

Copper and copper alloys — Rod for general purposes

The European Standard EN 12163:1998 has the status of a
British Standard

ICS 77.150.30

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National foreword

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The UK participation in its preparation was entrusted by Technical Committee NFE/34, Copper and copper alloys, to Subcommittee NFE/34/1, Wrought and unwrought copper and copper alloys, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 38, an inside back cover and a back cover.

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English version

Copper and copper alloys — Rod for general purposes

Cuivre et alliages de cuivre — Barres pour usages généraux

Kupfer und Kupferlegierungen — Stangen zur allgemeinen Verwendung

This European Standard was approved by CEN on 26 December 1997.

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CEN

European Committee for Standardization
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Foreword

This European Standard 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of an identical text or by endorsement, at the latest by July 1998, and conflicting national standards shall be withdrawn at the latest by July 1998.

Within its programme of work, Technical Committee CEN/TC 133 requested CEN/TC 133/WG 4, Rod/bar, wire, profiles, to prepare the following standard:

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

This is one of a series of European Standards for copper and copper alloy products in rod, wire and profile form. Other products are, or will be, specified as follows:

EN 12164, *Copper and copper alloys — Rod for free machining 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 rectangular bar for general purposes*.

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

...¹⁾, *Copper and copper alloys — Rod and wire for welding and brazewelding*.
(WI: 00133021)

...¹⁾, *Copper and copper alloys — Copper rod, bar and wire for general electrical purposes*.
(WI: 00133025)

...¹⁾, *Copper and copper alloys — Drawn round copper wire for the manufacture of electrical conductors*.
(WI: 00133025)

...¹⁾, *Copper and copper alloys — Copper profiles for electrical purposes*.
(WI: 00133056)

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

¹⁾ In course of preparation.

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1 Scope

This European Standard specifies the composition, property requirements and dimensional tolerances for copper and copper alloy rod supplied in straight lengths, intended for general purposes.

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

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 1655, *Copper and copper alloys — Declarations of conformity.*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test (at ambient temperature).*

EN 10003-1, *Metallic materials — Brinell hardness test — Part 1: Test method.*

EN 10204, *Metallic products — Types of inspection documents.*

EN ISO 196, *Wrought copper and copper alloys — Detection of residual stress — Mercury (I) nitrate test.* (ISO 196:1978)

EN ISO 6509: 1995, *Corrosion of metals and alloys — Determination of dezincification resistance of brass.* (ISO 6509:1981)

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

ISO 6507-1, *Metallic materials — Hardness test — Vickers test — Part 1: HV 5 to HV 100.*

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

NOTE Informative references to documents used in the preparation of this standard, and cited at the appropriate places in the text, are listed in a bibliography; see annex A.

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1

rod

solid wrought product of uniform cross-section along its whole length, supplied in straight lengths. The cross-sections are in the shape of circles or regular polygons. Products with a polygonal cross-section may have corners rounded along their whole length

3.2

circularity (round rod)

difference between the maximum and the minimum diameters measured at any one cross-section of a round rod

4 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or number (see Tables 1 to 8).

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;

NOTE 1 Products in the H... condition may be specified to Brinell or Vickers hardness. The material condition designation H... is the same for both hardness test methods.

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

NOTE 2 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 5m), 5n) 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.

