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Types of bearings

Definitions

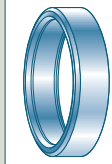
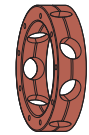
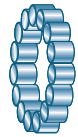
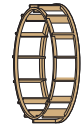
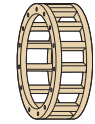
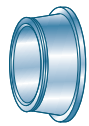
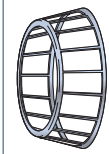
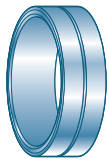
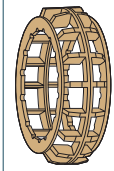
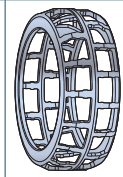
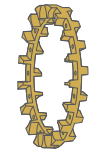
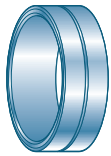
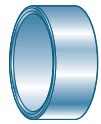
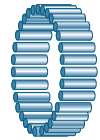
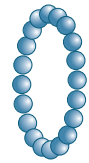
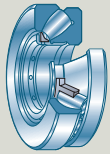
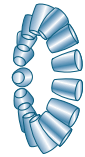
A bearing is a mechanical unit that provides a mobile link between two parts that rotate in relation to one another. Its function is to permit relative rotation of these parts, under load, with accuracy and minimum friction.

A bearing consists of:

- two rings, one associated with a fixed element, the other with the moving element and featuring raceways
- rolling elements allowing relative displacement of the two rings with minimum friction
- a cage separating the rolling elements

There are two large bearing families:

- ball bearings, allowing high speeds of rotation and where the ball-raceway interface is theoretically point contact
- roller bearings, where the ball-raceway interface is theoretically line contact. Roller bearings can withstand higher radial loads than ball bearings

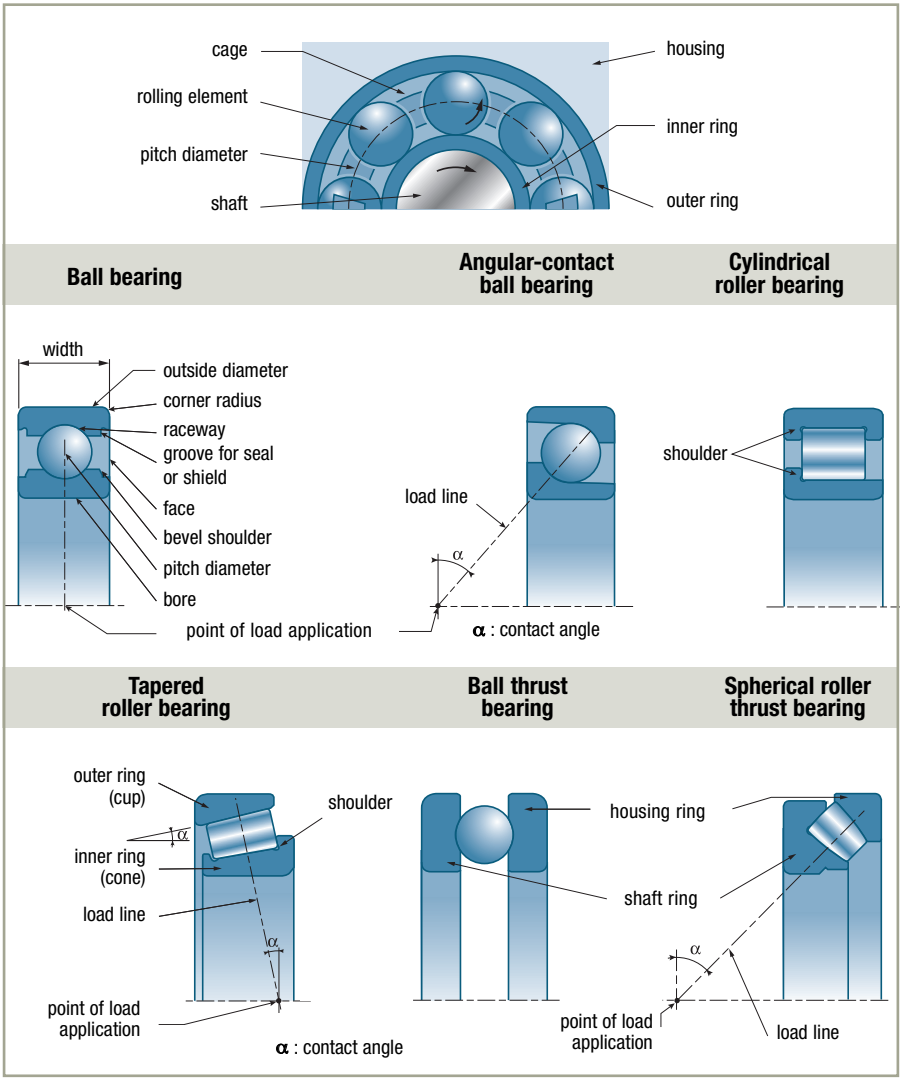
Type	Outer ring	Inner ring	Rolling elements	Synthetic material	Pressed steel	Integrally machined
Ball bearing						
Cylindrical roller bearing						
Tapered roller bearing	(cup)	 (cone)				
Double-row spherical roller bearing						
Needle bearing						
Ball thrust bearing		(housing ring)	(shaft ring)			
Spherical roller thrust bearing		(housing ring)	(shaft ring)			

Types of bearings *(continued)*

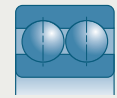
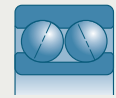
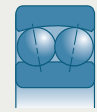
Vocabulary

Standard ISO 5593 has established a vocabulary of standard terms applicable to bearings and bearing technology.

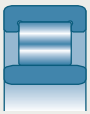
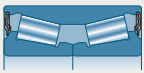
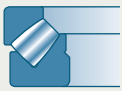
The terms and definitions are given in a multilingual glossary.

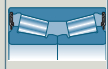


Capabilities

General characteristics and capabilities		Application examples
■ Ball bearings		
◗ Single- or double-row radial ball bearings Popular bearings due to their cost/performance compromise. Numerous variants (shielded, sealed etc.) and large selection of dimensions.	 	Electric motor Wheel of trailer Household electrical appliances Woodworking machine spindles Small reducing gear Gear box
◗ Single-row angular-contact ball bearings Always mounted in opposition with another bearing of the same type. Give great assembly rigidity, especially when preloaded		Reduction gear box Machine-tool spindle
◗ Double-row angular-contact ball bearings Withstand axial loads in both directions. Can be used alone as a double bearing.		Reducing gear Automobile wheels Agricultural machinery
◗ 4-point angular contact ball bearings Withstand axial loads in both directions. Often associated with a radial contact bearing.		Reducing gear
■ Double-row self-aligning ball or spherical roller bearings		
◗ Double-row self-aligning ball bearings The spherical raceway of the outer ring permits angular displacement. A variant with a tapered bore simplifies fitting.		For long shaft with deflection
◗ Spherical roller bearings The spherical raceway of the outer ring permits angular displacement A variant with a tapered bore simplifies fitting.		Roll stand Large reducing gear Large industrial fan Printing machine roller Quarry machine

