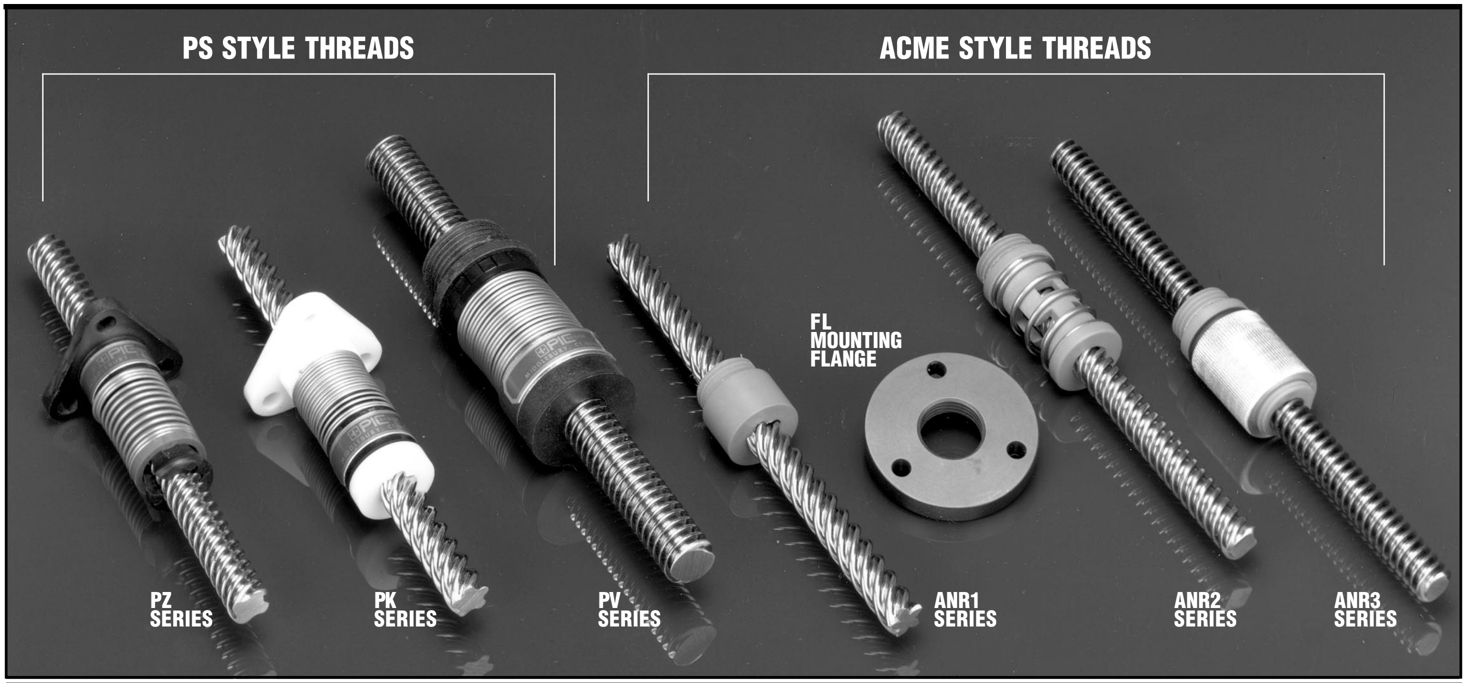
PIC DESIGN®
PRECISION INDUSTRIAL COMPONENTS

LEAD SCREWS & NUTS

A Range Of Styles / Inch And Metric Sizes



PIC Design has significantly increased its range of lead screws and nuts to provide users with the most complete line in the industry. Designers are no longer confined to the original Acme lead screws … the new and innovative PS Series employs a modified thread form that is designed for maximum life and quiet operation when used in conjunction with the patented anti-backlash nuts.

PIC DESIGN LEAD SCREWS

Lead screws provide an economical solution for the transfer of rotary motion to linear motion. All PIC Design lead screws are precision rolled from 303 stainless steel with a lead accuracy of .0006 in/in (mm/mm). They are stocked in both inch and metric sizes with diameters that range from $^3/_{16}$" to $^3/_4$". Lengths are available up to six feet.

The now familiar precision rolled Acme lead screws are available with the above noted accuracy when used with Turcite X (Acetal-Teflon and Silicone filled) nuts.

The new PS style lead screws have accuracies similar to that of the Acme line, but feature a positional repeatability to within 50 micro-inches. These lead screws feature a burnished finish of 16 micro-inches, and a straightness of .003 in/ft.

PS style lead screws are available uncoated or coated with a custom composition of baked-on Teflon. This coating greatly improves lubricity and extends the normal life of the assembly by as much as 300%.

PS STYLE THREADS

Anti-Backlash Nuts

The standard method for taking up backlash is to bias two nut halves axially using a type of compliant spring. Using this method, the spring force must be at least as great as the load to be moved.

The new PS style lead screws use a patented axial take-up mechanism, which effectively puts a stiff spacer between the nut halves. By using this design, the nut functions independently of the load, resulting in a low drag torque. Nuts are a self-lubricating polyacetal material.

