भारतीय मानक

Indian Standard

IS 13730 (Part 0/Sec 4) : 2024
IEC 60317-0-4 : 2020

विशेष प्रकार की कुंडलण तारों की विशिष्टि

भाग 0 सामान्य अपेक्षाएँ

अनुभाग 4 काँच-तंतु की क्षत रेजिन अथवा वार्निश संचेचित, नंगी अथवा अनेमलित आयताकार कॉपर की तार

(तीसरा पुनरीक्षण)

Specification for Particular Types of Winding Wires

Part 0 General Requirements

Section 4 Glass-Fibre Wound Resin or Varnish Impregnated, Bare or Enamelled Rectangular Copper Wire

(Third Revision)

ICS 29.060.10

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

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Winding Wire Sectional Committee, ETD 33

NATIONAL FOREWORD

This Indian Standard (Part 0/Sec 4) (Third Revision) which is identical to IEC 60317-0-4 : 2020 'Specifications for particular types of winding wires — Part 0: General requirements, Section 4 Glass-fibre wound, resin or varnish impregnated, bare or enamelled rectangular 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 is published in various parts. Other parts in this series are:

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 enammelled 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

This standard was first published in 1993 and subsequently revised in 2011 and 2018. This revision has been undertaken to align it with the latest version of IEC 60317-0-4 : 2020.

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 exist. The corresponding Indian Standards, which are to be substituted, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60851 (all parts) Winding wires — Test methods	IS 13778 (Part 1) : 2011/IEC 60851-1 : 1996 Winding wires — Test methods: Part 1 General (*first revision*)	Identical
	IS 13778 (Part 2) : 2013/IEC 60851-2 : 2009 Winding wires — Test methods: Part 2 Determination of dimensions (*first revision*)	Identical
	IS 13778 (Part 3) : 2012/ IEC 60851-3 : 2009 Winding wires — Test methods: Part 3 Mechanical properties (*first revision*)	Identical
	IS 13778 (Part 4) : 2018/IEC 60851-4 : 2016 Winding wires — Test methods: Part 4 Chemical properties (*second revision*)	Identical
	IS 13778 (Part 5) : 2012/IEC 60851-5 : 2008 Winding wires — Test methods: Part 5 electrical properties (*first revision*)	Identical
	IS 13778 (Part 6) : 2018/IEC 60851-6 : 2012 Winding wires — Test methods: Part 6 Thermal properties (*second revision*)	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.

International Standard	*Title*
ISO 3	Preferred numbers — Series of preferred numbers
ISO 1190-1	Copper and copper alloys — Code of designation — Part 1: Designation of materials for code of designation
EN 1977	Copper and copper alloys — Copper drawing stock (wire rod)
ASTM B49	Standard specification for copper rod for electrical purposes

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.

CONTENTS

INTRODUCTION

This part of IEC 60317 belongs to 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 Standard

SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES

PART 0 GENERAL REQUIREMENTS

SECTION 4 GLASS - FIBRE WOUND RESIN OR VARNISH IMPREGNATED, BARE OR ENAMELLED RECTANGULAR COPPER WIRE

(Third Revision)

1 Scope

This part of IEC 60317 specifies general requirements of glass-fibre wound, resin or varnish impregnated, bare or enamelled rectangular copper wire.

The range of nominal conductor dimensions is given in 4.1 and 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*

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

EN 1977, *Copper and copper alloys – Copper drawing stock (wire rod)*

ISO 1190-1, *Copper and copper alloys − Code of designation – Part 1: Designation of materials for code of designation*

ASTM B49, *Standard Specification for Copper Rod for Electrical Purposes*

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

3.1.2
conductor
bare metal after removal of the insulation

3.1.3
covering
material that is wound, wrapped or braided around a bare or insulated conductor

3.1.4
crack
opening in the insulation that 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
range of thickness of the insulation of a wire

3.1.7
insulation
coating or covering on the conductor with the specific function of withstanding voltage

3.1.8
nominal conductor dimension
designation of the conductor size in accordance with the IEC 60317 series

3.1.9
normal vision
20/20 vision, with corrective lenses if necessary

3.1.10
winding wire
wire used for winding a coil to provide a magnetic field

3.1.11
wire
conductor coated or covered with insulation

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 corresponding test numbers in the IEC 60851 series of standards.

In the case of inconsistencies between the publication on methods of test and this document, IEC 60317-0-4 shall prevail.

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

Unless otherwise specified, all tests shall be carried out at a temperature from 15 °C to 40 °C and a relative humidity from 25 % 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 it is not 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 in accordance with a standard of the IEC 60317 series, the following information is given in the description:

– reference of the IEC specification;

– nominal conductor dimensions in millimetres (width × thickness);

– grade.

