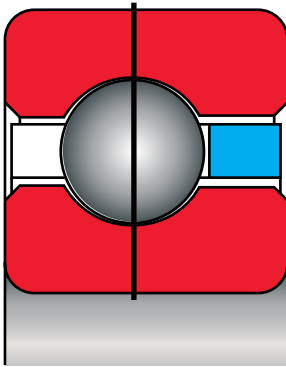


Bearing Selection

Type C—Radial Contact



The Type C Radial Contact ball bearing is a single-row radial ball bearing with extra deep ball grooves in both rings (groove depth = 25% of ball diameter). Normally this bearing is assembled by eccentric displacement of the inner race within the outer race which permits insertion of about half of a full complement of balls. After insertion of the balls, the races are positioned concentrically and the balls are spaced about the entire circumference for assembly of the separator. This method of assembly is commonly termed “Conrad Assembly.”

An alternate method of assembly is to insert balls through a “filling slot” made by notching the raceway shoulder of one or both races. This method permits assembly with up to a full complement of balls for additional load capacity, however, there are limitations on the operating conditions and these are discussed under Separator Types.

Type C bearings perform best with a small amount of clearance between the balls and races (diametral clearance). Standard bearings are supplied with clearances for:

- Interference fitting between bearing races and mounting members;
- Differential thermal expansion or contraction of steel races;
- Misalignment between shaft and housing and other factors may require the clearance to be adjusted accordingly.

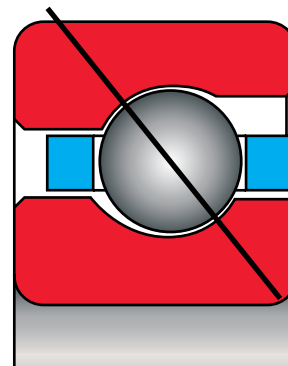
The Type C radial contact bearing is designed to have ball to race contact in the plane of the ball centers when pure radial load is

applied and thrust forces are absent. Necessary diametral clearance may be increased or decreased to meet operating conditions.

While designed primarily for radial load application, the Type C bearing, without a filling slot, will accept some axial (thrust) load in either direction. Its ability to resist axial load, however, is dependent upon the amount of clearance in the bearing after installation. It is this clearance which allows the balls, under axial load, to contact the races at an angle, thereby offering resistance to such load. In the case of the bearing with a filling slot, the notches interrupt the ball contact paths under axial load, minimizing the dynamic thrust capability. Where axial load is present, therefore, rotation of the filling slot bearing must be restricted.

By increasing the diametral clearance beyond the standard amount, the Type C bearing can have a greater angle of contact under axial load, and thus greater thrust capacity. In this case, it is proper to adjust the bearing against another bearing of similar construction to reduce axial movement under reversing thrust forces. Used in this manner, the bearing is essentially an angular contact rather than a radial contact bearing.

Type A—Angular Contact



Type A Angular Contact ball bearings differ from Type C bearings in that Type A bearings have sufficient diametral clearance to produce a substantial angle of contact for resistance to axial load. This contact angle is 30° in the standard bearing. As in the Type C bearing, extra deep ball grooves are used (25% of ball diameter).

The distinguishing feature of the Type A bearing lies in the method of assembly. One ring, usually the outer, is counter-

Bearing Selection (continued)

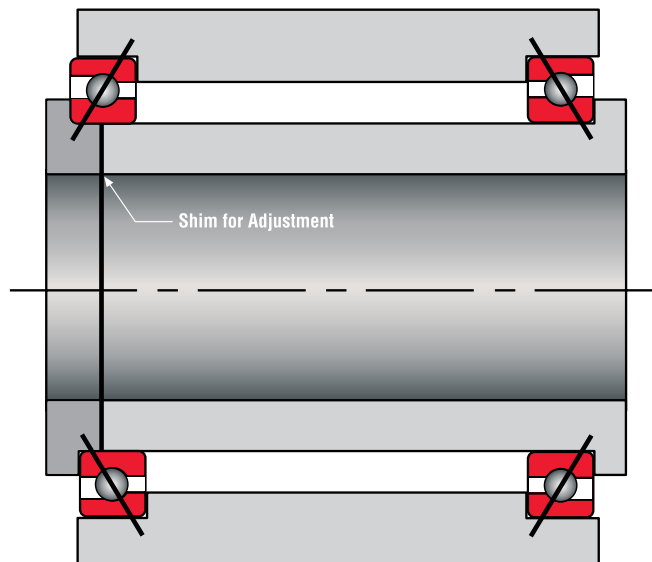
bored to reduce one shoulder of the raceway to the extent that with the assistance of a temperature differential between the two rings, the outer ring can be installed over the inner race, ball, and separator assembly. This provides a non-separable bearing capable of carrying greater radial loads while resisting a substantial axial force in one direction. With an axial force applied, the faces of the inner and outer rings are approximately flush to minimize preload adjustments.

