BS EN 60317-0-1:2014

BSI Standards Publication

Specifications for particular types of winding wires

Part 0-1: General requirements — Enamelled round copper wire

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National foreword

This British Standard is the UK implementation of EN 60317-0-1:2014. It is identical to IEC 60317-0-1:2013. It supersedes BS EN 60317-0-1:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/55, Winding wires.

A list of organizations represented on this committee can be obtained on request to its secretary.

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

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(IEC 60317-0-1:2013)

Spécifications pour types particuliers de fils de bobinage - Partie 0-1: Exigences générales - Fil de section circulaire en cuivre émaillé (CEI 60317-0-1:2013)

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European Committee for Electrotechnical Standardization
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Foreword

The text of document 55/1409/FDIS, future edition 4 of IEC 60317-0-1, prepared by IEC/TC 55 "Winding wires" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60317-0-1:2014.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-08-11
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-11-11

This document supersedes EN 60317-0-1:2008.

EN 60317-0-1:2014 includes the following significant technical changes with respect to EN 60317-0-1:2008:

– revision to the definition of nominal conductor dimension;

– new subclause containing general notes on winding wire, formerly a part of the scope;

– revision to elongation requirements in Table 4;

– revisions to Clause 13, Breakdown voltage, to include new requirements for intermediate wire diameters;

– revision to continuity of insulation requirements in Table 13;

– revision to the introduction of Annex A;

– revision to B.2 of Annex B;

– revision to Table C.1 of Annex C.

This standard is to be read in conjunction with the EN 60851 series. The clause numbers used in this part of EN 60317 are identical with the respective test numbers of the EN 60851 series.

In case of inconsistencies between EN 60851 and this part of EN 60317, the latter prevails.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60317-0-1:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60264 Series	NOTE	Harmonized as EN 60264 Series (not modified).
IEC 60317 Series	NOTE	Harmonized as EN 60317 Series (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60172	-	Test procedure for the determination of the temperature index of enamelled winding wires	EN 60172	-
IEC 60851	Series	Winding wires - Test methods	EN 60851	Series
ISO 3	-	Preferred numbers - Series of preferred numbers	-	-

CONTENTS

INTRODUCTION

This part of IEC 60317 is one of a series which deals with insulated wires used for windings in electrical equipment. The series has three groups describing:

1) Winding wires – Test methods (IEC 60851);
2) Specifications for particular types of winding wires (IEC 60317);
3) Packaging of winding wires (IEC 60264).

SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

Part 0-1: General requirements – Enamelled round copper wire

1 Scope

This part of IEC 60317 specifies general requirements of enamelled round copper winding wires with or without bonding layer.

The range of nominal conductor diameters is given in the relevant specification sheet.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60172, *Test procedure for the determination of the temperature index of enamelled winding wires*

IEC 60851 (all parts), *Winding wires – Test methods*

ISO 3, *Preferred numbers – Series of preferred numbers*

3 Terms, definitions, general notes and appearance

For the purposes of this document, the following terms and definitions apply.

3.1 Terms and definitions

3.1.1
bonding layer
material which is deposited on an enamelled wire and which has the specific function of bonding wires together

3.1.2
class
thermal performance of a wire expressed by the temperature index and the heat shock temperature

3.1.3
coating
material which is deposited on a conductor or wire by a suitable means and then dried and/or cured

3.1.4
conductor
bare metal after removal of the insulation

3.1.5
crack
opening in the insulation which exposes the conductor to view at the stated magnification

3.1.6
dual coating
insulation composed of two different materials, an underlying and a superimposed coating

3.1.7
enamelled wire
wire coated with an insulation of cured resin

3.1.8
grade
range of thickness of the insulation of a wire

3.1.9
insulation
coating or covering on the conductor with the specific function of withstanding voltage

3.1.10
nominal conductor dimension
designation of the conductor size in accordance with the IEC 60317 series

3.1.11
normal vision
20/20 vision, with corrective lenses, if necessary

3.1.12
sole coating
insulation composed of one material

3.1.13
winding wire
wire used for winding a coil to provide a magnetic field

3.1.14
wire
conductor coated or covered with an insulation

3.2 General notes

3.2.1 Methods of test

All methods of test to be used for this part of IEC 60317 are given in the IEC 60851 series.

The clause numbers used in this standard are identical to the corresponding test numbers in the IEC 60851 series of standards.

In case of inconsistencies between the publication on methods of test and this standard, IEC 60317-0-1 shall prevail.

Where no specific range of nominal conductor diameters is given for a test, the test applies to all nominal conductor diameters covered by the specification sheet.

Unless otherwise specified, all tests shall be carried out at a temperature from 15 °C to 35 °C and a relative humidity from 45 % to 75 %. Before measurements are made, the specimens

shall be preconditioned under these atmospheric conditions for a time sufficient to allow the specimens to reach stability.

The wire to be tested shall be removed from the packaging in such a way that the wire will not be subjected to tension or unnecessary bends. Before each test, sufficient wire should be discarded to ensure that any damaged wire is not included in the test specimens.

3.2.2 Winding wire

See the relevant specification sheet.

In addition, when reference is made to a winding wire according to a standard of the IEC 60317 series mentioned under Clause 2, the following information is given in the description:

– reference to IEC specification;
– nominal conductor diameter in millimetres;
– grade.

EXAMPLE IEC 60317-1 – 0,500 Grade 2

3.3 Appearance

The film coating shall be essentially smooth and continuous, free from streaks, blisters and foreign material when examined with normal vision, as wound on the original spool or reel.

When agreed upon between the user and supplier, examination using 6× to 10× magnification shall be used for wires with a nominal diameter less than 0,1 mm.

