

# Bronze

## Chemical Composition

| Designation               |                          |                        | Chemical composition in % (mm) |         |         |        |        |         |         |         |         |         |                   |
|---------------------------|--------------------------|------------------------|--------------------------------|---------|---------|--------|--------|---------|---------|---------|---------|---------|-------------------|
| Classification of symbols | Numerical classification | European Standard (EN) | Min. Cu                        | Max. Fe | Max. Ni | Min. P | Max. P | Max. Pb | Min. Sn | Max. Sn | Min. Zn | Max. Zn | Others total max. |
| CuSn4                     | CW450K                   | EN 1652/1654           | Rest                           | 0.1     | 0.2     | 0.01   | 0.4    | 0.02    | 3.5     | 4.5     | -       | 0.2     | 0.2               |
| CuSn6                     | CW452K                   | EN 1652/1654           | Rest                           | 0.1     | 0.2     | 0.01   | 0.4    | 0.02    | 5.5     | 7.0     | -       | 0.2     | 0.2               |
| CuSn8                     | CW453K                   | EN 1652/1654           | Rest                           | 0.1     | 0.2     | 0.01   | 0.4    | 0.02    | 7.5     | 8.5     | -       | 0.2     | 0.2               |
| CuSn3Zn9                  | CW454K                   | EN 1654                | Rest                           | 0.1     | 0.2     | -      | 0.2    | 0.10    | 1.5     | 3.5     | 7.5     | 10.0    | 0.2               |

## Equivalents

| Classification of symbols | Numerical classification | European Standard (EN) | APPROXIMATE INTERNATIONAL EQUIVALENTS |             |            |
|---------------------------|--------------------------|------------------------|---------------------------------------|-------------|------------|
|                           |                          |                        | US (AISI)                             | Japan (JIS) | China (GB) |
| CuSn4                     | CW450K                   | EN 1652/1654           |                                       |             |            |
| CuSn6                     | CW452K                   | EN 1652/1654           | C51900                                | C 5191      |            |
| CuSn8                     | CW453K                   | EN 1652/1654           |                                       |             |            |
| CuSn3Zn9                  | CW454K                   | EN 1654                | C42500                                |             |            |

## Mechanical properties

**MECHANICAL PROPERTIES EN 1652 / EN 1654**

| Designations              |                          | Tensile strength Rm     |            | Conventional yield strength at 0.2% Rp <sub>0.2</sub> | Elongation                                                   |                                  | HV hardness |      |      |     |
|---------------------------|--------------------------|-------------------------|------------|-------------------------------------------------------|--------------------------------------------------------------|----------------------------------|-------------|------|------|-----|
|                           |                          | N/mm <sup>2</sup>       |            |                                                       | A <sub>50mm</sub> for thicknesses up to 2.5 mm (inclusive) % | A for thicknesses above 2.5 mm % |             |      |      |     |
| Material                  |                          | Metallurgical condition | min.       | max.                                                  | N/mm <sup>2</sup>                                            | min.                             | min.        | min. | max. |     |
| Classification of symbols | Numerical classification |                         |            |                                                       |                                                              |                                  |             |      |      |     |
| CuSn4                     | CW450K                   | R290                    | 290        | 390                                                   | (max. 190)                                                   | 40                               | 50          | -    | -    |     |
|                           |                          | H070                    | -          | -                                                     | -                                                            | -                                | -           | -    | 70   | 100 |
|                           |                          | R390                    | 390        | 490                                                   | (min. 210)                                                   | 11                               | 13          | -    | -    |     |
|                           |                          | H115                    | -          | -                                                     | -                                                            | -                                | -           | -    | 115  | 155 |
|                           |                          | R480                    | 480        | 570                                                   | (min. 420)                                                   | 4                                | 5           | -    | -    |     |
|                           |                          | H150                    | -          | -                                                     | -                                                            | -                                | -           | -    | 150  | 180 |
|                           |                          | R540                    | 540        | 930                                                   | (min. 490)                                                   | 3                                | -           | -    | -    |     |
|                           |                          | H170                    | -          | -                                                     | -                                                            | -                                | -           | -    | 170  | 200 |
|                           |                          | R610                    | 610        | -                                                     | (min. 540)                                                   | -                                | -           | -    | -    |     |
|                           |                          | H190                    | -          | -                                                     | -                                                            | -                                | -           | -    | 190  | -   |
|                           |                          | H350                    | 350        | 420                                                   | (min. 300)                                                   | 45                               | 55          | -    | -    |     |
|                           |                          | H080                    | -          | -                                                     | -                                                            | -                                | -           | -    | 80   | 110 |
| R420                      | 420                      | 520                     | (min. 260) | 17                                                    | 20                                                           | -                                | -           |      |      |     |
| H125                      | -                        | -                       | -          | -                                                     | -                                                            | -                                | 125         | 165  |      |     |