EXAMPLE IEC 60317-31 – 4,00 × 1,00 Grade 2GL1

3.3 Appearance

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

The fibres shall be wound evenly, bound to the copper or coating and not loose.

NOTE Evidence of physical damage includes gashes, broken fibre strands, and the like.

4 Dimensions

4.1 Conductor dimensions

The dimensions for widths and thicknesses of conductors of winding wires with rectangular cross-section, recommended in this document, shall be in accordance with Table 1, and are taken from the R 20 series in ISO 3.

Preferred and intermediate sizes are combinations of width and thickness, both in accordance with the R 20 series.

Intermediate sizes are combinations of width or thickness in accordance with the R 20 series with the other dimension in accordance with the R 40 series.

This document covers:

– widths from 2,00 mm up to and including 16,00 mm;

– thicknesses from 0,80 mm up to and including 5,60 mm.

For thickness over 5,60 mm up to and including 10 mm and for widths over 16 mm up to and including 25 mm where, the R 40 series shall be used when, for technical reasons, additional sizes may be needed. The ratio width/thickness shall be within the specified limits, and combinations of R 40 and R 40 are not allowed in the case of additional sizes.

The ratio width/thickness shall be greater than or equal to 1,4:1 and shall not exceed 8:1.

The actual values of dimensions are given in Table 1.

The nominal cross-sectional areas for preferred sizes are given in Table 1 and the nominal cross-sectional areas for intermediate sizes are given in Annex A.

Table 1 – Nominal cross-sectional areas of preferred sizes

Width	Thickness →																		
	mm	0,80	0,90	1,00	1,12	1,25	1,40	1,60	1,80	2,00	2,24	2,50	2,80	3,15	3,55	4,00	4,50	5,00	5,60
		Corner radius (0,5 mm[a])			Corner radius (0,5 mm[a])				Corner radius (0,65 mm[a])			Corner radius (0,80 mm[a])				Corner radius (1,0 mm[a])			
	2,00	1,463	1,626	1,785	2,025	2,285	2,585												
	2,24	1,655	1,842	2,205	2,294	2,585	2,921	3,369											
	2,50	1,863	2,076	2,285	2,585	2,910	3,285	3,785	4,137										
	2,80	2,103	2,346	2,585	2,921	3,285	3,705	4,265	4,677	5,237			Not recommended Ratio width/thickness smaller than 1,4:1						
	3,15	2,383	2,661	2,935	3,313	3,723	4,195	4,825	5,307	5,937	6,693								
	3,55	2,703	3,021	3,335	3,761	4,223	4,755	5,465	6,027	6,737	7,589	8,326							
	4,00	3,063	3,426	3,785	4,265	4,785	5,385	6,185	6,831	7,637	8,597	9,451	10,65						
	4,50	3,463	3,876	4,285	4,825	5,410	6,085	6,85	7,737	8,631	9,717	10,70	12,05	13,63					
	5,00	3,863	4,326	4,785	5,385	6,035	6,785	7,785	8,637	9,637	10,84	12,18	13,45	15,20	17,20				
	5,60	4,363	4,866	5,385	6,057	6,785	7,625	8,745	9,717	10,84	12,18	13,45	15,13	17,09	19,33	21,54			
	6,30	4,903	5,496	6,085	6,841	7,660	8,605	9,865	10,98	12,24	13,75	15,20	17,09	19,30	21,82	24,34	27,49		
	7,10		6,216	6,885	7,737	8,660	9,725	11,15	12,42	13,84	15,54	17,20	19,33	21,82	24,66	27,54	31,09	34,64	
	8,00			7,785	8,745	9,785	10,99	12,59	14,04	15,64	17,56	19,45	21,85	24,65	27,85	31,14	35,14	39,14	43,94
	9,00				9,865	11,04	12,39	14,19	15,84	17,64	19,80	21,95	24,65	27,80	31,40	35,14	39,64	44,14	49,54
	10,0					12,29	13,79	15,79	17,64	19,64	22,04	24,45	27,45	30,95	34,95	39,14	44,14	49,14	55,14
	11,2						15,47	17,71	19,80	22,04	24,79	27,46	30,81	34,73	39,21	43,94	49,54	55,14	61,86
	12,5	Not recommended Ratio width/thickness over 8:1						19,79	22,14	24,64	27,64	30,70	34,45	38,83	43,83	49,14	55,39	61,64	69,14
	14,0								24,84	27,64	31,00	34,45	38,65	43,55	49,15	55,14	62,14	69,14	77,54
	16,0									31,64	35,48	39,45	44,25	49,85	56,25	63,14	71,14	79,14	88,74

[a] Nominal thickness

4.2 Tolerance on conductor dimensions

The conductor dimensions shall not differ from the nominal values by more than the tolerance given in Table 2.

