Bearing Mounting and Fitting

Mounting & Fitting

After a bearing selection has been made, the product or system designer should pay careful attention to details of bearing mounting and fitting.

Bearing seats on shafts and housings must be accurately machined, and should match the bearing ring width to provide maximum seating surface.

Recommendations for geometry and surface finish of bearing seats and shoulders are shown in Table 3. Dimensional accuracy recommendations for shafts and housings can be found in Tables 1 and 2.

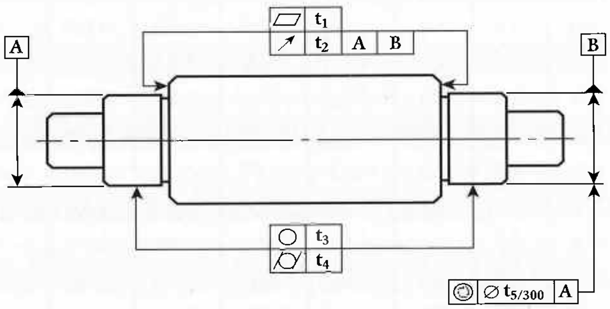

Table 1: Dimensional accuracy recommendations for shafts.

Characteristic	OUTSIDE DIAMETER OF SHAFT BEARING SEAT, mm							
	<6	6-10	11-18	19-30	31-50	51-80	81-120	121-180
⏥ Flatness, t_1	30	60	80	100	100	120	150	200
↗ Runout, t_2	40	100	120	150	150	200	250	300
○ Roundness, t_3	25	50	60	75	75	100	125	150
⌭ Taper, t_4	25	50	60	75	75	100	125	150
◎ Concentricity, t_5	40	100	120	150	150	200	250	300

Values in microinches.

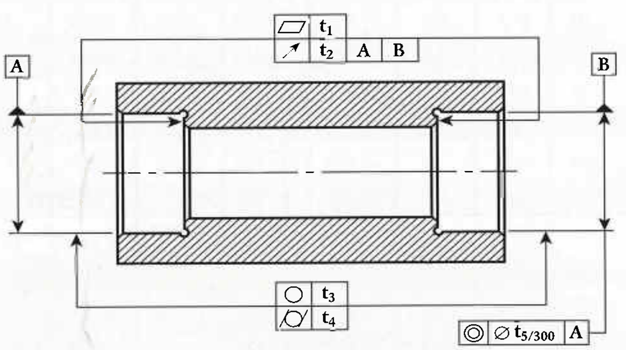

Table 2: Dimensional accuracy recommendations for housings.

Characteristic	BORE DIAMETER OF BEARING HOUSING, mm							
	<10	10-18	19-30	31-50	51-80	81-120	121-180	181-250
⏥ Flatness, t_1	65	80	100	100	120	150	200	300
↗ Runout, t_2	100	120	150	150	200	250	300	400
○ Roundness, t_3	60	75	100	125	150	150	200	250
⌭ Taper, t_4	50	60	75	75	100	125	150	200
◎ Concentricity, t_5	100	120	150	150	200	250	300	400

Values in microinches.

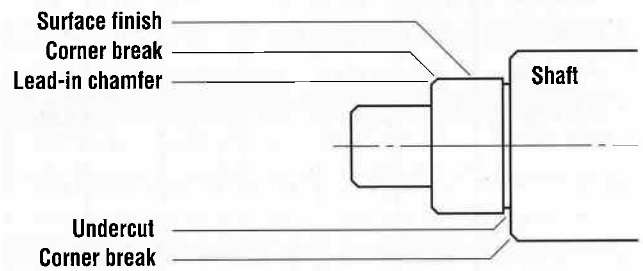

Table 3: Recommended finish of bearing seats and shoulders.

Detail or Characteristic	Specification
Lead-in chamfer	Required
Undercut	Preferred
All corners	Burr-free at 5x magnification
Surface finish	16 microinch AA maximum
Bearing seats	Clean at 5x magnification

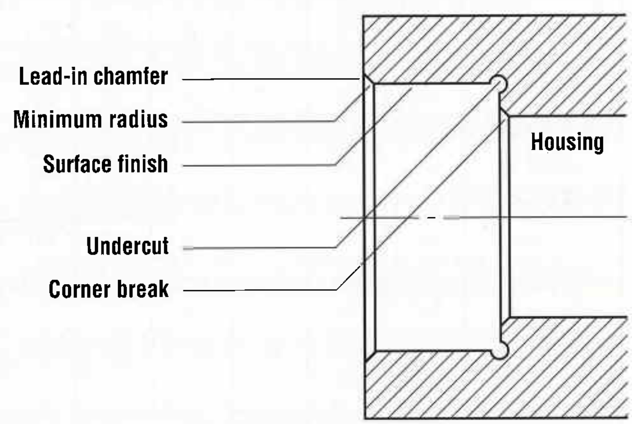

Table 4: Recommended geometry of corners.

