NMB Minebea
Spherical, Rod End

and Sleeve Bearings „metric"

BEARING CLASSIFICATIONS

Bearings are divided into two basic categories:
(1) rolling element or “anti-friction” bearings.
(2) sliding surface or “plain” bearings. Except as noted, all bearings in this guide are of the “plain” bearing classification.

TABLE 1 - NMB BEARING CLASSIFICATION BY CONSTRUCTION ELEMENTS

- Plain Bearings
  - Self Aligning Bearings
    - Spherical
      - Lubricated
        - Non Separable
          - Swaged Type
          - Insert Type
        - Separable
          - Fractured Race
            - Single Fracture
            - Double Fracture
          - Split Ball
          - Loader Slot
      - Self Lubricating
        - Dry Film
          - Non Separable
            - Swaged Type
          - Separable
            - Fractured Race
              - Single Fracture
              - Double Fracture
            - Split Ball
            - Loader Slot
        - PTFE Lined
          - Swaged
            - Sealed
            - Standard
        - Minelon TN
          - Molded
    - Rod End
      - Lubricated
        - Swaged
        - Insert
        - Split Ball
        - Loader Slot
        - Die Cast
      - Self Lubricating
        - Dry Film
          - Swaged
          - Split Ball
          - Loader Slot
        - PTFE Lined
          - Swaged
            - Sealed
            - Standard
        - Minelon TN
          - Molded
  - Journal Bearings
    - Self Lubricating
      - PTFE Lined
        - Plain
        - Flanged
- Rolling Element Bearings
  - Engineering information on rolling element (anti-friction) bearings is presented in other NMB publications except that self-aligning, anti-friction, double row, ball bearing rod end data is included in this guide. (See page 10).

BEARING CLASSIFICATIONS

TABLE 2 - NMB CATALOG BEARING SERIES BY CLASSIFICATION
(Bearing Series listed include both aircraft and commercial types)

CLASSIFICATION		INCH SERIES				METRIC SERIES	
SPHERICAL BEARINGS	Metal / Metal	ABG ABW ABK ABC-G ABC-VA	ABG-V ABW-V ABK-V ABC-VG ABC-GA	HABG ABY HABK ABB ABC-VGA	HABG-V ABY-V HABK-V ABB-S AM	MBG-CR MBW-CR MBY-CR SBH SBW	MBG-VCR MBW-VCR MBY-VCR SBWH
	PTFE lined	ABT ABYT HTY HTL	ABT-V ABYT-V HTY-V HTL-V	ABWT HT WHT WHTL	ABWT-V HT-V WHT-V WHTL-V	SBT MBT-V MBWT-V MBYT-V	 MBT MBWT MBYT
	Minelon TN	N/A				BM	
2 PIECE ROD ENDS	Metal / Metal	AHM	AHF			N/A	
	PTFE lined	AHMT	AHFT			RBT-E	RBT
3 PIECE ROD ENDS	Metal / Metal	AR ARYM AMM	AR-E ARYF AMF	ARH ARB	ARH-E ARB-E	HR-E HRH-E	HR HRH
	PTFE lined	ART ARYT ARNM	ART-E ARYT-E ARNF	ARHT ANM	ARHT-E ANF	HRT-E HRHT-E	HRT HRHT
4 PIECE ROD ENDS	Metal / Metal (insert type)	CAMR	CAFR	AMR	AFR	PR-E	PR
DIE CAST ROD ENDS	Metal / Metal	N/A				ER	
MOLDED RACE ROD ENDS	Minelon TN	CAMMR	CAMFR			RBM-E	RBM
JOURNAL BEARINGS	PTFE lined	AJ	AJF	AHJ	AHJF	MJ	MJF
BALL BEARING ROD ENDS	(Anti-friction)	ABR-M	ABR-F	ABR-H	ABR-S	PBR-E	PBR
•ROLLER BRGS	(Anti-friction)	ASR	ASRD	ASRDG.ASRDF	ASRD-V	N/A	
•ROLLER BRG ROD ENDS	(Anti-friction)	ARR-FFN ARR-SFN ARRDE-M	ARR-MFN ARRD-HFN	ARR-MFN-3 ARRD-SFN	ARR-HFN ARRE-M	N/A	

BEARING TYPES AND DETAILS OF CONSTRUCTION

NMB manufactures a wide range of spherical bearings and rod ends for both commercial and aerospace applications. Figures 1 through 6 show examples of 2-piece, 3-piece and 4-piece rod ends with configurational variations. All rods end shown are manufactured in both male and female versions. The metal-to-metal rod ends can be furnished with dry film lubricant coatings or, when size permits, be provided with grease lubrication grooves, holes and flush type or zerk type fittings. In general, lube fittings cannot be furnished on rod ends with bores of less than .250" (6.35mm).

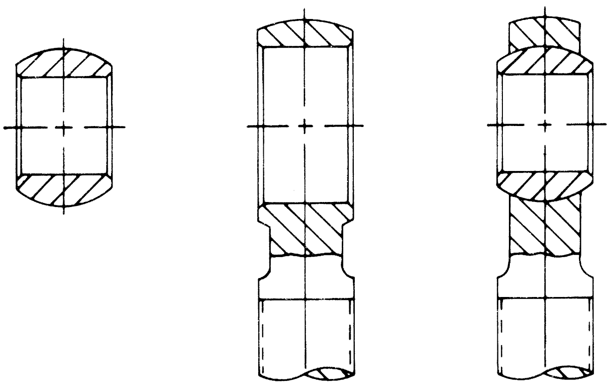


FIGURE 1 - 2- PIECE, SWAGE-COINED ROD END

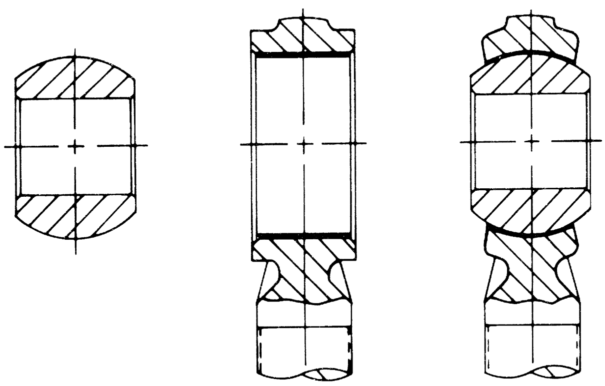


FIGURE 2 - 2- PIECE, MOHAWK ROD END

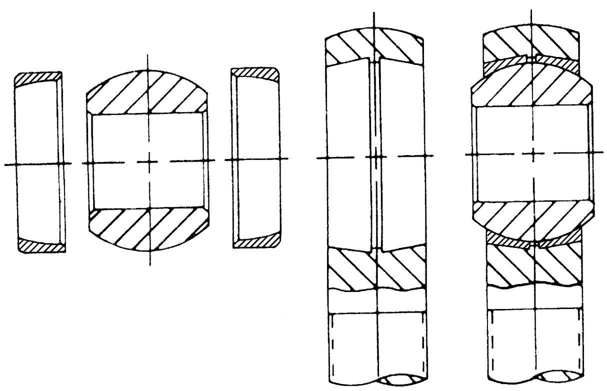


FIGURE 3 - 4- PIECE, INSERT-TYPE ROD END

RODS ENDS

Figure 1 illustrates a 2-piece swage coined rod end. The head of the rod end is coined or swaged around the ball and thus serves as the outer race. This type of rod end is generally used in static applications when maximum strength in a given envelope is required. By virtue of its design, however, the 2-piece coined rod ends has relatively poor ball to race conformity, particularly in the 6 o'clock area, and Teflon liners are not recommended. On the other hand, the simplicity of its design permits this type of rod end to be manufactured in miniature sizes with bores as small as .0469" (1.191mm).

Figure 2 represents Mohawk configuration. The Mohawk 2-piece design is an economical rod end serving a broad spectrum of commercial application. Figure 2 shows the configuration used for Teflon lined Mohawks. This design has good ball to race conformity and can be used in dynamic applications when loads are relatively light.

Figure 3 shows a 4-piece insert-type rod end construction. This configuration sees wide usage in commercial and general aviation applications. As catalog items, they are furnished with zinc or cadmium plated steel bodies having an ultimate tensile strength of 82.5ksi (569 N/mm^2), ball of through hardened bearing steel, chrome plated, and inserts of either copper alloy or 300 series stainless steel. 4-piece rod ends can be furnished with re-lubrication provisions, but are not available with Teflon liners.

BEARING TYPES AND DETAILS OF CONSTRUCTION

Figure 4 and 5 show 3-piece rod ends with 2 types of insert retention. All bearings shown can be furnished in grease lubricated, dry film lubricated or Teflon lined versions. The V-groove staked design illustrated in Figure 4 is the most widely used configuration in aerospace applications. Three V-groove types covering inch bearing sizes 3 through 24 have been standardized by MS bearing and rod end specifications. The V-groove is machined into the race face after swaging. The outer lip formed by this groove is flared over the housing chamfer. This method provides moderate thrust capacity and allows a worn bearing to be removed and replaced with no damage to the housing.

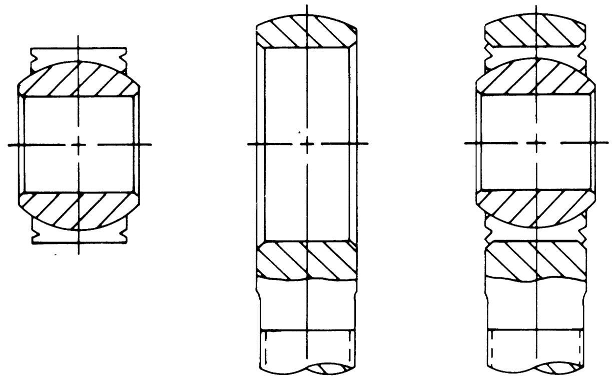


FIGURE 4 - 3- PIECE, V-GROOVE STAKED ROD END

Figure 5 illustrates a housing stake configuration. This method is generally used only when there is insufficient space on the race face for a V-groove, or when other factors such as non-ductile race material. Race shear strength or economy of production are considered.

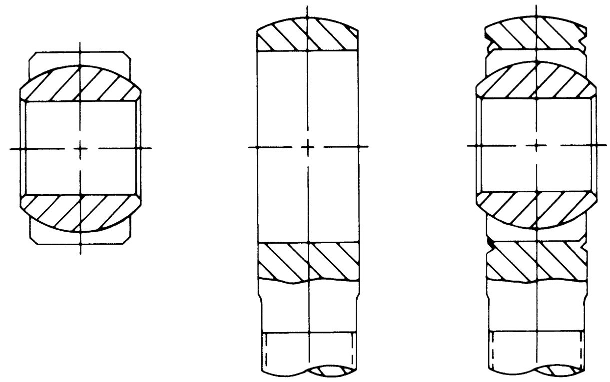


FIGURE 5 - 3- PIECE, HOUSING STAKED ROD END

Figure 6 shows a rod end design using the reverse Messerschmidt principle. The ball is not fractured but machined and ground in matched sets with zero gap at the separation plane. The body is usually of hardened CRES, the ball of copper alloy. Worn balls can be removed manually and replaced. Maximum body strength and bearing projected area results from the fact that loader slots are omitted.

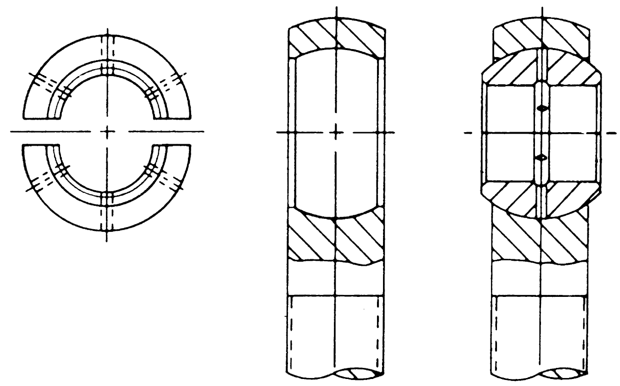


FIGURE 6 - 2- PIECE, SPLIT BALL ROD END

SPHERICAL BEARINGS

Figure 7 illustrate the procedures used in manufacturing a standard type swaged spherical bearing. The finished ball is inserted into the cylindrical race blank by slip fit and installed into the assembly die. After removal from the die, the race O.D. is spherical in shape as shown in the "As Swaged" view. At this stage, the ball and race are locked firmly, together and incapable of relative movement. Following subsequent machining, the bearing assembly is released (loosened) to the torque or radial clearance required and the O.D. is then ground to the finished size.

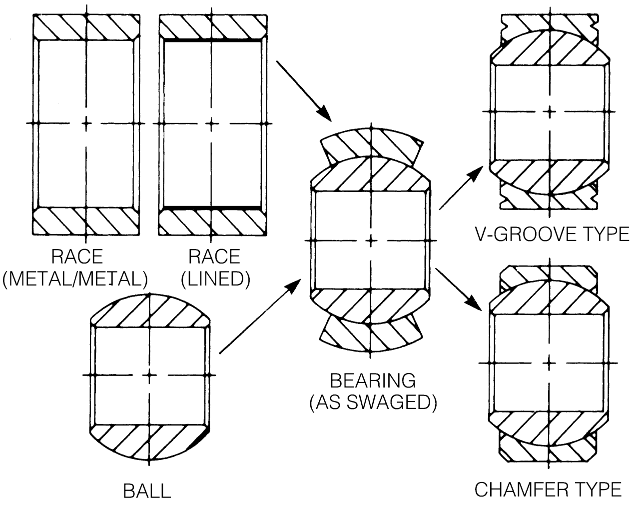


FIGURE 7 - SWAGED SPHERICAL BEARING

Figure 8 demonstrates an alternative swaging method used when the bearing geometry precludes or renders impractical the double swaging method shown in figure 7. The pre-form design is used when the bearing outer race is not symmetrical about the spherical centerline due to a flange or a wide overhang on one side or a combination of both. In such case, the problem side of the race is pre-formed by machining and grinding and the opposite side only is swaged.

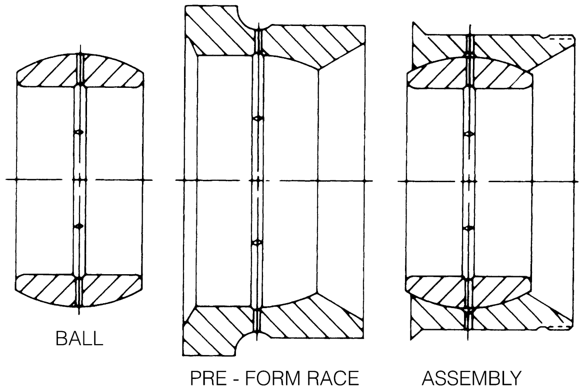


FIGURE 8 - SWAGED PRE - FORM BEARING

Figure 9 shows a loader slot, or "Messerschmidt" bearing design. This is a non-swaged bearing type. The spherical I.D. is machined and then precision ground after hardening. The loader slots are profile milled prior to heat treatment. This design permits the ball to be inserted and removed manually in the field without need of tooling. Additional advantages of this design are that extremely close tolerance radial and axial clearances can be attained, and very high strength materials and surface coatings can be used on the outer race. A major disadvantage of the design is the need to properly orient the slots with respect to the applied loads due to the loss of bearing projected area. In addition, it is difficult to retain grease and exclude contaminants unless the loader slots are sealed.

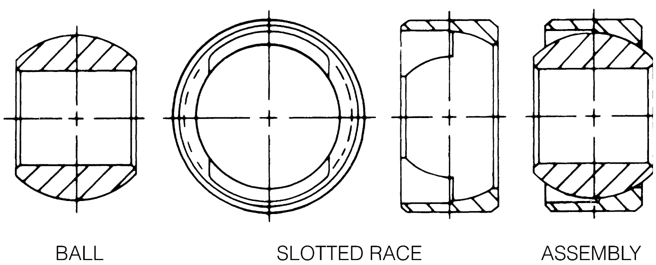


FIGURE 9 - LOADER SLOT BEARING

BEARING TYPES AND DETAILS OF CONSTRUCTION

Figure 10 illustrates a double fractured race bearing. This type of bearing can be furnished in either a single or double fractured configuration. The retaining ring groove is provided only on the double fractured race design and serves as a recess for a retaining wire or spring which holds the race halves together to facilitate handing until the bearing is installed into its housing. Both race and ball are made of bearing steel, through hardened and precision ground. All surfaces of the ball and race coated with zinc phosphate and a dry film of molybdenum disulfide (MoS_2). In addition, lube grooves and lube holes are provided to permit relubrication through either the housing or shaft. For corrosive environments, balls and races of through hardened stainless steel can be furnished. NMB manufactures catalog series of single and double fractured race bearings in both inch and metric sizes. Nitrile rubber (NBR) seals can be provided as option for all sizes.

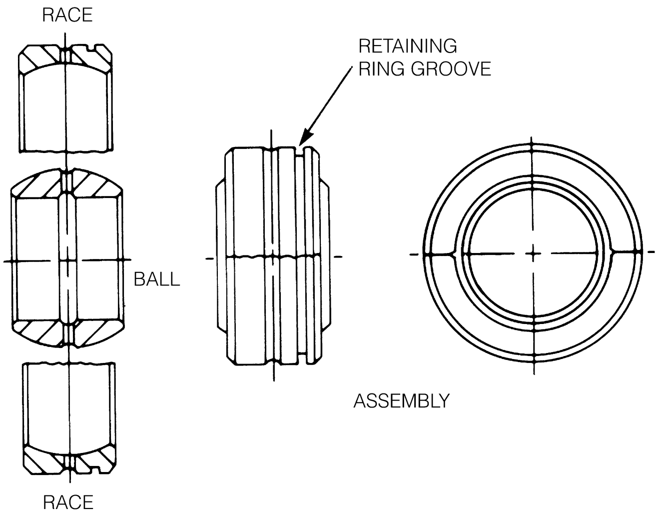


FIGURE 10 - FRACTURED RACE BEARING

Figure 11 shows two examples of snap-assembled or “pop-in” bearing configurations. When component geometry permits (a relatively large diameter, thin section, narrow ball and race), a bearing may be snap-assembled. Snap-assembly is accomplished by deflecting the race, ball, or both within their elastic limits to allow entry of the ball into the race. This type of design is generally used only when all other methods are impractical or impossible due to problem geometry or processing restraints.

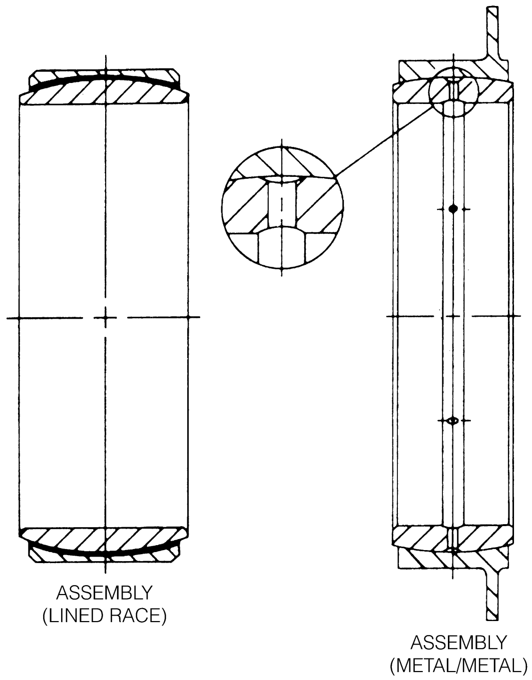


FIGURE 11 - SNAP-ASSEMBLED BEARINGS

JOURNAL BEARINGS (SELF-LUBRICATING) MS SERIES

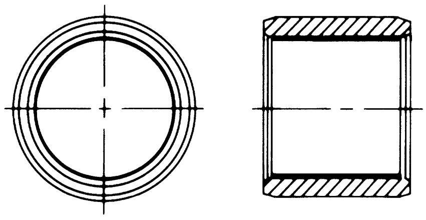


FIGURE 12 - PLAIN, TEFLON LINED

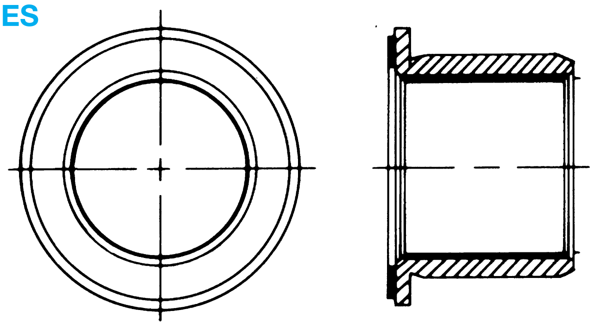


FIGURE 13 - FLANGE, TEFLON LINED

Figure 12 shows the NMB AJ and AHJ series which are approved for procurement to MS21240 and MS81934/1 series respectively.

Figure 13 shows the NMB AJF and AHJF series which are approved for procurement to MS21241 and MS81934/2 series respectively.

ROD END BEARINGS - AIRFAME (ANTI-FRICTION) SERIES

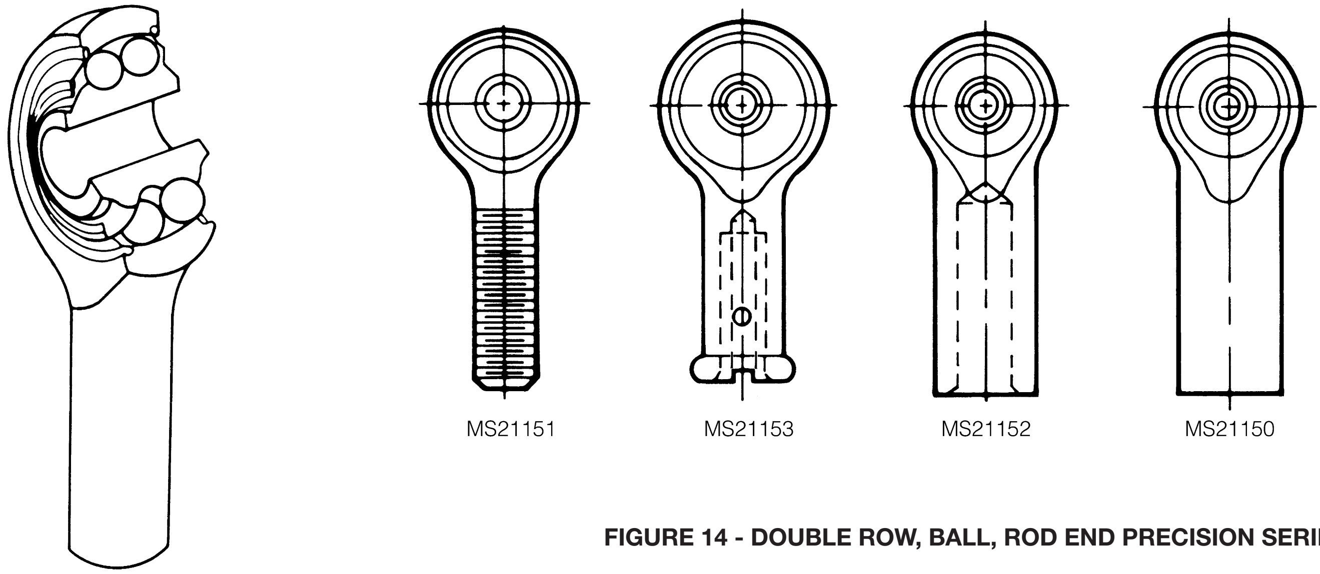


FIGURE 14 - DOUBLE ROW, BALL, ROD END PRECISION SERIES

Figure 14 shows internal construction of a double row ball bearing rod end. Ball bearing rod ends are typically used for low load, low friction, dynamic applications. Configuration permits bearing misalignment to 10° in either direction. Inner rings and balls are made of 52100 steel with bodies made of 4130 steel or 8620 steel. Bearings are cadmium plated for corrosion protection and prepacked in grease. NMB ball bearing rod ends are approved for procurement to AS6039 and MS21150, MS21151, MS21152, and MS21153.

