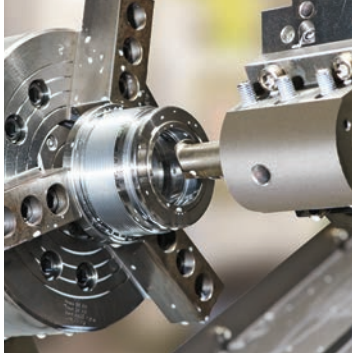










Heavy Duty Hydraulic Cylinders

Series H

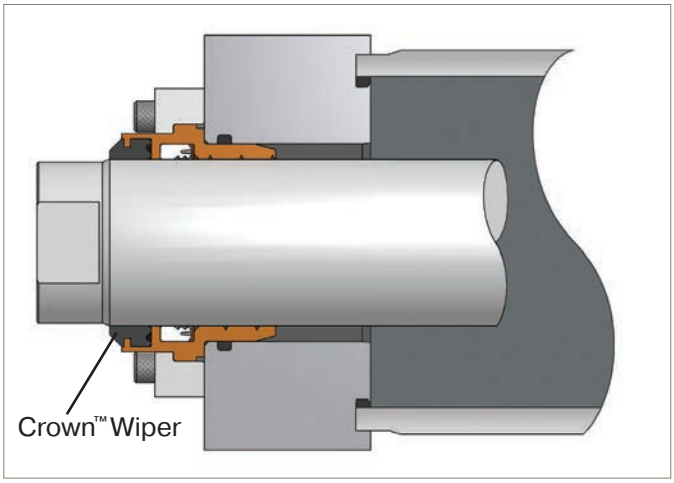


Parker ATLAS CYLINDERS

ENGINEERING YOUR SUCCESS.

ATLAS™ CYLINDERS

Abrasive particulate can cause significant wear to precision components when it enters the cylinder and migrates into the hydraulic system. The Atlas Crown Wiper is extremely effective in keeping contamination out of the cylinder to prevent if from shortening the actuator and system service life. Atlas showcases its commitment to reducing hydraulic system problems with the Crown Wiper. This innovative solution goes a long way toward improving equipment operation, lowering costs, extending component life and machine availability.



Product Features:

- The sharp leading edge cleans the piston rod on the retract stroke.
- The Crown Wiper acts as a secondary seal by wiping away any oil film adhering to it on the extended stroke.
- Durable polyurethane material works well for both Seal Class 1 and 4 Service.
- Available in fluorocarbon material for Class 5 service in elevated temperatures.
- Beveled design sheds abrasive contamination away from the bushing.
- Available in rod diameters 0.625" - 5.500".
- Does not change cylinder mounting dimensions.

In line with our policy of continuing product improvement, specifications and information contained in this catalog are subject to change.
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Piston Sealing Solutions for the Most Demanding Applications

Piston Seal Technology For The 21st Century

The new Atlas universal piston seal design addresses the performance balance between low pressure sealability, low friction, extrusion resistance and seal life.

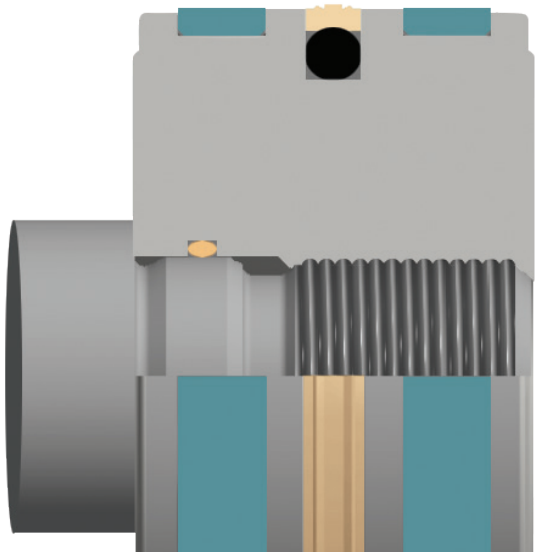
One piston style is used for all piston seal and wear ring configurations and will suit all application requirements. A common piston design permits field changing of seal configuration or seal and wear band material without replacing costly machined components when variations in application parameters occur, such as fluid, temperature or duty cycle.

All piston options include dual non-metallic wear rings to provide maximum stability and bearing area for protection against eccentric loads.

WearGard™ wear rings are internally lubricated for reduced friction and formulated for heavy-duty load-bearing applications.

The standard piston style for Class 1 and 4 service is HP; for 2, 3, 5, 6 and 8 service the standard is KP. If a different piston style is desired for an eligible seal class, enter an 'S' in the Special Modification field of the model number and specify the piston style in text.

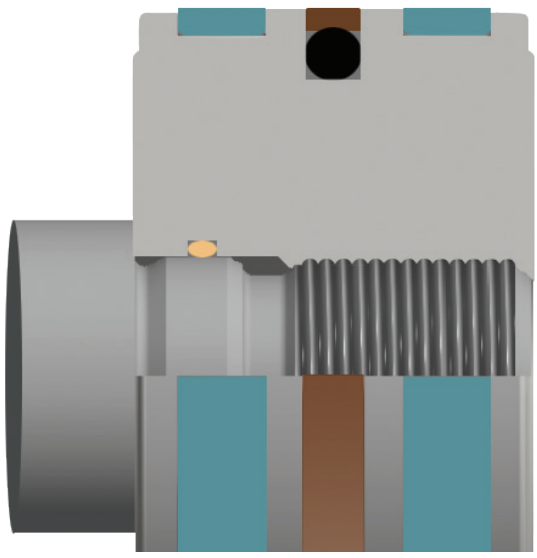
Atlas HP Polyurethane Piston Seal



The Atlas HP energized bi-directional piston seal improves upon the low friction and long wear of lipseals by including excellent low pressure sealing performance. Specially formulated polyurethane is long wearing and abrasion resistant with running friction comparable to lipseals. An o-ring energizer ensures virtually zero leakage in low pressure applications. Also, pressure trapping that can result with energized lipseals is not possible with a single energized seal.

The Atlas HP piston seal is an excellent choice for most industrial applications operating with mineral based hydraulic oil and is available in Seal Classes 1 and 4.

Atlas KP Filled PTFE Piston Seal



The Atlas KP bronze filled PTFE seal ring material has low running friction for accurate positioning in closed loop servo applications.

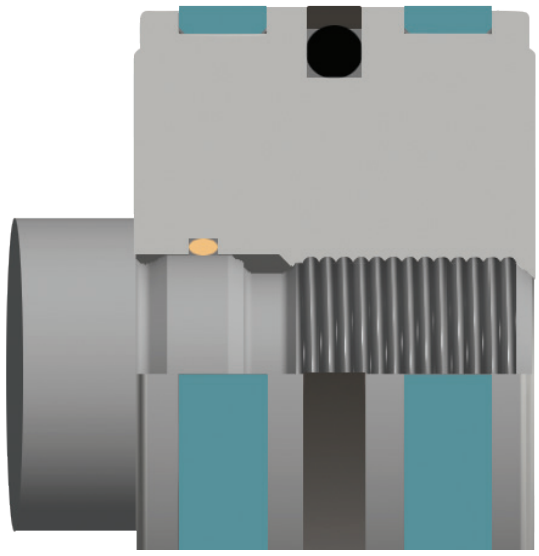
When combined with a fluorocarbon energizing ring the Atlas KP seal is rated for 400˚ F and will increase service intervals in high temperature applications even when compared to fluorocarbon lipseals.

By combining the Atlas KP seal with other energizer o-ring compounds and wear ring materials, the KP seal offers excellent service in all Seal Class environments.

Selection Guide

Application Demand	HP Seal	KP Seal	RP Seal	WP Seal
Load Holding	Best	Good	Good	Best
Fluid Compatibility	Good	Best	Better	Better
Heat Resistance	Good (200° F Max.)	Best (400° F Max.)	Better (300° F Max.)	Better (250° F Max.)
Dynamic Friction	Best	Best	Good	Better
Breakaway Friction	Good	Best	Good	Better
Extrusion Resistance	Good	Better	Best	Good
Fluid Isolation	N/A	N/A	N/A	Best

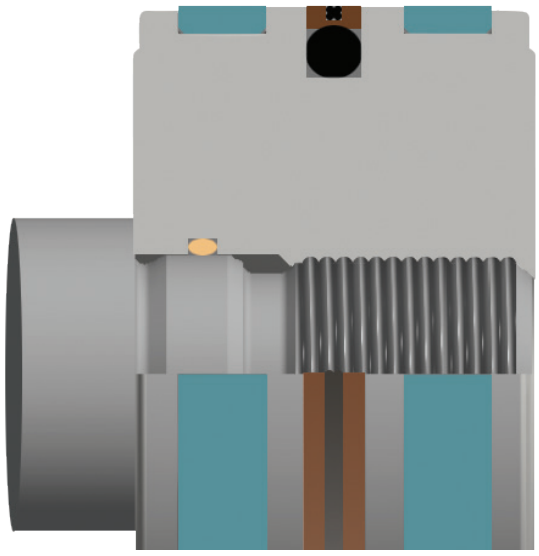
Atlas RP Thermoplastic Seal



The Atlas RP step cut ring is made of self-lubricating, glass reinforced, thermoplastic and is o-ring energized. Unlike cast iron rings that bypass oil, the Atlas RP seal provides drift free operation throughout the operating pressure range. This tough seal is fully extrusion resistant, even in the face of extreme pressure spikes, thus ensuring superior wear resistance in the most demanding applications.

Atlas RP can operate up to 300° F and is compatible with Seal Classes 1, 2, 3, 4, 5 and 6.

Atlas WP Mixed Media Seal

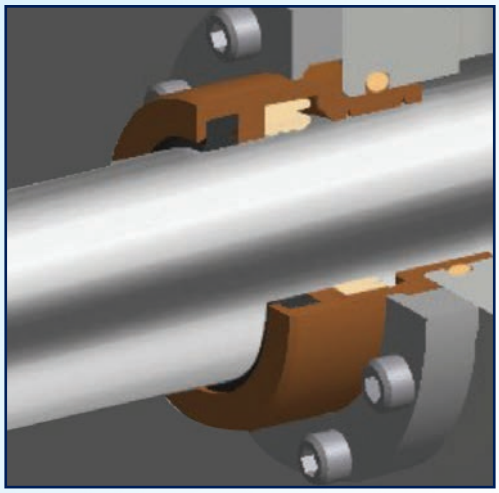


The Atlas WP Mixed Media seal is designed for applications requiring different media on either side of the piston. This option is ideal when hydraulic oil is on one side of the piston and air is on the opposite side; and it can be equally effective when dissimilar fluids are on either side of the piston.

Superior low-friction bi-directional sealing is accomplished by combining an energized filled PTFE seal with a redundant elastomer seal. Energizer and redundant elastomer seal materials are available for compatibility with seal classes 1, 2, 3, 5 and 6. Note: WP piston seal groove is not universal in 1.50" bore.

Versatile Piston Rod Sealing Systems Deliver Dry Rod Performance

Atlas offers the best performing and broadest selection of rod sealing options. Our Tri-lip bolted bushing sealing system is a proven anchor of the offering.



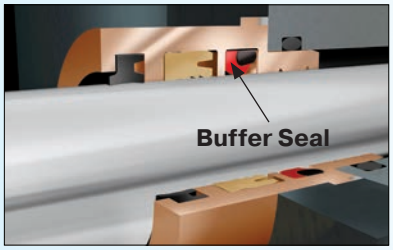
As the rod strokes out, its motion and friction dynamically flex the multi-sealing edges of the Tri-Lip rod seal to maintain their contact with the rod. This provides a cutting action to shear the oil from the rod, allowing the rod to pass out of the rod seal practically dry. Any oil film that remains on the rod is stopped by the inner lip of the Wiperseal and held between it and the rod seal.

On the return stroke any dirt or foreign matter collected on the rod is wiped off by the leading edge, or outer lip of the Wiperseal. At the same time, any oil which may be trapped between the Wiperseal and the rod seal is returned into the cylinder. In other words, we have an automatic check valve that prevents any appreciable amount of oil to leak past the seals, and then returns any oil that has managed to wipe by the rod seal.

Tri-Lip bushings are easily removed for service without loosening tie rods and disturbing the pressure envelope. Material options allow compatibility with Seal Classes 1, 2, 3, 4, 5 & 6.

Buffer Seal Bushing

The Atlas Buffer Seal, installed ahead of the primary rod seal, protects the primary seal from the effects of pressure spikes. The result is increased primary rod seal and wiperseal performance life when in severe applications.



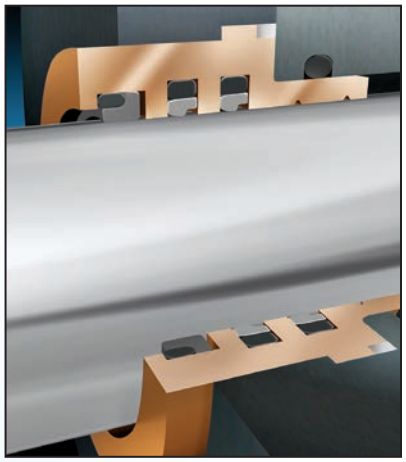
The Atlas Buffer Seal is a unique design that allows trapped pressure back into the cylinder. When the rod extends from the cylinder the Buffer Seal is riding on a high compression sealing point to limit leakage. On the retract stroke the seal rocks forward to allow trapped fluid to pass under the seal and return to the system.

Buffer Seals are available with Seal Classes 1, 2, 4 & 5. To order, enter an 'S' in the Special Modification field of the model number and specify Buffer Seal.

To accommodate the Buffer Seal, rod bushing length is extended 0.31" to 0.81", depending on rod diameter. See Buffer Seal Bushing page 61 for piston rod extension details.

Low Friction Bushing

The Atlas Low Friction Bushing is designed to minimize 'slip-stick' and 'chatter' in servo and 'dither' applications. Two unidirectional bronze filled PTFE primary rod seals and a bronze filled PTFE wiperseal minimize both breakaway and running friction.



Low Friction Rod Seals are available for rod diameters 1.000" - 5.500" in 1.50" - 8.00" bores.

See Piston & Bushing Friction page for comparative seal friction data.

To order, enter an 'S' in the Special Modification field of the model number and specify Low Friction Bushing. Available with Seal Classes 1, 2, 3, 4 ,5, 6 & 8.

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Section A

Series H
Heavy Duty Hydraulic Cylinders

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Application Checklist	4
Mounting Styles & Tips for Applying Them	5
H Family Model Code / How To Order	6-7
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The inside story on why H Series is your best choice in heavy duty hydraulic cylinders

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

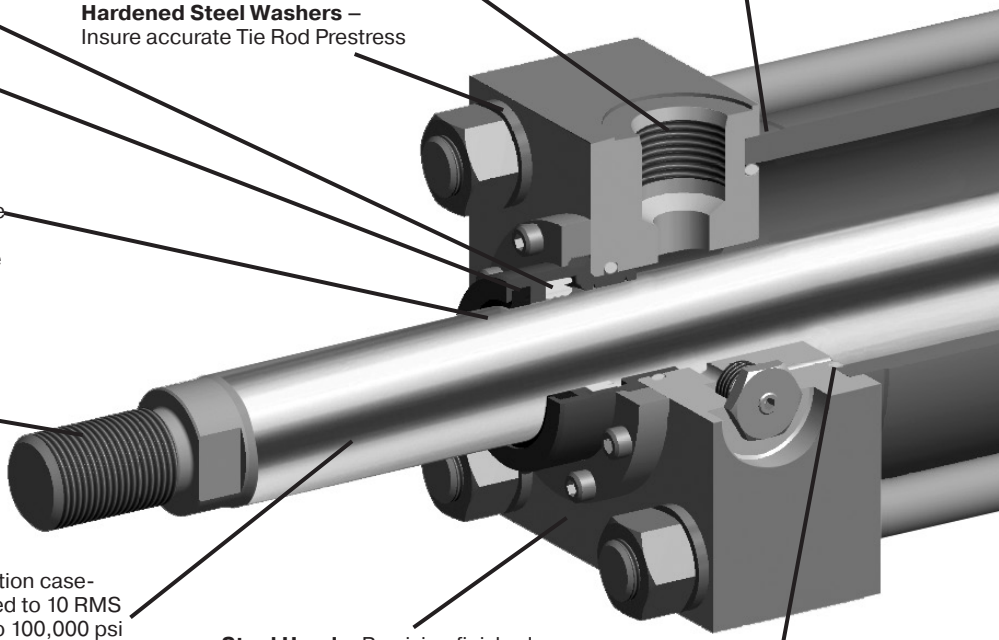
Primary Seal – Tri-lip Rod Seal is a proven leakproof design – completely self-compensating and self-relieving to withstand variations and conform to mechanical deflection that may occur.

Ports – SAE "O" ring ports are standard.

Hardened Steel Washers – Insure accurate Tie Rod Prestress

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

Rod Bushing 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 bushing and head.



Piston Rod Thread – Male rod end styles #4A and #8A are integral cut threads on the piston rod. Optional studded KK small male thread, for piston rod diameters 2.000" and smaller, is available by specifying rod end style #4H.

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 .625" through 4.000" diameters. Larger diameters vary between 57,000 and 90,000 psi minimum material, depending on rod diameter.

Steel Head – Precision finished on all sides; bored and grooved to provide concentricity for mating parts.

End Seals – Pressure-actuated cylinder body-to-head and cap o-rings.

Atlas's stepped floating cushions combine the best features of known cushion technology.

Deceleration devices or built-in "cushions" are optional and can be supplied at head end, cap end, or both ends without change in envelope or mounting dimensions. Atlas cylinder cushions are a stepped design and combine the best features of known cushion technology.

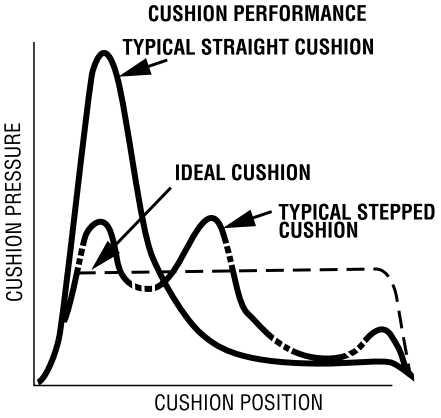
Standard straight or tapered cushions have been used in industrial cylinders over a very broad range of applications. Atlas research has found that both designs have their limitations.

As a result, Atlas has taken a new approach in cushioning of industrial hydraulic cylinders and for specific load and velocity conditions have been able to obtain deceleration curves that come very close to the ideal. The success lies in a stepped sleeve or spear concept where the steps are calculated to approximate theoretical orifice area curves.

In the cushion performance chart, pressure traces show the results of typical orifice flow conditions. Tests of a three-step sleeve or spear show three pressure pulses coinciding with the steps. The deceleration cushion plunger curves shape comes very close to being theoretical, with the exception of the last $^{1}/_{2}$ inch of travel. This is a constant shape in order to have some flexibility in application. The stepped cushion design shows reduced pressure peaks for most load and speed conditions, with comparable reduction of objectionable stopping forces being transmitted to the load and the support structure.

All Atlas H cushions are adjustable.

The H Series 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 strengths.

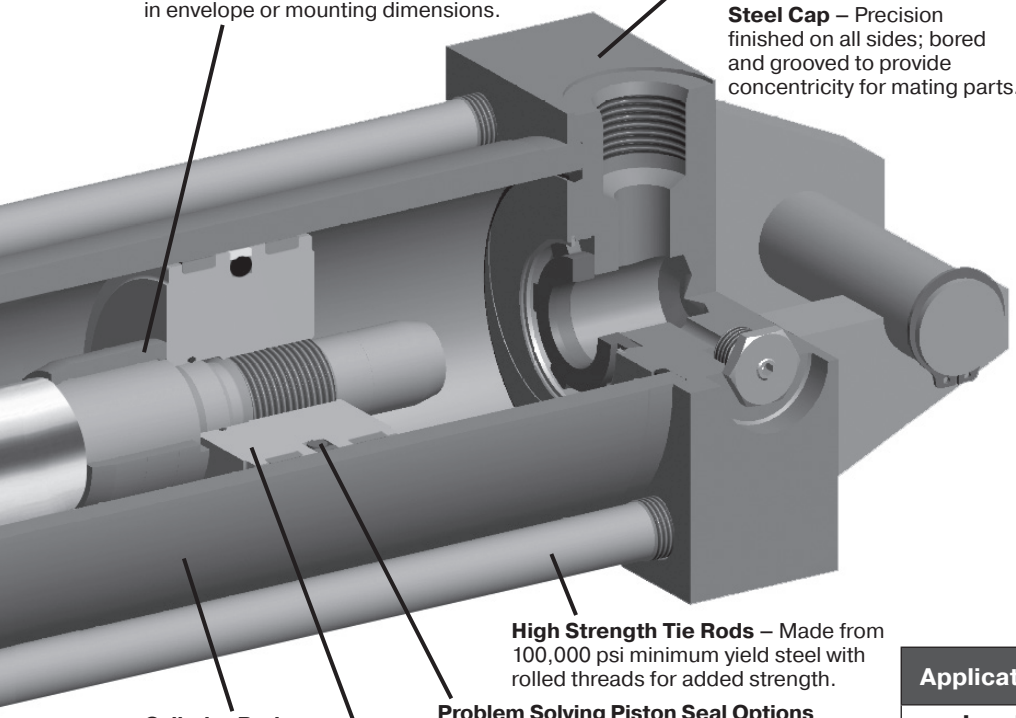


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Adjustable Floating Stepped Cushions – For maximum performance – economical and flexible for even the most demanding applications – provides superior performance in reducing shock. Cushions are optional and can be supplied at head end, cap end, or both ends without change in envelope or mounting dimensions.

Optional Ports – NPTF ports are optional at no extra charge. Oversize NPTF and SAE ports are available at extra charge.

Steel Cap – Precision finished on all sides; bored and grooved to provide concentricity for mating parts.



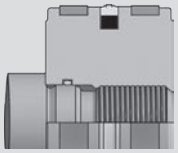
High Strength Tie Rods – Made from 100,000 psi minimum yield steel with rolled threads for added strength.

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

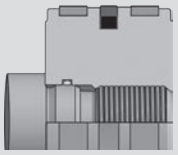
Problem Solving Piston Seal Options – Atlas's new piston seal designs address the performance balance between low pressure seal ability, low friction, extrusion resistance and seal life.

One-Piece Nodular Iron Piston – Two non-metallic wear bands that minimize tube scoring are standard with all seal styles. Piston to rod connection is pre-stressed to maximize fatigue life. An o-ring on the piston ID ensures a leak free joint and anaerobic adhesive further secures the threaded connection.

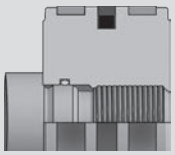
One Common Piston for 4 Seal Styles



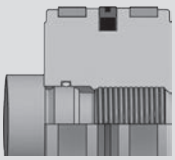
Standard HP style with polyurethane piston seal – excellent for most cycling and load holding applications.



Optional KP style with filled PTFE piston seal – low friction, high heat resistance for cycling and load holding service.



Optional RP style with thermoplastic piston seal – superior extrusion resistance to extreme pressure spikes with drift-free performance.



Optional WP style mixed media piston seal – low friction primary seal with redundant elastomer delivers superior performance with dissimilar media on either side of the piston.

Application Demand	HP Seal	KP Seal	RP Seal	WP Seal
Load Holding	Best	Good	Good	Best
Fluid Compatibility	Good	Best	Better	Better
Heat Resistance	Good	Best	Better	Better
Dynamic Friction	Best	Best	Good	Better
Breakaway Friction	Good	Best	Good	Better
Extrusion Resistance	Good	Better	Best	Good
Fluid Isolation	N/A	N/A	N/A	Best

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

a. A self-centering stepped sleeve is furnished on the piston rod assembly.

b. A cartridge style needle valve is provided that is flush with the side of the head even when wide open. It is located on side number 2, in all mounting style models except ME5, ME6, TM1, TM2, TM3 and TM4. In these styles it is located on side number 3.

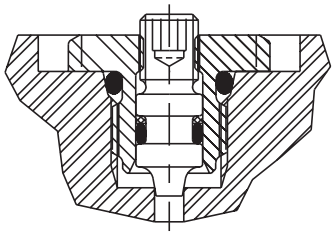
c. All cylinder bores utilize a slotted sleeve as a check valve.

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

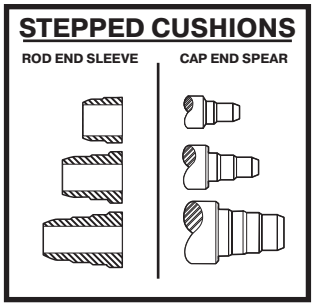
a. A stepped cushion spear is provided on the piston rod.

b. A "float check" self-centering bushing is provided in 1.50" - 6.00" bore cylinders, which incorporates a large flow check valve for fast "out-stroke" action. 7.00" bore and larger cylinders utilize a springless check valve located and identified in the same manner as the head end.

c. A cartridge style 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 models except ME5, ME6, TM1, TM2, TM3 and TM4. In these styles it is located on side number 3.



Cartridge Style Needle Valve



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Application Checklist

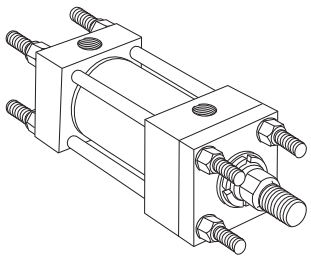
The following checklist should be used to select the best possible cylinder for a given application. Additional information can be referenced in the following pages to help assist in this process. In the event that you have additional questions or concerns, or if more information is required, please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

1. **Establish the system requirements**..... Series H
   - 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**..... Pages 5 & 54
   - Determine the best mounting style for the application.
   - If your application requires a mounting style that is not exactly matched by one of our catalog offerings, we can supply the mounting you need. If the required mounting resembles one of our standards, specify that style, enter 'S' in the Special Modification field and provide a dimension drawing of your mount. Special mounting styles that do not resemble a standard style will be designated as style TX by the factory.
3. **Cylinder Bore and Operating Pressure** .....Pages 100-101
   - Review the theoretical push and pull force for a given bore size to determine.
4. **Piston Rod**.....Pages 112-114
   - 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** ..... Pages II and III
   - Determine the best seal type for your application. All selections are high load style that include dual non-metallic wear bands straddling the piston seal.
   - **Atlas HP** polyurethane piston seal can hold a load in position and is your best choice for general industrial applications utilizing mineral based fluids in Seal Classes 1 & 4.
   - **Atlas KP** filled PTFE piston seal is our lowest friction and highest heat resistance (up to 400˚ F) offering that will hold a load in position and can withstand high load and is available in all Seal Classes.
   - **Atlas RP** self-lubricating, reinforced, heat-stabilized thermoplastic piston seal has the highest resistance to extrusion in extreme pressure spike conditions, can hold a load in position and has long wear characteristics comparable to cast iron rings. RP seals are available in Seal Classes 1, 2, 3, 4 and 6.
   - **Atlas WP** mixed-media piston seal is for applications requiring different media on either side of the piston and is ideal with hydraulic fluid on one side of the piston and compressed air on the opposite side. WP seals are available in Seal Classes 1, 2, 3, 5 and 6.
6. **Cushioning**..... Pages 115-120
   - Determine if cushions are required to safely stop the load.
   - Determine whether optional solid cap cushion construction should be selected over standard floating cushion bushing style.
7. **Ports** .....Pages 108-109
   - Select the best possible port size for a given speed requirement.
   - Select port position.
8. **Piston rod and mounting accessories**..... Pages 68-75
   - Determine how you will attach the cylinder to the load.
9. **Custom modifications** .....Pages 86-98

⚠**PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Mounting Styles & Tips for Applying Them

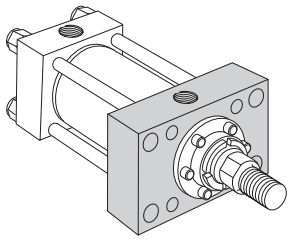
Extended Tie Rod Mountings – TB, TC, and TD



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

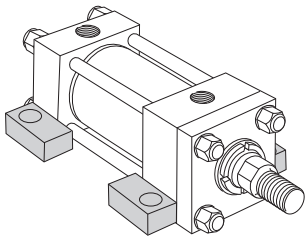
Flange Mountings – J, JB, JJ, H, HB, and HH



Application:
- Straight line force transfer
- Compression loads (push) – use H, HB or HH
- 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

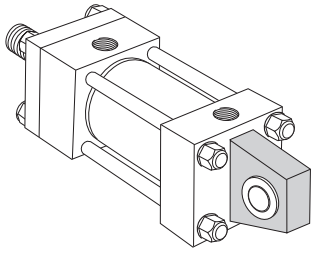


Application:
- Straight line force transfer
- Can be used in compression or tension loads
- Thrust key and secure mounting area are vital

Advantages:
- Ease of mounting

Recommendation:
- Styles F & C should have a minimum stroke at least equal to the bore diameter

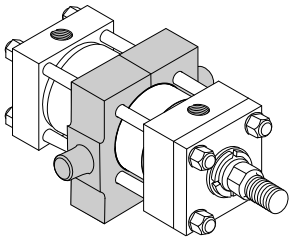
Pivot Mountings – BB, SB and SE



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 or SE mountings

Advantages:
- Ease of mounting
- Design flexibility
- Self aligning (SB or SE)

Trunnion Mountings – D, DB, DD and DE



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

Advantages:
- Ease of mounting
- Design flexibility
- Self aligning

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A Overview

H Model Code

5.00	C	K	F	P	TB	H	H	N	H
Bore Dia.	Cushion Head	Double Rod End Cylinder	Mounting Style	Mounting Modification	Combination Mounting Style[5]	Series Designator	Piston Seal	Piston Magnet	Bushing & Seal

Bore Dia.
Specify bore dia. in inches
1.50
2.00
2.50
3.25
4.00
5.00
6.00
7.00
8.00

Cushion Head
Use "C" only if head end cushion is required.

Double Rod End Cylinder
Use "K" only if a double rod end cylinder is required.[1]

Mounting Style
Mounting style offering varies by series. See 'Standard Specifications' pages for availability.
T = Basic, No Mount MX0
TB = Tie Rods Extended Head MX3
TC = Tie Rods Extended Cap MX2
TD = Tie Rods Extended Both Ends MX1
J = Head Rectangular Flange MF1
JB = Head Square Flange MF5
JJ = Head Rectangular ME5
H = Cap Rectangular Flange MF2
HB = Cap Square Flange MF6
HH = Cap Rectangular ME6
C = Side Lug[2] MS2
F = Side Tapped[2] MS4
BB = Cap Fixed Clevis MP1
D = Head Trunnion MT1
DB = Cap Trunnion MT2
DD = Intermediate Fixed Trunnion[3] MT4
DE = Heavy Duty Intermediate Fixed Trunnion[3]
SB = Spherical Bearing
SE = Heavy Duty Spherical Bearing
TX = Special Mounting (Consult Factory)[4]

Mounting Modification
P = Use only if Thrust Key required. (Style C or F.)
M = Use only for Manifold Port O-Ring Seal. Applies to C Mount only.

Combination Mounting Style[5]
Any practical mounting style listed.

Series Designator
1.50"- 8.00" Bore H
See Section C for 10.00 - 20.00" bores

Piston Seal
H = HP (standard) Piston Seal
K = KP (universal) Piston Seal[6]
R = RP (extrusion resistant) Piston Seal
W = WP (mixed media) Piston Seal

Piston Magnet
N = No Magnet
3 = Magnet Piston with SS Cylinder Tube for Global Switches
7 = Magnet with Carbon Steel Cylinder Tube for ALS Switches

Bushing & Seal
H = Bolt-on Bushing with Tri Lip Rod Seal (for Class 1 & 4 service) - additional Seal Classes are available
K = Bolt-on Lipseal Bushing with Buffer Seal (Not available 0.625" rod)
All Series
F = Bushing with dual PTFE Rod Seals and PTFE Wiperseal[6]

Series H Minimum Stroke Table

Bore Ø	All Mounting Styles Except DD & DE	Mounting Styles DD & DE
1.50	1.062	2.875
2.00	1.562	3.750
2.50	1.437	3.625
3.25	1.687	4.375
4.00	1.937	5.000
5.00	1.937	5.437
6.00	2.562	6.687
7.00	3.437	8.062
8.00	2.937	8.250

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:
4.00CKTDHT14A28AC10.000

[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] Special mounting styles that do not resemble a standard catalog offering will be designated as style TX by the factory.

[5] 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.

[6] Piston seal code K and Bushing & Seal code F must be selected for Class 8 service. Dual PTFE rod seals with PTFE wiperseal not available for 0.625" rod.

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H Model Code

T	1	S	1	4	2	A	C	16.000
Port Type	Seals	Special Modification	Piston Rod Number[9]	Piston Rod End	Piston Rod Alternate Thread[11]	Piston Rod Threads	Cushion Cap	Stroke[8]

Seals
1 = Standard Seals
2 = Water Base Fluid Seals
3 = EPR Seals
4 = Low Temperature Seals
5 = Fluorocarbon Seals
6 = High Water Content Fluid
8 = Energized PTFE Seals
E = Fluorocarbon Seals – Piston Rod only
N = High Temperature Rod Bushing[7]

Special Modification
Use only if special modifications are required:
Oversize Ports
Port Position Change
Special Seals
Stop Tube[8]
Stroke Adjusters
Tie Rod Supports
Other

Piston Rod Number[9]
1
2
3
4
5

Piston Rod Alternate Thread[11]
Use only for male thread two times longer than standard.

Cushion Cap
C = Standard Floating Cushion Bushing Design
1.50" - 6.00" Bore
F = Solid Cap Orifice Design

Piston Rod Threads
A = UNF Standard Integral Cut Thread
H = UNF Optional High Strength Stud (Style 4 through 2.000" rod only)
M = Metric
N = No Thread[12]

Stroke[8]
Specify in inches

Port Type
T = SAE Straight Thread O-Ring (Std.)
U = NPTF Ports (Dry Seal Pipe Thread)
R = BSP Ports (Parallel Thread ISO 228)
P = SAE 4-Bolt Flange Ports (3,000 psi)
B = BSPT Ports (Taper Thread)
G = Metric Thread Ports
Y = Metric Thread Ports per ISO 6149
M = Used only for Manifold Port O-ring Seal. M option must be specified (Mounting Modification), applies to Mounting Style C only.

Piston Rod End
4 = Style 4 Small Male
4B = Style 4 Small Male with Buffer Seal Bushing
7 = Style 7 Female Thread for Spherical Rod Eye for Piston Rod Codes larger than Code #1 (Style SB only)
7B = Style 7 Female Thread with Buffer Seal Bushing
8 = Style 8 Intermediate Male
8B = Style 8 Intermediate Male with Buffer Seal Bushing
9 = Style 9 Short Female[9]
9B = Style 9 Short Female[9] with Buffer Seal Bushing
55 = Style 55 Rod End for Flange Coupling
55B = Style 55 Rod End with Buffer Seal Bushing
3 = Style 3 Special (Specify)[10]
3B = Style 3 Special (Specify)[10] with Buffer Seal Bushing

Shaded boxes identify required model number fields.

[7] Energized PTFE rod seals & wiperseal. All other cylinder seals are fluorocarbon. Not available for 0.625" rod.

[8] 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

See tables on these pages for minimum allowable strokes for Series H and Piston Rod End Styles 9 & 9B.

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

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

[11] Available only in combination with Style 4 or Style 8.

[12] Must be specified for Piston Rod End Style 55.

Style 9 Minimum Stroke Table

Bore Ø	Rod Ø	Minimum Stroke	
		Style 9	Style 9B
1.50 - 4.00	All	None	None
5.00	2.000	None	None
	2.500	1.000	0.56
	3.000	1.375	0.94
	3.500	1.625	1.19
6.00	2.500	None	None
	3.000	1.375	0.94
	3.500	1.375	0.94
	4.000	2.000	1.56
7.00	3.000	1.250	0.81
	3.500	1.500	1.06
	4.000	1.500	1.06
	4.500	2.500	2.06
	5.000	3.125	2.31
8.00	3.500	1.500	1.06
	4.000	1.500	1.06
	4.500	2.375	1.94
	5.000	2.875	2.06
	5.500	3.625	2.81

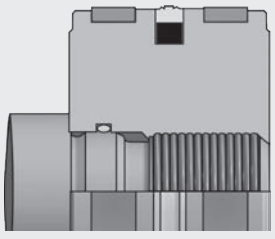
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Piston Seal Selection

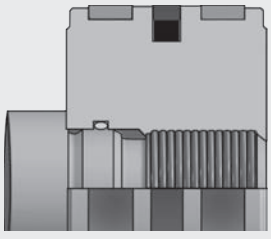
Atlas Piston Seal options HP, KP, RP and WP are available in a number of different Seal Classes. Because the Atlas Model Number includes Seal Class but does not include a code for piston seal style, a default piston seal style is designated for each seal class. In the table below rows list each seal class and columns column list each piston style. Available piston styles for each seal class are identified with an 'X' and the default piston seal style is in the shaded cell. To specify an available piston seal style that is not standard, place an 'S' in the Special Modification field of the model number and specify the required piston seal style with text.

Seal Class	Piston Seal Options (Shaded cell is default standard)			
	HM	**KM**	**RM**	**WM**
TG - Class 1 - Polyurethane & Nitrile	X	X	X	X
NG - Class 2 - Nitrile	N/A	X	X	X
XG - Class 3 - EPR	N/A	X	X	X
LG - Class 4 - Low Temperature Nitrile	X	X	X	N/A
VG - Class 5 - Fluorocarbon	N/A	X	X	X
EG - Class 5 Rod Bushing Seals Only	N/A	X	X	X
JG - Class 6 - Nitroxile	N/A	X	X	X
HG - Class 8 - Filled PTFE High Temperature	N/A	X	N/A	N/A
GG - Class 8 Rod Bushing Seals Only (all others Fluorocarbon)	N/A	X	X	X

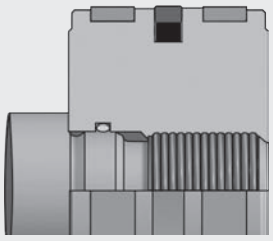
One Common Piston for 4 Seal Styles



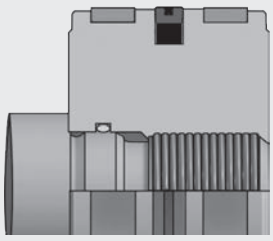
Standard HP style with polyurethane piston seal – excellent for most cycling and load holding applications.



Optional RP style with thermoplastic piston seal – superior extrusion resistance to extreme pressure spikes with drift-free performance.



Optional KP style with filled PTFE piston seal – low friction, high heat resistance for cycling and load holding service.



Optional WP style mixed media piston seal – low friction primary seal with redundant elastomer delivers superior performance with dissimilar media on either side of the piston.

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Section B

Series H 1.50" - 6.00" / 7.00" & 8.00" Bore
Heavy Duty Hydraulic Cylinders

	1.50" - 6.00" Bore	7.00" & 8.00" Bore
Specifications, Mounting Styles	11	–
Rod End Styles and Dimensions	12-13	31
T, TD, TB, TC Mount Dimensions	14	32
J Mount Dimensions	15	33
JB Mount Dimensions	16	34
JJ Mount Dimensions	17	35
H Mount Dimensions	18	36
HB Mount Dimensions	19	37
HH Mount Dimensions	20	37
C Mount Dimensions	21	38
F Mount Dimensions	22	38
BB Mount Dimensions	23	39
D Mount Dimensions	24	40
DB Mount Dimensions	25	41
DD Mount Dimensions	26	42
DE Mount Dimensions	27	43
Style SB Spherical Bearing Mounting	28	–
Style SE Spherical Bearing Mounting	29	44
Double Rod Cylinders	30	45

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Notes

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Standard Specifications

- Heavy Duty Service – ANSI/(NFPA) T3.6.7R3 - 2009 Specifications and Mounting Dimension Standards
- Standard Construction – Square Head – Tie Rod Design
- Nominal Pressure – 3000 psi[1]
- Standard Fluid – Hydraulic Oil
- Standard Temperature – –10°F to +165°F[2]
- Bore Diameters – 1.50" through 8.00" (Larger sizes available)

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

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

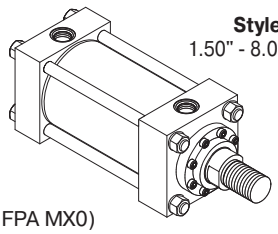
- Piston Rod Diameter – 0.625" through 5.500"
- Mounting Styles – 19 standard styles at various application ratings
- Strokes – Available in any practical stroke length
- Cushions – Optional at either end or both ends of stroke. "Float Check" standard at cap end of 1.50" - 6.00" bore.
- Rod Ends – Four Standard Choices – Specials to Order

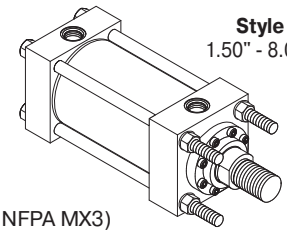
[1] If hydraulic operating pressure exceeds 3000 psi, send application data for engineering evaluation and recommendation. See Section D for actual design factors.

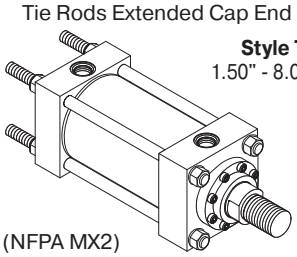
[2] See Section D for higher temperature service.

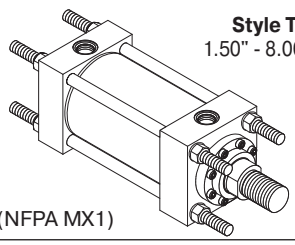
Available Mounting Styles

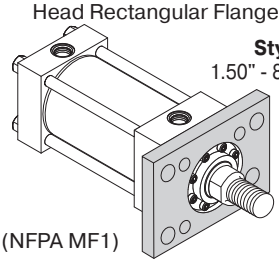
Most of the illustrated mounting styles below are available in double rod cylinders.

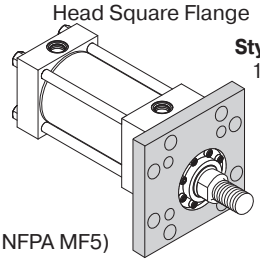
Basic
Style T
1.50" - 8.00"

(NFPA MX0)

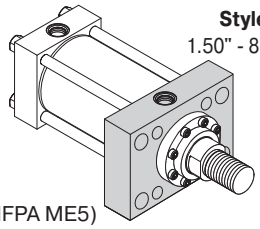
Tie Rods Extended Head End
Style TB
1.50" - 8.00"

(NFPA MX3)

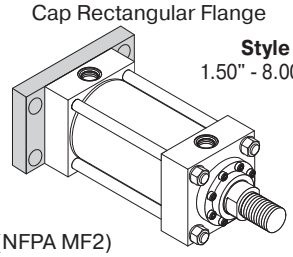
Tie Rods Extended Cap End
Style TC
1.50" - 8.00"

(NFPA MX2)

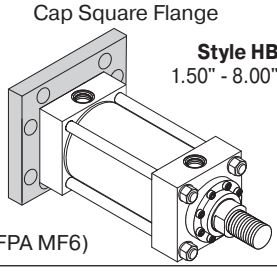
Tie Rods Extended Both Ends
Style TD
1.50" - 8.00"

(NFPA MX1)

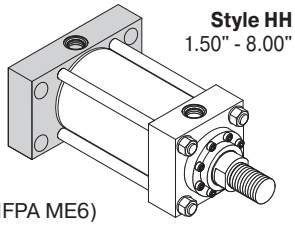
Head Rectangular Flange
Style J
1.50" - 8.00"

(NFPA MF1)

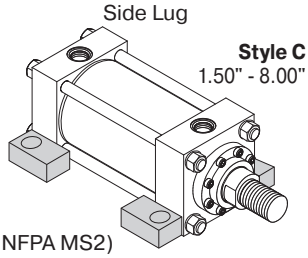
Head Square Flange
Style JB
1.50" - 8.00"

(NFPA MF5)

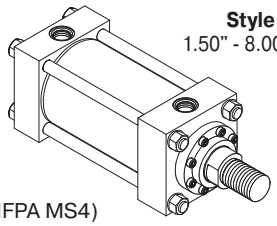
Head Rectangular
Style JJ
1.50" - 8.00"

(NFPA ME5)

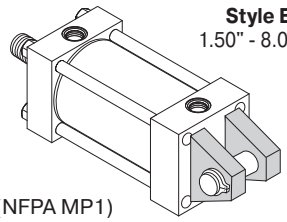
Cap Rectangular Flange
Style H
1.50" - 8.00"

(NFPA MF2)

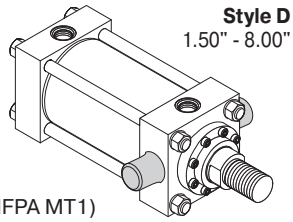
Cap Square Flange
Style HB
1.50" - 8.00"

(NFPA MF6)

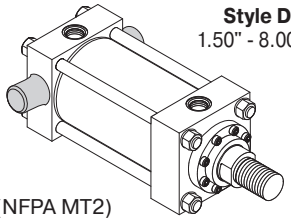
Cap Rectangular
Style HH
1.50" - 8.00"

(NFPA ME6)

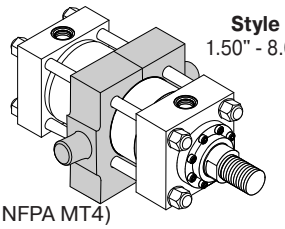
Side Lug
Style C
1.50" - 8.00"

(NFPA MS2)

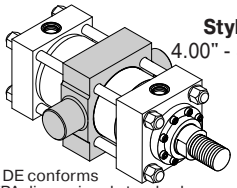
Side Tapped
Style F
1.50" - 8.00"

(NFPA MS4)

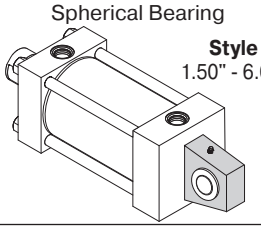
Cap Fixed Clevis
Style BB
1.50" - 8.00"

(NFPA MP1)

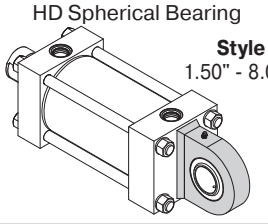
Head Trunnion
Style D
1.50" - 8.00"

(NFPA MT1)

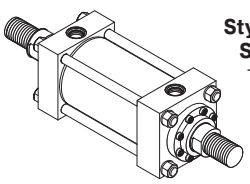
Cap Trunnion
Style DB
1.50" - 8.00"

(NFPA MT2)

Intermediate Fixed Trunnion
Style DD
1.50" - 8.00"

(NFPA MT4)

HD Intermediate Fixed Trunnion
Style DE
4.00" - 8.00"

Style DE conforms to NFPA dimensional standard.

Spherical Bearing
Style SB
1.50" - 6.00"


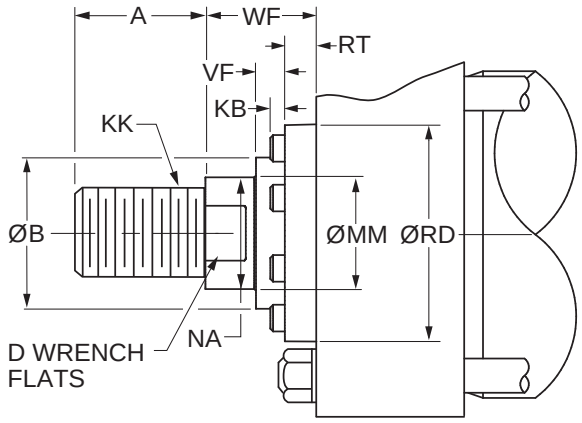
HD Spherical Bearing
Style SE
1.50" - 8.00"


Double Rod Cylinders
Style KT
Shown
1.50" - 8.00"


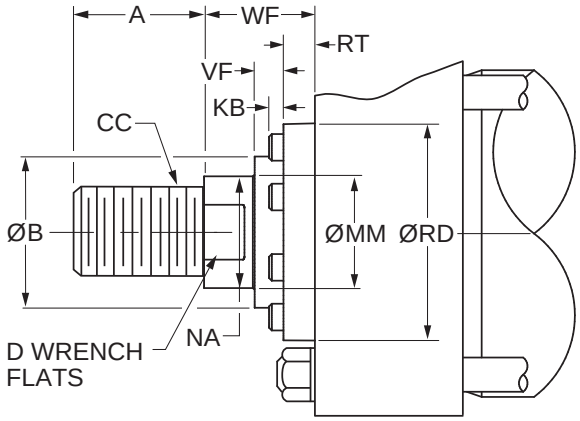
⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Rod End Dimensions – circular bolt-on retainer construction

Thread Style 4 (NFPA Style SM)
Small Male



Thread Style 8 (NFPA Style IM)
Intermediate Male



See Bushing Retention page to determine which bore, rod and mounting style combinations have circular bolt-on retainers and which have tie rod retained bushings.

Rod End Dimensions

Bore Ø	Rod No.	MM Rod Ø	Thread		A	B Ø +.000 -.002	D	F	KB	NA	RD	RT	V	VF	W	WF
			Style 8 CC	Style 4 KK												
1.50	1 (Std.)	0.625	1/2-20	7/16-20	0.75	1.124	0.50	0.38	0.03	0.56	1.94	0.36	0.25	0.27	0.63	1.00
	2	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.38	0.03	0.94	2.38	0.36	0.50	0.52	1.00	1.38
2.00	1 (Std.)	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.63	0.03	0.94	2.38	0.36	0.25	0.52	0.75	1.38
	2	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.63	0.19	1.31	2.87	0.36	0.38	0.64	1.00	1.63
2.50	1 (Std.)	1.000	7/8-14	3/4-16	1.13	1.499	0.88	0.63	0.03	0.94	2.38	0.36	0.25	0.52	0.75	1.38
	2	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.63	0.03	1.69	3.47	0.60	0.50	0.53	1.25	1.88
	3	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.63	0.19	1.31	2.87	0.36	0.38	0.64	1.00	1.63
3.25	1 (Std.)	1.375	1 1/4-12	1-14	1.63	1.999	1.13	0.75	0.19	1.31	2.87	0.36	0.25	0.64	0.88	1.63
	2	2.000	1 3/4-12	1 1/2-12	2.25	2.624	1.69	0.75	0.13	1.94	3.72	0.60	0.38	0.53	1.25	2.00
	3	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.75	0.03	1.69	3.47	0.60	0.38	0.53	1.13	1.88
4.00	1 (Std.)	1.750	1 1/2-12	1 1/4-12	2.00	2.374	1.50	0.88	0.03	1.69	3.47	0.60	0.25	0.53	1.00	1.88
	2	2.500	2 1/4-12	1 7/8-12	3.00	3.124	2.06	0.88	0.25	2.38	4.25	0.60	0.38	0.65	1.38	2.25
	3	2.000	1 3/4-12	1 1/2-12	2.25	2.624	1.69	0.88	0.13	1.94	3.72	0.60	0.25	0.53	1.13	2.00
5.00	1 (Std.)	2.000	1 3/4-12	1 1/2-12	2.25	2.624	1.69	0.88	0.13	1.94	3.72	0.60	0.25	0.53	1.13	2.00
	2	3.500	3 1/4-12	2 1/2-12	3.50	4.249	3.00	0.88	-	3.38	5.76	0.91	0.38	0.34	1.38	2.25
	3	2.500	2 1/4-12	1 7/8-12	3.00	3.124	2.06	0.88	0.25	2.38	4.25	0.60	0.38	0.65	1.38	2.25
	4	3.000	2 3/4-12	2 1/4-12	3.50	3.749	2.63	0.88	-	2.88	5.26	0.85	0.38	0.41	1.38	2.25
6.00	1 (Std.)	2.500	2 1/4-12	1 7/8-12	3.00	3.124	2.06	1.00	0.25	2.38	4.25	0.60	0.25	0.65	1.25	2.25
	2	4.000	3 3/4-12	3-12	4.00	4.749	3.38	1.00	-	3.88	6.31	0.91	0.25	0.34	1.25	2.25
	3	3.000	2 3/4-12	2 1/4-12	3.50	3.749	2.63	1.00	-	2.88	5.26	0.85	0.25	0.41	1.25	2.25
	4	3.500	3 1/4-12	2 1/2-12	3.50	4.249	3.00	1.00	-	3.38	5.76	0.91	0.25	0.34	1.25	2.25

"Special" Thread Style 3 (Previous Style X)

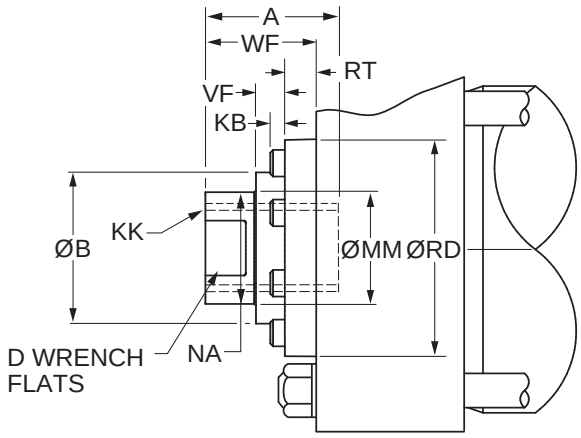
Special thread, extension, rod eye, blank, etc., are also available.

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

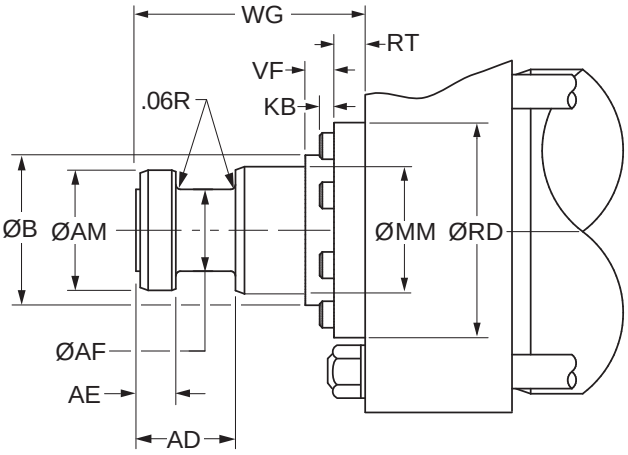
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Rod End Dimensions – circular bolt-on retainer construction

Thread Style 9[2]
(NFPA Style SF) Small Female



Style 55[1]
Flanged Rod End



See Bushing Retention page to determine which bore, rod and mounting style combinations have circular bolt-on retainers and which have tie rod retained bushings.

Rod End Dimensions

Bore Ø	Rod No.	MM Rod Ø	Thread Style 9 KK	A	AD	AE +.001 -.001	AF Ø	AM Ø	B Ø +.000 -.002	D	KB	NA	RD	RT	VF	WF	WG
1.50	1 (Std.)	0.625	7/16-20	0.75	0.63	0.249	0.38	0.57	1.124	0.50	0.03	0.56	1.94	0.36	0.27	1.00	1.75
	2	1.000	3/4-16	1.13	0.94	0.374	0.69	0.95	1.499	0.88	0.03	0.94	2.38	0.36	0.52	1.38	2.38
2.00	1 (Std.)	1.000	3/4-16	1.13	0.94	0.374	0.69	0.95	1.499	0.88	0.03	0.94	2.38	0.36	0.52	1.38	2.38
	2	1.375	1-14	1.63	1.06	0.374	0.88	1.32	1.999	1.13	0.19	1.31	2.87	0.36	0.64	1.63	2.75
2.50	1 (Std.)	1.000	3/4-16	1.13	0.94	0.374	0.69	0.95	1.499	0.88	0.03	0.94	2.38	0.36	0.52	1.38	2.38
	2	1.750	1 1/4-12	2.00	1.31	0.499	1.13	1.70	2.374	1.50	0.03	1.69	3.47	0.60	0.53	1.88	3.13
	3	1.375	1-14	1.63	1.06	0.374	0.88	1.32	1.999	1.13	0.19	1.31	2.87	0.36	0.64	1.63	2.75
3.25	1 (Std.)	1.375	1-14	1.63	1.06	0.374	0.88	1.32	1.999	1.13	0.19	1.31	2.87	0.36	0.64	1.63	2.75
	2	2.000	1 1/2-12	2.25	1.69	0.624	1.38	1.95	2.624	1.69	0.13	1.94	3.72	0.60	0.53	2.00	3.75
	3	1.750	1 1/4-12	2.00	1.31	0.499	1.13	1.70	2.374	1.50	0.03	1.69	3.47	0.60	0.53	1.88	3.13
4.00	1 (Std.)	1.750	1 1/4-12	2.00	1.31	0.499	1.13	1.70	2.374	1.50	0.03	1.69	3.47	0.60	0.53	1.88	3.13
	2	2.500	1 7/8-12	3.00	1.94	0.749	1.75	2.45	3.124	2.06	0.25	2.38	4.25	0.60	0.65	2.25	4.50
	3	2.000	1 1/2-12	2.25	1.69	0.624	1.38	1.95	2.624	1.69	0.13	1.94	3.72	0.60	0.53	2.00	3.75
5.00	1 (Std.)	2.000	1 1/2-12	2.25	1.69	0.624	1.38	1.95	2.624	1.69	0.13	1.94	3.72	0.60	0.53	2.00	3.75
	2	3.500	2 1/2-12	3.50	2.69	0.999	2.50	3.45	4.249	3.00	-	3.38	5.76	0.91	0.34	2.25	5.63
	3	2.500	1 7/8-12	3.00	1.94	0.749	1.75	2.45	3.124	2.06	0.25	2.38	4.25	0.60	0.65	2.25	4.50
	4	3.000	2 1/4-12	3.50	2.44	0.874	2.25	2.95	3.749	2.63	-	2.88	5.26	0.85	0.41	2.25	4.88
6.00	1 (Std.)	2.500	1 7/8-12	3.00	1.94	0.749	1.75	2.45	3.124	2.06	0.25	2.38	4.25	0.60	0.65	2.25	4.50
	2	4.000	3-12	4.00	2.69	0.999	3.00	3.95	4.749	3.38	-	3.88	6.31	0.91	0.34	2.25	5.75
	3	3.000	2 1/4-12	3.50	2.44	0.874	2.25	2.95	3.749	2.63	-	2.88	5.26	0.85	0.41	2.25	4.88
	4	3.500	2 1/2-12	3.50	2.69	0.999	2.50	3.45	4.249	3.00	-	3.38	5.76	0.91	0.34	2.25	5.63

"Special" Thread Style 3 (Previous Style X)

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

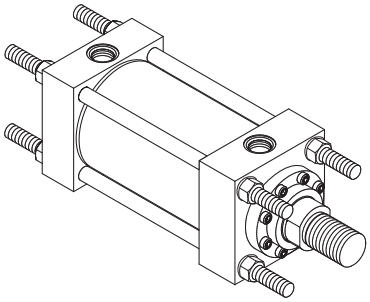
To order, specify "Style 3" and give desired dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

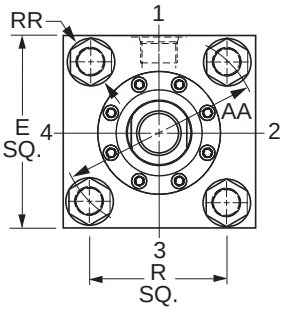
[1] For special WG dimension, specify "Style 3" and give desired dimension for WG. For other changes, place "S" in the model code, and describe rod end with dimensioned sketch.

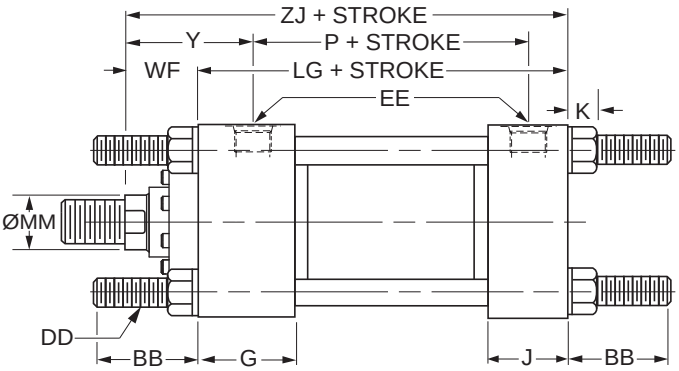
[2] Style 9 stroke restrictions may apply. See Style 9 Minimum Stroke Table on How to Order page for details.

