Balls for rolling bearings and general industrial use

DIN 5401

ICS 21.100.20

Wälzlager – Kugeln für Wälzlager und allgemeinen Industriebedarf

Supersedes DIN 5401-1 and DIN 5401-2, November 1993 editions.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Foreword

This standard has been prepared by the *Arbeitsausschuss Wälzlager* (Rolling Bearings Standards Committee).

Ball sizes are also expressed in inches, for guidance. It should be noted, however, that the use of such units is prohibited under Council Directive 80/181/EEC.

See Explanatory notes for connection with International Standard ISO 3290 : 2001 published by the International Organization for Standardization (ISO).

Amendments

This standard differs from DIN 5401-1 and DIN 5401-2, November 1993 editions, as follows:

a) The two parts of the standard have been combined into one standard.
b) Further steel grades have been specified.
c) The range of ball sizes has been updated.
d) Further concepts are defined.
e) The standard has been editorially revised.

Previous editions

DIN 5401: 1953-01,1956-04, 1959-11, 1964-01, 1978-01; DIN 5401-1: 1993-11; DIN 5401-2: 1993-11.

1 Scope

This standard specifies requirements for balls for rolling bearings and for general industrial use. It covers balls made of full hardening steel, special steel and other metallic or non-metallic materials.

Continued on pages 2 to 14.

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original should be consulted as the authoritative text.

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2 Normative references

This 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 titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN EN 10016-2	Non-alloy steel rod for drawing or cold rolling – Specific requirements for general purpose rod
DIN EN 10088-3	Stainless steels – Part 3: Technical delivery conditions for general purpose semi-finished products, bars, rod and sections
DIN EN 10263-3	Steel rod, bars and wire for cold heading and cold extrusion – Part 3: Technical delivery conditions for case hardening steels
DIN EN 12163	Copper and copper alloys – Rod for general purposes
DIN EN 12166	Copper and copper alloys – Wire for general purposes
DIN EN ISO 683-17	Heat-treated steels, alloy steels and free-cutting steels – Part 17: Ball and roller bearing steels (ISO 683-17 : 1999)
DIN EN ISO 4288	GPS – Surface texture: Profile method – Rules and procedures for the assessment of surface texture (ISO 4288 : 1996)
DIN EN ISO 6506-1	Metallic materials – Brinell hardness test – Part 1: Test method (ISO 6506-1 : 1999)
DIN EN ISO 6507-1	Metallic materials – Vickers hardness test – Part 1: Test method (ISO 6507-1 : 1997)
DIN EN ISO 6508-1	Metallic materials – Rockwell hardness test – Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-1 : 1999)
ISO 4291 : 1985	Methods for the assessment of departure from roundness – Measurement of variations in radius
ISO 3290 : 2001	Rolling bearings – Balls – Dimensions and tolerances

Council Directive of 20 December 1979 on the approximation of the laws of the Member States relating to units of measurement, EC Official Gazette, 1980, No. L 39, pp. 40–50 (80/181/EEC)

3 Concepts

3.1 Nominal ball diameter

The diameter used to identify a ball size; designated by D_w.

3.2 Single ball diameter

The distance between two parallel planes tangential to the surface of a ball; designated by D_{ws}.

3.3 Mean ball diameter

The arithmetical mean of the largest and the smallest of the single diameters of a ball; designated by D_{wm}.

3.4 Ball diameter variation

The difference between the largest and smallest of the single diameters of a ball; designated by V_{Dws}.

3.5 Deviation from spherical form

The greatest radial distance, in any equatorial plane, between the smallest circumscribed sphere and the greatest inscribed sphere, calculated using the least squares centre method; designated by t_{Dws}.

NOTE: Information regarding the measurement of the deviation from spherical form is given in Annex B.

3.6 Lot

For the purposes of this standard, a definite quantity of balls manufactured under conditions which are presumed uniform, and which is considered an entity.

3.7 Lot mean diameter

The arithmetic mean of the mean diameters of the largest ball and the smallest ball in a lot (designated by D_{wmL})

3.8 Lot diameter variations

The difference between the mean diameter of the largest ball and the smallest ball in a lot; designated by V_{DwL}.

