

# INTERNATIONAL STANDARD



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## Specifications for particular types of winding wires – Part 0-2: General requirements – Enamelled rectangular copper wire



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# INTERNATIONAL STANDARD



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**Specifications for particular types of winding wires –  
Part 0-2: General requirements – Enamelled rectangular copper wire**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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## CONTENTS

|                                                                                                      |    |
|------------------------------------------------------------------------------------------------------|----|
| FOREWORD .....                                                                                       | 4  |
| INTRODUCTION .....                                                                                   | 7  |
| 1 Scope .....                                                                                        | 8  |
| 2 Normative references .....                                                                         | 8  |
| 3 Terms, definitions, general notes and appearance .....                                             | 8  |
| 3.1 Terms and definitions .....                                                                      | 8  |
| 3.2 General notes .....                                                                              | 10 |
| 3.2.1 Methods of test .....                                                                          | 10 |
| 3.2.2 Winding wire .....                                                                             | 10 |
| 3.3 Appearance .....                                                                                 | 10 |
| 4 Dimensions .....                                                                                   | 10 |
| 4.1 Conductor dimensions .....                                                                       | 10 |
| 4.2 Tolerance on conductor dimensions .....                                                          | 11 |
| 4.3 Rounding of corners .....                                                                        | 11 |
| 4.4 Increase in dimensions due to the insulation and the bonding layer .....                         | 14 |
| 4.4.1 Enamelled wires without a bonding layer .....                                                  | 14 |
| 4.4.2 Enamelled wires with a bonding layer .....                                                     | 14 |
| 4.5 Overall dimensions .....                                                                         | 14 |
| 4.5.1 Nominal overall dimensions .....                                                               | 14 |
| 4.5.2 Minimum overall dimensions .....                                                               | 15 |
| 4.5.3 Maximum overall dimensions .....                                                               | 15 |
| 5 Electrical resistance .....                                                                        | 15 |
| 6 Elongation .....                                                                                   | 15 |
| 7 Springiness (applicable to nominal proof strength $\leq 80 \text{ N} \cdot \text{mm}^{-2}$ ) ..... | 16 |
| 8 Flexibility and adherence .....                                                                    | 16 |
| 8.1 Mandrel winding test .....                                                                       | 16 |
| 8.2 Adherence test .....                                                                             | 16 |
| 9 Heat shock .....                                                                                   | 17 |
| 10 Cut-through .....                                                                                 | 17 |
| 11 Resistance to abrasion .....                                                                      | 17 |
| 12 Resistance to solvents .....                                                                      | 17 |
| 13 Breakdown voltage .....                                                                           | 17 |
| 14 Continuity of insulation .....                                                                    | 18 |
| 15 Temperature index .....                                                                           | 18 |
| 16 Resistance to refrigerants .....                                                                  | 18 |
| 17 Solderability .....                                                                               | 18 |
| 18 Heat or solvent bonding .....                                                                     | 18 |
| 19 Dielectric dissipation factor .....                                                               | 18 |
| 20 Resistance to transformer oil .....                                                               | 18 |
| 21 Loss of mass .....                                                                                | 18 |
| 23 Pin hole test .....                                                                               | 18 |
| 30 Packaging .....                                                                                   | 19 |

|                                                                                                |               |
|------------------------------------------------------------------------------------------------|---------------|
| Annex A (informative) Nominal cross-sectional areas for preferred and intermediate sizes ..... | 20            |
| <del>Annex B (informative) Special tolerances .....</del>                                      | <del>20</del> |
| Bibliography .....                                                                             | 37            |
| Table 1 – Conductor tolerances .....                                                           | 11            |
| Table 2 – Nominal cross-sectional areas of preferred sizes .....                               | 12            |
| Table 3 – Corner radii .....                                                                   | 14            |
| Table 4 – Increases in dimensions .....                                                        | 14            |
| Table 5 – Percentage elongation after fracture .....                                           | 16            |
| Table 6 – Proof strength and resistivity .....                                                 | 16            |
| Table 7 – Mandrel winding .....                                                                | 16            |
| Table 8 – Breakdown voltage .....                                                              | 17            |
| Table A.1 – Nominal cross-sectional areas .....                                                | 20            |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

## Part 0-2: General requirements – Enamelled rectangular copper wire

## FOREWORD

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**This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.**

International Standard IEC 60317-0-2 has been prepared by IEC technical committee 55: Winding wires.

This fourth edition cancels and replaces the third edition published in 2013. This edition constitutes a technical revision.

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

- a) revision to Clause 2 to add new normative references for specifications for copper rods;
- b) revision to 3.1 to add a new definition for the term “bonding layer”;
- c) revision to 3.2.1 to the conditions specified for tests to be carried out;
- d) revision to 4.5 to add requirements for minimal, nominal and maximal overall dimensions with a bonding layer;
- e) revision to Clause 5 to reference specifications for rectangular and square copper rod;
- f) revision to Clause 6 to take into account nominal proof strength;
- g) revision to 8.2 to the adherence test requirement;
- h) revision to Clause 18 to make reference to the relevant specification sheet

The text of this International Standard is based on the following documents:

| FDIS         | Report on voting |
|--------------|------------------|
| 55/1847/FDIS | 55/1865/RVD      |

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

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

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

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

The numbering of clauses in this standard is not continuous from Clauses 21 and 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
- amended.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## 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](#)).

## SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

### Part 0-2: General requirements – Enamelled rectangular copper wire

#### 1 Scope

This part of IEC 60317 specifies the general requirements of enamelled rectangular copper winding wires.

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 60172, *Test procedure for the determination of the temperature index of enamelled and tape wrapped winding wires*

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

IEC 60851-3, *Winding wires – Test methods – Part 3: Mechanical properties*

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

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

ISO 6892-1:2016, *Metallic materials – Tensile testing – Part 1: Method of test at room temperature*

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

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 terms and definitions given in ISO 6892-1:2016 and the following 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****class**

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

**3.1.2****coating**

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

**3.1.3****conductor**

bare metal after removal of the insulation

**3.1.4****crack**

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

**3.1.5****dual coating**

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

**3.1.6****enamelled wire**

wire coated with an insulation of cured resin

**3.1.7****grade**

<enamelled rectangular copper wire>

~~range of thickness of the insulation of a wire~~

range of increase in the overall diameter of the wire due to the enamel

**3.1.8****insulation**

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

**3.1.9****nominal conductor dimension**

designation of the conductor size in accordance with the IEC 60317 series

**3.1.10****normal vision**

20/20 vision, with corrective lenses, if necessary

**3.1.11****winding wire**

wire used for winding a coil to provide a magnetic field

**3.1.12****wire**

conductor coated or covered with an insulation

**3.1.13****bonding layer**

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

## 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 IEC 60851 (all parts).

In case of inconsistencies between the publication on methods of test and this document, IEC 60317-0-2 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 ~~35~~ 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.

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 dimensions in millimetres (width × thickness);
- grade;
- nominal proof strength minimum (and maximum) value.

EXAMPLE: IEC 60317-17 – 4,00 × 1,00 Grade 1  $R_{p0.2} = 120 \text{ N}\cdot\text{mm}^{-2}$

## 3.3 Appearance

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

## 4 Dimensions

### 4.1 Conductor dimensions

The dimensions for width and thickness of conductors of winding wires with rectangular cross-section, recommended in this document, are taken from the R 20 ~~and R 40~~ series in ISO 3.

Preferred 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~~ 31,50 mm;

- thicknesses from 0,80 mm up to and including ~~5,60~~ 10,00 mm.

~~For thicknesses over 5,60 mm up to and including 10 mm and for widths over 16 mm up to and including 25 mm where, for technical reasons, additional sizes may be needed, the R 40 series shall be used.~~ The ratio width/thickness shall be within the specified limits. 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 2\*.

The nominal cross-sectional areas for preferred sizes are given in Table 2, and the nominal cross-sectional areas for intermediate sizes are given in Table A.1.

## 4.2 Tolerance on conductor dimensions

The conductor dimensions shall not differ from the nominal values by more than the tolerance given in Table 1.

**Table 1 – Conductor tolerances**

| Nominal width or thickness of the conductor<br>Mm |                     | Tolerance<br>±<br>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                |
| 16,00                                             | 22,40               | 0,130                |
| 22,40                                             | 31,50               | 0,150                |

## 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 radiused corners complying with Table 3. The specified radii shall be maintained within  $\pm 25\%$ .

