Kaydon white paper

Slewing bearing selection, simplified

by Jeff Lauber, engineering specialist

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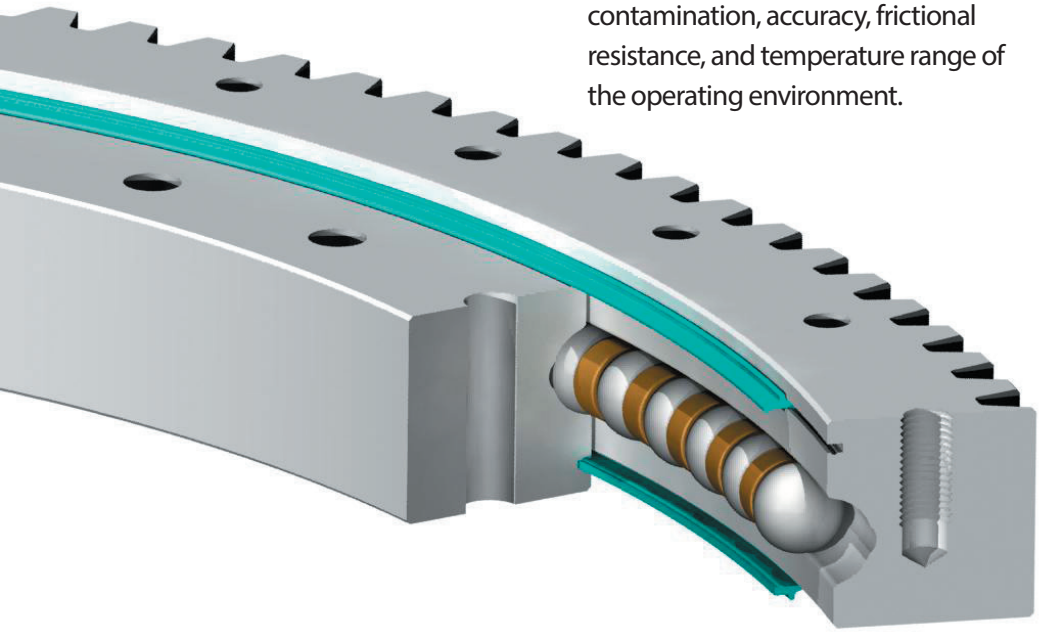
Selecting the right slewing bearing

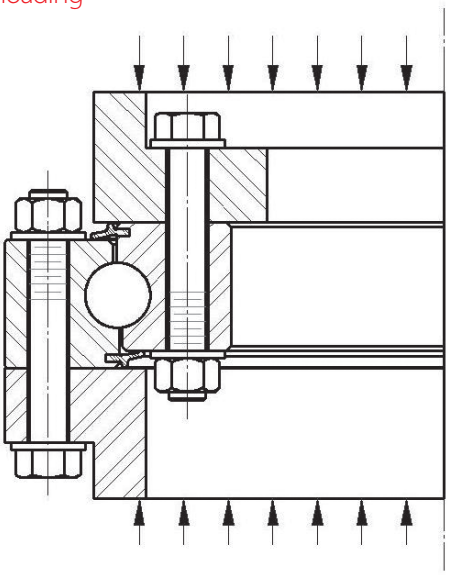
Slewing bearings are typically used in applications where their ability to transmit relatively high loads is of primary importance. However, there are other potential application requirements that can have a significant impact in the selection of an appropriate slewing bearing, and they should be thoroughly considered during the selection process. These considerations include, among others, rotational speed, protection from contamination, accuracy, frictional resistance, and temperature range of the operating environment.



