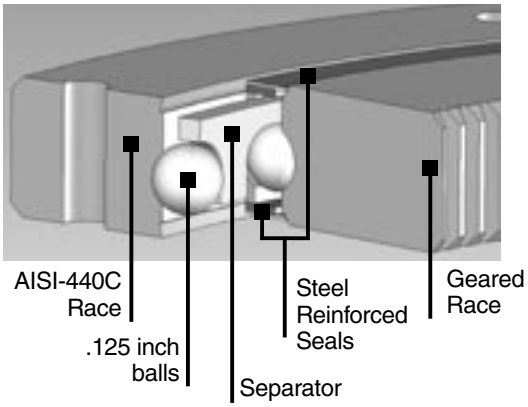
Only from KAYDON®: REALI-SLIM TT® Series — the new generation of small-scale, thin-section turntable bearings

To save weight, reduce product design envelope sizes and increase design flexibility — without compromising bearing performance and life — customers told us they'd welcome a more compact turntable bearing design.

We listened and responded, by designing the first small-scale, thin-section turntable bearings available for such demanding applications as robotics, radar antennae, and factory positioning and inspection tables… REALI-SLIM TT® Series. The advantages of this new series vs. conventional turntable bearings include:

- Significantly smaller size for greater design versatility and reduced weight;
- Greater accuracy — extended radial bearing section increases rigidity, and optional preload or clearances to meet application torque or deflection requirements;
- Easier to use — fast installation and changeout;
- Custom configurations to meet your application's specific needs — many drive options, gearing/timing belt, mounting hole types; and
- Designed to withstand harsh operating environments — AISI-440C steel races, steel reinforced seals.

Figure 2-12



The configurations and specifications you need for more compact, more precise turntable designs

Example of part number breakdown

T 01 - 00225 E A C

T = 4-point contact radial ball bearing
01 = Ball size in (1/8) inch
00225 = Ball pitch diameter in inches x 100

Gearing
E = External Gear
N = Internal Gear
P = Plain - no gear

Inner Hole
A = Inner Hole Style of through holes
B = Tapped mounting holes
C = Countersunk mounting holes

Outer Hole
A = Outer Hole Style of through holes
B = Tapped mounting holes
C = Countersunk mounting holes

Holes sized for #4-40 screws, tapped, countersunk, or through gears set at full depth involute, 64 DP., 20° pressure angle

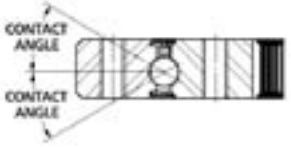
Four-Point Contact Bearing (REALI-SLIM TT™ Series)

Bearings are most often designed to handle either radial or axial load conditions. The unique feature about the REALI-SLIM TT™ Series four-point contact bearing line is that the gothic arch geometry of the inner and outer races enables a single bearing to carry three types of loading (radial, axial and moment) simultaneously. This makes it the bearing of choice for many applications since a single four-point contact bearing can often replace two bearings, providing a simplified design.

REALI-SLIM TT™ Series bearings may also be furnished with an internal diametral preload for those applications requiring greater stiffness or zero free play. This is accomplished by using balls that are larger than the space provided in the raceways. The balls and raceways, therefore, have some elastic deformation in the absence of an external load.

Figure 2-13

REALI-SLIM TT™ Series



REALI-SLIM TT™ SERIES TURNTABLE BEARINGS (continued)

Four-Point Contact Bearing (REALI-SLIM TT™ Series)

Basic Part Number	Radial (lbs.)		Thrust (lbs.)		Moment (in. - lbs.)		Static Torque (in . - lbs.)	Weight (lbs.)
	Static	Dynamic	Static	Dynamic	Static	Dynamic		
T01-00225	680	520	1,710	790	770	440	3.4	0.35
T01-00275	830	580	2,090	910	1,150	600	4.4	0.43
T01-00325	990	640	2,470	1,010	1,600	780	5.5	0.50
T01-00375	1,140	700	2,850	1,110	2,130	980	6.5	0.59
T01-00425	1,290	750	3,220	1,210	2,740	1,200	7.4	0.67
T01-00450	1,370	780	3,410	1,260	3,070	1,320	7.9	0.70
T01-00475	1,440	810	3,600	1,310	3,420	1,440	8.5	0.74
T01-00500	1,520	830	3,790	1,350	3,790	1,560	9.0	0.78
T01-00525	1,590	860	3,980	1,400	4,180	1,690	9.5	0.82
T01-00575	1,750	910	4,360	1,480	5,020	1,950	10.4	0.89
T01-00625	1,900	950	4,740	1,570	5,930	2,230	11.3	0.98
T01-00675	2,050	1,000	5,120	1,650	6,910	2,530	12.2	1.05

Torque based on seal drag in addition to a light preload

Note: REALI-SLIM TT™ Series turntable bearings are custom designed to meet your application's needs. Contact KAYDON for lead time.

Non-geared Bearings

Part Number with Through Holes	Bore	O.D.	Inner Land	Outer Land	Inner Bolt Circle	Number of holes	Outer Bolt Circle	Number of holes
T01-00225PAA	1.500	3.000	2.148	2.356	1.813	6	2.688	8
T01-00275PAA	2.000	3.500	2.648	2.856	2.313	8	3.188	10
T01-00325PAA	2.500	4.000	3.148	3.356	2.813	9	3.688	12
T01-00375PAA	3.000	4.500	3.648	3.856	3.313	10	4.188	14
T01-00425PAA	3.500	5.000	4.148	4.356	3.813	12	4.688	15
T01-00450PAA	3.750	5.250	4.398	4.606	4.063	12	4.938	16
T01-00475PAA	4.000	5.500	4.648	4.856	4.313	14	5.188	16
T01-00500PAA	4.250	5.750	4.898	5.106	4.563	14	5.438	18
T01-00525PAA	4.500	6.000	5.148	5.356	4.813	15	5.688	18
T01-00575PAA	5.000	6.500	5.648	5.856	5.313	16	6.188	20
T01-00625PAA	5.500	7.000	6.148	6.356	5.813	18	6.688	22
T01-00675PAA	6.000	7.500	6.648	6.856	6.313	20	7.188	22

Externally Geared Bearings

Part Number with Through Holes	Bore	Gear O.D.	Inner Land	Outer Land	Inner Bolt Circle	Number of holes	Outer Bolt Circle	Number of holes	Gear Pitch Dia.	Number of teeth
T01-00225EAA	1.500	3.078	2.148	2.356	1.813	6	2.688	8	3.047	195
T01-00275EAA	2.000	3.578	2.648	2.856	2.313	8	3.188	10	3.547	227
T01-00325EAA	2.500	4.078	3.148	3.356	2.813	9	3.688	12	4.047	259
T01-00375EAA	3.000	4.578	3.648	3.856	3.313	10	4.188	14	4.547	291
T01-00425EAA	3.500	5.078	4.148	4.356	3.813	12	4.688	15	5.047	323
T01-00450EAA	3.750	5.328	4.398	4.606	4.063	12	4.938	16	5.297	339
T01-00475EAA	4.000	5.578	4.648	4.856	4.313	14	5.188	16	5.547	355
T01-00500EAA	4.250	5.828	4.898	5.106	4.563	14	5.438	18	5.797	371
T01-00525EAA	4.500	6.078	5.148	5.356	4.813	15	5.688	18	6.047	387
T01-00575EAA	5.000	6.578	5.648	5.856	5.313	16	6.188	20	6.547	419
T01-00625EAA	5.500	7.078	6.148	6.356	5.813	18	6.688	22	7.047	451
T01-00675EAA	6.000	7.578	6.648	6.856	6.313	20	7.188	22	7.547	483

REALI-SLIM TT™ SERIES TURNTABLE BEARINGS (continued)

Internally Geared Bearings

Part Number with Through Holes	Gear I.D.	O.D.	Inner Land	Outer Land	Inner Bolt Circle	Number of holes	Outer Bolt Circle	Number of holes	Gear Pitch Dia.	Number of teeth
T01-00225NAA	1.422	3.000	2.148	2.356	1.813	6	2.688	8	1.453	93
T01-00275NAA	1.922	3.500	2.648	2.856	2.313	8	3.188	10	1.953	125
T01-00325NAA	2.422	4.000	3.148	3.356	2.813	9	3.688	12	2.453	157
T01-00375NAA	2.922	4.500	3.648	3.856	3.313	10	4.188	14	2.953	189
T01-00425NAA	3.422	5.000	4.148	4.356	3.813	12	4.688	15	3.453	221
T01-00450NAA	3.672	5.250	4.398	4.606	4.063	12	4.938	16	3.703	237
T01-00475NAA	3.922	5.500	4.648	4.856	4.313	14	5.188	16	3.953	253
T01-00500NAA	4.172	5.750	4.898	5.106	4.563	14	5.438	18	4.203	269
T01-00525NAA	4.422	6.000	5.148	5.356	4.813	15	5.688	18	4.453	285
T01-00575NAA	4.922	6.500	5.648	5.856	5.313	16	6.188	20	4.953	317
T01-00625NAA	5.422	7.000	6.148	6.356	5.813	18	6.688	22	5.453	349
T01-00675NAA	5.922	7.500	6.648	6.856	6.313	20	7.188	22	5.953	381

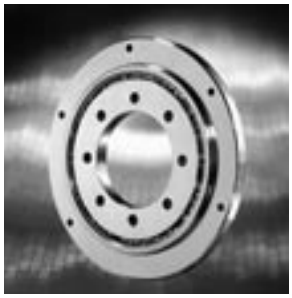
The design features and options you asked for

Custom REALI-SLIM TT™ Series thin-section bearings are the proven, single four-point contact ball radial design, consisting of a single row of balls with a unique gothic arch raceway and brass separators for low frictional torque. Radial, axial and moment load-capable, the bearings are prelubricated and ready for use; simply position the bearings on the mounting face and tighten the mounting screws! Bearing versions available with optional internal or external spur gear for ease of drive setup, or non-geared designs.

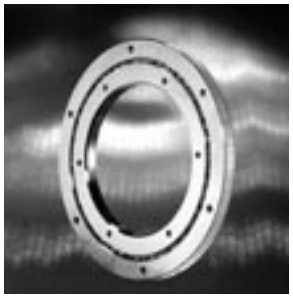
Geared options are 64 diametral pitch with 20° pressure angle, up to AGMA Class 10, and provide low-backlash service. Built-in seals are a low-torque design, and made of rugged, reliable, steel-reinforced nitrile rubber.

Mounting holes are sized for #4-40 UNC fasteners with optional styles — .136 through holes and countersunk holes, and tapped through. Non-geared races have mounting piloting diameters controlled to .0008 inches.

The bearings are cleaned and packaged in a Class 10,000 clean room; Class 100 clean room standards are also available.



No gear with through holes



External gear with tapped holes

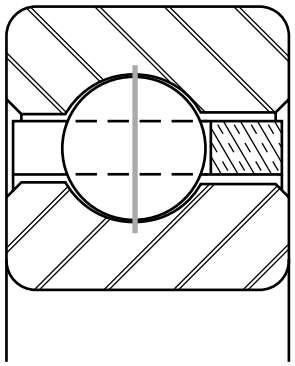
Externally geared bearing with countersunk holes

Internal gear with tapped holes

Section 3—Applications Engineering

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:

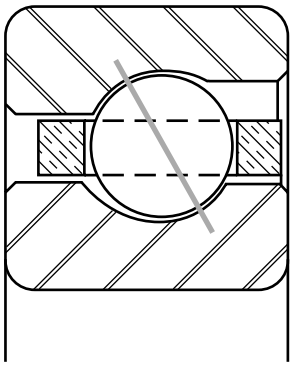
- Interference fitting between bearing races and mounting members;
- Differential thermal expansion or contraction of steel races;
- Misalignment between shaft and housing and other factors may require the clearance to be adjusted accordingly.

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).

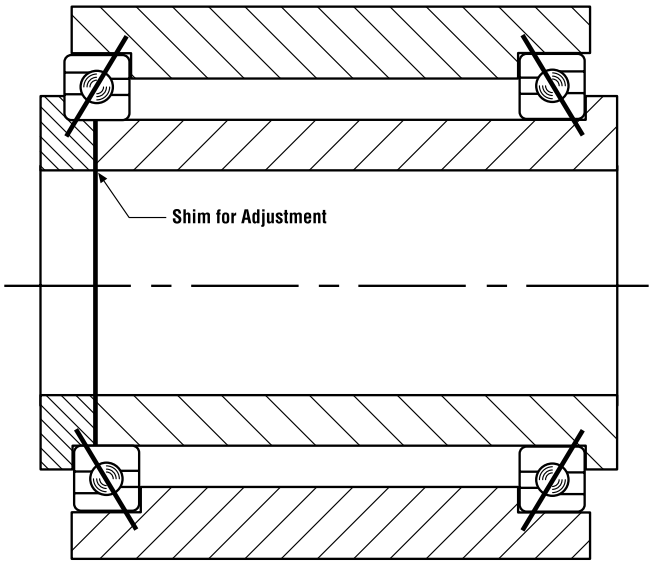
The distinguishing feature of the Type A bearing lies in the method of assembly. One ring, usually the outer, is counterbored to reduce one shoulder of the raceway to the extent that with the assistance of a temperature differential between the two rings, the outer ring can be installed over the inner 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 uni-directional 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

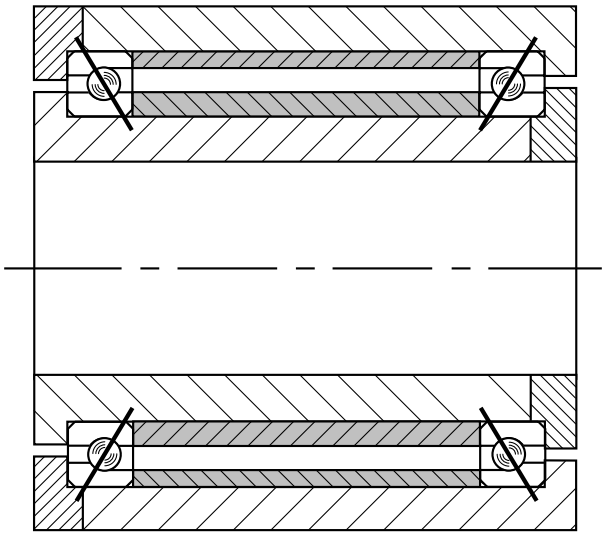
Figure 3-1



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 3, Mounting.)

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

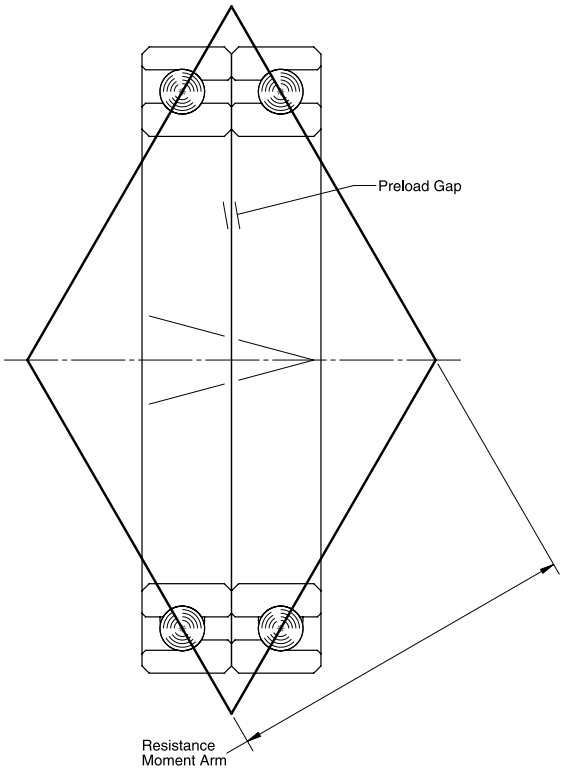


Figure 3-4
Face-to-face (Type DF)

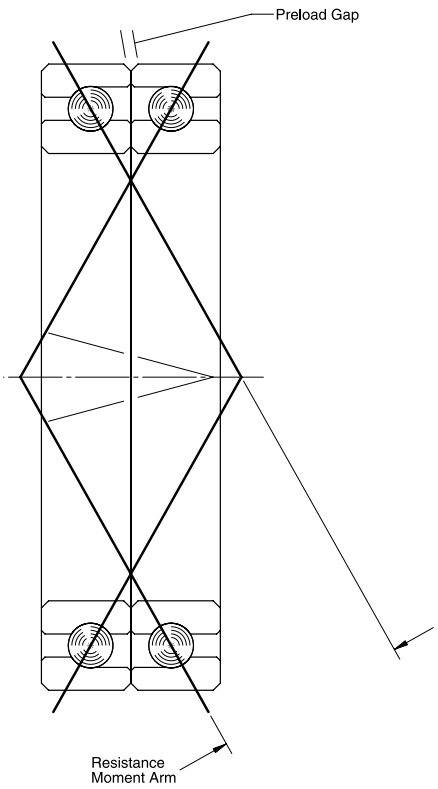
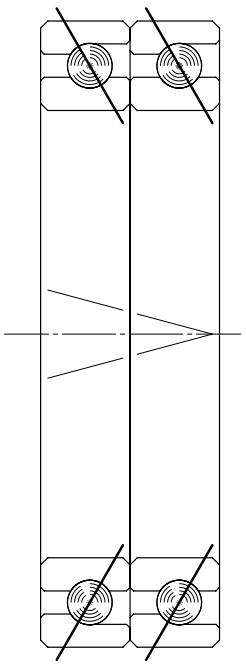


Figure 3-5
Tandem (Type DT)

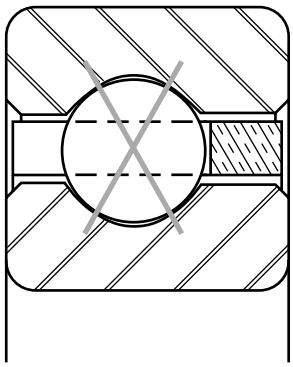


- Tandem bearing sets have single direction thrust capacity and must be mounted opposed to another bearing or set.

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.

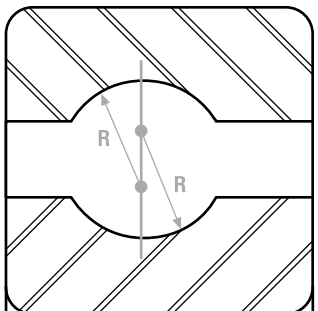


Figure 3-6
Type C

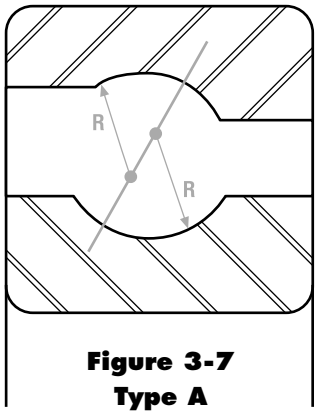


Figure 3-7
Type A

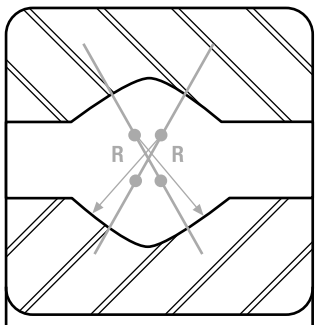


Figure 3-8
Type X

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.

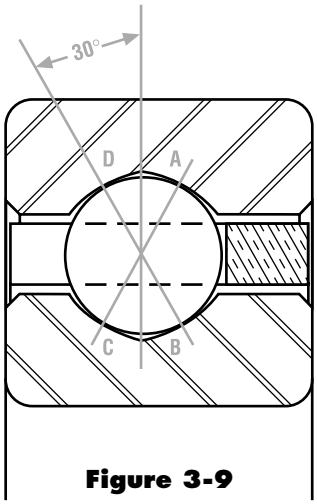


Figure 3-9

Moment or Overturning Load

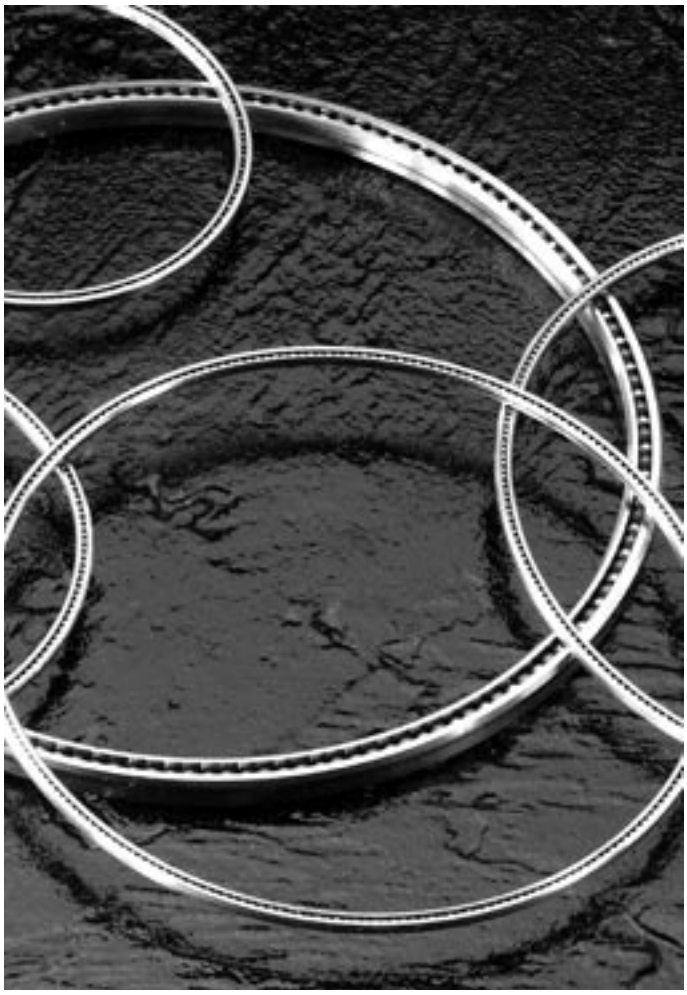
A moment or overturning load is similar to two thrust loads acting in opposite directions at diametrically opposite sides of the bearing. With a moment load, the loading on one side of the bearing will pass from point B to D, relieving points A and C. Directly across the bearing, the load passes from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



Capacity, Life, and Load Analysis of REALI-SLIM® Ball Bearings

Increased Capacity

Starting with the 2007 edition of this catalog, KAYDON has changed the method used for calculating the dynamic capacity of REALI-SLIM® bearings. The radial and moment capacities of most REALI-SLIM® bearings have been increased.

The increased capacities are based on over five years of actual test data. These changes are also supported by modern bearing fatigue life theory. These values are consistent with both ABMA Std. 9 and ISO-281 calculations, when the proper assumptions are considered. The increased capacities apply to bearings with standard internal clearance. The new values assume that a certain amount of clearance is left in the bearing after installation.

The biggest increase is in the radial capacity of four-point contact (X-Type) bearings. Under the old rating system, four-point contact bearings were given the same capacity as radial (C-Type) bearings. However, in this type of bearing the ball loads are distributed over two lines of contact on each race. This gives lower contact stress and longer life, as demonstrated by KAYDON testing.

Life

The dynamic capacity values shown in this catalog are based on actual data from fatigue life testing. The capacities are based on 1,000,000 revolutions L_{10} fatigue life. This is the industry standard that was established for ease of calculation. It is not advisable to apply loads equal to the dynamic capacities in an actual application. Continuous rotation under these conditions would not normally yield acceptable life.

L_{10} fatigue life is that life which 90% of a representative group of identical bearings can be expected to achieve or exceed before evidence of subsurface material fatigue appears. The life of the remaining 10% is unpredictable. The life which 50% of the bearings may be expected to achieve or exceed is approximately 5 times the L_{10} life. This is known as the L_{50} or median life.

There is no significant difference between the dynamic capacity for inner race rotation versus outer race rotation. This is due to the relatively small ratio of ball diameter to pitch diameter in REALI-SLIM® bearings.

Static load capacities are shown in this catalog. However, the actual static load a REALI-SLIM® bearing can withstand is dependent upon the amount of support provided by the shaft and housing.

The published capacity numbers allow the user to quickly estimate the bearing L_{10} life for a one-dimensional load case. The life can be estimated using one of the following equations:

$$L_{10} = \left(\frac{C}{P}\right)^3 \bullet 1{,}000{,}000 \text{ revolutions}$$

Where: L_{10} = life in revolutions
C = KAYDON dynamic rating
P = Applied load (effective)

or

For determining the life in hours at a given speed of rotation the above formula can be changed to read:

$$L_h = \left(\frac{C}{P}\right)^3 \bullet \left(\frac{16{,}667}{S}\right) \text{ hours}$$

Where: $L_h = L_{10}$ life in hours
S = Speed in RPM

For multiple load cases or non-standard internal fits, the analysis becomes more complicated. Contact KAYDON Engineering for these cases or consult REALI-DESIGN™ software available on our website www.kaydonbearings.com.

It should be noted that the capacities published in this catalog are best used for comparison purposes. The actual value of a life calculation is only valid for an individual load case and the internal fitup for which the number was derived. Since it is very rare to have a truly radial or axial or moment load, these are not normally used for a life calculation.

Load Analysis

Previous versions of this catalog have discussed applying the loads from a free body diagram to a bearing system and solving for each of four reactions. As there are generally three equations (one for radial, one for axial, one for moment loads) and four unknowns, one of the reactions has been assumed to be zero. Once the remaining reactions are resolved, the life of the bearing can be determined.

This method had several drawbacks, including:

- It suggested very low bearing life for systems with predominantly axial loads.
- Internal bearing fitup could not be included in the life calculation.
- All loading was assumed to be distributed around the bearing as though it were a pure radial load… regardless of its origin.

CAPACITY, LIFE, AND LOAD ANALYSIS OF REALI-SLIM® BALL BEARINGS (continued)

Modern computers and software allow for a more complicated and accurate method of determining life. Illustrated here are the results of this process. The actual loads are applied to the bearing and the resultant load on each and every ball in that bearing is determined. From this data, the static safety factor and dynamic L_{10} life can be determined.

To better understand this, the following should be considered:

Primary Radial Loading

- Larger clearances will have fewer balls carrying the loads, resulting in lower dynamic lives.
- Larger preloads may overload the bearing before the loads are applied.

Primary Axial and Moment Loading

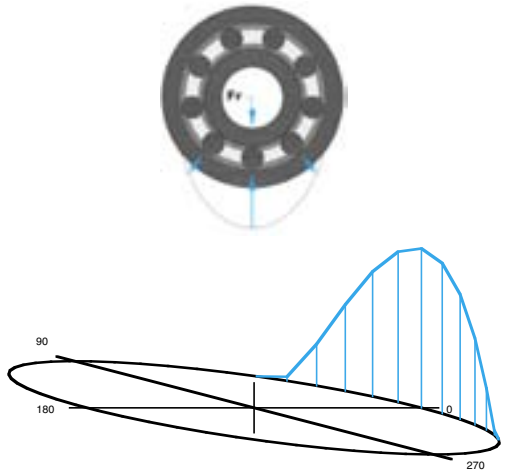
- Larger clearances will permit a higher contact angle than the ball has with the raceway, and thus better support the applied loading.
  - – However, the ball-to-raceway contact area may spill over the edge of the race causing other problems.
- Larger preloads may again overload the bearing before the loads are applied.

The method for calculating either a static safety factor or dynamic life requires the use of a computer to determine the individual ball loads throughout the bearing. When these have been calculated, the maximum loaded ball is used to determine a maximum stress level and thus a static safety factor. All of the ball loads are used in a weighted analysis to determine the dynamic L_{10} life.

Since these calculations require a computer, the mathematics required are not shown here. To complete such an analysis, utilize the KAYDON supplied software — REALI-DESIGN™ or REALI-DESIGN MM™ — available at www.kaydonbearings.com.

To better understand these principles, graphical representations of ball distribution around each of three common bearing types are shown in Figures 3-10 through 3-12. Here the ball load distribution and magnitude can be visualized. The higher the peak, the higher the loads.

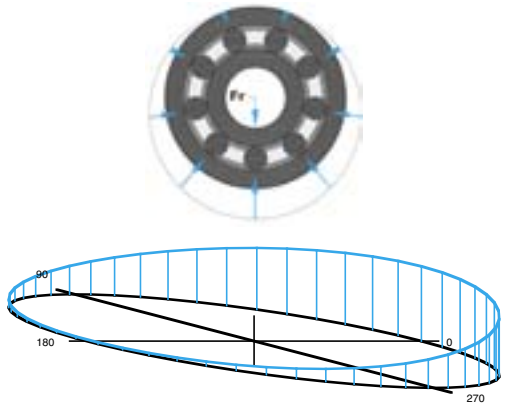
Figure 3-10



KA040CP0 with 100 lbs. radial load
Clearance in the bearing; few balls carry the load.

