

Interference

For rolling bearings, inner and outer rings are fixed on the shaft or in the housing so that relative movement does not occur between fitting surfaces during operation or under load. This relative movement between the fitting surfaces of the bearing and the shaft or housing can occur in a radial direction, an axial direction, or in the direction of rotation. Types of fitting include tight, transition and loose fitting, which may be selected depending on whether or not there is interference.

The most effective way to fix the fitting surfaces between a bearing’s raceway and shaft or housing is to apply a “tight fit.” The advantage of this tight fit for thin walled bearings is that it provides uniform load support over the entire ring circumference without any loss of load carrying capacity. However, with a tight fit, ease of installation and disassembly is lost; and when using a non-separable bearing as the floating-side bearing, axial displacement is not possible. For this reason, a tight fit cannot be recommended in all cases.

The necessity of a proper fit

In some cases, improper fit may lead to damage and shorten bearing life, therefore it is necessary to make a careful investigation in selecting a proper fit. Some of the bearing failure caused by improper fit are listed below.

- Raceway cracking, early flaking and displacement of raceway
- Raceway and shaft or housing abrasion caused by creeping and fretting corrosion
- Seizing caused by negative internal clearances
- Increased noise and deteriorated rotational accuracy due to raceway groove deformation

Fit selection

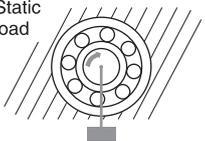
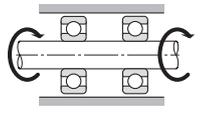
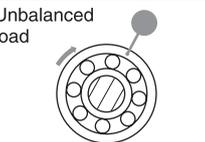
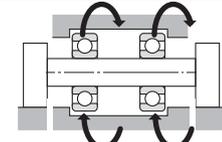
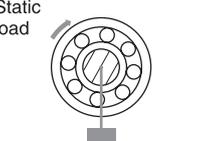
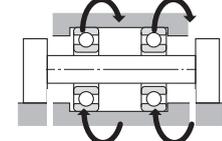
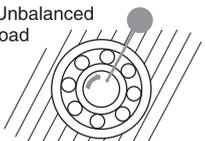
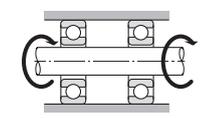
Selection of a proper fit is dependent upon thorough analysis of bearing operating conditions, including consideration of:

- Shaft and housing material, wall thickness, finished surface accuracy, etc.
- Machinery operating conditions (nature and magnitude of load, rotational speed, temperature, etc.)

“Tight fit” or “Loose fit”

