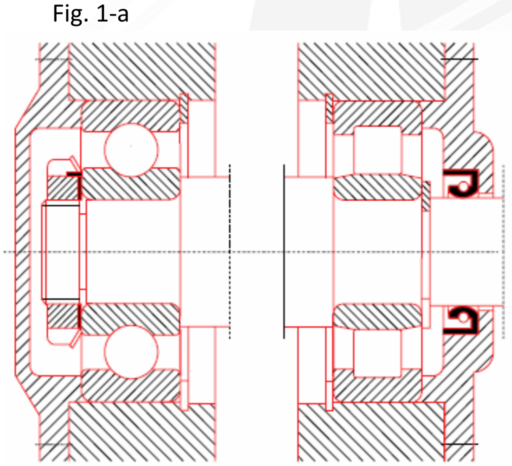
Radial Roller Bearings – Fitting and Mounting

Fixed Bearings and Float Bearings

Radial and axial loads in bearing units can be transmitted by fixed and floating bearings. A fixed bearing is generally used for medium and large -sized shafts that can reach high temperatures during operation. It has to support radially the shaft assembly and to locate it axially in both directions. A floating bearing supports the shaft assembly only radially. It also allows axial displacement in relation to the housing to take place so that additional axial loading is avoided. Axial displacement can take place either in the housing bore seating or in the bearing itself. In case the shaft is supported by more than two bearings, only one of them will be a fixed bearing and it will be the one with the lightest radial load.
In case of small-sized shafts, two floating bearings with limited displacement can be used. Each of them can accommodate axial loads in a single direction, having thus mutual location. Fig.1 shows a few of the most representative applications of fixed and floating bearings, as follows:

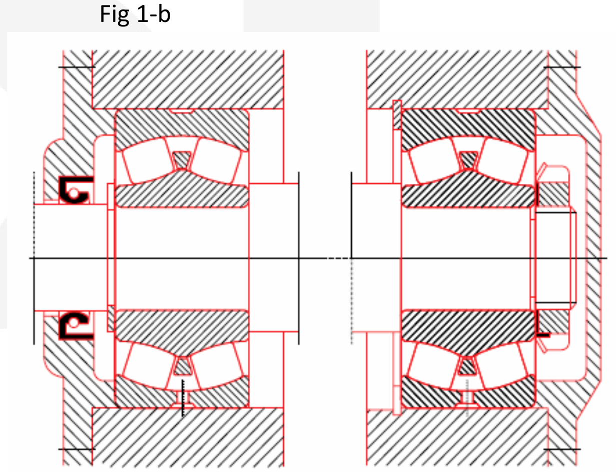
a) The fixed bearing is a single row deep groove ball bearing and the floating one is a cylindrical roller bearing with both rings tightly fitted on the shaft and into the housing, respectively.
b) Both bearings are supported by spherical roller bearings. The fixed bearing is tightly fitted both on the shaft and into the housing. The floating bearing has the outer ring mounted with clearance into the housing and thus allows axial displacement in both directions.
c) The fixed bearing consists of a cylindrical roller bearing, NUP type and the floating bearing consists of a cylindrical roller bearing, NU type.
d) The fixed bearings consist of a cylindrical roller bearing. NU type which takes over radial loads and of a four-point contact ball bearing (unloaded on the outside). The floating bearing consists of a cylindrical roller bearing, NU type.

Fig. 1-a



Fixed bearing Floating bearing

Fig 1-b



Floating bearing Fixed bearing

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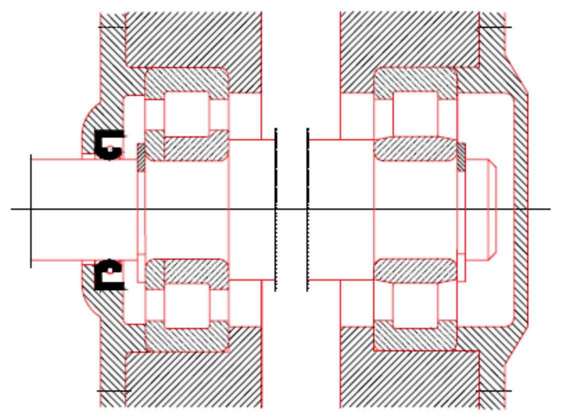
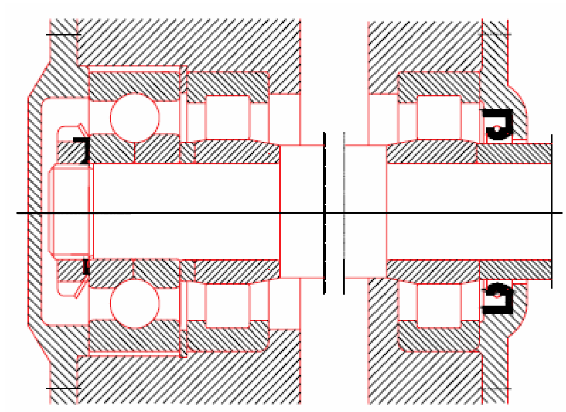
Fig 1-c



Fixed bearing   Floating bearing

Fig 1-d



Fixed bearing   Floating bearing

RECOMMEMDATION FOR BEARING FITS SELECTION

Selecting the bearing fits

Bearing fits are selected on the basis of the following criteria:

a) firm location and uniform support of bearings;
b) simple mounting and dismounting;
c) axial displacement of non-locating bearing.

