PBC Linear®

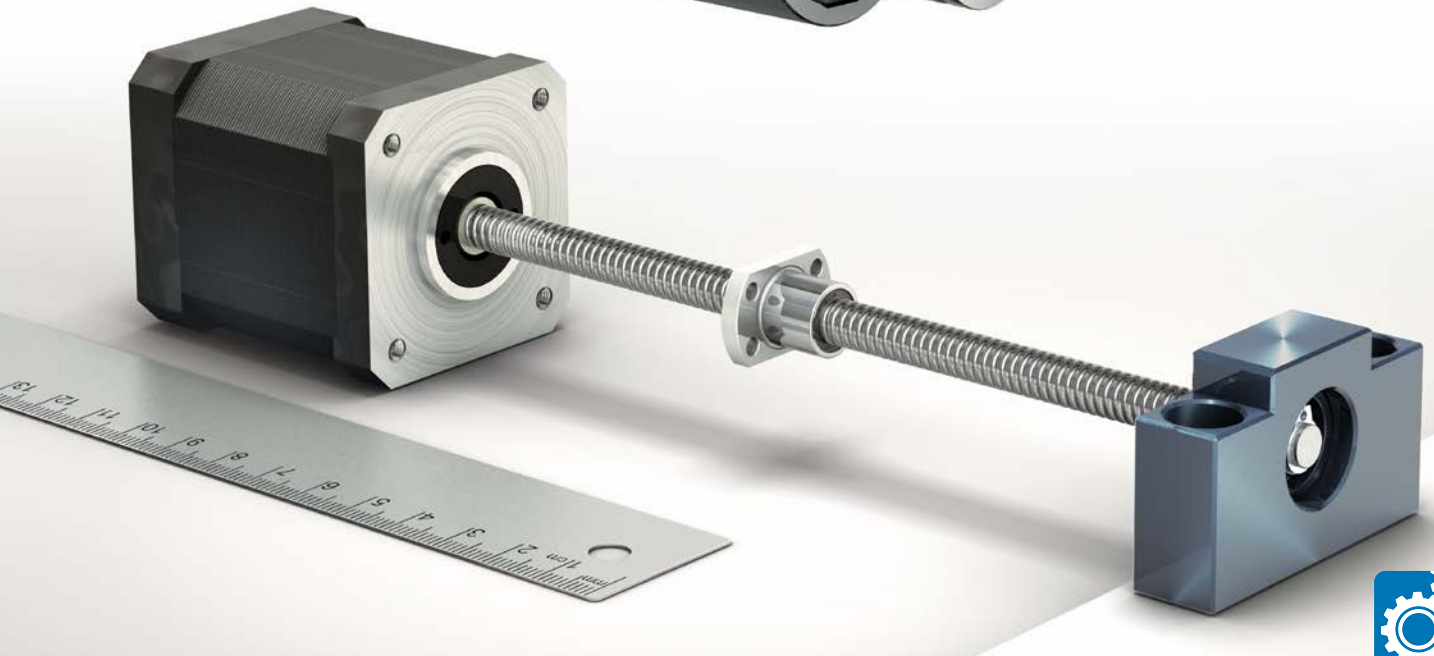
Miniature Metric BALL SCREW Assemblies

Linear Motion Solutions

6 mm

8 mm

10 mm



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PBC Linear

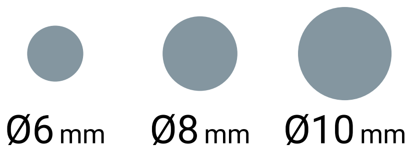
Supreme Performance in Small-Scale Applications

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.

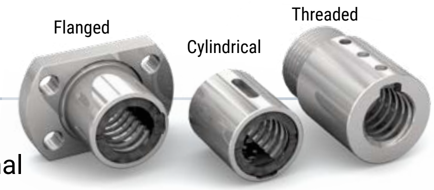
Available Sizes & Options

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



- 1050 steel ball screws
- Standard and special machined journals
- End support blocks and bearings
- Grade 5, 7, or 10 accuracy

Compact Nut



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

Standard Features:

- Flanged, cylindrical, and threaded nut configurations
- Maximum of 0.05 mm backlash as standard
- 100Cr6 steel nut bodies
- High axial load capacities

Ball Screw Nut Fit Options

Available options for ball screw nut fits include: **Reduced Backlash Ball Nuts** (<= 13 um or 0.0005") and **Transitional Fit Ball Nuts** (from <= 8 um backlash to < 3% preload) with miniature rolled ball screws.
Selection details on page 6.

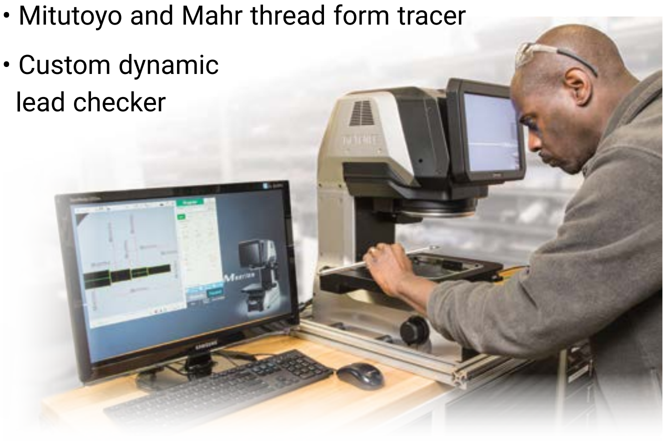
Different tolerance ranges for the **Journal Bearing Seats** are available. Standard tolerances used for precision fit of bearings on journals and additional clearance fits to make installation easier.
See page 10–11 for details.

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 and Mahr thread form tracer
- Custom dynamic lead checker



Ball Screw Design Considerations

Wipers & Contamination Protection

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

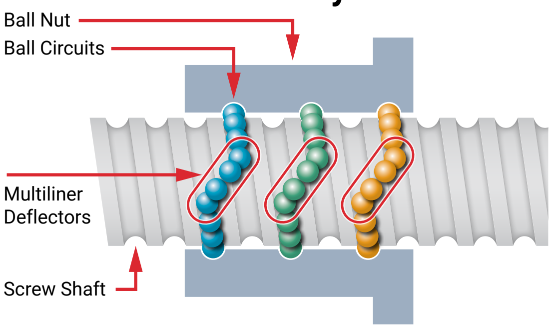
The wipers are designed to provide tight clearances that maximize contamination protection without adding drag or increased friction to the assembly.

Cylindrical nuts that have external threads do not have wipers.

Internal Ball Screw Return System

Ball screw nuts use an internal ball return that guides each turn of balls back to the same threads creating multiple 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 (Example: **Mobil® DTE™ Heavy Medium Oil**).

Do not use grease containing graphite, MoS_2, or other solid lubricating additives. See pages 32 and 33 for more information on lubrication options.

Operating Temperature Considerations

Understanding the thermal behavior of ball screws is essential for ensuring accuracy, longevity, and reliability in demanding applications and environments.

Ball screws typically operate within a temperature range of –20°C to +80°C (–4°F to +176°F) under standard conditions. Ball screw systems can tolerate higher and lower temperatures with specialized materials, lubricants, and seals.

Customers should verify a ball screw system has suitable performance and life in their application and with their lubricant, especially in extreme applications and environments.

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

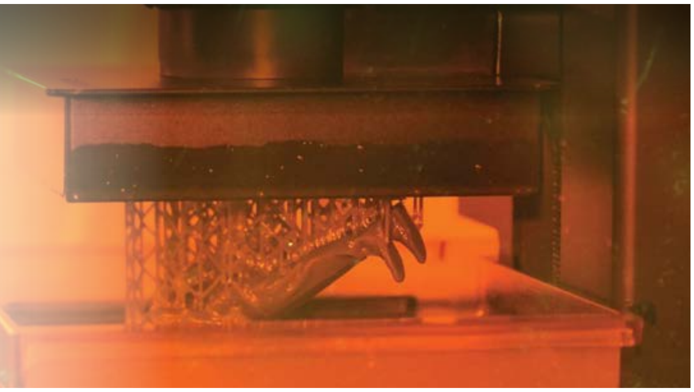
High load capacity in a small footprint (load density) is a requirement for many medical applications. Ball screws are ideal for medical applications where clean, quiet and smooth operation is critical.

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.

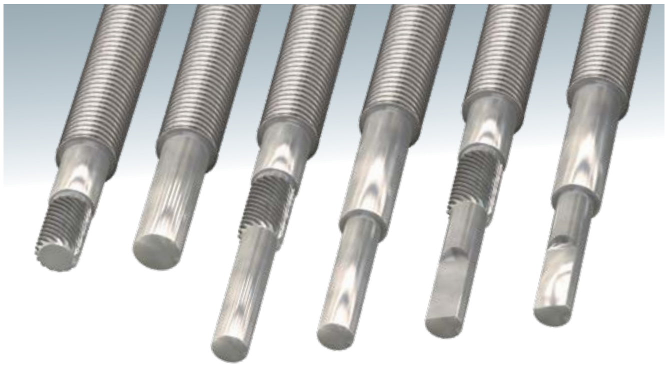


American Made

USA Manufactured* & Tested

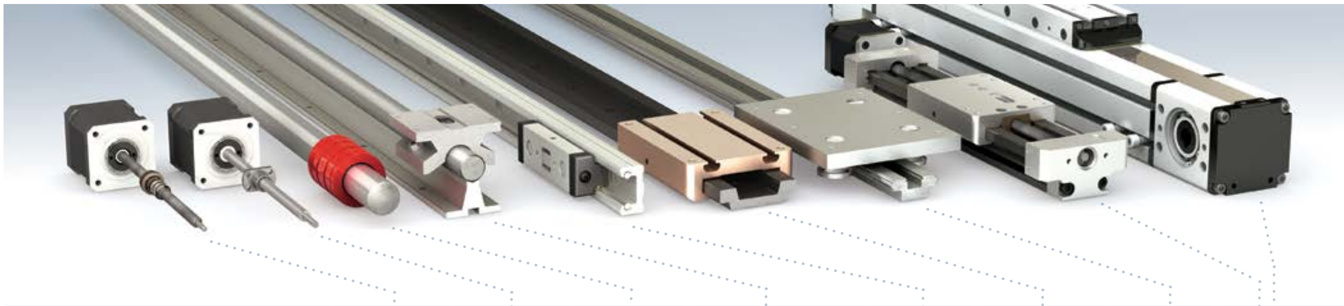
Our ball screw production process offers shorter lead times, avoiding costly downtimes and delays getting to market!
Standard ball screws and nuts ship assembled together, but can be ordered separately.

Machined End Customization



Contact PBC Linear about available custom machining options 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	Gliding 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

Part Number Configurator

Type	Thread Dir.	Diameter and Lead	Accuracy Class	Screw Type		Overall Screw Length		Nut Options	Nut Fit		Left End		Right End	Bearing Seat Ø	Encoder Option
BS	R	0000A	TX	R	-	0000	-	FL	S	-	000	-	AFA	–	E

Type
BS = Ball Screw

Thread Direction
R = Right Hand Thread

Diameter and Lead
0601A = 6 mm dia., 1 mm lead
0602A = 6 mm dia., 2 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*
TX = Grade 10, Transport
T7 = Grade 7, Transport
T5 = Grade 5, Transport
P5 = Grade 5, Positioning

Type of Screw
R = Rolled

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* **Reference ISO 3408-3** for more details about ball screw grades see page 15 for Permissible Deviations for Ball Screw Grades

Note: Floating option bearing blocks not available for 6 mm ball screws
Standard Ball Screw assemblies come assembled. Also available as unassembled.
Journal tolerances correspond to the ball screw grade accuracy.
Contact an Application Engineer for special journals

Screw Length
Metric = 0000 mm

Type of Nut
FL = Flanged on Left
FR = Flanged on Right
CN = Cylindrical
TL = OD Thread on Left
TR = OD Thread on Right

Backlash
S = Standard
(0.05 mm MAX)
R = Reduced Backlash
(0.013 mm MAX, no preload)
T = Transitional Fit
(0.008 mm MAX to <=3% preload)

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)
NNN = None

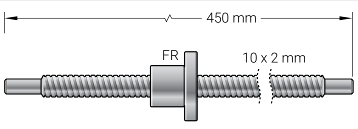
Encoder
E = Encoder Ready
N = No Option

Bearing Seat Dia. Tolerance
– = Standard Diameter Tol.
X = Increased Clearance Diameter Tol.

