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Edition 4.0 2020-04

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Specifications for particular types of winding wires – Part 0-4: General requirements – Glass-fibre wound, resin or varnish impregnated, bare or enamelled rectangular copper wire

IEC 60317-0-4:2020-04 RLV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

Part 0-4: General requirements – Glass-fibre wound, resin or varnish impregnated, bare or enamelled rectangular copper wire

FOREWORD

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International Standard IEC 60317-0-4 has been prepared by IEC technical committee 55: Winding wires.

This fourth edition cancels and replaces the third edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) addition of dimensional requirements for grade 1 enamelled wire in Table 4;
b) addition of dielectric breakdown requirements for grade 1 enamelled wire in Table 7.
c) addition of requirement for the adherence test in 8.2.1 and 8.2.2.

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

FDIS	Report on voting
55/1835A/FDIS	55/1852/RVD

Full information on the voting for the approval of this document 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.

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

In the case of inconsistencies between IEC 60851 and this standard, the latter prevails.

The numbering of clauses in this standard is not continuous from Clauses 21 through 30 in order to reserve space for possible future wire requirements prior to those for wire packaging.

A list of all parts in the IEC 60317 series, published 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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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).

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SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

Part 0-4: General requirements – Glass-fibre wound, resin or varnish impregnated, bare or enamelled rectangular copper wire

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 ~~on tests~~ 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

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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 ~~with~~ to the ~~respective~~ corresponding test numbers in the IEC 60851 series of standards.

In the case of inconsistencies between the publication on ~~test~~ 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 ~~45~~ 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.

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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 ~~and continuous~~ 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.

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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	~~2,582~~ 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

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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.

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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.

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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.

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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 ~~loss of adhesion~~ loosening, fraying or detachment of the ~~glass-fibre~~ covering.

8.2.2 Glass-fibre covered enamelled wires

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

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.

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Table 7 – Breakdown voltage

Type of insulation		Minimum breakdown voltage ((~~root-mean-square value~~) 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.

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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.

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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 mm	Nominal thickness mm	Radius on corners mm	Nominal cross-sectional area mm^2
2,00	0,80	a	1,463
	0,85	a	1,545
	0,90	a	1,626
	0,95	a	1,706
	1,00	a	1,785
	1,06	0,5	1,905
	1,12	0,5	2,025
	1,18	0,5	2,145
	1,25	0,5	2,285
	1,32	0,5	2,425
	1,40	0,5	2,585
2,12	0,80	a	1,559
	0,90	a	1,734
	1,00	a	1,905
	1,12	0,5	2,160
	1,25	0,5	2,435
	1,40	0,5	2,753
2,24	0,80	a	1,655
	0,85	a	1,749
	0,90	a	1,842
	0,95	a	1,934
	1,00	a	2,025
	1,06	0,5	2,160
	1,12	0,5	2,294
	1,18	0,5	2,429
	1,25	0,5	2,585
	1,32	0,5	2,742
	1,40	0,5	2,921
	1,50	0,5	3,145
	1,60	0,5	3,369
2,36	0,80	a	1,751
	0,90	a	1,950
	1,00	a	2,145
	1,12	0,5	2,429
	1,25	0,5	2,735
	1,40	0,5	3,089
	1,60	0,5	3,561
2,50	0,80	a	1,863
	0,85	a	1,970
	0,90	a	2,076
	0,95	a	2,181
	1,00	a	2,285
	1,06	0,5	2,435
	1,12	0,5	2,585
	1,18	0,5	~~2,736~~ 2,735
2,50	1,25	0,5	2,910
	1,32	0,5	3,085
	1,40	0,5	3,285
	1,50	0,5	3,535
	1,60	0,5	3,785
	1,70	0,65	3,887
	1,80	0,65	4,137
2,65	0,80	a	1,983
	0,90	a	2,211
	1,00	a	2,435
	1,12	0,5	2,753
	1,25	0,5	3,098
	1,40	0,5	3,495
	1,60	0,5	4,025
	1,80	0,65	4,407
2,80	0,80	a	2,103
	0,85	a	2,225
	0,90	a	2,346
	0,95	a	2,466
	1,00	a	2,585
	1,06	0,5	2,753
	1,12	0,5	2,921
	1,18	0,5	3,089
	1,25	0,5	3,285
	1,32	0,5	3,481
	1,40	0,5	3,705
	1,50	0,5	3,985
	1,60	0,5	4,265
	1,70	0,65	4,397
	1,80	0,65	4,677
	1,90	0,65	4,957
	2,00	0,65	5,237
3,00	0,80	a	2,263
	0,90	a	2,526
	1,00	a	2,785
	1,12	0,5	3,145
	1,25	0,5	3,535
	1,40	0,5	3,985
	1,60	0,5	4,585
	1,80	0,65	5,037
3,15	0,80	a	2,383
	0,85	a	2,522

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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

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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

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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

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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

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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

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