NOTE: This definition only applies to ball grades G3 to G200, except grade G80.

3.9 Ball gauge tolerance

Range within which diameter D_{wmL} may vary for a particular ball gauge, designated by S_T.

3.10 Ball diameter variation within a gauge

The difference between the largest and the smallest mean ball diameters established for a particular gauge; designated by V_{dwA}.

NOTE: This definition only applies to ball grades G500 to G700 and G80.

3.11 Gauge interval

One of the intervals into which the limit deviation for the nominal diameter of a ball is divided; designated by I_G.

3.12 Ball grade

A specific combination of dimensional, form and sorting tolerances, and of surface roughness for balls.

NOTE: A ball grade is identified by the letter G followed by a number.

3.13 Ball gauge

The amount by which the mean ball diameter of a lot (for V_{DwL}) or of a subset of a lot (for V_{DwA}), differs from the nominal ball diameter, rounded to a whole multiple of the ball gauge interval; designated by S.

3.14 Gauge deviation

The maximum deviation of the mean ball diameter from the nominal diameter.

3.15 Arithmetical mean deviation of the profile

The arithmetical average value of the departure of the profile of a surface from the mean line throughout a specified sampling length, with deviations of form and waviness being ignored; designated by R_a.

3.16 Waviness

Surface irregularities of random or periodical deviation from the ideal spherical form.

3.17 Surface defect

Any deviation of the surface from the ideal spherical form. Surface defects include irregularities originating from manufacture (e.g. inhomogenous surface texture), mechanical damage, cracks or staining.

3.18 Hardness

Measure of resistance to penetration as determined by specific methods.

NOTE: The values indicated in table 2 refer to Brinell hardness (HB), Vickers hardness (HV10) and Rockwell hardness (HRC), determined by the methods specified in DIN EN ISO 6506-1, DIN EN ISO 6507-1 and DIN EN ISO 6508-1, respectively.

3.19 Material group

Collective term to denote materials of specific properties.

4 Dimensions and designation

Recommended nominal diameters of steel balls shall be as specified in table 1, other sizes being subject to agreement.

The designation shall include the material number or name. Group 1 materials need not be included in the designation.

EXAMPLES:

Designation of a ball with a nominal diameter, D_w, of 6 mm, made of hardened steel of grade 100 Cr6 (material number: 1.3505), ball grade G10:

Ball DIN 5401 – 6 G10

Designation of a ball with a nominal diameter, D_w, of 6 mm, made of hardened steel of grade X45Cr13 (material number: 1.3541), ball grade G20:

Ball DIN 5401 – 6 G20 – 1.3541

Designation of a ball with a nominal diameter, D_w, of 6 mm, made of sintered ceramics, ball grade G5:

Ball DIN 5401 – 6 G5 – Si3N4

Table 1: Nominal diameters and mass of steel balls

Nominal ball diameter, D_w, in		Size recommended for material of group[2])									Approx. mass per 1 000 units (7,85 g/cm³), in kg[3])
mm	in[1])	1	2	3	4	5	6	7	8	9	
0,4		X		X						X	0,000 26
0,5		X		X						X	0,000 51
1		X	X	X	X			X	X	X	0,004 11
1,5		X	X	X	X	X		X	X	X	0,013 9
1,588	1/16	X	X	X	X	X		X	X	X	0,016 5
2		X	X	X	X	X		X	X	X	0,032 9
2,381	3/32	X	X	X	X	X		X	X	X	0,055 5
2,5		X	X	X	X	X		X	X	X	0,064 2
2,778	7/64	X	X	X	X	X				X	0,088 1
3		X	X	X	X	X		X	X	X	0,111
3,175	1/8	X	X	X	X	X		X	X	X	0,132
3,5		X	X	X	X	X		X	X	X	0,176
3,969	5/32	X	X	X	X	X		X	X	X	0,257
4		X	X	X	X	X		X	X	X	0,263
4,5		X	X	X	X	X		X	X	X	0,375
4,762	3/16	X	X	X	X	X		X	X	X	0,444
5		X	X	X	X	X		X	X	X	0,514
5,5		X	X	X	X	X		X	X	X	0,684
5,556	7/32	X	X	X	X	X		X	X	X	0,705
5,953	15/64	X								X	0,84
6		X	X	X	X	X	X	X	X	X	0,888
6,35	1/4	X	X	X	X	X	X	X	X	X	1,05
6,5		X	X	X	X	X	X	X	X	X	1,13
6,747	17/64	X					X			X	1,26
7		X	X	X	X	X	X	X	X	X	1,41
7,144	9/32	X	X	X	X	X	X	X	X	X	1,5
7,5		X	X	X	X	X	X			X	1,73
7,938	5/16	X	X	X	X	X	X	X	X	X	2,06
8		X	X	X	X	X	X	X	X	X	2,11
8,5		X	X	X			X			X	2,52
8,731	11/32	X	X	X	X	X	X		X	X	2,74
9		X	X	X	X	X	X		X	X	3
9,5		X	X	X	X	X	X				3,52
9,525	3/8	X	X	X	X	X	X	X	X	X	3,55
10		X	X	X	X	X	X	X	X	X	4,11
10,319	13/32	X	X	X	X	X	X			X	4,52
10,5		X		X	X	X	X			X	4,75
11		X	X	X	X	X	X	X	X	X	5,47
11,112	7/16	X	X	X	X	X	X	X	X	X	5,64
11,5		X			X	X	X				6,25
11,906	15/32	X	X	X	X	X	X			X	6,94
12		X	X	X	X	X	X	X	X		7,1
12,303	31/64	X				X	X				7,65
12,5		X	X	X		X	X				8,03
12,7	1/2	X	X	X	X	X	X	X	X	X	8,42
13		X	X	X	X	X	X	X	X	X	9,03

(continued)

Table 1 (continued)

Nominal ball diameter, D_w, in		Size recommended for material of group[2])									Approx. mass per 1 000 units (7,85 g/cm³), in kg[3])
mm	in[1])	1	2	3	4	5	6	7	8	9	
13,494	17/32	X	X	X		X	X				10,1
14		X	X	X	X	X	X	X	X	X	11,3
14,288	9/16	X	X	X	X	X	X			X	12
15		X	X	X	X	X	X	X	X	X	13,9
15,081	19/32	X	X	X		X	X				14,1
15,875	5/8	X	X	X	X	X	X	X	X	X	16,4
16		X	X	X	X	X	X	X	X	X	16,8
16,669	21/32	X	X	X							19
17		X	X	X	X			X	X	X	20,2
17,462	11/16	X	X	X						X	21,9
18		X	X	X	X		X	X	X	X	24
18,256	23/32	X	X	X							25
19		X	X	X						X	28,2
19,05	3/4	X	X	X	X			X	X	X	28,4
19,844	25/32	X									32,1
20		X	X	X	X		X	X	X	X	32,9
20,5		X									35,4
20,638	13/16	X	X	X	X					X	36,1
21		X								X	38,1
21,431	27/32	X									40,5
22		X	X	X	X		X			X	43,8
22,225	7/8	X	X	X	X					X	45,1
23		X		X						X	50
23,019	29/32	X									50,1
23,812	15/16	X	X		X					X	55,5
24		X	X	X	X					X	56,8
24,606	31/32	X	X								61,2
25		X	X	X	X			X	X	X	64,2
25,4	1	X	X	X	X						67,4
26		X			X					X	72,2
26,988	1 1/16	X		X							80,8
28		X		X	X						90,2
28,575	1 1/8	X	X	X				X	X		95,9
30		X	X	X	X			X	X		111
30,162	1 3/16	X		X							113
31,75	1 1/4	X	X	X	X						132
32		X		X							135
33,338	1 5/16	X									152
34		X									162
34,925	1 3/8	X		X							175
35		X			X			X	X		176
36		X		X							192
36,512	1 7/16	X									200
38		X									226
38,1	1 1/2	X	X	X	X						227
39,688	1 9/16	X									257

