

Rolling bearings: ball bearings, cylindrical and spherical roller bearings

Part 1. Specification for dimensions of ball bearings, cylindrical and spherical roller bearings (metric series)

Roulements: roulements à billes, roulements à rouleaux cylindriques et roulements à rotules sur rouleau

Partie 1. Spécification dimensionnelle des roulements à billes, des roulements à rouleaux cylindriques et des roulements à rotules sur rouleau (série métrique)

Wälzlager: Kugellager, Zylinderrollen- und Pendelrollenlager

Teil 1. Spezifikation für die Abmessungen von Kugellagern, Zylinderrollen- und Pendelrollenlagern (metrische Reihe)

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Foreword

This Part of this British Standard forms part of a revision of BS 292 and has been prepared under the direction of the Mechanical Engineering Standards Committee. It is concerned only with metric bearings and the format and contents reflect the adoption as British Standards of related international standards prepared by Technical Committee ISO/TC 4, Rolling bearings, of the International Organization for Standardization (ISO).

This Part of the standard has been extended to cover other types of metric bearings: single row radial shielded and sealed ball bearings, single row radial filling slot ball bearings, single row angular contact ball bearings of various contact angles, four point contact (duplex) ball bearings and spherical roller bearings.

A bearing designation system commonly employed worldwide by bearing manufacturers has been adopted to replace the bearing reference symbols formerly used. For a comparison between these systems, see appendix A.

Values for 'normal tolerance class' are provided but the former precision tolerance classes EP 5 and EP 7 have not been included as the equivalent ISO tolerance classes 5 and 4, together with classes 6 and 2, are now given in BS 6107 : Part 2. Radial internal clearance tables additional to those previously given in BS 292 for metric bearings cover double

row self-aligning ball bearings, matched and interchangeable cylindrical roller bearings and spherical roller bearings.

Certain ranges and sizes of radial bearings, for which experience has shown there to be a very limited demand, are no longer included, nor are metric thrust ball bearings which are now covered in BS 5989. In addition, the dimensions of locating snap rings and snap ring grooves for single row radial ball bearings are no longer included as these are covered in BS 5646 : Part 5.

During the preparation of this Part of the standard, it was recognized that inch series bearings will continue to be required for replacement purposes. It was therefore decided to reissue the requirements for such bearings given in the 1969 edition as a further Part of the standard and for inch series bearings reference should be made to BS 292 : Part 2.

In support of the change to the metric system, it cannot be too strongly emphasized that, for all new design applications, users should adopt the sizes and designations given in this Part of BS 292 and the other relevant British Standards listed in appendix B.

BS 292 : 1969, having been superseded by this Part and Part 2, is withdrawn.

British Standard

Rolling bearings: ball bearings, cylindrical and spherical roller bearings

Part 1. Specification for dimensions of ball bearings, cylindrical and spherical roller bearings (metric series)

1. Scope

This Part of BS 292 specifies those external dimensions affecting the dimensional interchangeability of radial ball, cylindrical and spherical roller bearings as complete assemblies, and their radial internal clearance.

Other features of internal design and dimensions, materials and methods of manufacture, which may affect functional interchangeability, are not covered.

All the bearings covered by this Part of the standard incorporate a cage and are to normal tolerance class (but see also 9.2).

An explanation of the ISO general plan for boundary dimensions and the construction of bearing designations is provided. Guidance regarding basic load and life ratings is given but bearing manufacturers should be consulted for the basic static and dynamic load ratings as well as the speed ratings of any bearing.

For information purposes appendix A has been included to provide a comparison between the new designations adopted for metric series bearings and those previously given in BS 292 : 1969, and appendix B comprises a comprehensive list of the current British Standards for rolling bearings, features, accessories and spherical plain bearings.

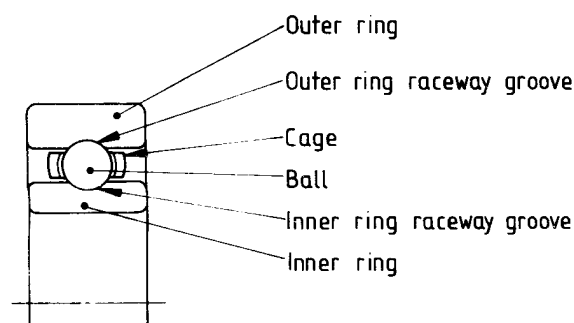
2. References

2.1 The titles of the standards publications referred to in this standard are listed on the inside back cover.

2.2 A comprehensive list of the current British Standards for rolling bearings, features, accessories and spherical plain bearings is given in appendix B.

