Bearing arrangements

The bearing arrangement of a rotating machine component, e.g. a shaft, generally requires two bearings to support and locate the component radially and axially relative to the stationary part of the machine, such as a housing. Depending on the application, load, requisite running accuracy and cost considerations the arrangement may consist of

- locating and non-locating bearing arrangements,
- adjusted bearing arrangements, or
- “floating” bearing arrangements.

Bearing arrangements consisting of a single bearing which can support radial, axial and moment loads, e.g. for an articulated joint, are not dealt with in this catalogue. If such arrangements are required it is advisable to contact the SKF application engineering service.

Locating and non-locating bearing arrangements

The locating bearing at one end of the shaft provides radial support and at the same time locates the shaft axially in both directions. It must, therefore, be fixed in position both on the shaft and in the housing. Suitable bearings are radial bearings which can accommodate combined loads, e.g. deep groove ball bearings, double row or paired single row angular contact ball bearings, self-aligning ball bearings, spherical roller bearings or matched taper roller bearings. Combinations of a radial bearing that can accommodate purely radial load, e.g. a cylindrical roller bearing having one ring without flanges, with a deep groove ball bearing, four-point contact ball bearing or a double direction thrust bearing can also be used as the locating bearing. The second bearing then provides axial location in both directions but must be mounted with radial freedom (i.e. have a clearance fit) in the housing.

The non-locating bearing at the other end of the shaft provides radial support only. It must also allow axial displacement so that the bearings do not mutually stress each other, e.g. when the shaft length changes as a result of thermal expansion. Axial displace-

Fig 1

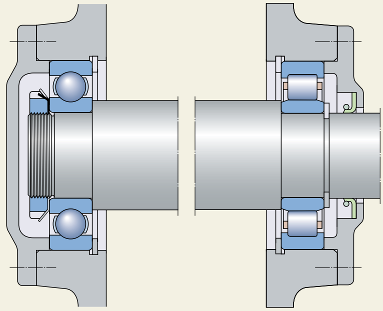


Fig 2

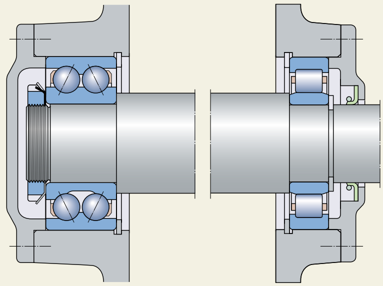


Fig 3

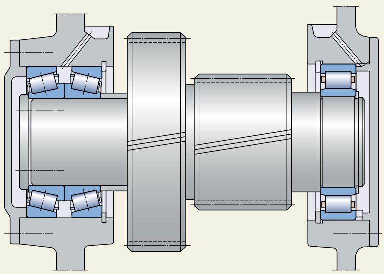


Fig 4

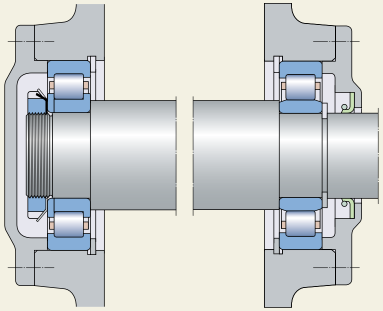


Fig 5

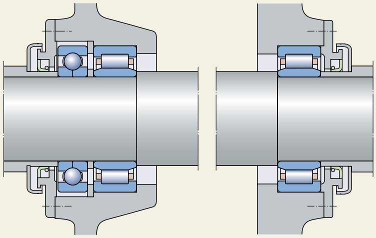
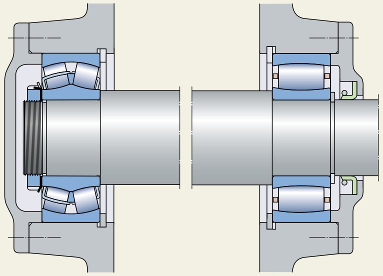


Fig 6



ment can take place within the bearing in the case of needle roller bearings, NU- and N-design cylindrical roller bearings and CARB toroidal roller bearings, or between one of the bearing rings and its seating, preferably between the outer ring and its seating in the housing bore.

From the large number of locating/non-locating bearing combinations the popular combinations are described in the following.

For stiff bearing arrangements where "frictionless" axial displacements should take place within the bearing the following combinations may be used:

- deep groove ball bearing/cylindrical roller bearing (➔ **fig** 1),
- double row angular contact ball bearing/cylindrical roller bearing (➔ **fig** 2),
- matched single row taper roller bearings/cylindrical roller bearing (➔ **fig** 3),
- NUP-design cylindrical roller bearing/NU-design cylindrical roller bearing (➔ **fig** 4), or
- NU-design cylindrical roller bearing and four-point contact ball bearing/NU-design cylindrical roller bearing (➔ **fig** 5).

For the above combinations, angular misalignment of the shaft must be kept to a minimum. If this is not possible it is advisable to use combinations of self-aligning bearings to allow for misalignment, viz.

- self-aligning ball bearing/CARB toroidal roller bearing or
- spherical roller bearing/CARB toroidal roller bearing (➔ **fig** 6).

The abillity of these arrangements to accommodate angular misalignments as well as axial displacements avoids generating internal axial forces in the bearing system.

For bearing arrangements with rotating inner ring load, where changes in the shaft length are to be accommodated between the bearing and its seating, axial displacement should take place between the outer ring of the bearing and the housing. The most usual combinations are

- deep groove ball bearing/deep groove ball bearing (➔ **fig 7**),
- self-aligning ball or spherical roller bearing/self-aligning ball or spherical roller bearing (➔ **fig 8**) and
- matched single row angular contact ball bearings/deep groove ball bearing (➔ **fig 9**).

Adjusted bearing arrangements
In adjusted bearing arrangements the shaft is axially located in one direction by the one bearing and in the opposite direction by the other bearing. This type of arrangement is referred to as "cross located" and is generally used for short shafts. Suitable bearings include all types of radial bearings that can accommodate axial loads in at least one direction, including

- angular contact ball bearings (➔ **fig 10**) and
- taper roller bearings (➔ **fig 11**).

In certain cases where single row angular contact ball bearings or taper roller bearings are used for cross-located arrangements, preload may be necessary (➔ **page 206**).

"Floating" bearing arrangements
Floating bearing arrangements are also cross located and are suitable where demands regarding axial location are moderate or where other components on the shaft serve to locate it axially.

Suitable bearings for this type of arrangement are:

- deep groove ball bearings (➔ **fig 12**),
- self-aligning ball bearings or
- spherical roller bearings.

In these types of arrangements it is important that one ring of each bearing should be able to move on or in its seating, preferably the outer ring in the housing. A floating bearing arrangement can also be obtained with two NJ-design cylindrical roller bearings, with offset inner rings (➔ **fig 13**). In this case the axial movement can take place within the bearing.

Fig 7

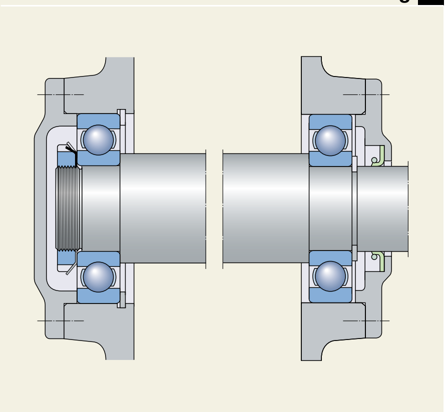


Fig 8

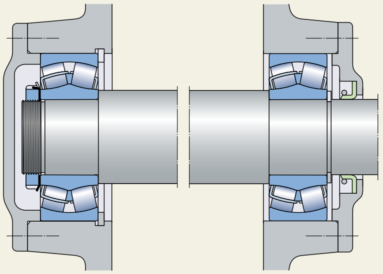


Fig 11

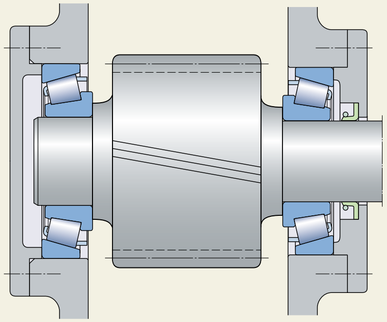


Fig 9

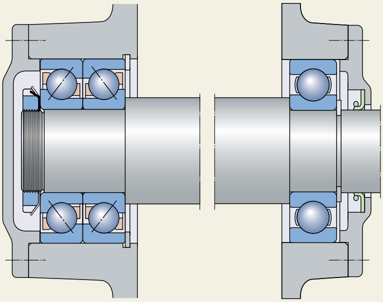


Fig 12

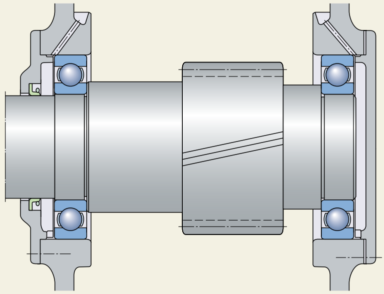


Fig 10

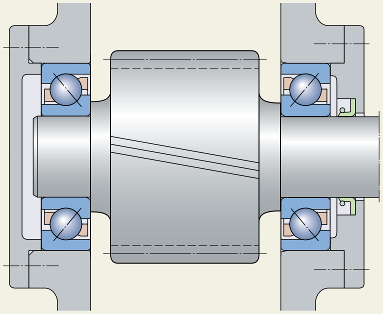
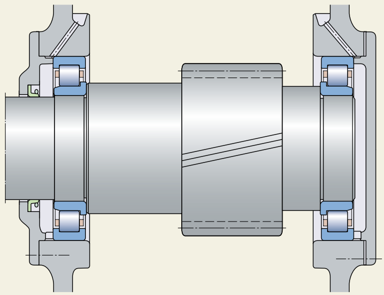


Fig 13



Radial location of bearings

If the load carrying ability of a bearing is to be fully utilized, its rings or washers must be fully supported around their complete circumference and across the entire width of the raceway. The support, which must be firm and even can be provided by a cylindrical or tapered seating or, for thrust bearing washers, by a flat (plane) support surface. This means that bearing seatings must be made with adequate accuracy and that their surface should be uninterrupted by grooves, holes or other features. In addition, the bearing rings must be reliably secured to prevent them from turning on or in their seatings under load.

Generally speaking, satisfactory radial location and adequate support can only be obtained when the rings are mounted with an appropriate degree of interference. Inadequately or incorrectly secured bearing rings generally cause damage to the bearings and associated components. However, when easy mounting and dismounting are desirable, or when axial displacement is required with a non-locating bearing, an interference fit cannot always be used. In certain cases where a loose fit is employed it is necessary to take special precautions to limit the inevitable wear from creep, as for example, by surface hardening of the bearing seating and abutments, lubrication of the mating surfaces via special lubrication grooves and the removal of wear particles, or slots in the bearing ring side faces to accommodate keys or other holding devices.

Selection of fit
When selecting a fit, the factors discussed in this section should be considered, together with the general guidelines given.

1. Conditions of rotation

Conditions of rotation refer to the bearing ring being considered in relation to the direction of the load (➔ **table 1**). Essentially there are three different conditions: “rotating load”, “stationary load” and “direction of load indeterminate”.

“Rotating load” pertains if the bearing ring rotates and the load is stationary, or if the ring is stationary and the load rotates so that all points on the raceway are subjected to load in the course of one revolution. Heavy loads which do not rotate but oscillate, for example, those acting on connecting rod bearings, are generally considered as rotating loads.

A bearing ring subjected to a rotating load will turn (creep or wander) on its seating if mounted with a clearance fit, and wear (fretting corrosion) of the contact surfaces will result. To prevent this, interference fits must be used. The degree of interference needed is dictated by the operating conditions (➔ **points 2** and **4** below).

“Stationary load” pertains if the bearing ring is stationary and the load is also stationary, or if the ring and the load rotate at the same speed, so that the load is always directed towards the same position on the raceway. Under these conditions, a bearing ring will normally not turn on its seating. Therefore, the ring need not necessarily have an interference fit unless this is required for other reasons.

“Direction of load indeterminate” represents variable external loads, shock loads, vibrations and unbalance loads in high-speed machines. These give rise to changes in the direction of load, which cannot be accurately described. When the direction of load is indeterminate and particularly where heavy loads are involved, it is desirable that both rings have an interference fit. For the inner ring the recommended fit for a rotating load is normally used. However, when the outer ring must be free to move axially in the housing, and the load is not heavy, a somewhat looser fit than that recommended for a rotating load may be used.

2. Magnitude of the load

The interference fit of a bearing inner ring on its seating will be loosened with increasing load, as the ring will deform. Under the influence of rotating load the ring may begin to creep. The degree of interference must therefore be related to the magnitude of the load; the heavier the load, particularly if it is a shock load, the greater the interference fit required (➔ **fig** 14).

