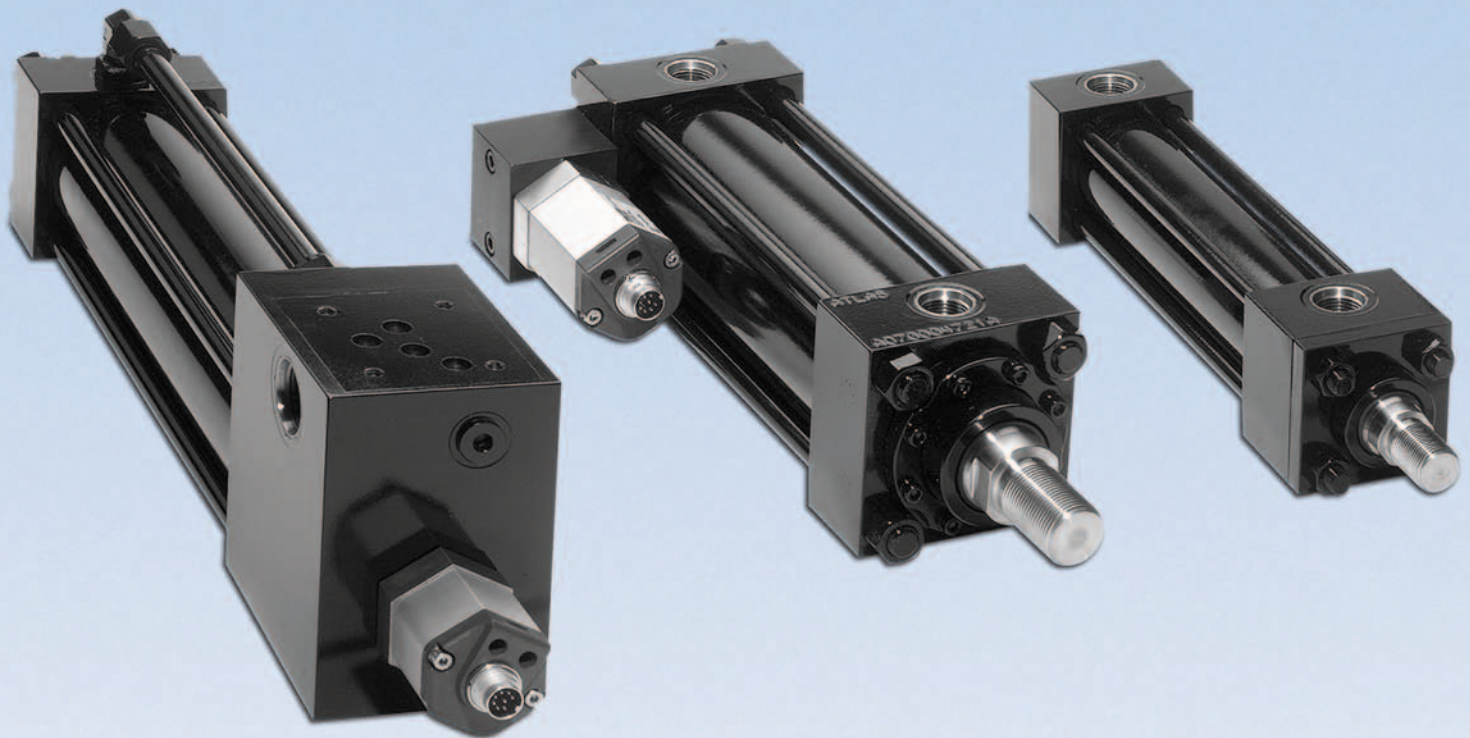


Electronic Stroke Positioning Cylinders

*Series ES
Series EM
Series EP*

*Catalog ESP700
November, 2003*



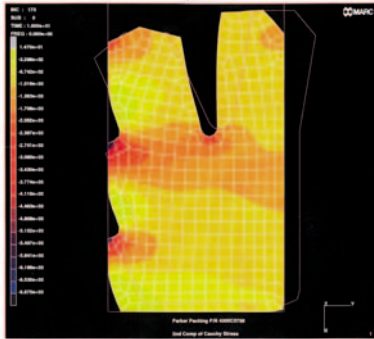
ATLAS
CYLINDERS

Atlas Cylinders “Tri-Lip” Seal Designed To Eliminate Rod Seal Leakage

Atlas Cylinders Series ES, EM, EP Hydraulic Cylinders with the “Tri-Lip” seal offers positive protection against cylinder rod leakage under the most demanding applications.

The “Tri-Lip” seal is the product of countless hours of research, development and extensive field-testing and is only available on Atlas Cylinders.

Based on a proven BS seal profile, the Atlas Cylinders “Tri-Lip” seal incorporates the pressure-compensated, uni-directional characteristics of a U-cup with the multiple edge sealing effectiveness of compression-type stacked-packing.

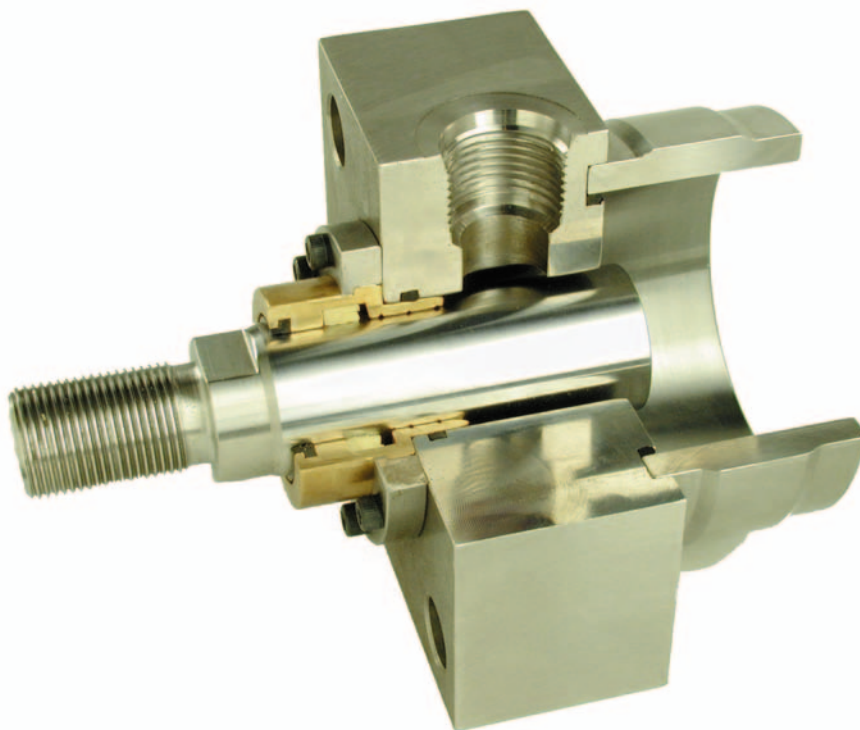


The goal for Atlas Cylinders was to design a rod seal suitable for all types of applications, regardless of pressure profile. It had to be composed of a material that would not react chemically with hydraulic fluids, and it had to produce better and more reliable “dry rod” performance than the standard lip-seal designs in a broad range of applications.



Atlas Cylinders “Tri-Lip” seal can handle the heat

The result is the Atlas Cylinders “Tri-Lip” rod seal, designed specifically to eliminate rod seal leakage in the most demanding applications. It features a special polyurethane material that will not react chemically with petroleum based hydraulic fluid, is extremely resistant to abrasion and extrusion, and provides exceptional service life. It has more sealing edges than other seals on the market, which in turn produces “dry rod” performance. The seal geometry was refined for maximum stability in the groove and has excellent performance characteristics throughout a broad range of pressures and piston rod velocities.



Atlas Cylinders Heavy Duty Electrohydraulic Cylinders

Series ES
Series EM
Series EP



- Standard Bore Sizes – 1" through 8"
- Heavy Duty Service – Industrial Tie-Rod Construction
- Nominal Pressure Ratings to 3000 PSI
- Piston Rod Diameters – 5/8" through 5-1/2"
- Wide Selection of Electronic Feedback Options

Series ES



See pages 4 through 25

- One piece, integral manifold block as cap end.
- Manifold Block hard plumbed to rod end retract port.
- Full stroke position sensing
- Accepts MTS or Balluff brand transducers.
- Manifold block valve footprint patterns for specified valves.
- Available with transducer covers, or false stage (extension) to protect transducer or to add a cap end mount.
- Low friction rod seals and gland drain options available.
- Many electrical connections and output options available. (See electronic condition option and accessories page)
- Transducer optional

Series EM



See pages 26 through 45

- Embedded transducer configuration
- External, side mounted electronics conditioning module.
- Meets standard NFPA envelope dimensions on 2-1/2 inch bore and larger sizes. Smaller bores, add 1 inch to the overall length.
- Offers shorter overall length than Series ES while still using a magnetostrictive type transducer.
- Can be provided with sub-plate mounted manifolds for mounting valves directly to the cylinder. (See manifold accessories page)
- Low friction rod seals and gland drain options available.
- Many electrical connections and output options available. (See electronic condition option and accessories page)
- Transducer included

Series EP



See pages 46 through 65

- Embedded transducer (VRVT) configuration.
- Side mounted electrical connector.
- Allows for remote electronic conditioning module.
- Meets standard NFPA envelope dimension for all bore sizes.
- Can be provided with sub-plate mounted manifolds for mounting valves directly to the cylinder. (See manifold accessories page)
- Low friction rod seals and gland drain options available.
- Many electrical connections and output options available. (See electronic condition option and accessories page)
- Transducer included

Atlas Series ES, EM, EP Index Cylinders & Electronics

	Page		Page
SERIES ES			
How to Order Cylinders	6–7	Non-Servo Cylinders	12
How to Order Balluff	8–9	Probe Covers	15
How to Order MTS	10–11	Servo Valve Mounting	12–14
Mounting Styles	5		
SERIES EM			
Electronic Module Dimensions	33	How to Order EM Electronics	32
Electronic Specifications	30–32	Mounting Styles	27
How to Order Cylinders	28–29	Protective Cover	33
SERIES EP			
1.0" Bore Dimensions	52–53	How to Order Cylinders	48–49
Electronic Specifications	50–51	Mounting Styles	47
ACCESSORIES & MODIFICATIONS			
Index	66		

Service Policy

On cylinders returned to the factory for repairs, it is standard policy for the 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 would exceed the costs of a new one, you will be notified.

Warning

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

This document and other information from The Company, its subsidiaries and authorized distributors provide product and/or system options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application, including consequences of any failure and review the information concerning the product or system in the current product catalog. Due to the variety of operating conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the application are met.

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

Offer of Sale

The items described in this document are hereby offered for sale by The Company, its subsidiaries or its authorized distributors. This offer and its acceptance are governed by provisions stated on a separate page of this catalog in the document entitled 'Offer of Sale'.

ATLAS SERIES ES

The ES Series provides the same heavy duty performance and reliability you have come to expect from us, now with improved rod bearing retention.

**S
E
R
I
E
S**

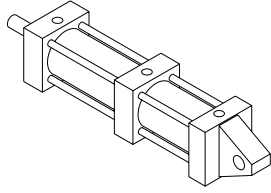
- Chrome-plated induction hardened piston rods
- Tie rods have rolled threads
- Standard SAE O-ring ports or integral servo heads
- Non-contact transducer – no parts to wear out
- Every cylinder is individually tested before it leaves the plant
- Designed to accept all major brands of magnetostrictive transducers
- Low friction piston seals



MOUNTING STYLES

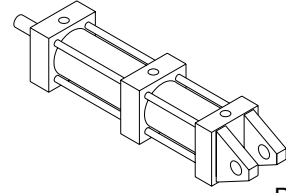
SERIES ES

ES-PB-1
NFA STYLE MP3
PIVOT EYE



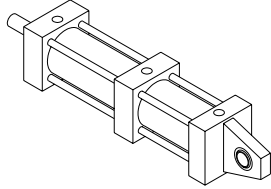
PAGE 22, 23

ES-PB-2
NFA STYLE MP1
FIXED CLEVIS



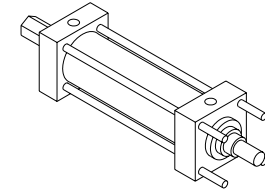
PAGE 22, 23

ES-SA
NFA STYLE MPU3
SELF ALIGNING EYE



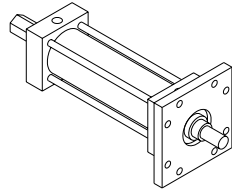
PAGE 22, 23

ES-NM-3
NFA STYLE MX3
TIE ROD EXTENDED
ROD END



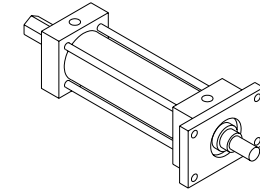
PAGE 16, 17

ES-REF-1
NFA STYLE MF5
ROD END FLANGE
SQUARE



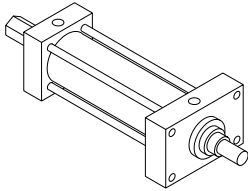
PAGE 18, 19

ES-REF-2
NFA STYLE MF1
ROD END FLANGE
RECTANGULAR



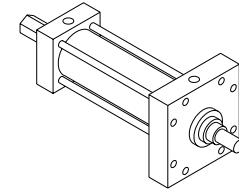
PAGE 18, 19

ES-ME-5
NFA STYLE ME5
FLANGE HEAD



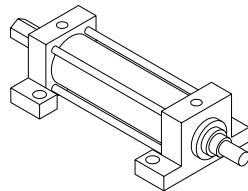
PAGE 18, 19

ES-IH-3
FLANGE HEAD



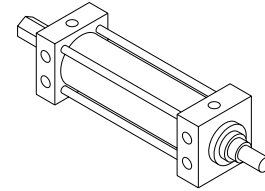
PAGE 18, 19

ES-SL
NFA STYLE MS2
SIDE LUG



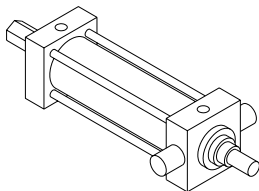
PAGE 20, 21

ES-FS
NFA STYLE MS4
SIDE TAPPED



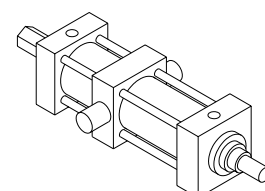
PAGE 20, 21

ES-TM-1
NFA STYLE MT1
ROD END
TRUNNION



PAGE 24, 25

ES-TM-3
NFA STYLE MT4
INTERMEDIATE
TRUNNION



PAGE 24, 25

How to Order Series ES Cylinders

Data Required on All Cylinder Orders

When ordering series ES cylinder, be sure to specify each of the following requirements:

- 1. Series Designation (ES)**
- 2. Bore**
- 3. Mounting Style**
Specify your choice of mounting as shown and dimensioned in this catalog.
- 4. Piston Rod Diameter**
Specify rod diameter. Standard (smallest) rod diameter will be furnished if not specified, unless stroke length makes the application questionable.
- 5. Piston Rod End Style**
Specify the rod end style or specify dimensions if non-standard. Rod end style 1 will be furnished if not specified.
- 6. Cushions**
Cushions are not standard, but will be furnished if required. Consult factory.
- 7. Ports**
SAE straight thread ports are standard on series ES hydraulic cylinders. Servo cylinders use SAE connections for the port tube run and on either side of the head for pressure and tank connections. The port size used for the pressure and tank port connections (EE in the dimension charts) may be a different size than the hard-plumbed rod end ports.
- 8. Seals**
A low friction PTFE piston seal with Buna-N expander, the Atlas "Tri-Lip" enhanced Polyurethane rod seal, Buna-N static seals, and a Polyurethane wiper are all standard, for use with mineral oil based hydraulic fluids. Fluorocarbon, EPR, Nitroxile and other compounds may be specified, but depend on application temperature range and fluid used. Low friction PTFE rod seals may be specified in the special options section.
- 9. Stroke**
Specify length required.
- 10. Special Options**
Specify. Consult factory with questions.

Note: Duplicate cylinders can be ordered by giving the serial number from the rod end head of the original cylinder. Factory records will supply a quick and positive identification.

Certified Dimensions

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

Series ES Ordering Guide

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SERIES	BORE	MOUNT	ROD	ROD END	CUSHIONS	PORTS	SEALS	STROKE	OPTIONS
ES	015 (1.50")	REF1	0100 (1.00")	1 (<i>KK MALE</i>)	NC (<i>NONE</i>) ++	S (<i>SAE</i>) **	P (<i>POLY</i>)	XXX.XX	S
	020 (2.00")	REF2	0137 (1.38")	2 (CC MALE)		N (NPTF)	V (FLUOROCARBON)	(SPECIFY	(SEE
	025 (2.50")	IH3	0175 (1.75")	3 (KK FEMALE)		I (ISO 6149)	E (EPR)	GROSS	BELOW)
	032 (3.25")	ME5	0200 (2.00")	4 (SPECIAL+)		F (FLANGE)	B (NITROXILE)	STROKE	
	040 (4.00")	SL	0250 (2.50")	5 (SPLIT COUPLER)		X (OTHER)	M (STD. POLY	IF STOP	
	050 (5.00")	FS	0300 (3.00")	6 (STUB END)		(SPECIFY)	W/ BRASS	TUBE IS	
	060 (6.00")	NM3	0350 (3.50")				SCRAPER)	REQUIRED)	
	070 (7.00")	PB1 *	0400 (4.00")				X (SPECIAL)		
	080 (8.00")	PB2 *	0450 (4.50")				(SPECIFY)		
		SA *	0500 (5.00")						
		TM1	0550 (5.50")						
		TM3 (specify dimension XI)							

**SAE IS STANDARD WITH SERVO HEADS

++ CONSULT FACTORY IF CUSHIONS ARE REQUIRED

+ MUST SPECIFY **WF** (ROD EXTENSION), **A** (THREAD LENGTH),
AND **KK** OR **CC** (THREAD SIZE AND PITCH)

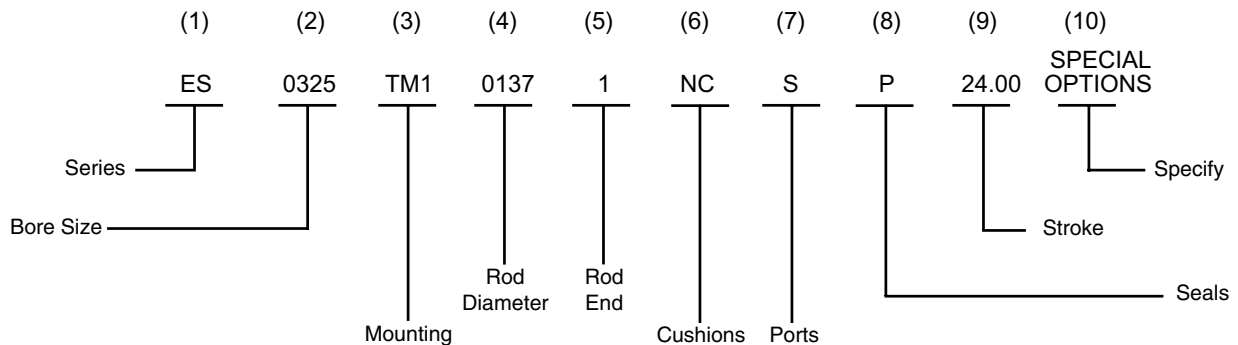
* Requires false stage—see options below (1.50" bore requires 2.00" size)

NOTE: Items in italics are standard and will be supplied unless otherwise specified

OPTIONS

Prepare for wand	Specify brand and stroke length of transducer probe
Probe cover	Specify light duty, heavy duty, or false stage, if required
Machine for valve	Specify valve group from page 12 (or indicate if no valve & specify port type)
Stop tube	Specify stop tube length and net stroke
Stainless piston rod	Specify if desired
Low friction rod seals	Specify if desired
Rod gland drain	Specify if desired

Sample Model Code



NOTE: If replacing existing cylinder or ordering parts, include the old serial number.

Balluff MICROPULSE™

Order your Atlas Cylinders ES Series with Balluff Micropulse® sensor.
The Micropulse® sensor uses EMT (enhanced magnetostrictive technology).

SERIES ES

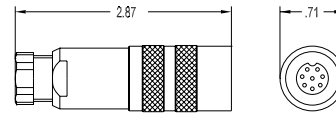
PARAMETER	SPECIFICATION
Measured Variable:	Displacement
Resolution:	Analog: 16-bit Digital: Processing dependent
Non-Linearity*:	±100 µm to 500 mm stroke ±0.02% 500 to 3850 mm stroke
Repeatability:	≤ 6 µm (Hysteresis + Resolution)
Hysteresis:	≤ 4 µm (0.00016 in.)
Outputs:	Analog: Voltage or Current Digital: Start/Stop or PWM
Measuring Range:	Analog: 25 to 3556 mm (1 to 140 in.) Digital: 25 to 3556 mm (1 to 140 in.)
Operating Voltage:	24 Vdc ±20% or ± 15 Vdc ±2% (optional)
Power Consumption:	≤100 mA ≤150mA
Operating Temperature:	Head Electronics: - 40 to 85°C (- 40 to 185°F) Sensing Element: - 40 to 105°C (- 40 to 221°F)
EMC Test:	EN 55 011 Group 1, Class A; IEC 1000-4-2, 3, 4, 6, (immunity) CE Qualified
Shock Rating:	100 g (single hit)/IEC standard 68-2-27 (survivability)
Vibration Rating:	12 g/10-2000 Hz/IEC standard 68-2-6
Adjustability:	Field adjustable zero and span <i>(for Analog sensors only)</i>
Update Time:	Analog: ≤ 1 ms Digital: Minimum = [Stroke (specified in inches) + 3] x 9.0 µs
Operating Pressure:	8700 psi (installed)
Housing Style/Enclosure:	Aluminum die-cast head, anodized aluminum IP 67 stainless steel rod & flange (when BKS-532/33 is installed)
Magnet Type:	Ring magnet

* Non-linearity increases with multiple circulations.

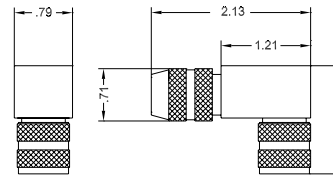
The above specifications for analog sensors are assuming that output ripple is averaged by the measuring device as with any typical analog device. Specifications are subject to change without notice. Contact Balluff to confirm specifications that are critical to your needs.

CE The CE-Marking confirms that our products meet the requirements of the EC Directive 89/336/EEG (EMC Directive) and the EMC Law.

Connector Dimensions



BKS-S-32M



BKS-S-33M

Ordering Code	BKS-S-32M-_*	BKS-S-33M-_*
Solder Connection	max. 0.75 mm	max 0.75 mm
Housing Material	CuZn, nickel plated	ZnAlCu1, nickel plated
Contact Surface	0.8 µm Au	0.8 µm Au
Cable Opening	PG 9 cord seal 68 mm	PG 9 cord seal 68 mm
Cable	7 X 0.25 mm	7 X 0.25 mm

* Please indicate cable length in ordering code.
Code 00 for connector only. Code 05, 10, 15,
25, 30 m for finished assembled cable.

Additional product information available on the
Balluff web site at www.balluff.com or call
1-800-543-8390

How to Order

B T L - 5 - - M - Z - -

Balluff - Transducer - Linear

Generation 5

Output Signal

- A = 0...10V
- B = -5...+5 V
- C = 0...20 mA
- E = 4...20 mA
- G = -10...+10 V
- M = differential Start/Stop - leading edge active
- N = single-ended Start/Stop - leading edge active
- P = differential Start/Stop - trailing edge active
- R = differential pulse width recirculated

Supply Voltage

- 1 = 24 V ±20%
- 2 = ±15 V ±2%

Output Signal (analog only)

If A,B, or G output signal

- 1 = Vmin or Vmax at connector end, i.e. user selectable rising or falling

If C or E output signal

- 0 = Imin at connector end (rising towards opposite end)
- 7 = Imax at connector end (falling towards opposite end)

Nominal stroke in mm

0305 = 305 mm active electrical stroke

Housing geometry

Z = standard rod style -(3/4 x 16) threads

Connection type

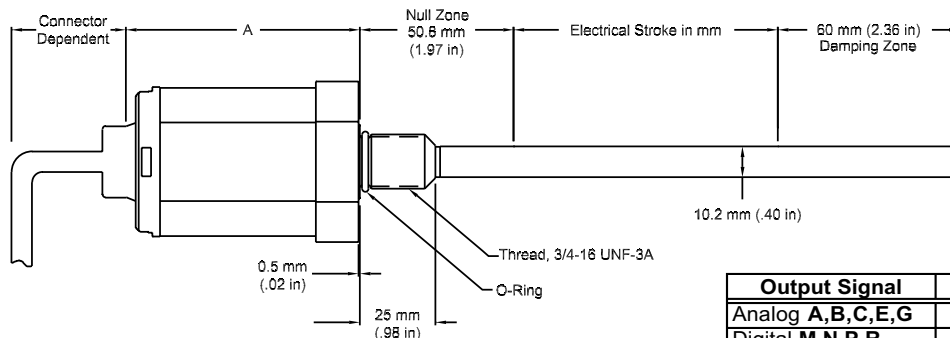
S32 = 8 pin quick disconnect metal connector
KA05 = integral axial cable (with 5 m cable; specify length in meters)

Interrogation (R output only)

- I = Internal Interrogation
- E = External Interrogation

Recirculations (R output only)

1 = 1 circulation, 2 = 2 circulation, 4 = 4 recirculations, 8 = 8 recirculations, 16 = 16 recirculations



Output Signal	A Dimension
Analog A,B,C,E,G	2.91 (74 mm)
Digital M,N,P,R	2.24 (57 mm)

MTS Temposonics® L Series

Order your Atlas Cylinders ES Series with MTS Temposonics® L Series sensor. The L Series sensor uses non-contacting magnetostrictive technology.

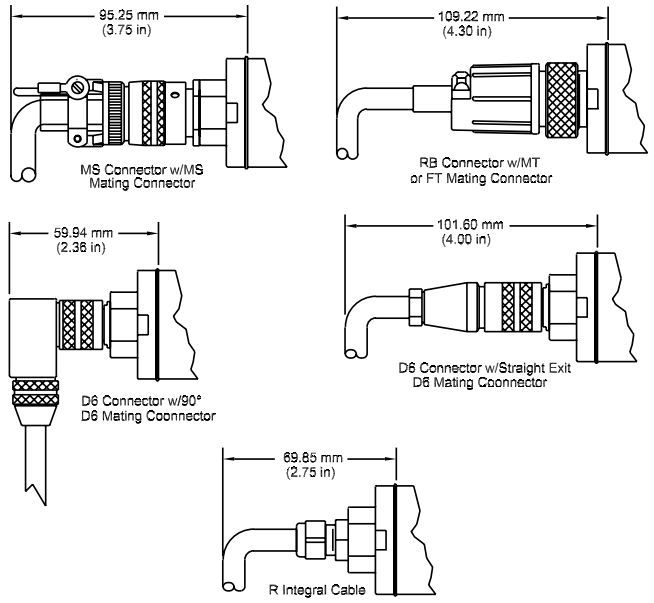
SERIES ES

PARAMETER	SPECIFICATION
Measured Variable:	Displacement
Resolution:	<i>Analog:</i> Infinite <i>Digital:</i> $1 \div [\text{gradient} \times \text{crystal freq. (mHz)} \times \text{circulation}]$
Non-Linearity*:	$\pm 0.02\%$ or $\pm 0.05 \text{ mm}$ ($\pm 0.002 \text{ in.}$), whichever is greater 0.002 in. is the minimum absolute linearity and varies with sensor model
Repeatability:	Equal to resolution
Hysteresis:	$< 0.02 \text{ mm}$ (0.0008 in.)
Outputs:	<i>Analog:</i> Voltage or Current <i>Digital:</i> Start/Stop or PWM
Measuring Range:	<i>Analog:</i> 25 to 2000 mm (1 to 78 in.) <i>Digital:</i> 25 to 7600 mm (1 to 300 in.)
Operating Voltage:	+ 13.5 to 26.4 Vdc ($\pm 0\%$): Strokes $\leq 1525 \text{ mm}$ (60 in.) + 24 Vdc ($\pm 10\%$): Strokes $> 1525 \text{ mm}$ (60 in.)
Power Consumption:	100 mA
Operating Temperature:	<i>Head Electronics:</i> - 40 to 85°C (- 40 to 185°F) <i>Sensing Element:</i> - 40 to 105°C (- 40 to 221°F)
EMC Test:	DIN IEC 801-4, Type 4, CE Qualified; DIN EN 50081-1 (Emissions), DIN EN 50082-2 (Immunity)**
Shock Rating:	100 g (single hit)/IEC standard 68-2-27 (survivability)
Vibration Rating:	5 g/10-150 Hz/IEC standard 68-2-6
Adjustability:	Field adjustable zero and span to 5% of active stroke <i>(for Analog sensors only)</i>
Update Time:	<i>Analog:</i> $\leq 1 \text{ ms}$ <i>Digital:</i> Minimum = [Stroke (specified in inches) + 3] x 9.1 μs
Operating Pressure:	5000 psi static; 10,000 psi spike
Housing Style/Enclosure:	Aluminum die-cast head, IP 67 stainless steel rod & flange (LH flange: M18 x 1.5 or 3/4-16 UNF-3A)
Magnet Type:	Ring magnet

* Non-linearity increases with multiple circulations.
** EMC test specification does not include sensors with the RB connection style.
The above specifications for analog sensors are assuming that output ripple is averaged by the measuring device as with any typical analog device. Specifications are subject to change without notice. Contact MTS to confirm specifications that are critical to your needs.

Additional product information available on the MTS web site at www.temposonics.com or call 1-800-633-7609.

Connector Dimensions



EXTENSION CABLES

SENSORS CONNECTION TYPE

SENSORS CONNECTION TYPE

- MT = Molded Connector, Standard (For use with style RB sensors)
- FT = Field Installable Connector (For use with style RB sensors)
- MS = Mating Connector for 10-Pin MS or RM Bayonet-style Connector
- D6 = Female Mating Connector for D6 Straight-exit style sensor only
- DA = Female Mating Connector for D6 90° exit style sensor only

CABLE LENGTHS

For Sensor Connection Types MT, RG, RA or D6 (see above)

- 005 = 5 ft.
- 015 = 15 ft.
- 025 = 25 ft.
- 050 = 50 ft.
- 100 = 100 ft.

For Sensor Connection Types MS or FT (see above)

- _____ = Cable Length (Range 5 ft. 100 ft.; Encode: 005 to 100)

Custom Cable Length for Connection Type D6 (see above)

- _____ = Custom cable length (in feet). Maximum cable length is dependent upon output. Consult MTS Applications Engineering.

CABLE TERMINATION

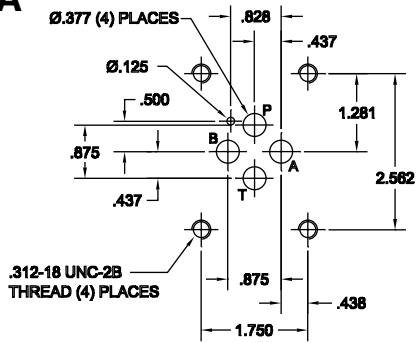
- P0 = Pigtail connection
- D6M = Male D6 connector (For connection types D6 and DA only)



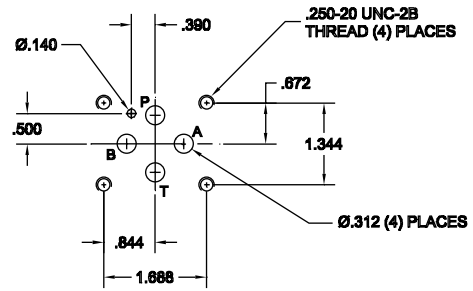
Servo Valve Mount Chart

SERIES ES

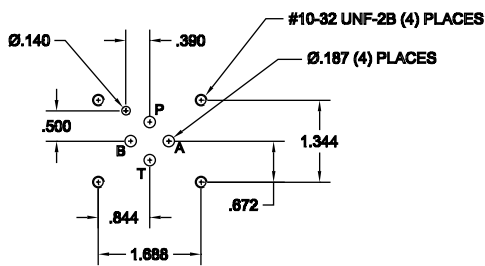
Group A



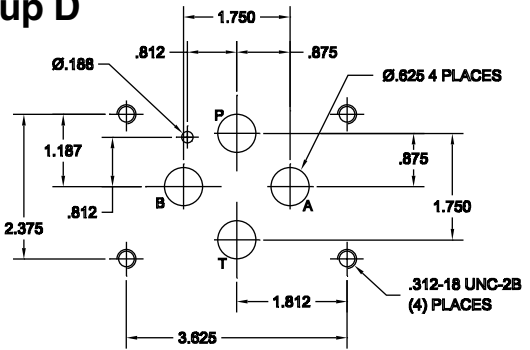
Group B



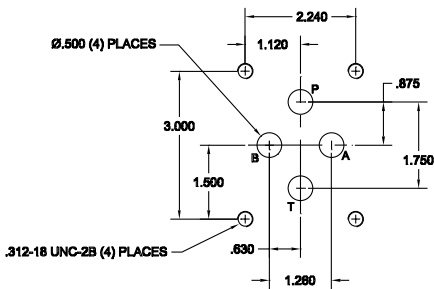
Group C



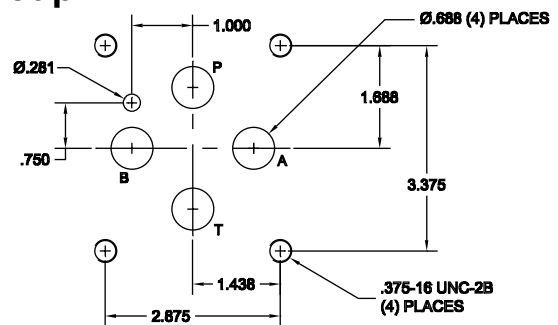
Group D



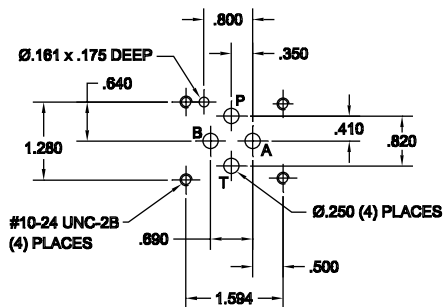
Group E



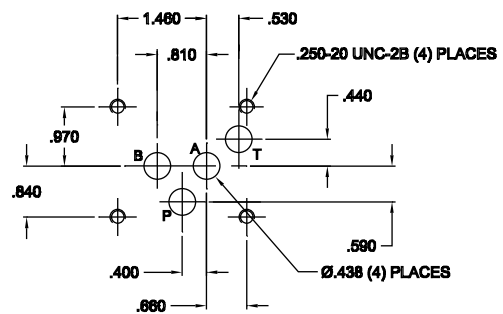
Group F



Group G (D03)



Group H (D05)



NOTE: "B" PORT TO ROD END UNLESS OTHERWISE SPECIFIED
X AND Y PORTS NOT SUPPLIED UNLESS SPECIFIED

Servo Valve Mounting Interchange Chart

(all valves in each group use the same mounting)

Group A

Atchley 215A-XXX
 Moog 62 Series
 Moog 73 Series
 Moog 760 Series
 Parker BD-15
 Parker ST-10
 Parker ST-15
 Vickers SM4-20-X-X-10
 Vickers SM4-30-X-X-10

Group B

Atchley 218-XXX
 Pegasus 142A
 Pegasus 162A
 Pegasus 162R
 Pegasus 162M
 Vickers SM4-15-X-X-10

Group C

Atchley 208A-XXX
 Atchley 209-XXX
 Pegasus 122A

Group D

Atchley 240-XXX
 Moog 78 Series
 Parker BD-30
 Parker ST-40
 Pegasus 180L
 Pegasus 180R
 Vickers SM4-40-X-X-10

Group E

Atchley 231
 Atchley 242-XXX
 Vickers SM4-30-X-X-20

Group F

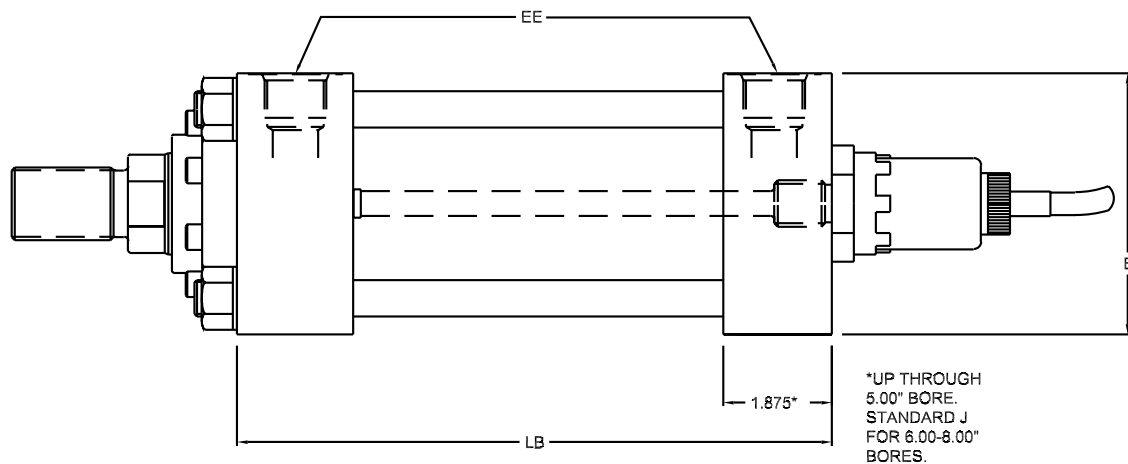
Atchley 261-XX
 Moog 72 Series
 Pegasus 1282A

SERIES ES

Cylinders without Servo Heads

ES series cylinders ordered without servo valve mounting will be shipped with standard ports the same size as the equivalent bore H series hydraulic cylinder (see EE on chart below for SAE and NPTF port sizes). The base end head will have a standard E dimension, which is the same as the rod head. For cylinders up to and including 5 inch bore the base end will be 1.875 inches thick, to accommodate a standard transducer wand. Larger sizes use a standard thickness H series head. These dimensions can also be found in this catalog under column J for PB1 and PB2 mountings. Dimension LB is unchanged whether a servo is used or not.