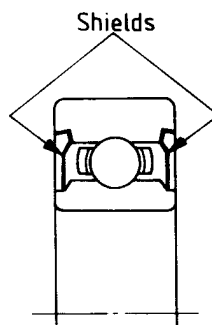
3. Terminology

The terminology associated with the component parts of bearings is given in the following figures 1 to 6.

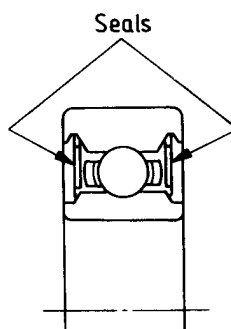


(a) Basic design

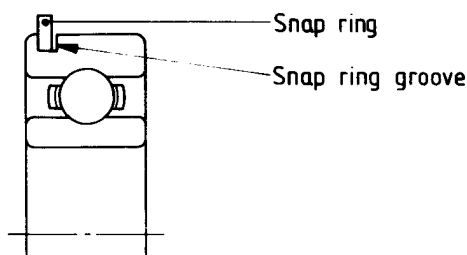
Figure 1. Single row radial ball bearing



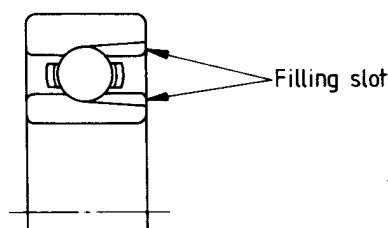
(b) Double shielded (capped bearing)



(c) Double sealed (capped bearing)



(d) With snap ring groove and snap ring



(e) With filling slot

Figure 1 (concluded)

