BRITISH STANDARD

BS 6360:1991

Incorporating Amendment Nos. 1, 2, 3 and 4

Specification for

Conductors in insulated cables and cords

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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:

Aluminium Federation
Association of Consulting Engineers
Association of Manufacturers of Domestic Electrical Appliances
British Approvals Service for Cables
British Cable Makers Confederation
British Plastics Federation
British Railways Board
British Steel Industry
British Telecommunications plc
Department of the Environment (Property Services Agency)
Department of Trade and Industry (Consumer Safety Unit, CA Division)
ERA Technology Ltd
Electricity Supply Industry in United Kingdom
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 Supervisory and Executive Engineers
British Non-Ferrous Metals Federation
Ministry of Defence

This British Standard, having been prepared under the direction of the Cables and Insulation Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 30 April 1991

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Contents

Foreword

This edition of BS 6360 has been prepared under the direction of the Cables and Insulation Standards Policy Committee and it supersedes BS 6360:1981, which is withdrawn.

This edition includes alterations introduced by Amendment Nos 1 and 2 to BS 6360:1981 (published in September 1983 and March 1985 respectively) 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.

The 1981 edition revised the requirements for copper conductors in insulated cables and cords included in the first edition of this standard and it also included and revised the requirements for aluminium conductors in insulated cables and copper-clad aluminium conductors in insulated cables previously given in BS 6791:1969 and BS 4990:1973 respectively.

This edition does not include the specification for copper-clad aluminium conductors.

This standard is intended for use in the preparation of standards for electric cables so that the cable specification can either cross refer to this standard or include the appropriate information.

For conductors of the types used in cables and cords covered by CENELEC[1)] Harmonization Documents HD 21 and HD 22 and their supplements, this standard implements CENELEC Harmonization Document HD 383 for which the reference document is IEC[2)] Publication 228:1978 "Conductors of insulated cables".

The content of this standard differs from that of IEC Publication 228 as follows:

a) The requirements for metal-coated aluminium and plain or metal-coated aluminium alloy have not been included as these types of material are not in general use in the United Kingdom.

b) Additional requirements have been included covering the following items as these are necessary for other British Standards:

1) materials for aluminium conductors;

2) hard-drawn copper conductors;

3) tests for tinning and mechanical properties of wires when these are specifically required for cable specifications;

4) sectoral solid aluminium conductors previously covered in BS 6791;

5) three nominal cross-sectional areas of flexible copper conductors, 0.22 mm^2, 1.25 mm^2 and 1.35 mm^2.

The most notable differences in requirements in this standard from those in the British Standards it replaces are as follows.

a) For conductors in cables for fixed installations the maximum resistance specified for each cross-sectional area of the same metal (i.e. copper or aluminium) is the same for single and multicore cables and for solid and stranded conductors, whatever the number of wires.

However the differences between plain and metal-coated copper conductors is maintained.

b) For the nominal cross-sectional areas up to and including 10 mm^2, the specified maximum resistance of aluminium conductor is the same as for the next smaller standard nominal cross-sectional area of copper conductor.

Consistent with IEC Publication 228, the smallest nominal cross-sectional area of shaped cross section is now 25 mm^2, and the designations by the classes 1, 2, 5 and 6 follow the nomenclature of IEC Publication 228.

[1)] European Committee for Electrotechnical Standardization.

[2)] International Electrotechnical Commission.

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Appendix E constitutes a guide to dimensional limits of circular conductors and includes other subsidiary information.

This edition includes the necessary amendment to align with Amendment 1 to HD 383 S2 being the endorsement of IEC 228 and IEC 228A.

Differences in the text between this edition and BS 6360:1981 are indicated by a sideline in the margin.

