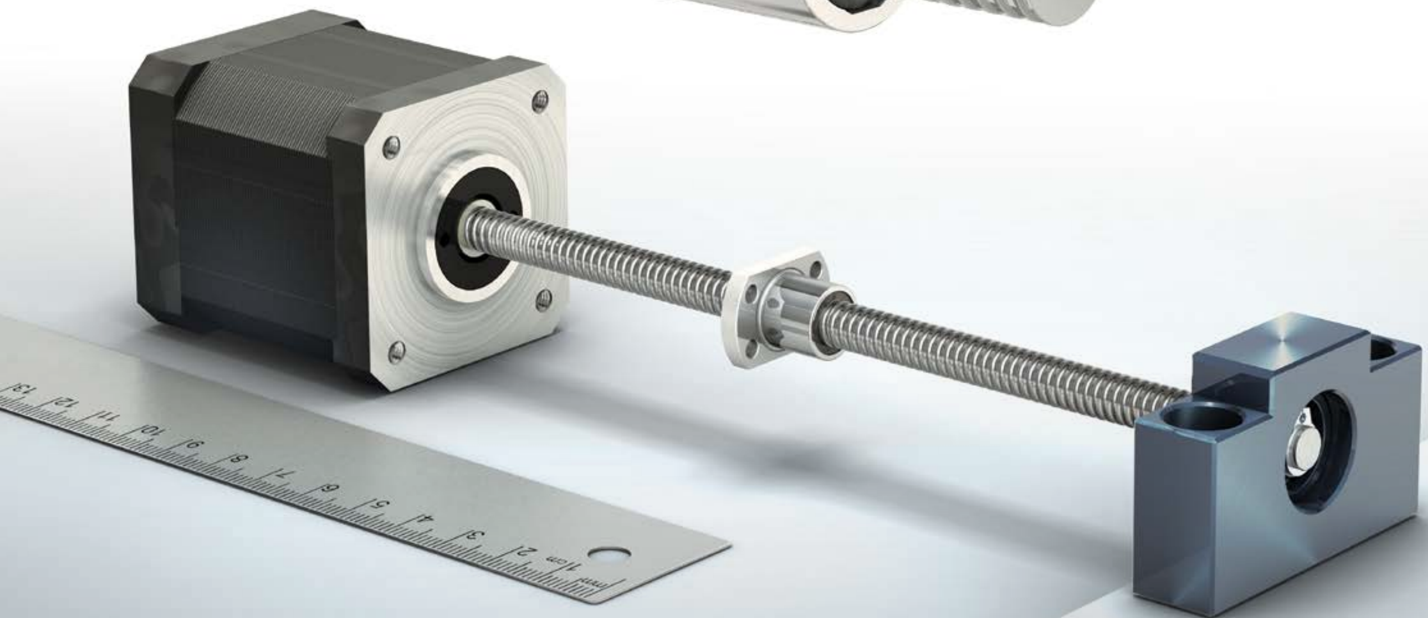
Miniature Metric BALL SCREW Assemblies

Linear Motion Solutions



Configure Online at
pbclinear.com

+1.800.962.8979

PBC Linear®

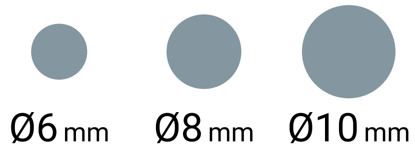
Supreme Performance in Small-Scale Applications

Miniature ball screw assemblies from PBC Linear have a range of leads with small screw diameters for high precision linear motion. Our ball screws are precision-rolled to achieve lead accuracy and consistency over the full length of the screw, making them a critical asset to laboratory machines, medical devices, and mechatronic applications.

Ball screws from PBC Linear are manufactured in America, avoiding the long lead times associated with overseas shipping.

Available Sizes

- 5 metric sizes, measured in diameters x leads:
  - 6 x 1
  - 8 x 1
  - 8 x 2
  - 8 x 2.5
  - 10 x 2



- Standard and special machined journals available
- End support blocks and bearings available

Compact Nut

Our compact nut designs utilize internal returns to minimize the nut size and provide quiet motion.

Standard Features:

- Flanged and cylindrical nut configurations
- Maximum of 0.05 mm backlash
- High axial load capacities

Optional Features:

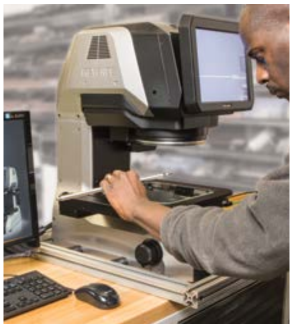
- Contact PBC Application Engineering about reduced backlash options.

State of the Art Metrology & Inspection

Our commitment to thorough testing is applied to our line of ball screw assemblies.

Metrology Devices include:

- Keyence optical comparator
- Mitutoyo thread form tracer
- Custom dynamic lead checker



Ball Screw Design Considerations

Wipers & Contamination Protection

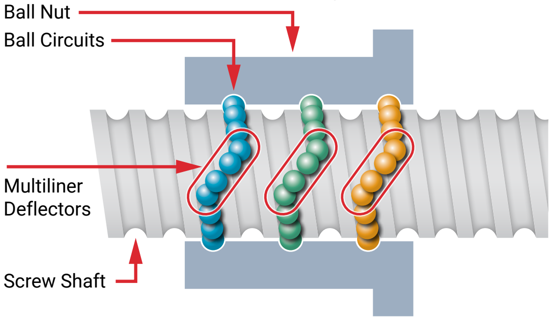
Wipers are located at each end of the nut to help prevent the ingress of debris and particulates that could damage the internal balls and affect the ball screw and nut performance.

The wipers are designed to provide tight clearances that maximize contamination protection without adding drag or increased friction to the assembly.

Internal Ball Screw Return Systems

Ball screw nuts use an internal ball return that guides each turn of balls back to the same threads creating ball circuits within the nuts.

Multiliner System



Lubrication

Nuts and screws are shipped with only a light anti-rust protective coating applied. This anti-rust coating should be removed with a clean solvent wash and then a lubricant applied that is specific to your application and maintenance preferences.