Steps for selecting a slewing bearing

Figure 1

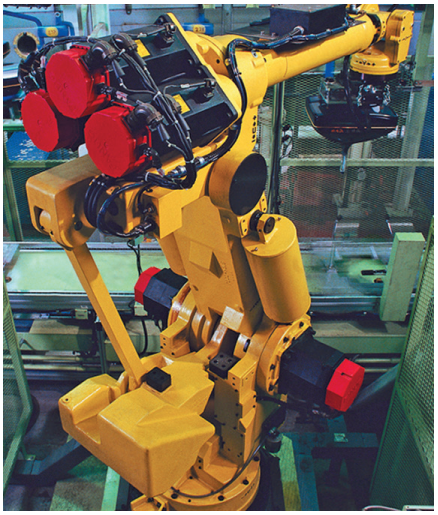
Compressive thrust and moment loading



This white paper outlines nine steps to follow in order to select the appropriate slewing bearing for a given application. Note that these guidelines apply to 'normal slewing applications,' which are defined as those that meet the following conditions:

- Vertical axis of rotation
- Compressive thrust and moment loading (see Figure 1)
- Radial load less than 10% of the thrust load
- Oscillation or intermittent rotation with occasional pitch line velocity (limited time for speeds to 500fpm for single row bearings and 300fpm for multi-row bearings)
- Operating temperature within -20°F to +140°F (-29°C to +60°C)
- Mounting surfaces reinforced and machined to bearing manufacturer's criteria
- Proper installation (see the Kaydon white paper 'How mounting can optimize slewing bearing performance' for more information.
- Periodic lubrication
- Periodic confirmation of specified bolt tension

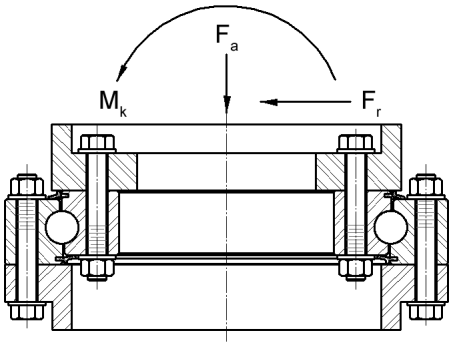
If yours is not a 'normal application,' consultation with your bearing supplier during the early stages of a project can help assure success.



9 steps for selecting a slewing bearing: steps 1&2

Figure 2

Resultant forces acting on or about a bearing



Step 1

Determine what is required of your application in terms of load, speed, accuracy, torque, environment, coatings, mounting arrangements, and lubrication. Kaydon's Specification Data Sheet lists the more common requirements; download the data sheet, use the online form, or see pages 125 and 126 of Kaydon Catalog 390. Early consultation with your bearing manufacturer will help assure selection of a bearing that provides the necessary features to meet your requirements.

Step 2

Determine all maximum bearing loads, being sure to include all dynamic and static loads imposed on the bearing.

Consider all applied forces to the bearing and gear — not only at rated and working loads, but also loads imposed during:

- extreme weather conditions
- impact or testing
- assembly or disassembly
- all other situations

These loads in turn must be simplified into the forces acting at the bearing's center. See Figure 2.

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Step 3

Multiply the resultant bearing forces by the applicable service factor (SF). See Table 1 (on the next page) for the service factors of common applications, or use the Kaydon Bearings slewing bearing selector tool.

Application service factors are based on a number of considerations. The primary considerations are the frequency of use at higher vs. normal loads and potential for extreme or impact loads. These factors may be superseded by customer specification, finite element analysis (FEA), or regulations by certifying authorities.

If the intended equipment and application do not appear in Table 1, select a comparable application for initial sizing. If unsure, consult with the bearing manufacturer.

Table 1

Application	Service factor (SF)
Aerial lift devices – Aerial baskets, platforms, ladders, etc.	1.00
Conveyors	1.00
Cranes	
Mobile - (loads limited by machine stability)	
Normal construction duty (tire mounted)	1.00
Normal construction duty (crawler mounted)	1.10
Production duty such as scrap and ship yards	1.25
Forestry handling (logging)	1.50
Stacker cranes (must include dynamic forces as loads)	1.25
Pedestal or tower - (loads not limited by machine stability)	
Loads continually monitored by safe load device	1.25
Applications with risk of sudden impact load application	1.50
Excavators	
Load limited by tipping	1.25
Load limited by hydraulic pressure relief	1.50
Index and turnstile tables* – (include any shock loads for evaluation)	
Occasional use with intermittent rotation	1.00
Frequent use with intermittent rotation	1.25
Frequent use with intermittent rotation and impact loads	1.50
Industrial manipulators and robots	
Occasional service	1.00
Frequent service	1.25
Steering gear – (must include dynamic and shock loads due to transit forces)	
Pneumatic tires	1.25
Solid tires	1.50