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.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Table 2 — Class 2 stranded conductors for single-core and multicore cables

1	2	3	4	5	6	7	8	9	10
Nominal cross-sectional area	Minimum number of wires in the conductors						Maximum resistance of conductor at 20 °C		
	Circular conductor		Circular compacted conductor		Shaped conductor		Annealed copper conductor[a]		Aluminium conductor
	Cu	Al	Cu	Al	Cu	Al	Plain wires	Metal-coated wires	
mm²							Ω/km	Ω/km	Ω/km
0.5	7	—	—	—	—	—	36.0	36.7	—
0.75	7	—	—	—	—	—	24.5	24.8	—
1	7	—	—	—	—	—	18.1	18.2	—
1.5	7	—	6	—	—	—	12.1	12.2	—
2.5	7	—	6	—	—	—	7.41	7.56	—
4	7	7[b]	6	—	—	—	4.61	4.70	7.41
6	7	7[b]	6	—	—	—	3.08	3.11	4.61
10	7	7	6	—	—	—	1.83	1.84	3.08
16	7	7	6	6	—	—	1.15	1.16	1.91
25	7	7	6	6	6	6	0.727	0.734	1.20
35	7	7	6	6	6	6	0.524	0.529	0.868
50	19	19	6	6	6	6	0.387	0.391	0.641
70	19	19	12	12	12	12	0.268	0.270	0.443
95	19	19	15	15	15	15	0.193	0.195	0.320
120	37	37	18	15	18	15	0.153	0.154	0.253
150	37	37	18	15	18	15	0.124	0.126	0.206
185	37	37	30	30	30	30	0.0991	0.100	0.164
240	61	61	34	30	34	30	0.0754	0.0762	0.125
300	61	61	34	30	34	30	0.0601	0.0607	0.100
400	61	61	53	53	53	53	0.0470	0.0475	0.0778
500	61	61	53	53	53	53	0.0366	0.0369	0.0605
630	91	91	53	53	53	53	0.0283	0.0286	0.0469
800	91	91	53	53	—	—	0.0221	0.0224	0.0367
960 (4 × 240)	Number of wires not specified						0.0189		0.0313
1 000	91	91	53	53	—	—	0.0176	0.0177	0.0291
1 200	Number of wires not specified				—	—	0.0151		0.0247
1 600					—	—	0.0113		0.0186
2 000					—	—	0.0090		0.0149

[a] To obtain the maximum resistance of hard-drawn conductors the values in columns 8 and 9 should be divided by 0.97.

[b] See **6.2.1**.

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Table 3 — Class 5 flexible copper conductors for single-core and multicore cables

1	2	3	4
Nominal cross-sectional area	Maximum diameter of wires in conductor	Maximum resistance of conductor at 20 °C	
		Plain wires	Metal-coated wires
mm^2	mm	Ω/km	Ω/km
0.22	0.21	92.0	92.4
0.5	0.21	39.0	40.1
0.75	0.21	26.0	26.7
1	0.21	19.5	20.0
1.25	0.21	15.6	16.1
1.35	0.31	14.6	15.0
1.5	0.26	13.3	13.7
2.5	0.26	7.98	8.21
4	0.31	4.95	5.09
6	0.31	3.30	3.39
10	0.41	1.91	1.95
16	0.41	1.21	1.24
25	0.41	0.780	0.795
35	0.41	0.554	0.565
50	0.41	0.386	0.393
70	0.51	0.272	0.277
95	0.51	0.206	0.210
120	0.51	0.161	0.164
150	0.51	0.129	0.132
185	0.51	0.106	0.108
240	0.51	0.0801	0.0187
300	0.51	0.0641	0.0654
400	0.51	0.0486	0.0495
500	0.61	0.0384	0.0391
630	0.61	0.0287	0.0292

Table 4 — Class 6 flexible copper conductors for single-core and multicore cables