This radial bearing has clearance in it. There are only three balls supporting this load, with a very high maximum value for the bottom ball.

Figure 3-11

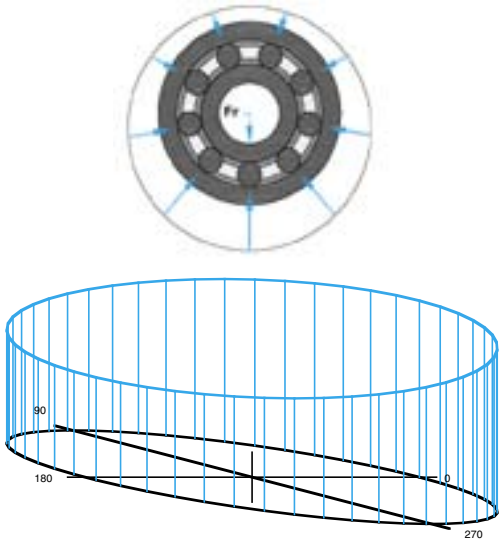


KA040CP0K with 100 lbs. radial load
Light preload in the bearing; all balls carry the load.

This radial bearing has a light preload in it. All the balls have some load on them, and as can be seen, the bottom middle ball has far less load than the example above.

CAPACITY, LIFE, AND LOAD ANALYSIS OF REALI-SLIM® BALL BEARINGS (continued)

Figure 3-12



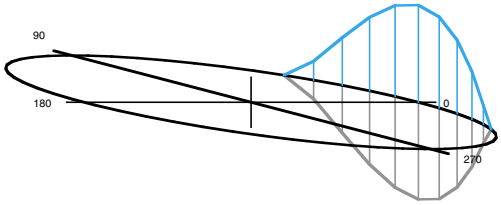
KA040CP0P with 100 lbs. radial load.
Heavy preload.

This radial contact bearing has a very heavy preload in it. All the balls have load on them, and the load on the bottom ball is just as high as the bearing with clearance in the first example.

- Increased Capacity
- Increased Life
- Backed by Theory and Testing

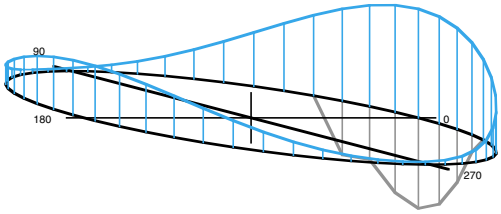
Similar diagrams are shown below for other instances.

Figure 3-13



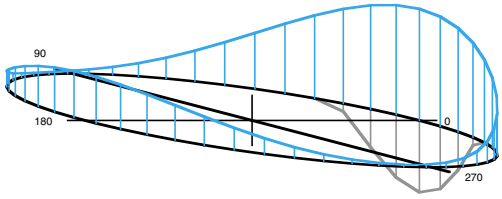
KA040XP0 with 100 lbs. Radial Load
Clearance in bearing; few balls carry the load.

Figure 3-14



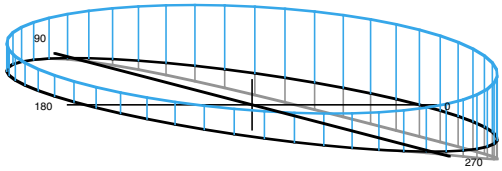
KA040XP0 with
100 lbs. Radial Load, 100 lbs. Axial Load
Lower ball contact, mostly unloaded.

Figure 3-15



KA040XP0 with
100 lbs. Radial Load, 100 lbs. Axial Load
30 Inch-lbs. Moment Load

Figure 3-16



KA040XP0K with
100 lbs. Radial Load, 100 lbs. Axial Load
30 Inch-lbs. Moment Load

CAPACITY, LIFE, AND LOAD ANALYSIS OF REALI-SLIM® BALL BEARINGS (continued)

Figure 3-17 shows a typical mounting of two angular contact bearings subject to external forces F_r and F_t.

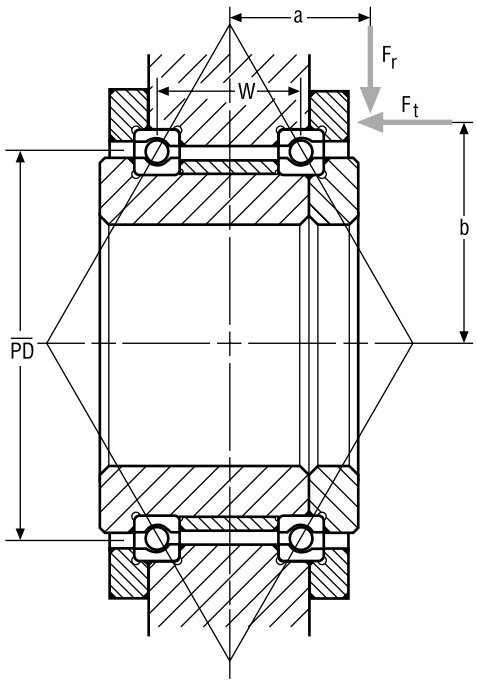


Figure 3-17

Load Diagram for a Back-to-Back Duplex Pair

Radial Load = F_r
Axial Load = F_t
Moment Load = $F_r a - F_t b$

Consult KAYDON REALI-DESIGN™ software for resultant load calculations.

Variable Load Cases

Often a bearing system must operate in several modes such as "idle" and "working." In this instance, the loads may vary substantially. It is advantageous to calculate the life of the bearing under the total loading spectrum. To do this, the individual life under each load case can be calculated alone, then combined to provide the system life for a particular duty cycle.

To perform this calculation, break the loading up into discrete sections which can have their respective percentage of revolutions represented as part of the total, such as:

Case 1	Case 2	Case 3
$Radial_1$	$Radial_2$	$Radial_3$
$Axial_1$	$Axial_2$	$Axial_3$
$Moment_1$	$Moment_2$	$Moment_3$
$\%\ time_1$	$\%\ time_2$	$\%\ time_3$
L_1	L_2	L_3

Substitute the individual "L_n" lives into the equation below with "t_n" where $t_n = \%\ time_n$

The total weighted L_{10} life for this system =

$$L_{10w} = \frac{100}{\frac{t_1}{L_1} + \frac{t_2}{L_2} + \frac{t_3}{L_3}}$$

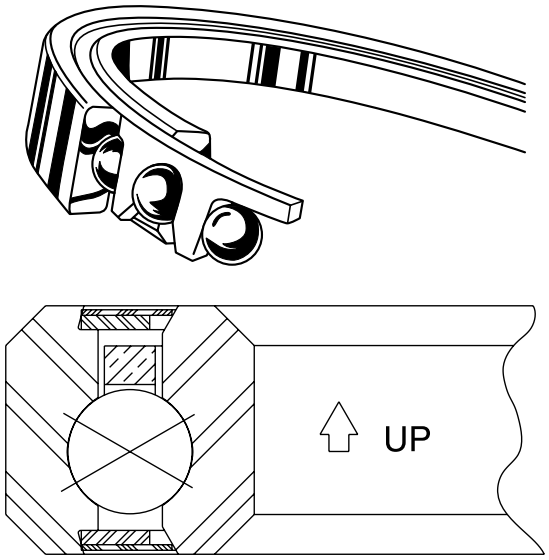
KAYDON software for REALI-SLIM® bearings available at: www.kaydonbearings.com

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.

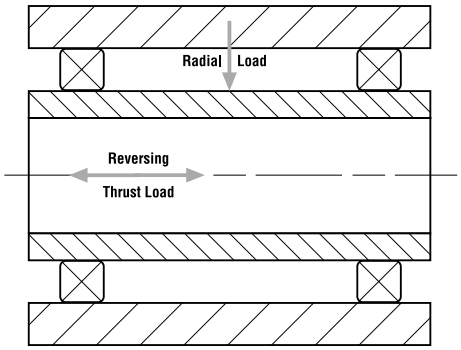
Accuracy

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.

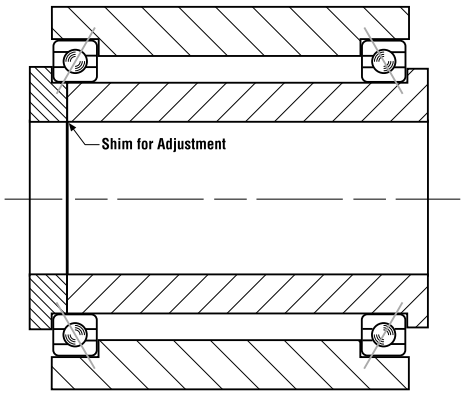
Considering the load condition of Figure 3-19, it can be seen that with internal looseness (diametral clearance) in a Type C or Type X bearing, the thrust load will cause axial movement of the shaft relative to the housing. Because of its unique internal geometry with "built-in" contact angles, a Type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

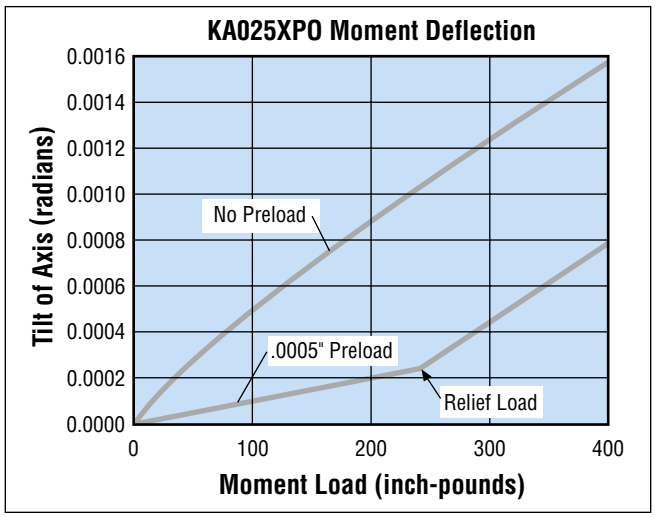
Figure 3-20



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:

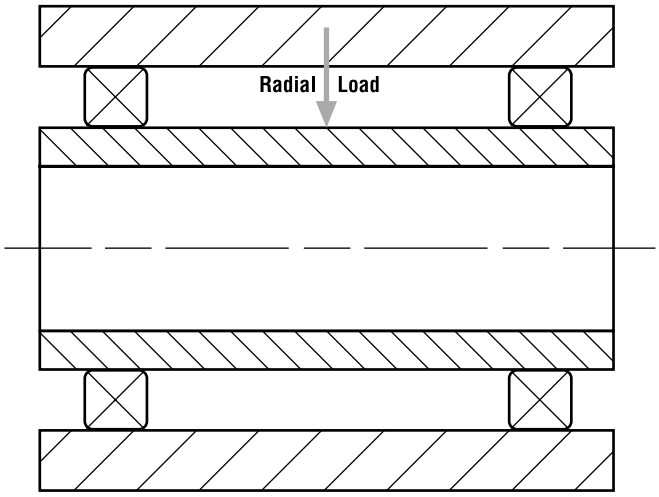
- a breadth of products.
- a wide range of options.
- additional information on our bearings through KAYDON Engineering.

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

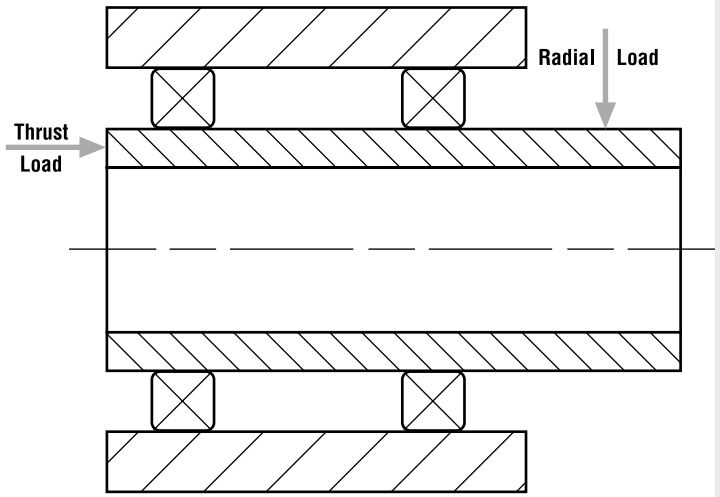
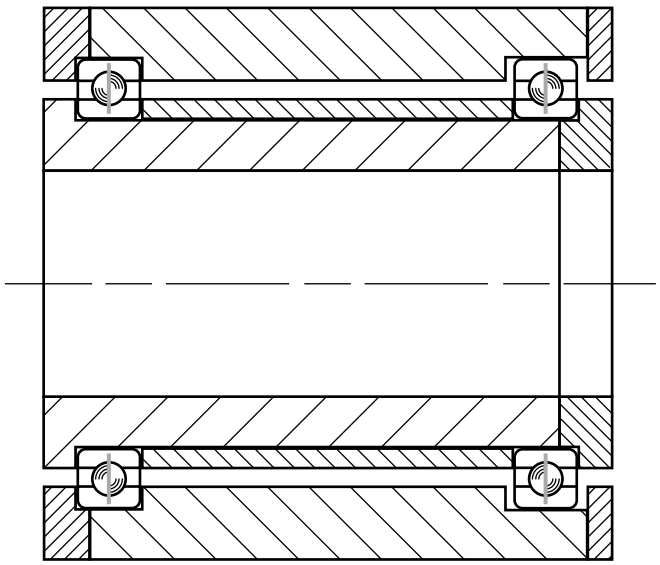


Figure 3-24



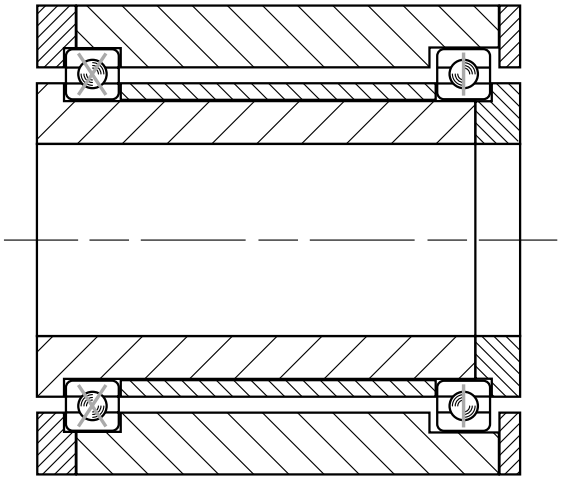
Speed

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

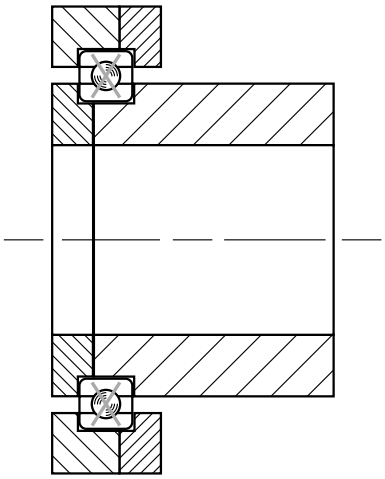


Figure 3-27A - Back to Back

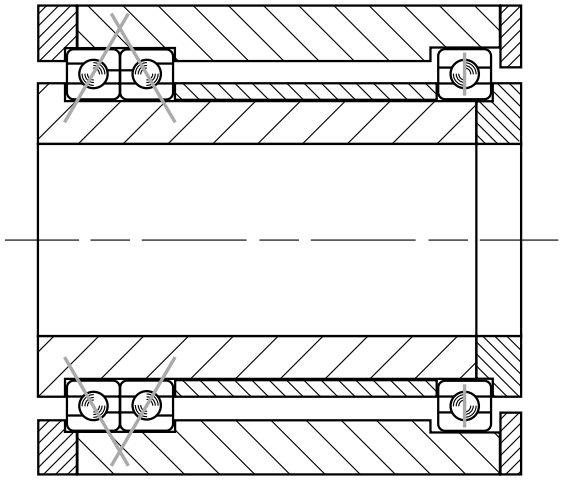
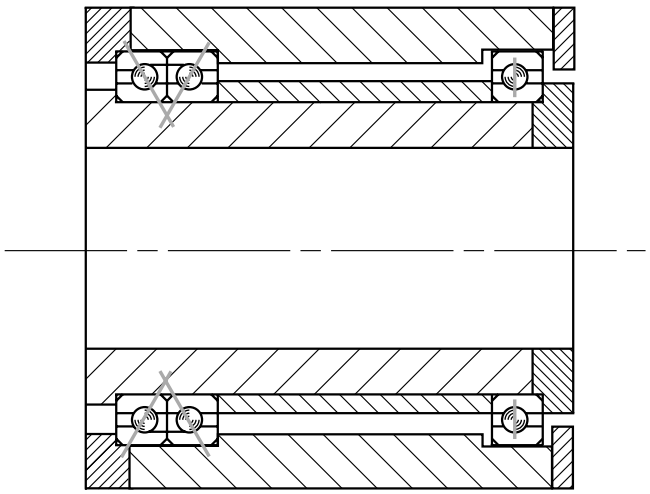
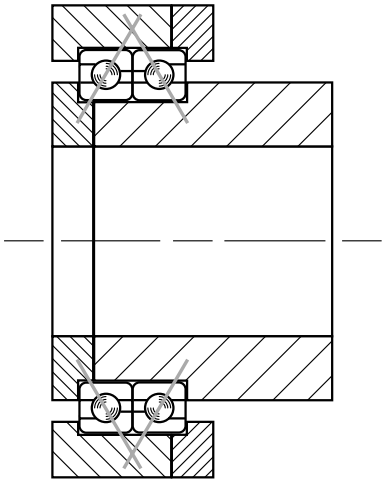


Figure 3-27B - Face to Face



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.

Precision Tolerances and Recommended Fits for REALI-SLIM® Ball Bearings in Normal Applications

TYPE C – PRECISION CLASS 1 (REF. ABEC 1F)												
Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* Before Installation	
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000	Shaft Diameter Nominal		Housing Bore Nominal			
010	–.0004	–.0005	.0005	.0008	+.0004	+.0005	–.0004	–.0008	–.0005	–.0010	.0010	.0016
015	–.0005	–.0005	.0006	.0008	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0012	.0018
017	–.0006	–.0005	.0008	.0010	+.0006	+.0005	–.0006	–.0012	–.0005	–.0010	.0012	.0024
020	–.0006	–.0005	.0008	.0010	+.0006	+.0005	–.0006	–.0012	–.0005	–.0010	.0012	.0024
025	–.0006	–.0005	.0008	.0010	+.0006	+.0005	–.0006	–.0012	–.0005	–.0010	.0012	.0024
030	–.0006	–.0006	.0008	.0010	+.0006	+.0006	–.0006	–.0012	–.0006	–.0012	.0012	.0024
035	–.0008	–.0006	.0010	.0012	+.0008	+.0006	–.0008	–.0016	–.0006	–.0012	.0016	.0028
040	–.0008	–.0006	.0010	.0012	+.0008	+.0006	–.0008	–.0016	–.0006	–.0012	.0016	.0028
042	–.0008	–.0008	.0010	.0014	+.0008	+.0008	–.0008	–.0016	–.0008	.–0016	.0016	.0028
045	–.0008	–.0008	.0010	.0014	+.0008	+.0008	–.0008	–.0016	–.0008	–.0016	.0016	.0028
047	–.0010	–.0008	.0012	.0014	+.0010	+.0008	–.0010	–.0020	–.0008	–.0016	.0020	.0034
050	–.0010	–.0008	.0012	.0014	+.0010	+.0008	–.0010	–.0020	–.0008	–.0016	.0020	.0034
055	–.0010	–.0010	.0012	.0016	+.0010	+.0010	–.0010	–.0020	–.0010	–.0020	.0020	.0034
060	–.0010	–.0010	.0012	.0016	+.0010	+.0010	–.0010	–.0020	–.0010	–.0020	.0020	.0034
065	–.0010	–.0010	.0012	.0016	+.0010	+.0010	–.0010	–.0020	–.0010	–.0020	.0020	.0034
070	–.0010	–.0012	.0012	.0016	+.0010	+.0012	–.0010	–.0020	–.0012	–.0024	.0024	.0042
075	–.0012	–.0012	.0016	.0018	+.0012	+.0012	–.0012	–.0024	–.0012	–.0024	.0024	.0042
080	–.0012	–.0012	.0016	.0018	+.0012	+.0012	–.0012	–.0024	–.0012	–.0024	.0024	.0042
090	–.0012	–.0012	.0016	.0018	+.0012	+.0012	–.0012	–.0024	–.0012	–.0024	.0024	.0042
100	–.0014	–.0014	.0018	.0020	+.0014	+.0014	–.0014	–.0028	–.0014	–.0028	.0028	.0048
110	–.0014	–.0014	.0018	.0020	+.0014	+.0014	–.0014	–.0028	–.0014	–.0028	.0028	.0048
120	–.0014	–.0014	.0018	.0020	+.0014	+.0014	–.0014	–.0028	–.0014	–.0028	.0028	.0048
140	–.0016	–.0016	.0018	.0020	+.0016	+.0016	–.0016	–.0032	–.0016	–.0032	.0032	.0052
160	–.0018	–.0018	.0018	.0020	+.0018	+.0018	–.0018	–.0036	–.0018	–.0036	.0036	.0056
180	–.0018	–.0018	.0020	.0020	+.0018	+.0018	–.0018	–.0036	–.0018	–.0036	.0036	.0056
200	–.0020	–.0020	.0020	.0020	+.0020	+.0020	–.0020	–.0040	–0020	–.0040	.0040	.0060
210	–.0020	–.0020	.0020	.0020	+.0020	+.0020	–.0020	–.0040	–0020	–.0040	.0040	.0060
220	–.0020	–.0020	.0020	.0020	+.0020	+.0020	–.0020	–.0040	–0020	–.0040	.0040	.0060
250	–.0030	–.0030	.0020	.0020	+.0030	+.0030	–.0030	–.0060	–.0030	–.0060	.0060	.0080
300	–.0030	–.0030	.0020	.0020	+.0030	+.0030	–.0030	–.0060	–.0030	–.0060	.0060	.0080
350	–.0040	–.0040	.0020	.0020	+.0040	+.0040	–.0040	–.0080	–.0040	–.0080	.0080	.0100
400	–.0040	–.0040	.0020	.0020	+.0040	+.0040	–.0040	–.0080	–.0040	–.0080	.0080	.0100

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Race Width Tolerance:

Up thru 12" Bearing Bore	+.000 –.005
Over 12" Bearing Bore	+.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR REALI-SLIM® BEARINGS

TYPE X AND A – PRECISION CLASS 1 (REF. ABEC 1F)

Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X" only) Before Installation	
							Shaft Diameter Nominal		Housing Bore Nominal			
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000						
010	–.0004	–.0005	.0003	.0004	+.0004	+.0005	–.0004	–.0008	–.0005	–.0010	.0010	.0015
015	–.0005	–.0005	.0004	.0004	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0012	.0017
017	–.0006	–.0005	.0005	.0005	+.0006	+.0005	–.0006	–.0012	–.0005	–.0010	.0012	.0022
020	–.0006	–.0005	.0005	.0005	+.0006	+.0005	–.0006	–.0012	–.0005	–.0010	.0012	.0022
025	–.0006	–.0005	.0005	.0005	+.0006	+.0005	–.0006	–.0012	–.0005	–.0010	.0012	.0022
030	–.0006	–.0006	.0006	.0006	+.0006	+.0006	–.0006	–.0012	–.0006	–.0012	.0012	.0022
035	–.0008	–.0006	.0006	.0006	+.0008	+.0006	–.0008	–.0016	–.0006	–.0012	.0016	.0026
040	–.0008	–.0006	.0006	.0006	+.0008	+.0006	–.0008	–.0016	–.0006	–.0012	.0016	.0026
042	–.0008	–.0008	.0008	.0008	+.0008	+.0008	–.0008	–.0016	–.0008	.–0016	.0016	.0026
045	–.0008	–.0008	.0008	.0008	+.0008	+.0008	–.0008	–.0016	–.0008	–.0016	.0016	.0026
047	–.0010	–.0008	.0008	.0008	+.0010	+.0008	–.0010	–.0020	–.0008	–.0016	.0020	.0030
050	–.0010	–.0008	.0008	.0008	+.0010	+.0008	–.0010	–.0020	–.0008	–.0016	.0020	.0030
055	–.0010	–.0010	.0010	.0010	+.0010	+.0010	–.0010	–.0020	–.0010	–.0020	.0020	.0030
060	–.0010	–.0010	.0010	.0010	+.0010	+.0010	–.0010	–.0020	–.0010	–.0020	.0020	.0030
065	–.0010	–.0010	.0010	.0010	+.0010	+.0010	–.0010	–.0020	–.0010	–.0020	.0020	.0030
070	–.0010	–.0012	.0010	.0010	+.0010	+.0012	–.0010	–.0020	–.0012	–.0024	.0024	.0034
075	–.0012	–.0012	.0012	.0012	+.0012	+.0012	–.0012	–.0024	–.0012	–.0024	.0024	.0034
080	–.0012	–.0012	.0012	.0012	+.0012	+.0012	–.0012	–.0024	–.0012	–.0024	.0024	.0034
090	–.0012	–.0012	.0012	.0012	+.0012	+.0012	–.0012	–.0024	–.0012	–.0024	.0024	.0034
100	–.0014	–.0014	.0014	.0014	+.0014	+.0014	–.0014	–.0028	–.0014	–.0028	.0028	.0038
110	–.0014	–.0014	.0014	.0014	+.0014	+.0014	–.0014	–.0028	–.0014	–.0028	.0028	.0038
120	–.0014	–.0014	.0014	.0014	+.0014	+.0014	–.0014	–.0028	–.0014	–.0028	.0028	.0038
140	–.0014	–.0014	.0014	.0014	+.0014	+.0014	–.0014	–.0028	–.0014	–.0028	.0028	.0038
160	–.0016	–.0016	.0016	.0016	+.0016	+.0016	–.0016	–.0032	–.0016	–.0032	.0032	.0042
180	–.0016	–.0016	.0016	.0016	+.0016	+.0016	–.0016	–.0032	–.0016	–.0032	.0032	.0042
200	–.0018	–.0018	.0018	.0018	+.0018	+.0018	–.0018	–.0036	–0018	–.0036	.0036	.0046
210	–.0018	–.0018	.0018	.0018	+.0018	+.0018	–.0018	–.0036	–0018	–.0036	.0036	.0046
220	–.0018	–.0018	.0018	.0018	+.0018	+.0018	–.0018	–.0036	–0018	–.0036	.0036	.0046
250	–.0018	–.0018	.0018	.0018	+.0018	+.0018	–.0018	–.0036	–.0018	–.0036	.0036	.0046
300	–.0018	–.0018	.0018	.0018	+.0018	+.0018	–.0018	–.0036	–.0018	–.0036	.0036	.0046
350	–.0020	–.0020	.0020	.0020	+.0020	+.0020	–.0020	–.0040	–.0020	–.0040	.0040	.0050
400	–.0020	–.0020	.0020	.0020	+.0020	+.0020	–.0020	–.0040	–.0020	–.0040	.0040	.0050

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:

Up thru 12" Bearing Bore	+.000 –.010
Over 12" Bearing Bore	+.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:

Up thru 12" Bearing Bore	+.000 –.005
Over 12" Bearing Bore	+.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR REALI-SLIM® BEARINGS

TYPE C, X AND A – PRECISION CLASS 3 (REF. ABEC 3F)

Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X" and "C" only) Before Installation	
							Shaft Diameter Nominal		Housing Bore Nominal			
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000						
010	–.0002	–.0003	.0003	.0004	+.0002	+.0003	–.0002	–.0004	–.0003	–.0006	.0007	.0011
015	–.0003	–.0003	.0004	.0004	+.0003	+.0003	–.0003	–.0006	–.0003	–.0006	.0008	.0012
017	–.0004	–.0004	.0004	.0005	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0018
020	–.0004	–.0004	.0004	.0005	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0018
025	–.0004	–.0004	.0004	.0005	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0018
030	–.0004	–.0004	.0004	.0006	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0018
035	–.0005	–.0004	.0005	.0006	+.0005	+.0004	–.0005	–.0010	–.0004	–.0008	.0010	.0020
040	–.0005	–.0004	.0005	.0006	+.0005	+.0004	–.0005	–.0010	–.0004	–.0008	.0010	.0020
042	–.0005	–.0005	.0005	.0008	+.0005	+.0005	–.0005	–.0010	–.0005	.–0010	.0010	.0020
045	–.0005	–.0005	.0005	.0008	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0020
047	–.0006	–.0005	.0006	.0008	+.0006	+.0005	–.0006	–.0012	–.0005	–.0010	.0012	.0022
050	–.0006	–.0005	.0006	.0008	+.0006	+.0005	–.0006	–.0012	–.0005	–.0010	.0012	.0022
055	–.0006	–.0006	.0006	.0009	+.0006	+.0006	–.0006	–.0012	–.0006	–.0012	.0012	.0022
060	–.0006	–.0006	.0006	.0009	+.0006	+.0006	–.0006	–.0012	–.0006	–.0012	.0012	.0022
065	–.0006	–.0006	.0006	.0009	+.0006	+.0006	–.0006	–.0012	–.0006	–.0012	.0012	.0022
070	–.0006	–.0007	.0006	.0010	+.0006	+.0007	–.0006	–.0012	–.0007	–.0014	.0014	.0024
075	–.0007	–.0007	.0008	.0010	+.0007	+.0007	–.0007	–.0014	–.0007	–.0014	.0014	.0024
080	–.0007	–.0007	.0008	.0010	+.0007	+.0007	–.0007	–.0014	–.0007	–.0014	.0014	.0024
090	–.0007	–.0007	.0008	.0010	+.0007	+.0007	–.0007	–.0014	–.0007	–.0014	.0014	.0024
100	–.0008	–.0008	.0010	.0012	+.0008	+.0008	–.0008	–.0016	–.0008	–.0016	.0016	.0026
110	–.0008	–.0008	.0010	.0012	+.0008	+.0008	–.0008	–.0016	–.0008	–.0016	.0016	.0026
120	–.0008	–.0009	.0010	.0014	+.0008	+.0009	–.0008	–.0016	–.0009	–.0018	.0018	.0028
140	–.0008	–.0009	.0012	.0014	+.0008	+.0009	–.0008	–.0016	–.0009	–.0018	.0018	.0028
160	–.0009	–.0010	.0014	.0016	+.0009	+.0010	–.0009	–.0018	–.0010	–.0020	.0020	.0030
180	–.0009	–.0010	.0014	.0016	+.0009	+.0010	–.0009	–.0018	–.0010	–.0020	.0020	.0030
200	–.0010	–.0012	.0016	.0018	+.0010	+.0012	–.0010	–.0020	–.0012	–.0024	.0024	.0034

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:

Up thru 12" Bearing Bore	+.000 –.010
Over 12" Bearing Bore	+.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:

Up thru 12" Bearing Bore	+.000 –.005
Over 12" Bearing Bore	+.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR REALI-SLIM® BEARINGS

TYPE C, X AND A – PRECISION CLASS 4 (REF. ABEC 5F)

Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout				Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X" and "C" only) Before Installation	
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race		Outer Race		Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000	Shaft Diameter Nominal		Housing Bore Nominal			
			Radial	Axial	Radial	Axial								
010	–.0002	–.0002	.0002	.0003	.0002	.0003	+.0002	+.0002	–.0002	–.0004	–.0002	–.0004	.0005	.0009
015	–.0002	–.0002	.0002	.0003	.0002	.0003	+.0002	+.0002	–.0002	–.0004	–.0002	–.0004	.0005	.0009
017	–.0003	–.0003	.0002	.0003	.0003	.0004	+.0003	+.0003	–.0003	–.0006	–.0003	–.0006	.0006	.0012
020	–.0003	–.0003	.0002	.0003	.0003	.0004	+.0003	+.0003	–.0003	–.0006	–.0003	–.0006	.0006	.0012
025	–.0003	–.0003	.0002	.0003	.0003	.0004	+.0003	+.0003	–.0003	–.0006	–.0003	–.0006	.0006	.0012
030	–.0003	–.0003	.0002	.0003	.0004	.0005	+.0003	+.0003	–.0003	–.0006	–.0003	–.0006	.0006	.0012
035	–.0003	–.0003	.0003	.0004	.0004	.0005	+.0003	+.0003	–.0003	–.0006	–.0003	–.0006	.0006	.0012
040	–.0003	–.0003	.0003	.0004	.0004	.0005	+.0003	+.0003	–.0003	–.0006	–.0003	–.0006	.0006	.0012
042	–.0003	–.0004	.0003	.0004	.0004	.0005	+.0003	+.0004	–.0003	–.0006	–.0004	–.0008	.0008	.0014
045	–.0003	–.0004	.0003	.0004	.0004	.0005	+.0003	+.0004	–.0003	–.0006	–.0004	–.0008	.0008	.0014
047	–.0004	–.0004	.0003	.0004	.0004	.0005	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0014
050	–.0004	–.0004	.0003	.0004	.0004	.0005	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0014
055	–.0004	–.0005	.0003	.0004	.0005	.0006	+.0004	+.0005	–.0004	–.0008	–.0005	–.0010	.0010	.0016
060	–.0004	–.0005	.0003	.0004	.0005	.0006	+.0004	+.0005	–.0004	–.0008	–.0005	–.0010	.0010	.0016
065	–.0004	–.0005	.0003	.0004	.0005	.0006	+.0004	+.0005	–.0004	–.0008	–.0005	–.0010	.0010	.0016
070	–.0004	–.0005	.0003	.0004	.0005	.0006	+.0004	+.0005	–.0004	–.0008	–.0005	–.0010	.0010	.0016
075	–.0005	–.0005	.0004	.0005	.0005	.0006	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0016
080	–.0005	–.0005	.0004	.0005	.0005	.0006	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0016
090	–.0005	–.0005	.0004	.0005	.0005	.0006	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0016
100	–.0005	–.0005	.0005	.0006	.0006	.0007	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0016
110	–.0005	–.0005	.0005	.0006	.0006	.0007	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0016
120	–.0005	–.0006	.0005	.0006	.0007	.0008	+.0005	+.0006	–.0005	–.0010	–.0006	–.0012	.0012	.0018
140	–.0006	–.0006	.0005	.0007	.0007	.0008	+.0006	+.0006	–.0006	–.0012	–.0006	–.0012	.0012	.0018
160	–.0006	–.0007	.0007	.0008	.0008	.0009	+.0006	+.0007	–.0006	–.0012	–.0007	–.0014	.0014	.0020
180	–.0006	–.0007	.0007	.0008	.0008	.0009	+.0006	+.0007	–.0006	–.0012	–.0007	–.0014	.0014	.0020
200	–.0007	–.0008	.0008	.0009	.0009	.0010	+.0007	+.0008	–.0006	–.0014	–.0007	–.0016	.0016	.0022

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:

Up thru 12" Bearing Bore	+.000 –.010
Over 12" Bearing Bore	+.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:

Up thru 12" Bearing Bore	+.000 –.005
Over 12" Bearing Bore	+.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR REALI-SLIM® BEARINGS

TYPE C, X AND A – PRECISION CLASS 6 (REF. ABEC 7F)

Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X"and "C" only) Before Installation	
							Shaft Diameter Nominal		Housing Bore Nominal			
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000						
010	–.00015	–.00020	.00015	.0002	+.00015	+.00020	–.00015	–.00030	–.00020	–.00040	.0004	.0008
015	–.00020	–.00020	.00015	.0002	+.00020	+.00020	–.00020	–.00040	–.00020	–.00040	.0004	.0008
017	–.0002	–.0002	.00015	.0002	+.0002	+.0002	–.0002	–.0004	–.0002	–.0004	.0004	.0010
020	–.0002	–.0002	.00015	.0002	+.0002	+.0002	–.0002	–.0004	–.0002	–.0004	.0004	.0010
025	–.0002	–.0002	.00015	.0002	+.0002	+.0002	–.0002	–.0004	–.0002	–.0004	.0004	.0010
030	–.0002	–.0003	.00015	.0002	+.0002	+.0003	–.0002	–.0004	–.0003	–.0006	.0006	.0012
035	–.00025	–.00030	.0002	.0002	+.00025	+.00030	–.00025	–.00050	–.00030	–.00060	.0006	.0012
040	–.00025	–.00030	.0002	.0002	+.00025	+.00030	–.00025	–.00050	–.00030	–.00060	.0006	.0012
042	–.00025	–.00040	.0002	.0003	+.00025	+.00040	–.00025	–.00050	–.00040	–.00080	.0008	.0014
045	–.00025	–.00040	.0002	.0003	+.00025	+.00040	–.00025	–.00050	–.00040	–.00080	.0008	.0014
047	–.0003	–.0004	.0003	.0003	+.0003	+.0004	–.0003	–.0006	–.0004	–.0008	.0008	.0014
050	–.0003	–.0004	.0003	.0003	+.0003	+.0004	–.0003	–.0006	–.0004	–.0008	.0008	.0014
055	–.0003	–.0004	.0003	.0003	+.0003	+.0004	–.0003	–.0006	–.0004	–.0008	.0008	.0014
060	–.0003	–.0004	.0003	.0003	+.0003	+.0004	–.0003	–.0006	–.0004	–.0008	.0008	.0014
065	–.0003	–.0004	.0003	.0003	+.0003	+.0004	–.0003	–.0006	–.0004	–.0008	.0008	.0014
070	–.0003	–.0004	.0003	.0004	+.0003	+.0004	–.0003	–.0006	–.0004	–.0008	.0008	.0014
075	–.0004	–.0004	.0003	.0004	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0014
080	–.0004	–.0004	.0003	.0004	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0014
090	–.0004	–.0004	.0003	.0004	+.0004	+.0004	–.0004	–.0008	–.0004	–.0008	.0008	.0014
100	–.0005	–.0005	.0004	.0004	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0016
110	–.0005	–.0005	.0004	.0004	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0016
120	–.0005	–.0005	.0004	.0005	+.0005	+.0005	–.0005	–.0010	–.0005	–.0010	.0010	.0016
140	–.0005	–.0006	.0004	.0005	+.0005	+.0006	–.0005	–.0010	–.0006	–.0012	.0012	.0018

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:

Up thru 12" Bearing Bore	+.000 –.010
Over 12" Bearing Bore	+.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:

Up thru 12" Bearing Bore	+.000 –.005
Over 12" Bearing Bore	+.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR ENDURA-SLIM® BEARINGS

TYPE C WITH ENDURAKOTE® PLATING – PRECISION CLASS 1

Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X"and "C" only) Before Installation	
							Shaft Diameter Nominal		Housing Bore Nominal			
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000						
010	-.0006	-.0007	.0005	.0008	.0006	.0007	-.0006	-.0012	-.0007	-.0014	.0010	.0016
015	-.0007	-.0007	.0006	.0008	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0012	.0018
017	-.0008	-.0007	.0008	.0010	.0008	.0007	-.0008	-.0016	-.0007	-.0014	.0012	.0024
020	-.0008	-.0007	.0008	.0010	.0008	.0007	-.0008	-.0016	-.0007	-.0014	.0012	.0024
025	-.0008	-.0007	.0008	.0010	.0008	.0007	-.0008	-.0016	-.0007	-.0014	.0012	.0024
030	-.0008	-.0008	.0008	.0010	.0008	.0008	-.0008	-.0016	-.0008	-.0016	.0012	.0024
035	-.0010	-.0008	.0010	.0012	.0010	.0008	-.0010	-.0020	-.0008	-.0016	.0016	.0028
040	-.0009	-.0007	.0010	.0012	.0009	.0007	-.0009	-.0018	-.0007	-.0014	.0016	.0028
042	-.0009	-.0009	.0010	.0014	.0009	.0009	-.0009	-.0018	-.0009	-.0018	.0016	.0028
045	-.0009	-.0009	.0010	.0014	.0009	.0009	-.0009	-.0018	-.0009	-.0018	.0016	.0028
047	-.0011	-.0009	.0012	.0014	.0011	.0009	-.0011	-.0022	-.0009	-.0018	.0020	.0034
050	-.0011	-.0009	.0012	.0014	.0011	.0009	-.0011	-.0022	-.0009	-.0018	.0020	.0034
055	-.0011	-.0011	.0012	.0016	.0011	.0011	-.0011	-.0022	-.0011	-.0022	.0020	.0034
060	-.0011	-.0011	.0012	.0016	.0011	.0011	-.0011	-.0022	-.0011	-.0022	.0020	.0034
065	-.0011	-.0011	.0012	.0016	.0011	.0011	-.0011	-.0022	-.0011	-.0022	.0020	.0034
070	-.0011	-.0013	.0012	.0016	.0011	.0013	-.0011	-.0022	-.0013	-.0026	.0024	.0042
075	-.0013	-.0013	.0016	.0018	.0013	.0013	-.0013	-.0026	-.0013	-.0026	.0024	.0042
080	-.0013	-.0013	.0016	.0018	.0013	.0013	-.0013	-.0026	-.0013	-.0026	.0024	.0042
090	-.0013	-.0013	.0016	.0018	.0013	.0013	-.0013	-.0026	-.0013	-.0026	.0024	.0042
100	-.0015	-.0015	.0018	.0020	.0015	.0015	-.0015	-.0030	-.0015	-.0030	.0028	.0048
110	-.0015	-.0015	.0018	.0020	.0015	.0015	-.0015	-.0030	-.0015	-.0030	.0028	.0048
120	-.0015	-.0015	.0018	.0020	.0015	.0015	-.0015	-.0030	-.0015	-.0030	.0028	.0048
140	-.0017	-.0017	.0018	.0020	.0017	.0017	-.0017	-.0034	-.0017	-.0034	.0032	.0052
160	-.0019	-.0019	.0018	.0020	.0019	.0019	-.0019	-.0038	-.0019	-.0038	.0036	.0056
180	-.0019	-.0019	.0020	.0020	.0019	.0019	-.0019	-.0038	-.0019	-.0038	.0036	.0056
200	-.0021	-.0021	.0020	.0020	.0021	.0021	-.0021	-.0042	-.0021	-.0042	.0040	.0060
210	-.0021	-.0021	.0020	.0020	.0021	.0021	-.0021	-.0042	-.0021	-.0042	.0040	.0060
220	-.0021	-.0021	.0020	.0020	.0021	.0021	-.0021	-.0042	-.0021	-.0042	.0040	.0060
250	-.0031	-.0031	.0020	.0020	.0031	.0031	-.0031	-.0062	-.0031	-.0062	.0060	.0080
300	-.0031	-.0031	.0020	.0020	.0031	.0031	-.0031	-.0062	-.0031	-.0062	.0060	.0080
350	-.0041	-.0041	.0020	.0020	.0041	.0041	-.0041	-.0082	-.0041	-.0082	.0080	.0100
400	-.0041	-.0041	.0020	.0020	.0041	.0041	-.0041	-.0082	-.0041	-.0082	.0080	.0100

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:
Up thru 12" Bearing Bore +.000 –.010
Over 12" Bearing Bore +.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:
Up thru 12" Bearing Bore +.000 –.005
Over 12" Bearing Bore +.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR ENDURA-SLIM® BEARINGS

TYPE X AND A WITH ENDURAKOTE® PLATING - PRECISION CLASS 1

Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X"and "C" only) Before Installation	
							Shaft Diameter Nominal		Housing Bore Nominal			
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000						
010	-.0006	-.0007	.0003	.0004	.0006	.0007	-.0006	-.0012	-.0007	-.0014	.0010	.0015
015	-.0007	-.0007	.0004	.0004	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0012	.0017
017	-.0008	-.0007	.0005	.0005	.0008	.0007	-.0008	-.0016	-.0007	-.0014	.0012	.0022
020	-.0008	-.0007	.0005	.0005	.0008	.0007	-.0008	-.0016	-.0007	-.0014	.0012	.0022
025	-.0008	-.0007	.0005	.0005	.0008	.0007	-.0008	-.0016	-.0007	-.0014	.0012	.0022
030	-.0008	-.0008	.0006	.0006	.0008	.0008	-.0008	-.0016	-.0008	-.0016	.0012	.0022
035	-.0010	-.0008	.0006	.0006	.0010	.0008	-.0010	-.0020	-.0008	-.0016	.0016	.0026
040	-.0009	-.0007	.0006	.0006	.0009	.0007	-.0009	-.0018	-.0007	-.0014	.0016	.0026
042	-.0009	-.0009	.0008	.0008	.0009	.0009	-.0009	-.0018	-.0009	-.0018	.0016	.0026
045	-.0009	-.0009	.0008	.0008	.0009	.0009	-.0009	-.0018	-.0009	-.0018	.0016	.0026
047	-.0011	-.0009	.0008	.0008	.0011	.0009	-.0011	-.0022	-.0009	-.0018	.0020	.0030
050	-.0011	-.0009	.0008	.0008	.0011	.0009	-.0011	-.0022	-.0009	-.0018	.0020	.0030
055	-.0011	-.0011	.0010	.0010	.0011	.0011	-.0011	-.0022	-.0011	-.0022	.0020	.0030
060	-.0011	-.0011	.0010	.0010	.0011	.0011	-.0011	-.0022	-.0011	-.0022	.0020	.0030
065	-.0011	-.0011	.0010	.0010	.0011	.0011	-.0011	-.0022	-.0011	-.0022	.0020	.0030
070	-.0011	-.0013	.0010	.0010	.0011	.0013	-.0011	-.0022	-.0013	-.0026	.0024	.0034
075	-.0013	-.0013	.0012	.0012	.0013	.0013	-.0013	-.0026	-.0013	-.0026	.0024	.0034
080	-.0013	-.0013	.0012	.0012	.0013	.0013	-.0013	-.0026	-.0013	-.0026	.0024	.0034
090	-.0013	-.0013	.0012	.0012	.0013	.0013	-.0013	-.0026	-.0013	-.0026	.0024	.0034
100	-.0015	-.0015	.0014	.0014	.0015	.0015	-.0015	-.0030	-.0015	-.0030	.0028	.0038
110	-.0015	-.0015	.0014	.0014	.0015	.0015	-.0015	-.0030	-.0015	-.0030	.0028	.0038
120	-.0015	-.0015	.0014	.0014	.0015	.0015	-.0015	-.0030	-.0015	-.0030	.0028	.0038
140	-.0015	-.0015	.0014	.0014	.0015	.0015	-.0015	-.0030	-.0015	-.0030	.0028	.0038
160	-.0017	-.0017	.0016	.0016	.0017	.0017	-.0017	-.0034	-.0017	-.0034	.0032	.0042
180	-.0017	-.0017	.0016	.0016	.0017	.0017	-.0017	-.0034	-.0017	-.0034	.0032	.0042
200	-.0019	-.0019	.0018	.0018	.0019	.0019	-.0019	-.0038	-.0019	-.0038	.0036	.0046
210	-.0019	-.0019	.0018	.0018	.0019	.0019	-.0019	-.0038	-.0019	-.0038	.0036	.0046
220	-.0019	-.0019	.0018	.0018	.0019	.0019	-.0019	-.0038	-.0019	-.0038	.0036	.0046
250	-.0019	-.0019	.0018	.0018	.0019	.0019	-.0019	-.0038	-.0019	-.0038	.0036	.0046
300	-.0019	-.0019	.0018	.0018	.0019	.0019	-.0019	-.0038	-.0019	-.0038	.0036	.0046
350	-.0021	-.0021	.0020	.0020	.0021	.0021	-.0021	-.0042	-.0021	-.0042	.0040	.0050
400	-.0021	-.0021	.0020	.0020	.0021	.0021	-.0021	-.0042	-.0021	-.0042	.0040	.0050

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:

Up thru 12" Bearing Bore	+.000 –.010
Over 12" Bearing Bore	+.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:

Up thru 12" Bearing Bore	+.000 –.005
Over 12" Bearing Bore	+.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR ENDURA-SLIM® BEARINGS

TYPE C, X, AND A WITH ENDURAKOTE® PLATING – PRECISION CLASS 3

Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X"and "C" only) Before Installation	
							Shaft Diameter Nominal		Housing Bore Nominal			
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000						
010	-.0004	-.0005	.0003	.0004	.0004	.0005	-.0004	-.0008	-.0005	-.0010	.0007	.0011
015	-.0005	-.0005	.0004	.0004	.0005	.0005	-.0005	-.0010	-.0005	-.0010	.0008	.0012
017	-.0006	-.0006	.0004	.0005	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0018
020	-.0006	-.0006	.0004	.0005	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0018
025	-.0006	-.0006	.0004	.0005	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0018
030	-.0006	-.0006	.0004	.0006	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0018
035	-.0007	-.0006	.0005	.0006	.0007	.0006	-.0007	-.0014	-.0006	-.0012	.0010	.0020
040	-.0007	-.0006	.0005	.0006	.0007	.0006	-.0007	-.0014	-.0006	-.0012	.0010	.0020
042	-.0007	-.0007	.0005	.0008	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0020
045	-.0007	-.0007	.0005	.0008	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0020
047	-.0008	-.0007	.0006	.0008	.0008	.0007	-.0008	-.0016	-.0007	-.0014	.0012	.0022
050	-.0008	-.0007	.0006	.0008	.0008	.0007	-.0008	-.0016	-.0007	-.0014	.0012	.0022
055	-.0008	-.0008	.0006	.0009	.0008	.0008	-.0008	-.0016	-.0008	-.0016	.0012	.0022
060	-.0008	-.0008	.0006	.0009	.0008	.0008	-.0008	-.0016	-.0008	-.0016	.0012	.0022
065	-.0008	-.0008	.0006	.0009	.0008	.0008	-.0008	-.0016	-.0008	-.0016	.0012	.0022
070	-.0008	-.0009	.0006	.0010	.0008	.0009	-.0008	-.0016	-.0009	-.0018	.0014	.0024
075	-.0009	-.0009	.0008	.0010	.0009	.0009	-.0009	-.0018	-.0009	-.0018	.0014	.0024
080	-.0009	-.0009	.0008	.0010	.0009	.0009	-.0009	-.0018	-.0009	-.0018	.0014	.0024
090	-.0009	-.0009	.0008	.0010	.0009	.0009	-.0009	-.0018	-.0009	-.0018	.0014	.0024
100	-.0010	-.0010	.0010	.0012	.0010	.0010	-.0010	-.0020	-.0010	-.0020	.0016	.0026
110	-.0010	-.0010	.0010	.0012	.0010	.0010	-.0010	-.0020	-.0010	-.0020	.0016	.0026
120	-.0010	-.0011	.0010	.0014	.0010	.0011	-.0010	-.0020	-.0011	-.0022	.0018	.0028
140	-.0010	-.0011	.0012	.0014	.0010	.0011	-.0010	-.0020	-.0011	-.0022	.0018	.0028
160	-.0011	-.0012	.0014	.0016	.0011	.0012	-.0011	-.0022	-.0012	-.0024	.0020	.0030
180	-.0011	-.0012	.0014	.0016	.0011	.0012	-.0011	-.0022	-.0012	-.0024	.0020	.0030
200	-.0012	-.0014	.0016	.0018	.0012	.0014	-.0012	-.0024	-.0014	-.0028	.0024	.0034

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:
Up thru 12" Bearing Bore +.000 –.010
Over 12" Bearing Bore +.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:
Up thru 12" Bearing Bore +.000 –.005
Over 12" Bearing Bore +.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR ENDURA-SLIM® BEARINGS

TYPE C, X, AND A WITH ENDURAKOTE® PLATING – PRECISION CLASS 4

Bearing Size (inch series)	Bearing Diameters		Radial and Axial Runout				Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X" and "C" Only) Before Installation	
	Bearing Bore Nominal +.0000	Bearing OD Nominal +.0000	Inner Race		Outer Race		Shaft Diameter Nominal –.0000	Housing Bore Nominal –.0000	Shaft Diameter Nominal		Housing Bore Nominal			
			Radial	Axial	Radial	Axial								
010	-.0004	-.0004	.0002	.0003	.0002	.0003	.0004	.0004	-.0004	-.0008	-.0004	-.0008	.0005	.0009
015	-.0004	-.0004	.0002	.0003	.0002	.0003	.0004	.0004	-.0004	-.0008	-.0004	-.0008	.0005	.0009
017	-.0005	-.0005	.0002	.0003	.0003	.0004	.0005	.0005	-.0005	-.0010	-.0005	-.0010	.0006	.0012
020	-.0005	-.0005	.0002	.0003	.0003	.0004	.0005	.0005	-.0005	-.0010	-.0005	-.0010	.0006	.0012
025	-.0005	-.0005	.0002	.0003	.0003	.0004	.0005	.0005	-.0005	-.0010	-.0005	-.0010	.0006	.0012
030	-.0005	-.0005	.0002	.0003	.0004	.0005	.0005	.0005	-.0005	-.0010	-.0005	-.0010	.0006	.0012
035	-.0005	-.0005	.0003	.0004	.0004	.0005	.0005	.0005	-.0005	-.0010	-.0005	-.0010	.0006	.0012
040	-.0005	-.0005	.0003	.0004	.0004	.0005	.0005	.0005	-.0005	-.0010	-.0005	-.0010	.0006	.0012
042	-.0005	-.0006	.0003	.0004	.0004	.0005	.0005	.0006	-.0005	-.0010	-.0006	-.0012	.0008	.0014
045	-.0005	-.0006	.0003	.0004	.0004	.0005	.0005	.0006	-.0005	-.0010	-.0006	-.0012	.0008	.0014
047	-.0006	-.0006	.0003	.0004	.0004	.0005	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0014
050	-.0006	-.0006	.0003	.0004	.0004	.0005	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0014
055	-.0006	-.0007	.0003	.0004	.0005	.0006	.0006	.0007	-.0006	-.0012	-.0007	-.0014	.0010	.0016
060	-.0006	-.0007	.0003	.0004	.0005	.0006	.0006	.0007	-.0006	-.0012	-.0007	-.0014	.0010	.0016
065	-.0006	-.0007	.0003	.0004	.0005	.0006	.0006	.0007	-.0006	-.0012	-.0007	-.0014	.0010	.0016
070	-.0006	-.0007	.0003	.0004	.0005	.0006	.0006	.0007	-.0006	-.0012	-.0007	-.0014	.0010	.0016
075	-.0007	-.0007	.0004	.0005	.0005	.0006	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0016
080	-.0007	-.0007	.0004	.0005	.0005	.0006	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0016
090	-.0007	-.0007	.0004	.0005	.0005	.0006	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0016
100	-.0007	-.0007	.0005	.0006	.0006	.0007	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0016
110	-.0007	-.0007	.0005	.0006	.0006	.0007	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0016
120	-.0007	-.0008	.0005	.0006	.0007	.0008	.0007	.0008	-.0007	-.0014	-.0008	-.0016	.0012	.0018
140	-.0008	-.0008	.0005	.0007	.0007	.0008	.0008	.0008	-.0008	-.0016	-.0008	-.0016	.0012	.0018
160	-.0008	-.0009	.0007	.0008	.0008	.0009	.0008	.0009	-.0008	-.0016	-.0009	-.0018	.0014	.0020
180	-.0008	-.0009	.0007	.0008	.0008	.0009	.0008	.0009	-.0008	-.0016	-.0009	-.0018	.0014	.0020
200	-.0009	-.0010	.0008	.0009	.0009	.0010	.0009	.0010	-.0009	-.0018	-.0010	-.0020	.0016	.0022

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:

Up thru 12" Bearing Bore	+.000 –.010
Over 12" Bearing Bore	+.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:

Up thru 12" Bearing Bore	+.000 –.005
Over 12" Bearing Bore	+.000 –.010

PRECISION TOLERANCES AND RECOMMENDED FITS FOR ENDURA-SLIM® BEARINGS

TYPE C, X, AND A WITH ENDURAKOTE® PLATING – PRECISION CLASS 6

Bearing Size (Inch Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance* (Type "X"and "C" only) Before Installation	
							Shaft Diameter Nominal		Housing Bore Nominal			
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000						
010	-.00035	-.0004	.00015	.0002	.00035	.0004	-.00035	-.0007	-.0004	-.0008	.0004	.0008
015	-.0004	-.0004	.00015	.0002	.0004	.0004	-.0004	-.0008	-.0004	-.0008	.0004	.0008
017	-.0004	-.0004	.00015	.0002	.0004	.0004	-.0004	-.0008	-.0004	-.0008	.0004	.0010
020	-.0004	-.0004	.00015	.0002	.0004	.0004	-.0004	-.0008	-.0004	-.0008	.0004	.0010
025	-.0004	-.0004	.00015	.0002	.0004	.0004	-.0004	-.0008	-.0004	-.0008	.0004	.0010
030	-.0004	-.0005	.00015	.0002	.0004	.0005	-.0004	-.0008	-.0005	-.0010	.0006	.0012
035	-.00045	-.0005	.0002	.0002	.00045	.0005	-.00045	-.0009	-.0005	-.0010	.0006	.0012
040	-.00045	-.0005	.0002	.0002	.00045	.0005	-.00045	-.0009	-.0005	-.0010	.0006	.0012
042	-.00045	-.0006	.0002	.0003	.00045	.0006	-.00045	-.0009	-.0006	-.0012	.0008	.0014
045	-.00045	-.0006	.0002	.0003	.00045	.0006	-.00045	-.0009	-.0006	-.0012	.0008	.0014
047	-.0005	-.0006	.0003	.0003	.0005	.0006	-.0005	-.0010	-.0006	-.0012	.0008	.0014
050	-.0005	-.0006	.0003	.0003	.0005	.0006	-.0005	-.0010	-.0006	-.0012	.0008	.0014
055	-.0005	-.0006	.0003	.0003	.0005	.0006	-.0005	-.0010	-.0006	-.0012	.0008	.0014
060	-.0005	-.0006	.0003	.0003	.0005	.0006	-.0005	-.0010	-.0006	-.0012	.0008	.0014
065	-.0005	-.0006	.0003	.0003	.0005	.0006	-.0005	-.0010	-.0006	-.0012	.0008	.0014
070	-.0005	-.0006	.0003	.0004	.0005	.0006	-.0005	-.0010	-.0006	-.0012	.0008	.0014
075	-.0006	-.0006	.0003	.0004	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0014
080	-.0006	-.0006	.0003	.0004	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0014
090	-.0006	-.0006	.0003	.0004	.0006	.0006	-.0006	-.0012	-.0006	-.0012	.0008	.0014
100	-.0007	-.0007	.0004	.0004	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0016
110	-.0007	-.0007	.0004	.0004	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0016
120	-.0007	-.0007	.0004	.0005	.0007	.0007	-.0007	-.0014	-.0007	-.0014	.0010	.0016
140	-.0007	-.0008	.0004	.0005	.0007	.0008	-.0007	-.0014	-.0008	-.0016	.0012	.0018

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in inches.

