Series H Heavy Duty Industrial Hydraulic Cylinders

Catalog HY04-AC1140-5/US
August, 2015

ATLAS CYLINDERS

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ESP Series Cylinders

Operating Pressure to 3000 PSI

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

EM Series Cylinders

Operating Pressure to 3000 PSI

Remote Electronics with resolution to .0005", operating pressure to 3000 PSI. Electronic module change out without removing or disassembly of the cylinder.

MH Series Cylinders

Standard Operating Pressure to 2000 PSI

Mill Hydraulic with bolted head construction, standard operating pressure to 2000 PSI and modified to 3000 PSI. Only standard non tie rod Mill Cylinder to meet NFPA interchange.

Custom Cylinders

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

⚠ WARNING

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Atlas Series H Heavy-Duty Hydraulic Cylinder

When the application demands a heavy-duty cylinder with maximum performance, specify Atlas Series H. This cylinder has standard design features to maximize machine uptime. The standard bronze rod gland, case-hardened piston rod, high strength piston rod stud and tie rod material combine to make Series H the cylinder for demanding applications up to 3000 psi.

Thorough inspection and performance testing of each cylinder before shipment assure Series H cylinder quality. See the following pages for the inside story on all the features that make Series H the high performance, long lasting choice for all your heavy-duty hydraulic applications.

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Standard Specifications

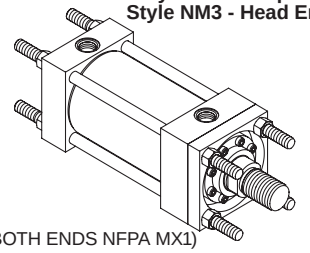
- Heavy Duty Service – ANSI (NFPA) T3.6.7R3-2009 Mounting and Specification Dimensions
- Standard Construction – Square Head – Tie Rod Design
- Nominal Pressure – 3000 P.S.I.*
- Standard Fluid – Hydraulic Oil
- Standard Temperature – -10° F to +165° F
- Bore Sizes – 1 1/2" through 6"
- Piston Rod Diameter – 5/8" through 4"
- Mounting Styles – 16 standard styles at various application ratings
- Standard – Externally removable bolted gland assembly
- Strokes – Available in any practical stroke length
- Cushions – Optional at either end or both ends of stroke. "Float Check" at cap end.
- Rod Ends – Four Standard Choices – Specials to Order

*If hydraulic operating pressure exceeds 3000 P.S.I., send application data for engineering evaluation and recommendation. See page 58 for actual design factors.

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

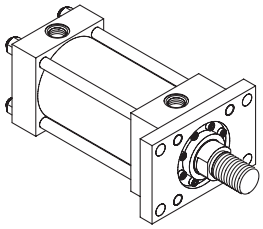
Mounting Styles

Tie Rods Extended
Style NM1 - Both Ends
Style NM2 - Cap End
Style NM3 - Head End



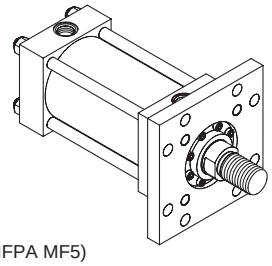
(BOTH ENDS NFPA MX1)
(CAP END NFPA MX2)
(HEAD END NFPA MX3)

Head Rectangular Flange
Style REF2



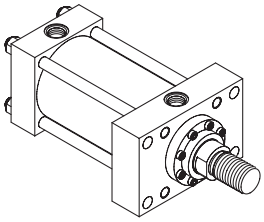
(NFPA MF1)

Head Square Flange
Style REF1



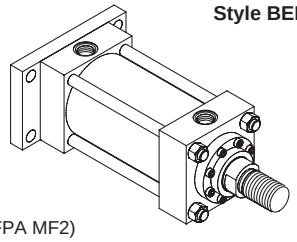
(NFPA MF5)

Head Rectangular
Style ME5



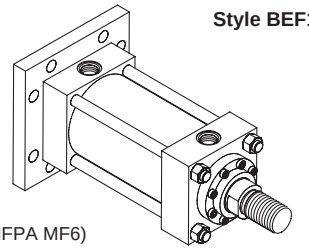
(NFPA ME5)

Cap Rectangular Flange
Style BEF2



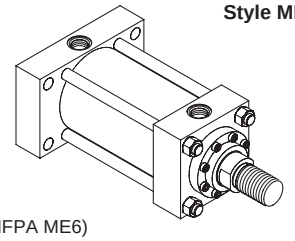
(NFPA MF2)

Cap Square Flange
Style BEF1



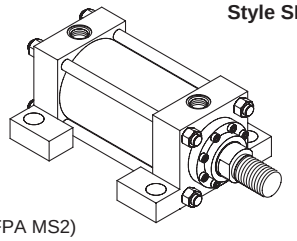
(NFPA MF6)

Cap Rectangular
Style ME6



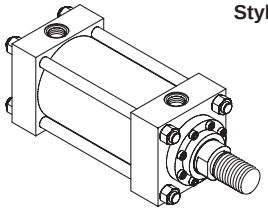
(NFPA ME6)

Side Lug
Style SL



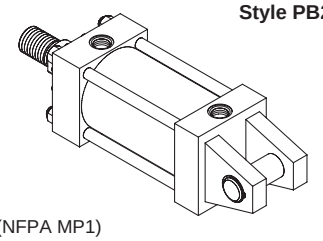
(NFPA MS2)

Side Tap
Style FS



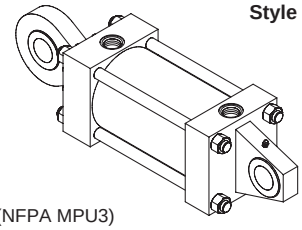
(NFPA MS4)

Cap Fixed Clevis
Style PB2



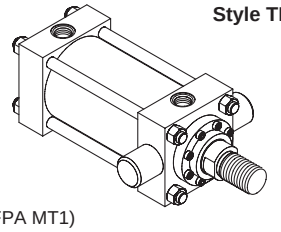
(NFPA MP1)

Cap Fixed Eye with Spherical Bearing
Style SA



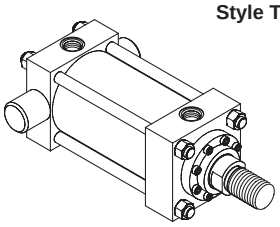
(NFPA MPU3)

Head Trunnion
Style TM1



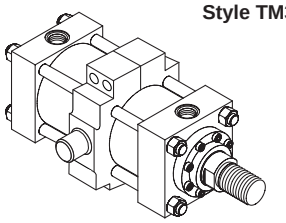
(NFPA MT1)

Cap Trunnion
Style TM2



(NFPA MT2)

Intermediate Trunnion
Style TM3



(NFPA MT4)

Atlas. . .
Series H – your best choice in heavy duty hydraulic cylinders

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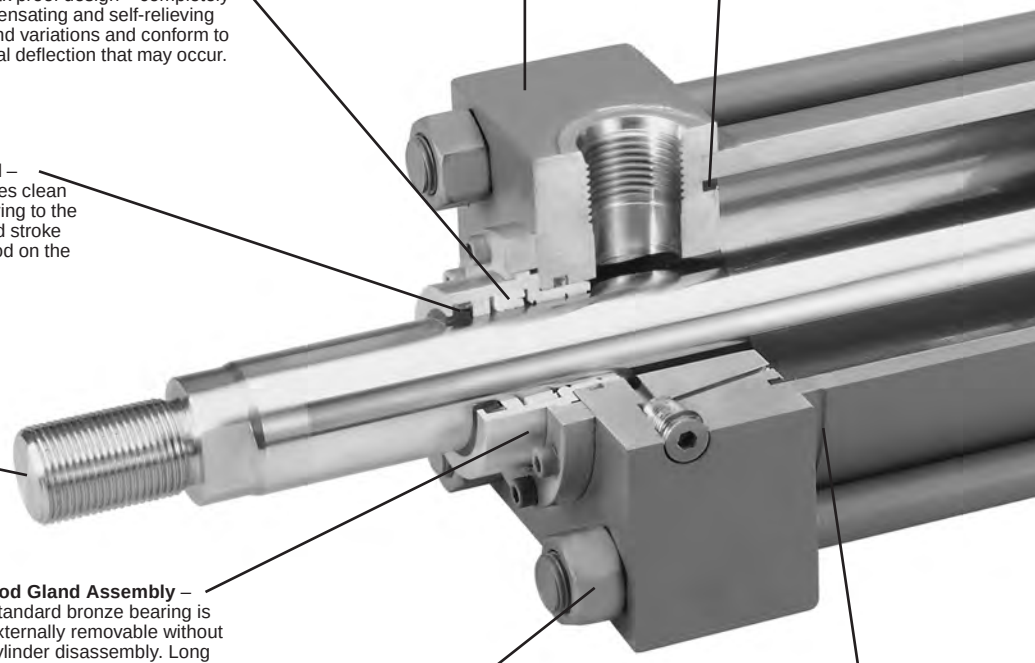


Steel Head – Bored and grooved to provide concentricity for mating parts.

End Seal – Pressure-actuated cylinder tube-to-head and cap "O" rings.

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

Secondary Seal – Rod Wiper – wipes clean any oil film adhering to the rod on the extend stroke and cleans the rod on the return stroke.

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

Rod Gland Assembly – Standard bronze bearing is externally removable without cylinder disassembly. Long inboard bearing surface is ahead of the seals assuring lubrication by cylinder operating fluid. A spiral groove on the bearing area helps eliminate drag pressure that can cause damage to the rod seal and provides positive lubrication for less wear.

Alloy Steel Tie Rod Nuts

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

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, extensive research has found that both designs have their limitations.

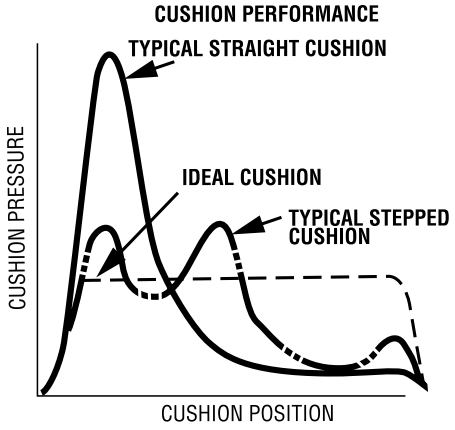
As a result, we have taken a new approach in cushioning of industrial hydraulic cylinders and for specific load and velocity conditions have been able to obtain deceleration curves that come very close to the ideal. The success lies in a stepped sleeve or spear concept where the steps are calculated to approximate theoretical orifice areas 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 curve 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 Series H cylinder design incorporates the longest cushion sleeves or cushion spears that can be provided in the standard envelope without decreasing the rod bearing and piston bearing lengths.



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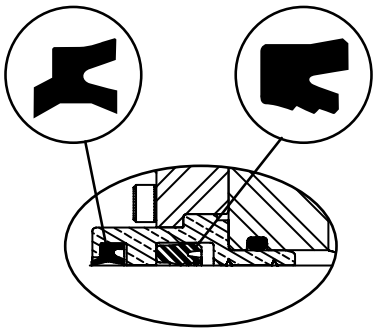
Piston Rod – Medium carbon steel, induction case-hardened, hard chrome-plated and polished to 10 RMS finish.

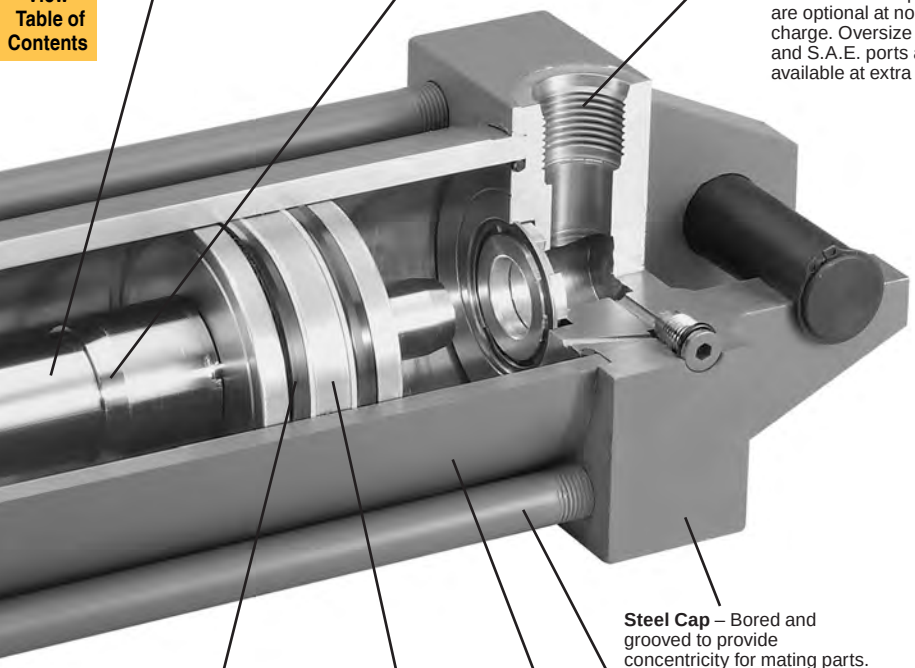
Adjustable Floating Stepped Cushions – For maximum performance – economical and flexible for even the most demanding applications – provides superior performance in reducing shock. Cushions are optional and can be supplied at head end, cap end, or both ends without change in envelope or mounting dimensions.

Ports – S.A. E. "O"-ring ports are standard

OPTIONAL PORTS

Ports – N.P.T.F. ports are optional at no extra charge. Oversize N.P.T.F. and S.A.E. ports are available at extra charge.





Atlas Gland Assembly with "Tri-Lip" Rod Seal
Gland Assembly externally removable without cylinder disassembly. An O-ring is used as a seal between the gland and head. The "Tri-Lip" rod seal has multiple sealing edges to produce "dry rod" performance. It is molded from a special polyurethane material that is extremely resistant to abrasion and extrusion, resulting in exceptional service life. Wiperseal cleans rod of dirt, preventing it from entering the gland and also acts as a secondary rod seal.

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

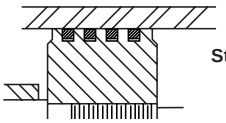
Lipseal™ Piston – Zero leakage under static conditions for hydraulic pressures up to 3000 PSI. Seals are self-compensating to conform to variations in pressure, mechanical deflection, and wear. Back-up washer prevents extrusion.

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

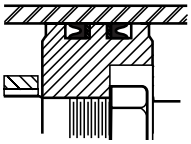
One-Piece Nodular Iron Piston – The wide piston surface contacting cylinder bore reduces bearing loads. Anaerobic adhesive is used to permanently lock and seal the piston to the rod.

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

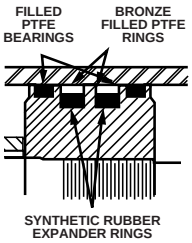
OPTIONAL PISTONS



Step cut iron piston rings are optional.



Piston with Retainer Nut – Optional at no extra charge.



Hi Load Piston – Optional at extra charge ($1^1/_2$-6 inch bores). Includes wear rings and bronze-filled PTFE seals. Two wear rings serve as bearings which deform radially under side-loading, enabling the load to be spread over a larger area and reduce unit loading. Bronze-filled PTFE seals are designed for extrusion-free, leak-proof service and longer cylinder life than the lipseal type piston. Not available with retainer nut.

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(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 needle valve is provided that is flush with the side of the head even when wide open. It may be identified by the fact that it is socket-keyed. It is located on side number 2, in all mounting styles except ME5, ME6, TM1, TM2 and TM3. In these styles it is located on side number 3.

c. On 6" bore and larger cylinders, a springless check valve is provided that is also flush with the side of the head and is mounted adjacent to the needle valve except on mounting style SL, where it is mounted opposite the needle valve. It may be identified by the fact that it is slotted.

d. On $1^1/_2$" - 5" bore cylinders a slotted sleeve design is used in place of the check valve.

e. $1^1/_2$" - $2^1/_2$" bore cylinders use cartridge style needle valve (see Figure A).

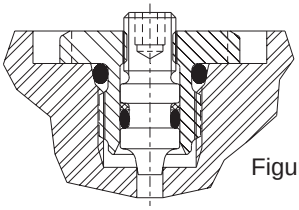


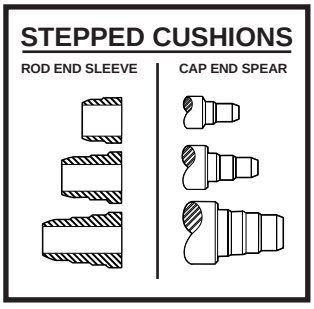
Figure A

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

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

b. A "float check" self-centering bushing is provided which incorporates a large flow check valve for fast "out-stroke" action.

c. A socket-keyed needle valve is provided that is flush with the side of the cap when wide open. It is located on side number 2 in all mounting styles except ME5, ME6, TM1, TM2 and TM3. In these styles it is located on side number 3.



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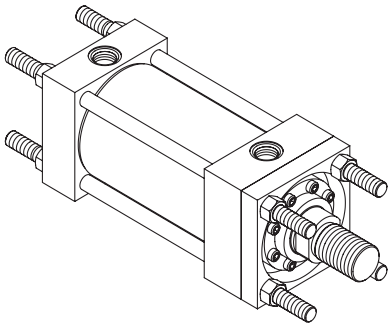
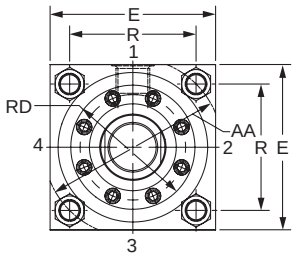
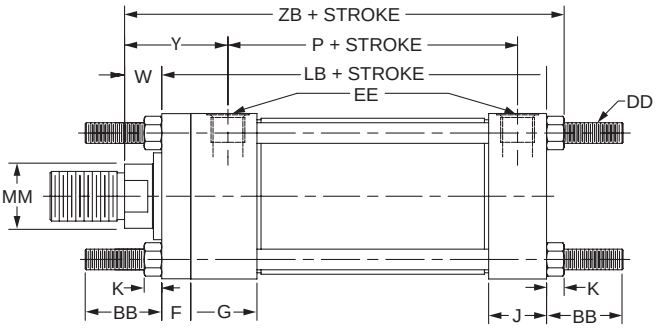
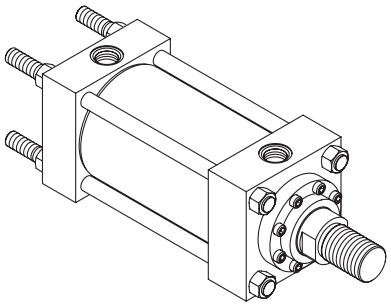
Tie Rods Extended Both Ends Mount Style NM1

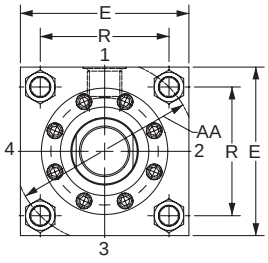


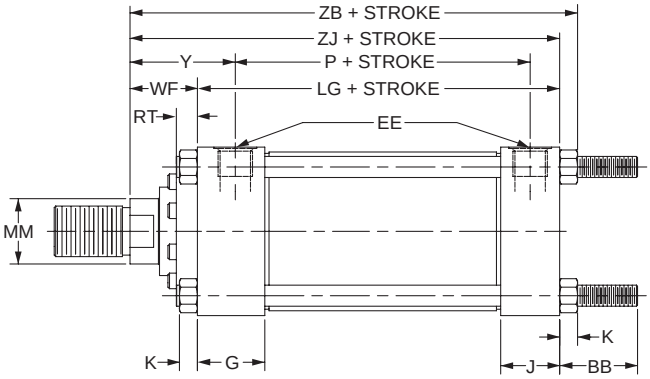




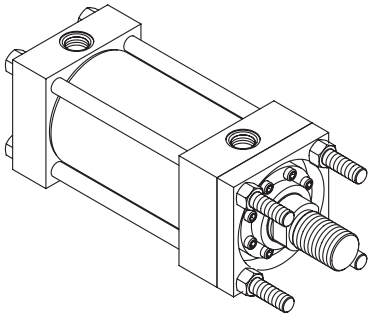
Tie Rods Extended Cap End Mount Style NM2

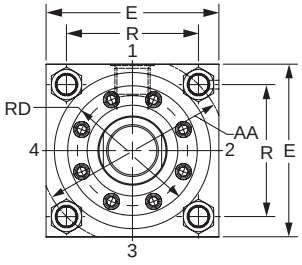


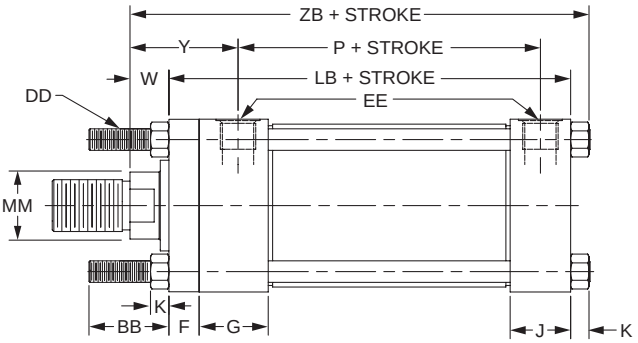




Tie Rods Extended Head End Mount Style NM3



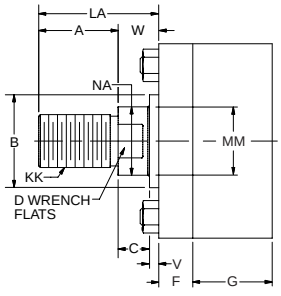




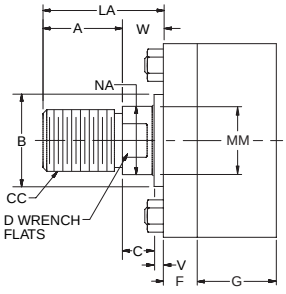
Rod End Dimensions (for Retainer Held Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

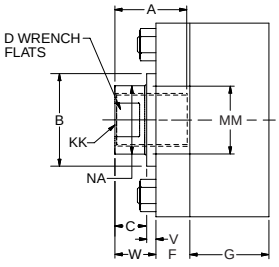
Thread Style 1
Small Male



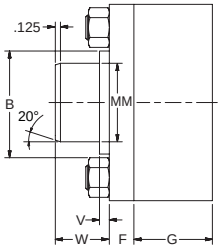
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

"Special" Thread Style 4

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

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

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Table 1—Envelope and Mounting Dimensions

Bore	AA	BB	DD	E	EE		F	G	J	K	R	Add Stroke		
					NPTF⊖	SAE★						LB	LG	P
1½	2.3	1⅜	⅜-24	2½	½	8	⅜	1¾	1½	⅜	1.63	5	4⅝	2⅞
2	2.9	1 13/16	½-20	3	½	8	⅝	1¾	1½	7/16	2.05	5¼	4⅝	2⅞
2½	3.6	1 13/16	½-20	3½	½	8	⅝	1¾	1½	7/16	2.55	5⅜	4¾	3
3¼	4.6	2 5/16	⅝-18	4½	¾	12	¾	2	1¾	9/16	3.25	6¼	5½	3½
4	5.4	2 5/16	⅝-18	5	¾	12	⅞	2	1¾	9/16	3.82	6⅝	5¾	3¾
5	7.0	3 3/16	⅞-14	6½	¾	12	⅞	2	1¾	13/16	4.95	7⅛	6¼	4¼
6	8.1	3⅝	1-14	7½	1	16	1	2¼	2¼	⅞	5.73	8⅜	7⅜	4⅞

★SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

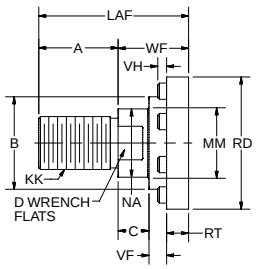
Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions															Add Stroke	
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LA	LAF	NA	RD (Max.)	RT	V	VF	VH	W	WF	Y	ZB	ZJ
1½	⅝	½-20	7/16-20	¾	1.124	⅜	½	1⅜	1¾	9/16	1 15/16	⅜	¼	¼	⅜	⅝	1	2	6	5⅝
	1	⅞-14	¾-16	1⅛	1.499	½	⅞	2⅛	2½	15/16	2⅜	⅜	½	½	⅜	1	1⅜	2⅜	6⅜	6
2	1	⅞-14	¾-16	1⅛	1.499	½	⅞	1⅞	2½	15/16	2⅜	⅜	¼	½	⅜	¾	1⅜	2⅜	6 7/16	6
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	2⅝	3¼	1 5/16	2⅞	⅜	⅜	⅝	⅜	1	1⅝	2⅝	6 11/16	6¼
2½	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	⅜	–	1⅜	2⅜	6 9/16	6⅛
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1 5/16	2⅞	⅜	⅜	⅝	⅜	–	1⅝	2⅝	6 13/16	6⅜
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	½	½	⅜	–	1⅞	2⅞	7 1/16	6⅝
3¼	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1 5/16	2⅞	⅜	¼	⅝	⅜	–	1⅝	2¾	7 11/16	7⅛
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	⅜	½	⅜	–	1⅞	3	7 15/16	7⅜
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	⅜	½	¼	–	2	3⅛	8 1/16	7½
4	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	¼	½	⅜	–	1⅞	3	8 3/16	7⅝
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2	3⅛	8 5/16	7¾
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼	3⅜	8 9/16	8
5	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2	3⅛	9 1/16	8¼
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼	3⅜	9 5/16	8½
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	⅜	5/16	–	–	2¼	3⅜	9 5/16	8½
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	⅜	5/16	–	–	2¼	3⅜	9 5/16	8½
6	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	¼	⅝	¼	–	2¼	3½	10½	9⅝
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	¼	5/16	–	–	2¼	3½	10½	9⅝
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	¼	5/16	–	–	2¼	3½	10½	9⅝
	4	3¾-12	3-12	4	4.749	1	3⅜	–	6¼	3⅞	6 5/16	15/16	¼	5/16	–	–	2¼	3½	10½	9⅝

Table 3 — Envelope and Mounting Dimensions

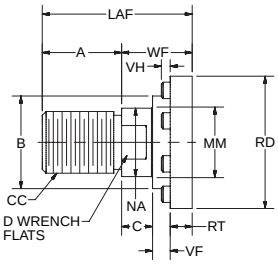
Rod End Dimensions (for Bolted Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

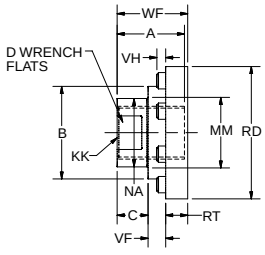
Thread Style 1
Small Male



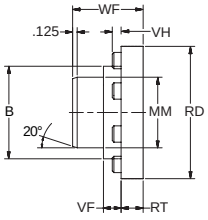
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

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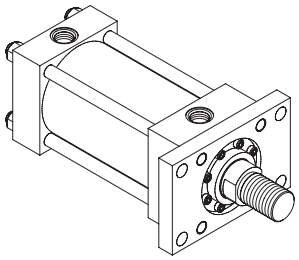
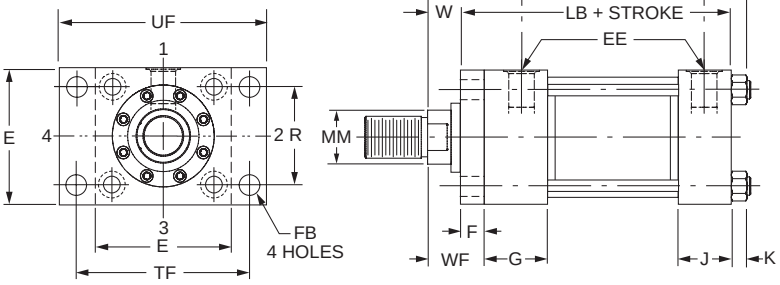
Head Rectangular Flange Mount Style REF2



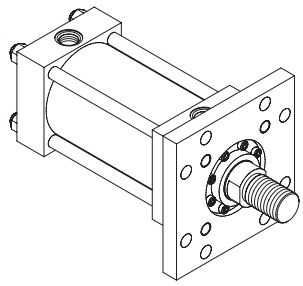
Maximum Pressure Rating - PSI
Push Application

Bore	Rod Dia 5/8	1	1 3/8	1 3/4	2
1 1/2	1400	1000	–	–	–
2	–	2000	1200	–	–
2 1/2	–	700	700	1000	–
3 1/4	–	–	800	800	600
4	–	–	–	1000	1000
5	–	–	–	–	850

Bore	Rod Dia 2 1/2	3	3 1/2	4	5
4	700	–	–	–	–
5	850	450	800	–	–
6	650	650	400	400	–



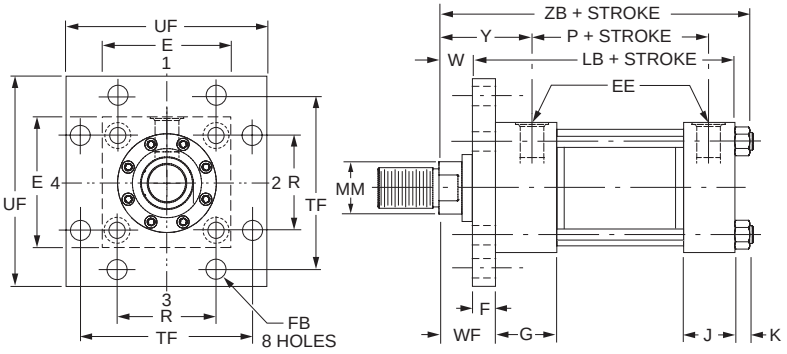
Head Square Flange Mount Style REF1



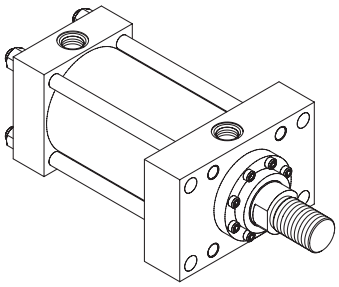
Maximum Pressure Rating - PSI
Push Application

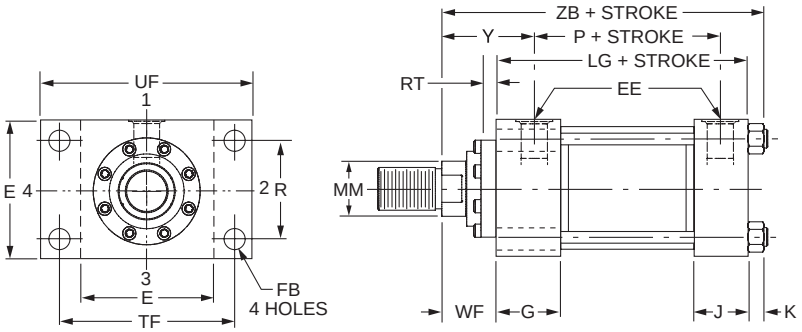
Bore	Rod Dia 5/8	1	1 3/8	1 3/4	2
1 1/2	3000	3000	–	–	–
2	–	3000	3000	–	–
2 1/2	–	3000	3000	3000	–
3 1/4	–	–	3000	3000	3000
4	–	–	–	3000	3000
5	–	–	–	–	2500

Bore	Rod Dia 2 1/2	3	3 1/2	4	5
4	3000	–	–	–	–
5	2500	1800	2300	–	–
6	2000	2000	1600	1600	–



Head Rectangular Mount Style ME5

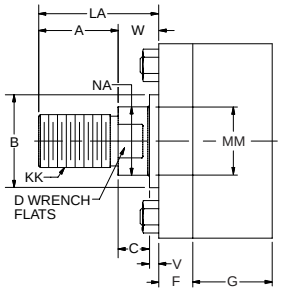




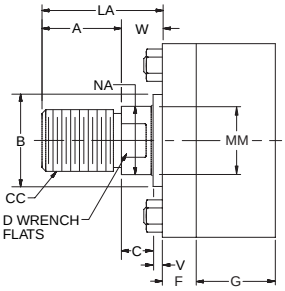
Rod End Dimensions (for Retainer Held Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

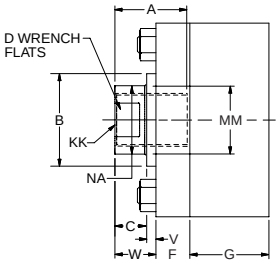
Thread Style 1
Small Male



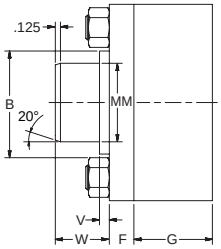
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

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Table 1—Envelope and Mounting Dimensions

Bore	E	EE		F	FB	G	J	K	R	TF	UF	Add Stroke		
		NPTF⊖	SAE★									LB	LG	P
1½	2½	½	8	⅜	7/16	1¾	1½	⅜	1.63	3 7/16	4¼	5	4⅝	2⅞
2	3	½	8	⅝	9/16	1¾	1½	7/16	2.05	4⅛	5⅛	5¼	4⅝	2⅞
2½	3½	½	8	⅝	9/16	1¾	1½	7/16	2.55	4⅝	5⅝	5⅜	4¾	3
3¼	4½	¾	12	¾	11/16	2	1¾	9/16	3.25	5⅞	7⅛	6¼	5½	3½
4	5	¾	12	⅞	11/16	2	1¾	9/16	3.82	6⅜	7⅝	6⅝	5¾	3¾
5	6½	¾	12	⅞	15/16	2	1¾	13/16	4.95	8 3/16	9¾	7⅛	6¼	4¼
6	7½	1	16	1	1 1/16	2¼	2¼	⅞	5.73	9 7/16	11¼	8⅜	7⅜	4⅞

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

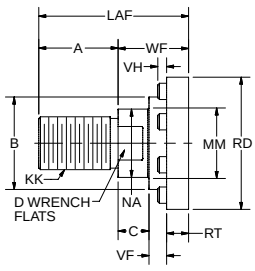
Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions														Y	Add Stroke ZB
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LA	LAF	NA	RD (Max.)	RT	V	VF	VH	W	WF		
1½	⅝	½-20	7/16-20	¾	1.124	⅜	½	1⅜	1¾	9/16	1 15/16	⅜	¼	¼	3/16	⅝	1	2	6
	1	⅞-14	¾-16	1⅛	1.499	½	⅞	2⅛	2½	15/16	2⅜	⅜	½	½	3/16	1	1⅜	2⅜	6⅜
2	1	⅞-14	¾-16	1⅛	1.499	½	⅞	1⅞	2½	15/16	2⅜	⅜	¼	½	3/16	¾	1⅜	2⅜	6 7/16
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	2⅝	3¼	1 5/16	2⅞	⅜	⅜	⅝	3/16	1	1⅝	2⅝	6 11/16
2½	1	⅞-14	¾-16	1⅛	1.499	½	⅞	1⅞	2½	15/16	2⅜	⅜	¼	½	3/16	¾	1⅜	2⅜	6 9/16
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	2⅝	3¼	1 5/16	2⅞	⅜	⅜	⅝	3/16	1	1⅝	2⅝	6 13/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	3¼	3⅞	1 11/16	3 15/32	⅝	½	½	3/16	1¼	1⅞	2⅞	7 1/16
3¼	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	2½	3¼	1 5/16	2⅞	⅜	¼	⅝	3/16	⅞	1⅝	2¾	7 11/16
	1¾	1½-12	1¼-12	2	2.374	¾	1½	3⅛	3⅞	1 11/16	3 15/32	⅝	⅜	½	3/16	1⅛	1⅞	3	7 15/16
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	3½	4¼	1 15/16	3 23/32	⅝	⅜	½	¼	1¼	2	3⅛	8 1/16
4	1¾	1½-12	1¼-12	2	2.374	¾	1½	3	3⅞	1 11/16	3 15/32	⅝	¼	½	3/16	1	1⅞	3	8 3/16
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	3⅜	4¼	1 15/16	3 23/32	⅝	¼	½	¼	1⅛	2	3⅛	8 5/16
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	4⅜	5¼	2⅜	4¼	⅝	⅜	⅝	¼	1⅜	2¼	3⅜	8 9/16
5	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	3⅜	4¼	1 15/16	3 23/32	⅝	¼	½	¼	1⅛	2	3⅛	9 1/16
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	4⅜	5¼	2⅜	4¼	⅝	⅜	⅝	¼	1⅜	2¼	3⅜	9 5/16
	3	2¾-12	2¼-12	3½	3.749	1	2 5/8	4⅞	5¾	2⅞	5 7/16	⅞	⅜	5/16	–	1⅜	2¼	3⅜	9 5/16
	3½	3¼-12	2½-12	3½	4.249	1	3	4⅞	5¾	3⅜	5 15/16	15/16	⅜	5/16	–	1⅜	2¼	3⅜	9 5/16
6	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	4¼	5¼	2⅜	4¼	⅝	¼	⅝	¼	1¼	2¼	3½	10½
	3	2¾-12	2¼-12	3½	3.749	1	2 5/8	4¾	5¾	2⅞	5 7/16	⅞	¼	5/16	–	1¼	2¼	3½	10½
	3½	3¼-12	2½-12	3½	4.249	1	3	4¾	5¾	3⅜	5 15/16	15/16	¼	5/16	–	1¼	2¼	3½	10½
	4	3¾-12	3-12	4	4.749	1	3⅜	5¼	6¼	3⅞	6 5/16	15/16	¼	5/16	–	1¼	2¼	3½	10½

Table 3—Envelope and Mounting Dimensions

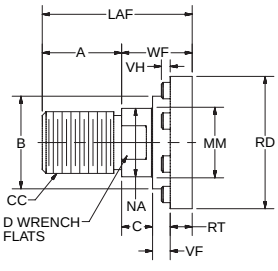
Rod End Dimensions (for Bolted Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

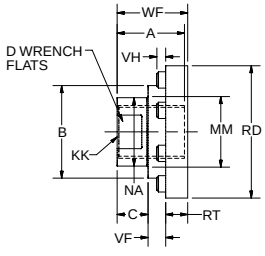
Thread Style 1
Small Male



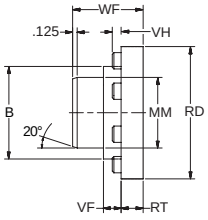
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



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

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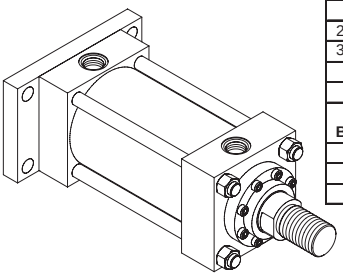
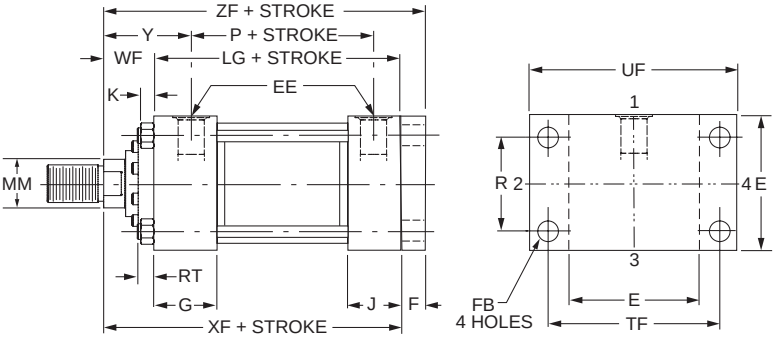
Cap Rectangular Flange Mount Style BEF2