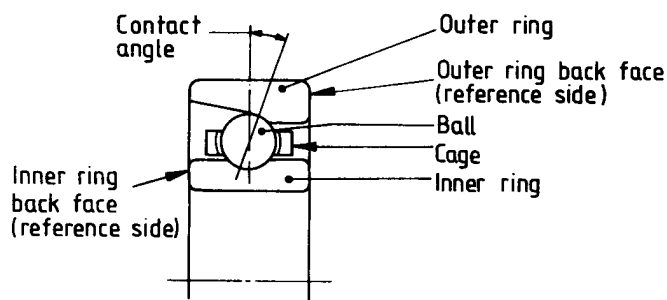


Figure 2. Single row angular contact ball bearing

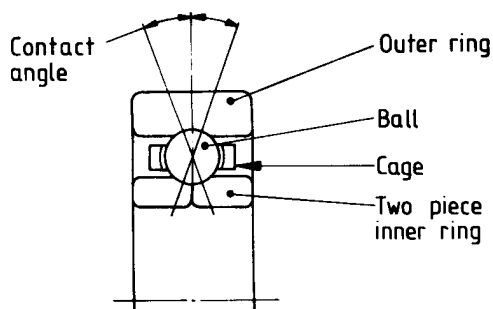


Figure 3. Four point contact (duplex) ball bearing with two piece inner ring

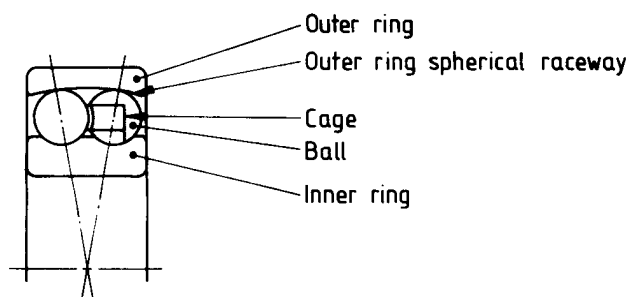
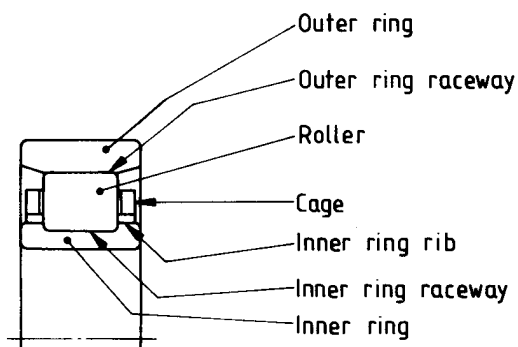
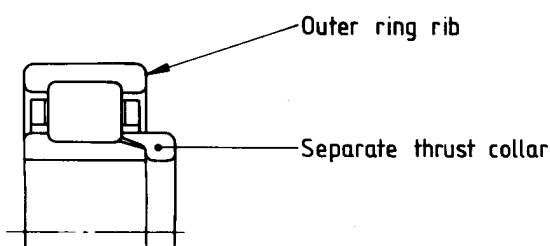


Figure 4. Double row self-aligning ball bearing



(a) Separable outer ring



(b) With separate thrust collar (separable inner ring)

Figure 5. Cylindrical roller bearing

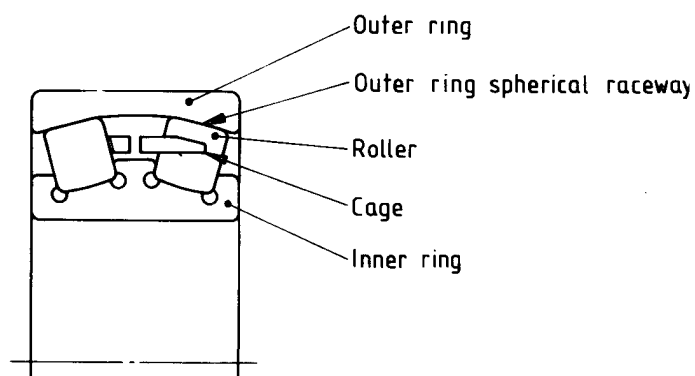


Figure 6. Spherical roller bearing

4. Definitions and symbols

4.1 Definitions. For the purposes of this Part of BS 292, the definitions concerning tolerances for bearings given in BS 6107 : Part 1 apply.

4.2 Symbols. For the purposes of this Part of BS 292, the following symbols apply (see also figure 7):

d	= nominal bore diameter
d_m	= mean bore diameter
d_{mp}	= single plane mean bore diameter
Δd_{mp}	= single plane mean bore diameter deviation
V_{dp}	= bore diameter variation in a single radial plane
V_{dmp}	= mean bore diameter variation
D	= nominal outside diameter
D_m	= mean outside diameter
D_{mp}	= single plane mean outside diameter
ΔD_{mp}	= single plane mean outside diameter deviation
V_{Dp}	= outside diameter variation in a single radial plane
V_{Dmp}	= mean outside diameter variation
B	= nominal ring width (inner and outer ring)
B_s	= single ring width (inner and outer ring)
ΔB_s	= deviation of a single ring width (inner and outer ring)
V_{B_s}	= ring width variation (inner and outer ring)
K_{ia}	= radial runout of assembled bearing inner ring
K_{ea}	= radial runout of assembled bearing outer ring
r_{smin}	= smallest single chamfer dimension (see also 7.1)
r_{smax}	= largest single chamfer dimension (see also 7.1)

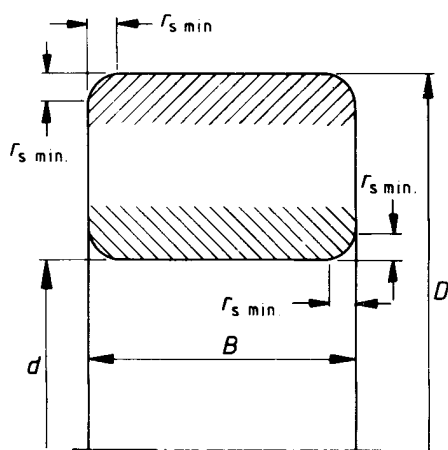


Figure 7. Symbols for boundary dimensions

5. ISO general plan for boundary dimensions

All ball bearings, cylindrical and spherical roller bearings given in this standard shall comply with dimension series which form part of the ISO general plan for boundary dimensions. (The ISO dimension series is referred to above each table of dimensions.)

