

General Data

Types of bearings	6
■ Definitions	6
■ Vocabulary	8
■ Capabilities	9
Standardization and interchangeability	12
■ The Standards	12
■ Interchangeability	12
Dimensions and part numbers	14
■ General designations	14
<i>Complete reference</i>	14
<i>Basic reference</i>	15
■ Designations of tapered roller bearing	16
■ Designation of special bearings	17
Bearing manufacturing precision	18
■ Standardization	18
<i>Tolerance definition</i>	19
<i>Equivalence of bearing precision standards</i>	22
■ Bearing tolerances	22
<i>Radial bearings - Normal tolerance classes</i>	23
<i>High-precision radial bearings - Tolerance class 6</i>	24
<i>High-precision radial bearings - Tolerance class 5</i>	25
<i>High-precision radial bearings - Tolerance class 4</i>	26
<i>High-precision radial bearings - Tolerance class 2</i>	27
<i>Tapered roller bearings - Normal tolerance class</i>	28
<i>High-precision tapered roller bearings - Tolerance class 6X</i>	29
<i>High-precision tapered roller bearings - Tolerance class 5</i>	30
<i>Ball thrust bearings - Normal tolerance class</i>	31
<i>Tapered bores: 1:12 and 1:30 taper</i>	32
Bearings initial radial internal clearance	34
■ Radial clearance of radial contact bearings. Definition	34
■ Internal radial clearance groups	34
Axial clearance of angular contact bearings	35
■ Recommended axial clearance	35

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.








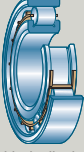






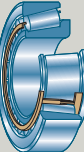





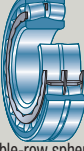



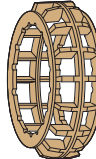
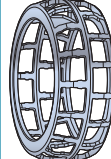

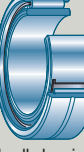















■ A bearing consists of:

- 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



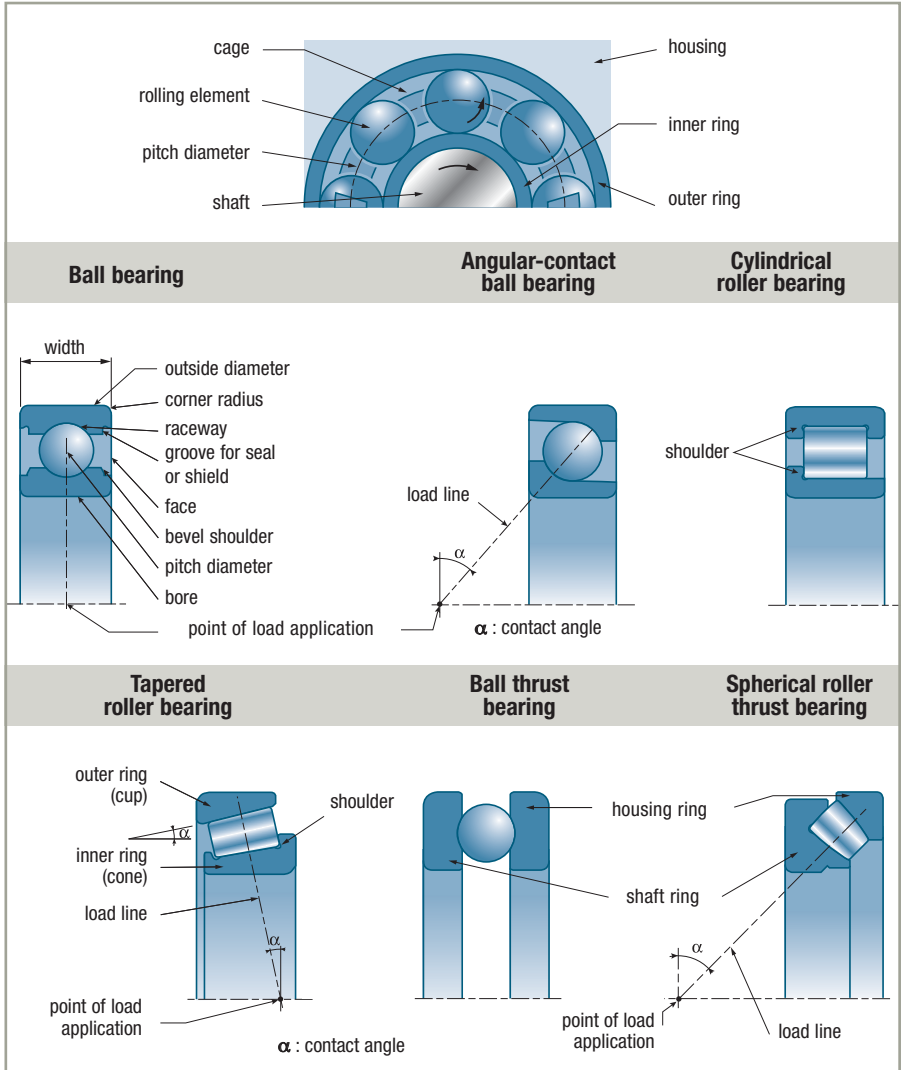
Type	Outer ring	Inner ring	Rolling elements	Synthetic material	Pressed steel	Integrally machined
 Ball bearing						
 Cylindrical roller bearing						
 Tapered roller bearing	 (cup)	 (cone)				
 Double-row spherical roller bearing						
 Needle bearing						
 Ball thrust bearing	 (housing ring)	 (shaft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