Fig 14

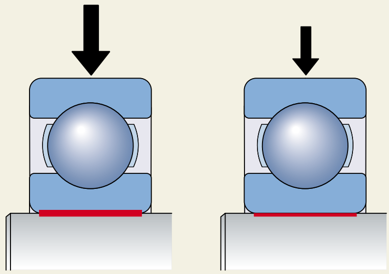
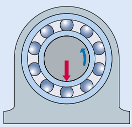
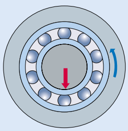
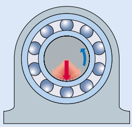
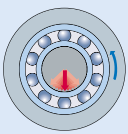


Table 1

Conditions of rotation and loading

Operating conditions	Schematic illustration	Load condition	Example	Recommended fits
Rotating inner ring Stationary outer ring Constant load direction		Rotating load on inner ring Stationary load on outer ring	Belt-driven shafts	Interference fit for inner ring Loose fit for outer ring
Stationary inner ring Rotating outer ring Constant load direction		Stationary load on inner ring Rotating load on outer ring	Conveyor idlers Car wheel hub bearings	Loose fit for inner ring Interference fit for outer ring
Rotating inner ring Stationary outer ring Load rotates with inner ring		Stationary load on inner ring Rotating load on outer ring	Vibratory applications Vibrating screens or motors	Interference fit for outer ring Loose fit for inner ring
Stationary inner ring Rotating outer ring Load rotates with outer ring		Rotating load on inner ring. Stationary load on outer ring	Gyratory crusher (Merry-go-round drives)	Interference fit for inner ring Loose fit for outer ring

3. Bearing internal clearance

An interference fit of a bearing on a shaft or in a housing means that the ring is elastically deformed (expanded or compressed) and that the bearing internal clearance is reduced. A certain minimum clearance should remain, however (➔ section "Bearing internal clearance", starting on **page 137**). The initial clearance and permissible reduction depend on the type and size of the bearing. The reduction in clearance due to the interference fit can be so large that bearings with an initial clearance, which is greater than Normal, have to be used in order to prevent the bearing from becoming preloaded (➔ **fig 15**).

4. Temperature conditions

In many applications the outer ring has a lower temperature in operation than the inner ring. This might lead to reduced internal clearance (➔ **fig 16**).

In service, bearing rings normally reach a temperature that is higher than that of the components to which they are fitted. This can result in an easing of the fit of the inner ring on its seating, while outer ring expansion may prevent the desired axial displacement of the ring in its housing.

Temperature differentials and the direction of heat flow in the bearing arrangement must therefore be carefully considered.

5. Running accuracy requirements

To reduce resilience and vibration, clearance fits should generally not be used for bearings where high demands are placed on running accuracy. Bearing seatings on the shaft and in the housing should be made to narrow dimensional tolerances, corresponding at least to grade 5 for the shaft and at least to grade 6 for the housing. Tight tolerances should also be applied to the cylindricity (➔ **table 11**, **page 196**).

6. Design and material of shaft and housing

The fit of a bearing ring on its seating must not lead to uneven distortion of the ring (out-of-round). This can be caused, for example,

Fig 15

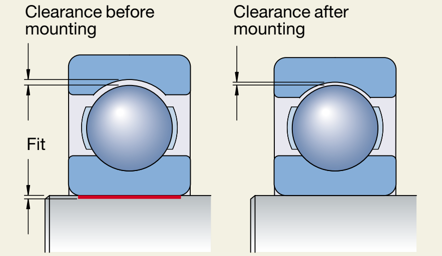
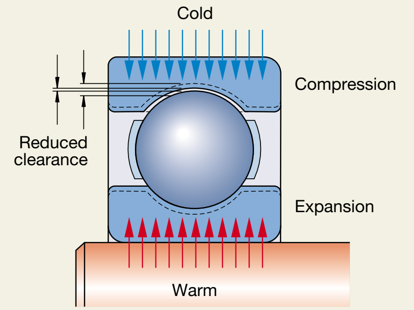


Fig 16



SKF

by discontinuities in the seating surface. Split housings are therefore not generally suitable where outer rings are to have a heavy interference fit and the selected tolerance should not give a tighter fit than that obtained with tolerance group H (or at the most K). To provide adequate support for bearing rings mounted in thin-walled housings, light alloy housings or on hollow shafts, heavier interference fits than those normally recommended for thick-walled steel or cast iron housings or for solid shafts should be used (➔ section "Fits for hollow shafts", starting on **page 172**).

7. Ease of mounting and dismounting

Bearings with clearance fits are usually easier to mount or dismount than those with interference fits. Where operating conditions necessitate interference fits and it is essential that mounting and dismounting can be done easily, separable bearings, or bearings with a tapered bore may be used. Bearings with a tapered bore can be mounted either directly on a tapered shaft seating or via adapter or withdrawal sleeves on smooth or stepped cylindrical shafts (➔ **figs** 26 and 27, **page 201**).

8. Displacement of the non-locating bearing

If non-separable bearings are used as non-locating bearings it is imperative that one of the bearing rings is free to move axially at all times during operation. Adopting a clearance fit for the ring that carries a stationary load will provide this (➔ **fig** 20, **page 199**). When the outer ring is under stationary load so that axial displacement is accommodated or takes place in the housing bore, a hardened intermediate bushing or sleeve is often fitted to the outer ring, for example, where light alloy housings are employed. In this way a "hammering out" of the housing seating because of the lower material hardness is avoided; it would otherwise result in the axial displacement being restricted or even prohibited over time.

If cylindrical roller bearings having one ring without flanges, needle roller bearings or CARB toroidal roller bearings are used, both bearing rings may be mounted with an interference fit because axial displacement will take place within the bearing.

Recommended fits

The tolerances for the bore and outside diameters of rolling bearings are internationally standardized (➔ section "Tolerances", starting on **page 120**).

To achieve an interference or a clearance fit for bearings with a cylindrical bore and cylindrical outside diameter, suitable tolerance ranges for the seatings on the shaft and in the housing bore are selected from the ISO tolerance system. Only a limited number of ISO tolerance grades need be considered for rolling bearing applications. The location of the most commonly used grades relative to the bearing bore and outside diameter tolerances are illustrated in **fig** 17**, page 168.**

Bearings with a tapered bore are mounted either directly on tapered shaft seatings or on adapter or withdrawal sleeves, having an external taper, which are fitted to cylindrical shaft seatings. In these cases, the fit of the bearing inner ring is not determined, as for bearings with a cylindrical bore, by the selected shaft tolerance but by the distance through which the ring is driven up on its tapered seating or sleeve. Special precautions with respect to the reduction of the internal clearance must be observed as mentioned in the sections "Self-aligning ball bearings", "Spherical roller bearings" and "CARB toroidal roller bearings".

If the bearings are to be secured using adapter or withdrawal sleeves, larger diameter tolerances are permitted for the sleeve seating, but the tolerances for cylindricity must be reduced (➔ section "Dimensional, form and running accuracy of bearing seatings and abutments", starting on **page 194**).

Tables with recommendations for fits
Recommendations for bearing fits for solid steel shafts will be found in:

Table 2: Radial bearings with cylindrical bore
Table 3: Thrust bearings

and for cast iron and steel housings in:

Table 4: Radial bearings – non-split housings
Table 5: Radial bearings – split or non-split housings
Table 6: Thrust bearings

These recommendations are based on the general selection guidelines described above. Years of experience have shown the recommendations to be correct for a very wide range of applications and bearing arrangements. The tables of housing tolerance recommendations also give information as to whether the outer ring can be axially displaced in the housing bore. Using this information it is possible to check that the chosen tolerance is suitable for non-separable bearings that are to be used as non-locating bearings.

Fig 17

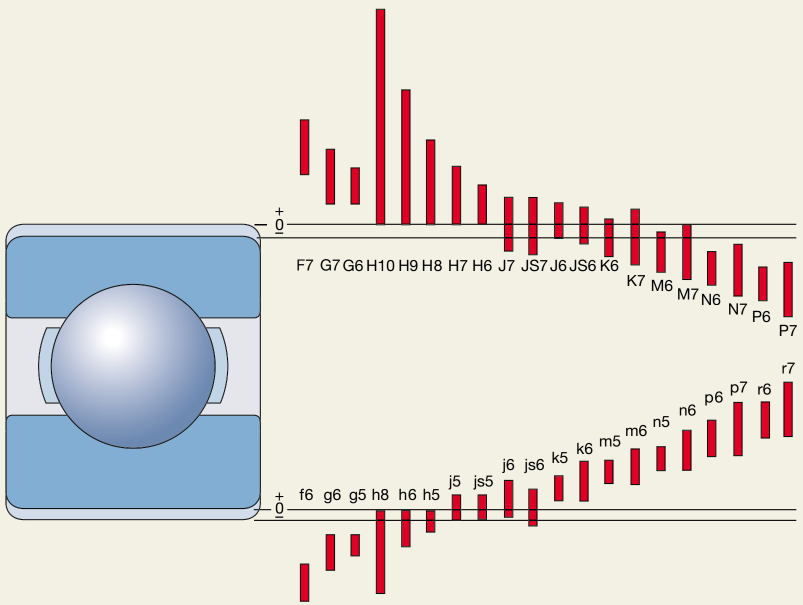


Table 2

Fits for solid steel shafts

Radial bearings with cylindrical bore

Conditions	Examples	Shaft diameter, mm Ball bearings	 Cylindrical and taper roller bearings	 CARB and spherical roller bearings	Tolerance
Rotating inner ring load or direction of load indeterminate					
Light and variable loads (P ≤ 0,06 C)	Conveyors, lightly loaded gearbox bearings	(18) to 100 (100) to 140	≤ 40 (40) to 100	–	j6 k6
Normal and heavy loads (P > 0,06 C)	Bearing applications generally, electric motors, turbines, pumps, internal combustion engines, gearing, woodworking machines	≤ 18 (18) to 100 (100) to 140 (140) to 200 (200) to 280 – – –	– ≤ 40 (40) to 100 (100) to 140 (140) to 200 (200) to 400 – –	– ≤ 40 (40) to 65 (65) to 100 (100) to 140 (140) to 280 (280) to 500 > 500	j5 k5 (k6)[1)] m5 (m6)[1)] m6 n6 p6 r6[2)] r7[2)]
Very heavy loads and shock loads with difficult working conditions (P > 0,12 C)	Axleboxes for heavy railway vehicles, traction motors, rolling mills	– – –	(50) to 140 (140) to 200 > 200	(50) to 100 (100) to 140 > 140	n6[2)] p6[2)] r6[2)]
High demands on running accuracy with light loads (P ≤ 0,06 C)	Machine tools	8 to 240 – – – –	– 25 to 40 (40) to 140 (140) to 200 (200) to 500	– – – – –	js4 js4 (j5)[3)] k4 (k5)[3)] m5[3)] n5[3)]
Stationary inner ring load					
Easy axial displacement of inner ring on shaft desirable	Wheels on non-rotating axles				g6[4)]
Easy axial displacement of inner ring on shaft unnecessary	Tension pulleys, rope sheaves				h6
Axial loads only					
	Bearing applications of all kinds	≤ 250 > 250	≤250 > 250	≤ 250 > 250	j6 js6

1) The tolerances in brackets are generally used for taper roller bearings and single row angular contact ball bearings, they can also be used for other types of bearing where speeds are moderate and the effect of bearing internal clearance variation is not significant

2) Bearings with radial internal clearance greater than Normal may be necessary

3) The tolerances in brackets apply to taper roller bearings. For lightly loaded taper roller bearings adjusted via the inner ring, js5 or js6 should be used

4) Tolerance f6 can be selected for large bearings to provide easy displacement

Table 3

Fits for solid steel shafts

Thrust bearings

Conditions	Shaft diameter, mm	Tolerance
Axial loads only		
Thrust ball bearings	–	h6
Cylindrical roller thrust bearings	–	h6 (h8)
Cylindrical roller and cage thrust assemblies	–	h8
Combined radial and axial loads acting on spherical roller thrust bearings		
Stationary load on shaft washer	≤ 250	j6
	> 250	js6
Rotating load on shaft washer, or direction of load indeterminate	≤200	k6
	(200) to 400	m6
	> 400	n6

Table 4

Fits for cast iron and steel housings

Radial bearings – non-split housings

Conditions	Examples	Tolerance	Displacement of outer ring
Rotating outer ring load			
Heavy loads on bearings in thin-walled housings, heavy shock loads (P > 0,12 C)	Roller bearing wheel hubs, big-end bearings	P7	Cannot be displaced
Normal and heavy loads (P > 0,06 C)	Ball bearing wheel hubs, big-end bearings, crane travelling wheels	N7	Cannot be displaced
Light and variable loads (P ≤ 0,06 C)	Conveyor rollers, rope sheaves, belt tensioner pulleys	M7	Cannot be displaced
Direction of load indeterminate			
Heavy shock loads	Electric traction motors	M7	Cannot be displaced
Normal and heavy loads (P > 0,06 C), axial displacement of outer ring unnecessary	Electric motors, pumps, crankshaft bearings	K7	Cannot be displaced as a rule
Accurate or quiet running[1]			
Ball bearings	Small electric motors	J6[2]	Can be displaced
Taper roller bearings	When adjusted via the outer ring	JS5	–
	Axially located outer ring	K5	–
	Rotating outer ring load	M5	–

[1] For high-precision bearings to tolerance class P5 or better, other recommendations apply (➔ the SKF catalogue “High-precision bearings”)
[2] When easy displacement is required use H6 instead of J6

