BS EN 12166:2016

BSI Standards Publication

Copper and copper alloys — Wire for general purposes

bsi.

National foreword

This British Standard is the UK implementation of EN 12166:2016. It supersedes BS EN 12166:2011 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee NFE/34, Copper and copper alloys.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2016

ISBN 978 0 580 91265 8

ICS 77.150.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2016.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12166

July 2016

ICS 77.150.30

Supersedes EN 12166:2011

English Version

Copper and copper alloys - Wire for general purposes

Cuivre et alliages de cuivre - Fils pour usages généraux

Kupfer und Kupferlegierungen - Drähte zur allgemeinen Verwendung

This European Standard was approved by CEN on 9 April 2016.

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Ref. No. EN 12166:2016 E

Contents

Page

Figures

Tables

European foreword

This document (EN 12166:2016) has been prepared by Technical Committee CEN/TC 133 “Copper and copper alloys”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12166:2011.

Within its programme of work, Technical Committee CEN/TC 133 requested CEN/TC 133/WG 4 “Extruded and drawn products, forgings and scrap” to revise the following standard:

— EN 12166:2011, *Copper and copper alloys — Wire for general purposes*.

This document is one of a series of European Standards for the copper and copper alloy products rod, wire, profile and forgings. Other products are specified as follows:

— EN 12163, *Copper and copper alloys — Rod for general purposes*;

— EN 12164, *Copper and copper alloys — Rod for free machining purposes*;

— EN 12165, *Copper and copper alloys — Wrought and unwrought forging stock*;

— EN 12167, *Copper and copper alloys — Profiles and bars for general purposes*;

— EN 12168, *Copper and copper alloys — Hollow rod for free machining purposes*;

— EN 13601, *Copper and copper alloys — Copper rod, bar and wire for general electrical purposes*;

— EN 13602, *Copper and copper alloys — Drawn, round copper wire for the manufacture of electrical conductors*;

— EN 13605, *Copper and copper alloys — Copper profiles and profiled wire for electrical purposes*.

In comparison with EN 12166:2011, the following significant technical changes were made:

a) introduction of an optional procedure how to refer to restrictions to the chemical composition imposed by the 4 MS Common Composition List for materials used for products accepted for contact with drinking water;

b) provisions for surface quality added.

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Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The European Committee for Standardization (CEN) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the alloy CuZn21Si3P (CW724R) given in 6.1.

CEN takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has ensured the CEN that he is willing to negotiate licenses either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with CEN. Information may be obtained from:

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CEN and CENELEC maintain online lists of patents relevant to their standards. Users are encouraged to consult the lists for the most up to date information concerning patents (ftp://ftp.cencenelec.eu/EN/IPR/Patents/IPRdeclaration.pdf).

Due to developing legislation, the composition of a material may be restricted to the composition specified in this European Standard with respect to individual uses (e.g. for the use in contact with drinking water in some Member States of the European Union). These individual restrictions are not part of this European Standard. Nevertheless, for materials for which traditional and major uses are affected, these restrictions are indicated. The absence of an indication, however, does not imply that the material can be used in any application without any legal restriction.

1 Scope

This European Standard specifies the composition, property requirements and dimensional tolerances for copper alloy wire, finally produced by drawing, rolling or extruding, intended for general purposes, spring and fastener manufacturing applications.

The sampling procedures and the methods of test for verification of conformity to the requirements of this European Standard are also specified.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1173, *Copper and copper alloys - Material condition designation*

EN 1412, *Copper and copper alloys - European numbering system*

EN 1655, *Copper and copper alloys - Declarations of conformity*

EN 10204, *Metallic products - Types of inspection documents*

EN ISO 2624, *Copper and copper alloys - Estimation of average grain size (ISO 2624)*

EN ISO 6507-1, *Metallic materials - Vickers hardness test - Part 1: Test method (ISO 6507-1)*

EN ISO 6892-1, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1)*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
wire
wound product of uniform cross-section along its whole length

Note 1 to entry: Rectangles may have round or sharp corners.

3.2
deviation from circular form
difference between the maximum and the minimum diameters measured at any one cross-section of a round product

[SOURCE: EN 12163:2016, 3.2]

4 Designation

4.1 Material

4.1.1 General

The material is designated either by symbol or by number (see Tables 1 to 6).

4.1.2 Symbol

The material symbol designation is based on the designation system given in ISO 1190-1.

NOTE Although material symbol designations used in this standard might be the same as those in other standards using the designation system given in ISO 1190-1, the detailed composition requirements are not necessarily the same.

4.1.3 Number

The material number designation is in accordance with the system given in EN 1412.

4.2 Material condition

For the purposes of this standard, the following designations, which are in accordance with the system given in EN 1173, apply for the material condition:

M material condition for the product as manufactured, without specified mechanical properties;

R... material condition designated by the minimum value of tensile strength requirement for the product with mandatory tensile property requirements;

H... material condition designated by the minimum value of Vickers hardness requirement for the product with mandatory hardness requirements;

S (suffix) material condition for a product which is stress relieved.

G... material condition designated by the mid-range value of grain size requirement for the product with mandatory grain size requirements (Table 13).

NOTE The G... material condition is normally applicable only to round wires in the soft material condition made from alloys given in Tables 3, 4 and non-leaded alloys given in Table 2.

Exact conversion between material conditions designated R..., H... and G... is not possible.

Except when the suffix S is used, material condition is designated by only one of the above designations.

4.3 Product

The product designation provides a standardized pattern of designation from which a rapid and unequivocal description of a product can be conveyed in communication. It provides mutual comprehension at the international level with regard to products which meet the requirements of the relevant European Standard.

The product designation is no substitute for the full content of the standard.

The product designation for products to this standard shall consist of:

— denomination (Wire);

— number of this European Standard (EN 12166);

— material designation, either symbol or number (see Tables 1 to 6);

— DW for compliance in the chemical composition according to the 4 MS Common Composition List. This information is mandatory in the case in which the product is used for drinking water applications according to the 4 MS Common Composition List and not to be given in other cases;

— material condition designation (see 4.2 and Tables 7 to 13);

— cross-sectional shape (the following designations shall be used as appropriate: RND for round, SQR for square, RCT for rectangular, HEX for hexagonal, OCT for octagonal, PFL for profile);

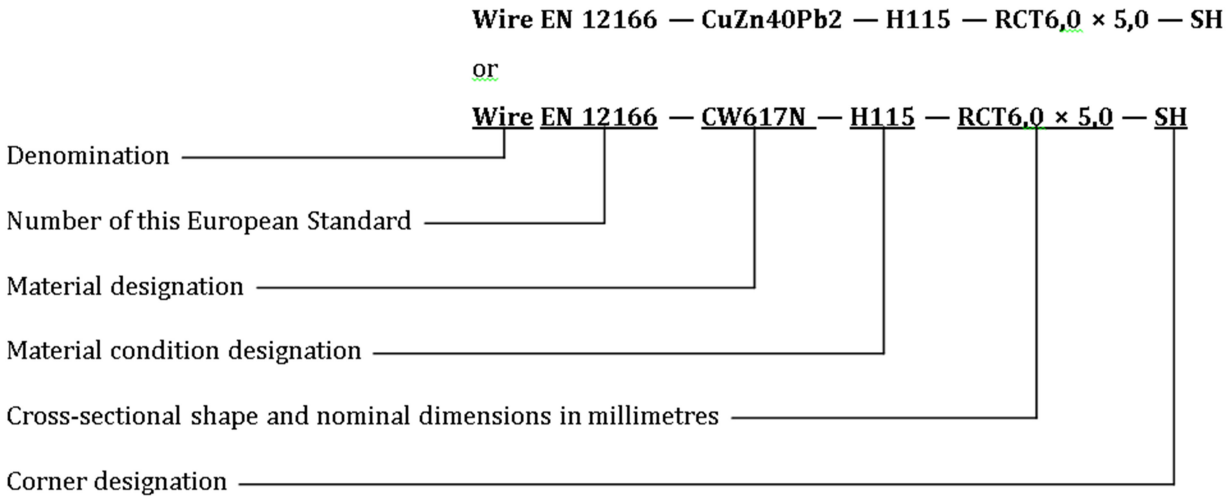
— nominal cross-sectional dimension(s) (or the number of the profile or a fully dimensioned and toleranced drawing);