Types of bearings *(continued)*

General characteristics and capabilities		Application examples
Roller bearings		
Cylindrical roller bearings Excellent resistance to instantaneous overloads and shocks. Simplification of installation thanks to their detachable elements. Certain types allow axial displacement; others allow a low axial load.		Heavy-duty electric motor Wagon axle box Pressure roller Rolling machine roll
Single-row tapered roller bearings Always mounted in opposition with another bearing of the same type. Give great assembly rigidity, especially when preloaded.		Reducing gear shaft Truck wheel Bevel gear transfer gearbox
Double-row tapered roller bearings (SNR TWINLINE) Accept axial loads in both directions. Often used alone as a double bearing.		TGV high-speed train axle box Automobile wheel
Needle bearings Accept relatively high radial loads with small space requirement and high radial rigidity.		
Thrust bearings		
Thrust bearings are often used with other types of bearing.		
Ball thrust bearings Withstand axial loads only. If radial load is applied must be associated with a radial bearing.		Vertical shaft Tailstock Plate pump
Spherical roller thrust bearings Can withstand a radial and axial load while accepting misalignment.		Heavy-duty vertical shaft Turbo-generator Crane pivot Plastic injection screw

Types	Cross-section	Load capabilities radial			Load capabilities axial			Limiting speed of rotation			Permissible misalignment between shaft and housing	
		low	medium	good	low	medium	good	low	medium	good	low	good
Radial ball bearing												
Double-row radial ball bearing												
Angular-contact ball bearing												
4-point angular-contact ball bearing												
Double-row angular contact ball bearing												
TWINLINE angular contact ball bearing												
Double-row self-aligning ball bearing												
Cylindrical roller bearing (1)												
Tapered roller bearing												
TWINLINE tapered roller bearing												
Double-row spherical roller bearing												
Single-direction ball thrust bearing												
Spherical roller thrust bearing												

(1) Types NJ and NUP accept low axial loads

Standardization and interchangeability

The standards

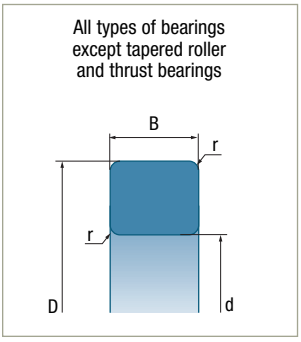
The mission of the International Standard Organisation (ISO) is to develop and coordinate standardization to facilitate the trade of products and services between nations. It encompasses the standards committees of 89 countries (AFNOR-France, DIN-Germany, UNI-Italy, BS-Great Britain, ANSI-United States, etc.).

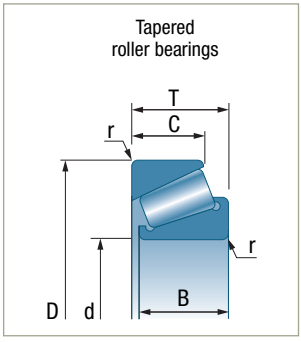
Bearing standardization is the responsibility of the ISO Technical Committee "TC 4" in which SNR plays an active part. The main standards used for bearings and thrust bearings are specified in the appendix page 147.

Interchangeability

■ **Dimensional interchangeability** is guaranteed by the values and tolerances on the bearing dimensions: d, D, B, C, r and T.

d Bore diameter
D Outside diameter
B Width of bearing or width of inner ring (cone)
C Width of bearing or width of outer ring (cup)
T Width or total height
r Corner radius





Strict application of the standards in the manufacture of the bearing enables one to obtain full interchangeability between bearings of the same part number, whoever the manufacturer, place or date of production.

Standardization of the bearing also allows dimensional interchangeability between bearings of different types, either total or partial. It is necessary to ensure the functional interchangeability.

Bearing series codes according to the different outside diameters and widths

For a given bore the standards provide for several diameter series (series 8, 9, 0, 1, 2, 3, 4 in ascending order).

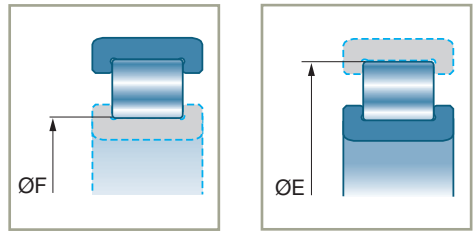
For each diameter series there are several width series (series 0, 1, 2, 3, 4 in ascending order).

Interchangeability of detachable elements of cylindrical or tapered roller bearings

Cylindrical or tapered roller bearings can be separated into two parts: a ring that is joined to the cage and rollers and a bare ring.

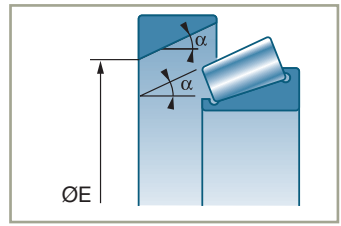
Cylindrical roller bearings

Interchangeability is ensured by the dimensions below the rollers F and above the rollers E.



Tapered roller bearings

The interchangeability of the internal sub-assemblies (fitted cones) and outer rings (cups) is ensured by standard ISO 355 which defines the contact angle α and the theoretical inside diameter of the cup E. One must check that the bearings are indeed identical (same suffix).



Caution : There is full interchangeability between SNR elements. ISO has standardized the values of the above dimensions without specifying their tolerances. Consequently, although the assembly of elements from different manufacturers presents no risk, it does not always give optimum performance and should therefore be avoided.

Dimensions and part numbers

General designations

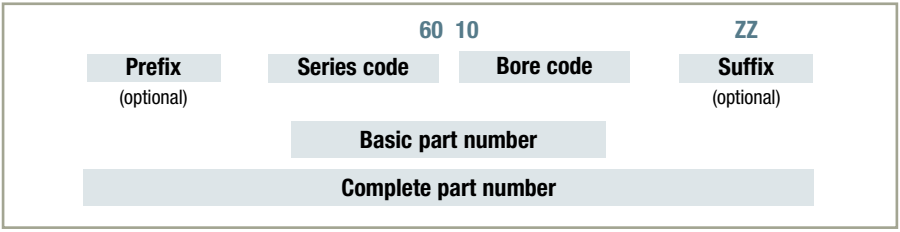
ISO has established standards in the form of a general plan of dimensions corresponding to standards ISO 15, ISO 355 and ISO 104. These standards allow universal use of the different types of bearings.

- The general designation system taken from standards ISO 15 and ISO 104 applies to all types of standardized bearings
- Tapered roller bearings have specific designations taken from standard ISO 355

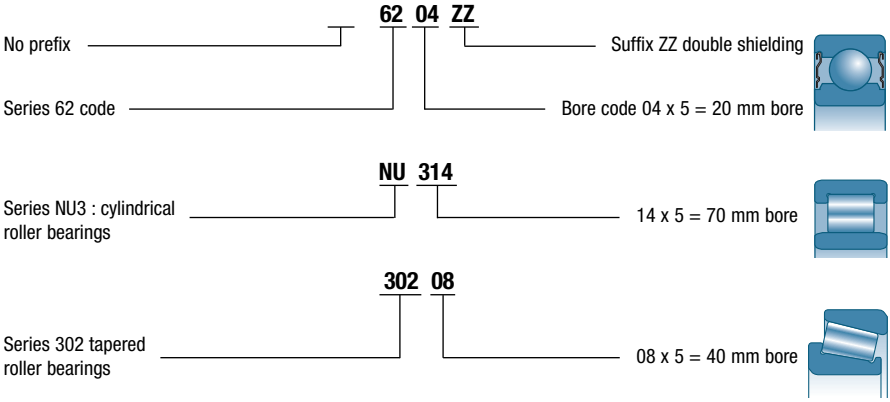
The special bearings have a specific numbering system.

Complete part number

■ Each bearing part number is comprised of the following components:



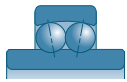
Examples:



The table on the following page specifies the different possibilities for the series codes and bore codes. The main suffixes and prefixes are specified in the chapter corresponding to each family.

