TriStar

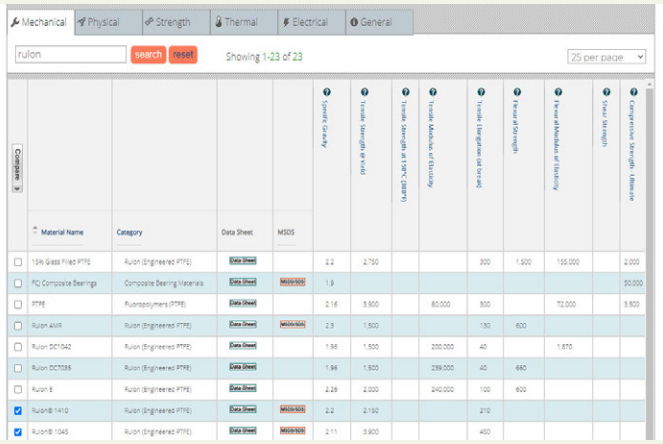
Engineered Plastic Solutions™

Composite Bearings

Engineering | Custom Fabrication | Manufacturing

Services

A partnership with TriStar will give you a competitive edge.



Material Data

Use our material database to filter and compare hundreds of the most popular high performance plastics in the industry based on specific characteristics.

Filter, compare and call on our engineering team to help you choose the right material and component geometry for your application.

Educational Seminars

We offer a series of training seminars on a variety of subjects relative to materials, component design and applications.

Custom seminars are available for your specific industry. Contact TriStar's technical department for more information.

Topic	Title
High Performance Materials	Pushing the Design Envelope of Plastics
Plane Bearing Technology	The Application of Self-Lubricating Materials in Bearings
Composites	Materials for Extreme Bearing Structural Applications
Fluoropolymers	Specific Overview of Fluoropolymers and their Applications

Analytical Services

We offer a complete array of surface analysis and materials characterization solutions by providing services that help companies get the critical information they need.

Our analytical techniques include:

- FTIR
- XPS
- AFM
- Goniometry
- Durometer [shore A shore D]
- Haze, Transmittance, Clarity [mainly transparent materials]
- Tensile Pull Testing [shear and T-peel]
- Compression Testing
- Flexural Testing

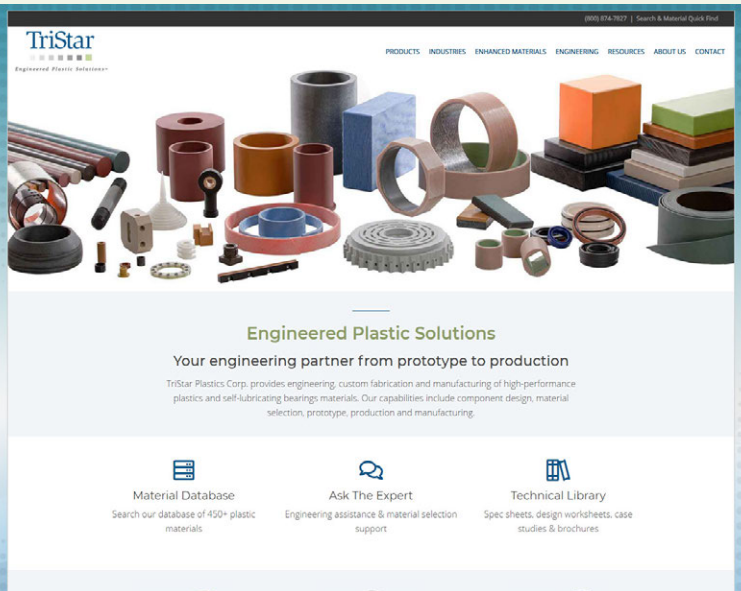
Enhanced Materials Division

From enhancing cell culture trays to bonding dissimilar materials, the scientists at TriStar's Enhanced Materials Division (EMD) can assist you in identifying problems and recommending solutions for your toughest surface issues.

Our expert technicians apply unique, dry, environmentally-friendly techniques to modify the surface of polymers, elastomers, and films in order to dramatically increase (or, if desired, decrease) the bond strength of adhesives, paint, markings, or specialty coatings.

Our services include:

- Plasma Treatment
- Asymmetric & Symmetric Filtration Membranes
- Specialized Primers & Coatings



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With our in-house technical and scientific staff we can resolve any challenge and help you find the right engineered plastic solution.

Composite Bearings

CJ composites are ideal for non-lubricated, high-load applications in a variety of climates and operating environments, exhibit a high load capacity similar to bronze, powdered metal and steel, and provide longer wear and extended operating life without the costs associated with lubrication. CJ composites are available with thick walls for drop in replacement of steel and bronze bearings. CJ composites also don't rust like metal components, so you can use them in environments where traditional metals corrode and fail. You'll find TriStar bearing materials in heavy-duty agricultural, automotive, construction, industrial, marine, railway, and material handling equipment. CJ composites possess a modulus of elasticity that falls between rigid metals and soft plastics. CJ components are rigid enough to support heavy loads, yet compliant enough to tolerate moderate amounts of shaft misalignment without highly stressing the ends. The composite wall acts like a spring and the thicker the wall section of the bearing the greater the deflection for a given load. Thick wall bearings tolerate greater shaft misalignment and provide better shock absorbency.

Features	Benefits
High-load capacity/ high-shock load capability	Accommodates tremendous compression loads that literally crush competing composite materials.
Self-lubricating design	Provides maintenance-free operation and eliminates the need for costly and messy greasing systems.
Low coefficient of friction	Reduces wear and extends operating life. Coefficients as low as 0.05 in dry applications and <0.009 in lubricated environments.
Temperature resistant	Operates flawlessly in temperatures ranging from cryogenic levels to a high of 300°F (149°C). Call for higher temperature availability.
Dimensionally stable in fluids	Absorption rates are negligible, providing near zero swell.
Chemical resistant	Compatible with a wide range of lubricants and media.
Flexible material design	Suitable for press fit, freeze fit, epoxy bonding, as well as conventional mechanical retention.
Low weight/high strength	Accommodates high-loads with superior strength to weight ratios.
Thick-wall availability	Drop in replacement for metal or bronze bearings.

Long-wearing, maintenance-free bearing material for high-load applications

CJ Composite Bearings

CJ Applications

- Backhoes
- Front end loaders
- Marine davits/sheaves
- Valve stem bushings
- Hitches
- Hydraulic cylinder pivots
- Graders
- Mining equipment
- Vending machines

FCJ Composite Bearings

FCJ Applications

- Material handling equipment
- Packaging machinery
- Farm implements
- Spreaders
- Marine pivots
- Robotics
- Business machines
- Linear bearings
- Amusement park rides

Light-weight, high-strength, fatigue-resistant CJ composites are the ideal bearing choice for non-lubricated high-load/low-speed applications. CJ bearings provide excellent resistance to impact and shock loads and are capable of withstanding a high degree of shaft misalignment.