\* ~~Dimensions according to R 20 series are printed in larger type.~~

[illegible]

• 0,5 nominal thickness.

| Thickness                 |              |                 |       |       |                        |       |       |       |       |       |       |       |       |       |       |       |       |                         |       |       |                        |       |       |                         |  |  |  |
|---------------------------|--------------|-----------------|-------|-------|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------------------|-------|-------|------------------------|-------|-------|-------------------------|--|--|--|
| Width                     | <div>→</div> |                 |       |       |                        |       |       |       |       |       |       |       |       |       |       |       |       |                         |       |       |                        |       |       |                         |  |  |  |
|                           | 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  | 6,30  | 7,10                   | 8,00  | 9,00  | 10,0                    |  |  |  |
|                           |              | Corner radius * |       |       | Corner radius (0,5 mm) |       |       |       |       |       |       |       |       |       |       |       |       | Corner radius (0,80 mm) |       |       | Corner radius (1,0 mm) |       |       | Corner radius (1,25 mm) |  |  |  |
|                           | 2,00         | 1,463           | 1,626 | 1,785 | 2,025                  | 2,285 | 2,585 |       |       |       |       |       |       |       |       |       |       |                         |       |       |                        |       |       |                         |  |  |  |
|                           | 2,24         | 1,655           | 1,842 | 2,025 | 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 |       |       |       |       |       |       |       |                         |       |       |                        |       |       |                         |  |  |  |
|                           | 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 | 6,837 | 7,637 | 8,597 | 9,451 | 10,65 |       |       |       |       |                         |       |       |                        |       |       |                         |  |  |  |
|                           | 4,50         | 3,463           | 3,876 | 4,285 | 4,825                  | 5,410 | 6,085 | 6,985 | 7,737 | 8,637 | 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 | 11,95 | 13,45 | 15,20 | 17,20 |       |       |                         |       |       |                        |       |       |                         |  |  |  |
|                           | 5,60         | 4,343           | 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 | 55,36 |                        |       |       |                         |  |  |  |
|                           | 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 | 61,66 | 69,66                  |       |       |                         |  |  |  |
|                           | 11,2         |                 |       |       |                        |       | 15,47 | 17,71 | 19,80 | 22,04 | 24,73 | 27,45 | 30,81 | 34,73 | 39,21 | 43,94 | 49,54 | 55,14                   | 61,86 | 69,22 | 78,18                  | 88,26 |       |                         |  |  |  |
|                           | 12,5         |                 |       |       |                        |       |       | 19,79 | 22,14 | 24,64 | 27,64 | 30,70 | 34,45 | 38,83 | 43,83 | 49,14 | 55,39 | 61,64                   | 69,14 | 77,41 | 87,41                  | 98,66 | 111,2 |                         |  |  |  |
|                           | 14,0         |                 |       |       |                        |       |       |       | 24,84 | 27,64 | 31,00 | 34,45 | 38,65 | 43,55 | 49,15 | 55,14 | 62,14 | 69,14                   | 77,54 | 86,86 | 98,06                  | 110,7 | 124,7 | 138,7                   |  |  |  |
|                           | 16,0         |                 |       |       |                        |       |       |       |       | 31,64 | 35,48 | 39,45 | 44,25 | 49,85 | 56,25 | 63,14 | 71,14 | 79,14                   | 88,74 | 99,46 | 112,3                  | 126,7 | 142,7 | 158,7                   |  |  |  |
|                           | 18,0         |                 |       |       |                        |       |       |       |       |       | 39,96 | 44,45 | 49,85 | 56,15 | 63,35 | 71,14 | 80,14 | 89,14                   | 99,94 | 112,1 | 126,5                  | 142,7 | 160,7 | 178,7                   |  |  |  |
|                           | 20,0         |                 |       |       |                        |       |       |       |       |       |       | 49,45 | 55,45 | 62,45 | 70,45 | 79,14 | 89,14 | 99,14                   | 111,1 | 124,7 | 140,7                  | 158,7 | 178,7 | 198,7                   |  |  |  |
|                           | 22,4         |                 |       |       |                        |       |       |       |       |       |       |       | 62,17 | 70,01 | 78,97 | 88,74 | 99,94 | 111,1                   | 124,6 | 139,8 | 157,7                  | 177,9 | 200,3 | 222,7                   |  |  |  |
|                           | 25,0         |                 |       |       |                        |       |       |       |       |       |       |       |       | 78,20 | 88,20 | 99,14 | 111,6 | 124,1                   | 139,1 | 156,2 | 176,2                  | 198,7 | 223,7 | 248,7                   |  |  |  |
| 28,0                      |              |                 |       |       |                        |       |       |       |       |       |       |       |       | 98,85 | 111,1 | 125,1 | 139,1 | 155,9                   | 175,1 | 197,5 | 222,7                  | 250,7 | 278,7 |                         |  |  |  |
| 31,5                      |              |                 |       |       |                        |       |       |       |       |       |       |       |       |       | 125,1 | 140,9 | 156,6 | 175,5                   | 197,1 | 222,3 | 250,7                  | 282,2 | 313,7 |                         |  |  |  |
| * 0,5 x nominal thickness |              |                 |       |       |                        |       |       |       |       |       |       |       |       |       |       |       |       |                         |       |       |                        |       |       |                         |  |  |  |

Not recommended  
Ratio width/thickness over 8:1Not recommended  
Ratio width/thickness smaller than 1,4:1

**Table 3 – Corner radii**

| Nominal thickness of conductor<br>mm |                     | Corner<br>radius<br>mm  |
|--------------------------------------|---------------------|-------------------------|
| Over                                 | Up to and including |                         |
| –                                    | 1,00                | 0,5 × nominal thickness |
| 1,00                                 | 1,60                | 0,50*                   |
| 1,60                                 | 2,24                | 0,65**                  |
| 2,24                                 | 3,55                | 0,80                    |
| 3,55                                 | 5,60                | 1,00                    |
| 5,60                                 | 10,00               | 1,25                    |

**NOTE** If agreed between purchaser and supplier, the corner radii for wires with a width greater than 4,8 mm may be:

\* 0,5 mm × t, where t is the nominal thickness of the conductor;

\*\* 0,80 mm.

#### 4.4 Increase in dimensions due to the insulation and the bonding layer

##### 4.4.1 Enamelled wires without a bonding layer

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

**Table 4 – Increases in dimensions**

| Grade | Increase in dimensions |         |         |
|-------|------------------------|---------|---------|
|       | mm                     |         |         |
|       | Minimum                | Nominal | Maximum |
| 1     | 0,06                   | 0,085   | 0,11    |
| 2     | 0,12                   | 0,145   | 0,17    |

##### 4.4.2 Enamelled wires with a bonding layer

The increase in dimensions due to the bonding layer for grades 1B and 2B shall be (0,04 ± 0,01) mm.

#### 4.5 Overall dimensions

##### 4.5.1 Nominal overall dimensions

###### 4.5.1.1 Nominal overall dimensions without a bonding layer

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

###### 4.5.1.2 Nominal overall dimensions with a bonding layer

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

## 4.5.2 Minimum overall dimensions

### 4.5.2.1 Minimum overall dimensions without a bonding layer

The minimum overall dimensions shall be calculated as the sum of the minimum bare conductor and the minimum increase in dimension due to the insulation. ~~See also note under 4.5.3.~~

### 4.5.2.2 Minimum overall dimensions with a bonding layer

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

## 4.5.3 Maximum overall dimensions

### 4.5.3.1 Maximum overall dimensions without a bonding layer

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

~~NOTE—When agreed between purchaser and supplier, special tolerances for grade 2 as given in Annex B can be used to calculate special maximum and minimum dimensions.~~

### 4.5.3.2 Maximum overall dimensions with a bonding layer

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

## 5 Electrical resistance

The copper rod being used shall comply with at least one of EN 1977, ISO 1190-1 or ASTM B49.

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 resistivity ~~of  $1/58 \Omega \cdot \text{mm}^2 \cdot \text{m}^{-1}$~~  given in Table 6.

One measurement shall be made.

## 6 Elongation

~~The elongation at fracture shall be in accordance with the values given in Table 5.~~

The percentage elongation after fracture shall be measured according to Clause 20 of ISO 6892-1:2016. When the nominal proof strength, plastic extension is not specified or a nominal proof strength, plastic extension of 80 N/mm<sup>2</sup> is required, the limits of Table 5 apply. Otherwise, the measurement is performed for reference only.

**Table 5 – Percentage elongation after fracture**

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

When the value of nominal proof strength, plastic extension is specified, the measured proof strength shall be within the tolerances given in Table 6.