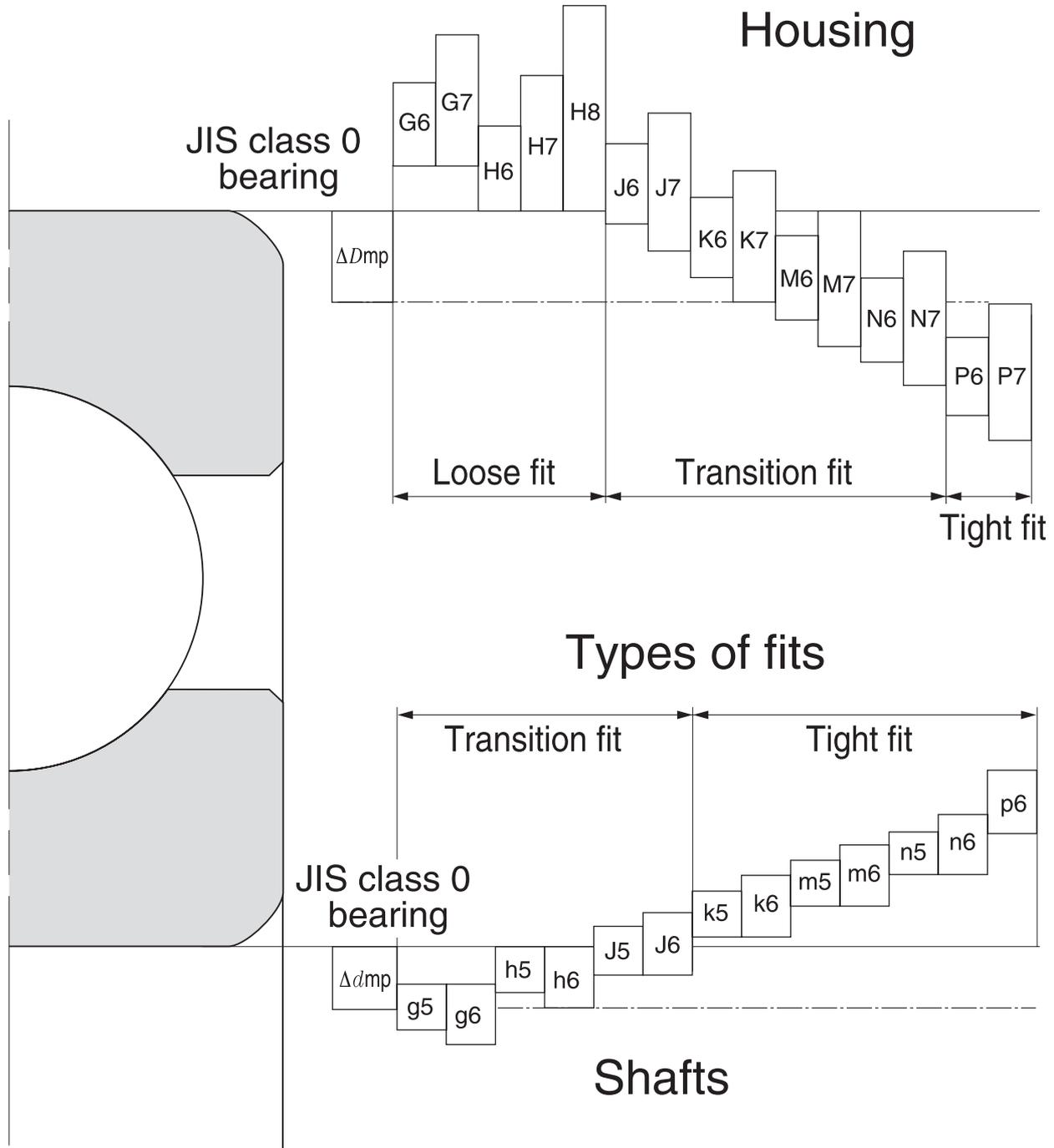
- (1) For raceways under rotating loads, a tight fit is necessary. “Raceways under rotating loads” refers to raceways receiving loads rotating relative to their radial direction. For raceways under static loads, on the other hand, a loose fit is sufficient.
- (2) For non-separable bearings, such as deep groove ball bearings, it is generally recommended that either the inner ring or outer ring be given a loose fit.

Radial load and bearing fit

Illustration	Bearing rotation	Ring load	Fit
 <p>Static load</p>	 <p>Inner ring: Rotating Outer ring: Stationary</p>	Rotating inner ring load	Inner ring : Tight fit
 <p>Unbalanced load</p>	 <p>Inner ring: Stationary Outer ring: Rotating</p>	Static outer ring load	Outer ring : Loose fit
 <p>Static load</p>	 <p>Inner ring: Stationary Outer ring: Rotating</p>	Static inner ring load	Inner ring : Loose fit
 <p>Unbalanced load</p>	 <p>Inner ring: Rotating Outer ring: Stationary</p>	Rotating outer ring load	Outer ring : Tight fit

Recommended Fits

Bearing fit is governed by the selection tolerances for bearing shaft diameters and housing bore diameters. Widely used fits for 0 Class tolerance bearings and various shaft and housing bore diameter tolerances are shown below.



Interference minimum and maximum values

The following points should be considered when it is necessary to calculate the interference for an application:

- In calculating the minimum required amount of interference keep in mind that:
 - 1) interference is reduced by radial loads
 - 2) interference is reduced by differences between bearing temperature and ambient temperature
 - 3) interference is reduced by variation of fitting surfaces
- The upper limit value should not exceed 1/1000 of the shaft diameter.