(continued)

Table 1 (concluded)

Nominal ball diameter, D_w, in		Size recommended for material of group[2])									Approx. mass per 1 000 units (7,85 g/cm³), in kg[3])
mm	in[1])	1	2	3	4	5	6	7	8	9	
40		X	X	X	X			X	X		263
41,275	$1\ ^5/_8$	X		X							289
42,862	$1\ ^{11}/_{16}$	X									324
44,45	$1\ ^3/_4$	X		X							361
45		X	X	X	X						375
46,038	$1\ ^{13}/_{16}$	X		X							401
47,625	$1\ ^7/_8$	X		X							444
50		X	X	X	X						514
50,8	2	X		X							539
53,975	$2\ ^1/_8$	X									646
55		X		X	X						684
57,15	$2\ ^1/_4$	X									767
60		X	X	X	X						888
60,325	$2\ ^3/_8$	X									902
63,5	$2\ ^1/_2$	X		X							1 052
65		X		X	X						1 129
66,675	$2\ ^5/_8$	X									1 218
69,85	$2\ ^3/_4$	X		X							1 401
70		X	X	X	X						1 410
73,025	$2\ ^7/_8$	X									1 601
75		X		X							1 734
76,2	3	X									1 819
80		X	X	X							2 100
82,55	$3\ ^1/_4$	X									2 312
85		X		X							2 524
88,9	$3\ ^1/_2$	X									2 888
90		X		X							2 996
95		X									3 524
95,25	$3\ ^3/_4$	X									3 552
100		X	X	X							4 110
110		X									5 471
114,3	$4\ ^1/_2$	X									6 138
120		X									7 103
150		X									13 872

[1]) Inch sizes, for information only.
[2]) See table 2 for classification of materials into groups.
[3]) Values for steel of group 1. When calculating mass for other materials, use the correction factor given in the last column of table 2.

5 Materials and hardness

Balls shall be made of one of the materials listed in table 2, the use of other materials being subject to agreement.

Table 2: Materials, hardness and grades of balls

Material			Ball diameter		Hardness [1]	Grade [2]														Correction factor (mass) [3]
number	designation	Relevant standard	Over	Up to		G3	G5	G10	G16	G20	G28	G40	G80	G100	G200	G300	G500	G600	G700	
Material group 1: Hardened steel for roller bearings (except for stainless steel)[4]																				
1.3505 1.3520 1.3536	100Cr6 100CrMnSi6-4 100CrMo7-3	DIN EN ISO 683-17 DIN EN ISO 683-17 DIN EN ISO 683-17	—	12,7	740 to 900 HV10		X	X	X		X		X		X		X	X		1
			12,7	25,4	60 to 66 HRC			X	X		X		X		X		X	X		
			25,4	38,1	60 to 66 HRC					X	X			X			X			
			38,1	50,8	60 to 66 HRC						X	X		X			X			
			50,8	70	59 to 65 HRC							X		X			X			
			70	100	57 to 63 HRC									X			X			
			100	120	57 to 63 HRC										X					
			120	150	55 to 61 HRC										X					
Material group 2: Hardened stainless steel for roller bearings																				
1.3541	X47Cr14	DIN EN ISO 683-17	—	12,7	580 to 700 HV10								X				X			0,98
			12,7	25,4	54 to 60 HRC								X				X			
			25,4	38,1	54 to 60 HRC									X						
			38,1	50,8	54 to 60 HRC									X						
			50,8	70	54 to 60 HRC									X						
			70	100	54 to 60 HRC										X					
1.3543 1.3549	X108CrMo17 X89CrMoV18-1	DIN EN ISO 683-17 DIN EN ISO 683-17	—	12,7	640 to 780 HV10								X							
			12,7	25,4	57 to 63 HRC								X							
			25,4	38,1	57 to 63 HRC									X						

(continued)

Table 2 (continued)

