

# ***Series A Heavy Duty Industrial Air Cylinders***

*Catalog HY04-AC0910-2/US  
April, 2006*



# **ATLAS CYLINDERS**

## L Series Cylinders

400 - 2300 PSI



Our popularly priced line of medium pressure hydraulic cylinders with bore sizes from 1½" to 8".

## H Series Cylinders

Operating Pressure to 3000 PSI



Atlas' heavy duty cylinder line for demanding hydraulic applications. Bore sizes from 1½" to 8".

## ESP Series Cylinders

Operating Pressure to 3000 PSI



Electronic Stroke Positioning heavy duty cylinders with resolution to .0005", operating pressure to 3000 PSI.

## Custom Cylinders



Bores to 42" and Strokes to 900". Full range of offering from micro cylinders to cylinders over 40,000 lbs.

### **Warning**

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

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The product described herein, including without limitation, product features, specifications, designs, availability and pricing, are subject to change by The Company and its subsidiaries at any time without notice.

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# Atlas Series A Heavy-Duty Air Cylinder

When the job calls for reliable, heavy-duty performance, specify Series A. A 100,000 psi yield strength chrome-plated, case-hardened piston rod. A 125,000 psi yield strength rod-end stud with rolled threads. 100,000 psi yield strength tie rods. With construction like this, the Atlas Series A is rated for air service to 250 psi. This is one heavy-duty air cylinder that's really heavy duty.

They're truly premium quality cylinders, factory prelubricated standard with a non-lube option for millions of maintenance-free cycles. And to make sure every cylinder is premium quality, we subject each and every one – not just batch samples – to tough inspection and performance tests. See the following pages for the inside story on all the features that make Series A the high performance, long lasting choice for all your heavy-duty air applications.

**Note:** Rod diameters over 2½" will use a threaded nose gland.

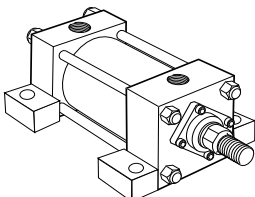
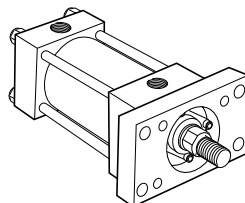
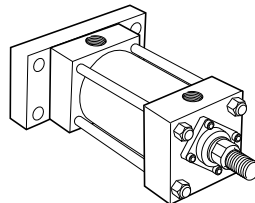
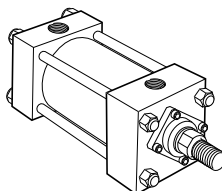
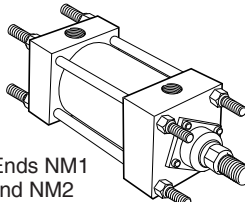
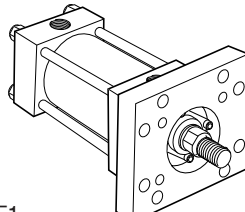
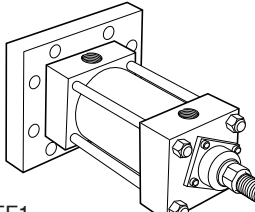
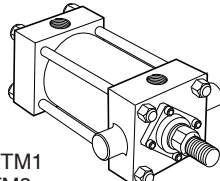
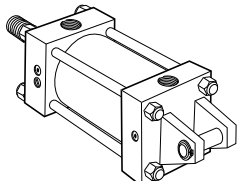
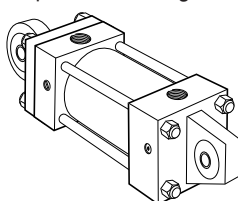
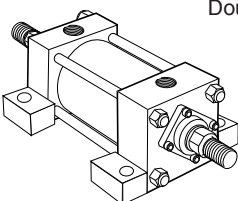


**Standard Specifications**

- Heavy Duty Service – ANSI/(NFPA) T3.6.7R2-1996 Specifications and Mounting Dimension Standards
- Standard Construction – Square Head – Tie Rod Design
- Nominal Pressure – Up to 250 PSI Air Service
- Standard Fluid – Filtered Air
- Standard Temperature – -10°F. to +165°F.
- Bore Sizes – 1½" through 14"
- Piston Rod Diameters – 5/8" through 4"
- Mounting Styles – 14 standard styles at various application ratings
- Strokes – Available in any practical stroke length
- Cushions – Optional at either end or both ends of stroke. "Float Check" at cap end.
- Rod Ends – Four Standard Choices – Specials to Order

In line with our policy of continuing product improvement, specifications in this catalog are subject to change.

**Mounting Styles and Ordering Notes**

Available in all bore and rod combinations.		Available in bore and rod combinations through 6" bore. 8"-14" bores supplied as Head Square (REF) and Cap Square (BEF) mounts.									
Side Lug  SL		Head Rectangular Flange  REF2		Cap Rectangular Flange  BEF2							
Side Tap  FS	Tie Rods Extended Both Ends  Both Ends NM1 Cap End NM2 Head End NM3		Head Square Flange  REF1		Cap Square Flange  BEF1						
Trunnion Mounts  Head TM1 Cap TM2 Intermediate Fixed TM3		Cap Fixed Clevis  PB2 Pivot Pin Included		<b>Rod Gland Construction</b>  B = Bolted Gland R = Retainer Held Gland			NM2 SL BEF2 TM1 SA	FS BEF1 TM2 TM3 PB2			
<b>Cap Fixed Eye with Spherical Bearing</b>  SA		<b>Double End Construction</b>   Available in all bore and rod combinations in the following mounting styles: XSL, XFS, XNM1, XNM3, XTM1, XTM3, and XREF2 (1½"-6"). XREF1 (1½"-6") and XREF (8"-14").			Bore	Rod Dia.					
					1½	5/8 1	B R	R R	R R	N/A N/A	
					2	5/8 1 1 3/8	B B R	R R R	B R R	N/A N/A N/A	
					2½	5/8 1 1 3/8 1 3/4	B B R R	R R R R	B R R R	N/A N/A N/A N/A	
					3¼	1 1 3/8 1 3/4, 2	B B B	B B R	B B R	N/A N/A N/A	
					4	1, 1 3/8 1 3/4, 2	B B	B B	B B	N/A N/A	
					5	1 - 2	B	B	B	N/A	
					6	1 3/8-2½	B	B	B	N/A	
					7*	1 3/8, 1 3/4, 2	B	B	N/A	B	
					8*	1 3/8 - 2½	B	B	N/A	B	
					10*	1 3/4 - 3	B	B	N/A	B	
					12*	2 - 3½	B	B	N/A	B	
					14*	2½ - 4	B	B	N/A	B	

\*REF1, REF2, BEF1, BEF2 not available in these bore sizes.



# The inside story on why Series A is your best choice in heavy duty air cylinders.

**Piston Rod** – Medium carbon steel, induction case-hardened to 54 Rc, hard chrome-plated and polished to 10 RMS finish. Piston rods are made from 90,000 to 100,000 psi minimum yield material in 5/8" through 4" diameters. The piston thread equals the catalog style #1 rod end thread for each rod diameter to assure proper piston-to-rod thread strength. Two wrench flats are provided for rod end attachment.

**Rod Seal** – The piston rod seal offers maximum sealing performance and efficiency with minimum friction. The highly resilient lips are pressure actuated and wear compensating, giving complete reliability through millions of cycles.

**Secondary Seal** – A Double-Service Wiperseal® Patent #2907596 acts as a secondary pressure seal on the extend stroke and cleans the rod on the return stroke.

**Bolt-On Rod Cartridge** – assures true concentricity and allows removal without tie rod disassembly.

**Piston Rod Stud** – Furnished on 2" diameter rods and smaller when standard style #1 rod end threads are required. Piston rod studs are also available in 2 times the catalog "A" dimension length. Studs have rolled threads and are made from high strength steel. Anaerobic adhesive is used to permanently lock the stud to the piston rod.

**Long Bearing Surface** – is inboard of the seals, assuring positive lubrication from within the cylinder. An "O" ring is used as a seal between cartridge and head.

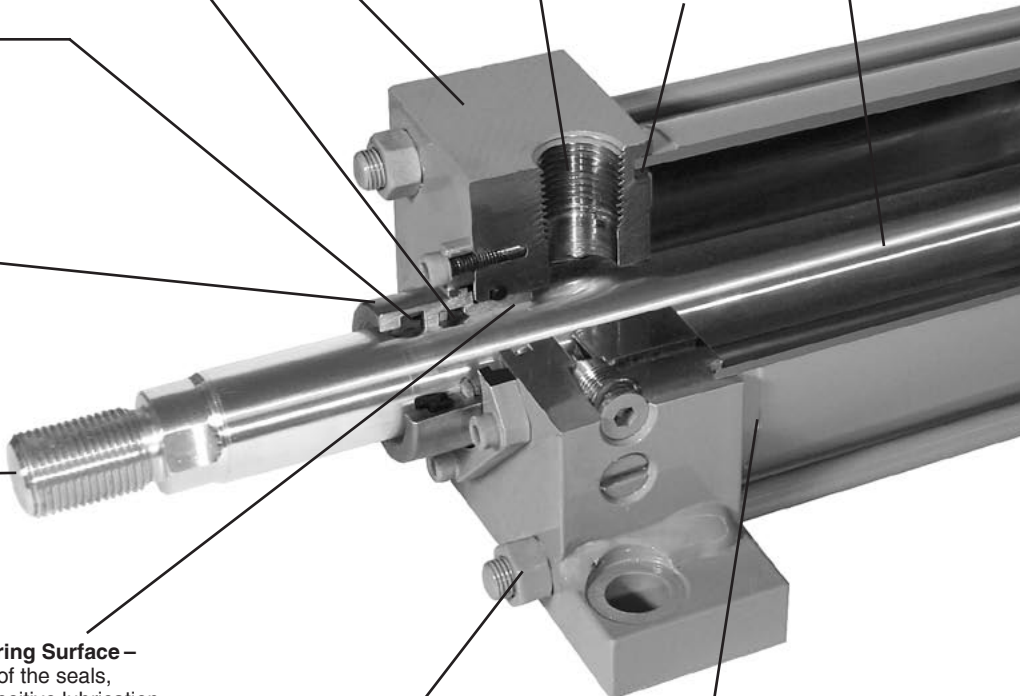
**Steel Head** – Bored and grooved to provide concentricity for mating parts.

**Ports** – NPTF ports are standard.

**End Seals** – Pressure-actuated cylinder body-to-head and cap "O" rings.

**Alloy Steel Tie Rod Nuts**

**Align-A-Groove** – (Patent #3043639) – A 3/16" wide surface machined at each end of the cylinder body. This makes precise mounting quick and easy.



## Adjustable floating cushions

Cushions are optional, and can be supplied at head end, cap end, or both ends without change in envelope or mounting dimensions. Cushions are adjustable.

The Series A cylinder design incorporates the longest cushion sleeve and cushion spear that can be provided in the standard envelope without decreasing the rod bearing and piston bearing lengths.

(1) When a cushion is specified at the head end:

- A self-centering sleeve is furnished on the piston rod assembly.
- A needle valve is provided that is flush with the side of the head when wide open. It may be identified by the fact that it is socket-keyed. Needle valves are located on side number 2, in all mounting styles except TM1, TM2 and TM3. These styles have needle valves located on side number 3.
- A springless check valve is provided that is also flush with the side of the head and is mounted adjacent to the needle valve except on certain

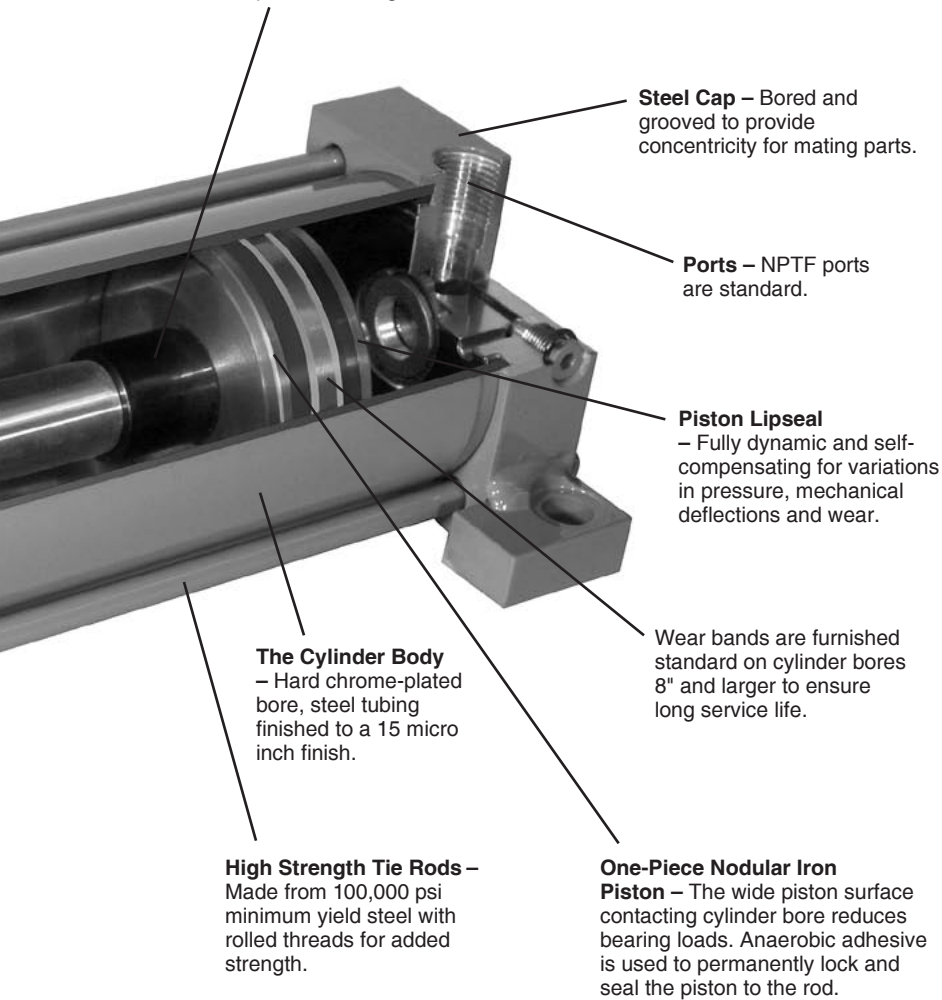
bores of mounting style SL where it is mounted opposite the needle valve. The check valve may be identified by the fact that it is slotted.

d. The check and needle valves are interchangeable in the head.

(2) When a cushion is specified at the cap end:

- A cushion spear is provided on the piston rod assembly.
- A "float check" self-centering bushing is provided which incorporates a large flow check valve for fast "out-stroke" action.
- A socket-keyed needle valve is provided that is flush with the side of the cap when wide open. It is located on side number 2 in all mounting styles except TM1, TM2 and TM3. These styles have needle valves located on side number 3.

**Adjustable Floating Cushions** – Cushions are optional and can be supplied at head end, cap end, or both ends without change in envelope or mounting dimensions.

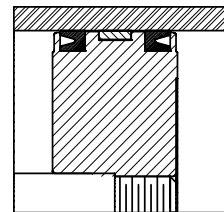


## Prelubricated Wearing Surfaces

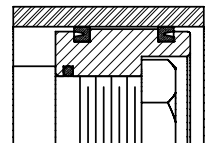
Atlas Series A Air Cylinders are factory pre-lubricated. Lube-A-Cyl applied to seals, piston, cylinder bore, piston rod and gland surfaces provides lubrication for normal operation.

Lube-A-Cyl has been field and laboratory tested, and is recommended by Atlas for air cylinders where lubricant should remain in the cylinder and not be expelled into the atmosphere.

**Note:** Threaded rod glands are supplied on cylinders with rod diameters over 2<sup>1</sup>/<sub>2</sub>".



**Piston with Wear Band**  
Standard 8"-14" Bore



**Nut Retained Piston**  
Optional at extra charge

## Cushion Length

Cylinder Bore (Inches)	Rod Diameter* (Inches)	Cushion Length (Inches)	
		Head*	Cap
1 <sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>8</sub>	<sup>7</sup> / <sub>8</sub>	<sup>13</sup> / <sub>16</sub>
	1	<sup>7</sup> / <sub>8</sub>	<sup>13</sup> / <sub>16</sub>
2	<sup>5</sup> / <sub>8</sub>	<sup>7</sup> / <sub>8</sub>	<sup>13</sup> / <sub>16</sub>
	1 <sup>3</sup> / <sub>8</sub>	<sup>7</sup> / <sub>8</sub>	<sup>13</sup> / <sub>16</sub>
2 <sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>8</sub>	<sup>7</sup> / <sub>8</sub>	<sup>13</sup> / <sub>16</sub>
	1 <sup>3</sup> / <sub>4</sub>	<sup>7</sup> / <sub>8</sub>	<sup>13</sup> / <sub>16</sub>
3 <sup>1</sup> / <sub>4</sub>	1	1 <sup>1</sup> / <sub>8</sub>	1
	2	<sup>13</sup> / <sub>16</sub>	1
4	1	1 <sup>1</sup> / <sub>8</sub>	1
	2	<sup>13</sup> / <sub>16</sub>	1
5	1	1 <sup>1</sup> / <sub>8</sub>	1
	2	<sup>13</sup> / <sub>16</sub>	1

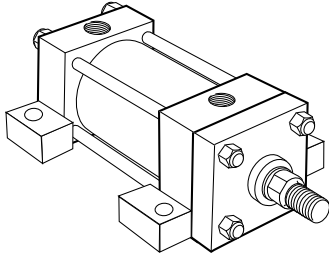
Cylinder Bore (Inches)	Rod Diameter* (Inches)	Cushion Length (Inches)	
		Head*	Cap
6	1 <sup>3</sup> / <sub>8</sub>	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>
	2 <sup>1</sup> / <sub>2</sub>	<sup>13</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>
7	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>
	2	1 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>
8	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>
	2 <sup>1</sup> / <sub>2</sub>	<sup>13</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>
10	1 <sup>3</sup> / <sub>4</sub>	1 <sup>5</sup> / <sub>16</sub>	1 <sup>3</sup> / <sub>4</sub>
	3	1 <sup>1</sup> / <sub>16</sub>	1 <sup>3</sup> / <sub>4</sub>
12	2	1 <sup>5</sup> / <sub>16</sub>	1 <sup>3</sup> / <sub>4</sub>
	3 <sup>1</sup> / <sub>2</sub>	1 <sup>5</sup> / <sub>16</sub>	1 <sup>3</sup> / <sub>4</sub>
14	2 <sup>1</sup> / <sub>2</sub>	1 <sup>3</sup> / <sub>4</sub>	2
	4	1 <sup>13</sup> / <sub>16</sub>	2

\*Head end cushions for rod diameters not listed have cushion lengths with the limits shown.

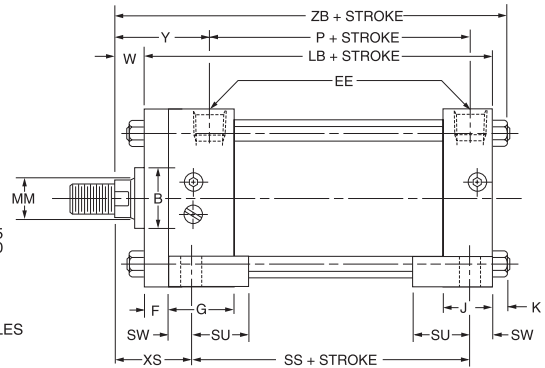
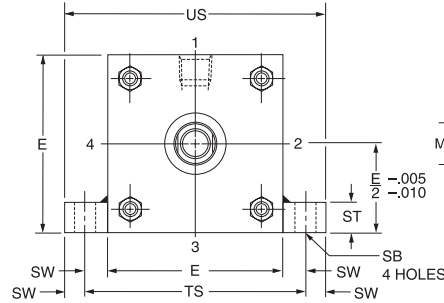
**Side Lug Mount**

**Style SL**

1 1/2" - 2" and 2 1/2" Bore  
 With Maximum Oversize Rods



**Retainer Held Gland**

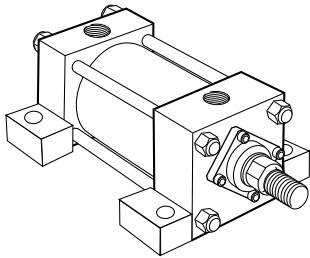


**Before determining dimensions:** See chart on [page 3](#) for cylinder rod combinations that have a bolted gland.

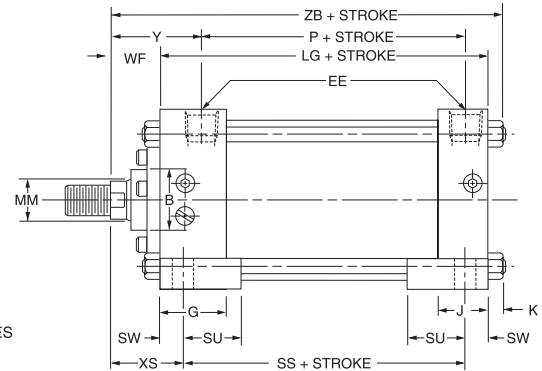
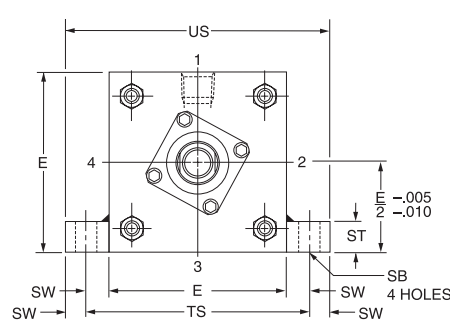
**Side Lug Mount**

**Style SL**

1 1/2" - 6" Bore



**Bolted Gland**

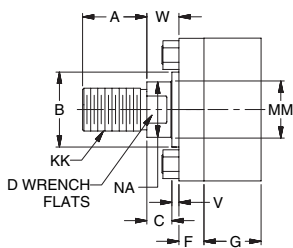


**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

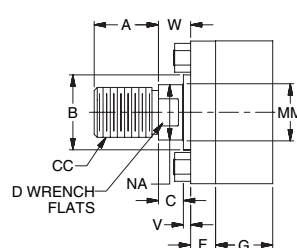
**Thread Style 1**

Small Male



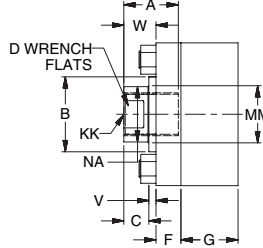
**Thread Style 2**

Intermediate Male



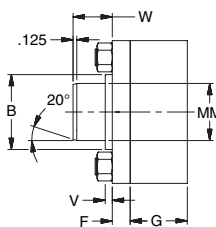
**Thread Style 3**

Short Female



**Style 6**

Stub End



**"Special" Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available.

To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.



Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF	F	G	J	K	SB•	ST	SU	SW	TS	US	Add Stroke			
													LB	LG	P	SS
1½	2	¾†	¾	1½	1	¼	7/16	½	15/16	¾	2¾	3½	4	35/8	2¼	27/8
2	2½	¾†	¾	1½	1	5/16	7/16	½	15/16	¾	3¼	4	4	35/8	2¼	27/8
2½	3	¾†	¾	1½	1	5/16	7/16	½	15/16	¾	3¾	4½	4½	3¾	25/8	3
3¼	3¾	½	5/8	1¾	1¼	¾	9/16	¾	1¼	½	4¾	5¾	47/8	4¼	25/8	3¼
4	4½	½	5/8	1¾	1¼	¾	9/16	¾	1¼	½	5½	6½	47/8	4¼	25/8	3¼
5	5½	½	5/8	1¾	1¼	7/16	13/16	1	19/16	11/16	67/8	8¼	5½	4½	27/8	3½
6	6½	¾	¾	2	1½	7/16	13/16	1	19/16	11/16	77/8	9¼	5¾	5	3½	35/8

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

• Upper surface spot-faced for socket head screws.

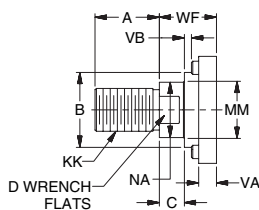
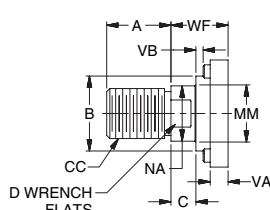
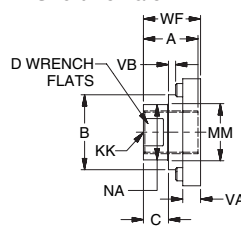
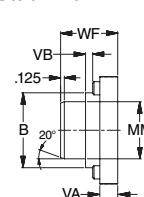
Table 2—Rod Dimensions

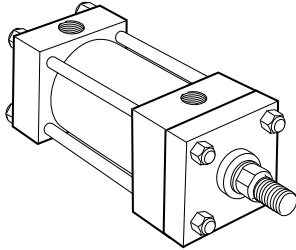
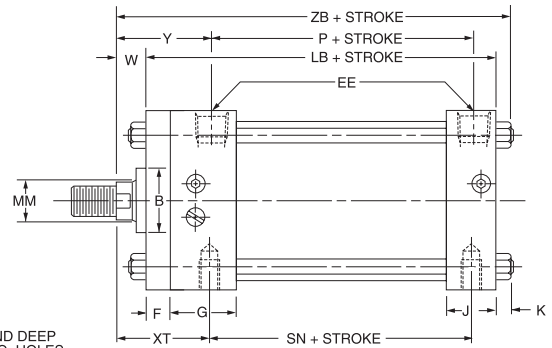
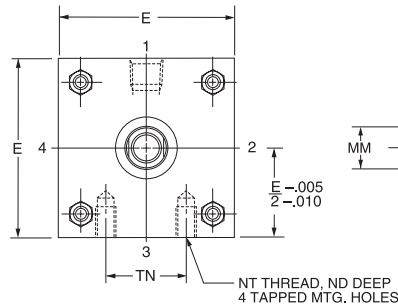
Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										XS	Y	Add Stroke ZB
		Style 2 CC	Style 1 & 3 KK	A	+0.00 -0.02 B	C	D	NA	V	VA	VB	W	WF			
1½	5/8	½-20	7/16-20	¾	1.124	¾	½	9/16	—	¼	3/16	—	1	1¾	115/16	47/8
	1	7/8-14	¾-16	1½	1.499	½	7/8	15/16	½	—	—	1	—	1¾	25/16	5¼
2	5/8	½-20	7/16-20	¾	1.124	¾	½	9/16	—	¼	3/16	—	1	1¾	115/16	415/16
	1	7/8-14	¾-16	1½	1.499	½	1½	15/16	—	¼	3/8	—	1¾	1¾	25/16	55/16
	1¾	1¼-12	1-14	15/8	1.999	5/8	7/8	15/16	5/8	—	—	1¼	—	2	29/16	59/16
2½	5/8	½-20	7/16-20	¾	1.124	¾	½	9/16	—	¼	3/16	—	1	1¾	115/16	51/16
	1	7/8-14	¾-16	1½	1.499	½	1½	15/16	—	—	—	1¼	—	2	29/16	511/16
	1¾	1¼-12	1-14	15/8	1.999	5/8	7/8	15/16	5/8	¼	3/8	—	1¾	1¾	25/16	57/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	111/16	¾	—	—	1½	—	2¼	213/16	515/16
3¼	1	7/8-14	¾-16	1½	1.499	½	7/8	15/16	—	¼	3/8	—	1¾	17/8	27/16	6
	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	—	¼	½	—	15/8	21/8	211/16	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	111/16	—	¼	9/16	—	17/8	25/8	215/16	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	111/16	115/16	—	¼	9/16	—	2	2½	31/16	65/8
4	1	7/8-14	¾-16	1½	1.499	½	7/8	15/16	—	¼	3/8	—	1¾	17/8	27/16	6
	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	—	¼	½	—	15/8	21/8	211/16	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	111/16	—	¼	9/16	—	17/8	25/8	215/16	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	111/16	115/16	—	¼	9/16	—	2	2½	31/16	65/8
5	1	7/8-14	¾-16	1½	1.499	½	7/8	15/16	—	¼	3/8	—	1¾	21/16	27/16	65/16
	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	—	¼	½	—	15/8	25/16	211/16	69/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	111/16	—	¼	9/16	—	17/8	29/16	215/16	613/16
	2	1¾-12	1½-12	2¼	2.624	7/8	111/16	115/16	—	¼	9/16	—	2	211/16	31/16	615/16
6	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	—	¼	7/16	—	15/8	25/16	213/16	71/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	111/16	—	¼	9/16	—	17/8	29/16	31/16	75/16
	2	1¾-12	1½-12	2¼	2.624	7/8	111/16	115/16	—	¼	9/16	—	2	211/16	33/16	77/16
	2½	2¼-12	17/8-12	3	3.124	1	21/16	23/8	—	¼	11/16	—	2¼	215/16	37/16	711/16

Table 3—Envelope and Mounting Dimensions

## Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

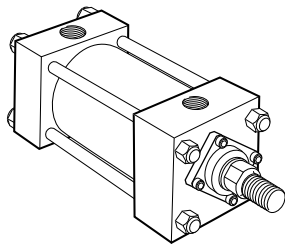
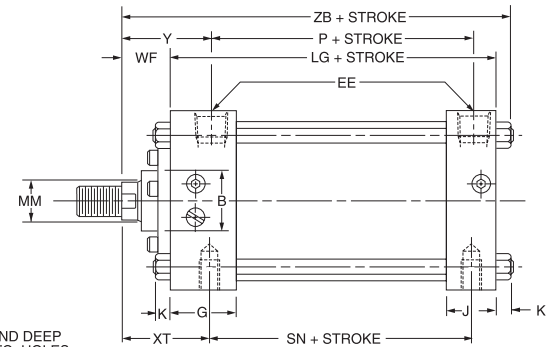
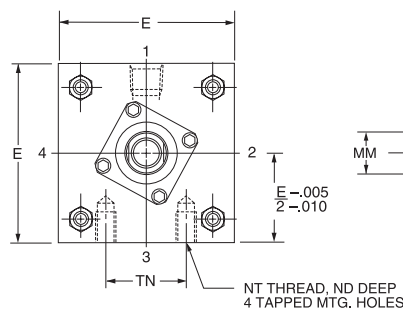
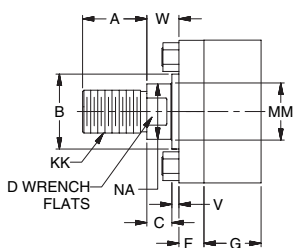
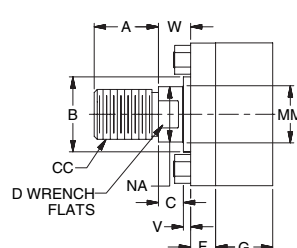
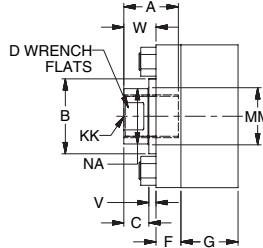
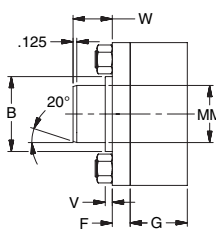
Thread Style 1  
Small MaleThread Style 2  
Intermediate MaleThread Style 3  
Short FemaleStyle 6  
Stub End“Special”  
Thread Style 4

**Side Tap Mount****Style FS**1 1/2" - 2" and 2 1/2" Bore  
With Maximum Oversize Rods**Retainer Held Gland**

Before determining dimensions: See chart on [page 3](#) for cylinder rod combinations that have a bolted gland.

**Side Tap Mount****Style FS**

1 1/2" - 6" Bore

**Bolted Gland****Rod End Dimensions (for Retainer Held Gland) — See Table 2**See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.**Thread Style 1**  
Small Male**Thread Style 2**  
Intermediate Male**Thread Style 3**  
Short Female**Style 6**  
Stub End**"Special" Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available.

To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF	F	G	J	K	NT	TN	Add Stroke			
									LB	LG	P	SN
1½	2	¾†	¾	1½	1	¼	¼-20	⅝	4	3⅝	2¼	2¼
2	2½	¾†	¾	1½	1	⅝	⅝-18	⅞	4	3⅝	2¼	2¼
2½	3	¾†	¾	1½	1	⅝	¾-16	1¼	4⅞	3¾	2⅝	2⅝
3¼	3¾	½	⅝	1¾	1¼	¾	1½-13	1½	4⅞	4¼	2⅝	2⅝
4	4½	½	⅝	1¾	1¼	¾	1½-13	2⅞	4⅞	4¼	2⅝	2⅝
5	5½	½	⅝	1¾	1¼	¾	⅝-11	2⅞	5⅞	4½	2⅞	2⅞
6	6½	¾	¾	2	1½	⅞	¾-10	3¼	5¾	5	3⅞	3⅞

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

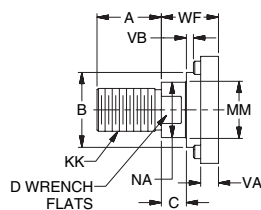
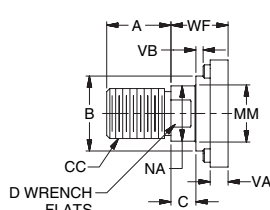
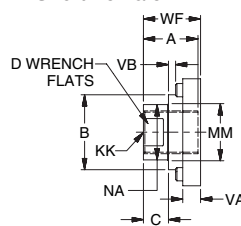
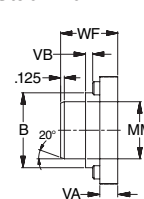
Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										XT	Y	ND	Add Stroke ZB
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	V	VA	VB	W	WF				
1½	⅝	½-20	⅞-20	¾	1.124	¾	½	⅞	—	¼	⅜	—	1	1⅝	1⅝	¾	4⅞
	1	⅞-14	¾-16	1⅞	1.499	½	⅞	1⅝	½	—	—	1	—	2⅝	2⅝	¾	5¼
2	⅝	½-20	⅞-20	¾	1.124	¾	½	⅞	—	¼	⅜	—	1	1⅝	1⅝	11/32	4⅝
	1	⅞-14	¾-16	1⅞	1.499	½	⅞	1⅝	—	¼	⅜	—	1⅜	2⅝	2⅝	11/32	5⅝
2½	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅞	1⅝	⅝	—	—	1¼	—	2⅞	2⅞	11/32	5⅞
	⅝	½-20	⅞-20	¾	1.124	¾	½	⅞	—	¼	⅜	—	1	1⅝	1⅝	7/16	5⅞
3¼	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅞	1⅝	⅝	—	—	1¼	—	2⅞	2⅞	7/16	5⅞
	1	⅞-14	¾-16	1⅞	1.499	½	⅞	1⅝	—	¼	⅜	—	1⅜	2⅝	2⅝	7/16	5⅞
4	1¾	1½-12	1¼-12	2	2.374	¾	1½	1⅝	¾	—	—	1½	—	2⅝	2⅝	7/16	5⅝
	1	⅞-14	¾-16	1⅞	1.499	½	⅞	1⅝	—	¼	⅜	—	1⅜	2⅝	2⅝	1/2	6
5	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅞	1⅝	—	¼	⅞	—	1⅝	2⅝	2⅝	1/2	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	1⅝	—	¼	1/2	—	1⅞	2⅝	2⅝	1/2	6½
6	2	1¾-12	1½-12	2¼	2.624	⅞	1⅞	1⅝	—	¼	⅞	—	2	3⅞	3⅞	1/2	6⅞
	1	⅞-14	¾-16	1⅞	1.499	½	⅞	1⅝	—	¼	⅜	—	1⅜	2⅝	2⅝	⅝	6
7	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅞	1⅝	—	¼	1/2	—	1⅝	2⅝	2⅝	¾	6⅞
	1¾	1½-12	1¼-12	2	2.374	¾	1½	1⅝	—	¼	⅞	—	1⅞	2⅝	2⅝	¾	6⅞
8	1¾	1½-12	1¼-12	2	2.374	¾	1½	1⅝	—	¼	⅞	—	1⅞	2⅝	2⅝	¾	6⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1⅞	1⅝	—	¼	⅞	—	2	3⅞	3⅞	¾	6⅞
9	1¾	1½-12	1¼-12	2	2.374	¾	1½	1⅝	—	¼	⅞	—	1⅞	2⅝	2⅝	¾	6⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1⅞	1⅝	—	¼	⅞	—	2	3⅞	3⅞	¾	6⅞
10	1¾	1½-12	1¼-12	2	2.374	¾	1½	1⅝	—	¼	⅞	—	1⅞	2⅝	2⅝	¾	6⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1⅞	1⅝	—	¼	⅞	—	2	3⅞	3⅞	¾	6⅞
11	1¾	1½-12	1¼-12	2	2.374	¾	1½	1⅝	—	¼	⅞	—	1⅞	2⅝	2⅝	¾	6⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1⅞	1⅝	—	¼	⅞	—	2	3⅞	3⅞	¾	6⅞
12	1¾	1½-12	1¼-12	2	2.374	¾	1½	1⅝	—	¼	⅞	—	1⅞	2⅝	2⅝	¾	6⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1⅞	1⅝	—	¼	⅞	—	2	3⅞	3⅞	¾	6⅞

Table 3—Envelope and Mounting Dimensions

## Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

Thread Style 1  
Small MaleThread Style 2  
Intermediate MaleThread Style 3  
Short FemaleStyle 6  
Stub End“Special”  
Thread Style 4

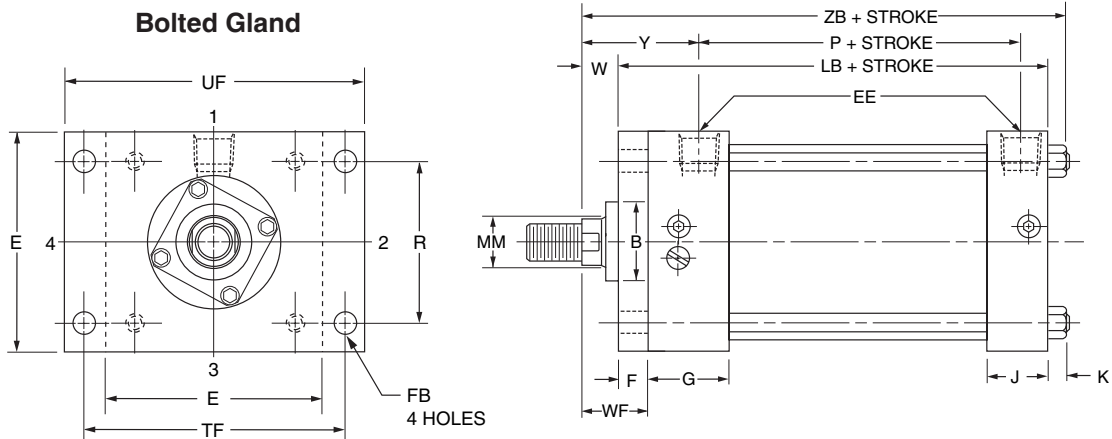
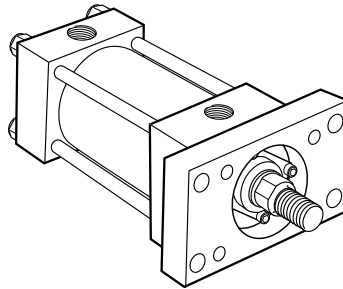
Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

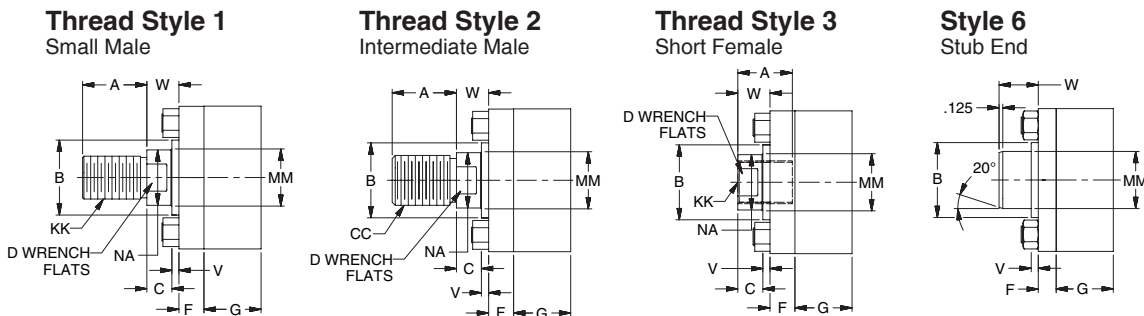
style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**Head Rectangular Flange Mount**  
**Style REF2**  
 1 1/2" - 6" Bore



**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.



A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**"Special" Thread Style 4**  
 Special thread, extension, rod eye, blank, etc., are also available. To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF	F	FB	G	J	K	R	TF	UF	Add Stroke	
											LB	P
1½	2	¾†	¾	5/16	1½	1	¼	1.43	2¾	3¾	4	2¼
2	2½	¾†	¾	¾	1½	1	5/16	1.84	3¾	4½	4	2¼
2½	3	¾†	¾	¾	1½	1	5/16	2.19	3¾	4¾	4½	2¾
3¼	3¾	1½	5/8	7/16	1¾	1¼	¾	2.76	4½	5½	4¾	2¾
4	4½	1½	5/8	7/16	1¾	1¼	¾	3.32	5¾	6¼	4¾	2¾
5	5½	1½	5/8	9/16	1¾	1¼	7/16	4.10	6¾	7¾	5½	2¾
6	6½	¾	¾	9/16	2	1½	7/16	4.88	7¾	8¾	5¾	3½

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

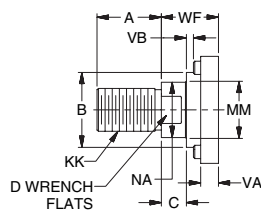
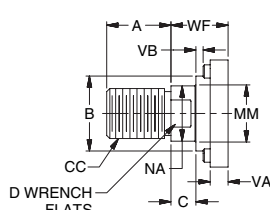
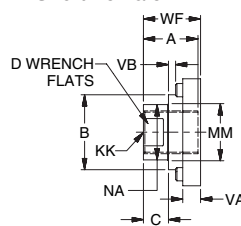
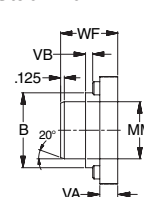
Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions								Y	ZB
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	V	W	WF		
1½	5/8	1/2-20	7/16-20	¾	1.124	¾	1/2	9/16	1/4	5/8	1	1½/16	4¾/8
	1	7/8-14	¾-16	1½	1.499	1/2	7/8	15/16	1/2	1	1¾/8	25/16	5¼
2	5/8	1/2-20	7/16-20	¾	1.124	¾	1/2	9/16	1/4	5/8	1	1½/16	4½/16
	1	7/8-14	¾-16	1½	1.499	1/2	7/8	15/16	1/2	1	1¾/8	25/16	55/16
	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	5/8	1¼	15/8	29/16	59/16
2½	5/8	1/2-20	7/16-20	¾	1.124	¾	1/2	9/16	1/4	5/8	1	1½/16	5½/16
	1	7/8-14	¾-16	1½	1.499	1/2	7/8	15/16	1/2	1	1¾/8	25/16	57/16
	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	5/8	1¼	15/8	29/16	511/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	¾	1½	17/8	213/16	515/16
3¼	1	7/8-14	¾-16	1½	1.499	1/2	7/8	15/16	1/4	¾	1¾/8	27/16	6
	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	¾	1	15/8	211/16	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	1/2	1¼	17/8	215/16	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	111/16	115/16	1/2	1¾	2	31/16	65/8
4	1	7/8-14	¾-16	1½	1.499	1/2	7/8	15/16	1/4	¾	1¾/8	27/16	6
	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	¾	1	15/8	211/16	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	1/2	1¼	17/8	215/16	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	111/16	115/16	1/2	1¾	2	31/16	65/8
5	1	7/8-14	¾-16	1½	1.499	1/2	7/8	15/16	1/4	¾	1¾/8	27/16	65/16
	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	¾	1	15/8	211/16	69/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	1/2	1¼	17/8	215/16	613/16
	2	1¾-12	1½-12	2¼	2.624	7/8	111/16	115/16	1/2	1¾	2	31/16	615/16
6	1¾	1¼-12	1-14	15/8	1.999	5/8	1½	15/16	1/4	7/8	15/8	213/16	71/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	¾	1½	17/8	31/16	75/16
	2	1¾-12	1½-12	2¼	2.624	7/8	111/16	115/16	¾	1¼	2	33/16	77/16
	2½	2¼-12	17/8-12	3	3.124	1	21/16	23/8	1/2	1½	2¼	37/16	711/16

Table 3—Envelope and Mounting Dimensions

## Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

Thread Style 1  
Small MaleThread Style 2  
Intermediate MaleThread Style 3  
Short FemaleStyle 6  
Stub End“Special”  
Thread Style 4

Special thread, extension, rod eye, blank, etc., are also available.

