BS ISO 3290-2:2014

BSI Standards Publication

Rolling bearings — Balls

Part 2: Ceramic balls

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National foreword

This British Standard is the UK implementation of ISO 3290-2:2014. It supersedes BS ISO 3290-2:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/7, Rolling bearings.

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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Rolling bearings — Balls —

Part 2: Ceramic balls

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Partie 2: Billes de roulement en céramique

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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 4, *Rolling bearings*, Subcommittee SC 12, *Ball bearings*.

This second edition cancels and replaces the first edition (ISO 3290-2:2008), which has been technically revised.

ISO 3290 consists of the following parts, under the general title *Rolling bearings — Balls*:

— *Part 1: Steel balls*

— *Part 2: Ceramic balls*

INTERNATIONAL STANDARD **ISO 3290-2:2014(E)**

Rolling bearings — Balls —

Part 2: Ceramic balls

1 Scope

This part of ISO 3290 specifies requirements for finished silicon nitride balls for rolling bearings.

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.

ISO 1132-1, *Rolling bearings — Tolerances — Part 1: Terms and definitions*

ISO 4288, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture*

ISO 5593, *Rolling bearings — Vocabulary*

ISO 12181-1, *Geometrical product specifications (GPS) — Roundness — Part 1: Vocabulary and parameters of roundness*

ISO 15241, *Rolling bearings — Symbols for physical quantities*

ISO 26602, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Silicon nitride materials for rolling bearing balls*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1132-1, ISO 5593, and the following apply.

3.1
ball gauge
amount by which the mean diameter of ball lot should differ from the nominal ball diameter, this amount being one of an established series

Note 1 to entry: Each ball gauge is a whole multiple of the ball gauge interval established for the ball grade in question.

Note 2 to entry: A ball gauge, in combination with the ball grade and nominal diameter, is considered as the most exact ball size specification to be used by a customer for ordering purposes.

[SOURCE: ISO 5593:1997, 05.04.09, modified — Note 1 and Note 2 to entry have been added.]

3.2
ball gauge interval
absolute difference of two consecutive ball gauges

3.3
ball grade
specific combination of dimensional, form, surface roughness, and sorting tolerances for balls

Note 1 to entry: Ball grade is identified by the letter G and a number, e.g. G 20.

[SOURCE: ISO 5593:1997, 05.04.08, modified — Note 1 to entry has been added.]

3.4
ball lot
definite quantity of balls manufactured under conditions presumed uniform and which is considered as an entity

[SOURCE: ISO 5593:1997, 05.04.05]

3.5
ball subgauge
amount of an established series of amounts, which is the nearest to the actual deviation from the ball gauge of a ball lot

Note 1 to entry: Each ball subgauge is a whole multiple of the ball subgauge interval established for the ball grade in question.

Note 2 to entry: The ball subgauge, in combination with the nominal ball diameter and the ball gauge, is used by ball manufacturers to denote the mean diameter of a ball lot and is not generally used by customers for ordering purposes.

[SOURCE: ISO 5593:1997, 05.04.11, modified — Notes 1 and 2 to entry have been added.]

3.6
ball subgauge interval
absolute difference of two consecutive ball subgauges

3.7
deviation from spherical ball surface
various types of deviation from the perfect spherical ball surface, uniformly or non-uniformly distributed and repeated around the ball surface

Note 1 to entry: The deviations to which limits can be attributed to are

— deviation from spherical form,

— surface defect,

— surface roughness, and

— waviness.

3.7.1
deviation from spherical form
radial distance between the smallest circumscribed sphere and the greatest inscribed sphere, with their centres common to the least squares sphere centre

Note 1 to entry: This definition supersedes ISO 5593:1997, 05.06.03.

3.7.2
surface defect
element, irregularity, or group of elements and irregularities of the real surface, unintentionally or accidentally caused during manufacture, storage, handling, or use of the surface

Note 1 to entry: These types of element or irregularity differ considerably from those constituting the surface roughness and are not considered during the measurement of the surface roughness.

Note 2 to entry: The limits for surface defects are not specified in this part of ISO 3290.

3.7.3
surface roughness
surface irregularities with relatively small spacings, which usually include irregularities resulting from the method of manufacture being used and/or other influences

Note 1 to entry: These irregularities are considered within the limits that are conventionally defined, e.g. within the limits of the sampling length.

3.7.4
waviness
surface irregularities of random or periodical deviation from the ideal spherical form

Note 1 to entry: Waviness shall be evaluated by default as velocity amplitude.