— tolerance class for round, square or polygonal wire, (see Tables 14 and 15);

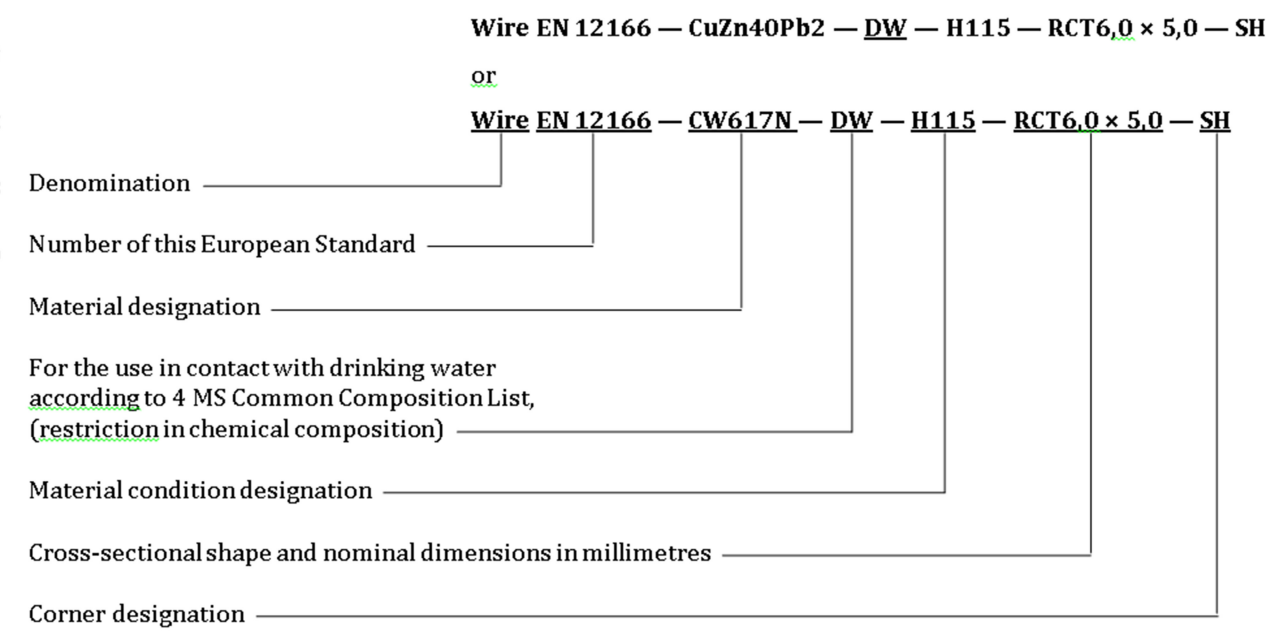
— for square, rectangular or polygonal wire, the corner shape (the following designations shall be used as appropriate: SH for sharp, RD for rounded), (see Table 17).

The derivation of a product designation is shown in the following examples.

EXAMPLE 1 Wire conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for standard applications in material condition H115, rectangular, nominal cross-sectional dimensions 6,0 mm × 5,0 mm, with sharp corners, will be designated as follows:



EXAMPLE 2 Wire conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for drinking water applications according to the 4 MS Common Composition List, in material condition H115, rectangular, nominal cross-sectional dimensions 6,0 mm × 5,0 mm, with sharp corners, will be designated as follows:



EXAMPLE 3 Wire conforming to this standard, in material designated either CuZn39Pb3 or CW614N, for standard applications in material condition R430, round, nominal diameter 6,0 mm, tolerance class B, will be designated as follows:

Wire EN 12166 **— CuZn39Pb3 — R430 — RND6,0B**

or

Wire EN 12166 **—** CW614**N — R430 — RND6,0B**

5 Ordering information

In order to facilitate the enquiry, order and confirmation of order procedures between the purchaser and the supplier, the purchaser shall state on his enquiry and order the following information:

a) mass of product required;

b) denomination (Wire);

c) number of this European Standard (EN 12166);

d) material designation (see Tables 1 to 6);

e) material condition designation (see 4.2 and Tables 7 to 13) if other than M;

f) DW for compliance in the chemical composition according to the 4 MS Common Composition List. This information is mandatory in the case in which the product is used for drinking water applications according to the 4 MS Common Composition List and not to be given in other cases;

g) cross-sectional shape;

h) nominal cross-sectional dimension(s) (diameter or width across-flats);

i) for round, square and regular polygonal wire, the tolerance class required, unless the tolerance class shall be left to the discretion of the supplier (see Tables 14 and 15); for profiles, the tolerances required (or a drawing with dimensions and tolerances);

j) for square or rectangular wire, whether 'sharp' or 'rounded' corners are required, unless the corner radii shall be left to the discretion of the supplier (see Table 17);

It is recommended that the product designation, as described in 4.3, is used for items b) to j).

In addition, the purchaser shall also state on the enquiry and order any of the following, if required:

k) for profiles, if the shape is such that the position of the cross-section within the coil, reel, spool or drum is of importance to the purchaser, this should be stated on the drawing (see Annex A for illustration);

l) for profiles, whether mechanical properties are required; if so, the method of test and the level of properties shall be agreed between the purchaser and the supplier;

m) whether the products shall be supplied in a thermally stress relieved material condition;

n) whether special surface quality is required (see 6.6);

o) whether a declaration of conformity is required (see 9.1);

p) whether an inspection document is required, and if so, which type (see 9.2);

q) whether there are any special requirements for marking, labelling or packaging including, if necessary, any limitation on dimensions or mass of coils, spools, reels or drums (see Clause 10).

EXAMPLE 1 Ordering details for 1 000 kg wire for general purposes conforming to EN 12166, in material designated either CuZn39Pb3 or CW614N, in material condition H115, rectangular, nominal cross-sectional dimensions 6,0 mm × 5,0 mm, with sharp corners, in 25 kg coils:

1 000 kg **Wire** **— CuZn39Pb3 — H115 — RCT 6,0 × 5,0 — SH**
EN 12166

— 25 kg coils

or

1 000 kg **Wire** **— CW614N — H115 — RCT 6,0 × 5,0 — SH**
EN 12166

— 25 kg coils

EXAMPLE 2 Ordering details for 5 000 kg wire for general purposes conforming to EN 12166, in material designated either CuZn40Pb2 or CW617N, for drinking water application according to the 4 MS Common Composition List, in material condition R430, round, nominal diameter 6,0 mm, tolerance class B, on 1 000 kg spools:

5 000 kg **Wire** **— CuZn40Pb2 — DW — R430 — RND6,0B**
EN 12166

— 1 000 kg spools

or

5 000 kg EN 12166	**Wire**	**— CW617N — DW — R430 — RND6,0B**
		— 1 000 kg spools

6 Requirements

6.1 Composition

The composition shall conform to the requirements for the appropriate material given in Tables 1 to 6.

Due to developing legislation, specific applications (see 4.3) may require restrictions in the chemical composition. In this case the limitations shall be specified in the ordering information [see Clause 5 list entry f)].