NOTE 1. International Standard, ISO 15*, is a general plan for boundary dimensions of radial bearings in diameter series 7, 8, 9, 0, 1, 2, 3 and 4. The 'diameter series' reference relates to different combinations of nominal bore diameters and nominal outside diameters. Series 7 provides the lightest radial sectioned bearings and, at the other extreme, series 4 gives dimensions for the heaviest radial sectioned bearings.

NOTE 2. For each combination of bore and outside diameter there is a selection of bearing widths and the complete boundary dimensions of a bearing are identified by 'dimension series' references, e.g. 00, 10, 20, 30, 40, 50 and 60. The right-hand numeral of each pair is the 'diameter series' (0) and the other numeral indicates different width series of bearings, advancing from narrow bearings to very wide bearings. An extract from the general plan applicable to the bearings covered by this Part of the standard is shown diagrammatically in figure 8.

NOTE 3. In the tolerance tables 1 and 2 the permissible values for bore diameter and outside diameter variations (V_{dp} and V_{Dp}) are referred to the different 'diameter series'. For easy cross reference, the following table lists the 'dimension series' given in this standard against each 'diameter series'.

Diameter series	8	0	1	2	3	4
Dimension series	18	10 30 40	31 41	02 22 32	03 13 23	04

6. Bearing types and dimensions

6.1 Radial bearings. Boundary dimensions of single row radial ball bearings and cylindrical roller bearings shall be as given in tables 7 to 13 and tables 24 to 27 respectively.

NOTE. Single row radial ball bearings and cylindrical roller bearings are designed to take radial load. Single row radial ball bearings will take moderate axial load in either direction alone or in combination with radial load. Cylindrical roller bearings with ribs on both rings will take axial load in one or both directions

depending on the design configuration but reference should be made to bearing manufacturers for details of the magnitude of the permissible axial load. This type of bearing will only tolerate minor misalignment.

6.2 Self-aligning bearings. Boundary dimensions of self-aligning double-row ball bearings and spherical roller bearings shall be as given in tables 20 to 23 and tables 28 to 35 respectively.

NOTE. Double row self-aligning ball bearings are designed to carry moderate radial load or a combination of radial and light axial load. The spherical roller bearing has a higher capacity for radial load and a moderate capacity for axial load. Both types will accommodate some misalignment and provide axial location in both directions.

6.3 Angular contact ball bearings. For the two basic types, single row angular contact ball bearings and four point contact (duplex) ball bearings, the dimensions shall be as given in tables 14 to 17 and tables 18 and 19 respectively.

NOTE 1. Single row angular contact ball bearings are expressly designed for axial or combined radial and axial load, the axial load being in one direction. These bearings are usually arranged so that they can be adjusted in an axial direction against another bearing, thus achieving axial location and the ability to take axial load in both directions.

NOTE 2. Single row angular contact ball bearings are available with different nominal contact angles and various manufacturers have selected certain angles as standard, e.g. 20°, 30° and 40°. Angles generally used for precision tolerance classes are 15°, 20°, 25° and 40°. Reference has to be made to manufacturers' catalogues to establish the applicable contact angles. (Nominal contact angle is defined in BS 5512 : Part 1.)

NOTE 3. Four point contact (duplex) ball bearings are single row angular contact bearings with a two piece inner ring having raceways arranged to carry a predominance of axial load in either direction. To perform ideally under dynamic conditions the axial load should always exceed the radial load. The nominal contact angle is 35° and the bearings have a small axial clearance, thus enabling a shaft to be located within close limits.

6.4 Shielded and sealed ball bearings (capped bearings).

The preferred sizes of single row radial ball bearings that have either one or two built-in closures, shall be as given in table 13. There are two types of closure: metal shields or contact seals (see figure 1(b) and 1(c)) and bearings with two closures shall be supplied prelubricated.

NOTE 1. Metal shields, which are retained to the outer ring by various means, have a small running clearance about the inner ring and, consequently, this type of closure offers only limited protection against the ingress of foreign matter.