ROLLER BEARINGS (SELF - ALIGNING) MS SERIES

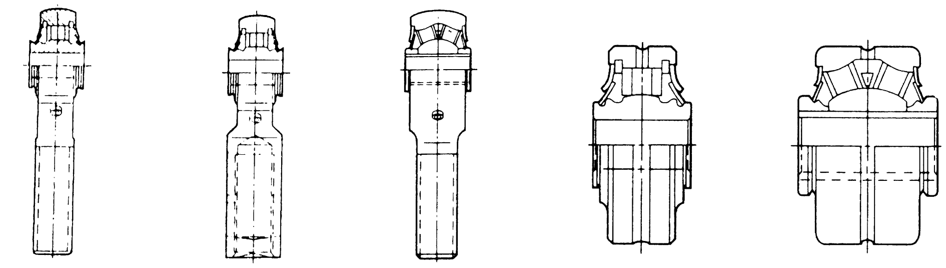


Figure 15 shows various MS series of roller bearing rod ends and bearings NMB roller bearings are approved for procurement to AS8952 & AS8914 and MS21221, MS21223, MS21220, MS21429, MS21431, MS28913 and MS28914.

TEFLON* OR POLYTETRAFLUOROETHYLENE

(PTFE) - has good wear and excellent low friction properties and makes the ideal bases for a self lubricating liner. However, pure PTFE has a very low strength and must therefore be reinforced in some way to produce an acceptable load carrying surface.

NMB Teflon liners have a woven textile backing (such as Glassfiber, Dacron or Nomex) to give required strength , with a PTFE fiber interwoven to provide the self lubricating properties. The PTFE fiber is concentrated towards the front of the liner where the low wear and self lubricating properties are required, with the majority of the reinforcing textile fiber at the back to ensure a good bonding surface. The liner is impregnated with Phenolic resin for added strength. (See Figure 16). A thermosetting bonding agent applied under temperature and pressure ensures a good bond between the liner and the base metal.

SOME CHARACTERISTICS OF THE PTFE LINER

1. Modulus of elasticity: 4.5×10^5 psi. (3.1×10^5 N/cm^2)
2. Coefficient of thermal expansion: 11.6×10^{-6} in/in/°F. (20.9×10^{-6} mm/mm/°C)
3. Low coefficient of friction ranging from approximately .02 to .10. As shown in Figure 17, the coefficient decreases as load and temperatures increase.
   However the coefficient also increases as surface speed and mating surface roughness increase.
4. Noiseless in operation.
5. Is non-corrosive.
6. Resistant to most chemicals, greases and oils, however wear rates may increase when movement takes place under contaminated conditions.
7. Is non-conductive and non-magnetic.
8. After an initial run-in period, wear rates remain low and relatively constant.
9. Can continue to function satisfactorily with wear as high as .010" (0.25mm).

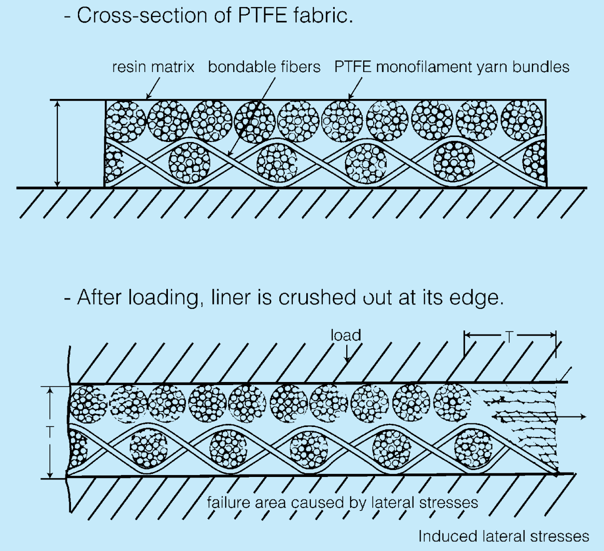


FIGURE 16 - ORIENTATION OF FIBERS AND RESIN IN PTFE FABRIC LINER

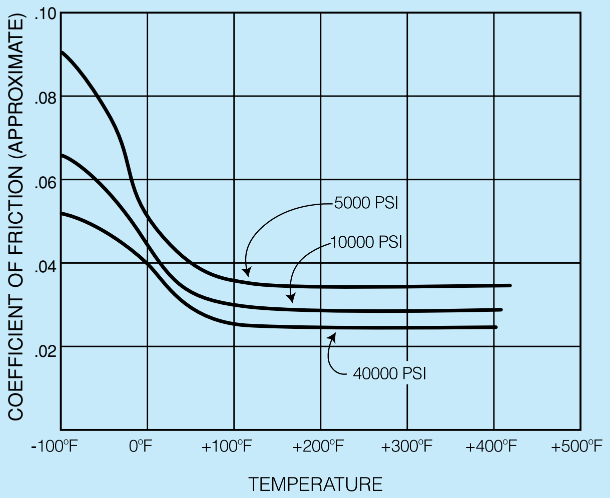


FIGURE 17 - EFFECT OF TEMPERATURE AND LOAD ON COEFFICIENT OF FRICTION

* A trade name of E.I. duPont de Nemours & Co., Inc

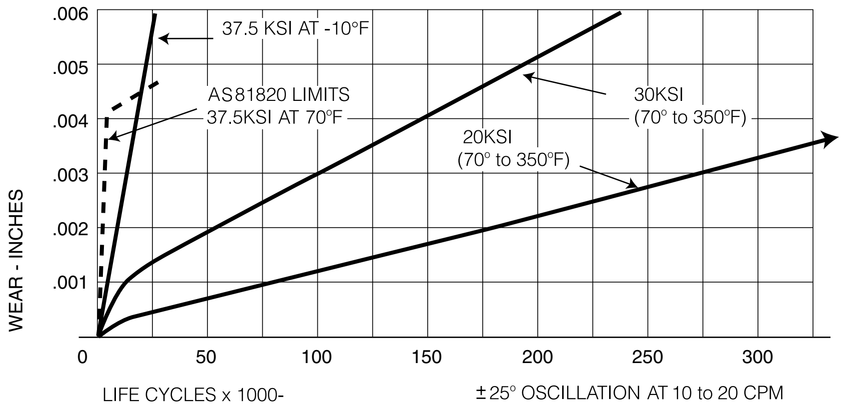
TABLE 3 - CHARACTERISTICS OF FOUR PRINCIPAL NMB LINER SYSTEMS

NMB LINER DESIGNATION	X-1118	X-1276	X-1276F	X-1820
Mil Specs	MIL-B-8942 MIL-B-8943			MIL-B-81820 MIL-B-81934
Backing Material	Glass Fiber	Dacron*	Dacron*	Nomex*
Thickness (ref.)	.0100”-.0114” (0.25-0.29mm)	.0118”-.0134” (0.30-0.34mm)	.0134”-.0150” (0.34-0.38mm)	.0134”-.0150” (0.34-0.38mm)
Temperature Range	-65° - +250°F (-54° - +121°C)	-65° - +250°F (-54° - +121°C)	-65° - +250°F (-54° - +121°C)	-65° - +325°F (-54° - +163°C)
Static Limit Load	69,900 psi (482N/mm^2)	69,900 psi (482N/mm^2)	69,900 psi (482N/mm^2)	78,500 psi (541N/mm^2)
Dynamic Load Capacity	31,900 psi (220N/mm^2)	31,900 psi (220N/mm^2)	31,900 psi (220N/mm^2)	39,900 psi (275N/mm^2)
Friction Coefficient	0.03-0.10	0.03-0.10	0.05-0.15	0.05-0.15

* A trade name of E.I. duPont de Nemours & Co., Inc.

FIGURE 18 - TYPICAL WEAR RATES OF NMB LINERS

LINER TYPE:
X-1820



LINER TYPES:
X-1118
X-1276
X-1276F

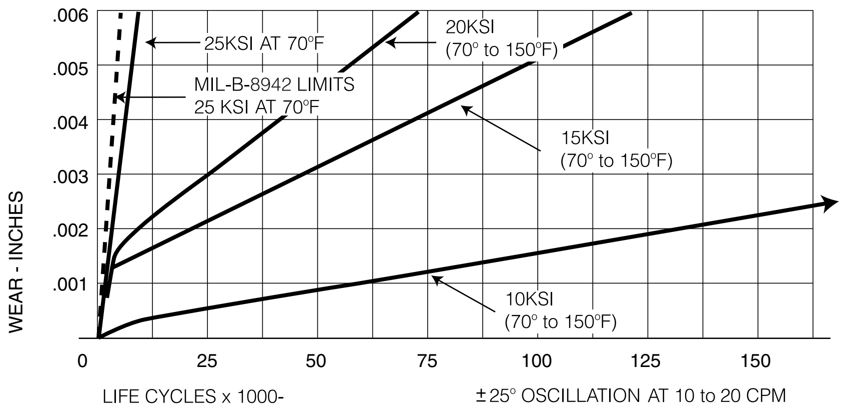
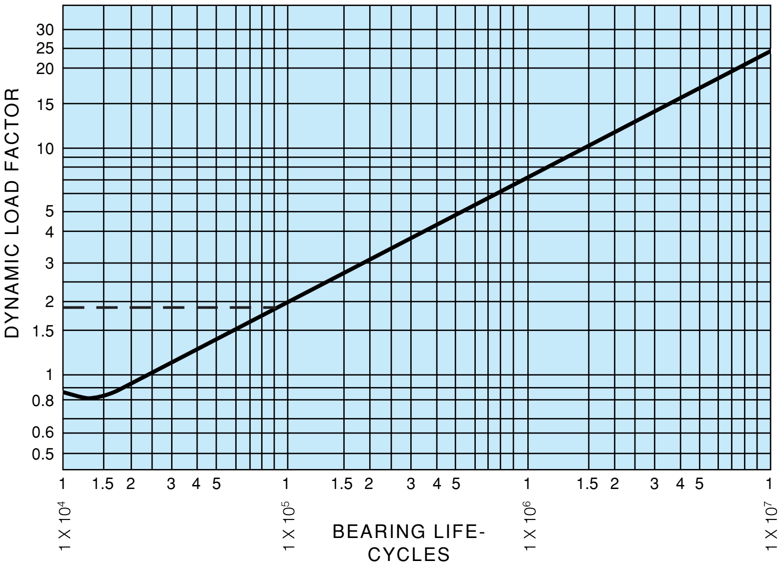


FIGURE 19 - PTFE BEARING EVALUATION CHART



T = µxFxR
where
T = torque, In·lb
µ = friction coefficient (Figure 17)
F = load in pounds
R = one-half of ball diameter for spherical bearings turning on ball; or one-half the bore diameter for plain journal bearings or spherical bearings turning on bore

FIGURE 20 - TORQUE FORMULA

TORQUE CALCULATION

The prediction of spherical bearing torque is more difficult than that of rolling element bearings. Friction coefficients of the sliding surfaces in these bearings vary depending on temperature and load. Torque at various loads is estimated by using the following formula:

INSTRUCTIONS FOR USE OF EVALUATION CHART

EXAMPLE 1

To select a PTFE-lined bearing to meet your need (for life other than 25,000 cycles):

(1) Multiply your expected radial dynamic load by the dynamic load factor corresponding to the required life cycles. Example:5,000 lbs. (22,240 N), expected radial load; life requirement 100,000 cycles. Using the chart, 100,000 cycles corresponds to a dynamic load factor of 1.9. Multiplying 5,000 lbs. (22,240 N) By 1.9 = 9,500 lbs. (42,256 N), the equivalent dynamic load.

(2) Using the equivalent dynamic load of 9,500 lbs. (42,256 N), select any self-lubricated bearing having an oscillating load rating equal to or higher than this amount.

EXAMPLE 2

To determine the expected life cycles for a particular self-lubricated bearing:

(1) Divide oscillating load rating of bearing by your expected radial load to determine the dynamic load factor. Example 9,500 lbs. (42,256 N) ÷ 5,000 lbs. (22,240 N) = 1.9 dynamic load factor.

(2) Using 1.9 dynamic load factor, determine the bearing life-approximately 100,000 cycle.

PER-LOAD TORQUE

Rotational Breakaway Torque is the highest value attained just prior to ball movement. The ball should be hand rotated through several revolutions immediately before testing.

Rotational Torque is that value required to maintain 2 rpm rotation of the ball about its centerline.

Misalignment Torque is the value required to move the ball in a mode other than rotation.

All torque testing should be performed with the outer race restrained in such a manner as to minimize bearing distortion and the resultant effect on the torque reading obtained. Torque readings can vary appreciably as the result of incorrect clamping, presence of contaminants, excessive speeds and differences in atmospheric conditions. The need, as specified above, for hand rotating the ball through several revolutions prior to checking breakaway torque is extremely important. Because of pre-load between ball and race, the liner, under compression, slowly conforms to the microscopic surface irregularities of the ball. To initiate rotation after a period of time, all of the microscopic liner projections into the ball surface must be sheared off. Once this has been accomplished, the torque reverts back to its rated value.

GAGING LINED BORES

Conventional bore measuring equipment such as air gages, inside micrometers, etc. will often indicate an apparent oversize condition when used in measuring fabric lined journal bores. Texture and resiliency of the fabric liner as well as the contact pressure exerted by the gaging instruments all contribute to the probability of obtaining a false reading.

The most widely accepted method for inspecting lined journal bores is with the use of plug gages. The diameter of the “go” member should be 0.0008” (0.002 mm) below the minimum bore diameter specified and that of the “no-go” should be .00005” (0.0012mm) larger than the maximum bore diameter specified. The “go” member should enter freely or with light to moderate force. The “no-go” member should not enter with light force but entry under moderate to heavy force is acceptable.

All edges of gage members should have a radius of .030” MIN (0.76mm), and surface finish of the gage should not exceed 8 RMS (0.2 µmRa) in order to prevent damage to the fabric when inspecting.

SELF-LUBRICATING LINER SYSTEMS

FACTORS AFFECTING THE SELECTION, PERFORMANCE AND EVALUATION OF PTFE-LINED SPHERICAL, ROD END JOURNAL BEARINGS

An answer to situations where the performance envelope cannot be covered by metal to metal bearings is to consider PTFE-lined bearings. Here, the lubricant configuration is such that it functions as the load carrying element of the bearing, as represented by the liner systems currently in use. PTFE bearings may be specified under all or some of the following situations:

1. Where lubrication is undesirable, difficult to perform, or impossible.
2. Where loads are high and angular movement is low. Under these circumstances, rolling element bearings fail rapidly.
3. Where space is limited. A PTFE-lined bearing in high load-low speed environments is usually much smaller in size than a rolling element bearing.
4. Where vibration is present. A PTFE-lined bearing is more likely to accept vibration than is a rolling element bearing.
5. Where temperature of the environment renders greasing unfeasible.
6. Where a joint must remain static for extended long periods of time before movement is initiated.
7. Where friction in a greased bearing would be so high as to render the joint area unless after a limited number of cycles or impose an unacceptable fatigue situation.
8. Where, in static joints, fretting is a problem.

While PTFE-lined bearings can do an excellent job in many areas, there have been areas of misapplication. Also, there exist some misunderstandings regarding life and failure as applied to hardware of this type. We may define some of these concepts as follows:

1. The PTFE-lined bearing starts life with a finite rotational pre-load torque or clearance.
2. This rotational pre-load torque always decreases with bearing usage and clearance always increases with usage.
3. A bearing may be said to have failed if the rotational pre-load torque drops below some specified value. This is always a systems application characteristic.
4. A bearing may be said to have failed when the clearance generated by wear exceeds some specified value. This, again, is always some specified systems characteristic.
5. A bearing may be said to have failed if the liner wears through enough to permit the ball to contact the race.
6. No bearing, including PTFE-lined bearings, will last forever. The “Lifetime” lubrication concept applies to the bearing alone, not to the end usage item.
7. The presence of liner debris on a bearing is not a definitive indication of failure.
8. PTFE-lined bearings tend to telegraph their impending failure by increased radial and axial play.

When evaluating the probable service life of a PTFE-lined bearing application, there are some factors that do not appear in the PV = K relationship. Some considerations for a given application might include:

1. Surface sliding speed.
2. Maximum ambient temperature.
3. Size of the heat sink.
4. Acceptable friction levels.
5. Load per unit of area, or liner stress level.
6. Mode of load application; i.e., the duty cycle.
7. Service alignment accuracy, particularly with respect to sleeve and flanged bearings.
8. Surrounding atmosphere.
9. Tolerable wear rate.
10. Surface finish of the bearing mating shaft and the shaft material.

Cost is not included in the above list since it does not affect the serviceability of any bearing. Higher individual bearing costs may many times result in a more economical or lower priced finished assembly.

Other aspects of applying PTFE-lined bearings relate to many obscure factors. The airframe industry is a case in particular. They readily accept the L_{10} life concept in evaluating rolling element bearings but tend to reject it in lined bearings. In dealing with the troubleshooting relating to lined bearings at the user level, we may summarize most of them as follows:

1. Customers specify bearings to certain generalized specifications which may or may not reflect end usage requirements.
2. Customers very often have no idea, nor can they define what loads or loading situations the bearings may be subjected to during the design stage.
3. Continued upgrading of TBO performance on the part of users may not be consistent with established structural envelopes.
4. A marked difference exists between what is acceptable on military aircraft versus civil aircraft. Apparently specification writers overlook this aspect entirely.
5. Most customers and users do not realize that life in a lined bearing is limited. They accept this fact on clutches and brakes, but they apparently cannot see the similarity with respect to lined bearings.
6. No acceptable criteria have been established with respect to design or acceptable life for this type of bearing. Therefore it is almost impossible for a bearing supplier to initiate all-encompassing test programs.
7. Many bearings are removed and replaced because of detectable play between ball and race. Some bearings have been removed that still have specification pre-load torque. We must conclude that the potential service life of the bearing is not being used.
8. Confusion exists with regard to liner wear. The term "extruded liner" often noted on field UR's is not sufficiently definitive. Wear debris is normal to this type of bearing and must be differentiated from true liner failure.
9. The term "dynamic load rating" or "oscillating load rating" should not be used to select a bearing for an application. These ratings have no relationship to actual applications and relate to a qualification condition only.
10. Many line bearings are removed because of fretting between the bearing outer race and the adjacent structure. The use of metal-to-metal bearings will not eliminate this problem. This situation can be cured only by proper selection of materials and interface surface finishes.

GREASE AND DRY LUBRICANTS

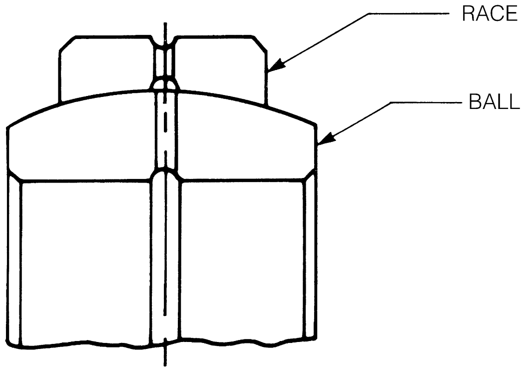


FIGURE 21

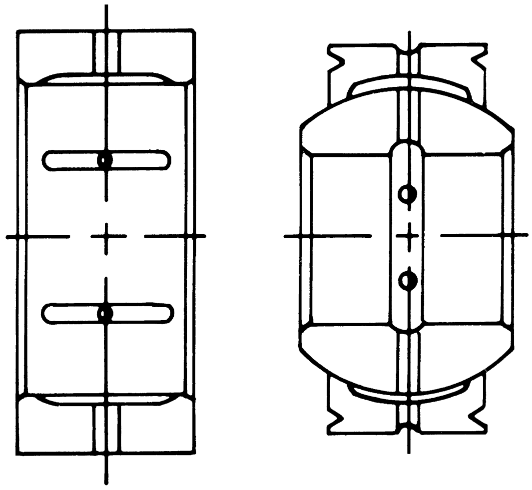


FIGURE 22

GREASE

When using a fluid (grease/oil) type lubricant, optimum lubrication is achieved when the moving member is supported by a hydrodynamic film. This hydrodynamic film is best generated under operating conditions of light loads and high speed rotation as characterized by typical ball bearing applications. The most common lubricated spherical bearing application, however, is typified by relatively high loads and slow oscillation, seldom by steady rotational movement.

In order to maximize distribution of the lubricant in spherical bearings, a radial clearance between the ball and race should be provided in the free state such that it is maintained after bearing installation. This clearance permits grease to flow between the ball and race surfaces. In addition, lube holes and interconnecting annular lube grooves should be provided as may be required. Annular lube grooves allow for 360° distribution of grease even when the bearing is relubricated under load.

Figure 21 illustrates a lubrication network which provides for lubricating both the ball/race and the ball/shaft (or pin) interfaces. Further, relubrication can be accomplished via the race housing or the ball shaft or pin. If relubrication is to be done via the race housing, and no lubrication is required in the ball bore, lube holes and I.D. lube groove in the ball may be omitted. Conversely, if relubrication is to be done via the shaft or pin, lube holes and O.D. groove in the race may be omitted.

Figure 22 shows a transverse lube groove configuration for use on medium to large size spherical bearings in critical applications where lubrication demands are more extreme. The transverse grooves are machined into the cylindrical race blank prior to swaging. These bearings are often bushed with copper alloy sleeves which in turn may incorporate transverse or equivalent lube groove patterns to provide for maximum possible lubrication.

TABLE 4 - GREASE LUBRICANTS

TYPE	SPECIFICATION	COMPOSISION	TEMPERATURE RANGE	USE AND REMARKS
Grease, aircraft and instruments, gear, and actuator screw	MIL-PRF-23827	Lithium soap, ester oil, antirust and E.P. agents	-100° to + 250°F (-73° to + 121°C)	General purpose grease, Extreme pressure properties, good water resistance.
Grease, MoS_2 for high and low temperatures	MIL-G-21164	Same as MIL-PRF-23827 except 5% MoS_2 added	-100° to + 250°F (-73° to + 121°C)	Similar to MIL-PRF-23827 but has added MoS_2 for extra E.P. properties and antiwear action under marginal lubrication conditions
Grease, aircraft, wide temperature range	MIL-PRF-81322	Synthetic oil and thickener	-65°F to + 350°F (-54°C to + 177°C)	Higher temperature range

GREASE AND DRY LUBRICANTS

TABLE 5 - DRY FILM LUBRICANTS

TYPE	SPECIFICATION	LUBRICANT	BINDER	TEMPERATURE RANGE	USE AND REMARKS
Solid film hear cured, corrosion inhibiting	MIL-PRF-46010	MoS_2 (no graphite or powdered metals), and corrosion inhibitors	Organic resins	-90° to + 400°F (-68° to + 204°C)	Good wear Life and provide corrosion protection to substrate. Used for most bearing applications other than extreme temperature situations Must have phosphate coating pretreatment for effective use on steel
Solid film, extreme environment	MIL-PRF-81329	MoS_2 and other solid lubricants	Inorganic binders	-300° to + 1200°F (-184° to + 648°C)	To be used in extreme environments, i.e., vacuum, liquid oxygen, high temperatures. Wear life not as good as resin-bonded types

Table 4 shows three most common grease lubricants used in NMB bearings and rod ends. Rod ends requiring relubrication are generally furnished with zerk type or flush type lube fittings except in those cases where relubrication is to be accomplished via the shaft or pin.

Proper, periodic relubrication of grease lubricated spherical bearings is essential to optimum bearing performance and long service life. Frequent relubrication reduces wear and friction, prevents fretting and galling, and minimize chemical corrosion.