6.2 Mechanical properties

The tensile properties of R... material condition or the hardness properties of H... material condition shall conform to the appropriate requirements given in Tables 7 to 12. The tests shall be carried out in accordance with 8.2 or 8.3.

6.3 Grain size

The grain size of G... material condition shall conform to the appropriate ranges in Table 13. The tests shall be carried out in accordance with 8.4.

6.4 Dimensions and tolerances

6.4.1 Diameter or width across-flats

The diameter or width across-flats shall conform to the tolerances given in Tables 14 to 16.

NOTE The diameter of round wire is calculated as the mean of one or more pairs of measurements taken at right angles at the same cross-section of the wire.

6.4.2 Shape tolerances for round wire

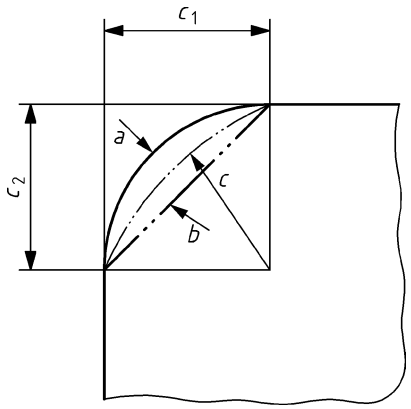
The deviation from circular form of round wire less than 3,0 mm diameter, shall not exceed half the range of the tolerance on diameter given in Table 14. The deviation from circular form of round wire equal to or greater than 3,0 mm diameter, shall not exceed the range of the tolerance on diameter given in Table 14.

6.4.3 Corner and edge geometry (wire with square and rectangular cross-section only)

The radii of the corners of wires shall conform to the requirements given in Table 17 for sharp or rounded corners.

For wires with the minimum width across-flats less than 3 mm the corners shall be calculated according to Figure 1. For wires with both widths across-flats equal to or greater than 3 mm, except in cases of dispute, the corners shall be measured directly, either by use of a gauge or an optical projector. In cases of dispute the method by optical projector shall be used.

Wire edges shall be smooth along the product length without discontinuity.



For sizes below 3 mm, the corner radius c is calculated from the formula:

$$c = \frac{c_1 + c_2}{2}$$

and may fall anywhere between fully circular 'a' and a chamfer 'b'.

Figure 1 — Calculation of corner radii

6.5 Joins

Welds made before the final drawing sequence are permissible. Joins made after the final drawing sequence are not permitted unless there has been agreement between the purchaser and the supplier on the method of performing and marking these joins.

6.6 Surface quality

The surfaces shall be clean and smooth. The wires may have a superficial film of drawing lubricant or, if annealed or thermally stress relieved, a superficial, dull, iridescent oxide film, securely adherent on the surfaces.

Discontinuous irregularities on the surfaces of the wires are permitted if they are within the dimensional tolerances.

Special requirements (e.g. pickling, degreasing, etc.) relating to the surface quality shall be agreed between the purchaser and the supplier [see Clause 5, list entry n)].

7 Sampling

7.1 General

When required (e.g. if necessary in accordance with specified procedures of a supplier's quality system, or when the purchaser requests inspection documents with test results, or for use in cases of dispute), an inspection lot shall be sampled in accordance with 7.2 and 7.3.

7.2 Analysis

The sampling rate shall be in accordance with Table 18. A test sample, depending on the analytical technique to be employed, shall be prepared from each sampling unit and used for the determination of the composition.

When preparing the test sample, care should be taken to avoid contaminating or overheating the test sample. Carbide tipped tools are recommended; steel tools, if used, should be made of magnetic material to assist in the subsequent removal of extraneous iron. If the test samples are in finely divided form (e.g. drillings, millings), they should be treated carefully with a strong magnet to remove any particles of iron introduced during preparation.

In cases of dispute concerning the results of analysis, the full procedure given in ISO 1811-2 should be followed.

Results may be used from analyses carried out at an earlier stage of manufacturing the product, e.g. at the casting stage, if the material identity is maintained and if the quality system of the manufacturer is certified e.g. as conforming to EN ISO 9001.

7.3 Tensile, hardness and grain size tests

The sampling rate shall be in accordance with Table 18. Sampling units shall be selected from the finished products. The test samples shall be cut from the sampling units. Test samples, and test pieces prepared from them, shall not be subjected to any further treatment other than any machining operations necessary in the preparation of the test pieces.

8 Test methods

8.1 Analysis

Analysis shall be carried out on the test pieces, or test portions, prepared from the test samples obtained in accordance with 7.2. Except in cases of dispute, the analytical methods used shall be at the discretion of the supplier. In cases of dispute, the methods of analysis to be used shall be agreed between the disputing parties. For expression of results, the rounding rules given in 8.6 shall be used.

8.2 Tensile test

The tensile test shall be performed on a coaxial test piece cut from a test sample obtained in accordance with 7.3. The test shall be carried out in accordance with the method given in EN ISO 6892-1. For expression of results, the rounding rules given in 8.6 shall be used.

For other than round wire, the tensile test results should be calculated using nominal cross-sectional areas.

NOTE Elongation requirements for wire of diameter:

a) less than 4 mm (A100 mm);

b) 4 mm up to and including 8 mm ($A_{11,3}$);

c) greater than 8 mm (A);

are based on original gauge lengths of 100 mm, 11,3 $\sqrt{S_0}$ mm and 5,65 $\sqrt{S_0}$ mm respectively, where S_o is the original cross-sectional area of the test piece in square millimetres.

Elongation values are not applicable to wire sizes less than 0,5 mm (or equivalent cross- sectional areas for polygonal wires).

8.3 Hardness test

Hardness shall be determined on test pieces cut from a test sample obtained in accordance with 7.3. The test shall be carried out in accordance with EN ISO 6507-1 and the indentation made:

a) for round wire 5 mm diameter and over, at a mid-radius position on a cross-section (see 2nd paragraph below);

b) for rectangular cross-sections, on the surface of the wire at the approximate mid-point of the major dimension;

c) for square or polygonal cross-sections, on the surface of the wire at the approximate mid-point of one of the flats;

d) for profiles, unless otherwise specified by the purchaser, on the cross-section at the mid-point of the thickest part.

In the case of round wire less than 5 mm diameter, the test should be performed at a position, and by a method, agreed between the supplier and the purchaser.

For the Vickers test according to EN ISO 6507-1 it is recommended to use a test force of 49,03 N, 98,07 N or 294,21 N.

8.4 Estimation of average grain size

When a purchaser specifies a grain size requirement [see Clause 5 list entry e)], the estimation of average grain size shall be carried out in accordance with EN ISO 2624.

8.5 Retests

If there is a failure of one, or more than one, of the tests in 8.1, 8.2, 8.3 or 8.4, two test samples from the same inspection lot shall be permitted to be selected for retesting the failed property (properties). One of these test samples shall be taken from the same sampling unit as that from which the original failed test piece was taken, unless that sampling unit is no longer available, or has been withdrawn by the supplier.

If the test pieces from both test samples pass the appropriate test(s), then the inspection lot represented shall be deemed to conform to the particular requirement(s) of this standard. If a test piece fails a test, the inspection lot represented shall be deemed not to conform to this standard.

8.6 Rounding of results

For the purpose of determining conformity to the limits specified in this standard an observed or a calculated value obtained from a test shall be rounded in accordance with the following procedure, which is based upon the guidance given in EN ISO 80000-1. It shall be rounded in one step to the same number of figures used to express the specified limit in this European Standard. Except for tensile strength and 0,2 % proof strength the rounding interval shall be 10 N/mm^2 [1)] and for elongation the value shall be rounded to the nearest 1 %.

