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climate control
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filtration
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hydraulics
pneumatics
process control
sealing & shielding



Medium Duty Hydraulic Cylinders

Series 3L



ENGINEERING YOUR SUCCESS.

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

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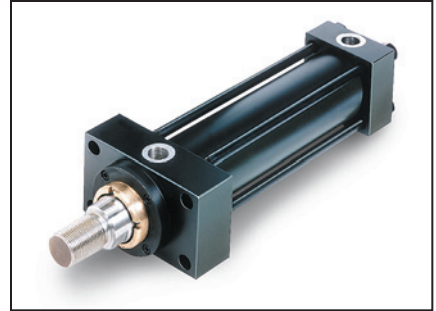
Series CHE / CHD

- 20 through 100mm Bore Sizes
- Stroke Lengths to 150mm
- Operating Pressure to 207 bar
- 4 Different Rod Ends Available



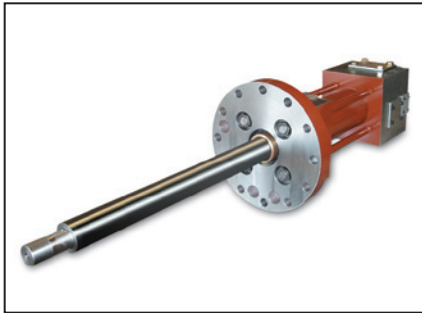
Series RDH

- 1.50 through 8.00 Bore Sizes
- Gross stroke available in any practical length
- Operating Pressure to 3,000 psi
- 9 Standard Mounting Styles



Series HMI

- Bore Sizes 25 through 200mm
- ISO 6020/2 Interchangeable
- 12 Standard Mounting Styles
- 210 Bar Hydraulic Pressure



Custom Cylinder

- Bore Sizes to 42.00"
- Stroke Lengths to 70'
- Operating Pressure to 10,000 psi
- Third Party Agency Approval



Series 2H

- Bore Sizes 1.50" through 6.00"
- 3000 psi Hydraulic Service
- 16 NFPA Mounting Styles
- Specials to Order



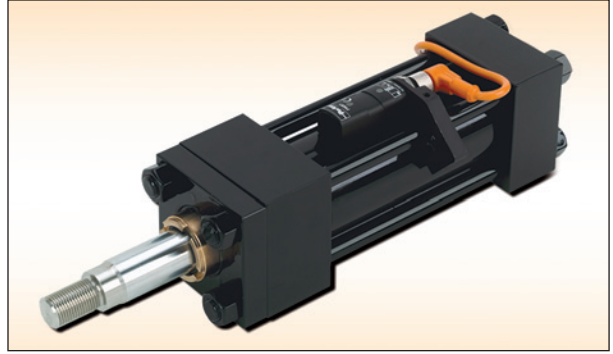
3LX

- Bore Sizes 2.00" through 8.00"
- LDT or LRT Feedback
- Integrated Manifolds Available
- Protective Covers Available

Parker Hannifin's Industrial Cylinder Division offers products that are designed to meet and exceed the most demanding application requirements. Our extensive product line offers OEM's and End Users hydraulic and pneumatic cylinder solutions that provide value through reduced maintenance, increased productivity, and long service life. Parker Industrial Cylinder's wide breadth of product encompasses NFPA, ISO, and Custom designed products in a multitude of configurations and sizes.

Series 3L/2H Magnetic Piston

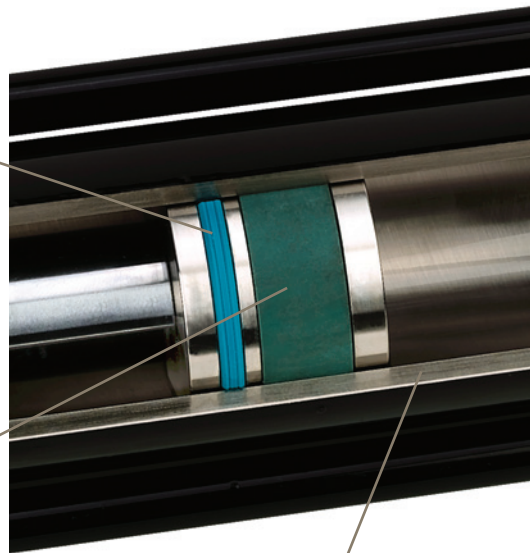
Position Sensing Technology
for Hydraulic Cylinders



Series 3L Cylinder – with Hi-Load magnetic piston

Durable polyurethane bi-directional seal – for positive sealing with no by-pass and long life.

WearGard™ wear band – improves resistance to bearing loads and provides support for magnet.



Cylinder Body – Standard steel material for ALS Switch or 316 stainless steel for conventional solid state or reed switches. Aluminum material available for global switches at reduced operating pressure rating. See facing page for details.

Customer Value Proposition:

Parker's magnetic sensing option for hydraulic steel/tie rod construction cylinders provides OEM's and end users the ability to sense piston position in an economical and reliable fashion through the use of innovative magnet and switching technology. The magnetic piston option offers all users the choice to eliminate added cylinder

machining costs, stand alone external brackets/hardware, and reduced system set-up time. By incorporating sensing capability into steel/tie rod style cylinders, the need to fabricate, install, wire, and adjust stand alone proximity switches can be eliminated – thus providing a clean and more efficient position monitoring system.

Product Features:

- Available for Series 3L, 2H and 2A cylinders
- Available for Series 2H in 1.50" - 6.00" bores. Series 3L and 2A in 1.00" - 4.00" bores.
- Available on 15 different mounting styles
- Adjustability over the entire working stroke length
- Multiple switches can be used per cylinder
- Non intrusive design eliminates potential leakage

Magnetic Switch Choices

Making The Best Choice
Parker's ALS Switch and Global Switch are designed to offer customers an alternative means of sensing hydraulic cylinder piston position. Depending on the application, and the budget, one switch type may be better suited to fulfill customer needs than the other. Some of the important things to consider when analyzing what switch to choose are listed at right.

- Can be positioned at any location along the cylinder to indicate end-of-stroke or mid-stroke locations.
- Allow multiple switches to be installed with numbers only restricted by available tie rod mounting space.
- Available for Series 2H in 1.50" - 6.00" bores. Series 3L and 2A in 1.00" - 4.00" bores.

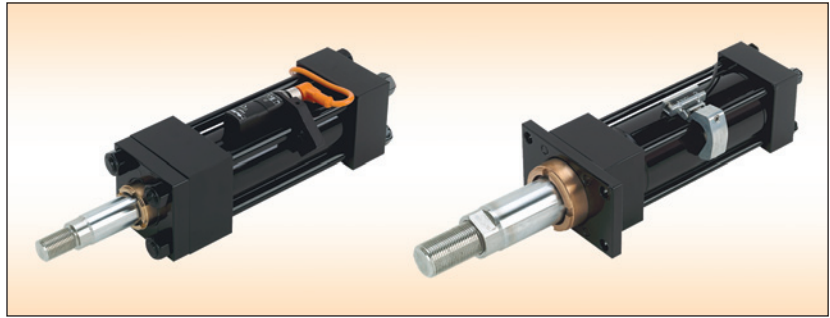
Maximum Pressure Rating for 3L Cylinder with Aluminum Tube

Bore Ø	Pressure Rating (psi) ¹
1.00	1900
1.50	1500
2.00	1100
2.50	950 ²
3.25	750
4.00	600

¹ When using Series 3L cylinders with aluminum bodies, do not introduce any shock or high inertia loading conditions. Pressure spikes must be avoided.

² Maximum pressure for aluminum tube in 2.50" bore with code 7 rod is 700 psi.

Technology Comparison

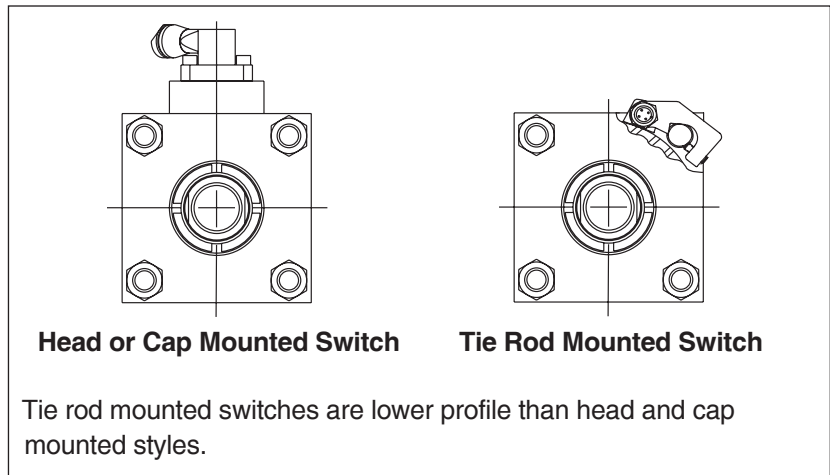


ALS Switch

- Compatible with standard steel tube
- +10 to +30 VDC power requirement
- PNP/NPN wired NO or NC
- Solid state construction
- 2 LED indicators (power & target)
- 12mm connector
- IP 67 rated
- Temperature Range: -25°C to +85°C
- Short circuit protection

Global Switch

- Uses 316 stainless steel tube (aluminum tube is optional in Series 3L and 2A)
- +10 to +30 VDC, +10 to +120 VAC power requirement
- PNP/NPN, Reed
- Solid state construction
- 1 power LED indicator
- 12mm or 8mm connector, flying leads
- IP 68 rated
- Temperature Range: -25°C to +75°C
- Short circuit protection



Extreme High Temperature Seal Option – Up to 400° F

For Series 3L, 2H/2HD, 3H/3HD and 2A Cylinders



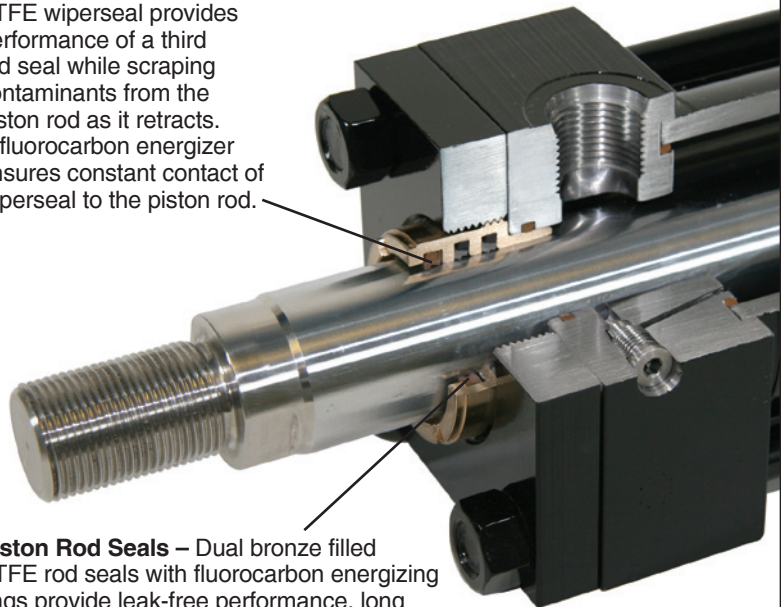
Customer Value Proposition:

Parker's Extreme High Temperature Seal Option will provide OEM's and End Users an increase in machine productivity through improved resistance to heat degradation as compared to typical fluorocarbon seals. With a maximum continuous temperature rating of 400° F, the Extreme High Temperature Seal Option will allow longer service life in applications that require the use of alternative fluid types and demand superior heat resistance. Parker's innovative seal design utilizes PTFE materials that are constantly energized to provide excellent seal performance and long life. Customers utilizing this design will realize a reduction in machine downtime due to seal failure associated with high temperature exposure.

Product Features:

- Operating temperature to 400° F
- Broad range of fluid compatibility
- Available bore sizes: 1.50" through 8.00"; rod diameters 1.000" through 5.500"
- Stainless steel spring loads both dynamic and static piston seal lips
- No additional delivery time

Wiperseal – Unique profile of bronze filled PTFE wiperseal provides performance of a third rod seal while scraping contaminants from the piston rod as it retracts. A fluorocarbon energizer ensures constant contact of wiperseal to the piston rod.



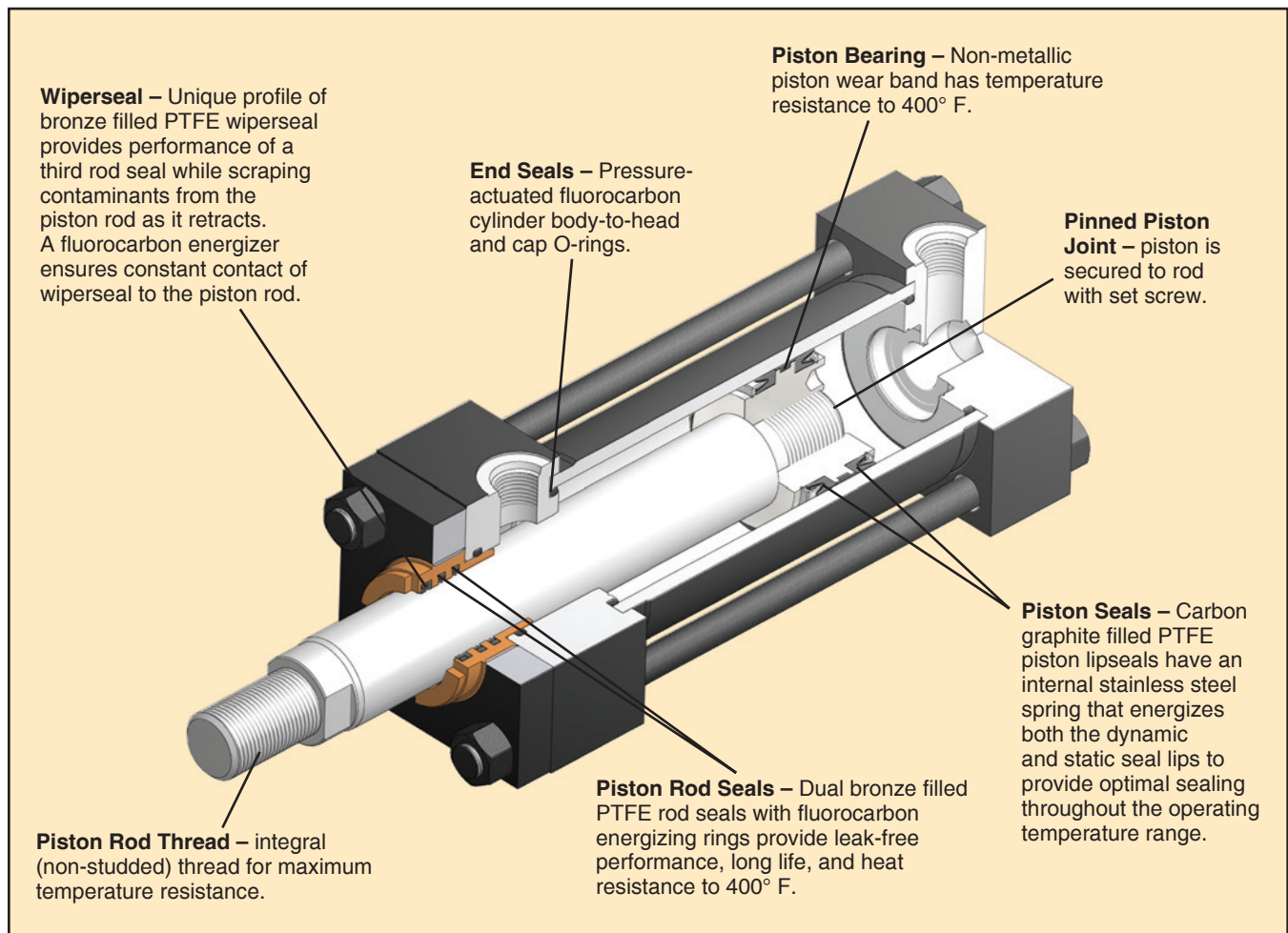
Piston Rod Seals – Dual bronze filled PTFE rod seals with fluorocarbon energizing rings provide leak-free performance, long life, and heat resistance to 400° F.

Cylinders for High Temperature Applications

When your customer demands a long life cylinder with outstanding heat resistance, look no further than Parker's new Extreme High Temperature Seal option.

Filled PTFE piston seals, rod seals, and wiperseal provide maximum resistance to extreme heat (up to 400° F) with excellent service life.

PTFE seals are mechanically energized to maintain uniform contact to dynamic sealing surfaces for positive leak-free performance across the entire operating pressure range. Static seals are fluorocarbon for a complete heat resistant assembly.





With annual sales exceeding \$13 billion in fiscal year 2012, Parker Hannifin is the world's leading diversified manufacturer of motion and control technologies and systems, providing precision-engineered solutions for a wide variety of mobile, industrial and aerospace markets. The company employs approximately 60,000 people in 48 countries around the world. Parker has increased its annual dividends paid to shareholders for 56 consecutive fiscal years, among the top five longest-running dividend-increase records in the S&P 500 index. For more information, visit the company's website at www.parker.com, or its investor information website at www.phstock.com.

Parker is Engineering

Fluid Power and application expertise provide customers the opportunity to use us as an extension of their design teams.



From new system design to improvements required for existing applications, Parker offers unparalleled engineering expertise. We'll help you develop cost saving, high performance solutions that provide value through increased productivity, improved machine efficiency, and reduced downtime.

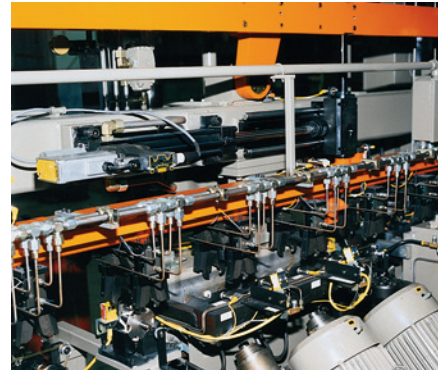
Our design engineers utilize the highest quality materials and cutting edge manufacturing processes available to push the envelope for performance, value and reliability.

Parker components and systems are made to last. We offer complete system solutions for the following industries:

- Plastics
- Metal Forming
- Steel
- Press
- Off Shore Oil
- Forestry
- Mining
- Entertainment
- Flight Simulation
- Fatigue Testing
- Automation

Worldwide Supplier to Industrial Markets

Parker Hannifin is the world's leading supplier of motion and control technologies that include; motion control products, systems, and complete engineered solutions for industrial markets. Parker's broad and extensive breadth of product



offer single source capability with limitless possibilities. Our industrial product solutions range from state of the art stand-alone components to complete engineered systems that are designed to provide value and efficiency to all of our customers. Each component and system is backed up with superior application expertise and technical support that you would expect from Parker Hannifin.

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Manufacturing Locations



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Corona, CA



Plymouth, MI



Goodland, IN

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Goodland, IN 47948
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Fax: (800) 328-8120

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Tel.: (734) 455-1700
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Fax: (800) 624-7996



Eugene, OR

Section A

Series 3L Medium Duty Hydraulic Cylinders

	1.00" - 5.00" Bore	6.00" & 8.00" Bore
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The medium-duty hydraulic cylinder with a proven record of performance.

Parker Series 3L cylinders provide value through proven reliability, efficient performance, and quality that you expect from every Parker Industrial Cylinder Division product line. Each Series 3L cylinder incorporates design features one would not expect to see in a 1,000 psi nominally rated cylinder. These features include the “Jewel” rod gland, adjustable floating cushions, case hardened piston rod assemblies, and high strength tie rods with

rolled threads instead of cut threads. Each and every Parker cylinder is hand built and tested before it leaves our facility to ensure leak and trouble free operation. At Parker, we place a high emphasis on quality and design to ensure value and productivity for all of our customers. Make the Parker Series 3L your choice for medium duty hydraulic cylinders today and for the future.



Standard Specifications

- Medium Duty Service – ANSI/(NFPA) T3.6.7R3-2009 Specifications and Mounting Dimension Standards
- Standard Construction – Square Head – Tie Rod Design
- Nominal Pressure – 1000 psi Dependent on Bore Size¹
- Standard Fluid – Hydraulic Oil
- Standard Temperature – -10°F to +165°F²
- Bore Sizes – 1.00" through 8.00"

Note: Series 3L Hydraulic Cylinders fully meet ANSI/(NFPA) T3.6.7R3-2009 Specifications and Mounting Dimensions for Square Head Industrial Fluid Power Cylinders.

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

- Piston Rod Diameter – 0.500" through 5.500"
- Mounting Styles – 15 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

¹ See Section D to determine maximum pressure rating by bore and rod combination.

² See Section D – Fluids/Temperature/Pressure Ratings for information regarding higher temperature service.



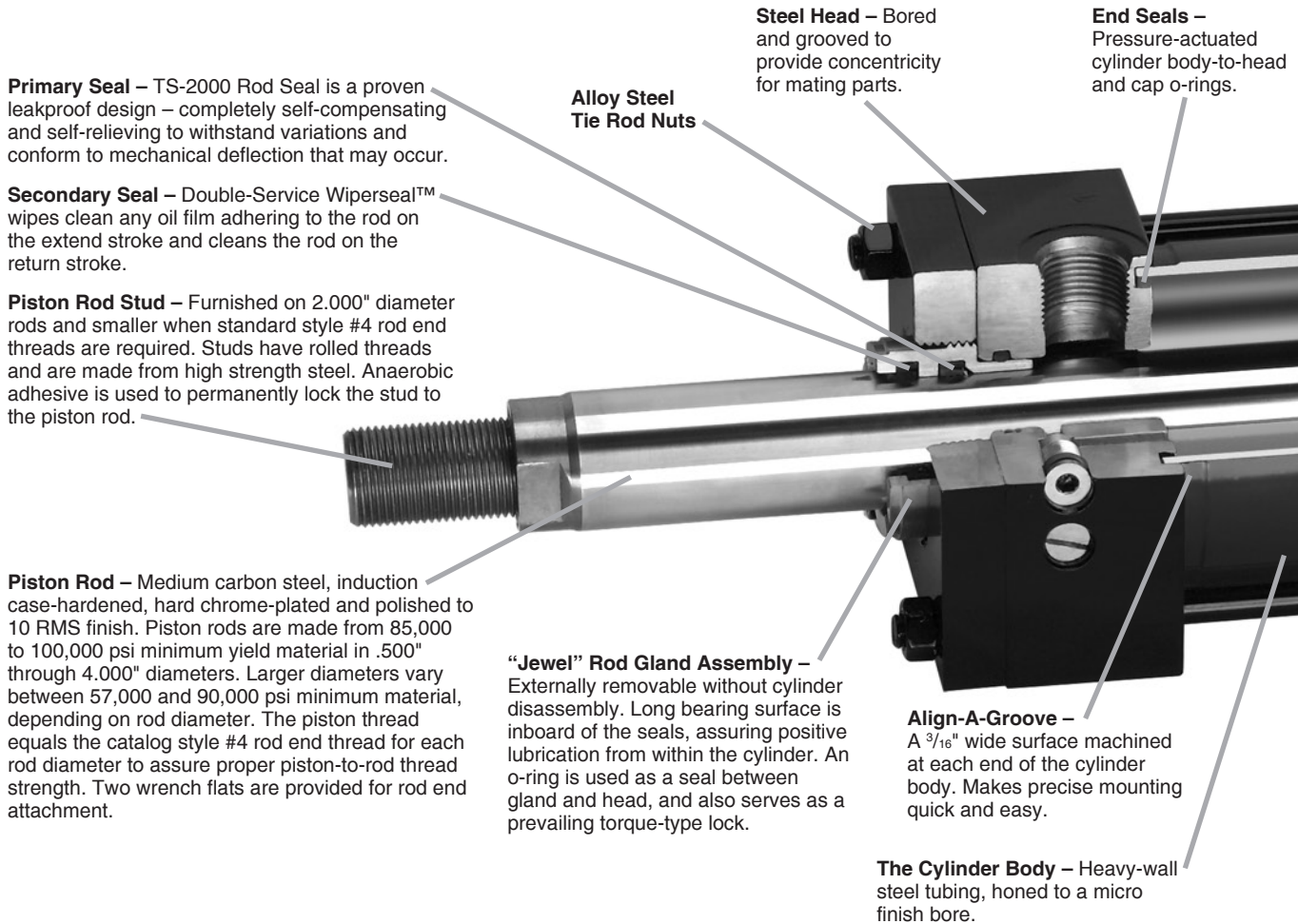
Available Mounting Styles

<p>Basic Style T</p> <p>(NFPA MX0)</p>	<p>Tie Rods Extended Head End Style TB</p> <p>(NFPA MX3)</p>	<p>Tie Rods Extended Cap End Style TC</p> <p>(NFPA MX2)</p>	<p>Tie Rods Extended Both Ends Style TD</p> <p>(NFPA MX1)</p>
<p>Head Rectangular Flange Style J</p> <p>(NFPA MF1)</p>	<p>Head Square Flange Style JB</p> <p>(NFPA MF5)</p>	<p>Head Rectangular Style JJ³</p>	<p>Cap Rectangular Flange Style H</p> <p>(NFPA MF2)</p>
<p>Cap Square Flange Style HB</p> <p>(NFPA MF6)</p>	<p>Side Lug Style C</p> <p>(NFPA MS2)</p>	<p>Side Tapped Style F</p> <p>(NFPA MS4)</p>	<p>Head Trunnion Style D</p> <p>(NFPA MT1)</p>
<p>Cap Trunnion Style DB</p> <p>(NFPA MT2)</p>	<p>Intermediate Fixed Trunnion Style DD</p> <p>(NFPA MT4)</p>	<p>Cap Fixed Clevis Style BB</p> <p>(NFPA MP1)</p>	<p>Spherical Bearing Style SB</p>
<p>Double Rod Cylinders</p> <p>Style KTB Shown</p>			

³Parker Style JJ mount for the Series 3L is a non-NFPA mount.

Most of the above illustrated mounting styles are available in double rod cylinders.

The inside story on why Series 3L is your best choice in medium duty hydraulic cylinders



Primary Seal – TS-2000 Rod Seal is a proven leakproof design – completely self-compensating and self-relieving to withstand variations and conform to mechanical deflection that may occur.

Secondary Seal – Double-Service Wiperseal™ wipes clean any oil film adhering to the rod on the extend stroke and cleans the rod on the return stroke.

Piston Rod Stud – Furnished on 2.000" diameter rods and smaller when standard style #4 rod end threads are required. Studs have rolled threads and are made from high strength steel. Anaerobic adhesive is used to permanently lock the stud to the piston rod.

Piston Rod – Medium carbon steel, induction case-hardened, hard chrome-plated and polished to 10 RMS finish. Piston rods are made from 85,000 to 100,000 psi minimum yield material in .500" through 4.000" diameters. Larger diameters vary between 57,000 and 90,000 psi minimum material, depending on rod diameter. The piston thread equals the catalog style #4 rod end thread for each rod diameter to assure proper piston-to-rod thread strength. Two wrench flats are provided for rod end attachment.

"Jewel" Rod Gland Assembly – Externally removable without cylinder disassembly. Long bearing surface is inboard of the seals, assuring positive lubrication from within the cylinder. An o-ring is used as a seal between gland and head, and also serves as a prevailing torque-type lock.

Align-A-Groove – A $\frac{3}{16}$ " wide surface machined at each end of the cylinder body. Makes precise mounting quick and easy.

The Cylinder Body – Heavy-wall steel tubing, honed to a micro finish bore.

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. All Parker cushions are adjustable.

The Series 3L 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. A self-centering sleeve is furnished on the piston rod assembly.
 - b. 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. It is located on side number 2, in all mounting styles except D, DB and DD. In these styles it is located on side number 3.
 - c. On 3.25" bores and larger, 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 C where it is mounted opposite the needle valve. It may be identified by the fact that it is slotted.

- d. The check and needle valves are interchangeable in the head.
 - e. 1.00" - 2.50" bore 3L's utilize a slotted sleeve design in place of the check valve.
- (2) When a cushion is specified at the cap end:
 - a. A cushion spear is provided on the piston rod assembly.
 - b. A "float check" self-centering bushing is provided which incorporates a large flow check valve for fast "out-stroke" action.
 - c. 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 D, DB, and DD. In these styles it is located on side number 3.

One-Piece Nodular Iron Piston – The wide piston surface contacting cylinder bore reduces bearing loads. Anaerobic adhesive is used to permanently lock and seal the piston to the rod.

High Strength Tie Rods – Made from 100,000 psi minimum yield steel with rolled threads for added strength.

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

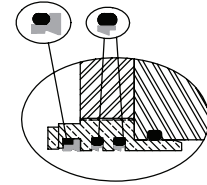
Ports – NPTF ports are standard.

Optional Ports

Ports – SAE “O” ring ports are optional at no extra charge. Oversize NPTF and SAE ports are available at extra charge.

Seals – Buna-N (Nitrile) seals are standard.

Fluorocarbon Seals – Optional at extra charge.



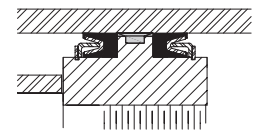
Optional High Temperature Gland – Dual filled PTFE rod seals and filled PTFE wiper seal are energized with fluorocarbon o-rings to maintain consistent contact with the piston rod. Excellent sealing performance produce dry rod on extend stroke with rod scraping to clean rod on retract. Combine with Spring Loaded PTFE Piston Seals for cylinder heat resistance to 400° F. See class 8 seal specification on Operating Fluids and Temperature Range page.

Lipseal Piston
 Zero leakage under static conditions. Seals are self-compensating to conform to variations in pressure, mechanical deflection, and wear. Back-up washers prevent extrusion.

Optional Spring Loaded PTFE Piston Seals

Filled PTFE piston Lipseals utilize an internal stainless steel spring to energize both the dynamic and static sealing lips to optimize seal performance throughout the operating temperature range. Non-metallic piston wear ring reduces possibility of damaging piston which can score expensive tubing. Combine with High Temperature Gland

for cylinder heat resistance to 400° F. See class 8 seal specification on Operating Fluids and Temperature Range page.



Cushion Length

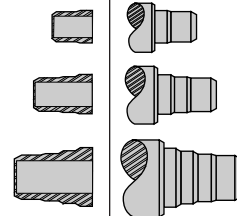
Bore Ø	Rod Ø ¹	Rod Number	Cushion Length	
			Head ¹	Cap
1.00	0.500	1	0.88	0.75
	0.625	2	0.88	0.75
1.50	0.625	1	0.88	0.81
	1.000	2	0.88	0.81
2.00	0.625	1	0.88	0.81
	1.375	2	0.88	0.81
2.50	1.000	1	0.88	0.81
	1.750	2	0.88	0.81
3.25	1.000	1	1.13	1.00
	2.000	2	0.81	1.00
4.00	1.375	1	1.13	1.00
	2.500	2	0.81	1.00
5.00	1.750	1	1.13	1.00
	3.500	2	0.81	1.00
6.00	1.750	1	1.38	1.25
	4.000	2	1.06	1.25
8.00	2.000	1	1.06	1.25
	5.500	2	0.94	1.25

¹Head end cushions for rod diameters not listed have cushion lengths within the limits shown.

Adjustable Stepped Floating Cushions – Optional at extra charge. For faster cycle time and increased productivity – for maximum performance – economical and flexible for even the most demanding applications – reduces shock and machine noise – lower maintenance costs – can be supplied at head, cap or both ends.

Optional Adjustable Floating Stepped Cushions

Sleeve Design | Spear Design



Application Checklist

The following checklist should be used to select the best possible cylinder for a given application. Additional information can be referenced in the following pages to help assist in this process. In the event that you have additional questions or concerns, or if more information is required, please contact your local Parker distributor or our customer service representatives for assistance.

- 1. Establish the system requirements**..... **Series 3L**
 - How heavy is the load to be moved?
 - What is the nominal operating pressure of the system?
 - How far does the load have to move?
 - What is the speed at which the load will move?
 - What is the fluid type and the temperature to which the cylinder will be exposed?

- 2. Mounting Style**..... Page 7
 - Determine the best mounting style for the application.

- 3. Cylinder Bore and Operating Pressure**..... Page 64
 - Review the theoretical push and pull force for a given bore size to determine.

- 4. Piston Rod**..... Page 74
 - Determine what rod size will be required to avoid buckling.
 - Determine if a single or double rod cylinder is required.
 - Determine the rod end style and rod end thread.
 - Will stop tubing be required?

- 5. Piston Seals**..... Page 5
 - Determine the best seal type for your application.
 - Select the proper seal type and configuration for the application.
 - Select the proper seal to assure fluid and temperature compatibility.

- 6. Cushioning**..... Page 78
 - Determine if cushions are required to safely stop the load.

- 7. Ports**..... Page 69
 - Select the best possible port size for a given speed requirement.
 - Select port position.

- 8. Piston rod and mounting accessories**..... Page 42
 - Determine how you will attach the cylinder to the load.

- 9. Custom modifications**..... Page 55

Mounting Styles & Tips for Applying Them

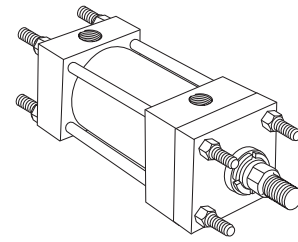
Extended Tie Rod Mountings – TB, TC and TD

Application:

- Straight line force transfer
- Compression loads (push)
– use TC or TD
- Tension loads (pull)
– use TB or TD

Advantages:

- Ease of mounting in tight spaces
- Force is transferred along the centerline of the cylinder



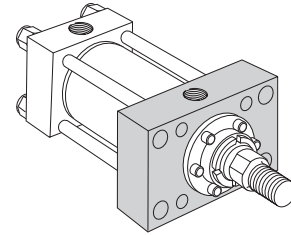
Flange Mountings – J, JB, JJ, H and HB

Application:

- Straight line force transfer
- Compression loads (push)
– use H or HB
- Tension loads (pull)
– use J, JB, or JJ

Advantages:

- Rigid base mounting due to large flange area
- Force is transferred along the centerline of the cylinder



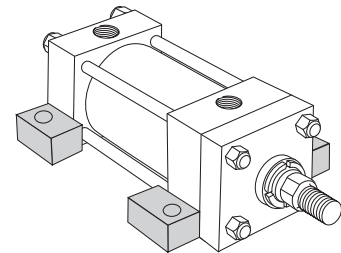
Side Tap Mounting – F / Side Lug Mounting – C

Application:

- Straight line force transfer
- Can be used in compression or tension loads
- Thrust key and secure mounting area are vital

Advantages:

- Ease of mounting



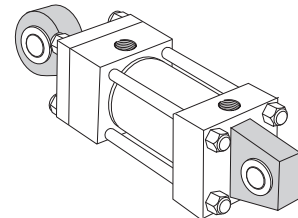
Pivot Mountings – BB and SB

Application:

- Curved or arc line force transfer
- Can be used in compression or tension loads
- Movement in a simple arc
– use BB mountings
- Movement in a compound arc
– use SB mountings

Advantages:

- Ease of mounting
- Design flexibility
- Self aligning (SB)



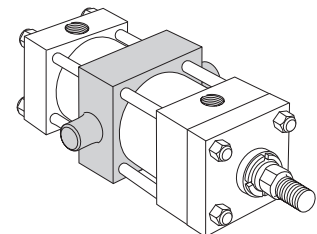
Trunnion Mountings – D, DB and DD

Application:

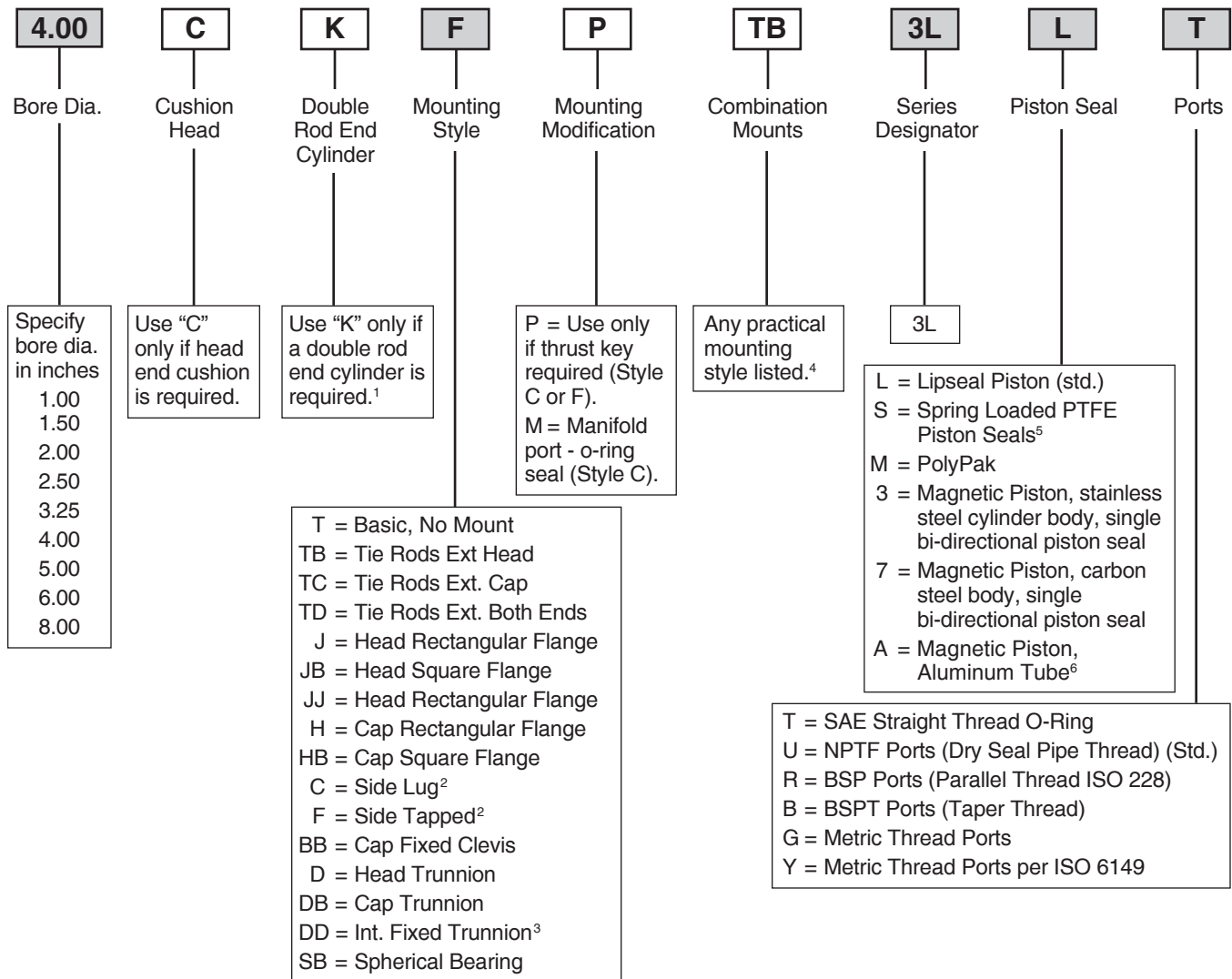
- Curved or arc line force transfer
- Can be used in compression or tension loads
- Compression loads – use DB or DD mountings
- Tension loads – use D or DD mountings

Advantages:

- Ease of mounting
- Design flexibility
- Self aligning



3L Model Code



Shaded boxes identify required model number fields.

¹ Available mounting styles for K Type cylinders are located at the end of Section A. When ordering a double rod end cylinder, the piston rod number and piston rod end threads are to be specified for both rod ends.

The model number should be created as viewing the primary rod end on the left hand side.

Example: K Type Cylinder:
4.00CKTD3LT14A28AC10.000

² Mounting Styles C and F should have a minimum stroke length equal to or greater than their bore size.

³ Specify XI dimension.