4 Dimensions

4.1 Conductor diameter

The series of preferred nominal conductor diameters shall correspond to series R 20 according to ISO 3. The actual values and their tolerances are given in Tables 1 and 2.

The series of intermediate diameters from which the user may select intermediate nominal conductor diameters, when required for technical reasons, shall correspond to series R 40 according to ISO 3. The actual values and their tolerances are given in Annex A.

The conductor diameter shall not differ from the nominal diameter by more than the limit given in Tables 1 or 2.

Table 1 – Dimensions of enamelled wires (R 20) – Preferred nominal conductor diameters *(1 of 2)*

Nominal conductor diameter	Conductor tolerance ±	Minimum increase due to the insulation mm			Maximum overall diameter mm		
mm	mm	Grade 1	Grade 2	Grade 3	Grade 1	Grade 2	Grade 3
0,018		0,002	0,004	0,006	0,022	0,024	0,026
0,020		0,002	0,004	0,007	0,024	0,027	0,030
0,022		0,002	0,005	0,008	0,027	0,030	0,033
0,025		0,003	0,005	0,008	0,031	0,034	0,037
0,028		0,003	0,006	0,009	0,034	0,038	0,042
0,032		0,003	0,007	0,010	0,039	0,043	0,047
0,036		0,004	0,008	0,011	0,044	0,049	0,053
0,040		0,004	0,008	0,012	0,049	0,054	0,058
0,045		0,005	0,009	0,013	0,055	0,061	0,066
0,050		0,005	0,010	0,014	0,060	0,066	0,072
0,056		0,006	0,011	0,015	0,067	0,074	0,081
0,063		0,006	0,012	0,017	0,076	0,083	0,090
0,071	0,003	0,007	0,012	0,018	0,084	0,091	0,098
0,080	0,003	0,007	0,014	0,020	0,094	0,101	0,108
0,090	0,003	0,008	0,015	0,022	0,105	0,113	0,120
0,100	0,003	0,008	0,016	0,023	0,117	0,125	0,132
0,112	0,003	0,009	0,017	0,026	0,130	0,139	0,147
0,125	0,003	0,010	0,019	0,028	0,144	0,154	0,163
0,140	0,003	0,011	0,021	0,030	0,160	0,171	0,181
0,160	0,003	0,012	0,023	0,033	0,182	0,194	0,205
0,180	0,003	0,013	0,025	0,036	0,204	0,217	0,229
0,200	0,003	0,014	0,027	0,039	0,226	0,239	0,252
0,224	0,003	0,015	0,029	0,043	0,252	0,266	0,280
0,250	0,004	0,017	0,032	0,048	0,281	0,297	0,312
0,280	0,004	0,018	0,033	0,050	0,312	0,329	0,345
0,315	0,004	0,019	0,035	0,053	0,349	0,367	0,384
0,355	0,004	0,020	0,038	0,057	0,392	0,411	0,428
0,400	0,005	0,021	0,040	0,060	0,439	0,459	0,478
0,450	0,005	0,022	0,042	0,064	0,491	0,513	0,533
0,500	0,005	0,024	0,045	0,067	0,544	0,566	0,587

Table 1 *(2 of 2)*

Nominal conductor diameter mm	Conductor tolerance ± mm	Minimum increase due to the insulation mm			Maximum overall diameter mm		
		Grade 1	Grade 2	Grade 3	Grade 1	Grade 2	Grade 3
0,560	0,006	0,025	0,047	0,071	0,606	0,630	0,653
0,630	0,006	0,027	0,050	0,075	0,679	0,704	0,728
0,710	0,007	0,028	0,053	0,080	0,762	0,789	0,814
0,800	0,008	0,030	0,056	0,085	0,855	0,884	0,911
0,900	0,009	0,032	0,060	0,090	0,959	0,989	1,018
1,000	0,010	0,034	0,063	0,095	1,062	1,094	1,124
1,120	0,011	0,034	0,065	0,098	1,184	1,217	1,248
1,250	0,013	0,035	0,067	0,100	1,316	1,349	1,381
1,400	0,014	0,036	0,069	0,103	1,468	1,502	1,535
1,600	0,016	0,038	0,071	0,107	1,670	1,706	1,740
1,800	0,018	0,039	0,073	0,110	1,872	1,909	1,944
2,000	0,020	0,040	0,075	0,113	2,074	2,112	2,148
2,240	0,022	0,041	0,077	0,116	2,316	2,355	2,392
2,500	0,025	0,042	0,079	0,119	2,578	2,618	2,656
2,800	0,028	0,043	0,081	0,123	2,880	2,922	2,961
3,150	0,032	0,045	0,084	0,127	3,233	3,276	3,316
3,550	0,036	0,046	0,086	0,130	3,635	3,679	3,721
4,000	0,040	0,047	0,089	0,134	4,088	4,133	4,176
4,500	0,045	0,049	0,092	0,138	4,591	4,637	4,681
5,000	0,050	0,050	0,094	0,142	5,093	5,141	5,186

NOTE Minimum overall diameter up to and inclusive of 0,060 mm is calculated from the maximum resistance value for each corresponding diameter of Table 3, then adding the minimum increase due to the insulation.