Detail \ Bearing	NOMINAL BORE DIAMETER, mm			
	<6	6-50	51-120	121-180
Corner break, min.	.001	.002	.003	.004
Minimum radius	.003	.003	.003	.004

Values in inches.

Bearing Mounting and Fitting

Shaft & Housing Fits

The ideal mounting for a precision bearing has a line-to-line fit, both on the shaft and in the housing. Such an idealized fit has no interference or looseness.

As a practical matter, many influencing factors have to be considered:

- Operating conditions such as load, speed, temperature.
- Provision for axial expansion.
- Ease of assembly and disassembly.
- Requirements for rigidity and rotational accuracy.
- Machining tolerances.

Thus, the appropriate fit may have moderate interference, moderate looseness or even a transitional nature, as governed by operating requirements and the mounting design. Tables 5 and 6 provide general guidelines for typical applications, according to dominant requirements.

Fitting Practice

Interference fits (press fits) may be required when there is:

- A need to avoid mass center shifts.
- Heavy radial loading.
- Vibration that could cause fretting and wear.
- A need for heat transfer.
- A lack of axial clamping.
- To compensate for centrifugal growth of inner ring.

Interference fits should be used cautiously, as they can distort the raceway and reduce radial play. In preloaded pairs, reduction of radial play increases the preload. If excessive, this can result in markedly reduced speed capability, higher operating temperature and premature failure.

Loose fits may be advisable when:

- There are axial clamping forces.
- Ease of assembly is important.
- There must be axial movement to accommodate spring loading or thermal movements.

Table 5: *Shaft/housing fits for miniature & instrument bearings.*

	Dominant Requirements*		Fit Extremes, inches**	
			Random Fitting	Selective Fitting
Shaft Fits	Inner ring clamped	Normal accuracy.	.0000 – .0004	– .0001 – .0003
		Very low runout, high radial rigidity.	+ .0001 – .0003	.0000 – .0002
	Inner ring not clamped	Normal accuracy.	+ .0001 – .0003	.0000 – .0002
		Very low runout, high radial rigidity.	+ .0003 – .0001	+ .0002 .0000
		Very high speed service.	+ .0002 – .0002	+ .0001 – .0001
		Inner ring must float to allow for expansion.	.0000 – .0004	– .0001 – .0003
		Inner ring must hold fast to rotating shaft.	+ .0003 – .0001	+ .0002 .0000
Housing Fits	Normal accuracy, low to high speeds. Outer ring can move readily in housing for expansion.		.0000 – .0004	– .0001 – .0003
	Very low runout, high radial rigidity. Outer ring need not move readily to allow for expansion.		+ .0001 – .0003	.0000 – .0002
	Heavy radial load. Outer ring rotates.		+ .0001 – .0003	.0000 – .0002
	Outer ring must hold fast to rotating housing. Outer ring not clamped.		+ .0004 .0000	+ .0003 + .0001

*Radial loads are assumed to be stationary with respect to rotating ring.
**Interference fits are positive (+) and loose fits negative (–) for use in shaft and housing size determination, page 35.

Bearing Mounting and Fitting

Loose fits for stationary rings can be a problem if there is a dominant rotating radial load (usually unbalanced). While axial clamping, tighter fits and anti-rotation devices can help, a better solution is good dynamic balancing of rotating mass.

The appropriate fit may also vary, as governed by operating requirements and mounting design. To ensure a proper fit, assemble only clean, burr-free parts. Even small amounts of dirt on the shaft or housing can cause severe bearing misalignment problems.

When press fitting bearings onto a shaft, force should be applied evenly and only to the ring being fitted or internal damage to the bearing — such as brinelling — could result. If mounting of bearings remains difficult, selective fitting practices should be considered. Selective fitting — utilizing a system of bearing calibration — allows better matching of bearing, shaft and housing tolerances, and can provide more control over assembly.

Fitting Notes:

1. Before establishing tight interference fits, consider their effect on radial internal clearance and bearing preloads (if present). Also realize that inaccuracies in shaft or housing geometry may be transferred to the bearings through interference fits.