PZ Series anti-backlash nuts are ideal for vertical applications requiring noise and vibration control. This series accommodates lead screws with moderate loads, and diameters from $^1/_4$" to $^1/_2$".

PK Series anti-backlash nuts are very low in frictional drag and are specifically designed for $^3/_8$" diameter lead screws.

PV Series anti-backlash nuts provide the maximum load carrying capability and the lightest axial and radial stiffness. This results in smooth, quiet operation, and long life. The PV series is best suited for higher loads, and is thus used on PIC's largest lead screws with $^1/_2$" and $^3/_4$" diameters.

ACME STYLE THREADS

Power And Anti-Backlash Nuts

PIC Design offers three Turcite X nuts that are compatible with Acme style lead screws. Each nut offers distinct advantages.

ANR1 Series power nuts are used where a range of .003" to .007" axial backlash can satisfy user requirements. The ANR1 is the most economical.

ANR2 Series anti-backlash nuts are designed for applications requiring positional accuracy and repeatability. The ANR2 anti-backlash nut assembly consists of two halves with an axially compliant spring that provides some ability to fine tune preload. The spring preload on the nut must be approximately 5% greater than the axial load on the system.

ANR3 Series anti-backlash nuts are designed to be adjusted. An "O" ring spacer is placed between the two halves of the nut. The back half of the nut is adjusted by simply turning the outside body until desired preload is obtained. The "O" ring provides for minor screw thread deviations. ANR3 series nuts can be used for higher loads than the ANR2 series.

TERMINOLOGY

The glossary of terms and basic formulas presented below will aid designers in evaluating system requirements. Critical system parameters such as torque, efficiency, maximum load and critical speed are easily evaluated.

- **Lead Screw Assembly:** A screw and nut device used for the purpose of transmitting motion or power as opposed to fastening.
- **Backlash:** Free axial movement between screw and nut.
- **Column Strength:** Maximum compressive load that can be applied to a shaft without taking a permanent set.
- **Critical Speed:** Operating speed of spinning shaft that develops severe vibrations during rotation. This is a function of length, diameter and end supports.
- **Drag Torque:** The torque necessary to drive the lead screw assembly alone.
- **Efficiency:** Ratio of work output to work input; varies with lead, thread angle and coefficient of friction (see screw data).
- **Lead:** Distance traveled by the nut in one revolution (equal to the screw pitch x the number of starts).
- **Lead Angle:** The angle made by the helix of the thread at the screw pitch line with plane perpendicular to the screw axis.
- **Major Diameter:** The diameter of a cylinder formed by the crests of the thread.
- **Minor Diameter:** The root diameter.
- **Pitch:** The distance as measured parallel to the thread axis between corresponding points on adjacent thread forms, generally equal to the lead divided by the number of starts.
- **Self Locking:** When it is impossible for a thrust load on a nut to create a torque on its screw, the screw and nut are said to be self-locking. A self-locking screw will not convert thrust to torque. Generally, Acme screws are self-locking while most high lead and ball screw are non self-locking. A non self-locking screw will require a mechanical brake or some other locking means to a sustain a load.
- **Stroke:** The axial distance traveled by the nut in either direction.
- **Thread per inch:** The reciprocal of the pitch is the number of threads per inch.

The application engineering information in this section should enable the designer to fully evaluate the lead screws offered in this catalog.

CRITICAL SPEED / ANGULAR VELOCITY

When a shaft is spinning, as in the case of an operating Lead screw, it will experience excessive vibration at a speed approximating its natural frequency of vibration. This speed is called the “Critical Speed” and good design practice dictates that speed should be limited to 85% of a shaft’s first order critical speed. First order critical speed is a function of shaft diameter, end fixity and unsupported length. These speeds are shown in graphic form for various shaft diameters, lengths and supports.

COLUMN STRENGTH / COMPRESSION LOAD

Under compressive loading a sufficiently slender shaft will fail by elastic instability at a load well below the shaft’s elastic limit or rated load. A graph is provide to show the maximum safe column load for various diameters, lengths and supports. Shaft slenderness ratios exceeding 200 are not recommended and the curves are dotted for these ratios. Column strength limitations do not apply to shafts under tension loads.

TORQUE, ROTARY TO LINEAR (Torque needed to move load)

$$\text{Torque (in. lbs.)} = \frac{\text{Load (lbs.)} \times \text{Lead (inches)}}{2\pi \times \text{efficiency}}$$

TORQUE, LINEAR TO ROTARY (Backdriving Torque)

$$\text{Torque to hold load} = \frac{\text{Load} \times \text{Lead} \times \text{Efficiency}}{2\pi}$$

FORWARD DRIVING EFFICIENCY (See screw data)

$$E_F = (\tan\lambda)\ [(\cos\Phi_n - f\tan\lambda) / (\cos\Phi_n \tan\lambda + f)]$$

BACKWARD DRIVING EFFICIENCY

$$E_B = (1/\tan\lambda)\ [(\cos\Phi_n \tan\lambda - f) / (\cos\Phi_n + f\tan\lambda)]$$

$$= \frac{\text{Load} \times \text{Lead} \times \text{Efficiency}}{2\pi}$$

f = Coefficient of friction
E_B = Back drive efficiency
E_F = Forward drive efficiency
λ = Thread lead angle
Φ_n = Thread angle in normal plane