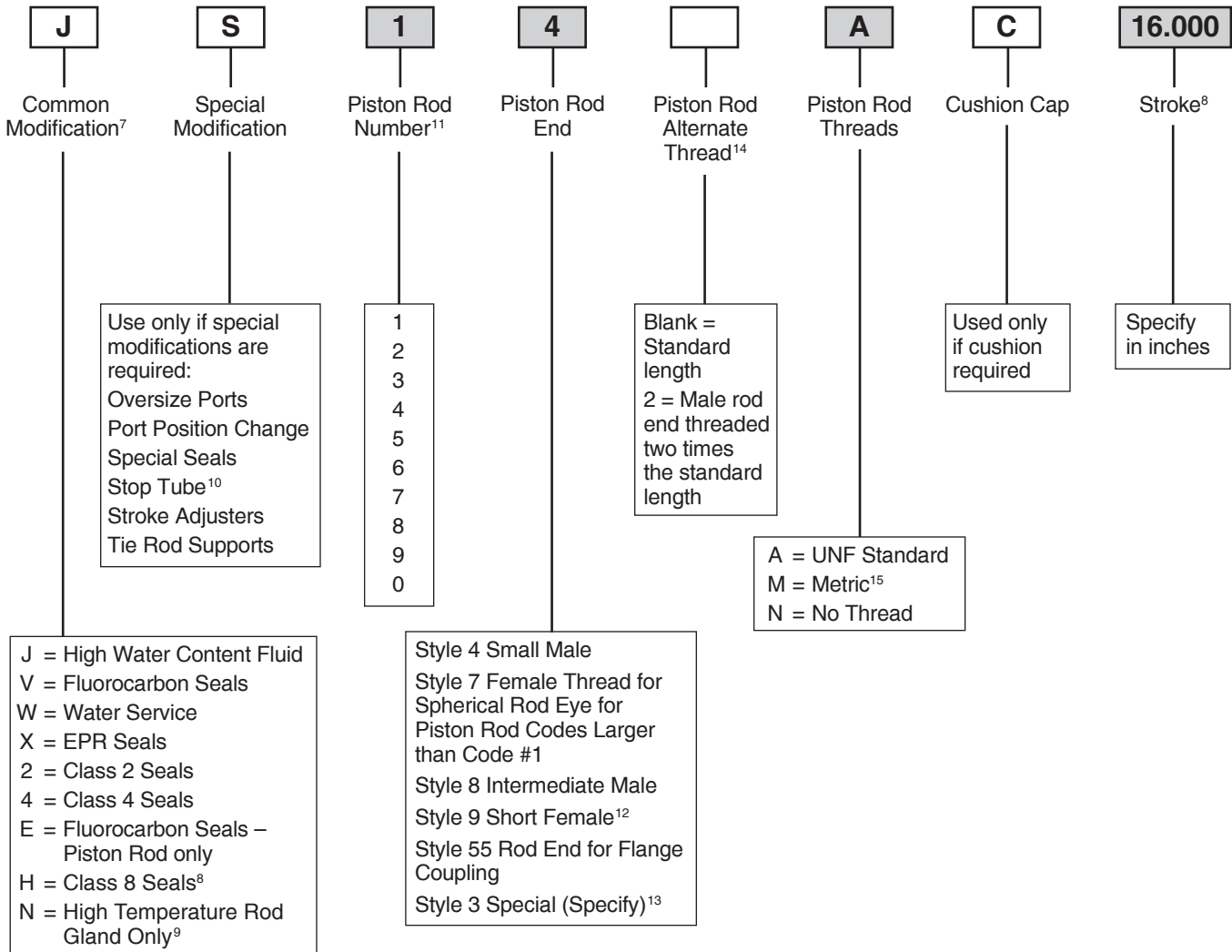
⁴ In general, the model numbers as read left to right corresponding to the cylinder as viewed from left to right with the primary end at the left. The second or subsequent mountings are mountings called out as they appear in the assembly moving away from the rod end. Except when tie rod extension mountings are part of a combination, all combinations should have a "S" (Special) in the model code and a note in the body of the order clarifying the mounting arrangement. The "P", as used to define a thrust key is not considered to be a mounting. However it is located at the primary end.

⁵ Spring loaded PTFE piston seals are not available in 1.50", 2.00" and 2.50" bore with Code 2 rod.

⁶ See 3L pressure rating table on Introduction page III for aluminum tube option associated with magnetic piston.



3L Model Code



Shaded boxes identify required model number fields.

⁷ See common modifications Section C for additional options.

⁸ Cast iron piston ring seals will be supplied in 1.50", 2.00" and 2.50" bores with Code 2 rod when Class 8 seals are specified.

⁹ Energized PTFE rod seals & wiper seal. All other seals are fluorocarbon.

¹⁰ S = Stop Tube. Specify: stop tube length, net stroke and gross stroke. Gross stroke = stop tube length + net stroke. Gross stroke to be placed in the model number field.

Example:

2.000 inches long stop tube
 +14.000 inches net stroke
 16.000 inches gross stroke

¹¹ Refer to Rod buckling chart in Section D to assure rod number selected will not buckle under load.

¹² Style 9 stroke restrictions may apply. See Style 9 Minimum Stroke Table for details.

¹³ Provide dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

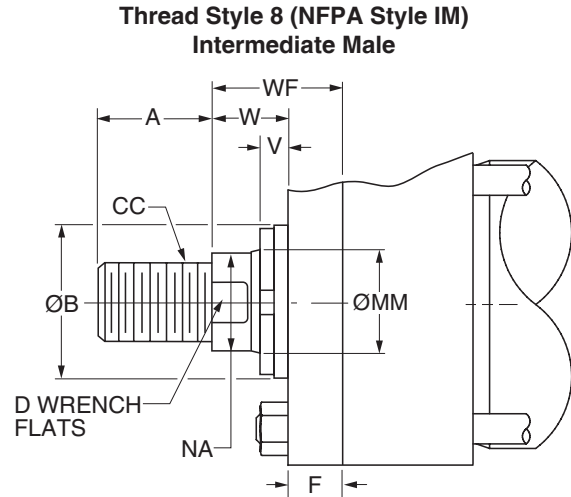
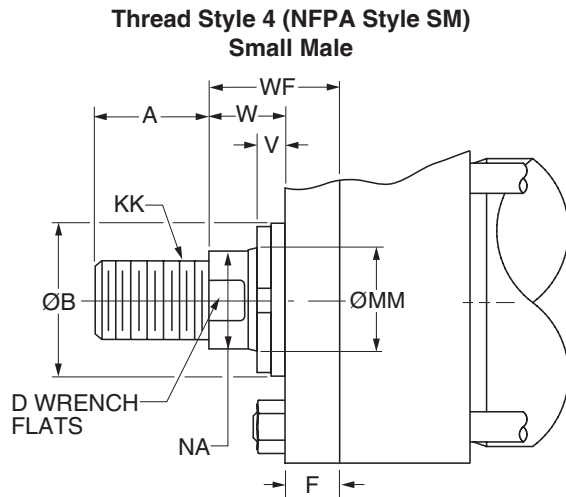
¹⁴ Available only in combination with rod end Style 4 or Style 8.

¹⁵ See Section C for detailed information regarding standard metric rod end thread sizes.

Style 9 Minimum Stroke Table

Bore Ø	Rod Ø	Minimum Stroke
1.00 - 4.00	All	None
5.00	2.000	None
	2.500	1.000
	3.000	1.375
	3.500	1.625
6.00	2.500	None
	3.000	1.375
	3.500	1.375
	4.000	2.000
8.00	3.500	1.500
	4.000	1.500
	5.000	2.875
	5.500	3.625

Rod End Dimensions



Rod End Dimensions

Bore Ø	Rod No.	MM Rod Ø	Thread		A	B Ø +.000 -.002	D	F	NA	V	W	WF
			Style 8 CC	Style 4 KK								
1.00	1 (Std.)	0.500	7/16-20	5/16-24	0.63	0.999	0.38	0.38	0.44	0.25	0.63	1.00
	2	0.625	1/2-20	7/16-20	0.75	1.124	0.50	0.38	0.56	0.25	0.63	1.00
1.50	1 (Std.)	0.625	1/2-20	7/16-20	0.75	1.124	0.50	0.38	0.56	0.25	0.63	1.00
	2	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.38	0.94	0.50	1.00	1.38
2.00	1 (Std.)	0.625	1/2-20	7/16-20	0.75	1.124	0.50	0.38	0.56	0.25	0.63	1.00
	2	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.38	1.31	0.63	1.25	1.63
	3	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.38	0.94	0.50	1.00	1.38
2.50	1 (Std.)	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.38	0.94	0.50	1.00	1.38
	2	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.38	1.69	0.75	1.50	1.88
	3	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.38	1.31	0.63	1.25	1.63
	7	0.625	1/2-20	7/16-20	0.75	1.124	0.50	0.38	0.56	0.25	0.63	1.00
3.25	1 (Std.)	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.63	0.94	0.25	0.75	1.38
	2	2.000	1 3/4-12	1 1/2-12	2.25	2.624	1.69	0.63	1.94	0.50	1.38	2.00
	3	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.63	1.31	0.38	1.00	1.63
	4	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.63	1.69	0.50	1.25	1.88
4.00	1 (Std.)	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.63	1.31	0.38	1.00	1.63
	2	2.500	2 1/4-12	1 7/8-12	3.00	3.124	2.06	0.63	2.38	0.63	1.63	2.25
	3	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.63	1.69	0.50	1.25	1.88
	4	2.000	1 3/4-12	1 1/2-12	2.25	2.624	1.69	0.63	1.94	0.50	1.38	2.00
	7	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.63	0.94	0.25	0.75	1.38
5.00	1 (Std.)	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.63	1.69	0.50	1.25	1.88
	2	3.500	3 1/4-12	2 1/2-12	3.50	4.249	3.00	0.63	3.38	0.63	1.63	2.25
	3	2.000	1 3/4-12	1 1/2-12	2.25	2.624	1.69	0.63	1.94	0.50	1.38	2.00
	4	2.500	2 1/4-12	1 7/8-12	3.00	3.124	2.06	0.63	2.38	0.63	1.63	2.25
	5	3.000	2 3/4-12	2 1/4-12	3.50	3.749	2.63	0.63	2.88	0.63	1.63	2.25
	7	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.63	0.94	0.25	0.75	1.38
	8	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.63	1.31	0.38	1.00	1.63

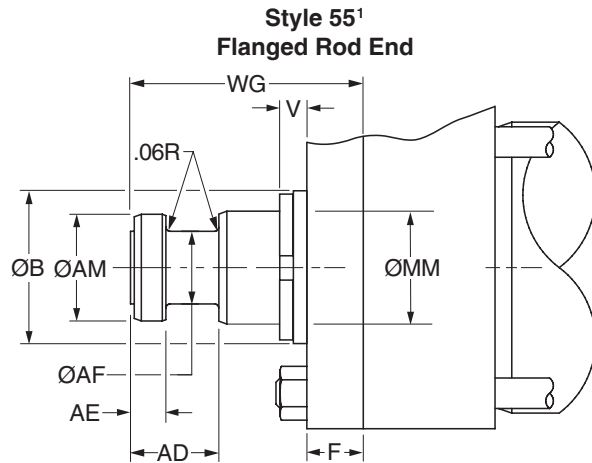
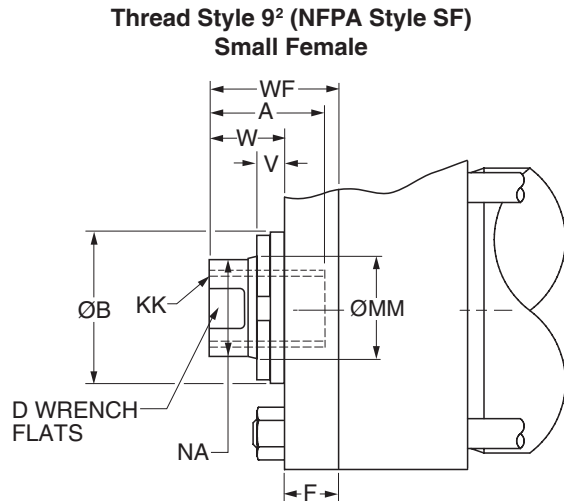
“Special” Thread Style 3

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

To order, specify “Style 3” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.



Rod End Dimensions



Rod End Dimensions

Bore Ø	Rod No.	MM Rod Ø	Thread Style 9 KK	Rod Extensions and Pilot Dimensions												
				A	AD	AE +.001 -.001	AF Ø	AM Ø	B Ø +.000 -.002	D	F	NA	V	W	WF	WG
1.00	1 (Std.)	0.500	5/16-24	0.63	—	—	—	—	0.999	0.38	0.38	0.44	0.25	0.63	1.00	—
	2	0.625	7/16-20	0.75	0.63	0.25	0.38	0.57	1.124	0.50	0.38	0.56	0.25	0.63	1.00	1.75
1.50	1 (Std.)	0.625	7/16-20	0.75	0.63	0.25	0.38	0.57	1.124	0.50	0.38	0.56	0.25	0.63	1.00	1.75
	2	1.000	3/4-16	1.13	0.94	0.38	0.69	0.95	1.499	0.88	0.38	0.94	0.50	1.00	1.38	2.38
2.00	1 (Std.)	0.625	7/16-20	0.75	0.63	0.25	0.38	0.57	1.124	0.50	0.38	0.56	0.25	0.63	1.00	1.75
	2	1.375	1-14	1.63	1.06	0.38	0.88	1.32	1.999	1.13	0.38	1.31	0.63	1.25	1.63	2.75
	3	1.000	3/4-16	1.13	0.94	0.38	0.69	0.95	1.499	0.88	0.38	0.94	0.50	1.00	1.38	2.38
2.50	1 (Std.)	1.000	3/4-16	1.13	0.94	0.38	0.69	0.95	1.499	0.88	0.38	0.94	0.50	1.00	1.38	2.38
	2	1.750	1 1/4-12	2.00	1.31	0.50	1.13	1.70	2.374	1.50	0.38	1.69	0.75	1.50	1.88	3.13
	3	1.375	1-14	1.63	1.06	0.38	0.88	1.32	1.999	1.13	0.38	1.31	0.63	1.25	1.63	2.75
	7	0.625	7/16-20	0.75	0.63	0.25	0.38	0.57	1.124	0.50	0.38	0.56	0.25	0.63	1.00	1.75
3.25	1 (Std.)	1.000	3/4-16	1.13	0.94	0.38	0.69	0.95	1.499	0.88	0.63	0.94	0.25	0.75	1.38	2.38
	2	2.000	1 1/2-12	2.25	1.69	0.63	1.38	1.95	2.624	1.69	0.63	1.94	0.50	1.38	2.00	3.75
	3	1.375	1-14	1.63	1.06	0.38	0.88	1.32	1.999	1.13	0.63	1.31	0.38	1.00	1.63	2.75
	4	1.750	1 1/4-12	2.00	1.31	0.50	1.13	1.70	2.374	1.50	0.63	1.69	0.50	1.25	1.88	3.13
4.00	1 (Std.)	1.375	1-14	1.63	1.06	0.38	0.88	1.32	1.999	1.13	0.63	1.31	0.38	1.00	1.63	2.75
	2	2.500	1 7/8-12	3.00	1.94	0.75	1.75	2.45	3.124	2.06	0.63	2.38	0.63	1.63	2.25	4.50
	3	1.750	1 1/4-12	2.00	1.31	0.50	1.13	1.70	2.374	1.50	0.63	1.69	0.50	1.25	1.88	3.13
	4	2.000	1 1/2-12	2.25	1.69	0.63	1.38	1.95	2.624	1.69	0.63	1.94	0.50	1.38	2.00	3.75
	7	1.000	3/4-16	1.13	0.94	0.38	0.69	0.95	1.499	0.88	0.63	0.94	0.25	0.75	1.38	2.38
5.00	1 (Std.)	1.750	1 1/4-12	2.00	1.31	0.50	1.13	1.70	2.374	1.50	0.63	1.69	0.50	1.25	1.88	3.13
	2	3.500	2 1/2-12	3.50	2.69	1.00	2.50	3.45	4.249	3.00	0.63	3.38	0.63	1.63	2.25	5.63
	3	2.000	1 1/2-12	2.25	1.69	0.63	1.38	1.95	2.624	1.69	0.63	1.94	0.50	1.38	2.00	3.75
	4	2.500	1 7/8-12	3.00	1.94	0.75	1.75	2.45	3.124	2.06	0.63	2.38	0.63	1.63	2.25	4.50
	5	3.000	2 1/4-12	3.50	2.44	0.88	2.25	2.95	3.749	2.63	0.63	2.88	0.63	1.63	2.25	4.88
	7	1.000	3/4-16	1.13	0.94	0.38	0.69	0.95	1.499	0.88	0.63	0.94	0.25	0.75	1.38	2.38
	8	1.375	1-14	1.63	1.06	0.38	0.88	1.32	1.999	1.13	0.63	1.31	0.38	1.00	1.63	2.75

“Special” Thread Style 3

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

To order, specify “Style 3” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

¹ For special WG dimension, specify “Style 3” and give desired dimension for WG. For other changes, place “S” in the model code, and describe rod end with dimensioned sketch.

² Style 9 stroke restrictions may apply. See Style 9 Minimum Stroke Table on How to Order page for details.



Mounting Information – 1.00" to 5.00" Bore

Tie Rods Extended Head End Mounting
Style TB
(NFFA Style MX3)

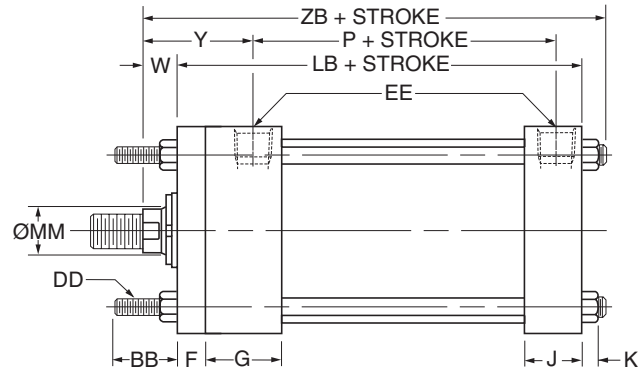
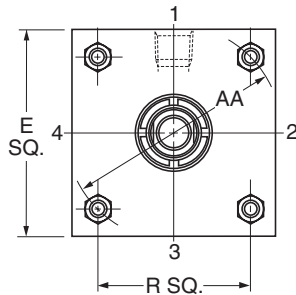
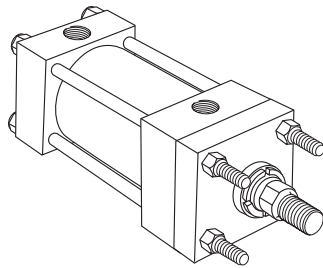


Table 1 – Dimensional and Mounting Data

Bore Ø	AA	BB	DD	E	EE		F	G	J	K	R	Add Stroke	
					NPTF ¹	SAE ²						LB	P
1.00 ³	1.53	0.75	10-24	4	1/4 ⁵	6	0.38	1.50	1.00	0.19	1.08	3.88	2.13
1.50	2.02	1.00	1/4-28	2.00	3/8 ⁵	6 ⁶	0.38	1.50	1.00	0.25	1.43	4.00	2.25
2.00	2.60	1.13	5/16-24	2.50	3/8 ⁵	6	0.38	1.50	1.00	0.31	1.84	4.00	2.25
2.50	3.10	1.13	5/16-24	3.00	3/8 ⁵	6	0.38	1.50	1.00	0.31	2.19	4.13	2.38
3.25	3.90	1.38	3/8-24	3.75	1/2	10	0.63	1.75	1.25	0.38	2.76	4.88	2.63
4.00	4.70	1.38	3/8-24	4.50	1/2	10	0.63	1.75	1.25	0.38	3.32	4.88	2.63
5.00	5.80	1.81	1/2-20	5.50	1/2	10	0.63	1.75	1.25	0.44	4.10	5.13	2.88

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke
					ZB Max
1.00	1 (Std.)	0.500	0.63	1.94	5.00
	2	0.625	0.63	1.94	5.00
1.50	1 (Std.)	0.625	0.63	1.94	5.06
	2	1.000	1.00	2.31	5.44
2.00	1 (Std.)	0.625	0.63	1.94	5.13
	2	1.375	1.25	2.56	5.75
2.50	1 (Std.)	1.000	1.00	2.31	5.63
	2	1.750	1.50	2.81	6.13
	3	1.375	1.25	2.56	5.88
	7	0.625	0.63	1.94	5.25
3.25	1 (Std.)	1.000	0.75	2.44	6.19
	2	2.000	1.38	3.06	6.81
	3	1.375	1.00	2.69	6.44
	4	1.750	1.25	2.94	6.69

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke
					ZB Max
4.00	1 (Std.)	1.375	1.00	2.69	6.44
	2	2.500	1.63	3.31	7.06
	3	1.750	1.25	2.94	6.69
	4	2.000	1.38	3.06	6.81
5.00	7	1.000	0.75	2.44	6.19
	1 (Std.)	1.750	1.25	2.94	7.06
	2	3.500	1.63	3.31	7.44
	3	2.000	1.38	3.06	7.31
	4	2.500	1.63	3.31	7.44
	5	3.000	1.63	3.31	7.44
	7	1.000	0.75	2.44	6.56
	8	1.375	1.00	2.69	6.81

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.

⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page.

⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.

⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.

Style TB (NFFA MX3) Head Tie Rods Extended, illustrated: **Style TC** (NFFA MX2), Cap Tie Rods Extended; and **Style TD** (NFFA MX1), Both Ends Tie Rod Extended area also available. All "T" styles can be dimensioned from Style TB drawing above. Basic Mounting (T) – NFFA MX0 – no tie rods extended can be supplied upon request.

Mounting Information – 1.00" to 6.00" Bore Series 3L

Head Rectangular Flange Mounting

Style J
(NFPA Style MF1)

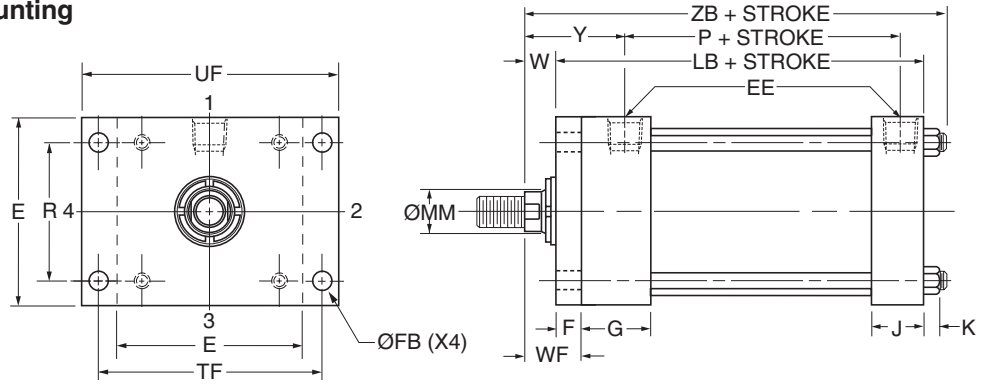
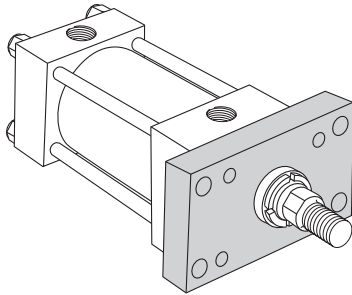


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	FB Ø	G	J	K	R	TF	UF	Add Stroke	
		NPTF ¹	SAE ²									LB	P
1.00 ³	4	1/4 ⁵	6	0.38	0.25	1.50	1.00	0.19	1.08	2.00	2.50	3.88	2.13
1.50	2.00	3/8 ⁵	6 ⁶	0.38	0.31	1.50	1.00	0.25	1.43	2.75	3.38	4.00	2.25
2.00	2.50	3/8 ⁵	6	0.38	0.38	1.50	1.00	0.31	1.84	3.38	4.13	4.00	2.25
2.50	3.00	3/8 ⁵	6	0.38	0.38	1.50	1.00	0.31	2.19	3.88	4.63	4.13	2.38
3.25	3.75	1/2	10	0.63	0.44	1.75	1.25	0.38	2.76	4.69	5.50	4.88	2.63
4.00	4.50	1/2	10	0.63	0.44	1.75	1.25	0.38	3.32	5.44	6.25	4.88	2.63
5.00	5.50	1/2	10	0.63	0.56	1.75	1.25	0.44	4.10	6.63	7.63	5.13	2.88
6.00	6.50	3/4	12	0.75	0.56	2.00	1.50	0.44	4.88	7.63	8.63	5.75	3.13

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	WF	Y	Add Stroke	
						ZB Max	
1.00	1 (Std.)	0.500	0.63	1.00	1.94	5.00	
	2	0.625	0.63	1.00	1.94	5.00	
1.50	1 (Std.)	0.625	0.63	1.00	1.94	5.06	
	2	1.000	1.00	1.38	2.31	5.44	
2.00	1 (Std.)	0.625	0.63	1.00	1.94	5.13	
	2	1.375	1.25	1.63	2.56	5.75	
	3	1.000	1.00	1.38	2.31	5.50	
2.50	1 (Std.)	1.000	1.00	1.38	2.31	5.63	
	2	1.750	1.50	1.88	2.81	6.13	
	3	1.375	1.25	1.63	2.56	5.88	
	7	0.625	0.63	1.00	1.94	5.25	
3.25	1 (Std.)	1.000	0.75	1.38	2.44	6.19	
	2	2.000	1.38	2.00	3.06	6.81	
	3	1.375	1.00	1.63	2.69	6.44	
	4	1.750	1.25	1.88	2.94	6.69	
4.00	1 (Std.)	1.375	1.00	1.63	2.69	6.44	
	2	2.500	1.63	2.25	3.31	7.06	
	3	1.750	1.25	1.88	2.94	6.69	
	4	2.000	1.38	2.00	3.06	6.81	
	7	1.000	0.75	1.38	2.44	6.19	

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.
² SAE straight thread ports are indicated by port number.

Table 3 – Maximum Operating Pressure

Bore Ø	Rod No.	MM Rod Ø	W	WF	Y	Add Stroke	Max. psi Push			
							Rod Code			
							1	2	3	4
1.00	1 (Std.)	1.750	1.25	1.88	2.94	7.06	1900	1500	–	–
	2	3.500	1.63	2.25	3.31	7.44	1400	850	–	–
	3	2.000	1.38	2.00	3.06	7.31	1050	450	800	–
	4	2.500	1.63	2.25	3.31	7.44	700	350	500	–
	5	3.000	1.63	2.25	3.31	7.44	1300	900	1300	1000
	7	1.000	0.75	1.38	2.44	6.56	900	700	900	900
	8	1.375	1.00	1.63	2.69	6.81	600	400	700	600
	1 (Std.)	1.750	1.13	1.88	3.06	7.56	700	450	700	700
5.00	2	4.000	1.50	2.25	3.44	7.94	Bore Ø			
	3	2.000	1.25	2.00	3.19	7.69	Max. psi Push			
	4	2.500	1.50	2.25	3.44	7.94	Rod Code			
	5	3.000	1.50	2.25	3.44	7.94	5	6	7	8
	6	3.500	1.50	2.25	3.44	7.94	2.50	–	700	–
	7	1.375	0.88	1.63	2.81	7.31	3.25	–	–	–
	4.00	–	–	–	–	–	4.00	–	900	–
5.00	450	–	600	800	–	5.00	450	–	600	800
6.00	650	600	700	–	–	6.00	650	600	700	–

³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.
⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page.
⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.
⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.



Mounting Information – 1.00" to 5.00" Bore Series 3L

**Head Square Flange Mounting
Style JB
(NFPA Style MF5)**

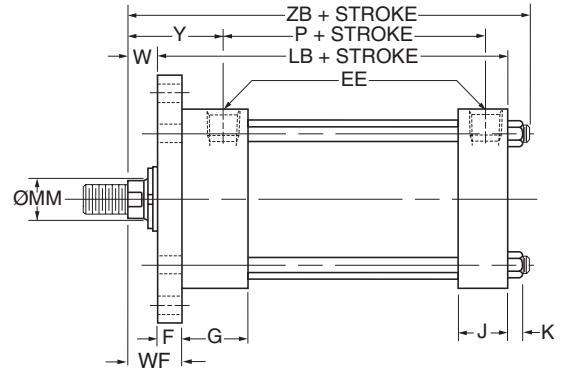
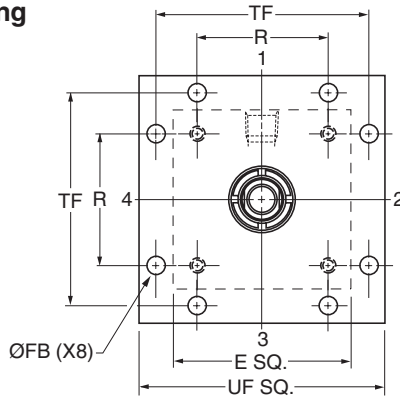
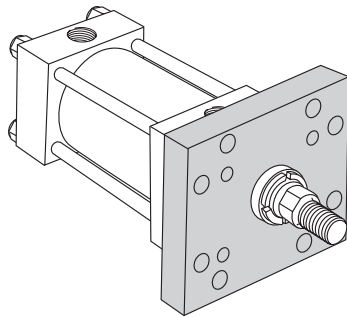


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	FB Ø	G	J	K	R	TF	UF	Add Stroke	
		NPTF ¹	SAE ²									LB	P
1.00 ³	4	1/4 ⁵	6	0.38	0.25	1.50	1.00	0.19	1.08	2.00	2.50	3.88	2.13
1.50	2.00	3/8 ⁵	6 ⁶	0.38	0.31	1.50	1.00	0.25	1.43	2.75	3.38	4.00	2.25
2.00	2.50	3/8 ⁵	6	0.38	0.38	1.50	1.00	0.31	1.84	3.38	4.13	4.00	2.25
2.50	3.00	3/8 ⁵	6	0.38	0.38	1.50	1.00	0.31	2.19	3.88	4.63	4.13	2.38
3.25	3.75	1/2	10	0.63	0.44	1.75	1.25	0.38	2.76	4.69	5.50	4.88	2.63
4.00	4.50	1/2	10	0.63	0.44	1.75	1.25	0.38	3.32	5.44	6.25	4.88	2.63
5.00	5.50	1/2	10	0.63	0.56	1.75	1.25	0.44	4.10	6.63	7.63	5.13	2.88

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	WF	Y	Add Stroke
						ZB Max.
1.00	1 (Std.)	0.500	0.63	1.00	1.94	5.00
	2	0.625	0.63	1.00	1.94	5.00
1.50	1 (Std.)	0.625	0.63	1.00	1.94	5.06
	2	1.000	1.00	1.38	2.31	5.44
2.00	1 (Std.)	0.625	0.63	1.00	1.94	5.13
	2	1.375	1.25	1.63	2.56	5.75
	3	1.000	1.00	1.38	2.31	5.50
2.50	1 (Std.)	1.000	1.00	1.38	2.31	5.63
	2	1.750	1.50	1.88	2.81	6.13
	3	1.375	1.25	1.63	2.56	5.88
	7	0.625	0.63	1.00	1.94	5.25
3.25	1 (Std.)	1.000	0.75	1.38	2.44	6.19
	2	2.000	1.38	2.00	3.06	6.81
	3	1.375	1.00	1.63	2.69	6.44
	4	1.750	1.25	1.88	2.94	6.69

Bore Ø	Rod No.	MM Rod Ø	W	WF	Y	Add Stroke
						ZB Max.
4.00	1 (Std.)	1.375	1.00	1.63	2.69	6.44
	2	2.500	1.63	2.25	3.31	7.06
	3	1.750	1.25	1.88	2.94	6.69
	4	2.000	1.38	2.00	3.06	6.81
5.00	7	1.000	0.75	1.38	2.44	6.19
	1 (Std.)	1.750	1.25	1.88	2.94	7.06
	2	3.500	1.63	2.25	3.31	7.44
	3	2.000	1.38	2.00	3.06	7.31
	4	2.500	1.63	2.25	3.31	7.44
	5	3.000	1.63	2.25	3.31	7.44
	7	1.000	0.75	1.38	2.44	6.56
	8	1.375	1.00	1.63	2.69	6.81

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.
² SAE straight thread ports are indicated by port number.
³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.
⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page.

⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.
⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.

Mounting Information – 1.50" to 6.00" Bore Series 3L

Head Rectangular Mounting
Style JJ³

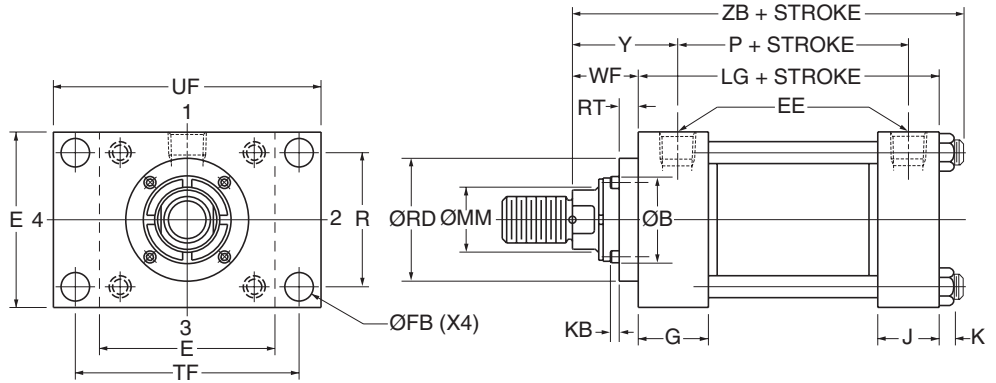
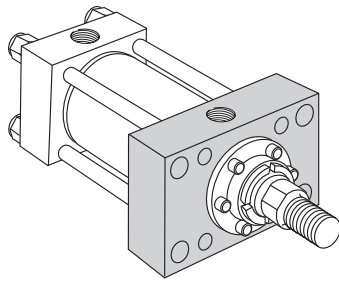


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		FB Ø	G	J	K	R	TF	UF	Add Stroke	
		NPTF ¹	SAE ²								LG	P
1.50	2.00	3/8 ⁴	6 ⁵	0.31	1.50	1.00	0.25	1.43	2.31	2.75	3.63	2.25
2.00	2.50	3/8 ⁴	6	0.38	1.50	1.00	0.31	1.84	2.88	3.38	3.63	2.25
2.50	3.00	3/8 ⁴	6	0.38	1.50	1.00	0.31	2.19	3.25	3.75	3.75	2.38
3.25	3.75	1/2	10	0.44	1.75	1.25	0.38	2.76	4.00	4.63	4.25	2.63
4.00	4.50	1/2	10	0.44	1.75	1.25	0.38	3.32	4.50	5.13	4.25	2.63
5.00	5.50	1/2	10	0.56	1.75	1.25	0.44	4.10	5.63	6.44	4.50	2.88
6.00	6.50	3/4	12	0.56	2.00	1.50	0.44	4.88	6.44	7.25	5.00	3.13

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	B Ø +0.000 -0.002	KB	RD Ø Max	RT	WF	Y	Add Stroke
									ZB Max
1.50	1 (Std.)	0.625	1.124	0.19	1.967	0.25	1.00	1.94	5.06
2.00	1 (Std.)	0.625	1.124	0.19	1.967	0.25	1.00	1.94	5.13
	3	1.000	1.499	0.25	2.467	0.38	1.38	2.31	5.50
2.50	1 (Std.)	1.000	1.499	0.25	2.467	0.38	1.38	2.31	5.63
	3	1.375	1.999	0.25	2.967	0.38	1.63	2.56	5.88
3.25	1 (Std.)	1.000	1.499	0.25	2.467	0.38	1.38	2.44	6.19
	3	1.375	1.999	0.25	2.967	0.38	1.63	2.69	6.44
4.00	1 (Std.)	1.375	1.999	0.25	2.967	0.38	1.63	2.69	6.44
	3	1.750	2.374	0.25	3.467	0.38	1.88	2.94	6.69
5.00	1 (Std.)	1.750	2.374	0.25	3.467	0.38	1.88	2.94	7.06
	3	2.000	2.624	0.25	3.717	0.38	2.00	3.06	7.31
6.00	1 (Std.)	1.750	2.374	0.25	3.467	0.38	1.88	3.06	7.56
	3	2.000	2.624	0.25	3.717	0.38	2.00	3.19	7.69

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ Parker Style JJ Mount is a Non-NFPA Mount.

⁴ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.

⁵ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.



Mounting Information – 1.00" to 6.00" Bore Series 3L

**Cap Rectangular Flange Mounting
Style H
(NFPA Style MF2)**

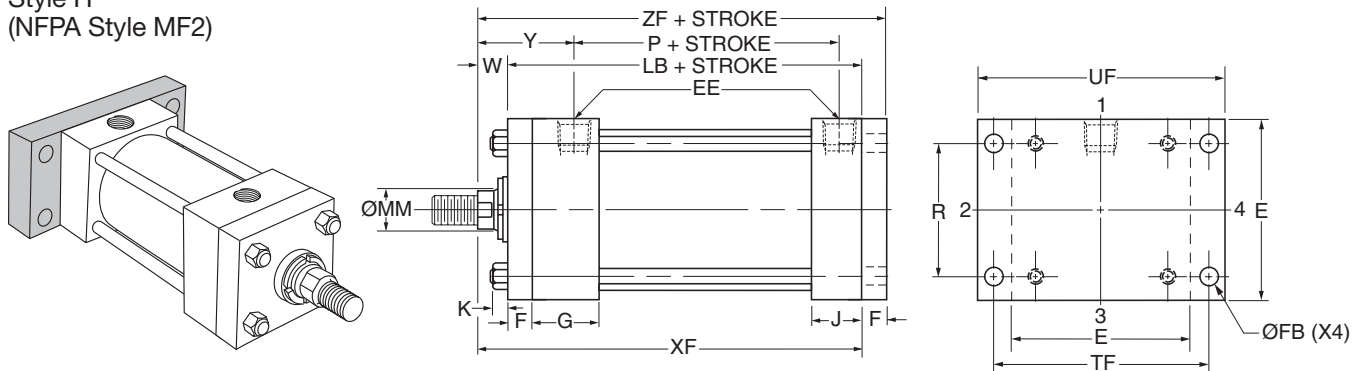


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	FB Ø	G	J	K	R	TF	UF	Add Stroke	
		NPTF ¹	SAE ²									LB	P
1.00 ⁵	4	1/4 ⁵	6	0.38	0.25	1.50	1.00	0.19	1.08	2.00	2.50	3.88	2.13
1.50	2.00	3/8 ⁵	6 ⁶	0.38	0.31	1.50	1.00	0.25	1.43	2.75	3.38	4.00	2.25
2.00	2.50	3/8 ⁵	6	0.38	0.38	1.50	1.00	0.31	1.84	3.38	4.13	4.00	2.25
2.50	3.00	3/8 ⁵	6	0.38	0.38	1.50	1.00	0.31	2.19	3.88	4.63	4.13	2.38
3.25	3.75	1/2	10	0.63	0.44	1.75	1.25	0.38	2.76	4.69	5.50	4.88	2.63
4.00	4.50	1/2	10	0.63	0.44	1.75	1.25	0.38	3.32	5.44	6.25	4.88	2.63
5.00	5.50	1/2	10	0.63	0.56	1.75	1.25	0.44	4.10	6.63	7.63	5.13	2.88
6.00	6.50	3/4	12	0.75	0.56	2.00	1.50	0.44	4.88	7.63	8.63	5.75	3.13

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XF	ZF
1.00	1 (Std.)	0.500	0.63	1.94	4.50	4.88
	2	0.625	0.63	1.94	4.50	4.88
1.50	1 (Std.)	0.625	0.63	1.94	4.63	5.00
	2	1.000	1.00	2.31	5.00	5.38
2.00	1 (Std.)	0.625	0.63	1.94	4.63	5.00
	2	1.375	1.25	2.56	5.25	5.63
	3	1.000	1.00	2.31	5.00	5.38
2.50	1 (Std.)	1.000	1.00	2.31	5.13	5.50
	2	1.750	1.50	2.81	5.63	6.00
	3	1.375	1.25	2.56	5.38	5.75
	7	0.625	0.63	1.94	4.75	5.13
3.25	1 (Std.)	1.000	0.75	2.44	5.63	6.25
	2	2.000	1.38	3.06	6.25	6.88
	3	1.375	1.00	2.69	5.88	6.50
	4	1.750	1.25	2.94	6.13	6.75
4.00	1 (Std.)	1.375	1.00	2.69	5.88	6.50
	2	2.500	1.63	3.31	6.50	7.13
	3	1.750	1.25	2.94	6.13	6.75
	4	2.000	1.38	3.06	6.25	6.88
4.00	7	1.000	0.75	2.44	5.63	6.25

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XF	ZF
5.00	1 (Std.)	1.750	1.25	2.94	6.38	7.00
	2	3.500	1.63	3.31	6.75	7.38
	3	2.000	1.38	3.06	6.50	7.13
	4	2.500	1.63	3.31	6.75	7.38
	5	3.000	1.63	3.31	6.75	7.38
	7	1.000	0.75	2.44	5.88	6.50
	8	1.375	1.00	2.69	6.13	6.75
6.00	1 (Std.)	1.750	1.13	3.06	6.88	7.63
	2	4.000	1.50	3.44	7.25	8.00
	3	2.000	1.25	3.19	7.00	7.75
	4	2.500	1.50	3.44	7.25	8.00
	5	3.000	1.50	3.44	7.25	8.00
	6	3.500	1.50	3.44	7.25	8.00
	7	1.375	0.88	2.81	6.63	7.38

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.
² SAE straight thread ports are indicated by port number.
³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.

⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page.
⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.
⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.



Mounting Information – 1.00" to 5.00" Bore Series 3L

Cap Square Flange Mounting

Style HB
(NFPA Style MF6)

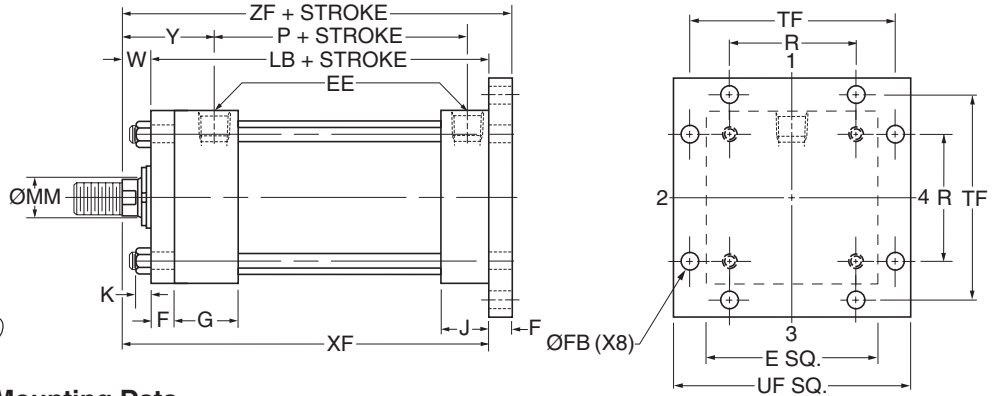
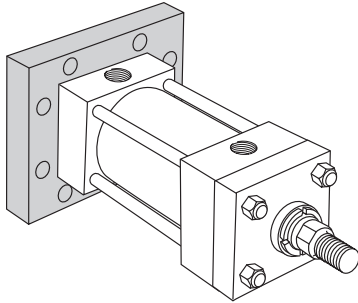


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	FB Ø	G	J	K	R	TF	UF	Add Stroke	
		NPTF ¹	SAE ²									LB	P
1.00 ³	4	1/4 ⁵	6	0.38	0.25	1.50	1.00	0.19	1.08	2.00	2.50	3.88	2.13
1.50	2.00	3/8 ⁵	6 ⁶	0.38	0.31	1.50	1.00	0.25	1.43	2.75	3.38	4.00	2.25
2.00	2.50	3/8 ⁵	6	0.38	0.38	1.50	1.00	0.31	1.84	3.38	4.13	4.00	2.25
2.50	3.00	3/8 ⁵	6	0.38	0.38	1.50	1.00	0.31	2.19	3.88	4.63	4.13	2.38
3.25	3.75	1/2	10	0.63	0.44	1.75	1.25	0.38	2.76	4.69	5.50	4.88	2.63
4.00	4.50	1/2	10	0.63	0.44	1.75	1.25	0.38	3.32	5.44	6.25	4.88	2.63
5.00	5.50	1/2	10	0.63	0.56	1.75	1.25	0.44	4.10	6.63	7.63	5.13	2.88

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XF	ZF
1.00	1 (Std.)	0.500	0.63	1.94	4.50	4.88
	2	0.625	0.63	1.94	4.50	4.88
1.50	1 (Std.)	0.625	0.63	1.94	4.63	5.00
	2	1.000	1.00	2.31	5.00	5.38
2.00	1 (Std.)	0.625	0.63	1.94	4.63	5.00
	2	1.375	1.25	2.56	5.25	5.63
	3	1.000	1.00	2.31	5.00	5.38
2.50	1 (Std.)	1.000	1.00	2.31	5.13	5.50
	2	1.750	1.50	2.81	5.63	6.00
	3	1.375	1.25	2.56	5.38	5.75
	7	0.625	0.63	1.94	4.75	5.13
3.25	1 (Std.)	1.000	0.75	2.44	5.63	6.25
	2	2.000	1.38	3.06	6.25	6.88
	3	1.375	1.00	2.69	5.88	6.50
	4	1.750	1.25	2.94	6.13	6.75

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XF	ZF
4.00	1 (Std.)	1.375	1.00	2.69	5.88	6.50
	2	2.500	1.63	3.31	6.50	7.13
	3	1.750	1.25	2.94	6.13	6.75
	4	2.000	1.38	3.06	6.25	6.88
5.00	7	1.000	0.75	2.44	5.63	6.25
	1 (Std.)	1.750	1.25	2.94	6.38	7.00
	2	3.500	1.63	3.31	6.75	7.38
	3	2.000	1.38	3.06	6.50	7.13
	4	2.500	1.63	3.31	6.75	7.38
	5	3.000	1.63	3.31	6.75	7.38
	7	1.000	0.75	2.44	5.88	6.50
	8	1.375	1.00	2.69	6.13	6.75

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.

⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page.

⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.

⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.



Mounting Information – 1.00" to 5.00" Bore Series 3L

Side Lug Mounting

Style C
(NFPA Style MS2)

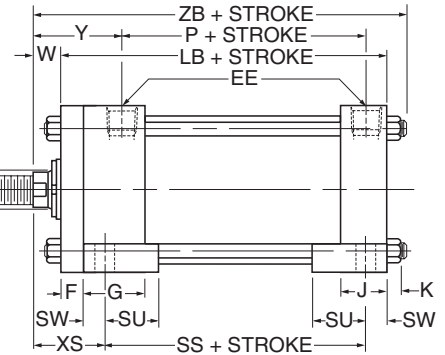
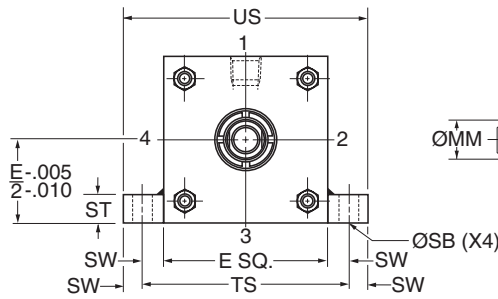
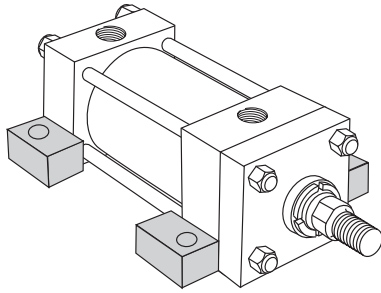


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	G	J	K	SB Ø	ST	SU	SW	TS	US	Add Stroke		
		NPTF ¹	SAE ²											LB	P	SS
1.00 ³	4	1/4 ⁵	6	0.38	1.50	1.00	0.19	0.28	0.31	0.75	0.31	2.13	2.75	3.88	2.13	2.88
1.50	2.00	3/8 ⁵	6 ⁶	0.38	1.50	1.00	0.25	0.44	0.50	0.94	0.38	2.75	3.50	4.00	2.25	2.88
2.00	2.50	3/8 ⁵	6	0.38	1.50	1.00	0.31	0.44	0.50	0.94	0.38	3.25	4.00	4.00	2.25	2.88
2.50	3.00	3/8 ⁵	6	0.38	1.50	1.00	0.31	0.44	0.50	0.94	0.38	3.75	4.50	4.13	2.38	3.00
3.25	3.75	1/2	10	0.63	1.75	1.25	0.38	0.56	0.75	1.25	0.50	4.75	5.75	4.88	2.63	3.25
4.00	4.50	1/2	10	0.63	1.75	1.25	0.38	0.56	0.75	1.25	0.50	5.50	6.50	4.88	2.63	3.25
5.00	5.50	1/2	10	0.63	1.75	1.25	0.44	0.81	1.00	1.56	0.69	6.88	8.25	5.13	2.88	3.13

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	XS	Y	Add Stroke
						ZB Max.
1.00	1 (Std.)	0.500	0.63	1.31	1.94	5.00
	2	0.625	0.63	1.31	1.94	5.00
1.50	1 (Std.)	0.625	0.63	1.38	1.94	5.06
	2	1.000	1.00	1.75	2.31	5.44
2.00	1 (Std.)	0.625	0.63	1.38	1.94	5.13
	2	1.375	1.25	2.00	2.56	5.75
	3	1.000	1.00	1.75	2.31	5.50
2.50	1 (Std.)	1.000	1.00	1.75	2.31	5.63
	2	1.750	1.50	2.25	2.81	6.13
	3	1.375	1.25	2.00	2.56	5.88
	7	0.625	0.63	1.38	1.94	5.25
3.25	1 (Std.)	1.000	0.75	1.88	2.44	6.19
	2	2.000	1.38	2.50	3.06	6.81
	3	1.375	1.00	2.13	2.69	6.44
	4	1.750	1.25	2.38	2.94	6.69

Bore Ø	Rod No.	MM Rod Ø	W	XS	Y	Add Stroke
						ZB Max.
4.00	1 (Std.)	1.375	1.00	2.13	2.69	6.44
	2	2.500	1.63	2.75	3.31	7.06
	3	1.750	1.25	2.38	2.94	6.69
	4	2.000	1.38	2.50	3.06	6.81
5.00	7	1.000	0.75	1.88	2.44	6.19
	1 (Std.)	1.750	1.25	2.56	2.94	7.06
	2	3.500	1.63	2.94	3.31	7.44
	3	2.000	1.38	2.69	3.06	7.31
	4	2.500	1.63	2.94	3.31	7.44
	5	3.000	1.63	2.94	3.31	7.44
	7	1.000	0.75	2.06	2.44	6.56
	8	1.375	1.00	2.31	2.69	6.81

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.

⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page. E/2 for this bore is .750 -.005/-.010.

⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.

⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.

Side Tapped Mounting
Style F
(NFPA Style MS4)

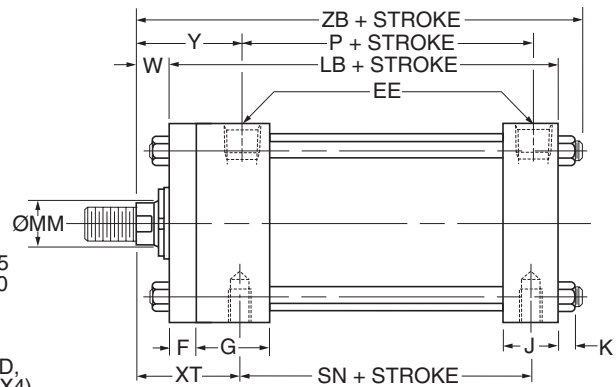
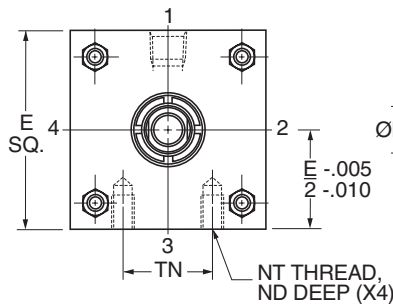
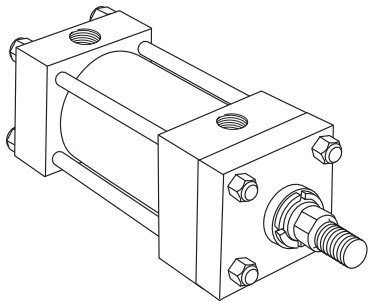


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	G	J	K	ND	NT	TN	Add Stroke		
		NPTF ¹	SAE ²								LB	P	SN
1.00 ³	4	1/4 ⁵	6	0.38	1.50	1.00	0.19	0.25	10-24	0.56	3.88	2.13	2.13
1.50	2.00	3/8 ⁵	6 ⁶	0.38	1.50	1.00	0.25	0.19	1/4-20	0.63	4.00	2.25	2.25
2.00	2.50	3/8 ⁵	6	0.38	1.50	1.00	0.31	0.34	5/16-18	0.88	4.00	2.25	2.25
2.50	3.00	3/8 ⁵	6	0.38	1.50	1.00	0.31	0.44	3/8-16	1.25	4.13	2.38	2.38
3.25	3.75	1/2	10	0.63	1.75	1.25	0.38	0.50	1/2-13	1.50	4.88	2.63	2.63
4.00	4.50	1/2	10	0.63	1.75	1.25	0.38	0.63	1/2-13	2.06	4.88	2.63	2.63
5.00	5.50	1/2	10	0.63	1.75	1.25	0.44	0.75	5/8-11	2.69	5.13	2.88	2.88

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	XT	Y	Add Stroke
						ZB Max.
1.00	1 (Std.)	0.500	0.63	1.94	1.94	5.00
	2	0.625	0.63	1.94	1.94	5.00
1.50	1 (Std.)	0.625	0.63	1.94	1.94	5.06
	2	1.000	1.00	2.31	2.31	5.44
2.00	1 (Std.)	0.625	0.63	1.94	1.94	5.13
	2	1.375	1.25	2.56	2.56	5.75
	3	1.000	1.00	2.31	2.31	5.50
2.50	1 (Std.)	1.000	1.00	2.31	2.31	5.63
	2	1.750	1.50	2.81	2.81	6.13
	3	1.375	1.25	2.56	2.56	5.88
	7	0.625	0.63	1.94	1.94	5.25
3.25	1 (Std.)	1.000	0.75	2.44	2.44	6.19
	2	2.000	1.38	3.06	3.06	6.81
	3	1.375	1.00	2.69	2.69	6.44
	4	1.750	1.25	2.94	2.94	6.69

Bore Ø	Rod No.	MM Rod Ø	W	XT	Y	Add Stroke
						ZB Max.
4.00	1 (Std.)	1.375	1.00	2.69	2.69	6.44
	2	2.500	1.63	3.31	3.31	7.06
	3	1.750	1.25	2.94	2.94	6.69
	4	2.000	1.38	3.06	3.06	6.81
5.00	7	1.000	0.75	2.44	2.44	6.19
	1 (Std.)	1.750	1.25	2.94	2.94	7.06
	2	3.500	1.63	3.31	3.31	7.44
	3	2.000	1.38	3.06	3.06	7.31
	4	2.500	1.63	3.31	3.31	7.44
	5	3.000	1.63	3.31	3.31	7.44
	7	1.000	0.75	2.44	2.44	6.56
	8	1.375	1.00	2.69	2.69	6.81

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.

⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page. E/2 for this bore is .750 -0.005/-0.010.

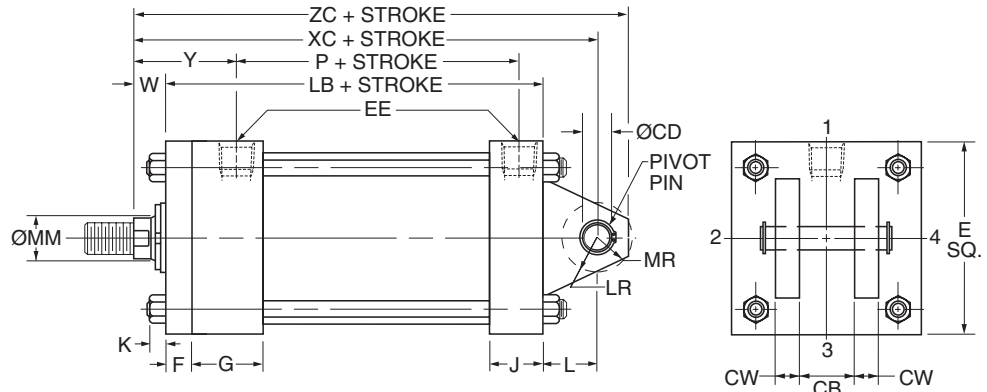
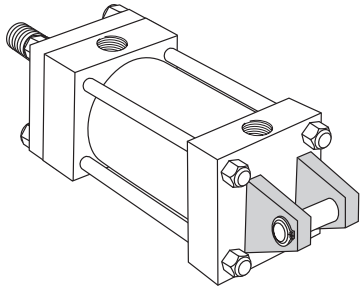
⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.

⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.



Mounting Information – 1.00" to 5.00" Bore Series 3L

Cap Fixed Clevis Mounting
Style BB
(NFPA Style MP1)



Note: Tie rod nuts are supplied on both ends, as shown, on 1.00, 4.00 and 5.00 bores. Tie rods are threaded into the cap on all other bore sizes.

Table 1 – Dimensional and Mounting Data

Bore Ø	CB	CD Ø +.000 -.002	CW	E	EE		F	G	J	K	L	LR	MR	Add Stroke	
					NPTF ¹	SAE ²								LB	P
1.00 ³	7	0.441 ⁷	7	4	1/4 ⁵	6	0.38	1.50	1.00	0.19	0.50	0.50	0.50	3.88	2.13
1.50	0.75	0.501	0.50	2.00	3/8 ⁵	6 ⁶	0.38	1.50	1.00	0.25	0.75	0.75	0.63	4.00	2.25
2.00	0.75	0.501	0.50	2.50	3/8 ⁵	6	0.38	1.50	1.00	0.31	0.75	0.75	0.63	4.00	2.25
2.50	0.75	0.501	0.50	3.00	3/8 ⁵	6	0.38	1.50	1.00	0.31	0.75	0.75	0.63	4.13	2.38
3.25	1.25	0.751	0.63	3.75	1/2	10	0.63	1.75	1.25	0.38	1.25	1.00	0.94	4.88	2.63
4.00	1.25	0.751	0.63	4.50	1/2	10	0.63	1.75	1.25	0.38	1.25	1.00	0.94	4.88	2.63
5.00	1.25	0.751	0.63	5.50	1/2	10	0.63	1.75	1.25	0.44	1.25	1.00	0.94	5.13	2.88

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XC	ZC
1.00	1 (Std.)	0.500	0.63	1.94	5.00	5.44
	2	0.625	0.63	1.94	5.00	5.44
1.50	1 (Std.)	0.625	0.63	1.94	5.38	5.88
	2	1.000	1.00	2.31	5.75	6.25
2.00	1 (Std.)	0.625	0.63	1.94	5.38	5.88
	2	1.375	1.25	2.56	6.00	6.50
2.50	1 (Std.)	1.000	1.00	2.31	5.88	6.38
	2	1.750	1.50	2.81	6.38	6.88
	3	1.375	1.25	2.56	6.13	6.63
	7	0.625	0.63	1.94	5.50	6.00
3.25	1 (Std.)	1.000	0.75	2.44	6.88	7.63
	2	2.000	1.38	3.06	7.50	8.25
	3	1.375	1.00	2.69	7.13	7.88
	4	1.750	1.25	2.94	7.38	8.13

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XC	ZC
4.00	1 (Std.)	1.375	1.00	2.69	7.13	7.88
	2	2.500	1.63	3.31	7.75	8.50
	3	1.750	1.25	2.94	7.38	8.13
	4	2.000	1.38	3.06	7.50	8.25
5.00	7	1.000	0.75	2.44	6.88	7.63
	1 (Std.)	1.750	1.25	2.94	7.63	8.38
	2	3.500	1.63	3.31	8.00	8.75
	3	2.000	1.38	3.06	7.75	8.50
	4	2.500	1.63	3.31	8.00	8.75
	5	3.000	1.63	3.31	8.00	8.75
	7	1.000	0.75	2.44	7.13	7.88
	8	1.375	1.00	2.69	7.38	8.13

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.

⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page.

⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.

⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.

⁷ In 1.00" bore size only, a single fixed eye mounting lug, .44" thick is used. Dimension CD (.441") is hole diameter. Pin not furnished.

Mounting Information – 1.00" to 5.00" Bore Series 3L

Head Trunnion Mounting

Style D
(NFPA Style MT1)

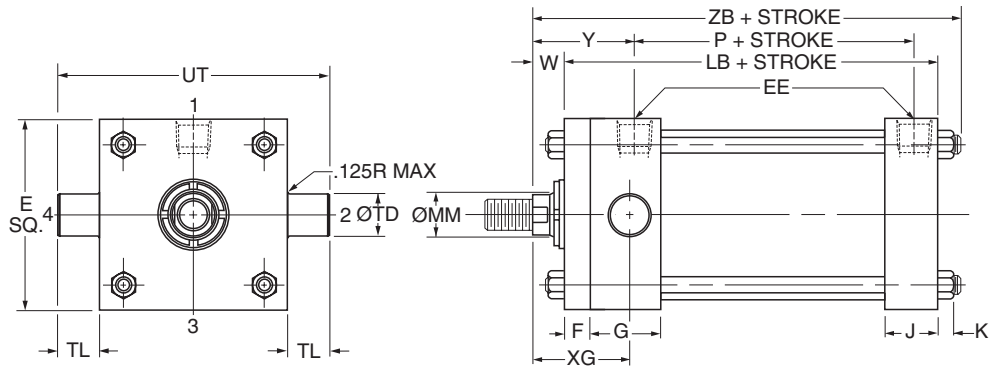
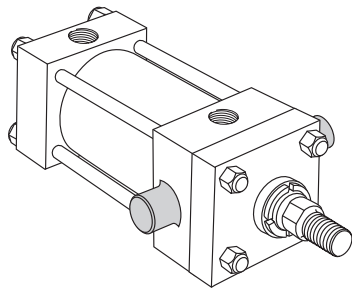


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	G	J	K	TD Ø +.000 -.001	TL	UT	Add Stroke	
		NPTF ¹	SAE ²								LB	P
1.00 ³	4	1/4 ⁵	6	0.38	1.50	1.00	0.19	0.750	0.75	3.00	3.88	2.13
1.50	2.00	3/8 ⁵	6 ⁶	0.38	1.50	1.00	0.25	1.000	1.00	4.00	4.00	2.25
2.00	2.50	3/8 ⁵	6	0.38	1.50	1.00	0.31	1.000	1.00	4.50	4.00	2.25
2.50	3.00	3/8 ⁵	6	0.38	1.50	1.00	0.31	1.000	1.00	5.00	4.13	2.38
3.25	3.75	1/2	10	0.63	1.75	1.25	0.38	1.000	1.00	5.75	4.88	2.63
4.00	4.50	1/2	10	0.63	1.75	1.25	0.38	1.000	1.00	6.50	4.88	2.63
5.00	5.50	1/2	10	0.63	1.75	1.25	0.44	1.000	1.00	7.50	5.13	2.88

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	XG	Y	Add Stroke
						ZB Max
1.00	1 (Std.)	0.500	0.63	1.75	1.94	5.00
	2	0.625	0.63	1.75	1.94	5.00
1.50	1 (Std.)	0.625	0.63	1.75	1.94	5.06
	2	1.000	1.00	2.13	2.31	5.44
2.00	1 (Std.)	0.625	0.63	1.75	1.94	5.13
	2	1.375	1.25	2.38	2.56	5.75
	3	1.000	1.00	2.13	2.31	5.50
2.50	1 (Std.)	1.000	1.00	2.13	2.31	5.63
	2	1.750	1.50	2.63	2.81	6.13
	3	1.375	1.25	2.38	2.56	5.88
	7	0.625	0.63	1.75	1.94	5.25
3.25	1 (Std.)	1.000	0.75	2.25	2.44	6.19
	2	2.000	1.38	2.88	3.06	6.81
	3	1.375	1.00	2.50	2.69	6.44
	4	1.750	1.25	2.75	2.94	6.69

Bore Ø	Rod No.	MM Rod Ø	W	XG	Y	Add Stroke
						ZB Max
4.00	1 (Std.)	1.375	1.00	2.50	2.69	6.44
	2	2.500	1.63	3.13	3.31	7.06
	3	1.750	1.25	2.75	2.94	6.69
	4	2.000	1.38	2.88	3.06	6.81
5.00	7	1.000	0.75	2.25	2.44	6.19
	1 (Std.)	1.750	1.25	2.75	2.94	7.06
	2	3.500	1.63	3.13	3.31	7.44
	3	2.000	1.38	2.88	3.06	7.31
	4	2.500	1.63	3.13	3.31	7.44
	5	3.000	1.63	3.13	3.31	7.44
	7	1.000	0.75	2.25	2.44	6.56
	8	1.375	1.00	2.50	2.69	6.81

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.

⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page.

⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.

⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.



Mounting Information – 1.00" to 5.00" Bore Series 3L

Cap Trunnion Mounting
Style DB
(NFPA Style MT2)

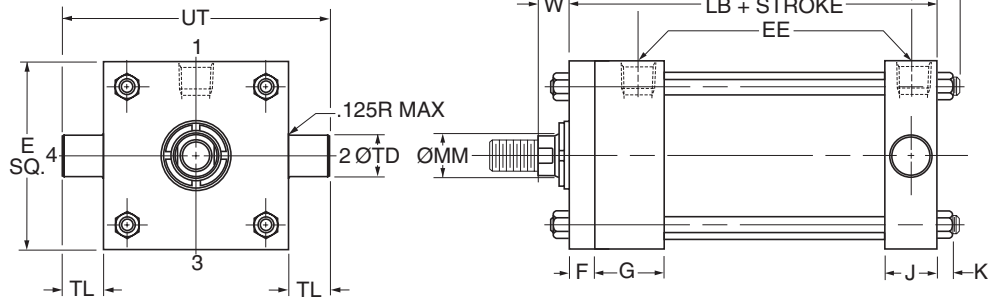
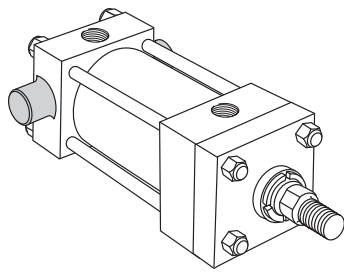


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	G	J	K	TD Ø +.000 -.001	TL	UT	Add Stroke	
		NPTF ¹	SAE ²								LB	P
1.00 ³	4	1/4 ⁵	6	0.38	1.50	1.00	0.19	0.750	0.75	3.00	3.88	2.13
1.50	2.00	3/8 ⁵	6 ⁶	0.38	1.50	1.00	0.25	1.000	1.00	4.00	4.00	2.25
2.00	2.50	3/8 ⁵	6	0.38	1.50	1.00	0.31	1.000	1.00	4.50	4.00	2.25
2.50	3.00	3/8 ⁵	6	0.38	1.50	1.00	0.31	1.000	1.00	5.00	4.13	2.38
3.25	3.75	1/2	10	0.63	1.75	1.25	0.38	1.000	1.00	5.75	4.88	2.63
4.00	4.50	1/2	10	0.63	1.75	1.25	0.38	1.000	1.00	6.50	4.88	2.63
5.00	5.50	1/2	10	0.63	1.75	1.25	0.44	1.000	1.00	7.50	5.13	2.88

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XJ	ZB Max
1.00	1 (Std.)	0.500	0.63	1.94	4.00	5.00
	2	0.625	0.63	1.94	4.00	5.00
1.50	1 (Std.)	0.625	0.63	1.94	4.13	5.06
	2	1.000	1.00	2.31	4.50	5.44
2.00	1 (Std.)	0.625	0.63	1.94	4.13	5.13
	2	1.375	1.25	2.56	4.75	5.75
	3	1.000	1.00	2.31	4.50	5.50
2.50	1 (Std.)	1.000	1.00	2.31	4.63	5.63
	2	1.750	1.50	2.81	5.13	6.13
	3	1.375	1.25	2.56	4.88	5.88
	7	0.625	0.63	1.94	4.25	5.25
3.25	1 (Std.)	1.000	0.75	2.44	5.00	6.19
	2	2.000	1.38	3.06	5.63	6.81
	3	1.375	1.00	2.69	5.25	6.44
	4	1.750	1.25	2.94	5.50	6.69

Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XJ	ZB Max
4.00	1 (Std.)	1.375	1.00	2.69	5.25	6.44
	2	2.500	1.63	3.31	5.88	7.06
	3	1.750	1.25	2.94	5.50	6.69
	4	2.000	1.38	3.06	5.63	6.81
5.00	7	1.000	0.75	2.44	5.00	6.19
	1 (Std.)	1.750	1.25	2.94	5.75	7.06
	2	3.500	1.63	3.31	6.13	7.44
	3	2.000	1.38	3.06	5.88	7.31
	4	2.500	1.63	3.31	6.13	7.44
	5	3.000	1.63	3.31	6.13	7.44
	7	1.000	0.75	2.44	5.25	6.56
	8	1.375	1.00	2.69	5.50	6.81

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.
² SAE straight thread ports are indicated by port number.
³ Cushion adjusting needle valve for 1.00" bore projects beyond sides of head and cap.
⁴ 1.00" bore 3L heads are rectangular — see 1.00" bore mounting information page.

⁵ On 1.00", 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.
⁶ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.

Mounting Information – 1.50" to 5.00" Bore Series 3L

Intermediate Fixed Trunnion Mounting

Style DD⁶
(NFPA Style MT4)

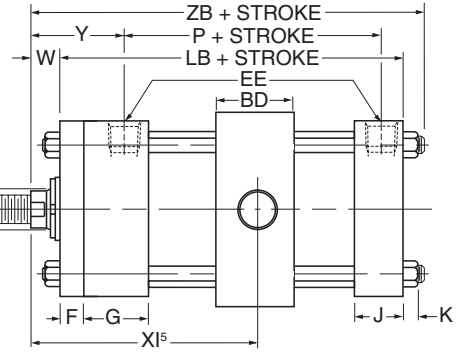
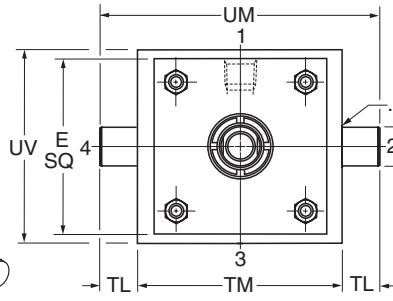
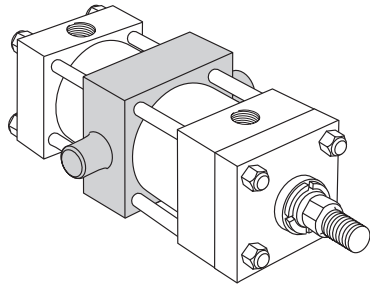


Table 1 – Dimensional and Mounting Data

Bore Ø	E	BD	EE		F	G	J	K	TD Ø +.000 -.001	TL	TM	UM	UV	Add Stroke	
			NPTF ¹	SAE ²										LB	P
1.50	2.00	1.25	3/8 ³	6 ⁴	0.38	1.50	1.00	0.25	1.000	1.00	2.50	4.50	2.50	4.00	2.25
2.00	2.50	1.50	3/8 ³	6	0.38	1.50	1.00	0.31	1.000	1.00	3.00	5.00	3.00	4.00	2.25
2.50	3.00	1.50	3/8 ³	6	0.38	1.50	1.00	0.31	1.000	1.00	3.50	5.50	3.50	4.13	2.38
3.25	3.75	2.00	1/2	10	0.63	1.75	1.25	0.38	1.000	1.00	4.50	6.50	4.25	4.88	2.63
4.00	4.50	2.00	1/2	10	0.63	1.75	1.25	0.38	1.000	1.00	5.25	7.25	5.00	4.88	2.63
5.00	5.50	2.00	1/2	10	0.63	1.75	1.25	0.44	1.000	1.00	6.25	8.25	6.00	5.13	2.88

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	XI ⁵ Min.	Min. Stroke	Y	Add Stroke
							ZB Max
1.50	1 (Std.)	0.625	0.63	3.19	0.25	1.94	5.06
	2	1.000	1.00	3.56	0.25	2.31	5.44
2.00	1 (Std.)	0.625	0.63	3.31	0.50	1.94	5.13
	2	1.375	1.25	3.94	0.50	2.56	5.75
	3	1.000	1.00	3.69	0.50	2.31	5.50
2.50	1 (Std.)	1.000	1.00	3.69	0.38	2.31	5.63
	2	1.750	1.50	4.19	0.38	2.81	6.13
	3	1.375	1.25	3.94	0.38	2.56	5.88
	7	0.625	0.63	3.31	0.38	1.94	5.25
3.25	1 (Std.)	1.000	0.75	4.19	0.88	2.44	6.19
	2	2.000	1.38	4.81	0.88	3.06	6.81
	3	1.375	1.00	4.44	0.88	2.69	6.44
	4	1.750	1.25	4.69	0.88	2.94	6.69

Bore Ø	Rod No.	MM Rod Ø	W	XI ⁵ Min.	Min. Stroke	Y	Add Stroke
							ZB Max
4.00	1 (Std.)	1.375	1.00	4.44	0.88	2.69	6.44
	2	2.500	1.63	5.06	0.88	3.31	7.06
	3	1.750	1.25	4.69	0.88	2.94	6.69
	4	2.000	1.38	4.81	0.88	3.06	6.81
	7	1.000	0.75	4.19	0.88	2.44	6.19
5.00	1 (Std.)	1.750	1.25	4.69	0.63	2.94	7.06
	2	3.500	1.63	5.06	0.63	3.31	7.44
	3	2.000	1.38	4.81	0.63	3.06	7.31
	4	2.500	1.63	5.06	0.63	3.31	7.44
	5	3.000	1.63	5.06	0.63	3.31	7.44
	7	1.000	0.75	4.19	0.63	2.44	6.56
	8	1.375	1.00	4.44	0.63	2.69	6.81

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ On 1.50", 2.00" and 2.50" bore sizes, the head end (only) pipe thread is not full depth on cylinders with No. 2 rods. Minimum of 3 full threads available.

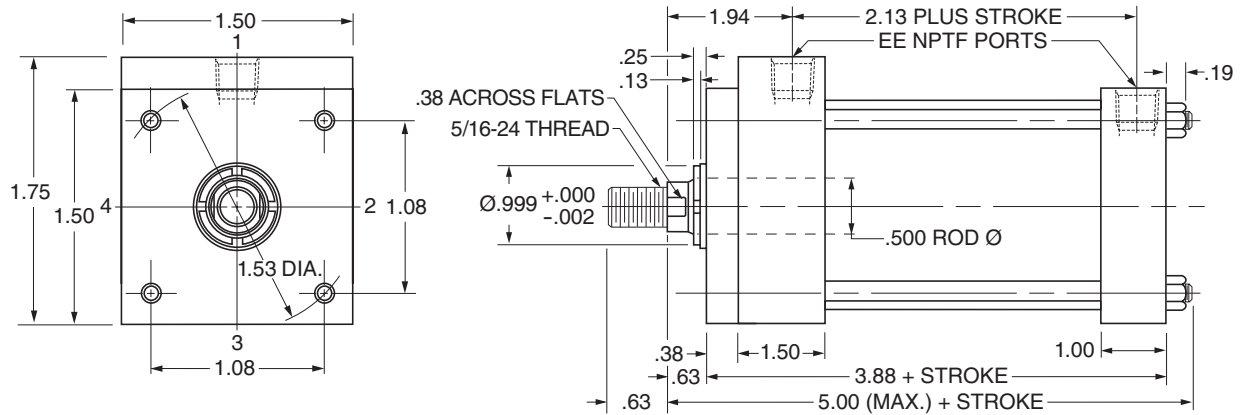
⁴ Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.

⁵ Dimension XI to be specified by customer.

⁶ Mounting style DD not available in 1.00" bore.

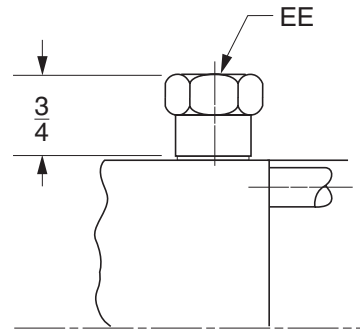


1.00" Bore Series 3L – Envelope and Head Dimensions



1.50" Bore Series 3L – Straight Thread Port Adapters

Straight thread ports on the cap end of 1.50" bore require an adapter fitting. An adapter fitting is also required on the head end of 1.50" bore with straight thread ports and Code 2 rod. Adapters are furnished as standard.



Spherical Bearing Mounting
Style SB

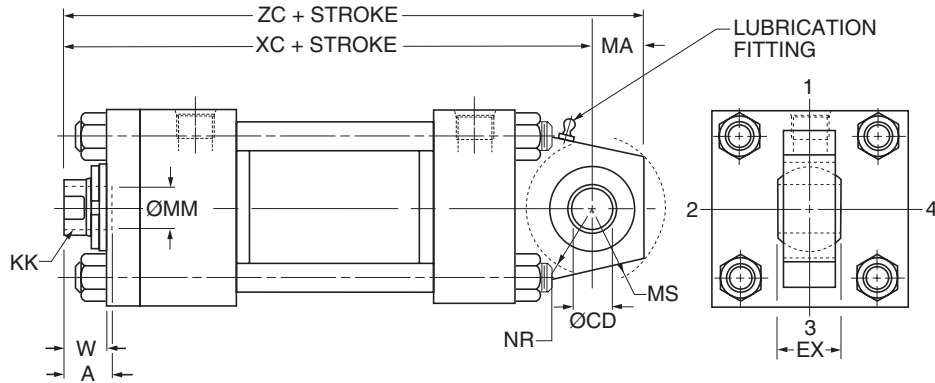


Table 1 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	Thread Style 7 KK ¹	Thread Style 9 KK ¹	A	CD ² Ø	EX	MA	MS	NR	W	Add Stroke		Max. Oper. PSI ³	
												XC	ZC		
1.50	1 (Std)	0.625	–	7/16-20	0.75	-.0005 .5000	0.44	0.75	0.94	0.63	0.63	5.38	6.13	1500	
	2	1.000	7/16-20	–	0.75							1.00	5.75		6.50
2.00	1 (Std)	0.625	–	7/16-20	0.75	-.0005 .5000	0.44	0.75	0.94	0.63	0.63	5.38	6.13	980	
	2	1.375	7/16-20	–	0.75							1.25	6.00		6.75
	3	1.000	7/16-20	–	0.75							1.00	5.75		6.50
2.50	1 (Std)	1.000	7/16-20	–	0.75	-.0005 .5000	0.44	0.75	0.94	0.63	1.00	5.88	6.63	630	
	2	1.750	7/16-20	–	0.75							1.50	6.38		7.13
	3	1.375	7/16-20	–	0.75							1.25	6.13		6.88
	7	0.625	–	7/16-20	0.75							0.63	5.50		6.25
3.25	1 (Std)	1.000	–	3/4-16	1.13	-.0005 .7500	0.66	1.00	1.38	1.00	0.75	6.88	7.88	830	
	2	2.000	3/4-16	–	1.13							1.38	7.50		8.50
	3	1.375	3/4-16	–	1.13							1.00	7.13		8.13
	4	1.750	3/4-16	–	1.13							1.25	7.38		8.38
4.00	1 (Std)	1.375	3/4-16	–	1.13	-.0005 .7500	0.66	1.00	1.38	1.00	1.00	7.13	8.13	550	
	2	2.500	3/4-16	–	1.13							1.63	7.75		8.75
	3	1.750	3/4-16	–	1.13							1.25	7.38		8.38
	4	2.000	3/4-16	–	1.13							1.38	7.50		8.50
	7	1.000	–	3/4-16	1.13							0.75	6.88		7.88
5.00	1 (Std)	1.750	3/4-16	–	1.13	-.0005 .7500	0.66	1.00	1.38	1.00	1.00	7.63	8.63	350	
	2	3.500	3/4-16	–	1.13							1.63	8.00		9.00
	3	2.000	3/4-16	–	1.13							1.38	7.75		8.75
	4	2.500	3/4-16	–	1.13							1.63	8.00		9.00
	5	3.000	3/4-16	–	1.13							1.63	8.00		9.00
	7	1.000	–	3/4-16	1.13							0.75	7.13		8.13
	8	1.375	3/4-16	–	1.13	1.00	7.38	8.38							

¹ Threads listed are also for a spherical rod eye which match style 9 or style 7. The spherical rod eye pin diameter matches the cap pin and (if required) needs to be purchased separately. See 3L Mounting Accessories for detailed information.