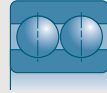
Application examples

■ 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.

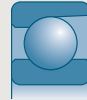


Electric motor
Wheel of trailer
Household electrical appliances
Woodworking machine spindles
Small reducing gear
Gear box

▶ Single-row angular-contact ball bearings

Always mounted in opposition with another bearing of the same type.

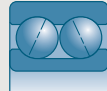
Give great assembly rigidity, especially when preloaded



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

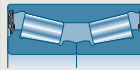
Always mounted in opposition with another bearing of the same type.
Give great assembly rigidity, especially when preloaded.



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.



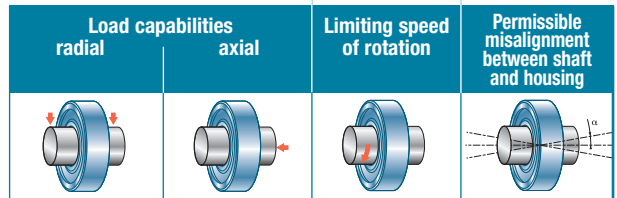
Vertical shaft
Tailstock
Plate pump

▶ 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

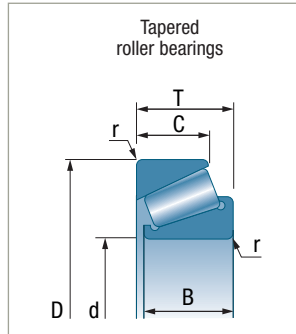
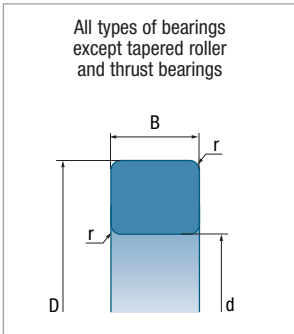
The mission of the International Standard Organisation (ISO) is to develop and coordinate standardization to facilitate the trade of products and services between nations. It encompasses the standards committees of 89 countries (AFNOR-France, DIN-Germany, UNI-Italy, BS-Great Britain, ANSI-United States,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

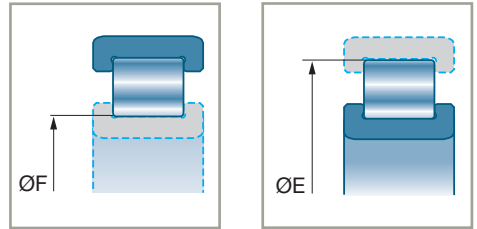
For each diameter series there are several width series (series 0, 1, 2, 3, 4 in ascending order).

■ 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.