Common, general-use lubricants would be a lithium based NLGI 2 grease with an EP additive (Example: Mobil Mobilux EP 2) or an oil such as Mobil DTE heavy medium oil.

Table of Contents

Miniature Ball Screw Applications

Defense

Ball screws meet the required precision and accuracy for various controls and guidance systems. Light weight and compact, ball screws are ideal for tight spaces and provide predictable reliability in critical applications.

Medical

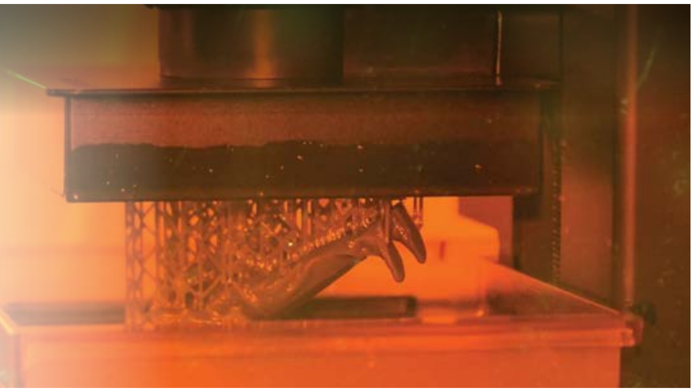
High load capacity in a small footprint (load density) is a requirement for many medical applications. Ball screws are ideal for medical applications where clean, quiet and smooth operation is critical.

Lab Automation

Testing and automation equipment requires high performance components capable of accurate and repeatable positioning.

3D Printing

Premium 3D printing equipment requires high accuracy ball screw assemblies built with minimal backlash to produce repeatable quality parts.

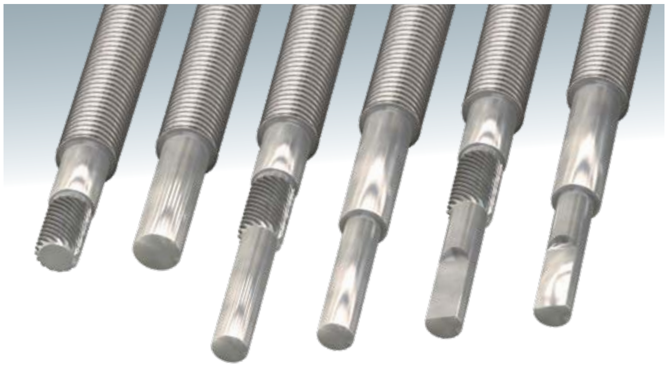


American Made

USA Made* & Tested

Our ball screw production process offers shorter lead times, avoiding costly downtimes and delays getting to market!
Standard ball screws and nuts ship assembled together, but can be ordered separetely.

Machined End Customization



Contact PBC Linear about custom machining options available at sales@pbclinear.com or call +1.815.389.5600.

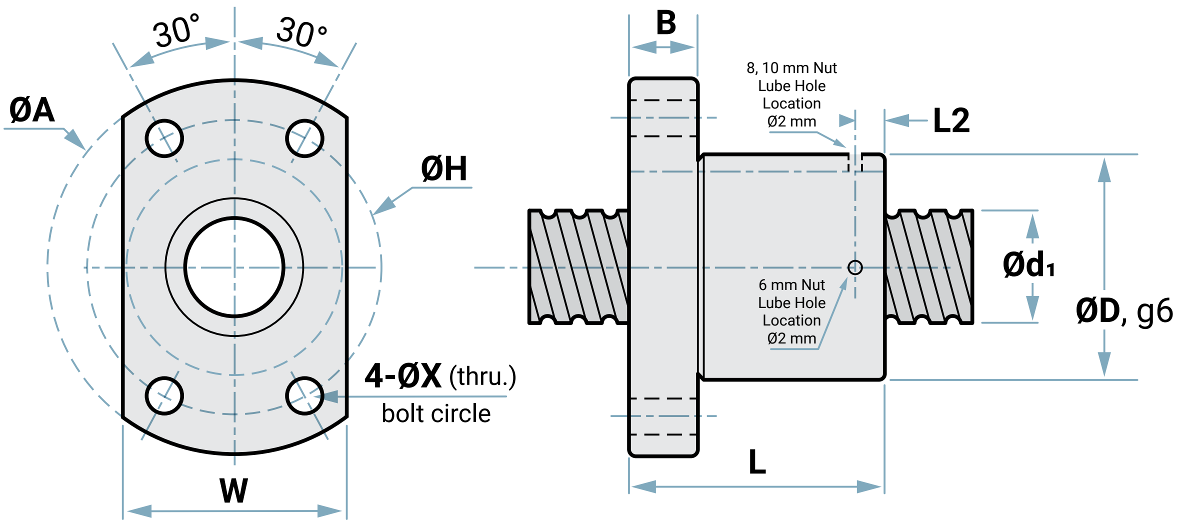
PBC Linear has a Wide Range of Linear Solutions to Fit Your Application

	Lead Screw	Ball Screw	Simplicity Bearings	Roller Pillow Block	Cam Roller	Glide Surface	Integral-V	Mechatronics Systems
Inexpensive	●	●	●	●	●	●	●	●
Low Maintenance	●	●	●	●		●		●
Compact Size	●	●				●		●
Low Noise	●		●					●
Multiple Configurations	●	●	●	●	●	●	●	●
Washdown Applications	●		●			●		●
Custom Design Support	●	●	●	●	●	●	●	●
Moderate to High Speed	●	●	●	●	●	●	●	●
Vacuum & Cleanroom Applications	●	●**	●			●		●
Food Processing	●	●**	●	●		●		
Ease of Installation	●	●			●		●	●

* PBC Linear ball screws are made in America using both domestic and foreign material sources.
** Only with special lubricants

Flange Ball Screw and Nut Sets

Ø10 x 2 | Ø8 x 2.5 | Ø8 x 2 | Ø8 x 1 | Ø6 x 1



Dimensions

Dia.x Lead mm	ØD mm	ØA mm	B mm	L mm	L2 mm	ØH mm	W mm	ØX mm
6 x 1	12	24	3.5	15	2.4	18	16	3.4
8 x 1	14	27	4.0	16	3.2	21	18	3.4
8 x 2	14	27	4.0	16	2.1	21	18	3.4
8 x 2.5	16	29	4.0	26	4.8	23	20	3.4
10 x 2	18	35	5.0	28	5.3	27	22	4.5