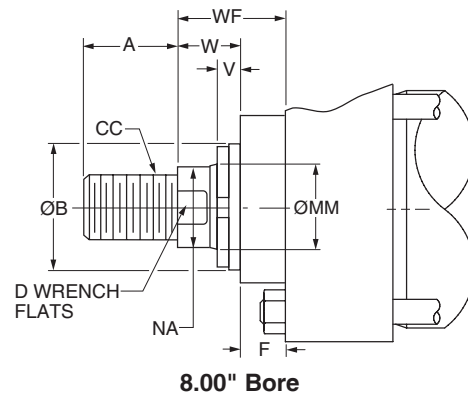
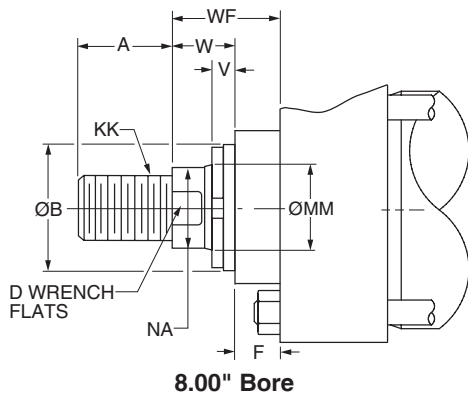
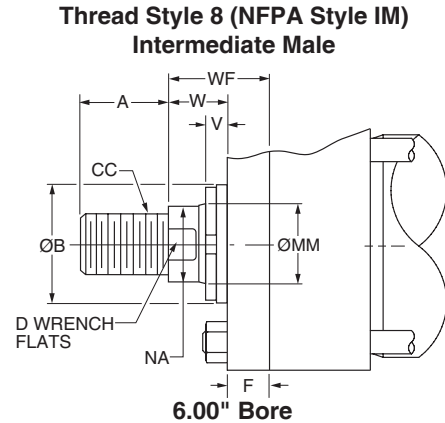
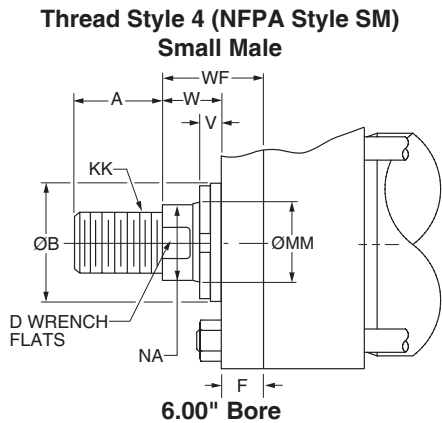
² Dimension CD is hole diameter.

³ Maximum operating pressure at 4:1 design factor is based on tensile strength of material.

Note: For additional dimensions, see Series 3L Style BB Mount.



Rod End Dimensions



Rod End Dimensions

Bore Ø	Rod No.	MM Rod Ø	Thread		A	B Ø +0.000 -0.002	D	F	NA	V	W	WF
			Style 8 CC	Style 4 KK								
6.00	1 (Std.)	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.75	1.69	0.38	1.13	1.88
	2	4.000	3 3/4-12	3-12	4.00	4.749	3.38	0.75	3.88	0.50	1.50	2.25
	3	2.000	1 3/4-12	1 1/2-12	2.25	2.624	1.69	0.75	1.94	0.38	1.25	2.00
	4	2.500	2 1/4-12	1 7/8-12	3.00	3.124	2.06	0.75	2.38	0.50	1.50	2.25
	5	3.000	2 3/4-12	2 1/4-12	3.50	3.749	2.63	0.75	2.88	0.50	1.50	2.25
	6	3.500	3 1/4-12	2 1/2-12	3.50	4.249	3.00	0.75	3.38	0.50	1.50	2.25
	7	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.75	1.31	0.25	0.88	1.63
8.00	1 (Std.)	2.000	1 3/4-12	1 1/2-12	2.25	2.624	1.69	0.75	1.94	0.38	1.25	2.00
	2	5.500	5 1/4-12	4-12	5.50	6.249	- ¹	0.75	5.38	0.50	1.50	2.25
	3	2.500	2 1/4-12	1 7/8-12	3.00	3.124	2.06	0.75	2.38	0.50	1.50	2.25
	4	3.000	2 3/4-12	2 1/4-12	3.50	3.749	2.63	0.75	2.88	0.50	1.50	2.25
	5	3.500	3 1/4-12	2 1/2-12	3.50	4.249	3.00	0.75	3.38	0.50	1.50	2.25
	6	4.000	3 3/4-12	3-12	4.00	4.749	3.38	0.75	3.88	0.50	1.50	2.25
	7	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.75	1.31	0.25	0.88	1.63
	8	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.75	1.69	0.38	1.13	1.88
	9	4.500	4 1/4-12	3 1/4-12	4.50	5.249	- ¹	0.75	4.38	0.50	1.50	2.25
	0	5.000	4 3/4-12	3 1/2-12	5.00	5.749	- ¹	0.75	4.88	0.50	1.50	2.25

"Special" Thread Style 3

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

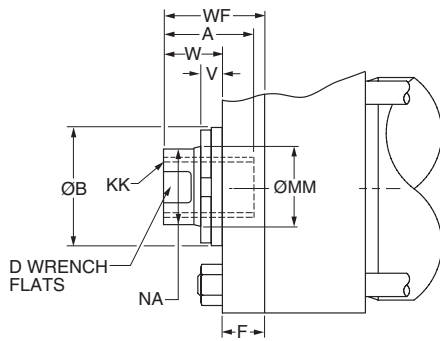
To order, specify "Style 3" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

¹ These piston rod numbers will have 4 spanner wrench holes (.515 Dia. X .75 Deep) instead of wrench flats.

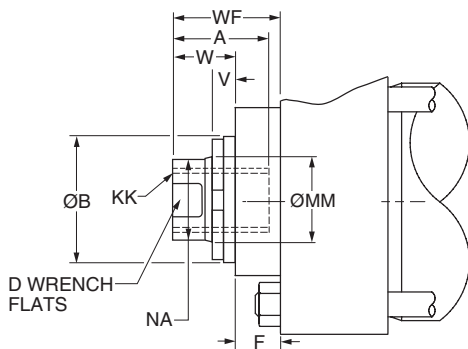


Rod End Dimensions

**Thread Style 9² (NFPA Style SF)
Small Female**

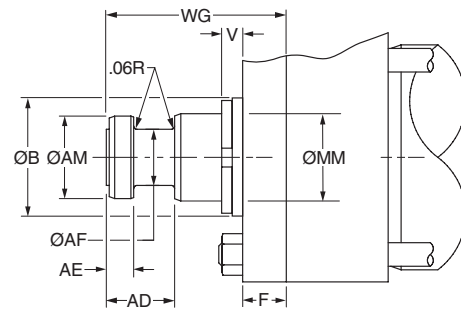


6.00" Bore

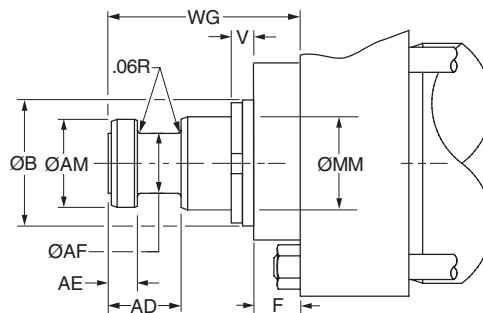


8.00" Bore

**Style 55¹
Flanged Rod End**



6.00" Bore



8.00" Bore

Rod End Dimensions

Bore Ø	Rod No.	MM Rod Ø	Thread	A	AD	AE +.001 -.001	AF	AM	B Ø +.000 -.002	D	F	NA	V	W	WF	WG
			Style 9													
6.00	1 (Std.)	1.750	1 1/4-12	2.00	1.31	0.50	1.13	1.70	2.374	1.50	0.75	1.69	0.38	1.13	1.88	3.13
	2	4.000	3-12	4.00	2.69	1.00	3.00	3.95	4.749	3.38	0.75	3.88	0.50	1.50	2.25	5.75
	3	2.000	1 1/2-12	2.25	1.69	0.63	1.38	1.95	2.624	1.69	0.75	1.94	0.38	1.25	2.00	3.75
	4	2.500	1 7/8-12	3.00	1.94	0.75	1.75	2.45	3.124	2.06	0.75	2.38	0.50	1.50	2.25	4.50
	5	3.000	2 1/4-12	3.50	2.44	0.88	2.25	2.95	3.749	2.63	0.75	2.88	0.50	1.50	2.25	4.88
	6	3.500	2 1/2-12	3.50	2.69	1.00	2.50	3.45	4.249	3.00	0.75	3.38	0.50	1.50	2.25	5.63
	7	1.375	1-14	1.63	1.06	0.38	0.88	1.32	1.999	1.13	0.75	1.31	0.25	0.88	1.63	2.75
8.00	1 (Std.)	2.000	1 1/2-12	2.25	1.69	0.63	1.38	1.95	2.624	1.69	0.75	1.94	0.38	1.25	2.00	3.75
	2	5.500	4-12	5.50	3.94	1.88	4.38	5.45	6.249	- ³	0.75	5.38	0.50	1.50	2.25	7.50
	3	2.500	1 7/8-12	3.00	1.94	0.75	1.75	2.45	3.124	2.06	0.75	2.38	0.50	1.50	2.25	4.50
	4	3.000	2 1/4-12	3.50	2.44	0.88	2.25	2.95	3.749	2.63	0.75	2.88	0.50	1.50	2.25	4.88
	5	3.500	2 1/2-12	3.50	2.69	1.00	2.50	3.45	4.249	3.00	0.75	3.38	0.50	1.50	2.25	5.63
	6	4.000	3-12	4.00	2.69	1.00	3.00	3.95	4.749	3.38	0.75	3.88	0.50	1.50	2.25	5.75
	7	1.375	1-14	1.63	1.06	0.38	0.88	1.32	1.999	1.13	0.75	1.31	0.25	0.88	1.63	2.75
	8	1.750	1 1/4-12	2.00	1.31	0.50	1.13	1.70	2.374	1.50	0.75	1.69	0.38	1.13	1.88	3.13
	9	4.500	3 1/4-12	4.50	3.19	1.50	3.50	4.45	5.249	- ³	0.75	4.38	0.50	1.50	2.25	6.50
	0	5.000	3 1/2-12	5.00	3.19	1.50	3.88	4.95	5.749	- ³	0.75	4.88	0.50	1.50	2.25	6.63

“Special” Thread Style 3

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

To order, specify “Style 3” and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

¹ For special WG dimension, specify “Style 3” and give desired dimension for WG. For other changes, place “S” in the model code, and describe rod end with dimensioned sketch.

² Style 9 stroke restrictions may apply. See Style 9 Minimum Stroke Table on How to Order page for details.

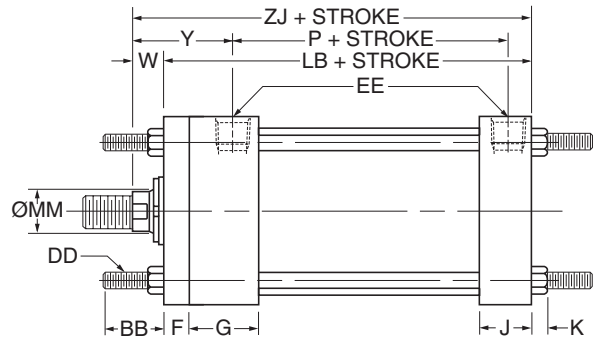
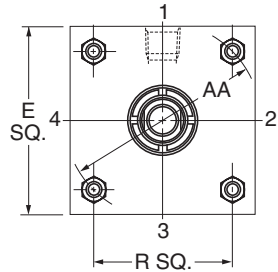
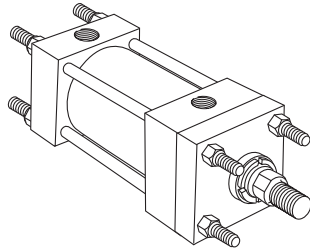
³ These piston rod numbers will have 4 spanner wrench holes (.515 Dia. X .75 Deep) instead of wrench flats.



Tie Rods Extended Both Ends Mounting

Style TD
(NFFPA Style MX3)

6.00" Bore



8.00" Bore

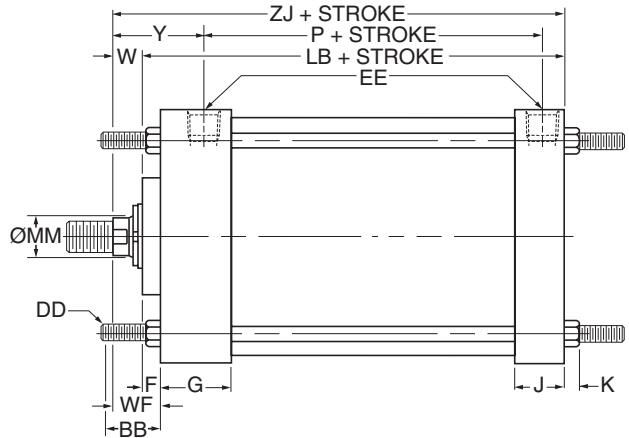
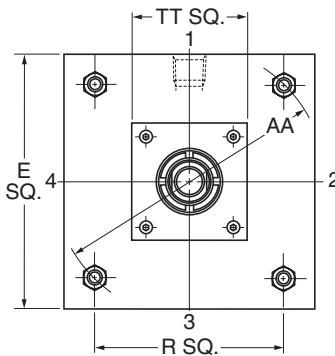
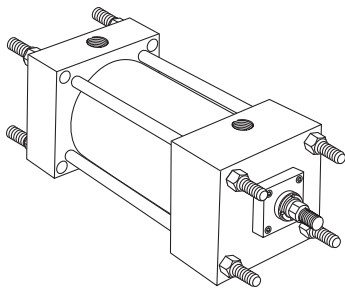


Table 1 – Dimensional and Mounting Data

Bore Ø	AA	BB	DD	E	EE		F	G	J	K	R	Add Stroke	
					NPTF ¹	SAE ²						LB	P
6.00	6.90	1.81	1/2-20	6.50	3/4	12	0.75	2.00	1.50	0.44	4.88	5.75	3.13
8.00	9.10	2.31	5/8-18	8.50	3/4	12	0.75	2.00	1.50	0.56	6.44	5.88	3.25

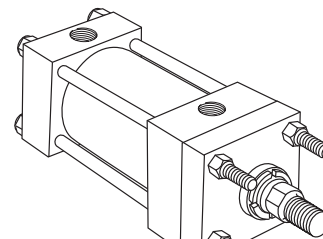
¹ NPTF Ports will be furnished as standard unless SAE Straight Thread Ports are specified.

² SAE straight thread ports are indicated by port number.

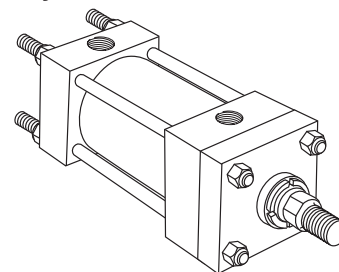
Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	TT	W	WF	Y	Add Stroke
							ZJ
6.00	1 (Std.)	1.750	–	1.13	–	3.06	6.88
	2	4.000	–	1.50	–	3.44	7.25
	3	2.000	–	1.25	–	3.19	7.00
	4	2.500	–	1.50	–	3.44	7.25
	5	3.000	–	1.50	–	3.44	7.25
	6	3.500	–	1.50	–	3.44	7.25
	7	1.375	–	0.88	–	2.81	6.63
8.00	1 (Std.)	2.000	4.00	1.25	2.00	3.19	7.13
	2	5.500	7.00	1.50	2.25	3.44	7.38
	3	2.500	4.00	1.50	2.25	3.44	7.38
	4	3.000	5.50	1.50	2.25	3.44	7.38
	5	3.500	5.50	1.50	2.25	3.44	7.38
	6	4.000	5.50	1.50	2.25	3.44	7.38
	7	1.375	4.00	0.88	1.63	2.81	6.75
	8	1.750	4.00	1.13	1.88	3.06	7.00
	9	4.500	7.00	1.50	2.25	3.44	7.38
	0	5.000	7.00	1.50	2.25	3.44	7.38

Style TB



Style TC

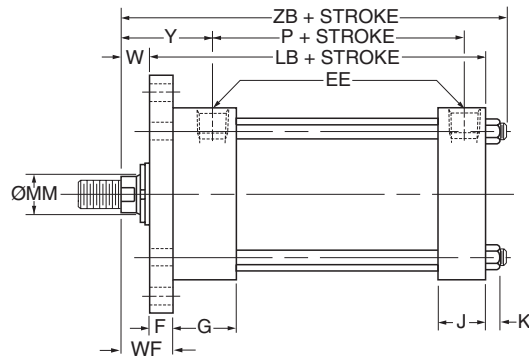
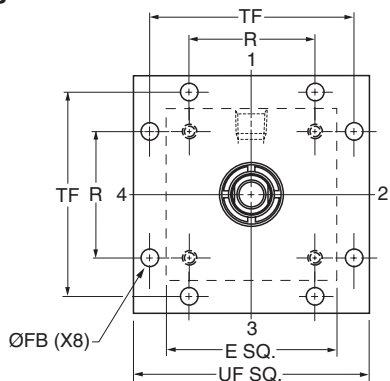
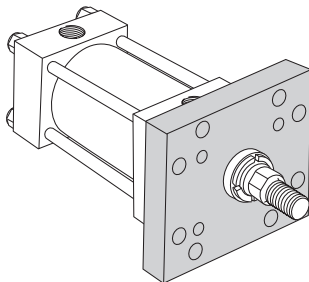


Style TD (NFFPA MX3) Both Ends Tie Rods Extended, illustrated: Style TC (NFFPA MX2), Cap Tie Rods Extended; and Style TB (NFFPA MX1), Head Tie Rods Extended are also available.

Basic Mounting (T) — NFFPA MX0 — no tie rods extended can be supplied upon request.

Head Square Flange Mounting
Style JB

6.00" Bore (NFFPA Style MF5)



8.00" Bore (NFFPA Style ME3)

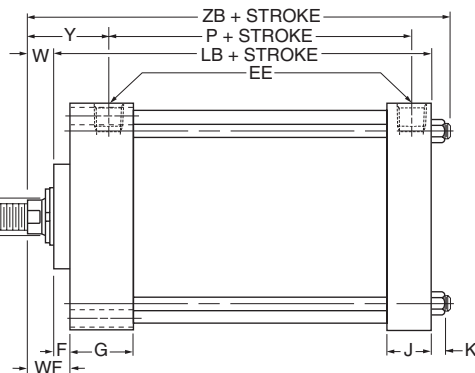
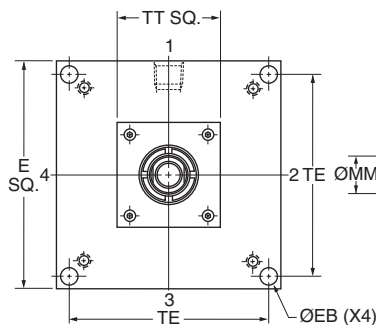
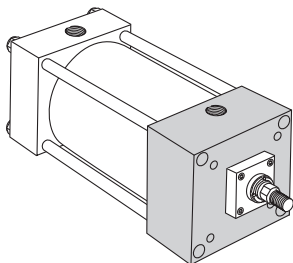


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EB Ø	EE		F	FB Ø	G	J	K	R	TE	TF	UF	Add Stroke	
			NPTF ¹	SAE ²										LB	P
6.00	6.50	–	3/4	12	0.75	0.56	2.00	1.50	0.44	4.88	–	7.63	8.63	5.75	3.13
8.00	8.50	0.69	3/4	12	0.75	0.56	2.00	1.50	0.56	–	7.57	–	–	5.88	3.25

¹ NPTF Ports will be furnished as standard unless SAE Straight Thread Ports are specified.

² SAE straight thread ports are indicated by port number.

Table 2 – Dimensional and Mounting Data

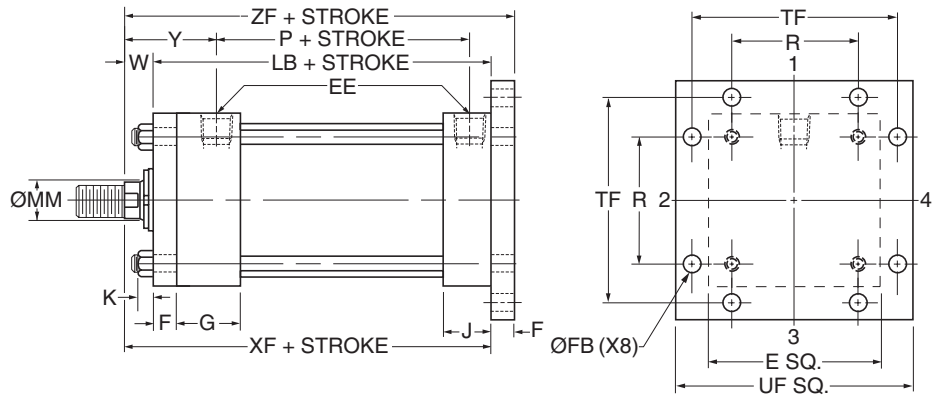
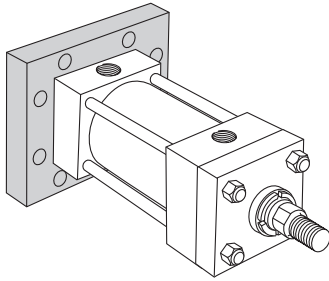
Bore Ø	Rod No.	MM Rod Ø	TT	W	WF	Y	Add Stroke
							ZB Max.
6.00	1 (Std.)	1.750	–	1.13	1.88	3.06	7.56
	2	4.000	–	1.50	2.25	3.44	7.94
	3	2.000	–	1.25	2.00	3.19	7.69
	4	2.500	–	1.50	2.25	3.44	7.94
	5	3.000	–	1.50	2.25	3.44	7.94
	6	3.500	–	1.50	2.25	3.44	7.94
	7	1.375	–	0.88	1.63	2.81	7.31
8.00	1 (Std.)	2.000	4.00	1.25	2.00	3.19	7.94
	2	5.500	7.00	1.50	2.25	3.44	8.19
	3	2.500	4.00	1.50	2.25	3.44	8.19
	4	3.000	5.50	1.50	2.25	3.44	8.19
	5	3.500	5.50	1.50	2.25	3.44	8.19
	6	4.000	5.50	1.50	2.25	3.44	8.19
	7	1.375	4.00	0.88	1.63	2.81	7.56
	8	1.750	4.00	1.13	1.88	3.06	7.81
	9	4.500	7.00	1.50	2.25	3.44	8.19
	0	5.000	7.00	1.50	2.25	3.44	8.19



Mounting Information – 6.00" & 8.00" Bore Series 3L

Cap Square Flange Mounting Style HB

6.00" Bore (NFFPA Style MF6)



8.00" Bore (NFFPA Style ME4)

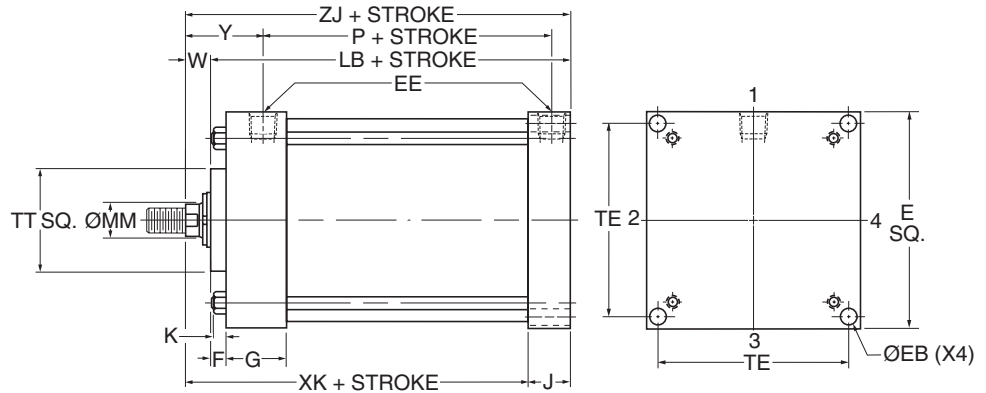
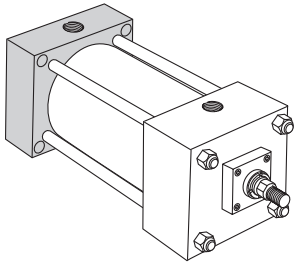


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EB Ø	EE		F	FB Ø	G	J	K	R	TE	TF	UF	Add Stroke	
			NPTF ¹	SAE ²										LB	P
6.00	6.50	–	3/4	12	0.75	0.56	2.00	1.50	0.44	4.88	–	7.63	8.63	5.75	3.13
8.00	8.50	0.69	3/4	12	0.75	–	2.00	1.50	0.56	–	7.57	–	–	5.88	3.25

¹ NPTF Ports will be furnished as standard unless SAE Straight Thread Ports are specified.

² SAE straight thread ports are indicated by port number.

Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	TT	W	Y	Add Stroke			
						XF	XK	ZF	ZJ
6.00	1 (Std.)	1.750	–	1.13	3.06	6.88	–	7.63	–
	2	4.000	–	1.50	3.44	7.25	–	8.00	–
	3	2.000	–	1.25	3.19	7.00	–	7.75	–
	4	2.500	–	1.50	3.44	7.25	–	8.00	–
	5	3.000	–	1.50	3.44	7.25	–	8.00	–
	6	3.500	–	1.50	3.44	7.25	–	8.00	–
	7	1.375	–	0.88	2.81	6.63	–	7.38	–
8.00	1 (Std.)	2.000	4.00	1.25	3.19	–	5.63	–	7.13
	2	5.500	7.00	1.50	3.44	–	5.88	–	7.38
	3	2.500	4.00	1.50	3.44	–	5.88	–	7.38
	4	3.000	5.50	1.50	3.44	–	5.88	–	7.38
	5	3.500	5.50	1.50	3.44	–	5.88	–	7.38
	6	4.000	5.50	1.50	3.44	–	5.88	–	7.38
	7	1.375	4.00	0.88	2.81	–	5.25	–	6.75
	8	1.750	4.00	1.13	3.06	–	5.50	–	7.00
	9	4.500	7.00	1.50	3.44	–	5.88	–	7.38
	0	5.000	7.00	1.50	3.44	–	5.88	–	7.38

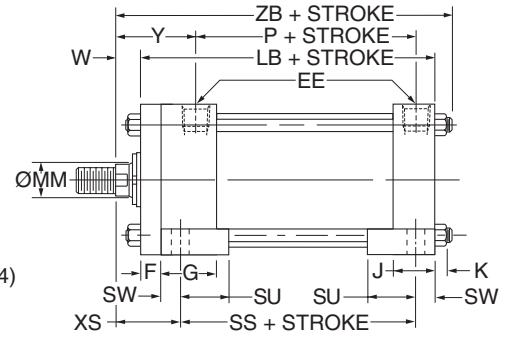
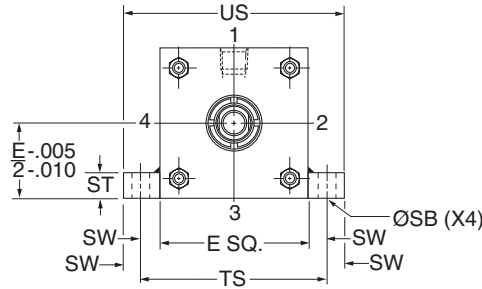
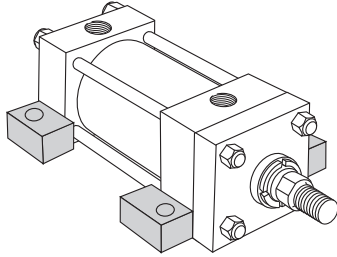


Side Lug Mounting

Style C

(NFPA Style MS2)

6.00" Bore



8.00" Bore

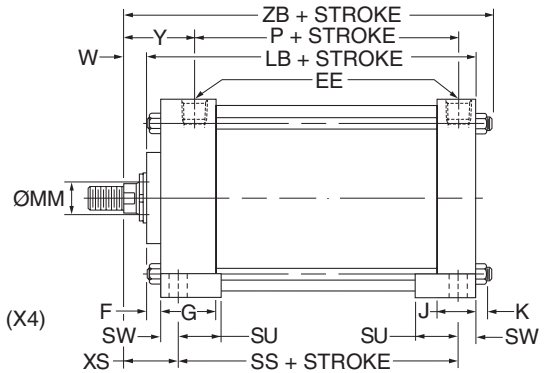
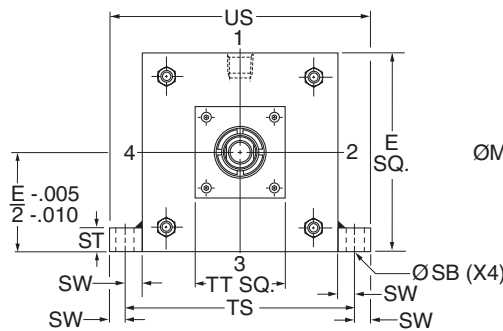
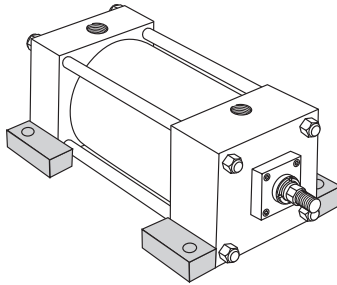


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	G	J	K	SB Ø	ST	SU	SW	TS	US	Add Stroke		
		NPTF ¹	SAE ²											LB	P	SS
6.00	6.50	3/4	12	0.75	2.00	1.50	0.44	0.81	1.00	1.56	0.69	7.88	9.25	5.75	3.13	3.63
8.00	8.50	3/4	12	0.75	2.00	1.50	0.56	0.81	1.00	1.56	0.69	9.88	11.25	5.88	3.25	3.75

¹ NPTF Ports will be furnished as standard unless SAE Straight Thread Ports are specified.

² SAE straight thread ports are indicated by port number.

Table 2 – Dimensional and Mounting Data

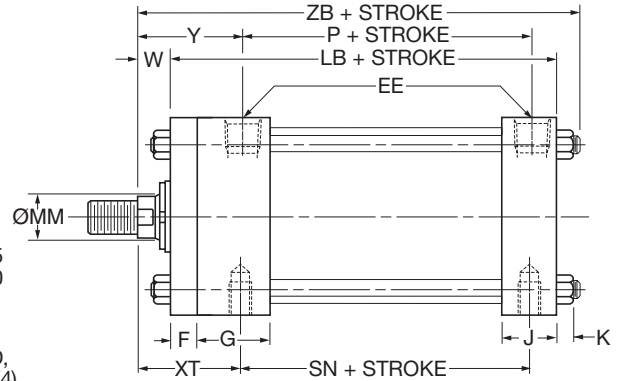
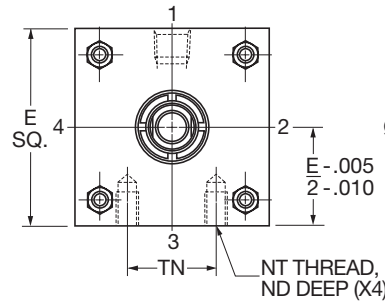
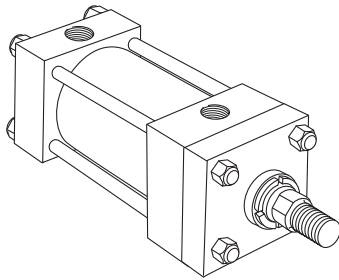
Bore Ø	Rod No.	MM Rod Ø	TT	W	XS	Y	Add Stroke
							ZB Max.
6.00	1 (Std.)	1.750	–	1.13	2.56	3.06	7.56
	2	4.000	–	1.50	2.94	3.44	7.94
	3	2.000	–	1.25	2.69	3.19	7.69
	4	2.500	–	1.50	2.94	3.44	7.94
	5	3.000	–	1.50	2.94	3.44	7.94
	6	3.500	–	1.50	2.94	3.44	7.94
	7	1.375	–	0.88	2.56	2.81	7.31
8.00	1 (Std.)	2.000	4.00	1.25	2.69	3.19	7.94
	2	5.500	7.00	1.50	2.94	3.44	8.19
	3	2.500	4.00	1.50	2.94	3.44	8.19
	4	3.000	5.50	1.50	2.94	3.44	8.19
	5	3.500	5.50	1.50	2.94	3.44	8.19
	6	4.000	5.50	1.50	2.94	3.44	8.19
	7	1.375	4.00	0.88	2.31	2.81	7.56
	8	1.750	4.00	1.13	2.56	3.06	7.81
	9	4.500	7.00	1.50	2.94	3.44	8.19
	0	5.000	7.00	1.50	2.94	3.44	8.19



Side Tapped Mounting

Style F
(NFPA Style MS4)

6.00" Bore



8.00" Bore

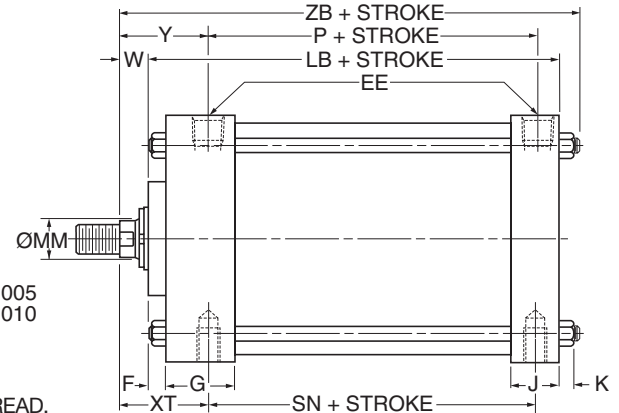
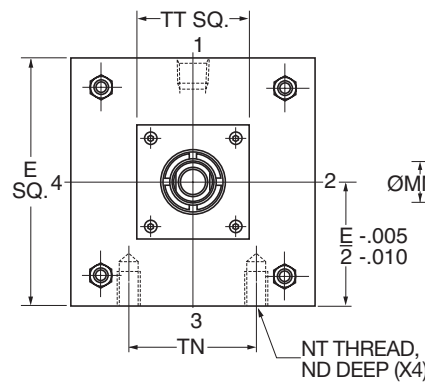
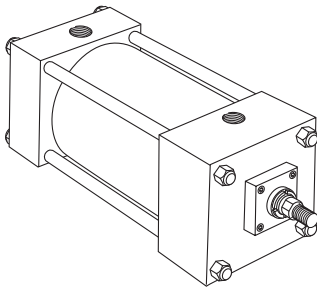


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	G	J	K	ND	NT	TN	Add Stroke		
		NPTF ¹	SAE ²								LB	P	SN
6.00	6.50	3/4	12	0.75	2.00	1.50	0.44	0.88	3/4-10	3.25	5.75	3.13	3.13
8.00	8.50	3/4	12	0.75	2.00	1.50	0.56	1.13	3/4-10	4.50	5.88	3.25	3.25

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

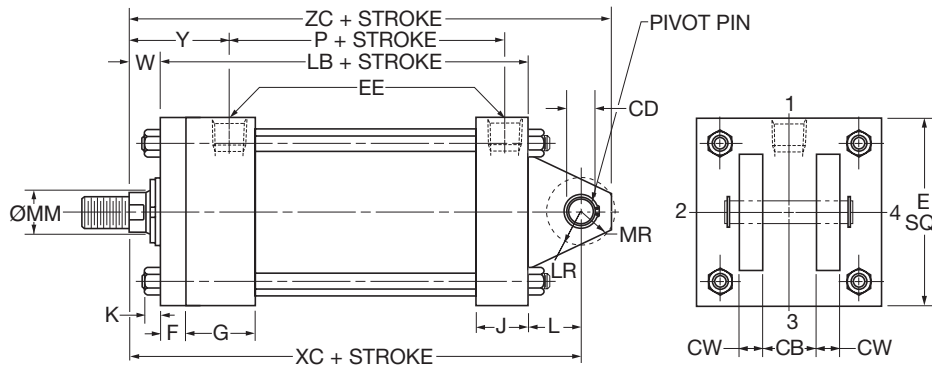
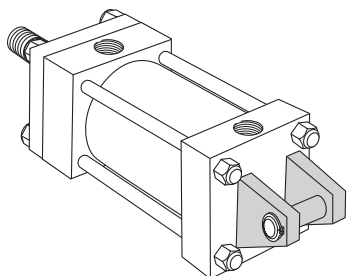
Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	TT	W	XT	Y	Add Stroke
							ZB Max.
6.00	1 (Std.)	1.750	–	1.13	3.06	3.06	7.56
	2	4.000	–	1.50	3.44	3.44	7.94
	3	2.000	–	1.25	3.19	3.19	7.69
	4	2.500	–	1.50	3.44	3.44	7.94
	5	3.000	–	1.50	3.44	3.44	7.94
	6	3.500	–	1.50	3.44	3.44	7.94
	7	1.375	–	0.88	2.81	2.81	7.31
8.00	1 (Std.)	2.000	4.00	1.25	3.19	3.19	7.94
	2	5.500	7.00	1.50	3.44	3.44	8.19
	3	2.500	4.00	1.50	3.44	3.44	8.19
	4	3.000	5.50	1.50	3.44	3.44	8.19
	5	3.500	5.50	1.50	3.44	3.44	8.19
	6	4.000	5.50	1.50	3.44	3.44	8.19
	7	1.375	4.00	0.88	2.81	2.81	7.56
	8	1.750	4.00	1.13	3.06	3.06	7.81
	9	4.500	7.00	1.50	3.44	3.44	8.19
0	5.000	7.00	1.50	3.44	3.44	8.19	

Cap Fixed Clevis Mounting

Style BB
(NFPA Style MP1)

6.00" Bore



8.00" Bore

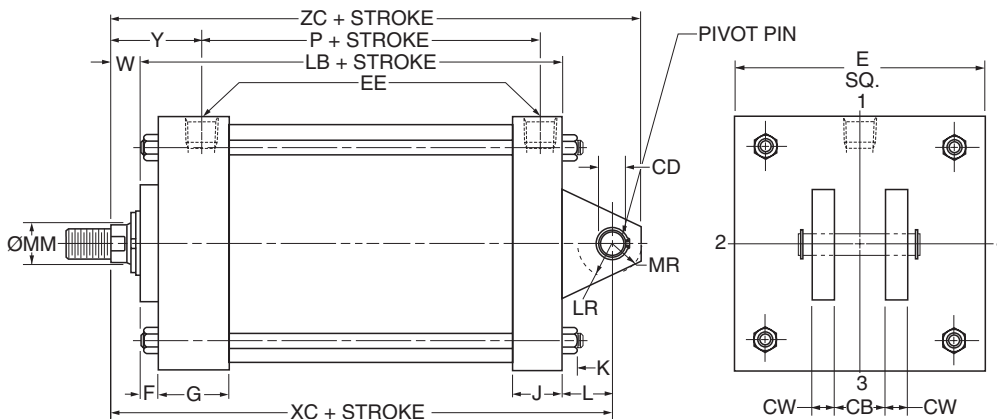
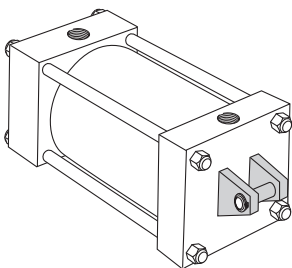


Table 1 – Dimensional and Mounting Data

Bore Ø	CB	CD ³ Ø +0.000 -0.002	CW	E	EE		F	G	J	K	L	LR	MR	Add Stroke	
					NPTF ¹	SAE ²								LB	P
6.00	1.50	1.001	0.75	6.50	3/4	12	0.75	2.00	1.50	0.44	1.50	1.25	1.19	5.75	3.13
8.00	1.50	1.001	0.75	8.50	3/4	12	0.75	2.00	1.50	0.56	1.50	1.25	1.19	5.88	3.25

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

³ Dimension CD is pin diameter.