Total Width Tolerance—Duplexed Type A Bearings:

Up thru 12" Bearing Bore	+.000 –.010
Over 12" Bearing Bore	+.000 –.020

Race Width Tolerance—Single Type C, X, A Bearings:

Up thru 12" Bearing Bore	+.000 –.005
Over 12" Bearing Bore	+.000 –.010

Precision Tolerances and Recommended Fits for REALI-SLIM MM™ Metric Series Bearings shown on pages 54 thru 59

KAYDON class 1 for A, C, X type bearings All dimensions in millimeters.

Bearing Size (mm Series)	Bearing Diameters		Radial & Axial Runout		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting				Bearing Diametral Clearance*	
	Bearing Bore Nominal +.0000	Bearing O.D. Nominal +.0000	Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000	Shaft Diameter Nominal		Housing Bore Nominal		Before Installation	
020	-.010	-.010	.008	.010	+.010	+.010	-.010	-.020	-.010	-.020	0.025	0.038
025	-.010	-.010	.008	.010	+.010	+.010	-.010	-.020	-.010	.020	0.025	0.038
050	-.012	-.013	.013	.013	+.012	+.013	-.012	-.024	-.013	-.026	0.030	0.056
060	-.015	-.013	.013	.013	+.015	+.013	-.015	-.030	-.015	-.030	0.030	0.056
070	-.015	-.015	.015	.015	+.015	+.015	-.015	-.030	-.015	-.030	0.030	0.056
080	-.015	-.015	.015	.015	+.015	+.015	-.015	-.030	-.015	-.030	0.030	0.056
090	-.020	-.015	.015	.015	+.020	+.015	-.020	-.040	-.020	-.040	0.041	0.066
100	-.020	-.015	.015	.015	+.020	+.015	-.020	-.040	-.020	-.040	0.041	0.066
110	-.020	-.018	.015	.020	+.020	+.018	-.020	-.040	-.020	-.040	0.041	0.066
120	-.020	-.018	.020	.020	+.020	+.018	-.020	-.036	-.020	-.036	0.041	0.066
130	-.025	-.018	.025	.025	+.025	+.018	-.025	-.051	-.018	-.036	0.051	0.076
140	-.025	-.025	.025	.025	+.025	+.025	-.025	-.051	-.025	-.051	0.051	0.076
150	-.025	-.025	.025	.025	+.025	+.025	-.025	-.051	-.025	-.051	0.051	0.076
160	-.025	-.025	.025	.025	+.025	+.025	-.025	-.051	-.025	-.051	0.051	0.076
170	-.025	-.025	.025	.025	+.025	+.025	-.025	-.051	-.025	-.051	0.051	0.076
180	-.025	-.030	.025	.025	+.025	+.030	-.025	-.051	-.030	-.061	0.051	0.076
190	-.025	-.030	.025	.025	+.025	+.030	-.025	-.051	-.030	-.061	0.051	0.076
200	-.030	-.030	.030	.030	+.030	+.030	-.030	-.061	-.030	-.061	0.061	0.086
250	-.036	-.036	.046	.051	+.036	+.036	-.036	-.071	-.036	-.071	0.071	0.100
300	-.036	-.036	.046	.051	+.036	+.036	-.036	-.071	-.036	-.071	0.071	0.100
320	-.036	-.036	.046	.051	+.036	+.036	-.036	-.071	-.036	-.071	0.071	0.100
340	-.036	-.036	.046	.051	+.036	+.036	-.036	-.071	-.036	-.071	0.071	0.100
360	-.036	-.036	.046	.051	+.036	+.036	-.036	-.071	-.036	-.071	0.071	0.100

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in millimeters.

Total Width Tolerance—Duplexed Type A Bearings:
Up thru 300 mm Bearing Bore +.000 –.254
Over 300 mm Bearing Bore +.000 –.508

Race Width Tolerance—Single Type C, X, A Bearings:
Up thru 300 mm Bearing Bore +.000 –.127
Over 300 mm Bearing Bore +.000 –.254

Precision Tolerances and Recommended Fits for ULTRA-SLIM™ Bearings shown on page 61

KAYDON class 1 for A, C, X type bearings All dimensions in millimeters.

Bearing Size (mm Series)	① Bore and O.D. Tolerances Nominal +0.000	② Radial and Axial Race Runouts		Rotating Shaft or Duplex DF Mounting		Stationary Shaft or Duplex DB Mounting		Bearing Diametral Clearance*, Type X & C Before Installation	
		Inner Race	Outer Race	Shaft Diameter Nominal +.0000	Housing Bore Nominal +.0000	Shaft Diameter Nominal	Housing Bore Nominal		
035	-0.013	0.010	0.010	35 +0.013/-0.000	41 +0.013/-0.000	34.987 +0.000/-0.013	40.987 +0.000/-0.013	0.030	0.046
060	-0.013	0.013	0.013	60 +0.013/-0.000	66 +0.013/-0.000	59.987 +0.000/-0.013	65.987 +0.000/-0.013	0.030	0.046
070	-0.013	0.015	0.015	70 +0.013/-0.000	76 +0.013/-0.000	69.987 +0.000/-0.013	75.987 +0.000/-0.013	0.030	0.046
074	-0.013	0.015	0.015	74 +0.013/-0.000	80 +0.013/-0.000	73.987 +0.000/-0.013	79.987 +0.000/-0.013	0.030	0.046
080	-0.013	0.015	0.015	80 +0.013/-0.000	86 +0.013/-0.000	79.987 +0.000/-0.013	85.987 +0.000/-0.013	0.030	0.046
090	-0.013	0.015	0.015	90 +0.013/-0.000	96 +0.013/-0.000	89.987 +0.000/-0.013	95.987 +0.000/-0.013	0.030	0.046
100	-0.013	0.015	0.015	100 +0.013/-0.000	106 +0.013/-0.000	99.987 +0.000/-0.013	105.987 +0.000/-0.013	0.030	0.046
110	-0.013	0.020	0.020	110 +0.013/-0.000	116 +0.013/-0.000	109.987 +0.000/-0.013	115.987 +0.000/-0.013	0.030	0.046
120	-0.013	0.020	0.020	120 +0.013/-0.000	126 +0.013/-0.000	119.987 +0.000/-0.013	125.987 +0.000/-0.013	0.030	0.046
130	-0.013	0.020	0.020	130 +0.013/-0.000	136 +0.013/-0.000	129.987 +0.000/-0.013	135.987 +0.000/-0.013	0.030	0.046
140	-0.013	0.025	0.025	140 +0.013/-0.000	146 +0.013/-0.000	139.987 +0.000/-0.013	145.987 +0.000/-0.013	0.030	0.046
150	-0.013	0.025	0.025	150 +0.013/-0.000	156 +0.013/-0.000	149.987 +0.000/-0.013	155.987 +0.000/-0.013	0.030	0.046
160	-0.013	0.025	0.025	160 +0.013/-0.000	166 +0.013/-0.000	159.987 +0.000/-0.013	165.987 +0.000/-0.013	0.030	0.046
170	-0.013	0.025	0.025	170 +0.013/-0.000	176 +0.013/-0.000	169.987 +0.000/-0.013	175.987 +0.000/-0.013	0.030	0.046

① Diameter tolerances apply to average dimensions. Due to the thin nature of these bearings, they cannot be measured with 2 point gauges.

② The runout values apply to individual bearing races.

* Diametral clearance after installation theoretically can range rather widely if all contributing bearing, housing, and shaft tolerances are at either of their extremes. Diametral clearances shown do not apply to Type A (angular contact) bearings.

Listed shaft and housing diameters are for steel supports with standard bearing diametral clearance. Recommended shaft and housing diameters can change greatly based on orientation, temperature, speed, non-standard diametral clearances, and desired performance characteristics. Contact KAYDON for design assistance when required.

All dimensions in millimeters.

Race Width Tolerance-Single Type C, X, A Bearings:
All sizes +.000 -.127

CONTACT KAYDON AT—

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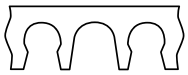
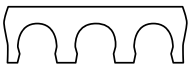
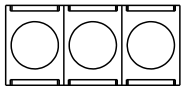
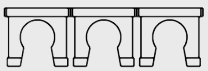
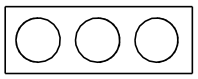
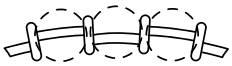
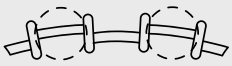
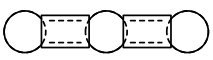
Section 4—Separator Types, Ball Count, and Performance

Overview of Separator Types Used in REALI-SLIM® Bearings

Code Letter*	Description	Design Features	Precautions	Material	Design
P	One piece formed ring with "snapover" pockets.	Standard ball complement. Used in Type C and X bearings for "KA" through "KG" cross-section bearings.	Commercial type cage, not recommended for low torque applications. Consult factory for temperatures below -65°F and above 250°F.	Brass or non-metallic composite.	
R	One piece formed ring with circular pockets.	Standard ball complement. Used in Type A bearings for "KA" through "KG" cross-section bearings.	Commercial type cage, not recommended for low torque applications. Consult factory for temperatures below -65°F and above 250°F.	Brass or non-metallic composite.	
L	One piece molded ring with "snapover" pockets.	Standard ball complement. Used in Type C and X KAA cross-section bearings.	Consult factory for temperatures below -65°F and above 250°F.	Nylon. Fiberglass reinforced.	
G	One piece molded ring with circular pockets.	Standard ball complement. Used in Type A KAA cross-section bearings.	Consult factory for temperatures below -65°F and above 250°F.	Nylon. Fiberglass reinforced.	
D	One piece machined ring with "snapover" pockets.	Standard ball complement. Used in Type C and X bearing when low torque, lightweight or vacuum impregnation is required.	Not recommended above 250°F. Longer lead time and higher cost than "P" type separators.	Phenolic laminate.	
H	One piece machined ring with circular pockets.	Standard ball complement. Used in Type A bearing when low torque, lightweight or vacuum impregnation is required.	Not recommended above 250°F. Longer lead time and higher cost than "R" type separators. Use toroid ball spacer when possible.	Phenolic laminate.	
N	Molded strip with "snap over" pockets	Slightly higher ball count, used in Type C and X bearings. Available for all diameters over 4 inches.	Shaft or housing protrusions can grab separator and remove from bearing. 180°F max suggested operating temp.	Nylon 12	
J	Molded strip with circular pockets	Slightly higher ball count, used in Type A bearings. Available for all diameters over 4 inches.	180°F max suggested operating temp.	Nylon 12	
X	One piece molded ring with "snap over" pockets	Excellent for vacuums	Limited availability	PEEK	
Q	One piece molded ring with circular pockets	Excellent for vacuums	Limited availability	PEEK	
M	Formed wire strip or segmental cage with "snapover" pockets.	Increased ball complement. Used in Type A, C, and X bearings for greater capacity (approx. 150%) and higher temperature.	Higher torque and lower speed capability than "R" type separators. Comparatively high wear rate. Requires loading notch for "C" and "X" bearings.	17-7 PH stainless steel	
W	Formed wire strip or segmental cage with "snapover" pockets.	Used in Type C and X bearings for high temperature applications. Standard ball complement.	Higher torque and lower speed capability than "R" type separators. Comparatively high wear rate.	17-7 PH stainless steel	
F	Full complement bearing.	Max. ball complement. Used in Type C, X, and A bearings for maximum capacity and stiffness.	High torque and low limiting speed due to ball rubbing. Not recommended for dynamic applications. Loading notches are required for "C" and "X" bearings.	Steel (Per ABMA Standard 10).	
S	Helical coil spring.	Reduced ball complement. Used in Type C and X bearings for low torque and high temperature.	Increased assembly cost. Should only be considered when PTFE spacer slugs cannot be used. Slow speed and light load only.	300 Series stainless steel.	
Z	Spacer slugs.	Standard ball complement. Used in Type C or X bearings for low torque. Prevents separator wind-up.	Not recommended for temperatures greater than 250°F or speeds in excess of 500 ft/min pitch line velocity. (Example: KA040CZ0 max speed = 450 rpm).	PTFE tubing	
Z	Toroid ball spacers.	Increased ball complement. Used in Type A bearings for low torque. Prevents separator wind-up.	Not recommended for speeds greater than 500 ft/min pitch line velocity. PTFE is limited to 250°F. Vespel® is limited to 500°F.	PTFE or Vespel® SP-1 polyamide plastic.	
Z	Spacer ball.	Requires a loading notch for C and X assembly. Low speed capability. Relatively high torque.	Increased ball complement. Used in Type A bearings for low torque. Prevents separator wind-up.	Steel per ABMA Standard 10. (Spacer balls are smaller than load carrying balls.)	

*Code descriptions are Position 7 of bearing identification number - see page 13.

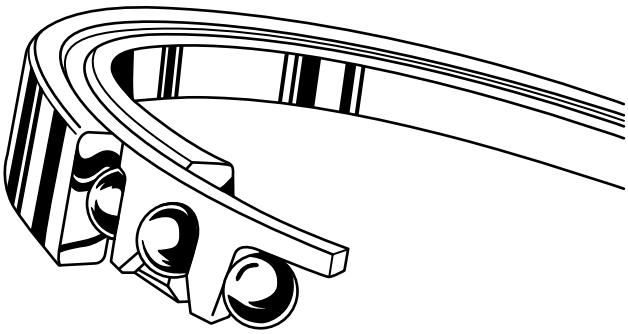
Separator Types

The principal function of a bearing separator is to space the rolling elements uniformly, thereby preventing contact between them. Minute differentials in rolling element motion result from differences in individual rolling element loads and the inherent elasticity of bearing and mounting components. Without a separator some rolling elements will eventually contact each other. Due to the shape of the rolling elements and the opposite direction of motion of the contacting surfaces, a combination of relatively high contact stress and rapid motion is possible. Consequent abrasion of the rolling elements and residue of wear in the raceways affect life and torque characteristics, limiting the use of full complement bearings to slow speed applications where relatively large torque variations can be tolerated.

KAYDON separators for REALI-SLIM® bearings are designated by a single letter character in coded part numbers (page 13), standard P, R, L, and G separators have proved to be suitable for a wide range of operating conditions. Requirements, however, may dictate the use of different materials. This may affect capacities. For assistance in selecting REALI-SLIM® bearings, contact KAYDON Engineering. Operating temperatures for various separator materials are shown on page 93.

Continuous Ring "Snapover Pocket" Separator

Figure 4-1 - Snapover Pocket



Designed for use in bearing types C and X, this style is installed after Conrad assembly of the races and balls. The tangs of the alternate "snap" pockets deform elastically to snap over the balls for retention of the separator. Centered on the balls at room temperature, the separator becomes outer race land riding or inner race land riding when temperatures cause differential thermal expansion or contraction.

Close control of roundness and wall thickness insures effective piloting in either case, limiting separator "whip" and friction between the separator and race lands for smooth operation.

Different materials are available for unusual operating conditions including stainless steel and non-metallics such as phenolic laminate, PTFE, and PEEK.

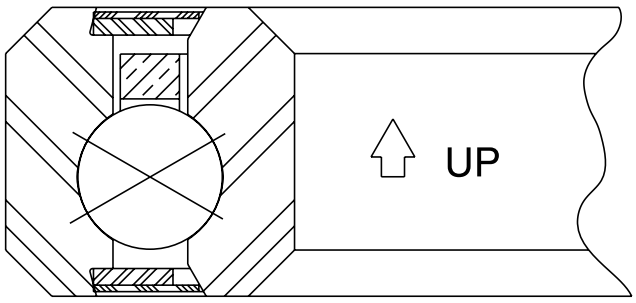
- Stainless steel separators are used in stainless steel bearings or high temperature applications for corrosion resistance.
- Phenolic laminate is used where light weight and/or lubricant absorption is desired.
- The "snap-over" non-metallic separator is ideal for high-speed applications of bearings too small in cross section for the two-piece riveted design (bearing Series C and lighter sections). It is also desirable in low speed, minimum torque applications.

For more information on how to use our bearings, contact KAYDON Engineering.

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 4-2



Correct bearing orientation is shown.

Continuous Ring Circular Separators

Figure 4-3 - Continuous Ring Pocket

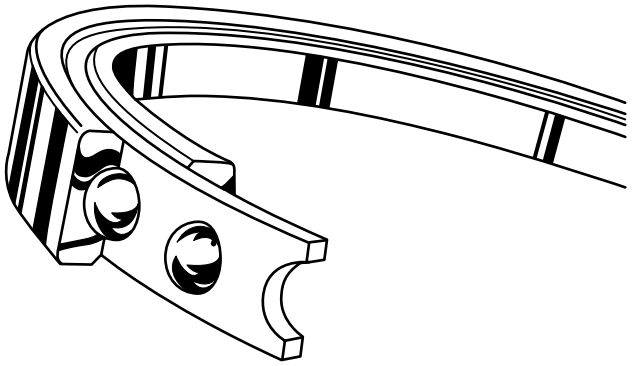
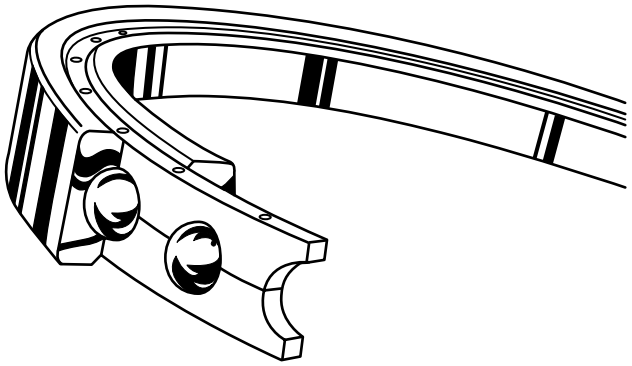


Figure 4-4 - Riveted Ring Circular Pocket



Designed for use in Type A bearings, the one-piece separator shown in Figure 4-3 is positioned around the inner race with the balls placed in pockets before the outer race is expanded thermally and dropped over the balls. This method of assembly permits the use of more balls than in the Conrad bearing Types C and X. In addition to the standard separators of brass, non-metallic composite and reinforced nylon, this style can be furnished in phenolic laminate, stainless steel, and aluminum.

Designed for use in non-standard bearings of Type C or Type X, the separator shown in Figure 4-4 is installed after Conrad assembly of the races and bearing and riveted together. Because of the space required for rivets, use is limited to Series D and heavier sections. Usually machined all over, this style is recommended in phenolic laminate for very high speeds. Where very high strength is required, it is furnished in bronze, aluminum, or stainless steel.

As in the case of the continuous ring "snapover" pocket separator, both of these styles are centered on the balls at room temperature, becoming either outer race land riding or inner race land riding as the temperature changes.

Segmental Separators

Segmental separators of either the ring or "snapover" design offer advantages for certain applications.

1. When larger diameter bearings are subjected to high temperatures, expansion differentials between the separator and the races may exceed the normal clearances provided.
2. When oscillatory motion, variable loading and a vertical axis combine to cause differential ball travel with no "vacation zone," torque may become objectionably high or erratic.

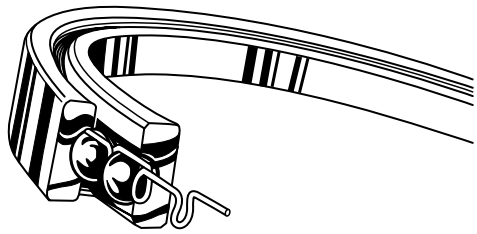
A segmental separator may consist of a one-piece open ring or it may be composed of two or more segments. Where differential expansion creates a problem, sufficient clearance is provided between the ends of the open ring or between the several segments to allow for this expansion. Where torque is of concern, the selection of the number of segments is made based upon experience. In all other respects, segmental separators satisfy the above descriptions for **Continuous Ring "Snapover Pocket" Separators or Continuous Ring "Circular Pocket" Separators.**

Segmenting the separator imposes somewhat greater restrictions on the bearings. Maximum allowable speed of rotation is reduced due to the centrifugal force ("brake banding") energized by the segments against the outer race lands. Also, in the case of the "snapover pocket" style, a shaft or housing shoulder should be extended to assure retention of the separator irrespective of the operating position of the bearing. See next page.

SEPARATOR TYPES (continued)

Formed Wire Separator

Figure 4-5



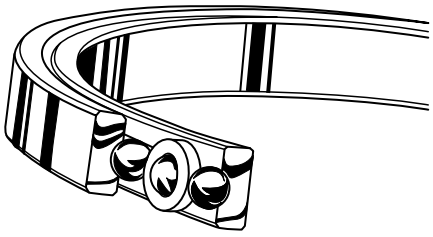
When the need exists for maximum capacity and thus the greatest possible number of balls, a formed wire separator may be used to avoid the disadvantages of a full complement bearing. It has been most successfully employed in Type A bearings, where the greater number of balls can be installed without resorting to use of a loading slot. Use in bearing Types C and X should be restricted to very low speed applications.

Comparatively high wear rate coupled with relatively light section can cause the wear life of the wire separator to be a limiting factor in the life a bearing, especially if the loads are high. However, where weight or space are at a premium and the added capacity is an important consideration, this separator may be considered a good compromise.

A bearing with a wire separator and maximum allowable ball complement has a static load capacity of 180% of the catalog static rating.

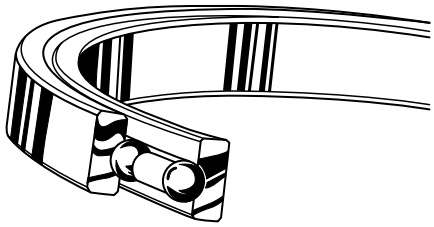
Toroid Separators

Figure 4-6A



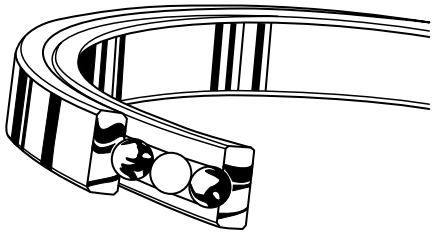
PTFE Spacer Slugs

Figure 4-6B



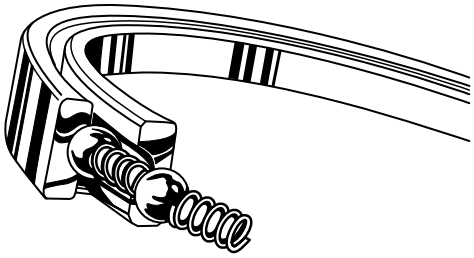
Spacer Balls

Figure 4-6C



Helical Spring Separators

Figure 4-6D



In some critical positioning applications, uniformity of torque is more important than the actual mean torque level. Specially designed toroids (Figure 4-6A), PTFE spacer slugs (Figure 4-6B), spacer balls (Figure 4-6C) or helical compression springs (Figure 4-6D) have proved in a number of such instances to be satisfactory for ball separation—by their nature they give a large amount of individual and cumulative circumferential freedom to the balls. To prevent this freedom from being abused, however, speeds must be low and loads comparatively light.

Applications involving use of these separators should be referred to KAYDON for review and recommendation.

Number of Balls in Standard REALI-SLIM® Bearings

Figure 4-7

Boring Size	Type A							Types C and X						
	KAA	KA	KB	KC	KD	KF	KG	KAA	KA	KB	KC	KD	KF	KG
010	28							21						
015	40							29						
017	44							33						
020		36	31						27	23				
025		44	38						33	28				
030		52	44						39	33				
035		60	51						45	38				
040		68	58	49	36	26	20		51	43	35	27	19	15
042		72	61	52	38	27	21		54	45	37	28	20	15
045		76	64	55	40	29	22		57	48	39	30	21	16
047		80	68	58	42	30	23		60	50	41	31	22	17
050		84	71	61	44	31	24		63	53	43	33	23	18
055		92	78	66	48	34	26		69	58	47	36	25	19
060		100	85	72	52	37	28		75	63	51	39	27	21
065		108	91	78	56	40	30		81	68	55	42	29	22
070		116	98	83	60	43	32		87	73	59	45	31	24
075		124	105	89	64	45	34		93	78	63	48	33	25
080		132	112	95	68	48	36		99	83	67	51	35	27
090		148	125	106	76	54	40		111	93	75	57	39	30
100		164	139	118	84	59	44		123	103	83	63	43	33
110		180	152	129	92	65	48		135	113	91	69	47	36
120		196	166	140	100	70	52		147	123	99	75	51	39
140			192	163	116	81	60			143	115	87	59	45
160			219	186	132	92	68			163	131	99	67	51
180			246	209	148	104	76			183	147	111	75	57
200			273	231	164	115	84			203	163	123	83	63
210					172							129		
220							92							69
250				288	204	142	104				203	153	103	78
300				345	244	170	124				243	183	123	93
350						198	144						143	108
400						226	164						163	123

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

Limiting Speeds

The following limiting speed information is provided for reference only. For actual speeds, use the REALI-DESIGN™ software found on our website, www.kaydonbearings.com.

The determination of maximum safe operating speeds is largely empirical. Various complex factors play a part in limiting the speed of rotation, some of which are:

- Bearing diameter
- Ratio of bearing diameter to cross-section
- Bearing type and internal configuration
- Ratio of ball groove radius to ball diameter
- Bearing internal fit-up (diametral clearance or preload)
- Operating contact angle(s)
- Bearing precision (runouts)
- Ball separator material and design
- Precision of mount (roundness, flatness under load)
- Lubrication
- Ambient temperature and provision for heat dissipation
- Seals
- Loads
- Life requirement

While precise speed limits cannot be set, experience in actual applications and in the KAYDON test laboratories can serve as a basis for setting general limits. Figure 4-10 takes into account some of the factors and assumes proper installation and adequate provision for heat dissipation. These limits are based upon achieving the full service life of 1,000,000 revolutions. If a shorter life is acceptable, higher speeds may be tolerated, except for bearings using formed wire and helical spring separators.

For speeds near or over the limits in the table, special attention must be given to lubrication and heat. Greases should be of types specially formulated for high speed bearings. Frequency of regreasing must be adequate to insure presence of lubricant at all times. If oil is used, viscous drag should be minimized by controlling the level, using slingers and/or metering small amounts as a liquid or mist. Windage effects at high speeds can make the introduction of oil to the critical surfaces very difficult, and the design of the lubrication system then becomes important. Please consult lubrication manufacturer.