Load Ratings

Dia.x Lead mm	**Static** C_{oa}(kN)	**Dynamic** C_a(kN)
6 x 1	0.97	0.74
8 x 1	1.34	0.90
8 x 2	1.70	1.32
8 x 2.5	1.70	1.32
10 x 2	2.18	1.49

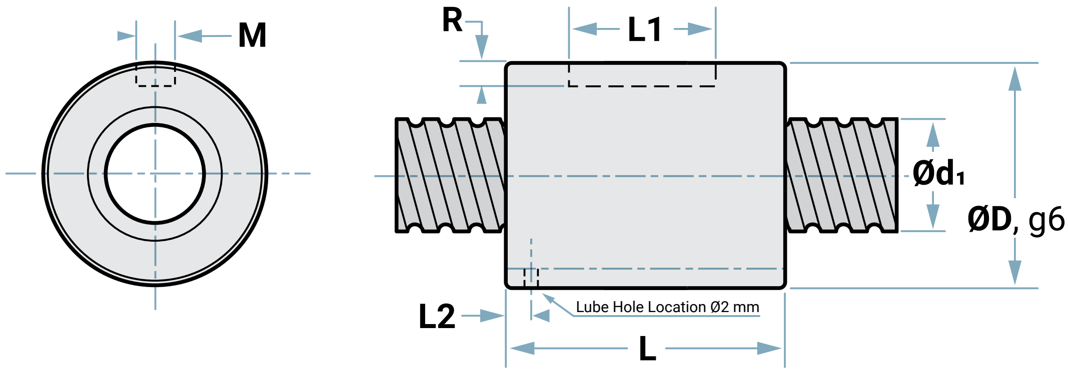
Geometry

Dia.x Lead mm	**Screw OD** d_1 (mm)	**Screw Root Ø** d_2 (mm)	**Lead** P_h (mm)	**Ball Diameter** D_w (mm)	**Starts x Circuits**
6 x 1	5.95	5.37	1.0	0.8	1 x 3
8 x 1	7.95	7.29	1.0	0.8	1 x 4
8 x 2	7.95	7.08	2.0	1.2	1 x 3
8 x 2.5	7.95	7.07	2.5	1.2	1 x 3
10 x 2	9.95	9.09	2.0	1.2	1 x 3

Note: The static and dynamic load ratings of PBC Linear balls crews were determined by the ISO 3408 standard calculations.
The dynamic load rating, $\mathbf{C_a}$, is the load at which 90% of properly lubricated identical ball screws will reach 1 x 10^6 revolutions.
The static load rating, $\mathbf{C_{oa}}$, is an axial static load which will produce a permanent deformation at contact points of the steel balls to ball grooves equal to 0.01% of the ball diameter.

Cylindrical Ball Screw and Nut Sets

Ø10 x 2   Ø8 x 2.5   Ø8 x 2   Ø8 x 1   Ø6 x 1



Dimensions

Dia.x Lead mm	ØD mm	L mm	L1 mm	L2 mm	M x R (P9) mm
6 x 1	12	15	8	2.4	1.92 x 1.2
8 x 1	14	16	8	3.4	1.92 x 1.2
8 x 2	14	16	8	2.1	1.92 x 1.2
8 x 2.5	16	26	10	4.8	2.92 x 2.0
10 x 2	18	28	10	5.3	2.92 x 1.2

Load Ratings

Dia.x Lead mm	Static C_{oa}(kN)	Dynamic C_a(kN)
6 x 1	0.97	0.74
8 x 1	1.34	0.90
8 x 2	1.70	1.32
8 x 2.5	1.70	1.32
10 x 2	2.18	1.49

Geometry

Dia.x Lead mm	Screw OD d_1 (mm)	Screw Root Ø d_2 (mm)	Lead P_h (mm)	Ball Diameter D_w (mm)	Starts x Circuits
6 x 1	5.95	5.37	1.0	0.8	1 x 3
8 x 1	7.95	7.29	1.0	0.8	1 x 4
8 x 2	7.95	7.08	2.0	1.2	1 x 3
8 x 2.5	7.95	7.07	2.5	1.2	1 x 3
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Part Number Configurator

Type	Thread Dir.	Diameter and Lead	Accuracy Class	Screw Type		Overall Screw Length		Nut	Nut Fit			Left End		Right End		Encoder Option
BS	R	00000	S	RU	-	0000	-	L	S	N	-	000	-	AFA	-	E

Type
BS - Ball Screw

Thread Direction
R - Right Hand Thread

Diameter and Lead
0601A - 6 mm dia., 1 mm lead
0801A - 8 mm dia., 1 mm lead
0802A - 8 mm dia., 2 mm lead
08025 - 8 mm dia., 2.5 mm lead
1002A - 10 mm dia., 2 mm lead

Accuracy Grade
S - PBC Linear Standard

Type of Screw
RU - Rolled

Screw Length
Metric - 0000 mm

Type of Nut
L - Flanged on Left
R - Flanged on Right
C - Cylindrical

Backlash
S - Standard
(0.05 mm MAX)

Not Used
N - Unused

Left End Only
080 - NEMA 8 Motor (16 mm)
(Requires a 6 mm screw)
Not available with encoder ready option.
111 - NEMA 11 Motor (23 mm)
(Requires a 6 mm screw)
140 - NEMA 14 Motor (31 mm)
(Requires a 6 mm, 8 mm, or 10 mm screw)
171 - NEMA 17 Motor (43 mm), Single Stack
(Requires a 6 mm, 8 mm, or 10 mm screw)
172 - NEMA 17 Motor (43 mm), Double Stack
(Requires a 10 mm screw)
231 - NEMA 23 Motor (56 mm), Single Stack
(Requires a 10 mm screw)
232 - NEMA 23 Motor (56 mm), Double Stack
(Requires a 10 mm screw)
23P - NEMA 23 Motor (56 mm), Power Plus
(Requires a 10 mm screw)