General standards for radial bearing fits (JIS Class 0, 6X, 6)

Tolerance class of shafts commonly used for radial bearings (classes 0, 6X and 6)

Conditions	Ball bearings		Cylindrical roller bearing Tapered roller bearing		Spherical roller bearing		Shaft tolerance class	Remarks	
	Shaft diameter (mm)								
	Over	Under	Over	Under	Over	Under			
Cylindrical bore bearing (Classes 0, 6X and 6)									
Inner ring rotational load or load of undetermined direction	Light load or fluctuating load	— 18 100	18 100 200	— 40 140	— 40 200	— — —	— — —	h5 js6 k6 m6	When greater accuracy is required js5, k5, and m5 may be substituted for js6, k6, and m6.
	Ordinary load	— 18 100 140 200	18 100 140 200 280	— 40 100 140 200	— 40 100 140 200 400	— — 40 65 100 140 280	— 40 65 100 140 280 500	js5 k5 m5 m6 n6 p6 r6	Alteration of inner clearances to accommodate fit is not a consideration with single-row angular contact bearings and tapered roller bearings. Therefore, k5 and m5 may be substituted for k6 and m6.
	Heavy load or impact load	— — —	— — —	50 140 200	140 200 —	50 100 140	100 140 200	n6 p6 r6	Use bearings with larger internal clearances than CN clearance bearings.
Inner ring static load	Inner ring must move easily over shaft	Overall shaft diameter						g6	When greater accuracy is required use g5. For large bearings, f6 will suffice for to facilitate movement.
	Inner does not have to move easily over shaft	Overall shaft diameter						h6	When greater accuracy is required use h5.
Center axial load	Overall shaft diameter						js6	Generally, shaft and inner rings are not fixed using interference.	
Tapered bore bearing (class 0) (with adapter or withdrawal sleeve)									
Overall load	Overall shaft diameter						h9/IT5	h10/IT7 will suffice for power transmitting shafts.	

Tolerance class of housing bore commonly used for radial bearings (classes 0, 6X and 6)

Housing	Conditions		Toleration class of housing bore	Remarks	
	Types of load	Outer ring axial direction movement			
Single housing or divided housing	Outer ring static load	All types of loads	Able to move.	H7	G7 will suffice for large bearings or bearings with large temperature differential between the outer ring and housing.
		Light load or ordinary load	Able to move.	H8	—
		Shaft and inner ring become hot.	Able to move easily.	G7	F7 will suffice for large bearings or bearings with large temperature differential between the outer ring and housing.
Single housing	Indeterminate load	Requires precision rotation with light or ordinary loads.	As a rule, cannot move.	K6	Primarily applies to roller bearings.
			Able to move.	JS6	Primarily applies to ball bearings.
		Requires quiet operation.	Able to move.	H6	—
	Outer ring rotational load	Light or ordinary load	Able to move.	JS7	If precision is required, JS6 and K6 are used in place of JS7 and K7.
		Ordinary load or heavy load	As a rule, cannot move.	K7	
		Large impact load	Cannot move.	M7	—
	Outer ring rotational load	Light or fluctuating load	Cannot move.	M7	—
Ordinary or heavy load		Cannot move.	N7	Primarily applies to ball bearings.	
Heavy load or large impact load with thin housing		Cannot move.	P7	Primarily applies to roller bearings.	

Standard fits for thrust bearings (JIS Class 0 and 6)

Shaft fits

Bearing type	Load conditions	Fit	Shaft diameter mm over incl.	Tolerance class
All thrust bearings	Centered axial load only	Transition fit	All sizes	js6 or h6
Spherical roller thrust bearings	Combined load	Inner ring static load	All sizes	js6
		Inner ring rotating load or Indeterminate load	— ~ 200	k6 or js6
			200 ~ 400	m6 or k6
		Tight fit	400 ~	n6 or m6

Housing fits

Bearing type	Load conditions	Fit	Tolerance class	Remarks
All thrust bearings	Centered axial load only	Loose fit	Select a tolerance class that will provide clearance between outer ring and housing.	
			H8	Greater accuracy required with thrust ball bearings
Spherical roller thrust bearings	Combined load	Outer ring static load	H7	—
			Indeterminate load or outer ring rotating load	Transition fit
		M7		For relatively large radial loads

Note: All values and fits listed in the above tables are for cast iron or steel housings.