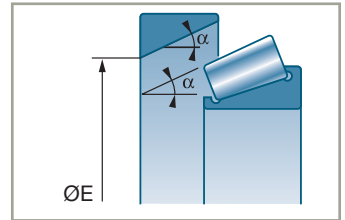
Cylindrical roller bearings

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

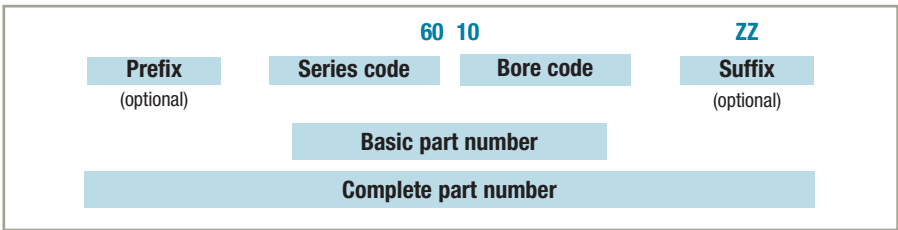
General designations

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.

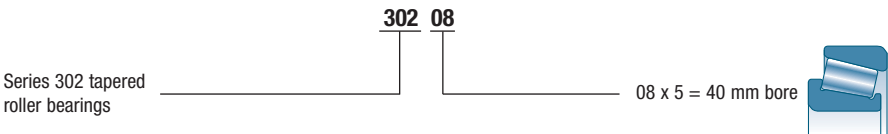
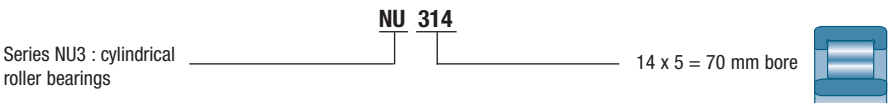
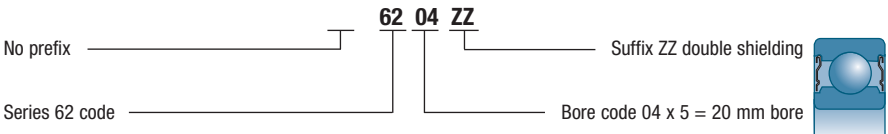
- The general designation system taken from standards ISO 15 and ISO 104 applies to all types of standardized bearings
 - Tapered roller bearings have specific designations taken from standard ISO 355
- The special bearings have a specific numbering system.

→ Complete part number

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










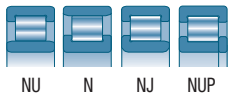

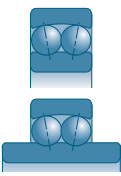


Examples:



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

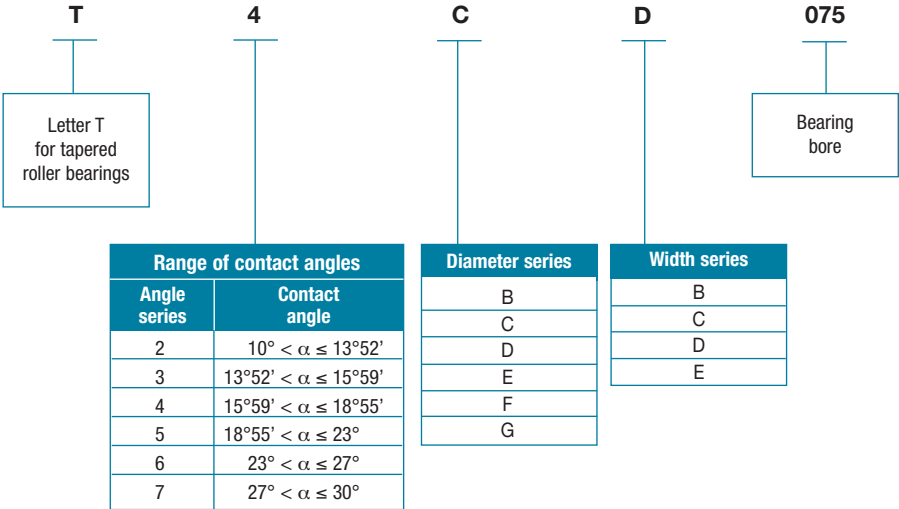
Part number	Type of bearing	Part number	Type of bearing	Bore code	Bore diameter mm
60 X 62 X 63 XX 64 XX 160 XX 618 XX 619 XX 622 XX 623 XX	Radial ball bearing  With 1 row of balls	72 XX 73 XX 718 XX	Angular-contact ball bearing  With 1 row of balls	3 /4 4	3 4 4
2 XX 3 XX	 With a filling slot	QJ2 XX QJ3 XX	 With 4 points of contact	5 6 /6	5 6 6
42 XX 43 XX	 With 2 rows of balls	32 XX 33 XX	 With 2 rows of balls	7 /7	7 7
302 XX 303 XX 313 XX 320 XX 322 XX 323 XX 330 XX 331 XX 332 XX	Tapered roller bearing 	52 XX 53 XX	 With 2 rows of balls ZZ or EE	8 /8	8 8
N..2 XX N..3 XX N..4 XX N..10 XX N..22 XX N..23 XX	Cylindrical roller bearing  NU N NJ NUP	213 XX 222 XX 223 XX 230 XX 231 XX 232 XX 240 XX 241 XX	Double-row spherical roller bearing 	9 00 01 02 03 /22 /28 /32	10 12 15 17 22 28 32
12 XX 13 XX 22 XX 23 XX	Double-row self-aligning ball bearing  Wide inner ring	511 XX 512 XX 513 XX 514 XX	Ball thrust bearing 	04 05 06 07 08 09 10	04x5 = 20 05x5 = 25 06x5 = 30 07x5 = 35 08x5 = 40
112 XX 113 XX		293 XX 294 XX	Spherical roller thrust bearing 		