This assembly method permits the use of a greater complement of balls than is possible in the Type C bearing without filling slots, and together with the sizable contact angle, gives the Type A bearing its greater thrust capacity.

Because of its unidirectional thrust capability, this bearing should be mounted opposed to another bearing such that an axial force is present to establish and maintain the contact angle and to minimize axial movement under reversing thrust loads.

Back-to-back Mounting

Figure 3-1

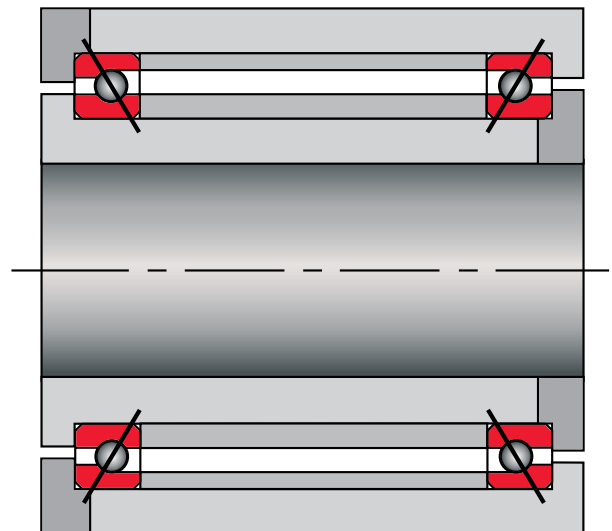


Typical mountings of Type A bearings are shown in Figures 3-1 and 3-2. In Figure 3-1, the bearings are mounted with the lines of

contact converging outside of the bearings. This is commonly called a “back-to-back” mounting. In this figure, the bearings are adjustable through the inner races by use of shims under the inner race clamping ring. Sufficient shim thickness is provided initially to allow axial movement of the shaft relative to the housing. The total axial movement can then be measured and the shim thickness reduced by the amount of movement plus any additional amount desired for preload. When two bearings are opposed to each other to the extent that all internal clearance is removed and elastic deformation occurs between the balls and raceways, the bearings are said to be “preloaded.”

Face-to-face Mounting

Figure 3-2



In Figure 3-2, the bearings are mounted “face-to-face” with the contact lines converging inward. Spacers are used between both the inner and outer races and adjustment is possible by varying the length of one spacer relative to the other. Normally, however, the spacers are equal in length and the bearings are furnished as a matched pair with a predetermined internal fit. If the outer race spacer were removed from this assembly, the bearings could be adjusted by use of shims under the outer race clamping ring.

Bearing Selection (continued)

Duplexed Bearings

Type A bearings are furnished as matched sets — available direct from the factory — when they are to be mounted adjacent or with equal length inner and outer race spacers. When required, Kaydon can supply assemblies with matched ground spacers. The arrangements shown in Figures 3-3, 3-4, and 3-5 are known as duplexed bearings — back-to-back, face-to-face, and tandem, respectively. Sets of three, four or more bearings can also be matched where conditions require additional capacity and there is insufficient space radially for larger bearings.

The bearings in these sets are matched within close limits for size of bore and outside diameter. Each set is marked with a “V” across the bores and outside diameters at the high point of radial runout and indicate the proper orientation of the races at installation (Figure 3-5).

The pairs shown in Figures 3-3 and 3-4 are normally furnished with the race faces ground to provide preload when installed. To

accomplish this, a gap is provided between the inner races of the pair in Figure 3-3 and between the outer races of the pair in Figure 3-4. When the bearings are installed and clamped axially, the gap is closed, producing a preload on the bearings.

Back-to-back arrangement of Figures 3-1 and 3-3 offers greater rigidity under moment loading and should be used when the space between single bearings is small or when a single pair of adjacent bearings is employed.

Face-to-face arrangement is more tolerant of misalignment between the shaft and housing and should be considered when there are multiple pairs of bearings along an axis. When single bearings are mounted face-to-face, they must be spaced sufficiently to provide resistance to moment load. If required, a face-to-face pair can be mounted in conjunction with another bearing in a “fixed-float” arrangement with the pair in the fixed position. (Also see Section 5, Mounting.)

Tandem bearing sets have single direction thrust capacity and must be mounted opposed to another bearing or set.