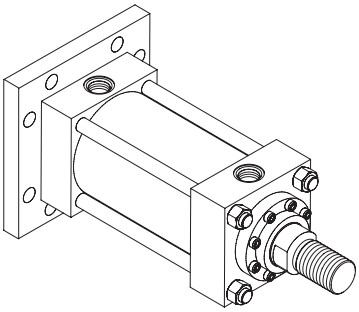
Maximum Pressure Rating - PSI
Pull Application

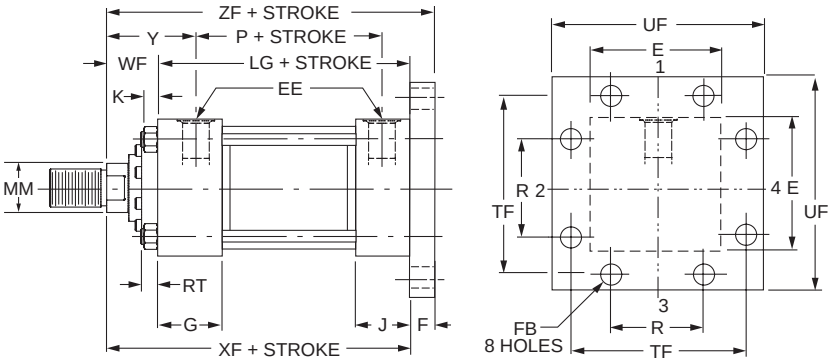
Bore	Rod Dia 5/8	1	1 3/8	1 3/4	2
1 1/2	2500	3000	–	–	–
2	–	3000	3000	–	–
2 1/2	–	3000	3000	3000	–
3 1/4	–	–	3000	3000	3000
4	–	–	–	3000	3000
5	–	–	–	–	2000

Bore	Rod Dia 2 1/2	3	3 1/2	4	5
4	3000	–	–	–	–
5	2000	2500	3000	–	–
6	1800	2000	2000	2500	–

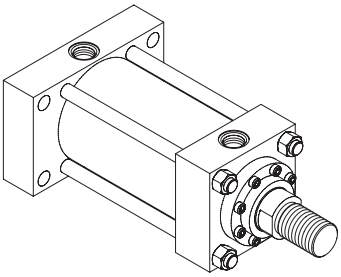


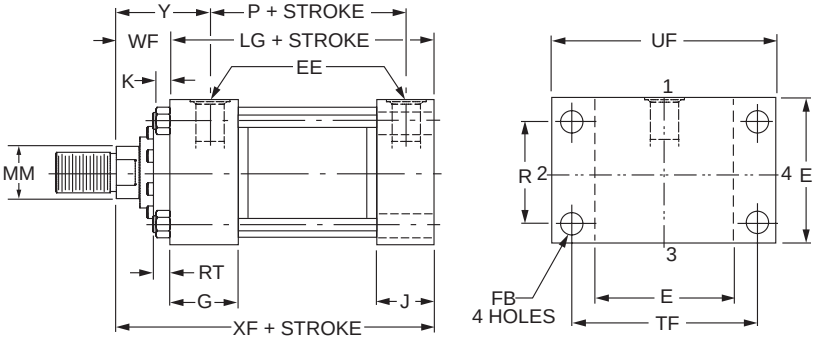
Cap Square Flange Mount Style BEF1





Cap Rectangular Mount Style ME6

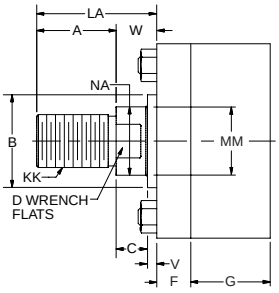




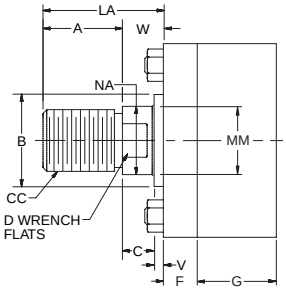
Rod End Dimensions (for Retainer Held Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

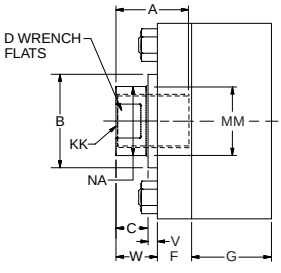
Thread Style 1
Small Male



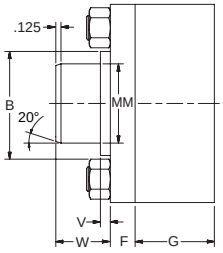
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

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Table 1—Envelope and Mounting Dimensions

Bore	E	EE		F	FB	G	J	K	R	TF	UF	Add Stroke	
		NPTF⊖	SAE★									LG	P
1½	2½	½	8	⅜	7/16	1¾	1½	⅜	1.63	3 7/16	4¼	4⅝	2⅞
2	3	½	8	⅝	9/16	1¾	1½	7/16	2.05	4⅛	5⅛	4⅝	2⅞
2½	3½	½	8	⅝	9/16	1¾	1½	7/16	2.55	4⅝	5⅝	4¾	3
3¼	4½	¾	12	¾	11/16	2	1¾	9/16	3.25	5⅞	7⅛	5½	3½
4	5	¾	12	⅞	11/16	2	1¾	9/16	3.82	6⅜	7⅝	5¾	3¾
5	6½	¾	12	⅞	15/16	2	1¾	13/16	4.95	8 3/16	9¾	6¼	4¼
6	7½	1	16	1	1 1/16	2¼	2¼	⅞	5.73	9 7/16	11¼	7⅜	4⅞

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

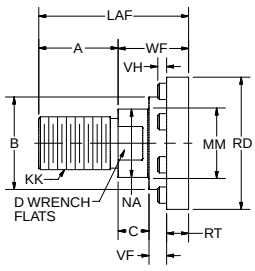
Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions														Add Stroke	
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LA	LAF	NA	RD (Max.)	RT	V	VF	VH	W	WF	Y	XF	ZF
1½	⅝	½-20	7/16-20	¾	1.124	⅜	½	–	1¾	9/16	1 15/16	⅜	¼	¼	⅜	–	1	2	5⅝	6
	1	⅞-14	¾-16	1⅛	1.499	½	⅞	2⅛	2½	15/16	2⅜	⅜	½	½	⅜	1	1⅜	2⅜	6	6⅜
2	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	⅜	–	1⅜	2⅜	6	6⅝
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	2⅝	3¼	1 5/16	2⅞	⅜	⅜	⅝	⅜	1	1⅝	2⅝	6¼	6⅞
2½	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	⅜	–	1⅜	2⅜	6⅛	6¾
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1 5/16	2⅞	⅜	⅜	⅝	⅜	–	1⅝	2⅝	6⅜	7
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	½	½	⅜	–	1⅞	2⅞	6⅝	7¼
3¼	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1 5/16	2⅞	⅜	¼	⅝	⅜	–	1⅝	2¾	7⅛	7⅞
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	⅜	½	⅜	–	1⅞	3	7⅜	8⅛
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	⅜	½	¼	–	2	3⅛	7½	8¼
4	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	¼	½	⅜	–	1⅞	3	7⅝	8½
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2	3⅛	7¾	8⅝
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼	3⅜	8	8⅞
5	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2	3⅛	8¼	9⅛
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼	3⅜	8½	9⅜
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	⅜	5/16	–	–	2¼	3⅜	8½	9⅜
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	⅜	5/16	–	–	2¼	3⅜	8½	9⅜
6	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	¼	⅝	¼	–	2¼	3½	9⅝	10⅝
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	¼	5/16	–	–	2¼	3½	9⅝	10⅝
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	¼	5/16	–	–	2¼	3½	9⅝	10⅝
	4	3¾-12	3-12	4	4.749	1	3⅜	–	6¼	3⅞	6 5/16	15/16	¼	5/16	–	–	2¼	3½	9⅝	10⅝

Table 3—Envelope and Mounting Dimensions

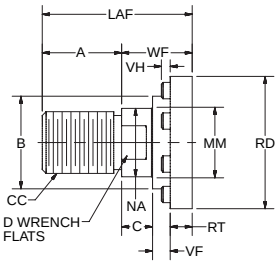
Rod End Dimensions (for Bolted Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

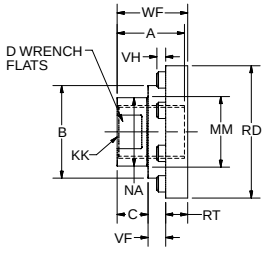
Thread Style 1
Small Male



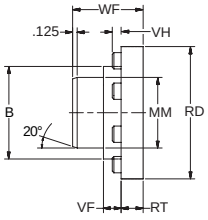
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

"Special" Thread Style 4

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

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

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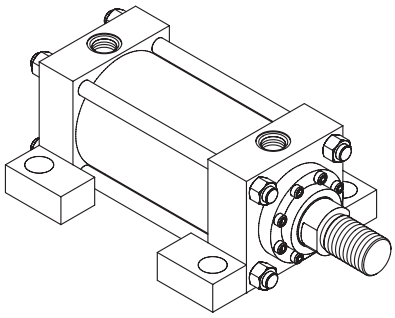
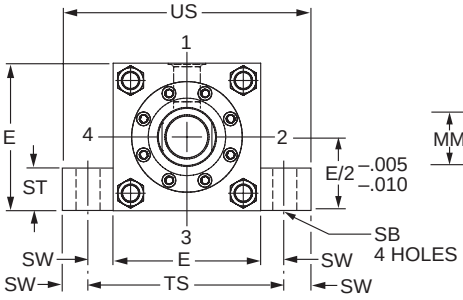
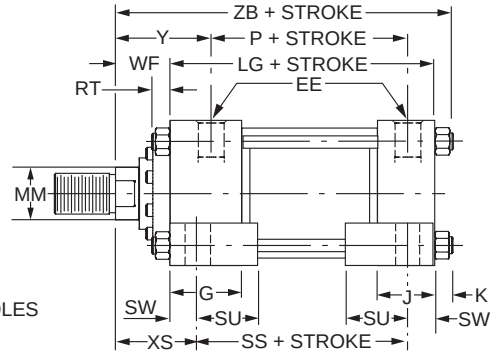
Side Lug Mount
Style SL

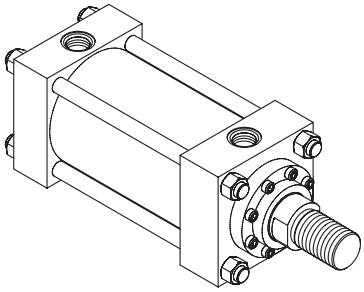


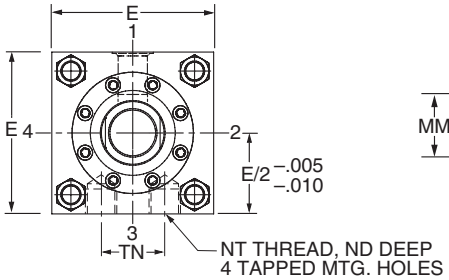


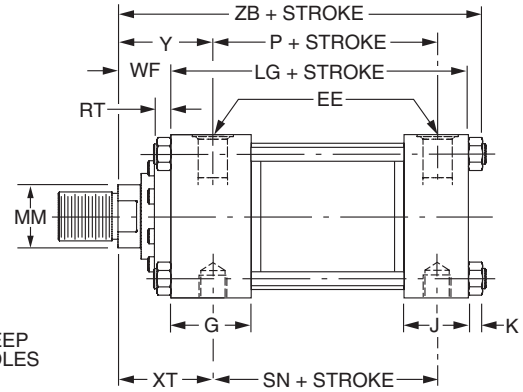


Style SL cylinders have mounting lugs welded to the head and cap, and are considered to be a fixed mount that does not absorb force on its centerline. The plane of the mounting surface is not through the centerline of the cylinder, and for this reason Style SL cylinders produce a turning moment as the cylinder applies force to the load. This turning moment tends to rotate the cylinder about its mounting bolts. If the cylinder is not well secured to the machine member on which it is mounted or the load is not well-guided, this turning moment results in side load applied to rod gland and piston bearings. **To avoid this problem, Style SL cylinders should be specified with a stroke length at least equal to the bore size.**

Side Tap Mount
Style FS





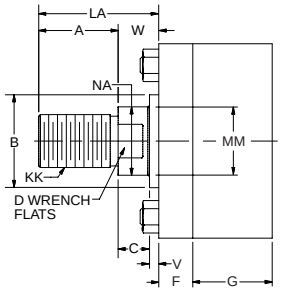


Style FS cylinders have side tapped holes for flush mounting, and are considered to be a fixed mount that does not absorb force on its centerline. The plane of the mounting surface is not through the centerline of the cylinder, and for this reason Style FS cylinders produce a turning moment as the cylinder applies force to the load. This turning moment tends to rotate the cylinder about its mounting bolts. If the cylinder is not well secured to the machine member on which it is mounted or the load is not well-guided, this turning moment results in side load applied to rod gland and piston bearings. **To avoid this problem, Style FS cylinders should be specified with a stroke length at least equal to the bore size.**

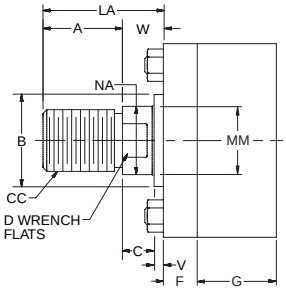
Rod End Dimensions (for Retainer Held Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

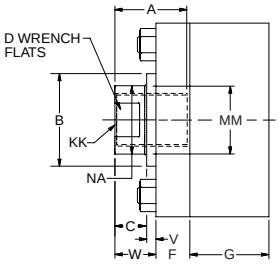
Thread Style 1
Small Male



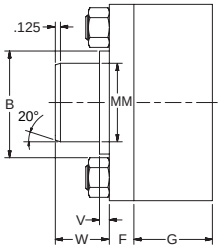
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

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Table 1—Envelope and Mounting Dimensions

Bore	E	EE NPTF⊖	EE SAE★	F	G	J	K	NT	R	SB	ST	SU	SW	TN	TS	US	Add Stroke LG	Add Stroke P	Add Stroke SN	Add Stroke SS
1½	2½	½	8	⅜	1¾	1½	⅜	⅜-16	1.63	7/16	½	15/16	⅜	¾	3¼	4	4⅝	2⅞	2⅞	3⅞
2	3	½	8	⅝	1¾	1½	7/16	½-13	2.05	9/16	¾	1¼	½	15/16	4	5	4⅝	2⅞	2⅞	3⅝
2½	3½	½	8	⅝	1¾	1½	7/16	⅝-11	2.55	13/16	1	1 9/16	11/16	1 5/16	4⅞	6¼	4¾	3	3	3⅜
3¼	4½	¾	12	¾	2	1¾	9/16	¾-10	3.25	13/16	1	1 9/16	11/16	1½	5⅞	7¼	5½	3½	3½	4⅛
4	5	¾	12	⅞	2	1¾	9/16	1-8	3.82	1 1/16	1¼	2	⅞	2 1/16	6¾	8½	5¾	3¾	3¾	4
5	6½	¾	12	⅞	2	1¾	13/16	1-8	4.95	1 1/16	1¼	2	⅞	2 15/16	8¼	10	6¼	4¼	4¼	4½
6	7½	1	16	1	2¼	2¼	⅞	1¼-7	5.73	1 5/16	1½	2½	1⅛	3 5/16	9¾	12	7⅜	4⅞	5⅛	5⅛

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread Style 2 CC	Thread Style 1 & 3 KK	Rod Extensions and Pilot Dimensions A	+.000 -.002 B Ø	C	D	LA	LAF	NA	RD (Max.)	RT	V	VF	VH	W	WF
1½	⅝	½-20	7/16-20	¾	1.124	⅜	½	–	1¾	9/16	1 15/16	⅜	¼	¼	⅜	–	1
	1	⅞-14	¾-16	1⅛	1.499	½	⅞	2⅛	2½	15/16	2⅜	⅜	½	½	⅜	1	1⅜
2	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	⅜	–	1⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	2⅝	3¼	1 5/16	2⅞	⅜	⅜	⅝	⅜	1	1⅝
2½	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	⅜	–	1⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1 5/16	2⅞	⅜	⅜	⅝	⅜	–	1⅝
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	½	½	⅜	–	1⅞
3¼	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1 5/16	2⅞	⅜	¼	⅝	⅜	–	1⅝
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	⅜	½	⅜	–	1⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	⅜	½	¼	–	2
4	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	¼	½	⅜	–	1⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼
5	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	⅜	5/16	–	–	2¼
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	⅜	5/16	–	–	2¼
6	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	¼	⅝	¼	–	2¼
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	¼	5/16	–	–	2¼
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	¼	5/16	–	–	2¼
	4	3¾-12	3-12	4	4.749	1	3⅜	–	6¼	3⅞	6 5/16	15/16	¼	5/16	–	–	2¼

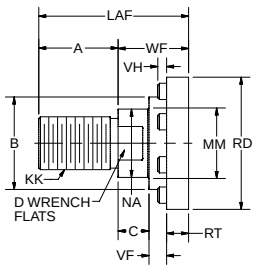
Table 3 — Envelope and Mounting Dimensions

Bore	ND	XS	XT	Y	Add Stroke ZB
1½	⅜	1⅜	2	2	6
	⅜	1¾	2⅜	2⅜	6⅜
2	7/16	1⅞	2⅜	2⅜	6 7/16
	7/16	2⅛	2⅝	2⅝	6 11/16
2½	½	2 1/16	2⅜	2⅜	6 9/16
	½	2 5/16	2⅝	2⅝	6 13/16
	½	2 9/16	2⅞	2⅞	7 1/16
3¼	11/16	2 5/16	2¾	2¾	7 11/16
	11/16	2 9/16	3	3	7 15/16
	11/16	2 11/16	3⅛	3⅛	8 1/16
4	11/16	2¾	3	3	8 3/16
	11/16	2⅞	3⅛	3⅛	8 5/16
	11/16	3⅛	3⅜	3⅜	8 9/16
5	1	2⅞	3⅛	3⅛	9 1/16
	1	3⅛	3⅜	3⅜	9 5/16
	1	3⅛	3⅜	3⅜	9 5/16
	1	3⅛	3⅜	3⅜	9 5/16
6	1¼	3⅜	3½	3½	10½
	1¼	3⅜	3½	3½	10½
	1¼	3⅜	3½	3½	10½
	1¼	3⅜	3½	3½	10½

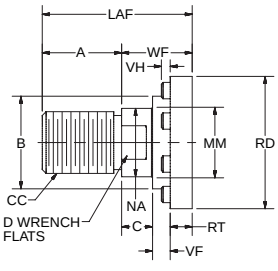
Rod End Dimensions (for Bolted Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

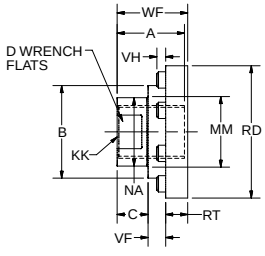
Thread Style 1
Small Male



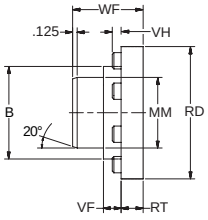
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

"Special" Thread Style 4

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

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

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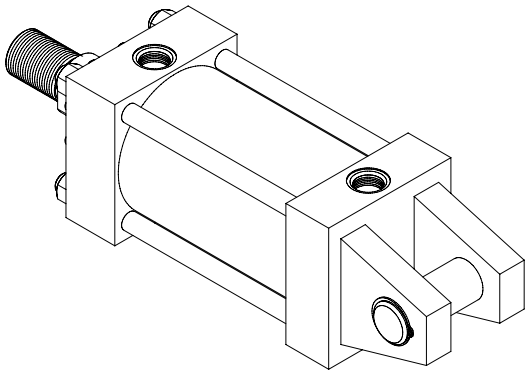
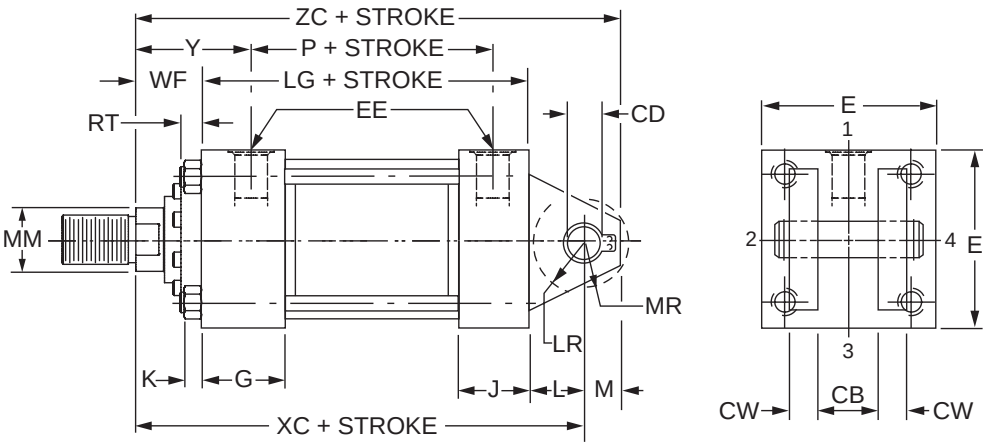
Cap Fixed Clevis Mount
Style PB2

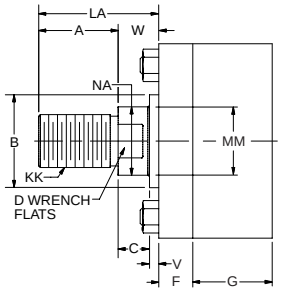




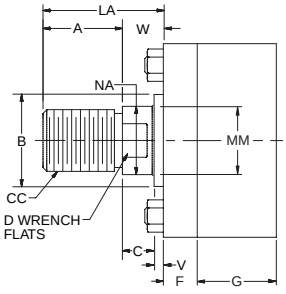
Rod End Dimensions (for Retainer Held Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

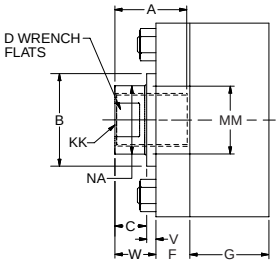
Thread Style 1
Small Male



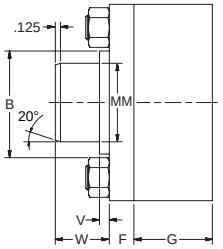
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

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Table 1—Envelope and Mounting Dimensions

Bore	CB	+.000 -.002 CDØ†	CW	E	EE NPTF⊖	EE SAE★	F	G	J	K	L	LR	M	MR	Add Stroke LG	Add Stroke P
1½	¾	.501	½	2½	½	8	⅜	1¾	1½	⅜	¾	9/16	½	⅝	4⅝	2⅞
2	1¼	.751	⅝	3	½	8	⅝	1¾	1½	7/16	1¼	1	¾	15/16	4⅝	2⅞
2½	1¼	.751	⅝	3½	½	8	⅝	1¾	1½	7/16	1¼	15/16	¾	15/16	4¾	3
3¼	1½	1.001	¾	4½	¾	12	¾	2	1¾	9/16	1½	1¼	1	1 3/16	5½	3½
4	2	1.376	1	5	¾	12	⅞	2	1¾	9/16	2⅛	1¾	1⅜	1⅝	5¾	3¾
5	2½	1.751	1¼	6½	¾	12	⅞	2	1¾	13/16	2¼	2 1/16	1¾	2⅛	6¼	4¼
6	2½	2.001	1¼	7½	1	16	1	2¼	2¼	⅞	2½	2 5/16	2	2⅜	7⅜	4⅞

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge. †Dimension CD is pin diameter.

Table 2—Rod Dimensions

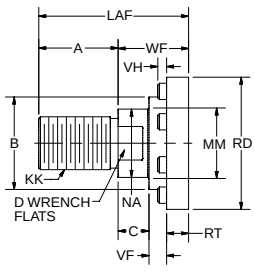
Bore	Rod Dia. MM	Thread Style 2 CC	Thread Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LA	LAF	NA	RD (Max.)	RT	V	VF	VH	W	WF	Y	Add Stroke XC	Add Stroke ZC
1½	⅝	½-20	7/16-20	¾	1.124	⅜	½	–	1¾	9/16	1 15/16	⅜	¼	¼	⅜	–	1	2	6⅜	6⅞
	1	⅞-14	¾-16	1⅛	1.499	½	⅞	2⅛	2½	15/16	2⅜	⅜	½	½	⅜	1	1⅜	2⅜	6¾	7¼
2	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	⅜	–	1⅜	2⅜	7¼	8
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	2⅝	3¼	1⅝	2⅞	⅜	⅜	⅝	⅜	1	1⅝	2⅝	7½	8¼
2½	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	⅜	–	1⅜	2⅜	7⅜	8⅛
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1⅝	2⅞	⅜	⅜	⅝	⅜	–	1⅝	2⅝	7⅝	8⅜
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	½	½	⅜	–	1⅞	2⅞	7⅞	8⅝
3¼	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1⅝	2⅞	⅜	¼	⅝	⅜	–	1⅝	2¾	8⅝	9⅝
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	⅜	½	⅜	–	1⅞	3	8⅞	9⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	⅜	½	¼	–	2	3⅛	9	10
4	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	¼	½	⅜	–	1⅞	3	9¾	11⅛
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2	3⅛	9⅞	11¼
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼	3⅜	10⅛	11½
5	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2	3⅛	10½	12¼
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼	3⅜	10¾	12½
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	⅜	5/16	–	–	2¼	3⅜	10¾	12½
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	⅜	5/16	–	–	2¼	3⅜	10¾	12½
6	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	¼	⅝	¼	–	2¼	3½	12⅛	14⅛
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	¼	5/16	–	–	2¼	3½	12⅛	14⅛
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	¼	5/16	–	–	2¼	3½	12⅛	14⅛
	4	3¾-12	3-12	4	4.749	1	3⅜	–	6¼	3⅞	6 5/16	15/16	¼	5/16	–	–	2¼	3½	12⅛	14⅛

Table 3 — Envelope and Mounting Dimensions

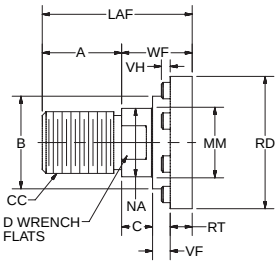
Rod End Dimensions (for Bolted Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

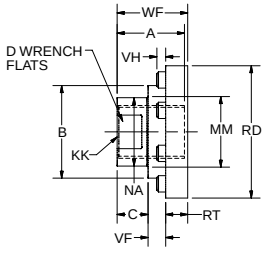
Thread Style 1
Small Male



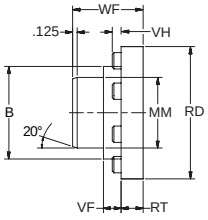
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



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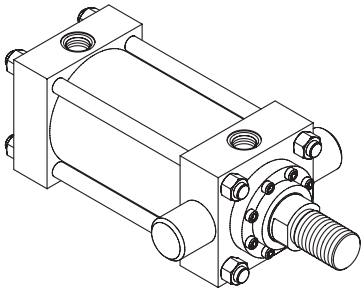
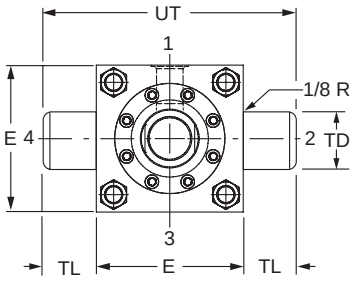
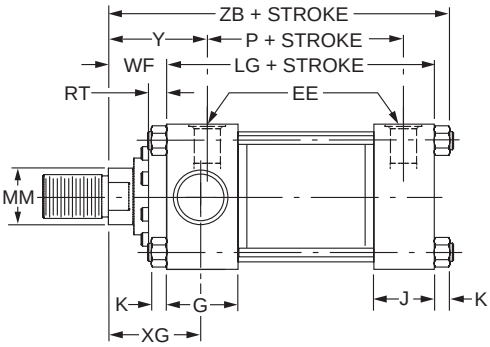
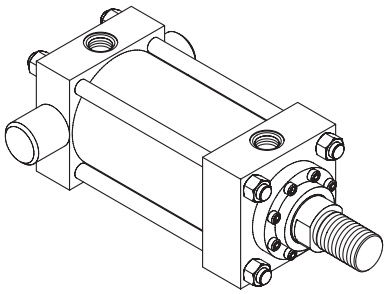
Head Trunnion Mount Style TM1

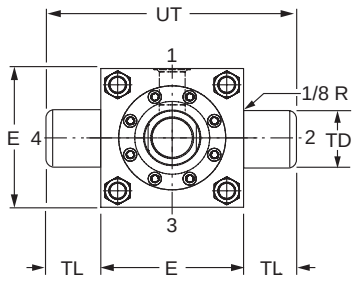


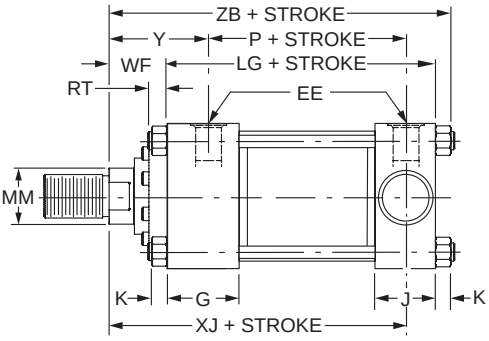




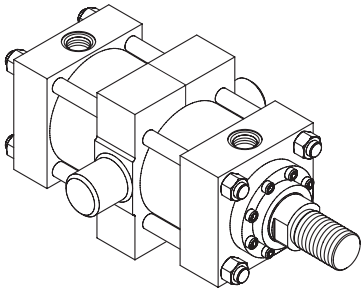
Cap Trunnion Mount Style TM2

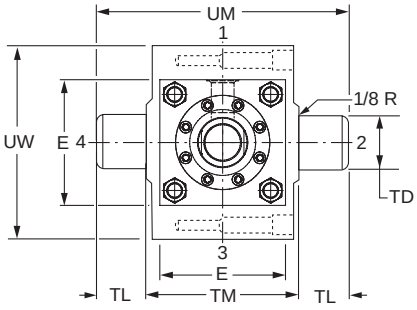


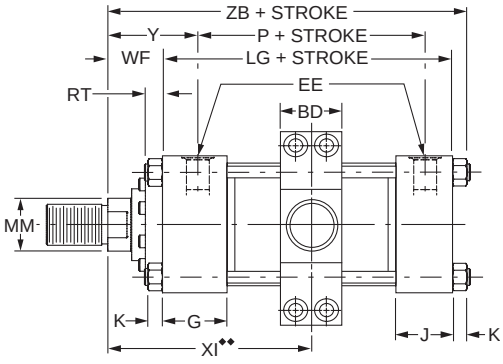




Intermediate Trunnion Mount Style TM3





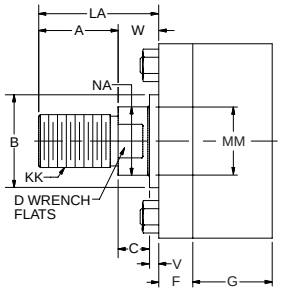


◆◆ Dimension XI to be specified by customer.

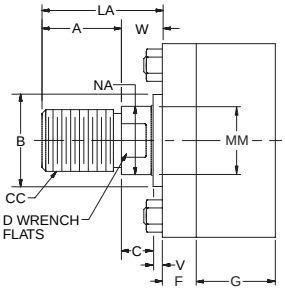
Rod End Dimensions (for Retainer Held Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

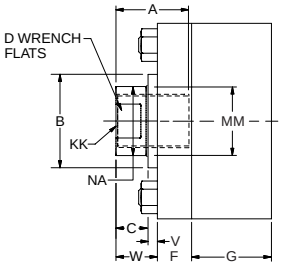
Thread Style 1
Small Male



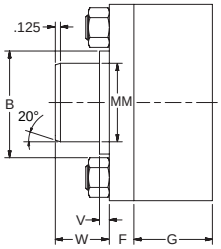
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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Table 1—Envelope and Mounting Dimensions

Bore	BD	E	EE NPTF⊖	EE SAE★	F	G	J	K	+.000 -.001 TD Ø	TL	TM	UM	UT	UW	Add Stroke LG	Add Stroke P	Style TM3 Minimum Stroke
1½	1¼	2½	½	8	⅜	1¾	1½	⅜	1.000	1	3	5	4½	3⅜	4⅝	2⅞	0
2	1½	3	½	8	⅝	1¾	1½	7/16	1.375	1⅜	3½	6¼	5¾	4⅛	4⅝	2⅞	¼
2½	1½	3½	½	8	⅝	1¾	1½	7/16	1.375	1⅜	4	6¾	6¼	4⅝	4¾	3	⅛
3¼	2	4½	¾	12	¾	2	1¾	9/16	1.750	1¾	5	8½	8	5 13/16	5½	3½	⅜
4	2	5	¾	12	⅞	2	1¾	9/16	1.750	1¾	5½	9	8½	6⅜	5¾	3¾	⅛
5	2	6½	¾	12	⅞	2	1¾	13/16	1.750	1¾	7	10½	10	7¾	6¼	4¼	0
6	3	7½	1	16	1	2¼	2¼	⅞	2.000	2	8½	12½	11½	10⅜	7⅜	4⅞	¼

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread Style 2 CC	Thread Style 1 & 3 KK	Rod Extensions and Pilot Dimensions A	+.000 -.002 B Ø	C	D	LA	LAF	NA	RD (Max.)	RT	V	VF	VH	W	WF
1½	⅝	½-20	7/16-20	¾	1.124	⅜	½	–	1¾	9/16	1 15/16	⅜	¼	¼	3/16	–	1
	1	⅞-14	¾-16	1⅛	1.499	½	⅞	2⅛	2½	15/16	2⅜	⅜	½	½	3/16	1	1⅜
2	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	3/16	–	1⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	2⅝	3¼	1 5/16	2⅞	⅜	⅜	⅝	3/16	1	1⅝
2½	1	⅞-14	¾-16	1⅛	1.499	½	⅞	–	2½	15/16	2⅜	⅜	¼	½	3/16	–	1⅜
	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1 5/16	2⅞	⅜	⅜	⅝	3/16	–	1⅝
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	½	½	3/16	–	1⅞
3¼	1⅜	1¼-12	1-14	1⅝	1.999	⅝	1⅛	–	3¼	1 5/16	2⅞	⅜	¼	⅝	3/16	–	1⅝
	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	⅜	½	3/16	–	1⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	⅜	½	¼	–	2
4	1¾	1½-12	1¼-12	2	2.374	¾	1½	–	3⅞	1 11/16	3 15/32	⅝	¼	½	3/16	–	1⅞
	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼
5	2	1¾-12	1½-12	2¼	2.624	⅞	1 11/16	–	4¼	1 15/16	3 23/32	⅝	¼	½	¼	–	2
	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	⅜	⅝	¼	–	2¼
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	⅜	5/16	–	–	2¼
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	⅜	5/16	–	–	2¼
6	2½	2¼-12	1⅞-12	3	3.124	1	2 1/16	–	5¼	2⅜	4¼	⅝	¼	⅝	¼	–	2¼
	3	2¾-12	2¼-12	3½	3.749	1	2⅝	–	5¾	2⅞	5 7/16	⅞	¼	5/16	–	–	2¼
	3½	3¼-12	2½-12	3½	4.249	1	3	–	5¾	3⅜	5 15/16	15/16	¼	5/16	–	–	2¼
	4	3¾-12	3-12	4	4.749	1	3⅜	–	6¼	3⅞	6 5/16	15/16	¼	5/16	–	–	2¼

Table 3 — Envelope and Mounting Dimensions

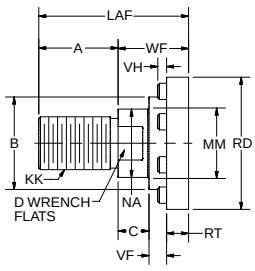
Bore	XG	Min. XI ◆◆	Y	Add Stroke XJ	Add Stroke ZB
1½	1⅞	3 7/16	2	4⅞	6
	2¼	3 13/16	2⅜	5¼	6⅜
2	2¼	3 15/16	2⅜	5¼	6 7/16
	2½	4 3/16	2⅝	5½	6 11/16
2½	2¼	3 15/16	2⅜	5⅜	6 9/16
	2½	4 3/16	2⅝	5⅝	6 13/16
	2¾	4⅞16	2⅞	5⅞	7 1/16
3¼	2⅝	4 11/16	2¾	6¼	7 11/16
	2⅞	4 15/16	3	6½	7 15/16
	3	5 1/16	3⅛	5⅝	8 1/16
4	2⅞	4 15/16	3	6¾	8 3/16
	3	5 1/16	3⅛	6⅞	8 5/16
	3¼	5 5/16	3⅜	7⅛	8 9/16
5	3	5 1/16	3⅛	7⅜	9 1/16
	3¼	5 5/16	3⅜	7⅝	9 5/16
	3¼	5 5/16	3⅜	7⅝	9 5/16
	3¼	5 5/16	3⅜	7⅝	9 5/16
6	3⅜	6 1/16	3½	8⅜	10½
	3⅜	6 1/16	3½	8⅜	10½
	3⅜	6 1/16	3½	8⅜	10½
	3⅜	6 1/16	3½	8⅜	10½

◆◆ Dimension XI to be specified by customer.

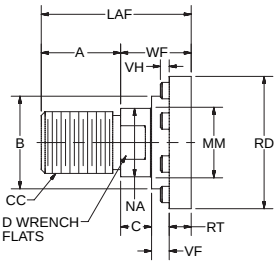
Rod End Dimensions (for Bolted Gland) – See Table 2

See chart on page 32 to determine which bore, rod and mount combinations have this feature.

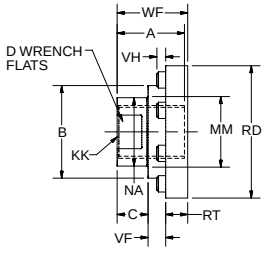
Thread Style 1
Small Male



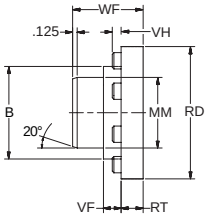
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



A high strength rod end stud is supplied on thread style 1 through 2" diameter rods. Larger sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 1 rod ends are recommended through 2" piston rod diameters and style 2 rod ends are recommended on larger diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied.