SCREW RPM

$$\text{RPM} = \frac{\text{Velocity (in/min)}}{\text{Lead (in/rev)}}$$

COLUMN LOAD STRENGTH (Based on Eulers Formula)

$$Pcr = \frac{14.03 \times 10^6 Fcd^4}{L^2}$$

Pcr = maximum load (lbs.)
Fc = end support factor (see page 3-3)
= .25 one end fixed, other free
= 1.00 both ends supported
= 2.00 one end fixed, other supported
= 4.00 both ends fixed
d = root diameter of screw (inches)
L = maximum distance between nut & load carrying bearing (inches)

When possible, design for tension loads to eliminate the buckling factor and reduce the required screw size.

CRITICAL SCREW SHAFT SPEED

(Maximum rotational speed of a screw)

$$Cs = F \times 4.76 \times 10^6 \times \frac{d}{L^2}$$

Cs = Critical speed (RPM)
d = root diameter of screw (inches)
L = Length between supports (inches)
F = end support factor (see page 3-3)
.36 one end fixed, other free
1.00 simple supports both ends
1.47 one end fixed, one simple
2.23 both ends fixed

Critical shaft speed should be reduced to 85% to allow for other factors such as alignment and straightness.

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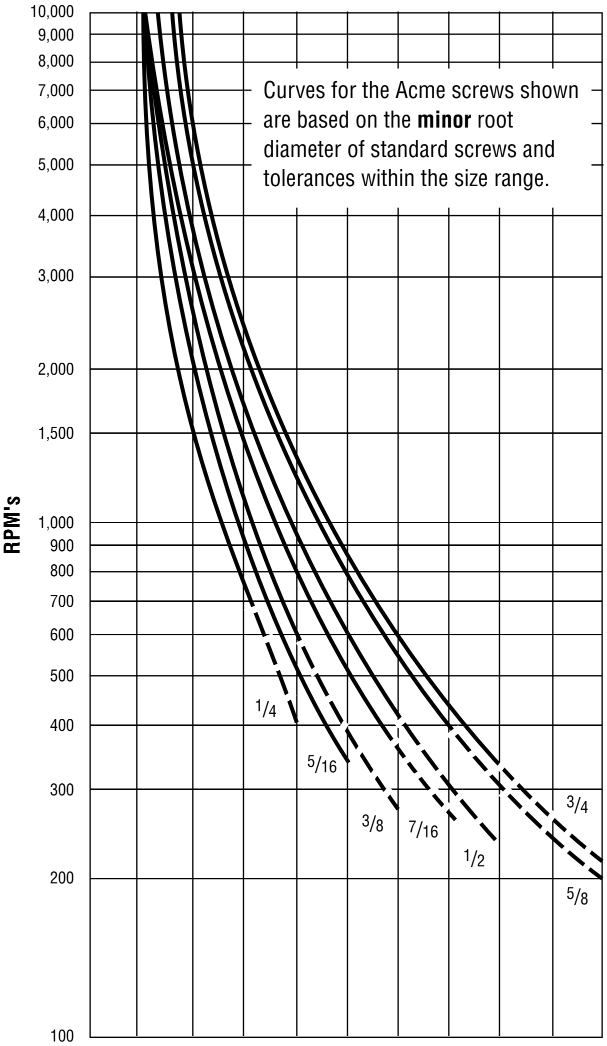
CRITICAL LEAD SCREW SPEED vs. LEAD SCREW LENGTH



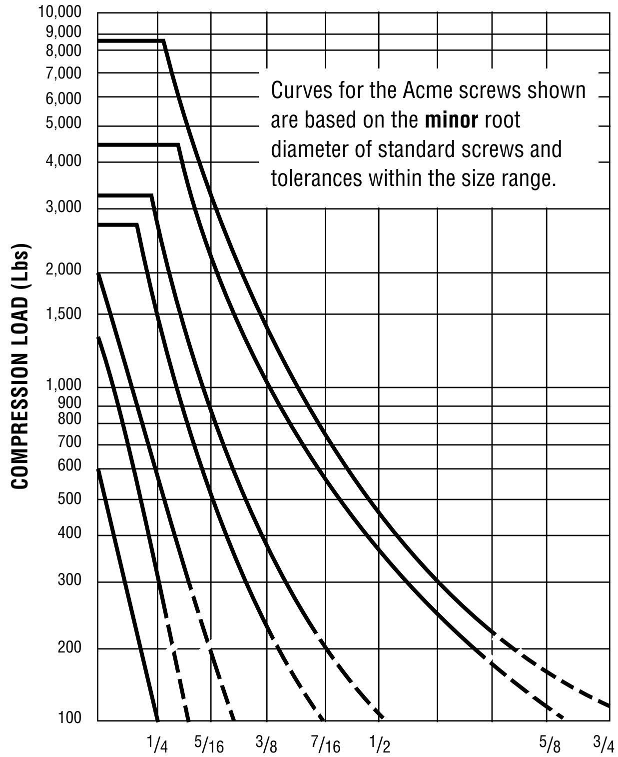
Maximum Length Between Bearings (Inches)

