
Plain bearings — Copper alloys —

Part 1:

**Cast copper alloys for solid and
multilayer thick-walled plain bearings**

Paliers lisses — Alliages de cuivre —

*Partie 1: Alliages de cuivre moulés pour paliers lisses à paroi épaisse,
massifs et multicouches*

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Contents

	Page
Foreword.....	iv
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Requirements.....	1
4.1 General.....	1
4.2 Chemical composition.....	2
4.3 Analysis.....	2
5 Material properties.....	2
5.1 General.....	2
5.2 Test methods.....	5
5.2.1 Hardness test.....	5
5.2.2 Tensile test.....	5
6 Designation and ordering information.....	5
Annex A (informative) Guidance for uses of bearing metals and for the hardness of the mating bearing part (shaft).....	7
Bibliography.....	8

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions*.

This third edition cancels and replaces the second edition (ISO 4382-1:1991), which has been technically revised.

The main changes compared to the previous edition are as follows:

- [Clause 2](#) "Normative references" has been updated;
- [Clause 3](#) "Terms and definitions" has been implemented;
- [Table 1](#) and [Table 2](#) have been updated.

A list of all parts in the ISO 4382 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Plain bearings — Copper alloys —

Part 1:

Cast copper alloys for solid and multilayer thick-walled plain bearings

1 Scope

This document specifies requirements for cast copper alloys for use in solid and multilayer thick-walled plain bearings. It gives a limited selection of alloys currently available for general purposes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4384-1, *Plain bearings — Hardness testing of bearing metals — Part 1: Multilayer bearings materials*

ISO 4384-2, *Plain bearings — Hardness testing of bearing metals — Part 2: Solid materials*

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

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Requirements

4.1 General

If the purchaser's requirements necessitate limits for any element not specified, or limits different from those already specified, these should be agreed upon between supplier and purchaser.

WARNING — Lead's (Pb) toxicity has been recognized, and its use has since been phased out of many applications. However, many countries still allow the sale of products that expose humans to lead. Lead is a neurotoxin (see [Figure 1](#)).



GHS 07



GHS 08



GHS 09

Figure 1 — Reach compliance symbols

4.2 Chemical composition

The chemical composition shall be within the limits specified in [Table 1](#) and [Table 2](#), where single figures denote maximum values.

4.3 Analysis

Methods of analysis for alloying elements or impurities shall either be as specified in relevant International Standards or as mutually agreed between supplier, purchaser and any mutually acceptable arbitrator.

5 Material properties

5.1 General

The minimum tensile strength and elongation values quoted in [Table 1](#) and [Table 2](#) are included as properties which may assist designers. Brinell hardness is the mandatory quality control check. If tensile strength and elongation tests are required, this should be stated by the purchaser at the time of ordering.

For finished bearings, Brinell hardness will normally be checked.

Table 1 — Copper/lead/tin and copper/aluminium casting alloys for solid and multilayer thick-walled plain bearings

Chemical elements and properties	Chemical composition				
	mass fraction %				
	CuPb9Sn5	CuPb10Sn10 ^a	CuPb15Sn8	CuPb20Sn5	CuAl10Fe5Ni5
Cu	Remainder	Remainder	Remainder	Remainder	Remainder
Sn	4 to 6	9 to 11	7 to 9	4 to 6	0,2
Pb	8 to 10	8 to 11	13 to 17	18 to 23	0,1
Zn	2	2	2	2	0,5
Fe	0,25	0,25	0,25	0,25	3,5 to 5,5
Ni	2	2	2	2,5	3,5 to 6,5
Sb	0,5	0,5	0,5	0,75	—
P	0,1 ^b	0,05 ^b	0,1 ^b	0,1 ^b	—
Al	0,01	0,01	0,01	0,01	8 to 11
Mn	0,2	0,2	0,2	0,2	3
Si	0,01	0,01	0,01	0,01	0,1
S	0,1	0,1	0,1	0,1	—

Table 1 (continued)