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| Designations              |                          | Tensile strength Rm     |      | Conventional yield strength at 0.2% Rp0.2 | Elongation                                                   |                                  | HV hardness |      |      |
|---------------------------|--------------------------|-------------------------|------|-------------------------------------------|--------------------------------------------------------------|----------------------------------|-------------|------|------|
|                           |                          | N/mm <sup>2</sup>       |      |                                           | A <sub>50mm</sub> for thicknesses up to 2.5 mm (inclusive) % | A for thicknesses above 2.5 mm % |             |      |      |
| Material                  |                          | Metallurgical condition | min. | max.                                      | N/mm <sup>2</sup>                                            | min.                             | min.        | min. | max. |
| Classification of symbols | Numerical classification |                         |      |                                           |                                                              |                                  |             |      |      |
| CuSn6                     | CW452K                   | R500                    | 500  | 590                                       | (min. 450)                                                   | 8                                | 10          | -    | -    |
|                           |                          | H160                    | -    | -                                         | -                                                            | -                                | -           | 160  | 190  |
|                           |                          | R560                    | 560  | 650                                       | (min. 500)                                                   | 5                                | -           | -    | -    |
|                           |                          | H180                    | -    | -                                         | -                                                            | -                                | -           | 180  | 210  |
|                           |                          | R640                    | 640  | 730                                       | (min. 600)                                                   | 3                                | -           | -    | -    |
|                           |                          | H200                    | -    | -                                         | -                                                            | -                                | -           | 200  | 230  |
|                           |                          | R720                    | 720  | -                                         | (min. 690)                                                   | -                                | -           | -    | -    |
|                           |                          | H220                    | -    | -                                         | -                                                            | -                                | -           | 220  | -    |
|                           |                          | R370                    | 370  | 450                                       | (max. 300)                                                   | 50                               | 60          | -    | -    |
|                           |                          | H90                     | -    | -                                         | -                                                            | -                                | -           | 90   | 120  |
| CuSn8                     | CW453K                   | R450                    | 450  | 550                                       | (min. 280)                                                   | 20                               | 23          | -    | -    |
|                           |                          | H135                    | -    | -                                         | -                                                            | -                                | -           | 136  | 175  |
|                           |                          | R640                    | 540  | 630                                       | (min. 460)                                                   | 13                               | 16          | -    | -    |
|                           |                          | H170                    | -    | -                                         | -                                                            | -                                | -           | 170  | 200  |
|                           |                          | R600                    | 600  | 690                                       | (min. 530)                                                   | 5                                | 7           | -    | -    |
|                           |                          | H190                    | -    | -                                         | -                                                            | -                                | -           | 190  | 220  |
|                           |                          | R660                    | 660  | 750                                       | (min. 620)                                                   | 3                                | -           | -    | -    |
|                           |                          | H210                    | -    | -                                         | -                                                            | -                                | -           | 210  | 240  |