Ⓐ Fixed-Free	6	12	18	24	30	36	42	48	54	60
Ⓑ Simple-Simple	10	20	30	40	50	60	70	80	90	100
Ⓒ Fixed-Simple	12	24	36	48	61	73	85	97	109	121
Ⓓ Fixed-Fixed	15	30	45	60	75	90	105	119	134	149

ASCERTAINING CRITICAL SHAFT SPEED

1. Examine the drawings to the right and determine the type of lead screw end support bearing employed — A, B, C or D.
2. Determine the maximum length between end supports. Locate that number, in the table above, opposite the appropriate end support.
3. Locate the vertical line on the graph that matches the number in step 2. Where this line intersects the appropriate diameter lead screw curve, determine critical shaft speed. PIC Design recommends operating at a speed less than 85% of this number in order to allow for any misalignments.

MAXIMUM COMPRESSION LOAD vs. LEAD SCREW LENGTH



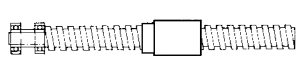
Maximum Length Between Bearings (Inches)

Ⓐ Fixed-Free	5	10	15	20	25	30	35	40	45
Ⓑ Simple-Simple	10	20	30	40	50	60	70	80	90
Ⓒ Fixed-Simple	14	28	42	57	71	85	99	113	127
Ⓓ Fixed-Fixed	20	40	60	80	100	120	140	160	180

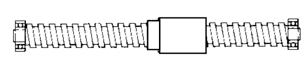
ASCERTAINING COMPRESSION LOADS

Use procedure similar to that for finding critical shaft speed

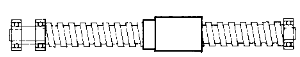
END SUPPORT CONFIGURATIONS



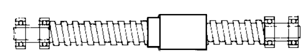
Ⓐ Fixed-Free



Ⓑ Simple-Simple



Ⓒ Fixed-Simple



Ⓓ Fixed-Fixed

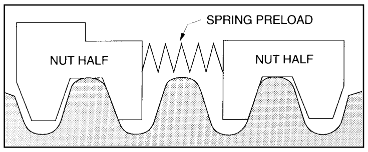
TECHNICAL SECTION

Axial Take-Up Mechanisms

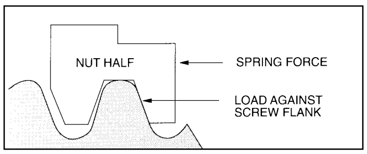
TYPICAL SOLUTIONS —

Backlash Compensation Without High Drag Torque

The standard method for taking up backlash is to bias two nut halves axially using some type of compliant spring. (Wavy washer, compression spring, rubber washer, etc.)



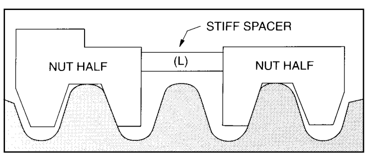
The unit is very stiff in the direction in which the nut half is loaded against the flank of the screw thread. However, in the direction away from the screw thread, the nut is only as axially stiff as the amount of preload which the spring exerts.

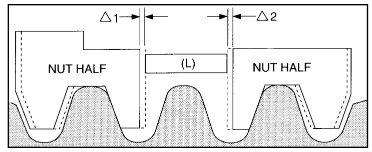


For example, if the maximum axial load which the system is subjected to is 50 lbs., the amount of spring preload must be equal to or greater than 50 lbs. in order to maintain intimate screw/nut contact. The problems arising from preloading in this manner are increased torque and nut wear.

An alternate method would thus be to replace the spring with a stiff spacer sized to fit exactly between the two nut halves.

There would then be no excessive preload force at the interface and the unit would be capable of carrying high axial loads in either direction with no backlash.





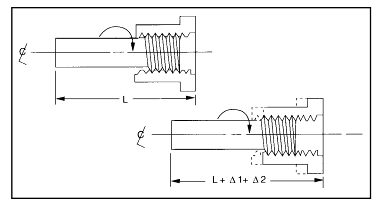
This is fine initially. However, as use time increases, wear begins on the nut threads causing a gap to develop between the spacer (L) and the nut halves. This gap (Δ1 + Δ2) is now the amount of backlash which has developed in the unit. This backlash can be removed by replacing the stiff spacer with a new spacer equal to (L + Δ1 + Δ2). This process, although effective, would be extremely costly and difficult to implement on a continuous basis.

A PATENTED SOLUTION

What is needed, then, is a stiff spacer which will continually expand to accommodate the wear which occurs during use.

This is done by creating a spacer threaded at one end with a complimentary nut torsionally biased to advance when a gap develops.