Material			Ball diameter		Hardness [1]	Grade [2]														Correction factor (mass) [3]
number	designation	Relevant standard	Over	Up to		G3	G5	G10	G16	G20	G28	G40	G80	G100	G200	G300	G500	G600	G700	
Material group 3: Hardened stainless steel																				
1.4034	X46Cr13	DIN EN 10088-3	–	12,7	580 HV10 to 700 HV10					X			X				X			0,98
			12,7	25,4	54 HRC to 60 HRC								X				X			
			25,4	38,1	54 HRC to 60 HRC									X						
			38,1	50,8	54 HRC to 60 HRC									X						
			50,8	70	54 HRC to 60 HRC										X					
			70	100	54 HRC to 60 HRC										X					
1.4112	X90CrMoV18	DIN EN 10088-3	–	12,7									X							
			12,7	25,4									X							
1.4125	X105CrMo17	DIN EN 10088-3	25,4	50,8	55 HRC to 60 HRC									X						
Material group 4: Stainless steel, non-hardenable																				
1.4301	X5CrNi18-10	DIN EN 10088-3	–	5	280 HV10 to 380 HV10											X	X	X		1,01
1.4401	X5CrNiMo17-12-2	DIN EN 10088-3	5	25,4	280 HV10 to 380 HV10											X	X			
1.4571	X6CrNiMoTi7-12-2	DIN EN 10088-3	25,4	70	280 HV10 to 380 HV10											X				
Material group 5: Hardened carbon steel																				
1.0616	C86D	DIN EN 10016-2	–	20	700 HV10 to 860 HV10								X		X		X			1
Material group 6: Carbon steel, non-hardenable																				
1.1132	C15E2C	DIN EN 10263-3	–	25,4	120 HV10 to 180 HV10												X			1
1.0304	C9D	DIN EN 10016-2	–	25,4	120 HV10 to 260 HV10												X			

(continued)

Table 2 (concluded)

Material			Ball diameter		Hardness [1]	Grade [2]														Correction factor (mass) [3]
number	designation	Relevant standard	Over	Up to		G3	G5	G10	G16	G20	G28	G40	G80	G100	G200	G300	G500	G600	G700	
Material group 7: Copper-zinc alloy																				
CW508L	CuZn37	DIN EN 12163 DIN EN 12166	–	25,4	120 HB to 280 HB											X				1,09
			25,4	50,8	120 HB to 280 HB											X				
			50,8	75	120 HB to 280 HB												X			
Material group 8: Copper-tin alloy																				
CW453K	CuSn8	DIN EN 12166	–	25,4	120 HB to 280 HB											X				1,12
			25,4	50,8	120 HB to 280 HB											X				
			50,8	75	120 HB to 280 HB												X			
Material group 9: Sintered ceramics																				
–	Si3N4	–	–	25,4	1 550 HV10 to 1 900 HV10	X	X	X												0,41

[1]) Material groups 1 to 3 and 5:
The (surface) hardness values specified are achieved by heat treatment. During subsequent processing, work hardening in the surface zone may cause the upper hardness limit in that zone to be slightly exceeded.
Material groups 4 and 6 to 8:
Guideline values. Work hardening due to the manufacturing process may result in slightly deviating values.

[2]) Boxes shaded grey indicate all sizes covered by this standard, with boxes marked with an X identifying sizes to which preference should be given.

[3]) See footnote [3]) in table 1.

[4]) The choice of the steel grade is up to the manufacturer.