Table 6: *Shaft and housing fits for spindle and turbine bearings.*

	Dominant Requirements*			Fit Extremes, inches** Nominal Bore Diameter, mm 7–30	31–80	81–180
Shaft Fits	Inner ring clamped	Very low runout, high radial rigidity.		+ .0002 – .0001	+ .0003 – .0001	+ .0004 – .0002
		Low to high speeds, low to moderate radial loads.		+ .00015 – .00015	+ .0002 – .0002	+ .0003 – .0003
		Heavy radial load	Inner ring rotates	+ .0003 .0000	+ .0004 .0000	+ .0006 .0000
			Outer ring rotates	.0000 – .0003	+ .0001 – .0003	+ .0001 – .0005
	Inner ring not clamped	Very low runout, high radial rigidity, light to moderate radial loads.		+ .0003 .0000	+ .0004 .0000	+ .0006 .0000
		Heavy radial load	Inner ring rotates	+ .0004 + .0001	+ .0005 + .0001	+ .0007 + .0001
			Outer ring rotates	.0000 – .0003	+ .0001 – .0003	+ .0001 – .0005
		Inner ring must float to allow for expansion, low speed only.		.0000 – .0003	– .0001 – .0005	– .0008 – .0002
				Nominal Outside Diameter, mm 18–80	**81–120**	**121–250**
Housing Fits	Normal accuracy, low to high speeds, moderate temperature.			.0000 – .0004	+ .0001 – .0005	+ .0002 – .0006
	Very low runout, high radial rigidity. Outer ring need not move readily to allow for expansion.			+ .0001 – .0003	+ .0002 – .0004	+ .0002 – .0006
	High temperature, moderate to high speed. Outer ring can move readily to allow for expansion.			– .0001 – .0005	– .0001 – .0007	– .0002 – .0010
	Heavy radial load, outer ring rotates.			+ .0004 .0000	+ .0006 .0000	+ .0008 .0000

*Radial loads are assumed to be stationary with respect to rotating ring.
**Interference fits are positive (+) and loose fits negative (–) for use in shaft and housing size determination, page 35.

Bearing Mounting and Fitting

2. Radial internal clearance is reduced by up to 80% of an interference fit. Thus, an interference of .00025" could cause an estimated .0002" decrease in internal clearance. Bearings with Code 3 radial play or less should have little or no interference fitting.

3. Keep in mind that mounting fits may be substantially altered at operating temperatures due to differential expansion of components. Excessive thermal expansion can quickly cause bearing failure if the radial play is reduced to zero or less, creating a radial preload.

4. An axially floating loose fit for one bearing of two-bearing system is usually needed to avoid preloading caused by thermal expansion during operation.

5. When an interference fit is used, it is generally applied to the rotating ring. The stationary ring is fitted loose for ease of assembly.

6. Spring-loaded bearings require a loose fit to ensure that the spring loading remains operational.

7. In the case of loose fits, inner and outer rings should be clamped against shoulders to minimize the possibility of non-repetitive runout.

8. Diameter and squareness tolerances for shaft and housing mounting surfaces and shoulders should be similar to those for the bearing bore and O.D. The surface finish and hardness of mating components should be suitable for prolonged use, to avoid deterioration of fits during operation.

9. Proper press-fitting techniques must be used to prevent damage during assembly. Mounting forces must never be transmitted through the balls from one ring to the other. Thus, if the inner ring is being press fitted, force must be applied directly to the inner ring.

10. When a more precise fit is desired, bearings can be obtained that are calibrated into narrower bore and O.D. tolerance groups. These can be matched to similarly calibrated shafts and housings to cut the fit tolerance range by 50% or more.

11. Mounting bearings directly in soft non-ferrous alloy housings is considered poor practice unless loads are very light and temperatures are normal and steady — not subject to wide extremes. When temperatures vary drastically, as in aircraft applications, where aluminum is a common structural material, steel housing liners should be used to resist the effects of excessive thermal contraction or expansion upon bearing fits. Such liners should be carefully machined to the required size and tolerance while in place in the housing, to minimize possibility of runout errors.

    Other problems associated with non-ferrous alloys are galling during assembly and "pounding out" of bearing seats. Any questions that arise in unusual mounting situations should be discussed with the Barden Product Engineering Department.

12. For a more secure mounting of a bearing on a shaft or in a housing, clamping plates are considered superior to threaded nuts or collars. Plates are easily secured with separate screws.

When used with shafts and housings that are not shouldered, threaded nuts or collars can misalign bearings. Care must be taken to assure that threaded members are machined square to clamping surfaces. For high-speed precision applications, it may be necessary to custom scrape the contact faces of clamping nuts. In all cases, the clamping forces developed should not be capable of distorting the mating parts.

Shaft and Housing Size Determination

The fits listed in Tables 5 and 6 (pages 33 and 34) apply to normal operating temperatures and are based on average O.D. and bore sizes. The size and tolerance of the shaft or housing for a particular application can be readily computed by working back from the resulting fit, as shown in the example. Note that the total fit tolerance is always the sum of the bearing bore or O.D. tolerance plus the mating shaft or housing tolerance.