Table 5

Fits for cast iron and steel housings

Radial bearings – split or non-split housings

Conditions	Examples	Tolerance	Displacement of outer ring
Direction of load indeterminate			
Light and normal loads ($P \leq 0{,}12$ C), axial displacement of outer ring desirable	Medium-sized electrical machines, pumps, crankshaft bearings	J7	Can be displaced as a rule
Stationary outer ring load			
Loads of all kinds	General engineering, railway axleboxes	H7[1]	Can be displaced
Light and normal loads ($P \leq 0{,}12$ C) with simple working conditions	General engineering	H8	Can be displaced
Heat conduction through shaft	Drying cylinders, large electrical machines with spherical roller bearings	G7[2]	Can be displaced

[1] For large bearings ($D > 250$ mm) and temperature differences between outer ring and housing > 10 °C, G7 should be used instead of H7
[2] For large bearings ($D > 250$ mm) and temperature differences between outer ring and housing > 10 °C, F7 should be used instead of G7

Table 6

Fits for cast iron and steel housings

Thrust bearings

Conditions	Tolerance	Remarks
Axial loads only		
Thrust ball bearings	H8	For less accurate bearing arrangements there can be a radial clearance of up to 0,001 D
Cylindrical roller thrust bearings	H7 (H9)	
Cylindrical roller and cage thrust assemblies	H10	
Spherical roller thrust bearings where separate bearings provide radial location	–	Housing washer must be fitted with adequate radial clearance so that no radial load whatsoever can act on the thrust bearings
Combined radial and axial loads on spherical roller thrust bearings		
Stationary load on housing washer	H7	See also “Design of associated components” in section “Spherical roller thrust bearings” on **page 877**
Rotating load on housing washer	M7	

Tolerance tables

The values shown in **tables** 7 and 8 for the shaft and housing tolerances enable the character of the fit to be established:

- the upper and lower limits of Normal tolerances for the bearing bore and outside diameter deviations;
- the upper and lower limits of the shaft and housing bore diameter deviations in accordance with ISO 286-2:1988;
- the smallest and largest values of the theoretical interference (+) or clearance (–) in the fit;
- the smallest and largest values of the probable interference (+) or clearance (–) in the fit.

The appropriate values for rolling bearing seatings on shafts are listed for the tolerances:

e7, f5, f6, g5, g6 in **table** 7a, **pages 174** and **175**
h5, h6, h8, h9, j5 in **table** 7b, **pages 176** and **177**
j6, js5, js6, js7, k4 in **table** 7c, **pages 178** and **179**
k5, k6, m5, m6, n5 in **table** 7d, **pages 180** and **181**
n6, p6, p7, r6, r7 in **table** 7e, **pages 182** and **183**

The appropriate values for the rolling bearing housing seatings are listed for the tolerances:

F7, G6, G7, H5, H6 in **table** 8a, **pages 184** and **185**
H7, H8, H9, H10, J6 in **table** 8b, **pages 186** and **187**
J7, JS5, JS6, JS7, K5 in **table** 8c, **pages 188** and **189**
K6, K7, M5, M6, M7 in **table** 8d, **pages 190** and **191**
N6, N7, P6, P7 in **table** 8e, **pages 192** and **193**

The Normal tolerances for the bore and outside diameter for which the limiting values have been calculated are valid for all metric rolling bearings with the exception of metric taper roller bearings when $d \leq 30$ mm and $D \leq 150$ mm and for thrust bearings when $D \leq 150$ mm.

The values for the probable interference or clearance cover 99 % of all the combinations of the theoretical interference or clearance.

When bearings of higher accuracy than Normal are used, the reduced bore and outside tolerances mean that the interference or clearance of the fits is reduced correspondingly. If, in such cases, a more accurate calculation of the limits is required it is advisable to contact the SKF application engineering service.

Fits for hollow shafts

If bearings are to be mounted with an interference fit on a hollow shaft it is generally necessary to use a heavier interference fit than would be used for a solid shaft in order to achieve the same surface pressure between the inner ring and shaft seating. The following diameter ratios are important when deciding on the fit to be used:

$$c_i = \frac{d_i}{d} \text{ and } c_e = \frac{d}{d_e}$$

The fit is not appreciably affected until the diameter ratio of the hollow shaft $c_i \geq 0{,}5$. If the outside diameter of the inner ring is not known, the diameter ratio c_e can be calculated with sufficient accuracy using the equation

$$c_e = \frac{d}{k\,(D - d) + d}$$

where

c_i = diameter ratio of the hollow shaft
c_e = diameter ratio of the inner ring
d = outside diameter of the hollow shaft, bore diameter of bearing, mm
d_i = internal diameter of the hollow shaft, mm
d_e = outside diameter of the inner ring, mm
D = outside bearing diameter, mm
k = a factor for the bearing type
for self-aligning ball bearings in the 22 and 23 series, $k = 0{,}25$
for cylindrical roller bearings, $k = 0{,}25$
for all other bearings, $k = 0{,}3$

To determine the requisite interference fit for a bearing to be mounted on a hollow shaft, use the mean probable interference between the shaft seating and bearing bore obtained for the tolerance recommendation for a solid shaft of the same diameter. If the plastic deformation (smoothing) of the mating surfaces produced during mounting is neglected, then the effective interference can be equated to the mean probable interference.

The interference Δ_H needed for a hollow steel shaft can then be determined in relation to the known interference Δ_V for the solid shaft from **diagram 1**. Δ_V equals the mean value of the smallest and largest values of the probable interference for the solid shaft. The tolerance for the hollow shaft is then selected so that the mean probable interference is as close as possible to the interference Δ_H obtained from **diagram 1**.

Example

A 6208 deep groove ball bearing with d = 40 mm and D = 80 mm is to be mounted on a hollow shaft having a diameter ratio $c_i = 0,8$. What is the requisite interference and what are the appropriate shaft limits?

If the bearing were to be mounted on a solid steel shaft and subjected to normal loads, a tolerance k5 would be recommended. From **table 7d**, **page 180**, a shaft diameter of 40 mm, the mean probable interference $\Delta_V = (22 + 5)/2 = 13,5$ µm. For $c_i = 0,8$ and

$$c_e = \frac{40}{0,3\,(80 - 40) + 40} = 0,77$$

so that from **diagram 1** the ratio $\Delta_H/\Delta_V = 1,7$. Thus the requisite interference for the hollow shaft $\Delta_H = 1,7 \times 13,5 = 23$ µm. Consequently, tolerance m6 is selected for the hollow shaft as this gives a mean probable interference of this order.

Diagram 1

Relation of interference Δ_H, needed for a hollow steel shaft, to the known interference Δ_V for a solid steel shaft

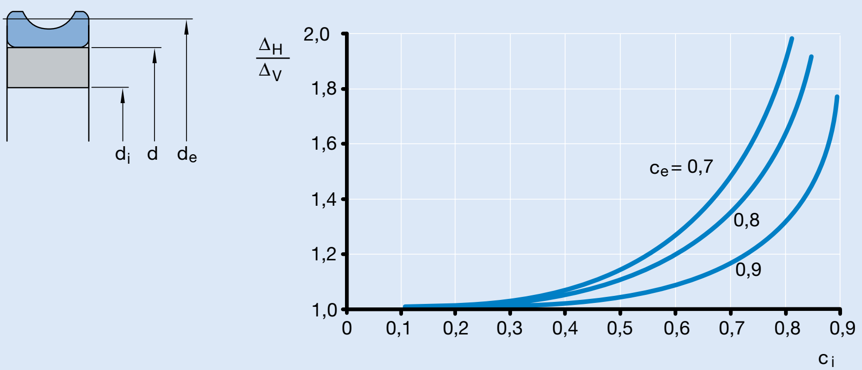
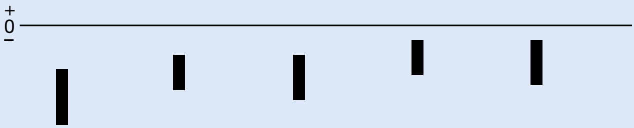


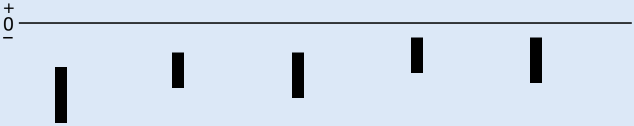
Table 7a

Shaft tolerances and resultant fits



Shaft Nominal diameter d		**Bearing** Bore diameter tolerance Δ_{dmp}		**Deviations of shaft diameter, resultant fits** Tolerances									
				e7		f5		f6		g5		g6	
over	incl.	low	high	Deviations (shaft diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)									
mm		µm		µm									
1	**3**	–8	0	–14	–24	–6	–10	–6	–12	–2	–6	–2	–8
				–6	–24	+2	–10	+2	–12	+6	–6	+6	–8
				–8	–22	+1	–9	0	–10	+5	–5	+4	–6
3	**6**	–8	0	–20	–32	–10	–15	–10	–18	–4	–9	–4	–12
				–12	–32	–2	–15	–2	–18	+4	–9	+4	–12
				–14	–30	–3	–14	–4	–16	+3	–8	+2	–10
6	**10**	–8	0	–25	–40	–13	–19	–13	–22	–5	–11	–5	–14
				–17	–40	–5	–19	–5	–22	+3	–11	+3	–14
				–20	–37	–7	–17	–7	–20	+1	–9	+1	–12
10	**18**	–8	0	–32	–50	–16	–24	–16	–27	–6	–14	–6	–17
				–24	–50	–8	–24	–8	–27	+2	–14	+2	–17
				–27	–47	–10	–22	–10	–25	0	–12	0	–15
18	**30**	–10	0	–40	–61	–20	–29	–20	–33	–7	–16	–7	–20
				–30	–61	–10	–29	–10	–33	+3	–16	+3	–20
				–33	–58	–12	–27	–13	–30	+1	–14	0	–17
30	**50**	–12	0	–50	–75	–25	–36	–25	–41	–9	–20	–9	–25
				–38	–75	–13	–36	–13	–41	+3	–20	+3	–25
				–42	–71	–16	–33	–17	–37	0	–17	–1	–21
50	**80**	–15	0	–60	–90	–30	–43	–30	–49	–10	–23	–10	–29
				–45	–90	–15	–43	–15	–49	+5	–23	+5	–29
				–50	–85	–19	–39	–19	–45	+1	–19	+1	–25
80	**120**	–20	0	–72	–107	–36	–51	–36	–58	–12	–27	–12	–34
				–52	–107	–16	–51	–16	–58	+8	–27	+8	–34
				–59	–100	–21	–46	–22	–52	+3	–22	+2	–28
120	**180**	–25	0	–85	–125	–43	–61	–43	–68	–14	–32	–14	–39
				–60	–125	–18	–61	–18	–68	+11	–32	+11	–39
				–68	–117	–24	–55	–25	–61	+5	–26	+4	–32
180	**250**	–30	0	–100	–146	–50	–70	–50	–79	–15	–35	–15	–44
				–70	–146	–20	–70	–20	–79	+15	–35	+15	–44
				–80	–136	–26	–64	–28	–71	+9	–29	+7	–36
250	**315**	–35	0	–110	–162	–56	–79	–56	–88	–17	–40	–17	–49
				–75	–162	–21	–79	–21	–88	+18	–40	+18	–49
				–87	–150	–29	–71	–30	–79	+10	–32	+9	–40
315	**400**	–40	0	–125	–182	–62	–87	–62	–98	–18	–43	–18	–54
				–85	–182	–22	–87	–22	–98	+22	–43	+22	–54
				–98	–169	–30	–79	–33	–87	+14	–35	+11	–43
400	**500**	–45	0	–135	–198	–68	–95	–68	–108	–20	–47	–20	–60
				–90	–198	–23	–95	–23	–108	+25	–47	+25	–60
				–105	–183	–32	–86	–35	–96	+16	–38	+13	–48

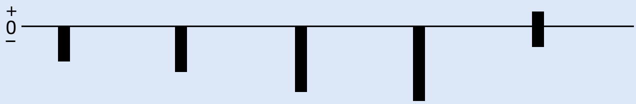
Shaft tolerances and resultant fits



Shaft Nominal diameter d		**Bearing** Bore diameter tolerance Δ_{dmp}		**Deviations of shaft diameter, resultant fits** Tolerances									
				e7		f5		f6		g5		g6	
				Deviations (shaft diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
over	incl.	low	high										
mm		µm		µm									
500	**630**	–50	0	–145 –95 –111	–215 –215 –199	–76 –26 –36	–104 –104 –94	–76 –26 –39	–120 –120 –107	–22 +28 +18	–50 –50 –40	–22 +28 +15	–66 –66 –53
630	**800**	–75	0	–160 –85 –107	–240 –240 –218	–80 –5 –17	–112 –112 –100	–80 –5 –22	–130 –130 –113	–24 +51 +39	–56 –56 –44	–24 +51 +34	–74 –74 –57
800	**1 000**	–100	0	–170 –70 –97	–260 –260 –233	–86 +14 0	–122 –122 –108	–86 +14 –6	–142 –142 –122	–26 +74 +60	–62 –62 –48	–26 +74 +54	–82 –82 –62
1 000	**1 250**	–125	0	–195 –70 –103	–300 –300 –267	–98 +27 +10	–140 –140 –123	–98 +27 +3	–164 –164 –140	–28 +97 +80	–70 –70 –53	–28 +97 +73	–94 –94 –70
1 250	**1 600**	–160	0	–220 –60 –100	–345 –345 –305	–110 +50 +29	–160 –160 –139	–110 +50 +20	–188 –188 –158	–30 +130 +109	–80 –80 –59	–30 +130 +100	–108 –108 –78
1 600	**2 000**	–200	0	–240 –40 –90	–390 –390 –340	–120 +80 +55	–180 –180 –155	–120 +80 +45	–212 –212 –177	–32 +168 +143	–92 –92 –67	–32 +168 +133	–124 –124 –89