DRY FILM

Dry film, also referred to as “solid film”, lubricants are generally used in applications which preclude the use of grease lubricated or PTFE lined bearings. In certain cases, however, they may be used as a “back-up” for grease lubricated bearings.

The majority of dry film lubricants consist of MoS_2 and small quantities of other materials, such as graphite or powered metals. Coatings may be applied by spraying, brushing or dipping and are hardened by cure baking at temperatures which may vary from 200° to 1,000°F (93° to 538°C). Both organic resins and inorganic binders may be used.

Table 5 lists two common types of dry film lubricants used in aerospace bearings. In addition to these, however, NMB uses a wide variety of dry film compounds selected by our engineers to best meet the requirements of specific applications. Dry film selection factors include:

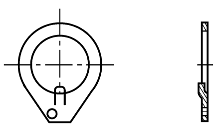
- Temperature Range
- Compatibility with oils and greases
- Static load capacity
- Dynamic wear characteristics
- Exposure to extreme environments, i.e., vacuum LOX, radiation, etc.

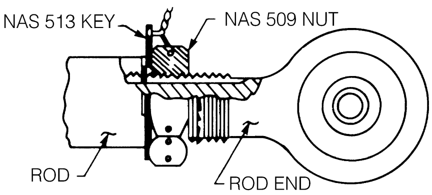
LOCKING DEVICES, KEYS AND KEYWAYS

Keys are represented here are metallic locking devices which, when assembled into keyways and keyslots, prevent relative motion between mating components of bearing linkage assemblies.
NMB does not supply keys, nuts or lock wire as separate items. These items are readily available from other sources.
Keyways and keyslot are optional. To specify, add suffix “W” to NMB catalog rod end part number.

NAS 513 KEY

NAS 513





NAS 513 KEY, TYPICAL INSTALLATION

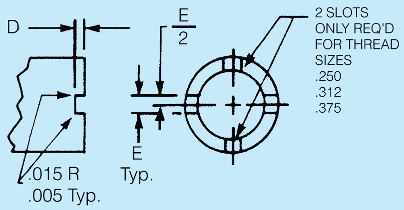


FIGURE 23 - FEMALE KEYSLOT

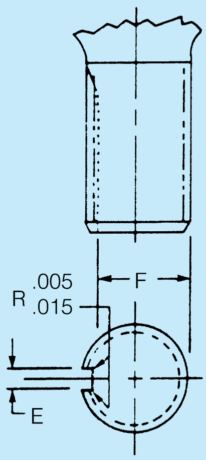


FIGURE 24 - MALE KEYWAY

Thread Size ②	D +.005 -.000	E +.005 -.000	F +.000 -.005
.2500	.056	.062	.201
.3125	.056	.062	.260
.3750	.056	.093	.311
.4375	.069	.093	.370
.5000	.069	.093	.436
.5625	.077	.125	.478
.6250	.077	.125	.541
.7500	.077	.125	.663
.8750	.086	.156	.777
1.0000	.094	.156	.900
1.1250	.094	.187	1.010
1.2500	.116	.187	1.136
1.3750	.116	.250	1.236
1.5000	.116	.250	1.361
1.6250	.129	.250	1.477
1.7500	.129	.312	1.589
1.8750	.129	.312	1.714
2.0000	.129	.312	1.839
2.1250	.129	.312	1.955
2.2500	.129	.312	2.080

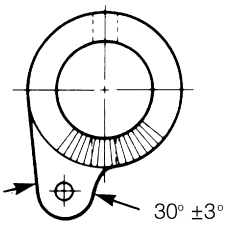
NOTES:

1. NAS 513 keys are used on MIL-B-81935 size -10 through -16 and MS21151 and MS21153 rod ends when optioned. The keyways and keyslots used in conjunction with these keys are shown in Fig. 23 and Fig. 24.

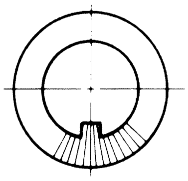
② NAS 513 keys are available for thread sizes 1/4 through 2-1/4 inches.

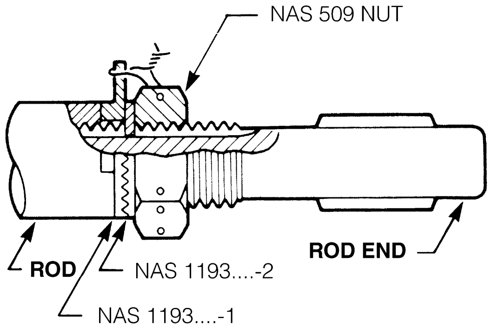
NAS 1193 KEY

NAS 1193-1



NAS 1193-2





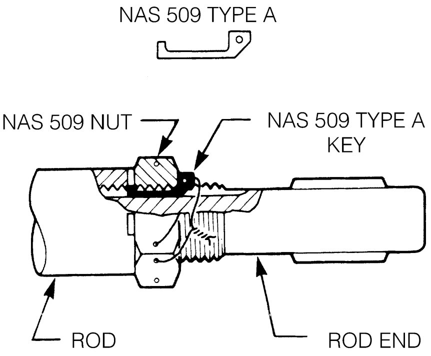
NAS 1193 KEY, TYPICAL INSTALLATION

NOTES:

1. NAS 1193 keys are for positive indexing. They are used in applications in which a fine adjustment is required, within .001 inches.
2. These keys can be used in conjunction with NAS 513, NAS 559 and AS81935/3 keyways or keyslots are available for thread sizes 1/4 through 2-1/4 inches.

LOCKING DEVICES, KEYS AND KEYWAYS

NAS 559 TYPE A KEY



NAS 559 KEY, TYPICAL INSTALLATION

NOTES:

① The keyways and keyslots used in conjunction with these keys are shown in Fig. 25 and Fig. 26. The NAS 559 keys are available for thread sizes 1/4 through 2-1/4 inches.

② Keyway flat may vary from standard on smaller size rod ends but shall extend at least beyond minimum thread length in all cases.

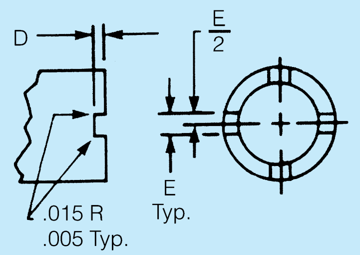


FIGURE 25 - FEMALE KEYSLOT

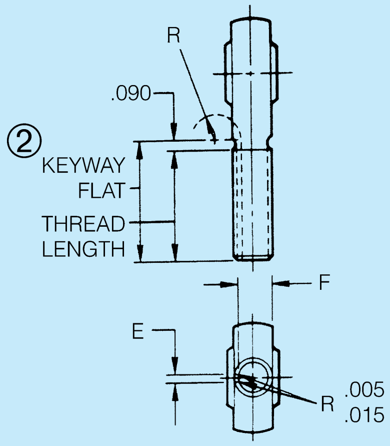
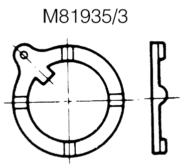
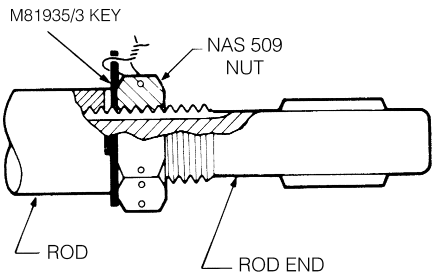


FIGURE 26 - MALE KEYWAY

Thread Size ①	D +.005 -.000	E +.005 -.000	F +.000 -.005	R ±.010
.2500	.056	.062	.201	.255
.3125	.056	.062	.260	.255
.3750	.056	.093	.311	.255
.4375	.069	.093	.370	.255
.5000	.069	.093	.436	.255
.5625	.077	.125	.478	.255
.6250	.077	.125	.541	.255
.7500	.077	.125	.663	.255
.8750	.086	.156	.777	.318
1.0000	.094	.156	.900	.318
1.1250	.094	.187	1.010	.382
1.2500	.116	.187	1.136	.382
1.3750	.116	.250	1.236	.445
1.5000	.116	.250	1.361	.445
1.6250	.129	.250	1.477	.445
1.7500	.129	.312	1.589	.508
1.8750	.129	.312	1.714	.508
2.0000	.129	.312	1.839	.508
2.1250	.129	.312	1.955	.508
2.2500	.129	.312	1.080	.508

AS81935/3 key





AS81935/3 KEY, TYPICAL INSTALLATION

NOTES:

1. AS81935/3 keys are used on AS81935 sizes -3 through - 8 when optioned. The keyways and keyslots used in conjunction with these keys are shown in Fig. 27 and Fig. 28.

② AS81935/3 keys are available for thread sizes 1/4 through 1/2 inches.

Thread Size (Male) ②	E +.005 -.000	F +.000 -.005
.2500-28UNJF-3	.062	.207
.3125-24UNJF-3	.062	.268
.3750-28UNJF-3	.093	.319
.4375-20UNJF-3	.093	.383
.5000-20UNJF-3	.093	.445

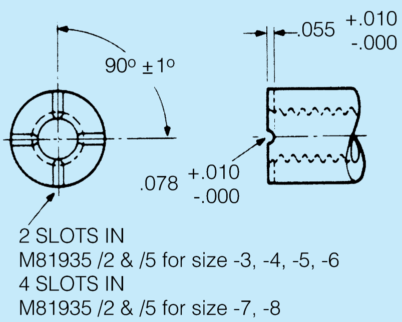


FIGURE 27 - FEMALE KEYWAY

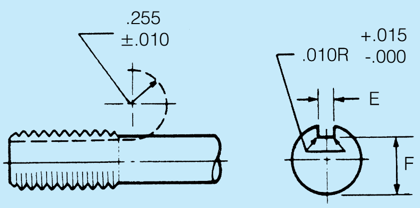


FIGURE 28 - MALE KEYWAY

BEARING INSTALLATION AND RETENTION

GENERAL

A bearing in the free state is not a functioning bearing. Its performance begins only after its has been installed into its end assembly, and the methods, fits and forces applied in installation will often determine its success or failure in service.

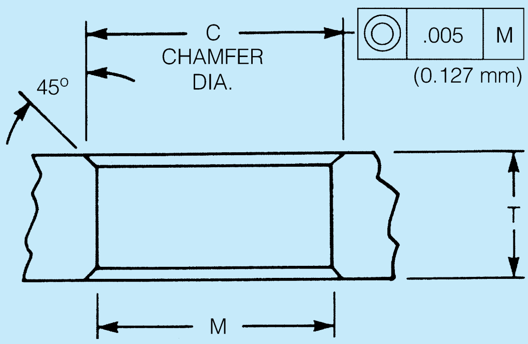
A surprising percentage of early bearing failures can be traced directly to improper mounting conditions. Some examples of frequently occurring installation errors are:
(1) excessive interference fit between housing bore and bearing O.D. (2) improperly designed staking tools. (3) excessive staking forces applied.

The following pages are offered not as a comprehensive guide to answer all questions regarding fits, installation, retention, etc., but rather to point out to the bearing user certain areas that require attention and consideration if the installation is to provide for optimum bearing performance and life.

HOUSINGS

The housing into which the bearing is to be mounted should be designed to ensure the structural integrity and dynamic performance capability of the bearing. NMB offers the following housing design recommendations:

1. Bearing-to-housing fit: (See table 7).
2. Bore finish : 32 RMS (0.8 μmRa)
3. Roundness within the bore diametrical tolerance.
4. Bore perpendicular to housing faces within .002" (0.05 mm).
5. Housing width : uniform within .005" (0.13 mm) to ensure staking integrity.
6. Maximum edge breaks of .005" (0.13 mm) when housing is to be staked over bearing.
7. Chamber sizes as calculated per figure 29 formula for V-groove staking retention.
8. Provide for plating or other surface treatments (as may be required) if housing and bearing are of dissimilar metals. (See table 6).



CHAMFER DIAMETER
(C) = bearing O.D. + [T-H + (2 × E)]
T = housing thickness
H = outer race thickness
E = V groove depth in race

FIGURE 29 - HOUSING CHAMFER CALCULATION FOR V-GROOVE STAKING.

Another material consideration, in addition to dissimilar metals, is that of differing coefficients of thermal expansion between the bearing and housing materials. When the bearing is to be operating over a broad temperature range, and the mating bearing and housing have different coefficients of expansion, special adjustments may be required in the bearing to housing fit to prevent either excessive looseness or excessive torque at temperature extremes.

TABLE 6 - TREATMENTS TO PREVENT GALVANIC CORROSION OF DISSIMILAR METALS

Bearing Material (Bore and O.D. Surface)	Housing or Shaft Material				
	Aluminum Alloys	Low Alloy Steel	Titanium	Corrosion Resistant Steel	Superalloys
Aluminum alloys	A	A,C	A	A,C	A,C
Bronze and brass	A,C	C	S	S	S
Bronze and brass, cadmium plated	A	C	X	S	S
52100 and low alloy steels	A,C	C	X	C	C
440C stainless steel	A,C	C	S	S	S
440C with wet primer	A	C	S	S	S
Corrosion resistant steels, 300 series, 17-4PH, 15-5PH, PH13-8Mo, etc	A,C	C	S	S	S
Superalloys	A,C	C	S	S	S

X = Incompatible
A = Anodize aluminum per MIL-A-8625,Type II, or Alodine per MIL-C-5541
C = Cadmium plate per AMS-QQ-P-416, Type I, Class2
S = Satisfactory for use with no surface treatment required.

TABLE 7 - HOUSING BORE TOLERANCES FOR METAL TO METAL AND PTFE LINED BEARINGS

BEARING				HOUSING BORE			
TYPE	STYLE	O.D.		Tolerances		Fit-up	
		inch	mm	inch	mm	inch	mm
METAL TO METAL	Sphericals	Up to 1.750	Up to 44.45	+.0000 -.0005	+0.000 -0.013	Line to Line to .0010 tight	Line to Line to 0.025 tight
		1.750 and over	44.45 and over	+.0000 -.0008	+0.000 -0.020	Line to Line to .0013 tight	Line to Line to 0.033 tight
PTFE LINED	Sphericals	All	All	+.0005 -.0000	+0.013 -0.000	Line to Line to .0010 loose	Line to Line to 0.025 loose
	Plain and Flanged Journal (Sleeve) Bearings	Up to 1.000	Up to 25.40	-.0007 -.0012	-0.018 -0.030	.0002 to .0012 tight	0.005 to 0.030 tight
		1.000 and over	25.40 and over	-.0010 -.0015	-0.025 -0.038	.0005 to .0015 tight	0.013 to 0.038 tight

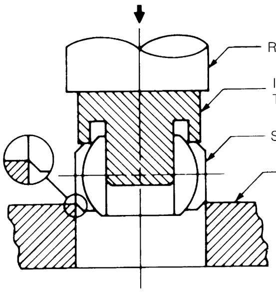


FIGURE 30

SPHERICAL BEARING INSTALLATION

Use of an arbor press or hydraulic press is recommended. Under no circumstances should a hammer or any other type of shock including impact method be used. A suitable installation tool (as shown in Figure 30) is advised. A guide pin aligns the ball in a 90° position, but all force is applied to the outer race only. A lead chamfer or radius on either the bearing or housing is essential.

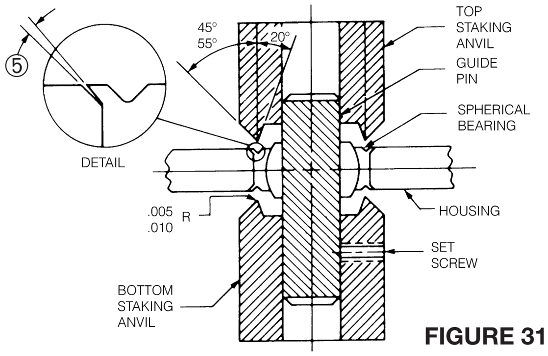


FIGURE 31

V-GROOVE RETENTION (V-GROOVE SERIES)

For bearings with race staking grooves, a double anvil staking method as shown in Figure 31 is recommended. This method is best performed on a hydraulic or pneumatic press.

STAKING PROCEDURE:

1. Install bearing into housing per Figure 30 and position it symmetrical about housing centerline within .005" (0.127 mm).
2. Mount bearing and top anvil over bottom anvil guide pin as shown in Figure 31.
3. A trial assembly should be made for each new bearing lot to determine the staking force necessary to meet the axial retention load required. Excessive force should be avoided since this may result in bearing distortion and seriously impair bearing function and life. (See Staking Force, Page 21.)
4. Apply the staking force established by trial assembly, rotate assembly 90° and re-apply force. Repeat operation through a minimum of 3 rotations to ensure 360° uniformity of lip swaging.
5. After staking, a slight gap may exist between race lip and housing chamfer as shown in detail in Figure 31. This gap should not be a cause for rejection providing bearing meets the thrust load specified.

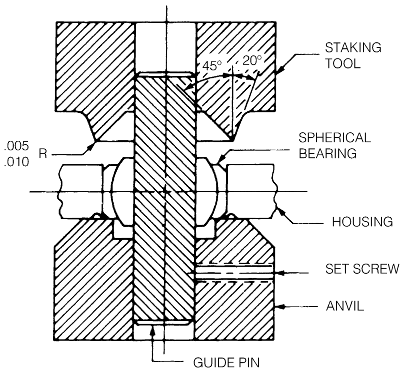


FIGURE 32

HOUSING STAKE RETENTION (CHAMFERED BEARING SERIES)

Retention of chamfered bearings may be accomplished by many methods and may vary according to housing configuration, material, hardness and the axial thrust load requiered When axial loads are light to moderate, a housing ring staking tool as shown in Figure 32 may be used. The bearing and housing are supported by an anvil while the annular staking tool is forced into one side of the housing flaring a small amount of the housing material over the race chamfer. The opposite side of the housing is then staked in the same manner. When this method is used, the housing crosshole edges should be sharp to a .005" (0.13 mm) maximum radius or chamfer. As with the V-groove staking, excessive staking forces should be avoided in order to prevent deformation of the spherical bearing.

LINED JOURNAL BEARING INSTALLATION

The same general procedure as outlined for spherical bearings should be followed. (See Figure 30). In the case of fabric Lined bores, however, it is mandatory that both the insertion tool guide pin and the mating shaft have ends free of both burrs and sharp edges. A .030" (0.76 mm) blended radius or 15° lead (as shown in Figure 34) is recommended, since it is virtually impossible to install a sharp edged shaft without inflicting some damage to the fabric liner. For maximum support of the fabric lined bore, the effective length of the insertion tool guide pin should exceed the journal bearing length.

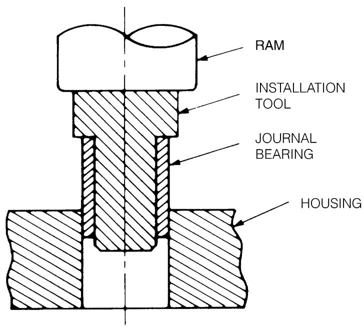


FIGURE 33

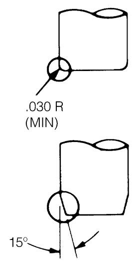


FIGURE 34

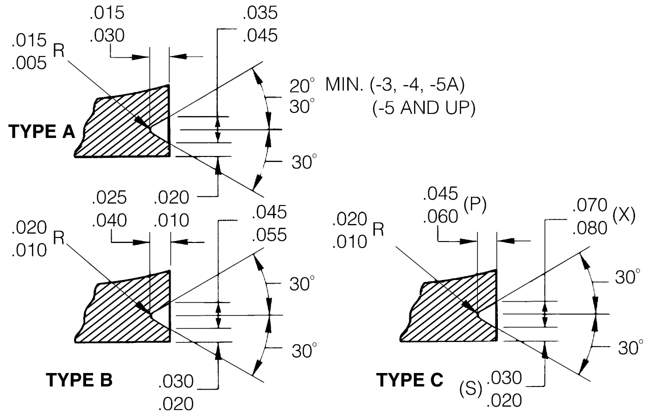


FIGURE 35 - STANDARD V-GROOVE TYPES & SIZES

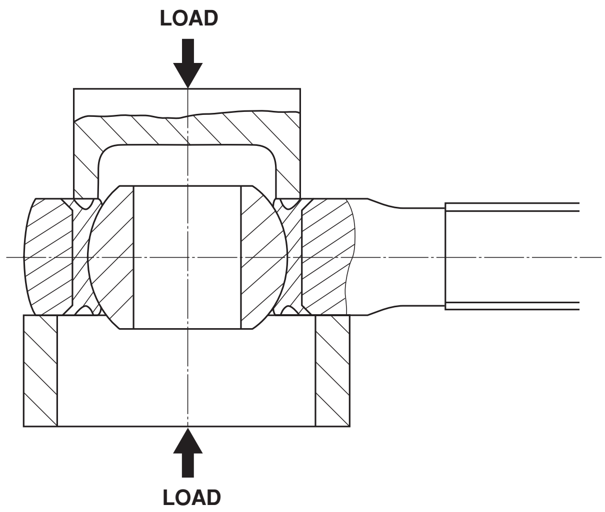


FIGURE 36 - STAKING BEARING PROOF LOAD TEST METHOD

TABLE 8 - V-GROOVE STAKING FORCE

GROOVE TYPE*	A	B	C
CONSTANT (lbs)	7,700	12,000	17,700
CONSTANT [N]	34,250	53,376	78,730
*SEE FIGURE 35 FOR GROOVE SIZES			

STAKING FORCE

The force required to stake V-groove bearing is approximately equal to the product of the O.D. and a constant for each groove size. For example, a 1.500” (38.10 mm) O.D. bearing having a “B” size groove should require a staking force of approximately 18,000 lbs (80064 N). Constants shown in Table 8 are based on outer race material having an ultimate tensile strength of 140,000 psi (984.6 N/mm^2). Staking force constants for other materials are proportional to the ultimate tensile of those materials as compared to 140,000 psi (984.6 N/mm^2). Staking forces derived by this formula should be used as a reference guide only to establish a starting point. Please refer to STAKING PROCEDURE steps outlined on page 22.

PROOF LOADING

Figure 36 shows the test set-up specified in AS81935 for axial static proof load testing of rod ends with V-groove staked inserts. This is the generally accepted method used by spherical bearing and airframe manufactures for checking axial retention of the stake. The rod end assembly is mounted on a rigid ring which clears the flared O.D. of the insert and supports the rod end body only. The axial proof load is applied to the ball face, the bearing is then reversed 180° and the axial load is repeated on the opposite side.
The approximate proof load can be estimated from TABLE 9.