ES series cylinders can also be ordered with the aluminum valve blocks shown on page 67, although not all the valve patterns shown here are available.



Bore	EE	
	SAE	NPTF
1 1/2, 2, 2 1/2	#8	1/2
3 1/4, 4, 5	#12	3/4
6	#16	1
7	#20	1 1/4
8	#24	1 1/2

Notes for Servo Cylinders

- Because of interference between the port tube fittings, there are minimum strokes for cylinders with servo heads. Mid-trunnion mounting increases the minimum stroke because of additional interference between the trunnion and the fittings. The table below lists the minimums for both.
- Shorter strokes can be accomplished with an alternate fitting design. Consult factory for further information.
- Minimum XI as shown in the table for TM3 mounts will keep the trunnion clear of the fitting on the rod head. If shorter XI is required an alternate method of connecting the tubing can be used. Consult factory.

MINIMUM XI

BORE	MIN. XI		MAX. XI + STROKE	
	NON-SERVO	SERVO	NON-SERVO	SERVO
1.50	3.75	3.75	4.75	4.75
2.00	4.13	4.13	4.88	4.88
2.50	4.19	5.00	4.94	5.00
3.25	4.69	5.50	5.19	5.50
4.00	4.94	5.88	5.56	5.88
5.00	5.06	5.94	5.63	5.94

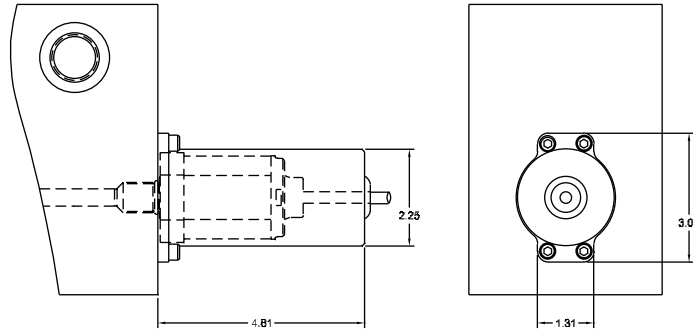
MINIMUM STROKE

BORE	MIN. STROKE		TM3 MIN. STROKE	
	GR. A,B,C,G	GR. D,E,F,H	GR. A,B,C,G	GR. D,E,F,H
1.50	1.44	2.94	1.44	2.94
2.00	1.44	2.94	1.44	2.94
2.50	1.31	2.75	2.25	3.69
3.25	1.75	3.25	2.75	4.25
4.00	1.63	3.25	3.00	4.50
5.00	1.50	3.00	2.56	4.25
6.00	3.13	4.63		
7.00	1.25	2.75		
8.00	0.61	2.12		

Series ES

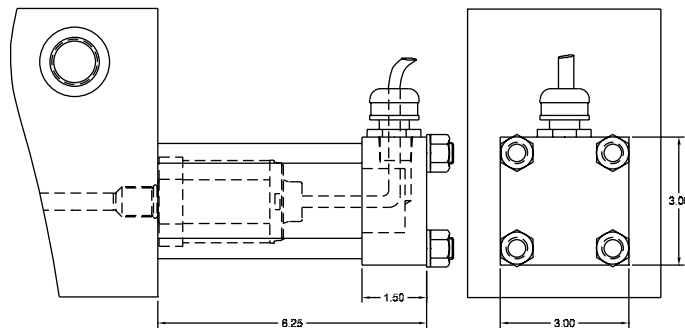
Protective Transducer Covers

Light Duty Cover

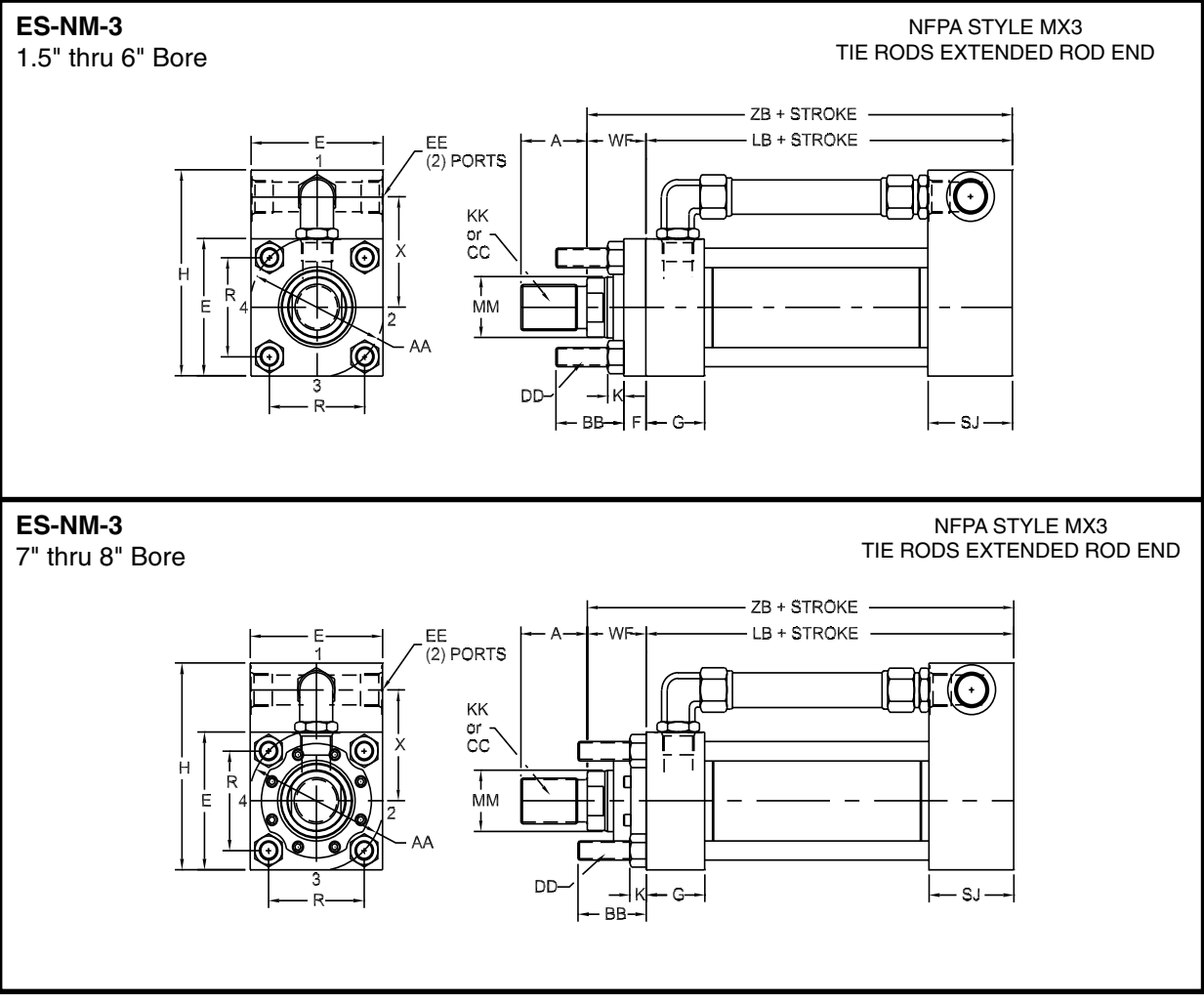


- Billet aluminum construction
- Provides protection against dust and dirt
- Offers protection against minor impacts
- Easy access to electronics

Heavy Duty Cover



- Offers maximum protection from the elements
- Water-tight protection available upon request
- Exceptional resistance to impacts and abuse



ROD END DIMENSIONS

<p>STYLE 1 <i>Standard Male Thread</i></p> <p>If rod end is not specified Style 1 will be supplied.</p>	<p>STYLE 2 <i>OverSize Male Thread</i></p>	<p>STYLE 3 <i>Female Thread</i></p> <p>"A" THREAD DEPTH</p>
<p>STYLE 4 <i>"SPECIALS" THREAD STYLE 4</i></p> <p>Special thread, extension, rod eye, blank, etc., are also available.</p> <p>To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.</p>	<p>STYLE 5 <i>Split Coupler</i></p> <p>See Page 74 for dimensional data.</p>	<p>STYLE 6 <i>Stub End</i></p>

4 1/2" rod and larger have spanner wrench holes in place of wrench flats.
 NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.



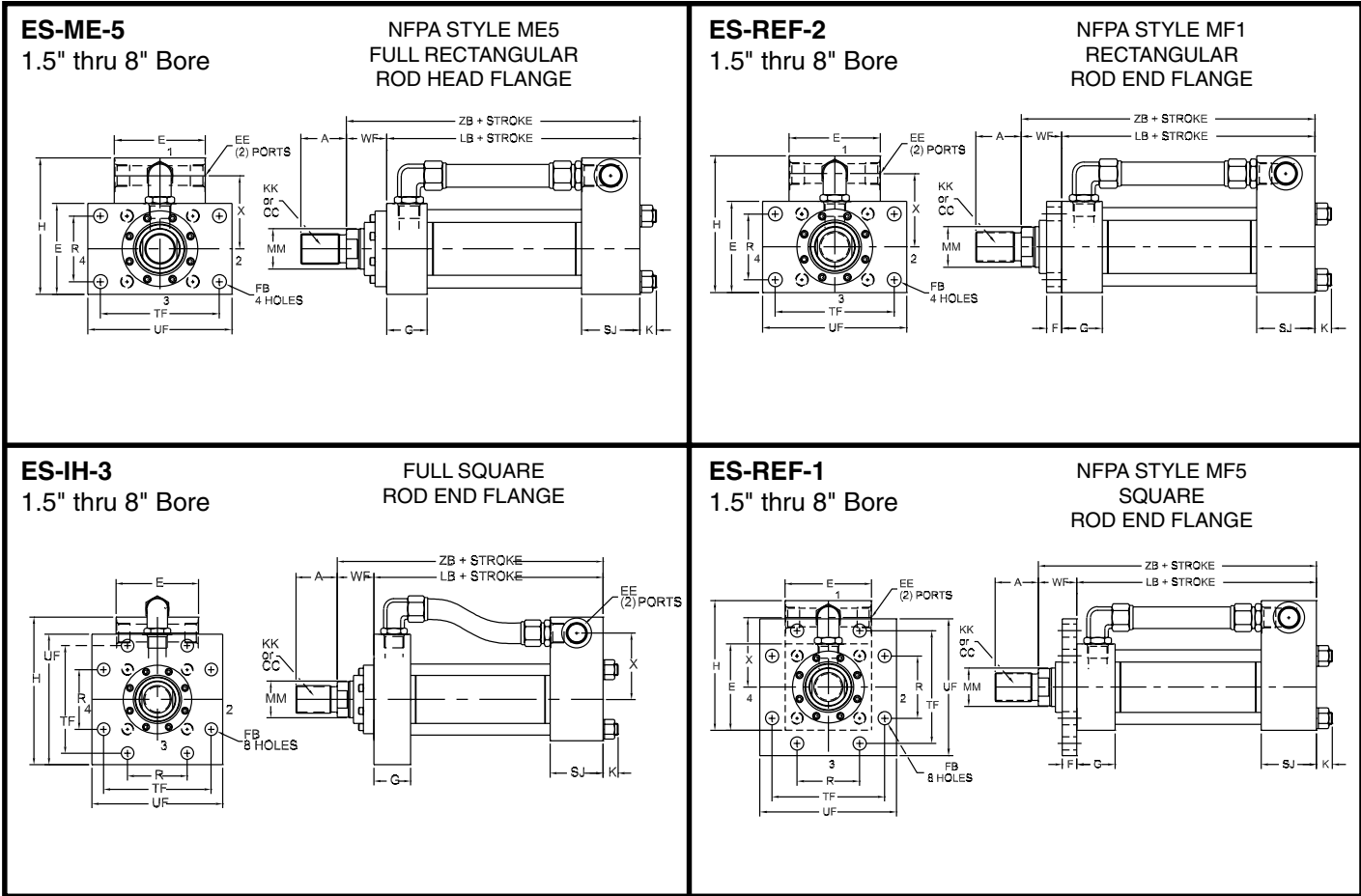
Envelope and Mounting Dimensions

Bore	AA	BB	DD	E	EE SAE	F	G
1 1/2	2.3	1 3/8	3/8 - 24	2 1/2	#12	3/8	1 3/4
2	2.9	1 13/16	1/2 - 20	3	#12	5/8	1 3/4
2 1/2	3.6	1 13/16	1/2 - 20	3 1/2	#12	5/8	1 3/4
3 1/4	4.6	2 5/16	5/8 - 18	4 1/2	#12	3/4	2
4	5.4	2 5/16	5/8 - 18	5	#12	7/8	2
5	7.0	3 3/16	7/8 - 14	6 1/2	#12	7/8	2
6	8.1	3 5/8	1 - 14	7 1/2	#16	1	2 1/4
7	9.3	4 1/8	1 1/8 - 12	8 1/2	#16	-	2 3/4
8	10.6	4 1/2	1 1/4 - 12	9 1/2	#16	-	3

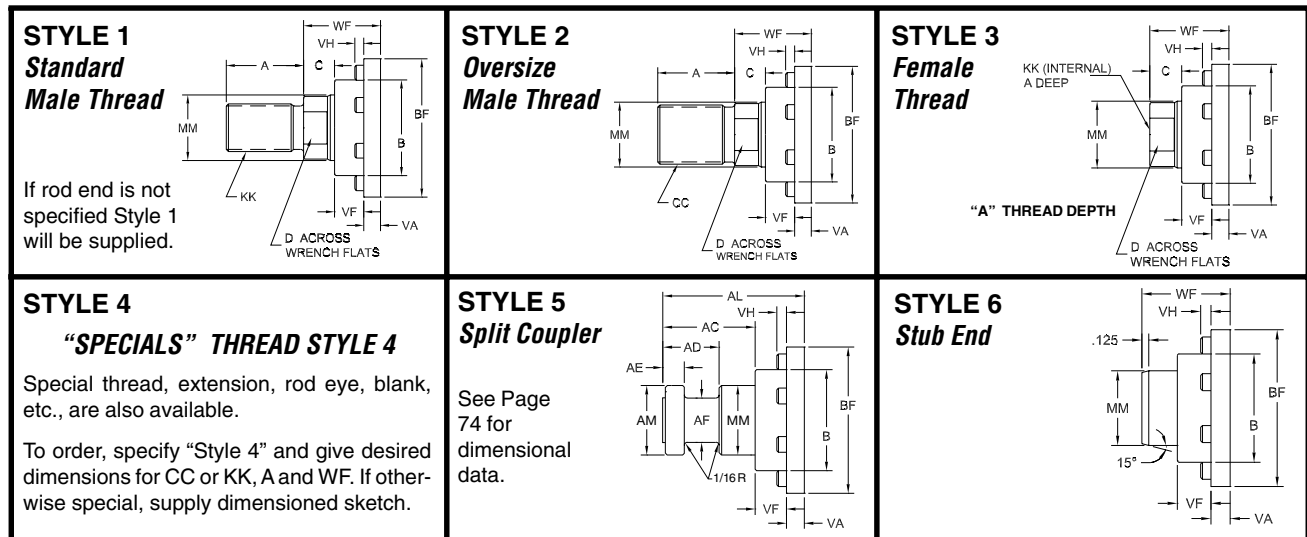
Bore	H	SJ A,B,C,G	SJ D,E,F,H	K	R	X	Add Stroke LB
1 1/2	4 7/8	2 7/8	-	1/2	1.63	2.50	5 7/8
2	4 7/8	2 7/8	-	5/8	2.05	2.50	5 7/8
2 1/2	5 3/8	2 7/8	4 3/8	5/8	2.55	2.75	6
3 1/4	6 3/4	2 7/8	4 3/8	3/4	3.25	3.62	6 1/2
4	7 1/4	2 7/8	4 3/8	3/4	3.82	3.88	6 5/8
5	8 3/4	2 7/8	4 3/8	1	4.95	4.62	6 3/4
6	9 3/4	2 7/8	4 3/8	1 1/8	5.73	5.00	7 3/8
7	11	2 7/8	4 3/8	1 1/4	6.58	5.75	7 3/4
8	12	2 7/8	4 3/8	1 1/2	7.50	6.25	8 1/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	Add Stroke
		Style 1 & 3 KK	Style 2 CC										ZB
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/8
2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	1 5/8
2 1/2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	1 5/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	1 7/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	8 1/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	8 1/2
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	8 1/2
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	8 5/8
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	8 7/8
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	8 3/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	9
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	9
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	9
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	9 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	9 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	9 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	9 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	10
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	10
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	10
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	10
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	10
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	10 1/2
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	10 1/2
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	10 1/2
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	10 1/2
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	10 1/2



ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

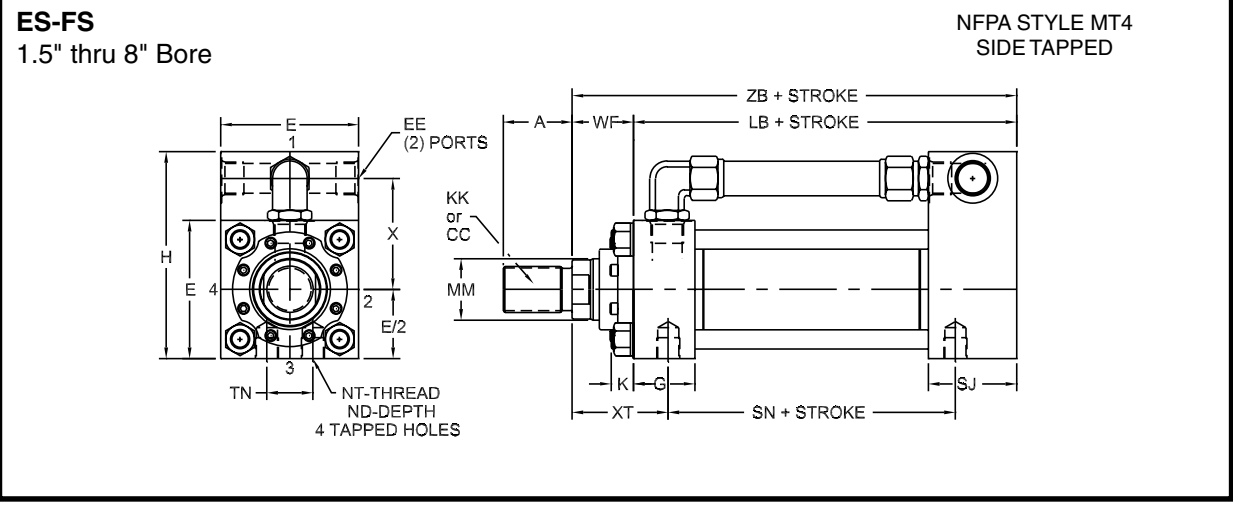
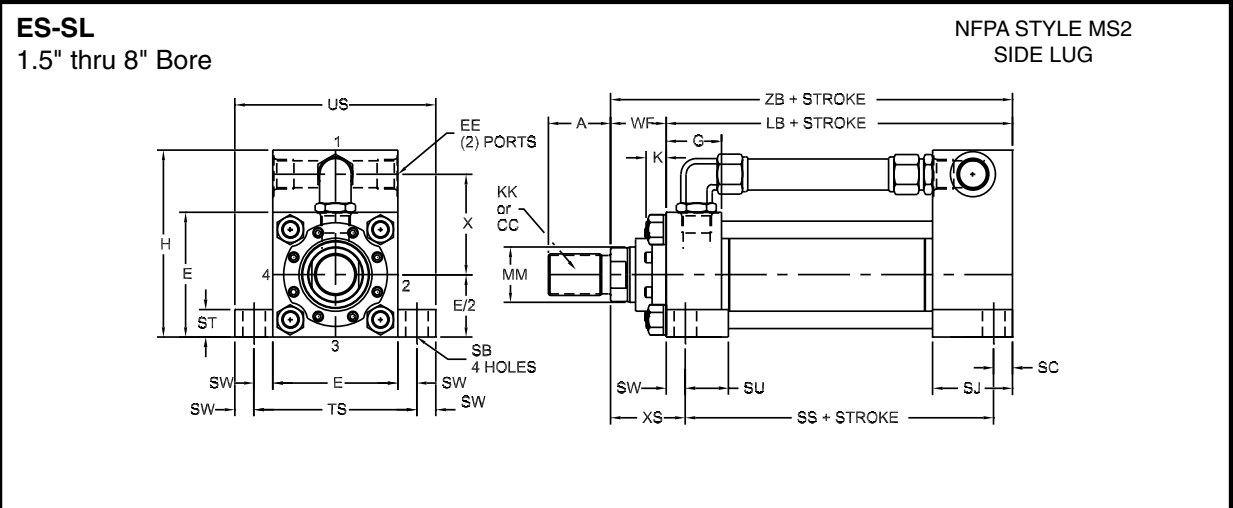
Envelope and Mounting Dimensions

Bore	E	EE SAE	F	FB	G	H	K
1 1/2	2 1/2	#12	3/8	7/16	1 3/4	4 7/8	1/2
2	3	#12	5/8	9/16	1 3/4	4 7/8	5/8
2 1/2	3 1/2	#12	5/8	9/16	1 3/4	5 3/8	5/8
3 1/4	4 1/2	#12	3/4	11/16	2	6 3/4	3/4
4	5	#12	7/8	11/16	2	7 1/4	3/4
5	6 1/2	#12	7/8	15/16	2	8 3/4	1
6	7 1/2	#16	1	1 1/16	2 1/4	9 3/4	1 1/8
7	8 1/2	#16	1	1 3/16	2 3/4	11	1 1/4
8	9 1/2	#16	1	1 5/16	3	12	1 1/2

Bore	R	SJ A,B,C,G	SJ D,E,F,H	TF	UF	X	Add Stroke LB
1 1/2	1.63	2 7/8	-	3 7/16	4 1/4	2.50	5 7/8
2	2.05	2 7/8	-	4 1/8	5 1/8	2.50	5 7/8
2 1/2	2.55	2 7/8	4 3/8	4 5/8	5 5/8	2.75	6
3 1/4	3.25	2 7/8	4 3/8	5 7/8	7 1/8	3.62	6 1/2
4	3.82	2 7/8	4 3/8	6 3/8	7 5/8	3.88	6 5/8
5	4.95	2 7/8	4 3/8	8 3/16	9 3/4	4.62	6 3/4
6	5.73	2 7/8	4 3/8	9 7/16	11 1/4	5.00	7 3/8
7	6.58	2 7/8	4 3/8	10 5/8	12 5/8	5.75	7 3/4
8	7.50	2 7/8	4 3/8	11 13/16	14	6.25	8 1/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	Add Stroke
		Style 1 & 3 KK	Style 2 CC										ZB
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	7 1/4
2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	7 1/2
2 1/2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	7 5/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	7 7/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	8 1/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	8 1/2
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	8 1/2
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	8 5/8
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	8 7/8
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	8 3/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	9
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	9
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	9
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	9 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	9 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	9 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	9 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	10
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	10
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	10
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	10
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	10
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	10 1/2
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	10 1/2
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	10 1/2
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	10 1/2
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	10 1/2



ROD END DIMENSIONS

<p>STYLE 1 <i>Standard Male Thread</i></p> <p>If rod end is not specified Style 1 will be supplied.</p>	<p>STYLE 2 <i>Overize Male Thread</i></p>	<p>STYLE 3 <i>Female Thread</i></p> <p>"A" THREAD DEPTH</p>
<p>STYLE 4 <i>"SPECIALS" THREAD STYLE 4</i></p> <p>Special thread, extension, rod eye, blank, etc., are also available.</p> <p>To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.</p>	<p>STYLE 5 <i>Split Coupler</i></p> <p>See Page 74 for dimensional data.</p>	<p>STYLE 6 <i>Stub End</i></p>

4 1/2" rod and larger have spanner wrench holes in place of wrench flats.
 NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimensions

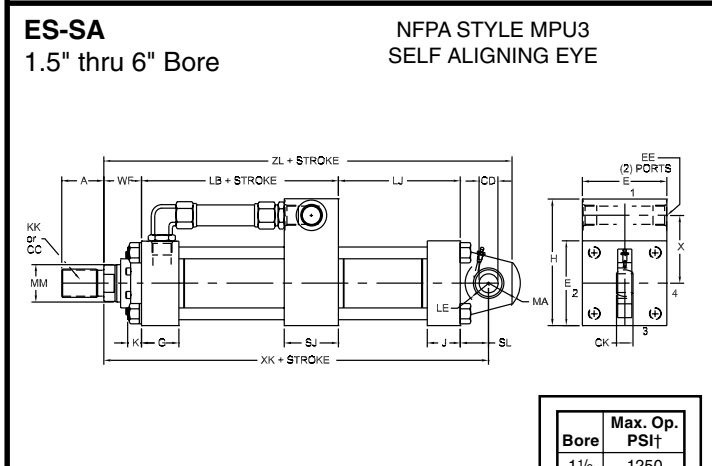
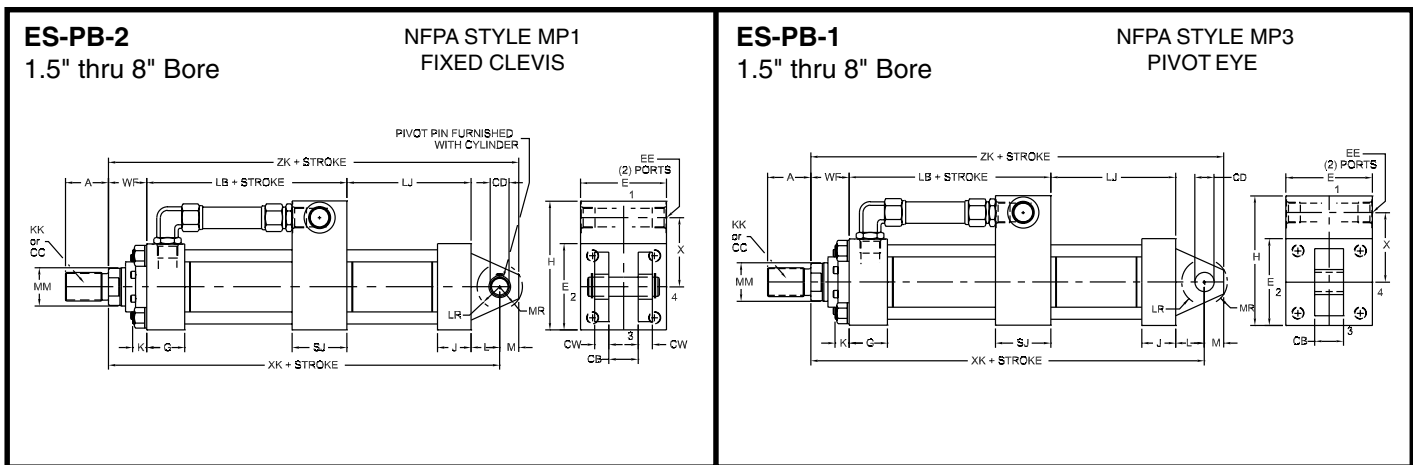
Bore	E	EE SAE	G	H	K	ND	NT	SB	SC	SJ A,B,C,G	SJ D,E,F,H
1 1/2	2 1/2	#12	1 3/4	4 7/8	1/2	3/8	3/8 - 16	7/16	1 3/4	2 7/8	-
2	3	#12	1 3/4	4 7/8	5/8	7/16	1/2 - 13	9/16	1 3/4	2 7/8	-
2 1/2	3 1/2	#12	1 3/4	5 3/8	5/8	1/2	5/8 - 11	13/16	1 15/16	2 7/8	4 3/8
3 1/4	4 1/2	#12	2	6 3/4	3/4	11/16	3/4 - 10	13/16	1 11/16	2 7/8	4 3/8
4	5	#12	2	7 1/4	3/4	11/16	1 - 8	1 1/16	1 7/8	2 7/8	4 3/8
5	6 1/2	#12	2	8 3/4	1	1	1 - 8	1 1/16	1 1/4	2 7/8	4 3/8
6	7 1/2	#16	2 1/4	9 3/4	1 1/8	1 1/4	1 1/4 - 7	1 5/16	1 1/8	2 7/8	4 3/8
7	8 1/2	#16	2 3/4	11	1 1/4	1 1/8	1 1/2 - 6	1 9/16	1 3/8	2 7/8	4 3/8
8	9 1/2	#16	3	12	1 1/2	1 1/2	1 1/2 - 6	1 9/16	1 3/8	2 7/8	4 3/8

Bore	ST	SU	SW	TN	TS	US	X	Add Stroke				
								LB	SN	SN	SN	SS
1 1/2	1/2	15/16	3/8	3/4	3 1/4	4	2 1/2	5 7/8	3 15/16	3 15/16	3 15/16	3 3/4
2	3/4	1 1/4	1/2	15/16	4	5	2 1/2	5 7/8	3 15/16	3 15/16	3 15/16	3 5/8
2 1/2	1	1 9/16	11/16	1 5/16	4 7/8	6 1/4	2 3/4	6	4 1/8	4 1/16	4 1/16	3 3/8
3 1/4	1	1 9/16	11/16	1 1/2	5 7/8	7 1/4	3 5/8	6 1/2	4 7/16	4 7/16	4 7/16	4 1/8
4	1 1/4	2	7/8	2 1/16	6 3/4	8 1/2	3 7/8	6 5/8	4 5/8	4 5/8	4 5/8	3 7/8
5	1 1/4	2	7/8	2 15/16	8 1/8	10	4 5/8	6 3/4	4 5/8	4 1/2	4 1/2	4 5/8
6	1 1/2	2 1/2	1 1/8	3 5/16	9 3/4	12	5	7 3/8	5 3/16	5 1/8	5 1/8	5 1/8
7	1 3/4	2 7/8	1 3/8	3 3/4	11 1/4	14	5 3/4	7 3/4	5 3/16	5 1/16	5 1/16	5 1/4
8	1 3/4	2 7/8	1 3/8	4 1/4	12 1/4	15	6 1/4	8 1/4	5 15/16	5 7/16	5 7/16	6

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	ND	XS	XT	Add Stroke ZB
		Style 1 & 3 KK	Style 2 CC													
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	3/8	1 3/4	2 5/16	7 1/4
2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	7/16	2 1/8	2 9/16	7 1/2
2 1/2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	1/2	2 5/16	2 9/16	7 5/8
3 1/4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	1/2	2 9/16	2 13/16	7 7/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	11/16	2 5/16	2 9/16	8 1/8
3 1/4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	11/16	2 9/16	2 13/16	8 3/8
3 1/4	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	11/16	2 11/16	2 15/16	8 1/2
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	11/16	2 3/4	2 15/16	8 1/2
4	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	11/16	2 7/8	3 1/16	8 5/8
4	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	11/16	3 1/8	3 5/16	8 7/8
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	1	2 7/8	3	8 3/4
5	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	1	3 1/8	3 1/4	9
5	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	1	3 1/8	3 1/4	9
5	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	1	3 1/8	3 1/4	9
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	1 1/4	3 3/8	3 5/16	9 5/8
6	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	1 1/4	3 3/8	3 5/16	9 5/8
6	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	1 1/4	3 3/8	3 5/16	9 5/8
6	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3	15/16	5/16	-	2 1/4	1 1/4	3 3/8	3 5/16	9 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	1 1/8	3 5/8	3 13/16	10
7	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	1 1/8	3 5/8	3 13/16	10
7	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	1 1/8	3 5/8	3 13/16	10
7	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	1 1/8	3 5/8	3 13/16	10
7	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	1 1/8	3 5/8	3 13/16	10
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	1 1/2	3 5/8	3 15/16	10 1/2
8	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	1 1/2	3 5/8	3 15/16	10 1/2
8	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	1 1/2	3 5/8	3 15/16	10 1/2
8	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	1 1/2	3 5/8	3 15/16	10 1/2
8	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	1 1/2	3 5/8	3 15/16	10 1/2

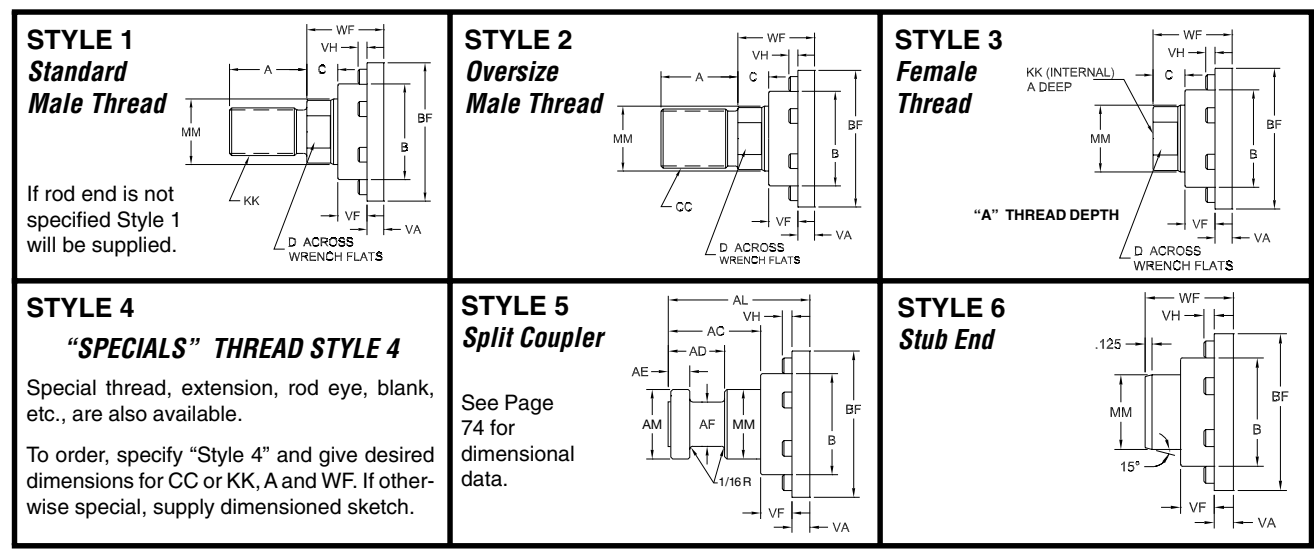




Bore	Max. Op. PSI†
1 1/2	1250
2	2200
2 1/2	1450
3 1/4	1500
4	1850
5	2000
6	1800

†See Table 1 on pg. 73 for recommended maximum swivel angles.

ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.
NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

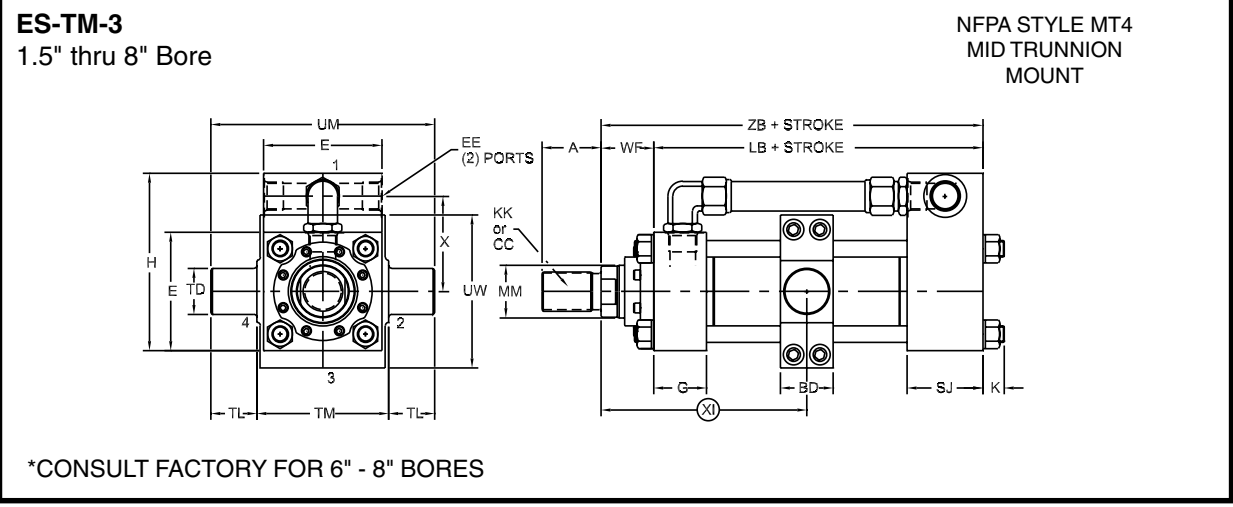
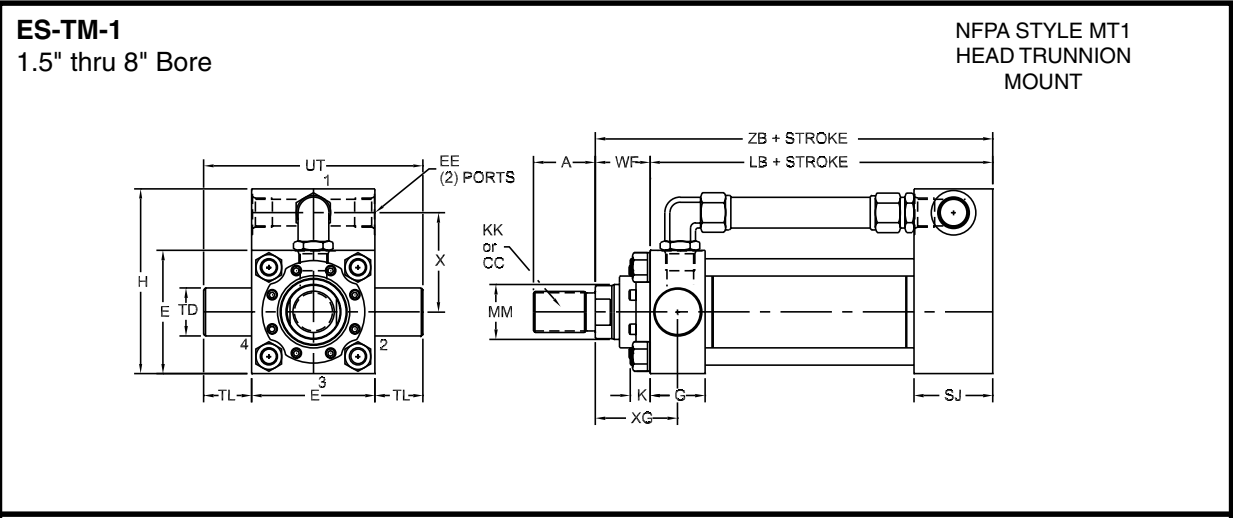
Envelope and Mounting Dimensions

Bore	CB	CD	CK	CW	E	EE SAE	F	G	H	J	SJ A,B,C,G	SJ D,E,F,H
1 1/2	3/4	0.501	7/16	1/2	2 1/2	#12	3/8	1 3/4	4 7/8	1 1/2	2 7/8	-
2	1 1/4	0.751	21/32	5/8	3	#12	5/8	1 3/4	4 7/8	1 1/2	2 7/8	-
2 1/2	1 1/4	0.751	21/32	5/8	3 1/2	#12	5/8	1 3/4	5 3/8	1 1/2	2 7/8	4 3/8
3 1/4	1 1/2	1.001	7/8	3/4	4 1/2	#12	3/4	2	6 3/4	1 3/4	2 7/8	4 3/8
4	2	1.376	1 3/16	1	5	#12	7/8	2	7 1/4	1 3/4	2 7/8	4 3/8
5	2 1/2	1.751	1 17/32	1 1/4	6 1/2	#12	7/8	2	8 3/4	1 3/4	2 7/8	4 3/8
6	2 1/2	2.001	1 3/4	1 1/4	7 1/2	#16	1	2 1/4	9 3/4	2 1/4	2 7/8	4 3/8
7	3	2.501	-	1 1/2	8 1/2	#16	1	2 3/4	11	2 3/4	2 7/8	4 3/8
8	3	3.001	-	1 1/2	9 1/2	#16	1	3	12	3	2 7/8	4 3/8

Bore	K	L	LE	LJ	LR	M	MA	MR	SL	X	Add Stroke LB
1 1/2	1/2	3/4	7/8	6 1/4	9/16	1/2	1 1/4	5/8	3/4	2.50	5 7/8
2	5/8	1 1/4	7/8	6 1/4	1	3/4	1 1/4	15/16	1 1/4	2.50	5 7/8
2 1/2	5/8	1 1/4	7/8	6 1/4	15/16	3/4	1 1/4	15/16	1 1/4	2.75	6
3 1/4	3/4	1 1/2	1 1/8	6 1/2	1 1/4	1	1 1/2	1 3/16	1 1/2	3.62	6 1/2
4	3/4	2 1/8	1 1/2	6 1/2	1 3/4	1 3/8	1 3/4	1 5/8	2 1/8	3.88	6 5/8
5	1	2 1/4	1 15/16	6 1/2	2 1/16	1 3/4	2 1/4	2 1/8	2 1/4	4.62	6 3/4
6	1 1/8	2 1/2	2 3/16	7	2 5/16	2	2 3/4	2 3/8	2 1/2	5.00	7 3/8
7	1 1/4	3	-	7 1/2	2 3/4	2 1/2	-	2 7/8	-	5.75	7 3/4
8	1 1/2	3 1/4	-	7 3/4	3 1/4	2 3/4	-	3 1/8	-	6.25	8 1/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	Add Stroke			
		Style 1 & 3 KK	Style 2 CC										XK	XL	ZK	ZL
1 1/2	1	3/4-16	7/8-14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	14 1/4	14 1/4	14 3/4	15 1/2
2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	15	15	15 3/4	16 1/4
2 1/2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	15 1/8	15 1/8	15 7/8	16 3/8
2 1/2	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	15 3/8	15 3/8	16 1/8	16 5/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	16 1/8	16 1/8	17 1/8	17 5/8
3 1/4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	16 3/8	16 3/8	17 3/8	17 7/8
3 1/4	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	16 1/2	16 1/2	17 1/2	18
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	17 1/8	17 1/8	18 1/2	18 7/8
4	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	17 1/4	17 1/4	18 5/8	19
4	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	17 1/2	17 1/2	18 7/8	19 1/4
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	17 1/2	17 1/2	19 1/4	19 3/4
5	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	17 3/4	17 3/4	19 1/2	20
5	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	17 3/4	17 3/4	19 1/2	20
5	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	17 3/4	17 3/4	19 1/2	20
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	19 1/8	19 1/8	21 1/8	21 7/8
6	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	19 1/8	19 1/8	21 1/8	21 7/8
6	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	19 1/8	19 1/8	21 1/8	21 7/8
6	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	19 1/8	19 1/8	21 1/8	21 7/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	20 1/2	-	23	-
7	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	20 1/2	-	23	-
7	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	20 1/2	-	23	-
7	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	20 1/2	-	23	-
7	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	20 1/2	-	23	-
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	21 1/2	-	24 1/4	-
8	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	21 1/2	-	24 1/4	-
8	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	21 1/2	-	24 1/4	-
8	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	21 1/2	-	24 1/4	-
8	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	21 1/2	-	24 1/4	-



NOTE: If using bolt on manifold plates, see pg. 69 for information on min./max. XI dimension.

ROD END DIMENSIONS

<p>STYLE 1 <i>Standard Male Thread</i></p> <p>If rod end is not specified Style 1 will be supplied.</p>	<p>STYLE 2 <i>OverSize Male Thread</i></p>	<p>STYLE 3 <i>Female Thread</i></p> <p>"A" THREAD DEPTH</p>
<p>STYLE 4 <i>"SPECIALS" THREAD STYLE 4</i></p> <p>Special thread, extension, rod eye, blank, etc., are also available.</p> <p>To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.</p>	<p>STYLE 5 <i>Split Coupler</i></p> <p>See Page 74 for dimensional data.</p>	<p>STYLE 6 <i>Stub End</i></p>

4 1/2" rod and larger have spanner wrench holes in place of wrench flats.
NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimension

Bore	BD	E	EE SAE	G	H	K	SJ A,B,C,G	SJ D,E,F,H
1 1/2	1 1/4	2 1/2	#12	1 3/4	4 7/8	1/2	2 7/8	-
2	1 1/2	3	#12	1 3/4	4 7/8	5/8	2 7/8	-
2 1/2	1 1/2	3 1/2	#12	1 3/4	5 3/8	5/8	2 7/8	4 3/8
3 1/4	2	4 1/2	#12	2	6 3/4	3/4	2 7/8	4 3/8
4	2	5	#12	2	7 1/4	3/4	2 7/8	4 3/8
5	2	6 1/2	#12	2	8 3/4	1	2 7/8	4 3/8
6	3	7 1/2	#16	2 1/4	9 3/4	1 1/8	2 7/8	4 3/8
7	3	8 1/2	#16	2 3/4	11	1 1/4	2 7/8	4 3/8
8	3 1/2	9 1/2	#16	3	12	1 1/2	2 7/8	4 3/8

Bore	TD	TL	TM	UM	UT	UW	X	Add Stroke
								LB
1 1/2	1.000	1	3	5	4 1/2	3 3/8	2.50	5 7/8
2	1.375	1 3/8	3 1/2	6 1/4	5 3/4	4 1/8	2.50	5 7/8
2 1/2	1.375	1 3/8	4	6 3/4	6 1/4	4 5/8	2.75	6
3 1/4	1.750	1 3/4	5	8 1/2	8	5 13/16	3.62	6 1/2
4	1.750	1 3/4	5 1/2	9	8 1/2	6 3/8	3.88	6 5/8
5	1.750	1 3/4	7	10 1/2	10	7 3/4	4.62	6 3/4
6	2.000	2	8 1/2	12 1/2	11 1/2	10 3/8	5.00	7 3/8
7	2.500	2 1/2	9 3/4	14 3/4	13 1/2	11 1/2	5.75	7 3/4
8	3.000	3	11	17	15 1/2	13 3/8	6.25	8 1/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	XG	XI MIN.	Add Stroke ZB
		Style 1 & 3 KK	Style 2 CC												
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/4	3 13/16	7 1/4
2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 1/2	4 3/16	7 1/2
2 1/2	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 1/2	4 3/16	7 5/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 3/4	4 7/16	7 7/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	4 11/16	8 1/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	4 15/16	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	5 1/16	8 1/2
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	4 15/16	8 1/2
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	5 1/16	8 5/8
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/4	5 5/16	8 7/8
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	5 1/16	8 3/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/4	5 5/16	9
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 1/4	5 5/16	9
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 1/4	5 5/16	9
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	6 1/16	9 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 3/8	6 1/16	9 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 3/8	6 1/16	9 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 3/8	6 1/16	9 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 5/8	6 9/16	10
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 5/8	6 9/16	10
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 5/8	6 9/16	10
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	3 5/8	6 9/16	10
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	3 5/8	6 9/16	10
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 3/4	7 1/16	10 1/2
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 3/4	7 1/16	10 1/2
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	3 3/4	7 1/16	10 1/2
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	3 3/4	7 1/16	10 1/2
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	3 3/4	7 1/16	10 1/2

*XI MINIMUM IS FOR CYLINDERS WITHOUT SERVOHEAD. SEE PAGE 69 FOR COMPLETE INFORMATION.

THE NEW SERIES EM FROM ATLAS

From the innovators of the first ESP (**E**lectronic **S**troke **P**ositioning) cylinder comes the next generation in feedback cylinders – the Series EM. Now finite control is available in a smaller, more serviceable, and more cost-effective package. This revolutionary new design makes electronic sensing practical for any cylinder operation with NFPA standard mounts.

**S
E
R
I
E
S
E
M**

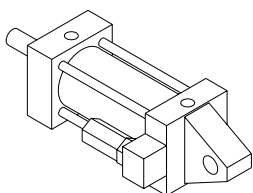
- Self-contained cylinder package, complete with transducer and electronics
- Compact magnetostrictive cylinder assembly
- Externally mounted electronics provide hassle-free service
- Pivot mounts available without adding a false stage
- Auto-tuning electronics allow plug and play adaptation to existing systems
- Replacement costs are low. If there's a problem with the electronics, replace only the electronics, not the entire wand



ATLAS
CYLINDERS

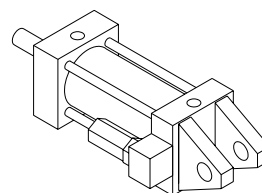
MOUNTING STYLES SERIES EM

EM-PB-1
NFA STYLE MP3
PIVOT EYE



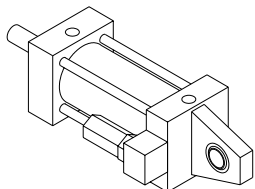
PAGE 42, 43

EM-PB-2
NFA STYLE MP1
FIXED CLEVIS



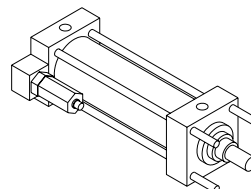
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EM-SA
NFA STYLE MPU3
SELF ALIGNING EYE



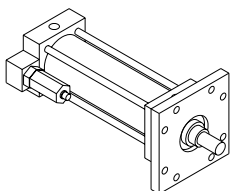
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EM-NM
NFA STYLE MX
TIE ROD EXTENDED
MOUNTS



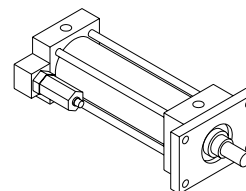
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EM-REF-1
NFA STYLE MF5
ROD END FLANGE
SQUARE



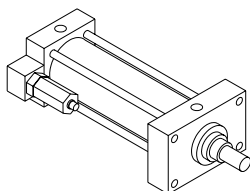
PAGE 36, 37

EM-REF-2
NFA STYLE MF1
ROD END FLANGE
RECTANGULAR



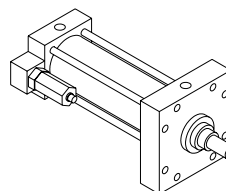
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EM-ME-5
NFA STYLE ME5
FLANGE HEAD



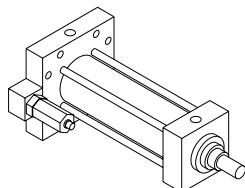
PAGE 38, 39

EM-IH-3
FLANGE HEAD



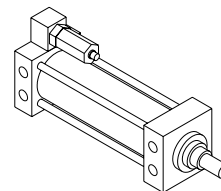
PAGE 38, 39

EM-IH-4
FLANGE HEAD



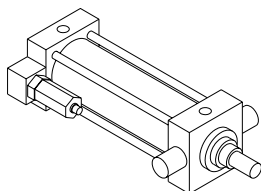
PAGE 38, 39

EM-FS
NFA STYLE MS4
SIDE TAPPED



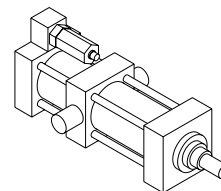
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EM-TM-1
NFA STYLE MT1
ROD END
TRUNNION



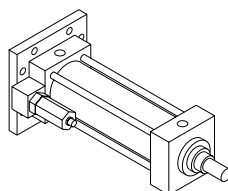
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EM-TM-3
NFA STYLE MT4
INTERMEDIATE
TRUNNION



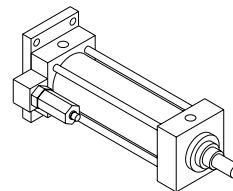
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EM-BEF-1
NFA STYLE MF6
CAP END FLANGE
SQUARE



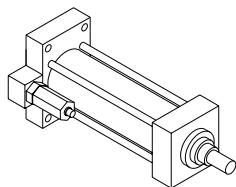
PAGE 36, 37

EM-BEF-2
NFA STYLE MF2
CAP END FLANGE
RECTANGULAR



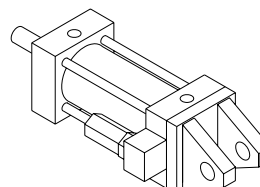
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EM-ME-6
NFA STYLE ME6
FLANGE HEAD



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EM-MP-2
NFA STYLE MP2
DETACHABLE
CLEVIS



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SERIES EM

How to Order Series EM Cylinders

Data Required on All Cylinder Orders

When ordering series EM cylinder, be sure to specify each of the following requirements:

- 1. Series Designation (ES)**
- 2. Bore**
- 3. Mounting Style**
Specify your choice of mounting as shown and dimensioned in this catalog.
- 4. Piston Rod Diameter**
Specify rod diameter. Standard (smallest) rod diameter will be furnished if not specified, unless stroke length makes the application questionable.
- 5. Piston Rod End Style**
Specify the rod end style or specify dimensions if non-standard. Rod end style 1 will be furnished if not specified.
- 6. Cushions**
Cushions are not standard, but will be furnished if required. Consult factory.
- 7. Ports**
SAE straight thread ports are standard on series EM hydraulic cylinders. Cylinders with servo manifolds use SAE connections for the port tube run and on either side of the manifold plate for pressure and tank connection. EE is the size of the port on the head without a manifold; ports on the manifold plates are listed on page 67.
- 8. Seals**
A low friction PTFE piston seal with Buna-N expander, the Atlas "Tri-Lip" enhanced Polyurethane rod seal, Buna-N static seals, and a Polyurethane wiper are all standard, for use with mineral oil based hydraulic fluids. Fluorocarbon, EPR, Nitroxile and other compounds may be specified, but depend on application temperature range and fluid used. Low friction PTFE rod seals may be specified in the special options section.
- 9. Stroke**
Specify length required.
- 10. Special Options**
Specify. Consult factory with questions.

Note: Duplicate cylinders can be ordered by giving the serial number from the rod end head of the original cylinder. Factory records will supply a quick and positive identification.

Certified Dimensions

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

Series EM Ordering Guide

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SERIES	BORE	MOUNT	ROD	ROD END	CUSHIONS	PORTS	SEALS	STROKE	OPTIONS
EM	015 (1.50")	BEF1	0100 (1.00")	1 (<i>KK MALE</i>)	NC (<i>NONE</i>)**	S (<i>SAE</i>)	P (<i>POLY</i>)	XXX.XX	S
	020 (2.00")	BEF2	0137 (1.38")	2 (CC MALE)		N (NPTF)	V (FLUOROCARBON)	(SPECIFY	(SEE
	025 (2.50")	FS	0175 (1.75")	3 (KK FEMALE)		I (ISO 6149)	E (EPR)	GROSS	BELOW)
	032 (3.25")	IH3	0200 (2.00")	4 (SPECIAL+)		F (FLANGE)	B (NITROXILE)	STROKE	
	040 (4.00")	IH4	0250 (2.50")	5 (SPLIT COUPLER)		X (OTHER)	M (STD. POLY	IF STOP	
	050 (5.00")	ME5	0300 (3.00")	6 (STUB END)		(SPECIFY)	W/ BRASS	TUBE IS	
	060 (6.00")	ME6	0350 (3.50")				SCRAPER)	REQUIRED)	
	070 (7.00")	MP2	0400 (4.00")				X (SPECIAL)		
	080 (8.00")	NM1	0450 (4.50")				(SPECIFY)		
		NM2	0500 (5.00")						
		NM3	0550 (5.50")						
		PB1							
		PB2							
		REF1							
		REF2							
		SA							
		TM1							
		TM3							

**CONSULT FACTORY IF CUSHIONS ARE REQUIRED

+ MUST SPECIFY **WF** (ROD EXTENSION), **A** (THREAD LENGTH),
AND **KK** OR **CC** (THREAD SIZE AND PITCH)

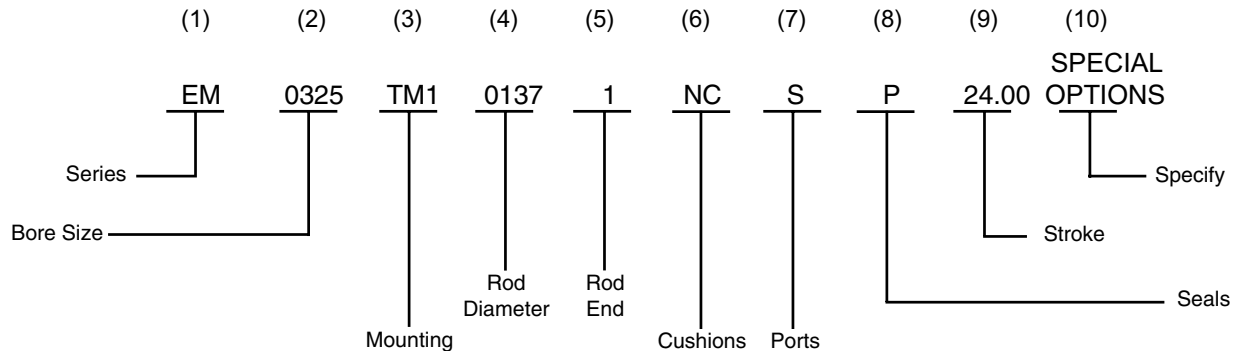
TM3 (specify dimension XI)

NOTE: Items in italics are standard and will be supplied unless otherwise specified

OPTIONS

Add valve subplate	Specify valve group from page
Stop tube	Specify stop tube length and net stroke
Stainless piston rod	Specify if desired
Low friction rod seals	Specify if desired
Rod gland drain	Specify if desired
Electronic cover	Specify if desired

Sample Model Code



NOTE: If replacing existing cylinder or ordering parts, include the old serial number.

Atlas Cylinders **MICROPULSE** Embedded Sensor

Order your Atlas Cylinders EM Series with the Atlas Cylinders Micropulse® embedded sensor. The Micropulse® sensor uses EMT (enhanced magnetostrictive technology).

SERIES EM

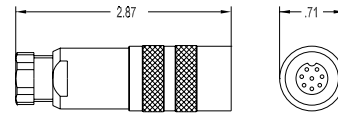
PARAMETER	SPECIFICATION
Measured Variable:	Displacement
Resolution:	Analog: 16-bit Digital: Processing dependent
Non-Linearity*:	±100 µm to 500 mm stroke ±0.02% 500 to 3850 mm stroke
Repeatability:	≤ 6 µm (Hysteresis + Resolution)
Hysteresis:	≤ 4 µm (0.00016 in.)
Outputs:	Analog: Voltage or Current Digital: Start/Stop or PWM
Measuring Range:	Analog: 25 to 3556 mm (1 to 140 in.) Digital: 25 to 3556 mm (1 to 140 in.)
Operating Voltage:	24 Vdc ±20% or ± 15 Vdc ±2% (optional)
Power Consumption:	≤100 mA ≤150mA
Operating Temperature:	Head Electronics: - 40 to 85°C (- 40 to 185°F) Sensing Element: - 40 to 105°C (- 40 to 221°F)
EMC Test:	EN 55 011 Group 1, Class A; IEC 1000-4-2, 3, 4, 6, (immunity) CE Qualified
Shock Rating:	100 g (single hit)/IEC standard 68-2-27 (survivability)
Vibration Rating:	12 g/10-2000 Hz/IEC standard 68-2-6
Adjustability:	Field adjustable zero and span <i>(for Analog sensors only)</i>
Update Time:	Analog: ≤ 1 ms Digital: Minimum = [Stroke (specified in inches) + 3] x 9.0 µs
Operating Pressure:	8700 psi (installed)
Housing Style/Enclosure:	Aluminum die-cast head, anodized aluminum IP 67 stainless steel rod & flange (when BKS-532/33 is installed)
Magnet Type:	Ring magnet

* Non-linearity increases with multiple circulations.

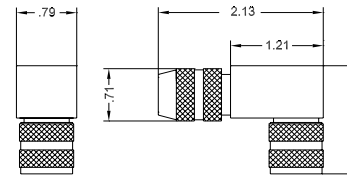
The above specifications for analog sensors are assuming that output ripple is averaged by the measuring device as with any typical analog device. Specifications are subject to change without notice. Contact Atlas Cylinders to confirm specifications that are critical to your needs.

CE The CE-Marking confirms that our products meet the requirements of the EC Directive 89/336/EEG (EMC Directive) and the EMC Law.

Connector Dimensions



BKS-S-32M



BKS-S-33M

Ordering Code	BKS-S-32M-_*	BKS-S-33M-_*
Solder Connection	max. 0.75 mm	max 0.75 mm
Housing Material	CuZn, nickel plated	ZnAlCu1, nickel plated
Contact Surface	0.8 µm Au	0.8 µm Au
Cable Opening	PG 9 cord seal 68 mm	PG 9 cord seal 68 mm
Cable	7 X 0.25 mm	7 X 0.25 mm

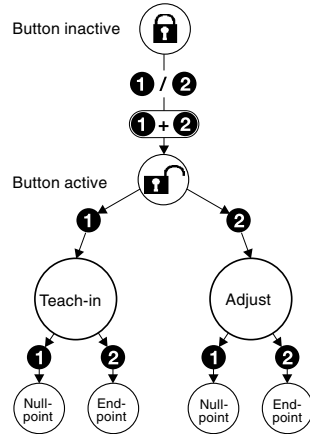
* Please indicate cable length in ordering code. Code 00 for connector only. Code 05, 10, 15, 25, 30 m for finished assembled cable.

Micropulse is a registered trademark of Balluff, Inc.

Analog Interface

100% Null and endpoint calibration

Null and endpoint of the analog signal can be button-set to the desired position. Depending on the application, teach-in or adjust mode is used, selectable by pressing a button combination.



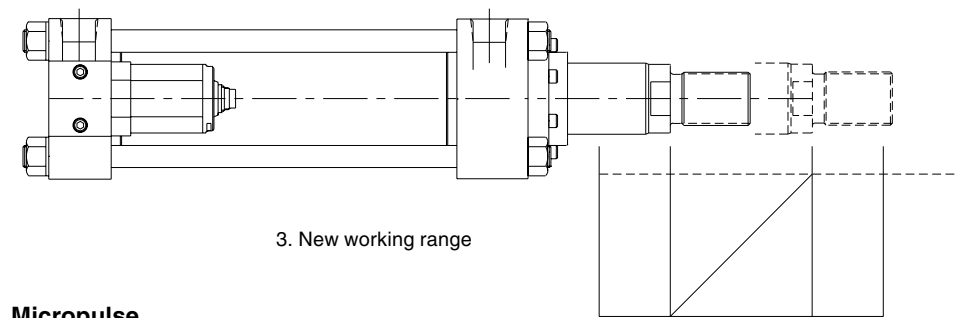
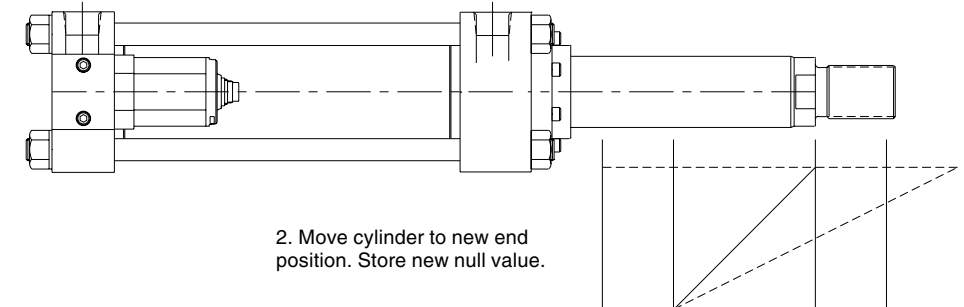
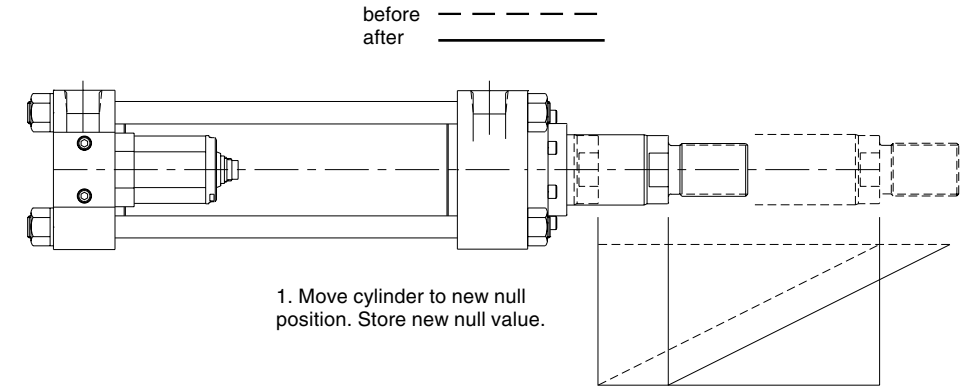
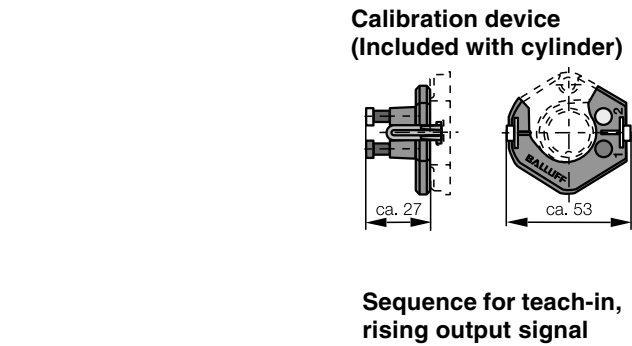
Cal mode selection

Teach-in

You wish to replace the factory set null and endpoint with new values. First move the cylinder to the new null, then to the new end position and store their associated value by pressing the button.

Adjust

Here you can adjust to a new start and/or end value. This may be required when you cannot physically move the cylinder to the standard null and/or endpoint. Alternately move the cylinder to the new start and end position, and adjust the displayed value by pressing the button until the desired output values are reached.