*Excludes coilers/uncoilers

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Step 4

If an integral gear is desired, determine the required gear capacity. As with bearing loads, consider all conditions that would generate potential gear loads. Examples include dynamic loads while working vs static loads; loads on incline; and overload testing. Consider also the duty cycle at each of these conditions.

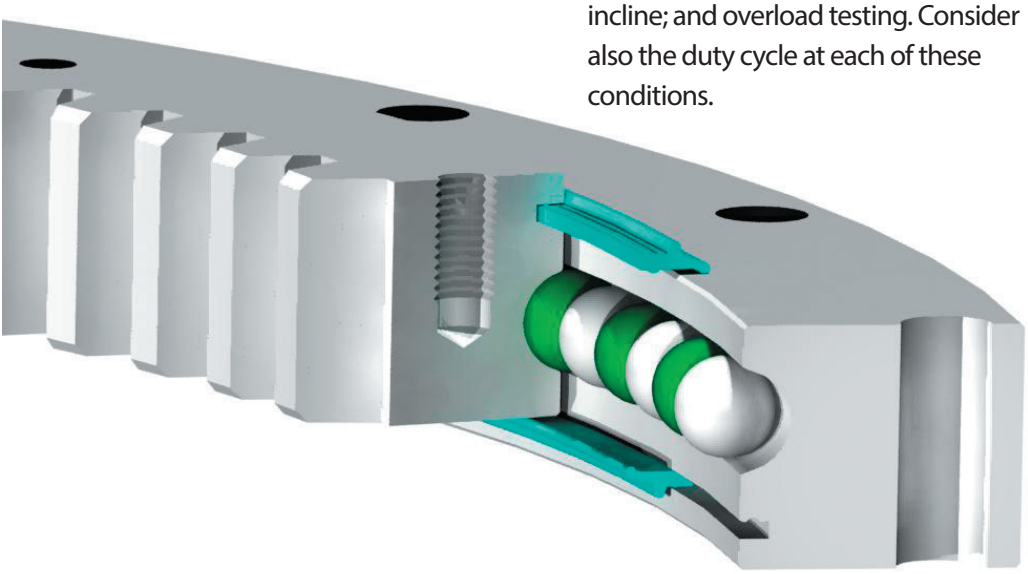

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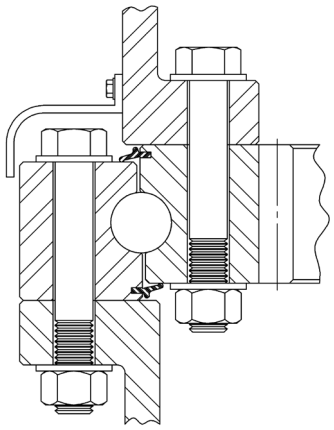
Figure 3



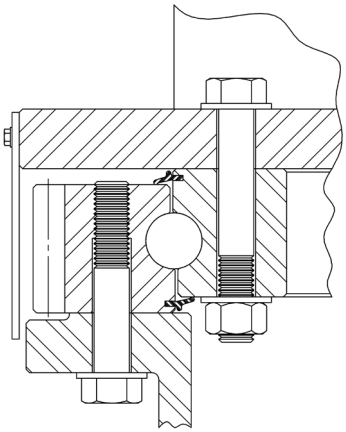
Pinion is attached to outer ring support and the upper structure is supported by the inner ring. A shroud over the outer seal and bolts prevents contamination under extreme conditions. Through bolt arrangement shown.

Step 5

Determine the preferred mounting arrangement, considering the pinion and gear location. Consider the requirements for installation and continued maintenance of the bearing and retaining bolts. Slewing bearings can be designed to suit a number of mounting arrangements.