1	2	3	4
Nominal cross-sectional area	Maximum diameter of wires in conductor	Maximum resistance of conductor at 20 °C	
		Plain wires	Metal-coated wires
mm^2	mm	Ω/km	Ω/km
0.5	0.16	39.0	40.1
0.75	0.16	26.0	26.7
1	0.16	19.5	20.0
1.5	0.16	13.3	13.7
2.5	0.16	7.98	8.21
4	0.16	4.95	5.09
6	0.21	3.30	3.39
10	0.21	1.91	1.95
16	0.21	1.21	1.24
25	0.21	0.780	0.795
35	0.21	0.554	0.565
50	0.31	0.386	0.393
70	0.31	0.272	0.277
95	0.31	0.206	0.210
120	0.31	0.161	0.164
150	0.31	0.129	0.132
185	0.41	0.106	0.108
240	0.41	0.0801	0.0817
300	0.41	0.0641	0.0654

Table 5 — Temperature correction factors

Temperature correction factors k_t for conductor resistance to correct the measured resistance at t °C to 20 °C

1	2
Temperature of conductor at time of measurement, t °C	**Correction factor, k_t** **All conductors**
5	1.064
6	1.059
7	1.055
8	1.050
9	1.046
10	1.042
11	1.037
12	1.033
13	1.029
14	1.025
15	1.020
16	1.016
17	1.012
18	1.008
19	1.004
20	1.000
21	0.996
22	0.992
23	0.988
24	0.984
25	0.980
26	0.977
27	0.973
28	0.969
29	0.965
30	0.962
31	0.958
32	0.954
33	0.951
34	0.947
35	0.943

NOTE The values of correction factors k_t are based on a resistance-temperature coefficient of 0.004 per °C at 20 °C.
The values of temperature correction factors specified in column 2 are approximate but give practical values well within the accuracies that can normally be achieved in the measurements of conductor temperature and length of cables or flexible cords.
For more accurate values for the temperature correction factors for copper and aluminium, reference should be made to Appendix D. However, these should not be treated as a requirement for testing in compliance with this standard in the assessment of resistances.

Table 6 — Permissible mass of copper dissolved in tinning

Diameter of wire		Maximum mass of copper dissolved
Above mm	Up to and including mm	g/m^2
0.149	0.51	5
0.51	3.2	3

Table 7 — Elongation of annealed copper wires

Diameter of wire		Minimum elongation
Above mm	Up to and including mm	%
—	0.14	5.5
0.14	0.21	9
0.21	0.51	14
0.51	1.36	18
1.36	—	22.5

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Appendix A Measurement of resistance

Keep the cable in the test area, which should be at a reasonably constant temperature, for sufficient time to ensure that the cable temperature is equal to the ambient temperature.

Measure the d.c. resistance of the conductor(s) either on a complete length of cable or flexible cord or on a sample of cable or flexible cord of at least 1 m in length at room temperature and record the temperature at which the measurement is made.

Calculate the resistance per kilometre length of cable from the length of the complete cable and not from the length of the individual cores or wires.

Appendix B Tinning test

B.1 Selection of test samples and preparation of test specimens. Cut a test sample of the length given in column 4 of Table 8 from each core of the finished cable and remove the insulation by any method that does not cause injury to the tin coating, e.g. the insulation may be loosened from the conductor by drawing a solvent and/or oil up the interstitial spaces of the conductor.

Take two groups of specimens each comprising the number of single wires given in column 5 of Table 8 from the test samples and mark these 40 mm from each end by means of a grease pencil or in some other manner that does not cause damage to the tin coating.

Select the wires for these groups at random from the various cores of multicore cables. In the event of insulation adhering to the test specimen, clean the wire if necessary, before winding the helix, by rubbing with a pad of clean cotton wool soaked in a suitable solvent, e.g. 1,1,1-trichloroethane or toluene. In refractory cases carry out a preliminary treatment with hot solvent to facilitate the removal of the adherent insulation. Wind each group of test specimens into one helix upon a smooth mandrel in such a manner as to ensure that no twisting moment is imparted to the wires. The diameter of the mandrel shall be as given in Table 9. The 40 mm end portions shall not be wrapped round the mandrel but so arranged as to project above the surface of the testing solution in which the helix is immersed. The radius of any necessary bends shall not be less than half the diameter of the mandrel used to produce the helix. The helix shall not be wrapped so tightly as to inhibit the entry of the solution.