"Special" Thread Style 4

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

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

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NOTES

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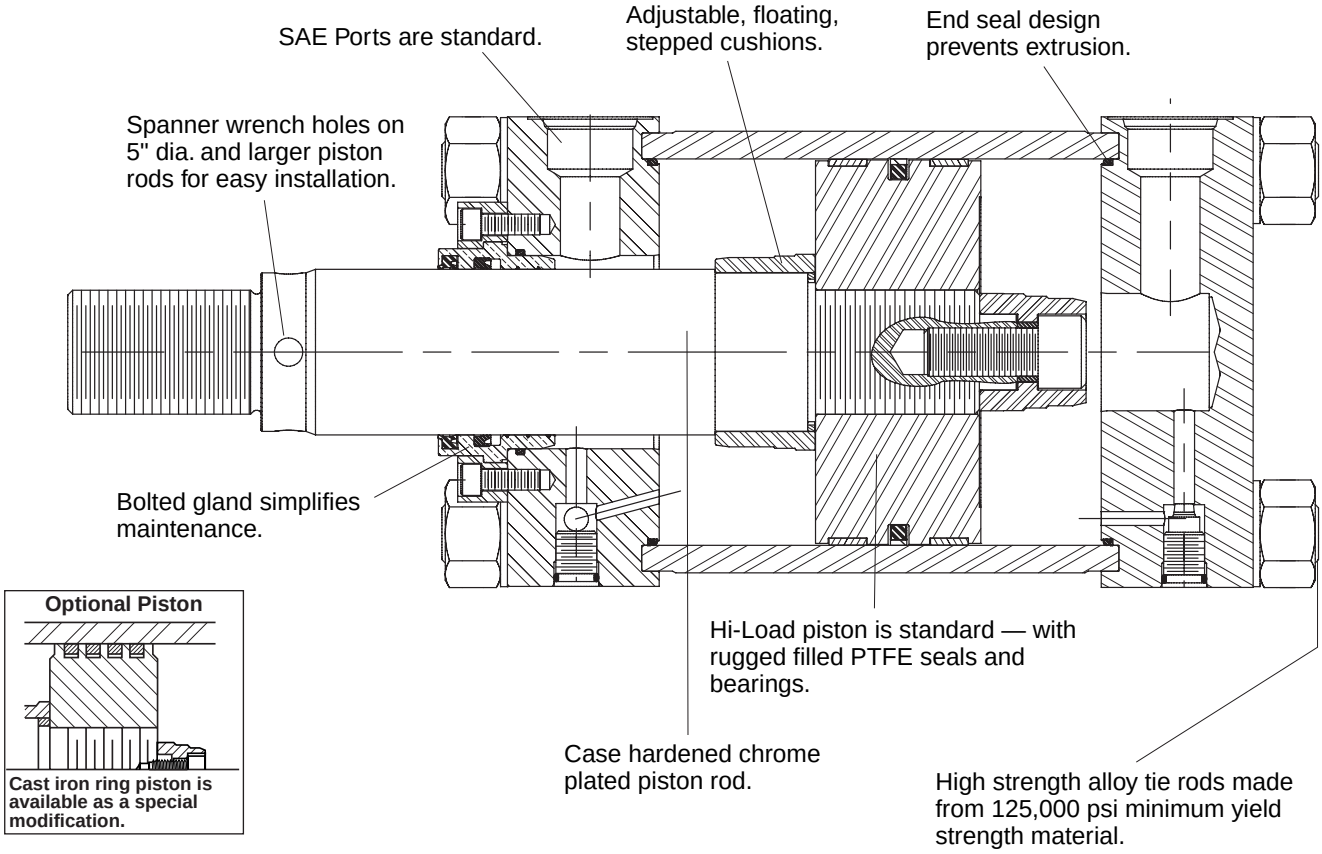
Series H
7" and 8" Bore
Heavy Duty High Pressure Hydraulic Cylinders

- Bolted gland for ease of maintenance.
- Hi-Load piston is standard.
- Cylinder tube seal groove design and high-strength tie rods ensure trouble-free performance even in severe applications.
- Floating cushions with float-check action and positive metal-to-metal seal.

Every cylinder is *individually* tested before it leaves our plant.



Optional Piston

Cast iron ring piston is available as a special modification.

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*
- Standard Fluid — Hydraulic Oil
- Standard Temperature — -10° F. to +165° F.
- Piston Rod Diameter — 3" through 5 1/2"
- Mounting Styles — 15 standard styles at various application ratings
- Strokes — Available in any practical stroke length
- Cushions — Optional at either end or both ends of stroke
- Rod Ends — Four Standard Choices — specials to order

*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.

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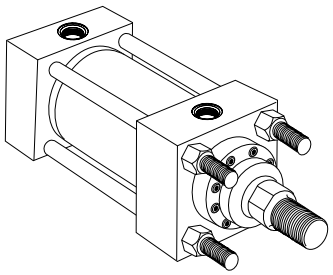
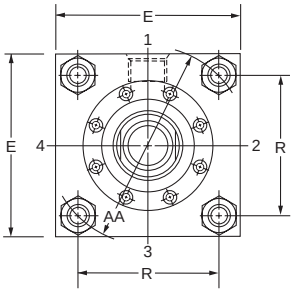
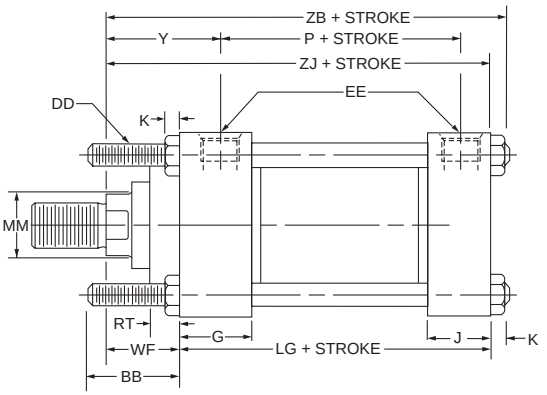
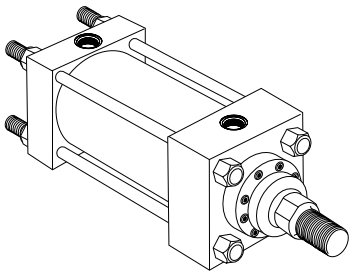
Tie Rods Extended Head End Mount Style NM3

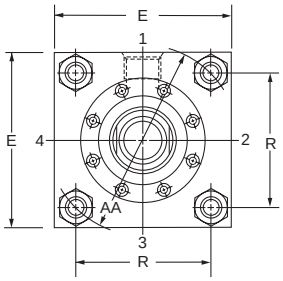


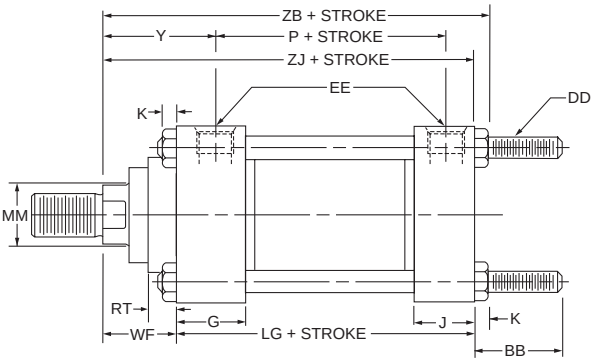




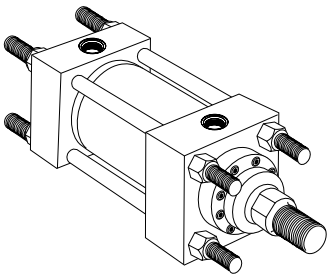
Tie Rods Extended Cap End Mount Style NM2

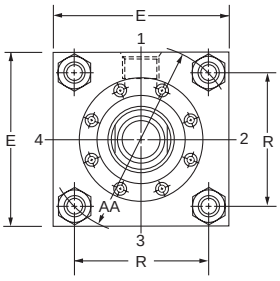


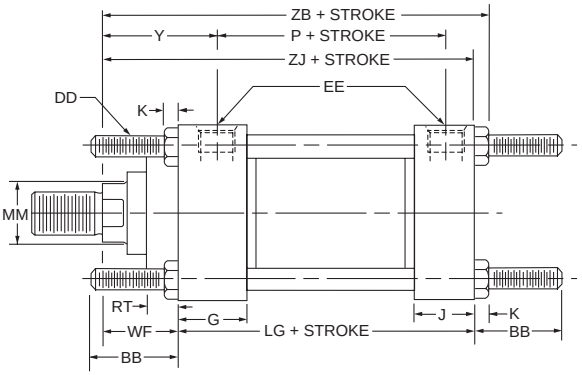




Tie Rods Extended Both Ends Mount Style NM1

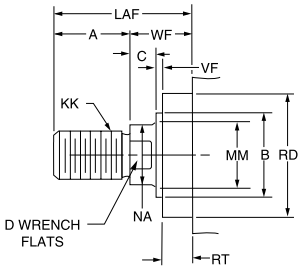




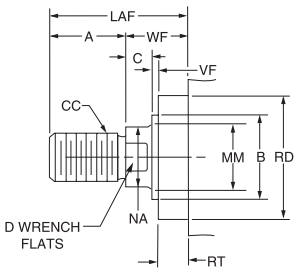


Rod End Dimensions — see Table 2

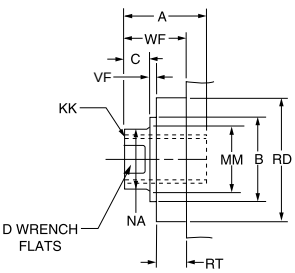
Thread Style 1
Small Male



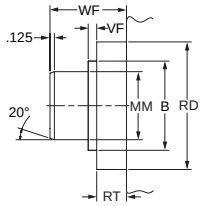
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

Over 2" rod sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 2 rod ends are recommended over 2" piston rod diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied. On 5" rods and above, (4) .515 dia. spanner wrench holes will be provided instead of wrench flats.

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Table 1—Envelope and Mounting Dimensions

Bore	AA	BB	DD	E	EE		G	J	K	R	Add Stroke	
					NPTF⊖	SAE★					LG	P
7	9.3	4 1/8	1 1/8-12	8 1/2	1 1/4	20	2 3/4	2 3/4	1 1/4	6.58	8 1/2	5 5/8
8	10.6	4 1/2	1 1/4-12	9 1/2	1 1/2	24	3	3	1 1/2	7.50	9 1/2	6 3/8

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Add Stroke		
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LAF	NA	RD (Max.)	RT	VF	WF	Y	ZB	ZJ
7	3	2 3/4-12	2 1/4-12	3 1/2	3.749	1	2 5/8	5 3/4	2 7/8	5 7/16	7/8	5/16	2 1/4	3 11/16	12	10 3/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4	3 11/16	12	10 3/4
	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4	3 11/16	12	10 3/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4	3 11/16	12	10 3/4
8	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4	3 13/16	13 1/4	11 3/4
	5 1/2	5 1/4-12	4-12	5 1/2	6.249	1	–	7 3/4	5 3/8	7 15/16	15/16	5/16	2 1/4	3 13/16	13 1/4	11 3/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4	3 13/16	13 1/4	11 3/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4	3 13/16	13 1/4	11 3/4

Table 3 — Envelope and Mounting Dimensions

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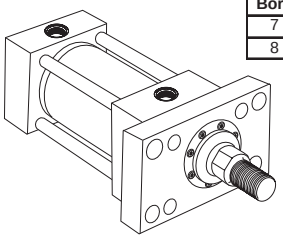
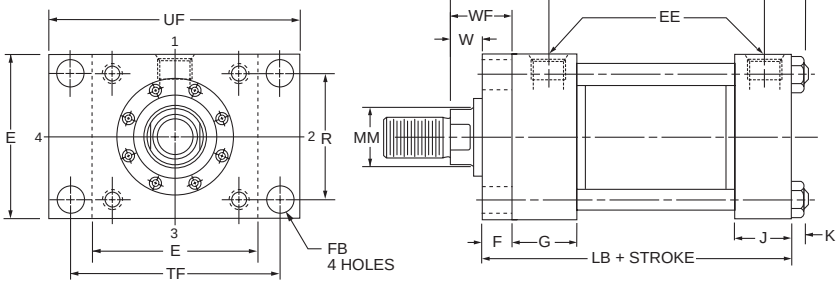
Head Rectangular Flange Mount Style REF2



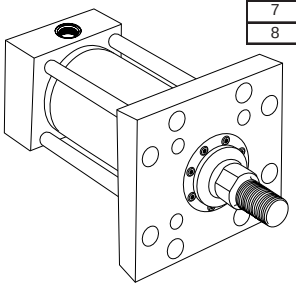
Maximum Pressure Rating - PSI
Push Application

Bore	Rod Dia				
	3	3 1/2	4	5	5 1/2
7	1000	800	400	400	–
8	–	800	700	400	400



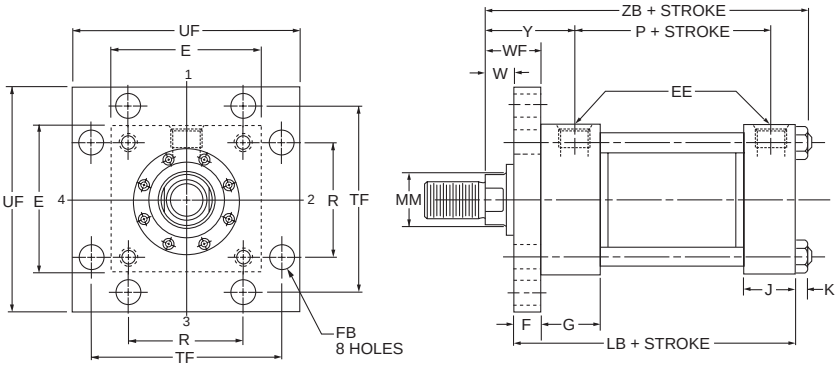
For pressures exceeding those shown use Style REF1 or Style ME5.

Head Square Flange Mount Style REF1

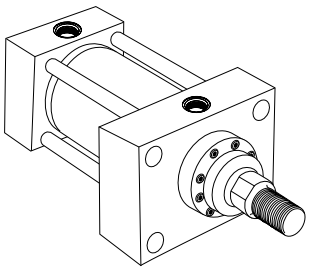


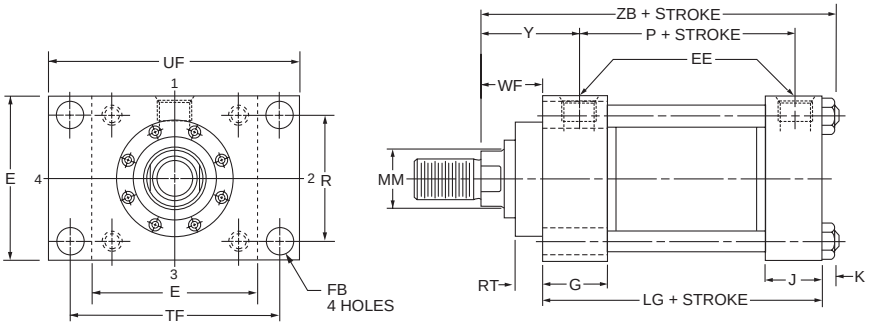
Maximum Pressure Rating - PSI
Push Application

Bore	Rod Dia				
	3	3 1/2	4	5	5 1/2
7	2500	2200	1500	1500	–
8	–	2000	2000	1400	1400



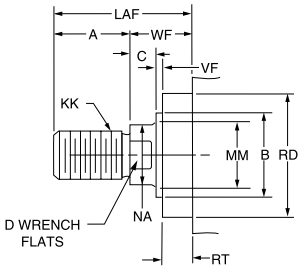
Head Rectangular Mount Style ME5



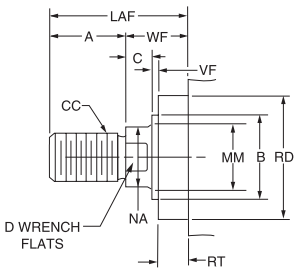


Rod End Dimensions — see Table 2

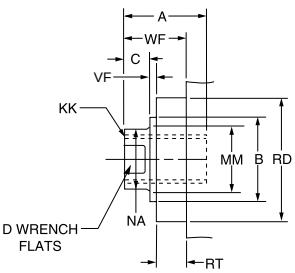
Thread Style 1
Small Male



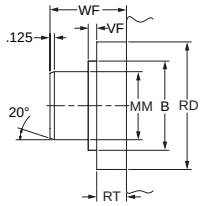
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

Over 2" rod sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 2 rod ends are recommended over 2" piston rod diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied. On 5" rods and above, (4) .515 dia. spanner wrench holes will be provided instead of wrench flats.

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Table 1—Envelope and Mounting Dimensions

Bore	E	EE		F	FB	G	J	K	R	TF	UF	Add Stroke		
		NPTF⊖	SAE★									LB	LG	P
7	8 1/2	1 1/4	20	1	1 3/16	2 3/4	2 3/4	1 1/4	6.58	10 5/8	12 5/8	9 1/2	8 1/2	5 5/8
8	9 1/2	1 1/2	24	1	1 5/16	3	3	1 1/2	7.50	11 13/16	14	10 1/2	9 1/2	6 3/8

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions											Add Stroke	
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LAF	NA	RD (Max.)	RT	VF	W	WF	Y	ZB
7	3	2 3/4-12	2 1/4-12	3 1/2	3.749	1	2 5/8	5 3/4	2 7/8	5 7/16	7/8	5/16	1 1/4	2 1/4	3 11/16	12
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	1 1/4	2 1/4	3 11/16	12
	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	1 1/4	2 1/4	3 11/16	12
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	1 1/4	2 1/4	3 11/16	12
8	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	1 1/4	2 1/4	3 13/16	13 1/4
	5 1/2	5 1/4-12	4-12	5 1/2	6.249	1	–	7 3/4	5 3/8	7 15/16	15/16	5/16	1 1/4	2 1/4	3 13/16	13 1/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	1 1/4	2 1/4	3 13/16	13 1/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	1 1/4	2 1/4	3 13/16	13 1/4

Table 3 — Envelope and Mounting Dimensions

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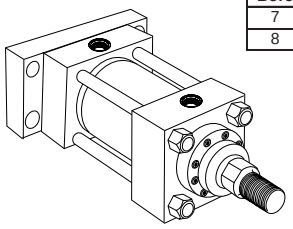
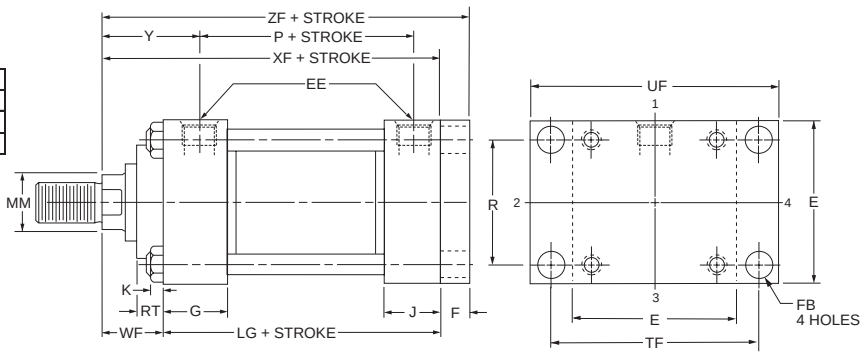
Cap Rectangular Flange Mount Style BEF2

Maximum Pressure Rating - PSI
Pull Application

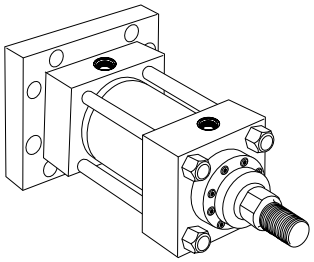
Bore	Rod Dia				
	3	3 1/2	4	5	5 1/2
7	2000	2000	2500	3000	–
8	–	1700	1700	2200	2500

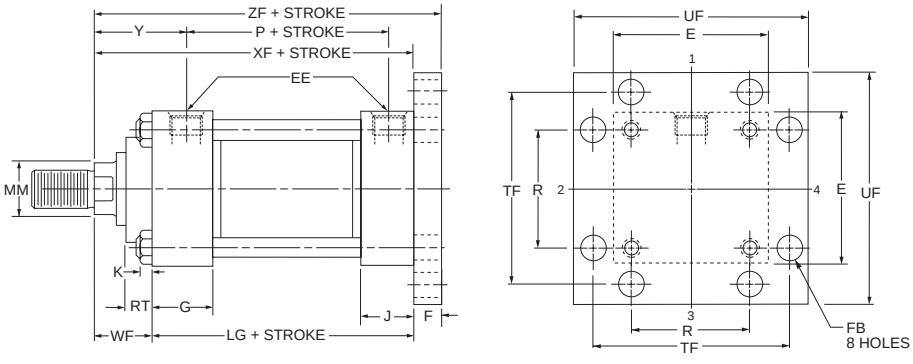




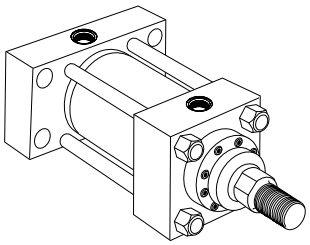
For pressures exceeding those shown use Style BEF1 or Style ME6.

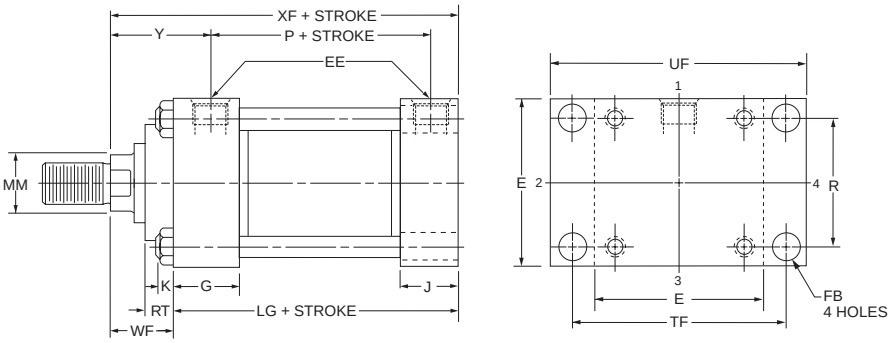
Cap Square Flange Mount Style BEF1





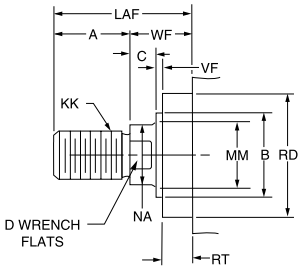
Cap Rectangular Mount Style ME6



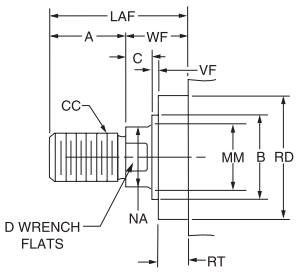


Rod End Dimensions — see Table 2

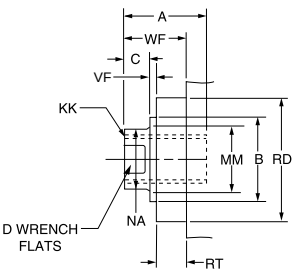
Thread Style 1
Small Male



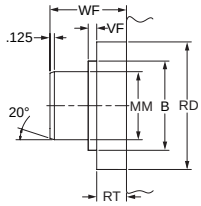
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

Over 2" rod sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 2 rod ends are recommended over 2" piston rod diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied. On 5" rods and above, (4) .515 dia. spanner wrench holes will be provided instead of wrench flats.

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Table 1—Envelope and Mounting Dimensions

Bore	E	EE		F	FB	G	J	K	R	TF	UF	Add Stroke	
		NPTF⊖	SAE★									LG	P
7	8 1/2	1 1/4	20	1	1 3/16	2 3/4	2 3/4	1 1/4	6.58	10 5/8	12 5/8	8 1/2	5 5/8
8	9 1/2	1 1/2	24	1	1 5/16	3	3	1 1/2	7.50	11 13/16	14	9 1/2	6 3/8

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Add Stroke	
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LAF	NA	RD (Max.)	RT	VF	WF	Y	XF	ZF
7	3	2 3/4-12	2 1/4-12	3 1/2	3.749	1	2 5/8	5 3/4	2 7/8	5 7/16	7/8	5/16	2 1/4	3 11/16	10 3/4	11 3/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4	3 11/16	10 3/4	11 3/4
	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4	3 11/16	10 3/4	11 3/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4	3 11/16	10 3/4	11 3/4
8	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4	3 13/16	11 3/4	12 3/4
	5 1/2	5 1/4-12	4-12	5 1/2	6.249	1	–	7 3/4	5 3/8	7 15/16	15/16	5/16	2 1/4	3 13/16	11 3/4	12 3/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4	3 13/16	11 3/4	12 3/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4	3 13/16	11 3/4	12 3/4

Table 3 — Envelope and Mounting Dimensions

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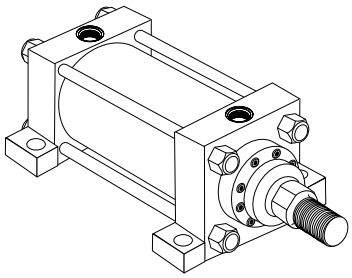
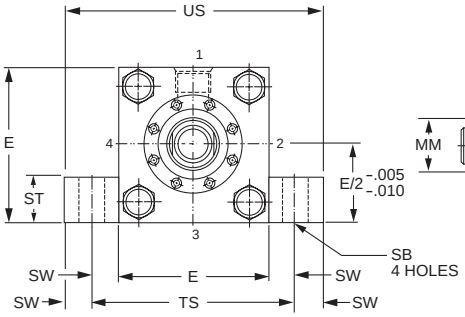
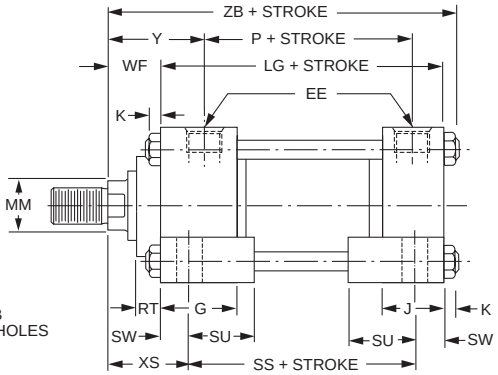
Side Lug Mount
Style SL

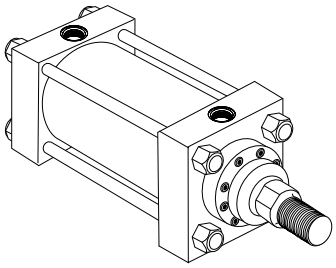


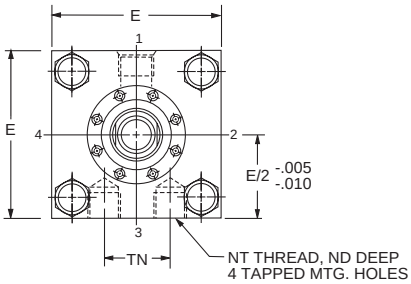


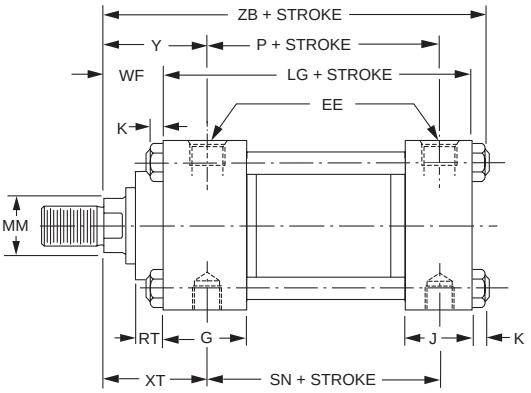


Style SL cylinders have mounting lugs welded to the head and cap, and are considered to be a fixed mount that does not absorb force on its centerline. The plane of the mounting surface is not through the centerline of the cylinder, and for this reason Style SL cylinders produce a turning moment as the cylinder applies force to the load. This turning moment tends to rotate the cylinder about its mounting bolts. If the cylinder is not well secured to the machine member on which it is mounted or the load is not well-guided, this turning moment results in side load applied to rod gland and piston bearings. **To avoid this problem, Style SL cylinders should be specified with a stroke length at least equal to the bore size.**

Side Tap Mount
Style FS



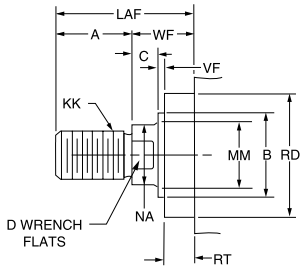




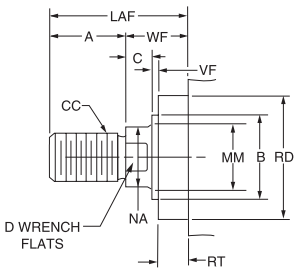
Style FS cylinders have side tapped holes for flush mounting, and are considered to be a fixed mount that does not absorb force on its centerline. The plane of the mounting surface is not through the centerline of the cylinder, and for this reason Style FS cylinders produce a turning moment as the cylinder applies force to the load. This turning moment tends to rotate the cylinder about its mounting bolts. If the cylinder is not well secured to the machine member on which it is mounted or the load is not well-guided, this turning moment results in side load applied to rod gland and piston bearings. **To avoid this problem, Style FS cylinders should be specified with a stroke length at least equal to the bore size.**

Rod End Dimensions — see Table 2

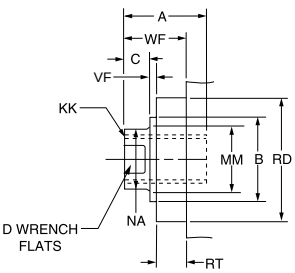
Thread Style 1
Small Male



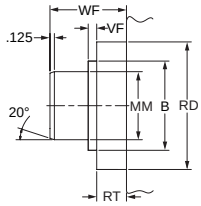
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

Over 2" rod sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 2 rod ends are recommended over 2" piston rod diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied. On 5" rods and above, (4) .515 dia. spanner wrench holes will be provided instead of wrench flats.

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Table 1—Envelope and Mounting Dimensions

Bore	E	EE		G	J	K	NT	SB	ST	SU	SW	TN	TS	US	Add Stroke			
		NPTF⊖	SAE★												LG	P	SN	SS
7	8 1/2	1 1/4	20	2 3/4	2 3/4	1 1/4	1 1/2-6	1 9/16	1 3/4	2 7/8	1 3/8	3 3/4	11 1/4	14	8 1/2	5 5/8	5 7/8	5 3/4
8	9 1/2	1 1/2	24	3	3	1 1/2	1 1/2-6	1 9/16	1 3/4	2 7/8	1 3/8	4 1/4	12 1/4	15	9 1/2	6 3/8	6 5/8	6 3/4

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions										Table 3 — Envelope and Mounting Dimensions				Add Stroke
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LAF	NA	RD (Max.)	RT	VF	WF	ND	XS	XT	Y	ZB
7	3	2 3/4-12	2 1/4-12	3 1/2	3.749	1	2 5/8	5 3/4	2 7/8	5 7/16	7/8	5/16	2 1/4	1 1/8	3 5/8	3 13/16	3 11/16	12
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4	1 1/8	3 5/8	3 13/16	3 11/16	12
	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4	1 1/8	3 5/8	3 13/16	3 11/16	12
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4	1 1/8	3 5/8	3 13/16	3 11/16	12
8	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4	1 1/2	3 5/8	3 15/16	3 13/16	13 1/4
	5 1/2	5 1/4-12	4-12	5 1/2	6.249	1	–	7 3/4	5 3/8	7 15/16	15/16	5/16	2 1/4	1 5/16	3 5/8	3 15/16	3 13/16	13 1/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4	1 1/2	3 5/8	3 15/16	3 13/16	13 1/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4	1 1/2	3 5/8	3 15/16	3 13/16	13 1/4

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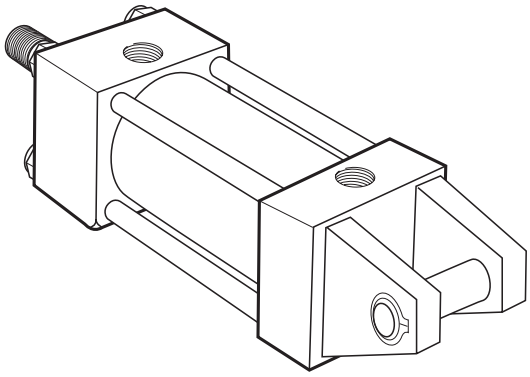
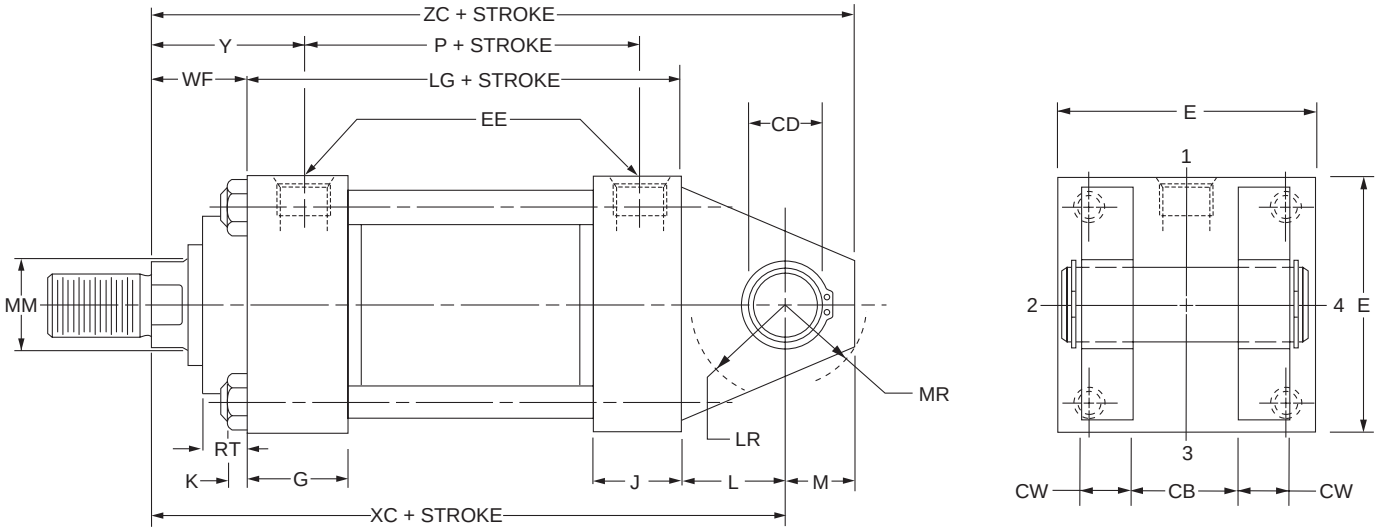
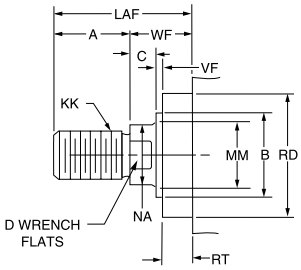
Cap Fixed Clevis Mount
Style PB2



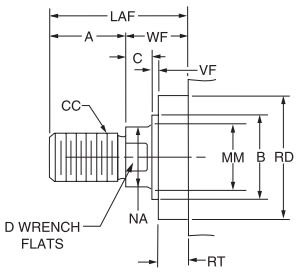


Rod End Dimensions — see Table 2

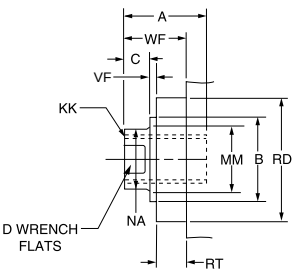
Thread Style 1
Small Male



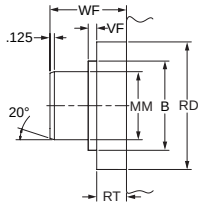
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

Over 2" rod sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 2 rod ends are recommended over 2" piston rod diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied. On 5" rods and above, (4) .515 dia. spanner wrench holes will be provided instead of wrench flats.

