CELEBRATING 75 YEARS

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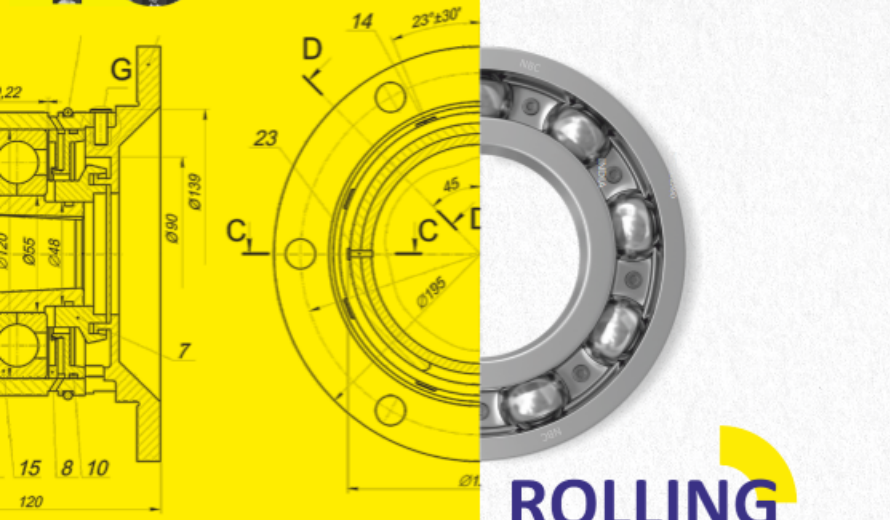

ROLLING BEARINGS

Fits

2 WHEELERS | 3 WHEELERS | 4 WHEELERS | TRACTORS | LCV, HCV | INDUSTRIES | RAILWAYS

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About National Engineering Industries Ltd. (NBC Bearings)

A symbol of dependability and flexible engineering solutions, NBC Bearings is the brand of National Engineering Industries. Founded in 1946, National Engineering Industries Ltd (NEI) is India's leading bearings manufacturer and exporter, renowned for excellence in quality and delivery. In 2021, NBC bearings completed 75 years of its incorporation.

Headquartered in Jaipur, Having started with 30,000 bearings in 19 sizes in 1946, NBC has evolved to manufacture over 200 million bearings each year offering in 2300+ variants to serve a host of customers in India and over 30 other countries across five continents in automotive, railways and industrial segments. NBC also serves the Indian aftermarket through a countrywide network of 550+ authorized stockists and thousands of retailers.

Award & Recognitions :

NBC has been the recipient of several award and accolades for its quality consciousness and manufacturing prowess. Most prominent being the coveted Deming Grand Prize which is the highest honour in quality awarded to a company for excellence in Total Quality Management (TQM). NBC bearings is the only bearing manufacturer to win both - The Deming Application Award and The Deming Grand Prize Award.

The award is given by the Japanese Union of Scientists and Engineers (JUSE) to companies for demonstrating practicing TQM in the areas of production, customer service, safety, human resource, corporate social responsibility, environment, etc. NBC stands committed to an endless journey of continuous improvement through TQM.

Fits

10.1 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 analysis while selecting a proper fit.

Some of the negative conditions caused by improper fit are listed below:

- Raceway cracking, early pitting and displacement of raceways
- Raceway & shaft or housing abrasion caused by creeping in fretting corrosion
- Seizing caused by loss of internal clearance
- Increased noise & lowered rotational accuracy due to raceway groove deformation.

Selection of fits : Selection of proper fit depended upon thorough analysis of bearing operating conditions, including consideration of following factors:

(1) Condition of Rotation

This condition refer to the rotation of bearing ring being considered in relation to the direction of load. There are 3 different conditions:

- Rotating load
- Stationery load
- Direction of load indeterminate

(2) Magnitude of the load

The interference fit of a bearing's inner ring on its seating will be loosened with the increasing load, as the ring will expand under the influence of rotating load, & ring may begin co creep. If it is of shock character, greater interference is required.