Table 2 – Dimensions of enamelled wires with a bonding layer (R 20) – Preferred nominal conductor diameters *(1 of 2)*

Nominal conductor diameter	Conductor tolerance ±	Minimum increase underlying coating mm		Minimum increase bonding layer	Maximum overall diameter mm	
mm	mm	Grade 1B	Grade 2B	mm	Grade 1B	Grade 2B
0,020		0,002	0,004	0,002	0,026	0,029
0,022		0,002	0,005	0,002	0,030	0,033
0,025		0,003	0,005	0,002	0,034	0,037
0,028		0,003	0,006	0,003	0,038	0,042
0,032		0,003	0,007	0,003	0,044	0,048
0,036		0,004	0,008	0,003	0,050	0,055
0,040		0,004	0,008	0,003	0,055	0,060
0,045		0,005	0,009	0,003	0,062	0,068
0,050		0,005	0,010	0,003	0,068	0,074
0,056		0,006	0,011	0,003	0,075	0,082
0,063		0,006	0,012	0,005	0,085	0,092
0,071	0,003	0,007	0,012	0,005	0,094	0,101
0,080	0,003	0,007	0,014	0,005	0,105	0,112
0,090	0,003	0,008	0,015	0,005	0,117	0,125
0,100	0,003	0,008	0,016	0,005	0,129	0,137
0,112	0,003	0,009	0,017	0,008	0,143	0,152
0,125	0,003	0,010	0,019	0,009	0,158	0,168
0,140	0,003	0,011	0,021	0,010	0,175	0,186
0,160	0,003	0,012	0,023	0,010	0,197	0,209
0,180	0,003	0,013	0,025	0,010	0,220	0,233
0,200	0,003	0,014	0,027	0,011	0,243	0,256
0,224	0,003	0,015	0,029	0,012	0,270	0,284
0,250	0,004	0,017	0,032	0,013	0,300	0,316
0,280	0,004	0,018	0,033	0,013	0,331	0,348
0,315	0,004	0,019	0,035	0,014	0,369	0,387
0,355	0,004	0,020	0,038	0,015	0,413	0,432
0,400	0,005	0,021	0,040	0,016	0,461	0,481
0,450	0,005	0,022	0,042	0,016	0,514	0,536
0,500	0,005	0,024	0,045	0,017	0,568	0,590
0,560	0,006	0,025	0,047	0,017	0,630	0,654

Table 2 *(2 of 2)*

Nominal conductor diameter	Conductor tolerance ±	Minimum increase underlying coating mm		Minimum increase bonding layer	Maximum overall diameter mm	
mm	mm	Grade 1B	Grade 2B	mm	Grade 1B	Grade 2B
0,630	0,006	0,027	0,050	0,018	0,704	0,729
0,710	0,007	0,028	0,053	0,019	0,788	0,815
0,800	0,008	0,030	0,056	0,020	0,882	0,911
0,900	0,009	0,032	0,060	0,020	0,987	1,017
1,000	0,010	0,034	0,063	0,021	1,091	1,123
1,120	0,011	0,034	0,065	0,022	1,214	1,247
1,250	0,013	0,035	0,067	0,022	1,346	1,379
1,400	0,014	0,036	0,069	0,023	1,499	1,533
1,600	0,016	0,038	0,071	0,023	1,702	1,738
1,800	0,018	0,039	0,073	0,024	1,905	1,942
2,000	0,020	0,040	0,075	0,025	2,108	2,146

NOTE Minimum overall diameter up to and inclusive of 0,060 mm is calculated from the maximum resistance value for each corresponding diameter of Table 3, then adding the minimum increase due to the insulation, plus minimum increase due to the bonding layer.

4.2 Out of roundness of conductor (nominal conductor diameters over 0,063 mm)

The difference between the minimum and maximum diameter, at any one point, shall not be more than the figure given in column 2 of Table 1 or Table 2.

4.3 Minimum increase in diameter due to the insulation and the bonding layer (nominal conductor diameters over 0,063 mm)

4.3.1 Enamelled wires without a bonding layer

The minimum increase in diameter due to the insulation shall not be less than the values given in Table 1.

4.3.2 Enamelled wires with a bonding layer

The minimum increase in diameter due to the insulation including the bonding layer shall not be less than the values given in Table 2.

4.3.3 Intermediate nominal conductor diameters

For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next larger nominal conductor diameter in Table 1 or Table 2 shall apply.

4.4 Maximum overall diameter

4.4.1 Enamelled wires without a bonding layer

The maximum overall diameter shall not exceed the values given in Table 1.

4.4.2 Enamelled wires with a bonding layer

The maximum overall diameter shall not exceed the values given in Table 2.

5 Electrical resistance

For nominal conductor diameters up to and including 0,280 mm the resistance at 20 °C shall be within the limits given in Table 3.

By agreement between purchaser and supplier, resistance measurements may be made for nominal conductor diameters over 0,0280 mm. In case of such an agreement, the resistance at 20 °C shall be within the limits given in Annex C.

Table 3 – Electrical resistance

Nominal conductor diameter mm	Resistance Ω/m		
	Minimum	Nominal	Maximum
0,018	60,46	67,18	73,89
0,020	48,97	54,41	59,85
0,022	40,47	44,97	49,47
0,025	31,34	34,82	38,31
0,028	24,99	27,76	30,54
0,032	19,13	21,25	23,38
0,036	15,282	16,79	18,305
0,040	12,379	13,60	14,827
0,045	9,781	10,75	11,715
0,050	7,922	8,706	9,489
0,056	6,316	6,940	7,565
0,063	4,990	5,484	5,977
0,071	3,929	4,318	4,706
0,080	3,133	3,401	3,703
0,090	2,495	2,687	2,900
0,100	2,034	2,176	2,333
0,112	1,632	1,735	1,848
0,125	1,317	1,393	1,475
0,140	1,055	1,110	1,170
0,160	0,812 2	0,850 2	0,890 6
0,180	0,644 4	0,671 8	0,700 7
0,200	0,523 7	0,544 1	0,565 7
0,224	0,418 8	0,433 8	0,449 5
0,250	0,334 5	0,348 2	0,362 8
0,280	0,267 6	0,277 6	0,288 2

NOTE 1 Values for nominal conductor diameter up to and including 0,071 mm are calculated according to B.1 of Annex B.

NOTE 2 Values for nominal conductor diameters above 0,071 mm are calculated according to B.2 of Annex B.