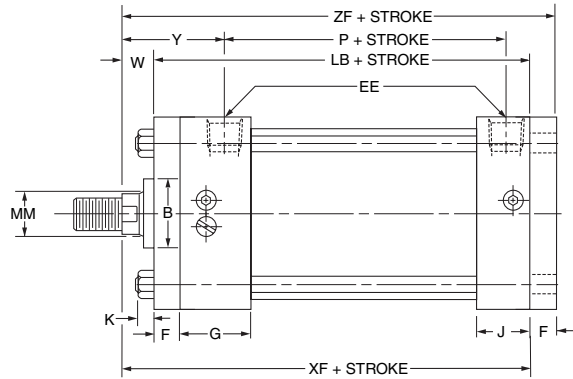
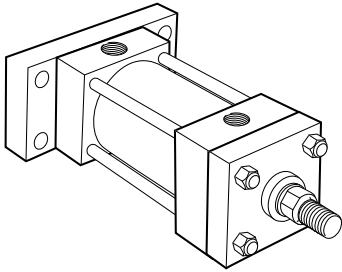
To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

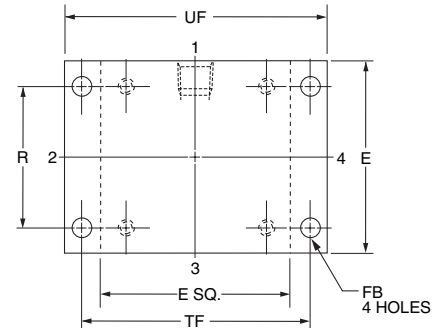
style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**Cap Rectangular Flange Mount**  
**Style BEF2**

1 1/2" - 2" and 2 1/2" Bore  
 With Maximum Oversize Rods



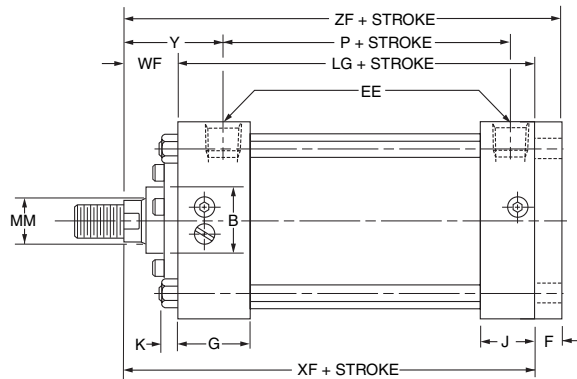
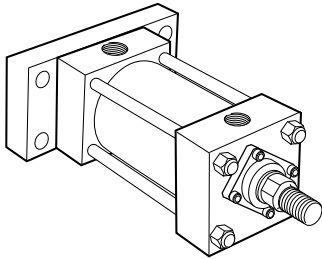
**Retainer Held Gland**



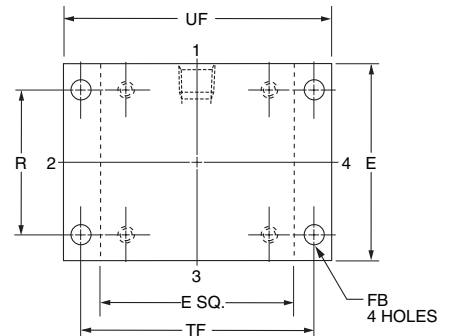
Before determining dimensions: See chart on [page 3](#) for cylinder rod combinations that have a bolted gland.

**Cap Rectangular Flange Mount**  
**Style BEF2**

1 1/2" - 6" Bore



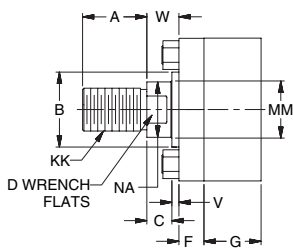
**Bolted Gland**



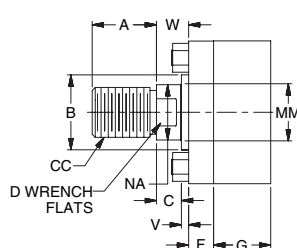
**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

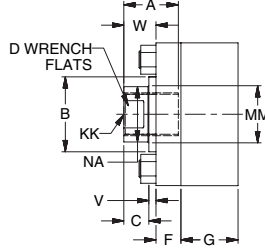
**Thread Style 1**  
 Small Male



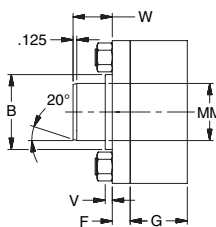
**Thread Style 2**  
 Intermediate Male



**Thread Style 3**  
 Short Female



**Style 6**  
 Stub End



**"Special" Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available.

To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.



Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF	F	FB	G	J	K	R	TF	UF	Add Stroke		
											LB	LG	P
1½	2	3⁄8†	3⁄8	5⁄16	1½	1	¼	1.43	2¾	3⁄8	4	3⁄8	2¼
2	2½	3⁄8†	3⁄8	3⁄8	1½	1	5⁄16	1.84	3¾	4⅞	4	3⁄8	2¼
2½	3	3⁄8†	3⁄8	3⁄8	1½	1	5⁄16	2.19	3⅞	4⅞	4⅞	3¾	2¾
3¼	3¾	½	5⁄8	7⁄16	1¾	1¼	3⁄8	2.76	4⅞	5½	—	4¼	2⅝
4	4½	½	5⁄8	7⁄16	1¾	1¼	3⁄8	3.32	5⅞	6¼	—	4¼	2⅝
5	5½	½	5⁄8	9⁄16	1¾	1¼	7⁄16	4.10	6⅝	7⅝	5⅞	4½	2⅞
6	6½	¾	¾	9⁄16	2	1½	7⁄16	4.88	7⅝	8⅝	5¾	5	3⅞

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

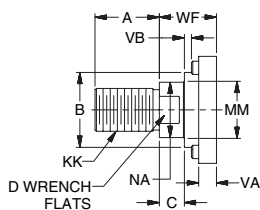
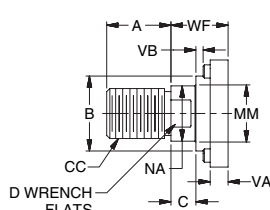
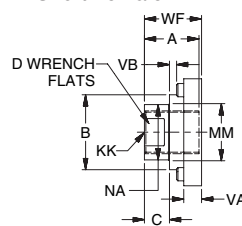
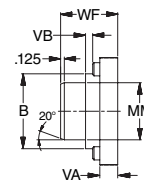
Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Add Stroke		
		Style 2 CC	Style 1 & 3 KK	A	+0.00 -0.02 B	C	D	NA	V	VA	VB	W	WF	Y	XF	ZF
1½	5⁄8	1½-20	7⁄16-20	3⁄4	1.124	3⁄8	1⁄2	9⁄16	—	1⁄4	3⁄16	—	1	1¹⁵⁄₁₆	4⁹⁄₈	5
	1	7⁄8-14	3⁄4-16	1⅞	1.499	1⁄2	7⁄8	1⁵⁄₁₆	1⁄2	—	—	1	—	2⁵⁄₁₆	5	5³⁄₈
2	5⁄8	1½-20	7⁄16-20	3⁄4	1.124	3⁄8	1⁄2	9⁄16	—	1⁄4	3⁄16	—	1	1¹⁵⁄₁₆	4⁹⁄₈	5
	1	7⁄8-14	3⁄4-16	1⅞	1.499	1⁄2	7⁄8	1⁵⁄₁₆	—	1⁄4	3⁄8	—	1⅜	2⁵⁄₁₆	5	5³⁄₈
2½	1⅜	1¼-12	1-14	1⅝	1.999	5⁄8	1⅞	1⁵⁄₁₆	5⁄8	—	—	1¼	—	2⁹⁄₁₆	5¼	5⅝
	5⁄8	1½-20	7⁄16-20	3⁄4	1.124	3⁄8	1⁄2	9⁄16	—	1⁄4	3⁄16	—	1	1¹⁵⁄₁₆	4¾	5⅞
	1	7⁄8-14	3⁄4-16	1⅞	1.499	1⁄2	7⁄8	1⁵⁄₁₆	—	1⁄4	3⁄8	—	1⅜	2⁵⁄₁₆	5⅞	5½
	1⅜	1¼-12	1-14	1⅝	1.999	5⁄8	1⅞	1⁵⁄₁₆	5⁄8	—	—	1¼	—	2⁹⁄₁₆	5⅝	5¾
3¼	1⅜	1½-12	1¼-12	2	2.374	3⁄4	1½	1¹¹⁄₁₆	3⁄4	—	—	1½	—	2¹³⁄₁₆	5⅝	6
	1	7⁄8-14	3⁄4-16	1⅞	1.499	1⁄2	7⁄8	1⁵⁄₁₆	—	1⁄4	3⁄8	—	1⅜	2⁷⁄₁₆	5⅞	6¼
	1⅜	1¼-12	1-14	1⅝	1.999	5⁄8	1⅞	1⁵⁄₁₆	—	1⁄4	1⁄2	—	1⅝	2¹¹⁄₁₆	5⅞	6½
	1¾	1½-12	1¼-12	2	2.624	3⁄4	1½	1¹¹⁄₁₆	—	1⁄4	9⁄16	—	1⅞	2¹⁵⁄₁₆	6⅞	6¾
4	1	7⁄8-14	3⁄4-16	1⅞	1.499	1⁄2	7⁄8	1⁵⁄₁₆	—	1⁄4	3⁄8	—	1⅜	2⁷⁄₁₆	5⅞	6¼
	1⅜	1¼-12	1-14	1⅝	1.999	5⁄8	1⅞	1⁵⁄₁₆	—	1⁄4	1⁄2	—	1⅝	2¹¹⁄₁₆	5⅞	6½
	1¾	1½-12	1¼-12	2	2.374	3⁄4	1½	1¹¹⁄₁₆	—	1⁄4	9⁄16	—	1⅞	2¹⁵⁄₁₆	6⅞	6¾
	2	1¾-12	1½-12	2¼	2.624	7⁄8	1⅞	1¹⁵⁄₁₆	—	1⁄4	9⁄16	—	2	3⅞	6¼	6⅞
5	1	7⁄8-14	3⁄4-16	1⅞	1.499	1⁄2	7⁄8	1⁵⁄₁₆	—	1⁄4	3⁄8	—	1⅜	2⁷⁄₁₆	5⅞	6½
	1⅜	1¼-12	1-14	1⅝	1.999	5⁄8	1⅞	1⁵⁄₁₆	—	1⁄4	1⁄2	—	1⅝	2¹¹⁄₁₆	6⅞	6¾
	1¾	1½-12	1¼-12	2	2.374	3⁄4	1½	1¹¹⁄₁₆	—	1⁄4	9⁄16	—	1⅞	2¹⁵⁄₁₆	6⅞	7
	2	1¾-12	1½-12	2¼	2.624	7⁄8	1⅞	1¹⁵⁄₁₆	—	1⁄4	9⁄16	—	2	3⅞	6½	7⅞
6	1⅜	1¼-12	1-14	1⅝	1.999	5⁄8	1⅞	1⁵⁄₁₆	—	1⁄4	7⁄16	—	1⅝	2¹³⁄₁₆	6⅞	7¾
	1¾	1½-12	1¼-12	2	2.374	3⁄4	1½	1¹¹⁄₁₆	—	1⁄4	9⁄16	—	1⅞	3⅞	6⅞	7⅞
	2	1¾-12	1½-12	2¼	2.624	7⁄8	1⅞	1¹⁵⁄₁₆	—	1⁄4	9⁄16	—	2	3⅞	7	7¾
	2½	2¼-12	1⅞-12	3	3.124	1	2⅞	2⅜	—	1⁄4	1⅞	—	2¼	3⅞	7¼	8

Table 3—Envelope and Mounting Dimensions

## Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

Thread Style 1  
Small MaleThread Style 2  
Intermediate MaleThread Style 3  
Short FemaleStyle 6  
Stub End“Special”  
Thread Style 4

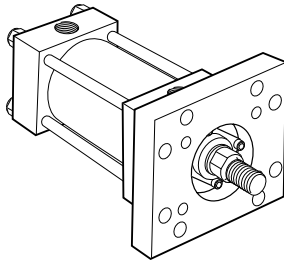
Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

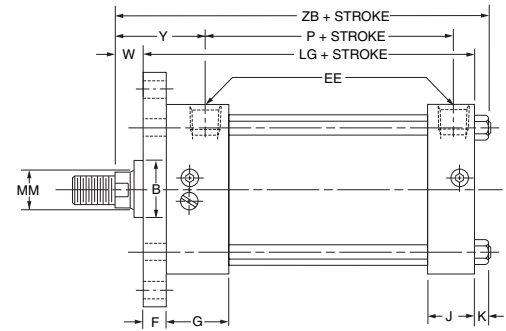
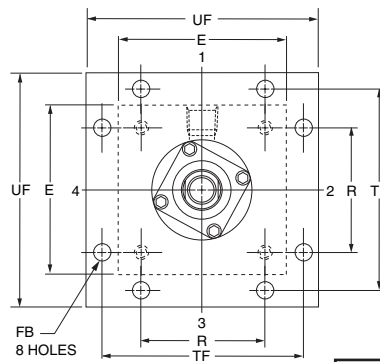
A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**Head Square Flange Mount**  
**Style REF1**  
 1 ½" - 6" Bore

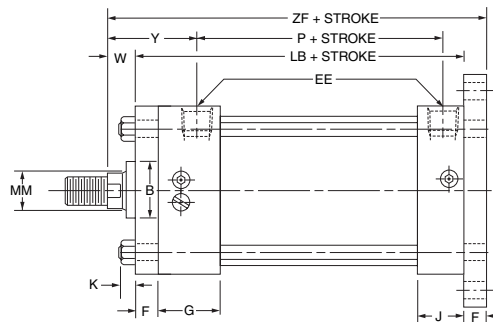
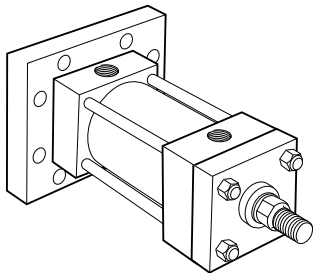


**Bolted Gland**

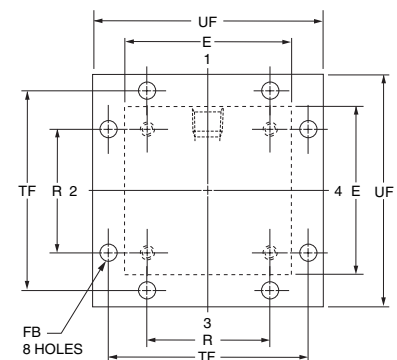


**Before determining dimensions:** See chart on [page 3](#) for cylinder rod combinations that have a bolted gland.

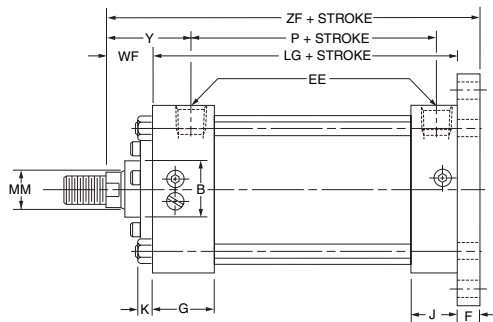
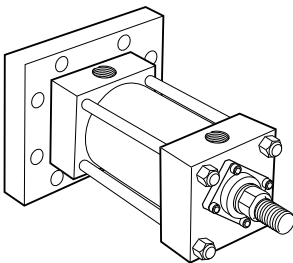
**Cap Square Flange Mount**  
**Style BEF1**  
 1 ½" - 2" and 2 ½" Bore  
 With Maximum Oversize Rods



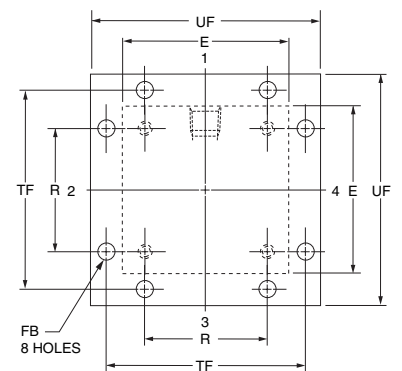
**Retainer Held Gland**



**Cap Square Flange Mount**  
**Style BEF1**  
 1 ½" - 6" Bore



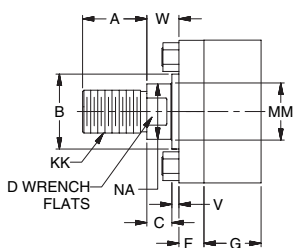
**Bolted Gland**



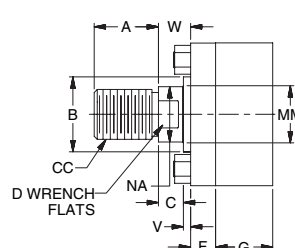
**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

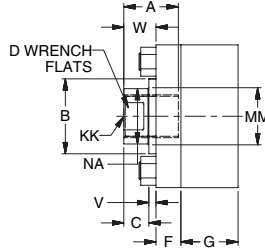
**Thread Style 1**  
 Small Male



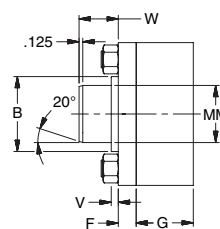
**Thread Style 2**  
 Intermediate Male



**Thread Style 3**  
 Short Female



**Style 6**  
 Stub End



**"Special" Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available. To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF	F	FB	G	J	K	R	TF	UF	Add Stroke		
											LB	LG	P
1½	2	¾†	¾	5/16	1½	1	¼	1.43	2¾	3¾	4	3⅝	2¼
2	2½	¾†	¾	¾	1½	1	5/16	1.84	3¾	4⅞	4	3⅝	2¼
2½	3	¾†	¾	¾	1½	1	5/16	2.19	3⅞	4⅞	4⅞	3¾	2⅝
3¼	3¾	1½	5/8	7/16	1¾	1¼	¾	2.76	4⅞	5½	4⅞	4¼	2⅝
4	4½	1½	5/8	7/16	1¾	1¼	¾	3.32	5⅞	6¼	4⅞	4¼	2⅝
5	5½	1½	5/8	9/16	1¾	1¼	7/16	4.10	6⅝	7⅝	5⅞	4½	2⅞
6	6½	¾	¾	9/16	2	1½	7/16	4.88	7⅝	8⅝	5¾	5	3⅞

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

Table 2—Rod Dimensions

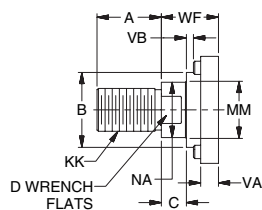
Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Add Stroke		
		Style 4 CC	Style 2 & 3 KK	A	+0.000 -0.002 B	C	D	NA	V	VA	VB	W	WF	Y	ZB	ZF
1½	5/8	1/2-20	7/16-20	¾	1.124	¾	1/2	9/16	1/4**	1/4	3/16	1/4	1	1½/16	4⅞	5
	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	15/16	1/2	—	—	1	—	2½/16	5¼	5⅝
2	5/8	1/2-20	7/16-20	¾	1.124	¾	1/2	9/16	1/4**	1/4	3/16	5/8	1	1½/16	4⅞	5
	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	15/16	1/2**	1/4	3/8	1	1⅜	2½/16	5⅝	5⅝
2½	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	5/8	—	—	1¼	—	2⅞/16	5⅞	5⅝
	5/8	1/2-20	7/16-20	¾	1.124	¾	1/2	9/16	1/4**	1/4	3/16	5/8	1	1½/16	5⅞	5⅞
3¼	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	15/16	1/2**	1/4	3/8	1	1⅜	2½/16	5⅞	5⅞
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	5/8	—	—	1¼	—	2⅞/16	5⅞	5⅞
4	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	5/8	—	—	1¼	—	2⅞/16	5⅞	5⅞
	3/4	1/2-12	1¼-12	2	2.374	¾	1½	1⅞/16	¾	—	—	1½	—	2⅞/16	5⅞	6
5	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	15/16	1/4**	1/4	3/8	3/4	1⅜	2⅞/16	6	6¼
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	3/8**	1/4	1/2	1	1⅝	2⅞/16	6¼	6¼
6	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	3/8**	1/4	1/2	1	1⅝	2⅞/16	6¼	6¼
	2	1⅜-12	1½-12	2¼	2.624	7/8	1⅞/16	1⅝/16	1/2**	1/4	9/16	1⅜	2	3⅞/16	6⅝	6⅞
7	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	15/16	1/4**	1/4	3/8	3/4	1⅜	2⅞/16	6	6¼
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	3/8**	1/4	1/2	1	1⅝	2⅞/16	6¼	6¼
8	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	3/8**	1/4	1/2	1	1⅝	2⅞/16	6¼	6¼
	3/4	1/2-12	1¼-12	2	2.374	¾	1½	1⅞/16	1/2**	1/4	9/16	1¼	1⅞	2⅞/16	6¼	6¼
9	2	1⅜-12	1½-12	2¼	2.624	7/8	1⅞/16	1⅝/16	1/2**	1/4	9/16	1⅜	2	3⅞/16	6⅝	6⅞
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	¾	1/4	7/16	7/8	1⅝	2⅞/16	7⅞	7⅞
10	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⅝/16	¾	1/4	7/16	7/8	1⅝	2⅞/16	7⅞	7⅞
	2	1⅜-12	1½-12	2¼	2.624	7/8	1⅞/16	1⅝/16	1/2**	1/4	9/16	1¼	2	3⅞/16	7⅞	7⅞
11	2	1⅜-12	1½-12	2¼	2.624	7/8	1⅞/16	1⅝/16	1/2**	1/4	9/16	1¼	2	3⅞/16	7⅞	7⅞
	2½	2¼-12	1⅞-12	3	3.124	1	2⅞/16	2⅞/16	1/2**	1/4	1⅞/16	1½	2¼	3⅞/16	7⅞	8

\*\* For all REF1 mounts and BEF1 mounts with maximum oversized rods.

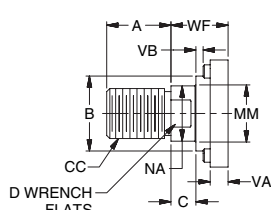
### Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

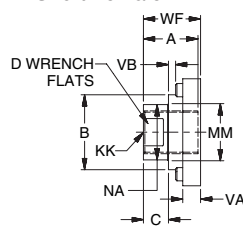
**Thread Style 1**  
Small Male



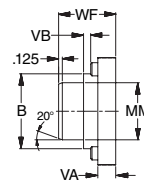
**Thread Style 2**  
Intermediate Male



**Thread Style 3**  
Short Female



**Style 6**  
Stub End



**“Special” Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

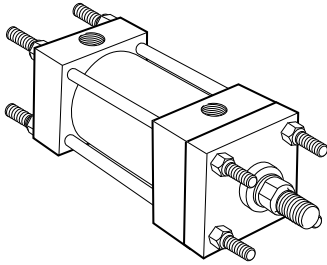
style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**Tie Rods Extended Mount**

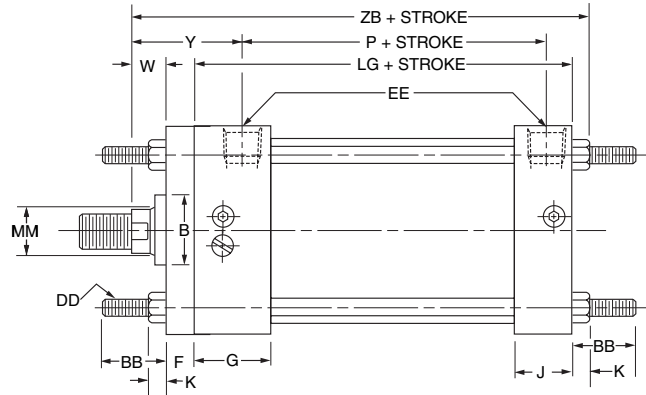
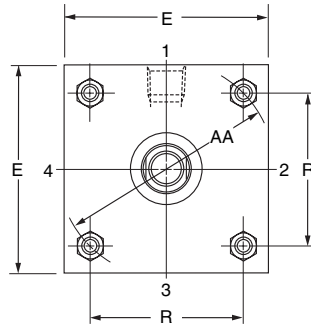
**Style NM1**

1 1/2" - 2" and 2 1/2" Bore – All Rod Sizes

3 1/4" Bore with 1 3/4" & 2" Rods



**Retainer Held Gland**



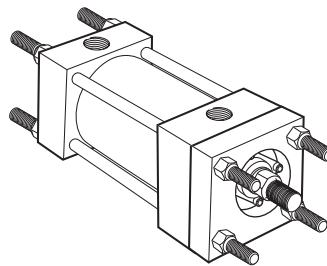
**Tie Rods can be extended:** Both Ends — Model NM1;  
 Cap End — Model NM2; Head End — Model NM3.

**Before determining dimensions:** See chart on [page 3](#) for  
 cylinder rod combinations that have a bolted gland.

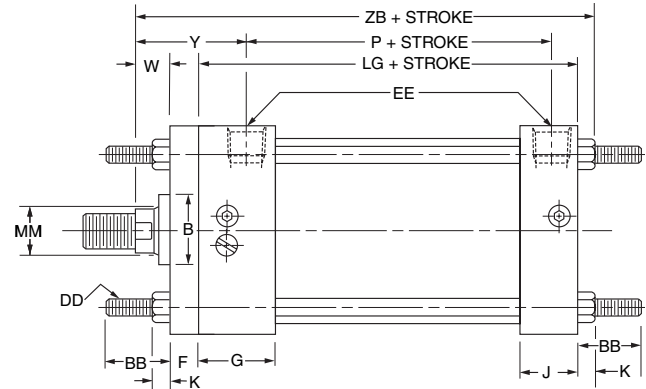
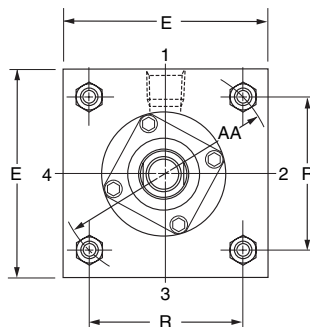
**Tie Rods Extended Mount**

**Style NM1**

1 1/2" - 6" Bore



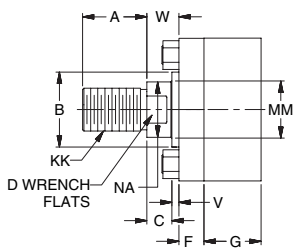
**Bolted Gland**



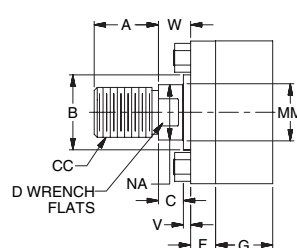
**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

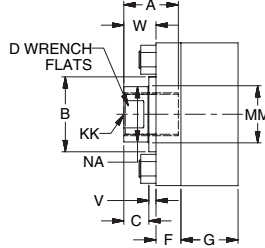
**Thread Style 1**  
 Small Male



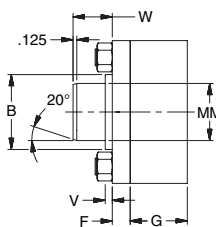
**Thread Style 2**  
 Intermediate Male



**Thread Style 3**  
 Short Female



**Style 6**  
 Stub End



**“Special” Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

Table 1—Envelope and Mounting Dimensions

Bore	AA	BB	DD	E	EE NPTF	F	G	J	K	R	Add Stroke	
											LG	P
1½	2.02	1	¼-28	2	⅜†	⅜	1½	1	¼	1.43	3⅝	2¼
2	2.6	1⅝	5/16-24	2½	⅜†	⅜	1½	1	5/16	1.84	3⅝	2¼
2½	3.1	1⅝	5/16-24	3	⅜†	⅜	1½	1	5/16	2.19	3¾	2⅜
3¼	3.9	1⅝	3/8-24	3¾	½	5/8	1¾	1¼	3/8	2.76	4¼	2⅝
4	4.7	1⅝	3/8-24	4½	½	5/8	1¾	1¼	3/8	3.32	4¼	2⅝
5	5.8	1⅝	1/2-20	5½	½	5/8	1¾	1¼	7/16	4.10	4½	2⅞
6	6.9	1⅝	1/2-20	6½	¾	¾	2	1½	7/16	4.88	5	3⅝

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

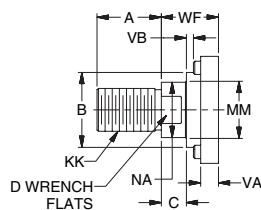
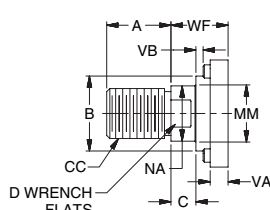
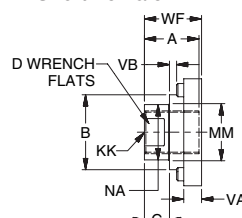
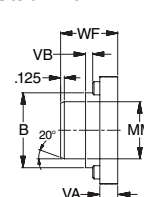
Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Y	Add Stroke ZB
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	V	VA	VB	W	WF		
1½	5/8	1/2-20	7/16-20	¾	1.124	3/8	1/2	9/16	—	1/4	3/16	—	1	1½/16	4⅞
	1	7/8-14	¾-16	1⅝	1.499	1/2	7/8	15/16	1/2	—	—	1	—	25/16	5¼
2	5/8	1/2-20	7/16-20	¾	1.124	3/8	1/2	9/16	—	1/4	3/16	—	1	1½/16	4½/16
	1	7/8-14	¾-16	1⅝	1.499	1/2	7/8	15/16	—	1/4	3/8	—	1⅜	25/16	55/16
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅝	15/16	5/8	—	—	1¼	—	29/16	59/16
2½	5/8	1/2-20	7/16-20	¾	1.124	3/8	1/2	9/16	—	1/4	3/16	—	1	1½/16	5¼
	1	7/8-14	¾-16	1⅝	1.499	1/2	7/8	15/16	—	1/4	3/8	—	1⅜	25/16	57/16
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅝	15/16	5/8	—	—	1¼	—	29/16	511/16
3¼	1⅝	1¼-12	1¼-12	2	2.374	¾	1½	11/16	¾	—	—	1½	—	213/16	515/16
	1	7/8-14	¾-16	1⅝	1.499	1/2	7/8	15/16	—	1/4	3/8	—	1⅜	27/16	6
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅝	15/16	—	1/4	1/2	—	1⅝	211/16	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	—	1/4	9/16	—	1⅞	215/16	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	11/16	15/16	—	1/4	9/16	—	2	31/16	65/8
4	1	7/8-14	¾-16	1⅝	1.499	1/2	7/8	15/16	—	1/4	3/8	—	1⅜	27/16	6
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅝	15/16	—	1/4	1/2	—	1⅝	211/16	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	—	1/4	9/16	—	1⅞	215/16	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	11/16	15/16	—	1/4	9/16	—	2	31/16	65/8
5	1	7/8-14	¾-16	1⅝	1.499	1/2	7/8	15/16	—	1/4	3/8	—	1⅜	27/16	65/16
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅝	15/16	—	1/4	1/2	—	1⅝	211/16	69/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	—	1/4	9/16	—	1⅞	215/16	613/16
	2	1¾-12	1½-12	2¼	2.624	7/8	11/16	15/16	—	1/4	9/16	—	2	31/16	615/16
6	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅝	15/16	—	1/4	7/16	—	1⅝	213/16	71/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	—	1/4	9/16	—	1⅞	31/16	75/16
	2	1¾-12	1½-12	2¼	2.624	7/8	11/16	15/16	—	1/4	9/16	—	2	33/16	77/16
	2½	2¼-12	1⅞-12	3	3.124	1	21/16	23/8	—	1/4	11/16	—	2¼	37/16	711/16

Table 3—Envelope and Mounting Dimensions

## Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

Thread Style 1  
Small MaleThread Style 2  
Intermediate MaleThread Style 3  
Short FemaleStyle 6  
Stub End“Special”  
Thread Style 4

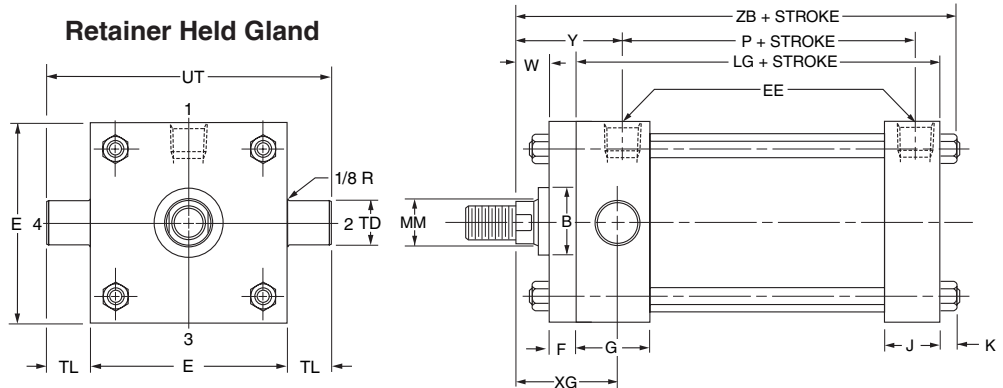
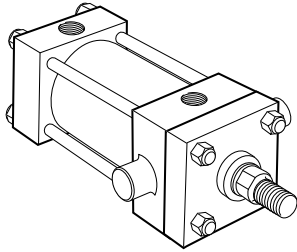
Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

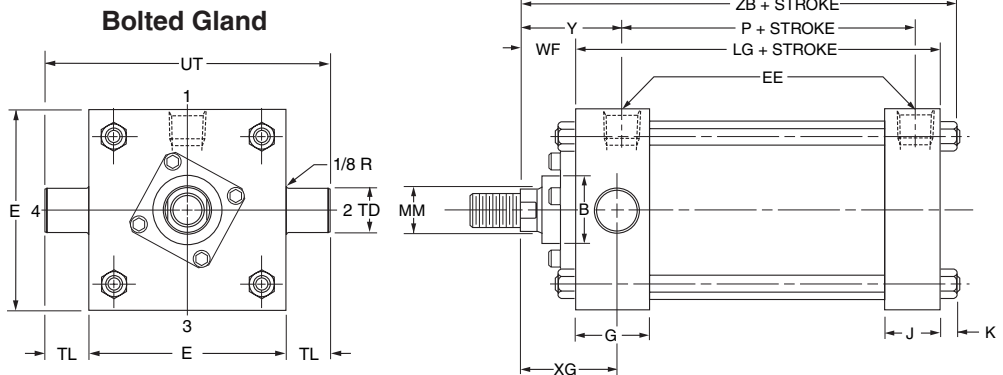
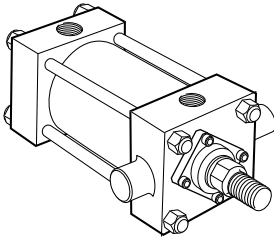
style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**Head Trunnion Mount**  
**Style TM1**  
 1 1/2" - 2" and 2 1/2" Bore  
 With Maximum Oversize Rods



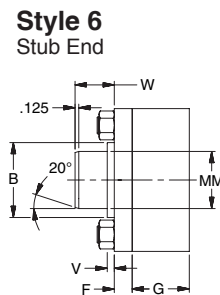
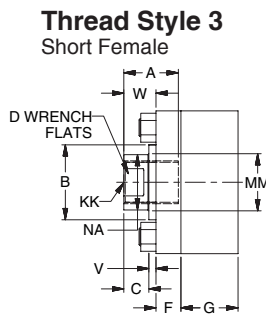
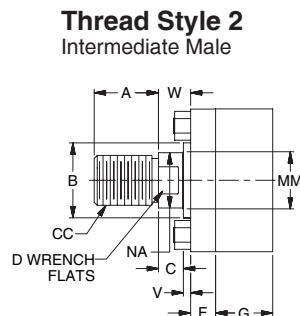
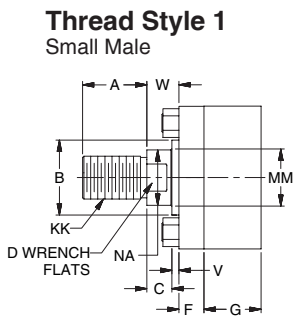
**Before determining dimensions:** See chart on [page 3](#) for cylinder rod combinations that have a bolted gland.