Table 2 – Dimensional and Mounting Data

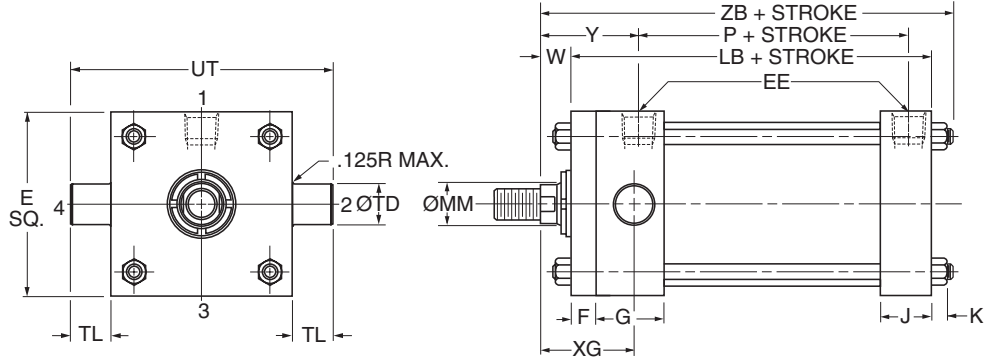
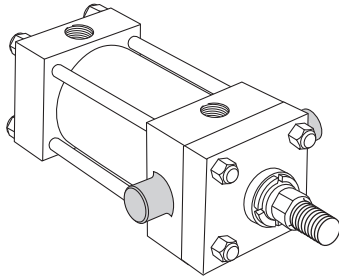
Bore Ø	Rod No.	MM Rod Ø	W	Y	Add Stroke	
					XC	ZC
6.00	1 (Std.)	1.750	1.13	3.06	8.38	9.38
	2	4.000	1.50	3.44	8.75	9.75
	3	2.000	1.25	3.19	8.50	9.50
	4	2.500	1.50	3.44	8.75	9.75
	5	3.000	1.50	3.44	8.75	9.75
	6	3.500	1.50	3.44	8.75	9.75
	7	1.375	0.88	2.81	8.13	9.13
8.00	1 (Std.)	2.000	1.25	3.19	8.63	9.63
	2	5.500	1.50	3.44	8.88	9.88
	3	2.500	1.50	3.44	8.88	9.88
	4	3.000	1.50	3.44	8.88	9.88
	5	3.500	1.50	3.44	8.88	9.88
	6	4.000	1.50	3.44	8.88	9.88
	7	1.375	0.88	2.81	8.25	9.25
	8	1.750	1.13	3.06	8.50	9.50
	9	4.500	1.50	3.44	8.88	9.88
	0	5.000	1.50	3.44	8.88	9.88



Head Trunnion Mounting

Style D
(NFPA Style MT1)

6.00" Bore



8.00" Bore

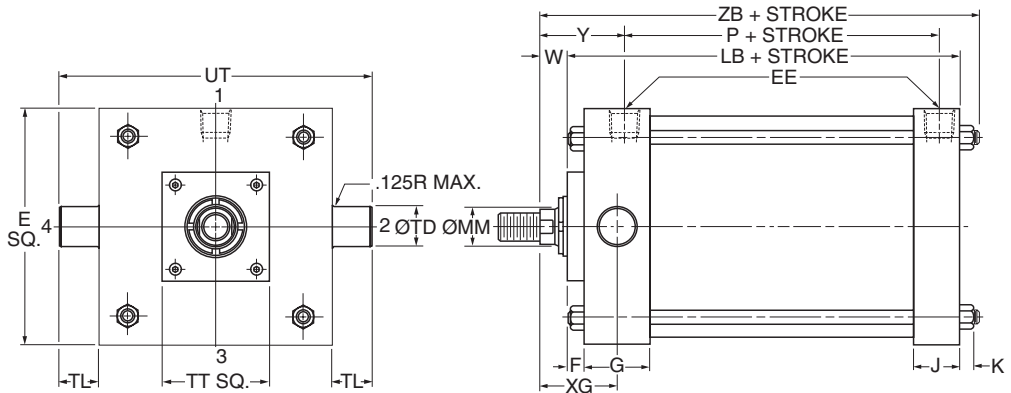
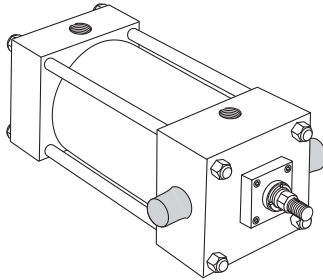


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	G	J	K	TD Ø +.000 -.001	TL	UT	Add Stroke	
		NPTF ¹	SAE ²								LB	P
6.00	6.50	3/4	12	0.75	2.00	1.50	0.44	1.375	1.38	9.25	5.75	3.13
8.00	8.50	3/4	12	0.75	2.00	1.50	0.56	1.375	1.38	11.25	5.88	3.25

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

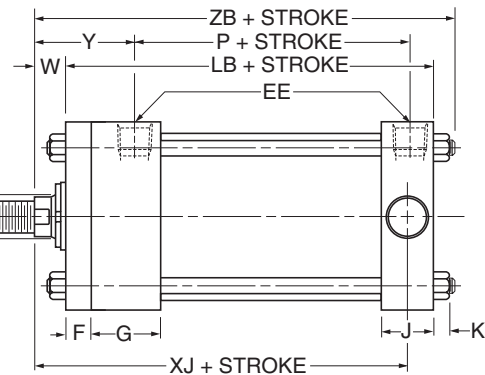
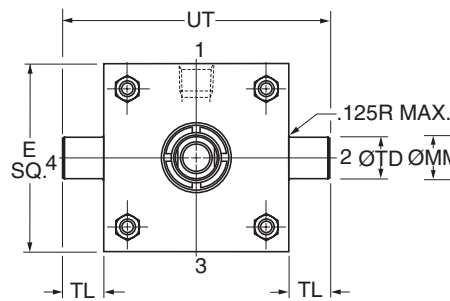
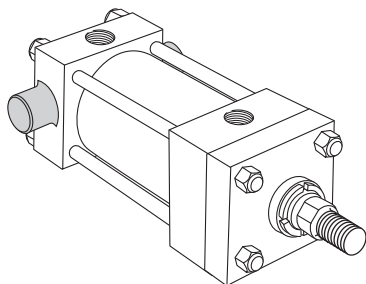
Table 2 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	TT	W	XG	Y	Add Stroke
							ZB Max.
6.00	1 (Std.)	1.750	–	1.13	2.88	3.06	7.56
	2	4.000	–	1.50	3.25	3.44	7.94
	3	2.000	–	1.25	3.00	3.19	7.69
	4	2.500	–	1.50	3.25	3.44	7.94
	5	3.000	–	1.50	3.25	3.44	7.94
	6	3.500	–	1.50	3.25	3.44	7.94
	7	1.375	–	0.88	2.63	2.81	7.31
8.00	1 (Std.)	2.000	4.00	1.25	3.00	3.19	7.94
	2	5.500	7.00	1.50	3.25	3.44	8.19
	3	2.500	4.00	1.50	3.25	3.44	8.19
	4	3.000	5.50	1.50	3.25	3.44	8.19
	5	3.500	5.50	1.50	3.25	3.44	8.19
	6	4.000	5.50	1.50	3.25	3.44	8.19
	7	1.375	4.00	0.88	2.63	2.81	7.56
	8	1.750	4.00	1.13	2.88	3.06	7.81
	9	4.500	7.00	1.50	3.25	3.44	8.19
0	5.000	7.00	1.50	3.25	3.44	8.19	

Cap Trunnion Mounting

Style DB
(NFPA Style MT2)

6.00" Bore



8.00" Bore

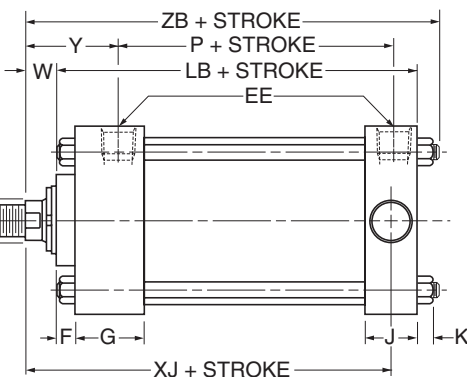
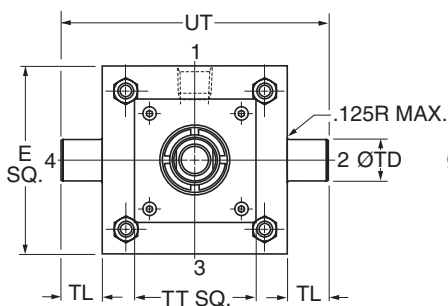
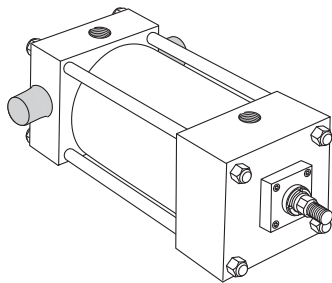


Table 1 – Dimensional and Mounting Data

Bore Ø	E	EE		F	G	J	K	TD Ø +0.000 -0.001	TL	UT	Add Stroke	
		NPTF ¹	SAE ²								LB	P
6.00	6.50	3/4	12	0.75	2.00	1.50	0.44	1.375	1.38	9.25	5.75	3.13
8.00	8.50	3/4	12	0.75	2.00	1.50	0.56	1.375	1.38	11.25	5.88	3.25

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

Table 2 – Dimensional and Mounting Data

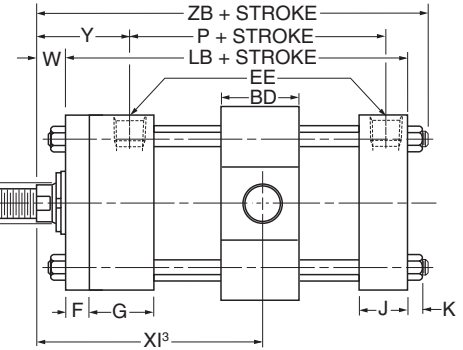
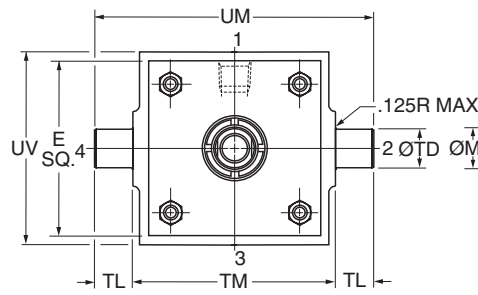
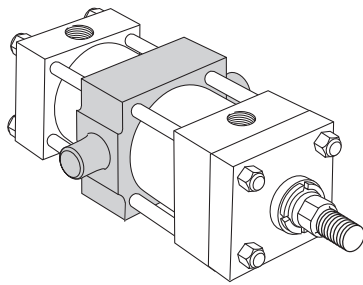
Bore Ø	Rod No.	MM Rod Ø	TT	W	Y	Add Stroke	
						XJ	ZB Max.
6.00	1 (Std.)	1.750	–	1.13	3.06	6.13	7.56
	2	4.000	–	1.50	3.44	6.50	7.94
	3	2.000	–	1.25	3.19	6.25	7.69
	4	2.500	–	1.50	3.44	6.50	7.94
	5	3.000	–	1.50	3.44	6.50	7.94
	6	3.500	–	1.50	3.44	6.50	7.94
	7	1.375	–	0.88	2.81	5.88	7.31
8.00	1 (Std.)	2.000	4.00	1.25	3.19	6.38	7.94
	2	5.500	7.00	1.50	3.44	6.63	8.19
	3	2.500	4.00	1.50	3.44	6.63	8.19
	4	3.000	5.50	1.50	3.44	6.63	8.19
	5	3.500	5.50	1.50	3.44	6.63	8.19
	6	4.000	5.50	1.50	3.44	6.63	8.19
	7	1.375	4.00	0.88	2.81	6.00	7.56
	8	1.750	4.00	1.13	3.06	6.25	7.81
	9	4.500	7.00	1.50	3.44	6.63	8.19
	0	5.000	7.00	1.50	3.44	6.63	8.19



Intermediate Fixed Trunnion Mounting

Style DD
(NFPA Style MT4)

6.00" Bore



8.00" Bore

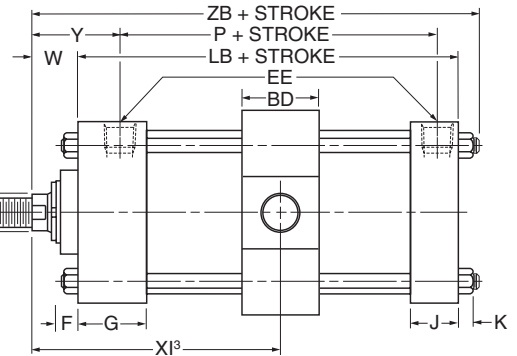
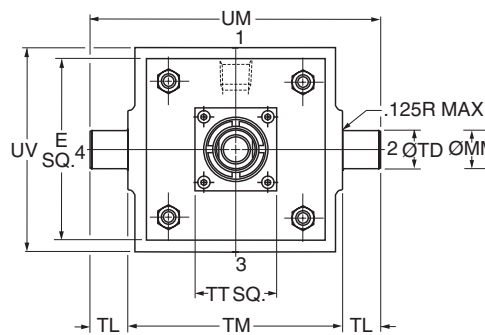
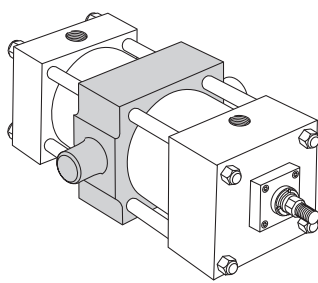


Table 1 – Dimensional and Mounting Data

Bore Ø	BD	E	EE		F	G	J	K	TD Ø +.000 - .001	TL	TM	UM	UV	Add Stroke	
			NPTF ¹	SAE ²										LB	P
6.00	2.50	6.50	3/4	12	0.75	2.00	1.50	0.44	1.375	1.38	7.63	10.38	7.00	5.75	3.13
8.00	2.50	8.50	3/4	12	0.75	2.00	1.50	0.56	1.375	1.38	9.75	12.50	9.50	5.88	3.25

¹ NPTF ports will be furnished as standard unless SAE straight thread ports are specified.

² SAE straight thread ports are indicated by port number.

Table 2 – Dimensional and Mounting Data

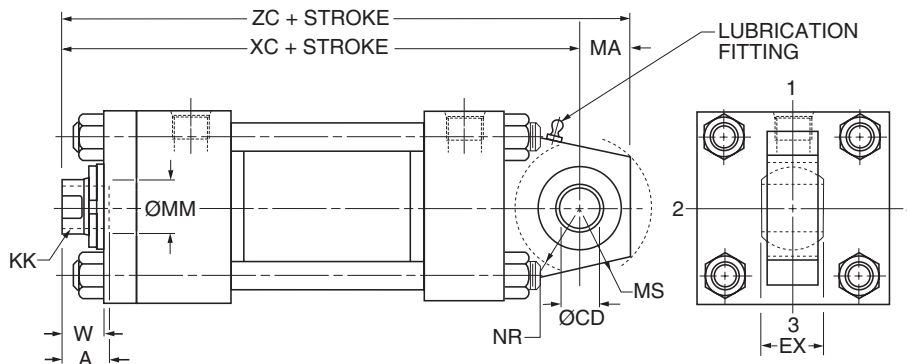
Bore Ø	Rod No.	MM Rod Ø	TT	W	Min. ³ XI	Min. Stroke	Y	Add Stroke
								ZB Max.
6.00	1 (Std.)	1.750	–	1.13	5.19	0.88	3.06	7.56
	2	4.000	–	1.50	5.56	0.88	3.44	7.94
	3	2.000	–	1.25	5.31	0.88	3.19	7.69
	4	2.500	–	1.50	5.56	0.88	3.44	7.94
	5	3.000	–	1.50	5.56	0.88	3.44	7.94
	6	3.500	–	1.50	5.56	0.88	3.44	7.94
	7	1.375	–	0.88	4.94	0.88	2.81	7.31
8.00	1 (Std.)	2.000	4.00	1.25	5.31	0.75	3.19	7.94
	2	5.500	7.00	1.50	5.56	0.75	3.44	8.19
	3	2.500	4.00	1.50	5.56	0.75	3.44	8.19
	4	3.000	5.50	1.50	5.56	0.75	3.44	8.19
	5	3.500	5.50	1.50	5.56	0.75	3.44	8.19
	6	4.000	5.50	1.50	5.56	0.75	3.44	8.19
	7	1.375	4.00	0.88	4.94	0.75	2.81	7.56
	8	1.750	4.00	1.13	5.19	0.75	3.06	7.81
	9	4.500	7.00	1.50	5.56	0.75	3.44	8.19
	0	5.000	7.00	1.50	5.56	0.75	3.44	8.19

³ Dimension XI to be specified by customer.

Spherical Bearing Mounting

Style SB

6.00" Bore



8.00" Bore

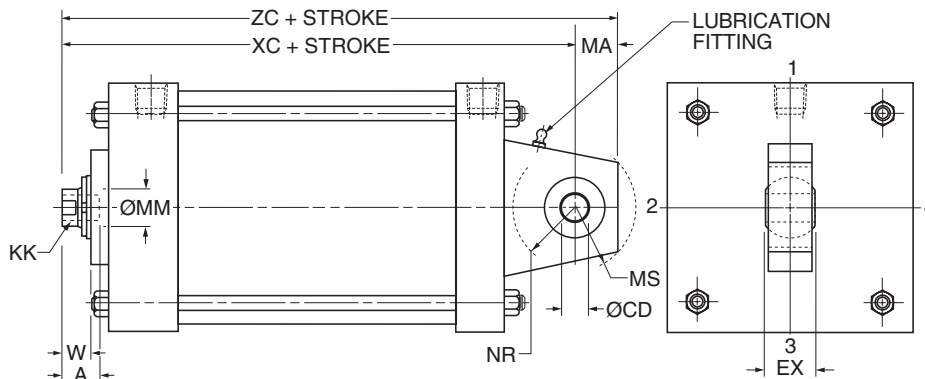


Table 1 – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	Rod End Thread		A	CD ² Ø	EX	MA	MS	NR	W	Add Stroke		Max. Oper. psi ³
			Style 7 KK ¹	Style 9 KK ¹								XC	ZC	
6.00	1 (Std.)	1.750	1-14	–	1.63	-.0005 1.0000	0.88	1.25	1.69	1.25	1.13	8.38	9.63	440
	2	4.000	1-14	–	1.63						1.50	8.75	10.00	
	3	2.000	1-14	–	1.63						1.25	8.50	9.75	
	4	2.500	1-14	–	1.63						1.50	8.75	10.00	
	5	3.000	1-14	–	1.63						1.50	8.75	10.00	
	6	3.500	1-14	–	1.63						1.50	8.75	10.00	
	7	1.375	–	1-14	1.63						0.88	8.13	9.38	
8.00	1 (Std.)	2.000	1-14	–	1.63	-.0005 1.0000	0.88	1.25	1.69	1.25	1.25	8.63	9.88	250
	2	5.500	1-14	–	1.63						1.50	8.88	10.13	
	3	2.500	1-14	–	1.63						1.50	8.88	10.13	
	4	3.000	1-14	–	1.63						1.50	8.88	10.13	
	5	3.500	1-14	–	1.63						1.50	8.88	10.13	
	6	4.000	1-14	–	1.63						1.50	8.88	10.13	
	7	1.375	–	1-14	1.63						0.88	8.25	9.50	
	8	1.750	1-14	–	1.63						1.13	8.50	9.75	
	9	4.500	1-14	–	1.63						1.50	8.88	10.13	
	0	5.000	1-14	–	1.63						1.50	8.88	10.13	

¹ Threads listed are also for a spherical rod eye which match style 9 or style 7. The spherical rod eye pin diameter matches the cap pin and (if required) needs to be purchased separately. See 3L Mounting Accessories for detailed information.

² Dimension CD is hole diameter.

³ 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 Series 3L, Style BB mount.



Double Rod Models – 1.00" to 8.00" Bore

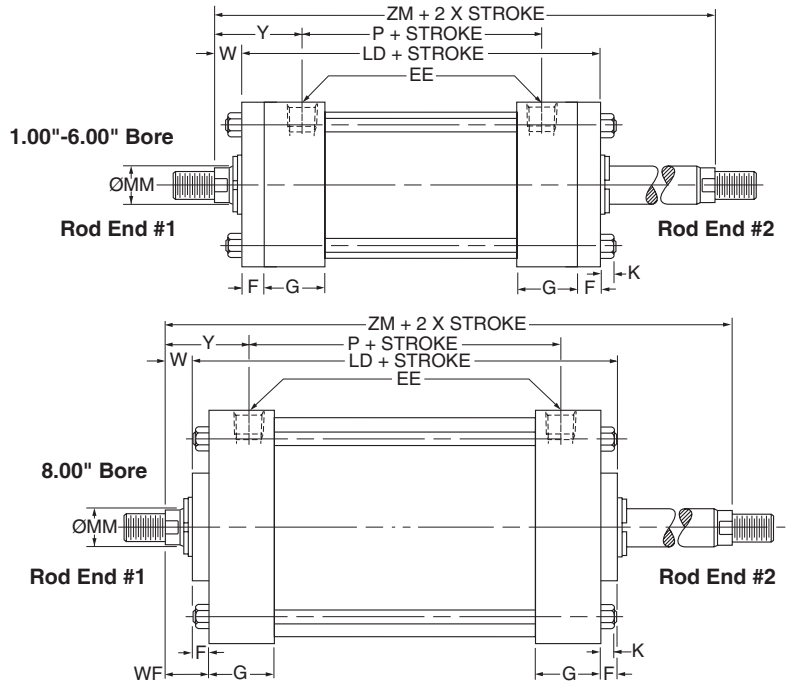
Mounting Styles for Single Rod Models	Mounting Styles for Corresponding Double Rod Models ¹	Dimensions Shown on This Page Supplement Dimensions on Pages Listed Below	
		1.00" - 5.00" Bores Page No.	6.00" & 8.00" Bores Page No.
T	KT	12	28
TB	KTB	12	28
TD	KTD	12	28
J	KJ	13	13 ³
JB	KJB	14	29
JJ	KJJ	15	–
C	KC	18	31
F	KF	19	32
D	KD	21	34
DD	KDD ²	23	36

¹ If only one end of these Double Rod Cylinders is to be cushioned, be sure to specify clearly which end this will be.

² Specify XI dimension from rod end #1.

³ 6.00" bore only.

How to Use Double Rod Cylinder Dimension Drawings



Bore Ø	Rod No.	MM Rod Ø	Add Stroke			Add 2X Stroke
			LD	SNK	SSK	ZM
1.00	1 (Std.)	0.500	4.75	2.13	3.38	6.00
	2	0.625	4.75	2.13	3.38	6.00
1.50	1 (Std.)	0.625	4.88	2.25	3.38	6.13
	2	1.000	4.88	2.25	3.38	6.88
2.00	1 (Std.)	0.625	4.88	2.25	3.38	6.13
	2	1.375	4.88	2.25	3.38	7.38
2.50	1 (Std.)	1.000	5.00	2.38	3.50	7.00
	2	1.750	5.00	2.38	3.50	8.00
	3	1.375	5.00	2.38	3.50	7.50
	7	0.625	5.00	2.38	3.50	6.25
3.25	1 (Std.)	1.000	6.00	2.63	3.75	7.50
	2	2.000	6.00	2.63	3.75	8.75
	3	1.375	6.00	2.63	3.75	8.00
	4	1.750	6.00	2.63	3.75	8.50
Replaces On single rod mounting styles:			LB	SN	SS	–
			All Mtg. Styles	F	C	All Mtg. Styles

Bore Ø	Rod No.	MM Rod Ø	Add Stroke			Add 2X Stroke
			LD	SNK	SSK	ZM
4.00	1 (Std.)	1.375	6.00	2.63	3.75	8.00
	2	2.500	6.00	2.63	3.75	9.25
	3	1.750	6.00	2.63	3.75	8.50
	4	2.000	6.00	2.63	3.75	8.75
5.00	7	1.000	6.00	2.63	3.75	7.50
	1 (Std.)	1.750	6.25	2.88	3.63	8.75
	2	3.500	6.25	2.88	3.63	9.50
	3	2.000	6.25	2.88	3.63	9.00
	4	2.500	6.25	2.88	3.63	9.50
	5	3.000	6.25	2.88	3.63	9.50
	7	1.000	6.25	2.88	3.63	7.75
	8	1.375	6.25	2.88	3.63	8.25
6.00	1 (Std.)	1.750	7.00	3.13	4.13	9.25
	2	4.000	7.00	3.13	4.13	10.00
	3	2.000	7.00	3.13	4.13	9.50
	4	2.500	7.00	3.13	4.13	10.00
	5	3.000	7.00	3.13	4.13	10.00
	6	3.500	7.00	3.13	4.13	10.00
	7	1.375	7.00	3.13	4.13	8.75
8.00	1 (Std.)	2.000	7.13	3.25	4.25	9.63
	2	5.500	7.13	3.25	4.25	10.13
	3	2.500	7.13	3.25	4.25	10.13
	4	3.000	7.13	3.25	4.25	10.13
	5	3.500	7.13	3.25	4.25	10.13
	6	4.000	7.13	3.25	4.25	10.13
	7	1.375	7.13	3.25	4.25	8.88
	8	1.750	7.13	3.25	4.25	9.38
	9	4.500	7.13	3.25	4.25	10.13
	0	5.000	7.13	3.25	4.25	10.13
Replaces On single rod mounting styles:			LB	SN	SS	–
			All Mtg. Styles	F	C	All Mtg. Styles

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. (See table above.) After selecting necessary dimensions from that drawing, return to this page and supplement the single rod dimensions with those shown on drawings above and dimension table below. Note that double rod cylinders have a head (Dim. G) at both ends and that dimension LD replaces LB. 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 pos. 2, 3 or 4 when viewed from rod end #1 only. (See port position information in Section D.)

Notes

Notes

Section B

Cylinder Accessories and Replacement Parts

Cylinder Mounting Accessories	42
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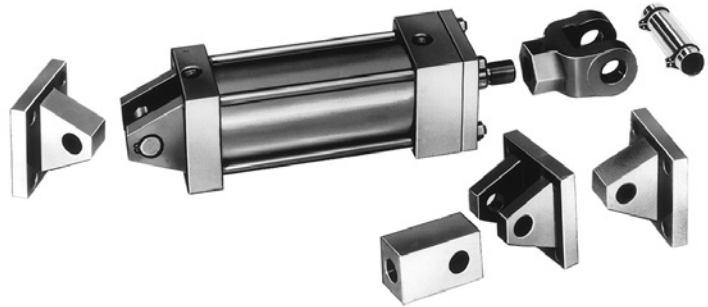
B

Cylinder Accessories

Parker offers a complete range of cylinder accessories to assure flexibility and versatility in present or future cylinder applications.

Rod End Accessories

Accessories offered for the rod end of the cylinder include: Rod Clevis, Eye Bracket, Knuckle, Clevis Bracket and Pivot Pin. To select the proper part number for any desired accessory, refer to Chart A below and look opposite the thread size of the rod end as indicated in the first column. The Pivot Pins, Eye Brackets and Clevis Brackets are listed opposite the thread size which their mating Knuckles or Clevises fit.



Accessory Load Capacity

The various accessories on this and the following pages have been load rated for your convenience. The load capacity shown 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.

Chart A

Thread Size	Pin Ø	Rod Clevis		Mounting Plate or Eye Bracket		Pivot Pin	
		Part Number	Load Capacity (lb)	Forged Steel or Cast Ductile Iron		Part Number	Shear Capacity (lb)
				Part Number	Load Capacity (lb)		
5/16-24	0.312	0512210000 ¹	2600	0959810031	1850	-	-
7/16-20	0.500	0509400000	4250	0959810050 ²	4620	0683680000	8600
1/2-20	0.500	0509410000	4900	0959810050 ²	4620	0683680000	8600
3/4-16	0.750	0509420000	11200	0959810075 ²	12370	0683690000	19300
3/4-16	0.750	1332840000	11200	0959810075 ²	12370	0683690000	19300
7/8-14	1.000	0509430000	18800	0959810100 ²	20450	0683700000	34300
1-14	1.000	0509440000	19500	0959810100 ²	20450	0683700000	34300
1-14	1.000	1332850000	19500	0959810100 ²	20450	0683700000	34300
1 1/4-12	1.375	0509450000	33500	0959810138	33500	0683710000	65000
1 1/4-12	1.375	1332860000	33500	0959810138	33500	0683710000	65000
1 1/2-12	1.750	0509460000	45600	0959810175	49480	0683720000	105200
1 3/4-12	2.000	0509470000	65600	0959810200 ²	70100	0683730000	137400
1 7/8-12	2.000	0509480000	65600	0959810200 ²	70100	0683730000	137400
2 1/4-12	2.500	0509490000	98200	0959810250 ²	98200	0683740000	214700
2 1/2-12	3.000	0509500000	98200	0959810300 ²	121940	0683750000	309200
2 3/4-12	3.000	0509510000	98200	0959810300 ²	121940	0683750000	309200
3 1/4-12	3.500	0509520000	156700	0959810350	187910	0735450000	420900
3 1/2-12	4.000	0509530000	193200	0959810400	268000	0735470000	565800
4-12	4.000	0509540000	221200	0959810400	268000	0735470000	565800

¹ Includes pivot pin.

² Cylinder accessory dimensions conform to ANSI/NFPA/T3.6.8 R3-2010.

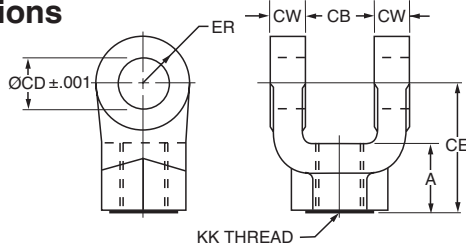
Mounting Plates

Mounting Plates for Style BB (clevis mounted) cylinders are offered. To select proper part number for your application, refer to Chart B at right.

Chart B

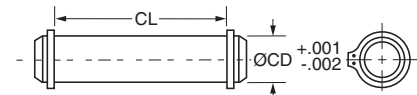
Series 3L	
Mounting Plate Part Number	Bore Ø
0960160044	1.00
0959810050	1.50, 2.00, 2.50
0959810075	3.25, 4.00, 5.00
0959810100	6.00, 8.00

Rod Clevis Dimensions



Part Number ¹	Pin Ø	A	CB	CD Ø	CE	CW	ER	KK Thread
0512210000 ²	0.310	0.81	0.34	0.314	2.25	0.20	0.30	5/16-24
0509400000	0.500	0.75	0.77	0.503	1.50	0.49	0.50	7/16-20
0509410000	0.500	0.75	0.77	0.503	1.50	0.49	0.50	1/2-20
0509420000	0.750	1.13	1.27	0.753	2.13	0.62	0.75	3/4-16
1332840000	0.750	1.13	1.27	0.753	2.38	0.62	0.75	3/4-16
0509430000	1.000	1.63	1.52	1.003	2.94	0.74	1.00	7/8-14
0509440000	1.000	1.63	1.52	1.003	2.94	0.74	1.00	1-14
1332850000	1.000	1.63	1.52	1.003	3.13	0.74	1.00	1-14
0509450000	1.375	1.88	2.04	1.378	3.75	0.99	1.38	1 1/4-12
1332860000	1.375	2.00	2.04	1.378	4.13	0.99	1.38	1 1/4-12
0509460000	1.750	2.25	2.54	1.753	4.50	1.24	1.75	1 1/2-12
0509470000	2.000	3.00	2.54	2.003	5.50	1.24	2.00	1 3/4-12
0509480000	2.000	3.00	2.54	2.003	5.50	1.24	2.00	1 7/8-12
0509490000	2.500	3.50	3.04	2.503	6.50	1.49	2.50	2 1/4-12
0509500000	3.000	3.50	3.04	3.003	6.75	1.49	2.75	2 1/2-12
0509510000	3.000	3.50	3.04	3.003	6.75	1.49	2.75	2 3/4-12
0509520000	3.500	3.50 ³	4.04	3.503	7.75	1.98	3.50	3 1/4-12
0509530000	4.000	4.00 ³	4.54	4.003	8.81	2.23	4.00	3 1/2-12
0509540000	4.000	4.00 ³	4.54	4.003	8.81	2.23	4.00	4-12

Pivot Pin Dimensions



Part Number	CD Ø	CL
0683680000	0.500	1.88
0683690000	0.750	2.63
0683700000	1.000	3.13
0683710000	1.375	4.19
0683720000	1.750	5.19
0683730000	2.000	5.19
0683740000	2.500	6.19
0683750000	3.000	6.25
0735450000	3.500	8.25
0735470000 ⁴	4.000	9.00

⁴ This size supplied with cotter pins.

Notes:

- Pivot Pins are furnished with Clevis Mounted Cylinders as standard.
- Pivot Pins are furnished with (2) Retainer Rings.
- Pivot Pins must be ordered as a separate item if to be used with Knuckles, Rod Clevises, or Clevis Brackets.

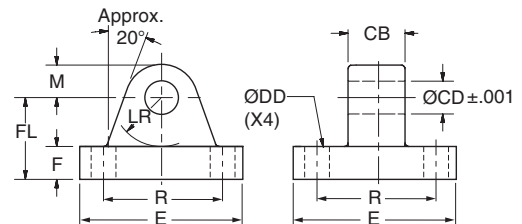
¹ Rod Clevises with pin diameters 0.312 thru 1.375 are forged steel. Rod Clevises with 1.750 pin diameter and larger are cast ductile iron.

² Includes Pivot Pin

³ Consult appropriate cylinder rod end dimensions for compatibility.

Forged Steel or Cast Ductile Iron Mounting Plate or Eye Bracket Dimensions⁵

Note: Cast ductile iron eye brackets must not be welded in place.



Cast or Forged ⁶ Part Number	Pin Ø	CB	CD Ø	DD Ø	E (As Cast)	F	FL	LR	M (As Cast)	R
0959810031	0.312	0.31	0.314	0.27	2.25	0.38	1.00	0.59	0.38	1.75
0959810050	0.500	0.75	0.503	0.41	2.50	0.38	1.13	0.69	0.50	1.63
0959810075	0.750	1.25	0.753	0.53	3.50	0.63	1.88	1.13	0.75	2.55
0959810100	1.000	1.50	1.003	0.66	4.50	0.88	2.38	1.37	1.00	3.25
0959810138	1.375	2.00	1.378	0.66	5.00	1.00 ⁷	3.00	1.88	1.38	3.82
0959810175	1.750	2.50	1.753	0.91	6.50	1.25 ⁷	3.38	2.13	1.75	4.95
0959810200	2.000	2.50	2.003	1.06	7.50	1.50	4.00	2.38	2.00	5.73
0959810250	2.500	3.00	2.503	1.19	8.50	1.75	4.75	2.88	2.50	6.58
0959810300	3.000	3.00	3.003	1.31	9.50	2.00	5.25	3.13	3.00	7.50
0959810350	3.500	4.00	3.503	1.81	12.63	2.50 ⁸	6.50 ⁸	3.88	3.50	9.62
0959810400	4.000	4.50	4.003	2.06	14.88	3.00 ⁸	7.50 ⁸	4.38	4.06	11.45

⁵ When used to mate with the Rod Clevis, select by pin diameter in the table above.

⁶ Eye Brackets with pin diameters 0.500 thru 1.000 are forged steel. Eye Brackets with 0.312 and 1.375 pin diameter and larger are cast ductile iron.

⁷ These dimensions vary from NFPA standard. F is increased by 0.13. Sufficient LR clearance remains for full swing arc with Parker cap clevis cylinders and rod clevises.

⁸ Mounting base thickness dimension F is increased on these sizes to provide greater load capacity than the former fabricated steel design. Cast ductile iron dimensions F and FL are 0.81 larger for 3.500 pin diameter and 1.06 larger for 4.000 pin diameter.



Rod End Accessories

Accessories offered for the rod end of the cylinder include Rod Clevis, Eye Bracket, Knuckle, 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 4 be specified on your cylinder order.

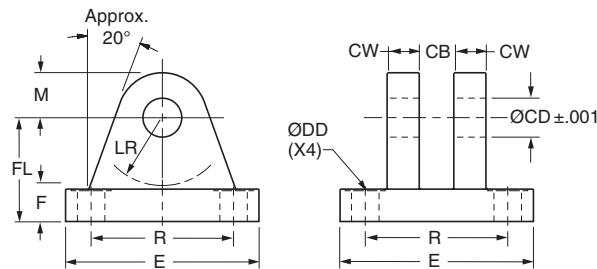
Accessory Load Capacity

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	Pin Ø	Knuckle		Clevis Bracket				Pivot Pin	
		Part Number	Load Capacity (lb)	Forged Steel or Cast Ductile Iron		Fabricated Steel		Part Number	Shear Capacity (lb)
				Part Number	Load Capacity (lb)	Part Number	Load Capacity (lb)		
5/16-24	0.438	0740750000	3300	0960160044	2830	0740760000	3600	0740780000	6600
7/16-20	0.500	0690890000	5000	0960160050	7740	0692050000	7300	0683680000	8600
1/2-20	0.500	0690900000	5700	0960160050	7740	0692050000	7300	0683680000	8600
3/4-16	0.750	0690910000	12100	0960160075	13600	0692060000	10880	0683690000	19300
7/8-14	1.000	0690920000	13000	0960160100	23000	0692070000	15180	0683700000	34300
1-14	1.000	0690930000	21700	0960160100	23000	0692070000	15180	0683700000	34300
1 1/4-12	1.375	0690940000	33500	0960160138	39500	0692080000	23560	0683710000	65000
1 1/2-12	1.750	0690950000	45000	0960160175	49480	0692090000	21520	0683720000	105200
1 3/4-12	2.000	0690960000	53500	0960160200	72400	0692100000	26000	0692150000	137400
1 7/8-12	2.000	0962160000	75000	0960160200	72400	0692100000	26000	0692150000	137400
2 1/4-12	2.500	0962170000	98700	0960160250	98700	0692110000	28710	0683740000	214700
2 1/2-12	3.000	0962180000	110000	0960160300	123300	0692120000	28190	0683750000	309200
2 3/4-12	3.000	0962190000	123300	N/A	N/A	0692130000	31390	0692160000	309200
3 1/4-12	3.500	0962200000	161300	0960160350	200400	0735420000	80250	0735450000	420900
3 1/2-12	3.500	0962210000	217300	0960160350	200400	0735420000	80250	0735450000	420900
4-12	4.000	0962220000	273800	0960160400	292100	0735430000	98420	0821810000	565800
N/A	4.000	N/A	N/A	N/A	N/A	N/A	N/A	0735470000 ¹	565800

¹ This size supplied with cotter pins.

Forged Steel or Cast Ductile Iron Clevis Bracket Dimensions

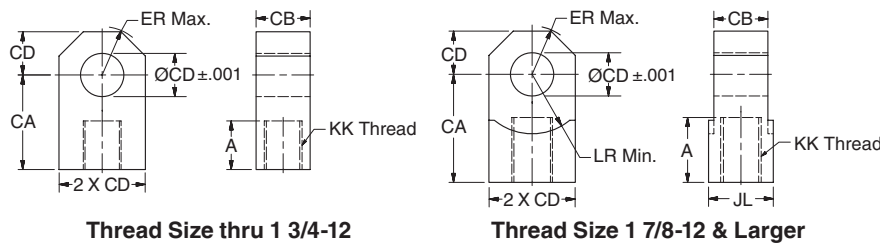


Note: Cast ductile iron clevis brackets must not be welded in place.