FCJ bearings are the ideal choice for combination motion-oscillatory, linear, and/or rotary applications. Their ability to run successfully against mild steel shafting makes for a cost-competitive system. Their versatility makes them excellent general purpose self-lubricating bearings.

The self-lubricating wear surface of CJ and FCJ composites are capable of reducing both equipment costs and the need for maintenance. Use CJ bearings in applications where:

- Conventional lubricants will not function.
- Shock loads are present.
- Stick-slip operation is undesirable.
- Low cost is an issue, particularly when taking into consideration the bearing, lubrication system, or maintenance.

Use CJ when your application requires:

- High-load capacity.
- Resistance to chemical, galvanic, or fretting corrosion.
- Minimal galling and scoring.
- Reduced weight.
- Electrical insulation.

The FCJ is used in applications with low loads and speeds up to 500 sf/m. They typically replace porous and cast bronze bearings. They are corrosion resistant, practically chemically inert and electrically insulative.

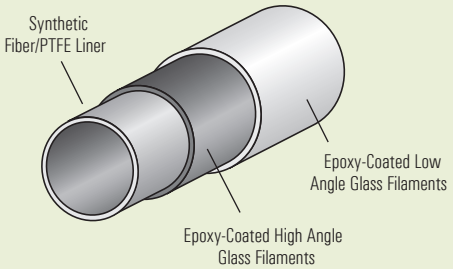
FCJ bearings are more tolerant of small contaminants than standard CJ bearings because of the ID liner. They are also easily machined using standard techniques.

Standard FCJ sizes interchange with standard bronze bearings making them an excellent alternative to metal and a perfect fit.

Typical Specifications

Recommended Operating Limits and Engineering Information

Properties		CJ	FCJ
Maximum Pressure (P)			
(static)	psi	60,000 [1]	20,000
	MPa	414	138
(dynamic)	psi	30,000	20,000
	MPa	207	140
Maximum Velocity (V)	ft/min	150	500
(no load)	m/sec	.76	2.54
Lubrication		No	No
Temperature	°F	-320/+300	-320/+300
— Typical Range	°C	-195/+149	-195/+149
Shaft Hardness — Minimum, Rockwell Scale		Rc 50	Rb 25
Shaft Finish Recommended Ra (Microinches)		8-16	8-16
Shaft Material		Steel	Steel
Coefficient of Friction (Static/Dynamic Range)		.02 - .25	.01 - .20
Water Absorption ASTM D570		<.5%	<.5%
Corrosion Resistance		Excellent	Excellent
Linear Coefficient of Thermal Expansion (ASTM D696) 78°F to 300°F	in/in/°F	7×10^{-6}	7×10^{-6}
26°C to 149°C	cm/cm/°C	13×10^{-6}	13×10^{-6}



CJ Bearing Construction

Figure A
Typical Wear Behavior For Composite Bearings

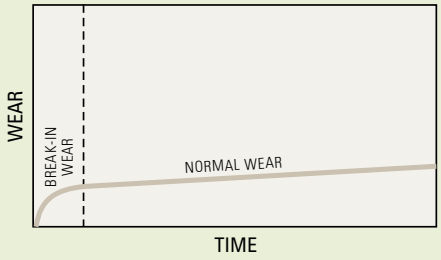


Figure B
Wear vs. Surface Finish

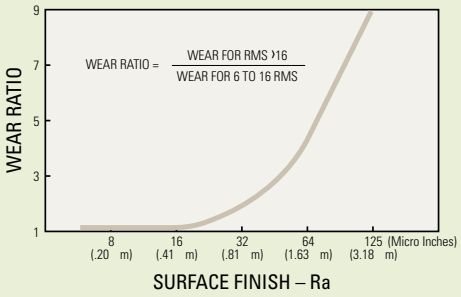


Figure C
Deflection
Chart shows the deflection and the permanent set of a typical CJ Composite Bearing at load.

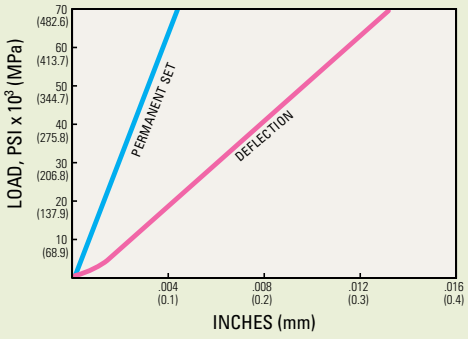
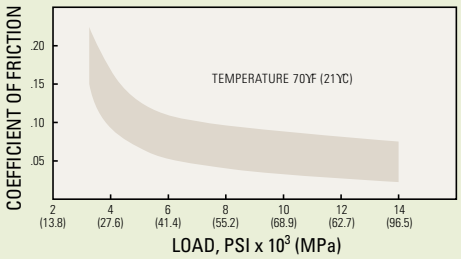


Figure D
Coefficient of Friction vs. Load



General Description

The CJ composite bearing is a multi-layer structure. The inner-most layer consists of a synthetic fiber/PTFE layer. The second layer consists of epoxy-coated high-angle glass filaments. The outer-most layer consists of epoxy-coated low-angle glass filiments.

The synthetic and PTFE fibers used in the liner have a long history of successful use as a bearing wear surface for rod end and aircraft spherical bearings. The high-load capacity and reliability of these bearings has made them the preferred design for many applications.

Fiberglass/epoxy filament wound composites were originally developed for use as pressure vessels and rocket motor cases. Their light weight, high strength, and fatigue resistance make them ideal materials for structural applications. When used to make a bearing, this material allows the selection of fiber angles to provide optimum strength and rigidity. The resulting structure has a modulus of elasticity of approximately 2 x 10^6 psi (13.79 GPa) placing it in an intermediate area between rigid metals and soft plastic. It is rigid enough to support heavy loads, and at the same time compliant enough to tolerate moderate amounts of shaft misalignment without highly stressing the bearing corners. The composite wall acts like a spring and the thicker the wall section of the bearing the greater the deflection for a given load (See Figure C). This allows thick wall bearings to tolerate greater shaft misalignment. The wear surface will support the shaft primarily as a function of the load rather than the shaft clearance. As load is applied, the wear surface will conform to the shaft assuring a large contact area. In contrast, the contact area of metal bearings decreases sharply as shaft clearances increase, and increase only slightly with load.

Bearing Wear

Figure A depicts the typical wear behavior of a CJ or FCJ bearing. There is an initial break-in period during which a transfer film is established on the mating surface. In some situations, up to .001" [.03mm] of wear may occur at break-in and in other situations the wear may be negligible. After the break-in period, the wear rate stabilizes and remains relatively constant for the life of the bearing. There is a transfer film of PTFE, epoxy, and some synthetic fiber that clings tenaciously to the metal surface, and acts as a lubricant between the shaft and the bearing.