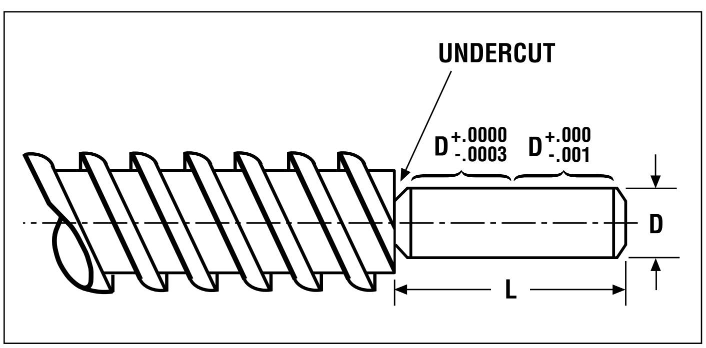
The thread at the end of the spacer is a fine helix such that an axial load will not backdrive the nut once spacer growth has occurred.



The amount of preload on the unit is only that necessary to turn the spacer nut on the spacer rod and is independent of the external system loadings. THIS PATENTED DESIGN HAS A SELF-WEAR COMPENSATING UNIT WHICH HAS EXTREMELY LOW FRICTIONAL DRAG TORQUE YET HIGH AXIAL STIFFNESS.

JOURNAL/END MACHINING & MOUNTING ACCESORIES

For Use With Series S10 and S12 Blocks



End Machining

Available at an additional cost. PIC offers a typical journal for use with a bearing/mount support. Custom end machining available. Send drawing with your RFQ.

Please Note:

- **— Bearing Shaft Spacers are listed in Catalog Section 6**
- **— Couplings are listed in Catalog Section 7**
- **— Linear Bearings and Shafting are listed in Catalog Section 4**

The data presented below will be useful when designing lead screw systems using Series S10 Universal Bearing Blocks and Series S12 Bearing Blocks.

When Using Series S10 Universal Bearing Blocks

Screw Dia.	D Journal Dia.	L Journal Length	Ball Bearing	Retaining Ring	Shim Pack	Shaft Collar
3/16	0.1247	1.00	E1-3	Z1-1	SP-06	C1-1
1/4	0.1247	1.00	E1-3	Z1-1	SP-06	C1-1
5/16	0.1872	1.12	E1-8	Z1-2	SP-08	C1-2
3/8	0.2497	1.12	E1-9	Z1-3	SP-10	C1-3
7/16	0.2497	1.12	E1-9	Z1-3	SP-10	C1-3
1/2	0.3747	1.38	E1-15	Z1-5	SP-14	C1-10
5/8	0.3747	1.38	E1-15	Z1-5	SP-14	C1-10

When Using Series S12 Bearing Blocks

Screw Dia.	D Journal Dia.	L Journal Length	Flange Adaptor	Flange Spacer	Flanged Ball Bearing	Bearing Housing
3/16	0.1247	0.6	LMB-4		E2-3	S12-4
1/4	0.1247	0.6	LMB-4		E2-3	S12-4
5/16	0.1872	0.75	LMB-6		E2-6	S12-5
3/8	0.2497	0.813	LMB-8		E2-9	S12-8
7/16	0.2497	0.813	LMB-8		E2-9	S12-8
1/2	0.2497	0.813	LMB-8	SMB-8	E2-9	S12-8
5/8	0.3747	1.083	LMB-10	SMB-10	E2-15	S12-10

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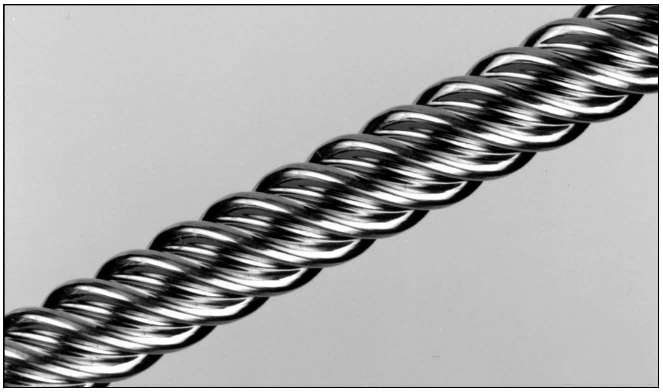
PRECISION PS STYLE LEAD SCREWS

.0006 Inch/Inch (mm/mm) Lead Accuracy



Material: 303 Stainless Steel

Repeatability: .000050 inches

System (lead screw and nut) Specification

Operating Temperature Range: 32°F - 200°F (0°C - 93°C)

Coefficient Of Friction (Nut To Screw): .08 Static
.15 Dynamic
(.09 when TFE coated)

Features:

- Precision rolled
- Lead screw accuracy of .0006 in./in. (mm/mm)
- Straightness tolerance of .003 in/ft.
- Screws have burnished finish of better than 16 micro-inch due to the rolling process
- 303 Stainless steel used for uniform grain structure to improve lead accuracy
- Available with custom TFE coating to extend normal life in as much as 300%

Part Number

PS □ □ – □ □

- Part Number from Table
- **Coating:** T = Teflon, Blank = no coating
- Length in inches (Consult factory for special lengths)