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Tie Rods Extended Both Ends Mounting
Style TD
(NFPA Style MX1)





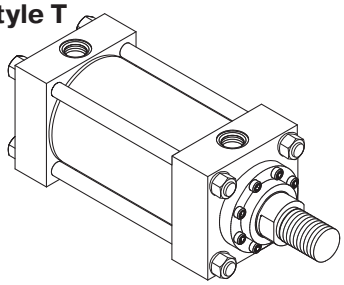


Style TD – Dimensional and Mounting Data

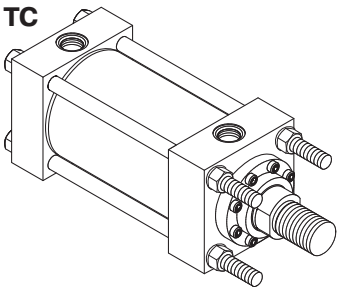
Bore Ø	Rod No.	MM Rod Ø	AA	BB	DD	E	EE		G	J	K Max.	R	RR	WF	Y	Add Stroke		
							NPTF[1]	SAE[2]								LG	P	ZJ
1.50	1 (std.)	0.625	2.31	1.38	3/8-24	2.50	1/2	10†	1.75	1.50	0.42	1.63	0.68	1.00	2.00	4.63	2.88	5.63
	2	1.000	2.31	1.38	3/8-24	2.50	1/2	10†	1.75	1.50	0.42	1.63	0.68	1.38	2.38	4.63	2.88	6.00
2.00	1 (std.)	1.000	2.90	1.81	1/2-20	3.00	1/2	10†	1.75	1.50	0.57	2.05	0.90	1.38	2.38	4.63	2.88	6.00
	2	1.375	2.90	1.81	1/2-20	3.00	1/2	10†	1.75	1.50	0.57	2.05	0.90	1.63	2.63	4.63	2.88	6.25
2.50	1 (std.)	1.000	3.61	1.81	1/2-20	3.50	1/2	10†	1.75	1.50	0.57	2.55	0.90	1.38	2.38	4.75	3.00	6.13
	2	1.750	3.61	1.81	1/2-20	3.50	1/2	10†	1.75	1.50	0.57	2.55	0.90	1.88	2.88	4.75	3.00	6.63
	3	1.375	3.61	1.81	1/2-20	3.50	1/2	10†	1.75	1.50	0.57	2.55	0.90	1.63	2.63	4.75	3.00	6.38
3.25	1 (std.)	1.375	4.60	2.31	5/8-18	4.50	3/4	12	2.00	1.75	0.68	3.25	1.11	1.63	2.75	5.50	3.50	7.13
	2	2.000	4.60	2.31	5/8-18	4.50	3/4	12	2.00	1.75	0.68	3.25	1.11	2.00	3.13	5.50	3.50	7.50
	3	1.750	4.60	2.31	5/8-18	4.50	3/4	12	2.00	1.75	0.68	3.25	1.11	1.88	3.00	5.50	3.50	7.38
4.00	1 (std.)	1.750	5.40	2.31	5/8-18	5.00	3/4	12	2.00	1.75	0.68	3.82	1.11	1.88	3.00	5.75	3.75	7.63
	2	2.500	5.40	2.31	5/8-18	5.00	3/4	12	2.00	1.75	0.68	3.82	1.11	2.25	3.38	5.75	3.75	8.00
	3	2.000	5.40	2.31	5/8-18	5.00	3/4	12	2.00	1.75	0.68	3.82	1.11	2.00	3.13	5.75	3.75	7.75
5.00	1 (std.)	2.000	7.00	3.19	7/8-14	6.50	3/4	12	2.00	1.75	0.94	4.95	1.55	2.00	3.13	6.25	4.25	8.25
	2	3.500	7.00	3.19	7/8-14	6.50	3/4	12	2.00	1.75	0.94	4.95	1.55	2.25	3.38	6.25	4.25	8.50
	3	2.500	7.00	3.19	7/8-14	6.50	3/4	12	2.00	1.75	0.94	4.95	1.55	2.25	3.38	6.25	4.25	8.50
	4	3.000	7.00	3.19	7/8-14	6.50	3/4	12	2.00	1.75	0.94	4.95	1.55	2.25	3.38	6.25	4.25	8.50
6.00	1 (std.)	2.500	8.10	3.63	1-14	7.50	1	16	2.25	2.25	1.05	5.73	1.77	2.25	3.50	7.38	4.88	9.63
	2	4.000	8.10	3.63	1-14	7.50	1	16	2.25	2.25	1.05	5.73	1.77	2.25	3.50	7.38	4.88	9.63
	3	3.000	8.10	3.63	1-14	7.50	1	16	2.25	2.25	1.05	5.73	1.77	2.25	3.50	7.38	4.88	9.63
	4	3.500	8.10	3.63	1-14	7.50	1	16	2.25	2.25	1.05	5.73	1.77	2.25	3.50	7.38	4.88	9.63

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

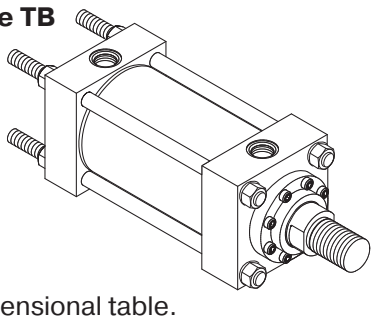
Style T



Style TC



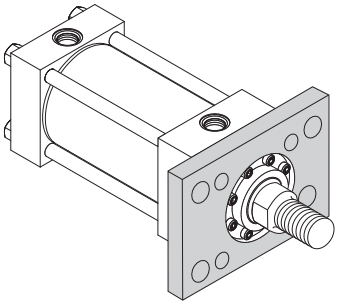
Style TB

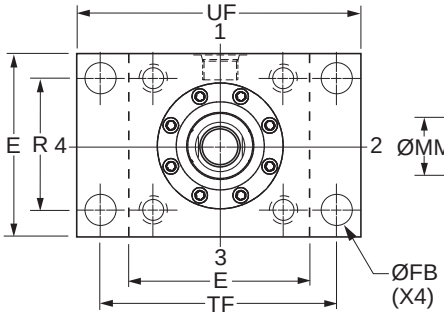


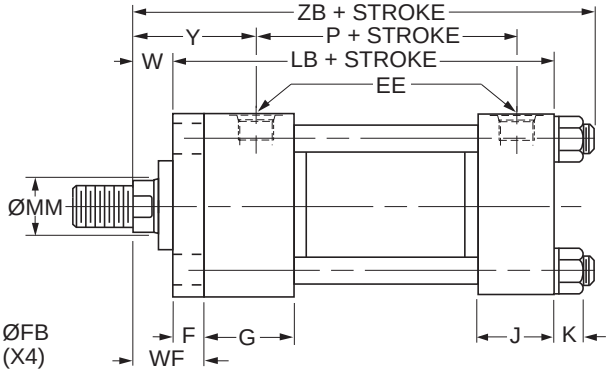
Dimensions for T, TB and TC Mount may be obtained from the above dimensional table.

Head Rectangular Flange Mounting

Style J
(NFPA Style MF1)







Style J – Dimensional and Mounting Data

Bore Ø	E	EE		F	FB Ø	G	J	K Max.	R	TF	UF	Add Stroke	
		NPTF[1]	SAE[2]									LB	P
1.50	2.50	1/2	10†	0.38	0.44	1.75	1.50	0.42	1.63	3.44	4.25	5.00	2.88
2.00	3.00	1/2	10†	0.63	0.56	1.75	1.50	0.57	2.05	4.13	5.13	5.25	2.88
2.50	3.50	1/2	10†	0.63	0.56	1.75	1.50	0.57	2.55	4.63	5.63	5.38	3.00
3.25	4.50	3/4	12	0.75	0.69	2.00	1.75	0.68	3.25	5.88	7.13	6.25	3.50
4.00	5.00	3/4	12	0.88	0.69	2.00	1.75	0.68	3.82	6.38	7.63	6.63	3.75
5.00	6.50	3/4	12	0.88	0.94	2.00	1.75	0.94	4.95	8.19	9.75	7.13	4.25
6.00	7.50	1	16	1.00	1.06	2.25	2.25	1.05	5.73	9.44	11.25	8.38	4.88

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style J – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	WF	Y	Add Stroke
						ZB Max.
1.50	1 (std.)	0.625	0.63	1.00	2.00	6.29
	2	1.000	1.00	1.38	2.38	6.67
2.00	1 (std.)	1.000	0.75	1.38	2.38	6.81
	2	1.375	1.00	1.63	2.63	7.06
2.50	1 (std.)	1.000	0.75	1.38	2.38	6.93
	2	1.750	1.25	1.88	2.88	7.43
	3	1.375	1.00	1.63	2.63	7.18
3.25	1 (std.)	1.375	0.88	1.63	2.75	8.06
	2	2.000	1.25	2.00	3.13	8.43
	3	1.750	1.13	1.88	3.00	8.31
4.00	1 (std.)	1.750	1.00	1.88	3.00	8.56
	2	2.500	1.38	2.25	3.38	8.94
	3	2.000	1.13	2.00	3.13	8.68
5.00	1 (std.)	2.000	1.13	2.00	3.13	9.44
	2	3.500	1.38	2.25	3.38	9.69
	3	2.500	1.38	2.25	3.38	9.69
	4	3.000	1.38	2.25	3.38	9.69
6.00	1 (std.)	2.500	1.25	2.25	3.50	10.93
	2	4.000	1.25	2.25	3.50	10.93
	3	3.000	1.25	2.25	3.50	10.93
	4	3.500	1.25	2.25	3.50	10.93

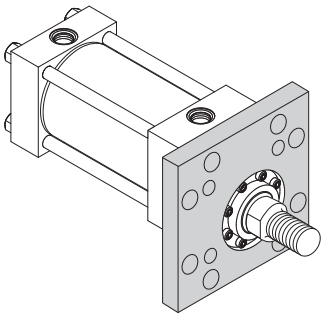
Style J – Maximum Operating Pressure

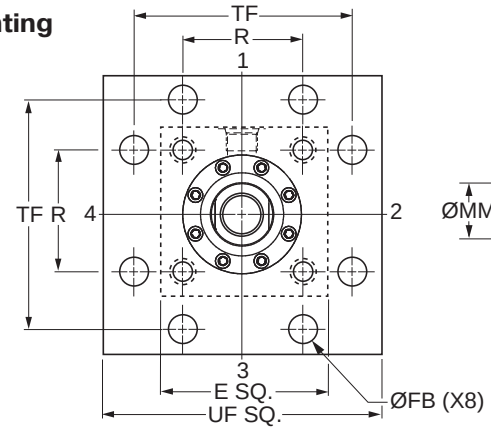
Bore Ø	Maximum psi Push[3]			
	Rod Code			
	1	2	3	4
1.50	1400	1000	-	-
2.00	2000	1200	-	-
2.50	700	1000	700	-
3.25	800	600	800	-
4.00	1000	700	1000	-
5.00	850	800	850	450
6.00	650	400	650	400

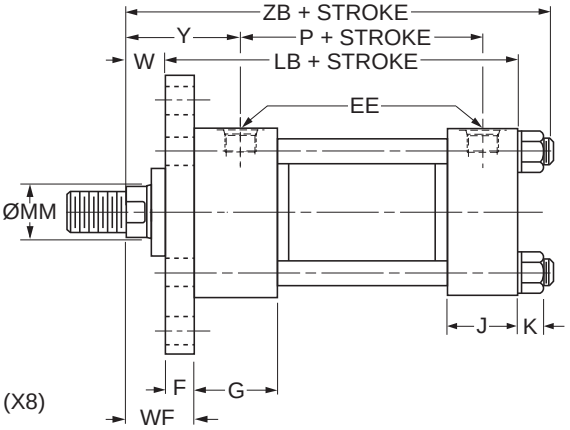
[3]Maximum Pressure Rating – Push Application.

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Square Flange Mounting
Style JB
(NFPA Style MF5)







Style JB – Dimensional and Mounting Data

Bore Ø	E	EE		F	FB Ø	G	J	K Max.	R	TF	UF	Add Stroke	
		NPTF[1]	SAE[2]									LB	P
1.50	2.50	1/2	10†	0.38	0.44	1.75	1.50	0.42	1.63	3.44	4.25	5.00	2.88
2.00	3.00	1/2	10†	0.63	0.56	1.75	1.50	0.57	2.05	4.13	5.13	5.25	2.88
2.50	3.50	1/2	10†	0.63	0.56	1.75	1.50	0.57	2.55	4.63	5.63	5.38	3.00
3.25	4.50	3/4	12	0.75	0.69	2.00	1.75	0.68	3.25	5.88	7.13	6.25	3.50
4.00	5.00	3/4	12	0.88	0.69	2.00	1.75	0.68	3.82	6.38	7.63	6.63	3.75
5.00	6.50	3/4	12	0.88	0.94	2.00	1.75	0.94	4.95	8.19	9.75	7.13	4.25
6.00	7.50	1	16	1.00	1.06	2.25	2.25	1.05	5.73	9.44	11.25	8.38	4.88

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style JB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	W	WF	Y	Add Stroke
						ZB Max.
1.50	1 (std.)	0.625	0.63	1.00	2.00	6.29
	2	1.000	1.00	1.38	2.38	6.67
2.00	1 (std.)	1.000	0.75	1.38	2.38	6.81
	2	1.375	1.00	1.63	2.63	7.06
2.50	1 (std.)	1.000	0.75	1.38	2.38	6.93
	2	1.750	1.25	1.88	2.88	7.43
	3	1.375	1.00	1.63	2.63	7.18
3.25	1 (std.)	1.375	0.88	1.63	2.75	8.06
	2	2.000	1.25	2.00	3.13	8.43
	3	1.750	1.13	1.88	3.00	8.31
4.00	1 (std.)	1.750	1.00	1.88	3.00	8.56
	2	2.500	1.38	2.25	3.38	8.94
	3	2.000	1.13	2.00	3.13	8.68
5.00	1 (std.)	2.000	1.13	2.00	3.13	9.44
	2	3.500	1.38	2.25	3.38	9.69
	3	2.500	1.38	2.25	3.38	9.69
	4	3.000	1.38	2.25	3.38	9.69
6.00	1 (std.)	2.500	1.25	2.25	3.50	10.93
	2	4.000	1.25	2.25	3.50	10.93
	3	3.000	1.25	2.25	3.50	10.93
	4	3.500	1.25	2.25	3.50	10.93

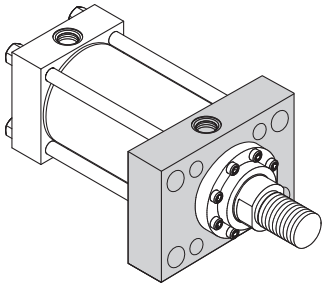
Style JB – Maximum Operating Pressure

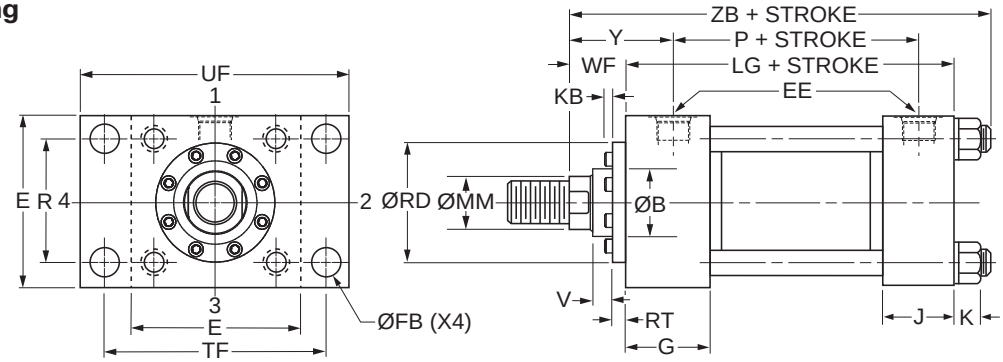
Bore Ø	Maximum psi Push[3]			
	Rod Code			
	1	2	3	4
1.50	3000	3000	-	-
2.00	3000	3000	-	-
2.50	3000	3000	3000	-
3.25	3000	3000	3000	-
4.00	3000	3000	3000	-
5.00	2500	2300	2500	1800
6.00	2000	1600	2000	1600

[3]Maximum Pressure Rating – Push Application.

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Rectangular Mounting
Style JJ
(NFPA Style ME5)





Style JJ – Dimensional and Mounting Data

Bore Ø	E	EE		FB Ø	G	J	K Max.	R	TF	UF	Add Stroke	
		NPTF[1]	SAE[2]								LG	P
1.50	2.50	1/2	10†	0.44	1.75	1.50	0.42	1.63	3.44	4.25	4.63	2.88
2.00	3.00	1/2	10†	0.56	1.75	1.50	0.57	2.05	4.13	5.13	4.63	2.88
2.50	3.50	1/2	10†	0.56	1.75	1.50	0.57	2.55	4.63	5.63	4.75	3.00
3.25	4.50	3/4	12	0.69	2.00	1.75	0.68	3.25	5.88	7.13	5.50	3.50
4.00	5.00	3/4	12	0.69	2.00	1.75	0.68	3.82	6.38	7.63	5.75	3.75
5.00	6.50	3/4	12	0.94	2.00	1.75	0.94	4.95	8.19	9.75	6.25	4.25
6.00	7.50	1	16	1.06	2.25	2.25	1.05	5.73	9.44	11.25	7.38	4.88

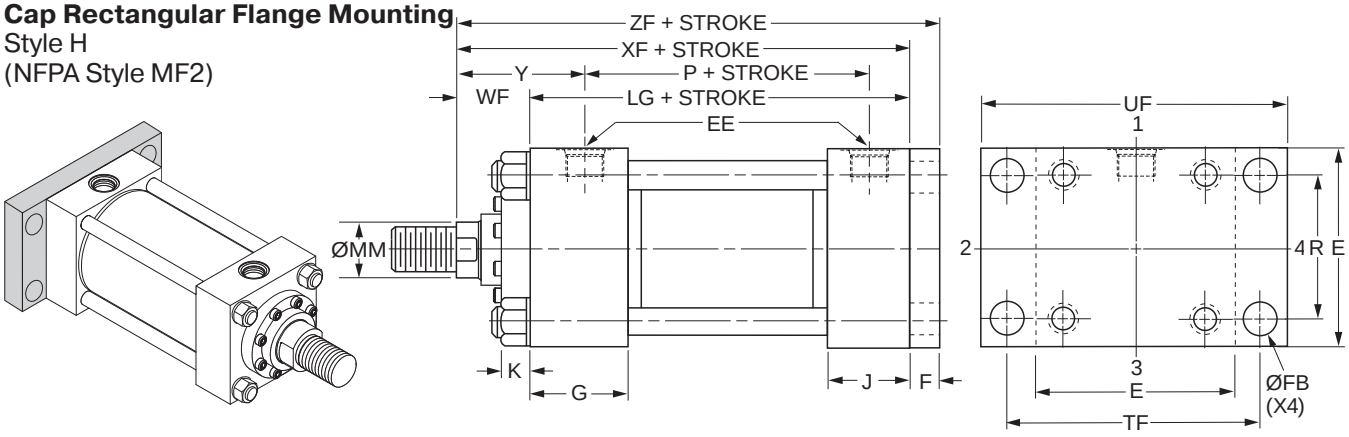
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style JJ – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	B Ø +.000 -.002	KB	RD Ø	RT	V	WF	Y	Add Stroke
										ZB Max
1.50	1 (std.)	0.625	1.124	0.03	1.94	0.36	0.27	1.00	2.00	6.29
	2	1.000	1.499	0.03	2.38	0.36	0.52	1.38	2.38	6.67
2.00	1 (std.)	1.000	1.499	0.03	2.38	0.36	0.52	1.38	2.38	6.81
	2	1.375	1.999	0.19	2.87	0.36	0.64	1.63	2.63	7.06
2.50	1 (std.)	1.000	1.499	0.03	2.38	0.36	0.52	1.38	2.38	6.93
	2	1.750	2.374	0.03	3.47	0.60	0.53	1.88	2.88	7.43
	3	1.375	1.999	0.19	2.87	0.36	0.64	1.63	2.63	7.18
3.25	1 (std.)	1.375	1.999	0.19	2.87	0.36	0.64	1.63	2.75	8.06
	2	2.000	2.624	0.13	3.72	0.60	0.53	2.00	3.13	8.43
	3	1.750	2.374	0.03	3.47	0.60	0.53	1.88	3.00	8.31
4.00	1 (std.)	1.750	2.374	0.03	3.47	0.60	0.53	1.88	3.00	8.56
	2	2.500	3.124	0.25	4.25	0.60	0.65	2.25	3.38	8.94
	3	2.000	2.624	0.13	3.72	0.60	0.53	2.00	3.13	8.68
5.00	1 (std.)	2.000	2.624	0.13	3.72	0.60	0.53	2.00	3.13	9.44
	2	3.500	4.249	-	5.76	0.91	0.34	2.25	3.38	9.69
	3	2.500	3.124	0.25	4.25	0.60	0.65	2.25	3.38	9.69
	4	3.000	3.749	-	5.26	0.85	0.41	2.25	3.38	9.69
6.00	1 (std.)	2.500	3.124	0.25	4.25	0.60	0.65	2.25	3.50	10.93
	2	4.000	4.749	-	6.31	0.91	0.34	2.25	3.50	10.93
	3	3.000	3.749	-	5.26	0.85	0.41	2.25	3.50	10.93
	4	3.500	4.249	-	5.76	0.91	0.34	2.25	3.50	10.93

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Rectangular Flange Mounting
Style H
(NFPA Style MF2)



Style H – Dimensional and Mounting Data

Bore Ø	E	EE		F	FB Ø	G	J	K Max.	R	TF	UF	Add Stroke	
		NPTF[1]	SAE[2]									LG	P
1.50	2.50	1/2	10†	0.38	0.44	1.75	1.50	0.42	1.63	3.44	4.25	4.63	2.88
2.00	3.00	1/2	10†	0.63	0.56	1.75	1.50	0.57	2.05	4.13	5.13	4.63	2.88
2.50	3.50	1/2	10†	0.63	0.56	1.75	1.50	0.57	2.55	4.63	5.63	4.75	3.00
3.25	4.50	3/4	12	0.75	0.69	2.00	1.75	0.68	3.25	5.88	7.13	5.50	3.50
4.00	5.00	3/4	12	0.88	0.69	2.00	1.75	0.68	3.82	6.38	7.63	5.75	3.75
5.00	6.50	3/4	12	0.88	0.94	2.00	1.75	0.94	4.95	8.19	9.75	6.25	4.25
6.00	7.50	1	16	1.00	1.06	2.25	2.25	1.05	5.73	9.44	11.25	7.38	4.88

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style H – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	Y	Add Stroke	
					XF	ZF
1.50	1 (std.)	0.625	1.00	2.00	5.63	6.00
	2	1.000	1.38	2.38	6.00	6.38
2.00	1 (std.)	1.000	1.38	2.38	6.00	6.63
	2	1.375	1.63	2.63	6.25	6.88
2.50	1 (std.)	1.000	1.38	2.38	6.13	6.75
	2	1.750	1.88	2.88	6.63	7.25
	3	1.375	1.63	2.63	6.38	7.00
3.25	1 (std.)	1.375	1.63	2.75	7.13	7.88
	2	2.000	2.00	3.13	7.50	8.25
	3	1.750	1.88	3.00	7.38	8.13
4.00	1 (std.)	1.750	1.88	3.00	7.63	8.50
	2	2.500	2.25	3.38	8.00	8.88
	3	2.000	2.00	3.13	7.75	8.63
5.00	1 (std.)	2.000	2.00	3.13	8.25	9.13
	2	3.500	2.25	3.38	8.50	9.38
	3	2.500	2.25	3.38	8.50	9.38
	4	3.000	2.25	3.38	8.50	9.38
6.00	1 (std.)	2.500	2.25	3.50	9.63	10.63
	2	4.000	2.25	3.50	9.63	10.63
	3	3.000	2.25	3.50	9.63	10.63
	4	3.500	2.25	3.50	9.63	10.63

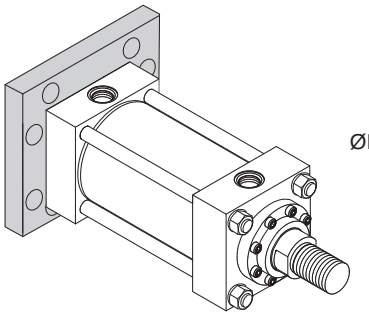
Style H – Maximum Operating Pressure

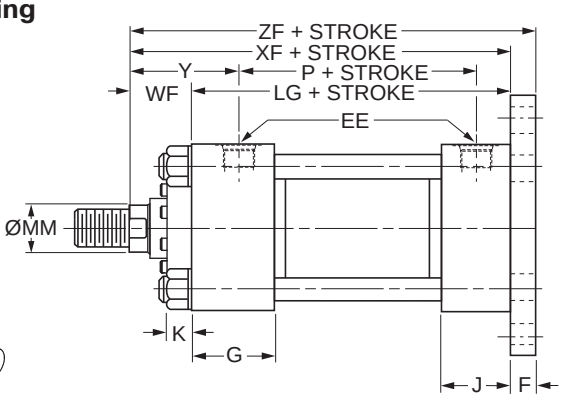
Bore Ø	Maximum psi Pull[3]			
	Rod Code			
	1	2	3	4
1.50	2500	3000	-	-
2.00	3000	3000	-	-
2.50	3000	3000	3000	-
3.25	3000	3000	3000	-
4.00	3000	3000	3000	-
5.00	2000	3000	2000	2500
6.00	1800	2500	2000	2000

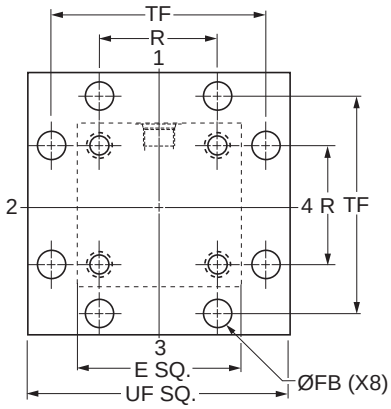
[3] Maximum pressure rating — pull application.

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Square Flange Mounting
Style HB
(NFPA Style MF6)







Style HB – Dimensional and Mounting Data

Bore Ø	E	EE		F	FB Ø	G	J	K Max.	R	TF	UF	Add Stroke	
		NPTF[1]	SAE[2]									LG	P
1.50	2.50	1/2	10†	0.38	0.44	1.75	1.50	0.42	1.63	3.44	4.25	4.63	2.88
2.00	3.00	1/2	10†	0.63	0.56	1.75	1.50	0.57	2.05	4.13	5.13	4.63	2.88
2.50	3.50	1/2	10†	0.63	0.56	1.75	1.50	0.57	2.55	4.63	5.63	4.75	3.00
3.25	4.50	3/4	12	0.75	0.69	2.00	1.75	0.68	3.25	5.88	7.13	5.50	3.50
4.00	5.00	3/4	12	0.88	0.69	2.00	1.75	0.68	3.82	6.38	7.63	5.75	3.75
5.00	6.50	3/4	12	0.88	0.94	2.00	1.75	0.94	4.95	8.19	9.75	6.25	4.25
6.00	7.50	1	16	1.00	1.06	2.25	2.25	1.05	5.73	9.44	11.25	7.38	4.88

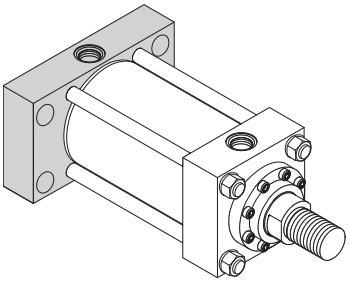
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

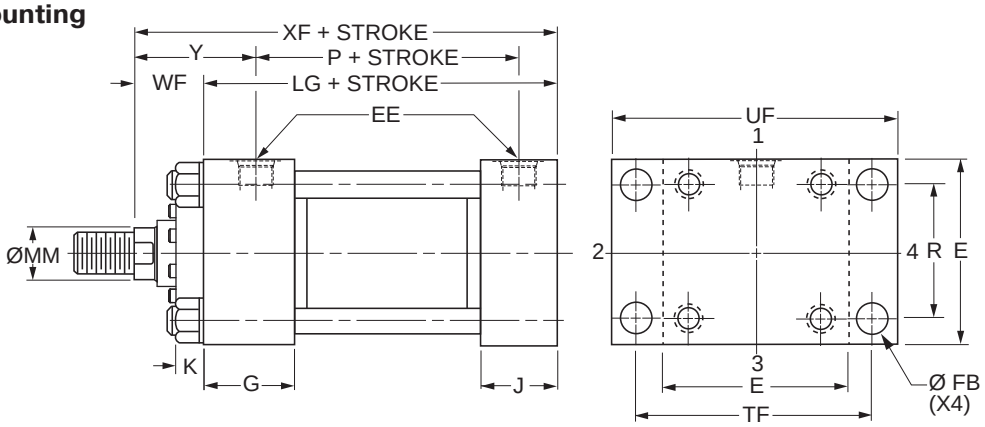
Style HB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	Y	Add Stroke	
					XF	ZF
1.50	1 (std.)	0.625	1.00	2.00	5.63	6.00
	2	1.000	1.38	2.38	6.00	6.38
2.00	1 (std.)	1.000	1.38	2.38	6.00	6.63
	2	1.375	1.63	2.63	6.25	6.88
2.50	1 (std.)	1.000	1.38	2.38	6.13	6.75
	2	1.750	1.88	2.88	6.63	7.25
	3	1.375	1.63	2.63	6.38	7.00
3.25	1 (std.)	1.375	1.63	2.75	7.13	7.88
	2	2.000	2.00	3.13	7.50	8.25
	3	1.750	1.88	3.00	7.38	8.13
4.00	1 (std.)	1.750	1.88	3.00	7.63	8.50
	2	2.500	2.25	3.38	8.00	8.88
	3	2.000	2.00	3.13	7.75	8.63
5.00	1 (std.)	2.000	2.00	3.13	8.25	9.13
	2	3.500	2.25	3.38	8.50	9.38
	3	2.500	2.25	3.38	8.50	9.38
	4	3.000	2.25	3.38	8.50	9.38
6.00	1 (std.)	2.500	2.25	3.50	9.63	10.63
	2	4.000	2.25	3.50	9.63	10.63
	3	3.000	2.25	3.50	9.63	10.63
	4	3.500	2.25	3.50	9.63	10.63

⚠**PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Rectangular Flange Mounting
Style HH
(NFPA Style ME6)





Style HH – Dimensional and Mounting Data

Bore Ø	E	EE		FB Ø	G	J	K Max.	R	TF	UF	Add Stroke	
		NPTF[1]	SAE[2]								LG	P
1.50	2.50	1/2	10†	0.44	1.75	1.50	0.42	1.63	3.44	4.25	4.63	2.88
2.00	3.00	1/2	10†	0.56	1.75	1.50	0.57	2.05	4.13	5.13	4.63	2.88
2.50	3.50	1/2	10†	0.56	1.75	1.50	0.57	2.55	4.63	5.63	4.75	3.00
3.25	4.50	3/4	12	0.69	2.00	1.75	0.68	3.25	5.88	7.13	5.50	3.50
4.00	5.00	3/4	12	0.69	2.00	1.75	0.68	3.82	6.38	7.63	5.75	3.75
5.00	6.50	3/4	12	0.94	2.00	1.75	0.94	4.95	8.19	9.75	6.25	4.25
6.00	7.50	1	16	1.06	2.25	2.25	1.05	5.73	9.44	11.25	7.38	4.88

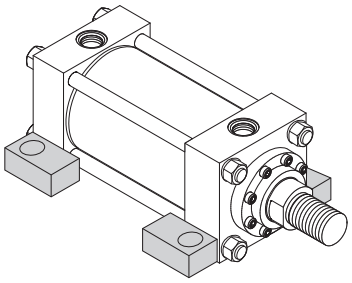
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

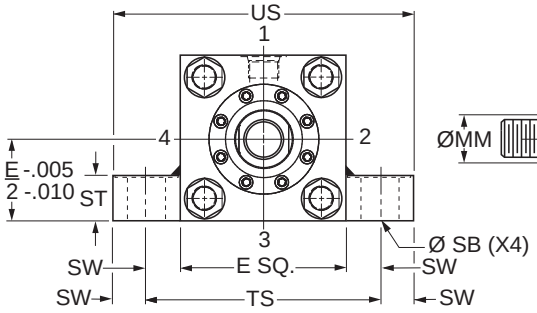
Style HH – Dimensional and Mounting Data

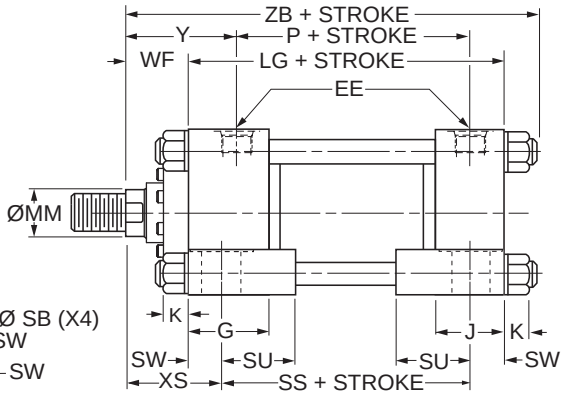
Bore Ø	Rod No.	MM Rod Ø	WF	Y	Add Stroke
					XF
1.50	1 (std.)	0.625	1.00	2.00	5.63
	2	1.000	1.38	2.38	6.00
2.00	1 (std.)	1.000	1.38	2.38	6.00
	2	1.375	1.63	2.63	6.25
2.50	1 (std.)	1.000	1.38	2.38	6.13
	2	1.750	1.88	2.88	6.63
	3	1.375	1.63	2.63	6.38
3.25	1 (std.)	1.375	1.63	2.75	7.13
	2	2.000	2.00	3.13	7.50
	3	1.750	1.88	3.00	7.38
4.00	1 (std.)	1.750	1.88	3.00	7.63
	2	2.500	2.25	3.38	8.00
	3	2.000	2.00	3.13	7.75
5.00	1 (std.)	2.000	2.00	3.13	8.25
	2	3.500	2.25	3.38	8.50
	3	2.500	2.25	3.38	8.50
	4	3.000	2.25	3.38	8.50
6.00	1 (std.)	2.500	2.25	3.50	9.63
	2	4.000	2.25	3.50	9.63
	3	3.000	2.25	3.50	9.63
	4	3.500	2.25	3.50	9.63

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Side Lug Mounting
Style C
(NFPA Style MS2)







Style C – Dimensional and Mounting Data

Bore Ø	E	EE		G	J	K Max.	SB[3] Ø	ST	SU	SW	TS	US	Add Stroke		
		NPTF[1]	SAE[2]										LG	P	SS
1.50	2.50	1/2	10†	1.75	1.50	0.42	0.44	0.50	0.94	0.38	3.25	4.00	4.63	2.88	3.88
2.00	3.00	1/2	10†	1.75	1.50	0.57	0.56	0.75	1.25	0.50	4.00	5.00	4.63	2.88	3.63
2.50	3.50	1/2	10†	1.75	1.50	0.57	0.81	1.00	1.56	0.69	4.88	6.25	4.75	3.00	3.38
3.25	4.50	3/4	12	2.00	1.75	0.68	0.81	1.00	1.56	0.69	5.88	7.25	5.50	3.50	4.13
4.00	5.00	3/4	12	2.00	1.75	0.68	1.06	1.25	2.00	0.88	6.75	8.50	5.75	3.75	4.00
5.00	6.50	3/4	12	2.00	1.75	0.94	1.06	1.25	2.00	0.88	8.25	10.00	6.25	4.25	4.50
6.00	7.50	1	16	2.25	2.25	1.05	1.31	1.50	2.50	1.13	9.75	12.00	7.38	4.88	5.13

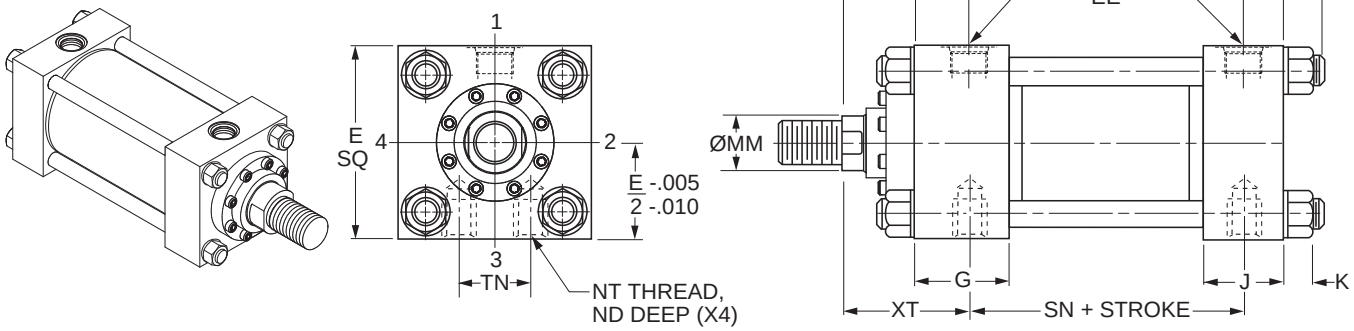
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
[3]Upper surface spot faced for socket head screws.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style C – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	XS	Y	Add Stroke
						ZB Max.
1.50	1 (std.)	0.625	1.00	1.38	2.00	6.29
	2	1.000	1.38	1.75	2.38	6.67
2.00	1 (std.)	1.000	1.38	1.88	2.38	6.81
	2	1.375	1.63	2.13	2.63	7.06
2.50	1 (std.)	1.000	1.38	2.06	2.38	6.93
	2	1.750	1.88	2.56	2.88	7.43
	3	1.375	1.63	2.31	2.63	7.18
3.25	1 (std.)	1.375	1.63	2.31	2.75	8.06
	2	2.000	2.00	2.69	3.13	8.43
	3	1.750	1.88	2.56	3.00	8.31
4.00	1 (std.)	1.750	1.88	2.75	3.00	8.56
	2	2.500	2.25	3.13	3.38	8.94
	3	2.000	2.00	2.88	3.13	8.68
5.00	1 (std.)	2.000	2.00	2.88	3.13	9.44
	2	3.500	2.25	3.13	3.38	9.69
	3	2.500	2.25	3.13	3.38	9.69
	4	3.000	2.25	3.13	3.38	9.69
6.00	1 (std.)	2.500	2.25	3.38	3.50	10.93
	2	4.000	2.25	3.38	3.50	10.93
	3	3.000	2.25	3.38	3.50	10.93
	4	3.500	2.25	3.38	3.50	10.93

⚠**PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Side Tapped Mounting
Style F
(NFPA Style MS4)



Style F – Dimensional and Mounting Data

Bore Ø	E	EE		G	J	K Max.	ND	NT	TN	Add Stroke		
		NPTF[1]	SAE[2]							LG	P	SN
1.50	2.50	1/2	10†	1.75	1.50	0.42	0.38	3/8-16	0.75	4.63	2.88	2.88
2.00	3.00	1/2	10†	1.75	1.50	0.57	0.44	1/2-13	0.94	4.63	2.88	2.88
2.50	3.50	1/2	10†	1.75	1.50	0.57	0.50	5/8-11	1.31	4.75	3.00	3.00
3.25	4.50	3/4	12	2.00	1.75	0.68	0.69	3/4-10	1.50	5.50	3.50	3.50
4.00	5.00	3/4	12	2.00	1.75	0.68	0.69	1-8	2.06	5.75	3.75	3.75
5.00	6.50	3/4	12	2.00	1.75	0.94	1.00	1-8	2.94	6.25	4.25	4.25
6.00	7.50	1	16	2.25	2.25	1.05	1.25	1 1/4 -7	3.31	7.38	4.88	5.13

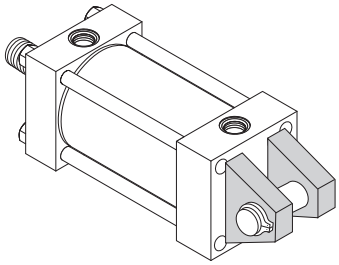
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

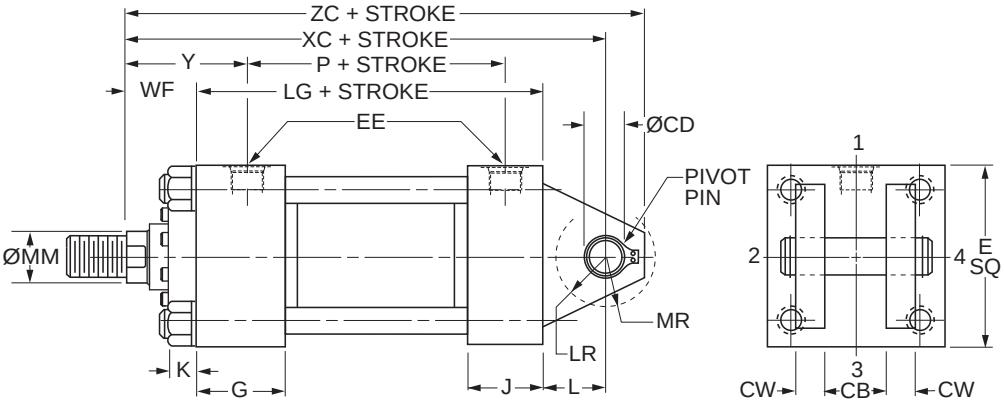
Style F – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	XT	Y	Add Stroke
						ZB Max.
1.50	1 (std.)	0.625	1.00	2.00	2.00	6.29
	2	1.000	1.38	2.38	2.38	6.67
2.00	1 (std.)	1.000	1.38	2.38	2.38	6.81
	2	1.375	1.63	2.63	2.63	7.06
2.50	1 (std.)	1.000	1.38	2.38	2.38	6.93
	2	1.750	1.88	2.88	2.88	7.43
	3	1.375	1.63	2.63	2.63	7.18
3.25	1 (std.)	1.375	1.63	2.75	2.75	8.06
	2	2.000	2.00	3.13	3.13	8.43
	3	1.750	1.88	3.00	3.00	8.31
4.00	1 (std.)	1.750	1.88	3.00	3.00	8.56
	2	2.500	2.25	3.38	3.38	8.94
	3	2.000	2.00	3.13	3.13	8.68
5.00	1 (std.)	2.000	2.00	3.13	3.13	9.44
	2	3.500	2.25	3.38	3.38	9.69
	3	2.500	2.25	3.38	3.38	9.69
	4	3.000	2.25	3.38	3.38	9.69
6.00	1 (std.)	2.500	2.25	3.50	3.50	10.93
	2	4.000	2.25	3.50	3.50	10.93
	3	3.000	2.25	3.50	3.50	10.93
	4	3.500	2.25	3.50	3.50	10.93

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Fixed Clevis Mounting
Style BB
(NFPA Style MP1)





Style BB – Dimensional and Mounting Data

Bore Ø	E	EE		CB	CD[3] Ø +.000 -.002	CW	G	J	K Max.	L	LR	MR	Add Stroke	
		NPTF[1]	SAE[2]										LG	P
1.50	2.50	1/2	10†	0.75	.501	0.50	1.75	1.50	0.42	0.75	0.56	0.63	4.63	2.88
2.00	3.00	1/2	10†	1.25	.751	0.63	1.75	1.50	0.57	1.25	1.00	0.94	4.63	2.88
2.50	3.50	1/2	10†	1.25	.751	0.63	1.75	1.50	0.57	1.25	0.94	0.94	4.75	3.00
3.25	4.50	3/4	12	1.50	1.001	0.75	2.00	1.75	0.68	1.50	1.25	1.19	5.50	3.50
4.00	5.00	3/4	12	2.00	1.376	1.00	2.00	1.75	0.68	2.13	1.75	1.63	5.75	3.75
5.00	6.50	3/4	12	2.50	1.751	1.25	2.00	1.75	0.94	2.25	2.06	2.13	6.25	4.25
6.00	7.50	1	16	2.50	2.001	1.25	2.25	2.25	1.05	2.50	2.31	2.38	7.38	4.88

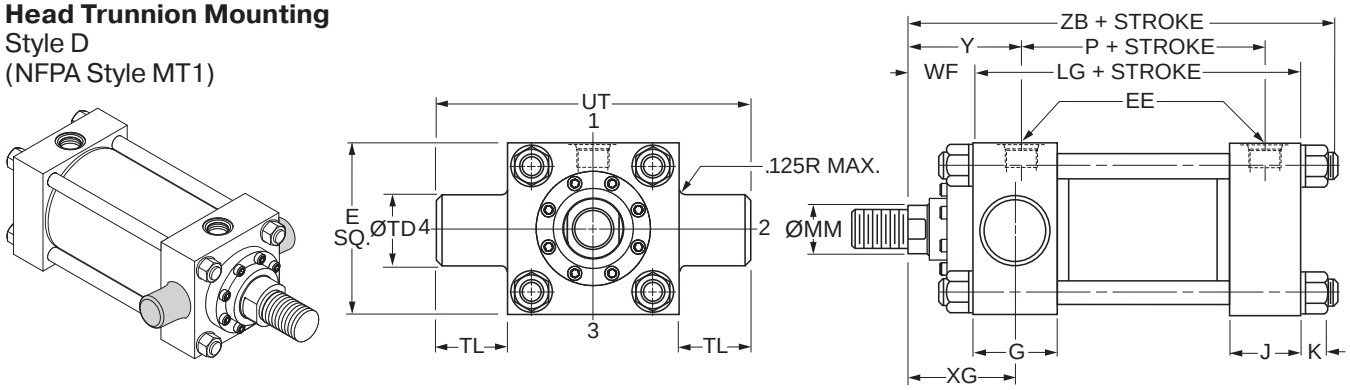
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
[3]Diameter CD is Pin Diameter.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style BB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	Y	Add Stroke	
					XC	ZC
1.50	1 (std.)	0.625	1.00	2.00	6.38	6.88
	2	1.000	1.38	2.38	6.75	7.25
2.00	1 (std.)	1.000	1.38	2.38	7.25	8.00
	2	1.375	1.63	2.63	7.50	8.25
2.50	1 (std.)	1.000	1.38	2.38	7.38	8.13
	2	1.750	1.88	2.88	7.88	8.63
	3	1.375	1.63	2.63	7.63	8.38
3.25	1 (std.)	1.375	1.63	2.75	8.63	9.63
	2	2.000	2.00	3.13	9.00	10.00
	3	1.750	1.88	3.00	8.88	9.88
4.00	1 (std.)	1.750	1.88	3.00	9.75	11.13
	2	2.500	2.25	3.38	10.13	11.50
	3	2.000	2.00	3.13	9.88	11.25
5.00	1 (std.)	2.000	2.00	3.13	10.50	12.25
	2	3.500	2.25	3.38	10.75	12.50
	3	2.500	2.25	3.38	10.75	12.50
	4	3.000	2.25	3.38	10.75	12.50
6.00	1 (std.)	2.500	2.25	3.50	12.13	14.13
	2	4.000	2.25	3.50	12.13	14.13
	3	3.000	2.25	3.50	12.13	14.13
	4	3.500	2.25	3.50	12.13	14.13

⚠**PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Trunnion Mounting
Style D
(NFPA Style MT1)



Style D – Dimensional and Mounting Data

Bore Ø	E	EE		G	J	K Max.	TD Ø +.000 -.001	TL	UT	Add Stroke	
		NPTF[1]	SAE[2]							LG	P
1.50	2.50	1/2	10†	1.75	1.50	0.42	1.000	1.00	4.50	4.63	2.88
2.00	3.00	1/2	10†	1.75	1.50	0.57	1.375	1.38	5.75	4.63	2.88
2.50	3.50	1/2	10†	1.75	1.50	0.57	1.375	1.38	6.25	4.75	3.00
3.25	4.50	3/4	12	2.00	1.75	0.68	1.750	1.75	8.00	5.50	3.50
4.00	5.00	3/4	12	2.00	1.75	0.68	1.750	1.75	8.50	5.75	3.75
5.00	6.50	3/4	12	2.00	1.75	0.94	1.750	1.75	10.00	6.25	4.25
6.00	7.50	1	16	2.25	2.25	1.05	2.000	2.00	11.50	7.38	4.88

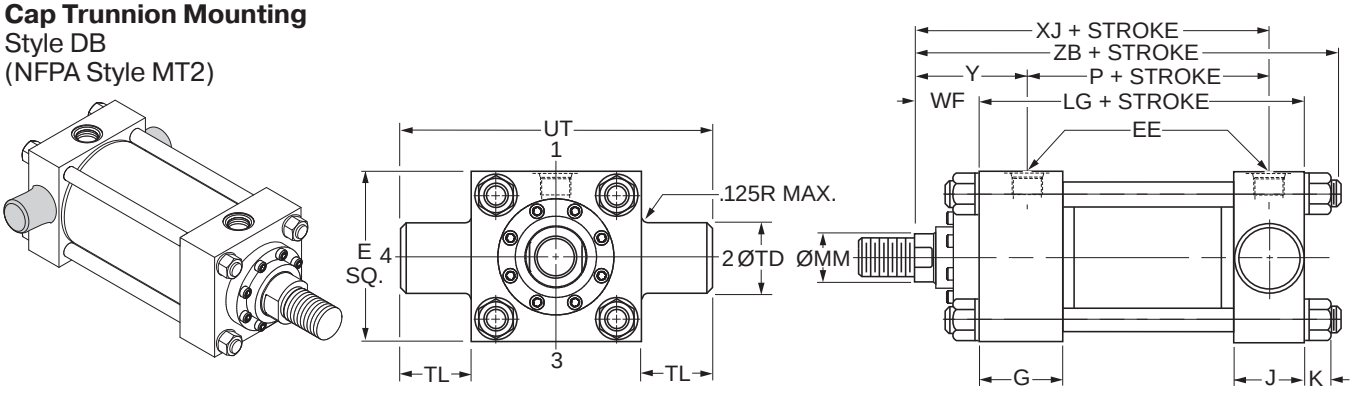
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style D – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	XG	Y	Add Stroke
						ZB Max.
1.50	1 (std.)	0.625	1.00	1.88	2.00	6.29
	2	1.000	1.38	2.25	2.38	6.67
2.00	1 (std.)	1.000	1.38	2.25	2.38	6.81
	2	1.375	1.63	2.50	2.63	7.06
2.50	1 (std.)	1.000	1.38	2.25	2.38	6.93
	2	1.750	1.88	2.75	2.88	7.43
	3	1.375	1.63	2.50	2.63	7.18
3.25	1 (std.)	1.375	1.63	2.63	2.75	8.06
	2	2.000	2.00	3.00	3.13	8.43
	3	1.750	1.88	2.88	3.00	8.31
4.00	1 (std.)	1.750	1.88	2.88	3.00	8.56
	2	2.500	2.25	3.25	3.38	8.94
	3	2.000	2.00	3.00	3.13	8.68
5.00	1 (std.)	2.000	2.00	3.00	3.13	9.44
	2	3.500	2.25	3.25	3.38	9.69
	3	2.500	2.25	3.25	3.38	9.69
	4	3.000	2.25	3.25	3.38	9.69
6.00	1 (std.)	2.500	2.25	3.38	3.50	10.93
	2	4.000	2.25	3.38	3.50	10.93
	3	3.000	2.25	3.38	3.50	10.93
	4	3.500	2.25	3.38	3.50	10.93

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Trunnion Mounting
Style DB
(NFPA Style MT2)



Style DB – Dimensional and Mounting Data

Bore Ø	E	EE		G	J	K Max.	TD Ø +.000 -.001	TL	UT	Add Stroke	
		NPTF[1]	SAE[2]							LG	P
1.50	2.50	1/2	10†	1.75	1.50	0.42	1.000	1.00	4.50	4.63	2.88
2.00	3.00	1/2	10†	1.75	1.50	0.57	1.375	1.38	5.75	4.63	2.88
2.50	3.50	1/2	10†	1.75	1.50	0.57	1.375	1.38	6.25	4.75	3.00
3.25	4.50	3/4	12	2.00	1.75	0.68	1.750	1.75	8.00	5.50	3.50
4.00	5.00	3/4	12	2.00	1.75	0.68	1.750	1.75	8.50	5.75	3.75
5.00	6.50	3/4	12	2.00	1.75	0.94	1.750	1.75	10.00	6.25	4.25
6.00	7.50	1	16	2.25	2.25	1.05	2.000	2.00	11.50	7.38	4.88

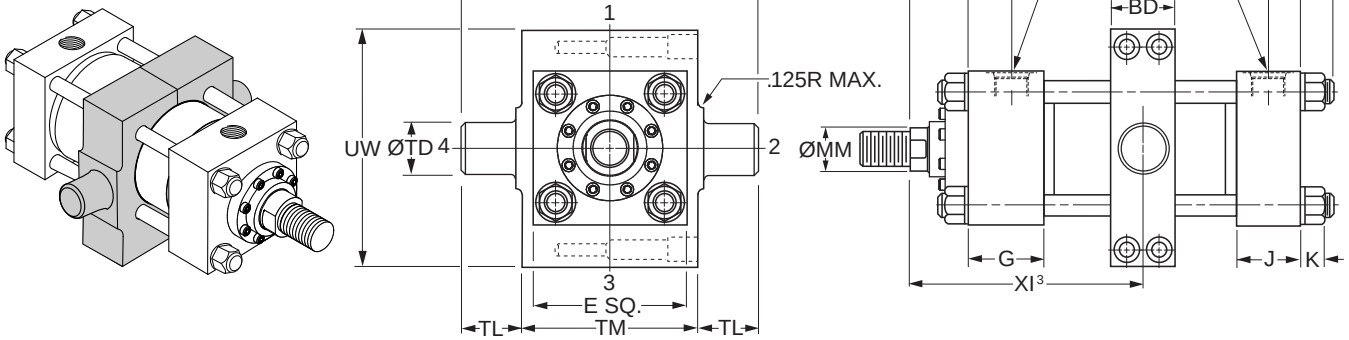
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style DB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	Y	Add Stroke	
					XJ	ZB Max.
1.50	1 (std.)	0.625	1.00	2.00	4.88	6.29
	2	1.000	1.38	2.38	5.25	6.67
2.00	1 (std.)	1.000	1.38	2.38	5.25	6.81
	2	1.375	1.63	2.63	5.50	7.06
2.50	1 (std.)	1.000	1.38	2.38	5.38	6.93
	2	1.750	1.88	2.88	5.88	7.43
	3	1.375	1.63	2.63	5.63	7.18
3.25	1 (std.)	1.375	1.63	2.75	6.25	8.06
	2	2.000	2.00	3.13	6.63	8.43
	3	1.750	1.88	3.00	6.50	8.31
4.00	1 (std.)	1.750	1.88	3.00	6.75	8.56
	2	2.500	2.25	3.38	7.13	8.94
	3	2.000	2.00	3.13	6.88	8.68
5.00	1 (std.)	2.000	2.00	3.13	7.38	9.44
	2	3.500	2.25	3.38	7.63	9.69
	3	2.500	2.25	3.38	7.63	9.69
	4	3.000	2.25	3.38	7.63	9.69
6.00	1 (std.)	2.500	2.25	3.50	8.38	10.93
	2	4.000	2.25	3.50	8.38	10.93
	3	3.000	2.25	3.50	8.38	10.93
	4	3.500	2.25	3.50	8.38	10.93

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Intermediate Fixed Trunnion Mounting
Style DD
(NFPA Style MT4)



Style DD – Dimensional and Mounting Data

Bore Ø	BD	E	EE		G	J	K Max.	TD Ø +.000 -.001	TL	TM	UM	UW	Add Stroke	
			NPTF[1]	SAE[2]									LG	P
1.50	1.25	2.50	1/2	10†	1.75	1.50	0.42	1.000	1.00	3.00	5.00	3.38	4.63	2.88
2.00	1.50	3.00	1/2	10†	1.75	1.50	0.57	1.375	1.38	3.50	6.25	4.13	4.63	2.88
2.50	1.50	3.50	1/2	10†	1.75	1.50	0.57	1.375	1.38	4.00	6.75	4.63	4.75	3.00
3.25	2.00	4.50	3/4	12	2.00	1.75	0.68	1.750	1.75	5.00	8.50	5.81	5.50	3.50
4.00	2.00	5.00	3/4	12	2.00	1.75	0.68	1.750	1.75	5.50	9.00	6.38	5.75	3.75
5.00	2.00	6.50	3/4	12	2.00	1.75	0.94	1.750	1.75	7.00	10.50	7.75	6.25	4.25
6.00	3.00	7.50	1	16	2.25	2.25	1.05	2.000	2.00	8.50	12.50	10.38	7.38	4.88

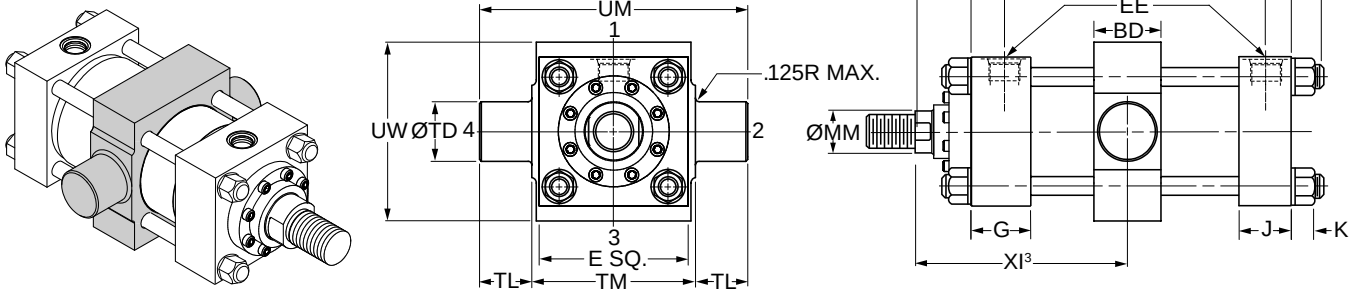
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style DD – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	Y	Minimum XI[3]		Style DD Min. Stroke	Add Stroke		ZB Max
					Styles 4, 8 & 9	Style 55		Maximum XI[4]		
								Styles 4, 8 & 9	Style 55	
1.50	1 (std.)	0.625	1.00	2.00	3.44	4.19	0	3.44	4.19	6.29
	2	1.000	1.38	2.38	3.81	4.81	0	3.81	4.81	6.67
2.00	1 (std.)	1.000	1.38	2.38	3.94	4.94	0.25	3.69	4.69	6.81
	2	1.375	1.63	2.63	4.19	5.31	0.25	3.94	5.06	7.06
2.50	1 (std.)	1.000	1.38	2.38	3.94	4.94	0.13	3.81	4.81	6.93
	2	1.750	1.88	2.88	4.44	5.69	0.13	4.31	5.56	7.43
	3	1.375	1.63	2.63	4.19	5.31	0.13	4.06	5.19	7.18
3.25	1 (std.)	1.375	1.63	2.75	4.69	5.81	0.38	4.31	5.44	8.06
	2	2.000	2.00	3.13	5.06	6.81	0.38	4.69	6.44	8.43
	3	1.750	1.88	3.00	4.94	6.19	0.38	4.56	5.81	8.31
4.00	1 (std.)	1.750	1.88	3.00	4.94	6.19	0.13	4.81	6.06	8.56
	2	2.500	2.25	3.38	5.31	7.56	0.13	5.19	7.44	8.94
	3	2.000	2.00	3.13	5.06	6.81	0.13	4.94	6.69	8.68
5.00	1 (std.)	2.000	2.00	3.13	5.06	6.81	0	5.44	7.19	9.44
	2	3.500	2.25	3.38	5.31	8.69	0	5.69	9.06	9.69
	3	2.500	2.25	3.38	5.31	7.56	0	5.69	7.94	9.69
	4	3.000	2.25	3.38	5.31	7.94	0	5.69	8.31	9.69
6.00	1 (std.)	2.500	2.25	3.50	6.06	8.31	0.25	5.81	8.06	10.93
	2	4.000	2.25	3.50	6.06	9.56	0.25	5.81	9.31	10.93
	3	3.000	2.25	3.50	6.06	8.69	0.25	5.81	8.44	10.93
	4	3.500	2.25	3.50	6.06	9.44	0.25	5.81	9.19	10.93

[3]Dimension XI to be specified by customer. Reference point for rod end Style 55 is end of piston rod.
[4]Dimensions shown are valid for standard WF and WG dimension.

