BS EN 12164:2016

BSI Standards Publication

Copper and copper alloys — Rod for free machining purposes

National foreword

This British Standard is the UK implementation of EN 12164:2016. It supersedes BS EN 12164:2011 which is withdrawn.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.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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EUROPEAN STANDARD

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EN 12164

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English Version

Copper and copper alloys - Rod for free machining purposes

Cuivre et alliages de cuivre - Barres pour décolletage

Kupfer und Kupferlegierungen - Stangen für die spanende Bearbeitung

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

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 12164:2016) 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of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.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 12164:2011.

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 12164:2011, *Copper and copper alloys — Rod for free machining 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 12165, *Copper and copper alloys — Wrought and unwrought forging stock*;

— EN 12166, *Copper and copper alloys — Wire for general purposes*;

— 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 12164:2011, the following significant technical changes were made:

a) addition of four new materials: CuZn37Pb1 (CW605N), CuZn35Pb1,5AlAs (CW625N), CuZn33Pb1,5AlAs (CW626N) and CuZn33Pb1AlSiAs (CW725R) due to the market requirements on restriction of lead and modification of the chemical composition for CuZn39Pb1 (CW611N);

b) 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;

c) requirements and test methods for resistance of dezincification modified;

d) provisions for surface quality added;

e) mechanical properties for CuZn21Si3P (CW724R) modified.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, 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) and CuZn33Pb1AlSiAs (CW725R) 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.

— For CuZn21Si3P (CW724R) information may be obtained from:

Wieland-Werke AG
Graf Arco Straße 36
D-89079 Ulm
GERMANY

— For CuZn33Pb1AlSiAs (CW725R) information may be obtained from:

Diehl Metall Messing
Heinrich-Diehl-Straße 9
D-90552 Röthenbach/Pegnitz
GERMANY

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

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 rod, in the shape of circles, squares, hexagons or octagons, finally produced by drawing or extruding, especially intended for free machining purposes.

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 14977, *Copper and copper alloys - Detection of tensile stress - 5 % ammonia test*

EN ISO 6506-1, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1)*

EN ISO 6509-1, *Corrosion of metals and alloys - Determination of dezincification resistance of copper alloys with zinc - Part 1: Test method (ISO 6509-1)*

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*

ISO 6957, *Copper alloys — Ammonia test for stress corrosion resistance*

3 Terms and definitions

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

3.1
rod
straight product of uniform cross-section along its whole length

[SOURCE: EN 12163:2016, 3.1]

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 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or by number (see Tables 2 to 7).

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 hardness requirement for the product with mandatory hardness requirements;

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

Products in the M, R… or H… condition may be specially processed (i.e. mechanically or thermally stress relieved) in order to lower the residual stress level to improve the resistance to stress corrosion and the dimensional stability on machining [see Clause 5, list entry l), list entry m) and 8.5].

Exact conversion between material conditions designated R... and H... 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 (Rod);

— number of this European Standard (EN 12164);

— material designation, either symbol or number (see Tables 2 to 7);

— 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 Tables 8 to 13);

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

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

— for round rod, the tolerance class (see Table 14);

— for square, hexagonal or octagonal rod, the corner shape (the following designations shall be used as appropriate: SH for sharp, RD for rounded) (see Table 18).

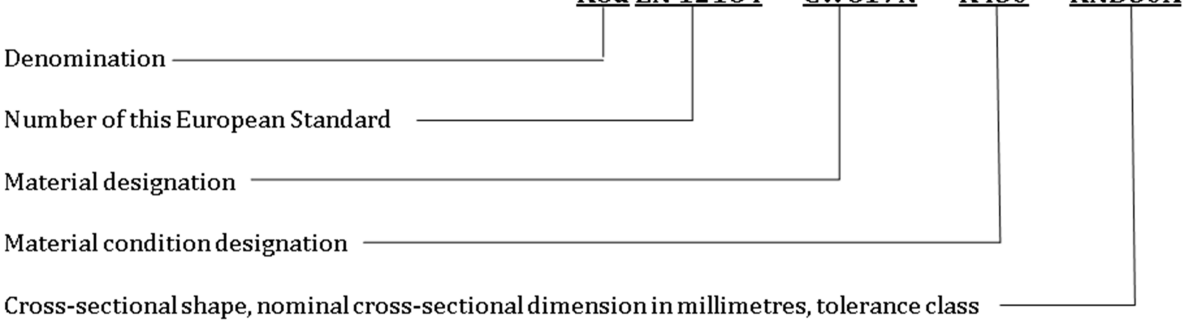
The derivation of a product designation is shown in the following examples.

