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(पहला पुनरीक्षण)

Specification for Particular Types of Winding Wires

Part 0 General Requirements

Section 6 Glass-Fibre Wound Resin or Varnish
Impregnated, Bare or Enamelled Round
Copper Wire

(First Revision)

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NATIONAL FOREWORD

This Indian Standard (Part 0/Sec 6) (First Revision) which is identical to IEC 60317-0-6 : 2020 'Specifications for particular types of winding wires — Part 0-6: General requirements — Glass-fibre wound resin or varnish impregnated, bare or enamelled round copper wire' Issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Winding Wire Sectional Committee and approval of the Electrotechnical Division Council.

This standard was originally published in 2012. This revision has been undertaken to align it with the latest version of IEC 60317-0-6 : 2020.

This standard is published in various parts. Other parts in this series are:

Part 0	General requirements
Part 1	Polyvinyl acetal enamelled round copper wire, class 105
Part 2	Solderable polyurethane enamelled round copper wire, class 130, with a bonding layer
Part 3	Polyester enamelled round copper wire, class 155
Part 4	Solderable polyurethane enamelled round copper wire, class 130
Part 5	Polyester enamelled round aluminium wire, Class 155
Part 6	Oleo-resinous enamelled round aluminium wire, class 105
Part 8	Polyesterimide enamelled round copper wire, class 180
Part 9	Polyester enamelled round aluminium wire, class 138
Part 12	Polyvinyl acetal enamelled round copper wire, class 120
Part 13	Polyester or polyesterimide overcoated with polyamide- imide enamelled round copper wire, class 200
Part 15	Polyesterimide enamelled round aluminium wire, class 180
Part 16	Polyester enamelled rectangular copper wire class 155
Part 17	Polyvinyl acetal enamelled rectangular copper wire, class 105
Part 20	Solderable polyurethane enamelled round copper wire, class 155
Part 21	Solderable polyurethane enamelled round copper wire overcoated with polyamide, class 155
Part 23	Solderable polyesterimide enamelled round copper wire, class 180
Part 25	Polyester or polyesterimide overcoated with polyamide - Imide enamelled round aluminium wire, class 200
Part 26	Polyamide-imide enamelled round copper wire, class 200
Part 27	Paper tape covered rectangular copper wire
Part 28	Polyesterimide enamelled rectangular copper wire, class 180
Part 29	Polyester or polyesterimide overcoated with polyamide-imide enamelled rectangular copper wire, class 200
Part 31	Glass fibre wound, resin or varnish impregnated, bare or enamelled rectangular copper wire, temperature index 180

Part 32	Glass fibre wound, resin or varnish impregnated, bare or enamelled rectangular copper wire, temperature index 155
Part 33	Glass fibre wound, resin or varnish impregnated, bare or enamelled rectangular copper wire, temperature index 200
Part 34	Polyester enamelled round copper wire, class 130 L
Part 35	Solderable polyurethane enamelled round copper wire, class 155, with a bonding layer
Part 36	Solderable polyesterimide enamelled round copper wire, class 180, with a bonding layer
Part 37	Polyesterimide enamelled round copper wire, class 180, with a bonding layer
Part 38	Polyester or polyesterimide overcoated with polyamide-imide, enamelled round copper wire, class 200, with a bonding layer
Part 39	Glass-fibre braided resin or varnish - Impregnated, bare or enamelled rectangular copper wire, temperature index 180
Part 43	Aromatic polyimide tape wrapped round copper wire, class 240
Part 44	Aromatic polyimide tape wrapped rectangular copper wire, class 240
Part 45	Polyester enamelled round copper wire, class 130
Part 46	Aromatic polyimide enamelled round copper wire, class 240
Part 47	Aromatic polyimide enamelled rectangular copper wire, class 240
Part 48	Glass-fibre wound resin or varnish impregnated, bare or enamelled round copper wire, temperature index 155
Part 49	Glass-fibre wound, high temperature resin or varnish-impregnated, bare or enamelled round copper wire, class 180
Part 50	Glass-fibre wound, silicone resin or varnish impregnated, bare or enamelled round copper wire, class 200
Part 53	Aromatic polyimide (Aramid) tape wrapped rectangular copper wire, temperature index 220