The following rules shall be used for rounding:

a) if the figure immediately after the last figure to be retained is less than 5, the last figure to be retained shall be kept unchanged;

b) if the figure immediately after the last figure to be retained is equal to or greater than 5, the last figure to be retained shall be increased by one.

9 Declaration of conformity and inspection documentation

9.1 Declaration of conformity

When requested by the purchaser [see Clause 5 list entry m)] and agreed with the supplier, the supplier shall issue for the products the appropriate declaration of conformity in accordance with EN 1655.

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1) 1 N/mm^2 is equivalent to 1 MPa.

9.2 Inspection documentation

When requested by the purchaser [(see Clause 5 list entry n)] and agreed with the supplier, the supplier shall issue for the products the appropriate inspection document, in accordance with EN 10204.

10 Marking, packaging, labelling

Unless otherwise specified by the purchaser and agreed by the supplier, the marking, packaging and labelling shall be left to the discretion of the supplier [see Clause 5 list entry o)].

Table 1 — Composition of low alloyed copper alloys

Material designation		Composition % (mass fraction)																Density [a] g/cm^3
Symbol	Number	Element	Cu	Be	Co	Cr	Fe	Mn	Ni	P	Pb	Si	S	Te	Zn	Zr	others total	approx.
CuBe2	CW101C	min.	Rem.	1,8	—	—	—	—	—	—	—	—	—	—	—	—	—	8,3
		max.	—	2,1	0,3	—	0,2	—	0,3	—	—	—	—	—	—	—	0,5	
CuBe2Pb	CW102C	min.	Rem.	1,8	—	—	—	—	—	—	0,2	—	—	—	—	—	—	8,3
		max.	—	2,0	0,3	—	0,2	—	0,3	—	0,6	—	—	—	—	—	0,5	
CuCo1Ni1Be	CW103C	min.	Rem.	0,4	0,8	—	—	—	0,8	—	—	—	—	—	—	—	—	8,3
		max.	—	0,7	1,3	—	0,2	—	1,3	—	—	—	—	—	—	—	0,5	
CuCo2Be	CW104C	min.	Rem.	0,4	2,0	—	—	—	—	—	—	—	—	—	—	—	—	8,8
		max.	—	0,7	2,8	—	0,2	—	0,3	—	—	—	—	—	—	—	0,5	
CuCr1Zr	CW106C	min.	Rem.	—	—	0,5	—	—	—	—	—	—	—	—	—	0,03	—	8,8
		max.	—	—	—	1,2	0,08	—	—	—	—	0,1	—	—	—	0,3	0,2	
CuFe2P	CW107C	min.	Rem.	—	—	—	2,1	—	—	0,015	—	—	—	—	0,05	—	—	8,8
		max.	—	—	—	—	2,8	—	—	0,15	0,03	—	—	—	0,20	—	0,2	
CuNi1Si	CW109C	min.	Rem.	—	—	—	—	—	1,0	—	—	0,4	—	—	—	—	—	8,9
		max.	—	—	—	—	0,2	0,1	1,6	—	0,02	0,7	—	—	—	—	0,3	
CuNi2Si	CW111C	min.	Rem.	—	—	—	—	—	1,6	—	—	0,4	—	—	—	—	—	8,8
		max.	—	—	—	—	0,2	0,1	2,5	—	0,02	0,8	—	—	—	—	0,3	
CuSP	CW114C	min.	Rem.	—	—	—	—	—	—	0,003	—	—	0,2	—	—	—	—	8,9
		max.	—	—	—	—	—	—	—	0,012	—	—	0,7	—	—	—	0,1	

Material designation		Composition % (mass fraction)																Density [a] g/cm^3
Symbol	Number	Element	Cu	Be	Co	Cr	Fe	Mn	Ni	P	Pb	Si	S	Te	Zn	Zr	others total	approx.
CuTeP	CW118C	min.	Rem.	—	—	—	—	—	—	0,003	—	—	—	0,4	—	—	—	8,8
		max.	—	—	—	—	—	—	—	0,012	—	—	—	0,7	—	—	0,1	

Material designation		**Composition** % (mass fraction)																**Density** [a] g/cm^3
Symbol	Number	Element	Cu	Be	Co	Cr	Fe	Mn	Ni	P	Pb	Si	S	Te	Zn	Zr	others total	approx.
CuZr	CW120C	min.	Rem.	—	—	—	—	—	—	—	—	—	—	—	—	0,1	—	8,9
		max.	—	—	—	—	—	—	—	—	—	—	—	—	—	0,2	0,1	

[a] For information only.

Table 2 — Composition of copper-nickel-zinc alloys

Material designation		Composition % (mass fraction)									Density [a] g/cm^3
Symbol	Number	Element	Cu	Fe	Mn	Ni	Pb	Sn	Zn	others total	approx.
CuNi7Zn39Pb3Mn2	CW400J	min.	47,0	—	1,5	6,0	2,3	—	Rem.	—	8,5
		max.	50,0	0,3	3,0	8,0	3,3	0,2	—	0,2	
CuNi12Zn24	CW403J	min.	63,0	—	—	11,0	—	—	Rem.	—	8,7
		max.	66,0	0,3	0,5	13,0	0,03	0,03	—	0,2	
CuNi12Zn30Pb1	CW406J	min.	56,0	—	—	11,0	0,5	—	Rem.	—	8,6
		max.	58,0	0,3	0,5	13,0	1,5	0,2	—	0,2	
CuNi18Zn19Pb1	CW408J	min.	59,5	—	—	17,0	0,5	—	Rem.	—	8,7
		max.	62,5	0,3	0,7	19,0	1,5	0,2	—	0,2	
CuNi18Zn20	CW409J	min.	60,0	—	—	17,0	—	—	Rem.	—	8,7
		max.	63,0	0,3	0,5	19,0	0,03	0,03	—	0,2	

[a] For information only.

Table 3 — Composition of copper-tin alloys

Material designation		Composition % (mass fraction)									Density [a] g/cm^3
Symbol	Number	Element	Cu	Fe	Ni	P	Pb	Sn	Zn	others total	approx.
CuSn4	CW450K	min.	Rem.	—	—	0,01	—	3,5	—	—	8,9
		max.	—	0,1	0,2	0,4	0,02	4,5	0,2	0,2	
CuSn6	CW452K	min.	Rem.	—	—	0,01	—	5,5	—	—	8,8
		max.	—	0,1	0,2	0,4	0,02	7,0	0,2	0,2	
CuSn8	CW453K	min.	Rem.	—	—	0,01	—	7,5	—	—	8,8
		max.	—	0,1	0,2	0,4	0,02	8,5	0,2	0,2	

[a] For information only.

Table 4 — Composition of copper-zinc alloys

Material designation		**Composition**[b] % (mass fraction)									**Density** [a] g/cm^3
Symbol	Number	Element	Cu	Al	Fe	Ni	Pb	Sn	Zn	others total	approx.
CuZn10	CW501L	min.	89,0	—	—	—	—	—	Rem.	—	8,8
		max.	91,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn15	CW502L	min.	84,0	—	—	—	—	—	Rem.	—	8,8
		max.	86,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn20	CW503L	min.	79,0	—	—	—	—	—	Rem.	—	8,7
		max.	81,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn30	CW505L	min.	69,0	—	—	—	—	—	Rem.	—	8,5
		max.	71,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn36	CW507L	min.	**63,5**	**—**	**—**	**—**	**—**	**—**	**Rem.**	**—**	8,4
		max.	65,5	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn37	CW508L	min.	**62,0**	**—**	**—**	**—**	**—**	**—**	**Rem.**	**—**	8,4
		max.	64,0	0,05	0,1	0,3	0,1	0,1	—	0,1	
CuZn40	CW509L	min.	59,0	—	—	—	—	—	Rem.	—	8,4
		max.	61,5	0,05	0,2	0,3	0,2	0,2	—	0,2	
CuZn42	CW510L	min.	57,0	—	—	—	—	—	Rem.	—	8,4
		max.	59,0	0,05	0,3	0,3	0,2	0,3	—	0,2	

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List.

