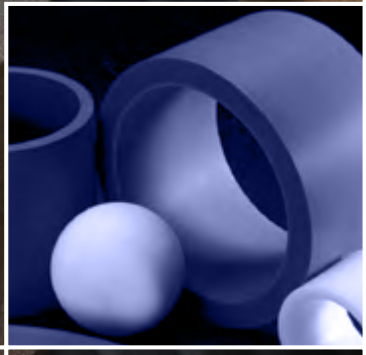
CoorsTek
Amazing Solutions.®



TETRALON® POLYMER BUSHINGS & BEARINGS

www.coorstek.com

Table of Contents

Established in 1910, **CoorsTek** is an industry leader in the design and manufacture of high-performance ceramic and non-metallic materials and components.

CoorsTek El Segundo, established in 1956 as a PTFE processor and precision machining company, evolved into a highly technical organization credited with major breakthroughs in the areas of sealing and bearing technology.

Our products are used in a variety of industrial, medical, aerospace, aircraft and process equipment applications.

A selection of over 100 proprietary Tetralon materials are formulated to offer superior performance in specific applications ranging from cryogenic to high temperature, hard vacuum to high pressure.

Our staff of design and application engineers offer extensive experience in the field of high-performance material applications in seal bearing and machined component environments.

For over fifty years, our design and materials expertise has offered engineers and designers a cost effective approach to optimum performance in component design.

Tetralon® Bearing Manual
General Information

Tetralon Bearings
The Tetralon family of bearing materials are designed to meet or exceed component performance requirements in a vast array of application areas. Tetralon bearings offer component design and performance solutions in most applications burdened by temperature extremes, high friction and wear, corrosion or lubrication problems.

Design Flexibility
Tetralon materials offer temperature capabilities from -400 °F to + 550 °F and compressive strengths from 1,000 to over 50,000 psi. Tetralon bearings are formulated to meet specific application needs and substrate hardness requirements. Whether it's plastic, aluminum, stainless steel, or hardened steel, there's a Tetralon bearing for the application.

Lubrication Free Operation
In most applications, Tetralon bearings are designed to run dry – offering the design engineer the freedom to eliminate costly lubrication systems. In lubricated applications, Tetralon bearings offer superior performance by eliminating unacceptable wear rates associated with start up and where stick slip is a problem.

Cost Effective
In addition to offering space and weight reductions, Tetralon bearings reduce system costs when compared to the material, hardware, lubrication, and maintenance costs of metallic plane and rolling element bearings.

Application Solutions
Tetralon bearings offer superior performance in vacuum environments, corrosive media, non-lubricating liquids, and high-humidity applications. Custom compounding of our materials provides advanced friction, wear, thermal, and electrical properties. Whether high or low speed, high or low load, conductive or insulative, Tetralon materials can be formulated to meet or exceed critical property requirements.

In choosing the appropriate Tetralon Bearing, the critical parameters of the application must first be determined. Bearing load, speed, temperature, mating surface, dynamic function, etc. all play an essential part in component performance. The more important criteria are described below and their values are listed in the Design Criteria chart (page 8.8).

Load

The ability of a bearing to carry load is dependent upon the material and its deformation under stress, hardware deflections, and clearances. An important factor for the design of a load-carrying bearing is the Bearing Load – measured in pounds per square inch (psi). It is calculated by dividing the total load (in pounds) the bearing is carrying by the projected area (ID x length, in inches) see figure below. This gives the average pressure (psi) the bearing must support. Expressed as a formula:

$$BL[psi] = \frac{Load[lb]}{ID[in] * L[in]}$$

This calculation may be reversed to find the minimum axial length of the bearing, given that a material has been chosen from CoorsTek offerings found on page 8.8.

This can be done by dividing the product of the estimated load applied to the bearing and the factor of safety (2 to 3 is recommended) by the product of the Max P (from table on page 8.8) and the bearing ID. Expressed as a formula:

$$L\ min[in] = \frac{FS * Load[lb]}{P[psi] * ID[in]}$$

Bearing Load Sample Calculation:

If the load the bearing carries is 1500 lb. and the rod diameter is 1.5 inches and 0.266 inches in length, the bearing load is then

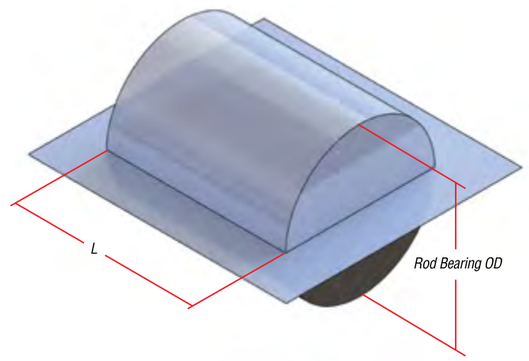
$$BL = \frac{1500}{1.5 * 0.267} = 3745\ psi$$

Bearing Length Sample Calculation

If the load the bearing carries is 1500 lbs. and the rod diameter is 1.5 inches and the material of interest is Tetralon 930, with a maximum pressure of 7500 (from table on page 8.8) then

$$L = \frac{2 * 1500}{7500 * 1.5} = 0.267\ in.$$

0.267 in. is the minimum length a bearing shall have based on the given conditions.



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Tetralon® Bearing Manual
Bearing Design Principles & Performance Features

Speed

Bearing speed is determined by first calculating the circumference of the shaft in inches and multiplying by the RPM of the shaft and dividing by 12 to determine the surface feet per minute (SFM). This gives the speed or surface velocity of the shaft and, in turn, determines the SFM requirement of the bearing. Tetralon bearings are generally limited to 400 feet per minute under dry, low-load operation. Liquid cooling or lubrication will significantly increase these limits.

Bearing PV

Bearing PV is the product of operating pressure and surface velocity, defined as P x V = PV. Simply stated, it is a measure of the work the bearing is doing. While it is not the definitive answer, PV is a valuable general guide when considering bearing materials for a specific application.

Shaft Hardness and Surface Finish

Tetralon bearings are designed to operate against various surfaces with minimum hardness and finish requirements. Although exceptions can be made in some application areas, these requirements should be followed to ensure the material's dynamic properties and predicted wear rate.

Friction

Tetralon bearings utilize custom, proprietary base resin compounds and fillers. As such, Tetralon materials exhibit very low friction in dry running application and extremely low friction and wear properties in lubricated service. These properties are unique to these types of materials and give Tetralon bearings their smooth start/stop and long-life characteristics. Tetralon materials include specially designed fillers to reduce friction in dynamic surfaces, which in turn, reduces the heat generation and hence inhibits material degradation. The use of lubricants can further diminish wear and friction and are recommended for use, with the exception of greases with higher percentages of solid-filler content. When using lubrication, it is recommended to design “feeding channels“ on the hardware, such as holes or channels on shafts or rods and channels on bores or bearing grooves.

Lubrication

Tetralon bearing materials are compatible with most commercially available lubricants. The preferred lubricant is grease with its various fillers, followed by hydraulic oil. As mentioned in the preceding paragraph, greases with higher percentages of solid-filler content are generally not recommended for use for lubrication in bearing applications. Careful and considerable testing should be taken under consideration when the bearing material comes in contact with water and water-based liquids, such as in hydraulic pump bearings and/or hydraulic turbine shaft bearings.