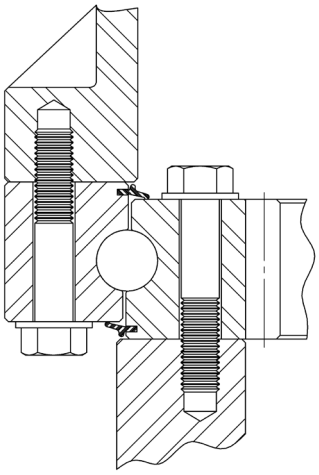
See Figures 3 through 6 for examples of basic arrangements available from Kaydon Bearings, which can be varied to suit the requirements of a specific application. The mounting structures shown are intended to be illustrative only.

Figure 4



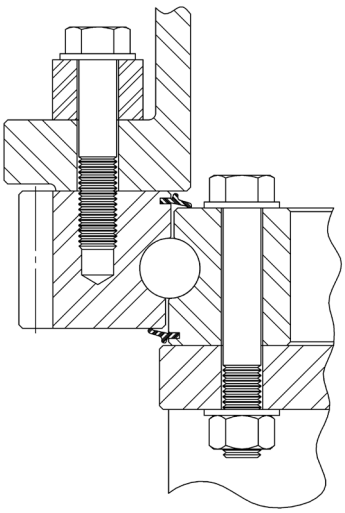
Inner ring with through bolts supports the upper structure with pinion. An external shroud protects the gear teeth on the outer ring, supported by the lower structure with threaded bolts.

Figure 5



Pinion is attached to upper structure supported by outer ring. Location of gear on inner ring can provide protection from harsh external conditions. Threaded bolt arrangement shown.

Figure 6



Pinion is attached to lower structure supporting inner ring. Geared outer race supports upper structure. Through bolts used on inner ring and threaded bolts on outer ring.

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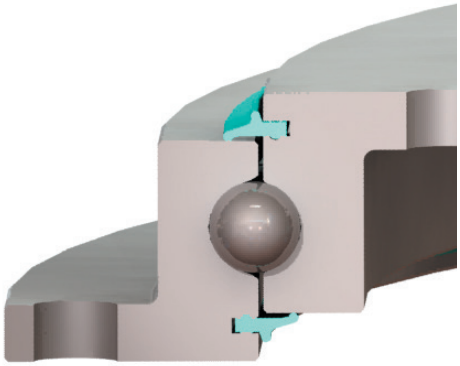
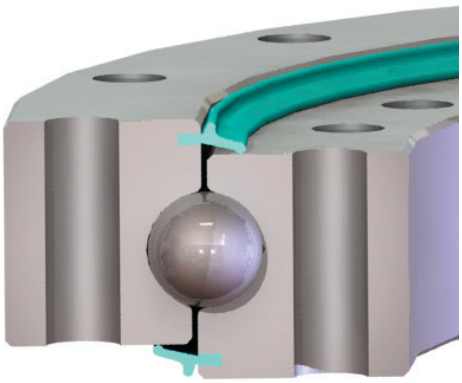
Figure 7

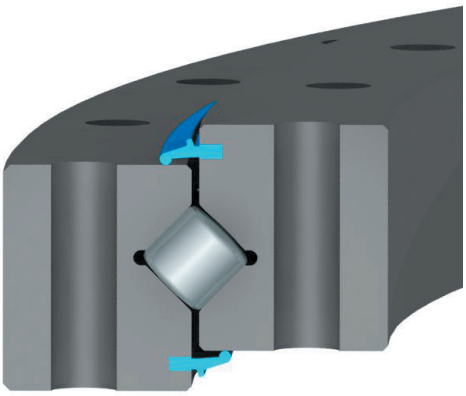
Cross-sections of available Kaydon slewing bearings



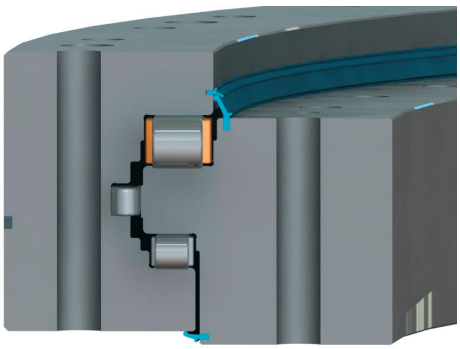
RK Series



MT Series



XR Series



TR Series

Step 6

Review available bearing styles and cross-sections. Figure 7 features a few of the slewing bearing designs available from Kaydon. Kaydon's slewing bearing Catalog 390 provides detailed information about the design features, sizes, and ratings of each bearing series. Download the catalog.