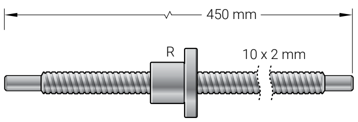
Encoder
E - Encoder Ready
N - No Option

Left and/or Right Ends
AFN - Float Journal
AFA - Float Journal and Bearing Block-Axial Mount
AFB - Float Journal and Bearing Block-Base Mount
ALN - Fixed Journal
ALA - Fixed Journal and Bearing Block-Axial Mount
ALB - Fixed Journal and Bearing Block-Base Mount
BFN - Float Journal with Drive Extension
BFA - Float Journal with Drive Extension and Bearing Block-Axial Mount
BFB - Float Journal with Drive Extension and Bearing Block-Base Mount
BLN - Fixed Journal w/Drive Extension
BLA - Fixed Journal w/Drive Extension and Bearing Block-Axial Mount
BLB - Fixed Journal w/Drive Extension and Bearing Block-Base Mount
CFN - Float Journal w/Drive Extension-w/Flat
CFA - Float Journal w/Drive Extension-w/Flat and Bearing Block-Axial Mount
CFB - Float Journal w/Drive Extension-w/Flat and Bearing Block-Base Mount
CLN - Fixed Journal w/Drive Extension-w/Flat
CLA - Fixed Journal w/Drive Extension-w/Flat and Bearing Block-Axial Mount
CLB - Fixed Journal w/Drive Extension-w/Flat and Bearing Block-Base Mount
NNN - None

Note: Floating option bearing blocks not available for 6 mm ball screws
Standard Ball Screw assemblies come assembled. Also available as unassembled.

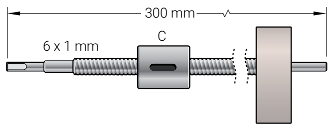
Sample Part Numbers

Left Right



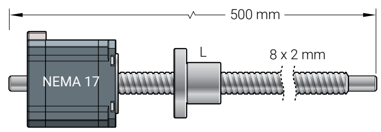
BSR1002ASRU-0450-RSN-AFN-AFN-N

Left Right



BSR0601ASRU-0300-CSN-CFN-BFB-N

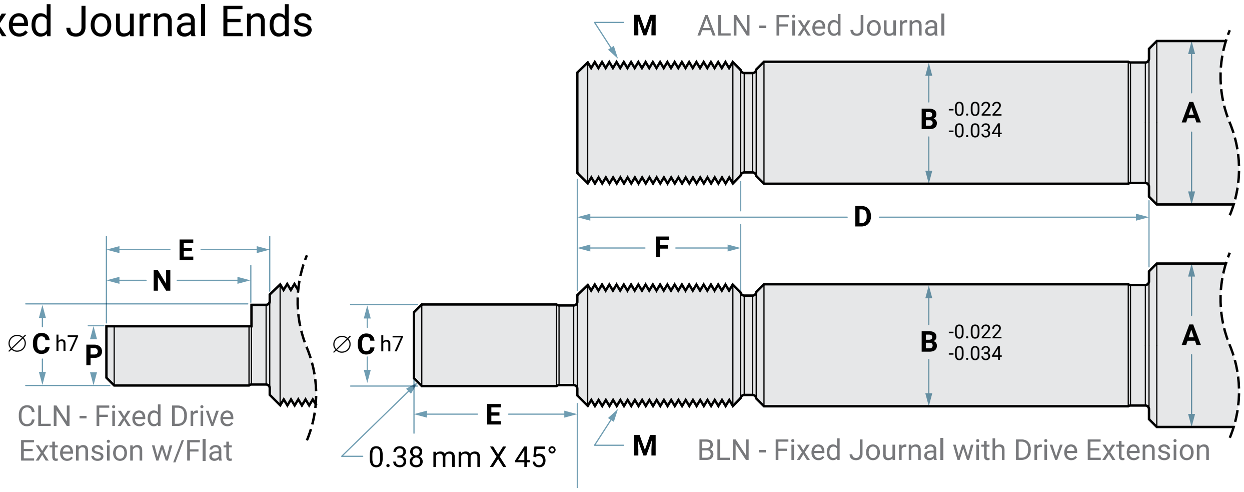
Left Right



BSR0802ASRU-0500-LSN-171-AFN-E

Machined Ends for Bearing Blocks

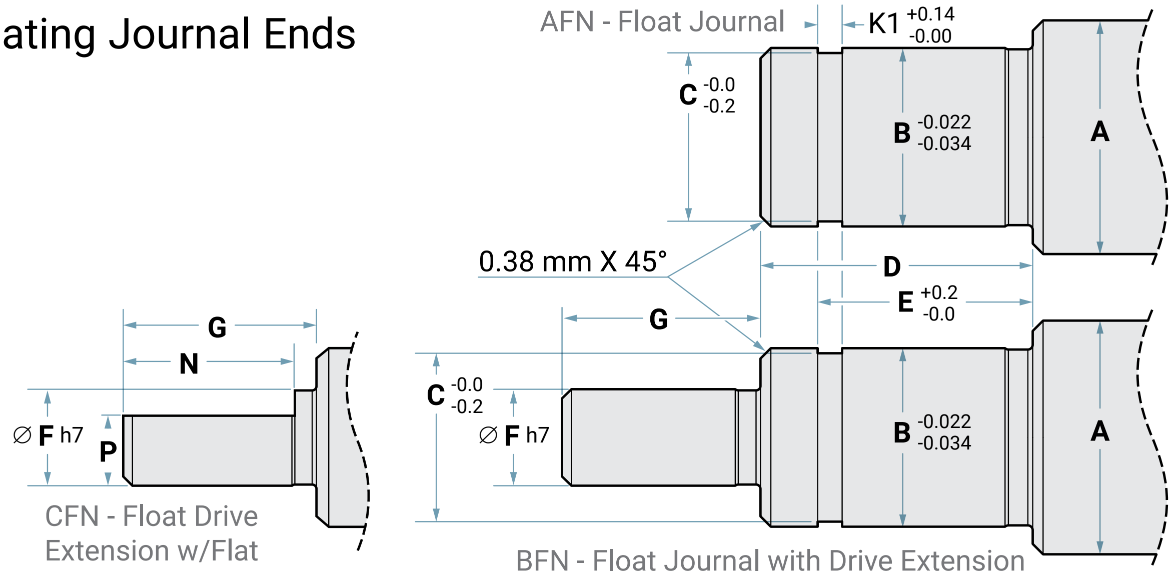
Fixed Journal Ends



Dimensions

End Block	A mm	B mm	C mm	D mm	E mm	F mm	M	N mm	P mm
EK05 FK05	8	5	4	23	6	7	M5 x 0.50-6g	5	3.5
EK06 FK06	8	6	4	28	8	8	M6 x 0.75-6g	7	3.5
EK08 FK08	10	8	6	32	9	10	M8 x 1.00-6g	8	5.5

