and generation utilities

Part 3. Specification for distribution cables of rated voltage 0.6/1 kV

Section 3.2 PVC insulated split concentric cables with copper conductors

(Implementation of HD 603)

ICS 29.060.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee GEL/20, Electric cables, to subcommittee GEL/20/2, Mains cables 1kV and above, upon which the following bodies were represented:

Association of Consulting Engineers
British Approvals Service for Cables
British Cable Makers Confederation
British Iron and Steel Producers' Association
British Plastics Federation
ERA Technology Ltd.
Electricity Association
Engineering Equipment and Materials Users' Association
Institution of Incorporated Executive Engineers
London Underground Ltd.
British Railways Board
British Steel Industry

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Contents

Foreword

BS 7870 was prepared by Technical Committee GEL/20. It implements the nationally applicable parts of Harmonization Documents HD 603, 604, 605, 620, 622, 626 and 627 published by the European Committee for Electrotechnical Standardization (CENELEC) in accordance with the decision of the CENELEC Technical Board.

BS 7870 applies to cables for fixed installations having a rated voltage U_o/U up to and including 19/33kV and is published as a series of separate Parts and Sections, as listed in the table in the foreword of Part 1.

Section 3.2 of BS 7870 implements part of HD 603 Part 3N and is to be read in conjunction with BS 7870 : Parts 1 and 2.

The cable type included in this section is single-core PVC insulated stranded copper phase conductor with split concentric copper wire neutral/earth (Type 3N3).

A guide to use for this type of cable is under consideration.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

WARNING. The methods of test described in this British Standard do not detail all precautions necessary to meet the requirements of the Health and Safety at Work, etc, Act 1974. Attention should be paid to any appropriate safety precautions and the tests should only be carried out by authorized personnel.

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

1 Scope

This Section of BS 7870 specifies requirements and dimensions for PVC insulated single-phase split concentric cables.

The cables have a central phase conductor insulated with red PVC and a concentric layer comprising bare copper wires (earth continuity conductor) and copper wires covered with black PVC (neutral conductor).

The maximum conductor temperature for normal operating conditions is 70 °C.

The maximum conductor temperature for short-circuit conditions is 160 °C.

2 References

2.1 Normative references

This Section of BS 7870 incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed on the inside back page. For dated reference, only the cited edition applies; any subsequent amendments to or revisions of the publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This Section of BS 7870 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 page, but reference should be made to the latest editions.

3 Voltage designation

Cables are designated by the voltage U_0, U and U_m expressed in the form U_0/U (U_m).

The voltage designation of cables in this standard is:

0.6/1 (1.2) kV.

In an a.c. system, the rated voltage of the cable shall be at least equal to the nominal voltage of the system for which it is intended. If used in d.c. systems, the cables of this standard shall have a maximum voltage against earth not exceeding 1.5 kV.

4 Phase conductor

The phase conductor shall be circular stranded or compacted stranded plain annealed copper (class 2) in accordance with BS 6360. The d.c. resistance shall conform to the values given in table 2.

5 Insulation

The insulation of the central phase conductor shall be red PVC compound type TI 1 conforming to the requirements of BS 7655 : Section 3.1.

Insulation shall be applied by the extrusion process and shall form a compact homogeneous body.

The thickness of insulation, determined by taking the average of a number of measurements, as described in **2.1.1** of BS 7870 : Part 2 : 1996, shall not be less than the value given in table 2, and the smallest of the measured values shall not fall below the prescribed value by more than (10 % + 0.1 mm).

The colours shall either be on the external surface or extend throughout the insulation. The colours shall be durable such that when tested in accordance with **2.5.4** of BS 7870 : Part 2 : 1996, they shall not be effaced.

6 Concentric layer

6.1 Neutral conductor

The neutral conductor shall be manufactured from plain annealed copper wires. The number of wires and the d.c. resistance shall conform to the values given in table 2.