**Table 6 – Proof strength and resistivity**

| Proof strength                                   |            | Maximum resistivity<br>$\Omega \cdot \text{mm}^2 \cdot \text{m}^{-1}$ |
|--------------------------------------------------|------------|-----------------------------------------------------------------------|
| Nominal value<br>$\text{N} \cdot \text{mm}^{-2}$ | Tolerance  |                                                                       |
| 80                                               | –0 / +30 % | 1/58                                                                  |
| 120                                              | –0 / +20 % | 1/58                                                                  |
| 150                                              | –0 / +20 % | 1/58                                                                  |
| 180                                              | –0 / +20 % | 1/57,5                                                                |

The proof strength, plastic extension shall be measured at the specified percentage of plastic extension, with the method described in Clause 13 of ISO 6892-1:2016; if not otherwise specified, the percentage shall be 0,2 % ( $R_{p0,2}$ ).

If required by the customer, the test shall be performed according to Clause 10 of ISO 6892-1:2016. Otherwise, the test shall be performed as described in IEC 60851-3.

## 7 Springiness (applicable to nominal proof strength $\leq 80 \text{ N} \cdot \text{mm}^{-2}$ )

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

## 8 Flexibility and adherence

### 8.1 Mandrel winding test

The coating shall show no crack after the wire has been bent flatwise and edgewise on a mandrel with a diameter as specified in Table 7.

**Table 7 – Mandrel winding**

| Wire bent on |                                 | Mandrel diameter |
|--------------|---------------------------------|------------------|
| Width        | Sizes up to and including 10 mm | 4 × width        |
|              | Sizes over 10 mm                | 5 × width        |
| Thickness    | All sizes                       | 4 × thickness    |

### 8.2 Adherence test

The wire shall be stretched by 15 % or to the breaking point, whichever is less. The distance of loss of adherence shall be less than 1 × width.

## 9 Heat shock

The coating shall show no crack after the wire has been bent flatwise on a mandrel with a diameter of six times the thickness.

The minimum heat shock temperature is given in the relevant specification sheet.

## 10 Cut-through

Test **requirement** under consideration.

## 11 Resistance to abrasion

Test inappropriate.

## 12 Resistance to solvents

Using a pencil of hardness "H" and standard solvent, the coating shall not be removed.

## 13 Breakdown voltage

When tested at room temperature, at least four of the five specimens tested shall not break down at a voltage less than or equal to that given in Table 8, and the fifth shall not break down at less than 50 % of the values specified.

When required by the purchaser, the wire shall be tested at elevated temperature.

The elevated temperature is given in the relevant specification sheet.

**Table 8 – Breakdown voltage**

| Grade | Minimum-breakdown-voltage (r.m.s.)<br>V |                      |
|-------|-----------------------------------------|----------------------|
|       | Room temperature                        | Elevated temperature |
| 1     | 1 000                                   | 750                  |
| 2     | 2 000                                   | 1 500                |

| Grade | Minimum breakdown voltage (RMS)<br>V |                      |                    |                      |
|-------|--------------------------------------|----------------------|--------------------|----------------------|
|       | Without bonding layer                |                      | With bonding layer |                      |
|       | Room temperature                     | Elevated temperature | Room temperature   | Elevated temperature |
| 1     | 1 000                                | 750                  | 1 500              | 1 000                |
| 2     | 2 000                                | 1 500                | 2 500              | 2 000                |

## 14 Continuity of insulation

Test inappropriate.

## 15 Temperature index

The test shall be carried out on a rectangular wire in accordance with IEC 60172, unless otherwise agreed between the purchaser and the supplier.

When required by a purchaser, the supplier of the enamelled wire shall supply evidence that the wire meets the requirements for the temperature index.

NOTE 1 The temperature index requirement based on an extrapolated life of 20 000 h relates to enamelled wires tested unvarnished and not as part of an insulation system.

NOTE 2 Temperature in degrees Celsius corresponding to the temperature index is not necessarily that at which it is recommended that the wire be operated, and this will depend on many factors including the type of equipment involved.

## 16 Resistance to refrigerants

Test inappropriate.

## 17 Solderability

Test inappropriate.

## 18 Heat or solvent bonding

~~Test inappropriate.~~ For requirements, the relevant specification sheet applies.

## 19 Dielectric dissipation factor

For requirements, the relevant specification sheet applies.

## 20 Resistance to transformer oil

For requirements, the relevant specification sheet applies.

## 21 Loss of mass

Test inappropriate.

## 23 Pin hole test

Test inappropriate.

### 30 Packaging

The kind of packaging may influence certain properties of the wire, for example ~~springback~~ **springiness and proof strength**. 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. No spool or container shall contain more than one length of wire unless agreed to by 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 to by the purchaser and the supplier.

Where wires are delivered in coils, the dimensions and the maximum weights of such coils shall be agreed between the purchaser and the supplier. Any additional protection for coils shall also 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) **having a bonding layer (if any);**
- d) **nominal proof strength;**
- e) net mass of wire;
- f) nominal dimension(s) of wire and grade of insulation;
- g) 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<br>mm | Nominal thickness<br>mm | Radius-on corners<br>mm | Nominal cross-section area<br>mm <sup>2</sup> | Nominal width<br>mm | Nominal thickness<br>mm | Radius-on corners<br>mm | Nominal cross-section area<br>mm <sup>2</sup> |
|---------------------|-------------------------|-------------------------|-----------------------------------------------|---------------------|-------------------------|-------------------------|-----------------------------------------------|
| 2,00                | 0,80                    | *                       | 1,463                                         | 2,50                | 1,25                    | 0,5                     | 2,910                                         |
|                     | 0,85                    | *                       | 1,545                                         |                     | 1,32                    | 0,5                     | 3,085                                         |
|                     | 0,90                    | *                       | 1,626                                         |                     | 1,40                    | 0,5                     | 3,285                                         |
|                     | 0,95                    | *                       | 1,706                                         |                     | 1,50                    | 0,5                     | 3,535                                         |
|                     | 1,00                    | *                       | 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                                         |                     | 2,65                    | 0,80                    | *                                             |
|                     | 1,25                    | 0,5                     | 2,285                                         |                     |                         | 0,90                    | *                                             |
|                     | 1,32                    | 0,5                     | 2,425                                         |                     |                         | 1,00                    | *                                             |
|                     | 1,40                    | 0,5                     | 2,585                                         |                     |                         |                         |                                               |
| 2,12                | 0,80                    | *                       | 1,559                                         | 2,80                | 1,12                    | 0,5                     | 2,753                                         |
|                     | 0,90                    | *                       | 1,734                                         |                     | 1,25                    | 0,5                     | 3,098                                         |
|                     | 1,00                    | *                       | 1,905                                         |                     | 1,40                    | 0,5                     | 3,495                                         |
|                     | 1,12                    | 0,5                     | 2,160                                         |                     | 1,60                    | 0,5                     | 4,025                                         |
|                     | 1,25                    | 0,5                     | 2,435                                         |                     | 1,80                    | 0,65                    | 4,407                                         |
|                     | 1,40                    | 0,5                     | 2,753                                         |                     | 0,80                    | *                       | 2,103                                         |
| 2,24                | 0,80                    | *                       | 1,655                                         |                     | 0,85                    | *                       | 2,225                                         |
|                     | 0,85                    | *                       | 1,749                                         |                     | 0,90                    | *                       | 2,346                                         |
|                     | 0,90                    | *                       | 1,842                                         |                     | 0,95                    | *                       | 2,466                                         |
|                     | 0,95                    | *                       | 1,934                                         |                     | 1,00                    | *                       | 2,585                                         |
|                     | 1,00                    | *                       | 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                                         |
| 2,36                | 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                                         |
|                     | 0,80                    | *                       | 1,751                                         |                     | 1,80                    | 0,65                    | 4,677                                         |
|                     | 0,90                    | *                       | 1,950                                         |                     | 1,90                    | 0,65                    | 4,957                                         |
|                     | 1,00                    | *                       | 2,145                                         |                     | 2,00                    | 0,65                    | 5,237                                         |
|                     | 1,12                    | 0,5                     | 2,429                                         | 3,00                | 0,80                    | *                       | 2,263                                         |
|                     | 1,25                    | 0,5                     | 2,735                                         |                     | 0,90                    | *                       | 2,526                                         |
|                     | 1,40                    | 0,5                     | 3,089                                         |                     | 1,00                    | *                       | 2,785                                         |
|                     | 1,60                    | 0,5                     | 3,561                                         |                     | 1,12                    | 0,5                     | 3,145                                         |
| 2,50                | 0,80                    | *                       | 1,863                                         |                     | 1,25                    | 0,5                     | 3,535                                         |
|                     | 0,85                    | *                       | 1,970                                         |                     | 1,40                    | 0,5                     | 3,985                                         |
|                     | 0,90                    | *                       | 2,076                                         |                     | 1,60                    | 0,5                     | 4,585                                         |
|                     | 0,95                    | *                       | 2,181                                         |                     | 1,80                    | 0,65                    | 5,037                                         |
|                     | 1,00                    | *                       | 2,285                                         |                     | 2,00                    | 0,65                    | 5,637                                         |
|                     | 1,06                    | 0,5                     | 2,435                                         | 3,15                | 0,80                    | *                       | 2,383                                         |
|                     | 1,12                    | 0,5                     | 2,585                                         |                     | 0,85                    | *                       | 2,522                                         |
|                     | 1,18                    | 0,5                     | 2,736                                         |                     |                         |                         |                                               |