Wear

Tetralon bearings are self lubricating due to a characteristic of the materials known as boundary lubrication. During start up, a limited quantity of bearing material is transferred into the surface finish of the mating surface. After initial break in of the bearing, the wear rate levels out as the dynamic interface becomes saturated with the Tetralon's internal boundary lubricant. Under recommended application parameters, extremely long bearing life is possible.

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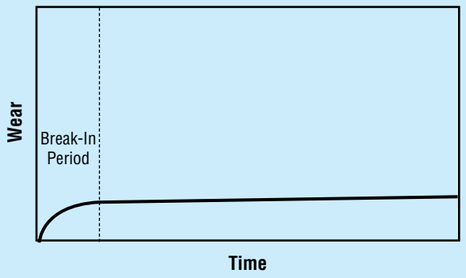
For continuous dry running service, Tetralon bearings are capable of operating at PV values up to approximately 20,000. The Radial Wear chart shows wear rates of Tetralon 921 as a function of time at various PV values. For intermittent or short duration operation, higher PV values can be used. Use of lubricants or cooling fluids also permit higher PV values.

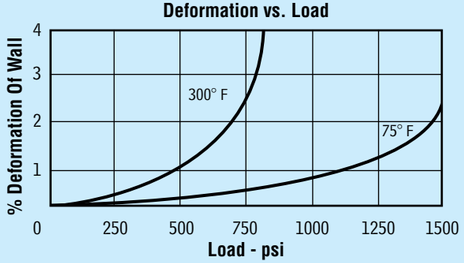
Typical Wear Behavior - Tetralon Bearings



Load

Actual deformation is function of wall thickness, temperature, and load. Because the wall thickness of the Tetralon affects deformation under load, load limits can be increased by using thin-wall bearings such as Tetraliner or Tetralon Bonded Bearings. In cases of extreme-load conditions, Tetralon T should be considered. Contact CoorsTek Engineering if your application has a bearing load greater than 1000 psi.

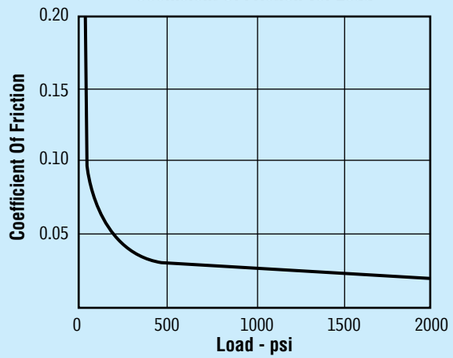
Tetralon 921
Deformation vs. Load



Friction

As shown in the friction vs. load chart below, friction decreases rapidly with the increase of load in most Tetralon materials. Because the start up and low speed friction is extremely low, stick-slip is virtually non-existent. This makes them ideal for start/stop and oscillating applications. When lubricated with grease or oil, Tetralon bearings exhibit a coefficient of friction in the 0.01 to 0.08 range.

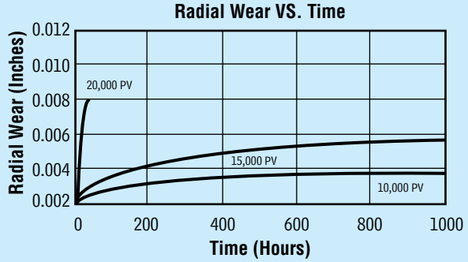
Tetralon 921
Coefficient Of Friction vs. Load



Speed

Tetralon bearings are generally limited to 400 feet per minute under dry (see page 8.5 for calculation), low-load operation. Higher speeds are possible with lubricants or liquid coolants.

Tetralon 921
Radial Wear VS. Time



Tetralon® Bearing Manual
Bearing Design Principles & Performance Features

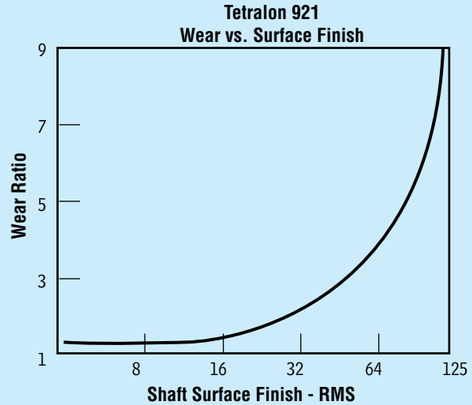
Mating Surface

Performance is enhanced when the hardest possible running surface is utilized. Mild or cold rolled steel is acceptable in most cases. Softer shaft materials such as plastics, brass, aluminum or stainless steel should use the Tetralon bearing materials specifically formulated for that purpose.

Surface Finish

Optimum performance is achieved with a surface finish in the 8-16 rms range. However, due to the transfer process associated with most Tetralon bearings, acceptable performance can be obtained with finishes up to a 32 rms in some applications.

Tetralon 921
Wear vs. Surface Finish



Bearing Failure

Under extreme loads, speeds, elevated temperatures, or severe shaft misalignment problems, Tetralon bearings will not shatter, but can deform. This performance feature eliminates sudden catastrophic breakdowns and possible damage to hardware and other components.

Corrosion Resistance

Most Tetralon bearing materials are unaffected by acids, bases, and solvents. To insure proper application, contact CoorsTek Technical Support to review chemical compatibility issues.

RECOMMENDED DESIGN PARAMETERS

Material Code	Temperature °F	Max PV* (continuous)	Max P (psi, static)	Max V (low load) spm	Shaft Hardness	Shaft Finish	Shaft Material
Tetralon 920	-400/+550	10,000	1,000	400	Rc35	8 -16 rms	6
Tetralon 921	-400/+550	10,000	1,000	400	Rc35	8 -16 rms	6
Tetralon 922	-40/+200	3,000	1,000	100	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 923	-400/+550	10,000	1,000	400	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 924	-400/+550	10,000	1,000	400	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 925	-400/+550	10,000	1,000	400	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 926	-40/+180	4,000	1,200	50	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 927	-400/+550	17,000	1,000	400	Rb25	8 -16 rms	1,2,3,4,6,7
Tetralon 928	-400/+550	10,000	1,000	400	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 929	-400/+550	18,000	800	400	Rc35	8 -16 rms	1,2,3,6,7
Tetralon 930	-400/+550	7,500	7,500	400	Rb25	8 -16 rms	1 - 8
Tetralon 931	-400/+550	10,000	1,000	400	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 932	-400/+550	10,000	1,000	400	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 933	-400/+550	10,000	1,000	400	Rb25	8 -16 rms	1,2,3,6,7
Tetralon 934	-400/+550	10,000	1,000	400	Rc35	8 -16 rms	6,7
Tetralon 935†	-40/+250	20,000	50,000**	100	Rb25	8 -16 rms	1,2,3,6,7

*PV units: psi ft/min, **Designates compressive strength at yield, †See tech data on page 8.12

Shaft Material Guide

(1) 316 stainless steel (3) 304 stainless steel (5) plastic (7) mild steel
(2) 303 stainless steel (4) non-ferrous (6) steel (8) aluminum

Look up the materials section for further information about the wide variety of CoorsTek materials offerings.