Cast or Forged ² Part Number	Pin Ø	CB	CD Ø	CW	DD Ø	E (As Cast)	F	FL	LR	M (As Cast)	R
0960160044	0.438	0.46	0.440	0.37	0.27	2.25	0.38	1.00	0.56	0.44	1.75
0960160050	0.500	0.78	0.503	0.50	0.41	2.50	0.38	1.13	0.63	0.56	1.63
0960160075	0.750	1.28	0.753	0.63	0.53	3.50	0.63	1.88	1.06	0.75	2.56
0960160100	1.000	1.53	1.003	0.75	0.66	4.50	0.75	2.25	1.25	1.00	3.25
0960160138	1.375	2.03	1.378	1.00	0.66	5.00	0.88	3.00	1.94	1.38	3.81
0960160175	1.750	2.53	1.753	1.25	0.91	6.50	0.94	3.13	2.00	1.75	4.94
0960160200	2.000	2.53	2.003	1.25	1.06	7.50	1.38	3.75	2.25	2.00	5.75
0960160250	2.500	3.03	2.503	1.50	1.19	8.50	1.50	4.50	2.81	2.50	6.59
0960160300	3.000	3.03	3.003	1.50	1.31	9.50	1.88	5.38	3.31	3.00	7.50
0960160350	3.500	4.03	3.503	2.00	1.81	12.63	2.31	6.38	3.88	3.50	9.62
0960160400	4.000	4.53	4.003	2.25	2.06	14.88	2.88	7.50	4.50	4.00	11.50

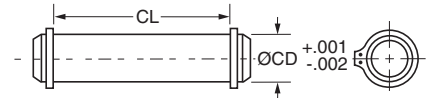
² Clevis Brackets with pin diameters 0.500 thru 1.000 are forged steel. Clevis Brackets with 0.438 and 1.375 pin diameter and larger are cast ductile iron.

Knuckle Dimensions



Part Number	Pin Ø	A	CA	CB	CD Ø	ER	JL	LR min	KK Thread
0740750000	0.438	0.75	1.50	0.43	0.440	0.53	—	—	5/16-24
0690890000	0.500	0.75	1.50	0.75	0.503	0.59	—	—	7/16-20
0690900000	0.500	0.75	1.50	0.75	0.503	0.59	—	—	1/2-20
0690910000	0.750	1.13	2.06	1.25	0.753	0.87	—	—	3/4-16
0690920000	1.000	1.13	2.38	1.50	1.003	1.15	—	—	7/8-14
0690930000	1.000	1.63	2.81	1.50	1.003	1.15	—	—	1-14
0690940000	1.375	2.00	3.44	2.00	1.378	1.55	—	—	1 1/4-12
0690950000	1.750	2.25	4.00	2.50	1.753	1.96	—	—	1 1/2-12
0690960000	2.000	2.25	4.38	2.50	2.003	2.24	—	—	1 3/4-12
0962160000	2.000	3.00	5.00	2.50	2.003	2.24	3.00	2.77	1 7/8-12
0962170000	2.500	3.50	5.81	3.00	2.503	2.76	3.50	3.09	2 1/4-12
0962180000	3.000	3.50	6.13	3.00	3.003	3.30	4.00	3.58	2 1/2-12
0962190000	3.000	3.63	6.50	3.50	3.003	3.30	4.00	3.58	2 3/4-12
0962200000	3.500	4.50	7.63	4.00	3.503	3.87	6.00	4.18	3 1/4-12
0962210000	3.500	5.00	7.63	4.00	3.503	3.87	6.00	4.18	3 1/2-12
0962220000	4.000	5.50	9.13	4.50	4.003	4.43	6.00	4.80	4-12

Pivot Pin Dimensions



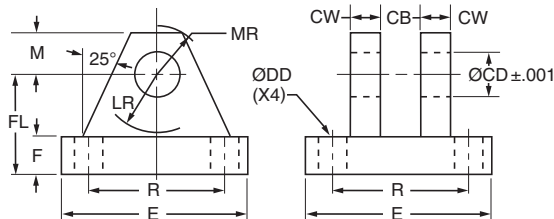
Part Number	CD Ø	CL
0740780000	0.438	1.31
0683680000	0.500	1.88
0683690000	0.750	2.63
0683700000	1.000	3.13
0683710000	1.375	4.19
0683720000	1.750	5.19
0692150000	2.000	5.69
0683740000	2.500	6.19
0683750000	3.000	6.25
0692160000	3.000	6.75
0735450000	3.500	8.25
0821810000	4.000	8.69
0735470000 ¹	4.000	9.00

¹This size supplied with cotter pins.

Notes:

- Pivot Pins are furnished with Clevis Mounted Cylinders as standard.
- Pivot Pins are furnished with (2) Retainer Rings.
- Pivot Pins must be ordered as a separate item if to be used with Knuckles, Rod Clevises, or Clevis Brackets.

Fabricated Steel Clevis Bracket Dimensions



Fabricated Steel Part Number	Pin ² Ø	CB	CD Ø	CW	DD Ø	E	F	FL	LR	M	MR	R
0692050000	0.500	0.80	0.503	0.50	0.41	3.50	0.50	1.50	0.75	0.50	0.63	2.55
0692060000	0.750	1.30	0.753	0.63	0.53	5.00	0.63	1.88	1.19	0.75	0.91	3.82
0692070000	1.000	1.59	1.003	0.75	0.66	6.50	0.75	2.25	1.50	1.00	1.25	4.95
0692080000	1.375	2.09	1.378	1.00	0.66	7.50	0.88	3.00	2.00	1.38	1.66	5.73
0692090000	1.750	2.59	1.753	1.25	0.91	9.50	0.88	3.63	2.75	1.75	2.22	7.50
0692100000	2.000	2.59	2.003	1.50	1.06	12.75	1.00	4.25	3.19	2.25	2.78	9.40
0692110000	2.500	3.09	2.503	1.50	1.19	12.75	1.00	4.50	3.50	2.50	3.13	9.40
0692120000	3.000	3.09	3.003	1.50	1.31	12.75	1.00	6.00	4.25	3.00	3.59	9.40
0692130000	3.000	3.59	3.003	1.50	1.31	12.75	1.00	6.00	4.25	3.00	3.59	9.40
0735420000	3.500	4.09	3.503	2.00	1.81	15.50	1.69	6.69	5.00	3.50	4.13	12.00
0735430000	4.000	4.59	4.003	2.00	2.06	17.50	1.94	7.69	5.75	4.00	4.88	13.75

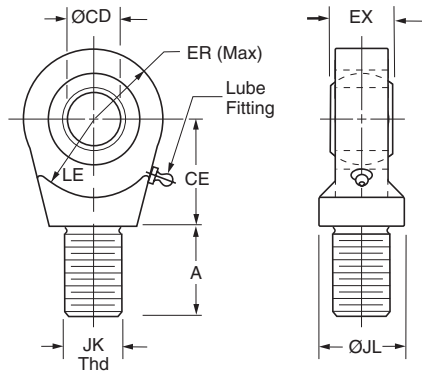
² Clevis Bracket for 0.438 diameter pin is only available in cast ductile iron construction. See part number 0960160044 on previous page.



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

bearing mount cylinders include the Rod Eye, Pivot Pin and Clevis Bracket. To select the proper part number for any desired accessory refer to the tables below.

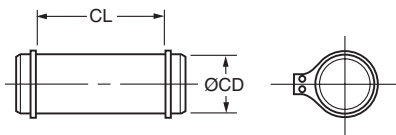
Spherical Rod Eye Dimensions



Bore Ø	Part Number	CD Ø	A	CE	EX	ER	LE	JK Thread	JL Ø	Load Capacity (lb)
1.50, 2.00, 2.50	0961000050	.5000 ⁻⁰⁰⁰⁵	0.72	0.86	0.44	0.80	0.78	7/16-20	0.88	2644
3.25, 4.00, 5.00	0961000075	.7500 ⁻⁰⁰⁰⁵	1.02	1.25	0.66	1.14	1.06	3/4-16	1.31	9441
6.00, 8.00	0961000100	1.0000 ⁻⁰⁰⁰⁵	1.52	1.88	0.88	1.34	1.45	1-14	1.50	16860

Order to fit Piston Rod Thread Size.

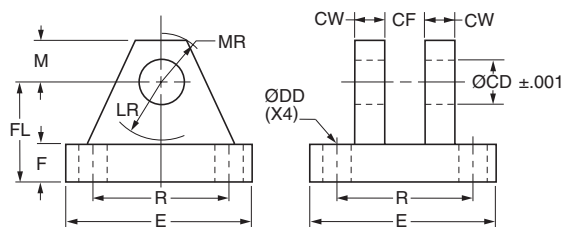
Pivot Pin Dimensions



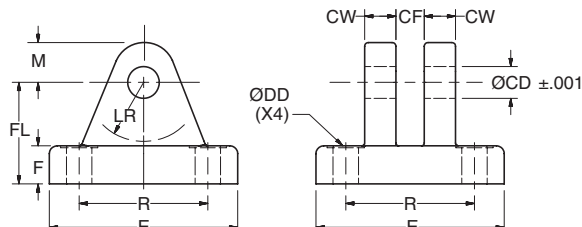
Bore Ø	Part Number	CD Ø	CL	Shear Capacity (lb)
1.50, 2.00, 2.50	0839620000	.4997 ⁻⁰⁰⁰⁴	1.56	8600
3.25, 4.00, 5.00	0839630000	.7497 ⁻⁰⁰⁰⁵	2.03	19300
6.00, 8.00	0839640000	.9997 ⁻⁰⁰⁰⁵	2.50	34300

Pivot Pins are furnished with (2) Retainer Rings.

Clevis Bracket Dimensions



Fabricated Steel



Cast Ductile Iron

Order to fit Cylinder Cap or Rod Eye.

Bore Ø	Pin Ø	Cast Ductile Iron Part Number	Fabricated Steel Part Number	CD Ø	CF	CW	DD Ø	E	F	FL	LR	M	MR	R	Load Capacity (lb)
1.50, 2.00, 2.50	0.500	0959450000	0839470000	0.503	0.45	0.50	0.41	3.00	0.50	1.50	0.94	0.50	0.63	2.05	5770
3.25, 4.00, 5.00	0.750	0959300000	0839480000	0.753	0.67	0.63	0.53	3.75	0.63	2.00	1.38	0.88	1.00	2.76	9450
6.00, 8.00	1.000	0959310000	0839490000	1.003	0.89	0.75	0.53	5.50	0.75	2.50	1.69	1.00	1.19	4.10	14300

Linear Alignment Couplers



- Simplify Cylinder Installation
- Reduce Assembly Time
- Increase Cylinder Bearing and Seal Life
- Reliable Performance In “Push” *and* “Pull” Applications

Linear Alignment Couplers are available in 19 standard thread sizes...

Cost Saving Features and Benefits Include...

- Maximum reliability for trouble-free operation, long life and lower operating costs
- Increased cylinder life by reducing wear on Piston and Rod bearings
- Simplifying Cylinder installation and reducing assembly costs
- Increase Rod Bearing and Rod Seal life for lower maintenance costs

Alignment Coupler

See Table 1 for Part Numbers and Dimensions

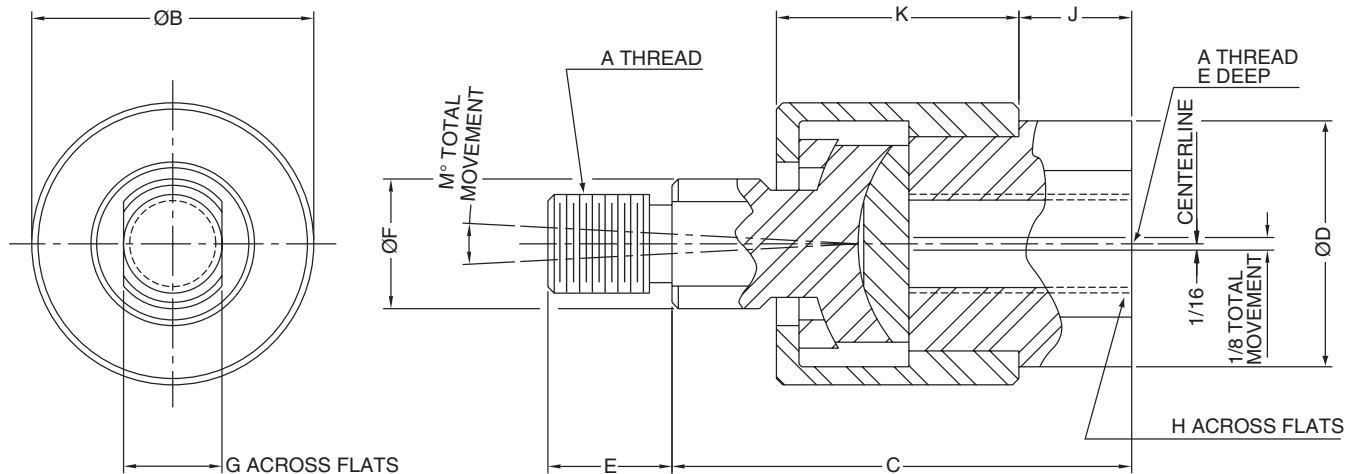
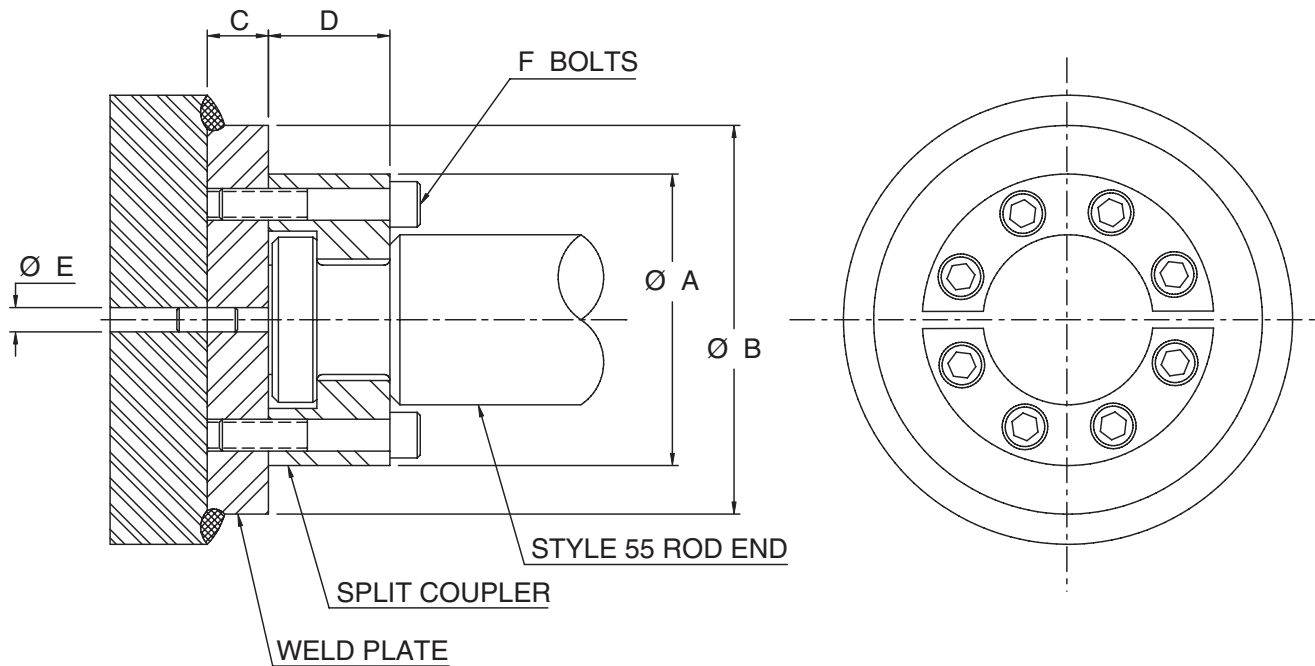


Table 1 — Part Numbers and Dimensions

Part Number	A	B Ø	C	D Ø	E	F Ø	G	H	J	K	M	Max. Pull Load (lbs.)	Approx. Weight (lbs.)
1347570031	5/16-24	1.13	1.75	0.94	0.50	0.50	0.38	0.75	0.38	0.94	6°	1200	.35
1347570038	3/8-24	1.13	1.75	0.94	0.50	0.50	0.38	0.75	0.38	0.94	6°	2425	.35
1347570044	7/16-20	1.38	2.00	1.13	0.75	0.63	0.50	0.88	0.38	1.09	6°	3250	.55
1347570050	1/2-20	1.38	2.00	1.13	0.75	0.63	0.50	0.88	0.38	1.09	6°	4450	.55
1347570063	5/8-18	1.38	2.00	1.13	0.75	0.63	0.50	0.88	0.38	1.09	6°	6800	.55
1347570075	3/4-16	2.00	2.31	1.63	1.13	0.94	0.75	1.31	0.44	1.28	6°	9050	1.4
1347570088	7/8-14	2.00	2.31	1.63	1.13	0.94	0.75	1.31	0.44	1.28	6°	14450	1.4
1347570100	1-14	3.13	3.00	2.38	1.63	1.44	1.25	1.88	0.75	1.78	6°	19425	4.8
1347570125	1 1/4-12	3.13	3.00	2.38	1.63	1.44	1.25	1.88	0.75	1.78	6°	30500	4.8
1337390125	1 1/4-12	3.50	4.00	2.00	2.00	1.50	1.25	1.69	0.75	2.50	6°	30500	6.9
1337390150	1 1/2-12	4.00	4.38	2.25	2.25	1.75	1.50	2.00	0.88	2.75	10°	45750	9.8
1337390175	1 3/4-12	4.00	4.38	2.25	2.25	1.75	1.50	2.00	0.88	2.75	10°	58350	9.8
1337390188	1 7/8-12	5.00	5.63	3.00	3.00	2.25	2.00	2.63	1.38	3.38	10°	67550	19.8
1337390200	2-12	5.00	5.63	3.00	3.00	2.25	2.00	2.63	1.38	3.38	10°	77450	19.8
1337390225	2 1/4-12	6.75	6.38	3.25	3.50	2.75	2.38	2.88	1.63	3.75	10°	99250	35.3
1337390250	2 1/2-12	7.00	6.50	4.00	3.50	3.25	2.88	3.38	1.63	3.88	10°	123750	45.3
1337390275	2 3/4-12	7.00	6.50	4.00	3.50	3.25	2.88	3.38	1.63	3.88	10°	150950	45.3
1337390300	3-12	7.00	6.50	4.00	3.50	3.25	2.88	3.38	1.63	3.88	10°	180850	45.3
1337390325	3 1/4-12	9.25	8.50	5.25	4.50	4.00	3.38	4.50	2.00	5.50	10°	213450	-
1337390425	4 1/4-12	12.88	11.25	7.75	4.50	5.50	4.88	7.00	1.50	8.75	10°	370850	-

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” or “CC” dimension is 3/4" - 16", specify coupler part number 1347570075.

Parker “Style 55” 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 Ø	B Ø	C	D	E Ø	F	Bolt Size	Bolt Circle	Split Coupler Part Number	Weld Plate Part Number
.625	1.50	2.00	.50	.56	.250	4	#10-24 x .94 LG	1.125	1472340062	1481740062
1.000	2.00	2.50	.50	.88	.250	6	.250-20 x 1.25 LG	1.500	1472340100	1481740100
1.375	2.50	3.00	.63	1.00	.250	6	.312-18 x 1.00 LG	2.000	1472340138	1481740138
1.750	3.00	4.00	.63	1.25	.250	8	.312-18 x 1.75 LG	2.375	1472340175	1481740175
2.000	3.50	4.00	.75	1.63	.375	12	.375-16 x 2.25 LG	2.687	1472340200	1481740200
2.500	4.00	4.50	.75	1.88	.375	12	.375-16 x 2.50 LG	3.187	1472340250	1481740250
3.000	5.00	5.50	1.00	2.38	.375	12	.500-13 x 3.25 LG	4.000	1472340300	1481740300
3.500	5.88	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	4.687	1472340350	1481740350
4.000	6.38	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	5.187	1472340400	1481740400
4.500	6.88	8.00	1.00	3.13	.375	12	.625-11 x 4.00 LG	5.687	1472340450	1481740450
5.000	7.38	8.00	1.00	3.13	.375	12	.625-11 x 4.00 LG	6.187	1472340500	1481740500
5.500	8.25	9.00	1.25	3.88	.375	12	.750-10 x 5.00 LG	6.875	1472340550	1481740550

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

Dual Axis Knuckle

Using a Dual Axis Knuckle permits increased angular movement from the cylinder center line. Clevis or Eye mounted cylinders often require movement beyond the plane that two pivot pins allow. Spherical bearing mounts permit angular movement up to 4.5° within the pivoting plane. A Dual Axis Knuckle, with two pin holes 90° apart, installed at the cap and rod end of a mounting style BB cylinder adds two pivot points, thereby providing up to 30° movement in another plane at each end.

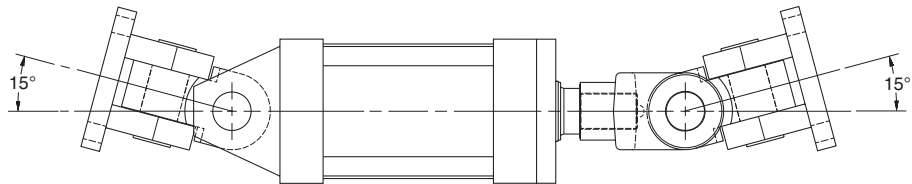
Dual Axis Knuckle Benefits

- Increased angular movement range compared to spherical bearing mount.
- Significantly higher dynamic load rating than spherical bearing mount.
- Reduced bearing loads and wear that results from misalignment.
- Allows faster assembly of pivoting cylinders to the machine.

Maximum Achievable Angular Movement from Cylinder Centerline¹

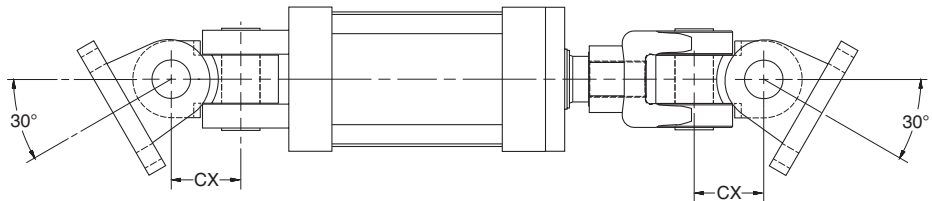
Inboard Pin –

15° maximum movement for cylinder misalignment only.



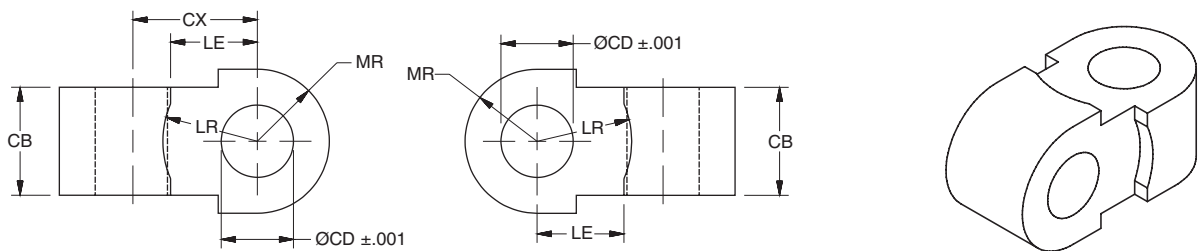
Outboard Pin –

30° maximum movement when applying force to a load moving in a curved plane.



¹Maximum movement is achieved with cast clevis brackets. Movement is reduced when using fabricated clevis brackets.

Dual Axis Knuckle Dimensions and Usage

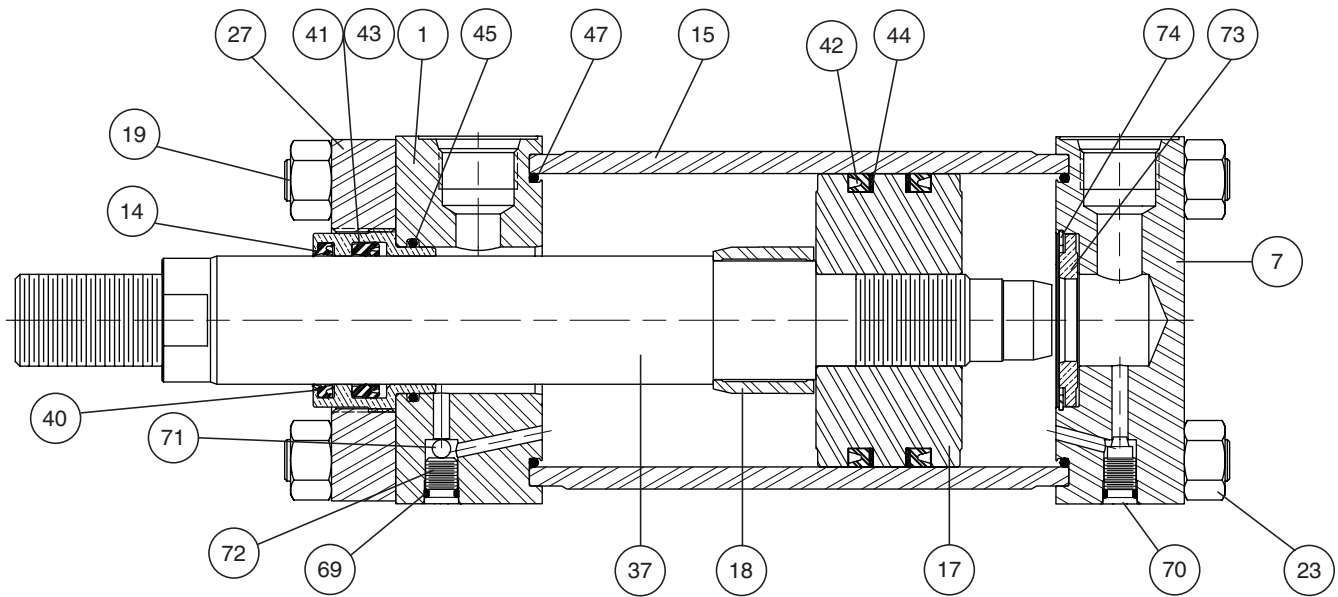


Part Number	Pin Ø	Load Capacity (lb)	CB	CD Ø	CX	LE	LR	MR	Mating Parts		BB Mount Usage by Series & Bore 3L
									Clevis Bracket	Rod Clevis	
0952670000	0.500	4380	0.75	0.503	0.88	0.54	0.63	0.50	0960160050	0509400000, 0509410000	1.50, 2.00, 2.50
0952680000	0.750	12370	1.25	0.753	1.19	0.80	0.94	0.75	0960160075	0509420000, 1332840000	3.25, 4.00, 5.00
0952690000	1.000	20500	1.50	1.003	1.69	1.05	1.22	1.00	0960160100	0509430000, 0509440000, 1332850000	6.00, 8.00
0952700000	1.375	30500	2.00	1.378	2.38	1.44	1.69	1.38	0960160138	0509450000, 1332860000	–
0952710000	1.750	49500	2.50	1.753	3.06	1.81	2.19	1.75	0960160175	0509460000	–
0952720000	2.000	68000	2.50	2.003	3.63	2.09	2.44	2.00	0960160200	0509470000, 0509480000	–

Notes

B

1.00" through 8.00" Bore



Piston and Rod Assemblies

Factory assembled piston and rod assemblies (that include seals for piston type specified) are recommended.

Tie Rod Torque

Bore Ø	Tie Rod Torque Series 3L
1.00	35-40 lb-in
1.50	60-70 lb-in
2.00	11-12 lb-ft
2.50	11-12 lb-ft
3.25	25-26 lb-ft
4.00	25-26 lb-ft
5.00	60-64 lb-ft
6.00	60-64 lb-ft
8.00	110-114 lb-ft

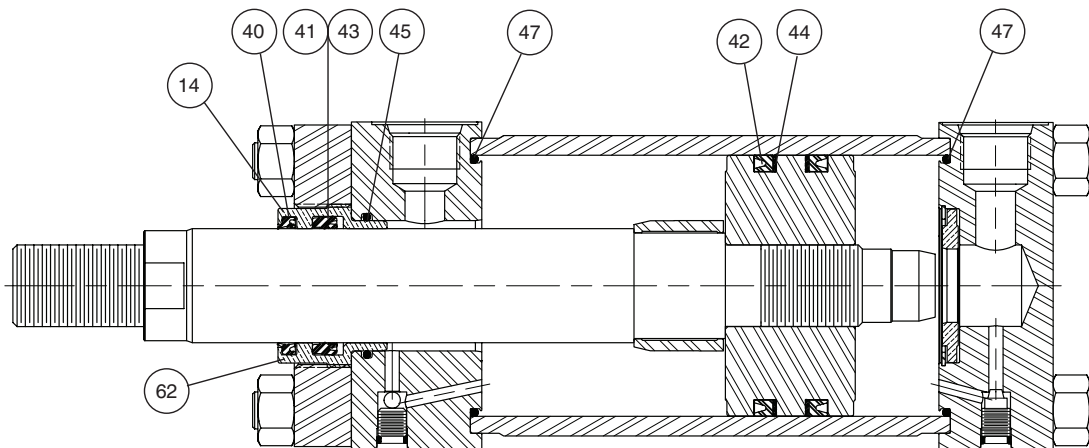
Note: The tie rod torque values are for cylinders rated at 1,000 psi. Consult factory for torque values for cylinders rated above 1,000 psi.

Parts List — 1.00" through 8.00" Bore

Symbol	Description
1	Head
7	Cap
14	Rod Gland
15	Cylinder tube
17	Piston, lipseal type
18	Cushion sleeve, rod head cushion
19	Tie rod
23	Tie rod nut
27	Retainer
37	Piston rod, single rod type
40	Rod Wiper
41	Rod Seal

Symbol	Description
42	Lipseal, piston
43	Back-up washer, rod seal
44	Back-up washer, piston
45	Gland O-ring
47	O-ring, cylinder tube to head and cap seal
69	O-ring, cushion adjustment and check valve plug screw
70	Needle, cushion adjustment valve
71	Ball, cushion check valve
72	Plug screw, cushion check valve
73	Bushing, float check, cushion on cap end
74	Retaining ring, float check cushion bushing

1.00" through 8.00" Bore



Symbol	Description
14	Rod Gland
40	Rod Wiper
41	Rod Seal
42	Piston Lipseal
43	Rod Seal Back-up Washer
44	Piston Seal Back-up Washer
45	Gland to head o-ring
47	End seal o-ring
62	Gland Cartridge Kit ¹

¹Gland Cartridge Kit contains: 14, 40, 41, 43 and 45.

Service Kit Numbers – Gland Cartridge Kits and Rod Seal Kits

Rod Ø	Seal Type			
	Class 1 Service (Polyurethane & Nitrile)		Class 2 Service ² (Nitrile)	
	Gland Cartridge Kits ¹	Rod Seal Kits ³	Gland Cartridge Kits ¹	Rod Seal Kits ³
0.500	RG2HLTS051	RK2HLTS051	RG2AHL0051	RK2AHL0051
0.625	RG2HLTS061	RK2HLTS061	RG2AHL0061	RK2AHL0061
1.000	RG2HLTS101	RK2HLTS101	RG2AHL0101	RK2AHL0101
1.375	RG2HLTS131	RK2HLTS131	RG2AHL0131	RK2AHL0131
1.750	RG2HLTS171	RK2HLTS171	RG2AHL0171	RK2AHL0171
2.000	RG2HLTS201	RK2HLTS201	RG2AHL0201	RK2AHL0201
2.500	RG2HLTS251	RK2HLTS251	RG2AHL0251	RK2AHL0251
3.000	RG2HLTS301	RK2HLTS301	RG2AHL0301	RK2AHL0301
3.500	RG2HLTS351	RK2HLTS351	RG2AHL0351	RK2AHL0351
4.000	RG2HLTS401	RK2HLTS401	RG2AHL0401	RK2AHL0401
4.500	RG2HLTS451	RK2HLTS451	RG2AHL0451	RK2AHL0451
5.000	RG2HLTS501	RK2HLTS501	RG2AHL0501	RK2AHL0501
5.500	RG2HLTS501	RK2HLTS551	RG2AHL0551	RK2AHL0551

² Series 3L rod gland cartridge kit rod seal kit, piston seal kit and body seal kit part numbers shown identify class 2 seals. To order class 5 or 6 seals substitute 5 or 6 as required for the last digit of the kit number.

³ Rod Seal Kits contain items 40, 41, 45 (43 class 2, 5 & 6 only).

⁴ Piston Lipseal Kits – (Includes Cylinder Body End Seals). Contain two each of items 47, 42, & 44.

Piston Seal Kits and Body Seal Kits

Bore Ø	Class 1 & 2 Service ²	
	Piston Lipseal Kits ⁴	Body Seal Kits
1.00	PK102HLL01	CB102HL001
1.50	PK152HLL01	CB152HL001
2.00	PK202HLL01	CB202HL001
2.50	PK252HLL01	CB252HL001
3.25	PK322HLL01	CB322HL001
4.00	PK402HLL01	CB402HL001
5.00	PK502HLL01	CB502HL001
6.00	PK602HLL01	CB602HL001
8.00	PK802HLL01	CB802HL001

Retainer Bolt Torque for Cylinders with Round Gland Retainers

Torque values are for bolts installed with lubrication.

Screw Size	Torque
# 10	56 - 58 lb-in
1/4"	11 - 12 lb-ft
5/16"	23 - 24 lb-ft
3/8"	41 - 43 lb-ft
7/16"	65 - 68 lb-ft



**Piston Seal Kits for Series 3L with
Magnetic Piston Option**

Bore Ø	Piston Seal Kit ¹ for Magnetic Piston	
	Class 1 Service	Class 5 Service
1.00	PK103LM001	PK103LM005
1.50	PK153LM001	PK153LM005
2.00	PK203LM001	PK203LM005
2.50	PK253LM001	PK253LM005
3.25	PK323LM001	PK323LM005
4.00	PK403LM001	PK403LM005

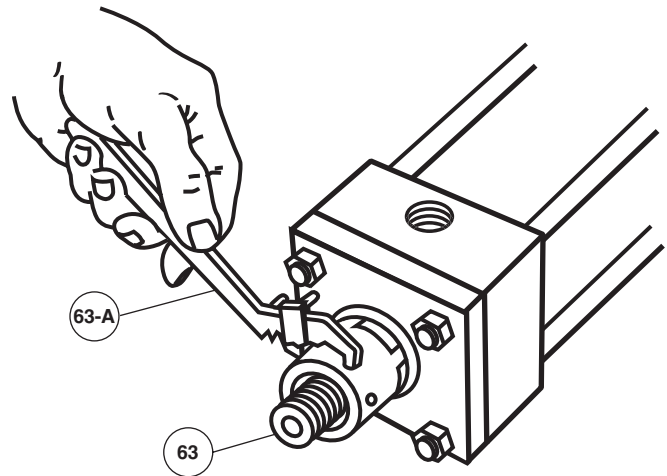
¹ Kit includes 1 piece each of bi-directional piston seal, piston seal energizer o-ring (2 lipseals and no energizer ring in 1.00 inch bore), piston wear band and 2 pieces each of cylinder tube to head and cap o-ring seal.

Gland Cartridge Wrenches

Parker's exclusive gland cartridge design makes gland replacement only a minute's work...and the Gland Cartridge Wrench Set makes it even simpler. A specially designed face-type gland wrench with flared lugs slips into an exact, sure fit on the gland, while a self-locking spanner wrench grips the gland wrench securely. No fumbling for adjustment – no accidental scoring of the piston rod, the job is done quickly...easily...safely.

You can order the Cartridge Wrench or Spanner Wrench to fit the piston rod size used in your Parker Hannifin Cylinder.

Rod Ø	Gland Wrench (Symbol 63)	Spanner Wrench (Symbol 63-A)
0.625	0695900000	0116760000
1.000	0695910000	
1.375	0695920000	0117030000
1.750	0695930000	0116770000
2.000	0695940000	
2.500	0695950000	0116770000
3.000	0695960000	
3.500	0695970000	
4.000	0695980000	0116780000
4.500	0838770000	
5.000	0695990000	
5.500	0696000000	



Section C

Series 3L Custom Modifications

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Common Modifications

Modifications: The following modifications can be supplied on most Parker cylinders.

Metallic Rod Wiper

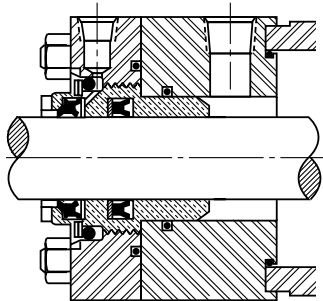
When specified metallic rod wipers can be supplied instead of the standard synthetic rubber wiperseal. Recommended in applications where contaminants tend to cling to the extended piston rod and would damage the synthetic rubber wiperseal. Installation of metallic rod wiper does not affect cylinder dimensions. It is available at extra cost.

Gland Drain

Hydraulic fluids tend to adhere to the piston rods, during the extend stroke, and an accumulation of fluid can collect in the cavity behind the gland wiperseal on long stroke cylinders.

A 1/8" NPTF gland drain port can be provided in the gland retainer. A passage in the gland between the wiperseal and lipseal is provided to drain off any accumulation of fluid between the seals. See drawing below.

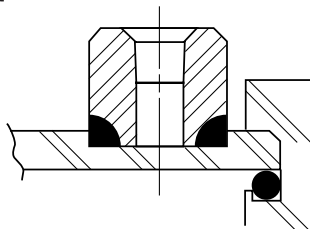
It is recommended that the gland drain port be piped back to the fluid reservoir and that the reservoir be located below the level of the head of the cylinder.



Air Bleeds

In most hydraulic circuits, cylinders are considered self-bleeding when cycled full stroke. If air bleeds are required and specified, 1/8" NPTF Air Bleed Ports for venting air can be provided at both ends of the cylinder body, or on the head or cap. To order, specify "Bleed Port", and indicate position desired.

Air Bleed Port



Rod End Boots

Cylinders have a hardened bearing surface on the piston rod to resist external damage, and are equipped with the high efficiency "Wiperseal" to remove external dust and dirt. Exposed piston rods that are subjected to contaminants with air hardening properties, such as paint, should be protected. In such applications, the use

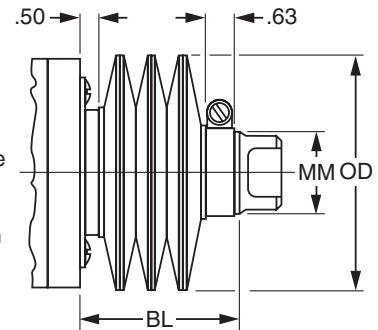
Medium Duty Hydraulic Cylinders Series 3L Custom Modifications

of a collapsing cover should be considered. This is commonly referred to as a "boot". Calculate the longer rod end required to accommodate the collapsed length of the boot from the following data.

LF	.13	.13	.13	.13	.13	.13	.13	.10	.10	.10	.10	.10
OD	2.25	2.25	2.63	3.00	3.38	3.75	4.38	5.13	5.63	6.25	7.00	7.50
MM	.500	.625	1.000	1.380	1.750	2.000	2.500	3.000	3.500	4.000	5.000	5.500

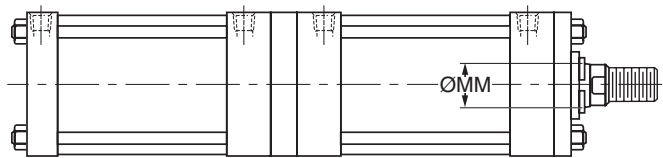
To determine extra length of piston rod required to accommodate boot, calculate
 $BL = \text{Stroke} \times LF + 1.125"$
 $BL + \text{Std. W} + A = \text{length of piston rod to extend beyond the retainer.}$

NOTE: Check all Boot O.D's against std. "E" dimension from catalog. This may be critical on foot mounted cylinders.