Remove the helix from the mandrel by slipping it off endwise without further distortion of the wire.

Immerse the test helix for a period of 10 s in a suitable solvent, e.g. 1,1,1-trichloroethane or toluene, contained in one vessel, followed by a similar period of immersion in solvent contained in a second vessel, the helix being agitated during each immersion and allowed to dry before immersion in the test solution. Should colouration of the solvent due to dissolved material become discernible, renew the solution taking care to ensure that the vessel containing the cleaner liquid is used for the second (and final) wash.

B.2 Preparation of testing solution. Prepare the testing solutions as follows:

a) *Persulphate solution.* Dissolve 10 g of fresh crystalline ammonium persulphate in distilled water, add 20 ml of ammonia solution (ρ = 0.880 g/ml at 20 °C) and make up to 1 litre with distilled water.

b) *Standard colour reagent.* Dissolve 3.927 g of pure copper sulphate ($CuSO_4 \cdot 5H_2O$) in distilled water with 50 ml of ammonia solution (ρ = 0.880 g/ml at 20 °C) and make up to 1 litre with distilled water. 1 ml of this solution is equivalent to 0.001 g of copper.

B.3 Immersion for test. Carry out the test at normal room temperature but immediately before the immersion of the helix bring the test solution to a temperature of 20 ± 2 °C.

After cleaning, immerse the helix for 10 min in a vessel containing the persulphate solution specified in **B.2** in such a manner that the surface of the wire between the marks (see column 6 of Table 8) is exposed to the testing solution and the 40 mm ends project above the surface.

The volume of the solution shall be:

for wires up to and including 1.78 mm diameter	75 ml
for wires above 1.78 mm diameter	200 ml

B.4 Determination of mass of copper dissolved. Determine the mass of copper dissolved from the wire by the persulphate solution colorimetrically by comparison with the standard colour reagent specified in **B.2**. Express the mass as grams of copper per square metre surface area of wire immersed.

B.5 Assessment of results. If the result of one group of specimens exceeds the specified maximum value, repeat the test on a fresh group of specimens cut from the wires from which the defective group was taken to ensure that the failure was not due purely to "end effect". If this additional group fails to pass the test the conductor represented by this sample shall be deemed not to comply with the requirements.

Table 8 — Test specimen for tinning test

1	2	3	4	5	6	7
Test sample				Test specimens		
Diameter and number of wires in conductor			Length	Number	Length between marks	
Diameter		Number			For each specimen	Total for each group
Above mm	Up to and including mm		mm		mm	mm
0.149	0.3	7 or more	1 080	5	1 000	5 000
0.3	0.67	7 or more	747	3	667	2 000
0.67	3.2	7 or more	413	3	333	1 000
0.67	3.2	1	1 080	1	1 000	1 000

Table 9 — Mandrel diameter for tinning test

Diameter of wire		Diameter of mandrel
Above mm	Up to and including mm	mm
0.149	0.41	20
0.41	0.67	25
0.67	0.85	30
0.85	1.13	35
1.13	1.53	45
1.53	1.78	55
1.78	2.25	65
2.25	2.52	75
2.52	2.85	85
2.85	3.20	95

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Appendix C Tests of mechanical properties

C.1 Elongation after break. Apply the load gradually and uniformly to a straightened length of wire having an original gauge length of 200 mm, or alternatively 250 mm. Measure the elongation on the gauge length after the fractured ends have been fitted together.

Express the elongation after break as a percentage of the original gauge length.

The determination shall be valid, whatever the position of fracture, if the specified value is reached. If the specified value is not reached, the determination shall be valid only if the fracture occurs between the gauge marks and not closer than 22 mm to either mark. If a valid result is not obtained the test shall be repeated.