TABLE 9 - THRUST LOADS BASED ON FIGURE 35 GROOVE TYPES AND MATERIALS SPECIFIED

V-Groove Type	X		P		S		Axial Static Proof Load lbs (N)	
	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)		
	+.000 -.010	+0.00 -0.25	+.000 -.015	+0.000 -0.038	+.000 -.010	+0.00 -0.25	Steel Race (30 ~ 35 HRC)	Al-Bz Race
A	.045	1.14	.030	0.76	.020	0.51	1,700 × D” (298 × D mm)	1,100 × D” (193 × D mm)
B	.055	1.40	.040	1.02	.030	0.76	2,090 × D” (367 × D mm)	1,360 × D” (239 × D mm)
C	.080	2.03	.060	1.52	.030	0.76	2,340 × D” (411 × D mm)	1,520 × D” (267 × D mm)

LOAD RATINGS AND MISALIGNMENT CAPABILITIES

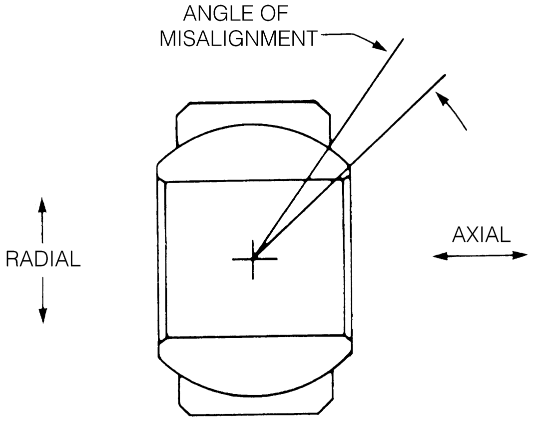


FIGURE 37

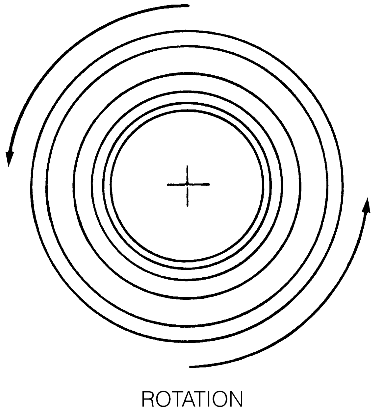


FIGURE 38

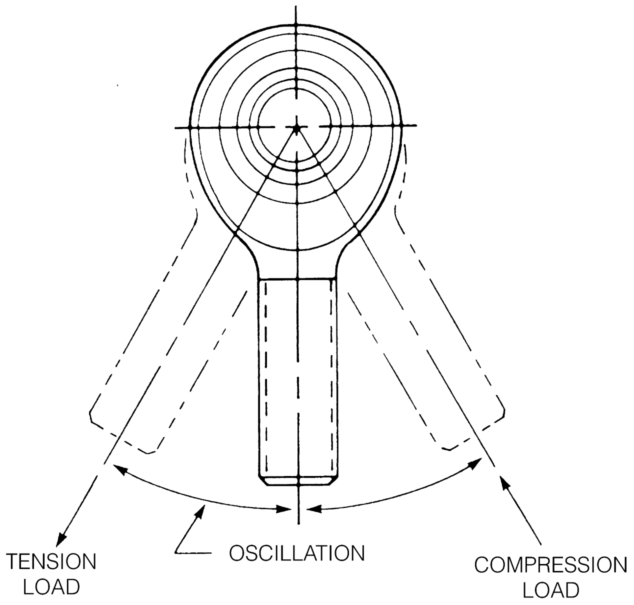


FIGURE 39

DEFINITIONS FOR ROD END AND SPHERICAL BEARING TERMINOLOGY

Radial Load

A load applied normally to the bearing bore axis. (See Figure 37).

Axial Load

A load applied along the bearing bore axis. (See Figure 37).

Static Load

Is the load to be supported while the bearing is stationary.

Dynamic Load

Is the load to be supported while the bearing is moving.

Static Radial Limit Load *

That static load required to produce a specified permanent set in the bearing. It will vary for a given size as a function of configuration. It may also be pin limited or, may be limited as a function of body restraints as in the case of a rod end bearing. Structurally, it is the maximum load which the bearing can see once in its application without impairing its performance.

Static Radial Ultimate Load *

That load which can be applied to a bearing without fracturing the ball, race or rod end eye. The ultimate load rating is usually, but not always, 1.5 times (1.25 times for rod end) the limit load.

Static Axial Limit Load

That load which can be applied to a bearing to produce a specified permanent set in the bearing structure. Structurally, it is the maximum load which the bearing can see once in its application without impairing its performance.

Static Axial Ultimate Load

That load which can be applied to a bearing without separating the ball from the race. The ultimate load rating is usually, but not always, 1.5 times the limit load.

Axial Static Proof Load

That axial load which can be applied to a mounted spherical bearing without pushout of the bearing from the rodend body.

Fatigue Load

That load which can be applied a rod end bearing withstanding a minimum of 50,000 cycles of alternate load. The loading shall be tension-tension with 100% of fatigue load and 10% of fatigue load.

*** LOAD CAPACITY FOR NECK BALL TYPE BEARINGS**

Load figures given on the Table of Dimension are based on outer race load capacity.
Pin deformation due to fit, hardness and so on may result in crack of ball (inner race).

LOAD RATINGS AND MISALIGNMENT CAPABILITIES

OSCILLATING RADIAL LOAD OR DYNAMIC LOAD

The uni-directional load producing a specified maximum amount of wear when the bearing is oscillated at a specified frequency and amplitude. This rating is usually applied to self-lubricating bearings only. The dynamic capability of metal to metal bearings depends upon the degree and frequency of grease lubrication, and that of dry film lubricated bearings upon the characteristics of the specific dry film lubricant applied.

RADIAL PLAY

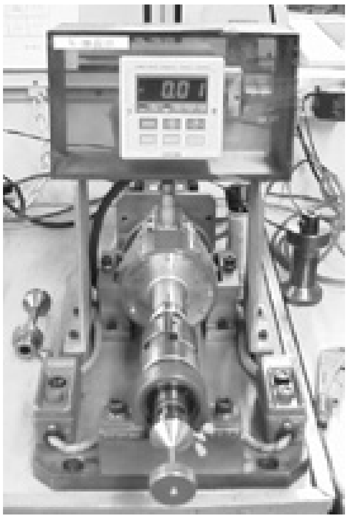
Radial play (or radial clearance) is the total movement between the ball and the race in both radial directions less shaft clearance (when applicable). US military specifications have established the gaging load at 5.5lbs. (24.5 N) and this is now considered as the industry standard (See Figure 42). Unless otherwise specified, the industry wide standard for metal-to-metal spherical bearing and rod end radial clearance is “free-running to .002” (51 μm) MAX” Radial play is sometimes referred to as “Diametral play”. The two terms are synonymous.

AXIAL PLAY

Axial play (or axial clearance) is the total movement between the ball and the race in both axial directions. The gaging load at again 5.5lbs. (24.5 N). Axial play is a resultant, being a function of radial play, of ball diameter and race width. The ratio between radial and axial play varies with bearing geometry.

TORQUE

(See Self-Lubricating Liner Systems Section).



TORQUE METER

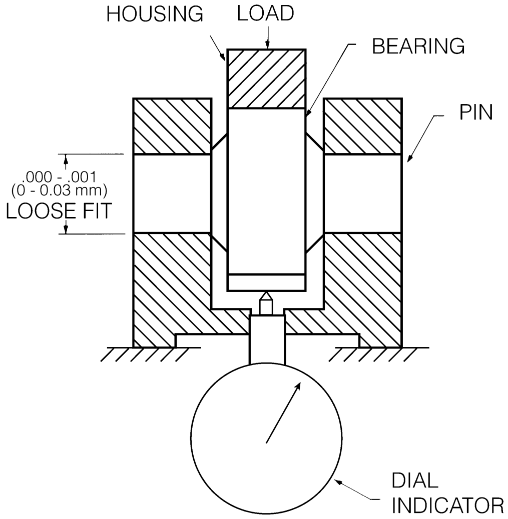


FIGURE 40 - RADIAL TEST FIXTURE

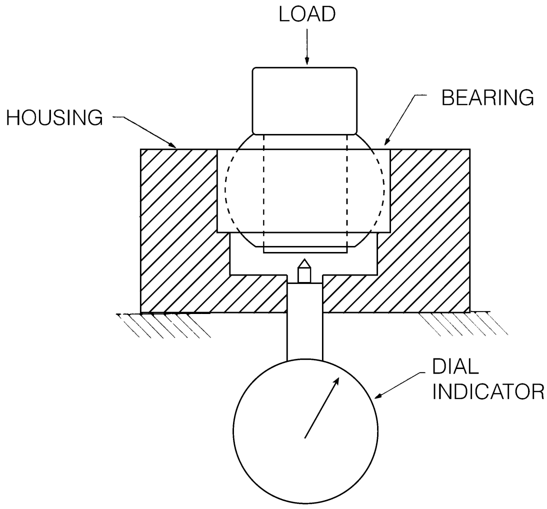


FIGURE 41 - AXIAL TEST FIXTURE

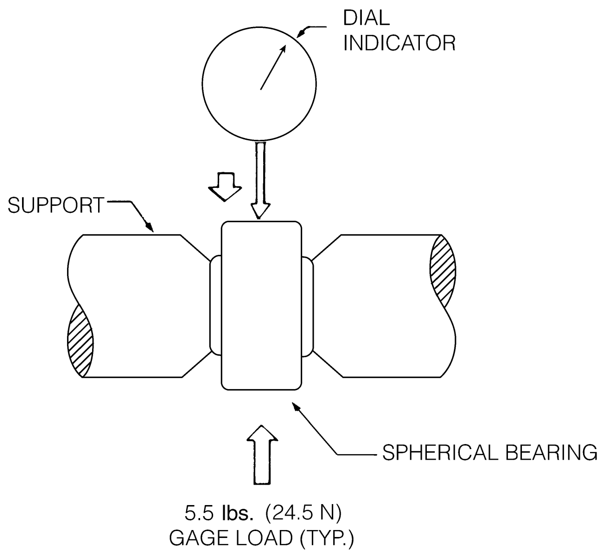


FIGURE 42 - METHOD OF MEASURING RADIAL PLAY

LOAD RATINGS AND MISALIGNMENT CAPABILITIES

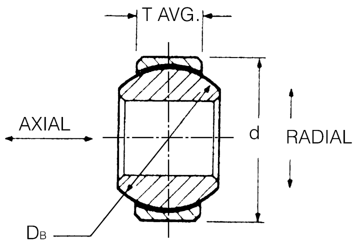
LOAD RATINGS

The load rating of a bearing is determined by the dimensions and strength of its weakest component. External factors, such as mounting components, pins, bolts, and housings are not considered part of a bearing when load ratings are investigated but should be considered separately.

SPHERICAL BEARING LOAD RATINGS

The weakest part, or load-limiting area, of a spherical bearings is its race. For this reason, formulas have been developed that use the race to calculate static load ratings based on size and material strength. The static load rating formulas for self-lubricating and metal-to-metal spherical bearings are shown in figure 43 and 44. These formulas will yield approximate ratings, which should be used as ballpark numbers for bearing design.

The allowable radial stress figures given in the tables were determined from the ultimate tensile strength specifications for various race materials. Allowable axial stress figures were derived from material yield strengths.



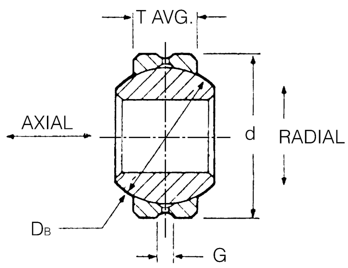
Allowable Stress
Teflon-Lined Bearings

Load = Projected area x allowable stress
Radial Projected Area = $(.91T)\ (D_B)$
Axial Projected Area = $.636T^2 - .05D_B$

FIGURE 43 - Static load rating formulas for self-lubricating spherical bearings.

Allowable Stress Teflon X-1820 Lined Bearings (psi)

Race Material	Radial		Axial	
	Ultimate	Limit	Ultimate	Limit
17-4PH, 28 HRC MIN	112,500 (775 N/mm²)	75,000 (517 N/mm²)	67,500 (465 N/mm²)	45,000 (310 N/mm²)
ALUM 2024-T351	60,000 (413 N/mm²)	40,000 (276 N/mm²)	36,000 (248 N/mm²)	24,000 (164 N/mm²)



Allowable Stress
Metal To Metal Bearings

Load = Projected Area x Allowable stress
Radial Projected Area = $(.83T - .92G)\ (D_B)$
Axial Projected Area = $.636T^2$

Standard Groove Size		
Bearing Size	**G**	
Bore Code	**Width**	**(mm)**
3 & 4	.062	(1.57)
5-10	.078	(1.98)
12-16	.094	(2.39)
20 & above	.109	(2.77)

FIGURE 44 - Static load rating formulas for metal to metal spherical bearings.

Allowable Stress Metal To Metal Bearings (psi)

Race Material	Radial		Axial	
	Ultimate	Limit	Ultimate	Limit
17-4PH, 32-36 HRC	150,000 (1034 N/mm²)	100,000 (689 N/mm²)	125,000 (861 N/mm²)	83,000 (572 N/mm²)
4130 32-36 HRC	150,000 (1034 N/mm²)	100,000 (689 N/mm²)	125,000 (861 N/mm²)	83,000 (572 N/mm²)
A286 (AMS 5737)	140,000 (965 N/mm²)	93,000 (641 N/mm²)	95,000 (655 N/mm²)	63,000 (434 N/mm²)
C62300 Al-Bz (ASTM B150)	75,000 (517 N/mm²)	50,000 (345 N/mm²)	45,000 (310 N/mm²)	30,000 (207 N/mm²)

LOAD RATINGS AND MISALIGNMENT CAPABILITIES

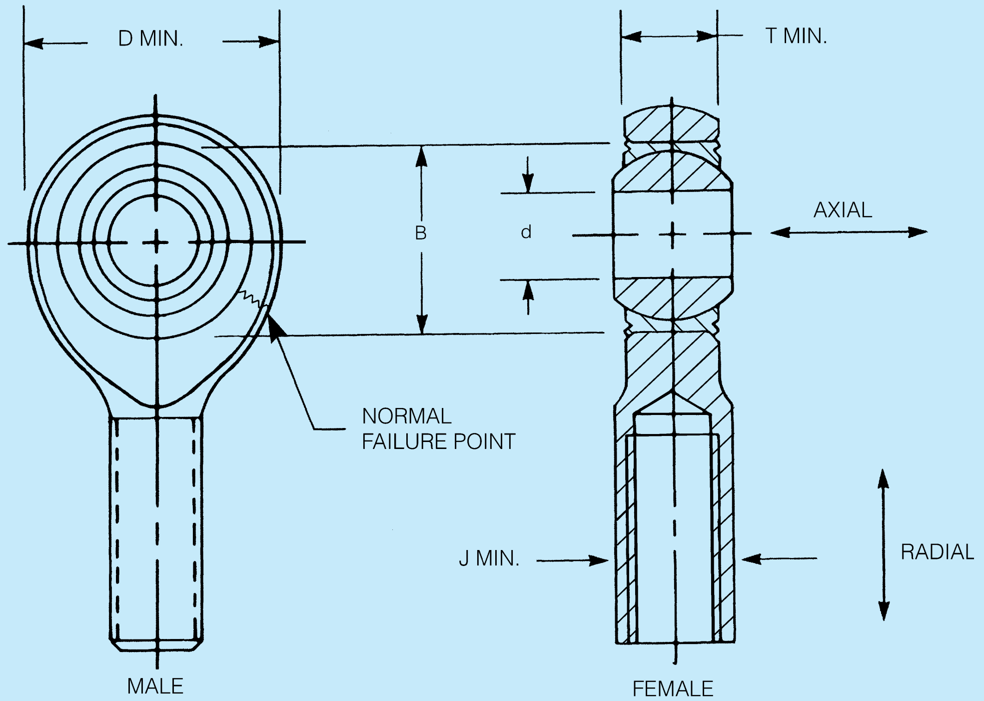


FIGURE 45

Rod end bearing load ratings can be generated only after carefully determining the load restrictions that each element of the rod end bearing imposes on the entire unit. It order to generate a frame of reference, consider the rod end bearing as a clock face, with the shank pointing down to the 6 o'clock position. The limiting factors in rating a rod end bearing are as follows:

1. The double shear capability of the bolt passing through the ball bore.
2. The bearing capability, a function of race material or self-lubricating liner system.
3. The rod end eye or hoop tension stress in the 3 o'clock-9 o'clock position.
4. The shank stress area, as function of male or female rod end configuration.
5. The stress in the transition area between the threaded shank transition diameter and the rod end eye or hoop.

Most rod ends will fail under tension loading in about the 4 o'clock-8 o'clock portion of the eye or hoop. The hoop stress area (HSA) can be found as follows:

$$HSA = .008762 \times D^2 \times \sin^{-1}\frac{T}{D} + \frac{T}{2} \times \sqrt{D^2 - T^2} - B \times T$$

The shank stress area (SSA) is a function of being either male or female, as follows:

For the male:

$$SSA = (\text{minor thread diameter})^2/4$$

For the female:

$$SSA = [J^2 - (\text{major thread diameter})^2]/4$$

Pin shear stress (PSS) for a load "F" is as follows:

$$PSS = \frac{2F}{d^2}$$

The axial load capability of a rod end is a function of the following:

1. The retention method used to mount the bearing in the rod end eye.
2. The axial load capability of the bearing element.
3. The bending moment, if any, placed on the rod end.
4. The race half width $\frac{T}{2}$ of the bearing element.

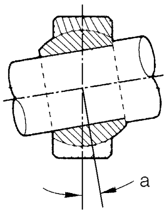
   This is a function of the axial projected area (APA) of the bearing.

$$APA = \left(\frac{T}{2}\right)^2$$

LOAD RATINGS AND MISALIGNMENT CAPABILITIES

FORMULA FOR DETERMINING MISALIGNMENT OF ROD END & SPHERICAL BEARINGS

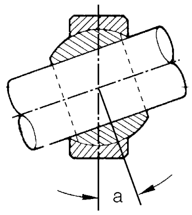
FIGURE 46



$a = SIN^{-1}\frac{W}{E} - SIN^{-1}\frac{T}{E}$

STANDARD METHOD
MOST STANDARD ROD END & SPHERICAL BEARING MISALIGNMENT ANGLES SPECIFIED IN NMB CATALOGS ARE BASED ON THIS METHOD.

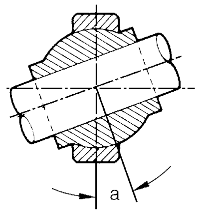
FIGURE 47



$a = COS^{-1}\frac{R}{E} - SIN^{-1}\frac{T}{E}$

DESIGN REFERENCE
THIS METHOD MAY BE USED AS DESIGN REFERENCE FOR INSTALLATION PURPOSES, BUT SHOULD NOT BE USED AS A FUNCTIONING MISALIGNMENT UNDER LOAD.

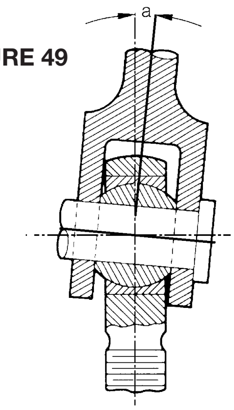
FIGURE 48



$a = COS^{-1}\frac{S}{E} - SIN^{-1}\frac{T}{E}$

HIGH MISALIGNMENT SERIES METHOD
(NECK BALL ONLY)

FIGURE 49



$a = SIN^{-1}\frac{W}{D} - SIN^{-1}\frac{T}{D}$

ROD END CLEVIS MISALIGNMENT

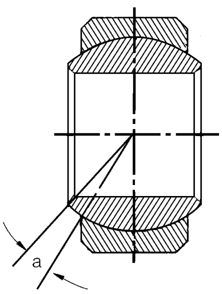
The misalignment angle of a rod end or spherical bearing refers to the angle between the ball centerline and the outer member centerline when the ball is misaligned to the extreme position allowed by the clevis or shaft design, as applicable.

NOTE:
SINCE ANGLE "a" APPLIES EQUALLY ON BOTH SIDES OF THE CENTERLINE, IT FOLLOWS THAT TOTAL MISALIGNMENT OF THE BEARING IS DOUBLE THE VALUE OBTAINED FOR "a".

Figure 46 through 49 illustrate varying types of bearing misalignment and a formula for calculating each.

WHERE;
a = Angle of Misalignment
B = Bore of Ball
D = Head Diameter (Rod End)
E = Ball spherical Diameter
S = Shoulder Diameter (Neck Ball)
T = Housing (Race) Width
W = Width of Ball

HOW NMB SPECIFIES CATALOG BEARING AND ROD END MISALIGNMENT



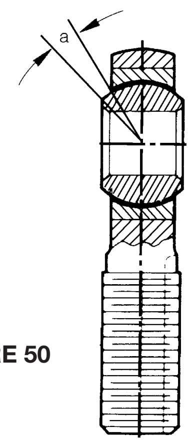


FIGURE 50

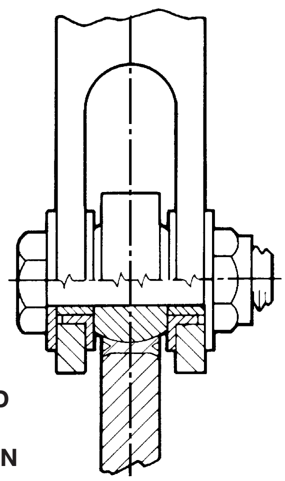


FIGURE 51 - TYPICAL ROD END/CLEVIS INSTALLATION

Figure 51 illustrates how misalignment angles for standard ball spherical bearings and rod ends are represented in NMB catalog. The misalignment angle is calculated per Figure 46 formula. Neck ball (high misalignment) bearings and rod ends are represented in the same manner, but are calculated per Figure 48 formula.

NMB prefers not to use rod end clevis misalignment for the following reason. The rod end clevis misalignment formula presupposes a clevis configuration as shown in Figure 49 in which the clevis slot and ball faces are of equal width and in direct contact. In aircraft applications the configuration shown in Figure 51 is more typical than that of Figure 51 is more typical than that of Figure 49. As pictured in Figure 51, the clevis slot is wider than the ball to permit installation of flanged bushings and/or spacers. This results in a higher but more variable misalignment capability and the angle of misalignment becomes a function of the user's bushing flange or spacer diameter instead of the fixed rod end head diameter.

LOAD RATINGS AND MISALIGNMENT CAPABILITIES

PV Factor

While not a type of loading, the PV factor is very useful in comparing and predicting test results on high speed-low load applications such as helicopter conditions.

PV is the product of the stress (psi or N/mm²) and the velocity (fpm or m/min) applied to a bearing. Caution must be advised when considering extreme values of psi (N/mm²) and fpm (m/min). The extreme must be considered individually as well as together.

Because the PV factor is derived from the geometry and operating conditions of a bearing, it serves as a common denominator in comparing or predicting test results.

The formula for determining the PV value for a spherical bearing is as follows:

$$PV = (x)\,(cpm)\,(D_B)\,(psi)\,(.00073)$$

Where:

x = Total angular travel in degrees per cycle

cpm = cycles per minute

DB = ball diameter

psi = bearing stress (use N/mm² for metric)

Dynamic Oscillating Radial Load

The dynamic oscillating radial load ratings given in this catalog for HT, WHT, HTL and WHTL series self-lubricating spherical bearings are based on testing in accordance with AS81820. For conditions other than those specified by AS81820 for catalog part number, use the formula given below to predict wear.

$$W = \frac{C}{\left(\frac{L_R}{L_A}\right)^{2.13} \times \frac{(100)}{X} \times 25{,}000} \times .0045 \; (.114mm)$$

Where:

W = calculated wear

C = actual total cycles

L_R = rated dynamic load (see product tables)

L_A = actual dynamic load

x = total angular travel in degrees per cycle

For special self-lubricating bearings that do not appear in this catalog, determine the radial projected area and multiply by 39,900 psi (275 N/mm²). This determines L_R, and the formula can then be used to predict wear.

LOAD DEFINITIONS (Rod End Bearings, Anti-Friction Bearings)

LIFE FACTOR CHART

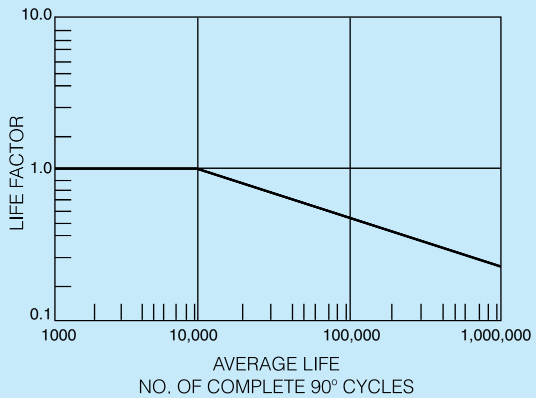


FIGURE 52

RADIAL LOAD - A load applied normal to the bearing bore axis.