Heavy Duty Intermediate Fixed Trunnion Mounting
Style DE
(NFPA Style MT4)



Style DE – Dimensional and Mounting Data

Bore Ø	BD	E	EE		G	J	K Max.	TD Ø +.000 -.001	TL	TM	UM	UW	Add Stroke	
			NPTF[1]	SAE[2]									LG	P
4.00	2.25	5.00	3/4	12	2.00	1.75	0.68	2.000	1.75	5.50	9.00	6.00	5.75	3.75
5.00	2.75	6.50	3/4	12	2.00	1.75	0.94	2.500	1.75	7.00	10.50	7.50	6.25	4.25
6.00	3.25	7.50	1	16	2.25	2.25	1.05	3.000	2.00	8.50	12.50	9.50	7.38	4.88

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

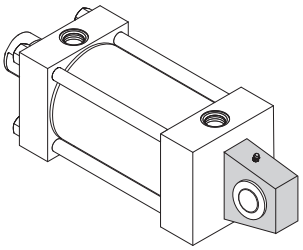
Style DE – Dimensional and Mounting Data

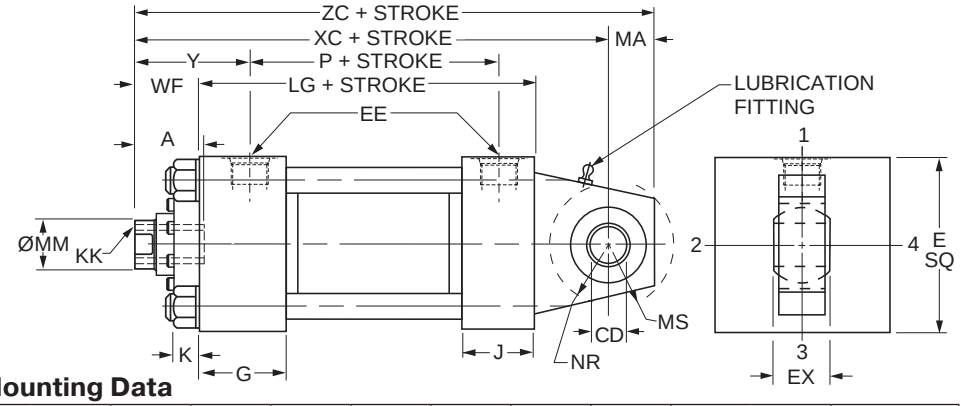
Bore Ø	Rod No.	MM Rod Ø	WF	Y	Minimum XI[3]		Style DE Minimum Stroke	Add Stroke		ZB Max.
					Styles 4, 8 & 9	Style 55		Maximum XI[4]		
								Styles 4, 8 & 9	Style 55	
4.00	1 (std.)	1.750	1.88	3.00	5.06	6.31	0.38	4.69	5.94	8.56
	2	2.500	2.25	3.38	5.44	7.69	0.38	5.06	7.31	8.94
	3	2.000	2.00	3.13	5.19	6.94	0.38	4.81	6.56	8.68
5.00	1 (std.)	2.000	2.00	3.13	5.44	7.19	0.38	5.06	6.81	9.44
	2	3.500	2.25	3.38	5.69	9.06	0.38	5.31	8.69	9.69
	3	2.500	2.25	3.38	5.69	7.94	0.38	5.31	7.56	9.69
	4	3.000	2.25	3.38	5.69	8.31	0.38	5.31	7.94	9.69
6.00	1 (std.)	2.500	2.25	3.50	6.19	8.44	0.50	5.69	7.94	10.93
	2	4.000	2.25	3.50	6.19	9.69	0.50	5.69	9.19	10.93
	3	3.000	2.25	3.50	6.19	8.81	0.50	5.69	8.31	10.93
	4	3.500	2.25	3.50	6.19	9.56	0.50	5.69	9.06	10.93

[3]Dimension XI to be specified by customer. Reference point for rod end Style 55 is end of piston rod.
[4]Dimensions shown are valid for standard WF and WG dimension.

⚠**PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Spherical Bearing Mounting
Style SB





Style SB – Dimensional and Mounting Data

Bore Ø	A	CD[1] Ø +0.0000 -0.0005	E	EE		EX	G	J	K Max.	MA	MS	NR	Add Stroke		Maximum Operating psi[2]
				NPTF[4]	SAE[5]								LG	P	
1.50	0.75	0.5000	2.50	1/2	10†	0.44	1.75	1.50	0.42	0.75	0.94	0.63	4.63	2.88	1500
2.00	1.13	0.7500	3.00	1/2	10†	0.66	1.75	1.50	0.57	1.00	1.38	1.00	4.63	2.88	2200
2.50	1.13	0.7500	3.50	1/2	10†	0.66	1.75	1.50	0.57	1.00	1.38	1.00	4.75	3.00	1450
3.25	1.63	1.0000	4.50	3/4	12	0.88	2.00	1.75	0.68	1.25	1.69	1.25	5.50	3.50	1500
4.00	2.00	1.3750	5.00	3/4	12	1.19	2.00	1.75	0.68	1.88	2.44	1.63	5.75	3.75	1850
5.00	2.25	1.7500	6.50	3/4	12	1.53	2.00	1.75	0.94	2.50	2.88	2.06	6.25	4.25	2000
6.00	3.00	2.0000	7.50	1	16	1.75	2.25	2.25	1.05[3]	2.50	3.31	2.38	7.38	4.88	1800

[1] Diameter CD is hole diameter.
[2] Maximum operating pressure at 4:1 design factor is based on tensile strength of material. Pressure ratings are based on standard bearing ratings.
[3] 6.00" bore is constructed with tie rod nuts on both ends.
[4] NPTF ports are available at no extra charge.
[5] SAE straight thread ports are standard and are indicated by port number.
† Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style SB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	Thread		WF	Y	Add Stroke		
			Style 9 KK[6]	Style 7 KK[6]			XC	XL	ZC
1.50	1 (std.)	0.625	7/16-20	—	1.00	2.00	6.38	7.25	7.13
	2	1.000	—	7/16-20	1.38	2.38	6.75	7.63	7.50
2.00	1 (std.)	1.000	3/4-16	—	1.38	2.38	7.25	8.50	8.25
	2	1.375	—	3/4-16	1.63	2.63	7.50	8.75	8.50
2.50	1 (std.)	1.000	3/4-16	—	1.38	2.38	7.38	8.63	8.38
	2	1.750	—	3/4-16	1.88	2.88	7.88	9.13	8.88
	3	1.375	—	3/4-16	1.63	2.63	7.63	8.88	8.63
3.25	1 (std.)	1.375	1-14	—	1.63	2.75	8.63	10.50	9.88
	2	2.000	—	1-14	2.00	3.13	9.00	10.88	10.25
	3	1.750	—	1-14	1.88	3.00	8.88	10.75	10.13
4.00	1 (std.)	1.750	1 1/4-12	—	1.88	3.00	9.75	11.88	11.63
	2	2.500	—	1 1/4-12	2.25	3.38	10.13	12.25	12.00
	3	2.000	—	1 1/4-12	2.00	3.13	9.88	12.00	11.75
5.00	1 (std.)	2.000	1 1/2-12	—	2.00	3.13	10.50	13.00	13.00
	2	3.500	—	1 1/2-12	2.25	3.38	10.75	13.25	13.25
	3	2.500	—	1 1/2-12	2.25	3.38	10.75	13.25	13.25
	4	3.000	—	1 1/2-12	2.25	3.38	10.75	13.25	13.25
6.00	1 (std.)	2.500	1 7/8-12	—	2.25	3.50	12.13	14.88	14.63
	2	4.000	—	1 7/8-12	2.25	3.50	12.13	14.88	14.63
	3	3.000	—	1 7/8-12	2.25	3.50	12.13	14.88	14.63
	4	3.500	—	1 7/8-12	2.25	3.50	12.13	14.88	14.63

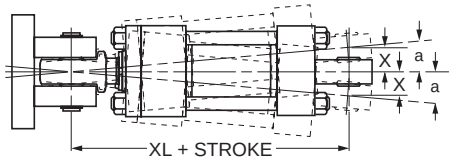
[6] Style 9 and Style 7 threads listed are for a spherical rod eye (sold separately) with pin diameter that matches the cap pin.

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

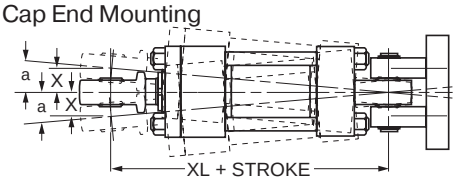
Bore Ø	Head End Mounted		Cap End Mounted	
	Angle a	Tan. of a	Angle a	Tan. of a
1.50	2.00°	.035	2.00°	.035
2.00	2.50°	.044	4.50°	.079
2.50	2.50°	.044	4.50°	.079
3.25	3.00°	.052	3.00°	.052
4.00	2.50°	.044	3.00°	.052
5.00	3.00°	.052	3.00°	.052
6.00	3.00°	.052	3.00°	.052

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

Mounting Information
Head End Mounting

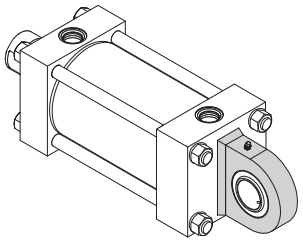


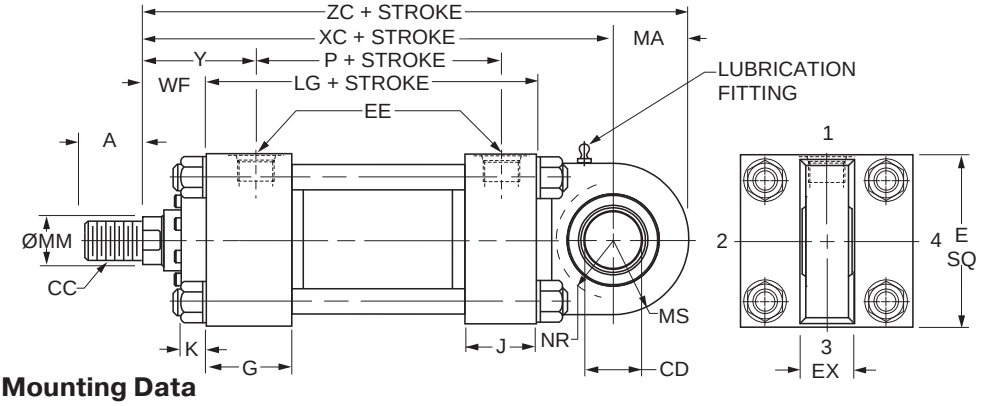
Cap End Mounting



⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Spherical Bearing Mounting
Style SE





Style SE – Dimensional and Mounting Data

Bore Ø	A	CD[1] Ø +0.0000 -0.0005	E	EE		EX	G	J	K Max.	MA	MS	NR	Add Stroke	
				NPTF[3]	SAE[4]								LG	P
1.50	0.75	0.7500	2.50	1/2	10†	0.66	1.75	1.50	0.42	1.00	1.00	0.75	4.63	2.88
2.00	1.13	1.0000	3.00	1/2	10†	0.88	1.75	1.50	0.57	1.25	1.25	1.00	4.63	2.88
2.50	1.13	1.2500	3.50	1/2	10†	1.09	1.75	1.50	0.57	1.50	1.50	1.31	4.75	3.00
3.25	1.63	1.5000	4.50	3/4	12	1.31	2.00	1.75	0.68	2.00	2.00	1.75	5.50	3.50
4.00	2.00	2.0000	5.00	3/4	12	1.75	2.00	1.75	0.68	2.25	2.25	2.13	5.75	3.75
5.00	2.25	2.5000	6.50	3/4	12	2.19	2.00	1.75	0.94	3.00	3.00	2.75	6.25	4.25
6.00	3.00	3.0000	7.50	1	16	2.63	2.25	2.25	1.05	3.50	3.50	3.13	7.38	4.88

[1] Diameter CD is hole diameter.
[2] 6.00" bore is constructed with tie rod nuts on both ends.
[3] NPTF ports are available at no extra charge.
[4] SAE straight thread ports are standard and are indicated by port number.
†Previously number 8 SAE in 1.50 thru 2.50 bores now number 10 SAE.

Style SE – Dimensional and Mounting Data

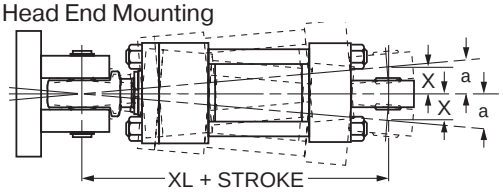
Bore Ø	Rod No.	MM Rod Ø	Thread Style 8 CC[5]	A	WF	Y	Add Stroke XC	XL	ZC
1.50	1 (std.)	0.625	1/2-20	0.75	1.00	2.00	6.88	9.01	7.88
	2	1.000	[5]	[5]	1.38	2.38	7.25	9.38	8.25
2.00	1 (std.)	1.000	7/8-14	1.13	1.38	2.38	7.56	10.56	8.81
	2	1.375	[5]	[5]	1.63	2.63	7.81	10.81	9.06
2.50	1 (std.)	1.000	7/8-14	1.13	1.38	2.38	7.75	10.75	9.25
	2	1.750	[5]	[5]	1.88	2.88	8.25	11.25	9.75
	3	1.375	[5]	[5]	1.63	2.63	8.00	11.00	9.50
3.25	1 (std.)	1.375	1 1/4-12	1.63	1.63	2.75	9.25	13.38	11.25
	2	2.000	[5]	[5]	2.00	3.13	9.63	13.75	11.63
	3	1.750	[5]	[5]	1.88	3.00	9.50	13.63	11.50
4.00	1 (std.)	1.750	1 1/2-12	2.00	1.88	3.00	10.13	15.13	12.38
	2	2.500	[5]	[5]	2.25	3.38	10.50	15.50	12.75
	3	2.000	[5]	[5]	2.00	3.13	10.25	15.25	12.50
5.00	1 (std.)	2.000	1 3/4-12	2.25	2.00	3.13	11.50	17.25	14.50
	2	3.500	[5]	[5]	2.25	3.38	11.75	17.50	14.75
	3	2.500	[5]	[5]	2.25	3.38	11.75	17.50	14.75
	4	3.000	[5]	[5]	2.25	3.38	11.75	17.50	14.75
6.00	1 (std.)	2.500	2 1/4-12	3.00	2.25	3.50	13.38	20.38	16.88
	2	4.000	[5]	[5]	2.25	3.50	13.38	20.38	16.88
	3	3.000	[5]	[5]	2.25	3.50	13.38	20.38	16.88
	4	3.500	[5]	[5]	2.25	3.50	13.38	20.38	16.88

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

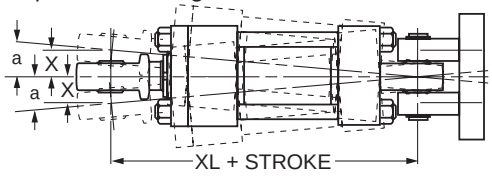
Bore Ø	Head End Mounted		Cap End Mounted	
	Angle a	Tan. of a	Angle a	Tan. of a
1.50	2.50°	0.044	3.00°	0.052
2.00	3.00°	0.052	3.00°	0.052
2.50	3.00°	0.052	3.00°	0.052
3.25	3.00°	0.052	2.75°	0.048
4.00	3.00°	0.052	3.00°	0.052
5.00	3.00°	0.052	3.00°	0.052
6.00	3.00°	0.052	3.00°	0.052

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

Mounting Information
Head End Mounting



Cap End Mounting

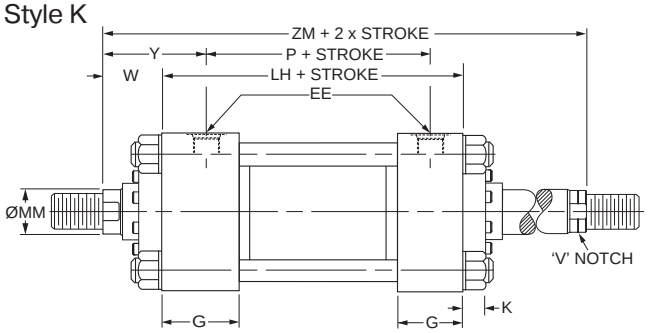


[5] To match pin diameter in rod eye and cap, when an oversize rod is required, specify rod end style '3', 'CC' thread and 'A' thread length for the standard rod diameter (Rod No. 1 for the bore), and 'WF' for the oversize rod. Order the rod eye and clevis bracket for the required bore size from the tables on the Style SE Spherical Bearing Accessories page.

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Double Rod Cylinder

Style K



Rod End #1 **Rod End #2**

Double Rod End Mounting Styles

Mounting Styles for Single Rod Models	Mounting Styles for Corresponding Double Rod Models[1]		Dimensions Shown on This Page Supplement Dimensions on 1.50"-6.00" Bore Pages Listed Below
	Load Connected To Rod On Cylinder Mounting End	Load Connected To Rod Opposite Cylinder Mounting End	
T	KT	KT	10
TB	KTB	KTC	10
TD	KTD	KTD	10
J	KJ	KH	11
JB	KJB	KHB	12
JJ	KJJ	KHH	13
C	KC	KC	17
F	KF	KF	18
D	KD	KDB	20
DD	KDD[2]	KDD[2]	22
DE	KDE[2]	KDE[2]	23

[1] Connect load to piston rod without 'V' notch. If only one end of the Double Rod Cylinder is to be cushioned, be sure to clearly specify which end this will be.

[2] Specify XI dimension for Styles DD & DE from #1 rod end (without 'V' notch).

How to Use Double Rod Cylinder Dimension Drawings

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 supplement the single rod dimensions with those shown on drawing at right and dimension table below. Note that double rod cylinders have a head (Dim. G) at both ends and that dimension LH replaces LG. The double rod dimensions differ from, or are in addition to those for single rod cylinders shown on preceding pages and provide the information needed to completely dimension a double rod cylinder.

On a double rod cylinder where the two rod ends are different, be sure to clearly state which rod end is to be assembled at which end. Port position 1 is standard. If other than standard, specify pos. 2, 3 or 4 when viewed from rod end #1 only.

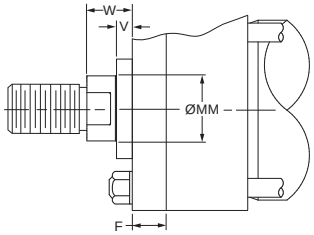
Bore Ø	Rod No.	MM Rod Ø	Add Stroke			Add 2X Stroke
			LH	SNK	SSK	ZM
1.50	1 (std.)	0.625	4.88	2.88	4.13	6.88
	2	1.000	4.88	2.88	4.13	7.63
2.00	1 (std.)	1.000	4.88	2.88	3.88	7.63
	2	1.375	4.88	2.88	3.88	8.13
2.50	1 (std.)	1.000	5.00	3.00	3.63	7.75
	2	1.750	5.00	3.00	3.63	8.75
	3	1.375	5.00	3.00	3.63	8.25
3.25	1 (std.)	1.375	5.75	3.50	4.38	9.00
	2	2.000	5.75	3.50	4.38	9.75
	3	1.750	5.75	3.50	4.38	9.50
4.00	1 (std.)	1.750	6.00	3.75	4.25	9.75
	2	2.500	6.00	3.75	4.25	10.50
	3	2.000	6.00	3.75	4.25	10.00
5.00	1 (std.)	2.000	6.50	4.25	4.75	10.50
	2	3.500	6.50	4.25	4.75	11.00
	3	2.500	6.50	4.25	4.75	11.00
	4	3.000	6.50	4.25	4.75	11.00
6.00	1 (std.)	2.500	7.38	4.88	5.13	11.88
	2	4.000	7.38	4.88	5.13	11.88
	3	3.000	7.38	4.88	5.13	11.88
	4	3.500	7.38	4.88	5.13	11.88
Replaces On single rod mounting styles:			**LG**	**SN**	**SS**	–
			All Mtg. Styles	**F**	**C**	**All Mtg. Styles**

Series H Bushing Retention[3]

B = Bolt -On Bushing with Circular Retainer
R = Tie Rod Retained Bushing

[3] Bushing retention style may vary when thrust key retainer or bushing drain option is included. Contact factory for details.

Tie Rod Retained Bushing

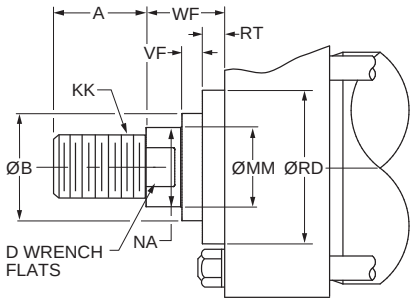


Bore Ø	Rod No.	MM Rod Ø	Mounting Style			
			TC, H, HB, HH, C, F, D, DB, DD, DE, BB, SB, SE	TB, TD	J, JB	JJ
1.50	1 (Std.)	0.625	B	R	R	B
	2	1.000	R	R	R	B
2.00	1 (Std.)	1.000	B	R	R	B
	2	1.375	R	R	R	B
2.50	1 (Std.)	1.000	B	B	B	B
	2	1.750	B	B	R	B
	3	1.375	B	B	B	B
3.25	All	All	B	B	B	B
4.00	All	All	B	B	B	B
5.00	1 (Std.)	2.000	B	B	B	B
	2	3.500	B	B	R	B
	3	2.500	B	B	B	B
	4	3.000	B	B	B	B
6.00	All	All	B	B	B	B

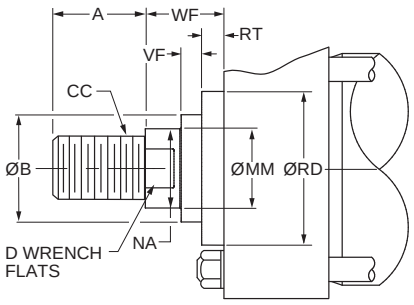
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Rod End Dimensions

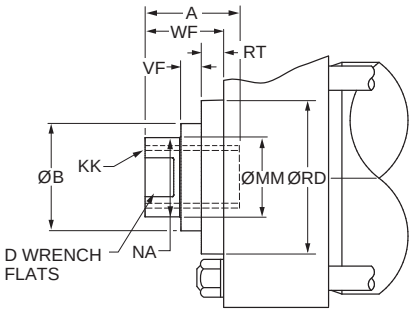
Thread Style 4 (NFPA Style SM)
Small Male



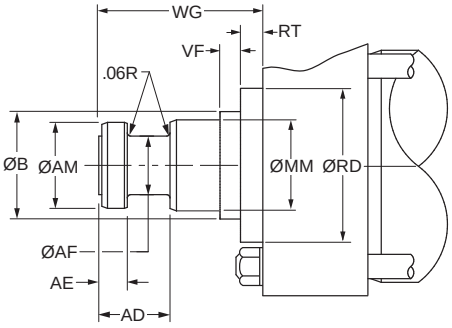
Thread Style 8 (NFPA Style IM)
Intermediate Male



Thread Style 9[2] (NFPA Style SF)
Small Female



Thread Style 55[1]



Rod End Dimensions

Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions							
			Style 8 CC	Style 4 & 9 KK	A	B Ø +.000 -.002	D	NA	VF	RD Ø	RT	WF
7.00	1 (std.)	3.000	2 3/4-12	2 1/4-12	3.50	3.749	2.63	2.88	0.40	5.26	0.85	2.25
	2	5.000	4 3/4-12	3 1/2-12	5.00	5.749	-[3]	4.88	0.34	7.25	0.91	2.25
	3	3.500	3 1/4-12	2 1/2-12	3.50	4.249	3.00	3.38	0.34	5.76	0.91	2.25
	4	4.000	3 3/4-12	3-12	4.00	4.749	3.38	3.88	0.34	6.31	0.91	2.25
	5	4.500	4 1/4-12	3 1/4-12	4.50	5.249	-[3]	4.38	0.34	6.94	0.91	2.25
8.00	1 (std.)	3.500	3 1/4-12	2 1/2-12	3.50	4.249	3.00	3.38	0.34	5.76	0.91	2.25
	2	5.500	5 1/4-12	4-12	5.50	6.249	-[3]	5.38	0.34	7.94	0.91	2.25
	3	4.000	3 3/4-12	3-12	4.00	4.749	3.38	3.88	0.34	6.31	0.91	2.25
	4	4.500	4 1/4-12	3 1/4-12	4.50	5.249	-[3]	4.38	0.34	6.94	0.91	2.25
	5	5.000	4 3/4-12	3 1/2-12	5.00	5.749	-[3]	4.88	0.34	7.25	0.91	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.

Style 55 Rod End

MM Rod Ø	AD	AE +.001 -.001	AF Ø	AM Ø	WG[1]
3.000	2.44	0.874	2.25	2.95	4.88
3.500	2.69	0.999	2.50	3.45	5.63
4.000	2.69	0.999	3.00	3.95	5.75
4.500	3.19	1.499	3.50	4.45	6.50
5.000	3.19	1.499	3.88	4.95	6.63
5.500	3.94	1.874	4.38	5.45	7.50

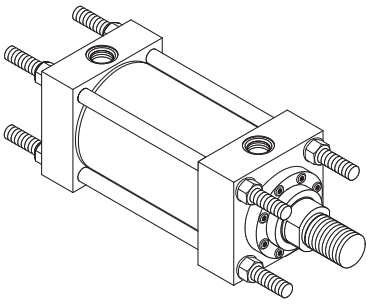
[1] For special WG dimension, specify "Style 3" and give desired dimension for WG. For other changes, place "S" in the model code, and describe rod end with dimensioned sketch.

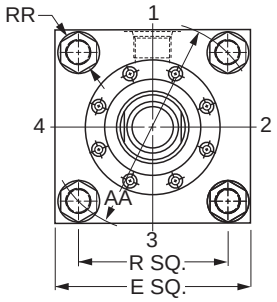
[2] Style 9 stroke restrictions may apply. See Style 9 Minimum Stroke Table on How to Order page for details.

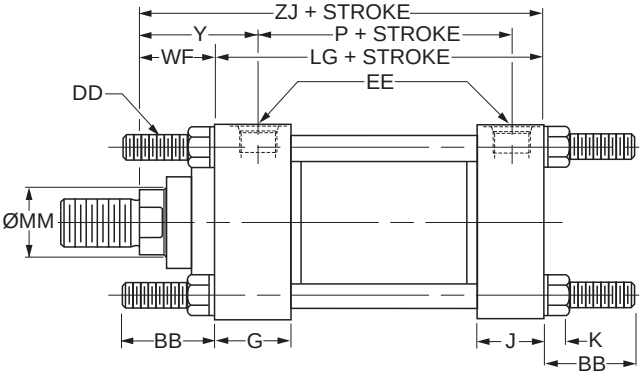
[3] These piston rod numbers will have 4 spanner wrench holes instead of wrench flats. See rod drawings on 3H Large Bore Piston Rod Ends page for dimensions.

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Tie Rods Extended Both Ends
Style TD
(NFPA Style MX1)







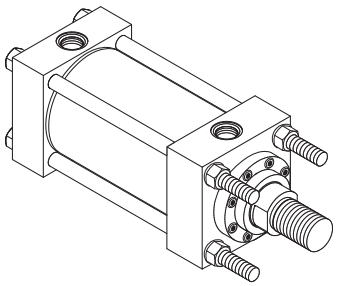
Basic Mounting (T) — NFPA MXO — Not shown is no tie rod extended and can be supplied upon request.

Style TD – Dimensional and Mounting Data

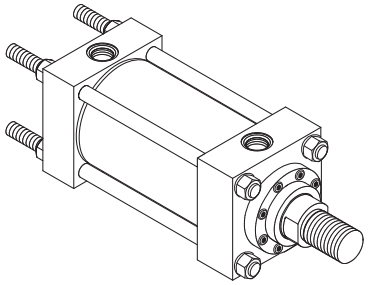
Bore Ø	Rod No.	MM Rod Ø	AA	BB	DD	E	EE		G	J	K Max.	R	RR	WF	Y	Add Stroke		
							NPTF[1]	SAE[2]								LG	P	ZJ
7.00	1 (std.)	3.000	9.31	4.13	1 1/8-12	8.50	1 1/4	20	2.75	2.75	1.16	6.58	2.00	2.25	3.69	8.50	5.63	10.75
	2	5.000	9.31	4.13	1 1/8-12	8.50	1 1/4	20	2.75	2.75	1.16	6.58	2.00	2.25	3.69	8.50	5.63	10.75
	3	3.500	9.31	4.13	1 1/8-12	8.50	1 1/4	20	2.75	2.75	1.16	6.58	2.00	2.25	3.69	8.50	5.63	10.75
	4	4.000	9.31	4.13	1 1/8-12	8.50	1 1/4	20	2.75	2.75	1.16	6.58	2.00	2.25	3.69	8.50	5.63	10.75
	5	4.500	9.31	4.13	1 1/8-12	8.50	1 1/4	20	2.75	2.75	1.16	6.58	2.00	2.25	3.69	8.50	5.63	10.75
8.00	1 (std.)	3.500	10.61	4.50	1 1/4-12	9.50	1 1/2	24	3.00	3.00	1.28	7.50	2.19	2.25	3.81	9.50	6.38	11.75
	2	5.500	10.61	4.50	1 1/4-12	9.50	1 1/2	24	3.00	3.00	1.28	7.50	2.19	2.25	3.81	9.50	6.38	11.75
	3	4.000	10.61	4.50	1 1/4-12	9.50	1 1/2	24	3.00	3.00	1.28	7.50	2.19	2.25	3.81	9.50	6.38	11.75
	4	4.500	10.61	4.50	1 1/4-12	9.50	1 1/2	24	3.00	3.00	1.28	7.50	2.19	2.25	3.81	9.50	6.38	11.75
	5	5.000	10.61	4.50	1 1/4-12	9.50	1 1/2	24	3.00	3.00	1.28	7.50	2.19	2.25	3.81	9.50	6.38	11.75

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

Style TB



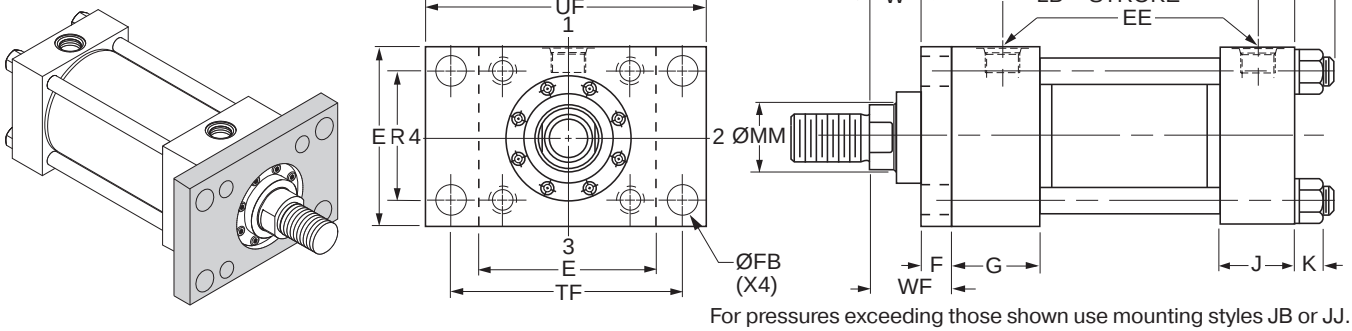
Style TC



Dimensions for Style TB & TC may be obtained from the above dimensional table.

⚠**PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Rectangular Flange Mounting
Style J
(NFPA Style MF1)



For pressures exceeding those shown use mounting styles JB or JJ.

Style J – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EE		F	FB Ø	G	J	K Max.	R	TF	UF	W	WF	Y	Add Stroke		
				NPTF[1]	SAE[2]												LB	P	ZB Max.
7.00	1 (std.)	3.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
	2	5.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
	3	3.500	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
	4	4.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
	5	4.500	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
8.00	1 (std.)	3.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28
	2	5.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28
	3	4.000	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28
	4	4.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28
	5	5.000	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

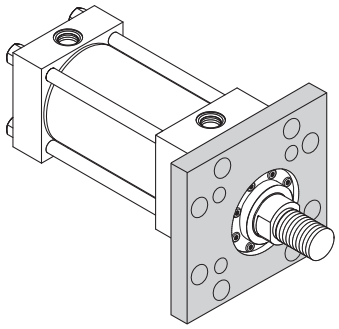
Style J –
Maximum Operating Pressure

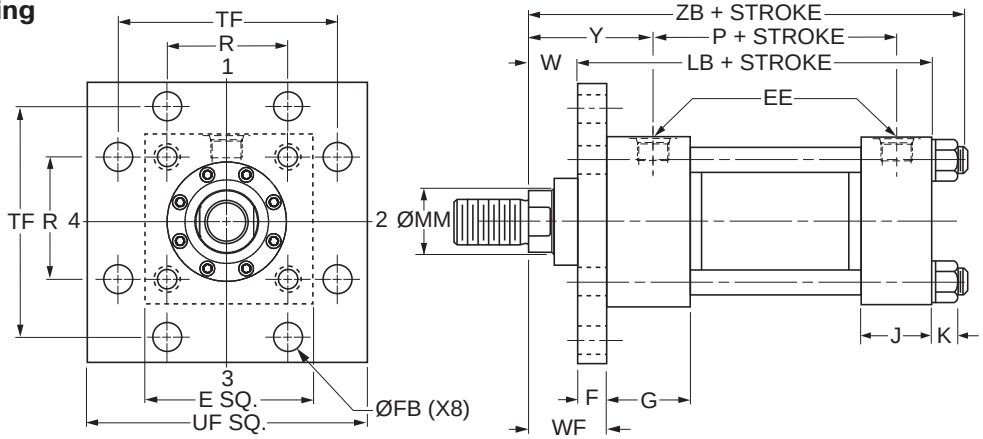
Bore Ø	Max. psi Push[3]				
	Rod Code				
	1	2	3	4	5
7.00	1000	400	800	400	400
8.00	800	400	700	400	400

[3]Maximum pressure rating – push application.

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Square Flange Mounting
Style JB
(NFPA Style MF5)





Style JB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EE		F	FB Ø	G	J	K Max.	R	TF	UF	W	WF	Y	Add Stroke		
				NPTF[1]	SAE[2]												LB	P	ZB Max.
7.00	1 (std.)	3.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
	2	5.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
	3	3.500	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
	4	4.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
	5	4.500	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	1.25	2.25	3.69	9.50	5.63	12.16
8.00	1 (std.)	3.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28
	2	5.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28
	3	4.000	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28
	4	4.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28
	5	5.000	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	1.25	2.25	3.81	10.50	6.38	13.28

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

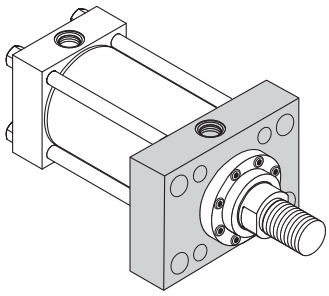
Style JB – Maximum Operating Pressure

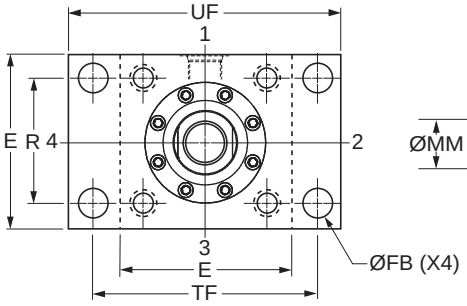
Bore Ø	Max. psi Push[3]				
	Rod Code				
	1	2	3	4	5
7.00	2500	1500	2200	1500	1500
8.00	2000	1400	2000	1400	1400

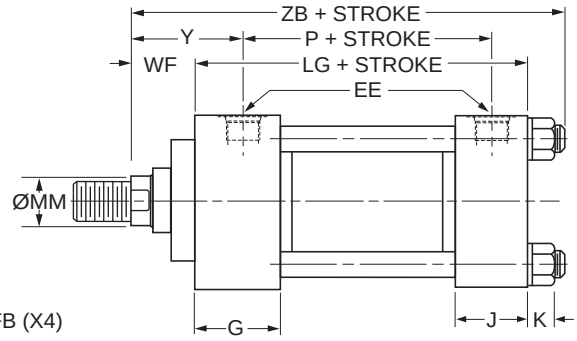
[3]Maximum pressure rating – push application.

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Head Rectangular Mounting
Style JJ
(NFPA Style ME5)







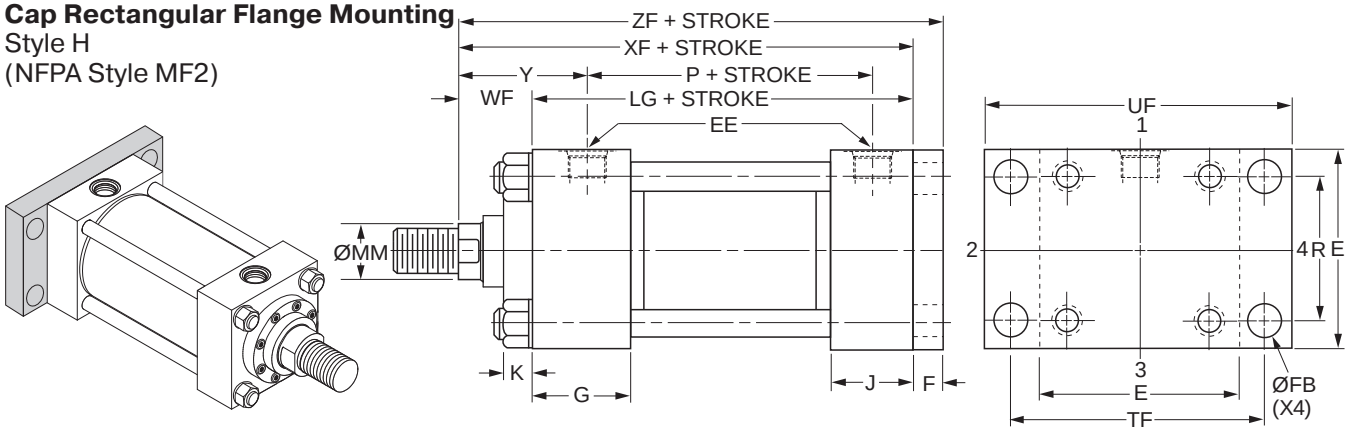
Style JJ – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EE		FB Ø	G	J	K Max.	R	TF	UF	WF	Y	Add Stroke		
				NPTF[1]	SAE[2]										LG	P	ZB Max.
7.00	1 (std.)	3.000	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	12.16
	2	5.000	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	12.16
	3	3.500	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	12.16
	4	4.000	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	12.16
	5	4.500	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	12.16
8.00	1 (std.)	3.500	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	13.28
	2	5.500	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	13.28
	3	4.000	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	13.28
	4	4.500	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	13.28
	5	5.000	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	13.28

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Rectangular Flange Mounting
Style H
(NFPA Style MF2)



Style H – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EE		F	FB Ø	G	J	K Max.	R	TF	UF	WF	Y	Add Stroke			
				NPTF[1]	SAE[2]											LG	P	XF	ZF
7.00	1 (std.)	3.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
	2	5.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
	3	3.500	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
	4	4.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
	5	4.500	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
8.00	1 (std.)	3.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75
	2	5.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75
	3	4.000	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75
	4	4.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75
	5	5.000	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

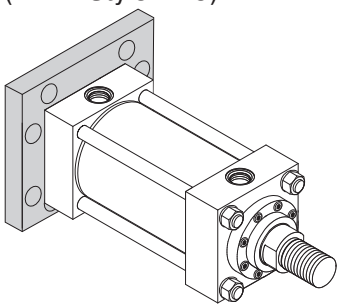
Style H – Maximum Operating Pressure

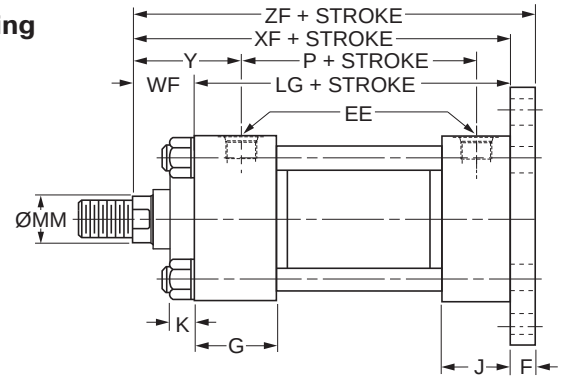
Bore Ø	Max. psi Pull[3]				
	Rod Code				
	1	2	3	4	5
7.00	2000	3000	2000	2500	2800
8.00	1700	2500	1700	1800	2200

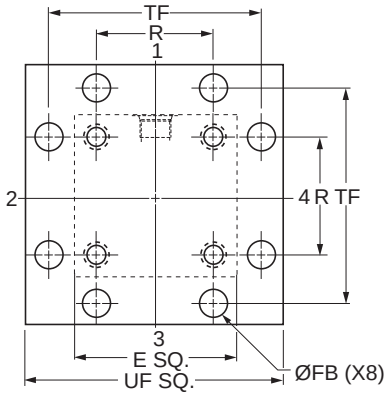
[3]Maximum pressure rating – pull application.

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Square Flange Mounting
Style HB
(NFPA Style MF6)





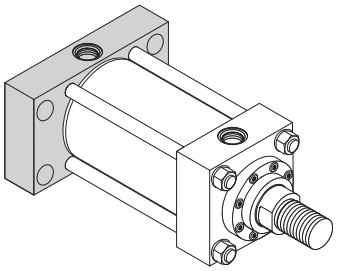


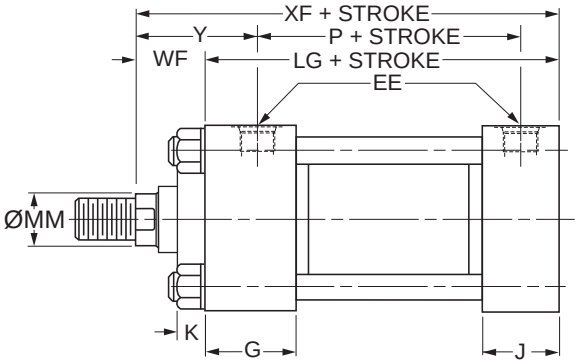
Style HB (Model 66) – Dimensional and Mounting Data

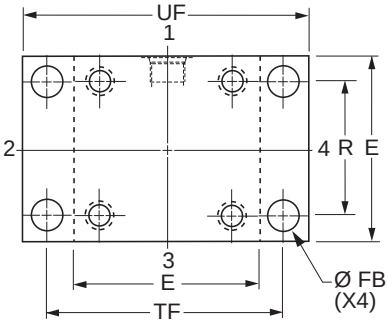
Bore Ø	Rod No.	MM Rod Ø	E	EE		F	FB Ø	G	J	K Max.	R	TF	UF	WF	Y	Add Stroke			
				NPTF[1]	SAE[2]											LG	P	XF	ZF
7.00	1 (std.)	3.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
	2	5.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
	3	3.500	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
	4	4.000	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
	5	4.500	8.50	1 1/4	20	1.00	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75	11.75
8.00	1 (std.)	3.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75
	2	5.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75
	3	4.000	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75
	4	4.500	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75
	5	5.000	9.50	1 1/2	24	1.00	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75	12.75

[1]NPTF ports are available at no extra charge. [2]SAE straight thread ports are standard and are indicated by port number.

Cap Rectangular Mounting
Style HH
(NFPA Style ME6)







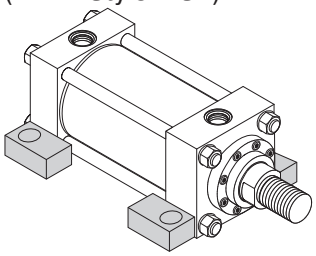
Style HH – Dimensional and Mounting Data

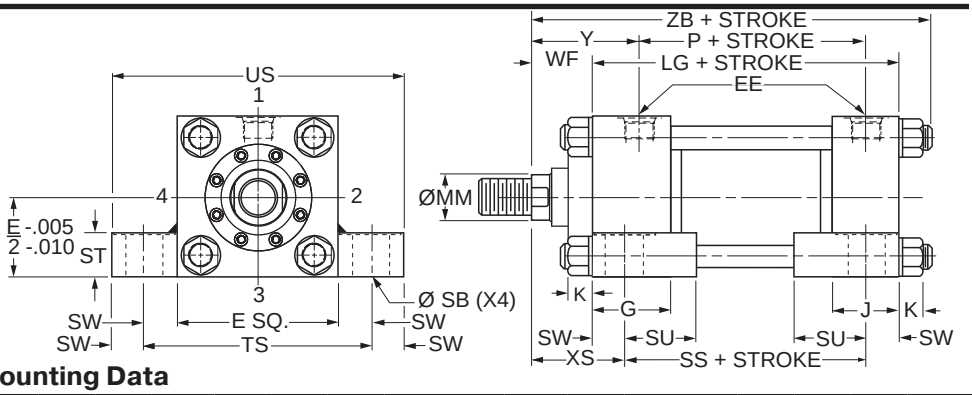
Bore Ø	Rod No	MM Rod Ø	E	EE		FB Ø	G	J	K Max.	R	TF	UF	WF	Y	Add Stroke		
				NPTF[1]	SAE[2]										LG	P	XF
7.00	1 (std.)	3.000	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75
	2	5.000	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75
	3	3.500	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75
	4	4.000	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75
	5	4.500	8.50	1 1/4	20	1.19	2.75	2.75	1.16	6.58	10.63	12.63	2.25	3.69	8.50	5.63	10.75
8.00	1 (std.)	3.500	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75
	2	5.500	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75
	3	4.000	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75
	4	4.500	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75
	5	5.000	9.50	1 1/2	24	1.31	3.00	3.00	1.28	7.50	11.81	14.00	2.25	3.81	9.50	6.38	11.75

[1]NPTF ports are available at no extra charge. [2]SAE straight thread ports are standard and are indicated by port number.

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Side Lug Mounting
Style C
(NFPA Style MS2)



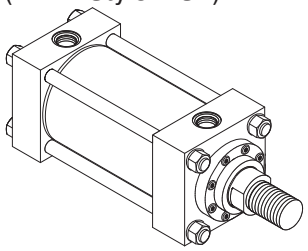


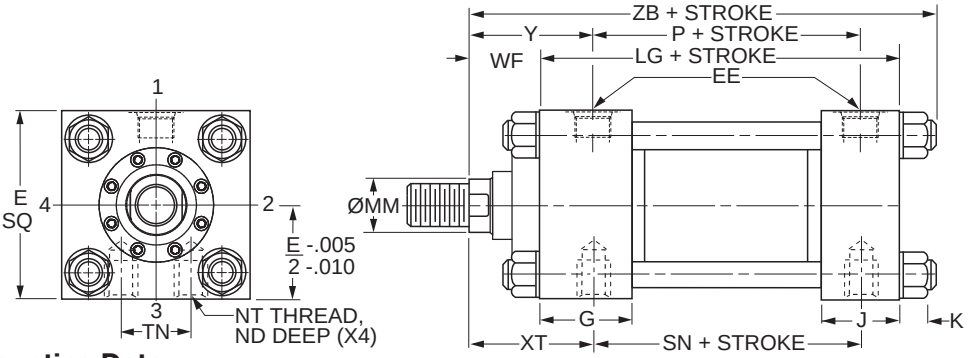
Style C – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EE		G	J	K Max.	SB Ø	ST	SU	SW	TS	US	WF	XS	Y	Add Stroke			
				NPTF[1]	SAE[2]													LG	P	SS	ZB Max.
7.00	1 (std.)	3.000	8.50	1 1/4	20	2.75	2.75	1.16	1.56	1.75	2.88	1.38	11.25	14.00	2.25	3.63	3.69	8.50	5.63	5.75	12.16
	2	5.000	8.50	1 1/4	20	2.75	2.75	1.16	1.56	1.75	2.88	1.38	11.25	14.00	2.25	3.63	3.69	8.50	5.63	5.75	12.16
	3	3.500	8.50	1 1/4	20	2.75	2.75	1.16	1.56	1.75	2.88	1.38	11.25	14.00	2.25	3.63	3.69	8.50	5.63	5.75	12.16
	4	4.000	8.50	1 1/4	20	2.75	2.75	1.16	1.56	1.75	2.88	1.38	11.25	14.00	2.25	3.63	3.69	8.50	5.63	5.75	12.16
	5	4.500	8.50	1 1/4	20	2.75	2.75	1.16	1.56	1.75	2.88	1.38	11.25	14.00	2.25	3.63	3.69	8.50	5.63	5.75	12.16
8.00	1 (std.)	3.500	9.50	1 1/2	24	3.00	3.00	1.28	1.56	1.75	2.88	1.38	12.25	15.00	2.25	3.63	3.81	9.50	6.38	6.75	13.28
	2	5.500	9.50	1 1/2	24	3.00	3.00	1.28	1.56	1.75	2.88	1.38	12.25	15.00	2.25	3.63	3.81	9.50	6.38	6.75	13.28
	3	4.000	9.50	1 1/2	24	3.00	3.00	1.28	1.56	1.75	2.88	1.38	12.25	15.00	2.25	3.63	3.81	9.50	6.38	6.75	13.28
	4	4.500	9.50	1 1/2	24	3.00	3.00	1.28	1.56	1.75	2.88	1.38	12.25	15.00	2.25	3.63	3.81	9.50	6.38	6.75	13.28
	5	5.000	9.50	1 1/2	24	3.00	3.00	1.28	1.56	1.75	2.88	1.38	12.25	15.00	2.25	3.63	3.81	9.50	6.38	6.75	13.28

[1]NPTF ports are available at no extra charge. [2]SAE straight thread ports are standard and are indicated by port number.

Side Tapped Mounting
Style F
(NFPA Style MS4)



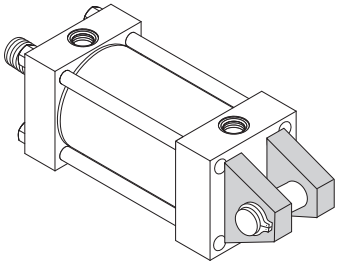


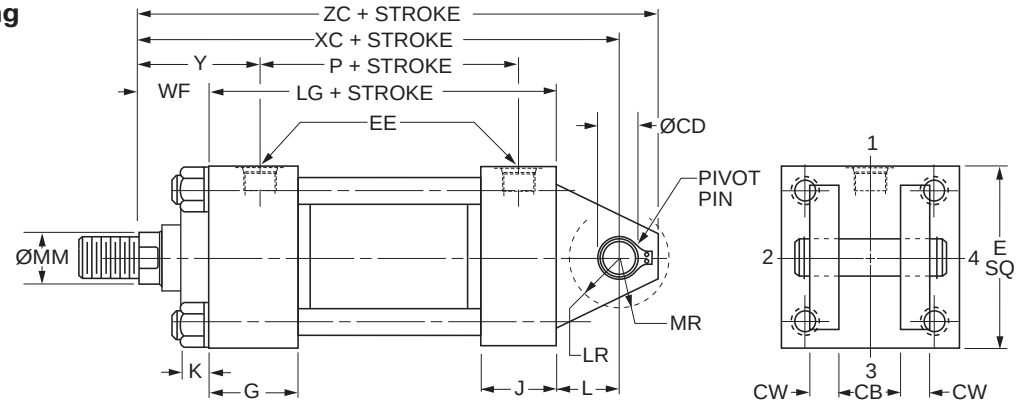
Style F – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EE		G	J	K Max.	ND	NT	TN	WF	XT	Y	Add Stroke			
				NPTF[1]	SAE[2]										LG	P	SN	ZB Max.
7.00	1 (std.)	3.000	8.50	1 1/4	20	2.75	2.75	1.16	1.13	1 1/2-6	3.75	2.25	3.81	3.69	8.50	5.63	5.88	12.16
	2	5.000	8.50	1 1/4	20	2.75	2.75	1.16	1.13	1 1/2-6	3.75	2.25	3.81	3.69	8.50	5.63	5.88	12.16
	3	3.500	8.50	1 1/4	20	2.75	2.75	1.16	1.13	1 1/2-6	3.75	2.25	3.81	3.69	8.50	5.63	5.88	12.16
	4	4.000	8.50	1 1/4	20	2.75	2.75	1.16	1.13	1 1/2-6	3.75	2.25	3.81	3.69	8.50	5.63	5.88	12.16
	5	4.500	8.50	1 1/4	20	2.75	2.75	1.16	1.13	1 1/2-6	3.75	2.25	3.81	3.69	8.50	5.63	5.88	12.16
8.00	1 (std.)	3.500	9.50	1 1/2	24	3.00	3.00	1.28	1.50	1 1/2-6	4.25	2.25	3.94	3.81	9.50	6.38	6.63	13.28
	2	5.500	9.50	1 1/2	24	3.00	3.00	1.28	1.50	1 1/2-6	4.25	2.25	3.94	3.81	9.50	6.38	6.63	13.28
	3	4.000	9.50	1 1/2	24	3.00	3.00	1.28	1.50	1 1/2-6	4.25	2.25	3.94	3.81	9.50	6.38	6.63	13.28
	4	4.500	9.50	1 1/2	24	3.00	3.00	1.28	1.50	1 1/2-6	4.25	2.25	3.94	3.81	9.50	6.38	6.63	13.28
	5	5.000	9.50	1 1/2	24	3.00	3.00	1.28	1.50	1 1/2-6	4.25	2.25	3.94	3.81	9.50	6.38	6.63	13.28

[1]NPTF ports are available at no extra charge. [2]SAE straight thread ports are standard and are indicated by port number.

Cap Fixed Clevis Mounting
Style BB
(NFPA Style MP1)





Style BB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	CB	CD[3] Ø +.000 -.002	CW	E	EE		G	J	K Max.	L	LR	MR
							NPTF[1]	SAE[2]						
7.00	1 (std.)	3.000	3.00	2.501	1.50	8.50	1 1/4	20	2.75	2.75	1.16	3.00	2.75	2.88
	2	5.000	3.00	2.501	1.50	8.50	1 1/4	20	2.75	2.75	1.16	3.00	2.75	2.88
	3	3.500	3.00	2.501	1.50	8.50	1 1/4	20	2.75	2.75	1.16	3.00	2.75	2.88
	4	4.000	3.00	2.501	1.50	8.50	1 1/4	20	2.75	2.75	1.16	3.00	2.75	2.88
	5	4.500	3.00	2.501	1.50	8.50	1 1/4	20	2.75	2.75	1.16	3.00	2.75	2.88
8.00	1 (std.)	3.500	3.00	3.001	1.50	9.50	1 1/2	24	3.00	3.00	1.28	3.25	3.25	3.13
	2	5.500	3.00	3.001	1.50	9.50	1 1/2	24	3.00	3.00	1.28	3.25	3.25	3.13
	3	4.000	3.00	3.001	1.50	9.50	1 1/2	24	3.00	3.00	1.28	3.25	3.25	3.13
	4	4.500	3.00	3.001	1.50	9.50	1 1/2	24	3.00	3.00	1.28	3.25	3.25	3.13
	5	5.000	3.00	3.001	1.50	9.50	1 1/2	24	3.00	3.00	1.28	3.25	3.25	3.13

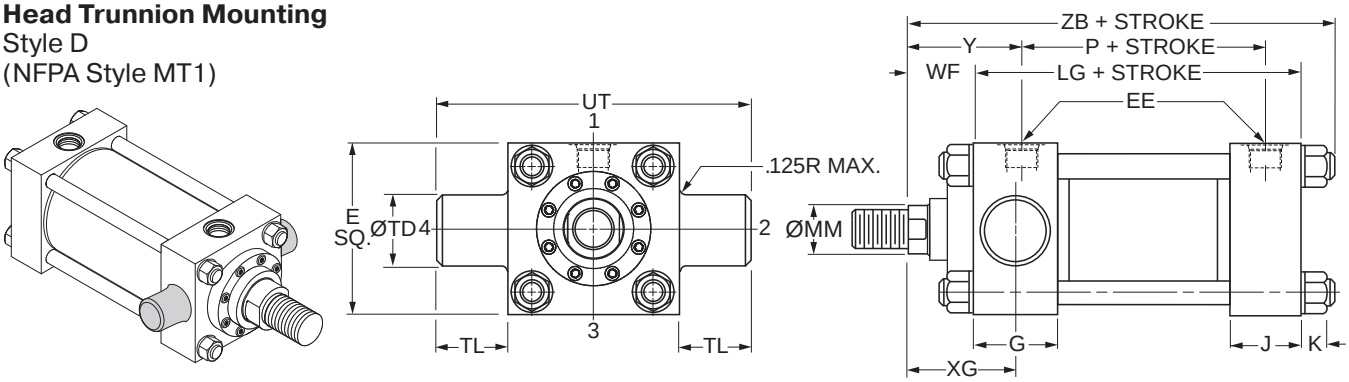
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
[3]Diameter CD is pin diameter.

Style BB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	WF	Y	Add Stroke			
					LG	P	XC	ZC
7.00	1 (std.)	3.000	2.25	3.69	8.50	5.63	13.75	16.25
	2	5.000	2.25	3.69	8.50	5.63	13.75	16.25
	3	3.500	2.25	3.69	8.50	5.63	13.75	16.25
	4	4.000	2.25	3.69	8.50	5.63	13.75	16.25
	5	4.500	2.25	3.69	8.50	5.63	13.75	16.25
8.00	1 (std.)	3.500	2.25	3.81	9.50	6.38	15.00	17.75
	2	5.500	2.25	3.81	9.50	6.38	15.00	17.75
	3	4.000	2.25	3.81	9.50	6.38	15.00	17.75
	4	4.500	2.25	3.81	9.50	6.38	15.00	17.75
	5	5.000	2.25	3.81	9.50	6.38	15.00	17.75

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Trunnion Mounting
Style D
(NFPA Style MT1)



Style D – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EE		G	J	K Max.	TD Ø +.000 -.002	TL	UT	WF	Y	XG
				NPTF[1]	SAE[2]									
7.00	1 (std.)	3.000	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69	3.63
	2	5.000	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69	3.63
	3	3.500	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69	3.63
	4	4.000	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69	3.63
	5	4.500	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69	3.63
8.00	1 (std.)	3.500	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81	3.75
	2	5.500	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81	3.75
	3	4.000	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81	3.75
	4	4.500	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81	3.75
	5	5.000	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81	3.75

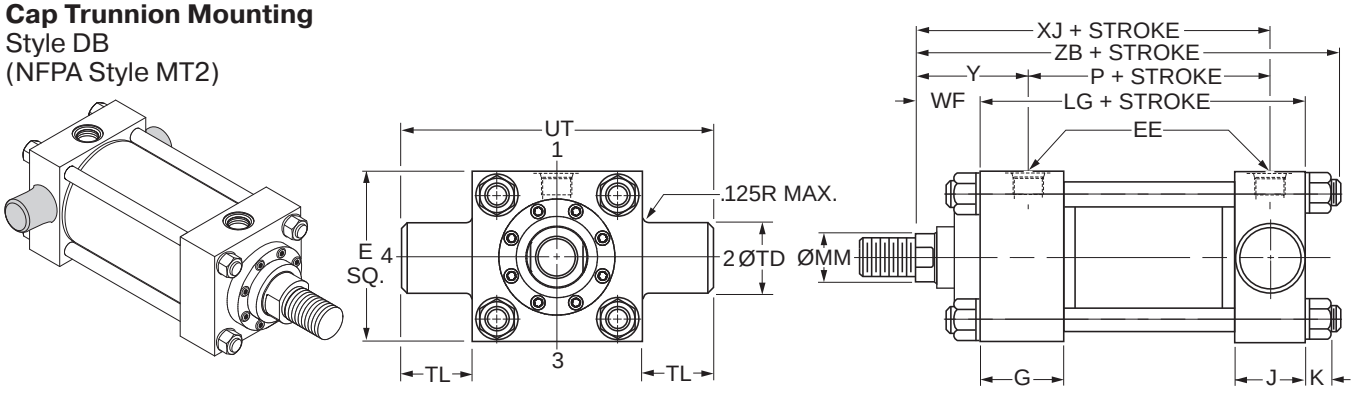
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

Style D – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	Add Stroke		
			LG	P	ZB Max.
7.00	1 (std.)	3.000	8.50	5.63	12.16
	2	5.000	8.50	5.63	12.16
	3	3.500	8.50	5.63	12.16
	4	4.000	8.50	5.63	12.16
	5	4.500	8.50	5.63	12.16
8.00	1 (std.)	3.500	9.50	6.38	13.28
	2	5.500	9.50	6.38	13.28
	3	4.000	9.50	6.38	13.28
	4	4.500	9.50	6.38	13.28
	5	5.000	9.50	6.38	13.28

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Trunnion Mounting
Style DB
(NFPA Style MT2)



Style DB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EE		G	J	K Max.	TD Ø +.000 -.002	TL	UT	WF	Y
				NPTF[1]	SAE[2]								
7.00	1 (std.)	3.000	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69
	2	5.000	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69
	3	3.500	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69
	4	4.000	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69
	5	4.500	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	13.50	2.25	3.69
8.00	1 (std.)	3.500	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81
	2	5.500	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81
	3	4.000	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81
	4	4.500	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81
	5	5.000	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	15.50	2.25	3.81

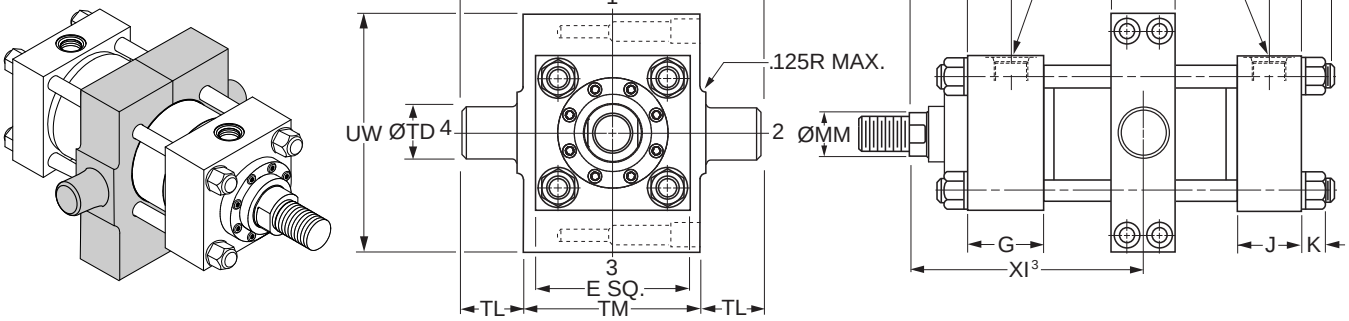
[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

Style DB – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	Add Stroke			
			LG	P	XJ	ZB Max
7.00	1 (std.)	3.000	8.50	5.63	9.38	12.16
	2	5.000	8.50	5.63	9.38	12.16
	3	3.500	8.50	5.63	9.38	12.16
	4	4.000	8.50	5.63	9.38	12.16
	5	4.500	8.50	5.63	9.38	12.16
8.00	1 (std.)	3.500	9.50	6.38	10.25	13.28
	2	5.500	9.50	6.38	10.25	13.28
	3	4.000	9.50	6.38	10.25	13.28
	4	4.500	9.50	6.38	10.25	13.28
	5	5.000	9.50	6.38	10.25	13.28

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Intermediate Fixed Trunnion Mounting
Style DD
(NFPA Former Standard Style MT4)



Style DD – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	BD	E	EE		G	J	K Max.	TD Ø +.000 -.002	TL	TM	UM	UW	WF	Y
					NPTF[1]	SAE[2]										
7.00	1 (std.)	3.000	3.00	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	9.75	14.75	11.50	2.25	3.69
	2	5.000	3.00	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	9.75	14.75	11.50	2.25	3.69
	3	3.500	3.00	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	9.75	14.75	11.50	2.25	3.69
	4	4.000	3.00	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	9.75	14.75	11.50	2.25	3.69
	5	4.500	3.00	8.50	1 1/4	20	2.75	2.75	1.16	2.500	2.50	9.75	14.75	11.50	2.25	3.69
8.00	1 (std.)	3.500	3.50	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	11.00	17.00	13.38	2.25	3.81
	2	5.500	3.50	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	11.00	17.00	13.38	2.25	3.81
	3	4.000	3.50	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	11.00	17.00	13.38	2.25	3.81
	4	4.500	3.50	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	11.00	17.00	13.38	2.25	3.81
	5	5.000	3.50	9.50	1 1/2	24	3.00	3.00	1.28	3.000	3.00	11.00	17.00	13.38	2.25	3.81

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

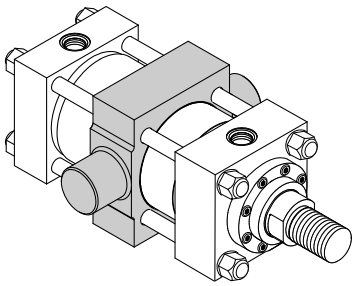
Style DD – Dimensional and Mounting Data

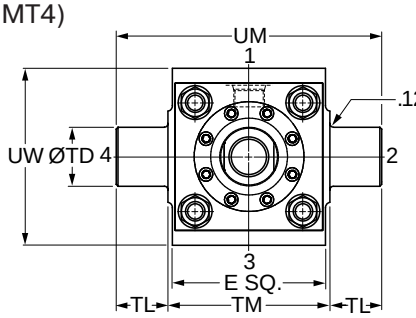
Bore Ø	Rod No.	MM Rod Ø	Minimum XI[3]		Style DD Minimum Stroke	Add Stroke				ZB Max.
			Styles 4, 8 & 9	Style 55		LG	P	Maximum XI[4]		
								Styles 4, 8 & 9	Style 55	
7.00	1 (std.)	3.000	6.56	9.19	0.13	8.50	5.63	6.44	9.06	12.16
	2	5.000	6.56	10.94	0.13	8.50	5.63	6.44	10.81	12.16
	3	3.500	6.56	9.94	0.13	8.50	5.63	6.44	9.81	12.16
	4	4.000	6.56	10.06	0.13	8.50	5.63	6.44	9.94	12.16
	5	4.500	6.56	10.81	0.13	8.50	5.63	6.44	10.69	12.16
8.00	1 (std.)	3.500	7.06	10.44	0.13	9.50	6.38	6.94	10.31	13.28
	2	5.500	7.06	12.31	0.13	9.50	6.38	6.94	12.19	13.28
	3	4.000	7.06	10.56	0.13	9.50	6.38	6.94	10.44	13.28
	4	4.500	7.06	11.31	0.13	9.50	6.38	6.94	11.19	13.28
	5	5.000	7.06	11.44	0.13	9.50	6.38	6.94	11.31	13.28

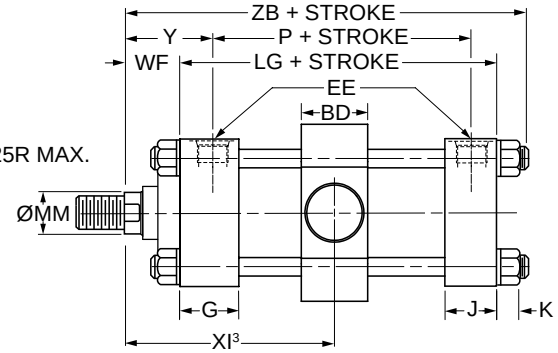
[3]Dimension XI to be specified by customer. Reference point for rod end Style 55 is end of piston rod.
[4]Dimensions shown are valid for standard WF and WG dimension.