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Table 1—Envelope and Mounting Dimensions

Bore	CB	+.000 -.002 CDØ†	CW	E	EE NPTF⊖	EE SAE★	G	J	K	L	LR	M	MR	R	Add Stroke LG	Add Stroke P
7	3	2.501	1 1/2	8 1/2	1 1/4	20	2 3/4	2 3/4	1 1/4	3	2 3/4	2 1/2	2 7/8	6.58	8 1/2	5 5/8
8	3	3.001	1 1/2	9 1/2	1 1/2	24	3	3	1 1/2	3 1/4	3 1/4	2 3/4	3 1/8	7.50	9 1/2	6 3/8

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.
† Dimension CD is pin diameter.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread Style 2 CC	Thread Style 1 & 3 KK	Rod Extensions and Pilot Dimensions A	+.000 -.002 B Ø	C	D	LAF	NA	RD (Max.)	RT	VF	WF	Add Stroke Y	Add Stroke XC	Add Stroke ZC
7	3	2 3/4-12	2 1/4-12	3 1/2	3.749	1	2 5/8	5 3/4	2 7/8	5 7/16	7/8	5/16	2 1/4	3 11/16	13 3/4	16 1/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4	3 11/16	13 3/4	16 1/4
	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4	3 11/16	13 3/4	16 1/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4	3 11/16	13 3/4	16 1/4
8	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4	3 13/16	15	17 3/4
	5 1/2	5 1/4-12	4-12	5 1/2	6.249	1	–	7 3/4	5 3/8	7 15/16	15/16	5/16	2 1/4	3 13/16	15	17 3/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4	3 13/16	15	17 3/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4	3 13/16	15	17 3/4

Table 3 — Envelope and Mounting Dimensions

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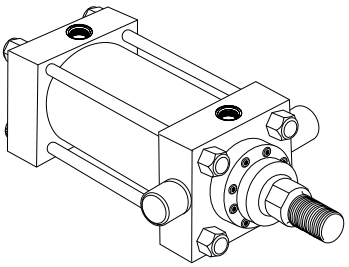
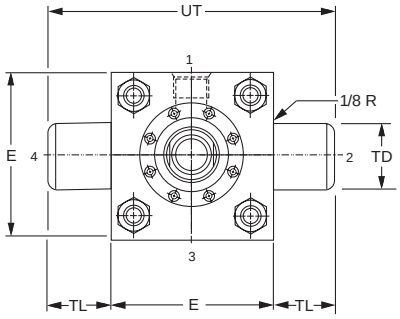
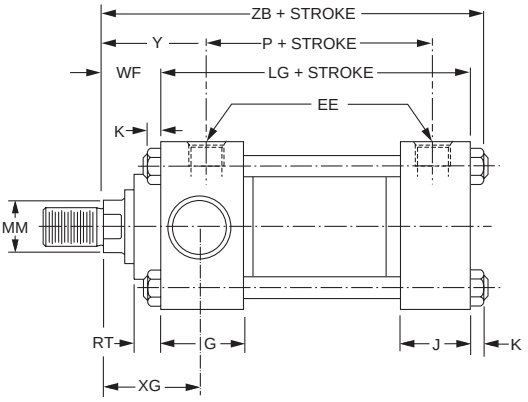
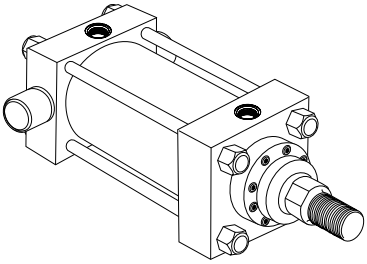
Head Trunnion Mount Style TM1

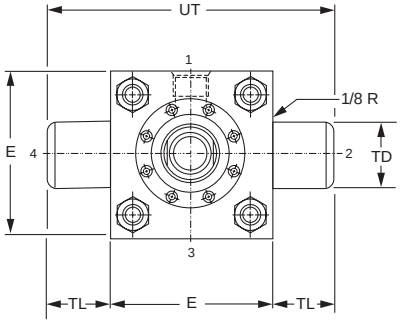


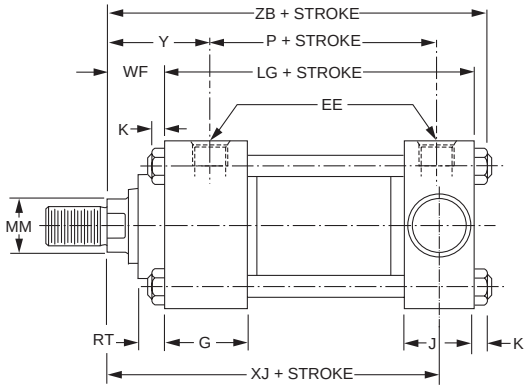




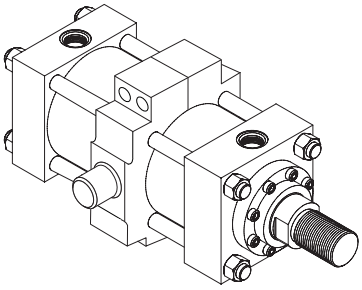
Cap Trunnion Mount Style TM2

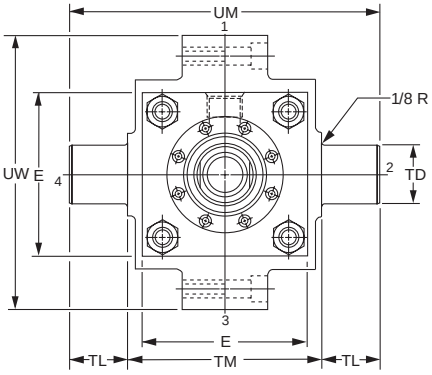


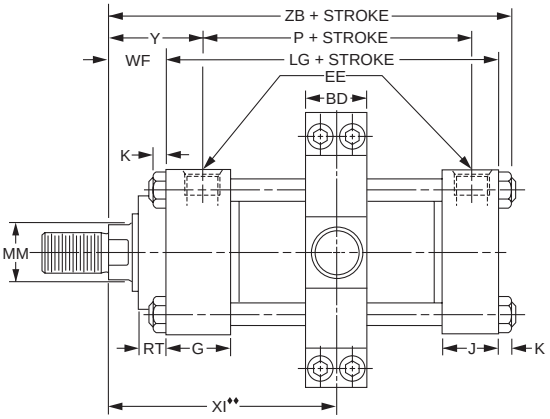




Intermediate Trunnion Mount Style TM3



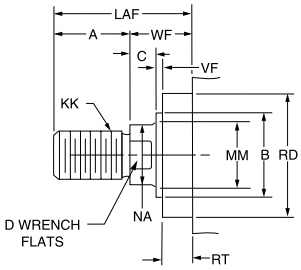




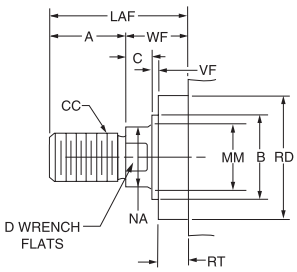
◆◆ Dimension XI to be specified by customer.

Rod End Dimensions — see Table 2

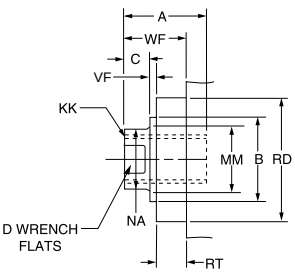
Thread Style 1
Small Male



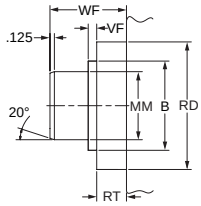
Thread Style 2
Intermediate Male



Thread Style 3
Short Female



Style 6
Stub End



"Special" Thread Style 4

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

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

Over 2" rod sizes or special rod ends are cut threads. Style 1 rod ends are recommended where the workpiece is secured against the rod shoulder. When the workpiece is not shouldered, style 2 rod ends are recommended over 2" piston rod diameters. Use style 3 for applications where female rod end threads are required. If rod end is not specified, style 1 will be supplied. On 5" rods and above, (4) .515 dia. spanner wrench holes will be provided instead of wrench flats.

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Table 1—Envelope and Mounting Dimensions

Bore	BD	E	EE		G	J	K	+.000 -.001 TD Ø	TL	TM	UM	UT	UW	Add Stroke	
			NPTF ⊖	SAE★										LG	P
7	3	8 1/2	1 1/4	20	2 3/4	2 3/4	1 1/4	2.500	2 1/2	9 3/4	14 3/4	13 1/2	11 1/2	8 1/2	5 5/8
8	3 1/2	9 1/2	1 1/2	24	3	3	1 1/2	3.000	3	11	17	15 1/2	13 3/8	9 1/2	6 3/8

★ SAE straight thread ports are standard and are indicated by port number.
⊖ NPTF ports are available at no extra charge.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread		Rod Extensions and Pilot Dimensions									
		Style 2 CC	Style 1 & 3 KK	A	+.000 -.002 B Ø	C	D	LAF	NA	RD (Max.)	RT	VF	WF
7	3	2 3/4-12	2 1/4-12	3 1/2	3.749	1	2 5/8	5 3/4	2 7/8	5 7/16	7/8	5/16	2 1/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4
	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4
8	3 1/2	3 1/4-12	2 1/2-12	3 1/2	4.249	1	3	5 3/4	3 3/8	5 15/16	15/16	5/16	2 1/4
	5 1/2	5 1/4-12	4-12	5 1/2	6.249	1	–	7 3/4	5 3/8	7 15/16	15/16	5/16	2 1/4
	4	3 3/4-12	3-12	4	4.749	1	3 3/8	6 1/4	3 7/8	6 5/16	15/16	5/16	2 1/4
	5	4 3/4-12	3 1/2-12	5	5.749	1	–	7 1/4	4 7/8	7 7/16	15/16	5/16	2 1/4

♦♦ Dimension XI to be specified by customer.

Table 3 — Envelope and Mounting Dimensions

Bore	XG	Min. XI♦♦	Y	Add Stroke	
				XJ	ZB
7	3 5/8	6 9/16	3 11/16	9 3/8	12
	3 5/8	6 9/16	3 11/16	9 3/8	12
	3 5/8	6 9/16	3 11/16	9 3/8	12
	3 5/8	6 9/16	3 11/16	9 3/8	12
8	3 3/4	7 1/16	3 13/16	10 1/4	13 1/4
	3 3/4	7 1/16	3 13/16	10 1/4	13 1/4
	3 3/4	7 1/16	3 13/16	10 1/4	13 1/4
	3 3/4	7 1/16	3 13/16	10 1/4	13 1/4

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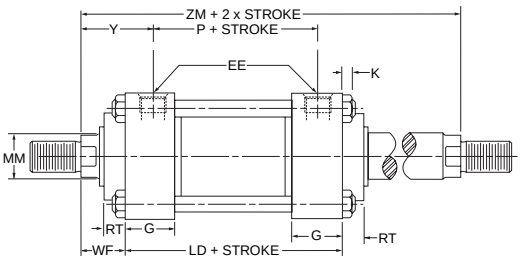
How to Use Double Rod Cylinder Dimension Drawings

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. After selecting necessary dimensions from that drawing return to this page, supplement the single rod dimensions with those shown on drawing and dimension table. Note that double rod cylinders have a head (Dim. G) at both ends and that dimension LD 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.



Bore	Rod Dia. MM	Add Stroke LD	Add Stroke Style FS SN	Add Stroke Style SL SS	Add 2X Stroke ZM
1 1/2	5/8	4 7/8	2 7/8	4 1/8	6 7/8
2	1	4 7/8	2 7/8	3 7/8	7 5/8
2 1/2	1	5	3	3 5/8	7 3/4
3 1/4	1 3/8	5 3/4	3 1/2	4 3/8	9
4	1 3/4	6	3 3/4	4 1/4	9 3/4
5	2	6 1/2	4 1/4	4 3/4	10 1/2
6	2 1/2	7 3/8	4 7/8	5 1/8	11 7/8
7	3	8 1/2	5 3/8	5 3/4	13
8	3 1/2	9 1/2	6 1/8	6 3/4	14

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 one end only.

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

Bolted & Full Plate Retainer Held Gland

Bore	Rod Dia.	NM2, BEF1, BEF2, ME6, SL, FS, TM1, TM2, PB2, TM3, SA	NM1, NM3, REF1, REF2	ME5
1 1/2	5/8	B	R	B
	1	R	R	B
2	1	B	R	B
	1 3/8	R	R	B
2 1/2	1	B	B	B
	1 3/8	B	B	B
	1 3/4	B	R	B
3 1/4	1 3/8	B	B	B
	1 3/4	B	B	B
	2	B	B	B
4	1 3/4	B	B	B
	2	B	B	B
	2 1/2	B	B	B
5	2	B	B	B
	2 1/2	B	B	B
	3	B	B	B
	3 1/2	B	R	B
6	2 1/2	B	B	B
	3	B	B	B
	3 1/2	B	B	B
	4	B	B	B
7	3	B	B	B
	3 1/2	B	B	B
	4	B	B	B
	5	B	B	B
8	3 1/2	B	B	B
	4	B	B	B
	5	B	B	B
	5 1/2	B	B	B

The chart at the left specifies the gland retainer construction – Bolted Retainer or Full Face Retainer – that will be supplied based on the bore, rod diameter and mounting combination selected in the cylinder model number.

Rod Bearing Construction
B = Bolted Gland
R = Retainer Held Gland

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NOTES

Series H
Large Bore
High Pressure Hydraulic Cylinders

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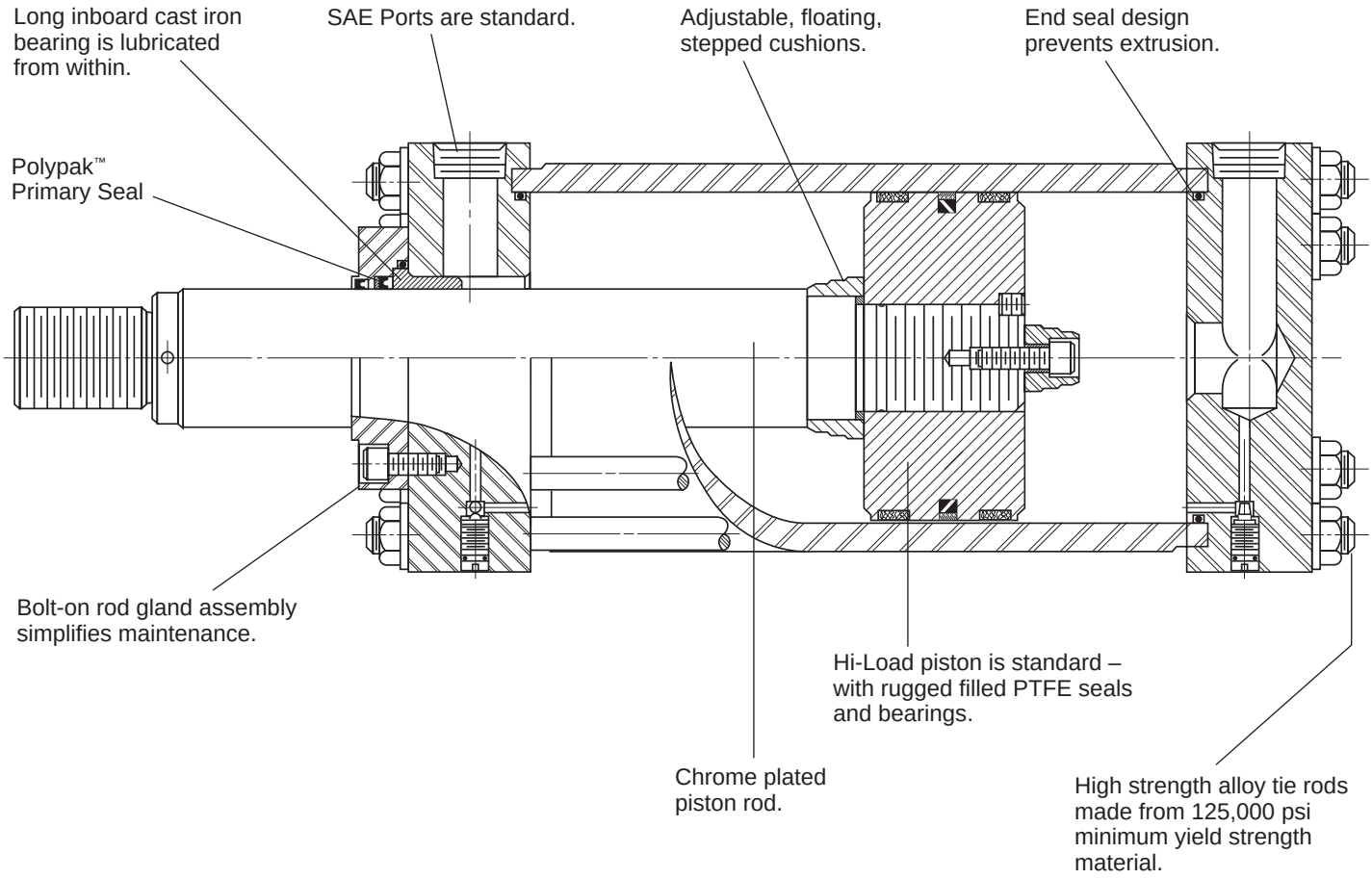

Standard Specifications

- Heavy Duty Service
- Standard Construction – Square Head – Tie Rod Design
- Nominal Pressure – 3000 PSI*
- Standard Fluid – Hydraulic Oil
- Standard Temperature – –10°F. to +165°F.**
- Bore Sizes – 10" through 20" (Larger sizes available)
- Piston Rod Diameter – 4 1/2" through 10"
- Mounting Styles – Twelve 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 – Two Standard Choices – Specials to Order

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

*If hydraulic operating pressure exceeds 3000 PSI, send application data for engineering evaluation and recommendation. See page 58 for actual design factors.

** See page 57 for higher temperature service.

Series H
Large Bore
High Pressure Hydraulic Cylinders

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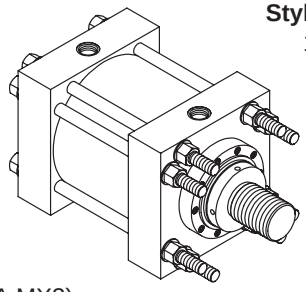
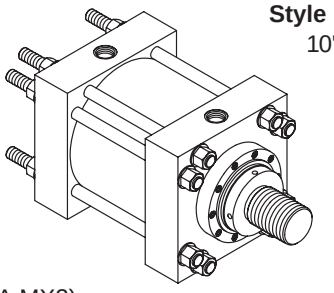
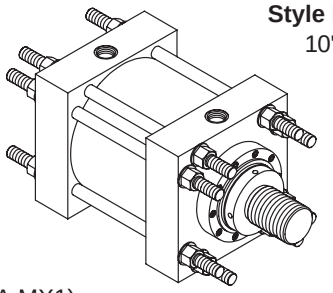
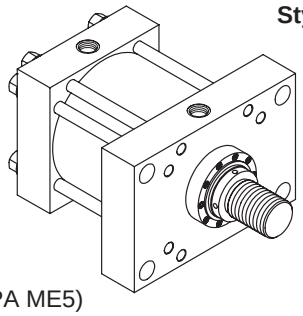
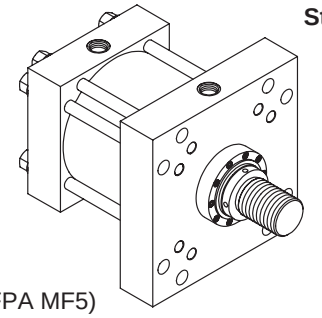
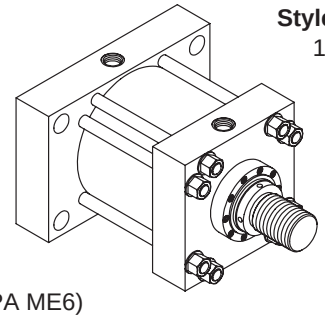
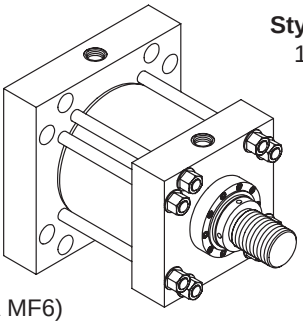
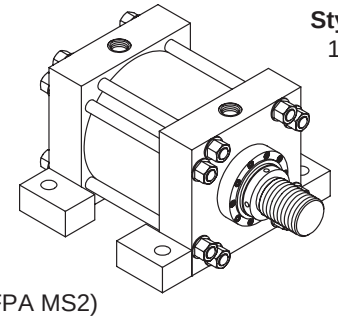
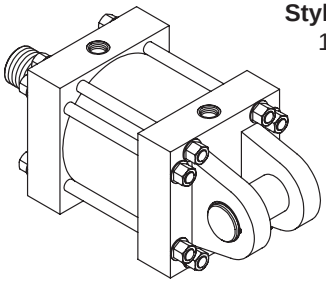
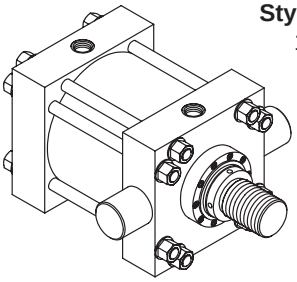
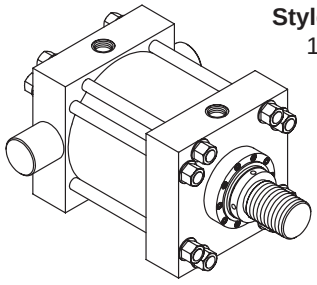
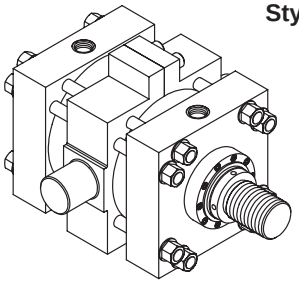
Available Mounting Styles

Tie Rods Extended Head End **Style NM3** 10"-14"  (NFPA MX3)	Tie Rods Extended Cap End **Style NM2** 10"-14"  (NFPA MX2)	Tie Rods Extended Both Ends **Style NM1** 10"-14"  (NFPA MX1)
Head Rectangular **Style ME5** 10"-20"  (NFPA ME5)	Head Square Flange **Style IH3** 10"-20"  (NFPA MF5)	Cap Rectangular **Style ME6** 10"-20"  (NFPA ME6)
Cap Square Flange **Style IH4** 10"-20"  (NFPA MF6)	Side Lug **Style SL** 10"-14"  (NFPA MS2)	Cap Fixed Clevis **Style PB2** 10"-20"  (NFPA MP1)
Head Trunnion **Style TM1** 10"-14"  (NFPA MT1)	Cap Trunnion **Style TM2** 10"-14"  (NFPA MT2)	Intermediate Fixed Trunnion **Style TM3** 10"-14"  (NFPA MT4)

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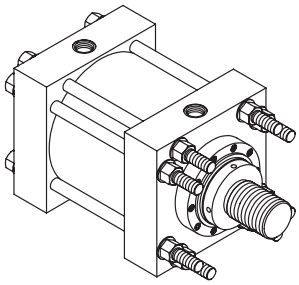
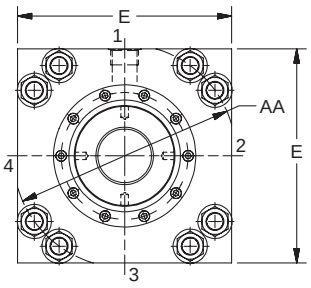
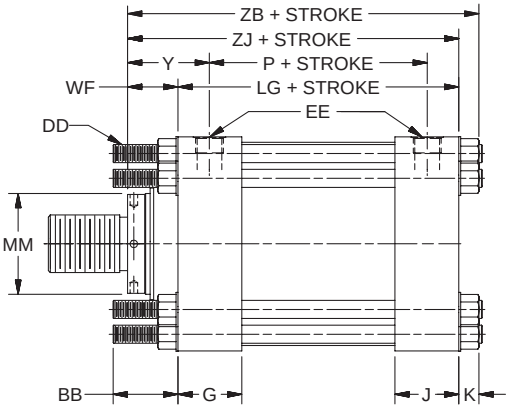
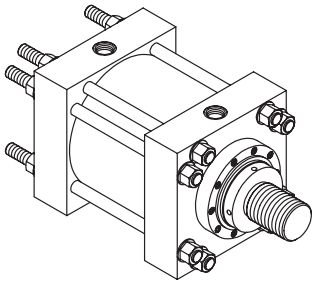
Tie Rods Extended Head End
Style NM3
(NFPA Style MX3)

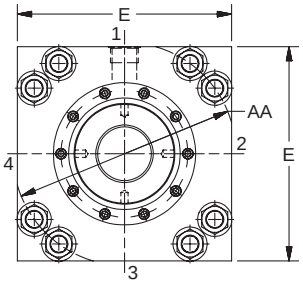


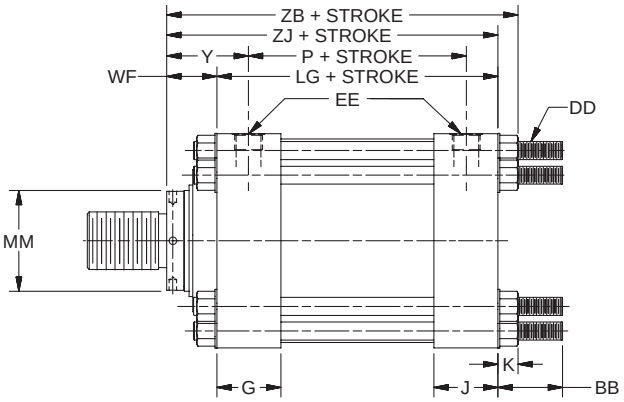




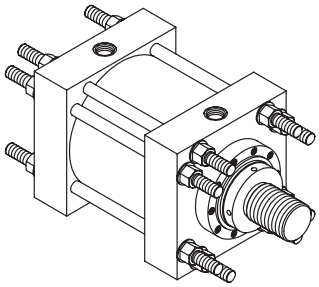
Tie Rods Extended Cap End
Style NM2
(NFPA Style MX2)



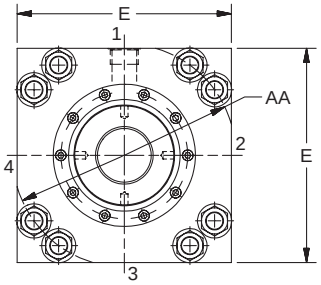


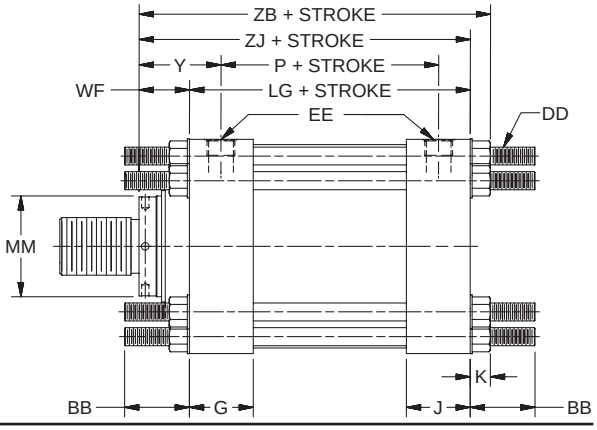


Tie Rods Extended Both Ends
Style NM1
(NFPA Style MX1)



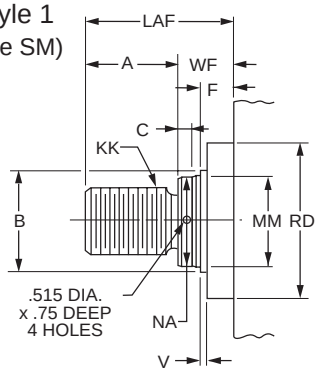
Basic Mounting (NM0) — Not shown is no tie rod extended and can be supplied upon request.





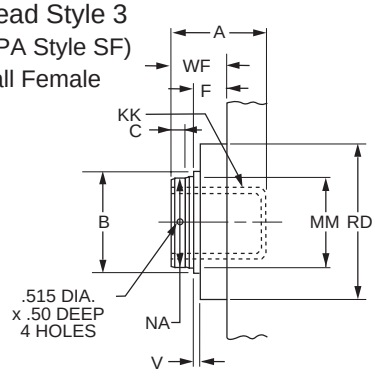
Rod End Dimensions — see Table 2

Thread Style 1
(NFPA Style SM)
Small Male



If rod end is not specified, Style 1 will be furnished.

Thread Style 3
(NFPA Style SF)
Small Female



Use Style 3 for applications where female rod ends are required.

Special Thread Style 4

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

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

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Table 1—Envelope and Mounting Dimensions

Bore	AA	BB	DD	E	EE* NPTF	EEf▲ S.A.E. FLANGE PORT	EE** S.A.E. STRAIGHT THREAD	G	J	K	RA	RB	RC	RR	Add Stroke LG	Add Stroke P
10	13.00	4 1/8	1 1/8-12	12 5/8	2	2	24	3 11/16	3 11/16	1 9/32	5.291	3.775	–	2 1/8	12 1/8	8 1/2
12	15.50	4 1/2	1 1/4-12	14 7/8	2 1/2	2 1/2	24	4 7/16	4 7/16	1 13/32	6.270	4.555	–	2 3/8	14 1/2	10 1/8
14	17.38	4 1/2	1 1/4-12	17 1/8	2 1/2	2 1/2	24	4 7/8	4 7/8	1 13/32	7.485	6.143	4.409	2 1/4	15 5/8	10 7/8

* NPTF ports are available at no extra charge.

▲ Optional SAE flange ports may be specified – flange to be supplied by customer. See Table 4 for flange port pattern dimensions.

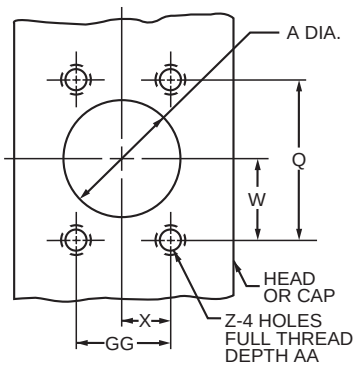
** SAE straight thread ports are standard and are indicated by port number.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread KK	Rod Extensions and Pilot Dimensions A	+.000 -.005 B Ø	C	F	LAF	NA	RD	V	WF	Y	Add Stroke ZB	Add Stroke ZJ
10	4 1/2	3 1/4-12	4 1/2	5.249	1	1 15/16	7 7/16	4 3/8	8 1/4	1/4	2 15/16	4 3/4	16 11/32	15 1/16
	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2	5 5/16	16 29/32	15 5/8
	5	3 1/2-12	5	5.749	1	1 15/16	8 3/16	4 7/8	8 7/8	1/4	3 3/16	5	16 19/32	15 5/16
	5 1/2	4-12	5 1/2	6.249	1	1 15/16	8 11/16	5 3/8	9 3/8	1/4	3 3/16	5	16 19/32	15 5/16
12	5 1/2	4-12	5 1/2	6.249	1	1 15/16	8 11/16	5 3/8	9 3/8	1/4	3 3/16	5 3/8	19 3/32	17 11/16
	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4	6 3/16	19 29/32	18 1/2
	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2	5 11/16	19 13/32	18
14	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2	5 7/8	20 17/32	19 1/8
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2	6 7/8	21 17/32	20 1/8
	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4	6 3/8	21 1/32	19 5/8

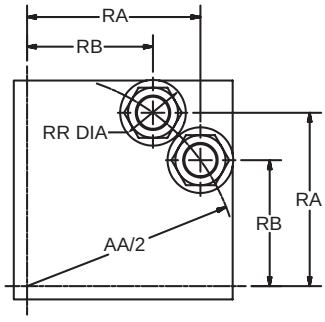
Table 3 — Envelope and Mounting Dimensions

Table 4—Optional SAE Flange Port Pattern

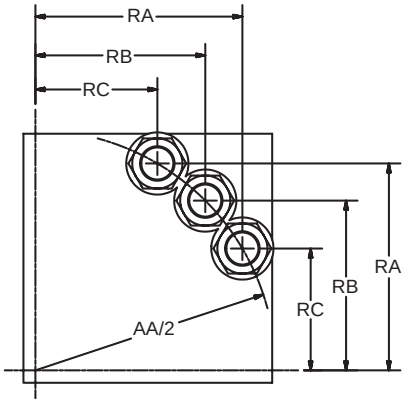


Nom. Flange Size	S.A.E. Flange Dash Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.
1 1/2	-24	1.50	2.750	1.406	1.38	0.70	1/2-13	1.06
2	-32	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06
2 1/2	-40	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19
3	-48	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19

Table 5—Tie Rod Information see Table 1 for dimensions



10", 12" Bores, 8 Tie Rods



14" Bores, 12 Tie Rods

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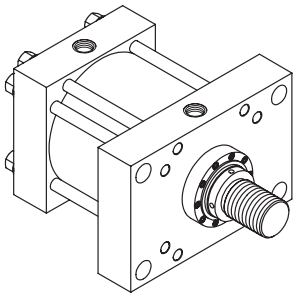
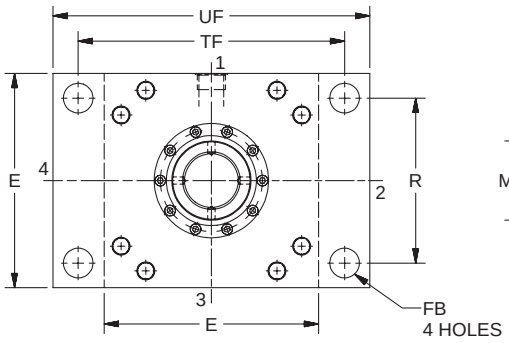
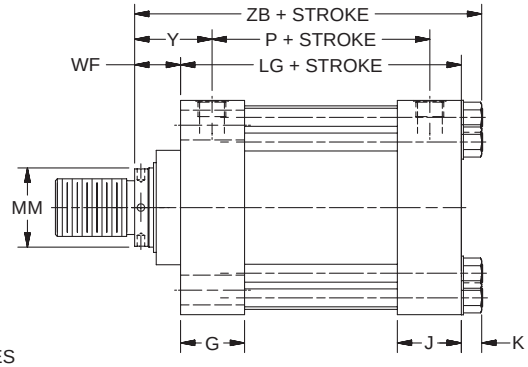
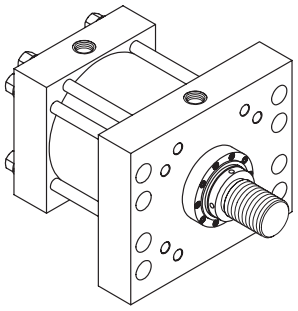
Head Rectangular Mounting
Style ME5 (10"-14" Bore)
(NFPA Style ME5)

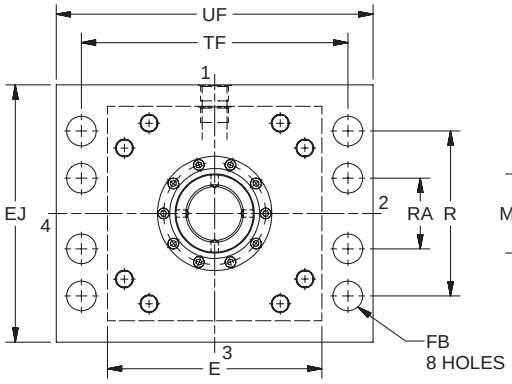


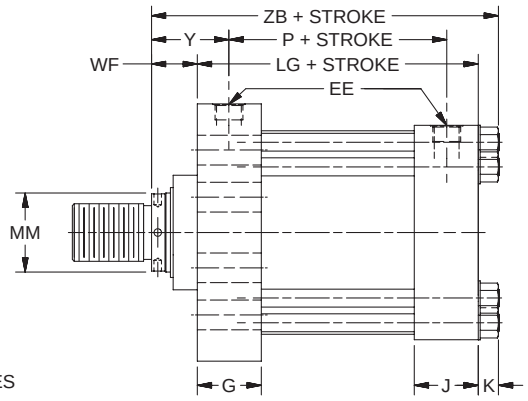




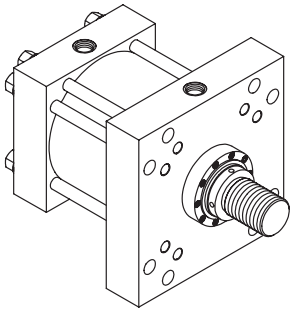
Head Rectangular Mounting
Style ME5 (16"-20" Bore)
(NFPA Style ME5)

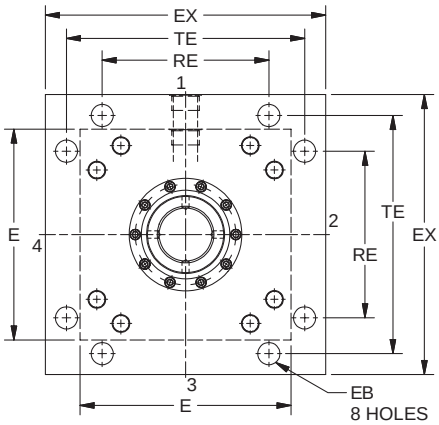


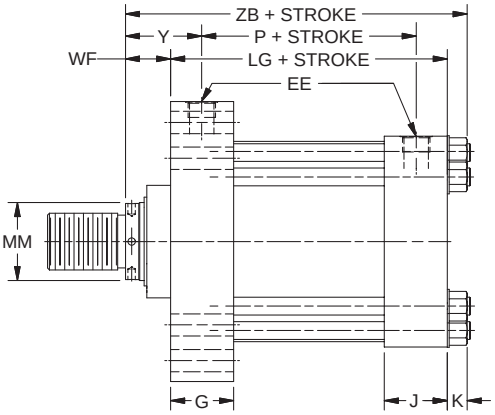




Head Square Flange Mounting
Style IH3
(NFPA Style MF5)

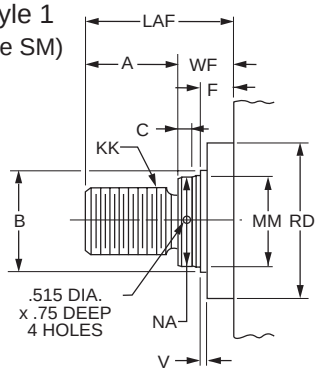






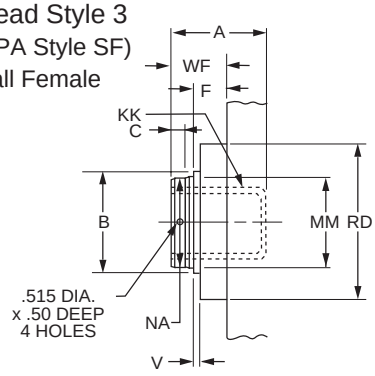
Rod End Dimensions — see Table 2

Thread Style 1
(NFPA Style SM)
Small Male



If rod end is not specified, Style 1 will be furnished.

Thread Style 3
(NFPA Style SF)
Small Female



Use Style 3 for applications where female rod ends are required.

Special Thread Style 4

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

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

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Table 1—Envelope and Mounting Dimensions

Bore	E	EB	EE* NPTF	EEf▲ S.A.E. FLANGE PORT	EE** S.A.E. STRAIGHT THREAD	EX	FB	G	J	K	R	RE	TE	TF	UF	Add Stroke LG	Add Stroke P
10	12 5/8	1 5/16	2	2	24	16 5/8	1 13/16	3 11/16	3 11/16	1 9/32	9.62	9.89	14.13	15 7/8	19	12 1/8	8 1/2
12	14 7/8	1 9/16	2 1/2	2 1/2	24	19 3/4	2 1/16	4 7/16	4 7/16	1 13/32	11.45	11.75	16.79	18 1/2	22	14 1/2	10 1/8
14	17 1/8	1 13/16	2 1/2	2 1/2	24	21 3/4	2 5/16	4 7/8	4 7/8	1 13/32	13.26	12.90	18.43	21	25	15 5/8	10 7/8

Table 1A—Envelope and Mounting Dimensions

Bore	E	EB	EE (SAE)	EE (FLANGE)	EJ	EX	FB	G	J	K	R	RA	RE	TE	TF	UF	Add Stroke LG	Add Stroke P
16	19	1 13/16	24	3	20	24 1/2	1 13/16	5 7/8	5 7/8	1 29/32	15 1/2	8	15.28	21.03	21	24 1/2	18 1/8	12 1/8
18	22	2 1/16	24	3	23	26 1/2	2 1/16	6 7/8	6 7/8	1 29/32	18	7 1/4	16.45	22.65	24 1/4	28 1/4	21 1/8	15 1/8
20	24	2 1/16	24	3	25	29	2 1/16	7 7/8	7 7/8	1 29/32	20	8	18.07	24.87	26 1/2	30 1/2	23 5/8	17 5/8

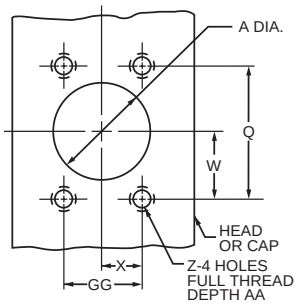
* NPTF ports are available at no extra charge.
▲Optional SAE flange ports may be specified – flange to be supplied by customer. See Table 4 for flange port pattern dimensions.
** SAE straight thread ports are standard and are indicated by port number.