NOTE 2. Contact seals are of various designs but all have a flexible lip which makes rubbing contact with the inner ring, offering better protection than metal shields but absorbing more power. The most common type of seal is moulded in nitrile rubber and vulcanized to a metal insert. These seals are suitable for operational temperatures ranging from approximately -20 °C to +100 °C. Where higher or lower temperatures are involved, it is necessary to consult the bearing manufacturers.

NOTE 3. To allow for minor distortions of the outer ring caused by the insertion of shields or seals, the normal tolerance values for the outside diameter variation in a single radial plane (V_{Dp}) are larger than those for bearings without shields and seals. The V_{Dp} values are given for normal tolerance class in table 2 under the column headed 'Capped bearings'; see also figures 1(b) and 1(c).

*See BS 6267 : 1982.

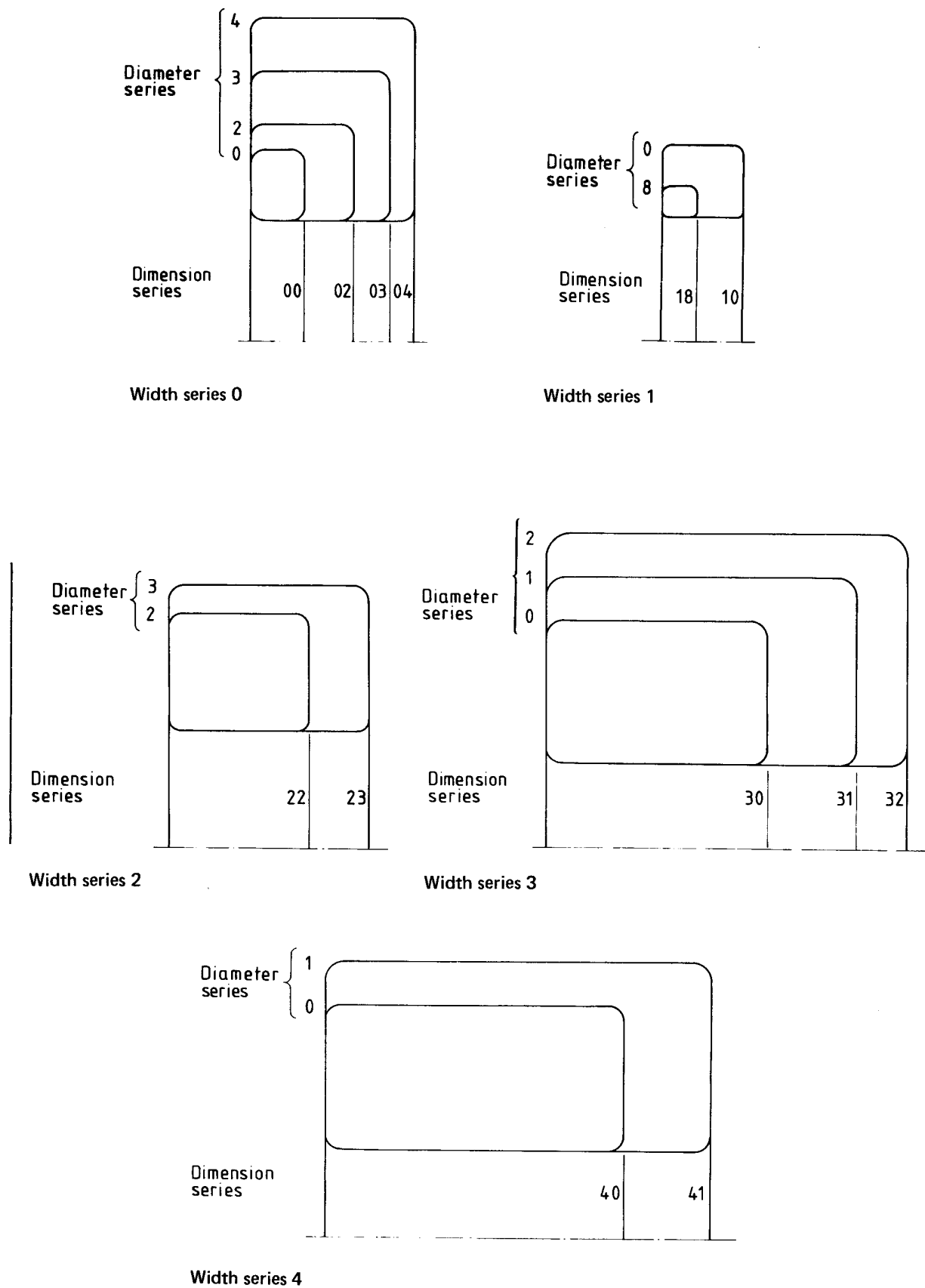


Figure 8. Extract from the ISO general plan for boundary dimensions

6.5 Radial ball bearings with filling slot. The preferred sizes of single row radial ball bearings of the filling slot type shall be as given in table 13

NOTE. A filling slot is provided on one side of the bearing to enable a larger complement of balls to be fitted. Whilst this increases the radial load carrying capacity, the bearings are not recommended for taking axial load only. Axial load in combination with radial load is severely limited and reference should be made to the bearing manufacturers for technical details.

6.6 Radial ball bearings with snap ring groove and snap ring. The preferred sizes of radial ball bearings with snap ring groove and also complete with snap ring shall be as given in table 13. The dimensions of snap ring grooves and snap rings, as fitted, shall be as specified in BS 5646 : Part 5.

NOTE. A snap ring fitted to a radial ball bearing provides a simple means for locating it axially in one direction in a housing.

7. Chamfer dimensions, fillets and abutments

7.1 Chamfer dimensions. Chamfers shall be formed at the corners of the bearings and shall fall between the extreme positions indicated in figure 9.

The maximum chamfer dimensions, r_{smax} , in the radial and axial directions shall be as specified in table 1 of BS 5988 : 1980, which gives details of both minimum and maximum chamfer dimensions.