**Head Trunnion Mount**  
**Style TM1**  
 1 1/2" - 6" Bore



**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.



**“Special” Thread Style 4**  
 Special thread, extension, rod eye, blank, etc., are also available.  
 To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.



Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF	F	G	J	K	+0.000 TD -0.001	TL	UT	Add Stroke	
										LG	P
1½	2	⅜†	⅜	1½	1	¼	1.000	1	4	3⅝	2¼
2	2½	⅜†	⅜	1½	1	⅝	1.000	1	4½	3⅝	2¼
2½	3	⅜†	⅜	1½	1	⅝	1.000	1	5	3¾	2⅝
3¼	3¾	½	⅝	1¾	1¼	⅜	1.000	1	5¾	4¼	2⅝
4	4½	½	⅝	1¾	1¼	⅜	1.000	1	6½	4¼	2⅝
5	5½	½	⅝	1¾	1¼	⅜	1.000	1	7½	4½	2⅝
6	6½	¾	¾	2	1½	⅞	1.375	1⅜	9¼	5	3⅝

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

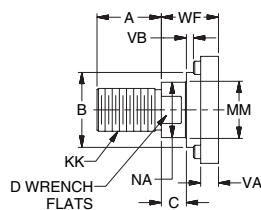
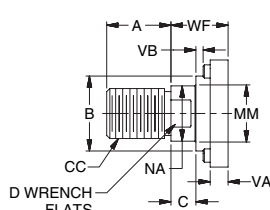
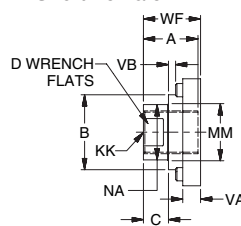
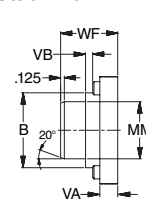
Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										XG	Y	Add Stroke ZB
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	V	VA	VB	W	WF			
1½	⅝	1/2-20	7/16-20	¾	1.124	⅜	1/2	9/16	—	¼	3/16	—	1	1¾	1¹⁵/₁₆	4⁷/₈
	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	1⁵/₁₆	1/2	—	—	1	—	2⅞	2⁵/₁₆	5¼
2	⅝	1/2-20	7/16-20	¾	1.124	⅜	1/2	9/16	—	¼	3/16	—	1	1¾	1¹⁵/₁₆	4¹⁵/₁₆
	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	1⁵/₁₆	—	¼	3/8	—	1⅜	2⅞	2⁵/₁₆	5⁵/₁₆
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⁵/₁₆	5/8	—	—	1¼	—	2⅜	2⁹/₁₆	5⁹/₁₆
2½	⅝	1/2-20	7/16-20	¾	1.124	⅜	1/2	9/16	—	¼	3/16	—	1	1¾	1¹⁵/₁₆	5¹/₁₆
	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	1⁵/₁₆	—	¼	3/8	—	1⅜	2⅞	2⁵/₁₆	5⁷/₁₆
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⁵/₁₆	5/8	—	—	1¼	—	2⅜	2⁹/₁₆	5¹¹/₁₆
	1¾	1½-12	1¼-12	2	2.374	¾	1½	1¹¹/₁₆	¾	—	—	1½	—	2⅝	2¹³/₁₆	5¹⁵/₁₆
3¼	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	1⁵/₁₆	—	¼	3/8	—	1⅜	2¼	2⁷/₁₆	6
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⁵/₁₆	—	¼	9/16	—	1⅝	2½	2¹¹/₁₆	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	1¹¹/₁₆	—	¼	1½	—	1⅞	2¾	2¹⁵/₁₆	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	1⅞	1¹⁵/₁₆	—	¼	9/16	—	2	2⅞	3¹/₁₆	6⁵/₈
4	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	1⁵/₁₆	—	¼	3/8	—	1⅜	2¼	2⁷/₁₆	6
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⁵/₁₆	—	¼	1½	—	1⅝	2½	2¹¹/₁₆	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	1¹¹/₁₆	—	¼	9/16	—	1⅞	2¾	2¹⁵/₁₆	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	1⅞	1¹⁵/₁₆	—	¼	9/16	—	2	2⅞	3¹/₁₆	6⁵/₈
5	1	7/8-14	¾-16	1⅞	1.499	1/2	7/8	1⁵/₁₆	—	¼	3/8	—	1⅜	2¼	2⁷/₁₆	6⁵/₁₆
	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⁵/₁₆	—	¼	1½	—	1⅝	2½	2¹¹/₁₆	6⁹/₁₆
	1¾	1½-12	1¼-12	2	2.374	¾	1½	1¹¹/₁₆	—	¼	9/16	—	1⅞	2¾	2¹⁵/₁₆	6¹³/₁₆
	2	1¾-12	1½-12	2¼	2.624	7/8	1⅞	1¹⁵/₁₆	—	¼	9/16	—	2	2⅞	3¹/₁₆	6¹⁵/₁₆
6	1⅜	1¼-12	1-14	1⅝	1.999	5/8	1⅞	1⁵/₁₆	—	¼	7/16	—	1⅝	2⅝	2¹³/₁₆	7¹/₁₆
	1¾	1½-12	1¼-12	2	2.374	¾	1½	1¹¹/₁₆	—	¼	9/16	—	1⅞	2⅞	3¹/₁₆	7⁵/₁₆
	2	1¾-12	1½-12	2¼	2.624	7/8	1⅞	1¹⁵/₁₆	—	¼	9/16	—	2	3	3³/₁₆	7⁷/₁₆
	2½	2¼-12	1⅞-12	3	3.124	1	2¹/₁₆	2³/₈	—	¼	1¹/₁₆	—	2¼	3¼	3⁷/₁₆	7¹¹/₁₆

Table 3—Envelope and Mounting Dimensions

## Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

Thread Style 1  
Small MaleThread Style 2  
Intermediate MaleThread Style 3  
Short FemaleStyle 6  
Stub End“Special”  
Thread Style 4

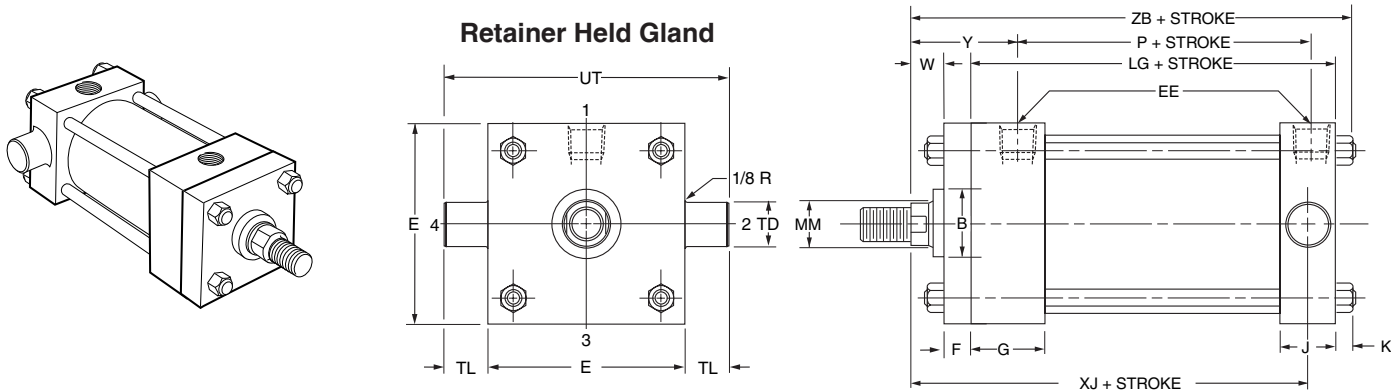
Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

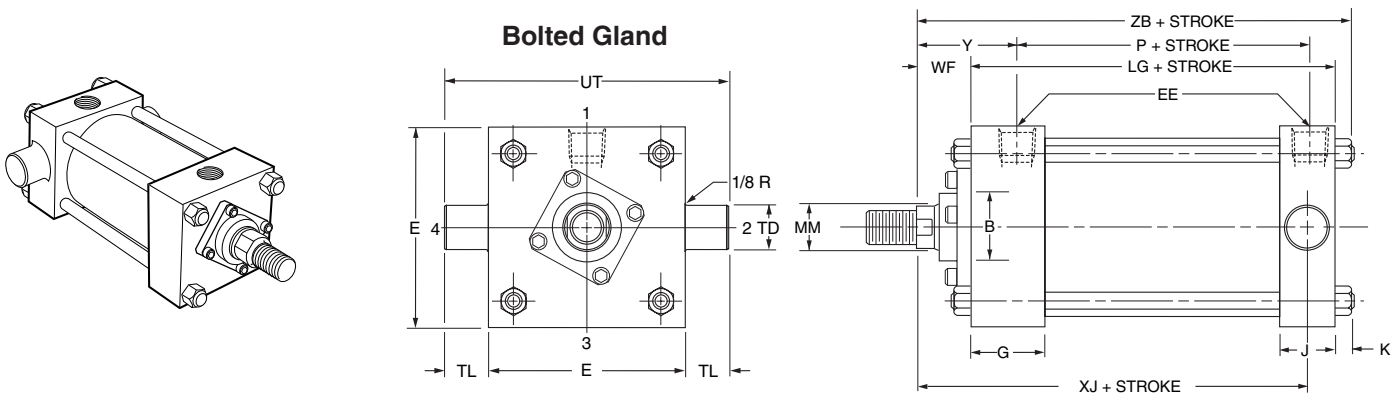
style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**Cap Trunnion Mount**  
**Style TM2**  
 1 1/2" - 2" and 2 1/2" Bore  
 With Maximum Oversize Rods



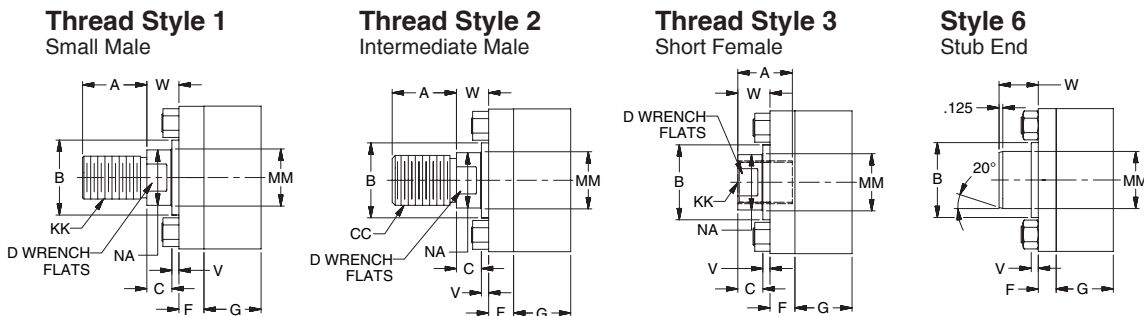
**Before determining dimensions:** See chart on [page 3](#) for cylinder rod combinations that have a bolted gland.

**Cap Trunnion Mount**  
**Style TM2**  
 1 1/2" - 6" Bore



**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.



A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**"Special" Thread Style 4**  
 Special thread, extension, rod eye, blank, etc., are also available. To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF	F	G	J	K	+0.000 TD -0.001	TL	UT	Add Stroke	
										LG	P
1½	2	⅜†	⅜	1½	1	¼	1.000	1	4	3⅝	2¼
2	2½	⅜†	⅜	1½	1	⅝	1.000	1	4½	3⅝	2¼
2½	3	⅜†	⅜	1½	1	⅝	1.000	1	5	3¾	2⅝
3¼	3¾	½	⅝	1¾	1¼	⅜	1.000	1	5¾	4¼	2⅝
4	4½	½	⅝	1¾	1¼	⅜	1.000	1	6½	4¼	2⅝
5	5½	½	⅝	1¾	1¼	⅜	1.000	1	7½	4½	2⅞
6	6½	¾	¾	2	1½	⅞	1.375	1⅝	9¼	5	3⅝

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

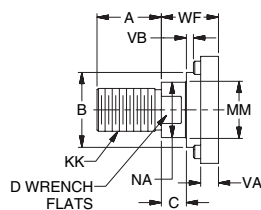
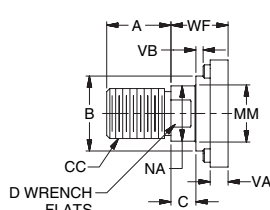
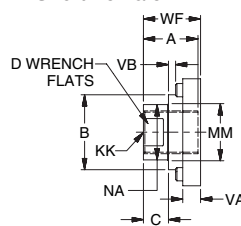
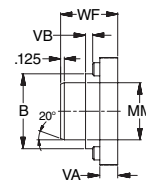
Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Y	Add Stroke	
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	V	VA	VB	W	WF		XJ	ZB
1½	⅝	1/2-20	7/16-20	¾	1.124	⅜	½	9/16	—	¼	3/16	—	1	1½/16	4⅞	4⅞
	1	7/8-14	¾-16	1⅞	1.499	½	7/8	15/16	½	—	—	1	—	25/16	4½	5¼
2	⅝	1/2-20	7/16-20	¾	1.124	⅜	½	9/16	—	¼	3/16	—	1	1½/16	4⅞	4½/16
	1	7/8-14	¾-16	1⅞	1.499	½	7/8	15/16	—	¼	3/8	—	1⅜	25/16	4½	55/16
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅞	15/16	5/8	—	—	1¼	—	29/16	4¾	59/16
2½	⅝	1/2-20	7/16-20	¾	1.124	⅜	½	9/16	—	¼	3/16	—	1	1½/16	4¼	5⅞
	1	7/8-14	¾-16	1⅞	1.499	½	7/8	15/16	—	¼	3/8	—	1⅜	25/16	4⅝	5⅞
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅞	15/16	5/8	—	—	1¼	1⅝	29/16	4⅞	511/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	¾	—	—	1½	—	213/16	5⅞	515/16
3¼	1	7/8-14	¾-16	1⅞	1.499	½	7/8	15/16	—	¼	3/8	—	1⅜	27/16	5	6
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅞	15/16	—	¼	1/2	—	1⅝	211/16	5¼	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	—	¼	9/16	—	1⅞	215/16	5½	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	1⅞	115/16	—	¼	9/16	—	2	31/16	5⅝	6⅝
4	1	7/8-14	¾-16	1⅞	1.499	½	7/8	15/16	—	¼	3/8	—	1⅜	27/16	5	6
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅞	15/16	—	¼	1/2	—	1⅝	211/16	5¼	6¼
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	—	¼	9/16	—	1⅞	215/16	5½	6½
	2	1¾-12	1½-12	2¼	2.624	7/8	1⅞	115/16	—	¼	9/16	—	2	31/16	5⅝	6⅝
5	1	7/8-14	¾-16	1⅞	1.499	½	7/8	15/16	—	¼	3/8	—	1⅜	27/16	5¼	65/16
	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅞	15/16	—	¼	1/2	—	1⅝	211/16	5½	69/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	—	¼	9/16	—	1⅞	215/16	5¾	613/16
	2	1¾-12	1½-12	2¼	2.624	7/8	1⅞	115/16	—	¼	9/16	—	2	31/16	5⅞	615/16
6	1⅝	1¼-12	1-14	1⅝	1.999	5/8	1⅞	15/16	—	¼	7/16	—	1⅝	213/16	5⅞	71/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	11/16	—	¼	9/16	—	1⅞	31/16	6⅞	75/16
	2	1¾-12	1½-12	2¼	2.624	7/8	1⅞	115/16	—	¼	9/16	—	2	33/16	6¼	77/16
	2½	2¼-12	1⅞-12	3	3.124	1	21/16	23/8	—	¼	11/16	—	2¼	37/16	6½	711/16

Table 3—Envelope and Mounting Dimensions

## Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

Thread Style 1  
Small MaleThread Style 2  
Intermediate MaleThread Style 3  
Short FemaleStyle 6  
Stub End“Special”  
Thread Style 4

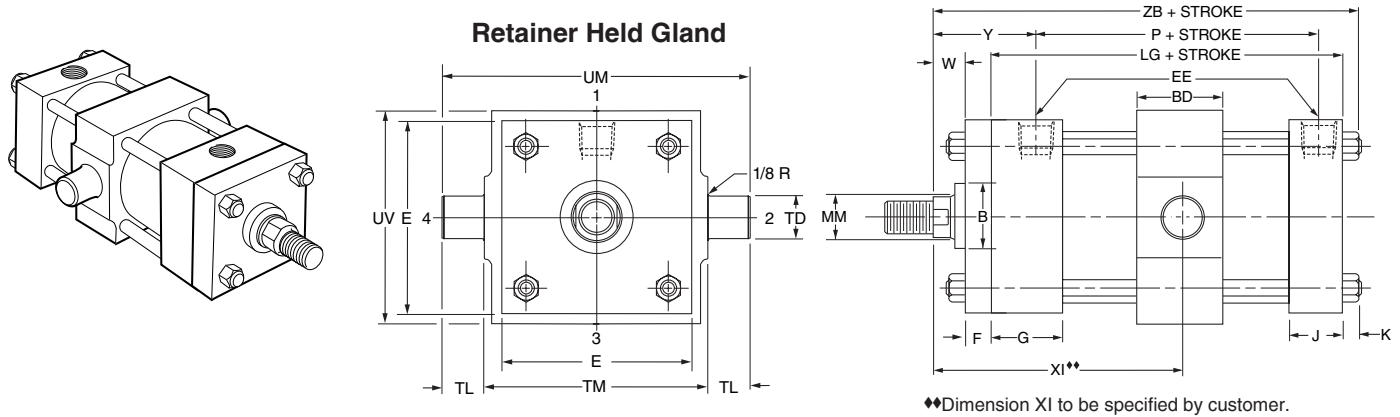
Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

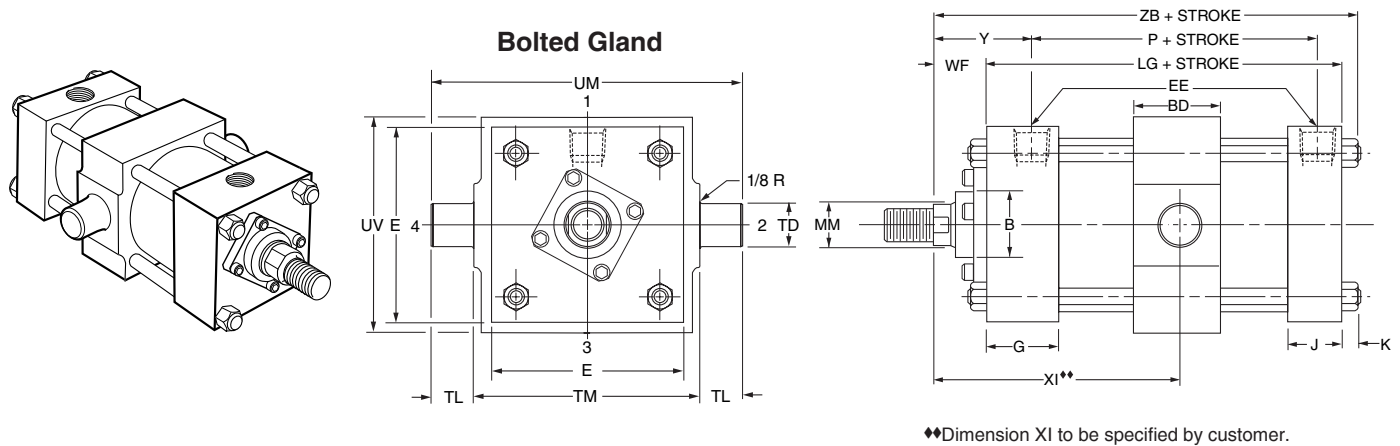
style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**Intermediate Fixed Trunnion Mount**  
**Style TM3**  
 1 1/2" - 2" and 2 1/2" Bore  
 With Maximum Oversize Rods



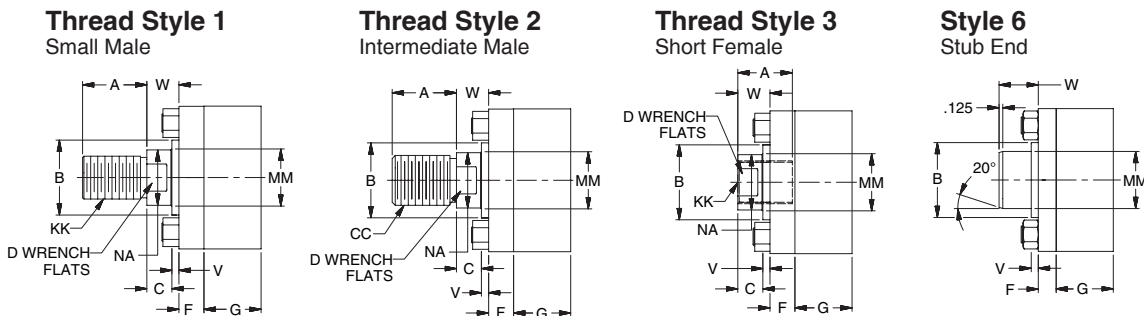
**Before determining dimensions:** See chart on [page 3](#) for cylinder rod combinations that have a bolted gland.

**Intermediate Fixed Trunnion Mount**  
**Style TM3**  
 1 1/2" - 6" Bore



**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.



A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

Table 1—Envelope and Mounting Dimensions

Bore	BD	E	EE NPTF	F	G	J	K	+.000 TD -.001	TL	TM	UM	UV	Minimum Stroke	Add Stroke	
														LG	P
1½	1¼	2	¾†	¾	1½	1	¼	1.000	1	2½	4½	2½	¼	3⅝	2¼
2	1½	2½	¾†	¾	1½	1	⅝	1.000	1	3	5	3	½	3⅝	2¼
2½	1½	3	¾†	¾	1½	1	⅝	1.000	1	3½	5½	3½	¾	3¾	2⅜
3¼	2	3¾	½	⅝	1¾	1¼	¾	1.000	1	4½	6½	4¼	⅞	4¼	2⅝
4	2	4½	½	⅝	1¾	1¼	¾	1.000	1	5¼	7¼	5	⅞	4¼	2⅝
5	2	5½	½	⅝	1¾	1¼	⅞	1.000	1	6¼	8¼	6	⅝	4½	2⅞
6	2½	6½	¾	¾	2	1½	⅞	1.375	1⅝	7⅝	10⅜	7	1½	5	3⅝

†On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

Table 2—Rod Dimensions

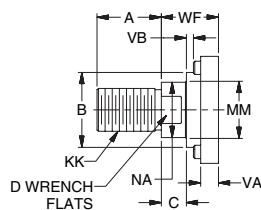
Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Min.** XI	Y	Add Stroke ZB
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B	C	D	NA	V	VA	VB	W	WF			
1½	⅝	½-20	7/16-20	¾	1.124	¾	½	9/16	—	¼	3/16	—	1	3⅜	1⅝	4⅞
	1	7/8-14	¾-16	1⅝	1.499	½	7/8	1⅝	½	—	—	1	—	3⅞	2⅝	5¼
2	⅝	½-20	7/16-20	¾	1.124	¾	½	9/16	—	¼	3/16	—	1	3⅝	1⅝	4⅝
	1	7/8-14	¾-16	1⅝	1.499	½	7/8	1⅝	—	¼	3/8	—	1⅝	3⅞	2⅝	5⅝
2½	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝	⅝	—	—	1¼	—	3⅝	2⅞	5⅞
	⅝	½-20	7/16-20	¾	1.124	¾	½	9/16	—	¼	3/16	—	1	3⅝	1⅝	5⅞
3¼	1	7/8-14	¾-16	1⅝	1.499	½	7/8	1⅝	—	¼	3/8	—	1⅝	4⅜	2⅞	6
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝	—	¼	½	—	1⅝	4⅞	2⅞	6¼
4	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝	—	¼	½	—	1⅝	4⅞	2⅞	6¼
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝	—	¼	½	—	1⅝	4⅞	2⅞	6¼
5	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝	—	¼	½	—	1⅝	4⅞	2⅞	6¼
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝	—	¼	½	—	1⅝	4⅞	2⅞	6¼
6	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝	—	¼	½	—	1⅝	4⅞	2⅞	6¼
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝	—	¼	½	—	1⅝	4⅞	2⅞	6¼

\*\* Dimension XI to be specified by customer.

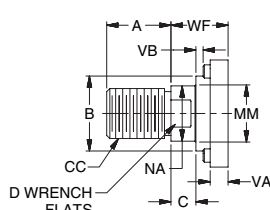
### Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

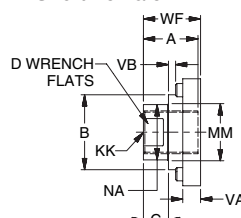
**Thread Style 1**  
Small Male



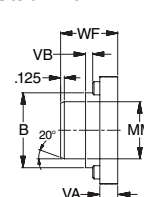
**Thread Style 2**  
Intermediate Male



**Thread Style 3**  
Short Female



**Style 6**  
Stub End



**“Special”  
Thread Style 4**

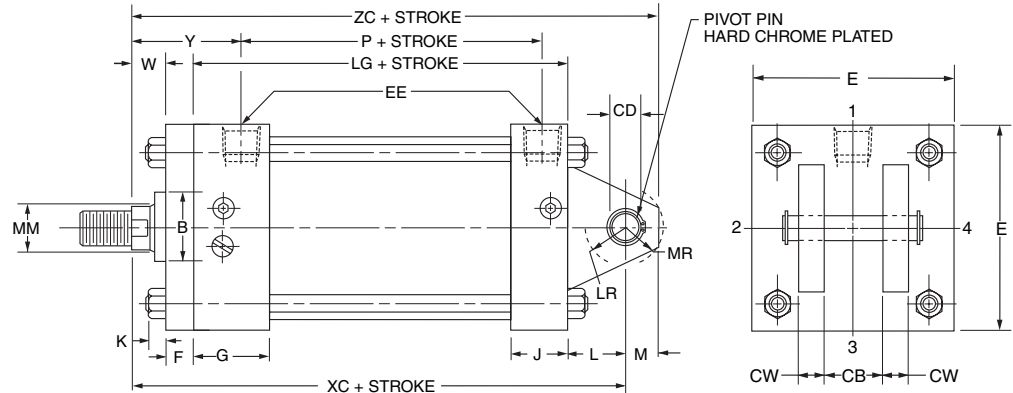
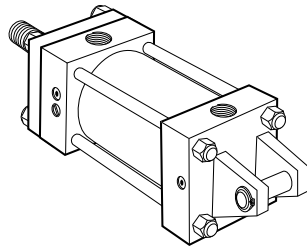
Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

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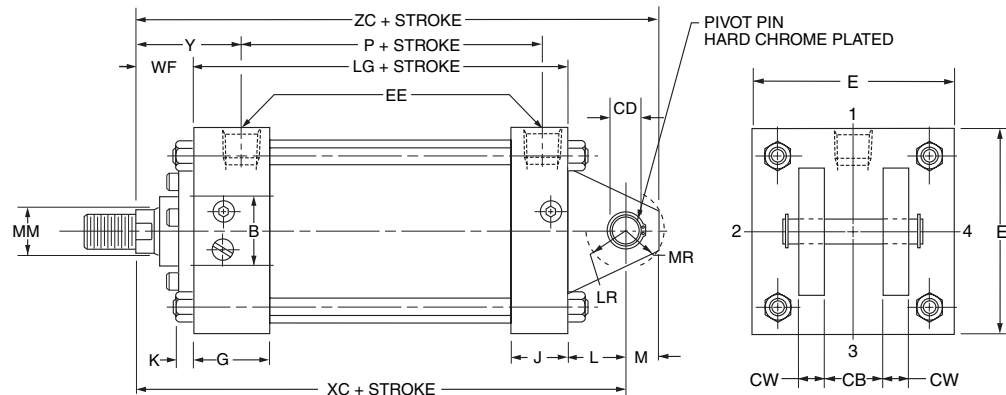
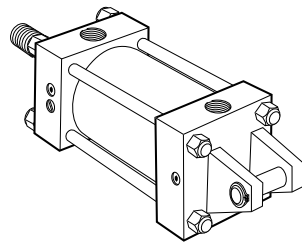
**Cap Fixed Clevis Mount**  
**Style PB2**  
 1 1/2" - 2" and 2 1/2" Bore  
 With Maximum Oversize Rods



The 4", 5" and 6" bore sizes have the tie rod nuts at both ends as shown.  
 Tie rods thread into cap on all other bore sizes.

**Before determining dimensions:** See chart on [page 3](#) for cylinder rod combinations that have a bolted gland.

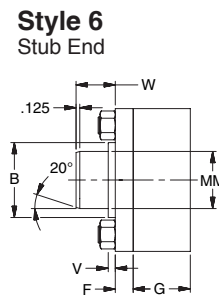
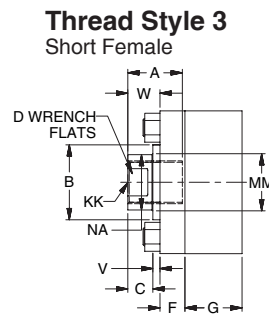
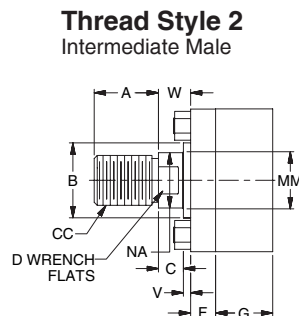
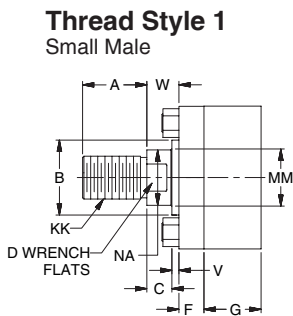
**Cap Fixed Clevis Mount**  
**Style PB2**  
 1 1/2" - 6" Bore



The 4", 5" and 6" bore sizes have the tie rod nuts at both ends as shown.  
 Tie rods thread into cap on all other bore sizes.

**Rod End Dimensions (for Retainer Held Gland) — See Table 2**

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.



**"Special" Thread Style 4**  
 Special thread, extension, rod eye, blank, etc., are also available.  
 To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.



Table 1—Envelope and Mounting Dimensions

Bore	CB	+.000 CD• -.002	CW	E	EE NPTF	F	G	J	K	L	LR	M	MR	Add Stroke	
														LG	P
1½	¾	.501	½	2	¾†	¾	1½	1	¼	¾	¾	½	⅝	3⅝	2¼
2	¾	.501	½	2½	¾†	¾	1½	1	⅝ <sub>16</sub>	¾	¾	½	⅝	3⅝	2¼
2½	¾	.501	½	3	¾†	¾	1½	1	⅝ <sub>16</sub>	¾	¾	½	⅝	3¾	2⅜
3¼	1¼	.751	⅝	3¾	½	⅝	1¾	1¼	¾	1¼	1	¾	1⅝ <sub>16</sub>	4¼	2⅝
4	1¼	.751	⅝	4½	½	⅝	1¾	1¼	¾	1¼	1	¾	1⅝ <sub>16</sub>	4¼	2⅝
5	1¼	.751	⅝	5½	½	⅝	1¾	1¼	7 <sub>16</sub>	1¼	1	¾	1⅝ <sub>16</sub>	4½	2⅞
6	1½	1.001	¾	6½	¾	¾	2	1½	7 <sub>16</sub>	1½	1¼	1	1⅝ <sub>16</sub>	5	3⅝

† On 1½", 2" and 2½" bore sizes, the head-end (only) pipe thread is not full depth on cylinders with maximum oversize rods. Minimum of three full threads available.

• Dimension CD is pin diameter.

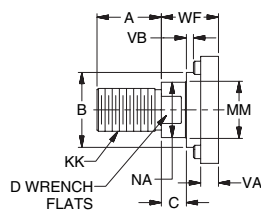
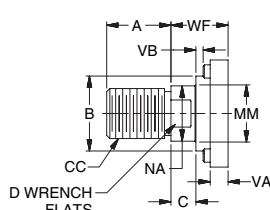
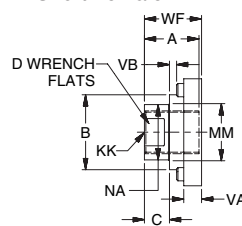
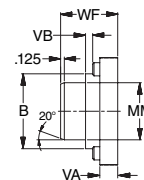
Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Add Stroke		
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B	C	D	NA	V	VA	VB	W	WF	Y	XC	ZC
1½	⅝	½-20	7 <sub>16</sub> -20	¾	1.124	¾	½	9 <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1	1 <sup>15</sup> / <sub>16</sub>	5⅝	5 <sup>7</sup> / <sub>8</sub>
	1	7 <sub>8</sub> -14	¾-16	1⅝	1.499	½	7 <sub>8</sub>	15 <sub>16</sub>	½	—	—	1	—	2 <sup>5</sup> / <sub>16</sub>	5¾	6¼
2	⅝	½-20	7 <sub>16</sub> -20	¾	1.124	¾	½	9 <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1	1 <sup>15</sup> / <sub>16</sub>	5⅝	5 <sup>7</sup> / <sub>8</sub>
	1	7 <sub>8</sub> -14	¾-16	1⅝	1.499	½	7 <sub>8</sub>	15 <sub>16</sub>	—	¼	3 <sub>8</sub>	—	1⅝	2 <sup>5</sup> / <sub>16</sub>	5¾	6¼
2½	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝ <sub>16</sub>	⅝	—	—	1¼	—	2 <sup>9</sup> / <sub>16</sub>	6	6½
	⅝	½-20	7 <sub>16</sub> -20	¾	1.124	¾	½	9 <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1	1 <sup>15</sup> / <sub>16</sub>	5½	6
	1	7 <sub>8</sub> -14	¾-16	1⅝	1.499	½	7 <sub>8</sub>	15 <sub>16</sub>	—	¼	3 <sub>8</sub>	—	1⅝	2 <sup>5</sup> / <sub>16</sub>	5⅞	6⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝ <sub>16</sub>	⅝	—	—	1¼	1⅝	2 <sup>9</sup> / <sub>16</sub>	6⅜	6⅝
3¼	⅝	½-20	7 <sub>16</sub> -20	¾	1.124	¾	½	9 <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1	1 <sup>15</sup> / <sub>16</sub>	5½	6
	1	7 <sub>8</sub> -14	¾-16	1⅝	1.499	½	7 <sub>8</sub>	15 <sub>16</sub>	—	¼	3 <sub>8</sub>	—	1⅝	2 <sup>5</sup> / <sub>16</sub>	5⅞	6⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝ <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1⅝	2 <sup>9</sup> / <sub>16</sub>	6⅜	6⅝
	1⅜	1¼-12	1¼-12	2	2.374	¾	1½	1 <sup>11</sup> / <sub>16</sub>	¾	—	—	1½	—	2 <sup>13</sup> / <sub>16</sub>	6⅞	6⅞
4	⅝	½-20	7 <sub>16</sub> -20	¾	1.124	¾	½	9 <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1	1 <sup>15</sup> / <sub>16</sub>	5½	6
	1	7 <sub>8</sub> -14	¾-16	1⅝	1.499	½	7 <sub>8</sub>	15 <sub>16</sub>	—	¼	3 <sub>8</sub>	—	1⅝	2 <sup>5</sup> / <sub>16</sub>	5⅞	6⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝ <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1⅝	2 <sup>9</sup> / <sub>16</sub>	6⅜	6⅝
	1⅜	1¼-12	1¼-12	2	2.374	¾	1½	1 <sup>11</sup> / <sub>16</sub>	¾	—	—	1½	—	2 <sup>13</sup> / <sub>16</sub>	6⅞	6⅞
5	⅝	½-20	7 <sub>16</sub> -20	¾	1.124	¾	½	9 <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1	1 <sup>15</sup> / <sub>16</sub>	5½	6
	1	7 <sub>8</sub> -14	¾-16	1⅝	1.499	½	7 <sub>8</sub>	15 <sub>16</sub>	—	¼	3 <sub>8</sub>	—	1⅝	2 <sup>5</sup> / <sub>16</sub>	5⅞	6⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝ <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1⅝	2 <sup>9</sup> / <sub>16</sub>	6⅜	6⅝
	1⅜	1¼-12	1¼-12	2	2.374	¾	1½	1 <sup>11</sup> / <sub>16</sub>	¾	—	—	1½	—	2 <sup>13</sup> / <sub>16</sub>	6⅞	6⅞
6	⅝	½-20	7 <sub>16</sub> -20	¾	1.124	¾	½	9 <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1	1 <sup>15</sup> / <sub>16</sub>	5½	6
	1	7 <sub>8</sub> -14	¾-16	1⅝	1.499	½	7 <sub>8</sub>	15 <sub>16</sub>	—	¼	3 <sub>8</sub>	—	1⅝	2 <sup>5</sup> / <sub>16</sub>	5⅞	6⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅝	1⅝ <sub>16</sub>	—	¼	3 <sub>16</sub>	—	1⅝	2 <sup>9</sup> / <sub>16</sub>	6⅜	6⅝
	1⅜	1¼-12	1¼-12	2	2.374	¾	1½	1 <sup>11</sup> / <sub>16</sub>	¾	—	—	1½	—	2 <sup>13</sup> / <sub>16</sub>	6⅞	6⅞

Table 3—Envelope and Mounting Dimensions

## Rod End Dimensions (for Bolted Gland) — See Table 2

See chart on [page 3](#) to determine which bore, rod, and mount combinations have this feature.