Dimensions and part numbers (continued)

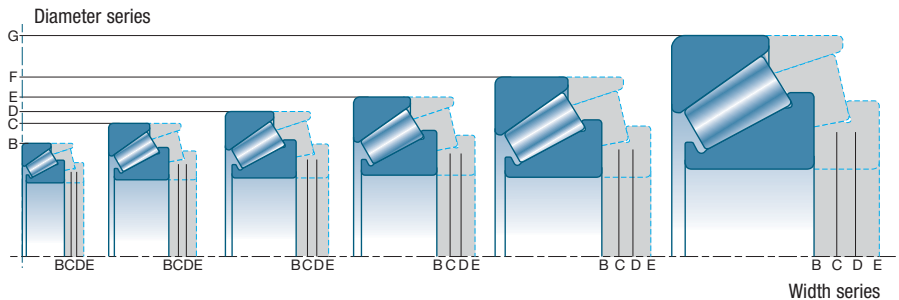
Designations of tapered roller bearings

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.

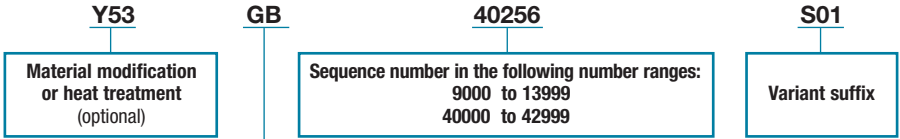





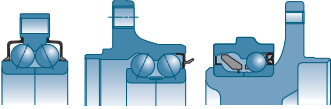












Width and diameter series



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.



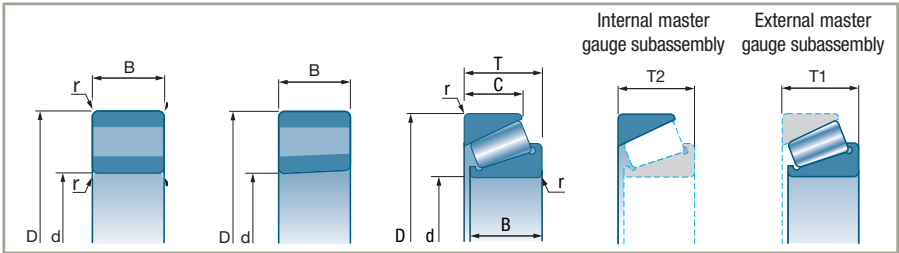
	Type of bearing	Examples
AB	Single-row radial contact ball bearing	
BB	Single-row angular contact ball bearing	
GB	Two-part double-row angular contact ball bearing	
TGB	Single-flange double-row angular contact ball bearing	
HGB	Two-flange double-row angular contact ball bearing	
DB	Double-row radial 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:

Clearance category 3 C3 P5 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 $20^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($68^{\circ}\text{F} \pm 1.8$).