Table 2 – Conductor tolerances

Nominal width or thickness of the conductor mm		Tolerance mm
Over	Up to and including	
–	3,15	±0,030
3,15	6,30	±0,050
6,30	12,50	±0,070
12,50	16,00	±0,100

4.3 Rounding of corners

The arc shall merge smoothly into the flat surfaces of the conductor and the strip shall be free from sharp, rough and projecting edges. The conductor shall have corner radii complying with Table 3. The specified radii shall be maintained within ±25 %.

Table 3 – Corner radii

Nominal thickness of the conductor mm		Corner radius mm
Over	Up to and including	
–	1,00	0,5 nominal thickness
1,00	1,60	0,50[a]
1,60	2,24	0,65[b]
2,24	3,55	0,80
3,55	5,60	1,00
5,60	10,00	1,25
If agreed between purchaser and supplier, the corner radii for wires with a width greater than 4,8 mm may be: [a] 0,5 mm × t, where t is the nominal thickness of the conductor; [b] 0,8 mm.		

4.4 Increase in dimensions due to the insulation

The increase in width or thickness due to the insulation shall be as specified in Table 4.

Table 4 – Increase in dimensions

Nominal width of the conductor mm		Increase in dimensions mm																	
		Glass-fibre covering over bare conductor						Glass-fibre covering over grade 1 enamelled wire						Glass-fibre covering over grade 2 enamelled wire					
		Single covering (GL1)			Double covering (GL2)			Single covering (grade 1 GL1)			Double covering (grade 1 GL2)			Single covering (grade 2 GL1)			Double covering (grade 2 GL2)		
Over	Up to and incl.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
–	3,15	0,10	0,14	0,18	0,21	0,27	0,33	0,16	0,23	0,30	0,27	0,36	0,45	0,23	0,29	0,35	0,35	0,42	0,49
3,15	6,30	0,12	0,16	0,20	0,23	0,30	0,37	0,18	0,25	0,32	0,29	0,39	0,49	0,25	0,31	0,37	0,38	0,45	0,52
6,30	12,50	0,14	0,19	0,24	0,27	0,35	0,43	0,20	0,28	0,36	0,33	0,44	0,55	0,27	0,34	0,41	0,43	0,50	0,57
12,50	16,00	0,17	0,23	0,29	0,31	0,39	0,47	0,23	0,32	0,41	0,37	0,48	0,59	0,30	0,38	0,46	0,46	0,54	0,62

The maximum increase in thickness or width due to the insulation may be exceeded, provided the overall thickness or width of the insulated wire does not exceed the sum of the maximum thickness or width of the bare wire plus the maximum increase in dimension.

NOTE The minimum increases in dimensions apply only to the increase in thickness.

4.5 Overall dimensions

4.5.1 Nominal overall dimensions

The nominal overall dimensions shall be calculated as the sum of the nominal bare conductor dimension and the nominal increase in dimension due to the insulation.

4.5.2 Minimum overall dimensions

The minimum overall dimensions shall be calculated as the sum of the minimum bare conductor dimension and the minimum increase in dimension due to the insulation.

4.5.3 Maximum overall dimensions

The maximum overall dimensions shall be calculated as the sum of the maximum bare conductor dimension and the maximum increase in dimension due to the insulation.

5 Electrical resistance

The copper rod being used shall comply with one of EN 1977:2013, ISO 1190-1:1982 and ASTM B49-17.

The resistance of the wire shall be expressed as the DC resistance at 20 °C. The method used shall provide an accuracy of 0,5 %.

The maximum value of resistance shall be not greater than the value calculated for the minimum tolerated cross-sectional area of the conductor resulting from the minimum dimensions in thickness and width and the maximum for the corner radius, and with a maximum resistivity of 1 / 58,5 Ω mm^2 m^{-1}.

One measurement shall be made.

6 Elongation

The elongation at fracture shall be in accordance with Table 5.

Table 5 – Elongation

Nominal thickness of the conductor mm		**Minimum elongation**
Over	**Up to and including**	%
–	2,50	30
2,50	5,60	32
5,60	10,00	35

7 Springiness

The wire shall not exceed the maximum springback of:

– 5,0° for glass-fibre covered bare wires;
– 5,5° for glass-fibre covered enamelled wires.

8 Flexibility and adherence

8.1 Mandrel winding test

The covering shall show no crack after the wire has been bent flatwise and edgewise on a mandrel with a diameter as specified in Table 6.