Table 7b

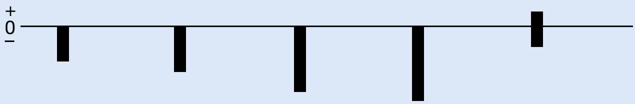
Shaft tolerances and resultant fits



Deviations (shaft diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)

Shaft Nominal diameter d		**Bearing** Bore diameter tolerance Δ_{dmp}		**Deviations of shaft diameter, resultant fits** Tolerances h5		h6		h8		h9		j5	
over	incl.	low	high										
mm		µm		µm									
1	**3**	–8	0	0	–4	0	–6	0	–14	0	–25	+2	–2
				+8	–4	+8	–6	+8	–14	+8	–25	+10	–2
				+7	–3	+6	–4	+6	–12	+5	–22	+9	–1
3	**6**	–8	0	0	–5	0	–8	0	–18	0	–30	+3	–2
				+8	–5	+8	–8	+8	–18	+8	–30	+11	–2
				+7	–4	+6	–6	+5	–15	+5	–27	+10	–1
6	**10**	–8	0	0	–6	0	–9	0	–22	0	–36	+4	–2
				+8	–6	+8	–9	+8	–22	+8	–36	+12	–2
				+6	–4	+6	–7	+5	–19	+5	–33	+10	0
10	**18**	–8	0	0	–8	0	–11	0	–27	0	–43	+5	–3
				+8	–8	+8	–11	+8	–27	+8	–43	+13	–3
				+6	–6	+6	–9	+5	–24	+5	–40	+11	–1
18	**30**	–10	0	0	–9	0	–13	0	–33	0	–52	+5	–4
				+10	–9	+10	–13	+10	–33	+10	–52	+15	–4
				+8	–7	+7	–10	+6	–29	+6	–48	+13	–2
30	**50**	–12	0	0	–11	0	–16	0	–39	0	–62	+6	–5
				+12	–11	+12	–16	+12	–39	+12	–62	+18	–5
				+9	–8	+8	–12	+7	–34	+7	–57	+15	–2
50	**80**	–15	0	0	–13	0	–19	0	–46	0	–74	+6	–7
				+15	–13	+15	–19	+15	–46	+15	–74	+21	–7
				+11	–9	+11	–15	+9	–40	+9	–68	+17	–3
80	**120**	–20	0	0	–15	0	–22	0	–54	0	–87	+6	–9
				+20	–15	+20	–22	+20	–54	+20	–87	+26	–9
				+15	–10	+14	–16	+12	–46	+12	–79	+21	–4
120	**180**	–25	0	0	–18	0	–25	0	–63	0	–100	+7	–11
				+25	–18	+25	–25	+25	–63	+25	–100	+32	–11
				+19	–12	+18	–18	+15	–53	+15	–90	+26	–5
180	**250**	–30	0	0	–20	0	–29	0	–72	0	–115	+7	–13
				+30	–20	+30	–29	+30	–72	+30	–115	+37	–13
				+24	–14	+22	–21	+18	–60	+17	–102	+31	–7
250	**315**	–35	0	0	–23	0	–32	0	–81	0	–130	+7	–16
				+35	–23	+35	–32	+35	–81	+35	–130	+42	–16
				+27	–15	+26	–23	+22	–68	+20	–115	+34	–8
315	**400**	–40	0	0	–25	0	–36	0	–89	0	–140	+7	–18
				+40	–25	+40	–36	+40	–89	+40	–140	+47	–18
				+32	–17	+29	–25	+25	–74	+23	–123	+39	–10
400	**500**	–45	0	0	–27	0	–40	0	–97	0	–155	+7	–20
				+45	–27	+45	–40	+45	–97	+45	–155	+52	–20
				+36	–18	+33	–28	+28	–80	+26	–136	+43	–11

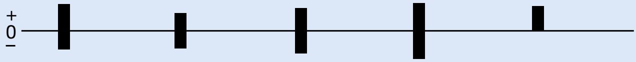
Shaft tolerances and resultant fits



Shaft Nominal diameter d		Bearing Bore diameter tolerance Δ_{dmp}		Deviations of shaft diameter, resultant fits Tolerances									
				h5		h6		h8		h9		j5	
over	incl.	low	high	Deviations (shaft diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
mm		µm		µm									
500	**630**	–50	0	0	–28	0	–44	0	–110	0	–175	–	–
				+50	–28	+50	–44	+50	–110	+50	–175	–	–
				+40	–18	+37	–31	+31	–91	+29	–154	–	–
630	**800**	–75	0	0	–32	0	–50	0	–125	0	–200	–	–
				+75	–32	+75	–50	+75	–125	+75	–200	–	–
				+63	–20	+58	–33	+48	–98	+45	–170	–	–
800	**1 000**	–100	0	0	–36	0	–56	0	–140	0	–230	–	–
				+100	–36	+100	–56	+100	–140	+100	–230	–	–
				+86	–22	+80	–36	+67	–107	+61	–191	–	–
1 000	**1 250**	–125	0	0	–42	0	–66	0	–165	0	–260	–	–
				+125	–42	+125	–66	+125	–165	+125	–260	–	–
				+108	–25	+101	–42	+84	–124	+77	–212	–	–
1 250	**1 600**	–160	0	0	–50	0	–78	0	–195	0	–310	–	–
				+160	–50	+160	–78	+160	–195	+160	–310	–	–
				+139	–29	+130	–48	+109	–144	+100	–250	–	–
1 600	**2 000**	–200	0	0	–60	0	–92	0	–230	0	–370	–	–
				+200	–60	+200	–92	+200	–230	+200	–370	–	–
				+175	–35	+165	–57	+138	–168	+126	–296	–	–

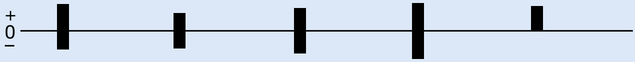
Table 7c

Shaft tolerances and resultant fits



Shaft Nominal diameter d		**Bearing** Bore diameter tolerance Δ_{dmp}		**Deviations of shaft diameter, resultant fits** Tolerances									
				j6		js5		js6		js7		k4	
over	incl.	low	high	Deviations (shaft diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)									
mm		µm		µm									
1	**3**	–8	0	+4	–2	+2	–2	+3	–3	+5	–5	+3	0
				+12	–2	+10	–2	+11	–3	+13	–5	+11	0
				+10	0	+9	–1	+9	–1	+11	–3	+10	+1
3	**6**	–8	0	+6	–2	+2,5	–2,5	+4	–4	+6	–6	+5	+1
				+14	–2	+10,5	–2,5	+12	–4	+14	–6	+13	+1
				+12	0	+9	–1	+10	–2	+12	–4	+12	+2
6	**10**	–8	0	+7	–2	+3	–3	+4,5	–4,5	+7,5	–7,5	+5	+1
				+15	–2	+11	–3	+12,5	–4,5	+15,5	–7,5	+13	+1
				+13	0	+9	–1	+11	–3	+13	–5	+12	+2
10	**18**	–8	0	+8	–3	+4	–4	+5,5	–5,5	+9	–9	+6	+1
				+16	–3	+12	–4	+13,5	–5,5	+17	–9	+14	+1
				+14	–1	+10	–2	+11	–3	+14	–6	+13	+2
18	**30**	–10	0	+9	–4	+4,5	–4,5	+6,5	–6,5	+10,5	–10,5	+8	+2
				+19	–4	+14,5	–4,5	+16,5	–6,5	+20,5	–10,5	+18	+2
				+16	–1	+12	–2	+14	–4	+17	–7	+16	+4
30	**50**	–12	0	+11	–5	+5,5	–5,5	+8	–8	+12,5	–12,5	+9	+2
				+23	–5	+17,5	–5,5	+20	–8	+24,5	–12,5	+21	+2
				+19	–1	+15	–3	+16	–4	+20	–8	+19	+4
50	**80**	–15	0	+12	–7	+6,5	–6,5	+9,5	–9,5	+15	–15	+10	+2
				+27	–7	+21,5	–6,5	+24,5	–9,5	+30	–15	+25	+2
				+23	–3	+18	–3	+20	–5	+25	–10	+22	+5
80	**120**	–20	0	+13	–9	+7,5	–7,5	+11	–11	+17,5	–17,5	+13	+3
				+33	–9	+27,5	–7,5	+31	–11	+37,5	–17,5	+33	+3
				+27	–3	+23	–3	+25	–5	+31	–11	+30	+6
120	**180**	–25	0	+14	–11	+9	–9	+12,5	–12,5	+20	–20	+15	+3
				+39	–11	+34	–9	+37,5	–12,5	+45	–20	+40	+3
				+32	–4	+28	–3	+31	–6	+37	–12	+36	+7
180	**250**	–30	0	+16	–13	+10	–10	+14,5	–14,5	+23	–23	+18	+4
				+46	–13	+40	–10	+44,5	–14,5	+53	–23	+48	+4
				+38	–5	+34	–4	+36	–6	+43	–13	+43	+9
250	**315**	–35	0	+16	–16	+11,5	–11,5	+16	–16	+26	–26	+20	+4
				+51	–16	+46,5	–11,5	+51	–16	+61	–26	+55	+4
				+42	–7	+39	–4	+42	–7	+49	–14	+49	+10
315	**400**	–40	0	+18	–18	+12,5	–12,5	+18	–18	+28,5	–28,5	+22	+4
				+58	–18	+52,5	–12,5	+58	–18	+68,5	–28,5	+62	+4
				+47	–7	+44	–4	+47	–7	+55	–15	+55	+11
400	**500**	–45	0	+20	–20	+13,5	–13,5	+20	–20	+31,5	–31,5	+25	+5
				+65	–20	+58,5	–13,5	+65	–20	+76,5	–31,5	+70	+5
				+53	–8	+49	–4	+53	–8	+62	–17	+63	–12

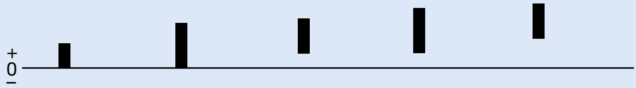
Shaft tolerances and resultant fits



Shaft Nominal diameter d		Bearing Bore diameter tolerance Δ_{dmp}		Deviations of shaft diameter, resultant fits Tolerances									
				j6		js5		js6		js7		k4	
over	incl.	low	high	Deviations (shaft diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
mm		µm		µm									
500	**630**	–50	0	+22	–22	+14	–14	+22	–22	+35	–35	–	–
				+72	–22	+64	–14	+72	–22	+85	–35	–	–
				+59	–9	+54	–4	+59	–9	+69	–19	–	–
630	**800**	–75	0	+25	–25	+16	–16	+25	–25	+40	–40	–	–
				+100	–25	+91	–16	+100	–25	+115	–40	–	–
				+83	–8	+79	–4	+83	–8	+93	–18	–	–
800	**1 000**	–100	0	+28	–28	+18	–18	+28	–28	+45	–45	–	–
				+128	–28	+118	–18	+128	–28	+145	–45	–	–
				+108	–8	+104	–4	+108	–8	+118	–18	–	–
1 000	**1 250**	–125	0	+33	–33	+21	–21	+33	–33	+52	–52	–	–
				+158	–33	+146	–21	+158	–33	+177	–52	–	–
				+134	–9	+129	–4	+134	–9	+145	–20	–	–
1 250	**1 600**	–160	0	+39	–39	+25	–25	+39	–39	+62	–62	–	–
				+199	–39	+185	–25	+199	–39	+222	–62	–	–
				+169	–9	+164	–4	+169	–9	+182	–22	–	–
1 600	**2 000**	–200	0	+46	–46	+30	–30	+46	–46	+75	–75	–	–
				+246	–46	+230	–30	+246	–46	+275	–75	–	–
				+211	–11	+205	–5	+211	–11	+225	–25	–	–