Fits for electric motor bearings

Bearing type	Shaft fits		Housing fits	
	Shaft diameter mm over incl.	Tolerance class	Housing bore diameter	Tolerance class
Deep groove ball bearings	~ 18	j5	All sizes	H6 or J6
	18 ~ 100	k5		
	100 ~ 160	m5		
Cylindrical roller bearings	~ 40	k5	All sizes	H6 or J6
	40 ~ 160	m5		
	160 ~ 200	n6		

Fitting against shaft - class 0

Nominal bore diameter of bearing		Mean bore diameter deviation		g5		g6		h5		h6		j5		js5		j6		
				bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	
d		Δd_{imp}																
over	incl.	high	low															
3	6	0	-8	4T~ 9L		4T~12L		8T~ 5L		8T~ 8L		11T~ 2L		10.5T~ 2.5L		14T~ 2L		
6	10	0	-8	3T~11L		3T~14L		8T~ 6L		8T~ 9L		12T~ 2L		11T ~ 3L		15T~ 2L		
10	18	0	-8	2T~14L		2T~17L		8T~ 8L		8T~11L		13T~ 3L		12T ~ 4L		16T~ 3L		
18	30	0	-10	3T~16L		3T~20L		10T~ 9L		10T~13L		15T~ 4L		14.5T~ 4.5L		19T~ 4L		
30	50	0	-12	3T~20L		3T~25L		12T~ 11L		12T~16L		18T~ 5L		17.5T~ 5.5L		23T~ 5L		
50	80	0	-15	5T~23L		5T~29L		15T~ 13L		15T~19L		21T~ 7L		21.5T~ 6.5L		27T~ 7L		
80	120	0	-20	8T~27L		8T~34L		20T~ 15L		20T~22L		26T~ 9L		27.5T~ 7.5L		33T~ 9L		
120	140	0	-25	11T~32L		11T~39L		25T~ 18L		25T~25L		32T~11L		34T ~ 9L		39T~11L		
140	160																	
160	180																	
180	200	0	-30	15T~35L		15T~44L		30T~20L		30T~29L		37T~13L		40T ~10L		46T~13L		
200	225																	
225	250																	
250	280	0	-35	18T~40L		18T~49L		35T~23L		35T~32L		42T~16L		46.5T~11.5L		51T~16L		
280	315																	
315	355	0	-40	22T~43L		22T~54L		40T~25L		40T~36L		47T~18L		52.5T~12.5L		58T~18L		
355	400																	
400	450	0	-45	25T~47L		25T~60L		45T~27L		45T~40L		52T~20L		58.5T~13.5L		65T~20L		
450	500																	

Fitting against housing - class 0

Nominal outside diameter of bearing		Mean outside diameter deviation		G7		H6		H7		J6		J7		Js7		K6	
				housing	bearing	housing	bearing	housing	bearing	housing	bearing	housing	bearing	housing	bearing	housing	bearing
D		ΔD_{mp}															
over	incl.	high	low														
6	10	0	-8	5L~ 28L		0~ 17L		0~ 23L		4T~13L		7T~16L		7.5T~15.5L		7T~10L	
10	18	0	-8	6L~ 32L		0~ 19L		0~ 26L		5T~14L		8T~18L		9T ~17L		9T~10L	
18	30	0	-9	7L~ 37L		0~ 22L		0~ 30L		5T~17L		9T~21L		10.5T~19.5L		11T~11L	
30	50	0	-11	9L~ 45L		0~ 27L		0~ 36L		6T~21L		11T~25L		12.5T~23.5L		13T~14L	
50	80	0	-13	10L~ 53L		0~ 32L		0~ 43L		6T~26L		12T~31L		15T ~28L		15T~17L	
80	120	0	-15	12L~ 62L		0~ 37L		0~ 50L		6T~31L		13T~37L		17.5T~32.5L		18T~19L	
120	150	0	-18	14L~ 72L		0~ 43L		0~ 58L		7T~36L		14T~44L		20T ~38L		21T~22L	
150	180	0	-25	14L~ 79L		0~ 50L		0~ 65L		7T~43L		14T~51L		20T ~45L		21T~29L	
180	250	0	-30	15L~ 91L		0~ 59L		0~ 76L		7T~52L		16T~60L		23T ~53L		24T~35L	
250	315	0	-35	17L~104L		0~ 67L		0~ 87L		7T~60L		16T~71L		26T ~61L		27T~40L	
315	400	0	-40	18L~115L		0~ 76L		0~ 97L		7T~69L		18T~79L		28.5T~68.5L		29T~47L	
400	500	0	-45	20L~128L		0~ 85L		0~108L		7T~78L		20T~88L		31.5T~76.5L		32T~53L	