According to the operation conditions, between the inner ring and the shaft, between the outer ring and the housing, respectively clearance fits, intermediate fits or interference fits may be performed. When selecting the fit, one has to consider the difference of temperature which may occur between ring and shaft or between ring and housing. The tolerance classes are available for bearing fits which do not exceed +120°C during operation.
A high tightening is recommended for roller bearings and large size bearings in comparison to ball bearings of the same size. In case of a tight fit, the inner ring is supported by the entire shaft contact surface, thus bearing is used at full load carrying capacity. When selecting a fit, the load of the rotating ring has to be considered to avoid the excessive clearances or tightening. The excessive tightening will not eliminate only the radial mounting clearance of the bearing itself, but can even cause the damage of the ring in the mounting process (because of the tensions stress that are resulting from the ring).

Special fits for some types of bearings
In only a few special cases will special fits be required, for example in bearings of main shafts of grinding machines, high precision lathes and for bearings of high rotation speed where it is necessary to limit the centrifugal forces resulting from the rotation of the non-balanced elements. The shaft and housing construction must be rigid and their accuracy must be at the level of bearing precision. Since in the mounting process the bearing rings conform to the shape of the mating part, it is useless use high precision bearings mounted on the shafts and housings of poor quality.

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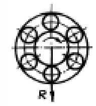
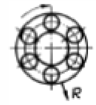
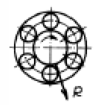
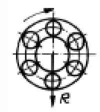
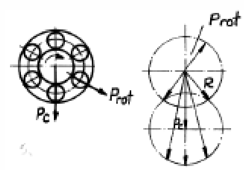
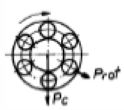
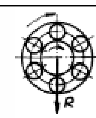
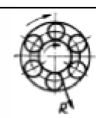
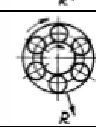
Loading determination chart

Table 3.1

Operating conditions				Ring	
Ring inner	Ring outer	Load	Draft	inner Load	outer Load
It rotates	It doesn't rotate	The resultant load has a constant direction		Rotating	Stationary
It doesn't rotate	It rotates	The resultant load rotates with the outer ring			
It rotates	It doesn't rotate	The resultant load rotates at the same time with the inner ring		Rotating	Rotating
It doesn't rotate	It rotates	The resultant load has a constant direction			
It rotates	It doesn't rotate	P_{rot} load rotates toghether with the inner ring P_c load has a constant direction $P_{rot} < P_c$	  The resultant represented with heavy stroke corresponds to the position of P_{rot} load; other positions of resultant are indicated by dote-dash line.	Rotating	Rotating
It doesn't rotate	It rotates	P_{rot} load rotates toghether with the outer ring P_c load has a constant direction $P_{rot} < P_c$			
Both rings are rotating in the same or opposite directions with different rotation speed		The resultant has a constant direction		Rotating	Rotating
		The resultant load rotates toghether with the inner ring		Stationary	Rotating
		The resultant load rotates toghether with the outer ring		Rotating	Stationary

Housing fit recommendations

Operating conditions	Examples	Tolerance class symbol	Remarks
RADIAL BEARINGS			
SOLID HOUSING			
Rotating outer ring load			
Heavy loads on bearings in twinwalled housings, heavy shock loads (P>0,12C)	Roller bearing wheel hubs, connecting rod bearing	P7	Outer ring cannot be displaced
Normal and heavy loads (P>0,06C)	Ball bearing wheel hubs, connecting rod bearings, crane traveling wheels	N7	
Light and variable loads (P≤0,06C)	Conveyer rollers, rope sheaves, belt tension pulleys	M7	
Direction of load indeterminate			
Heavy shock loads	Traction motors	M7	Outer ring cannot be displaced
Normal and heavy loads (P>0,06C). Outer ring displacement is not necessary	Electric motors, pumps, crankshafts main bearings	K7	
SPLIT OR SOLID HOUSINGS			
Direction of load indeterminate			
Light and normal loads. Desirable outer ring displacement. (P≤0,12C)	Medium sized electric motors, pumps, crankshafts main bearings	J7	Outer ring can be displaced
Stationary outer ring load			
Any type of loads	General mechanical railway axleboxes	H7	Outer ring can be easily displaced
Light and normal loads with simple conditions (P≤0,12C)	Gearing	H8	
Heat conduction thrugh shaft	Drying cylinders, large electric machines with spherical roller bearings	G7	
SPLIT HOUSINGS			
High accuracy rotation, quiet running			
High shiftness at variable loads	Main shafts for machine tools D≤125 with roller bearings D>125	M6 N6	Outer ring cannot be displaced
Light loads, indeterminate direction load	Shaft operating surface for grinding machines with ball bearings, free bearings for high speed superchargers	K6	Outer ring cannot be displaced
Desirable outer ring displacement	Shaft operating surface for grinding machines with ball bearings, free bearings for high speed superchargers	J6	Outer ring can be displaced
Quiet running	Small-sized electrical machines	H6	Outer ring can be easily displaced