6 Requirements

6.1 Dimensional and form tolerances, and surface roughness

Table 3: Dimensional and form tolerances, and surface roughness

Grade	D_w Nominal size, in mm Over	Up to	Limit deviations, in µm[5]	t_{Dws}, V_{Dws}, in µm Max.	R_a[6], in µm Max.	V_{DwL}[5], in µm Max.	V_{DwA}[5], in µm Max.	I_G, S_T, in µm	Preferred gauges[7], values in µm		
G3	—	12,7	± 5,32	0,08	0,01	0,13	—	0,5	— 5 to — 0,5	0	+ 0,5 to + 5
G5	—	12,7	± 5,63	0,13	0,014	0,25	—	1	— 5 to — 1	0	+ 1 to + 5
G10	—	25,4	± 9,75	0,25	0,02	0,5	—	1	— 9 to — 1	0	+ 1 to + 9
G16[1]	—	25,4	± 11,4	0,4	0,025	0,8	—	2	— 10 to — 2	0	+ 2 to + 10
G20[1]	—	38,1	± 11,5	0,5	0,032	1	—	2	— 10 to — 2	0	+ 2 to + 10
G28[1]	—	50,8	± 13,7	0,7	0,05	1,4	—	2	— 12 to — 2	0	+ 2 to + 12
G40	—	100	± 19	1	0,06	2	—	4	— 16 to — 4	0	+ 4 to + 16
G80[2]	—	100	± 14	2	0,1	—	4,0	4	— 12 to — 4	0	+ 4 to + 12
G100	—	150	± 47,5	2,5	0,1	5	—	10	— 40 to — 10	0	+ 10 to + 40
G200	—	150	± 72,5	5	0,15	10	—	10	— 60 to — 10	0	+ 10 to + 60
G300[1]	—	25,4	± 70	10	0,2	—	20	20	— 60 to — 20	0	+ 20 to + 60
G300[3]	25,4	50,8	± 105	15	0,2	—	30	30	— 90 to — 30	0	+ 30 to + 90
G300	50,8	75	± 140	20	0,2	—	40	40	— 120 to — 40	0	+ 40 to + 120
G500[4]	—	25,4	± 75	25	—	—	50	50	— 50	0	+ 50
G500	25,4	50,8	± 112,5	25	—	—	75	75	— 75	0	+ 75
G500	50,8	75	± 150	25	—	—	100	100	— 100	0	+ 100
G500	75	100	± 187,5	32	—	—	125	125	— 125	0	+ 125
G500	100	125	± 225	38	—	—	150	150	— 150	0	+ 150
G500	125	150	± 262,5	44	—	—	175	175	— 175	0	+ 175
G600[4]	all		± 200	—	—	—	400	—	—	0	—
G700[4]	all		± 1 000	—	—	—	2 000	—	—	0	—

[1] In some cases and subject to agreement, half the gauge interval values may be used for grades G16, G20, G28 and G 300.
[2] Not specified in ISO 3290.
[3] Not specified in ISO 3290.
[4] Not specified in ISO 3290.
[5] Values relate to the mean diameter of a ball, D_{wm}.
[6] See DIN EN ISO 4288. For smaller ball sizes (not covered in this standard), values are subject to agreement.
[7] Graded in intervals equal to I_G (cf. subclause 3.11).

6.2 Waviness and appearance

The quality of rolling bearings is mainly a function of the waviness and appearance of the surface (cf. subclause 3.17). Since there are no recognized assessment criteria in this field, the requirements for these characteristics should be agreed between customer and supplier.

6.3 Additional requirements for sintered ceramics

The fracture toughness of sintered ceramics shall be not less than 6 MPa $m^{1/2}$, their modulus of elasticity not less than 31 500 N/mm^2.

7 Packaging

Balls made of steel shall be supplied with corrosion protection applied.

Each gauge lot shall be packed separately. When indicating the gauge, the letter P may be used to denote plus, M, minus and N, zero.

Where no particular agreement has been made, the ball gauge supplied shall be at the manufacturer's discretion.

If a consignment consists of several packs and a variety of gauges, then each pack shall contain balls of one particular gauge.

For balls of grades G3 to G200, except grade G80, packs should contain only one grade, even though they are of the same gauge, since the gauge deviation, S_T, may vary.

Packaging shall be marked with the ball nominal diameter, grade, gauge and material number (or material designation). Where the ball is of group 1 material, the material need not to be indicated unless the customer requests a particular grade, or a different material.

For balls of grades G3 to G200, except grade G80, the marking of a pack shall include the mean deviation for diameter D_w (in brackets).