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Step 7

Make a preliminary selection by comparing the resultant operating bearing forces, including service factor (SF), to the bearing's rating curve.

In order for a bearing to be appropriate for a given application, all required resultant force combinations should fall below the curve.

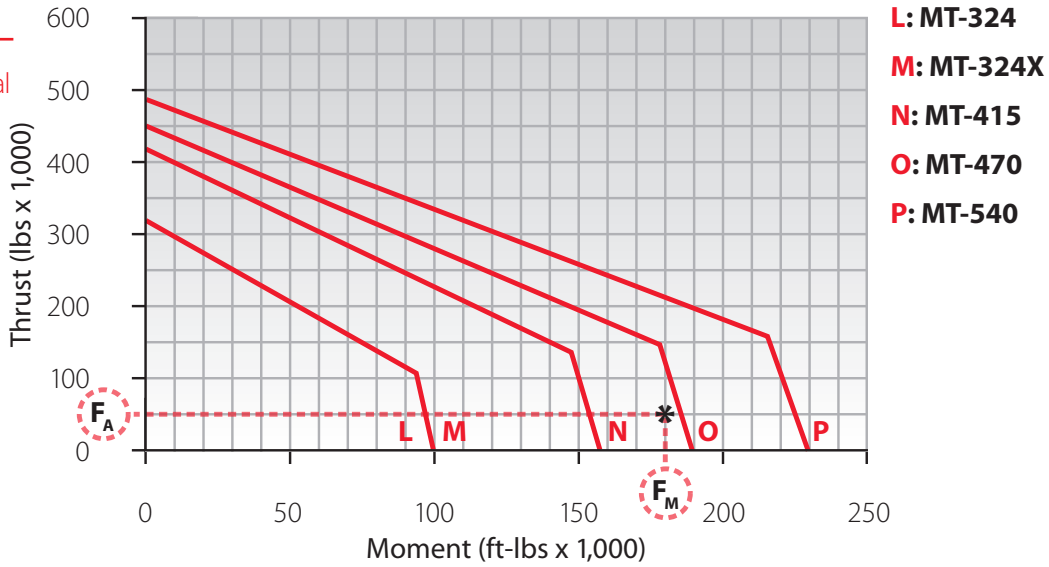
Assure all extreme load conditions fall below the bearing's rating curve. If extreme load condition is static and only occurs several times during bearing's service life do not include the service factor. Otherwise, include the service factor.

The maximum thrust rating of a bearing should exceed 3 times the maximum operating thrust force on the bearing, regardless of the moment force at that condition. This criteria is due to concern for rigidity of the supporting structure and ability to properly distribute the load around the bearing's diameter. If the bearing desired does not meet this criteria, contact the bearing manufacturer for assistance.

Load curves for Kaydon slewing bearings, such as the example in Figure 8, can be found using the Kaydon slewing bearing selector or Catalog 390. Several bearings may meet the required load ratings.

Figure 8

Maximum rating curves for several bearing types



*** Max resultant bearing forces**

$F_R \leq 0.10 \times F_a \times SF \leq 5{,}000$ lbs

$F_A = F_a \times SF = 50{,}000$ lbs

$F_M = F_m \times SF = 180{,}000$ lbs

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Step 8

Check the gear size, quality, and rating for suitability. A sample gear rating chart, from Kaydon Bearings, is shown in Figure 9.

The chart's gear tooth rating (Fz) indicates the maximum allowable tangential gear tooth load for normal slewing bearing applications. Refer to page 21 of Kaydon Catalog 390 for more details.