\*—0,5 nominal thickness



**Table A.1 (2 of 7)**

| Nominal width<br>mm | Nominal thickness<br>mm | Radius on corners<br>mm | Nominal cross-section area<br>mm <sup>2</sup> |  | Nominal width<br>mm | Nominal thickness<br>mm | Radius on corners<br>mm | Nominal cross-section area<br>mm <sup>2</sup> |
|---------------------|-------------------------|-------------------------|-----------------------------------------------|--|---------------------|-------------------------|-------------------------|-----------------------------------------------|
| 3,15                | 0,90                    | *                       | 2,661                                         |  | 3,75                | 0,80                    | *                       | 2,863                                         |
|                     | 0,95                    | *                       | 2,799                                         |  |                     | 0,90                    | *                       | 3,201                                         |
|                     | 1,00                    | *                       | 2,935                                         |  |                     | 1,00                    | *                       | 3,535                                         |
|                     | 1,06                    | 0,5                     | 3,124                                         |  |                     | 1,12                    | 0,5                     | 3,985                                         |
|                     | 1,12                    | 0,5                     | 3,313                                         |  |                     | 1,25                    | 0,5                     | 4,473                                         |
|                     | 1,18                    | 0,5                     | 3,502                                         |  |                     | 1,40                    | 0,5                     | 5,035                                         |
|                     | 1,25                    | 0,5                     | 3,723                                         |  |                     | 1,60                    | 0,5                     | 5,785                                         |
|                     | 1,32                    | 0,5                     | 3,943                                         |  | 4,00                | 1,80                    | 0,65                    | 6,387                                         |
|                     | 1,40                    | 0,5                     | 4,195                                         |  |                     | 2,00                    | 0,65                    | 7,137                                         |
|                     | 1,50                    | 0,5                     | 4,510                                         |  |                     | 2,24                    | 0,65                    | 8,037                                         |
|                     | 1,60                    | 0,5                     | 4,825                                         |  |                     | 2,50                    | 0,8                     | 8,826                                         |
|                     | 1,70                    | 0,65                    | 4,992                                         |  |                     | 0,80                    | *                       | 3,063                                         |
|                     | 1,80                    | 0,65                    | 5,307                                         |  |                     | 0,85                    | *                       | 3,245                                         |
|                     | 1,90                    | 0,65                    | 5,622                                         |  |                     | 0,90                    | *                       | 3,426                                         |
|                     | 2,00                    | 0,65                    | 5,937                                         |  |                     | 0,95                    | *                       | 3,606                                         |
|                     | 2,12                    | 0,65                    | 6,315                                         |  |                     | 1,00                    | *                       | 3,785                                         |
|                     | 2,24                    | 0,65                    | 6,693                                         |  |                     | 1,06                    | 0,5                     | 4,025                                         |
| 3,35                | 0,80                    | *                       | 2,543                                         |  |                     | 1,12                    | 0,5                     | 4,265                                         |
|                     | 0,90                    | *                       | 2,841                                         |  |                     | 1,18                    | 0,5                     | 4,505                                         |
|                     | 1,00                    | *                       | 3,135                                         |  |                     | 1,25                    | 0,5                     | 4,785                                         |
|                     | 1,12                    | 0,5                     | 3,537                                         |  |                     | 1,32                    | 0,5                     | 5,065                                         |
|                     | 1,25                    | 0,5                     | 3,973                                         |  |                     | 1,40                    | 0,5                     | 5,385                                         |
|                     | 1,40                    | 0,5                     | 4,475                                         |  |                     | 1,50                    | 0,5                     | 5,785                                         |
|                     | 1,60                    | 0,5                     | 5,145                                         |  |                     | 1,60                    | 0,5                     | 6,185                                         |
|                     | 1,80                    | 0,65                    | 5,667                                         |  |                     | 1,70                    | 0,65                    | 6,437                                         |
|                     | 2,00                    | 0,65                    | 6,337                                         |  |                     | 1,80                    | 0,65                    | 6,837                                         |
|                     | 2,24                    | 0,65                    | 7,141                                         |  |                     | 1,90                    | 0,65                    | 7,237                                         |
| 3,55                | 0,80                    | *                       | 2,703                                         |  | 4,25                | 2,00                    | 0,65                    | 7,637                                         |
|                     | 0,85                    | *                       | 2,862                                         |  |                     | 2,12                    | 0,65                    | 8,117                                         |
|                     | 0,90                    | *                       | 3,021                                         |  |                     | 2,24                    | 0,65                    | 8,597                                         |
|                     | 0,95                    | *                       | 3,179                                         |  |                     | 2,36                    | 0,8                     | 8,891                                         |
|                     | 1,00                    | *                       | 3,335                                         |  |                     | 2,50                    | 0,8                     | 9,451                                         |
|                     | 1,06                    | 0,5                     | 3,548                                         |  |                     | 2,65                    | 0,8                     | 10,05                                         |
|                     | 1,12                    | 0,5                     | 3,761                                         |  |                     | 2,80                    | 0,8                     | 10,65                                         |
|                     | 1,18                    | 0,5                     | 3,974                                         |  |                     | 0,80                    | *                       | 3,263                                         |
|                     | 1,25                    | 0,5                     | 4,223                                         |  |                     | 0,90                    | *                       | 3,651                                         |
|                     | 1,32                    | 0,5                     | 4,471                                         |  |                     | 1,00                    | *                       | 4,035                                         |
|                     | 1,40                    | 0,5                     | 4,755                                         |  |                     | 1,12                    | 0,5                     | 4,545                                         |
|                     | 1,50                    | 0,5                     | 5,110                                         |  |                     | 1,25                    | 0,5                     | 5,098                                         |
|                     | 1,60                    | 0,5                     | 5,465                                         |  |                     | 1,40                    | 0,5                     | 5,735                                         |
|                     | 1,70                    | 0,65                    | 5,672                                         |  |                     | 1,60                    | 0,5                     | 6,585                                         |
|                     | 1,80                    | 0,65                    | 6,027                                         |  |                     | 1,80                    | 0,65                    | 7,287                                         |
|                     | 1,90                    | 0,65                    | 6,382                                         |  |                     | 2,00                    | 0,65                    | 8,137                                         |
|                     | 2,00                    | 0,65                    | 6,737                                         |  |                     | 2,24                    | 0,65                    | 9,157                                         |
|                     | 2,12                    | 0,65                    | 7,163                                         |  |                     | 2,50                    | 0,8                     | 10,08                                         |
|                     | 2,24                    | 0,65                    | 7,589                                         |  |                     | 2,80                    | 0,8                     | 11,35                                         |
|                     | 2,36                    | 0,8                     | 7,829                                         |  |                     |                         |                         |                                               |
|                     | 2,50                    | 0,8                     | 8,326                                         |  |                     |                         |                         |                                               |