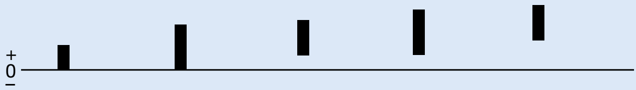
Table 7d

Shaft tolerances and resultant fits



Shaft Nominal diameter d		Bearing Bore diameter tolerance Δ_{dmp}		Deviations of shaft diameter, resultant fits Tolerances									
				k5		k6		m5		m6		n5	
over	incl.	low	high	Deviations (shaft diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
mm		µm		µm									
1	**3**	–8	0	+4	0	+6	0	+6	+2	+8	+2	+8	+4
				+12	0	+14	0	+14	+2	+16	+2	+16	+4
				+11	+1	+12	+2	+13	+3	+14	+4	+15	+5
3	**6**	–8	0	+6	+1	+9	+1	+9	+4	+12	+4	+13	+8
				+14	+1	+17	+1	+17	+4	+20	+4	+21	+8
				+13	+2	+15	+3	+16	+5	+18	+6	+20	+9
6	**10**	–8	0	+7	+1	+10	+1	+12	+6	+15	+6	+16	+10
				+15	+1	+18	+1	+20	+6	+23	+6	+24	+10
				+13	+3	+16	+3	+18	+8	+21	+8	+22	+12
10	**18**	–8	0	+9	+1	+12	+1	+15	+7	+18	+7	+20	+12
				+17	+1	+20	+1	+23	+7	+26	+7	+28	+12
				+15	+3	+18	+3	+21	+9	+24	+9	+26	+14
18	**30**	–10	0	+11	+2	+15	+2	+17	+8	+21	+8	+24	+15
				+21	+2	+25	+2	+27	+8	+31	+8	+34	+15
				+19	+4	+22	+5	+25	+10	+28	+11	+32	+17
30	**50**	–12	0	+13	+2	+18	+2	+20	+9	+25	+9	+28	+17
				+25	+2	+30	+2	+32	+9	+37	+9	+40	+17
				+22	+5	+26	+6	+29	+12	+33	+13	+37	+20
50	**80**	–15	0	+15	+2	+21	+2	+24	+11	+30	+11	+33	+20
				+30	+2	+36	+2	+39	+11	+45	+11	+48	+20
				+26	+6	+32	+6	+35	+15	+41	+15	+44	+24
80	**120**	–20	0	+18	+3	+25	+3	+28	+13	+35	+13	+38	+23
				+38	+3	+45	+3	+48	+13	+55	+13	+58	+23
				+33	+8	+39	+9	+43	+18	+49	+19	+53	+28
120	**180**	–25	0	+21	+3	+28	+3	+33	+15	+40	+15	+45	+27
				+46	+3	+53	+3	+58	+15	+65	+15	+70	+27
				+40	+9	+46	+10	+52	+21	+58	+22	+64	+33
180	**250**	–30	0	+24	+4	+33	+4	+37	+17	+46	+17	+51	+31
				+54	+4	+63	+4	+67	+17	+76	+17	+81	+31
				+48	+10	+55	+12	+61	+23	+68	+25	+75	+37
250	**315**	–35	0	+27	+4	+36	+4	+43	+20	+52	+20	+57	+34
				+62	+4	+71	+4	+78	+20	+87	+20	+92	+34
				+54	+12	+62	+13	+70	+28	+78	+29	+84	+42
315	**400**	–40	0	+29	+4	+40	+4	+46	+21	+57	+21	+62	+37
				+69	+4	+80	+4	+86	+21	+97	+21	+102	+37
				+61	+12	+69	+15	+78	+29	+86	+32	+94	+45
400	**500**	–45	0	+32	+5	+45	+5	+50	+23	+63	+23	+67	+40
				+77	+5	+90	+5	+95	+23	+108	+23	+112	+40
				+68	+14	+78	+17	+86	+32	+96	+35	+103	+49

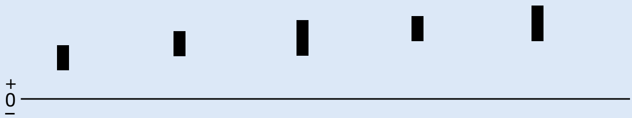
Shaft tolerances and resultant fits



Shaft Nominal diameter d		Bearing Bore diameter tolerance Δ_{dmp}		Deviations of shaft diameter, resultant fits Tolerances k5		k6		m5		m6		n5	
				Deviations (shaft diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
over	incl.	low	high										
mm		µm		µm									
500	**630**	–50	0	+29	0	+44	0	+55	+26	+70	+26	+73	+44
				+78	0	+94	0	+104	+26	+120	+26	+122	+44
				+68	+10	+81	+13	+94	+36	+107	+39	+112	+54
630	**800**	–75	0	+32	0	+50	0	+62	+30	+80	+30	+82	+50
				+107	0	+125	0	+137	+30	+155	+30	+157	+50
				+95	+12	+108	+17	+125	+42	+138	+47	+145	+62
800	**1 000**	–100	0	+36	0	+56	0	+70	+34	+90	+34	+92	+56
				+136	0	+156	0	+170	+34	+190	+34	+192	+56
				+122	+14	+136	+20	+156	+48	+170	+54	+178	+70
1 000	**1 250**	–125	0	+42	0	+66	0	+82	+40	+106	+40	+108	+66
				+167	0	+191	0	+207	+40	+231	+40	+233	+66
				+150	+17	+167	+24	+190	+57	+207	+64	+216	+83
1 250	**1 600**	–160	0	+50	0	+78	0	+98	+48	+126	+48	+128	+78
				+210	0	+238	0	+258	+48	+286	+48	+288	+78
				+189	+21	+208	+30	+237	+69	+256	+78	+267	+99
1 600	**2 000**	–200	0	+60	0	+92	0	+118	+58	+150	+58	+152	+92
				+260	0	+292	0	+318	+58	+350	+58	+352	+92
				+235	+25	+257	+35	+293	+83	+315	+93	+327	+117

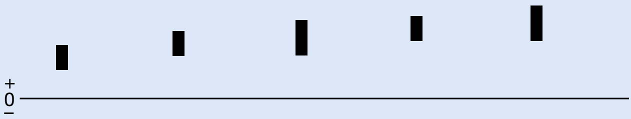
Table 7e

Shaft tolerances and resultant fits



Shaft Nominal diameter d		Bearing Bore diameter tolerance Δ_{dmp}		Deviations of shaft diameter, resultant fits Tolerances									
				n6		p6		p7		r6		r7	
over	incl.	low	high	Deviations (shaft diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)									
mm		µm		µm									
80	**100**	–20	0	+45	+23	+59	+37	+72	+37	+73	+51	+86	+51
				+65	+23	+79	+37	+92	+37	+93	+51	+106	+51
				+59	+29	+73	+43	+85	+44	+87	+57	+99	+58
100	**120**	–20	0	+45	+23	+59	+37	+72	+37	+76	+54	+89	+54
				+65	+23	+79	+37	+92	+37	+96	+54	+109	+54
				+59	+29	+73	+43	+85	+44	+90	+60	+102	+61
120	**140**	–25	0	+52	+27	+68	+43	+83	+43	+88	+63	+103	+63
				+77	+27	+93	+43	+108	+43	+113	+63	+128	+63
				+70	+34	+86	+50	+100	+51	+106	+70	+120	+71
140	**160**	–25	0	+52	+27	+68	+43	+83	+43	+90	+65	+105	+65
				+77	+27	+93	+43	+108	+43	+115	+65	+130	+65
				+70	+34	+86	+50	+100	+51	+108	+72	+122	+73
160	**180**	–25	0	+52	+27	+68	+43	+83	+43	+93	+68	+108	+68
				+77	+27	+93	+43	+108	+43	+118	+68	+133	+68
				+70	+34	+86	+50	+100	+51	+111	+75	+125	+76
180	**200**	–30	0	+60	+31	+79	+50	+96	+50	+106	+77	+123	+77
				+90	+31	+109	+50	+126	+50	+136	+77	+153	+77
				+82	+39	+101	+58	+116	+60	+128	+85	+143	+87
200	**225**	–30	0	+60	+31	+79	+50	+96	+50	+109	+80	+126	+80
				+90	+31	+109	+50	+126	+50	+139	+80	+156	+80
				+82	+39	+101	+58	+116	+60	+131	+88	+146	+90
225	**250**	–30	0	+60	+31	+79	+50	+96	+50	+113	+84	+130	+84
				+90	+31	+109	+50	+126	+50	+143	+84	+160	+84
				+82	+39	+101	+58	+116	+60	+135	+92	+150	+94
250	**280**	–35	0	+66	+34	+88	+56	+108	+56	+126	+94	+146	+94
				+101	+34	+123	+56	+143	+56	+161	+94	+181	+94
				+92	+43	+114	+65	+131	+68	+152	+103	+169	+106
280	**315**	–35	0	+66	+34	+88	+56	+108	+56	+130	+98	+150	+98
				+101	+34	+123	+56	+143	+56	+165	+98	+185	+98
				+92	+43	+114	+65	+131	+68	+156	+107	+173	+110
315	**355**	–40	0	+73	+37	+98	+62	+119	+62	+144	+108	+165	+108
				+113	+37	+138	+62	+159	+62	+184	+108	+205	+108
				+102	+48	+127	+73	+146	+75	+173	+119	+192	+121
355	**400**	–40	0	+73	+37	+98	+62	+119	+62	+150	+114	+171	+114
				+113	+37	+138	+62	+159	+62	+190	+114	+211	+114
				+102	+48	+127	+73	+146	+75	+179	+125	+198	+127
400	**450**	–45	0	+80	+40	+108	+68	+131	+68	+166	+126	+189	+126
				+125	+40	+153	+68	+176	+68	+211	+126	+234	+126
				+113	+52	+141	+80	+161	+83	+199	+138	+219	+141

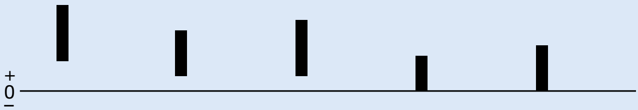
Shaft tolerances and resultant fits



Shaft Nominal diameter d		Bearing Bore diameter tolerance Δ_{dmp}		Deviations of shaft diameter, resultant fits Tolerances									
				n6		p6		p7		r6		r7	
				Deviations (shaft diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
over	incl.	low	high										
mm		µm		µm									
450	**500**	–45	0	+80	+40	+108	+68	+131	+68	+172	+132	+195	+132
				+125	+40	+153	+68	+176	+68	+217	+132	+240	+132
				+113	+52	+141	+80	+161	+83	+205	+144	+225	+147
500	**560**	–50	0	+88	+44	+122	+78	+148	+78	+194	+150	+220	+150
				+138	+44	+172	+78	+198	+78	+244	+150	+270	+150
				+125	+57	+159	+91	+182	+94	+231	+163	+254	+166
560	**630**	–50	0	+88	+44	+122	+78	+148	+78	+199	+155	+225	+155
				+138	+44	+172	+78	+198	+78	+249	+155	+275	+155
				+125	+57	+159	+91	+182	+94	+236	+168	+259	+171
630	**710**	–75	0	+100	+50	+138	+88	+168	+88	+225	+175	+255	+175
				+175	+50	+213	+88	+243	+88	+300	+175	+330	+175
				+158	+67	+196	+105	+221	+110	+283	+192	+308	+197
710	**800**	–75	0	+100	+50	+138	+88	+168	+88	+235	+185	+265	+185
				+175	+50	+213	+88	+243	+88	+310	+185	+340	+185
				+158	+67	+196	+105	+221	+110	+293	+202	+318	+207
800	**900**	–100	0	+112	+56	+156	+100	+190	+100	+266	+210	+300	+210
				+212	+56	+256	+100	+290	+100	+366	+210	+400	+210
				+192	+76	+236	+120	+263	+127	+346	+230	+373	+237
900	**1 000**	–100	0	+112	+56	+156	+100	+190	+100	+276	+220	+310	+220
				+212	+56	+256	+100	+290	+100	+376	+220	+410	+220
				+192	+76	+236	+120	+263	+127	+356	+240	+383	+247
1 000	**1 120**	–125	0	+132	+66	+186	+120	+225	+120	+316	+250	+355	+250
				+257	+66	+311	+120	+350	+120	+441	+250	+480	+250
				+233	+90	+287	+144	+317	+153	+417	+274	+447	+283
1 120	**1 250**	–125	0	+132	+66	+186	+120	+225	+120	+326	+260	+365	+260
				+257	+66	+311	+120	+350	+120	+451	+260	+490	+260
				+233	+90	+287	+144	+317	+153	+427	+284	+457	+293
1 250	**1 400**	–160	0	+156	+78	+218	+140	+265	+140	+378	+300	+425	+300
				+316	+78	+378	+140	+425	+140	+538	+300	+585	+300
				+286	+108	+348	+170	+385	+180	+508	+330	+545	+340
1 400	**1 600**	–160	0	+156	+78	+218	+140	+265	+140	+408	+330	+455	+330
				+316	+78	+378	+140	+425	+140	+568	+330	+615	+330
				+286	+108	+348	+170	+385	+180	+538	+360	+575	+370
1 600	**1 800**	–200	0	+184	+92	+262	+170	+320	+170	+462	+370	+520	+370
				+384	+92	+462	+170	+520	+170	+662	+370	+720	+370
				+349	+127	+427	+205	+470	+220	+627	+405	+670	+420
1 800	**2 000**	–200	0	+184	+92	+262	+170	+320	+170	+492	+400	+550	+400
				+384	+92	+462	+170	+520	+170	+692	+400	+750	+400
				+349	+127	+427	+205	+470	+220	+657	+435	+700	+450