EXAMPLE 1 Rod for free machining purposes conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for standard applications, in material condition R430, round cross-section, nominal diameter 30 mm, tolerance Class A, will be designated as follows:

Rod EN 12164 — CuZn40Pb2 — R430 — RND30A

or

Rod EN 12164 — CW617N — R430 — RND30A

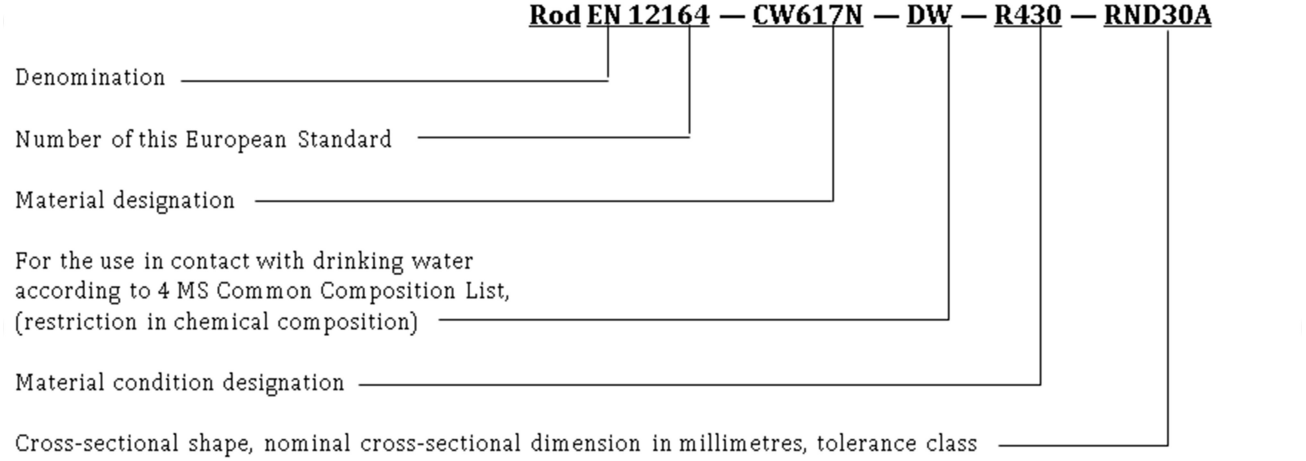


EXAMPLE 2 Rod for free machining purposes conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for drinking water applications according to the 4 MS Common Composition List, in material condition R430, round cross-section, nominal diameter 30 mm, tolerance Class A, will be designated as follows:

Rod EN 12164 — CuZn40Pb2 — DW — R430 — RND30A

or

Rod EN 12164 — CW617N — DW — R430 — RND30A



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 (Rod);

c) number of this European Standard (EN 12164);

d) material designation (see Tables 2 to 7);

e) material condition designation (see 4.2 and Tables 8 to 13) if it is 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 (diameter or width across-flats);

i) for round rod up to and including 30 mm diameter, whether Class A or Class B tolerances are required, unless the tolerance class shall be left to the discretion of the supplier (see Table 14);

j) for rod with square, hexagonal and octagonal cross-section, whether “sharp” or “rounded” corners are required unless the corner radii of the rod shall be left to the discretion of the supplier (see 6.5.5 and Table 18);

k) length of product required. Normally rod is supplied to "nominal length" tolerances (see Table 17). If "fixed lengths" are required, the length and tolerance shall be stated (see 6.5.4).

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

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

l) whether the products are required to pass a stress corrosion resistance test. If so which test method shall be used (see 8.5), if the choice is not to be left to the discretion of the supplier. If the purchaser chooses ISO 6957, the pH value for the test solution shall be selected;

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

n) whether the products shall be supplied with shaped ends which are different from those specified in 6.5.7;

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

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

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

r) whether there are any special requirements for marking, packaging or labelling (see Clause 10).

EXAMPLE Ordering details for 500 kg rod for free machining purposes conforming to EN 12164, in material designated either CuZn40Pb2 or CW617N, for drinking water application according to the 4 MS Common Composition List, in material condition R430, round cross-section, nominal diameter 30 mm, tolerance Class A, nominal length 3 000 mm:

500 kg Rod — CuZn40Pb2 — DW — R430 — RND30A
EN 12164

— nominal length 3 000 mm

or

500 kg Rod — CW617N — DW — R430 — RND30A
EN 12164

— nominal length 3 000 mm

6 Requirements

6.1 Composition

The composition shall conform to the requirements for the appropriate material given in Tables 2 to 7.

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 or the hardness properties shall conform to the appropriate requirements given in Tables 8 to 13. The tests shall be carried out in accordance with 8.2 or 8.3.

6.3 Resistance to dezincification

The maximum depth of dezincification, in any direction, of CuZn38As (CW511L), CuZn36Pb2As (CW602N), CuZn32Pb2AsFeSi (CW709R), CuZn21Si3P (CW724R) and CuZn33Pb1AlSiAs (CW725R) products shall be 100 µm. For the alloys CuZn35Pb1,5AlAs (CW625N), CuZn33Pb1,5AlAs (CW626N) the maximum depth of dezincification, in any direction, shall be 200 µm.

The test shall be carried out in accordance with 8.4.

NOTE Shape and distribution of beta phase aggregates can influence the dezincification resistance of products. Special requirements relating to shape and distribution of ß phase aggregates are subject to agreement between purchaser and supplier.

Products in alloys other than CuZn21Si3P (CW724R) shall be subjected to heat treatment approximately in the range 500 °C to 550 °C. Should the user need to heat the material above 530 °C (i.e. soldering, brazing or welding operations) then advice should be sought from the supplier.

6.4 Residual stress level

Products ordered and supplied in the stress relieved condition (see 4.2, 2nd paragraph) shall show no evidence of cracking when tested. The tests shall be carried out in accordance with 8.5.

6.5 Dimensions and tolerances

6.5.1 Diameter or width across-flats

The diameter or width across-flats shall conform to the tolerances given in Tables 14 or 15.

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

6.5.2 Shape tolerances

6.5.2.1 Round rod

The deviation from circular form shall not exceed half the range of the tolerance on diameter specified in Table 14.