C.2 Wrapping test. Wrap the wire round a wire of its own diameter to form a close helix of eight turns. Unwrap six turns and again wrap in the same direction as before.

Appendix D Exact formulae for the temperature correction factors

a) Annealed copper conductors: plain

$$k_{t,\,\mathrm{Cu}} = \frac{254.5}{234.5 + t} = \frac{1}{1 + 0.00393\,(t - 20)}$$

b) Aluminium conductors: plain

$$k_{t,\,\mathrm{Al}} = \frac{248}{228 + t} = \frac{1}{1 + 0.00403\,(t - 20)}$$

NOTE For aluminium alloys, reference should be made to the manufacturer.

c) Hard-drawn copper conductors: plain or metal-coated

$$k_{t,\,\mathrm{HCu}} = \frac{262.5}{242.5 + t} = \frac{1}{1 + 0.00381\,(t - 20)}$$

In all the above cases, t refers to the temperature of the conductor at the time of measurement in degrees Celsius.

Appendix E Guide to the dimensional limits of circular conductors and other subsidiary information

E.0 Introduction. The following text comprising this appendix is divided into two main clauses (**E.1** and **E.2**) neither of which constitutes specified requirements. They take the form of additional information.

Clause **E.1** is based on IEC Publication 228A. The minimum and maximum diameters listed are identical to the values in the IEC publication and can therefore be regarded as having a wide acceptance internationally as well as applying nationally.

NOTE **Shaped conductors**

a) In BS 6360 there is already a cross-reference to BS 3988, which gives dimensional data for the shaped solid aluminium conductors used in cables of the types for which such conductors are specified in current British Standards. The data in BS 3988 relates to the conductors for use in making the cables and not directly to the dimensions of the conductors in the manufactured cables. However, as the dimensions of the maximum envelopes of the conductors specified in BS 3988 are unlikely to increase as a result of the cablemaking process, these are a good guide for the designers and users of connectors intended to fit the conductors in the cables.

b) As shaped stranded copper and aluminium conductors are normally circularized before connection, it is considered unnecessary to standardize dimensional limits for these conductors.

Clause **E.2** contains further information regarded as useful data about the conductors in cables complying with British Standards. This type of information has been included in earlier editions of standards for these conductors.

E.1 Dimensional limits of circular conductors

E.1.1 *Object.* This appendix is intended as a guide to manufacturers of cables and cable connectors to assist in ensuring that connectors and cable conductors fit together. It gives guidance on dimensional limits for the following types of conductor included in this British Standard:

a) circular solid conductors, class 1, of copper and aluminium;

b) circular and compacted circular stranded conductors, class 2, of copper and aluminium;

c) flexible conductors, class 5, of copper;

d) flexible conductors, class 6, of copper.

E.1.2 *Dimensional limits for circular copper conductors.* The diameters of circular copper conductors should not exceed the values given in Table 10.

For circular copper conductors, maximum diameters only are given and for the stranded (class 2) conductors these are based on uncompacted conductors. The reason for this is that connectors will cope with a wider range of diameters with copper than with aluminium and, therefore, with copper it is generally only necessary to recommend the maximum diameters to be accommodated. Moreover, circular stranded copper conductors are more frequently used in the uncompacted form than are aluminium conductors.

If minimum diameters for circular copper conductors class 1 and class 2 are needed, reference can be made to the minimum diameters for solid and stranded compacted circular aluminium conductors indicated in Table 11.

NOTE The values given for flexible conductors are intended to allow for both class 5 and class 6 conductors.
For class 5 conductors only, the diameters of the 2.5 mm^2 and 4 mm^2 sizes will generally be smaller and not exceed the following:

2.5 mm^2 : 2.3 mm

4 mm^2 : 2.9 mm

E.1.3 *Dimensional limits for circular aluminium conductors.* The diameters of circular solid aluminium conductors and compacted circular stranded aluminium conductors should not exceed the maximum values and should be not less than the minimum values given in Table 11.