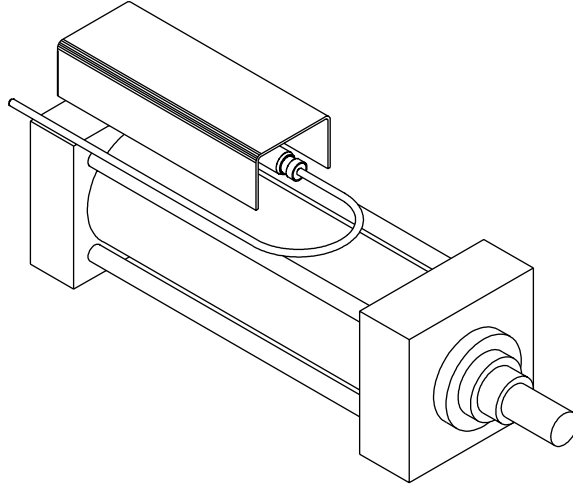


Micropulse ATL5-A/C/E/G...B features

- 100% adjustment of analog signal
 - 2 calibration modes: Teach-in and Adjust for null and endpoint
 - Electronics head can be replaced if damaged
 - Short housing
 - Error signal: Output signals above or below the preset values can be interpreted and reported with an error signal. Example: no magnet in measuring range or start program mode.
- Included with cylinder:
- Transducer
 - Calibration device 112774
 - User's manual

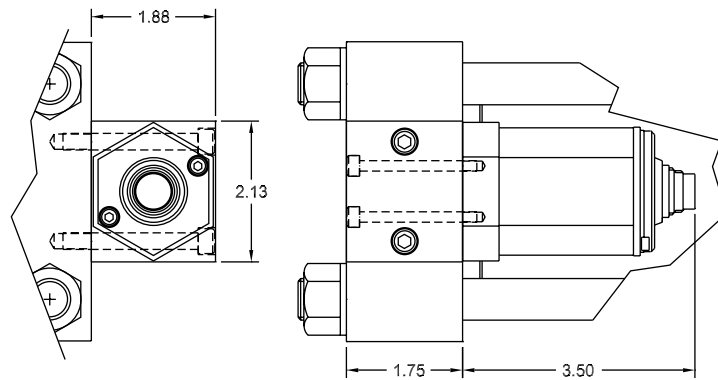
SERIES EM

Series EM Protective Electronics Cover



- Heavy gauge aluminum
- Offers resistance to impact for electronics and connector
- Easy electronics access

Electronics Module and Mounting Block



- Allows easy replacement or conversion between analog, digital, or pulse
- Can be reversed to clear mountings, if necessary

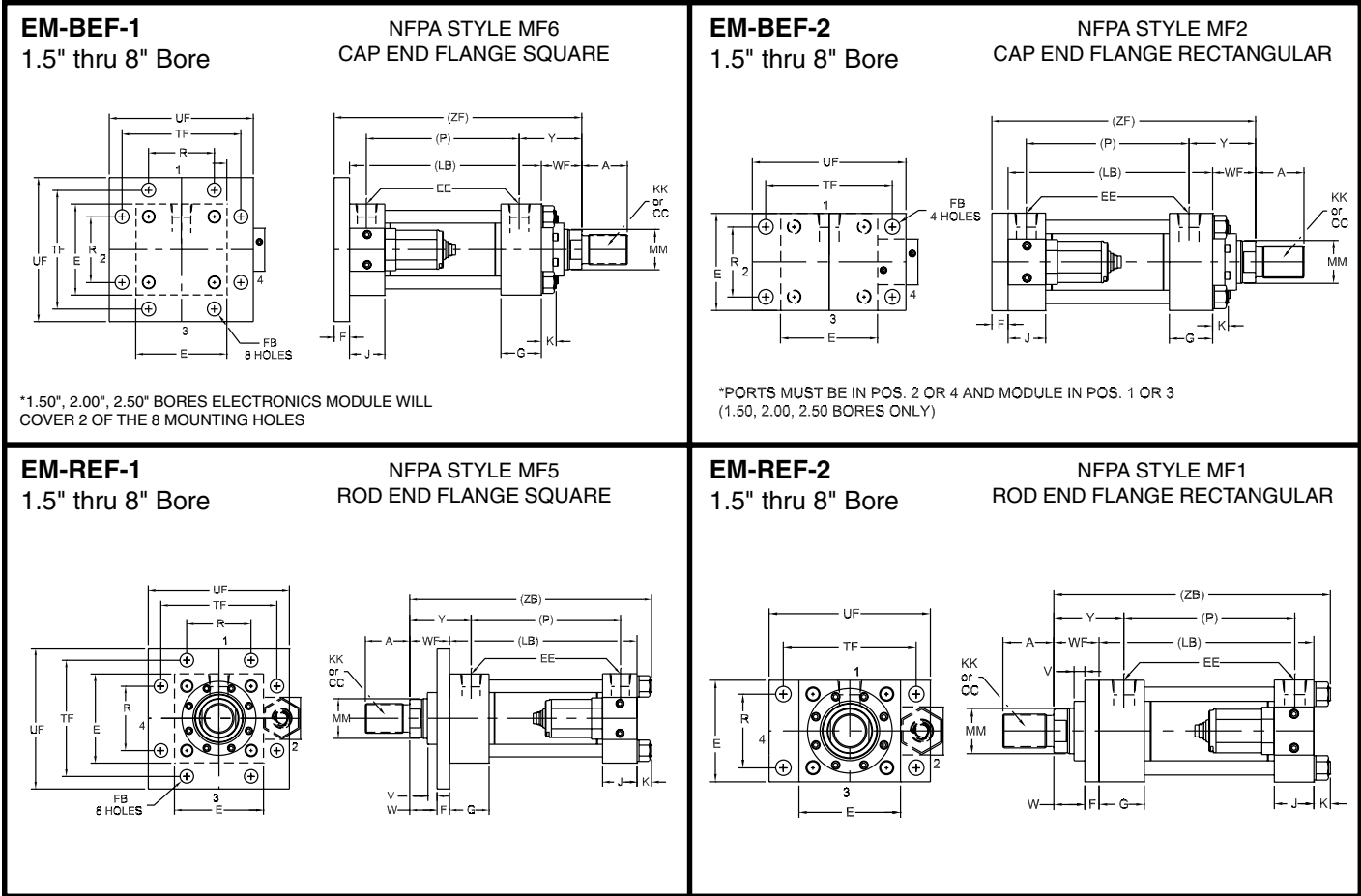
Envelope and Mounting Dimensions

Bore	AA	BB	DD	E	EE SAE	F	G	J	K	R	Add Stroke	
											LB	P
1 1/2	2.3	1 3/8	3/8 - 24	2 1/2	#8	3/8	1 3/4	2 1/2	1/2	1.63	5 5/8	3 3/4
2	2.9	1 13/16	1/2 - 20	3	#8	5/8	1 3/4	2 1/2	5/8	2.05	5 5/8	3 3/4
2 1/2	3.6	1 13/16	1/2 - 20	3 1/2	#8	5/8	1 3/4	1 1/2	5/8	2.55	4 3/4	3
3 1/4	4.6	2 5/16	5/8 - 18	4 1/2	#12	3/4	2	1 3/4	3/4	3.25	5 1/2	3 1/2
4	5.4	2 5/16	5/8 - 18	5	#12	7/8	2	1 3/4	3/4	3.82	5 3/4	3 3/4
5	7.0	3 3/16	7/8 - 14	6 1/2	#12	7/8	2	1 3/4	1	4.95	6 1/4	4 1/4
6	8.1	3 5/8	1 - 14	7 1/2	#16	1	2 1/4	2 1/4	1 1/8	5.73	7 3/8	4 7/8
7	9.3	4 1/8	1 1/8 - 12	8 1/2	#20	-	2 3/4	2 3/4	1 1/4	6.58	8 1/2	5 1/2
8	10.6	4 1/2	1 1/4 - 12	9 1/2	#24	-	3	3	1 1/2	7.50	9 1/2	6 1/4

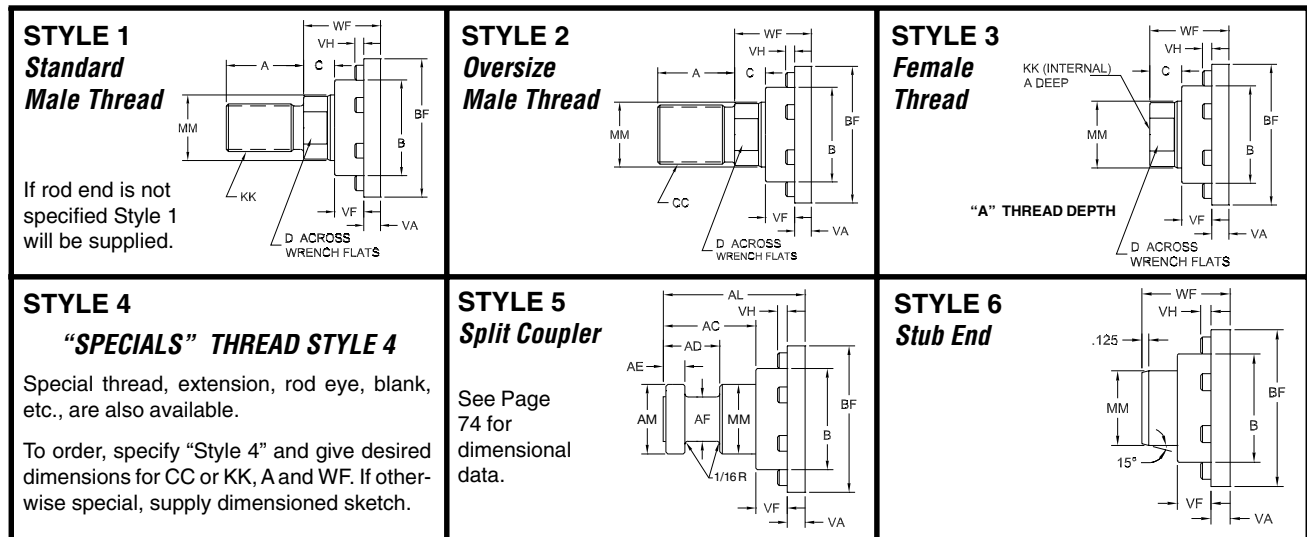
Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	KA	VA	VF	VH	WF	Y	Add Stroke	
		Style 1 & 3 KK	Style 2 CC												ZB	ZJ
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	5/16	3/8	1/2	3/16	1 3/8	2 3/8	7 1/2	7
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	27/64	3/8	1/2	3/16	1 3/8	2 3/8	7 5/8	7
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	27/64	3/8	5/8	3/16	1 5/8	2 5/8	7 7/8	7 1/4
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	27/64	3/8	1/2	3/16	1 3/8	2 3/8	6 3/4	6 1/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	27/64	3/8	5/8	3/16	1 5/8	2 5/8	7	6 3/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	27/64	5/8	1/2	3/16	1 7/8	2 7/8	7 1/4	6 5/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	17/32	3/8	5/8	3/16	1 5/8	2 3/4	7 7/8	7 1/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	17/32	5/8	1/2	3/16	1 7/8	3	8 1/8	7 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	17/32	5/8	1/2	1/4	2	3 1/8	8 1/4	7 1/2
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	17/32	5/8	1/2	3/16	1 7/8	3	8 3/8	7 5/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	17/32	5/8	1/2	1/4	2	3 1/8	8 1/2	7 3/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	17/32	5/8	5/8	1/4	2 1/4	3 3/8	8 3/4	8
	5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	23/32	5/8	1/2	1/4	2	3 1/8	9 1/4
5	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	23/32	5/8	5/8	1/4	2 1/4	3 3/8	9 1/2	8 1/2
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	23/32	15/16	5/16	-	2 1/4	3 3/8	9 1/2	8 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	23/32	15/16	5/16	-	2 1/4	3 3/8	9 1/2	8 1/2
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	13/16	15/16	5/16	-	2 1/4	3 1/2	10 3/4	9 5/8
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	13/16	5/8	5/8	1/4	2 1/4	3 1/2	10 3/4	9 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	13/16	15/16	5/16	-	2 1/4	3 1/2	10 3/4	9 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	13/16	15/16	5/16	-	2 1/4	3 1/2	10 3/4	9 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	13/16	15/16	5/16	-	2 1/4	3 1/2	10 3/4	9 5/8
	7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	15/16	5/16	-	2 1/4	3 3/4	12
7	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
	8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4
8	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4

SERIES EM



ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimensions

Bore	E	EE SAE	F	FB	G	J	K	R	TF	UF	Add Stroke	
											LB	P
1 1/2	2 1/2	#8	3/8	7/16	1 3/4	2 1/2	1/2	1.63	3 7/16	4 1/4	5 5/8	3 3/4
2	3	#8	5/8	9/16	1 3/4	2 1/2	5/8	2.05	4 1/8	5 1/8	5 5/8	3 3/4
2 1/2	3 1/2	#8	5/8	9/16	1 3/4	1 1/2	5/8	2.55	4 5/8	5 5/8	4 3/4	3
3 1/4	4 1/2	#12	3/4	11/16	2	1 3/4	3/4	3.25	5 7/8	7 1/8	5 1/2	3 1/2
4	5	#12	7/8	11/16	2	1 3/4	3/4	3.82	6 3/8	7 5/8	5 3/4	3 3/4
5	6 1/2	#12	7/8	15/16	2	1 3/4	1	4.95	8 3/16	9 3/4	6 1/4	4 1/4
6	7 1/2	#16	1	1 1/16	2 1/4	2 1/4	1 1/8	5.73	9 7/16	11 1/4	7 3/8	4 7/8
7	8 1/2	#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 1/2
8	9 1/2	#24	1	1 5/16	3	3	1 1/2	7.50	11 13/16	14	9 1/2	6 1/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	V	VA	VF	VH	W	WF	WG	Y	Add Stroke	
		Style 1 & 3 KK	Style 2 CC														ZB	ZF
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/2	3/8	1/2	3/16	1	1 3/8	1 3/8	2 3/8	7 1/2	7 3/8
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/4	3/8	1/2	3/16	3/4	1 3/8	1 3/8	2 3/8	7 5/8	7 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	3/8	5/8	3/16	1	1 5/8	1 5/8	2 5/8	7 7/8	7 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/4	3/8	1/2	3/16	3/4	1 3/8	2 1/2	2 3/8	6 3/4	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	3/8	5/8	3/16	1	1 5/8	3 1/4	2 5/8	7	7
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	1/2	5/8	1/2	3/16	1 1/4	1 7/8	3 7/8	2 7/8	7 1/4	7 1/4
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	1/4	3/8	5/8	3/16	7/8	1 5/8	3 1/4	2 3/4	7 7/8	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	3/8	5/8	1/2	3/16	1 1/8	1 7/8	3 7/8	3	8 1/8	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	3/8	5/8	1/2	1/4	1 1/4	2	4.25	3 1/8	8 1/4	8 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	1/4	5/8	1/2	3/16	1	1 7/8	1 7/8	3	8 3/8	8 1/2
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	1/4	5/8	1/2	1/4	1 1/8	2	2	3 1/8	8 1/2	8 5/8
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	3/8	5/8	5/8	1/4	1 3/8	2 1/4	5 1/4	3 3/8	8 3/4	8 7/8
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	1/4	5/8	1/2	1/4	1 1/8	2	2	3 1/8	9 1/4	9 1/8
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	3/8	5/8	5/8	1/4	1 3/8	2 1/4	2 1/4	3 3/8	9 1/2	9 3/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	3/8	15/16	5/16	-	1 3/8	2 1/4	5 3/4	3 3/8	9 1/2	9 3/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	3/8	15/16	5/16	-	1 3/8	2 1/4	5 3/4	3 3/8	9 1/2	9 3/8
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	1/4	5/8	5/8	1/4	1 1/4	2 1/4	2 1/4	3 1/2	10 3/4	10 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 1/2	10 3/4	10 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 1/2	10 3/4	10 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 1/2	10 3/4	10 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 3/4	12	11 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 3/4	12	11 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 3/4	12	11 3/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 3/4	12	11 3/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 3/4	12	11 3/4
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	2 1/4	3 7/8	13 1/4	12 3/4

SERIES EM

**For REF-1
& REF-2
Mount**

Max. PSI Push

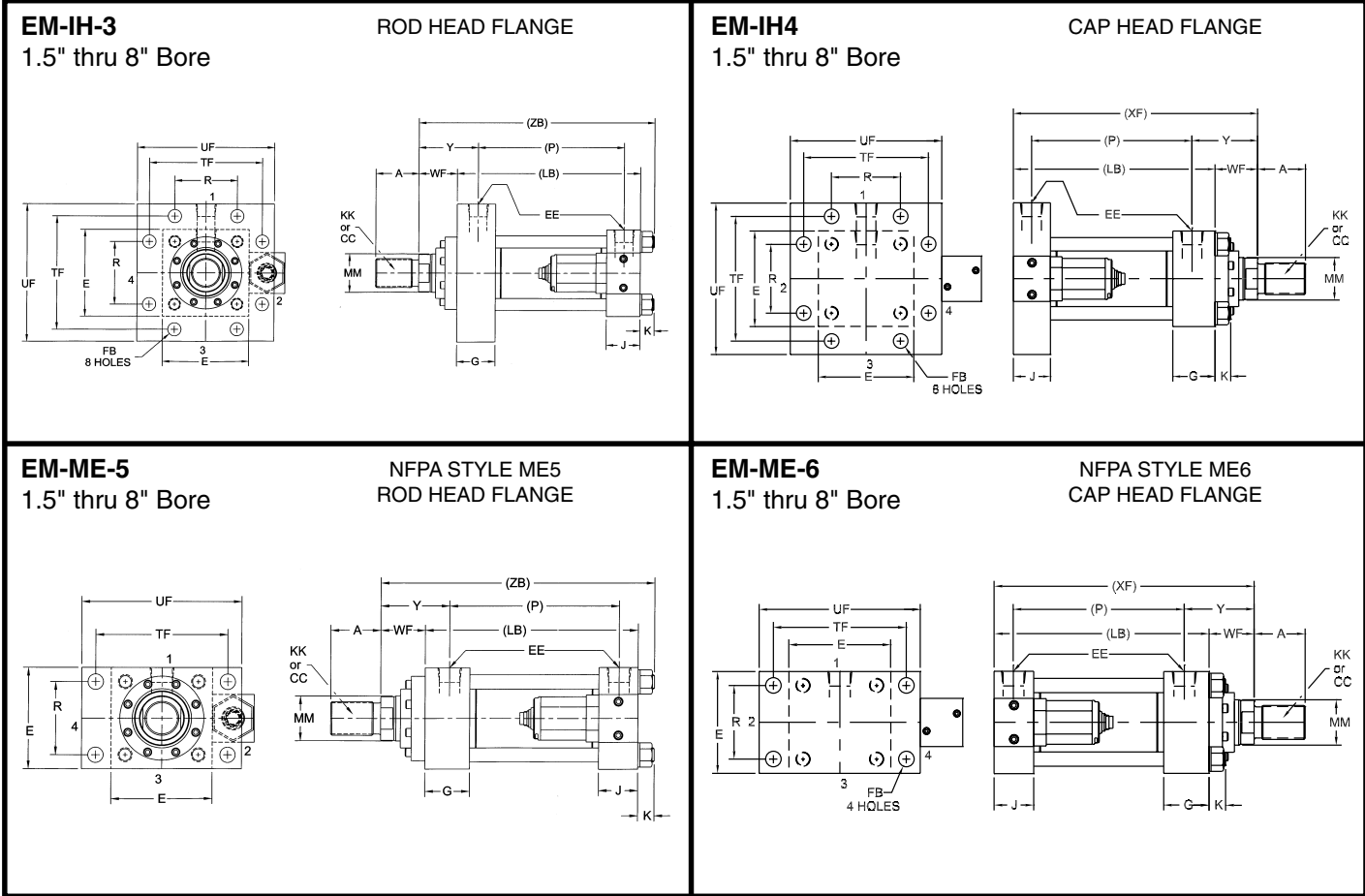
Bore	Rod Size											
	.62	1.00	1.38	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50
1.50	2500	1500	-	-	-	-	-	-	-	-	-	-
2.00	-	2500	1500	-	-	-	-	-	-	-	-	-
2.50	-	2500	1900	1500	-	-	-	-	-	-	-	-
3.25	-	-	2500	2100	1500	-	-	-	-	-	-	-
4.00	-	-	-	2500	1800	1500	-	-	-	-	-	-
5.00	-	-	-	-	2200	1650	1200	750	-	-	-	-
6.00	-	-	-	-	-	1800	1450	1100	750	-	-	-
7.00	-	-	-	-	-	-	1500	1250	1000	800	500	-
8.00	-	-	-	-	-	-	-	900	800	700	600	500

**For BEF-1
& BEF-2
Mount**

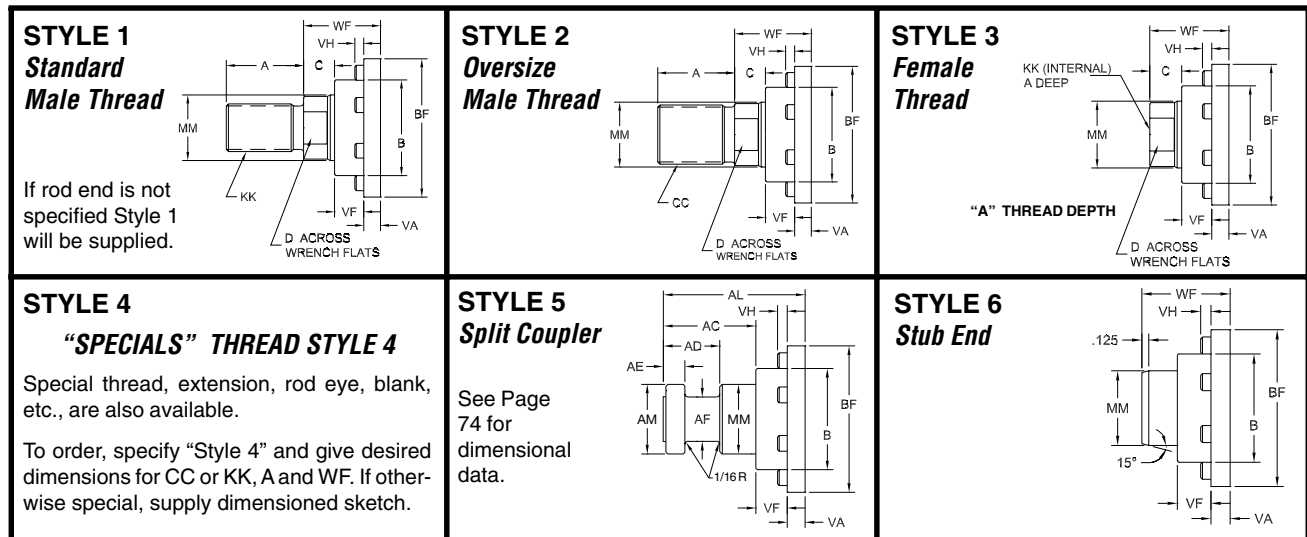
Max. PSI Pull

Bore	Rod Size											
	.62	1.00	1.38	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50
1.50	3000	3000	-	-	-	-	-	-	-	-	-	-
2.00	-	3000	3000	-	-	-	-	-	-	-	-	-
2.50	-	3000	3000	3000	-	-	-	-	-	-	-	-
3.25	-	-	3000	3000	3000	-	-	-	-	-	-	-
4.00	-	-	-	3000	3000	3000	-	-	-	-	-	-
5.00	-	-	-	-	2000	2500	2800	3000	-	-	-	-
6.00	-	-	-	-	-	2000	2500	2800	3000	-	-	-
7.00	-	-	-	-	-	-	1500	1700	1800	1900	2000	-
8.00	-	-	-	-	-	-	-	1500	1700	1800	1900	2000





ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

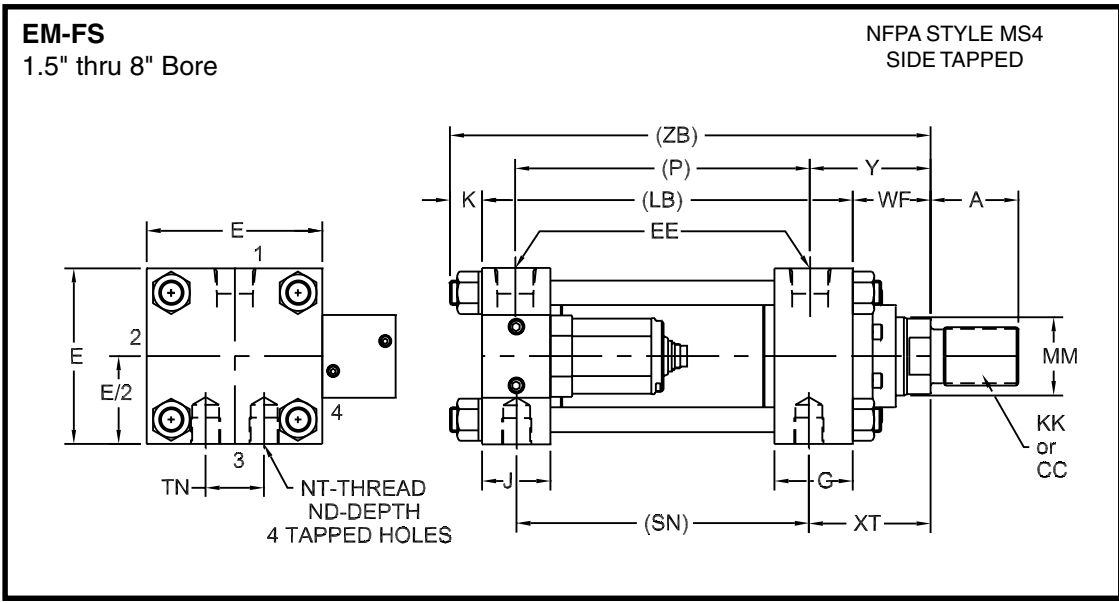
Envelope and Mounting Dimensions

Bore	E	EE SAE	F	FB	G	J	K	R	TF	UF	Add Stroke	
											LB	P
1 1/2	2 1/2	#8	3/8	7/16	1 3/4	2 1/2	1/2	1.63	3 7/16	4 1/4	5 5/8	3 3/4
2	3	#8	5/8	9/16	1 3/4	2 1/2	5/8	2.05	4 1/8	5 1/8	5 5/8	3 3/4
2 1/2	3 1/2	#8	5/8	9/16	1 3/4	1 1/2	5/8	2.55	4 5/8	5 5/8	4 3/4	3
3 1/4	4 1/2	#12	3/4	11/16	2	1 3/4	3/4	3.25	5 7/8	7 1/8	5 1/2	3 1/2
4	5	#12	7/8	11/16	2	1 3/4	3/4	3.82	6 3/8	7 5/8	5 3/4	3 3/4
5	6 1/2	#12	7/8	15/16	2	1 3/4	1	4.95	8 3/16	9 3/4	6 1/4	4 1/4
6	7 1/2	#16	1	1 1/16	2 1/4	2 1/4	1 1/8	5.73	9 7/16	11 1/4	7 3/8	4 7/8
7	8 1/2	#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 1/2
8	9 1/2	#24	1	1 5/16	3	3	1 1/2	7.50	11 13/16	14	9 1/2	6 1/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	WG	Y	Add Stroke	
		Style 1 & 3 KK	Style 2 CC												XF	ZB
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/8	2 3/8	6 7/8	7 3/8
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/8	2 3/8	6 7/8	7 1/2
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	1 5/8	2 5/8	7 1/8	7 3/4
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/2	2 3/8	6 1/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	3 1/4	2 5/8	6 3/8	7
3 1/4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3 7/8	2 7/8	6 5/8	7 1/4
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	4.25	3 1/8	7 1/2	8 1/4
4	1 3/4	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	3 1/4	2 3/4	7 1/8	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3 7/8	3	7 3/8	8 1/8
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	2	3 1/8	8 1/4	9 1/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	2 1/4	3 3/8	8 1/2	9 1/2
6	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	5 3/4	3 3/8	8 1/2	9 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	5 3/4	3 3/8	8 1/2	9 1/2
7	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	5 3/4	3 3/8	8 1/2	9 1/2
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	5 3/4	3 3/8	8 1/2	9 1/2
8	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	5 3/4	3 3/8	8 1/2	9 1/2
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	5 3/4	3 3/8	8 1/2	9 1/2

SERIES EM



ROD END DIMENSIONS

<p>STYLE 1 <i>Standard Male Thread</i></p> <p>If rod end is not specified Style 1 will be supplied.</p>	<p>STYLE 2 <i>Oversize Male Thread</i></p>	<p>STYLE 3 <i>Female Thread</i></p> <p>"A" THREAD DEPTH</p>
<p>STYLE 4 <i>"SPECIALS" THREAD STYLE 4</i></p> <p>Special thread, extension, rod eye, blank, etc., are also available.</p> <p>To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.</p>	<p>STYLE 5 <i>Split Coupler</i></p> <p>See Page 74 for dimensional data.</p>	<p>STYLE 6 <i>Stub End</i></p>

4 1/2" rod and larger have spanner wrench holes in place of wrench flats.
NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

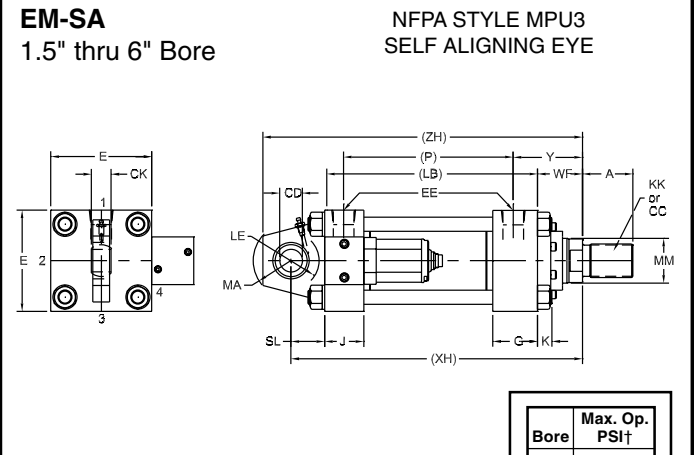
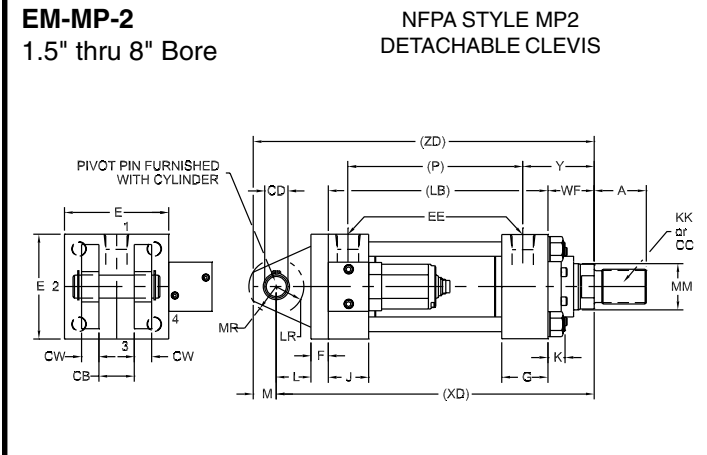
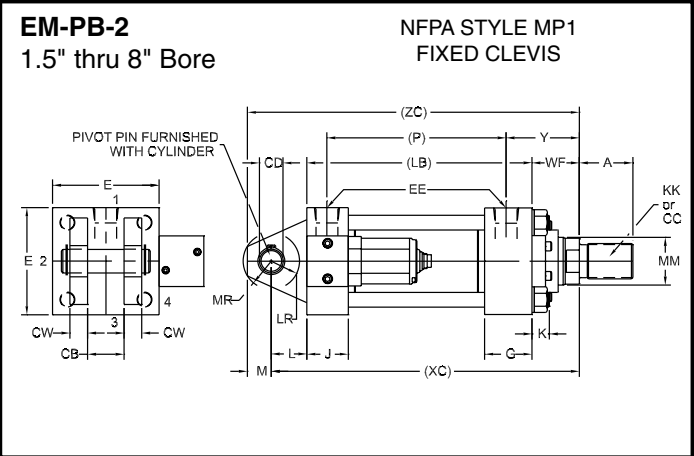
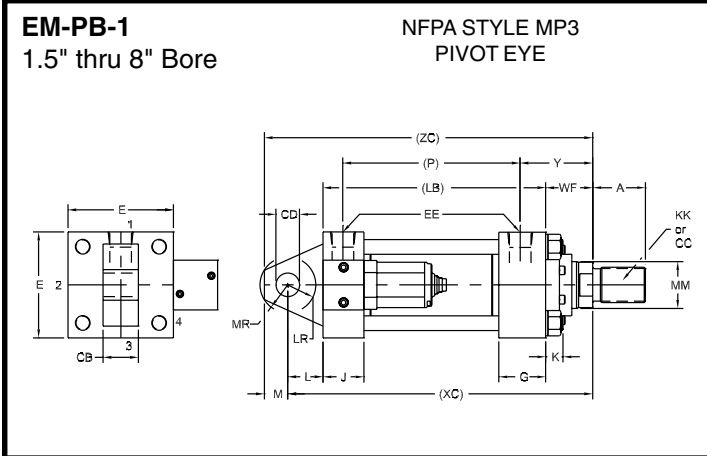
Envelope and Mounting Dimensions

Bore	E	EE SAE	G	J	K	NT	TN	Add Stroke		
								LB	P	SN
1 1/2	2 1/2	#8	1 3/4	2 1/2	1/2	3/8 - 16	3/4	5 5/8	3 3/4	2 7/8
2	3	#8	1 3/4	2 1/2	5/8	1/2 - 13	15/16	5 5/8	3 3/4	2 7/8
2 1/2	3 1/2	#8	1 3/4	1 1/2	5/8	5/8 - 11	1 5/16	4 3/4	3	3
3 1/4	4 1/2	#12	2	1 3/4	3/4	3/4 - 10	1 1/2	5 1/2	3 1/2	3 1/2
4	5	#12	2	1 3/4	3/4	1 - 8	2 1/16	5 3/4	3 3/4	3 3/4
5	6 1/2	#12	2	1 3/4	1	1 - 8	2 15/16	6 1/4	4 1/4	4 1/4
6	7 1/2	#16	2 1/4	2 1/4	1 1/8	1 1/4 - 7	3 5/16	7 3/8	4 7/8	5 1/8
7	8 1/2	#20	2 3/4	2 3/4	1 1/4	1 1/2 - 6	3 3/4	8 1/2	5 1/2	5 7/8
8	9 1/2	#24	3	3	1 1/2	1 1/2 - 6	4 1/4	9 1/2	6 1/4	6 5/8

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	V	VA	VF	VH	WF	WG	ND	XT	Y	Add Stroke
		Style 1 & 3 KK	Style 2 CC															ZB
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/2	3/8	1/2	3/16	1 3/8	1 3/8	3/8	2 5/16	2 3/8	7 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/4	3/8	1/2	3/16	1 3/8	1 3/8	7/16	2 5/16	2 3/8	7 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	3/8	5/8	3/16	1 5/8	1 5/8	7/16	2 9/16	2 5/8	7 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/4	3/8	1/2	3/16	1 3/8	2 1/2	1/2	2 5/16	2 3/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	3/8	5/8	3/16	1 5/8	3 1/4	1/2	2 9/16	2 5/8	7
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	1/2	5/8	1/2	3/16	1 7/8	3 7/8	1/2	2 13/16	2 7/8	7 1/4
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	1/4	3/8	5/8	3/16	1 5/8	3 1/4	11/16	2 9/16	2 3/4	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	3/8	5/8	1/2	3/16	1 7/8	3 7/8	11/16	2 13/16	3	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	3/8	5/8	1/2	1/4	2	4.25	11/16	2 15/16	3 1/8	8 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	1/4	5/8	1/2	3/16	1 7/8	1 7/8	11/16	2 15/16	3	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	1/4	5/8	1/2	1/4	2	2	11/16	3 1/16	3 1/8	8 1/2
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	3/8	5/8	5/8	1/4	2 1/4	5 1/4	11/16	3 5/16	3 3/8	8 3/4
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	1/4	5/8	1/2	1/4	2	2	1	3	3 1/8	9 1/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	3/8	5/8	5/8	1/4	2 1/4	2 1/4	1	3 1/4	3 3/8	9 1/2
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	3/8	15/16	5/16	-	2 1/4	5 3/4	1	3 1/4	3 3/8	9 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	3/8	15/16	5/16	-	2 1/4	5 3/4	1	3 1/4	3 3/8	9 1/2
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	1/4	5/8	5/8	1/4	2 1/4	2 1/4	1 1/4	3 5/16	3 1/2	10 3/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/4	3 5/16	3 1/2	10 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/4	3 5/16	3 1/2	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/4	3 5/16	3 1/2	10 3/4
	4 1/2	3 1/2 - 12	4 1/4 - 12	4 1/2	5.249	7 7/16	1	-	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/8	3 13/16	3 3/4	12
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/8	3 13/16	3 3/4	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/8	3 13/16	3 3/4	12
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/8	3 13/16	3 3/4	12
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/8	3 13/16	3 3/4	12
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/8	3 13/16	3 3/4	12
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/2	3 15/16	3 7/8	13 1/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/2	3 15/16	3 7/8	13 1/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/2	3 15/16	3 7/8	13 1/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/2	3 15/16	3 7/8	13 1/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	1/4	15/16	5/16	-	2 1/4	2 1/4	1 1/2	3 15/16	3 7/8	13 1/4

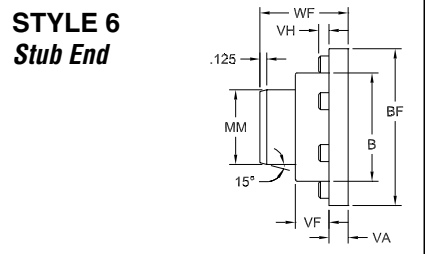
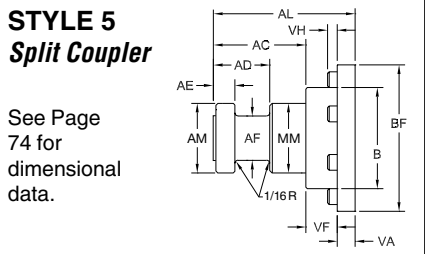
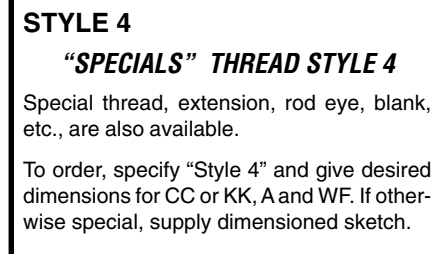
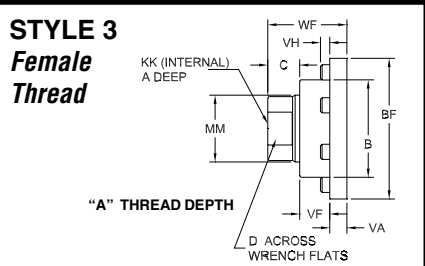
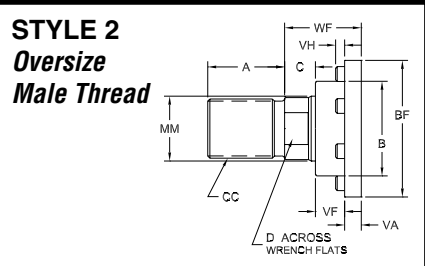
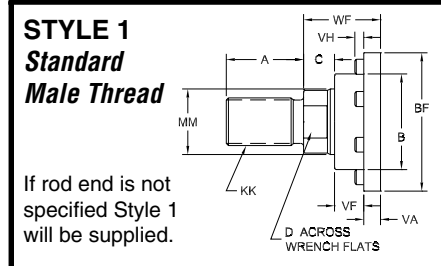
SERIES EM



Bore	Max. Op. PSI†
1 1/2	1250
2	2200
2 1/2	1450
3 1/4	1500
4	1850
5	2000
6	1800

†See Table 1 on pg. 73 for recommended maximum swivel angles.

ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.
NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimensions

Bore	CB	CD	CK	CW	E	EE SAE	F	G	J	K	L	LE	LR	M	MA	MR	SL	Add Stroke	
																		LB	P
1 1/2	3/4	0.501	7/16	1/2	2 1/2	#8	3/8	1 3/4	2 1/2	1/2	3/4	7/8	9/16	1/2	1 1/4	5/8	3/4	5 5/8	3 7/8
2	1 1/4	0.751	21/32	5/8	3	#8	5/8	1 3/4	2 1/2	5/8	1 1/4	7/8	1	3/4	1 1/4	15/16	1 1/4	5 5/8	3 7/8
2 1/2	1 1/4	0.751	21/32	5/8	3 1/2	#8	5/8	1 3/4	1 1/2	5/8	1 1/4	7/8	15/16	3/4	1 1/4	15/16	1 1/4	4 3/4	3
3 1/4	1 1/2	1.001	7/8	3/4	4 1/2	#12	3/4	2	1 3/4	3/4	1 1/2	1 1/8	1 1/4	1	1 1/2	1 3/16	1 1/2	5 1/2	3 1/2
4	2	1.376	1 3/16	1	5	#12	7/8	2	1 3/4	3/4	2 1/8	1 1/2	1 3/4	1 3/8	1 3/4	1 5/8	2 1/8	5 3/4	3 3/4
5	2 1/2	1.751	1 17/32	1 1/4	6 1/2	#12	7/8	2	1 3/4	1	2 1/4	1 15/16	2 1/16	1 3/4	2 1/4	2 1/8	2 1/4	6 1/4	4 1/4
6	2 1/2	2.001	1 3/4	1 1/4	7 1/2	#16	1	2 1/4	2 1/4	1 1/8	2 1/2	2 3/16	2 5/16	2	2 3/4	2 3/8	2 1/2	7 3/8	4 7/8
7	3	2.501	-	1 1/2	8 1/2	#20	1	2 3/4	2 3/4	1 1/4	3	-	2 3/4	2 1/2	-	2 7/8	-	8 1/2	5 1/2
8	3	3.001	-	1 1/2	9 1/2	#24	1	3	3	1 1/2	3 1/4	-	3 1/4	2 3/4	-	3 1/8	-	9 1/2	6 1/4

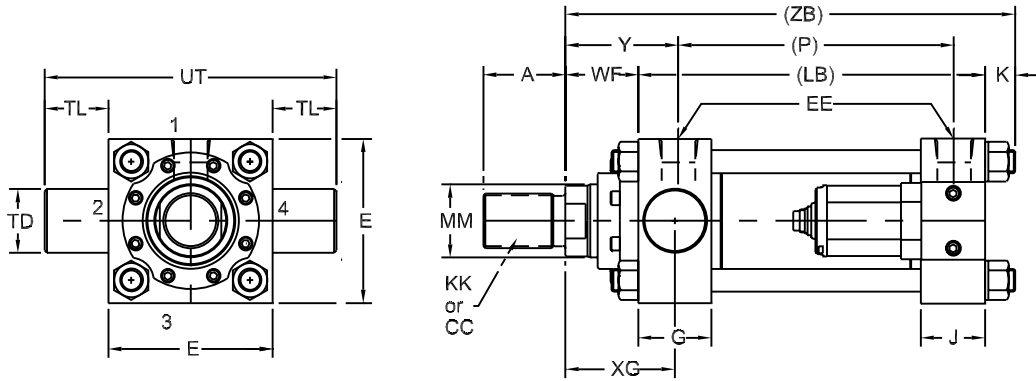
Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	WG	Y	Add Stroke					
		Style 1 & 3 KK	Style 2 CC												XC	XD	XH	ZC	ZD	ZH
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/8	2 3/8	7 3/4	8 1/8	7 3/4	8 1/4	8 5/8	8 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/8	2 3/8	8 1/4	8 7/8	8 1/4	9	9 5/8	9 1/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	1 5/8	2 5/8	8 1/2	9 1/8	8 1/2	9 1/4	9 7/8	9 1/2
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/8	2 3/8	7 3/8	8	7 3/8	8 1/8	8 3/4	8 3/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	1 5/8	2 5/8	7 5/8	8 1/4	7 5/8	8 3/8	9	8 5/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3 7/8	2 7/8	7 7/8	8 1/2	7 7/8	8 5/8	9 1/4	8 7/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	3 1/4	2 3/4	8 5/8	9 3/8	8 5/8	9 5/8	10 3/8	9 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3 7/8	3	8 7/8	9 5/8	8 7/8	9 7/8	10 5/8	10 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	4.25	3 1/8	9	9 3/4	9	10	10 3/4	10 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	1 7/8	3	9 3/4	10 5/8	9 3/4	11 1/8	12	11 5/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	2	3 1/8	9 7/8	10 3/4	9 7/8	11 1/4	12 1/8	11 3/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	5 1/4	3 3/8	10 1/8	11	10 1/8	11 1/2	12 3/8	12
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	2	3 1/8	10 1/2	11 3/8	10 1/2	12 1/8	13	13
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	2 1/4	3 3/8	10 3/4	11 5/8	10 3/4	12 1/2	13 3/8	13 1/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	5 3/4	3 3/8	10 3/4	11 5/8	10 3/4	12 1/2	13 3/8	13 1/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	5 3/4	3 3/8	10 3/4	11 5/8	10 3/4	12 1/2	13 3/8	13 1/4
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	2 1/4	3 1/2	12 1/8	13 1/8	12 1/8	14 1/8	15 1/8	14 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	2 1/4	3 1/2	12 1/8	13 1/8	12 1/8	14 1/8	15 1/8	14 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	2 1/4	3 1/2	12 1/8	13 1/8	12 1/8	14 1/8	15 1/8	14 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	2 1/4	3 1/2	12 1/8	13 1/8	12 1/8	14 1/8	15 1/8	14 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	2 1/4	3 7/8	15	16	-	17 3/4	18 3/4	-
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	2 1/4	3 7/8	15	16	-	17 3/4	18 3/4	-
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 7/8	15	16	-	17 3/4	18 3/4	-
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 7/8	15	16	-	17 3/4	18 3/4	-
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 7/8	15	16	-	17 3/4	18 3/4	-

SERIES EM

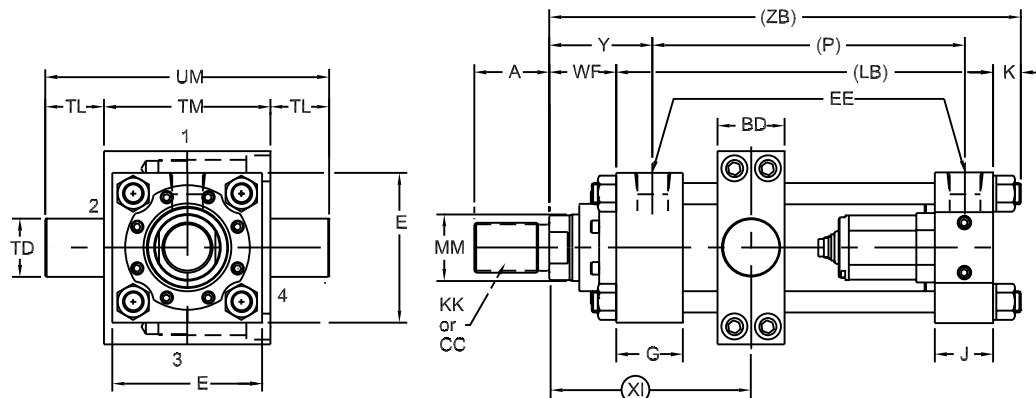
EM-TM-1
1.5" thru 8" Bore

NFPA STYLE MT1
ROD END TRUNNION



EM-TM-3
1.5" thru 8" Bore

NFPA STYLE MT4
INTERMEDIATE TRUNNION



NOTE: If using bolt on manifold plates, see pg. 69 for information on min./max. XI dimension.

ROD END DIMENSIONS

<p>STYLE 1 <i>Standard Male Thread</i></p> <p>If rod end is not specified Style 1 will be supplied.</p>	<p>STYLE 2 <i>Oversize Male Thread</i></p>	<p>STYLE 3 <i>Female Thread</i></p>
<p>STYLE 4 <i>"SPECIALS" THREAD STYLE 4</i></p> <p>Special thread, extension, rod eye, blank, etc., are also available.</p> <p>To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.</p>	<p>STYLE 5 <i>Split Coupler</i></p> <p>See Page 74 for dimensional data.</p>	<p>STYLE 6 <i>Stub End</i></p>

4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimensions

Bore	BD	E	EE SAE	G	J	K	TD	TL	TM	UM	UT	UW	Add Stroke	
													LB	P
1 1/2	1 1/4	2 1/2	#8	1 3/4	2 1/2	1/2	1.000	1	3	5	4 1/2	3 3/8	5 5/8	3 7/8
2	1 1/2	3	#8	1 3/4	2 1/2	5/8	1.375	1 3/8	3 1/2	6 1/4	5 3/4	4 1/8	5 5/8	3 7/8
2 1/2	1 1/2	3 1/2	#8	1 3/4	1 1/2	5/8	1.375	1 3/8	4	6 3/4	6 1/4	4 5/8	4 3/4	3
3 1/4	2	4 1/2	#12	2	1 3/4	3/4	1.750	1 3/4	5	8 1/2	8	5 13/16	5 1/2	3 1/2
4	2	5	#12	2	1 3/4	3/4	1.750	1 3/4	5 1/2	9	8 1/2	6 3/8	5 3/4	3 3/4
5	2	6 1/2	#12	2	1 3/4	1	1.750	1 3/4	7	10 1/2	10	7 3/4	6 1/4	4 1/4
6	3	7 1/2	#16	2 1/4	2 1/4	1 1/8	2.000	2	8 1/2	12 1/2	11 1/2	10 3/8	7 3/8	4 7/8
7	3	8 1/2	#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 1/2
8	3 1/2	9 1/2	#24	3	3	1 1/2	3.000	3	11	17	15 1/2	13 3/8	9 1/2	6 1/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	WG	XG	XI MIN.	Y	Add Stroke ZB
		Style 1 & 3 KK	Style 2 CC														
1 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/8	2 1/4	3 13/16	2 3/8	7 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/8	2 1/4	3 15/16	2 3/8	7 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	1 5/8	2 1/2	4 3/16	2 5/8	7 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/2	2 1/4	3 15/16	2 3/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	3 1/4	2 1/2	4 3/16	2 5/8	7
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3 7/8	2 3/4	4 7/16	2 7/8	7 1/4
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	3 1/4	2 5/8	4 11/16	2 3/4	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3 7/8	2 7/8	4 15/16	3	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	4.25	3	5 1/16	3 1/8	8 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	1 7/8	2 7/8	4 15/16	3	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	2	3	5 1/16	3 1/8	8 1/2
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	5 1/4	3 1/4	5 5/16	3 3/8	8 3/4
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	2	3	5 1/16	3 1/8	9 1/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	2 1/4	3 1/4	5 5/16	3 3/8	9 1/2
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	5 3/4	3 1/4	5 5/16	3 3/8	9 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	5 3/4	3 1/4	5 5/16	3 3/8	9 1/2
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	2 1/4	3 3/8	6 1/16	3 1/2	10 3/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	2 1/4	3 3/8	6 1/16	3 1/2	10 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	2 1/4	3 3/8	6 1/16	3 1/2	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	2 1/4	3 3/8	6 1/16	3 1/2	10 3/4
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	2 1/4	3 5/8	6 9/16	3 3/4	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	2 1/4	3 5/8	6 9/16	3 3/4	12
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	2 1/4	3 5/8	6 9/16	3 3/4	12
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 5/8	6 9/16	3 3/4	12
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 5/8	6 9/16	3 3/4	12
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	2 1/4	3 3/4	7 1/16	3 7/8	13 1/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	2 1/4	3 3/4	7 1/16	3 7/8	13 1/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 3/4	7 1/16	3 7/8	13 1/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 3/4	7 1/16	3 7/8	13 1/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	2 1/4	3 3/4	7 1/16	3 7/8	13 1/4

SERIES EM

THE NEW SERIES EP FROM ATLAS

The EP Series design makes electronic sensing practical for any cylinder operation with NFPA standard mounts. Our most cost effective feedback package — also the most compact, as electronics are mounted away from the cylinder.

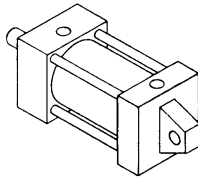
S E R I E S E P

- Self-contained cylinder package, complete with transducer and electronics
- Provides lower cost electronics
- Simple electrical connection on cylinder
- Remote location of electronics
- Compatible with all NFPA mounting dimensions
- Makes possible conversion of conventional hydraulic systems to electro-hydraulic control
- Replacement costs are low



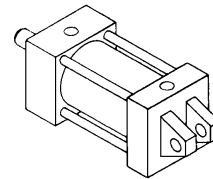
MOUNTING STYLES SERIES EP

EP-PB-1
NFPA STYLE MP3
PIVOT EYE



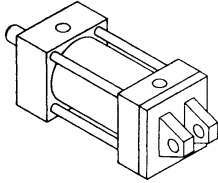
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EP-PB-2
NFPA STYLE MP1
FIXED CLEVIS



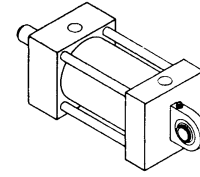
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EP-MP-2
NFPA STYLE MP2
DETACHABLE
CLEVIS



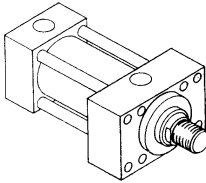
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EP-SA
NFPA STYLE MPU3
SELF ALIGNING
EYE



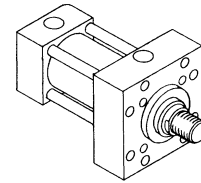
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EP-ME-5
NFPA STYLE ME5
FLANGE HEAD



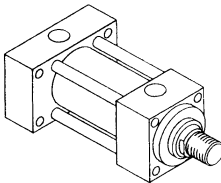
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EP-IH-3
FLANGE HEAD



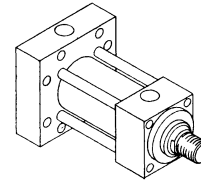
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EP-ME-6
NFPA STYLE ME6
FLANGE HEAD



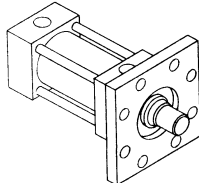
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EP-IH-4
FLANGE HEAD



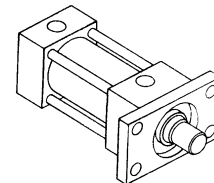
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EP-REF-1
NFPA STYLE MF5
ROD END FLANGE
SQUARE



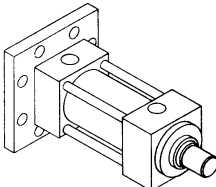
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EP-REF-2
NFPA STYLE MF1
ROD END FLANGE
RECTANGULAR



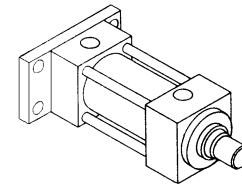
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EP-BEF-1
NFPA STYLE MF6
CAP END FLANGE
SQUARE



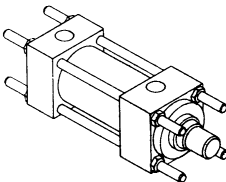
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EP-BEF-2
NFPA STYLE MF2
CAP END FLANGE
RECTANGULAR



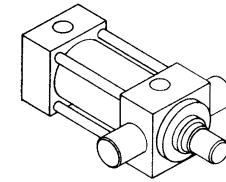
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EP-NM
NFPA STYLE MX
TIE ROD EXTENDED
MOUNTS



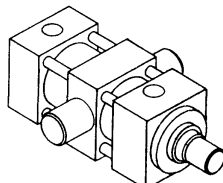
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EP-TM-1
NFPA STYLE MT1
ROD END
TRUNNION



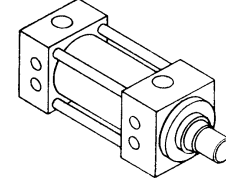
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EP-TM-3
NFPA STYLE MT4
INTERMEDIATE
TRUNNION



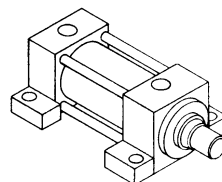
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EP-FS
NFPA STYLE MS4
SIDE TAPPED



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EM-SL
NFPA STYLE MS2
SIDE LUG



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How to Order Series EP Cylinders

Data Required on All Cylinder Orders

When ordering series EP cylinder, be sure to specify each of the following requirements:

1. **Series Designation (EP)**
2. **Bore**
3. **Electronics Module**
Specify module type 1, 2, or 3.
4. **Mounting Style**
Specify your choice of mounting as shown and dimensioned in this catalog.
5. **Piston Rod Diameter**
Specify rod diameter. Standard (smallest) rod diameter will be furnished if not specified, unless stroke length makes the application questionable.
6. **Piston Rod End Style**
Specify the rod end style or specify dimensions if non-standard. Rod end style 1 will be furnished if not specified.
7. **Cushions**
Cushions are not standard, but will be furnished if required. Consult factory.
8. **Ports**
SAE straight thread ports are standard on series EP hydraulic cylinders. Cylinders with servo manifolds use SAE connections for the port tube run and on either side of the manifold plate for pressure and tank connection. EE is the size of the port on the head without a manifold; ports on the manifold plates are listed on page 67.
9. **Seals**
A low friction PTFE piston seal with Buna-N expander, the Atlas "Tri-Lip" enhanced Polyurethane rod seal, Buna-N static seals, and a Polyurethane wiper are all standard, for use with mineral oil based hydraulic fluids. Fluorocarbon, EPR, Nitroxile and other compounds may be specified, but depend on application temperature range and fluid used. Low friction PTFE rod seals may be specified in the special options section.
10. **Stroke**
Specify length required.
11. **Special Options**
Specify. Consult factory with questions.

Note: Duplicate cylinders can be ordered by giving the serial number from the rod end head of the original cylinder. Factory records will supply a quick and positive identification.

Certified Dimensions

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

Series EP Ordering Guide

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SERIES	BORE	ELEC.	MOUNT	ROD	ROD END	CUSHIONS	PORTS	SEALS	STROKE	OPTIONS
EP	010 (1.00")	1	BEF1	0062 (.63")	1 (<i>KK MALE</i>)	NC (<i>NONE</i>)**	S (<i>SAE</i>)	P (<i>POLY</i>)	XXX.XX	S
	015 (1.50")	2	BEF2	0100 (1.00")	2 (CC MALE)		N (NPTF)	V (FLUOROCARBON)	(SPECIFY	(SEE
	020 (2.00")	3	FS	0137 (1.38")	3 (KK FEMALE)		I (ISO 6149)	E (EPR)	GROSS	BELOW)
	025 (2.50")		IH3	0175 (1.75")	4 (SPECIAL+)		F (FLANGE)	B (NITROXILE)	STROKE	
	032 (3.25")		IH4	0200 (2.00")	5 (SPLIT COUPLER)		X (OTHER)	M (STD. POLY	IF STOP	
	040 (4.00")		ME5	0250 (2.50")	6 (STUB END)		(SPECIFY)	W/ BRASS	TUBE IS	
	050 (5.00")		ME6	0300 (3.00")				SCRAPER)	REQUIRED)	
	060 (6.00")		MP2	0350 (3.50")				X (SPECIAL)		
	070 (7.00")		NM1	0400 (4.00")				(SPECIFY)		
	080 (8.00")		NM2	0450 (4.50")						
			NM3	0500 (5.00")						
			PB1	0550 (5.50")						

**CONSULT FACTORY IF CUSHIONS ARE REQUIRED

+ MUST SPECIFY **WF** (ROD EXTENSION), **A** (THREAD LENGTH),
AND **KK** OR **CC** (THREAD SIZE AND PITCH)

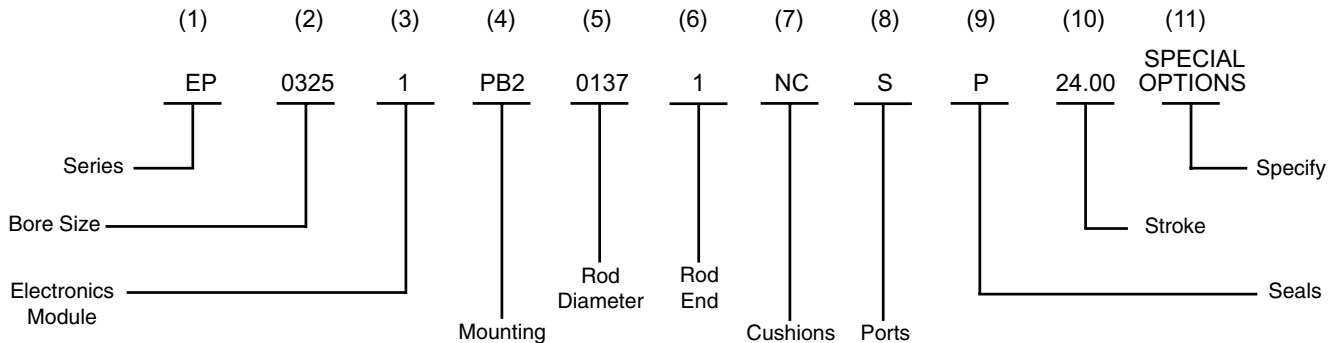
SL
TM1
TM3 (specify dimension XI)

NOTE: Items in italics are standard and will be supplied unless otherwise specified

OPTIONS

Add valve subplate	Specify valve group from page
Stop tube	Specify stop tube length and net stroke
Stainless piston rod	Specify if desired
Low friction rod seals	Specify if desired
Rod gland drain	Specify if desired

Sample Model Code



NOTE: If replacing existing cylinder or ordering parts, include the old serial number.

SERIES EP ELECTRONICS

The Atlas Cylinders EP Series Cylinders VRVT (Variable Resistive Vector Transducer) technology, developed by Penny & Giles, offers a highly reliable feedback in a compact package. EP Series cylinders can be mounted in the same locations as NFPA standard hydraulic cylinders and require only room for the electrical cable to the electronic module. The electronic module can be mounted up to 98 feet (30 meters) from the cylinder.

The feedback transducer is constructed of a copper alloy coil wound around the outside of an insulated 316/304 stainless steel pressure tube. This tube has the capability of working in pressures up to 3200 psi (220 bar). The coil is then encased in a metal screen and a non-metallic sheath for electrical magnetic interference and vibration resistance. This type of construction allows for operation in applications where the forces can exceed 40 G's. The outer tube is also manufactured from 316/304 stainless steel and is hermetically sealed. The pressure flanges and end caps are manufactured from 303S21 stainless steel. This type of construction allows the cylinder to work in most hydraulic fluids including 95/5 and water glycol without concern for the electronics.

SERIES EP

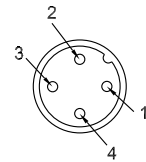
PERFORMANCE	SPECIFICATIONS
Resolution:	Infinite
Independent Linearity:	1" to 2.50" bores * Strokes 0.98 to 1.97" = < ±1% of stroke Strokes above 1.97" = < ±0.5% of stroke 3.25" bores and up < ±0.2% of stroke
Repeatability @ constant temperature:	±0.05% of full stroke (Typically ±0.03% of full stroke)
Outputs:	Voltages: 0 to 10Vdc; 0 to 5Vdc; -5 to +5Vdc 0.5 –4.5 Vdc (Mobile) Currents: 5 to 25 mA: 0 to 20mA; 4 to 20 mA
Measuring Range:	1" to 2.50" bores (14")† 3.25" to 8" bores (71")†
Operating Voltage:	±15Vdc or +18 to 30Vdc, 9-18 Vdc (Mobile)
Operating Temperature:	-40°F (-40°C) to 212°F (100°C) Sensor only
Temperature Performance:	Less than 56 ppm/deg. F (68° F to 140° F) (> 50 mm strokes) Less than 112 ppm/deg. F (-40° F to 212° F)
Operating Force:	120gf maximum (horizontal plane)
Insulation Resistance:	50 Mohm @ 100Vdc

*If the cylinder is to be used in a Mobile application the dimensional size of the cylinder is subject to change.

†For longer strokes consult factory

WIRING SCHEMATIC

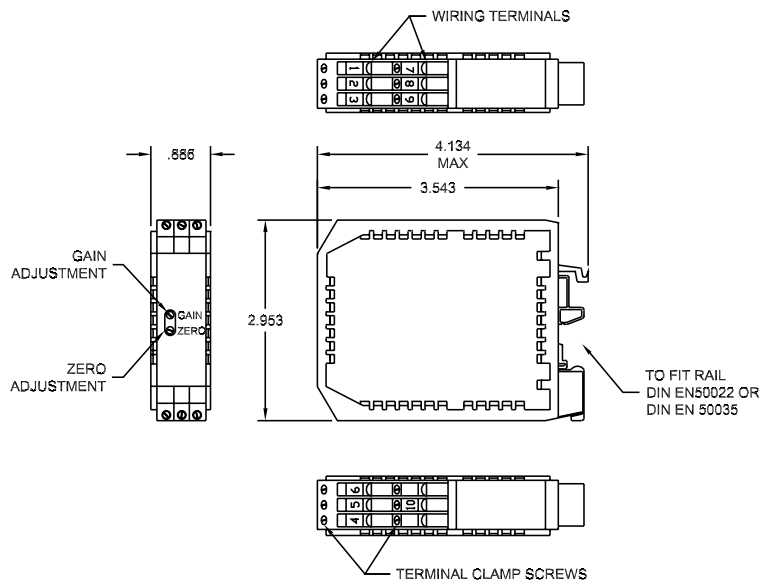
THE CONNECTOR ON THE CYLINDER FITS A STANDARD 4-PIN MICRO-CHANGE CONNECTOR



PIN #1 (BROWN) TO VRVT GREEN (CASE)
PIN #2 (NO WIRE)
PIN #3 (BLUE) TO VRVT YELLOW (+)
PIN #4 (BLACK) TO VRVT BLUE (-)

Included with cylinder:

- Transducer
- Electronic module
- User's manual



EP-1 Electronic Module

PERFORMANCE	SPECIFICATION
Supply Voltage	± 15 Vdc $\pm 10\%$ Regulated
Supply Current	<100 mA maximum
Line Regulation	<0.25% per Volt
Power on Settlement	<10% Span within 5 seconds <0.25% Span within 3 minutes
Output Adjustment	$\pm 10\%$ Span, 100% Zero Offset
Output Ripple	<5 mV RMS
Output Load	5K Minimum (Resistive to 0V Line)

OUTPUT VOLTAGE OPTIONS	
SHAFT RETRACTED	SHAFT EXTENDED
-10 V	+10 V
+10 V	-10 V
0 V	+10 V
+10 V	0 V
-10 V	0 V
0 V	-10 V
-5 V	+5 V
+5 V	-5 V
0 V	+5 V
+5 V	0 V
-5 V	0 V
0 V	-5 V

EP-2 Electronic Module

PERFORMANCE	SPECIFICATION
Supply Voltage	$\pm 18 - 30$ Vdc (Regulated)
Supply Current	<100 mA maximum
Line Regulation	<0.25% per Volt
Power on Settlement	<10% Span within 5 seconds <0.25% Span within 3 minutes
Output Adjustment	$\pm 10\%$ Span, 100% Zero Offset
Output Ripple	<5 mV RMS
Output Load	400 max @ 18 Vdc supply 700 max @ 24 Vdc supply 1000 max @ 30 Vdc supply

OUTPUT CURRENT OPTIONS	
SHAFT RETRACTED	SHAFT EXTENDED
4 mA	20 mA
20 mA	4 mA

EP-3 Electronic Module

PERFORMANCE	SPECIFICATION
Supply Voltage	$\pm 18 - 30$ Vdc (Regulated)
Supply Current	<100 mA maximum
Line Regulation	<0.25% per Volt
Power on Settlement	<10% Span within 5 seconds <0.25% Span within 3 minutes
Output Adjustment	$\pm 10\%$ Span, 100% Zero Offset
Output Ripple	<5 mV RMS
Output Load	5K Minimum (Resistive to 0V Line)

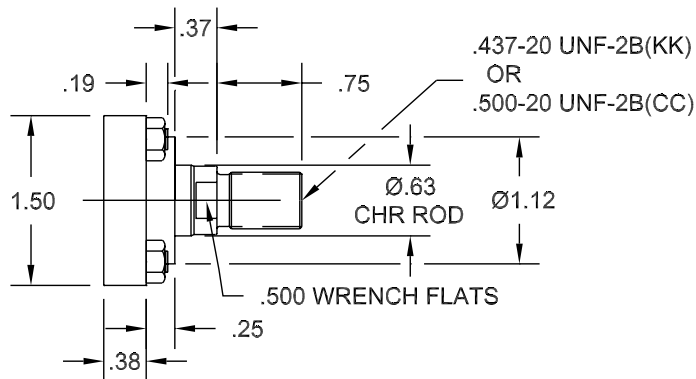
OUTPUT VOLTAGE OPTIONS	
SHAFT RETRACTED	SHAFT EXTENDED
0V	+10 V
+10 V	0V
-5 V	+5 V
+5 V	-5 V
0V	+5 V
+5 V	0V
-5 V	0V
0V	-5 V

SERIES EP CYLINDERS

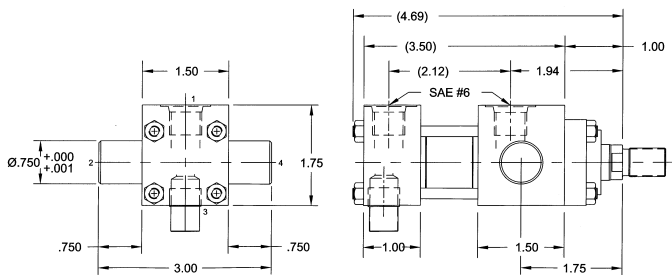
1.0" BORE

- 5/8" Rod – constant
- 1-piece solid piston rod construction
- 8 mounting configurations
- Non-contact internal feedback device accurate to .05% of stroke
- No external electronics on cylinder – mounted remotely up to 30 meters away
- Can be used as a slave cylinder
- Strokes to 14.00"