AXIAL LOAD - A load applied along the bearing bore axis.

RADIAL LIMIT LOAD - The static load required to produce a specified increase in radial play or permanent set in the bearing structure.

Values are based on the basic relationship: Limit Load (lbs)= KND^2,

where:

K = Load Rating Constant (typically 3200 for rod end bearings)

N = Number of Balls

D = Ball Diameter (inch)

AXIAL LIMIT LOAD - The static load required to produce a specified increase in axial play or permanent set in the bearing structure.

FRACTURE LOAD, RADIAL OR AXIAL - The load that can be applied to a bearing without fracturing parts or preventing free turning by hand.

The fracture load rating is usually 1.5 times the limit load.

DYNAMIC RADIAL LOAD - Load based on average "L-50" life of 10,000 complete 90° oscillatory cycles. Bearing failure is based upon inspection for evidence of pitting or surface fatigue on the balls or raceways.

Load ratings for a greater number of cycles may be determined by multiplying the basic load rating by a factor obtained from the life factor chart. (Figure 52)

SPHERICAL BEARING 〔SELF-LUBRICATING〕

SBT

SPHERICAL | SELF-LUBRICATING | WIDE

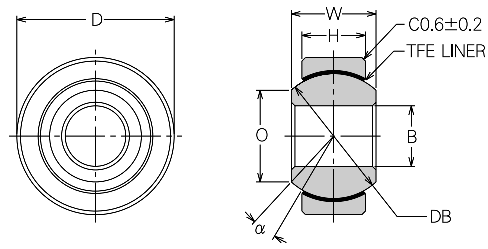
Materials

RACE	410 Stainless Steel / Heat Treated
BALL	440C Stainless Steel / Heat Treated
LINER	Teflon / Fabric

Description of Types

SBT D xx T

- T → No Leeer Indicates Standard Breakaway Torque. Letter "T" Indicates Low Breakaway Torque
- xx → Bearing Bore Code
- D → For X-1276 LINER add suffix "D"
- SBT → Basic Part No.



SBT

Dimensions in mm

MINEBEA Part No.	φB H7	φD 0 − 0.013	W 0 − 0.13	H ± 0.13	α (deg.)	φO Ref.	SφDB Ref.	No Load Rotational Breakaway Torque N・m	Static Limit Load kN		Dynamic Load kN	Approx. Weight g
								Standard	Radial	Axial		
SBT3	3	12	6	4.50	11	6.8	9.042	0.06 ～ 0.57 {0.6 ～ 5.8kgf・cm}	13.72	1.56	6.27	5
SBT4	4	14	7	5.25	12	7.6	10.319		17.65	2.25	8.04	7
SBT5	5	16	8	6.00	11	8.8	11.906	0.12 ～ 0.57 {1.2 ～ 5.8kgf・cm}	24.51	2.94	11.17	10
SBT6	6	18	9	6.75	10	11.1	14.288		36.28	3.72	16.57	14
SBT8	8	22	12	9.00	12	12.7	17.462		58.83	6.76	26.87	26
SBT10	10	26	14	10.50		15.2	20.638		81.39	9.21	37.16	42
SBT12	12	30	16	12.00	11	17.6	23.812		114.73	18.63	52.46	62
SBT14	14	34	19	13.50	14	19.2	26.988		147.09	23.53	67.27	89
SBT16	16	38	21	15.00	13	22.7	30.956		186.32	29.41	85.12	125
SBT18	18	42	23	16.50		24.1	33.338	0.23 ～ 0.90 {2.3 ～ 9.2kgf・cm}	215.74	35.30	98.65	165
SBT20	20	46	25	18.00	12	28.8	38.100		274.58	42.16	125.52	220
SBT22	22	50	28	20.00	13	30.3	41.275		333.42	51.97	152.39	285
SBT25	25	56	31	22.00	14	32.4	44.847	0.33 ～ 1.70 {3.4 ～ 17.3kgf・cm}	404.03	65.21	184.65	380
SBT30	30	66	37	25.00	16	38.2	53.181		545.24	84.33	249.28	605

Notes

1. Teflon liner permanently bonded to race I.D.
2. Made to order only.
3. No Load Rotational Breakaway Torque.
   Low Torque All Size: 0.02N・m MAX
   (Radial Clearance 0.05mm MAX)

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	～ 3	～ 6	～ 10	～ 18	～ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

SPHERICAL BEARING 〔SELF-LUBRICATING〕

MBT,MBT-V

SPHERICAL | SELF-LUBRICATING | NARROW

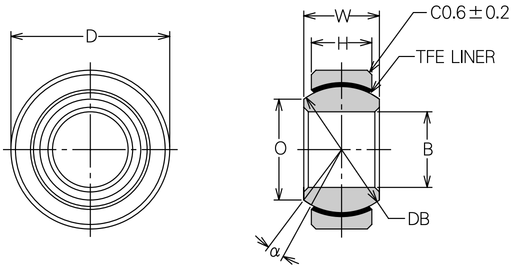
Materials

RACE	410 Stainless Steel / Heat Treated
BALL	440C Stainless Steel / Heat Treated
LINER	Teflon / Fabric

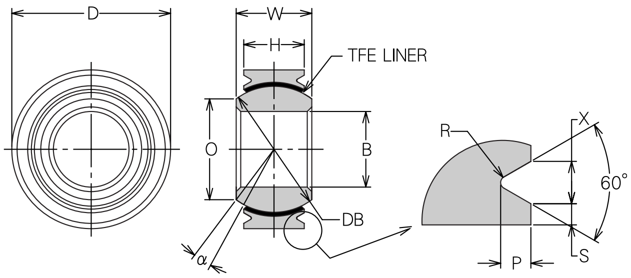
Description of Types

MBT D xx V T

- T: No Letter Indicates Standard Breakaway Torque; Letter "T" Indicates Low Breakaway Torque
- V: No Letter Indicates Chamfer Type; Letter "V" Indicates V-Groove Type
- xx: Bearing Bore Code
- D: For X-1276 LINER add suffix "D"
- MBT: Basic Part No.



MBT



MBT-V

Dimensions in mm

MINEBEA Part No.	φB H7	φD 0 −0.013	W 0 −0.13	H ±0.13	α (deg.)	φO Ref.	SφDB Ref.	No Load Rotational Breakaway Torque N・m Standard	Staking Groove S 0 −0.25	Staking Groove X 0 −0.25	Staking Groove R 0 −0.25	Staking Groove P 0 −0.4	Static Limit Load kN Radial	Static Limit Load kN Axial	Dynamic Load kN	Approx. Weight g
MBT3/MBT3V	3	10.0	5.0	3.5	15	5.1	7.144	0.12～0.57 {1.2～5.8kgf・cm}	0.5	1.0	0.4	0.7	7.84	0.98	3.43	3
MBT4/MBT4V	4	12.0	6.5	4.5	17	5.8	8.731						12.74	1.56	5.88	4
MBT5/MBT5V	5	14.5	7.0	5.5	10	7.6	10.319						18.63	2.45	8.72	7
MBT6/MBT6V	6	16.5	8.5	6.5	11	9.4	12.700		0.7	1.4	0.5	1.0	30.40	3.43	13.72	11
MBT8/MBT8V	8	19.0	9.5	7.0	12	10.7	14.288						37.26	3.92	16.67	14
MBT10/MBT10V	10	21.0	10.0	8.0	8	13.3	16.669						50.01	5.19	22.55	19
MBT12/MBT12V	12	25.0	13.0	10.0	10	15.0	19.844			2.0		1.5	74.53	8.33	33.34	32
MBT14/MBT14V	14	27.5	14.0	11.0	8	18.3	23.019						101.98	15.69	45.11	42
MBT15/MBT15V	15	29.0	15.0	12.0		19.5	24.606						118.66	18.63	52.95	50
MBT16/MBT16V	16	30.0	16.0	12.5	10	18.7							123.56	20.39	54.91	53
MBT18/MBT18V	18	34.0	18.0	14.0	9	22.2	28.575						161.80	25.49	72.56	78
MBT20/MBT20V	20	36.0	19.0	15.0		23.4	30.162						182.40	29.41	81.39	89
MBT22/MBT22V	22	40.0	22.0	18.0	8	25.0	33.338	0.23～0.90 {2.3～9.2kgf・cm}					243.20	42.16	108.85	130
MBT25/MBT25V	25	45.0	25.0	20.0	9	28.8	38.100						308.90	51.97	138.27	185
MBT28/MBT28V	28	50.0	28.0	22.0		34.0	44.053						393.24	63.74	176.51	255
MBT30/MBT30V	30	56.0	30.0	23.0	10	37.0	47.625						444.24	69.62	199.07	350

Notes

1. Teflon liner permanently bonded to race I.D.
2. MBT & MBT-V weights are similar.
3. Made to order only.
4. No Load Rotational Breakaway Torque.
   Low Torque All Size: 0.02N・m MAX
   (Radial Clearance 0.05mm MAX)

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	～3	～6	～10	～18	～30
H7 Tolerance (μm)	+10 0	+12 0	+15 0	+18 0	+21 0

SPHERICAL BEARING 〔SELF-LUBRICATING〕

MBWT,MBWT-V

SPHERICAL | **SELF-LUBRICATING** | **WIDE**

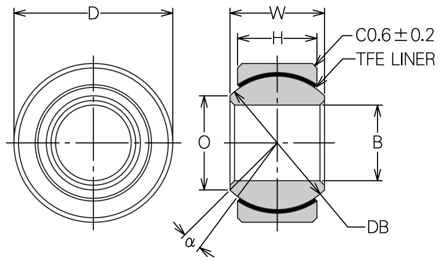
Materials

RACE	410 Stainless Steel / Heat Treated
BALL	440C Stainless Steel / Heat Treated
LINER	Teflon / Fabric

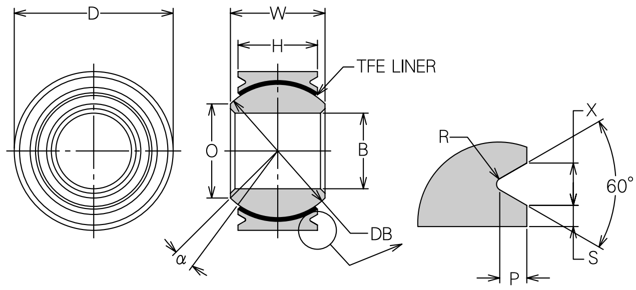
Description of Types

MBWT D xx V T

- T → No Letter Indicates Standard Breakaway Torque / Letter "T" Indicates Low Breakaway Torque
- V → No Letter Indicates Chamfer Type / Letter "V" Indicates V-Groove Type
- xx → Bearing Bore Code
- D → For X-1276 LINER add suffix "D"
- MBWT → Basic Part No.



MBWT



MBWT-V

Dimensions in mm

MINEBEA Part No.	φB H7	φD 0 −0.013	W 0 −0.13	H ±0.13	α (deg.)	φO Ref.	SφDB Ref.	No Load Rotational Breakaway Torque N・m	Staking Groove				Static Limit Load kN		Dynamic Load kN	Approx. Weight g
								Standard	S 0 −0.25	X 0 −0.25	R 0 −0.25	P 0 −0.4	Radial	Axial		
MBWT5/MBWT5V	5	16.0	11.0	8.5	15	7.8	13.494	0.06～0.57 {0.6～5.8kgf・cm}	0.5	1.0	0.4	0.7	43.14	5.98	18.63	14
MBWT6/MBWT6V	6							0.12～0.57 {1.2～5.8kgf・cm}								13
MBWT8/MBWT8V	8	17.5		8.0	14	10.9	15.478						46.09	5.29	20.59	14
MBWT10/MBWT10V	10	21.0	12.5	10.5	8	12.2	17.462		0.7	1.4	0.5	1.0	68.64	9.21	30.40	23
MBWT12/MBWT12V	12	26.0	16.0	13.0	10	15.4	22.225						116.69	21.57	51.97	46
MBWT14/MBWT14V	14	28.0	17.0	14.0	8	18.9	25.400						143.17	25.49	63.74	55
MBWT15/MBWT15V	15	29.0	18.0		11	19.0	26.194						148.08		65.70	59
MBWT16/MBWT16V	16	30.0	19.0	15.0	10	19.2	26.988			2.0		1.5	163.77	29.41	73.54	65
MBWT18/MBWT18V	18	33.0	20.0	16.0		20.4	28.575						184.36	33.34	82.37	80
MBWT20/MBWT20V	20	35.0	22.0		13	22.9	31.750						204.95		92.18	91
MBWT22/MBWT22V	22	41.0		19.0	6	27.1	34.925	0.23～0.90 {2.3～9.2kgf・cm}					268.70	47.07	120.62	150
MBWT25/MBWT25V	25	54.0	35.0	25.0	15	32.3	47.625						483.46	82.37	216.72	400
MBWT28/MBWT28V	28	60.0			14	36.8	50.800						515.82		231.43	490
MBWT30/MBWT30V	30	64.0	37.0	26.0		40.4	54.769						578.59	89.24	258.89	590
MBWT35/MBWT35V	35	65.0		29.0	9	44.7	58.000	0.33～1.70 {3.4～17.3kgf・cm}					682.54	109.83	303.02	
MBWT40/MBWT40V	40	68.0	38.0	31.0	8	46.9	60.325						759.03	125.52	337.34	615
MBWT45/MBWT45V	45	76.0	41.0	33.0		54.1	67.866						909.07	142.19	404.03	825
MBWT50/MBWT50V	50	82.0	44.0	35.0		60.3	74.612						1059.11	156.90	470.71	995

Notes

1. Teflon liner permanently bonded to race I.D.
2. MBWT & MBWT-V weights are similar.
3. Made to order only.
4. No Load Rotational Breakaway Torque.
   Low Torque All Size: 0.02N・m MAX
   (Radial Clearance 0.05mm MAX)

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	～3	～6	～10	～18	～30	～50
H7 Tolerance (μm)	+10 0	+12 0	+15 0	+18 0	+21 0	+25 0

SPHERICAL BEARING 〔SELF-LUBRICATING〕

MBYT,MBYT-V

Minebea eMINEBEA.COM

SPHERICAL | SELF-LUBRICATING | HIGH MISALIGNMENT

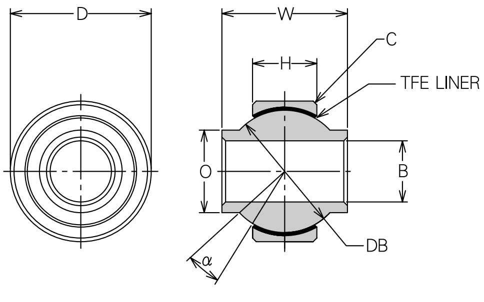
Materials

RACE 410 Stainless Steel / Heat Treated
BALL 440C Stainless Steel / Heat Treated
LINER Teflon / Fabric

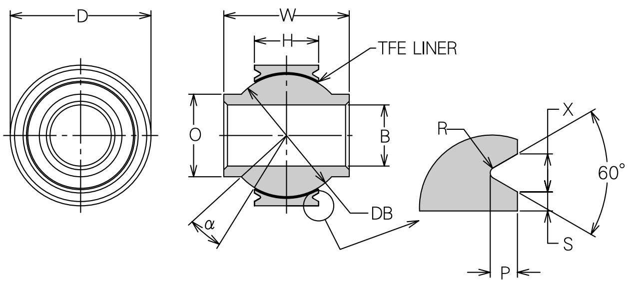
Description of Types

MBYT D xx V T

- T: No Letter Indicates Standard Breakaway Torque; Letter "T" Indicates Low Breakaway Torque
- V: No Letter Indecates Chamfer Type; Letter "V" Indicates V-Groove Type
- xx: Bearing Bore Code
- D: For X-1276 LINER add suffix "D"
- MBYT: Basic Part No.



MBYT



MBYT-V

Dimensions in mm

MINEBEA Part No.	φB H7	φD 0 −0.013	W 0 −0.13	H ±0.13	α (deg.)	φO Ref.	SφDB Ref.	No Load Rotational Breakaway Torque N・m	Chamfer	Staking Groove				Static Limit Load kN		Dynamic Load kN	Approx. Weight g
								Standard	C ±0.2	S 0 −0.25	X 0 −0.25	R 0 −0.25	P 0 −0.4	Radial	Axial		
MBYT5/MBYT5V	5	14	12.5	5.0	17	8.0	11.1	0.06 ~ 0.57 {0.6 ~ 5.8kgf・cm}	0.5	0.5	1.0	0.4	0.7	18.63	1.96	7.84	8
MBYT6/MBYT6V	6	19	15.0	6.5	23	10.0	15.1	0.12 ~ 0.57 {1.2 ~ 5.8kgf・cm}						36.26	3.43	14.70	18
MBYT8/MBYT8V	8	18	16.0		20	10.5			0.6								15
MBYT10/MBYT10V	10	23	20.5	8.5	22	13.5	20.0			0.7	1.4	0.5	1.0	63.70	5.97	28.42	32
MBYT12/MBYT12V	12	26	22.0			16.0	22.5							72.03		32.34	42
MBYT14/MBYT14V	14	29	23.5	10.0	20	19.0	26.0							98.00	8.33	44.10	60
MBYT15/MBYT15V	15	33	26.0	12.0	19	20.0	28.0							135.24	18.62	60.76	86
MBYT16/MBYT16V	16	35	30.5	14.0	21	21.5	31.8							179.34	25.48	80.36	120
MBYT18/MBYT18V	18	38	33.0	14.5	15	23.5	32.0		0.8		2.0		1.5	187.18	27.44	83.30	135
MBYT20/MBYT20V	20	40	35.5	15.5	18	25.0	35.0	0.23 ~ 0.90 {2.3 ~ 9.2kgf・cm}	1.0					219.52	31.36	98.00	155
MBYT22/MBYT22V	22	44				29.0	38.8							243.04		108.78	200

Notes

1. Teflon liner permanently bonded to race I.D.
2. MBYT & MBYT-V weights are similar.
3. Made to order only.
4. No Load Rotational Breakaway Torque.
   Low Torque All Size: 0.02N・m MAX
   (Radial Clearance 0.05mm MAX)

○ Please consult MINEBEA for availability of bearings in this series.

Bore size	~ 3	~ 6	~ 10	~ 18	~ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

SPHERICAL BEARING 〔METAL TO METAL〕

MBG-CR,MBG-VCR

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SPHERICAL | METAL TO METAL | STANDARD

Materials

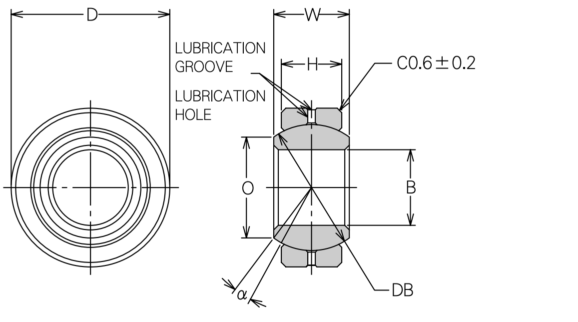
RACE 410 Stainless Steel

BALL 440C Stainless Steel

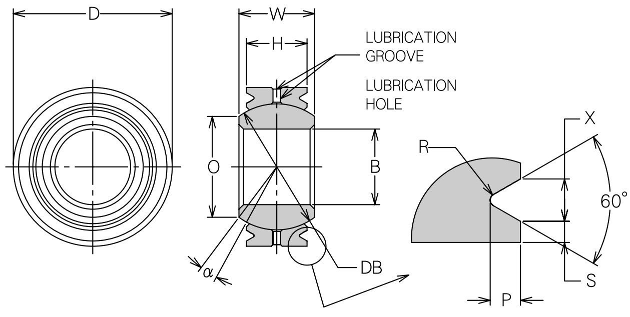
Description of Types

MBG xx V CR A

- A: No Letter Indicates No lubrication hole and groove on Ball I.D. Letter "A" Indicates lubrication hole and groove on Ball I.D.
- V: No Letter Indicates Chamfer Type Letter "V" Indicates V-Groove Type
- xx: Bearing Bore Code
- MBG, CR: Basic Part No.



MBG-CR



MBG-VCR

Dimensions in mm

MINEBEA Part No.	φB H7	φD 0 −0.013	W 0 −0.13	H ±0.13	α (deg.)	φO Ref.	SφDB Ref.	Staking Groove S 0 −0.25	Staking Groove X 0 −0.25	Staking Groove R 0 −0.25	Staking Groove P 0 −0.4	Static Limit Load kN Radial	Static Limit Load kN Axial	Approx. Weight g
MBG3CR/MBG3VCR	3	10.0	5.0	3.5	15	5.1	7.144	0.5	1.0	0.4	0.7	6.17	1.76	3
MBG4CR/MBG4VCR	4	12.0	6.5	4.5	17	5.8	8.731					12.16	2.94	4
MBG5CR/MBG5VCR	5	14.5	7.0	5.5	10	7.6	10.319					19.90	4.41	7
MBG6CR/MBG6VCR	6	16.5	8.5	6.5	11	9.4	12.700	0.7	1.4	0.5	1.0	31.08	6.27	11
MBG8CR/MBG8VCR	8	19.0	9.5	7.0	12	10.7	14.288					35.30	7.25	14
MBG10CR/MBG10VCR	10	21.0	10.0	8.0	8	13.3	16.669					49.81	9.51	19
MBG12CR/MBG12VCR	12	25.0	13.0	10.0	10	15.0	19.844		2.0		1.5	79.43	14.80	32
MBG14CR/MBG14VCR	14	27.5	14.0	11.0	8	18.3	23.019					103.95	28.34	42
MBG15CR/MBG15VCR	15	29.0	15.0	12.0		19.5	24.606					118.66	33.73	50
MBG16CR/MBG16VCR	16	30.0	16.0	12.5	10	18.7						124.54	36.67	53
MBG18CR/MBG18VCR	18	34.0	18.0	14.0	9	22.2	28.575					166.71	45.99	78
MBG20CR/MBG20VCR	20	36.0	19.0	15.0		23.4	30.162					192.21	52.75	89
MBG22CR/MBG22VCR	22	40.0	22.0	18.0	8	25.0	33.338					263.79	76.00	130
MBG25CR/MBG25VCR	25	45.0	25.0	20.0	9	28.8	38.100					340.29	93.84	185
MBG28CR/MBG28VCR	28	50.0	28.0	22.0		34.0	44.053					439.33	112.77	255
MBG30CR/MBG30VCR	30	56.0	30.0	23.0	10	37.0	47.625					500.13	123.56	350

Notes

1. MBG - CR & MBG - VCR weights are similar.
2. Made to order only.
3. Radial Clearance All Size: 0.051mm MAX

○ Please consult MINEBEA for availability of bearings in this series.

Bore size	~3	~6	~10	~18	~30
H7 Tolerance (μm)	+10 0	+12 0	+15 0	+18 0	+21 0

SPHERICAL BEARING 〔METAL TO METAL〕

MBW-CR,MBW-VCR

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SPHERICAL | METAL TO METAL | WIDE

Materials

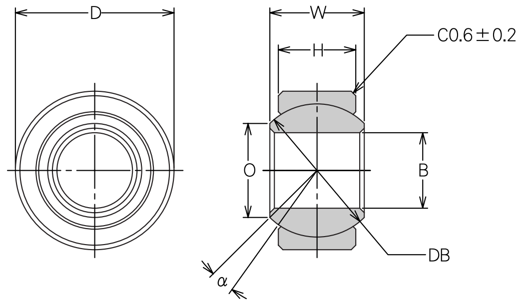
RACE 410 Stainless Steel

BALL 440C Stainless Steel

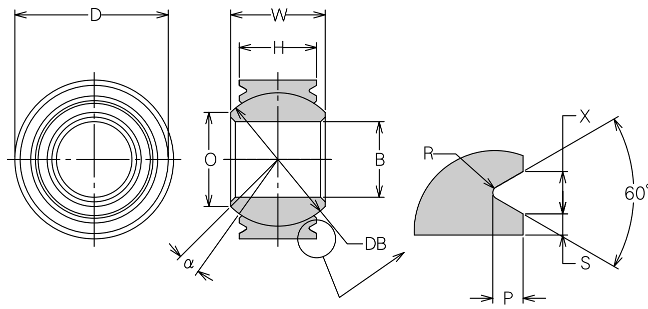
Description of Types

MBW xx V CR G A

- A: No Letter Indicates No lubrication hole and groove on Ball I.D. Letter "A" Indicates lubrication hole and groove on Baii I.D.
- G: No Letter Indicates No lubrication hole and groove on Race O.D. Letter "G" Indicates lubrication hole and groove on Race O.D.
- V: Letter "V" Indicates V-Groove Type. No Letter Indicates Chamfer Type
- xx: Bearing Bore Code
- MBW / CR: Basic Part No.