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| Designations              |                          | Tensile strength Rm     |      | Conventional yield strength at 0.2% Rp0.2 | Elongation                                                    |                                  | HV hardness |      |      |     |
|---------------------------|--------------------------|-------------------------|------|-------------------------------------------|---------------------------------------------------------------|----------------------------------|-------------|------|------|-----|
|                           |                          | N/mm <sup>2</sup>       |      |                                           | A <sub>50</sub> mm for thicknesses up to 2.5 mm (inclusive) % | A for thicknesses above 2.5 mm % |             |      |      |     |
| Material                  |                          | Metallurgical condition | min. | max.                                      | N/mm <sup>2</sup>                                             | min.                             | min.        | min. | max. |     |
| Classification of symbols | Numerical classification |                         |      |                                           |                                                               |                                  |             |      |      |     |
|                           |                          | R740                    | 740  | -                                         | (min. 700)                                                    | 2                                | -           | -    | -    |     |
|                           |                          | H230                    | -    | -                                         | -                                                             | -                                | -           | 230  | -    |     |
| CuSn3Zn9                  | CW454K                   | R430                    | 430  | 520                                       | (330)                                                         | 6                                | 8           | -    | -    |     |
|                           |                          | H140                    | -    | -                                         | -                                                             | -                                | -           | 140  | 170  |     |
|                           |                          | R510                    | 510  | 600                                       | (430)                                                         | 3                                | 5           | -    | -    |     |
|                           |                          | H160                    | -    | -                                         | -                                                             | -                                | -           | -    | 160  | 190 |
|                           |                          | R580                    | 580  | 690                                       | (520)                                                         | -                                | 2           | -    | -    |     |
|                           |                          | H180                    | -    | -                                         | -                                                             | -                                | -           | -    | 180  | 210 |
|                           |                          | R660                    | 660  | -                                         | (610)                                                         | -                                | -           | -    | -    |     |
|                           |                          | H200                    | -    | -                                         | -                                                             | -                                | -           | -    | 200  | 8   |

NOTE 1- The numbers in brackets are not requirements of the standard and are given for information purposes only.

## Finishes

### **BARE MATERIAL**

The strips must be clean and free of detrimental defects, which must be specified by agreement between the customer and the supplier when requesting the quote and in the order. Normally, a small residual layer of lubricant is left on cold-rolled products, which is authorised unless otherwise specified.

### **ROUGHNESS EN 1654**

This must be agreed between the customer and the supplier when requesting the quote and confirming the order.

### **SURFACE CONDITION EN 13599**

The strips must be clean and free of detrimental defects, which must be specified by agreement between the customer and the supplier in the request for quotes and in the order. Normally, a small residual layer of lubricant is left on cold-drawn products, and this is acceptable unless otherwise specified. Discolouration is acceptable, provided that it is not detrimental to the use of the product .

## TIN COATINGS

Tin coatings for strips and copper strips and copper alloys:

| Type of coating | Standard |
|-----------------|----------|
| Electrolytic    | EN 14436 |
| Hot dip         | EN 13148 |

### ELECTROLYTIC EN 14436

#### ELECTROLYTIC TIN PROCESS TYPES AND TYPES OF TIN COATINGS AND TIN ALLOYS EN 14436

| Process                                            | Description                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Process for matt electrolytic coatings.            | This is the standard finish of a traditional electrolytic bath.                                                                                                                                                                                                                                                                                   |
| Process for bright electrolytic coatings.          | Coatings with a bright appearance are obtained using baths that contain one or more suitable brightening agents (brighteners). Their presence may not be desirable in subsequent melting or soft soldering processes. Furthermore, they may be beneficial for frictional properties (low friction or sliding contacts).                           |
| Process for flow-brightened electrolytic coatings. | Flow-brightened electrolytic coatings are obtained by heating a matt electrolytic coating above its melting point for a few seconds and then cooling it. The coatings preserve their sheen after cooling. In practice, flow brightening is not used for coatings with thicknesses above 5 µm (slip risk) or for coatings that are already bright. |

NOTE - Tin electrolytic coatings may experience a spontaneous growth of metallic filaments (the combined effect of humidity and mechanical stresses, for example). This phenomenon is highly undesirable for electrotechnical applications (risk of short circuit). The risk of this occurring can be reduced by flow brightening, using tin-lead alloy coatings or inserting a suitable sublayer.

## TYPES OF STEEL ELECTROLYTIC COATINGS AND TIN ALLOYS ACCORDING TO APPLICABLE EN 14436

| Coating thickness $\mu\text{m}$ |      | Types of coatings |               |                          |
|---------------------------------|------|-------------------|---------------|--------------------------|
| min.                            | max. | Sn bright (Snb)   | Sn matt (Snm) | Sn flow-brightened (Snf) |
|                                 | 1    | As                | N/A           | As                       |
| 0.8                             | 1.2  | As                | N/A           | *                        |
| 1.5                             | 2.5  | B                 | As            | B - R                    |
| 2                               | 4    | B - C             | R             | B - R                    |
| 3                               | 6    | B - C             | R             | N/A                      |
| 5                               |      | B - C             | R - C         | N/A                      |

NOTE 1: Applications:

- N/A: not applicable
- B: improves the suitability for soft soldering
- \*: reduces frictional forces
- C: corrosion resistance
- R: reduction of electrical resistance on a contact
- As: improved appearance

NOTE 2: These typical values are for information purposes and can be replaced by agreement between the customer and the supplier.