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Heavy Duty Intermediate Fixed Trunnion Mounting
Style DE
(NFPA Current Standard Style MT4)







Style DE – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	BD	E	EE		G	J	K Max.	TD Ø +.000 -.002	TL	TM	UM	UW	WF	Y
					NPTF[1]	SAE[2]										
7.00	1 (std.)	3.000	4.000	8.50	1 1/4	20	2.75	2.75	1.16	3.500	2.50	9.75	14.75	11.38	2.25	3.69
	2	5.000	4.000	8.50	1 1/4	20	2.75	2.75	1.16	3.500	2.50	9.75	14.75	11.38	2.25	3.69
	3	3.500	4.000	8.50	1 1/4	20	2.75	2.75	1.16	3.500	2.50	9.75	14.75	11.38	2.25	3.69
	4	4.000	4.000	8.50	1 1/4	20	2.75	2.75	1.16	3.500	2.50	9.75	14.75	11.38	2.25	3.69
	5	4.500	4.000	8.50	1 1/4	20	2.75	2.75	1.16	3.500	2.50	9.75	14.75	11.38	2.25	3.69
8.00	1 (std.)	3.500	4.500	9.50	1 1/2	24	3.00	3.00	1.28	4.000	3.00	11.00	17.00	12.00	2.25	3.81
	2	5.500	4.500	9.50	1 1/2	24	3.00	3.00	1.28	4.000	3.00	11.00	17.00	12.00	2.25	3.81
	3	4.000	4.500	9.50	1 1/2	24	3.00	3.00	1.28	4.000	3.00	11.00	17.00	12.00	2.25	3.81
	4	4.500	4.500	9.50	1 1/2	24	3.00	3.00	1.28	4.000	3.00	11.00	17.00	12.00	2.25	3.81
	5	5.000	4.500	9.50	1 1/2	24	3.00	3.00	1.28	4.000	3.00	11.00	17.00	12.00	2.25	3.81

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.

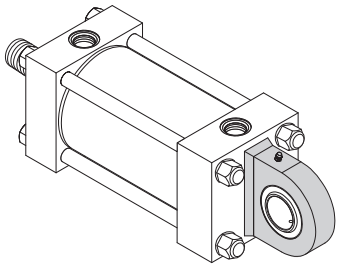
Style DE – Dimensional and Mounting Data

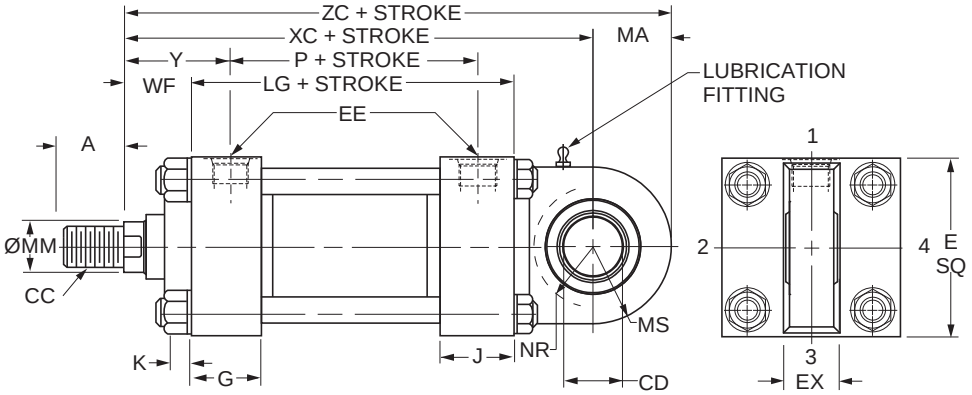
Bore Ø	Rod No.	MM Rod Ø	Minimum XI[3]		Style DE Minimum Stroke	Add Stroke				
			Styles 4, 8 & 9	Style 55		LG	P	Maximum XI[4]		ZB Max.
								Styles 4, 8 & 9	Style 55	
7.00	1 (std.)	3.000	7.06	9.69	1.13	8.50	5.63	5.94	8.56	12.16
	2	5.000	7.06	11.44	1.13	8.50	5.63	5.94	10.31	12.16
	3	3.500	7.06	10.44	1.13	8.50	5.63	5.94	9.31	12.16
	4	4.000	7.06	10.56	1.13	8.50	5.63	5.94	9.44	12.16
	5	4.500	7.06	11.31	1.13	8.50	5.63	5.94	10.19	12.16
8.00	1 (std.)	3.500	7.56	10.94	1.13	9.50	6.38	6.44	9.81	13.28
	2	5.500	7.56	12.81	1.13	9.50	6.38	6.44	11.69	13.28
	3	4.000	7.56	11.06	1.13	9.50	6.38	6.44	9.94	13.28
	4	4.500	7.56	11.81	1.13	9.50	6.38	6.44	10.69	13.28
	5	5.000	7.56	11.94	1.13	9.50	6.38	6.44	10.81	13.28

[3]Dimension XI to be specified by customer. Reference point for rod end Style 55 is end of piston rod.
[4]Dimensions shown are valid for standard WF and WG dimension.

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Spherical Bearing Mounting
Style SE)





Style SE — Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	A	CD[3] Ø +0.0000 -0.0005	E	EE		EX	G	J	K Max.	MS	MA	NR	WF	Y
						NPTF[1]	SAE[2]									
7.00	1 (std.)	3.000	3.50	3.5000	8.50	1 1/4	20	3.06	2.75	2.75	1.16	4.00	4.00	3.68	2.25	3.69
	2	5.000	3.50	3.5000	8.50	1 1/4	20	3.06	2.75	2.75	1.16	4.00	4.00	3.68	2.25	3.69
	3	3.500	3.50	3.5000	8.50	1 1/4	20	3.06	2.75	2.75	1.16	4.00	4.00	3.68	2.25	3.69
	4	4.000	3.50	3.5000	8.50	1 1/4	20	3.06	2.75	2.75	1.16	4.00	4.00	3.68	2.25	3.69
	5	4.500	3.50	3.5000	8.50	1 1/4	20	3.06	2.75	2.75	1.16	4.00	4.00	3.68	2.25	3.69
8.00	1 (std.)	3.500	3.50	4.0000	9.50	1 1/2	24	3.50	3.00	3.00	1.28	4.50	4.50	4.13	2.25	3.81
	2	5.500	3.50	4.0000	9.50	1 1/2	24	3.50	3.00	3.00	1.28	4.50	4.50	4.13	2.25	3.81
	3	4.000	3.50	4.0000	9.50	1 1/2	24	3.50	3.00	3.00	1.28	4.50	4.50	4.13	2.25	3.81
	4	4.500	3.50	4.0000	9.50	1 1/2	24	3.50	3.00	3.00	1.28	4.50	4.50	4.13	2.25	3.81
	5	5.000	3.50	4.0000	9.50	1 1/2	24	3.50	3.00	3.00	1.28	4.50	4.50	4.13	2.25	3.81

[1]NPTF ports are available at no extra charge.
[2]SAE straight thread ports are standard and are indicated by port number.
[3]Dimension CD is pin diameter.

Style SE – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	Thread Style 8 CC[4]	A	Add Stroke				
					LG	P	XC	XL	ZC
7.00	1 (std.)	3.000	2 3/4-12	3.50	8.50	5.63	15.25	23.25	19.25
	2	5.000	[4]	[4]	8.50	5.63	15.25	23.25	19.25
	3	3.500	[4]	[4]	8.50	5.63	15.25	23.25	19.25
	4	4.000	[4]	[4]	8.50	5.63	15.25	23.25	19.25
	5	4.500	[4]	[4]	8.50	5.63	15.25	23.25	19.25
8.00	1 (std.)	3.500	3 1/4-12	3.50	9.50	6.38	16.75	25.25	21.25
	2	5.500	[4]	[4]	9.50	6.38	16.75	25.25	21.25
	3	4.000	[4]	[4]	9.50	6.38	16.75	25.25	21.25
	4	4.500	[4]	[4]	9.50	6.38	16.75	25.25	21.25
	5	5.000	[4]	[4]	9.50	6.38	16.75	25.25	21.25

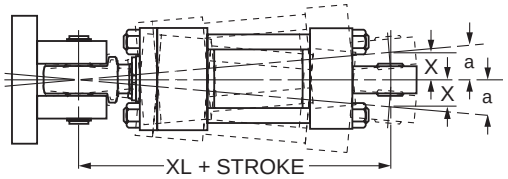
[4] To match pin diameter in rod eye and cap, when an oversize rod is required, specify rod end style '3', 'CC' thread and 'A' thread length for the standard rod diameter (Rod No. 1 for the bore), and 'WF' for the oversize rod.

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

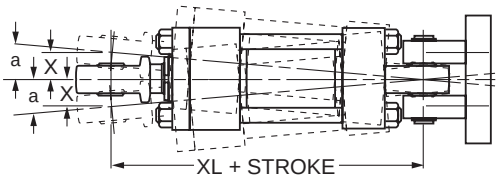
Bore Ø	Head End Mounted		Cap End Mounted	
	Angle a	Tan. of a	Angle a	Tan. of a
7.00	3.00°	0.052	3.00°	0.052
8.00	3.00°	0.052	3.00°	0.052

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

Mounting Information
Head End Mounting

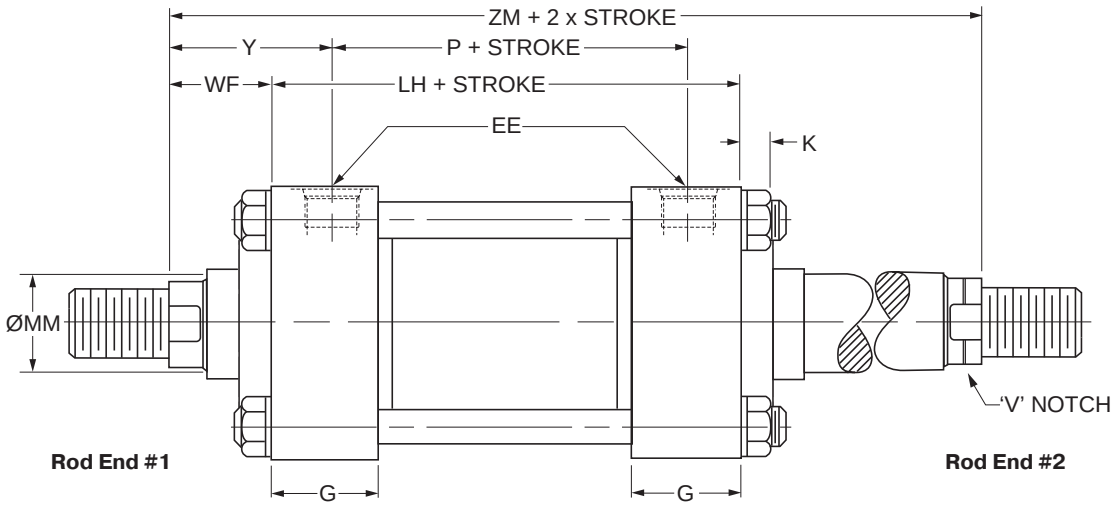


Cap End Mounting



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Double Rod Cylinder



Double Rod End Mounting Styles

Mounting Styles for Single Rod Models	Mounting Styles for Corresponding Double Rod Models[1]		Dimensions Shown on This Page Supplement Dimensions on 7.00" - 8.00" Bore Pages Listed Below
	Load Connected To Rod On Cylinder Mounting End	Load Connected To Rod Opposite Cylinder Mounting End	
TB	KTB	KTC	28
TD	KTD	KTD	28
J	KJ	KH	29
JB	KJB	KHB	30
JJ	KJJ	KHH	31
C	KC	KC	34
F	KF	KF	34
D	KD	KDB	36
DD	KDD[2]	KDD[2]	38
DE	KDE[2]	KDE[2]	39

[1] Connect load to piston rod without 'V' notch. If only one end of the Double Rod Cylinder is to be cushioned, be sure to clearly specify which end this will be.

[2] Specify XI dimension for Styles DD & DE from #1 rod end (without 'V' notch).

Bore Ø	Rod No.	MM Rod Ø	WF	Add Stroke			Add 2X Stroke
				LH	SNK	SSK	ZM
7.00	1 (std.)	3.00	2.25	8.50	5.38	5.75	13.00
	2	5.00	2.25	8.50	5.38	5.75	13.00
	3	3.50	2.25	8.50	5.38	5.75	13.00
	4	4.00	2.25	8.50	5.38	5.75	13.00
	5	4.50	2.25	8.50	5.38	5.75	13.00
8.00	1 (std.)	3.50	2.25	9.50	6.13	6.75	14.00
	2	5.50	2.25	9.50	6.13	6.75	14.00
	3	4.00	2.25	9.50	6.13	6.75	14.00
	4	4.50	2.25	9.50	6.13	6.75	14.00
	5	5.00	2.25	9.50	6.13	6.75	14.00
Replaces On single rod mounting styles:				**LG**	**SN**	**SS**	–
				All Mtg. Styles	**F**	**C**	**All Mtg. Styles**

How to Use Double Rod Cylinder Dimension Drawings

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 supplement the single rod dimensions with those shown on drawing at right and dimension table below. Note that double rod cylinders have a head (Dim. G) at both ends and that dimension LH replaces LG. The double rod dimensions differ from, or are in addition to those for single rod cylinders shown on preceding pages and provide the information needed to completely dimension a double rod cylinder.

On a double rod cylinder where the two rod ends are different, be sure to clearly state which rod end is to be assembled at which end. Port position 1 is standard. If other than standard, specify pos. 2, 3 or 4 when viewed from rod end #1 only.

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Notes

⚠**PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Section C

Series HV 10.00" - 20.00" Bore
Heavy Duty Hydraulic Cylinders

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⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

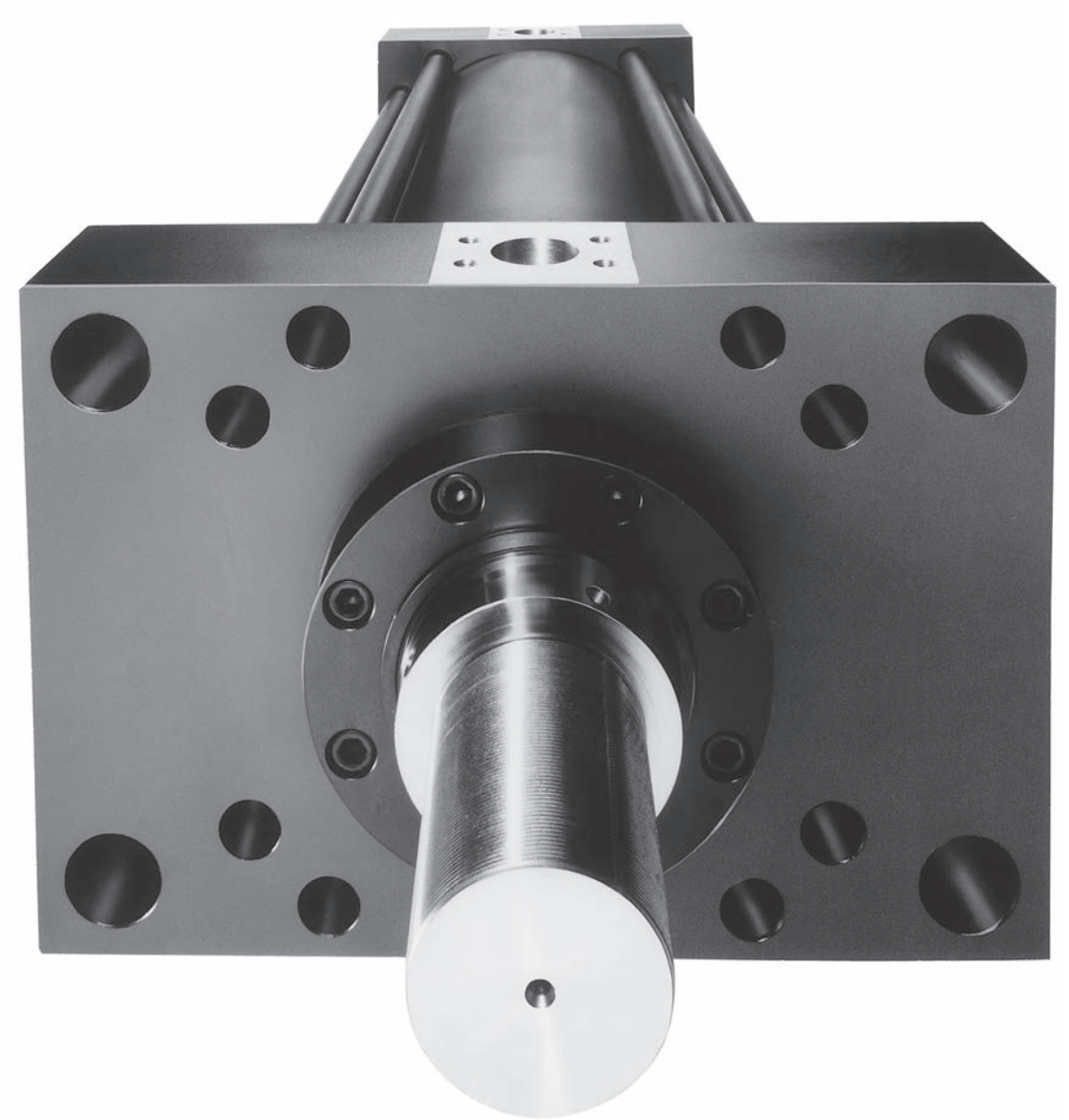
The large bore, high pressure hydraulic cylinder Atlas designed to meet your needs

Atlas H Series large bore cylinders provide unmatched reliability, performance, and innovative design features that aid in increasing productivity while reducing operating costs.

Atlas's externally removable bolted bushing assembly makes preventive and routine maintenance quick and easy! In many cases, the cylinder does not have to be removed or disassembled to facilitate service. Our innovative design provides for fast turn around, reduced downtime, and increased productivity.

In addition to our removable bushing assembly, H Series cylinders also include a multitude of innovative design features such as: anti-extrusion body end seals, floating cushions, hi load piston (standard), and various port and rod end options to meet your application requirements.

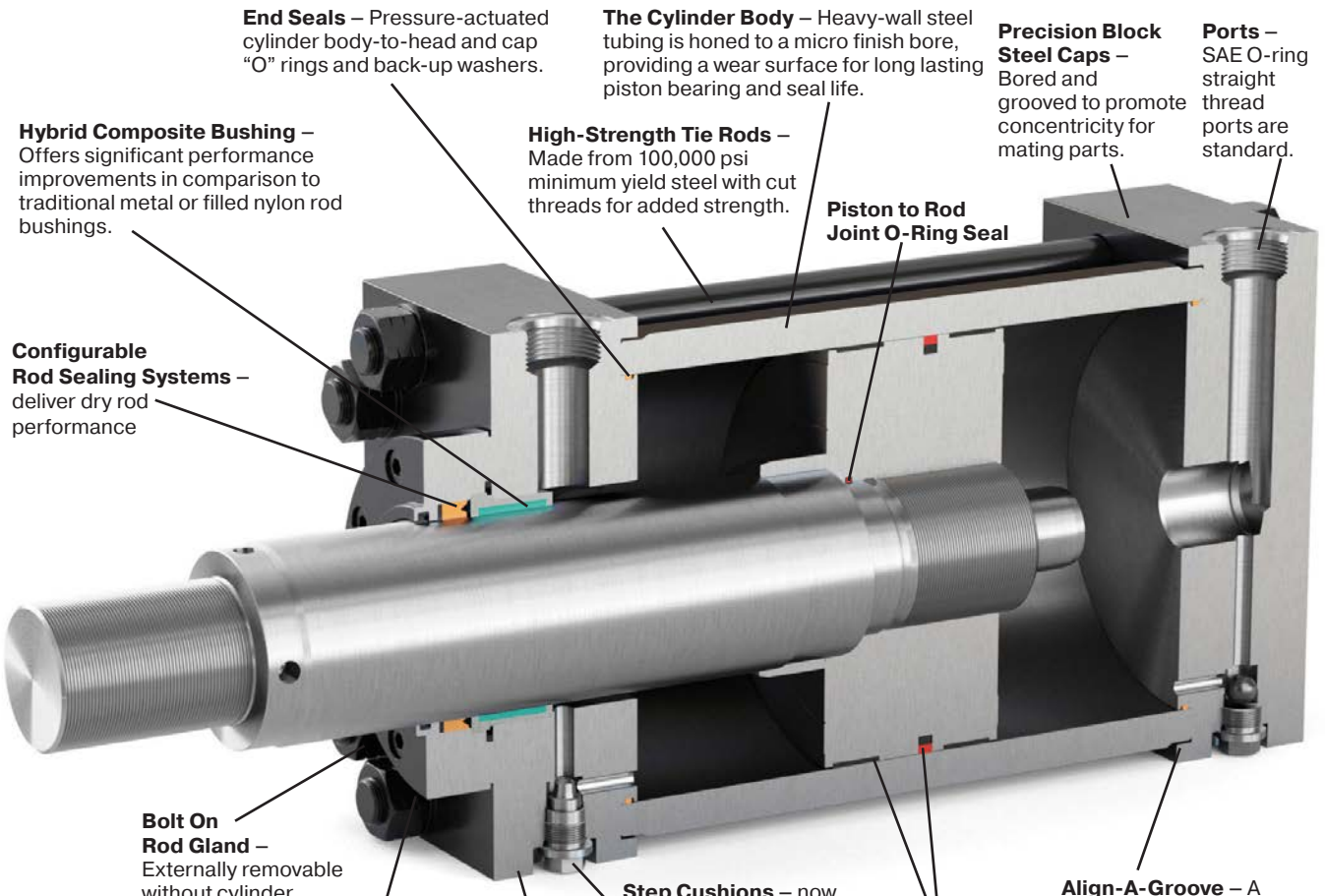
Every H Series cylinder is individually tested before leaving our plant to assure proper and leak free operation. All H Series cylinders come with an eighteen month warranty standard.



⚠**PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

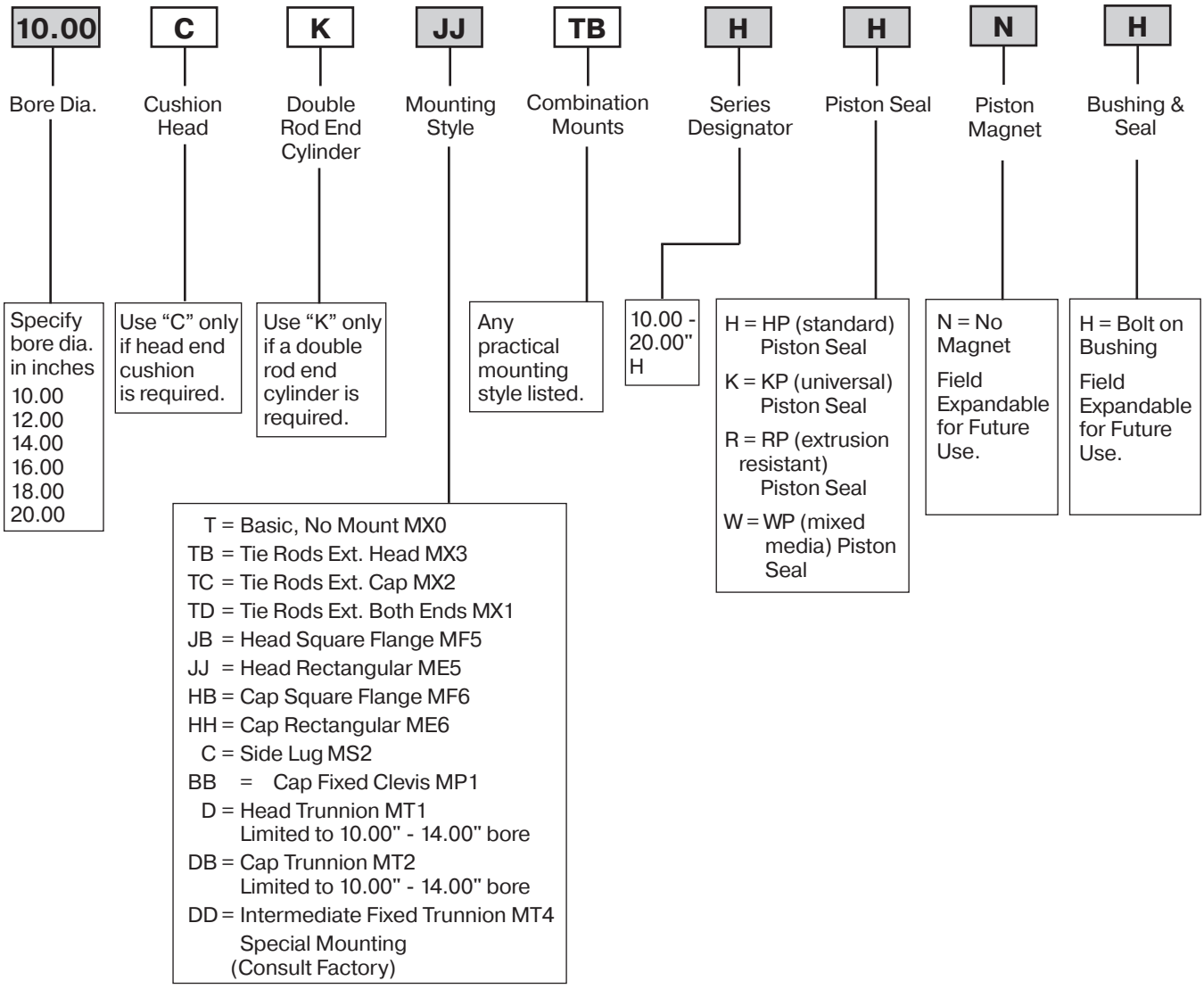
These innovative design features make Atlas H Series your best choice...

for all your large bore heavy duty hydraulic cylinder applications.



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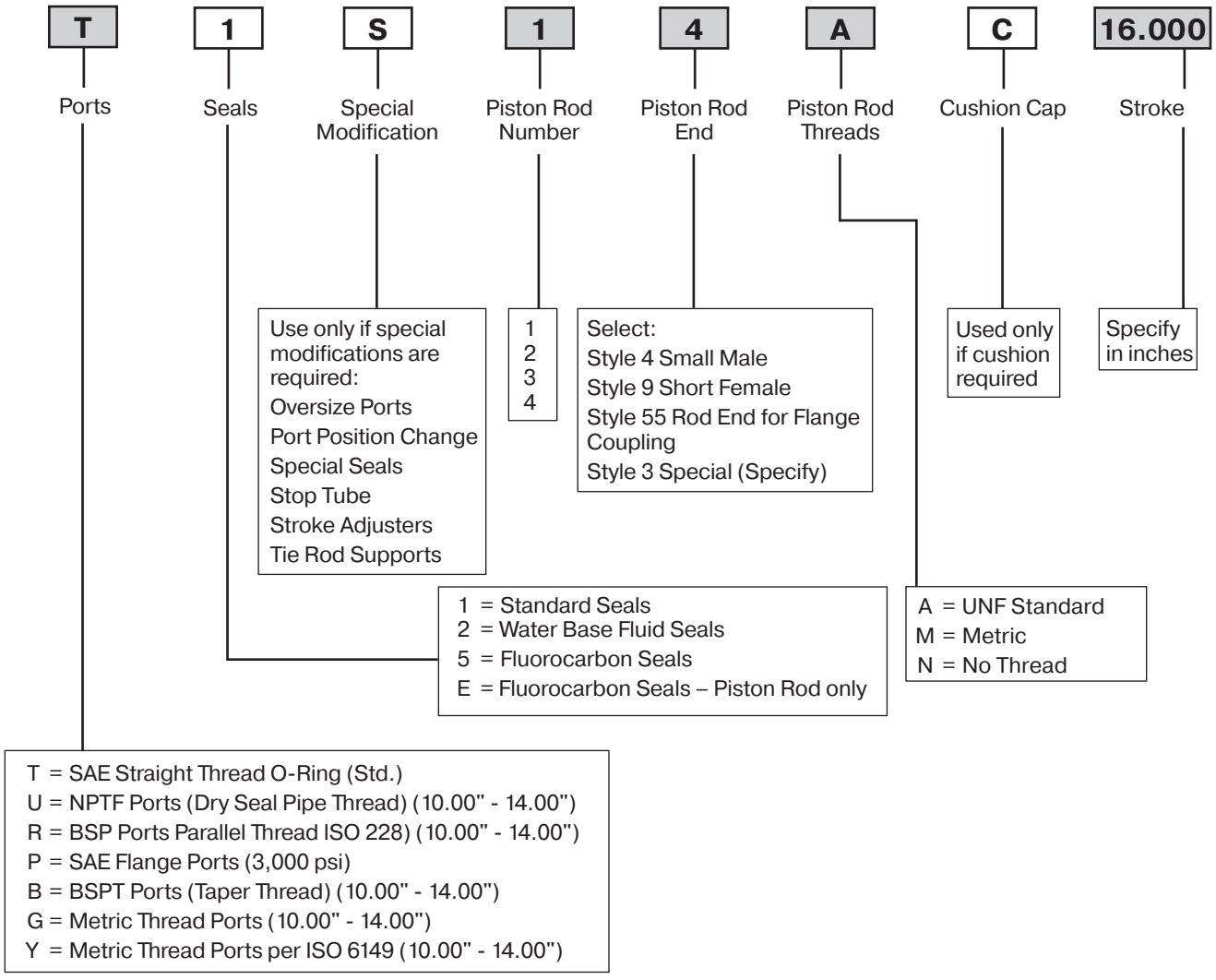
H Model Code



Shaded boxes identify required model number fields.

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

H Model Code



Style 9 Minimum Stroke Table

Bore Ø	Rod Ø	Minimum Stroke
10.00	4.500	1.125
	5.000	1.375
	5.500	2.000
	7.000	3.125
12.00	5.500	1.250
	7.000	2.375
	8.000	3.125
14.00	7.000	2.000
	8.000	2.750
	10.000	4.250

Bore Ø	Rod Ø	Minimum Stroke
16.00	8.000	1.750
	9.000	2.500
	10.000	3.250
18.00	9.000	1.500
	10.000	2.250
20.00	10.000	1.250

Shaded boxes identify required model number fields.

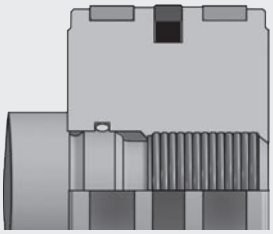
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Piston Seal Selection

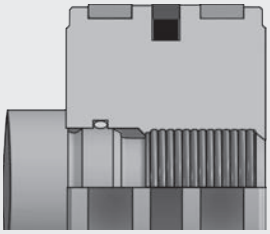
Atlas Piston Seal options HP, KP, RP and WP are available in a number of different Seal Classes. Because the Atlas Model Number includes Seal Class but does not include a code for piston seal style, a default piston seal style is designated for each seal class. In the table below rows list each seal class and columns list each piston style. Available piston styles for each seal class are identified with an 'X' and the default piston seal style is in the shaded cell. To specify an available piston seal style that is not standard, place an 'S' in the Special Modification field of the model number and specify the required piston seal style with text.

Seal Class	Piston Seal Options (Shaded cell is default standard)			
	HM	**KM**	**RM**	**WM**
TG - Class 1 - Polyurethane & Nitrile	X	X	X	X
NG - Class 2 - Nitrile	N/A	X	X	X
XG - Class 3 - EPR	N/A	X	X	X
LG - Class 4 - Low Temperature Nitrile	X	X	X	N/A
VG - Class 5 - Fluorocarbon	N/A	X	X	X
EG - Class 5 Rod Bushing Seals Only	N/A	X	X	X
JG - Class 6 - Nitroxile	N/A	X	X	X
HG - Class 8 - Filled PTFE High Temperature	N/A	X	N/A	N/A
GG - Class 8 Rod Bushing Seals Only (all others Fluorocarbon)	N/A	X	X	X

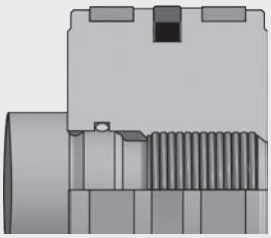
One Common Piston for 4 Seal Styles



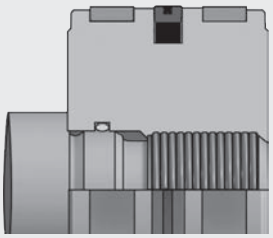
Standard HP style with polyurethane piston seal – excellent for most cycling and load holding applications.



Optional RP style with thermoplastic piston seal – superior extrusion resistance to extreme pressure spikes with drift-free performance.



Optional KP style with filled PTFE piston seal – low friction, high heat resistance for cycling and load holding service.



Optional WP style mixed media piston seal – low friction primary seal with redundant elastomer delivers superior performance with dissimilar media on either side of the piston.

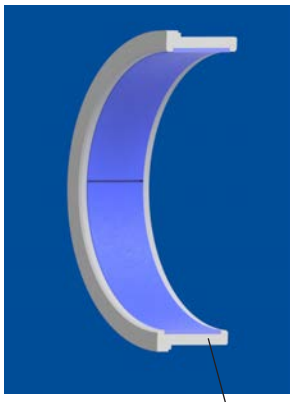
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

H Series Large Bore Hybrid Composite Bushing

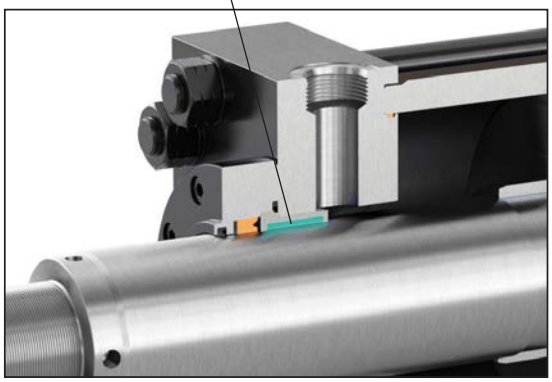
Innovative Solutions from Atlas Cylinders

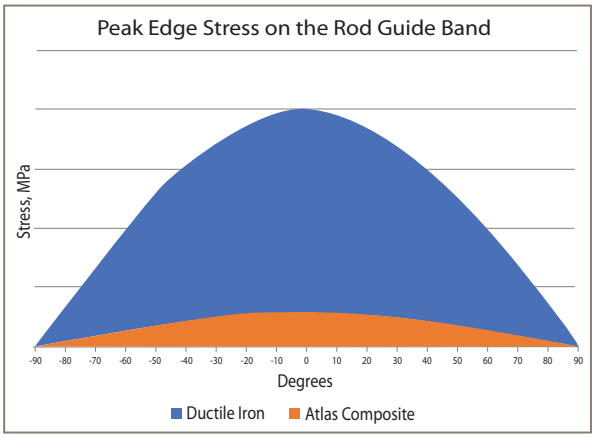


Customer Value Proposition:



The Atlas Cylinders H Series Large Bore Hybrid Composite Bushing installed inboard of the primary rod sealing package offers significant performance improvements in comparison to Metal or Filled Nylon Rod Bushings





Key Takeaway:
Contact stress is reduced when any side load force is distributed over a greater area. See how Atlas Cylinders' composite bearing performs over Ductile Iron.

Contact Information:

Atlas Cylinders
Hydraulic Actuator Division
500 S. Wolf Rd.
Des Plaines, IL 60016
www.parker.com/had

phone 847 298 2400
fax 800 892 1008

Product Features:

Atlas' Hybrid Composite Versus Metal Bushings

- Better ability to conform to bending deflections resulting in lower peak stresses
- Self lubricating with lower friction
- Ideal for High Water Content fluids

Atlas' Hybrid Composite Versus Filled Nylon Bushings

- Higher strength
- Very low water absorption
- Wider temperature range

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Standard Specifications

- Heavy Duty Service
- Standard Construction – Square Head – Tie Rod Design
- Nominal Pressure – 3000 psi[1]
- Standard Fluid – Hydraulic Oil
- Standard Temperature – -10°F to +165°F
- Bore Sizes – 10.00" through 20.00"
- Piston Rod Diameter – 4.500" through 10.000"
- Mounting Styles – 12 standard styles at various application ratings
- Strokes – Available in any practical stroke length
- Cushions – Optional at either end or both ends of stroke
- Rod Ends – Three Standard Choices – Specials to Order

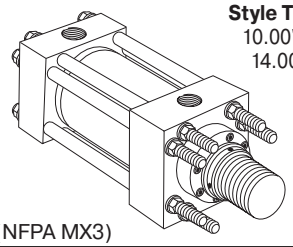
[1] If hydraulic operating pressure exceeds 3000 psi, send application data for engineering evaluation and recommendation.

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

Available Mounting Styles

Tie Rods Extended Head End

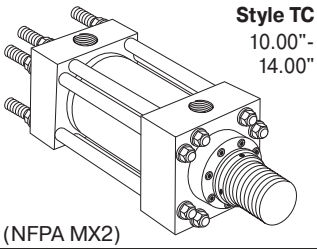
Style TB 10.00"-14.00"



(NFPA MX3)

Tie Rods Extended Cap End

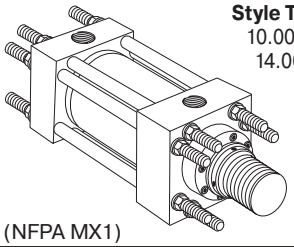
Style TC 10.00"-14.00"



(NFPA MX2)

Tie Rods Extended Both Ends

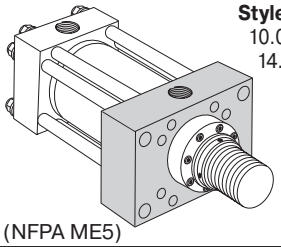
Style TD 10.00"-14.00"



(NFPA MX1)

Head Rectangular

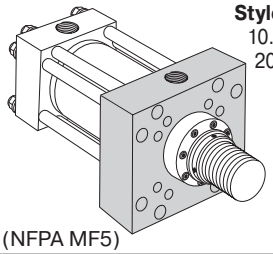
Style JJ 10.00"-14.00"



(NFPA ME5)

Head Square Flange

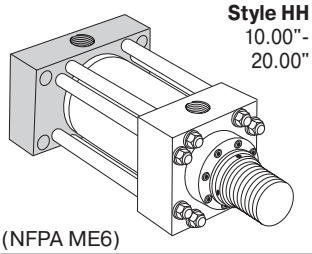
Style JB 10.00"-20.00"



(NFPA MF5)

Cap Rectangular

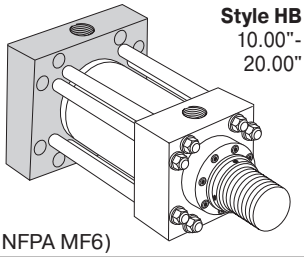
Style HH 10.00"-20.00"



(NFPA ME6)

Cap Square Flange

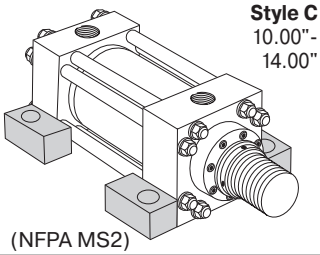
Style HB 10.00"-20.00"



(NFPA MF6)

Side Lug

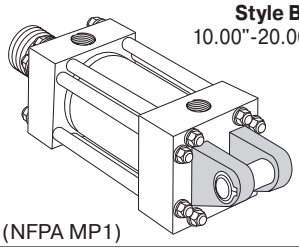
Style C 10.00"-14.00"



(NFPA MS2)

Cap Fixed Clevis

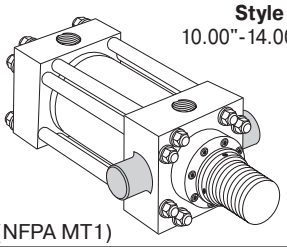
Style BB 10.00"-20.00"



(NFPA MP1)

Head Trunnion

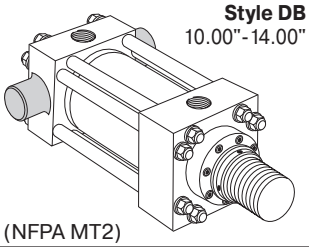
Style D 10.00"-14.00"



(NFPA MT1)

Cap Trunnion

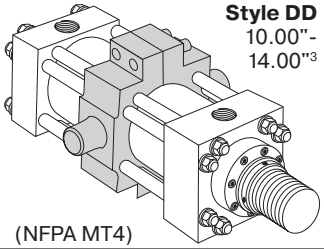
Style DB 10.00"-14.00"



(NFPA MT2)

Intermediate Fixed Trunnion

Style DD 10.00"-14.00"[3]

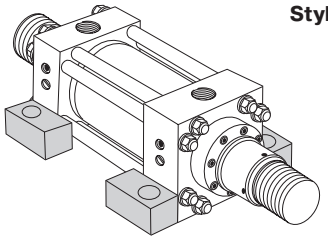


(NFPA MT4)

[3] Consult factory for 16.00"-20.00"

Double Rod Cylinders

Style KC Shown

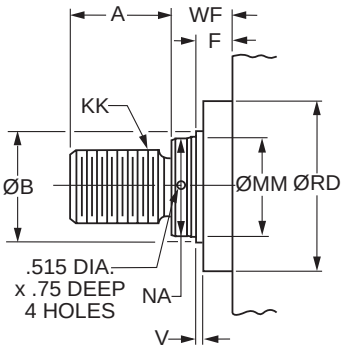


Most of the above illustrated mounting styles are available in double rod cylinders.

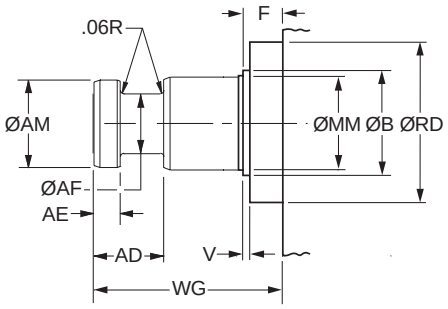
⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Rod End Dimensions – 10.00" - 20.00" Bore

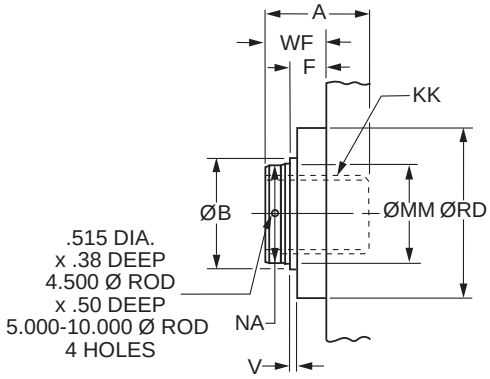
Thread Style 4 (NFPA Style SM)
Small Male



Thread Style 55[1]
Flanged Rod End



Thread Style 9[2] (NFPA Style SF)
Small Female



Rod End Dimensions – 10.00" - 20.00" Bore

Bore Ø	Rod No.	MM Rod Ø	Thread Style 4 & 9 KK	Rod Extensions and Pilot Dimensions						
				A	B Ø +.000 -.005	F	NA	RD -.005	V	WF
10.00	1 (std.)	4.500	3 1/4-12	4.50	5.249	1.94	4.38	8.249	0.25	2.94
	2	7.000	5-12	7.00	7.999	1.94	6.88	10.499	0.38	3.50
	3	5.000	3 1/2-12	5.00	5.749	1.94	4.88	8.874	0.25	3.19
	4	5.500	4-12	5.50	6.249	1.94	5.38	9.374	0.25	3.19
12.00	1 (std.)	5.500	4-12	5.50	6.249	1.94	5.38	9.374	0.25	3.19
	2	8.000	5 3/4-12	8.00	8.999	1.94	7.88	12.499	0.38	4.00
	3	7.000	5-12	7.00	7.999	1.94	6.88	10.499	0.38	3.50
14.00	1 (std.)	7.000	5-12	7.00	7.999	1.94	6.88	10.499	0.38	3.50
	2	10.000	7 1/4-12	10.00	10.999	1.94	9.88	14.499	0.38	4.50
	3	8.000	5 3/4-12	8.00	8.999	1.94	7.88	12.499	0.38	4.00
16.00	1	8.000	5 3/4-12	8.00	8.999	1.94	7.88	12.499	0.38	4.00
	3	9.000	6 1/2-12	9.00	9.999	1.94	8.88	13.499	0.38	4.25
	4	10.000	7 1/4-12	10.00	10.999	1.94	9.88	14.499	0.38	4.50
18.00	1	9.000	6 1/2-12	9.00	9.999	1.94	8.88	13.499	0.38	4.25
	3	10.000	7 1/4-12	10.00	10.999	1.94	9.88	14.499	0.38	4.50
20.00	1	10.000	7 1/4-12	10.00	10.999	1.94	9.88	14.499	0.38	4.50

"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 & 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.

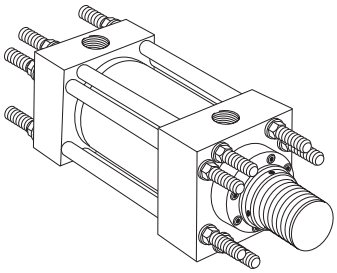
[2] Style 9 stroke restrictions may apply. See Style 9 Minimum Stroke Table on How to Order page for details.

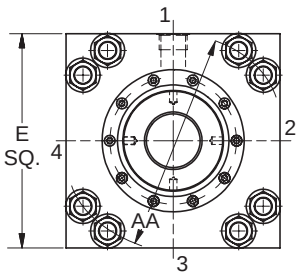
Style 55 Rod End

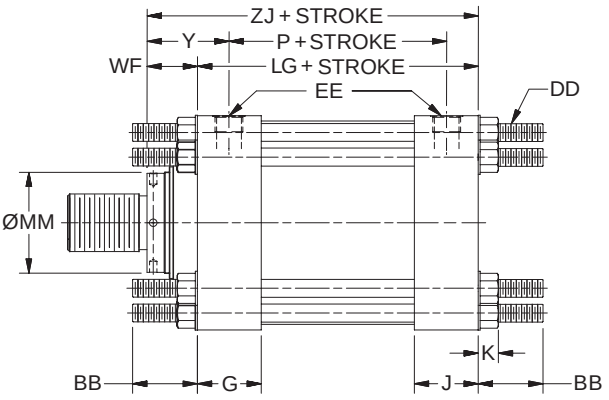
MM Rod Ø	AD	AE +.001 -.001	AF Ø	AM Ø	WG[1]
4.500	3.19	1.499	3.50	4.45	6.50
5.000	3.19	1.499	3.88	4.95	6.63
5.500	3.94	1.874	4.38	5.45	7.50
7.000	4.06	1.999	5.75	6.95	8.44
8.000	4.06	1.999	6.50	7.95	8.69
9.000	4.63	2.374	7.25	8.95	8.75
10.000	4.63	2.374	8.00	9.95	9.75

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Tie Rods Extended Both Ends Mounting
Style TD
(NFPA Style MX1)





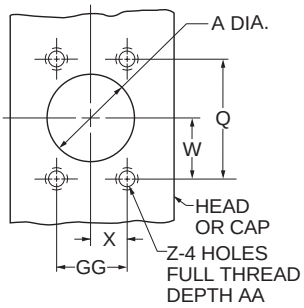


Style TD – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	AA	BB	DD	E	EE			G	J	K Max.	WF	Y	Add Stroke		
							NPTF[1]	SAE Flange Ports[2]	SAE Straight Thread[3]						LG	P	ZJ
10.00	1 (std.)	4.500	13.00	4.13	1 1/8-12	12.63	2.00	2.00	24	3.69	3.69	1.17	2.94	4.75	12.13	8.50	15.06
	2	7.000	13.00	4.13	1 1/8-12	12.63	2.00	2.00	24	3.69	3.69	1.17	3.50	5.31	12.13	8.50	15.63
	3	5.000	13.00	4.13	1 1/8-12	12.63	2.00	2.00	24	3.69	3.69	1.17	3.19	5.00	12.13	8.50	15.31
	4	5.500	13.00	4.13	1 1/8-12	12.63	2.00	2.00	24	3.69	3.69	1.17	3.19	5.00	12.13	8.50	15.31
12.00	1 (std.)	5.500	15.50	4.50	1 1/4-12	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	3.19	5.38	14.50	10.13	17.69
	2	8.000	15.50	4.50	1 1/4-12	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	4.00	6.19	14.50	10.13	18.50
	3	7.000	15.50	4.50	1 1/4-12	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	3.50	5.69	14.50	10.13	18.00
14.00	1 (std.)	7.000	17.38	4.50	1 1/4-12	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	3.50	5.88	15.63	10.88	19.13
	2	10.000	17.38	4.50	1 1/4-12	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	4.50	6.88	15.63	10.88	20.13
	3	8.000	17.38	4.50	1 1/4-12	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	4.00	6.38	15.63	10.88	19.63

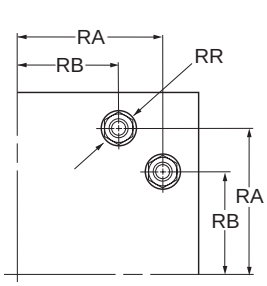
[1] NPTF ports are available at no extra charge.
[2] Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.
[3] SAE straight thread ports are standard and are indicated by port number.
[4] 2.50 SAE flange port is rated at 2500 psi

Optional SAE Flange Port Pattern

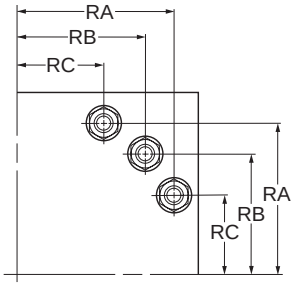


Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40

Model 51 – Tie Rod Information



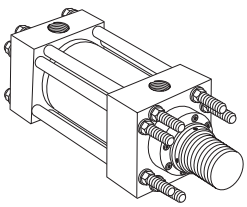
10.00", 12.00" Bores



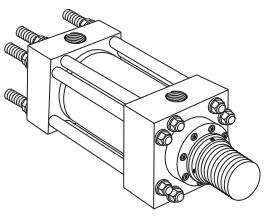
14.00" Bore

Bore Ø	10.00	12.00	14.00
Tie Rod Thread	1 1/8-12	1 1/4-12	1 1/4-12
RA	5.291	6.270	7.485
RB	3.775	4.555	6.143
RC	—	—	4.409
RR	2.00	2.19	2.19

Style TB



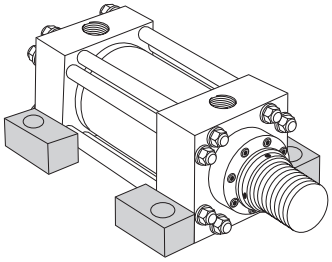
Style TC

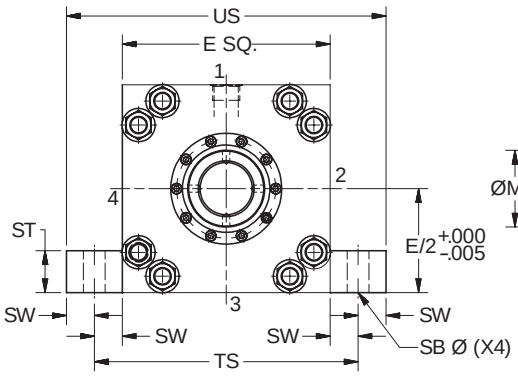


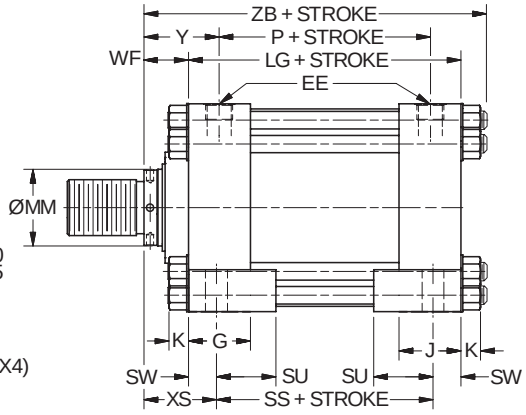
Dimensions for TB and TC may be obtained from the above dimensional table.

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Side Lugs Mounting
Style C
(NFPA Style MS2)







Style C – Dimensional and Mounting Data

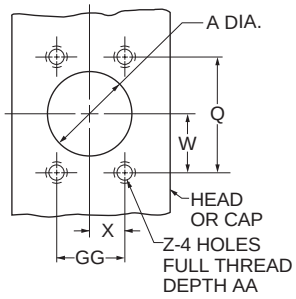
Bore Ø	Rod No.	MM Rod Ø	E	Ports (EE)			G	J	K Max.	SB Ø	ST	SU	SW	Y	TS	US	WF	XS
				NPTF[1]	SAE Flange Port[2]	SAE Straight Thread Port[3]												
10.00	1 (std.)	4.500	12.63	2.00	2.00	24	3.69	3.69	1.17	1.563	2.25	3.50	1.63	4.75	15.88	19.13	2.94	4.56
	2	7.000	12.63	2.00	2.00	24	3.69	3.69	1.17	1.563	2.25	3.50	1.63	5.31	15.88	19.13	3.50	5.13
	3	5.000	12.63	2.00	2.00	24	3.69	3.69	1.17	1.563	2.25	3.50	1.63	5.00	15.88	19.13	3.19	4.81
	4	5.500	12.63	2.00	2.00	24	3.69	3.69	1.17	1.563	2.25	3.50	1.63	5.00	15.88	19.13	3.19	4.81
12.00	1 (std.)	5.500	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	1.563	3.00	4.25	2.00	5.38	18.88	22.88	3.19	5.19
	2	8.000	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	1.563	3.00	4.25	2.00	6.19	18.88	22.88	4.00	6.00
	3	7.000	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	1.563	3.00	4.25	2.00	5.69	18.88	22.88	3.50	5.50
14.00	1 (std.)	7.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	2.313	4.00	4.75	2.25	5.88	21.63	26.13	3.50	5.75
	2	10.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	2.313	4.00	4.75	2.25	6.88	21.63	26.13	4.50	6.75
	3	8.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	2.313	4.00	4.75	2.25	6.38	21.63	26.13	4.00	6.25

[1]NPTF ports are available at no extra charge.
[2]Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.
[3]SAE straight thread ports are standard and are indicated by port number.
[4] 2.50 SAE flange port is rated at 2500 psi

Style C – Dimensional and Mounting Data (cont.)

