# 5 Specification

# 5.1 Bare conductor

### 5.1.1 Quality

Cu-ETP according to EN 1977
$CuAg_{0.1}$ according to EN 1977
In general according to DIN 40500 part 4.
Tolerances according to IEC 60317-0-2 § 4.2, table 1
Radius according to IEC 60317-0-2 § 4.3, table 3

### 5.1.2 Basic dimensions

| | unit | min | max |
|---|---|---|---|
| Number of strands (n) | | 5 | 83 |
| Thickness (t) | [mm] | 1.00 | 3.15 |
| Width (w) | [mm] | 3.00 | 12.50 |
| Ratio w/t | | 2 | 7.5 |
| Cross section (q) | [$mm^2$] | 4 | 31 |

Table 1

### 5.1.3 Mechanical properties

- Proof stress $Rp_{0.2\%}$
  - standard 70 – 100 [MPa]
  - increased 90 – 300 [MPa] (nominal value to be indicated)

  Tolerances 0 and + 30%

  In case proof stress $Rp_{0.2\%} \geq 240$ [MPa] it is advised to use silverbearing copper ($CuAg_{0.1}$).

- Limits
  - Proof stress

| | 170 MPa < $Rp_{0.2\%}$ ≤ 220 MPa | | 220 MPa < $Rp_{0.2\%}$ ≤ 300 MPa | |
|---|---|---|---|---|
| | min | max | min | max |
| Thickness [mm] | 1.10 | 2.90 | 1.20 | 2.24 |
| Cross section [$mm^2$] | 5.00 | 30.0 | 7.00 | 20.0 |

Table 2

Other values to be requested.

  - Transposition pitch
    - Transposing factor > 7 and < 15 no limits
    - Transposing factor ≥ 5 and ≤ 7 $Rp_{0.2\%}$ < 260 [MPa]

    In all other cases please contact us.

    For transposition pitch > 15 the transposition pitch will be reduced to ensure bundle stability during winding

# 5.2 Enamel

### 5.2.1 Basecoat

- SL-N Polyvinylacetale (PVA) acc. to IEC 60317-18, temperature class 120 [°C].
- SL-T Polyamide-imide (PAI), temperature class 200 [°C].

### 5.2.2 Bondcoat (EP)

- EP Standard epoxy, semi cured.
- BCL BondCoatLite epoxy, semi cured.

### 5.2.3 Increase

- Increase due to basecoat $0.10\ ^{+0.02}_{-0.02}\ [mm]$
- Increase due to bondcoat $0.05\ ^{+0.01}_{-0.01}\ [mm]$
- Increase due to BCL thickness $0.04\ ^{+0.01}_{-0.01}\ [mm]$
- width $0.01\ ^{+0.01}_{-0.01}\ [mm]$

Other values to be requested.

# 5.3 Inter-column separator

### 5.3.1 Material

- PSP Pressboard, thermally upgraded, thickness 100, 200, 300 [µm].
- TH Kraft paper thermally upgraded high density, thickness 105 [µm].
- NMX Nomex® type 410, thickness 80 [µm].

A separator can only be fitted if $\frac{n-3}{2} \cdot (t + e) \geq 8$ (when thickness = 0.30; ≥ 10).

# 5.4 CTC insulation

### 5.4.1 Insulation materials

| Description | Code | Thickness [µm] | Description acc. to IEC 554-3-5 |
|---|---|---|---|
| Kraft low density | KL | 60, 80, 100 | Type 5A2-1, L of M |
| Kraft, high density, thermally upgraded | TH | 60, 80, 105 | Type 5A4-1, L of M<br>and treated acc. to the insuldur-process or equal |
| Kraft high density thermally upgraded micro-crepe paper. | CIP | 76 | |
| Open Structure Polyester Tape | OSB | 75,100 | |
| Kraft, high density thermally upgraded micro-crepe paper. | DEN | 76 | |
| Kraft high density thermally upgraded micro-crepe paper with epoxy-coating 1 | DPX | 90 | |
| Nomex® | NMX | 50 | |

Table 3

Method of covering the insulation.

[1] Only as outer layer

Standard method of covering : all papers are wrapped in the same direction.

- Inner layers
  individual layers indexed 30 – 50 [%] of paper width and butt-lapped (-0.2 to + 1.0 [mm]).
- Outer layers
  wrapped as a pair of interlocked papers 50 [%] register one to another.