## COMPOSITION OF THE TIN AND TIN ALLOYS EN 14436

| Type of coating                           | Designation of the material | Composition in % (mass fraction) |               |
|-------------------------------------------|-----------------------------|----------------------------------|---------------|
|                                           |                             | Min. Sn                          | Others, total |
| Sn bright (Snb)                           | Sn99                        | 99                               | Remainder     |
| Sn matt (Snm) or Sn flow-brightened (Snf) | Sn99.50                     | 99.5                             | Remainder     |

## HOT DIP EN 13148

### APPEARANCE EN 13148. HOT DIP TINNING

Thicknesses (average values) and preferred thickness ranges for coatings:

| Thickness     | Thickness range |                   | Application                                                                      |
|---------------|-----------------|-------------------|----------------------------------------------------------------------------------|
| µm            | µm              |                   |                                                                                  |
| average value | from            | up to & including |                                                                                  |
| 1.45          | 0.7             | 2.2               | Preventing surface oxidation, decorative appearance, reducing frictional forces. |
| 2             | 1               | 3                 | Preventing surface oxidation, decorative appearance, reducing frictional forces. |
| 3.5           | 2               | 5                 | Preventing corrosion                                                             |
| 5             | 3               | 7                 | Extending the useful life                                                        |
| 7.5           | 5               | 10                | To aid soft soldering                                                            |
| 10            | 7               | 13                | To aid soft soldering                                                            |

The appearance depends on the type of liquid film cooling, the type of coating and the technique used to remove excess molten metal. The surface may have a bright or matt appearance, or a combination of both. The appearance of the coating does not affect its suitability. If there are special requirements for the appearance of the coating, these requirements must be agreed at the time of the quote and/or order.



## Tolerances

### THICKNESS TOLERANCES EN 13599 / EN 1652

| Nominal thickness  |     | Thickness tolerance for nominal widths according to EN 13599/ EN 1652 |                   |                 |                 |                  |                   |
|--------------------|-----|-----------------------------------------------------------------------|-------------------|-----------------|-----------------|------------------|-------------------|
| >                  | ≤   | 10 < and ≤ 200                                                        |                   | 200 < and ≤ 350 | 350 < and ≤ 700 | 700 < and ≤ 1000 | 1000 < and ≤ 1250 |
|                    |     | normal (Class A)                                                      | special (Class B) |                 |                 |                  |                   |
| 0.05 <sup>1)</sup> | 0.1 | ± 10% <sup>2)</sup>                                                   |                   | -               | -               | -                | -                 |
| 0.1                | 0.2 | ± 0.010                                                               | ± 0.007           | ± 0.015         | -               | -                | -                 |
| 0.2                | 0.3 | ± 0.015                                                               | ± 0.010           | ± 0.020         | ± 0.03          | ± 0.04           | -                 |
| 0.3                | 0.4 | ± 0.018                                                               | ± 0.012           | ± 0.022         | ± 0.04          | ± 0.05           | ± 0.07            |
| 0.4                | 0.5 | ± 0.020                                                               | ± 0.015           | ± 0.025         | ± 0.05          | ± 0.06           | ± 0.08            |
| 0.5                | 0.8 | ± 0.025                                                               | ± 0.018           | ± 0.030         | ± 0.06          | ± 0.07           | ± 0.09            |
| 0.8                | 1.2 | ± 0.030                                                               | ± 0.022           | ± 0.040         | ± 0.07          | ± 0.09           | ± 0.10            |
| 1.2                | 1.8 | ± 0.035                                                               | ± 0.028           | ± 0.06          | ± 0.08          | ± 0.10           | ± 0.11            |
| 1.8                | 2.5 | ± 0.045                                                               | ± 0.035           | ± 0.07          | ± 0.09          | ± 0.11           | ± 0.13            |
| 2.5                | 3.2 | ± 0.055                                                               | ± 0.040           | ± 0.08          | ± 0.10          | ± 0.13           | ± 0.17            |
| 3.2                | 4.0 | -                                                                     | -                 | ± 0.10          | ± 0.12          | ± 0.15           | ± 0.20            |
| 4.0                | 5.0 | -                                                                     | -                 | ± 0.12          | ± 0.14          | ± 0.17           | ± 0.23            |
| 5.0                | 6.0 | -                                                                     | -                 | ± 0.14          | ± 0.16          | ± 0.20           | ± 0.26            |

Measurements in mm.