6.5.2.2 Rod with square, hexagonal or octagonal cross-section (see above)

The width across-flats, measured at the centre of the faces at any one cross-section, shall not differ by more than half the range of the tolerance given for the size in Table 15.

6.5.3 Straightness

For rod of diameter, or width across-flats, from 10 mm up to and including 50 mm, and of length 1 000 mm or over, the deviation from straightness, defined as the curvature (depth of arc) against a datum line when the product is lying flat in a horizontal plane, shall conform to the tolerances given in Table 16.

NOTE Outside this size range, the deviation from straightness is subject to agreement between the purchaser and the supplier.

6.5.4 Length

Products shall be supplied as “nominal lengths” unless “fixed lengths” are specifically ordered by the purchaser (see NOTE).

"Nominal lengths" are supplied in the preferred lengths given in Table 17 and shall conform to the tolerances given in the table.

Subject to agreement between the purchaser and the supplier, an agreed proportion of underlength rod may be included in a consignment of "nominal lengths" rod.

NOTE The length and the length tolerances of "fixed lengths" rod are subject to agreement between the purchaser and the supplier [see Clause 5 list entry k)].

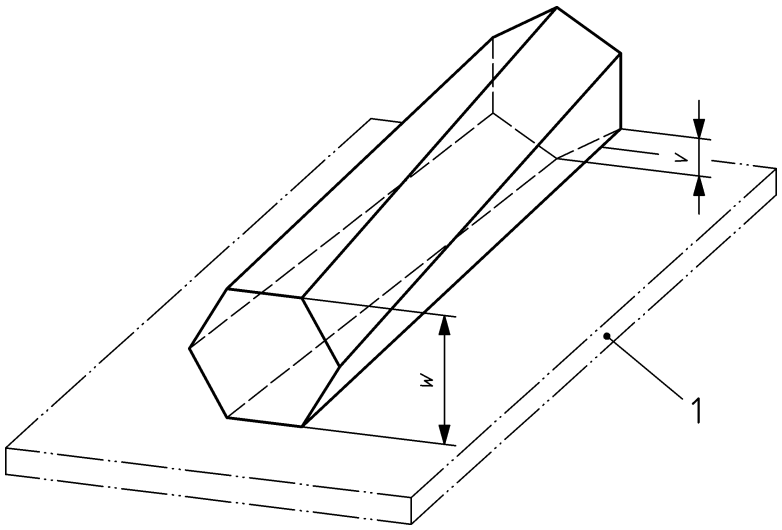
6.5.5 Corner radii

The corner radii of rod with square, hexagonal or octagonal cross-section shall conform to Table 18 [see Clause 5 list entry j)].

Except in cases of dispute, the corners should be measured directly, either by use of a gauge or an optical projector. In cases of dispute, the method by optical projector should be used.

6.5.6 Twist of polygonal rod

The maximum permitted twist *V* (see Figure 1) of rod with square, hexagonal or octagonal cross-section, as measured between two cross-sections along the rod, shall conform to Table 19.



Key

1 reference plane

V twist

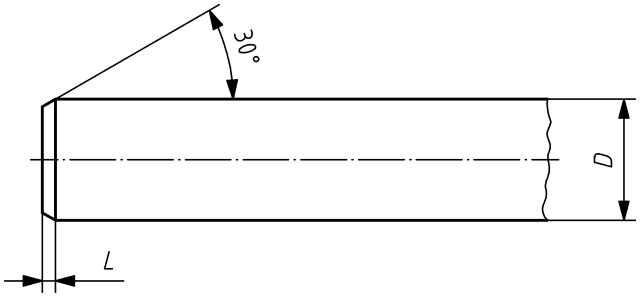
W width across-flats

Figure 1 — Measurement of twist of polygonal rod

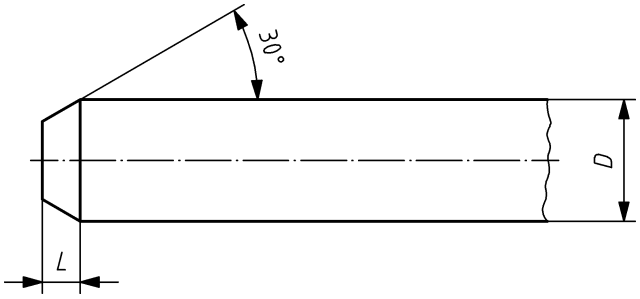
6.5.7 Shaped ends

Unless otherwise specified by the purchaser, products of sizes 2 mm up to and including 30 mm diameter, or width across-flats, shall be supplied with one end chamfered (Type A in Table 1) and the other end pointed (Type B in Table 1).

The length of chamfer/point is shown in Figure 2.



a) Shaped ends of rod, Type A – chamfered



b) Shaped ends of rod, Type B – pointed

Figure 2 — Shaped ends of rod, Types

Table 1 — Indicative shaped ends dimensions

Dimensions in millimetres

Nominal diameter *D* or width across-flats *W*		**Type A – Chamfer** [a] **Length *l***		**Type B – Point** [b] **Length *l***	
over	up to and including	min.	max.	min.	max.
2	5	0,2	1,0	1,5	4
5	10	0,2	1,5	2	7
10	20	0,2	2	3	10
20	30	0,2	3	4	12

[a] Chamfering is applied to remove any burrs.