The loss of interference due to increasing load can be estimated using the following equation:

When Fr ≤: 0.3Cor

$$\Delta dp = 0.08 \sqrt{\frac{d.Fr}{B}}$$

When Fr ≥ 0.3 Cor

Δdp=0.02 (Fr/B)

where,

Δdp = Interference decrease of inner ring (μm)

Fr = Radial load (N)

B = Inner ring width (mm)

Cor= Basic static load (N)

(3) Bearing Internal Clearance

An interference fit of a bearing on the shaft or in housing means that ring is elastically deformed (expanded or compressed) and bearing's internal clearance reduced.

The internal clearance and permissible reduction depend on the type and size of the bearing.

- The reduction in clearance due to interference fit can be so large that bearings with an internal clearance which is greater than normal have to be used.
- The expansion of the inner ring and contraction of outer ring can be assumed to be approximately 60-80% of the interference, depending on the material of shaft and housing.

(4) Temperature Condition

Interference between inner ring & steel shalt is reduced as a result of temperature increase (difference between bearing temperature and ambient temperature). This can result in an easing of fit of the inner ring on its seating. While outer ring expansion may result in increase in clearance.

The decrease of the interference of the inner ring due to this temperature difference may be calculated using following equation: Δdt=0.0015 x d x Δ T

Where Δdt= effective interference for temperature difference (μm)

ΔT=Temperature difference between bearing temperature ambient temperature (deg. C).

d =Bearing bore diameter (mm)

(5) Running Accuracy Requirement

To reduce resilience and vibration, clearance fit should generally not be used for bearings, where high demands are placed on running accuracy.

(6) Design& Material of Shaft & Housing

The fit of a bearing ring on its seating must not lead to uneven distortion of the ring (out of roundness).This can be caused by discontinuity in the housing surface. Split housings are therefore not suitable where outer rings are to have an interference fit.

(7) Ease of Mounting &Dismounting

Bearings with clearance fit are usually easier to mount or dismount than those having interference fit. Where operating condition necessitate interference fit and it is essential that mounting &dismounting can be done easily, separable bearings or bearings with taper bore and adaptor or withdrawal sleeve may be used.

(8) Displacement of Non-Locating bearings

If non-separable bearings are used as floating bearings, if the ring is under stationary load, so that axial displacement has to take place in the housing bore, a hardened intermediate bushing is often fitted to the outer ring.

(9) Effective Interference and finish of shaft &housing

Roughness of the fitted surface is reduced since the roughness of the fitted surface is reduced during fitting, the effective interference becomes less than the apparent interference.

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The amount of this interference decrease varies depending on roughness of the surfaces.

Normally, manufacturers assume the following interference reductions:

For ground shaft: 1-2.5 Micron

Machined Shaft: 5-7 Micron

(10) Fitting stress & ring expansion and contraction

While calculating the minimum required amount of interference, following factors should be factors should be taken into consideration:

- Interference is reduced by radial load
- Interference is reduced by difference between bearing temperature and ambient temperature
- Interference is reduced by variation of fitted surfaces

Important details on fits: Maximum interference should not exceed the ratio of 1:1000 of shaft or outside diameter.

Tight interference fits are recommended for:

(a) Operating conditions with large vibrations or shock loads

(b) Application using hollow shaft of housing with thin walls

(c) Application using housing made of light alloys or plastic.

Loose interferences are recommended for:

(a) Application requiring high running accuracy

(b) Application using small size bearings or thin walled bearings.

Shaft and housing material, geometry, hardness and surface finish must be carefully controlled.

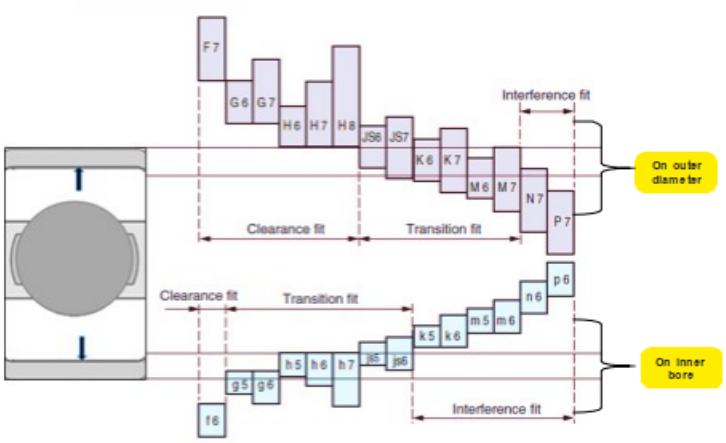
- Ground shafts should be finished to 1.3 micron Ra or better;
- For turned shafts a finish of 2.5 micron Ra or better; and
- Housing bores should be finished to 4 micron Ra or better.