Table 6 – Mandrel winding

Wire bent on		Mandrel diameter
Width	Sizes up to and including 8 mm	10 × width
	Sizes over 8 mm	15 × width
Thickness	All sizes	10 × thickness

Specimens showing no crack or opening shall meet the requirements of Clause 13.

8.2 Adherence test

8.2.1 Glass-fibre covered bare wires

The specimen shall be elongated by 10 %. There shall be no loosening, fraying or detachment of the covering.

8.2.2 Glass-fibre covered enamelled wires

The specimen shall be elongated by 10 %. There shall be no loosening, fraying or detachment of the covering or no cracks visible in the coating, when examined without removing the glass-fibre covering.

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

The wire shall meet the requirements of Table 7.

Table 7 – Breakdown voltage

Type of insulation		Minimum breakdown voltage (RMS) V
Bare conductor with	Single covering (GL1)	350
	Double covering (GL2)	560
Grade 1 enamelled wire with	Single covering (grade 1 GL1)	1 350
	Double covering (grade 1 GL2)	1 560
Grade 2 enamelled wire with	Single covering (grade 2 GL1)	2 350
	Double covering (grade 2 GL2)	2 560

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 the purchaser and the 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 transformer oil

Test inappropriate.

21 Loss of mass

Test inappropriate.

23 Pin hole test

Test inappropriate.

30 Packaging

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

The wire shall be evenly and compactly wound on spools or placed in containers. In order to reduce the risk of wire damage, the spool with the wire shall be delivered and used with its axis in the horizontal position. No spool or container shall contain more than one length of wire unless agreed between the purchaser and the 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 between the purchaser and the supplier.

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

a) manufacturer’s name and/or trademark;

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)

Nominal cross-sectional areas for preferred and intermediate sizes

Table A.1 provides nominal cross-sectional areas for preferred and intermediate sizes of rectangular copper bare conductors, from which the user may select intermediate sizes only for technical reasons.

Table A.1 – Nominal cross-sectional areas

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area	Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2	mm	mm	mm	mm^2
2,00	0,80	a	1,463	2,50	1,25	0,5	2,910
	0,85	a	1,545		1,32	0,5	3,085
	0,90	a	1,626		1,40	0,5	3,285
	0,95	a	1,706		1,50	0,5	3,535
	1,00	a	1,785		1,60	0,5	3,785
	1,06	0,5	1,905		1,70	0,65	3,887
	1,12	0,5	2,025		1,80	0,65	4,137
	1,18	0,5	2,145				
	1,25	0,5	2,285	2,65	0,80	a	1,983
	1,32	0,5	2,425		0,90	a	2,211
	1,40	0,5	2,585		1,00	a	2,435
2,12	0,80	a	1,559		1,12	0,5	2,753
	0,90	a	1,734		1,25	0,5	3,098
	1,00	a	1,905		1,40	0,5	3,495
					1,60	0,5	4,025
	1,12	0,5	2,160				
	1,25	0,5	2,435		1,80	0,65	4,407
	1,40	0,5	2,753				
				2,80	0,80	a	2,103
2,24	0,80	a	1,655		0,85	a	2,225
	0,85	a	1,749		0,90	a	2,346
	0,90	a	1,842		0,95	a	2,466
	0,95	a	1,934		1,00	a	2,585
	1,00	a	2,025				
					1,06	0,5	2,753
	1,06	0,5	2,160		1,12	0,5	2,921
	1,12	0,5	2,294		1,18	0,5	3,089
	1,18	0,5	2,429		1,25	0,5	3,285
	1,25	0,5	2,585		1,32	0,5	3,481
	1,32	0,5	2,742		1,40	0,5	3,705
	1,40	0,5	2,921		1,50	0,5	3,985
	1,50	0,5	3,145		1,60	0,5	4,265
	1,60	0,5	3,369				
					1,70	0,65	4,397
2,36	0,80	a	1,751		1,80	0,65	4,677
	0,90	a	1,950		1,90	0,65	4,957
	1,00	a	2,145		2,00	0,65	5,237
	1,12	0,5	2,429	3,00	0,80	a	2,263
	1,25	0,5	2,735		0,90	a	2,526
	1,40	0,5	3,089		1,00	a	2,785
	1,60	0,5	3,561				
					1,12	0,5	3,145
2,50	0,80	a	1,863		1,25	0,5	3,535
	0,85	a	1,970		1,40	0,5	3,985
	0,90	a	2,076		1,60	0,5	4,585
	0,95	a	2,181				
	1,00	a	2,285		1,80	0,65	5,037
	1,06	0,5	2,435				
	1,12	0,5	2,585	3,15	0,80	a	2,383
	1,18	0,5	2,735		0,85	a	2,522