Basic part number

60 XX

Part number	Type of bearing
	Radial ball bearing
60 X	
62 X	
63 XX	
64 XX	
160 XX	
618 XX	
619 XX	With 1 row of balls
622 XX	
623 XX	
2 XX	
3 XX	With a filling slot
42 XX	
43 XX	With 2 rows of balls
	Tapered roller bearing
302 XX	
303 XX	
313 XX	
320 XX	
322 XX	
323 XX	
330 XX	
331 XX	
332 XX	
N..2 XX	Cylindrical roller bearing
N..3 XX	
N..4 XX	
N..10 XX	
N..22 XX	
N..23 XX	NU N NJ NUP
	Double-row self-aligning ball bearing
12 XX	
13 XX	
22 XX	
23 XX	
112 XX	
113 XX	 Wide inner ring

Part number	Type of bearing
	Angular-contact ball bearing
72 XX	
73 XX	
718 XX	
	With 1 row of balls
QJ2 XX	
QJ3 XX	
	With 4 points of contact
32 XX	
33 XX	With 2 rows of balls
52 XX	
53 XX	With 2 rows of balls ZZ or EE
	Double-row spherical roller bearing
213 XX	
222 XX	
223 XX	
230 XX	
231 XX	
232 XX	
240 XX	
241 XX	
	Ball thrust bearing
511 XX	
512 XX	
513 XX	
514 XX	
	Spherical roller thrust bearing
293 XX	
294 XX	

Bore code	Bore diameter mm
3	3
/4	4
4	4
5	5
6	6
/6	6
7	7
/7	7
8	8
/8	8
9	9
00	10
01	12
02	15
03	17
/22	22
/28	28
/32	32
04	04x5 = 20
05	05x5 = 25
06	06x5 = 30
07	07x5 = 35
08	08x5 = 40
09	…
10	…

Dimensions and part numbers *(continued)*

Designations of tapered roller bearings

Standard ISO 355 defines the series of dimensions of tapered roller bearings.

➔ The old part numbering system has been maintained in this catalog. The new designation is however mentioned for the bearings of the new series.

T — Letter T for tapered roller bearings

4 — Range of contact angles

Angle series	Contact angle
2	10° < α ≤ 13°52’
3	13°52’ < α ≤ 15°59’
4	15°59’ < α ≤ 18°55’
5	18°55’ < α ≤ 23°
6	23° < α ≤ 27°
7	27° < α ≤ 30°

C — Diameter series

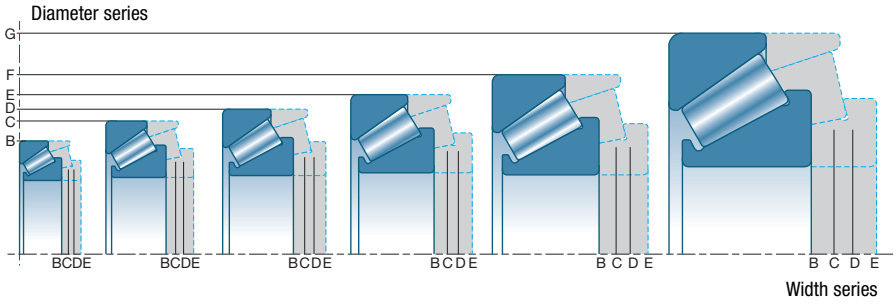
B
C
D
E
F
G

D — Width series

B
C
D
E

075 — Bearing bore

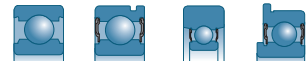
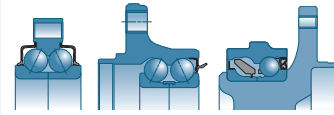
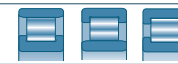
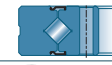
Width and diameter series



Designation of special bearings

The part numbers of special bearings is not standard and is specific to each manufacturer. The designation system defined by SNR is given below.

Y53	GB	40256	S01
Material modification or heat treatment (optional)		**Sequence number in the following number ranges:** **9000 to 13999** **40000 to 42999**	**Variant suffix**

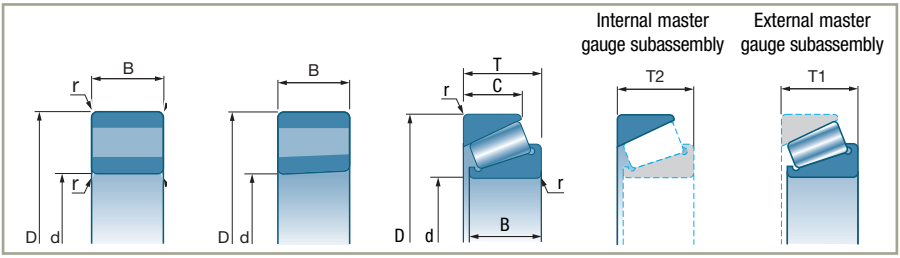
	Type of bearing	Examples
AB	Single-row radial contact ball bearing	
BB	Single-row angular contact ball bearing	
GB	Two-part double-row angular contact ball bearing	
TGB	Single-flange double-row angular contact ball bearing	
HGB	Two-flange double-row angular contact ball bearing	
DB	Double-row radial contact ball bearing	
AP	Ball thrust bearing	
QJ	4-point angular contact bearings	
TJ	3-point angular contact bearings	
N..	Cylindrical roller bearing: **N, NU, NUP**	
GNU	Cylindrical roller bearing	
EC	Single-row tapered roller bearing	
FC	Double-row tapered roller bearing	
TFC	Single-flange double-row tapered roller bearing	
QR	Crossed roller bearing	
X...	Sensor bearings **XGB, XTGB, XHGB, XFC, XTFC**	
CH	Ceramic Rolling Elements	

Bearing manufacturing precision

Standardization

■ Standard ISO 492 specifies the tolerances applicable to the dimensions and precision of rotation of metric series radial bearings.

The dimensional tolerances defined by this standard bear the following symbols:



■ Tolerance classes defined by standard ISO 492:

- The Normal class, which is that of all the standard bearings, and is not usually indicated in the bearing designation
- The High precision classes which are, in ascending order of precision: ISO 6, ISO 5, ISO 4, ISO 2

These classes are indicated in the suffix added to the bearing reference.

Example:

C3 P5

Clearance category 3 — ISO precision class 5

Standard ISO 199 sets the tolerances on thrust bearing dimensions.

Standard ISO 582 sets the tolerances on bearing corner radii. The dimensions applicable to fillets and shoulders are indicated in the table of bearing characteristics.

Standard ISO 5753 defines the tolerances on the radial clearance of the bearings.

Tolerance definition

The tolerance classes fix several types of tolerances and characteristics given for a temperature of 20°C ± 1°C (68°F ±1.8).