The text of the IEC standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appears referring to this standard, they should be read as 'Indian Standard'; and
- b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to International Standards for which Indian Standards also exists. The corresponding Indian Standards, which are to be substituted, are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60851 (all parts), Winding wires — Test methods	IS 13778 (Part 1) : 2011/ IEC 60851-1 : 1996 Winding wires — Test methods: Part 1 General (<i>first revision</i>)	Identical
	IS 13778 (Part 2) : 2013/IEC 60851-2 : 2009 Winding wires — Test methods: Part 2 Determination of dimensions (<i>first revision</i>)	Identical

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60851 (all parts), Winding wires — Test methods	IS 13778 (Part 3) : 2012 IEC 60851-3 : 2009 Winding wires — Test methods: Part 3 Mechanical properties (<i>first revision</i>)	Identical
	IS 13778 (Part 4) : 2018/IEC 60851-4 : 2016 Winding wires — Test methods: Part 4 Chemical properties (<i>second revision</i>)	Identical
	IS 13778 (Part 5) : 2012/IEC 60851-5 : 2008 Winding wires — Test methods: Part 5 Electrical properties (<i>first revision</i>)	Identical
	IS 13778 (Part 6) : 2018/IEC 60851-6 : 2012 Winding wires — Test methods: Part 6 Thermal properties (<i>second revision</i>)	Identical

The Committee has reviewed the provisions of the following International Standards referred in this adopted standard and decided that they are acceptable for use in conjunction with this standard.

<i>International Standard</i>	<i>Title</i>
ISO 3	Preferred numbers — Series of preferred numbers

Only English language text has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in the International Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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INTRODUCTION

This part of IEC 60317 forms an element of a series of standards which deals with insulated wires used for windings in electrical equipment. It is composed of the following series:

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

Indian Standards
SPECIFICATION FOR PARTICULAR TYPES OF
WINDING WIRES

PART 0 GENERAL REQUIREMENTS

**SECTION 6 GLASS-FIBRE WOUND RESIN OR VARNISH IMPREGNATED,
BARE OR ENAMELLED ROUND COPPER WIRE**

(*First Revision*)

1 Scope

This part of IEC 60317 specifies the general requirements of glass-fibre wound resin or varnish impregnated, bare or enamelled, round copper winding wires.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60851 (all parts), *Winding wires – Test methods*

IEC 60851-5:2008, *Winding wires – Test methods – Part 5: Electrical properties*
IEC 60851-5/AMD1:2011
IEC 60851-5/AMD2:2019

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

3 Terms, definitions, general notes and appearance

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>:

3.1.1

coating

material deposited on a conductor or wire by suitable means and then dried and/or cured

3.1.2

conductor

bare metal after removal of the insulation

3.1.3

covering

material which is wound, wrapped or braided around a bare or insulated conductor

3.1.4
crack

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

3.1.5
enamelled wire

wire coated with an insulation of cured resin

3.1.6
grade

increase in the overall diameter of glass fibre covered wire due to the glass fibre covering and/or enamel

3.1.7
insulation

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

3.1.8
nominal conductor diameter

designation of conductor size in accordance with the IEC 60317 series

3.1.9
winding wire

wire used for winding a coil to provide a magnetic field

3.1.10
wire

conductor coated or covered with an insulation

3.1.11
normal vision

20/20 vision, with corrective lenses, if necessary

3.2 General notes

3.2.1 Methods of test

All methods of test to be used for this document are given in IEC 60851 (all parts).

The clause numbers used in this document are identical to the respective test numbers in IEC 60851 (all parts).

In case of inconsistencies between the IEC 60851 parts concerning methods of test and this document, IEC 60317-0-6 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 ranging between 15 °C and 40 °C and a relative humidity between 25 % and 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

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 of coating and glass covering.