In the exceptional case of uncompacted circular stranded aluminium conductors the maximum diameters should not exceed the corresponding values for copper conductors given in column 3 of Table 10.

The dimensional limits of aluminium conductors, with cross-sectional areas smaller than 16 mm^2, are not given because of the variations of dimensions that exist depending on the wide range of materials and combinations of materials used.

The dimensional limits of aluminium conductors with cross-sectional areas above 630 mm^2 are not given as the compaction technology is not generally established.

Table 10 — Maximum diameters of circular copper conductors

1	2	3	4
Cross-sectional area	Conductors in cables for fixed installations		
	Solid (class 1)	Stranded (class 2)	Flexible conductors (classes 5 and 6)
mm^2	mm	mm	mm
0.5	0.9	1.1	1.1
0.75	1.0	1.2	1.3
1	1.2	1.4	1.5
1.5	1.5	1.7	1.8
2.5	1.9	2.2	2.6
4	2.4	2.7	3.2
6	2.9	3.3	3.9
10	3.7	4.2	5.1
16	4.6	5.3	6.3
25	5.7	6.6	7.8
35	6.7	7.9	9.2
50	7.8	9.1	11.0
70	9.4	11.0	13.1
95	11.0	12.9	15.1
120	12.4	14.5	17.0
150	13.8	16.2	19.0
185	—	18.0	21.0
240	—	20.6	24.0
300	—	23.1	27.0
400	—	26.1	31.0
500	—	29.2	35.0
630	—	33.2	39.0
800	—	37.6	—
1 000	—	42.2	—

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Table 11 — Minimum and maximum diameters of circular aluminium conductors

1	2	3	4	5
Cross-sectional area	Solid conductors (class 1)		Stranded compacted conductors (class 2)	
	Minimum diameter	Maximum diameter	Minimum diameter	Maximum diameter
mm²	mm	mm	mm	mm
16	4.1	4.6	4.6	5.2
25	5.2	5.7	5.6	6.5
35	6.1	6.7	6.6	7.5
50	7.2	7.8	7.7	8.6
70	8.7	9.4	9.3	10.2
95	10.3	11.0	11.0	12.0
120	11.6	12.4	12.5	13.5
150	12.9	13.8	13.9	15.0
185	14.5	15.4	15.5	16.8
240	16.7	17.6	17.8	19.2
300	18.8	19.8	20.0	21.6
400	—	—	22.9	24.6
500	—	—	25.7	27.6
630	—	—	29.3	32.5

E.2 Conceptual constructions, nominal diameters of circular conductors and weights

NOTE The term "conceptual construction" is used for the conductor construction from which the specified maximum resistance values were originally calculated. The conceptual constructions are theoretically feasible constructions for uncompacted circular conductors, not necessarily used in practice.

Additional data for annealed copper conductors and aluminium or aluminium alloy conductors of cables for fixed installations are given in Table 12 and Table 13 respectively. Additional data for flexible copper conductors are given in Table 14.

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Table 12 — Additional data for annealed copper conductors of cables for fixed installations