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

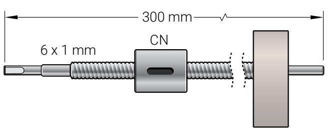
Sample Part Numbers

Left Right



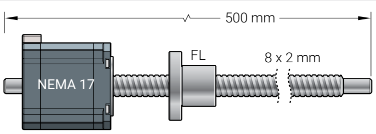
BSR1002ATXR-0450-FRS-AFN-AFN-N

Left Right

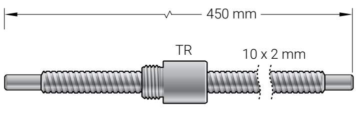


BSR0601AT7R-0300-CNS-CFN-BFB-N

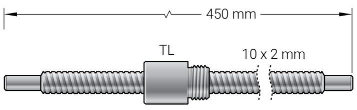
Left Right



BSR0802AP5R-0500-FLS-171-AFN-E



BSR1002AT7R-0450-TRS-AFN-AFN-N



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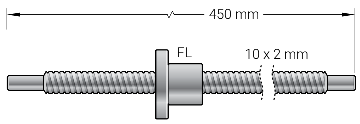

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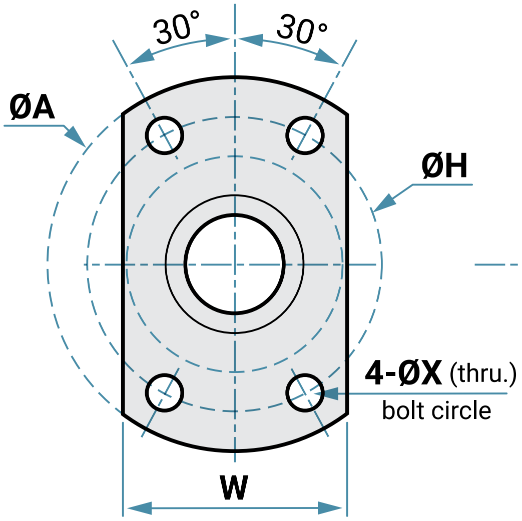
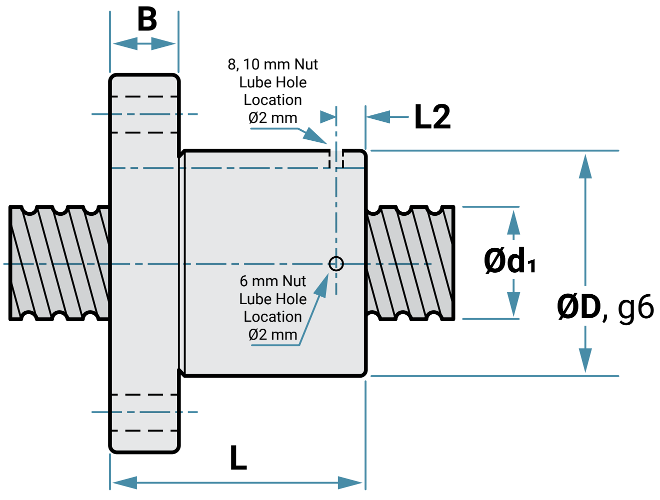
Flange Ball Nuts





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
6 x 2	12	24	4.0	17	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

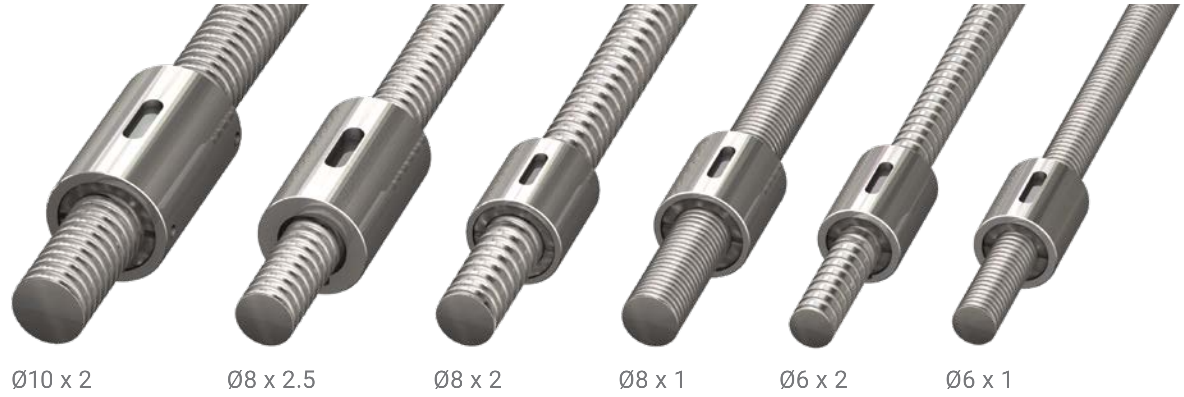
Dia. x Lead mm	Static C_{oa}(kN)	Dynamic C_a(kN)
6 x 1	0.97	0.74
6 x 2	1.14	1.05
8 x 1	1.34	0.90
8 x 2	1.70	1.32
8 x 2.5	1.70	1.32
10 x 2	2.18	1.49

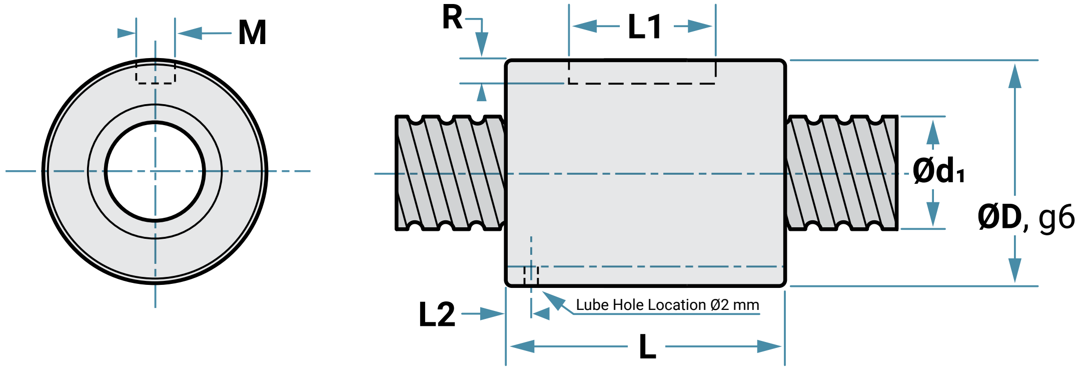
Geometry

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
6 x 2	5.95	5.13	2.0	1.2	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 Nuts





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	2 x 1.2
6 x 2	12	17	8	2.4	2 x 1.2
8 x 1	14	16	8	3.4	2 x 1.2
8 x 2	14	16	8	2.1	2 x 1.2
8 x 2.5	16	26	10	4.8	3 x 2.0
10 x 2	18	28	10	5.3	3 x 1.2

Load Ratings

Dia. x Lead mm	Static C_{oa}(kN)	Dynamic C_a(kN)
6 x 1	0.97	0.74
6 x 2	1.14	1.05
8 x 1	1.34	0.90
8 x 2	1.70	1.32
8 x 2.5	1.70	1.32
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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
6 x 2	5.95	5.13	2.0	1.2	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
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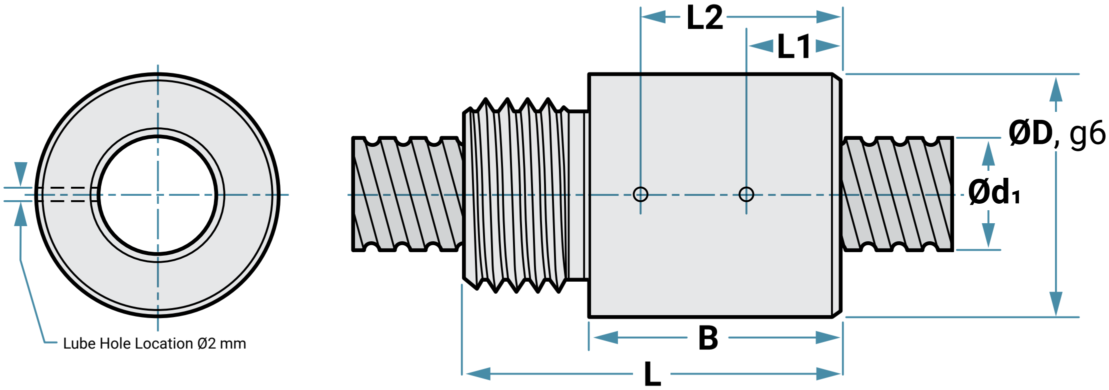
External Thread Ball Nuts

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



Dimensions

Dia. x Lead mm	ØD mm	B mm	L mm	L1 mm	L2 mm	External Thread mm
6 x 1	12.5	12	18	4.5	9.9	M10 x 1
6 x 2	16.0	14	22	6.4	11.7	M12 x 1
8 x 1	16.0	14	22	6.4	11.7	M14 x 1
8 x 2	16.0	17	25	2.1	8.9	M14 x 1
8 x 2.5	16.0	18	26	7.6	15.8	M14 x 1
10 x 2	18.0	20	28	8.9	18.0	M16 x 1

Load Ratings

Dia. x Lead mm	Static C_{oa}(kN)	Dynamic C_a(kN)
6 x 1	0.97	0.74
6 x 2	1.14	1.05
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
6 x 2	5.95	5.13	2.0	1.2	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: Cylindrical nuts that have external threads do not have wipers.
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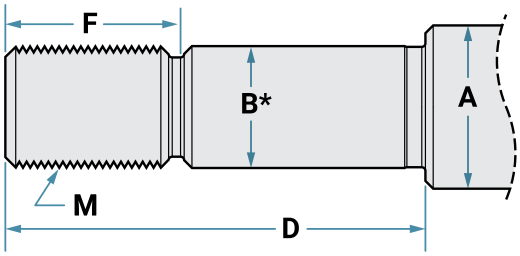
The static load rating, $\mathbf{C_{oa}}$, is an axial static load which will produce a permanent deformation at contact points of the steel balls to ball grooves equal to 0.01% of the ball diameter.

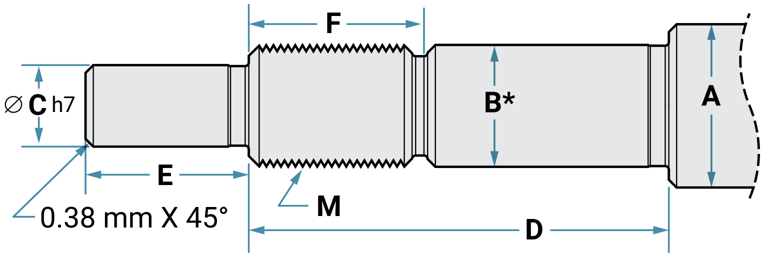
Machined Ends for Bearing Blocks

Fixed Journal Ends

ALN - Fixed Journal



BLN - Fixed Journal with Drive Extension

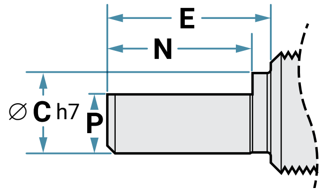


Fixed Journal Dimensions

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

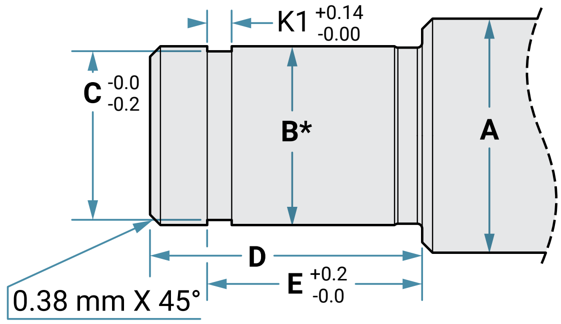
* See next page for journal tolerances based on screw size and accuracy.

CLN - Fixed Drive Extension w/Flat

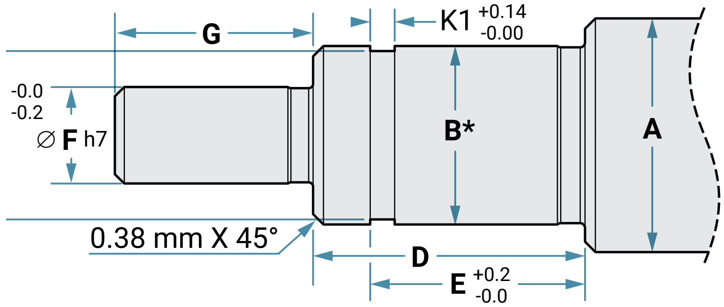


Floating Journal Ends

AFN - Float Journal



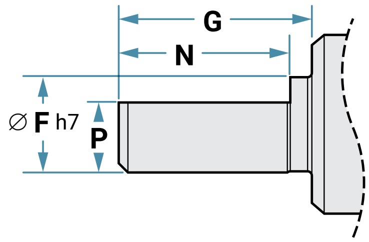
BFN - Float Journal with Drive Extension



Floating Journal Dimensions

A mm	B* mm	C mm	D mm	E mm	K1 mm	F mm	G mm	N mm	P mm	Available End Blocks
6	5	4.7	8	5.7	0.7	4	8	7	3.5	**None****
8	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	**EF10 FF10**

CFN - Float Drive Extension w/Flat



* See next page for journal tolerances based on screw size and accuracy.
** No standard end block, contact PBC Linear for custom end block options.

Note: Contact Application Engineer for special journals and/or special end blocks.

Machined End Journal Tolerances

Bearing Seat Tolerances Chart Dimension B

Journal tolerances based on ball screw size and grade accuracy.