Note 2 to entry: In practice, the waviness components are separated from the real surface by a waviness analyser (filters).

3.8
deviation of a ball lot from ball gauge
difference between the mean diameter of a ball lot and the sum of the nominal ball diameter and the ball gauge

[SOURCE: ISO 5593:1997, 05.04.10]

3.9
hardness
<rolling bearings> measure of resistance to penetration as determined by a specific test method

Note 1 to entry: For ceramics balls, such a test method is the Vickers hardness test.

3.10
mean ball diameter
arithmetical mean of the largest and the smallest of the single diameters of a ball

[SOURCE: ISO 5593:1997, 05.04.03]

3.11
mean diameter of ball lot
arithmetical mean of the mean diameters of the largest ball and the smallest ball in a ball lot

[SOURCE: ISO 5593:1997, 05.04.06]

3.12
nominal ball diameter
diameter value which is used for the general identification of a ball size

[SOURCE: ISO 5593:1997, 05.04.01]

3.13
single ball diameter
distance between two parallel planes tangential to the actual surface of a ball

[SOURCE: ISO 5593:1997, 05.04.02]

3.14
variation of ball diameter
difference between the largest and the smallest of the single diameters of a ball

[SOURCE: ISO 5593:1997, 05.04.04]

3.15
variation of ball lot diameter
difference between the mean diameters of the largest ball and the smallest ball in a ball lot

[SOURCE: ISO 5593:1997, 05.04.07]

4 Symbols

For the purposes of this document, the symbols given in ISO 15241 and the following apply.

The symbols (except those for tolerances) and the values given in Table 1, Table 2, and Table 3 denote nominal dimensions, unless specified otherwise.

D_w	nominal ball diameter
D_{wm}	mean ball diameter
D_{wmL}	mean diameter of ball lot
D_{ws}	single ball diameter
G	ball grade
Ra	arithmetical mean deviation of surface texture (see ISO 4287[1])
S	ball gauge
V_{DwL}	variation of ball lot diameter
V_{Dws}	variation of ball diameter
Δ_{RSw}	deviation from spherical form
Δ_S	deviation of a ball lot from a ball gauge

NOTE $\Delta_S = D_{wmL} - (D_w + S)$

5 Requirements

5.1 Ball size

The preferred nominal ball diameters are given in Table 1 and, where applicable, the corresponding inch sizes are given for reference purposes only.

5.2 Quality of geometry and surface

Requirements for:

— variation of ball diameter (see Table 2);

— deviation from spherical form, (see Table 2);

— waviness (see Note 1);

— surface roughness (see Table 2);

— surface appearance (see Note 2 and Note 3).

Measurement of surface roughness shall be carried out in accordance with ISO 4288.

NOTE 1 Limits and measuring methods for waviness are subject to agreement between the customer and supplier.

NOTE 2 Local inhomogeneities in colour, densification, pressing defects, snowflakes, etc. and cracks inherent to the material and its processing are subject to agreement between the customer and supplier.

NOTE 3 Local defects originating from machining and handling are subject to agreement between the customer and supplier.

5.3 Sorting accuracy and ball gauges

Table 3 comprises the applicable values for

— variation of ball lot diameter,

— gauge interval,

— preferred gauges,

— subgauge interval, and

— subgauges.

6 Material

The balls shall be manufactured from silicon nitride material in accordance with ISO 26602.

7 Dimensions and tolerances

7.1 General

The preferred nominal ball diameters are given in Table 1. Tolerances for form and surface roughness are given in Table 2. Sorting tolerances and ball gauges are given in Table 3.

7.2 Shortened formats for nominal diameter identification

7.2.1 Metric option

For purchasing and other general administrative purposes, some users optionally identify nominal metric ball diameters with only three digits following the decimal comma.

This option does not identify the diameter with adequate precision for manufacturing purposes and the full long diameter values given in Table 1 with four or five digits following the decimal comma to precisely identify the size shall always be used for gauge and subgauge sorting purposes to avoid any possibility of ambiguity.

7.2.2 Imperial option

For purchasing and other general administrative purposes, some users optionally continue to identify nominal ball diameters with imperial exact fraction or decimal sizes which carry no risk of ambiguity. Metric equivalents are sometimes also shown but not used as the primary administrative identifier.