Thread Style 1  
Small MaleThread Style 2  
Intermediate MaleThread Style 3  
Short FemaleStyle 6  
Stub End“Special”  
Thread Style 4

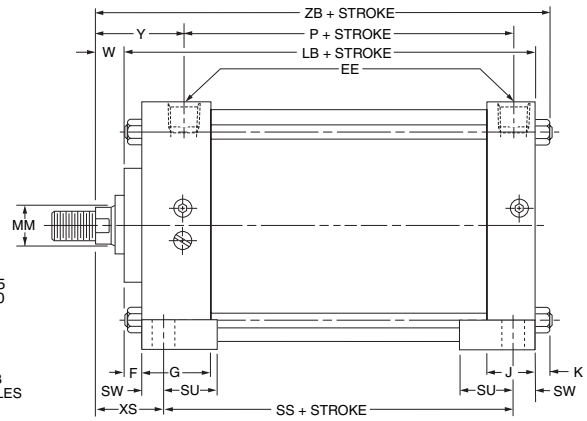
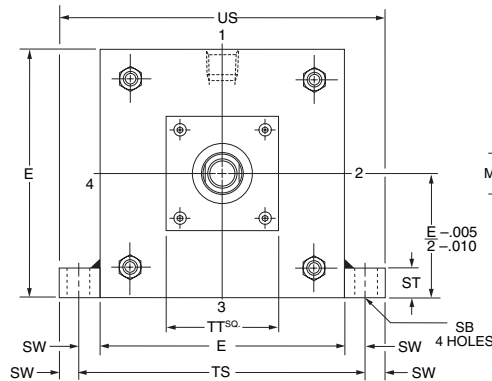
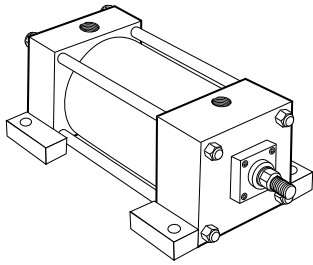
Special thread, extension, rod eye, blank, etc., are also available.

To order, specify “Style 4” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

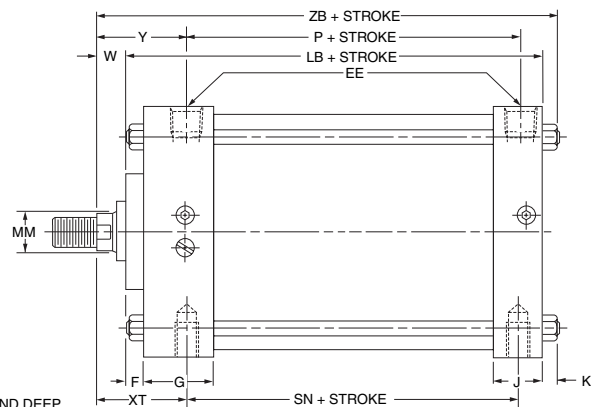
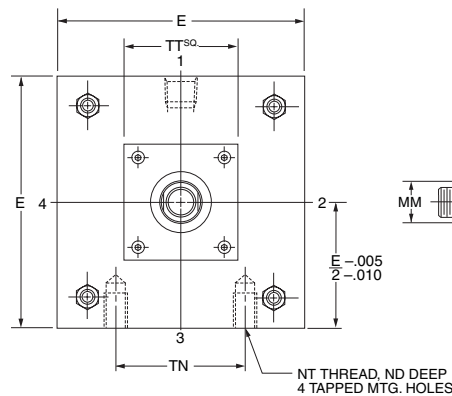
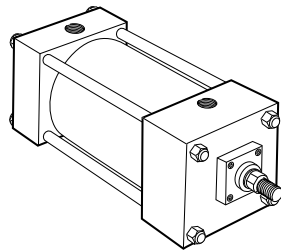
A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

**Side Lug Mount**  
**Style SL**  
 7" - 14" Bore

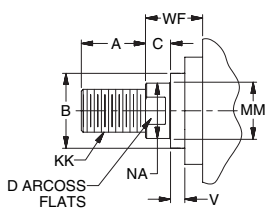


**Side Tap Mount**  
**Style FS**  
 7" - 14" Bore

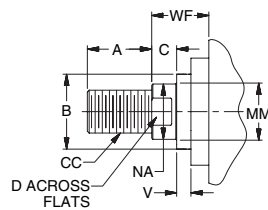


**Rod End Dimensions — See Table 2**

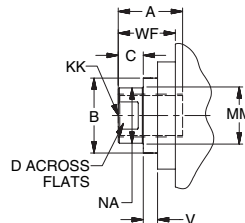
**Thread Style 1**  
 Small Male



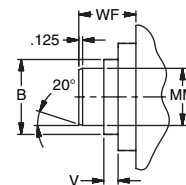
**Thread Style 2**  
 Intermediate Male



**Thread Style 3**  
 Short Female



**Style 6**  
 Stub End



**"Special" Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available. To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF	F	G	J	K	ND	NT	SB*	ST	SU	SW	TN	TS	US	Add Stroke			
																LB	P	SN	SS
7	7 <sup>1</sup> / <sub>2</sub>	<sup>3</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>2</sub>	<sup>9</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	<sup>3</sup> / <sub>4</sub> -10	<sup>13</sup> / <sub>16</sub>	1	1 <sup>9</sup> / <sub>16</sub>	<sup>11</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>2</sub>	8 <sup>7</sup> / <sub>8</sub>	10 <sup>1</sup> / <sub>4</sub>	5 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>4</sub>
8	8 <sup>1</sup> / <sub>2</sub>	<sup>3</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>2</sub>	<sup>9</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	<sup>3</sup> / <sub>4</sub> -10	<sup>13</sup> / <sub>16</sub>	1	1 <sup>9</sup> / <sub>16</sub>	<sup>11</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>2</sub>	9 <sup>7</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>4</sub>	5 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>4</sub>
10	10 <sup>5</sup> / <sub>8</sub>	1	<sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	2	<sup>11</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1-8	1 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	2	<sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	12 <sup>3</sup> / <sub>8</sub>	14 <sup>1</sup> / <sub>8</sub>	7 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>8</sub>	4 <sup>5</sup> / <sub>8</sub>
12	12 <sup>3</sup> / <sub>4</sub>	1	<sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	2	<sup>11</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1-8	1 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	2	<sup>7</sup> / <sub>8</sub>	7 <sup>1</sup> / <sub>4</sub>	14 <sup>1</sup> / <sub>2</sub>	16 <sup>1</sup> / <sub>4</sub>	7 <sup>5</sup> / <sub>8</sub>	4 <sup>5</sup> / <sub>8</sub>	4 <sup>5</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>8</sub>
14	14 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub>	2 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub>	1 <sup>7</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -7	1 <sup>5</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>8</sub>	8 <sup>3</sup> / <sub>8</sub>	17	19 <sup>1</sup> / <sub>4</sub>	8 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	5 <sup>1</sup> / <sub>2</sub>	5 <sup>7</sup> / <sub>8</sub>

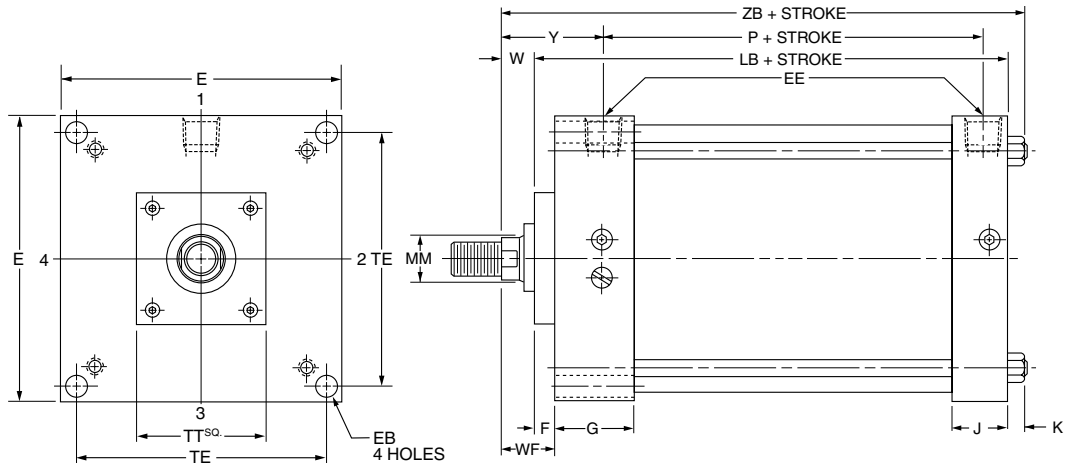
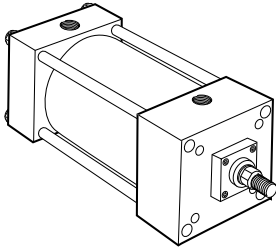
\*Upper surface spotfaced for socket head cap screw.

Table 2—Rod Dimensions

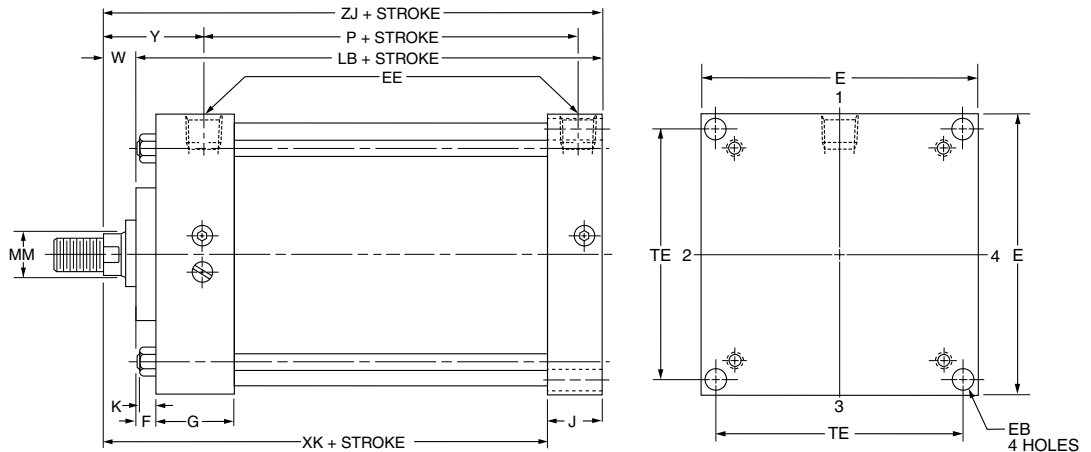
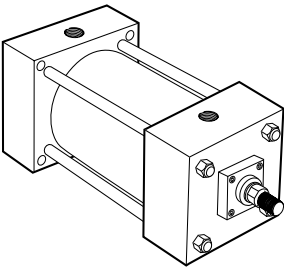
Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions								XS	XT	Y	Add Stroke ZB
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	TT	V	W				
7	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -12	1-14	1 <sup>5</sup> / <sub>8</sub>	1.999	<sup>5</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	4	<sup>1</sup> / <sub>4</sub>	<sup>7</sup> / <sub>8</sub>	2 <sup>5</sup> / <sub>16</sub>	2 <sup>13</sup> / <sub>16</sub>	2 <sup>13</sup> / <sub>16</sub>	7 <sup>5</sup> / <sub>16</sub>
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	<sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	7 <sup>9</sup> / <sub>16</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	<sup>7</sup> / <sub>8</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	2 <sup>11</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>16</sub>	7 <sup>11</sup> / <sub>16</sub>
8	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -12	1-14	1 <sup>5</sup> / <sub>8</sub>	1.999	<sup>5</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	4	<sup>1</sup> / <sub>4</sub>	<sup>7</sup> / <sub>8</sub>	2 <sup>5</sup> / <sub>16</sub>	2 <sup>13</sup> / <sub>16</sub>	2 <sup>13</sup> / <sub>16</sub>	7 <sup>5</sup> / <sub>16</sub>
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	<sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	7 <sup>9</sup> / <sub>16</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	<sup>7</sup> / <sub>8</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	2 <sup>11</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>16</sub>	7 <sup>11</sup> / <sub>16</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>15</sup> / <sub>16</sub>	3 <sup>7</sup> / <sub>16</sub>	3 <sup>7</sup> / <sub>16</sub>	7 <sup>15</sup> / <sub>16</sub>
10	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	<sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	8 <sup>5</sup> / <sub>16</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	<sup>7</sup> / <sub>8</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	2 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub>	9 <sup>1</sup> / <sub>16</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>2</sub>	9 <sup>5</sup> / <sub>16</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>2</sub>	9 <sup>5</sup> / <sub>16</sub>
12	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	<sup>7</sup> / <sub>8</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	2 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub>	9 <sup>9</sup> / <sub>16</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>2</sub>	9 <sup>13</sup> / <sub>16</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>2</sub>	9 <sup>13</sup> / <sub>16</sub>
	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	4.249	1	3	3 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>2</sub>	9 <sup>13</sup> / <sub>16</sub>
14	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	3 <sup>13</sup> / <sub>16</sub>	3 <sup>13</sup> / <sub>16</sub>	11 <sup>1</sup> / <sub>8</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	3 <sup>13</sup> / <sub>16</sub>	3 <sup>13</sup> / <sub>16</sub>	11 <sup>1</sup> / <sub>8</sub>
	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	4.249	1	3	3 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	3 <sup>13</sup> / <sub>16</sub>	3 <sup>13</sup> / <sub>16</sub>	11 <sup>1</sup> / <sub>8</sub>
	4	3 <sup>3</sup> / <sub>4</sub> -12	3-12	4	4.749	1	3 <sup>3</sup> / <sub>8</sub>	3 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	3 <sup>13</sup> / <sub>16</sub>	3 <sup>13</sup> / <sub>16</sub>	11 <sup>1</sup> / <sub>8</sub>

Table 3—Envelope and Mounting Dimensions

**Head Square Mount**  
**Style REF**  
 7" - 14" Bore

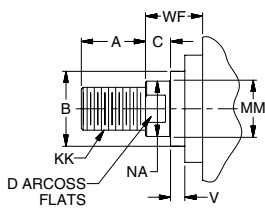


**Cap Square Mount**  
**Style BEF**  
 7" - 14" Bore

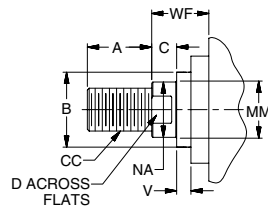


**Rod End Dimensions — See Table 2**

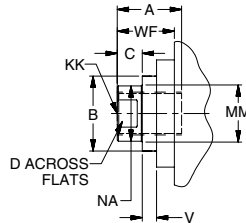
**Thread Style 1**  
 Small Male



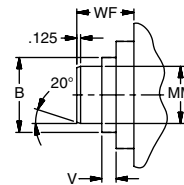
**Thread Style 2**  
 Intermediate Male



**Thread Style 3**  
 Short Female



**Style 6**  
 Stub End



**"Special" Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available.  
 To order, specify "Style 4" and give desired dimensions for  $KK$ ,  $A$ ,  $W$  or  $WF$ . If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

Table 1—Envelope and Mounting Dimensions

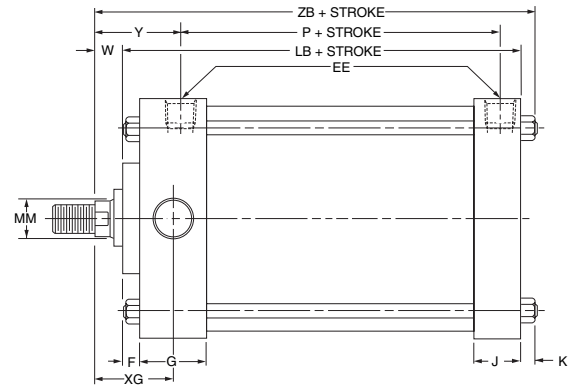
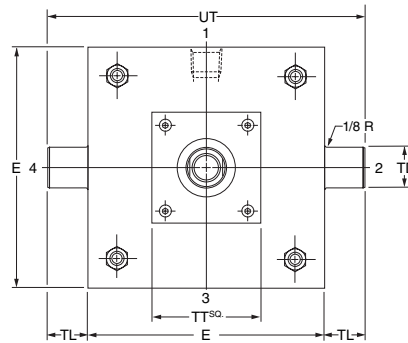
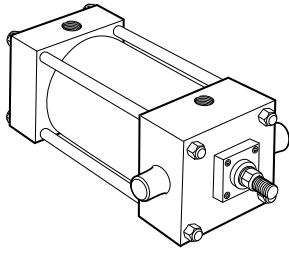
Bore	E	EB	EE NPTF	F	G	J	K	TE	Add Stroke	
									LB	P
7	7 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>16</sub>	6.75	5 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>
8	8 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>16</sub>	7.57	5 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>
10	10 <sup>5</sup> / <sub>8</sub>	13 <sup>1</sup> / <sub>16</sub>	1	3 <sup>1</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	2	11 <sup>1</sup> / <sub>16</sub>	9.40	7 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>8</sub>
12	12 <sup>3</sup> / <sub>4</sub>	13 <sup>1</sup> / <sub>16</sub>	1	3 <sup>1</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	2	11 <sup>1</sup> / <sub>16</sub>	11.10	7 <sup>5</sup> / <sub>8</sub>	4 <sup>5</sup> / <sub>8</sub>
14	14 <sup>3</sup> / <sub>4</sub>	15 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub>	2 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub>	12.87	8 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>

Table 2—Rod Dimensions

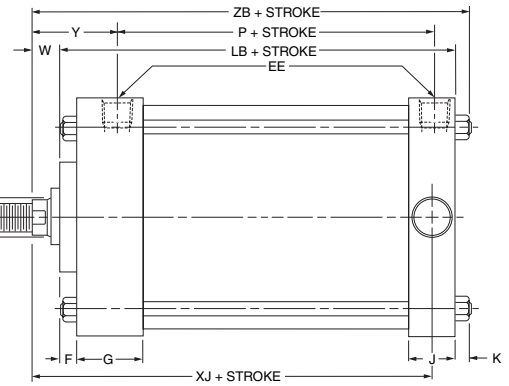
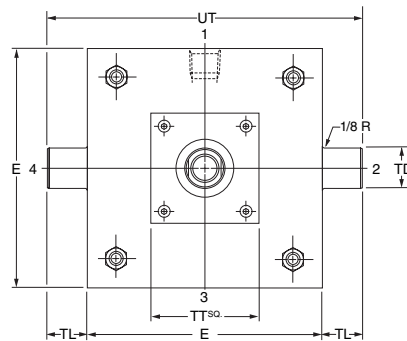
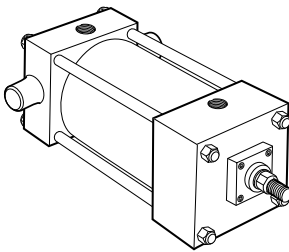
Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions									Y	Add Stroke		
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	TT	V	W	WF		XK	ZB	ZJ
7	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -12	1-14	1 <sup>5</sup> / <sub>8</sub>	1.999	5 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	4	1 <sup>1</sup> / <sub>4</sub>	7 <sup>8</sup> / <sub>16</sub>	1 <sup>5</sup> / <sub>8</sub>	2 <sup>13</sup> / <sub>16</sub>	5 <sup>1</sup> / <sub>4</sub>	7 <sup>5</sup> / <sub>16</sub>	6 <sup>3</sup> / <sub>4</sub>
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	3 <sup>4</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>16</sub>	5 <sup>1</sup> / <sub>2</sub>	7 <sup>9</sup> / <sub>16</sub>	7
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	7 <sup>8</sup> / <sub>16</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	2	3 <sup>3</sup> / <sub>16</sub>	5 <sup>7</sup> / <sub>8</sub>	7 <sup>11</sup> / <sub>16</sub>	7 <sup>1</sup> / <sub>8</sub>
8	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -12	1-14	1 <sup>5</sup> / <sub>8</sub>	1.999	5 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	4	1 <sup>1</sup> / <sub>4</sub>	7 <sup>8</sup> / <sub>16</sub>	1 <sup>5</sup> / <sub>8</sub>	2 <sup>13</sup> / <sub>16</sub>	5 <sup>1</sup> / <sub>4</sub>	7 <sup>5</sup> / <sub>16</sub>	6 <sup>3</sup> / <sub>4</sub>
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	3 <sup>4</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>16</sub>	5 <sup>1</sup> / <sub>2</sub>	7 <sup>9</sup> / <sub>16</sub>	7
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	7 <sup>8</sup> / <sub>16</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	2	3 <sup>3</sup> / <sub>16</sub>	5 <sup>7</sup> / <sub>8</sub>	7 <sup>11</sup> / <sub>16</sub>	7 <sup>1</sup> / <sub>8</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>7</sup> / <sub>16</sub>	5 <sup>7</sup> / <sub>8</sub>	7 <sup>15</sup> / <sub>16</sub>	7 <sup>3</sup> / <sub>8</sub>
10	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	3 <sup>4</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	6 <sup>1</sup> / <sub>4</sub>	8 <sup>15</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>4</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	7 <sup>8</sup> / <sub>16</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	2	3 <sup>1</sup> / <sub>4</sub>	6 <sup>3</sup> / <sub>8</sub>	9 <sup>1</sup> / <sub>16</sub>	8 <sup>3</sup> / <sub>8</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	6 <sup>5</sup> / <sub>8</sub>	9 <sup>5</sup> / <sub>16</sub>	8 <sup>5</sup> / <sub>8</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	6 <sup>5</sup> / <sub>8</sub>	9 <sup>5</sup> / <sub>16</sub>	8 <sup>5</sup> / <sub>8</sub>
12	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	7 <sup>8</sup> / <sub>16</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	2	3 <sup>1</sup> / <sub>4</sub>	6 <sup>7</sup> / <sub>8</sub>	9 <sup>9</sup> / <sub>16</sub>	8 <sup>7</sup> / <sub>8</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	7 <sup>1</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>8</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	7 <sup>1</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>8</sub>
	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	4.249	1	3	3 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	7 <sup>1</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>8</sub>
14	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>13</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>8</sub>	10 <sup>3</sup> / <sub>8</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>13</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>8</sub>	10 <sup>3</sup> / <sub>8</sub>
	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	4.249	1	3	3 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>13</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>8</sub>	10 <sup>3</sup> / <sub>8</sub>
	4	3 <sup>3</sup> / <sub>4</sub> -12	3-12	4	4.749	1	3 <sup>3</sup> / <sub>8</sub>	3 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>13</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>8</sub>	10 <sup>3</sup> / <sub>8</sub>

Table 3—Envelope and  
Mounting Dimensions

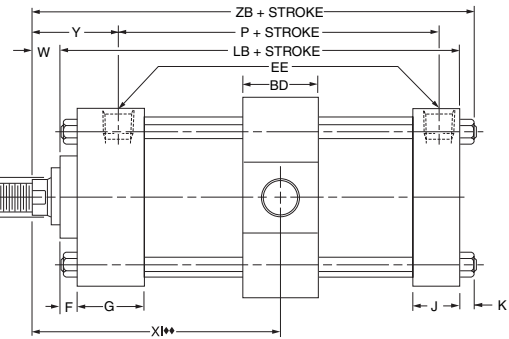
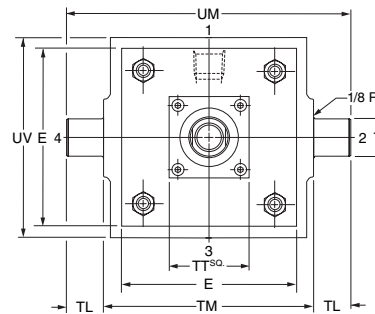
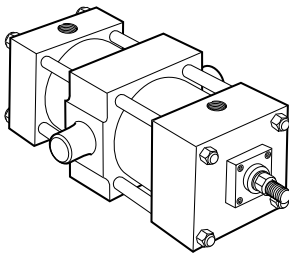
**Head Trunnion Mount  
Style TM1**  
7" - 14" Bore



**Cap Trunnion Mount  
Style TM2**  
7" - 14" Bore



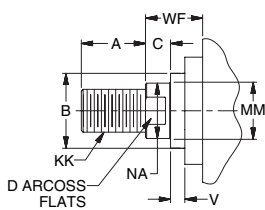
**Intermediate Fixed Trunnion Mount  
Model TM3**  
8" - 14" Bore



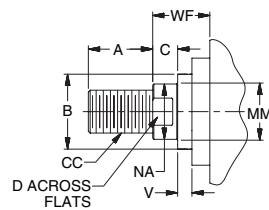
♦♦Dimension XI to be specified by customer.

**Rod End Dimensions — See Table 2**

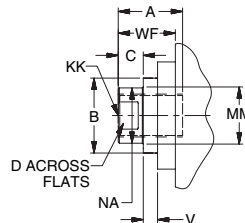
**Thread Style 1**  
Small Male



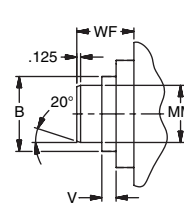
**Thread Style 2**  
Intermediate Male



**Thread Style 3**  
Short Female



**Style 6**  
Stub End



**"Special" Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available.  
To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.



Table 1—Envelope and Mounting Dimensions

Bore	BD	E	EE NPTF	F	G	J	K	+0.000 TD -0.001	TL	TM	UT	UM	UV	Add Stroke	
														LB	P
7	—	7 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>16</sub>	1.375	1 <sup>3</sup> / <sub>8</sub>	—	10 <sup>1</sup> / <sub>4</sub>	—	—	5 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>
8	2 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>16</sub>	1.375	1 <sup>3</sup> / <sub>8</sub>	9 <sup>3</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>4</sub>	12 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>2</sub>	5 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>
10	3	10 <sup>5</sup> / <sub>8</sub>	1	3 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>16</sub>	1.750	1 <sup>3</sup> / <sub>4</sub>	12	14 <sup>1</sup> / <sub>8</sub>	15 <sup>1</sup> / <sub>2</sub>	11 <sup>3</sup> / <sub>4</sub>	7 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>8</sub>
12	3	12 <sup>3</sup> / <sub>4</sub>	1	3 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>16</sub>	1.750	1 <sup>3</sup> / <sub>4</sub>	14	16 <sup>1</sup> / <sub>4</sub>	17 <sup>1</sup> / <sub>2</sub>	13 <sup>3</sup> / <sub>4</sub>	7 <sup>5</sup> / <sub>8</sub>	4 <sup>5</sup> / <sub>8</sub>
14	3 <sup>1</sup> / <sub>2</sub>	14 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>4</sub>	2 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>4</sub>	2.000	2	16 <sup>1</sup> / <sub>4</sub>	18 <sup>3</sup> / <sub>4</sub>	20 <sup>1</sup> / <sub>4</sub>	16	8 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>

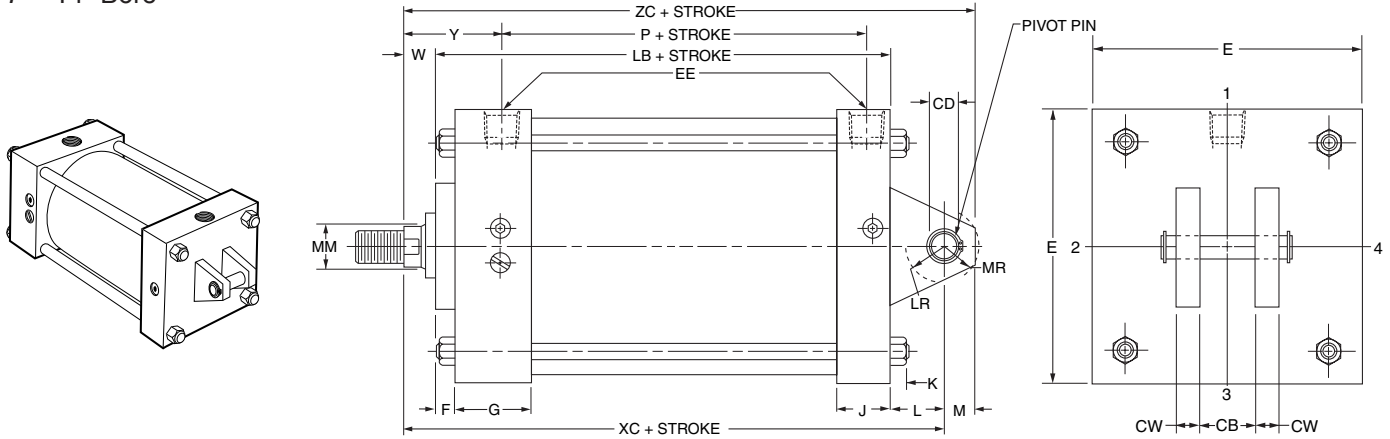
Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions								XG	XI* (Min.)	Y	Add Stroke	
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	TT	V	W				XJ	ZB
7	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -12	1-14	1 <sup>5</sup> / <sub>8</sub>	1.999	5 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	4	1 <sup>1</sup> / <sub>4</sub>	7 <sup>8</sup> / <sub>16</sub>	2 <sup>5</sup> / <sub>8</sub>	—	2 <sup>13</sup> / <sub>16</sub>	6	7 <sup>5</sup> / <sub>16</sub>
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	3 <sup>4</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	—	3 <sup>1</sup> / <sub>16</sub>	6 <sup>1</sup> / <sub>4</sub>	7 <sup>9</sup> / <sub>16</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	7 <sup>8</sup> / <sub>16</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	3	—	3 <sup>3</sup> / <sub>16</sub>	6 <sup>3</sup> / <sub>8</sub>	7 <sup>11</sup> / <sub>16</sub>
8	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -12	1-14	1 <sup>5</sup> / <sub>8</sub>	1.999	5 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	4	1 <sup>1</sup> / <sub>4</sub>	7 <sup>8</sup> / <sub>16</sub>	2 <sup>5</sup> / <sub>8</sub>	4 <sup>15</sup> / <sub>16</sub>	2 <sup>13</sup> / <sub>16</sub>	6	7 <sup>5</sup> / <sub>16</sub>
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	3 <sup>4</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>3</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	6 <sup>1</sup> / <sub>4</sub>	7 <sup>9</sup> / <sub>16</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	7 <sup>8</sup> / <sub>16</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	3	5 <sup>5</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>16</sub>	6 <sup>3</sup> / <sub>8</sub>	7 <sup>11</sup> / <sub>16</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub>	5 <sup>9</sup> / <sub>16</sub>	3 <sup>7</sup> / <sub>16</sub>	6 <sup>5</sup> / <sub>8</sub>	7 <sup>15</sup> / <sub>16</sub>
10	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	3 <sup>4</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>8</sub>	3	5 <sup>11</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>8</sub>	7 <sup>1</sup> / <sub>4</sub>	8 <sup>15</sup> / <sub>16</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	7 <sup>8</sup> / <sub>16</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>8</sub>	5 <sup>13</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>4</sub>	7 <sup>3</sup> / <sub>8</sub>	9 <sup>1</sup> / <sub>16</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	6 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>2</sub>	7 <sup>5</sup> / <sub>8</sub>	9 <sup>5</sup> / <sub>16</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	6 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>2</sub>	7 <sup>5</sup> / <sub>8</sub>	9 <sup>5</sup> / <sub>16</sub>
12	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	7 <sup>8</sup> / <sub>16</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	3 <sup>8</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>8</sub>	5 <sup>13</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>4</sub>	7 <sup>7</sup> / <sub>8</sub>	9 <sup>9</sup> / <sub>16</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	6 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	6 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>
	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	4.249	1	3	3 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>8</sub>	6 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>
14	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>5</sup> / <sub>8</sub>	6 <sup>13</sup> / <sub>16</sub>	3 <sup>13</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>8</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>5</sup> / <sub>8</sub>	6 <sup>13</sup> / <sub>16</sub>	3 <sup>13</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>8</sub>
	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	4.249	1	3	3 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>5</sup> / <sub>8</sub>	6 <sup>13</sup> / <sub>16</sub>	3 <sup>13</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>8</sub>
	4	3 <sup>3</sup> / <sub>4</sub> -12	3-12	4	4.749	1	3 <sup>3</sup> / <sub>8</sub>	3 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	3 <sup>5</sup> / <sub>8</sub>	6 <sup>13</sup> / <sub>16</sub>	3 <sup>13</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>8</sub>

\* Dimension XI to be specified by customer.

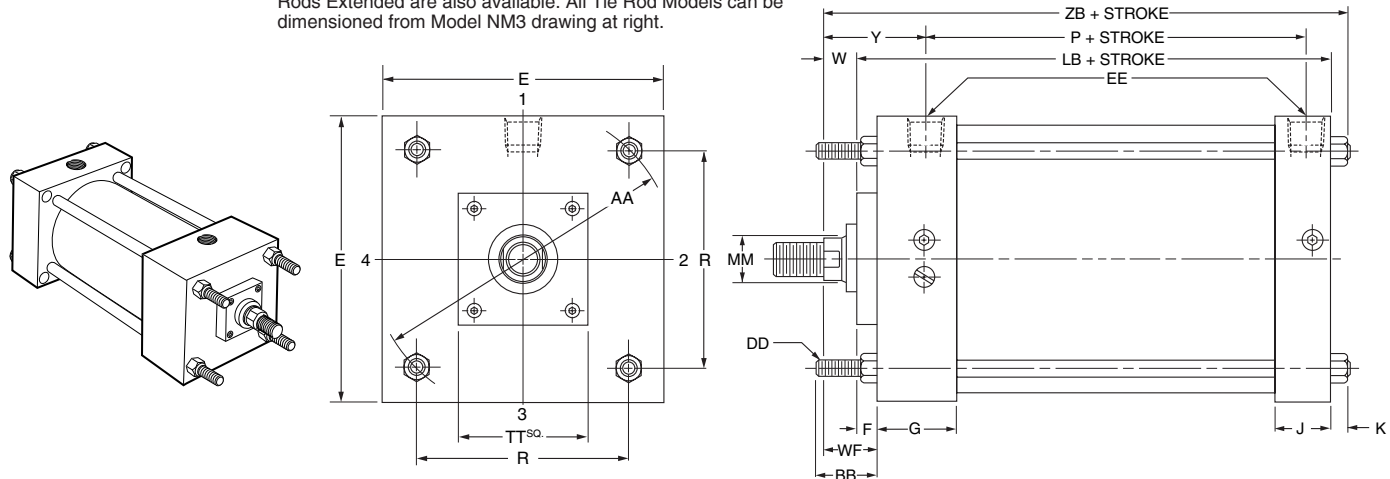
Table 3—Envelope and  
Mounting Dimensions

**Cap Fixed Clevis Mount**  
**Style PB2**  
 7" - 14" Bore



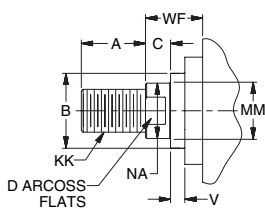
**Tie Rod Extended Mount**  
**Style NM3**  
 7" - 14" Bore

Model NM3 Head Tie Rods Extended, Illustrated. Model NM2 Cap Tie Rods Extended; and Model NM1, Both Ends Tie Rods Extended are also available. All Tie Rod Models can be dimensioned from Model NM3 drawing at right.

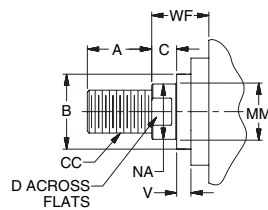


**Rod End Dimensions — See Table 2**

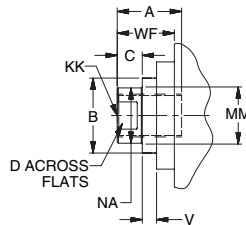
**Thread Style 1**  
 Small Male



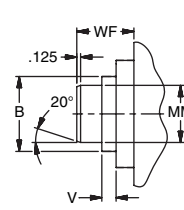
**Thread Style 2**  
 Intermediate Male



**Thread Style 3**  
 Short Female



**Style 6**  
 Stub End



**"Special" Thread Style 4**

Special thread, extension, rod eye, blank, etc., are also available. To order, specify "Style 4" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered,

style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

Table 1—Envelope and Mounting Dimensions

Bore	AA	BB	CB	+0.000 CD* -0.001	CW	DD	E	EE NPTF	F	G	J	K	L	LR	M	MR	R	Add Stroke	
																		LB	P
7	8.1	2 <sup>5</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1.000	<sup>3</sup> / <sub>4</sub>	<sup>5</sup> / <sub>8</sub> -18	7 <sup>1</sup> / <sub>2</sub>	<sup>3</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>2</sub>	<sup>9</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>4</sub>	1	1 <sup>3</sup> / <sub>16</sub>	5.73	5 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>
8	9.1	2 <sup>5</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1.000	<sup>3</sup> / <sub>4</sub>	<sup>5</sup> / <sub>8</sub> -18	8 <sup>1</sup> / <sub>2</sub>	<sup>3</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub>	2	1 <sup>1</sup> / <sub>2</sub>	<sup>9</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>4</sub>	1	1 <sup>3</sup> / <sub>16</sub>	6.44	5 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>4</sub>
10	11.2	2 <sup>11</sup> / <sub>16</sub>	2	1.375	1	<sup>3</sup> / <sub>4</sub> -16	10 <sup>5</sup> / <sub>8</sub>	1	<sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	2	<sup>11</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>8</sub>	1 <sup>7</sup> / <sub>8</sub>	1 <sup>3</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>8</sub>	7.92	7 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>8</sub>
12	13.3	2 <sup>11</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>2</sub>	1.750	1 <sup>1</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub> -16	12 <sup>3</sup> / <sub>4</sub>	1	<sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	2	<sup>11</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>8</sub>	1 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>8</sub>	9.40	7 <sup>5</sup> / <sub>8</sub>	4 <sup>5</sup> / <sub>8</sub>
14	15.4	3 <sup>3</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>2</sub>	2.000	1 <sup>1</sup> / <sub>4</sub>	<sup>7</sup> / <sub>8</sub> -14	14 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub>	2 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>4</sub>	<sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>2</sub>	2 <sup>3</sup> / <sub>8</sub>	2	2 <sup>3</sup> / <sub>8</sub>	10.90	8 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>

\* CD is pin diameter.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions									Y	Add Stroke		
		Style 2 CC	Style 1 & 3 KK	A	+0.000 -0.002 B	C	D	NA	TT	V	W	WF		XC	ZB	ZC
7	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -12	1-14	1 <sup>5</sup> / <sub>8</sub>	1.999	<sup>5</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	4	<sup>1</sup> / <sub>4</sub>	<sup>7</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>8</sub>	2 <sup>13</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>4</sub>	7 <sup>5</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>4</sub>
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	<sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>2</sub>	7 <sup>9</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>2</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	<sup>7</sup> / <sub>8</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	2	3 <sup>3</sup> / <sub>16</sub>	8 <sup>5</sup> / <sub>8</sub>	7 <sup>11</sup> / <sub>16</sub>	9 <sup>5</sup> / <sub>8</sub>
8	1 <sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub> -12	1-14	1 <sup>5</sup> / <sub>8</sub>	1.999	<sup>5</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>16</sub>	4	<sup>1</sup> / <sub>4</sub>	<sup>7</sup> / <sub>8</sub>	1 <sup>5</sup> / <sub>8</sub>	2 <sup>13</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>4</sub>	7 <sup>5</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>4</sub>
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	<sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>2</sub>	7 <sup>9</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>2</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	<sup>7</sup> / <sub>8</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	2	3 <sup>3</sup> / <sub>16</sub>	8 <sup>5</sup> / <sub>8</sub>	7 <sup>11</sup> / <sub>16</sub>	9 <sup>5</sup> / <sub>8</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>7</sup> / <sub>16</sub>	8 <sup>7</sup> / <sub>8</sub>	7 <sup>15</sup> / <sub>16</sub>	9 <sup>7</sup> / <sub>8</sub>
10	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> -12	1 <sup>1</sup> / <sub>4</sub> -12	2	2.374	1	1 <sup>1</sup> / <sub>2</sub>	1 <sup>11</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>8</sub>	1 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	10 <sup>3</sup> / <sub>8</sub>	8 <sup>15</sup> / <sub>16</sub>	11 <sup>3</sup> / <sub>4</sub>
	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	1	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	2	3 <sup>1</sup> / <sub>4</sub>	10 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>16</sub>	11 <sup>7</sup> / <sub>8</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	10 <sup>3</sup> / <sub>4</sub>	9 <sup>5</sup> / <sub>16</sub>	12 <sup>1</sup> / <sub>8</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	10 <sup>3</sup> / <sub>4</sub>	9 <sup>5</sup> / <sub>16</sub>	12 <sup>1</sup> / <sub>8</sub>
12	2	1 <sup>3</sup> / <sub>4</sub> -12	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	2.624	<sup>7</sup> / <sub>8</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>15</sup> / <sub>16</sub>	4	<sup>3</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	2	3 <sup>1</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>8</sub>	9 <sup>9</sup> / <sub>16</sub>	12 <sup>7</sup> / <sub>8</sub>
	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	11 <sup>3</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>	13 <sup>1</sup> / <sub>8</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	11 <sup>3</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>	13 <sup>1</sup> / <sub>8</sub>
	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	4.249	1	3	3 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	11 <sup>3</sup> / <sub>8</sub>	9 <sup>13</sup> / <sub>16</sub>	13 <sup>1</sup> / <sub>8</sub>
14	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub> -12	1 <sup>7</sup> / <sub>8</sub> -12	3	3.124	1	2 <sup>1</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	4	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>13</sup> / <sub>16</sub>	12 <sup>7</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>8</sub>	14 <sup>7</sup> / <sub>8</sub>
	3	2 <sup>3</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	3.749	1	2 <sup>5</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>13</sup> / <sub>16</sub>	12 <sup>7</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>8</sub>	14 <sup>7</sup> / <sub>8</sub>
	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub> -12	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	4.249	1	3	3 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>13</sup> / <sub>16</sub>	12 <sup>7</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>8</sub>	14 <sup>7</sup> / <sub>8</sub>
	4	3 <sup>3</sup> / <sub>4</sub> -12	3-12	4	4.749	1	3 <sup>3</sup> / <sub>8</sub>	3 <sup>7</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>2</sub>	<sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	3 <sup>13</sup> / <sub>16</sub>	12 <sup>7</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>8</sub>	14 <sup>7</sup> / <sub>8</sub>

Table 3—Envelope and Mounting Dimensions

To determine dimensions for a double rod cylinder, first refer to the desired single rod mounting style cylinder shown on preceding pages of this catalog. After selecting necessary dimensions from that drawing, return to this page and supplement the single rod dimensions with those shown on the drawing and dimension table below. Note that double rod cylinders have a head (Dim. G) at both ends and that dimension LD or LF replaces LB or LG. The double rod dimensions differ from, or are in addition to those for single rod cylinders shown on preceding pages and provide the information needed to completely dimension a double rod cylinder. On a double rod cylinder where the two rod ends are different, be sure to clearly state which rod end is to be assembled at which end.