To avoid shearing of aluminum and magnesium housing during bearing installation, steel inserts should be used; alternatively special lubricants may be used for Freezing and heating to facilitate assembly. A minimum interference fit of 0.0015" and 0.001" per inch of diameter is required for magnesium and aluminum housing respectively.

Where bearings are to be pressed onto a hollow shaft, allowance must be made for contraction of the hollow shaft in order to maintain the desired radial pressure.

10.2 Housing & Shaft Tolerance Class

NEI engineering department should be consulted for proper fitting practices on all special applications. For normal class bearing shaft and housing tolerances are given in table below. The tolerances are for solid steel shaft & housing of cast iron and steel.



Shaft & Housing tolerances

Shaft tolerance class generally for radial bearings (classes 0, 6X and 6)

Type of load	Condition	Example	Shaft diameters			
			Ball bearings	Cylindrical, needle and tapered roller bearings	Spherical roller bearings	Tolerance class symbol
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, pups, gearboxes,	≤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, arduous 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 runningaccuracy, light loads (P<0,06C)	Machine tools	≤ 18 > 18...100 > 100...200 -	- ≤ 40 > 40...100 > 140...200	- - - -	h5 j5 k5 m5
Stationary inner ring load	Radial bearings with cylindrical core		All diameters			
	Easy axial displacement of inner ring on shaft desirable	Wheels on non-roating shafts (free wheels)				g6(f6)
	Axial displacement of inner ring on shaft not necessary	Tension pullys, sheaves				h6
Axial load	Common to all shaft diameter. Shaft & inner is not fixed		≤250 >250	≤250 >250	<250 >250	j6 js6

Fits for shaft for Tapered bore bearing (normal class) with adapter / withdrawal sleeve

All loads	For all sizes general applications	All shaft diameters	h9

Housing tolerance class generally for radial bearings (classes 0, 6X and 6)

Split or Single (Housing rotating outer ring load)

Load type	Conditions	Example	Tolerance class	Outer ring axial displacement in non - separable bearing
Rotating outer ring load	Light and variable loads (P≤0,06C)	Roller bearing wheel hubs, connecting rod bearing	M7	Outer ring cannot move axially
	Normal and heavy loads (P>0,06C)	Ball bearing wheel hubs, connecting rod bearings, crane travelling wheels	N7	
	Rotating outer ring load Heavy loads on bearings in thin walled housings, heavy shock loads (P>0,12C)	Conveyer rollers, rope sheaves, belt tension pulleys	P7	
Direction of load indeterminate	Normal and heavy loads (P > 0,06C). Outer ring displacement is not necessary	Crank shaft main bearing	K7	Outer ring cannot move axially
		Electric motors, pumps crankshaft main bearing		
	Heavy shock loads	Traction motors	M7	

Split or Single Housing (Stationary outer load)

Load type	Conditions	Example	Tolerance class	Outer ring axial displacement in non- separable bearing
Stationary outer load	Loads of all kinds	General mechanical engineering, railway axle boxes	H7	Outer ring can move axially
	Light and normal loads Desirable outer ring displacement (Ps0,12 C)		H8	Outer ring cannot move axially
	Quiet operation	Electric motor	H6	
	Heat conduction through shaft	Drying cylinders, large electrical machines with spherical roller bearings	G7	
Direction of load indeterminate	Light and normal loads Desirable outer ring displacement (Ps0,12 C)	medium-sized electric motors, pumps, crankshaft main bearings	J7	Outer ring can move axially

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Numeric value table of fitting for radial bearing of 'Normal class' for metric size