If this option is applied, gauge and subgauge diameter tolerances in micrometres shall be added to the imperial nominal reference size or its exact metric equivalent with four or five digits following the decimal comma according to Table 1 of this part of ISO 3290, for sorting purposes during manufacturing procedures.

Table 1 — Preferred nominal ball diameters

Nominal ball diameter D_w mm	**Corresponding inch size** (reference) in
0,3	—
0,396 88	1/64
0,4	—
0,5	—
0,508	1/50
0,6	—
0,635	1/40
0,68	—
0,7	—
0,793 75	1/32
0,8	—
1	—
1,190 62	3/64
1,2	—
1,5	—
1,587 5	1/16
1,984 38	5/64
2	—
2,381 25	3/32
2,5	—
2,778 12	7/64
3	—
3,175	1/8
3,5	—
3,571 88	9/64
3,968 75	5/32
4	—
4,365 62	11/64
4,5	—
4,762 5	3/16
5	—
5,159 38	13/64
5,5	—
5,556 25	7/32
5,953 12	15/64
6	—
6,35	1/4
6,5	—
6,746 88	17/64

Table 1 *(continued)*

Nominal ball diameter D_W mm	**Corresponding inch size** (reference) in
7	—
7,143 75	9/32
7,5	—
7,540 62	19/64
7,937 5	5/16
8	—
8,334 38	21/64
8,5	—
8,731 25	11/32
9	—
9,128 12	23/64
9,5	—
9,525	3/8
9,921 88	25/64
10	—
10,318 75	13/32
10,5	—
11	—
11,112 5	7/16
11,5	—
11,509 38	29/64
11,906 25	15/32
12	—
12,303 12	31/64
12,5	—
12,7	1/2
13	—
13,493 75	17/32
14	—
14,287 5	9/16
15	—
15,081 25	19/32
15,875	5/8
16	—
16,668 75	21/32
17	—
17,462 5	11/16
18	—
18,256 25	23/32

Table 1 *(continued)*

Nominal ball diameter D_w mm	**Corresponding inch size** (reference) in
19	—
19,05	3/4
19,843 75	25/32
20	—
20,5	—
20,637 5	13/16
21	—
21,431 25	27/32
22	—
22,225	7/8
22,5	—
23	—
23,018 75	29/32
23,812 5	15/16
24	—
24,606 25	31/32
25	—
25,4	1
26	—
26,193 75	1 1/32
26,987 5	1 1/16
28	—
28,575	1 1/8
30	—
30,162 5	1 3/16
31,75	1 1/4
32	—
33	—
33,337 5	1 5/16
34	—
34,925	1 3/8
35	—
36	—
36,512 5	1 7/16
38	—
38,1	1 1/2
39,687 5	1 9/16
40	—
41,275	1 5/8

Table 1 *(continued)*

Nominal ball diameter D_w mm	Corresponding inch size (reference) in
42,862 5	1 11/16
44,45	1 3/4
45	—
46,037 5	1 13/16
47,625	1 7/8
49,212 5	1 15/16
50	—
50,8	2
53,975	2 1/8
55	—
57,15	2 1/4

Table 2 — Form and surface roughness tolerances

Tolerance values in micrometres

Ball grade	Variation of ball diameter[a] V_{Dws} max.	Deviation from spherical form[a] Δ_{RSw} max.	Surface roughness[a] Ra max.
G 3	0,08	0,08	0,01
G 5	0,13	0,13	0,014
G 10	0,25	0,25	0,02
G 16	0,4	0,4	0,025
G 20	0,5	0,5	0,032
G 24	0,6	0,6	0,04
G 28	0,7	0,7	0,05
G 40	1	1	0,06
G 60	1,5	1,5	0,08
G 100	2,5	2,5	0,1

[a] The values do not take into account surface defects; hence, measurement shall be taken outside such defects.

Table 3 — Sorting tolerances and ball gauges

Tolerance values in micrometres

Ball grade	Variation of ball lot diameter V_{DwL} max.	Ball gauge interval	Preferred ball gauges	Ball subgauge interval	Ball subgauges
G 3	0,13	0,5	−5, … −0,5, 0, +0,5, … +5	0,1	−0,2, −0,1, 0, +0,1, +0,2
G 5	0,25	1	−5, … −1, 0, +1, … +5	0,2	−0,4, −0,2, 0, +0,2, +0,4
G 10	0,5	1	−9, … −1, 0, +1, … +9	0,2	−0,4, −0,2, 0, +0,2, +0,4