The equilibrium wear rate depends on a number of factors including loads, speeds, shaft hardness, and shaft surface finish. Under laboratory conditions, radial wear is approximately proportional to both sliding distance and load. The wear rate is often reported as a factor K. This relationship can be expressed as follows:

$$W = KPVT$$

W = Radial wear in inches
K = Wear factor
P = Load in psi
V = Sliding velocity (ft/min)
T = Time in hours

The following table shows the actual measured wear factor for a number of conditions of oscillation and rotation. These values were obtained using Rc 50 shafts with a surface finish of 16 Ra[.4 µm]. The wear factor would increase if the shaft material was softer or the surface finish rougher. The performance using the softer shafts was significantly lower, especially at the higher load condition. While performance is lower, it is adequate for many less demanding applications.

Measured Wear Factors for CJ Composite Bearings

Type of Operation	P lbs/in^2	V ft/min	K in^{3}xmin/lbxftxhr
Oscillation ±25°	229	43.6	9.6×10^{-10}
	4,900	2.0	1.9×10^{-10}
	15,000	.73	2.0×10^{-9}
Rotation	64	78.5	39.8×10^{-10}
	64	157.0	24.9×10^{-10}
	256	39.3	14.9×10^{-10}
	512	39.3	12.4×10^{-10}

Measured Wear Factors for FCJ Composite Bearings

Type of Operation	P lbs/in^2	V ft/min	K in^{3}xmin/lbxft x hr
Oscillation ±25°	229	43.6	7.4×10^{-10}
	4,900	2.0	1.6×10^{-10}
	14,000	.73	5.52×10^{-10}
Rotation	64	78.5	33.1×10^{-10}
	64	157.00	19.9×10^{-10}
	256	39.3	14.6×10^{-10}
	512	39.3	12.41×10^{-10}

Using wear factors, the radial wear of a CJ bearing can be estimated by calculating W and adding .001" [.025 mm] for break-in wear. The liner can sustain .015-.020" [.38 mm-.51 mm] wear and still operate normally. Bearings having an inside diameter of over 2-1/2" have a thicker liner capable of sustaining .025" to .030" [.64mm - .76mm] wear. Surface finish affects wear rate as shown in [See Figure B, page 6] Field experience has shown that hard chrome plating gives excellent wear performance and protects the shaft from corrosion. Softer coatings such as cadmium and zinc will not stand up in service and quickly wear off.

Load Capacity

Normal application of load will cause a simple elastic deflection of the CJ bearing along with some permanent set. The set is primarily due to compaction of the synthetic fiber/PTFE liner. We do not typically recommend subjecting the bearings to over 35,000 psi [241 MPa] load. In common with other materials, fiberglass/epoxy composites can undergo fatigue after repeated application of stress. Fatigue has not been a limiting factor in the use of the CJ bearing. In fact, laboratory tests have shown that in many cases the bearing is more fatigue-resistant than the shaft. Laboratory tests show that the bearings fail by a gradual crushing action rather than a rapid catastrophic failure. This is consistent with typical composite behavior in which stress is supported by many fibers. If one fiber breaks, the load is redistributed among the others. Breakage of the entire structure will not occur until a large number of the individual fibers are broken. CJ composite bearings can easily withstand over 35,000 psi [241 MPa] static load or 20,000 psi [140 MPa] dynamic load with a great deal of reliability. In many cases, higher loading can be tolerated if the design and conditions of service are discussed fully with a TriStar bearing specialist.

Length to diameter ratio is also an important design consideration. Test results from the laboratory and the field have shown that the optimum performance can be attained by specifying a length to inside diameter ratio [L/D] ranging from .5 to 2. When the L/D ratio of less than .5 is used, it is possible to create highly stressed areas at the corner of the bearing and cracking will occur at this location prematurely. If the L/D ratio is over 2, with any amount of shaft misalignment, cross corner jamming will occur and unit stresses can exceed the 15,000 psi [103 MPa] safe dynamic limit or the 35,000 psi [241 MPa] static limit of the bearings. Bearings built with the proper L/D ratio will accept misalignment and shock load without premature failure.

Coefficient of Friction

The coefficient of friction of a synthetic fiber/PTFE lined composite journal bearing running against a hardened Rc 50 steel shaft with a 16 Ra [.4 µm] surface, or less, varies from .02 to .25 depending on the load, the relative sliding velocity, and the bearing surface temperature. Generally, the coefficient of friction decreases with increasing load [See Figure D, page 6].

This information indicates that if the lowest coefficient of friction is desired, the smallest bearing capable of sustaining the load should be used, and that the bearings are capable of performing best under peak operating conditions when temperatures and loads may be higher.

General Description continued

Lubrication

The synthetic fiber/PTFE fabric wear surface of the CJ bearing is a self-contained boundary lubrication system; however, the addition of conventional lubricants often improves the overall performance of the CJ bearing. "Lubricant" is a very general term, and it is often said that any liquid will act as a lubricant. To some extent, this is true if hydrodynamic conditions are established, and the surfaces have minimal contact. The composite bearing, in earth moving equipment, operates generally in a state of boundary lubrication. Hydrocarbon oils are advantageous and can produce tenfold reductions in wear rates. Liquid lubricants can carry away heat and reduce the coefficient of friction. Greases can be used for lubrication, to prevent corrosion, and keep contamination out of the journal. In oscillating motion, the synthetic fiber/PTFE liner acts as a true boundary lubricant when the direction of motion changes and the lubrication film collapses. In rotation, with oil lubrication, the wear rate of the CJ composite has been found equal to sintered or cast bronze bearings. Fluorocarbon oils and greases should be avoided because they have been found to soften the synthetic fibers and greatly increase the rate of wear.

It is possible to add lubrication holes to the CJ bearing, but grooves are impractical. The abrasion resistance of the synthetic fibers makes groove fabrication difficult and costly.

Thermal Properties

The operating temperature range for CJ bearings is -320°F to +300°F (-195°C to +149°C). The bearing has been heat stabilized at a temperature above 300°F (149°C) and very little dimensional change will occur in the bearing during operation. In the free state, the coefficient of expansion of the CJ bearing in the radial direction is approximately 7 x 10^{-6} in/in/°F. When press fit into a housing, the CJ bearing assumes the coefficient of expansion of the housing material, as long as the press fit is maintained, and thus the elastic modulus of the bearing is maintained, because the elastic modulus of the bearing is lower than the elastic modulus of most metals.

The CJ composite is a thermal insulator and when heat is generated from running friction, the bearing wear surface may be hotter than the adjacent housing due to the thermal lag.

Since the installed bearing cannot expand outward, it grows inward, reducing the shaft clearance. For this reason, the shaft clearance should be increased for dry running applications that have high running velocities. Naturally, fluid cooling and lubricants will reduce the operating temperatures. Heat transfer through the bearing wall is proportional to the wall thickness, and the thinner the composite wall, the greater the transfer of heat.

Figure E
Deflection
Chart shows the deflection and the permanent set of a typical FCJ Composite Bearing at load.