NOTE 3 Nominal resistance values are provided for information only and are calculated according to Annex C.

6 Elongation

The elongation at fracture shall not be less than the value given in Table 4.

Table 4 – Elongation

Nominal conductor diameter mm	Elongation minimum %	Nominal conductor diameter mm	Elongation minimum %	Nominal conductor diameter mm	Elongation minimum %
0,018	5	0,180	23	1,800	34
0,020	6	0,200	24	2,000	34
0,022	6	0,224	24	2,240	35
0,025	7	0,250	25	2,500	35
0,028	7	0,280	26	2,800	36
0,032	8	0,315	26	3,150	36
0,036	8	0,355	27	3,550	36
0,040	10	0,400	27	4,000	37
0,045	12	0,450	28	4,500	37
0,050	14	0,500	28	5,000	38
0,056	15	0,560	29		
0,063	16	0,630	29		
0,071	17	0,710	30		
0,080	17	0,800	30		
0,090	18	0,900	31		
0,100	19	1,000	32		
0,112	20	1,120	32		
0,125	20	1,250	33		
0,140	21	1,400	33		
0,160	22	1,600	33		

For intermediate nominal conductor diameters, the elongation value of the next larger nominal conductor diameter shall be taken.

7 Springiness

7.1 Nominal conductor diameters from 0,080 mm up to and including 1,600 mm

The wire shall not exceed the maximum springback as given in Table 5, when tested on the mandrel required using the specified tension.

7.2 Nominal conductor diameters over 1,600 mm

The wire shall not exceed the maximum springback of 5 degrees.

Table 5 – Springiness

Nominal conductor diameter mm	Mandrel diameter mm	Tension N	Maximum springback Degrees		
			Grade 1	Grade 2 and grade 1B	Grade 3 and grade 2B
0,080	5	0,25	70	80	100
0,090			67	77	94
0,100			64	73	90
0,112	7	0,50	64	73	88
0,125			62	70	84
0,140			59	67	79
0,160	10	1,0	59	67	78
0,180			57	65	75
0,200			54	62	72
0,224	12,5	2,0	51	59	68
0,250			49	56	65
0,280			47	53	61
0,315	19	4,0	50	55	62
0,355			48	53	59
0,400			45	50	55
0,450	25	8,0	44	48	53
0,500			43	47	51
0,560			41	44	48
0,630	37,5	12,0	46	50	53
0,710			44	47	50
0,800			41	43	46
0,900	50	15,0	45	48	51
1,000			42	45	47
1,120			39	41	43
1,250			35	37	39
1,400			32	34	36
1,600			28	30	32
For intermediate nominal conductor diameters, the springback figure of the next larger nominal diameter shall be taken.					

8 Flexibility and adherence

8.1 Mandrel winding test (nominal conductor diameters up to and including 1,600 mm)

The coating shall show no crack after the wire has been elongated as specified in Table 6 and wound on the appropriate mandrel.

Table 6 – Mandrel winding

Nominal conductor diameter mm		Elongation before winding on mandrel	Mandrel diameter
Above	Up to and including	%	mm
–	0,050	20[a]	0,150
0,050	0,063	15[a]	0,150
0,063	0,080	10	0,150
0,080	0,112	5	0,150
0,112	0,140	0	0,150
0,140	1,600	0	d [b]

[a] Or to the breaking-point of copper, whichever is less.

[b] d = nominal conductor diameter of the wire.

8.2 Stretching test (nominal conductor diameters over 1,600 mm)

The coating shall show no crack after the wire has been elongated 32 %.

8.3 Jerk test (nominal conductor diameters up to and including 1,000 mm)

The coating shall show no crack or loss of adhesion.

8.4 Peel test (nominal conductor diameters over 1,000 mm)

The coating shall show no loss of adhesion after the specimen has been subjected to the number of revolutions R required by its nominal conductor diameter d_{nom}:

$R = \dfrac{K}{d_{nom}}$ rounded down to a whole number of revolutions.

The constant K used for the calculation is given in the relevant specification sheet.

9 Heat shock

9.1 Nominal conductor diameters up to and including 1,600 mm

The coating shall show no crack. The mandrel diameter shall be as specified in Table 7. The minimum heat shock temperature is given in the relevant specification sheet.

Table 7 – Heat shock

Nominal conductor diameter mm	**Mandrel diameter** mm
0,160	0,250
0,180	0,280
0,200	0,315
0,224	0,355
0,250	0,400
0,280	0,630
0,315	0,710
0,355	0,800
0,400	0,900
0,450	1,000
0,500	1,120
0,560	1,250
0,630	1,400
0,710	1,600
0,800	1,800
0,900	2,000
1,000	2,240
1,120	3,550
1,250	4,000
1,400	4,500
1,600	5,000
For nominal conductor diameters up to and including 0,140 mm, Table 6 shall be applied. For intermediate nominal conductor diameters, the mandrel diameter of the next smaller nominal conductor diameter shall be taken.	

9.2 Nominal conductor diameters over 1,600 mm

The coating shall show no crack after having been elongated 25 %. The minimum heat shock temperature is given in the relevant specification sheet.

10 Cut-through

For requirements, the relevant specification sheet applies.

11 Resistance to abrasion

For requirements, the relevant specification sheet applies.

12 Resistance to solvents

Following immersion in standard solvent, the coating shall not be removed using a pencil of hardness "H".

13 Breakdown voltage

13.1 General

The wire shall meet the requirements given in 13.2, 13.3 and 13.4, respectively, when tested at room temperature and at elevated temperature when this is required by the purchaser.

The elevated temperature is given in the relevant specification sheet.

13.2 Nominal conductor diameters up to and including 0,100 mm

At least four of the five specimens tested shall not break down at a voltage less than or equal to that given in Table 8 for preferred nominal conductor diameters corresponding to series R 20 and in Table 9 for intermediate nominal conductor diameters corresponding to series R 40.