MBW-CR



MBW-VCR

Dimensions in mm

MINEBEA Part No.	φB H7	φD 0 −0.013	W 0 −0.13	H ±0.13	α (deg.)	φO Ref.	SφDB Ref.	Staking Groove S 0 −0.25	Staking Groove X 0 −0.25	Staking Groove R 0 −0.25	Staking Groove P 0 −0.4	Static Limit Load kN Radial	Static Limit Load kN Axial	Approx. Weight g
MBW5CR/MBW5VCR	5	16.0	11.0	8.5	15	7.8	13.494	0.5	1.0	0.4	0.7	59.03	10.68	14
MBW6CR/MBW6VCR	6													13
MBW8CR/MBW8VCR	8	17.5		8.0	14	10.9	15.478					63.74	9.51	14
MBW10CR/MBW10VCR	10	21.0	12.5	10.5	8	12.2	17.462	0.7	1.4	0.5	1.0	94.43	16.37	23
MBW12CR/MBW12VCR	12	26.0	16.0	13.0	10	15.4	22.225					148.08	39.61	46
MBW14CR/MBW14VCR	14	28.0	17.0	14.0	8	18.9	25.400					182.40	45.99	55
MBW15CR/MBW15VCR	15	29.0	18.0		11	19.0	26.194					188.28		59
MBW16CR/MBW16VCR	16	30.0	19.0	15.0	10	19.2	26.988		2.0		1.5	207.90	52.75	65
MBW18CR/MBW18VCR	18	33.0	20.0	16.0		20.4	28.575					235.35	60.11	80
MBW20CR/MBW20VCR	20	35.0	22.0		13	22.9	31.750					260.85		91
MBW22CR/MBW22VCR	22	41.0		19.0	6	27.1	34.925					341.27	84.72	150
MBW25CR/MBW25VCR	25	54.0	35.0	25.0	15	32.3	47.625					612.91	146.11	400
MBW28CR/MBW28VCR	28	60.0			14	36.8	50.800					654.10		490
MBW30CR/MBW30VCR	30	64.0	37.0	26.0		40.4	54.769					733.53	157.88	590

Notes

1. MBW - CR & MBW - VCR weights are similar.
2. Made to order only.
(3) For below 4mm in Bore size, bearings are without lubrication grooves.
4. Radial Clearance All Size: 0.051mm MAX
◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	～3	～6	～10	～18	～30
H7 Tolerance (μm)	+10 0	+12 0	+15 0	+18 0	+21 0

SPHERICAL BEARING 〔METAL TO METAL〕

MBY-CR,MBY-VCR

SPHERICAL | METAL TO METAL | HIGH MISALIGNMENT

Materials

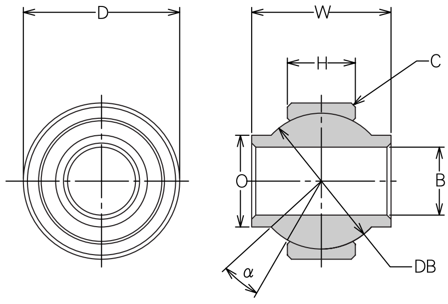
RACE 410 Stainless Steel

BALL 440C Stainless Steel

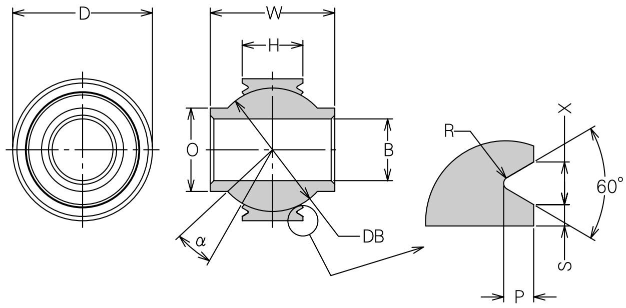
Description of Types

MBY xx V CR G A

- A: No Letter Indicates no lubrication hole and groove on Ball I.D. Letter "A" Indicates lubrication hole and groove on Ball I.D.
- G: No Letter Indicates nooooo lubrication hole and groove on Race O.D. Letter "G" Indicates lubrication hole and groove on Race O.D.
- V: No Letter Indicates Chamfer Type Letter "V" Indicates V-Groove Type
- xx: Bearing Bore Code
- MBY: Basic Part No.



MBY-CR



MBY-VCR

Dimensions in mm

MINEBEA Part No.	φB H7	φD 0 −0.013	W 0 −0.13	H ±0.13	α (deg.)	φO Ref.	SφDB Ref.	Chamfer C ±0.2	Staking Groove S 0 −0.25	Staking Groove X 0 −0.25	Staking Groove R 0 −0.25	Staking Groove P 0 −0.4	Static Limit Load kN Radial	Static Limit Load kN Axial	Approx. Weight g
MBY3CR	3	10.0	8.0	3.0	29	5.0	8.00	0.3	0.5	1.0	0.4	0.7	11.76	1.27	3
MBY4CR	4	12.0	10.5	4.0		6.0	10.00						20.49	2.35	5
MBY5CR/MBY5VCR	5	14.0	12.5	5.0	17	8.0	11.10	0.5					28.43	3.62	8
MBY6CR/MBY6VCR	6	19.0	15.0	6.5	23	10.0	15.10						50.50	6.27	18
MBY8CR/MBY8VCR	8	18.0	16.0		20	10.5									15
MBY10CR/MBY10VCR	10	23.0	20.5	8.5	22	13.5	20.00	0.6	0.7	1.4	0.5	1.0	87.57	10.68	32
MBY12CR/MBY12VCR	12	26.0	22.0			16.0	22.50						98.06	42	42
MBY14CR/MBY14VCR	14	29.0	23.5	10.0	20	19.0	26.00						133.37	14.80	60
MBY15CR/MBY15VCR	15	33.0	26.0	12.0	19	20.0	28.00						172.59	33.73	86
MBY16CR/MBY16VCR	16	35.0	30.5	14.0	21	21.5	31.80						228.49	45.99	120
MBY18CR/MBY18VCR	18	38.0	33.0	14.5	15	23.5	32.00	0.8		2.0		1.5	238.30	49.32	135
MBY20CR/MBY20VCR	20	40.0	35.5	15.5	18	25.0	35.00	1.0					279.48	56.38	155
MBY22CR/MBY22VCR	22	44.0				29.0	38.80						308.90		200

Notes

1. MBY - CR & MBY - VCR weights are similar.
2. Made to order only.

(3) For below 4mm in Bore size, bearings are without lubrication grooves.

4. Radial Clearance All Size: 0.051mm MAX

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	~3	~6	~10	~18	~30
H7 Tolerance (μm)	+10 0	+12 0	+15 0	+18 0	+21 0

BM

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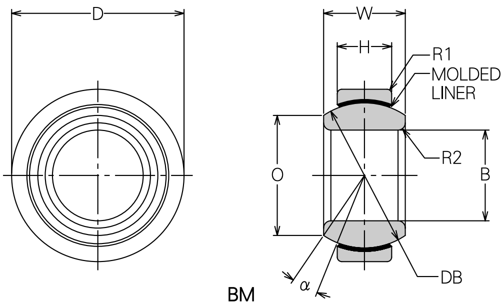
SPHERICAL | MOLD TYPE | MINELON®

Materials

RACE	Bearing Steel / Heat Treated / Black Oxide Treated
BALL	Bearing Steel / Heat Treated / Chrome Plated
MOULDED LINER	Minelon®



Dimensions in mm

MINEBEA Part No.	ϕB	ϕD	W 0 −0.12	H 0 −0.24	ϕO Ref.	R1 ±0.2	R2 ±0.2	α (deg.)	SϕDB Ref.	No Load Rotational Breakaway Torque N・m	Radial Clearance mm	Radial Static Limit Load kN	Axial Static Limit Load kN	Dynamic Load kN	Approx. Weight g
BM10	10	19	9	6	13.1	0.5	0.8	12	16.0	0	0.03MAX	22.55	8.38	0.50	10
BM12	12	22	10	7	15.3	0.8		10	18.0	0.03MAX {0.35kgf・cmMAX}		30.89	11.47	0.72	15
BM15	15	26	12	9	18.7			8	22.0	0.06MAX {0.58kgf・cmMAX}	0.05MAX	46.77	17.35	1.15	25
BM17	17	30	14	10	21.2	1.0		10	25.0			59.03	21.86	1.36	40
BM20	20	35	16	12	23.7			9	29.0			72.47	26.87	1.58	62
BM25	25	42	20	16	29.3			7	35.5	0.11MAX {1.15kgf・cmMAX}		103.26	38.24	1.93	102

Notes

① Operating temperature range: −50 ℃〜+100 ℃

② Dynamic Load Ratings: Cd

1. Reversing & Alternating Load
   Dynamic Load Ratings shall be reduced by half from the values given in the table under the use of reversing and alternating load condition.
2. Factor of Operating Temperature and Sliding Speed
   Dynamic Load Ratings shall be determined by formula below under the use of High-Temperature and Sliding-Speed condition.
   Cdt・v=ft・fv・Cd
   Cdt・v: Dynamic Load Ratings under the use of High-Temperature and Sliding speed.
   ft: Coefficient of Temperature
   fv: Coefficient of Sliding speed

Table 1

Temp. ℃	〜40	〜60	〜80	〜100
ft	1.0	0.95	0.8	0.6

Table 2

Sliding Speed m/min	〜0.3	〜0.4	〜0.5	〜0.6	〜0.7	〜0.8	〜0.9	〜1.1	〜1.5	〜2.5
fv	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1

③ Static Load Ratings: Cs

1. Dynamic Load Ratings shall be reduced to one-thirds of the values given in the table under the use of that High-Load will be applied con-tiniously or periodically and be reduced to one-sixth of the values given under Reversing and Alternating Load and Impact Load conditions.
2. Factor of Operating Temperature
   Dynamic Load Ratings shall be determined by formula below under the use of High-Temperature conditions.
   Cs・t=ft・Cs
   Cs・t: Dynamic Load Ratings under the use of High-Temperature condition.
   ft: Coefficient of Temperature
   Cs: Static Load given in the table

Table 3

Temp. ℃	〜30	〜40	〜60	〜80	〜90	〜100
ft	1.0	0.95	0.85	0.6	0.5	0.3

④ Thrust Load: Pt
Please use thrust load in the range, which does not exceed the thrust load (Table 1 application under temperature environment) from catalogue, and "1/3 of Actual radial Load."

○ Please consult MINEBEA for availability of bearings in this series.

Tolerances

Measure range		Ball permitted tolerances Bm		Ball permitted tolerances B		Race permitted tolerances Dm		Race permitted tolerances D		permitted tolerances of Ball width W		permitted tolerances of Race width H	
Over	Under	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
—	10	0	−0.008	+0.002	−0.010	—	—	—	—	0	−0.120	0	−0.240
10	18	0	−0.008	+0.003	−0.011	—	—	—	—	0	−0.120	0	−0.240
18	30	0	−0.010	+0.003	−0.013	0	−0.009	+0.005	−0.014	0	−0.120	0	−0.240
30	50	0	−0.012	+0.003	−0.015	0	−0.011	+0.008	−0.019	0	−0.120	0	−0.240

Bm & Dm indicate averages of I.D. & O.D..

2 PIECE ROD END BEARING 〔SELF-LUBRICATING〕

RBT-E

ROD END MALE | SELF-LUBRICATING | 2 PIECE

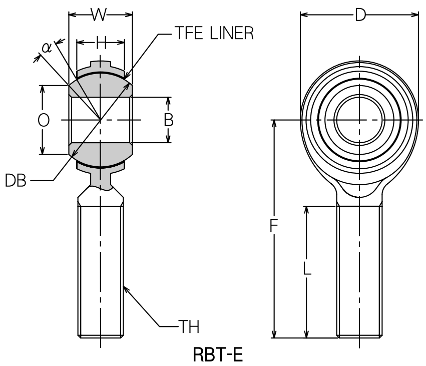
Materials

BODY	303 Stainless Steel
BALL	440C Stainless Steel
LINER	Teflon / Fabric

Description of Types

RBT D L xx E T

- T → No Letter Indicates Standard Breakaway Torque; Letter "T" Indicates Low Breakaway Torque
- xx → Bearing Bore Code
- L → No Letter Indicates Right Hand Thread; Letter "L" Indicates Left Hand Thread
- D → For X-1276 LINER add suffix "D"
- RBT … E → Basic Part No.



RBT-E

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.50	W 0 − 0.13	H ± 0.3	F ± 0.5	TH JIS Class 2	L ± 0.7	α (deg.)	φO Ref.	SφDB Ref.	Radial Static Limit Load kN	Static Ultimate Load kN	Approx. Weight g
RBT3E	3	12	6	4.50	27	M3 × 0.5	15	11	6.8	9.04	0.41	1.66	6
RBT4E	4	14	7	5.25	30	M4 × 0.7	17	12	7.6	10.32	0.60	2.45	10
RBT5E	5	16	8	6.00	33	M5 × 0.8	20		8.8	11.91	0.98	3.92	12
RBT6E	6	18	9	6.75	36	M6 × 1.0	22	10	11.1	14.29	1.44	5.78	19
RBT8E	8	22	12	9.00	42	M8 × 1.25	25	12	12.7	17.46	2.69	10.78	32
RBT10E	10	26	14	10.50	48	M10 × 1.5	29		15.2	20.64	4.16	16.67	54
RBT12E	12	30	16	12.00	54	M12 × 1.75	33		17.6	23.81	5.88	23.53	85
RBT14E	14	34	19	13.50	60	M14 × 2.0	36	14	19.2	26.99	6.61	26.47	126
RBT15E	15	36	20	14.50	63		38	13	21.5	29.37	8.09	32.36	150
RBT16E	16	38	21	15.00	66	M16 × 2.0	40	15	19.4	28.58	8.33	33.34	185
RBT18E	18	42	23	16.50	72	M18 × 1.5	44	15	21.9	31.75	11.52	46.09	258
RBT20E	20	46	25	18.00	78	M20 × 1.5	47	14	24.4	34.93	12.01	48.05	340
RBT22E	22	50	28	20.00	84	M22 × 1.5	51	15	25.8	38.10	13.48	53.93	435
RBT25E	25	56	31	22.00	94	M24 × 2.0	57		29.6	42.86	17.40	69.62	730
RBT28E	28	62	35	24.00	103	M27 × 2.0	62	17	32.3	47.63	20.83	83.35	1000
RBT30E	30	66	37	25.00	110	M30 × 2.0	66		34.8	50.80	24.76	99.04	1320

Notes

1. Teflon liner permanently bonded to Body I.D.
2. Oscillation load shall be kept within the static load range, as Teflon liner load endurance is greater than body breaking load.
3. Made to order only. (from RBT15E to RBT30E)
4. No Load Rotational Breakaway Torque.
   Standard All Size: 0.02 ～ 0.34N・m
   Low Torque All Size: 0.02N・m MAX
   (Radial Clearance 0.05mm MAX)

○ Please consult MINEBEA for availability of bearings in this series.

Bore size	～3	～6	～10	～18	～30
H7 Tolerance (μm)	+10 0	+12 0	+15 0	+18 0	+21 0

2 PIECE ROD END BEARING 〔SELF-LUBRICATING〕

RBT

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ROD END FEMALE | SELF-LUBRICATING | 2 PIECE

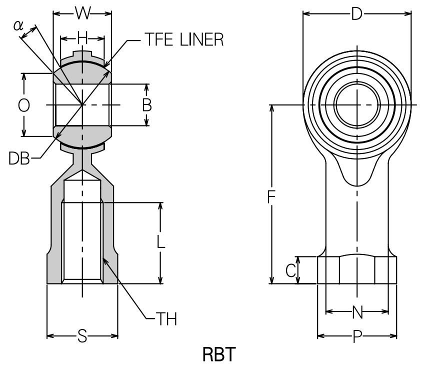
Materials

BODY 303 Stainless Steel
BALL 440C Stainless Steel
LINER Teflon / Fabric

Description of Types

RBT D L xx T

- T: No Letter Indicates Standard Breakaway Torque; Letter "T" Indicates Low Breakaway Torque
- xx: Bearing Bore Code
- L: No Letter Indicates Right Hand Thread; Letter "L" Indicates Right Hand Thread
- D: For X-1276 LINER add suffix "D"
- RBT: Basic Part No.



RBT

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.5	W 0 − 0.13	H ± 0.3	F ± 0.5	TH JIS Class 2	L ± 0.7	φN ± 0.5	φP ± 0.5	C ± 0.7	S ± 0.25	α (deg.)	φO Ref.	SφDB Ref.	Radial Static Limit Load kN	Static Ultimate Load kN	Approx. Weight g
RBT3	3	12	6	4.50	21	M3 × 0.5	10.0	6.5	8.0	3.0	7	11	6.8	9.04	0.41	1.66	10
RBT4	4	14	7	5.25	24	M4 × 0.7	12.0	8.0	9.5	4.0	8	12	7.6	10.32	0.60	2.45	12
RBT5	5	16	8	6.00	27	M5 × 0.8	12.5	9.0	11.0		9		8.8	11.91	0.98	7.84	16
RBT6	6	18	9	6.75	30	M6 × 1.0	13.5	10.0	13.0	5.0	11	10	11.1	14.29	1.44	8.62	25
RBT8	8	22	12	9.00	36	M8 × 1.25	16.0	12.5	16.0		14	12	12.7	17.46	2.69	11.76	43
RBT10	10	26	14	10.50	43	M10 × 1.5	19.5	15.0	19.0	6.5	17		15.2	20.64	4.16	16.67	72
RBT12	12	30	16	12.00	50	M12 × 1.75	24.0	17.5	22.0		19		17.6	23.81	5.88	23.53	107
RBT14	14	34	19	13.50	57	M14 × 2.0	27.0	20.0	25.0	8.0	22	14	19.2	26.99	6.61	26.47	160
RBT15	15	36	20	14.50	61		30.0	21.0	26.0			13	21.5	29.37	8.09	32.36	185
RBT16	16	38	21	15.00	64	M16 × 2.0	33.0	22.0	27.0			15	19.4	28.58	8.33	33.34	210
RBT18	18	42	23	16.50	71	M18 × 1.5	36.0	25.0	31.0	10.0	27	15	21.9	31.75	11.52	46.09	295
RBT20	20	46	25	18.00	77	M20 × 1.5	40.0	27.5	34.0		30	14	24.4	34.93	12.01	48.05	380
RBT22	22	50	28	20.00	84	M22 × 1.5	43.0	30.0	37.0	12.0	32	15	25.8	38.10	13.48	53.93	490
RBT25	25	56	31	22.00	94	M24 × 2.0	48.0	33.5	42.0		36		29.6	42.86	17.40	69.62	870
RBT28	28	62	35	24.00	103	M27 × 2.0	53.0	37.5	46.0		41	17	32.3	47.63	20.83	83.35	1180
RBT30	30	66	37	25.00	110	M30 × 2.0	56.0	40.0	50.0	15.0			34.8	50.80	24.76	99.04	1450

Notes

1. Teflon liner permanently bonded to race I.D.
2. Oscillation load shall be kept within the static load range, as Teflon liner load endurance is greater than body breaking load.
3. Made to order only. (from RBT15 to RBT30)
4. No Load Rotational Breakaway Torque.
   Standard All Size: 0.02 ～ 0.34N・m
   Low Torque All Size: 0.02N・m MAX
   (Radial Clearance 0.05mm MAX)

○ Please consult MINEBEA for availability of bearings in this series.

Bore size	～ 3	～ 6	～ 10	～ 18	～ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

HRT-E

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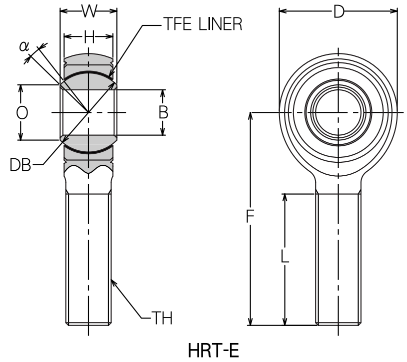
MALE ROD ENDS | **SELF-LUBRICATING** | **3 PIECE**

Materials

	HRT-E	HRT-ECR
BODY	Chromium-Molybdenum Steel Zinc Plated	SUS630 Stainless Steel Passivated
RACE	410 Stainless Steel / Heat Treated	410 Stainless Steel / Heat Treated
BALL	440C Stainless Steel / Heat Treated	440C Stainless Steel / Heat Treated
LINER	Teflon / Fabric	Teflon / Fabric



Description of Types

HRT D L xx E CR T

- T: No Letter Indicates Standard Breakaway Torque; Letter "T" Indicates Low Breakaway Torque
- CR: No Letter Indicates Chromium-Molybdenum Steel; Letter "CR" Indicates SUS630 for Body
- E: Basic Part No.
- xx: Bearing Bore Code
- L: No Letter Indicates Right Hand Thread; Letter "L" Indicates Left Hand Thread
- D: For X-1276 LINER add suffix "D"
- HRT: Basic Part No.

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.50	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	α (deg.)	φO Ref.	SφDB Ref.	No Load Rotational Breakaway Torque N・m Standard	Static Limit Load kN(3) Radial	Static Limit Load kN(3) Axial (2)	Radial Static Ultimate Load (3) kN	Fatigue Load (3) kN	Approx. Weight g
HRT3E	3	16.0	7.0	5.25	30.0	M3 × 0.5	10.0	18	5.2	8.73	0.06 ～ 0.68 {0.6 ～ 6.9kgf・cm}	3.62	1.96	4.51	0.73	25
HRT4E	4	18.0	9.5	7.75	35.0	M4 × 0.7	16.0	16	5.8	11.11		6.27	3.53	7.84	1.27	30
HRT5E	5	20.5	11.0	8.75	39.5	M5 × 0.8	22.0	15	7.8	13.49		10.29	5.09	12.84	2.10	35
HRT6E	6					M6 × 1.0						14.51		18.14	2.99	
HRT8E	8	23.0		8.25	46.0	M8 × 1.25	29.0	14	10.9	15.48	0.12 ～ 1.13 {1.2 ～ 11.5kgf・cm}	26.77	5.29	33.44	5.54	40
HRT10E	10	26.0	12.5	10.75	47.0	M10 × 1.5		8	12.2	17.46		37.65	6.76	47.07	7.84	65
HRT12E	12	34.0	16.0	13.25	62.0	M12 × 1.75	37.0	10	15.4	22.22		62.46	8.33	78.06	12.94	126
HRT14E	14	36.0	17.0	14.25	64.0	M14 × 2.0	38.0	8	18.9	25.40		82.96	9.02	103.65	17.25	140
HRT15E	15	38.0	18.0		65.0			11	19	26.19		100.71	9.70	125.81	20.98	165
HRT16E	16	39.0	19.0	15.25	66.5	M16 × 2.0	39.5	10	19.2	26.99						195
HRT17E	17	41.0	20.0		72.5	M16 × 1.5	42.0	12	20.4	28.58		101.40	10.29	126.70	21.08	220
HRT18E	18	43.0		16.30	79.5	M18 × 1.5	46.0	10				120.62	12.16	150.72	25.10	250
HRT20E	20	45.0	22.0		83.0	M20 × 1.5	50.0	13	22.9	31.75		121.30	12.84	151.61	25.20	290
HRT22E	22	52.0		19.30	86.0	M22 × 1.5	51.0	6	27.1	34.92	0.23 ～ 1.80 {2.3 ～ 18.4kgf・cm}	156.21	15.10	195.25	32.55	450
HRT25E	25	70.0	35.0	25.30	105.0	M24 × 2.0	59.0	15	32.3	47.62		300.08	20.88	375.10	62.56	1150
HRT28E	28	75.0			110.0	M27 × 2.0	62.0	14	36.8	50.80		283.70	23.24	354.60	59.13	1500
HRT30E	30	78.0	37.0	26.30	120.0	M30 × 2.0	65.0		40.4	54.77		271.93	24.81	339.89	56.68	1800

Notes

1. Teflon liner permanently bonded to race I.D.
(2) Axial load indicates either the smaller value of static load or proof load.
(3) Special specification can bare higher fatigue load.
4. Made to order only.
5. No Load Rotational Breakaway Torque.
   Low Torque All Size: 0.02N・m MAX
   (Radial Clearance 0.05mm MAX)

○ Please consult MINEBEA for availability of bearings in this series.