1) Including the value 0.05.

2) ± 10% of the nominal thickness

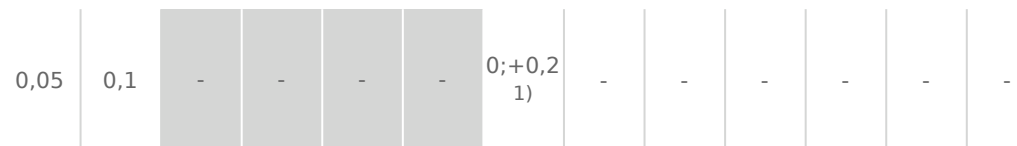
## THICKNESS TOLERANCE FOR COATED MATERIAL

EN 13148. The thickness of the tinned strip must meet the required combination of tolerances for the thickness of the strip (table above) and the range of thicknesses of the coatings ordered, for both sides.

EN 14436. The thickness of the strip prior to tinning must be in accordance with the approximate tolerances given in the table above. The thickness tolerance of the tinned strip must take into account the minimum and maximum thicknesses of the coating.

## WIDTH TOLERANCES OF THE STRIPS

| Nominal thickness t |     | Standard slitting tolerances for Metalle Schmidt <sup>2)</sup> |                           |                           |              | Width tolerances for nominal widths according to EN 13599/ EN 1654 |                                 |                                  |                                  |                                  |                                  |                                   |
|---------------------|-----|----------------------------------------------------------------|---------------------------|---------------------------|--------------|--------------------------------------------------------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|
| <                   | ≤   | 3-15                                                           | 15-50                     | 50-150                    | >150         | up to & including 50                                               | over 50 and up to 100 inclusive | over 100 and up to 200 inclusive | over 200 and up to 350 inclusive | over 350 and up to 500 inclusive | over 500 and up to 700 inclusive | over 700 and up to 1250 inclusive |
| 0,1                 | 0,2 | 0;+0,1<br>5 <sup>3)</sup>                                      | 0;+0,1<br>5 <sup>3)</sup> | 0;+0,1<br>5 <sup>3)</sup> | 0;+0,2<br>3) | 0;+0,2                                                             | 0;+0,3                          | 0;+0,4                           | 0;+0,6                           | 0;+1,0                           | 0;+1,5                           | 0;+2,0                            |
| 0,2                 | 0,4 | 0;+0,1<br>5                                                    | 0;+0,1<br>5               | 0;+0,1<br>5               | 0;+0,2       | 0;+0,2                                                             | 0;+0,3                          | 0;+0,4                           | 0;+0,6                           | 0;+1,0                           | 0;+1,5                           | 0;+2,0                            |
| 0,4                 | 1   | 0;+0,1<br>7                                                    | 0;+0,1<br>8               | 0;+0,2                    | 0;+0,2<br>4  | 0;+0,2                                                             | 0;+0,3                          | 0;+0,4                           | 0;+0,6                           | 0;+1,0                           | 0;+1,5                           | 0;+2,0                            |
| 1                   | 1,5 | 0;+0,2                                                         | 0;+0,2                    | 0;+0,2                    | 0;+0,3       | 0;+0,3                                                             | 0;+0,4                          | 0;+0,5                           | 0;+1,0                           | 0;+1,2                           | 0;+1,5                           | 0;+2,0                            |
| 1,5                 | 2   | on request                                                     | 0;+0,2<br>6               | 0;+0,3                    | 0;+0,3<br>2  | 0;+0,3                                                             | 0;+0,4                          | 0;+0,5                           | 0;+1,0                           | 0;+1,2                           | 0;+1,5                           | 0;+2,0                            |
| 2                   | 2,5 | on request                                                     | 0;+0,2<br>6               | 0;+0,3                    | 0;+0,3<br>2  | 0;+0,5                                                             | 0;+0,6                          | 0;+0,7                           | 0;+1,2                           | 0;+1,5                           | 0;+2,0                           | 0;+2,5                            |