Our highly experienced Design team is ready to analyze your bearing application and provide material, product, and technical recommendations for use. A simple call to CoorsTek will allow you to speak directly with industry experts to guide you with dimensioning calculations.

Please call the CoorsTek Design team when electrical insulation is required in your application for material use suggestions.

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A simple and cost effective approach to bearing design, the CoorsTek Tetraliner offers superior bearing performance at a relatively low cost. Originally designed for use in automated packaging equipment, the Tetraliner reduces component cost by reducing the amount of material in the bearing.

Although lower in cost, the Tetraliner Bearing offers the same or better dynamic surface performance as thicker wall section bearings but with lower deformation, improved heat transfer and easy replacement. With a continuous, unlubricated operation rating of up to 20,000 PV and intermittent service to 50,000 PV, the Tetraliner Bearing is the cost effective solution to many application dilemmas.

Tetraliner Bearings can be retained without shells by designing undercuts in the housing or shaft shoulders. Or by various shell materials and configurations including metals, plastics, and bearing-grade composites.

Tetraliner Design Criteria

Tetraliner Bearings can be supplied as standards or easily designed using the following criteria:

1. Determine P (psi)
   As a guide,1000 psi is recommended with 2000 psi being the maximum pressure at room temperature.

2. Determine Tetraliner thickness according to shaft diameter, per the following table

Rod Diameter Bore Diameter	Tetraliner Thickness	Tetraliner Width	Groove Width Min.	Groove Width Max.
¼ to ¾	0.030	0.125	0.130	0.140
¾ to 1	0.030	0.188	0.193	0.203
1 to 1½	0.030	0.250	0.255	0.265
1½ to 2½	0.040	0.313	0.318	0.328
2½ to 6	0.060	0.375	0.380	0.390
6 to 12	0.093	0.438	0.443	0.453
12 to 36	0.125	1.000	1.005	1.015

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3. Determine Tetraliner length, in inches, using the following formulas:
   a. Rod configuration:
      $L = (Ørod + h) * 0.99\ \pi - 0.34$
   b. Piston configuration:
      $L = (Øbore - h) * 0.99\ \pi - 0.34$

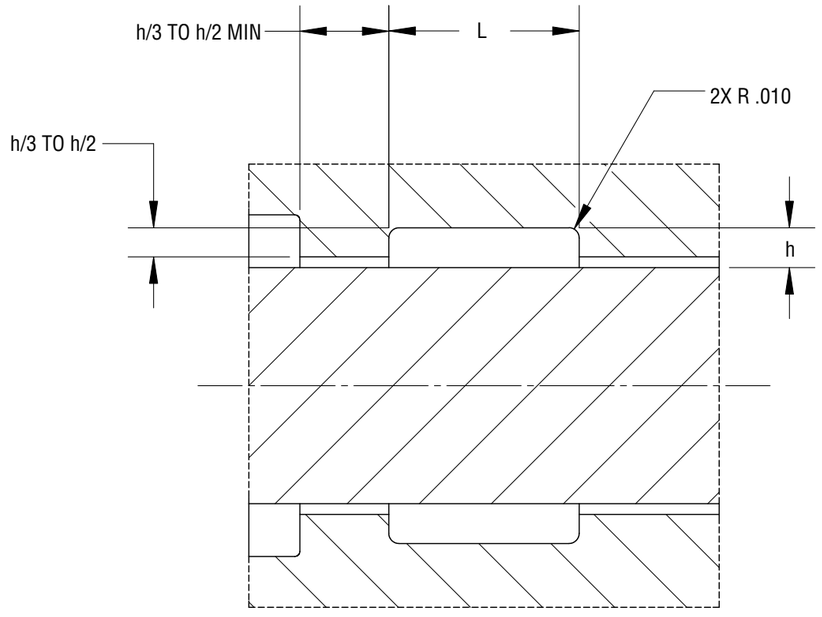
Where *L* is the length of the bearing,
Ø rod is the nominal rod diameter,
Ø bore is the nominal bore diameter,
h is the bearing thickness, per table on previous page.

4. Determine housing dimensions:
   a. Multiply the maximum Tetraliner thickness by two.
   b. Add normal running clearance (typical .001" to .003").
   c. Add maximum shaft diameter.

Retaining lip height should be 1/3 to 1/2 of the Tetraliner thickness. The lip thickness should be at least equal to the lip height.

Housing length (L) should be the bearing length plus .005" to .015" normal clearance. To calculate the bearing length, multiply the Factor of Safety (2 to 3 is recommended) by the estimated load applied to the bearing and dividing by the product of the maximum compressive load of the bearing material and the minimum diameter of the shaft or piston groove according to

$$L\min[in] = \frac{FS * Load[lb]}{P[psi] * ID[in]}$$



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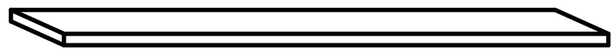

Tetraliner Part Number System

TTL - 16 20 - 300

- TTL - Bearing Type
- 16 - ID (1/32" increments)
- 20 - OD (1/32" increments)
- 300 - Tetralon Bearing Material (PTFE, if omitted)

Materials
Most Tetralon Bearing materials can be utilized in this configuration. Contact Technical Support for specific material and dimensional information on non-standard Tetraliner requirements.

Nominal Size ID x OD	Shaft Diameter	Housing Bore	Length ±005"	Tetraliner Part Number
¼ x 11/32	0.250	0.3437 / 0.3452	0.375	TTL - 0811
5/16 x 7/16	0.3125	0.4380 / 0.4395	0.437	TTL - 1014
⅜ x ½	0.375	0.4990 / 0.5000	0.500	TTL - 1216
½ x ⅝	0.500	0.6240 / 0.6250	0.500	TTL - 1620
⅝ x ¾	0.625	0.7490 / 0.7500	0.750	TTL - 2024
¾ x ⅞	0.750	0.8740 / 0.8750	0.750	TTL - 2428
⅞ x 1	0.875	0.9900 / 1.000	0.750	TTL - 2832
1 x 1⅛	1.000	1.124 / 1.125	1.000	TTL - 3236
1⅛ x 1¼	1.125	1.249 / 1.250	1.000	TTL - 3640
1¼ x 1⅜	1.250	1.374 / 1.375	1.000	TTL - 4044

Non-Standard Tetralon Bearings can be dimensioned by either the appropriate fractional increments or, if required, decimal call outs showing actual dimesion including appropriate tolerance. As all Tetralon Bearing dimensions include calculations for press fit, thermal expansion and running clearance, we suggest consultation with our Technical Support department to verify dimensions prior to placement of order.

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Tetralon T is a series of premium high load, self-lubricating bearing materials consisting of a modified thermoset resin system with synthetic fabric reinforcement impregnanted with solid lubricants.

Tetralon T bearings are primarily designed for high load, low speed applications and are especially well suited to reciprocating and oscillating environments.

Tetralon T offers the benefit of extremely low liquid absorption levels. As such, the material will not swell nor is it degraded by most liquid media except acetones and ketones.

As the material is designed to trap low viscosity fluids in its dynamic surface, Tetralon T becomes hydrodynamic and therefore rides on a thin fluid layer at low speeds in lubricated environments. This performance characteristic can reduce frictional coefficients to as low as 0.02 and allows the use of Tetralon T bearings at relatively high speeds in some applications.

