

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Specifications for particular types of winding wires –
Part 0-1: General requirements – Enamelled round copper wire**

**Spécifications pour types particuliers de fils de bobinage –
Partie 0-1: Exigences générales – Fil de section circulaire en cuivre émaillé**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SPECIFICATIONS FOR PARTICULAR TYPES
OF WINDING WIRES –****Part 0-1: General requirements –
Enamelled round copper wire**

FOREWORD

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International Standard IEC 60317-0-1 has been prepared by IEC technical committee 55: Winding wires.

This third edition cancels and replaces the second edition published in 1997, its amendment 1 (1999), and its amendment 2 (2005) and constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

- addition of Grade 3 minimum insulation increases and maximum overall diameters for wires up to 0,071 mm nominal conductor diameter in Tables 1 and A.1;
- revisions to minimum increase in bonding layer for wires up to 0,100 mm nominal conductor diameter in Tables 2 and A.2;
- addition of Grade 3 dielectric breakdown requirements for wires up to 0,071 mm nominal conductor diameter;

- new pin hole test requirement for Grade 3 polyurethane wires.

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

In case of inconsistencies between IEC 60851 and this part of IEC 60317, the latter shall prevail.

The text of this standard is based on the following documents:

CDV	Report on Voting
55/1033/CDV	55/1053A/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 60317 series, under the general title *Specifications for particular types of winding wires*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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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).

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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.

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

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.

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

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

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

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

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

3 Terms, definitions and general notes on methods of test 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 IEC 60317

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 on methods of test

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

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.

3.3 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.

NOTE For wires up to and including 0,063 mm nominal conductor diameter, see Table 3.

Table 1 – Dimensions of enamelled wires (R 20)

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
0,018		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
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

For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next larger nominal conductor diameter shall be taken.

NOTE 1 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.

NOTE 2 The dimensions of intermediate nominal conductor diameters for R 40 series are given in Annex A.

Table 2 – Dimensions of enamelled wires with a bonding layer (R 20)

Nominal conductor diameter	Conductor tolerance	Minimum increase underlying coating		Minimum increase bonding layer	Maximum overall diameter	
		mm			mm	
		Grade 1B	Grade 2B		Grade 1B	Grade 2B
mm	± mm			mm		
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	0,049	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
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

For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next larger nominal conductor diameter shall be taken.

NOTE 1 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 bondcoat.

NOTE 2 The dimensions of intermediate nominal conductor diameters for R 40 series are given in Annex A.

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.

4.4 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 0,063 mm the resistance at 20 °C shall be within the limits given in Table 3.

For nominal conductor diameters greater than 0,063 mm no resistance values are specified.

By agreement between purchaser and supplier, resistance measurements may be made for nominal conductor diameters over 0,063 mm up to and including 1,000 mm. In case of such an agreement, the resistance at 20 °C shall be within the limits given in Annex C.

Table 3 – Electrical resistances

Nominal conductor diameter mm	Resistance Ω/m		Nominal conductor diameter mm	Resistance Ω/m	
	Minimum	Maximum		Minimum	Maximum
0,018	60,46	73,89	0,036	15,16	18,42
0,020	48,97	59,85	0,040	12,28	14,92
0,022	40,47	49,47	0,045	9,705	11,79
0,025	31,34	38,31	0,050	7,922	9,489
0,028	24,99	30,54	0,056	6,316	7,565
0,032	19,13	23,38	0,063	5,045	5,922

NOTE 1 The limits shown are derived from calculations made according to Annex B.
NOTE 2 For the nominal resistance, see Annex C.