Screw Dia.	Lead (in. or mm)	Root Dia. in. (mm)	Efficiency EF (%)	Standard Length (in.)	** Part No.
1/4	0.062 0.250 1.000 1.5 mm	0.170 0.168 0.170 0.172 (4.37)	52 79 84 51	12, 36, 72	**PS4006** □ - □□ **PS4025** □ - □□ **PS4100** □ - □□ **PS4M01.5** □ - □□
3/8	0.100 0.200 0.300 0.500 1.000 1.200 2 mm 5 mm	0.266 0.266 0.255 0.265 0.254 0.254 0.254 (6.45) 0.266 (6.76)	53 69 76 81 84 84 47 69	12, 36, 72	**PS6010** □ - □□ * **PS6020** □ - □□ **PS6030** □ - □□ **PS6050** □ - □□ * **PS6100** □ - □□ **PS6120** □ - □□ **PS6M02** □ - □□ **PS6M05** □ - □□
7/16	0.250 0.500 3 mm 5 mm	0.325 0.328 0.363 (9.22) 0.313 (7.95)	70 80 52 65	24, 48, 72	**PS7025** □ - □□ **PS7050** □ - □□ **PS7M03** □ - □□ **PS7M05** □ - □□
1/2	0.050 0.100 0.200 0.500 1.000	0.433 0.364 0.366 0.352 0.372	28 46 63 79 84	24, 48, 72	**PS8005** □ - □□ **PS8010** □ - □□ * **PS8020** □ - □□ * **PS8050** □ - □□ **PS8100** □ - □□ *
3/4	1.000 2.000	0.619 0.611	81 84	24, 48, 72	**PS12100** □ - □□ * **PS12200** □ - □□

NOTES: When Teflon coating is used, do not use lubrication. Random voids in the teflon coating have no effect on system performance. The lubricant, although solid, has some "spreading" ability as in fluid lubricants

Uncoated screws should not require lubrication. For those instances where lubrication may be desired, one of the following lubricants or similar would be appropriate.

ESSO / Humble Oil — Teresso Series Grade 43 oil
ESSO / Humble Oil — Esstic Series Grade 50 oil
Union Carbide — Union 50 H.B. 50
Dow Corning — 550 Fluid D

* Left hand thread available.

** For Teflon coating insert a **T** before dash.
For Example: **PS4006T - 72**

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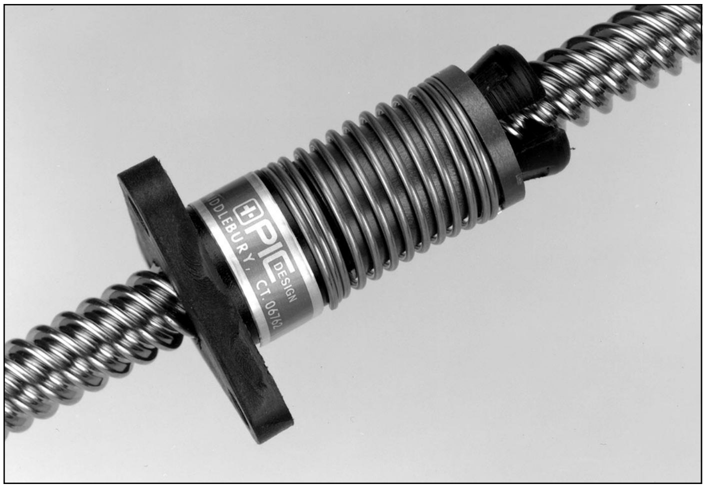
PZ STYLE LEAD SCREW NUTS

For Use With PS Series Lead Screws



PZ style nuts provide anti-backlash for light loads operating at moderate speeds. These nuts utilize a patented self-lubricating polyacetal radially pre-loaded nut. They are ideally suited for vertical applications requiring noise and vibration control. PZ style nuts are used in conjunction with
1/4" to 1/2" diameter lead screws.

This anti-backlash assembly offers an effective linear actuator for design operations requiring precise positional accuracy and repeatability, with minimum cost.

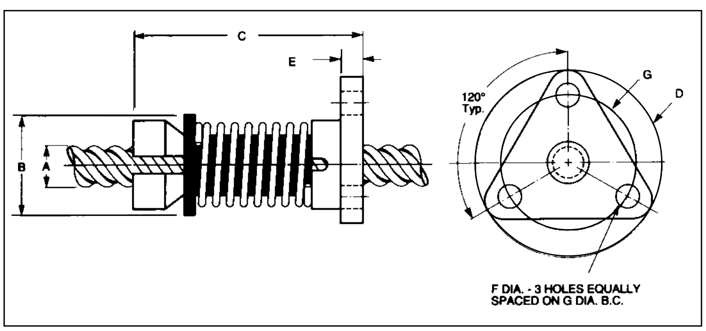
NUT SPECIFICATIONS

Material: Polyacetal with lubricating additive
Tensile Strength: 9,700 PSI at 73°F
Shear Strength: 9,500 PSI at 73°F

SYSTEM (NUT AND LEAD SCREW) SPECIFICATIONS

Temperature Range: 32°F to 200°F
Coefficient of Friction: .08 Static to .15 Dynamic
Coefficient of Thermal Expansion: 6 x 10^{-5} in./in./°F