Table 2—Rod Dimensions

Bore	Rod Dia. MM	Thread KK	Rod Extensions and Pilot Dimensions A	+.000 -.005 B Ø	C	F	LAF	NA	RD	V	WF	Y	Add Stroke ZB
10	4 1/2	3 1/4-12	4 1/2	5.249	1	1 15/16	7 7/16	4 3/8	8 1/4	1/4	2 15/16	4 3/4	16 11/32
	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2	5 5/16	16 29/32
	5	3 1/2-12	5	5.749	1	1 15/16	8 3/16	4 7/8	8 7/8	1/4	3 3/16	5	16 19/32
	5 1/2	4-12	5 1/2	6.249	1	1 15/16	8 11/16	5 3/8	9 3/8	1/4	3 3/16	5	16 19/32
12	5 1/2	4-12	5 1/2	6.249	1	1 15/16	8 11/16	5 3/8	9 3/8	1/4	3 3/16	5 3/8	19 3/32
	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4	6 3/16	19 29/32
	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2	5 11/16	19 13/32
14	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2	5 7/8	20 17/32
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2	6 7/8	21 17/32
	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4	6 3/8	21 1/32
16	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4	7	24 1/32
	9	6 1/2-12	9	9.999	1	1 15/16	13 1/4	8 7/8	13 1/2	3/8	4 1/4	7 1/4	24 9/32
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2	7 1/2	24 17/32
18	9	6 1/2-12	9	9.999	1	1 15/16	13 1/4	8 7/8	13 1/2	3/8	4 1/4	7 1/4	27 9/32
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2	7 1/2	27 17/32
20	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2	7 1/2	30 1/32

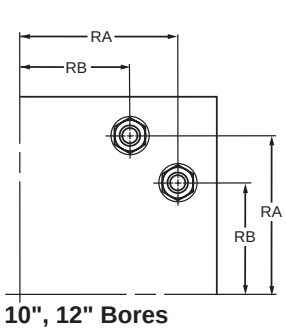
Table 3 —Envelope and Mounting Dimensions

Table 4—Optional SAE Flange Port Pattern

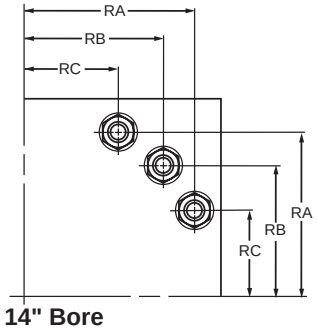


Nom. Flange Size	S.A.E. Flange Dash Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.
1 1/2	-24	1.50	2.750	1.406	1.38	0.70	1/2-13	1.06
2	-32	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06
2 1/2	-40	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19
3	-48	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19

Table 5—Tie Rod Information



10", 12" Bores



14" Bore

Bore	10	12	14	16	18	20
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	*	*	*

*Consult factory for dimensions

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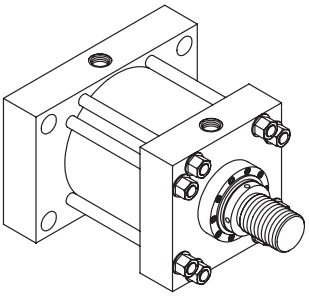
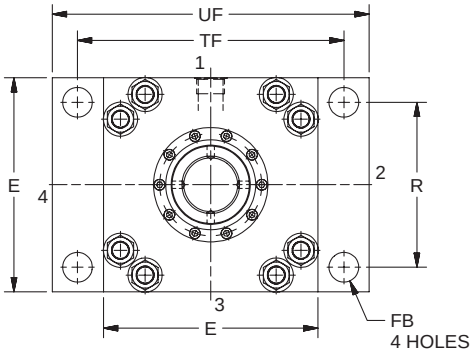
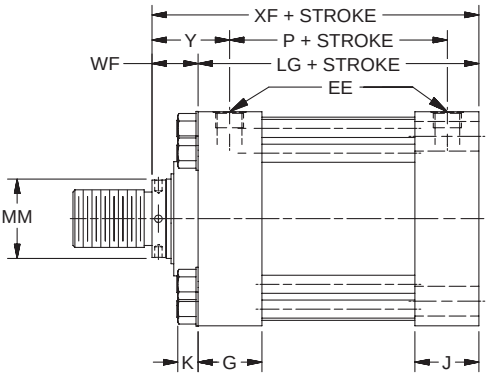
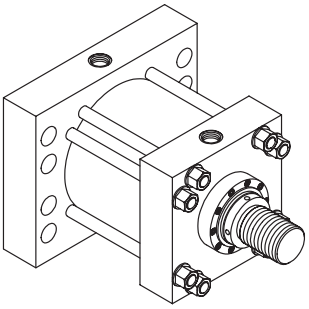
Cap Rectangular Mountings
Style ME6 (10"-14" Bore)
(NFPA Style ME6)

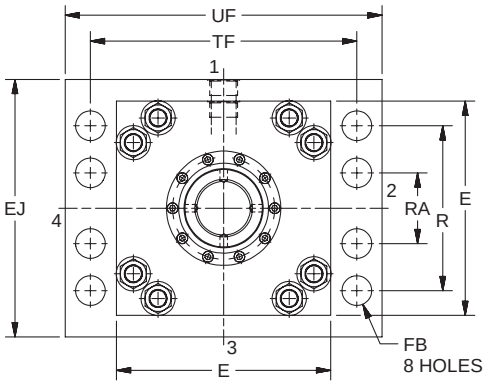


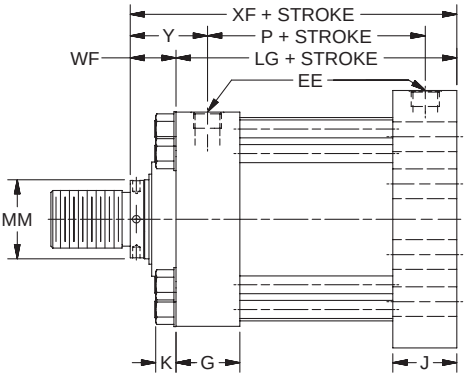




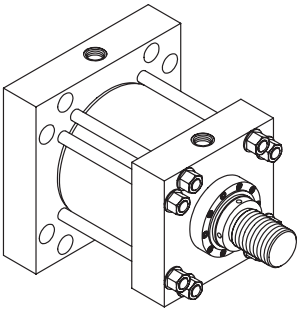
Cap Rectangular Mountings
Style ME6 (16"-20" Bore)
(NFPA Style ME6)

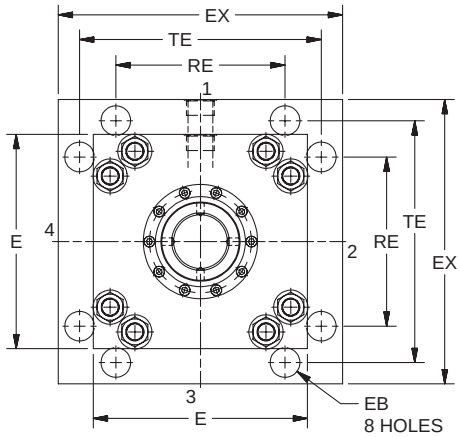


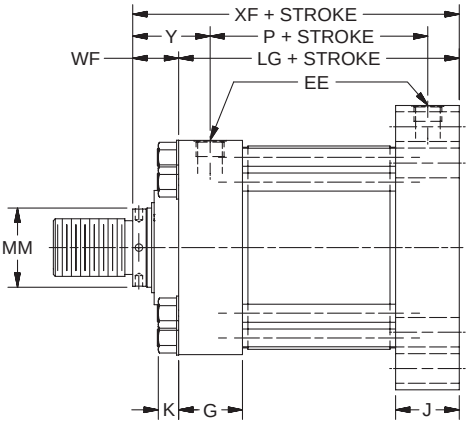




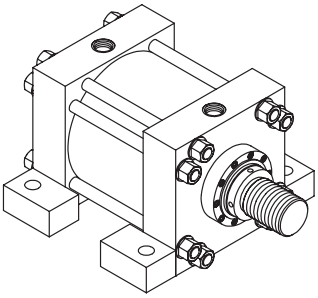
Cap Square Flange Mounting
Style IH4
(NFPA Style MF6)



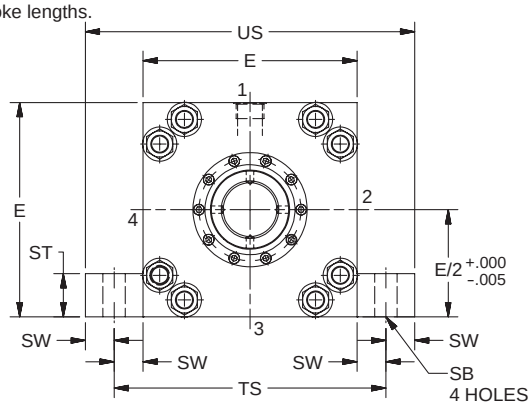


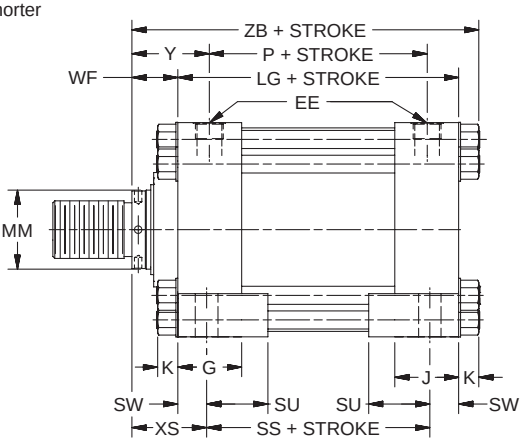


Side Lugs Mounting
Style SL
10"-14" Bore only
(NFPA Style MS2)



Note: Stroke lengths on lug mounted cylinders should not be shorter than the cylinder bore diameter. Consult factory for recommendations on shorter stroke lengths.





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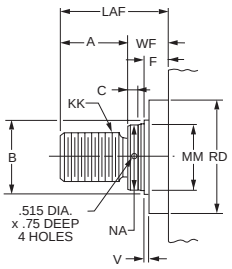
Rod End Dimensions — see Table 2

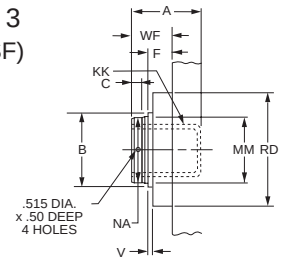
Thread Style 1
(NFPA Style SM)
Small Male

If rod end is not specified, Style 1 will be furnished.



Thread Style 3
(NFPA Style SF)
Small Female

Use Style 3 for applications where female rod ends are required.



Special Thread Style 4

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

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

Table 1—Envelope and Mounting Dimensions

Bore	E	EB	EE* NPTF	EEf▲ S.A.E. FLANGE PORT	EE** S.A.E. STRAIGHT THREAD	EX	FB	G	J	K	R	RE	SB	ST	SU	SW	TE	TF	TS	UF	US	Add Stroke LG	Add Stroke P	Add Stroke SS
10	12 5/8	1 5/16	2	2	24	16 5/8	1 13/16	3 11/16	3 11/16	1 9/32	9.62	9.89	1 9/16	2 1/4	3 1/2	1 5/8	14.13	15 7/8	15 7/8	19	19 1/8	12 1/8	8 1/2	8 7/8
12	14 7/8	1 9/16	2 1/2	2 1/2	24	19 3/4	2 1/16	4 7/16	4 7/16	1 13/32	11.45	11.75	1 9/16	3	4 1/4	2	16.79	18 1/2	18 7/8	22	22 7/8	14 1/2	10 1/8	10 1/2
14	17 1/8	1 13/16	2 1/2	2 1/2	24	21 3/4	2 5/16	4 7/8	4 7/8	1 13/32	13.26	12.90	2 5/16	4	4 3/4	2 1/4	18.43	21	21 5/8	25	26 1/8	15 5/8	10 7/8	11 1/8

Table 1A—Envelope and Mounting Dimensions

Bore	E	EB	EE (SAE)	EE (FLANGE)	EJ	EX	FB	G	J	K	R	RA	RE	TE	TF	UF	Add Stroke LG	Add Stroke P
16	19	1 13/16	24	3	20	24 1/2	1 13/16	5 7/8	5 7/8	1 29/32	15 1/2	8	15.28	21.03	21	24 1/2	18 1/8	12 1/8
18	22	2 1/16	24	3	23	26 1/2	2 1/16	6 7/8	6 7/8	1 29/32	18	7 1/4	16.45	22.65	24 1/4	28 1/4	21 1/8	15 1/8
20	24	2 1/16	24	3	25	29	2 1/16	7 7/8	7 7/8	1 29/32	20	8	18.07	24.87	26 1/2	30 1/2	23 5/8	17 5/8

* NPTF ports are available at no extra charge.
▲ Optional SAE flange ports may be specified – flange to be supplied by customer. See Table 4 for flange port pattern dimensions.
** SAE straight thread ports are standard and are indicated by port number.

Table 2—Rod Dimensions

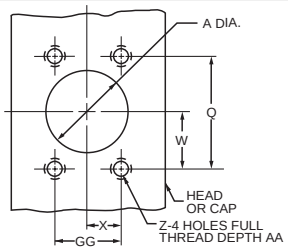
Bore	Rod Dia. MM	Thread KK	Rod Extensions and Pilot Dimensions A	+.000 -.005 B Ø	C	F	LAF	NA	RD	V	WF
10	4 1/2	3 1/4-12	4 1/2	5.249	1	1 15/16	7 7/16	4 3/8	8 1/4	1/4	2 15/16
	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2
	5	3 1/2-12	5	5.749	1	1 15/16	8 3/16	4 7/8	8 7/8	1/4	3 3/16
	5 1/2	4-12	5 1/2	6.249	1	1 15/16	8 11/16	5 3/8	9 3/8	1/4	3 3/16
12	5 1/2	4-12	5 1/2	6.249	1	1 15/16	8 11/16	5 3/8	9 3/8	1/4	3 3/16
	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4
	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2
14	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2
	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4
16	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4
	9	6 1/2-12	9	9.999	1	1 15/16	13 1/4	8 7/8	13 1/2	3/8	4 1/4
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2
18	9	6 1/2-12	9	9.999	1	1 15/16	13 1/4	8 7/8	13 1/2	3/8	4 1/4
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2
20	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2

Table 3 —Envelope and Mounting Dimensions

Bore	Rod Dia. MM	Thread KK	Add Stroke Y	Add Stroke XS	Add Stroke XF	Add Stroke ZB
10	4 1/2	3 1/4-12	4 3/4	4 9/16	15 1/16	16 11/32
	7	5-12	5 5/16	5 1/8	15 5/8	16 29/32
	5	3 1/2-12	5	4 13/16	15 5/16	16 19/32
	5 1/2	4-12	5	4 13/16	15 5/16	16 19/32
12	5 1/2	4-12	5 3/8	5 3/16	17 11/16	19 3/32
	8	5 3/4-12	6 3/16	6	18 1/2	19 29/32
	7	5-12	5 11/16	5 1/2	18	19 13/32
14	7	5-12	5 7/8	5 3/4	19 1/8	20 17/32
	10	7 1/4-12	6 7/8	6 3/4	20 1/8	21 17/32
	8	5 3/4-12	6 3/8	6 1/4	19 5/8	21 1/32
16	8	5 3/4-12	7	*	22 1/8	*
	9	6 1/2-12	7 1/4	*	22 3/8	*
	10	7 1/4-12	7 1/2	*	22 5/8	*
18	9	6 1/2-12	7 1/4	*	25 3/8	*
	10	7 1/4-12	7 1/2	*	25 5/8	*
20	10	7 1/4-12	7 1/2	*	28 1/8	*

*Consult Factory

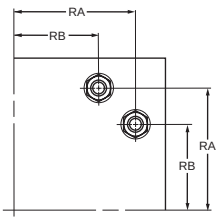
Table 4—Optional SAE Flange Port Pattern



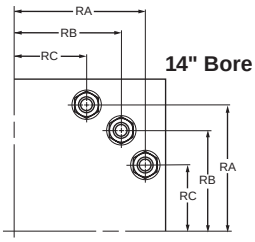
Nom. Flange Size	S.A.E. Flange Dash Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.
1 1/2	-24	1.50	2.750	1.406	1.38	0.70	1/2-13	1.06
2	-32	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06
2 1/2	-40	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19
3	-48	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19

Table 5—Tie Rod Information

10", 12" Bores



14" Bore



Bore	10	12	14	16	18	20
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	*	*	*

*Consult factory for dimensions

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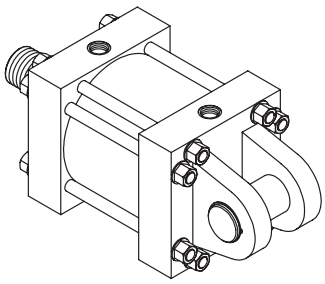
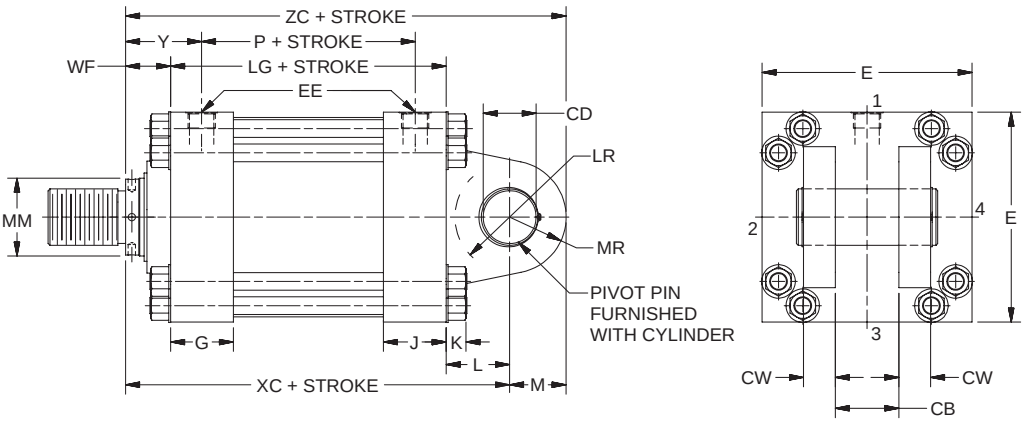
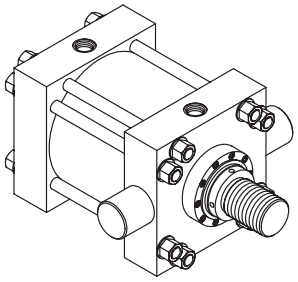
Cap Fixed Clevis Mountings
Style PB2
(NFPA Style MP1)



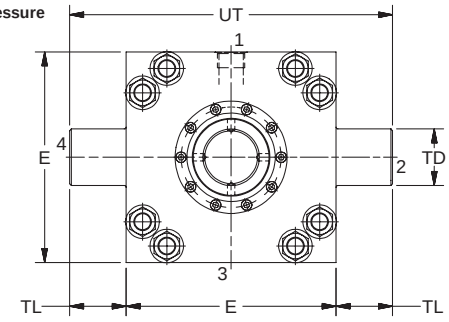


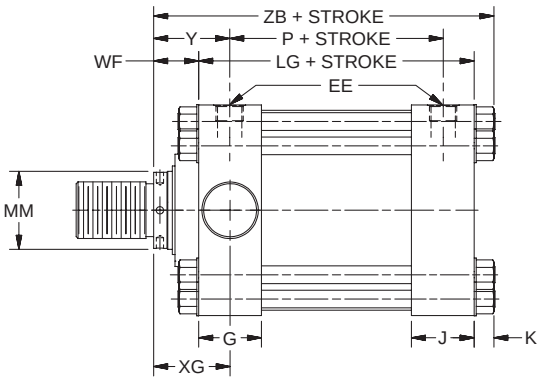
Head Trunnion Mounting
Style TM1
10"-14" Bore only
(NFPA Style MT1)



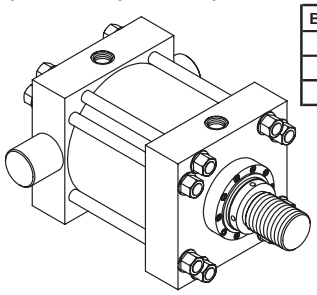
For Style TM1 Mount Maximum Pressure Rating - PSI

Bore	PSI
10	2800
12	2350
14	2200



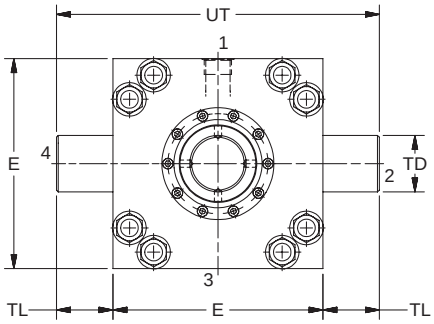


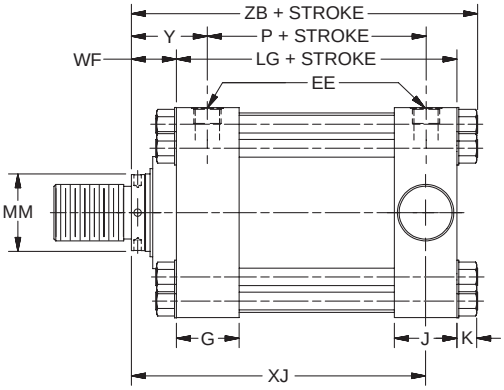
Cap Trunnion Mounting
Style TM2
10"-14" Bore only
(NFPA Style MT2)



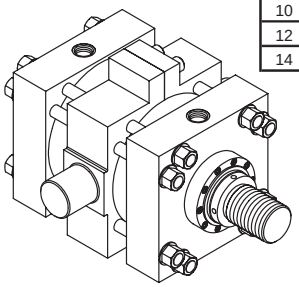
For Style TM2 Mount Maximum Pressure Rating - PSI

Bore	PSI
10	2800
12	2350
14	2200



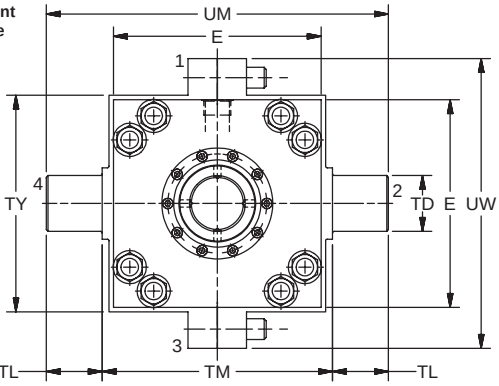


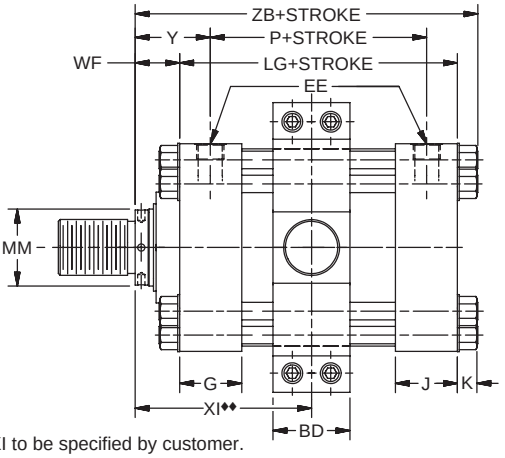
Intermediate Fixed Trunnion Mounting
Style TM3
(10"-14" Bore Only)
(NFPA Style MT4)



For Style TM3 Mount Maximum Pressure Rating - PSI

Bore	PSI
10	2800
12	2350
14	2200





♦♦ Dimension XI to be specified by customer.

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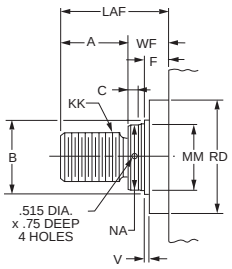
Rod End Dimensions — see Table 2

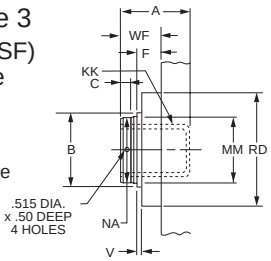
Thread Style 1
(NFPA Style SM)
Small Male

If rod end is not specified, Style 1 will be furnished.



Thread Style 3
(NFPA Style SF)
Small Female

Use Style 3 for applications where female rod ends are required.



Special Thread Style 4

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

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

Table 1—Envelope and Mounting Dimensions

Bore	BD	CB	+.001 -.003 CD Ø	CW	E	EE* NPTF	EEf▲ S.A.E. FLANGE PORT	EE** S.A.E. STRAIGHT THREAD	G	J	K	L	LR	M	MR	+.000 -.001 TD Ø	TL	TM	TY	UM	UT	UW	Add Stroke LG	Add Stroke P
10	4 1/2	4	3.500	2	12 5/8	2	2	24	3 11/16	3 11/16	1 9/32	4	3 3/8	3 1/2	3 1/2	3.500	3 1/2	14	13	21	19 5/8	17 1/2	12 1/8	8 1/2
12	5 1/2	4 1/2	4.000	2 1/4	14 7/8	2 1/2	2 1/2	24	4 7/16	4 7/16	1 13/32	4 1/2	3 7/8	4	4	4.000	4	16 1/2	15 1/2	24 1/2	22 7/8	20 3/4	14 1/2	10 1/8
14	5 1/2	6	5.000	3	17 1/8	2 1/2	2 1/2	24	4 7/8	4 7/8	1 13/32	5 3/4	4 3/16	5	5	4.500	4 1/2	19 1/2	19 1/4	28 1/2	26 1/8	24 3/4	15 5/8	10 7/8

Table 1A—Envelope and Mounting Dimensions (Style PB2 only)

Bore	E	EE (SAE)	EE (FLANGE)	CB	CD	CW	G	J	K	L	LR	M	MD	MR	Add Stroke LG	Add Stroke P
16	19	24	3	7	6	3 1/2	5 7/8	5 7/8	1 29/32	7	6 1/4	6	16	6	18 1/8	12 1/8
18	22	24	3	8	6 1/2	4	6 7/8	6 7/8	1 29/32	7 5/8	6 3/4	6 1/2	18	6 1/2	21 1/8	15 1/8
20	24	24	3	9	7 1/2	4 1/2	7 7/8	7 7/8	1 29/32	8 3/4	7 3/4	7 1/2	20	7 1/2	23 5/8	17 5/8

* NPTF ports are available at no extra charge.
▲ Optional SAE flange ports may be specified – flange to be supplied by customer. See Table 4 for flange port pattern dimensions.
** SAE straight thread ports are standard and are indicated by port number.
Dimension CD is pin diameter.

Table 2—Rod Dimensions

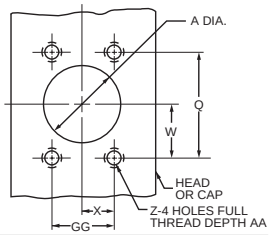
Bore	Rod Dia. MM	Thread KK	Rod Extensions and Pilot Dimensions: A	+.000 -.005 B Ø	C	F	LAF	NA	RD	V	WF
10	4 1/2	3 1/4-12	4 1/2	5.249	1	1 15/16	7 7/16	4 3/8	8 1/4	1/4	2 15/16
	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2
	5	3 1/2-12	5	5.749	1	1 15/16	8 3/16	4 7/8	8 7/8	1/4	3 3/16
	5 1/2	4-12	5 1/2	6.249	1	1 15/16	8 11/16	5 3/8	9 3/8	1/4	3 3/16
12	5 1/2	4-12	5 1/2	6.249	1	1 15/16	8 11/16	5 3/8	9 3/8	1/4	3 3/16
	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4
	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2
14	7	5-12	7	7.999	1	1 15/16	10 1/2	6 7/8	10 1/2	3/8	3 1/2
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2
	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4
16	8	5 3/4-12	8	8.999	1	1 15/16	12	7 7/8	12 1/2	3/8	4
	9	6 1/2-12	9	9.999	1	1 15/16	13 1/4	8 7/8	13 1/2	3/8	4 1/4
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2
18	9	6 1/2-12	9	9.999	1	1 15/16	13 1/4	8 7/8	13 1/2	3/8	4 1/4
	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2
20	10	7 1/4-12	10	10.999	1	1 15/16	14 1/2	9 7/8	14 1/2	3/8	4 1/2

* Dimension XI to be specified by customer. **Consult Factory.

Table 3—Envelope and Mounting Dimensions

Bore	XG	Min. XI*	Y	Add Stroke XC	Add Stroke XJ	Add Stroke ZB	Add Stroke ZC
10	4 3/4	9 1/16	4 3/4	19 1/16	13 3/8	16 11/32	22 9/16
	5 5/16	9 5/8	5 5/16	19 5/8	13 15/16	16 29/32	23 1/8
	5	9 5/16	5	19 5/16	13 5/8	16 19/32	22 13/16
	5	9 5/16	5	19 5/16	13 5/8	16 19/32	22 13/16
12	5 3/8	10 5/8	5 3/8	22 3/16	15 1/2	19 3/32	26 3/16
	6 3/16	11 1/2	6 3/16	23	16 5/16	19 29/32	27
	5 11/16	10 15/16	5 11/16	22 1/2	15 13/16	19 13/32	26 1/2
14	5 15/16	11 7/16	5 7/8	24 7/8	16 11/16	20 17/32	29 7/8
	6 15/16	12 7/16	6 7/8	25 7/8	17 11/16	21 17/32	30 7/8
	6 7/16	11 15/16	6 3/8	25 3/8	17 3/16	21 1/32	30 3/8
16	**	**	7	29 1/8	**	**	35 1/8
	**	**	7 1/4	29 3/8	**	**	35 3/8
	**	**	7 1/2	29 5/8	**	**	35 5/8
18	**	**	7 1/4	33	**	**	39 1/2
	**	**	7 1/2	33 1/4	**	**	39 3/4
20	**	**	7 1/2	36 7/8	**	**	44 3/8

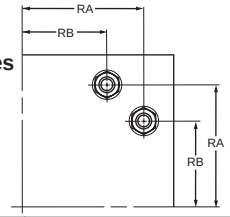
Table 4—Optional SAE Flange Port Pattern



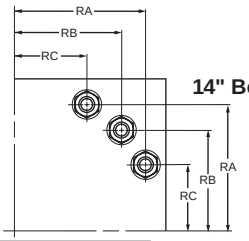
Nom. Flange Size	S.A.E. Flange Dash Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.
1 1/2	-24	1.50	2.750	1.406	1.38	0.70	1/2-13	1.06
2	-32	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06
2 1/2	-40	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19
3	-48	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19

Table 5—Tie Rod Information

10", 12" Bores



14" Bore



Bore	10	12	14	16	18	20
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	*	*	*

*Consult factory for dimensions

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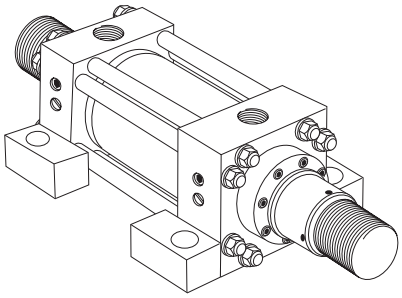
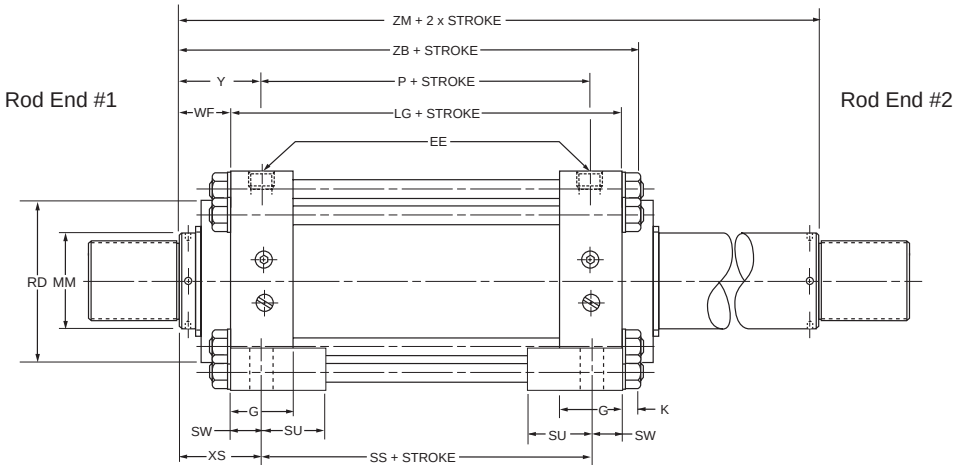
How to Use Double Rod Cylinder Dimensioned Drawings





Mounting Styles for Single Rod Models	Dimension Shown on This Page Supplement Dimensions on Pages Listed Below
NM3	36, 37
NM2	36, 37
NM1	36, 37
ME5	38, 39
IH3	38, 39
SL	40, 41
TM1	42, 43
TM3‡	42, 43

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

‡ Specify XI dimension from rod end #1.

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 at left.) 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. See port position information on page 60.

Bore	Rod Dia.	Add 2X Stroke ZM
10	4 1/2	18
	7	19 1/8
	5	18 1/2
	5 1/2	18 1/2
12	5 1/2	20 7/8
	8	22 1/2
	7	21 1/2
14	7	22 5/8
	10	24 5/8
	8	23 5/8
16	8	26 1/8
	9	26 5/8
	10	27 1/8
18	9	29 5/8
	10	30 1/8
20	10	32 5/8

Mounting Recommendations and Other Mountings

In addition to the standard mountings dimensioned on the preceding pages, the following information covers mounting ideas that may prove helpful in your applications. When needed, special heads, caps, and flanges can be provided. Sketches of your requirements, together with specifications relative to the application and forces involved should be submitted.

Mounting Bolts — High tensile socket head screws are recommended for all mounting styles. Use 1/16" smaller than hole size.

Flange Mountings — Cylinders can be properly centered by measuring from piston rod diameter. After mounting, the flange may be drilled for pins or dowels to prevent shifting.

Side Lug Mountings — Caution, cylinders which do not absorb force on their centerline (Group 3) tend to sway when under load. Short stroke, non-centerline mounted cylinders can subject mounting bolts to large tension forces which when combined with shear forces can overstress standard mounting bolts. Side lug mounted cylinders should always be prevented from shifting through use of shear keys so located as to resist the major load, whether push or pull.

Trunnion Mountings — Cylinders require lubricated pillow blocks with minimum bearing clearances. Pillow blocks should be carefully aligned and rigidly mounted so the trunnions will not be subjected to bending moments. The rod end connection should also be pivoted, with the customer's pin in the piston rod eye parallel to the trunnions.

Clevis Mountings — Cylinders should be pivoted at both ends, with the customer's pin in the piston rod eye parallel to the pivot pin supplied with the clevis.

Metallic Rod Wiper

When specified, metallic rod wipers can be supplied at extra cost, instead of the standard synthetic rubber wiperseal. Recommended in applications where atmospheric particles or splashings tend to cling to the extended piston rod and otherwise damage the synthetic rubber wiperseal. Installation of metallic rod wiper does not affect cylinder dimensions.

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

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Cost Saving Features and Benefits Include...

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

Alignment Coupler

See Table 1 for Part Numbers and Dimensions

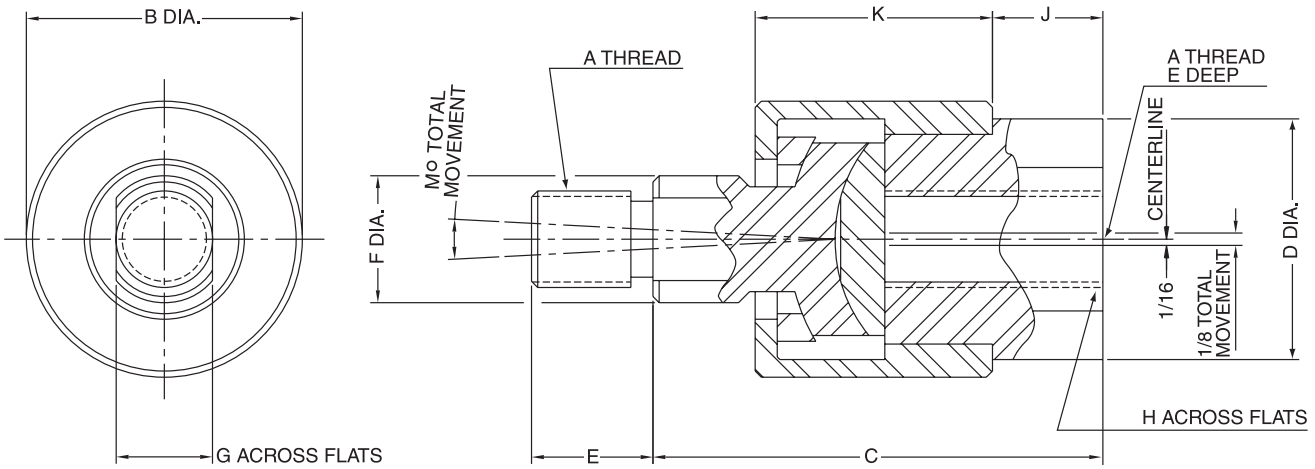

Table 1 — Part Numbers and Dimensions

Part No.	A	B	C	D	E	F	G	H	J	K	M	Max. Pull Load (lbs.)	Approx. Weight (lbs.)
RC-3-5	5/16-24	1 1/8	1 3/4	15/16	1/2	1/2	3/8	3/4	3/8	15/16	6°	1200	.35
RC-3-6	3/8-24	1 1/8	1 3/4	15/16	1/2	1/2	3/8	3/4	3/8	15/16	6°	2425	.35
RC-3-7	7/16-20	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	3250	.55
RC-3-8	1/2-20	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	4450	.55
RC-3-10	5/8-18	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	6800	.55
RC-3-12	3/4-16	2	2 5/16	1 5/8	1 1/8	15/16	3/4	1 5/16	7/16	1 9/32	6°	9050	1.4
RC-3-14	7/8-14	2	2 5/16	1 5/8	1 1/8	15/16	3/4	1 5/16	7/16	1 9/32	6°	14450	1.4
RC-3-16	1-14	3 1/8	3	2 3/8	1 5/8	1 7/16	1 1/4	1 7/8	3/4	1 25/32	6°	19425	4.8
RC-3-20	1 1/4-12	3 1/8	3	2 3/8	1 5/8	1 7/16	1 1/4	1 7/8	3/4	1 25/32	6°	30500	4.8
RC-2-24	1 1/2-12	4	4 3/8	2 1/4	2 1/4	1 3/4	1 1/2	1 15/16	7/8	2 3/4	10°	45750	9.8
RC-2-28	1 3/4-12	4	4 3/8	2 1/4	2 1/4	1 3/4	1 1/2	1 15/16	7/8	2 3/4	10°	58350	9.8
RC-2-30	1 7/8-12	5	5 5/8	3	3	2 1/4	1 15/16	2 5/8	1 3/8	3 3/8	10°	67550	19.8
RC-2-32	2-12	5	5 5/8	3	3	2 1/4	1 15/16	2 5/8	1 3/8	3 3/8	10°	77450	19.8
RC-2-36	2 1/4-12	6 3/4	6 3/8	3 1/4	3 1/2	2 3/4	2 3/8	2 7/8	1 5/8	3 3/4	10°	99250	35.3
RC-2-40	2 1/2-12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	123750	45.3
RC-2-44	2 3/4-12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	150950	45.3
RC-2-48	3-12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	180850	45.3
RC-2-52	3 1/4-12	9 1/4	8 1/2	5 1/4	4 1/2	4	3 3/8	4 1/2	2	5 1/2	10°	213450	–
RC-2-68	4 1/4-12	12 7/8	11 1/4	7 3/4	4 1/2	5 1/2	4 7/8	7	1 1/2	8 3/4	10°	370850	–

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

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Rod End Accessories

Accessories offered for the rod end of the cylinder include: Rod Clevis, Eye Bracket, Rod Eye, Clevis Bracket and Pivot Pin. To select the proper part number for any desired rod mounted accessory, refer to the table 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 pin diameter that fits their mating Rod Eyes or Clevises.