[b] Pointing is applied to guide rods through automaic feeding machines.

Unless otherwise specified by the purchaser the shape of the ends of products of sizes over 30 mm diameter, or width across-flats, shall be at the supplier's discretion.

If a purchaser requires other end shapes than those specified, these should be agreed with the supplier and stated in the enquiry and order [see Clause 5 list entry n)].

6.6 Surface quality

The surfaces shall be clean and smooth. The rods 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 rods 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 o)].

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 Subclauses 7.2 to 7.4.

7.2 Analysis

The sampling rate shall be in accordance with Table 20. 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 Mechanical tests

The sampling rate shall be in accordance with Table 20. 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.

7.4 Dezincification resistance and stress corrosion resistance tests

The sampling rate which shall be applied to finished products, shall be:

— for products that have been heat treated: one sampling unit per heat treatment batch;

— for products that have not been heat treated: in accordance with Table 20.

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 case 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 8.8 shall be used.

8.2 Tensile test

8.2.1 General

Tensile test pieces shall be prepared in accordance with 8.2.2 and 8.2.3 and the test shall be carried out in accordance with 8.2.4.

8.2.2 Location of test pieces

Test pieces shall be machined from one of the following locations in the test sample obtained in accordance with 7.3:

a) for test samples from products up to and including 30 mm diameter, or width across-flats, the test piece shall be coaxial with the product;

b) for test samples from products over 30 mm diameter, or width across-flats, the longitudinal axis of the test piece shall be parallel to that of the product and shall be between 15 mm and 20 mm from the surface of the product.

8.2.3 Shape and size of test pieces

Test pieces shall be in accordance with EN ISO 6892-1, except that 200 mm gauge length is not permitted.

NOTE Elongation requirements for rod of diameter or width across-flats:

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.

8.2.4 Procedure for testing

The tensile test shall be carried out in accordance with the method given in EN ISO 6892-1.

8.2.5 Determination of results

The tensile strength, 0,2 % proof strength and the elongation shall be determined from the tensile test results obtained in accordance with 8.2.4. For expression of results the rounding rules given in 8.8 shall be used.

8.3 Hardness test

Hardness shall be determined on the test piece cut from the test sample obtained in accordance with 7.3. The test shall be carried out in accordance with EN ISO 6506-1.

The position of the impression/indentation shall be:

a) for rod of diameter or width across-flats less than 5 mm upon agreement between customer and supplier;

b) for rod of diameter or width across-flats greater (equal) than 5 mm on the cross-section of the product mid-way between the central axis and the outside surface.

8.4 Dezincification resistance test

The test method given in EN ISO 6509-1 shall be used on the test samples obtained in accordance with 7.4.

A test piece shall be taken from each test sample so as to expose a prepared cross-sectional surface to the test solution.

At the completion of the test the maximum depth of dezincification in a longitudinal direction shall be measured.

8.5 Stress corrosion resistance test

The test method given in either ISO 6957 or EN 14977 shall be used on the test pieces prepared from the test samples obtained in accordance with 7.4. The choice of which of these tests is used shall be at the discretion of the supplier, unless a preference is expressed by the purchaser [see Clause 5 list entry l)].

8.6 Determination of the electrical conductivity

If not otherwise specified the test method is left to the discretion of the supplier, e.g. eddy current method or resistance bridge.

The electrical conductivity shall be determined on the finished product.

8.7 Retests

8.7.1 Analysis, tensile test, hardness test and dezincification resistance test, determination of the electrical conductivity

If there is a failure of one, or more than one, of the tests in 8.1, 8.2, 8.3, 8.4 or 8.6, 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.

NOTE If an inspection lot of dezincification resistant alloys fails the dezincification resistance test when tested or retested, the supplier has the option to heat treat, or to further heat treat, the inspection lot and resubmit it for all the tests called for on the order, except for analysis.

8.7.2 Stress corrosion resistance test

If a test piece fails the test, the inspection lot represented by the failed test piece shall be permitted to be subjected to a stress relieving treatment. A further test sample shall then be selected in accordance with 7.4.

If a test piece from the further test sample passes the test, the stress relieved products shall be deemed to conform to the requirements of this standard for residual stress level and shall then be subjected to all the other tests called for on the purchase order, except for analysis. If the test piece from the further test sample fails the test, the stress relieved products shall be deemed not to conform to this standard.

8.8 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 p)] and agreed with the supplier, the supplier shall issue for the products the appropriate declaration of conformity in accordance with EN 1655.

9.2 Inspection documentation

When requested by the purchaser [(see Clause 5 list entry q)] 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 r)].

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

Table 2 — Composition of low alloyed copper alloys

Material designation		Composition % (mass fraction)											Density[a] g/cm^3	Electrical conductivity[a, b]	
Symbol	Number	Element	Cu	Be	Co	Fe	Ni	P	Pb	S	Te	Others total	approx.	MS/m approx.	% IACS approx.
CuBe2Pb	CW102C	min.	Rem.	1,8	—	—	—	—	0,2	—	—	—	8,3	15	26
		max.	—	2,0	0,3	0,2	0,3	—	0,6	—	—	0,5			
CuPb1P	CW113C	min.	Rem.	—	—	—	—	0,003	0,7	—	—	—	8,9	50	86
		max.	—	—	—	—	—	0,012	1,5	—	—	0,1			
CuSP	CW114C	min.	Rem.	—	—	—	—	0,003	—	0,2	—	—	8,9	50	86
		max.	—	—	—	—	—	0,012	—	0,7	—	0,1			
CuTeP	CW118C	min.	Rem.	—	—	—	—	0,003	—	—	0,4	—	8,9	50	86
		max.	—	—	—	—	—	0,012	—	—	0,7	0,1			

[a] For information only.