Other methods must be indicated on the enquiry-form.


standard way of wrapping each layer wrapped overlapped

**Figure 1**

# 5.5 CTC dimensions

### 5.5.1 CTC Bundle dimensions including insulation

- Axial Width maximal 26 [mm]
- Radial Height maximal 90 [mm]

### 5.5.2 CTC Bundle dimensions excluding insulation

- Axial Width minimal 6.2 [mm]
- Radial Height minimal 4.2 [mm]

### 5.5.3 Calculation of the transposing factor

$$B_a = \frac{(W_d \cdot \pi)}{n} \; [mm] \qquad \text{factor} = \frac{B_a}{w}$$

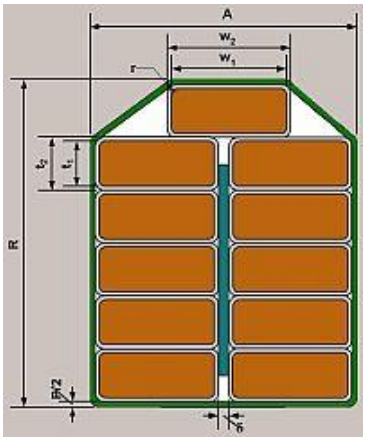


**Figure 2 CTC**

### 5.5.4 Calculation of the Axial and Radial CTC dimensions

| | |
|---|---|
| Nominal Axial Width (AW $_{nom}$) | $2 \cdot (w + e) + i + p \; [mm]$ |
| Maximum Axial Width | $AW_{nom} + 0.05 \; [mm]$ |
| Minimum Axial Width | $AW_{nom} - 0.10 \; [mm]$ |
| Nominal Radial Height (RH $_{nom}$) | $\frac{n+1}{2} \cdot (t + e) + p \; [mm]$ |
| Maximum Radial Height | $RH_{nom} + K \; [mm]$ |
| Minimum Radial Height | $\frac{n+1}{2} \cdot (t + e - 0.03) + p - \Delta p \; [mm]$ |

where

- n = number of strips in CTC
- t = thickness of the conductor
- w = width of the conductor
- e = total enamel increase,
  - PVA = 0.10 [mm],
  - PVA + EP = 0.16 [mm],
  - PVA + BCL = 0.14 [mm] (thickness)
- p = overall paper covering
- K = graded positive space allowance affecting the radial dimension, given in Table 4 Space allowance K

- Δp = tolerance on paper increase, given in table 2
- i = thickness inter-column separator, if any.
- Wd = Winding diameter
- Ba = transposing pitch

| n | w = 3.00 - 7.50 [mm] | | w = 8.00 - 12.00 [mm] | |
|---|---|---|---|---|
| | t = 1.00 - 1.80 [mm] | t = 1.90 - 3.20 [mm] | t = 1.60 - 2.50 [mm] | t = 2.60 - 3.20 [mm] |
| 5 | 0,2 | 0,3 | 0,3 | 0,4 |
| 7 | 0,2 | 0,3 | 0,4 | 0,5 |
| 9 | 0,3 | 0,3 | 0,4 | 0,6 |
| 11 | 0,3 | 0,4 | 0,5 | 0,6 |
| 13 | 0,3 | 0,4 | 0,5 | 0,7 |
| 15 | 0,3 | 0,5 | 0,6 | 0,7 |
| 17 | 0,3 | 0,5 | 0,6 | 0,8 |
| 19 | 0,4 | 0,5 | 0,7 | 0,9 |
| 21 | 0,4 | 0,6 | 0,7 | 1,0 |
| 23 | 0,4 | 0,6 | 0,8 | 1,0 |
| 25 | 0,4 | 0,6 | 0,8 | 1,1 |
| 27 | 0,5 | 0,6 | 0,9 | 1,1 |
| 29 | 0,5 | 0,6 | 1,0 | 1,2 |
| 31 | 0,5 | 0,7 | 1,0 | 1,3 |
| 33 | 0,5 | 0,7 | 1,0 | 1,3 |
| 35 | 0,5 | 0,7 | 1,0 | 1,3 |
| 37 | 0,5 | 0,7 | 1,0 | 1,3 |
| 39 | 0,5 | 0,7 | 1,0 | 1,3 |
| 41 | 0,6 | 0,8 | 1,1 | 1,4 |
| 43 | 0,6 | 0,8 | 1,1 | 1,4 |
| 45 | 0,8 | 1,3 | contact Smit Draad | |
| 47 | 0,8 | 1,3 | | |
| 49 | 0,8 | 1,3 | | |
| 51 | 0,8 | 1,3 | | |
| 53 | 0,8 | 1,3 | | |
| 55 | 0,8 | 1,3 | | |
| 57 | 1,1 | 1,4 | | |
| 59 | 1,1 | 1,4 | | |
| 61 | 1,1 | 1,4 | | |
| 63 | 1,1 | 1,4 | | |
| 65 | 1,1 | 1,4 | | |
| 67 | 1,1 | 1,4 | | |
| 69 | 1,1 | 1,4 | | |
| 71 | 1,1 | 1,4 | | |
| 73 | 1,1 | 1,4 | | |
| 75 | 1,1 | 1,4 | | |
| 77 | 1,1 | 1,4 | | |
| 79 | 1,1 | 1,4 | | |
| 81 | | | | |
| 83 | | | | |
| 85 | | | | |

Table 4 Space allowance K

| p = paperincrease [mm] | | Tolerance [%] | |
|---|---|---|---|
| from | up to incl. | + | - |
| 0.25 | 0.50 | 0 | -10 |
| 0.51 | 1.25 | 0 | -7.5 |
| 1.26 | | 0 | -5 |

Table 5 Tolerance on the increase due to covering according to IEC 60317-27

# 5.6 Tests

### 5.6.1 Measurement of the insulated CTC dimensions

The axial and radial dimensions of the CTC are measured with a special micrometer with a specific measuring pressure of 100 N/cm$^2$ .The anvils are approximately 6 mm.