Bearings Fits



Unit μm

js6		k5		k6		m5		m6		n6		p6		r6		Nominal bore diameter of bearing <i>d</i> mm over incl.
bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	
12T ~ 4L		14T~1T		17T~1T		17T~ 4T		20T~ 4T		24T~ 8T		28T~12T	—	—	3	6
12.5T~ 4.5L		15T~1T		18T~1T		20T~ 6T		23T~ 6T		27T~10T		32T~15T	—	—	6	10
13.5T~ 5.5L		17T~1T		20T~1T		23T~ 7T		26T~ 7T		31T~12T		37T~18T	—	—	10	18
16.5T~ 6.5L		21T~2T		25T~2T		27T~ 8T		31T~ 8T		38T~15T		45T~22T	—	—	18	30
20T ~ 8L		25T~2T		30T~2T		32T~ 9T		37T~ 9T		45T~17T		54T~26T	—	—	30	50
24.5T~ 9.5L		30T~2T		36T~2T		39T~11T		45T~11T		54T~20T		66T~32T	—	—	50	80
31T ~11L		38T~3T		45T~2T		48T~13T		55T~13T		65T~23T		79T~37T	—	—	80	120
37.5T~12.5L		46T~3T		53T~3T		58T~15T		65T~15T		77T~27T		93T~43T	113T~ 63T	120	140	
													115T~ 65T	140	160	
													118T~ 68T	160	180	
44.5T~14.5L		54T~4T		63T~4T		67T~17T		76T~17T		90T~31T		109T~50T	136T~ 77T	180	200	
													139T~ 80T	200	225	
													143T~ 84T	225	250	
51T ~16L		62T~4T		71T~4T		78T~20T		87T~20T		101T~34T		123T~56T	161T~ 94T	250	280	
													165T~ 98T	280	315	
58T ~18L		69T~4T		80T~4T		86T~21T		97T~21T		113T~37T		138T~62T	184T~108T	315	355	
													190T~114T	355	400	
65T ~20L		77T~5T		90T~4T		95T~23T		108T~23T		125T~40T		153T~68T	211T~126T	400	450	
													217T~132T	450	500	

Unit μm

K7		M7		N7		P7		Nominal outside diameter of bearing <i>D</i> mm over incl.	
housing	bearing	housing	bearing	housing	bearing	housing	bearing		
10T~13L		15T~ 8L		19T~ 4L		24T~ 1T		6	10
12T~14L		18T~ 8L		23T~ 3L		29T~ 3T		10	18
15T~15L		21T~ 9L		28T~ 2L		35T~ 5T		18	30
18T~18L		25T~11L		33T~ 3L		42T~ 6T		30	50
21T~22L		30T~13L		39T~ 4L		51T~ 8T		50	80
25T~25L		35T~15L		45T~ 5L		59T~ 9T		80	120
28T~30L		40T~18L		52T~ 6L		68T~10T		120	150
28T~37L		40T~25L		52T~13L		68T~ 3T		150	180
33T~43L		46T~30L		60T~16L		79T~ 3T		180	250
36T~51L		52T~35L		66T~21L		88T~ 1T		250	315
40T~57L		57T~40L		73T~24L		98T~ 1T		315	400
45T~63L		63T~45L		80T~28L		108T~ 0		400	500