Generally speaking, operating temperature will be limited by the allowable maximum temperature for the lubricant. If, however, bearing temperature is expected to exceed 250°F for extended periods, the bearings should be given stabilization treatment by KAYDON. This treatment will permit operation at temperatures up to 400°F.

While maximum temperature is important, consideration must also be given to possible temperature differential across the bearing. Generally, heat is lost through the housing at a higher rate than through the shaft. The housing fit and the bearing internal clearance before installation must be sufficient to allow for this as well as for the shaft fit if the necessary running clearance is to be realized.

Examples of Limiting Speed Calculations

Example 1 (Standard Bearing)

Limited speed calculation for bearing part number KG040XP0.

Conditions: light thrust loads (<20%), grease lubrication.

From Figure 4-8: slimness symbol = I

From Figure 4-9: derating factor = 1.0

From Figure 4-10: Type X; Separator P; Grease;
Class 1; Charted figure = 9

Calculation: $N = \frac{(1.0)\ (9)\ (1000)}{4} = 2{,}250$

Example 2 (High Performance Bearing)

Limiting speed calculation for bearing number KD100AH6.

Conditions: loading at 25%, oil lubrication

From Figure 4-8: slimness symbol = II

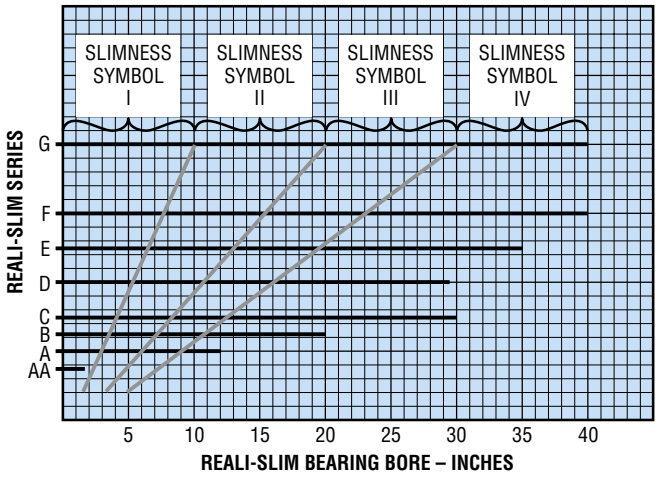
From Figure 4-9: derating factor = 0.9

From Figure 4-10: Type A; Separator H; Oil;
Class 6; Charted figure = 32

Calculation: $N = \frac{(0.9)\ (32)\ (1000)}{10} = 2{,}880$

LIMITING SPEEDS (continued)

Figure 4-8 - Slimness Symbol (S_s)



Limiting Speeds for Unsealed Lightly Loaded REALI-SLIM® Ball Bearings

$$\text{Limiting Speed (N)} = \frac{(F_l)\,(C_f)\,(1000)}{D}$$

where

D = Bearing bore in inches

N = RPM

Figure 4-9 - Derating Factor (F_l)

For bearings loaded to following percent of dynamic rating	Multiply DN values by following factors
20	1.0
33	.9
50	.8
67	.7
100	.5
150	.2

Figure 4-10 - Charted Figures (C_f)

Bearing Type	Load Conditions	Separator Type	PRECISION CLASS AND LUBRICATION																			
			CLASS 1, 3 & 4								CLASS 6											
			GREASE				OIL				GREASE				OIL				OIL MIST			
Slimness Symbol from Figure 4-8			I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
C with Diametral Clearance	Radial	P, L, X	15	12	9	6	21	18	15	12	21	18	15	12	27	24	21	18	30	27	24	21
		K	20	16	12	8	28	24	20	16	28	24	20	16	36	32	28	24	40	36	32	28
A Spring Loaded or Axially Adjusted	Radial and/or Thrust	R	15	12	9	6	21	18	15	12	21	18	15	12	27	24	21	18	30	27	24	21
		G, H	20	16	12	8	28	24	20	16	28	24	20	16	36	32	28	24	40	36	32	28
		M	8	6	5	3	11	9	8	6	11	9	8	6	14	12	11	9	15	14	12	11
X with Diametral Clearance	Thrust Only	P, L, X	9	8	7	6	11	10	9	8	11	10	9	8	14	12	11	9	15	14	12	11
	Radial Only or Combined Loading	P, L, X	3.0	2.5	2.0	1.5	4	3.5	3	2	4	3.5	3	2	4.5	4	3.5	3	5	4.5	4	3.5

Torque Considerations

Torque, as it applies to bearings, is defined as the moment required to turn the rotating race with respect to the stationary race.

Usually the torque requirement of a ball bearing is only a small part of the demand of a mechanical system. In many REALI-SLIM® bearing applications, however, masses and consequent inertias are slight and the amount of work being done is not great. In such cases, it may be important to know as accurately as possible how much turning effort must be provided.

Many factors contribute to the resistance to rotation of a lightly loaded anti-friction bearing, and most of this resistance comes from the more unpredictable ones—separator drag; viscous drag of the lubricant; minute deviations from true geometry in the balls, race ways, and mounting surfaces of bearing, shaft, and housing; internal fit-up of the bearing; and the presence of contaminants.

Bearings can be furnished to a maximum torque level specification.

In the selection of the lubricant and lubricating system, their effects on torque should be kept in mind. To be considered are operating temperatures; speeds of rotation; type, viscosity and quantity of lubricant. All are major factors in determining lubricant drag. Please consult lubrication manufacturer.

In tolerancing the shaft and housing it is important to set limits for out-of-roundness and out-of-flatness of the bearing seats. For normal requirements a good rule of thumb is to use the bearing radial and axial runout tolerances as the respective limits. For critical torque applications, closer tolerances should be specified since even a very small amount of localized internal preload (negative clearance) will create surprisingly large ball loads and consequent high torque. Where torque must be minimized it is important to limit out-of-roundness of housing or shaft to values which will insure against complete loss of internal clearance.

Cleanliness is extremely important in maintaining uniformity of torque as well as a low level of torque. Very small amounts of microscopic particles of lint, dust, and other common contaminants can cause bearing torque to vary several hundred percent in just a few degrees of rotation. For this reason bearings should be kept in their original unopened package until time for installation. Every effort should be made to protect them from foreign matter, whether or not torque is critical.

The accompanying charts show approximate torque levels of REALI-SLIM® bearings under stated conditions. Estimates can be furnished for more unusual situations. Information submitted should contain all operating conditions of load, speed, lubricant, and environment including temperature together with a print of the intended mounting, showing materials and radial sections. If a limit has been set on permissible system error in terms of axis deviation—radial translation, axial translation, or angular rotation (page 102) — this information should also be submitted.

Additional processing is used to achieve the lowest possible torque levels. High precision races and balls, super-finished ball tracks, and precisely set internal fit-ups assure optimum performance.

- Low-torque ball separators
- Clean-room assembly
- Factory-lubricated bearings
- ABMA Grade 10 balls
- Super-finish ball track

Materials

Races	AISI 52100 (Precision Class 6)
Balls	AISI 52100 (Grade 10)
Cage (Type A)	PTFE or Vespel® toroid ball spacers
Cage (Types C, X)	Slugs

Starting Torque vs. Load

Computer generated torque curves for mounted REALI-SLIM® bearings can be provided by KAYDON Product Engineering

Figure 4-11

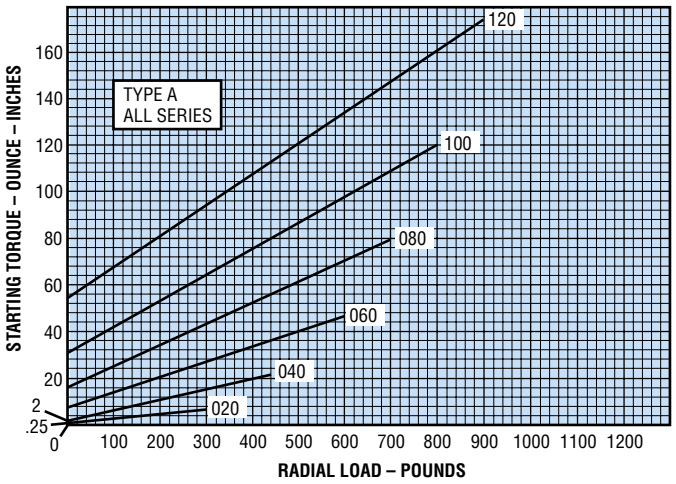


Figure 4-12

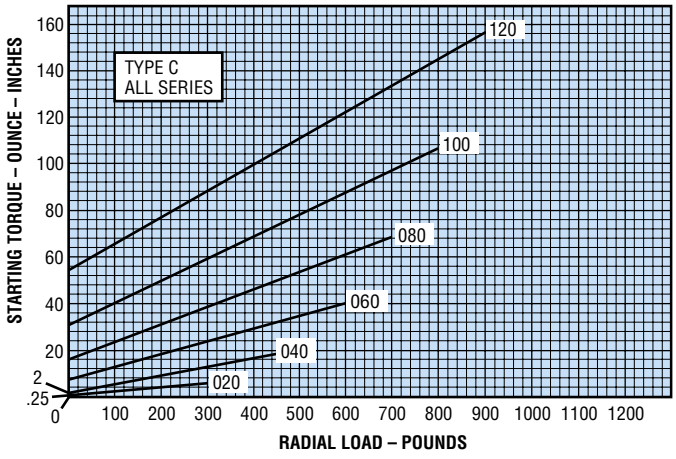


Figure 4-13

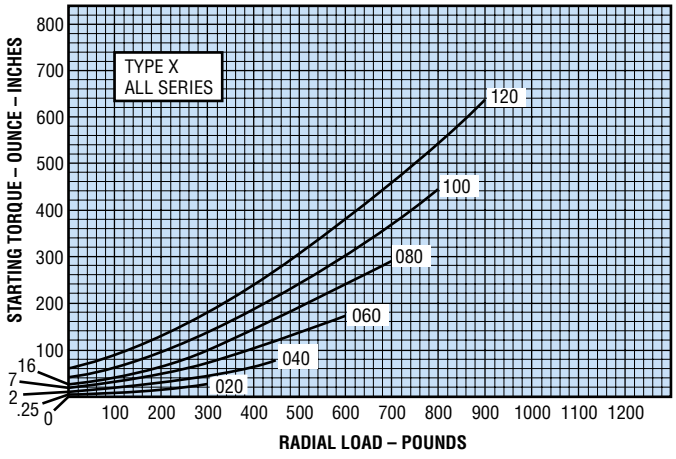
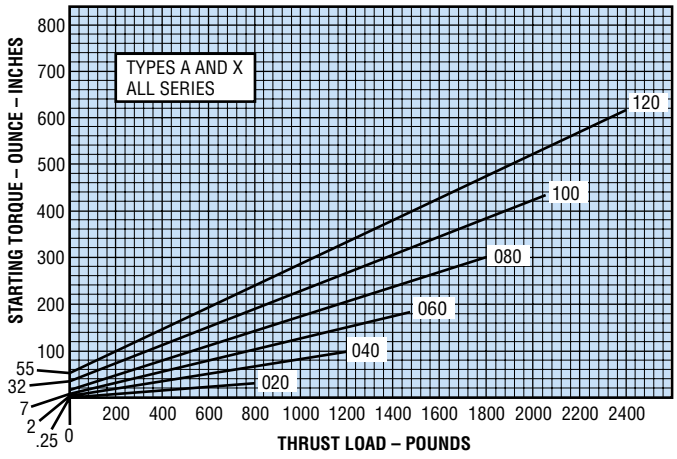


Figure 4-14



Notes Applying to These Charts

1. Values shown are statistical ratings* based on:
   - KAYDON Precision Class 1 bearings with some internal clearance remaining after installation
   - A rigid mounting, round and flat within respective radial and axial bearing runout limits
   - Light oil lubrication
   - Room temperature
2. Running torque at speeds up to 10 RPM usually averages from 25 to 50% of starting torque, and increases with increasing speed to as much as 200% at maximum allowable diametral clearance (page 103).
3. Interpolate for intermediate sizes.
4. Curve number indicates bearing bore in tenths of an inch.

*Usually not more than 10% of a group of bearings will have torque demands higher than those shown.

Bearing Axis Deviation Due to Clearance And Deflection

REALI-SLIM® bearings are often used in applications where the position of a rotating part relative to the stationary structure is critical. Knowledge of the displacement of the axis of rotation and the factors contributing to it are thus important.

The axis of rotation can be displaced from its true position in three ways—radially, axially, and angularly. These deviations are referred to as radial translation, axial translation, and tilt (angular rotation) respectively.

In addition to the obvious effects of bearing runout, total deviation of bearing axis in any one of the above conditions is due to the effects of bearing diametral clearance and elastic deflection (deformation) at the ball or roller contacts. The diametral clearance after installation changes due to the combined effects of external fitting practice, differential thermal expansion or contraction of the bearing races and mounting structures, and relative rigidity of the races and mating parts.

Elastic deflection at the ball or roller contacts results from the externally applied bearing loads and is influenced by ball or roller diameter, race groove radius, raceway diameters, and contact angle.

The following three equations are given to aid in determining displacement. The internal diametral clearance (DC) must be calculated or approximated. The remaining independent variables can be obtained from the graphs on pages 104 through 109.

$$RT = RD + \frac{DC}{2}$$

$$AT = AD + \frac{AC}{2}$$

$$AR = MD + AC/PD$$

Where:

RT = Radial Translation – in inches

AT = Axial Translation – in inches

AR = Angular Rotation – in inches/inch or radians

RD = Radial deflection due to radial load – in inches

AD = Axial deflection due to axial load – in inches

MD = Moment deflection due to moment load – in inches/inch or radians

DC = Diametral clearance – in inches

AC = Axial clearance – in inches

PD = Pitch diameter $\frac{O.D. + Bore}{2}$ – in inches

The equations may be used in applications where the radial, axial, or moment load is applied singly or where one type of loading predominates. For assistance in selecting REALI-SLIM® bearings, contact KAYDON Engineering.

Computer-generated reports and graphs for REALI-SLIM® bearings are available from KAYDON engineering and from our REALI-DESIGN™ computer software, available for download at kaydonbearings.com.

Axial Clearance vs. Diametral Clearance

Figure 4-15

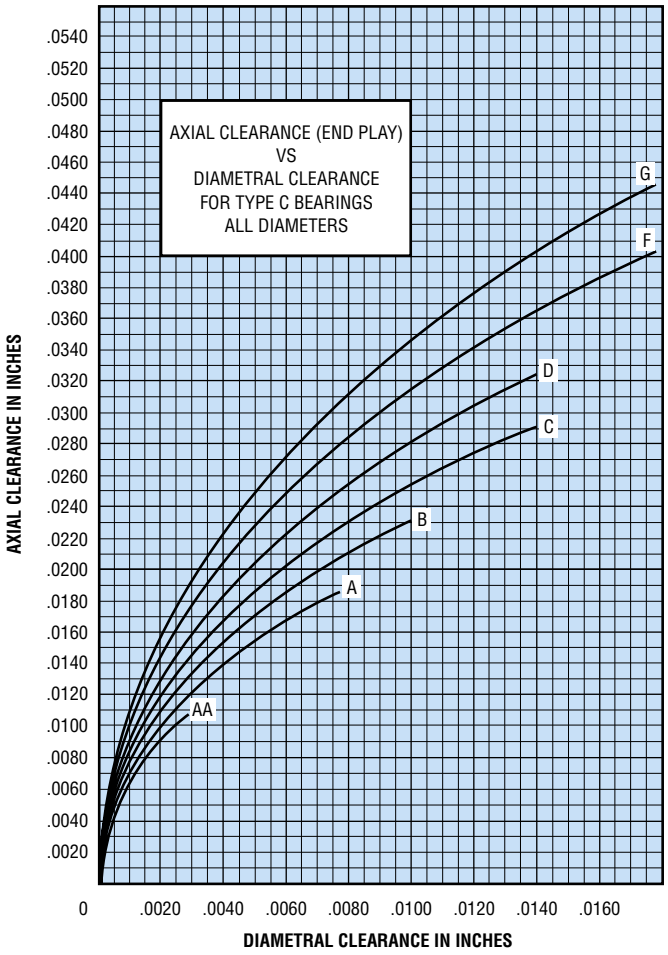
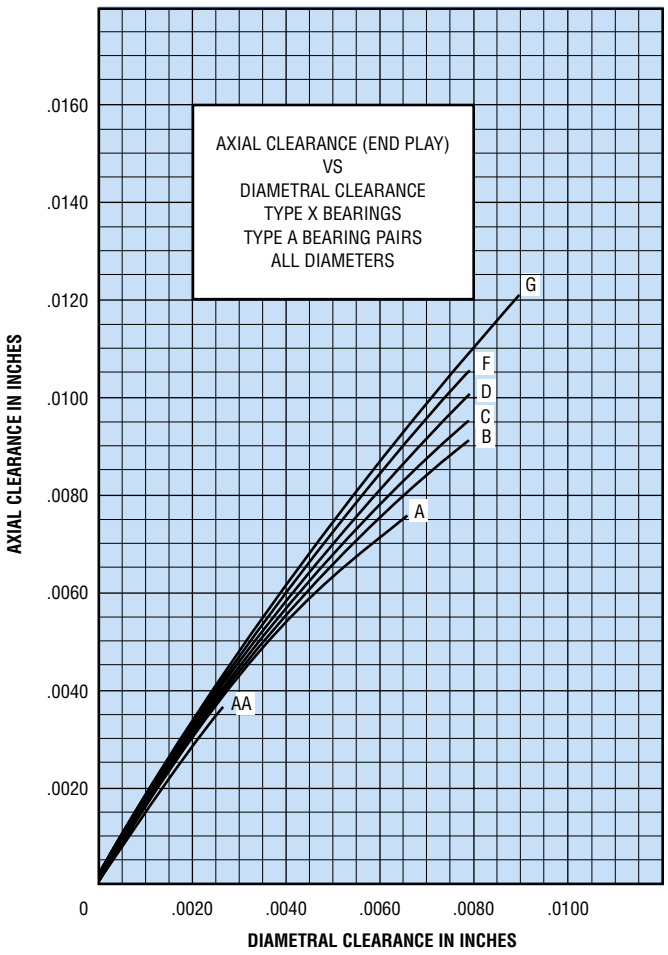


Figure 4-16



Axial Deflection vs. Axial Load

Type A Angular Contact

For more detailed information, use KAYDON REALI-DESIGN™ software

Figure 4-17

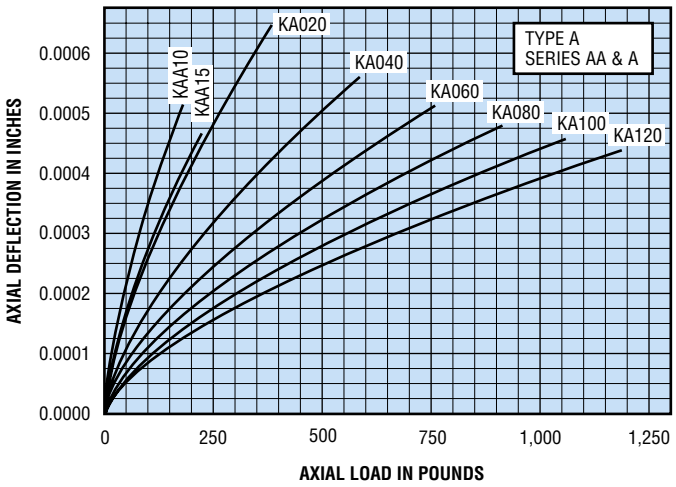


Figure 4-18

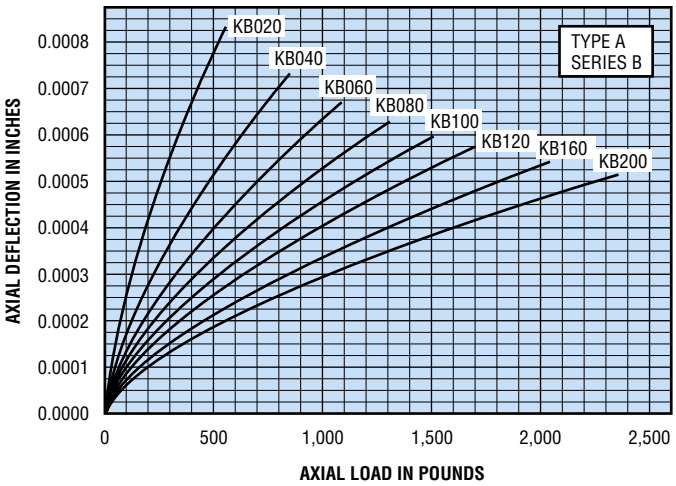


Figure 4-19

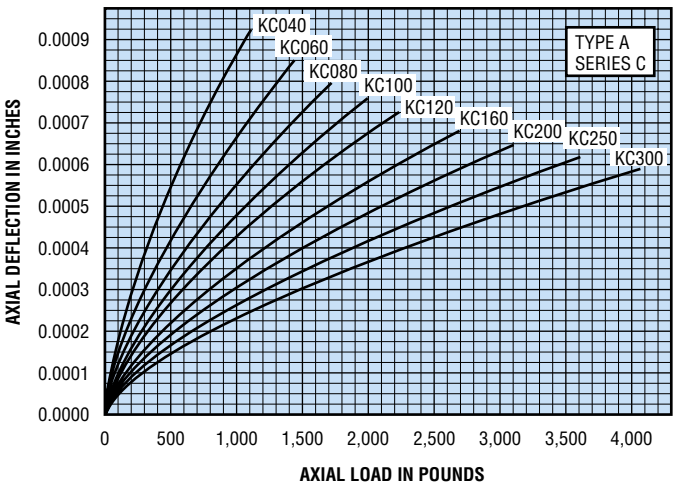


Figure 4-20

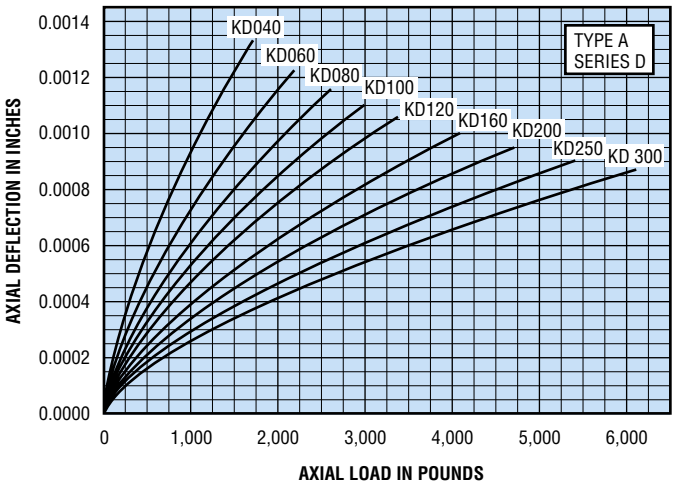


Figure 4-21

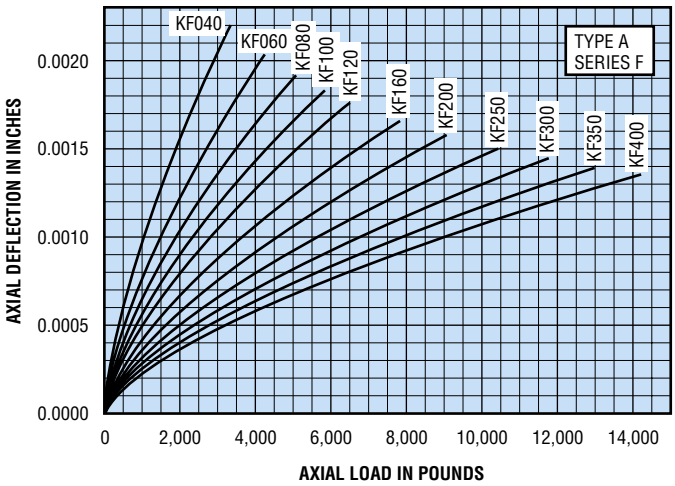
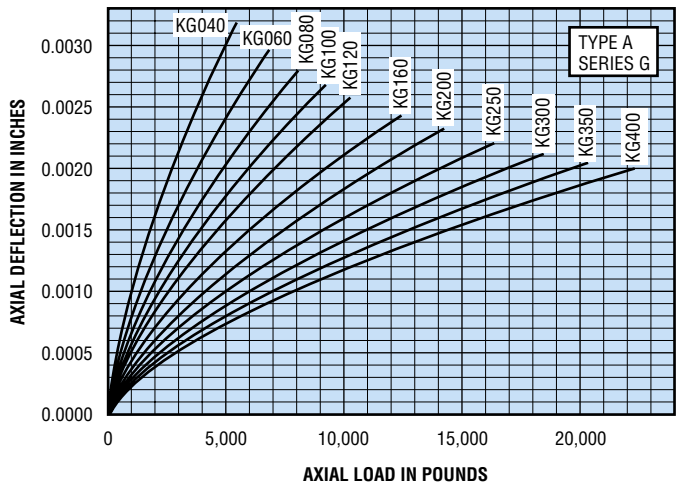