[b] Only for solution heat treated and precipitation hardened material conditions, where applicable.

Table 3 — 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	
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	

[a] For information only.

Table 4 — Composition of copper-tin alloys

Material designation		Composition % (mass fraction)										Density[a] g/cm^3
Symbol	Number	Element	Cu	Fe	Ni	P	Pb	Sn	Te	Zn	Others total	approx.
CuSn4Pb4Zn4	CW456K	min.	Rem.	—	—	0,01	3,5	3,5	—	3,5	—	8,9
		max.	—	0,1	0,2	0,4	4,5	4,5	0,2	4,5	0,2	
CuSn5Pb1	CW458K	min.	Rem.	—	—	0,01	0,5	3,5	—	—	—	8,8
		max.	—	0,1	0,2	0,4	1,5	5,5	—	0,3	0,2	

[a] For information only.

Table 5 — Composition of copper-zinc alloys

Material designation		**Composition**[b] % (mass fraction)											**Density**[a] g/cm^3
Symbol	Number	Element	Cu	As	Al	Fe	Mn	Ni	Pb	Sn	Zn	Others total	approx.
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	
CuZn38As	CW511L	min.	61,5	0,02	—	—	—	—	—	—	Rem.	—	8,4
		max.	63,5	0,15	0,05	0,1	—	0,3	0,2	0,1	—	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 copper-zinc-lead alloys

Material designation		Composition[b] % (mass fraction)											Density[a] g/cm^3
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	Pb	Sn	Zn	Others total	approx.
Group A alloys — These alloys have excellent machinability, but very limited cold workability.													
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	
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	
Group B alloys — These alloys have good machinability and some cold workability.													
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	
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	

Material designation		Composition[b] % (mass fraction)											Density[a] g/cm^3
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	Pb	Sn	Zn	Others total	approx.
Group C alloys — These alloys are machinable and have good to very good cold workability.													
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	
CuZn37Pb1	CW605N	min.	61,0	—	—	—	—	—	0,8	—	Rem.	—	8,5
		max.	62,5	0,05	—	0,3	—	0,3	1,6	0,3	—	0,2	
CuZn38Pb1	CW607N	min.	60,0	—	—	—	—	—	0,8	—	Rem.	—	8,4
		max.	61,0	0,05	—	0,2	—	0,3	1,6	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	
CuZn39Pb1	CW611N	min.	59,0	—	—	—	—	—	0,8	—	Rem.	—	8,4
		max.	60,0	0,05	—	0,3	—	0,3	1,6	0,3	—	0,2	
Group D alloy — This alloy is dezincification resistant with good machinability and some cold workability.													
CuZn36Pb2As	CW602N	min.	61,0	—	0,02	—	—	—	1,7	—	Rem.	—	8,4
		max.	63,0	0,05	0,15	0,1	0,1	0,3	2,8	0,1	—	0,2	
CuZn35Pb1,5AlAs	CW625N	min.	62,0	0,5	0,02	—	—	—	1,2	—	Rem.	—	8,4
		max.	64,0	0,7	0,15	0,3	0,1	0,2	1,6	0,3	—	0,2	
CuZn33Pb1,5AlAs	CW626N	min.	64,0	0,8	0,02	—	—	—	1,2	—	Rem.	—	8,4
		max.	66,0	1,0	0,15	0,3	0,1	0,2	1,7	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 — Composition of complex copper-zinc alloys

Material designation		Composition[b] % (mass fraction)													Density[a] g/cm^3
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Others total	approx.
CuZn32Pb2AsFeSi	CW709R	min.	64,0	—	0,03	0,1	—	—	—	1,5	0,45	—	Rem.	—	8,4
		max.	66,5	0,05	0,08	0,2	—	0,3	—	2,2	0,8	0,3	—	0,2	
CuZn37Mn3Al2PbSi	CW713R	min.	57,0	1,3	—	—	1,5	—	—	0,2	0,3	—	Rem.	—	8,1
		max.	59,0	2,3	—	1,0	3,0	1,0	—	0,8	1,3	0,4	—	0,3	
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	
CuZn40Mn1Pb1AlFeSn	CW721R	min.	57,0	0,3	—	0,2	0,8	—	—	0,8	—	0,2	Rem.	—	8,3
		max.	59,0	1,3	—	1,2	1,8	0,3	—	1,6	—	1,0	—	0,3	
CuZn40Mn1Pb1FeSn	CW722R	min.	56,5	—	—	0,2	0,8	—	—	0,8	—	0,2	Rem.	—	8,3
		max.	58,5	0,1	—	1,2	1,8	0,3	—	1,6	—	1,0	—	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	
CuZn33Pb1AlSiAs	CW725R	min.	64,0	0,1	0,05	—	—	—	—	0,4	0,1	—	Rem.	—	8,5
		max.	67,0	0,4	0,08	0,3	0,1	0,2	0,02	0,9	0,3	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.