EXAMPLE IEC 60317-48 – 1,000 Grade 1 GL1

The coating is characterised by the following different grades of thickness:

- GL1, bare conductor with 1 layer of glass fibre;
- GL2, bare conductor with 2 layers of glass fibre;
- grade 1 GL1, enamelled grade 1 (grade 1) with 1 layer of glass fibre (GL1);
- grade 1 GL2, enamelled grade 1 (grade 1) with 2 layers of glass fibre (GL2);
- grade 2 GL1, enamelled grade 2 (grade 2) with 1 layer of glass fibre (GL1);
- grade 2 GL2, enamelled grade 2 (grade 2) with 2 layers of glass fibre (GL2).

3.3 Appearance

The fibrous covering shall be smooth as agreed upon between customer and supplier in accordance with good commercial practice and be free from physical damage and foreign material when examined with normal vision, as wound on the original spool or reel.

4 Dimensions

4.1 Conductor diameter

The series of preferred nominal conductor diameters shall correspond to series R20 according to ISO 3. The actual values and their tolerances are given in Table 1 and Table 2.

The series of intermediate diameters from which the user shall select intermediate nominal conductor diameters, when required for technical reasons, shall correspond to series R40 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 Table 1 and Table 2.

Table 1 – Diameters for single glass-fibre covered grade 1 or grade 2 enamelled round wires

Nominal conductor diameter mm	Conductor diameter tolerance ± mm	Minimum increase of single glass-fibre covering mm	Maximum overall diameter of single glass-fibre covering mm	
			Grade 1 GL1	Grade 2 GL1
0,500	0,005	0,064	0,665	0,685
0,560	0,006	0,102	0,776	0,795
0,630	0,006	0,102	0,839	0,864
0,710	0,007	0,102	0,922	0,949
0,800	0,008	0,102	1,020	1,047
0,900	0,009	0,102	1,125	1,155
1,000	0,010	0,102	1,230	1,260
1,120	0,011	0,102	1,352	1,385
1,250	0,013	0,102	1,485	1,518
1,400	0,014	0,102	1,640	1,676
1,600	0,016	0,102	1,841	1,880
1,800	0,018	0,102	2,048	2,085
2,000	0,020	0,102	2,247	2,285
2,240	0,022	0,102	2,496	2,535
2,500	0,025	0,102	2,760	2,800
2,800	0,028	0,114	3,088	3,130
3,150	0,032	0,114	3,449	3,492
3,550	0,036	0,114	3,852	3,896
4,000	0,040	0,114	4,308	4,353
4,500	0,045	0,114	4,815	4,861
5,000	0,050	0,114	5,322	5,370

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

NOTE 1 The dimensions of the intermediate nominal conductor diameters for the R40 series are given in Annex A.

NOTE 2 Grade 1G1 is a single glass-fibre covering over grade 1 enamelled wire. Grade 2G1 is a single glass-fibre covering over grade 2 enamelled wire.

Table 2 – Diameters for double glass-fibre covered, bare, grade 1 or grade 2 enamelled round wires

Nominal conductor diameter mm	Conductor diameter tolerance ± mm	Minimum increase of double glass-fibre covering mm	Maximum overall diameter of double glass-fibre covering mm		
			GL2	Grade 1 GL2	Grade 2 GL2
0,500	0,005	0,115	0,670	0,723	0,745
0,560	0,006	0,150	0,802	0,853	0,877
0,630	0,006	0,150	0,873	0,925	0,951

Nominal conductor diameter mm	Conductor diameter tolerance ± mm	Minimum increase of double glass-fibre covering mm	Maximum overall diameter of double glass-fibre covering mm		
			GL2	Grade 1 GL2	Grade 2 GL2
0,710	0,007	0,150	0,958	1,010	1,037
0,800	0,008	0,150	1,048	1,103	1,132
0,900	0,009	0,150	1,149	1,208	1,240
1,000	0,010	0,150	1,249	1,311	1,348
1,120	0,011	0,150	1,370	1,434	1,467
1,250	0,013	0,150	1,511	1,576	1,610
1,400	0,014	0,150	1,662	1,730	1,764
1,600	0,016	0,150	1,867	1,937	1,973
1,800	0,018	0,150	2,068	2,140	2,177
2,000	0,020	0,150	2,269	2,343	2,381
2,240	0,022	0,150	2,516	2,593	2,632
2,500	0,025	0,150	2,782	2,860	2,900
2,800	0,028	0,180	3,123	3,204	3,246
3,150	0,032	0,180	3,481	3,563	3,606
3,550	0,036	0,180	3,883	3,968	4,012
4,000	0,040	0,180	4,335	4,438	4,483
4,500	0,045	0,180	4,843	4,934	4,980
5,000	0,050	0,180	5,345	5,438	5,486

