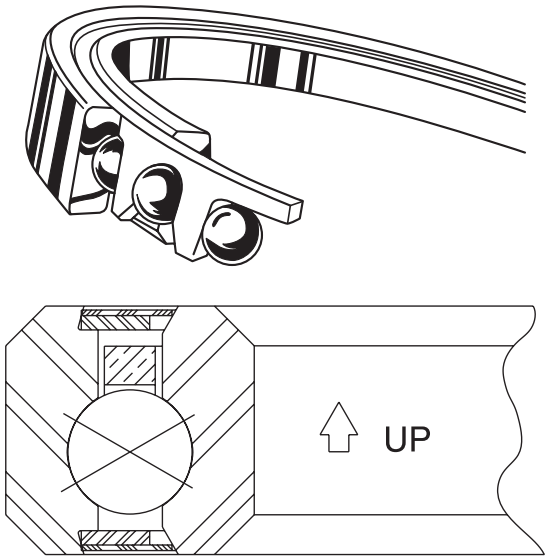
Mounting

Orientation

It is suggested that in an application where the bearing axis will be within 45° of vertical, the bearing be positioned with separator pocket openings down or that a shoulder of the shaft or housing be extended as added assurance of retention. Sealed and shielded bearings have this orientation instruction etched on the O.D. by an arrow and the word "up" as shown below.

Figure 3-18



Correct bearing orientation is shown.

Accuracy

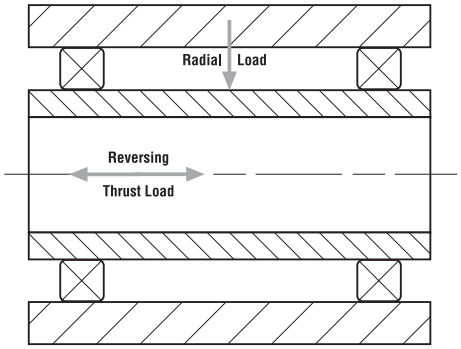
Three primary sources of displacement should be considered in a bearing application. These are looseness, deflection and geometric imperfections of the bearing and mating parts. Bearing imperfections consist of radial runout or eccentricity and axial or face runout. Corresponding to these, and of primary concern, are out-of-round and out-of-flat mounting surfaces of the mating parts.

Looseness can occur either between the bearing and the shaft and housing or within the bearing itself. In some applications, looseness cannot be tolerated, especially within the bearing.

Considering the load condition of Figure 3-19, it can be seen that with internal looseness (diametral clearance) in a Type C or Type X bearing, the thrust load will cause axial movement of the shaft relative to the housing.

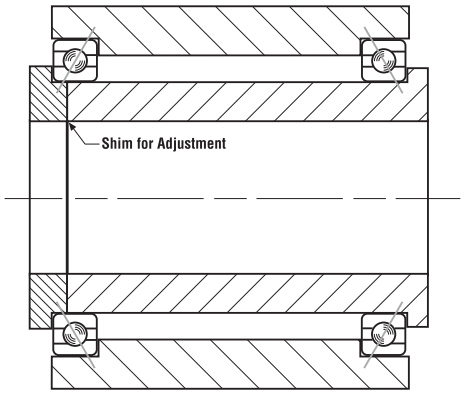
Because of its unique internal geometry with "built-in" contact angles, a Type X bearing exhibits much less axial movement (axial play) than a Type C bearing of the same dimensions, having the same diametral clearance. So even though the thrust force is within the thrust capability of the Type C bearing, the Type X bearing is the better choice where control of axial movement is important.

Figure 3-19



Where axial movement must be completely restricted, the Type X bearing can be preloaded by using balls of greater diameter than the space provided for them between the raceways. This is common practice and provides excellent control of axial play. Where speed is appreciable, however, preload is not acceptable in the Type X bearing due to increased friction and wear. The alternative, then, is to use the mounting of Figure 3-20 employing two Type A bearings. Their geometry is more tolerant of preload, and they offer the advantage of adjustment after installation, making it possible to remove clearance while minimizing preload.