Accuracy Grade	Style	Fitting	Tolerance
TX = Grade 10, Transport and **T7** = Grade 7, Transport	Turned	Standard h7	+0/-12 um for Journals from 3 mm to <= 6 mm dia. +0/-15 um for Journals from 6 mm to <= 10 mm dia.
		Optional f7	-10/-22 um for Journals from 3 mm to <= 6 mm dia. -13/-28 um for Journals from 6 mm to <= 10 mm dia.
T5 = Grade 5, Transport and **P5** = Grade 5, Positioning	Ground	Standard h6	+0/-8 um for Journals from 3 mm to <= 6 mm dia. +0/-9 um for Journals from 6 mm to <= 10 mm dia.
		Optional g6	-4/-12 um for Journals from 3 mm to <= 6 mm dia. -5/-14 um for Journals from 6 mm to <= 10 mm dia.

Ball Screw Nut Transfer Arbor

Reverse Ball Screw Nut Orientation

PBC Linear offers a Transfer Arbor for installation or removal of a ball screw nut from the ball screw. The Arbor aids in preventing the loss of ball bearings from the ball screw nut during the transition process.

See chart below for proper screw/lead to Arbor size.

Ordering Information

Ball Screw Size	Transfer Arbor Part No.
6 x 1	6090113
6 x 2	6090121
8 x 1	6090112
8 x 2 & 8 x 2.5	6090111
10 x 2	6090110

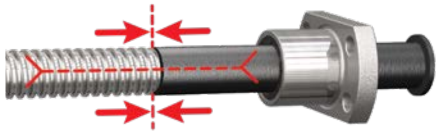
Ball Screw Handling Guidelines

Check that the area is clean before mounting. Dirt or foreign matter on a screw ball race or inside the nut may cause increased wear and premature failure. Please consult our lubrication recommendation before mounting or operating ball screws.

1. Remove the transport lock (cap) on one side.

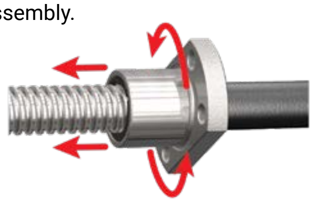
Make sure to keep spool piece and nut in a horizontal position; otherwise, the nut may slide off from the spool piece and balls may fall out of the ball race. In the event such an incident does occur, balls must be properly re-inserted. Otherwise, the ball screw might be damaged or not operate properly. If in doubt, please contact PBC Linear.

2. Insert the screw end up to the spool piece. The spool piece and screw must be held concentric to each other and against each other.



CAUTION: Operator must be able to advance the end of the spool piece up to the tread intake; otherwise, balls may fall out of the ball race and damage or block the assembly.

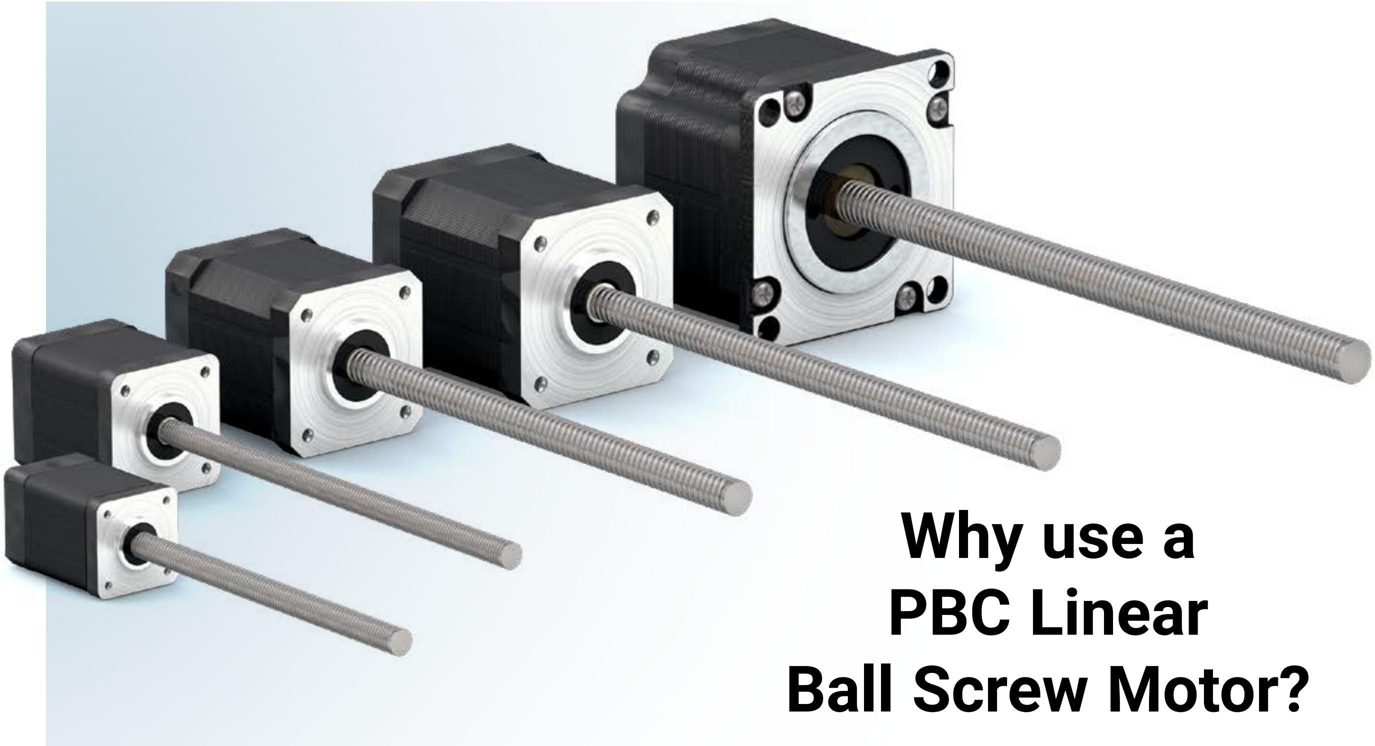
3. Gently turn the nut onto the screw.



CAUTION: Do not use grease containing graphite, MoS2, or other solid lubricating additives.

No Liability - Compliance with the above handling, mounting, and lubricating instructions is critically important. PBC Linear shall not be held liable for any loss or damage, whether direct, indirect, or consequential, resulting from the failure to observe all or any of said instructions or from inappropriate or deficient compliance therewith.

Ball Screw Motors



Why use a PBC Linear Ball Screw Motor?

Cost Reduction

Fusing the motor and screw together eliminates the need for a motor mount and coupling. This also reduces setup time.

Improved Performance

Built-in alignment of the motor and screw means direct out of the box precision.

Variety

Three nut styles choices and screw options, to cover many application needs.

Support & Customs

Not finding what you need or need a custom solution? PBC Linear has your engineering support covered!
Phone: 1-888-389-6266 or
pbc_applicationsengineering@pbclinear.com

PBC Linear ball screw motor products are designed based on the know-how technology of hybrid step motors, ball screws and nuts. The NEMA Series ball screw motors provide high torque, high precision, and high efficiency to fit the application needs of designers. The combination of ball screw motor styles, sizes, ball-screws and nuts, gives the freedom to use motors of different form factors to exactly fit in the application. And, it provides excellent performance with any drive and power supply.

- Five stepper motor frame Sizes: 8, 11, 14, 17, 23
- Multiple motor lengths and special PowerPlus motors, provide more than 10 different motor sizes
- Integrate any ball screw from PBC Linear
- Each frame size motor offers different standard ball screws
- Each frame size motor has different selections of nuts

PBC Linear has committed to product innovation design and technical improvement, with excellent product quality,application technology, fast and flexible services,which provide customers with high level motion control solutions.

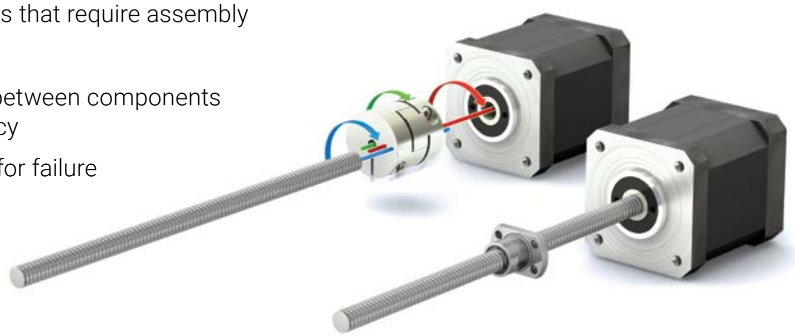
Hybrid Linear Ball Screw Actuator Selection Chart

Motor Frame	Screw Sizes		
	6 mm	8 mm	10 mm
NEMA 8	●		
NEMA 11	●		
NEMA 14	●	●	●
NEMA 17, Single Stack	●	●	●
NEMA 17, Double Stack		●	●
NEMA 23, Single Stack			●
NEMA 23, Double Stack			●
NEMA 23, Power Plus			●

Ball Screw to Motor Connection Method Matters

Traditional Motor/Screw Setup

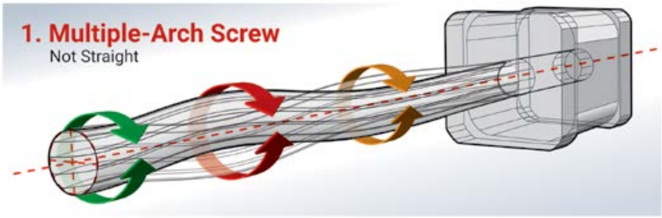
- Multiple components that require assembly
- Difficult to align
- Play and tolerance between components result in lost accuracy
- Increased potential for failure
- Higher costs

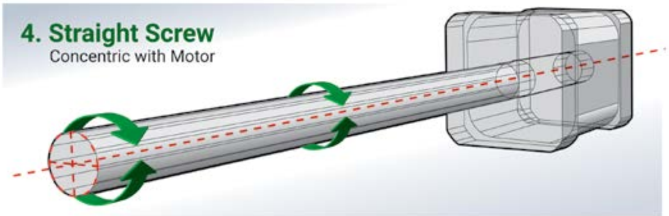


Integrated Hybrid Linear Actuator Setup

- Ball screw aligned and fixed directly with stepper motor
  - Fewer components
  - Greater accuracy
  - More reliable
  - Higher rigidity
  - Greater value

Common Ball Screw Straightness Issues





PBC Linear utilizes an automated straightening process and holds tight TIR tolerances to eliminate common ball screw run out and straightness issues

NEMA 8 Series Stepper Motor

Phases 2
Steps/Revolution 200
Step Accuracy .... ±5%
IP Rating 40

Approvals .... RoHS
Operating Temp. .... -20°C–+50°C
Insulation Class .... B (130°C)
Insulation Resistance .... 100 MΩ
Mechanical Axial Limit* .... 135 N

Step Motor - 4 Lead Bi-Polar

Motor Style	Motor Body Length (mm)	Electrical Connection	Rated Current (Amps)	Winding	
				Ohms	mH
				±10% at 20°C	Typical
NEMA 8	29.5	Plug In Connector	0.4	13.9	4

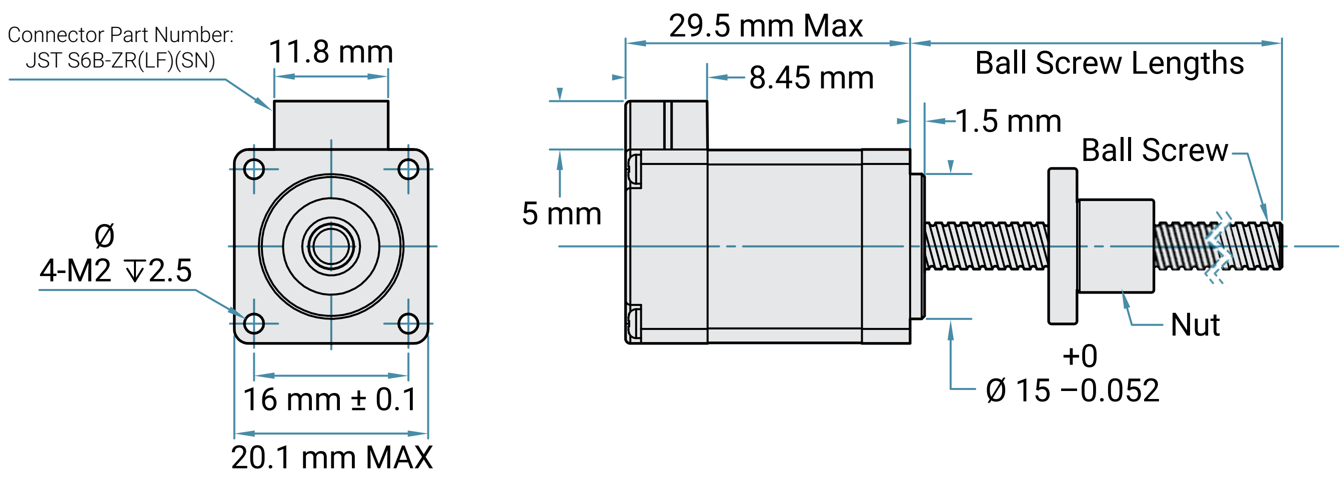
Ball Screw Style for NEMA 8 Series

Ball Screw Style	External Diameter	Lead	Travel Per 1.8° Step
0601A	6 mm	1 mm	0.005"
0602A		2 mm	0.010 mm