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

NOTE 1 The dimensions of the intermediate nominal conductor diameters for the R40 series are given in Annex A.

NOTE 2 Grade G2 is a double glass-fibre covering over bare wire. Grade 1G2 is a double glass-fibre covering over grade 1 enamelled wire. Grade 2G2 is a double glass-fibre covering over grade 2 enamelled wire.

4.2 Out of roundness of the conductor

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 covering

The minimum increase in diameter due to the covering shall not be less than the values given in Table 1 or Table 2.

4.4 Maximum overall diameter

The maximum overall diameter shall not exceed the values given in Table 1 or Table 2.

5 Electrical resistance

No minimum and maximum resistance values are specified.

For nominal resistance values see Annex B.

6 Elongation

The minimum elongation shall not be less than the values given in Table 3. These requirements shall apply to nominal conductor diameters over 0,630 mm.

Table 3 – Elongation

Nominal conductor diameter mm		With glass-fibre covering Minimum elongation %
Over	Up to and including	
0,630	1,250	15
1,250	2,800	20
2,800	5,000	30

7 Springiness

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

No requirements specified.

7.2 Nominal conductor diameters over 1,600 mm

The wire shall not exceed the maximum springback of:

- 5° for wires with a glass-fibre covering over a bare conductor;
- 5,5° for wires with a glass-fibre covering over an enamelled conductor.

8 Flexibility and adherence

The covering shall not open sufficiently to expose the bare or enamelled wire after bending on a mandrel diameter of ten times the nominal conductor diameter.

9 Heat shock

Test inappropriate.

10 Cut-through

Test inappropriate.

11 Resistance to abrasion

Test inappropriate.

12 Resistance to solvents

Test inappropriate.

13 Breakdown voltage

13.1 Glass-fibre covered bare round copper wires

Method of test according to 4.6 of IEC 60851-5:2008 shall apply.

The wire shall meet the requirements of Table 4.

Table 4 – Breakdown voltage for glass-fibre covered bare round copper wires

Nominal conductor diameter mm		Mandrel diameter mm	Minimum breakdown voltage V	
Over	Up to and including		GL1 single glass-fibre covering	GL2 double glass- fibre covering
–	0,500	25	–	200
0,500	2,500	25	–	260
2,500	5,000	50	–	300

13.2 Glass-fibre covered enamelled round copper wires

Method of test according to 4.6 of IEC 60851-5:2008 shall apply.

The wire shall meet the requirements of Table 5.

Table 5 – Breakdown voltage of glass fibre-covered enamelled round copper wires

Nominal conductor diameter mm		Mandrel diameter mm	Minimum breakdown voltage V			
Over	Up to and including		Grade 1 GL1 single glass- fibre covering	Grade 1 GL2 double glass-fibre covering	Grade 2 GL1 single glass- fibre covering	Grade 2 GL2 double glass-fibre covering
0,50	1,00	25	750	1 000	1 000	1 200
1,12	2,50	25	1 000	1 200	1 260	1 500
2,50	5,00	50	1 200	1 500	1 600	1 800

14 Continuity of insulation

Test inappropriate.

15 Temperature index

The temperature index is dependent on the type of impregnating agent used. The method of test used shall be agreed between purchaser and supplier. The maximum service temperature shall be determined by experience.

16 Resistance to refrigerants

Test inappropriate.

17 Solderability

Test inappropriate.

18 Heat or solvent bonding

Test inappropriate.

19 Dielectric dissipation factor

Test inappropriate.

20 Resistance to hydrolysis and to transformer oil

Test inappropriate.

21 Loss of mass

Test inappropriate.