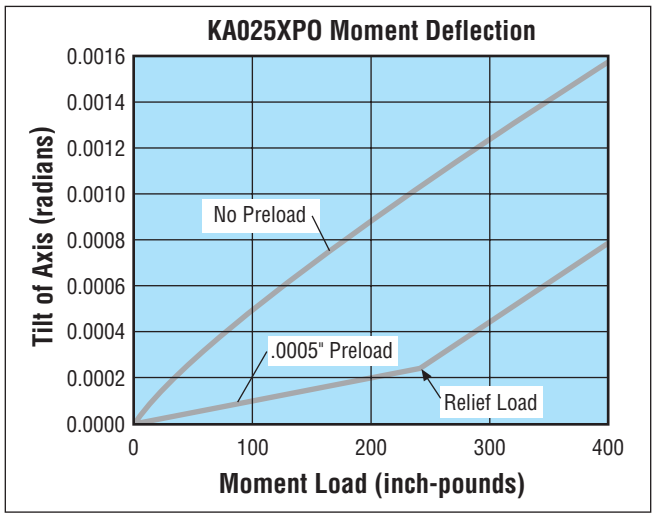
Figure 3-20



MOUNTING (continued)

Regarding bearing deflection, questions as to bearing spring rate (ratio of load to deflection) are common. To answer them, the nature and magnitude of the load must be considered. Deflection can occur in three modes: axial, radial, and angular, corresponding to the three types of loads. Therefore, there are three types of spring rates. Moreover, deflection in a ball bearing is non-linear and thus the spring rate is not constant. Typical load vs. deflection curves are shown in Figure 3-21.

Figure 3-21



Use KAYDON REALI-DESIGN™ software to generate graphics illustrating the effect of shaft and housing fits for all REALI-SLIM® standard bearings.

Deflection data for the three bearing types is shown on pages 104 through 109.

Deflection (the amount of movement associated with compression or stretching of bearing components when placed under load) varies from one type to another within a given series as a function of the contact angle and the number of balls. Conrad assembled bearings (C and X types) will exhibit greater deflection than those assembled by "loading notch" or than a Type A bearing since C and X types have fewer balls. When two bearings are spaced apart to support a moment load, the space between the bearings is most important when considering angular deflection (tilt-of-axis).

Preloading is also a significant factor in reducing deflection, as shown in the load-deflection curve. In Figure 3-21 it can be seen that a deflection is non-linear for the non-preloaded bearing. In addition, the rate of deflection is higher for lower loads than higher loads.

Deflection for the preloaded bearings is linear up to the point of preload relief. For loads that exceed the preload relief, the subsequent deflection follows the same slope as the non-preloaded curve but at a reduced rate.

Thus if preload is used, the deflection due to the work load will be markedly less whether preload is relieved or not.

The Type A bearing is more tolerant of preload than is the Type X bearing. If maximum stiffness is required and speed of rotation is significant, Type A bearings are preferred.

Bearing precision, which influences accuracy, is independent of bearing type. Radial and axial runout, bore and O.D. tolerances, etc., are essentially the same for Types C, A, and X bearings of a given precision class.

KAYDON offers:

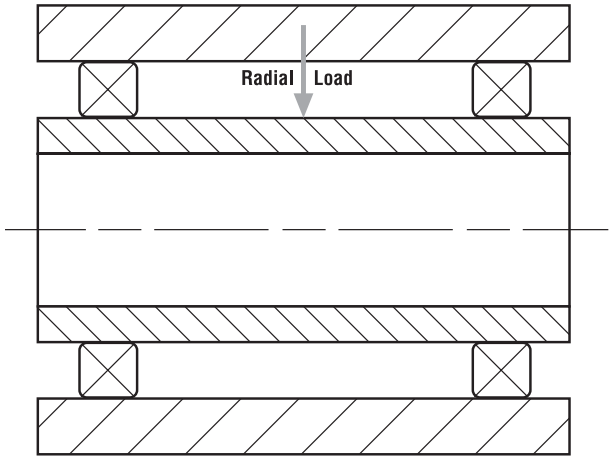
- a breadth of products.
- a wide range of options.
- additional information on our bearings through KAYDON Engineering.