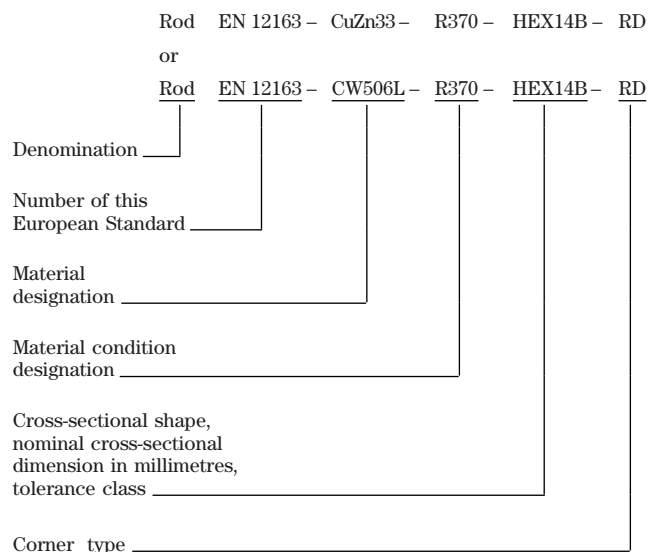
4.3 Product

The product designation provides a standardized pattern of designation from which a rapid and unequivocal description of a product is 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 12163);
- material designation, either symbol or number (see Tables 1 to 8);
- material condition designation (see Tables 9 to 16);
- 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 dimensions (diameter or width across-flats);
- tolerance class (see Table 17);
- corner type for polygonal rod (the following designations shall be used as appropriate: SH for sharp; RD for rounded; see Table 19).



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

EXAMPLE

Rod for general purposes conforming to this standard, in material designated either CuZn33 or CW506L, in material condition R370, hexagonal, nominal width across-flats 14 mm, tolerance class B, rounded corners, shall be designated as follows:

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) quantity of product required (mass);
 - b) denomination (Rod);
 - c) number of this European Standard (EN 12163);
 - d) material designation (see Tables 1 to 8);
 - e) material condition designation (see 4.2 and Tables 9 to 16) if it is other than M. The purchaser may request, and it shall then be subject to agreement between the supplier and the purchaser, that the informative values of 0,2 % proof strength become mandatory, in which case the specified tensile strength values become informative;
 - f) cross-sectional shape;
 - g) nominal cross-sectional dimension (diameter or width across-flats);
 - h) whether other than class A tolerances are required (see Table 17);
 - i) for polygonal rod: whether “sharp” or “rounded” corners are required unless the corner radii are to be left to the discretion of the supplier (see 6.5.5 and Table 19);
 - j) length and length tolerance (see 6.5.4).
- NOTE It is recommended that the product designation, as described in 4.3, is used for items b) to i).
- In addition, the purchaser shall also state on the enquiry and order any of the following, if required:
- k) for products in alloy CuZn32Pb2AsFeSi (CW709R): whether the dezincification resistance acceptance criterion required is other than grade A (see 6.3);
 - l) test method to be used for measurement of hardness, i.e. Brinell or Vickers (see 8.3) unless the test method is to be left to the discretion of the supplier;
 - m) whether the products are required to pass a stress corrosion resistance test. If so, which test method is to 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 is to be selected;
 - n) whether the products are to be supplied in a thermally stress relieved condition;
 - 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 (see clause 10).

EXAMPLE

Ordering details for 500 kg rod for general purposes conforming to EN 12163, in material designated either CuZn33 or CW506L, in material condition R370, hexagonal, nominal width across-flats 14 mm, tolerance class B, rounded corners, length 3 000 mm $\pm$ 100 mm:

500 kg Rod EN12163 – CuZn33 – R370 – HEX14B – RD
– length 3 000 mm $\pm$ 100 mm

or

500 kg Rod EN 12163 – CW506L – R370 – HEX14B – RD
– length 3 000 mm $\pm$ 100 mm

6 Requirements

6.1 Composition

The composition shall conform to the requirements for the appropriate material given in Tables 1 to 8.

6.2 Mechanical properties

The tensile or the hardness properties shall conform to the appropriate requirements given in Tables 9 to 16. The tests shall be carried out in accordance with 8.2 or 8.3.

6.3 Resistance to dezincification

The depth of dezincification of CuZn32Pb2AsFeSi (CW709R) products shall be:

- for grade A: maximum 200 μ m;
- for grade B: mean not to exceed 200 μ m and maximum 400 μ m [see 5k)].

The test shall be carried out in accordance with 8.4.

NOTE Products in this alloy may be subjected to heat treatment in the range 525 °C to 575 °C during manufacture. If the user needs to heat the material above 550 °C during subsequent processing then advice should be sought from the supplier.

6.4 Residual stress level

Products ordered and supplied in the stress relieved condition (see note 2 to 4.2) 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 Table 17.

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 circularity shall not exceed half the range of the tolerance on diameter given in Table 17.