Figure 4-22



Radial Deflection vs. Radial Load

Type A Angular Contact

For more detailed information, use KAYDON REALI-DESIGN™ software

Figure 4-23

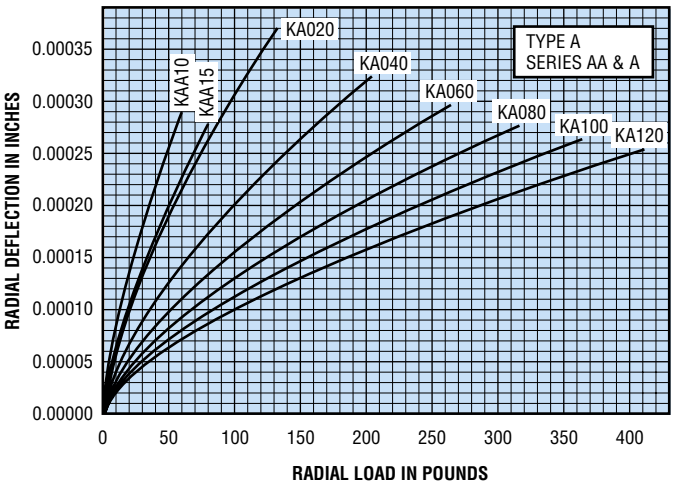


Figure 4-24

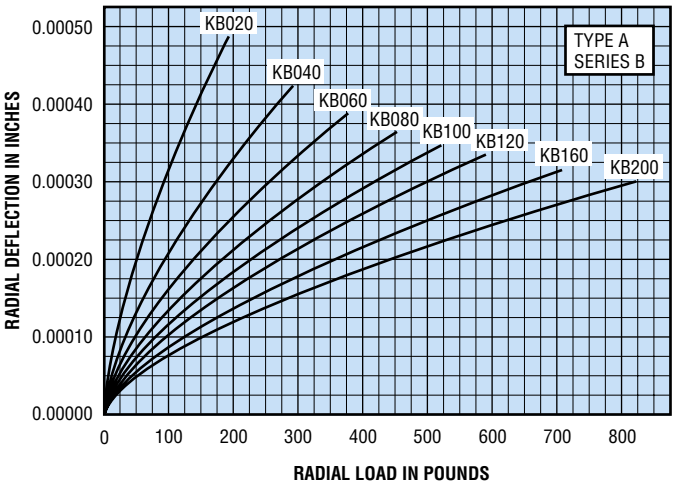


Figure 4-25

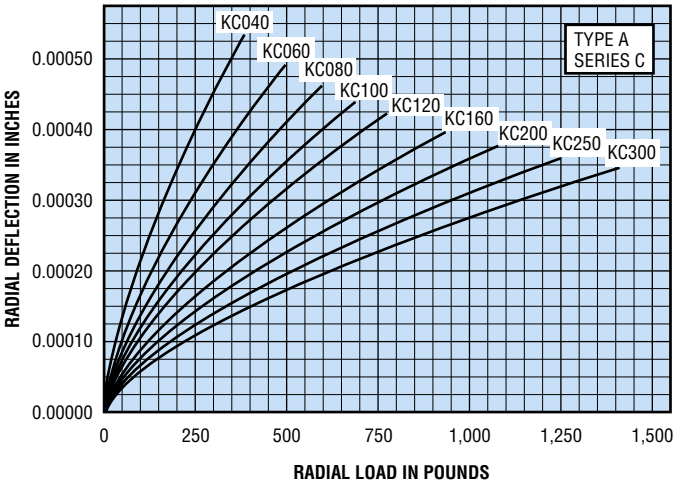


Figure 4-26

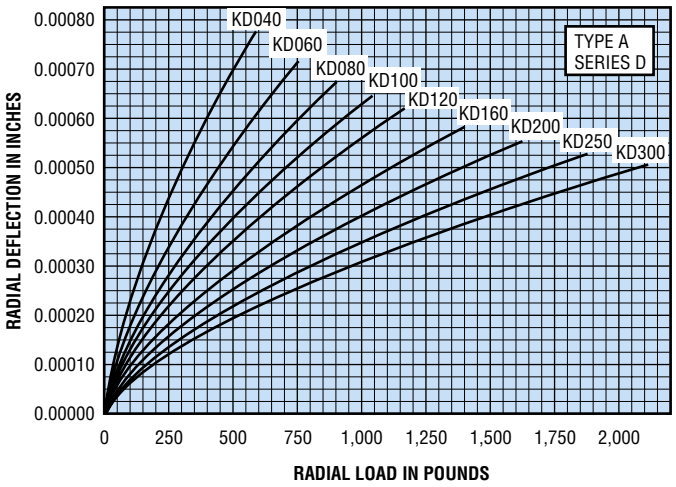


Figure 4-27

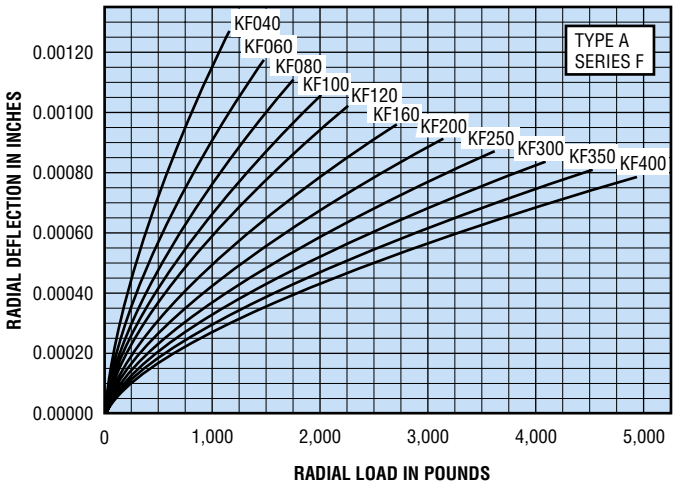
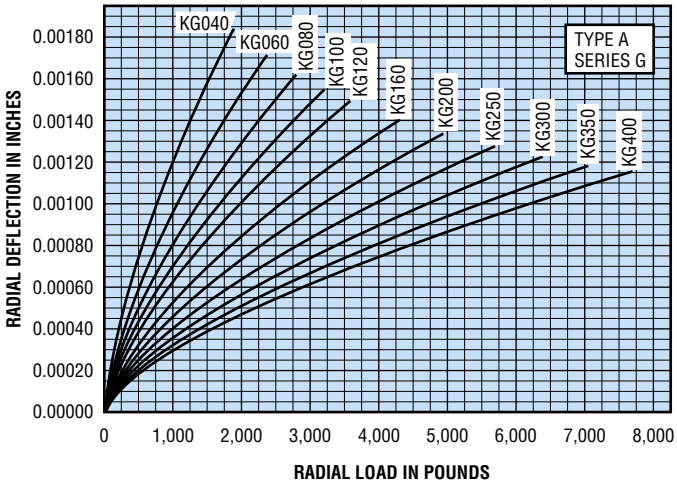


Figure 4-28



Radial Deflection vs. Radial Load

Type C Radial Contact

For more detailed information, use KAYDON REALI-DESIGN™ software

Figure 4-29

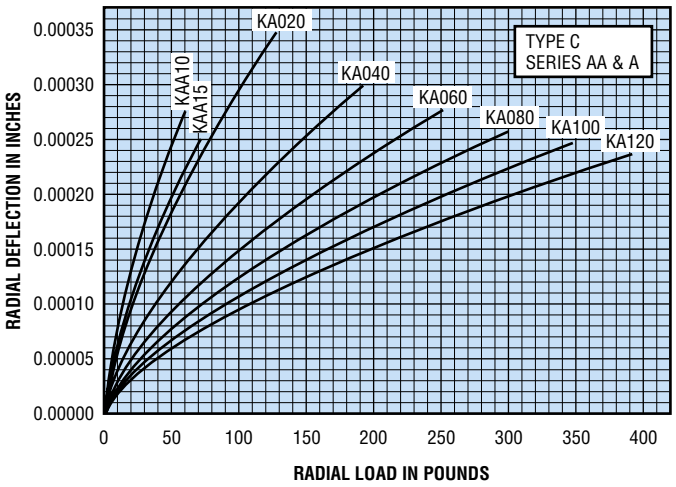


Figure 4-30

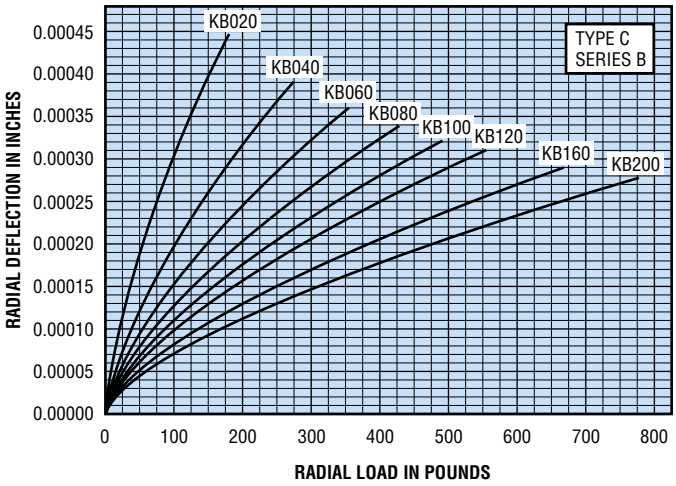


Figure 4-31

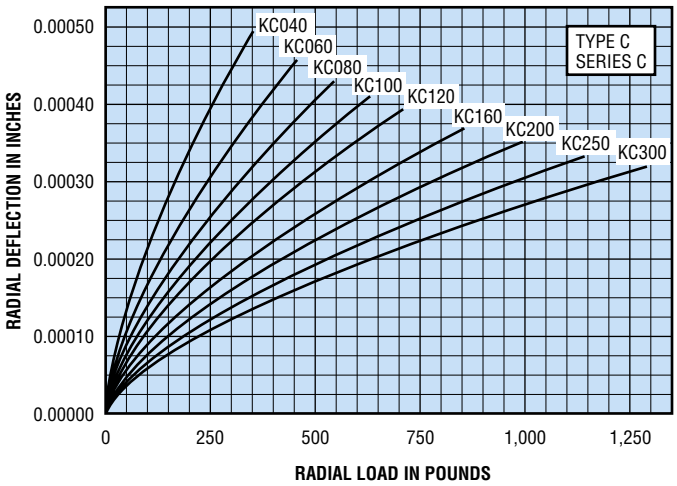


Figure 4-32

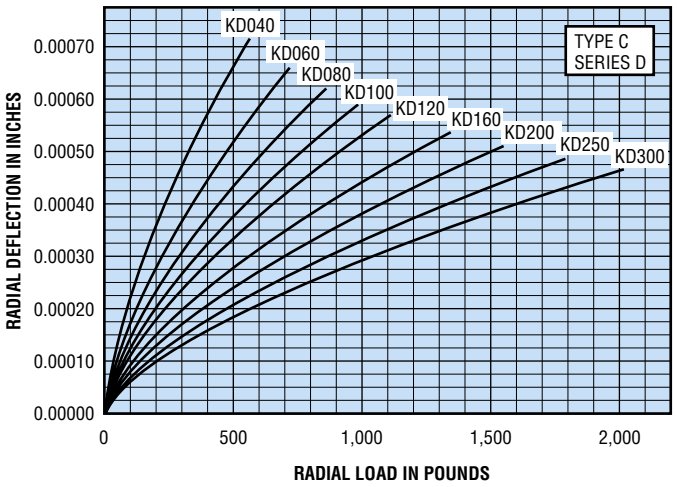


Figure 4-33

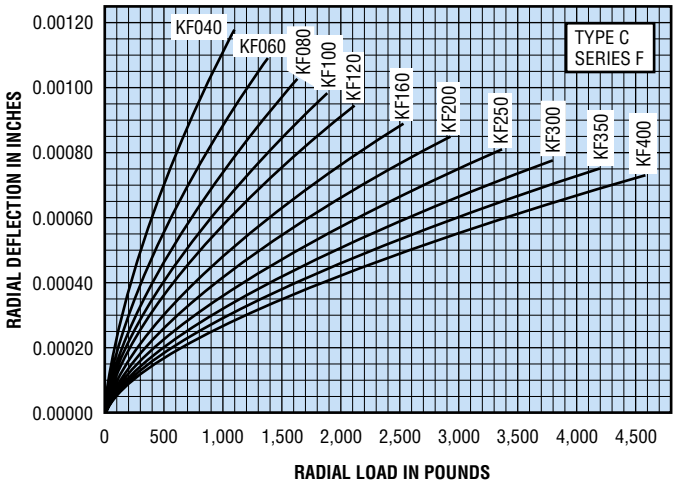
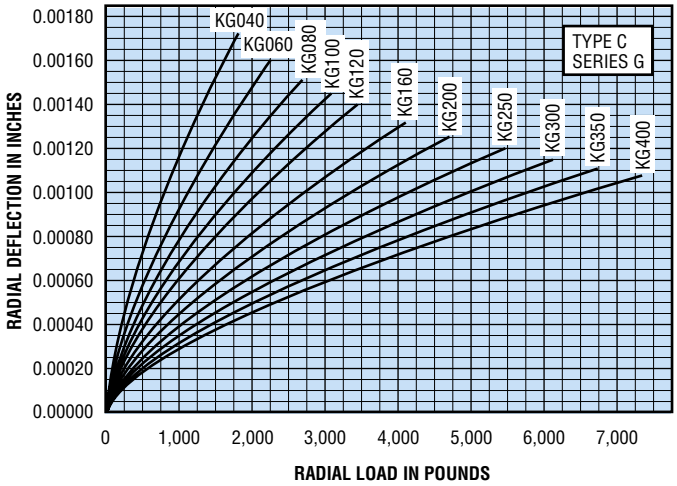


Figure 4-34



Axial Deflection vs. Axial Load

Type X Four-Point Contact

For more detailed information, use KAYDON REALI-DESIGN™ software

Figure 4-35

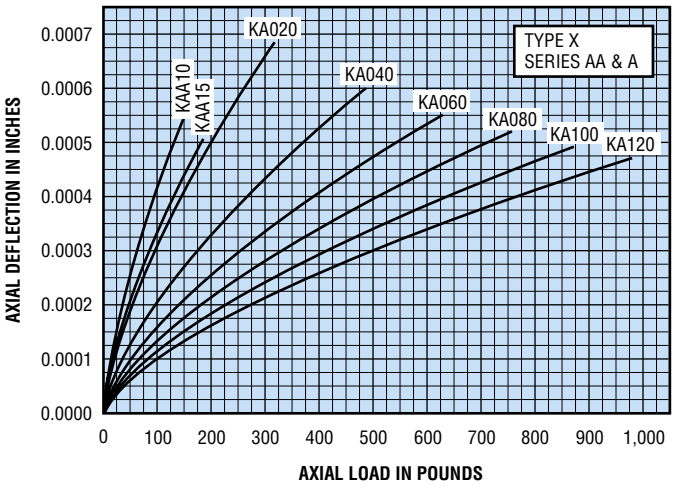


Figure 4-36

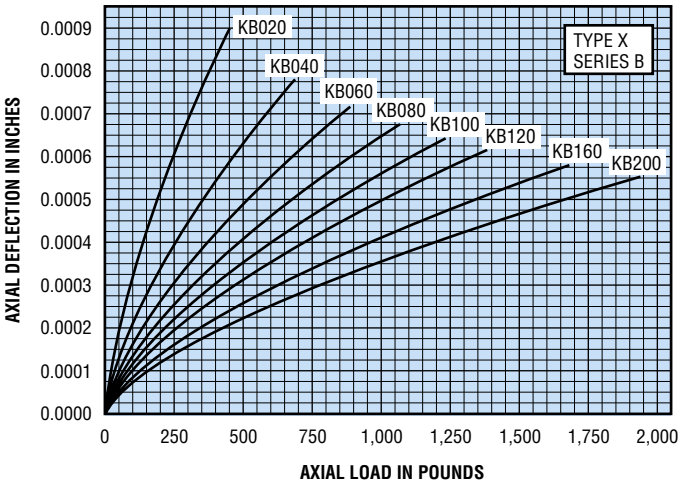


Figure 4-37

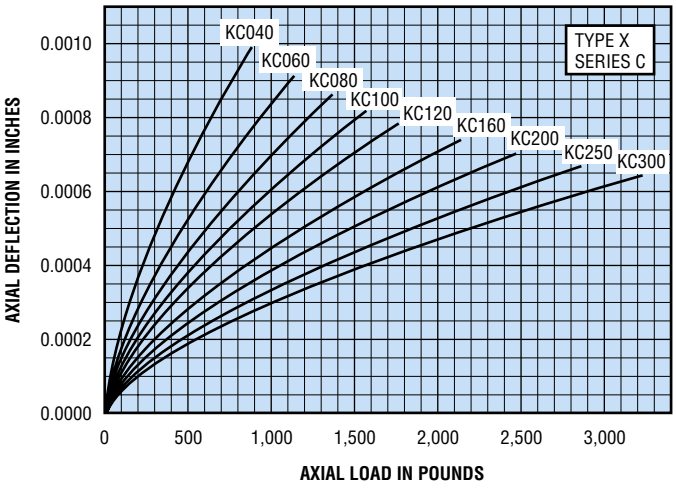


Figure 4-38

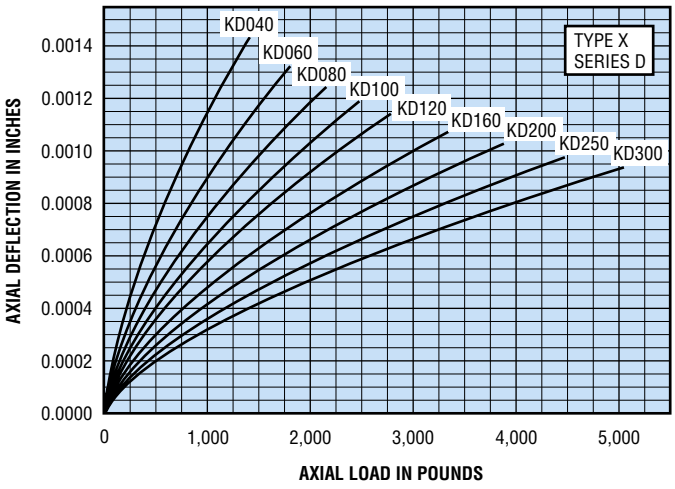


Figure 4-39

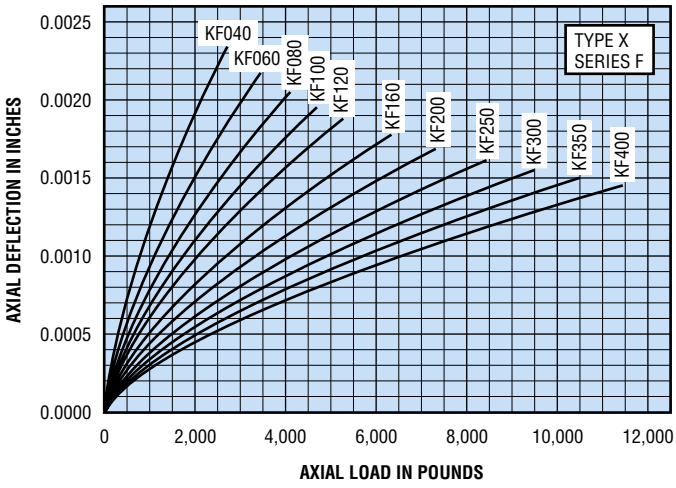
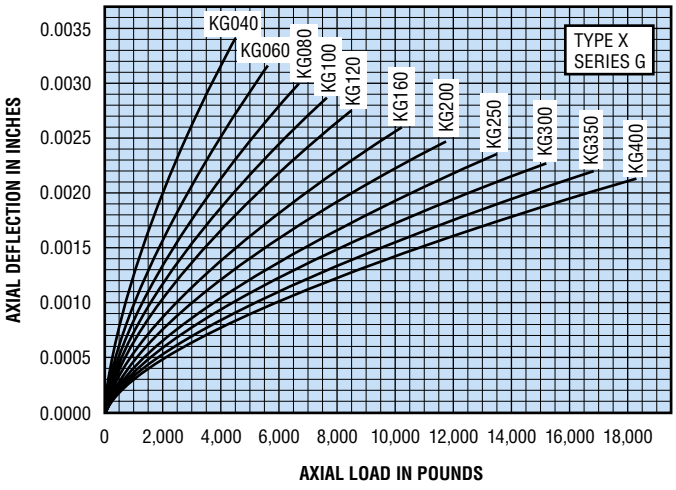


Figure 4-40



Radial Deflection vs. Radial Load

Type X Four-Point Contact

For more detailed information, use KAYDON REALI-DESIGN™ software

Figure 4-41

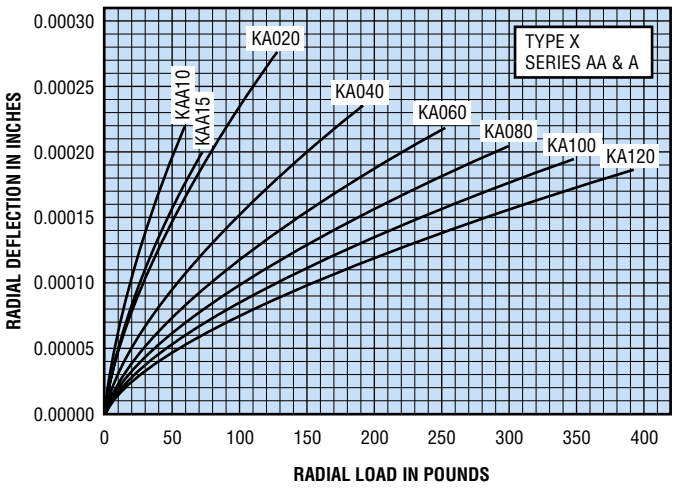


Figure 4-42

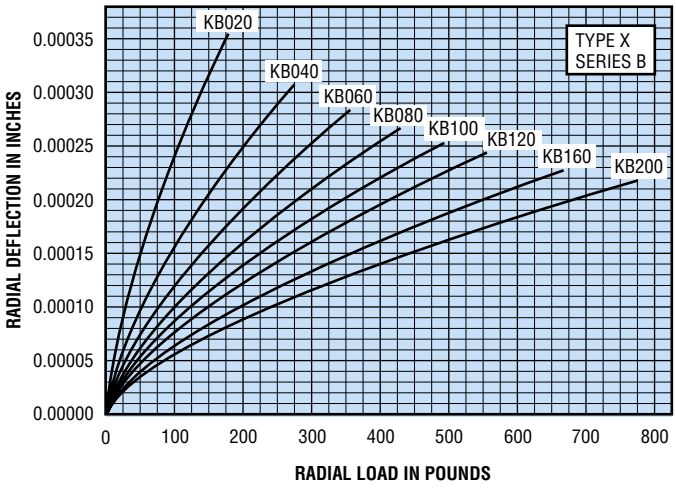


Figure 4-43

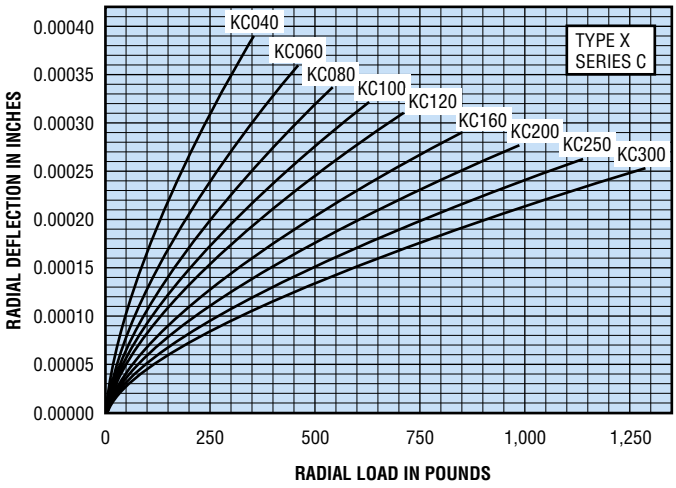


Figure 4-44

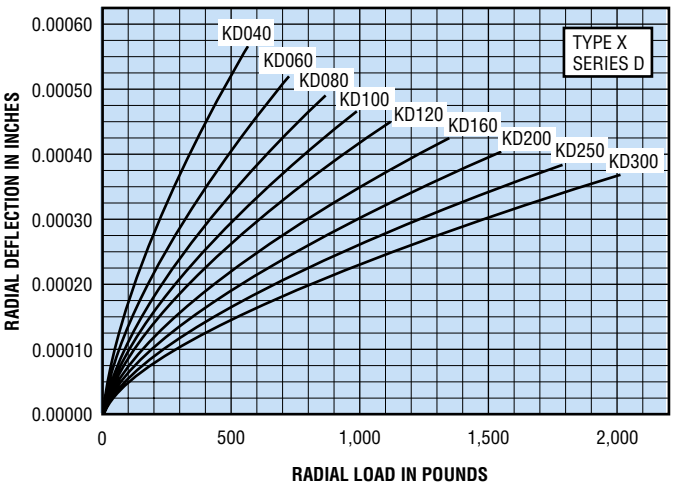


Figure 4-45

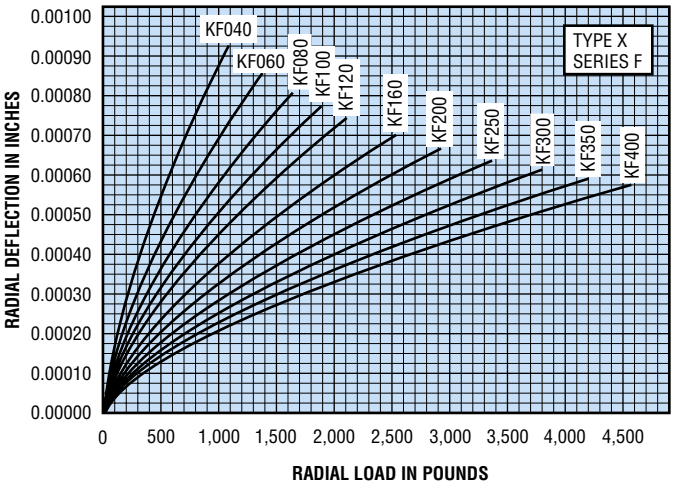
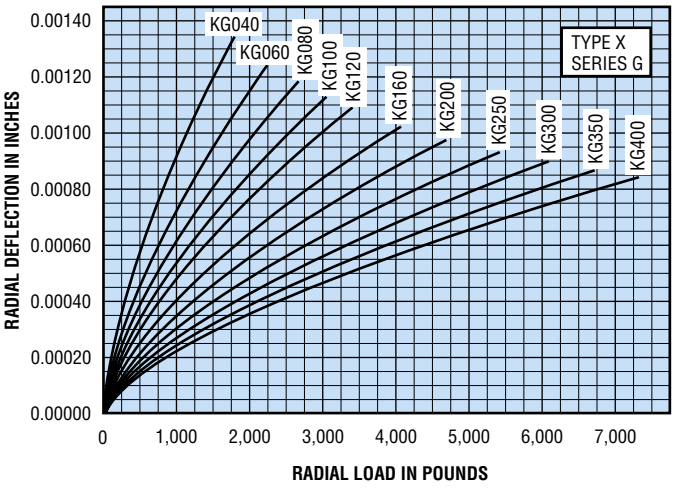


Figure 4-46



Moment Deflection vs. Moment Load

Type X Four-Point Contact

For more detailed information, use KAYDON REALI-DESIGN™ software

Figure 4-47

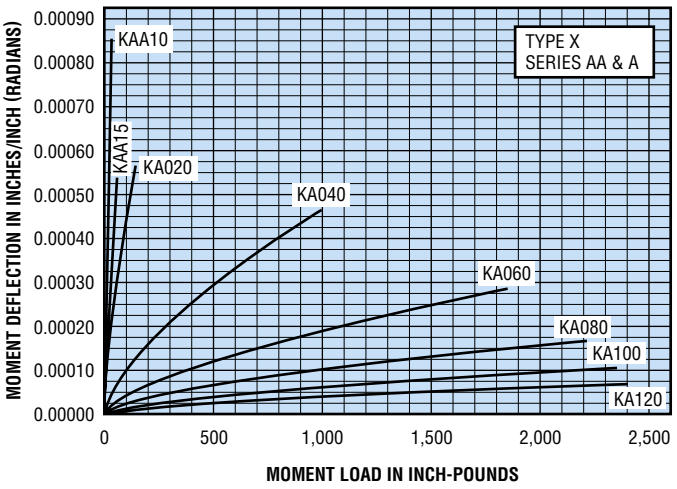


Figure 4-48

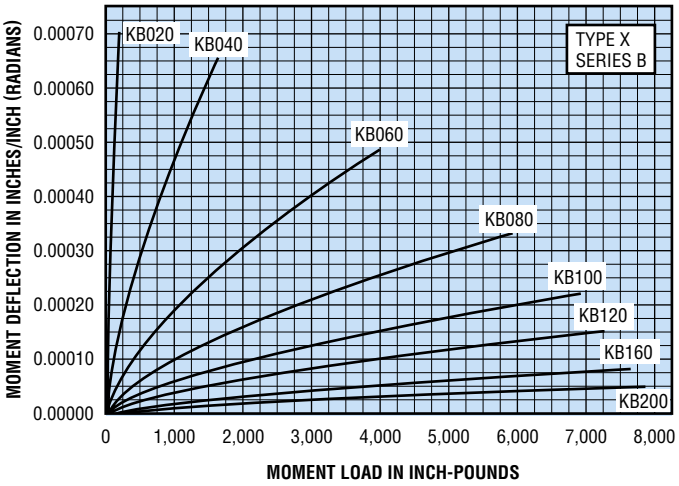


Figure 4-49

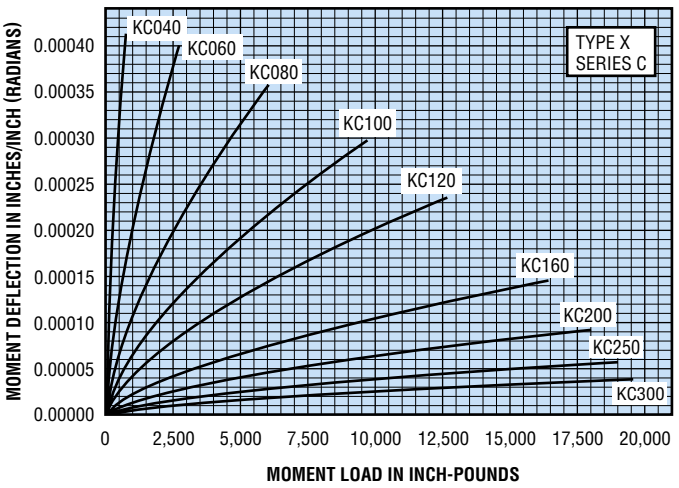


Figure 4-50

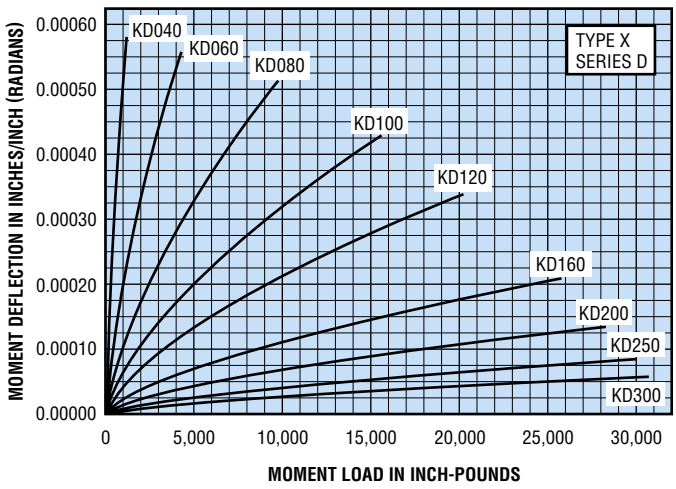


Figure 4-51

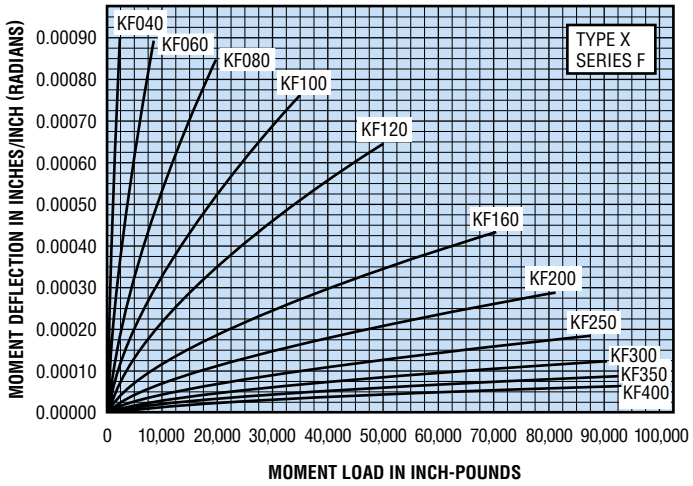
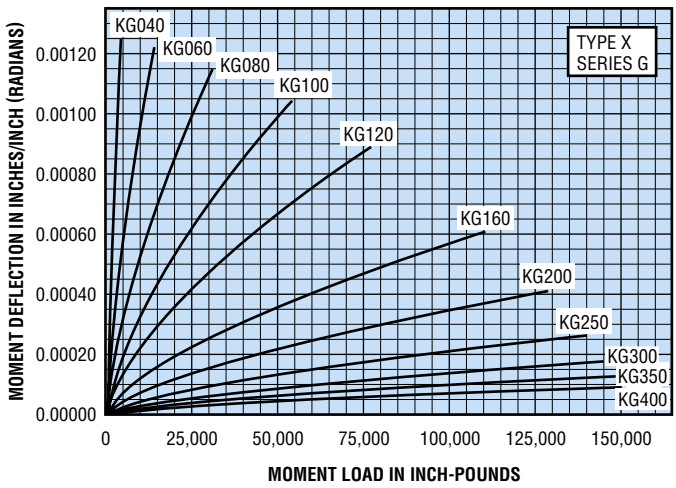


Figure 4-52



Section 5—Installation and Maintenance of REALI-SLIM® Thin-Section Bearings

Inspection and Installation Procedures for REALI-SLIM® Thin-Section Bearings

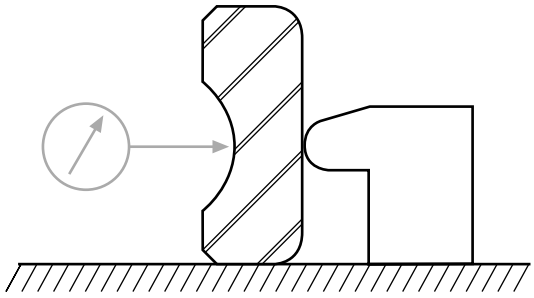
Inspection

The unique proportions of REALI-SLIM® bearings make some of the usual gaging practices impractical. Since very light pressure is sufficient to deflect the thin rings, conventional two-point measurement of bearing bore and outside diameter must not be used. Air gages of the open jet type, or other proximity devices, must be used to hold error from distortion to an acceptable level. Measurements must be made at enough points to yield a true average size, which may not be the mean of the maximum and minimum measurement. A REALI-SLIM® bearing may be out-of-round in the free state① more than the ABMA tolerance for its precision class. This presents no problem since the races will conform readily to a round shaft diameter and housing bore.