Tetralon T is available in finished machined sleeve, flange, and thrust bearing configurations – including tube stock. Tube stock is supplied from 1/4" ID x 3/4" OD, up to 37" ID x 39 1/2" OD, please contact our Technical Support department if you need tubes (billets) of larger diameters (up to 52"). The length of the tubes has an inverse relation with the diameter of the tube, we provide up to 6" in length for small-diameter tubes and 3" to 4" long billets for diameters up to 40".

Tube diameters are supplied with over/under OD and ID dimensions for customer machining requirements.

Three standard material formulations offer superior performance in most application areas. Tetralon 935, for general engineering applications; Tetralon 936, for applications requiring acid/alkali resistance; and Tetralon 937, a high temperature formulation offering continuous service to 450° F.

Custom formulations to meet specific application requirements are available. Contact Technical Support for further information.

TETRALON 935 PROPERTIES	
Temperature °F	-40 °F/+250 °F
Compressive Strength	20,000
normal to laminate	50,000 psi
parallel to laminate	14,500 psi
V Speed	100 sfm
Shaft Material	Steel
Shaft Hardness	Rb25 (min)
Shaft Finish	8 - 16 rms
Tensile Strength	8,300 psi
Modulus of Elasticity	48 X 10^6 psi
Coefficient of Friction	0.12 - 0.17
Swell (% wall thickness)	< 0.1
Hardness	100 Rm

The Tetralon Bonded Bearing consists of a thin-wall section Tetralon Bearing bonded into a mild steel or aluminum shell. The Tetralon Bonded Bearing offers superior dry running operation with self lubrication, tighter tolerances, increased load and speed capabilities, improved thermal dissipation properties, and press fit retention through thermal cycles.

The construction of the Tetralon Bonded Bearing eliminates several problems encountered with the use of heavy-wall plastic and other steel backed bearing designs.

- Higher load capacity with outer shell.
- Minimal deformation under load with reduced bearing thickness.
- Increased heat transfer via shell material.
- ID close-in at elevated temperatures is virtually eliminated by thin wall design.
- Increased ability to handle shaft misalignment versus other steel backed bearings with a very thin, sprayed-on PTFE coating over porous bronze.
- In tight tolerance requirements, the Tetralon Bonded Bearing can be installed and the ID machined for very close ID relationships. Most other steel shell plastic and porous bronze/PTFE film bearings cannot be machined in the inside diameter either before or after installation.

RECOMMENDED OPERATING PARAMETERS	
Temperature °F	-400 °F/+400 °F
PV Max (continuous)	25,000
Max P (static)	2,500 psi
Max V	400 fpm
Shaft Material	Per Tetralon Material
Shaft Hardness	Per Tetralon Material
Shaft Finish	8 -16 rms
Coefficient of Friction	0.10 - 0.30
Water Absorption	0%
Flammability	Non-Flammable
Chemical Resistance	Limited to Shell
Coefficient of Thermal Expansion	Per Tetralon Material

Tetralon Bonded Bearings may be supplied with numerous shell materials for optimum application performance. To eliminate the possibility of catastrophic bearing failure in critical applications, Tetralon Bearings may be bonded into shells produced from other bearing-grade materials such as bronze, alloyed metals, and bearing-grade composites. This combination offers a simple, redundant bearing system.

Tetralon 510 is a specially formulated linear bearing material designed to improve the performance of sliding surfaces in a variety of applications. Originally designed for use on gibs and guideways of machine tools, Tetralon 510 reduces the friction and wear and improves the positioning accuracy of critical machine tool sliding members. Its uniform low friction values and an inherent vibration absorption capability offers machine designers and rebuilders a simple, cost-effective approach to optimum machine performance.

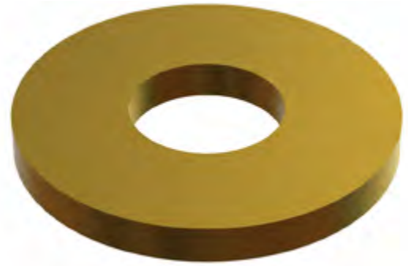
- Eliminates stick-slip
- Prevents wear
- Ensures fast, accurate positioning and smooth, chatter-free travel
- Renews worn equipment
- Reduces high breakaway friction
- Holds position
- Self lubricating
- Tough and durable
- Wear resistant
- Controlled low friction
- Cost effective

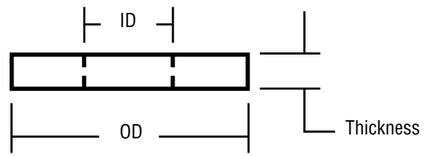
Load Capacity
Tetralon 510 Linear Bearings perform best under loads up to 800 psi. Dependent upon performance criteria, Tetralon 510 Linear Bearings may be used up to 1,600 psi in some applications.

In most design configurations, Tetralon 510 Linear Bearings provide a load capacity far greater than the work piece load capacity offered by the machine size. For example, a small machine tool table two feet in length with approximately 1/2" ways would have a total Tetralon 510 bearing area of 24 square inches or a load capacity of 38,400 pounds.

Availability
Tetralon 510 is available in sheet form, in dimensional increments up to 1/8" thick and 24 inches wide. The material can be supplied etched on one side for bonding to a properly prepared surface with the Tetrabond adhesive. If required, Tetralon 510 can then be ground, milled, or skived to yield the exact dimensions required for the application.

Detailed technical and application data is available upon request. Contact CoorsTek Customer Service for further information.





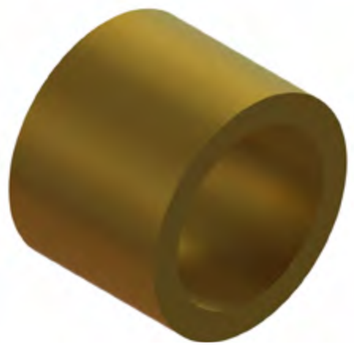
Tetralon Thrust Bearings - Part Number System

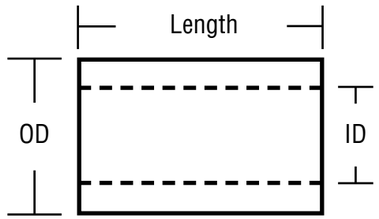
TB T - 16 20 - 6 - 921

- TB T: Tetralon Bearing; Bearing Type
- 16: ID (1/16" increments)
- 20: OD
- 6: Bearing Thickness (1/16") increments
- 921: Tetralon Bearing Material

Nominal Size	Thickness	Part Number
1/8 x 1/4	1/16	TBT-0204-1
3/16 x 5/16	1/16	TBT-0305-1
1/4 x 3/8	1/16	TBT-0406-1
5/16 x 1/2	1/16	TBT-0508-1
3/8 x 9/16	1/8	TBT-0609-2
7/16 x 5/8	1/8	TBT-0710-2
1/2 x 3/4	1/8	TBT-0812-2
9/16 x 13/16	1/8	TBT-0913-2
5/8 x 7/8	1/8	TBT-1014-2
11/16 x 15/16	1/8	TBT-1115-2
3/4 x 1	1/8	TBT-1216-2
13/16 x 1 1/16	1/8	TBT-1317-2
7/8 x 1 1/8	1/8	TBT-1418-2
15/16 x 1 3/16	1/8	TBT-1519-2
1 x 1 1/4	1/8	TBT-1620-2
1 1/8 x 1 3/8	1/8	TBT-1822-2
1 3/16 x 1 7/16	1/8	TBT-1923-2
1 1/4 x 1 1/2	1/8	TBT-2024-2
1 3/8 x 1 5/8	1/8	TBT-2226-2