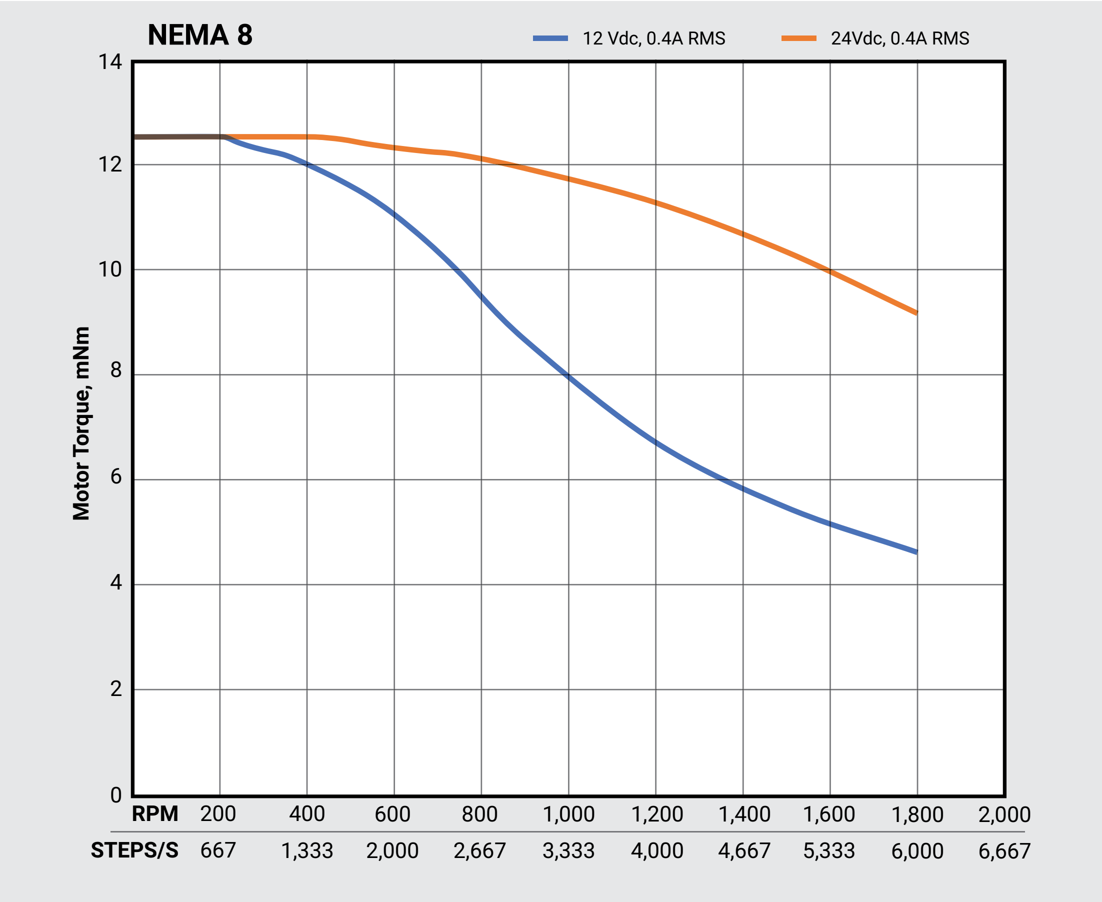
Note: See page 25 for wiring harness information and diagram.

***Motor Mechanical Limit Definition:** Since the motor output may exceed the force which the bearing can bear, so we take the motor bearing limit as the mechanical limit. Howerver, linear motor fatigue and resultant life are determined by each customer's unique application. Load, speed, frequency, temperature, stability of guidance mechanism, etc., should all be considered before choosing a linear motor.

NEMA 8 Series Stepper Motor



Speed Torque Curves



NEMA 11 Series Stepper Motor

Phases 2
Steps/Revolution 200
Step Accuracy .... ±5%
IP Rating 40

Approvals .... RoHS
Operating Temp. .... -20°C–+50°C
Insulation Class .... B (130°C)
Insulation Resistance .... 100 MΩ
Mechanical Axial Limit* .... 135 N

Step Motor - 4 Lead Bi-Polar

Motor Style	Motor Body Length (mm)	Electrical Connection	Rated Current (Amps)	Winding	
				Ohms	mH
				±10% at 20°C	Typical
NEMA 11	41	Plug In Connector	1	2.7	2.5

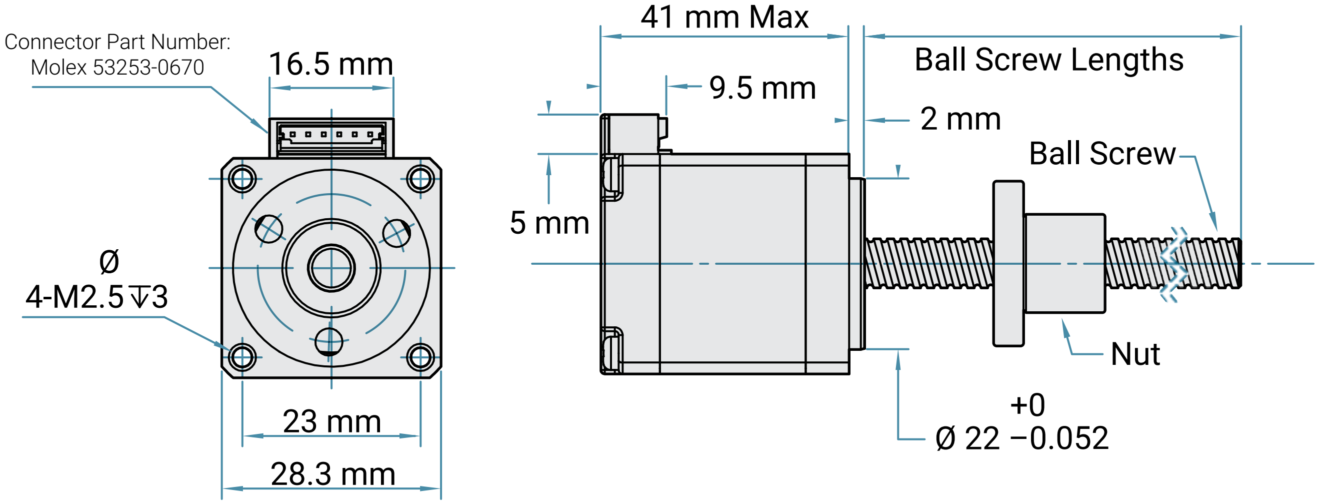
Ball Screw Style for NEMA 11 Series

Ball Screw Style	External Diameter	Lead	Travel Per 1.8° Step
0601A	6 mm	1 mm	0.005"
0602A		2 mm	0.005 mm
0801A	8 mm	1 mm	0.020 mm
0802A		2 mm	0.010 mm
08025		2.5 mm	0.0125 mm

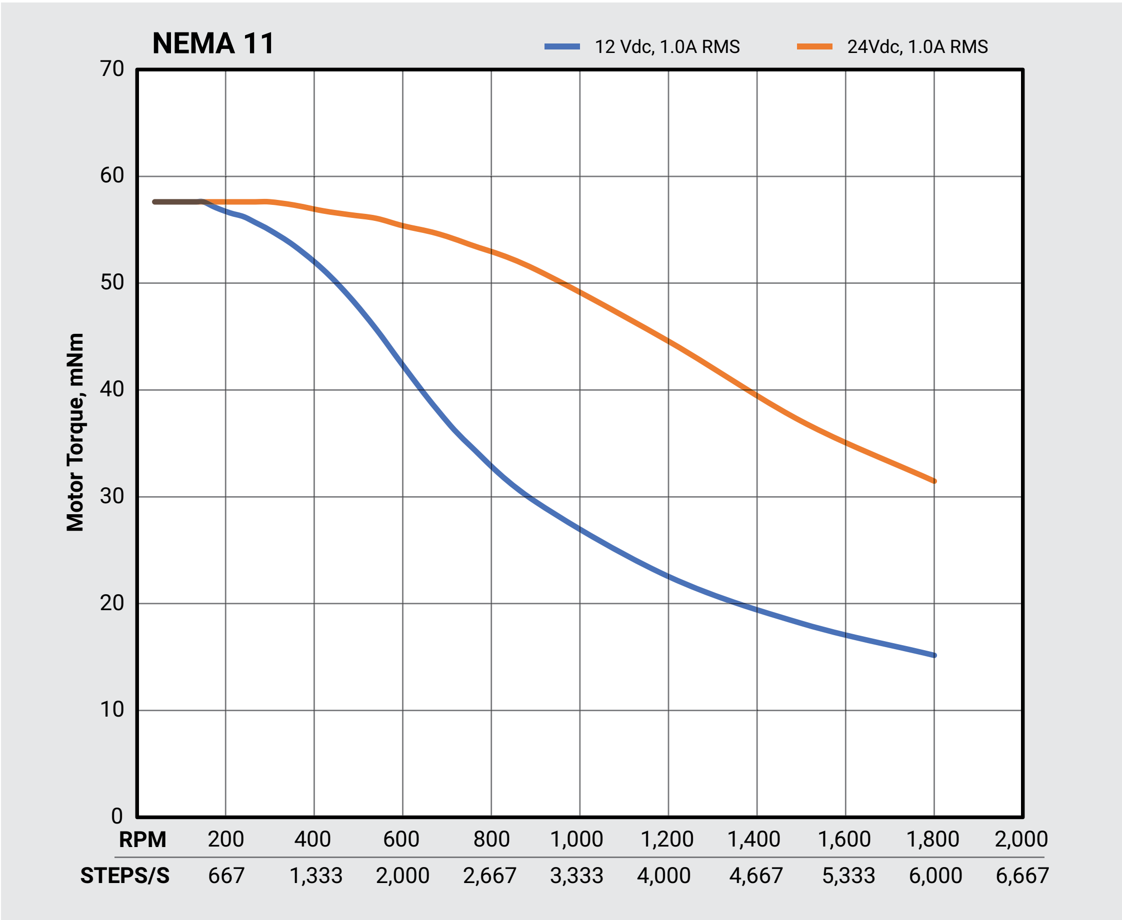
Note: See page 25 for wiring harness information and diagram.

***Motor Mechanical Limit Definition:** Since the motor output may exceed the force which the bearing can bear, so we take the motor bearing limit as the mechanical limit. Howerver, linear motor fatigue and resultant life are determined by each customer's unique application. Load, speed, frequency, temperature, stability of guidance mechanism, etc., should all be considered before choosing a linear motor.

NEMA 11 Series Stepper Motor



Speed Torque Curves



NEMA 14 Series Stepper Motor

Phases 2
Steps/Revolution 200
Step Accuracy .... ±5%
IP Rating 40

Approvals .... RoHS
Operating Temp. .... -20°C–+50°C
Insulation Class .... B (130°C)
Insulation Resistance .... 100 MΩ
Mechanical Axial Limit* .... 320 N

Step Motor - 4 Lead Bi-Polar

Motor Style	Motor Body Length (mm)	Electrical Connection	Rated Current (Amps)	Winding	
				Ohms	mH
				±10% at 20°C	Typical
NEMA 14	36	Plug In Connector	1.5	1.61	2.5

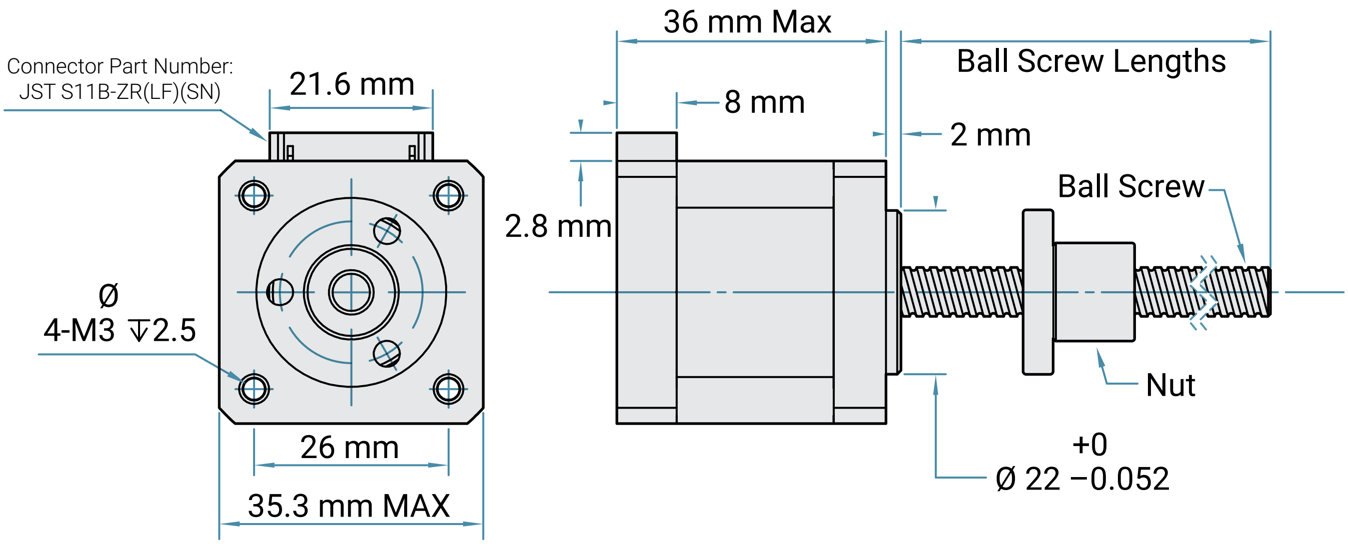
Ball Screw Style for NEMA 14 Series

Ball Screw Style	External Diameter	Lead	Travel Per 1.8° Step
0601A	6 mm	1 mm	0.005 mm
0602A		2 mm	0.010 mm
0801A	8 mm	1 mm	0.005 mm
0802A		2 mm	0.010 mm
08025		2.5 mm	0.0125 mm
1002A	10 mm	2 mm	0.010 mm