For other intermediate nominal conductor diameters, the value of the next larger nominal conductor diameter shall apply.

Table 8 – Breakdown voltage – Preferred nominal conductor diameters (R 20) (0,018 mm up to and including 0,100 mm)

Nominal conductor diameter mm	**Minimum breakdown voltage at room temperature (r.m.s. value)** V		
	Grade 1 and grade 1B	**Grade 2 and grade 2B**	**Grade 3**
0,018	110	225	350
0,020	120	250	410
0,022	130	275	470
0,025	150	300	470
0,028	170	325	530
0,032	190	375	590
0,036	225	425	650
0,040	250	475	710
0,045	275	550	710
0,050	300	600	830
0,056	325	650	890
0,063	375	700	1 020
0,071	425	700	1 100
0,080	425	850	1 200
0,090	500	900	1 300
0,100	500	950	1 400

Table 9 – Breakdown voltage – Intermediate nominal conductor diameters (R 40) (0,019 mm up to and including 0,095 mm)

Nominal conductor diameter mm	Minimum breakdown voltage at room temperature (r.m.s. value) V		
	Grade 1 and grade 1B	Grade 2 and grade 2B	Grade 3
0,019	115	240	380
0,021	125	265	440
0,024	145	290	470
0,027	165	315	510
0,030	180	350	560
0,034	210	400	620
0,038	240	450	680
0,043	265	520	710
0,048	290	580	780
0,053	315	625	860
0,060	355	680	960
0,067	400	700	1 060
0,075	425	765	1 140
0,085	465	875	1 250
0,095	500	925	1 350
NOTE Values are derived through linear interpolation of the values in Table 8.			

13.3 Nominal conductor diameters over 0,100 mm up to and including 2,500 mm

At least four of the five specimens tested shall not break down at a voltage less than or equal to that given in Table 10 for preferred nominal conductor diameters corresponding to series R 20, and in Table 11 for intermediate nominal conductor diameters corresponding to series R 40. For other intermediate nominal conductor diameters, the value of the next larger nominal conductor diameter shall apply.

Table 10 – Breakdown voltage – Preferred nominal conductor diameters (R 20) (0,112 mm up to and including 2,500 mm)

Nominal conductor diameter	Minimum breakdown voltage (r.m.s. value) V					
	Grade 1 and grade 1B		Grade 2 and grade 2B		Grade 3	
mm	Room temperature	Elevated temperature	Room temperature	Elevated temperature	Room temperature	Elevated temperature
0,112	1 300	1 000	2 700	2 000	3 900	2 900
0,125	1 500	1 100	2 800	2 100	4 100	3 100
0,140	1 600	1 200	3 000	2 300	4 200	3 200
0,160	1 700	1 300	3 200	2 400	4 400	3 300
0,180	1 700	1 300	3 300	2 500	4 700	3 500
0,200	1 800	1 400	3 500	2 600	5 100	3 800
0,224	1 900	1 400	3 700	2 800	5 200	3 900
0,250	2 100	1 600	3 900	2 900	5 500	4 100
0,280	2 200	1 700	4 000	3 000	5 800	4 400
0,315	2 200	1 700	4 100	3 100	6 100	4 600
0,355	2 300	1 700	4 300	3 200	6 400	4 800
0,400	2 300	1 700	4 400	3 300	6 600	5 000
0,450	2 300	1 700	4 400	3 300	6 800	5 100
0,500	2 400	1 800	4 600	3 500	7 000	5 300
0,560	2 500	1 900	4 600	3 500	7 100	5 300
0,630	2 600	2 000	4 800	3 600	7 100	5 300
0,710	2 600	2 000	4 800	3 600	7 200	5 400
0,800	2 600	2 000	4 900	3 700	7 400	5 600
0,900	2 700	2 000	5 000	3 800	7 600	5 700
1,000 up to and including 2,500	2 700	2 000	5 000	3 800	7 600	5 700

Table 11 – Breakdown voltage – Intermediate nominal conductor diameters (R 40) (0,106 mm up to and including 0,950 mm)

Nominal conductor diameter mm	Minimum breakdown voltage (r.m.s. value) V					
	Grade 1 and grade 1B		Grade 2 and grade 2B		Grade 3	
	Room temperature	Elevated temperature	Room temperature	Elevated temperature	Room temperature	Elevated temperature
0,106	1 200	950	2 650	1 950	3 800	2 800
0,118	1 400	1 050	2 750	2 050	4 000	3 000
0,132	1 550	1 150	2 900	2 200	4 150	3 150
0,150	1 650	1 250	3 100	2 350	4 300	3 250
0,170	1 700	1 300	3 250	2 450	4 550	3 400
0,190	1 750	1 350	3 400	2 550	4 900	3 650
0,212	1 850	1 400	3 600	2 700	5 150	3 850
0,236	2 000	1 500	3 800	2 850	5 350	4 000
0,265	2 150	1 650	3 950	2 950	5 650	4 250
0,300	2 200	1 700	4 050	3 050	5 950	4 500
0,335	2 250	1 700	4 200	3 150	6 250	4 700
0,375	2 300	1 700	4 350	3 250	6 500	4 900
0,425	2 300	1 700	4 400	3 300	6 700	5 050
0,475	2 350	1 750	4 500	3 400	6 900	5 200
0,530	2 450	1 850	4 600	3 500	7 050	5 300
0,600	2 550	1 950	4 700	3 550	7 100	5 300
0,670	2 600	2 000	4 800	3 600	7 150	5 350
0,750	2 600	2 000	4 850	3 650	7 300	5 500
0,850	2 650	2 000	4 950	3 750	7 500	5 650
0,950	2 700	2 000	5 000	3 800	7 600	5 700

NOTE Values are derived through linear interpolation of the values in Table 10.