\* — 0,5 nominal thickness

**Table A.1 (3 of 7)**

| Nominal width           | Nominal thickness | Radius-on corners | Nominal cross-section area |      | Nominal width | Nominal thickness | Radius-on corners | Nominal cross-section area |       |
|-------------------------|-------------------|-------------------|----------------------------|------|---------------|-------------------|-------------------|----------------------------|-------|
| mm                      | mm                | mm                | mm <sup>2</sup>            |      | mm            | mm                | mm                | mm <sup>2</sup>            |       |
| 4,50                    | 0,80              | *                 | 3,463                      |      | 5,00          | 1,70              | 0,65              | 8,137                      |       |
|                         | 0,85              | *                 | 3,670                      |      |               | 1,80              | 0,65              | 8,637                      |       |
|                         | 0,90              | *                 | 3,876                      |      |               | 1,90              | 0,65              | 9,137                      |       |
|                         | 0,95              | *                 | 4,081                      |      |               | 2,00              | 0,65              | 9,637                      |       |
|                         | 1,00              | *                 | 4,285                      |      |               | 2,12              | 0,65              | 10,24                      |       |
|                         |                   |                   |                            |      |               | 2,24              | 0,65              | 10,84                      |       |
|                         | 1,06              | 0,5               | 4,555                      |      |               |                   |                   |                            |       |
|                         | 1,12              | 0,5               | 4,825                      |      |               | 2,36              | 0,8               | 11,25                      |       |
|                         | 1,18              | 0,5               | 5,095                      |      |               | 2,50              | 0,8               | 11,95                      |       |
|                         | 1,25              | 0,5               | 5,410                      |      |               | 2,65              | 0,8               | 12,70                      |       |
|                         | 1,32              | 0,5               | 5,725                      |      |               | 2,80              | 0,8               | 13,45                      |       |
|                         | 1,40              | 0,5               | 6,085                      |      |               | 3,00              | 0,8               | 14,45                      |       |
|                         | 1,50              | 0,5               | 6,535                      |      |               | 3,15              | 0,8               | 15,20                      |       |
|                         | 1,60              | 0,5               | 6,985                      |      |               | 3,35              | 0,8               | 16,20                      |       |
|                         |                   |                   |                            |      |               | 3,55              | 0,8               | 17,20                      |       |
|                         | 1,70              | 0,65              | 7,287                      |      | 5,30          | 0,80              | *                 | 4,103                      |       |
|                         | 1,80              | 0,65              | 7,737                      |      |               | 0,90              | *                 | 4,596                      |       |
|                         | 1,90              | 0,65              | 8,187                      |      |               | 1,00              | *                 | 5,085                      |       |
|                         | 2,00              | 0,65              | 8,637                      |      |               |                   |                   |                            |       |
|                         | 2,12              | 0,65              | 9,177                      |      |               | 1,12              | 0,5               | 5,721                      |       |
|                         | 2,24              | 0,65              | 9,717                      |      |               | 1,25              | 0,5               | 6,410                      |       |
|                         |                   |                   |                            |      |               | 1,40              | 0,5               | 7,205                      |       |
|                         | 2,36              | 0,8               | 10,07                      |      |               | 1,60              | 0,5               | 8,265                      |       |
|                         | 2,50              | 0,8               | 10,70                      |      |               |                   |                   |                            |       |
|                         | 2,65              | 0,8               | 11,38                      |      |               | 1,80              | 0,65              | 9,177                      |       |
|                         | 2,80              | 0,8               | 12,05                      |      |               | 2,00              | 0,65              | 10,24                      |       |
|                         | 3,00              | 0,8               | 12,95                      |      |               | 2,24              | 0,65              | 11,51                      |       |
|                         | 3,15              | 0,8               | 13,63                      |      | 5,60          | 2,50              | 0,8               | 12,70                      |       |
|                         | 4,75              | 0,80              | *                          |      |               | 3,663             | 2,80              | 0,8                        | 14,29 |
|                         |                   | 0,90              | *                          |      |               | 4,101             | 3,15              | 0,8                        | 16,15 |
|                         |                   | 1,00              | *                          |      |               | 4,535             | 3,55              | 0,8                        | 18,27 |
|                         |                   |                   |                            |      |               |                   |                   |                            |       |
| 1,12                    |                   | 0,5               | 5,105                      | 0,80 |               | *                 | 4,343             |                            |       |
| 1,25                    |                   | 0,5               | 5,723                      | 0,85 |               | *                 | 4,605             |                            |       |
| 1,40                    |                   | 0,5               | 6,435                      | 0,90 |               | *                 | 4,866             |                            |       |
| 1,60                    |                   | 0,5               | 7,385                      | 0,95 |               | *                 | 5,126             |                            |       |
|                         |                   |                   |                            | 1,00 |               | *                 | 5,385             |                            |       |
| 1,80                    |                   | 0,65              | 8,188                      |      |               |                   |                   |                            |       |
| 2,00                    |                   | 0,65              | 9,137                      | 1,06 |               | 0,5               | 5,721             |                            |       |
| 2,24                    |                   | 0,65              | 10,28                      | 1,12 |               | 0,5               | 6,057             |                            |       |
| 5,00                    | 2,50              | 0,8               | 11,33                      | 1,18 |               | 0,5               | 6,393             |                            |       |
|                         | 2,80              | 0,8               | 12,75                      | 1,25 |               | 0,5               | 6,785             |                            |       |
|                         | 3,15              | 0,8               | 14,41                      | 1,32 |               | 0,5               | 7,177             |                            |       |
|                         |                   |                   |                            | 1,40 |               | 0,5               | 7,625             |                            |       |
|                         | 0,80              | *                 | 3,863                      | 1,50 |               | 0,5               | 8,185             |                            |       |
|                         | 0,85              | *                 | 4,095                      | 1,60 |               | 0,5               | 8,745             |                            |       |
|                         | 0,90              | *                 | 4,326                      |      |               |                   |                   |                            |       |
|                         | 0,95              | *                 | 4,556                      | 1,70 |               | 0,65              | 9,157             |                            |       |
|                         | 1,00              | *                 | 4,785                      | 1,80 |               | 0,65              | 9,717             |                            |       |
|                         |                   |                   |                            | 1,90 |               | 0,65              | 10,28             |                            |       |
|                         | 1,06              | 0,5               | 5,085                      | 2,00 |               | 0,65              | 10,84             |                            |       |
|                         | 1,12              | 0,5               | 5,385                      | 2,12 |               | 0,65              | 11,51             |                            |       |
|                         | 1,18              | 0,5               | 5,685                      | 2,24 |               | 0,65              | 12,18             |                            |       |
|                         | 1,25              | 0,5               | 6,035                      |      |               |                   |                   |                            |       |
|                         | 1,32              | 0,5               | 6,385                      | 2,36 |               | 0,8               | 12,67             |                            |       |
|                         | 1,40              | 0,5               | 6,785                      | 2,50 |               | 0,8               | 13,45             |                            |       |
|                         | 1,50              | 0,5               | 7,285                      | 2,65 |               | 0,8               | 14,29             |                            |       |
|                         | 1,60              | 0,5               | 7,785                      | 2,80 |               | 0,8               | 15,13             |                            |       |
| *—0,5 nominal thickness |                   |                   |                            |      |               |                   |                   |                            |       |