Chemical elements and properties		Chemical composition				
		mass fraction %				
		CuPb9Sn5	CuPb10Sn10 ^a	CuPb15Sn8	CuPb20Sn5	CuAl10Fe5Ni5
Cu+ Fe+ Ni+ Al+ Mn		—	—	—	—	> 99,2
Material properties of test bar						
Brinell hardness^c HBW 2,5/62,5/10, min.	GS	55	65	60	45	140
	GM	60	65	60	50	140
	GZ	60	70	65	50	140
	GC	60	70	65	50	140
Tensile strength R_m N/mm ² , min.	GS	160	180	170	150	600
	GM	200	220	200	170	600
	GZ	220	220	220	180	680
	GC	230	220	220	180	680
Elongation after fracture A %, min.	GS	7	7	5	5	10
	GM	5	3	3	5	12
	GZ	6	6	8	7	12
	GC	9	6	8	7	12
0,2 % proof stress $R_{p0,2}$ N/mm ² , min.	GS	60	80	80	60	250
	GM	80	140	100	80	250
	GZ	80	110	100	80	280
	GC	130	110	100	80	280
Elastic modulus E kN/mm ² ≈		85	90	85	75	120
Linear thermal expansion coefficient α_1 10 ⁻⁶ /K ≈		18	18	18	19	16
Thermal conductivity λ , at 15 °C W/(m·K) ≈		71	47	47	59	60
Density, ρ kg/dm ³ ≈		9	9	9,1	9,3	7,6
GS: Sand GM: Permanent mould GZ: Centrifugal GC: Continuous ^a The chemical composition of this alloy differs from that of thin-walled multilayer plain bearings (see ISO 4383). ^b For continuous casting, the phosphorus content may be increased to a maximum of 1,5 % by agreement. ^c For hardness testing, see ISO 4384-1 and ISO 4384-2. NOTE Table A.1 gives some general guidance on the characteristics and principal uses of the different bearing alloys.						

Table 2 — Copper/tin/zinc casting alloys for solid plain bearings

Chemical elements and properties		Chemical composition				
		mass fraction %				
		CuSn8Pb2	CuSn10P	CuSn12Pb2	CuPb5Sn5Zn5	CuSn7Pb7Zn3
Cu		Remainder	Remainder	Remainder	Remainder	Remainder
Sn		6 to 9	10 to 11,5	11 to 13 ^a	4 to 6	6 to 8
Pb		0,5 to 4	0,25	1 to 2,5	4 to 6	5 to 8
Zn		3	0,05	2	4 to 6	2 to 5
Fe		0,2	0,1	0,2	0,3	0,2
Ni		2,5	0,1	2	2,5	2
Sb		0,25	0,05	0,2	0,25	0,35
P		0,05 ^b	0,5 to 1	0,05 to 0,4 ^{b,c}	0,05 ^b	0,1 ^b
Al		0,01	0,01	0,01	0,01	0,01
Mn		—	0,5	0,2	—	—
Si		0,01	0,02	0,01	0,01	0,01
S		0,1	0,05	0,05	0,1	0,1
Material properties of test bar						
Brinell hardness^d HBW 2,5/62,5/10, min.	GS	60	70	80	60	65
	GM	85	95	—	60	65
	GZ	85	95	90	65	70
	GC	85	95	90	65	70
Tensile strength R_m N/mm ² , min.	GS	250	220	240	200	210
	GM	220	310	—	200	210
	GZ	230	330	280	250	260
	GC	270	360	280	250	260
Elongation after fracture A %, min.	GS	3	3	7	13	12
	GM	2	2	—	13	12
	GZ	4	4	5	13	12
	GC	5	6	7	13	12
0,2 % proof stress $R_{p0,2}$ N/mm ² , min.	GS	130	130	130	90	100
	GM	130	170	—	90	100
	GZ	130	170	150	100	120
	GC	130	170	150	100	120
Elastic modulus E kN/mm ² ≈		75	95	95	90	85
Linear thermal expansion coefficient α_1 10 ⁻⁶ /K ≈		18	18	18	18	18
Thermal conductivity λ , at 15 °C W/(m·K) ≈		47	50	54	71	59
Density ρ kg/dm ³ ≈		8,8	8,8	8,7	8,7	8,8

Table 2 (continued)

Chemical elements and properties	Chemical composition				
	mass fraction %				
	CuSn8Pb2	CuSn10P	CuSn12Pb2	CuPb5Sn5Zn5	CuSn7Pb7Zn3
GS: Sand					
GM: Permanent mould					
GZ: Centrifugal					
GC: Continuous					
a	For centrifugal and continuous casting, a tin content of 10,5 % to 13 % is admissible.				
b	For continuous casting, the phosphorus content may be increased to a maximum of 1,5 % by agreement.				
c	The phosphorus content shall be fixed by agreement.				
d	For hardness testing, see ISO 4384-1 and ISO 4384-2.				
NOTE	Table A.1 gives some general guidance on the characteristics and principal uses of the different bearing alloys.				