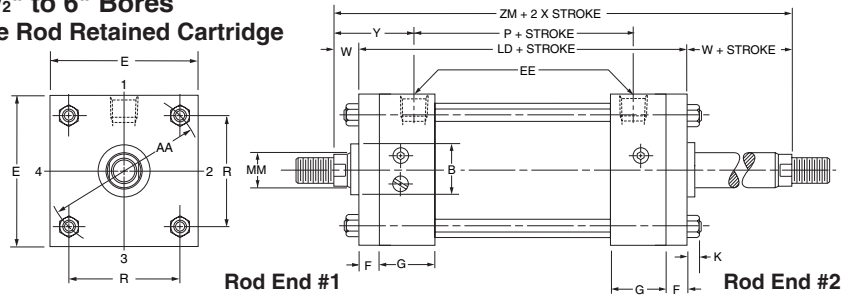
Port position 1 is standard. If other than standard, specify position 2, 3, or 4 when viewed from one end only.

If only one end of these Double Rod Cylinders is to be cushioned, be sure to specify clearly which end this will be.

Specify XI dimension from rod end #1.

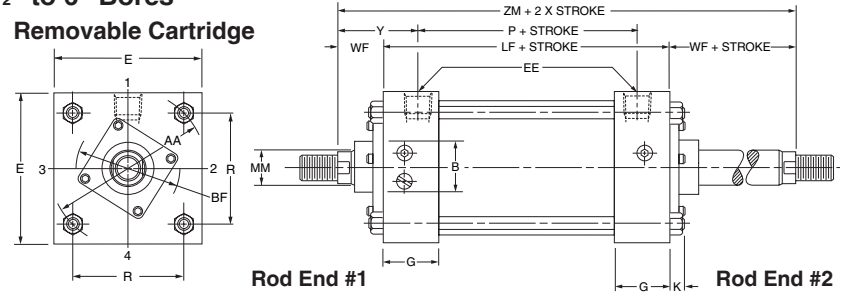
### How to Use Double Rod Cylinder Dimension Drawings 1½" to 6" Bores

#### Tie Rod Retained Cartridge

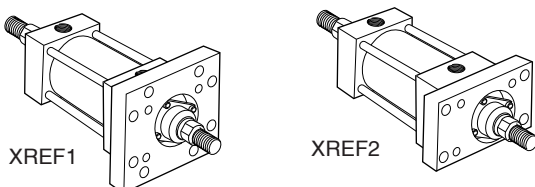
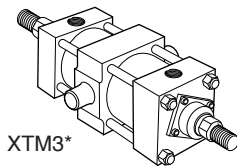
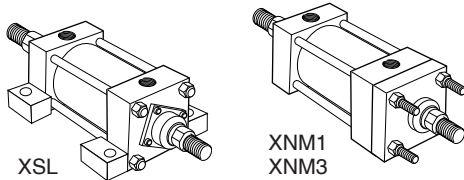
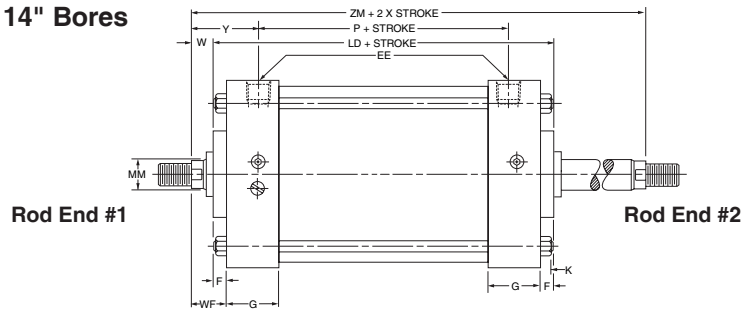


#### 1½" to 6" Bores

##### Removable Cartridge



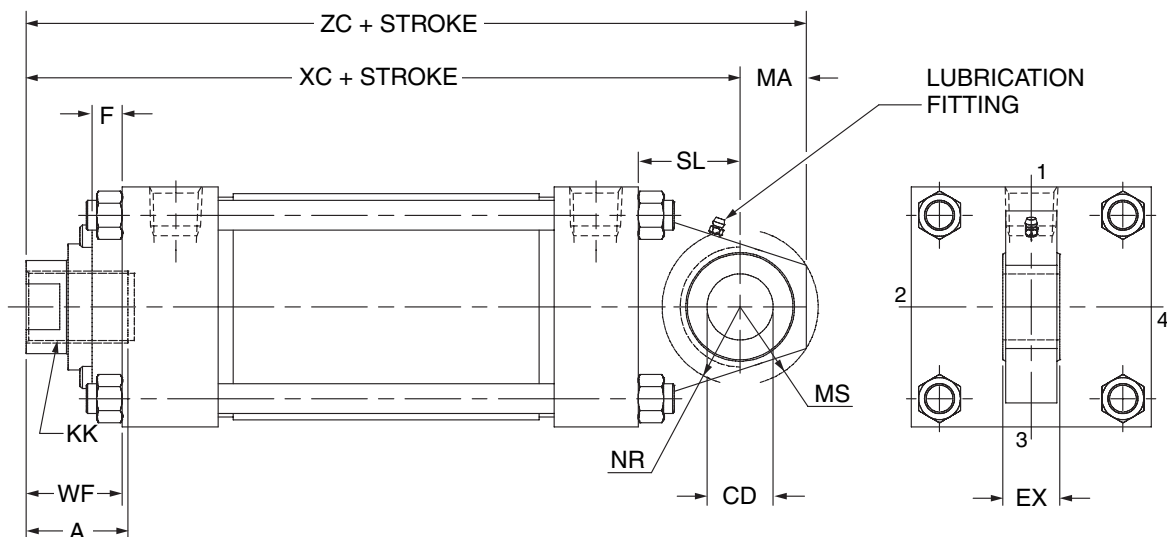
#### 7" to 14" Bores



All dimensions are in inches and apply to standard rod sizes only. For alternate rod sizes, determine all envelope dimensions (within LD dim.) as described above and then use appropriate rod end dimensions for proper rod size from single rod cylinder.

Bore	Rod Dia. MM	Add Stroke			Add 2X Stroke
		LD	LF	SS	ZM
1½	5⁄8	4⁷⁄₈	4¹⁄₈	3³⁄₈	6¹⁄₈
2	5⁄₈	4⁷⁄₈	4¹⁄₈	3³⁄₈	6¹⁄₈
2½	5⁄₈	5	4¹⁄₄	3½	6¼
3¼	1	6	4¾	3¾	7½
4	1	6	4¾	3¾	7½
5	1	6¼	5	3⁵⁄₈	7¾
6	1³⁄₈	7	5½	4¹⁄₈	8¾
7	1³⁄₈	7¹⁄₈	5⁵⁄₈	4¼	8⁷⁄₈
8	1³⁄₈	7¹⁄₈	5⁵⁄₈	4¼	8⁷⁄₈
10	1¾	8¹⁄₈	6⁵⁄₈	4⁷⁄₈	10³⁄₈
12	2	8⁵⁄₈	7¹⁄₈	5³⁄₈	11¹⁄₈
14	2½	10¹⁄₈	8⁵⁄₈	6³⁄₈	13¹⁄₈
Replaces: On single rod mounting styles:		LB	LG	SS	—
		All Mtg. Styles		SL	All Mtgs.

\*Mounting style XTM3 not available in 7" bore size.

**Spherical Bearing Mount – Style SA****1½" to 6" Bore Sizes**

Bore	Rod Dia. MM	Thread**	A	WF	Add Stroke		CD*	EX	MA	MS	NR	Max. Oper. PSI†
		Style 3 KK			XC	ZC						
1½	5/8	7/16-20	¾	1	5¾	6⅞	.5000 - .0005	7/16	¾	15/16	5/8	250
	1	¾-16	1⅛	1⅜	5¾	6½						
2	5/8	7/16-20	¾	1	5¾	6⅞	.5000 - .0005	7/16	¾	15/16	5/8	250
	1	¾-16	1⅛	1⅜	5¾	6½						
2½	1⅜	1-14	1⅝	1⅝	6	6¾	.5000 - .0005	7/16	¾	15/16	5/8	250
	5/8	7/16-20	¾	1	5½	6¼						
	1	¾-16	1⅛	1⅜	5⅞	6⅝						
	1⅜	1-14	1⅝	1⅝	6⅞	7⅞						
3¼	1	¾-16	1⅛	1⅜	6⅞	7⅞	.7500 - .0005	21/32	1	1⅜	1	250
	1⅜	1-14	1⅝	1⅝	7⅞	8⅞						
	1⅜	1¼-12	2	1⅞	7⅜	8⅜						
	2	1½-12	2¼	2	7½	8½						
4	1	¾-16	1⅛	1⅜	6⅞	7⅞	.7500 - .0005	21/32	1	1⅜	1	250
	1⅜	1-14	1⅝	1⅝	7⅞	8⅞						
	1⅜	1¼-12	2	1⅞	7⅜	8⅜						
	2	1½-12	2¼	2	7½	8½						
5	1	¾-16	1⅛	1⅜	7⅞	8⅞	.7500 - .0005	21/32	1	1⅜	1	250
	1⅜	1-14	1⅝	1⅝	7⅜	8⅜						
	1⅜	1¼-12	2	1⅞	7⅝	8⅝						
	2	1½-12	2¼	2	7¾	8¾						
6	1⅜	1-14	1⅝	1⅝	8⅞	9⅞	1.0000 - .0005	7/8	1¼	1⅞	1¼	250
	1⅜	1¼-12	2	1⅞	8⅜	9⅜						
	2	1½-12	2¼	2	8½	9¼						
	2½	1⅞-12	3	2¼	8¾	10						

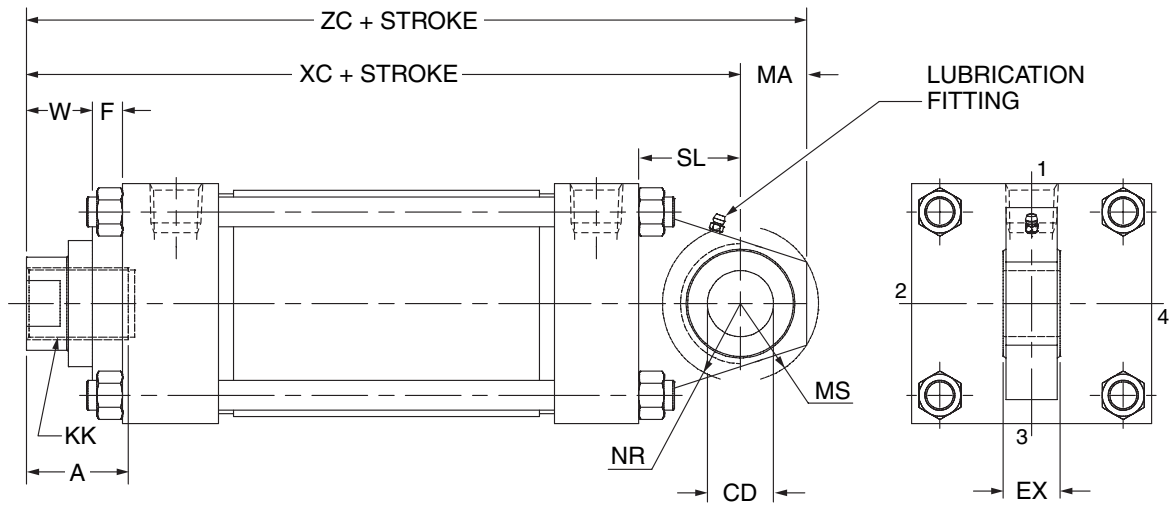
† Maximum operating pressure at 4:1 design factor is based on tensile strength of material.  
Pressure ratings are based on standard commercial bearing ratings.

Note: For additional dimensions see [page 24](#).

\* Dimension CD is hole diameter.

\*\* To match pin diameter in rod eye and cap, when an oversize rod is required, specify rod end style '4', 'KK' thread and 'A' thread length for the standard rod diameter (first rod listed for the bore), and 'W' for the oversize rod. Order the rod eye and clevis bracket for the required bore size from the tables on the [spherical bearings accessory page](#).

**Spherical Bearing Mount – Style SA**  
**8" to 14" Bore Sizes**



Bore	Rod Dia. MM	Thread**		A	W	Add Stroke		CD*	EX	MA	MS	NR	Max. Oper. PSI†
		Style 3	KK			XC	ZC						
8	1 <sup>3</sup> / <sub>8</sub>	1-14	1 <sup>5</sup> / <sub>8</sub>	7 <sub>8</sub>	8 <sup>1</sup> / <sub>4</sub>	9 <sup>1</sup> / <sub>2</sub>		1.0000 ±.0005	7 <sub>8</sub>	1 <sup>1</sup> / <sub>4</sub>	1 <sup>11</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>4</sub>	250
	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub> -12	2	1 <sup>1</sup> / <sub>8</sub>	8 <sup>1</sup> / <sub>2</sub>	9 <sup>3</sup> / <sub>4</sub>							
	2	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub>	8 <sup>5</sup> / <sub>8</sub>	9 <sup>7</sup> / <sub>8</sub>							
	2 <sup>1</sup> / <sub>2</sub>	1 <sup>7</sup> / <sub>8</sub> -12	3	1 <sup>1</sup> / <sub>2</sub>	8 <sup>7</sup> / <sub>8</sub>	10 <sup>1</sup> / <sub>8</sub>							
10	1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub> -12	2	1 <sup>1</sup> / <sub>8</sub>	10 <sup>3</sup> / <sub>8</sub>	12 <sup>1</sup> / <sub>4</sub>		1.3750 ±.0005	1 <sup>3</sup> / <sub>16</sub>	1 <sup>7</sup> / <sub>8</sub>	2 <sup>7</sup> / <sub>16</sub>	1 <sup>5</sup> / <sub>8</sub>	250
	2	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub>	10 <sup>1</sup> / <sub>2</sub>	12 <sup>3</sup> / <sub>8</sub>							
	2 <sup>1</sup> / <sub>2</sub>	1 <sup>7</sup> / <sub>8</sub> -12	3	1 <sup>1</sup> / <sub>2</sub>	10 <sup>3</sup> / <sub>4</sub>	12 <sup>5</sup> / <sub>8</sub>							
	3	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	10 <sup>3</sup> / <sub>4</sub>	12 <sup>5</sup> / <sub>8</sub>							
12	2	1 <sup>1</sup> / <sub>2</sub> -12	2 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>8</sub>	13 <sup>5</sup> / <sub>8</sub>		1.7500 ±.0005	1 <sup>17</sup> / <sub>32</sub>	2 <sup>1</sup> / <sub>2</sub>	2 <sup>7</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	250
	2 <sup>1</sup> / <sub>2</sub>	1 <sup>7</sup> / <sub>8</sub> -12	3	1 <sup>1</sup> / <sub>2</sub>	11 <sup>3</sup> / <sub>8</sub>	13 <sup>7</sup> / <sub>8</sub>							
	3	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	11 <sup>3</sup> / <sub>8</sub>	13 <sup>7</sup> / <sub>8</sub>							
	3 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	11 <sup>3</sup> / <sub>8</sub>	13 <sup>7</sup> / <sub>8</sub>							
14	2 <sup>1</sup> / <sub>2</sub>	1 <sup>7</sup> / <sub>8</sub> -12	3	1 <sup>1</sup> / <sub>2</sub>	12 <sup>7</sup> / <sub>8</sub>	15 <sup>3</sup> / <sub>8</sub>		2.0000 ±.0005	1 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>2</sub>	3 <sup>5</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>8</sub>	250
	3	2 <sup>1</sup> / <sub>4</sub> -12	3 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	12 <sup>7</sup> / <sub>8</sub>	15 <sup>3</sup> / <sub>8</sub>							
	3 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub> -12	3 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	12 <sup>7</sup> / <sub>8</sub>	15 <sup>3</sup> / <sub>8</sub>							
	4	3-12	4	1 <sup>1</sup> / <sub>2</sub>	12 <sup>7</sup> / <sub>8</sub>	15 <sup>3</sup> / <sub>8</sub>							

† Maximum operating pressure at 4:1 design factor is based on tensile strength of material.  
 Pressure ratings are based on standard commercial bearing ratings.

Note: For additional dimensions see [page 32](#).

\* Dimension CD is hole diameter.

\*\* To match pin diameter in rod eye and cap, when an oversize rod is required, specify rod end style '4', 'KK' thread and 'A' thread length for the standard rod diameter (first rod listed for the bore), and 'W' for the oversize rod. Order the rod eye and clevis bracket for the required bore size from the tables on the [spherical bearings accessory page](#).



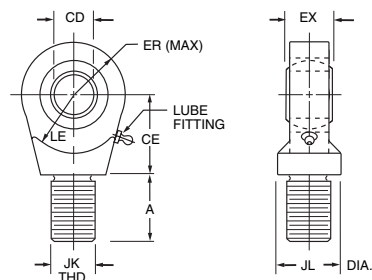
## Cylinder Accessories

### Spherical Bearing Mount – Style SA

Atlas offers a complete range of Cylinder Accessories to assure you of the greatest versatility in present or future cylinder applications. Accessories offered for the

respective cylinder include the Rod Eye, Pivot Pin and Clevis Bracket. To select the proper part number for any desired accessory refer to the charts below.

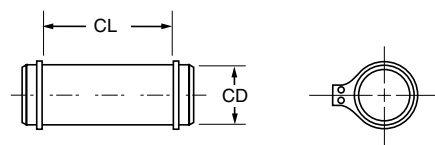
#### Spherical Rod Eye



Order to fit Piston Rod Thread Size.

Bore Sizes	1 1/2, 2 & 2 1/2	3 1/4, 4 & 5	6 & 8	10	12	14
Part No.	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6
CD	.5000-.0005	.7500-.0005	1.0000-.0005	1.3750-.0005	1.7500-.0005	2.0000-.0005
A	1 1/16	1	1 1/2	2	2 1/8	2 7/8
CE	7/8	1 1/4	1 7/8	2 1/8	2 1/2	2 3/4
EX	7/16	2 1/32	7/8	1 3/16	1 17/32	1 3/4
ER	1 3/16	1 1/8	1 1/4	1 11/16	2 1/16	2 1/2
LE	3/4	1 1/16	1 7/16	1 7/8	2 1/8	2 1/2
JK	7/16-20	3/4-16	1-14	1 1/4-12	1 1/2-12	1 7/8-12
JL	7/8	1 5/16	1 1/2	2	2 1/4	2 3/4
LOAD CAPACITY LBS.	2644	9441	16860	28562	43005	70193

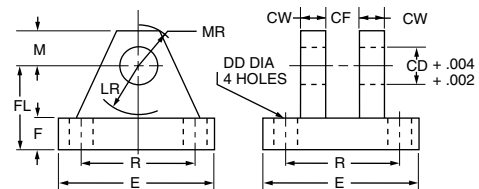
#### Pivot Pin



Pivot Pins are furnished with  
 (2) Retainer Rings.

Bore Sizes	1 1/2, 2 & 2 1/2	3 1/4, 4 & 5	6 & 8	10	12	14
Part No.	PP-616	PP-624	PP-632	PP-644	PP-656	PP-654
CD	.4997-.0004	.7497-.0005	.9997-.0005	1.3746-.0006	1.7496-.0006	1.9996-.0007
CL	1 9/16	2 1/32	2 1/2	3 5/16	4 7/32	4 15/16
LOAD CAPACITY LBS.	8600	19300	34300	65000	105200	137400

#### Clevis Bracket



Order to fit Cap or Rod Eye.

Bore Sizes	1 1/2, 2 & 2 1/2	3 1/4, 4 & 5	6 & 8	10	12	14
Part No.	SAB-1	SAB-2	SAB-3	SAB-4	SAB-5	SAB-6
CD	1/2	3/4	1	1 3/8	1 3/4	2
CF	7/16	2 1/32	7/8	1 3/16	1 17/32	1 3/4
CW	1/2	5/8	3/4	1	1 1/4	1 1/2
DD	1 3/32	1 7/32	1 7/32	2 1/32	2 9/32	2 9/32
E	3	3 3/4	5 1/2	6 1/2	8 1/2	10 5/8
F	1/2	5/8	3/4	7/8	1 1/4	1 1/2
FL	1 1/2	2	2 1/2	3 1/2	4 1/2	5
LR	1 5/16	1 3/8	1 11/16	2 7/16	2 7/8	3 5/16
M	1/2	7/8	1	1 3/8	1 3/4	2
MR	5/8	1	1 3/16	1 5/8	2 1/16	2 3/8
R	2.05	2.76	4.10	4.95	6.58	7.92
LOAD CAPACITY LBS.	5770	9450	14300	20322	37800	50375

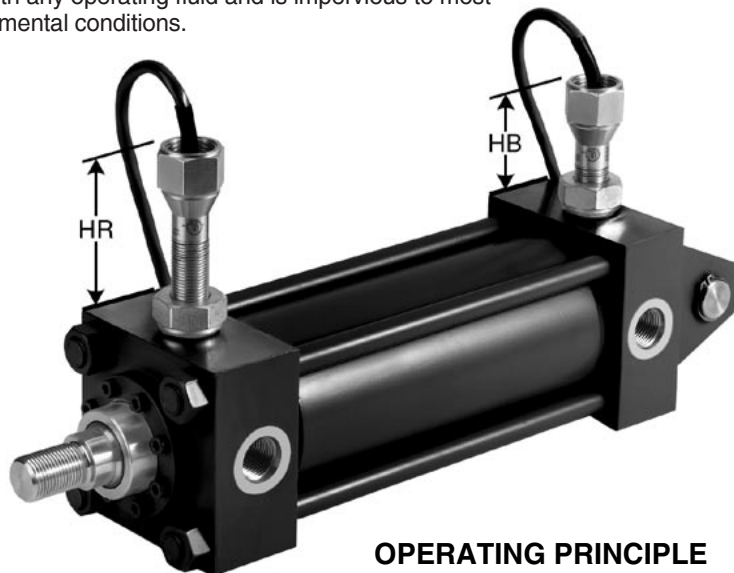
Part numbers for clevis bracket include pins and keepers.

# End of Stroke Magnetic Principle Type Proximity Switch

**Reliable:** Proximity type sensor never contacts cylinder moving parts; eliminating wear and adjustments.

**Positive Action:** Multiple magnet design provides "snap action." Eliminates creep and false signals.

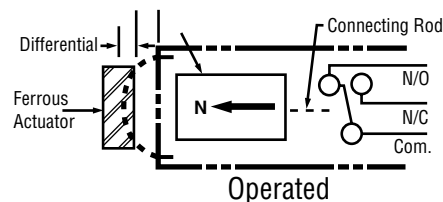
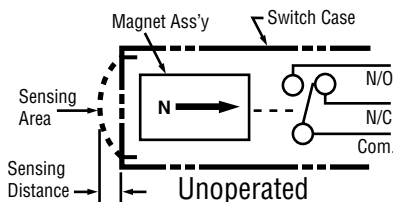
**Versatile:** Sealed stainless steel switch body can be used with any operating fluid and is impervious to most environmental conditions.



Switch Extension in Inches

Bore	Rod Dia.	HR	HB
1 1/2	5/8	3 3/8	3 1/8
	1	3 1/2	
2	5/8	3 3/16	2 7/8
	1	3 5/16	
	1 3/8	3 7/16	
2 1/2	5/8	2 15/16	2 5/8
	1	3 1/16	
	1 3/8	3 1/4	
	1 3/4	3 7/16	
3 1/4	1	3 1/8	2 3/4
	1 3/8	3 1/4	
	1 3/4	3 1/2	
	2	3 11/16	
4	1	2 3/4	2 7/16
	1 3/8	2 15/16	
	1 3/4	3 1/8	
	2	3 1/4	
5	1	2 1/4	1 15/16
	1 3/8	2 7/16	
	1 3/4	2 5/8	
	2	2 3/4	
6	1 3/8	1 15/16	1 1/2
	1 3/4	2 1/8	
	2	2 1/4	
	2 1/2	2 5/8	
7	1 3/8	2 3/4	1
	1 3/4	2 15/16	
	2	2 1/8	
	2 1/2	2 5/8	
8	1 3/8	2 7/16	2
	1 3/4	2 5/8	
	2	2 3/4	
	2 1/2	3 1/8	
10	1 3/4	1 1/2	1 1/8
	2	1 3/4	
	2 1/2	2	
	3	2 1/4	

## OPERATING PRINCIPLE



### Switch Options

Quick disconnect.  
Explosion proof.  
Extra-long leads.

As shown in the sketches above, these switches are magnetically operated. Dual magnets provide a dependable "snap action" for positive position sensing.

In the "unoperated" position, the magnet assembly is attracted in the direction of the arrow, causing a finely ground stainless steel connecting rod to hold the contacts open.

In the "operated" position a ferrous part (cushion or piston) enters the sensing area and attracts the magnet assembly which causes the rod to draw the contacts closed.

### How to Order:

To order switches, enter an "S" in the Options field of the cylinder model code. Describe the modification in notes by specifying:

1. Magnaswitch
2. Installation in head, cap, or both ends of the cylinder
3. Location in the head or cap (position #1, 2, 3, or 4) not occupied by a port or mounting

## Specifications

**Switch Type:**  
Magnetic Principle

**Contacts:**  
Single Pole-Double Throw (SPDT)

**Contact Rating\*:**  
2 Amp at 110-240 VAC (UL & CSA)  
100 MA at 12 VDC 50 MA at 24 VDC (CSA)

Note: Check current draw of solenoid valves.

**Connection:** 36" long, 3 wire, potted in cable. Can be wired Normally Open or Normally Closed. Leads are tagged (Com, N/O, N/C)

**Switch Pressure Rating:** 3000 PSI  
Non Shock

**Temperature Range:**  
-20°F to +200°F (UL 104°F. Max.)

**Sensing Gap:**  
.030 to .060 inch

**Trip Point:** Factory Set with Piston Bottomed out

**Release Point:** Approximately 1/4" Piston Travel

Min. Cyl. stroke 1/2" on 1 1/2" & 2" bore, 3/4" stroke on 2 1/2" and up.

\*UL and CSA approved for industrial control, general purpose use. If Class I, Division 1 or 2 is required, please specify.



Approved switches are in compliance with current bulletins 1243, 1273 and 1308

# **Atlas Non-Lube Heavy-Duty Air Cylinders**

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## **AL Series**



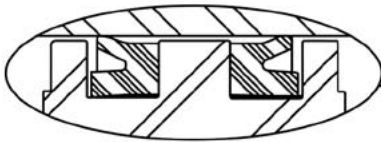
## **For millions of trouble free cycles**

- Nominal pressure — 250 PSI — Air Service
- Standard Bore Sizes — 1½" through 14"
- Piston Rod Diameters — ⅝" through 4"
- 14 Standard Mounting Styles
- NFPA Interchangeable
- Exceeds Automotive Specifications

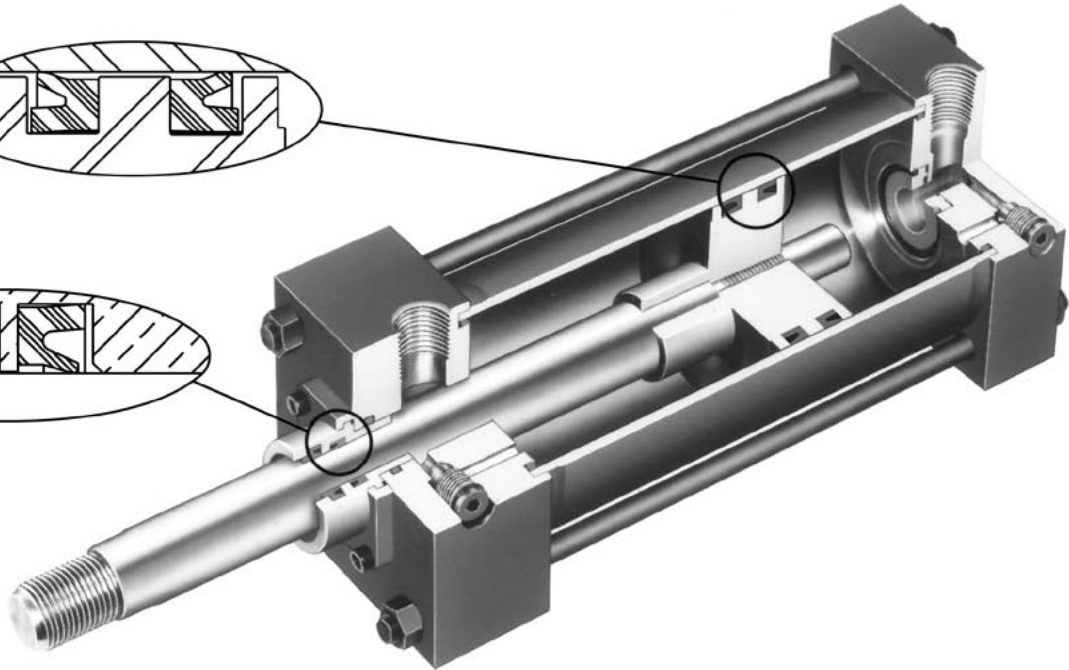
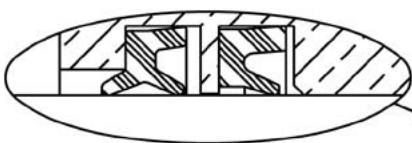
# The AL Series Non-Lube Air Cylinder with Proven Performance

## Millions of trouble free cycles with ZERO LEAKAGE.

Piston Lipseals



Gland Lipseal



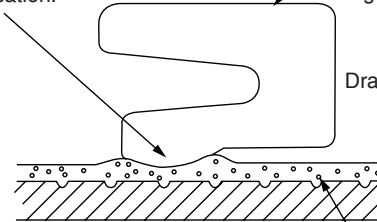
**Increased Market Demand** and continuous research and testing efforts inspired the development of the AL Series Non-Lubricated Air Cylinder. The AL Series piston rod and cylinder barrel surfaces act as highly efficient lubricant reservoirs, maintaining their own lubricant film. Other manufacturers pack grease into grooves and pockets and call them reservoirs. The fact of the matter is that as those grooves empty out over time; grease is being transported out of the cylinder and into the control system components and the atmosphere. The AL Series concept eliminates that problem by maintaining the lubricant film where it belongs: on the seals, bearing surfaces, piston rod and cylinder bore.

**Benefits include**...long seal and bearing life and since no oil is added through the use of lubricators – no oil is expelled into the atmosphere with the exhaust air as the cylinder strokes.

### Anatomy of AL Series Sealing and Lubricant Retention Systems

Rounded sealing lip glides over lubricant film instead of scraping it off. Reduces friction, increases life and eliminates the need for added lubrication.

Increased heel thickness and outer lip extension improve stability, resist rolling.



Drawing not to scale

High integrity lubricant film with suspended PTFE particles

## In the AL Series you get all the cost saving benefits and features of the popular heavy-duty Series A air cylinder including...

- Bolt-On Rod Gland Assembly for positive no leak sealing
- Piston rod, hard chrome-plated and case-hardened steel
- High strength rolled thread Piston Rod Stud

- Steel tube cylinder body with chrome-plated micro finish bore...

**Plus** the innovative “Non-Lube” feature which further increases your benefits of lower operating and maintenance costs.

### Standard Specifications

- Heavy-Duty Service — ANSI/(NFPA) T3.6.7 R2-1996 Mounting Dimension Standards
- Standard Construction — Square Head — Tie Rod Design
- Standard Temperature — -10°F to +165°F

- Standard Fluid — Filtered Air
- Strokes — Available in any practical stroke length
- Cushions — Optional at either end or both ends of stroke. “Float Check” at cap end.

*In line with our policy of continuing product improvement, specifications in this bulletin are subject to change.*

### Available Bore and Rod Sizes

Bore Sizes Available	1 1/2"	2"	2 1/2"	3 1/4"	4"	5"	6"	8"	10"	12"	14"
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Rod Sizes Available	5/8"	1"	1 3/8"	1 3/4"	2"	2 1/2"	3"	3 1/2"	4"
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## How to Order AL Series Non-Lube Air Cylinders

### Data Required on all AL Cylinder Orders

When ordering AL Series cylinders, be sure to specify each of the following requirements:

(**Note:** Duplicate cylinders can be ordered by giving the SERIAL NUMBER from the nameplate of the original cylinder. Factory records supply a quick, positive identification.)

#### a) Bore Size

#### b) Mounting Style

Specify your choice of mounting style — as shown in this catalog. If double rod is wanted, specify “with double rod.”

#### c) Series Designation (AL)

#### d) Length of Stroke

#### e) Piston Rod Diameter

Specify rod diameter in AL Series cylinders, standard rod diameters will be furnished if not otherwise specified, unless length of stroke makes the application questionable.

#### f) Piston Rod End Thread Style

Give thread style number or specify dimensions. Thread style number 1 will be supplied if not otherwise specified.

#### g) Cushions (if required)

Specify “Cushion-head end,” “Cushion-cap end” or “Cushion-both ends” as required. If cylinder is to have a double rod and only one cushion is required, be sure to specify clearly which end of the cylinder is to be cushioned.

See [page 65](#) for complete model code requirements.

**Cylinder Accessories**

Atlas offers a complete range of cylinder accessories to assure you of the greatest versatility in present and future cylinder applications.

**Rod End Accessories**

Accessories offered for the rod end of the cylinder include Rod Clevis, Eye Bracket, Female Rod Eye, Clevis Bracket, and Pivot Pin. To select the proper part number for any desired accessory, refer to the table below or on the [opposite page](#) and look in the row to the right of the rod thread in the first column. For economical accessory selection, it is recommended that rod end style 1 be specified on your cylinder order.

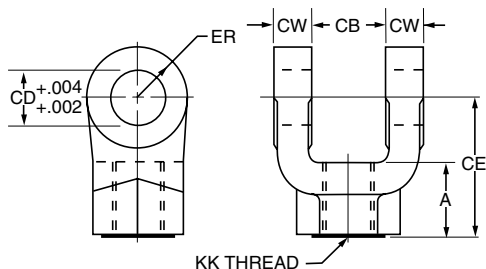
**Accessory Load Capacity**

The various accessories have been load rated for your convenience. The load Capacity in lbs. Is the recommended maximum load for that accessory based on a 4:1 design factor in tension. (Pivot Pin is rated in shear.) Before specifying, compare the actual load or the tension (pull) force at maximum operating pressure of the cylinder with the load capacity of the accessory you plan to use. If load or pull force of cylinder exceeds load capacity of accessory, consult factory.