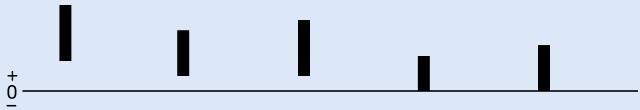
Table 8a

Housing tolerances and resultant fits



Housing Nominal bore diameter D		Bearing Outside diameter tolerance Δ_{Dmp}		Deviations of housing bore diameter, resultant fits Tolerances F7		G6		G7		H5		H6	
over	incl.	high	low	Deviations (housing bore diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)									
mm		µm		µm									
6	**10**	0	–8	+13	+28	+5	+14	+5	+20	0	+6	0	+9
				–13	–36	–5	–22	–5	–28	0	–14	0	–17
				–16	–33	–7	–20	–8	–25	–2	–12	–2	–15
10	**18**	0	–8	+16	+34	+6	+17	+6	+24	0	+8	0	+11
				–16	–42	–6	–25	–6	–32	0	–16	0	–19
				–19	–39	–8	–23	–9	–29	–2	–14	–2	–17
18	**30**	0	–9	+20	+41	+7	+20	+7	+28	0	+9	+0	+13
				–20	–50	–7	–29	–7	–37	0	–18	0	–22
				–23	–47	–10	–26	–10	–34	–2	–16	–3	–19
30	**50**	0	–11	+25	+50	+9	+25	+9	+34	0	+11	0	+16
				–25	–61	–9	–36	–9	–45	0	–22	0	–27
				–29	–57	–12	–33	–13	–41	–3	–19	–3	–24
50	**80**	0	–13	+30	+60	+10	+29	+10	+40	0	+13	0	+19
				–30	–73	–10	–42	–10	–53	0	–26	0	–32
				–35	–68	–14	–38	–15	–48	–3	–23	–4	–28
80	**120**	0	–15	+36	+71	+12	+34	+12	+47	0	+15	0	+22
				–36	–86	–12	–49	–12	–62	0	–30	0	–37
				–41	–81	–17	–44	–17	–57	–4	–26	–5	–32
120	**150**	0	–18	+43	+83	+14	+39	+14	+54	0	+18	0	+25
				–43	–101	–14	–57	–14	–72	0	–36	0	–43
				–50	–94	–20	–51	–21	–65	–5	–31	–6	–37
150	**180**	0	–25	+43	+83	+14	+39	+14	+54	0	+18	0	+25
				–43	–108	–14	–64	–14	–79	0	–43	0	–50
				–51	–100	–21	–57	–22	–71	–6	–37	–7	–43
180	**250**	0	–30	+50	+96	+15	+44	+15	+61	0	+20	0	+29
				–50	–126	–15	–74	–15	–91	0	–50	0	–59
				–60	–116	–23	–66	–25	–81	–6	–44	–8	–51
250	**315**	0	–35	+56	+108	+17	+49	+17	+69	0	+23	0	+32
				–56	–143	–17	–84	–17	–104	0	–58	0	–67
				–68	–131	–26	–75	–29	–92	–8	–50	–9	–58
315	**400**	0	–40	+62	+119	+18	+54	+18	+75	0	+25	0	+36
				–62	–159	–18	–94	–18	–115	0	–65	0	–76
				–75	–146	–29	–83	–31	–102	–8	–57	–11	–65
400	**500**	0	–45	+68	+131	+20	+60	+20	+83	0	+27	0	+40
				–68	–176	–20	–105	–20	–128	0	–72	0	–85
				–83	–161	–32	–93	–35	–113	–9	–63	–12	–73
500	**630**	0	–50	+76	+146	+22	+66	+22	+92	0	+28	0	+44
				–76	–196	–22	–116	–22	–142	0	–78	0	–94
				–92	–180	–35	–103	–38	–126	–10	–68	–13	–81

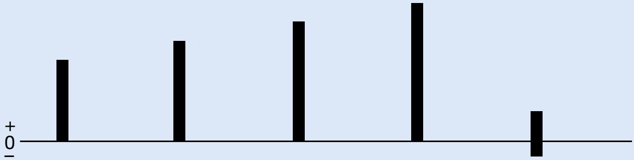
Housing tolerances and resultant fits



Housing Nominal bore diameter D		Bearing Outside diameter tolerance Δ_{Dmp}		Deviations of housing bore diameter, resultant fits Tolerances									
				F7		G6		G7		H5		H6	
				Deviations (housing bore diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)									
over	incl.	high	low										
mm		µm		µm									
630	**800**	0	–75	+80	+160	+24	+74	+24	+104	0	+32	0	+50
				–80	–235	–24	–149	–24	–179	0	–107	0	–125
				–102	–213	–41	–132	–46	–157	–12	–95	–17	–108
800	**1 000**	0	–100	+86	+176	+26	+82	+26	+116	0	+36	0	+56
				–86	–276	–26	–182	–26	–216	0	–136	0	–156
				–113	–249	–46	–162	–53	–189	–14	–122	–20	–136
1 000	**1 250**	0	–125	+98	+203	+28	+94	+28	+133	0	+42	0	+66
				–98	–328	–28	–219	–28	–258	0	–167	0	–191
				–131	–295	–52	–195	–61	–225	–17	–150	–24	–167
1 250	**1 600**	0	–160	+110	+235	+30	+108	+30	+155	0	+50	0	+78
				–110	–395	–30	–268	–30	–315	0	–210	0	–238
				–150	–355	–60	–238	–70	–275	–21	–189	–30	–208
1 600	**2 000**	0	–200	+120	+270	+32	+124	+32	+182	0	+60	0	+92
				–120	–470	–32	–324	–32	–382	0	–260	0	–292
				–170	–420	–67	–289	–82	–332	–25	–235	–35	–257
2 000	**2 500**	0	–250	+130	+305	+34	+144	+34	+209	0	+70	0	+110
				–130	–555	–34	–394	–34	–459	0	–320	0	–360
				–189	–496	–77	–351	–93	–400	–30	–290	–43	–317

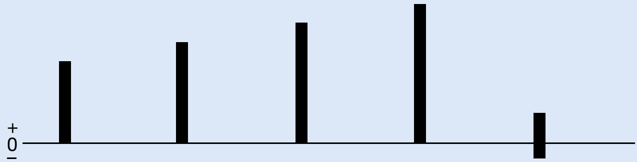
Table 8b

Housing tolerances and resultant fits



Housing Nominal bore diameter D		Bearing Outside diameter tolerance Δ_{Dmp}		Deviations of housing bore diameter, resultant fits Tolerances									
				H7		H8		H9		H10		J6	
				Deviations (housing bore diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
over	incl.	high	low										
mm		µm		µm									
6	**10**	0	–8	0	+15	0	+22	0	+36	0	+58	–4	+5
				0	–23	0	–30	0	–44	0	–66	+4	–13
				–3	–20	–3	–27	–3	–41	–3	–63	+2	–11
10	**18**	0	–8	0	+18	0	+27	0	+43	0	+70	–5	+6
				0	–26	0	–35	0	–51	0	–78	+5	–14
				–3	–23	–3	–32	–3	–48	–3	–75	+3	–12
18	**30**	0	–9	0	+21	0	+33	0	+52	0	+84	–5	+8
				0	–30	0	–42	0	–61	0	–93	+5	–17
				–3	–27	–3	–39	–4	–57	–4	–89	+2	–14
30	**50**	0	–11	0	+25	0	+39	0	+62	0	+100	–6	+10
				0	–36	0	–50	0	–73	0	–111	+6	–21
				–4	–32	–4	–46	–5	–68	–5	–106	+3	–18
50	**80**	0	–13	0	+30	0	+46	0	+74	0	+120	–6	+13
				0	–43	0	–59	0	–87	0	–133	+6	–26
				–5	–38	–5	–54	–5	–82	–6	–127	+2	–22
80	**120**	0	–15	0	+35	0	+54	0	+87	0	+140	–6	+16
				0	–50	0	–69	0	–102	0	–155	+6	–31
				–5	–45	–6	–63	–6	–96	–7	–148	+1	–26
120	**150**	0	–18	0	+40	0	+63	0	+100	0	+160	–7	+18
				0	–58	0	–81	0	–118	0	–178	+7	–36
				–7	–51	–7	–74	–8	–110	–8	–170	+1	–30
150	**180**	0	–25	0	+40	0	+63	0	+100	0	+160	–7	+18
				0	–65	0	–88	0	–125	0	–185	+7	–43
				–8	–57	–10	–78	–10	–115	–11	–174	0	–36
180	**250**	0	–30	0	+46	0	+72	0	+115	0	+185	–7	+22
				0	–76	0	–102	0	–145	0	–215	+7	–52
				–10	–66	–12	–90	–13	–132	–13	–202	–1	–44
250	**315**	0	–35	0	+52	0	+81	0	+130	0	+210	–7	+25
				0	–87	0	–116	0	–165	0	–245	+7	–60
				–12	–75	–13	–103	–15	–150	–16	–229	–2	–51
315	**400**	0	–40	0	+57	0	+89	0	+140	0	+230	–7	+29
				0	–97	0	–129	0	–180	0	–270	+7	–69
				–13	–84	–15	–114	–17	–163	–18	–252	–4	–58
400	**500**	0	–45	0	+63	0	+87	0	+155	0	+250	–7	+33
				0	–108	0	–142	0	–200	0	–295	+7	–78
				–15	–93	–17	–125	–19	–181	–20	–275	–5	–66
500	**630**	0	–50	0	+70	0	+110	0	+175	0	+280	–	–
				0	–120	0	–160	0	–225	0	–330	–	–
				–16	–104	–19	–141	–21	–204	–22	–308	–	–

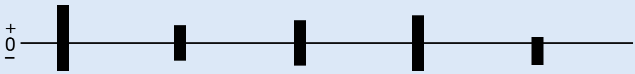
Housing tolerances and resultant fits



Housing Nominal bore diameter D		**Bearing** Outside diameter tolerance Δ_{Dmp}		**Deviations of housing bore diameter, resultant fits** Tolerances									
				H7		H8		H9		H10		J6	
				Deviations (housing bore diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
over	incl.	high	low										
mm		µm		µm									
630	**800**	0	–75	0	+80	0	+125	0	+200	0	+320	–	–
				0	–155	0	–200	0	–275	0	–395	–	–
				–22	–133	–27	–173	–30	–245	–33	–362	–	–
800	**1 000**	0	–100	0	+90	0	+140	0	+230	0	+360	–	–
				0	–190	0	–240	0	–330	0	–460	–	–
				–27	–163	–33	–207	–39	–291	–43	–417	–	–
1 000	**1 250**	0	–125	0	+105	0	+165	0	+260	0	+420	–	–
				0	–230	0	–290	0	–385	0	–545	–	–
				–33	–197	–41	–249	–48	–337	–53	–492	–	–
1 250	**1 600**	0	–160	0	+125	0	+195	0	+310	0	+500	–	–
				0	–285	0	–355	0	–470	0	–660	–	–
				–40	–245	–51	–304	–60	–410	–67	–593	–	–
1 600	**2 000**	0	–200	0	+150	0	+230	0	+370	0	+600	–	–
				0	–350	0	–430	0	–570	0	–800	–	–
				–50	–300	–62	–368	–74	–496	–83	–717	–	–
2 000	**2 500**	0	–250	0	+175	0	+280	0	+440	0	+700	–	–
				0	–425	0	–530	0	–690	0	–950	–	–
				–59	–366	–77	–453	–91	–599	–103	–847	–	–