Tandem Cylinders

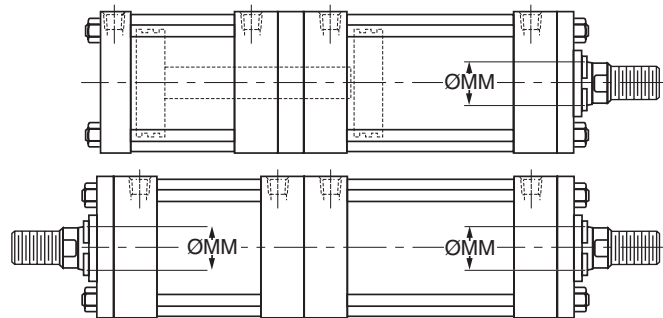
A tandem cylinder is made up of two cylinders mounted in line with pistons connected by a common piston rod and rod seals installed between the cylinders to permit double acting operation of each. Tandem cylinders allow increased output force when mounting width or height are restricted.



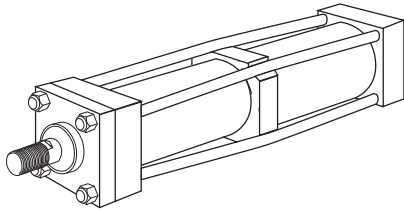
Reduced operating pressure is required for this construction. Please contact the factory.

Duplex Cylinders

A duplex cylinder is made up of two cylinders mounted in line with pistons not connected and with rod seals installed between the cylinders to permit double acting operation of each. Cylinders may be mounted with piston rod to piston (as shown) or back to back and are generally used to provide three position operation.



Reduced operating pressure is required for this construction. Please contact the factory.



Tie Rod Supports

Rigidity of Envelope – The pre-stressed tie rod construction of Parker cylinders has advantages in rigidity within the limits of the cylinder tube to resist buckling. For long stroke cylinders within practical limits, Parker provides exclusive TIE ROD SUPPORTS (see table below) which move the tie rod centerlines radially outward.

Standard tie rod supports are kept within the envelope dimensions of the head and cap, and generally do not interfere with mounting a long cylinder.

Number of Supports Required	Bore Ø	Stroke (Inches)												
		36	48	60	72	84	96	108	120	132	144	156	168	
1.00	—	1	1	1	2	Consult Factory							3	4
1.50	—	—	1	1	1	2	2	3	3	3	3	3	4	
2.00	—	—	—	1	1	1	1	2	2	2	2	3	3	
2.50	—	—	—	—	—	1	1	1	1	1	2	2	2	
3.25	—	—	—	—	—	—	—	1	1	1	1	1	1	
4.00	—	—	—	—	—	—	—	—	—	1	1	1	1	

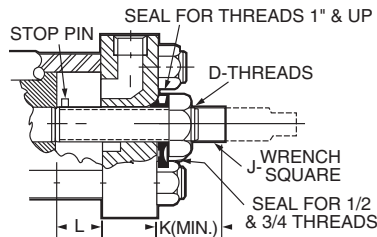
Note: 5.00" through 8.00" bore sizes — no supports required.

Stroke Adjusters

For the requirement where adjusting the stroke is specified. Parker has several designs to offer, one of which is illustrated below. This is suitable for infrequent adjustment and is economical¹.

Bore Ø Series 3L	D	J	K	L (Max.)
1.50, 2.00	1/2 - 20	0.31	0.94	5.00
2.50, 3.25, 4.00	3/4 - 16	0.44	1.25	8.00
5.00, 6.00	1 - 14	0.63	1.69	9.00
8.00	1 1/2 - 12	0.94	2.13	18.00

Here a “retracting stroke adjuster” must be called for in specifications, and the length of the adjustment must be specified.

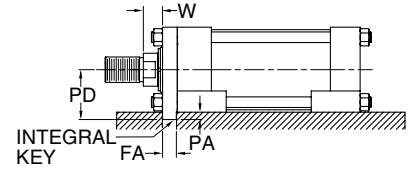


Where frequent adjustment or cushions at the cap end are required, other designs are available according to application needs.

¹Infrequent is defined by positioning the retract stroke in a couple of attempts at original machine set up. The frequent stroke adjuster is recommended for adjustments required after the original equipment has been adjusted by the original machine manufacturer.

Thrust Key Mountings

Thrust key mountings eliminate the need of using fitted bolts or external keys on side mounted cylinders. Parker cylinders in mounting styles CP and FP can be provided with the gland retainer plate extended below the mounting side of the cylinder (see illustration below). This extended retainer plate can then be fitted into a keyway milled into the mounting surface of the machine member. This is referred to as the “P” Modification of any side mounting style.



Bore Ø	FA	PA	PD Mtg. Styles CP & FP
1.00	.312 ^{-.002} / _{+.000}	0.19	0.94
1.50	.312 ^{-.002} / _{+.000}	0.19	1.19
2.00	.312 ^{-.002} / _{+.000}	0.19	1.44
2.50	.312 ^{-.002} / _{+.000}	0.19	1.69
3.25	.562 ^{-.002} / _{+.000}	0.31	2.19
4.00	.562 ^{-.002} / _{+.000}	0.31	2.56
5.00	.562 ^{-.002} / _{+.000}	0.31	3.06
6.00	.687 ^{-.002} / _{+.000}	0.38	3.63

Metric Piston Rod Thread

The table below lists the standard thread supplied when Piston Rod Thread type M is specified in the cylinder model code.

MM Rod Ø	Thread		A
	Styles 4M & 9M KK	Style 8M CC	
0.625	M10x1.5	M12x1.5	0.75
1.000	M20x1.5	M22x1.5	1.13
1.375	M26x1.5	M30x2	1.63
1.750	M33x2	M39x2	2.00
2.000	M39x2	M45x2	2.25
2.500	M48x2	M56x2	3.00
3.000	M58x2	M68x2	3.50
3.500	M64x2	M76x2	3.50
4.000	M76x2	M95x2	4.00
4.500	M80x2	M110x2	4.50
5.000	M90x2	M110x2	5.00
5.500	M100x2	M130x2	5.50



Cylinder End-of-Stroke Proximity Switches

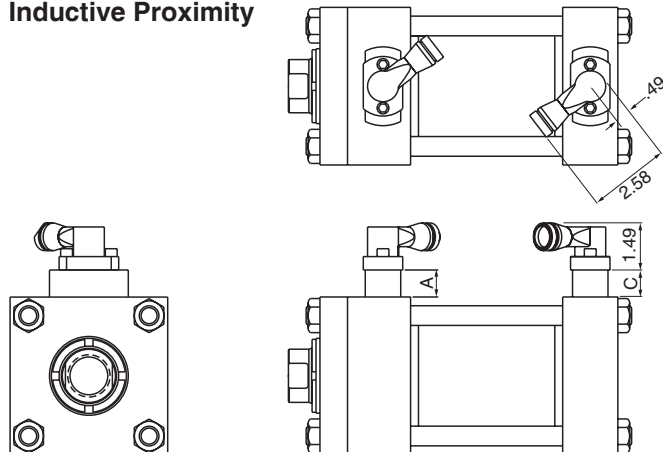


“EPS” Style Inductive Sensors
For General Industrial AC and DC Applications

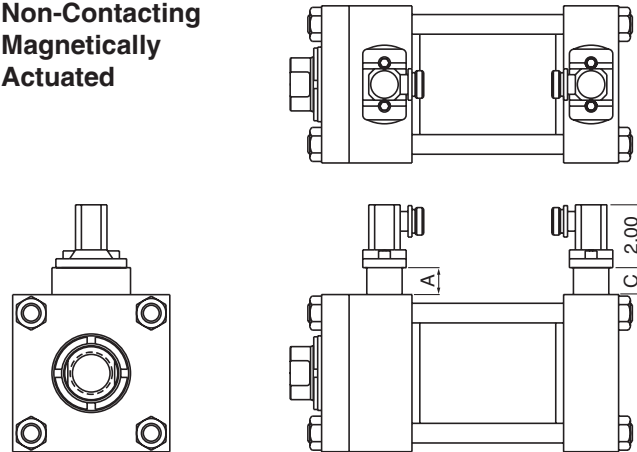
“CLS” Style Magnetic Sensors
Including Extreme Temperature Applications

All Sensors Are:
Non-Contacting
Water Resistant
Weld-Field Immune
Shock and Vibration Resistant
Flange-Mounted to Cylinder End Caps

**EPS 7 & 6 Sensors
Inductive Proximity**



**CLS 1 & 4 Sensors
Non-Contacting
Magnetically
Actuated**



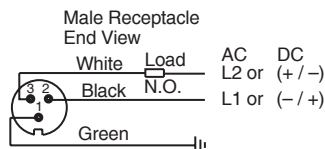
**Spacer Height
EPS & CLS Sensors**

A max.	C max.
1.55	1.05

For exact dimensions, see Bulletin 0840-G-E1.

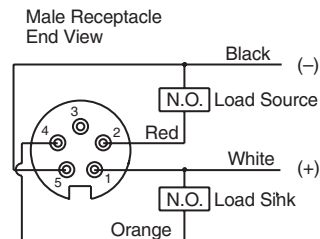
Connector Pin Numbering

3-Pin Mini



EPS-7

5-Pin Mini



EPS-6

Series and Parallel Wiring

When Parker EPS-6 or 7 sensors are used as inputs to programmable controllers the preferred practice is to connect each sensor to a separate input channel of the PLC. Series or parallel operations may then be accomplished by the internal PLC programming.

EPS-6 or 7 sensors may be hard wired for series operation, but the voltage drop through the sensors (see specifications) must not reduce the available voltage below what is needed to actuate the load.

EPS-6 or 7 sensors may also be hard wired for parallel operation. However, the leakage current of each sensor will pass through the load. The total of all leakage currents must not exceed the current required to actuate the load. When wiring EPS-6 sensors in parallel it is recommended that decoupling diodes be used.

Minimum Stroke

The minimum stroke for EPS-6 or 7 and CLS-1 or 4 sensors, utilizing standard components, is the cushion sleeve or spear length for the cylinder series in which the sensor is installed. See the individual Industrial Cylinder series catalog for cushion length details. Contact the factory if a shorter stroke is required.



Specifications				
Style:	EPS-7	EPS-6	CLS-1	CLS-4
Code Designator:	H	D	F	B
Description:	Economical, General Purpose, 2 wire device, primarily for AC applications. (Not suitable for 3 wire 24 volt Sinking or Sourcing applications.) Also for automotive industry applications.	Economical, General Purpose, 3 wire, DC sensor, dual output: sinking and sourcing	Functional replacement for AB (Mechanical) Limit Switches in many applications, or where customer needs NC contacts, zero leakage, zero voltage drop, higher or lower load current than EPS-style	Functional replacement for AB (Mechanical) Limit Switches in many High Temperature applications, or where customer needs NC contacts, zero leakage, zero voltage drop, higher or lower load current than EPS-style.
Supply Voltage:	20 to 250 VAC/DC	10 to 30 VDC	24 to 240 VAC/DC	24 to 240 VAC/DC
Load Current, min:	8 mA	N/A	NA	NA
Load Current, max:	300 mA	200 mA	4 AMPS @ 120 VAC 3 AMPS @ 24VDC	4 AMPS @ 120 VAC 3 AMPS @ 24 VDC
Leakage Current:	1.7 mA, max.	10 micro amps max	–	–
Voltage Drop:	7 V, max.	2 VDC max.	N/A	NA
Operating Temperature:	-14° to +158° F	-14° to +158°F	-40°F to +221°F	-40°F to +400°F
Sensor Type:	Inductive proximity	Inductive proximity	non-contacting magnetically actuated	non-contacting magnetically actuated
Part Number:	148897 ¹	148896 ¹	148275 ¹	149109 ¹
Part Number Suffix¹:	¹4-digit suffix indicates probe length: 0125=1.25", 0206=2.06", 0288=2.875", 0456=4.562"			
Connection:	3 pin mini	5 pin mini	3 pin mini	144" PTFE Coated Flying Leads with 1/2" conduit hub
Enclosure Rating:	IEC IP67	IEC IP67	NEMA 1, 2, 3, 4, 4x, 5, 6, 6P, 11, 12, 12K, 13	NEMA 1, 2, 3, 4, 4x, 5
LED indication:	Yes	Yes	Yes	No
Short Circuit Protection:	Yes	Yes	No	No
Weld Field Immunity:	Yes	Yes	Yes	Yes
Output:	2 wire, Normally Open with leakage current	Dual Output: DC Sinking and DC Sourcing, user selectable via wiring	SPDT (Single Pole Double Throw), Normally Open/Normally Closed, Form C	SPDT (Single Pole Double Throw), Normally Open/Normally Closed, Form C
Approvals/Marks:	CE, UL, CSA	CE, UL, CSA	UL or CSA ²	UL or CSA ²
Make/Break Location:	0.13" from end of stroke, typical. Tolerance is +0"/-0.13"			
Wiring Instructions:	Pin 1: AC Ground (Green) Pin 2: Output (Black) Pin 3: AC Line (White)	Pin 1: +10 to 30 VDC (White) Pin 2: Sourcing Output (Red) Pin 3: Grounded (not connected or required) Pin 4: Sinking Output (Orange) Pin 5: DC Common (Black)	Pin 1: Common (Green) Pin 2: Normally Closed (Black) Pin 3: Normally Open (White)	Common: (Black) Normally Open: (Blue) Normally Closed: (Red)
Cable: 6'	0853550006	0859170006	0853550006	–
Cable: 12'	0853550012	0859170012	0853550012	–
Cable: 6', Right Angle	0875470006	–	0875470006	–

²CSA available upon request – contact factory.

How to Specify EPS Proximity Switches

Parker EPS proximity switches may be ordered on Series 3L cylinders as follows:

- 1) Complete the basic cylinder model number.
- 2) Place an "S" in the model number to denote switches and/or special features.
- 3) Mounting styles D, DB, JJ, J, or H should be used with caution because of possible mounting interferences. Consult bulletin 0840-G-E1 for additional information.
- 4) Special modifications to cylinders other than switches must have a written description.

5) Specify letter prefix "H" for EPS-7, "D" for EPS-6, and "F" for CLS-1, or "B" for CLS-4, then fill in the four blanks specifying port location, switch orientation and actuation point for both head and cap. If only one switch is used, place "XXXX" in the unused blanks.

Example = H13AGG-XXXX denotes a switch on the head end only, EPS-7

Example = XXXX-H42AGG denotes a switch on the cap end only, EPS-7

Head End

H	1	3	A	GG
Specify: "H" = EPS-7 "D" = EPS-6 "F" = CLS-1 ¹ "B" = CLS-4 ¹ "N" = Prep for EPS-6 and EPS-7 switches "P" = Prep for CLS-1 and CLS-4 switches "T" = Prep for CLS-2 switch	Port Location See Figure 1.	Switch Location See Figure 1.	Switch Orientation See Figure 2 for CLS-1, CLS-4, EPS-6 and EPS-7 only.	Actuation Point GG = End of Stroke FF = Stroke to Go; See Bulletins 0840-G-E1, 2 or 3 for stroke remaining.

Cap End

H	4	2	A	GG
Specify: "H" = EPS-7 "D" = EPS-6 "F" = CLS-1 "B" = CLS-4 "N" = Prep for EPS-6 and EPS-7 switches "P" = Prep for CLS-1 and CLS-4 switches "T" = Prep for CLS-2 switch	Port Location See Figure 1.	Switch Location See Figure 1.	Switch Orientation See Figure 2 for CLS-1, CLS-4, EPS-6 and EPS-7 only.	Actuation Point GG = End of Stroke FF = Stroke to Go; See Bulletins 0840-G-E1, 2 or 3 for stroke remaining.

Note: All specified switch and port locations are as seen from rod end of cylinder.

¹CLS-1 and CLS-4 proximity switches are not available on the head end of 1.50" bore with 1.00" rod and 2.00" bore with 1.375" rod

Figure 1

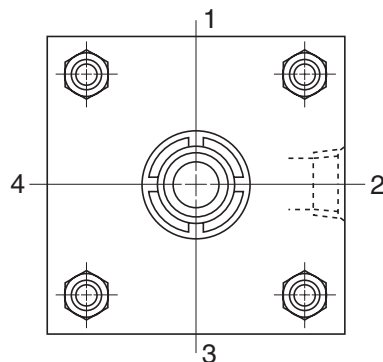
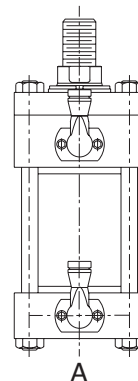


Figure 2



Notes

Section D

Series 3L Engineering Data

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Offer of Sale	IBC

D

Theoretical Push Forces for Hydraulic Cylinders

Bore Ø	Piston Area (Sq. In.)	Cylinder Push Stroke Force in Pounds at Various Pressures					
		100	250	500	1000	1500	2000
1.00	0.79	79	196	392	785	1178	1570
1.50	1.767	177	443	885	1770	2651	3540
2.00	3.14	314	785	1570	3140	4712	6280
2.50	4.91	491	1228	2455	4910	7363	9820
3.25	8.30	830	2075	4150	8300	12444	16600
4.00	12.57	1257	3143	6285	12570	18850	25140
5.00	19.64	1964	4910	9820	19640	29453	39280
6.00	28.27	2827	7068	14135	28270	42412	56540
8.00	50.27	5027	12568	25135	50270	75398	100540

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.

Theoretical Pull Forces for Hydraulic Cylinders

Bore Ø	Piston Rod Ø	Piston Rod Area (Sq. In.)	Cylinder Pull Force in Pounds at Various Pressures					
			100	250	500	1000	1500	2000
1.00	0.500	0.196	59	149	297	594	891	1188
	0.625	0.307	48	121	242	483	725	966
1.50	0.625	0.307	146	365	730	1460	2190	2920
	1.000	0.785	98	245	491	982	1473	1964
2.00	0.625	0.307	283	708	1417	2833	4250	5666
	1.375	1.48	166	415	830	1660	2490	3320
	1.000	0.785	236	589	1178	2355	3533	4710
2.50	1.000	0.785	413	1031	2063	4125	6188	8250
	1.750	2.41	250	625	1250	2500	3750	5000
	1.375	1.48	343	858	1715	3430	5145	6860
	0.625	0.307	460	1151	2302	4603	6905	9206
3.25	1.000	0.785	752	1879	3758	7515	11273	15030
	2.000	3.14	516	1290	2580	5160	7740	10320
	1.375	1.48	682	1705	3410	6820	10230	13640
	1.750	2.41	589	1473	2945	5890	8835	11780
4.00	1.375	1.48	1109	2773	5545	11090	16635	22180
	2.500	4.91	766	1915	3830	7660	11490	15320
	1.750	2.41	1016	2540	5080	10160	15240	20320
	2.000	3.14	943	2358	4715	9430	14145	18860
	1.000	0.785	1179	2946	5893	11785	17678	23570
5.00	1.750	2.41	1723	4308	8615	17230	25845	34460
	3.500	9.62	1002	2505	5010	10020	15030	20040
	2.000	3.14	1650	4125	8250	16500	24750	33000
	2.500	4.91	1473	3683	7365	14730	22095	29460
	3.000	7.07	1257	3143	6285	12570	18855	25140
	1.000	0.785	1886	4714	9428	18855	28283	37710
	1.375	1.48	1816	4540	9080	18160	27240	36320
6.00	1.750	2.41	2586	6465	12930	25860	38790	51720
	4.000	12.57	1570	3925	7850	15700	23550	31400
	2.000	3.14	2513	6283	12565	25130	37695	50260
	2.500	4.91	2336	5840	11680	23360	35040	46720
	3.000	7.07	2120	5300	10600	21200	31800	42400
	3.500	9.62	1865	4663	9325	18650	27975	37300
	1.375	1.48	2679	6698	13395	26790	40185	53580
8.00	2.000	3.14	4713	11783	23565	47130	70695	94260
	5.500	23.76	2651	6628	13255	26510	39765	53020
	2.500	4.91	4536	11340	22680	45360	68040	90720
	3.000	7.07	4320	10800	21600	43200	64800	86400
	3.500	9.62	4065	10163	20325	40650	60975	81300
	4.000	12.57	3770	9425	18850	37700	56550	75400
	1.375	1.48	4879	12198	24395	48790	73185	97580
	1.750	2.41	4786	11965	23930	47860	71790	95720
	4.500	15.90	3437	8593	17185	34370	51555	68740
	5.000	19.63	3064	7660	15320	30640	45960	61280



Cylinder Weights

**Medium Duty Hydraulic Cylinders
Series 3L Engineering Data**

The weights shown below are for standard Series 3L hydraulic cylinders equipped with various diameter piston rods. To determine the net weights 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 Code 1 weight for the cylinder bore size involved.

Table A Cylinder Weights, in pounds, for Series 3L hydraulic cylinders

Bore Ø	Rod Ø	Single Rod Cylinders Basic Wt. Zero Stroke		Add Per Inch of Stroke	Double Rod Cylinders Basic Wt. Zero Stroke		Add Per Inch of Stroke
		F, H, J, T, TB, TC, TD	BB, C, D, DB, DD, HB, JB		KJ, KF, KT, KTD, KTB	KJB, KC, KD, KDD	
1.00	0.500	2.5	2.9	0.20	4.7	5.5	0.40
	0.625	2.6	3.0	0.23	4.9	5.7	0.46
1.50	0.625	3.7	4.3	0.3	4.2	4.8	0.6
	1.000	4.5	5.1	0.4	5.8	6.7	0.8
2.00	0.625	6.5	6.9	0.5	8.2	8.6	1.0
	1.000	7.0	7.5	0.63	9.0	9.5	1.3
	1.375	8.5	8.9	0.8	11.2	11.6	1.6
2.50	0.625	9.0	9.7	0.6	11.4	12.1	1.2
	1.000	9.5	10.0	0.73	12.0	12.5	1.5
	1.750	13.2	13.6	1.1	19.8	20.5	2.2
3.25	1.000	16.5	17.5	0.8	22.0	23.0	1.6
	1.375	17.0	18.0	1.0	22.5	23.5	2.0
	2.000	27.0	28.0	1.4	43.0	44.0	2.8
4.00	1.000	26.0	31.0	1.0	33.0	38.0	2.0
	1.375	26.5	31.5	1.2	33.5	38.5	2.5
	2.500	36.0	42.0	2.0	53.0	58.0	4.0
5.00	1.000	39.0	46.0	1.1	48.0	55.0	2.2
	1.375	39.5	46.5	1.3	48.5	55.5	2.6
	3.500	63.0	66.0	3.6	96.0	103.0	7.2
6.00	1.375	68.0	77.0	1.5	80.0	89.0	3.0
	4.000	100.0	102.0	4.5	144.0	153.0	9.0
8.00	1.375	94.0	99.0	2.0	108.0	113.0	4.0
	5.500	168.0	172.0	8.0	256.0	261.0	16.0

Table B Piston Rod Weights, in pounds, for Series 3L hydraulic cylinders

Rod Ø	Piston Rod Wt. Per Inch	Rod Ø	Piston Rod Wt. Per Inch	Rod Ø	Piston Rod Wt. Per Inch
0.625	0.09	2.000	0.89	4.000	3.56
1.000	0.22	2.500	1.40	4.500	4.51
1.375	0.42	3.000	2.00	5.000	5.56
1.750	0.68	3.500	2.72	5.500	6.72



Operating Fluids and Temperature Range

Fluidpower cylinders are designed for use with pressurized air, hydraulic oil and fire resistant fluids, in some cases special seals are required.

Standard Seals (class 1)

Class 1 seals are what is normally provided in a cylinder unless otherwise specified. 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). Generally they are nitrile except for piston rod seals in hydraulic cylinders. However the individual seals may be nitrile (Buna-N) enhanced polyurethane, polymyte, P.T.F.E. or filled P.T.F.E.

Water Base Fluid Seals (class 2)

Generally class 2 seals are intended for use with water base fluids within the temperature of -10°F (-23°C) to +165°F (+74°C) except for High Water Content Fluids (H.W.C.F.) in which case Class 6 seals should be used. Typical water base fluids are: Water, Water-Glycol, Water-in Emulsion, Houghto-Safe 27, 620, 5040, Mobil Pyrogard D, Shell Iruis 905, Ucon Hydrolube J-4. These seals are nitrile. Lipseal will have polymyte or P.T.F.E. back-up washer when required. O-rings will have nitrile back-up washers when required.

Ethylene Propylene (E.P.R.) Seals (class 3)

Class 3 seals are intended for use with some Phosphate Ester Fluids between the temperatures of -10°F (-23°C) to +130°F (+54°C). Typical fluids compatible with E.P.R. seals are Skydrol 500 and 700. E.P.R. are Ethylene Propylene. Lipseals will have a P.T.F.E. back-up washer when required. O-rings will have EPR back-up washers when required.

Note: E.P.R. seals are not compatible with mineral base hydraulic oil or greases. Even limited exposure to these fluids will cause severe swelling. P.T.F.E. back-up washer may not be suitable when used in a radiation environment.

Low Temperature Nitrile Seals (class 4)

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). Lipseals will have leather, polymyte or P.T.F.E. 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.

Fluorocarbon Seals (class 5)

Class 5 seals are intended for elevated temperature service or for some Phosphate Ester Fluids such as Houghto-Safe 1010, 1055, 1120; Fyrquel 150, 220, 300, 350; Mobile Pyrogard 42, 43, 53, and 55. **Note:** In addition, class 5 seals can be used with fluids listed below under standard service. However, they are not compatible with Phosphate Ester Fluids such as Skydrols. Class 5 seals can operate with a temperature range of -10°F (-23°C) to +250°F (+121°C). Class 5 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 and thread and a pinned piston to rod connection. Class 5 Lipseals will have P.T.F.E. back-up washers when required. O-rings will have fluorocarbon back-up when required.

H.W.C.F. Seals (class 6)

Class 6 seals are intended for High Water Content Fluids (H.W.C.F.) such as Houghto Hydrolubric 120B and Sonsol Lubrizol within the temperature range of +40°F (+4°C) to +120°F (+49°C). Class 6 seals are special nitrile compound dynamic seals. Lipseals will have P.T.F.E. and or polymyte back-up washers when required. O-rings will have nitrile

back-up washers when required. Because of the viscosity of these fluids, cylinders specified with class 6 seals, will also be modified to have lipseal piston seals and straight cushions.

Energized PTFE Seals (class 8)

Class 8 seals consist of PTFE piston lipseals, rod seal and wiperseal. Piston seals have an internal stainless steel spring to energize both the static and dynamic sealing lips. They are intended for high temperature applications, to 400° F (204° C), where longer seal life and improved high temperature sealing performance is required. Minimum operating temperature is -15°F (-26°C). Body and gland o-ring seals will be fluorocarbon. Fluid resistance is comparable to Class 5.

Warning ⚠

The piston rod stud and the piston rod to piston threaded connections are secured with an anaerobic adhesive which is temperature sensitive. Cylinders are assembled with anaerobic adhesive having a maximum temperature rating of +250°F (+121°C). Cylinders specified with all other seal compounds (built before 1997) were assembled with anaerobic adhesive having 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 (before 1997) 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 re-assembled to withstand the higher temperature service.

Lipseal Pistons

Under most conditions lipseals provide the best all around service for pneumatic applications. Lipseals with a back-up washer 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. A high load piston option is recommended when operating at high pressures and especially with large bore hydraulic cylinders.

Water Service

Series 3L cylinders can be modified to make them more suitable for use with water as the operating medium. The modifications include chrome-plated cylinder bore; electroless nickel-plated head, cap and piston; chrome-plated 17-4 stainless steel piston rod; chrome plated cushion sleeve or cushion spear.

Modified cylinders may also be used for higher operating pressures, up to 2000 psi, depending on bore size. See pressure rating for Hydraulic Cylinders on the next page. Series 3L hydraulic cylinders can also be modified for water operation and supplied with chrome-plated cylinder bore; electroless nickel-plated head, cap and piston; chrome-plated precipitation hardened stainless steel piston rod, chrome-plated cushion sleeve or cushion spear. When high water base fluids are the operating medium, hydraulic cylinders are usually supplied with high water base rod wiper and seals. Water and high water base fluid operated cylinders are best used on short stroke applications or where high pressure is applied only to clamp the load.

Warranty

Parker Hannifin will warrant cylinders modified for water or high water content fluid service to be free of defects in materials or workmanship, but cannot accept responsibility to premature failure due to excessive wear due to lack of lubricity or where failure is caused by corrosion, electrolysis or mineral deposits within the cylinder.

Fluids and Temperature Range

Class Number	Typical Fluids	Temperature Range
1 (Standard) (Nitrile Polyurethane)	Air, Nitrogen Hydraulic Oil, Mil-H-5606 Oil	-10°F (-23°C) to +165°F (+74°C)
2 Optional Water Base Fluid Seal	Water, Water-Glycol, H.W.C.F. — See Class 6 below. Water-in-Oil Emulsion Houghto-Safe, 271, 620, 5040. Mobil Pyrogard D, Shell Iruis 905. Ucon Hydrolube J-4	-10°F (-23°C) to +165°F (+74°C)
3 Special (E.P.R.) (At extra cost)	Some Phosphate Ester Fluids Skydrol 500, 7000	-10°F (-23°C) to +130°F (+54°C)
Note: (E.P.R.) seals are not compatible with Hydraulic Oil		
4 Special (Nitrile) (At extra cost)	Low Temperature Air or Hydraulic Oil	-50°F (-46°C) to +150°F (+66°C)
5 Optional (At extra cost) (Fluorocarbon Seals)	High Temperature Houghto-Safe 1010, 1055, 1120 Fyrquel 150, 220, 300, 550 Mobil Pyrogard 42,43,53,55	See paragraph on Fluorocarbon seals for recommended temperature range.
Note: Fluorocarbon seals are not suitable for use with Skydrol fluid, but can be used with hydraulic oil if desired.		
6 Optional (HWCF) (At extra cost)	Houghton, Hydrolubric 120B Sonsol Lubrizol, for other HWCF — consult factory.	+40°F (+4°C) to +120°F (+49°C)
8 Optional (At extra cost) Energized PTFE	See Class 5 Seals	-15°F (-26°C) to 400°F (204°C)

Application Data

The proper application of a fluid power cylinder requires consideration of the operating pressure, the fluid medium, the mounting style, the length of stroke, the type of piston rod connection to the load, thrust or

tension loading on the rod, mounting attitude, the speed of stroke, and how the load in motion will be stopped. Information given here provides pressure rating data for pneumatic and hydraulic cylinders.

Pressure Ratings

Pressure ratings for Series 3L hydraulic cylinders vary by bore size and rod size as shown in the table. For pressures

higher than those indicated, Series 2H heavy duty cylinders should be used.

Series 3L Hydraulic Cylinders Maximum Pressure Rating

Bore Ø	Rod No.	Rod Ø	Pressure Rating At 4:1 Design ¹ Factor (On Tensile)
1.00	1	0.500	1900
	2	0.625	1900
1.50	1	0.625	2000
	2	1.000	2300
2.00	1	0.625	1100
	3	1.000	2000
	2	1.375	2000
2.50	7	0.625	700
	1	1.000	1400
	3	1.375	1400
	2	1.750	1400
3.25	1	1.000	1300
	3	1.375	1300
	4	1.750	1300
	2	2.000	1300
4.00	7	1.000	900
	1	1.375	900
	3	1.750	900
	4	2.000	900
	2	2.500	900

Bore Ø	Rod No.	Rod Ø	Pressure Rating At 4:1 Design ¹ Factor (On Tensile)
5.00	7	1.000	600
	8	1.375	950
	1	1.750	950
	3	2.000	950
	4	2.500	950
	5	3.000	950
6.00	2	3.500	950
	7	1.375	700
	1	1.750	700
	3	2.000	700
	4	2.500	700
	5	3.000	700
8.00	6	3.500	700
	2	4.000	700
	7	1.375	400
	8	1.750	650
	1	2.000	650
	3	2.500	650
	4	3.000	650
	5	3.500	650
	6	4.000	650
	9	4.500	650
0	5.000	650	
2	5.500	650	

¹ Applies to all mountings except J.

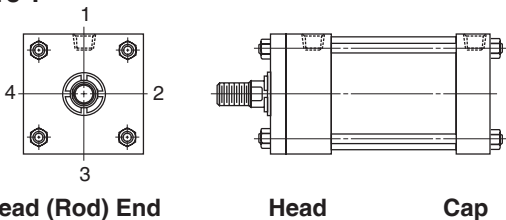


Ports

Series 3L cylinders can be supplied with S.A.E. straight O-ring ports or 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 positions 2 and 4 (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



Cylinder Port Options

- Option “T” SAE Straight Thread O-Ring Port. Recommended for most hydraulic applications.
- Option “U” Conventional NPTF Ports (Dry-Seal Pipe Threads). Recommended for pneumatic applications only.
- Option “R” BSPP Port (British Parallel Thread). ISO 228 port commonly used in Europe.
- Option “B” BSPT (British Tapered Thread).
- Option “G” Metric Straight Thread Port similar to Option “R” with metric thread. Popular in some European applications.
- Option “Y” ISO-6149-1 Metric Straight Thread Port. Recommended for all hydraulic applications designed per ISO standards.

Table A

Mounting Style	Port Position Available	
	Head End	Cap End
T, TB, TC, TD, H, HB, J, JB, DD	1, 2, 3 or 4	1, 2, 3 or 4
BB, DB, SB	1,2, 3 or 4	1 or 3
D, JJ	1 or 3	1, 2, 3 or 4
C, F	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.

Available Ports for Series 3L Cylinders

Bore Ø	“T” SAE Straight Thread	“U” NPTF Pipe Thread	“R” BSPP Parallel Thread	“B” BSPT Taper Thread	“G” Metric Straight Thread	“Y” ISO-6149-1 Metric Straight Thread
1.00	#6	1/4	1/4	1/4	M14 x 1.5	M14 x 1.5 ¹
1.50	#6	3/8	3/8	3/8	M14 x 1.5	M14 x 1.5 ¹
2.00	#6	3/8	3/8	3/8	M14 x 1.5	M14 x 1.5
2.50	#6	3/8	3/8	3/8	M14 x 1.5	M14 x 1.5
3.25	#10	1/2	1/2	1/2	M22 x 1.5	M22 x 1.5
4.00	#10	1/2	1/2	1/2	M22 x 1.5	M22 x 1.5
5.00	#10	1/2	1/2	1/2	M22 x 1.5	M22 x 1.5
6.00	#12	3/4	3/4	3/4	M26 x 1.5	M27 x 2
8.00	#12	3/4	3/4	3/4	M26 x 1.5	M27 x 2

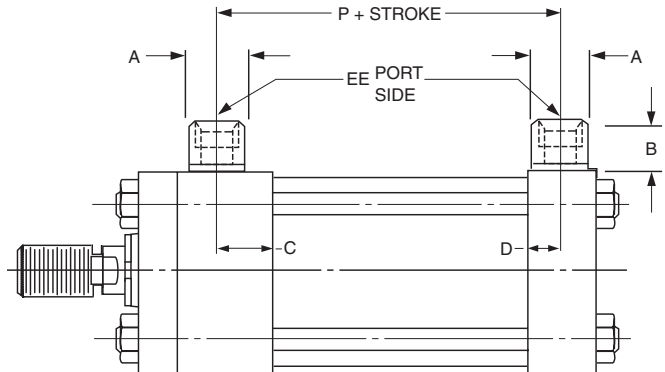
¹ Not available on code 2 rods



Oversize Ports

Oversize NPTF or SAE straight thread 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 drawings and tables below. Series 3L cylinders equipped with cushions at the cylinder cap end can sustain damage to the cushion check valve (cushion bushing) if excessive oil flow enters the cylinder from the cap end port. Cylinders which are equipped with cap end cushions and ordered with one size oversize ports having hydraulic fluid flow exceeding 25 ft./sec. in the line entering the cap end of the cylinder should be ordered with a “solid cushion” at cap end. All cylinders ordered with double oversize ports should always be ordered with a “solid cushion” at cap end.

Cylinders which are connected to a meter out flow control with flow entering the cap end of a cylinder provided by an accumulator may also experience damage to the cushion bushing due to high instantaneous fluid flows. This condition can be eliminated by using a meter in flow control or “solid cushions” at cap end.



Oversize NPTF Port Boss Dimensions

Bore Ø	EE (NPTF)	A Ø	B	C	D	P
1.00	3/8	0.88	0.75	0.56	0.50	2.06
1.50	1/2	1.13	0.94	0.56	0.50	2.19
2.00	1/2	1.13	0.94	0.56	0.50	2.19
2.50	1/2	1.13	0.94	0.56	0.50	2.31
3.25	3/4	1.38	1.00	0.69	0.63	2.56
4.00	3/4	1.38	1.00	0.69	0.63	2.56
5.00	3/4	1.38	1.00	0.69	0.63	2.81
6.00	1	1.75	1.19	0.94	0.75	3.19
8.00	1	1.75	1.19	0.94	0.75	3.31

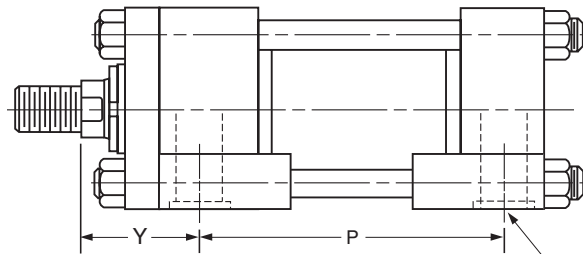
Oversize SAE Straight Thread Port Boss Dimensions

Bore Ø	EE (SAE)	A Ø	B	C	D	P
1.00	8	1.13	0.94	0.56	0.50	2.06
1.50	8	1.13	0.94	0.56	0.50	2.19
2.00	8	1.13	0.94	0.56	0.50	2.19
2.50	8	1.13	0.94	0.56	0.50	2.31
3.25	12	1.38	1.00	0.69	0.63	2.56
4.00	12	1.38	1.00	0.69	0.63	2.56
5.00	12	1.38	1.00	0.69	0.63	2.81
6.00	16 ¹	1.75	1.19	0.94	0.75	3.19
8.00	16 ¹	1.75	1.19	0.94	0.75	3.31

¹ Available at head end only. For cap end, consult factory.

Manifold Ports

Side mounted cylinders, Style C can be furnished with the cylinder ports arranged for mounting and sealing to a manifold surface. The ports are drilled and counterbored for O-ring seals which are provided. With these specifications, the mounting is designated Style CM or KCM.



**Dimensions —
Manifold Ports for Single and Double Rod Cylinders**

Bore Ø	Rod No.	Rod Ø	Y ±.031	P ±.031	EE	ED
1.00	All	All	1.94	2.13	0.38	0.69
1.50	1	0.625	2.00	2.13	0.50	0.81
	2	1.000	2.38			
2.00	1	0.625	2.00	2.13	0.50	0.81
	2	1.375	2.63			
	3	1.000	2.38			
2.50	1	1.000	2.38	2.25	0.50	0.81
	2	1.750	2.88			
	3	1.375	2.63			
3.25	1	1.000	2.44	2.63	0.63	0.94
	2	2.000	3.06			
	3	1.375	2.69			
	4	1.750	2.94			
4.00	1	1.375	2.69	2.63	0.63	0.94
	2	2.500	3.31			
	3	1.750	2.94			
	4	2.000	3.06			
	7	1.000	2.44			
5.00	1	1.750	2.94	2.88	0.63	0.94
	2	3.500	3.31			
	3	2.000	3.06			
	4	2.500	3.31			
	5	3.000	3.31			
	7	1.000	2.44			
	8	1.375	2.69			

Bore Ø	Rod No.	Rod Ø	Y ±.031	P ±.031	EE	ED
6.00	1	1.750	3.06	3.13	0.88	1.19
	2	4.000	3.44			
	3	2.000	3.19			
	4	2.500	3.44			
	5	3.000	3.44			
	6	3.500	3.44			
	7	1.375	2.81			
8.00	1	2.000	3.19	3.25	0.88	1.19
	2	5.500	3.44			
	3	2.500	3.44			
	4	3.000	3.44			
	5	3.500	3.44			
	6	4.000	3.44			
	7	1.375	2.81			
	8	1.750	3.06			
	9	4.500	3.44			
	0	5.000	3.44			



Stroke Data

Parker cylinders are available in any practical stroke length. The following information should prove helpful to you in selecting the proper stroke for your cylinder application.