**Table A.1 (4 of 7)**

| Nominal width | Nominal thickness | Radius-on corners | Nominal cross-section area |      | Nominal width | Nominal thickness | Radius-on corners | Nominal cross-section area |       |       |
|---------------|-------------------|-------------------|----------------------------|------|---------------|-------------------|-------------------|----------------------------|-------|-------|
| mm            | mm                | mm                | mm <sup>2</sup>            |      | mm            | mm                | mm                | mm <sup>2</sup>            |       |       |
| 5,60          | 3,00              | 0,8               | 16,25                      |      | 6,30          | 3,75              | 1,0               | 22,77                      |       |       |
|               | 3,15              | 0,8               | 17,09                      |      |               | 4,00              | 1,0               | 24,34                      |       |       |
|               | 3,35              | 0,8               | 18,21                      |      |               | 4,25              | 1,0               | 25,92                      |       |       |
|               | 3,55              | 0,8               | 19,33                      |      |               | 4,50              | 1,0               | 27,49                      |       |       |
|               | 3,75              | 1,0               | 20,14                      |      | 6,70          | 0,90              | *                 | 5,856                      |       |       |
|               | 4,00              | 1,0               | 21,54                      |      |               | 1,00              | *                 | 6,485                      |       |       |
|               | 6,00              | 0,80              | *                          |      |               | 4,663             |                   | 1,12                       | 0,5   | 7,289 |
|               |                   | 0,90              | *                          |      |               | 5,226             |                   | 1,25                       | 0,5   | 8,160 |
| 1,00          |                   | *                 | 5,785                      | 1,40 | 0,5           | 9,165             |                   |                            |       |       |
| 1,60          |                   | 0,5               | 9,385                      | 1,60 | 0,5           | 10,51             |                   |                            |       |       |
|               | 1,12              | 0,5               | 6,505                      |      |               | 1,80              | 0,65              | 11,70                      |       |       |
|               | 1,25              | 0,5               | 7,285                      |      |               | 2,00              | 0,65              | 13,04                      |       |       |
|               | 1,40              | 0,5               | 8,185                      |      |               | 2,24              | 0,65              | 14,65                      |       |       |
|               | 1,80              | 0,65              | 10,44                      |      |               | 2,50              | 0,8               | 16,20                      |       |       |
|               | 2,00              | 0,65              | 11,64                      |      |               | 2,80              | 0,8               | 28,21                      |       |       |
|               | 2,24              | 0,65              | 13,08                      |      |               | 3,15              | 0,8               | 20,56                      |       |       |
|               | 2,50              | 0,8               | 14,45                      |      |               | 3,55              | 0,8               | 23,24                      |       |       |
|               | 2,80              | 0,8               | 16,25                      |      |               | 4,00              | 1,0               | 25,94                      |       |       |
|               | 3,15              | 0,8               | 18,35                      |      |               | 4,50              | 1,0               | 29,29                      |       |       |
|               | 3,55              | 0,8               | 20,75                      |      |               | 7,10              | 0,90              | *                          | 6,216 |       |
|               | 4,00              | 1,0               | 23,14                      |      |               |                   | 0,95              | *                          | 6,551 |       |
|               | 0,80              | *                 | 4,903                      |      |               |                   | 1,00              | *                          | 6,885 |       |
| 6,30          | 0,85              | *                 | 5,200                      |      |               |                   | 1,06              | 0,5                        | 7,311 |       |
|               | 0,90              | *                 | 5,496                      |      |               | 1,12              | 0,5               | 7,737                      |       |       |
|               | 0,95              | *                 | 5,791                      |      |               | 1,18              | 0,5               | 8,163                      |       |       |
|               | 1,00              | *                 | 6,085                      |      |               | 1,25              | 0,5               | 8,660                      |       |       |
|               | 1,06              | 0,5               | 6,463                      |      |               | 1,32              | 0,5               | 9,157                      |       |       |
|               | 1,12              | 0,5               | 6,841                      |      |               | 1,40              | 0,5               | 9,725                      |       |       |
|               | 1,18              | 0,5               | 7,219                      |      |               | 1,50              | 0,5               | 10,44                      |       |       |
|               | 1,25              | 0,5               | 7,660                      |      |               | 1,60              | 0,5               | 11,15                      |       |       |
|               | 1,32              | 0,5               | 8,101                      |      |               | 1,70              | 0,65              | 11,71                      |       |       |
|               | 1,40              | 0,5               | 8,605                      |      |               | 1,80              | 0,65              | 12,42                      |       |       |
|               | 1,50              | 0,5               | 9,235                      |      |               | 1,90              | 0,65              | 13,13                      |       |       |
|               | 1,60              | 0,5               | 9,865                      |      |               | 2,00              | 0,65              | 13,84                      |       |       |
|               | 1,70              | 0,65              | 10,35                      |      |               | 2,12              | 0,65              | 14,69                      |       |       |
|               | 1,80              | 0,65              | 10,98                      |      |               | 2,24              | 0,65              | 15,54                      |       |       |
|               | 1,90              | 0,65              | 11,61                      |      |               | 2,36              | 0,8               | 16,21                      |       |       |
|               | 2,00              | 0,65              | 12,24                      |      |               | 2,50              | 0,8               | 17,20                      |       |       |
|               | 2,12              | 0,65              | 12,99                      |      |               | 2,65              | 0,8               | 18,27                      |       |       |
|               | 2,24              | 0,65              | 13,75                      |      |               | 2,80              | 0,8               | 19,33                      |       |       |
|               | 2,36              | 0,8               | 14,32                      |      |               | 3,00              | 0,8               | 20,75                      |       |       |
|               | 2,50              | 0,8               | 15,20                      |      |               | 3,15              | 0,8               | 21,82                      |       |       |
|               | 2,65              | 0,8               | 16,15                      |      |               | 3,35              | 0,8               | 23,24                      |       |       |
|               | 2,80              | 0,8               | 17,09                      |      |               | 3,55              | 0,8               | 24,66                      |       |       |
|               | 3,00              | 0,8               | 18,35                      |      |               | 3,75              | 1,0               | 25,77                      |       |       |
|               | 3,15              | 0,8               | 19,30                      |      |               | 4,00              | 1,0               | 27,54                      |       |       |
|               | 3,35              | 0,8               | 20,56                      |      |               | 4,25              | 1,0               | 29,32                      |       |       |
|               | 3,55              | 0,8               | 21,82                      |      |               |                   |                   |                            |       |       |

\*—0,5-nominal thickness

\* — 0,5 nominal thickness

**Table A.1 (5 of 7)**

| Nominal width | Nominal thickness | Radius-on corners | Nominal cross-section area |      | Nominal width | Nominal thickness | Radius-on corners | Nominal cross-section area |
|---------------|-------------------|-------------------|----------------------------|------|---------------|-------------------|-------------------|----------------------------|
| mm            | mm                | mm                | mm <sup>2</sup>            |      | mm            | mm                | mm                | mm <sup>2</sup>            |
| 7,10          | 4,50              | 1,0               | 31,09                      |      | 8,50          | 1,12              | 0,5               | 9,305                      |
|               | 4,75              | 1,0               | 32,87                      |      |               | 1,25              | 0,5               | 10,41                      |
|               | 5,00              | 1,0               | 34,64                      |      |               | 1,40              | 0,5               | 11,69                      |
| 7,50          | 1,00              | *                 | 7,285                      |      | 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             |                            |
|               | 1,12              | 0,5               | 8,185                      |      | 2,80          | 0,8               | 23,25             |                            |
|               | 1,25              | 0,5               | 9,160                      |      | 3,15          | 0,8               | 26,23             |                            |
|               | 1,40              | 0,5               | 10,29                      |      | 3,55          | 0,8               | 29,63             |                            |
|               | 1,60              | 0,5               | 11,79                      |      | 4,00          | 1,0               | 33,14             |                            |
|               | 1,80              | 0,65              | 13,14                      |      | 4,50          | 1,0               | 37,39             |                            |
|               | 2,00              | 0,65              | 14,64                      |      | 5,00          | 1,0               | 41,64             |                            |
| 2,24          | 0,65              | 16,44             | 5,60                       |      | 1,0           | 46,74             |                   |                            |
| 8,00          | 1,00              | *                 | 7,785                      | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 8,265                      | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 9,240                      | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 10,36                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 11,79                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 13,24                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 14,64                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 16,44             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 8,50          | 1,00              | *                 | 8,285                      | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 8,745                      | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 9,720                      | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 10,84                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 12,29                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 13,74                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 15,14                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 16,94             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 9,00          | 1,00              | *                 | 8,785                      | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 9,205                      | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 10,180                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 11,30                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 12,75                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 14,20                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 15,60                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 17,40             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 9,50          | 1,00              | *                 | 9,285                      | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 9,665                      | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 10,640                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 11,76                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 13,21                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 14,66                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 16,06                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 17,86             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 10,00         | 1,00              | *                 | 10,285                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 10,085                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 11,060                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 12,18                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 13,63                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 15,08                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 16,48                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 18,28             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 10,50         | 1,00              | *                 | 10,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 10,505                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 11,480                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 12,60                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 14,05                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 15,50                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 16,90                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 18,70             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 11,00         | 1,00              | *                 | 11,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 11,005                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 12,080                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 13,20                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 14,65                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 16,10                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 17,50                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 19,30             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 11,50         | 1,00              | *                 | 12,285                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 11,425                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 12,500                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 13,62                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 15,07                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 16,52                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 17,92                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 19,72             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 12,00         | 1,00              | *                 | 12,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 11,845                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 12,920                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 14,04                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 15,49                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 16,94                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 18,34                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 20,14             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 12,50         | 1,00              | *                 | 13,285                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 12,265                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 13,340                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 14,46                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 15,91                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 17,36                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 18,76                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 20,56             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 13,00         | 1,00              | *                 | 13,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 12,685                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 13,760                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 14,88                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 16,33                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 17,78                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 19,18                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 20,98             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 13,50         | 1,00              | *                 | 14,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 13,125                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 14,200                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 15,32                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 16,77                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 18,22                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 19,62                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 21,42             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 14,00         | 1,00              | *                 | 15,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 14,065                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 15,140                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 16,26                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 17,71                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 19,16                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 20,56                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 22,36             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 14,50         | 1,00              | *                 | 16,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 15,005                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 16,080                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 17,20                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 18,65                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 20,10                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 21,50                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 23,30             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 15,00         | 1,00              | *                 | 17,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 16,025                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 17,100                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 18,22                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 19,67                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 21,12                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 22,52                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 24,32             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 15,50         | 1,00              | *                 | 18,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 17,005                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 18,080                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 19,20                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 20,65                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 22,10                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 23,50                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 25,30             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 16,00         | 1,00              | *                 | 19,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 18,025                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 19,100                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 20,22                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 21,67                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 23,12                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 24,52                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 26,32             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 16,50         | 1,00              | *                 | 20,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 19,005                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 20,080                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 21,20                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 22,65                      | 7,50 | 1,0           | 68,24             |                   |                            |
|               | 1,80              | 0,65              | 24,10                      | 8,00 | 1,0           | 72,74             |                   |                            |
|               | 2,00              | 0,65              | 25,50                      | 8,50 | 1,0           | 77,24             |                   |                            |
| 2,24          | 0,65              | 27,30             | 9,00                       | 1,0  | 81,74         |                   |                   |                            |
| 17,00         | 1,00              | *                 | 21,785                     | 4,00 | 1,0           | 33,14             |                   |                            |
|               |                   |                   |                            | 4,50 | 1,0           | 37,39             |                   |                            |
|               |                   |                   |                            | 5,00 | 1,0           | 41,64             |                   |                            |
|               |                   |                   |                            | 5,60 | 1,0           | 46,74             |                   |                            |
|               |                   |                   |                            | 6,00 | 1,0           | 50,99             |                   |                            |
|               | 1,12              | 0,5               | 20,025                     | 6,30 | 1,0           | 55,24             |                   |                            |
|               | 1,25              | 0,5               | 21,100                     | 6,60 | 1,0           | 59,49             |                   |                            |
|               | 1,40              | 0,5               | 22,22                      | 7,00 | 1,0           | 63,74             |                   |                            |
|               | 1,60              | 0,5               | 2                          |      |               |                   |                   |                            |