NOTE. Although usually radiused, the chamfer need not necessarily be a true blending radius.

7.2 Fillets. The largest single shaft and housing fillet radius shall not exceed the smallest permissible single chamfer dimension of the corresponding bearing ring, see also BS 5988.

7.3 Abutments. The minimum abutment shoulder heights for bearing rings shall be greater than the radial direction r_{smax} values given in table 1 of BS 5988 : 1980.

NOTE. If the bearing rings are required to transmit axial load, larger abutment heights may be required and it is necessary to refer to recommendations given in manufacturers' catalogues. The face outside diameter of inner rings and face inner diameters of outer rings are not standardized and when considering large abutment

heights or designing components for fitment adjacent to the bearing, care needs to be taken to ensure that subsequent interchangeability of bearings is not affected

8. Temperature for measurement and operation

8.1 Measurement. At a temperature of 20 °C, and provided that the bearing parts are completely unstressed by external forces, including measuring loads and the gravitational force on the part itself, a boundary dimension of a bearing or bearing part shall not deviate from the nominal dimension by more than the tolerance to be applied.

8.2 Operation. The normal operating temperature range for standard heat treated open bearings shall be -40 °C to +125 °C and for prelubricated shielded and sealed bearings shall be -20 °C to +100 °C.

NOTE. For operating temperatures outside these ranges, reference should be made to bearing manufacturers.

9. Tolerance classes

9.1 The tolerances for the bearings in this standard shall comply with the requirements given in tables 1 and 2 covering 'normal tolerance class'.

9.2 If bearings to other tolerance classes are required, the appropriate tolerance class shall be stated, i.e. class 6, 5, 4 or 2, and the tolerances shall comply with the requirements given in BS 6107 : Part 2.

NOTE 1. Not all bearing sizes and types in this standard are necessarily available to tolerance classes 6, 5, 4 and 2 and hence reference should be made to manufacturers or their catalogues for details.