Bore Ø	Rod No.	MM Rod Ø	Add Stroke			
			LG	P	SS	ZB Max.
10.00	1 (std.)	4.500	12.13	8.50	8.88	16.49
	2	7.000	12.13	8.50	8.88	17.05
	3	5.000	12.13	8.50	8.88	16.74
	4	5.500	12.13	8.50	8.88	16.74
12.00	1 (std.)	5.500	14.50	10.13	10.50	19.24
	2	8.000	14.50	10.13	10.50	20.05
	3	7.000	14.50	10.13	10.50	19.55
14.00	1 (std.)	7.000	15.63	10.88	11.13	20.68
	2	10.000	15.63	10.88	11.13	21.68
	3	8.000	15.63	10.88	11.13	21.18

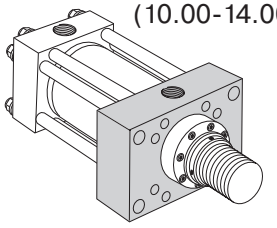
Optional SAE Flange Port Pattern

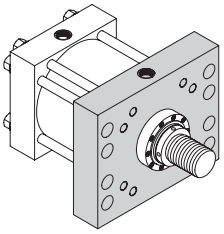


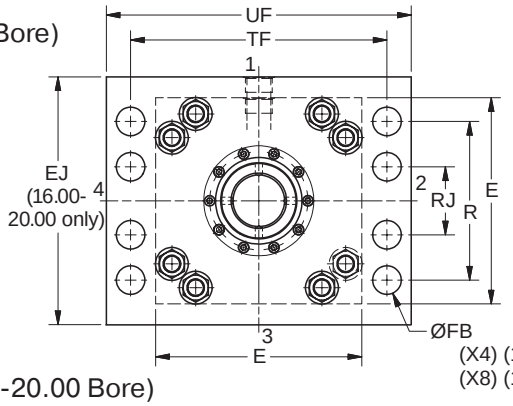
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40

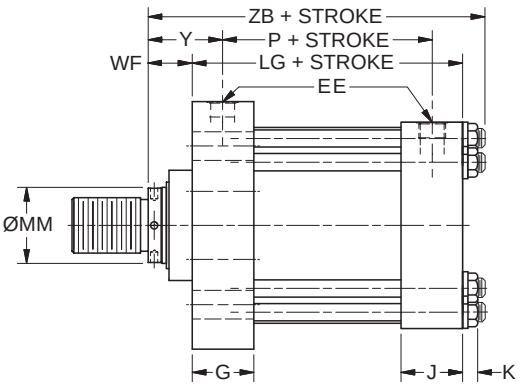
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Rectangular Mounting
Style JJ
(NFPA Style ME5)


(10.00-14.00 Bore)


(16.00-20.00 Bore)



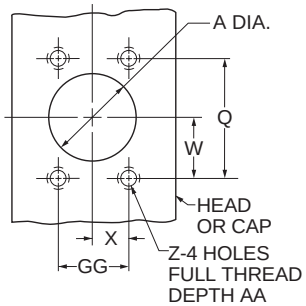


Style JJ – Dimensional and Mounting Data

Bore Ø	Rod No.	MM Rod Ø	E	EJ	Ports (EE)			FB Ø	G	J	K Max.	R	RJ	TF	UF	WF	Y	Add Stroke		
					NPTF[1]	SAE Flange Port[2]	SAE Straight Thread Port[3]											LG	P	ZB Max.
10.00	1 (std.)	4.500	12.63	-	2.00	2.00	24	1.81	3.69	3.69	1.17	9.62	-	15.88	19.00	2.94	4.75	12.13	8.50	16.49
	2	7.000	12.63	-	2.00	2.00	24	1.81	3.69	3.69	1.17	9.62	-	15.88	19.00	3.50	5.31	12.13	8.50	17.05
	3	5.000	12.63	-	2.00	2.00	24	1.81	3.69	3.69	1.17	9.62	-	15.88	19.00	3.19	5.00	12.13	8.50	16.74
	4	5.500	12.63	-	2.00	2.00	24	1.81	3.69	3.69	1.17	9.62	-	15.88	19.00	3.19	5.00	12.13	8.50	16.74
12.00	1 (std.)	5.500	14.88	-	2.50	2.50[4]	24	2.06	4.44	4.44	1.30	11.45	-	18.50	22.00	3.19	5.38	14.50	10.13	19.24
	2	8.000	14.88	-	2.50	2.50[4]	24	2.06	4.44	4.44	1.30	11.45	-	18.50	22.00	4.00	6.19	14.50	10.13	20.05
	3	7.000	14.88	-	2.50	2.50[4]	24	2.06	4.44	4.44	1.30	11.45	-	18.50	22.00	3.50	5.69	14.50	10.13	19.55
14.00	1 (std.)	7.000	17.13	-	2.50	2.50[4]	24	2.31	4.88	4.88	1.30	13.26	-	21.00	25.00	3.50	5.88	15.63	10.88	20.68
	2	10.000	17.13	-	2.50	2.50[4]	24	2.31	4.88	4.88	1.30	13.26	-	21.00	25.00	4.50	6.88	15.63	10.88	21.68
	3	8.000	17.13	-	2.50	2.50[4]	24	2.31	4.88	4.88	1.30	13.26	-	21.00	25.00	4.00	6.38	15.63	10.88	21.18
16.00	1 (std.)	8.000	19.00	20.00	-	3.00[5]	24	1.81	5.88	5.88	1.70	15.50	8.00	21.00	24.50	4.00	7.00	18.13	12.13	24.08
	3	9.000	19.00	20.00	-	3.00[5]	24	1.81	5.88	5.88	1.70	15.50	8.00	21.00	24.50	4.25	7.25	18.13	12.13	24.33
	4	10.000	19.00	20.00	-	3.00[5]	24	1.81	5.88	5.88	1.70	15.50	8.00	21.00	24.50	4.50	7.50	18.13	12.13	24.58
18.00	1 (std.)	9.000	22.00	23.00	-	3.00[5]	24	2.06	6.88	6.88	1.70	18.00	7.25	24.25	28.25	4.25	7.25	21.13	15.13	27.33
	3	10.000	22.00	23.00	-	3.00[5]	24	2.06	6.88	6.88	1.70	18.00	7.25	24.25	28.25	4.50	7.50	21.13	15.13	27.58
20.00	1 (std.)	10.000	24.00	25.00	-	3.00[5]	24	2.06	7.88	7.88	1.70	20.00	8.00	26.50	30.50	4.50	7.50	23.63	17.63	30.08

[1] NPTF ports are available at no extra charge.
[2] Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.
[3] SAE straight thread ports are standard and are indicated by port number.
[4] 2.50 SAE flange port is rated at 2500 psi
[5] 3.00 SAE flange port is rated at 2000 psi

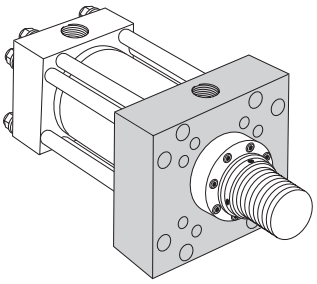
Optional SAE Flange Port Pattern

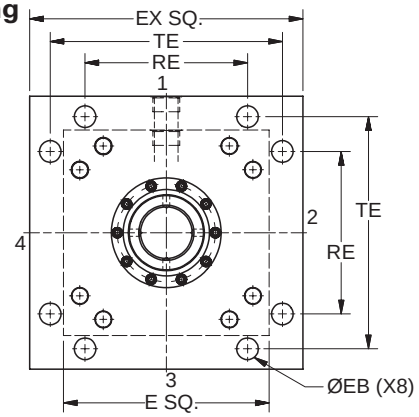


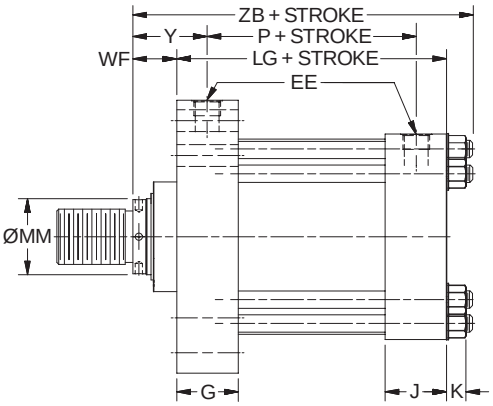
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19	48

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Square Flange Mounting
Style JB
(NFPA Style MF5)





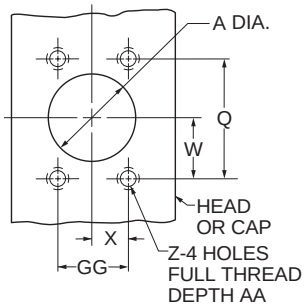


Style JB – Dimensional and Mounting Data

Bore Ø	MM Rod Ø	E	EB Ø	Ports (EE)			EX	G	J	K Max.	RE	TE	WF	Y	Add Stroke		
				NPTF[1]	SAE Flange Port[2]	SAE Straight Thread Port[3]									LG	P	ZB Max.
10.00	4.500	12.63	1.31	2.00	2.00	24	16.63	3.69	3.69	1.17	9.89	14.13	2.94	4.75	12.13	8.50	16.49
	5.000	12.63	1.31	2.00	2.00	24	16.63	3.69	3.69	1.17	9.89	14.13	3.19	5.00	12.13	8.50	16.74
	5.500	12.63	1.31	2.00	2.00	24	16.63	3.69	3.69	1.17	9.89	14.13	3.19	5.00	12.13	8.50	16.74
	7.000	12.63	1.31	2.00	2.00	24	16.63	3.69	3.69	1.17	9.89	14.13	3.50	5.31	12.13	8.50	17.05
12.00	5.500	14.88	1.56	2.50	2.50[4]	24	19.75	4.44	4.44	1.30	11.75	16.79	3.19	5.38	14.50	10.13	19.24
	7.000	14.88	1.56	2.50	2.50[4]	24	19.75	4.44	4.44	1.30	11.75	16.79	3.50	5.69	14.50	10.13	19.55
	8.000	14.88	1.56	2.50	2.50[4]	24	19.75	4.44	4.44	1.30	11.75	16.79	4.00	6.19	14.50	10.13	20.05
14.00	7.000	17.13	1.81	2.50	2.50[4]	24	21.75	4.88	4.88	1.30	12.90	18.43	3.50	5.88	15.63	10.88	20.68
	8.000	17.13	1.81	2.50	2.50[4]	24	21.75	4.88	4.88	1.30	12.90	18.43	4.00	6.38	15.63	10.88	21.18
	10.000	17.13	1.81	2.50	2.50[4]	24	21.75	4.88	4.88	1.30	12.90	18.43	4.50	6.88	15.63	10.88	21.68
16.00	8.000	19.00	1.81	-	3.00[5]	24	24.50	5.88	5.88	1.70	15.28	21.03	4.00	7.00	18.13	12.13	24.08
	9.000	19.00	1.81	-	3.00[5]	24	24.50	5.88	5.88	1.70	15.28	21.03	4.25	7.25	18.13	12.13	24.33
	10.000	19.00	1.81	-	3.00[5]	24	24.50	5.88	5.88	1.70	15.28	21.03	4.50	7.50	18.13	12.13	24.58
18.00	9.000	22.00	2.06	-	3.00[5]	24	26.50	6.88	6.88	1.70	16.45	22.65	4.25	7.25	21.13	15.13	27.33
	10.000	22.00	2.06	-	3.00[5]	24	26.50	6.88	6.88	1.70	16.45	22.65	4.50	7.50	21.13	15.13	27.58
20.00	10.000	24.00	2.06	-	3.00[5]	24	29.00	7.88	7.88	1.70	18.07	24.87	4.50	7.50	23.63	17.63	30.08

[1] NPTF ports are available at no extra charge.
[2] Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.
[3] SAE straight thread ports are standard and are indicated by port number.
[4] 2.50 SAE flange port is rated at 2500 psi
[5] 3.00 SAE flange port is rated at 2000 psi

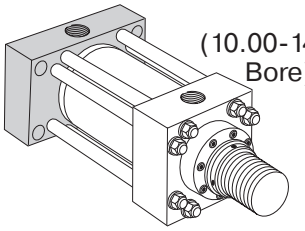
Optional SAE Flange Port Pattern

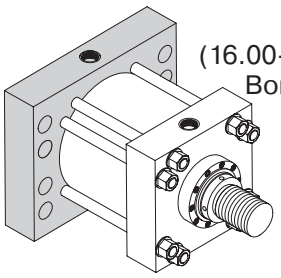


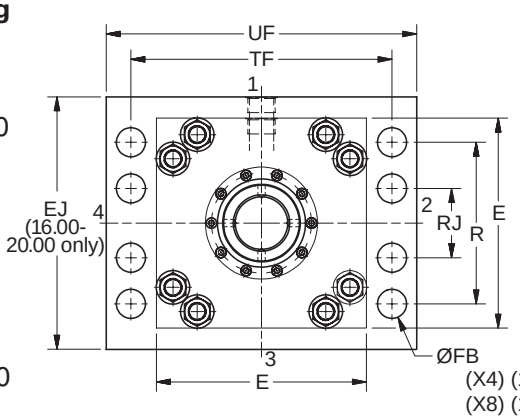
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19	48

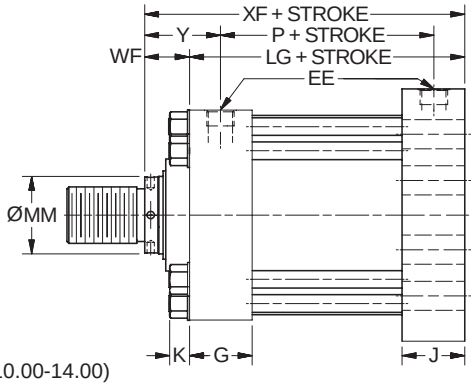
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Rectangular Mounting
Style HH
(NFPA Style ME6)









Style HH – Dimensional and Mounting Data

Bore Ø	MM Rod Ø	E	Ports (EE)			EJ	FB Ø	G	J	K Max.	R	RJ	TF	UF	WF	Y	Add Stroke		
			NPTF[1]	SAE Flange Port[2]	SAE Straight Thread Port[3]												LG	P	XF
10.00	4.500	12.63	2.00	2.00	24	-	1.81	3.69	3.69	1.17	9.62	-	15.88	19.00	2.94	4.75	12.13	8.50	15.06
	5.000	12.63	2.00	2.00	24	-	1.81	3.69	3.69	1.17	9.62	-	15.88	19.00	3.19	5.00	12.13	8.50	15.31
	5.500	12.63	2.00	2.00	24	-	1.81	3.69	3.69	1.17	9.62	-	15.88	19.00	3.19	5.00	12.13	8.50	15.31
	7.000	12.63	2.00	2.00	24	-	1.81	3.69	3.69	1.17	9.62	-	15.88	19.00	3.50	5.31	12.13	8.50	15.63
12.00	5.500	14.88	2.50	2.50[4]	24	-	2.06	4.44	4.44	1.30	11.45	-	18.50	22.00	3.19	5.38	14.50	10.13	17.69
	7.000	14.88	2.50	2.50[4]	24	-	2.06	4.44	4.44	1.30	11.45	-	18.50	22.00	3.50	5.69	14.50	10.13	18.00
	8.000	14.88	2.50	2.50[4]	24	-	2.06	4.44	4.44	1.30	11.45	-	18.50	22.00	4.00	6.19	14.50	10.13	18.50
14.00	7.000	17.13	2.50	2.50[4]	24	-	2.31	4.88	4.88	1.30	13.26	-	21.00	25.00	3.50	5.88	15.63	10.88	19.13
	8.000	17.13	2.50	2.50[4]	24	-	2.31	4.88	4.88	1.30	13.26	-	21.00	25.00	4.00	6.38	15.63	10.88	19.63
	10.000	17.13	2.50	2.50[4]	24	-	2.31	4.88	4.88	1.30	13.26	-	21.00	25.00	4.50	6.88	15.63	10.88	20.13
16.00	8.000	19.00	-	3.00[5]	24	20.00	1.81	5.88	5.88	1.70	15.50	8.00	21.00	24.50	4.00	7.00	18.13	12.13	22.13
	9.000	19.00	-	3.00[5]	24	20.00	1.81	5.88	5.88	1.70	15.50	8.00	21.00	24.50	4.25	7.25	18.13	12.13	22.38
	10.000	19.00	-	3.00[5]	24	20.00	1.81	5.88	5.88	1.70	15.50	8.00	21.00	24.50	4.50	7.50	18.13	12.13	22.63
18.00	9.000	22.00	-	3.00[5]	24	23.00	2.06	6.88	6.88	1.70	18.00	7.25	24.25	28.25	4.25	7.25	21.13	15.13	25.38
	10.000	22.00	-	3.00[5]	24	23.00	2.06	6.88	6.88	1.70	18.00	7.25	24.25	28.25	4.50	7.50	21.13	15.13	25.63
20.00	10.000	24.00	-	3.00[5]	24	25.00	2.06	7.88	7.88	1.70	20.00	8.00	26.50	30.50	4.50	7.50	23.63	17.63	28.13

[1]NPTF ports are available at no extra charge.

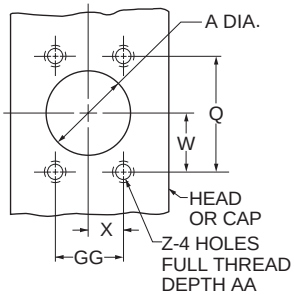
[2]Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.

[3]SAE straight thread ports are standard and are indicated by port number.

[4] 2.50 SAE flange port is rated at 2500 psi

[5] 3.00 SAE flange port is rated at 2000 psi

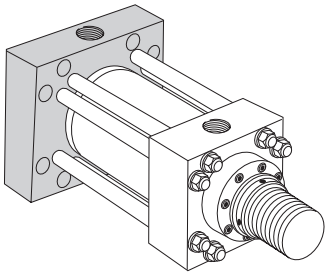
Optional SAE Flange Port Pattern

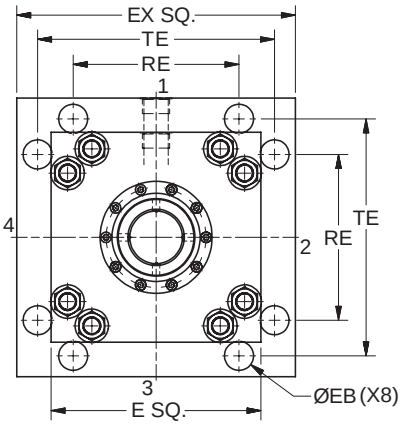


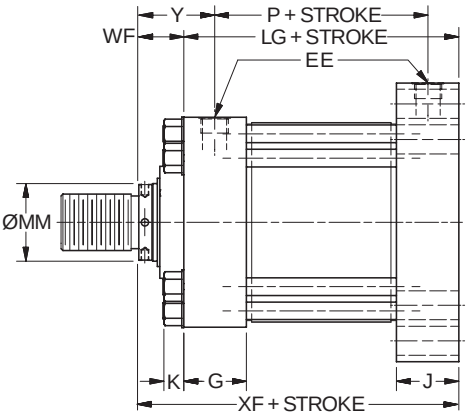
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19	48

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Square Flange Mounting
Style HB
(NFPA Style MF6)





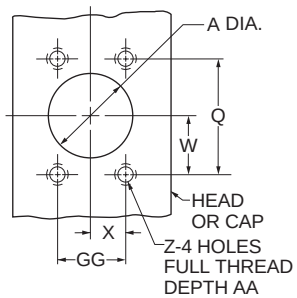


Style HB – Dimensional and Mounting Data

Bore Ø	MM Rod Ø	E	EB Ø	Ports (EE)			EX	G	J	K Max.	RE	TE	WF	Y	Add Stroke		
				NPTF[1]	SAE Flange Port[2]	SAE Straight Thread Port[3]									LG	P	XF
10.00	4.500	12.63	1.31	2.00	2.00	24	16.63	3.69	3.69	1.17	9.89	14.13	2.94	4.75	12.13	8.50	15.06
	5.000	12.63	1.31	2.00	2.00	24	16.63	3.69	3.69	1.17	9.89	14.13	3.19	5.00	12.13	8.50	15.31
	5.500	12.63	1.31	2.00	2.00	24	16.63	3.69	3.69	1.17	9.89	14.13	3.19	5.00	12.13	8.50	15.31
	7.000	12.63	1.31	2.00	2.00	24	16.63	3.69	3.69	1.17	9.89	14.13	3.50	5.31	12.13	8.50	15.63
12.00	5.500	14.88	1.56	2.50	2.50[4]	24	19.75	4.44	4.44	1.30	11.75	16.79	3.19	5.38	14.50	10.13	17.69
	7.000	14.88	1.56	2.50	2.50[4]	24	19.75	4.44	4.44	1.30	11.75	16.79	3.50	5.69	14.50	10.13	18.00
	8.000	14.88	1.56	2.50	2.50[4]	24	19.75	4.44	4.44	1.30	11.75	16.79	4.00	6.19	14.50	10.13	18.50
14.00	7.000	17.13	1.81	2.50	2.50[4]	24	21.75	4.88	4.88	1.30	12.90	18.43	3.50	5.88	15.63	10.88	19.13
	8.000	17.13	1.81	2.50	2.50[4]	24	21.75	4.88	4.88	1.30	12.90	18.43	4.00	6.38	15.63	10.88	19.63
	10.000	17.13	1.81	2.50	2.50[4]	24	21.75	4.88	4.88	1.30	12.90	18.43	4.50	6.88	15.63	10.88	20.13
16.00	8.000	19.00	1.81	-	3.00[5]	24	24.50	5.88	5.88	1.70	15.28	21.03	4.00	7.00	18.13	12.13	22.13
	9.000	19.00	1.81	-	3.00[5]	24	24.50	5.88	5.88	1.70	15.28	21.03	4.25	7.25	18.13	12.13	22.38
	10.000	19.00	1.81	-	3.00[5]	24	24.50	5.88	5.88	1.70	15.28	21.03	4.50	7.50	18.13	12.13	22.63
18.00	9.000	22.00	2.06	-	3.00[5]	24	26.50	6.88	6.88	1.70	16.45	22.65	4.25	7.25	21.13	15.13	25.38
	10.000	22.00	2.06	-	3.00[5]	24	26.50	6.88	6.88	1.70	16.45	22.65	4.50	7.50	21.13	15.13	25.63
20.00	10.000	24.00	2.06	-	3.00[5]	24	29.00	7.88	7.88	1.70	18.07	24.87	4.50	7.50	23.63	17.63	28.13

[1]NPTF ports are available at no extra charge.
[2]Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.
[3]SAE straight thread ports are standard and are indicated by port number.
[4] 2.50 SAE flange port is rated at 2500 psi
[5] 3.00 SAE flange port is rated at 2000 psi

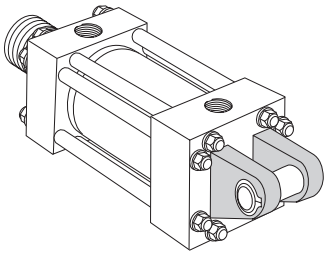
Optional SAE Flange Port Pattern

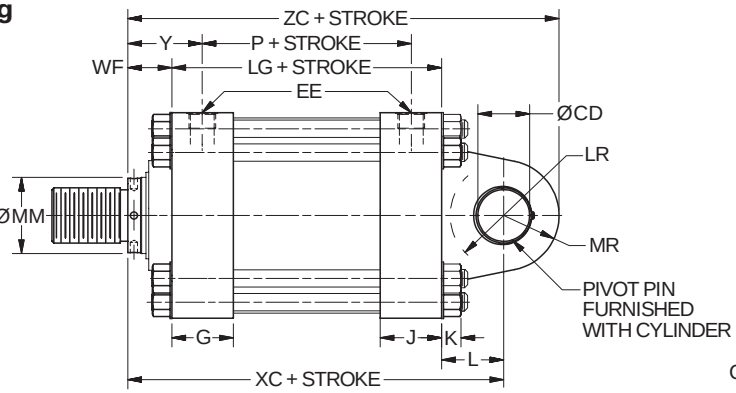


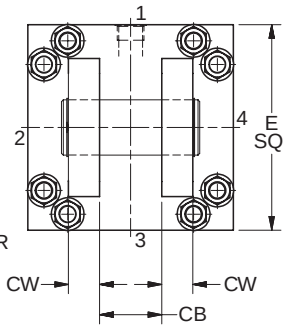
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19	48

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Fixed Clevis Mounting
Style BB(NFPA Style MP1)





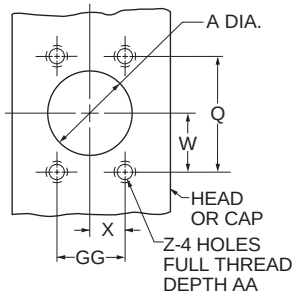


Style BB – Dimensional and Mounting Data

Bore Ø	MM Rod Ø	CB	CD[4] Ø +.000 -.002	CW	E	EE Ports			G	J	K Max.	L	LR	MR	WF	Y	Add Stroke			
						NPTF[1]	SAE Flange Port[2]	SAE Straight Thread Port[3]									LG	P	XC	ZC
10.00	4.500	4.00	3.501	2.00	12.63	2.00	2.00	24	3.69	3.69	1.17	4.00	3.38	3.50	2.94	4.75	12.13	8.50	19.06	22.56
	5.000	4.00	3.501	2.00	12.63	2.00	2.00	24	3.69	3.69	1.17	4.00	3.38	3.50	3.19	5.00	12.13	8.50	19.31	22.81
	5.500	4.00	3.501	2.00	12.63	2.00	2.00	24	3.69	3.69	1.17	4.00	3.38	3.50	3.19	5.00	12.13	8.50	19.31	22.81
	7.000	4.00	3.501	2.00	12.63	2.00	2.00	24	3.69	3.69	1.17	4.00	3.38	3.50	3.50	5.31	12.13	8.50	19.63	23.13
12.00	5.500	4.50	4.001	2.25	14.88	2.50	2.50[5]	24	4.44	4.44	1.30	4.50	3.88	4.00	3.19	5.38	14.50	10.13	22.19	26.19
	7.000	4.50	4.001	2.25	14.88	2.50	2.50[5]	24	4.44	4.44	1.30	4.50	3.88	4.00	3.50	5.69	14.50	10.13	22.50	26.50
	8.000	4.50	4.001	2.25	14.88	2.50	2.50[5]	24	4.44	4.44	1.30	4.50	3.88	4.00	4.00	6.19	14.50	10.13	23.00	27.00
14.00	7.000	6.00	5.001	3.00	17.13	2.50	2.50[5]	24	4.88	4.88	1.30	5.75	4.19	5.00	3.50	5.88	15.63	10.88	24.88	29.88
	8.000	6.00	5.001	3.00	17.13	2.50	2.50[5]	24	4.88	4.88	1.30	5.75	4.19	5.00	4.00	6.38	15.63	10.88	25.38	30.38
	10.000	6.00	5.001	3.00	17.13	2.50	2.50[5]	24	4.88	4.88	1.30	5.75	4.19	5.00	4.50	6.88	15.63	10.88	25.88	30.88
16.00	8.000	7.00	6.001	3.50	19.00	-	3.00[6]	24	5.88	5.88	1.70	7.00	6.25	6.00	4.00	7.00	18.13	12.13	29.13	35.13
	9.000	7.00	6.001	3.50	19.00	-	3.00[6]	24	5.88	5.88	1.70	7.00	6.25	6.00	4.25	7.25	18.13	12.13	29.38	35.38
	10.000	7.00	6.001	3.50	19.00	-	3.00[6]	24	5.88	5.88	1.70	7.00	6.25	6.00	4.50	7.50	18.13	12.13	29.63	35.63
18.00	9.000	8.00	6.501	4.00	22.00	-	3.00[6]	24	6.88	6.88	1.70	7.63	6.75	6.50	4.25	7.25	21.13	15.13	33.00	39.50
	10.000	8.00	6.501	4.00	22.00	-	3.00[6]	24	6.88	6.88	1.70	7.63	6.75	6.50	4.50	7.50	21.13	15.13	33.25	39.75
20.00	10.000	9.00	7.501	4.50	24.00	-	3.00[6]	24	7.88	7.88	1.70	8.75	7.75	7.50	4.50	7.50	23.63	17.63	36.88	44.38

[1]NPTF ports are available at no extra charge.
[2]Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.
[3]SAE straight thread ports are standard and are indicated by port number.
[4] Diameter CD is pin diameter.
[5] 2.50 SAE flange port is rated at 2500 psi
[6] 3.00 SAE flange port is rated at 2000 psi

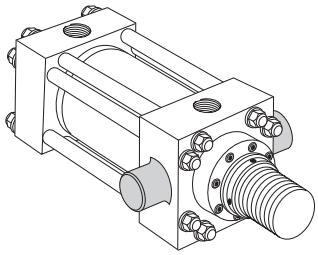
Optional SAE Flange Port Pattern

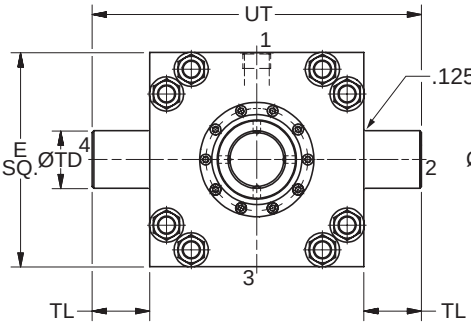


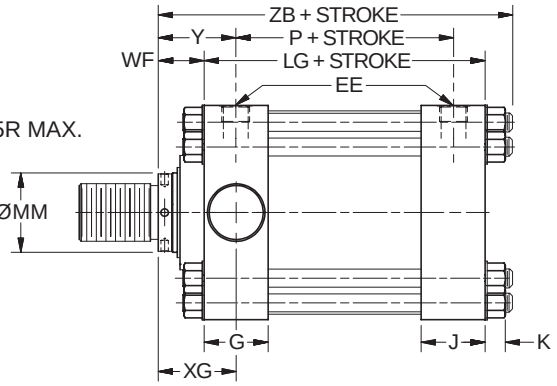
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19	48

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Head Trunnion Mounting
Style D
(NFPA Style MT1)







Style D – Dimensional and Mounting Data

Bore Ø	MM Rod Ø	E	Ports (EE)			G	J	K Max.	TD Ø +.000 -.001	TL	UT	WF	XG	Y	Add Stroke		
			NPTF[1]	SAE Flange Port[2]	SAE Straight Thread Port[3]										LG	P	ZB Max.
10.00	4.500	12.63	2.00	2.00	24	3.69	3.69	1.17	3.500	3.50	19.63	2.94	4.75	4.75	12.13	8.50	16.49
	5.000	12.63	2.00	2.00	24	3.69	3.69	1.17	3.500	3.50	19.63	3.19	5.00	5.00	12.13	8.50	16.74
	5.500	12.63	2.00	2.00	24	3.69	3.69	1.17	3.500	3.50	19.63	3.19	5.00	5.00	12.13	8.50	16.74
	7.000	12.63	2.00	2.00	24	3.69	3.69	1.17	3.500	3.50	19.63	3.50	5.31	5.31	12.13	8.50	17.05
12.00	5.500	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	4.000	4.00	22.88	3.19	5.38	5.38	14.50	10.13	19.24
	7.000	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	4.000	4.00	22.88	3.50	5.69	5.69	14.50	10.13	19.55
	8.000	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	4.000	4.00	22.88	4.00	6.19	6.19	14.50	10.13	20.05
14.00	7.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	4.500	4.50	26.13	3.50	5.94	5.88	15.63	10.88	20.68
	8.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	4.500	4.50	26.13	4.00	6.44	6.38	15.63	10.88	21.18
	10.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	4.500	4.50	26.13	4.50	6.94	6.88	15.63	10.88	21.68

[1] NPTF ports are available at no extra charge.

[2] Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.

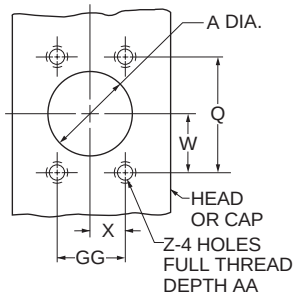
[3] SAE straight thread ports are standard and are indicated by port number.

[4] 2.50 SAE flange port is rated at 2500 psi

Style D – Maximum Operating Pressure

Bore Ø	psi
10.00	2800
12.00	2350
14.00	2200

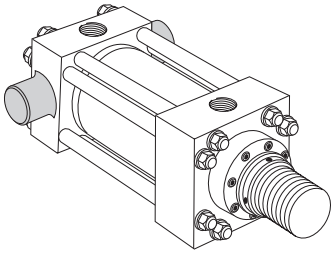
Optional SAE Flange Port Pattern

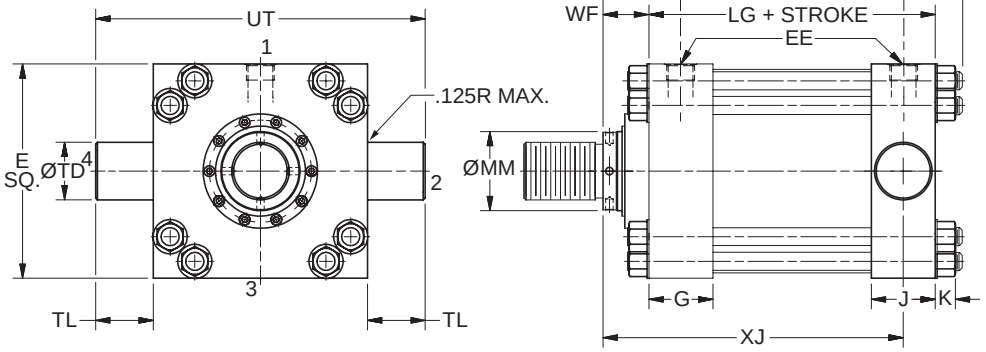


Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cap Trunnion Mounting
Style DB
(NFPA Style MT2)





Style DB – Dimensional and Mounting Data

Bore Ø	MM Rod Ø	E	Ports (EE)			G	J	K Max.	TD Ø +.000 -.001	TL	UT	WF	Y	Add Stroke			
			NPTF[1]	SAE Flange Port[2]	SAE Straight Thread Port[3]									LG	P	XJ	ZB Max.
10.00	4.500	12.63	2.00	2.00	24	3.69	3.69	1.17	3.500	3.50	19.63	2.94	4.75	12.13	8.50	13.38	16.49
	5.000	12.63	2.00	2.00	24	3.69	3.69	1.17	3.500	3.50	19.63	3.19	5.00	12.13	8.50	13.63	16.74
	5.500	12.63	2.00	2.00	24	3.69	3.69	1.17	3.500	3.50	19.63	3.19	5.00	12.13	8.50	13.63	16.74
	7.000	12.63	2.00	2.00	24	3.69	3.69	1.17	3.500	3.50	19.63	3.50	5.31	12.13	8.50	13.94	17.05
12.00	5.500	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	4.000	4.00	22.88	3.19	5.38	14.50	10.13	15.50	19.24
	7.000	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	4.000	4.00	22.88	3.50	5.69	14.50	10.13	15.81	19.55
	8.000	14.88	2.50	2.50[4]	24	4.44	4.44	1.30	4.000	4.00	22.88	4.00	6.19	14.50	10.13	16.31	20.05
14.00	7.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	4.500	4.50	26.13	3.50	5.88	15.63	10.88	16.69	20.68
	8.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	4.500	4.50	26.13	4.00	6.38	15.63	10.88	17.19	21.18
	10.000	17.13	2.50	2.50[4]	24	4.88	4.88	1.30	4.500	4.50	26.13	4.50	6.88	15.63	10.88	17.69	21.68

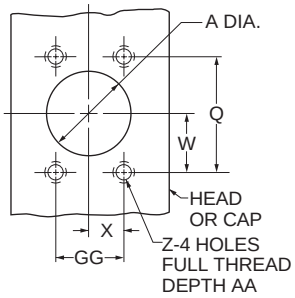
[1] NPTF ports are available at no extra charge.

[2] Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.

[3] SAE straight thread ports are standard and are indicated by port number.

[4] 2.50 SAE flange port is rated at 2500 psi

Optional SAE Flange Port Pattern



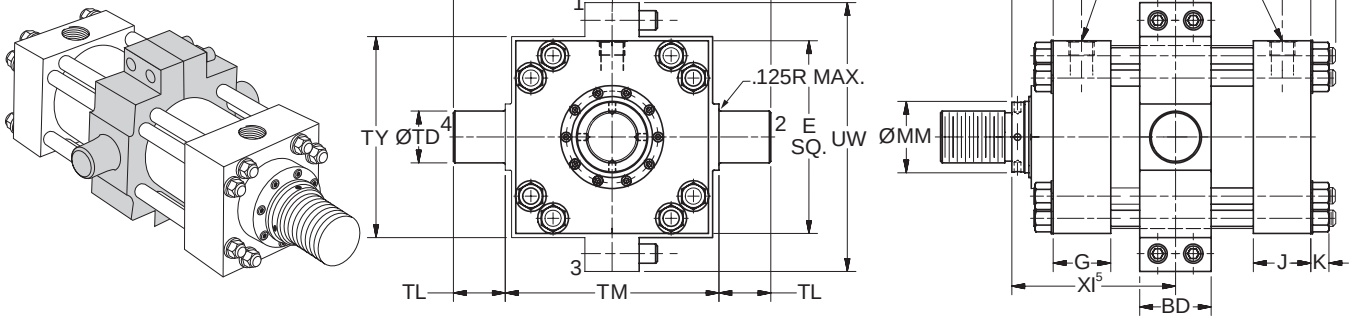
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40

Style DB – Maximum Operating Pressure

Bore Ø	psi
10.00	2800
12.00	2350
14.00	2200

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Intermediate Fixed Trunnion Mounting
Style DD)
(NFPA Style MT4)

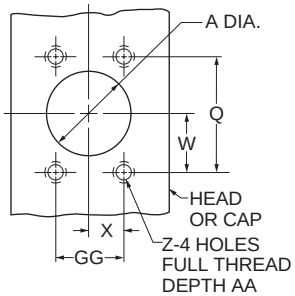


Style DD – Dimensional and Mounting Data

Bore Ø	MM Rod Ø	E	EE Ports			BD	G	J	K Max.	TD Ø +.000 -.001	TL	TM	TY	UM	UW	WF	Min. XI[5] Styles 2 & 4	Y	Add Stroke		
			NPTF[1]	SAE Flge. Port[2]	SAE Str. Thr. Port[3]														LG	P	ZB Max.
10.00	4.500	12.63	2.00	2.00	24	4.50	3.69	3.69	1.17	3.500	3.50	14.00	13.00	21.00	17.50	2.94	9.06	4.75	12.13	8.50	16.49
	5.000	12.63	2.00	2.00	24	4.50	3.69	3.69	1.17	3.500	3.50	14.00	13.00	21.00	17.50	3.19	9.31	5.00	12.13	8.50	16.74
	5.500	12.63	2.00	2.00	24	4.50	3.69	3.69	1.17	3.500	3.50	14.00	13.00	21.00	17.50	3.19	9.31	5.00	12.13	8.50	16.74
	7.000	12.63	2.00	2.00	24	4.50	3.69	3.69	1.17	3.500	3.50	14.00	13.00	21.00	17.50	3.50	9.63	5.31	12.13	8.50	17.05
12.00	5.500	14.88	2.50	2.50[6]	24	5.50	4.44	4.44	1.30	4.000	4.00	16.50	15.50	24.50	20.75	3.19	10.63	5.38	14.50	10.13	19.24
	7.000	14.88	2.50	2.50[6]	24	5.50	4.44	4.44	1.30	4.000	4.00	16.50	15.50	24.50	20.75	3.50	10.94	5.69	14.50	10.13	19.55
	8.000	14.88	2.50	2.50[6]	24	5.50	4.44	4.44	1.30	4.000	4.00	16.50	15.50	24.50	20.75	4.00	11.50	6.19	14.50	10.13	20.05
14.00	7.000	17.13	2.50	2.50[6]	24	5.50	4.88	4.88	1.30	4.500	4.50	19.50	19.25	28.50	24.75	3.50	11.44	5.88	15.63	10.88	20.68
	8.000	17.13	2.50	2.50[6]	24	5.50	4.88	4.88	1.30	4.500	4.50	19.50	19.25	28.50	24.75	4.00	11.94	6.38	15.63	10.88	21.18
	10.000	17.13	2.50	2.50[6]	24	5.50	4.88	4.88	1.30	4.500	4.50	19.50	19.25	28.50	24.75	4.50	12.44	6.88	15.63	10.88	21.68
16.00	8.000	19.00	[4]	3.00[7]	24	[4]	5.88	5.88	1.70	[4]	[4]	[4]	[4]	[4]	[4]	4.00	[4]	7.00	18.13	12.13	24.08
	9.000	19.00	[4]	3.00[7]	24	[4]	5.88	5.88	1.70	[4]	[4]	[4]	[4]	[4]	[4]	4.25	[4]	7.25	18.13	12.13	24.33
	10.000	19.00	[4]	3.00[7]	24	[4]	5.88	5.88	1.70	[4]	[4]	[4]	[4]	[4]	[4]	4.50	[4]	7.50	18.13	12.13	24.58
18.00	9.000	22.00	[4]	3.00[7]	24	[4]	6.88	6.88	1.70	[4]	[4]	[4]	[4]	[4]	[4]	4.25	[4]	7.25	21.13	15.13	27.33
	10.000	22.00	[4]	3.00[7]	24	[4]	6.88	6.88	1.70	[4]	[4]	[4]	[4]	[4]	[4]	4.50	[4]	7.50	21.13	15.13	27.58
20.00	10.000	24.00	[4]	3.00[7]	24	[4]	7.88	7.88	1.70	[4]	[4]	[4]	[4]	[4]	[4]	4.50	[4]	7.50	23.63	17.63	30.08

[1]NPTF ports are available at no extra charge.
[2]Optional SAE flange ports may be specified – flange to be supplied by customer. See Optional SAE Flange Port Pattern table for dimensions.
[3]SAE straight thread ports are standard and are indicated by port number.
[4]Consult Factory
[5]Dimension XI to be specified by customer. Reference point for rod end Style 9 is end of piston rod.
[6]2.50 SAE flange port is rated at 2500 psi
[7]3.00 SAE flange port is rated at 2000 psi

Optional SAE Flange Port Pattern



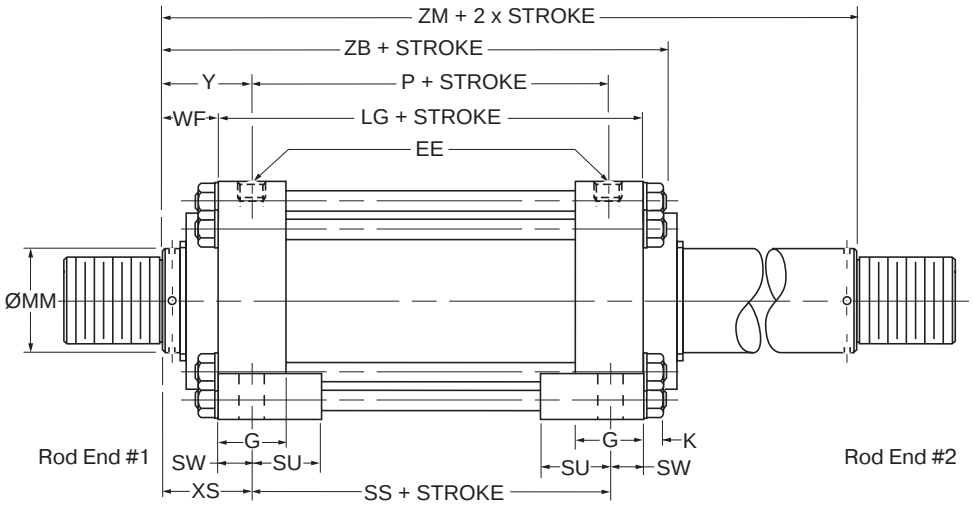
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.	SAE
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06	32
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19	40
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19	48

Style DD – Maximum Operating Pressure

Bore Ø	psi
10.00	2800
12.00	2350
14.00	2200

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Double Rod Cylinder



Mounting Styles for Single Rod Models	Mounting Styles for Corresponding Double Rod Models[1]	Dimension Shown on This Page Supplement Dimensions on Pages Listed Below
TB	KTB	50
TD	KTD	50
C	KC	51
JJ	KJJ	52
JB	KJB	53
D	KD	57
DD	KDD[2]	59

[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.

Bore Ø	Rod Code	Rod Ø	Add 2X Stroke
			ZM
10.00	1	4.500	18.00
	2	7.000	19.12
	3	5.000	18.50
	4	5.500	18.50
12.00	1	5.500	20.88
	2	8.000	22.50
	3	7.000	21.50
14.00	1	7.000	22.63
	2	10.000	24.63
	3	8.000	23.63
16.00	1	8.000	26.13
	3	9.000	26.63
	4	10.000	27.13
18.00	1	9.000	29.63
	3	10.000	30.13
20.00	1	10.000	32.63

How to Use Double Rod Cylinder Dimension Drawings

To obtain dimensioning information on a double rod cylinder, first select the desired mounting style and refer to the corresponding single rod cylinder model shown on the preceding pages. (See table above.) After you have determined all necessary dimensions from that drawing, turn back to this page and supplement those dimensions with additional ones from the drawing above and table at right. These added dimensions differ from, or are in addition to, those shown on the preceding pages and provide the additional information needed to completely dimension a double rod cylinder model.

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.

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Section D

Cylinder Accessories and Replacement Parts

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Cylinder Accessories
Atlas 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	
				Forged Steel or Cast Ductile Iron			
		Part Number	Load Capacity (lb)	Part Number	Load Capacity (lb)	Part Number	Shear Capacity (lb)
5/16-24	0.312	0512210000[1]	2,600	0959810031	1,850	–	–
7/16-20	0.500	0509400000	4,250	0959810050[2]	4,620	0683680000	8,600
1/2-20	0.500	0509410000	4,900	0959810050[2]	4,620	0683680000	8,600
3/4-16	0.750	0509420000	11,200	0959810075[2]	12,370	0683690000	19,300
3/4-16	0.750	1332840000	11,200	0959810075[2]	12,370	0683690000	19,300
7/8-14	1.000	0509430000	18,800	0959810100[2]	20,450	0683700000	34,300
1-14	1.000	0509440000	19,500	0959810100[2]	20,450	0683700000	34,300
1-14	1.000	1332850000	19,500	0959810100[2]	20,450	0683700000	34,300
1 1/4-12	1.375	0509450000	33,500	0959810138	33,500	0683710000	65,000
1 1/4-12	1.375	1332860000	33,500	0959810138	33,500	0683710000	65,000
1 1/2-12	1.750	0509460000	45,600	0959810175	49,480	0683720000	105,200
1 3/4-12	2.000	0509470000	65,600	0959810200[2]	70,100	0683730000	137,400
1 7/8-12	2.000	0509480000	65,600	0959810200[2]	70,100	0683730000	137,400
2 1/4-12	2.500	0509490000	98,200	0959810250[2]	98,200	0683740000	214,700
2 1/2-12	3.000	0509500000	98,200	0959810300[2]	121,940	0683750000	309,200
2 3/4-12	3.000	0509510000	98,200	0959810300[2]	121,940	0683750000	309,200
3 1/4-12	3.500	0509520000	156,700	0959810350	187,910	0735450000	420,900
3 1/2-12	4.000	0509530000	193,200	0959810400	268,000	0735470000	565,800
4-12	4.000	0509540000	221,200	0959810400	268,000	0735470000	565,800

[1] Includes pivot pin.

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

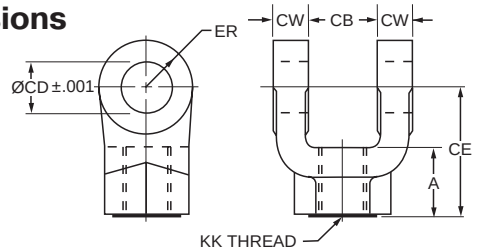
Mounting Plates
Mounting Plates for Style BB (clevis mounted) cylinders are offered. To select proper part number for your application, refer to Chart B at right.

Chart B

Series 2H, 2HD, 2HB		Series 3H, 3HD	
Mounting Plate Part Number	Bore Ø	Mounting Plate Part Number	Bore Ø
0959810050	1.50	0959810250	7.00
0959810075	2.00, 2.50	0959810300	8.00
0959810100	3.25	0959810350	10.00
0959810138	4.00	0959810400	12.00
0959810175	5.00		
0959810200	6.00		

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Rod Clevis Dimensions



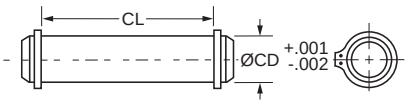
Part Number[1]	Pin Ø	A	CB	CD Ø	CE	CW	ER	KK Thread
0512210000[2]	0.310	0.81	0.34	0.314	2.25	0.20	0.30	5/16-24
0509400000	0.500	0.75	0.77	0.503	1.50	0.49	0.50	7/16-20
0509410000	0.500	0.75	0.77	0.503	1.50	0.49	0.50	1/2-20
0509420000	0.750	1.13	1.27	0.753	2.13	0.62	0.75	3/4-16
1332840000	0.750	1.13	1.27	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

[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.

Pivot Pin Dimensions



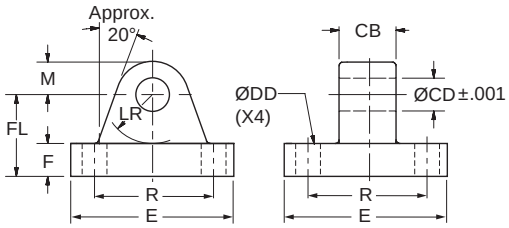
Part Number	CD Ø	CL
0683680000	0.500	1.88
0683690000	0.750	2.63
0683700000	1.000	3.13
0683710000	1.375	4.19
0683720000	1.750	5.19
0683730000	2.000	5.19
0683740000	2.500	6.19
0683750000	3.000	6.25
0735450000	3.500	8.25
0735470000[4]	4.000	9.00

[4] This size supplied with cotter pins.

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

Forged Steel or Cast Ductile Iron Mounting Plate or Eye Bracket Dimensions[5]

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 1.375 are forged steel. Eye Brackets with 0.312 and 1.750 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 Atlas 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.

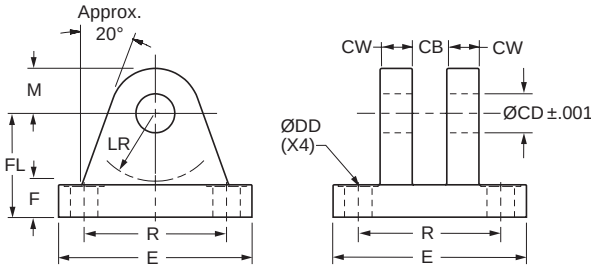
Accessory Load Capacity

The various accessories have been load rated for your convenience. The Load Capacity in pounds 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	3,300	0960160044	2,830	0740760000	3,600	0740780000	6,600
7/16-20	0.500	0690890000	5,000	0960160050	7,740	0692050000	7,300	0683680000	8,600
1/2-20	0.500	0690900000	5,700	0960160050	7,740	0692050000	7,300	0683680000	8,600
3/4-16	0.750	0690910000	12,100	0960160075	13,600	0692060000	10,880	0683690000	19,300
7/8-14	1.000	0690920000	13,000	0960160100	23,000	0692070000	15,180	0683700000	34,300
1-14	1.000	0690930000	21,700	0960160100	23,000	0692070000	15,180	0683700000	34,300
1 1/4-12	1.375	0690940000	33,500	0960160138	39,500	0692080000	23,560	0683710000	65,000
1 1/2-12	1.750	0690950000	45,000	0960160175	49,480	0692090000	21,520	0683720000	105,200
1 3/4-12	2.000	0690960000	53,500	0960160200	72,400	0692100000	26,000	0692150000	137,400
1 7/8-12	2.000	0962160000	75,000	0960160200	72,400	0692100000	26,000	0692150000	137,400
2 1/4-12	2.500	0962170000	98,700	0960160250	98,700	0692110000	28,710	0683740000	214,700
2 1/2-12	3.000	0962180000	110,000	0960160300	123,300	0692120000	28,190	0683750000	309,200
2 3/4-12	3.000	0962190000	123,300	N/A	N/A	0692130000	31,390	0692160000	309,200
3 1/4-12	3.500	0962200000	161,300	0960160350	200,400	0735420000	80,250	0735450000	420,900
3 1/2-12	3.500	0962210000	217,300	0960160350	200,400	0735420000	80,250	0735450000	420,900
4-12	4.000	0962220000	273,800	0960160400	292,100	0735430000	98,420	0821810000	565,800
N/A	4.000	N/A	N/A	N/A	N/A	N/A	N/A	0735470000[1]	565,800

[1] This size supplied with cotter pins.

Forged Steel or Cast Ductile Iron Clevis Bracket Dimensions

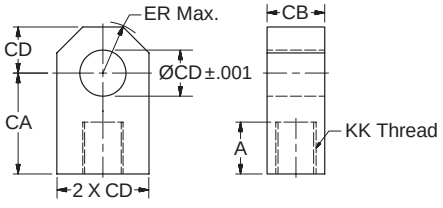


Note: Cast ductile iron clevis brackets must not be welded in place.

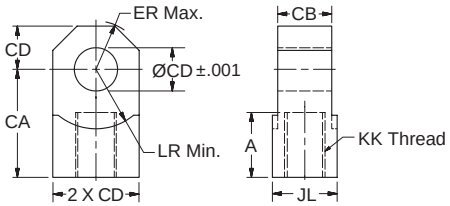
Cast or Forged[2] Part Number	Pin Ø	CB	CD Ø	CW	DD Ø	E (As Cast)	F	FL	LR	M (As Cast)	R
0960160044	0.438	0.46	0.440	0.37	0.27	2.25	0.38	1.00	0.56	0.44	1.75
0960160050	0.500	0.78	0.503	0.50	0.41	2.50	0.38	1.13	0.63	0.56	1.63
0960160075	0.750	1.28	0.753	0.63	0.53	3.50	0.63	1.88	1.06	0.75	2.56
0960160100	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 1.375 are forged steel. Clevis Brackets with 0.438 and 1.750 pin diameter and larger are cast ductile iron.

Knuckle Dimensions



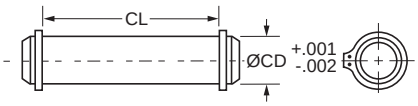
Thread Size thru 1 3/4-12



Thread Size 1 7/8-12 & Larger

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

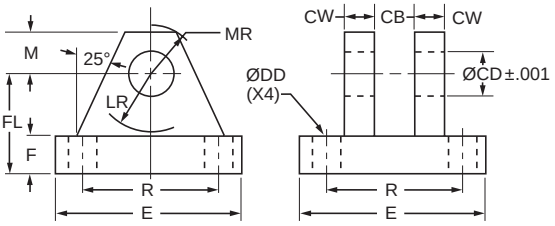


Part Number	CD Ø	CL
0740780000	0.438	1.31
0683680000	0.500	1.88
0683690000	0.750	2.63
0683700000	1.000	3.13
0683710000	1.375	4.19
0683720000	1.750	5.19
0692150000	2.000	5.69
0683740000	2.500	6.19
0683750000	3.000	6.25
0692160000	3.000	6.75
0735450000	3.500	8.25
0821810000	4.000	8.69
0735470000[1]	4.000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

[1]This size supplied with cotter pins.

1. Pivot Pins are furnished with Clevis Mounted Cylinders as standard.
2. Pivot Pins are furnished with (2) Retainer Rings.
3. 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



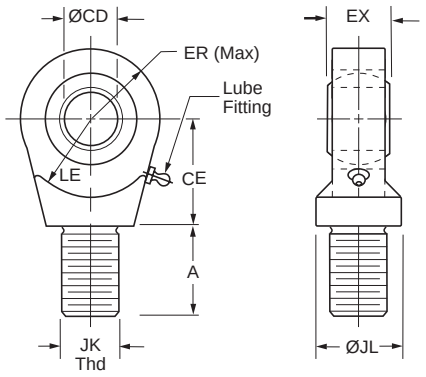
Fabricated Steel Part Number	Pin[2] Ø	CB	CD Ø	CW	DD Ø	E	F	FL	LR	M	MR	R
0692050000	0.500	0.80	0.503	0.50	0.41	3.50	0.50	1.50	0.75	0.50	0.63	2.55
0692060000	0.750	1.30	0.753	0.63	0.53	5.00	0.63	1.88	1.19	0.75	0.91	3.82
0692070000	1.000	1.59	1.003	0.75	0.66	6.50	0.75	2.25	1.50	1.00	1.25	4.95
0692080000	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.

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Atlas 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.

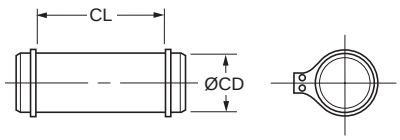
Spherical Rod Eye Dimensions



Bore Ø	Part Number	CD Ø	A	CE	EX	ER	LE	JK Thread	JL Ø	Load Capacity (lb)
1.50	0961000050	.5000-0005	0.72	0.86	0.44	0.80	0.78	7/16-20	0.88	2,644
2.00 & 2.50	0961000075	.7500-0005	1.02	1.25	0.66	1.14	1.06	3/4-16	1.31	9,441
3.25	0961000100	1.0000-0005	1.52	1.88	0.88	1.34	1.45	1-14	1.50	16,860
4.00	0961000138	1.3750-0005	2.02	2.13	1.19	1.67	1.91	1 1/4-12	2.00	28,562
5.00	0961000175	1.7500-0005	2.14	2.50	1.53	2.05	2.16	1 1/2-12	2.00	43,005
6.00	0961000200	2.0000-0005	2.89	2.75	1.75	2.60	2.50	1 7/8-12	2.75	70,193

Order to fit Piston Rod Thread Size.

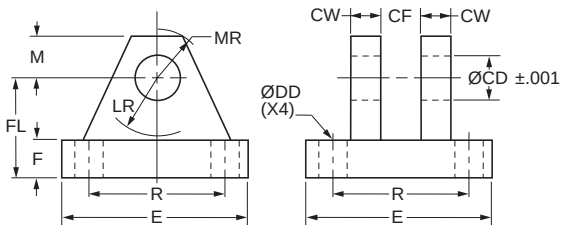
Pivot Pin Dimensions



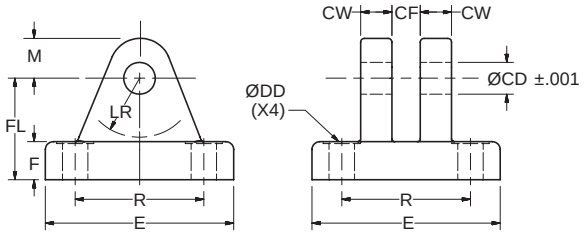
Bore Ø	Part Number	CD Ø	CL	Shear Capacity (lb)
1.50	0839620000	.4997-0004	1.56	8,600
2.00 & 2.50	0839630000	.7497-0005	2.03	19,300
3.25	0839640000	.9997-0005	2.50	34,300
4.00	0839650000	1.3746-0006	3.31	65,000
5.00	0839660000	1.7496-0006	4.22	105,200
6.00	0839670000	1.9996-0007	4.94	137,400

Pivot Pins are furnished with (2) Retainer Rings.

Clevis Bracket Dimensions



Fabricated Steel



Cast Ductile Iron

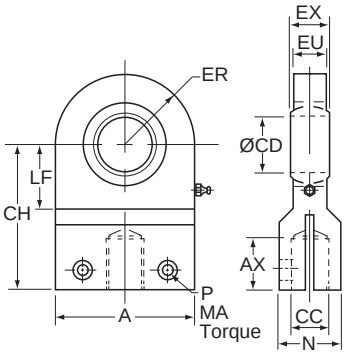
Order to fit Cylinder Cap or Rod Eye.

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	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	5,770
2.00 & 2.50	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	9,450
3.25	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	14,300
4.00	1.375	0959320000	0839500000	1.378	1.20	1 .00	0.66	6.50	0.88	3.50	2.44	1.38	1.63	4.95	20,322
5.00	1.750	0959330000	0839510000	1.753	1.55	1.25	0.91	8.50	1.25	4.50	2.88	1.75	2.06	6.58	37,800
6.00	2.000	0959340000	0839520000	2.003	1.77	1.50	0.91	10.63	1.50	5.00	3.00	2.00	2.38	7.92	50,375

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Atlas 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.

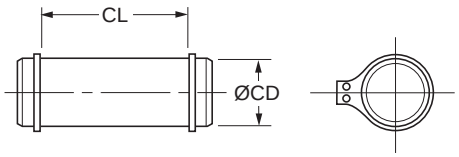
Spherical Rod Eye Dimensions



Bore Ø	Part Number	A	AX (min.)	CH	CD Ø	ER	EU	EX	CC Thread	LF	MA (lb-ft)	N	P (SHCS)	Load Cap. (lb)
1.50	0978200075	1.75	0.75	1.75	0.7500 -0.0004	0.88	0.56	0.656	1/2-20	0.94	11	0.88	1/4-28	5,301
2.00	0978200100	2.50	1.13	2.50	1.0000 -0.0004	1.25	0.75	0.875	7/8-14	1.19	40	1.25	3/8-24	9,425
2.50	0978200125	3.00	1.13	2.75	1.2500 -0.0005	1.50	0.94	1.093	7/8-14	1.44	40	1.38	3/8-24	14,726
3.25	0978200150	4.00	1.63	3.75	1.5000 -0.0005	2.00	1.13	1.312	1 1/4-12	1.75	100	2.00	1/2-20	24,887
4.00	0978200200	4.50	2.00	4.50	2.0000 -0.0005	2.25	1.50	1.750	1 1/2-12	2.25	185	2.50	5/8-18	37,699
5.00	0978200250	6.00	2.25	5.25	2.5000 -0.0006	3.00	1.88	2.187	1 3/4-12	2.81	325	2.75	3/4-16	58,905
6.00	0978200300	7.00	3.00	6.75	3.0000 -0.0006	3.50	2.25	2.625	2 1/4-12	3.31	525	3.50	7/8-14	84,823
7.00	0978200350	8.00	3.50	8.00	3.5000 -0.0008	4.00	2.63	3.062	2 3/4-12	3.94	800	4.50	1-14	115,454
8.00	0978200400	9.00	3.50	8.50	4.0000 -0.0008	4.50	3.00	3.500	3 1/4-12	4.50	800	5.00	1-14	150,796

Order to fit Piston Rod Thread Size.

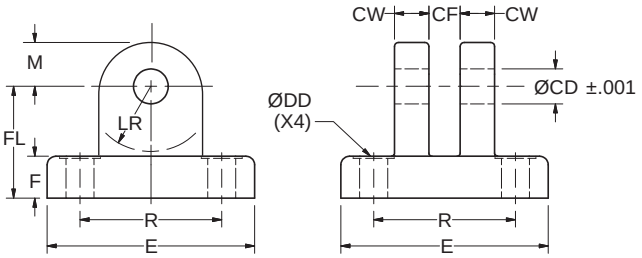
Pivot Pin Dimensions



Pivot Pins are furnished with (2) Retainer Rings.

Bore Ø	Pin Ø	Part Number	CD Ø	CL	Shear Capacity (lb)
1.50	0.750	0977260075	0.7497 -0.0005	1.78	19,300
2.00	1.000	0977260100	0.9997 -0.0005	2.00	34,300
2.50	1.250	0977260125	1.2496 -0.0006	2.50	53,600
3.25	1.500	0977260150	1.4996 -0.0006	3.00	77,300
4.00	2.000	0977260200	1.9996 -0.0007	3.94	137,400
5.00	2.500	0977260250	2.4996 -0.0007	4.88	214,700
6.00	3.000	0977260300	2.9996 -0.0007	5.31	309,100
7.00	3.500	0977260350	3.4995 -0.0009	6.25	420,700
8.00	4.000	0977260400	3.9995 -0.0009	6.69	549,400

Forged Steel or Cast Ductile Iron Clevis Bracket Dimensions[1]



Order to fit Cylinder Cap or Rod Eye.