KAYDON software for REALI-SLIM® bearings available at: www.kaydonbearings.com

Load

With a pure radial load such as shown in Figure 3-22, it can be seen that the Type C bearings in Figure 3-24 would be ideal. They are designed for radial load, require no adjustment at installation, and are available in a wide variety of sizes. As shown, one bearing is fixed axially on both races and the other bearing is free to "float" in the housing. This arrangement permits differential expansion to occur between the shaft and housing without imposing axial loading on the bearings.

Figure 3-22



With an axial load applied as in Figure 3-19, consideration must be given to the thrust capability of the bearings. Type C bearings will accept some thrust loading, but where this loading is substantial, the Type X or Type A bearing is a better choice. The Type X bearing can be used with a Type C bearing as shown in Figure 3-25. This mounting is the same as that of Figure 3-24 except for the Type X bearing which is used at the "fixed" position to resist thrust in either direction while the Type C bearing "floats" and resists only radial load. With Type A bearings, the mounting could be as shown in Figures 3-27A and 3-27B.

In the third load condition (Figure 3-23), the bearing arrangement in Figure 3-24 will be satisfactory for small thrust loads. Where thrust is significant, the arrangement of Figures 3-20, 3-25, and 3-26 should be considered. In the latter case, one Type X bearing will accommodate the combined loads while effecting savings in space, weight, and cost.

Figure 3-23

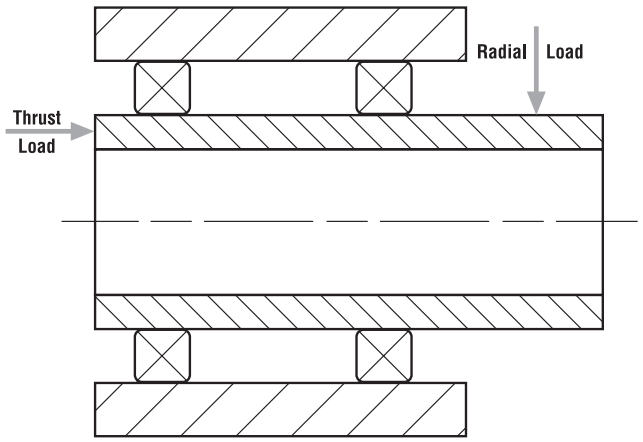
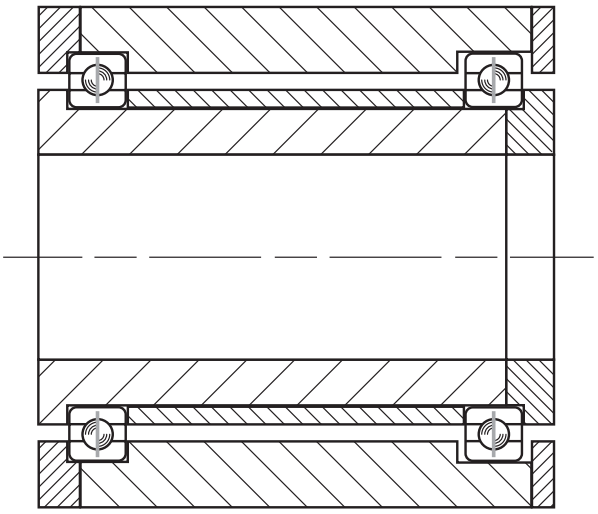