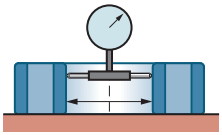
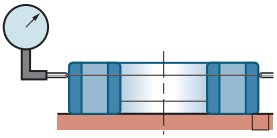
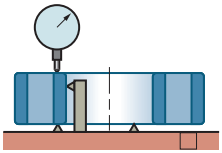
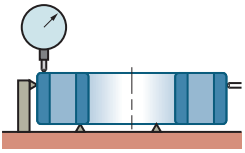
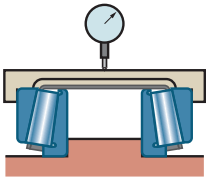
Dimensional tolerances

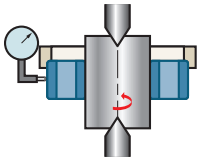
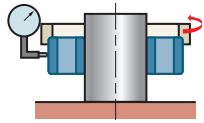
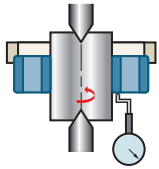
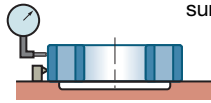
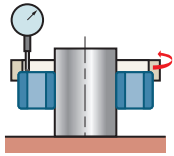
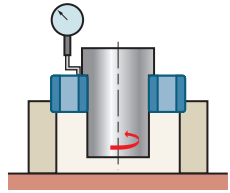
Standard ISO 492 sets the tolerances for the three main dimensions of a bearing:
- the bore diameter d
- the outside diameter D
- the width of each ring B and C with, in addition, for tapered bearings, the total width T

Functional tolerances

The standard also defines the precision of rotation of the bearings:
- the raceway radial runout of each ring. It is measured on the moving ring with respect to the fixed ring
- side face runout with reference to the bore of the inner ring
- outer ring side face runout with respect to the outer diameter
- side face runout with respect to the track

Bearing manufacturing precision *(continued)*

Dimensional tolerances	Deviations
d: nominal bore diameter 	**Δdmp** • Deviation of a mean bore diameter in an isolated plane (tolerance on the mean diameter) **Vdp** • Variation in the bore diameter in an isolated radial plane (ovality) **Vdmp** • Variation in the mean bore diameter (applies only to a supposedly cylindrical bore) in different planes
D: nominal outside diameter 	**ΔDmp** • Deviation of a mean outside diameter in an isolated plane (tolerance on the mean diameter) **VDp** • Variation in the outside diameter in an isolated radial plane (ovality) **VDmp** • Variation in the mean outside diameter in different planes
B: nominal width of ring 	**ΔBs** • Deviation of an isolated width of the inner ring (width tolerance) **VBs** • Variation in the width of the inner ring (face parallelism)
C: nominal width of ring 	**ΔCs** • Deviation of an isolated width of the outer ring (width tolerance) **VCs** • Variation in the width of the outer ring (face parallelism)
T : nominal width of tapered bearing T1: effective nominal width of the internal sub-assembly T2: effective nominal width of the external sub-assembly 	**ΔTs** • Deviation in the actual width of the bearing **ΔT1s** • Deviation in the effective actual width of the internal sub-assembly **ΔT2s** • Deviation in the effective actual width of the external sub-assembly

Functional tolerances	Deviations
radial run-out  	**Kia** • Radial run-out of the inner ring on the assembled bearing **Kea** • Radial run-out of the outer ring on the assembled bearing
run-out of the reference face  	**Sd** • Axial run-out of the reference face (or large face if applicable) of the inner ring with respect to the bore (run-out of the face of the inner ring) **SD** • Perperpendicularity error of the external surface with respect to the reference face (or large face) of the outer ring (external surface run-out)
bearing raceway run-out  	**Sea** • Axial run-out of the reference face (or large face) of the outer ring with respect to the bearing raceway, on the assembled bearing (run-out of outer ring raceway) **Sia** • Axial run-out of the reference face (or large face) of the inner ring with respect to the bearing raceway on the assembled bearing (run-out of the inner ring raceway)

Consult SNR for the method of measurement.

Bearing manufacturing precision *(continued)*

Equivalence of bearing precision standards

	ISO tolerance class	AFNOR tolerance class	ABEC tolerance class	DIN tolerance class
Standard Precision	Normal	Normal	1	P0
High Precision	6 5 4 2	6 5 4 2	3 5 7 9	P6 P5 P4 P2

The values given by the various standards for certain characteristics are not rigorously identical.
The tolerance class, when indicated on the bearing, imposes compliance with all the tolerances in the said class.
Nevertheless, certain bearing applications require special tolerances on certain dimensions or characteristics.
To avoid using an excessively expensive high-precision bearing, SNR can supply bearings with reduced tolerances on certain dimensions or characteristics. For example, run-out of inner ring of high-speed bearings for wood-working machine spindles.

Consult SNR.

Bearing tolerances

Radial bearings — Standard ISO 492

- Normal tolerance class — page 23
- Tolerance class 6 — page 24
- Tolerance class 5 — page 25
- Tolerance class 4 — page 26
- Tolerance class 2 — page 27

Tapered roller bearings — Standard ISO 492

- Normal tolerance class — page 28
- Tolerance class 6X — page 29
- Tolerance class 5 — page 30

Thrust bearings — Standard ISO 199

- Normal tolerance class, 6 and 5 — page 31

Tapered bores — Standard ISO 492

- Bore with 1:12 and 1:30 taper — page 32

Radial bearings - Normal tolerance classes

With the exception of tapered roller bearings and thrust bearings. Standard ISO 492.

Inner ring

Tolerances in micrometers

d mm	ΔdmpUpper	ΔdmpLower	Vdp(1) Diameter series 9	Vdp(1) Diameter series 0,1	Vdp(1) Diameter series 2,3,4	Vdmp	Kia	ΔBs all	ΔBs normal	ΔBs modified(1)	VBs
	upper	lower	max			max	max	upper	lower		max
0,6 ≤d≤ 2,5	0	-8	10	8	6	6	10	0	-40	–	12
2,5 <d≤ 10	0	-8	10	8	6	6	10	0	-120	-250	15
10 <d≤ 18	0	-8	10	8	6	6	10	0	-120	-250	20
18 <d≤ 30	0	-10	13	10	8	8	13	0	-120	-250	20
30 <d≤ 50	0	-12	15	12	9	9	15	0	-120	-250	20
50 <d≤ 80	0	-15	19	19	11	11	20	0	-150	-380	25
80 <d≤ 120	0	-20	25	25	15	15	25	0	-200	-380	25
120 <d≤ 180	0	-25	31	31	19	19	30	0	-250	-500	30
180 <d≤ 250	0	-30	38	38	23	23	40	0	-300	-500	30
250 <d≤ 315	0	-35	44	44	26	26	50	0	-350	-500	35
315 <d≤ 400	0	-40	50	50	30	30	60	0	-400	-630	40
400 <d≤ 500	0	-45	56	56	34	34	65	0	-450	–	50
500 <d≤ 630	0	-50	63	63	38	38	70	0	-500	–	60
630 <d≤ 800	0	-75	–	–	–	–	80	0	-750	–	70
800 <d≤1000	0	-100	–	–	–	–	90	0	-1000	–	80

(1) Relates to the rings of isolated bearings for installation in pairs or per unit.

Outer ring

Tolerances in micrometers

D mm	ΔDmpUpper	ΔDmpLower	VDp(1) Open bearings Diameter series 9	VDp(1) Open bearings Diameter series 0,1	VDp(1) Open bearings Diameter series 2,3,4	VDp(1) Shielded bearings 2,3,4	VDmp(1)	Kea	ΔCs ΔC1s(2)	VCs VC1s(2)
	upper	lower	max				max	max	upper	lower	max
2,5 ≤D≤ 6	0	-8	10	8	6	10	6	15			
6 <D≤ 18	0	-8	10	8	6	10	6	15			
18 <D≤ 30	0	-9	12	9	7	12	7	15			
30 <D≤ 50	0	-11	14	11	8	16	8	20	Identical to ΔBs and VBs of the inner ring of the same bearing		
50 <D≤ 80	0	-13	16	13	10	20	10	25			
80 <D≤120	0	-15	19	19	11	26	11	35			
120 <D≤ 150	0	-18	23	23	14	30	14	40			
150 <D≤180	0	-25	31	31	19	38	19	45			
180 <D≤250	0	-30	38	38	23	-	23	50			
250 <D≤315	0	-35	44	44	26	-	26	60			
315 <D≤400	0	-40	50	50	30	-	30	70			
400 <D≤500	0	-45	56	56	34	-	34	80			
500 <D≤ 630	0	-50	63	63	38	-	38	100			
630 <D≤ 800	0	-75	94	94	55	-	55	120			
800 <D≤1000	0	-100	125	125	75	-	75	140			

Note: The tolerances on the outside diameter, D1, of the flange on the outer ring are given in standard ISO 492.
(1) Taken before fitting and after removal of the inner or outer snap ring.
(2) Only applies to ball and grooved bearings.