Stroke Tolerances

Stroke length tolerances are required due to buildup of tolerances of piston, head, cap and cylinder tube. Standard production of stroke tolerances run $+0.031"$ to

$-0.015"$ up to 20" stroke, $+0.031"$ to $-0.020"$ for 21" to 60" and $+0.031"$ to $-0.031"$ for greater than 60" stroke. For closer tolerances on stroke length, it is necessary to specify the required tolerance plus the 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.

Mounting Groups

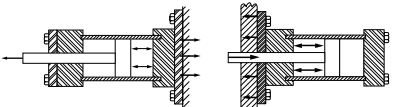
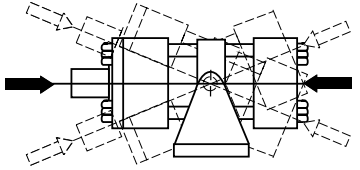
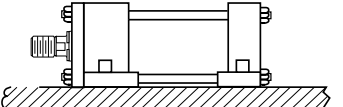
Standard mountings for fluid power cylinders fall into three basic groups. The groups can be summarized as follows:

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.

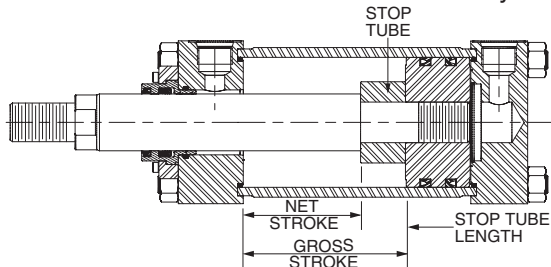
Group 3 Straight Line Force Transfer with fixed mounts which do not absorb force on cylinder centerline.

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 Styles C and F.

Group 1 FIXED MOUNTS which absorb force on cylinder centerline.	
<p>Heavy-Duty Service For Thrust Loads For Tension Loads</p>	 <p>Styles HB, TC Styles JB, JJ, TB</p>
<p>Medium-Duty Service For Thrust Loads For Tension Loads</p>	<p>Styles H, HB Styles J, JB</p>
<p>Light-Duty Service For Thrust Loads For Tension Loads</p>	<p>Style H Style J</p>
Group 2 PIVOT MOUNTS which absorb force on cylinder centerline.	
<p>Heavy-Duty Service For Thrust Loads For Tension Loads</p>	 <p>Styles DD, D Styles BB, DD, D, DB</p>
<p>Medium-Duty Service For Thrust Loads For Tension Loads</p>	<p>Styles BB, SB Styles BB, SB</p>
Group 3 FIXED MOUNTS which do not absorb force on the centerline.	
<p>Heavy-Duty Service For Thrust Loads For Tension Loads</p>	 <p>Styles C, CP Styles C, CP</p>
<p>Medium-Duty Service For Thrust Loads For Tension Loads</p>	<p>Styles F, FP Styles F, FP</p>

Stop Tubing

Stop tube is recommended to lengthen the distance between the rod bearing and piston bearing to reduce bearing loads on long push stroke cylinders when the cylinder is fully extended. This is especially true of horizontally mounted cylinders. As part of the piston assembly and positioned between the piston and head, a stop tube restricts the extended position of the rod using the increased distance to achieve additional stability.



Use the following steps to determine the need for stop tube and, if required, how long it should be.

1. Examine the groups of cylinder illustrations below and determine which mounting and rod guiding group type match the required cylinder application.

2. Establish the Basic Length (L), with the piston rod fully extended, for the selected illustration by using the dimensional tables on previous pages of this catalog. For pivot mounted cylinders, the pin-to-pin dimension with the piston rod fully extended must be used. Regardless of mounting style, be sure to include any extended piston rod length beyond the catalog standard.

3. In the Stop Tube Table select the column for the appropriate mounting style and rod end guiding type. In the Basic Length (L) column, find the row with the range that includes the value calculated in Step 2. The next respective column to the right has the required length of stop tube.

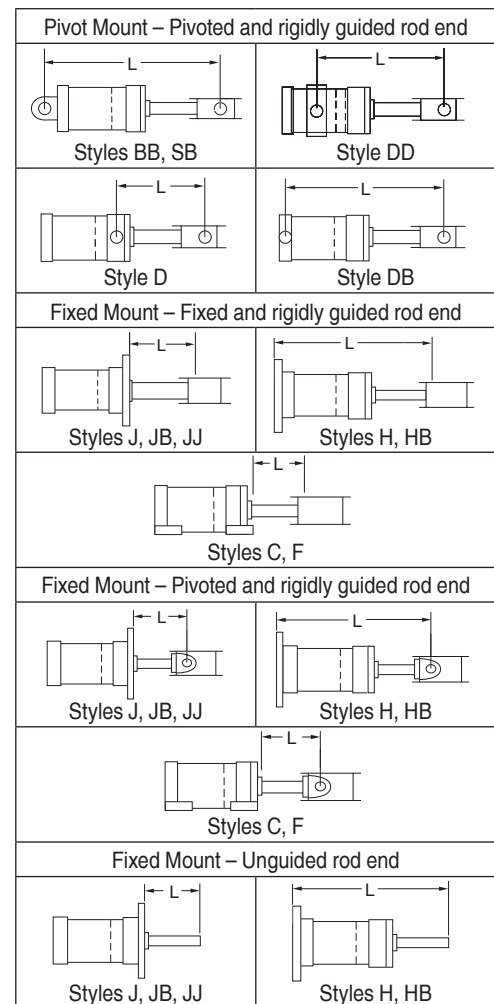
Note: Mounting Styles BB, DB, H, HB and SB that are mounted horizontally should also be checked for turning moments and loads between the rod bearing and piston to ensure they are not excessive. Weight of oil must be included in determining bearing loads.

When specifying cylinders with 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.

Stop Tube Length vs Basic Length (L)

Pivot Mounts (BB, D, DB, DD and SB)		Fixed Mounts (C, F, H, HB, J, JB, JJ, TB, TC, TD)					
Pivoted and Rigidly Guided Rod End		Fixed & Rigidly Guided Rod End		Pivoted & Rigidly Guided Rod End		Unguided Rod End	
Basic Length (L)	Stop Tube Length	Basic Length (L)	Stop Tube Length	Basic Length (L)	Stop Tube Length	Basic Length (L)	Stop Tube Length
0 - 40	0	0 - 80	0	0 - 57	0	0 - 20	0
41 - 50	1	81 - 100	1	58 - 71	1	21 - 25	1
51 - 60	2	101 - 120	2	72 - 86	2	26 - 30	2
61 - 70	3	121 - 140	3	87 - 100	3	31 - 35	3
71 - 80	4	141 - 160	4	101 - 114	4	36 - 40	4
81 - 90	5	161 - 180	5	115 - 129	5	41 - 45	5
91 - 100	6	181 - 200	6	130 - 143	6	46 - 50	6
101 - 110	7	201 - 220	7	144 - 157	7	51 - 55	7
111 - 120	8	221 - 240	8	158 - 171	8	56 - 60	8
121 - 130	9	241 - 260	9	172 - 186	9	61 - 65	9
131 - 140	10	261 - 280	10	187 - 200	10	66 - 70	10
141 - 150	11	281 - 300	11	201 - 214	11	71 - 75	11
151 - 160	12			215 - 229	12	76 - 80	12
161 - 170	13			230 - 243	13	81 - 85	13
171 - 180	14			244 - 257	14	86 - 90	14
181 - 190	15			258 - 271	15	91 - 95	15
191 - 200	16			272 - 286	16	96 - 100	16
201 - 210	17			287 - 300	17	101 - 105	17
211 - 220	18					106 - 110	18
221 - 230	19					111 - 115	19
231 - 240	20	Consult Factory				116 - 120	20
241 - 250	21					121 - 125	21
251 - 260	22					126 - 130	22
261 - 270	23			Consult Factory		131 - 135	23
271 - 280	24					136 - 140	24
281 - 290	25					141 - 145	25
291 - 300	26					146 - 150	26
Consult Factory						Consult Factory	

Cylinder Mounting and Rod Guiding Groups



Piston Rod Diameter Selection

Long stroke cylinders that work on push with the piston rod loaded in compression should be checked, using the following steps, to ensure an appropriate piston rod diameter is specified.

1. First, determine whether stop tubing is required as described on the previous page.
2. Use the Basic Length (L) that was established for determining the stop tube length and then add the required stop tube length to the Basic Length to obtain an Adjusted Basic Length (L_A).
3. In the table below, for the mounting style and rod end guiding condition that will be used, find the row for the Bore and Rod combination that is required.
4. Follow the Bore and Rod row to the right and find the Operating Pressure column that is closest, but exceeds the system pressure. Note that Operating Pressure column

values are different for bore size ranges 1.00 - 3.25 and 4.00 - 8.00. The intersection of the Bore and Rod row and Operating Pressure column displays the maximum allowable L_A. If L_A in the table is greater than or equal to the calculated L_A, the rod diameter selected is satisfactory for the application.

5. If L_A in the table is less than the calculated Adjusted Basic Length move down the column to a rod diameter with an L_A that exceeds the requirement.
6. If the L_A specifies a rod diameter in a larger bore then restart the process of sizing the stop tube and re-check the rod diameter. Contact the factory if L_A exceeds 300 inches.

Note: Data in these tables assume standard rod extension (W dimension) and standard rod end accessories. If different, consult factory.

Maximum Basic Lengths (L_A) (all dimensions in inches)

Bore Ø	Rod Ø	Front and Side Fixed Mounts (J ¹ , JB, JJ, TB, TD, C, F)																								
		Fixed and Rigidly Guided Rod End Max. Allowable Basic Length (L _A) at psi:								Pivoted and Rigidly Guided Rod End Max. Allowable Basic Length (L _A) at psi:								Unguided Rod End Max. Allowable Basic Length (L _A) at psi:								
		250	500	750	1000	1250	1500	1750	2000	250	500	750	1000	1250	1500	1750	2000	250	500	750	1000	1250	1500	1750	2000	
1.00	0.500	68	48	39	34	30	28	26	24	49	34	28	24	22	20	18	17	17	12	10	9	8	7	6	6	
	0.625	106	75	61	53	48	43	40	38	76	54	44	38	34	31	29	27	27	19	15	13	12	11	10	9	
	0.625	71	50	41	35	32	29	27	25	51	36	29	25	23	21	19	18	18	13	10	9	8	7	7	6	
	1.000	181	128	105	91	81	74	69	64	130	92	75	65	58	53	49	46	45	32	26	23	20	19	17	16	
1.50	0.625	53	38	31	27	-	-	-	-	38	27	22	19	-	-	-	-	13	9	8	7	-	-	-	-	
	1.000	136	96	79	68	61	56	51	48	97	69	56	49	43	40	37	34	34	24	20	17	15	14	13	12	
	1.375	257	182	149	129	115	105	97	91	184	130	106	92	82	75	69	65	64	45	37	32	29	26	24	23	
2.00	0.625	43	30	25	-	-	-	-	-	30	21	18	-	-	-	-	-	11	8	6	-	-	-	-	-	
	1.000	109	77	63	54	49	44	-	-	78	55	45	39	35	32	-	-	27	19	16	14	12	11	-	-	
	1.375	206	146	119	103	92	84	-	-	147	104	85	73	66	60	-	-	51	36	30	26	23	21	-	-	
	1.750	300	236	192	167	149	136	-	-	238	168	137	119	106	97	-	-	83	59	48	42	37	34	-	-	
2.50	1.000	84	59	48	42	37	-	-	-	60	42	35	30	27	-	-	-	21	15	12	10	9	-	-	-	
	1.375	158	112	91	79	71	-	-	-	113	80	65	57	51	-	-	-	40	28	23	20	18	-	-	-	
	1.750	256	181	148	128	115	-	-	-	183	130	106	92	82	-	-	-	64	45	37	32	29	-	-	-	
	2.000	300	237	193	167	150	-	-	-	239	169	138	120	107	-	-	-	84	59	48	42	37	-	-	-	
Bore Ø	Rod Ø	Max. Allowable Basic Length (L _A) at psi:								Max. Allowable Basic Length (L _A) at psi:								Max. Allowable Basic Length (L _A) at psi:								
		125	250	375	500	625	750	875	1000	125	250	375	500	625	750	875	1000	125	250	375	500	625	750	875	1000	
4.00	1.000	96	68	56	48	43	39	36	34	69	49	40	34	31	28	26	24	24	17	14	12	11	10	9	9	
	1.375	182	129	105	91	81	74	69	64	130	92	75	65	58	53	49	46	45	32	26	23	20	19	17	16	
	1.750	295	208	170	147	132	120	111	104	210	149	122	105	94	86	80	74	74	52	43	37	33	30	28	26	
	2.000	300	272	222	192	172	157	145	136	275	194	159	137	123	112	104	97	96	68	56	48	43	39	36	34	
	2.500	300	300	300	300	269	245	227	213	300	300	248	215	192	175	162	152	150	106	87	75	67	61	57	53	
5.00	1.000	77	54	44	38	34	-	-	-	55	39	32	27	25	-	-	-	19	14	11	10	9	-	-	-	
	1.375	146	103	84	73	65	59	55	51	104	73	60	52	46	42	39	37	36	26	21	18	16	15	14	13	
	1.750	236	167	136	118	105	96	89	83	168	119	97	84	75	69	64	60	59	42	34	29	26	24	22	21	
	2.000	300	218	178	154	138	126	116	109	220	155	127	110	98	90	83	78	77	54	44	38	34	31	29	27	
	2.500	300	300	300	300	300	283	262	245	300	300	286	247	221	202	187	175	173	122	100	87	77	71	65	61	
6.00	3.500	300	300	300	300	300	300	300	300	300	300	300	300	300	275	255	238	236	167	136	118	105	96	89	83	
	1.375	121	86	70	61	54	50	-	-	87	61	50	43	39	35	-	-	30	21	18	15	14	12	-	-	
	1.750	196	139	113	98	88	80	-	-	140	99	81	70	63	57	-	-	49	35	28	25	22	20	-	-	
	2.000	257	181	148	128	115	105	-	-	183	130	106	92	82	75	-	-	64	45	37	32	29	26	-	-	
	2.500	300	283	231	200	179	164	-	-	286	202	165	143	128	117	-	-	100	71	58	50	45	41	-	-	
8.00	3.000	300	300	300	300	289	258	236	-	-	300	292	238	206	184	168	-	-	144	102	83	72	65	59	-	-
	3.500	300	300	300	300	300	300	-	-	300	300	300	281	251	229	-	-	196	139	113	98	88	80	-	-	
	4.000	300	300	300	300	300	300	-	-	300	300	300	300	300	299	-	-	257	181	148	128	115	105	-	-	
	1.375	91	64	53	-	-	-	-	-	65	46	38	-	-	-	-	-	23	16	13	-	-	-	-	-	
	1.750	147	104	85	74	66	-	-	-	105	74	61	53	47	-	-	-	37	26	21	18	16	-	-	-	

¹ Maximum operating pressure is limited for Mounting Style J. Please refer to maximum operating pressure per bore in Pressure Ratings table located on the dimension page for Mounting Style J.



Maximum Basic Lengths (L_A) (all dimensions in inches)

Bore Ø	Rod Ø	Rear Fixed Mounts (H, HB, TC)																							
		Fixed and Rigidly Guided Rod End Max. Allowable Basic Length (L _A) at psi:								Pivoted and Rigidly Guided Rod End Max. Allowable Basic Length (L _A) at psi:								Unguided Rod End Max. Allowable Basic Length (L _A) at psi:							
		250	500	750	1000	1250	1500	1750	2000	250	500	750	1000	1250	1500	1750	2000	250	500	750	1000	1250	1500	1750	2000
1.00	0.500	94	66	54	47	42	38	36	33	67	47	39	34	30	27	25	24	23	17	14	12	11	10	9	8
	0.625	142	101	82	71	64	58	54	50	102	72	59	51	45	42	38	36	36	25	21	18	16	15	13	13
	1.000	230	162	133	119	103	94	87	81	164	116	95	82	73	67	62	58	57	41	33	29	26	23	22	20
1.50	0.625	98	69	57	49	44	40	37	35	70	50	41	35	31	29	27	25	25	17	14	12	11	10	9	9
	1.000	230	162	133	119	103	94	87	81	164	116	95	82	73	67	62	58	57	41	33	29	26	23	22	20
	1.375	74	53	43	37	-	-	-	-	53	38	31	27	-	-	-	-	19	13	11	9	-	-	-	-
2.00	1.000	182	129	105	91	82	74	69	65	130	92	75	65	58	53	49	46	46	32	26	23	20	19	17	16
	1.375	300	218	178	154	138	126	116	109	220	155	127	110	98	90	83	78	77	54	44	38	34	31	29	27
	1.750	60	42	35	-	-	-	-	-	43	30	25	-	-	-	-	-	15	11	9	-	-	-	-	-
2.50	1.000	149	106	86	75	67	61	-	-	107	75	62	53	48	44	-	-	37	26	22	19	17	15	-	-
	1.375	264	187	153	132	118	108	-	-	189	134	109	94	84	77	-	-	66	47	38	33	30	27	-	-
	1.750	300	268	219	189	169	155	-	-	270	191	156	135	121	110	-	-	95	67	55	47	42	39	-	-
3.25	1.000	117	83	67	58	52	48	-	-	83	59	48	42	37	34	-	-	29	21	17	15	13	12	-	-
	1.375	213	151	123	107	95	87	-	-	152	108	88	76	68	62	-	-	53	38	31	27	24	22	-	-
	1.750	300	228	186	161	144	132	-	-	231	163	133	115	103	94	-	-	81	57	47	40	36	33	-	-
2.000	300	279	228	197	176	161	-	-	282	199	163	141	126	115	-	-	99	70	57	49	44	40	-	-	
Bore Ø	Rod Ø	Max. Allowable Basic Length (L _A) at psi:								Max. Allowable Basic Length (L _A) at psi:								Max. Allowable Basic Length (L _A) at psi:							
		125	250	375	500	625	750	875	1000	125	250	375	500	625	750	875	1000	125	250	375	500	625	750	875	1000
4.00	1.000	135	96	78	68	60	55	51	48	96	68	56	48	43	39	36	34	34	24	19	17	15	14	13	12
	1.375	251	178	145	126	112	103	95	89	180	127	104	90	80	73	68	64	63	44	36	31	28	26	24	22
	1.750	300	279	228	197	176	161	149	139	281	199	163	141	126	115	106	100	99	70	57	49	44	40	37	35
	2.000	300	300	287	248	222	203	188	176	300	251	205	177	159	145	134	125	124	88	72	62	56	51	47	44
	2.500	300	300	300	300	300	285	264	247	300	300	288	249	223	204	188	176	174	123	101	87	78	71	66	62
5.00	1.000	108	77	63	54	48	-	-	-	77	55	45	39	35	-	-	-	27	19	16	14	12	-	-	-
	1.375	203	144	117	102	91	83	77	72	145	103	84	73	65	59	55	51	51	36	29	25	23	21	19	18
	1.750	300	229	187	162	145	132	122	114	231	163	133	115	103	94	87	82	81	57	47	40	36	33	31	29
	2.000	300	293	239	207	185	169	157	146	296	209	171	148	132	121	112	105	104	73	60	52	46	42	39	37
	2.500	300	300	300	300	272	248	230	215	300	300	250	217	194	177	164	153	152	107	88	76	68	62	57	54
	3.000	300	300	300	300	300	300	280	260	300	300	300	283	253	231	214	200	198	140	114	99	89	81	75	70
3.500	300	300	300	300	300	300	300	300	300	300	300	300	300	300	277	256	240	237	168	137	119	106	97	90	84
6.00	1.375	170	120	98	85	76	70	-	-	122	86	70	61	54	50	-	-	43	30	25	21	19	17	-	-
	1.750	274	193	158	137	122	112	-	-	195	138	113	98	87	80	-	-	68	48	39	34	31	28	-	-
	2.000	300	250	204	177	158	144	-	-	253	179	146	126	113	103	-	-	88	63	51	44	40	36	-	-
	2.500	300	300	300	268	239	219	-	-	300	270	221	191	171	156	-	-	134	95	77	67	60	55	-	-
	3.000	300	300	300	300	300	298	-	-	300	300	300	261	233	213	-	-	183	129	105	91	82	75	-	-
	3.500	300	300	300	300	300	300	-	-	300	300	300	300	294	268	-	-	230	163	133	115	103	94	-	-
4.000	300	300	300	300	300	300	-	-	300	300	300	300	300	300	-	-	272	192	157	136	122	111	-	-	
8.00	1.375	128	91	74	-	-	-	-	-	92	65	53	-	-	-	-	-	32	23	19	-	-	-	-	-
	1.750	207	146	120	104	93	-	-	-	148	105	85	74	66	-	-	-	52	37	30	26	23	-	-	-
	2.000	270	191	156	135	121	-	-	-	193	136	111	96	86	-	-	-	67	48	39	34	30	-	-	-
	2.500	300	294	240	208	186	-	-	-	297	210	172	149	133	-	-	-	104	74	60	52	47	-	-	-
	3.000	300	300	300	294	263	-	-	-	300	296	242	210	188	-	-	-	147	104	85	73	66	-	-	-
	3.500	300	300	300	300	300	-	-	-	300	300	300	276	247	-	-	-	193	137	112	97	86	-	-	-
	4.000	300	300	300	300	300	-	-	-	300	300	300	300	300	-	-	-	241	171	139	121	108	-	-	-
	4.500	300	300	300	300	300	-	-	-	300	300	300	300	300	-	-	-	287	203	166	144	129	-	-	-
	5.000	300	300	300	300	300	-	-	-	300	300	300	300	300	-	-	-	300	233	190	165	147	-	-	-
	5.500	300	300	300	300	300	-	-	-	300	300	300	300	300	-	-	-	300	259	212	183	164	-	-	-



Maximum Basic Lengths (L_A) (all dimensions in inches)

Bore Ø	Rod Ø	Rear Pivot Mounts (BB, SB ¹ , DB)								Front and Intermediate Pivot Mounts (D, DD)							
		Pivoted & Rigidly Guided Rod End Max. Allowable Basic Length (L _A) at psi:								Pivoted & Rigidly Guided Rod End Max. Allowable Basic Length (L _A) at psi:							
		250	500	750	1000	1250	1500	1750	2000	250	500	750	1000	1250	1500	1750	2000
1.00	0.500	47	33	27	23	21	19	18	17	34	24	20	17	15	14	13	12
	0.625	71	50	41	36	32	29	27	25	53	38	31	27	24	22	20	19
1.50	0.625	49	35	28	25	22	20	19	17	35	25	20	18	16	14	13	13
	1.000	115	81	66	57	51	47	43	41	91	64	52	45	41	37	34	32
2.00	0.625	37	26	21	19	-	-	-	-	27	19	15	13	-	-	-	-
	1.000	91	65	53	46	41	37	34	32	68	48	39	34	30	28	26	24
	1.375	154	109	89	77	69	63	58	54	129	91	74	64	58	53	49	45
2.50	0.625	30	21	17	-	-	-	-	-	21	15	12	-	-	-	-	-
	1.000	75	53	43	37	33	31	-	-	54	38	31	27	24	22	-	-
	1.375	132	93	76	66	59	54	-	-	103	73	59	51	46	42	-	-
	1.750	189	134	109	95	85	77	-	-	167	118	96	83	75	68	-	-
3.25	1.000	58	41	34	29	26	24	-	-	42	30	24	21	19	17	-	-
	1.375	107	75	62	53	48	44	-	-	79	56	46	40	35	32	-	-
	1.750	161	114	93	81	72	66	-	-	128	91	74	64	57	52	-	-
	2.000	197	139	114	99	88	80	-	-	167	118	97	84	75	68	-	-
Bore Ø	Rod Ø	Max. Allowable Basic Length (L _A) at psi:								Max. Allowable Basic Length (L _A) at psi:							
		125	250	375	500	625	750	875	1000	125	250	375	500	625	750	875	1000
4.00	1.000	68	48	39	34	30	28	26	24	48	34	28	24	22	20	18	17
	1.375	126	89	73	63	56	51	48	44	91	64	53	45	41	37	34	32
	1.750	197	139	114	99	88	80	74	70	147	104	85	74	66	60	56	52
	2.000	248	176	143	124	111	101	94	88	192	136	111	96	86	79	73	68
	2.500	300	247	201	174	156	142	132	123	300	213	174	150	134	123	114	106
5.00	1.000	54	38	31	27	24	-	-	-	38	27	22	19	17	-	-	-
	1.375	102	72	59	51	45	41	38	36	73	51	42	36	33	30	27	26
	1.750	162	114	93	81	72	66	61	57	118	83	68	59	53	48	45	42
	2.000	207	146	120	104	93	85	78	73	154	109	89	77	69	63	58	54
	2.500	300	215	175	152	136	124	115	107	241	170	139	120	108	98	91	85
	3.000	300	280	229	198	177	162	150	140	300	245	200	173	155	141	131	122
6.00	3.500	300	300	274	237	212	194	179	168	300	300	272	236	211	192	178	167
	1.375	85	60	49	43	38	35	-	-	61	43	35	30	27	25	-	-
	1.750	137	97	79	68	61	56	-	-	98	69	57	49	44	40	-	-
	2.000	177	125	102	88	79	72	-	-	128	91	74	64	57	52	-	-
	2.500	268	189	155	134	120	109	-	-	200	142	116	100	90	82	-	-
	3.000	300	258	211	183	163	149	-	-	289	204	167	144	129	118	-	-
	3.500	300	300	266	230	206	188	-	-	300	278	227	196	176	160	-	-
4.000	300	300	300	272	243	222	-	-	300	300	296	257	229	209	-	-	
8.00	1.375	64	45	37	-	-	-	-	-	45	32	26	-	-	-	-	-
	1.750	104	73	60	52	46	-	-	-	74	52	43	37	33	-	-	-
	2.000	135	95	78	67	60	-	-	-	96	68	56	48	43	-	-	-
	2.500	208	147	120	104	93	-	-	-	150	106	87	75	67	-	-	-
	3.000	294	208	169	147	131	-	-	-	216	153	125	108	97	-	-	-
	3.500	300	273	223	193	173	-	-	-	295	208	170	147	132	-	-	-
	4.000	300	300	278	241	216	-	-	-	300	272	222	192	172	-	-	-
	4.500	300	300	300	287	257	-	-	-	300	300	281	244	218	-	-	-
	5.000	300	300	300	300	295	-	-	-	300	300	300	300	269	-	-	-
5.500	300	300	300	300	300	-	-	-	300	300	300	300	300	-	-	-	

¹ Maximum operating pressure is limited for Mounting Style SB. Please refer to maximum operating pressure per bore in Pressure Ratings table located on the dimension page for Mounting Styles SB.

Application and Design Data

The spherical bearing life is influenced by many factors, i.e., bearing pressure, load direction oscillating angle and lubrication. The maximum operating pressure ratings of the spherical bearing mountings are based on standard commercial bearing ratings. The 4:1 design factor rating is based on the tensile strength of the material.

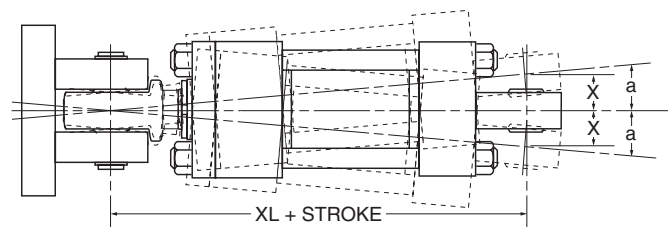
The spherical bearings are dimensioned to ensure a satisfactory bearing life under normal operating conditions. The bearing races are made of through-hardened steel and are precision ground. They are phosphate treated and coated with dry film lubricant to minimize friction of contacting surfaces. In the case of a permanent unidirectional load to the bearing, or other unusual operating conditions, the use of a larger bearing may be required.

For longer bearing life, regular lubrication will protect the spherical plain bearing from premature wear and corrosion. Rust-inhibiting EP greases of lithium base, preferably with molybdenum disulphide additives are particularly suited. The radial bearings have lubricating holes and grooves in the races permitting lubrication. The bearing housings at the cap and rod end are provided with grease fittings for lubrication.

Maximum angle of swivel in relation to the center line of the pivot pin is shown as angle **a** in the table below. It is recommended that this angle is not exceeded when mounting the cylinder.

Mounting Information

Head End Mounting



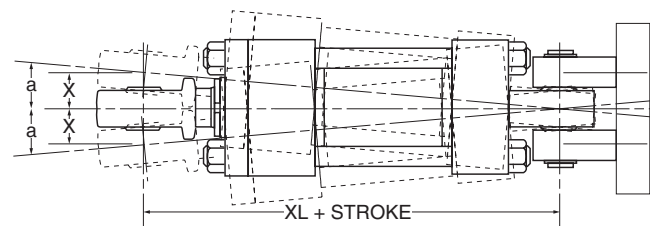
Recommended maximum swivel angle on each side of the cylinder centerline.

Table 1

Bore Ø	Head End Mounted		Cap End Mounted	
	Angle a	Tan. of a	Angle a	Tan. of a
1.50	2.50°	0.035	2.50°	0.035
2.00	2.50°	0.044	4.50°	0.079
2.50	2.50°	0.044	4.50°	0.079
3.25	3.50°	0.052	3.50°	0.052
4.00	2.50°	0.044	3.50°	0.052
5.00	3.50°	0.052	3.50°	0.052
6.00	3.50°	0.052	3.50°	0.052
8.00	3.50°	0.052	3.50°	0.052

Note: Dimension X is the maximum off center mounting of the cylinder. To determine dimension X for various stroke lengths multiply distance between pivot pin holes by tangent of angle a. For extended position use $X = XL + 2X \text{ stroke}$.

Cap End Mounting



An Introduction to Cushioning

Cushioning is recommended as a means of controlling the deceleration of masses, or for applications where piston speed is in excess of 4 in/sec and the piston will make full stroke. Cushioning extends cylinder life and reduces undesirable noise and hydraulic shock. Built-in “cushions” are optional and can be supplied at the head and cap ends of a cylinder without affecting its envelope or mounting dimensions.

Standard Cushioning

Ideal cushion performance shows an almost uniform absorption of energy along the cushioning length, as shown. Many forms of cushioning exist, and each has its own specific merits and advantages.

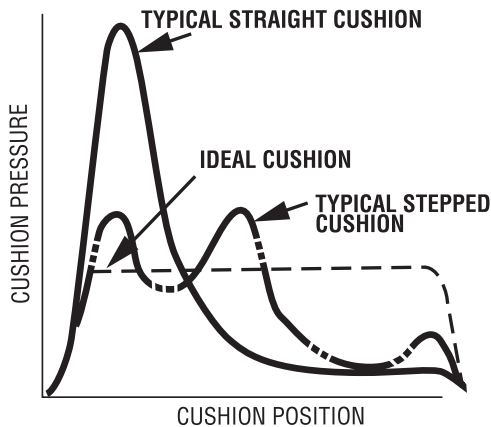
In order to cover the majority of applications, 3L cylinders are supplied with profiled cushioning as standard. Final speed may be adjusted using the cushion screw. The performance of profiled cushioning is indicated on the diagram below.

Note: Cushion performance will be affected by the use of water or high water based fluids. Please consult factory for details.

Cushion Length

Where specified, 3L cylinders incorporate the longest cushion sleeve and spear that can be accommodated within the standard envelope without reducing the rod bearing and piston bearing length. See cushion lengths at right. Cushions are adjustable via recessed needle valves.

Cushion Performance



Cushion Length

Cylinder Bore (Inches)	Rod Ø ¹ (Inches)	Rod Number	Cushion Length (Inches)	
			Head ¹	Cap
1.00	0.500	1	0.88	0.75
	0.625	2	0.88	0.75
1.50	0.625	1	0.88	0.81
	1.000	2	0.88	0.81
2.00	0.625	1	0.88	0.81
	1.375	2	0.88	0.81
2.50	1.000	1	0.88	0.81
	1.750	2	0.88	0.81
3.25	1.000	1	1.13	1.00
	2.000	2	0.81	1.00
4.00	1.375	1	1.13	1.00
	2.500	2	0.81	1.00
5.00	1.750	1	1.13	1.00
	3.500	2	0.81	1.00
6.00	1.750	1	1.38	1.25
	4.000	2	1.06	1.25
8.00	2.000	1	1.06	1.25
	5.500	2	0.94	1.25

¹ Head end cushions for rod diameters not listed have cushion lengths within the limits shown.

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 Parker Hannifin Corporation (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 1-847-298-2400, or go to www.parker.com, for telephone numbers of the appropriate 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 reviewed 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 or 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 retorque 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 retorque 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 Industrial 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.

Offer of Sale

The items described in this document and other documents and descriptions provided by Parker Hannifin Corporation, its subsidiaries and its authorized distributors ("Seller") are hereby offered for sale at prices to be established by Seller. 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 item described in its document, when communicated to Seller verbally, or in writing, shall constitute acceptance of this offer. All goods, services or work described will be referred to as "Products".

1. Terms and Conditions. Seller's willingness to offer Products, or accept an order for Products, to or from Buyer is subject to these Terms and Conditions or any newer version of the terms and conditions found on-line at www.parker.com/saleterms/. Seller objects to any contrary or additional terms or conditions of Buyer's order or any other document issued by Buyer.

2. Price Adjustments; Payments. Prices stated on Seller's quote or other documentation offered by Seller are valid for 30 days, and do not include any sales, use, or other taxes unless specifically stated. Unless otherwise specified by Seller, all prices are F.C.A. Seller's facility (INCOTERMS 2010). Payment is subject to credit approval and is due 30 days from the date of invoice or such other term as required by Seller's Credit Department, after which Buyer shall pay interest on any unpaid invoices at the rate of 1.5% per month or the maximum allowable rate under applicable law.

3. Delivery Dates; Title and Risk; Shipment. All delivery dates are approximate and Seller shall not be responsible for any damages resulting from any delay. Regardless of the manner of shipment, title to any products and risk of loss or damage shall pass to Buyer upon placement of the products with the shipment carrier at Seller's facility. Unless otherwise stated, Seller may exercise its judgment in choosing the carrier and means of delivery. No deferral of shipment at Buyers' request beyond the respective dates indicated will be made except on terms that will indemnify, defend and hold Seller harmless against all loss and additional expense. Buyer shall be responsible for any additional shipping charges incurred by Seller due to Buyer's acts or omissions.

4. Warranty. Seller warrants that the Products sold hereunder shall be free from defects in material or workmanship for a period of eighteen months from the date of delivery to Buyer. The prices charged for Seller's products are based upon the exclusive limited warranty stated above, and upon the following disclaimer: **DISCLAIMER OF WARRANTY: THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO PRODUCTS PROVIDED HEREUNDER. SELLER DISCLAIMS ALL OTHER WARRANTIES, EXPRESS AND IMPLIED, INCLUDING DESIGN, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

5. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon delivery. No claims for shortages will be allowed unless reported to the Seller within 10 days of delivery. No other claims against Seller will be allowed unless asserted in writing within 30 days after delivery. Buyer shall notify Seller of any alleged breach of warranty within 30 days after the date the defect is or should have been discovered by Buyer. Any action based upon breach of this agreement or upon any other claim arising out of this sale (other than an action by Seller for an amount due on any invoice) must be commenced within 12 months from the date of the breach without regard to the date breach is discovered.

6. LIMITATION OF LIABILITY. UPON NOTIFICATION, SELLER WILL, AT ITS OPTION, REPAIR OR REPLACE A DEFECTIVE PRODUCT, OR REFUND THE PURCHASE PRICE. IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF, OR AS THE RESULT OF, THE SALE, DELIVERY, NON-DELIVERY, SERVICING, USE OR LOSS OF USE OF THE PRODUCTS OR ANY PART THEREOF, OR FOR ANY CHARGES OR EXPENSES OF ANY NATURE INCURRED WITHOUT SELLER'S WRITTEN CONSENT, EVEN IF SELLER HAS BEEN NEGLIGENT, WHETHER IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN NO EVENT SHALL SELLER'S LIABILITY UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS.

7. User Responsibility. The user, through its own analysis and testing, is solely responsible for making the final selection of the system and Product and assuring that all performance, endurance, maintenance, safety and warning requirements of the application are met. The user must analyze all aspects of the application and follow applicable industry standards and Product information. If Seller provides Product or system options, the user is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the Products or systems.

8. Loss to 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, will be considered obsolete and may be destroyed by Seller after two consecutive years have elapsed without Buyer ordering the items 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. Special Tooling. A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture Products. 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 Products, 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.

10. Buyer's Obligation; Rights of Seller. To secure payment of all sums due or otherwise, Seller shall retain a security interest in the goods delivered and this agreement shall be deemed a Security Agreement under the Uniform Commercial Code. Buyer authorizes Seller as its attorney to execute and file on Buyer's behalf all documents Seller deems necessary to perfect its security interest.

11. Improper use and Indemnity. Buyer shall indemnify, defend, and hold Seller harmless from any claim, liability, damages, lawsuits, and costs (including attorney fees), whether for personal injury, property damage, patent, trademark or copyright

infringement or any other claim, brought by or incurred by Buyer, Buyer's employees, or any other person, arising out of: (a) improper selection, improper application or other misuse of Products purchased by Buyer from Seller; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of patterns, plans, drawings, or specifications furnished by Buyer to manufacture Product; or (d) Buyer's failure to comply with these terms and conditions. Seller shall not indemnify Buyer under any circumstance except as otherwise provided.

12. Cancellations and Changes. Orders shall not be subject to cancellation or change by Buyer for any reason, except with Seller's written consent and upon terms that will indemnify, defend and hold Seller harmless against all direct, incidental and consequential loss or damage. Seller may change product features, specifications, designs and availability with notice to Buyer.

13. Limitation on Assignment. Buyer may not assign its rights or obligations under this agreement without the prior written consent of Seller.

14. Force Majeure. Seller does not assume the risk 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, strikes or labor disputes, acts of any government or government agency, acts of nature, delays or failures in delivery from carriers or suppliers, shortages of materials, or any other cause beyond Seller's reasonable control.

15. Waiver and Severability. Failure to enforce any provision of this agreement will not waive that provision nor will any such failure prejudice Seller's right to enforce that provision in the future. Invalidation of any provision of this agreement by legislation or other rule of law shall not invalidate any other provision herein. The remaining provisions of this agreement will remain in full force and effect.

16. Termination. Seller may terminate this agreement for any reason and at any time by giving Buyer thirty (30) days written notice of termination. Seller may immediately terminate this agreement, in writing, if Buyer: (a) commits a breach of any provision of this agreement (b) appoints a trustee, receiver or custodian for all or any part of Buyer's property (c) files a petition for relief in bankruptcy on its own behalf, or by a third party (d) makes an assignment for the benefit of creditors, or (e) dissolves or liquidates all or a majority of its assets.

17. Governing Law. This agreement and the sale and delivery of all Products hereunder shall be deemed to have taken place in and shall be governed and construed in accordance with the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute, controversy or claim arising out of or relating to this agreement.

18. 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 Section. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets ("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 a Product sold pursuant to this Agreement 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 a Product 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 the Product, replace or modify the Product so as to make it noninfringing, or offer to accept return of the Product 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 Products 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 Product sold hereunder. The foregoing provisions of this Section shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

19. Entire Agreement. This agreement contains the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of sale. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter are herein merged.

20. Compliance with Law, U. K. Bribery Act and U.S. Foreign Corrupt Practices Act. Buyer agrees to comply with all applicable laws and regulations, including both those of the United Kingdom and the United States of America, and of the country or countries of the Territory in which Buyer may operate, including without limitation the U. K. Bribery Act, the U.S. Foreign Corrupt Practices Act ("FCPA") and the U.S. Anti-Kickback Act (the "Anti-Kickback Act"), and agrees to indemnify and hold harmless Seller from the consequences of any violation of such provisions by Buyer, its employees or agents. Buyer acknowledges that they are familiar with the provisions of the U. K. Bribery Act, the FCPA and the Anti-Kickback Act, and certifies that Buyer will adhere to the requirements thereof. In particular, Buyer represents and agrees that Buyer shall not make any payment or give anything of value, directly or indirectly to any governmental official, any foreign political party or official thereof, any candidate for foreign political office, or any commercial entity or person, for the purpose of influencing such person to purchase products or otherwise benefit the business of Seller.





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