Bore Ø	Pin Ø	Part Number	CD Ø ±0.001	CF	CW	DD Ø	E	F	FL	LR	M	R	Load Capacity (lb)
1.50	0.750	0977270075	0.753	0.67	0.50	0.41	2.75	0.38	1.63	1.06	0.63	2.00	5,301
2.00	1.000	0977270100	1.003	0.89	0.50	0.47	3.25	0.50	2.00	1.31	0.81	2.44	9,425
2.50	1.250	0977270125	1.253	1.11	0.63	0.53	4.00	0.75	2.50	1.56	1.00	3.00	14,726
3.25	1.500	0977270150	1.503	1.33	0.75	0.66	5.00	0.75	3.00	2.06	1.25	3.75	24,887
4.00	2.000	0977270200	2.003	1.77	1.00	0.66	5.50	1.00	3.50	2.31	1.63	4.31	37,699
5.00	2.500	0977270250	2.503	2.20	1.25	0.91	7.00	1.25	4.50	3.06	2.00	5.44	58,905
6.00	3.000	0977270300	3.003	2.64	1.25	1.06	8.25	1.50	5.25	3.56	2.50	6.38	84,823
7.00	3.500	0977270350	3.503	3.08	1.50	1.19	9.25	1.75	6.00	4.06	3.00	7.38	115,454
8.00	4.000	0977270400	4.003	3.52	1.50	1.31	10.50	2.00	6.75	4.56	3.50	8.50	150,796

[1] Clevis Brackets with pin diameters 0.750 thru 2.000 are forged steel. Clevis Brackets with 2.500 pin diameter and larger are cast ductile iron.

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

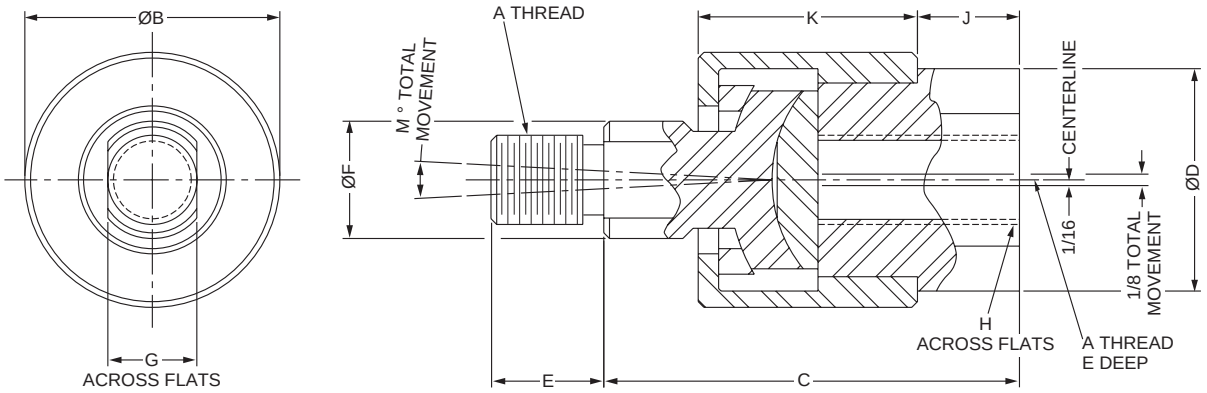
Linear Alignment Couplers are available in 19 standard thread sizes…



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



Part Numbers and Dimensions

Part Number	A	B Ø	C	D Ø	E	F Ø	G	H	J	K	M	Max. Pull Load (lb)	Max. Approx. Weight (lb)
1347570031	5/16-24	1.13	1.75	0.94	0.50	0.50	0.38	0.75	0.38	0.94	6°	1,200	.35
1347570038	3/8-24	1.13	1.75	0.94	0.50	0.50	0.38	0.75	0.38	0.94	6°	2,425	.35
1347570044	7/16-20	1.38	2.00	1.13	0.75	0.63	0.50	0.88	0.38	1.09	6°	3,250	.55
1347570050	1/2-20	1.38	2.00	1.13	0.75	0.63	0.50	0.88	0.38	1.09	6°	4,450	.55
1347570063	5/8-18	1.38	2.00	1.13	0.75	0.63	0.50	0.88	0.38	1.09	6°	6,800	.55
1347570075	3/4-16	2.00	2.31	1.63	1.13	0.94	0.75	1.31	0.44	1.28	6°	9,050	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°	14,450	1.4
1347570100	1-14	3.13	3.00	2.38	1.63	1.44	1.25	1.88	0.75	1.78	6°	19,425	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°	30,500	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	10°	30,500	6.9
1337390150	1 1/2-12	4.00	4.38	2.25	2.25	1.75	1.50	1.94	0.88	2.75	10°	45,750	9.8
1337390175	1 3/4-12	4.00	4.38	2.25	2.25	1.75	1.50	1.94	0.88	2.75	10°	58,350	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°	67,550	19.8
1337390200	2-12	5.00	5.63	3.00	3.00	2.25	2.00	2.63	1.38	3.38	10°	77,450	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°	99,250	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°	123,750	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°	150,950	45.3
1337390300	3-12	7.00	6.50	4.00	3.50	3.25	2.88	3.38	1.63	3.88	10°	180,850	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°	213,450	–
1337390425	4 1/4-12	12.88	11.25	7.75	4.50	5.50	4.88	7.00	1.50	8.75	10°	370,850	–

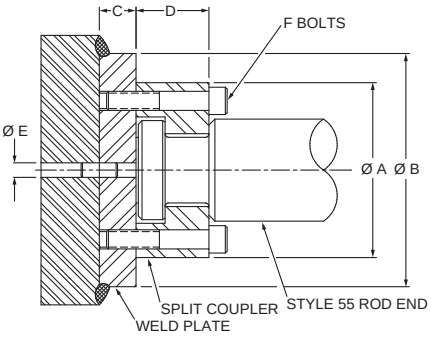
How to Order Linear Alignment Couplers — When ordering a cylinder with a threaded male rod end, specify the coupler of equal thread size by part number as listed in Table 1, i.e.; Piston Rod “KK” or “CC” dimension is 3/4" - 16", specify coupler part number 1347570075.

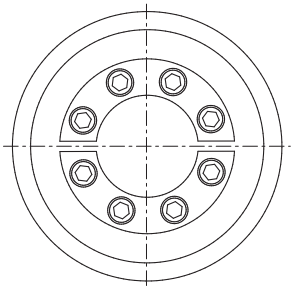
⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Split Couplers and Weld Plates
for Atlas "Style 55" Piston Rod End

Rod Ø	A Ø	B Ø	C	D	E Ø	F	Bolt Size	Bolt Circle	Split Coupler Part Number	Weld Plate Part Number
0.625	1.50	2.00	0.50	0.56	0.25	4	#10-24 x .94 LG	1.125	1472340062	1481740062
1.000	2.00	2.50	0.50	0.88	0.25	6	.250-20 x 1.25 LG	1.500	1472340100	1481740100
1.375	2.50	3.00	0.63	1.00	0.25	6	.312-18 x 1.50 LG	2.000	1472340138	1481740138
1.750	3.00	4.00	0.63	1.25	0.25	8	.312-18 x 1.75 LG	2.375	1472340175	1481740175
2.000	3.50	4.00	0.75	1.63	0.38	12	.375-16 x 2.25 LG	2.687	1472340200	1481740200
2.500	4.00	4.50	0.75	1.88	0.38	12	.375-16 x 2.50 LG	3.187	1472340250	1481740250
3.000	5.00	5.50	1.00	2.38	0.38	12	.500-13 x 3.25 LG	4.000	1472340300	1481740300
3.500	5.88	7.00	1.00	2.63	0.38	12	.625-11 x 3.50 LG	4.687	1472340350	1481740350
4.000	6.38	7.00	1.00	2.63	0.38	12	.625-11 x 3.50 LG	5.187	1472340400	1481740400
4.500	6.88	8.00	1.00	3.13	0.38	12	.625-11 x 4.00 LG	5.687	1472340450	1481740450
5.000	7.38	8.00	1.00	3.13	0.38	12	.625-11 x 4.00 LG	6.187	1472340500	1481740500
5.500	8.25	9.00	1.25	3.88	0.38	12	.750-10 x 5.00 LG	6.875	1472340550	1481740550
7.000	10.38	11.00	1.75	4.00	0.50	12	1.00-8 x 5.50 LG	8.750	1472340700	1481740700
8.000	11.38	12.00	2.00	4.00	0.50	16	1.00-8 x 5.50 LG	9.750	1472340800	1481740800
9.000	13.12	14.00	2.25	4.00	0.50	12	1.25-7 x 6.00 LG	11.125	1472340900	1481740900
10.000	14.12	15.00	2.50	4.50	0.50	16	1.25-7 x 6.50 LG	12.125	1472341000	1481741000

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





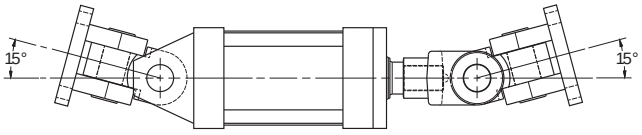
⚠WARNING: Piston rod separation from the machine member can result in severe personal injury or even death to nearby personnel. The cylinder user must make sure the weld holding the weld plate to the machine is of sufficient quality and size to hold the intended load. The cylinder user must also make 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.

Dual Axis Knuckles

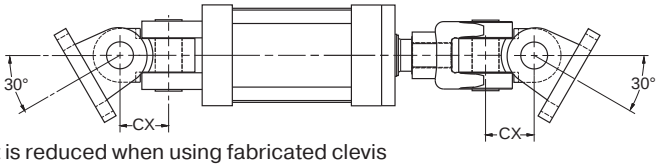
Using a Dual Axis Knuckle permits increased angular movement from the cylinder center line. Clevis or Eye mounted cylinders often require movement beyond the plane that two pivot pins allow. Spherical bearing mounts permit angular movement up to 4.5˚ within the pivoting plane. A Dual Axis Knuckle, with 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.

Maximum Achievable Angular Movement from Cylinder Centerline[1]

Inboard Pin - 15˚ maximum movement for cylinder misalignment only.



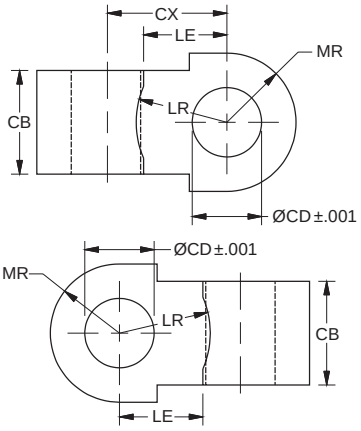
Outboard Pin - 30˚ maximum movement when applying force to a load moving in a curved plane.



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

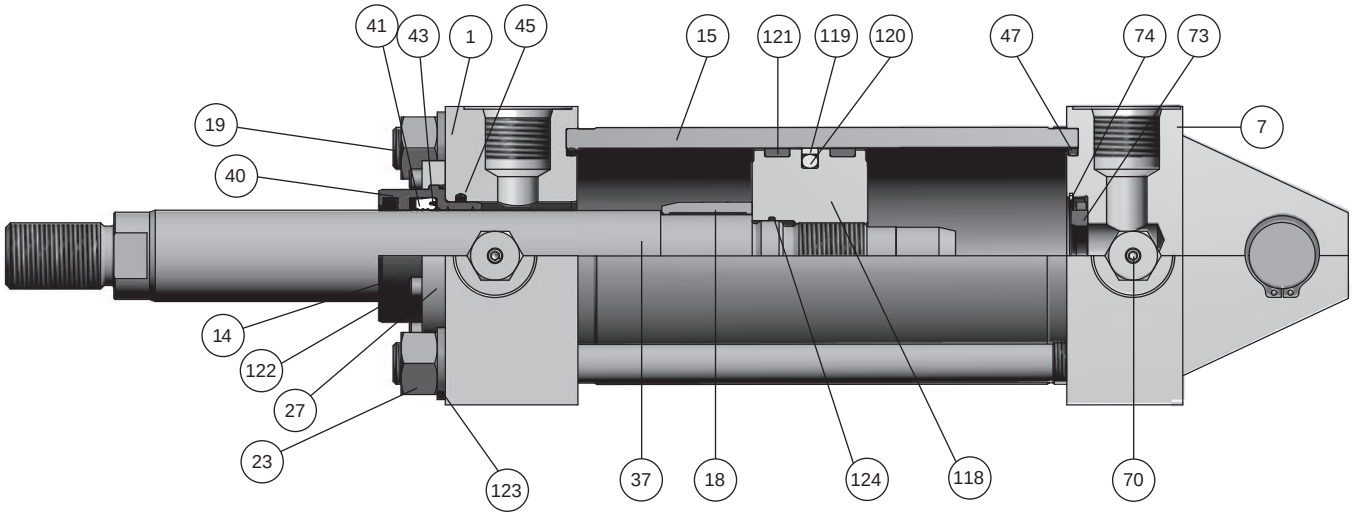
Dual Axis Knuckle Dimensions and Usage

Part Number	Pin Ø	Load Cap. (lb)	CB	CD Ø	CX	LE	LR	MR	Mating Parts		BB Mount Usage by Series & Bore
									Clevis Bracket	Rod Clevis	2H, 2HD, 2HB
0952670000	0.500	4,380	0.75	0.503	0.88	0.54	0.63	0.50	0960160050	0509400000, 0509410000	1.50
0952680000	0.750	12,370	1.25	0.753	1.19	0.80	0.94	0.75	0960160075	0509420000, 1332840000	2.00, 2.50
0952690000	1.000	20,500	1.50	1.003	1.69	1.05	1.22	1.00	0960160100	0509430000, 0509440000, 1332850000	3.25
0952700000	1.375	30,500	2.00	1.378	2.38	1.44	1.69	1.38	0960160138	0509450000, 1332860000	4.00
0952710000	1.750	49,500	2.50	1.753	3.06	1.81	2.19	1.75	0960160175	0509460000	5.00
0952720000	2.000	68,000	2.50	2.003	3.63	2.09	2.44	2.00	0960160200	0509470000, 0509480000	6.00



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1.50" - 8.00" Bore Series HV



Piston and Rod Assemblies

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

Parts List — 1.50" through 8.00" Bore

Symbol	Description
1	Head
7	Cap
14	Rod Gland
15	Cylinder Body
18	Cushion Sleeve, head end cushion
19	Tie Rod
23	Tie Rod Nut
27	Retainer
37	Piston Rod, single rod type
40	Rod Wiper
41	Rod Seal
43	Back-up Washer, rod seal

Symbol	Description
45	Gland O-Ring
47	O-Ring, cylinder tube to head and cap seal
70	Needle Valve, cushion adjustment cartridge
73	Bushing, float check, cushion on cap end
74	Retaining Ring, float check cushion bushing
118	Piston
119	Piston Seal
120	Piston Seal Energizer
121	Wear Ring
122	Retainer Bolt
123	Washer, tie rod nut
124	O-Ring, piston to rod seal

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Gland Cartridge Kits and Rod Seal Kits

Rod Dia.	Class 1 Service (Polyurethane & Nitrile)		Class 3 Service (EPR)		Class 5 Service (FKM)		Class 2 & 6 Service (Nitroxile)	
	Contains 1 ea. Sym, #41,40,41 & 45		Contains 1 ea. Sym, #41,40,41 & 45		Contains 1 ea. Sym, #41,40,41 & 45		Contains 1 ea. Sym, #41,40,41 & 45	
	Gland Cartridge Kits	Rod Seal Kits	Gland Cartridge Kits	Rod Seal Kits	Gland Cartridge Kits	Rod Seal Kits	Gland Cartridge Kits	Rod Seal Kits
0.625	H-RG110-63	H-RK110-63	H-RG310-63	H-RK310-63	H-RG510-63	H-RK510-63	H-RG210-63	H-RK210-63
1.000	H-RG110-100	H-RK110-100	H-RG310-100	H-RK310-100	H-RG510-100	H-RK510-100	H-RG210-100	H-RK210-100
1.375	H-RG110-138	H-RK110-138	H-RG310-138	H-RK310-138	H-RG510-138	H-RK510-138	H-RG210-138	H-RK210-138
1.750	H-RG110-175	H-RK110-175	H-RG310-175	H-RK310-175	H-RG510-175	H-RK510-175	H-RG210-175	H-RK210-175
2.000	H-RG110-200	H-RK110-200	H-RG310-200	H-RK310-200	H-RG510-200	H-RK510-200	H-RG210-200	H-RK210-200
2.500	H-RG110-250	H-RK110-250	H-RG310-250	H-RK310-250	H-RG510-250	H-RK510-250	H-RG210-250	H-RK210-250
3.000	H-RG110-300	H-RK110-300	H-RG310-300	H-RK310-300	H-RG510-300	H-RK510-300	H-RG210-300	H-RK210-300
3.500	H-RG110-350	H-RK110-350	H-RG310-350	H-RK310-350	H-RG510-350	H-RK510-350	H-RG210-350	H-RK210-350
4.000	H-RG110-400	H-RK110-400	H-RG310-400	H-RK310-400	H-RG510-400	H-RK510-400	H-RG210-400	H-RK210-400
4.500	H-RG110-450	H-RK110-450	H-RG310-450	H-RK310-450	H-RG510-450	H-RK510-450	H-RG210-450	H-RK210-450
5.000	H-RG110-500	H-RK110-500	H-RG310-500	H-RK310-500	H-RG510-500	H-RK510-500	H-RG210-500	H-RK210-500
5.500	H-RG110-550	H-RK110-550	H-RG310-550	H-RK310-550	H-RG510-550	H-RK510-550	H-RG210-550	H-RK210-550

[1]Rod Seal Kits do not includes Sym. #14

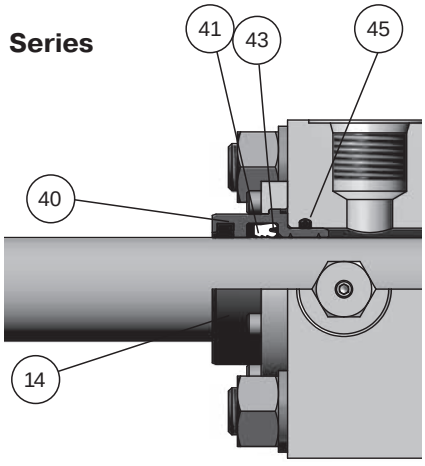
Series Crown Wiper Gland Cartridge Kits and Rod Seal Kits

Rod Dia.	Class 1 Service (Polyurethane & Nitrile)		Class 5 Service (FKM)		Retainer Bolt Torque (Torque values are for bolts installed with lubrication)
	Contains 1 ea. Sym, #41,40,41 & 45		Contains 1 ea. Sym, #41,40,41 & 45		
	Crown Wiper Gland Cartridge Kits	Crown Wiper Rod Seal Kits	Crown Wiper Gland Cartridge Kits	Crown Wiper Rod Seal Kits	
0.625	H-RG11C-63	H-RK11C-63	H-RG51C-63	H-RK51C-63	40 - 42 lb-in
1.000	H-RG11C-100	H-RK11C-100	H-RG51C-100	H-RK51C-100	40 - 42 lb-in
1.375	H-RG11C-138	H-RK11C-138	H-RG51C-138	H-RK51C-138	46 - 58 lb-in
1.750	H-RG11C-175	H-RK11C-175	H-RG51C-175	H-RK51C-175	46 - 58 lb-in
2.000	H-RG11C-200	H-RK11C-200	H-RG51C-200	H-RK51C-200	11 - 12 ft-lb
2.500	H-RG11C-250	H-RK11C-250	H-RG51C-250	H-RK51C-250	11 - 12 ft-lb
3.000	H-RG11C-300	H-RK11C-300	H-RG51C-300	H-RK51C-300	23 - 25 ft-lb
3.500	H-RG11C-350	H-RK11C-350	H-RG51C-350	H-RK51C-350	23 - 25 ft-lb
4.000	H-RG11C-400	H-RK11C-400	H-RG51C-400	H-RK51C-400	41 - 43 ft-lb
4.500	H-RG11C-450	H-RK11C-450	H-RG51C-450	H-RK51C-450	41 - 43 ft-lb
5.000	H-RG11C-500	H-RK11C-500	H-RG51C-500	H-RK51C-500	41 - 43 ft-lb
5.500	H-RG11C-550	H-RK11C-550	H-RG51C-550	H-RK51C-550	41 - 43 ft-lb

Rod Gland Cartridge Kit and Rod Seal Kit Parts Identification

- Gland Cartridge Kits contain items 14, 40, 41 and 45 (43 in class 2, 5 & 6 kits only)
- Rod Seal Kits contain items 40, 41 and 45 (43 in class 2, 5 & 6 kits only)

Series



D Engineering Data

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Piston Seal Kits – Series RP – Includes cylinder body end seals

Bore Size	Piston Seal RP, No Magnet				
	Class 1 Service	Class 2,6 Service	Class 3 Service	Class 4 Service	Class 5 Service
	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120
1.50	H-KBR01-150	H-KBR02-150	H-KBR03-150	H-KBR04-150	H-KBR05-150
2.00	H-KBR01-200	H-KBR02-200	H-KBR03-200	H-KBR04-200	H-KBR05-200
2.50	H-KBR01-250	H-KBR02-250	H-KBR03-250	H-KBR04-250	H-KBR05-250
3.25	H-KBR01-325	H-KBR02-325	H-KBR03-325	H-KBR04-325	H-KBR05-325
4.00	H-KBR01-400	H-KBR02-400	H-KBR03-400	H-KBR04-400	H-KBR05-400
5.00	H-KBR01-500	H-KBR02-500	H-KBR03-500	H-KBR04-500	H-KBR05-500
6.00	H-KBR01-600	H-KBR02-600	H-KBR03-600	H-KBR04-600	H-KBR05-600
7.00	H-KBR01-700	H-KBR02-700	H-KBR03-700	H-KBR04-700	H-KBR05-700
8.00	H-KBR01-800	H-KBR02-800	H-KBR03-800	H-KBR04-800	H-KBR05-800

Bore Size	Piston Seal RP, With Magnet				
	Class 1 Service	Class 2,6 Service	Class 3 Service	Class 4 Service	Class 5 Service
	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121
1.50	H-KBRM1-150	H-KBRM2-150	H-KBRM3-150	H-KBRM4-150	H-KBRM5-150
2.00	H-KBRM1-200	H-KBRM2-200	H-KBRM3-200	H-KBRM4-200	H-KBRM5-200
2.50	H-KBRM1-250	H-KBRM2-250	H-KBRM3-250	H-KBRM4-250	H-KBRM5-250
3.25	H-KBRM1-325	H-KBRM2-325	H-KBRM3-325	H-KBRM4-325	H-KBRM5-325
4.00	H-KBRM1-400	H-KBRM2-400	H-KBRM3-400	H-KBRM4-400	H-KBRM5-400
5.00	H-KBRM1-500	H-KBRM2-500	H-KBRM3-500	H-KBRM4-500	H-KBRM5-500
6.00	H-KBRM1-600	H-KBRM2-600	H-KBRM3-600	H-KBRM4-600	H-KBRM5-600
7.00	N/A	N/A	N/A	N/A	N/A
8.00	N/A	N/A	N/A	N/A	N/A

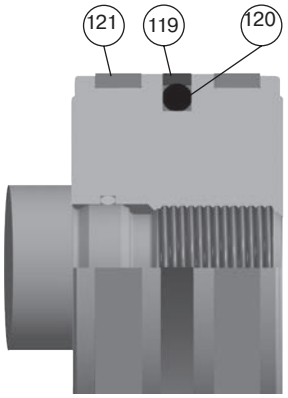
Tie Rod Torque 1.50 - 4.00	1.50	2.00	2.50	3.25	4.00
	18 -19 lb-ft	45 -49 lb-ft	45 -49 lb-ft	120 -124 lb-ft	131 -135 lb-ft

Tie Rod Torque 5.00 - 8.00	5.00	6.00	7.00	8.00
	312 -316 lb-ft	528 -544 lb-ft	800 -816 lb-ft	1168 -1184 lb-ft

Note: The tie rod torque values are for cylinders rated at 3,000 psi. Consult the factory for torque values for cylinders rated above 3,000 psi

Note: Item 47, cylinder body end seal, is not shown.

RP Piston



⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Piston Seal Kits – Series WP – Includes cylinder body end seals

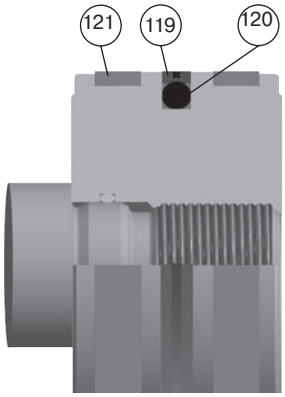
Bore Size	Piston Seal WP, With Magnet			
	Class 1 Service	Class 2,6 Service	Class 3 Service	Class 5 Service
	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121
1.50	H-KBWM1-150	H-KBWM2-150	H-KBWM3-150	H-KBWM5-150
2.00	H-KBWM1-200	H-KBWM2-200	H-KBWM3-200	H-KBWM5-200
2.50	H-KBWM1-250	H-KBWM2-250	H-KBWM3-250	H-KBWM5-250
3.25	H-KBWM1-325	H-KBWM2-325	H-KBWM3-325	H-KBWM5-325
4.00	H-KBWM1-400	H-KBWM2-400	H-KBWM3-400	H-KBWM5-400
5.00	H-KBWM1-500	H-KBWM2-500	H-KBWM3-500	H-KBWM5-500
6.00	H-KBWM1-600	H-KBWM2-600	H-KBWM3-600	H-KBWM5-600
7.00	N/A	N/A	N/A	N/A
8.00	N/A	N/A	N/A	N/A

Bore Size	Piston Seal WP, No Magnet			
	Class 1 Service	Class 2,6 Service	Class 3 Service	Class 5 Service
	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120
1.50	H-KBW01-150	H-KBW02-150	H-KBW03-150	H-KBW05-150
2.00	H-KBW01-200	H-KBW02-200	H-KBW03-200	H-KBW05-200
2.50	H-KBW01-250	H-KBW02-250	H-KBW03-250	H-KBW05-250
3.25	H-KBW01-325	H-KBW02-325	H-KBW03-325	H-KBW05-325
4.00	H-KBW01-400	H-KBW02-400	H-KBW03-400	H-KBW05-400
5.00	H-KBW01-500	H-KBW02-500	H-KBW03-500	H-KBW05-500
6.00	H-KBW01-600	H-KBW02-600	H-KBW03-600	H-KBW05-600
7.00	H-KBW01-700	H-KBW02-700	H-KBW03-700	H-KBW05-700
8.00	H-KBW01-800	H-KBW02-800	H-KBW03-800	H-KBW05-800

Tie Rod Torque 1.50 - 4.00	1.50	2.00	2.50	3.25	4.00
	18 -19 lb-ft	45 -49 lb-ft	45 -49 lb-ft	120 -124 lb-ft	131 -135 lb-ft

Tie Rod Torque 5.00 - 8.00	5.00	6.00	7.00	8.00
	312 -316 lb-ft	528 -544 lb-ft	800 -816 lb-ft	1168 -1184 lb-ft

WP Piston



Note: The tie rod torque values are for cylinders rated at 3,000 psi. Consult the factory for torque values for cylinders rated above 3,000 psi

[1] Item 119 for piston style WP (model number code W) includes both the PTFE primary seal and the redundant quad ring seal.

[2] The 1.50" bore WP seal groove is unique and not universal to the other seal styles. Changing an existing 1.50" bore cylinder either from or to a WP piston seal requires that a new piston and rod assembly be ordered.

Note: Item 47, cylinder body end seal, is not shown.

D Engineering Data

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Piston Seal Kits – Series HP – Includes cylinder body end seals

Bore Size	Piston Seal HP, No Magnet	
	Class 1 Service	**Class 4 Service**
	Contains two each #47, 121, and one each #119 &120	**Contains two each #47, 121, and one each #119 &120**
1.50	H-KBH01-150	H-KBH04-150
2.00	H-KBH01-200	H-KBH04-200
2.50	H-KBH01-250	H-KBH04-250
3.25	H-KBH01-325	H-KBH04-325
4.00	H-KBH01-400	H-KBH04-400
5.00	H-KBH01-500	H-KBH04-500
6.00	H-KBH01-600	H-KBH04-600
7.00	H-KBH01-700	H-KBH04-700
8.00	H-KBH01-800	H-KBH04-800

Bore Size	Piston Seal HP, With Magnet	
	Class 1 Service	**Class 4 Service**
	Contains two each #47 and one each #119, 120 & 121	**Contains two each #47 and one each #119, 120 & 121**
1.50	H-KBHM1-150	H-KBHM4-150
2.00	H-KBHM1-200	H-KBHM4-200
2.50	H-KBHM1-250	H-KBHM4-250
3.25	H-KBHM1-325	H-KBHM4-325
4.00	H-KBHM1-400	H-KBHM4-400
5.00	H-KBHM1-500	H-KBHM4-500
6.00	H-KBHM1-600	H-KBHM4-600
7.00	N/A	N/A
8.00	N/A	N/A

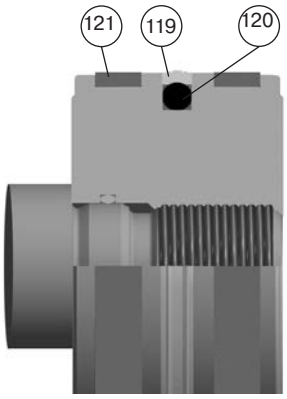
Tie Rod Torque 1.50 - 4.00	1.50	2.00	2.50	3.25	4.00
	18 -19 lb-ft	45 -49 lb-ft	45 -49 lb-ft	120 -124 lb-ft	131 -135 lb-ft

Tie Rod Torque 5.00 - 8.00	5.00	6.00	7.00	8.00
	312 -316 lb-ft	528 -544 lb-ft	800 -816 lb-ft	1168 -1184 lb-ft

Note: The tie rod torque values are for cylinders rated at 3,000 psi. Consult the factory for torque values for cylinders rated above 3,000 psi

Note: Item 47, cylinder body end seal, is not shown.

HP Piston



⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Piston Seal Kits – Series KP – Includes cylinder body end seals

Bore Size	Piston Seal KP, No Magnet					
	Class 1 Service	Class 2,6 Service	Class 3 Service	Class 4 Service	Class 5 Service	Class 8 Service
	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120	Contains two each #47, 121, and one each #119 &120
1.50	H-KBK01-150	H-KBK02-150	H-KBK03-150	H-KBK04-150	H-KBK05-150	H-KBK08-150
2.00	H-KBK01-200	H-KBK02-200	H-KBK03-200	H-KBK04-200	H-KBK05-200	H-KBK08-200
2.50	H-KBK01-250	H-KBK02-250	H-KBK03-250	H-KBK04-250	H-KBK05-250	H-KBK08-250
3.25	H-KBK01-325	H-KBK02-325	H-KBK03-325	H-KBK04-325	H-KBK05-325	H-KBK08-325
4.00	H-KBK01-400	H-KBK02-400	H-KBK03-400	H-KBK04-400	H-KBK05-400	H-KBK08-400
5.00	H-KBK01-500	H-KBK02-500	H-KBK03-500	H-KBK04-500	H-KBK05-500	H-KBK08-500
6.00	H-KBK01-600	H-KBK02-600	H-KBK03-600	H-KBK04-600	H-KBK05-600	H-KBK08-600
7.00	H-KBK01-700	H-KBK02-700	H-KBK03-700	H-KBK04-700	H-KBK05-700	H-KBK08-700
8.00	H-KBK01-800	H-KBK02-800	H-KBK03-800	H-KBK04-800	H-KBK05-800	H-KBK08-800

Bore Size	Piston Seal K, With Magnet				
	Class 1 Service	Class 2,6 Service	Class 3 Service	Class 4 Service	Class 5 Service
	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121	Contains two each #47 and one each #119, 120 & 121
1.50	H-KBKM1-150	H-KBKM2-150	H-KBKM3-150	H-KBKM4-150	H-KBKM5-150
2.00	H-KBKM1-200	H-KBKM2-200	H-KBKM3-200	H-KBKM4-200	H-KBKM5-200
2.50	H-KBKM1-250	H-KBKM2-250	H-KBKM3-250	H-KBKM4-250	H-KBKM5-250
3.25	H-KBKM1-325	H-KBKM2-325	H-KBKM3-325	H-KBKM4-325	H-KBKM5-325
4.00	H-KBKM1-400	H-KBKM2-400	H-KBKM3-400	H-KBKM4-400	H-KBKM5-400
5.00	H-KBKM1-500	H-KBKM2-500	H-KBKM3-500	H-KBKM4-500	H-KBKM5-500
6.00	H-KBKM1-600	H-KBKM2-600	H-KBKM3-600	H-KBKM4-600	H-KBKM5-600
7.00	N/A	N/A	N/A	N/A	N/A
8.00	N/A	N/A	N/A	N/A	N/A

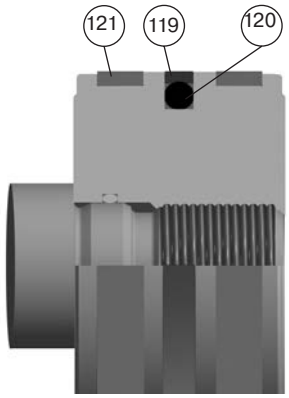
Tie Rod Torque 1.50 - 4.00	1.50	2.00	2.50	3.25	4.00
	18 -19 lb-ft	45 -49 lb-ft	45 -49 lb-ft	120 -124 lb-ft	131 -135 lb-ft

Tie Rod Torque 5.00 - 8.00	5.00	6.00	7.00	8.00
	312 -316 lb-ft	528 -544 lb-ft	800 -816 lb-ft	1168 -1184 lb-ft

Note: The tie rod torque values are for cylinders rated at 3,000 psi. Consult the factory for torque values for cylinders rated above 3,000 psi

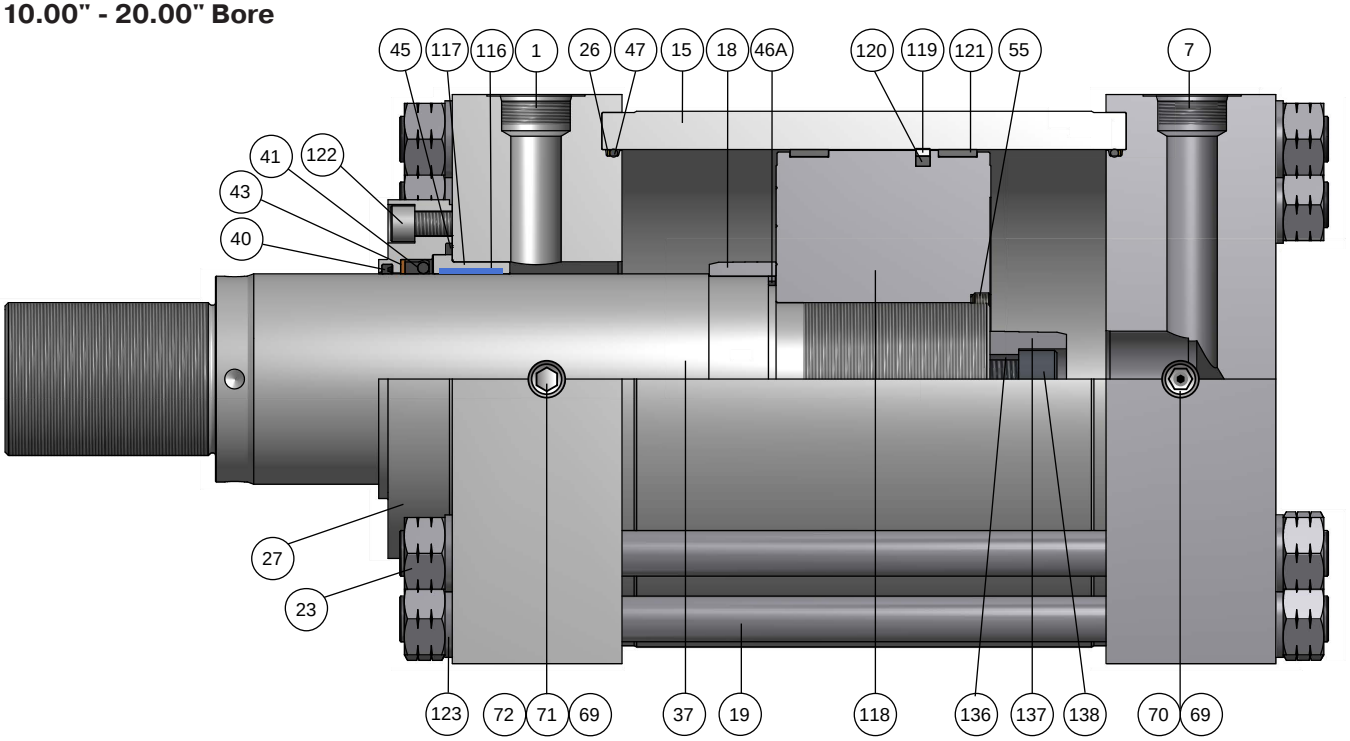
Note: Item 47, cylinder body end seal, is not shown.

KP Piston



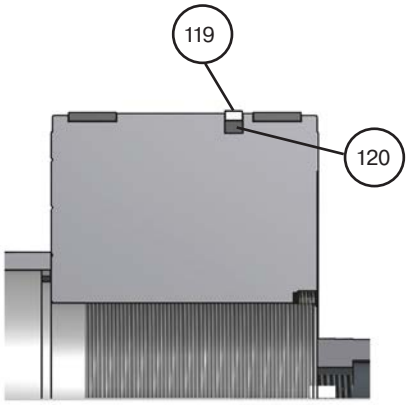
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

10.00" - 20.00" Bore

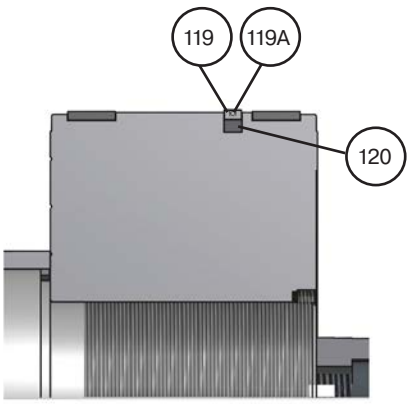


Symbol	Description
1	Head
7	Cap
15	Cylinder Body
18	Cushion Sleeve, head end cushion
19	Tie Rod
23	Tie Rod Nut
26	Back-up Washer, tube end seal
27	Retainer
37	Piston Rod, single rod type
40	Rod Wiperseal
41	Rod Seal
43	Back-up Washer, rod seal
45	Gland O-Ring
46A	Cushion Sealing Ring
47	O-Ring, cylinder tube to head and cap seal

Symbol	Description
55	Set Screw, piston lock
70	Cushion Adjusting Needle Assembly
72,71,69	Check Valve Screw, Ball, O-Ring
116	Wear Ring Rod
117	Rod Bushing (Gland)
118	Piston
119	Piston Seal
119 A	Quad (WP only) Ring (see closeup below)
120	Piston Seal Energizer
121	Wear Ring
122	Retainer Bolt
123	Washer, tie rod nut
136	Spacer, cushion
137	Cushion Spear, detachable
138	Bolt, cushion spear



Standard HP Style Piston Seal



Optional WP Style Mixed Media Piston Seal

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10.00" - 20.00" Bore

Large Bore Rod Seal Kits

Rod Dia.	Rod Seal Kits (including Wear Ring)			Rod Seal Kits (including Wear Ring & Bushing)		
	Contains Symbols			Contains Symbols		
	40, 41, 43, 45, 116			40, 41, 43, 45, 116, 117		
	CLASS 1	CLASS 2	CLASS 5	CLASS 1	CLASS 2	CLASS 5
4.500	H-RKL110-450	H-RKL210-450	H-RKL510-450	H-RGL110-450	H-RGL210-450	H-RGL510-450
5.000	H-RKL110-500	H-RKL210-500	H-RKL510-500	H-RGL110-500	H-RGL210-500	H-RGL510-500
5.500	H-RKL110-550	H-RKL210-550	H-RKL510-550	H-RGL110-550	H-RGL210-550	H-RGL510-550
7.000	H-RKL110-700	H-RKL210-700	H-RKL510-700	H-RGL110-700	H-RGL210-700	H-RGL510-700
8.000	H-RKL110-800	H-RKL210-800	H-RKL510-800	H-RGL110-800	H-RGL210-800	H-RGL510-800
9.000	H-RKL110-900	H-RKL210-900	H-RKL510-900	H-RGL110-900	H-RGL210-900	H-RGL510-900
10.000	H-RKL110-1000	H-RKL210-1000	H-RKL510-1000	H-RGL110-1000	H-RGL210-1000	H-RGL510-1000

Ø Rod	Retainer Bolt Torques	
	Nom. Bolt Size	Torque
4.500	1/2	100 - 105 lb-ft
5.000	5/8	185 - 194 lb-ft
5.500	5/8	185 - 194 lb-ft
7.000	1/2	100 - 105 lb-ft
8.000	3/4	330 - 346 lb-ft
9.000	3/4	330 - 346 lb-ft
10.000	3/4	330 - 346 lb-ft

Ø Bore	Tie Rod Torques
10.00	800 - 850 lb-ft
12.00	1300 - 1350 lb-ft
14.00	1175 - 1225 lb-ft
16.00	2900 - 3000 lb-ft
18.00	2350 - 2450 lb-ft
20.00	2900 - 3000 lb-ft

Ø Bore	Cylinder Body End Seals		
	Contains Symbols		
	(2X) 47	(2X) 26, (2X) 47	
	Group 1	Group 2	Group 5
10.00	CB1003HG01	CB1003HG02	CB1003HG05
12.00	CB1203HG01	CB1203HG02	CB1203HG05
14.00	CB1403HG01	CB1403HG02	CB1403HG05
16.00	CB1603HG01	CB1603HG02	CB1603HG05
18.00	CB1803HG01	CB1803HG02	CB1803HG05
20.00	CB2003HG01	CB2003HG02	CB2003HG05

Large Bore Piston Seal Kits

Bore	Piston Seal Kits			
	Contains Symbols			
	Contains two ea. 47, 121 and one ea. 119, 120, 119A (WP Kit only)			
	HP CLASS 1	KP CLASS 1	RP CLASS 1	WP CLASS 1
10.00	H-KBH01-1000	H-KBK01-1000	H-KBR01-1000	H-KBW01-1000
12.20	H-KBH01-1200	H-KBK01-1200	H-KBR01-1200	H-KBW01-1200
14.00	H-KBH01-1400	H-KBK01-1400	H-KBR01-1400	H-KBW01-1400
16.00	H-KBH01-1600	H-KBK01-1600	H-KBR01-1600	H-KBW01-1600
18.00	H-KBH01-1800	H-KBK01-1800	H-KBR01-1800	H-KBW01-1800
20.00	H-KBH01-2000	H-KBK01-2000	H-KBR01-2000	H-KBW01-2000

Bore	Piston Seal Kits					
	Contains Symbols					
	Contains two ea. 26, 47, 121 and one ea. 119, 120, 119A (WP Kit only)					
	KP CLASS 2	RP CLASS 2	WP CLASS 2	KP CLASS 5	RP CLASS 5	WP CLASS 5
10.00	H-KBK02-1000	H-KBR02-1000	H-KBW02-1000	H-KBK05-1000	H-KBR05-1000	H-KBW05-1000
12.20	H-KBK02-1200	H-KBR02-1200	H-KBW02-1200	H-KBK05-1200	H-KBR05-1200	H-KBW05-1200
14.00	H-KBK02-1400	H-KBR02-1400	H-KBW02-1400	H-KBK05-1400	H-KBR05-1400	H-KBW05-1400
16.00	H-KBK02-1600	H-KBR02-1600	H-KBW02-1600	H-KBK05-1600	H-KBR05-1600	H-KBW05-1600
18.00	H-KBK02-1800	H-KBR02-1800	H-KBW02-1800	H-KBK05-1800	H-KBR05-1800	H-KBW05-1800
20.00	H-KBK02-2000	H-KBR02-2000	H-KBW02-2000	H-KBK05-2000	H-KBR05-2000	H-KBW05-2000

⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Notes

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Section E

Custom Modifications

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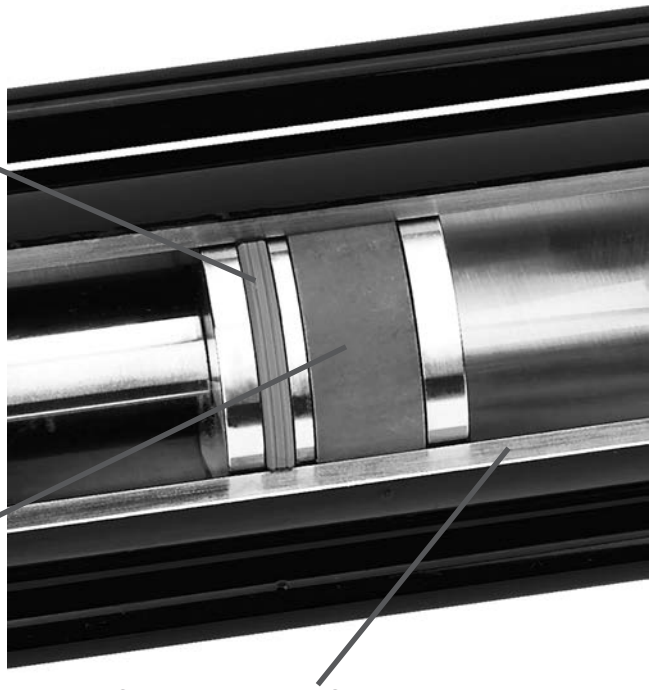
Series H Magnetic Piston

Position Sensing Technology for Hydraulic Cylinders – 1.50" thru 6.00" Bore

Customer Value Proposition

Atlas's magnetic sensing option for heavy duty hydraulic cylinders provides OEM's and end users the ability to sense piston position economically and reliably through the use of innovative magnet and switching technology. The magnetic piston option offers all users the ability to eliminate added cylinder machining costs, stand alone external brackets / hardware and reduced system set-up time. By incorporating sensing capability into hydraulic cylinders, the need to install, wire and adjust stand alone proximity switches can be eliminated – thus providing a clean and more efficient position monitoring system.

Series H Cylinder with magnetic piston



Sensing Technologies

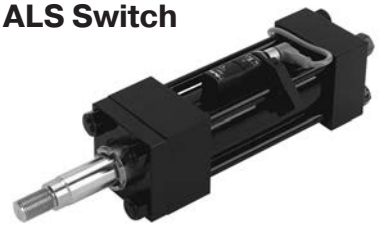
- Atlas's ALS switch works with a magnetic piston in a standard steel tube by detecting the change in polarity of the steel material as the magnet passes under the switch. Standard steel tube is more economical in longer strokes than non-ferrous stainless steel tubes required for conventional sensors. Solid State ALS switches are available in both PNP and NPN outputs and can be wired either normally open or normally closed. Magnetic piston with steel tube for ALS switches is available 1.50" – 6.00" bore and is specified with a '7' in the Piston Magnet field of the cylinder model number.
- Atlas Global Switches are available in both Reed and Solid State types. Solid State switches are available in both PNP and NPN outputs. They work with a magnetic piston in a 316 stainless steel tube. Magnetic piston with a stainless steel tube for Global Switches is available 1.50" – 4.00" bore and is specified with a '3' in the Piston Magnet field of the cylinder model number.

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Magnetic Switch Choices

Atlas'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 deciding which technology to choose are shown below. For more details on ALS and Global switches as well as other position sensing options see catalog HY08-1132.

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

ALS Switch Kit Part Numbers

Switches are packaged with a mounting bracket.

Part Number		Switch Bracket Usage
PNP	NPN	
ALS-PH	ALS-NH	Series 2H 1.50 – 4.00 Bore
ALS-PHA	ALS-NHA	Series 2H 5.00 & 6.00 Bore

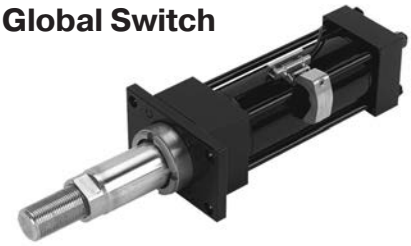
Minimum Stroke for ALS Switch

Bore Ø	Minimum Stroke
1.50	3.00
2.00	3.00
2.50	2.88
3.25	2.75

Bore Ø	Minimum Stroke
4.00	2.63
5.00	2.38
6.00	2.19

ALS Switches allow a .38 - .50 inch stroke-to-go piston travel for end-of-stroke mounting locations.

Global Switch



- Uses 316 stainless steel tube
- +10 to +30 VDC power requirement
- PNP/NPN, Reed
- Solid state construction
- 1 power LED indicator
- 8mm connector or flying leads
- IP67 rated
- Temperature Range: -25°C to + 75°C
- Short circuit protection

Global Drop-In Switches

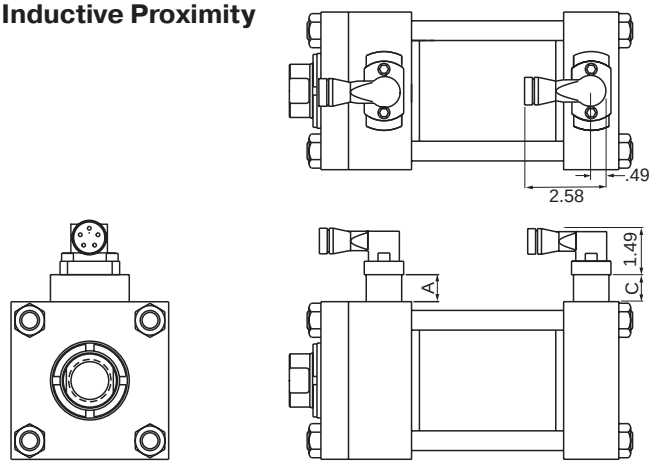
Wiring	Reed	PNP Switch	NPN Switch
3m Flying Leads	P8SAGRFAX	P8SAGPFAX	P8SAGNFAX
10m Flying Leads	P8SAGRFDX2	P8SAGPFDX	P8SAGNFDX
0.3m Lead with 8mm connector	P8SAGRCHX	P8SAGPCHX	P8SAGNCHX

Wiring	PNP Switch ATEX Certified	PNP Switch High Temperature
3m Flying Leads	P8SAGPFAXS	P8S-GPFLH

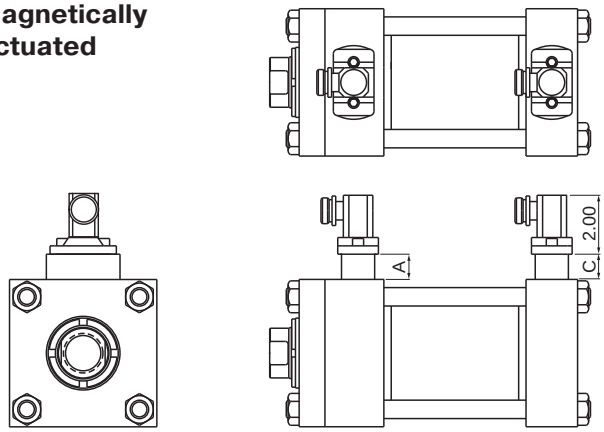
Global switch tie rod mounting bracket, part number P8S-TMA0X, must be ordered separately.

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

EPS 7 & 6 Sensors
Inductive Proximity



CLS 1 & 4 Sensors
Non-Contacting
Magnetically
Actuated

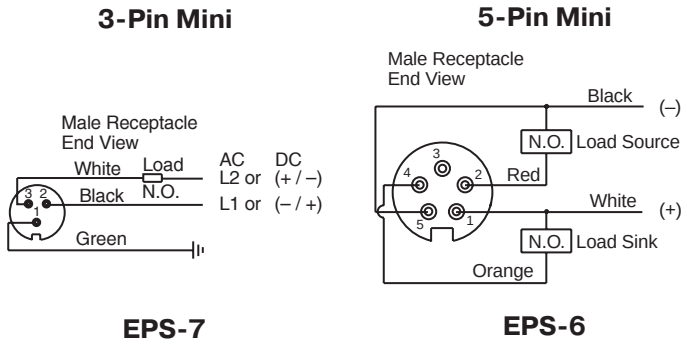


Spacer Height
EPS & CLS Sensors

A max.	C max.
.86	1.75

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

Connector Pin Numbering



EPS-7 **EPS-6**

Series and Parallel Wiring

When Atlas 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.

Atlas 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.

Atlas 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. In most cases, the use of two or more EPS-6 or 7 sensors in parallel will require the use of a bypass (shunt) resistor.

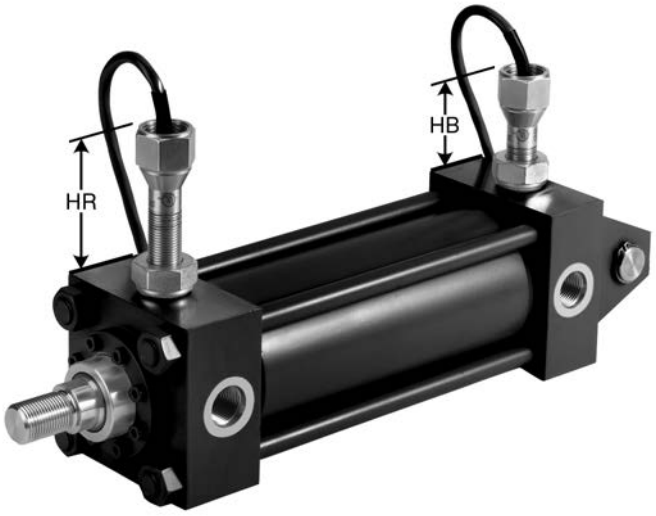
Minimum Stroke

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 Cushion Length Chart in this catalog for details. Contact the factory if a shorter stroke is required.

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CLS-2 Threaded Style Switches

Spacers are not required. Threaded switches can be adjusted for small changes to end of stroke position sensing.



Switch Height

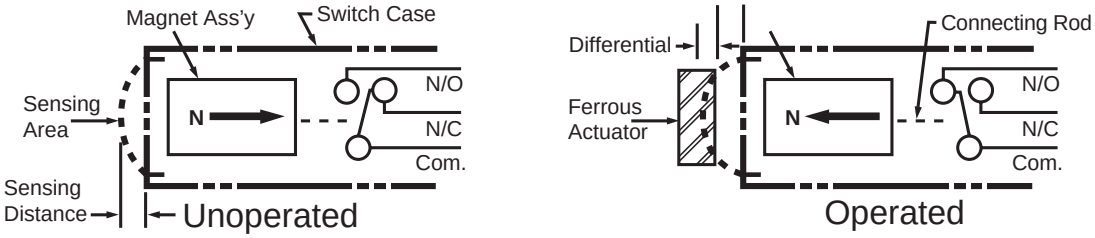
Bore Ø	Rod Ø	HR	HB
1.50	0.625	2.56	3.31
	1.000	2.75	
2.00	1.000	2.56	3.25
	1.375	2.69	
2.50	1.000	2.31	2.94
	1.375	2.50	
	1.750	2.69	
3.25	1.375	2.94	2.56
	1.750	3.13	
	2.000	3.31	
4.00	1.750	2.88	2.44
	2.000	3.06	
	2.500	2.50	
5.00	2.000	2.31	2.31
	2.500	2.63	
	3.000	2.88	
	3.500	3.13	
6.00	2.500	2.13	3.00
	3.000	2.38	
	3.500	2.63	
	4.000	2.88	
7.00	3.000	3.38	2.69
	3.500	2.13	
	4.000	2.38	
	4.500	2.63	
	5.000	3.00	
8.00	3.500	3.13	2.25
	4.000	3.38	
	4.500	2.13	
	5.000	2.50	
	5.500	2.69	

As shown in the illustrations below, these switches are magnetically operated. Dual magnets provide a dependable “snap action” for positive position sensing.

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

In the “Operated” position a ferrous part (cushion or piston) enters the sensing area and attracts the magnet assembly which causes the rod to draw the contacts together.

Operating Principle



Sensing gap: .030" to .060"

Trip point: Factory set with piston bottomed out.

Release point: Approx. 0.25" piston travel.

Minimum cylinder stroke is .50" on 1.50" & 2.00" bores; and .75" on 2.50" bore and larger.

See the CLS Specification table for additional details.

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Specifications					
Style:	**EPS-7**	**EPS-6**	**CLS-1**	**CLS-4**	**CLS-2**
Code Designator:	H	D	F	B	G
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.	For applications where the customer needs NC contacts, zero leakage, zero voltage drop, higher or lower load current than EPS style. Threaded style permits small adjustability of make/break location.
Supply Voltage:	20 to 250 VAC/DC	10 to 30 VDC	24 to 240 VAC/DC	24 to 240 VAC/DC	24 to 240 VAC/DC
Load Current, min:	8 mA	N/A	NA	NA	NA
Load Current, max:	300 mA	200 mA	4 AMPS @ 120 VAC 3 AMPS @ 24 VDC	4 AMPS @ 120 VAC 3 AMPS @ 24 VDC	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	None
Operating Temperature:	-14˚ to +158˚ F	-14˚ to +158˚F	-40˚F to +221˚F	-40˚F to +400˚F	-40˚F to +221˚F
Sensor Type:	Inductive proximity	Inductive proximity	non-contacting magnetically actuated	non-contacting magnetically actuated	non-contacting magnetically actuated
Part Number:	148897[1]	148896[1]	148275[1]	149109[1]	117000, 117017, 117034
Part Number Suffix[1]:	**[1]4-digit suffix indicates probe length: 0125=1.25", 0206=2.06", 0287=2.875", 0456=4.562"**				Switch selection is application dependent – Contact Factory
Connection:	3 pin mini	5 pin mini	3 pin mini	144" PTFE Coated Flying Leads with 1/2" conduit hub	36" Potted-in PVC cable (most sizes also 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	NEMA 4, 4X, 6, 6P, 7, 9
LED indication:	Yes	Yes	Yes	No	No
Short Circuit Protection:	Yes	Yes	No	No	No
Weld Field Immunity:	Yes	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	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]	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)	Common (Black) Normally Open (Blue) Normally Closed (Red)
Cable: 6'	0853550006	0859170006	0853550006	–	–
Cable: 12'	0853550012	0859170012	0853550012	–	–
Cable: 6', Right Angle	0875470006	–	0875470006	–	–

[2]CSA available upon request – contact factory.

How to Specify EPS Proximity Switches

Atlas EPS proximity switches may be ordered on Series H 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. See Available Switch Position table below for additional details.

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, "B" for CLS-4 or "G" for CLS-2, 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, CLS-4

Head End

H	1	3	A	GG
Specify: "H" = EPS-7 "D" = EPS-6 "F" = CLS-1[1] "B" = CLS-4[1] "G" = CLS-2 "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 EPS-7, EPS-6, CLS-1 and CLS-4.	Actuation Point GG = End of Stroke FF = Stroke to Go[2]; 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[1] "B" = CLS-4[1] "G" = CLS-2 "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 EPS-7, EPS-6, CLS-1 and CLS-4.	Actuation Point GG = End of Stroke FF = Stroke to Go[2]; 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.

[1] CLS-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.

[2] FF Stroke to Go not available with CLS-2 switch.