Table 5 — Composition of copper-zinc-lead alloys

Material designation		**Composition**[b] % (mass fraction)									**Density** [a] g/cm^3
Symbol	Number	Element	Cu	Al	Fe	Ni	Pb	Sn	Zn	others total	approx.
CuZn35Pb1	CW600N	min.	62,5	—	—	—	0,8	—	Rem.	—	8,5
		max.	64,0	0,05	0,1	0,3	1,6	0,1	—	0,1	
CuZn35Pb2	CW601N	min.	62,0	—	—	—	1,6	—	Rem.	—	8,5
		max.	63,5	0,05	0,1	0,3	2,5	0,1	—	0,1	
CuZn36Pb3	CW603N	min.	60,0	—	—	—	2,5	—	Rem.	—	8,5
		max.	62,0	0,05	0,3	0,3	3,5	0,2	—	0,2	
CuZn37Pb2	CW606N	min.	61,0	—	—	—	1,6	—	Rem.	—	8,4
		max.	62,0	0,05	0,2	0,3	2,5	0,2	—	0,2	
CuZn38Pb2	CW608N	min.	60,0	—	—	—	1,6	—	Rem.	—	8,4
		max.	61,0	0,05	0,2	0,3	2,5	0,2	—	0,2	
CuZn39Pb0,5	CW610N	min.	59,0	—	—	—	0,2	—	Rem.	—	8,4
		max.	60,5	0,05	0,2	0,3	0,8	0,2	—	0,2	
CuZn39Pb2	CW612N	min.	59,0	—	—	—	1,6	—	Rem.	—	8,4
		max.	60,0	0,05	0,3	0,3	2,5	0,3	—	0,2	
CuZn39Pb3	CW614N	min.	57,0	—	—	—	2,5	—	Rem.	—	8,4
		max.	59,0	0,05	0,3	0,3	3,5	0,3	—	0,2	
CuZn40Pb2	CW617N	min.	57,0	—	—	—	1,6	—	Rem.	—	8,4
		max.	59,0	0,05	0,3	0,3	2,5	0,3	—	0,2	

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List.

Table 6 — Composition of complex copper-zinc alloys

Material designation			Composition[b] % (mass fraction)											Density[a] g/cm^3
Symbol	Number	Element	Cu	Al	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	others total	approx.
CuZn36Sn1Pb	CW712R	min.	61,0	—	—	—	—	—	0,2	—	1,0	Rem.	—	8,3
		max.	63,0	—	0,1	—	0,2	—	0,6	—	1,5	—	0,2	
CuZn40Mn1Pb1	CW720R	min.	57,0	—	—	0,5	—	—	1,0	—	—	Rem.	—	8,3
		max.	59,0	0,2	0,3	1,5	0,6	—	2,0	0,1	0,3	—	0,3	
CuZn21Si3P	CW724R	min.	75,0	—	—	—	—	0,02	—	2,7	—	Rem.	—	8,3
		max.	77,0	0,05	0,3	0,05	0,2	0,10	0,10	3,5	0,3	—	0,2	

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List.

Table 7 — Mechanical properties of wire of low alloyed copper alloys

Designations			Diameter[a] mm		Tensile strength R_m N/mm^2 (MPa)	0,2 % proof strength $R_{p\,0,2}$ N/mm^2 (MPa)	Elongation			Hardness HV	
Material		Material condition					$A_{100\,mm}$ %	$A_{11,3}$ %	A %		
Symbol	Number		from	up to and including	min.	min.	min.	min.	min.	min.	max.
CuBe2 CuBe2P	CW101C CW102C	M	All		As manufactured						
		R1150	0,2	10	1 150	1 000	—	—	2	—	—
		H350	1,5	10	—	—	—	—	—	350	420
		R1300	0,2	10	1 300	1 100	—	—	2	—	—
		H370	1,5	10	—	—	—	—	—	370	440
CuCo1Ni1Be CuCo2Be	CW103C CW104C	M	All		As manufactured						
		R680	1	10	680	550	3	6	10	—	—
		H230	1,5	10	—	—	—	—	—	230	290
		R730	1	10	730	610	2	5	8	—	—
		H240	1,5	10	—	—	—	—	—	240	330

Designations			**Diameter** [a]		**Tensile strength**	**0,2 % proof strength**	**Elongation**			**Hardness**	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)	$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	min.	min.	min.	min.	max.
CuCr1Zr	CW106C	M	All		As manufactured						
		R370	2	10	370	250	8	12	16	—	—
		H125	2	10	—	—	—	—	—	125	170
		R430	2	10	430	350	5	8	10	—	—
		H145	2	10	—	—	—	—	—	145	185
		R470	2	10	470	420	3	6	8	—	—
		H160	2	10	—	—	—	—	—	160	190
CuFe2P	CW107C	M	All		As manufactured						
		R300	1,5	12	300	110	17	20	23	—	—
		H050	1,5	12	—	—	—	—	—	50	100
		R400	0,3	8	400	350	6	7	—	—	—
		H110	1,5	8	—	—	—	—	—	110	140
		R500	0,1	3	500	450	2	—	3	—	—
		H150	1,5	3	—	—	—	—	—	150	180
CuNi1Si	CW109C	M	All		As manufactured						
		R440	1,5	15	440	300	6	8	16	—	—
		H130	1,5	15	—	—	—	—	—	130	190
		R540	1,5	15	540	470	4	6	12	—	—
		H150	1,5	15	—	—	—	—	—	150	200
		R590	1,5	12	590	540	3	5	10	—	—
		H170	1,5	12	—	—	—	—	—	170	220
CuNi2Si	CW111C	M	All		As manufactured						
		R550	1,5	15	550	430	5	8	15	—	—
		H160	1,5	15	—	—	—	—	—	160	210
		R600	1,5	15	600	520	4	6	10	—	—
		H175	1,5	15	—	—	—	—	—	175	220
		R640	1,5	12	640	590	3	5	8	—	—
		H190	1,5	12	—	—	—	—	—	190	250

Designations			**Diameter** [a]		**Tensile strength**	**0,2 % proof strength**	**Elongation**			**Hardness**	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)	$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	min.	min.	min.	min.	max.
CuSP CuTeP	CW114C CW118C	M	All		As manufactured						
		R250	1,5	12	250	180	2	4	7	—	—
		H090	1,5	12	—	—	—	—	—	90	130
		R300	1,5	12	300	240	—	3	5	—	—
		H110	1,5	12	—	—	—	—	—	110	140
		R360	1,5	10	360	300	—	—	—	—	—
		H120	1,5	10	—	—	—	—	—	120	—
CuZr	CW120C	M	All		As manufactured						
		R250	0,1	12	250	170	8	15	20	—	—
		H080	1,5	12	—	—	—	—	—	80	120
		R280	0,1	12	280	210	6	12	15	—	—
		H095	1,5	12	—	—	—	—	—	95	135
		R350	0,1	10	350	260	5	10	12	—	—
		H125	1,5	10	—	—	—	—	—	125	165

[a] Or equivalent cross-sectional area for polygonal wire.