Table for fit on shaft

Unit µm

Nominal bore diameter of bearing d (mm)		Δdmp high		g_5	g_6	h_5	h_6	j_{S5}	j_{S6}
3	6	0	-8	4T - 9L	4T - 12L	8T - 5L	8T - 8L	11T - 2L	10.5T - 2.5L
6	10	0	-8	3T - 11L	3T - 14L	8T - 9L	8T - 9L	12T - 2L	11T - 3L
10	18	0	-8	2T - 14L	2T - 17L	8T - 8L	8T - 11L	13T - 3L	12T - 4L
18	30	0	-10	3T - 16L	3T - 20L	10T - 9L	10T - 13L	15T - 4L	14.5T - 4.5L
30	50	0	-12	3T - 20L	3T - 25L	12T - 11L	12T - 16L	18T - 5L	17.5T - 5.5L
50	80	0	-15	5T - 23L	5T - 29L	15T - 13L	15T - 19L	21 - 7L	21.5T - 6.5L
80	120	0	-20	8T - 27L	8T - 34L	20T - 15L	20T - 22L	26T - 9L	27.5T - 7.5L
120	140								
140	160	0	-25	11T - 32L	11T - 39L	25T - 18L	25T - 25L	32T - 11L	34T - 9L
160	180								
180	200								
200	225	0	-30	15T - 35L	15T - 44L	30T - 20L	30T - 29L	37T - 13L	40T - 10L
225	250								
250	280								
280	315	0	-35	18T - 40L	18T - 49L	35T - 23L	35T - 32L	42T - 16L	46.5T-11.5L
315	355								
355	400	0	-40	22T - 43L	22T - 54L	40T - 25L	40T - 36L	47T - 18L	52.5T - 12.5L
400	450								
450	500	0	-45	25T - 47L	25T - 60L	45T - 27L	45T - 40L	52T - 20L	58.5T-13.5L

Table for fit on Housing

Unit µm

Nominal outside diameter of bearing D (mm)		ΔDmp								
Over	Incl.	high	low							
6	10	0	- 8	5L - 28L	0 - 17L	0 - 23L	4T - 13L	7T - 16L	7.5 - 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 - 47L	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 - 104	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

Numeric value table of fitting for radial bearing of 'Normal class' for metric size

Table for fit on shaft

Unit µm

Nominal bore diameter of bearing d (mm)		Δdmp		j_{S6}	k_5	k_6	m_5	m_6	n_6	p_6	r_6
3	6	0	-8	12T - 4L	14T - 1T	17T - 1T	17T - 4T	20T - 4T	24T - 8T	28T - 12T	-
6	10	0	-8	12.5T - 4.5L	15T - 1T	18T - 1T	20T - 6T	23T - 6T	27T - 10T	32T - 15T	-
10	18	0	-8	13.5T - 5.5L	17T - 1T	20T - 1T	23T - 7T	26T - 7T	31T - 12T	37T - 18T	-
18	30	0	-10	16.5T - 6.5L	21T - 2T	25T - 2T	27T - 8T	31T - 8T	38T - 15T	45T - 22T	-
30	50	0	-12	20T - 8L	25T - 2T	30T - 2T	32T - 9T	37T - 9T	45T - 17T	54T - 26T	-
50	80	0	-15	24.5T - 9.5L	30T - 2T	36T - 2T	39T - 11T	45T - 11T	54T - 20T	66T - 32T	-
80	120	0	-20	31T - 11L	38T - 3T	45T - 3T	48T - 13T	55T - 13T	65T - 23T	79T - 37T	-
120	140										
140	160	0	-25	37.5T-12.5L	46T - 3T	53T - 3T	58T - 15T	65T - 15T	77T - 27T	93T - 43T	113T - 63T
160	180										115T - 65T
180	200										118T - 68T
200	225	0	-30	44.5T-14.5L	54T - 4T	63T - 4T	67T - 17T	76T - 17T	90T - 31T	109T- 50T	136T - 77T
225	250										139T - 80T
250	280										143T - 84T
280	315	0	-35	51T - 16L	62T - 4T	71T - 4T	78T - 20T	87T - 20T	101T - 34T	123T - 56T	161T - 94T
315	355										165T - 98T
355	400	0	-40	58T - 18L	69T - 4T	80T - 4T	86T - 21T	97T - 21T	113T - 37T	138T - 62T	184T - 108T
400	450										190T - 114T
450	500	0	-45	65T - 20T	77T - 5T	90T - 4T	95T - 23T	108T- 23T	125T - 40T	153T - 68T	211T - 126T
											217T - 132T