Floating Journal Ends



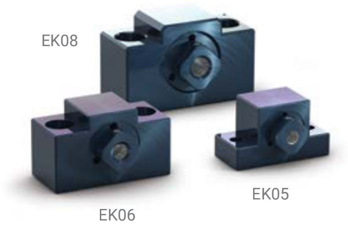
Dimensions

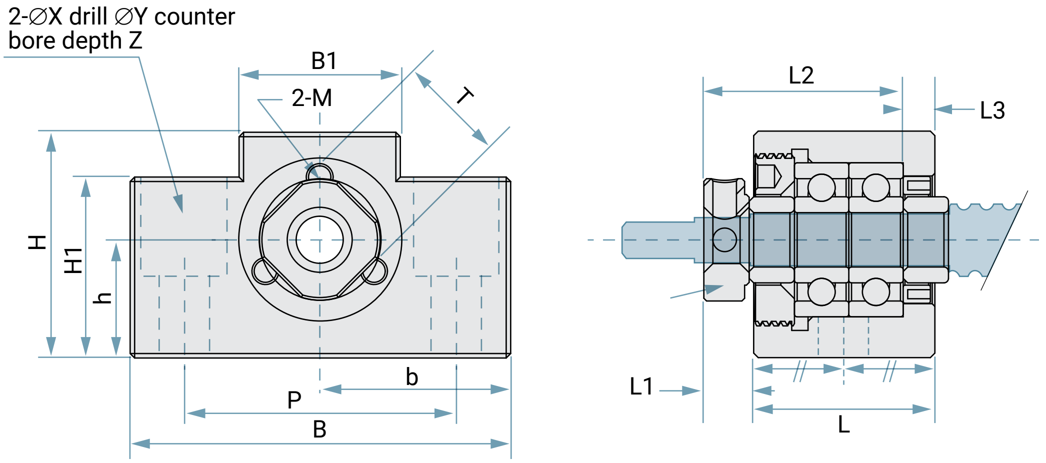
End Block	A mm	B mm	C mm	D mm	E mm	K1 mm	F mm	G mm	N mm	P mm
EF06 FF06	8	6	5.7	9	6.8	0.8	4	8	7	3.5
EF08	10	6	5.7	9	6.8	0.8	4	8	7	3.5
EF10 FF10	10	8	7.6	10	7.9	0.9	6	9	9	5.5

Note: Contact Application Engineer regarding Grade of journal.

Fixed Bearing Blocks

EK Base Mount Fixed Bearing Blocks



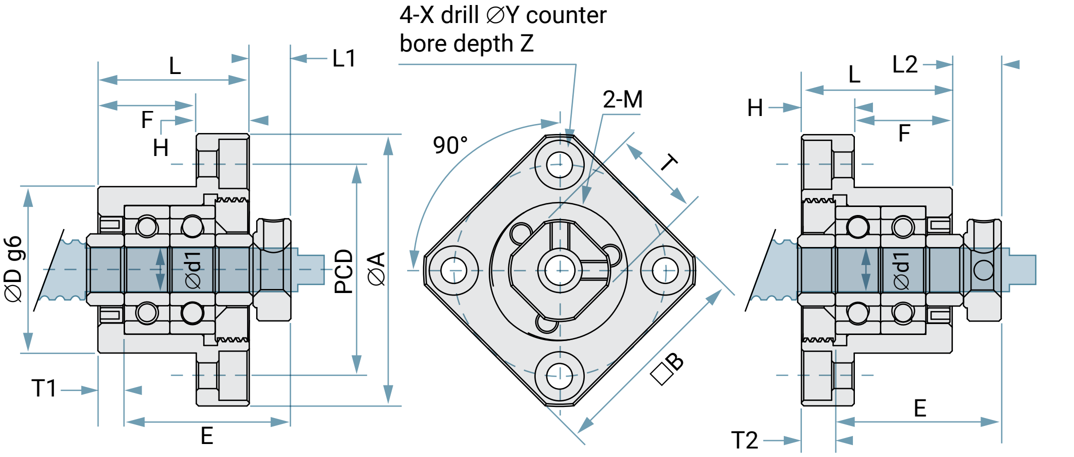


Supported Journals:
ALN - Fixed Journal End
BLN - Fixed Journal End with Drive Extension
CLN - Fixed Journal End with Drive Extension/Flat

Dimensions

Model No.	d1 Journal Diameter	L mm	L1 mm	L2 mm	L3 mm	B mm	H mm	b ±0.02	h ±0.02	B1 mm	H1 mm	P mm	X mm	Y mm	Z mm	M mm	T mm	Weight Kgs
BSBLEB-05MMP	5	16.5	5.5	18.5	3.5	36	21	18	11	20	8	28	4.5	-	-	M3	11	0.10
BSBLEB-06MMP	6	20	5.5	22	3.5	42	25	21	13	18	20	30	5.5	9.5	11	M3	12	0.15
BSBLEB-08MMP	8	23	7.0	26	4.0	52	32	26	17	25	26	38	6.6	11	12	M3	14	0.26

FK Axial Mount Fixed Bearing Blocks



Mounting Method A

Mounting Method B

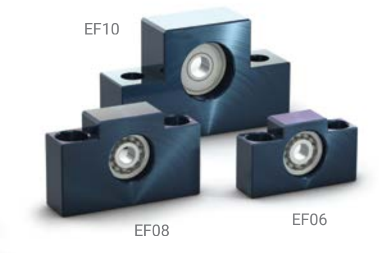
Supported Journals:
ALN - Fixed Journal End
BLN - Fixed Journal End with Drive Extension
CLN - Fixed Journal End with Drive Extension/Flat