Thread Size	Rod Clevis		Eye Bracket		Pivot Pin	
	Part Number	Load Capacity (Lbs.)	Part Number	Load Capacity (Lbs.)	Part Number	Shear Capacity (Lbs.)
7/16-20	JIC-40	2950	EB-195	3375	PP-368A	58900
1/2-20	JIC-41	4000	EB-195	3375	PP-368A	58900
3/4-16	JIC-42A	11200	EB-196	8400	PP-369A	13250
3/4-16	JIC-42	9300	EB-196	8400	PP-369A	13250
7/8-14	JIC-43A	18800	EB-197	13500	PP-370A	23560
7/8-14	JIC-43	12700	EB-197	13500	PP-370A	23560
1-14	JIC-44A	19500	EB-197	13500	PP-370A	23560
1-14	JIC-44	16875	EB-197	13500	PP-370A	23560
1 1/4-12	JIC-45A	33500	EB-198	24700	PP-371A	44550
1 1/4-12	JIC-45	26800	EB-198	24700	PP-371A	44550
1 1/2-12	JIC-46	39500	EB-199	39375	PP-372A	72150
1 3/4-12	JIC-47	54700	EB-200	45000	PP-215A	94250
1 7/8-12	JIC-48	56250	EB-200	45000	PP-215A	94250
2 1/4-12	JIC-49	84375	EB-201	67500	PP-374A	94250
2 1/2-12	JIC-50	84375	EB-202	67500	PP-375A	147250
2 3/4-12	JIC-51	84375	EB-202	67500	PP-216A	212050
3 1/4-12	JIC-52A	156700	EB-38	126000	PP-545A	288600
3 1/4-12	JIC-52	157500	EB-38	126000	PP-545A	288600
3 1/2-12	JIC-53A	193200	EB-39	162000	PP-547A	377000
3 1/2-12	JIC-53	202500	EB-39	162000	PP-547A	377000
4-12	JIC-54A	221200	EB-39	162000	PP-547A	377000
4-12	JIC-54	202500	EB-39	162000	PP-547A	377000



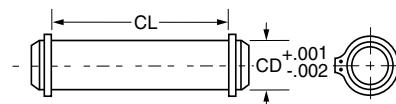
### Rod Clevis Dimensions



Part Number	A	CB	CD	CE	CW	ER	KK
JIC-40	3/4	3/4	1/2	1 1/2	1/2	1/2	7/16-20
JIC-41	3/4	3/4	1/2	1 1/2	1/2	1/2	1/2-20
JIC-42A	1 1/8	1 1/4	3/4	2 1/8	5/8	3/4	3/4-16
JIC-42	1 1/8	1 1/4	3/4	2 3/8	5/8	3/4	3/4-16
JIC-43A	1 5/8	1 1/2	1	2 15/16	3/4	1	7/8-14
JIC-43	1 5/8	1 1/2	1	3 1/8	3/4	1	7/8-14
JIC-44A	1 5/8	1 1/2	1	2 15/16	3/4	1	1-14
JIC-44	1 5/8	1 1/2	1	3 1/8	3/4	1	1-14
JIC-45A	1 7/8	2	1 3/8	3 3/4	1	1 3/8	1 1/4-12
JIC-45	2	2	1 3/8	4 1/8	1	1 3/8	1 1/4-12
JIC-46	2 1/4	2 1/2	1 3/4	4 1/2	1 1/4	1 3/4	1 1/2-12
JIC-47	3	2 1/2	2	5 1/2	1 1/4	2	1 3/4-12
JIC-48	3	2 1/2	2	5 1/2	1 1/4	2	1 7/8-12
JIC-49	3 1/2	3	2 1/2	6 1/2	1 1/2	2 1/2	2 1/4-12
JIC-50	3 1/2	3	3	6 3/4	1 1/2	2 3/4	2 1/2-12
JIC-51	3 1/2	3	3	6 3/4	1 1/2	2 3/4	2 3/4-12
JIC-52A	3 1/2	4	3 1/2	7 3/4	2	3 1/2	3 1/4-12
JIC-52	4 1/2	4	3 1/2	8 1/2	2	3 1/2	3 1/4-12
JIC-53A	4 $\frac{1}{2}$	4 1/2	4	8 13/16	2 1/4	4	3 1/2-12
JIC-53	5	4 1/2	4	9 13/16	2 1/4	4	3 1/2-12
JIC-54A	4 $\frac{1}{2}$	4 1/2	4	8 13/16	2 1/4	4	4-12
JIC-54	5 1/2	4 1/2	4	10	2 1/4	4	4-12

‡Consult appropriate cylinder rod end dimensions for compatibility.  
 Part numbers for Rod Clevis include pins and keepers.

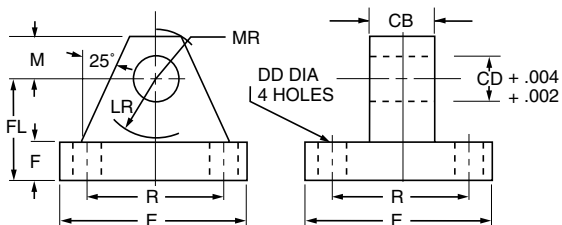
### Pivot Pin Dimensions



Part Number	CD	CL
PP-368A	1/2	1 7/8
PP-369A	3/4	2 5/8
PP-370A	1	3 1/8
PP-371A	1 3/8	4 1/8
PP-372A	1 3/4	5 3/16
PP-373A	2	5 3/16
PP-374A	2 1/2	6 3/16
PP-375A	3	6 1/4
PP-545A	3 1/2	8 1/4
PP-547A	4	9

1. Pivot Pins are furnished with Clevis Mounted Cylinders as standard.
2. Pivot Pins are furnished with (2) Retainer Rings.

### Eye Bracket Dimensions



1. When used to mate with the Rod Clevis, select by thread size in table above.
2. When used to mount the Style PB2 Cylinder, select by bore size below.

Part Number	CB	CD	DD	E	F	FL	LR	M	MR	R	Bore
EB-195	3/4	1/2	13/32	2 1/2	3/8	1 1/8	3/4	1/2	9/16	1.63	1 1/2", 2", 2 1/2"
EB-196	1 1/4	3/4	17/32	3 1/2	5/8	1 7/8	1 1/4	3/4	7/8	2.55	3 1/4", 4", 5"
EB-197	1 1/2	1	21/32	4 1/2	3/4	2 1/4	1 1/2	1	1 1/4	3.25	6", 7", 8"
EB-198	2	1 3/8	21/32	5	7/8	3	2 1/8	1 3/8	1 5/8	3.82	10"
EB-199	2 1/2	1 3/4	29/32	6 1/2	7/8	3 1/8	2 1/4	1 3/4	2 1/8	4.95	12"
EB-200	2 1/2	2	1 1/16	7 1/2	1	3 1/2	2 1/2	2	2 7/16	5.73	14"
EB-201	3	2 1/2	1 3/16	8 1/2	1	4	3	2 1/2	3	6.58	—
EB-202	3	3	1 5/16	9 1/2	1	4 1/4	3 1/4	2 3/4	3 1/4	7.50	—
EB-38	4	3 1/2	1 13/16	12 5/8	1 11/16	5 11/16	4	3 1/2	4 1/8	9.62	—
EB-39	4 1/2	4	2 1/16	14 7/8	1 15/16	6 7/16	4 1/2	4	5 1/4	11.45	—

### Rod End Accessories

Accessories offered for the rod end of the cylinder include Rod Clevis, Eye Bracket, Female Rod Eye, Clevis Bracket, and Pivot Pin. To select the proper part number for any desired accessory, refer to the table below or on the opposite page and look in the row to the right of the rod thread in the first column. For economical accessory selection, it is recommended that rod end style 1 be specified on your cylinder order.

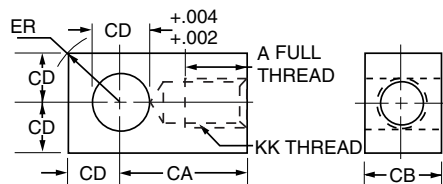
### Accessory Load Capacity

The various accessories have been load rated for your convenience. The load Capacity in lbs. is the recommended maximum load for that accessory based on a 4:1 design factor in tension. (Pivot Pin is rated in shear.) Before specifying, compare the actual load or the tension (pull) force at the maximum operating pressure of the cylinder with the load capacity of the accessory you plan to use. If load or pull force of cylinder exceeds load capacity of accessory, consult factory.

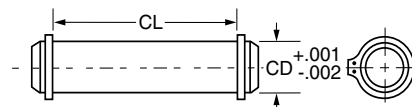
Thread Size	Female Rod Eye		Clevis Bracket		Pivot Pin	
	Part Number	Load Capacity (Lbs.)	Part Number	Load Capacity (Lbs.)	Part Number	Shear Capacity (Lbs.)
7/16-20	REE-89	2950	CB-205	4500	PP-368A	5890
1/2-20	REE-90	3375	CB-205	4500	PP-368A	5890
3/4-16	REE-91	8400	CB-206	8400	PP-369A	13250
7/8-14	REE-92	12700	CB-207	13500	PP-370A	23560
1-14	REE-93	13500	CB-207	13500	PP-370A	23560
1 1/4-12	REE-94	24750	CB-208	24700	PP-371A	44550
1 1/2-12	REE-95	39375	CB-209	39375	PP-372A	72150
1 3/4-12	REE-96	45000	CB-210	54000	PP-215A	94250
1 7/8-12	REE-97	45000	CB-210	54000	PP-215A	94250
2 1/4-12	REE-98	67500	CB-211	67500	PP-374A	147250
2 1/2-12	REE-99	81000	CB-212	124000	PP-375A	212050
2 3/4-12	REE-100	94500	CB-213	124000	PP-216A	212050
3 1/4-12	REE-36	126000	CB-242	126000	PP-545A	288600
3 1/2-12	REE-37	126000	CB-242	126000	PP-545A	288600
4-12	REE-38	162000	CB-243	144000	PP-546A	288600
4 1/2-12	REE-39	180000	CB-244	144000	PP-547A*	377000

\*This size supplied with cotter pins.

### Female Rod Eye Dimensions



### Pivot Pin Dimensions

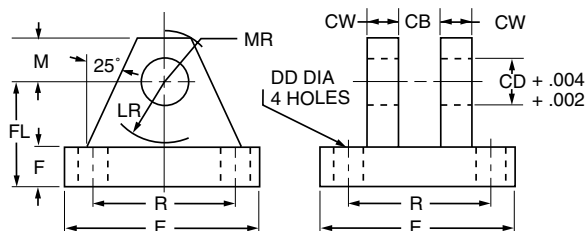


Part Number	A	CA	CB	CD	ER	KK
REE-89	3/4	1 1/2	3/4	1/2	23/32	7/16-20
REE-90	3/4	1 1/2	3/4	1/2	23/32	1/2-20
REE-91	1 1/8	2 1/16	1 1/4	3/4	1 1/16	3/4-16
REE-92	1 1/8	2 3/8	1 1/2	1	1 7/16	7/8-14
REE-93	1 5/8	2 13/16	1 1/2	1	1 7/16	1-14
REE-94	2	3 7/16	2	1 3/8	1 31/32	1 1/4-12
REE-95	2 1/4	4	2 1/2	1 3/4	2 1/2	1 1/2-12
REE-96	2 1/4	4 3/8	2 1/2	2	2 27/32	1 3/4-12
REE-97	3	5	2 1/2	2	2 27/32	1 7/8-12
REE-98	3 1/2	5 13/16	3	2 1/2	3 9/16	2 1/4-12
REE-99	3 1/2	6 1/8	3	3	4 1/4	2 1/2-12
REE-100	3 5/8	6 1/2	3 1/2	3	4 1/4	2 3/4-12
REE-36	4 1/2	7 5/8	4	3 1/2	4 31/32	3 1/4-12
REE-37	5	7 5/8	4	3 1/2	4 31/32	3 1/2-12
REE-38	5 1/2	9 1/8	4 1/2	4	5 11/16	4-12
REE-39	5 1/2	9 1/8	5	4	5 11/16	4 1/2-12

Part Number	CD	CL
PP-368A	1/2	1 7/8
PP-369A	3/4	2 5/8
PP-370A	1	3 1/8
PP-371A	1 3/8	4 1/8
PP-372A	1 3/4	5 3/16
PP-215A	2	5 11/16
PP-374A	2 1/2	6 3/16
PP-375A	3	6 1/4
PP-216A	3	6 3/4
PP-545A	3 1/2	8 1/4
PP-546A	4	8 5/8
PP-547A*	4	9

- Pivot Pins are furnished with Clevis Mounted Cylinders as standard.
- Pivot Pins are furnished with (2) Retainer Rings.

### Clevis Bracket Dimensions



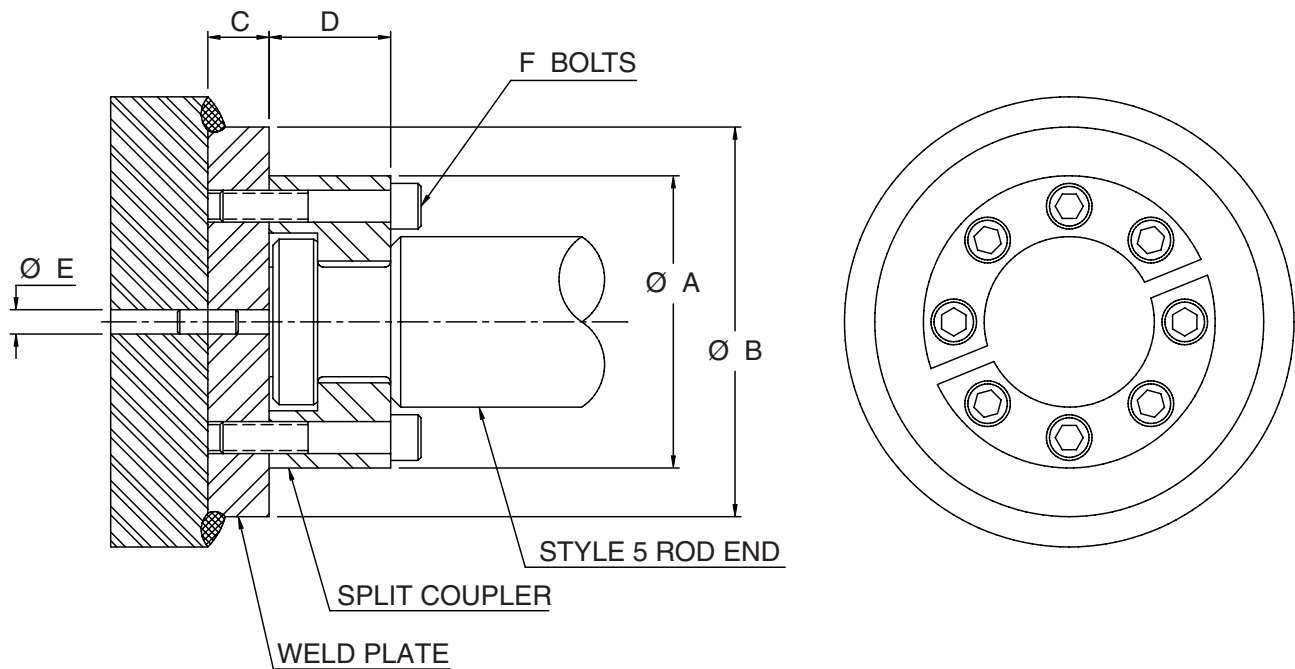
Part Number	CB	CD	CW	DD	E	F	FL	LR	M	MR	R
CB-205	3/4	1/2	1/2	13/32	3 1/2	1/2	1 1/2	3/4	1/2	5/8	2.55
CB-206	1 1/4	3/4	5/8	17/32	5	5/8	1 7/8	1 3/16	3/4	29/32	3.82
CB-207	1 1/2	1	3/4	21/32	6 1/2	3/4	2 1/4	1 1/2	1	1 1/4	4.95
CB-208	2	1 3/8	1	21/32	7 1/2	7/8	3	2	1 3/8	1 21/32	5.73
CB-209	2 1/2	1 3/4	1 1/4	29/32	9 1/2	7/8	3 5/8	2 3/4	1 3/4	2 7/32	7.50
CB-210	2 1/2	2	1 1/2	1 1/16	12 3/4	1	4 1/4	3 3/16	2 1/4	2 25/32	9.40
CB-211	3	2 1/2	1 1/2	1 3/16	12 3/4	1	4 1/2	3 1/2	2 1/2	3 1/8	9.40
CB-212	3	3	1 1/2	1 5/16	12 3/4	1	6	4 1/4	3	3 19/32	9.40
CB-213	3 1/2	3	1 1/2	1 5/16	12 3/4	1	6	4 1/4	3	3 19/32	9.40
CB-242	4	3 1/2	2	1 13/16	15 1/2	1 11/16	6 11/16	5	3 1/2	4 1/8	12.00
CB-243	4 1/2	4	2	2 1/16	17 1/2	1 15/16	7 11/16	5 3/4	4	4 7/8	13.75
CB-244	5	4	2	2 1/16	17 1/2	1 15/16	7 11/16	5 3/4	4	4 7/8	13.75

- This size supplied with cotter pins.

Part numbers for clevis bracket include pins and keepers.

# “Style 5” Piston Rod End

## Split Couplers and Weld Plates



**⚠ WARNING:** Piston rod separation from the machine member can result in severe personal injury or even death to nearby personnel. The cylinder user must make sure the weld holding the weld plate to the machine is of sufficient quality and size to hold the intended load. The cylinder user must also make sure the bolts holding split coupler to the weld plate are of sufficient strength to hold the intended load and installed in such a way that they will not become loose during the machine’s operation.

Table 1 – Part Numbers and Dimensions

ROD DIA.	A	B	C	D	E	F	BOLT SIZE	SPLIT COUPLER PART NO.	WELD PLATE PART NO.
<sup>5</sup> / <sub>8</sub>	1.50	2.00	.50	.56	.250	4	#10-24 x .94 LG	SC-062	WP-062
1	2.00	2.50	.50	.88	.250	6	.250-20 x 1.25 LG	SC-100	WP-100
1 <sup>3</sup> / <sub>8</sub>	2.50	3.00	.63	1.00	.250	6	.312-18 x 1.0" LG	SC-138	WP-138
1 <sup>3</sup> / <sub>4</sub>	3.00	4.00	.63	1.25	.250	8	.312-18 x 1.75 LG	SC-175	WP-175
2	3.50	4.00	.75	1.63	.375	12	.375-16 x 2.25 LG	SC-200	WP-200
2 <sup>1</sup> / <sub>2</sub>	4.00	4.50	.75	1.88	.375	12	.375-16 x 2.50 LG	SC-250	WP-250
3	5.00	5.50	1.00	2.38	.375	12	.500-13 x 3.25 LG	SC-300	WP-300
3 <sup>1</sup> / <sub>2</sub>	5.88	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	SC-350	WP-350
4	6.38	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	SC-400	WP-400

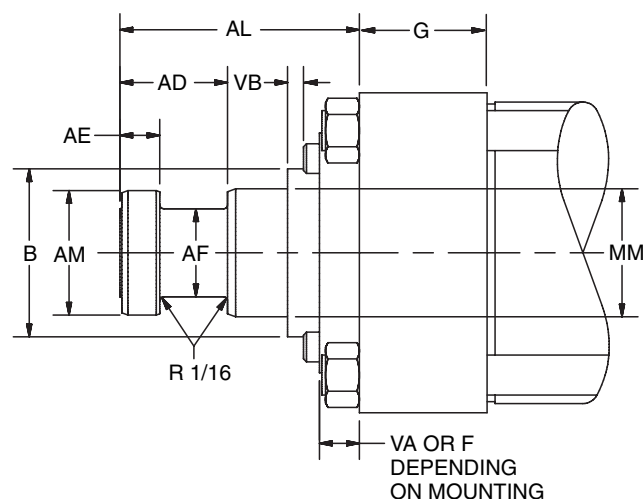
Note: Screws are not included with split coupler or weld plate.

# Atlas “Style 5” Piston Rod End

## Split Flange Coupling Rod End

- Simplifies alignment
- Reduces assembly time
- Allows full rated pneumatic pressure in push and pull directions
- Available in 5/8" through 4" piston rod diameters

### Style 5 Rod End



### Dimensions Style 5 Rod End

MM Rod Dia.	AD	AE	AF	AM	AL
5/8	5/8	1/4	3/8	.57	1 3/4
1	15/16	3/8	11/16	.95	2 1/2
1 3/8	1 1/16	3/8	7/8	1.32	2 3/4
1 3/4	1 5/16	1/2	1 1/8	1.70	3 1/8
2	1 11/16	5/8	1 3/8	1.95	3 3/4
2 1/2	1 15/16	3/4	1 3/4	2.45	4 1/2
3	2 7/16	7/8	2 1/4	2.95	4 7/8
3 1/2	2 11/16	1	2 1/2	3.45	5 5/8
4	2 11/16	1	3	3.95	5 3/4

See cylinder dimension pages for B, F, G, VA and VB per bore and rod diameter.

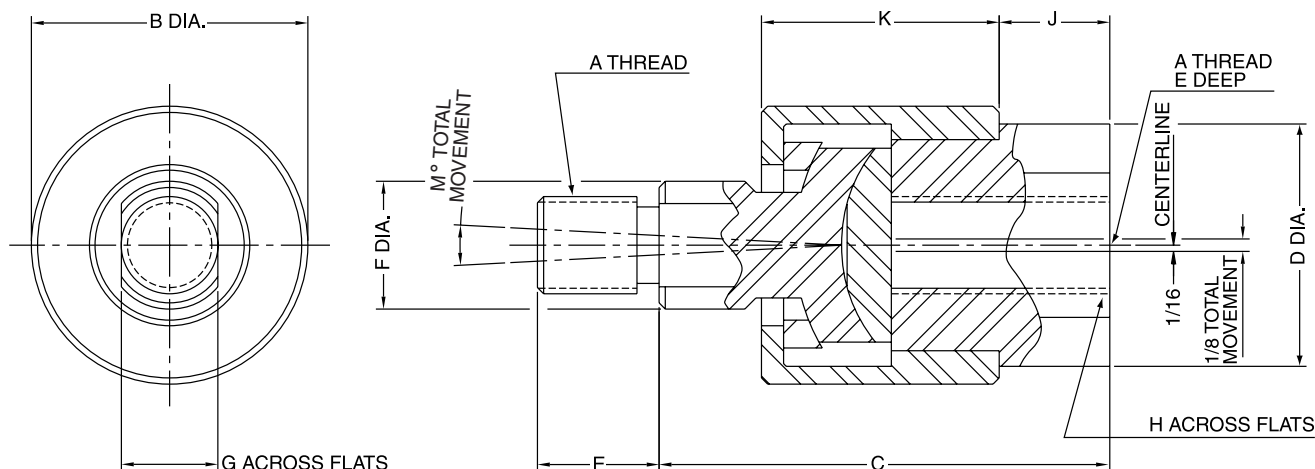
# Linear Alignment Couplers are available in 18 standard thread sizes...

## Cost Saving Features and Benefits Include...

- Maximum reliability for trouble-free operation, long life and lower operating costs
- Simplifying cylinder installation and reducing assembly costs
- Increased cylinder life by reducing wear on piston and rod bearings
- Increase rod bearing and rod seal life for lower maintenance costs

## Alignment Coupler

See Table 1 for Part Numbers and Dimensions



**Table 1 – Part Numbers and Dimensions**

Part No.	A	B	C	D	E	F	G	H	J	K	M	Max. Pull Load (lbs.)	Approx. Weight (lbs.)
RC-3-5	5/16-24	1 1/8	1 3/4	15/16	1/2	1/2	3/8	3/4	3/8	15/16	6°	1200	.35
RC-3-6	3/8-24	1 1/8	1 3/4	15/16	1/2	1/2	3/8	3/4	3/8	15/16	6°	2425	.35
RC-3-7	7/16-20	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	3250	.55
RC-3-8	1/2-20	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	4450	.55
RC-3-10	5/8-18	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	6800	.55
RC-3-12	3/4-16	2	2 5/16	1 5/8	1 1/8	15/16	3/4	1 5/16	7/16	1 9/32	6°	9050	1.4
RC-3-14	7/8-14	2	2 5/16	1 5/8	1 1/8	15/16	3/4	1 5/16	7/16	1 9/32	6°	14450	1.4
RC-3-16	1-14	3 1/8	3	2 3/8	1 5/8	1 7/16	1 1/4	1 7/8	3/4	1 25/32	6°	19425	4.8
RC-3-20	1 1/4-12	3 1/8	3	2 3/8	1 5/8	1 7/16	1 1/4	1 7/8	3/4	1 25/32	6°	30500	4.8
RC-2-24	1 1/2-12	4	4 3/8	2 1/4	2 1/4	1 3/4	1 1/2	1 15/16	7/8	2 3/4	10°	45750	9.8
RC-2-28	1 3/4-12	4	4 3/8	2 1/4	2 1/4	1 3/4	1 1/2	1 15/16	7/8	2 3/4	10°	58350	9.8
RC-2-30	1 7/8-12	5	5 5/8	3	3	2 1/4	1 15/16	2 5/8	1 3/8	3 3/8	10°	67550	19.8
RC-2-32	2-12	5	5 5/8	3	3	2 1/4	1 15/16	2 5/8	1 3/8	3 3/8	10°	77450	19.8
RC-2-36	2 1/4-12	6 3/4	6 3/8	3 1/4	3 1/2	2 3/4	2 3/8	2 7/8	1 5/8	3 3/4	10°	99250	35.3
RC-2-40	2 1/2-12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	123750	45.3
RC-2-44	2 3/4-12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	150950	45.3
RC-2-48	3-12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	180850	45.3
RC-2-52	3 1/4-12	9 1/4	8 1/2	5 1/4	4 1/2	4	3 3/8	4 1/2	2	5 1/2	10°	213450	—

**How to Order Linear Alignment Couplers** — When ordering a cylinder with a threaded male rod end, specify the coupler of equal thread size by part number as listed in Table 1, i.e.; Piston Rod “KK” dimension is 3/4" - 16", specify coupler part number RC-3-12.

## Theoretical Push and Pull Forces

### Push Force and Displacement

Cyl. Bore Size (Inches)	Piston Area (Sq. In.)	Cylinder Push Stroke Force In Pounds At Various Pressures						Cu. Ft. Free Air At 80 Lbs. Pressure, Required To Move Max. Load 1 Inch
		25	50	65	80	100	250	
1½	1.767	44	88	115	142	177	443	.00659
2	3.14	79	157	204	251	314	785	.01171
2½	4.91	123	245	319	393	491	1228	.01830
3¼	8.30	208	415	540	664	830	2075	.03093
4	12.57	314	628	817	1006	1257	3143	.04685
5	19.64	491	982	1277	1571	1964	4910	.07320
6	28.27	707	1414	1838	2262	2827	7068	.10541
7	38.49	962	1924	2502	3079	3849	9623	.14347
8	50.27	1257	2513	3268	4022	5027	12568	.18740
10	78.54	1964	3927	5105	6283	7854	19635	.29280
12	113.10	2828	5655	7352	9048	11310	28275	.42164
14	153.94	3849	7697	10006	12315	15394	38485	.57389

### Deductions for Pull Force and Displacement

Piston Rod Dia. (Inches)	Piston Area (Sq. In.)	Piston Rod Diameter Force In Pounds At Various Pressures						Cu. Ft. Free Air At 80 Lbs. Pressure, Required To Move Max. Load 1 Inch
		To determine Cylinder Pull Force or Displacement, deduct the following Force or Displacement corresponding to Rod Size, from selected Push Stroke Force or Displacement corresponding to Bore Size in table above.						
		25	50	65	80	100	250	
5/8	.307	8	15	20	25	31	77	.00114
1	.785	20	39	51	65	79	196	.00293
1 3/8	1.49	37	75	97	119	149	373	.00554
1 3/4	2.41	60	121	157	193	241	603	.00897
2	3.14	79	157	204	251	314	785	.01171
2 1/2	4.91	123	245	319	393	491	1228	.01830
3	7.07	177	354	460	566	707	1767	.02635
3 1/2	9.62	241	481	625	770	962	2405	.03587
4	12.57	314	628	817	1006	1257	3143	.04685

### General Formula

The cylinder output forces are derived from the formula:

$$F = P \times A$$

Where F = Force in pounds.

P = Pressure at the cylinder in pounds per square inch, gauge.

A = Effective area of cylinder piston in square inches.

Free Air refers to normal atmospheric conditions of the air at sea level (14.7 psi). Use above cu. ft. free air required data to

compute CFM required from a compressor at 80 psi. cu. ft. of free air required at other pressures can be calculated using formula below.

$$V_1 = \frac{(P_2 + 14.7) V_2}{14.7}$$

Where V1 = Free air consumption per inch of stroke (cubic feet).

V2 = Cubic feet displaced per inch of stroke.

P2 = Gauge pressure required to move maximum load.



**Operating Fluids and Temperature Range**

Series A cylinders are equipped with seals for use with lubricated air. In some cases special seals are required.

**Class 1 Seals**

Class 1 seals are the standard seals provided in a cylinder assembly. They are intended for use with fluids such as: air, nitrogen, mineral base hydraulic oil or MIL-H-5606 within the temperature range of -10°F (-23°C) to +165°F (+74°C). The individual seals may be nitrile (Buna-N), enhanced polyurethane, polymyte, PTFE or filled PTFE.

**Class 4 Seals — Nitrile Seals**

Class 4 seals are intended for low temperature service with the same type of fluids as used with Class 1 seals within the temperature range of -50°F (-46°C) to +150°F (+66°C). Class 4 seals are nitrile seals. Lipseals will have leather, polymyte or PTFE back-up washers when required. O-rings will have nitrile back-up washers when required.

Note: Certain fluids may react adversely with Class 4 seals compared to Class 1 seals.

**Class 5 Seals — Fluorocarbon Seals**

Class 5 seals are intended for elevated temperature service. Note: In addition, Class 5 seals can be used with fluids listed below under Class 1 service. Class 5 seals can operate with a temperature range of -10°F (-23°C) to +250°F (+121°C). Fluorocarbon seals may be operated to +400°F (+204°C) with limited service life. For temperatures above +250°F (+121°C) the cylinder must be manufactured with non-studded piston rod thread and a pinned piston to rod connection. Class 5 seals are fluorocarbon seals. Lipseals will have PTFE back-up washers when required. O-rings will have fluorocarbon back-up when required.

**Lipseal Pistons**

Under most conditions lipseals provide the best all around service for pneumatic applications. Lipseals with a back-up washers are often used for hydraulic applications when virtually zero static leakage is required. Lipseals will function properly in these applications when used in conjunction with moderate hydraulic pressures.

**Warning!**

The piston rod stud and the piston rod to piston threaded connections are secured with an anaerobic adhesive which is temperature sensitive. Cylinders specified with fluorocarbon seals are assembled with anaerobic adhesive having a maximum temperature rating of +250°F (+121°C). Cylinders specified with all other seal compounds are assembled with anaerobic adhesive have a maximum operating temperature rating +165°F (+74°C). These temperature limitations are necessary to prevent the possible loosening of the threaded connections. Cylinders originally manufactured with Class 1 seals (Nitrile) that will be exposed to ambient temperatures above +165°F (+74°C) must be modified for higher temperature service. Contact the factory immediately and arrange for the piston to rod and the stud to piston rod connections to be properly reassembled to withstand the higher temperature service.

Class No.	Typical Fluids	Temperature Range
1 Standard Nitrile	Air, Nitrogen Hydraulic Oil, Mil-H-5606 Oil	-10°F (-23°C) to +165°F (+74°C)
4 Special (Nitrile) (At extra cost)	Low Temperature Air	-50°F (-46°C) to +150°F (+66°C)
5 Optional (At extra cost) (Fluorocarbon Seals)	High Temperature	See above paragraph on Fluorocarbon seals for recommended temperature range.

## Ports

Atlas Series A pneumatic cylinders are supplied with NPTF pipe thread ports. If specified on your order, extra ports can be provided on the sides of heads or caps that are not occupied by mountings or cushion valve.

Standard port location is position 1 as shown on line drawings in product catalog and Figure 1 below. Cushion adjustment needle and check valves are at position 2 (or 3), depending on mounting style. Heads or caps which do not have an integral mounting can be rotated and assembled with ports at 90° or 180° from standard position. Mounting styles on which head or cap can be rotated at no extra charge are shown in Table A below. To order, specify by position number. In such assemblies the cushion adjustment needle and check valve rotate accordingly since their relationship with port position does not change.

Figure 1

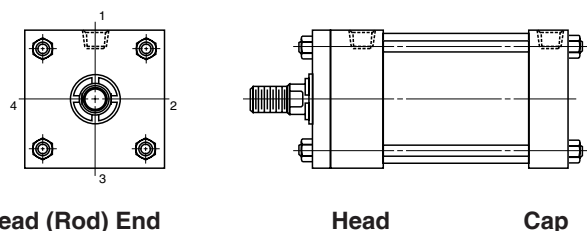


Table A

Model	Port Position Available	
	Head End	Cap End
NM1, NM2, NM3, REF2, BEF2, REF, BEF, REF1, BEF1, TM3	1, 2, 3 or 4	1, 2, 3 or 4
TM2, PB2, SA	1, 2, 3 or 4	1 or 3
TM1	1 or 3	1, 2, 3 or 4
SL, FS	1	1

Ports can be supplied at positions other than those shown in Table A at an extra charge. To order, specify port position as shown in Figure 1.

## International Ports

Other port configurations to meet international requirements are available at extra cost. Atlas Series A cylinders can be supplied, on request, with British standard taper port (BSPT). Such port has a taper of 1 in 16 measured on the diameter ( $1/16$ " per inch). The thread form is Whitworth System, and size and number of threads per inch are as follows:

Table B

British Standard Pipe Threads

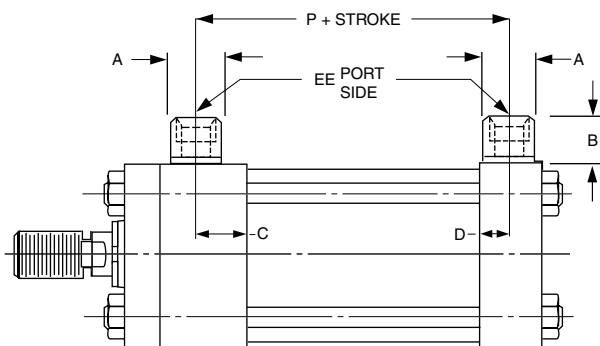
Nominal Pipe Size	No. Threads Per Inch	Pipe O.D.
$1/8$	28	.383
$1/4$	19	.518
$3/8$	19	.656
$1/2$	14	.825
$3/4$	14	1.041
1	11	1.309
$1 1/4$	11	1.650
$1 1/2$	11	1.882
2	11	2.347

British standard parallel internal threads are designated as BSPP and have the same thread form and number of threads per inch as the BSPT type and can be supplied, on request, at extra cost. Unless otherwise specified, the BSPP or BSPT port size supplied will be the same nominal pipe size as the NPTF port for a given bore size cylinder.

Metric ports can also be supplied to order at extra cost. Consult factory.

## Oversize Ports

Oversize NPTF ports can be provided, at an extra charge. For ports one size larger than standard, welded port bosses which protrude from the side of the head or cap are supplied. For dimensions, see drawing below and table.



## Oversize NPTF Port Boss Dimensions

Bore	EE (NPTF)	A (Dia.)	B	C	D	P
$1 1/2$	$1/2$	$1 1/8$	$15/16$	$9/16$	$1/2$	$2 3/16$
2	$1/2$	$1 1/8$	$15/16$	$9/16$	$1/2$	$2 3/16$
$2 1/2$	$1/2$	$1 1/8$	$15/16$	$9/16$	$1/2$	$2 5/16$
$3 1/4$	$3/4$	$1 3/8$	1	$1 1/16$	$5/8$	$2 9/16$
4	$3/4$	$1 3/8$	1	$1 1/16$	$5/8$	$2 9/16$
5	$3/4$	$1 3/8$	1	$1 1/16$	$5/8$	$2 13/16$
6	1	$1 3/4$	$1 3/16$	$15/16$	$3/4$	$3 3/16$
7-8	1	$1 3/4$	$1 3/16$	$15/16$	$3/4$	$3 5/16$
10	$1 1/4$	$2 1/4$	$1 5/16$	$1 1/8$	1	$4 1/4$
12	$1 1/4$	$2 1/4$	$1 5/16$	$1 1/8$	1	$4 3/4$
14	$1 1/2$	$2 1/2$	$1 9/16$	$1 1/4$	$1 1/8$	$5 1/2$

## Stroke Tolerance

Stroke length tolerances are required due to buildup of tolerances of piston, head, cap and cylinder body. Standard production stroke tolerances run  $+1/32"$  to  $-1/64"$  up to 20" stroke,  $+1/32"$  to  $-.20"$  for 21" to 60" and  $+1/32"$  to  $-1/32"$  for greater than 60" stroke. For closer tolerances on stroke length, it is necessary to specify the required tolerance plus the operating pressure

and temperature at which the cylinder will operate. Stroke tolerances smaller than .015" are not generally practical due to elasticity of cylinders. If machine design requires such close tolerances, use of a stroke adjuster may achieve the desired result.

## Cylinder Weights

The weights shown in Table A are for Atlas Series A and AL cylinders with various piston rod diameters. To determine the net weight of a cylinder, first select the proper basic weight for zero stroke, then calculate the weight of the cylinder stroke and add the result to the basic weight. For extra rod extension, use piston

rod weights per inch shown in Table B. Weights of cylinders with intermediate rods may be estimated from table below by taking the difference between the piston rod weights per inch and adding it to the standard rod diameter weight for the cylinder bore size involved.

**Table A** Cylinder Weights, in pounds, for Series A & AL cylinders

Bore Size	Rod Dia.	Single Rod Cylinders Basic Wt. Zero Stroke		Add Per Inch of Stroke	Double Rod Cylinders Basic Wt. Zero Stroke		Add Per Inch of Stroke
		NM1, NM2, NM3, REF2, BEF2, REF, BEF, FS	REF1, BEF1, SL, TM1, TM2, PB2, TM3, SA		XNM1, XNM3, XREF2, XFS	XREF2, XSL, XTM1, XTM3	
1 1/2"	5/8"	3.7	4.3	.3	4.2	4.8	.6
	1"	4.5	5.1	.4	5.8	6.7	.8
2"	5/8"	6.5	6.9	.5	8.2	8.6	1.0
	1"	7.0	7.5	.63	9.0	9.5	1.3
	1 3/8"	8.5	8.9	.8	11.2	11.6	1.6
2 1/2"	5/8"	9.0	9.7	.6	11.4	12.1	1.2
	1"	9.5	10.0	.73	12.0	12.5	1.5
	1 3/4"	13.2	13.6	1.1	19.8	20.5	2.2
3 1/4"	1"	16.5	17.5	.8	22.0	23.0	1.6
	1 3/8"	17.0	18.0	1.0	22.5	23.5	2.0
	2"	27.0	28.0	1.4	43.0	44.0	2.8
4"	1"	26.0	31.0	1.0	33.0	38.0	2.0
	1 3/8"	26.5	31.5	1.2	33.5	38.5	2.5
	2 1/2"	36.0	42.0	2.0	53.0	58.0	4.0
5"	1"	39.0	46.0	1.1	48.0	55.0	2.2
	1 3/8"	39.5	46.5	1.3	48.5	55.5	2.6
	2"	40.0	57.0	1.7	59.0	66.0	3.4
6"	1 3/8"	68.0	77.0	1.5	80.0	89.0	3.0
	2 1/2"	78.0	87.0	2.3	88.0	107.0	4.5
7"	1 3/8"	80.0	85.0	2.0	92.0	97.0	4.0
	2"	82.0	87.0	3.5	96.0	101.0	7.0
8"	1 3/8"	94.0	99.0	2.0	108.0	113.0	4.0
	2 1/2"	104.0	109.0	2.8	126.0	131.0	5.5
10"	1 3/4"	182.0	188.0	2.5	178.0	184.0	5.0
	2 1/2"	190.0	196.0	3.1	193.0	199.0	6.5
12"	2"	274.0	282.0	3.5	270.0	280.0	7.0
	3 1/2"	290.0	298.0	5.3	302.0	312.0	10.6
14"	2 1/2"	435.0	448.0	4.5	440.0	655.0	9.0
	4"	456.0	469.0	6.7	482.0	697.0	13.4

**Table B**

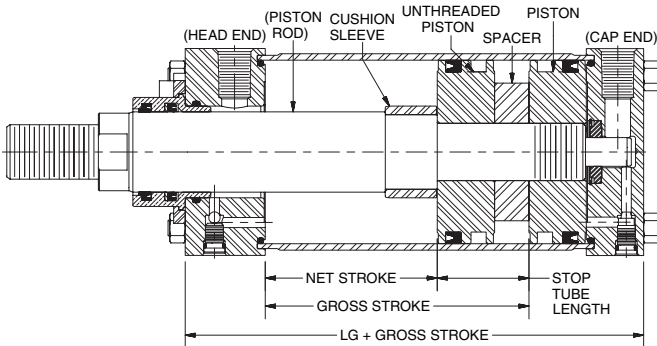
Rod Dia.	Piston Rod Wt. Per Inch	Rod Dia.	Piston Rod Wt. Per Inch	Rod Dia.	Piston Rod Wt. Per Inch
5/8"	.09	1 3/4"	.68	3"	2.00
1"	.22	2"	.89	3 1/2"	2.72
1 3/8"	.42	2 1/2"	1.40	4"	3.56

Stop Tubing

Stop tube is recommended to lengthen the distance between the bushing and piston to reduce bearing loads when the cylinder is fully extended. This is especially true of horizontally mounted and long stroke cylinders. Long stroke cylinders achieve additional stability through the use of a stop tube.