Figure 3-24



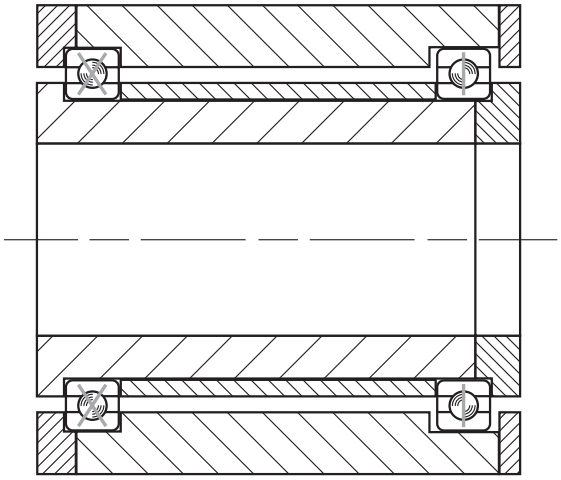
Speed

In bearing selection, speed of rotation is equally as important as loading.

Referring to Figure 3-19, arrangements of both Figure 3-20 and Figure 3-25 would satisfy the load conditions, but their suitability for high speed must be considered.

MOUNTING (continued)

Figure 3-25



The better arrangement for high speed operation is that using Type A bearings (Figure 3-20), which can be adjusted to provide the optimum internal fit.

There is the possibility of differential expansion creating a problem when two Type A bearings a sizable distance apart are clamped against each other with all internal clearance removed. If this is the case, a "fixed-floating" arrangement can be used as shown in Figures 3-27A and 3-27B with a duplexed pair of Type A bearings at the "fixed" position and a Type C bearing at the "float" position. Another possibility is to spring load the Type A bearings of Figure 3-20.

Figure 3-26

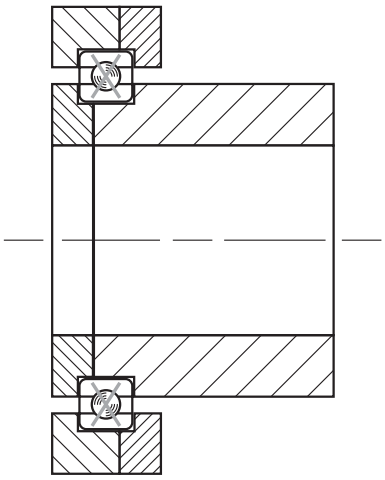


Figure 3-27A - Back to Back

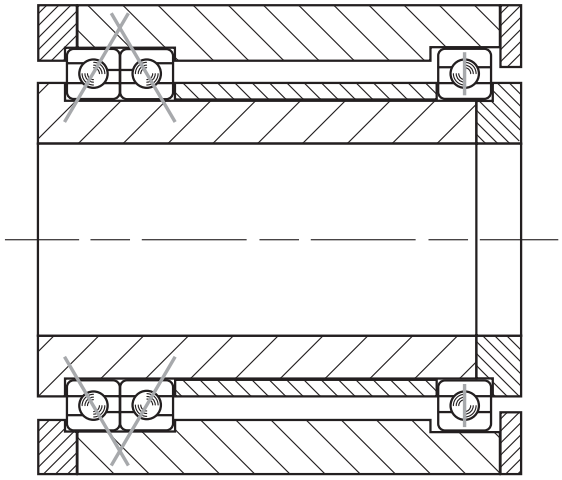
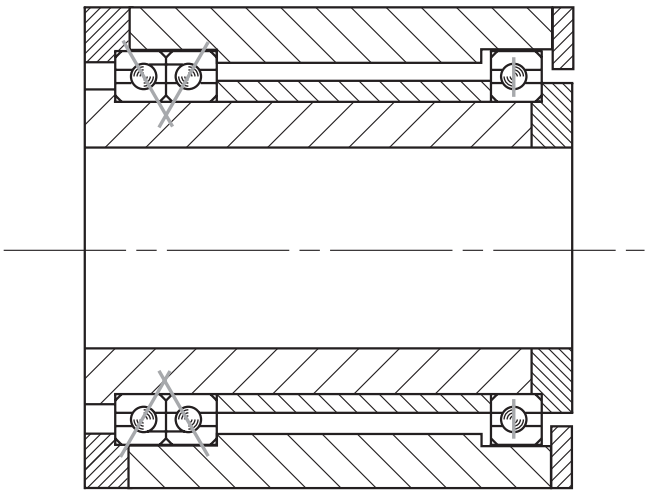
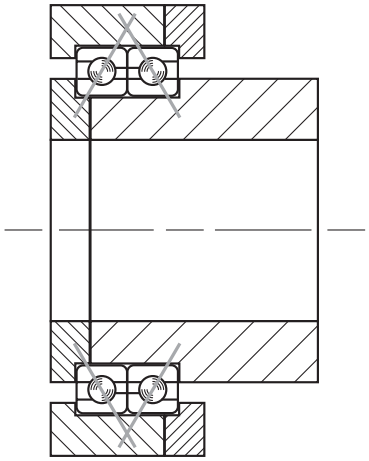