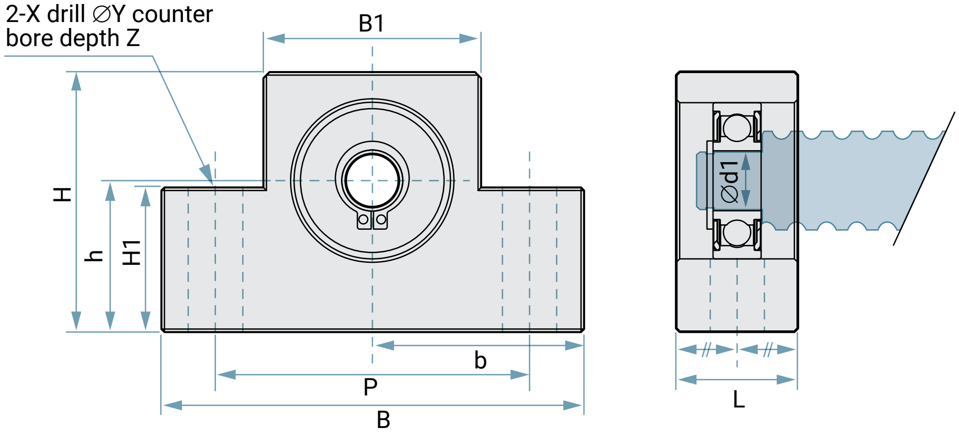
Dimensions

Model No.	d1 Journal Diameter	L mm	H mm	E mm	Dg6 -0.007 -0.02	A mm	PCD mm	B mm	Mounting A L1	Mounting A T1	Mounting B L2	Mounting B T2	X mm	Y mm	Z mm	M mm	T mm	Weight Kgs
BSALEB-05MMP	5	16.5	6	18.5	20	34	26	26	5.5	3.5	5	3	3.4	6.5	3.5	M3	11	0.08
BSALEB-06MMP	6	20	7	22	22	36	28	26	5.5	3.5	6.5	4.5	3.4	6.5	4	M3	12	0.10
BSALEB-08MMP	8	23	9	26	28	43	35	35	7	4	8	5	3.4	6.5	4	M3	14	0.15

Floating Bearing Blocks

EF Base Mount Floating Bearing Blocks



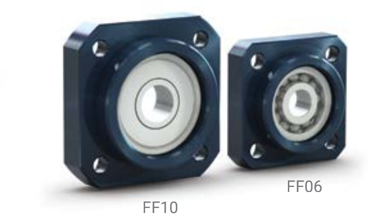


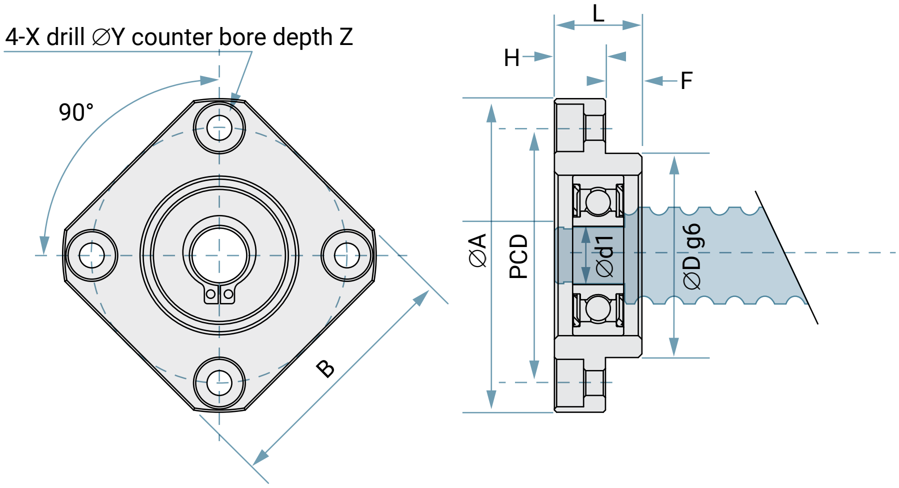
Supported Journals:
AFN - Float Journal End
BFN - Float Journal End with Drive Extension
CFN - Float Journal End with Drive Extension/Flat

Dimensions

Model No.	d1 Journal Diameter	L mm	B mm	H mm	b ±0.02	h ±0.02	B1 mm	H1 mm	P mm	X mm	Y mm	Z mm	Bearing mm	Snap Ring mm	Weight Kgs
BSBFEB-06MMP	6	12	42	25	21	13	18	20	30	5.5	9.5	11	606ZZ	S 06	0.10
BSBFEB-08MMP	6	14	52	32	26	17	25	26	38	6.6	11	12	606ZZ	S 06	0.15
BSBFEB-10MMP	8	20	70	43	36	25	36	24	52	9	-	-	608ZZ	S 08	0.33

FF Axial Mount Floating Bearings Blocks





Supported Journals:
AFN - Float Journal End
BFN - Float Journal End with Drive Extension
CFN - Float Journal End with Drive Extension/Flat

Dimensions

Model No.	d1 Journal Diameter	L mm	H mm	F mm	Dg6 -0.007 -0.02	A mm	PCD mm	B mm	X mm	Y mm	Z mm	Bearing	Snap Ring	Weight Kgs
BSAFEB-06MMP	6	10	6	4	22	36	28	28	3.4	6.5	3.5	606ZZ	S 06	0.06
BSAFEB-10MMP	8	12	7	5	28	43	35	35	3.4	6.5	4	608ZZ	S 08	0.10

Calculating the Maximum Speed of a Ball Screw System

The maximum speed possible for a ball screw assembly depends on the ball screw diameter, the unsupported length of the ball screw, how the ball screw is supported, the type of lubrication system (oil or grease), and the construction of the ball return system in the ball nut.