Figure 9

Example: Part number table including gear tooth ratings

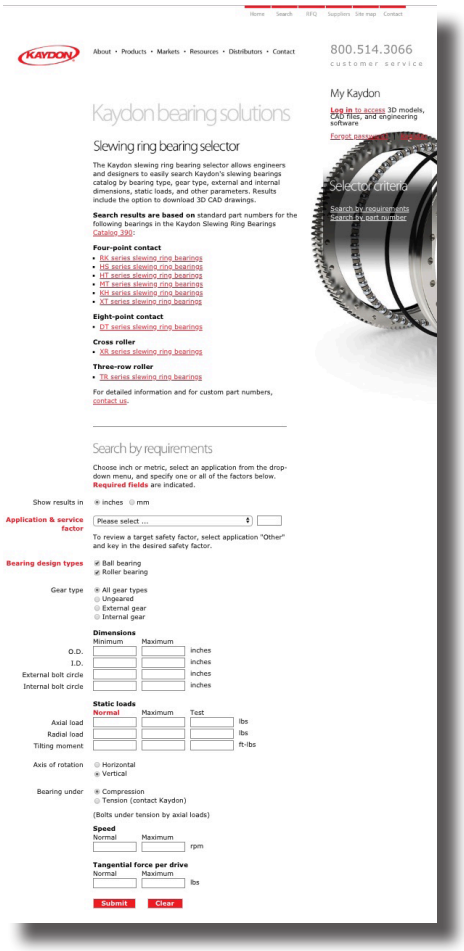
External gear

Kaydon part number	Outline dimensions and weight					Hole data				Gear data Full depth involute $P_d = 6, \alpha$ 20°, AGMA Q8			Gear tooth rating F_z
						Outer ring		Inner ring					
	D_o in	d_i in	D_i in	d_o in	G approx lbs	L_o in	n_o	L_i in	n_i	D_2 in	b_2 in	z_2	lbs
KH-125E	16.500	8.625	12.750	12.250	75	14.750	16	10.250	16	16.167	2.000	97	5,480
KH-166E	20.500	12.750	16.875	16.375	100	18.875	20	14.375	20	20.167	2.000	121	5,570
KH-225E	26.667	18.500	22.750	22.250	140	24.500	18	20.500	18	26.333	2.000	158	5,670
KH-275E	31.667	23.500	27.750	27.250	175	29.500	24	25.500	24	31.333	2.000	188	5,700
KH-325E	36.667	28.500	32.750	32.250	205	34.500	28	30.500	28	36.333	2.000	218	5,730
Tolerances	**+0/-.020**	**±.050**	***Note**	***Note**		**⌖ .030**		**⌖ .030**			**±.030**		

Step 9

Figure 10

Kaydon Bearings slewing bearing selector tool



Step 9

Finally, confirm that the bearing you select meets all of your design requirements. The Kaydon slewing bearing selector (Figure 10) can help with obtaining preliminary data. Consult with bearing and other component manufacturers, and submit a completed specification data sheet to the bearing manufacturer to confirm proper bearing selection. Ultimately, the responsibility for choosing the appropriate bearing rests with the equipment designer.

Conclusion

Like all bearings, slewing bearings serve as a connection between two adjacent structures, allowing rotation and transmission of load between them. In addition, a slewing bearing typically includes features for simple and quick attachment to those adjacent structures, and a feature to facilitate the mechanical rotation of one ring and its adjoining structure relative to the other.

Slewing ring bearings have traditionally been thought of as large-diameter, heavy section, low-precision bearings. But today they are also readily available with bore sizes as small as 50 mm, making them ideal for robotics, radar pedestals, and other precision applications.

The use of a single large-diameter bearing makes it possible for wiring and plumbing to run through the bore of the bearing. This can simplify overall design, help protect components, and improve appearance.

Selecting the right slewing bearing is key. With attention to all relevant design requirements and with help from the bearing manufacturer, a slewing bearing can be specified that meets or exceeds all application requirements.

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