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| Nominal thickness t |   | Standard slitting tolerances for Metalle Schmidt <sup>2)</sup> |            |             |             | Width tolerances for nominal widths according to EN 13599/ EN 1654 |                                 |                                  |                                  |                                  |                                  |                                   |     |   |            |            |             |             |        |        |        |        |        |        |        |  |
|---------------------|---|----------------------------------------------------------------|------------|-------------|-------------|--------------------------------------------------------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----|---|------------|------------|-------------|-------------|--------|--------|--------|--------|--------|--------|--------|--|
| <                   | ≤ | 3-15                                                           | 15-50      | 50-150      | >150        | up to & including 50                                               | over 50 and up to 100 inclusive | over 100 and up to 200 inclusive | over 200 and up to 350 inclusive | over 350 and up to 500 inclusive | over 500 and up to 700 inclusive | over 700 and up to 1250 inclusive | 2,5 | 3 | on request | on request | 0;+0,3<br>2 | 0;+0,3<br>5 | 0;+1,0 | 0;+1,1 | 0;+1,2 | 0;+1,5 | 0;+2,0 | 0;+2,5 | 0;+3,0 |  |
| 3                   | 5 | on request                                                     | on request | 0;+0,3<br>2 | 0;+0,3<br>5 | 0;+2,0                                                             | 0;+2,3                          | 0;+2,5                           | 0;+3,0                           | 0;+4,0                           | 0;+5,0                           | 0;+6,0                            |     |   |            |            |             |             |        |        |        |        |        |        |        |  |

Measurements in mm.

- 1) Including the value t=0.05
- 2) Other, closer dimensional tolerances are possible under a commercial agreement .
- 3) Including the value t=0,1

### LENGTH TOLERANCES 13599

Length tolerances of thick sheets, thin sheets and strips in cut lengths of up to 5000mm.

| Length              | Nominal thickness             | Length tolerance |
|---------------------|-------------------------------|------------------|
| Without rolling (M) | up to & including 25          | ±50              |
|                     | 5 and above                   | 0; +10           |
| Fixed length (F)    | over 5 and up to 10 inclusive | 0; +15           |

Measurements in mm.

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## EDGE CAMBER TOLERANCES

| Nominal width (W) | Edge curve tolerances under commercial agreement |             | Edge curve tolerances according to the EN 13599 Standard |                   |                    |                    |                               |
|-------------------|--------------------------------------------------|-------------|----------------------------------------------------------|-------------------|--------------------|--------------------|-------------------------------|
|                   | Maximum deviation<br>1000 mm<br>Thickness (t)    |             | Maximum deviation<br>1000 mm<br>Thickness (t)            |                   |                    |                    |                               |
|                   | t ≤ 1.20 mm                                      | t > 1.20 mm | t ≤ 0.5 mm                                               | 0.5 < t ≤ 1.20 mm | 1.20 < t ≤ 2.50 mm | 2.50 < t ≤ 3.20 mm | 3.20 < t ≤ 5.00 mm            |
| 3 ≤ W < 6         | 2.50                                             | 4.00        | -                                                        | -                 | -                  | -                  | -                             |
| 6 < W ≤ 10        | 2.00                                             | 3.00        | -                                                        | -                 | -                  | -                  | -                             |
| 10 < W ≤ 15       | 1.00                                             | 1.50        | 7.00 <sup>1)</sup>                                       | 10.00             | -                  | -                  | -                             |
| 15 < W ≤ 20       | 1.00                                             | 1.50        | 4.00                                                     | 6.00              | 8.00               | -                  | -                             |
| 20 < W ≤ 30       | 0.50                                             | 1.00        | 4.00                                                     | 6.00              | 8.00               | -                  | -                             |
| 30 < W ≤ 50       | 0.50                                             | 1.00        | 3.00                                                     | 4.00              | 6.00               | 7.00               | *under a commercial agreement |
| 50 < W ≤ 350      | 0.50                                             | 1.00        | 2.00                                                     | 3.00              | 4.00               | 5.00               |                               |
| 350 < W ≤ 1250    | -                                                | -           | 2.00                                                     | 3.00              | 4.00               | 5.00               |                               |

Measurements in mm.

1) Including nominal width 10mm.