I. Critical Speed of the Ball Screw

The critical speed of a ball screw is its first natural frequency. PBC Linear recommends operating below 80% of the ball screw's critical speed. The critical speed of a ball screw is dependent on its root diameter, its unsupported length, and how its ends are supported. Fig. 1 shows the 80% critical speed values for PBC ball screws corresponding to the formula below.

$$n_{max} = K \cdot 10^6 \cdot \frac{d_2}{l_a^2} \cdot S.F.$$

where:

n_{max} = maximum rotational speed (rpm)

K = factor for the type of ball screw supports (see fig. 2)

d_2 = screw thread root diameter (mm)

l_a = maximum unsupported length (mm) (see fig. 2)

$S.F.$ = safety factor 0.8

PBC Linear Ball Screws: 80% Critical Speeds

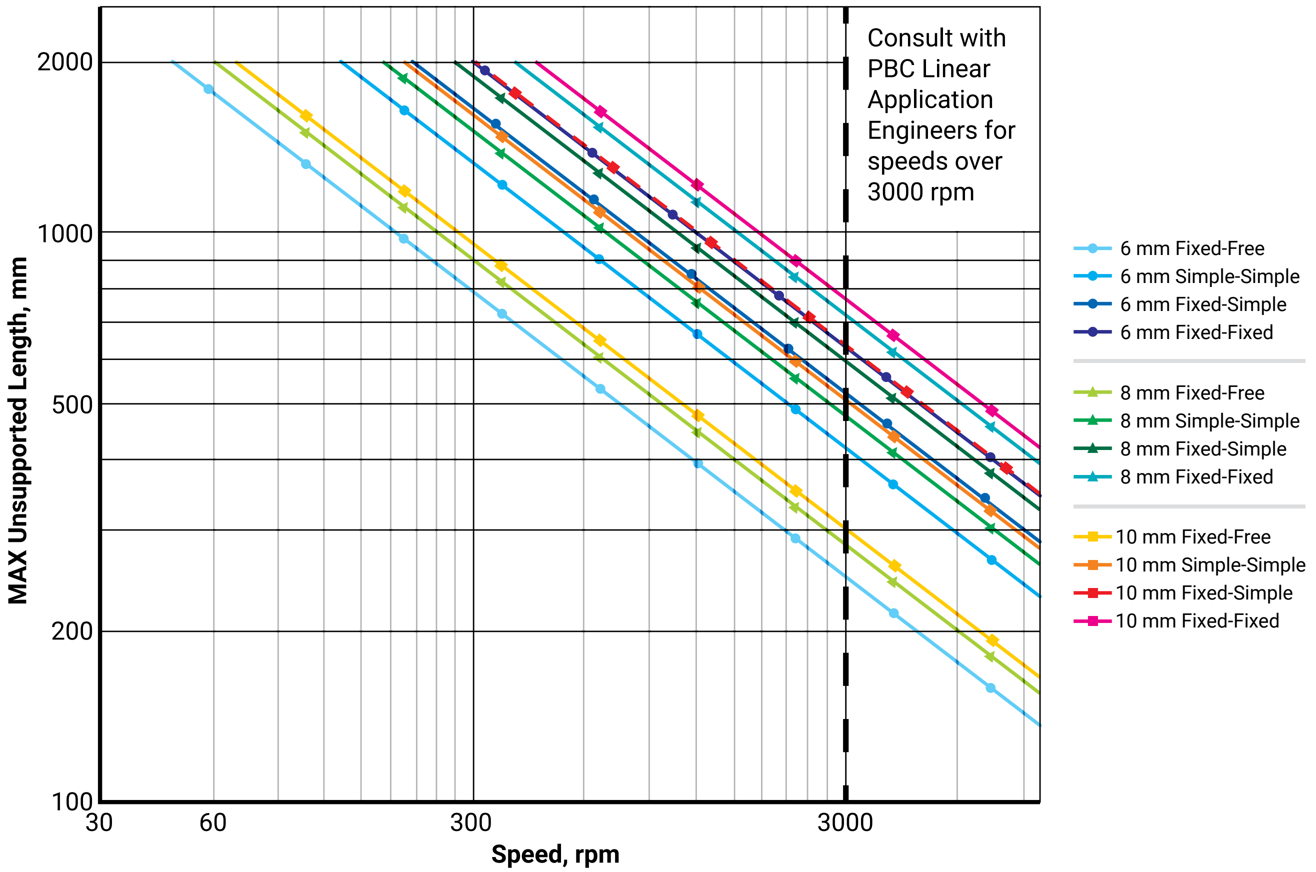


Figure 1

Types of Ball Screw Supports

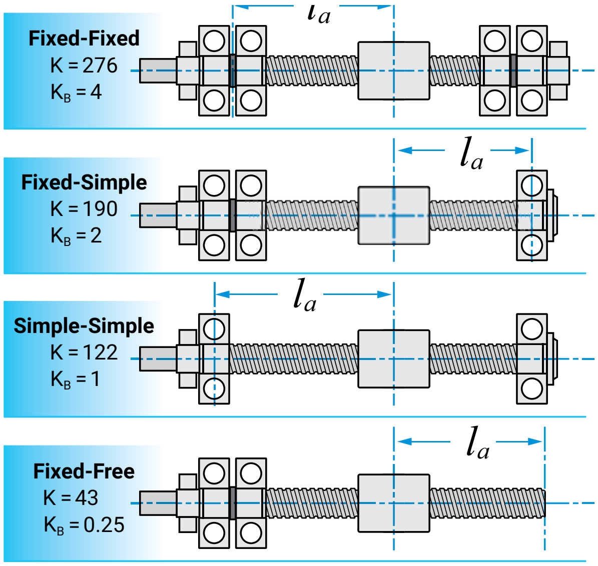


Figure 2

II. Maximum Speed of the Ball Return System
The rotational speed characteristic for ball nuts with multiliner ball returns and rolled ball screws. If the ball screw is relatively lightly loaded and it is properly lubricated, the maximum possible speed allowed by the ball return system can be estimated by the formulas below.

$$D_m \cdot N \leq 50{,}000$$

$$n_{max} = \frac{D_m \cdot N}{d_1}$$

where:

n_{max} = maximum rotational speed (rpm)

$D_m \cdot N$ = rotational speed characteristic of the ball return system (rpm • mm)

d_1 = ball screw's nominal (outside) diameter (mm)

Note: For maximum speeds greater than 3000 rpm, please consult with a PBC Linear Applications Engineer.