To determine the true runout of each race, by excluding the effect of out of roundness, measurement is made of variation in individual wall thickness. This is schematically illustrated in Figure 5-1. The indicator must contact the raceway at the ball or roller contact, and must be properly positioned for the particular runout (axial or radial) being checked.

Measurement of Radial Runout of Type C Inner Race

Figure 5-1



Diametral clearance of REALI-SLIM® bearings is controlled by selective assembly of races and balls following measurement with gages specially designed for this purpose.

Standard inspection and quality control procedures at KAYDON meet the requirements of government procurement agencies and major aerospace industries. However, a certificate of compliance to specifications can be furnished if required.

Installation

To realize the potential accuracy and long life of a REALI-SLIM® bearing, it is important that the installation be properly done in a clean environment. Cleanliness is vital to satisfactory bearing performance. Work surfaces and tools must be free of dirt, chips, and burrs. Disposable wipers or clean, lint-free cloths should be used.

Under no circumstances should a bearing be used as a gage during grinding or machining of mating parts. Just a few grains of grinding grit or chips of metal (soft as well as hard) can seriously damage the precise geometry and finishes of bearing raceways and rolling elements, and are nearly impossible to remove from an assembled bearing.

The shaft and housing should be thoroughly cleaned, special attention being given to holes and crevices which could hold dirt, chips, and cutting oil. Unfinished surfaces of castings should be painted or otherwise sealed. The mounting surfaces for the bearing must be carefully checked, cleaned, and lightly oiled to ease fitting and minimize danger of scoring. Housing bore, shaft diameter, shoulder squareness, and fillet sizes should all be verified.

The bearing should not be removed from its protective package until this preparation is complete and it is time for installation.

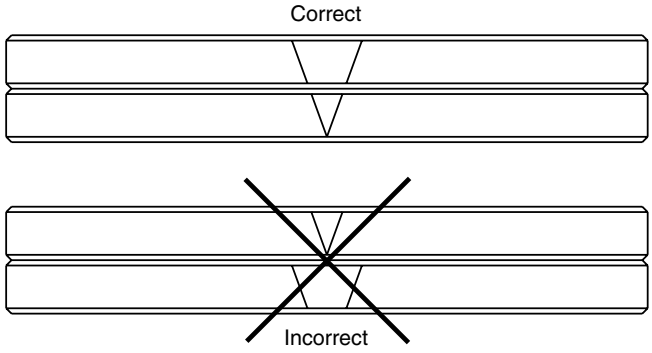
① As explained in ABMA Standard 26.2

INSPECTION AND INSTALLATION PROCEDURES FOR REALI-SLIM® THIN-SECTION BEARINGS (continued)

Interference fitting any bearing to the shaft or housing must be carefully done to avoid damage to the bearing. For REALI-SLIM® bearings, the use of temperature difference to expand the outer member is recommended to minimize or eliminate the installation force necessary. To calculate the differential required, use a coefficient of expansion of .000007 inch per inch per degree F for AISI 52100 steel races and .0000056 for AISI 440C races. For a KAYDON Precision Class 1 bearing of 2" bore to be fitted to a steel shaft, the differential required to eliminate all interference between a maximum diameter shaft and minimum diameter bearing is 90°F; for a 4" bore it is 60°F. Either dry heat or hot oil may be used. Electrical resistance tape is convenient for the large bearings. Care must be taken to avoid overheating the bearing. Do not exceed 250°F.

If pressure is necessary, an arbor press should be used with a suitable pusher to apply the force to the full face of the ring being press fitted — never through the bearing, as damage will be done to the balls and raceways.

All duplexed bearings are marked with a single "V" on the bores and outside diameters to indicate the proper relative circumferential position of inner and outer races. This "V" is located at the high points of race eccentricity so that these may be placed at the low points of shaft and housing eccentricity for the canceling effect.



After mounting, the bearings must be given continued protection from contamination until the assembly is closed. Adherence to these procedures will assure a successful installation.

If it is necessary to return a bearing to KAYDON, it should be coated with protective oil and wrapped the same as when shipped from the factory to prevent damage during transit. If bearings are being returned after use for a failure analysis, they should be returned in the as removed condition, since the condition of the part (cleanliness, lubricated condition, etc.) will provide important data for failure analysis.

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Lubrication and Maintenance of REALI-SLIM® Thin-Section Bearings

The lubricant in an anti-friction bearing serves to reduce friction and wear between moving parts, to dissipate heat, and to prevent corrosion of critical surfaces. KAYDON recommends the selection of the proper lubricant be based on an evaluation by the system design engineer of the operating conditions, including at a minimum: rotational speed, type and magnitude of loads, and ambient temperature.

The three types of lubricant commonly used are oil, grease, and dry film or surface treatment.

Oil normally provides more complete lubrication. Because of its liquid state, it provides better coverage of the critical surfaces and assists in dissipating heat more readily, the latter being especially true when circulation and cooling are provided. In high-speed applications where the heating effect is more pronounced, oil is specified (see page 99). Where minimum torque is a requirement, oil will usually provide lower friction values.

Grease offers certain advantages of its own. Because it is more easily retained, the design of bearing housings and seals is simplified. In many applications, the lubricant itself serves to exclude contaminants when used in conjunction with labyrinths or close clearances between the rotating and stationary structures. For the higher speeds within the range suitable for grease lubrication, a channeling type of grease is often selected.

Dry films and surface treatments have been used as bearing lubricants in applications subject to environmental extremes, particularly where conventional lubricants cannot be tolerated or will not survive. A wide variety of types are available for selection; options include Tungsten disulfide, graphite, and Molybdenum disulfide.

It is important to note that the quantity of lubricant affects bearing performance under certain operating conditions. Only relatively small amounts of lubricant are necessary to reduce friction and wear if a film can be maintained on all contacting surfaces. Where speed is significant, excessive amounts of oil or grease will result in higher operating temperatures, leading to the possibility of early bearing fatigue.

Unsealed bearings are supplied with a coating of preservative-type lubricating oil for the prevention of corrosion during storage. KAYDON recommends that this preservative be removed with clean petroleum solvent prior to lubrication. If the lubricant is not removed, the compatibility of the lubricant with the preservative oil must be confirmed.

In applications where minimum torque is required, the coating should be removed by washing with a clean petroleum solvent followed by immediate relubrication with an oil selected for the application. An option is to have REALI-SLIM® bearings factory lubricated with a commercial grease or oil selected by the customer in order to facilitate installation.

Sealed bearings are packed approximately one-third full with a multi-purpose industrial grease. Exterior surfaces are given a light coating of the same lubricant for protection during storage in the original package.

LUBRICATION AND MAINTENANCE OF REALI-SLIM® THIN-SECTION BEARINGS (continued)

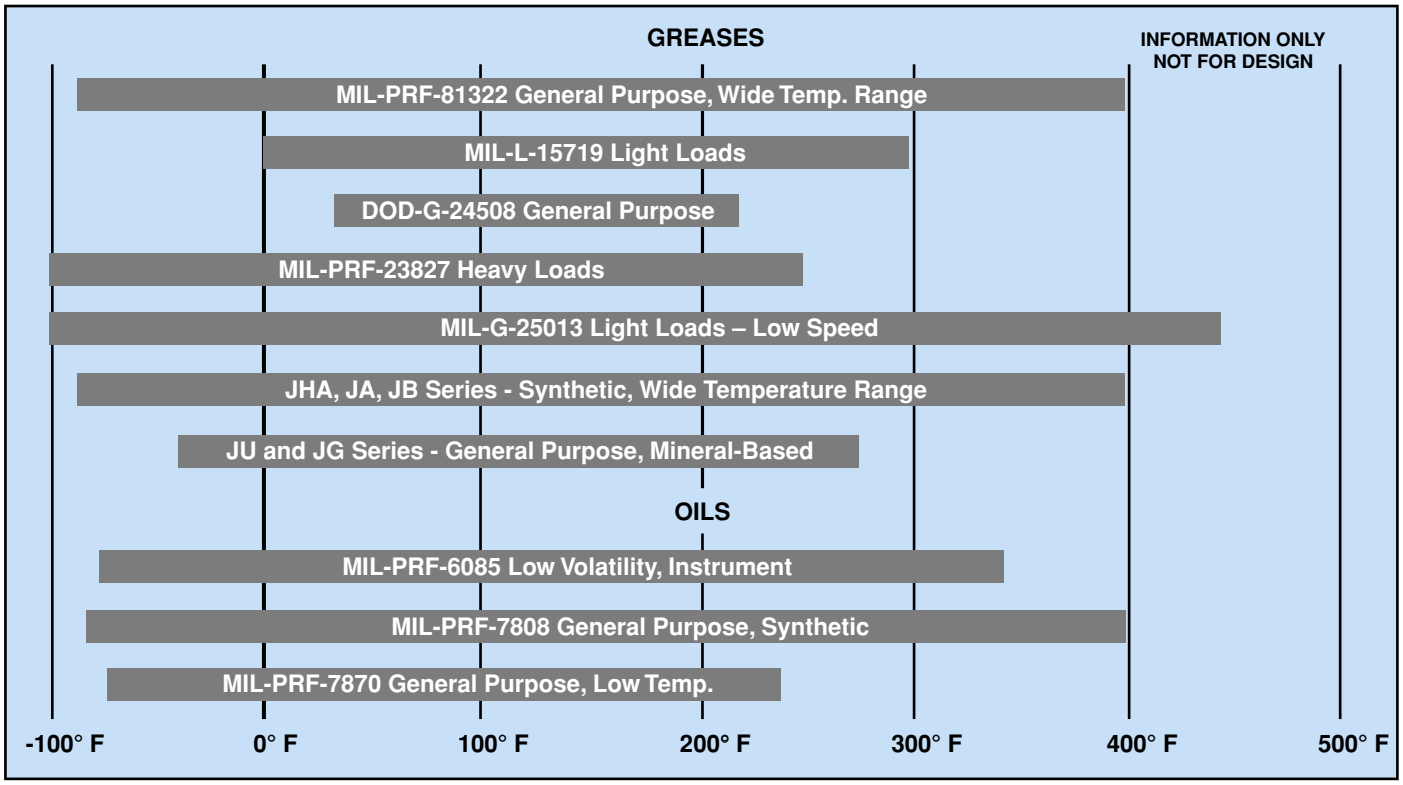
Bearings, with or without seals, can be supplied with optional lubricants. Shown in the accompanying table are some of the greases and oils more frequently specified. Several have been developed to meet the requirements of unusual operating conditions. **Because of this and the variation in cost, it is recommended that lubricants be selected with the assistance of a lubrication expert.**

Due to the finite shelf life of any wet lubricant, factory lubricated bearings should not be held more than two years prior to use. Contact KAYDON for refurbishment instructions for product held beyond two years of receipt.

To realize the full potential of a REALI-SLIM® bearing, KAYDON recommends that the customer's maintenance instructions and schedules consider the operating conditions and include procedures to assure the bearings are adequately protected against the intrusion of foreign matter of all types, and fresh oil or grease introduced with sufficient frequency to cleanse the bearing and assure adequate lubrication.

Figure 5-2

Lubrication Temperature Ranges



Section 6—Other Products

Metric Series Ball Bearings (BB Series)
Drop-in Replacements For Cross-Roller Bearings

KAYDON BB Metric Series four-point contact ball bearings are dimensionally interchangeable with cross-roller bearings.

BB Series Bearings Are Available to Match the Bores and Widths of Common Cross-Roller Bearings.

When factors such as cost, availability, corrosion resistance, tighter tolerances, torque, seal/shield options, and temperature resistance are important in your application, it pays to consider BB Series four-point contact metric ball bearings as an alternative to cross-roller bearings. The additional design flexibility they offer can often help you achieve your design objectives with optimum performance and economy.

Additional features not commonly available in standard cross-roller bearings include a protective package for corrosion resistance, custom sealing for extreme environments, application-specific lubrication and temperature capability.

Optimize Your Design Options

With additional features not commonly available in standard cross-roller bearings, BB Series bearings provide greater design flexibility.

ENDURAKOTE® plating—For applications requiring superior corrosion resistance we offer our proprietary ENDURAKOTE® plating. This thin, dense chrome plating gives AISI 52100 bearing material corrosion resistance equal to or better than that of AISI 440C stainless steel. Unlike many traditional chrome platings, the extremely hard surface of ENDURAKOTE® plating doesn't peel and flake from the bearing race under stress, so corrosion resistance is retained and surface wear is minimized. The performance of ENDURAKOTE® plating has been proven in critical military, aerospace, and deep space applications.

Seals/Shields—Standard industry seals are generally available from nitrile rubber. KAYDON can also provide custom seals manufactured from silicone or Viton® materials for applications where high temperature or extreme environments are likely to be encountered.

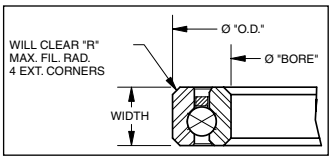
Temperature Capability—Standard cross-roller bearings have a maximum full capacity operating temperature of only 212°F. In contrast, KAYDON bearings can operate at higher temperatures due to our heat treating procedures.

Lubrication Options—KAYDON offers a full range of lubricants, allowing you to optimize bearing performance in a range of applications with special requirements for moisture resistance, hot or cold temperatures, vacuum, and low torque.

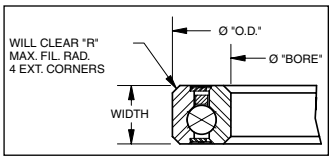
Separators—The common roller spacer for many cross-roller bearings is a non-metallic composite. High temperature and/or horizontal axis applications, however, require non-standard materials or a non-standard separator design. KAYDON four-point contact ball bearings are available with separator options to meet a wide range of applications.

Internal Fitup—KAYDON can help you optimize internal fitup of our BB Series four-point contact ball bearings to provide the desired operating performance. Pre-loaded bearings are recommended for greater stiffness, and diametral clearance is recommended for lower torque applications.

METRIC SERIES BALL BEARINGS - BB SERIES (continued)



Open Bearing



Sealed Bearing

All dimensions in mm

(REALI-SLIM® replacements for RB Series standard cross-roller bearings)

Model Number	KAYDON Part No.	Weight (kg)	Bore (nominal +0)	O.D. (nominal +0)	Width (nominal +0)	"R"	Dynamic Capacity		
							Radial (kg)	Axial (kg)	Moment (Nm)
BB3010	**39318001**	0.1	30 -0.01	55 -0.013	10 -0.12	1	497	675	78
BB3510	**39319001**	0.11	35 -0.012	60 -0.013	10 -0.12	1	513	709	90
BB4010	**39320001**	0.12	40 -0.012	65 -0.013	10 -0.12	1	553	776	107
BB4510	**39321001**	0.13	45 -0.012	70 -0.013	10 -0.12	1	591	839	125
BB5013	**39322001**	0.24	50 -0.012	80 -0.013	13 -0.12	1	948	1321	227
BB6013	**39323001**	0.3	60 -0.015	90 -0.013	13 -0.12	1	1010	1436	279
BB7013	**39324001**	0.31	70 -0.015	100 -0.015	13 -0.12	1	1108	1601	346
BB8016	**39325001**	0.62	80 -0.015	120 -0.015	16 -0.12	1	1679	2417	618
BB9016	**39326001**	0.73	90 -0.02	130 -0.015	16 -0.12	1.5	1773	2584	718
BB10020	**39327001**	1.21	100 -0.02	150 -0.015	20 -0.12	1.5	2395	3480	1102
BB11015	**39328001**	0.66	110 -0.02	145 -0.018	15 -0.12	1	1390	2097	652
BB11020	**39329001**	1.36	110 -0.02	160 -0.02	20 -0.12	1.5	2524	3720	1300
BB12025	**39330001**	2.13	120 -0.02	180 -0.02	25 -0.12	2	3981	5745	2197
BB13025	**39331001**	2.27	130 -0.025	190 -0.025	25 -0.12	2	4098	5968	2412
BB14025	**39332001**	2.5	140 -0.025	200 -0.025	25 -0.12	2	4359	6402	2726
BB15013	**39333001**	0.61	150 -0.025	180 -0.025	13 -0.12	1	1590	2455	965
BB15025	**39334001**	2.72	150 -0.025	210 -0.025	25 -0.12	2	4468	6614	2959
BB15030	**39335001**	4.54	150 -0.025	230 -0.025	30 -0.12	2	6403	9325	4475
BB20025	**39336001**	3.4	200 -0.03	260 -0.03	25 -0.12	2.5	5121	7820	4333
BB20030	**39337001**	5.72	200 -0.03	280 -0.03	30 -0.12	2.5	7288	10980	6435
BB20035	**39338001**	8.17	200 -0.03	295 -0.03	35 -0.12	2.5	9367	13921	8529
BB25025	**39339001**	4.09	250 -0.03	310 -0.035	25 -0.12	3	5718	8939	5891
BB25030	**39340001**	7.04	250 -0.03	330 -0.035	30 -0.12	3	8100	12519	8641
BB25040	**39341001**	9.08	250 -0.03	355 -0.035	40 -0.12	3	10324	15812	11489
BB30025	**39342001**	4.99	300 -0.035	360 -0.035	25 -0.12	3	6163	9821	7482
BB30035	**39343001**	11.8	300 -0.035	395 -0.035	35 -0.12	3	11263	17595	14399
BB30040	**39344001**	15.44	300 -0.035	405 -0.035	40 -0.12	3	11240	17595	14576
BB40035	**39345001**	12.03	400 -0.04	480 -0.04	35 -0.25	3.5	12701	20518	20560
BB40040	**39346001**	20.66	400 -0.04	510 -0.04	40 -0.25	3.5	12888	20919	21572
BB50040	**39347001**	22.7	500 -0.045	600 -0.045	40 -0.25	3.5	14381	23996	29099
BB50050	**39348001**	38.05	500 -0.045	625 -0.045	50 -0.25	3.5	14555	24367	30120
BB60040	**39349001**	27.24	600 -0.045	700 -0.045	40 -0.2	4	15709	26887	37565
BB70045	**39350001**	44.95	700 -0.045	815 -0.045	45 -0.25	4	16887	29634	47062
BB80070	**39351001**	98.52	800 -0.05	950 -0.05	70 -0.25	5	26846	47799	86420
BB90070	**39352001**	109.87	900 -0.05	1050 -0.05	70 -0.25	5	28307	51478	101535

Note 1: Capacities listed are not simultaneous. For combined loading see discussion of Bearing Selection and Load Analysis. Dynamic capacities are based upon 1 million revolutions of L10 life. Published capacities do not apply to hybrid series bearings P, X, and Y - contact KAYDON product engineering for values.

Note 2: Standard bearings are supplied without seals and shields, and they are assembled with a light clearance. Alternate features can be obtained by adding the following suffix letter to the basic part number.

U = single seal
UU = double seal
CO = standard clearance
CI = greater than standard clearance
CCO = preload
T = single shield
TT = double shield
Check for availability.

METRIC SERIES BALL BEARINGS - BB SERIES (continued)

All dimensions in mm

Model Number	Bore (nominal +0)	O.D. (nominal +0)	Width (nominal +0)	Standard Diametral Clearance	Radial and Axial Runout	
					Inner	Outer
BB3010	30 -0.01	55 -0.013	10 -0.12	0.025-0.038	0.01	0.01
BB3510	35 -0.012	60 -0.013	10 -0.12	0.03-0.043	0.01	0.01
BB4010	40 -0.012	65 -0.013	10 -0.12	0.03-0.043	0.013	0.013
BB4510	45 -0.012	70 -0.013	10 -0.12	0.03-0.043	0.013	0.013
BB5013	50 -0.012	80 -0.013	13 -0.12	0.03-0.056	0.013	0.013
BB6013	60 -0.015	90 -0.013	13 -0.12	0.03-0.056	0.013	0.013
BB7013	70 -0.015	100 -0.015	13 -0.12	0.03-0.056	0.015	0.015
BB8016	80 -0.015	120 -0.015	16 -0.12	0.03-0.056	0.015	0.015
BB9016	90 -0.02	130 -0.015	16 -0.12	0.041-0.066	0.015	0.015
BB10020	100 -0.02	150 -0.015	20 -0.12	0.041-0.066	0.015	0.015
BB11015	110 -0.02	145 -0.018	15 -0.12	0.041-0.066	0.015	0.02
BB11020	110 -0.02	160 -0.02	20 -0.012	0.041-0.066	0.015	0.02
BB12025	120 -0.02	180 -0.02	25 -0.12	0.05-0.08	0.02	0.02
BB13025	130 -0.025	190 -0.025	25 -0.12	0.05-0.08	0.025	0.025
BB14025	140 -0.025	200 -0.025	25 -0.12	0.05-0.08	0.025	0.025
BB15013	150 -0.025	180 -0.025	13 0.23	0.05-0.08	0.025	0.025
BB15025	150 -0.025	210 -0.025	25 -0.12	0.05-0.08	0.025	0.025
BB15030	150 -0.025	230 -0.025	30 -0.12	0.05-0.08	0.025	0.025
BB20025	200 -0.03	260 -0.03	25 -0.12	0.06-0.09	0.03	0.03
BB20030	200 -0.03	280 -0.03	30 -0.12	0.06-0.09	0.03	0.03
BB20035	200 -0.03	295 -0.03	35 -0.12	0.06-0.09	0.03	0.03
BB25025	250 -0.03	310 -0.035	25 -0.12	0.07-0.1	0.035	0.035
BB25030	250 -0.03	330 -0.035	30 -0.12	0.07-0.1	0.035	0.035
BB25040	250 -0.03	355 -0.035	40 0.12	0.07-0.1	0.035	0.035
BB30025	300 -0.035	360 -0.035	25 -0.12	0.07-0.1	0.035	0.035
BB30035	300 -0.035	395 -0.035	35 -0.12	0.07-0.1	0.035	0.035
BB30040	300 -0.035	405 -0.035	40 -0.12	0.07-0.1	0.035	0.035
BB40035	400 -0.04	480 -0.04	35 -0.25	0.08-0.11	0.04	0.04
BB40040	400 -0.04	510 -0.04	40 -0.2	0.08-0.11	0.04	0.04
BB50040	500 -0.045	600 -0.045	40 -0.25	0.09-0.12	0.045	0.045
BB50050	500 -0.045	625 -0.045	50 -0.25	0.09-0.12	0.045	0.045
BB60040	600 -0.045	700 -0.045	40 -0.25	0.09-0.12	0.045	0.045
BB70045	700 -0.045	815 -0.045	45 -0.25	0.09-0.12	0.045	0.045
BB80070	800 -0.05	950 -0.05	70 -0.25	0.09-0.12	0.05	0.05
BB90070	900 -0.05	1050 -0.05	70 -0.25	0.1-0.13	0.05	0.05

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Harsh Environment Bearings
(Material Codes S, P, X, and Y)

KAYDON stainless steel bearings are used where high precision and corrosion resistance are required.

REALI-SLIM® thin-section bearings are available in AISI 440C stainless steel races, brass or non-metallic separators, and your choice of either stainless steel or ceramic balls. Offered in either radial contact "C," angular contact "A," or four-point contact "X" configurations. These bearings, available in popular sizes, minimize the surface degradation and particulate formation so common in harsh environment applications. (See pages 49-52.)

Hybrid bearings are very well suited for applications where lubrication is marginal.

KAYDON REALI-SLIM® thin-section bearing product line has been expanded to include several additional bearing series specifically engineered to bring the advantages of REALI-SLIM® bearings to designs intended for service in the most severe or extreme environments. We offer REALI-SLIM® bearings with a variety of packaged features to meet specific operation requirements for:

- Chemical resistance/high temperature—P Series (See next page.)
- High performance/low torque—Q Series
- High performance/low particle—X, Y Series

Applications requiring low particle generation, high accuracy, high speeds, and/or which must operate in adverse or no-lube conditions, can benefit from hybrid bearings. Tests have shown that significant reductions in particle generation can be obtained with hybrid designs which incorporate the use of ceramic rolling elements on hardened steel races. In addition, the physical properties of the ceramic rolling elements (precision, hardness, light weight) provide additional benefits such as improved repeatability, low torque, high stiffness, and resistance to breakdown under marginal or no-lube conditions.

Tremendous benefits in performance can be obtained by matching not just size but also material to the application. These alternative race and ball materials interact differently than traditional chrome steel bearings. Capacities, life calculations and stiffness will differ from other products in this catalog. Contact KAYDON for technical characteristics of hybrid REALI-SLIM® bearings.

HARSH ENVIRONMENT BEARINGS (continued)

Series P—Chemical Resistant

In applications where both corrosion resistance and chemical resistance are required, series P bearings may be required. These bearings feature AISI 17-4PH steel races and ceramic balls. They're manufactured to provide a greater level of corrosion and chemical resistance than either KAYDON Series N or Series S bearings. Due to the hardening limitations of AISI 17-4PH steel, an adjustment factor of .17 must be applied to the standard dynamic capacity ratings. Thus, the use of P Series bearings should be carefully reviewed prior to selection to determine if the life and capacity are adequate.