Table 8 — Mechanical properties of wire of copper-nickel-zinc alloys

Designations			Diameter [a]		Tensile strength	0,2 % proof strength		Elongation			Hardness	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuNi7Zn39Pb3Mn2	CW400J	M	All		As manufactured							
		H115	1,5	12	—	—	—	—	—	—	115	—
		R500	1,5	12	500	350	—	8	10	12	—	—
		H130	1,5	12	—	—	—	—	—	—	130	170
		R600	1,5	12	600	400	—	2	3	5	—	—
		H165	1,5	12	—	—	—	—	—	—	165	200
		R700	1,5	5	700	500	—	—	—	—	—	—
		H190	1,5	5	—	—	—	—	—	—	190	—
CuNi12Zn24	CW403J	M	All		As manufactured							
		R380	1,5	20	380	—	290	28	33	38	—	—
		H090	1,5	20	—	—	—	—	—	—	90	130
		R450	1,5	12	450	200	—	8	10	12	—	—
		H130	1,5	12	—	—	—	—	—	—	130	160
		R540	0,1	10	540	400	—	2	3	5	—	—
		H170	1,5	10	—	—	—	—	—	—	170	200
		R640	0,1	4	640	500	—	—	—	—	—	—
		H200	1,5	4	—	—	—	—	—	—	200	—
		R800	0,1	1,5	800	700	—	—	—	—	—	—
		H220	—	1,5	—	—	—	—	—	—	220	—
CuNi12Zn30Pb1 CuNi18Zn19Pb1	CW406J CW408J	M	All		As manufactured							
		R420	1,5	12	420	260	—	12	16	20	—	—
		H115	1,5	12	—	—	—	—	—	—	115	155
		R520	1,5	10	520	420	—	3	5	6	—	—
		H135	1,5	10	—	—	—	—	—	—	135	165
		R650	1,5	8	650	580	—	—	—	—	—	—
		H160	1,5	8	—	—	—	—	—	—	160	190

Designations			**Diameter** [a]		**Tensile strength**	**0,2 % proof strength**		**Elongation**			**Hardness**	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuNi18Zn20	CW409J	M	All		As manufactured							
		R400	1,5	20	400	—	290	25	30	35	—	—
		H105	1,5	20	—	—	—	—	—	—	105	145
		R480	0,1	12	480	250	—	7	9	11	—	—
		H145	1,5	12	—	—	—	—	—	—	145	185
		R580	0,1	10	580	400	—	2	3	5	—	—
		H180	1,5	10	—	—	—	—	—	—	180	220
		R660	0,1	4	660	550	—	—	—	—	—	—
		H210	1,5	4	—	—	—	—	—	—	210	—
		R800	0,1	1,5	800	750	—	—	—	—	—	—
		H230	—	1,5	—	—	—	—	—	—	230	—

[a] Or equivalent cross-sectional area for polygonal wire.

Table 9 — Mechanical properties of wire of copper-tin alloys

Designations			**Diameter** [a]		**Tensile strength**	**0,2 % proof strength**		**Elongation**			**Hardness**	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuSn4	CW450K	M	All		As manufactured							
		R330	1,5	20	330	—	220	35	40	45	—	—
		H085	1,5	20	—	—	—	—	—	—	85	115
		R420	0,1	12	420	220	—	20	25	30	—	—
		H125	1,5	12	—	—	—	—	—	—	125	155
		R520	0,1	8	520	380	—	5	6	—	—	—
		H150	1,5	8	—	—	—	—	—	—	150	185
		R650	0,1	4	650	500	—	—	—	—	—	—
		H210	1,5	4	—	—	—	—	—	—	210	
		R850	0,1	1,5	850	750	—	—	—	—	—	—
		H230	—	1,5	—	—	—	—	—	—	230	—
CuSn6	CW452K	M	All		As manufactured							
		R340	1,5	20	340	—	270	35	40	45	—	—
		H085	1,5	20	—	—	—	—	—	—	85	115
		R420	0,1	12	420	220	—	20	25	30	—	—
		H125	1,5	12	—	—	—	—	—	—	125	165
		R520	0,1	8	520	400	—	3	5	—		
		H155	1,5	8	—	—	—	—	—	—	155	190
		R700	0,1	4	700	600	—	—	—	—		
		H190	1,5	4	—	—	—	—	—	—	190	225
		R900	0,1	1,5	900	800	—	—	—	—	—	—
		H245	—	—	—	—	—	—	—	—	245	—

Designations			**Diameter** [a]		**Tensile strength**	**0,2 % proof strength**		**Elongation**			**Hardness**	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuSn8	CW453K	M	All		As manufactured							
		R390	0,1	12	390	—	280	35	40	45	—	—
		H090	1,5	12	—	—	—	—	—	—	90	130
		R450	0,1	12	450	280	—	18	22	26	—	—
		H140	1,5	12	—	—	—	—	—	—	140	170
		R550	0,1	12	550	400	—	10	12	15	—	—
		H170	1,5	12	—	—	—	—	—	—	170	200
		R620	0,1	8	620	500	—	4	6	—	—	—
		H185	1,5	8	—	—	—	—	—	—	185	—
		R750	0,1	4	750	680	—	—	—	—	—	—
		H220	1,5	4	—	—	—	—	—	—	220	—
		R920	0,1	1,5	920	800	—	—	—	—	—	—
		H265	—	1,5	—	—	—	—	—	—	265	—

[a] Or equivalent cross-sectional area for polygonal wire.

Table 10 — Mechanical properties of wire of copper-zinc alloys

Designations			Diameter [a]		Tensile strength	0,2 % proof strength		Elongation			Hardness	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A_{100} mm %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn10	CW501L	M	All		As manufactured							
		R240	4	20	240	—	150	43	45	47	—	—
		H050	4	20	—	—	—	—	—	—	50	100
		R320	1,5	20	320	220	—	20	23	25	—	—
		H095	1,5	20	—	—	—	—	—	—	95	125
		R380	0,5	10	380	280	—	10	11	12	—	—
		H115	1,5	10	—	—	—	—	—	—	115	155
		R440	0,5	6	440	330	—	4	5	—	—	—
		H135	1,5	6	—	—	—	—	—	—	135	180
		R530	0,5	4	530	450	—	—	—	—	—	—
		H160	1,5	4	—	—	—	—	—	—	160	—
CuZn15	CW502L	M	All		As manufactured							
		R260	4	20	260	—	170	33	35	38	—	—
		H060	4	20	—	—	—	—	—	—	60	120
		R340	1,5	20	340	200	—	18	20	22		
		H105	1,5	20	—	—	—	—	—	—	105	135
		R430	0,5	5	430	350	—	6	8	—	—	—
		H135	1,5	5	—	—	—	—	—	—	135	175
		R530	0,5	3	530	450	—	3	—	—	—	—
		H155	1,5	3	—	—	—	—	—	—	155	—
CuZn20	CW503L	M	All		As manufactured							
		R260	4	20	260		170	40	42	45	—	—
		H065	4	20	—	—	—	—	—	—	65	105
		R360	1,5	20	360	210	—	16	18	20	—	—
		H105	1,5	20	—	—	—	—	—	—	105	140
		R450	0,5	5	450	300	—	5	6	—	—	—

Designations			**Diameter** [a]		**Tensile strength**	**0,2 % proof strength**		**Elongation**			**Hardness**	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A_{100} mm %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
		H140	1,5	5	—	—	—	—	—	—	140	200
		R540	0,1	3	540	450	—	2	—	—	—	—
		H165	1,5	3	—	—	—	—	—	—	165	—