Figure 1

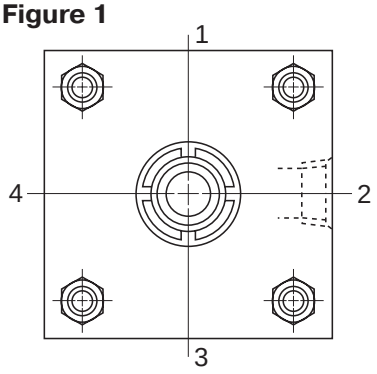
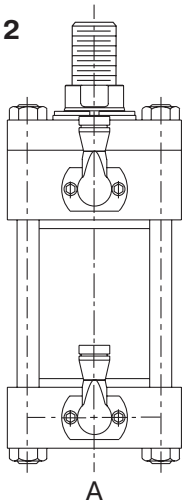


Figure 2



Available Mounting Positions[1] for EPS-6, EPS-7, CLS-1, CLS-4

MOUNTING STYLES		Bore Ø							
		1.50	2.00	2.50	3.25	4.00	5.00	6.00	7.00	8.00
T,TB,TC, TD,BB,DD, DE,SB,SE	HEAD	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
	CAP	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
J,D,JJ[2]	HEAD	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
	CAP	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
H,DB,HH	HEAD	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
	CAP	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
C[3]	HEAD	1	1	1	1	1	1	1,2,4	1,2,4	1,2,4
	CAP	1	1	1	1	1	1	1,2,4	1,2,4	1,2,4
F	HEAD	1	1	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4
	CAP	1	1	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4
JB	HEAD	NA	NA	NA	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
	CAP	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
HB	HEAD	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
	CAP	NA	NA	NA	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4

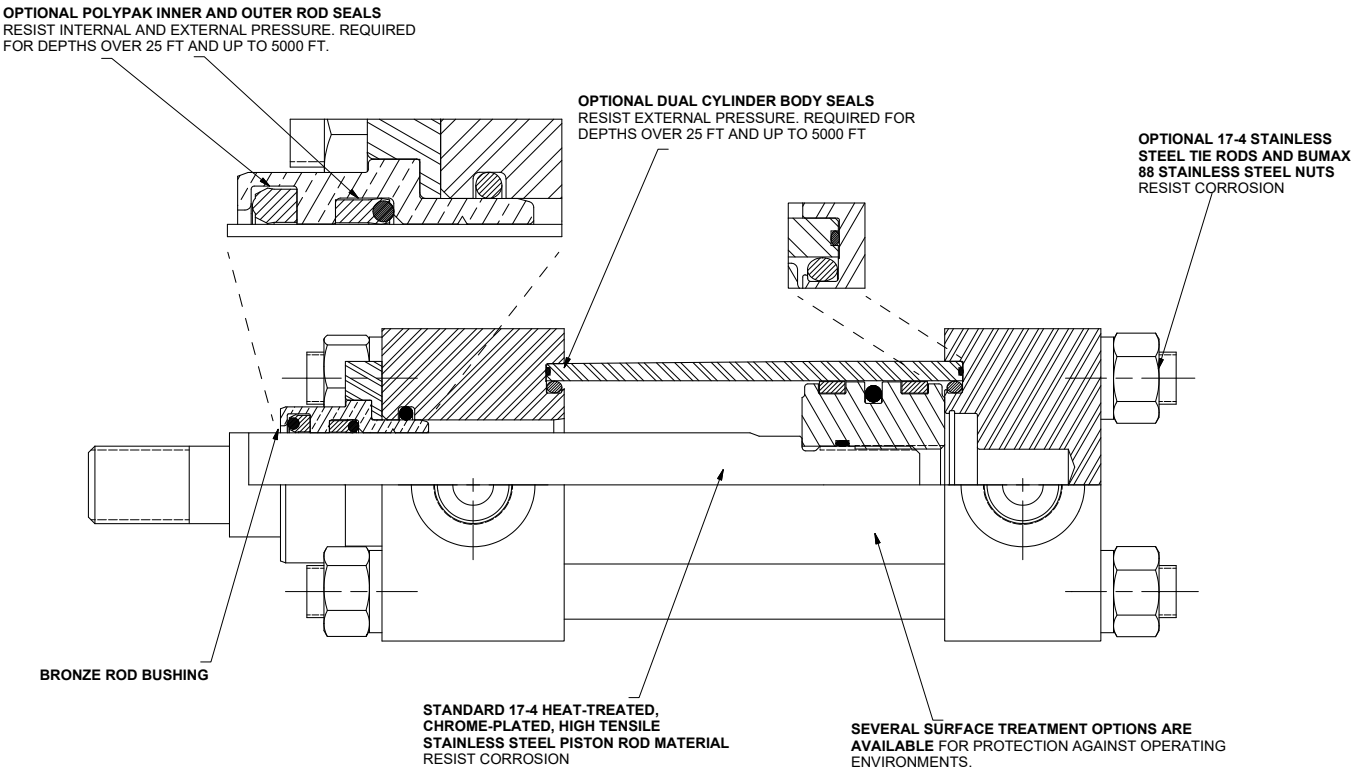
[1] Positions 1, 2, 3 and 4 are determined by viewing cylinder from piston rod end (See Figure 1). The electrical connector orientation may be restricted in some cases.

[2] On 1.50" - 5.00" bore Style JJ cylinders, switches will extend beyond mounting surface of cylinder.

[3] On 6.00" bore cylinders and larger switches mounted in position 2 or 4 will interfere with the installation and removal of mounting bolts.

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Water Submersible Option for Series H Hydraulic Cylinders



Specifications:

- Submersion Depth: up to 5000 ft
- Heavy Duty Service – ANSI (NFPA) T3.6.7R2 – 1996 Specifications and Mounting Dimension Standards
- Nominal Pressure – 3000 psi
- Operating Temperature – -10°F to +165°F
- 17-4 PH chrome plated stainless steel piston rod
- Stainless steel name tag affixed with stainless steel wire around tie rod

Cylinder Seal Construction:

- Up to 25 ft – Standard rod seal and body seals
- Over 25 ft to 5000 ft
  - Subsea rod seal package that includes a Polypak oil seal and an outward facing Polypak wiper to seal against water intrusion.
  - Subsea body seal package with ID oil seal and body-end o-ring to seal against water intrusion.
  - Not available with 0.625 Ø piston rod

Standard Options for Water Submersible Cylinders:

Material

- 17-4 PH stainless steel tie rods and Bumax 88 stainless steel tie rod nuts
- Chrome plated body ID

Surface Treatments for Corrosion Protection

- Electroless nickel plated exterior (head, cap, body and retainer)
- Inorganic zinc primer (zinc primer only – without bond coating)
- Inorganic zinc primer with epoxy undercoat and anacrylic topcoat
- Epoxy undercoat and topcoat

Custom Options available for Special Order:

- End-of-Stroke Switches
- All stainless steel construction

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Water Submersible Option for Series H Hydraulic Cylinders

How to order:

1. Specify the complete Atlas Cylinder Model Number.
2. Put an "S" in the model number to indicate a special cylinder.
3. Include the 3 digit Submersible Code.
4. For custom options, such as switches, provide a complete description or drawing of your requirements.

Submersible Code

When selecting the submersible option, an S must be placed in the Model Number. Select Submersible Code values for the required Submersion Depth, Cylinder Body, and Corrosion Protection. See the example Model Number below:

Feature	Code	Specification	For
Submersion Depth	1	Conventional rod gland and body seal design	Depths to 25 ft
	2	Submersible rod gland and dual cylinder body seals	Depths to 5000 ft
	3	Other	Specify depth / requirements
Cylinder Body	P	Plain ID	
	C	Chrome plated ID	
Corrosion Protection	1	Inorganic zinc primer	Splash & short term immersion service where equipment is top coated by the customer
	2	Inorganic zinc primer with stainless steel tie rods, nuts, & fasteners	
	3	Electroless nickel plated exterior with stainless steel tie rods, nuts, & fasteners	
	4	Inorganic zinc primer, epoxy undercoat, & anacrylic topcoat.	Splash & short term immersion service
	5	Inorganic zinc primer, epoxy undercoat, & anacrylic topcoat with stainless steel tie rods, nuts, & fasteners	
	6	Epoxy base & top coat.	Long term immersion service
	7	Epoxy base & top coat. with stainless steel tie rods, nuts, & fasteners	
	9	Other	Specify requirements

Example:

4.00 BB HK T S 14 X 24.00

S=Submersible Code: 2P1

(describes a 4" x 24" cylinder for submersion up to 5000 ft, with a plain cylinder body ID and Inorganic Zinc Primer corrosion protection.)

Water Submersible Codes and Features Supplied - Depths to 5000 ft[1]

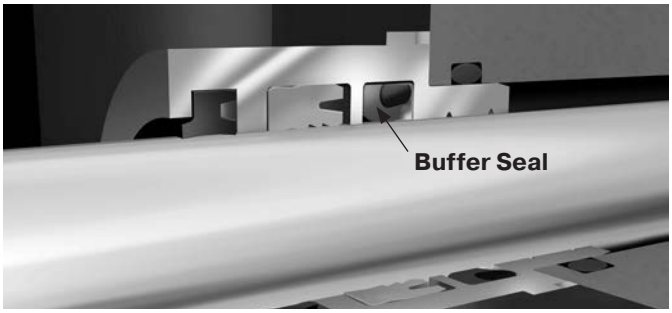
Submersible Cylinder Feature	Water Submersible Code[1]													
	2P1	2P2	2P3	2P4	2P5	2P6	2P7	2C1	2C2	2C3	2C4	2C5	2C6	2C7
17-4 PH piston rod	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Stainless steel tag	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Submersible rod gland	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dual cylinder body seals	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chrome plated cylinder ID								X	X	X	X	X	X	X
SS tie rods, nuts, & fasteners		X	X		X		X		X	X		X		X
Electroless nickel plated exterior			X							X				
Inorganic zinc primer	X	X						X	X					
Inorganic zinc primer with topcoats				X	X						X	X		
Epoxy base & topcoat						X	X						X	X

[1] Corresponding submersible codes for depths to 25 ft begin with 1 (e.g. 1P1, 1P2, etc.) and include all of the features marked for 5000 ft depth **except** Submersible Rod Gland and Dual Cylinder Body Seals.

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Atlas Buffer Seal's Unique Design

The Atlas Buffer Seal Gland is recommended for heavy duty applications where pressure spikes on the rod side of the piston produce premature rod seal failure. Whether the pressure spikes are caused by an external force or intensification due to differential piston areas,



the resultant rod seal damage drives the need for more frequent unplanned service downtime.

Atlas Buffer Seal is a secondary, upstream seal that protects the primary rod seal from damage caused by pressure spikes. The polyurethane Buffer Seal for Class 1 service and filled PTFE Buffer Seal for all other Seal Classes is o-ring energized, low friction and extrusion resistant.

The Atlas Buffer Seal is a unique design that allows trapped pressure back into the cylinder. When the rod extends from the cylinder the Buffer Seal is riding on a high compression sealing point to limit leakage. On the retract stroke the seal rocks forward to allow trapped fluid to pass under the seal and return to the system.

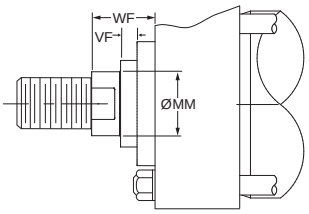
Buffer Seals are available with Series HJ in 1.50"-8.00" bores. They are available with Seal Classes 1, 2, 3, 4, 5 & 6. Selection of the Buffer Seal is made with a code in the cylinder model number.

Rod Extension Dimensions for Buffer Seal Glands

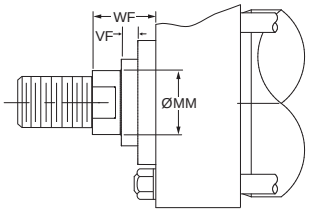
Buffer Seal glands are from 0.31" to 0.81" longer (see table at right) than glands without a Buffer Seal. The longer gland causes the piston rod to extend beyond its location for a standard gland. A differentiating rod end style 4B vs. 4, 9B vs. 9 etc. must also be specified when selecting the Buffer Seal gland option. Rod end extension dimensions – V, VF, W, WF and WG – for Buffer Seal rod end styles are in the table at right. All other rod end dimensions are unchanged and can be found on the Piston Rod Ends page for each series.

Series H 1.50" - 8.00" Bore
Rod End Styles

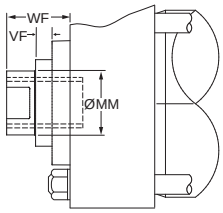
Style 4B – Small Male



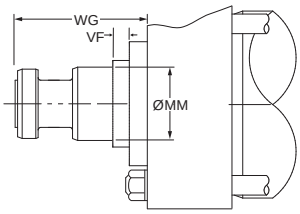
Style 8B – Intermediate Male



Style 9B – Short Female



Style 55B – Flanged Rod End



Rod End Dimensions

Bore Ø	Rod No.	MM Rod Ø	Gland Length Increase	V[1]	VF	W[1]	WF	WG[2]
1.50	1 (Std.)	0.625	Buffer Seal Not Available in 0.625" Rod					
	2	1.000	0.31	0.81	0.83	1.31	1.69	2.38
2.00	1 (Std.)	1.000	0.31	0.56	0.83	1.06	1.69	2.38
	2	1.375	0.38	0.75	1.02	1.38	2.00	2.75
2.50	1 (Std.)	1.000	0.31	0.56	0.83	1.06	1.69	2.38
	2	1.750	0.44	0.94	0.97	1.69	2.31	3.13
	3	1.375	0.38	0.75	1.02	1.38	2.00	2.75
3.25	1 (Std.)	1.375	0.38	0.63	1.02	1.25	2.00	2.75
	2	2.000	0.44	0.81	0.97	1.69	2.44	3.75
	3	1.750	0.44	0.81	0.97	1.56	2.31	3.13
4.00	1 (Std.)	1.750	0.44	0.69	0.97	1.44	2.31	3.13
	2	2.500	0.44	0.81	1.09	1.81	2.69	4.50
	3	2.000	0.44	0.69	0.97	1.56	2.44	3.75
5.00	1 (Std.)	2.000	0.44	0.69	0.97	1.56	2.44	3.75
	2	3.500	0.44	0.81	0.78	1.81	2.69	5.63
	3	2.500	0.44	0.81	1.09	1.81	2.69	4.50
	4	3.000	0.44	0.81	0.85	1.81	2.69	4.88
6.00	1 (Std.)	2.500	0.44	0.69	1.09	1.69	2.69	4.50
	2	4.000	0.44	0.69	0.78	1.69	2.69	5.75
	3	3.000	0.44	0.69	0.85	1.69	2.69	4.88
	4	3.500	0.44	0.69	0.78	1.69	2.69	5.63
7.00	1 (Std.)	3.000	0.44	1.06	0.84	1.69	2.69	4.88
	2	5.000	0.81	1.15	1.15	2.06	3.06	6.63
	3	3.500	0.44	1.07	0.78	1.69	2.69	5.63
	4	4.000	0.44	0.94	0.78	1.69	2.69	5.75
	5	4.500	0.44	0.94	0.78	1.69	2.69	6.50
8.00	1 (Std.)	3.500	0.44	1.06	0.78	1.69	2.69	5.63
	2	5.500	0.81	1.15	1.15	2.06	3.06	7.50
	3	4.000	0.44	0.94	0.78	1.69	2.69	5.75
	4	4.500	0.44	0.94	0.78	1.69	2.69	6.50
	5	5.000	0.81	1.15	1.15	2.06	3.06	6.63

1 'V' and "W' dimensions are for Mounting Styles J & JB and tie rod retained gland styles.

2 The 'WG' dimension for Buffer Seal Glands matches the 'WG' for standard glands.

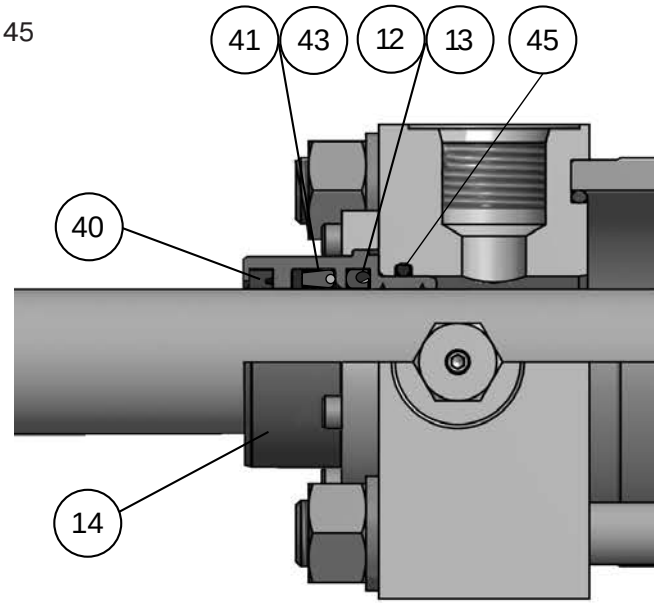
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

2HD/3HD & 2HB/3HB Buffer Seal Rod Gland Cartridge Kit and Rod Seal Kit Parts Identification

- Gland Cartridge Kits contain items 12, 13, 14, 40, 41 and 45 (43 in class 2, 5, and 6 kits only)
- Rod Seal Kits contain items 12, 13, 40, 41 and 45 (43 in class 2, 5 and 6 kits only)

Parts List — Buffer Seal Gland

Symbol	Description
12	Buffer Seal
13	Buffer Seal Energizer
14	Rod Gland
40	Rod Wiper
41	Rod Seal
43	Back-up Washer, rod seal
45	Gland O-Ring



Series 2HD / 3HD & 2HB / 3HB Buffer Seal Gland Cartridge Kits and Rod Seal Kits

Rod Dia.	Seal Type							
	Class 1 Service		Class 2 Service		Class 3 Service		Class 5 Service	
	Contains 1 ea. Sym.# 14,40,41 & 45*		Contains 1 ea. Sym.# 14,40,41 & 45*		Contains 1 ea. Sym.# 14,40,41 & 45*		Contains 1 ea. Sym.# 14,40,41 & 45*	
	Gland Cartridge Kits	Rod Seal Kits	Gland Cartridge Kits	Rod Seal Kits	Gland Cartridge Kits	Rod Seal Kits	Gland Cartridge Kits	Rod Seal Kits
1.000	H-RG11B-100	H-RK11B-100	H-RG21B-100	H-RK21B-100	H-RG31B-100	H-RK31B-100	H-RG51B-100	H-RK51B-100
1.375	H-RG11B-138	H-RK11B-138	H-RG21B-138	H-RK21B-138	H-RG31B-138	H-RK31B-138	H-RG51B-138	H-RK51B-138
1.750	H-RG11B-175	H-RK11B-175	H-RG21B-175	H-RK21B-175	H-RG31B-175	H-RK31B-175	H-RG51B-175	H-RK51B-175
2.000	H-RG11B-200	H-RK11B-200	H-RG21B-200	H-RK21B-200	H-RG31B-200	H-RK31B-200	H-RG51B-200	H-RK51B-200
2.500	H-RG11B-250	H-RK11B-250	H-RG21B-250	H-RK21B-250	H-RG31B-250	H-RK31B-250	H-RG51B-250	H-RK51B-250
3.000	H-RG11B-300	H-RK11B-300	H-RG21B-300	H-RK21B-300	H-RG31B-300	H-RK31B-300	H-RG51B-300	H-RK51B-300
3.500	H-RG11B-350	H-RK11B-350	H-RG21B-350	H-RK21B-350	H-RG31B-350	H-RK31B-350	H-RG51B-350	H-RK51B-350
4.000	H-RG11B-400	H-RK11B-400	H-RG21B-400	H-RK21B-400	H-RG31B-400	H-RK31B-400	H-RG51B-400	H-RK51B-400
4.500	H-RG11B-450	H-RK11B-450	H-RG21B-450	H-RK21B-450	H-RG31B-450	H-RK31B-450	H-RG51B-450	H-RK51B-450
5.000	H-RG11B-500	H-RK11B-500	H-RG21B-500	H-RK21B-500	H-RG31B-500	H-RK31B-500	H-RG51B-500	H-RK51B-500
5.500	H-RG11B-550	H-RK11B-550	H-RG21B-550	H-RK21B-550	H-RG31B-550	H-RK31B-550	H-RG51B-550	H-RK51B-550

[1]Rod seal kits do not include item 14.

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

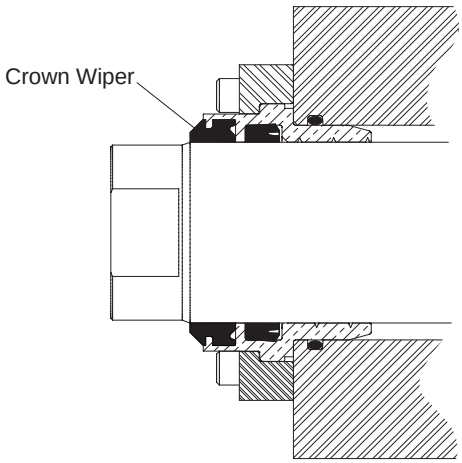
Metallic Rod Scraper

When specified metallic rod scrapers 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 scraper does not affect cylinder dimensions. It is available at extra cost.

Atlas Crown Wiper™ for Series H 1.50" thru 8.00" bore

For environments that contain fine abrasive particulate specify the Crown Wiper option. The Crown Wiper is a proven superior alternative to piston rod end boots or metallic wipers that can ingest particulate. It has a sharp leading edge to effectively clean the piston rod and a beveled shape to prevent contaminant intrusion by channeling it away from the bushing. It also acts as a secondary seal to wipe clean any oil film adhering to the rod on the extend stroke.

Standard Crown Wiper material for Seal Class 1 and 4 service is durable polyurethane. Optional FKM material is available for Class 5 service. The Crown Wiper requires a unique bushing but does not change cylinder mounting dimensions



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 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.

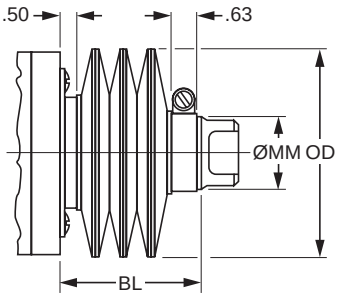
LF	.13	.13	.13	.13	.13	.13	.10	.10	.10	.10	.10
OD	2.25	2.63	3.00	3.38	3.75	4.38	5.13	5.63	6.25	7.00	7.50
MM	.625	1.000	1.375	1.750	2.000	2.500	3.000	3.500	4.000	5.000	5.500

To determine extra length of piston rod required to accommodate boot, calculate

BL = Stroke x LF + 1.13"

BL + Std. W or WF = 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.



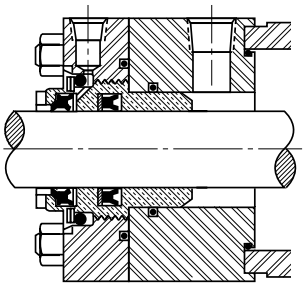
Bushing Drain

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 bushing wiperseal on long stroke cylinders.

A 1/8" NPTF bushing drain port can be provided in the bushing retainer. A passage in the bushing 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 bushing drain port be piped back to the fluid reservoir and that the reservoir be located below the level of the head of the cylinder.

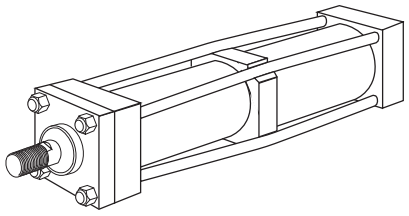
On 1.50" bore with 0.625" rod the drain port is located in the head adjacent to the port. The retainer thickness on 1.50" bore with 1.000" rod and bushing drain is increased to 0.63". On 2.00"-8.00" bore sizes the drain port is located in the retainer as shown. On Style JJ with bushing drain, the drain port is in the head.



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.

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Tie Rod Supports

Rigidity of Envelope – Atlas heavy duty hydraulic cylinders have advantages in rigidity within the limits of the cylinder tube to resist buckling. For long stroke tie rod cylinders, within practical limits, Atlas provides Tie Rod Supports (see table below) that 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
	1.50	—	—	1	1	1	2	2	2	3	3	3	4
	2.00	—	—	—	1	1	1	1	2	2	2	2	3
	2.50	—	—	—	—	—	1	1	1	1	1	2	2
	3.25	—	—	—	—	—	—	—	1	1	1	1	1
	4.00	—	—	—	—	—	—	—	—	—	1	1	1

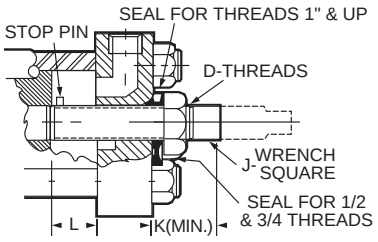
Note: 5.00" through 14.00" bore sizes — no supports required.

Stroke Adjusters

For the requirement where adjusting the stroke is specified. Atlas has several designs to offer, one of which is illustrated below. This is suitable for infrequent adjustment and is economical[1].

Bore Ø	D	J	K	L (Max.)
1.50	1/2 - 20	0.31	0.94	5
2.00	3/4 - 16	0.44	1.25	8
2.50, 3.25	1 - 14	0.63	1.69	9
4.00	1 1/2 - 12	0.94	2.13	18
5.00	2 - 12	0.94	2.69	20
6.00	2 1/2 - 12	1.69	3.13	20
7.00	3 - 12	2.00	3.25	20
8.00	3 1/2 - 12	2.38	3.50	20

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

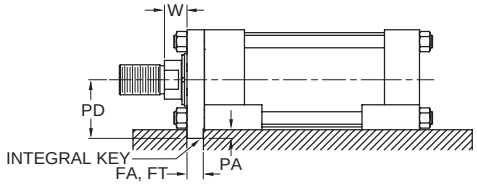


Where frequent adjustment or cushions at the cap end are required, other designs are available according to application needs.

[1] Infrequent 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. Atlas cylinders in mounting styles CP and FP can be provided with the bushing 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	FT	PA	PD Mtg. Styles CP & FP
1.50	.361 -.001 +.000	.312 -.002 +.000	0.19	1.44
2.00	.611 -.001 +.000	.562 -.002 +.000	0.31	1.81
2.50	.611 -.001 +.000	.562 -.002 +.000	0.31	2.06
3.25	.736 -.001 +.000	.687 -.003 +.000	0.38	2.63
4.00	.861 -.001 +.000	.812 -.003 +.000	0.44	2.94
5.00	.861 -.001 +.000	.812 -.003 +.000	0.44	3.69
6.00	.986 -.001 +.000	.937 -.003 +.000	0.50	4.25
7.00	.986 -.001 +.000	.937 -.003 +.000	0.50	4.75
8.00	.986 -.001 +.000	.937 -.003 +.000	0.50	5.25

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
	Style 8M CC	Styles 4M & 9M KK	
0.625	M12x1.5	M10x1.5	0.75
1.000	M22x1.5	M20x1.5	1.13
1.375	M30x2	M26x1.5	1.63
1.750	M39x2	M33x2	2.00
2.000	M45x2	M39x2	2.25
2.500	M56x2	M48x2	3.00
3.000	M68x2	M58x2	3.50
3.500	M76x2	M64x2	3.50
4.000	M95x2	M76x2	4.00
4.500	M110x2	M80x2	4.50
5.000	M110x2	M90x2	5.00
5.500	M130x2	M100x2	5.50
7.000	-	M125x4	7.00
8.000	-	M140x4	8.00
9.000	-	M160x4	9.00
10.000	-	M180x4	10.00

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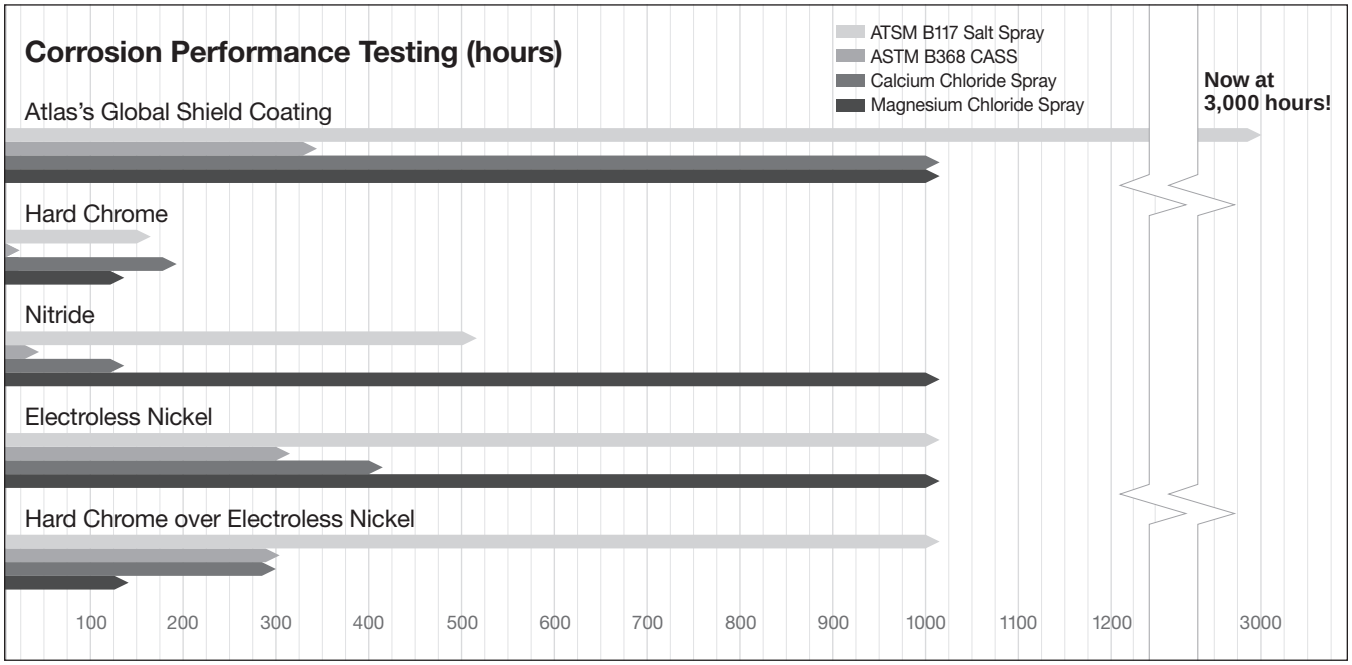
Global Shield™ Rod Coating Technology
A Dramatically Different Approach to Resisting Corrosion

Atlas's **Global Shield** rod coating technology is specifically designed to address corrosion resistance requirements of challenging industrial applications. When compared to traditional rod coatings, **Global Shield** has the following advantages:

- **Significantly Improved Corrosion Resistance** from the single-layer, fully dense, submicron structure and the lack of micro cracks inherent to chrome plating.
- **Lower Friction**
- **Ductile and Tough** so when the rod bends, it does too
- **Engineered Hardness** (HRC 54 minimum) for wear-resistance

The **value** that you will receive from **Global Shield** includes:

- **Less Downtime** from reduced maintenance intervals (cylinder repairs and seal replacements)
- **Longer Seal Life** in corrosive environments
- **Lower Service Costs** since you won't need to replace the piston rod due to corrosion



Performance Validated in the Lab and in the field

This breakthrough proprietary technology, owned and manufactured by Parker Hannifin Corporation, has been thoroughly tested in the lab and in the field to validate performance in the areas of corrosion and dynamic wear resistance. Cylinders protected with Atlas's Global Shield coating have demonstrated resistance to corrosion up to 8x longer than conventional coatings. Tests also confirm leak-free performance even after 1 million cycles and 2,000 hours of salt spray.

Availability

- Rod diameters from ½" to 15"
- Rod lengths to 13 feet
- Standard thickness – 0.001"
  Up to 0.020" available; corrosion protection increases as the thickness increases
- Standard substrate – 1045/1050 carbon steel
  Other substrates available

How to Order

Enter an 'S' in the Special Modifications field of the model number and specify Global Shield Piston Rod Coating. Unless otherwise specified, standard 0.001" thickness will be supplied.

For additional Global Shield information see Bulletin HY08-0896.

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Section F

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Theoretical Push Forces for Hydraulic Cylinders

Cylinder Bore Ø	Piston Area (Sq. In.)	Cylinder Push Stroke Force in Pounds at Various Pressures						
		100	250	500	1000	1500	2000	3000
1.50	1.77	177	443	885	1770	2651	3540	5310
2.00	3.14	314	785	1570	3140	4712	6280	9420
2.50	4.91	491	1228	2455	4910	7363	9820	14730
3.25	8.30	830	2075	4150	8300	12444	16600	24900
4.00	12.57	1257	3143	6285	12570	18850	25140	37710
5.00	19.64	1964	4910	9820	19640	29453	39280	58920
6.00	28.27	2827	7068	14135	28270	42412	56540	84810
7.00	38.49	3849	9623	19245	38490	57727	76980	115470
8.00	50.27	5027	12568	25135	50270	75398	100540	150810
10.00	78.54	7854	19635	39270	78540	117810	157080	235620
12.00	113.10	11310	28275	56550	113100	169650	226200	339300
14.00	153.94	15394	38485	76970	153940	230910	307880	461820
16.00	201.06	20106	50265	100530	201060	301590	402120	603180
18.00	254.47	25447	63620	127230	254470	381700	508940	763410
20.00	314.16	31416	78540	157080	314160	471240	628320	942480

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.

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Theoretical Pull Forces for Hydraulic Cylinders

Cylinder Bore Ø	Piston Rod Ø	Piston Rod Area (Sq. In.)	Cylinder Pull Force in Pounds at Various Pressures (psi)						
			100	250	500	1000	1500	2000	3000
1.50	0.625	0.307	146	365	730	1460	2190	2920	4380
	1.000	0.785	98	245	491	982	1473	1964	2946
2.00	1.000	0.785	236	589	1178	2355	3533	4710	7065
	1.375	1.48	166	414	828	1655	2483	3310	4965
2.50	1.000	0.785	413	1031	2063	4125	6188	8250	12375
	1.375	1.48	343	856	1713	3425	5138	6850	10275
	1.750	2.41	250	625	1250	2500	3750	5000	7500
3.25	1.375	1.48	682	1704	3408	6815	10223	13630	20445
	1.750	2.41	589	1473	2945	5890	8835	11780	17670
	2.000	3.14	516	1290	2580	5160	7740	10320	15480
4.00	1.750	2.41	1016	2540	5080	10160	15240	20320	30480
	2.000	3.14	943	2358	4715	9430	14145	18860	28290
	2.500	4.91	766	1915	3830	7660	11490	15320	22980
5.00	2.000	3.14	1650	4125	8250	16500	24750	33000	49500
	2.500	4.91	1473	3683	7365	14730	22095	29460	44190
	3.000	7.07	1257	3143	6285	12570	18855	25140	37710
	3.500	9.62	1002	2505	5010	10020	15030	20040	30060
6.00	2.500	4.91	2336	5840	11680	23360	35040	46720	70080
	3.000	7.07	2120	5300	10600	21200	31800	42400	63600
	3.500	9.62	1865	4663	9325	18650	27975	37300	55950
	4.000	12.57	1570	3925	7850	15700	23550	31400	47100
7.00	3.000	7.07	3142	7855	15710	31420	47130	62840	94260
	3.500	9.62	2887	7218	14435	28870	43305	57740	86610
	4.000	12.57	2592	6480	12960	25920	38880	51840	77760
	4.500	15.90	2259	5648	11295	22590	33885	45180	67770
	5.000	19.63	1886	4715	9430	18860	28290	37720	56580
8.00	3.500	9.62	4065	10163	20325	40650	60975	81300	121950
	4.000	12.57	3770	9425	18850	37700	56550	75400	113100
	4.500	15.90	3437	8593	17185	34370	51555	68740	103110
	5.000	19.63	3064	7660	15320	30640	45960	61280	91920
	5.500	23.76	2651	6628	13255	26510	39765	53020	79530
10.00	4.500	15.90	6264	15660	31320	62640	93960	125280	187920
	5.000	19.63	5891	14728	29455	58910	88365	117820	176730
	5.500	23.76	5478	13695	27390	54780	82170	109560	164340
	7.000	38.48	4006	10015	20030	40060	60090	80120	120180
12.00	5.500	23.76	8934	22335	44670	89340	134010	178680	268020
	7.000	38.48	7462	18655	37310	74620	111930	149240	223860
	8.000	50.26	6284	15710	31420	62840	94260	125680	188520
14.00	7.000	38.48	11546	28865	57730	115460	173190	230920	346380
	8.000	50.26	10368	25920	51840	103680	155520	207360	311040
	10.000	78.54	7540	18850	37700	75400	113100	150800	226200
16.00	8.000	50.26	15080	37700	75400	150800	226200	301600	452400
	9.000	63.62	13744	34360	68720	137440	206160	274880	412320
	10.000	78.54	12252	30630	61260	122520	183780	245040	367560
18.00	9.000	63.62	19085	47713	95425	190850	286275	381700	572550
	10.000	78.54	17593	43983	87965	175930	263895	351860	527790
20.00	10.000	78.54	23562	58905	117810	235620	353430	471240	706860

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Notes

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The weights shown below are for standard Series H 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 C. 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 H (7.00" & 8.00") hydraulic cylinders

Bore Ø	Rod Ø	Rod Code	Single Rod Cylinders Basic Weight Zero Stroke		Add Per Inch of Stroke	Double Rod Cylinders Basic Weight Zero Stroke		Add Per Inch of Stroke
			F, H, HB, J, JB T, TB, TC, TD	BB, C, D, DB, DD, DE, HH, JJ, SB, SE		KF, KJ KJB KT, KTB, KTD	KC, KD, KDD, KDE, KJJ	
1.50	0.625	1	7.8	9.0	0.5	9.7	10.8	0.6
	1.000	2	8.4	9.3	0.6	9.1	10.7	0.8
2.00	1.000	1	11.6	13.2	0.8	14.6	16.8	1.0
	1.375	2	13.5	17.1	1.0	19.4	20.6	1.4
2.50	1.000	1	17.0	19.5	1.1	21.0	24.5	1.3
	1.750	2	22.5	25.5	1.5	27.0	30.0	2.2
3.25	1.375	1	32.0	41.0	1.8	43.0	52.0	2.2
	2.000	2	37.0	46.0	2.2	48.0	57.0	3.1
4.00	1.750	1	48.0	53.0	2.5	59.0	63.0	3.2
	2.500	2	52.0	58.0	3.2	92.0	97.0	4.6
5.00	2.000	1	76.0	82.0	3.4	96.0	102.0	4.8
	3.500	2	88.0	86.0	5.2	117.0	123.0	7.9
6.00	2.500	1	125.0	133.0	5.2	153.0	159.0	6.6
	4.000	2	133.0	140.0	7.3	182.0	190.0	10.9
7.00	3.000	1	233.0	242.0	6.7	320.0	339.0	8.7
	5.000	2	240.0	253.0	10.3	341.0	360.0	15.9
8.00	3.500	1	262.0	276.0	9.0	323.0	331.0	11.7
	5.500	2	300.0	309.0	13.0	390.0	411.0	19.7

Table B Cylinder Weights, in pounds, for Series H large bore hydraulic cylinders

Bore Ø	Rod Ø	Rod Code	Single Rod Cylinders Basic Weight Zero Stroke					Double Rod Cylinders	
			D, DB	DD, JJ, HH	JB, HB	BB, C	Add Per Inch of Stroke	Basic Weight Zero Stroke Add to All Mounting Styles	Add Per Inch of Stroke
10.00	4.500	1	562	646	684	607	15	43	20
	5.000	3	574	656	695	619	16	50	21
	5.500	4	583	667	705	628	17	64	24
	7.000	2	620	704	742	665	21	101	32
12.00	5.500	1	924	1057	1136	1000	22	64	29
	7.000	3	961	1094	1173	1036	26	101	37
	8.000	2	1022	1155	1234	1097	29	162	43
14.00	7.000	1	1335	1520	1582	1485	28	101	39
	8.000	3	1396	1581	1643	1546	31	162	45
	10.000	2	1496	1681	1743	1646	39	262	61

Bore Ø	Rod Ø	Rod Code	Single Rod Cylinders Basic Weight Zero Stroke				Double Rod Cylinders	
			JJ, HH	JB, HB	BB	Add Per Inch of Stroke	Basic Weight Zero Stroke Add to All Mounting Styles	Add Per Inch of Stroke
16.00	8.000	1	2073	2257	2226	35	149	49
	9.000	3	2122	2305	2275	39	198	57
	10.000	4	2181	2364	2334	43	257	65
18.00	9.000	1	3165	3256	3330	45	198	63
	10.000	3	3224	3315	3390	50	257	72
20.00	10.000	1	4231	4406	4551	57	257	79

Table C Extra weight for longer than standard rod extensions can be calculated from the table below.

Rod Ø	Piston Rod Weight Per Inch	Rod Ø	Piston Rod Weight Per Inch	Rod Ø	Piston Rod Weight Per Inch
0.625	0.09	2.500	1.40	5.000	5.56
1.000	0.22	3.000	2.00	5.500	6.72
1.375	0.42	3.500	2.72	7.000	10.89
1.750	0.68	4.000	3.56	8.000	14.22
2.000	0.89	4.500	4.51	10.000	22.23

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Operating Fluids and Temperature Range
Fluid Power cylinders are designed for use with pressurized air, hydraulic oil and fire resistant fluids, in some cases special seals are required.

Class 1 – Standard Seals
Class 1 seals 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, PTFE or filled PTFE.

Class 2 – Water Base Fluid Seals
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 (HWCF) in which case Class 6 seals should be used. Typical water base fluids are: Water, Water-Glycol, Water-in-Oil Emulsion, Houghto-Safe 27, 620, 5040, Mobil Pyrogard D, Shell Irus 905, Ucon Hydrolube J-4. These seals are nitrile.

Class 3 – Ethylene Propylene (EPR) Seals
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 EPR seals are Skydrol 500 and 700. EPR are Ethylene Propylene. Note: EPR seals are not compatible with mineral base hydraulic oil or greases. Even limited exposure to these fluids will cause severe swelling.

Class 4 – Low Temperature Nitrile Seals
Class 4 seals are intended for low temperature service with the same type of fluids as used with Class 1 seals within the temperature range of -50°F (-46°C) to +150°F (+66°C). Note: Certain fluids may react adversely with Class 4 seals compared to Class 1 seals.

Class 5 – Fluorocarbon (FKM) Seals
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. 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 +300°F (+149°C). 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 E – Fluorocarbon piston rod bushing seals only
Intended for applications where only the rod bushing is exposed to fluids or temperatures needing fluorocarbon compatibility.

Class 6 – HWCF Seals
Class 6 seals are intended for High Water Content Fluids (HWCF) such as Houghton, 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. Because of the viscosity of these fluids, cylinders specified with class 6 seals, will also be modified to have straight cushions.

Class 8 – High Temperature Seals
Class 8 seals consist of filled PTFE piston seal, rod seals and wiperseal. 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 bushing o-ring seals will be fluorocarbon. Fluid resistance is comparable to Class 5. Cylinders incorporating Class 8 Seals will not have studded piston rods.

Class N – Class 8 piston rod bushing seals only – all other seals are fluorocarbon
Intended for applications where only the rod bushing is exposed to fluids or temperatures needing filled PTFE seal compatibility.

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.

Water Service
Series H 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. 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.

Seal Materials & Piston Seal Availability by Seal Class

Seal Code (Class)	Description	Busing Codes A, H & K			Piston Wear Rings	Piston Seal Material & Availability by Type				Piston Seal Energizer1	Piston Joint O-Ring	Body End Seals	Seal Back-Up Washer (If required)
		Rod Wiper-seal	Rod Seal	Gland O-Ring		HP Urethane	KP Filled PTFE	RP Thermo-plastic	WP Filled PTFE				
1	Standard Seals	Urethane	Urethane	Nitrile	WearGard™	Yes	Yes	Yes	Yes	Nitrile	Urethane	Urethane	Nitrile
2	Water Base Fluid Seals	Nitrile	Nitrile	Nitlrile	Polyester Resin/Fabric	No	Yes	Yes	Yes	Nitrile	Nitrile	Nitrile	Nitrile
3	EPR Seals	EPR	EPR	EPR	WearGard™	No	Yes	Yes	Yes	EPR	EPR	EPR	EPR
4	Low Temp. Nitrile Seals	Nitrile	Nitrile	Nitrile	WearGard™	Yes	Yes	Yes	No	Nitrile	Nitrile	Nitrile	Nitrile
5	Fluorocarbon Seals	FKM	FKM	FKM	WearGard™	No	Yes	Yes	Yes	FKM	FKM	FKM	FKM
6	HWCF Seals	Nitrile	Nitrile	Nitrile	Polyester Resin/Fabric	No	Yes	Yes	Yes	Nitrile	Nitrile	Nitrile	Nitrile
8	High Temp. Seals	Filled PTFE	Filled PTFE	FKM	HT Resin/ Aramid	No	Yes	No	No	FKM	FKM	FKM	FKM
E	Fluorocarbon Bushing Seals	FKM	FKM	FKM	WearGard™	Yes	Yes	Yes	Yes	FKM	FKM	FKM	FKM
N	High Temp. Bushing Seals	Filled PTFE	Filled PTFE	FKM	HT Resin/ Aramid	Yes	Yes	Yes	Yes	FKM	FKM	FKM	FKM

[1] Includes material of redundant quad ring seal for Atlas WP Mixed Media Seal

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Fluids and Temperature Range

Class No.	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, HWCF — See Class 6 below. Water-in-Oil Emulsion Houghto-Safe, 271, 620, 5040. Mobil Pyrogard D, Shell Irus 905. Ucon Hydrolube J-4	-10°F (-23°C) to +165°F (+74°C)
3 Special (EPR) (at extra cost) Note: (EPR) seals are not compatible with Hydraulic Oil	Some Phosphate Ester Fluids Skydrol 500, 7000	-10°F (-23°C) to +130°F (+54°C)
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) Note: Fluorocarbon seals are not suitable for use with Skydrol fluid, but can be used with hydraulic oil if desired.	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.
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 hydraulic cylinders.

Pressure Ratings

Standard operating fluid — clean, filtered hydraulic oil. Pressure ratings for heavy-duty hydraulic cylinders are shown in the table.

Series H hydraulic cylinders are recommended for pressures to 3000 psi for heavy-duty service with hydraulic oil. The 4:1 design factor ratings shown are based on tensile strength of material and are for standard rod diameter only. The rating is conservative for continuous severe applications. Design factors at other pressures can be calculated from this rating. In addition, mounting styles, stroke, etc., should be considered because of the limiting effect they may have on these ratings.

Series H Hydraulic Cylinders
Maximum Pressure Ratings

Bore Ø	Rod Ø	4:1[1] Design Factor (Tensile) (psi)	Heavy-Duty Service (psi)
1.50	0.625	2530	3000
2.00	1.000	2950	3000
2.50	1.000	2340	3000
3.25	1.375	2250	3000
4.00	1.750	2130	3000
5.00	2.000	2170	3000
6.00	2.500	2270	3000
7.00	3.000	2030	3000
8.00	3.500	2040	3000
10.00	4.500	2720	3000
12.00	5.500	2580	3000
14.00	7.000	2320	3000
16.00	8.000	2750	3000
18.00	9.000	2900	3000
20.00	10.000	2640	3000

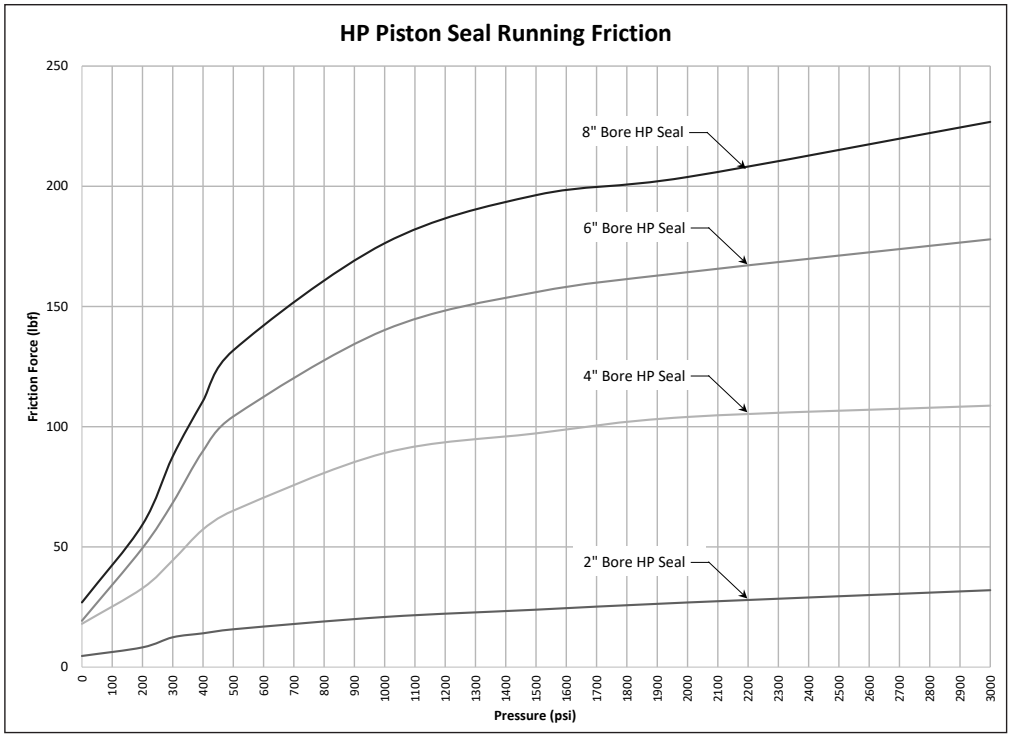
[1] Applies to all mountings except Styles J, JB and H.

F Custom Modifications

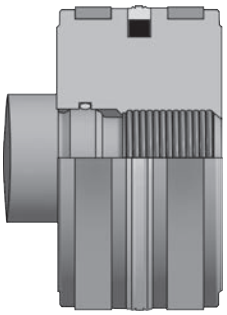
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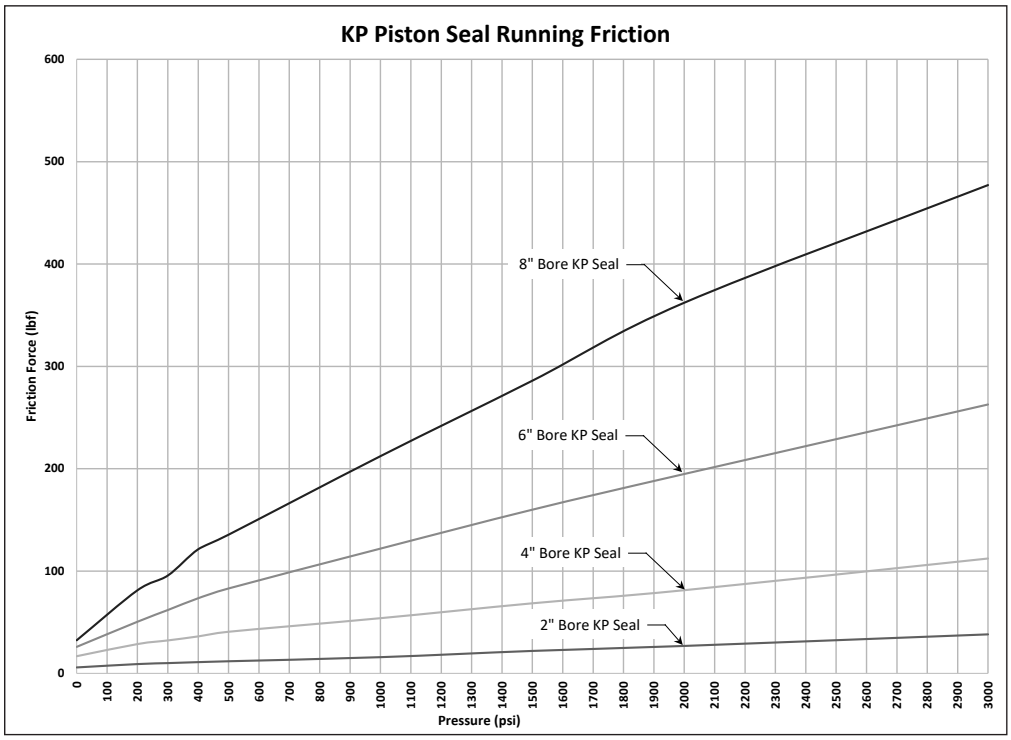
Piston Friction

Atlas's new universal piston design provides not only superior sealing and wear performance, but also conserves operating energy with reduced running friction when compared to traditional sealing technologies. Running friction test results for the most popular seal configurations, HP Polyurethane Piston Seal and KP filled PTFE Piston Seal in 2.00", 4.00", 6.00" and 8.00" bores are shown in graphs below. Friction for intermediate bore sizes can be estimated using curves for bore sizes tested.

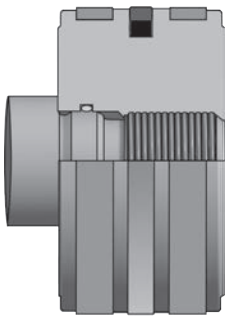


Atlas HP Polyurethane Piston Seal





Atlas KP Filled PTFE Piston Seal

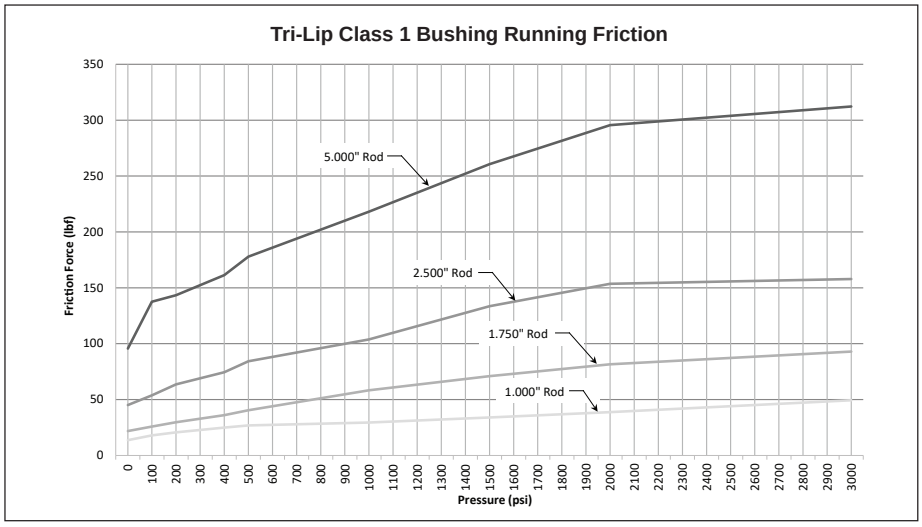


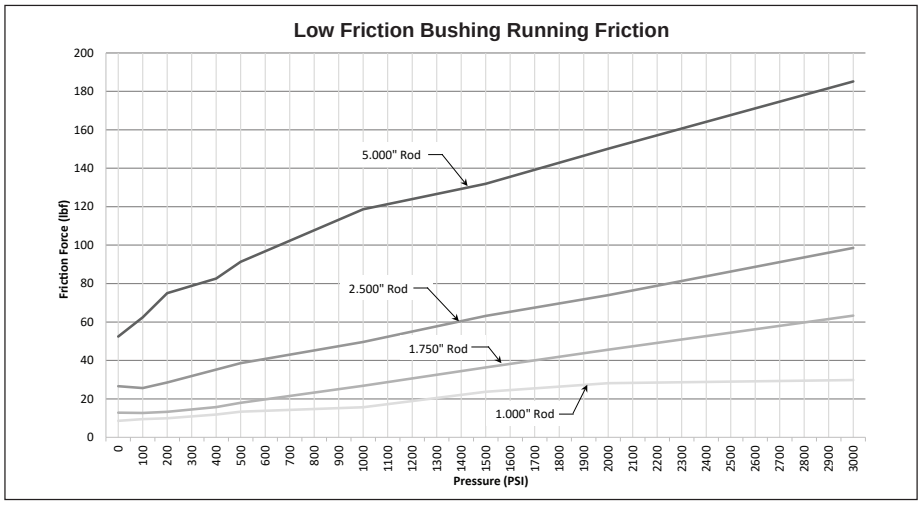
F Custom Modifications

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Bushing Friction

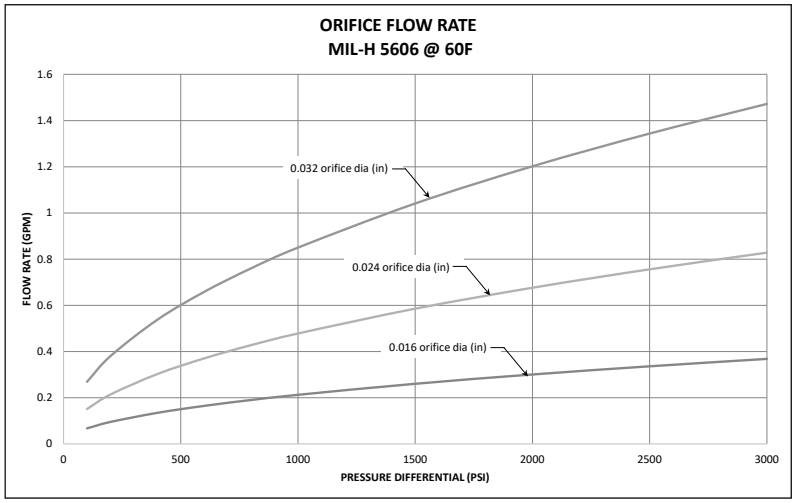
Bushing friction is also a factor in cylinder operating efficiency and combined with piston seal friction will yield an overall cylinder running friction value. Running friction test results for H (Tri-Lip) and Low Friction bushings in 1.000", 1.750", 2.500" and 5.000" piston rod diameters are shown in the graphs below. Friction for intermediate rod diameters can be estimated using curves for bore sizes tested.





Piston Orifice

Atlas's RP Thermoplastic piston seal is fully extrusion resistant and the choice for applications formerly served by cast iron rings. For some applications, cast iron rings are selected because of the inherent piston bypass. Where bypass is required for the RP seal (or any other universal piston seal style), a piston orifice option is available. There are three orifice diameters to choose from, 0.016", 0.024" and 0.032". Flow charts at right detail the bypass flow at various pressures for each orifice. Specify the orifice by placing an 'S' in the Special Modification field of the model number and describe the orifice as in the following example: S = 0.024" Piston Orifice (insert desired orifice dia). Piston orifice not available in bores 1.50", 2.00" and 2.50" with rod codes 2 & 3.



F Custom Modifications

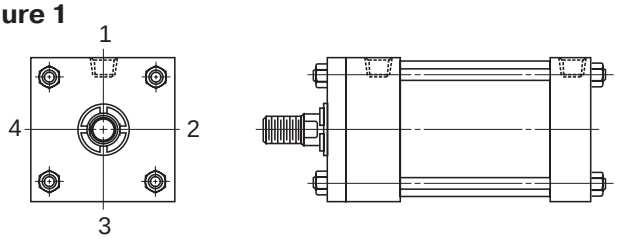
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Ports

Series H cylinders can be supplied with SAE 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



Head (Rod) End **Head** **Cap**

Table A

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

Straight Thread Ports

The SAE straight thread O-ring port is recommended for hydraulic applications. Atlas will furnish this port configuration at positions shown in Table A. This port can also be provided at positions other than those shown in Table A at an extra charge. SAE port size numbers are listed next to the NPTF pipe thread counterparts for each bore size in the respective product catalogs. Size number, tube O.D., and port thread size for SAE ports are listed in Table B.

Table B — SAE Straight Thread O-Ring Ports

Size No.	Tube O.D. (In.)	Thread Size	Size No.	Tube O.D. (In.)	Thread Size
2	0.13	5/16 - 24	12	0.75	1 1/16 - 12
3	0.19	3/8 - 24	—	—	—
4	0.25	7/16 - 20	16	1.00	1 5/16 - 12
5	0.31	1/2 - 20	20	1.25	1 5/8 - 12
6	0.38	9/16 - 18	24	1.50	1 7/8 - 12
8	0.50	3/4 - 16	32	2.00	2 1/2 - 12
10	0.63	7/8 - 14	—	—	—

Note: For the pressure ratings of individual connectors, contact your connector supplier. Hydraulic cylinders applied with meter out or deceleration circuits are subject to intensified pressure at the cylinder piston rod end. The rod end pressure is approximately equal to:

$$\frac{\text{Effective Cap End Piston Area}}{\text{Effective Rod End Piston Area}} \times \text{Operating Pressure}$$

International Ports

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

Table C — British Standard Pipe Threads

Nominal Pipe Size	No. Threads Per Inch	Pipe O.D.
1/8	28	0.383
1/4	19	0.518
3/8	19	0.656
1/2	14	0.825
3/4	14	1.041
1	11	1.309
1 1/4	11	1.650
1 1/2	11	1.882
2	11	2.347

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

Metric ports can also be supplied to order at extra cost. See table below for standard port size for each bore.

Table D – Standard Port Sizes

Bore Ø	T SAE	U NPTF	P SAE Code 61 Flange	Y ISO 6149	B BSPT R BSPP	G Metric
1.50	10	1/2	N/A	M22 x 1.5	1/2	M22 x 1.5
2.00	10	1/2	N/A	M22 x 1.5	1/2	M22 x 1.5
2.50	10	1/2	1/2[1]	M22 x 1.5	1/2	M22 x 1.5
3.25	12	3/4	3/4	M27 x 2	3/4	M27 x 2
4.00	12	3/4	3/4	M27 x 2	3/4	M27 x 2
5.00	12	3/4	3/4	M27 x 2	3/4	M27 x 2
6.00	16	1	1	M33 x 2	1	M33 x 2
7.00	20	1 1/4	1 1/4	M42 x 2	1 1/4	M42 x 2
8.00	24	1 1/2	1 1/2	M48 x 2	1 1/2	M48 x 2
10.00	24	2	2	M48 x 2	2	M48 x 2
12.00	24	2 1/2	2 1/2	M48 x 2	2 1/2	M48 x 2
14.00	24	2 1/2	2 1/2	M48 x 2	2 1/2	M48 x 2
16.00-20.00	24	–	3	–	–	–

[1]Available with 1.000 inch rod diameter only.