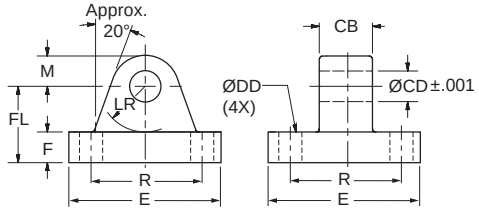
Accessory Load Capacity

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

Thread Size	Pin Ø	Rod Clevis		Mounting Plate or Eye Bracket Forged Steel or Cast Ductile Iron		Pivot Pin	
		Part Number[1]	Load Capacity (lb)	Part Number	Load Capacity (lb)	Part Number	Shear Capacity (lb)
7/16-20	0.500	JIC-40	4250	EB-195C[2]	4620	PP-368A	8600
1/2-20	0.500	JIC-41	4900	EB-195C[2]	4620	PP-368A	8600
3/4-16	0.750	JIC-42A	11200	EB-196C[2]	12370	PP-369A	19300
3/4-16	0.750	JIC-42	11200	EB-196C[2]	12370	PP-369A	19300
7/8-14	1.000	JIC-43A	18800	EB-197C[2]	20450	PP-370A	34300
1-14	1.000	JIC-44A	19500	EB-197C[2]	20450	PP-370A	34300
1-14	1.000	JIC-44	19500	EB-197C[2]	20450	PP-370A	34300
1 1/4-12	1.375	JIC-45A	33500	EB-198C[2]	33500	PP-371A	65000
1 1/4-12	1.375	JIC-45	33500	EB-198C[2]	33500	PP-371A	65000
1 1/2-12	1.750	JIC-46	45600	EB-199C[2]	49480	PP-372A	105200
1 3/4-12	2.000	JIC-47	65600	EB-200C[2]	70100	PP-373A	137400
1 7/8-12	2.000	JIC-48	65600	EB-200C[2]	70100	PP-373A	137400
2 1/4-12	2.500	JIC-49	98200	EB-201C[2]	98200	PP-374A	214700
2 1/2-12	3.000	JIC-50	98200	EB-202C[2]	121940	PP-375A	309200
2 3/4-12	3.000	JIC-51	98200	EB-202C[2]	121940	PP-375A	309200
3 1/4-12	3.500	JIC-52A	156700	EB-38C	187910	PP-545A	420900
3 1/2-12	4.000	JIC-53A	193200	EB-39C	268000	PP-547A	565800
4-12	4.000	JIC-54A	221200	EB-39C	268000	PP-547A	565800

[1] Part numbers for Rod Clevises include pin and keepers.
[2] Cylinder accessory dimensions conform to ANSI/NFPA/T3.6.8 R3-2010.

Forged Steel or Cast Ductile Iron Mounting Plate or Eye Bracket Dimensions[3]



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

Cast or Forged[5] Part Number	Pin Ø	CB	CD Ø	DD Ø	E (As Cast)	F	FL	LR	M (As Cast)	R
EB-195C	0.500	0.75	0.503	0.41	2.50	0.38	1.13	0.69	0.50	1.63
EB-196C	0.750	1.25	0.753	0.53	3.50	0.63	1.88	1.13	0.75	2.55
EB-197C	1.000	1.50	1.003	0.66	4.50	0.88	2.38	1.37	1.00	3.25
EB-198C	1.375	2.00	1.378	0.66	5.00	1.00[4]	3.00	1.88	1.38	3.82
EB-199C	1.750	2.50	1.753	0.91	6.50	1.25[4]	3.38	2.13	1.75	4.95
EB-200C	2.000	2.50	2.003	1.06	7.50	1.50	4.00	2.38	2.00	5.73
EB-201C	2.500	3.00	2.503	1.19	8.50	1.75	4.75	2.88	2.50	6.58
EB-202C	3.000	3.00	3.003	1.31	9.50	2.00	5.25	3.13	3.00	7.50
EB-38C	3.500	4.00	3.503	1.81	12.63	2.50[6]	6.50[6]	3.88	3.50	9.62
EB-39C	4.000	4.50	4.003	2.06	14.88	3.00[6]	7.50[6]	4.38	4.06	11.45

[3] When used to mate with the Rod Clevis, select by pin diameter in the table above.
[4] 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.
[5] Eye Brackets with pin diameters 0.500 thru 1.375 are forged steel. Eye Brackets with 1.750 pin diameter and larger are cast ductile iron.
[6] 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.

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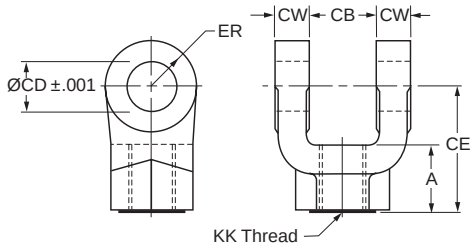
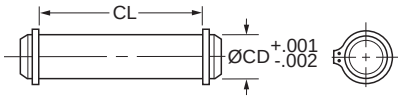
Rod Clevis Dimensions



Part Number[1,2]	Pin Ø	A	CB	CD Ø	CE	CW	ER	KK Thread
JIC-40	0.500	0.75	0.77	0.503	1.50	0.49	0.50	7/16-20
JIC-41	0.500	0.75	0.77	0.503	1.50	0.49	0.50	1/2-20
JIC-42A	0.750	1.13	1.27	0.753	2.13	0.62	0.75	3/4-16
JIC-42	0.750	1.13	1.27	0.753	2.38	0.62	0.75	3/4-16
JIC-43A	1.000	1.63	1.52	1.003	2.94	0.74	1.00	7/8-14
JIC-44A	1.000	1.63	1.52	1.003	2.94	0.74	1.00	1-14
JIC-44	1.000	1.63	1.52	1.003	3.13	0.74	1.00	1-14
JIC-45A	1.375	1.88	2.04	1.378	3.75	0.99	1.38	1 1/4-12
JIC-45	1.375	2.00	2.04	1.378	4.13	0.99	1.38	1 1/4-12
JIC-46	1.750	2.25	2.54	1.753	4.50	1.24	1.75	1 1/2-12
JIC-47	2.000	3.00	2.54	2.003	5.50	1.24	2.00	1 3/4-12
JIC-48	2.000	3.00	2.54	2.003	5.50	1.24	2.00	1 7/8-12
JIC-49	2.500	3.50	3.04	2.503	6.50	1.49	2.50	2 1/4-12
JIC-50	3.000	3.50	3.04	3.003	6.75	1.49	2.75	2 1/2-12
JIC-51	3.000	3.50	3.04	3.003	6.75	1.49	2.75	2 3/4-12
JIC-52A	3.500	3.50[3]	4.04	3.503	7.75	1.98	3.50	3 1/4-12
JIC-53A	4.000	4.00[3]	4.54	4.003	8.81	2.23	4.00	3 1/2-12
JIC-54A	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] Part numbers for Rod Clevises include pin and keepers.
[3] Consult appropriate cylinder rod end dimensions for compatibility.

Pivot Pin Dimensions



Part Number	CD Ø	CL
PP-368A	0.500	1.88
PP-369A	0.750	2.63
PP-370A	1.000	3.13
PP-371A	1.375	4.19
PP-372A	1.750	5.19
PP-373A	2.000	5.19
PP-374A	2.500	6.19
PP-375A	3.000	6.25
PP-545A	3.500	8.25
PP-547A[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 Rod Eyes, Rod Clevises, or Clevis Brackets.

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Rod End Accessories

Accessories offered for the rod end of the cylinder include Rod Clevis, Eye Bracket, Rod Eye, Clevis Bracket, and Pivot Pin. To select the proper part number for any rod mounted accessory, refer to the table below and look in the row to the right of the rod thread in the first column. The Pivot Pins, Eye Brackets and Clevis Brackets are listed opposite the pin diameter that fits their mating Rod Eyes or Clevises.

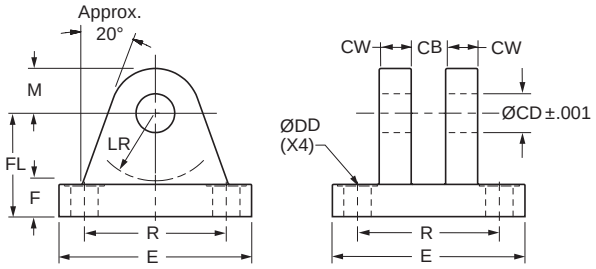
Accessory Load Capacity

The various accessories have been load rated for your convenience. The load capacity, shown in the table below, 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	Rod Eye		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)		
7/16-20	0.500	REE-89	5000	CB-205C	7740	CB-205	7300	PP-368A	8600
1/2-20	0.500	REE-90	5700	CB-205C	7740	CB-205	7300	PP-368A	8600
3/4-16	0.750	REE-91	12100	CB-206C	13600	CB-206	10880	PP-369A	19300
7/8-14	1.000	REE-92	13000	CB-207C	23000	CB-207	15180	PP-370A	34300
1-14	1.000	REE-93	21700	CB-207C	23000	CB-207	15180	PP-370A	34300
1 1/4-12	1.375	REE-94	33500	CB-208C	39500	CB-208	23560	PP-371A	65000
1 1/2-12	1.750	REE-95	45000	CB-209C	49480	CB-209	21520	PP-372A	105200
1 3/4-12	2.000	REE-96	53500	CB-210C	72400	CB-210	26000	PP-215A	137400
1 7/8-12	2.000	REE-97W	75000	CB-210C	72400	CB-210	26000	PP-215A	137400
2 1/4-12	2.500	REE-98W	98700	CB-211C	98700	CB-211	28710	PP-374A	214700
2 1/2-12	3.000	REE-99W	110000	CB-212C	123300	CB-212	28190	PP-375A	309200
2 3/4-12	3.000	REE-100W	123300	CB-213C	N/A	CB-213	31390	PP-216A	309200
3 1/4-12	3.500	REE-36W	161300	CB-242C	200400	CB-242	80250	PP-545A	420900
3 1/2-12	3.500	REE-37W	217300	CB-242C	200400	CB-242	80250	PP-545A	420900
4-12	4.000	REE-38W	273800	CB-243C	292100	CB-243	98420	PP-547A[1]	565800

[1] This size supplied with cotter pins.

Forged Steel or Cast Ductile Iron Clevis Bracket Dimensions



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

Cast or Forged[2,3] Part Number	Pin Ø	CB	CD Ø	CW	DD Ø	E (As Cast)	F	FL	LR	M (As Cast)	R
CB-205C	0.500	0.78	0.503	0.50	0.41	2.50	0.38	1.13	0.63	0.56	1.63
CB-206C	0.750	1.28	0.753	0.63	0.53	3.50	0.63	1.88	1.06	0.75	2.56
CB-207C	1.000	1.53	1.003	0.75	0.66	4.50	0.75	2.25	1.25	1.00	3.25
CB-208C	1.375	2.03	1.378	1.00	0.66	5.00	0.88	3.00	1.94	1.38	3.81
CB-209C	1.750	2.53	1.753	1.25	0.91	6.50	0.94	3.13	2.00	1.75	4.94
CB-210C	2.000	2.53	2.003	1.25	1.06	7.50	1.38	3.75	2.25	2.00	5.75
CB-211C	2.500	3.03	2.503	1.50	1.19	8.50	1.50	4.50	2.81	2.50	6.59
CB-212C	3.000	3.03	3.003	1.50	1.31	9.50	1.88	5.38	3.31	3.00	7.50
CB-242C	3.500	4.03	3.503	2.00	1.81	12.63	2.31	6.38	3.88	3.50	9.62
CB-243C	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 1.750 pin diameter and larger are cast ductile iron.
[3] Part numbers for Clevis Brackets include pin and keepers.

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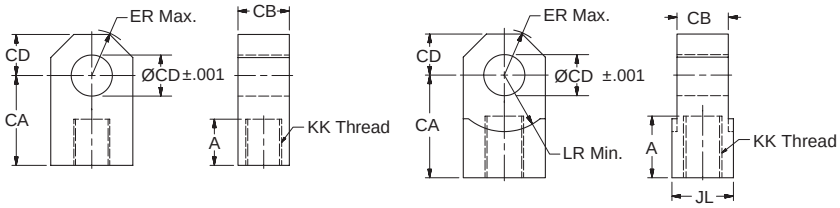
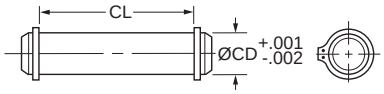
Female Rod Eye Dimensions



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
REE-89	0.500	0.75	1.50	0.75	0.503	0.59	–	–	7/16-20
REE-90	0.500	0.75	1.50	0.75	0.503	0.59	–	–	1/2-20
REE-91	0.750	1.13	2.06	1.25	0.753	0.87	–	–	3/4-16
REE-92	1.000	1.13	2.38	1.50	1.003	1.15	–	–	7/8-14
REE-93	1.000	1.63	2.81	1.50	1.003	1.15	–	–	1-14
REE-94	1.375	2.00	3.44	2.00	1.378	1.55	–	–	1 1/4-12
REE-95	1.750	2.25	4.00	2.50	1.753	1.96	–	–	1 1/2-12
REE-96	2.000	2.25	4.38	2.50	2.003	2.24	–	–	1 3/4-12
REE-97W	2.000	3.00	5.00	2.50	2.003	2.24	3.00	2.77	1 7/8-12
REE-98W	2.500	3.50	5.81	3.00	2.503	2.76	3.50	3.09	2 1/4-12
REE-99W	3.000	3.50	6.13	3.00	3.003	3.30	4.00	3.58	2 1/2-12
REE-100W	3.000	3.63	6.50	3.50	3.003	3.30	4.00	3.58	2 3/4-12
REE-36W	3.500	4.50	7.63	4.00	3.503	3.87	6.00	4.18	3 1/4-12
REE-37W	3.500	5.00	7.63	4.00	3.503	3.87	6.00	4.18	3 1/2-12
REE-38W	4.000	5.50	9.13	4.50	4.003	4.43	6.00	4.80	4-12

Pivot Pin Dimensions

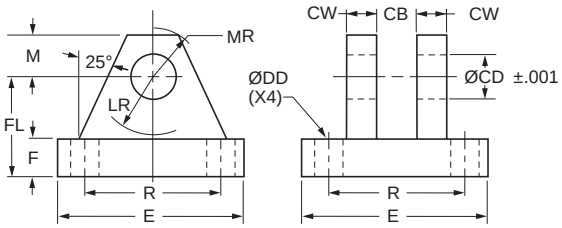


Part Number	CD Ø	CL
PP-368A	0.500	1.88
PP-369A	0.750	2.63
PP-370A	1.000	3.13
PP-371A	1.375	4.19
PP-372A	1.750	5.19
PP-215A	2.000	5.69
PP-374A	2.500	6.19
PP-375A	3.000	6.25
PP-216A	3.000	6.75
PP-545A	3.500	8.25
PP-547A[1]	4.000	9.00

[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 Rod Eyes, Rod Clevises, or Clevis Brackets.

Fabricated Steel Clevis Bracket Dimensions



Fabricated Steel Part Number[2]	Pin Ø	CB	CD Ø	CW	DD Ø	E	F	FL	LR	M	MR	R
CB-205	0.500	0.80	0.503	0.50	0.41	3.50	0.50	1.50	0.75	0.50	0.63	2.55
CB-206	0.750	1.30	0.753	0.63	0.53	5.00	0.63	1.88	1.19	0.75	0.91	3.82
CB-207	1.000	1.59	1.003	0.75	0.66	6.50	0.75	2.25	1.50	1.00	1.25	4.95
CB-208	1.375	2.09	1.378	1.00	0.66	7.50	0.88	3.00	2.00	1.38	1.66	5.73
CB-209	1.750	2.59	1.753	1.25	0.91	9.50	0.88	3.63	2.75	1.75	2.22	7.50
CB-210	2.000	2.59	2.003	1.50	1.06	12.75	1.00	4.25	3.19	2.25	2.78	9.40
CB-211	2.500	3.09	2.503	1.50	1.19	12.75	1.00	4.50	3.50	2.50	3.13	9.40
CB-212	3.000	3.09	3.003	1.50	1.31	12.75	1.00	6.00	4.25	3.00	3.59	9.40
CB-213	3.000	3.59	3.003	1.50	1.31	12.75	1.00	6.00	4.25	3.00	3.59	9.40
CB-242	3.500	4.09	3.503	2.00	1.81	15.50	1.69	6.69	5.00	3.50	4.13	12.00
CB-243	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] Part numbers for Clevis Brackets include pin and keepers.

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Dual Axis Knuckle

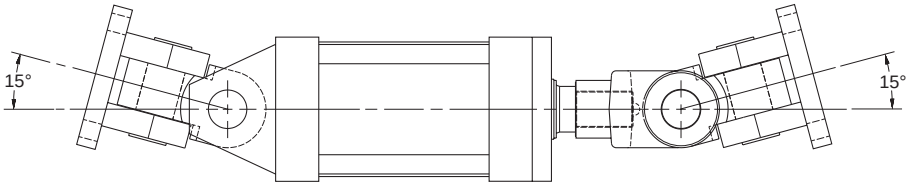
Using a Dual Axis Knuckle permits increased angular movement from the cylinder center line. Clevis or Eye mounted cylinders often require movement beyond the plane that two pivot pins allow. Spherical bearing mounts permit angular movement up to 4.5° within the pivoting plane. A Dual Axis Knuckle, with two pin holes 90° apart, installed at the cap and rod end of a mounting style PB2 cylinder adds two pivot points, thereby providing up to 30° movement in another plane at each end.

Dual Axis Knuckle Benefits

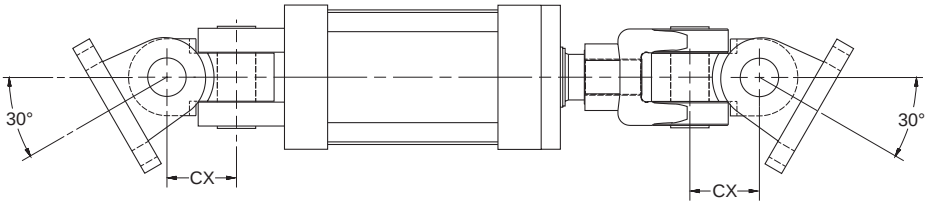
- Increased angular movement range compared to spherical bearing mount.
- Significantly higher dynamic load rating than spherical bearing mount.
- Reduced bearing loads and wear that results from misalignment.
- Allows faster assembly of pivoting cylinders to the machine.

Maximum Achievable Angular Movement from Cylinder Centerline*

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

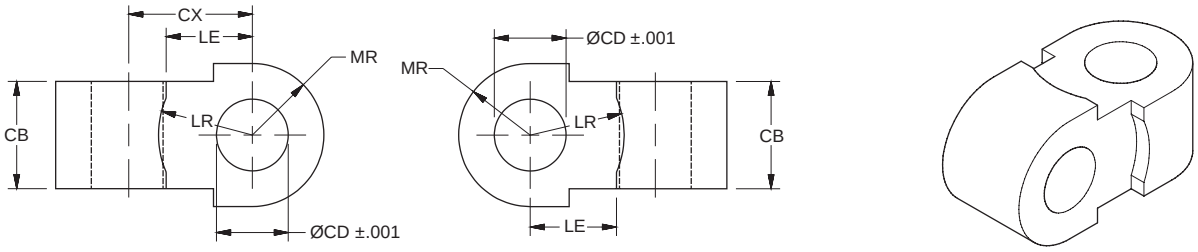


Outboard Pin -
30° maximum movement when applying force to a load moving in a curved plane.



*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 Capacity (lb)	CB	CD Ø	CX	LE	LR	MR	Mating Parts		PB2 Mount Usage by Series & Bore	
									Clevis Bracket	Rod Clevis	A & L	H
0952670000	0.500	4380	0.75	0.503	0.88	0.54	0.63	0.50	CB-205C	JIC-40, JIC-41	1.50, 2.00, 2.50	1.50
0952680000	0.750	12370	1.25	0.753	1.19	0.80	0.94	0.75	CB-206C	JIC-42, JIC-42A	3.25, 4.00, 5.00	2.00, 2.50
0952690000	1.000	20500	1.50	1.003	1.69	1.05	1.22	1.00	CB-207C	JIC-43, JIC-44, JIC-44A	6.00, 7.00, 8.00	3.25
0952700000	1.375	30500	2.00	1.378	2.38	1.44	1.69	1.38	CB-208C	JIC-45, JIC-45A	10.00	4.00
0952710000	1.750	49500	2.50	1.753	3.06	1.81	2.19	1.75	CB-209C	JIC-46	12.00	5.00
0952720000	2.000	68000	2.50	2.003	3.63	2.09	2.44	2.00	CB-210C	JIC-47, JIC-48	14.00	6.00

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Spherical Bearings for Series H Cylinders

Spherical Bearing Mount That Maintains Alignment Through Push and Pull Strokes.

Benefits Are...

- Simplify installation of cylinder
- Reduce cylinder friction
- Eliminate side loading in hard to align applications
- Increase cylinder life by reducing wear on piston and rod bearings
- Save assembly time
- Maintain alignment through push and pull strokes
- Increase rod bearing and rod seal life
- Simplify machine design problems

Series H hydraulic cylinders are available with spherical bearing mounts at both ends or head and cap end only. The bearing at the cap end is housed in a single stud ear welded to the cap to form an integral structure. At the head end the bearing is mounted in a steel rod eye threaded to the piston rod. Grease fittings are provided for lubrication.

The spherical bearing mount provides swivel connections at both ends of the cylinder to reduce misalignment problems and to maintain alignment through push and pull strokes.

The bearing races are designed primarily for radial loads and moderate misalignment not to exceed angle "**a**" as shown in Table 1 on the next page.

The accessories, rod eye, pivot pin and clevis brackets are all designed to take maximum loading of the cylinder.

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Application and Design Data

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

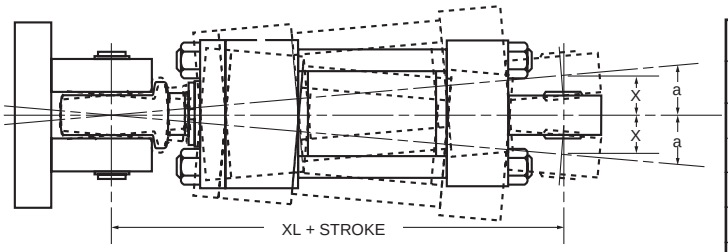
The spherical bearings are dimensioned to ensure a satisfactory bearing life under normal operating conditions. The bearing races are made of through-hardened steel and are precision ground. They are phosphate treated and coated with dry film lubricant to minimize friction of contacting surfaces. In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

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

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

Mounting Information

Head End Mounting



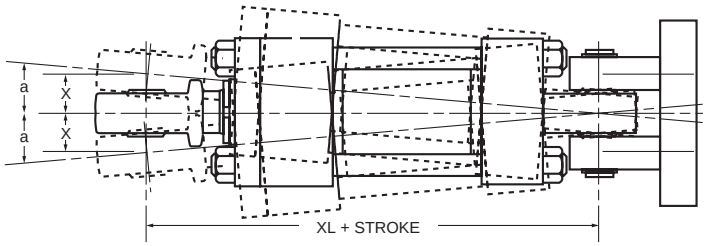
Recommended maximum swivel angle on each side of the cylinder centerline.

Table 1

	Head End Mounted		Cap End Mounted	
Bore	**Angle a**	**Tan. of a**	**Angle a**	**Tan. of a**
1½	2°	.035	2°	.035
2	2½°	.044	4½°	.079
2½	2½°	.044	4½°	.079
3¼	3°	.052	3°	.052
4	2½°	.044	3°	.052
5	3°	.052	3°	.052
6	3°	.052	3°	.052

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

Cap End Mounting



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Cap Fixed Eye Mount with Spherical Bearing Style SA

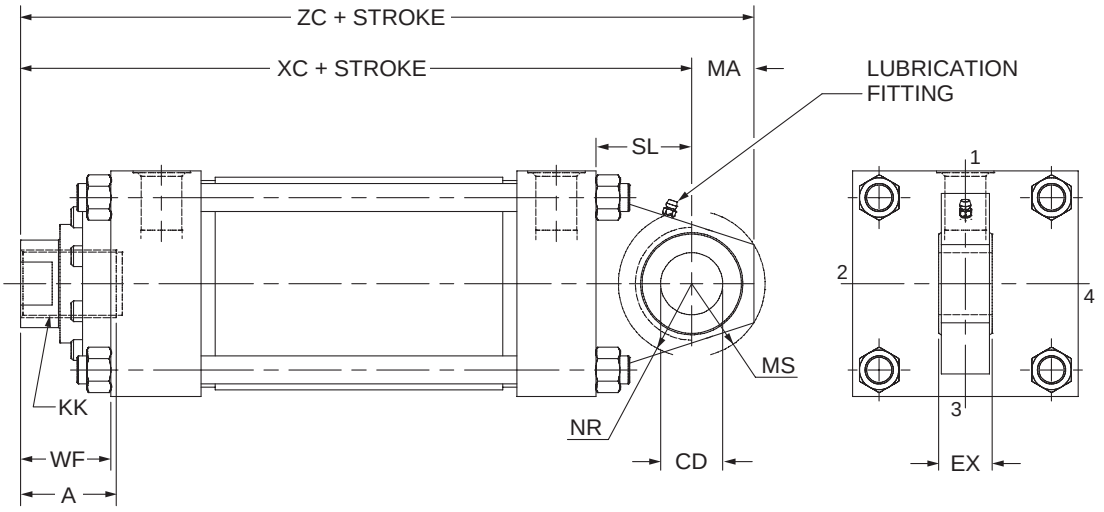

Table 1 — Dimensions

Bore	Rod Dia. MM	Thread** Style 3 KK	A	WF	Add Stroke XC	Add Stroke ZC	CD*	EX	MA	MS	NR	SL	Max. Oper. PSI†
1½	⅝	7/16-20	¾	1	6⅜	7⅛	.5000 -.0005	7/16	¾	15/16	⅝	¾	1500
	1	¾-16	1⅛	1⅜	6¾	7½							
2	1	¾-16	1⅛	1⅜	7¼	8¼	.7500 -.0005	21/32	1	1⅜	1	1¼	2200
	1⅜	1-14	1⅝	1⅝	7½	8½							
2½	1	¾-16	1⅛	1⅜	7⅜	8⅜	.7500 -.0005	21/32	1	1⅜	1	1¼	1450
	1¾	1¼-12	2	1⅞	7⅞	8⅞							
	1⅜	1-14	1⅝	1⅝	7⅝	8⅝							
3¼	1⅜	1-14	1⅝	1⅝	8⅝	9⅞	1.0000 -.0005	⅞	1¼	1 11/16	1¼	1½	1500
	2	1½-12	2¼	2	9	10¼							
	1¾	1¼-12	2	1⅞	8⅞	10⅛							
4	1¾	1¼-12	2	1⅞	9¾	11⅝	1.3750 -.0005	1 3/16	1⅞	2 7/16	1⅝	2⅛	1850
	2½	1⅞-12	3	2¼	10⅛	12							
	2	1½-12	2¼	2	9⅞	11¾							
5	2	1½-12	2¼	2	10½	13	1.7500 -.0005	1 17/32	2½	2⅞	2 1/16	2¼	2000
	3½	2½-12	3½	2¼	10¾	13¼							
	2½	1⅞-12	3	2¼	10¾	13¼							
	3	2¼-12	3½	2¼	10¾	13¼							
6	2½	1⅞-12	3	2¼	12⅛	14⅝	2.0000 -.0005	1¾	2½	3 5/16	2⅜	2½	1800
	4	3-12	4	2¼	12⅛	14⅝							
	3	2¼-12	3½	2¼	12⅛	14⅝							
	3½	2½-12	3½	2¼	12⅛	14⅝							

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

* Dimension “CD” is hole diameter.

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

Atlas Cylinders 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.

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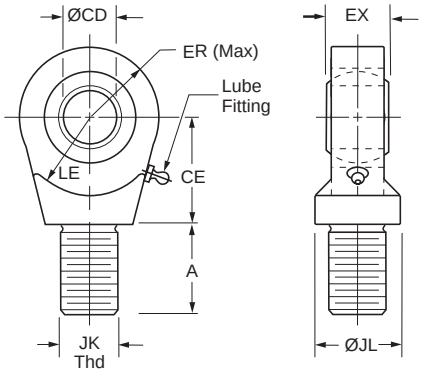
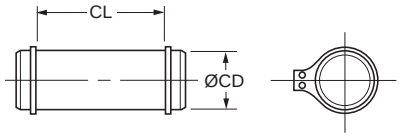
Spherical Rod Eye Dimensions



Bore Ø	Part Number	CD Ø	A	CE	EX	ER	LE	JK Thread	JL Ø	Load Capacity (lb)
1.50	SB-1	.5000-0005	0.72	0.86	0.44	0.80	0.78	7/16-20	0.88	2644
2.00 & 2.50	SB-2	.7500-0005	1.02	1.25	0.66	1.14	1.06	3/4-16	1.31	9441
3.25	SB-3	1.0000-0005	1.52	1.88	0.88	1.34	1.45	1-14	1.50	16860
4.00	SB-4	1.3750-0005	2.02	2.13	1.19	1.67	1.91	1 1/4-12	2.00	28562
5.00	SB-5	1.7500-0005	2.14	2.50	1.53	2.05	2.16	1 1/2-12	2.00	43005
6.00	SB-6	2.0000-0005	2.89	2.75	1.75	2.60	2.50	1 7/8-12	2.75	70193

Order to fit Piston Rod Thread Size.

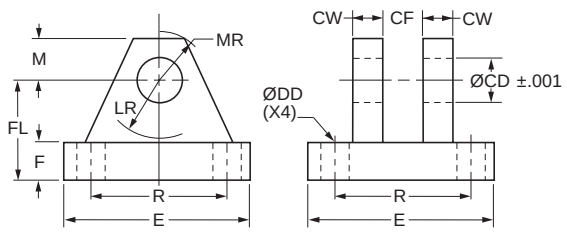
Pivot Pin Dimensions



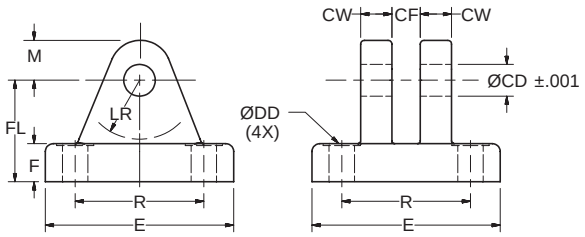
Bore Ø	Part Number	CD Ø	CL	Shear Capacity (lb)
1.50	PP-616	.4997-0004	1.56	8600
2.00 & 2.50	PP-624	.7497-0005	2.03	19300
3.25	PP-632	.9997-0005	2.50	34300
4.00	PP-644	1.3746-0006	3.31	65000
5.00	PP-656	1.7496-0006	4.22	105200
6.00	PP-664	1.9996-0007	4.94	137400

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[1]	Fabricated Steel Part Number[1]	CD Ø	CF	CW	DD Ø	E	F	FL	LR	M	MR	R	Load Capacity (lb)
1.50	0.500	SAB-1C	SAB-1	0.503	0.45	0.50	0.41	3.00	0.50	1.50	0.94	0.50	0.63	2.05	5770
2.00 & 2.50	0.750	SAB-2C	SAB-2	0.753	0.67	0.63	0.53	3.75	0.63	2.00	1.38	0.88	1.00	2.76	9450
3.25	1.000	SAB-3C	SAB-3	1.003	0.89	0.75	0.53	5.50	0.75	2.50	1.69	1.00	1.19	4.10	14300
4.00	1.375	SAB-4C	SAB-4	1.378	1.20	1 .00	0.66	6.50	0.88	3.50	2.44	1.38	1.63	4.95	20322
5.00	1.750	SAB-5C	SAB-5	1.753	1.55	1.25	0.91	8.50	1.25	4.50	2.88	1.75	2.06	6.58	37800
6.00	2.000	SAB-6C	SAB-6	2.003	1.77	1.50	0.91	10.63	1.50	5.00	3.00	2.00	2.38	7.92	50375

[1] Part numbers for Clevis Brackets include pin and keepers.

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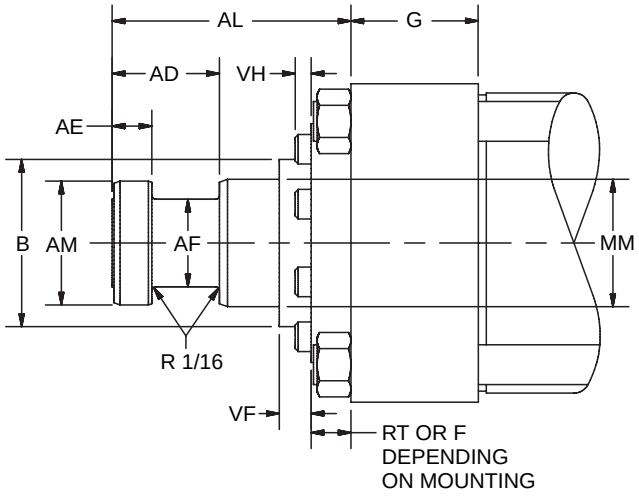
Atlas "Style 5" Piston Rod End

Split Flange Coupling Rod End

- Simplifies alignment
- Reduces assembly time
- Allows full rated hydraulic pressure in push and pull directions
- Available in 5/8" through 10" piston rod diameters

Style 5 Rod End



Dimensions Style 5 Rod End

MM Rod Dia.	AD	AE	AF	AM	AL
5/8	5/8	1/4	3/8	.57	1 3/4
1	15/16	3/8	11/16	.95	2 1/2
1 3/8	1 1/16	3/8	7/8	1.32	2 3/4
1 3/4	1 5/16	1/2	1 1/8	1.70	3 1/8
2	1 11/16	5/8	1 3/8	1.95	3 3/4
2 1/2	1 15/16	3/4	1 3/4	2.45	4 1/2
3	2 7/16	7/8	2 1/4	2.95	4 7/8
3 1/2	2 11/16	1	2 1/2	3.45	5 5/8
4	2 11/16	1	3	3.95	5 3/4
4 1/2	3 3/16	1 1/2	3 1/2	4.45	6 1/2
5	3 3/16	1 1/2	3 7/8	4.95	6 5/8*
5 1/2	3 15/16	1 7/8	4 3/8	5.45	7 1/2**
7	4 1/16	2	5 3/4	6.95	8 11/16
8	4 1/16	2	6 1/2	7.95	8 15/16
9	4 5/8	2 3/8	7 1/4	8.95	9 3/16
10	4 5/8	2 3/8	8	9.95	9 3/16

* AL = 7 5/16 for 5" diameter rod in 10" bore.
** AL = 8 7/16 for 5 1/2" diameter rod in 10" and 12" bores.
See previous catalog pages for B, F, G, RT, VF and VH per bore and rod diameter.