■ **Dimensional tolerances**

Standard **ISO 492** sets the tolerances for the three main dimensions of a bearing:

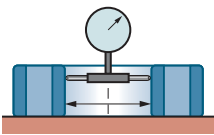
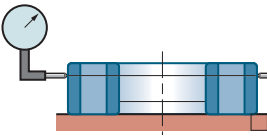
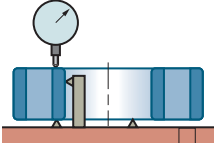
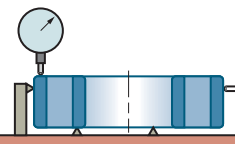
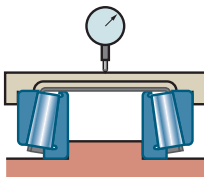
- the bore diameter d
- the outside diameter D
- the width of each ring B and C with, in addition, for tapered bearings, the total width T

■ **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

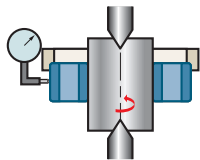
Bearing manufacturing precision *(continued)*

Dimensional tolerances	Deviations
<p>d: nominal bore diameter</p> 	<p>Δd_{mp} • Deviation of a mean bore diameter in an isolated plane (tolerance on the mean diameter)</p> <p>V_{dp} • Variation in the bore diameter in an isolated radial plane (ovality)</p> <p>V_{dmp} • Variation in the mean bore diameter (applies only to a supposedly cylindrical bore) in different planes</p>
<p>D: nominal outside diameter</p> 	<p>ΔD_{mp} • Deviation of a mean outside diameter in an isolated plane (tolerance on the mean diameter)</p> <p>V_{Dp} • Variation in the outside diameter in an isolated radial plane (ovality)</p> <p>V_{Dmp} • Variation in the mean outside diameter in different planes</p>
<p>B: nominal width of ring</p> 	<p>ΔB_s • Deviation of an isolated width of the inner ring (width tolerance)</p> <p>V_{B_s} • Variation in the width of the inner ring (face parallelism)</p>
<p>C: nominal width of ring</p> 	<p>ΔC_s • Deviation of an isolated width of the outer ring (width tolerance)</p> <p>V_{C_s} • Variation in the width of the outer ring (face parallelism)</p>
<p>T : nominal width of tapered bearing</p> <p>T1: effective nominal width of the internal sub-assembly</p> <p>T2: effective nominal width of the external sub-assembly</p> 	<p>ΔT_s • Deviation in the actual width of the bearing</p> <p>$\Delta T1_s$ • Deviation in the effective actual width of the internal sub-assembly</p> <p>$\Delta T2_s$ • Deviation in the effective actual width of the external sub-assembly</p>

Functional tolerances

Deviations

radial run-out

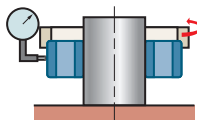


Kia

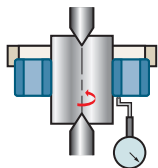
- Radial run-out of the inner ring on the assembled bearing

Kea

- Radial run-out of the outer ring on the assembled bearing



run-out of the reference face

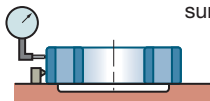


Sd

- 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

- Perpendicularity error of the external surface with respect to the reference face (or large face) of the outer ring (external surface run-out)



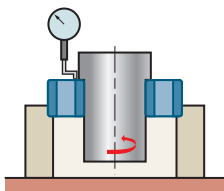
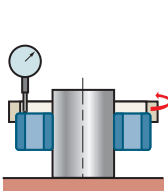
bearing raceway run-out

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	6	3	P6
	5	5	5	P5
	4	4	7	P4
	2	2	9	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

- Normal tolerance class
- Tolerance class 6
- Tolerance class 5
- Tolerance class 4
- Tolerance class 2