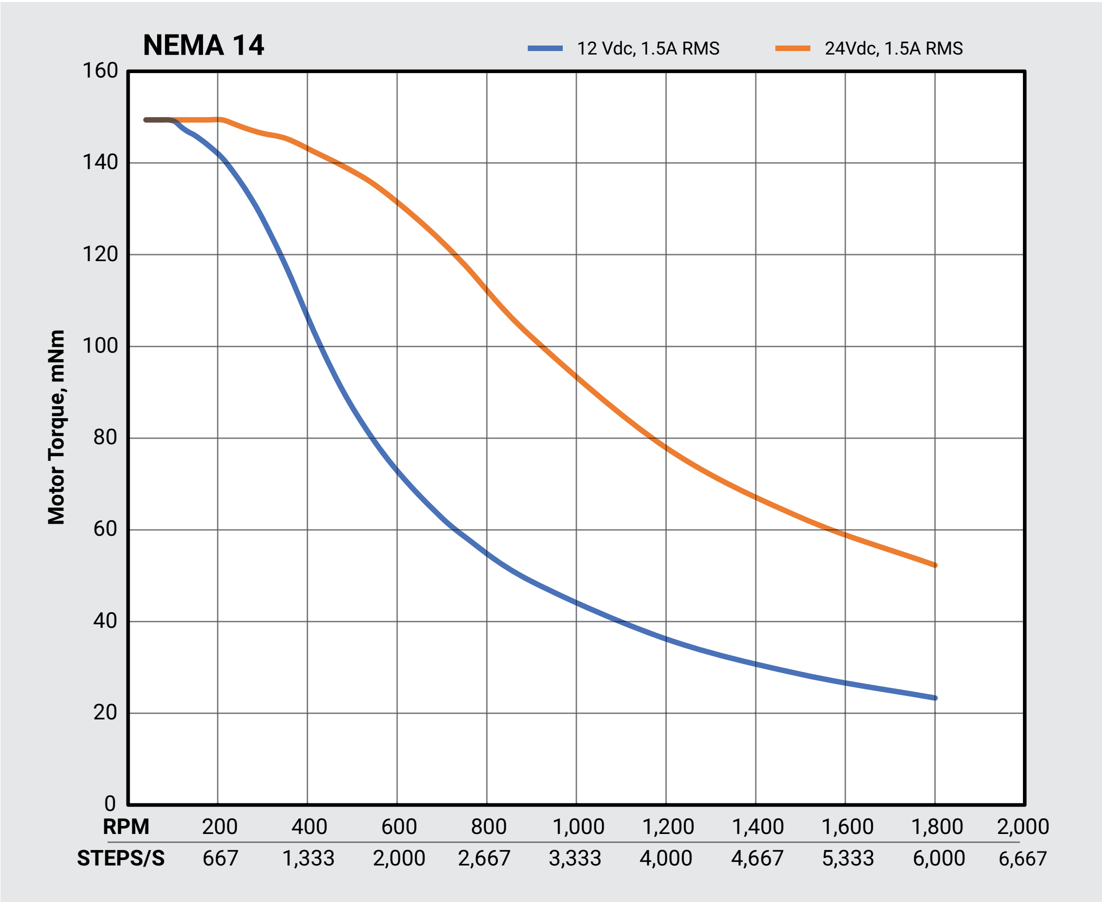
Note: See page 25 for wiring harness information and diagram.

***Motor Mechanical Limit Definition:** Since the motor output may exceed the force which the bearing can bear, so we take the motor bearing limit as the mechanical limit. Howerver, linear motor fatigue and resultant life are determined by each customer's unique application. Load, speed, frequency, temperature, stability of guidance mechanism, etc., should all be considered before choosing a linear motor.

NEMA 14 Series Stepper Motor



Speed Torque Curves



NEMA 17 Series Stepper Motor

Phases 2
Steps/Revolution 200
Step Accuracy .... ±5%
IP Rating 40

Approvals .... RoHS
Operating Temp. .... -20°C–+50°C
Insulation Class .... B (130°C)
Insulation Resistance .... 100 MΩ
Mechanical Axial Limit* .... 320 N

Step Motor - 4 Lead Bi-Polar

Motor Style	Motor Body Length (mm)	Electrical Connection	Rated Current (Amps)	Winding	
				Ohms ±10% at 20°C	mH Typical
NEMA 17 Single Stack	39.8	Plug In Connector	2	1.04	2.73
NEMA 17 Double Stack	48.3	Plug In Connector	2	1.30	2.90

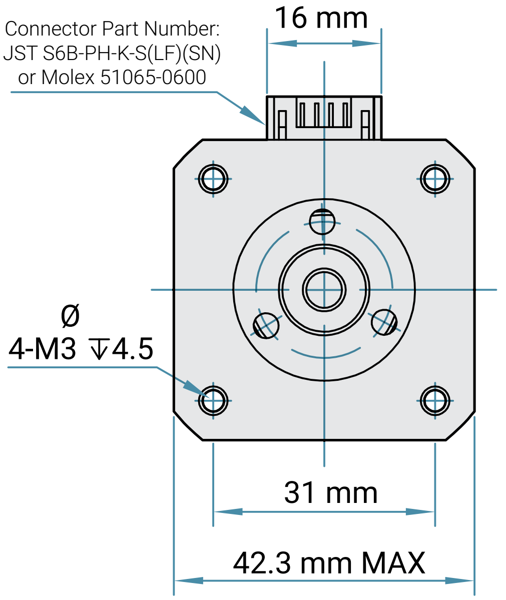
Ball Screw Style for NEMA 17 Series

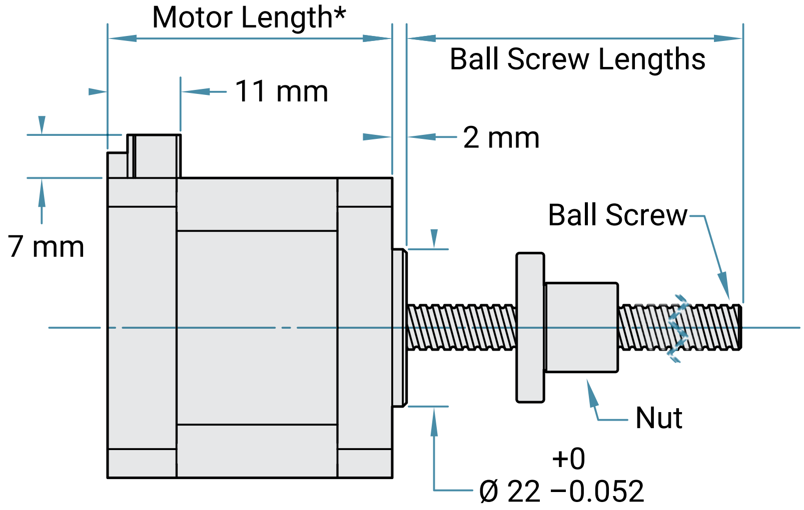
Ball Screw Style	External Diameter	Lead	Travel Per 1.8° Step
0601A	6 mm	1 mm	0.005 mm
0602A		2 mm	0.010 mm
0801A	8 mm	1 mm	0.005 mm
0802A		2 mm	0.010 mm
08025		2.5 mm	0.0125 mm
1002A	10 mm	2 mm	0.010 mm

Note: See page 25 for wiring harness information and diagram.

***Motor Mechanical Limit Definition:** Since the motor output may exceed the force which the bearing can bear, so we take the motor bearing limit as the mechanical limit. Howerver, linear motor fatigue and resultant life are determined by each customer's unique application. Load, speed, frequency, temperature, stability of guidance mechanism, etc., should all be considered before choosing a linear motor.

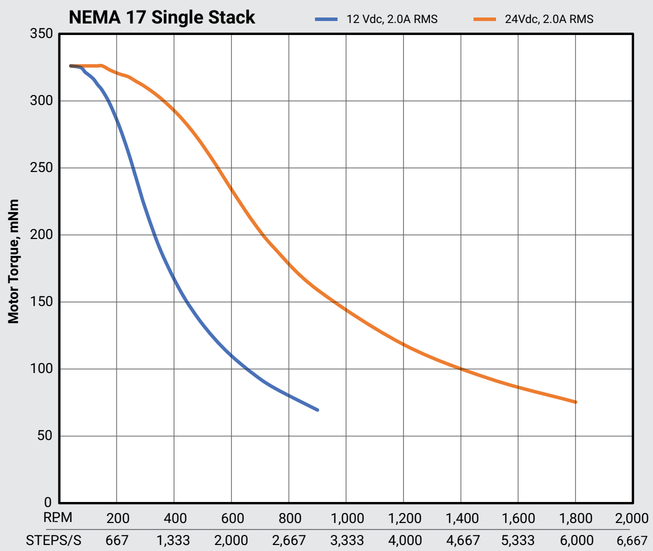
NEMA 17 Series Stepper Motor

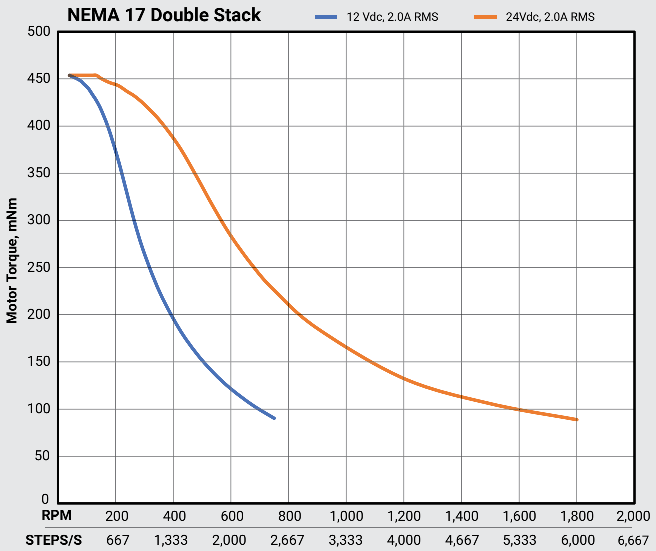




*** Motor Lengths:**
NEMA 17 Single Stack (171): 39.8 mm
NEMA 17 Double Stack (172): 48.3 mm

Speed Torque Curves





NEMA 23 Series Stepper Motor

Phases 2
Steps/Revolution 200
Step Accuracy .... ±5%
IP Rating 40

Approvals .... RoHS
Operating Temp. .... -20°C–+50°C
Insulation Class .... B (130°C)
Insulation Resistance .... 100 MΩ
Mechanical Axial Limit* .... 1,050 N

Step Motor - 4 Lead Bi-Polar

Motor Style	Motor Body Length (mm)	Electrical Connection	Rated Current (Amps)	Winding		Note
				Ohms ±10% at 20°C	mH Typical	
NEMA 23 Single Stack	57	Plug In Connector	2.2	1.6	7.2	Standard
NEMA 23 Double Stack	79	Plug In Connector	3.0	1.1	5.0	Standard
NEMA 23 Power Plus	79	Plug In Connector	3.0	1.1	3.7	PowerPlus