Designations			**Diameter** [a]		**Tensile strength**	**0,2 % proof strength**		**Elongation**			**Hardness**	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A_{100} mm %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn30	CW505L	M	All		As manufactured							
		R280	4	20	280	—	250	37	40	43	—	—
		H070	4	20	—	—	—	—	—	—	70	120
		R370	1,5	20	370	230	—	12	14	16	—	—
		H110	1,5	20	—	—	—	—	—	—	110	140
		R460	0,5	5	460	310	—	4	7	—	—	—
		H140	1,5	5	—	—	—	—	—	—	140	—
		R550	0,1	3	550	450	—	3	—	—	—	—
		H165	1,5	3	—	—	—	—	—	—	165	—
CuZn36 CuZn37	CW507L CW508L	M	All		As manufactured							
		R290	0,5	20	290	—	230	30	40	45	—	—
		H055	1,5	20	—	—	—	—	—	—	55	110
		R370	0,5	20	370	240	—	10	12	14	—	—
		H095	1,5	20	—	—	—	—	—	—	95	140
		R460	0,5	5	460	330	—	4	6	—	—	—
		H115	1,5	5	—	—	—	—	—	—	115	155
		R550	0,5	4	550	450	—	2	5	—	—	—
		H130	1,5	4	—	—	—	—	—	—	130	170
		R700	0,5	4	700	550	—	—	—	—	—	—
		H160	1,5	4	—	—	—	—	—	—	160	—
CuZn40	CW509L	M	All		As manufactured							
		R360	0,5	20	360	—	300	10	15	20	—	—
		H080	1,5	20	—	—	—	—	—	—	80	110
		R410	0,5	14	410	220	—	8	10	12	—	—
		H100	1,5	14	—	—	—	—	—	—	100	160
		R500	0,5	8	500	350	—	2	5	—	—	—
		H130	1,5	8	—	—	—	—	—	—	130	—

Designations			**Diameter** [a]		**Tensile strength**	**0,2 % proof strength**		**Elongation**			**Hardness**	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\ 0,2}$ N/mm^2 (MPa)		A_{100} mm %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn42	CW510L	M	All		As manufactured							
		R360	6	20	360	—	320	—	15	20	—	—
		H095	6	20	—	—	—	—	—	—	95	130
		R430	0,5	14	430	220	—	6	8	10	—	—
		H115	1,5	14	—	—	—	—	—	—	115	170
		R500	0,5	8	500	350	—	2	5	—	—	—
		H145	1,5	8	—	—	—	—	—	—	145	

[a] Or equivalent cross-sectional area for polygonal wire.

Table 11 — Mechanical properties of wire of copper-zinc-lead alloys

Designations			Diameter[a]		Tensile strength	0,2 % proof strength		Elongation			Hardness	
Material		Material condition	mm		R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HV	
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn35Pb1 CuZn35Pb2 CuZn36Pb3 CuZn37Pb2	CW600N CW601N CW603N CW606N	M	All		As manufactured							
		R340	0,5	20	340	—	280	10	15	20	—	—
		H080	1,5	20	—	—	—	—	—	—	80	130
		R400	0,5	14	400	200	—	4	8	12	—	—
		H100	1,5	14	—	—	—	—	—	—	100	150
		R480	0,5	8	480	350	—	2	5	—	—	—
		H135	1,5	8	—	—	—	—	—	—	135	—
CuZn38Pb2 CuZn39Pb0,5 CuZn39Pb2	CW608N CW610N CW612N	M	All		As manufactured							
		R360	0,5	20	360	—	300	10	15	20	—	—
		H080	1,5	20	—	—	—	—	—	—	80	110
		R410	0,5	14	410	220	—	8	10	12	—	—
		H100	1,5	14	—	—	—	—	—	—	100	160
		R500	0,5	8	500	350	—	2	5	—	—	—
		H130	1,5	8	—	—	—	—	—	—	130	—
CuZn39Pb3 CuZn40Pb2	CW614N CW617N	M	All		As manufactured							
		R360	6	20	360	—	320	—	15	20	—	—
		H095	6	20	—	—	—	—	—	—	95	130
		R430	0,5	14	430	220	—	6	8	10	—	—
		H115	1,5	14	—	—	—	—	—	—	115	170
		R500	0,5	8	500	350	—	2	5	—	—	—
		H145	1,5	8	—	—	—	—	—	—	145	—

[a] Or equivalent cross-sectional area for polygonal wire.

Table 12 — Mechanical properties of wire of complex copper-zinc alloys

Designations			Diameter [a] mm		Tensile strength R_m N/mm² (MPa)	0,2 % proof strength $R_{p\,0,2}$ N/mm² (MPa)		Elongation			Hardness HV	
Material		Material condition						$A_{100\,mm}$ %	$A_{11,3}$ %	A %		
Symbol	Number		from	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn36Sn1Pb	CW712R	M	All		As manufactured							
		R340	0,5	20	340	160	—	15	20	25	—	—
		H085	1,5	20	—	—	—	—	—	—	85	125
		R400	0,1	8	400	200	—	10	16	—	—	—
		H110	1,5	8	—	—	—	—	—	—	110	140
CuZn40Mn1Pb1	CW720R	M	All		As manufactured							
		R390	0,5	20	390	180	—	10	16	20	—	—
		H100	1,5	20	—	—	—	—	—	—	100	135
		R440	0,1	8	440	250	—	8	15	—	—	—
		H110	1,5	8	—	—	—	—	—	—	110	155
CuZn21Si3P	CW724R	M	All		As manufactured							
		R500	0,5	20	500	—	450	12	13	15	—	—
		H110	1,5	20	—	—	—	—	—	—	110	170
		R600	0,5	8	600	300	—	10	11	12	—	—
		H130	1,5	8	—	—	—	—	—	—	130	190
		R670	0,5	8	670	400	—	8	9	10	—	—
		H160	1,5	8	—	—	—	—	—	—	160	220
		R750	0,5	8	750	450	—	2	3	—	—	—
		H200	1,5	8	—	—	—	—	—	—	200	—

[a] Or equivalent cross-sectional area for polygonal wire.

Table 13 — Grain size designations

Grain size designation	Range of average grain size mm	
	min.	max.
G015	—	0,025
G025	0,015	0,035
G040	0,025	0,055
G055	0,035	0,070
G085	0,050	0,120
G100	0,070	—

NOTE 1 Average grain size ranges other than those in this table are subject to agreement between the purchaser and the supplier.

NOTE 2 The G... material condition is normally applicable only to round wires in the soft material condition made from alloys given in Tables 1, 3, 4 and to non-leaded alloys in Table 2.

Table 14 — Tolerances on diameter of round wire

Dimensions in millimetres

Nominal diameter		Tolerance				
over	up to and including	class A	class B	class C	class D	class E
—	0,25	±0,005	—	—	$^{0}_{-0,025}$	$^{0}_{-0,006}$
0,25	0,5	±0,008	—	—	$^{0}_{-0,03}$	$^{0}_{-0,010}$
0,5	1,0	±0,012	—	—	$^{0}_{-0,03}$	$^{0}_{-0,014}$
1,0	2,0	±0,02	$^{0}_{-0,10}$	$^{0}_{-0,06}$	$^{0}_{-0,04}$	$^{0}_{-0,025}$
2,0	4,0	±0,03	$^{0}_{-0,10}$	$^{0}_{-0,06}$	$^{0}_{-0,04}$	$^{0}_{-0,025}$
4,0	6,0	±0,04	$^{0}_{-0,12}$	$^{0}_{-0,08}$	$^{0}_{-0,05}$	$^{0}_{-0,030}$
6,0	10,0	±0,06	$^{0}_{-0,15}$	$^{0}_{-0,09}$	$^{0}_{-0,06}$	$^{0}_{-0,036}$
10,0	20,0	±0,08	$^{0}_{-0,18}$	$^{0}_{-0,11}$	$^{0}_{-0,07}$	$^{0}_{-0,043}$