Bearing manufacturing precision *(continued)*

➔ High-precision radial bearings – Tolerance class 6

With the exception of tapered roller bearings and thrust bearings. Standard ISO 492.

■ Inner ring

Tolerances in micrometers

d mm	ΔdmpUpper	ΔdmpLower	VdpDiameter series 9 max	VdpDiameter series 0,1 max	VdpDiameter series 2,3,4 max	VdmpMax	KiaMax	ΔBsAll Upper	ΔBsNormal Lower	ΔBsModified(1) Lower	VBsMax
0,6 ≤d≤ 2,5	0	-7	9	7	5	5	5	0	-40	–	12
2,5 <d≤ 10	0	-7	9	7	5	5	6	0	-120	-250	15
10 <d≤ 18	0	-7	9	7	5	5	7	0	-120	-250	20
18 <d≤ 30	0	-8	10	8	6	6	8	0	-120	-250	20
30 <d≤ 50	0	-10	13	10	8	8	10	0	-120	-250	20
50 <d≤ 80	0	-12	15	15	9	9	10	0	-150	-380	25
80<d≤ 120	0	-15	19	19	11	11	13	0	-200	-380	25
120<d≤ 180	0	-18	23	23	14	14	18	0	-250	-500	30
180<d≤ 250	0	-22	28	28	17	17	20	0	-300	-500	30
250<d≤ 315	0	-25	31	31	19	19	25	0	-350	-500	35
315<d≤ 400	0	-30	38	38	23	23	30	0	-400	-630	40
400<d≤ 500	0	-35	44	44	26	26	35	0	-450	–	45
500<d≤ 630	0	-40	50	50	30	30	40	0	-500	–	50

(1) Relates to the rings of isolated bearings for installation in pairs or per unit.

■ Outer ring

Tolerances in micrometers

D mm	ΔDmpUpper	ΔDmpLower	VDp(1) Open bearings Diameter series 9 max	VDp(1) Open bearings Diameter series 0,1 max	VDp(1) Open bearings Diameter series 2,3,4 max	VDp(1) Shielded bearings 0,1,2,3,4 max	VDmp(1) Max	Kea Max	ΔCs ΔC1s(2) Upper	ΔCs ΔC1s(2) Lower	VCs VC1s(2) Max
2,5 ≤D≤ 6	0	-7	9	7	5	9	5	8			
6 <D≤ 18	0	-7	9	7	5	9	5	8			
18 <D≤ 30	0	-8	10	8	6	10	6	9			
30 <D≤ 50	0	-9	11	9	7	13	7	10	Identical to ΔBs and VBs of the inner ring of the same bearing		
50 <D≤ 80	0	-11	14	11	8	16	8	13			
80 <D≤ 120	0	-13	16	16	10	20	10	18			
120 <D≤ 150	0	-15	19	19	11	25	11	20			
150 <D≤ 180	0	-18	23	23	14	30	14	23			
180 <D≤ 250	0	-20	25	25	15	–	15	25			
250 <D≤ 315	0	-25	31	31	19	–	19	30			
315 <D≤ 400	0	-28	35	35	21	–	21	35			
400 <D≤ 500	0	-33	41	41	25	–	25	40			
500 <D≤ 630	0	-38	48	48	29	–	29	50			
630 <D≤ 800	0	-45	56	56	34	–	34	60			
800 <D≤1000	0	-60	75	75	45	–	45	75			

Note: The tolerances on the outside diameter, D1, of the flange on the outer ring are given in standard ISO 492.
(1) Taken before fitting and after removal of the inner or outer snap ring.
(2) Only applies to ball and grooved bearings.

High-precision radial bearings – Tolerance class 5

With the exception of tapered roller bearings and thrust bearings. Standard ISO 492.

Inner ring

Tolerances in micrometers

d mm	Δdmp		Vdp		Vdmp	Kia	Sd	Sia(1)	ΔBs			VBs
			Diameter series 9	Diameter series 0,1,2,3,4					all	normal	modified(2)	
	upper	lower	max		max	max	max	max	upper	lower		max
0,6 ≤d≤ 2,5	0	-5	5	4	3	4	7	7	0	-40	-250	5
2,5 <d≤ 10	0	-5	5	4	3	4	7	7	0	-40	-250	5
10 <d≤ 18	0	-5	5	4	3	4	7	7	0	-80	-250	5
18 <d≤ 30	0	-6	6	5	3	4	8	8	0	-120	-250	5
30 <d≤ 50	0	-8	8	6	4	5	8	8	0	-120	-250	5
50 <d≤ 80	0	-9	9	7	5	5	8	8	0	-150	-250	6
80 <d≤ 120	0	-10	10	8	5	6	9	9	0	-200	-380	7
120 <d≤ 180	0	-13	13	10	7	8	10	10	0	-250	-380	8
180 <d≤ 250	0	-15	15	12	8	10	11	13	0	-300	-500	10
250 <d≤ 315	0	-18	18	14	9	13	13	15	0	-350	-500	13
315 <d≤ 400	0	-23	23	18	12	15	15	20	0	-400	-630	15

(1) Only applies to ball and grooved bearings
(2) Relates to the rings of isolated bearings for installation in pairs or per unit.

Outer ring

Tolerances in micrometers

D mm	ΔDmp		VDp		VDmp	Kea	SD(1) SD1(2)	Sea(1)(2)	Sea1(2)	ΔCs ΔC1s(2)		VCs VC1s(2)
			Diameter series 9	Diameter series 0,1,2,3,4								
	upper	lower	max		max	max	max	max	max	max	lower	max
2,5 ≤D≤ 6	0	-5	5	4	3	5	8	8	11	Identical to ΔBs of the inner ring of the same bearing		5
6 <D≤ 18	0	-5	5	4	3	5	8	8	11			5
18 <D≤ 30	0	-5	6	5	3	6	8	8	11			5
30 <D≤ 50	0	-7	7	5	4	7	8	8	11			5
50 <D≤ 80	0	-9	9	7	5	8	8	10	14			6
80 <D≤120	0	-10	10	8	5	10	9	11	16			8
120 <D≤ 150	0	-11	11	8	6	11	10	13	18			8
150 <D≤ 180	0	-13	13	10	7	13	10	14	20			8
180 <D≤ 250	0	-15	15	11	8	15	11	15	21			10
250 <D≤ 315	0	-18	18	14	9	18	13	18	25			11
315 <D≤ 400	0	-20	20	15	10	20	13	20	28			13
400 <D≤ 500	0	-23	23	17	12	23	15	23	33			15
500 <D≤ 630	0	-28	28	21	14	25	18	25	35			18
630 <D≤ 800	0	-35	35	26	18	30	20	30	42			20

Note: The tolerances on the outside diameter, D1, of the flange on the outer ring are given in standard ISO 492.
(1) Does not apply to bearings with a flange-type outer ring.
(2) Only applies to ball and grooved bearings.