23 Pin hole test

Test inappropriate.

30 Packaging

The type of packaging can influence certain properties of the wire, for example springback. Therefore, the type of packaging, for example the kind 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 between purchaser and supplier. The 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 between purchaser and supplier.

Where wires are delivered in coils, the dimensions and the maximum mass 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 securely attached to the flange of each spool and (where applicable) container and shall include the following information:

- a) manufacturer's name and/or trademark;
- b) type of wire and insulation;
- c) net mass of wire;
- d) diameter(s) of wire and grade of insulation;
- e) date of manufacture;
- f) appropriate IEC specification number.

Annex A
(informative)

Diameters for intermediate nominal conductor diameters (R40)

Annex A sets out intermediate nominal conductor diameters from which the user may select intermediate sizes only for technical reasons (see Table A.1 and Table A.2).

Table A.1 – Diameters for single glass-fibre covered grade 1 or grade 2 enamelled round wires (R40)

Nominal conductor diameter mm	Conductor diameter tolerance ± mm	Minimum increase of single glass-fibre covering mm	Maximum overall diameter of single glass-fibre covering mm	
			Grade 1 GL1	Grade 2 GL1
0,530	0,006	0,102	0,746	0,765
0,600	0,006	0,102	0,809	0,834
0,670	0,007	0,102	0,882	0,909
0,750	0,008	0,102	0,970	0,997
0,850	0,009	0,102	1,075	1,105
0,950	0,010	0,102	1,170	1,210
1,060	0,011	0,102	1,290	1,325
1,180	0,012	0,102	1,412	1,448
1,320	0,013	0,102	1,560	1,596
1,500	0,015	0,102	1,741	1,780
1,700	0,017	0,102	1,948	1,985
1,900	0,019	0,102	2,147	2,185
2,120	0,021	0,102	2,376	2,415
2,360	0,024	0,102	2,620	2,660
2,650	0,027	0,114	2,948	2,990
3,000	0,030	0,114	3,299	3,342
3,350	0,034	0,114	3,652	3,696
3,750	0,038	0,114	4,058	4,103
4,250	0,043	0,114	4,565	4,611
4,750	0,048	0,114	5,072	5,120

Table A.2 – Diameters for double glass-fibre covered, bare, grade 1 or grade 2 enamelled round wires (R40)

Nominal conductor diameter mm	Conductor diameter tolerance ± mm	Minimum increase of double glass-fibre covering mm	Maximum overall diameter, of double glass-fibre covering mm		
			GL2	Grade 1 GL2	Grade 2 GL2
0,530	0,006	0,150	0,772	0,823	0,847
0,600	0,006	0,150	0,843	0,895	0,921
0,670	0,007	0,150	0,918	0,970	0,997
0,750	0,008	0,150	0,998	1,053	1,082
0,850	0,009	0,150	1,099	1,158	1,190
0,950	0,010	0,150	1,199	1,261	1,298
1,060	0,011	0,150	1,310	1,374	1,407
1,180	0,012	0,150	1,441	1,506	1,540
1,320	0,013	0,150	1,582	1,650	1,684
1,500	0,015	0,150	1,767	1,837	1,873
1,700	0,017	0,150	1,968	2,040	2,077
1,900	0,019	0,150	2,169	2,243	2,281
2,120	0,021	0,150	2,396	2,473	2,512
2,360	0,024	0,150	2,642	2,720	2,760
2,650	0,027	0,180	2,973	3,054	3,096
3,000	0,030	0,180	3,331	3,413	3,456
3,350	0,034	0,180	3,665	3,756	3,800
3,750	0,038	0,180	4,085	4,188	4,233
4,250	0,043	0,180	4,593	4,684	4,730
4,750	0,048	0,180	5,095	5,188	5,236

Annex B
(informative)

Resistance

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

Table B.1 – Electrical resistances

Nominal conductor diameter mm	Nominal resistance Ω/m
0,500	0,087 06
0,560	0,069 40
0,630	0,054 84
0,710	0,043 18
0,800	0,034 01
0,900	0,026 87
1,000	0,021 76
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 8706

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