NOTE 2. The ISO codes for the different tolerance classes have not been adopted by all bearing manufacturers and, for guidance, the alternative codes used are as follows:

ISO code	Normal	6	5	4	2
Alternative codes	Normal	P6	P5	P4	P2
	Normal	—	EP5	EP7	EP9

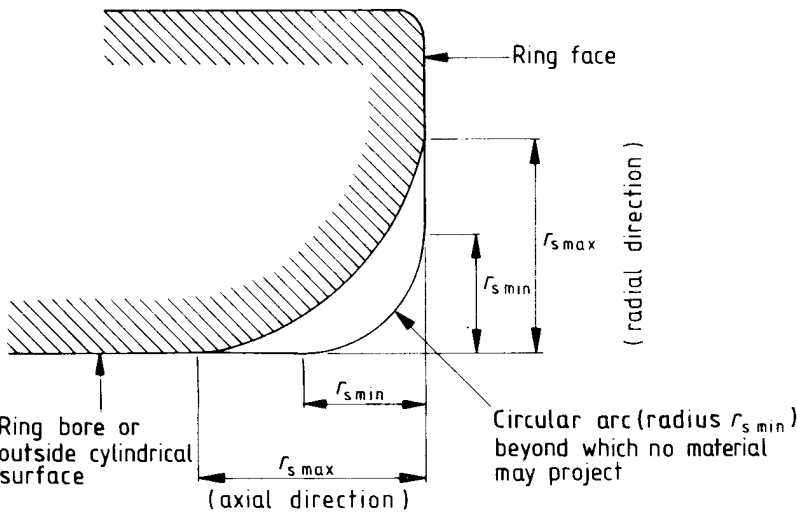


Figure 9. External corners of bearings

Table 1. Inner ring tolerances (normal tolerance class)

Single row radial ball, double row self-aligning ball, single row angular contact ball, four point contact (duplex) ball, cylindrical roller and spherical roller bearings.

Tolerance values in micrometres.

d mm		Δ_{dmp}		V_{dp}			V_{dmp}	K_{ia}	Δ_{Bs}^*		V_{Bs}
				diameter series							
				8	0, 1	2, 3, 4					
over	incl.	high	low	max.			max.	max.	high	low	max.
2.5	10	0	−8	10	8	6	6	10	0	−120	15
10	18	0	−8	10	8	6	6	10	0	−120	20
18	30	0	−10	13	10	8	8	13	0	−120	20
30	50	0	−12	15	12	9	9	15	0	−120	20
50	80	0	−15	19	19	11	11	20	0	−150	25
80	120	0	−20	25	25	15	15	25	0	−200	25
120	180	0	−25	31	31	19	19	30	0	−250	30
180	250	0	−30	38	38	23	23	40	0	−300	30
250	315	0	−35	44	44	26	26	50	0	−350	35
315	400	0	−40	50	50	30	30	60	0	−400	40
400	500	0	−45	56	56	34	34	65	0	−450	50

*These width tolerances do not apply to the rings of bearings adjusted for paired or stack mounting.

Table 2. Outer ring tolerances (normal tolerance class)

Tolerance values in micrometres.

<i>D</i> mm		Δ_{Dmp}		$V_{Dp}^\dagger$				$V_{Dmp}^\dagger$	K_{ea}	Δ_{Bs}		V_{Bs}
				Open bearings		Capped bearings*						
				diameter series								
8	0, 1	2, 3, 4	2, 3, 4									
over	incl.	high	low	max.				max.	max.	high	low	max.
6	18	0	−8	10	8	6	10	6	15	Identical to Δ_{Bs} and V_{Bs} of inner ring of same bearing		
18	30	0	−9	12	9	7	12	7	15			
30	50	0	−11	14	11	8	16	8	20			
50	80	0	−13	16	13	10	20	10	25			
80	120	0	−15	19	19	11	26	11	35			
120	150	0	−18	23	23	14	30	14	40			
150	180	0	−25	31	31	19	38	19	45			
180	250	0	−30	38	38	23	—	23	50			
250	315	0	−35	44	44	26	—	26	60			
315	400	0	−40	50	50	30	—	30	70			
400	500	0	−45	56	56	34	—	34	80			
500	630	0	−50	63	63	38	—	38	100			
630	800	0	−75	94	94	55	—	55	120			
800	1 000	0	−100	125	125	75	—	75	140			

*No values have been established for diameter series 8, 0 and 1.

†Applies before mounting and after removal of internal or external snap ring.

10. Radial internal clearances

10.1 Radial internal clearances for unmounted single row radial ball bearings, double row self-aligning ball bearings, cylindrical roller bearings and spherical roller bearings shall be as given in tables 3, 4, 5 and 6, which have been extracted from BS 6107 : Part 3.