Table for fit on Housing

Unit µm

Nominal outside diameter of bearing D (mm)		ΔDmp high	K_7	M_7	N_7	P_7
6	10	0 - 8	10T - 13L	15T - 8L	19T - 4L	24T - 1L
10	18	0 - 8	12T - 14L	18T - 8L	23T - 3L	29T - 3L
18	30	0 - 9	15T - 15L	21T - 9L	28T - 2L	35T - 5L
30	50	0 - 11	18T - 18L	25T - 11L	33T - 3L	42T - 6L
50	80	0 - 13	21T - 22L	30T - 13L	39T - 4L	52T - 8L
80	150	0 - 15	25T - 25L	35T - 15L	45T - 5L	59T - 9L
120	180	0 - 18	28T - 30L	40T - 18L	52T - 6L	68T - 10L
150	200	0 - 25	28T - 37L	40T - 25L	52T - 13L	68T - 3L
180	250	0 - 30	33T - 43L	46T - 30L	60T - 16L	79T - 3L
250	315	0 - 35	36T - 51L	52T - 35L	66T - 21L	88T - 1L
315	400	0 - 40	40T - 57L	57T - 40L	73T - 24L	98T - 1L
400	500	0 - 45	45T - 63L	63T - 45L	80T - 28L	108T - 0

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10.3 Taper roller bearing -AFBMA recommended fitting practice

AFBMA limits & fitting guidelines

Shaft and housing material, geometry, hardness and surface finish must be carefully controlled. Ground shafts should be finished to 1.3 micron Ra or better; for turned shafts a finish of 2.5µm Ra or better; and housing bores should be finished to 4 micron Ra or better.

To avoid shearing aluminum and magnesium housing during bearing installation, steel inserts should be used; alternatively special lubricants may be used for freezing and heating to facilitate assembly. A minimum interference fit is required for aluminum of 0.0010" per inch of diameter, for magnesium of 0.0015" per inch of diameter.

Where bearings are to be pressed onto a hollow shaft, allowance must be considered for contraction of the hollow shaft in order to maintain the desired radial pressure.

The NEI applications engineer should be consulted for proper fitting practice on all special applications. .

AFBMA Automotive Tapered Cone Fitting Practice.

Use	Application	Fit Type	Cone Bore B*	Shaft Diameter B*	Fit	Cone Bore B*	Shaft Diameter B*	Fit
Automotive Rotating Shafts	Pinion, transmission rear wheels, crossshaft, transfer case	Adjustable cones	+0.0005 -0.0000	+0.0005 +0.0000	0.0005T 0.0005L	+0.0010 -0.0000	+0.0015 +0.0005	0.0015T 0.0005L
		Non-Adjustable cones	+0.0005 -0.0000	+0.0015 -0.0010	0.0015T 0.0005T	+0.0010 -0.0000	+0.0025 +0.0015	0.0025T 0.0005T
	Differential	Non-Adjustable cones	+0.0005 -0.0000	+0.0025 +0.0015	0.0025T 0.0010T	+0.0010 -0.0000	+0.0035 +0.0025	0.0035T 0.0015T
Automotive Stationary Shafts	Front wheels, full floating rear wheels trailer wheels	Adjustable cones	+0.0005 -0.0000	-0.0002 -0.0007	0.0002L 0.0012L	+0.0010 -0.0000	-0.0002 -0.0012	0.0002L 0.0022L

AFBMA Automotive Tapered Cup Fitting Practice.

Use	Application	Fit Type	Cup O.D. D*	Housing Bore D*	Fit	Cup O.D. D*	Housing Bore D*	Fit	Cup O.D. D*	Housing Bore D*	Fit
			Less 3" O.D.			3" to 5"O.D.			Above 5" O.D.		
Auto-motive	Front wheels, full floating rear wheels, pinion, differential	Non-Adjustable cups	+0.0010 -0.0000	-0.0015 -0.0005	0.0025T 0.0005T	+0.0010 -0.0000	-0.0020 -0.0010	0.0030T 0.0010T	+0.0010 -0.0000	-0.0030 -0.0010	0.0040T 0.0010T
	Differential	Non-Adjustable cups	+0.0010 -0.0000	+0.0010 +0.0020	0.0000L 0.0020L	+0.0010 -0.0000	+0.0010 +0.0020	0.0000L 0.0020L	+0.0010 -0.0000	-0.0000 +0.0020	0.0010T 0.0020L
	Rear wheels, trans-mission, cross shaft & other application	Adjustable cups	+0.0010 -0.0000	-0.0000 +0.0010	0.0010T 0.0010L	-0.0010 -0.0000	+0.0000 +0.0010	0.0010T 0.0010L	-0.0010 -0.0000	-0.0000 +0.0020	0.0010T 0.0020L