Figure 3-27B - Face to Face



Where space is limited, combined loading exists, and speed is relatively high, a pair of Type A bearings as shown in Figure 3-28 would be given preference over the single Type X bearing of Figure 3-26. In this event preloading must be minimized. This can be accomplished by using a short spacer between the outer races and adjusting the bearings through the inner races.

Figure 3-28



Limiting speeds are given in Section 4.

Other Considerations

Friction Torque

In applications where minimum driving force is a requirement, consideration should be given to friction torque. For low torque, preload should be avoided if possible. Type X bearings under combined loading can be expected to have more friction than Type A bearings. The separators, ball-to-raceway conformity, lubrication method, shaft and housing fits and temperature are among the factors influencing bearing friction. Awareness of a low torque requirement enables the bearing engineer to weigh the compatibility of these factors. Additional information on friction torque is in Section 4. For more information, submit Request for Proposal Data form (see page 129 or website) to KAYDON product engineering or consult REALI-DESIGN™ software.

Bearing Mounting

What materials are to be used for the shaft and housing? What range of operating temperatures will be encountered? Will there be a temperature differential between the shaft and housing? The answers to these questions are necessary for proper bearing selection and application. Significant differential expansion will cause marked changes in both the external and internal bearing fits, especially in the case of the thin-section, REALI-SLIM® bearings. These changes affect accuracy, friction, and bearing life.

Ideal Mounting Conditions

- Shaft and housing of material with coefficient of thermal expansion of approximately .000007 inch per inch per degree F
- Shaft and housing diameters round within bearing radial runout tolerances
- Shoulders flat within bearing axial runout tolerances
- Cross sections sufficiently rigid to provide good load distribution within bearing
- Suitable sealing or shielding to protect bearing from contamination

Typical Arrangements

Type C and Type A bearings

- Used with a second bearing with sufficient separation to resist moment loads
- When the axis of rotation is within 45° of vertical, snapover separators should be positioned with pocket openings down, or the shaft or housing should be extended as added assurance of separator retention.

All Types

- Fixed races located axially by positive means
- Snap rings used only for positioning and light loads
- Shoulders, sleeves, or clamping rings used for heavy loads
- No reliance upon interference fits for resistance to applied axial loads

Temperature

- Means provided to maintain race temperature between –65°F and +250°F with no appreciable differential across the bearing

Lubrication

- Standard bearings are shipped with preservative oil only.
- Preserved bearings must be flushed and lubricated with oil or grease suitable for speed and temperature conditions. See Section 5.

Speed

- Within limits of chart in Section 4 — Consult REALI-DESIGN™ software.

Load

- Static loads within catalog rating after applying the recommended safety factor
- Check that dynamic L_{10} life is sufficient (see page 71). Consult REALI-DESIGN™ software.