13.4 Nominal conductor diameters over 2,500 mm

At least four of the five specimens tested shall not break down at a voltage less than or equal to that given in Table 12.

Table 12 – Breakdown voltage – Nominal conductor diameters over 2,500 mm

Nominal conductor diameter mm	Minimum breakdown voltage (r.m.s. value) V					
	Grade 1 and grade 1B		Grade 2 and grade 2B		Grade 3	
	Room temperature	Elevated temperature	Room temperature	Elevated temperature	Room temperature	Elevated temperature
over 2,500	1 300	1 000	2 500	1 900	3 800	2 900

14 Continuity of insulation (nominal conductor diameters up to and including 1,600 mm)

The number of faults per 30 m of wire shall not exceed the values given in Table 13.

Table 13 – Continuity of insulation

Nominal conductor diameter mm		Maximum number of faults per 30 m		
Over	Up to and including	Grade 1 and grade 1B	Grade 2 and grade 2B	Grade 3
–	0,050	40	10	–
0,050	0,080	40	5	3
0,080	0,125	30	5	3
0,125	1,600	10	5	3

15 Temperature index

The test shall be carried out in accordance with IEC 60172.

The temperature index shall not be less than given in the relevant specification sheet and the time to failure at the lowest test temperature shall not be less than 5 000 h.

16 Resistance to refrigerants

For requirements the relevant specification sheet applies.

17 Solderability

For requirements, the relevant specification sheet applies.

18 Heat or solvent bonding

For requirements, the relevant specification sheet applies.

19 Dielectric dissipation factor

For requirements, the relevant specification sheet applies.

20 Resistance to transformer oil

For requirements, the relevant specification sheet applies.

21 Loss of mass

For requirements, the relevant specification sheet applies.

23 Pin hole test

By agreement between purchaser and supplier, a pin hole test may be made.

In case of such an agreement, the number of pin holes present shall be within the limits given in Table 14.

Table 14 – Maximum number of pin holes

Enamel grade	Standard	Polyurethane
Grade 1	5	8
Grade 2	3	5
Grade 3	2	3
NOTE Polyurethane enamelled wires include those covered in IEC 60317-2, IEC 60317-4, IEC 60317-19, IEC 60317-20, IEC 60317-21, IEC 60317-23, IEC 60317-35, IEC 60317-36, IEC 60317-51 and IEC 60317-55.		

30 Packaging

The kind of packaging may influence certain properties of the wire, for example springback. Therefore the kind of packaging, for example the type of spool, shall be agreed between purchaser and supplier.

The wire shall be evenly and compactly wound on spools or placed in containers. No spool or container shall contain more than one length of wire unless agreed to by purchaser and supplier. Marking of the label when there is more than one length and/or identification of the separate lengths in the package shall be agreed to by purchaser and supplier.

Where wires are delivered in coils, the dimensions and the maximum weights of such coils shall be agreed between purchaser and supplier. Any additional protection for coils shall also be agreed between purchaser and supplier.

Labels shall be attached to each packaging unit as agreed between supplier and user and shall include the following information:

a) manufacturer's name and/or trade mark;

b) type of wire and insulation, for instance trade name and/or IEC specification number;

c) net mass of wire;

d) nominal dimension(s) of wire and grade of insulation;

e) date of manufacture.

Annex A
(informative)

Dimensions for intermediate nominal conductor diameters (R 40)

This annex provides intermediate nominal conductor diameters from which the user may select intermediate sizes only for technical reasons. Table A.1 shows the dimensions of enamelled wires (R 40) without a bonding layer. Table A.2 shows the dimensions of enamelled wires (R 40) with a bonding layer.

Table A.1 – Dimensions of enamelled wires (R 40) – Intermediate nominal conductor diameters *(1 of 2)*

Nominal conductor diameter	Conductor tolerance ±	Minimum increase due to the insulation mm			Maximum overall diameter mm		
mm	mm	Grade 1	Grade 2	Grade 3	Grade 1	Grade 2	Grade 3
0,019		0,002	0,004	0,007	0,023	0,026	0,028
0,021		0,002	0,004	0,007	0,026	0,028	0,031
0,024		0,002	0,005	0,008	0,029	0,032	0,035
0,027		0,003	0,005	0,009	0,033	0,036	0,040
0,030		0,003	0,006	0,009	0,037	0,041	0,044
0,034		0,003	0,006	0,010	0,041	0,046	0,050
0,038		0,004	0,008	0,011	0,046	0,051	0,055
0,043		0,004	0,009	0,012	0,052	0,058	0,063
0,048		0,005	0,010	0,014	0,059	0,064	0,069
0,053		0,005	0,010	0,015	0,064	0,070	0,076
0,060		0,006	0,011	0.016	0,072	0,079	0,085
0,067	0,003	0,007	0,012	0,018	0,080	0,088	0.095
0,075	0,003	0,007	0,013	0,020	0,089	0,095	0,102
0,085	0,003	0,008	0,014	0,021	0,100	0,107	0,114
0,095	0,003	0,008	0,016	0,023	0,111	0,119	0,126
0,106	0,003	0,009	0,017	0,026	0,123	0,132	0,140
0,118	0,003	0,010	0,019	0,028	0,136	0,145	0,154
0,132	0,003	0,011	0,021	0,030	0,152	0,162	0,171
0,150	0,003	0,012	0,023	0,033	0,171	0,182	0,193
0,170	0,003	0,013	0,025	0,036	0,194	0,205	0,217
0,190	0,003	0,014	0,027	0,039	0,216	0,228	0,240
0,212	0,003	0,015	0,029	0,043	0,240	0,254	0,268
0,236	0,004	0,017	0,032	0,048	0,267	0,283	0,298
0,265	0,004	0,018	0,033	0,050	0,297	0,314	0,330
0,300	0,004	0,019	0,035	0,053	0,334	0,352	0,360
0,335	0,004	0,020	0,038	0,057	0,372	0,391	0,408
0,375	0,005	0,021	0,040	0,060	0,414	0,434	0,453
0,425	0,005	0,022	0,042	0,064	0,466	0,488	0,508
0,475	0,005	0,024	0,045	0,067	0,519	0,541	0,562
0,530	0,006	0,025	0,047	0,071	0,576	0,600	0,623