*D - Normal cup O.D., L - Loose, T - Tight

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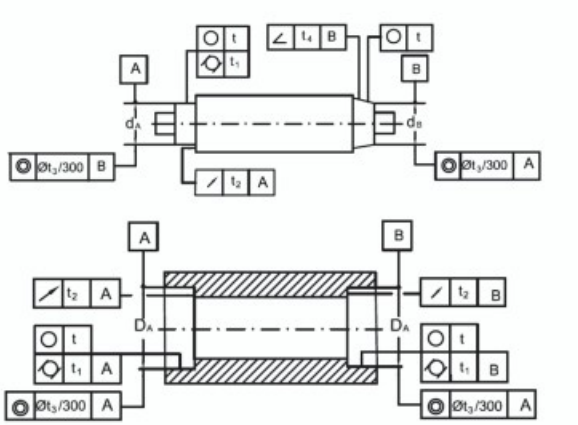
10.4 Shaft and housing accuracies



Tolerance name	Fit	Symbol of deviation		Permissible deviation depending on the tolerance class				
				P0 P6X	P6	P5	P4(SP)	P2(UP)
Tolerance of dimension	shaft	-	-	IT6 (IT5)	IT5	IT4	IT4	IT3
	housing			IT7 (IT6)	IT6	IT5	IT4	IT4
Tolerance of roundness and cylindricity	shaft		t,t[1]	IT4 (IT3 / 2)	IT3 (IT2 / 2)	IT2	IT1	IT0
	housing		t,t[1]	IT5 / 2 (IT4 / 2)	IT4 / 2 (IT2 / 2)	IT3 / 2	IT2 / 2	IT1 / 2
Tolerance of face runout	shaft		t[2]	IT4 (IT3)	IT3 (IT2)	IT2	IT1	IT0
	housing			IT5 (IT4)	IT4 (IT3)	IT2	IT2	IT1
Tolerance of concentricity	shaft		t[3]					
	housing							
Tolerance of angularity	shaft	<	t[4]	IT7 / 2	IT6 / 2	IT4 / 2	IT3 / 2	IT2 / 2

For IT grade values refer table for ISO tolerance grade.

Table: ISO Tolerance grade for dimensions

Nominal Dimension Over	incl.	Tolerance Grade IT 0	IT 1	IT 2	IT 3	IT 4	IT 5	IT 6	IT 7	IT 8	IT 9	IT 10	IT 11	IT 12
mm		µm												
1	3	0.5	0.8	1.2	2	3	4	6	10	14	25	40	60	100
3	6	0.6	1	1.5	2.5	4	5	8	12	18	30	48	75	120
6	10	0.6	1	1.5	2.5	4	6	9	15	22	36	58	90	150
10	18	0.8	1.2	2	3	5	8	11	18	27	43	70	110	180
18	30	1	1.5	2.5	4	6	9	13	21	33	52	84	130	210
30	50	1	1.5	2.5	4	7	11	16	25	39	62	100	160	250
50	80	1.2	2	3	5	8	13	19	30	46	74	120	190	300
80	120	1.5	2.5	4	6	10	15	22	35	54	87	140	220	350
120	180	2	3.5	5	8	12	18	25	40	63	100	160	250	400
180	250	3	4.5	7	10	14	20	29	46	72	115	185	290	460
250	315	4	6	8	12	16	23	32	52	81	130	210	320	520
315	400	5	7	9	13	18	25	36	57	89	140	230	360	570
400	500	6	8	10	15	20	27	40	63	97	155	250	400	630
500	630	-	-	-	-	-	28	44	70	110	175	280	440	700
630	800	-	-	-	-	-	35	50	80	125	200	320	500	800
800	1000	-	-	-	-	-	36	56	90	140	230	360	560	900
1000	1250	-	-	-	-	-	42	66	105	165	260	420	660	1050
1250	1600	-	-	-	-	-	50	78	125	195	310	500	780	1250
1600	2000	-	-	-	-	-	60	92	150	230	370	600	920	1500
2000	2500	-	-	-	-	-	70	110	175	280	440	700	1100	1750

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