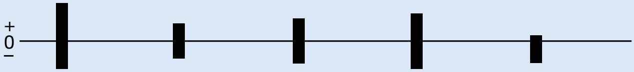
Table 8c

Housing tolerances and resultant fits



Housing Nominal bore diameter D		Bearing Outside diameter tolerance Δ_{Dmp}		Deviations of housing bore diameter, resultant fits Tolerances									
				J7		JS5		JS6		JS7		K5	
				Deviations (housing bore diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
over	incl.	high	low										
mm		µm		µm									
6	**10**	0	–8	–7	+8	–3	+3	–4,5	+4,5	–7,5	+7,5	–5	+1
				+7	–16	+3	–11	+4,5	–12,5	+7,5	–15,5	+5	–9
				+4	–13	+1	–9	+3	–11	+5	–13	+3	–7
10	**18**	0	–8	–8	+10	–4	+4	–5,5	+5,5	–9	+9	–6	+2
				+8	–18	+4	–12	+5,5	–13,5	+9	–17	+6	–10
				+5	–15	+2	–10	+3	–11	+6	–14	+4	–8
18	**30**	0	–9	–9	+12	–4,5	+4,5	–6,5	+6,5	–10,5	+10,5	–8	+1
				+9	–21	+4,5	–13,5	+6,5	–15,5	+10,5	–19,5	+8	–10
				+6	–18	+2	–11	+4	–13	+7	–16	+6	–8
30	**50**	0	–11	–11	+14	–5,5	+5,5	–8	+8	–12,5	+12,5	–9	+2
				+11	–25	+5,5	–16,5	+8	–19	+12,5	–23,5	+9	–13
				+7	–21	+3	–14	+5	–16	+9	–20	+6	–10
50	**80**	0	–13	–12	+18	–6,5	+6,5	–9,5	+9,5	–15	+15	–10	+3
				+12	–31	+6,5	–19,5	+9,5	–22,5	+15	–28	+10	–16
				+7	–26	+3	–16	+6	–19	+10	–23	+7	–13
80	**120**	0	–15	–13	+22	–7,5	+7,5	–11	+11	–17,5	+17,5	–13	+2
				+13	–37	+7,5	–22,5	+11	–26	+17,5	–32,5	+13	–17
				+8	–32	+4	–19	+6	–21	+12	–27	+9	–13
120	**150**	0	–18	–14	+26	–9	+9	–12,5	+12,5	–20	+20	–15	+3
				+14	–44	+9	–27	+12,5	–30,5	+20	–38	+15	–21
				+7	–37	+4	–22	+7	–25	+13	–31	+10	–16
150	**180**	0	–25	–14	+26	–9	+9	–12,5	+12,5	–20	+20	–15	+3
				+14	–51	+9	–34	+12,5	–37,5	+20	–45	+15	–28
				+6	–43	+3	–28	+6	–31	+12	–37	+9	–22
180	**250**	0	–30	–16	+30	–10	+10	–14,5	+14,5	–23	+23	–18	+2
				+16	–60	+10	–40	+14,5	–44,5	+23	–53	+18	–32
				+6	–50	+4	–34	+6	–36	+13	–43	+12	–26
250	**315**	0	–35	–16	+36	–11,5	+11,5	–16	+16	–26	+26	–20	+3
				+16	–71	+11,5	–46,5	+16	+51	+26	–61	+20	–38
				+4	–59	+4	–39	+7	–42	+14	–49	+12	–30
315	**400**	0	–40	–18	+39	–12,5	+12,5	–18	+18	–28,5	+28,5	–22	+3
				+18	–79	+12,5	–52,5	+18	–58	+28,5	–68,5	+22	–43
				+5	–66	+4	–44	+7	–47	+15	–55	+14	–35
400	**500**	0	–45	–20	+43	–13,5	+13,5	–20	+20	–31,5	+31,5	–25	+2
				+20	–88	+13,5	–58,5	+20	–65	+31,5	–76,5	+25	–47
				+5	–73	+4	–49	+8	–53	+17	–62	+16	–38
500	**630**	0	–50	–	–	–14	+14	–22	+22	–35	+35	–	–
				–	–	+14	–64	+22	–72	+35	–85	–	–
				–	–	+4	–54	+9	–59	+19	–69	–	–

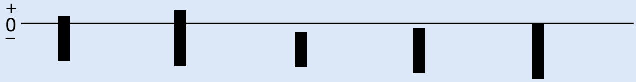
Housing tolerances and resultant fits



Housing Nominal bore diameter D		**Bearing** Outside diameter tolerance Δ_{Dmp}		**Deviations of housing bore diameter, resultant fits** Tolerances									
				J7		JS5		JS6		JS7		K5	
				Deviations (housing bore diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)									
over	incl.	high	low										
mm		µm		µm									
630	**800**	0	–75	–	–	–16	+16	–25	+25	–40	+40	–	–
				–	–	+16	–91	+25	–100	+40	–115	–	–
				–	–	+4	–79	+8	–83	+18	–93	–	–
800	**1 000**	0	–100	–	–	–18	+18	–28	+28	–45	+45	–	–
				–	–	+18	–118	+28	–128	+45	–145	–	–
				–	–	+4	–104	+8	–108	+18	–118	–	–
1 000	**1 250**	0	–125	–	–	–21	+21	–33	+33	–52	+52	–	–
				–	–	+21	–146	+33	–158	+52	–177	–	–
				–	–	+4	–129	+9	–134	+20	–145	–	–
1 250	**1 600**	0	–160	–	–	–25	+25	–39	+39	–62	+62	–	–
				–	–	+25	–185	+39	–199	+62	–222	–	–
				–	–	+4	–164	+9	–169	+22	–182	–	–
1 600	**2 000**	0	–200	–	–	–30	+30	–46	+46	–75	+75	–	–
				–	–	+30	–230	+46	–246	+75	–275	–	–
				–	–	+5	–205	+11	–211	+25	–225	–	–
2 000	**2 500**	0	–250	–	–	–35	+35	–55	+55	–87	+87	–	–
				–	–	+35	–285	+55	–305	+87	–337	–	–
				–	–	+5	–255	+12	–262	+28	–278	–	–

Table 8d

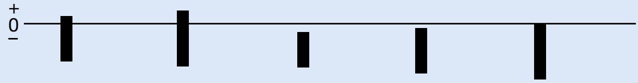
Housing tolerances and resultant fits



Housing Nominal bore diameter D over	incl.	Bearing Outside diameter tolerance Δ_{Dmp} high	low	Deviations of housing bore diameter, resultant fits Tolerances K6		K7		M5		M6		M7	
				Deviations (housing bore diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
mm		µm		µm									
6	**10**	0	–8	–7	+2	–10	+5	–10	–4	–12	–3	–15	0
				+7	–10	+10	–13	+10	–4	+12	–5	+15	–8
				+5	–8	+7	–10	+8	–2	+10	–3	+12	–5
10	**18**	0	–8	–9	+2	–12	+6	–12	–4	–15	–4	–18	0
				+9	–10	+12	–14	+12	–4	+15	–4	+18	–8
				+7	–8	+9	–11	+10	–2	+13	–2	+15	–5
18	**30**	0	–9	–11	+2	–15	+6	–14	–4	–17	–4	–21	0
				+11	–11	+15	–15	+14	–4	+17	–5	+21	–9
				+8	–8	+12	–12	+12	–2	+14	–2	+18	–6
30	**50**	0	–11	–13	+3	–18	+7	–16	–5	–20	–4	–25	0
				+13	–14	+18	–18	+16	–6	+20	–7	+25	–11
				+10	–11	+14	–14	+13	–3	+17	–4	+21	–7
50	**80**	0	–13	–15	+4	–21	+9	–19	–6	–24	–5	–30	0
				+15	–17	+21	–22	+19	–7	+24	–8	+30	–13
				+11	–13	+16	–17	+16	–4	+20	–4	+25	–8
80	**120**	0	–15	–18	+4	–25	+10	–23	–8	–28	–6	–35	0
				+18	–19	+25	–25	+23	–7	+28	–9	+35	–15
				+13	–14	+20	–20	+19	–3	+23	–4	+30	–10
120	**150**	0	–18	–21	+4	–28	+12	–27	–9	–33	–8	–40	0
				+21	–22	+28	–30	+27	–9	+33	–10	+40	–18
				+15	–16	+21	–23	+22	–4	+27	–4	+33	–11
150	**180**	0	–25	–21	+4	–28	+12	–27	–9	–33	–8	–40	0
				+21	–29	+28	–37	+27	–16	+33	–17	+40	–25
				+14	–22	+20	–29	+21	–10	+26	–10	+32	–17
180	**250**	0	–30	–24	+5	–33	+13	–31	–11	–37	–8	–46	0
				+24	–35	+33	–43	+31	–19	+37	–22	+46	–30
				+16	–27	+23	–33	+25	–13	+29	–14	+36	–20
250	**315**	0	–35	–27	+5	–36	+16	–36	–13	–41	–9	–52	0
				+27	–40	+36	–51	+36	–22	+41	–26	+52	–35
				+18	–31	+24	–39	+28	–14	+32	–17	+40	–23
315	**400**	0	–40	–29	–7	–40	+17	–39	–14	–46	–10	–57	0
				+29	–47	+40	–57	+39	–26	+46	–30	+57	–40
				+18	–36	+27	–44	+31	–18	+35	–19	+44	–27
400	**500**	0	–45	–32	+8	–45	+18	–43	–16	–50	–10	–63	0
				+32	–53	+45	–63	+43	–29	+50	–35	+63	–45
				+20	–41	+30	–48	+34	–20	+38	–23	+48	–30
500	**630**	0	–50	–44	0	–70	0	–	–	–70	–26	–96	–26
				+44	–50	+70	–50	–	–	+70	–24	+96	–24
				+31	–37	+54	–34	–	–	+57	–11	+80	–8

SKF

Housing tolerances and resultant fits



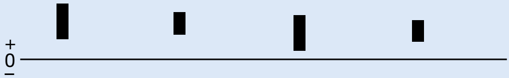
Housing Nominal bore diameter D		Bearing Outside diameter tolerance Δ_{Dmp}		Deviations of housing bore diameter, resultant fits Tolerances									
				K6		K7		M5		M6		M7	
over	incl.	high	low	Deviations (housing bore diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
mm		µm		µm									
630	**800**	0	–75	–50	0	–80	0	–	–	–80	–30	–110	–30
				+50	–75	+80	–75	–	–	+80	–45	+110	–45
				+33	–58	+58	–53	–	–	+63	–28	+88	–23
800	**1 000**	0	–100	–56	0	–90	0	–	–	–90	–34	–124	–34
				+56	–100	+90	–100	–	–	+90	–66	+124	–66
				+36	–80	+63	–73	–	–	+70	–46	+97	–39
1 000	**1 250**	0	–125	–66	0	–105	0	–	–	–106	–40	–145	–40
				+66	–125	+105	–125	–	–	+106	–85	+145	–85
				+42	–101	+72	–92	–	–	+82	–61	+112	–52
1 250	**1 600**	0	–160	–78	0	–125	0	–	–	–126	–48	–173	–48
				+78	–160	+125	–160	–	–	+126	–112	+173	–112
				+48	–130	+85	–120	–	–	+96	–82	+133	–72
1 600	**2 000**	0	–200	–92	0	–150	0	–	–	–158	–58	–208	–58
				+92	–200	+150	–200	–	–	+150	–142	+208	–142
				+57	–165	+100	–150	–	–	+115	–107	+158	–92
2 000	**2 500**	0	–250	–110	0	–175	0	–	–	–178	–68	–243	–68
				+110	–250	+175	–250	–	–	+178	–182	+243	–182
				+67	–207	+116	–191	–	–	+135	–139	+184	–123

Table 8e

Housing tolerances and resultant fits

Housing Nominal bore diameter D over	incl.	Bearing Outside diameter tolerance Δ_{Dmp} high	low	Deviations of housing bore diameter, resultant fits Tolerances N6		N7		P6		P7	
				Deviations (housing bore diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)							
mm		µm		µm							
6	**10**	0	–8	–16	–7	–19	–4	–21	–12	–24	–9
				+16	–1	+19	–4	+21	+4	+24	+1
				+14	+1	+16	–1	+19	+6	+21	+4
10	**18**	0	–8	–20	–9	–23	–5	–26	–15	–29	–11
				+20	+1	+23	–3	+26	+7	+29	+3
				+18	+3	+20	0	+24	+9	+26	+6
18	**30**	0	–9	–24	–11	–28	–7	–31	–18	–35	–14
				+24	+2	+28	–2	+31	+9	+35	+5
				+21	+5	+25	+1	+28	+12	+32	+8
30	**50**	0	–11	–28	–12	–33	–8	–37	–21	–42	–17
				+28	+1	+33	–3	+37	+10	+42	+6
				+25	+4	+29	+1	+34	+13	+38	+10
50	**80**	0	–13	–33	–14	–39	–9	–45	–26	–51	–21
				+33	+1	+39	–4	+45	+13	+51	+8
				+29	+5	+34	+1	+41	+17	+46	+13
80	**120**	0	–15	–38	–16	–45	–10	–52	–30	–59	–24
				+38	+1	+45	–5	+52	+15	+59	+9
				+33	+6	+40	0	+47	+20	+54	+14
120	**150**	0	–18	–45	–20	–52	–12	–61	–36	–68	–28
				+45	+2	+52	–6	+61	+18	+68	+10
				+39	+8	+45	+1	+55	+24	+61	+17
150	**180**	0	–25	–45	–20	–52	–12	–61	–36	–68	–28
				+45	–5	+52	–13	+61	+11	+68	+3
				+38	+2	+44	–5	+54	+18	+60	+11
180	**250**	0	–30	–51	–22	–60	–14	–70	–41	–79	–33
				+51	–8	+60	–16	+70	+11	+79	+3
				+43	0	+50	–6	+62	+19	+69	+13
250	**315**	0	–35	–57	–25	–66	–14	–79	–47	–88	–36
				+57	–10	+66	–21	+79	+12	+88	+1
				+48	–1	+54	–9	+70	+21	+76	+13
315	**400**	0	–40	–62	–26	–73	–16	–87	–51	–98	–41
				+62	–14	+73	–24	+87	+11	+98	+1
				+51	–3	+60	–11	+76	+22	+85	+14
400	**500**	0	–45	–67	–27	–80	–17	–95	–55	–108	–45
				+67	–18	+80	–28	+95	+10	+108	0
				+55	–6	+65	–13	+83	+22	+93	+15
500	**630**	0	–50	–88	–44	–114	–44	–122	–78	–148	–78
				+88	–6	+114	–6	+122	+28	+148	+28
				+75	+7	+98	+10	+109	+41	+132	+44

Housing tolerances and resultant fits



Housing Nominal bore diameter D		**Bearing** Outside diameter tolerance Δ_{Dmp}		**Deviations of housing bore diameter, resultant fits** Tolerances N6		N7		P6		P7	
over	incl.	high	low	Deviations (housing bore diameter) / Theoretical interference (+)/clearance (–) / Probable interference (+)/clearance (–)							
mm		µm		µm							
630	**800**	0	–75	–100	–50	–130	–50	–138	–88	–168	–88
				+100	–25	+130	–25	+138	+13	+168	+13
				+83	–8	+108	–3	+121	+30	+146	+35
800	**1 000**	0	–100	–112	–56	–146	–56	–156	–100	–190	–100
				+112	–44	+146	–44	+156	0	+190	0
				+92	–24	+119	–17	+136	+20	+163	+27
1 000	**1 250**	0	–125	–132	–66	–171	–66	–186	–120	–225	–120
				+132	–59	+171	–59	+186	–5	+225	–5
				+108	–35	+138	–26	+162	+19	+192	+28
1 250	**1 600**	0	–160	–156	–78	–203	–78	–218	–140	–265	–140
				+156	–82	+203	–82	+218	–20	+265	–20
				+126	–52	+163	–42	+188	+10	+225	+20
1 600	**2 000**	0	–200	–184	–92	–242	–92	–262	–170	–320	–170
				+184	–108	+242	–108	+262	–30	+320	–30
				+149	–73	+192	–58	+227	+5	+270	+20
2 000	**2 500**	0	–250	–220	–110	–285	–110	–305	–195	–370	–195
				+220	–140	+285	–140	+305	–55	+370	–55
				+177	–97	+226	–81	+262	–12	+311	+4

Dimensional, form and running accuracy of bearing seatings and abutments
The accuracy of cylindrical bearing seatings on shafts and in housing bores, of seatings for thrust bearing washers and of the support surfaces (abutments for bearings provided by shaft and housing shoulders etc.) should correspond to the accuracy of the bearings used. In the following, guideline values for the dimensional, form and running accuracy are provided. These should be followed when machining the seatings and abutments.