Screw Dia.	Lead (in. or mm)	Drag Torque	Design Load	Part No.
1/4	0.062	1-4 oz.- in.	5 lbs.	**PZ4006N**
	0.250			**PZ4025N**
	1.000			**PZ4100N**
	1.5 mm	(.007 - .03NM)	(2kg)	**PZ4M01.5N**
3/8	0.100	2-5 oz.- in.	10 lbs.	**PZ6010N**
	0.200			**PZ6020N**
	0.300			**PZ6030N**
	0.500			**PZ6050N**
	1.000			**PZ6100N**
	1.200			**PZ6120N**
	2 mm	(.014 - .035NM)	(5kg)	**PZ6M02N**
	5 mm			**PZ6M05N**
7/16	0.250	3-6 oz.- in.	15 lbs.	**PZ7025N**
	0.500			**PZ7050N**
	3 mm	(.021 - .04NM)	(7kg)	**PZ7M03N**
	5 mm			**PZ7M05N**
1/2	0.050	3-6 oz.- in. (.021 - .04NM)	25 lbs. (.021 - .04NM)	**PZ8005N**
	0.100			**PZ8010N**
	0.200			**PZ8020N**
	0.500			**PZ8050N**
	1.000			**PZ8100N**



INTEGRALLY MOLDED FLANGE MOUNT

PZ Standard Mounting Dimensions

Series	Screw Dia. A		Nut Dia. B		Nut Length C		Flange Dia. D		Flange Width E		Mounting Holes F		Bolt Circle Dia. G	
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
PZ4000	1/4	(6.35)	.50	(12.70)	1.0	(25.40)	1.00	(25.40)	.18	(4.57)	.143	(3.63)	.750	(19.05)
PZ6000	3/8	(9.53)	.70	(17.78)	1.9	(48.28)	1.50	(38.10)	.18	(4.57)	.200	(5.08)	1.125	(28.58)
PZ7000	7/16	(11.11)	.800	(20.32)	1.9	(48.26)	1.50	(38.10)	.18	(4.57)	.200	(5.08)	1.125	(28.58)
PZ8000	1/2	(12.70)	.890	(22.61)	2.0	(50.80)	1.62	(41.15)	.26	(6.60)	.200	(5.08)	1.250	(31.75)

Other Mountings Available — Please Contact PIC For Information

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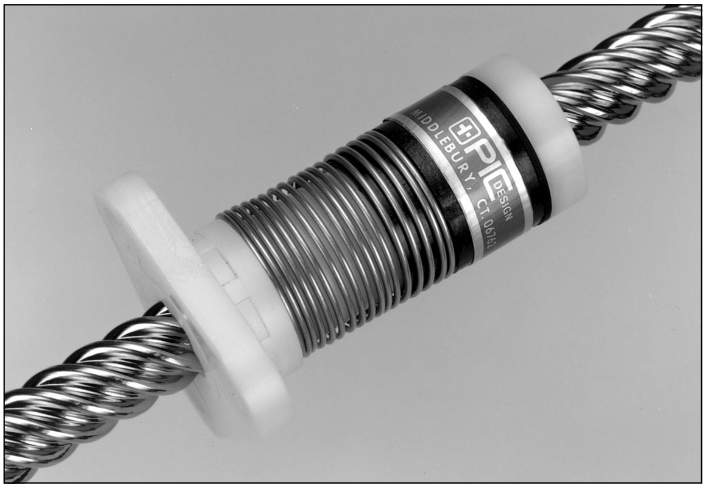
PK STYLE LEAD SCREW NUTS

For Use With PS Series Lead Screws



PK style anti-backlash nuts feature a patented split nut with torsional take up to provide increased load capacity and axial stiffness. This design while high in axial stiffness is very low in frictional drag torque (1-3 oz-in). The type of anti-backlash mechanism used in the PK type nut eliminates the need for load compensating preload forces. This series is specifically made for screws of $^{3}/_{8}$" diameter, moderate loads and speeds.

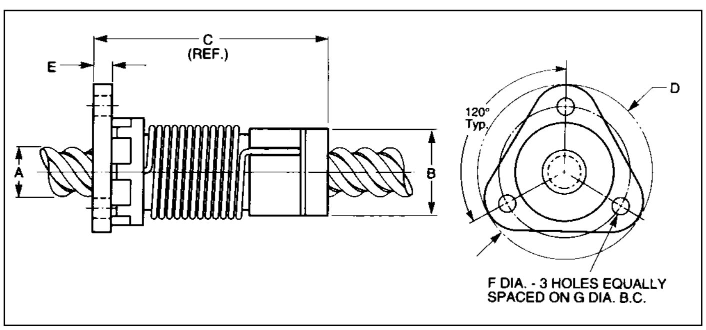
NUT SPECIFICATIONS

Material: Polyacetal with lubricating additive
Tensile Strength: 9,700 PSI at 73°F
Shear Strength: 9,500 PSI at 73°F

SYSTEM (NUT AND LEAD SCREW) SPECIFICATIONS

Temperature Range: 32°F to 200°F
Coefficient of Friction: .08 Static to .15 Dynamic
Coefficient of Thermal Expansion: 6 x 10^{-5} in./in./°F