Standard ISO 492

- page 23
- page 24
- page 25
- page 26
- page 27

■ Tapered roller bearings

- Normal tolerance class
- Tolerance class 6X
- Tolerance class 5

Standard ISO 492

- page 28
- page 29
- page 30

■ Thrust bearings

- Normal tolerance class, 6 and 5

Standard ISO 199

- page 31

■ Tapered bores

- Bore with 1:12 and 1:30 taper

Standard ISO 492

- 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	Δdmp		Vdp ⁽¹⁾			Vdmp	Kia	ΔBs			VBs
			Diameter series					all	normal	modified ⁽¹⁾	
	upper	lower	9	0,1	2,3,4	max	max				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	ΔDmp		VDp ⁽¹⁾				VDmp ⁽¹⁾	Kea	ΔCs		VCs
			Open bearings			Shielded bearings			ΔC1s ⁽²⁾		
	upper	lower	9	0,1	2,3,4		2,3,4	max	max	upper	lower
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			
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	Δdmp		Vdp			Vdmp	Kia	ΔBs			VBs
			Diameter series					all	normal	modified ⁽¹⁾	
	9	0,1	2,3,4	upper	lower	max					
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	ΔDmp		VDp ⁽¹⁾				VDmp ⁽¹⁾	Kea	ΔCs		VCs
			Open bearings			Shielded bearings			ΔC1s ⁽²⁾		
	9	0,1	2,3,4	0,1,2,3,4	max		max	upper	lower	max	
2,5 ≤ D ≤ 6	0	-7	9	7	5	9	5	8	Identical to ΔBs and VBs of the inner ring of the same bearing		
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			
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						all	normal	modified ⁽²⁾	
	upper	lower	9	0,1,2,3,4	max	max	max	max				upper
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							all	lower	
	upper	lower	9	0,1,2,3,4	max	max	max	max	max			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		Vdmp	Kia	Sd	Sia ⁽²⁾	ΔBs			VBs
					9	0,1,2,3,4					all	normal	modified ⁽²⁾	
	upper	lower	upper	lower			max	max	max	max				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		VDmp	Kea	Sd ⁽²⁾ Sd1 ⁽³⁾	Sea ⁽²⁾⁽³⁾	Sea1 ⁽³⁾	ΔCs ΔC1s ⁽³⁾		VCs VC1s ⁽³⁾
					9	0,1,2,3,4						upper	lower	
	upper	lower	upper	lower			max	max	max	max	max			max
2,5 ≤ D ≤ 6	0	-4	0	-4	4	3	2	3	4	5	7	Identical to ΔBs of the inner ring of the same bearing	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		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	Δd_{mp}		Δd_s		$V_{dp}^{(1)}$	V_{dmp}	K_{ia}	S_d	$S_{ia}^{(2)}$	ΔB_s			V_{Bs}
	upper	lower	upper	lower	max	max	max	max	max	all	normal	modified ⁽³⁾	max
										upper			
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	ΔD_{mp}		ΔD_s		$V_{Dp}^{(1)}$	V_{Dp}	K_{ea}	$S_{d1}^{(2)}$	$S_{d1}^{(3)}$	$S_{ia}^{(2)(3)}$	$S_{ia1}^{(3)}$	ΔC_s $\Delta C1s^{(3)}$		V_{Cs} $V_{C1s}^{(3)}$
	upper	lower	upper	lower	max	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	1,5	3	Identical to ΔB_s 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

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

■ Diameter and radial run-out - Inner ring

Tolerances in micrometers

d mm	Δd_{mp}		V _{dp}	V _{dmp}	K _{ia}
	upper	lower	max	max	max
10 $\leq d \leq$ 18	0	-12	12	9	15
18 $< d \leq$ 30	0	-12	12	9	18
30 $< d \leq$ 50	0	-12	12	9	20
50 $< d \leq$ 80	0	-15	15	11	25
80 $< d \leq$ 120	0	-20	20	15	30
120 $< d \leq$ 180	0	-25	25	19	35
180 $< d \leq$ 250	0	-30	30	23	50
250 $< d \leq$ 315	0	-35	35	26	60
315 $< d \leq$ 400	0	-40	40	30	70