Nominal Size	Thickness	Part Number
1 7/16 x 1 11/16	1/8	TBT-2327-2
1 1/2 x 1 3/4	1/8	TBT-2428-2
1 5/8 x 1 7/8	1/8	TBT-2630-2
1 3/4 x 2	1/8	TBT-2832-2
1 15/16 x 2 7/16	1/8	TBT-3139-2
2 x 2 1/4	1/8	TBT-3236-2
2 3/16 x 2 7/16	3/16	TBT-3539-3
2 1/4 x 2 1/2	3/16	TBT-3640-3
2 7/16 x 2 11/16	3/16	TBT-3943-3
2 1/2 x 2 3/4	3/16	TBT-4044-3
2 3/4 x 3	3/16	TBT-4448-3
2 15/16 x 3 3/16	3/16	TBT-4751-3
3 x 3 1/4	3/16	TBT-4852-3
3 3/16 x 3 7/16	1/4	TBT-5155-4
3 7/16 x 3 11/16	1/4	TBT-5559-4
3 15/16 x 4 3/16	1/4	TBT-6367-4
4 x 4 1/4	1/4	TBT-6468-4
4 7/16 x 4 11/16	1/4	TBT-7175-5





Tetralon Sleeve Bearings - Part Number System

TB S - 16 20 - 6 - 921

- TB: Tetralon Bearing
- S: Bearing Type
- 16: ID (1/16" increments)
- 20: OD
- 6: Bearing Length (1/8") increments
- 921: Tetralon Bearing Material

Nominal Size ID x OD	Recommended Housing Bore Diameter	Recommended Shaft Diameter	Length +/- .005"	Part Number
1/8 x 1/4	0.249 / 0.250	0.1240 / 0.125	1/4 3/8	TBS-0204-2 TBS-0204-3
3/16 x 5/16	0.311 / 0.312	0.186 / 0.187	1/4 3/8 1/2	TBS-0305-2 TBS-0305-3 TBS-0305-4
1/4 x 3/8	0.374 / 0.375	0.249 / 0.250	1/4 3/8 1/2	TBS-0406-2 TBS-0406-3 TBS-0406-4
5/16 x 1/2	0.499 / 0.500	0.311 / 0.312	3/8 1/2	TBS-0508-3 TBS-0508-4
3/8 x 9/16	0.561 / 0.562	0.374 / 0.375	3/8 1/2 3/4	TBS-0609-3 TBS-0609-4 TBS-0609-6
7/16 x 5/8	0.624 / 0.625	0.436 / 0.437	3/8 1/2 3/4	TBS-0710-3 TBS-0710-4 TBS-0710-6

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Tetralon® Bearing Manual
Tetralon Sleeve Bearings

Nominal Size ID x OD	Recommended Housing Bore Diameter	Recommended Shaft Diameter	Length +/- .005"	Part Number
1/2 x 3/4	0.749 / 0.750	0.499 / 0.500	1/2 3/4 1	TBS-0812-4 TBS-0812-6 TBS-0812-8
9/16 x 13/16	0.811 / 0.812	0.561 / 0.562	1/2 3/4 1	TBS-0913-4 TBS-0913-6 TBS-0913-8
5/8 x 7/8	0 .874 / 0.875	0.624 / 0.625	5/8 3/4 1	TBS-1014-5 TBS-1014-6 TBS-1014-8
11/16 x 15/16	0.936 / 0.937	0.686 / 0.687	3/4 1	TBS-1115-6 TBS-1115-8
3/4 x 1	0.999 / 1.000	0.749 / 0.750	1/2 3/4 1	TBS-1216-4 TBS-1216-6 TBS-1216-8
13/16 x 1 1/16	1.061 / 1.062	0.805 / 0.806	3/4 1	TBS-1317-6 TBS-1317-8
7/8 x 1 1/8	1.124 / 1.125	0 .874 / 0.875	3/4 1	TBS-1418-6 TBS-1418-8
15/16 x 1 3/16	1.185 / 1.186	0.929 / 0.930	3/4 1 1 1/8	TBS-1519-6 TBS-1519-8 TBS-1519-9
1 x 1 1/4	1.249 / 1.250	0.999 / 1.000	3/4 1 1 1/2	TBS-1620-6 TBS-1620-8 TBS-1620-12
1 1/8 x 1 3/8	1.374 / 1.375	1.124 / 1.125	3/4 1 1 1/2	TBS-1822-6 TBS-1822-8 TBS-1822-12
1 1/4 x 1 1/2	1.499 / 1.500	1.249 / 1.250	3/4 1 1 1/2 2	TBS-2024-6 TBS-2024-8 TBS-2024-12 TBS-2024-16
1 3/8 x 1 5/8	1.624 / 1.625	1.374 / 1.375	1 1 1/2	TBS-2226-8 TBS-2226-12
1 1/2 x 1 3/4	1.749 / 1.750	1.499 / 1.500	1 1 1/2 2	TBS-2428-8 TBS-2428-12 TBS-2428-16
1 5/8 x 1 7/8	1.874 / 1.875	1.6235 / 1.625	1 3/4	TBS-2630-14
1 3/4 x 2	1.999 / 2.000	1.7485 / 1.750	1 3/4	TBS-2832-14
1 7/8 x 2 1/8	2.124 / 2.125	1.8735 / 1.875	2	TBS-3034-15

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Nominal Size ID x OD	Recommended Housing Bore Diameter	Recommended Shaft Diameter	Length +/- .005"	Part Number
2 x 2 ¼	2.247 / 2.250	1.998 / 2.000	2 2 ½	TBS-3236-16 TBS-3236-20
2 ¼ x 2 ½	2.497 / 2.500	2.248 / 2.250	2 ½ 3	TBS-3640-20 TBS-3640-24
2 ½ x 2 ¾	2.747 / 2.750	2.498 / 2.500	2 ½ 3	TBS-4044-20 TBS-4044-24
2 ¾ x 3	2.997 / 3.000	2.748 / 2.750	3 3 ½	TBS-4448-24 TBS-4448-28
3 x 3 ¼	3.247 / 3.250	2.998 / 3.000	3 3 ½ 4	TBS-4852-24 TBS-4852-28 TBS-4852-32
3 ½ x 3 ¾	3.747 / 3.750	3.498 / 3.500	3 ½ 4	TBS-5660-28 TBS-5660-32
4 x 4 ¼	4.247 / 4.250	3.998 / 4.000	4 4 ½	TBS-6468-32 TBS-6468-36

Note: Non-Standard Tetralon Bearings can be dimensioned by either the appropriate fractional increments or, if required, decimal call outs showing actual dimesion including appropriate tolerance. As all Tetralon Bearing dimensions include calculations for press fit, thermal expansion and running clearance, we suggest consultation with our Technical Support department to verify dimensions prior to placement of order.