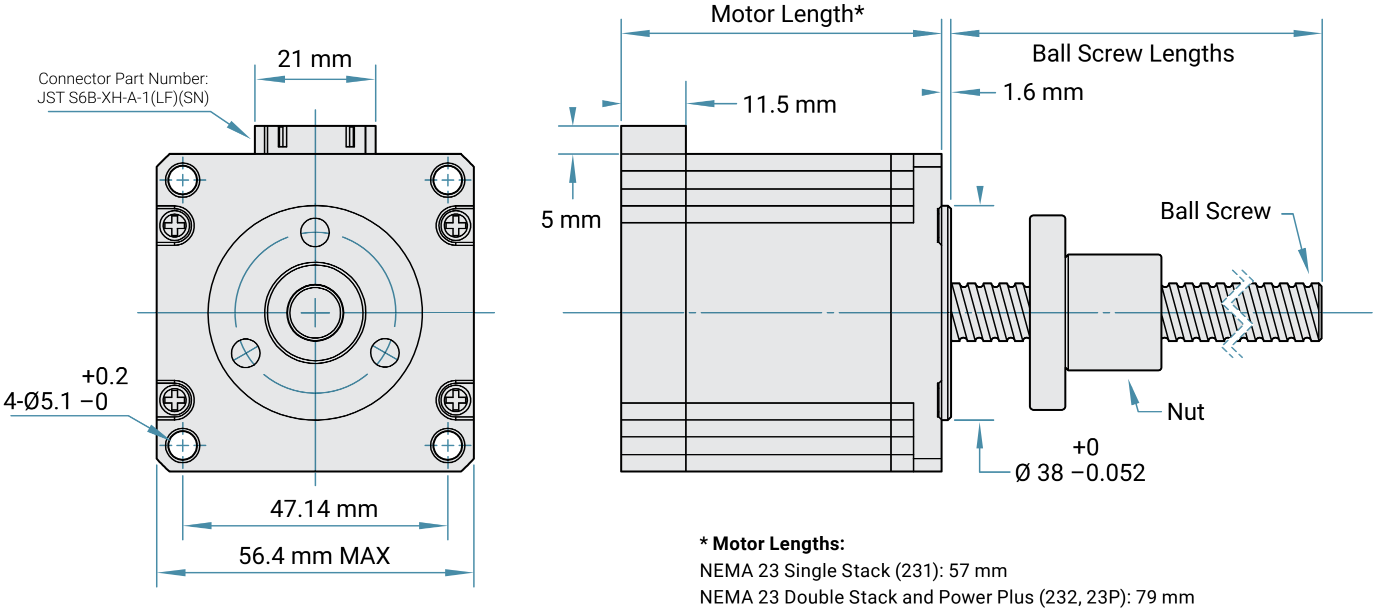
Ball Screw Style for NEMA 23 Series

Ball Screw Style	External Diameter	Lead	Travel Per 1.8° Step
1002A	10 mm	2 mm	0.010 mm

Note: See page 25 for wiring harness information and diagram.

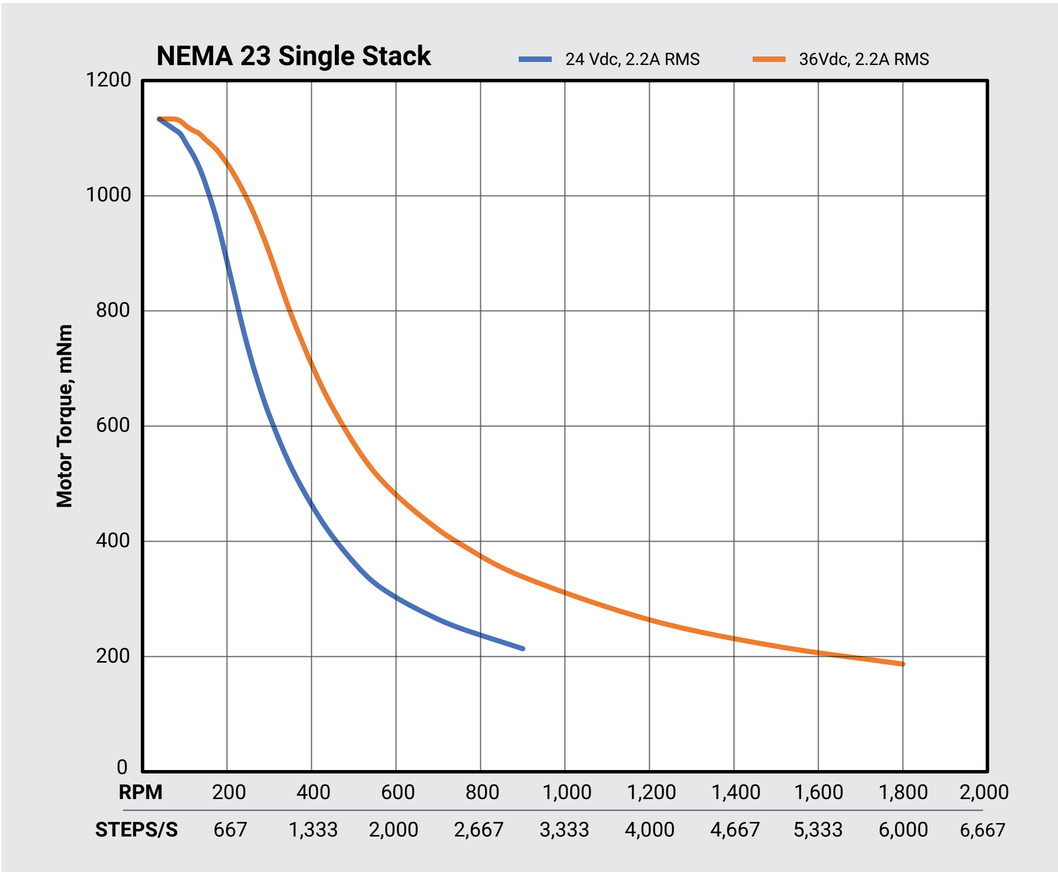
***Motor Mechanical Limit Definition:** Since the motor output may exceed the force which the bearing can bear, so we take the motor bearing limit as the mechanical limit. Howerver, linear motor fatigue and resultant life are determined by each customer's unique application. Load, speed, frequency, temperature, stability of guidance mechanism, etc., should all be considered before choosing a linear motor.

NEMA 23 Series Stepper Motor

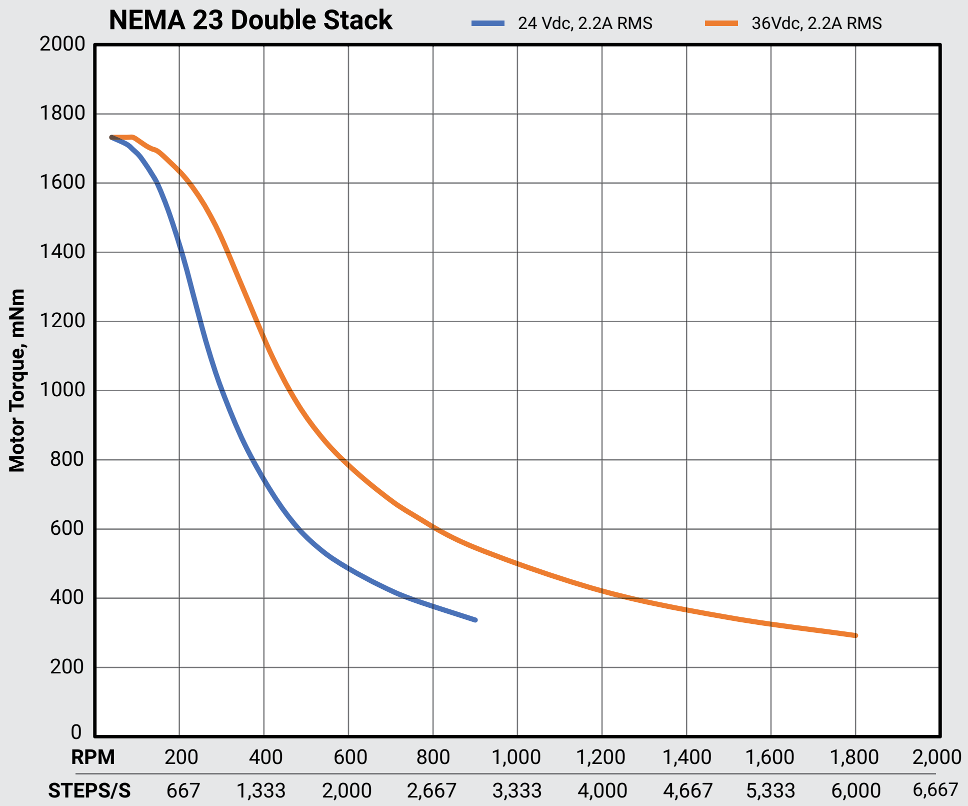


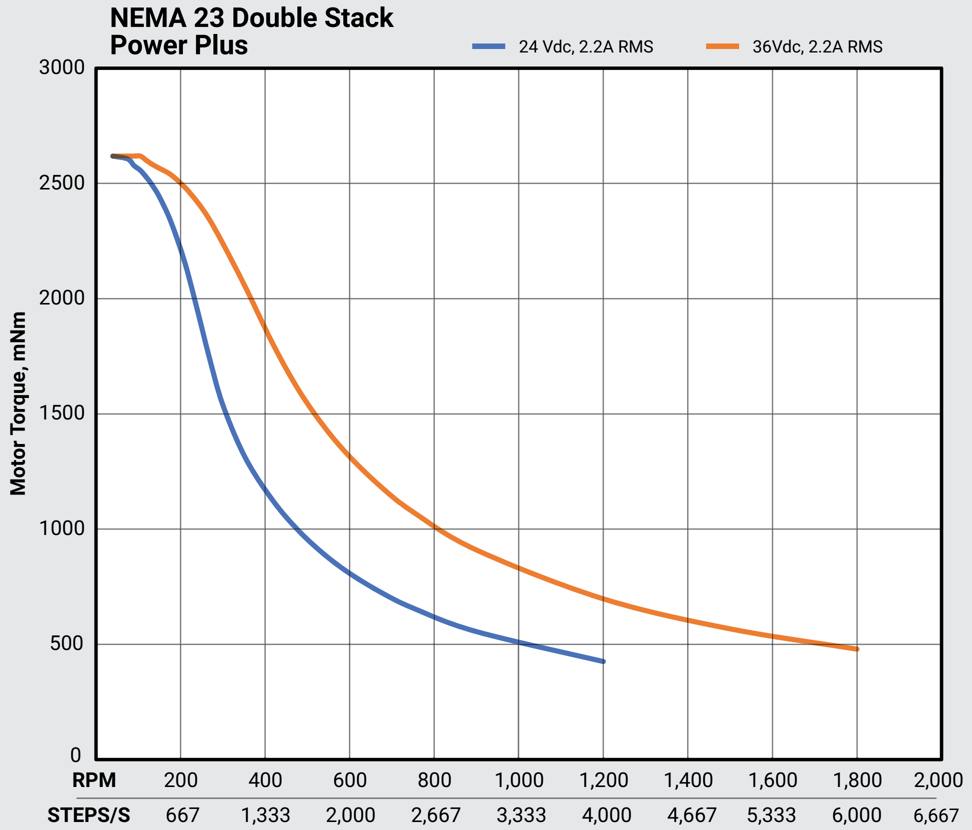
*** Motor Lengths:**
NEMA 23 Single Stack (231): 57 mm
NEMA 23 Double Stack and Power Plus (232, 23P): 79 mm

Speed Torque Curves



NEMA 23 Series Stepper Motor - Speed Torque Curves





Wiring Diagram

Bipolar, Full Step

Step	Phase 1 A	Phase 1 C	Phase 2 B	Phase 2 D
1	+	−	+	−
2	−	+	+	−
3	−	+	−	+
4	+	−	−	+

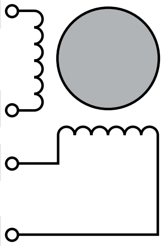
CW ↓ ↑ CCW

CW & CCW rotation when seen from flange side of the motor.