To distinguish the neutral from the earth continuity conductor, each wire shall be covered by extrusion with a black PVC compound (having a tensile strength of not less than 4 N/mm^2 and an elongation at break of not less than 50 %) to a diameter approximately the same as that of the individual wires in the earth continuity conductor.

NOTE. The covering should not be regarded as insulation.

6.2 Earth continuity conductor

The earth continuity conductor shall be manufactured from bare, plain annealed copper wires. The number and diameter of the wires before cabling, and the d.c. resistance shall conform to the values given in table 2.

6.3 PVC string separators

PVC string separators shall be approximately the same diameter as the individual bare wires forming the earth continuity conductor.

6.4 Application of concentric layer

The concentric layer shall be applied with a right hand direction of lay. The wires forming the neutral conductor and earth continuity conductor shall be applied in individual groups over the insulation with PVC string separators.

Either one or two PVC string separator(s) shall be located on either side of the group of bare copper wires to separate it from the group of covered wires.

The length of lay and the number of strings shall be such that a coverage of approximately 90% is achieved.

For the 16 mm^2, 25 mm^2 and 35 mm^2 sizes, the length of lay shall be not less than the value given in table 2.

7 Binders

One or more overlapped synthetic binder tape(s) shall be applied immediately over the concentric layer.

8 Oversheath

The oversheath shall be an extruded layer of black PVC Type TM 1 conforming to the requirements of BS 7655 : Section 4.1.

When measured in accordance with **2.1.2** of BS 7870 : Part 2 : 1996, the minimum thickness of the oversheath shall not fall below the value given in table 2 by an amount more than (15 % + 0.1 mm).

NOTE. Oversheaths should normally be black, but colours other than black may be provided by agreement between the manufacturer and the purchaser, subject to their suitability for the particular conditions in which the cables are to be used.

9 Cable marking

9.1 External marking

The external surface of all cables conforming to this British Standard shall be legibly marked with the following elements.

	Element	*Example of marking*
a)	Electric cable	ELECTRIC CABLE
b)	Voltage designation	600/1000V
c)	British Standard number	BS 7870/3.2
d)	Manufacturer's identification	XYZ
e)	Number of cores and nominal area of phase/neutral/earth conductors, e.g. 1 × 35/35/25	

The marking of the items a) to d) shall be by embossing or indenting on the oversheath.

For cables with tabulated approximate overall diameters greater than 15 mm, items a), b) and c) shall appear, in any sequence that is deemed neither to confuse nor conflict, on two or more primary lines along the axis of the cable, approximately equally spaced around the circumference of the cable. Items d) and e) shall appear, together or separately, in any sequence that is deemed neither to confuse nor conflict, on either one of the primary lines, or on a secondary line or lines.

For cables with tabulated approximate overall diameters of 15 mm or less, the items shall be disposed as for cables of greater than 15 mm diameter, except that the marking for items a), b) and c) shall appear on one or more primary lines.

The letters and figures shall consist of upright block characters. The characters shall have a minimum height of 3 mm.

The distance between the end of one element of marking and the beginning of the next identical element shall be not greater than 550 mm for items a), b) and c), and not greater than 1100 mm for items d) and e).

Conformity shall be checked by visual examination and measurement.

9.2 Identification of year of manufacture

A means of identifying the year of manufacture of the cable shall be provided throughout the length of the cable, either internally or by marking on the surface of the cable.

If the identification mark is internal, the distance between the end of one mark and the beginning of the next mark shall be not greater than 550 mm.

NOTE. An identification thread may be used as an alternative internal marking.

If the identification is by marking on the surface it shall conform to **9.1**d) and e) in respect of the maximum distance between marks.

9.3 The mark of an approval organization

If the mark of an approval organization is used, it shall be provided throughout the length of the cable, either as a mark on the surface of the cable, or as an identification thread, as specified by the approval organization.

If the mark is applied to the cable it shall be on the surface in the form of the symbol(s) specified by the approval organization, and shall conform to **9.1**d) and e) in respect of the maximum distance between marks.