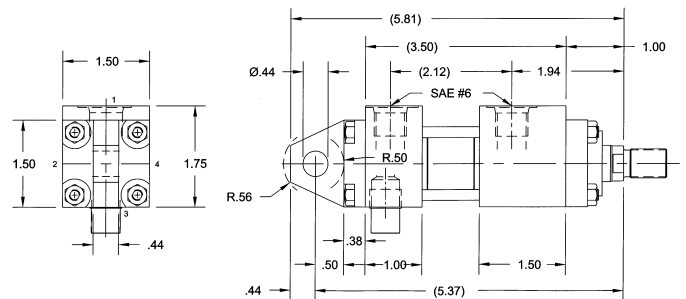
END DIMENSIONS
1.00" BORE/.625 ROD



EP-TM1
1.00" BORE/.625 ROD

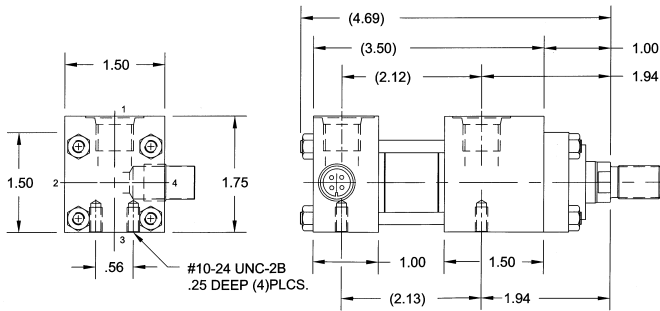


EP-PB1 (DETACHABLE)
1.00" BORE/.625 ROD

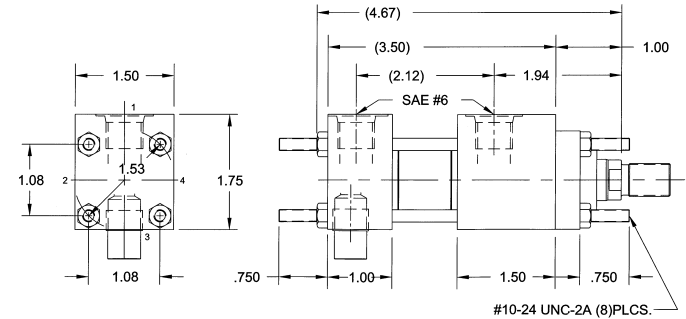


NOTE: ADD STROKE TO DIMENSIONS IN PARENTHESES

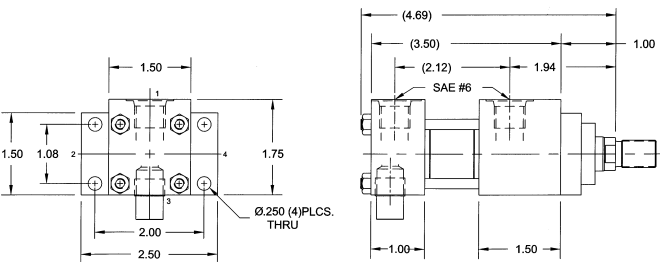
EP-FS
1.00" BORE/.625 ROD



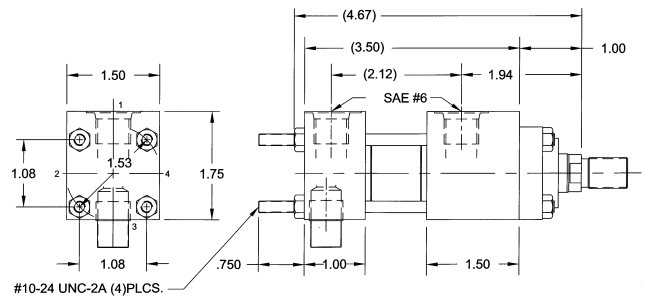
EP-NM1
1.00" BORE/.625 ROD



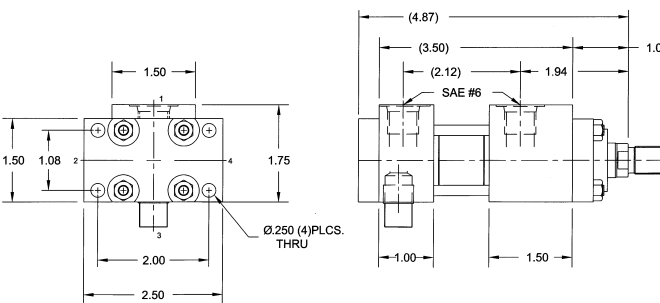
EP-REF2
1.00" BORE/.625 ROD



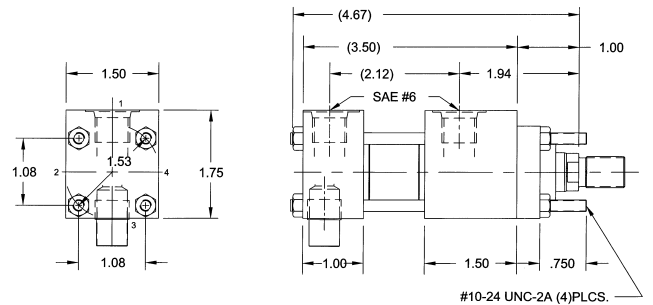
EP-NM2
1.00" BORE/.625 ROD



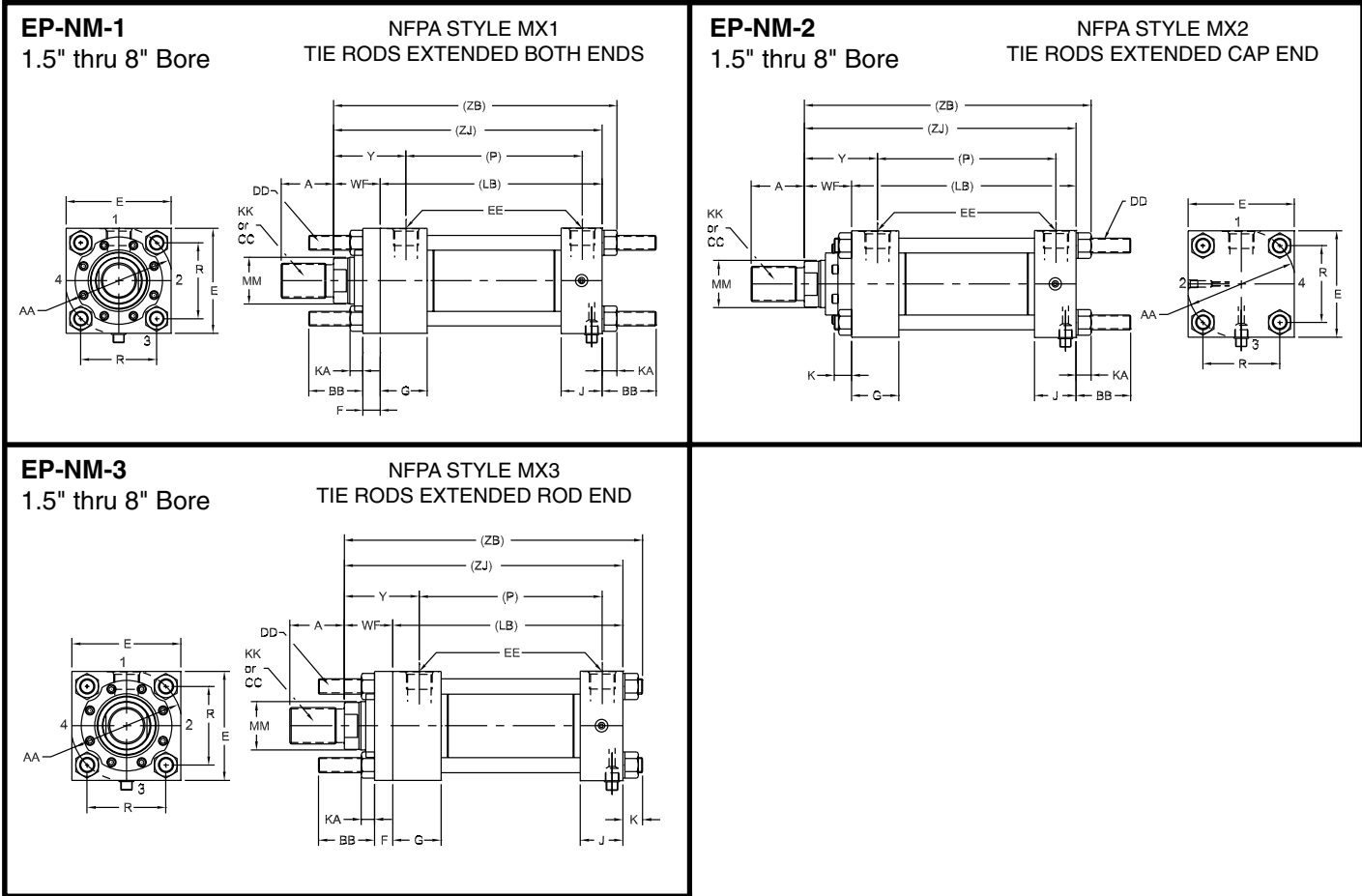
EP-BEF2
1.00" BORE/.625 ROD



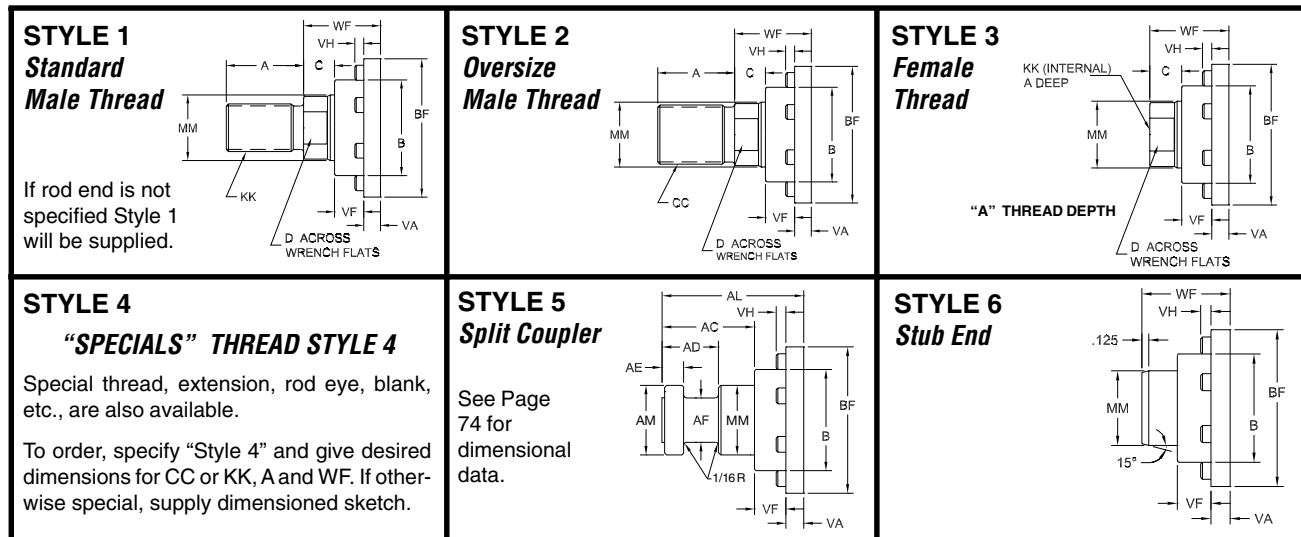
EP-NM3
1.00" BORE/.625 ROD



NOTE: ADD STROKE TO DIMENSIONS IN PARENTHESES



ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

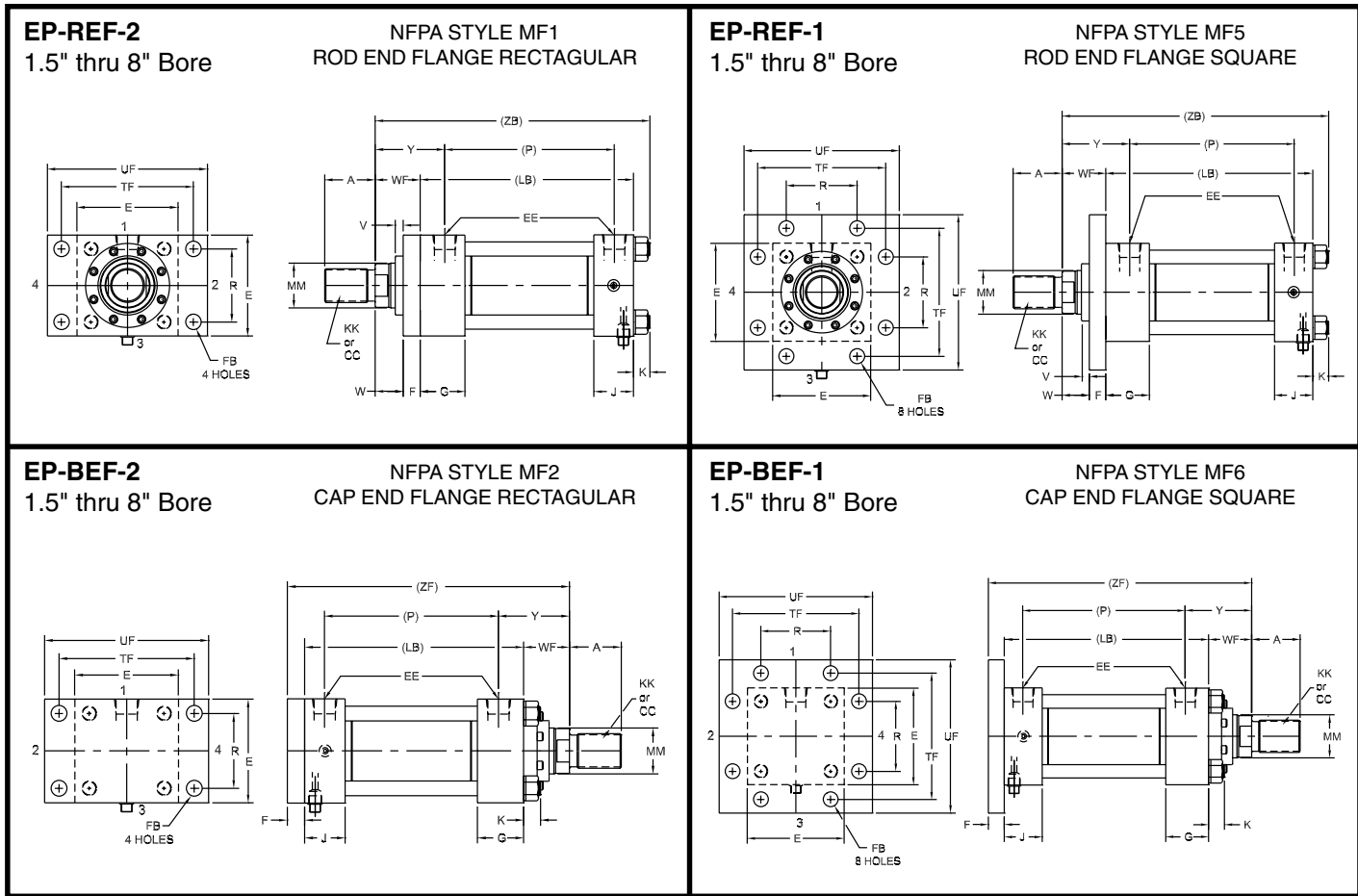
Envelope and Mounting Dimensions

Bore	AA	BB	DD	E	EE SAE	F	G	J	K	R	Add Stroke	
											LB	P
1 1/2	2.3	1 3/8	3/8 - 24	2 1/2	#8	3/8	1 3/4	1 1/2	1/2	1.63	4 5/8	2 7/8
2	2.9	1 13/16	1/2 - 20	3	#8	5/8	1 3/4	1 1/2	5/8	2.05	4 5/8	2 7/8
2 1/2	3.6	1 13/16	1/2 - 20	3 1/2	#8	5/8	1 3/4	1 1/2	5/8	2.55	4 3/4	3
3 1/4	4.6	2 5/16	5/8 - 18	4 1/2	#12	3/4	2	1 3/4	3/4	3.25	5 1/2	3 1/2
4	5.4	2 5/16	5/8 - 18	5	#12	7/8	2	1 3/4	3/4	3.82	5 3/4	3 3/4
5	7.0	3 3/16	7/8 - 14	6 1/2	#12	7/8	2	1 3/4	1	4.95	6 1/4	4 1/4
6	8.1	3 5/8	1 - 14	7 1/2	#16	1	2 1/4	2 1/4	1 1/8	5.73	7 3/8	4 7/8
7	9.3	4 1/8	1 1/8 - 12	8 1/2	#20	-	2 3/4	2 3/4	1 1/4	6.58	8 1/2	5 1/2
8	10.6	4 1/2	1 1/4 - 12	9 1/2	#24	-	3	3	1 1/2	7.50	9 1/2	6 1/4

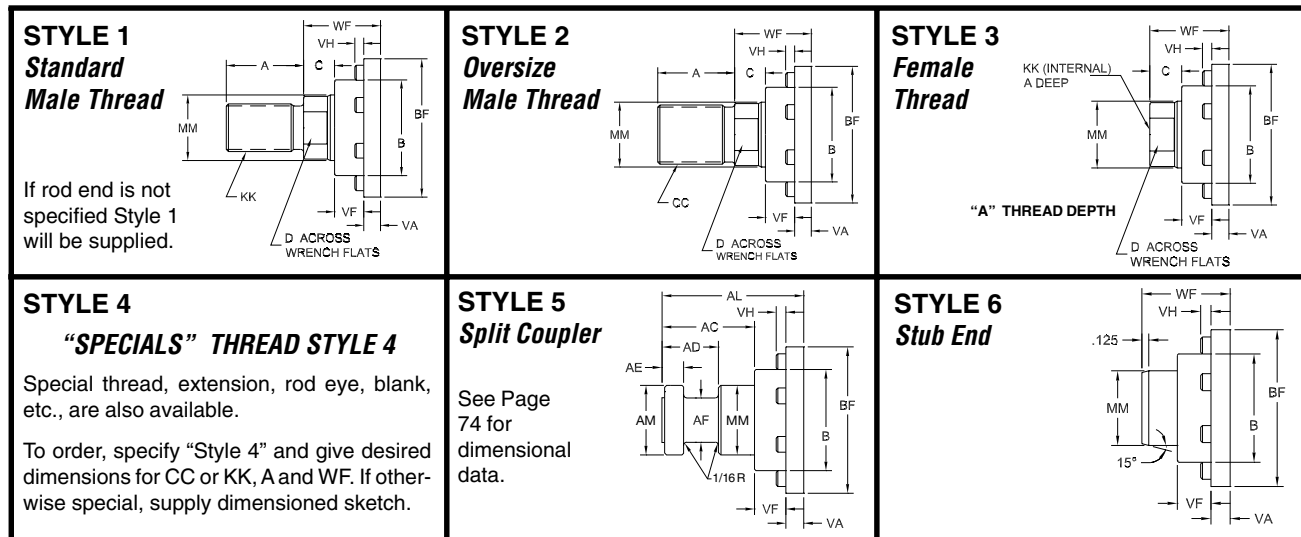
Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	KA	VA	VF	VH	WF	Y	Add Stroke	
		Style 1 & 3 KK	Style 2 CC												ZB	ZJ
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	5/16	3/8	1/4	3/16	1	2	6 1/8	5 5/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	5/16	3/8	1/2	3/16	1 3/8	2 3/8	6 1/2	6
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	27/64	3/8	1/2	3/16	1 3/8	2 3/8	6 5/8	6
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	27/64	3/8	5/8	3/16	1 5/8	2 5/8	6 7/8	6 1/4
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	27/64	3/8	1/2	3/16	1 3/8	2 3/8	6 3/4	6 1/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	27/64	3/8	5/8	3/16	1 5/8	2 5/8	7	6 3/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	27/64	5/8	1/2	3/16	1 7/8	2 7/8	7 1/4	6 5/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	17/32	3/8	5/8	3/16	1 5/8	2 3/4	7 7/8	7 1/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	17/32	5/8	1/2	3/16	1 7/8	3	8 1/8	7 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	17/32	5/8	1/2	1/4	2	3 1/8	8 1/4	7 1/2
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	17/32	5/8	1/2	3/16	1 7/8	3	8 3/8	7 5/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	17/32	5/8	1/2	1/4	2	3 1/8	8 1/2	7 3/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	17/32	5/8	5/8	1/4	2 1/4	3 3/8	8 3/4	8
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	23/32	5/8	1/2	1/4	2	3 1/8	9 1/4	8 1/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	23/32	5/8	5/8	1/4	2 1/4	3 3/8	9 1/2	8 1/2
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	23/32	15/16	5/16	-	2 1/4	3 3/8	9 1/2	8 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	23/32	15/16	5/16	-	2 1/4	3 3/8	9 1/2	8 1/2
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	13/16	5/8	5/8	1/4	2 1/4	3 1/2	10 3/4	9 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	13/16	15/16	5/16	-	2 1/4	3 1/2	10 3/4	9 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	13/16	15/16	5/16	-	2 1/4	3 1/2	10 3/4	9 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	13/16	15/16	5/16	-	2 1/4	3 1/2	10 3/4	9 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	15/16	5/16	-	2 1/4	3 3/4	12	10 3/4
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	1 1/32	15/16	5/16	-	2 1/4	3 7/8	13 1/4	11 3/4

SERIES EP



ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimensions

Bore	E	EE SAE	F	FB	G	J	K	R	TF	UF	Add Stroke	
											LB	P
1 1/2	2 1/2	#8	3/8	7/16	1 3/4	1 1/2	1/2	1.63	3 7/16	4 1/4	4 5/8	2 7/8
2	3	#8	5/8	9/16	1 3/4	1 1/2	5/8	2.05	4 1/8	5 1/8	4 5/8	2 7/8
2 1/2	3 1/2	#8	5/8	9/16	1 3/4	1 1/2	5/8	2.55	4 5/8	5 5/8	4 3/4	3
3 1/4	4 1/2	#12	3/4	11/16	2	1 3/4	3/4	3.25	5 7/8	7 1/8	5 1/2	3 1/2
4	5	#12	7/8	11/16	2	1 3/4	3/4	3.82	6 3/8	7 5/8	5 3/4	3 3/4
5	6 1/2	#12	7/8	15/16	2	1 3/4	1	4.95	8 3/16	9 3/4	6 1/4	4 1/4
6	7 1/2	#16	1	1 1/16	2 1/4	2 1/4	1 1/8	5.73	9 7/16	11 1/4	7 3/8	4 7/8
7	8 1/2	#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 1/2
8	9 1/2	#24	1	1 5/16	3	3	1 1/2	7.50	11 13/16	14	9 1/2	6 1/4

Dimensions Affected by Rod Size

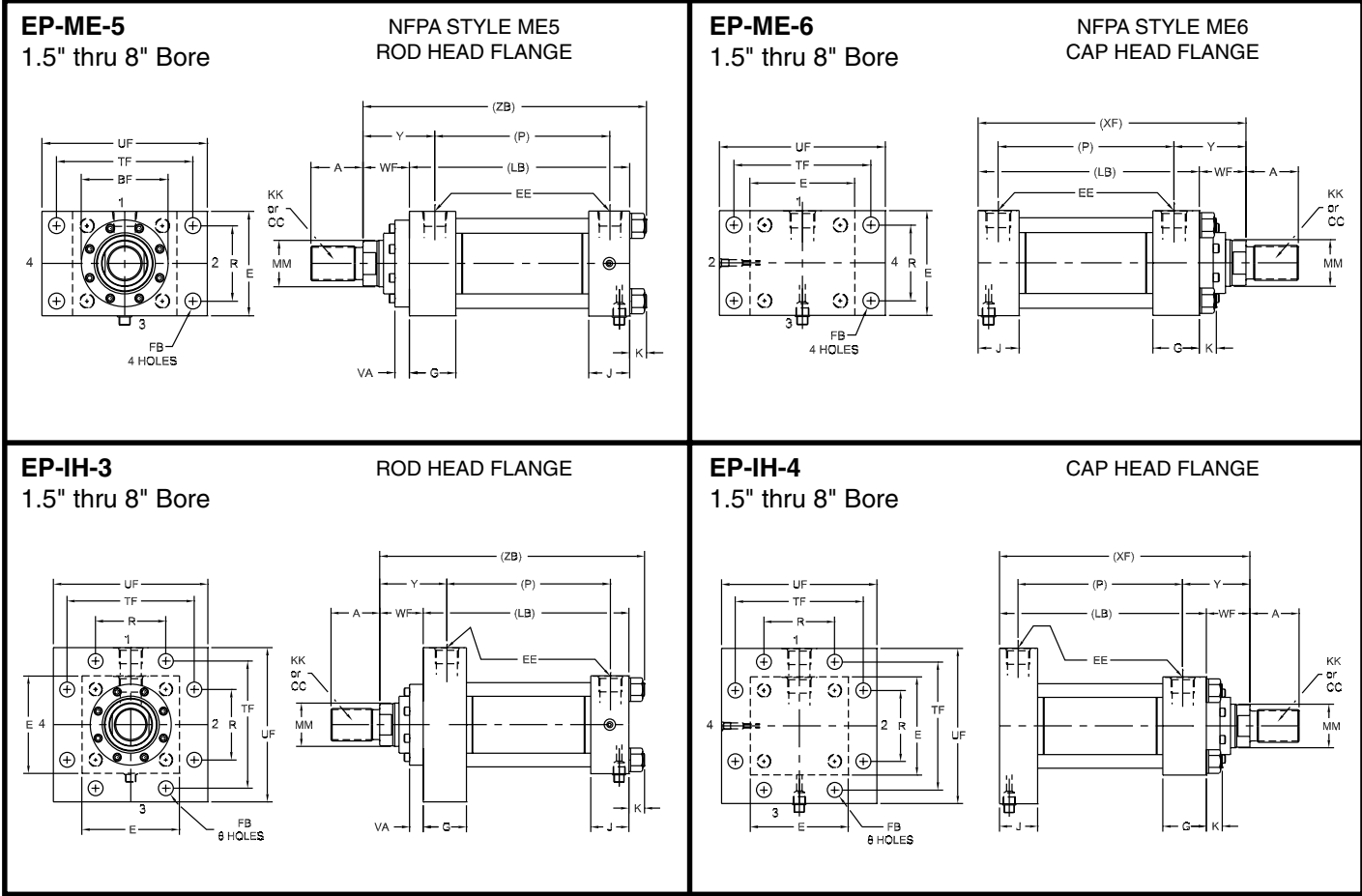
Bore	MM Rod Size	Thread		A	B	BF	C	D	V	VA	VF	VH	W	WF	Y	Add Stroke	
		Style 1 & KK	Style 2 CC													ZB	ZF
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	1/4	3/8	1/4	3/16	5/8	1	2	6 1/8	6
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/2	3/8	1/2	3/16	1	1 3/8	2 3/8	6 1/2	6 3/8
2	1 3/8	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/4	3/8	1/2	3/16	3/4	1 3/8	2 3/8	6 5/8	6 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	3/8	5/8	3/16	1	1 5/8	2 5/8	6 7/8	6 7/8
2 1/2	1 3/8	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/4	3/8	1/2	3/16	3/4	1 3/8	2 3/8	6 3/4	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	3/8	5/8	3/16	1	1 5/8	2 5/8	7	7
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	1/2	5/8	1/2	3/16	1 1/4	1 7/8	2 7/8	7 1/4	7 1/4
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	1/4	3/8	5/8	3/16	7/8	1 5/8	2 3/4	7 7/8	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	3/8	5/8	1/2	3/16	1 1/8	1 7/8	3	8 1/8	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	3/8	5/8	1/2	1/4	1 1/4	2	3 1/8	8 1/4	8 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	1/4	5/8	1/2	3/16	1	1 7/8	3	8 3/8	8 1/2
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	1/4	5/8	1/2	1/4	1 1/8	2	3 1/8	8 1/2	8 5/8
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	3/8	5/8	5/8	1/4	1 3/8	2 1/4	3 3/8	8 3/4	8 7/8
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	1/4	5/8	1/2	1/4	1 1/8	2	3 1/8	9 1/4	9 1/8
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	3/8	5/8	5/8	1/4	1 3/8	2 1/4	3 3/8	9 1/2	9 3/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	3/8	15/16	5/16	-	1 3/8	2 1/4	3 3/8	9 1/2	9 3/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	3/8	15/16	5/16	-	1 3/8	2 1/4	3 3/8	9 1/2	9 3/8
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	1/4	5/8	5/8	1/4	1 1/4	2 1/4	3 1/2	10 3/4	10 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	1/4	15/16	5/16	-	1 1/4	2 1/4	3 1/2	10 3/4	10 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	1 1/4	2 1/4	3 1/2	10 3/4	10 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	1 1/4	2 1/4	3 1/2	10 3/4	10 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	1/4	15/16	5/16	-	1 1/4	2 1/4	3 3/4	12	11 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	1 1/4	2 1/4	3 3/4	12	11 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	1 1/4	2 1/4	3 3/4	12	11 3/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	3 3/4	12	11 3/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	3 3/4	12	11 3/4
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	1 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	1 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	1/4	15/16	5/16	-	1 1/4	2 1/4	3 7/8	13 1/4	12 3/4

For REF-1
& REF-2
Mount
Max. PSI Push

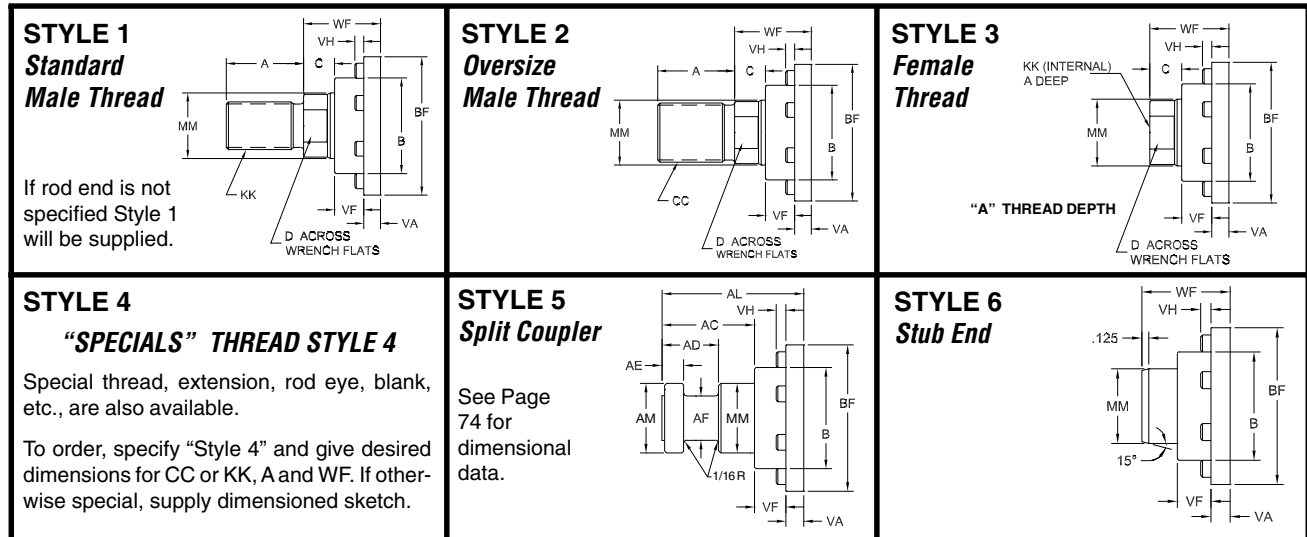
Bore	Rod Size											
	.62	1.00	1.38	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50
1.50	2500	1500	-	-	-	-	-	-	-	-	-	-
2.00	-	2500	1500	-	-	-	-	-	-	-	-	-
2.50	-	2500	1900	1500	-	-	-	-	-	-	-	-
3.25	-	-	2500	2100	1500	-	-	-	-	-	-	-
4.00	-	-	-	2500	1800	1500	-	-	-	-	-	-
5.00	-	-	-	-	2200	1650	1200	750	-	-	-	-
6.00	-	-	-	-	-	1800	1450	1100	750	-	-	-
7.00	-	-	-	-	-	-	1500	1250	1000	800	500	-
8.00	-	-	-	-	-	-	-	900	800	700	600	500

For BEF-1
& BEF-2
Mount
Max. PSI Pull

Bore	Rod Size											
	.62	1.00	1.38	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50
1.50	3000	3000	-	-	-	-	-	-	-	-	-	-
2.00	-	3000	3000	-	-	-	-	-	-	-	-	-
2.50	-	3000	3000	3000	-	-	-	-	-	-	-	-
3.25	-	-	3000	3000	3000	-	-	-	-	-	-	-
4.00	-	-	-	3000	3000	3000	-	-	-	-	-	-
5.00	-	-	-	-	2000	2500	2800	3000	-	-	-	-
6.00	-	-	-	-	-	2000	2500	2800	3000	-	-	-
7.00	-	-	-	-	-	-	1500	1700	1800	1900	2000	-
8.00	-	-	-	-	-	-	-	1500	1700	1800	1900	2000



ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

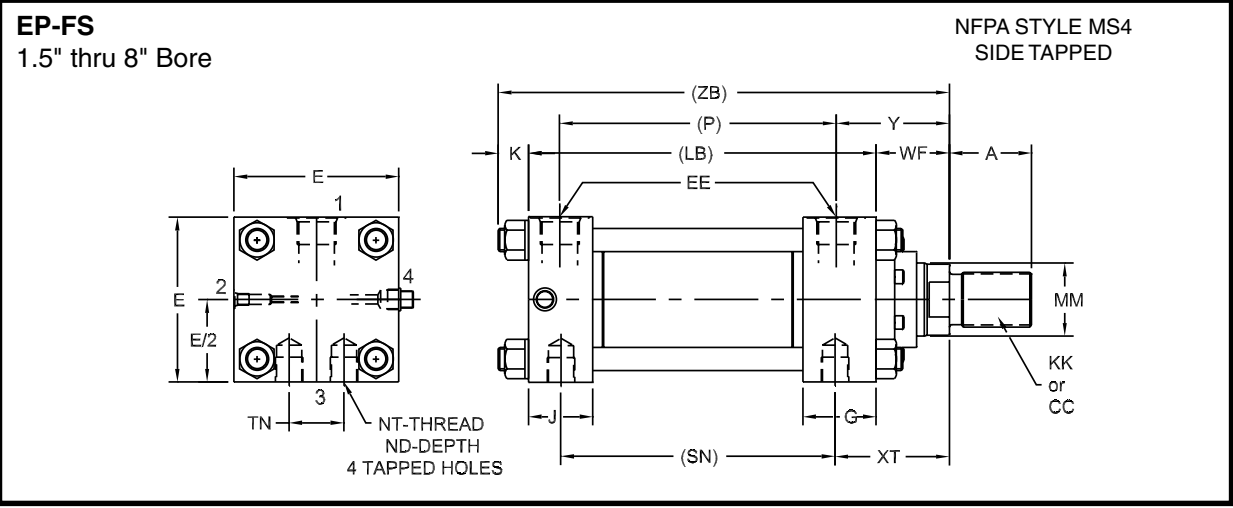
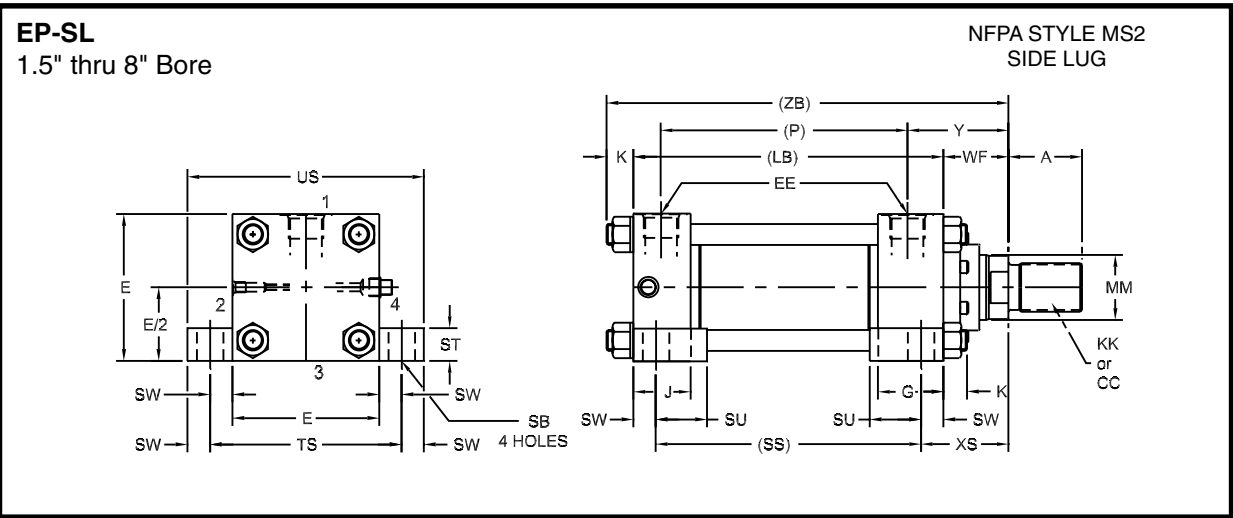
Envelope and Mounting Dimensions

Bore	E	EE SAE	F	FB	G	J	K	R	TF	UF	Add Stroke	
											LB	P
1 1/2	2 1/2	#8	3/8	7/16	1 3/4	1 1/2	1/2	1.63	3 7/16	4 1/4	4 5/8	2 7/8
2	3	#8	5/8	9/16	1 3/4	1 1/2	5/8	2.05	4 1/8	5 1/8	4 5/8	2 7/8
2 1/2	3 1/2	#8	5/8	9/16	1 3/4	1 1/2	5/8	2.55	4 5/8	5 5/8	4 3/4	3
3 1/4	4 1/2	#12	3/4	11/16	2	1 3/4	3/4	3.25	5 7/8	7 1/8	5 1/2	3 1/2
4	5	#12	7/8	11/16	2	1 3/4	3/4	3.82	6 3/8	7 5/8	5 3/4	3 3/4
5	6 1/2	#12	7/8	15/16	2	1 3/4	1	4.95	8 3/16	9 3/4	6 1/4	4 1/4
6	7 1/2	#16	1	1 1/16	2 1/4	2 1/4	1 1/8	5.73	9 7/16	11 1/4	7 3/8	4 7/8
7	8 1/2	#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 1/2
8	9 1/2	#24	1	1 5/16	3	3	1 1/2	7.50	11 13/16	14	9 1/2	6 1/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	Y	Add Stroke	
		Style 1 & 3 KK	Style 2 CC											XF	ZB
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	3/8	1/4	3/16	1	2	5 5/8	6 1/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	6	6 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	6	6 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	6 1/4	6 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	6 1/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	6 3/8	7
3 1/4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	6 5/8	7 1/4
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	7 1/8	7 7/8
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3	7 3/8	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	7 1/2	8 1/4
4	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	7 5/8	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	7 3/4	8 1/2
5	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	8 1/2	9 1/2
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	8 1/2	9 1/2
5	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 3/8	8 1/2	9 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 3/8	8 1/2	9 1/2
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/2	9 5/8	10 3/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 1/2	9 5/8	10 3/4
6	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 1/2	9 5/8	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 1/2	9 5/8	10 3/4
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 3/4	10 3/4	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 3/4	10 3/4	12
7	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 3/4	10 3/4	12
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	3 3/4	10 3/4	12
7	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	3 3/4	10 3/4	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 7/8	11 3/4	13 1/4
8	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 7/8	11 3/4	13 1/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	3 7/8	11 3/4	13 1/4
8	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	3 7/8	11 3/4	13 1/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	3 7/8	11 3/4	13 1/4

SERIES EP



ROD END DIMENSIONS

<p>STYLE 1 <i>Standard Male Thread</i></p> <p>If rod end is not specified Style 1 will be supplied.</p>	<p>STYLE 2 <i>Overize Male Thread</i></p>	<p>STYLE 3 <i>Female Thread</i></p> <p>"A" THREAD DEPTH</p>
<p>STYLE 4 <i>"SPECIALS" THREAD STYLE 4</i></p> <p>Special thread, extension, rod eye, blank, etc., are also available.</p> <p>To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.</p>	<p>STYLE 5 <i>Split Coupler</i></p> <p>See Page 74 for dimensional data.</p>	<p>STYLE 6 <i>Stub End</i></p>

4 1/2" rod and larger have spanner wrench holes in place of wrench flats.
NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimension

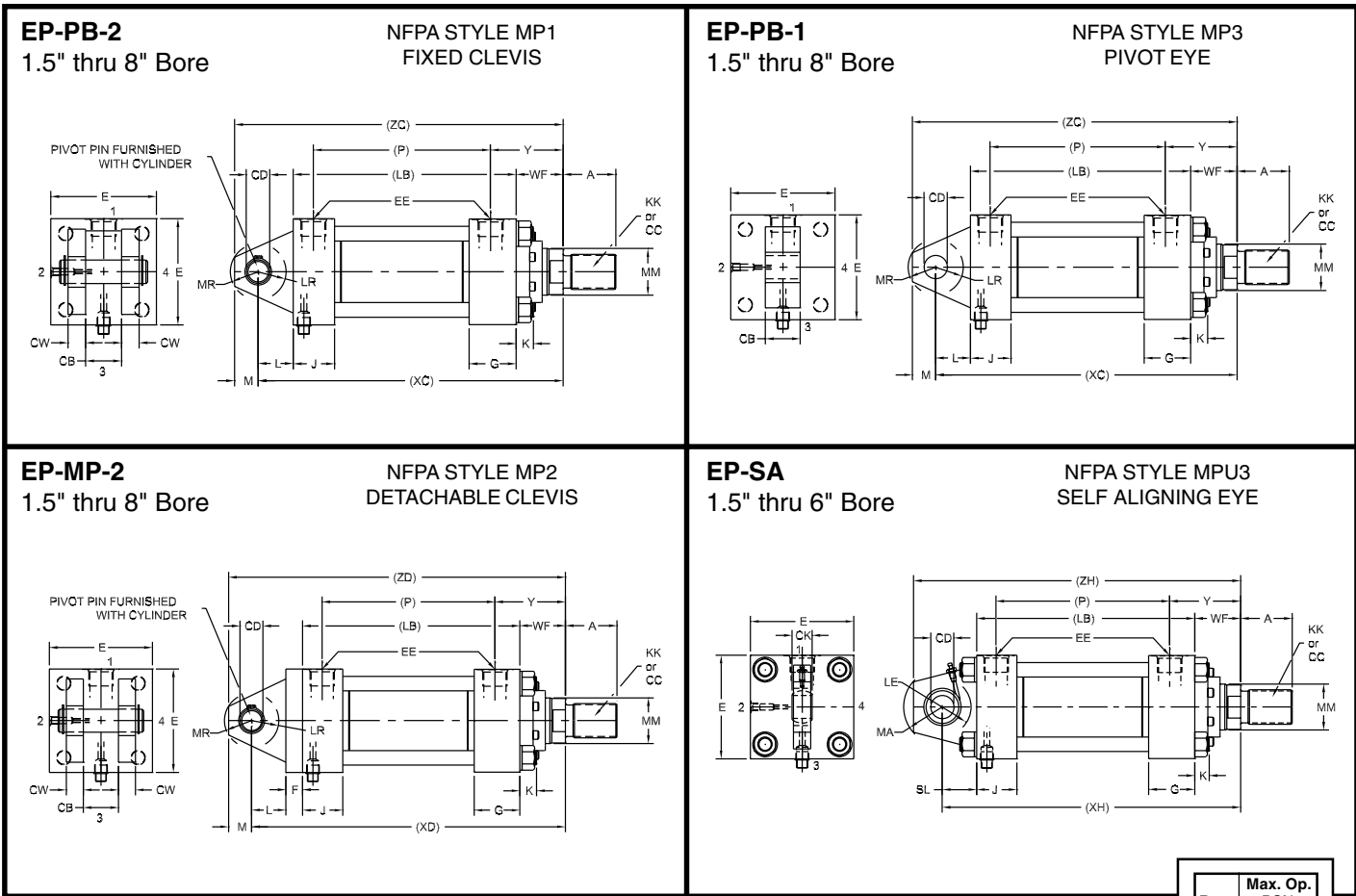
Bore	E	EE SAE	G	J	K	ND	NT	SB	ST
1 1/2	2 1/2	#8	1 3/4	1 1/2	1/2	3/8	3/8 - 16	7/16	1/2
2	3	#8	1 3/4	1 1/2	5/8	7/16	1/2 - 13	9/16	3/4
2 1/2	3 1/2	#8	1 3/4	1 1/2	5/8	1/2	5/8 - 11	13/16	1
3 1/4	4 1/2	#12	2	1 3/4	3/4	11/16	3/4 - 10	13/16	1
4	5	#12	2	1 3/4	3/4	11/16	1 - 8	1 1/16	1 1/4
5	6 1/2	#12	2	1 3/4	1	1	1 - 8	1 1/16	1 1/4
6	7 1/2	#16	2 1/4	2 1/4	1 1/8	1 1/4	1 1/4 - 7	1 5/16	1 1/2
7	8 1/2	#20	2 3/4	2 3/4	1 1/4	1 1/8	1 1/2 - 6	1 9/16	1 3/4
8	9 1/2	#24	3	3	1 1/2	1 1/2	1 1/2 - 6	1 9/16	1 3/4

Bore	SU	SW	TN	TS	US	Add Stroke			
						LB	P	SN	SS
1 1/2	15/16	3/8	3/4	3 1/4	4	4 5/8	2 7/8	2 7/8	3 7/8
2	1 1/4	1/2	15/16	4	5	4 5/8	2 7/8	2 7/8	3 5/8
2 1/2	1 9/16	11/16	1 5/16	4 7/8	6 1/4	4 3/4	3	3	3 3/8
3 1/4	1 9/16	11/16	1 1/2	5 7/8	7 1/4	5 1/2	3 1/2	3 1/2	4 1/8
4	2	7/8	2 1/16	6 3/4	8 1/2	5 3/4	3 3/4	3 3/4	4
5	2	7/8	2 15/16	8 1/8	10	6 1/4	4 1/4	4 1/4	4 1/2
6	2 1/2	1 1/8	3 5/16	9 3/4	12	7 3/8	4 7/8	5 1/8	5 1/8
7	2 7/8	1 3/8	3 3/4	11 1/4	14	8 1/2	5 1/2	5 7/8	5 3/4
8	2 7/8	1 3/8	4 1/4	12 1/4	15	9 1/2	6 1/4	6 5/8	6 3/4

Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	V	VA	VF	VH	WF	XS	XT	Y	Add Stroke
		Style 1 & 3 KK	Style 2 CC														ZB
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	1/4	3/8	1/4	3/16	1	1 3/8	1 15/16	2	6 1/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/2	3/8	1/2	3/16	1 3/8	1 3/4	2 5/16	2 3/8	6 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/4	3/8	1/2	3/16	1 3/8	1 7/8	2 5/16	2 3/8	6 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	3/8	5/8	3/16	1 5/8	2 1/8	2 9/16	2 5/8	6 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	1/4	3/8	1/2	3/16	1 3/8	2 1/16	2 5/16	2 3/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	3/8	5/8	3/16	1 5/8	2 5/16	2 9/16	2 5/8	7
3 1/4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	1/2	5/8	1/2	3/16	1 7/8	2 9/16	2 13/16	2 7/8	7 1/4
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	3/8	5/8	1/2	1/4	2	2 11/16	2 15/16	3 1/8	7 7/8
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	1/4	5/8	1/2	3/16	1.875	2 3/4	2 15/16	3	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	1/4	5/8	1/2	1/4	2	2 7/8	3 1/16	3 1/8	8 1/2
5	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	3/8	5/8	1/2	1/4	2	2 7/8	3	3 1/8	9 1/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	3/8	15/16	5/16	-	2 1/4	3 1/8	3 1/4	3 3/8	9 1/2
6	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	3/8	15/16	5/16	-	2 1/4	3 1/8	3 1/4	3 3/8	9 1/2
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	2 1/4	3 3/8	3 5/16	3 1/2	10 3/4
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	1/4	15/16	5/16	-	2 1/4	3 5/8	3 13/16	3 3/4	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	2 1/4	3 5/8	3 13/16	3 3/4	12
8	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	2 1/4	3 5/8	3 13/16	3 3/4	12
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1/4	15/16	5/16	-	2 1/4	3 5/8	3 13/16	3 3/4	12
5	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	1/4	15/16	5/16	-	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	1/4	15/16	5/16	-	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4
5 1/2	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	1/4	15/16	5/16	-	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	1/4	15/16	5/16	-	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4
5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	1/4	15/16	5/16	-	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4	

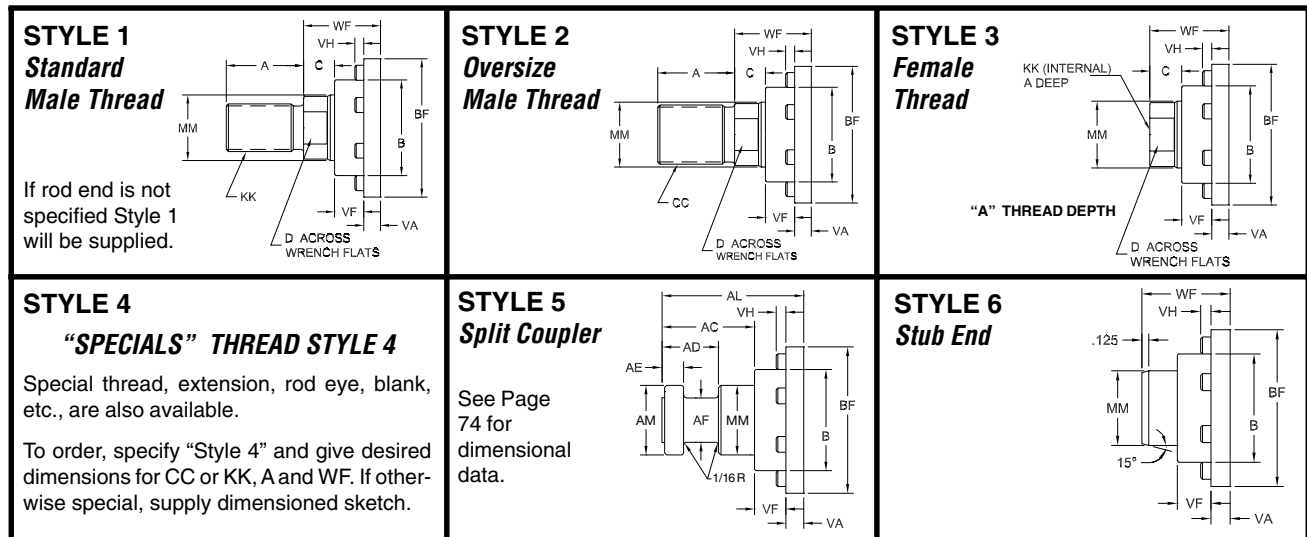
SERIES EP



†See Table 1 on pg. 73 for recommended maximum swivel angles.

Bore	Max. Op. PSI†
1½	1250
2	2200
2½	1450
3¼	1500
4	1850
5	2000
6	1800

ROD END DIMENSIONS



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimensions

Bore	CB	CD	CK	CW	E	EE SAE	F	G	J
1 1/2	3/4	0.501	7/16	1/2	2 1/2	#8	3/8	1 3/4	1 1/2
2	1 1/4	0.751	21/32	5/8	3	#8	5/8	1 3/4	1 1/2
2 1/2	1 1/4	0.751	21/32	5/8	3 1/2	#8	5/8	1 3/4	1 1/2
3 1/4	1 1/2	1.001	7/8	3/4	4 1/2	#12	3/4	2	1 3/4
4	2	1.376	1 3/16	1	5	#12	7/8	2	1 3/4
5	2 1/2	1.751	1 17/32	1 1/4	6 1/2	#12	7/8	2	1 3/4
6	2 1/2	2.001	1 3/4	1 1/4	7 1/2	#16	1	2 1/4	2 1/4
7	3	2.501	-	1 1/2	8 1/2	#20	1	2 3/4	2 3/4
8	3	3.001	-	1 1/2	9 1/2	#24	1	3	3

Bore	K	L	LE	LR	M	MA	MR	SL	Add Stroke	
									LB	P
1 1/2	1/2	3/4	7/8	9/16	1/2	1 1/4	5/8	3/4	4 5/8	2 7/8
2	5/8	1 1/4	7/8	1	3/4	1 1/4	15/16	1 1/4	4 5/8	2 7/8
2 1/2	5/8	1 1/4	7/8	15/16	3/4	1 1/4	15/16	1 1/4	4 3/4	3
3 1/4	3/4	1 1/2	1 1/8	1 1/4	1	1 1/2	1 3/16	1 1/2	5 1/2	3 1/2
4	3/4	2 1/8	1 1/2	1 3/4	1 3/8	1 3/4	1 5/8	2 1/8	5 3/4	3 3/4
5	1	2 1/4	1 15/16	2 1/16	1 3/4	2 1/4	2 1/8	2 1/4	6 1/4	4 1/4
6	1 1/8	2 1/2	2 3/16	2 5/16	2	2 3/4	2 3/8	2 1/2	7 3/8	4 7/8
7	1 1/4	3	-	2 3/4	2 1/2	-	2 7/8	-	8 1/2	5 1/2
8	1 1/2	3 1/4	-	3 1/4	2 3/4	-	3 1/8	-	9 1/2	6 1/4

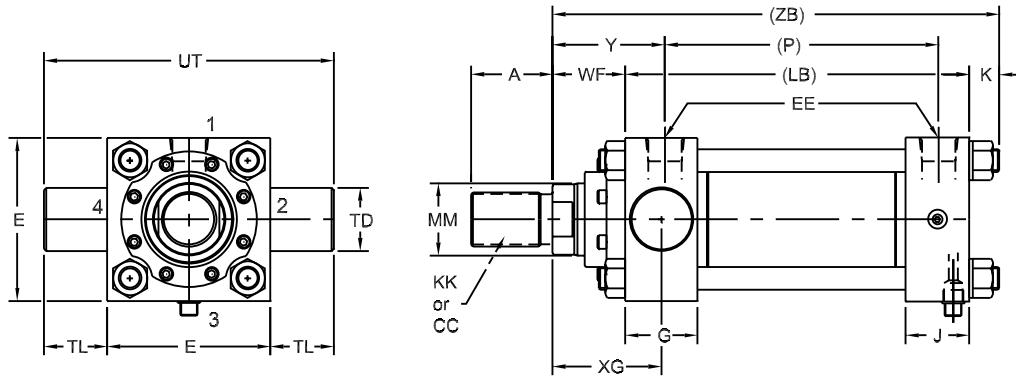
Dimensions Affected by Rod Size

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	Y	Add Stroke					
		Style 1 & 3 KK	Style 2 CC											XC	XD	XH	ZC	ZD	ZH
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	3/8	1/4	3/16	1	2	6 3/8	6 3/4	6 3/8	6 7/8	7 1/4	7 1/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	6 3/4	7 1/8	6 3/4	7 1/4	7 5/8	7 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	7 1/4	7 7/8	7 1/4	8	8 5/8	8 1/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	7 1/2	8 1/8	7 1/2	8 1/4	8 7/8	8 1/2
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	7 3/8	8	7 3/8	8 1/8	8 3/4	8 3/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	7 5/8	8 1/4	7 5/8	8 3/8	9	8 5/8
3 1/4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3	8 7/8	9 5/8	8 7/8	9 7/8	10 5/8	10 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	9	9 3/4	9	10	10 3/4	10 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3	9 3/4	10 5/8	9 3/4	11 1/8	12	11 5/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	9 7/8	10 3/4	9 7/8	11 1/4	12 1/8	11 3/4
5	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2	3 1/8	10 1/2	11 3/8	10 1/2	12 1/8	13	13
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 3/8	10 3/4	11 5/8	10 3/4	12 1/2	13 3/8	13 1/4
6	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 3/8	10 3/4	11 5/8	10 3/4	12 1/2	13 3/8	13 1/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 1/2	12 1/8	13 1/8	12 1/8	14 1/8	15 1/8	14 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
8	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
8	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	3 3/4	13 3/4	14 3/4	-	16 1/4	17 1/4	-
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	3 7/8	15	16	-	17 3/4	18 3/4	-

SERIES EP

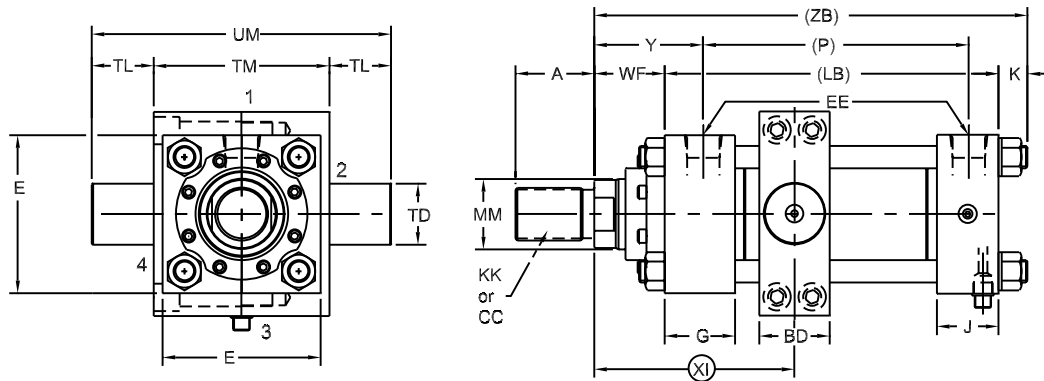
EP-TM-1
1.5" thru 8" Bore

NFPA STYLE MT1
ROD END TRUNNION



EP-TM-3
1.5" thru 8" Bore

NFPA STYLE MT4
INTERMEDIATE TRUNNION



NOTE: If using bolt on manifold plates, see pg. 69 for information on min./max. XI dimension.

ROD END DIMENSIONS

<p>STYLE 1 <i>Standard Male Thread</i></p> <p>If rod end is not specified Style 1 will be supplied.</p>	<p>STYLE 2 <i>Oversize Male Thread</i></p>	<p>STYLE 3 <i>Female Thread</i></p> <p>"A" THREAD DEPTH</p>
<p>STYLE 4 <i>"SPECIALS" THREAD STYLE 4</i></p> <p>Special thread, extension, rod eye, blank, etc., are also available.</p> <p>To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.</p>	<p>STYLE 5 <i>Split Coupler</i></p> <p>See Page 74 for dimensional data.</p>	<p>STYLE 6 <i>Stub End</i></p>

4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

NOTE: Style 3 rod thread will be shorter than the "A" dimension shown for rods 3" diameter and greater. Consult factory.

Envelope and Mounting Dimensions

Bore	BD	E	EE SAE	G	J	K	TD	TL	TM	UM	UT	UW	Add Stroke	
													LB	P
1 1/2	1 1/4	2 1/2	#8	1 3/4	1 1/2	1/2	1.000	1	3	5	4 1/2	3 3/8	4 5/8	2 7/8
2	1 1/2	3	#8	1 3/4	1 1/2	5/8	1.375	1 3/8	3 1/2	6 1/4	5 3/4	4 1/8	4 5/8	2 7/8
2 1/2	1 1/2	3 1/2	#8	1 3/4	1 1/2	5/8	1.375	1 3/8	4	6 3/4	6 1/4	4 5/8	4 3/4	3
3 1/4	2	4 1/2	#12	2	1 3/4	3/4	1.750	1 3/4	5	8 1/2	8	5 13/16	5 1/2	3 1/2
4	2	5	#12	2	1 3/4	3/4	1.750	1 3/4	5 1/2	9	8 1/2	6 3/8	5 3/4	3 3/4
5	2	6 1/2	#12	2	1 3/4	1	1.750	1 3/4	7	10 1/2	10	7 3/4	6 1/4	4 1/4
6	3	7 1/2	#16	2 1/4	2 1/4	1 1/8	2.000	2	8 1/2	12 1/2	11 1/2	10 3/8	7 3/8	4 7/8
7	3	8 1/2	#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 1/2
8	3 1/2	9 1/2	#24	3	3	1 1/2	3.000	3	11	17	15 1/2	13 3/8	9 1/2	6 1/4

Dimensions Affected by Rod Si:

Bore	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	XG	XI MIN.	Y	Add Stroke	
		Style 1 & 3 KK	Style 2 CC													XJ	ZB
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	3/8	1/4	3/16	1	1 7/8	3 7/16	2	4 7/8	6 1/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/4	3 13/16	2 3/8	5 1/4	6 1/2
2	3/8	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/4	3 15/16	2 3/8	5 1/4	6 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 1/2	4 3/16	2 5/8	5 1/2	6 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/4	3 15/16	2 3/8	5 3/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 1/2	4 3/16	2 5/8	5 5/8	7
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 3/4	4 7/16	2 7/8	5 7/8	7 1/4
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	4 11/16	2 3/4	6 1/4	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	4 15/16	3	6 1/2	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	5 1/16	3 1/8	6 5/8	8 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	4 15/16	3	6 3/4	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	5 1/16	3 1/8	6 7/8	8 1/2
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/4	5 5/16	3 3/8	7 1/8	8 3/4
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	5 1/16	3 1/8	7 3/8	9 1/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/4	5 5/16	3 3/8	7 5/8	9 1/2
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 1/4	5 5/16	3 3/8	7 5/8	9 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 1/4	5 5/16	3 3/8	7 5/8	9 1/2
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	6 1/16	3 1/2	8 3/8	10 3/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 3/8	6 1/16	3 1/2	8 3/8	10 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 3/8	6 1/16	3 1/2	8 3/8	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 3/8	6 1/16	3 1/2	8 3/8	10 3/4
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	-	2 1/4	3 5/8	6 9/16	3 3/4	9 3/8	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 5/8	6 9/16	3 3/4	9 3/8	12
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 5/8	6 9/16	3 3/4	9 3/8	12
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	3 5/8	6 9/16	3 3/4	9 3/8	12
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	3 5/8	6 9/16	3 3/4	9 3/8	12
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	-	2 1/4	3 3/4	7 1/16	3 7/8	10 1/4	13 1/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	-	2 1/4	3 3/4	7 1/16	3 7/8	10 1/4	13 1/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	-	15/16	5/16	-	2 1/4	3 3/4	7 1/16	3 7/8	10 1/4	13 1/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	-	15/16	5/16	-	2 1/4	3 3/4	7 1/16	3 7/8	10 1/4	13 1/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	-	15/16	5/16	-	2 1/4	3 3/4	7 1/16	3 7/8	10 1/4	13 1/4

SERIES EP

Atlas Series ES, EM, EP

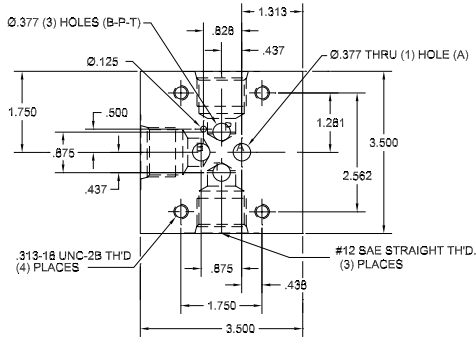
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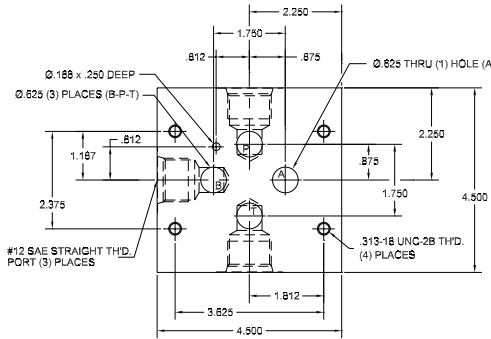
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Available Bolt-on Manifold Valve Patterns

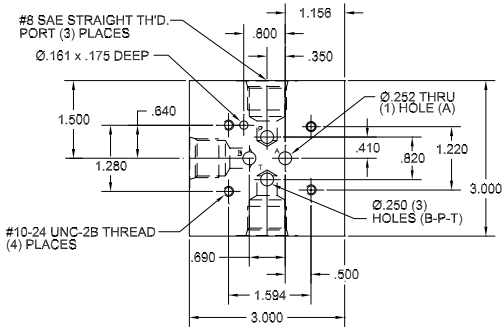
Group A – Servo



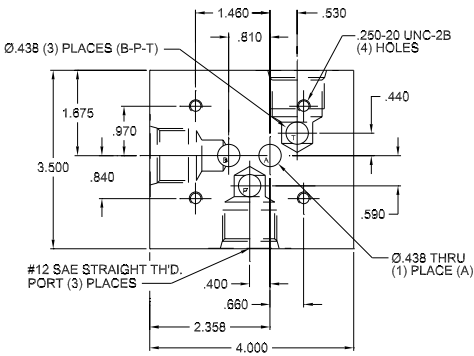
Group D – Servo



Group G – NFPA D03



Group H – NFPA D05



Servo Valve Mount Interchange Chart

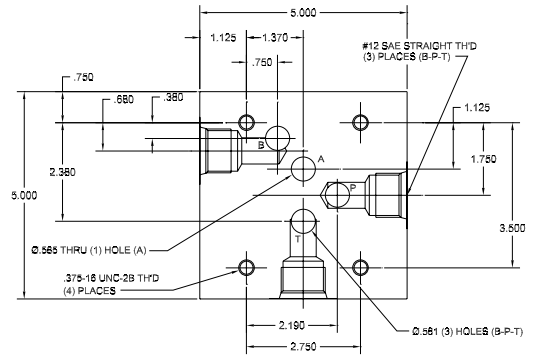
Group A

Atchley 215A-XXX
Moog 62 Series
Moog 73 Series
Moog 760 Series
Parker BD-15
Parker ST-10
Parker ST-15
Vickers SM4-20-X-X-10
Vickers SM4-30-X-X-10

Group D

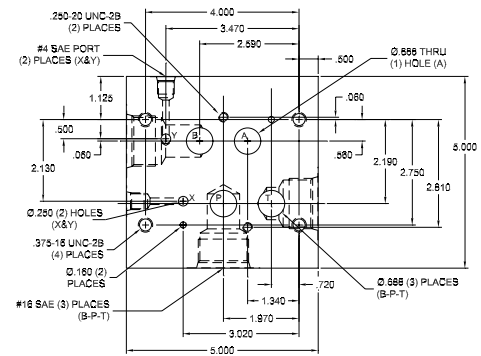
Atchley 240-XXX
Moog 78 Series
Parker BD-30
Parker ST-40
Pegasus 180L
Pegasus 180R
Vickers SM4-40-X-X-10

Group J – NFPA D06



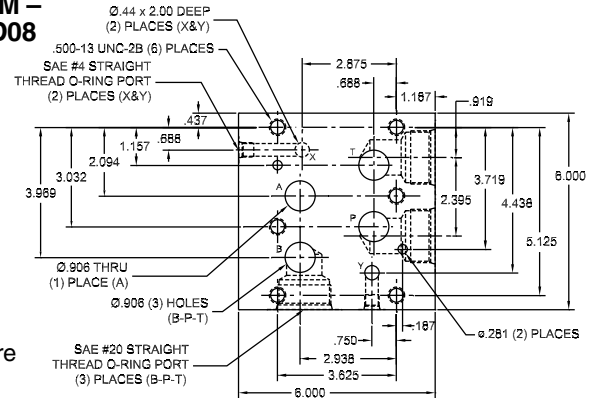
6"-8" Bore

Group K – NFPA D07



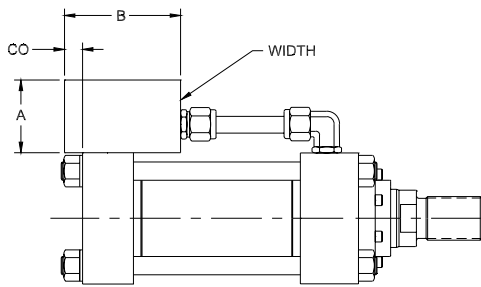
6"-8" Bore

Group M – NFPA D08

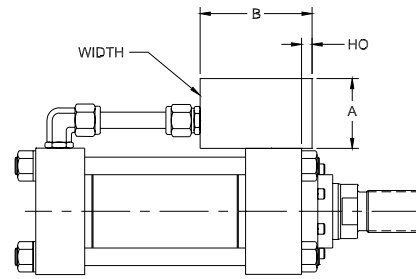


6"-8" Bore

NOTE: B PORT TO ROD END UNLESS OTHERWISE SPECIFIED



CAP END MANIFOLD MOUNT



HEAD END MANIFOLD MOUNT

BOLT-ON MANIFOLD DIMENSIONS

GROUP	A	B	WIDTH	PORT
GR-A	2.500	3.500	3.500	#12 SAE
GR-D	2.500	4.500	4.500	#12 SAE
GR-G	2.500	3.000	3.000	#8 SAE
GR-H	2.500	4.000	3.500	#12 SAE
GR-J	2.500	5.000	5.000	#12 SAE
GR-K	3.000	5.000	5.000	#16 SAE
GR-M	3.500	6.000	6.000	#20 SAE

BOLT-ON MANIFOLD MINIMUM STROKE

BORE	GROUP A				GROUP D			
	MIN. STROKE		OVERHANG		MIN. STROKE		OVERHANG	
	FRONT	REAR	HO	CO	FRONT	REAR	HO	CO
2	1.625	1.625	0.313	0.562	N/A	N/A	N/A	N/A
2.5	1.500	1.500	0.313	0.562	N/A	N/A	N/A	N/A
3.25	0.875	0.875	0.218	0.468	1.875	1.875	0.281	0.531
4	0.625	0.625	0.218	0.468	1.625	1.625	0.281	0.531
5	0.125	0.125	0.218	0.468	1.125	1.125	0.281	0.531
6	0.000	0.000	0.062	0.062	0.500	0.500	0.125	0.125
7	0.000	0.375	0.188	0.188	0.000	0.000	0.125	0.125
8	N/A	0.000	0.313	0.313	0.000	0.000	0.250	0.250

BORE	GROUP G				GROUP H			
	MIN. STROKE		OVERHANG		MIN. STROKE		OVERHANG	
	FRONT	REAR	HO	CO	FRONT	REAR	HO	CO
2	0.875	0.875	0.157	0.406	1.750	0.406	1.750	0.891
2.5	0.750	0.750	0.157	0.406	1.625	0.406	1.625	0.891
3.25	0.250	0.250	0.062	0.312	1.125	0.312	1.125	0.797
4	0.000	0.000	0.062	0.312	0.875	0.312	0.875	0.797
5	0.000	0.000	0.062	0.312	0.375	0.312	0.375	0.797
6	0.000	0.000	0.109	N/A	0.000	0.000	0.000	0.391
7	0.000	0.000	0.344	0.344	0.500	0.500	0.141	0.141
8	0.000	0.000	0.469	0.469	0.000	0.000	0.016	0.016

BORE	GROUP J				GROUP K			
	MIN. STROKE		OVERHANG		MIN. STROKE		OVERHANG	
	FRONT	REAR	HO	CO	FRONT	REAR	HO	CO
2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	0.625	0.625	0.620	0.620	1.104	1.104	0.590	0.590
7	0.250	0.250	0.375	0.375	0.750	0.750	0.344	0.344
8	0.000	0.000	0.250	0.250	0.000	0.000	0.219	0.219

BORE	GROUP M			
	MIN. STROKE		OVERHANG	
	FRONT	REAR	HO	CO
2	N/A	N/A	N/A	N/A
2.5	N/A	N/A	N/A	N/A
3.25	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A
6	1.750	1.750	0.500	1.566
7	1.375	1.375	1.031	1.031
8	0.625	0.625	0.906	0.906

ACCESSORIES & MODIFICATIONS

CAP END MOUNTED BOLT-ON MANIFOLD MINIMUM AND MAXIMUM "XI" LOCATION FOR TM-3 MOUNT

BORE	MN	MX						
		GR-A	GR-D	GR-G	GR-H	GR-J	GR-K	GR-M
2	2.500	0.937	N/A	1.281	0.766	N/A	N/A	N/A
2.5	2.500	1.062	N/A	1.406	0.891	N/A	N/A	N/A
3.25	3.000	1.468	0.531	1.813	1.297	N/A	N/A	N/A
4	3.000	1.718	0.781	2.063	1.547	N/A	N/A	N/A
5	3.000	2.218	1.281	2.563	2.047	N/A	N/A	N/A
6	CONSULT FACTORY							
7	CONSULT FACTORY							
8	CONSULT FACTORY							

FORMULA

MINIMUM "XI" = WF + MN

MAXIMUM "XI" = WF + MX + STROKE

HEAD END MOUNTED BOLT-ON MANIFOLD MINIMUM AND MAXIMUM "XI" LOCATION FOR TM-3 MOUNT

BORE	MX	MN						
		GR-A	GR-D	GR-G	GR-H	GR-J	GR-K	GR-M
2	2.375	3.938	N/A	3.594	4.109	N/A	N/A	N/A
2.5	2.500	3.938	N/A	3.594	4.109	N/A	N/A	N/A
3.25	2.750	4.282	5.219	3.938	4.453	N/A	N/A	N/A
4	3.000	4.281	5.219	3.938	4.453	N/A	N/A	N/A
5	3.500	4.281	5.219	3.938	4.453	N/A	N/A	N/A
6	CONSULT FACTORY							
7	CONSULT FACTORY							
8	CONSULT FACTORY							

FORMULA

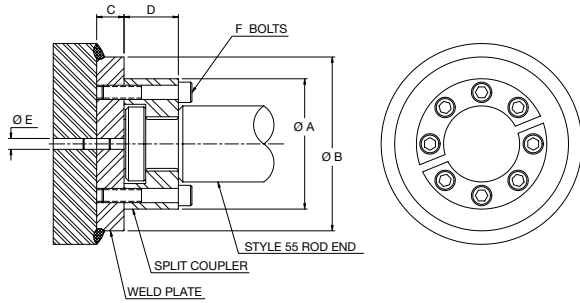
MINIMUM "XI" = WF + MN

MAXIMUM "XI" = WF + MX + STROKE

SUB-PLATE SCREW TORQUE VALUES

GROUP	A	D	G	H	J	K	M
SIZE	5/16 - 18	5/16 - 18	#10 - 24	1/4 - 20	3/8 - 16	3/8 - 16	1/2 - 13
TORQUE	156 in. lbs. +/- 36 in. lbs.	156 in. lbs. +/- 36 in. lbs.	45 in. lbs. +/- 10 in. lbs.	72 in. lbs. +/- 18 in. lbs.	22 ft. lbs. +/- 5 ft. lbs.	22 ft. lbs. +/- 5 ft. lbs.	60 ft. lbs. +/- 10 ft. lbs.

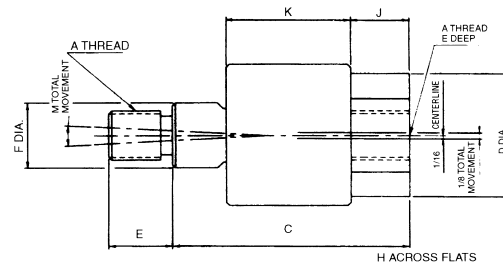
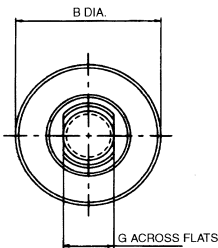
ROD END MOUNTING ACCESSORY DIMENSIONS



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.

ROD DIA.	A	B	C	D	E	F	BOLT SIZE	SPLIT COUPLER PART NO.	WELD PLATE PART NO.
.625	1.50	2.00	.50	.56	.250	4	#10-24 x .94 LG	SC-062	WP-062
1.00	2.00	2.50	.50	.88	.250	6	.250-20 x 1.25 LG	SC-100	WP-100
1.375	2.50	3.00	.63	1.00	.250	6	.312-18 x 1.5" LG	SC-138	WP-138
1.75	3.00	4.00	.63	1.25	.250	8	.312-18 x 1.75 LG	SC-175	WP-175
2.00	3.50	4.00	.75	1.63	.375	12	.375-16 x 2.25 LG	SC-200	WP-200
2.50	4.00	4.50	.75	1.88	.375	12	.375-16 x 2.50 LG	SC-250	WP-250
3.00	5.00	5.50	1.00	2.38	.375	12	.500-13 x 3.25 LG	SC-300	WP-300
3.50	5.88	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	SC-350	WP-350
4.00	6.38	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	SC-400	WP-400
4.50	6.88	8.00	1.00	3.13	.375	12	.625-11 x 4.00 LG	SC-450	WP-450
5.00	7.38	8.00	1.00	3.13	.375	12	.625-11 x 4.00 LG	SC-500	WP-500
5.50	8.25	9.00	1.25	3.88	.375	12	.750-10 x 5.00 LG	SC-550	WP-550

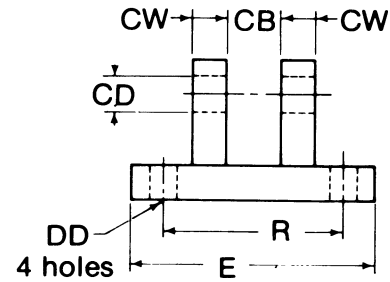
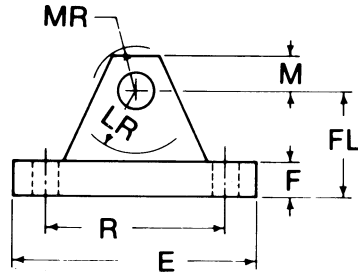
Note: Screws are not included with safety coupler or weld plate.