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
3,15	0,90	a	2,661
	0,95	a	2,799
	1,00	a	2,935
	1,06	0,5	3,124
	1,12	0,5	3,313
	1,18	0,5	3,502
	1,25	0,5	3,723
	1,32	0,5	3,943
	1,40	0,5	4,195
	1,50	0,5	4,510
	1,60	0,5	4,825
	1,70	0,65	4,992
	1,80	0,65	5,307
	1,90	0,65	5,622
	2,00	0,65	5,937
	2,12	0,65	6,315
	2,24	0,65	6,693
3,35	0,80	a	2,543
	0,90	a	2,841
	1,00	a	3,135
	1,12	0,5	3,537
	1,25	0,5	3,973
	1,40	0,5	4,475
	1,60	0,5	5,145
	1,80	0,65	5,667
	2,00	0,65	6,337
	2,24	0,65	7,141
3,55	0,80	a	2,703
	0,85	a	2,862
	0,90	a	3,021
	0,95	a	3,179
	1,00	a	3,335
	1,06	0,5	3,548
	1,12	0,5	3,761
	1,18	0,5	3,974
	1,25	0,5	4,223
	1,32	0,5	4,471
	1,40	0,5	4,755
	1,50	0,5	5,110
	1,60	0,5	5,465
	1,70	0,65	5,672
	1,80	0,65	6,027
	1,90	0,65	6,382
	2,00	0,65	6,737
	2,12	0,65	7,163
	2,24	0,65	7,589
	2,36	0,8	7,829
	2,50	0,8	8,326

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
3,75	0,80	a	2,863
	0,90	a	3,201
	1,00	a	3,535
	1,12	0,5	3,985
	1,25	0,5	4,473
	1,40	0,5	5,035
	1,60	0,5	5,785
	1,80	0,65	6,387
	2,00	0,65	7,137
	2,24	0,65	8,037
	2,50	0,8	8,826
4,00	0,80	a	3,063
	0,85	a	3,245
	0,90	a	3,426
	0,95	a	3,606
	1,00	a	3,785
	1,06	0,5	4,025
	1,12	0,5	4,265
	1,18	0,5	4,505
	1,25	0,5	4,785
	1,32	0,5	5,065
	1,40	0,5	5,385
	1,50	0,5	5,785
	1,60	0,5	6,185
	1,70	0,65	6,437
	1,80	0,65	6,837
	1,90	0,65	7,237
	2,00	0,65	7,637
	2,12	0,65	8,117
	2,24	0,65	8,597
	2,36	0,8	8,891
	2,50	0,8	9,451
	2,65	0,8	10,05
	2,80	0,8	10,65
4,25	0,80	a	3,263
	0,90	a	3,651
	1,00	a	4,035
	1,12	0,5	4,545
	1,25	0,5	5,098
	1,40	0,5	5,735
	1,60	0,5	6,585
	1,80	0,65	7,287
	2,00	0,65	8,137
	2,24	0,65	9,157
	2,50	0,8	10,08
	2,80	0,8	11,35

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
4,50	0,80	a	3,463
	0,85	a	3,670
	0,90	a	3,876
	0,95	a	4,081
	1,00	a	4,285
	1,06	0,5	4,555
	1,12	0,5	4,825
	1,18	0,5	5,095
	1,25	0,5	5,410
	1,32	0,5	5,725
	1,40	0,5	6,085
	1,50	0,5	6,535
	1,60	0,5	6,985
	1,70	0,65	7,287
	1,80	0,65	7,737
	1,90	0,65	8,187
	2,00	0,65	8,637
	2,12	0,65	9,177
	2,24	0,65	9,717
	2,36	0,8	10,07
	2,50	0,8	10,70
	2,65	0,8	11,38
	2,80	0,8	12,05
	3,00	0,8	12,95
	3,15	0,8	13,63
4,75	0,80	a	3,663
	0,90	a	4,101
	1,00	a	4,535
	1,12	0,5	5,105
	1,25	0,5	5,723
	1,40	0,5	6,435
	1,60	0,5	7,385
	1,80	0,65	8,188
	2,00	0,65	9,137
	2,24	0,65	10,28
	2,50	0,8	11,33
	2,80	0,8	12,75
	3,15	0,8	14,41
5,00	0,80	a	3,863
	0,85	a	4,095
	0,90	a	4,326
	0,95	a	4,556
	1,00	a	4,785
	1,06	0,5	5,085
	1,12	0,5	5,385
	1,18	0,5	5,685
	1,25	0,5	6,035
	1,32	0,5	6,385
	1,40	0,5	6,785
	1,50	0,5	7,285
	1,60	0,5	7,785