6.5.2.2 Polygonal rod

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 17.

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 18.

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

6.5.4 Length

The length and length tolerance shall conform to the requirements stated on the enquiry and order [see 5j)].

6.5.5 Corner radii

The corner radii of polygonal rod shall conform to Table 19 [see 5i)].

NOTE 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 polygonal rod, as measured between two cross-sections along the rod, shall conform to Table 20.

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 to 7.4.

7.2 Analysis

The sampling rate shall be in accordance with Table 21. 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.

NOTE 1 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.

NOTE 2 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 as conforming to EN ISO 9001 or EN ISO 9002.

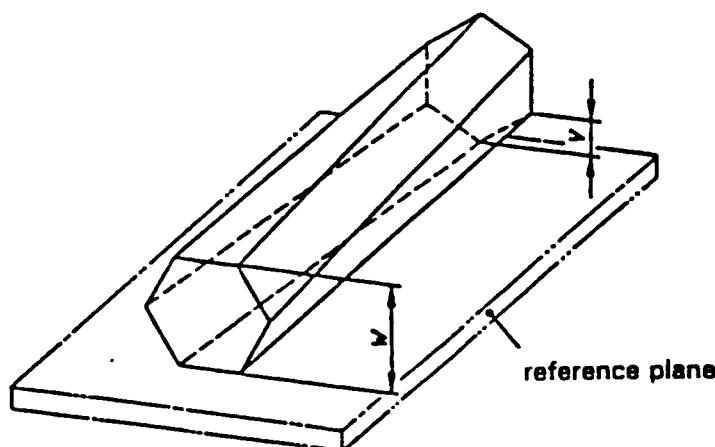


Figure 1 — Measurement of twist of polygonal rod

7.3 Mechanical tests

The sampling rate shall be in accordance with Table 21. 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 material, 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 21.

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. For expression of results, the rounding rules given in 8.7 shall be used.

NOTE In cases of dispute concerning the results of analysis, the methods of analysis to be used should be agreed between the disputing parties.

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 10002-1, 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;
- b) 4 mm up to and including 8 mm;
- c) greater than 8 mm

are based on original gauge lengths of 100 mm, $11,3\sqrt{S_0}$ and $5,65\sqrt{S_0}$ respectively, where S_0 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 10002-1.

8.2.5 Determination of results

The tensile 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 8.7 shall be used.

NOTE Elongation measurements less than 5 % may be reported as "less than 5 %". This accords with the precision of the method given in EN 10002-1.

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 10003-1 or ISO 6507-1 and the impression/indentation made on the cross-section of the product mid-way between the central axis and the outside surface.

For the Vickers test in accordance with ISO 6507-1 a test force of 49,03 N, 98,07 N or 294,21 N shall be used.

For the Brinell test in accordance with EN 10003-1, a $0,102F/D^2$ ratio of 10 shall be used, i.e. use a 1,00 mm diameter ball and a force of 98,07 N, or a 2,5 mm diameter ball and a force of 612,9 N, or a 10,0 mm diameter ball and a force of 9 807 N.

8.4 Dezincification resistance test

The test method given in EN ISO 6509 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:

- for grade A, the maximum depth of dezincification in a longitudinal direction shall be measured;
- for grade B, the mean depth of dezincification (in accordance with annex B) and 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 ISO 196 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 5m)].

8.6 Retests

8.6.1 Analysis, tensile, hardness and dezincification resistance tests

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.

NOTE If an inspection lot of alloy CuZn32Pb2AsFeSi (CW709R) 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.

8.6.2 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 material 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 material shall be deemed not to conform to this standard.

8.7 Rounding of results

For the purpose of determining conformity to the limits specified in this standard, excluding dimensions, 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 annex B of ISO 31-0:1992. It shall be rounded in one step to the same number of figures used to express the specified limit in this standard, except that for tensile strength the rounding interval shall be 10 N/mm² and for elongation the value shall be rounded to the nearest 0,5 %.

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 5o)] 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 5p)] and agreed with the supplier, the supplier shall issue for the products the appropriate inspection document, in accordance with EN 10204.