Materials

Races	AISI 17-4PH steel
Balls	Borosilicate, glass, or ceramic
Cage	Type A; PTFE or Vespel® toroid ball spacers or 300 series steel ring
	Types C & X; Stainless steel or non-metallic composite ring

Specifications for Hybrid REALI-SLIM® Bearings

ITEM	DESCRIPTION	REFERENCE SPECIFICATION
	MATERIAL ANALYSIS	
RACES	AISI 440C Stainless steel	ASTM A-756
BALLS	AISI 440C Stainless steel or ceramic: Silicon Nitride	
SEPARATORS	P Type—Brass or non-metallic composite L Type—Nylon, fiberglass reinforced } other options, see p. 93	ASTM B-36 or B-134
C, X BEARINGS		
A BEARINGS	R Type—Brass or non-metallic composite G Type—Nylon, fiberglass reinforced } other options, see p. 93	ASTM B-36 or B-134
	PRECISION	
RACE DIMENSIONS	KAYDON Precision Class 1, Higher classes available	ABMA ABEC-1F or better
RACE RUNOUTS	KAYDON Precision Class 1, Higher classes available	ABMA ABEC-1F or better
BALLS	ABMA Grade 10 Stainless steel or Grade 5 ceramic	ANSI/ABMA/ISO 3290

KT Series
Tapered Roller Bearings

The KAYDON concept of standard bearings with light weight, thin sections, and large bore diameters includes tapered and radial roller bearings as well as ball bearings.

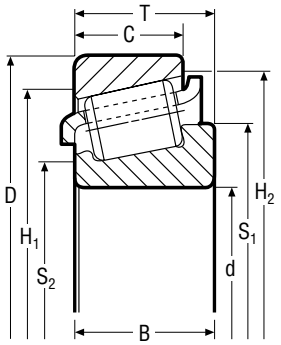
KT Series tapered roller bearings offer advantages to those designs requiring a bearing of higher capacity, which would benefit from the many unique advantages of a thin-section bearing. KT tapered roller bearings are used to advantage in applications ranging from oil field equipment to machine tool tables where space and weight considerations are meaningful.

KT Series standard tapered roller bearings have races and rollers of through-hardened AISI 52100 steel with a one-piece stamped steel cage. When specified, they can be furnished in pairs match ground for use with or without spacers.

The tapered roller bearings in this catalog are of the single-row radial type, designed primarily for application of radial load. While of separable construction, the rolling elements are retained in the separator.

Since this bearing assumes a contact angle of approximately 12° under an axial force, it does have a reasonable amount of thrust capacity. This capacity is uni-directional and is realized when the axial force is applied to the wide faces of the races.

As in the case of the angular contact ball bearing, the single row tapered roller bearing is commonly mounted in opposition to another bearing (usually of similar construction) to provide an axial force for establishing and maintaining the angle of contact. Two bearings of this type maybe mounted with the lines of contact converging outside of the bearings (back-to-back) or inside (face-to-face) with the former preferred for stability in the presence of overturning load.



KAYDON Bearing Number	Bore d (IN)	Outside Dia. D (IN)	Assem. Width T (IN)	Factor K (IN)	Rating at 500 RPM for 3000 hrs. L-10		Cone Width B (IN)	Cup Width C (IN)	Shoulder Diameters				Bearing Wt. (LB)
									Shaft		Housing		
					Radial (LB)	Thrust (LB)			S1 (IN)	S2 (IN)	H1 (IN)	H2 (IN)	
KT-070	**7.000**	8.500	.812	1.74	4970	2860	.812	.625	7.375	7.300	8.125	8.250	3.11
KT-091	**9.125**	10.250	.718	1.79	4920	2750	.722	.597	9.625	9.312	9.850	10.050	2.88
• **KT-098**	**9.875**	11.500	1.062	1.85	9260	5000	1.062	.875	10.375	10.225	11.063	11.250	6.05
KT-100	**10.000**	11.125	.625	1.79	4020	2250	.625	.500	10.500	10.300	10.750	10.900	2.88
KT-110	**11.000**	12.500	.875	1.86	7620	4100	.875	.688	11.438	11.250	12.000	12.250	5.06
KT-112	**11.250**	12.750	.812	1.86	7150	3860	.812	.625	11.688	11.500	12.313	12.500	4.72
KT-118	**11.875**	13.562	.937	1.76	7250	4120	.812	1.125	12.438	12.210	13.000	13.320	6.63
KT-130	**13.000**	14.562	.843	1.44	5580	3880	.843	.594	13.438	13.320	14.125	14.300	5.20
KT-132	**13.250**	15.000	.937	1.69	6160	3650	.937	.750	13.875	13.625	14.375	14.500	6.79
KT-151	**15.125**	17.375	1.125	1.72	11760	6840	1.125	.812	15.750	15.625	16.750	16.875	13.57
KT-165	**16.500**	18.750	.875	1.78	8220	4620	.882	.812	17.250	17.000	18.125	18.500	11.14
KT-180	**18.000**	19.625	.812	1.69	7400	4330	.812	.687	18.438	18.375	19.188	19.300	8.19
KT-200	**20.000**	21.750	.812	1.80	7930	4400	.812	.687	20.625	20.375	21.125	21.250	9.78

• Available from Stock—check for availability of other sizes.

Tolerances are: Bore: +.001" – .000" up to KT-110; +.002" – .000" for KT-110 to KT-200
Outside Diameter: Same as for bore.
Width: ±.010" up to KT-112; ±.015" for KT-112 to KT-200
Cup Radial Runout .0015" Max. F.I.M., Cone Radial Runout .0020" Max. F.I.M.

Section 7—Appendix and Sales Information

Bearing Definitions and Terms

Axial Clearance:

The total amount of free axial movement between the inner and outer race of a bearing. Bearings with internal clearance will contain both axial and radial clearance.

Axial Load:

Load applied to the bearing parallel with the bearing axis of rotation — also known as thrust load.

Capacity:

Dynamic capacity is the basic "C" rating which represents a load that the bearing can theoretically endure for 1 million revolutions. Static capacity is the approximate load the bearing can endure before permanent deformation occurs on the ball or raceway. Published capacities do not apply to hybrid series bearings P, X, and Y. Contact KAYDON product engineering.

Deflection:

The amount of movement associated with compression or stretching of bearing components when placed under load.

Diameter Tolerance:

The range in which the average diameter of a bore or O.D. may fall. REALI-SLIM® bearings are considered "non-rigid" rings and all diameters are averaged using multi-point gaging techniques per ABMA Std. 26.2.

Diametral Clearance:

The total free movement of the inner race relative to the outer race in a radial plane, also referred to as radial clearance. "X" and "C" type bearings are made with some internal clearance as a standard factory internal fit before mounting.

L_{10} Life:

The theoretical life span of a bearing under a specific set of dynamic operating conditions associated with 90% reliability.

Moment Load:

Load such that when applied to a bearing system, tends to overturn or bend the axis of rotation in an angular direction.

Pitch Diameter:

The theoretical median diameter of a bearing, which passes through the center of the rolling elements. REALI-SLIM® pitch diameters are equivalent to: (OD+Bore)/2.

Preload:

The amount of load placed on the rolling elements before the application of any external loads. Preload can be created in "X" and "C" type bearings by controlling internal fits of the ball and the raceway at the factory. Preload in angular contact bearings is controlled by a "preload gap" between the duplexed races. Tight mounting conditions will increase the final bearing preload. Preload stiffens the bearing and eliminates axial and radial play, but the load on the balls increases friction and shortens L_{10} life.

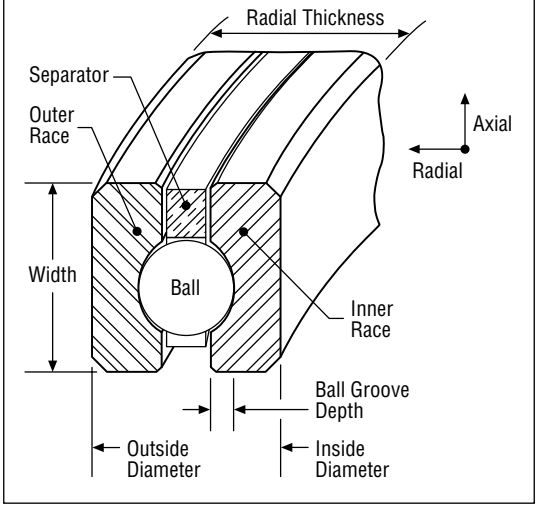
Radial Load:

Load applied perpendicular to the bearing axis of rotation.

Runout:

The maximum axial or radial race wall thickness variation of an inner or outer bearing race. Runout influences the repeatable location variation of rotating components.

Standard bearing nomenclature



Warranty Information and Legal Notices

Disclaimer

The design and application information contained in this catalog is for illustration only. Responsibility for the application of the products contained in this catalog rests solely with the equipment designer or user. In spite of our best efforts, the material contained in this catalog may contain inaccuracies and typographical errors.

Hazard Notice

The use of any part, such as those described in this catalog, may be hazardous and have the potential to cause serious injury, including death, to people or property. The purchaser is responsible for evaluating the hazards associated with any part used in their application.

KAYDON Standard Terms and Conditions of Sale

1) Scope. Prices quoted are for acceptance within thirty (30) days from date of quotation unless otherwise stated. The terms and conditions of sale set forth below apply to all quotations made and purchase orders accepted by Seller.

2) Acceptance of Orders. All orders are subject to acceptance by authorized officials at Seller's division or subsidiary offices.

3) Scheduling. Shipping dates are approximate and are based upon prompt receipt of all necessary information. Buyer shall furnish to Seller written shipping instructions in sufficient time to permit Seller to make shipment at Seller's option within any time or times herein specified for shipment. In the event of a delay in delivery due to any reason described in Section 16 below, the delivery date shall be deferred for a period equal to the time lost by reason of delay. In the event such delay shall continue for more than two weeks, then, at Seller's option, the order will be deemed cancelled without liability to Seller.

4) Quantities. Seller reserves the right to ship quantities (or weight, as applicable) that are within ten percent (10%) of the quantity (or weight) specified by Buyer, and Seller shall not be liable for any overshipment or undershipment within this limit. In the event of any overshipment within this limit, Buyer shall pay for the actual quantity (or weight) shipped.

5) Delivery and Transportation. Seller's delivery dates are approximate. Seller shall not be liable for delays in delivery or other defaults in performance of this order arising out of causes beyond Seller's control. Unless otherwise agreed to in writing by Seller, delivery of the products hereunder shall be made F.O.B. at the point of shipment with delivery to the initial carrier to constitute delivery to the Buyer. Title to products passes to Buyer and products are at risks to Buyer from and after delivery to the initial carrier. Transportation expenses will be paid by Buyer and risk of loss, shortage, delay or damage to products in transit shall fall upon Buyer, whose responsibility it shall be to file claims with the carrier.

6) Terms of Payment. Invoices are due and payable (30) thirty days from the date of invoice unless other terms are shown on the face hereof. A 1-1/2% (one-and-a-half percent) carrying charge will be applied to all past due amounts. If shipments are delayed by Buyer, payments shall become due on the date when Seller is prepared to make shipment. If the work covered by the purchase order is delayed by Buyer, payments shall be made based on the purchase price and the percentage of completion. Seller reserves the right to ship to its order and make collection by sight draft with bill of lading attached.

7) Taxes. Prices do not include foreign or domestic sales, use, excise or similar taxes. Consequently, in addition to the prices specified herein, the amount of any present or future sales, use, excise or other general or specific tax, or imports, duties or penalties or other governmental charges fixed or imposed by any lawful authority(s) upon or applicable to the production, sale, shipment, delivery or use of the products sold hereunder shall be added to the price and be paid by Buyer or, in lieu thereof, Buyer shall provide Seller with a tax exemption certificate acceptable to the taxing authorities. If such tax is paid by Seller, Buyer shall reimburse Seller upon presentation of invoice.

8) Warranty. Seller warrants the products manufactured by it to be free from defects in material and workmanship only. The extent of Seller's obligation hereunder is to either repair or replace its work or the defective products, F.O.B. Seller's plant, if returned within twelve (12) months after date of delivery. No allowance will be granted for repairs or alterations made by Buyer without Seller's written approval. The warranty shall not be construed to cover the cost of any work done by Buyer on material furnished by Seller or the cost of removal or installation of product. Products and parts not manufactured by Seller are warranted only to the extent and in the manner that the same are warranted to Seller by Seller's vendors and then only to the extent Seller is able to enforce such warranty. There is no other warranty, expressed or implied, in fact or by law.

THE FOREGOING STATES THE SOLE AND EXCLUSIVE WARRANTY OF BUYER AND THE SOLE AND EXCLUSIVE WARRANTY OF SELLER. THE WARRANTIES STATED IN THIS PARAGRAPH ARE IN LIEU OF ALL OTHER WARRANTIES WRITTEN OR VERBAL, STATUTORY, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED.

Seller's agreement to sell the products is made upon the condition and agreement that, with respect to the products, there have been no representations or undertakings made by or on behalf of Seller and Seller makes no guarantees or warranties, expressed or implied, in fact or in law, except as expressly stated above.

9) Limitation of Liability. Seller shall not be responsible, obligated, or liable for any injury or damage resulting from an application or use of its products, either singly or in combination with other products. SELLER'S SOLE LIABILITY FOR BREACH OF WARRANTY OR ANY OTHER CLAIM SHALL BE LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCTS OR RETURN OF THE PURCHASE PRICE, AT SELLER'S SOLE OPTION. SELLER SHALL NOT BE LIABLE FOR DAMAGES, INCLUDING BUT NOT LIMITED TO CONSEQUENTIAL OR SPECIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THE PRODUCTS OR ARISING OUT OF ACCEPTANCE OF THIS ORDER.

10) Acceptance of Products. Products will be deemed accepted without any claim by Buyer unless written notice of non-acceptance is received by Seller within thirty (30) days of delivery if shipped F.O.B. point of shipment, or ten (10) days of delivery if shipped F.O.B. point of destination. Such written notice shall not be considered received by Seller unless it is accompanied by all freight bills for such shipment, with agent's notations as to damages, shortages and conditions of equipment, containers and seals. Non-accepted products are subject to return policy stated below.

11) Return of Products. No product may be returned to Seller without Seller's prior written permission, which permission may be withheld by Seller in its sole discretion.

WARRANTY INFORMATION AND LEGAL NOTICES (continued)

12) Damages to Returned Products. If Buyer elects to return product(s) to Seller for refurbishment, Buyer agrees to accept all risk of damage or destruction of such returned product(s), and Seller shall not be liable for any failure or inability on the part of Seller to complete refurbishment upon any such returned products.

13) Limitations of Actions. Irrespective of whether Seller agreed to perform field start-up or any other service after the delivery of the product, all claims or actions must be brought within one (1) year of date of tender of delivery, or eighteen (18) months of Buyer's order, if no tender of delivery is made, notwithstanding any statutory period of limitation to the contrary.

14) Patents. Buyer shall hold Seller harmless against any expense or loss resulting from infringement of patents or trademarks arising from compliance with Buyer's design, specifications or instructions.

The sale of products or parts thereof by Seller does not convey any license by implication, estoppel, or otherwise under patent claims covering combinations of these products or parts with other devices or elements.

15) Financial Responsibility. If in the sole judgment of Seller the financial resources of Buyer become impaired or unsatisfactory at any time during the term of the agreement between the parties, then Seller may require of Buyer a deposit or suitable security or margin for performance by Buyer in such amount or amounts from time to time as Seller shall specify. Upon requirement of deposit, Buyer shall make such deposit not later than the close of Seller's next business day. If Buyer fails to make such deposit, then Seller may at its option (1) cancel the agreement between the parties or the undelivered portion thereof, in which case Buyer agrees to pay Seller the difference between the market price on date of cancellation and the contract price; (2) resell at any time for Buyer's account all or any undelivered portion of the products, in which case Buyer agrees to pay Seller the difference between the resale price and the contract price, or (3) otherwise change the terms of payment. In the event Buyer shall be or becomes insolvent, or admits in writing Buyer's inability to pay Buyer's debts as they mature, or if Buyer shall make an assignment with creditors or if there are instituted by or against Buyer proceedings in bankruptcy or under any insolvency laws or for reorganization, receivership or dissolution, Seller may terminate the agreement between the parties at any time and without notice.

16) Force Majeure. In the event of war, fire, epidemics, quarantine restrictions, flood, strike, labor trouble, breakage of equipment, accident, riot, the imposition of any government price control regulation or any other act of governmental authority, acts of God or other contingencies (whether similar or dissimilar to the foregoing) beyond the reasonable control of Seller, interfering with the production, supply, transportation, or consumption practice of Seller at the time respecting the products covered by the agreement between the parties or in the event of inability to obtain on terms deemed by Seller to be practicable any raw material (including energy source) used in connection therewith, quantities so affected shall be eliminated from the contract without liability, but the contract shall otherwise remain unaffected. Seller may during any period of shortage due to any of these causes, allocate its supply of such raw material among its various uses therefore (e.g. manufacturing and sales) in such manner as Seller deems practicable and allocate its supply of such products among such various uses thereof in any manner which Seller deems fair and reasonable.

17) Reasonable Attorneys' Fees. In the event suit or other proceeding shall be brought for the recovery of the purchase price, or any unpaid balance or the breach by Buyer of any term of the agreement between Seller and Buyer, Buyer shall pay to Seller, in addition to any damages provided by law, reasonable attorneys' fees and costs of collection.

18) Security Title. Security title and right of possession of the products sold hereunder shall remain with Seller until all payments due from Buyer to Seller (including deferred payments whether evidenced by notes or otherwise) shall have been made in cash and Buyer agrees to do all acts necessary to perfect and maintain such security right and title in Seller.

19) Cancellations. Buyer may cancel an order only upon written consent and upon payment to Seller of cancellation charges, which shall take into account among other things expenses incurred and commitments already made by Seller, and Seller's profit margin.

20) General

(a) The agreement between Buyer and Seller and matters connected with the performance thereof shall be construed in accordance with and governed by the law of the State of Seller's accepting offices, as referenced in Section 2, as though it were executed and performed entirely within the State of Seller's accepting offices, as referenced in Section 2, and shall be construed to be between merchants.

(b) Any assignment of the agreement between Buyer and Seller or any rights or obligation of the agreement by Buyer without written consent of Seller shall be void.

(c) Except as may be expressly provided to the contrary in writing, the provisions of the agreement between Buyer and Seller are for the benefit of the parties hereto and not for any other person.

(d) No waiver by Seller of any breach of any provision of the agreement between Buyer and Seller will constitute a waiver of any other breach.

(e) The terms and conditions set forth above contain all the representations, stipulations, warranties, agreements and understandings with respect to the subject matter of the agreement between Buyer and Seller, and its execution has not been induced by any representation, stipulation, warranty, agreement or understanding (including any course of prior dealings between the parties hereto) of any kind other than those set forth above.

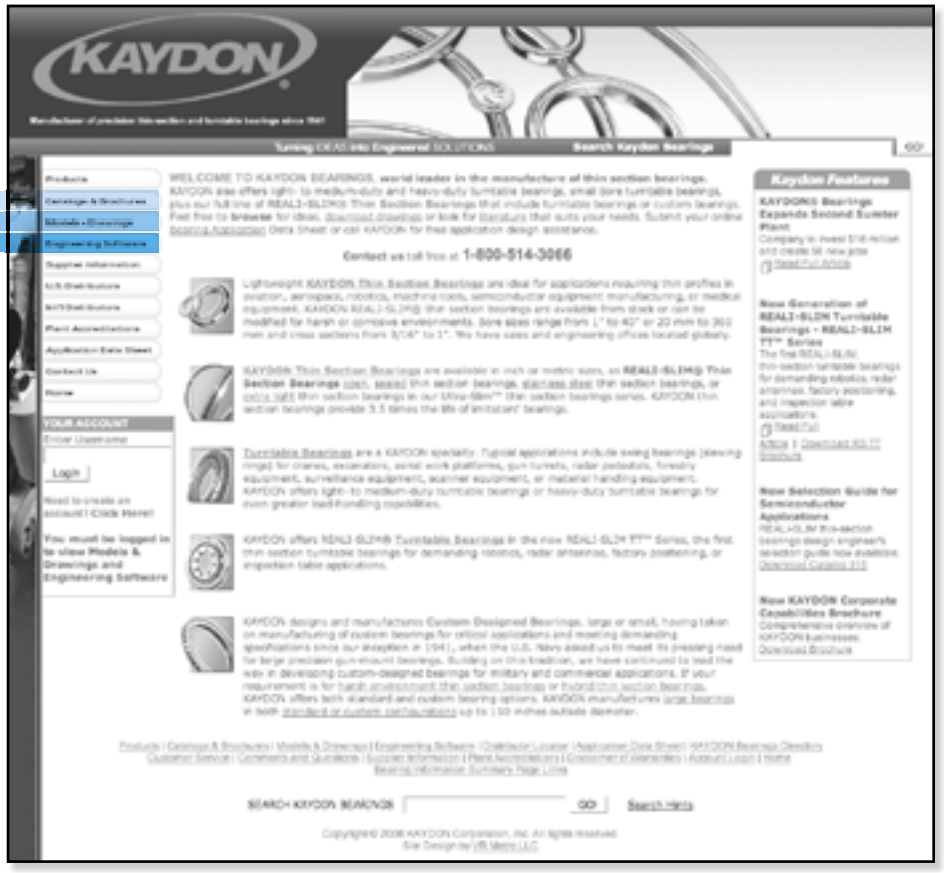
(f) No amendment, addition to, alteration, modification or waiver of all or part of the agreement between Buyer and Seller shall be of any force or effect unless in writing and signed by Seller. If the terms and conditions set forth above conflict with those of any purchase order of Buyer written in connection with the sale of the products or any portion thereof, then the terms set forth above shall govern.

21) Arbitration. Any controversy or claim arising out of or relating to the agreement between Buyer and Seller, or the breach thereof, shall be settled in the City and State of the Seller's accepting offices, as referenced in Section 2, by arbitration in accordance with the Rules of the American Arbitration Association, and judgment upon the award rendered by the arbitrator may be entered in any court having jurisdiction thereof.

Visit our website: www.kaydonbearings.com

for latest releases — newest features — and downloads of catalogs, software, or CAD drawings.

Click on **Catalogs & Brochures**



Click on **Engineering Software**

Click on **Models + Drawings**

Download KAYDON REALI-DESIGN™ and REALI-DESIGN MM™ software from our website: www.kaydonbearings.com

REALI-DESIGN™ and REALI-DESIGN MM™ Engineering Aids for KAYDON REALI-SLIM® Thin-Section Bearings

- Save hours of tedious computations.
- Reduce bearing selection time to seconds.
- Accurately compute essential life and load analyses.
- Determine safe operating speeds.
- Calculate load deflections.

Unlike some other software programs, the REALI-DESIGN™ program group is not simply a catalog on a disk. This innovative program is an actual engineering aid designed to apply the calculating power of the computer to your complex power transmission design computations. Use this program as a supplement to KAYDON Catalog 300. Use these programs to select the exact KAYDON REALI-SLIM® Thin-Section Bearing for your application.

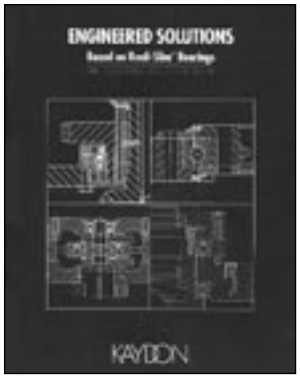
New — Introducing the newest addition to the KAYDON Engineering Program Group — REALI-DESIGN MM™. This program is provided to support the metric sizes for REALI-SLIM® thin-section bearings. The program looks and feels identical to the REALI-DESIGN™ program, so a new user can immediately feel at home using it.

Application Information to Help In Your Designs

Also available for download from our website www.kaydonbearings.com.

1. REALI-SLIM® thin-section bearings catalog

Complete engineering and selection information on the entire product line, including REALI-SLIM MM™ metric series, REALI-SLIM TT™ turntable series, and ULTRA-SLIM™ series. 132 pages. Request **Catalog 300**.

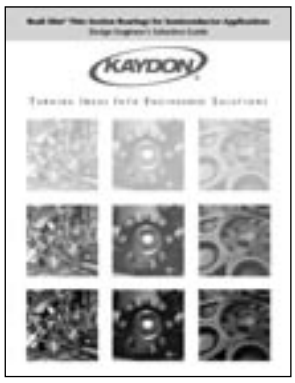


2. An illustrated mounting guide for REALI-SLIM® bearings

Gives ideas on how to improve designs through better mounting and use of bearing assemblies. 24 pages. Request **Catalog 306**.

3. REALI-DESIGN™ and REALI-DESIGN MM™ software on CD

Speeds REALI-SLIM® bearing selection process. Includes data sheets, life calculations, and CAD-ready DXF library for both inch and metric series. Software also downloadable from www.kaydonbearings.com.

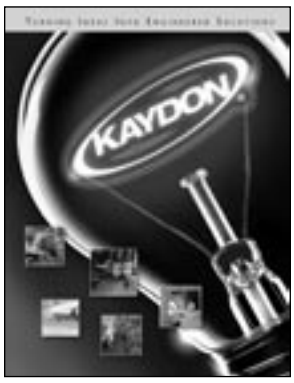


4. A design engineer's selection guide for REALI-SLIM® bearings in semiconductor applications

Engineering recommendations for use of KAYDON bearings in semiconductor manufacturing equipment. 8 pages. Request **Catalog 315**.

5. Large turntable bearing catalog

Complete engineering and selection information on standard and custom turntable bearings. 32 pages. Request **Catalog 390**.



6. Corporate capabilities brochure

Comprehensive overview of KAYDON Corporation businesses.

Request For Bearing Proposal Data Form

Detach and fax completed form or complete and submit online at www.kaydonbearings.com.

Attention: KAYDON Sales

Date: _____

TO: KAYDON Corporation
Muskegon, Michigan 49443
Fax: 231-759-4102 Phone: 231-755-3741

FROM: _____
_____
_____
_____

Project Description:
Application: _____
Type: _____
Annual Quantity: _____
Quotation Quantity:_____
Program Start Date: _____
Response from KAYDON Needed by:_____

☐ **For a preferred Size and Style of Bearing:**
Preselected KAYDON Bearing Model #: _____
or
Bore: _____ inches O.D.: _____ inches Width: _____ inches
or
Envelope Size : _____ Min. Bore inches _____ Max. O.D. inches _____ Max. Width inches

☐ **For an L_{10} life calculation: [Describe loads and/or mass on bearing]**
Dynamic Radial avg.: _____ pounds
Dynamic Axial avg.: _____ pounds
Dynamic Moment avg.: _____ inch-lbs.
RPM (max) _____ RPM (min) _____ **or** Oscillation: Angle _____ Duty Cycle _____
Bearing axis is (vert/horiz) with the (inner/outer) race rotation relative to load
Minimum Hours needed: _____

☐ **For a Safety factor calculation: [describe any maximum shock or impact Loads]**
[Note: Do not include Safety factor in these loading values !!!!]
Static Radial Max: _____ pounds
Static Axial Max: _____ pounds
Static Moment Max: _____ inch-lbs.

☐ **For determining Shaft and Housing sizes: [Attach proposed mounting sketch if possible]**

	Material	Radial Thickness	Low Temperature	Normal Temperature	High Temperature
Shaft	_____	_____	_____	_____	_____
Housing	_____	_____	_____	_____	_____

☐ **For Accuracy concerns:**
KAYDON Precision Class _____
or
Radial Runout _____ Axial Runout _____

☐ **For Stiffness or Deflection concerns:**
Springrate: _____
or
Movement under load: _____

☐ **For Torque to Rotate concerns:**
Maximum allowable Starting Torque: _____

☐ **For Other or Environmental Conditions:**
Operating Temperature Range: _____
Vacuum Range: _____
Proposed Lubricant is : _____
Seals or Shields: _____
Protective Coating: _____

Mounting Sketch

Fax Request for Bearing Proposal Data Form to:

(231) 759-4102

KAYDON Corporation
2860 McCracken Street
Muskegon, Michigan 49441 U.S.A.
Phone: (231) 755-3741
Fax: (231) 759-4102

Need Service Fast?
1-800-514-3066

Visit our website: **www.kaydonbearings.com**