Bore size	～ 3	～ 6	～ 10	～ 18	～ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

3 PIECE ROD END BEARINGS 〔SELF-LUBRICATING〕

HRT

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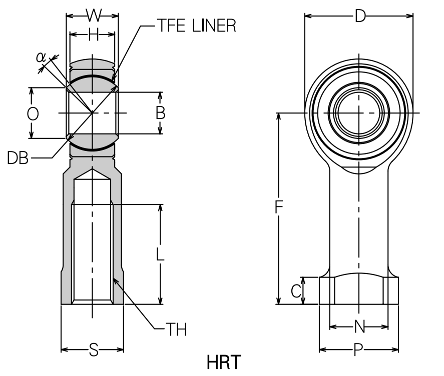
ROD END FEMALE | SELF-LUBRICATING | 3 PIECE

Materials

	HRT	HRT-CR
BODY	Chromium-Molybdenum Steel Zinc Plated	SUS630 Stainless Steel Passivated
RACE	410 Stainless Steel / Heat Treated	410 Stainless Steel / Heat Treated
BALL	440C Stainless Steel / Heat Treated	440C Stainless Steel / Heat Treated
LINER	Teflon / Fabric	Teflon / Fabric



Description of Types

HRT D L xx CR T

- T: No Letter Indicates Standard Breakaway Torque / Letter "T" Indicates Low Breakaway Torque
- CR: No Letter Indicates Chromium-Molybdenum Steel / Letter "CR" Indicates SUS630 for Body
- xx: Bearing Bore Code
- L: No Letter Indicates Right Hand Thread / Letter "L" Indicates Left Hand Thread
- D: For X-1276 LINER add suffix "D"
- HRT: Basic Part No.

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	φN ± 0.5	φP ± 0.5	C + 0.2 − 0.7	S ± 0.25	α (deg.)	φO Ref.	SφDB Ref.	No Load Rotational Breakaway Torque N・m	Static Limit Load kN(3)		Radial Static Ultimate Load (3) kN	Fatigue Load (3) kN	Approx. Weight g
															Standard	Radial	Axial (2)			
HRT3	3	16.0	7.0	5.25	30.0	M3 × 0.5	16	7.0	9	3.5	8	18	5.2	8.73	0.06 ～ 0.68 {0.6 ～ 6.9kgf・cm}	14.70	1.96	30.89	5.14	29
HRT4	4	18.0	9.5	7.75	32.0	M4 × 0.7		8.5	11		10	16	5.8	11.11		31.38	3.53	43.34	7.15	35
HRT5	5	20.5	11.0	8.75	35.0	M5 × 0.8	19	10.8	15	4.5	12	15	7.8	13.49		27.94	5.09	34.91	5.78	40
HRT6	6	20.5			37.0	M6 × 1.0														
HRT8	8	23.0		8.25	41.0	M8 × 1.25	22	12.5	17	6.5	14	14	10.9	15.48	0.12 ～ 1.13 {1.2 ～ 11.5kgf・cm}	34.02	5.29	42.46	7.06	51
HRT10	10	26.0	12.5	10.75	46.0	M10 × 1.5	24	14.0	19		15	8	12.2	17.46		37.65	6.76	47.07	7.84	73
HRT12	12	34.0	16.0	13.25	57.0	M12 × 1.75	32	18.5	24		20	10	15.4	22.22		78.06	8.33	97.57	16.18	150
HRT14	14	36.0	17.0	14.25	60.0	M14 × 2.0	33	19.0		7.5		8	18.9	25.40		82.96	9.02	103.65	17.25	165
HRT15	15	38.0	18.0		62.0		34	20.0	25	8.5	21	11	19.0	26.19		95.32	9.31	119.15	19.80	189
HRT16	16	39.0	19.0	15.25	63.5	M16 × 2.0	35	22.0	27	9.5	23	10	19.2	26.99		100.71	9.70	125.81	20.98	218
HRT17	17	41.0	20.0		68.0	M16 × 1.5	37	23.0	28		24	12	20.4	28.58		101.40	10.29	126.70	21.08	241
HRT18	18	43.0		16.30	74.0	M18 × 1.5	40	24.0	30	10.0	26	10				120.62	12.16	150.72	25.10	283
HRT20	20	45.0	22.0		76.0	M20 × 1.5	41	25.0			26	13	22.9	31.75		121.30	12.84	151.61	25.20	330
HRT22	22	52.0		19.30	85.0	M22 × 1.5	47	28.0	36	12.0	30	6	27.1	34.92	0.23 ～ 1.80 {2.3 ～ 18.4kgf・cm}	156.21	15.10	195.25	32.55	580
HRT25	25	70.0	35.0	25.30	105.0	M24 × 2.0	54	42.0	50	14.0	43	15	32.3	47.62		302.43	20.88	378.04	63.05	1230
HRT28	28	75.0			110.0	M27 × 2.0	58	44.0	56	15.0	47	14	36.8	50.80		283.70	23.24	354.60	59.13	1620
HRT30	30	78.0	37.0	26.30	120.0	M30 × 2.0	62	48.0	60	16.0	51		40.4	54.77		271.93	24.81	339.89	56.68	1930

Notes

1. Teflon liner permanently bonded to race I.D.
(2) Axial load indicates either the smaller value of static load or proof load.
(3) Select Type "CR" for higher load capability.
4. Made to order only.
5. No Load Rotational Breakaway Torque.
   Low Torque All Size: 0.02N・m MAX
   (Radial Clearance 0.05mm MAX)

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	～ 3	～ 6	～ 10	～ 18	～ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

HR-E

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MALE ROD ENDS | METAL TO METAL | 3 PIECE

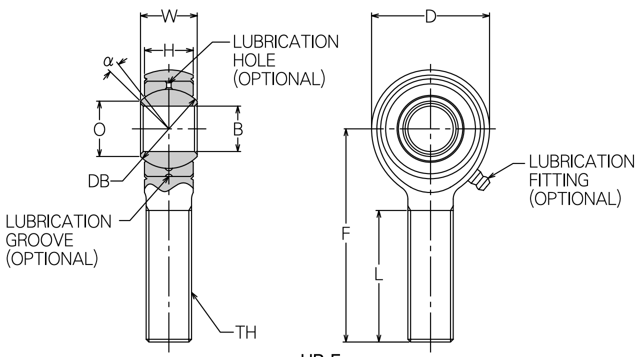
Materials

	HR-E	HR-ECR
BODY	Chromium-Molybdenum Steel Zinc Plated	SUS630 Stainless Steel Passivated
RACE	410 Stainless Steel / Heat Treated	410 Stainless Steel / Heat Treated
BALL	Bearing Steel / Chrome Plated	Bearing Steel / Heat Treated

Description of Types

HR L xx E CR F

- F: For Zerk Type Lubrication Fitting Add Suffix "F" to Part No. e.g.HR5EF
  For Flush Type Lubrication Fitting Add Suffix "FN" to Part No. e.g. HR5EFN
  For JIS ST'D Type (A-M6F) Lubriltion Fitting Add Suffix "FAS" to Part No.
  e.g. HR5EFAS
- CR: No Letter Indicates Chromium-Molybdenum Steel
  Letter "CR" Indicates SUS630 for Body
- xx: Bearing Bore Code
- L: No Letter Indicates Right Hand Thread
  Letter "L" Indicates Left Hand Thread
- HR, E: Basic Part No.



HR-E

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	α (deg.)	φO Ref.	SφDB Ref.	Static Limit Load kN Radial	Static Limit Load kN Axial (1)	Radial Static Ultimate Load kN	Fatigue Load (2) kN	Approx. Weight g
HR3E	3	16.0	7.0	5.25	30.0	M3 × 0.5	10.0	18	5.2	8.73	3.62	2.94	4.51	0.73	25
HR4E	4	18.0	9.5	7.75	35.0	M4 × 0.7	16.0	16	5.8	11.11	6.27	3.53	7.84	1.27	30
HR5E	5	20.5	11.0	8.75	39.5	M5 × 0.8	22.0	15	7.8	13.49	10.29	5.09	12.84	2.10	35
HR6E	6					M6 × 1.0					14.51		18.14	2.99	
HR8E	8	23.0		8.25	46.0	M8 × 1.25	29.0	14	10.9	15.48	26.77	5.58	33.44	5.54	40
HR10E	10	26.0	12.5	10.75	47.0	M10 × 1.5		8	12.2	17.46	37.65	6.76	47.07	7.84	65
HR12E	12	34.0	16.0	13.25	62.0	M12 × 1.75	37.0	10	15.4	22.22	62.46	8.33	78.06	12.94	126
HR14E	14	36.0	17.0	14.25	64.0	M14 × 2.0	38.0	8	18.9	25.40	82.96	9.02	103.65	17.25	140
HR15E	15	38.0	18.0		65.0			11	19.0	26.19	85.90	9.31	107.38	17.84	165
HR16E	16	39.0	19.0	15.25	66.5	M16 × 2.0	39.5	10	19.2	26.99	100.71	9.70	125.81	20.98	195
HR17E	17	41.0	20.0		72.5	M16 × 1.5	42.0	12	20.4	28.58	101.40	10.29	126.70	21.08	220
HR18E	18	43.0		16.30	79.5	M18 × 1.5	46.0	10			120.62	12.16	150.72	25.10	250
HR20E	20	45.0	22.0		83.0	M20 × 1.5	50.0	13	22.9	31.75	121.30	12.84	151.61	25.20	290
HR22E	22	52.0		19.30	86.0	M22 × 1.5	51.0	6	27.1	34.92	156.21	15.10	195.25	32.55	450
HR25E	25	70.0	35.0	25.30	105.0	M24 × 2.0	59.0	15	32.3	47.62	300.08	20.88	375.10	62.56	1150
HR28E	28	75.0			110.0	M27 × 2.0	62.0	14	36.8	50.80	283.70	23.24	354.60	59.13	1500
HR30E	30	78.0	37.0	26.30	120.0	M30 × 2.0	65.0		40.4	54.77	271.93	24.81	339.89	56.68	1800

Notes

(1) Axial load indicates either the smaller value of static load or proof load.
(2) Special specification can bare higher fatigue load.
3. Made to order only.
4. Radial clearance All Size: 0.051mm MAX
◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	～3	～6	～10	～18	～30
H7 Tolerance (μm)	+10 0	+12 0	+15 0	+18 0	+21 0

3 PIECE ROD END BEARING 〔METAL TO METAL〕

HR

ROD END FEMALE	METAL TO METAL	3 PIECE

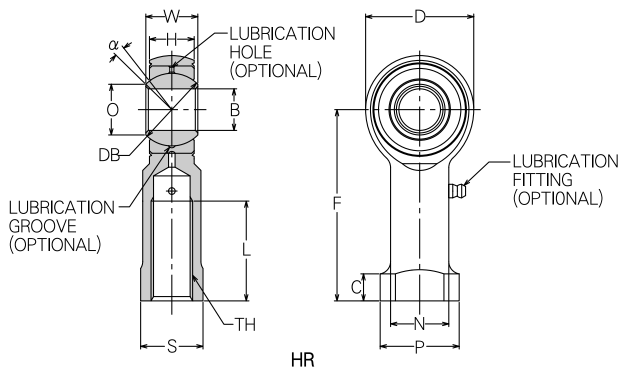
Materials

	HR	HR-CR
BODY	Chromium-Molybdenum Steel Zinc Plated	SUS630 Stainless Steel Passivated
RACE	Stainless Steel / Heat Treated	Stainless Steel / Heat Treated
BALL	Bearing Steel / Chrome Plated	Stainless Steel / Heat Treated

Description of Types

HR L xx CR F

- F: For Zerk type lubrication fitting add suffix "F" to part No. e.g. HR5F
  For Flush type lubrication fitting add suffix "FN" to part No. e.g. HR5FN
  For JIS ST'D type(A-M6F) lubrication fitting add suffix "FAS" to part No. e.g. HR5FAS
- CR: No Letter Indicates Chromium-Molybdenum Steel
  Letter "CR" Indicates SUS630 for Body
- xx: Bearing Bore Code
- L: No Letter Indicates Right Hand Thread
  Letter "L" Indicates Left Hand Thread
- HR: Basic Part No.



HR

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	φN ± 0.5	φP ± 0.5	C + 0.2 − 0.1	S ± 0.25	α (deg.)	φO Ref.	SφDB Ref.	Static Limit Load kN		Radial Static Ultimate Load kN	Fatigue Load (2) kN	Approx. Weight g
															Radial	Axial (1)			
HR3	3	16.0	7.0	5.25	30.0	M3 × 0.5	16	7.0	9	3.5	8	18	5.2	8.73	22.45	2.94	30.89	5.14	29
HR4	4	18.0	9.5	7.75	32.0	M4 × 0.7		8.5	11		10	16	5.8	11.11	34.71	3.53	43.34	7.15	35
HR5	5	20.5	11.0	8.75	35.0	M5 × 0.8	19	10.8	15	4.5	12	15	7.8	13.49	27.94	5.09	34.91	5.78	40
HR6	6				37.0	M6 × 1.0													
HR8	8	23.0		8.25	41.0	M8 × 1.25	22	12.5	17	6.5	14	14	10.9	15.48	34.02	5.58	43.44	7.06	51
HR10	10	26.0	12.5	10.75	46.0	M10 × 1.5	24	14.0	19		15	8	12.2	17.46	37.65	6.76	47.07	7.84	73
HR12	12	34.0	16.0	13.25	57.0	M12 × 1.75	32	18.5	24		20	10	15.4	22.22	78.06	8.33	97.57	16.18	150
HR14	14	36.0	17.0	14.25	60.0	M14 × 2.0	33	19.0		7.5		8	18.9	25.40	82.96	9.02	103.65	17.25	165
HR15	15	38.0	18.0		62.0		34	20.0	25	8.5	21	11	19.0	26.19	95.32	9.31	119.15	19.80	189
HR16	16	39.0	19.0	15.25	63.5	M16 × 2.0	35	22.0	27	9.5	23	10	19.2	26.99	100.71	9.70	125.81	20.98	218
HR17	17	41.0	20.0		68.0	M16 × 1.5	37	23.0	28	9.5	24	12	20.4	28.58	101.40	10.29	126.70	21.08	241
HR18	18	43.0		16.30	74.0	M18 × 1.5	40	24.0	30	10.0	26	10			120.62	12.16	150.72	25.10	283
HR20	20	45.0	22.0		76.0	M20 × 1.5	41	25.0				13	22.9	31.75	121.30	12.84	151.61	25.20	330
HR22	22	52.0		19.30	85.0	M22 × 1.5	47	28.0	36	12.0	30	6	27.1	34.92	156.21	15.10	195.25	32.55	580
HR25	25	70.0	35.0	25.30	105.0	M24 × 2.0	54	42.0	50	14.0	43	15	32.3	47.62	300.08	20.88	378.04	63.05	1230
HR28	28	75.0			110.0	M27 × 2.0	58	44.0	56	15.0	47	14	36.8	50.80	283.70	23.24	354.60	59.13	1620
HR30	30	78.0	37.0	26.30	120.0	M30 × 2.0	62	48.0	60	16.0	51		40.4	54.77	271.93	24.81	339.89	56.68	1930

Notes

(1) Axial load indicates either the smaller value of static load or proof load.

(2) Special specification can bare higher fatigue load.

3. Made to order only.

4. Radial Clearance All Size: 0.051mm MAX

○ Please consult MINEBEA for availability of bearings in this series.

Bore size	～ 3	～ 6	～ 10	～ 18	～ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

4 PIECE ROD END BEARING 〔METAL TO METAL〕

PR-E

ROD END MALE | METAL TO METAL | 4 PIECE

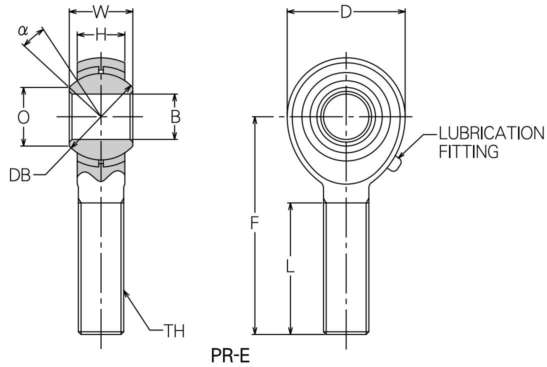
Materials

BODY Low Carbon Steel / Zinc Plated
INSERT Copper Alloy
BALL Bearing Steel / Chrome Plated

Description of Types

PR L xx E N Y

- Y: No Letter indicates standard radial clearance. Letter "Y" indicates low radial clearance
- N: No Letter Indicates standard. Rod ends without lubrication fitting are available. Specify by adding suffix "N" to part No.
- xx: Bearing Bore Code
- L: No Letter Indicates Right Hand Thread. Letter "L" Indicates Left Hand Thread
- PR, E: Basic Part No.



Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	α (deg.)	φO Ref.	SφDB Ref.	Radial Static Limit Load kN	Static Ultimate Load kN	Approx. Weight g
PR3E (1)	3	12	6	4.50	27	M3 × 0.5	15	14	5.2	7.94	1.56	2.45	7
PR4E (1)	4	14	7	5.25	30	M4 × 0.7	17	13	6.5	9.52	2.25	3.53	10
PR5E	5	16	8	6.00	33	M5 × 0.8	20		7.7	11.11	4.51	7.06	13
PR6E	6	18	9	6.75	36	M6 × 1.0	22		9.0	12.70	6.37	9.90	19
PR8E	8	22	12	9.00	42	M8 × 1.25	25	14	10.4	15.88	13.72	21.47	32
PR10E	10	26	14	10.50	48	M10 × 1.5	29	13	12.9	19.05	18.82	29.41	54
PR12E	12	30	16	12.00	54	M12 × 1.75	33		15.4	22.22	25.20	39.42	85
PR14E	14	34	19	13.50	60	M14 × 2.0	36	16	16.9	25.40	30.49	47.75	126
PR16E	16	38	21	15.00	66	M16 × 2.0	40	15	19.4	28.58	38.04	59.64	185
PR18E	18	42	23	16.50	72	M18 × 1.5	44		21.9	31.75	46.28	72.47	258
PR20E	20	46	25	18.00	78	M20 × 1.5	47	14	24.4	34.92	53.83	84.33	340
PR22E	22	50	28	20.00	84	M22 × 1.5	51	15	25.8	38.10	63.93	100.22	435

Notes

(1) Lubrication fitting are not available for PR3E, PR4E.

2. Radial Clearance
 Standard Clearance: 0.051mm MAX
 Low Clearance: 0.030mm MAX

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	~ 3	~ 6	~ 10	~ 18	~ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

4 PIECE ROD END BEARING 〔METAL TO METAL〕

PR

Minebea eMINEBEA.COM

ROD END FEMALE	METAL TO METAL	4 PIECE

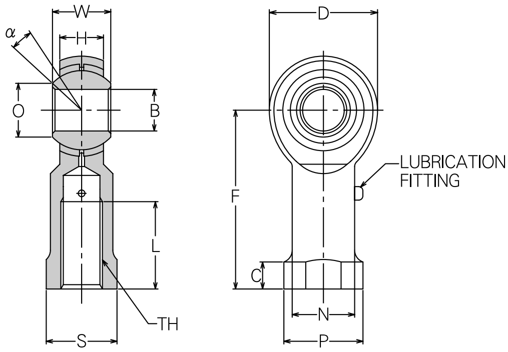
Materials

BODY Low Carbon Steel / Zinc Plated
INSERT Copper Alloy
BALL Bearing Steel / Chrome Plated

Description of Types

PR L xx N Y

- Y: No Letter indicates standard radial clearance. Letter "Y" indicates low radial clearance
- N: Rod ends without lubrication fitting are available. Specify by adding suffix "N" to part No.
- xx: Bearing Bore Code
- L: No Letter Indicates Right Hand Thread. Letter "L" Indicates Left Hand Thread
- PR: Basic Part No.



Dimensions in mm

MINEBEA Part No.	ϕB H7	ϕD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	ϕN ± 0.5	ϕP ± 0.5	C + 0.2 − 0.7	S ± 0.25	α (deg.)	ϕO Ref.	SϕDB Ref.	Radial Static Limit Load kN	Static Ultimate Load kN	Approx. Weight g
PR3 (1)	3	12	6	4.50	21	M3 × 0.5	10	6.5	8.0	3.0	7	14	5.2	7.94	4.60	7.15	9
PR4 (1)	4	14	7	5.25	24	M4 × 0.7	12	8.0	9.5	4.0	8	13	6.5	9.52	5.68	8.82	13
PR5	5	16	8	6.00	27	M5 × 0.8	14	9.0	11.0		9		7.7	11.11	7.84	12.25	17
PR6	6	18	9	6.75	30	M6 × 1.0		10.0	13.0	5.0	11		9.0	12.70	8.82	13.82	25
PR8	8	22	12	9.00	36	M8 × 1.25	17	12.5	16.0		14	14	10.4	15.88	13.63	21.28	43
PR10	10	26	14	10.50	43	M10 × 1.5	21	15.0	19.0	6.5	17	13	12.9	19.05	18.82	29.41	72
PR12	12	30	16	12.00	50	M12 × 1.75	24	17.5	22.0		19		15.4	22.22	25.20	39.42	107
PR14	14	34	19	13.50	57	M14 × 2.0	27	20.0	25.0	8.0	22	16	16.9	25.40	30.49	47.75	160
PR16	16	38	21	15.00	64	M16 × 2.0	33	22.0	27.0			15	19.4	28.58	38.04	59.64	210
PR18	18	42	23	16.50	71	M18 × 1.5	36	25.0	31.0	10.0	27		21.9	31.75	46.28	72.47	295
PR20	20	46	25	18.00	77	M20 × 1.5	40	27.5	34.0		30	14	24.4	34.92	53.83	84.33	380
PR22	22	50	28	20.00	84	M22 × 1.5	43	30.0	37.0	12.0	32	15	25.8	38.10	63.93	100.22	490

Notes

(1) Lubrication fitting are not available for PR3, PR4.