\* — 0,5 nominal thickness

**Table A.1 (6 of 7)**

| Nominal width<br>mm | Nominal thickness<br>mm | Radius-on corners<br>mm | Nominal cross-section area<br>mm <sup>2</sup> | Nominal width<br>mm | Nominal thickness<br>mm | Radius-on corners<br>mm | Nominal cross-section area<br>mm <sup>2</sup> |
|---------------------|-------------------------|-------------------------|-----------------------------------------------|---------------------|-------------------------|-------------------------|-----------------------------------------------|
| 9,50                | 2,50                    | 0,8                     | 23,20                                         | 11,20               | 1,70                    | 0,65                    | 18,68                                         |
|                     | 2,80                    | 0,8                     | 26,05                                         |                     | 1,80                    | 0,65                    | 19,80                                         |
|                     | 3,15                    | 0,8                     | 29,38                                         |                     | 1,90                    | 0,65                    | 20,92                                         |
|                     | 3,55                    | 0,8                     | 33,18                                         |                     | 2,00                    | 0,65                    | 22,04                                         |
|                     |                         |                         |                                               |                     | 2,12                    | 0,65                    | 23,38                                         |
|                     | 4,00                    | 1,0                     | 37,14                                         |                     | 2,24                    | 0,65                    | 24,73                                         |
|                     | 4,50                    | 1,0                     | 41,89                                         |                     |                         |                         |                                               |
|                     | 5,00                    | 1,0                     | 46,64                                         |                     | 2,36                    | 0,8                     | 25,88                                         |
|                     | 5,60                    | 1,0                     | 52,34                                         |                     | 2,50                    | 0,8                     | 27,45                                         |
|                     |                         |                         |                                               |                     | 2,65                    | 0,8                     | 29,13                                         |
|                     | 1,25                    | 0,5                     | 12,29                                         |                     | 2,80                    | 0,8                     | 30,81                                         |
|                     | 1,32                    | 0,5                     | 12,99                                         |                     | 3,00                    | 0,8                     | 33,05                                         |
|                     | 1,40                    | 0,5                     | 13,79                                         |                     | 3,15                    | 0,8                     | 34,73                                         |
|                     | 1,50                    | 0,5                     | 14,79                                         |                     | 3,35                    | 0,8                     | 36,97                                         |
|                     | 1,60                    | 0,5                     | 15,79                                         |                     | 3,55                    | 0,8                     | 39,21                                         |
| 10,00               |                         |                         |                                               | 11,80               |                         |                         |                                               |
|                     | 1,70                    | 0,65                    | 16,64                                         |                     | 3,75                    | 1,0                     | 41,14                                         |
|                     | 1,80                    | 0,65                    | 17,64                                         |                     | 4,00                    | 1,0                     | 43,94                                         |
|                     | 1,90                    | 0,65                    | 18,64                                         |                     | 4,25                    | 1,0                     | 46,74                                         |
|                     | 2,00                    | 0,65                    | 19,64                                         |                     | 4,50                    | 1,0                     | 49,54                                         |
|                     | 2,12                    | 0,65                    | 20,84                                         |                     | 4,75                    | 1,0                     | 52,34                                         |
|                     | 2,24                    | 0,65                    | 22,04                                         |                     | 5,00                    | 1,0                     | 55,14                                         |
|                     |                         |                         |                                               |                     | 5,30                    | 1,0                     | 58,50                                         |
|                     | 2,36                    | 0,8                     | 23,05                                         |                     | 5,60                    | 1,0                     | 61,86                                         |
|                     | 2,50                    | 0,8                     | 24,45                                         |                     |                         |                         |                                               |
|                     | 2,65                    | 0,8                     | 25,95                                         |                     | 1,60                    | 0,5                     | 18,67                                         |
|                     | 2,80                    | 0,8                     | 27,45                                         |                     |                         |                         |                                               |
|                     | 3,00                    | 0,8                     | 29,45                                         |                     | 1,80                    | 0,65                    | 20,88                                         |
|                     | 3,15                    | 0,8                     | 30,95                                         |                     | 2,00                    | 0,65                    | 23,24                                         |
|                     | 3,35                    | 0,8                     | 32,95                                         |                     | 2,24                    | 0,65                    | 26,07                                         |
|                     | 3,55                    | 0,8                     | 34,95                                         |                     |                         |                         |                                               |
|                     |                         |                         |                                               |                     | 2,50                    | 0,8                     | 28,95                                         |
|                     | 3,75                    | 1,0                     | 36,64                                         |                     | 2,80                    | 0,8                     | 32,49                                         |
|                     | 4,00                    | 1,0                     | 39,14                                         |                     | 3,15                    | 0,8                     | 36,62                                         |
|                     | 4,25                    | 1,0                     | 41,64                                         |                     | 3,55                    | 0,8                     | 41,34                                         |
|                     | 4,50                    | 1,0                     | 44,14                                         |                     |                         |                         |                                               |
|                     | 4,75                    | 1,0                     | 46,64                                         |                     | 4,00                    | 1,0                     | 46,34                                         |
|                     | 5,00                    | 1,0                     | 49,14                                         |                     | 4,50                    | 1,0                     | 52,24                                         |
|                     | 5,30                    | 1,0                     | 52,14                                         |                     | 5,00                    | 1,0                     | 58,14                                         |
|                     | 5,60                    | 1,0                     | 55,14                                         |                     | 5,60                    | 1,0                     | 65,22                                         |
| 10,60               | 1,40                    | 0,5                     | 14,63                                         | 12,50               | 1,60                    | 0,5                     | 19,79                                         |
|                     | 1,60                    | 0,5                     | 16,75                                         |                     |                         |                         |                                               |
|                     |                         |                         |                                               |                     | 1,70                    | 0,65                    | 20,89                                         |
|                     | 1,80                    | 0,65                    | 18,72                                         |                     | 1,80                    | 0,65                    | 22,14                                         |
|                     | 2,00                    | 0,65                    | 20,84                                         |                     | 1,90                    | 0,65                    | 23,39                                         |
|                     | 2,24                    | 0,65                    | 23,38                                         |                     | 2,00                    | 0,65                    | 24,64                                         |
|                     |                         |                         |                                               |                     | 2,12                    | 0,65                    | 26,14                                         |
|                     | 2,50                    | 0,8                     | 25,95                                         |                     | 2,24                    | 0,65                    | 27,64                                         |
|                     | 2,80                    | 0,8                     | 29,13                                         |                     |                         |                         |                                               |
|                     | 3,15                    | 0,8                     | 32,84                                         |                     | 2,36                    | 0,8                     | 28,95                                         |
|                     | 3,55                    | 0,8                     | 37,08                                         |                     | 2,50                    | 0,8                     | 30,70                                         |
|                     |                         |                         |                                               |                     | 2,65                    | 0,8                     | 32,58                                         |
|                     | 4,00                    | 1,0                     | 41,54                                         |                     | 2,80                    | 0,8                     | 34,45                                         |
|                     | 4,50                    | 1,0                     | 46,84                                         |                     | 3,00                    | 0,8                     | 36,95                                         |
|                     | 5,00                    | 1,0                     | 52,14                                         |                     | 3,15                    | 0,8                     | 38,83                                         |
|                     | 5,60                    | 1,0                     | 58,50                                         |                     | 3,35                    | 0,8                     | 41,33                                         |
| 11,20               |                         |                         |                                               |                     | 3,55                    | 0,8                     | 43,83                                         |
|                     | 1,40                    | 0,5                     | 15,47                                         |                     |                         |                         |                                               |
|                     | 1,50                    | 0,5                     | 16,59                                         |                     | 3,75                    | 1,0                     | 46,02                                         |
|                     | 1,60                    | 0,5                     | 17,71                                         |                     | 4,00                    | 1,0                     | 49,14                                         |
|                     |                         |                         |                                               |                     | 4,25                    | 1,0                     | 52,27                                         |