### 5.6.2 Inter-strand short-circuit test

All drums are tested on inter-strand short-circuit with 100 VDC between each and every strand. Inter-strand short-circuits are not allowed.

# 5.7 Drums

CTC is wound and delivered on wooden drums.
Standard returnable drum types, see Table 6.

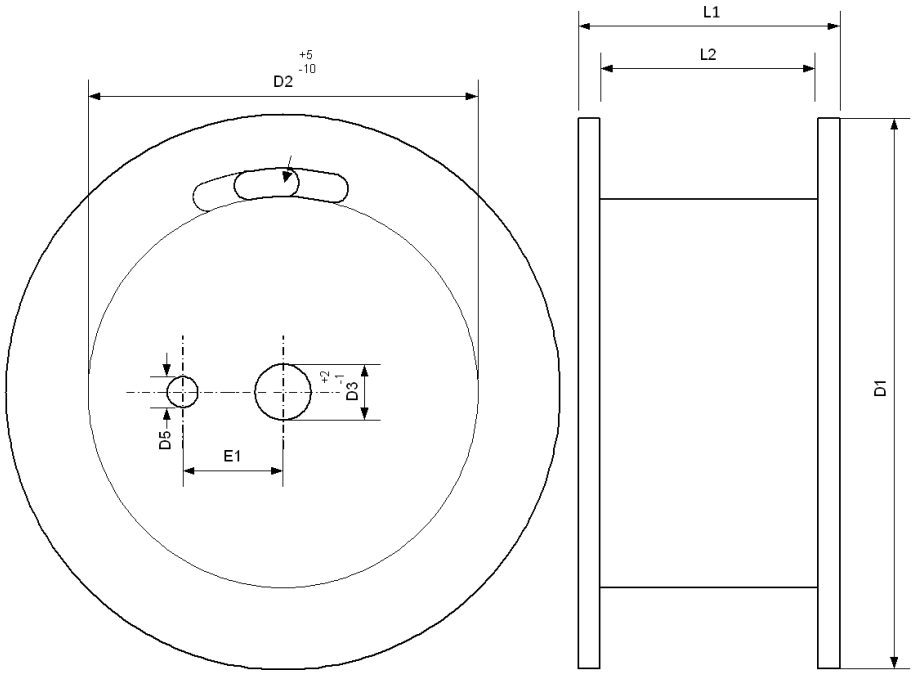


Figure 3

| Code | D1 [mm] | D2 [mm] | D3 [mm] | L1 [mm] | L2 [mm] | Cap. [kg] | Tare [kg] |
|---|---|---|---|---|---|---|---|
| HR34 | 1,000 | 500 | 82 | 320 | 250 | 650 | 45 |
| HR30 | 1,200 | 800 | 102 | 360 | 300 | 1000 | 80 |
| HR23 | 1,500 | 1,000 | 102 | 320 | 250 | 1,100 | 120 |

| Code | D1 [mm] | D2 [mm] | D3 [mm] | L1 [mm] | L2 [mm] | Cap. [kg] | Tare [kg] |
|---|---|---|---|---|---|---|---|
| HR19 | 1,500 | 1,000 | 102 | 480 | 330 | 1,400 | 155 |
| HR41 | 1,500 | 1,000 | 82 | 320 | 250 | 1,100 | 120 |
| HR42 | 1,600 | 1,000 | 82 | 460 | 310 | 1,500 | 155 |
| HR40 | 1,600 | 1,000 | 82 | 640 | 500 | 3000 | 210 |
| HR75 | 1,600 | 1,200 | 102 | 420 | 340 | 800 | 10 |
| HR22 | 1,600 | 1,000 | 102 | 640 | 487 | 2,500 | 210 |
| HR24 | 1,600 | 1,000 | 82 | 1000 | 800 | 4,500 | 10 |
| HR77 | 1,800 | 1,000 | 102 | 640 | 470 | 3,500 | 260 |
| HR29 | 1,900 | 1,000 | 102 | 640 | 500 | 4,500 | 350 |

Table 6

# 5.8 Packing

- Standard
  - A padded layer of paper is placed between each layer of conductor on the drum.
  - Stylex is wrapped on the outside layer of the CTC package on the drum to provide suitable protection.
- Special
  - The full CTC package is covered with polythene as protection against splash water.

# 5.9 Solder joints

Although making joints in single strand are prevented as much as possible, in rare occasions joint in single strands are made. The joints are made by special trained and qualified personnel.