Figure 3-3
Back-to-back (Type DB)

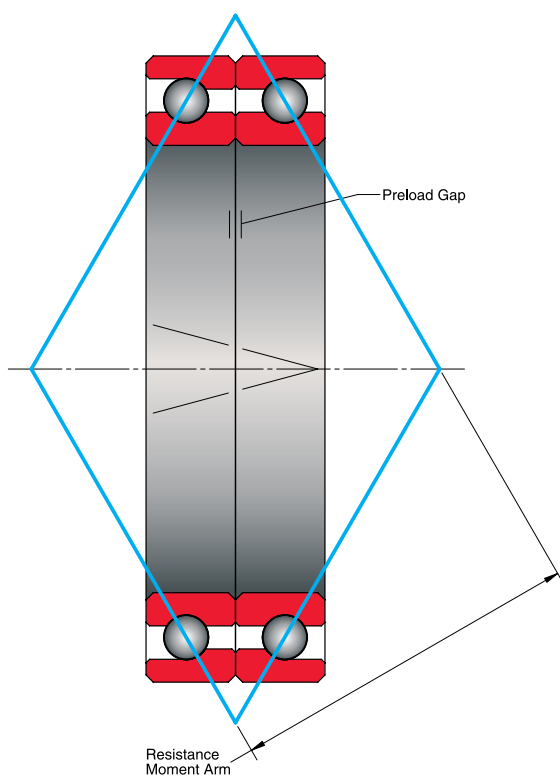


Figure 3-4
Face-to-face (Type DF)

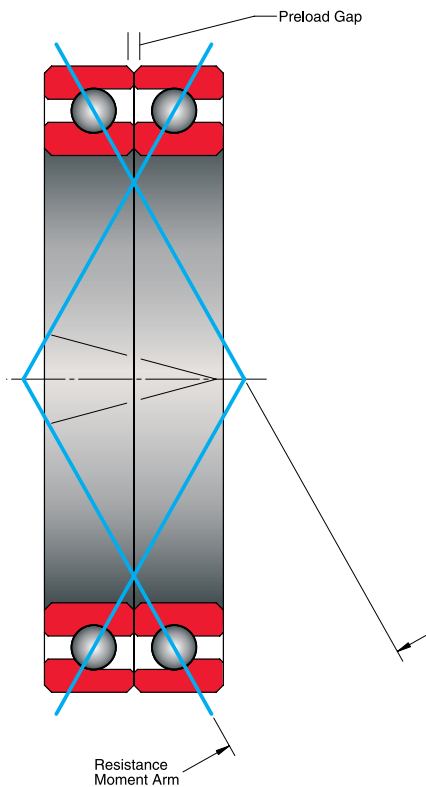
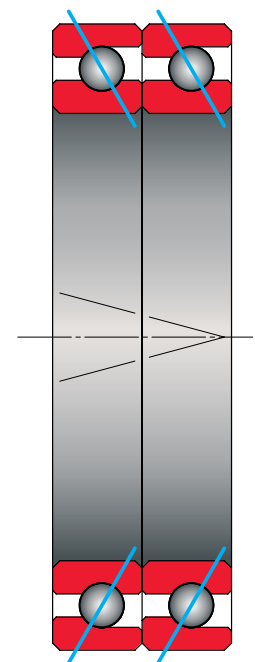


Figure 3-5
Tandem (Type DT)

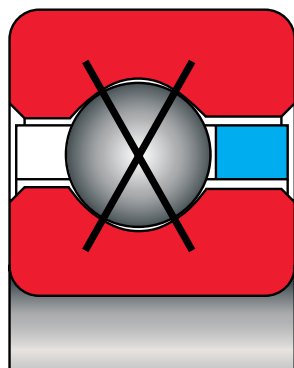


Bearing Selection (continued)

When applying catalog load ratings to matched sets, the total radial capacity is considered equal to the single bearing radial rating multiplied by $N^{0.7}$, where N is the number of bearings in the set. The thrust capacity in each direction is considered equal to the single bearing thrust rating multiplied by $N^{0.7}$, where N is the number of bearings resisting thrust in that direction.

Unless specifically requested, the outboard faces of bearing sets are not controlled. If outboard face flushness is required for preload purposes, universally ground bearings should be considered. On universally ground bearings, both inboard and outboard faces are matched under a specified gage load to control preload and allow for mounting orientation flexibility.