Examples

EXAMPLE 1

Marking of a pack containing balls of group 1 material (material number 1.3505), with a nominal diameter, D_w, of 6 mm, ball grade G10 and gauge + 3 (P3), with a mean deviation of D_w of +3,2 µm:

6 G10 P3 (+3,2)

EXAMPLE 2

Marking of a pack containing balls of group 2 material (material number 1.3541), with a nominal diameter, D_w, of 6 mm, ball grade G20 and gauge –4 (M4), with a mean deviation of D_w of –3,8 µm:

6 G20 M4 – 1.3541(–3,8)

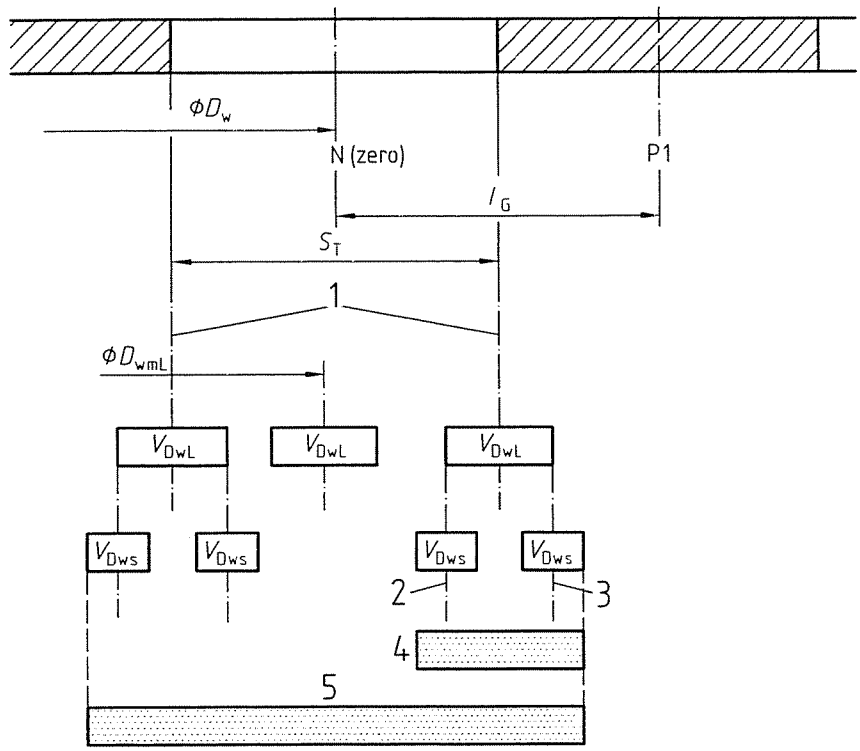
EXAMPLE 3

Marking of a pack containing balls of group 9 material (material designation: Si3N4), with a nominal diameter, D_w, of 6 mm, ball grade G5 and gauge 0 (N), with a mean deviation of D_w of +0,4 µm:

6 G5 N – Si3N4 (+0,4)

Annex A
Illustration of gauges and sorting principles

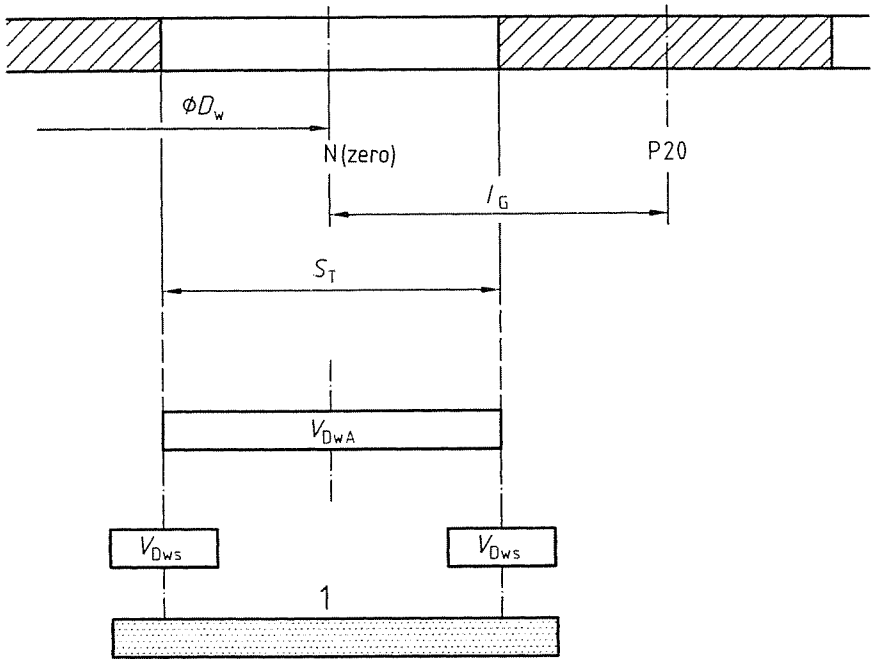
A.1 Details of sorting parameter V_{DwL} (applies to grades G3 to G200, except G80)