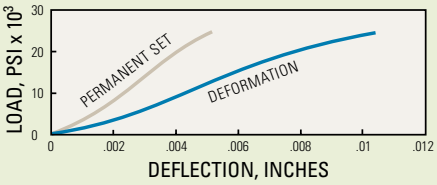
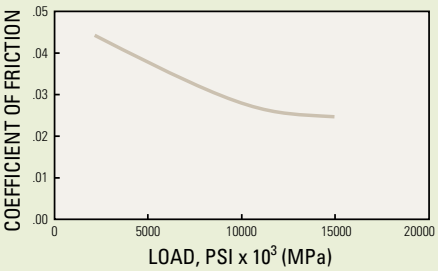


Figure F
Coefficient of Friction vs. Load for FCJ Bearing



Measuring Operating PV

PV is a means of measuring the performance capabilities of bearings. P is expressed as pressure or pounds per square inch on the projected bearing area. V is the velocity in feet per minute of the wear surface.

For sleeve bearings the surface speed V is .262 x RPM x diameter in inches. P is equal to the load on the bearing in pounds divided by the projected area in square inches. For sleeve bearings the projected area is the length times the diameter of the bearing.

PV is then obtained by multiplying the P x V as shown in the following example:

¾" Shaft @ 341 RPM;
90 lb. total load, bearing length 1"

V = .262 x RPM x Diameter
or .262 x 341 x .750 = 67 ft/min

P = Total load ÷ projected area
area = .750 x 1.0 = .75 in^2

P = 90 lbs ÷ .75 = 120 psi

PV = 120 psi x 67 fpm = 8040 PV

Mechanical Properties

The CJ bearing has withstood static loads in excess of 50,000 psi (345 MPa) at room temperature. However, we do not generally recommend static loads in excess of 35,000 psi (241 MPa). At the recommended load limits, minimal crushing will occur. As the temperature increases, the load capacity of the bearing decreases. The composite backing tends to act as a shock absorber and reduces vibration. The maximum speed is 150 surface feet per minute for dry running applications.

Corrosion Resistance

The CJ bearing is not affected by corrosive environments. Some solutions of highly concentrated acids will attack the backing material. Specific information can be obtained from our Technical Service Department. The shaft should be stainless steel or chrome-plated if an alloy steel is used. The CJ bearing cannot rust, but when using a lubricant, it should contain a rust inhibitor to protect the shaft.

Installation Procedures

Proper installation of components is critical to achieving the best results. TriStar recommends the following methods to ensure optimum bearing material performance.

Installation

Composite bearings install easily. Use a shouldered arbor plug for standard press-fit installation. The diagram below shows arbor, housing, bearing, and shaft relationships.

Press Fit Installation Using Standard Housings

The dimensions recommended here ensure proper interference fits. Using these standard bearing, shaft, and housing dimensions usually eliminates the need for further machining or reaming of the bearing.

Press Fit Installation Using Non-Standard Housings

When using non-standard housings, you can machine a small amount of material from the O.D. of CJ bearings. Be sure the bearing is mounted on a pin of the proper diameter to prevent out-of-roundness. TriStar recommends carbide or diamond tipped tool bits.

When replacing only the bearing, be sure to clean the existing housing. Thoroughly machine it to size if necessary. Take care to remove sharp edges and add proper chamfers.

Other Installation Methods

You can use other means of retention like staking, retainer rings, or bonding.

Fabrication & Machining Fabric Lined Bearings

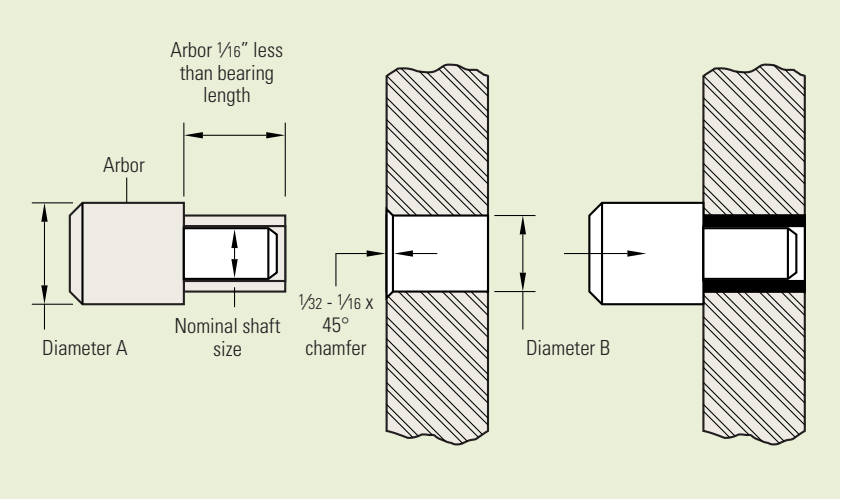
O.D. Machining: CJ bearings can be ground or turned to finished size. TriStar recommends carbide or diamond tipped tools for cutting.

Drilling: Cross drilling is acceptable for lubrication and installation, but take care not to damage the synthetic fiber/PTFE liner. Contact TriStar for assistance in drilling radial through holes.

Cutoff: TriStar recommends using a diamond wheel for abrasive cutoff. Chamfer I.D. and O.D. edges with a high-speed grinder.

I.D. Machining: Machining the I.D. of CJ bearings is not recommended. Broaching, reaming, grooving, honing or boring destroy the synthetic fiber/PTFE liner. If the bore must be modified, contact TriStar for guidance.

Bonding: Bond to housing using standard epoxies. No special surface treatment is required. Clean and degrease prior to bonding.



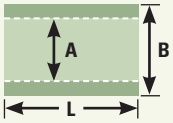
Standard Sizes for CJ Bearings

The CJ Part Numbering System:

Identification	Liner	Length
cj-braided composite		
cjp-knitted composite	e-metric & english braided	
fcj-filled PTFE tape composite	f-filled PTFE tape	
cjme-metric braided composite	p-knitted	in 1⁄8"
↓ XXX	↓ X	↓ XX – XX

↑ INSIDE Diameter in 1⁄16" (XX)

↑ OUTSIDE Diameter in 1⁄16" (XX – XX)



All corners are broken to permit proper installation.

Only braided and filled PTFE tape lined bearings are available as standard sizes listed in this catalog. Knitted liners and other filled PTFE tapes are available as special orders.