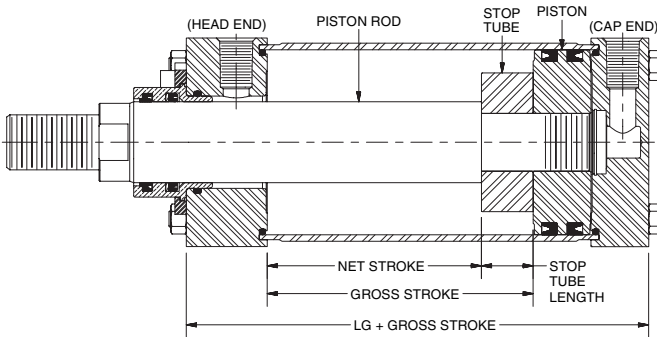
When specifying cylinders with long stroke and stop tube, be sure to call out the net stroke and the length of the stop tube. Machine design can be continued without delay by laying in a cylinder equivalent in length to the NET STROKE PLUS STOP TUBE LENGTH, which is referred to as GROSS STROKE.

Drawing A



Double piston design is supplied on air cylinders with cushion head end or both ends.

Drawing B



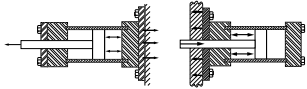
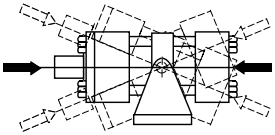
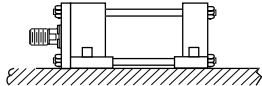
This design is supplied on all non-cushion cylinders.

Mounting Classes

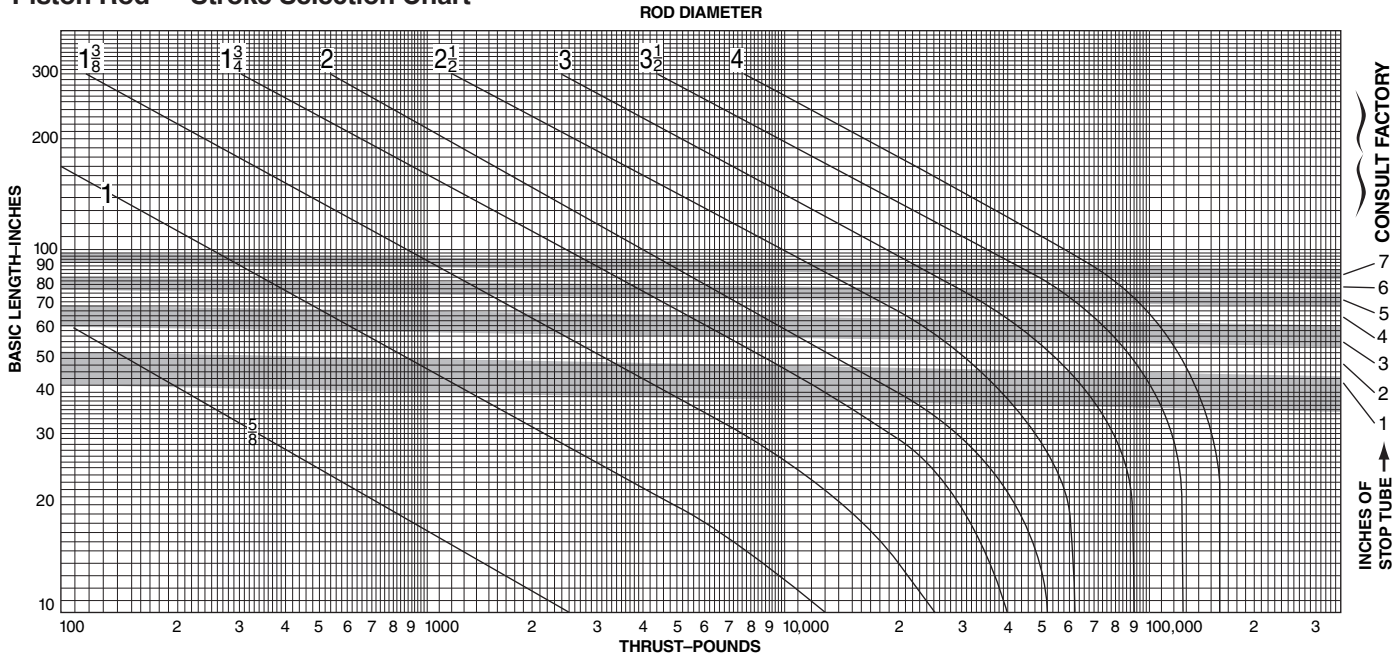
Standard mountings for fluid power cylinders fall into three basic groups. The groups can be summarized as follows:

- Group 1** Straight Line Force Transfer with fixed mounts which absorb force on cylinder centerline.
- Group 2** Pivot Force Transfer. Pivot mountings permit a cylinder to change its alignment in one plane.
- Group 3** Straight Line Force Transfer with fixed mounts which do not absorb force on cylinder centerline.

Because a cylinder's mounting directly affects the maximum pressure at which the cylinder can be used, the chart below should be helpful in selection of the proper mounting combination for your application. Stroke length, piston rod connection to load, extra piston rod length over standard, etc., should be considered for thrust loads. Alloy steel mounting bolts are recommended for all mounting styles, and thrust keys are recommended for Group 3.

Group 1 FIXED MOUNTS which absorb force on cylinder centerline.	
<b>Heavy-Duty Service</b> For Thrust Loads For Tension Loads	 Style NM2 Style NM3
<b>Medium-Duty Service</b> For Thrust Loads For Tension Loads	Styles BEF1, BEF2 Styles REF1, REF2
<b>Light-Duty Service</b> For Thrust Loads For Tension Loads	Style BEF2 Style REF2
Group 2 PIVOT MOUNTS which absorb force on cylinder centerline.	
<b>Heavy-Duty Service</b> For Thrust Loads For Tension Loads	 Styles TM1, TM3 Styles TM1, TM2, PB2, TM3
<b>Medium-Duty Service</b> For Thrust Loads For Tension Loads	Style PB2 Style PB2
Group 3 FIXED MOUNTS which do not absorb force on the centerline.	
<b>Heavy-Duty Service</b> For Thrust Loads For Tension Loads	 Style SL Style SL
<b>Medium-Duty Service</b> For Thrust Loads For Tension Loads	Style FS Style FS

**Piston Rod — Stroke Selection Chart**



**How to Use the Chart**

The selection of a piston rod for thrust (push) conditions requires the following steps:

1. Determine the type of cylinder mounting style and rod end connection to be used. Then consult the chart below and find the "stroke factor" that corresponds to the conditions used.
2. Using this stroke factor, determine the "basic length" from the equation:

$$\text{Basic Length} = \frac{\text{Actual Stroke}}{\text{Stroke Factor}}$$

The graph is prepared for standard rod extensions beyond the face of the gland retainers. For rod extensions greater than standard, add the increase to the stroke in arriving at the "basic length."

3. Find the load imposed for the thrust application by multiplying the full bore area of the cylinder by the system pressure.
4. Enter the graph along the values of "basic length" and "thrust" as found above and note the point of intersection:

- A) The correct piston rod size is read from the diagonally curved line labeled "Rod Diameter" next *above* the point of intersection.
- B) The required length of stop tube is read from the right of the graph by following the shaded band in which the point of intersection lies.
- C) If required length of stop tube is in the region labeled "consult factory," submit the following information for an individual analysis:
  - 1) Cylinder mounting style.
  - 2) Rod end connection and method of guiding load.
  - 3) Bore, required stroke, length of rod extension (Dim. "LA") if greater than standard, and series of cylinder used.
  - 4) Mounting position of cylinder. (Note: If at an angle or vertical, specify direction of piston rod.)
  - 5) Operating pressure of cylinder if limited to less than standard pressure for cylinder selected.

Recommended Mounting Styles for Maximum Stroke and Thrust Loads	Rod End Connection	Case	Stroke Factor
<b>Groups 1 or 3</b> Long stroke cylinders for thrust loads should be mounted using a heavy-duty mounting style at one end, firmly fixed and aligned to take the principal force. Additional mounting should be specified at the opposite end, which should be used for alignment and support. An intermediate support may also be desirable for long stroke cylinders mounted horizontally. Machine mounting pads can be adjustable for support mountings to achieve proper alignment.	Fixed and Rigidly Guided	I	.50
	Pivoted and Rigidly Guided	II	.70
	Supported but not Rigidly Guided	III	2.00
<b>Group 2</b> Style TM1 — Trunnion on Head	Pivoted and Rigidly Guided	IV	1.00
Style TM3 — Intermediate Trunnion	Pivoted and Rigidly Guided	V	1.50
Style TM2 — Trunnion on Cap or Style PB2 — Clevis on Cap	Pivoted and Rigidly Guided	VI	2.00



Cushion ratings for **air cylinders only** are described in Table B-7 and Graph B-3. To determine whether a cylinder will adequately stop a load without damage to the cylinder, the weight of the load (including the weight of the piston and the piston rod from Table B-6) and the maximum speed of the piston rod must first be determined. Once these two factors are known, the Kinetic Energy Graph may be used. Enter the graph at its base for the value of weight determined, and project vertically to the required speed value. The point of intersection of these two lines will be the cushion rating number required for the application.

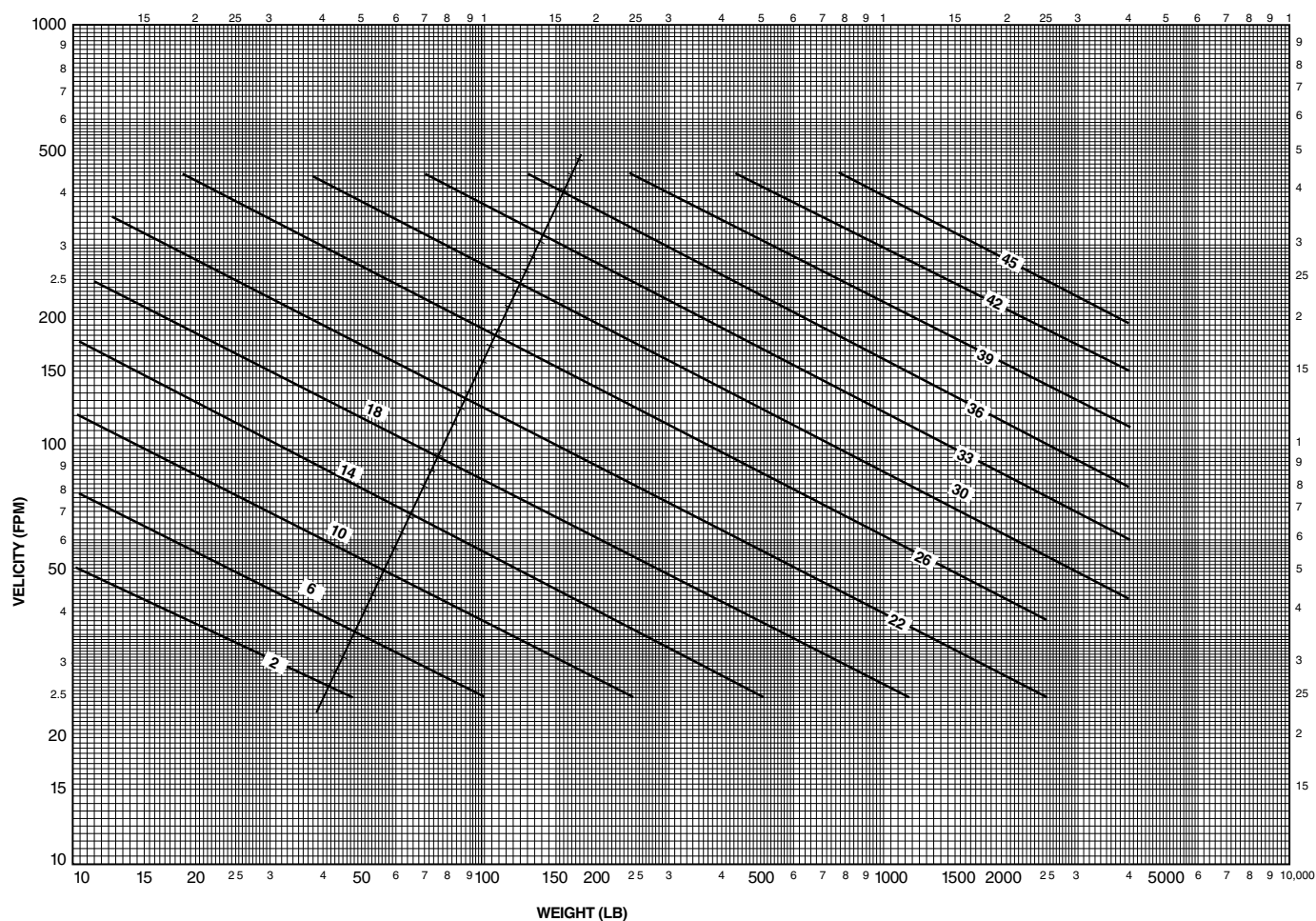
To determine the total load to be moved, the weight of the piston and rod must be included.

Total Weight = Weight of the piston and non-stroke rod length (Column 1) + weight of the rod per inch of stroke x the inches of stroke (Column 2) + the load to be moved.

**Table B-6 — Weight**

Bore Dia.	Column 1 Basic Wgt. (Lbs.) for Piston & Non-Stroke Rod	Rod Dia.	Column 2 Basic Wgt. (Lbs.) for 1" Stroke
1½	1.5	5/8	.087
2	3.0	1	.223
2½	5.4	1⅜	.421
3¼	8.3	1¾	.682
4	14.2	2	.89
5	29	2½	1.39
6	41	3	2.0
8	89	3½	2.73
10	115	4	3.56
12	161		
14	207		

Example: A 3-1/4" bore cylinder, having a 1" diameter rod and 25" stroke; load to be moved is 85 lbs. Total load to be moved is then 8.3 lbs. + .223 lbs./in. x 25 in. + 85 lbs. or a total of 99 lbs.

**Graph B3 — Kinetic Energy — Air Cylinders**

Now refer to Table B-7 and find the cushion ratings, using bore size and rod diameter of the cylinder selected. If a simple circuit is used, with no meter out or speed control, use the “no back pressure, Column A” values. If a meter out or speed control is to be used, use the back pressure column values. If the cushion rating found in Table B-7 (below) is **greater** than the number determined in Graph B-3, then

the cylinder will stop the load adequately. If the cushion rating in Table B-7 is **smaller** than the number found in Graph B-3, then a larger bore cylinder should be used. In those applications where back pressures exist in the exhaust lines, it is possible to exceed the cushion ratings shown in Table B-7. In these cases, consult the factory and advise the amount of back pressure.

**Table B-7 — Air Cylinder Cushion Ratings**

Bore Diameter	Rod Diameter	Rating with No Back Pressure	Rating with Back Pressure
1½	Cap End	12	17
	5/8	8	14
	1	3	8
2	Cap End	14	20
	5/8	12	18
	1	9	15
	1⅜	6	11
2½	Cap End	17	23
	5/8	14	20
	1	14	19
	1⅜	12	18
	1¾	8	13
3¼	Cap End	21	26
	5/8	18	24
	1⅜	17	23
	1¾	16	22
	2	13	19
4	Cap End	23	28
	1	20	27
	1⅜	20	26
	1¾	19	25
	2	17	23
	2½	17	22
5	Cap End	26	31
	1	23	28
	1⅜	23	28
	1¾	22	28
	2	20	26
6	Cap End	26	31
	1⅜	26	31
	1¾	26	31
	2	24	29
	2½	24	29
7	Cap End	28	33
	1⅜	28	33
	1¾	28	33
	2	26	31

Bore Diameter	Rod Diameter	Rating with No Back Pressure	Rating with Back Pressure
8	Cap End	29	35
	1⅜	29	35
	1¾	29	34
	2	27	33
	2½	26	32
10	Cap End	33	39
	1¾	32	38
	2	31	37
	2½	31	36
	3	30	36
12	Cap End	35	41
	2	33	39
	2½	33	38
	3	33	38
	3½	32	38
14	Cap End	38	43
	2½	37	42
	3	36	42
	3½	36	41
	4	36	41

**Air Requirement per Inch of Cylinder Stroke**

The amount of air required to operate a cylinder is determined from the volume of the cylinder and its cycle in strokes per minute. This may be determined by use of the following formulae which apply to a single-acting cylinder.

$$V = \frac{3.1416 L D^2}{4}$$

$$C = \frac{fV}{1728}$$

Where: V = Cylinder volume, cu. in.

L = Cylinder stroke length, in.

D = Internal diameter of cylinder in.

C = Air required, cfm

f = Number of strokes per minute

The air requirements for double-acting cylinder is almost double that of a single-acting cylinder, except for the volume of the piston rod.



The air flow requirements of a cylinder in terms of cfm should not be confused with compressor ratings which are given in terms of free air. If compressor capacity is involved in the consideration of cylinder air requirements it will be necessary to convert cfm values to free air values. This relationship varies for different gauge pressures.

Thrust (lbs.) = Operating Pressure x Area of Cylinder Bore

**Note:** On the "out" stroke the air pressure is working on the entire piston area, but on the "in" stroke the air pressure works on the piston area less the rod area.

Graph B-4 and B-5 offer a simple means to select pneumatic components for dynamic cylinder applications. It is only necessary to know the force required, the desired speed and the pressure which can be maintained at the inlet to the F-R-L "Combo." The graphs assume average

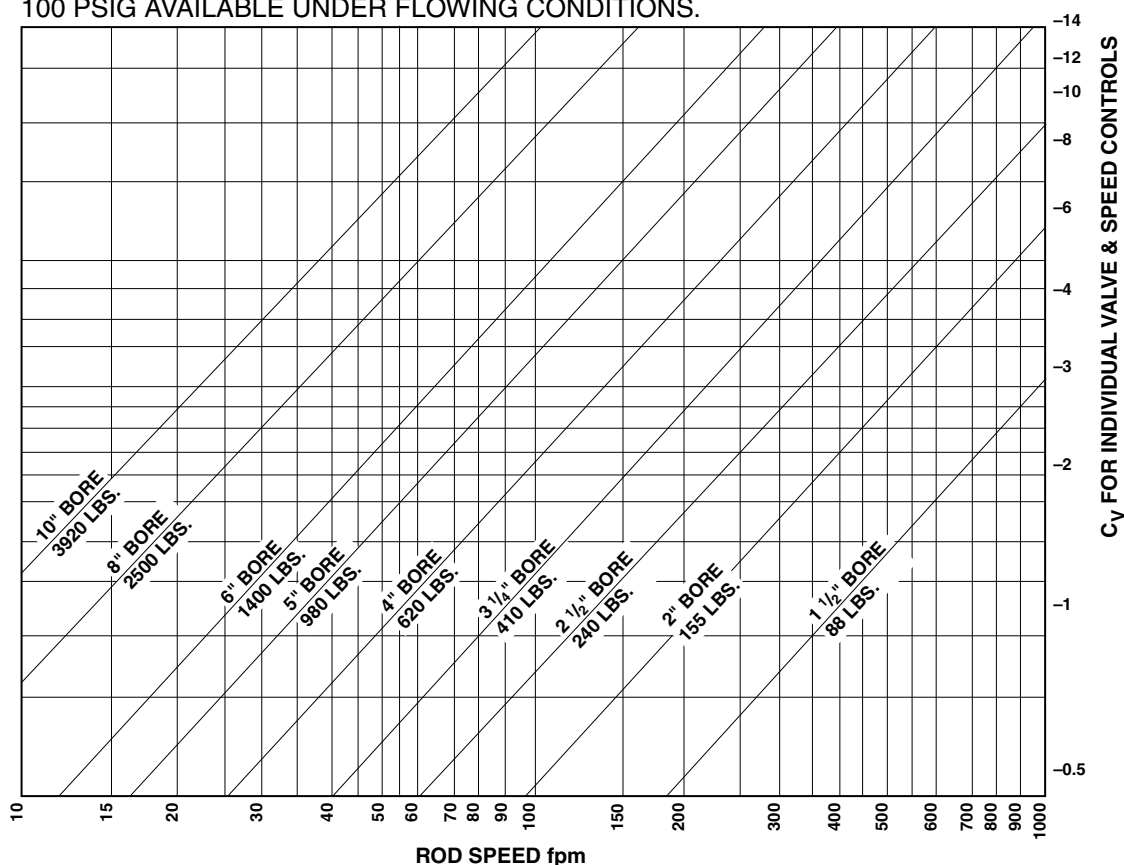
conditions relative to air line sizes, system layout, friction, etc. At higher speeds, consider appropriate cushioning of cylinders.

The general procedure to follow when using these graphs is:

1. Select the appropriate graph depending upon the pressure which can be maintained to the system — Graph B-4 for 100 psig and Graph B-5 for 80 psig.
2. Determine appropriate cylinder bore. Values underneath the diagonal cylinder bore lines indicate the maximum recommended dynamic thrust developed while the cylinder is in motion. The data in the table at the bottom of each graph indicates available static force for applications in which clamping force is a prime consideration in determining cylinder bore.

**Graph B-4 — This graph is determined by having 100 psig available under flowing conditions.**

THIS GRAPH IS DETERMINED BY HAVING  
100 PSIG AVAILABLE UNDER FLOWING CONDITIONS.



**Table B-8 — Thrust Developed**

Bore Size	1½	2	2½	3¼	4	5	6	8	10
Dynamic Thrust (lbs.)	88	155	240	410	620	980	1400	2500	3920
Static Thrust (lbs.)	177	314	491	830	1250	1960	2820	5020	7850

3. Read upward on appropriate rod speed line to intersection with diagonal cylinder bore line. Read right from intersection point to determine the required  $C_v$  of the valve and the speed controls. Both the valve and speed controls must have this  $C_v$ .

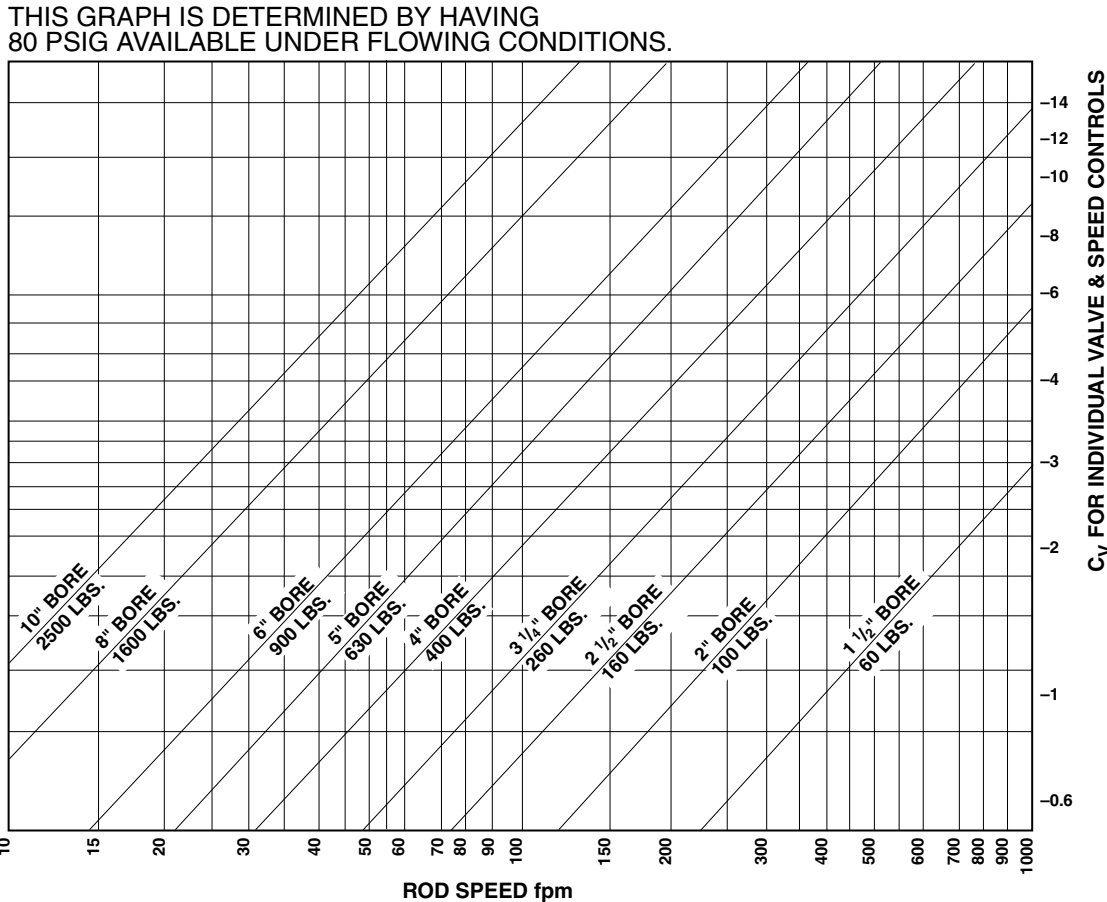
The following examples illustrate use of the graphs:

**Example 1:** Assume it is necessary to raise a 900 lb. load 24 inches in two seconds. With 100 psig maintained at the inlet to the F-R-L, use Graph B-4. The 5-inch bore cylinder is capable of developing the required thrust while in motion. Since 24 inches in two seconds is equal to 60 fpm, read upward on the 60 fpm line to the intersection of the 5-inch bore diagonal line. Reading to the right indicates that the required valve and speed controls must each have a  $C_v$  of over 1.9.

**Example 2:** Assume similar conditions to Example 1, except that only 80 psig will be available under flowing conditions. Using Graph B-5, a 6-inch bore cylinder is indicated. Read upward on the 60 fpm line to the intersection point. Interpolation of the right-hand scale indicates a required valve and speed control  $C_v$  of over 2.8.

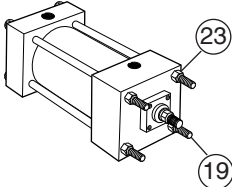
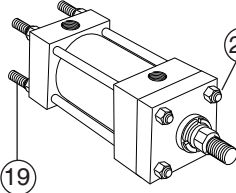
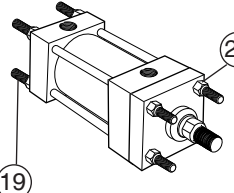
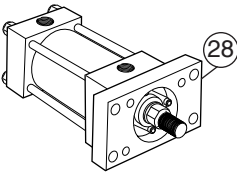
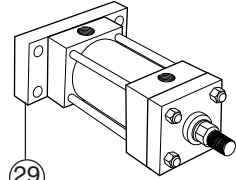
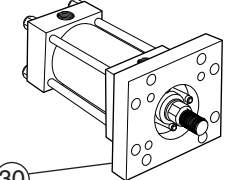
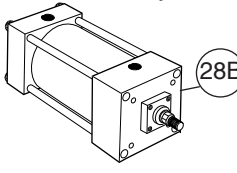
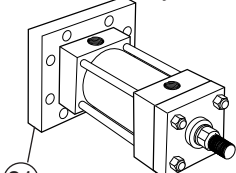
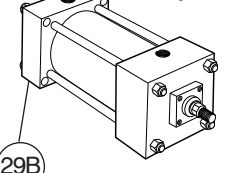
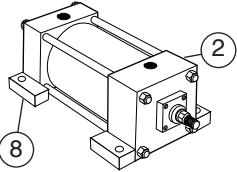
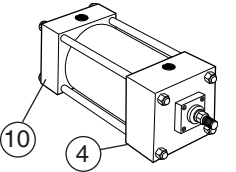
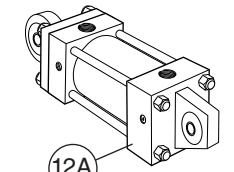
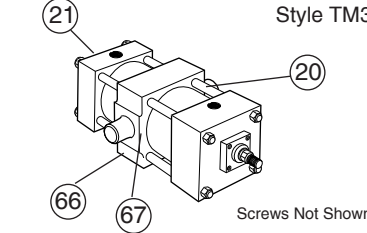
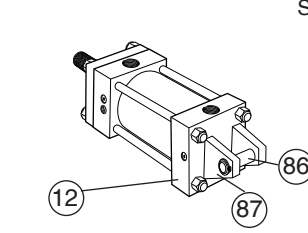
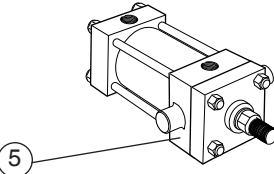
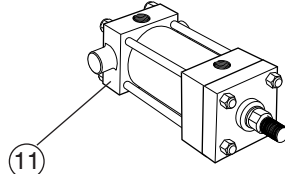
**Example 3:** Assume similar conditions to Example 1, except that the load is being moved in a horizontal plane with a coefficient of sliding friction of 0.2. Only a 180 lb. thrust is now required (900 lb. x 0.2). Consult Graph B-4. The 2½ inch bore cylinder will develop sufficient thrust, and at 60 fpm requires a valve and speed control  $C_v$  of about 0.5.

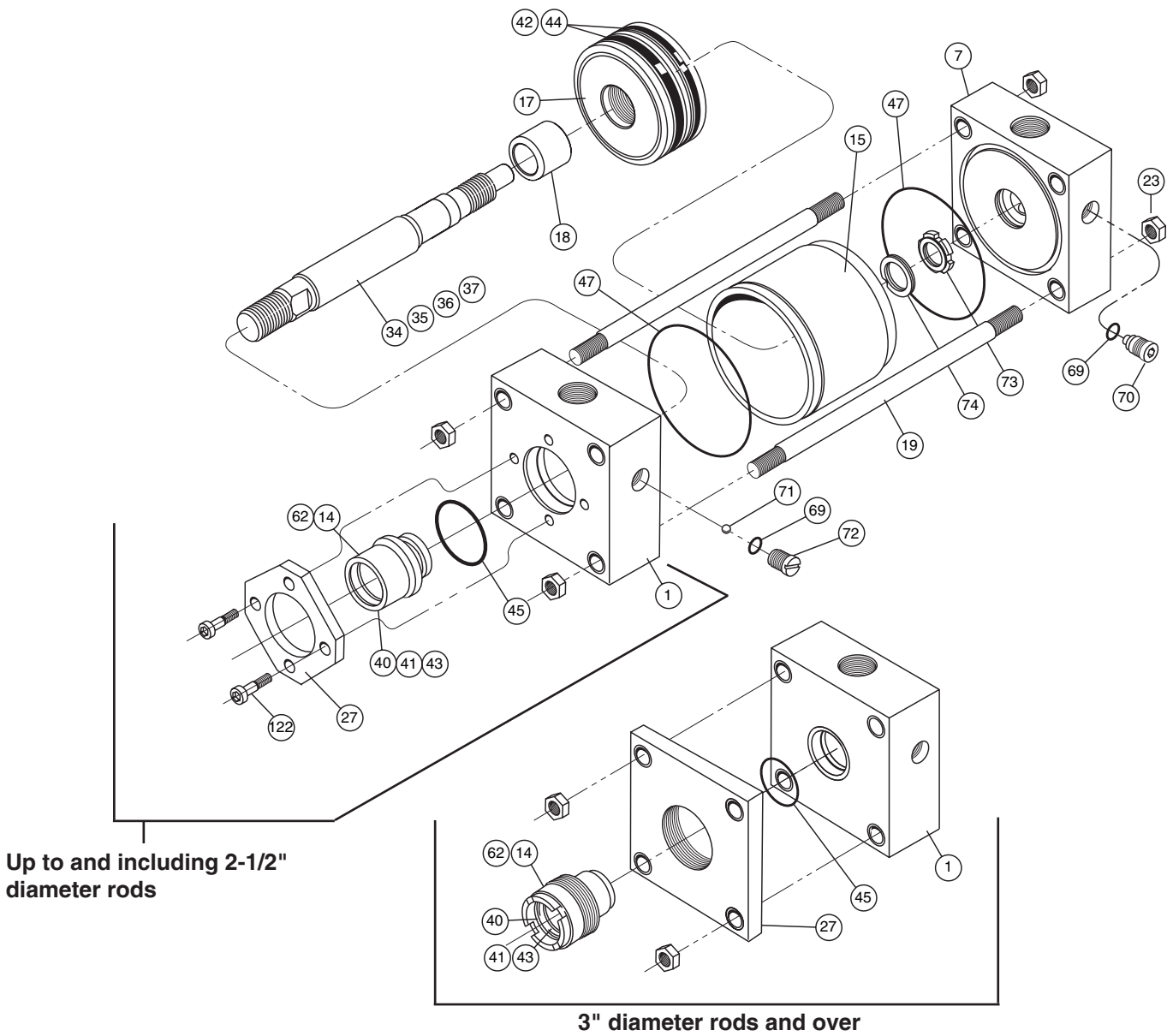
**Graph B-5 — This graph is determined by having 80 psig available under flowing conditions.**



**Table B-9 — Thrust Developed**

Bore Size	1½	2	2½	3¼	4	5	6	8	10
Dynamic Thrust (lbs.)	60	100	160	260	400	630	900	1600	2500
Static Thrust (lbs.)	141	251	393	663	1000	1570	2260	4010	6280

 <p>Style NM3</p>	 <p>Style NM2</p>	 <p>Style NM1</p>	<h2>Replacement Mountings &amp; Hardware</h2> <table><thead><tr><th>Symbol</th><th>Description</th></tr></thead><tbody><tr><td>2</td><td>Head, side lug mount</td></tr><tr><td>4</td><td>Head, side tap mount</td></tr><tr><td>5</td><td>Head, trunnion mount</td></tr><tr><td>8</td><td>Cap, side lug mount</td></tr><tr><td>10</td><td>Cap, side tap mount</td></tr><tr><td>11</td><td>Cap, trunnion mount</td></tr><tr><td>12</td><td>Cap, fixed clevis mount</td></tr><tr><td>12A</td><td>Cap, fixed eye,with spherical bearing</td></tr><tr><td>19</td><td>Tie rod</td></tr><tr><td>20</td><td>Tie rod, head end mount</td></tr><tr><td>21</td><td>Tie rod, cap end mount</td></tr><tr><td>23</td><td>Tie rod nut</td></tr><tr><td>28</td><td>Flange, rectangular, head mount</td></tr><tr><td>28B</td><td>Head, square mount</td></tr><tr><td>29</td><td>Flange, rectangular, cap mount</td></tr><tr><td>29B</td><td>Cap, square mount</td></tr><tr><td>30</td><td>Flange, square, head mount</td></tr><tr><td>31</td><td>Flange, square, cap mount</td></tr><tr><td>66</td><td>Intermediate trunnion</td></tr><tr><td>67</td><td>Screws, intermediate trunnion mount</td></tr><tr><td>86</td><td>Clevis pin</td></tr><tr><td>87</td><td>Retaining ring for clevis pin</td></tr></tbody></table>	Symbol	Description	2	Head, side lug mount	4	Head, side tap mount	5	Head, trunnion mount	8	Cap, side lug mount	10	Cap, side tap mount	11	Cap, trunnion mount	12	Cap, fixed clevis mount	12A	Cap, fixed eye,with spherical bearing	19	Tie rod	20	Tie rod, head end mount	21	Tie rod, cap end mount	23	Tie rod nut	28	Flange, rectangular, head mount	28B	Head, square mount	29	Flange, rectangular, cap mount	29B	Cap, square mount	30	Flange, square, head mount	31	Flange, square, cap mount	66	Intermediate trunnion	67	Screws, intermediate trunnion mount	86	Clevis pin	87	Retaining ring for clevis pin
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10	Cap, side tap mount																																																
11	Cap, trunnion mount																																																
12	Cap, fixed clevis mount																																																
12A	Cap, fixed eye,with spherical bearing																																																
19	Tie rod																																																
20	Tie rod, head end mount																																																
21	Tie rod, cap end mount																																																
23	Tie rod nut																																																
28	Flange, rectangular, head mount																																																
28B	Head, square mount																																																
29	Flange, rectangular, cap mount																																																
29B	Cap, square mount																																																
30	Flange, square, head mount																																																
31	Flange, square, cap mount																																																
66	Intermediate trunnion																																																
67	Screws, intermediate trunnion mount																																																
86	Clevis pin																																																
87	Retaining ring for clevis pin																																																
 <p>Style REF2</p>	 <p>Style BEF2</p>	 <p>Style REF1</p>																																															
 <p>Style REF</p> <p>7" thru 14" Bore</p>	 <p>Style BEF1</p>	 <p>Style BEF</p> <p>7" thru 14" Bore</p>																																															
 <p>Style SL</p>	 <p>Style FS</p>	 <p>Style SA</p>																																															
 <p>Style TM3</p> <p>Screws Not Shown</p>	 <p>Style PB2</p>																																																
 <p>Style TM1</p>	 <p>Style TM2</p>																																																
<h3>How to Order</h3> <p>Give cylinder model number, bore, stroke, serial number and symbol number shown above to insure proper replacement.</p>																																																	



Parts		Assemblies (Includes Symbol Numbers Shown)		
Symbol	Description	Symbol	Description	Lipseal Type Piston
1	Head, ported, non-cushioned	C1SA	Head, ported, cushioned	1, 69, 70, 71 & 72
7	Cap, ported, non-cushioned	C7SA	Cap, ported, cushioned	7, 69, 70, 73 & 74
14	Gland	62	Rod gland kit	14, 40, 41, 43 & 45
15	Tube	—	—	—
17	Piston, lipseal type	—	—	—
18	Cushion sleeve, cushioned cylinder only	—	—	—
19	Tie rod	—	—	—
23	Tie rod nut	—	—	—
27	Retainer	—	—	—
34	Piston rod, single rod type, non-cushioned	34SA	Piston & rod assembly, single rod type — non-cushioned	17, 34, 42 & 44
35	Piston rod, single rod type, cushioned head end	35SA	Piston & rod assembly, single rod type — cush. head end	17, 18, 35, 42 & 44
36	Piston rod, single rod type, cushioned cap end	36SA	Piston & rod assembly, single rod type — cush. cap end	17, 36, 42 & 44
37	Piston rod, single rod type, cushioned both ends	37SA	Piston & rod assembly, single rod type — cush. both ends	17, 18, 37, 42 & 44
40	Rod wiper	—	Seal Kits	—
41	Rod seal	—		—
42	Piston seal	—		—
43	Back-up washer, gland	—		—
44	Back-up washer, piston	—		—
45	O-ring, gland to head seal	—		—
47	O-ring, cylinder tube end seal	—		—
69	O-ring, cushion adjustment & check valve screw	—	Cushion Kits See table below.	—
70	Needle valve, cushion adjustment	—		—
71	Ball, check valve	—		—
72	Plug screw, check valve	—		—
73	Cushion bushing, cap end floating check valve	—		—
74	Retaining ring, floating cushion bushing	—		—
121	Piston Wear Ring	—		—
122	Socket cap screws	—		—

## Standard Design Cushion Hardware Kits

### Cushion Hardware Kits\*

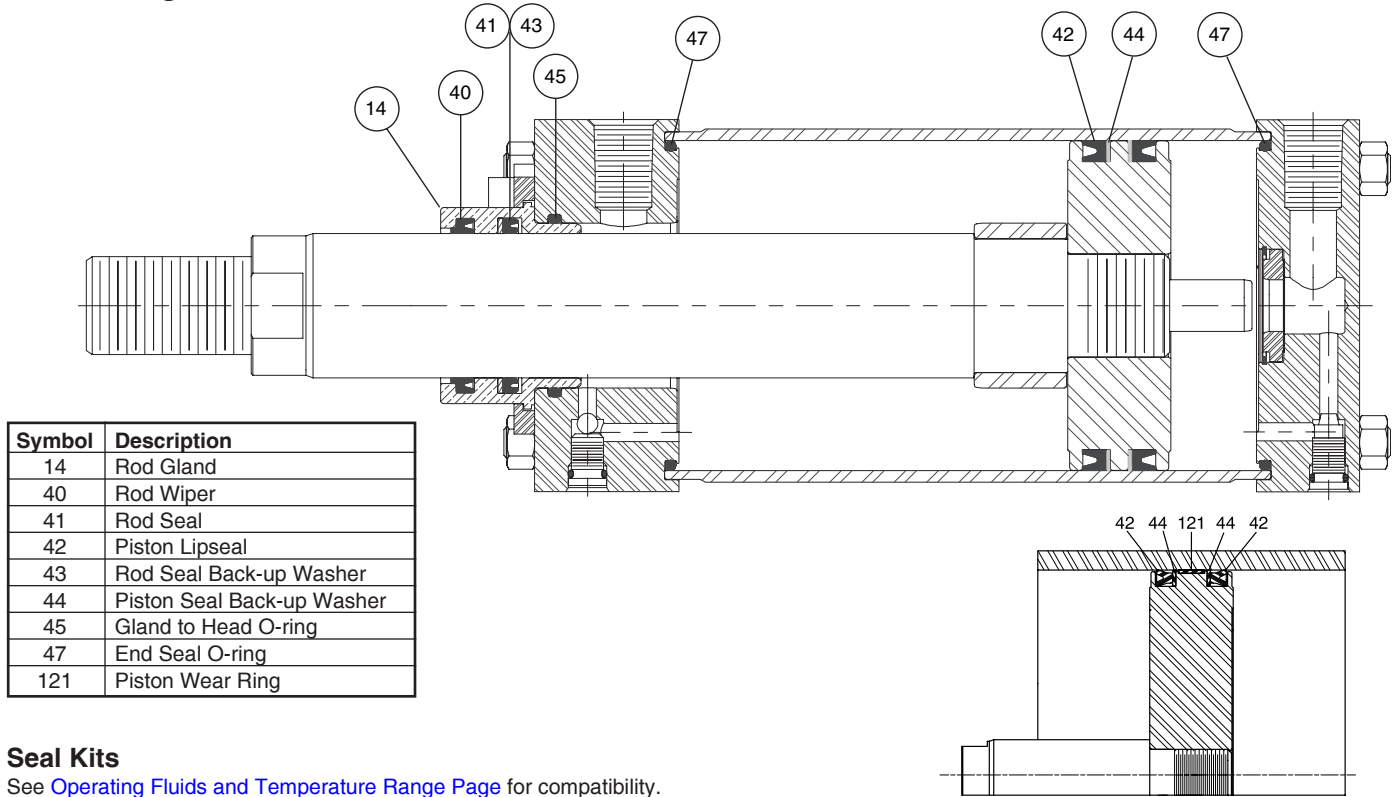
Bore Size	Rod Dia.	For Head Assemblies	For Cap Assemblies
1 1/2	5/8	ACUKH518	ACUKC522
	1	ACUKH518M	
2	5/8, 1	ACUKH518	ACUKC522
	1 3/8	ACUKH518M	
2 1/2	5/8 - 1 3/8	ACUKH518	ACUKC522
	1 3/4	ACUKH518M	
3 1/4	All	ACUKH519	ACUKC523
4	All	ACUKH519	ACUKC523
5	All	ACUKH519	ACUKC523
6	All	ACUKH521	ACUKC524
7	All	ACUKH521	ACUKC524
8	All	ACUKH521	ACUKC524
10	All	ACUKH521	ACUKC525
12	All	ACUKH521	ACUKC526
14	All	ACUKH521	ACUKC527

### Micro-Adjust Cushion Hardware Kits\*

Bore Size	Rod Dia.	For Head and Cap Assemblies
1 1/2 - 2 1/2	All	AMAKHC15
3 1/4 - 14	All	AMAKHC25

\* Cushion kits contain fluorocarbon seals and are suitable for class 1 & 5 service.