Nominal cross-sectional area	Conceptual construction no./diameter of wires	Nominal diameter of equivalent solid (class 1) conductor	Equivalent stranded (class 2) conductor no./diameter of wires	Nominal diameter of stranded (class 2) conductor	Nominal mass per km of conductor	
					Solid	Stranded
mm2	–/mm	mm	–/mm	mm	kg	kg
0.5	1/0.80	—	7/0.31	0.93	4.5	4.8
0.75	1/0.97	—	7/0.37	1.11	6.6	6.9
1	1/1.13	—	7/0.44	1.32	9.0	9.7
1.5	1/1.38	—	7/0.53	1.59	13.3	14.0
2.5	7/0.67	1.77	—	2.01	21.9	22.4
4	7/0.85	2.24	—	2.55	35.0	36.1
6	7/1.04	2.74	—	3.12	52.4	54.0
10	7/1.35	3.56	—	4.05	88.5	90.8
16	7/1.70	4.48	—	5.10	140	145
25	7/2.14	5.64	—	6.42	222	229
35	7/2.52	6.64	—	7.56	308	317
50	19/1.78	7.72	—	8.90	416	429
70	19/2.14	9.28	—	10.70	601	620
95	19/2.52	10.93	—	12.60	834	860
120	37/2.03	12.29	—	14.21	1 055	1 086
150	37/2.25	13.62	—	15.75	1 295	1 334
185	37/2.52	—	—	17.64	—	1 673
240	61/2.25	—	—	20.25	—	2 199
300	61/2.52	—	—	22.68	—	2 759
400	61/2.85	—	—	25.65	—	3 528
500	61/3.20	—	—	28.80	—	4 448
630	127/2.52	—	—	32.76	—	5 744
800	127/2.85	—	—	37.05	—	7 346
1 000	127/3.20	—	—	41.60	—	9 260

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Table 13 — Additional data for aluminium or aluminium alloy conductors of cables for fixed installations

Nominal cross-sectional area mm^2	Conceptual construction no./diameter of wires –/mm	Nominal diameter of equivalent solid (class 1) conductor mm	Nominal diameter of stranded (class 2) conductor mm	Nominal mass per km of conductor: Solid kg	Nominal mass per km of conductor: Stranded kg
16	7/1.70	4.46	5.10	42.2	43.9
25	7/2.14	5.58	6.42	66.2	69.5
35	7/2.52	6.58	7.56	91.8	96.4
50	19/1.78	7.65	8.90	124	131
70	19/2.14	9.20	10.70	180	189
95	19/2.52	10.83	12.60	249	262
120	37/2.03	12.18	14.21	315	331
150	37/2.25	13.50	15.75	387	406
185	37/2.52	15.12	17.64	485	509
240	61/2.25	17.33	20.25	638	669
300	61/2.52	19.41	22.68	800	839
400	61/2.85	—	25.65	—	1 073
500	61/3.20	—	28.80	—	1 353
630	127/2.52	—	32.76	—	1 746
800	127/2.85	—	37.05	—	2 233
1 000	127/3.20	—	41.60	—	2 816
	Sectoral circular conductors				
	No./cross section of sectors –/mm^2	**Nominal diameter of laid-up conductor** mm			
380	4/95	22.16	—	1 016	—
480	4/120	24.86	—	1 285	—
600	4/150	27.58	—	1 579	—
740	4/185	30.86	—	1 979	—
960	4/240	35.38	—	2 603	—
1 200	4/300	39.58	—	3 264	—

Table 14 — Additional data for flexible copper conductors

Nominal cross-sectional area	Conceptual construction of flexible conductors no./diameter of wires	Approximate diameter of conductor	
		Bunched	Multiple stranded
mm^2	–/mm	mm	mm
0.22	7/0.20	0.60	—
0.5	16/0.20	0.93	—
0.75	24/0.20	1.14	—
1	32/0.20	1.32	—
1.25	40/0.20	1.48	—
1.35	19/0.30	1.50	—
1.5	30/0.25	1.6	—
2.5	50/0.25	2.0	—
4	56/0.30	2.6	—
6	84/0.30	3.3	3.6
10	80/0.40	4.2	4.6
16	126/0.40	5.3	5.7
25	196/0.40	6.6	7.1
35	276/0.40	7.8	8.5
50	396/0.40	9.4	10.3
70	360/0.50	11.2	12.4
95	475/0.50	13.0	14.5
120	608/0.50	14.5	16
150	756/0.50	—	18
185	925/0.50	—	20
240	1 221/0.50	—	23
300	1 525/0.50	—	26
400	2 013/0.50	—	30
500	1 769/0.60	—	33.5
630	2 257/0.60	—	37

E.2.4 *Method of calculation of maximum resistance values.* The maximum resistance values given in Table 1, Table 2, Table 3 and Table 4 were calculated, using the conceptual constructions, from the formula:

$$R = \frac{4A}{n\pi d^2} K_1 K_2 K_3$$

where

R is the maximum resistance at 20 °C in Ω/km;

A is the volume resistivity at 20 °C of the conductor metal in Ω mm²/km, i.e.