2. Radial Clearance
   Standard Clearance: 0.051mm MAX
   Low Clearance: 0.030mm MAX

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	~ 3	~ 6	~ 10	~ 18	~ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

MOLDED ROD END BEARING 〔SELF-LUBRICATING〕

RBM-E

ROD END BEARING | MOLDED | MINELON TN

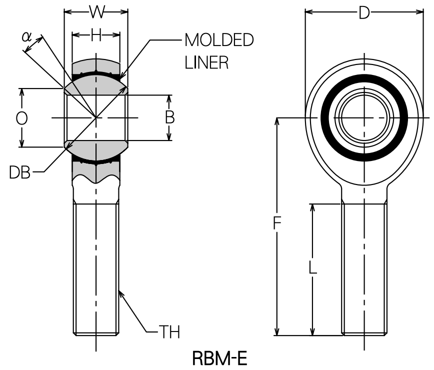
Materials

BODY Low Carbon Steel / Zinc Plated
BALL Bearing Steel / Heat Treated / Chrome Plated
LINER Minelon TN

Description of Types

RBM L xx E

- xx → Bearing Bore Code
- L → No Letter Indicates Right Hand Thread; Letter "L" Indicates Left Hand Thread
- RBM → Basic Part No.



RBM-E

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	α (deg.)	φO Ref.	SφDB Ref.	No Load Rotational Breakaway Torque N・m	Radial Clearance mm	Radial Static Limit Load kN	Dynamic Load kN	Approx. Weight g
RBM5E	5	16	8	6.00	33	M5 × 0.8	20	13	7.7	11.11	0.04MAX {0.4kgf・cmMAX}	0.03MAX	3.62	1.90	12
RBM6E	6	18	9	6.75	36	M6 × 1.0	22	13	9.0	12.70			5.05	2.17	20
RBM8E	8	22	12	9.00	42	M8 × 1.25	25	14	10.4	15.88	0.06MAX {0.6kgf・cmMAX}	0.05MAX	9.16	3.48	35
RBM10E	10	26	14	10.50	48	M10 × 1.5	29		12.9	19.05			14.61	5.14	55
RBM12E	12	30	16	12.00	54	M12 × 1.75	33	13	15.4	22.22	0.12MAX {1.2kgf・cmMAX}		18.14	6.52	90
RBM14E	14	34	19	13.50	60	M14 × 2.0	36	16	16.9	25.40	0.34MAX {3.5kgf・cmMAX}		24.02	8.72	130
RBM16E	16	38	21	15.00	66	M16 × 2.0	40	15	19.4	28.58			28.43	10.49	185
RBM18E	18	42	23	16.50	72	M18 × 1.5	44		21.9	31.75			35.79	13.23	250
RBM20E	20	46	25	18.00	78	M20 × 1.5	47		24.4	34.92	0.57MAX {5.8kgf・cmMAX}		41.18	15.39	310
RBM22E	22	50	28	20.00	84	M22 × 1.5	51		25.9	38.10			50.01	18.73	400

Notes

① Operating temperature range: − 50 ℃～＋ 100 ℃

② Dynamic Load Ratings: Cd

1. Reversing & Alternating Load
Dynamic Load Ratings shall be reduced by half from the values given in the table under the use of reversing and alternating load condition.

2. Factor of Operating Temperature and Sliding Speed
Dynamic Load Ratings shall be determined by formula below under the use of High-Temperature and Sliding-Speed condition.
Cdt・v=ft・fv・Cd
Cdt・v: Dynamic Load Ratings under the use of High-Temperature and Sliding speed.
ft: Coefficient of Temperature
fv: Coefficient of Sliding speed

③ Static Load Ratings: Cs

1. Dynamic Load Ratings shall be reduced to one-thirds of the values given in the table under the use of that High-Load will be applied continiously or periodically and be reduced to one-sixth of the values given under Reversing and Alternating Load and Impact Load conditions.

2. Factor of Operating Temperature
Dynamic Load Ratings shall be determined by formula below under the use of High-Temperature conditions.
Cs・t=ft・Cs
Cs・t: Dynamic Load Ratings under the use of High-Temperature condition.
ft: Coefficient of Temperature
Cs: Static Load given in the table

Table 1

Temp. ℃	～ 40	～ 60	～ 80	～ 100
ft	1.0	0.95	0.8	0.6

Table 2

Sliding Speed m/min	～ 0.3	～ 0.4	～ 0.5	～ 0.6	～ 0.7	～ 0.8	～ 0.9	～ 1.1	～ 1.5	～ 2.5
fv	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1

Table 3

Temp. ℃	～ 30	～ 40	～ 60	～ 80	～ 90	～ 100
ft	1.0	0.95	0.85	0.6	0.5	0.3

○ Please consult MINEBEA for availability of bearings in this series.

Bore size	～ 3	～ 6	～ 10	～ 18	～ 30
H7 Tolerance (μm)	＋ 10 0	＋ 12 0	＋ 15 0	＋ 18 0	＋ 21 0

MOLDED ROD END BEARING 〔SELF-LUBRICATING〕

RBM

ROD END BEARING FEMALE | MOLDED | MINELON TN

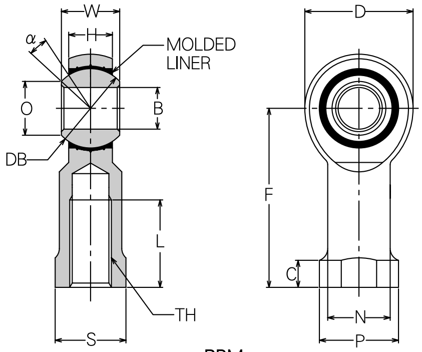
Materials

BODY Low Carbon Steel / Zinc Plated
BALL Bearing Steel / Heat Treated / Chrome Plated
LINER Minelon

Description of Types

RBM L xx

- xx → Bearing Bore Code
- L → No Letter Indicates right hands / Letter "L" Indicates left hands
- RBM → Basic Part No.



RBM

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	φN ± 0.5	φP ± 0.5	C + 0.2 − 0.7	S ± 0.25	α (deg.)	φO Ref.	SφDB Ref.	No Load Rotational Breakaway Torque N・m	Radial Clearance mm	Radial Static Limit Load kN	Dynamic Load kN	Approx. Weight g
RBM5	5	16	8	6.00	27	M5 × 0.8	14	9.0	11	4.0	9	13	7.7	11.11	0.04MAX {0.4kgf・cmMAX}	0.03MAX	5.98	1.90	16
RBM6	6	18	9	6.75	30	M6 × 1.0		10.0	13	5.0	11		9.0	12.70			7.55	2.17	25
RBM8	8	22	12	9.00	36	M8 × 1.25	17	12.5	16		14	14	10.4	15.88	0.06MAX {0.6kgf・cmMAX}	0.05MAX	10.29	3.48	45
RBM10	10	26	14	10.50	43	M10 × 1.5	21	15.0	19	6.5	17		12.9	19.05			14.61	5.14	75
RBM12	12	30	16	12.00	50	M12 × 1.75	24	17.5	22		19	13	15.4	22.22	0.12MAX {1.2kgf・cmMAX}		18.14	6.52	120
RBM14	14	34	19	13.50	57	M14 × 2.0	27	20.0	25	8.0	22	16	16.9	25.40	0.34MAX {3.5kgf・cmMAX}		24.02	8.72	160
RBM16	16	38	21	15.00	64	M16 × 2.0	33	22.0	27			15	19.4	28.58			28.43	10.49	220
RBM18	18	42	23	16.50	71	M18 × 1.5	36	25.0	31	10.0	27		21.9	31.75			35.79	13.23	300
RBM20	20	46	25	18.00	77	M20 × 1.5	40	27.5	34		30		24.4	34.92	0.57MAX {5.8kgf・cmMAX}		41.18	15.39	380
RBM22	22	50	28	20.00	84	M22 × 1.5	43	30.0	37	12.0	32		25.9	38.10			50.01	18.73	480

Notes

① Operating temperature range: − 50 ～＋ 100 ℃

② Dynamic Load Ratings: Cd

1. Reversing & Alternating Load
Dynamic Load Ratings shall be reduced by half from the values given in the table under the use of reversing and alternating load condition.

2. Factor of Operating Temperature and Sliding Speed
Dynamic Load Ratings shall be determined by formula below under the use of High-Temperature and Sliding-Speed condition.
Cdt・v=ft・fv・Cd
Cdt・v: Dynamic Load Ratings under the use of High-Temperature and Sliding speed.
ft: Coefficient of Temperature
fv: Coefficient of Sliding speed

Table 1

Temp. ℃	～ 40	～ 60	～ 80	～ 100
ft	1.0	0.95	0.8	0.6

Table 2

Sliding Speed m/min	～ 0.3	～ 0.4	～ 0.5	～ 0.6	～ 0.7	～ 0.8	～ 0.9	～ 1.1	～ 1.5	～ 2.5
fv	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1

③ Static Load Ratings: Cs

1. Dynamic Load Ratings shall be reduced to one-thirds of the values given in the table under the use of that High-Load will be applied continiously or periodically and be reduced to one-sixth of the values given under Reversing and Alternating Load and Impact Load conditions.

2. Factor of Operating Temperature
Dynamic Load Ratings shall be determined by formula below under the use of High-Temperature conditions.
Cs・t=ft・Cs
Cs・t: Dynamic Load Ratings under the use of High-Temperature condition.
ft: Coefficient of Temperature
Cs: Static Load given in the table

Table 3

Temp. ℃	～ 30	～ 40	～ 60	～ 80	～ 90	～ 100
ft	1.0	0.95	0.85	0.6	0.5	0.3

○ Please consult MINEBEA for availability of bearings in this series.

Bore size	～ 3	～ 6	～ 10	～ 18	～ 30
H7 Tolerance (μm)	+ 10 0	+ 12 0	+ 15 0	+ 18 0	+ 21 0

SLEEVE BEARING 〔SELF-LUBRICATING〕

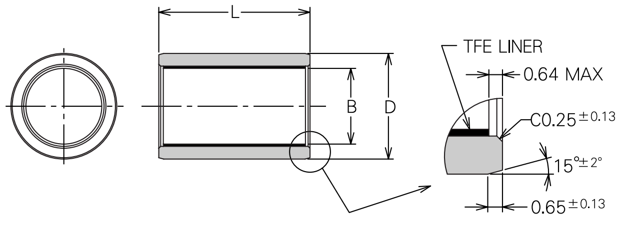
MJ-A,MJ-C

SLEEVE BEARING | TFE LINED | PLAIN TYPE

eMINEBEA.COM

Materials

	MJ-A	MJ-C
SLEEVE	Aluminium Alloy Anodised or Alodined	410 Stainless Steel
LINER	TFE	TFE



MJ-A
MJ-C

Description of Types

MJ xx x xx

- xx → Length Code
- x → Material Code (A, C)
- xx → Bore Code
- MJ → Basic Part No.

Dimensions in mm

MINEBEA Part No.	φB 0 − 0.025	φD (2)	WEIGHT g ALUMINIUM	STAINLESS STEEL
MJ06	6.035	10	0.14 × L	0.40 × L
MJ08	8.035	11	0.13 × L	0.35 × L
MJ09	9.035	13	0.20 × L	0.54 × L
MJ10	10.035	14	0.21 × L	0.59 × L
MJ12	12.035	16	0.25 × L	0.69 × L
MJ14	14.035	18	0.28 × L	0.79 × L
MJ16	16.035	20	0.32 × L	0.89 × L
MJ18	18.035	22	0.35 × L	0.98 × L
MJ20	20.035	24	0.39 × L	1.08 × L
MJ22	22.035	27	0.54 × L	1.51 × L
MJ25	25.035	30	0.61 × L	1.69 × L
MJ28	28.035	33	0.67 × L	1.87 × L
MJ32	32.035	37	0.76 × L	2.12 × L
MJ35	35.035	40	0.82 × L	2.30 × L
MJ38	38.035	45	1.28 × L	3.57 × L
MJ40	40.035	48	1.55 × L	4.33 × L
MJ45	45.035	51	1.26 × L	3.54 × L
MJ50	50.035	57	1.64 × L	4.60 × L

Notes

1. Teflon liner permanently bonded to Sleeve I.D.

(2) (a) Tolerances:
Aluminium ± 0.013
Stainless steel 0 to − 0.013
I.D. Size shall be inspected by plug Gauge.

3. Made to order only.

◯ Please consult MINEBEA for availability of bearings in this series.

Dimensions in mm

MINEBEA Part No.	L (± 0.2)											(± 0.3)															(± 0.5)														
	05	06	07	08	09	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
MJ06	5	6	7	8	9	10																																			
MJ08	5	6	7	8	9	10	12	14																																	
MJ09	5	6	7	8	9	10	12	14	16	18	20																														
MJ10	5	6	7	8	9	10	12	14	16	18	20	22	24																												
MJ12	5	6	7	8	9	10	12	14	16	18	20	22	24	26																											
MJ14	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30																									
MJ16	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34																							
MJ18	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36																						
MJ20	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38																					
MJ22	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44																		
MJ25	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50															
MJ28				8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60										
MJ32				8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60										
MJ35						10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70					
MJ38						10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70					
MJ40									16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
MJ45									16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
MJ50									16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80

SLEEVE BEARING 〔SELF-LUBRICATING〕

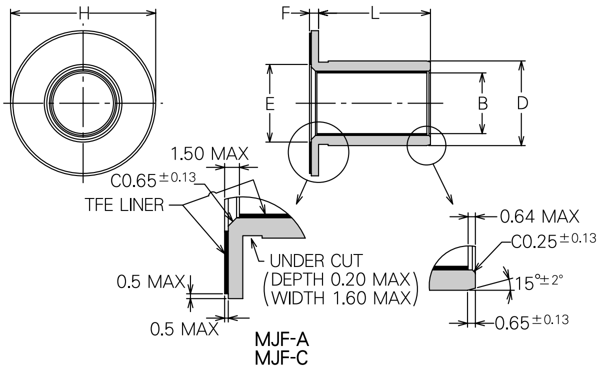
MJF-A,MJF-C

SLEEVE | **SELF-LUBRICATING** | **FLANGED**

Minebea eMINEBEA.COM

Materials

	MJF-A	MJF-C
SLEEVE	Aluminium Alloy Anodised or Alodined	410 Stainless Steel
LINER	TFE	TFE



Description of Types

MJF XX X XX

- XX → Length Code
- X → Material Code (A, C)
- XX → Bore Code
- MJF → Basic Part No.

Dimensions in mm

MINEBEA Part No.	φB 0 − 0.025	φD (2)	F 0 − 0.13	φH 0 − 0.5	φE 0 − 0.5	WEIGHT g ALUMINIUM	WEIGHT g STAINLESS STEEL
MJF06	6.035	10		19	8.5	1.08 + 0.14 × L	3.01 + 0.40 × L
MJF08	8.035	11		20	10.5	1.11 + 0.13 × L	3.11 + 0.35 × L
MJF09	9.035	13		22	11.5	1.33 + 0.20 × L	3.73 + 0.54 × L
MJF10	10.035	14		24	12.5	1.57 + 0.21 × L	4.40 + 0.59 × L
MJF12	12.035	16		25	14.5	1.59 + 0.25 × L	4.45 + 0.69 × L
MJF14	14.035	18	1.5	28	16.5	1.94 + 0.28 × L	5.43 + 0.79 × L
MJF16	16.035	20		32	18.5	2.53 + 0.32 × L	7.10 + 0.89 × L
MJF18	18.035	22		35	20.5	2.97 + 0.35 × L	8.33 + 0.98 × L
MJF20	20.035	24		38	22.5	3.44 + 0.39 × L	9.65 + 1.08 × L
MJF22	22.035	27		41	24.5	3.95 + 0.54 × L	11.06 + 1.51 × L
MJF25	25.035	30		45	27.5	4.62 + 0.61 × L	12.94 + 1.69 × L
MJF28	28.035	33		48	30.5	8.35 + 0.67 × L	23.40 + 1.87 × L
MJF32	32.035	37		50	34.5	8.11 + 0.76 × L	22.72 + 2.12 × L
MJF35	35.035	40		54	37.5	9.29 + 0.82 × L	26.03 + 2.30 × L
MJF38	38.035	45	2.5	57	40.5	9.91 + 1.28 × L	27.79 + 3.57 × L
MJF40	40.035	48		60	42.5	10.99 + 1.55 × L	30.79 + 4.33 × L
MJF45	45.035	51		64	47.5	11.37 + 1.26 × L	31.88 + 3.54 × L
MJF50	50.035	57		70	52.5	13.18 + 1.64 × L	36.94 + 4.60 × L

Notes

1. Teflon liner permanently bonded to sleeve I.D.

(2) (a) Tolerances:
Aluminium ± 0.013
Stainless steel 0 to − 0.013
I.D. Size shall be inspected by plug Gauge.

3. Made to order only.

◯ Please consult MINEBEA for availability of bearings in this series.

Dimensions in mm

MINEBEA Part No.	L																																								
	(± 0.2)											(± 0.3)															(± 0.5)														
	05	06	07	08	09	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
MJF06	5	6	7	8	9	10																																			
MJF08	5	6	7	8	9	10	12	14																																	
MJF09	5	6	7	8	9	10	12	14	16	18	20																														
MJF10	5	6	7	8	9	10	12	14	16	18	20	22	24																												
MJF12	5	6	7	8	9	10	12	14	16	18	20	22	24	26																											
MJF14	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30																									
MJF16	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34																							
MJF18	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36																						
MJF20	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38																					
MJF22	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44																		
MJF25	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50															
MJF28				8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60										
MJF32				8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60										
MJF35						10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70					
MJF38						10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70					
MJF40									16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
MJF45									16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
MJF50									16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80

BALL ROD END BEARING 〔LUBRICATED〕

PBR-EFN

ROD END MALE | BALL INSERT | LOW TORQUE

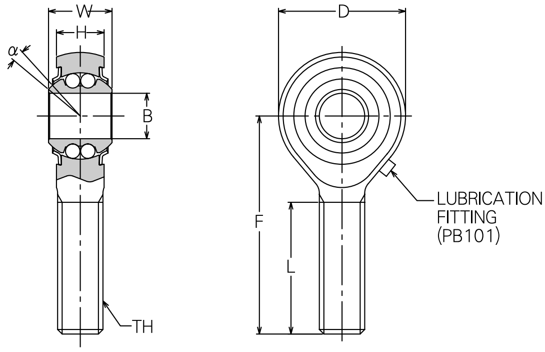
Materials

BODY	Chrome Molydbenum Steel / Zinc Plated
INNER RACE	Bearing Steel / Chrome Plated
BALL	Bearing Steel

Description of Types

PBR L xx EFN

- xx → Bearing Bore Code
- L → No Letter Indicates Right Hand Thread; Letter "L" Indicates Left Hand Thread
- PBR → Basic Part No.



PBR-EFN

Dimensions in mm

MINEBEA Part No.	φB H7	φD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	α (deg.)	Basic Static Limit Load kN	Basic Dynamic Limit Load kN	Approx. Weight g
PBR5EFN	5	18	8	6.75	33	M5 × 0.8	16	5.5	0.42	1.15	16
PBR6EFN	6	20	9	6.75	36	M6 × 1.0	22	8.0	0.64	2.74	19
PBR8EFN	8	24	12	9.00	42	M8 × 1.25	25	8.5	1.00	4.00	36
PBR10EFN	10	28	14	10.50	48	M10 × 1.5	29	8.0	1.44	4.45	60
PBR12EFN	12	32	16	12.00	54	M12 × 1.75	33	7.5	1.79	4.95	87
PBR14EFN	14	36	19	13.50	60	M14 × 2.0	36	6.0	2.00	5.59	135
PBR16EFN	16	42	21	15.00	66	M16 × 2.0	40	8.0	2.34	6.24	190
PBR18EFN	18	46	23	16.50	72	M18 × 1.5	44	8.5	2.89	7.10	270
PBR20EFN	20	50	25	18.00	78	M20 × 1.5	47	7.0	3.45	7.90	338
PBR22EFN	22	54	28	20.00	84	M22 × 1.5	51	8.0	3.98	9.29	450
PBR25EFN	25	64	31	22.00	94	M24 × 2.0	57	5.0	5.67	11.03	572
PBR30EFN	30	70	37	25.00	110	M30 × 2.0	66	7.5	7.45	14.15	992

Notes

1. Made to order only.
2. Lubrication: MIL-PRF-23827 (yellow) grease
3. Radial Clearance All Size: 0.010mm MAX

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	～3	～6	～10	～18	～30
H7 Tolerance (μm)	+ 10 / 0	+ 12 / 0	+ 15 / 0	+ 18 / 0	+ 21 / 0

BALL ROD END BEARING 〔LUBRICATED〕

PBR-FN

ROD END FEMALE | BALL INSERT | LOW TORQUE

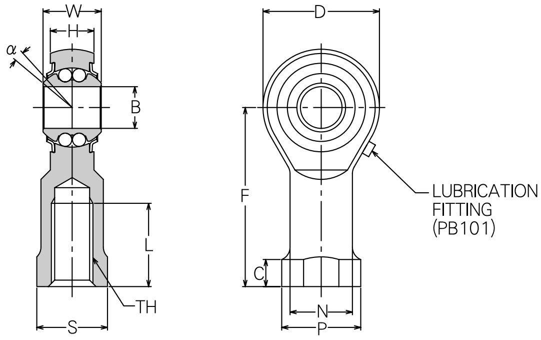
Materials

BODY Chrome Molydbenum Steel / Zinc Plated
INNER RACE Bearing Steel / Chrome Plated
BALL Bearing Steel

Description of Types

PBR L xx FN

- xx → Bearing Bore Code
- L → No Letter Indicates Right Hand Thread; Letter "L" Indicates Left Hand Thread
- PBR … FN → Basic Part No.



PBR-FN

Dimensions in mm

MINEBEA Part No.	ϕB H7	ϕD ± 0.5	W 0 − 0.13	H ± 0.13	F ± 0.5	TH JIS Class 2	L ± 0.7	ϕN ± 0.5	ϕP ± 0.5	C + 0.2 − 0.7	S ± 0.25	α (deg.)	Basic Static Limit Load kN	Basic Dynamic Limit Load kN	Approx. Weight g
PBR5FN	5	18	8	6.75	27	M5 × 0.8	14	9.0	11	4.0	9	5.5	0.42	1.15	20
PBR6FN	6	20	9	6.75	30	M6 × 1.0	12	10.0	13	5.0	11	8.0	0.64	2.74	24
PBR8FN	8	24	12	9.00	36	M8 × 1.25	16	12.5	16		14	8.5	1.00	4.00	44
PBR10FN	10	28	14	10.50	43	M10 × 1.5	20	15.0	19	6.5	17	8.0	1.44	4.45	72
PBR12FN	12	32	16	12.00	50	M12 × 1.75	22	17.5	22		19	7.5	1.79	4.95	107
PBR14FN	14	36	19	13.50	57	M14 × 2.0	25	20.0	25	8.0	22	6.0	2.00	5.59	160
PBR16FN	16	42	21	15.00	64	M16 × 2.0	28	22.0	27			8.0	2.34	6.24	224
PBR18FN	18	46	23	16.50	71	M18 × 1.5	32	25.0	31	10.0	27	8.5	2.89	7.10	293
PBR20FN	20	50	25	18.00	77	M20 × 1.5	33	27.5	34		30	7.0	3.45	7.90	367
PBR22FN	22	54	28	20.00	84	M22 × 1.5	37	30.0	38	12.0	32	8.0	3.98	9.29	480
PBR25FN	25	64	31	22.00	94	M24 × 2.0	42		35	10.0	30	5.0	5.67	11.03	602
PBR30FN	30	70	37	25.00	110	M30 × 2.0	51	40.0	50	15.0	41	7.5	7.45	14.15	978

Notes

1. Made to order only.
2. Lubrication: MIL-PRF-23827 (yellow) grease
3. Radial Clearance All Size: 0.010mm MAX

◯ Please consult MINEBEA for availability of bearings in this series.

Bore size	~ 3	~ 6	~ 10	~ 18	~ 30
H7 Tolerance (μm)	+ 10 / 0	+ 12 / 0	+ 15 / 0	+ 18 / 0	+ 21 / 0

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