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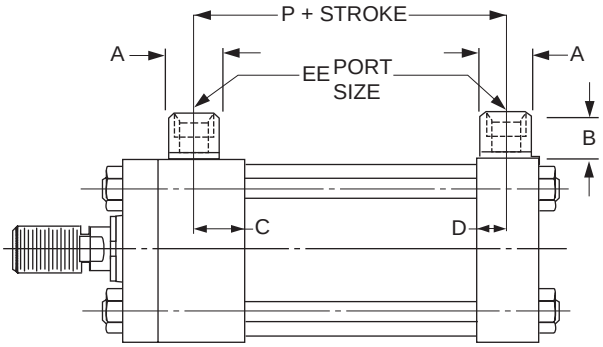
Oversize Ports

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 H 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 velocity 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
1.50	3/4	1.38	1.00	0.75	0.78	2.91
2.00	3/4	1.38	1.00	0.75	0.78	2.91
2.50	3/4	1.38	1.00	0.75	0.78	3.03
3.25	1	1.75	1.19	0.91	0.88	3.53
4.00	1	1.75	1.19	0.91	0.88	3.78
5.00	1	1.75	1.19	0.91	0.88	4.28
6.00	1 1/4	2.25	1.31	1.13	1.13	5.13
7.00	1 1/2	2.50	1.56	1.38	1.38	5.75
8.00	2	3.00	1.69	1.50	1.50	6.50



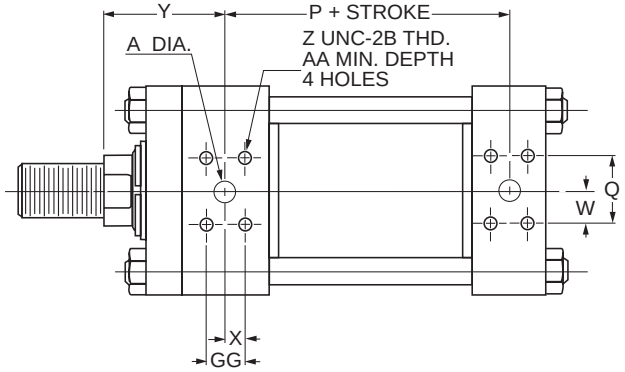
Oversize SAE Straight Thread Port Boss Dimensions

Bore Ø	EE (SAE)		A Ø	B	C	D	P
1.50	12[1]	12	1.38	1.00	0.81	0.78	2.97
2.00	12[1]	12	1.38	1.00	0.81	0.78	2.97
2.50	12[2]	12[3]	1.38	1.00	0.81	0.81	3.13
3.25	16	16	1.75	1.19	0.91	0.91	3.56
4.00	16	16	1.75	1.19	0.91	0.91	3.81
5.00	16	16	1.75	1.19	0.91	0.91	4.31
6.00	20[2]	20[2]	–	–	1.13	1.17	5.19
7.00	24[2]	24[2]	–	–	–	–	5.63
8.00	N/A	N/A	–	–	–	–	6.38

[1] Port tapped directly in head with code 1 rod these bores.
[2] Port tapped directly in head (all rod codes) and cap these bores.
[3] Port tapped directly in cap this bore.

Flange Ports (Code 61, 3000 psi) SAE 4 Bolt Flange Ports

Bore Ø	Rod No.	SAE Dash No.	A Ø	AA	GG	P	Q	W	X	Y	Z
2.50[4,5]	1	8	.50	.81	.69	3.00	1.50	.75	.34	2.38	5/16 - 18
3.25[4]	1	12	.75	.75	.87	3.50	1.87	.94	.44	2.75	3/8 - 16
	2									3.13	
	3									3.00	
4.00[4]	1	12	.75	.75	.87	3.75	1.87	.94	.44	3.00	3/8 - 16
	2									3.38	
	3									3.13	
5.00[4]	1	12	.75	.75	.87	4.25	1.87	.94	.44	3.13	3/8 - 16
	2									3.38	
	3									3.38	
	4									3.38	
6.00	All	16	1.00	.87	1.03	4.87	2.06	1.03	.52	3,50	3/8 - 16
7.00	All	20	1.25	1.00	1.19	5.50	2.31	1.16	.59	3.75	7/16 - 14
8.00	All	24	1.50	1.06	1.41	6.25	2.75	1.37	.70	3.88	1/2 - 13



[4] 2.50", 3.25", 4.00" & 5.00" bores cap-flange port not available on Style HB Style H not available at position 2 or 4. Port flange overhangs cap on Style HH. [5] 2.50" bore head flange port available with 1.000" rod only.

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Stroke Data

Atlas 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 +.031" to -.015" up to 20" stroke, +.031" to -.020" for 21" to 60" and +.031" to -.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

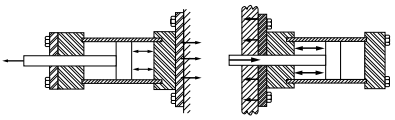
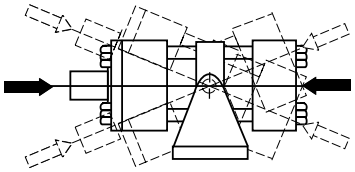
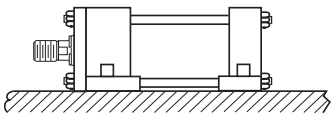
Standard mountings for fluid power cylinders fall into three basic groups. The groups can be summarized as follows:

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

Double Rod End Cylinders

The piston connection to rod #1 (without 'V' notch) of 1.50"-8.00" bore double rod end heavy duty hydraulic cylinders is pre-stressed for maximum fatigue life. For this reason the load should always be attached to the rod without 'V' notch. Extension rod #2 with 'V' notch is threaded to rod #1 and is recommended for non-load bearing attachment only.

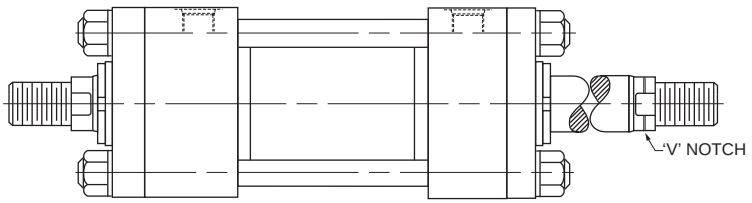
For thrust (compression) load applications where the mounting style end of a double rod end cylinder is opposite the rod connected to the load it should be specified as a cap mounting style. For example, a head trunnion mounting style opposite the rod connected to the load should be specified as DB. This will ensure that the rod end without 'V' notch will be oriented opposite the head trunnion end. See the table below for guidance in selecting mounting styles that fit this criteria.

Double Rod End Mounting Styles

Mounting Styles for Single Rod Models	Mounting Styles for Corresponding Double Rod Models with the Load Connected To Rod Opposite Cylinder Mounting End
TB	KTC
J	KH
JB	KHB
JJ	KHH
D	KDB

Double Rod Cylinder

Style K

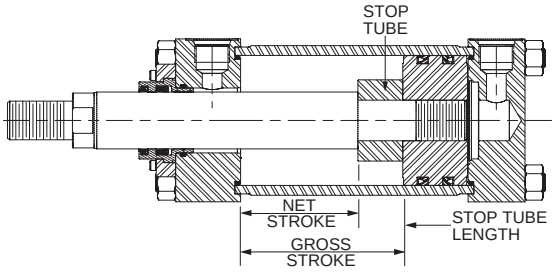


Rod End #1 **Rod End #2**

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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, HH, SB and SE 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.

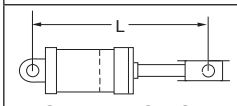
When specifying cylinders with stop tube be sure to call out the net stroke and the length of the stop tube. Machine design can be continued without delay by laying in a cylinder equivalent in length to the NET STROKE PLUS STOP TUBE LENGTH, which is referred to as GROSS STROKE.

Stop Tube Length vs Basic Length (L)

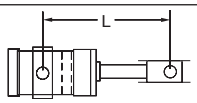
Pivot Mounts (BB, D, DB, DD, DE, SB and SE)		Fixed Mounts (C, F, H, HB, HH, J, JB, JJ, TB, TC, TD)					
Pivoted and Rigidly Guided Rod End		Fixed & Rigidly Guided Rod End		Pivoted & Rigidly Guided Rod End		Unguided Rod End	
Basic Length (L)	Stop Tube Length	Basic Length (L)	Stop Tube Length	Basic Length (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	Consult Factory		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			Consult Factory		106 - 110	18
221 - 230	19					111 - 115	19
231 - 240	20					116 - 120	20
241 - 250	21					121 - 125	21
251 - 260	22					126 - 130	22
261 - 270	23					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

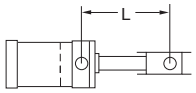
Pivot Mount – Pivoted and rigidly guided rod end



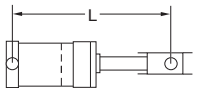
Styles BB, SB, SE



Styles DD, DE

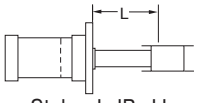


Style D

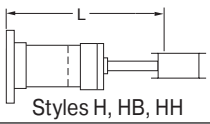


Style DB

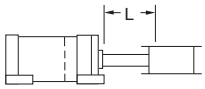
Fixed Mount – Fixed and rigidly guided rod end



Styles J, JB, JJ

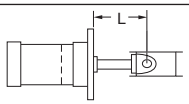


Styles H, HB, HH

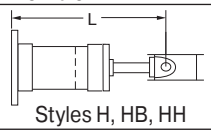


Styles C, F

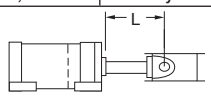
Fixed Mount – Pivoted and rigidly guided rod end



Styles J, JB, JJ

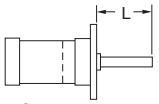


Styles H, HB, HH

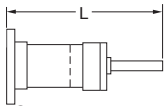


Styles C, F

Fixed Mount – Unguided rod end



Styles J, JB, JJ



Styles H, HB, HH

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F Custom Modifications

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. 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 or WF 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[1], 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:					
		500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000
1.50	0.625	50	35	29	25	22	20	36	25	21	18	16	15	13	9	7	6	6	5
	1.000	128	91	74	64	57	52	92	65	53	46	41	37	32	23	19	16	14	13
2.00	1.000	96	68	56	48	43	39	69	49	40	34	31	28	24	17	14	12	11	10
	1.375	182	129	105	91	81	74	130	92	75	65	58	53	45	32	26	23	20	19
2.50	1.000	77	54	44	38	34	31	55	39	32	27	25	22	19	14	11	10	9	8
	1.375	146	103	84	73	65	59	104	73	60	52	46	42	36	26	21	18	16	15
	1.750	236	167	136	118	105	96	168	119	97	84	75	69	59	42	34	29	26	24
3.25	1.375	112	79	65	56	50	46	80	57	46	40	36	33	28	20	16	14	13	11
	1.750	181	128	105	91	81	74	130	92	75	65	58	53	45	32	26	23	20	19
	2.000	237	167	137	118	106	97	169	120	98	85	76	69	59	42	34	30	26	24
4.00	1.750	147	104	85	74	66	60	105	74	61	53	47	43	37	26	21	18	16	15
	2.000	192	136	111	96	86	79	137	97	79	69	61	56	48	34	28	24	22	20
	2.500	300	213	174	150	134	123	215	152	124	107	96	88	75	53	43	38	34	31
5.00	2.000	154	109	89	77	69	63	110	78	63	55	49	45	38	27	22	19	17	16
	2.500	241	170	139	120	108	98	172	121	99	86	77	70	60	43	35	30	27	25
	3.000	300	245	200	173	155	141	247	175	143	124	111	101	87	61	50	43	39	35
	3.500	300	300	272	236	211	192	300	238	194	168	151	137	118	83	68	59	53	48
6.00	2.500	200	142	116	100	90	82	143	101	83	72	64	58	50	35	29	25	22	20
	3.000	289	204	167	144	129	118	206	146	119	103	92	84	72	51	42	36	32	29
	3.500	300	278	227	196	176	160	281	198	162	140	125	115	98	69	57	49	44	40
	4.000	300	300	296	257	229	209	300	259	212	183	164	150	128	91	74	64	57	52
7.00	3.000	247	175	143	124	111	101	177	125	102	88	79	72	62	44	36	31	28	25
	3.500	300	238	194	168	151	137	241	170	139	120	108	98	84	60	49	42	38	34
	4.000	300	300	254	220	197	180	300	222	181	157	140	128	110	78	63	55	49	45
	4.500	300	300	300	278	249	227	300	281	230	199	178	162	139	98	80	70	62	57
	5.000	300	300	300	300	300	281	300	300	283	245	220	200	172	121	99	86	77	70
8.00	3.500	295	208	170	147	132	120	210	149	122	105	94	86	74	52	43	37	33	30
	4.000	300	272	222	192	172	157	275	194	159	137	123	112	96	68	56	48	43	39
	4.500	300	300	281	244	218	199	300	246	201	174	156	142	122	86	70	61	54	50
	5.000	300	300	300	300	269	245	300	300	248	215	192	175	150	106	87	75	67	61
	5.500	300	300	300	300	300	297	300	300	300	260	232	212	182	129	105	91	81	74
10.00	4.500	300	276	225	195	174	159	278	197	161	139	124	114	97	69	56	49	44	40
	5.000	300	300	278	241	215	196	300	243	198	172	154	140	120	85	69	60	54	49
	5.500	300	300	300	291	260	238	300	294	240	208	186	170	146	103	84	73	65	59
	7.000	300	300	300	300	300	300	300	300	300	300	300	275	236	167	136	118	105	96
12.00	5.500	300	300	280	243	217	198	300	245	200	173	155	141	121	86	70	61	54	50
	7.000	300	300	300	300	300	300	300	300	300	281	251	229	196	139	113	98	88	80
	8.000	300	300	300	300	300	300	300	300	300	300	300	299	257	181	148	128	115	105
14.00	7.000	300	300	300	300	300	275	300	300	278	241	215	196	168	119	97	84	75	69
	8.000	300	300	300	300	300	300	300	300	300	300	281	256	220	155	127	110	98	90
	10.000	300	300	300	300	300	300	300	300	300	300	300	300	300	243	198	172	154	140
16.00	8.000	300	300	300	300	300	300	300	300	300	275	246	224	192	136	111	96	86	79
	9.000	300	300	300	300	300	300	300	300	300	300	300	284	244	172	141	122	109	99
	10.000	300	300	300	300	300	300	300	300	300	300	300	300	300	213	174	150	134	123
18.00	9.000	300	300	300	300	300	300	300	300	300	300	277	252	216	153	125	108	97	88
	10.000	300	300	300	300	300	300	300	300	300	300	300	300	267	189	154	134	120	109
20.00	10.000	300	300	300	300	300	300	300	300	300	300	300	281	241	170	139	120	108	98

[1] Maximum operating pressure is limited for Mounting Styles J and JB. Please refer to maximum operating pressure per bore in Pressure Ratings table located on the dimension page for each of these mounting styles.

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

Bore Ø	Rod Ø	Rear Fixed Mounts (H[1], HB[1], HH, 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:					
		500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000
1.50	0.625	70	50	40	35	31	29	50	35	29	25	22	20	18	12	10	9	8	7
	1.000	170	120	98	85	76	69	121	86	70	61	54	50	42	30	25	21	19	17
2.00	1.000	132	93	76	66	59	54	94	67	54	47	42	38	33	23	19	16	15	13
	1.375	232	164	134	116	104	95	166	117	96	83	74	68	58	41	33	29	26	24
2.50	1.000	107	76	62	54	48	44	77	54	44	38	34	31	27	19	16	13	12	11
	1.375	197	140	114	99	88	81	141	100	81	70	63	58	49	35	28	25	22	20
	1.750	300	213	174	151	135	123	215	152	124	108	96	88	75	53	43	38	34	31
3.25	1.375	156	110	90	78	70	64	111	79	64	56	50	45	39	28	22	19	17	16
	1.750	246	174	142	123	110	100	176	124	102	88	79	72	62	44	36	31	28	25
	2.000	300	221	181	157	140	128	224	158	129	112	100	91	78	55	45	39	35	32
4.00	1.750	203	144	117	102	91	83	145	103	84	73	65	59	51	36	29	25	23	21
	2.000	261	185	151	131	117	107	187	132	108	93	83	76	65	46	38	33	29	27
	2.500	300	274	224	194	173	158	277	196	160	138	124	113	97	69	56	48	43	40
5.00	2.000	214	151	123	107	96	87	153	108	88	76	68	62	53	38	31	27	24	22
	2.500	300	231	188	163	146	133	233	165	135	117	104	95	82	58	47	41	36	33
	3.000	300	300	261	226	202	184	300	228	186	161	144	132	113	80	65	56	50	46
	3.500	300	300	300	289	259	236	300	292	239	207	185	169	145	102	83	72	65	59
6.00	2.500	278	197	161	139	124	114	199	141	115	99	89	81	70	49	40	35	31	28
	3.000	300	278	227	197	176	161	281	199	162	140	126	115	98	70	57	49	44	40
	3.500	300	300	300	260	233	212	300	263	215	186	166	152	130	92	75	65	58	53
	4.000	300	300	300	300	292	266	300	300	269	233	208	190	163	115	94	82	73	67
7.00	3.000	300	241	197	171	153	139	244	172	141	122	109	100	85	60	49	43	38	35
	3.500	300	300	263	228	204	186	300	230	188	163	146	133	114	81	66	57	51	46
	4.000	300	300	300	289	259	236	300	292	239	207	185	169	145	102	83	72	65	59
	4.500	300	300	300	300	300	288	300	300	290	252	225	205	176	124	102	88	79	72
	5.000	300	300	300	300	300	300	300	300	300	296	264	241	207	146	119	103	93	84
8.00	3.500	300	288	235	203	182	166	291	205	168	145	130	119	102	72	59	51	45	42
	4.000	300	300	300	261	234	213	300	264	216	187	167	152	131	92	75	65	58	53
	4.500	300	300	300	300	290	264	300	300	267	231	207	189	162	114	93	81	72	66
	5.000	300	300	300	300	300	300	300	300	300	277	248	226	194	137	112	97	87	79
	5.500	300	300	300	300	300	300	300	300	300	300	289	264	226	160	131	113	101	92
10.00	4.500	300	300	300	269	241	220	300	272	222	192	172	157	135	95	78	67	60	55
	5.000	300	300	300	300	294	268	300	300	271	235	210	192	164	116	95	82	73	67
	5.500	300	300	300	300	300	300	300	300	300	280	250	229	196	139	113	98	88	80
	7.000	300	300	300	300	300	300	300	300	300	300	300	300	296	209	171	148	132	121
12.00	5.500	300	300	300	300	299	273	300	300	276	239	213	195	167	118	96	84	75	68
	7.000	300	300	300	300	300	300	300	300	300	300	300	300	260	184	150	130	116	106
	8.000	300	300	300	300	300	300	300	300	300	300	300	300	300	231	189	163	146	133
14.00	7.000	300	300	300	300	300	300	300	300	300	300	291	266	228	161	132	114	102	93
	8.000	300	300	300	300	300	300	300	300	300	300	300	300	290	205	167	145	129	118
	10.000	300	300	300	300	300	300	300	300	300	300	300	300	300	293	240	207	186	169
16.00	8.000	300	300	300	300	300	300	300	300	300	300	300	300	260	184	150	130	116	106
	9.000	300	300	300	300	300	300	300	300	300	300	300	300	300	227	186	161	144	131
	10.000	300	300	300	300	300	300	300	300	300	300	300	300	300	272	222	192	172	157
18.00	9.000	300	300	300	300	300	300	300	300	300	300	300	300	293	207	169	146	131	119
	10.000	300	300	300	300	300	300	300	300	300	300	300	300	300	250	204	177	158	144
20.00	10.000	300	300	300	300	300	300	300	300	300	300	300	300	300	231	188	163	146	133

[1] Maximum operating pressure is limited for Mounting Styles H and HB. Please refer to maximum operating pressure per bore in Pressure Ratings table located on the dimension page for each of these mounting styles.

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

Bore Ø	Rod Ø	Rear Pivot Mounts (BB, SB[1], SE, DB)						Front and Intermediate Pivot Mounts (D, DD, DE)					
		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:					
		500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000
1.50	0.625	35	25	20	18	16	14	25	18	14	13	11	10
	1.000	85	60	49	42	38	35	64	45	37	32	29	26
2.00	1.000	66	47	38	33	29	27	48	34	28	24	22	20
	1.375	116	82	67	58	52	47	91	64	53	45	41	37
2.50	1.000	54	38	31	27	24	22	38	27	22	19	17	16
	1.375	99	70	57	49	44	40	73	51	42	36	33	30
	1.750	151	106	87	75	67	61	118	83	68	59	53	48
3.25	1.375	78	55	45	39	35	32	56	40	32	28	25	23
	1.750	123	87	71	62	55	50	91	64	52	45	41	37
	2.000	157	111	90	78	70	64	118	84	68	59	53	48
4.00	1.750	102	72	59	51	45	41	74	52	43	37	33	30
	2.000	131	92	75	65	58	53	96	68	56	48	43	39
	2.500	194	137	112	97	87	79	150	106	87	75	67	61
5.00	2.000	107	76	62	53	48	44	77	54	44	38	34	31
	2.500	163	115	94	82	73	67	120	85	69	60	54	49
	3.000	226	160	130	113	101	92	173	122	100	87	77	71
	3.500	289	204	167	145	129	118	236	167	136	118	105	96
6.00	2.500	139	98	80	70	62	57	100	71	58	50	45	41
	3.000	197	139	114	98	88	80	144	102	83	72	65	59
	3.500	260	184	150	130	116	106	196	139	113	98	88	80
	4.000	300	231	188	163	146	133	257	181	148	128	115	105
7.00	3.000	171	121	99	85	76	70	124	87	71	62	55	50
	3.500	228	161	132	114	102	93	168	119	97	84	75	69
	4.000	289	204	167	145	129	118	220	155	127	110	98	90
	4.500	300	249	203	176	157	144	278	197	161	139	124	114
	5.000	300	293	239	207	185	169	300	243	198	172	154	140
8.00	3.500	203	144	117	102	91	83	147	104	85	74	66	60
	4.000	261	185	151	131	117	107	192	136	111	96	86	79
	4.500	300	229	187	162	145	132	244	172	141	122	109	99
	5.000	300	274	224	194	174	158	300	213	174	150	134	123
	5.500	300	300	261	226	202	185	300	257	210	182	163	149
10.00	4.500	269	190	155	135	120	110	195	138	112	97	87	80
	5.000	300	232	190	164	147	134	291	206	168	146	130	119
	5.500	300	277	226	196	175	160	300	300	272	236	211	192
	7.000	300	300	300	296	265	242	241	170	139	120	108	98
12.00	5.500	300	236	193	167	149	136	243	171	140	121	108	99
	7.000	300	300	300	260	233	213	300	300	296	257	229	209
	8.000	300	300	300	300	292	267	300	278	227	196	176	160
14.00	7.000	300	300	263	228	204	186	300	238	194	168	151	137
	8.000	300	300	300	290	259	236	300	300	300	300	300	281
	10.000	300	300	300	300	300	300	300	300	254	220	197	180
16.00	8.000	300	300	300	260	233	213	300	272	222	192	172	157
	9.000	300	300	300	300	288	263	300	300	281	244	218	199
	10.000	300	300	300	300	300	300	300	300	300	300	269	245
18.00	9.000	300	300	300	293	262	239	300	300	250	216	194	177
	10.000	300	300	300	300	300	289	300	300	300	267	239	218
20.00	10.000	300	300	300	300	292	267	300	300	278	241	215	196

[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.

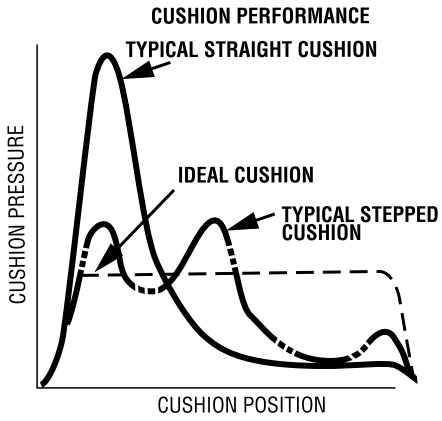
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An Introduction to Cushioning

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, H 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, and cushion performance for each of the rod sizes available is illustrated graphically in the charts on the following pages.

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, H 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 on the next page. Cushions are adjustable via recessed needle valves.

Cushion Calculation

The charts on the cushion energy absorption capacity data page show the energy absorption capacity for each bore/rod combination at the head (annulus) and the cap (full bore) ends of cylinder. The charts are valid for piston velocities within a range of 0.33 to 1 ft/s. For velocities between 1ft/s and 1.64 ft/s the energy values derived from the charts should be reduced by 25%. For velocities less than 0.33 ft/s where large masses are involved, and for velocities greater than 1.60 ft/s, a special cushion profile may be required. Please consult the factory for details.

The cushion capacity of the head end is less than the cap, and reduces to zero at high drive pressures due to the pressure intensification effect across the piston.

The energy absorption capacity of the cushion decreases with drive pressure.

Formula

Cushioning calculations are based on the formula $E=(1/2)mv^2$ for horizontal applications. For inclined or vertically downward or upward applications, this is modified to:

$E = (1/2)mv^2 + mg(L/12) \times \sin(a)$
(for inclined or vertically downward direction of mass)

$E = (1/2)mv^2 - mg(L/12) \times \sin(a)$
(for inclined vertically upward direction of mass)

where:

E = energy absorbed in ft-lb

g = acceleration due to gravity = 32.2 ft/s^2

v = velocity in ft/s

L = length of cushion in inches (see cushion length chart on the next page).

m = mass of load in slug (including piston, rod and rod end accessories.

a = angle to the horizontal in degrees

p = pressure in psi

Example:

The following example shows how to calculate the energy developed by masses moving in a straight line. For non-linear motion, other calculations are required; please consult the factory. The example assumes that the bore and rod diameter are already appropriate for the application. The effects of friction on the cylinder and load have been ignored.

Selected bore/rod 6.00" bore x 2.50" rod (No. 1 rod)

Cushion at the cap end.

Pressure = 2,500 psi

Mass = 685 slugs = weight in lb / (32.2 ft/s^2)

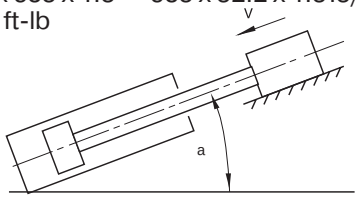
Velocity = 1.3 ft/s

Cushion length = 1.313 inch

a = 45˚

Sin (a) = 0.70

$E = (1/2)mv^2 + mgl/12 \times \text{Sin (a)}$
$= (1/2) \times 685 \times 1.3^2 + 685 \times 32.2 \times 1.313/12 \times 0.70$
= 2,268 ft-lb



Note: In the above example velocity is greater than 1 ft/s Therefore, a de-rating factor of 0.75 must be applied to the calculated value of E. Applying this correction factor will increase the energy value to 3024 ft-lb (2268/0.75 = 3024 ft-lb). A review of the graph for the cap end cushion of a 6 inch bore x 2.50" rod cylinder operating at 2500 psi indicates that it can absorb approximately 3200 ft-lb maximum of energy. Since 3024 ft-lb is less than the maximum allowable of 3200 ft-lb, the cylinder can be applied as indicated. If the calculated energy exceeds the value shown on the curve, select a larger bore cylinder and/or reduce the operating pressure and recalculate the energy. Compare the newly calculated energy value to the appropriate curve to ensure it does not exceed the maximum allowable energy.

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Cushion Length Chart (Series H Cylinders)

Bore Ø	Rod Ø	Effective Cushion Length	
		Head	Cap
1.50	0.625	0.924	1.000
	1.000	0.927	1.000
2.00	1.000	0.927	0.938
	1.375	0.925	0.938
2.50	1.000	0.927	0.938
	1.750	0.928	0.938
	1.375	0.925	0.938
3.25	1.375	1.175	1.125
	2.000	0.862	1.125
	1.750	1.178	1.125
4.00	1.750	1.178	1.063
	2.500	0.869	1.063
	2.000	0.862	1.063
5.00	2.000	0.862	0.938
	3.500	0.869	0.938
	2.500	0.869	0.938
	3.000	0.869	0.938
6.00	2.500	1.119	1.313
	4.000	1.119	1.313
	3.000	1.119	1.313
	3.500	0.869	1.313
7.00	3.000	1.619	1.750
	5.000	1.496	1.750
	3.500	1.619	1.750
	4.000	1.119	1.750
	4.500	1.496	1.750
8.00	3.500	1.869	1.813
	5.500	1.745	1.813
	4.000	1.119	1.813
	4.500	1.496	1.813
	5.000	1.496	1.813

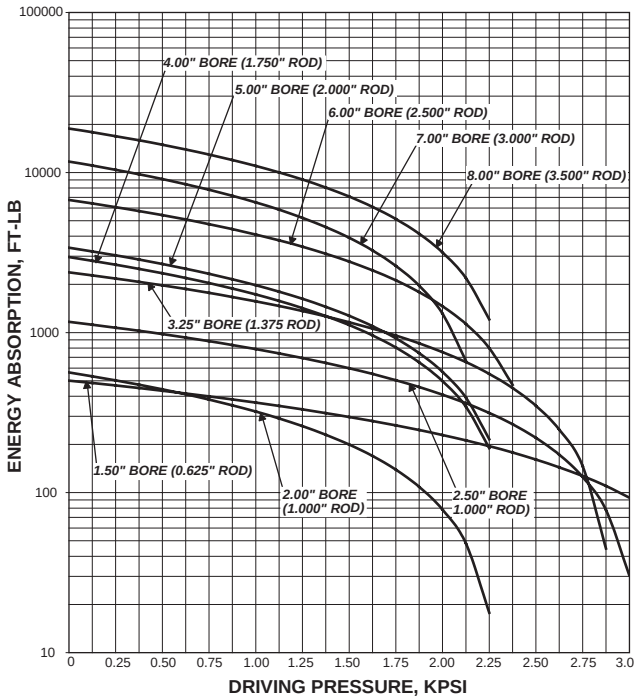
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Cushion Energy Absorption Capacity Data

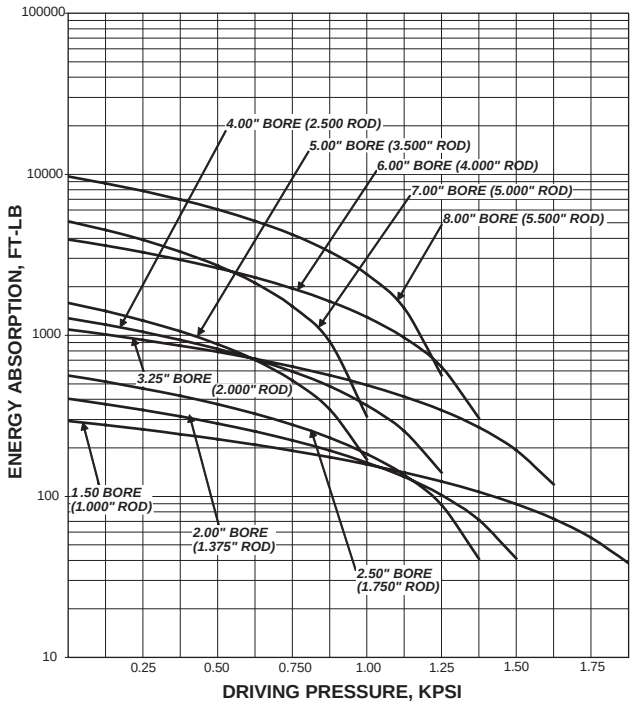
The cushion energy absorption data shown below is based on the maximum fatigue-free pressure developed in the tube. For application with a life cycle of less than 10^6 cycles, greater energy absorption figures can be applied. Please consult the factory if further information is required.

Head End

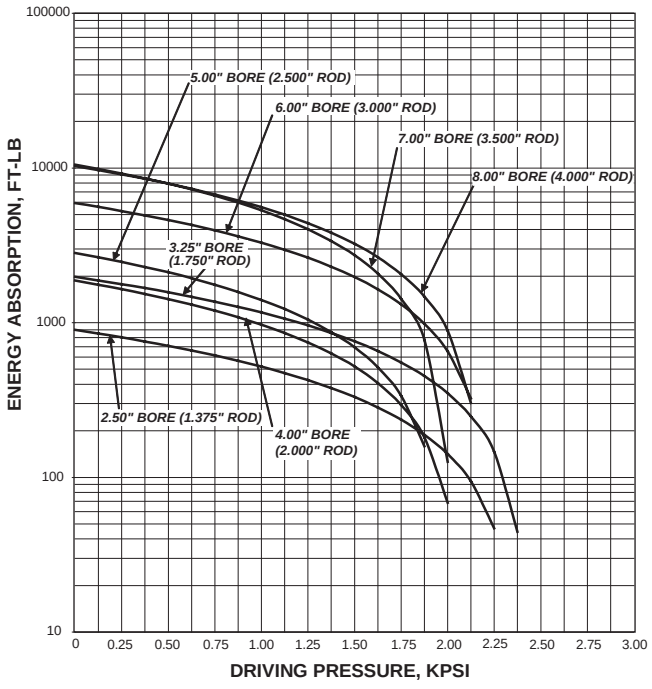
STANDARD ROD DIA.



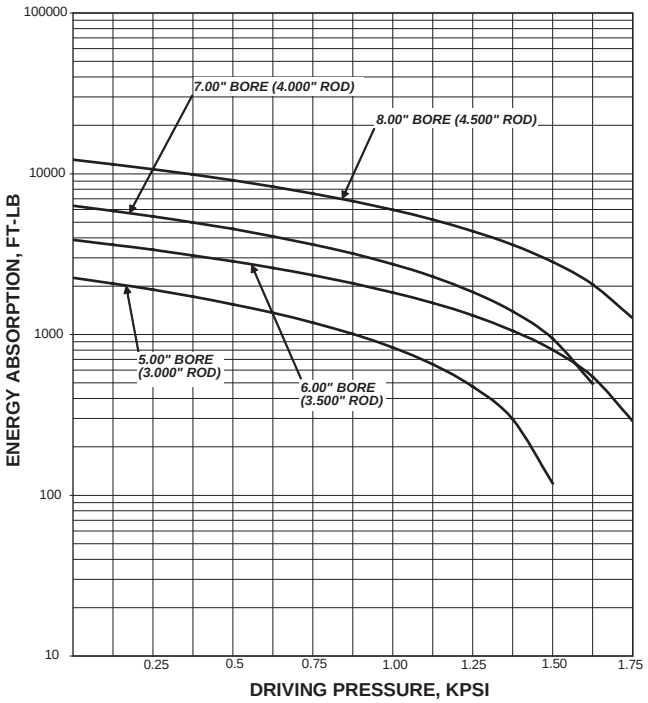
MAXIMUM ROD DIA.



FIRST OVERSIZE ROD DIA.



SECOND OVERSIZE ROD DIA.



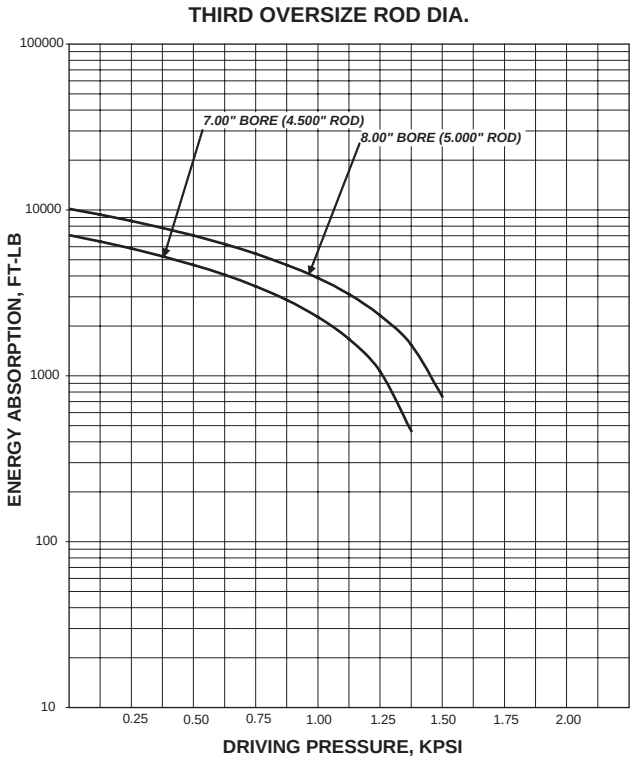
F Custom Modifications

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Cushion Energy Absorption Capacity Data

The cushion energy absorption data shown below is based on the maximum fatigue-free pressure developed in the tube. For application with a life cycle of less than 10^6 cycles, greater energy absorption figures can be applied. Please consult the factory if further information is required.

Head End



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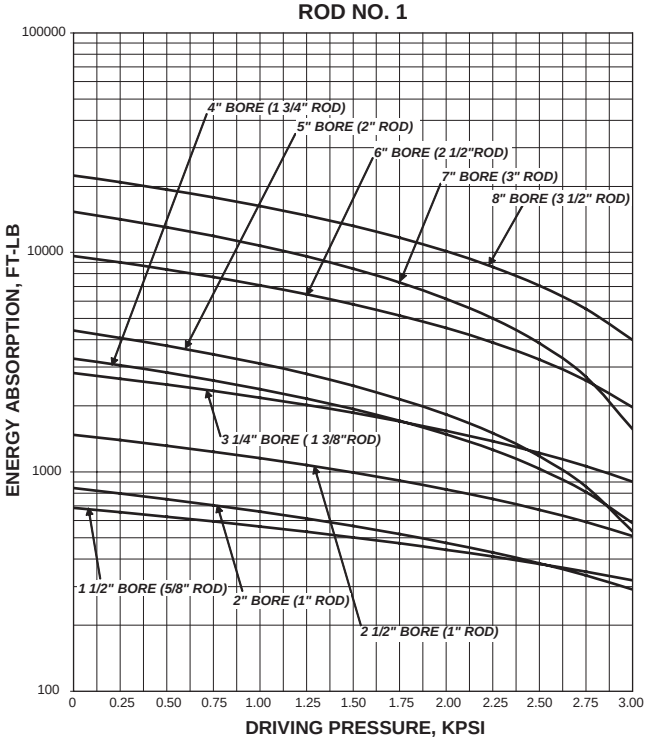
Cushion Energy Absorption Capacity Data

The cushion energy absorption data shown below is based on the maximum fatigue-free pressure developed in the tube. For application with a life cycle of less than 10^6 cycles, greater energy absorption figures can be applied. Please consult the factory if further information is required.

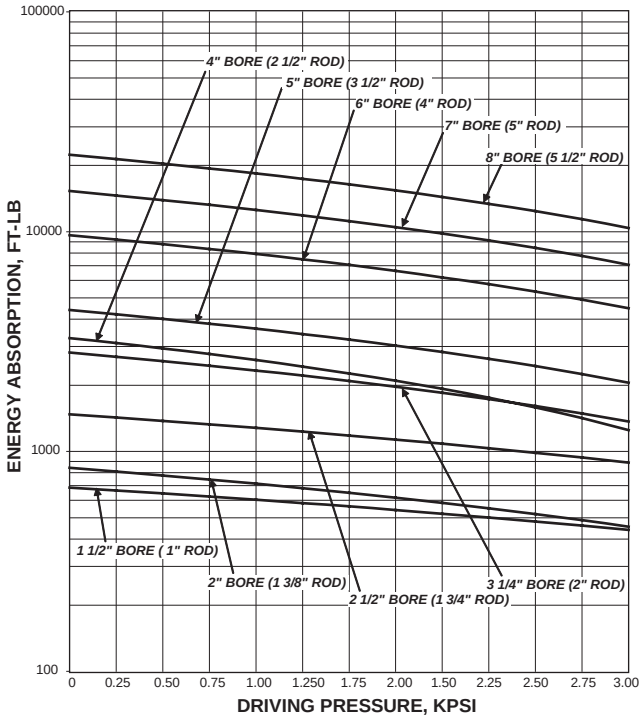
Note: Cap end cushioned cylinders with oversize port and hydraulic fluid flow entering the cap that exceeds 25 ft/second should be specified with solid cap cushion design.

Cap End

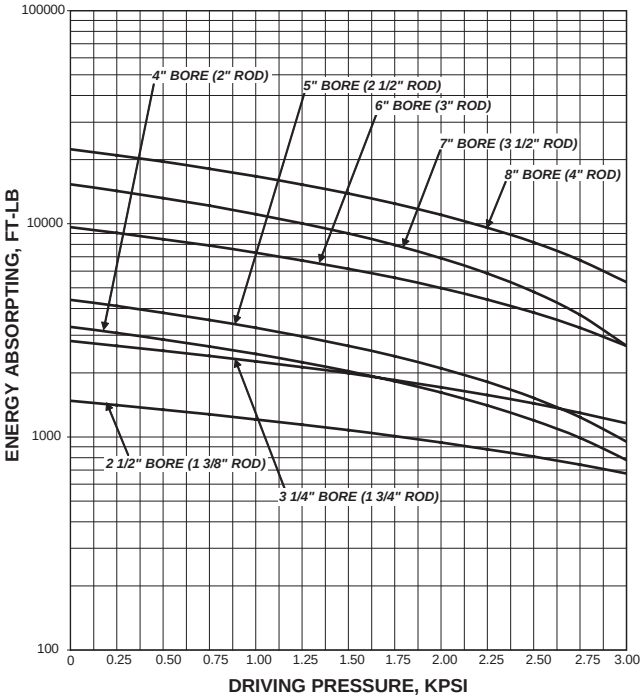
ROD NO. 1



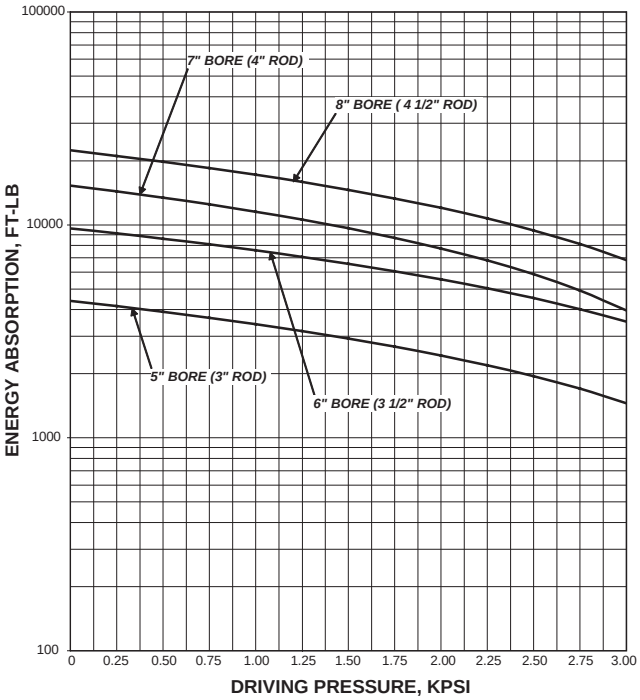
ROD NO. 2



ROD NO. 3



ROD NO. 4



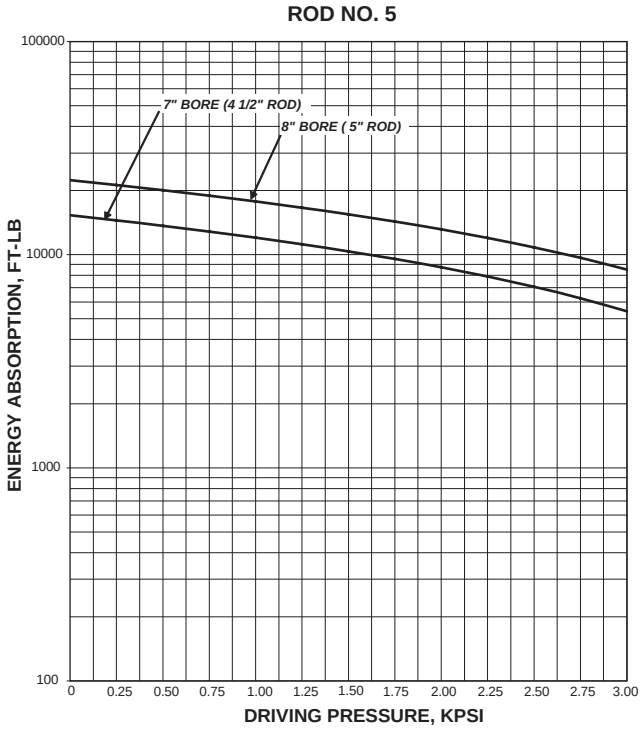
⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Cushion Energy Absorption Capacity Data

The cushion energy absorption data shown below is based on the maximum fatigue-free pressure developed in the tube. For application with a life cycle of less than 10^6 cycles, greater energy absorption figures can be applied. Please consult the factory if further information is required.

Note: Cap end cushioned cylinders with oversize port and hydraulic fluid flow entering the cap that exceeds 25 ft/second should be specified with solid cap cushion design.

Cap End



⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Notes

⚠ **PROP 65 WARNING** **WARNING:** This product can expose you to chemicals including **Lead and Lead Compounds** which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

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:

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

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 Hydraulic Actuator 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.

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. All sales of Products by Seller will be governed by, and are expressly conditioned upon Buyer's assent to, these Terms. These Terms are incorporated into any Quote provided by Seller to Buyer. Buyer's order for any Products whether communicated to Seller verbally, in writing, by electronic data interface or other electronic commerce, shall constitute acceptance of these Terms. Seller objects to any contrary or additional terms or conditions of Buyer. Reference in Seller's order acknowledgement to Buyer's purchase order or purchase order number shall in no way constitute an acceptance of any of Buyer's terms or conditions of purchase. Any Quote made by Seller to Buyer shall be considered a firm and definite offer and shall not be deemed to be otherwise despite any language on the face of the Quote. Seller reserves all rights to accept or reject any purported acceptance by Buyer to Seller's Quote if such purported acceptance attempts to vary the terms of the Quote. If Seller ships Products after Buyer issues an acceptance to the Quote, any additional or different terms proposed by Buyer will not become part of the parties' business relationship unless agreed to in a writing that is signed by an authorized representative of Seller, excluding email correspondence. If the transaction proceeds without such agreement on the part of Seller, the business relationship will be governed solely by these Terms and the specific terms in Seller's Quote.

2. Price; Payment. The Products set forth in the Quote are offered for sale at the prices indicated in the Quote. Unless otherwise specifically stated in the Quote, prices are valid for thirty (30) days and do not include any sales, use, or other taxes or duties. Seller reserves the right to modify prices for any reason and at any time by giving ten (10) days prior written notice. Unless otherwise specified by Seller, all prices are F.C.A. Seller's facility (INCOTERMS 2020). All sales are contingent upon credit approval and full payment for all purchases is due thirty (30) days from the date of invoice (or such date as may be specified in the Quote). Under any circumstances, Buyer may not withhold or suspend payment of any amounts due and payable as a deduction, set-off or recoupment of any amount, claim or dispute with Seller. Unpaid invoices beyond the specified payment date incur interest at the rate of 1.5% per month or the maximum allowable rate under applicable law. Seller reserves the right to require advance payment or provision of securities for first and subsequent deliveries if there is any doubt, in Seller's sole determination, regarding the Buyer's creditworthiness or for other business reasons. If the requested advance payment or securities are not provided to Seller's satisfaction, Seller reserves the right to suspend performance or reject the purchase order, in whole or in part, without prejudice to Seller's other rights or remedies, including the right to full compensation. Seller may revoke or shorten any payment periods previously granted in Seller's sole determination. The rights and remedies herein reserved to Seller are cumulative and in addition to any other or further rights and remedies available at law or in equity. No waiver by Seller of any breach by Buyer of any provision of these terms will constitute a waiver by Seller of any other breach of such provision.

3. Shipment; Delivery; Title and Risk of Loss. All delivery dates are approximate, and Seller is not responsible for damages or additional costs resulting from any delay. All deliveries are subject to our ability to procure materials from our suppliers. Regardless of the manner of shipment, delivery occurs and title and risk of loss or damage pass to Buyer, upon placement of the Products with the carrier at Seller's facility. Unless otherwise agreed prior to shipment and for domestic delivery locations only, Seller will select and arrange, at Buyer's sole expense, the carrier and means of delivery. When Seller selects and arranges the carrier and means of delivery, freight and insurance costs for shipment to the designated delivery location will be prepaid by Seller and added as a separate line item to the invoice. Buyer shall be responsible for any additional shipping charges incurred by Seller due to Buyer's acts or omissions. Buyer shall not return or repackage any Products without the prior written authorization from Seller, and any return shall be at the sole cost and expense of Buyer.

4. Warranty. The warranty for the Products is as follows: (i) Goods are warranted against defects in material or workmanship for a period of eighteen (18) months from the date of delivery or 2,000 hours of use, whichever occurs first; (ii) Services shall be performed in accordance with generally accepted practices and using the degree of care and skill that is ordinarily exercised and customary in the field to which the Services pertain and are warranted for a period of six (6) months from the date of completion of the Services; and (iii) Software is only warranted to perform in accordance with applicable specifications provided by Seller to Buyer for ninety (90) days from the date of delivery or, when downloaded by a Buyer or end-user, from the date of the initial download. All prices are based upon the exclusive limited warranty stated above, and upon the following disclaimer: **EXEMPTION CLAUSE; DISCLAIMER OF WARRANTY, CONDITIONS, REPRESENTATIONS: THIS WARRANTY IS THE SOLE AND ENTIRE WARRANTY, CONDITION, AND REPRESENTATION, PERTAINING TO PRODUCTS. SELLER DISCLAIMS ALL OTHER WARRANTIES, CONDITIONS, AND REPRESENTATIONS, WHETHER STATUTORY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THOSE RELATING TO DESIGN, NONINFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE SOFTWARE IS ERROR-FREE OR FAULT-TOLERANT, OR THAT BUYER'S USE THEREOF WILL BE SECURE OR UNINTERRUPTED, UNLESS OTHERWISE AUTHORIZED IN WRITING BY SELLER, THE SOFTWARE SHALL NOT BE USED IN CONNECTION WITH HAZARDOUS OR HIGH-RISK ACTIVITIES OR ENVIRONMENTS. EXCEPT AS EXPRESSLY STATED HEREIN, ALL PRODUCTS ARE PROVIDED "AS IS".**

5. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon receipt. No claims for shortages will be allowed unless reported to Seller within ten (10) days of delivery. Buyer shall notify Seller of any alleged breach of warranty within thirty (30) days after the date the non-conformance is or should have been discovered by Buyer. Any claim or action against Seller based upon breach of contract or any other theory, including tort, negligence, or otherwise must be commenced within twelve (12) months from the date of the alleged breach or other alleged event, without regard to the date of discovery.

6. LIMITATION OF LIABILITY. IN THE EVENT OF A BREACH OF WARRANTY, SELLER WILL, AT ITS OPTION, REPAIR OR REPLACE THE NON-CONFORMING PRODUCTS, RE-PERFORM THE SERVICES, OR REFUND THE PURCHASE PRICE PAID WITHIN A REASONABLE PERIOD OF TIME. IN NO EVENT IS SELLER LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDING ANY LOSS OF REVENUE OR PROFITS, WHETHER BASED IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN NO EVENT SHALL SELLER'S LIABILITY UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE PAID FOR THE PRODUCTS.

7. Confidential Information. Buyer acknowledges and agrees that Confidential Information has been and will be received in confidence and will remain the property of Seller. Buyer further agrees that it will not use Seller's Confidential Information for any purpose other than for the benefit of Seller and shall return all such Confidential Information to Seller within thirty (30) days upon request.

8. Loss to Buyer's Property. Buyer's Property will be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer ordering the Products manufactured using Buyer's Property. Also, Seller shall not be responsible for any loss or damage to Buyer's Property while it is in Seller's possession or control.

9. Special Tooling. Seller may impose a tooling charge for any Special Tooling. Special Tooling shall be and remain Seller's property. In no event will Buyer acquire any interest in the Special Tooling, even if such Special Tooling has been specially converted or adapted for manufacture of Goods for Buyer and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller has the right to alter, discard or otherwise dispose of any Special Tooling or other property owned by Seller in its sole determination at any time.

10. Security Interest. To secure payment of all sums due from Buyer, Seller retains a security interest in all Products delivered to Buyer and, Buyer's acceptance of these Terms is deemed to be 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 Seller's security interest.

11. User Responsibility. Buyer, through its own analysis and testing, is solely responsible for making the final selection of the Products and assuring that all performance, endurance, maintenance, safety and warning requirements of the application of the Products are met. Buyer must analyze all aspects of the application and follow applicable industry standards, specifications, and any technical information provided with the Quote or the Products, such as Seller's instructions, guides and specifications. If Seller provides options of or for Products based upon data or specifications provided by Buyer, Buyer is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the Products. In the event Buyer is not the end-user of the Products, Buyer will ensure such end-user complies with this paragraph.

12. Use of Products, Indemnity by Buyer. Buyer shall comply with all instructions, guides and specifications provided by Seller with the Quote or the Products. If Buyer uses or resells the Products in any way prohibited by Seller's instructions, guides or specifications, or Buyer otherwise fails to comply with Seller's instructions, guides and specifications, Buyer acknowledges that any such use, resale, or non-compliance is at Buyer's sole risk. Further, Buyer shall indemnify, defend, and hold Seller harmless from any losses, claims, liabilities, damages, lawsuits, judgments and costs (including attorney fees and defense costs), whether for personal injury, property damage, intellectual property infringement or any other claim, arising out of or in connection with: (a) improper selection, design, specification, application, or any misuse of Products; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of Buyer's Property; (d) damage to the Products from an external cause, repair or attempted repair by anyone other than Seller, failure to follow instructions, guides and specifications provided by Seller, use with goods not provided by Seller, or opening, modifying, deconstructing, tampering with or repackaging the Products; or (e) Buyer's failure to comply with these Terms, including any legal or administrative proceedings, collection efforts, or other actions arising from or relating to such failure to comply. Seller shall not indemnify Buyer under any circumstance except as otherwise provided in these Terms.

13. Cancellations and Changes. Buyer may not cancel or modify, including but not limited to movement of delivery dates for the Products, any order 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 and any additional expense. Seller, at any time, may change features, specifications, designs and availability of Products.

14. Assignment. Buyer may not assign its rights or obligations without the prior written consent of Seller.

15. Force Majeure. Seller is not liable for delay or failure to perform any of its obligations by reason of any events or circumstances beyond its reasonable control. Such circumstances include without limitation: accidents, labor disputes or stoppages, government acts or orders, acts of nature, pandemics, epidemics, other widespread illness, or public health emergency, cyber related disruptions, cyber-attacks, ransomware sabotage, delays or failures in delivery from carriers or suppliers, shortages of materials, sudden increases in the price of raw material or components, shutdowns or slowdowns affecting the supply of raw materials or components, or the transportation thereof, oil shortages or oil price increases, energy crisis, energy or fuel interruption, war (whether declared or not) or the serious threat of same, riots, rebellions, acts of terrorism, embargoes, fire or any reason whether similar to the foregoing or otherwise. Seller will resume performance as soon as practicable after the event of force majeure has been removed. All delivery dates affected by an event of force majeure shall be tolled for the duration of such event of force majeure and rescheduled for mutually agreed dates as soon as practicable after the event of force majeure ceases to exist. The right to allocate capacity is in the Seller's sole discretion. An event of force majeure shall not include financial distress, insolvency, bankruptcy, or other similar conditions affecting one of the parties, affiliates and/or sub¬contractors. An event of force majeure in the meaning of these Terms means any circumstances beyond Seller's control that permanently or temporarily hinders performance, even where that circumstance was already foreseen. Buyer shall not be entitled to cancel any orders following its claim of an event of force majeure.

16. Waiver and Severability. Failure to enforce any provision of these Terms will not invalidate that provision; nor will any such failure prejudice either party's right to enforce that provision in the future. Invalidation of any provision of these Terms shall not invalidate any other provision herein and, the remaining provisions will remain in full force and effect.

17. Duration. Unless otherwise stated in the Quote, any agreement governed by or arising from these Terms shall: (a) be for an initial duration of one (1) year; and (b) shall automatically renew for successive one-year terms unless terminated by Buyer with at least 180-days written notice to Seller or if Seller terminates the agreement pursuant to Section 19 of these Terms.

18. Termination. Seller may, without liability to Buyer, terminate any agreement governed by or arising from these Terms for any reason and at any time by giving Buyer thirty (30) days prior written notice. Seller may immediately terminate, in writing, if Buyer: (a) breaches any provision of these Terms, (b) becomes or is deemed insolvent, (c) appoints or has appointed a trustee, receiver or custodian for all or any part of Buyer's property,(d) files a petition for relief in bankruptcy on its own behalf, or one is filed against Buyer by a third party, (e) makes an assignment for the benefit of creditors; or (f) dissolves its business or liquidates all or a majority of its assets.

19. Ownership of Rights. Buyer agrees that (a) Seller (and/or its affiliates) owns or is the valid licensee of Seller's IP and (b) the furnishing of information, related documents or other materials by Seller to Buyer does not grant or transfer any ownership interest or license in or to Seller's IP to Buyer, unless expressly agreed in writing. Without limiting the foregoing, Seller retains ownership of all Software supplied to Buyer. In no event shall Buyer obtain any greater right in and to the Software than a right in a license limited to the use thereof and subject to compliance with any other terms provided with the Software. Buyer further agrees that it will not, directly or through intermediaries, reverse engineer, decompile, or disassemble any Software (including firmware) comprising or contained within a Product, except and only to the extent that such activity may be expressly permitted, either by applicable law or, in the case of open source software, the applicable open source license.

20. Indemnity for Infringement of Intellectual Property Rights. Seller is not liable for infringement of any Intellectual Property Rights except as provided in this Section. 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 a third-party claim that one or more of the Products infringes the Intellectual Property Rights of a third party in the country of delivery of the Products by Seller to Buyer. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of any such claim, and Seller having sole control over the defense of the claim including all negotiations for settlement or compromise. If one or more Products is subject to such a claim, Seller may, at its sole expense and option, procure for Buyer the right to continue using the Products, replace or modify the Products to render them non-infringing, or offer to accept return of the Products and refund the purchase price less a reasonable allowance for depreciation. Seller has no obligation or liability for any claim of infringement: (i) arising from information provided by Buyer (including Seller's use of Buyer's Property); or (ii) directed to any Products for which the designs are specified in whole or part by Buyer; or (iii) resulting from the modification, combination or use in a system of any Products. The foregoing provisions of this Section constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for claims of infringement of Intellectual Property Rights.

21. Governing Law. These Terms, the terms of any Quote, and the sale and delivery of all Products are 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 the sale and delivery of the Products.

22. Entire Agreement. These Terms, along with the terms set forth in the Quote, forms the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of sale and purchase. In the event of a conflict between any term set forth in the Quote and these Terms, the terms set forth in the Quote shall prevail. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter shall have no effect. No modification to these Terms will be binding on Seller unless agreed to in a writing that is signed by an authorized representative of Seller, excluding email correspondence, 'clickwrap' or other purported electronic assent to different or additional terms. Sections 2-25 of these Terms shall survive termination or cancellation of any agreement governed by or arising from these Terms.

23. No 'Wrap' Agreements/No Authority to Bind. Seller's clicking any buttons or any similar action, such as clicking "I Agree" or "Confirm," to utilize Buyer's software or webpage for the placement of orders, is NOT an agreement to Buyer's Terms and Conditions. NO EMPLOYEE, AGENT OR REPRESENTATIVE OF SELLER HAS THE AUTHORITY TO BIND SELLER BY THE ACT OF CLICKING ANY BUTTON OR SIMILAR ACTION ON BUYER'S WEBSITE OR PORTAL.

24. Compliance with Laws. Buyer agrees to comply with all applicable laws, regulations, and industry and professional standards, including those of the United States of America, and the country or countries in which Buyer may operate, including without limitation the U.S. Foreign Corrupt Practices Act ("FCPA"), the U.S. Anti-Kickback Act ("Anti-Kickback Act"), U.S. and E.U. export control and sanctions laws ("Export Laws"), the U.S. Food Drug and Cosmetic Act ("FDCA"), and the rules and regulations promulgated by the U.S. Food and Drug Administration ("FDA"), each as currently amended. Buyer agrees to indemnify, defend, and hold harmless Seller from the consequences of any violation of such laws, regulations and standards by Buyer, its employees or agents. Buyer represents that it is familiar with all applicable provisions of the FCPA, the Anti-Kickback Act, Export Laws, the FDCA and the FDA and certifies that Buyer will adhere to the requirements thereof and not take any action that would make Seller violate such requirements. Buyer represents and agrees that Buyer will not make any payment or give anything of value, directly or indirectly, to any governmental official, foreign political party or official thereof, candidate for foreign political office, or commercial entity or person, for any improper purpose, including the purpose of influencing such person to purchase Products or otherwise benefit the business of Seller. Buyer further represents and agrees that it will not receive, use, service, transfer or ship any Products from Seller in a manner or for a purpose that violates Export Laws or would cause Seller to be in violation of Export Laws. Buyer agrees to promptly and reliably provide Seller all requested information or documents, including end-user statements and other written assurances, concerning Buyer's ongoing compliance with Export Law. 9/22

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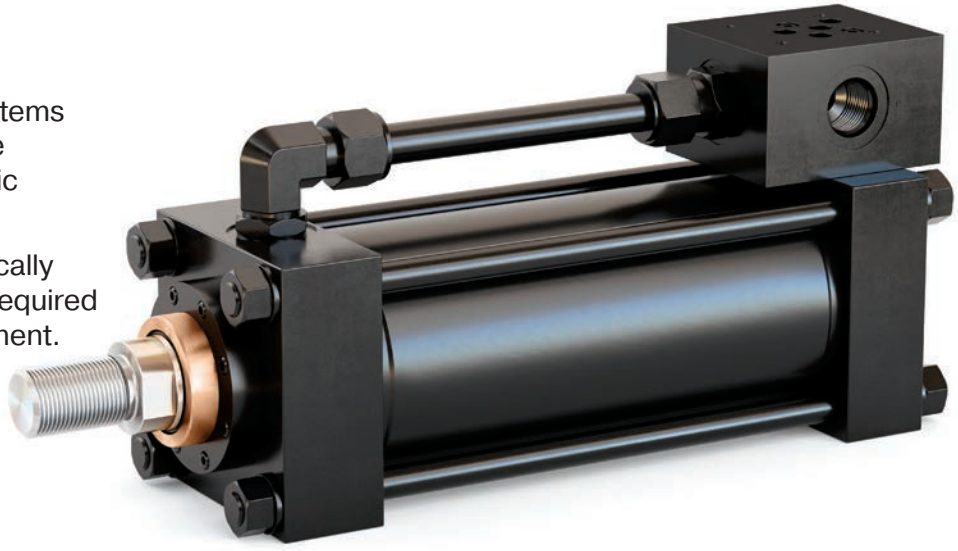


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