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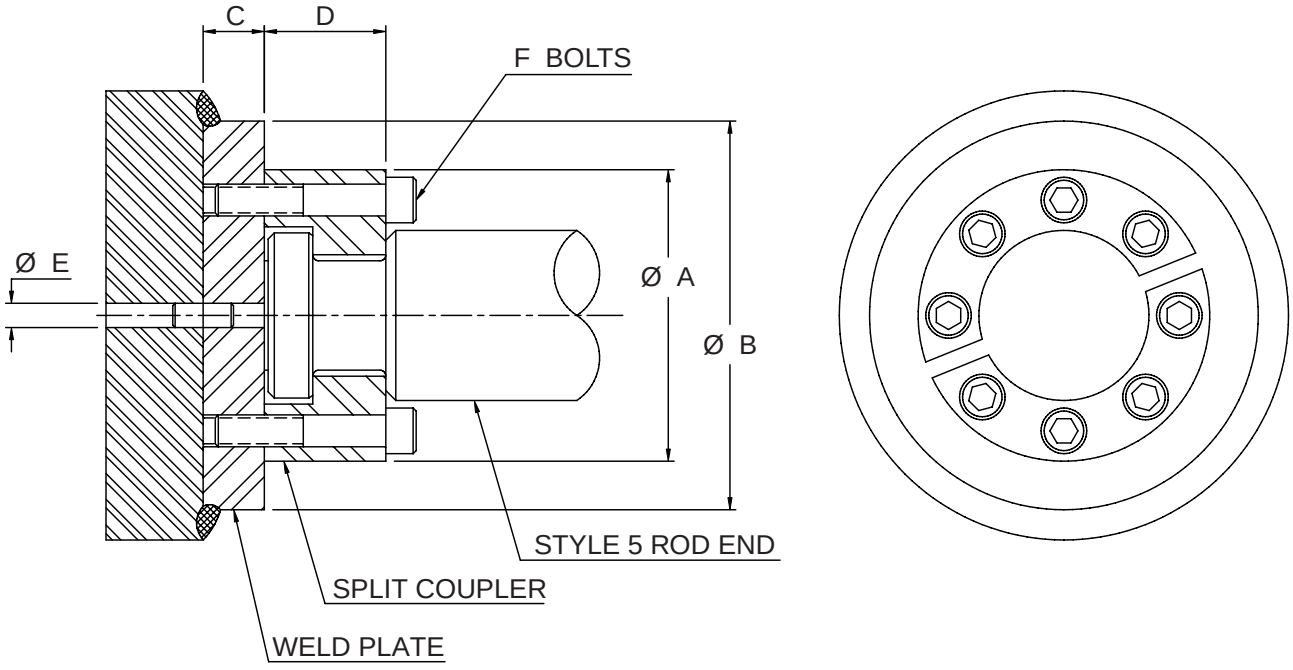
"Style 5" Piston Rod End

Split Couplers and Weld Plates



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

Table 1 — Part Numbers and Dimensions

ROD DIA.	A	B	C	D	E	F	BOLT SIZE	SPLIT COUPLER PART NO.	WELD PLATE PART NO.
5/8	1.50	2.00	.50	.56	.250	4	#10-24 x .94 LG	SC-062	WP-062
1	2.00	2.50	.50	.88	.250	6	.250-20 x 1.25 LG	SC-100	WP-100
1 3/8	2.50	3.00	.63	1.00	.250	6	.312-18 x 1.50 LG	SC-138	WP-138
1 3/4	3.00	4.00	.63	1.25	.250	8	.312-18 x 1.75 LG	SC-175	WP-175
2	3.50	4.00	.75	1.63	.375	12	.375-16 x 2.25 LG	SC-200	WP-200
2 1/2	4.00	4.50	.75	1.88	.375	12	.375-16 x 2.50 LG	SC-250	WP-250
3	5.00	5.50	1.00	2.38	.375	12	.500-13 x 3.25 LG	SC-300	WP-300
3 1/2	5.88	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	SC-350	WP-350
4	6.38	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	SC-400	WP-400
4 1/2	6.88	8.00	1.00	3.13	.375	12	.625-11 x 4.00 LG	SC-450	WP-450
5	7.38	8.00	1.00	3.13	.375	12	.625-11 x 4.00 LG	SC-500	WP-500
5 1/2	8.25	9.00	1.25	3.88	.375	12	.750-10 x 5.00 LG	SC-550	WP-550
7	10.38	11.00	1.75	4.00	.500	12	1.00-8 x 5.50 LG	SC-700	WP-700
8	11.38	12.00	2.00	4.00	.500	16	1.00-8 x 5.50 LG	SC-800	WP-800
9	13.12	14.00	2.25	4.00	.500	12	1.25-7 x 6.00 LG	SC-900	WP-900
10	14.12	15.00	2.50	4.50	.500	16	1.25-7 x 6.50 LG	SC-1000	WP-1000

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

Push and Pull Forces

Push Force and Displacement

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Cyl. Bore Size (Inches)	Piston Area (Sq. In.)	Cylinder Push Stroke Force In Pounds At Various Pressures										Displacement Per Inch Of Stroke (Gallons)
		25	50	65	80	100	250	500	1000	2000	3000	
1 1/2	1.767	44	88	115	142	177	443	885	1770	3540	5310	.00765
2	3.14	79	157	204	251	314	785	1570	3140	6280	9420	.0136
2 1/2	4.91	123	245	319	393	491	1228	2455	4910	9820	14730	.0213
3 1/4	8.30	208	415	540	664	830	2075	4150	8300	16600	24900	.0359
4	12.57	314	628	817	1006	1257	3143	6285	12570	25140	37710	.0544
5	19.64	491	982	1277	1571	1964	4910	9820	19640	39280	58920	.0850
6	28.27	707	1414	1838	2262	2827	7068	14135	28270	56540	84810	.1224
7	38.49	962	1924	2502	3079	3849	9623	19245	38490	76980	115470	.1666
8	50.27	1257	2513	3268	4022	5027	12568	25135	50270	100540	150810	.2176
10	78.54	1964	3927	5105	6283	7854	19635	39270	78540	157080	235620	.3400
12	113.10	2828	5655	7352	9048	11310	28275	56550	113100	226200	339300	.4896
14	153.94	3849	7697	10006	12315	15394	38485	76970	153940	307880	461820	.6664
16	201.06	5027	10053	13069	16085	20106	50265	100530	201060	402120	603180	.8704
18	254.47	6362	12724	16541	20358	25447	63618	127235	254470	508940	763410	1.1016
20	314.16	7854	15708	20420	25133	31416	78540	157080	314160	628320	942480	1.3600

Deductions for Pull Force and Displacement

Piston Rod Dia. (Inches)	Piston Area (Sq. In.)	Piston Rod Diameter Force In Pounds At Various Pressures To determine Cylinder Pull Force or Displacement, deduct the following Force or Displacement corresponding to Rod Size, from selected Push Stroke Force or Displacement corresponding to Bore Size in table above.										Displacement Per Inch Of Stroke (Gallons)
		25	50	65	80	100	250	500	1000	2000	3000	
5/8	.307	8	15	20	25	31	77	154	307	614	921	.0013
1	.785	20	39	51	65	79	196	392	785	1570	2355	.0034
1 3/8	1.49	37	75	97	119	149	373	745	1490	2980	4470	.0065
1 3/4	2.41	60	121	157	193	241	603	1205	2410	4820	7230	.0104
2	3.14	79	157	204	251	314	785	1570	3140	6280	9420	.0136
2 1/2	4.91	123	245	319	393	491	1228	2455	4910	9820	14730	.0213
3	7.07	177	354	460	566	707	1767	3535	7070	14140	21210	.0306
3 1/2	9.62	241	481	625	770	962	2405	4810	9620	19240	28860	.0416
4	12.57	314	628	817	1006	1257	3143	6285	12570	25140	37710	.0544
4 1/2	15.90	398	795	1034	1272	1590	3976	7952	15904	31808	47712	.0688
5	19.64	491	982	1277	1571	1964	4910	9820	19640	39280	58920	.0850
5 1/2	23.76	594	1188	1544	1901	2376	5940	11880	23760	47520	71280	.1028
7	38.49	962	1924	2502	3079	3849	9621	19243	38485	76970	115455	.1666
8	50.27	1257	2513	3267	4021	5027	12566	25133	50265	100530	150795	.2176
9	63.62	1590	3181	4135	5089	6362	15904	31809	63617	127234	190851	.2754
10	78.53	1964	3927	5105	6283	7854	19635	39270	78540	157080	235620	.3400

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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Operating Fluids and Temperature Range

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

Class 1 Seals

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

Class 2 (Nitrile) Seals

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 compatible with Class 2 seals are: Water, Water-Glycol, Water-in Emulsion, Houghto-Safe 27, 620 5040, Mobil Pyrogard D, Shell Irus 905, Ucon Hydrolube J-4. Class 2 seals are nitrile. Lipseal will have polymyte or PTFE back-up washer when required. O-rings will have nitrile back-up washers when required.

Class 3 Seals — Ethylene Propylene (E.P.R.) 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 Class 3 seals are Skydrol 500 and 700. Class 3 seals are Ethylene Propylene. Lipseals will have a PTFE back-up washer when required. O-rings will have EPR back-up washers when required. Note: Class 3 seals are not compatible with mineral base hydraulic oil or greases. Even limited exposure to these fluids will cause severe swelling. PTFE back-up washer may not be suitable when used in a radiation environment.

Class 4 Seals — Nitrile Seals

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

Class 5 Seals — Fluorocarbon Seals

Class 5 seals are intended for elevated temperature service or for some Phosphate Ester Fluids such as Houghto-Safe 1010, 1055, 1120; Fyrquel 150, 220, 300, 350; Mobil Pyrogard 42, 43, 53, and 55. Note: In addition, Class 5 seals can be used with fluids listed below under Class 1 or Class 2 service. However, they are not compatible with Phosphate Ester Fluids such as Skydrols. Class 5 seals can operate with a temperature range of -10°F (-23°C) to +250°F (+121°C). Fluorocarbon seals may be operated to +400°F (+204°C) with limited service life. For temperatures above +250°F (-121°C) the cylinder must be manufactured with non-studded piston rod thread and a pinned piston to rod connection. Class 5 seals are fluorocarbon seals. Lipseals will have PTFE back-up washers. O-rings will have fluorocarbon back-up when required.

Class 6 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. Lipseals will have PTFE and or polymyte back-up washers when required. O-rings will have nitrile back-up washers when required. Because of the viscosity of these fluids, cylinders specified with Class 6 seals, will also be modified to have lipseal piston seals and straight cushions.

Class 8 Seals – Spring Loaded PTFE Seals

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

Hi-Load Seals

Hi-Load seals consist of one or two filled PTFE dynamic piston seals with an elastomer expander underneath. Hi-Load piston arrangement normally consists of a wear ring on each end of the piston with the seals in the middle. These types of seals are virtually leak free seals under static conditions and can tolerate high pressure. The wear rings on the piston can also tolerate high side loads. The dynamic portion of the seal is bronze filled PTFE and compatible with all six classes of service. However, carbon filled PTFE will provide better seal life when used with Class 6 fluids. A nitrile expander will be provided unless Class 3 or 5 seals are specified. In those cases the expander will be of EPR or Fluorocarbon respectively. Note: It may be necessary to cycle the piston seals 40 or 50 times before achieving leakage free performance.

Lipseal Pistons

Lipseals with a back-up washers are standard in Series H cylinders and are often used for hydraulic applications when virtually zero static leakage is required. Lipseals will function properly in these applications when used in conjunction with moderate hydraulic pressures. A high load piston option is recommended when operating at high pressures and especially with large bore hydraulic cylinders.

Warning!

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

Low Friction Hydraulic Seals

Low Friction hydraulic seals are available as an option for both piston and piston rod seals for Series H cylinders. They are sometimes used when a cylinder is controlled by servo or proportional valve. The seal assembly itself is a two piece assembly consisting of a filled PTFE dynamic seal with an elastomer expander. A piston seal assembly consists of one seal assembly in the middle of the piston with a filled PTFE wear ring on each side of the piston. The piston rod seal assembly consists of two seal assemblies and an elastomer wiper seal. The filled PTFE seals are compatible with Class 1, 2, 3, 4 & 5 fluids and provide virtually leak free sealing. The expanders and rod wiper will be nitrile unless Class 3 or 5 seals are specified. In those cases the expanders and wiper will be EPR and fluorocarbon respectively. When specifying low friction seals specify if piston, piston rod seals or both are required. Note: It may be necessary to cycle these seals 40 or 50 times before achieving leakage free performance.

Cast Iron Piston Rings

Cast iron rings are optional piston seals for Series H cylinders. They offer the widest operating conditions by tolerating high operating pressures, wide temperature range and are compatible with most fluids. The only drawback of cast iron rings is that they allow a small amount of leakage. The leakage for a 4" bore cylinder, operating at 2000 psi, with mineral base hydraulic fluid will be less than 10in.^{3}/min. Leakage will increase as pressure, bore size and viscosity of the operating hydraulic fluid increases. For these reasons cast iron rings are not recommended when using water or Class 6 fluids.

Water Service

Series H hydraulic cylinders can be modified for water operation and supplied with chrome-plated cylinder bore; electroless nickel-plated head, cap and piston; chrome-plated precipitation hardened stainless steel piston rod, chrome-plated cushion plungers. When high water base fluids are the operating medium, hydraulic cylinders are usually supplied with high water base rod wiper and seals. Water and high water base fluid operated cylinders are best used on short stroke applications or where high pressure is applied only to clamp the load.

Warranty

Atlas 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.

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: Class 3 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: Class 5 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 Fryquel 150, 220, 300, 550 Mobil Pyrogard 42,43,53,55	See above 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) Spring Loaded PTFE	See Class 5 Seals	-15°F (-26°C) to 400°F (204°C)

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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 Series H 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 Size (Inches)	Rod Diameter (Inches)	4:1* Design Factor (Tensile)(PSI)	Heavy-Duty Service (PSI)
1 1/2	5/8	2530	3000
2	1	2950	3000
2 1/2	1	2340	3000
3 1/4	1 3/8	2250	3000
4	1 3/4	2130	3000
5	2	2170	3000
6	2 1/2	2270	3000
7	3	2030	3000
8	3 1/2	2040	3000
10	4 1/2	2720	3000
12	5 1/2	2580	3000
14	7	2320	3000
16	8	2750	3000
18	9	2900	3000
20	10	2640	3000

* Applies to all mountings except Styles REF1, REF2, BEF2, TM1, TM2, TM3.

Rod End Style 3 Minimum Stroke

Sufficient clearance must exist between machining for female rod end style 3 and the threaded piston-to-rod connection. This clearance is required to maintain pressure envelope integrity and envelope ratings shown above.

To maintain the required clearance, a minimum stroke is required for some bore and rod combinations. See the table below for minimum stroke requirements. Contact the factory when a style 3 rod end with a stroke shorter than shown in the table is required.

Bore	Rod Dia.	Minimum Stroke
1.50 - 4.00	All	None
5.00	2.000	None
	2.500	1.00
	3.000	1.38
	3.500	1.63
6.00	2.500	None
	3.000	1.38
	3.500	1.38
	4.000	2.00
7.00	3.000	1.25
	3.500	1.50
	4.000	1.50
	5.000	3.13
8.00	3.500	1.50
	4.000	1.50
	5.000	2.88
	5.500	3.63

Bore	Rod Dia.	Minimum Stroke
10.00	4.500	1.13
	5.000	1.38
	5.500	2.00
	7.000	3.13
12.00	5.500	1.25
	7.000	2.38
	8.000	3.13
14.00	7.000	2.00
	8.000	2.75
	10.000	4.25
16.00	8.000	1.75
	9.000	2.50
	10.000	3.25
18.00	9.000	1.50
	10.000	2.25
20.00	10.000	1.25

Cylinder Weights

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To determine the net weight of a cylinder, first select the proper basic weight for zero stroke, then calculate the weight of the cylinder stroke and add the result to the basic weight. For extra rod extension use piston rod weights per inch shown in Table B. Weights of cylinders with intermediate rods may be estimated from table below by taking the difference between the piston rod weights per inch and adding it to the standard rod diameter weight for the cylinder bore size involved.

Table A Cylinder Weights, in pounds

Bore Size	Rod Dia.	Single Rod Cylinders Basic Wt. Zero Stroke: FS, BEF2, BEF1, REF2, REF1, NM0, NM1, NM2, NM3	Single Rod Cylinders Basic Wt. Zero Stroke: PB2, SL, TM1, TM2, TM3, CL, ME6, ME5	Add Per Inch of Stroke	Double Rod Cylinders Basic Wt. Zero Stroke: FS, REF2, REF1, NM0, NM3	Double Rod Cylinders Basic Wt. Zero Stroke: SL, TM1, TM3, CL, ME5	Add Per Inch of Stroke
1 1/2"	5/8" 1"	7.8 8.4	9.0 9.3	.5 .6	9.1 9.7	10.7 10.8	.6 .8
2"	1" 1 3/8"	11.6 13.5	13.2 17.1	.8 1.0	14.6 19.4	16.8 20.6	1.0 1.4
2 1/2"	1" 1 3/4"	17.0 22.5	19.5 25.5	1.1 1.5	21.0 27.0	24.5 30.0	1.3 2.2
3 1/4"	1 3/8" 2"	32.0 37.0	41.0 46.0	1.8 2.2	43.0 48.0	52.0 57.0	2.2 3.1
4"	1 3/4" 2 1/2"	48.0 52.0	53.0 58.0	2.5 3.2	59.0 92.0	63.0 97.0	3.2 4.6
5"	2" 3 1/2"	76.0 88.0	82.0 86.0	3.4 5.2	96.0 117.0	102.0 123.0	4.8 7.9
6"	2 1/2" 4"	125.0 133.0	133.0 140.0	5.2 7.3	153.0 182.0	159.0 190.0	6.6 10.9
7"	3" 5"	233.0 240.0	242.0 253.0	6.7 10.3	320.0 341.0	339.0 360.0	8.7 15.9
8"	3 1/2" 5 1/2"	262.0 300.0	276.0 309.0	9.0 13.0	323.0 390.0	331.0 411.0	11.7 19.7

Bore Size	Rod Dia.	Single Rod Cylinders Basic Wt. Zero Stroke: TM1, TM2	TM3, ME5, ME6	IH3, IH4	PB2, SL	Add Per Inch of Stroke	Double Rod Cylinders Basic Wt. Zero Stroke: Add to All Mtg. Styles	Add Per Inch of Stroke
10"	4 1/2" 7"	562 620	646 704	684 742	607 665	15 21	43 101	20 32
12"	5 1/2" 8"	924 1022	1057 1155	1136 1234	1000 1097	22 29	64 162	29 43
14"	7" 10"	1335 1496	1520 1681	1582 1743	1485 1646	28 39	101 262	39 61

Bore Size	Rod Dia.	Single Rod Cylinders Basic Wt. Zero Stroke: ME5, ME6	IH3, IH4	PB2	Add Per Inch of Stroke	Double Rod Cylinders Basic Wt. Zero Stroke: Add to All Mtg. Styles	Add Per Inch of Stroke
16"	8"	2073	2257	2226	35	149	49
	9"	2122	2305	2275	39	198	57
	10"	2181	2364	2334	43	257	65
18"	9"	3165	3256	3330	45	198	63
	10"	3224	3315	3390	50	257	72
20"	10"	4231	4406	4551	57	257	79

Table B Piston Rod Weights, in pounds

Rod Dia.	Rod Wt. Per Inch	Rod Dia.	Rod Wt. Per Inch	Rod Dia.	Rod Wt. Per Inch	Rod Dia.	Rod Wt. Per Inch
5/8"	.09	2"	.89	4"	3.56	7"	10.89
1"	.22	2 1/2"	1.40	4 1/2"	4.51	8"	14.22
1 3/8"	.42	3"	2.00	5"	5.56	10"	22.23
1 3/4"	.68	3 1/2"	2.72	5 1/2"	6.72		

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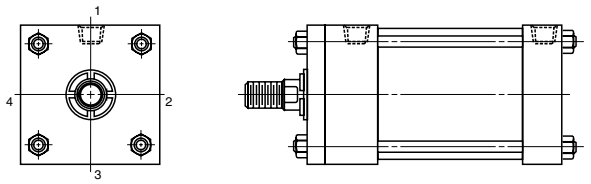
Ports

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
NM1, NM2, NM3, REF2, BEF2, REF1, BEF1, TM3	1, 2, 3 or 4	1, 2, 3 or 4
ME6, TM2, PB2, SA	1,2, 3 or 4	1 or 3
ME5, TM1	1 or 3	1, 2, 3 or 4
SL, FS	1	1

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

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	1/8	5/16 - 24	12	3/4	1 1/16 - 12
3	3/16	3/8 - 24	—	—	—
4	1/4	7/16 - 20	16	1	1 5/16 - 12
5	5/16	1/2 - 20	20	1 1/4	1 5/8 - 12
6	3/8	9/16 - 18	24	1 1/2	1 7/8 - 12
8	1/2	3/4 - 16	32	2	2 1/2 - 12
10	5/8	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	.383
1/4	19	.518
3/8	19	.656
1/2	14	.825
3/4	14	1.041
1	11	1.309
1 1/4	11	1.650
1 1/2	11	1.882
2	11	2.347

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

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

Table D – Standard Port Sizes

Bore	S SAE	N NPTF	F SAE Code 61 Flange	I ISO 6149	BSPT=B BSPP=R	G Metric
1 1/2	#8	1/2	N/A	M22 x 1.5	1/2	M22 x 1.5
2	#8	1/2	N/A	M22 x 1.5	1/2	M22 x 1.5
2 1/2	#8	1/2	1/2*	M22 x 1.5	1/2	M22 x 1.5
3 1/4	#12	3/4	3/4	M27 x 2	3/4	M27 x 2
4	#12	3/4	3/4	M27 x 2	3/4	M27 x 2
5	#12	3/4	3/4	M27 x 2	3/4	M27 x 2
6	#16	1	1	M33 x 2	1	M33 x 2
7	#20	1 1/4	1 1/4	M42 x 2	1 1/4	M42 x 2
8	#24	1 1/2	1 1/2	M48 x 2	1 1/2	M48 x 2
10	#24	1 1/2	2	M48 x 2	1 1/2	M48 x 2
12	#24	1 1/2	2 1/2	M48 x 2	1 1/2	M48 x 2
14	#24	1 1/2	1 1/2	M48 x 2	1 1/2	M48 x 2
16-20	#24	–	3	–	–	–

*Available with 1 inch rod diameter only.

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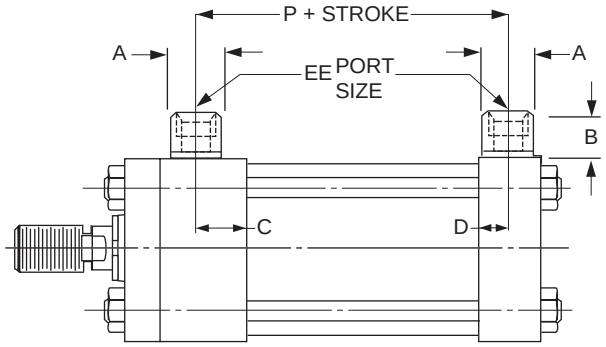
Oversize Ports

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 flow exceeding 25 ft./sec. in the line entering the cap end of the cylinder should be ordered with a "solid cushion" at cap end. All cylinders ordered with double oversize ports should always be ordered with a "solid cushion" at cap end.

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



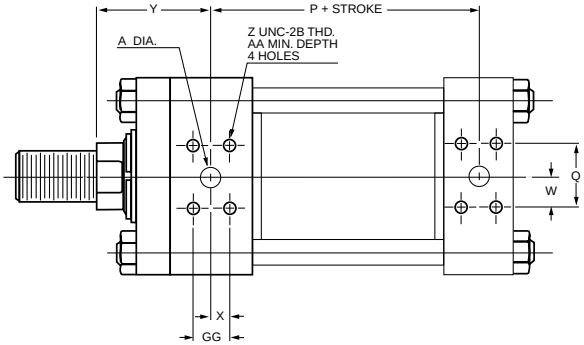
Oversize NPTF Port Boss Dimensions

Bore	EE (NPTF)	A (Dia.)	B	C	D	P
1 1/2	3/4	1 3/8	1	3/4	25/32	2 29/32
2	3/4	1 3/8	1	3/4	25/32	2 29/32
2 1/2	3/4	1 3/8	1	3/4	25/32	3 1/32
3 1/4	1	1 3/4	1 3/16	29/32	7/8	3 17/32
4	1	1 3/4	1 3/16	29/32	7/8	3 25/32
5	1	1 3/4	1 3/16	29/32	7/8	4 9/32
6	1 1/4	2 1/4	1 5/16	1 1/8	1 1/8	5 1/8
7	1 1/2	2 1/2	1 9/16	1 3/8	1 3/8	5 3/4
8	2	3	1 11/16	1 1/2	1 1/2	6 1/2

Oversize SAE Straight Thread Port Boss Dimensions

Bore	EE (SAE)	A (Dia.)	B	C	D	P
1 1/2	10*	–	–	–	–	2 7/8
2	10*	–	–	–	–	2 7/8
2 1/2	10*	–	–	–	–	3
3 1/4	16	1 3/4	1 3/16	7/8	7/8	3 7/16
4	16	1 3/4	1 3/16	7/8	7/8	3 11/16
5	16	1 3/4	1 3/16	7/8	7/8	4 3/16
6	20*	–	–	–	–	5 3/16
7	24*	–	–	–	–	5 1/2
8	N/A	–	–	–	–	6 1/4

*Port tapped directly into head and cap.



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

Bore Size	SAE Dash No.	Y	A	P	Q	W	X
2 1/2†*	8	2.39	.50	2.97	1.50	.75	.34
3 1/4†	12	2.80 3.17 3.05	.75	3.41	1.87	.94	.44
4†	12	3.05 3.42 3.17	.75	3.66	1.87	.94	.44
5†	12	3.17 3.42 3.42 3.42	.75	4.16	1.87	.94	.44
6	16	3.52	1.00	4.58	2.06	1.03	.52
7	20	3.70	1.25	5.59	2.31	1.16	.59
8	24	3.84	1.50	6.31	2.75	1.37	.70

Bore Size	SAE Dash No.	Z	AA	GG
2 1/2†	8	5/16 - 18	.81	.69
3 1/4†	12	3/8 - 16	.75	.87
4†	12	3/8 - 16	.75	.87
5†	12	3/8 - 16	.75	.87
6	16	3/8 - 16	.87	1.03
7	20	7/16 - 14	1.00	1.19
8	24	1/2 - 13	1.06	1.41

† 2 1/2", 3 1/4", 4" & 5" bores cap-flange port not available on Style BEF1.
Style BEF2 not available at position 2 or 4. Port flange overhangs cap on Style ME6.

*2 1/2" bore head flange port available with 1" and 1 3/8" rod only.

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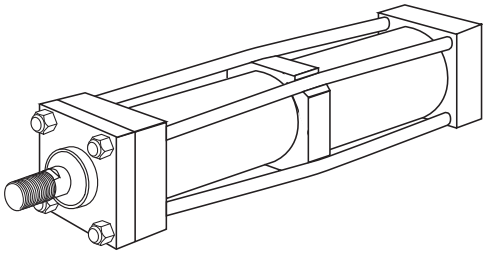
Stroke Data

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

Tie Rod Supports



Rigidity of Envelope

The prestressed tie rod construction of cylinders has advantages in rigidity within the limits of the cylinder tube to resist buckling. For long stroke cylinders within practical limits. Tie rod supports (see table below) which move the tie rod centerlines radially outward are used.

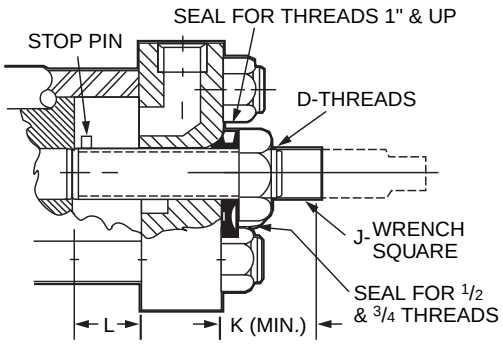
Standard tie rod supports are kept within the envelope dimensions of the head and cap, and generally do not interfere with mounting a long cylinder.

Number of Supports Required	Stroke (Inches)											
Bore	36	48	60	72	84	96	108	120	132	144	156	168
1 1/2	—	—	1	1	1	2	2	2	3	3	3	4
2	—	—	—	1	1	1	1	2	2	2	2	3
2 1/2	—	—	—	—	—	1	1	1	1	1	2	2
3 1/4	—	—	—	—	—	—	—	1	1	1	1	1
4	—	—	—	—	—	—	—	—	—	1	1	1

Note: 5" through 8" bore sizes — no supports required.

Stroke Adjusters

Where absolute precision in stroke length is required, a screwed adjustable stop can be supplied. Several types are available – the illustration shows a design suitable for infrequent* adjustment at the uncushioned cap end of a cylinder. Please contact the factory, specifying details of the application and the adjustment required.



Bore Size	D	J	K	L (Max.)
1 1/2	1/2 - 20	5/16	15/16	5
2	3/4 - 16	7/16	1 1/4	8
2 1/2, 3 1/4	1 - 14	5/8	1 11/16	9
4	1 1/2 - 12	15/16	2 1/8	18
5	2 - 12	1 5/16	2 11/16	20
6	2 1/2 - 12	1 11/16	3 1/8	20
7	3 - 12	2	3 1/4	20
8	3 1/2 - 12	2 3/8	3 1/2	20

* Infrequent is defined by positioning the retract stroke in a couple of attempts at original machine set-up. The frequent stroke adjuster is recommended when adjustments may be required by the end user.

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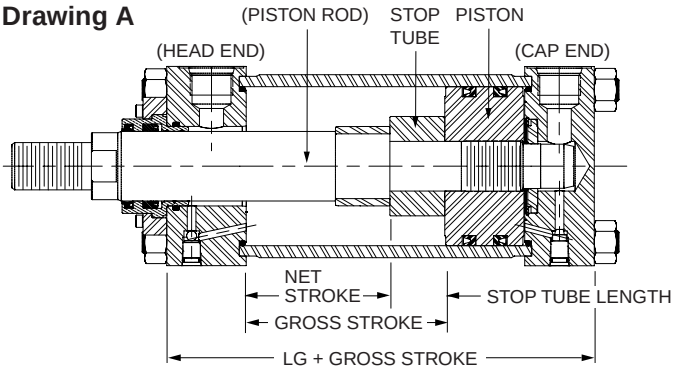
Stop Tubing

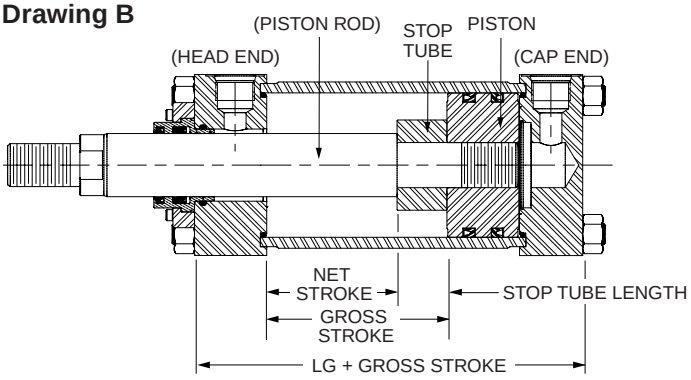
Stop tube is recommended to lengthen the distance between the rod bearing and piston to reduce bearing loads when the cylinder is fully extended. This is especially true of horizontally mounted and long stroke cylinders. Long stroke cylinders achieve additional stability through the use of a stop tube.

Drawing A



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

Drawing B



This design is supplied on all non-cushion cylinders.

Mounting Classes

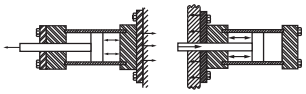
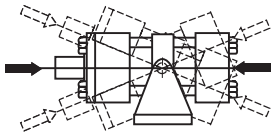
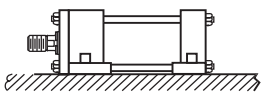
Standard mountings for fluid power cylinders fall into three basic groups. The groups can be summarized as follows:

Group 1 Straight Line Force Transfer with fixed mounts which absorb force on cylinder centerline.

Group 2 Pivot Force Transfer. Pivot mountings permit a cylinder to change its alignment in one plane.

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

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

Group 1 FIXED MOUNTS which absorb force on cylinder centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	 Styles NM2, BEF1, ME6 Styles NM3, REF1, ME5
Medium -Duty Service For Thrust Loads For Tension Loads	 Styles BEF1, BEF2 Styles REF1, REF2
Light-Duty Service For Thrust Loads For Tension Loads	 Style BEF2 Style BEF1
Group 2 PIVOT MOUNTS which absorb force on cylinder centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	 Styles TM1, TM3 Styles TM1, TM2, PB2, TM3
Medium-Duty Service For Thrust Loads For Tension Loads	 Style PB2 Style PB2
Group 3 FIXED MOUNTS which do not absorb force on the centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	 Style SL Style SL
Medium-Duty Service For Thrust Loads For Tension Loads	 Style FS Style FS

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How to Use the Chart

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

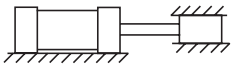
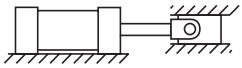
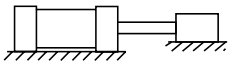
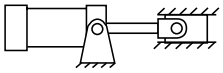
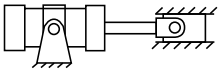
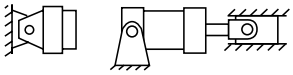
1. Determine the type of cylinder mounting style and rod end connection to be used. Then consult the chart below and find the "stroke factor" that corresponds to the conditions used.
2. Using this stroke factor, determine the "basic length" from the equation:

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

   The graph is prepared for standard rod extensions beyond the face of the rod gland retainers. For rod extensions greater than standard, add the increase to the stroke in arriving at the "basic length."
3. Find the load imposed for the thrust application by multiplying the full bore area of the cylinder by the system pressure.
4. Enter the graph along the values of "basic length" and "thrust" as found above and note the point of intersection:
   A) The correct piston rod size is read from the diagonally curved line labeled "Rod Diameter" next *above* the point of intersection.
   B) The required length of stop tube is read from the right of the graph by following the shaded band in which the point of intersection lies.
   C) If required length of stop tube is in the region labeled "consult factory," submit the following information for an individual analysis:
      1) Cylinder mounting style.
      2) Rod end connection and method of guiding load.
      3) Bore, required stroke, length of rod extension (Dim. "LA") if greater than standard, and series of cylinder used.
      4) Mounting position of cylinder. (Note: If at an angle or vertical, specify direction of piston rod.)
      5) Operating pressure of cylinder if limited to less than standard pressure for cylinder selected.

Warning ⚠

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 end to fail. If these types of additional loads are expected to be imposed on the piston rods, their magnitude should be made known to our Engineering Department so they may be properly addressed. Additionally, cylinder users should always make sure that the piston rod is securely attached to the machine member.

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

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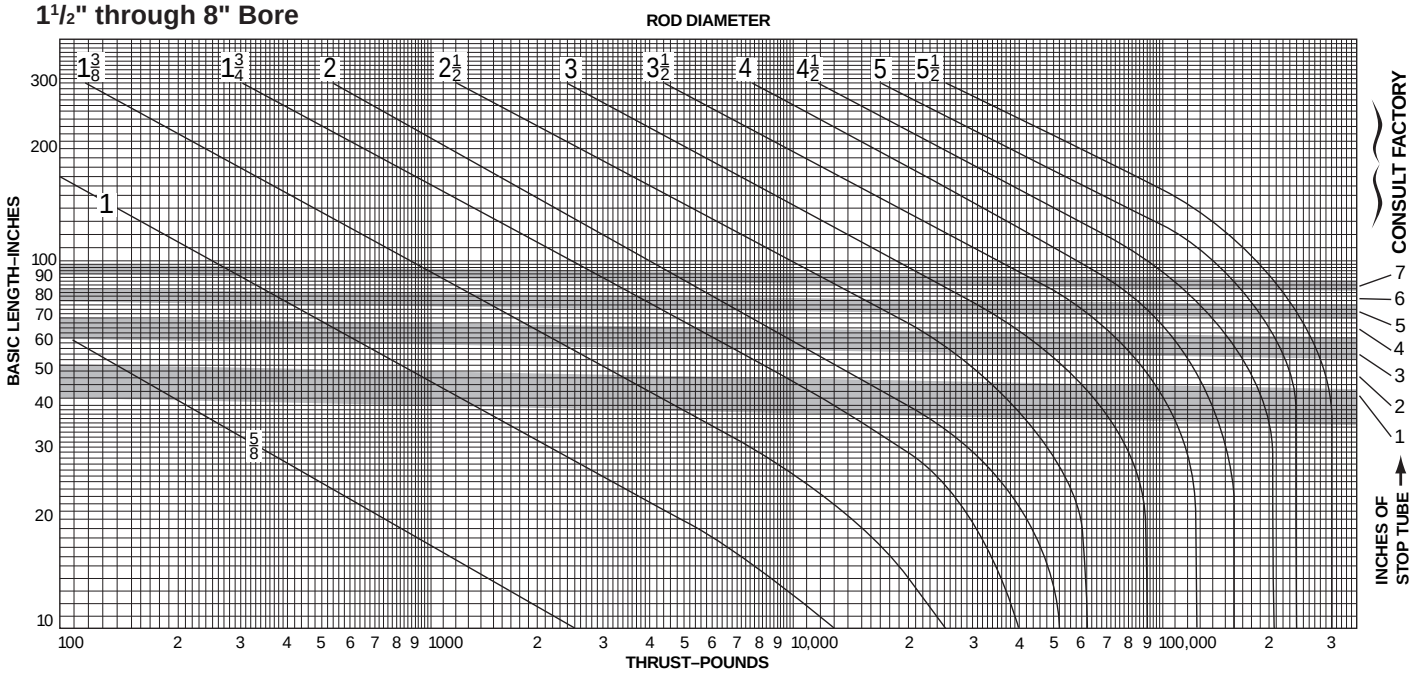
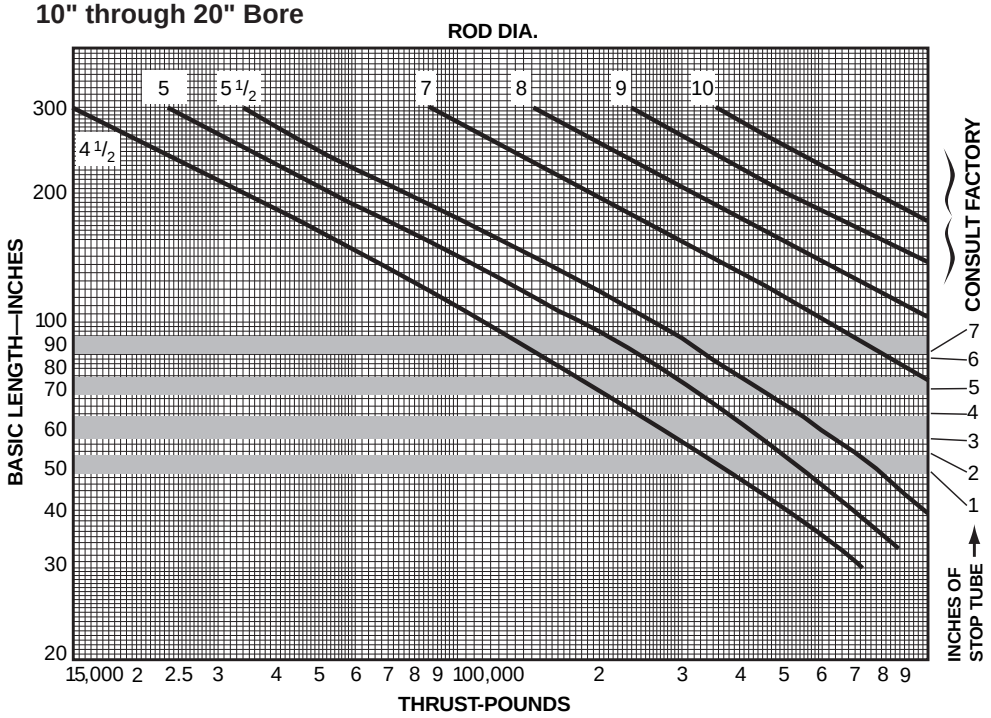
Piston Rod — Stroke Selection Chart

1½" through 8" Bore



Piston Rod — Stroke Selection Chart

10" through 20" Bore



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Rod Gland Drain

Rod gland drains permit capture of fluid that may accumulate between the primary rod seal and the wiperseal. A 1/8 NPTF port is provided in the gland retainer or cylinder head (see table below) for connection of plumbing that flows oil back to the reservoir. Use of translucent tubing as the drain to reservoir line can provide visual indication of a need for rod seal service when the cylinder gland is not easily visible within the equipment. Specify rod gland drain port option and the drain port location, position 1, 2, 3, or 4.

Drain Port Location

Bore	Rod Dia.	NM2, BEF1, BEF2, ME6, SL, FS, TM1, TM2, PB2, TM3, SA	NM1, NM3, REF1, REF2	ME5
1 1/2	5/8	Head	Head	Head
	1	Full Retainer	Full Retainer	Head
2	1	Bolted Retainer	Full Retainer	Head
	1 3/8	Full Retainer	Full Retainer	Head
2 1/2	1 - 1 3/8	Bolted Retainer	Head	Head
	1 3/4	Bolted Retainer	Full Retainer	Head
3 1/4	All	Bolted Retainer	Head	Head
4	All	Bolted Retainer	Head	Head
5	2 - 3	Bolted Retainer	Head	Head
	3 1/2	Bolted Retainer	Full Retainer	Head
6 - 8	All*	Bolted Retainer	Head	Head

* On 5$^{1}/_{2}$" diameter piston rods, with drain in position 2 or 4, the port will be offset 18 degrees clockwise from the position specified.

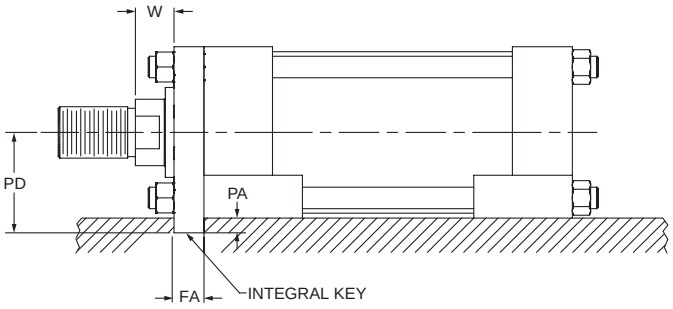
Note: When a key retainer and rod gland drain are specified the port location will be the same as mounting styles NM1, NM3, etc.