Thin Wall — 1⁄16"

Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	Length ±.005 (L)	CJ Part Number
½ x 5⁄8	.5040	.6265	.6250	.0020	.4990	¼	CJ08E10-2
	.5020	.6255	.6245	.0005	.4985	½	CJ08E10-4
						1	CJ08E10-8
5⁄8 x ¾	.6290	.7515	.7500	.0020	.6240	¼	CJ10E12-2
	.6270	.7505	.7495	.0005	.6235	½	CJ10E12-4
						1	CJ10E12-8
¾ x 7⁄8	.7555	.8765	.8750	.0020	.7490	½	CJ12E14-4
	.7525	.8755	.8745	.0005	.7485	¾	CJ12E14-6
						1	CJ12E14-8
7⁄8 x 1	.8805	1.0025	1.0000	.0030	.8745	Up to 12"	CJ14E16-
	.8775	1.0005	.9995	.0005	.8740		
1 x 1 1⁄8	1.0055	1.1275	1.1250	.0030	.9990	1	CJ16E18-8
	1.0025	1.1255	1.1245	.0005	.9985	1 ¼	CJ16E18-10
						1 ½	CJ16E18-12
1 1⁄8 x 1 ¼	1.1335	1.2525	1.2500	.0030	1.1250	Up to 12"	CJ18E20-
	1.1305	1.2505	1.2495	.0005	1.1245		
1 ¼ x 1 3⁄8	1.2555	1.3785	1.3750	.0040	1.2490	Up to 12"	CJ20E22-
	1.2525	1.3765	1.3745	.0010	1.2485		
1 3⁄8 x 1 ½	1.3830	1.5025	1.5000	.0030	1.3745	Up to 18"	CJ22E24-
	1.3790	1.5005	1.4995	.0005	1.3735		
1 ½ x 1 5⁄8	1.5080	1.6285	1.6250	.0040	1.4995	Up to 18"	CJ24E26-
	1.5040	1.6265	1.6245	.0015	1.4990		
1 5⁄8 x 1¾	1.6330	1.7535	1.7500	.0040	1.6245	Up to 18"	CJ26E28-
	1.6290	1.7515	1.7495	.0015	1.6240		
1¾ x 1 7⁄8	1.7580	1.8785	1.8750	.0040	1.7495	Up to 18"	CJ28E30-
	1.7540	1.8765	1.8745	.0015	1.7490		
2 x 2 1⁄8	2.0080	2.1285	2.1255	.0040	1.9995	Up to 18"	CJ32E34-
	2.0040	2.1265	2.1245	.0010	1.9985		

Size not listed above may be quoted upon request.

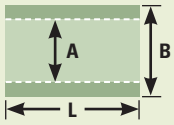
This series is designed to replace SAE sized porous powdered metal bearings below 3" ID.

Standard Wall — 1⁄8"

Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	Length* (L)	CJ Part Number
½ x ¾	.5040	.7515	.7500	.0020	.4990	½	CJ08E12-4
	.5020	.7505	.7495	.0005	.4985	¾	CJ08E12-6
						1	CJ08E12-8
5⁄8 x 7⁄8	.6290	.8765	.8750	.0020	.6240	½	CJ10E14-4
	.6270	.8755	.8745	.0005	.6235	¾	CJ10E14-6
						1	CJ10E14-8
¾ x 1	.7555	1.0025	1.0000	.0030	.7490	½	CJ12E16-4
	.7525	1.0005	.9995	.0005	.7485	¾	CJ12E16-6
						1	CJ12E16-8

*Length tolerance is +.005"/-.005" up to 2 ½" I.D.; +.008"/-.007" on I.D. 2 ½" and over. Sizes not listed above may be quoted upon request.

Standard Sizes for CJ Bearings continued

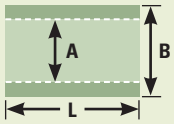


All corners are broken to permit proper installation.

Standard Wall — 1/8"

Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	Length* (L)	CJ Part Number
7/8 x 1 1/8	.8805 .8775	1.1275 1.1255	1.1250 1.1245	.0030 .0005	.8745 .8740	Up to 12"	CJ14E18-
1 x 1 1/4	1.0055 1.0025	1.2525 1.2505	1.2500 1.2495	.0030 .0005	.9990 .9985	1/2 5/8 3/4 1 1 1/4	CJ16E20-4 CJ16E20-5 CJ16E20-6 CJ16E20-8 CJ16E20-10
1 1/8 x 1 3/8	1.1335 1.1305	1.3785 1.3765	1.3750 1.3745	.0040 .0015	1.1250 1.1245	1/2 1 2	CJ18E22-4 CJ18E22-8 CJ18E22-16
1 1/4 x 1 1/2	1.2555 1.2525	1.5025 1.5005	1.5000 1.4995	.0030 .0005	1.2490 1.2485	1 1 1/2 2	CJ20E24-8 CJ20E24-12 CJ20E24-16
1 3/8 x 1 5/8	1.3830 1.3790	1.6285 1.6265	1.6250 1.6245	.0040 .0015	1.3745 1.3735	Up to 18"	CJ22E26-
1 1/2 x 1 3/4	1.5080 1.5040	1.7535 1.7515	1.7500 1.7495	.0040 .0015	1.4995 1.4990	1 1/2 2 3	CJ24E28-12 CJ24E28-16 CJ24E28-24
1 5/8 x 1 7/8	1.6330 1.6290	1.8785 1.8765	1.8750 1.8745	.0040 .0015	1.6245 1.6240	Up to 18"	CJ26E30-
1 3/4 x 2	1.7580 1.7540	2.0035 2.0015	2.0000 1.9995	.0040 .0015	1.7495 1.7490	Up to 18"	CJ28E32-
2 x 2 1/4	2.0080 2.0040	2.2535 2.2515	2.2505 2.2495	.0040 .0010	1.9995 1.9985	1 1/2 2 3	CJ32E36-12 CJ32E36-16 CJ32E36-24
2 1/4 x 2 1/2	2.2580 2.2540	2.5040 2.5020	2.5005 2.4995	.0045 .0015	2.2490 2.2485	Up to 18"	CJ36E40-
2 3/8 x 2 5/8	2.3850 2.3810	2.6290 2.6270	2.6255 2.6245	.0045 .0015	2.3750 2.3740		CJ38E42-
2 1/2 x 2 3/4	2.5100 2.5060	2.7540 2.7520	2.7505 2.7495	.0045 .0015	2.4995 2.4985	1 1/2 2 3	CJ40E44-12 CJ40E44-16 CJ40E44-24
2 5/8 x 2 7/8	2.6370 2.6330	2.8790 2.8770	2.8755 2.8745	.0045 .0015	2.6245 2.6235	Up to 18"	CJ42E46-
2 3/4 x 3	2.7620 2.7580	3.0040 3.0020	3.0005 2.9990	.0050 .0015	2.7495 2.7485	Up to 18"	CJ44E48-
3 x 3 1/4	3.0140 3.0100	3.2540 3.2520	3.2505 3.2490	.0050 .0015	2.9995 2.9985	Up to 18"	CJ48E52-
3 1/4 x 3 1/2	3.2640 3.2600	3.5040 3.5020	3.5010 3.4990	.0050 .0010	3.2495 3.2485	Up to 18"	CJ52E56-
3 1/2 x 3 3/4	3.5140 3.5100	3.7540 3.7520	3.7510 3.7490	.0050 .0010	3.4995 3.4985	Up to 18"	CJ56E60-
3 3/4 x 4	3.7640 3.7600	4.0040 4.0020	4.0010 3.9990	.0050 .0010	3.7495 3.7485	Up to 18"	CJ60E64-
4 x 4 1/4	4.0140 4.0100	4.2540 4.2520	4.2510 4.2490	.0050 .0010	3.9995 3.9985	Up to 18"	CJ64E68-
4 1/4 x 4 1/2	4.2640 4.2600	4.5040 4.5020	4.5010 4.4990	.0050 .0015	4.2495 4.2485	Up to 18"	CJ68E72-
4 1/2 x 4 3/4	4.5140 4.5100	4.7540 4.7520	4.7510 4.7490	.0050 .0010	4.4995 4.4985	Up to 18"	CJ72E76-
4 3/4 x 5	4.7640 4.7600	5.0040 5.0020	5.0010 4.9990	.0050 .0010	4.7495 4.7485	Up to 18"	CJ76E80-
5 x 5 1/4	5.0140 5.0100	5.2540 5.2520	5.2510 5.2490	.0050 .0010	4.9995 4.9985*	Up to 18"	CJ80E84-

*Length tolerance is +.005"/-.005" up to 2 1/2" I.D.; +.008"/-.007" on I.D. 2 1/2" and over. Sizes not listed above may be quoted upon request.