10 Marking, labelling, packaging

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

Table 1 — Composition of copper

Material designation		Composition in % (m/m)								Density ²⁾ g/cm ³
Symbol	Number	Element	Cu ¹⁾	Bi	O	P	Pb	Other elements (see note)		approx.
								total	excludng	
Cu-FRTP	CW006A	min. max.	99,90 —	— —	— 0,100	— —	— —	— 0,05	Ag, Ni, O	8,9
Cu-DLP	CW023A	min. max.	99,90 —	— 0,000 5	— —	0,005 0,013	— 0,005	— 0,03	Ag, Ni, P	8,9
Cu-DHP	CW024A	min. max.	99,90 —	— —	— —	0,015 0,040	— —	— —	—	8,9
¹⁾ Including Ag, up to a maximum of 0,015 %.										
²⁾ For information only.										
NOTE The total of other elements (than copper) is defined as the sum of Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, O, P, Pb, S, Sb, Se, Si, Sn, Te and Zn, subject to the exclusion of any individual elements indicated.										

NOTE A standard for copper rod for electrical purposes is in course of preparation (WI: 00133024).

Table 2 — Composition of low alloyed copper alloys

Material designation		Composition in % (m/m)															Density ¹⁾
Symbol	Number	Element	Cu	Al	Be	Co	Cr	Fe	Mn	Ni	P	Pb	Si	Zn	Zr	Others total	g/cm ³ approx.
CuBe2	CW101C	min.	Rem.	—	1,8	—	—	—	—	—	—	—	—	—	—	—	8,3
		max.	—	—	2,1	0,3	—	0,2	—	0,3	—	—	—	—	—	0,5	
CuCo1Ni1Be	CW103C	min.	Rem.	—	0,4	0,8	—	—	—	0,8	—	—	—	—	—	—	8,8
		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	
CuCr1	CW105C	min.	Rem.	—	—	—	0,5	—	—	—	—	—	—	—	—	—	8,9
		max.	—	—	—	—	1,2	0,08	—	—	—	—	0,1	—	—	0,2	
CuCr1Zr	CW106C	min.	Rem.	—	—	—	0,5	—	—	—	—	—	—	—	0,03	—	8,9
		max.	—	—	—	—	1,2	0,08	—	—	—	—	0,1	—	0,3	0,2	
CuNi1P	CW108C	min.	Rem.	—	—	—	—	—	—	0,8	0,15	—	—	—	—	—	8,9
		max.	—	—	—	—	—	—	—	1,2	0,25	—	—	—	—	0,1	
CuNi1Si	CW109C	min.	Rem.	—	—	—	—	—	—	1,0	—	—	0,4	—	—	—	8,8
		max.	—	—	—	—	—	0,2	0,1	1,6	—	0,02	0,7	—	—	0,3	
CuNi2Be	CW110C	min.	Rem.	—	0,2	—	—	—	—	1,4	—	—	—	—	—	—	8,8
		max.	—	—	0,6	0,3	—	0,2	—	2,4	—	—	—	—	—	0,5	
CuNi2Si	CW111C	min.	Rem.	—	—	—	—	—	—	1,6	—	—	0,4	—	—	—	8,8
		max.	—	—	—	—	—	0,2	0,1	2,5	—	0,02	0,8	—	—	0,3	
CuNi3Si1	CW112C	min.	Rem.	—	—	—	—	—	—	2,6	—	—	0,8	—	—	—	8,8
		max.	—	—	—	—	—	0,2	0,1	4,5	—	0,02	1,3	—	—	0,5	
CuSi3Mn1	CW116C	min.	Rem.	—	—	—	—	—	0,7	—	—	—	2,7	—	—	—	8,8
		max.	—	0,05	—	—	—	0,2	1,3	—	0,05	0,05	3,2	0,4	—	0,5	
CuZr	CW120C	min.	Rem.	—	—	—	—	—	—	—	—	—	—	—	0,1	—	8,9
		max.	—	—	—	—	—	—	—	—	—	—	—	—	0,2	0,1	

For information only.
NOTE Low alloyed copper rod for free machining purposes is included in EN 12164.