■ Diameter and radial run-out - Outer ring

Tolerances in micrometers

D mm	ΔD_{mp}		V _{Dp}	V _{Dmp}	K _{ea}
	upper	lower	max	max	max
18 $\leq D \leq$ 30	0	-12	12	9	18
30 $< D \leq$ 50	0	-14	14	11	20
50 $< D \leq$ 80	0	-16	16	12	25
80 $< D \leq$ 120	0	-18	18	14	35
120 $< D \leq$ 150	0	-20	20	15	40
150 $< D \leq$ 180	0	-25	25	19	45
180 $< D \leq$ 250	0	-30	30	23	50
250 $< D \leq$ 315	0	-35	35	26	60
315 $< D \leq$ 400	0	-40	40	30	70
400 $< D \leq$ 500	0	-45	45	34	80
500 $< D \leq$ 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	Δd_{mp}		V_{dp}	V_{dmp}	K_{ia}	S_d	ΔB_s		ΔT_s	
	upper	lower	max	max	max	max	upper	lower	upper	lower
10 $\leq d \leq$ 18	0	-7	5	5	5	7	0	-200	+200	-200
18 $< d \leq$ 30	0	-8	6	5	5	8	0	-200	+200	-200
30 $< d \leq$ 50	0	-10	8	5	6	8	0	-240	+200	-200
50 $< d \leq$ 80	0	-12	9	6	7	8	0	-300	+200	-200
80 $< d \leq$ 120	0	-15	11	8	8	9	0	-400	+200	-200
120 $< d \leq$ 180	0	-18	14	9	11	10	0	-500	+350	-250
180 $< d \leq$ 250	0	-22	17	11	13	11	0	-600	+350	-250

■ Outer ring (cup)

Tolerances in micrometers

D mm	Δd_{mp}		V_{dp}	V_{dmp}	K_{ea}	$S_d^{(1)}, SD1$	ΔT_s	
	upper	lower	max	max	max	max	upper	lower
18 $< D \leq$ 30	0	-8	6	5	6	8	Identical to ΔB_s of the inner ring of the same bearing	
30 $< D \leq$ 50	0	-9	7	5	7	8		
50 $< D \leq$ 80	0	-11	8	6	8	8		
80 $< D \leq$ 120	0	-13	10	7	10	9		
120 $< D \leq$ 150	0	-15	11	8	11	10		
150 $< D \leq$ 180	0	-18	14	9	13	10		
180 $< D \leq$ 250	0	-20	15	10	15	11		
250 $< D \leq$ 315	0	-25	19	13	18	13		
315 $< D \leq$ 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	
Δd_{mp}	Deviation in the mean bore diameter of the shaft ring of a single-direction thrust bearing, in an isolated plane	
V _{dp}	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	
ΔD_{mp}	Deviation in the mean outside diameter of the housing ring in an isolated plane	
V _{Dp}	Variation in the outside diameter of the housing ring in an isolated radial plane	
S _i	Variation in thickness between the bearing raceway and the contact face of the shaft ring	
S _e	Variation in thickness between the bearing raceway and the contact face of the housing ring	
ΔT_s	Variation in total height	

■ Shaft ring and height of thrust bearing

Tolerances in micrometers

d mm		Δd_{mp}		V _{dp}	S _i	ΔT_s	
>	≤	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		ΔD_{mp}		VDp	Se
>	\leq	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:

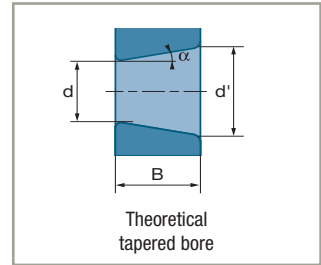
$$1/12 : \alpha = 2^\circ 23' 9.4'' = 2.38594^\circ = 0.041643 \text{ rad}$$

$$1/30 : \alpha = 0^\circ 57' 17.4'' = 0.95484^\circ = 0.016665 \text{ rad}$$

Nominal diameter at the largest theoretical width of the bore:

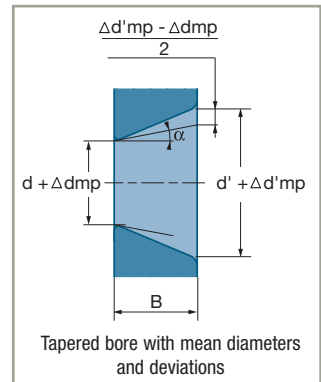
$$1/12 : d' = d + B / 12$$

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



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 $\Delta' mp - \Delta mp$,
- a tolerance on the diameter variation Vdp given by a maximum value applicable in any radial plane of the bore