Table 3 *(continued)*

Ball grade	Variation of ball lot diameter V_{DwL} max.	Ball gauge interval	Preferred ball gauges	Ball subgauge interval	Ball subgauges
G 16	0,8	2	−10, … −2, 0, +2, … +10	0,4	−0,8, −0,4, 0, +0,4, +0,8
G 20	1	2	−10, … −2, 0, +2, … +10	0,4	−0,8, −0,4, 0, +0,4, +0,8
G 24	1,2	2	−12, … −2, 0, +2, … +12	0,4	−0,8, −0,4, 0, +0,4, +0,8
G 28	1,4	2	−12, … −2, 0, +2, … +12	0,4	−0,8, −0,4, 0, +0,4, +0,8
G 40	2	4	−16, … −4, 0, +4, … +16	0,8	−1,6, −0,8, 0, +0,8, +1,6
G 60	3	6	−18, … −6, 0, +6, … +18	1,2	−2,4, −1,2, 0, +1,2, +2,4
G 100	5	10	−40, … −10, 0, +10, … +40	2	−4, −2, 0, +2, +4

Annex A
(normative)

Method for assessment of deviation from spherical form

The measurement of deviation from spherical form of a ball shall be carried out by the measurement of roundness deviation in three single equatorial planes at about 90° to each other.

The default evaluation method of roundness deviation in a single equatorial plane shall be carried out by the calculation from the least squares reference circle in accordance with ISO 12181-1.

The greatest roundness deviation in any of these single equatorial planes is assumed to be the deviation from spherical form.

For a detailed description of methods for the assessment of deviation from roundness, see ISO 4291. [2]

If a different evaluation method is used, it should be agreed between the customer and supplier.

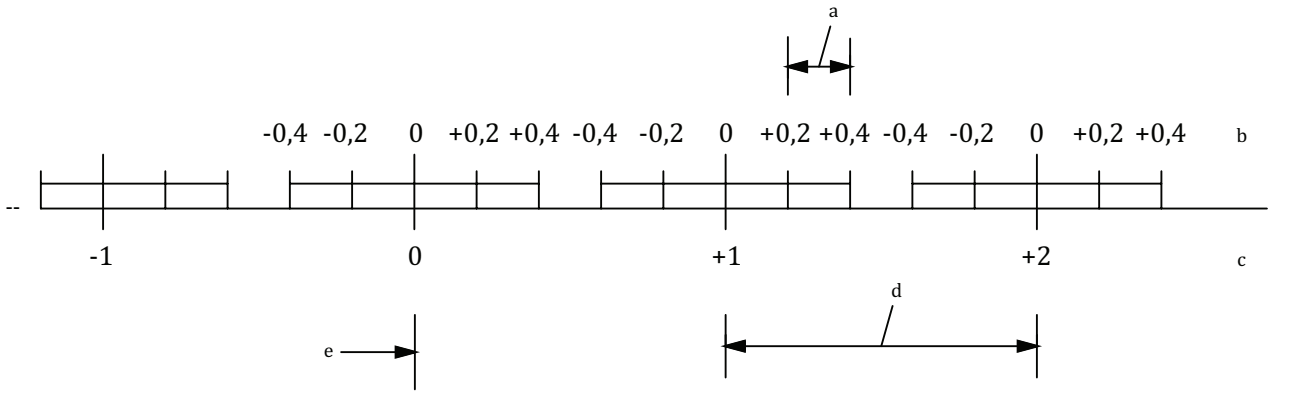
Annex B
(normative)

Illustration of ball gauges and sorting principles

B.1 Ball gauge and ball subgauge

Figure B.1 shows an example of ball gauge and ball subgauge for Grade G 5 balls.