Bearing manufacturing precision *(continued)*

➔ High-precision radial bearings – Tolerance class 4

With the exception of tapered roller bearings and thrust bearings. Standard ISO 492.

Inner ring

Tolerances in micrometers

d mm	Δdmp		Δds(1)		Vdp Ø series 9	Ø series 0,1,2,3,4	Vdmp	Kia	Sd	Sia(2)	ΔBs all	ΔBs normal	ΔBs modified(2)	VBs
	upper	lower	upper	lower	max		max	max	max	max	upper	lower		max
0,6 ≤d≤ 2,5	0	-4	0	-4	4	3	2	2,5	3	3	0	-40	-250	2,5
2,5 <d≤ 10	0	-4	0	-4	4	3	2	2,5	3	3	0	-40	-250	2,5
10 <d≤ 18	0	-4	0	-4	4	3	2	2,5	3	3	0	-80	-250	2,5
18 <d≤ 30	0	-5	0	-5	5	4	2,5	3	4	4	0	-120	-250	2,5
30 <d≤ 50	0	-6	0	-6	6	5	3	4	4	4	0	-120	-250	3
50 <d≤ 80	0	-7	0	-7	7	5	3,5	4	5	5	0	-150	-250	4
80 <d≤ 120	0	-8	0	-8	8	6	4	5	5	5	0	-200	-380	4
120 <d≤ 180	0	-10	0	-10	10	8	5	6	6	7	0	-250	-380	5
180 <d≤ 250	0	-12	0	-12	12	9	6	8	7	8	0	-300	-500	6

(1) These differences apply to diameter series 0, 1, 2, 3 and 4 only.
(2) Only applies to ball and grooved bearings
(3) Relates to the rings of isolated bearings for installation in pairs or per unit.

Outer ring

Tolerances in micrometers

D mm	ΔDmp		ΔDs(1)		VDp Ø series 9	Ø series 0,1,2,3,4	VDmp	Kea	Sd(2) Sd1(3)	Sea(2)(3)	Sea1(3)	ΔCs ΔC1s(3)		VCs VC1s(3)
	upper	lower	upper	lower	max		max	max	max	max	max	upper	lower	max
2,5 ≤D≤ 6	0	-4	0	-4	4	3	2	3	4	5	7			2,5
6 <D≤ 18	0	-4	0	-4	4	3	2	3	4	5	7			2,5
18 <D≤ 30	0	-5	0	-5	5	4	2,5	4	4	5	7			2,5
30 <D≤ 50	0	-6	0	-6	6	5	3	5	4	5	7	Identical to ΔBs of the inner ring of the same bearing		2,5
50 <D≤ 80	0	-7	0	-7	7	5	3,5	5	4	5	7			3
80 <D≤120	0	-8	0	-8	8	6	4	6	5	6	8			4
120 <D≤150	0	-9	0	-9	9	7	5	7	5	7	10			5
150 <D≤180	0	-10	0	-10	10	8	5	8	5	8	11			5
180 <D≤250	0	-11	0	-11	11	8	6	10	7	10	14			7
250 <D≤315	0	-13	0	-13	13	10	7	11	8	10	14			7
315 <D≤400	0	-15	0	-15	15	11	8	13	10	13	18			8

Note: The tolerances on the outside diameter, D1, of the flange on the outer ring are given in standard ISO 492.
(1) These differences apply to diameter series 0, 1, 2, 3 and 4 only.
(2) Only applies to ball and grooved bearings
(3) Relates to the rings of isolated bearings for installation in pairs or per unit.

High-precision radial bearings – Tolerance class 2

With the exception of tapered roller bearings and thrust bearings. Standard ISO 492.

Inner ring

Tolerances in micrometers

d mm	Δdmp		Δds		Vdp(1)	Vdmp	Kia	Sd	Sia(2)	ΔBs			VBs
										all	normal	modified(2)	
	upper	lower	upper	lower	max	max	max	max	max	upper	lower		max
0,6 ≤d≤ 2,5	0	-2,5	0	-2,5	2,5	1,5	1,5	1,5	1,5	0	-40	-250	1,5
2,5 <d≤ 10	0	-2,5	0	-2,5	2,5	1,5	1,5	1,5	1,5	0	-40	-250	1,5
10 <d≤ 18	0	-2,5	0	-2,5	2,5	1,5	1,5	1,5	1,5	0	-80	-250	1,5
18 <d≤ 30	0	-2,5	0	-2,5	2,5	1,5	2,5	1,5	2,5	0	-120	-250	1,5
30 <d≤ 50	0	-2,5	0	-2,5	2,5	1,5	2,5	1,5	2,5	0	-120	-250	1,5
50 <d≤ 80	0	-4	0	-4	4	2	2,5	1,5	2,5	0	-150	-250	1,5
80 <d≤ 120	0	-5	0	-5	5	2,5	2,5	2,5	2,5	0	-200	-380	2,5
120 <d≤ 150	0	-7	0	-7	7	3,5	2,5	2,5	2,5	0	-250	-380	2,5
150 <d≤ 180	0	-7	0	-7	7	3,5	5	4	5	0	-250	-380	4
180 <d≤ 250	0	-8	0	-8	8	4	5	5	5	0	-300	-500	5

(1) These differences apply to diameter series 0, 1, 2, 3 and 4 only.
(2) Only applies to ball and grooved bearings
(3) Relates to the rings of isolated bearings for installation in pairs or per unit.

Outer ring

Tolerances in micrometers

D mm	ΔDmp		ΔDs		VDp(1)	VDp	Kea	Sd(2) Sd1(3)	Sia(2)(3)	Sia1(3)	ΔCs ΔC1s(3)		VCs VC1s(3)
	upper	lower	upper	lower	max	max	max	max	max	max	upper	lower	max
2,5 ≤D≤ 6	0	-2,5	0	-2,5	2,5	1,5	1,5	1,5	1,5	3	Identical to ΔBs of the inner ring of the same bearing		1,5
6 <D≤ 18	0	-2,5	0	-2,5	2,5	1,5	1,5	1,5	1,5	3			1,5
18 <D≤ 30	0	-4	0	-4	4	2	2,5	1,5	2,5	4			1,5
30 <D≤ 50	0	-4	0	-4	4	2	2,5	1,5	2,5	4			1,5
50 <D≤ 80	0	-4	0	-4	4	2	4	1,5	4	6			1,5
80 <D≤ 120	0	-5	0	-5	5	2,5	5	2,5	5	7			2,5
120 <D≤ 150	0	-5	0	-5	5	2,5	5	2,5	5	7			2,5
150 <D≤ 180	0	-7	0	-7	7	3,5	5	2,5	5	7			2,5
180 <D≤ 250	0	-8	0	-8	8	4	7	4	7	10			4
250 <D≤ 315	0	-8	0	-8	8	4	7	5	7	10			5
315 <D≤ 400	0	-10	0	-10	10	5	8	7	8	11			7

Note: The tolerances on the outside diameter, D1, of the flange on the outer ring are given in standard ISO 492.
(1) These differences apply to diameter series 0, 1, 2, 3 and 4 only.
(2) Only applies to ball and grooved bearings
(3) Relates to the rings of isolated bearings for installation in pairs or per unit.