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
5,00	1,70	0,65	8,137
	1,80	0,65	8,637
	1,90	0,65	9,137
	2,00	0,65	9,637
	2,12	0,65	10,24
	2,24	0,65	10,84
	2,36	0,8	11,25
	2,50	0,8	11,95
	2,65	0,8	12,70
	2,80	0,8	13,45
	3,00	0,8	14,45
	3,15	0,8	15,20
	3,35	0,8	16,20
	3,55	0,8	17,20
5,30	0,80	a	4,103
	0,90	a	4,596
	1,00	a	5,085
	1,12	0,5	5,721
	1,25	0,5	6,410
	1,40	0,5	7,205
	1,60	0,5	8,265
	1,80	0,65	9,177
	2,00	0,65	10,24
	2,24	0,65	11,51
	2,50	0,8	12,70
	2,80	0,8	14,29
	3,15	0,8	16,15
	3,55	0,8	18,27
5,60	0,80	a	4,343
	0,85	a	4,605
	0,90	a	4,866
	0,95	a	5,126
	1,00	a	5,385
	1,06	0,5	5,721
	1,12	0,5	6,057
	1,18	0,5	6,393
	1,25	0,5	6,785
	1,32	0,5	7,177
	1,40	0,5	7,625
	1,50	0,5	8,185
	1,60	0,5	8,745
	1,70	0,65	9,157
	1,80	0,65	9,717
	1,90	0,65	10,28
	2,00	0,65	10,84
	2,12	0,65	11,51
	2,24	0,65	12,18
	2,36	0,8	12,67
	2,50	0,8	13,45
	2,65	0,8	14,29
	2,80	0,8	15,13

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
5,60	3,00	0,8	16,25
	3,15	0,8	17,09
	3,35	0,8	18,21
	3,55	0,8	19,33
	3,75	1,0	20,14
	4,00	1,0	21,54
6,00	0,80	[a]	4,663
	0,90	[a]	5,226
	1,00	[a]	5,785
	1,12	0,5	6,505
	1,25	0,5	7,285
	1,40	0,5	8,185
	1,60	0,5	9,385
	1,80	0,65	10,44
	2,00	0,65	11,64
	2,24	0,65	13,08
	2,50	0,8	14,45
	2,80	0,8	16,25
	3,15	0,8	18,35
	3,55	0,8	20,75
	4,00	1,0	23,14
6,30	0,80	[a]	4,903
	0,85	[a]	5,200
	0,90	[a]	5,496
	0,95	[a]	5,791
	1,00	[a]	6,085
	1,06	0,5	6,463
	1,12	0,5	6,841
	1,18	0,5	7,219
	1,25	0,5	7,660
	1,32	0,5	8,101
	1,40	0,5	8,605
	1,50	0,5	9,235
	1,60	0,5	9,865
	1,70	0,65	10,35
	1,80	0,65	10,98
	1,90	0,65	11,61
	2,00	0,65	12,24
	2,12	0,65	12,99
	2,24	0,65	13,75
	2,36	0,8	14,32
	2,50	0,8	15,20
	2,65	0,8	16,15
	2,80	0,8	17,09
	3,00	0,8	18,35
	3,15	0,8	19,30
	3,35	0,8	20,56
	3,55	0,8	21,82

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
6,30	3,75	1,0	22,77
	4,00	1,0	24,34
	4,25	1,0	25,92
	4,50	1,0	27,49
6,70	0,90	[a]	5,856
	1,00	[a]	6,485
	1,12	0,5	7,289
	1,25	0,5	8,160
	1,40	0,5	9,165
	1,60	0,5	10,51
	1,80	0,65	11,70
	2,00	0,65	13,04
	2,24	0,65	14,65
	2,50	0,8	16,20
	2,80	0,8	18,21
	3,15	0,8	20,56
	3,55	0,8	23,24
	4,00	1,0	25,94
	4,50	1,0	29,29
7,10	0,90	[a]	6,216
	0,95	[a]	6,551
	1,00	[a]	6,885
	1,06	0,5	7,311
	1,12	0,5	7,737
	1,18	0,5	8,163
	1,25	0,5	8,660
	1,32	0,5	9,157
	1,40	0,5	9,725
	1,50	0,5	10,44
	1,60	0,5	11,15
	1,70	0,65	11,71
	1,80	0,65	12,42
	1,90	0,65	13,13
	2,00	0,65	13,84
	2,12	0,65	14,69
	2,24	0,65	15,54
	2,36	0,8	16,21
	2,50	0,8	17,20
	2,65	0,8	18,27
	2,80	0,8	19,33
	3,00	0,8	20,75
	3,15	0,8	21,82
	3,35	0,8	23,24
	3,55	0,8	24,66
	3,75	1,0	25,77
	4,00	1,0	27,54
	4,25	1,0	29,32