Screw Dia.	Lead (in. or mm)	Drag Torque	Design Load	Part No.
$^{3}/_{8}$	0.100	1-3 oz.-in.	20 lbs.	**PK6010N**
	0.200			**PK6020N**
	0.300			**PK6030N**
	0.500			**PK6050N**
	1.000			**PK6100N**
	1.200			**PK6120N**
	2 mm	(.007 - .02NM)	(10kg)	**PK6M02N**
	5 mm			**PK6M05N**



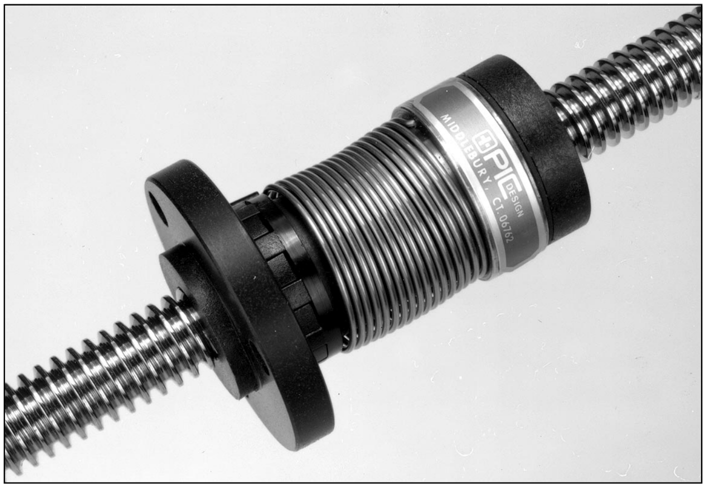
INTEGRALLY MOLDED FLANGE MOUNT

PK Standard Mounting Dimensions

Series	Screw Dia. A	Nut Dia. B	Nut Length C	Flange Dia. D	Flange Width E	Mounting Holes F	Bolt Circle Dia. G
PK6000 (in.)	$^{3}/_{8}$	.80	2.0	1.5	.19	.20	1.125
PK6000 (mm.)	9.53	20.32	50.80	38.10	4.83	5.08	28.58

PV STYLE LEAD SCREW NUTS

For Use With PS Series Lead Screws



PV style anti-backlash nuts provide a maximum load carrying capability and the lightest axial and radial stiffness of all PIC anti-backlash nuts. They are designed for smooth, quiet operation and long life, made possible by a patented axial take-up mechanism. Because this series is designed to operate with higher loads, operation is only possible with 1/2" and 3/4" diameter lead screws.

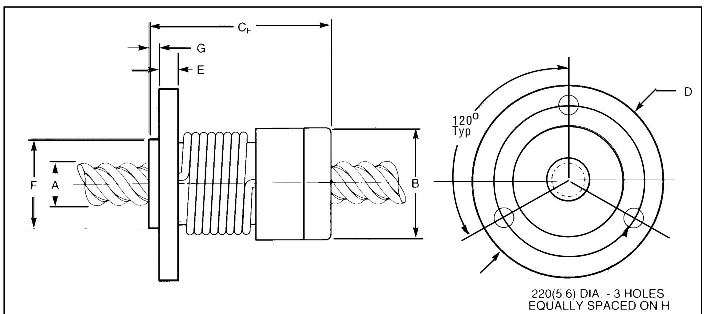
NUT SPECIFICATIONS

Material: Polyacetal with lubricating additive
Tensile Strength: 9,700 PSI at 73°F
Shear Strength: 9,500 PSI at 73°F

SYSTEM (NUT AND LEAD SCREW) SPECIFICATIONS

Temperature Range: 32°F to 200°F
Coefficient of Friction: .08 Static to .15 Dynamic
Coefficient of Thermal Expansion: 6×10^{-5} in./in./°F

Screw Dia.	Lead (in. or mm)	Drag Torque	Design Load	Part No.
1/2	0.050	2-6 oz.-in. (.01 - .04NM)	150 lbs. (68kg)	**PV8005N**
	0.100			**PV8010N**
	0.200			**PV8020N**
	0.500			**PV8050N**
	1.000			**PV8100N**
3/4	1.000	3-7 oz.-in. (.02 - .05NM)	350 lbs. (159kg)	**PV12100N**
	2.000			**PV12200N**



INTEGRALLY MOLDED FLANGE MOUNT

PV Standard Mounting Dimensions

Series	Screw Dia. A		Nut Dia. B		Nut Length CF		Flange Dia. D		Flange Width E		Pilot Dia. F		Pilot Depth G		Bolt Circle Dia. H	
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
PV8000	1/2	(12.70)	1.12	(28.45)	2.3	(58.42)	1.75	(44.45)	.23	(5.84)	.93	(23.63)	.12	(3.05)	1.406	(35.71)
PV12000	3/4	(19.05)	1.62	(41.15)	2.8	(71.12)	2.38	(60.45)	.31	(7.87)	—	—	—	—	2.00	(50.80)

Please Contact PIC For Optional Mounting Threads Or Special Configuration Requirements.

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