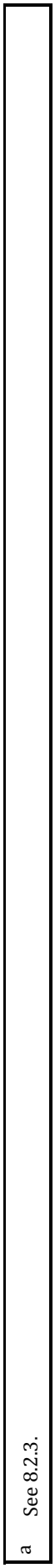
Table 8 — Mechanical properties of rod of low alloyed copper alloys

Designations			Diameter			Width across-flats			Tensile strength	0,2 % proof strength	Elongation[a]			Hardness	
Material		Material condition	mm			mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)	$A_{100\ mm}$ %	$A_{11,3}$ %	A %	HBW	
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	min.	min.	min.	min.	max.
CuBe2Pb	CW102C	M	All			All			As manufactured						
		R1150	—	25	80	—	25	80	1150	1000	—	—	2	—	—
		H340	—	25	80	—	25	80	—	—	—	—	—	340	410
		R1300	2	—	25	2	—	25	1300	1100	—	—	2	—	—
		H350	2	—	25	2	—	25	—	—	—	—	—	350	430
CuPb1P CuSP CuTeP	CW113C CW114C CW118C	M	All			All			As manufactured						
		R250	2	—	80	2	—	80	250	180	3	5	7	—	—
		H080	2	—	80	2	—	80	—	—	—	—	—	80	110
		R300	2	—	20	2	—	20	300	240	2	3	5	—	—
		H095	2	—	20	2	—	20	—	—	—	—	—	95	130
		R360	2	—	10	2	—	10	360	300	—	—	—	—	—
		H120	2	—	10	2	—	10	—	—	—	—	—	120	—

[a] See 8.2.3.

Table 9 — Mechanical properties of rod of copper-nickel-zinc alloys

Designations			Diameter			Width across-flats			Tensile strength	0,2 % proof strength	Elongation[a]			Hardness	
Material		Material condition	mm			mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)	$A_{100\ mm}$ %	$A_{11,3}$ %	A %	HBW	
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	min.	min.	min.	min.	max.
CuNi7Zn39Pb3Mn2	CW400J	M	All			All			As manufactured						
		R500	2	—	40	2	—	40	500	350	8	10	12	—	—
		H125	2	—	40	2	—	40	—	—	—	—	—	125	165
		R600	2	—	20	2	—	20	600	400	2	3	5	—	—
		H155	2	—	20	2	—	20	—	—	—	—	—	155	190
		R700	2	—	5	2	—	4	700	500	—	—	—	—	—
		H180	2	—	5	2	—	4	—	—	—	—	—	180	—
CuNi12Zn30Pb1 CuNi18Zn19Pb1	CW406J CW408J	M	All			All			As manufactured						
		R420	2	—	50	2	—	50	420	260	12	16	20	—	—
		H110	2	—	50	2	—	50	—	—	—	—	—	110	145
		R520	2	—	10	2	—	10	520	420	3	5	6	—	—
		H130	2	—	10	2	—	10	—	—	—	—	—	130	155
		R650	2	—	8	2	—	8	650	580	—	—	—	—	—
		H150	2	—	8	2	—	8	—	—	—	—	—	150	180



a See 8.2.3.

Table 10 — Mechanical properties of rod of copper-tin alloys

Designations			Diameter			Width across-flats			Tensile strength	0,2 % proof strength	Elongation[a]			Hardness	
Material		Material condition	mm			mm			R_m N/mm² (MPa)	$R_{p\,0,2}$ N/mm² (MPa)	$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HBW	
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	min.	min.	min.	min.	max.
CuSn4Pb4Zn4 CuSn5Pb1	CW456K CW458K	M	All			All			As manufactured						
		R450	2	—	12	—	—	—	450	350	6	8	10	—	—
		H115	2	—	12	—	—	—	—	—	—	—	—	115	150
		R550	2	—	6	—	—	—	550	480	3	5	—	—	—
		H140	2	—	6	—	—	—	—	—	—	—	—	140	170
		R640	2	—	4	—	—	—	640	580	—	—	—	—	—
		H160	2	—	4	—	—	—	—	—	—	—	—	160	180
		R720	2	—	4	—	—	—	720	620	—	—	—	—	—
		H180	2	—	4	—	—	—	—	—	—	—	—	180	210

[a] See 8.2.3.

Table 11 — Mechanical properties of rod of copper-zinc alloys

Designations			Diameter			Width across-flats			Tensile strength	0,2 % proof strength		Elongation[a]			Hardness	
Material		Material condition	mm			mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\ mm}$ %	$A_{11,3}$ %	A %	HBW	
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn40	CW509L	M	All			All			As manufactured							
		R360	6	—	80	5	—	60	360	—	300	—	15	20	—	—
		H070	6	—	80	5	—	60	—	—	—	—	—	—	70	100
		R410	2	—	40	2	—	35	410	230	—	8	10	12	—	—
		H100	2	—	40	2	—	35	—	—	—	—	—	—	100	145
		R500	2	—	14	2	—	10	500	350	—	3	5	8	—	—
		H120	2	—	14	2	—	10	—	—	—	—	—	—	120	—
CuZn42	CW510L	M	All			All			As manufactured							
		R360	6	—	80	5	—	60	360	—	320	—	15	20	—	—
		H090	6	—	80	5	—	60	—	—	—	—	—	—	90	125
		R430	2	—	40	2	—	35	430	220	—	6	8	10	—	—
		H110	2	—	40	2	—	35	—	—	—	—	—	—	110	160
		R500	2	—	14	2	—	10	500	350	—	—	3	5	—	—
		H135	2	—	14	2	—	10	—	—	—	—	—	—	135	—