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
7,10	4,50	1,0	31,09
	4,75	1,0	32,87
	5,00	1,0	34,64
7,50	1,00	[a]	7,285
	1,12	0,5	8,185
	1,25	0,5	9,160
	1,40	0,5	10,29
	1,60	0,5	11,79
	1,80	0,65	13,14
	2,00	0,65	14,64
	2,24	0,65	16,44
	2,50	0,8	18,20
	2,80	0,8	20,45
	3,15	0,8	23,08
	3,55	0,8	26,08
	4,00	1,0	29,14
	4,50	1,0	32,89
	5,00	1,0	36,64
8,00	1,00	[a]	7,785
	1,06	0,5	8,265
	1,12	0,5	8,745
	1,18	0,5	9,225
	1,25	0,5	9,785
	1,32	0,5	10,35
	1,40	0,5	10,99
	1,50	0,5	11,79
	1,60	0,5	12,59
	1,70	0,65	13,24
	1,80	0,65	14,04
	1,90	0,65	14,84
	2,00	0,65	15,64
	2,12	0,65	16,60
	2,24	0,65	17,56
	2,36	0,8	18,33
	2,50	0,8	19,45
	2,65	0,8	20,65
	2,80	0,8	21,85
	3,00	0,8	23,45
	3,15	0,8	24,65
	3,35	0,8	26,25
	3,55	0,8	27,85
	3,75	1,0	29,14
	4,00	1,0	31,14
	4,25	1,0	33,14
	4,50	1,0	35,14
	4,75	1,0	37,14
	5,00	1,0	39,14
	5,30	1,0	41,54
	5,60	1,0	43,94

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
8,50	1,12	0,5	9,305
	1,25	0,5	10,41
	1,40	0,5	11,69
	1,60	0,5	13,39
	1,80	0,65	14,94
	2,00	0,65	16,64
	2,24	0,65	18,68
	2,50	0,8	20,70
	2,80	0,8	23,25
	3,15	0,8	26,23
	3,55	0,8	29,63
	4,00	1,0	33,14
	4,50	1,0	37,39
	5,00	1,0	41,64
	5,60	1,0	46,74
9,00	1,12	0,5	9,865
	1,18	0,5	10,41
	1,25	0,5	11,04
	1,32	0,5	11,67
	1,40	0,5	12,39
	1,50	0,5	13,29
	1,60	0,5	14,19
	1,70	0,65	14,94
	1,80	0,65	15,84
	1,90	0,65	16,74
	2,00	0,65	17,64
	2,12	0,65	18,72
	2,24	0,65	19,80
	2,36	0,8	20,69
	2,50	0,8	21,95
	2,65	0,8	23,30
	2,80	0,8	24,65
	3,00	0,8	26,45
	3,15	0,8	27,80
	3,35	0,8	29,60
	3,55	0,8	31,40
	3,75	1,0	32,89
	4,00	1,0	35,14
	4,25	1,0	37,39
	4,50	1,0	39,64
	4,75	1,0	41,89
	5,00	1,0	44,14
	5,30	1,0	46,84
	5,60	1,0	49,54
9,50	1,25	0,5	11,66
	1,40	0,5	13,09
	1,60	0,5	14,99
	1,80	0,65	16,74
	2,00	0,65	18,64
	2,24	0,65	20,92

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
9,50	2,50	0,8	23,20
	2,80	0,8	26,05
	3,15	0,8	29,38
	3,55	0,8	33,18
	4,00	1,0	37,14
	4,50	1,0	41,89
	5,00	1,0	46,64
	5,60	1,0	52,34
10,00	1,25	0,5	12,29
	1,32	0,5	12,99
	1,40	0,5	13,79
	1,50	0,5	14,79
	1,60	0,5	15,79
	1,70	0,65	16,64
	1,80	0,65	17,64
	1,90	0,65	18,64
	2,00	0,65	19,64
	2,12	0,65	20,84
	2,24	0,65	22,04
	2,36	0,8	23,05
	2,50	0,8	24,45
	2,65	0,8	25,95
	2,80	0,8	27,45
	3,00	0,8	29,45
	3,15	0,8	30,95
	3,35	0,8	32,95
	3,55	0,8	34,95
	3,75	1,0	36,64
	4,00	1,0	39,14
	4,25	1,0	41,64
	4,50	1,0	44,14
	4,75	1,0	46,64
	5,00	1,0	49,14
	5,30	1,0	52,14
	5,60	1,0	55,14
10,60	1,40	0,5	14,63
	1,60	0,5	16,75
	1,80	0,65	18,72
	2,00	0,65	20,84
	2,24	0,65	23,38
	2,50	0,8	25,95
	2,80	0,8	29,13
	3,15	0,8	32,84
	3,55	0,8	37,08
	4,00	1,0	41,54
	4,50	1,0	46,84
	5,00	1,0	52,14
	5,60	1,0	58,50
11,20	1,40	0,5	15,47
	1,50	0,5	16,59
	1,60	0,5	17,71