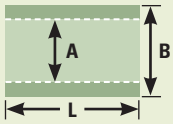
All corners are broken to permit proper installation.

Heavy Wall — ¼"

Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	Length* (L)	CJ Part Number
½ x 1	.5040 .5020	1.0025 1.0005	1.0000 .9995	.0030 .0005	.4990 .4985	Up to 12"	CJ08E16-
⅝ x 1 ⅛	.6290 .6270	1.1275 1.1255	1.1250 1.1245	.0030 .0005	.6240 .6235	Up to 12"	CJ10E18-
¾ x 1 ¼	.7555 .7525	1.2525 1.2505	1.2500 1.2495	.0030 .0005	.7490 .7485	Up to 12"	CJ12E20-
⅞ x 1 ⅜	.8805 .8775	1.3785 1.3765	1.3750 1.3745	.0040 .0015	.8745 .8740	Up to 12"	CJ14E22-
1 x 1 ½	1.0055 1.0025	1.5025 1.5005	1.5000 1.4995	.0030 .0005	.9990 .9985	1 1 ¼	CJ16E24-8 CJ16E24-10
1 ⅛ x 1 ⅝	1.1335 1.1305	1.6285 1.6265	1.6250 1.6245	.0040 .0015	1.1250 1.1245	Up to 12"	CJ18E26-
1 ¼ x 1 ¾	1.2555 1.2525	1.7535 1.7515	1.7500 1.7495	.0040 .0015	1.2490 1.2485	1 2	CJ20E28-8 CJ20E28-16
1 ⅜ x 1 ⅞	1.3830 1.3790	1.8785 1.8765	1.8750 1.8745	.0040 .0015	1.3745 1.3740	Up to 18"	CJ22E30-
1 ½ x 2	1.5080 1.5040	2.0035 2.0015	2.0000 1.9995	.0040 .0015	1.4995 1.4990	1 ½ 2	CJ24E32-12 CJ24E32-16
1 ⅝ x 2 ⅛	1.6330 1.6290	2.1285 2.1265	2.1255 2.1245	.0040 .0015	1.6246 1.6240	Up to 18"	CJ26E34-
1 ¾ x 2 ¼	1.7580 1.7540	2.2535 2.2515	2.2505 2.2495	.0040 .0010	1.7495 1.7490	Up to 18"	CJ28E36-
2 x 2 ½	2.0080 2.0040	2.5040 2.5020	2.5005 2.4995	.0045 .0015	1.9995 1.9985	1 ½ 2	CJ32E40-12 CJ32E40-16
2 ¼ x 2 ¾	2.2580 2.2540	2.7540 2.7520	2.7505 2.7495	.0045 .0015	2.2490 2.2480	Up to 18"	CJ36E44-
2 ⅜ x 2 ⅞	2.3850 2.3810	2.8790 2.8770	2.8755 2.8745	.0045 .0015	2.3750 2.3740	Up to 18"	CJ38E46-
2 ½ x 3	2.5100 2.5060	3.0040 3.0020	3.0005 2.9990	.0050 .0015	2.4995 2.4990	Up to 18"	CJ40E48-
2 ⅝ x 3 ⅛	2.6370 2.6330	3.1290 3.1270	3.1255 3.1240	.0050 .0015	2.6245 2.6240	Up to 18"	CJ42E50-
2 ¾ x 3 ¼	2.7620 2.7580	3.2540 3.2520	3.2505 3.2490	.0050 .0015	2.7495 2.7485	Up to 18"	CJ44E52-
3 x 3 ½	3.0140 3.0100	3.5040 3.5020	3.5010 3.4990	.0050 .0010	2.9995 2.9985	Up to 18"	CJ48E56-
3 ¼ x 3 ¾	3.2640 3.2600	3.7540 3.7520	3.7510 3.7490	.0050 .0010	3.2495 3.2485	Up to 18"	CJ52E60-
3 ½ x 4	3.5140 3.5100	4.0040 4.0020	4.0010 3.9990	.0050 .0010	3.4995 3.4985	Up to 18"	CJ56E64-
3 ¾ x 4 ¼	3.7640 3.7600	4.2540 4.2520	4.2510 4.2490	.0050 .0010	3.7495 3.7485	Up to 18"	CJ60E68-
4 x 4 ½	4.0140 4.0100	4.5040 4.5020	4.5010 4.4990	.0050 .0010	3.9995 3.9985	Up to 18"	CJ64E72-
4 ¼ x 4 ¾	4.2640 4.2600	4.7540 4.7520	4.7510 4.7490	.0050 .0010	4.2495 4.2485	Up to 18"	CJ68E76-
4 ½ x 5	4.5140 4.5100	5.0040 5.0020	5.0010 4.9990	.0050 .0010	4.4995 4.4985	Up to 18"	CJ72E80-
4 ¾ x 5 ¼	4.7640 4.7600	5.2540 5.2520	5.2510 5.2490	.0050 .0010	4.7495 4.7485	Up to 18"	CJ76E84-
5 x 5 ½	5.0140 5.0100	5.5040 5.5020	5.5010 5.4990	.0050 .0010	4.9995 4.9985	Up to 18"	CJ80E88-

*Length tolerance is +.005"/-.005" up to 2 ½" I.D.; +.008"/-.007" on I.D. 2 ½" and over. Sizes not listed above may be quoted upon request.

Standard Sizes for CJ Bearings continued



All corners are broken to permit proper installation.