Table 15 — Tolerances on width across-flats of square or regular polygonal wire

Dimensions in millimetres

Nominal width across-flats		Tolerance		
over	up to and including	class A	class B	class C
—	0,50	±0,015	—	—
0,5	1,0	±0,02	—	—
1,0	2,0	±0,03	—	—
2,0	4,0	±0,05	$^{0}_{-0,12}$	$^{0}_{-0,08}$
4,0	6,0	±0,06	$^{0}_{-0,12}$	$^{0}_{-0,08}$
6,0	10,0	±0,08	$^{0}_{-0,15}$	$^{0}_{-0,09}$
10,0	20,0	±0,10	$^{0}_{-0,18}$	$^{0}_{-0,11}$

Table 16 — Tolerances on width and thickness of rectangular wire

Dimensions in millimetres

Nominal width across-flats		Tolerance on width	Tolerance on thickness for range of thickness						
over	up to and including		up to and including 1,0	over 1,0 up to and including 2,0	over 2,0 up to and including 4,0	over 4,0 up to and including 6,0	over 6,0 up to and including 10,0	over 10,0 up to and including 18,0	over 18,0
—	1,0	±0,02	±0,02	—	—	—	—	—	—
1,0	2,0	±0,03	±0,02	±0,03	—	—	—	—	—
2,0	4,0	±0,05	±0,02	±0,03	±0,05	—	—	—	—
4,0	6,0	±0,06	±0,02	±0,03	±0,05	±0,06	—	—	—
6,0	10,0	±0,08	±0,02	±0,03	±0,05	±0,07	±0,08	—	—
10,0	18,0	±0,10	—	±0,03	±0,05	±0,07	±0,09	±0,10	—
18,0	—	±0,15	—	—	±0,05	±0,07	±0,09	±0,10	±0,15

Table 17 — Corner radii for square or rectangular wire

Dimensions in millimetres

Nominal thickness		**Radii for sharp and rounded corners**	
over	up to and including	sharp max.	rounded range
—	0,60	0,05	0,05 to 0,25
0,60	1,5	0,08	0,08 to 0,25
1,5	3,0	0,2	0,2 to 0,3
3,0	6,0	0,3	0,3 to 0,5
6,0	10,0	0,4	0,4 to 0,8
10,0	12,0	0,5	0,5 to 1,2

Table 18 — Sampling rate

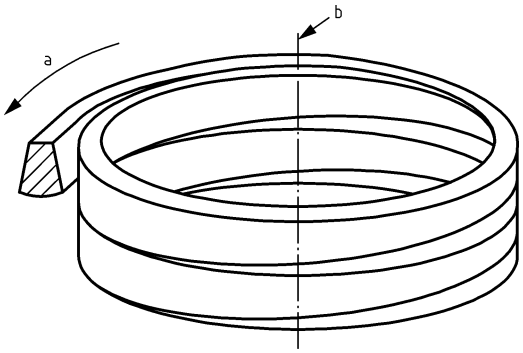
Nominal diameter [a] mm		**Mass of inspection lot for one test sample** Kg
over	up to and including	up to and including
0,1	0,8	200
0,8	3,0	500
3,0	10,0	1 000
10,0	—	2 000
If piece weights are greater than the weight of inspection lot indicated, the sampling rate may be reduced to one per piece weight.		
NOTE Larger quantities require sampling in proportion, up to a maximum of three test samples.		
[a] Or equivalent cross-sectional area for polygonal wire.		

Annex A
(informative)

Position of wire cross-section within a coil, reel, spool or drum

The position of the wire cross-section within the coil/reel/spool/drum is illustrated in Figure A.1 for coil and Figure A.2 for reel/spool/drum.

If a cross-section is characterized by one clearly defined base line the position of this base line in relation to the axis of the coil/reel/spool/drum may be defined by letter A, B, C or D, see Figure A.3 for coil and Figure A.4 for reel/spool/drum.

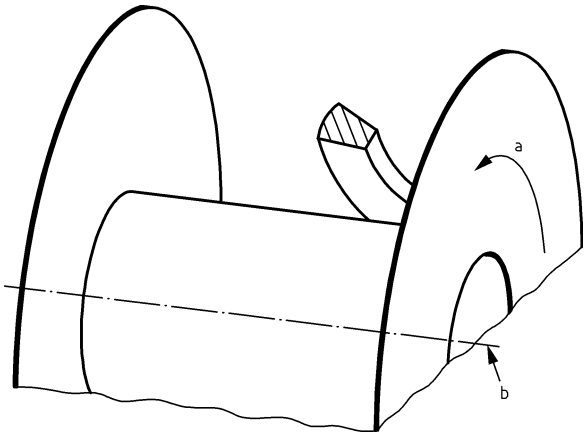


Key

a direction of decoiling

b axis

Figure A.1 — Illustration of position of wire cross-section within the coil (bunched wound or stagger/traverse wound)

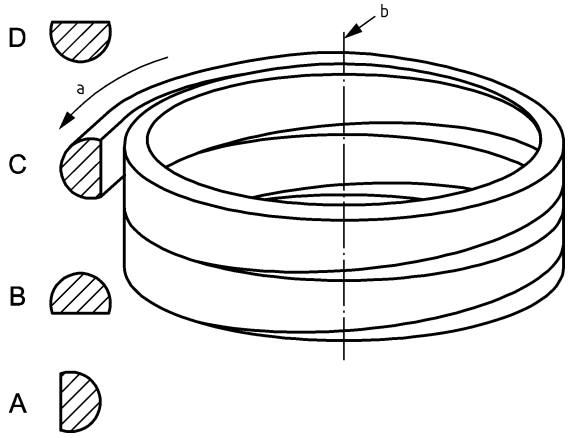


Key

a direction of decoiling

b axis

Figure A.2 — Illustration of position of wire cross-section within the reel/spool/drum (stagger/traverse wound)

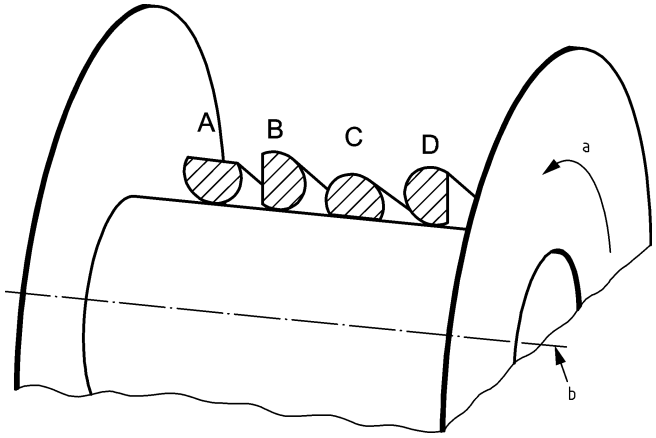


Key

a direction of decoiling

b axis

Figure A.3 — Illustration of position of wire cross-section within the coil (bunched wound or stagger/traverse wound)



Key

a direction of decoiling

b axis

Figure A.4 — Illustration of position of wire cross-section within the reel/spool/drum (stagger/traverse wound)

Bibliography

[1] EN 12163:2015, *Copper and copper alloys — Rod for general purposes*

[2] EN ISO 9001, *Quality management systems - Requirements (ISO 9001)*

[3] ISO 1811-2, *Copper and copper alloys — Selection and preparation of samples for chemical analysis — Part 2: Sampling of wrought products and castings*

[4] EN ISO 80000-1, *Quantities and units - Part 1: General (ISO 80000-1)*

[5] "Acceptance for metallic materials used for products in contact with drinking water", 4 MS Common approach, Part B "4 MS Common Composition List" (http://www.umweltbundesamt.de/themen/wasser/trinkwasser/trinkwasser-verteilen/anerkennung-harmonisierung-4ms-initiative)

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