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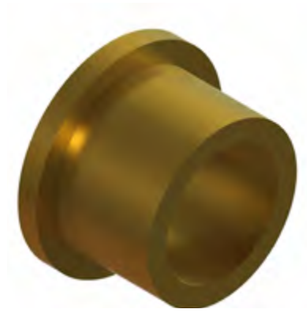

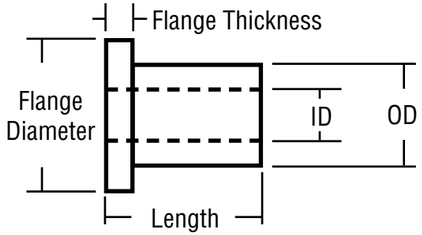

Tetralon Flange Bearings - Part Number System

TB F - 16 20 - 6 - 921

- TB F — Tetralon Bearing
- F — Bearing Type
- 16 — ID (1/16" increments)
- 20 — OD
- 6 — Bearing Length (1/8") increments
- 921 — Tetralon Bearing Material

Nominal Size ID x OD	Recommended Housing Bore Diameter	Recommended Shaft Diameter	Length +/- .005"	Flange Diameter	Flange Thickness	Part Number
⅛ x ¼	0.249 / 0.250	0.1240 / 0.125	¼ ⅜	⅜ ⅜	1⁄16 1⁄16	TBF-0204-2 TBF-0204-3
3⁄16 x 5⁄16	0.311 / 0.312	0.186 / 0.187	¼ ⅜ ½	7⁄16 7⁄16 7⁄16	1⁄16 1⁄16 1⁄16	TBF-0305-2 TBF-0305-3 TBF-0305-4
¼ x ⅜	0.374 / 0.375	0.249 / 0.250	¼ ⅜ ½	½ ½ ½	1⁄16 1⁄16 1⁄16	TBF-0406-2 TBF-0406-3 TBF-0406-4
5⁄16 x ½	0.499 / 0.500	0.311 / 0.312	⅜ ½	5⁄8 5⁄8	1⁄16 1⁄16	TBF-0508-3 TBF-0508-4
⅜ x 9⁄16	0.561 / 0.562	0.374 / 0.375	⅜ ½ ¾	11⁄16 11⁄16 11⁄16	⅛ ⅛ ⅛	TBF-0609-3 TBF-0609-4 TBF-0609-6
7⁄16 x 5⁄8	0.624 / 0.625	0.436 / 0.437	⅜ ½ ¾	⅞ ⅞ ⅞	⅛ ⅛ ⅛	TBF-0710-3 TBF-0710-4 TBF-0710-6
½ x ¾	0.749 / 0.750	0.499 / 0.500	½ ¾ 1	1 1 1	⅛ ⅛ ⅛	TBF-0812-4 TBF-0812-6 TBF-0812-8
9⁄16 x 13⁄16	0.811 / 0.812	0.561 / 0.562	½ ¾ 1	1 1⁄16 1 1⁄16 1 1⁄16	⅛ ⅛ ⅛	TBF-0913-4 TBF-0913-6 TBF-0913-8
5⁄8 x ⅞	0 .874 / 0.875	0.624 / 0.625	¾ 1	1 ⅛ 1 ⅛	⅛ ⅛	TBF-1014-6 TBF-1014-8
11⁄16 x 15⁄16	0.936 / 0.937	0.686 / 0.687	1	1 3⁄16	⅛	TBF-1115-8
¾ x 1	0.999 / 1.000	0.749 / 0.750	¾ 1	1 ¼ 1 ¼	⅛ ⅛	TBF-1216-6 TBF-1216-8

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Nominal Size ID x OD	Recommended Housing Bore Diameter	Recommended Shaft Diameter	Length +/- .005"	Flange Diameter	Flange Thickness	Part Number
7/8 x 1 1/8	1.124 / 1.125	0 .874 / 0.875	1	1 3/8	1/8	TBF-1418-8
1 x 1 1/4	1.249 / 1.250	0.999 / 1.000	1 1 1/2	1 1/2 1 1/2	1/8 1/8	TBF-1620-8 TBF-1620-12
1 1/8 x 1 3/8	1.374 / 1.375	1.124 / 1.125	1 1 1/2	1 5/8 1 5/8	1/8 1/8	TBF-1822-8 TBF-1822-12
1 3/16 x 1 7/16	1.436 / 1.437	1.186 / 1.187	1 1/2	1 11/16	1/8	TBF-1923-12
1 1/4 x 1 1/2	1.499 / 1.500	1.249 / 1.250	1 1/2 2	1 3/4 1 3/4	1/8 1/8	TBF-2024-12 TBF-2024-16
1 3/8 x 1 5/8	1.624 / 1.625	1.374 / 1.375	1 1 1/2	1 7/8 1 7/8	1/8 1/8	TBF-2226-8 TBF-2226-12
1 7/16 x 1 11/16	1.686 / 1.687	1.436 / 1.437	1 1 1/2	1 15/16 1 15/16	1/8 1/8	TBF-2327-8 TBF-2327-12
1 1/2 x 1 3/4	1.749 / 1.750	1.499 / 1.500	1 1/2 2	2 2	1/8 1/8	TBF-2428-12 TBF-2428-16
1 5/8 x 1 7/8	1.874 / 1.875	1.6235 / 1.625	1 3/4	2 1/8	1/8	TBF-2630-14
1 3/4 x 2	1.999 / 2.000	1.7485 / 1.750	1 3/4	2 1/4	1/8	TBF-2832-14
1 15/16 x 2 3/16	2.186 / 2.187	1.935 / 1.937	2 2 1/2	2 1/4 2 1/4	1/8 1/8	TBF-3135-16 TBF-3135-20
2 x 2 1/4	2.249 / 2.250	1.998 / 2.000	2 2 1/2	2 1/2 2 1/2	1/8 1/8	TBF-3236-16 TBF-3236-20
2 3/16 x 2 7/16	2.435 / 2.437	2.185 / 2.187	2 1/2 3	2 11/16 2 11/16	3/16 3/16	TBF-3539-20 TBF-3539-24
2 1/4 x 2 1/2	2.498 / 2.500	2.248 / 2.250	2 1/2 3	2 3/4 2 3/4	3/16 3/16	TBF-3640-20 TBF-3640-24
2 7/16 x 2 11/16	2.685 / 2.687	2.435 / 2.437	2 1/2 3	2 15/16 2 15/16	3/16 3/16	TBF-3943-20 TBF-3943-24
2 1/2 x 2 3/4	2.748 / 2.750	2.498 / 2.500	2 1/2 3	3 3	3/16 3/16	TBF-4044-20 TBF-4044-24
2 3/4 x 3	2.998 / 3.000	2.748 / 2.750	3 3 1/2	3 1/2 3 1/2	3/16 3/16	TBF-4448-24 TBF-4448-28
2 15/16 x 3 3/16	3.185 / 3.187	2.935 / 2.937	3 1/2	3 11/16	3/16	TBF-4751-28
3 x 3 1/4	3.248 / 3.250	2.998 / 3.000	3 3 1/2 4	3 1/4 3 3/4 3 3/4	1/4 1/4 1/4	TBF-4852-24 TBF-4852-28 TBF-4852-32
3 3/16 x 3 7/16	3.435 / 3.437	3.185 / 3.187	3 1/2 4	3 15/16 3 15/16	1/4 1/4	TBF-5155-28 TBF-5155-32
3 7/16 x 3 11/16	3.685 / 3.687	3.435 / 3.437	3 1/2 4	4 3/16 4 3/16	1/4 1/4	TBF-5559-28 TBF-5559-32
3 15/16 x 4 3/16	4.185 / 4.187	3.935 / 3.937	4 1/2	4 11/16	1/4	TBF-6367-36
4 x 4 1/4	4.248 / 4.250	3.998 / 4.000	4 4 1/2	4 3/4 4 3/4	1/4 1/4	TBF-6468-32 TBF-6468-36
4 7/16 x 4 11/16	4.685 / 4.687	4.435 / 4.437	4 1/2 5	5 3/16 5 3/16	5/16 5/16	TBF-7175-36 TBF-7175-40