Designations			Diameter			Width across-flats			Tensile strength	0,2 % proof strength		Elongation[a]			Hardness	
Material		Material condition	mm			mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\ mm}$ %	$A_{11,3}$ %	A %	HBW	
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn38As	CW511L	M	All			All			As manufactured							
		R280	6	—	80	5	—	60	280	—	200	—	25	30	—	—
		H070	6	—	80	5	—	60	—	—	—	—	—	—	70	110
		R320	6	—	60	5	—	50	320	200	—	—	15	20	—	—
		H090	6	—	60	5	—	50	—	—	—	—	—	—	90	135
		R400	4	—	15	4	—	13	400	250	—	—	5	8	—	—
		H105	4	—	15	4	—	13	—	—	—	—	—	—	105	—

[a] See 8.2.3.

Table 12 — Mechanical properties of rod of copper-zinc-lead alloys

Designations		Material condition	Diameter mm			Width across-flats mm			Tensile strength R_m N/mm² (MPa)	0,2 % proof strength $R_{p\,0,2}$ N/mm² (MPa)		Elongation[a] $A_{100\,mm}$ %	$A_{11,3}$ %	A %	Hardness HBW	
Material																
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
		M	All			All			As manufactured							
		R280	6	—	80	5	—	60	280	—	200	—	25	30	—	—
CuZn36Pb2As	CW602N	H070	6	—	80	5	—	60	—	—	—	—	—	—	70	110
CuZn35Pb1,5AlAs	CW625N	R320	6	—	60	5	—	50	320	200	—	—	15	20	—	—
CuZn33Pb1,5AlAs	CW626N	H090	6	—	60	5	—	50	—	—	—	—	—	—	90	135
		R400	4	—	15	4	—	13	400	250	—	—	5	8	—	—
		H105	4	—	15	4	—	13	—	—	—	—	—	—	105	—
		M	All			All			As manufactured							
		R340	10	—	80	10	—	60	340	—	280	—	—	20	—	—
CuZn35Pb1 CuZn35Pb2	CW600N CW601N	H070	10	—	80	10	—	60	—	—	—	—	—	—	70	120
CuZn37Pb1	CW605N	R400	2	—	25	2	—	20	400	200	—	4	8	12	—	—
CuZn36Pb3 CuZn37Pb2	CW603N CW606N	H100	2	—	25	2	—	20	—	—	—	—	—	—	100	140
		R480	2	—	14	2	—	10	480	350	—	3	5	8	—	—
		H125	2	—	14	2	—	10	—	—	—	—	—	—	125	—

Designations			Diameter			Width across-flats			Tensile strength	0,2 % proof strength		Elongation[a]			Hardness	
Material		Material condition	mm			mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\ mm}$ %	$A_{11,3}$ %	A %	HBW	
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn38Pb1 CuZn38Pb2 CuZn39Pb0,5 CuZn39Pb1 CuZn39Pb2	CW607N CW608N CW610N CW611N CW612N	M	All			All			As manufactured							
		R360	6	—	80	5	—	60	360	—	300	—	15	20	—	—
		H070	6	—	80	5	—	60	—	—	—	—	—	—	70	100
		R410	2	—	40	2	—	35	410	230	—	8	10	12	—	—
		H100	2	—	40	2	—	35	—	—	—	—	—	—	100	145
		R500	2	—	14	2	—	10	500	350	—	3	5	8	—	—
		H120	2	—	14	2	—	10	—	—	—	—	—	—	120	—
CuZn39Pb3 CuZn40Pb2	CW614N CW617N	M	All			All			As manufactured							
		R360	6	—	80	5	—	60	360	—	350	—	15	20	—	—
		H090	6	—	80	5	—	60	—	—	—	—	—	—	90	125
		R430	2	—	60	2	—	40	430	220	—	6	8	10	—	—
		H110	2	—	60	2	—	40	—	—	—	—	—	—	110	160
		R500	2	—	14	2	—	10	500	350	—	—	3	5	—	—
		H135	2	—	14	2	—	10	—	—	—	—	—	—	135	—

[a] See 8.2.3.

Table 13 — Mechanical properties of rod of complex copper-zinc alloys

Designations			Diameter			Width across-flats			Tensile strength	0,2 % proof strength		Elongation [a]			Hardness	
Material		Material condition	mm			mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\,mm}$ %	$A_{11,3}$ %	A %	HBW	
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn32Pb2AsFeSi	CW709R	M	All			All					As manufactured					
		R380	5	—	40	5	—	40	380	220	—	—	15	20	110	160
		R430	5	—	40	5	—	40	430	280	—	—	12	15	120	170
CuZn37Mn3Al2PbSi	CW713R	M	All			All			As manufactured							
		R540	5	—	80	5	—	60	540	280	—	—	12	15	—	—
		H130	5	—	80	5	—	60	—	—	—	—	—	—	130	170
		R590	5	—	50	5	—	40	590	370	—	—	8	10	—	—
		H150	5	—	50	5	—	40	—	—	—	—	—	—	150	220
CuZn40Mn1Pb1	CW720R	M	All			All			As manufactured							
		R440	—	40	80	—	40	60	440	180	—	—	—	20	—	—
CuZn40Mn1Pb1AlFeSn	CW721R	H100	—	40	80	—	40	60	—	—	—	—	—	—	100	140
CuZn40Mn1Pb1FeSn	CW722R	R500	5	—	40	5	—	40	500	270	—	—	10	12	—	—
		H130	5	—	40	5	—	40	—	—	—	—	—	—	130	—