4 Lead (bipolar)

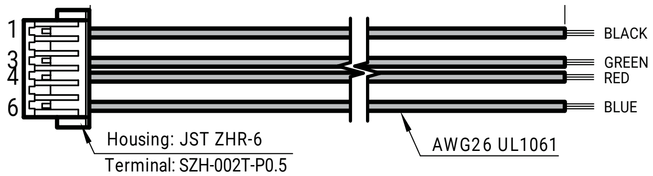
Connector Pin#

Motor Size 8, 11, 17, 23	Motor Size 14	
1	1	A
3	5	C
4	7	B
6	11	D

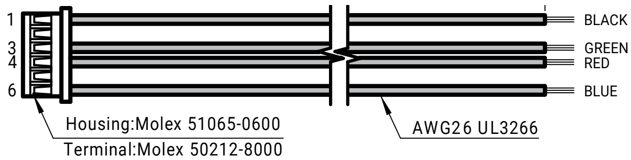


Wiring Harness

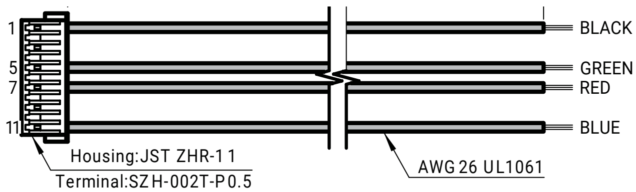
NEMA 08 Series		
Wire Length	300 mm	1,000 mm
Part Number	6200767	6200970



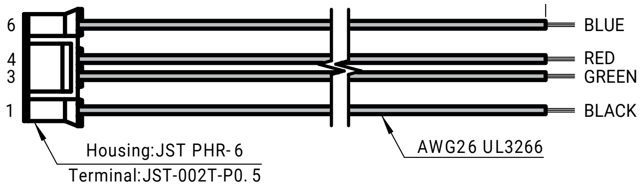
NEMA 11 Series			
Wire Length	300 mm	500 mm	1,000 mm
Part Number	6200727	6200963	6200964



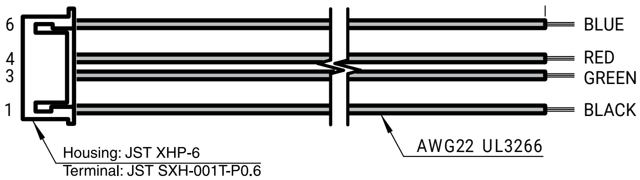
NEMA 14 Series			
Wire Length	300 mm	500 mm	1,000 mm
Part Number	6200728	6200965	6200966



NEMA 17 Series			
Wire Length	300 mm	500 mm	1,000 mm
Part Number	6200490	6200967	6200968

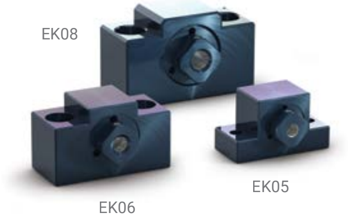


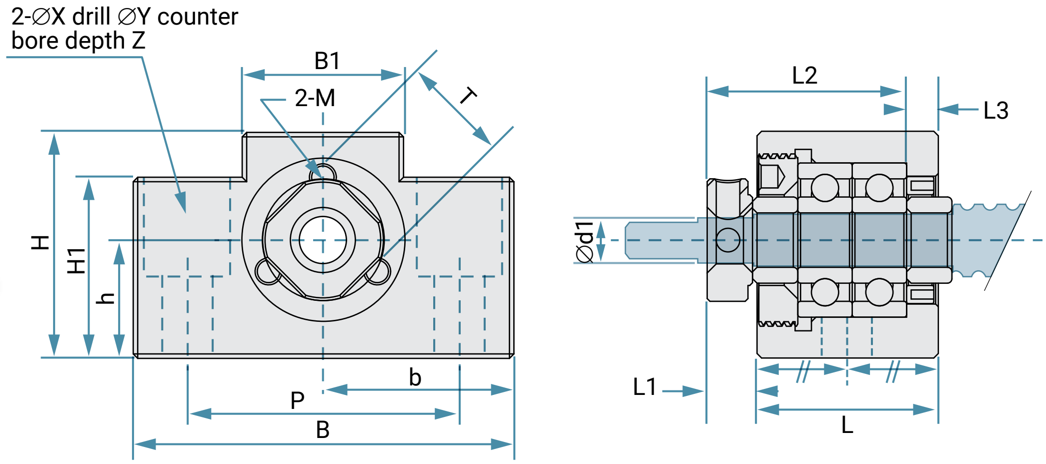
NEMA 23 Series		
Wire Length	300 mm	1,000 mm
Part Number	6200491	6200969



Fixed Bearing Blocks

EK Base Mount Fixed Bearing Blocks



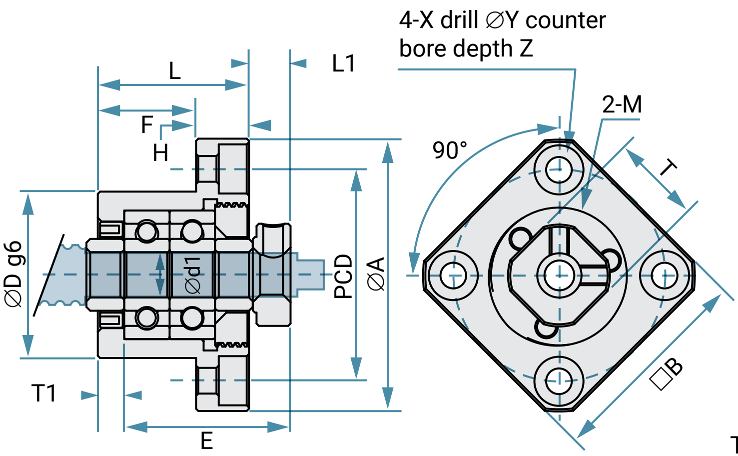


Supported Journals:
ALN - Fixed Journal End
BLN - Fixed Journal End with Drive Extension
CLN - Fixed Journal End with Drive Extension/Flat

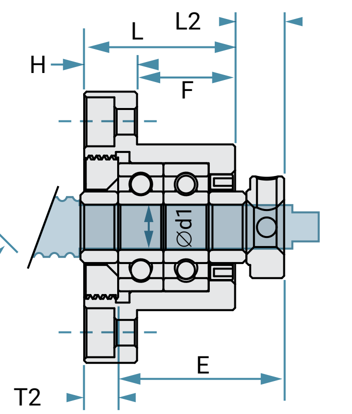
Dimensions

Model No./Part 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	**EK05**	5	16.5	5.5	18.5	3.5	36	21	18	11	20	8	28	4.5	-	-	M3	11	0.10
BSBLEB-06MMP	**EK06**	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	**EK08**	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

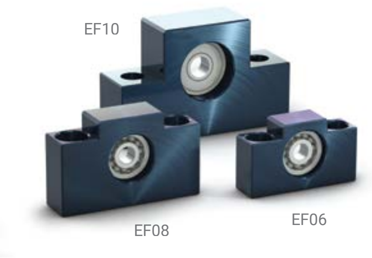
Supported Journals:
ALN - Fixed Journal End
BLN - Fixed Journal End with Drive Extension
CLN - Fixed Journal End with Drive Extension/Flat

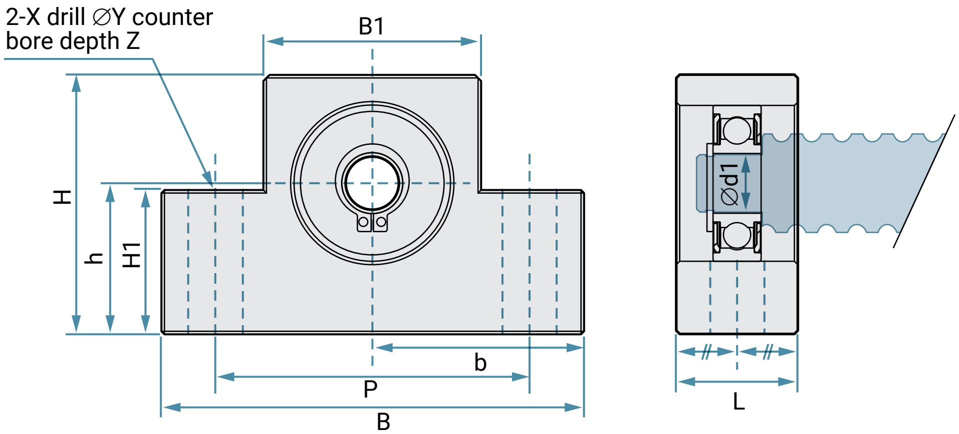
Dimensions

Model No./Part No.		d1 Journal Diameter	L mm	H mm	E mm	F 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	**FK05**	5	16.5	6	18.5	10.5	20	34	26	26	5.5	3.5	5	3	3.4	6.5	3.5	M3	11	0.08
BSALEB-06MMP	**FK06**	6	20	7	22	13	22	36	28	26	5.5	3.5	6.5	4.5	3.4	6.5	4	M3	12	0.10
BSALEB-08MMP	**FK08**	8	23	9	26	14	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



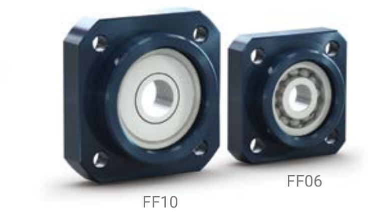


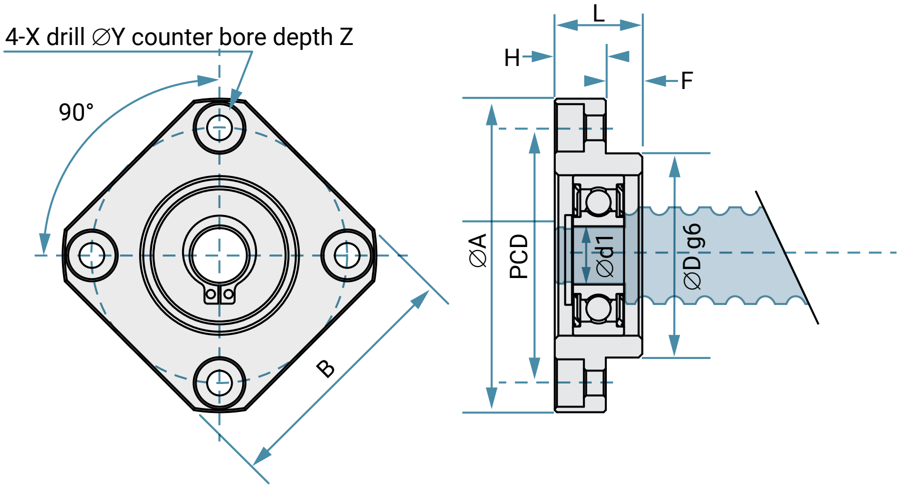
Supported Journals:
AFN - Float Journal End
BFN - Float Journal End with Drive Extension
CFN - Float Journal End with Drive Extension/Flat

Dimensions

Model No./Part 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	Snap Ring	Weight Kgs
BSBFEB-06MMP	**EF06**	6	12	42	25	21	13	18	20	30	5.5	9.5	11	606ZZ	S 06	0.10
BSBFEB-08MMP	**EF08**	6	14	52	32	26	17	25	26	38	6.6	11	12	606ZZ	S 06	0.15
BSBFEB-10MMP	**EF10**	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./Part 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	**FF06**	6	10	6	4	22	36	28	28	3.4	6.5	3.5	606ZZ	S 06	0.06
BSAFEB-10MMP	**FF10**	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