10.2 Limits for different clearance groups are specified and, for designation purposes, the groups shall be denoted C2, CN, C3, C4 and C5. Unless otherwise specified, bearings to clearance group CN shall be supplied.

NOTE 1. Equivalent designations commonly used by manufacturers are as follows:

ISO code	Group 2	Normal group	Group 3	Group 4	Group 5
Alternative codes	C2	CN	C3	C4	C5
	1-dot	2-dot	3-dot	4-dot	5-dot

NOTE 2. The bearing manufacturers do not necessarily mark the clearance group designation on bearings, this usually being the case for bearings of normal group CN.

10.3 Cylindrical roller bearings shall be manufactured either with inner ring, outer ring and rollers matched to give the specified clearance ranges given in table 5 under the columns headed 'matched', or such that the separable inner or outer ring is interchangeable with the ring from a bearing of the same size. The tolerances on radial internal clearance for bearings with interchangeable rings, which are wider than for bearings with matched rings, shall be as given in table 5 under the columns headed 'interchangeable'.

Matched rings shall be supplied unless interchangeable rings are specified when ordering.

NOTE 1. Values for axial internal clearance are not given as they are dependent on internal design features which are not within the scope of this standard. If it is necessary for a particular application to know the axial internal clearance of a bearing, the manufacturer should be consulted.

NOTE 2. Four point contact (duplex) ball bearings are designed to have controlled axial clearance values but, as these have not been standardized nationally or internationally, details should be obtained from the manufacturers.

NOTE 3. Radial internal clearance values for bearings with tapered bores are given in BS 6107 : Part 3.

Radial internal clearance values

Table 3. Single row radial ball bearings with cylindrical bore

Clearance values in micrometres.

Bore diameter <i>d</i> mm		Group 2		Normal group		Group 3		Group 4		Group 5	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
6	10	0	7	2	13	8	23	14	29	20	37
10	18	0	9	3	18	11	25	18	33	25	45
18	24	0	10	5	20	13	28	20	36	28	48
24	30	1	11	5	20	13	28	23	41	30	53
30	40	1	11	6	20	15	33	28	46	40	64
40	50	1	11	6	23	18	36	30	51	45	73
50	65	1	15	8	28	23	43	38	61	55	90
65	80	1	15	10	30	25	51	46	71	65	105
80	100	1	18	12	36	30	58	53	84	75	120
100	120	2	20	15	41	36	66	61	97	90	140
120	140	2	23	18	48	41	81	71	114	105	160
140	160	2	23	18	53	46	91	81	130	120	180
160	180	2	25	20	61	53	102	91	147	135	200
180	200	2	30	25	71	63	117	107	163	150	230

NOTE 1. Because it is difficult to obtain exact reproducibility in the measurement of radial internal clearance, the clearance obtained by users when checking an unmounted bearing is unlikely to be precise but should approximate to the tabulated values.

NOTE 2. For designation of groups, see 10.2.

NOTE 3. For radial internal clearance values for bearings having a bore diameter larger than 200 mm, the bearing manufacturers should be consulted.

Radial internal clearance values

Table 4. Double row self-aligning ball bearings with cylindrical bore

Clearance values in micrometres

Bore diameter <i>d</i> mm		Group 2		Normal group		Group 3		Group 4		Group 5	
over	incl	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
6	10	2	9	6	17	12	25	19	33	27	42
10	14	2	10	6	19	13	26	21	35	30	48
14	18	3	12	8	21	15	28	23	37	32	50
18	24	4	14	10	23	17	30	25	39	34	52
24	30	5	16	11	24	19	35	29	46	40	58
30	40	6	18	13	29	23	40	34	53	46	66
40	50	6	19	14	31	25	44	37	57	50	71
50	65	7	21	16	36	30	50	45	69	62	88
65	80	8	24	18	40	35	60	54	83	76	108
80	100	9	27	22	48	42	70	64	96	89	124
100	120	10	31	25	56	50	83	75	114	105	145
120	140	10	38	30	68	60	100	90	135	125	175
140	160	15	44	35	80	70	120	110	161	150	210

NOTE. For designation of groups, see 10.2.