Shaft fit recomendations

Operating conditions	Examples	Shaft diameter [mm]			
		Ball bearings	Cylindrical needle and tapered roller bearings	Spherical roller bearings	Tolerance class symbol
Radial bearings with cylindrical bore					
Stationary load on the inner ring					
Easy axial displacement of inner ring on shaft desirable	Wheels on non-rotating shafts (free wheels)	All diameters			g6 (f6)
Axial displacement of inner ring on shaft not necessary	Tension pullyes, sheaves				h6
Rotating inner ring load					
Light and variable loads (P<0,06C)	Conveyers, lightly loaded mechanisms bearings	18÷100 >100÷140	≤40 >40÷100		j6 k6
Normal and heavy loads (P>0,06C)	General mechanical engineering electric motors, turbines, pumps, gearboxes, woodworking machines	≤18 > 18÷100 >100÷140 >140÷200 >200÷280 - - -	- ≤40 >40÷100 >100÷140 >140÷200 >200÷400 - -	- ≤40 >40÷65 >65÷100 >100÷140 >140÷280 >280÷500 >500	j5 k5(k6) m5(m6) m6 n6 p6 r6 r7
Heavy loads and shock loads, ardous working conditions (P>0,12C)	Heavy duty railway vehicles axle bearings, traction motors, rolling mills	- - -	>50÷140 >140÷200 >200	>50÷100 >100÷200 >200	n6 p6 r6
High running accuracy, light loads (P<0,06C)	Machine tools	≤18 > 18÷100 >100÷200 -	- ≤40 >40÷140 >140÷200	- - - -	h5 j5 k5 m5
Axial loads					
	All kind of bearing application	≤250 >250	≤250 >250	<250 >250	j6 js6
Tapered bore bearings with withdrawal or adapter sleeve					
	Axle shaft for railway vehicles	All diameters			h9
	General mechanical engineering				h10

Shaft and housing surface finish recommendations

Recommended shaft and housing surfaces roughness are given in table 2. If bearings are mounted with adapter or withdrawal sleeves, shaft surface roughness should be of maximum Ra = 1,6 µm.

The roughness of the mounting surfaces of the shaft and housing — *Table 2*

Bearings. Tolerance class	Shaft. Diameter d, mm			Housing. Diameter D,mm		
	≤ 80	>80...500	> 500	≤ 80	> 80... 500	> 500
	Roughness R_a [µm].					
P0, P6X and P6	0,8 (N6)	1,6 (N7)	3,2 (N8)	0,8 (N6)	1,6 (N7)	3,2 (N8)
P5, SP and P4	0,4 (N5)	0,8 (N6)	1,6 (N7)	0,8 (N6)	1,6 (N7)	1,6 (N7)
P2 and UP	0,2 (N4)	0,4 (N5)	0,8 (N6)	0,4 (N5)	0,8 (N6)	0,8 (N6)

Bearing axial location

The axial location of bearings can be accomplished by a number of solutions, depending on the bearing type and magnitude of load. The most common design uses a keeper plate on the outer ring, and a locknut on the inner ring. In cases where no axial load is transmitted through a bearing, interference fit only can be used. Sometimes intermediate rings are required between the bearing and the locknut. Often a lock washer will be used between the bearing ring and the lock nut. The lock washer will have a tenon that engages in a groove in the shaft to eliminate the transmission of the friction forces to the nut thus eliminating the danger of loosening the lock nut.

Another axial location method uses a tapered sleeve. This system is possible only for tapered bore roller bearings and has the following advantages:

- - heavy axial loads could be taken over in both directions;
- - it is not necessary a high manufacturing precision for the shaft;
- - ensures an easy mounting and dismounting.

However, it may be necessary to axially retain the sleeve on the shaft for heavy axial loads.