Bearing manufacturing precision *(continued)*

Tapered roller bearings - Normal tolerance class

Diameter and radial run-out - Inner ring

Tolerances in micrometers

d mm	Δdmp		Vdp	Vdmp	Kia
	upper	lower	max	max	max
10 ≤d≤ 18	0	-12	12	9	15
18 <d≤ 30	0	-12	12	9	18
30 <d≤ 50	0	-12	12	9	20
50 <d≤ 80	0	-15	15	11	25
80 <d≤ 120	0	-20	20	15	30
120 <d≤ 180	0	-25	25	19	35
180 <d≤ 250	0	-30	30	23	50
250 <d≤ 315	0	-35	35	26	60
315 <d≤ 400	0	-40	40	30	70

Diameter and radial run-out - Outer ring

Tolerances in micrometers

D mm	ΔDmp		VDp	VDmp	Kea
	upper	lower	max	max	max
18 ≤D≤≤ 30	0	-12	12	9	18
30 <D≤ 50	0	-14	14	11	20
50 <D≤ 80	0	-16	16	12	25
80 <D≤ 120	0	-18	18	14	35
120 <D≤ 150	0	-20	20	15	40
150 <D≤ 180	0	-25	25	19	45
180 <D≤ 250	0	-30	30	23	50
250 <D≤ 315	0	-35	35	26	60
315 <D≤ 400	0	-40	40	30	70
400 <D≤ 500	0	-45	45	34	80
500 <D≤ 630	0	-50	50	38	100

Note: The tolerances on the outside diameter, D1, of the flange on the outer ring are given in standard ISO 492.

Width - Inner and outer rings, single-row bearings and single-row sub-assemblies

Tolerances in micrometers

d mm	ΔBs		ΔCs		ΔTs		ΔT1s		ΔT2s	
	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower
10 ≤d≤ 18	0	-120	0	-120	+200	0	+100	0	+100	0
18 <d≤ 30	0	-120	0	-120	+200	0	+100	0	+100	0
30 <d≤ 50	0	-120	0	-120	+200	0	+100	0	+100	0
50 <d≤ 80	0	-150	0	-150	+200	0	+100	0	+100	0
80 <d≤ 120	0	-200	0	-200	+200	-200	+100	-100	+100	-100
120 <d≤ 180	0	-250	0	-250	+350	-250	+150	-150	+200	-100
180 <d≤ 250	0	-300	0	-300	+350	-250	+150	-150	+200	-100
250 <d≤ 315	0	-350	0	-350	+350	-250	+150	-150	+200	-100
315 <d≤ 400	0	-400	0	-400	+400	-400	+200	-200	+200	-200

High-precision tapered roller bearings – Tolerance class 6X

The diameter and radial run-out tolerances of inner rings (cones) and outer rings (cups) in this tolerance class are the same as those given in page 28 for the normal class. The width tolerances are given below.

Width - Inner and outer rings, single-row bearings and single-row sub-assemblies

Tolerances in micrometers

d mm	ΔBs		ΔCs		ΔTs		ΔT1s		ΔT2s	
	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower
10 ≤d≤ 18	0	-50	0	-100	+100	0	+50	0	+50	0
18 <d≤ 30	0	-50	0	-100	+100	0	+50	0	+50	0
30 <d≤ 50	0	-50	0	-100	+100	0	+50	0	+50	0
50 <d≤ 80	0	-50	0	-100	+100	0	+50	0	+50	0
80 <d≤ 120	0	-50	0	-100	+100	0	+50	0	+50	0
120 <d≤ 180	0	-50	0	-100	+150	0	+50	0	+100	0
180 <d≤ 250	0	-50	0	-100	+150	0	+50	0	+100	0
250 <d≤ 315	0	-50	0	-100	+200	0	+100	0	+100	0
315 <d≤ 400	0	-50	0	-100	+200	0	+100	0	+100	0

Bearing manufacturing precision *(continued)*

High-precision tapered roller bearings - Tolerance class 5

Inner ring (cone) and width of single-row bearing

Tolerances in micrometers

d mm	Δdmp		Vdp	Vdmp	Kia	Sd	ΔBs		ΔTs	
	upper	lower	max	max	max	max	upper	lower	upper	lower
10 ≤d≤ 18	0	-7	5	5	5	7	0	-200	+200	-200
18 <d≤ 30	0	-8	6	5	5	8	0	-200	+200	-200
30 <d≤ 50	0	-10	8	5	6	8	0	-240	+200	-200
50 <d≤ 80	0	-12	9	6	7	8	0	-300	+200	-200
80 <d≤ 120	0	-15	11	8	8	9	0	-400	+200	-200
120 <d≤ 180	0	-18	14	9	11	10	0	-500	+350	-250
180 <d≤ 250	0	-22	17	11	13	11	0	-600	+350	-250

Outer ring (cup)

Tolerances in micrometers

D mm	Δdmp		Vdp	Vdmp	Kea	Sd(1), SD1	ΔTs	
	upper	lower	max	max	max	max	upper	lower
18 <D≤ 30	0	-8	6	5	6	8	Identical to ΔBs of the inner ring of the same bearing	
30 <D≤ 50	0	-9	7	5	7	8		
50 <D≤ 80	0	-11	8	6	8	8		
80 <D≤ 120	0	-13	10	7	10	9		
120 <D≤ 150	0	-15	11	8	11	10		
150 <D≤ 180	0	-18	14	9	13	10		
180 <D≤ 250	0	-20	15	10	15	11		
250 <D≤ 315	0	-25	19	13	18	13		
315 <D≤ 400	0	-28	22	14	20	13		

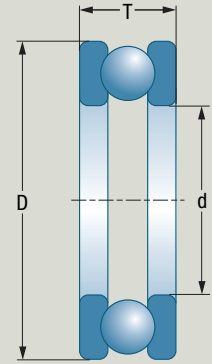
Note: The tolerances on the outside diameter, D1, of the flange on the outer ring are given in standard ISO 492.
(1) Does not apply to bearings with a flanged outer ring.

Ball thrust bearings - Normal tolerance class

Standard ISO 199

References

d	Nominal bore diameter of the shaft ring of a single-direction thrust bearing
Δdmp	Deviation in the mean bore diameter of the shaft ring of a single-direction thrust bearing, in an isolated plane
Vdp	Variation in the bore diameter of the shaft ring of a single-direction thrust bearing, in an isolated radial plane
D	Nominal outside diameter of the housing ring
ΔDmp	Deviation in the mean outside diameter of the housing ring in an isolated plane
VDp	Variation in the outside diameter of the housing ring in an isolated radial plane
Si	Variation in thickness between the bearing raceway and the contact face of the shaft ring
Se	Variation in thickness between the bearing raceway and the contact face of the housing ring
ΔTs	Variation in total height



Shaft ring and height of thrust bearing

Tolerances in micrometers

d mm		Δdmp		Vdp	Si	ΔTs	
>	≤	upper	lower	max	max	upper	lower
–	18	0	-8	6	10	+20	-250
18	30	0	-10	8	10	+20	-250
30	50	0	-12	9	10	+20	-250
50	80	0	-15	11	10	+20	-300
80	120	0	-20	15	15	+25	-300
120	180	0	-25	19	15	+25	-400
180	250	0	-30	23	20	+30	-400
250	315	0	-35	26	25	+40	-400
315	400	0	-40	30	30	+40	-500
400	500	0	-45	34	30	+50	-500