Type X—Four Point Contact



The Type X Four-Point Contact ball bearing is distinguished from Types A and C by the geometry of its ball grooves. In Type C, the centers of the radii both lie in the plane of the ball centers (Figure 3-6). In Type A with the races and balls in angular contact, the centers of the groove radii are offset equal amounts on either side of the plane of the ball centers (Figure 3-7). In the Type X bearing the groove in each race has two radii whose centers are offset from the plane of the ball centers (Figure 3-8). The latter construction gives the Type X bearing its unique “Gothic Arch” configuration, making possible four contact points between a ball and the raceways.

Type X bearings are assembled by the methods described in Type C bearings, either Conrad or filling slot. With a filling slot, both the dynamic radial and thrust capabilities are impaired by the interruption of the ball contact path, and speed of rotation must be limited.

The depth of groove in the Type X bearing is the same as in Types A and C (25% of ball diameter). The deep groove combined with the four-point contact geometry enables this bearing to resist a combination of radial, thrust, and moment loading. The manner in which the bearing accomplishes this is similar to that of a pair of Type A bearings duplexed back-to-back.

Figure 3-6
Type C

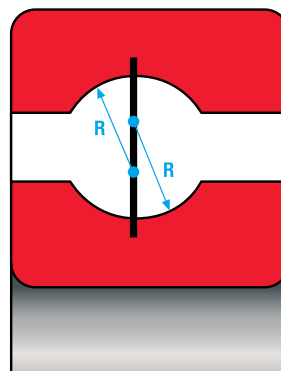


Figure 3-7
Type A

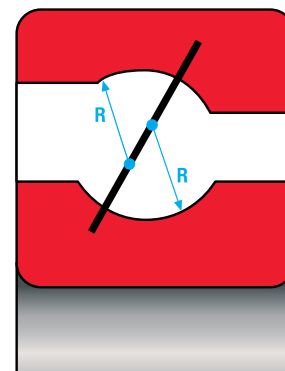
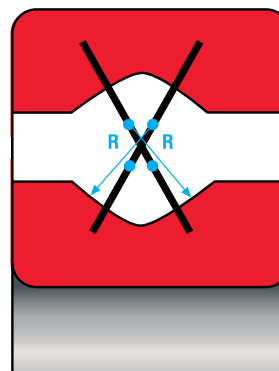


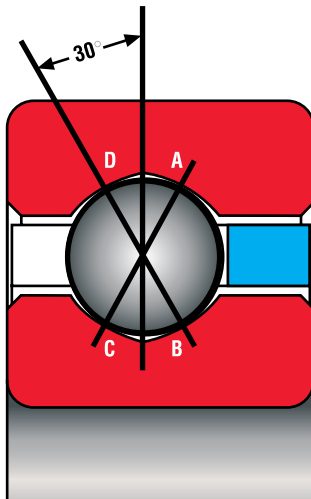
Figure 3-8
Type X



Bearing Selection (continued)

Referring to Figure 3-9, an axial force applied to the inner race from right to left is passed from the race to the ball at point B. It is then transmitted through the ball to point D where it passes into the outer race and support structure. The line of action BD forms a nominal 30° angle with the radial centerline of the bearing. Because of the elastic deformation of the ball and the race grooves along the load-transmission line, the ball load is relieved at points A and C, permitting smooth rotation around an axis perpendicular to line BD. With an axial force applied to the inner race from left to right, a similar transmission of load occurs between points C and A.

Figure 3-9



Moment or Overturning Load

A moment or overturning load is similar to two thrust loads acting in opposite directions at diametrically opposite sides of the bearing. With a moment load, the loading on one side of the bearing will pass from point B to D, relieving points A and C. Directly across the bearing, the load passes from point C to point A, relieving points B and D.

A radial load is resisted equally across the lines of contact CA and BD. Under combined loading the resistance is along both lines of contact with the magnitude of each reaction dependent upon the relationship of the individual loads.

By its ability to resist radial, thrust, and moment loads in any combination, the Type X bearing is often able to replace two bearings—a pair of angular contact ball bearings, a pair of

tapered roller bearings, or a combination of thrust and radial bearings, either ball or roller.

As in the case of the Type C bearing, Type X bearings are normally supplied with diametral clearance. The latter bearing, however, is not dependent upon this clearance for its nominal contact angle and thrust capacity. On the contrary, where thrust or moment loading is considerable, the clearance should be minimized to prevent the angle of contact from becoming excessive. For many applications requiring greater stiffness, Type X bearings are furnished with an internal preload. This is accomplished by using balls larger in diameter than the space provided between the raceways. The balls and raceways in this case have some elastic deformation without the presence of external load.

NOTE: Type X Bearings are designed to be used singularly. Use of two Type X bearings on a common shaft could result in objectionable friction torque.