17.241 for annealed copper,

28.264 for stranded aluminium conductors (based on material 1350 specified in BS 2627 in the H4 or H68 condition);

n is the number of wires in the conductor;

d is the nominal diameter of the wires in the conductor in mm;

K_1 is a factor depending on the diameter of the wires and the metal, as given in Table 15.

K_2 is a factor depending on conductor formation, as follows.

1.00 for solid conductors.

1.02 for stranded class 2 conductors if the nominal wire diameter exceeds 0.6 mm.

1.04 for stranded or flexible conductors if the nominal wire diameter does not exceed 0.6 mm.

K_3 is a factor depending upon whether the conductor has frequent use in multicore cables, making allowance for the lay of the cores, or is of a size generally used for single core cables. Values of K_3 are as follows.

1.00 for conductors of cables for fixed installations of nominal cross-sectional areas 500 mm^2 and above and for flexible conductors of 630 mm^2.

1.02 for conductors of cables for fixed installation of nominal cross-sectional areas up to and including 400 mm^2.

1.05 for flexible conductors of nominal cross-sectional areas up to and including 500 mm^2.

For circular sectoral aluminium conductors the maximum resistance is calculated from the maximum resistance specified for each of the four individual sector shaped conductors of which it consists. In effect, the value for one of the individual sector shaped conductors is divided by four in order to derive the maximum resistance value of the circular sectoral aluminium conductor.

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NOTE The value of resistivity for aluminium of 28.264 Ω mm²/km is the standard value for material in the H4 and H68 condition, as used for the wire sizes for stranded conductors, which are the conceptual constructions for calculation of specified resistances. In practice the larger sizes of solid conductor are made from material in condition 0 for which the standard resistivity is 28.03 Ω·mm²/km. However, the specified resistances of the solid conductors are the same as for the equivalent stranded conductors and the difference in resistivity is taken into account in the design dimensions of the solid conductors.

As the specified resistances are now the same for single core and multicore cables, the factor K_3 is now related to the nominal cross-sectional area of the conductor and not directly to whether the cable is single core or multicore.

Table 15 — Values of factor K_1

Maximum diameter of wires in conductor		K_1			
		Solid conductor		Stranded conductor	
Above mm	Up to and including mm	Plain copper	Metal coated copper	Plain copper	Aluminium or aluminium alloy
0.05	0.10	—	—	1.07	1.12
0.10	0.31	—	—	1.04	1.07
0.31	0.91	1.03	1.05	1.02	1.04
0.91	3.60	1.03	1.04	1.02	1.03
3.60	4.50	1.03	1.04	—	—
4.50	—	1.03	1.03	—	—

Publication(s) referred to

BS EN 10002-1, *Tensile testing of metallic materials.*
BS EN 10002-1, *Method of test at ambient temperature.*
BS 2627, *Specification for wrought aluminium for electrical purposes. Wire*
BS 3988, *Specification for wrought aluminium for electrical purposes. Solid conductors for insulated cables.*
HD 21, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*[3)].
HD 22, *Rubber insulated cables of rated voltages up to and including 450/750 V*[3)].
HD 383, *Conductors of insulated cables*[3)].
IEC 228, *Conductors of insulated cables*[3)].
IEC 228A, *First supplement. Guide to the dimensional limits of circular conductors.*

[3)] Referred to in the foreword only.

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