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2
11,20	1,70	0,65	18,68
	1,80	0,65	19,80
	1,90	0,65	20,92
	2,00	0,65	22,04
	2,12	0,65	23,38
	2,24	0,65	24,73
	2,36	0,8	25,88
	2,50	0,8	27,45
	2,65	0,8	29,13
	2,80	0,8	30,81
	3,00	0,8	33,05
	3,15	0,8	34,73
	3,35	0,8	36,97
	3,55	0,8	39,21
	3,75	1,0	41,14
	4,00	1,0	43,94
	4,25	1,0	46,74
	4,50	1,0	49,54
	4,75	1,0	52,34
	5,00	1,0	55,14
	5,30	1,0	58,50
	5,60	1,0	61,86
11,80	1,60	0,5	18,67
	1,80	0,65	20,88
	2,00	0,65	23,24
	2,24	0,65	26,07
	2,50	0,8	28,95
	2,80	0,8	32,49
	3,15	0,8	36,62
	3,55	0,8	41,34
	4,00	1,0	46,34
	4,50	1,0	52,24
	5,00	1,0	58,14
	5,60	1,0	65,22
12,50	1,60	0,5	19,79
	1,70	0,65	20,89
	1,80	0,65	22,14
	1,90	0,65	23,39
	2,00	0,65	24,64
	2,12	0,65	26,14
	2,24	0,65	27,64
	2,36	0,8	28,95
	2,50	0,8	30,70
	2,65	0,8	32,58
	2,80	0,8	34,45
	3,00	0,8	36,95
	3,15	0,8	38,83
	3,35	0,8	41,33
	3,55	0,8	43,83
	3,75	1,0	46,02
	4,00	1,0	49,14
	4,25	1,0	52,27

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area	Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm^2	mm	mm	mm	mm^2
12,50	4,50	1,0	55,39	14,00	4,75	1,0	65,64
	4,75	1,0	58,52		5,00	1,0	69,14
	5,00	1,0	61,64		5,30	1,0	73,34
	5,30	1,0	65,39		5,60	1,0	77,54
	5,60	1,0	69,14				
				15,00	2,00	0,65	29,64
13,20	1,80	0,65	23,40		2,24	0,65	33,24
	2,00	0,65	26,04				
	2,24	0,65	29,21		2,50	0,8	36,95
					2,80	0,8	41,45
	2,50	0,8	32,45		3,15	0,8	46,70
	2,80	0,8	36,41		3,55	0,8	52,70
	3,15	0,8	41,03				
	3,55	0,8	46,31		4,00	1,0	59,14
					4,50	1,0	66,64
	4,00	1,0	51,94		5,00	1,0	74,14
	4,50	1,0	58,54		5,60	1,0	83,14
	5,00	1,0	65,14				
	5,60	1,0	73,06	16,00	2,00	0,65	31,64
					2,12	0,65	33,56
14,00	1,80	0,65	24,84		2,24	0,65	35,48
	1,90	0,65	26,24				
	2,00	0,65	27,64		2,36	0,8	37,21
	2,12	0,65	29,32		2,50	0,8	39,45
	2,24	0,65	31,00		2,65	0,8	41,85
					2,80	0,8	44,25
	2,36	0,8	32,49		3,00	0,8	47,45
	2,50	0,8	34,45		3,15	0,8	49,85
	2,65	0,8	36,55		3,35	0,8	53,05
	2,80	0,8	38,65		3,55	0,8	56,25
	3,00	0,8	41,45				
	3,15	0,8	43,55		3,75	1,0	59,14
	3,35	0,8	46,35		4,00	1,0	63,14
	3,55	0,8	49,15		4,25	1,0	67,14
					4,50	1,0	71,14
	3,75	1,0	51,64		4,75	1,0	75,14
	4,00	1,0	55,14		5,00	1,0	79,14
	4,25	1,0	58,64		5,30	1,0	83,94
	4,50	1,0	62,14		5,60	1,0	88,74

[a] 0,5 mm nominal thickness.

Bibliography

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

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

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