Values in micrometres

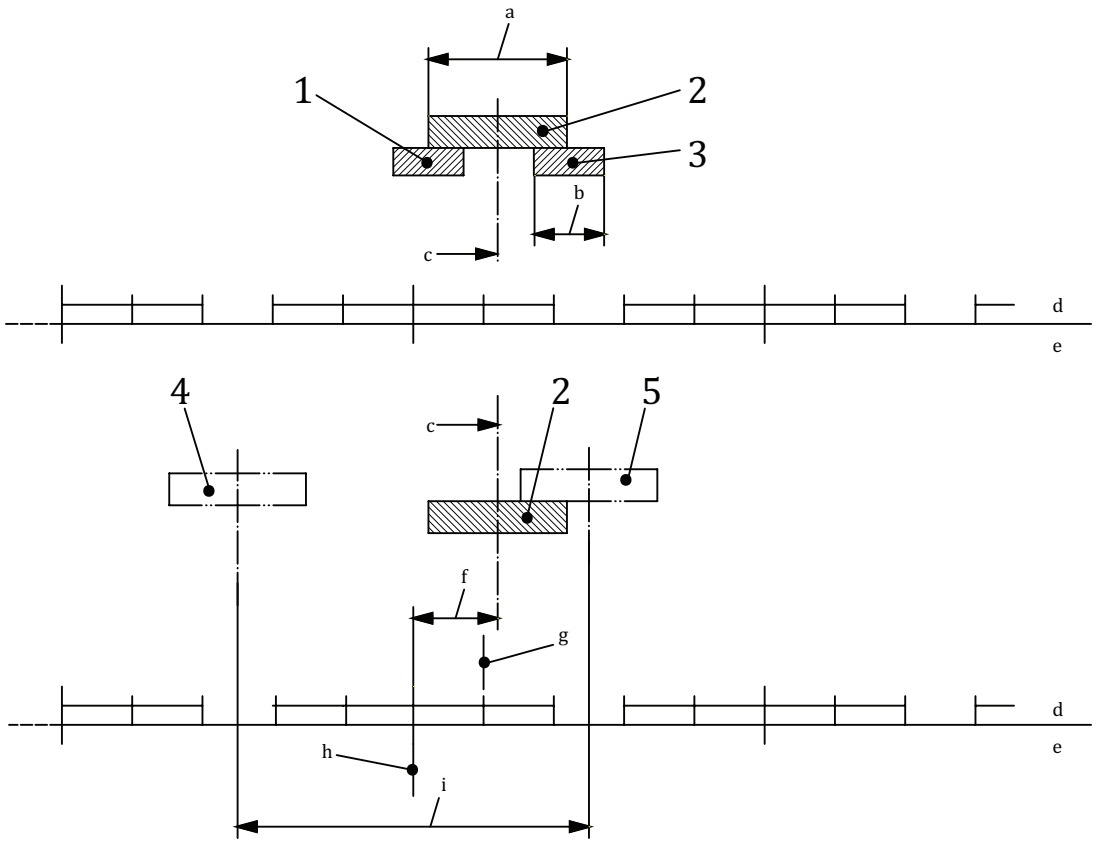


a Ball subgauge interval.
b Ball subgauge scale.
c Ball gauge scale.
d Ball gauge interval.
e Nominal ball diameter, D_W.

Figure B.1 — Example of ball gauge and ball subgauge for Grade G 5 balls

B.2 Ball lot and ball gauge deviation

Figure B.2 shows the relationship between a ball lot and its ball gauge.



Key

1 smallest ball in the ball lot
2 ball lot
3 largest ball in the ball lot
4 ball lot with smallest D_{wmL} to be referred to ball gauge *S*
5 ball lot with largest D_{wmL} to be referred to ball gauge *S*

a Variation of ball lot diameter, $V_{D\mathrm{wL}}$.
b Variation of ball diameter, $V_{D\mathrm{ws}}$.
c Mean diameter of ball lot, D_{wmL}.
d Ball subgauge scale.
e Ball gauge scale.
f Deviation of a ball lot from ball gauge, Δs.
g Ball subgauge to which the ball lot is assigned.
h Ball gauge, *S*.
i Range of mean diameter of ball lot for ball gauge *S*.

Figure B.2 — Relationship between a ball lot and its ball gauge

Annex C
(informative)

Examples of defect types and methods of inspection

C.1 General

Due to the material structure and manufacturing methods of silicon nitride balls, the defects listed in C.2.1 can occur. Methods for inspection/detections of these defects are listed in C.2.2.

C.2 Defects

C.2.1 Types of defects

The types of defect are

— inclusions,

— porosity,

— pits,

— scratches,

— nicks,

— scuffs,

— cracks, and

— colour variations.

C.2.2 Methods of inspection

The following are methods of inspection:

— visual white light (with or without artificial magnification);

— fluorescent penetrant inspection (FPI) (with or without artificial magnification);

— ultrasonic inspection.

NOTE The following methods are currently being developed, but still require extensive evaluation to be applicable:

a) resonance inspection (resonant ultrasound spectroscopy);

b) Raleigh wave;

c) acoustic microscopy.

Bibliography

[1] ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

[2] ISO 4291, *Methods for the assessement of departure from roundness — Measurement of variations in radius*

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