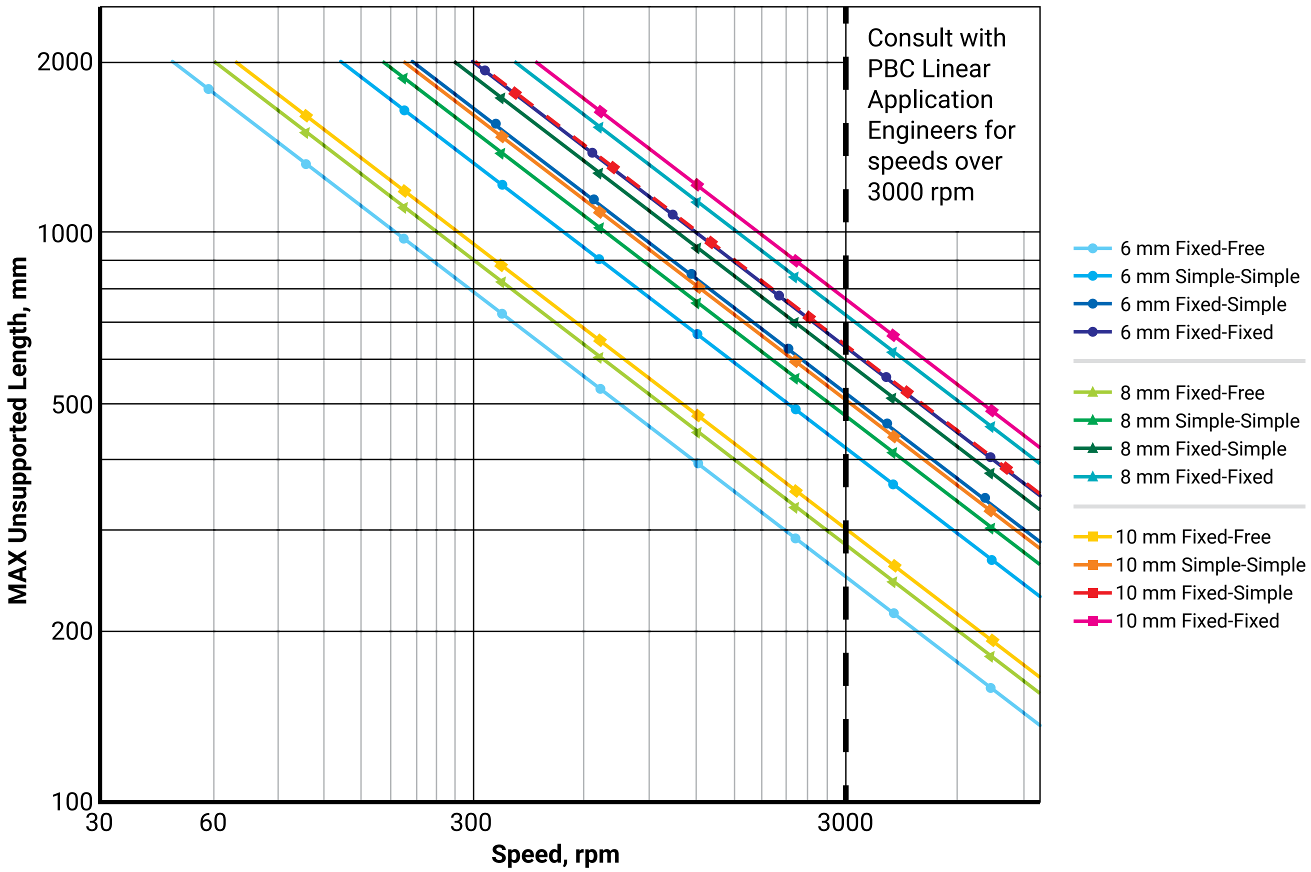


Figure 1

Types of Ball Screw Supports

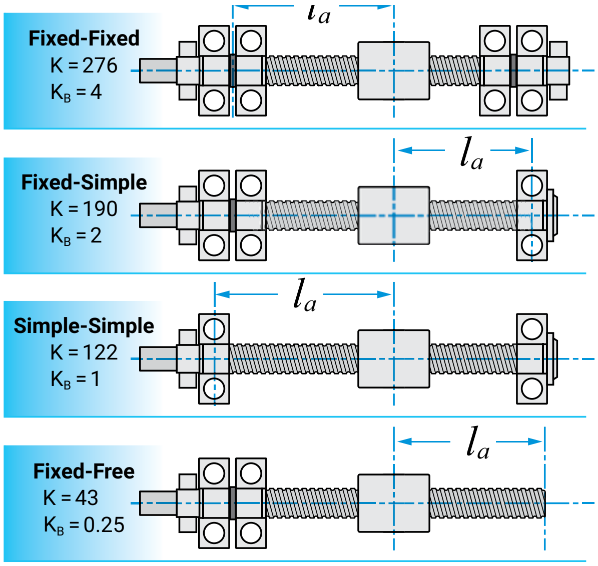


Figure 2

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

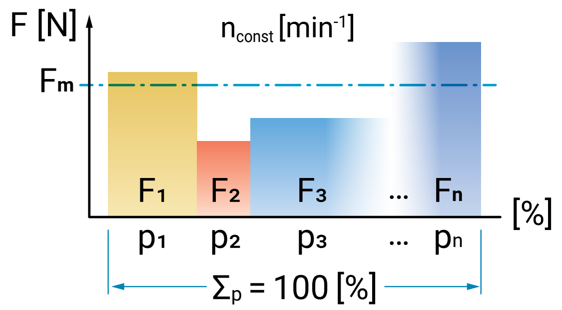
I. Average axial load F_m for constant rotational speed and varying axial load

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

where:

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

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



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

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

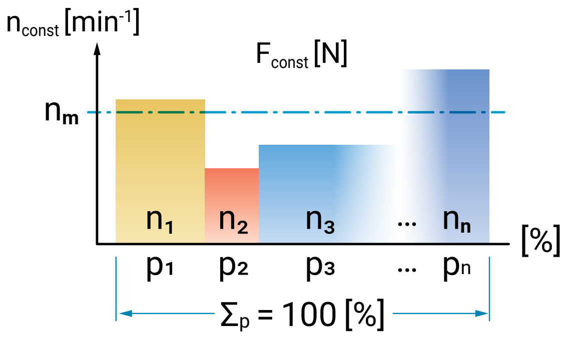
II. Average rotational speed at constant axial load F_{const} and variable rotational speed

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

where:

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

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



II. Average rotational speed (cont.)

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

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

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

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

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

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

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

Positioning or Transport Ball Screws

Ref: ISO 3408-3

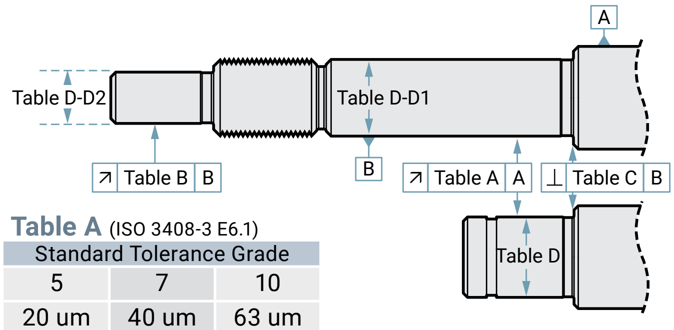


Table A (ISO 3408-3 E6.1)

Standard Tolerance Grade		
5	7	10
20 um	40 um	63 um

Table B (ISO 3408-3 E7.2)

Standard Tolerance Grade		
5	7	10
10 um	–	–

Table C (ISO 3408-3 E8.2)

Standard Tolerance Grade		
5	7	10
5 um	–	–

Table D Journal Diameters

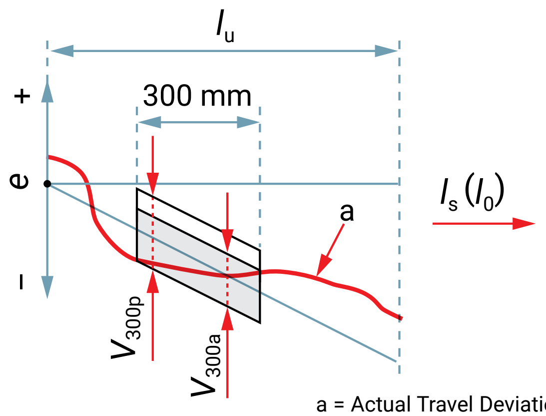
	D1	D2
Turned	Nom. -22 um/-34 um	Nom. h7
Ground	Nom. -8 um/-15 um	Nom. h7

Grade 7 and 10 ball screws have turned journals standard.
Grade 5 ball screws have ground journals standard.
Turned or ground journals can be requested where not standard.

Positioning or Transport Ball Screws

Ref: ISO 3408-3 E3

Checking of the travel variation V_{300} within an axial travel of 300 mm:



a = Actual Travel Deviation

Permissible Deviations

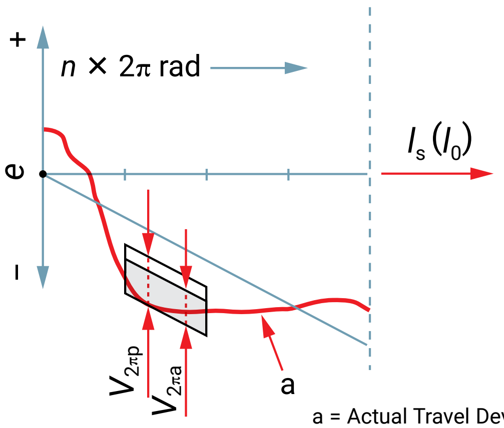
Standard Tolerance	V_{300p} µm
Grade 5	23
Grade 7	52[a]
Grade 10	210[a]

[a] = Only for transport ball screws

Positioning Ball Screws

Ref: ISO 3408-3 E4

Checking of the travel variation $V_{2\pi P}$ within 2π rad:



a = Actual Travel Deviation

Permissible Deviations

Standard Tolerance	$V_{2\pi p}$ µm
Grade 5	8

Technical • Ball Screw Lubrication

Oil Lubrication of Ball Screws

Many applications allow either oil or grease lubrication, but oil is sometimes preferred for applications that require continuous replenishment, easier distribution to multiple axes, or improved suitability in high-speed machine tools and automated equipment. When selecting an oil, the key engineering variables are viscosity, EP additives, anti-wear protection, thermal and oxidation stability, and corrosion protection. System design and the required oil flow rate will need to account for the application's speed, load, temperature, and contamination control. Low-viscosity spindle oils and precision machine oils are commonly recommended for high-speed systems, while industrial circulating oils and way oils may be used where the machine design calls for them. In food-related applications, NSF H1 food-grade oils are available and may be required when incidental contact compliance is required.

A well-designed oil lubrication system should deliver clean oil at the correct rate to each lubrication point through properly sized pumps, lines, valves, and metering devices. Filtration, sealing, and monitoring are important because contamination and oil starvation can rapidly affect ball-screw life and accuracy. For best results, the final oil grade and lubrication hardware should be matched to the machine's operating environment and the lubricant supplier's recommendations. Lubricant suppliers offer products such as Klüberspeed BF 72-22, Mobil Velocite Oil No. 6, Mobil Vactra Oil No. 2, Shell Morlina S2 B 68, and NSF H1 food-grade oils for ball screw applications where their specifications match the application's requirements.

Grease Lubrication of Ball Screws

The following lists includes potential grease lubricants for different types of applications using ball screws. For best results, contact your lubricant supplier for specific recommendations that pertain to the conditions of your application.

Light Duty Ball Screws

Trade Name & Product Number	Mfg.	Temp Range, C	Description	Performance Details
Fluorocarbon Gel 855D	Nye	-40 to 125	A PTFE thickened, light viscosity, synthetic hydrocarbon grease	Intended for light damping & noise reduction. Benefits include good water resistance.
Fluorocarbon Gel 866	Nye	-54 to 125	A PTFE thickened, light viscosity, synthetic hydrocarbon grease.	Intended for lightly loaded mechanical applications where torque is low.
Rheolube 362HF	Nye	-54 to 125	A light viscosity, lithium-thickened, synthetic hydrocarbon grease. PTFE fortified.	PTFE fortified for low starting torque.
UNIFLOR 8512	Nye	-50 to 225	Chemically resistant, fluorinated, wide-temperature grease.	For extreme conditions
Shell Gadus S2 V100 3	Shell	-20 to 120	Mineral oil based, lithium-calcium thickened EP grease. NLGI 2	General purpose grease, good EP protection, and good water resistance.

Precision & High-Speed Ball Screws

Trade Name & Product Number	Mfg.	Temp Range, C	Description	Performance Details
Instrument Grease 732C	Nye	-54 to 150	Ester-based grease	For high-speed, wide temperature, light-to-medium duty applications
Rheolube 733F	Nye	-54 to 125	A medium consistency, EP-& PTFE-fortified grease	For medium-duty precision ball screws, where smooth, precise motion is needed. Good low-temperature, low-noise properties.
ISOFLEX NBU 15	Klüber	-40 to 130	Combination of ester oil/ synthetic hydrocarbon oil/mineral oil and barium complex soap	Suitable for high speeds and ball screws subject to high loads.
Gadus S5 V100 2	Shell	-50 to 150	Synthetic base oil with lithium complex thickener	Suitable for high-speed ball screws

Technical • Ball Screw Lubrication

Medium to Heavy Duty Ball Screws

Trade Name & Product Number	Mfg.	Temp Range, C	Description	Performance Details
Fluorocarbon Gel 866R-MS	Nye	-40 to 125	EP-fortified, rust-inhibited, PTFE thickened	For heavily loaded, low torque applications.
Rheolube 380	Nye	-50 to 130	EP-fortified, lithium-gelled, synthetic hydrocarbon and ester formulation	For heavily loaded applications.
Klübersynth BM 44-42	Klüber	-40 to 140	Synthetic hydrocarbon base oil and lithium special soap	For long-term and lifetime lubrication of ball screws subject to high stresses.
Klüberplex BEM 34-131N	Klüber	-35 to 150	Synthetic hydrocarbon, mineral oil, calcium special soap	Very good lubricating effect in applications with micro-movements.
Mobilux EP 2	Mobil	-20 to 130	Lithium hydroxystearate grease	Recommended for most types of industrial applications. Rust protection, corrosion protection, and resist water wash-out.
Shell Gadus S3 V220C 2	Shell	-25 to 140	Mineral oil base with lithium complex thickener	General purpose grease for heavy duty applications

Vacuum & Cleanroom Applications

Trade Name & Product Number	Mfg.	Temp Range, C	Description	Performance Details
NyeTorr 5200	Nye	-45 to 150	Ester-based grease	Ultrafiltered, soft consistency grease with good load-carrying capability & very low vapor pressure characteristics for high-vacuum applications. PTFE-thickened to enhance low-temperature performance & reduce noise.
Nyetorr 5350	Nye	-55 to 250	A medium consistency, EP-& PTFE-fortified grease	Ultrafiltered, chemically resistant, wide temperature grease for extreme conditions. Low vapor pressure. Good wear resistance and endurance.
Klübersynth BEM 34-32	Klüber	-40 to 130	Synthetic hydrocarbon oil with special calcium soap thickener	Not recommended for high vacuum applications
Barrierta L55/2	Klüber	-40 to 260	PFPE base oil with PTFE thickener	High and low temperature for vacuum (resistant to radiation)

Food & Pharmaceutical Processing

Trade Name & Product Number	Mfg.	Temp Range, C	Description	Performance Details
Klübersynth UH1 14-151	Nye	-45 to 120	Synthetic hydrocarbon base oil and an aluminum complex soap.	Very good low temperature behavior. Good water resistance reduces the risk of corrosion and premature bearing failure.
Barrierta L55/2	Klüber	-40 to 260	PFPE base oil with PTFE thickener	Long term grease for ball screw under thermal stress. Very good runtime stability and corrosion protection. Tested and listed as NSF H1 for use in food-processing industry
Cassida RLS 2	Shell	-35 to 120	Synthetic base oil with aluminum complex thickener	Type H1 grease. NLGI 2

Aerospace

Trade Name & Product Number	Mfg.	Temp Range, C	Description	Performance Details
Aeroshell Grease 7	Shell	-73 to 121	Synthetic diester oil and clay thickener	Recommended for highly loaded actuator screw mechanisms

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