See next page for special orders.

Non-Standard Tetralon Bearings can be dimensioned by either the appropriate fractional increments or, if required, decimal call outs showing actual dimesion including appropriate tolerance. As all Tetralon Bearing dimensions include calculations for press fit, thermal expansion and running clearance, we suggest consultation with our Technical Support department to verify dimensions prior to order placement.

Tolerances
Tolerances closer than ± 0.001" are difficult to maintain and, in most instances, not required. Closer tolerances can be obtained by rough machining, annealing to stress relieve the material and then finish machining to proper dimension.

Machining
High-speed turning with a 0.015" per revolution feed rate offers best results. Carbide-tipped tools and cooling with a low viscosity cutting fluid is recommended.

Drilling
Low spindle speed with coolant is recommended.

Cutting
Hydraulic or kick press with steel knife blade can cut plate up to 1/4" thick and rod or tube diameters up to 1/2".

Sawing
Use skip tooth bandsaw blade or coolant on high volumes.

Stamping
Steel rule dies or blanking tools.

Broaching
Progressive dies can be utilized to achieve close tolerances. Removal of more than 10 % of finished cross section per pass is not recommended.

Surface Grinding
Tetralon materials in plate and skived tape form can be ground to a ± 0.002" or better tolerance.

Centerless Grinding
Medium grit, all purpose wheel with coolant.

Bonding
Most Tetralon materials must be etched prior to bonding. Opposing metal surfaces should be sandblasted and then flushed with acetone or isopropyl alcohol to insure cleanliness. Apply Tetrabond adhesive to both surfaces and clamp with 10 to 50 psi of pressure.

Fabrication guidelines pertain to all Tetralons except Tetralon 935.

Contact Technical Support for further information.

Lubrication
The wear surface of Tetralon Bearings contain an internal boundry lubricant. However, the addition of conventional lubricants will improve dynamic performance. Hydrocarbon oils are well suited and significantlly reduce wear rates. Liquid lubricants carry away heat and reduce friction. Greases can lubricate, prevent hardware corrosion, and help to prevent contaminates from migrating into the dynamic surface area. Do not use fluorocarbon (PTFE) or silicone based lubricants or greases as they interfere with the break-in process and have a detrimental effect on the benefits of the boundary lubrication in the materials.

Installation
Tetralon Bearings are easily installed in ambient temperature applications by standard press-fit methods. The dimensions recommended throughout this manual provide for proper interference fits. The Use of these application dimensions usually eliminates the need for further machining of the bearing.

If non-standard housings are used with standard bearings, a small amount of material may be machined from the bearing OD if the bearing is first mounted on a pin of the proper diameter to ensure concentricity. High-speed steel or carbide tool bits are recommended for machining Tetralon Bearing Materials.

Contact Technical Support for installation recommendations in applications where temperature extremes and/or thermal cycles are present.

Stock Shapes
Most Tetralon materials are available in stock shapes for customer machining. These materials are available in rod, tube, skived tape and molded plate forms. Consult our Customer Service department for specific product information and fabrication guidelines.

Technical Support Services
CoorsTek Technical Support offers design engineers easy access to today's high-performance materials technology. Complete in-house component engineering and design capabilities provide our customers with the benefit of over seventy-five years of combined experience in the application and design of non-metallic materials and components. If it's a problem with temperature, friction, wear, lubrication, or corrosion, CoorsTek expertise is just a phone call away, 310-322-8030.

Our highly experienced Design team is ready to analyze your bearing application and provide material, product, and technical recommendations for use. A simple call to CoorsTek gets you speaking directly with industry experts to guide you with dimensioning calculations.

Please call the CoorsTek Design team when electrical insulation is required in your application for suggestions on materials to use.

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Pressure Conversion Table

	atm	bar	in Hg	mbar	mm Hg	MPa	Pa	psf	psi	torr
atm	1	1.01	29.92	1013.25	760	$1.013x10^{-01}$	101325	2116.22	14.69	760
bar	0.99	1	29.53	1000	750.06	0.10	$1.000x10^{05}$	2088.54	14.50	750.06
in Hg	$3.334x10^{-02}$	$3.386x10^{-02}$	1	33.86	25.40	$3.386x10^{-03}$	3386.40	70.73	$4.911x10^{-01}$	25.40
mbar	$9.869x10^{-04}$	$1.000x10^{03}$	$2.953x10^{-02}$	1	$7.501x10^{-01}$	$1.000x10^{-04}$	100	2.09	$1.450x10^{-02}$	$7.501x10^{-01}$
mm Hg	$1.32x10^{-03}$	$1.333x10^{-03}$	$3.937x10^{-02}$	1.33	1	$1.333x10^{-04}$	133.30	2.78	$1.934x10^{-02}$	1
MPa	$9.869x10^{-01}$	10	295.33	$1.000x10^{04}$	7501.88	1	$1.000x10^{06}$	$2.089x10^{04}$	145.04	7501.88
Pa	$9.869x10^{-06}$	$1.000x10^{-05}$	$2.953x10^{-04}$	$1.000x10^{-02}$	$7.502x10^{-03}$	$1.000x10^{-06}$	1	$2.089x10^{-02}$	$1.450x10^{-04}$	$7.502x10^{-03}$
psf	$4.725x10^{-04}$	$4.788x10^{-04}$	$1.414x10^{-02}$	$4.787x10^{-01}$	$3.592x10^{-01}$	$4.787x10^{-05}$	47.87	1	$6.944x10^{-03}$	0.36
psi	$6.805x10^{-02}$	$6.895x10^{-02}$	2.04	68.97	$5.170x10^{01}$	$6.897x10^{-03}$	$6.897x10^{03}$	144.01	1	51.72
torr	$1.316x10^{-03}$	$1.333x10^{-03}$	$3.937x10^{-02}$	1.33	1	$1.333x10^{-04}$	133.32	2.78	$1.934x10^{-02}$	1

How to use this simple Pressure Conversion Table:

Find the intersection of the units of the pressure value to convert from on the left-most vertical column and the units of the value of the pressure to convert to on the top row. Multiply the known pressure value by the intersection value to get the pressure in the desired units.