Table A.1 *(2 of 2)*

Nominal conductor diameter	Conductor tolerance ±	Minimum increase due to the insulation mm			Maximum overall diameter mm		
mm	mm	Grade 1	Grade 2	Grade 3	Grade 1	Grade 2	Grade 3
0,600	0,006	0,027	0,050	0,075	0,649	0,674	0,698
0,670	0,007	0,028	0,053	0,080	0,722	0,749	0,774
0,750	0,008	0,030	0,056	0,085	0,805	0,834	0,861
0,850	0,009	0,032	0,060	0,090	0,909	0,939	0,968
0,950	0,010	0,034	0,063	0,095	1,012	1,044	1,074
1,060	0,011	0,034	0,065	0,098	1,124	1,157	1,188
1,180	0,012	0,035	0,067	0,100	1,246	1,279	1,311
1,320	0,013	0,036	0,069	0,103	1,388	1,422	1,455
1,500	0,015	0,038	0,071	0,107	1,570	1,606	1,640
1,700	0,017	0,039	0,073	0,110	1,772	1,809	1,844
1,900	0,019	0,040	0,075	0,113	1,974	2,012	2,048
2,120	0,021	0,041	0,077	0,116	2,196	2,235	2,272
2,360	0,024	0,042	0,079	0,119	2,438	2,478	2,516
2,650	0,027	0,043	0,081	0,123	2,730	2,772	2,811
3,000	0,030	0,045	0,084	0,127	3,083	3,126	3,166
3,350	0,034	0,046	0,086	0,130	3,435	3,479	3,521
3,750	0,038	0,047	0,089	0,134	3,838	3,883	3,926
4,250	0,043	0,049	0,092	0,138	4,341	4,387	4,431
4,750	0,048	0,050	0,094	0,142	4,843	4,891	4,936

NOTE Minimum overall diameter up to and inclusive of 0,060 mm is calculated from the maximum resistance value for each corresponding diameter of Table 3, then adding the minimum increase due to the insulation.

Table A.2 – Dimensions of enamelled wires with a bonding layer (R 40) – Intermediate nominal conductor diameters *(1 of 2)*

Nominal conductor diameter	Conductor tolerance ±	Minimum increase underlying coating mm		Minimum increase bonding layer	Maximum overall diameter mm	
mm	mm	Grade 1B	Grade 2B	mm	mm	mm
0,021		0,002	0,004	0,002	0,029	0,031
0,024		0,002	0,005	0,002	0,032	0,035
0,027		0,003	0,005	0,002	0,037	0,040
0,030		0,003	0,006	0,003	0,042	0,044
0,034		0,003	0,007	0,003	0,047	0,052
0,038		0,004	0,008	0,003	0,052	0,057
0,043		0,004	0,009	0,003	0,059	0,065
0,048		0,005	0,010	0,003	0,067	0,073
0,053		0,005	0,010	0,003	0,072	0,078
0,060		0,006	0,011	0,003	0,081	0,088
0,067	0,003	0,007	0,012	0,005	0,090	0,098
0,075	0,003	0,007	0,013	0,005	0,100	0,106
0,085	0,003	0,008	0,015	0,005	0,112	0,119
0,095	0,003	0,008	0,016	0,005	0,123	0,131
0,106	0,003	0,008	0,017	0,005	0,136	0,145
0,118	0,003	0,010	0,019	0,009	0,150	0,159
0,132	0,003	0,011	0,021	0,010	0,167	0,177
0,150	0,003	0,012	0,023	0,010	0,186	0,197
0,170	0,003	0,013	0,025	0,010	0,210	0,221
0,190	0,003	0,014	0,027	0,011	0,233	0,245
0,212	0,003	0,015	0,029	0,012	0,258	0,272
0,236	0,004	0,017	0,032	0,013	0,286	0,302
0,265	0,004	0,018	0,033	0,013	0,316	0,333
0,300	0,004	0,019	0,035	0,014	0,354	0,372
0,335	0,004	0,020	0,038	0,015	0,393	0,412
0,375	0,005	0,021	0,040	0,016	0,436	0,456
0,425	0,005	0,022	0,042	0,016	0,489	0,511
0,475	0,005	0,024	0,045	0,017	0,543	0,565
0,530	0,006	0,025	0,047	0,017	0,600	0,624
0,600	0,006	0,027	0,050	0,018	0,674	0,699

Table A.2 *(2 of 2)*

Nominal conductor diameter mm	**Conductor tolerance** ± mm	**Minimum increase underlying coating** mm		**Minimum increase bonding layer** mm	**Maximum overall diameter** mm	
		Grade 1B	**Grade 2B**		**Grade 1B**	**Grade 2B**
0,670	0,007	0,028	0,053	0,019	0,748	0,775
0,750	0,008	0,030	0,056	0,020	0,832	0,861
0,850	0,009	0,032	0,060	0,020	0,937	0,967
0,950	0,010	0,034	0,063	0,021	1,041	1,073
1,060	0,011	0,034	0,065	0,022	1,154	1,187
1,180	0,012	0,035	0,067	0,022	1,276	1,309
1,320	0,013	0,036	0,069	0,023	1,419	1,453
1,500	0,015	0,038	0,071	0,023	1,602	1,638
1,700	0,017	0,039	0,073	0,024	1,805	1,842
1,900	0,019	0,040	0,075	0,025	2,008	2,046

NOTE Minimum overall diameter up to and inclusive of 0,060 mm is calculated from the maximum resistance value for each corresponding diameter of Table 3, then adding the minimum increase due to the insulation, plus the minimum increase due to the bonding layer.