2.5 MM Wall Series Metric Dimensions (MM)

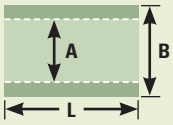
Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	CJ Part Number
12 x 17	12.143 12.093	17.068 17.043	17.018 17.000	.068 .025	12.000 11.982	CJME12E17-
15 x 20	15.146 15.096	20.071 20.046	20.021 20.000	.071 .025	15.000 14.982	CJME15E20-
18 x 23	18.201 18.121	23.096 23.046	23.021 23.000	.096 .025	18.000 17.982	CJME18E23-
20 x 25	20.201 20.121	25.096 25.046	25.021 25.000	.096 .025	20.000 19.979	CJME20E25-
22 x 27	22.201 22.121	27.096 27.046	27.021 27.000	.096 .025	22.000 21.979	CJME22E27-
25 x 30	25.205 25.125	30.100 30.050	30.025 30.000	.100 .029	25.000 24.979	CJME25E30-
30 x 35	30.205 30.125	35.100 35.050	35.025 35.000	.100 .025	30.000 29.979	CJME30E35-
35 x 40	35.225 35.125	40.100 40.050	40.025 40.000	.100 .025	35.000 34.975	CJME35E40-
40 x 45	40.225 40.125	45.100 45.050	45.025 45.000	.100 .025	40.000 39.975	CJME40E45-
45 x 50	45.230 45.130	50.105 50.055	50.025 50.000	.105 .030	45.000 44.975	CJME45E50-
50 x 55	50.225 50.155	55.105 55.055	55.030 55.000	.105 .025	50.000 49.975	CJME50E55-

5.0 MM Wall Series Metric Dimensions (MM)

Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	CJ Part Number
30 x 40	30.205 30.125	40.100 40.050	40.025 40.000	.100 .025	30.000 29.979	CJME30E40-
35 x 45	35.225 35.125	45.100 45.050	45.025 45.000	.100 .025	35.000 34.975	CJME35E45-
40 x 50	40.225 40.125	50.100 50.050	50.025 50.000	.100 .025	40.000 39.975	CJME40E50-
45 x 55	45.230 45.130	55.105 55.055	55.030 55.000	.105 .025	45.000 44.975	CJME45E55-
50 x 60	50.225 50.155	60.105 60.055	60.030 60.000	.105 .025	50.000 49.975	CJME50E60-
55 x 65	55.255 55.155	65.105 65.055	65.030 65.000	.105 .025	55.000 54.970	CJME55E65-
60 x 70	60.255 60.155	70.105 70.055	70.030 70.000	.105 .025	60.000 59.970	CJME60E70-
65 x 75	65.255 65.155	75.105 75.055	75.030 75.000	.105 .025	65.000 64.970	CJME65E75-
70 x 80	70.305 70.205	80.105 80.055	80.030 80.000	.105 .025	70.000 69.970	CJME70E80-
75 x 85	75.310 75.210	85.110 85.060	85.035 85.000	.110 .025	75.000 74.970	CJME75E85-
80 x 90	80.310 80.210	90.110 90.060	90.035 90.000	.110 .025	80.000 79.970	CJME80E90-
85 x 95	85.360 85.260	95.110 95.060	95.035 95.000	.110 .025	85.000 84.965	CJME85E95-
90 x 100	90.360 90.260	100.110 100.060	100.035 100.000	.110 .025	90.000 89.965	CJME90E100-
100 x 110	100.360 100.260	110.110 110.060	110.035 110.000	.110 .025	100.000 99.965	CJME100E110-
100 x 120	100.360 100.260	120.110 120.060	120.035 120.000	.110 .025	110.000 109.965	CJME110E120-
120 x 130	120.365 120.265	130.115 130.065	130.040 130.000	.115 .025	120.000 119.965	CJME120E130-

*Length tolerance: +0/-.25 mm for I.D. up to and including 55 mm, +0/-.40 mm for I.D. 60 mm and larger. Sizes not listed above may be quoted upon request.

Standard Sizes for FCJ Bearings



All corners are broken to permit proper installation.

Standard Wall — 1/8"

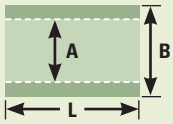
Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	Length* (L)	CJ Part Number
½ x ¾	.504 .502	.7515 .7505	.7500 .7495	.0020 .0005	.4995 .4985	½ ¾ 1	FCJ08F12-4 FCJ08F12-6 FCJ08F12-8
⅝ x ⅞	.629 .627	.8765 .8755	.8750 .8745	.0020 .0005	.6245 .6235	½ ¾ 1	FCJ10F14-4 FCJ10F14-6 FCJ10F14-8
¾ x 1	.7555 .7525	1.0025 1.0005	1.0000 .9995	.0030 .0005	.7495 .7485	Up to 12"	FCJ12F16-
⅞ x 1 ⅛	.8805 .8775	1.1275 1.1255	1.1250 1.1245	.0030 .0005	.8745 .8735	Up to 12"	FCJ14F18-
1 x 1 ¼	1.0055 1.0025	1.2525 1.2505	1.2500 1.2495	.0030 .0005	.9995 .9985	⅝ ¾ 1 1 ¼	FCJ16F20-5 FCJ16F20-6 FCJ16F20-8 FCJ16F20-10
1 ⅛ x 1 ⅜	1.1335 1.1305	1.3785 1.3765	1.3750 1.3745	.0040 .0015	1.1245 1.1235	½ 1 2	FCJ18F22-4 FCJ18F22-8 FCJ18F22-16
1 ¼ x 1 ½	1.2555 1.2525	1.5025 1.5005	1.5000 1.4995	.0030 .0005	1.2495 1.2485	1 1½ 2	FCJ20F24-8 FCJ20F24-12 FCJ20F24-16
1 ⅜ x 1 ⅝	1.3830 1.3790	1.6285 1.6265	1.6250 1.6245	.0040 .0015	1.3745 1.3735	Up to 18"	FCJ22F26-
1 ½ x 1 ¾	1.5080 1.5040	1.7535 1.7515	1.7500 1.7495	.0040 .0015	1.4995 1.4980	Up to 18"	FCJ24F28-
1 ¾ x 2	1.7580 1.7540	2.0035 2.0015	2.0000 1.9995	.0040 .0015	1.7495 1.7480	Up to 18"	FCJ28F32-
2 x 2 ¼	2.0080 2.0040	2.2535 2.2515	2.2505 2.2495	.0040 .0015	1.9995 1.9980	1½ 2 3	FCJ32F36-12 FCJ32F36-16 FCJ32F36-24

Heavy Wall — 1/4"

Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	Length* (L)	CJ Part Number
2 x 2 ½	2.0080 2.0040	2.5040 2.5020	2.5005 2.4995	.0045 .0015	1.9995 1.9980	1½ 2	FCJ32F40-12 FCJ32F40-16
2 ½ x 2 ¾	2.5100 2.5060	2.7540 2.7520	2.7505 2.7495	.0045 .0015	2.4995 2.4975	1½ 2 3	FCJ40F44-12 FCJ40F44-16 FCJ40F44-24
2 ½ x 3	2.5100 2.5060	3.0040 3.0020	3.0005 2.9990	.0050 .0015	2.4995 2.4975	Up to 18"	FCJ40F48-
3 x 3 ¼	3.0140 3.0100	3.2540 3.2520	3.2505 3.2490	.0050 .0015	2.9995 2.9975	Up to 18"	FCJ48F52-
3 x 3 ½	3.0140 3.0100	3.5040 3.5020	3.5010 3.4990	.0050 .0010	2.9995 2.9975	Up to 18"	FCJ48F56-
3 ½ x 4	3.5140 3.5100	4.0040 4.0020	4.0010 3.9990	.0050 .0010	3.4995 3.4965	Up to 18"	FCJ56F64-
4 x 4 ½	4.0140 4.0100	4.5040 4.5020	4.5010 4.4990	.0050 .0010	3.9995 3.9965	Up to 18"	FCJ64F72-
5 x 5 ½	5.0140 5.0100	5.5040 5.5020	5.5010 5.4990	.0050 .0010	4.9995 4.9960	Up to 18"	FCJ80F88-

*Length tolerance is +.005"/-.005" up to 2½"I.D.; +.008"/-.007" on I.D. 2½" and over. Sizes not listed above may be quoted upon request.