9.4 Additional marking

Where additional marking is made it shall be throughout the length of the cable, and on the external surface of the cable, or by means of a tape or thread within the cable, or by combination of these methods. If the additional marking is applied to the surface of the cable it shall not render illegible the marking specified in **9.1** to **9.3**.

The additional marking, however made, shall be repeated at intervals not exceeding 1100 mm.

10 Tests

Conformity shall be checked by inspection and by the tests specified in table 1.

11 Additional requirements

11.1 Sampling for thickness measurement

On a sample taken from one end of each drum length of cable selected for the test, having discarded any portion which may have suffered damage, make the measurements of thickness of insulation and oversheath listed in table 1.

If any of the thicknesses measured does not conform to table 2, two further samples shall be checked for the non-conforming factors. If both the samples meet the specified requirements, the cable shall be deemed to conform, but if either does not meet the requirements, the cable shall be deemed not to conform.

11.2 Voltage test on complete cable

When the voltage test is carried out in accordance with **3.2.1** of BS 7870 : Part 2 : 1996, using a test voltage of 3.5 kV a.c. for a duration of 5 min, the insulation shall not break down.

An additional voltage test of 500V d.c. shall be applied for 1 min between the bare earth continuity wires and the covered neutral wires in the concentric neutral layer. There shall be no breakdown of the covering.

11.3 Insulation resistance test

After completion of the voltage tests in accordance with **11.2**, the insulation resistance measured between the central phase conductor and all the wires in the concentric layer shall not be less than 5 MΩ/km at 20 °C.

11.4 Spark test

When spark testing is carried out in accordance with **3.6.1** of BS 7870 : Part 2 : 1996, the following voltage shall be used.

a)	Spark test on phase core	
	4 to 16 mm^2	6 kV a.c or 9 kV d.c.
	25 & 35 mm^2	10 kV a.c. or 15 kV d.c.
b)	Spark test on oversheath	
	4 to 16 mm^2	8.5 kV a.c. or 13 kV d.c.
	25 mm^2	9 kV a.c. or 13.5 kV d.c.
	35 mm^2	9.5 kV a.c. or 14.5 kV d.c.

11.5 Compatibility

When tested in accordance with **8.1.4** of BS EN 60811-1-2 : 1995 for 7 days at (80 ± 2 °C), the materials shall conform to table 3 of this standard.

12 Sealing and drumming

After completion of the manufacturer's tests, both ends of every length of cable shall be sealed to prevent the ingress of moisture during transportation and storage. The seal shall be effected either by using close fitting plastics caps fitted over the ends of the cable enclosing the oversheath and firmly secured to it by plastic adhesive tapes, or by other approved means.

NOTE. The cap should be sufficiently robust to withstand the effects of installing the cable but the possibility of damage to moisture seals during handling and installation of the cable should be borne in mind. Where such damage may have occurred, the seals should be inspected and remade if necessary.

Each drum shall bear a distinguishing number on the outside of one flange. Particulars of the cable, ie. voltage, length, conductor size, 'Copper', 'PVC', 'single-phase', length number, gross and net weights, shall be clearly shown on one flange of the drum. The direction of rolling shall be indicated by an arrow.