■ Tapered bore, 1:12 taper

Tolerances in micrometers

d mm	Δd_{mp}		$\Delta d'_{mp} - \Delta d_{mp}$		$V_{dp}^{(1)(2)}$
	upper	lower	upper	lower	max
$d \leq 10$	22	0	15	0	9
$10 < d \leq 18$	27	0	18	0	11
$18 < d \leq 30$	33	0	21	0	13
$30 < d \leq 50$	39	0	25	0	16
$50 < d \leq 80$	46	0	30	0	19
$80 < d \leq 120$	54	0	35	0	22
$120 < d \leq 180$	63	0	40	0	40
$180 < d \leq 250$	72	0	46	0	46
$250 < d \leq 315$	81	0	52	0	52
$315 < d \leq 400$	89	0	57	0	57
$400 < d \leq 500$	97	0	63	0	63
$500 < d \leq 630$	110	0	70	0	70
$630 < d \leq 800$	125	0	80	0	–
$800 < d \leq 1000$	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	Δd_{mp}		$\Delta d'_{mp} - \Delta d_{mp}$		$V_{dp}^{(1)(2)}$
	upper	lower	upper	lower	max
$50 < d \leq 80$	15	0	30	0	19
$80 < d \leq 120$	20	0	35	0	22
$120 < d \leq 180$	25	0	40	0	40
$180 < d \leq 250$	30	0	46	0	46
$250 < d \leq 315$	35	0	52	0	52
$315 < d \leq 400$	40	0	57	0	57
$400 < d \leq 500$	45	0	63	0	63
$500 < d \leq 630$	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

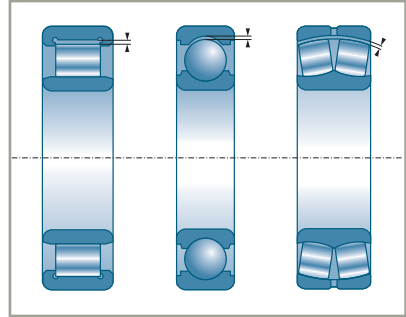
Radial clearance of radial contact bearings. Definition

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.

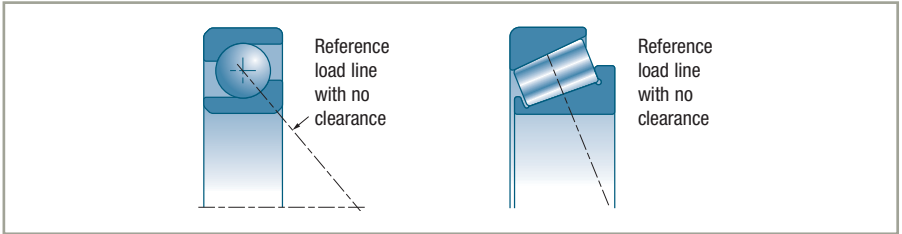
Radial clearance		Bearing designation	Other manufacturers
Type	Group	SNR suffix	
Normal clearance	N		Suitable for low or moderate loads, normal interference fit of only one of the two rings, normal temperatures.
Increased clearance	3	C3	Clearance frequently used in the following cases: - tight interference 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

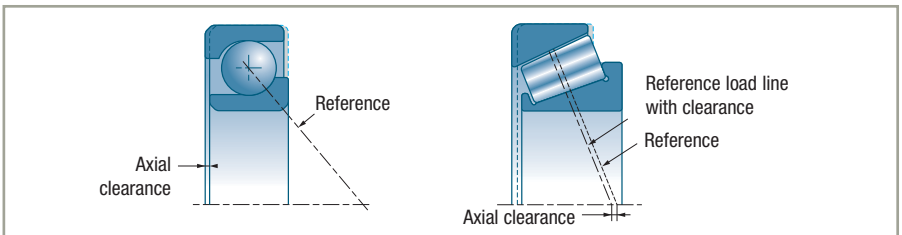
By construction, single-row angular contact ball bearings or tapered roller bearings have no internal clearance.

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