Dimensional tolerances

For bearings made to Normal tolerances, the dimensional accuracy of cylindrical seatings on the shaft should be at least to grade 6 and in the housing at least to grade 7. Where adapter or withdrawal sleeves are used, wider diameter tolerances (grades 9 or 10) can be permitted than for bearing seatings (➔ **table** 9). The numerical values of standard tolerance grades IT to ISO 286-1:1988 will be found in **table** 10. For bearings with higher accuracy, correspondingly better grades should be used.

Tolerances for cylindrical form

The cylindricity tolerances as defined in ISO 1101:1983 should be 1 to 2 IT grades better than the prescribed dimensional tolerance, depending on requirements. For example, if a bearing shaft seating has been machined to tolerance m6, then the accuracy of form should be to IT5 or IT4. The tolerance value t_1 for cylindricity is obtained for an assumed shaft diameter of 150 mm from t_1 = IT5/2 = 18/2 = 9 µm. However, the tolerance t_1 is for a radius, hence $2 \times t_1$ applies for the shaft diameter. **Table** 11, **page 196**, gives guideline values for the cylindrical form tolerance and the total runout tolerance for the different bearing tolerance classes.

When bearings are to be mounted on adapter or withdrawal sleeves, the cylindricity of the sleeve seating should be IT5/2 (for h9) or IT7/2 (for h10) (➔ **table** 9).

Tolerances for perpendicularity

Abutments for bearing rings should have a rectangularity tolerance as defined in ISO 1101:1983, which is better by at least one IT grade than the diameter tolerance of the associated cylindrical seating. For thrust bearing washer seatings, the tolerance for perpendicularity should not exceed the values of IT5. Guideline values for the tolerance for rectangularity and for the total axial runout will be found in **table** 11, **page 196**.

Table 9

Shaft tolerances for bearings mounted on sleeves

Shaft diameter d Nominal over	incl.	**Diameter and form tolerances** h9 Deviations high	low	IT5[1)] max	h10 Deviations high	low	IT7[1)] max
mm		µm					
10	**18**	0	–43	8	0	–70	18
18	**30**	0	–52	9	0	–84	21
30	**50**	0	–62	11	0	–100	25
50	**80**	0	–74	13	0	–120	30
80	**120**	0	–87	15	0	–140	35
120	**180**	0	–100	18	0	–160	40
180	**250**	0	–115	20	0	–185	46
250	**315**	0	–130	23	0	–210	52
315	**400**	0	–140	25	0	–230	57
400	**500**	0	–155	27	0	–250	63
500	**630**	0	–175	32	0	–280	70
630	**800**	0	–200	36	0	–320	80
800	**1 000**	0	–230	40	0	–360	90
1 000	**1 250**	0	–260	47	0	–420	105

1) The recommendation is for IT5/2 or IT7/2, because the tolerance zone t is a radius, however in the table above the values relate to a nominal shaft diameter and are therefore not halved

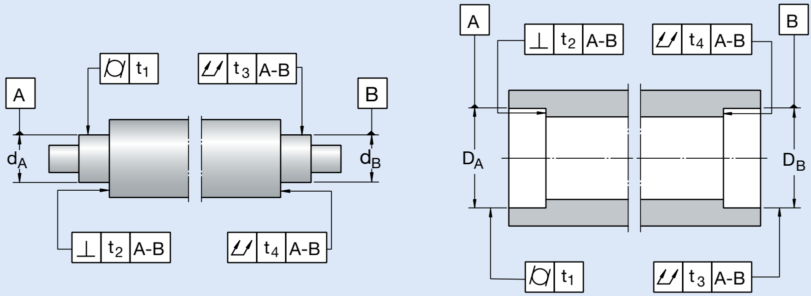
Table 10

ISO tolerance grades for dimensions (lengths, widths, diameters etc.)

Nominal dimension over	incl.	**Tolerance grades** IT1 max	IT2	IT3	IT4	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12
mm		µm											
1	**3**	0,8	1,2	2	3	4	6	10	14	25	40	60	100
3	**6**	1	1,5	2,5	4	5	8	12	18	30	48	75	120
6	**10**	1	1,5	2,5	4	6	9	15	22	36	58	90	150
10	**18**	1,2	2	3	5	8	11	18	27	43	70	110	180
18	**30**	1,5	2,5	4	6	9	13	21	33	52	84	130	210
30	**50**	1,5	2,5	4	7	11	16	25	39	62	100	160	250
50	**80**	2	3	5	8	13	19	30	46	74	120	190	300
80	**120**	2,5	4	6	10	15	22	35	54	87	140	220	350
120	**180**	3,5	5	8	12	18	25	40	63	100	160	250	400
180	**250**	4,5	7	10	14	20	29	46	72	115	185	290	460
250	**315**	6	8	12	16	23	32	52	81	130	210	320	520
315	**400**	7	9	13	18	25	36	57	89	140	230	360	570
400	**500**	8	10	15	20	27	40	63	97	155	250	400	630
500	**630**	–	–	–	–	32	44	70	110	175	280	440	700
630	**800**	–	–	–	–	36	50	80	125	200	320	500	800
800	**1 000**	–	–	–	–	40	56	90	140	230	360	560	900
1 000	**1 250**	–	–	–	–	47	66	105	165	260	420	660	1050
1 250	**1 600**	–	–	–	–	55	78	125	195	310	500	780	1250
1 600	**2 000**	–	–	–	–	65	92	150	230	370	600	920	1 500
2 000	**2 500**	–	–	–	–	78	110	175	280	440	700	1 100	1 750

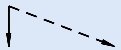
Table 11

Accuracy of form and position for bearing seatings on shafts and in housings



Surface Characteristic	Symbol for characteristic	tolerance zone	**Permissible deviations** Bearings of tolerance class[1)] Normal, CLN	P6	P5	
Cylindrical seating						
Cylindricity	⌭	t_1	IT5/2	IT4/2	IT3/2	IT2/2
Total radial runout	⌰	t_3	IT5/2	IT4/2	IT3/2	IT2/2
Flat abutment						
Rectangularity	⊥	t_2	IT5	IT4	IT3	IT2
Total axial runout	⌰	t_4	IT5	IT4	IT3	IT2

Explanation



For normal demands

For special demands with respect to running accuracy or even support

1) For bearings of higher accuracy (tolerance class P4 etc.) please refer to SKF catalogue "High-precision bearings"

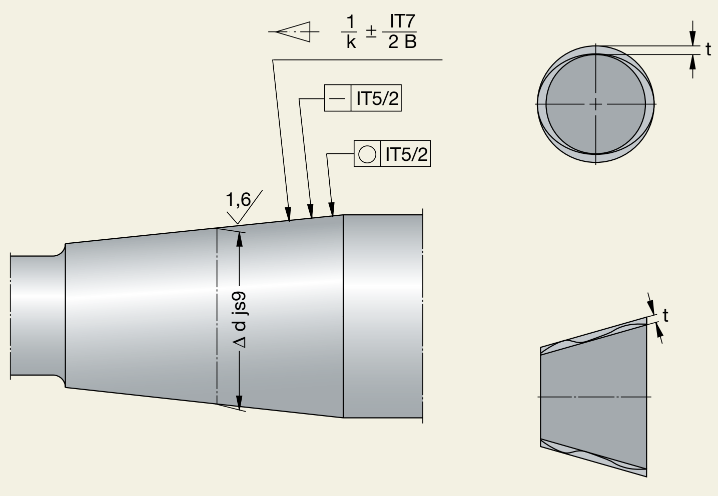
Tolerances for tapered journal seatings

When a bearing is mounted directly onto a tapered shaft seating, the seating diameter tolerance can be wider than in the case of cylindrical seatings. **Fig** 18 shows a grade 9 diameter tolerance, while the form tolerance stipulations are the same as for a cylindrical shaft seating. SKF recommendations for tapered shaft seatings for rolling bearings are as follows.

- The permissible taper deviation for machining the taper seatings is a ± tolerance in accordance with IT7/2 based on the bearing width. The value is determined according to the formula shown in **fig** 18, where
  k = factor for the taper
  12 for taper 1: 12
  30 for taper 1: 30
  B = bearing width
- The straightness tolerance is IT5/2, based on the diameter d and is defined as:
  "In each axial plane through the tapered surface of the shaft, the tolerance zone is limited by two parallel lines a distance "t" apart."
- The radial deviation from circularity is IT5/2, based on the diameter d and is defined as:
  "In each radial plane along the tapered surface of the shaft, the tolerance zone is limited by two concentric circles a distance "t" apart."
  When particularly stringent running accuracy requirements are stipulated, IT4/2 is to apply instead.

The best way to check that the taper is within the recommended tolerances is to measure with dial gauges. A more practical method, but less accurate, is to use ring gauges, special taper gauges or sine bars.

Fig 18



Surface roughness of bearing seatings

The roughness of bearing seating surfaces does not have the same degree of influence on bearing performance as the dimensional, form and running accuracies. However, a desired interference fit is much more accurately obtained the smoother the mating surfaces are. For less critical bearing arrangements relatively large surface roughness is permitted.

For bearing arrangements where demands for accuracy are high, guideline values for the mean surface roughness R_a are given in **table 12** for different dimensional accuracies of the bearing seatings. These recommendations apply to ground seatings, which are normally assumed for shaft seatings.

Raceways on shafts and in housings

Raceways machined in associated components for cylindrical roller bearings with only one ring and for cylindrical roller and cage thrust assemblies, must have a hardness of between 58 and 64 HRC if the load carrying capacity of the bearing or assembly is to be fully exploited.

The surface roughness should be $R_a \leq 0,2$ µm or $R_z \leq 1$ µm. For less demanding applications, lower hardness and rougher surfaces may be used.

The out-of-round and deviation from cylindrical form must not exceed 25 and 50 %, respectively, of the actual diameter tolerance of the raceway.

The permissible axial runouts of raceways for thrust assemblies are the same as for the shaft and housing washers of thrust bearings, shown in **table 10**, **page 132**.

Suitable materials for the seatings include through-hardening steels, e.g. 100 Cr 6 to ISO 683-17:1999, case-hardening steels, e.g. 20Cr3 or 17MnCr5 to ISO 683-17:1999) as well as induction hardening steels which can be partially hardened.

The case depth that is recommended for raceways machined in associated components depends on various factors including the dynamic and static load ratios (P/C and P_0/C_0 respectively) as well as the core hardness, and it is difficult to generalize. For example, under conditions of purely static load up to the magnitude of the basic static load rating and with a core hardness of 350 HV, the recommended case depth is in the order of 0,1 times the rolling element diameter. Smaller case depths are permitted for dynamic loads. For additional information, please consult the SKF application engineering service.

Table 12

Guideline values for surface roughness of bearing seatings

Diameter of seatings d (D)[2] over	incl.	Recommended R_a value for ground seatings (Roughness grade numbers) Diameter tolerance to IT7	IT6	IT5
mm		µm		
–	**80**	1,6 (N7)	0,8 (N6)	0,4 (N5)
80	**500**	1,6 (N7)	1,6 (N7)	0,8 (N6)
500	**1 250**	3,2 (N8)[1]	1,6 (N7)	1,6 (N7)

1) When using the oil injection method for mounting R_a should not exceed 1,6 µm
2) For diameters > 1 250 mm consult the SKF application engineering service

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