Table 1.Schedule of Tests

Test	Requirements given in clause:	Test method described in:
Routine tests		
Phase conductor resistance	table 2	Part 2 : 1996, **3.1.1**
Neutral conductor resistance	table 2	Part 2 : 1996, **3.1.1**
Earth continuity conductor resistance	table 2	Part 2 : 1996, **3.1.1**
Voltage test on complete cable	**11.2**	Part 2 : 1996, **3.2.1**
Insulation resistance	**11.3**	**11.3**
Spark test:		
a) insulation	**11.4**a	Part 2 : 1996, **3.6.1**
b) oversheath	**11.4**b	Part 2 : 1996, **3.6.1**
Cable markings	**9**	visual
Sample tests		
Phase conductor material and construction	**4**	BS 6360
Insulation:		
a) application	**5**	visual
b) thickness	**5**	Part 2 : 1996, **2.1.1**
c) colour	**5**	visual
d) durability of colour	**5**	Part 2 : 1996, **2.5.4**
Concentric layer:		
a) neutral conductor material	**6.1**	visual
b) earth continuity conductor material	**6.2**	visual
Oversheath:		
a) application	**8**	visual
b) thickness	**8**	Part 2 : 1996, **2.1.2**
Type tests		
Insulation	**5**	BS EN 60811
Neutral covering material	**6.1**	BS EN 60811
Oversheath	**8**	BS EN 60811
Compatibility	table 3	**11.5**

Table 2. Single-phase split concentric cables with stranded copper conductors and copper wire neutral and earth continuity conductors

Nominal area of phase conductor	Thickness of insulation on phase conductor	Number and approximate diameter of wires for concentric conductors		Minimum lay length	Thickness of oversheath	Approximate overall diameter	Maximum d.c. resistance per km of cable at 20°C		
		Neutral	Earth continuity				Phase	Neutral	Earth continuity conductor
mm^2	mm	mm	mm	mm	mm	mm	Ω	Ω	Ω
4[1]	0.8[3]	7/0.85	3/1.35	–	1.4	10.2	4.61	4.8	4.8
6[1]	1.0	7/1.04	4/1.53	–	1.4	11.2	3.08	3.2	3.2
10[1]	1.0	7/1.35	4/1.78	–	1.4	12.6	1.83	1.9	1.9
16[2]	1.0	7/1.70	4/2.25	144	1.4	14.6	1.15	1.2	1.2
25[2]	1.2[3]	11/1.70	4/2.25	193	1.5	18.1	0.727	0.76	1.2
35[2]	1.2[3]	15/1.70	6/2.25	258	1.6	22.6	0.524	0.55	0.76

[1] Circular stranded (class 2)
[2] Circular stranded or compacted circular (class 2)
[3] Enhanced thickness may be found on finished cables in order to accommodate the number of neutral and earth continuity wires.

Table 3. Requirements for compatibility of insulation and oversheath

Component	Test	Requirement	
		TI 1	TM 1
Insulation	Minimum tensile strength (N/mm^2)	12.5	–
	Minimum elongation at break (%)	125	–
	Maximum variation[1] of tensile strength (%)	20	–
	Maximum variation[1] of elongation at break (%)	20	–
Oversheath	Minimum tensile strength (N/mm^2)	–	12.5
	Minimum elongation at break (%)	–	125
	Maximum variation[1] of tensile strength (%)	–	20
	Maximum variation[1] of elongation at break (%)	–	20

[1] The variation is the difference between the respective values obtained prior to and after heat treatment, expressed as a percentage of the former.

List of references

Normative references

British Standards publications
BRITISH STANDARDS INSTITUTION, London

BS 6360 : 1991	*Specification for conductors in insulated cables and cords*
BS 7655	*Specification for insulating and sheathing materials for cables*
BS 7655 : Part 3:	*PVC insulating compounds*
BS 7655 : Section 3.1 : 1993	*Harmonized types*
BS 7655 : Part 4	*PVC sheathing compounds*
BS 7655 : Section 4.1 : 1993	*Harmonized types*
BS 7870 :	*Specification for LV & MV polymeric insulated cables for use by distribution and generation utilities*
BS 7870 : Part 1 : 1996	*General*
BS 7870 : Part 2 : 1996	*Test methods*
BS EN 60811	*Insulating and sheathing materials of electric cables*
BS EN 60811 : Part 1:	*Methods for test for general applications*
BS EN 60811 : Section 1-2 : 1995	*Thermal ageing methods*

Informative references

British Standards publications
BRITISH STANDARDS INSTITUTION, London

BS 4066 (series)	*Tests on electric cables under fire conditions*

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