**Table A.1 (7 of 7)**

| Nominal width<br>mm | Nominal thickness<br>mm | Radius-on corners<br>mm | Nominal cross-section area<br>mm <sup>2</sup> | Nominal width<br>mm | Nominal thickness<br>mm | Radius-on corners<br>mm | Nominal cross-section area<br>mm <sup>2</sup> |
|---------------------|-------------------------|-------------------------|-----------------------------------------------|---------------------|-------------------------|-------------------------|-----------------------------------------------|
| 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                                         |                     | 2,50                    | 0,8                     | 36,95                                         |
|                     | 2,24                    | 0,65                    | 29,21                                         |                     | 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                                         |                     | 4,00                    | 1,0                     | 59,14                                         |
|                     | 3,55                    | 0,8                     | 46,31                                         |                     | 4,50                    | 1,0                     | 66,64                                         |
| 14,00               | 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                                         | 16,00               | 2,00                    | 0,65                    | 31,64                                         |
|                     | 5,60                    | 1,0                     | 73,06                                         |                     | 2,12                    | 0,65                    | 33,56                                         |
|                     | 1,80                    | 0,65                    | 24,84                                         |                     | 2,24                    | 0,65                    | 35,48                                         |
|                     | 1,90                    | 0,65                    | 26,24                                         |                     | 2,36                    | 0,8                     | 37,21                                         |
|                     | 2,00                    | 0,65                    | 27,64                                         |                     | 2,50                    | 0,8                     | 39,45                                         |
|                     | 2,12                    | 0,65                    | 29,32                                         |                     | 2,65                    | 0,8                     | 41,85                                         |
|                     | 2,24                    | 0,65                    | 31,00                                         |                     | 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                                         |                     | 3,75                    | 1,0                     | 59,14                                         |
|                     | 3,15                    | 0,8                     | 43,55                                         |                     | 4,00                    | 1,0                     | 63,14                                         |
|                     | 3,35                    | 0,8                     | 46,35                                         |                     | 4,25                    | 1,0                     | 67,14                                         |
|                     | 3,55                    | 0,8                     | 49,15                                         |                     | 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                                         |

| Nominal width | Nominal thickness | Corner radius | Nominal cross-section area | Nominal width | Nominal thickness | Corner radius | Nominal cross-section area |
|---------------|-------------------|---------------|----------------------------|---------------|-------------------|---------------|----------------------------|
| mm            | mm                | mm            | mm <sup>2</sup>            | mm            | mm                | mm            | mm <sup>2</sup>            |
| 2,00          | 0,80              | *             | 1,463                      | 2,50          | 1,18              | 0,5           | 2,735                      |
|               | 0,85              | *             | 1,545                      |               | 1,25              | 0,5           | 2,910                      |
|               | 0,90              | *             | 1,626                      |               | 1,32              | 0,5           | 3,085                      |
|               | 0,95              | *             | 1,706                      |               | 1,40              | 0,5           | 3,285                      |
|               | 1,00              | *             | 1,785                      |               | 1,50              | 0,5           | 3,535                      |
|               |                   |               |                            |               | 1,60              | 0,5           | 3,785                      |
|               | 1,06              | 0,5           | 1,905                      |               |                   |               |                            |
|               | 1,12              | 0,5           | 2,025                      |               | 1,70              | 0,65          | 3,887                      |
|               | 1,18              | 0,5           | 2,145                      |               | 1,80              | 0,65          | 4,137                      |
|               | 1,25              | 0,5           | 2,285                      | 2,65          | 0,80              | *             | 1,983                      |
|               | 1,32              | 0,5           | 2,425                      |               | 0,90              | *             | 2,211                      |
|               | 1,40              | 0,5           | 2,585                      |               | 1,00              | *             | 2,435                      |
| 2,12          | 0,80              | *             | 1,559                      |               |                   |               |                            |
|               | 0,90              | *             | 1,734                      |               | 1,12              | 0,5           | 2,753                      |
|               | 1,00              | *             | 1,905                      |               | 1,25              | 0,5           | 3,098                      |
|               |                   |               |                            |               | 1,40              | 0,5           | 3,495                      |
|               | 1,12              | 0,5           | 2,160                      |               | 1,60              | 0,5           | 4,025                      |
|               | 1,25              | 0,5           | 2,435                      |               |                   |               |                            |
|               | 1,40              | 0,5           | 2,753                      |               | 1,80              | 0,65          | 4,407                      |
| 2,24          | 0,80              | *             | 1,655                      | 2,80          | 0,80              | *             | 2,103                      |
|               | 0,85              | *             | 1,749                      |               | 0,85              | *             | 2,225                      |
|               | 0,90              | *             | 1,842                      |               | 0,90              | *             | 2,346                      |
|               | 0,95              | *             | 1,934                      |               | 0,95              | *             | 2,466                      |
|               | 1,00              | *             | 2,025                      |               | 1,00              | *             | 2,585                      |
|               |                   |               |                            |               |                   |               |                            |
|               | 1,06              | 0,5           | 2,160                      |               | 1,06              | 0,5           | 2,753                      |
|               | 1,12              | 0,5           | 2,294                      |               | 1,12              | 0,5           | 2,921                      |
|               | 1,18              | 0,5           | 2,429                      |               | 1,18              | 0,5           | 3,089                      |
|               | 1,25              | 0,5           | 2,585                      |               | 1,25              | 0,5           | 3,285                      |
|               | 1,32              | 0,5           | 2,742                      |               | 1,32              | 0,5           | 3,481                      |
|               | 1,40              | 0,5           | 2,921                      |               | 1,40              | 0,5           | 3,705                      |
|               | 1,50              | 0,5           | 3,145                      |               | 1,50              | 0,5           | 3,985                      |
|               | 1,60              | 0,5           | 3,369                      |               | 1,60              | 0,5           | 4,265                      |
| 2,36          | 0,80              | *             | 1,751                      | 3,00          | 1,70              | 0,65          | 4,397                      |
|               | 0,90              | *             | 1,950                      |               | 1,80              | 0,65          | 4,677                      |
|               | 1,00              | *             | 2,145                      |               | 1,90              | 0,65          | 4,957                      |
|               |                   |               |                            |               | 2,00              | 0,65          | 5,237                      |
|               | 1,12              | 0,5           | 2,429                      |               | 0,80              | *             | 2,263                      |
|               | 1,25              | 0,5           | 2,735                      |               | 0,90              | *             | 2,526                      |
|               | 1,40              | 0,5           | 3,089                      |               | 1,00              | *             | 2,785                      |
| 2,50          | 1,60              | 0,5           | 3,561                      |               |                   |               |                            |
|               | 0,80              | *             | 1,863                      |               | 1,12              | 0,5           | 3,145                      |
|               | 0,85              | *             | 1,970                      |               | 1,25              | 0,5           | 3,535                      |
|               | 0,90              | *             | 2,076                      |               | 1,40              | 0,5           | 3,985                      |
|               | 0,95              | *             | 2,181                      |               | 1,60              | 0,5           | 4,585                      |
|               | 1,00              | *             | 2,285                      |               |                   |               |                            |
|               |                   |               |                            |               | 1,80              | 0,65          | 5,037                      |
|               | 1,06              | 0,5           | 2,435                      |               | 2,00              | 0,65          | 5,637                      |
|               | 1,12              | 0,5           | 2,585                      |               |                   |               |                            |
|               |                   |               |                            |               |                   |               |                            |

\* 0,5 × nominal thickness