5.2 Test methods

5.2.1 Hardness test

Hardness testing shall be carried out in accordance with ISO 4384-1 and ISO 4384-2. If the specimen size does not permit this, the test method may be agreed between supplier and purchaser. Acceptable minimum values shall then be as agreed.

5.2.2 Tensile test

The tensile test shall be carried out in accordance with ISO 6892-1. If specimen sizes do not permit the use of standard test pieces, then test methods and mandatory values shall be as agreed between supplier and purchaser.

In the case of sand casting and permanent mould casting, the test bars are cast separately. In the case of continuous casting, the test bars are taken from the casting and, in the case of centrifugal casting, they may also be taken from the casting.

The test bars may be tested either as cast or machined.

Cast test bars shall have diameters between 12 mm and 25 mm; machined test bars shall have a finished diameter between 10 mm and 18 mm. In the latter case, a diameter of 14 mm ± 0,5 mm is recommended.

6 Designation and ordering information

The designation is separated into the following types of casting:

GS – Sand

GM – Permanent mould

GZ – Centrifugal

GC – Continuous

The following tests may be requested by the purchaser:

R: Test of tensile strength

ISO 4382-1:2021(E)

RA: Test of tensile strength and elongation

H: Test of Brinell hardness (on cast material or finished solid plain bearing)

EXAMPLE Designation of the bearing metal made of continuous casting (GC) having the symbol CuPb10Sn10, when the test for tensile strength and elongation (RA) is to be carried out on the test bar:

Bearing metal ISO 4382 – GC – CuPb10Sn10 – RA

For finished machined material, the dimensions may be selected, for example, from ISO 4379.

For unmachined material, the manufacturer's recommended allowances for machining should be added to the outside diameter and subtracted from the inside diameter.

The purchaser shall indicate whether a certificate of conformance is required.

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Annex A (informative)

Guidance for uses of bearing metals and for the hardness of the mating bearing part (shaft)

Table A.1 — Guidance for uses of bearing metals and for the hardness of the mating bearing part (shaft)

Bearing alloys	Characteristics and principal uses ^a	Minimum hardness of the shaft ^b
CuPb9Sn5	Soft copper-based bearing alloys suitable for moderate loads and moderate to high sliding velocities. Increasing the tin content increases the hardness and wear resistance.	250 HBW
CuPb10Sn10		
CuPb15Sn8	Soft copper-based bearing alloys suitable for moderate loads and moderate to high sliding velocities. Increasing the tin content increases the hardness and wear resistance. Tolerant of water lubrication.	250 HBW
CuPb20Sn5	Soft copper-based bearing alloys suitable for moderate loads and moderate to high sliding velocities. Increasing the tin content increases the hardness and water resistance. Suitable for water lubrication	200 HBW
CuAl10Fe5Ni5	Very hard alloy for structural components under sliding conditions. Suitable for marine environments. Hardened shafts essential. Relatively poor embeddability.	55 HRC
CuSn8Pb2	For non-critical applications with low to moderate loads; when there is adequate lubrication.	300 HBW
CuSn7Pb7Zn3		
CuSn10P	For hardened shafts with a combination of high load, high sliding velocity, impact loading or pounding; when there is adequate lubrication and good alignment.	55 HRC
CuSn12Pb2		
CuPb5Sn5Zn5	For non-critical applications with low loads; adequate lubrication.	250 HBW
^a Higher lead content improves the tolerance of poor alignment and intermittent lubrication.		
^b The shaft hardness should be four times higher than the bearing alloy hardness. The difference in hardness between bearing material and shaft material shall be such that welding of the bearing material under working conditions is safely avoided. The lubrication conditions have considerable influence on the selection of the shaft material, in particular on the hardness. The tabulated hardness values for shaft material are minimum values which are valid for most cases of application.		