Bearing manufacturing precision *(continued)*

Housing ring

Tolerances in micrometers

D mm		ΔDmp		VDp	Se
>	≤	upper	lower	max	max
10	18	0	-11	8	Identical to Si of the shaft ring of the same type
18	30	0	-13	10	
30	50	0	-16	12	
50	80	0	-19	14	
80	120	0	-22	17	
120	180	0	-25	19	
180	250	0	-30	23	
250	315	0	-35	26	
315	400	0	-40	30	
400	500	0	-45	34	
500	630	0	-50	38	

Tapered bores: 1:12 and 1:30 taper

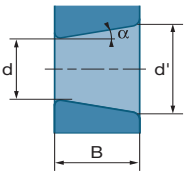
Standard ISO 492

- Nominal half-angle at apex of cone:

1/12 : α = 2° 23' 9.4" = 2.38594° = 0.041643 rad
1/30 : α = 0° 57' 17.4" = 0.95484° = 0.016665 rad

- Nominal diameter at the largest theoretical width of the bore:

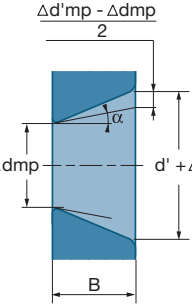
1/12 : d' = d + B / 12
1/30 : d' = d + B / 30



Theoretical tapered bore

- The tolerances on a tapered bore comprise:

- a tolerance on the mean diameter, given by the limits of the actual deviation of the mean diameter at the smallest theoretical width of the bore Δmp,
- a taper tolerance, given by the limits of the deviation between the mean diameter deviations at each end of the bore Δ'mp - Δmp,
- a tolerance on the diameter variation Vdp given by a maximum value applicable in any radial plane of the bore



Tapered bore with mean diameters and deviations

Tapered bore, 1:12 taper

Tolerances in micrometers

d mm	Δdmp		Δd'mp - Δdmp		Vdp(1)(2)
	upper	lower	upper	lower	max
d≤ 10	22	0	15	0	9
10 <d≤ 18	27	0	18	0	11
18 <d≤ 30	33	0	21	0	13
30 <d≤ 50	39	0	25	0	16
50 <d≤ 80	46	0	30	0	19
80 <d≤ 120	54	0	35	0	22
120 <d≤ 180	63	0	40	0	40
180 <d≤ 250	72	0	46	0	46
250 <d≤ 315	81	0	52	0	52
315 <d≤ 400	89	0	57	0	57
400 <d≤ 500	97	0	63	0	63
500 <d≤ 630	110	0	70	0	70
630 <d≤ 800	125	0	80	0	–
800 <d≤1000	140	0	90	0	–

(1) Applies to any isolated radial plane of the bore.
(2) Does not apply to diameter series 7 and 8.

Tapered bore, 1:30 taper

Tolerances in micrometers

d mm	Δdmp		Δd'mp - Δdmp		Vdp(1)(2)
	upper	lower	upper	lower	max
50 <d≤ 80	15	0	30	0	19
80 <d≤ 120	20	0	35	0	22
120 <d≤ 180	25	0	40	0	40
180 <d≤ 250	30	0	46	0	46
250 <d≤ 315	35	0	52	0	52
315 <d≤ 400	40	0	57	0	57
400 <d≤ 500	45	0	63	0	63
500 <d≤ 630	50	0	70	0	70

(1) Applies to any isolated radial plane of the bore.
(2) Does not apply to diameter series 7 and 8.

Bearings initial radial internal clearance

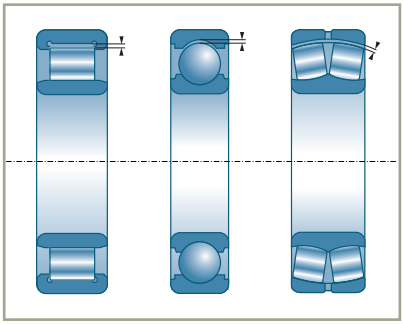
Radial clearance of radial contact bearings. Definition

The internal radial clearance is the load-free displacement of one ring with respect to the other in the radial direction.

Radial contact bearings to run correctly must have a slight radial clearance.

Radial contact bearings have a built in internal clearance. When the bearing is fitted, a residual clearance must remain.

This radial clearance leads to an axial clearance (except in the case of cylindrical roller bearings).



Internal radial clearance groups

The clearance tolerances of groups are standard (ISO 5753 standard).

The internal clearance group is chosen according to the application specifications and the residual clearance calculation.

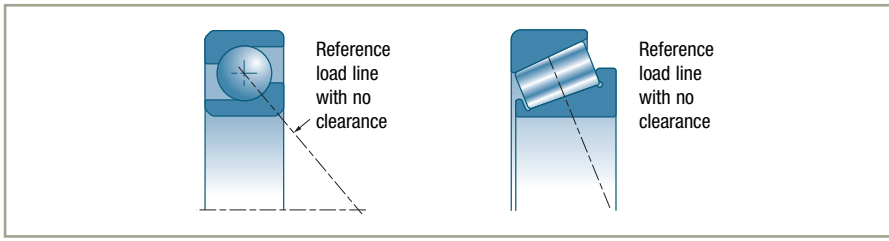
Radial clearance		Bearing designation	Other manufacturers
Type	Group	SNR suffix	
Normal clearance	N		Suitable for low or moderate loads, normal interference fit of only one of the two rings, normal temperatures.
Increased clearance	3	C3	Clearance frequently used in the following cases: - tight interference fit of one ring or slight on both rings - possible misalignment, bending of shaft - to increase the contact angle of highly-loaded radial contact ball bearings - high temperatures Clearance groups 4 and 5 are used in the above cases when group 3 is insufficient.
	4	C4	
	5	C5	
Reduced clearance	2	C2	This clearance group is used (rarely) when very good guidance with reduced clearance is required, and in applications with alternating loads and high impact levels. The use of this clearance group is highly particular because its aim is usually to cancel the bearing operating clearance. The study of the assembly (alignment), fits and operating conditions (temperature, speed) must be carried out with particular care. Consult SNR.

Axial clearance of angular contact bearings

Recommended axial clearance

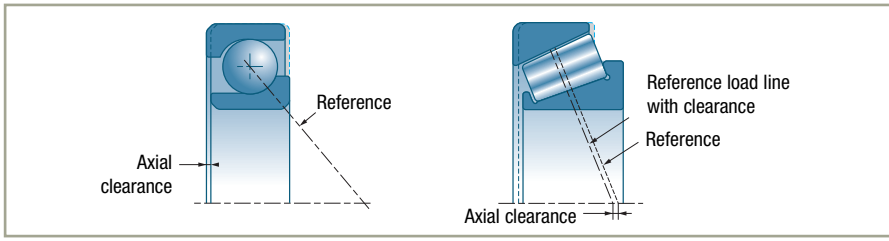
By construction, single-row angular contact ball bearings or tapered roller bearings have no internal clearance.

The bearing clearance is zero when its inner ring, rolling elements and outer ring are in contact without any load applied.



When the bearing is mounted it can be given a clearance or a preload with respect to this reference position.

The figure opposite shows the positions of the components when there is an axial clearance.



Magnitude of the axial clearance of an assembly in operation

The value of the initial clearance on fitting must take into account the operating conditions.

The relation between the axial clearance and radial clearance of a two-bearing assembly is indicated for each type of bearing in chapter corresponding to each family.

d = bearing bore	Ja = axial clearance
d < 20 mm	Ja = 0.03 up to 0.08 mm
20 < d ≤ 80 mm	Ja = 0.05 up to 0.15 mm
80 < d ≤ 120 mm	Ja = 0.05 up to 0.25 mm
d > 120 mm	Ja = 0.10 up to 0.30 mm