The full square retainer, key retainer, or mounting flange thickness is increased on three bore and rod combinations. The piston rod is extended on NM1, NM3, REF1, and REF2 mounts to provide the standard ‘W’ dimension.

Bore	Rod Dia.	Retainer or Mounting Flange Thickness
1 1/2	1	5/8
2	1 3/8	3/4
2 1/2	1 3/4	7/8

Thrust Key Mountings

Thrust key mountings eliminate the need of using fitted bolts or external keys on side mounted cylinders. Cylinder Styles SL and FS can be provided with the gland retainer plate extended below the mounting side of the cylinder (see illustration below). This extended retainer plate can then be fitted into a keyway milled into the mounting surface of the machine member.



Bore	+.000" -.001" Dim. FA	Dim. PA	Dim. PD Styles SL, FS
$1^{1}/_{2}$	.361	$^{3}/_{16}$	$1^{7}/_{16}$
2	.611	$^{5}/_{16}$	$1^{13}/_{16}$
$2^{1}/_{2}$	.611	$^{5}/_{16}$	$2^{1}/_{16}$
$3^{1}/_{4}$	.736	$^{3}/_{8}$	$2^{5}/_{8}$
4	.861	$^{7}/_{16}$	$2^{15}/_{16}$
5	.861	$^{7}/_{16}$	$3^{11}/_{16}$
6	.986	$^{1}/_{2}$	$4^{1}/_{4}$
8	.986	$^{1}/_{2}$	$5^{1}/_{4}$

End of Stroke Magnetic Principle Type
Proximity Switch

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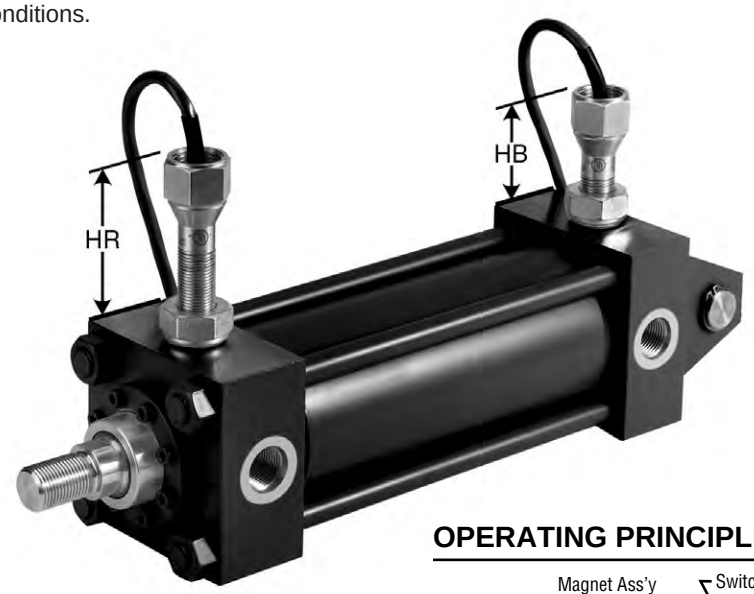
Reliable: Proximity type sensor never contacts cylinder moving parts; eliminating wear and adjustments.

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

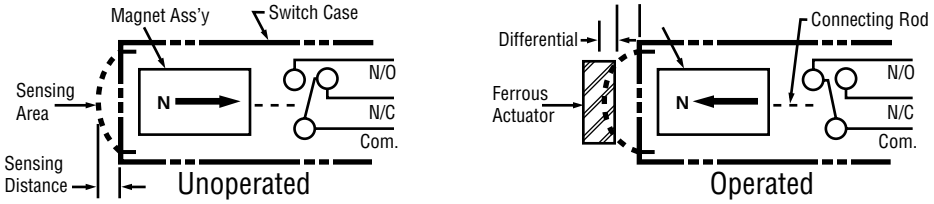
Versatile: Sealed stainless steel switch body can be used with any operating fluid and is impervious to most environmental conditions.



Switch Extension in Inches

Bore	Rod Dia.	HR	HB
1 1/2	5/8	3 7/16	3 5/16
	1	3 5/8	
2	1	3 7/16	3 1/4
	1 3/8	3 5/8	
2 1/2	1	3 1/4	2 15/16
	1 3/8	3 7/16	
	1 3/4	3 5/8	
3 1/4	1 3/8	2 15/16	2 9/16
	1 3/4	3 1/8	
	2	3 5/16	
4	1 3/4	2 7/8	2 7/16
	2	3 1/16	
	2 1/2	3 3/8	
5	2	2 1/4	2 5/16
	2 1/2	2 5/8	
	3	2 7/8	
	3 1/2	3 1/8	
6	2 1/2	2 1/8	3
	3	2 3/8	
	3 1/2	2 5/8	
	4	2 7/8	
7	3	3 3/8	2 11/16
	3 1/2	2 1/8	
	4	2 3/8	
	5	2 15/16	
8	3 1/2	3 1/8	2 1/4
	4	3 3/8	
	5	3 5/8	
	5 1/2	2 5/8	

OPERATING PRINCIPLE



Switch Options
Quick disconnect.
Explosion proof.
Sub sea, to 2000 feet depths.
Extra-long leads.

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

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

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

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

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

Specifications

Switch Type:
Magnetic Principle

Contacts:
Single Pole-Double Throw (SPDT)

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

Note: Check current draw of solenoid valves.

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

Pressure Rating: 3000 PSI
Non Shock

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

Sensing Gap:
.030 to .060 inch

Trip Point: Factory Set with Piston Bottomed out

Release Point: Approximately 1/4" Piston Travel

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

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

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

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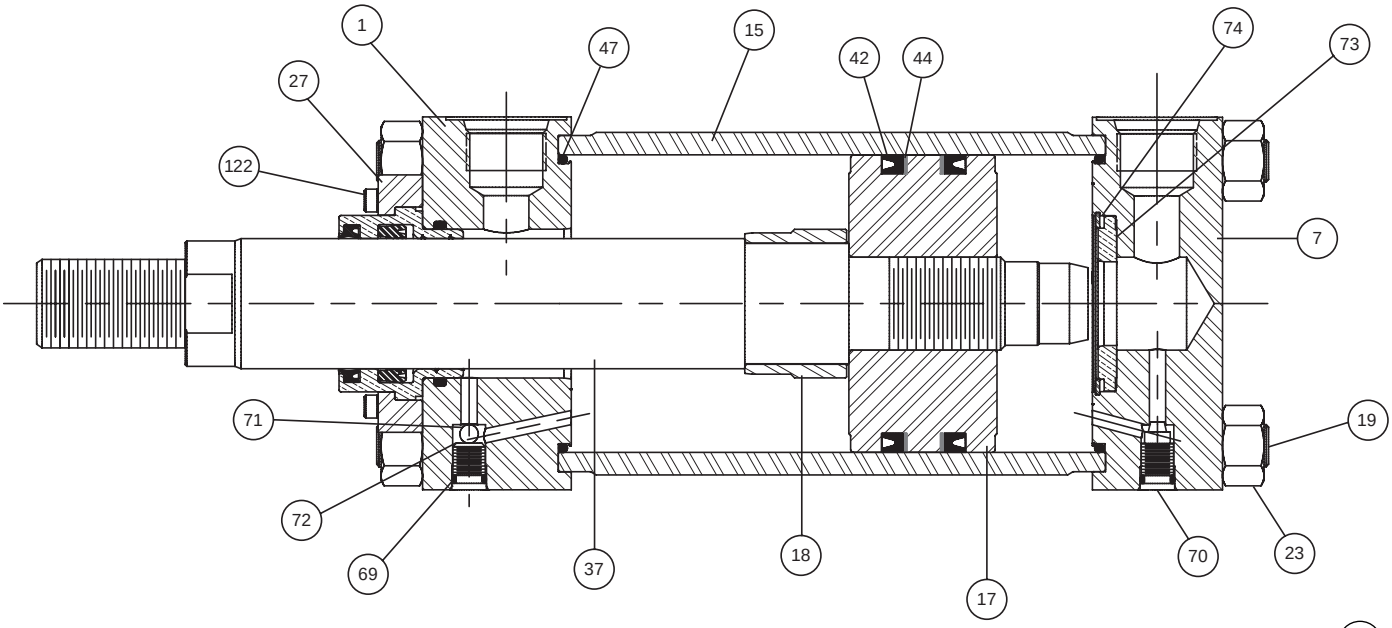
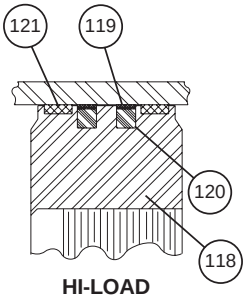
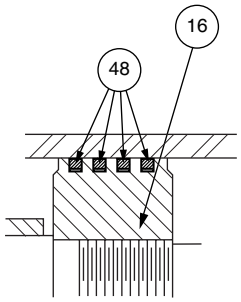
1½" through 6" Bore Sizes





HI-LOAD PISTON



OPTIONAL RING TYPE PISTON

Parts List — 1 1/2" through 6" Bore Sizes

Symbol	Description
1	Head
7	Cap
15	Cylinder tube
16	Piston, ring type
17	Piston, lipseal type
18	Cushion plunger, rod head cushion
19	Tie rod
23	Tie rod nut
27	Retainer
37	Piston rod, single rod type
42	Lipseal, piston
44	Back-up washer, piston
47	O-ring, cylinder tube to head and cap seal
48	Piston ring, iron
69	O-ring, cushion adjustment and check valve plug screw
70	Needle, cushion adjustment valve
71	Ball, cushion check valve
72	Plug screw, cushion check valve
73	Bushing, float check, cushion on cap end
74	Retaining ring, float check cushion bushing
118	Piston, Hi-Load type
119	Outer Ring
120	Inner Ring
121	Wear Ring
122	Retainer bolt

Piston and Rod Assemblies

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

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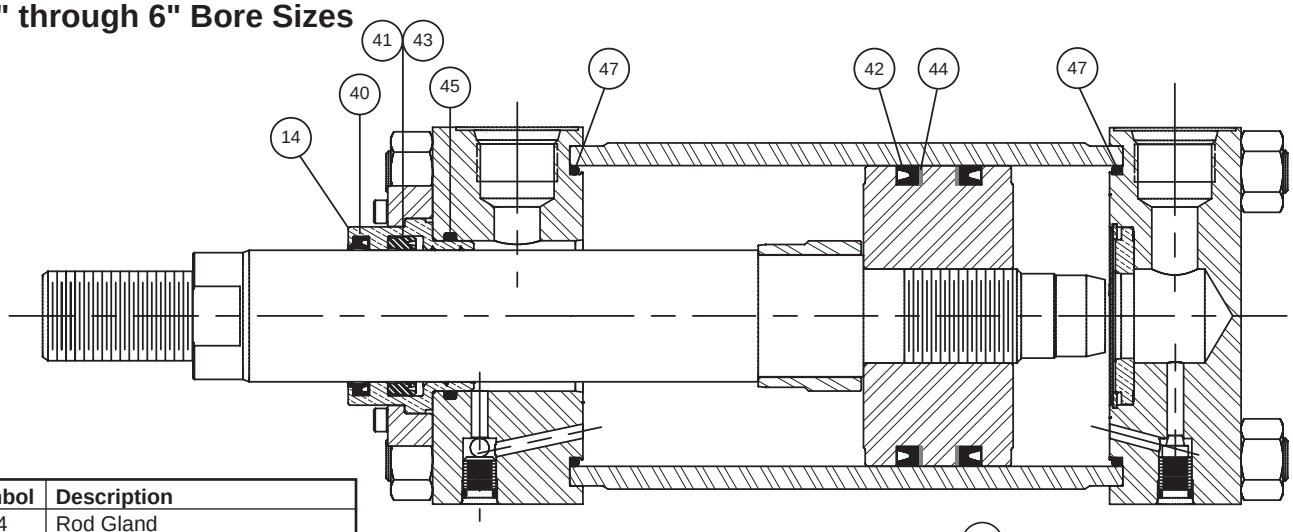
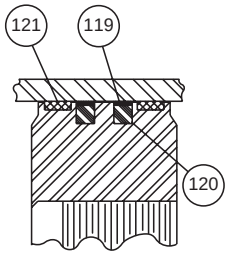
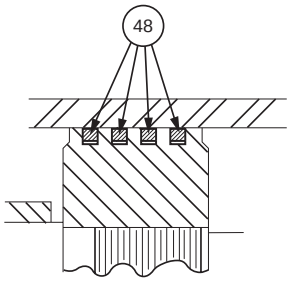
1½" through 6" Bore Sizes



Symbol	Description
14	Rod Gland
40	Rod Wiper
41	Rod Seal
42	Piston Lipseal
43	Rod Seal Back-up Washer
44	Piston Seal Back-up Washer
45	Gland to head o-ring
47	End seal o-ring
48	Piston ring
119	Outer Ring
120	Inner Ring
121	Wear Ring



HI-LOAD PISTON



OPTIONAL RING TYPE PISTON

Seal Kits

See Operating Fluids and Temperature Range Page for compatibility.

Piston Seal Kits

Bore Size	Class 1 & 2 Buna-N				
	Piston Lipseal Kits (Contains: 2 Each Sym. #42, 44, & 47)	**Piston Ring Kits** (Contains: 4 Each Sym. #48 & 2 Each Sym. #47)	**Hi-Load Piston Seal Kits** (Contains: 2 Each Sym. #47 119, 120, & 121)	**Poly Flex Piston Seal Kits** (Contains: 2 Each Sym. #42, 44, & 47)	**Tie Rod Nut Torque[1]**
1 1/2	PH00LH015	PH00CH015	PH00KH015	UH00MH015	18 - 19 lb-ft
2	PH00LH020	PH00CH020	PH00KH020	UH00MH020	45 - 49 lb-ft
2 1/2	PH00LH025	PH00CH025	PH00KH025	UH00MH025	45 - 49 lb-ft
3 1/4	PH00LH032	PH00CH032	PH00KH032	UH00MH032	120 - 124 lb-ft
4	PH00LH040	PH00CH040	PH00KH040	UH00MH040	131 - 135 lb-ft
5	PH00LH050	PH00CH050	PH00KH050	UH00MH050	312 - 316 lb-ft
6	PH00LH060	PH00CH060	PH00KH060	UH00MH060	528 - 544 lb-ft

Bore Size	Class 5 Fluorocarbon			
	Piston Lipseal Kits (Contains: 2 Each Sym. #42, 44, & 47)	**Piston Ring Kits** (Contains: 4 Each Sym. #48 & 2 Each Sym. #47)	**Hi-Load Piston Seal Kits** (Contains: 2 Each Sym. #47 119, 120, & 121)	**Tie Rod Nut Torque[1]**
1 1/2	VH00LH015	VH00CH015	VH00KH015	18 - 19 lb-ft
2	VH00LH020	VH00CH020	VH00KH020	45 - 49 lb-ft
2 1/2	VH00LH025	VH00CH025	VH00KH025	45 - 49 lb-ft
3 1/4	VH00LH032	VH00CH032	VH00KH032	120 - 124 lb-ft
4	VH00LH040	VH00CH040	VH00KH040	131 - 135 lb-ft
5	VH00LH050	VH00CH050	VH00KH050	312 - 316 lb-ft
6	VH00LH060	VH00CH060	VH00KH060	528 - 544 lb-ft

[1]When assembling the cylinder, be sure to torque the tie rods evenly.

Rod Gland and Rod Seal Kits

Rod Dia.	Class 1 Polyurethane & Buna-N		**Retainer Bolt Torque** (Torque values are for bolts installed with lubrication.)
	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, & 45)	**Rod Seal Kits** (Contains: 1 Each Sym. #40, 41, & 45)	
5/8	PH06RH000	PH06SH000	56 - 58 lb-in
1	PH10RH000	PH10SH000	56 - 58 lb-in
1 3/8	PH13RH000	PH13SH000	56 - 58 lb-in
1 3/4	PH17RH000	PH17SH000	56 - 58 lb-in
2	PH20RH000	PH20SH000	11 - 12 lb-ft
2 1/2	PH25RH000	PH25SH000	11 - 12 lb-ft
3	PH30RH000	PH30SH000	41 - 43 lb-ft
3 1/2	PH35RH000	PH35SH000	41 - 43 lb-ft
4	PH40RH000	PH40SH000	41 - 43 lb-ft

Rod Dia.	Class 5 Fluorocarbon		**Retainer Bolt Torque** (Torque values are for bolts installed with lubrication.)
	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, 43[2], 45)	**Rod Seal Kits** (Contains: 1 Each Sym. #40, 41, 43[2], & 45)	
5/8	VH06RH000	VH06SH000	56 - 58 lb-in
1	VH10RH000	VH10SH000	56 - 58 lb-in
1 3/8	VH13RH000	VH13SH000	56 - 58 lb-in
1 3/4	VH17RH000	VH17SH000	56 - 58 lb-in
2	VH20RH000	VH20SH000	11 - 12 lb-ft
2 1/2	VH25RH000	VH25SH000	11 - 12 lb-ft
3	VH30RH000	VH30SH000	41 - 43 lb-ft
3 1/2	VH35RH000	VH35SH000	41 - 43 lb-ft
4	VH40RH000	VH40SH000	41 - 43 lb-ft

[2]Item 43 not required for 5/8" & 1" rod diameter.

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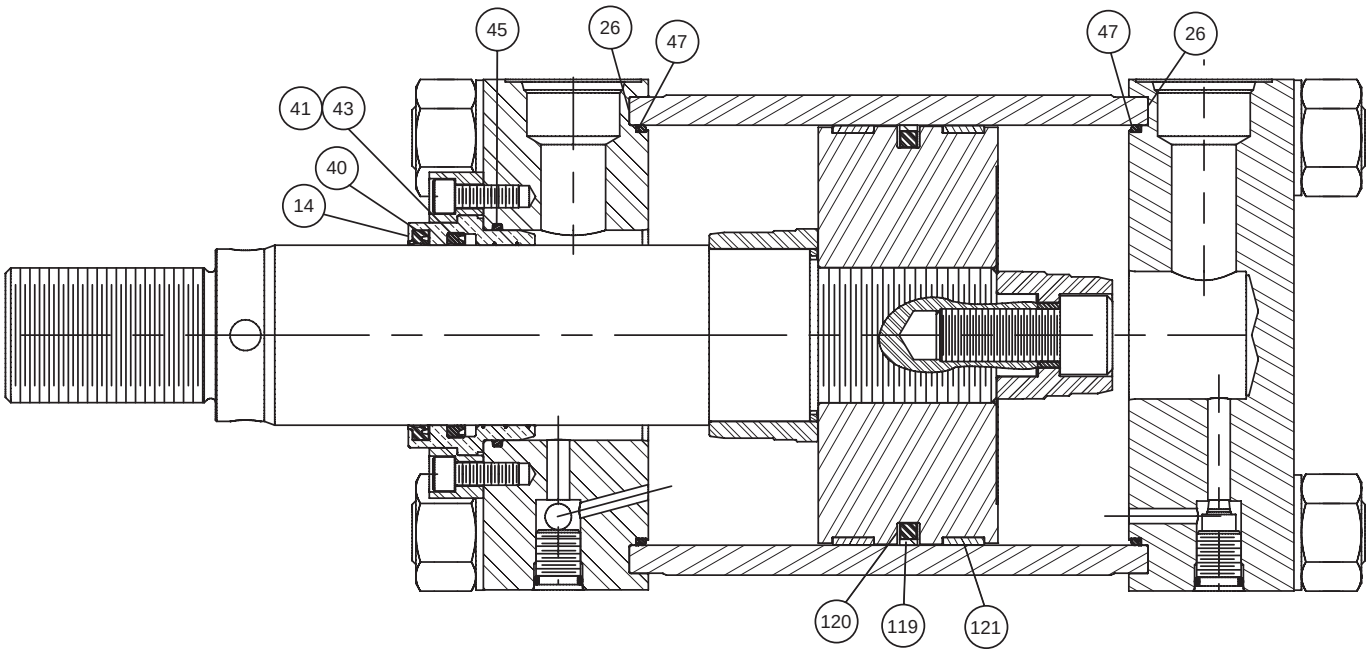
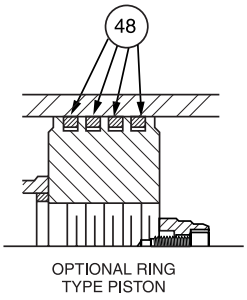
7" and 8" Bore Sizes



Parts Identification

Sym. No.	Description	Sym. No.	Description
14	Rod Bearing	47	End Seal O-Ring
40	Rod Wiper	48	Piston Ring
41	Rod Seal	62	Bushing Kit
43	Rod Seal Back Up Washer	119	Outer Ring
26	End Seal Back Up Washer	120	Inner Ring
45	Gland to Head O-Ring	121	Wear Ring



Rod Gland and Rod Seal Kits

Rod Dia.	Class 1 Polyurethane & Buna-N		Class 5 Service Fluorocarbon		Retainer Bolt Torque (Torque values are for bolts installed with lubrication.)
	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, & 45)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, & 45)	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, 43, & 45)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, 43, & 45)	
3	PH30RH000	PH30SH000	VH30RH000	VH30SH000	41 - 43 lb-ft
3 1/2	PH35RH000	PH35SH000	VH35RH000	VH35SH000	41 - 43 lb-ft
4	PH40RH000	PH40SH000	VH40RH000	VH40SH000	41 - 43 lb-ft
5	PH50RH000	PH50SH000	VH50RH000	VH50SH000	41 - 43 lb-ft
5 1/2	PH55RH000	PH55SH000	VH55RH000	VH55SH000	41 - 43 lb-ft

Piston Seal Kits

Bore Size	Class 1 & 2 Buna-N			Class 5 Fluorocarbon		Tie Rod Nut Torque[1]
	Piston Ring Kits (Contains: 4 Each Sym. #48 & 2 Each Sym. #26 & 47)	Hi-Load Piston Seal Kits (Contains: 2 Each Sym. #26, 47, & 121 2 Each Sym. #119 & 120)	Poly Flex Piston Seal Kits (Contains: 2 Each Sym. #26, 42, 44, & 47)	Piston Ring Kits (Contains: 4 Each Sym. #48 & 2 Each Sym. #26 & 47)	Hi-Load Piston Seal Kits (Contains: 2 Each Sym. #26, 47, & 121 2 Each Sym. #119 & 120)	
7	PH00CH070	PH00KH070	UH00MH070	VH00CH070	VH00KH070	800 - 816 lb-ft
8	PH00CH080	PH00KH080	UH00MH080	VH00CH080	VH00KH080	1168 - 1184 lb-ft

[1]When assembling the cylinder, be sure to torque the tie rods evenly.

10" through 20" Bore Sizes

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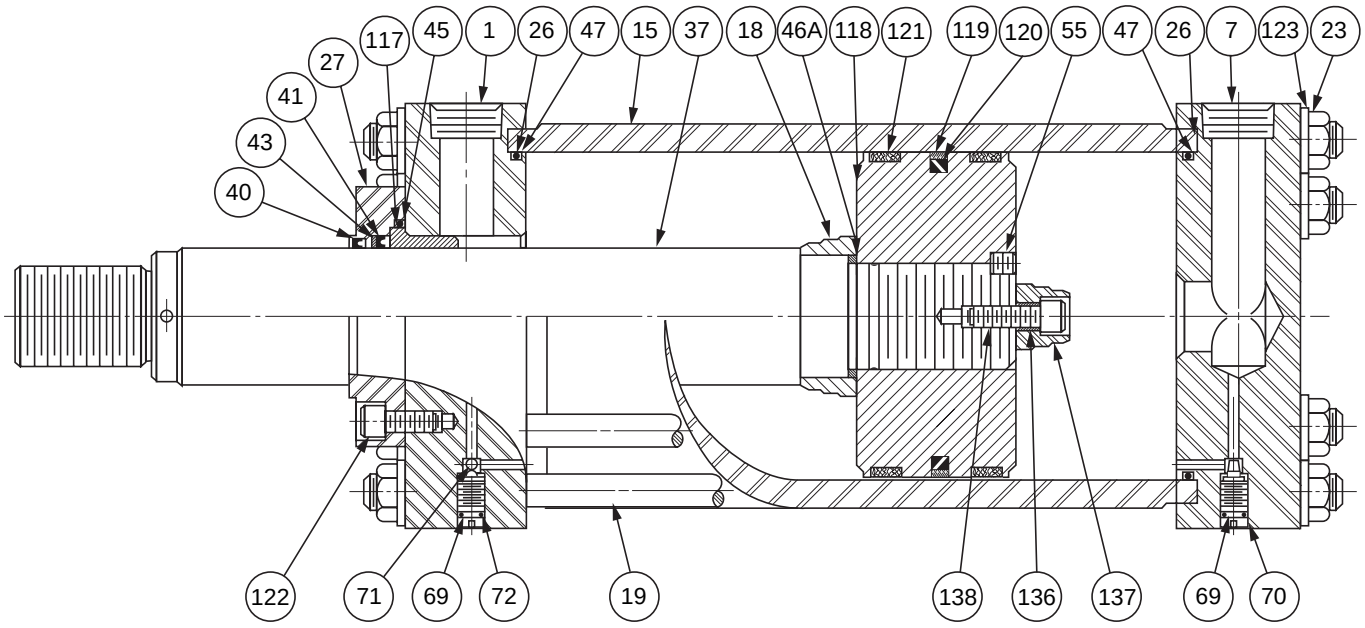

Sym. No.	
1	Head
7	Cap
15	Cylinder Body
16	Piston Body – Ring Type Piston
18	Cushion Sleeve
19	Tie Rod
23	Tie Rod Nut – Non-Locking
26	Back-Up Washer, Cylinder Body
27	Retainer
37	Piston Rod
40	Wiperseal
41	Rod Seal (Polypak)
43	Back-Up Washer, Polypak
45	O-Ring, Gland to Head
46A	Cushion Sealing Ring
47	O-Ring Cylinder Body

Sym. No.	
48	Piston Ring
55	Piston Lock Pin
69	O-Ring, Cushion Adj. & Check Screws
70	Cushion Adjusting Needle Screw
71	Check Valve Ball
72	Check Valve Screw
117	Rod Bearing
118	Piston Body – Hi-Load
119	Outer Piston Ring
120	Inner Piston Ring
121	Wear Ring
122	Retainer Bolt
123	Washer, Tie Rod Nut
136	Spacer, Cushion
137	Cushion Spear, Detachable
138	Bolt, Cushion Spear

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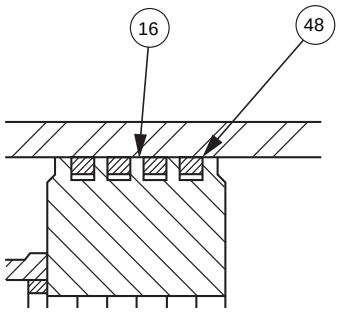
10" through 20" Bore Sizes

Optional Cast Iron Piston Ring Kit



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

Buna-N

Buna-N seals are supplied on all standard pneumatic and hydraulic cylinders. They are suitable for use with pressured air, nitrogen, hydraulic oil, water-in oil emulsions or water glycol fluids. The recommended operating temperature range for Buna-N seals is -10°F (-23°C) to +165°F (+74°C).

Fluorocarbon seals

Fluorocarbon seals can be supplied, on request, and are especially suitable for some fire resistant fluids as shown in the table on page 57 or for elevated temperature service.

When using Fluorocarbon seals for high temperature service or fluid compatibility within a temperature range of -10°F (-23°C) to +250°F (+121°C) specify Class 5 seals.

For elevated temperature service above +250°F (+121°C) specify Class 5 seals. Class 5 seals can operate up to a maximum of +400°F (+204°C) with reduced service life.

Rod Gland and Rod Seal Kits

Rod Dia.	Class 1 Polyurethane & Buna-N		Class 5 Service Fluorocarbon		Retainer Bolt Torque (Torque values are for bolts installed with lubrication.)
	Rod Gland Kits (Contains: 1 Each Sym. #40, 41, 43, 45 & 117)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, 43, & 45)	Rod Gland Kits (Contains: 1 Each Sym. #40, 41, 43, 45 & 117)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, 43, & 45)	
4 1/2	PH45RH005	PH45SH005	VH45RH005	VH45SH005	100 - 105 lb-ft
5	PH50RH005	PH50SH005	VH50RH005	VH50SH005	185 - 194 lb-ft
5 1/2	PH55RH005	PH55SH005	VH55RH005	VH55SH005	185 - 194 lb-ft
7	PH70RH005	PH70SH005	VH70RH005	VH70SH005	100 - 105 lb-ft
8	PH80RH005	PH80SH005	VH80RH005	VH80SH005	330 - 346 lb-ft
9	PH90RH005	PH90SH005	VH90RH005	VH90SH005	330 - 346 lb-ft
10	PH1LRH005	PH1LSH005	VH1LRH005	VH1LSH005	330 - 346 lb-ft

Piston Seal Kits

Bore Size	Class 1 & 2 Buna-N			Class 5 Fluorocarbon		Tie Rod Nut Torque[1]
	Piston Ring Kits (Contains: 4 Each Sym. #48 & 2 Each Sym. #47 & 26)	Hi-Load Piston Seal Kits (Contains: 2 Each Sym. #47 & 121 1 Each Sym. #119 & 120)	Poly Flex Piston Seal Kits (Contains: 2 Each Sym. #42, 44, & 47)	Piston Ring Kits (Contains: 4 Each Sym. #48 & 2 Each Sym. #47)	Hi-Load Piston Seal Kits (Contains: 2 Each Sym. #47 & 121 1 Each Sym. #119 & 120)	
10	PH00CH100	PH00KH100	UH00MH100	VH00CH100	VH00KH100	700 - 716 lb-ft
12	PH00CH120	PH00KH120	UH00MH120	VH00CH120	VH00KH120	1320 - 1336 lb-ft
14	PH00CH140	PH00KH140	UH00MH140	VH00CH140	VH00KH140	1000 - 1016 lb-ft
16 - 20	Consult Factory					2900 - 3000 lb-ft

[1]When assembling the cylinder, be sure to torque the tie rods evenly.

How to Order Series H Cylinders

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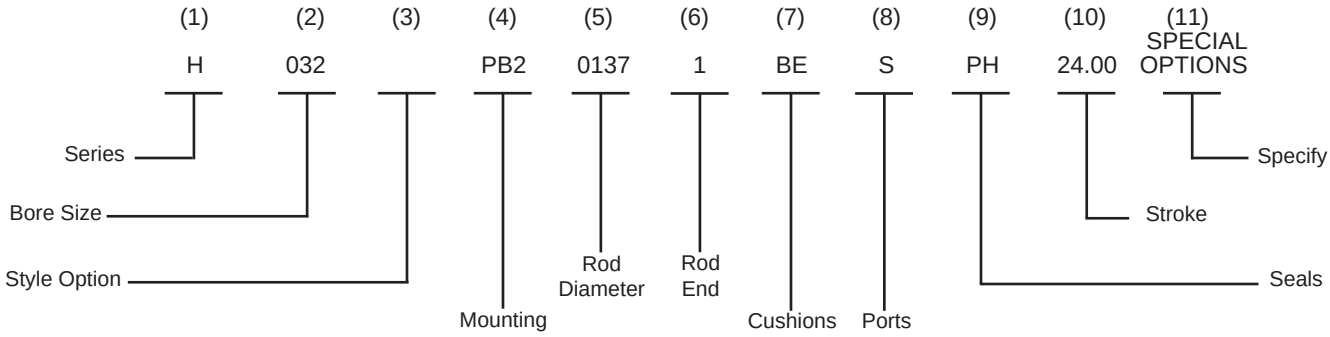
Data Required On All Cylinder Orders

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

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

1. **Series Designation (“H”)**
2. **Bore**
3. **Style Option (X for double rod or Y for duplex designs, blank otherwise)**
4. **Mounting Style**
   Specify your choice of mounting as shown and dimensioned in this catalog.
5. **Piston Rod Diameter**
   Call out rod diameter. Standard (smallest) rod diameter will be furnished if not specified, unless stroke length makes the application questionable.
6. **Piston Rod End Style**
   Call out the rod end style or specify dimensions if non-standard. Rod end style 1 will be furnished if not specified.
7. **Cushions**
   Specify cushions if required and at which end, using the codes provided. If double rod end with only one end cushioned, be sure to clearly indicate which end.
8. **Ports**
   Atlas recommends SAE straight thread ports for leak-proof connections on Series “H” hydraulic cylinders.
9. **Seals**
   Nitrile piston seals, the Atlas “Tri-Lip” Enhanced Polyurethane rod seal, Buna-N static seals and a wiper seal are all standard, for use with mineral oil based hydraulic fluids. Fluorocarbon, EPR, Nitroxile and other compounds can be specified, subject to application temperature range and fluid used. Cast iron piston rings or low friction PTFE piston seals can be specified in the special options section.
10. **Stroke**
    Specify length required.
11. **Special Options**
    Specify. Consult factory for questions.

Sample Model Code



NOTE: On double rod end cylinders, repeat rod size and specify rod end threads for each side.
For duplex cylinders, the entire model code for each cylinder should be included and indicated as "back to back" or "rod to rod."
If replacing existing cylinder or ordering parts, include the serial number.

Style 4 Rod End

A style 4 rod end indicates a special rod end configuration. All special rod ends must be described by at least **all three**: KK; A; or W/WF specified with the rod fully retracted. A sketch or drawing should be submitted for rod ends requiring special machining such as snap ring grooves, keyways, tapers, multiple diameters, etc. It is good design practice to have this machining done on a diameter at least 0.065 inches smaller than the piston rod diameter. This allows the piston rod to have a chamfer preventing rod seal damage during assembly or maintenance.

Service Policy

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

Certified Dimensions

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

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Series H Ordering Guide

(1) SERIES	(2) BORE	(3) STYLE	(4) MOUNT	(5) ROD	(6) ROD END	(7) CUSHIONS	(8) PORTS	(9) SEALS	(10) STROKE	(11) OPTIONS
H	**015** (1.50")	***(Leave***	**BEF1**	See "Piston Rod	***1 (KK Male)***	***NC (None)***	***S (SAE)***	See "Operating	**XXX.XX**	**S***
***HA**	**020** (2.00")	***Blank***	**BEF2**	Selection Chart"	**2** (CC Male)	**HE** (Head End)	**N** (NPTF)	Fluids" on	(Specify	(See
***HL**	**025** (2.50")	***if***	**FS**	on page 64.	**3** (KK Female)	**CE** (Cap End)	**I** (ISO 6149)	page 57.	Gross Stroke	Below)
HW	**032** (3.25")	***Standard)***	**IH3**	**0062** (.63")	**4** (Special†)	**BE** (Both Ends)	**F** (Flange)	**PH** Standard Tri-Lip Rod Seal, Nitrile Piston Lipseals (Class 1 Seals)	if Stop Tube	
	040 (4.00")		**IH4**	**0100** (1.00")	**5** (Split Coupler)		**B** BSPT		is	
	050 (5.00")	**X**	**ME5**	**0137** (1.38")	**6** (Stub End)		**R** BSPP		Required)	
	060 (6.00")	(Double	**ME6**	**0175** (1.75")			**G** Metric			
	070 (7.00")	Rod End)	**NM1**	**0200** (2.00")			**X** (Other)	**VH** Fluorocarbon Seals (Class 5 Seals)		
	080 (8.00")		**NM2**	**0250** (2.50")	† Must Specify:		(Specify)			
	100 (10.0")	**Y**	**NM3**	**0300** (3.00")	**WF** (Rod Extension)			**EH** EPR Seals (Class 3 Seals)		
	120 (12.0")	(Duplex)	**PB2**	**0350** (3.50")	**A** (Thread Length)			**BH** H.W.C.F. (Class 6 Seals)		
	140 (14.0")		**REF1**	**0400** (4.00")	**KK** (Thread Size and Pitch)			**MH** Class 1 Seals with Brass Scraper		
	160 (16.0")		**REF2**	**0450** (4.50")				**HH** Spring Loaded PTFE Seals (Class 8 Seals)		
	180 (18.0")		**SA**	**0500** (5.00")				**UH** Standard Tri-Lip Rod Seal, Polyurethane Poly Flex Piston Seals[2]		
	200 (20.0")		**SL**	**0550** (5.50")				**XH** Special - Specify		
			TM1	**0700** (7.00")						
			TM2	**0800** (8.00")						
			TM3	**1000** (10.0")						
			(specify dimension XI)							

***** **HA** is the same cylinder supplied for pneumatic service with a chrome plated barrel I.D.

HL is also for pneumatic service with chromed barrel, but prelubricated.

HW – Wood Products H Cylinder (available 1½" - 8" bores) – see below

[2] Contact Factory for 16"-20" Bores

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

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

- End-of-Stroke Switches
  - – EPS-5, EPS-6, EPS-7, CLS-1, CLS-4 Styles (See bulletin AC0840-B11)
  - – MagnaSwitch
- Gland Wear Ring
- Hi-Load Piston (1½"-6" Bores)
- Polymyte Rod Wiperseal

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

Cylinders for Wood Products Applications

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

■ Set screw piston to piston rod
Two axial screws in the piston-to-rod joint prevent the assembly from unthreading.

■ Polyurethane rod wiperseal
Durable rod wiperseal cleans any oil adhering to the rod on the extend stroke and wipes the rod on the return stroke.

■ 'Solid' cap end cushion
Cushion machined directly in the cap for improved resistance to pressure spikes. High flow ball check valves for quick out-of-cushion performance.

■ Poly Flex Piston Seals
Durable polyurethane material with o-ring energizer for long life and positive sealing.

To order your Atlas cylinder with the **Wood Products** options (available 1½"-8" bores) specify '**HW**' Series and '**UH**' in the seal field of the model code. See the example below.

HW	**032**	**PB2**	**0137**	**1**	**BE**	**S**	**UH**	**10.000**
Series	Bore	Mount	Rod	Rod End	Cushions	Ports	Seals	Stroke

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

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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.

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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 head and loosen it from the cylinder body. Confirm that this condition is not occurring. If it does, re-tighten the head firmly against the cylinder body.

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. 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 bearing wear. If clearance is excessive, replace rod bearing 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 a loose head. Torque the head 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 head 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 head 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 bearing or piston bearing due to load misalignment – Correct cylinder-to-load alignment.

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

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

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

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

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Offer of Sale

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

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

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

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

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

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

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

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

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

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

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

11. Improper use and Indemnity. Buyer shall indemnify, defend, and hold Seller harmless from any claim, liability, damages, lawsuits, and costs (including attorney fees), whether for personal injury, property damage, patent, trademark or copyright infringement or any other claim, brought by or incurred by Buyer, Buyer's employees, or any other person, arising out of: (a) improper selection, improper application or other misuse of Products purchased by Buyer from Seller; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of patterns, plans, drawings, or specifications furnished by Buyer to manufacture Product; or (d) Buyer's failure to comply with these terms and conditions. Seller shall not indemnify Buyer under any circumstance except as otherwise provided.

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

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

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

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

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

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

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

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

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

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