Standard Sizes for FCJ Bearings continued



All corners are broken to permit proper installation.

2.5 MM Wall Series Metric Dimensions (MM)

Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	FCJ Part Number
12 x 17	12.143 12.093	17.068 17.043	17.018 17.000	.068 .025	12.000 11.982	FCJE12E17-
15 x 20	15.146 15.096	20.071 20.046	20.021 20.000	.071 .025	15.000 14.982	FCJE15E20-
18 x 23	18.201 18.121	23.096 23.046	23.021 23.000	.096 .025	18.000 17.982	FCJE18E23-
20 x 25	20.201 20.121	25.096 25.046	25.021 25.000	.096 .025	20.000 19.979	FCJE20E25-
22 x 27	22.201 22.121	27.096 27.046	27.021 27.000	.096 .025	22.000 21.979	FCJE22E27-
25 x 30	25.205 25.125	30.100 30.050	30.025 30.000	.100 .029	25.000 24.979	FCJE25E30-
30 x 35	30.205 30.125	35.100 35.050	35.025 35.000	.100 .025	30.000 29.979	FCJE30E35-
35 x 40	35.225 35.125	40.100 40.050	40.025 40.000	.100 .025	35.000 34.975	FCJE35E40-
40 x 45	40.225 40.125	45.100 45.050	45.025 45.000	.100 .025	40.000 39.975	FCJE40E45-
45 x 50	45.230 45.130	50.105 50.055	50.025 50.000	.105 .030	45.000 44.975	FCJE45E50-
50 x 55	50.225 50.155	55.105 55.055	55.030 55.000	.105 .025	50.000 49.975	FCJE50E55-

5.0 MM Wall Series Metric Dimensions (MM)

Nominal I.D. x O.D.	I.D. (A)	O.D. (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	FCJ Part Number
30 x 40	30.205 30.125	40.100 40.050	40.025 40.000	.100 .025	30.000 29.979	FCJE30E40-
35 x 45	35.225 35.125	45.100 45.050	45.025 45.000	.100 .025	35.000 34.975	FCJE35E45-
40 x 50	40.225 40.125	50.100 50.050	50.025 50.000	.100 .025	40.000 39.975	FCJE40E50-
45 x 55	45.230 45.130	55.105 55.055	55.030 55.000	.105 .025	45.000 44.975	FCJE45E55-
50 x 60	50.225 50.155	60.105 60.055	60.030 60.000	.105 .025	50.000 49.975	FCJE50E60-
55 x 65	55.255 55.155	65.105 65.055	65.030 65.000	.105 .025	55.000 54.970	FCJE55E65-
60 x 70	60.255 60.155	70.105 70.055	70.030 70.000	.105 .025	60.000 59.970	FCJE60E70-
65 x 75	65.255 65.155	75.105 75.055	75.030 75.000	.105 .025	65.000 64.970	FCJE65E75-
70 x 80	70.305 70.205	80.105 80.055	80.030 80.000	.105 .025	70.000 69.970	FCJE70E80-
75 x 85	75.310 75.210	85.110 85.060	85.035 85.000	.110 .025	75.000 74.970	FCJE75E85-
80 x 90	80.310 80.210	90.110 90.060	90.035 90.000	.110 .025	80.000 79.970	FCJE80E90-
85 x 95	85.360 85.260	95.110 95.060	95.035 95.000	.110 .025	85.000 84.965	FCJE85E95-
90 x 100	90.360 90.260	100.110 100.060	100.035 100.000	.110 .025	90.000 89.965	FCJE90E100-
100 x 110	100.360 100.260	110.110 110.060	110.035 110.000	.110 .025	100.000 99.965	FCJE100E110-
100 x 120	100.360 100.260	120.110 120.060	120.035 120.000	.110 .025	110.000 109.965	FCJE110E120-
120 x 130	120.365 120.265	130.115 130.065	130.040 130.000	.115 .025	120.000 119.965	FCJE120E130-

*Length tolerance: +0/-.25 mm for I.D. up to and including 55 mm, +0/-.40 mm for I.D. 60 mm and larger. Sizes not listed above may be quoted upon request.

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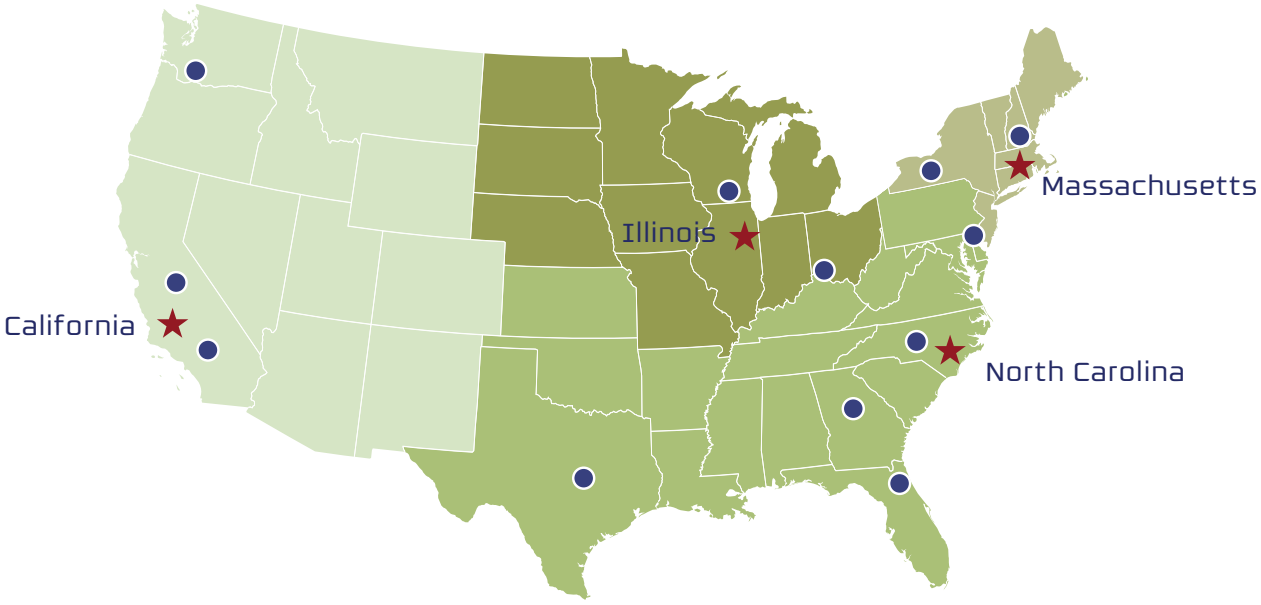

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