Annex B
(informative)

Method for the calculation of linear resistance

B.1 For nominal conductor diameters up to and including 0,071 mm

The values of the ratios:

K_{min} of the minimum resistance to the nominal resistance, and

K_{max} of the maximum resistance to the nominal resistance

are given for each nominal conductor diameter.

The linear resistance is calculated from:

$$R_{min} = K_{min} \times \rho_{nom} \times q^{-1}_{nom} \ (\Omega \cdot m^{-1})$$

$$R_{max} = K_{max} \times \rho_{nom} \times q^{-1}_{nom} \ (\Omega \cdot m^{-1})$$

where

K_{min} and K_{max} have the values given in Table B.1;

ρ_{nom} is 1/58,5 $\Omega \cdot mm^2 \cdot m^{-1}$;

q_{nom} is the cross-section of the conductor in square millimetres, calculated from d_{nom} by

$$q_{nom} = \frac{\pi}{4} \times d^2_{nom}$$

Table B.1 – Ratios

d_{nom} mm	K_{min}	K_{max}
0,018	0,900	1,100
0,020	0,900	1,100
0,022	0,900	1,100
0,025	0,900	1,100
0,028	0,900	1,100
0,032	0,900	1,100
0,036	0,910	1,090
0,040	0,910	1,090
0,045	0,910	1,090
0,050	0,910	1,090
0,056	0,910	1,090
0,063	0,910	1,090
0,071	0,910	1,090

B.2 For nominal conductor diameters over 0,071 mm up to and including 0,280 mm

The minimum and the maximum values of resistance are calculated from the minimum and maximum value of the resistivity by taking into account for each conductor diameter the relevant dimensional tolerance.

The linear resistance is calculated from:

$$R_{min} = \rho_{min} \times q^{-1}_{max} \ (\Omega \cdot m^{-1})$$

$$R_{max} = \rho_{max} \times q^{-1}_{min} \ (\Omega \cdot m^{-1})$$

where

ρ_{min} = 1/59 $\Omega \cdot mm^2 \cdot m^{-1}$;

ρ_{max} = 1/58 $\Omega \cdot mm^2 \cdot m^{-1}$;

q is the cross-section of the conductor, in square millimetres.

where

q_{max} is the maximum cross-section of the conductor in square millimetres, calculated from the nominal conductor diameter minus the dimensional tolerance;

q_{min} is the minimum cross-section of the conductor in square millimetres, calculated from the nominal conductor diameter plus the dimensional tolerance.

Annex C
(informative)

Resistance

The figures for nominal resistance in Table C.1 are given for information only. They are calculated on the basis of the nominal conductor diameter and a nominal resistivity of 1/58,5 $\Omega \cdot mm^2 \cdot m^{-1}$.

The minimum and maximum resistance limits for nominal conductor diameter over 0,071 mm up to and including 1,000 mm are derived from calculations made according to B.2 of Annex B.

Table C.1 – Electrical resistances – Nominal conductor diameters over 0,063 mm up to and including 1,000 mm *(1 of 2)*

Nominal conductor diameter	Resistance at 20 °C Ω/m		
mm	Minimum	Nominal	Maximum
0,018		67,18	
0,020		54,41	
0,022		44,97	
0,025		34,82	
0,028		27,76	
0,032		21,25	
0,036		16,79	
0,040		13,60	
0,045		10,75	
0,050		8,706	
0,056		6,940	
0,063		5,484	
0,071		4,318	
0,080	3,133	3,401	3,703
0,090	2,495	2,687	2,900
0,100	2,034	2,176	2,333
0,112	1,632	1,735	1,848
0,125	1,317	1,393	1,475
0,140	1,055	1,110	1,170
0,160	0,812 2	0,850 2	0,880 6
0,180	0,644 4	0,671 8	0,700 7
0,200	0,523 7	0,544 1	0,565 7
0,224	0,418 8	0,433 8	0,449 5
0,250	0,334 5	0,348 2	0,362 8
0.280	0,267 6	0,277 6	0,288 2

Table C.1 *(2 of 2)*

Nominal conductor diameter	Resistance at 20 °C Ω/m		
mm	**Minimum**	**Nominal**	**Maximum**
0.315	0,212 1	0,219 3	0,227 0
0.355	0,167 4	0,172 7	0,178 2
0,400	0,131 6	0,136 0	0,140 7
0,450	0,104 2	0,107 5	0,110 9
0,500	0,084 62	0,087 06	0,089 59
0,560	0,067 36	0,069 40	0,071 53
0,630	0,053 35	0,054 84	0,056 38
0,710	0,041 98	0,043 18	0,044 42
0,800	0,033 05	0,034 01	0,035 00
0,900	0,026 12	0,026 87	0,027 65
1,000	0,021 16	0,021 76	0,022 40
1,120		0,017 35	
1,250		0,013 93	
1,400		0,011 10	
1,600		0,008 502	
1,800		0,006 718	
2,000		0,005 441	
2,240		0,004 338	
2,500		0,003 482	
2,800		0,002 776	
3,150		0,002 193	
3,550		0,001 727	
4,000		0,001 360	
4,500		0,001 075	
5,000		0,000 870 6	

Bibliography

IEC 60264 (all parts), *Packaging of winding wires*

IEC 60317 (all parts), *Specifications for particular types of winding wires*

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