Example:

To convert 345 psf(pounds per square foot) into mbar(millibar):

The value of the intersection of the psf row and the mbar column is 4.787x10-01. Then carry out the following mathematical operation:

345 x 4.787x10-01 = 165.152

Then, 345 psf is approximately 165.152 mbar. It's that simple!

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CUSTOMER DATA

Company Name _____ Date Submitted _____

Address _____ Date Required _____

City, State, Zip, Country _____

Telephone _____ Fax _____ ☐ OEM

Contact Person _____ Title _____ ☐ Distributor

E-Mail _____ ☐ Rebuilder

Products Mfgd/Sold/Serviced _____ ☐ Consultant

_____

INTERNAL USE
EAR # _____
Territory # _____
Territory Mgr _____

APPLICAION DATA

1. Is this applicaton: New Design ☐ Retrofit ☐
2. Load Direction: Axial ☐ Radial ☐
3. Temperature: Min. _____ Normal _____ Max. _____ °C ☐ °F ☐
4. Lead: Min. _____ Normal _____ Max. _____ Bar ☐ PSI ☐ Proof_____
5. Media: _____
6. If retrofit, please describe why customer wants to consider a new bearing _____
   _____
7. If this is a change, is there a source ☐ spec ☐ control drawing? Dwg # _____
8. Disposition of existing parts: _____

HARDWARE DATA

All Dimensions are in: Millimeters ☐ Inches ☐

Groove: Dia _____ + _____ - _____ Finish _____ Groove Height _____

Groove: Width _____ + _____ - _____ Groove Sidewall Finish _____

Maximum Extrusion Gap: Radial _____ Diametral _____

1. Is hardware plated/coated? No ☐ Yes ☐ Specity _____
2. Bearing installation tooling required? No ☐ Yes ☐ Not Sure ☐
3. Can hardware design be changed? No ☐ Yes ☐ How? _____
   _____
4. Reference design specifications: _____
5. Indicate applicable hardware design requirements in sketch below while showing load magnitude and directions (with arrows)

Please see following page for sketches

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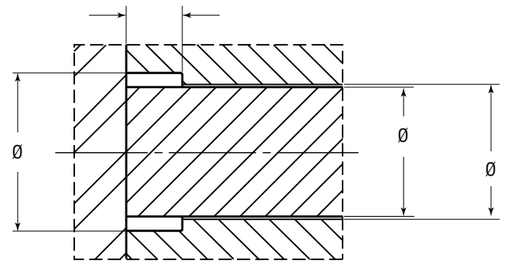

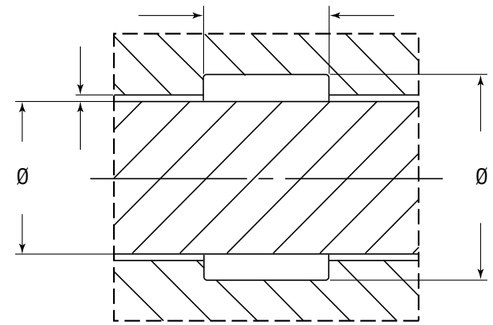

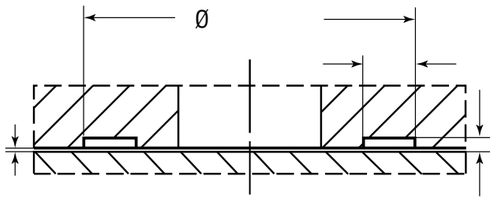

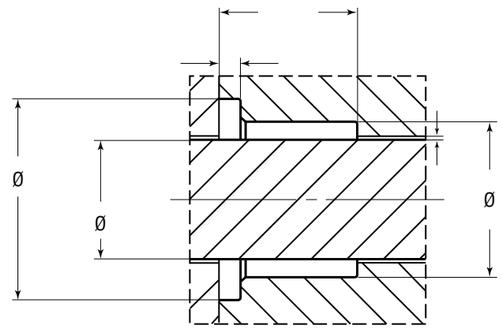

PERFORMANCE DATA

1. Desired service life: _____
2. Any special requirements? _____
   _____
   _____
3. Type of evaluation: Bench ☐ Field ☐ Both ☐ Start Date _____ Duration _____
4. Comments: _____
   _____
   _____

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Notes

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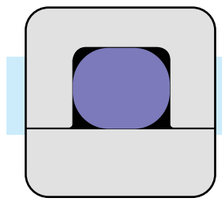
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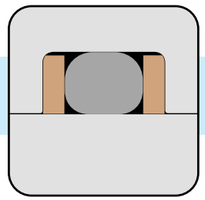
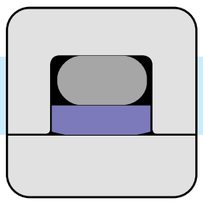
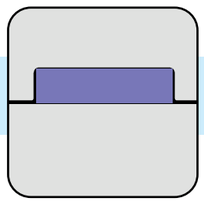
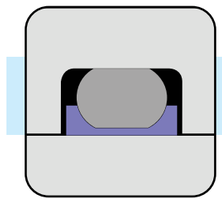

O-RING + BACK UP


DUORING


WEARRING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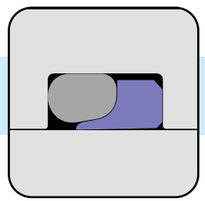
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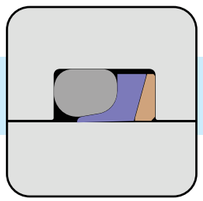
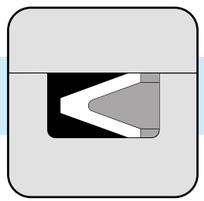
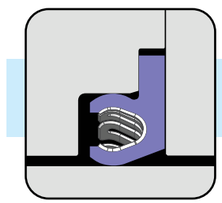
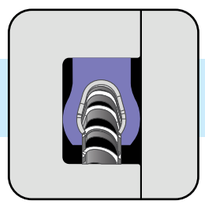
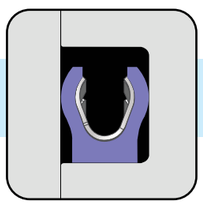
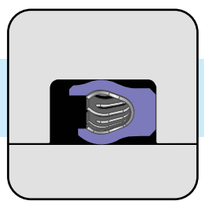

UNILOCK + BACK UP

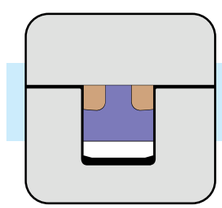

METALLIC SEALS

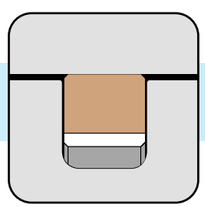

METAPLAST II ROTARY


METAPLAST II FACE


METAPLAST II OUTSIDE FACE


METAPLAST II RADIAL


REINFORCED TETRAFLEX I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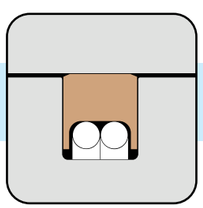
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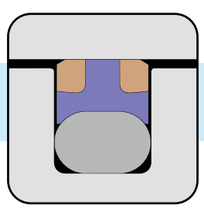
REINFORCED PISTON

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