Key:
1 Limits of D_{wmL} for a particular gauge
2 Smallest ball in a lot
3 Largest ball in a lot
4 Variation of V_{dWL} within a lot
5 Range of mean diameter of lot for ball gauge

Figure A.1: Details of sorting parameter V_{DwL}

A.2 Details of sorting parameter V_{DwA} (applies to grades G300 to G700 and G80)



Key:
1 Variation of V_{dWA} within a lot

Figure A.2: Details of sorting parameter V_{DwA}

Annex B

Measurement of deviation from spherical form

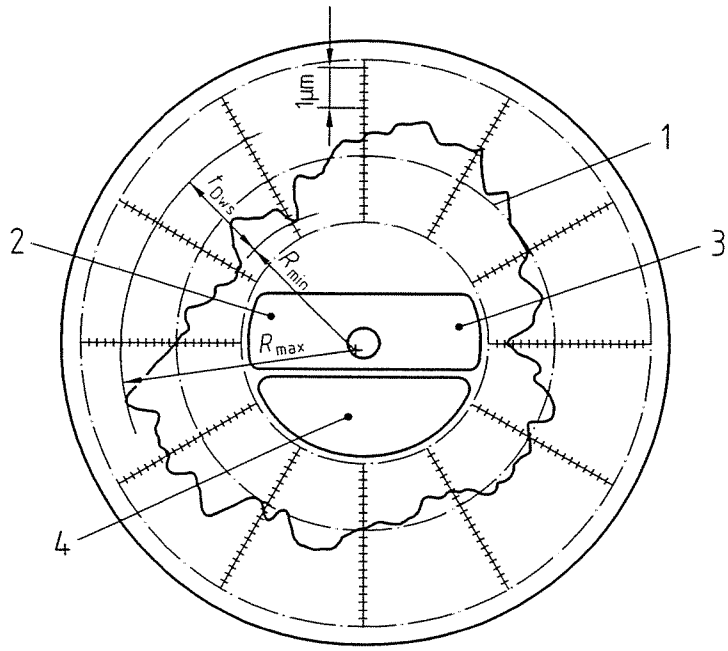
To establish the deviation from spherical form of balls, measure the roundness in a number of equatorial planes.

Evaluation of roundness in a single equatorial plane shall be made by calculations based on the least squares centre method.

The difference between the radii of the minimum circumscribed circle and the maximum inscribed circle (with both circles being concentric) shall be taken to be the deviation from spherical form.

In practice, it has been found sufficient to take measurements in three equatorial planes normal to each other.

See ISO 4291 for more details.



Key:

1 least squares mean circle
2 Space for marking 'Magnification × 10 000'
3 Space for marking 'Filter 1-50'
4 Space for marking 'Deviation from roundness, t_{DWs} = 2,48 µm'

Figure B.1: Assessment of deviation from roundness

Explanatory notes

This standard conforms to International Standard ISO 3290 in many respects, except that

- the number of ball grades has been enlarged (grades G 80 and G 500 to G 700) to meet the demand in fields other than roller bearings;
- materials other than steel for roller bearings have been specified (e.g. copper-tin alloys, ceramics).

It should also be noted that the ball nominal diameters are now specified to three decimal places (instead of five places) since this facilitates ball production without adversely affecting accuracy.