Designations			Diameter			Width across-flats			Tensile strength	0,2 % proof strength		Elongation [a]			Hardness	
Material		Material condition	mm			mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		$A_{100\ mm}$ %	$A_{11,3}$ %	A %	HBW	
Symbol	Number		from	over	up to and including	from	over	up to and including	min.	min.	max.	min.	min.	min.	min.	max.
CuZn21Si3P	CW724R	M	All			All			As manufactured							
		R500	6	—	80	35	—	80	500	—	450	—	—	15	—	—
		H130	6	—	80	35	—	80	—	—	—	—	—	—	130	180
		R600	10	—	40	15	—	40	600	300	—	—	—	12	—	—
		H150	10	—	40	15	—	40	—	—	—	—	—	—	150	220
		R670	2	—	20	2	—	15	670	400	—	8	9	10	—	—
		H170	2	—	20	2	—	15	—	—	—	—	—	—	170	
CuZn33Pb1AlSiAs	CW725R	M	All			All			As manufactured							
		R290	6	—	80	5	—	60	290	—	200	—	25	30	—	—
		H070	6	—	80	5	—	60	—	—	—	—	—	—	70	110
		R320	6	—	60	5	—	50	320	200	—	—	15	20	—	—
		H090	6	—	60	5	—	50	—	—	—	—	—	—	90	135
		R400	4	—	15	4	—	13	400	250	—	—	5	8	—	—
		H105	4	—	15	4	—	13	—	—	—	—	—	—	105	

[a] See 8.2.3.

Table 14 — Tolerances on diameter of round rod (including deviation from circular form)

Dimensions in millimetres

Nominal diameter		Tolerances[b]		
over	up to and including	class A	class B	class C
2[a]	3	$^{0}_{-0,04}$	$^{0}_{-0,025}$	$^{0}_{-0,015}$
3	6	$^{0}_{-0,05}$	$^{0}_{-0,030}$	$^{0}_{-0,020}$
6	10	$^{0}_{-0,06}$	$^{0}_{-0,036}$	$^{0}_{-0,025}$
10	18	$^{0}_{-0,07}$	$^{0}_{-0,043}$	—
18	30	$^{0}_{-0,08}$	$^{0}_{-0,052}$	—
30	50	$^{0}_{-0,16}$	—	—
50	80	$^{0}_{-0,19}$	—	—

[a] Including 2.

[b] For deviation from circular form refer to 6.5.1.

Table 15 — Tolerances on width across-flats of regular polygonal rod

Dimensions in millimetres

Nominal width across-flats		Tolerances
over	up to and including	
2[a]	3	$^{0}_{-0,06}$
3	6	$^{0}_{-0,08}$
6	10	$^{0}_{-0,09}$
10	18	$^{0}_{-0,11}$
18	30	$^{0}_{-0,13}$
30	50	$^{0}_{-0,16}$
50	60	$^{0}_{-0,19}$

[a] Including 2.

Table 16 — Tolerances on straightness of rod

Nominal diameter or width across-flats	**Maximum deviation from straightness** (see 6.5.3) mm			
	localized over any 400 mm length		over whole length L of rod in metres ($L \geq 1$ m)	
	for alloys in Tables 3, 4, 5 and 6	for alloys in Tables 2 and 7	for alloys in Tables 3, 4, 5 and 6	for alloys in Tables 2 and 7
Round rod				
from 10 mm up to and including 50 mm	0,4	0,8	1,0 × L	2,0 × L
Polygonal rod				
from 10 mm up to and including 50 mm	0,6	1,2	1,5 × L	3,0 × L
NOTE The tolerances of straightness shown in the table only apply to material condition foreseen in this standard				

Table 17 — Tolerances on length of nominal length rod

Dimensions in millimetres

Nominal diameter or width across-flats		**Preferred (available) lengths**	**Tolerance on length**
over	up to and including		
2[a]	30	3 000 or 4 000	±50
30	50	3 000 or 4 000	±100
50	80	3 000	±100
[a] Including 2.			

Table 18 — Corner radii for square, hexagonal and octagonal rod

Dimensions in millimetres

Nominal width across-flats		**Radii for sharp and rounded corners**	
over	up to and including	sharp max.	rounded range
2[a]	3	0,2	0,2 to 0,3
3	6	0,3	0,3 to 0,5
6	10	0,4	0,4 to 0,8
10	18	0,5	0,5 to 1,2
18	30	0,6	0,6 to 1,8
30	50	0,7	0,7 to 2,8
50	60	0,8	0,8 to 4,0
[a] Including 2.			

Table 19 — Maximum twist of square, hexagonal and octagonal rod

Dimensions in millimetres

Nominal width across-flats *W*		**Maximum permitted twist *V* in any 1 m length of rod**
over	up to and including	
10[a]	18	1,0
18	30	2,0
30	60	3,0

[a] Including 10.

Table 20 — Sampling rate

Nominal diameter or width across-flats mm		**Mass of inspection lot for one test sample** kg
over	up to and including	up to and including
—	25	1 000
25	—	2 000

NOTE Larger quantities require sampling in proportion, up to a maximum of three test samples.

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