**1½" through 14" Bore Sizes**



**Seal Kits**

See [Operating Fluids and Temperature Range Page](#) for compatibility.

**Rod Gland and Rod Seal Kits**

Rod Dia.	Class 1 Nitrile		Class 5 Fluorocarbon		Gland Wrench	Spanner Wrench	Retainer Screw Torque Inch Lbs. (-0%, +5% tolerance)
	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, 43 & 45)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, 43 & 45)	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, 43 & 45)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, 43 & 45)			
5/8	BH06RA000	BH06SA000	VH06RA000	VH06SA000	Not Required	Not Required	15
1	BH10RA000	BH10SA000	VH10RA000	VH10SA000			15
1 3/8	BH13RA000	BH13SA000	VH13RA000	VH13SA000			60
1 3/4	BH17RA000	BH17SA000	VH17RA000	VH17SA000			120
2	BH20RA000	BH20SA000	VH20RA000	VH20SA000			120
2 1/2	BH25RA000	BH25SA000	VH25RA000	VH25SA000			120
3	BH30RA000	BH30SA000	VH30RA000	VH30SA000	0695960000	0116770000	240
3 1/2	BH35RA000	BH35SA000	VH35RA000	VH35SA000	0695970000	0116770000	240
4	BH40RA000	BH40SA000	VH40RA000	VH40SA000	0695980000	0116780000	240

**Piston Seal Kits**

Bore Size	Class 1 Nitrile	Class 5 Fluorocarbon	Tie Rod Nut Specification Foot Lbs.* (-0%, +5% tolerance)
	Piston Seal Kits (Contains: 2 Each Sym. #42, 44, 47)	Piston Seal Kits (Contains: 2 Each Sym. #42, 44, 47)	
1 1/2	BH00LA015	VH00LL015	5
2	BH00LA020	VH00LL020	11
2 1/2	BH00LA025	VH00LL025	11
3 1/4	BH00LA032	VH00LL032	25
4	BH00LA040	VH00LL040	25
5	BH00LA050	VH00LL050	60

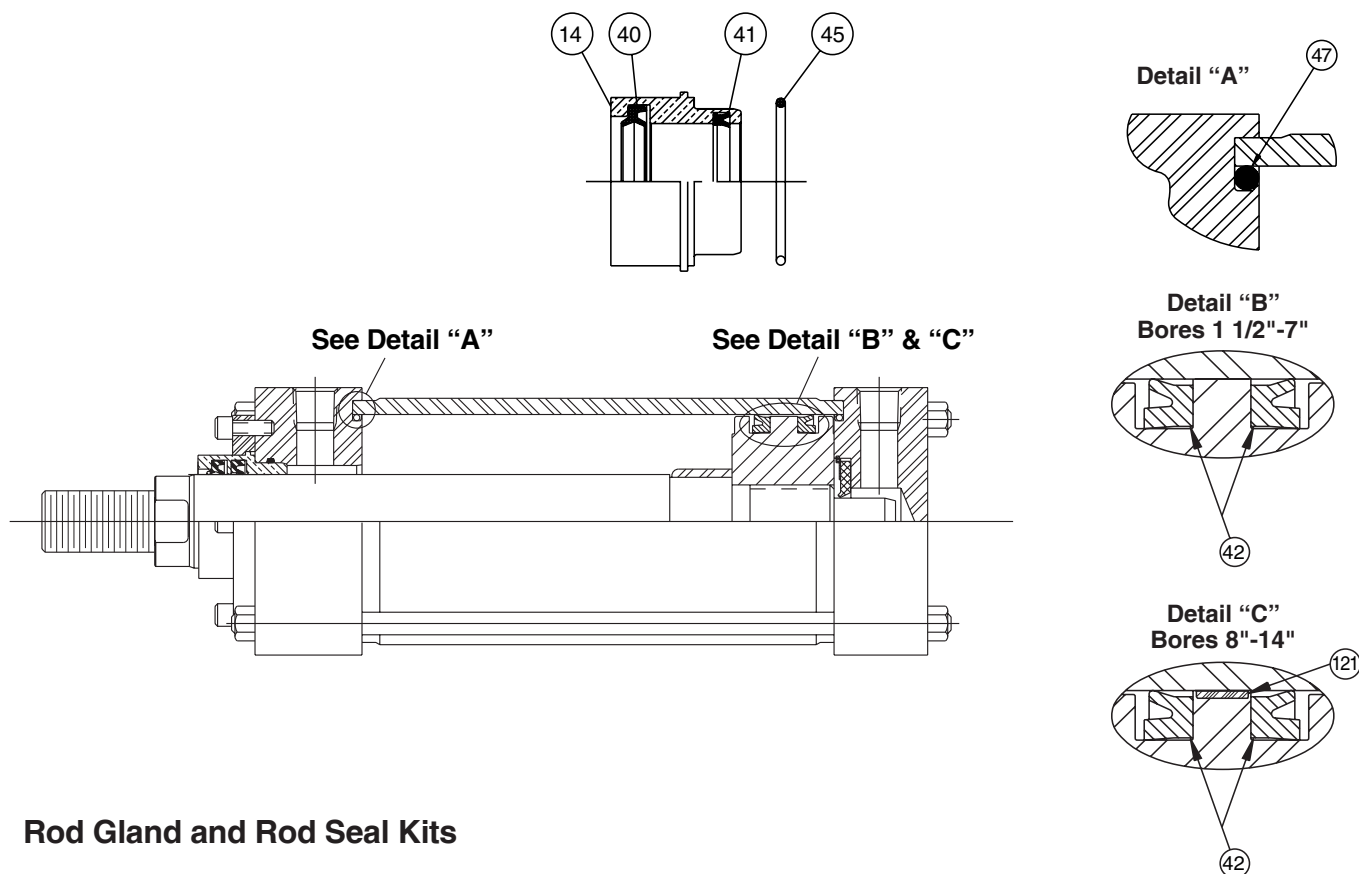
Bore Size	Class 1 Nitrile	Class 5 Fluorocarbon	Tie Rod Nut Specification Foot Lbs.* (-0%, +5% tolerance)
	Piston Seal Kits (Contains: 2 Each Sym. #42, 44, 47)	Piston Seal Kits (Contains: 2 Each Sym. #42, 44, 47)	
6	BH00LA060	VH00LL060	60
7	BH00LA070	VH00LL070	90
8	BH00LA080	VH00LL080	110
10	BH00LA100	VH00LL100	150
12	BH00LA120	VH00LL120	172
14	BH00LA140	VH00LL140	275

\*When assembling the cylinder, be sure to torque the tie rods evenly.

**Standard Seals** — Class 1 Service Kits are standard. In addition to standard seals, each kit includes the special composite components ready for installation. These seals are suitable for use when air is the operating medium.

The recommended operating temperature range for Class 1 seals is -10° F to +165°F.

### Series AL Seal Kits



### Rod Gland and Rod Seal Kits

#### AL Seal Kits for Class 1 Service

Rod Dia.	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, & 45)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, & 45)	Retainer Screw Torque Inch Lbs. (-0%, +5% tolerance)
5/8	BH06RL000	BH06SL000	15
1	BH10RL000	BH10SL000	15
1 3/8	BH13RL000	BH13SL000	60
1 3/4	BH17RL000	BH17SL000	120
2	BH20RL000	BH20SL000	120
2 1/2	BH25RL000	BH25SL000	120
3	BH30RL000	BH30SL000	240
3 1/2	BH35RL000	BH35SL000	240
4	BH40RL000	BH40SL000	240

Bore Size	Piston Seal Kits (Contains: 2 Each Sym. #42 & 47)	Tie Rod Nut Specification Foot Lbs. (-0%, +5% tolerance)
1 1/2	BH00LL015	5
2	BH00LL020	11
2 1/2	BH00LL025	11
3 1/4	BH00LL032	25
4	BH00LL040	25
5	BH00LL050	60
6	BH00LL060	60
7	BH00LL070	90
8	BH00LL080	110
10	BH00LL100	150
12	BH00LL120	172
14	BH00LL140	275



## How to Order Series A Cylinders

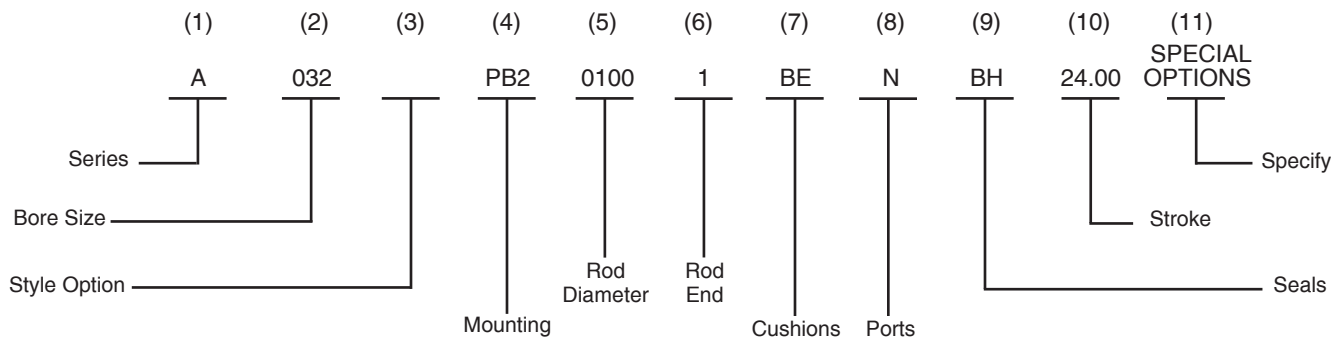
## Data Required On All Cylinder Orders

When ordering Series A cylinders, be sure to specify each of the following requirements:

(**NOTE:** – Duplicate cylinders can be ordered by giving the SERIAL NUMBER from the original cylinder. Factory records supply a quick, positive identification.)

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li><b>1. Series Designation ("A")</b></li> <li><b>2. Bore</b></li> <li><b>3. Style Option (X for double rod or Y for duplex designs, blank otherwise)</b></li> <li><b>4. Mounting Style</b><br/>Specify your choice of mounting as shown and dimensioned in this catalog.</li> <li><b>5. Piston Rod Diameter</b><br/>Call out rod diameter. Standard (smallest) rod diameter will be furnished if not specified, unless stroke length makes the application questionable.</li> <li><b>6. Piston Rod End Style</b><br/>Call out the rod end style or specify dimensions if non-standard. Rod end style 1 will be furnished if not specified.</li> </ol> | <ol style="list-style-type: none"> <li><b>7. Cushions</b><br/>Specify cushions if required and at which end, using the codes provided. If double rod end with only one end cushioned, be sure to clearly indicate which end.</li> <li><b>8. Ports</b><br/>NPTF is standard.</li> <li><b>9. Seals</b><br/>Nitrile piston seals, rod seal, Buna-N static seals and a wiper seal are all standard, for use with lubricated compressed air. Fluorocarbon and EPR can be specified, subject to application temperature range.</li> <li><b>10. Stroke</b><br/>Specify length required.</li> <li><b>11. Special Options</b><br/>Specify. Consult factory for questions.</li> </ol> |
|--|---|

## Sample Model Code



NOTE: On double rod end cylinders, repeat rod size and specify rod end threads for each side.  
 If replacing existing cylinder or ordering parts, include the serial number.

### Style 4 Rod End

A style 4 rod end indicates a special rod end configuration. All special rod ends must be described by at least **all three**: KK; A; or W/WF specified with the rod fully retracted. A sketch or drawing should be submitted for rod ends requiring special machining such as snap ring grooves.

keyways, tapers, multiple diameters, etc. It is good design practice to have this machining done on a diameter at least 0.065 inches smaller than the piston rod diameter. This allows the piston rod to have a chamfer preventing rod seal damage during assembly or maintenance.

## Service Policy

When cylinders are returned to the factory for repairs, it is standard policy for Atlas Cylinders to make such part replacements as will put the cylinder in as good as new condition. Should the condition of the returned cylinder be such that expenses for repair exceed the cost of a new one, you will be notified.

## Certified Dimensions

Atlas Cylinders guarantees that all cylinders ordered from this catalog will be built to dimensions shown. All dimensions are certified to be correct, and thus it is not necessary to request certified drawings.

## Series A Ordering Guide

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SERIES	BORE	STYLE	MOUNT	ROD	ROD END	CUSHIONS	PORTS	SEALS	STROKE	OPTIONS
<b>A</b>	<b>015</b> (1.50")	<i>(Leave Blank)</i>	<b>BEF</b>	See "Piston Rod Selection Chart" on <a href="#">page 54</a> .	<b>1 (KK Male)</b>	<b>NC (None)</b>	<b>N (NPTF)</b>	See "Operating Fluids" on <a href="#">page 50</a> .	<b>XXX.XX</b>	<b>S*</b>
<b>AL*</b>	<b>020</b> (2.00")	<i>if Standard</i>	<b>BEF1</b>		<b>2 (CC Male)</b>	<b>HE</b> (Head End)	<b>S</b> (SAE)		(Specify Gross Stroke if Stop Tube is Required)	(See Below)
<b>AW*</b>	<b>025</b> (2.50")		<b>BEF2</b>		<b>3 (KK Female)</b>	<b>CE</b> (Cap End)	<b>I</b> (ISO 6149)			
	<b>032</b> (3.25")		<b>FS</b>	<b>0062</b> (.63")	<b>4 (Special†)</b>	<b>BE</b> (Both Ends)	<b>X</b> (Other)	<b>BH</b> Nitrile Seals (Nitroxile Dynamic Seals) (Class 1 Seals)		
	<b>040</b> (4.00")		<b>NM1</b>	<b>0100</b> (1.00")	<b>5 (Split Coupler)</b>	<b>HM</b> (Head Micro Adjust)		<b>VH</b> Fluorocarbon Seals (Class 5 Seals)		
	<b>050</b> (5.00")	<b>X</b>	<b>NM2</b>	<b>0137</b> (1.38")	<b>6 (Stub End)</b>	<b>CM</b> (Cap Micro Adjust)		<b>EH</b> EPR Seals (Class 3 Seals)		
	<b>060</b> (6.00")	(Double Rod End)	<b>NM3</b>	<b>0175</b> (1.75")		<b>BM</b> (Both Micro Adjust)		<b>XH</b> Special - Specify		
	<b>070</b> (7.00")		<b>PB2</b>	<b>0200</b> (2.00")						
	<b>080</b> (8.00")		<b>REF</b>	<b>0250</b> (2.50")	† Must Specify:					
	<b>100</b> (10.0")	<b>Y</b>	<b>REF1</b>	<b>0300</b> (3.00")	<b>WF</b> (Rod Extension)					
	<b>120</b> (12.0")	(Duplex)	<b>REF2</b>	<b>0350</b> (3.50")	<b>A</b> (Thread Length)					
	<b>140</b> (14.0")		<b>SA</b>	<b>0400</b> (4.00")	<b>KK</b> (Thread Size and Pitch)					
			<b>SL</b>							
			<b>TM1</b>							
			<b>TM2</b>							
			<b>TM3</b>							
				(specify dimension XI)						

\* AL – Non-Lube Air Cylinder - see [pages 39-41](#).

AW – Wood Products Series A Cylinder - see below.

S\* The letter S refers to special options or modifications that deviate from the standard product offering. Non-standard modifications and options not identified in the cylinder model number should be added in the notes when placing an order.

**Modifications which can be placed under the designator "S" are as follows:**

- End-of-Stroke Switches
  - EPS-6, EPS-7, CLS-1, CLS-4 Styles (See bulletin AC0840-B11)
  - MagnaSwitch
- Piston Bumper Seals
  - (1½" - 5" Bores except 1½" x 1", 2" x 1⅜", 3¼" x 2", 4" x 1¾" and 4" x 2")

Note: The standard #1 port location is at the top of the cylinder, and the standard cushion adjustment screw is in position #2 when facing the rod end of the cylinder. If multiple ports are required, the last character of the part number should be "S", indicating modified and the desired port location specified in the notes.

## Cylinders for Wood Products Applications

Atlas Cylinders has built a solid reputation in the Wood Products Industry where demanding applications require a cylinder that is up to the task. That is why we offer an option that makes Atlas Cylinders the most dependable and long lasting actuator for Timber Industry service.

- ❖ **Set screw piston to piston rod**  
Two axial screws in the piston-to-rod joint prevent the assembly from unthreading.
- ❖ **Polyurethane rod wiperseal**  
Durable rod wiperseal cleans the rod on the extend stroke and wipes the rod on the return stroke.
- ❖ **Full square tie rod retained gland (up to 6" bore)**  
More secure gland retention to resist impact loading at cylinder head end.

To order your Atlas cylinder with the **Wood Products** options specify 'AW' Series in the model code. See the example below.

<b>AW</b>	<b>032</b>	<b>PB2</b>	<b>0137</b>	<b>1</b>	<b>BE</b>	<b>N</b>	<b>BH</b>	<b>10.000</b>
Series	Bore	Mount	Rod	Rod End	Cushions	Ports	Seals	Stroke

## Safety Guide for Selecting and Using Hydraulic, Pneumatic Cylinders and Their Accessories

**WARNING:**  **FAILURE OF THE CYLINDER, ITS PARTS, ITS MOUNTING, ITS CONNECTIONS TO OTHER OBJECTS, OR ITS CONTROLS CAN RESULT IN:**

- Unanticipated or uncontrolled movement of the cylinder or objects connected to it.
- Falling of the cylinder or objects held up by it.
- Fluid escaping from the cylinder, potentially at high velocity.

**THESE EVENTS COULD CAUSE DEATH OR PERSONAL INJURY BY, FOR EXAMPLE, PERSONS FALLING FROM HIGH LOCATIONS, BEING CRUSHED OR STRUCK BY HEAVY OR FAST MOVING OBJECTS, BEING PUSHED INTO DANGEROUS EQUIPMENT OR SITUATIONS, OR SLIPPING ON ESCAPED FLUID.**

Before selecting or using Atlas (The Company) cylinders or related accessories, it is important that you read, understand and follow the following safety information. Training is advised before selecting and using The Company's products.

### 1.0 General Instructions

**1.1 Scope** – This safety guide provides instructions for selecting and using (including assembling, installing, and maintaining) cylinder products. This safety guide is a supplement to and is to be used with the specific Company publications for the specific cylinder products that are being considered for use.

**1.2 Fail Safe** – Cylinder products can and do fail without warning for many reasons. All systems and equipment should be designed in a fail-safe mode so that if the failure of a cylinder product occurs people and property won't be endangered.

**1.3 Distribution** – Provide a free copy of this safety guide to each person responsible for selecting or using cylinder products. Do not select or use The Company's cylinders without thoroughly reading and understanding this safety guide as well as the specific Company publications for the products considered or selected.

**1.4 User Responsibility** – Due to very wide variety of cylinder applications and cylinder operating conditions, The Company does not warrant that any particular cylinder is suitable for any specific application. This safety guide does not analyze all technical parameters that must be considered in selecting a product. The hydraulic and pneumatic cylinders outlined in this catalog are designed to The Company's design guidelines and do not necessarily meet the design guideline of other agencies such as American Bureau of Shipping, ASME Pressure Vessel Code etc. The user, through its own analysis and testing, is solely responsible for:

- Making the final selection of the cylinders and related accessories.
- Determining if the cylinders are required to meet specific design requirements as required by the Agency(s) or industry standards covering the design of the user's equipment.
- Assuring that the user's requirements are met, OSHA requirements are met, and safety guidelines from the applicable agencies such as but not limited to ANSI are followed and that the use presents no health or safety hazards.
- Providing all appropriate health and safety warnings on the equipment on which the cylinders are used.

**1.5 Additional Questions** – Call the appropriate Company technical service department if you have any questions or require any additional information. See the Company publication for the product being considered or used, or call the number on the back cover of this catalog for the technical service department.

### 2.0 Cylinder and Accessories Selection

**2.1 Seals** – Part of the process of selecting a cylinder is the selection of seal compounds. Before making this selection, consult the "seal information page(s)" of the publication for the series of cylinders of interest.

The application of cylinders may allow fluids such as cutting fluids, wash down fluids etc. to come in contact with the external area of the cylinder. These fluids may attack the piston rod wiper and or the primary seal and must be taken into account when selecting and specifying seal compounds.

Dynamic seals will wear. The rate of wear will depend on many operating factors. Wear can be rapid if a cylinder is mis-aligned or if the cylinder has been improperly serviced. The user must take seal wear into consideration in the application of cylinders.

**2.2 Piston Rods** – Possible consequences of piston rod failure or separation of the piston rod from the piston include, but are not limited to are:

- Piston rod and or attached load thrown off at high speed.
- High velocity fluid discharge.
- Piston rod extending when pressure is applied in the piston retract mode.

Piston rods or machine members attached to the piston rod may move suddenly and without warning as a consequence of other conditions occurring to the machine such as, but not limited to:

- Unexpected detachment of the machine member from the piston rod.

- Failure of the pressurized fluid delivery system (hoses, fittings, valves, pumps, compressors) which maintain cylinder position.
- Catastrophic cylinder seal failure leading to sudden loss of pressurized fluid.
- Failure of the machine control system.

Follow the recommendations of the "Piston Rod Selection Chart and Data" in the publication for the series of cylinders of interest. The suggested piston rod diameter in these charts must be followed in order to avoid piston rod buckling.

Piston rods are not normally designed to absorb bending moments or loads which are perpendicular to the axis of piston rod motion. These additional loads can cause the piston rod to fail. If these types of additional loads are expected to be imposed on the piston rod, their magnitude should be made known to our engineering department.

The cylinder user should always make sure that the piston rod is securely attached to the machine member.

On occasion cylinders are ordered with double rods (a piston rod extended from both ends of the cylinder). In some cases a stop is threaded on to one of the piston rods and used as an external stroke adjuster. On occasions spacers are attached to the machine member connected to the piston rod and also used as a stroke adjuster. In both cases the stops will create a pinch point and the user should consider appropriate use of guards. If these external stops are not perpendicular to the mating contact surface, or if debris is trapped between the contact surfaces, a bending moment will be placed on the piston rod, which can lead to piston rod failure. An external stop will also negate the effect of cushioning and will subject the piston rod to impact loading. Those two (2) conditions can cause piston rod failure. Internal stroke adjusters are available with and without cushions. The use of external stroke adjusters should be reviewed with our engineering department.

The piston rod to piston and the stud to piston rod threaded connections are secured with an anaerobic adhesive. The strength of the adhesive decreases with increasing temperature. Cylinders which can be exposed to temperatures above +250°F (+121°C) are to be ordered with a non studded piston rod and a pinned piston to rod joint.

**2.3 Cushions** – Cushions should be considered for cylinder applications when the piston velocity is expected to be over 4 inches/second.

Cylinder cushions are normally designed to absorb the energy of a linear applied load. A rotating mass has considerably more energy than the same mass moving in a linear mode. Cushioning for a rotating mass application should be review by our engineering department.

**2.4 Cylinder Mountings** – Some cylinder mounting configurations may have certain limitations such as but not limited to minimum stroke for side or foot mounting cylinders or pressure de-ratings for certain mounts. Carefully review the catalog for these types of restrictions.

Always mount cylinders using the largest possible high tensile alloy steel socket head cap screws that can fit in the cylinder mounting holes and torque them to the manufacturer's recommendations for their size.

**2.5 Port Fittings** – Hydraulic cylinders applied with meter out or deceleration circuits are subject to intensified pressure at piston rod end.

The rod end pressure is approximately equal to:

$$\frac{\text{operating pressure} \times \text{effective cap end area}}{\text{effective rod end piston area}}$$

Contact your connector supplier for the pressure rating of individual connectors.

### 3.0 Cylinder and Accessories Installation and Mounting

#### 3.1 Installation

**3.1.1** – Cleanliness is an important consideration, and cylinders are shipped with the ports plugged to protect them from contaminants entering the ports. These plugs should not be removed until the piping is to be installed. Before making the connection to the cylinder ports, piping should be thoroughly cleaned to remove all chips and burrs which might have resulted from threading or flaring operations.

**3.1.2** – Cylinders operating in an environment where air drying materials are present such as fast-drying chemicals, paint, or weld splatter, or other hazardous conditions such as excessive heat, should have shields installed to prevent damage to the piston rod and piston rod seals.

**3.1.3** – Proper alignment of the cylinder piston rod and its mating component on the machine should be checked in both the extended and retracted positions. Improper alignment will result in excessive rod gland and/or cylinder bore wear. On fixed mounting cylinders attaching the piston rod while the rod is retracted will help in achieving proper alignment.

**3.1.4** – Sometimes it may be necessary to rotate the piston rod in order to thread the piston rod into the machine member. This operation must always be done with zero pressure being applied to either side of the piston. Failure to follow this procedure may result in loosening the piston to rod-threaded connection. In some rare cases the turning of the piston rod may rotate a threaded piston rod gland and loosen it from the cylinder head. Confirm that this condition is not occurring. If it does, re-tighten the piston rod gland firmly against the cylinder head.

For double rod cylinders it is also important that when attaching or detaching the piston rod from the machine member that the torque be applied to the piston rod end of the cylinder that is directly attaching to the machine member with the opposite end unrestrained. If the design of the machine is such that only the rod end of the cylinder opposite to where the rod attaches to the machine member can be rotated, consult the factory for further instructions.

## **3.2 Mounting Recommendations**

**3.2.1** – Always mount cylinders using the largest possible high tensile alloy steel socket head screws that can fit in the cylinder mounting holes and torque them to the manufacturer's recommendations for their size.

**3.2.2** – Side-Mounted Cylinders – In addition to the mounting bolts, cylinders of this type should be equipped with thrust keys or dowel pins located so as to resist the major load.

**3.2.3** – Tie Rod Mounting – Cylinders with tie rod mountings are recommended for applications where mounting space is limited. The standard tie rod extension is shown as BB in dimension tables. Longer or shorter extensions can be supplied. Nuts used for this mounting style should be torqued to the same value as the tie rods for that bore size.

**3.2.4** – Flange Mount Cylinders – The controlled diameter of the rod gland extension on head end flange mount cylinders can be used as a pilot to locate the cylinders in relation to the machine. After alignment has been obtained, the flanges may be drilled for pins or dowels to prevent shifting.

**3.2.5** – Trunnion Mountings – Cylinders require lubricated bearing blocks with minimum bearing clearances. Bearing blocks should be carefully aligned and rigidly mounted so the trunnions will not be subjected to bending moments. The rod end should also be pivoted with the pivot pin in line and parallel to axis of the trunnion pins.

**3.2.6** – Clevis Mountings – Cylinders should be pivoted at both ends with centerline of pins parallel to each other. After cylinder is mounted, be sure to check to assure that the cylinder is free to swing through its working arc without interference from other machine parts.

## **4.0 Cylinder and Accessories Maintenance, Troubleshooting and Replacement**

**4.1 Storage** – At times cylinders are delivered before a customer is ready to install them and must be stored for a period of time. When storage is required the following procedures are recommended.

**4.1.1** – Store the cylinders in an indoor area which has a dry, clean and noncorrosive atmosphere. Take care to protect the cylinder from both internal corrosion and external damage.

**4.1.2** – Whenever possible cylinders should be stored in a vertical position (piston rod up). This will minimize corrosion due to possible condensation which could occur inside the cylinder. This will also minimize seal damage.

**4.1.3** – Port protector plugs should be left in the cylinder until the time of installation.

**4.1.4** – If a cylinder is stored full of hydraulic fluid, expansion of the fluid due to temperature changes must be considered. Installing a check valve with free flow out of the cylinder is one method.

**4.1.5** – When cylinders are mounted on equipment that is stored outside for extended periods, exposed unpainted surfaces, e.g. piston rod, must be coated with a rust-inhibiting compound to prevent corrosion.

## **4.2 Cylinder Trouble Shooting**

### **4.2.1 – External Leakage**

**4.2.1.1** – Rod seal leakage can generally be traced to worn or damaged seals. Examine the piston rod for dents, gouges or score marks, and replace piston rod if surface is rough.

Rod seal leakage could also be traced to gland wear. If clearance is excessive, replace rod bushing and seal. Rod seal leakage can also be traced to seal deterioration. If seals are soft or gummy or brittle, check compatibility of seal material with lubricant used if air cylinder, or operating fluid if hydraulic cylinder. Replace with seal material, which is compatible with these fluids. If the seals are hard or have lost elasticity, it is usually due to exposure to temperatures in excess of 165°F. (+74°C). Shield the cylinder from the heat source to limit temperature to 350°F. (+177°C.) and replace with fluorocarbon seals.

**4.2.1.2** – Cylinder body seal leak can generally be traced to loose tie rods. Torque the tie rods to manufacturer's recommendation for that bore size.

Excessive pressure can also result in cylinder body seal leak. Determine maximum pressure to rated limits. Replace seals and retorquer tie rods as in paragraph above. Excessive pressure can also result in cylinder body seal leak. Determine if the pressure rating of the cylinder has been exceeded. If so, bring the operating pressure down to the rating of the cylinder and have the tie rods replaced.

Pinched or extruded cylinder body seal will also result in a leak. Replace cylinder body seal and retorquer as in paragraph above.

Cylinder body seal leakage due to loss of radial squeeze which shows up in the form of flat spots or due to wear on the O.D. or I.D. – Either of these are symptoms of normal wear due to high cycle rate or length of service. Replace seals as per paragraph above.

### **4.2.2 – Internal Leakage**

**4.2.2.1** – Piston seal leak (by-pass) 1 to 3 cubic inches per minute leakage is considered normal for piston ring construction. Virtually no static leak with lipseal type seals on piston should be expected. Piston seal wear is a usual cause of piston seal leakage. Replace seals as required.

**4.2.2.2** – With lipseal type piston seals excessive back pressure due to over-adjustment of speed control valves could be a direct cause of rapid seal wear. Contamination in a hydraulic system can result in a scored cylinder bore, resulting in rapid seal wear. In either case, replace piston seals as required.

**4.2.2.3** – What appears to be piston seal leak, evidenced by the fact that the cylinder drifts, is not always traceable to the piston. To make sure, it is suggested that one side of the cylinder piston be pressurized and the fluid line at the opposite port be disconnected. Observe leakage. If none is evident, seek the cause of cylinder drift in other component parts in the circuit.

### **4.2.3 – Cylinder Fails to Move the Load**

**4.2.3.1** – Pneumatic or hydraulic pressure is too low. Check the pressure at the cylinder to make sure it is to circuit requirements.

**4.2.3.2** – Piston Seal Leak – Operate the valve to cycle the cylinder and observe fluid flow at valve exhaust ports at end of cylinder stroke. Replace piston seals if flow is excessive.

**4.2.3.3** – Cylinder is undersized for the load – Replace cylinder with one of a larger bore size.

## **4.3 Erratic or Chatter Operation**

**4.3.1** – Excessive friction at rod gland or piston bearing due to load misalignment – Correct cylinder-to-load alignment.

**4.3.2** – Cylinder sized too close to load requirements – Reduce load or install larger cylinder.

**4.3.3** – Erratic operation could be traced to the difference between static and kinetic friction. Install speed control valves to provide a back pressure to control the stroke.

**4.4 Cylinder Modifications, Repairs, or Failed Component** – Cylinders as shipped from the factory are not to be disassembled and or modified. If cylinders require modifications, these modifications must be done at company locations or by The Company's certified facilities. The Cylinder Division Engineering Department must be notified in the event of a mechanical fracture or permanent deformation of any cylinder component (excluding seals). This includes a broken piston rod, tie rod, mounting accessory or any other cylinder component. The notification should include all operation and application details. This information will be used to provide an engineered repair that will prevent recurrence of the failure.

It is allowed to disassemble cylinders for the purpose of replacing seals or seal assemblies. However, this work must be done by strictly following all the instructions provided with the seal kits.

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**NOTES**



## Offer of Sale

The items described in this document and other documents or descriptions provided by Parker Hannifin Corporation, its subsidiaries and Divisions ("Company") and its authorized distributors, are hereby offered for sale at prices to be established by the Company, its subsidiaries and its authorized distributors. This offer and its acceptance by any customer ("Buyer") shall be governed by all of the following Terms and Conditions. Buyer's order for any such item, when communicated to the Company, its subsidiary or an authorized distributor ("Seller") verbally or in writing, shall constitute acceptance of this offer.

**1. Terms and Conditions of Sale:** All descriptions, quotations, proposals, offers, acknowledgments, acceptances and sales of Seller's products are subject to and shall be governed exclusively by the terms and conditions stated herein. Buyer's acceptance of any offer to sell is limited to these terms and conditions. Any terms or conditions in addition to, or inconsistent with those stated herein, proposed by Buyer in any acceptance of an offer by Seller, are hereby objected to. No such additional, different or inconsistent terms and conditions shall become part of the contract between Buyer and Seller unless expressly accepted in writing by Seller. Seller's acceptance of any offer to purchase by Buyer is expressly conditional upon Buyer's assent to all the terms and conditions stated herein, including any terms in addition to, or inconsistent with those contained in Buyer's offer. Acceptance of Seller's products shall in all events constitute such assent.

**2. Payment:** Payment shall be made by Buyer net 30 days from the date of delivery of the items purchased hereunder. Amounts not timely paid shall bear interest at the maximum rate permitted by law for each month or portion thereof that the Buyer is late in making payment. Any claims by Buyer for omissions or shortages in a shipment shall be waived unless Seller receives notice thereof within 30 days after Buyer's receipt of the shipment.

**3. Delivery:** Unless otherwise provided on the face hereof, delivery shall be made F.O.B. Seller's plant. Regardless of the method of delivery, however, risk of loss shall pass to Buyer upon Seller's delivery to a carrier. Any delivery dates shown are approximate only and Seller shall have no liability for any delays in delivery.

**4. Warranty:** Seller warrants that the items sold hereunder shall be free from defects in material or workmanship for a period of 18 months from date of shipment from the Company. **THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED.**

**NOTWITHSTANDING THE FOREGOING, THERE ARE NO WARRANTIES WHATSOEVER ON ITEMS BUILT OR ACQUIRED WHOLLY OR PARTIALLY, TO BUYER'S DESIGN OR SPECIFICATIONS.**

**5. Limitation of Remedy: SELLER'S LIABILITY ARISING FROM OR IN ANY WAY CONNECTED WITH THE ITEMS SOLD OR THIS CONTRACT SHALL BE LIMITED EXCLUSIVELY TO REPAIR OR REPLACEMENT OF THE ITEMS SOLD OR REFUND OF THE PURCHASE PRICE PAID BY BUYER, AT SELLER'S SOLE OPTION. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES OF ANY KIND OR NATURE WHATSOEVER, INCLUDING BUT NOT LIMITED TO LOST PROFITS ARISING FROM OR IN ANY WAY CONNECTED WITH THIS AGREEMENT OR ITEMS SOLD HEREUNDER, WHETHER ALLEGED TO ARISE FROM BREACH OF CONTRACT, EXPRESS OR IMPLIED WARRANTY, OR IN TORT, INCLUDING WITHOUT LIMITATION, NEGLIGENCE, FAILURE TO WARN OR STRICT LIABILITY.**

**6. Changes, Reschedules and Cancellations:** Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order, however, no such requested modification or cancellation shall become part of the contract between Buyer and Seller unless accepted by Seller in a written amendment to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller's discretion, and shall be upon such terms and conditions as Seller may require.

**7. Special Tooling:** A tooling charge may be imposed for any special tooling, including without limitations, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

**8. Buyer's Property:** Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer, or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

**9. Taxes:** Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

**10. Indemnity For Infringement of Intellectual Property Rights:** Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets (hereinafter "Intellectual Property Rights"). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, replace or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

**11. Force Majeure:** Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter "Events of Force Majeure"). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

**12. Entire Agreement/Governing Law:** The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of sale of the items sold hereunder or this Agreement may be brought by either party more than two (2) years after the cause of action accrues.

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