III. Maximum Traverse Speed
Once limiting n_{MAX} is found in I (Critical Speed) or II (Maximum Speed), the maximum traverse speed can be calculated using the formula below with the lower n_{MAX}:

$$V_{max} = \frac{n_{max} \cdot P_h}{60}$$

where:

V_{max} = maximum possible traverse speed (mm/sec)

P_h = thread lead (mm)

Maximum Static Loading Calculations

I. The maximum permissible static load, F_{per}

$$F_{per} = \frac{C_{0a}}{f_s} \; (N)$$

where:

F_{per} = maximum permissible static load derated for application conditions (N)

f_s = derate factor based on application conditions

Machine Type	Conditions	(f_s) Factor
General Machinery	No Vibration or Impacts	1.0 to 2.0
	with Vibration or Impacts	2.5 to 7.0
Machine Tools	No Vibration or Impacts	1.0 to 1.5
	with Vibration or Impacts	2.0 to 3.0

II. Permissible buckling force, F_B

Ball screws should be loaded in axial compression to levels below their maximum column loading. Exceeding the maximum column loading can result in instability due to screw bending or buckling.

$$F_B = \frac{K_B \cdot d_2^4}{S_B \cdot l_a^2} \cdot 10^5 \; (N)$$

where:

K_B = factor for end support designs (see fig.2)

d_2 = thread root diameter of the ball screw (mm)

S_B = factor of safety for buckling. Normally 2...4

l_a = maximum screw length acted upon by axial force (mm)

Calculating the Nominal Service Life L_{10} or L_h

The formula to calculate the service life that 90% of identical, properly lubricated ball screws are expected to reach is given below:

$$L_{10} = \left(\frac{C_a}{F_m}\right)^3 \cdot 10^6 \text{ (revolutions)}$$

where:

L_{10} = service life (revolutions)

C_a = dynamic load rating (N)

F_m = average axial load (N)

$$L_h = \frac{L_{10}}{n_m \cdot 60} \text{ (hours)}$$

where:

L_h = service life (hours)

n_m = average rotational speed (rpm)

In applications where vibration or impact loading is present, or if the application speed is very high, then the nominal life calculations can be adjusted as follows:

$$L_{10} = \left(\frac{C_a}{f_w \cdot F_m}\right)^3 \cdot 10^6 \text{ (revolutions)}$$

Load Drate Factor (f_w)

Vibration or Impact	(f_w) Factor
Minor	1.0 to 1.2
Low	1.2 to 1.5
Moderate	1.5 to 2.0
High	2.0 to 3.5

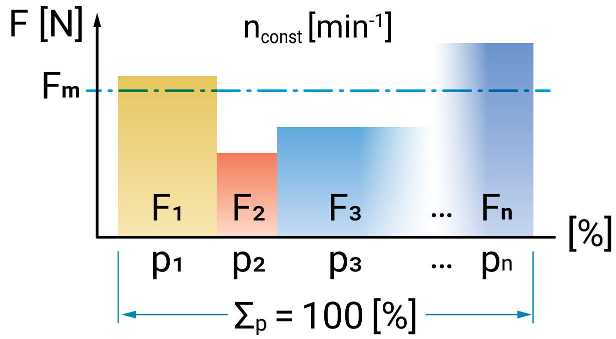
I. Average axial load F_m for constant rotational speed and varying axial load

$$F_m = \sqrt[3]{F_1^3 \cdot \frac{p_1}{100} + F_2^3 \cdot \frac{p_2}{100} + \cdots + F_n^3 \cdot \frac{p_n}{100}} \text{ (N)}$$

where:

$F_{1,2..n}$ = load per cycle unit (N)

$p_{1,2..n}$ = cycles (%)



$$L_{10} = \left(\frac{C_a}{F_m}\right)^3 \cdot 10^6 \text{ (revolutions)}$$

$$L_h = \frac{L_{10}}{n_m \cdot 60} \text{ (hours)}$$

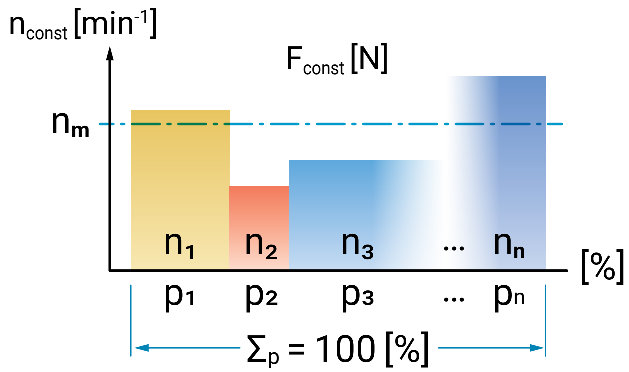
II. Average rotational speed at constant axial load F_{const} and variable rotational speed

$$n_m = n_1 \cdot \frac{P_1}{100} + n_2 \cdot \frac{P_2}{100} + \cdots + n_n \cdot \frac{P_n}{100} \ (rpm)$$

where:

$n_{1,2..n}$ = rotational speed per cycle unit (rpm)

$p_{1,2..n}$ = cycles (%)



$$L_{10} = \left(\frac{C_a}{F_{const}}\right)^3 \cdot 10^6 \ (revolutions)$$

$$L_h = \frac{L_{10}}{n_m \cdot 60} \ (hours)$$

III. Average axial force and average rotational speed when the axial load and the rotational speed vary between different values.

$$F_m = \sqrt[3]{\frac{F_1^3 \cdot \frac{p_1}{100} + F_2^3 \cdot \frac{p_2}{100} + \cdots + F_n^3 \cdot \frac{p_n}{100}}{n_m}} \ (N)$$

$$n_m = n_1 \cdot \frac{P_1}{100} + n_2 \cdot \frac{P_2}{100} + \cdots + n_n \cdot \frac{P_n}{100}$$

$$L_{10} = \left(\frac{C_a}{F_m}\right)^3 \cdot 10^6 \ (revolutions)$$

$$L_h = \frac{L_{10}}{n_m \cdot 60} \ (hours)$$

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