Atlas Part No.	PART NO.	A	B	C	D	E	F	G	H	J	K	M	MAX. PULL LOAD (LBS.)	APPROX. WT. (LBS.)
01019102	RC-3-5	5/16 - 24	1 1/8	1 3/4	1 5/16	1/2	1/2	3/8	3/4	3/8	1 5/16	6°	1200	.35
01019103	RC-3-6	3/8 - 24	1 1/8	1 3/4	1 5/16	1/2	1/2	3/8	3/4	3/8	1 5/16	6°	2425	.35
01019104	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
01019105	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
01019106	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
01019107	RC-3-12	3/4 - 16	2	2 5/16	1 5/8	1 1/8	1 5/16	3/4	1 5/16	7/16	1 9/32	6°	9050	1.4
01019108	RC-3-14	7/8 - 14	2	2 5/16	1 5/8	1 1/8	1 5/16	3/4	1 5/16	7/16	1 9/32	6°	14450	1.4
01019109	RC-3-16	1 - 14	3 1/8	2 15/16	2 3/8	1 5/8	1 7/16	1 1/4	1 7/8	5/8	1 25/32	6°	19425	4.8
01019110	RC-3-20	1 1/4 - 12	3 1/8	2 15/16	2 3/8	1 5/8	1 7/16	1 1/4	1 7/8	5/8	1 25/32	6°	30500	4.8
01006819	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
10002671	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
10002672	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
01009554	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
10002673	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
01009449	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
01009555	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
01009556	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
01009557	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	-
01009560	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	-

ACCESSORIES & MODIFICATIONS

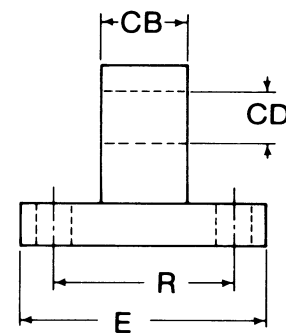
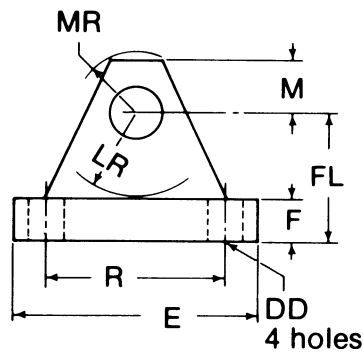
ROD END AND MOUNTING ACCESSORY DIMENSIONS



PART NUMBERS FOR CLEVIS BRACKET INCLUDE PINS AND KEEPERS

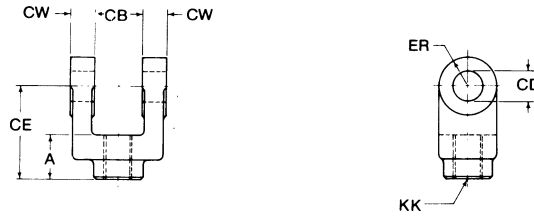
CLEVIS BRACKET												
PART	CB-205	CB-206	CB-207	CB-208	CB-209	CB-210	CB-211	CB-212	CB-213	CB-242	CB-243	CB-244
PART NO.	10012783	10012784	10012785	10012786	10012787	10012788	10012789	10012790	10012791	10012881	10012882	10012883
CB*	3/4	1 1/4	1 1/2	2	2 1/2	2 1/2	3	3	3 1/2	4	4 1/2	5
CD	1 1/2	3/4	1	1 3/8	1 3/4	2	2 1/2	3	3	3 1/2	4	4
CW	1 1/2	5/8	3/4	1	1 1/4	1 1/2	1 1/2	1 1/2	1 1/2	2	2	2
DD	13/32	17/32	21/32	21/32	29/32	1 1/16	1 3/16	1 5/16	1 5/16	1 13/16	2 1/16	2 1/16
E	3 1/2	5	6 1/2	7 1/2	9 1/2	12 3/4	12 3/4	12 3/4	12 3/4	15 1/2	17 1/2	17 1/2
F	1 1/2	5/8	3/4	7/8	7/8	1	1	1	1	1 11/16	1 15/16	1 15/16
FL	1 1/2	17/8	2 1/4	3	3 5/8	4 1/4	4 1/2	6	6	6 11/16	7 11/16	7 11/16
LR	3/4	1	1 1/4	1 7/8	2 1/2	2 7/8	3 1/8	4 1/2	4 1/2	4 1/2	5 1/4	5 1/4
M	1 1/2	3/4	1	1 3/8	1 3/4	2	2 1/2	3	3	3 1/2	4	4
MR	5/8	29/32	1 1/4	1 21/32	-	-	-	-	-	-	-	-
R	2.55	3.82	4.95	5.73	7.50	9.40	9.40	9.40	9.40	12.00	13.75	13.75
LOAD RATING LBS.	4500	8400	13500	24700	39375	54000	67500	124000	124000	126000	144000	144000

*Acceptable Tang Thickness



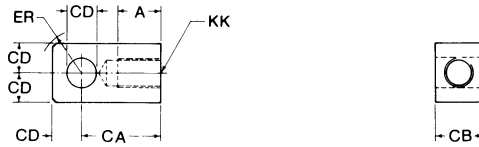
EYE BRACKET AND MOUNTING PLATE										
PART	EB-195	EB-196	EB-197	EB-198	EB-199	EB-200	EB-201	EB-202	EB-38	EB-39
PART NO.	10002567	10002568	10002569	10002570	10002571	10002572	10002573	10002574	10002575	10002576
CB	3/4	1 1/4	1 1/2	2	2 1/2	2 1/2	3	3	4	4 1/2
CD	1 1/2	3/4	1	1 3/8	1 3/4	2	2 1/2	3	3 1/2	4
DD	13/32	17/32	21/32	21/32	28/32	1 1/16	1 3/16	1 5/16	1 13/16	2 1/16
E	2 1/2	3 1/2	4 1/2	5	6 1/2	7 1/2	8 1/2	9 1/2	12 5/8	14 7/8
F	3/8	5/8	3/4	7/8	7/8	1	1	1	1 11/16	1 15/16
FL	1 1/8	1 7/8	2 1/4	3	3 1/8	3 1/2	4	4 1/4	5 11/16	6 7/16
LR	3/4	1 1/4	1 1/2	2 1/8	2 1/4	2 1/2	3	3 1/4	4	4 1/2
M	1 1/2	3/4	1	1 3/8	1 3/4	2	2 1/2	2 3/4	3 1/2	4
MR	9/16	7/8	1 1/4	-	-	-	-	-	-	-
R	1.63	2.55	3.25	3.82	4.95	5.73	6.58	7.50	9.62	11.45
LOAD RATING LBS.	3375	8400	13500	24700	39375	45000	67500	67500	126000	162000

ACCESSORIES & MODIFICATIONS



PART NUMBERS FOR
FEMALE ROD CLEVIS
INCLUDE PINS AND KEEPERS

FEMALE ROD CLEVIS																						
PART	JIC-40	JIC-41	JIC-42A	JIC-42	JIC-43A	JIC-43	JIC-44A	JIC-44	JIC-45A	JIC-45	JIC-46	JIC-47	JIC-48	JIC-49	JIC-50	JIC-51	JIC-52A	JIC-52	JIC-53A	JIC-53	JIC-54A	JIC-54
PART NO.	10012755	10012756	10012757	10012874	10012758	10012875	10012759	10012876	10012877	10012761	10012762	10012763	10012764	10012765	10012766	10012767	10012878	10012768	10012879	10012769	10012880	
A	3/4	3/4	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	2	2	2 1/4	3	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	5 1/2
CB	3/4	3/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	1 1/2	2	2	2 1/2	2 1/2	2 1/2	3	3	3	4	4	4 1/2	4 1/2	4 1/2	4 1/2
CD	1 1/2	1 1/2	3/4	3/4	1	1	1	1	1 3/8	1 3/8	1 3/4	2	2	2 1/2	3	3	3 1/2	3 1/2	4	4	4	4
CE	1 1/2	1 1/2	2 1/8	2 3/8	2 15/16	3 1/8	2 15/16	3 1/8	4 1/8	4 1/2	5 1/2	5 1/2	6 1/2	6 3/4	6 3/4	7 3/4	8 1/8	8 13/16	9 13/16	8 13/16	8 13/16	10
CW	1 1/2	1 1/2	5/8	5/8	3/4	3/4	3/4	3/4	1	1	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	2	2	2 1/4	2 1/4	2 1/4	2 1/4
ER	1 1/2	1 1/2	3/4	3/4	1	1	1	1	1 3/8	1 3/8	1 3/4	2	2	2 1/2	2 3/4	2 3/4	3 1/2	3 1/2	4	4	4	4
KK	7/16 - 20	1/2 - 20	3/4 - 16	3/4 - 16	7/8 - 14	7/8 - 14	1 - 14	1 - 14	1 1/4 - 12	1 1/4 - 12	1 1/2 - 12	1 3/4 - 12	1 3/4 - 12	2 1/4 - 12	2 1/2 - 12	2 3/4 - 12	3 1/4 - 12	3 1/4 - 12	3 1/2 - 12	3 1/2 - 12	4 - 12	4 - 12
LOAD RATING LBS.	2950	4000	11200	9300	18800	12700	19500	16875	33500	26800	39500	54700	56250	84375	84375	84375	156700	157500	193200	202500	221200	202500



FEMALE ROD EYE																
PART	REE-89	REE-90	REE-91	REE-92	REE-93	REE-94	REE-95	REE-96	REE-97	REE-98	REE-99	REE-100	REE-36	REE-37	REE-38	REE-39
PART NO.	10002638	10002639	10002640	10002641	10002643	10002644	10002646	10002647	10002648	10002649	10002650	10002651	10002652	10002653	10002654	10002655
A	3/4	3/4	1 1/8	1 1/8	1 1/8	2	2 1/4	2 1/4	3	3 1/2	3 1/2	3 3/8	4 1/2	5	5 1/2	5 1/2
CA	1 1/2	1 1/2	2 1/8	2 3/8	2 13/16	3 7/16	4	4 3/8	5	5 13/16	6 1/8	6 1/2	7 3/8	7 3/8	9 1/8	9 1/8
CB	3/4	3/4	1 1/4	1 1/2	1 1/2	2	2 1/2	2 1/2	2 1/2	3	3	3 1/2	4	4	4 1/2	5
CD	1 1/2	1 1/2	3/4	1	1	1 3/8	1 3/4	2	2	2 1/2	3	3	3 1/2	3 1/2	4	4
ER	1 1/8	1 1/8	1	1 1/4	1 1/4	1 7/8	2 1/2	2 13/16	2 13/16	3 1/8	4 1/4	4 1/4	4 1/2	4 1/2	5 1/4	5 1/4
KK	7/16 - 20	1/2 - 20	3/4 - 16	7/8 - 14	1 - 14	1 1/4 - 12	1 1/2 - 12	1 3/4 - 12	1 7/8 - 12	2 1/4 - 12	2 1/2 - 12	2 3/4 - 12	3 1/4 - 12	3 1/2 - 12	4 - 12	4 1/2 - 12
LOAD RATING LBS.	2950	3375	8400	12700	13500	24750	39375	45000	45000	67500	81000	94500	126000	126000	162000	180000



MALE ROD END EYE																
PART	MRE-89	MRE-90	MRE-91	MRE-92	MRE-93	MRE-94	MRE-95	MRE-96	MRE-97	MRE-98	MRE-99	MRE-100	MRE-36	MRE-37	MRE-38	MRE-39
PART NO.	1000262	10002623	10002624	10002625	10002626	10002627	10002628	10002629	10002630	10002631	10002632	10002633	10002634	10002635	10002636	10002637
A	3/4	3/4	1 1/8	1 1/8	1 1/8	2	2 1/4	2 1/4	3	3 1/2	3 1/2	3 1/2	4	5	5 1/2	5 1/2
CB	3/4	3/4	1 1/4	1 1/2	1 1/2	2	2 1/2	2 1/2	2 1/2	3	3	3 1/2	4	4	4 1/2	5
CD	1 1/2	1 1/2	3/4	1	1	1 3/8	1 3/4	2	2	2 1/2	3	3	3 1/2	3 1/2	4	4
L	5/8	5/8	7/8	7/8	1 1/8	1 5/8	2	2	2 1/4	2 3/4	4 1/4	4 1/4	5	5	5 3/4	5 3/4
KK	7/16 - 20	1/2 - 20	3/4 - 16	7/8 - 14	1 - 14	1 1/4 - 12	1 1/2 - 12	1 3/4 - 12	1 7/8 - 12	2 1/4 - 12	2 1/2 - 12	2 3/4 - 12	3 1/4 - 12	3 1/2 - 12	4 - 12	4 1/2 - 12
LOAD RATING LBS.	1925	2600	6100	8250	11050	17450	25700	35550	41050	60000	74700	90900	126000	126000	162000	180000

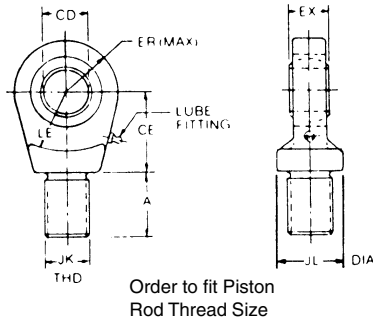


PIVOT PINS ARE FURNISHED
WITH (2) RETAINER RINGS

PIVOT PIN													
PART	PP-368A	PP-369A	PP-370A	PP-371A	PP-372A	PP-373A	PP-215A	PP-374A	PP-375A	PP-216A	PP-545A	PP-546A	PP-547A
PART NO.	10012770	10012771	10012772	10012773	10012774	10012775	10012776	10012777	10012778	10012779	10012780	10012791	10012782
CD	1 1/2	3/4	1	1 1/8	1 3/4	2	2	2 1/2	3	3	3 1/2	4	4
CL	1 7/8	2 5/8	3 1/8	4 1/8	5 3/8	5 3/8	5 11/8	6 3/8	6 1/4	6 3/4	8 1/4	8 5/8	9
LOAD RATING LBS.	5890	13250	23560	44550	72150	94250	94250	147250	212050	212050	288600	288600	377000

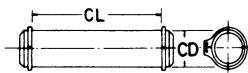
Spherical Bearing Mounting Accessories

SPHERICAL ROD EYE



PART	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6
PART NO.	01012646	01012647	01012648	01012649	01012650	01012651
CD	.5000	.7500	1.0000	1.3750	1.7500	2.0000
A	1 ¹ / ₁₆	1	1 ¹ / ₂	2	2 ¹ / ₈	2 ⁷ / ₈
CE	7 ⁷ / ₁₆	1 ¹ / ₄	1 ⁷ / ₈	2 ¹ / ₈	2 ¹ / ₂	2 ³ / ₄
EX	7 ⁷ / ₁₆	2 ¹ / ₃₂	7 ⁷ / ₈	1 ³ / ₁₆	1 ¹⁷ / ₃₂	1 ³ / ₄
ER	7 ⁷ / ₈	1 ¹ / ₄	1 ³ / ₈	1 ¹³ / ₁₆	2 ³ / ₁₆	2 ⁵ / ₈
LE	3 ³ / ₄	1 ¹ / ₁₆	1 ⁷ / ₁₆	1 ⁷ / ₈	2 ¹ / ₈	2 ¹ / ₂
JK	7 ⁷ / ₁₆ - 20	3 ³ / ₄ - 16	1 - 14	1 ¹ / ₄ - 12	1 ¹ / ₂ - 12	1 ⁷ / ₈ - 12
JL	7 ⁷ / ₈	1 ⁵ / ₁₆	1 ¹ / ₂	2	2 ¹ / ₄	2 ³ / ₄
LOAD CAPACITY LBS	2644	9441	16860	28562	43005	70193

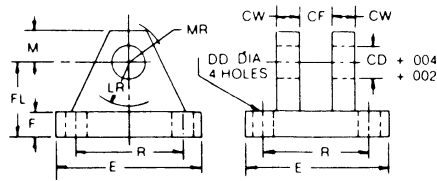
PIVOT PIN



Pivot Pins are furnished with (2) Retainer Rings

PART	PP-616	PP-624	PP-632	PP-644	PP-656	PP-664
PART NO.	10012798	10012799	10012800	10012801	10012802	10012803
CD	.4997-.0004	.7497-.0005	.9997-.0005	1.3746-.0006	1.7496-.0006	1.9996-.0007
CL	1 ⁹ / ₁₆	2 ¹ / ₃₂	2 ¹ / ₂	3 ⁵ / ₁₆	4 ⁷ / ₃₂	4 ¹⁵ / ₁₆
SHEAR CAPACITY LBS	8600	19300	34300	65000	105200	137400

CLEVIS BRACKET



Order to Fit Mounting Plate or Rod Eye

*Part numbers for clevis bracket include pins and keepers

PART	SAB-1	SAB-2	SAB-3	SAB-4	SAB-5	SAB-6
PART NO.	10012792	10012793	10012794	10012795	10012796	10012797
CD	1 ¹ / ₂	3 ³ / ₄	1	1 ³ / ₈	1 ³ / ₄	2
CF	7 ⁷ / ₁₆	2 ¹ / ₃₂	7 ⁷ / ₈	1 ³ / ₁₆	1 ¹⁷ / ₃₂	1 ³ / ₄
CW	1 ¹ / ₂	5 ⁵ / ₈	3 ³ / ₄	1	1 ¹ / ₄	1 ¹ / ₂
DD	1 ¹³ / ₃₂	1 ¹⁷ / ₃₂	1 ¹⁷ / ₃₂	2 ¹ / ₃₂	2 ²⁹ / ₃₂	2 ²⁹ / ₃₂
E	3	3 ³ / ₄	5 ¹ / ₂	6 ¹ / ₂	8 ¹ / ₂	10 ⁵ / ₈
F	1 ¹ / ₂	5 ⁵ / ₈	3 ³ / ₄	7 ⁷ / ₈	1 ¹ / ₄	1 ¹ / ₂
FL	1 ¹ / ₂	2	2 ¹ / ₂	3 ¹ / ₂	4 ¹ / ₂	5
LR	1 ¹⁵ / ₁₆	1 ³ / ₈	1 ¹¹ / ₁₆	2 ⁷ / ₁₆	2 ⁷ / ₈	3 ⁵ / ₁₆
M	1 ¹ / ₂	7 ⁷ / ₈	1	1 ³ / ₈	1 ³ / ₄	2
MR	5 ⁵ / ₈	1	1 ³ / ₁₆	1 ⁵ / ₈	2 ¹ / ₁₆	2 ³ / ₈
R	2.05	2.76	4.10	4.95	6.58	7.92
LOAD CAPACITY LBS	5770	9450	14300	20322	37800	50375

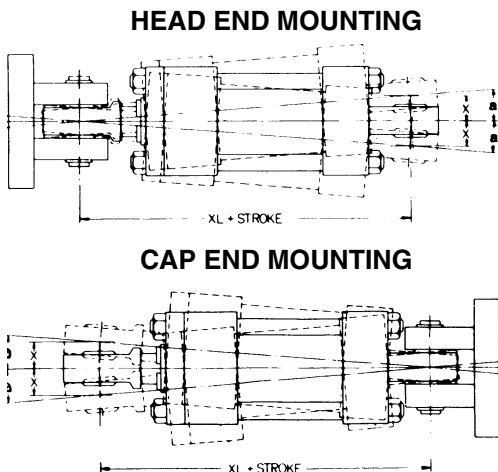
MOUNTING INFORMATION

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

TABLE 1

BORE	HEAD END MTD.		CAP END MTD.	
	ANGLE a	TAN. OF a	ANGLE a	TAN. OF a
1 ¹ / ₂	2°	.035	2°	.035
2	2 ¹ / ₂ °	.044	4 ¹ / ₂ °	.079
2 ¹ / ₂	2 ¹ / ₂ °	.044	4 ¹ / ₂ °	.079
3 ¹ / ₄	3°	.052	3°	.052
4	2 ¹ / ₂ °	.044	3°	.052
5	3°	.052	3°	.052
6	3°	.052	3°	.052

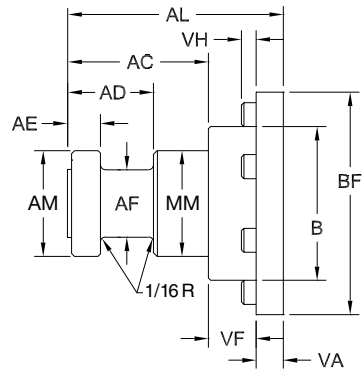
NOTE: Dimension X is the maximum off center mounting of the cylinder. To determine dimension X for various stroke lengths multiply the distance between pivot pin holes by tangent of angle a. For extended position use X = XL times 2X stroke.



SPLIT COUPLER ROD END DIMENSIONS

STYLE 5 *Safety Coupler*

Mating Couplers and Weld Plates on page 70



BORE	MM ROD DIA	AC	AD	AE	AF	AL	AM	B	BF	VA	VH	VF
1 1/2	5/8	1 1/8	5/8	1/4	3/8	1 3/4	.57	1.124	1 15/16	3/8	1/4	1/4
	1	1 5/8	15/16	3/8	11/16	2 1/2	.95	1.499	2 3/8	3/8	1/4	1/2
2	1	1 1/2	15/16	3/8	11/16	2 1/2	.95	1.499	2 3/8	3/8	1/4	1/2
	1 3/8	1 3/4	1 1/16	3/8	7/8	2 3/4	1.32	1.999	2 7/8	3/8	1/4	5/8
2 1/2	1	1 5/8	15/16	3/8	11/16	2 1/2	.95	1.499	2 3/8	3/8	1/4	1/2
	1 3/8	1 3/4	1 1/16	3/8	7/8	2 3/4	1.32	1.999	2 7/8	3/8	1/4	5/8
3 1/4	1 3/4	2	1 5/16	1/2	1 1/8	3 1/8	1.70	2.374	3 1/2	5/8	5/16	1/2
	1 3/8	1 3/4	1 1/16	3/8	7/8	2 3/4	1.32	1.999	2 7/8	3/8	1/4	5/8
4	1 3/4	2	1 5/16	1/2	1 1/8	3 1/8	1.70	2.374	3 1/2	5/8	5/16	1/2
	2	2 5/8	1 11/16	5/8	1 3/8	3 3/4	1.95	2.624	3 3/4	5/8	5/16	1/2
5	1 3/4	2	1 5/16	1/2	1 1/8	3 1/8	1.70	2.374	3 1/2	5/8	5/16	1/2
	2	2 5/8	1 11/16	5/8	1 3/8	3 3/4	1.95	2.624	3 3/4	5/8	5/16	1/2
6	2 1/2	3 1/4	1 15/16	3/4	1 3/4	4 1/2	2.45	3.124	4 1/4	5/8	5/16	5/8
	3	3 3/8	2 7/16	7/8	2 1/4	4 7/8	2.95	3.749	5 7/16	15/16	—	5/16
7	2 1/2	3 1/4	1 15/16	3/4	1 3/4	4 1/2	2.45	3.124	4 1/4	5/8	5/16	5/8
	3 1/2	4 3/8	2 11/16	1	2 1/2	5 5/8	3.45	4.249	5 15/16	15/16	—	5/16
8	2 1/2	3 1/4	1 15/16	3/4	1 3/4	4 1/2	2.45	3.124	4 1/4	5/8	5/16	5/8
	3	3 3/8	2 7/16	7/8	2 1/4	4 7/8	2.95	3.749	5 7/16	15/16	—	5/16
9	3 1/2	4 3/8	2 11/16	1	2 1/2	5 5/8	3.45	4.249	5 15/16	15/16	—	5/16
	4	4 1/2	2 11/16	1	3	5 3/4	3.95	4.749	6 5/16	15/16	—	5/16
10	3 1/2	4 3/8	2 11/16	1	2 1/2	5 5/8	3.45	4.249	5 15/16	15/16	—	5/16
	4 1/2	5 1/4	3 3/16	1 1/2	3 1/2	6 1/2	4.45	5.249	6 15/16	15/16	—	5/16
11	4 1/2	5 1/4	3 3/16	1 1/2	3 1/2	6 1/2	4.45	5.249	6 15/16	15/16	—	5/16
	5	5 3/8	3 3/16	1 1/2	3 7/8	6 5/8	4.95	5.749	7 7/16	15/16	—	5/16
12	5 1/2	6 1/4	3 15/16	1 7/8	4 3/8	7 1/2	5.45	6.249	7 15/16	15/16	—	5/16

ACCESSORIES & MODIFICATIONS

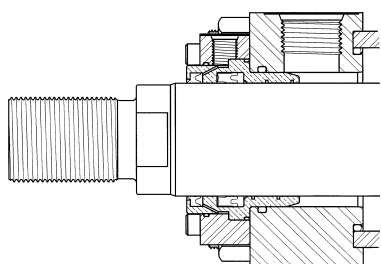
Metallic Rod Wiper

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

Gland Drain

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

An SAE #4 gland drain port can be provided in the gland retainer. A passage in the gland between the wiperseal and Tri-Lip seal is provided to drain off any accumulation



of fluid between the seals. See drawing below.

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

Air Bleeds

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

Rod End Boots

Cylinders have a hardened bearing surface on the piston rod to resist external damage, and are equipped with the high efficiency "Wiperseal" to remove external dust and dirt. Exposed piston rods that are subjected to contaminants with air hardening properties, such as paint, should be protected. In such applications, the use of a collapsing cover should be considered. This is commonly referred to as a "boot." Calculate the longer rod end required to accommodate the collapsed length of the boot from the following data.

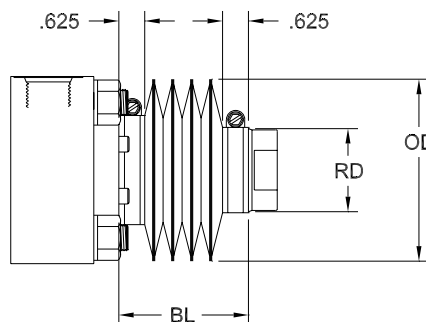
LF	.13	.13	.13	.13	.13	.13	.13	.10	.10	.10	.10	.10
OD	2 1/4	2 1/4	2 5/8	3	3 3/8	3 3/4	4 3/8	5 1/8	5 5/8	6 1/4	7	7 1/2
RD	1/2	5/8	1	1 3/8	1 3/4	2	2 1/2	3	3 1/2	4	5	5 1/2

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

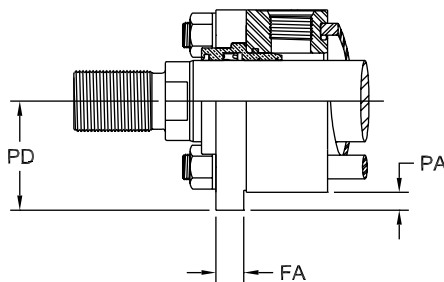
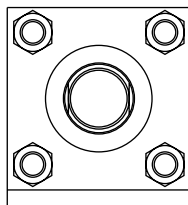
$$BL = \text{Stroke} \times LF + 1\frac{1}{8}"$$

$$BL + VA + C = WF \text{ for piston rod with rod boot.}$$

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



THRUST-KEY RETAINER PLATE OPTION



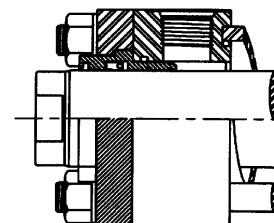
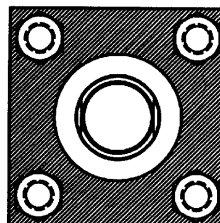
BORE	E	FA+.000	PA	PD
1.50	2.50	.312-.002	.188	1.437
2.00	3.00	.562-.002	.312	1.812
2.50	3.50	.562-.002	.312	2.062
3.25	4.50	.687-.003	.375	2.625
4.00	5.00	.812-.003	.437	2.937
5.00	6.50	.812-.003	.437	3.687
6.00	7.50	.937-.003	.500	4.250
7.00	8.50	.937-.003	.500	4.750
8.00	9.50	.937-.003	.500	5.250

ROD CARTRIDGE RETAINERS

Cylinder mountings with these bore and rod diameters use a full plate rod cartridge retainer as a standard component.

- 1 1/2" NFPA MX1/NM-1 & MX3/NM-3 with 5/8" rods.
- 1 1/2" All mountings with 1" rod.
- 2" NFPA MX1/NM-1 & MX3/NM-3 with 1" rods.
- 2" All mountings with 1 3/8" rod.
- 2 1/2" NFPA MX1/NM-1 & MX3/NM-3 with 1 3/4" rods.
- 5" NFPA MX1/NM-1 & MX3/NM-3 with 3 1/2" rods.

NOTE: A full Retainer plate can be included as an option instead of the packing cap on bore sizes 1 1/2" thru 6".



HYDRAULIC CYLINDER SPEEDS

Figures in the body of this chart are cylinder rod travel speeds in "inches per minute." Lines with rod diameter as NONE are extension speeds, using the full piston area. Lines with rod diameters are retraction speeds, using "net"

CYL BORE	ROD DIA	1 GPM	3 GPM	5 GPM	8 GPM	12 GPM	15 GPM	20 GPM	25 GPM	30 GPM	40 GPM	50 GPM	75 GPM
1½	NONE	130	392	654	1034								
	5/8	158	476	792	1265								
	1	235	706	1176	1880								
2	NONE	73	221	368	588	883	1120						
	1	97	294	490	782	1175	1465						
	1¾	139	418	697	1115	1673	2090						
2½	NONE	47	141	235	376	565	675	940	1175				
	1	56	168	280	448	672	840	1120	1400				
	1¾	67	203	339	542	813	1015	1355	1695				
3¼	NONE	28	83	139	223	334	417	557	696	836	1115		
	1¾	34	102	170	271	407	510	680	850	1020	1360		
	1¾	39	118	196	313	472	588	784	980	1176	1568		
4	NONE	18	55	92	147	220	276	368	460	552	736	920	
	1¾	22	68	113	182	273	339	452	565	678	904	1130	
	2	24	73	122	196	294	366	488	610	732	976	1220	
5	NONE	12	35	58	94	141	174	232	290	348	464	500	870
	2	14	42	70	112	168	210	280	350	420	560	700	1050
	2½	16	47	78	125	188	235	315	390	470	630	780	1170
6	NONE	8	24	41	65	98	123	162	202	245	320	405	606
	2½	10	30	50	79	118	150	200	250	300	400	495	750
	3	11	33	54	87	130	165	217	270	325	435	545	810
7	NONE	6	18	30	48	72	90	120	150	180	240	300	450
	3	7	22	37	59	88	110	145	185	220	295	365	555
	3½	8	24	40	64	96	120	160	200	240	320	400	600
8	NONE	4	14	23	36	55	69	92	115	135	185	230	345
	3½	5.5	17	28	45	68	85	115	140	170	230	285	420
	4	6	18	30	49	73	90	122	150	180	240	305	450
8	NONE	4	14	23	36	55	69	92	115	135	185	230	345
	4½	7	20	34	54	81	101	134	168	202	269	336	504
	5	8	23	38	60	90	113	151	189	226	302	377	566
8	NONE	4	14	23	36	55	69	92	115	135	185	230	345
	5½	8.5	26	43	70	104	129	172	215	255	345	430	645

Stop Tubing

Long stroke cylinders tend to jackknife on push load applications, resulting in high bearing loads at the rod bearing or piston. Use of a stop tube to lengthen the distance between the gland and piston when the rod is fully extended is recommended. Dual piston stop tubes can also be utilized to add additional bearing when the stop tube length is significant. Refer to the chart to determine recommended stop tube length.

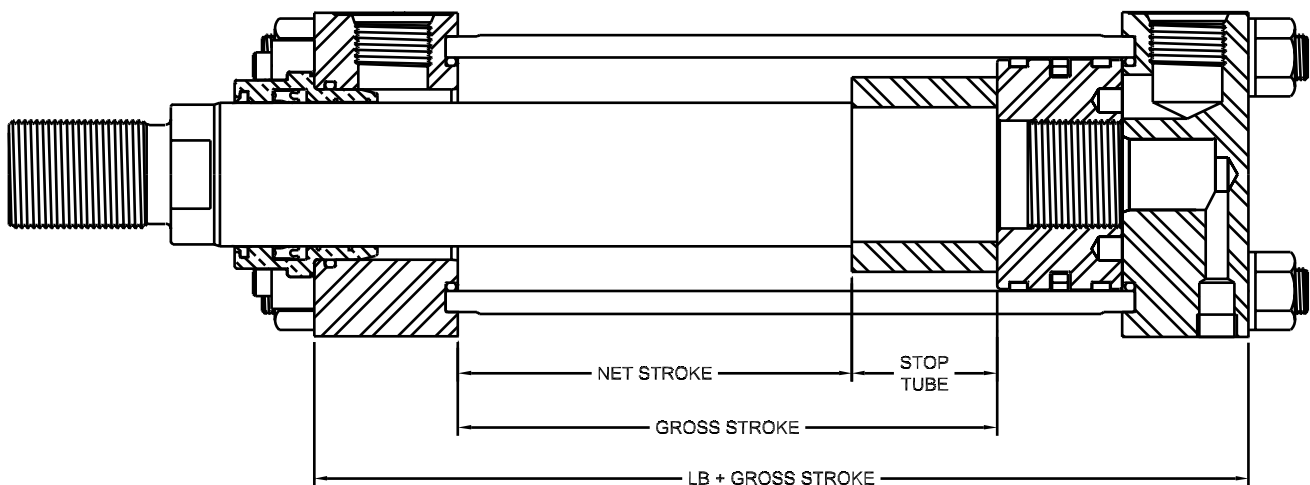
When specifying stop tubes, use the gross stroke in the stroke field of the model code, and indicate 'S' in the special field at the end of the code. Then specify the stop tube length and the desired net stroke.

Stop Tube Information: Max. Stroke per Mount

Bore	Case 1, 2 Rigid Mounts with rod support	Case 3 Rigid Mounts without Support	Case 4, 5, 6 Pivot Mounts
1 1/2 & 2"	48 in.	30 in.	24 in.
2 1/2 to 4"	48 in.	38 in.	30 in.
5 to 14"	48 in.	40 in.	36 in.

Extra rod extension is added into stroke
1" of stop tube for every 10" over maximum

Drawing A



Mounting Classes

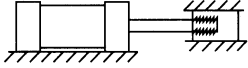
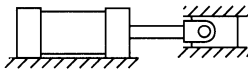
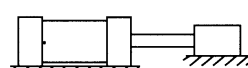
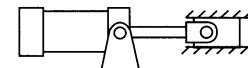
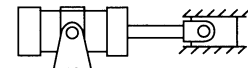

Standard mountings fall into three basic groups, which are summarized as follows:

Group 1	Straight line force transfer with fixed mounting which absorbs forces on the cylinder centerline.	
Heavy duty service	thrust	BEF1, MN2, IH4, ME6
	tension	REF1, MN3, IH3, ME5
Medium duty service	thrust	BEF2, REF1
	tension	REF2, BEF1
Light duty service	thrust	REF2
	tension	BEF2

Group 2	Pivot force transfer with mounting which permits alignment to change in a single plane along cylinder centerline. Stroke length will influence service rating.	
Heavy duty service	thrust	TM1, TM3
	tension	PB1, PB2, TM1, TM2, TM3
Medium duty service	thrust	PB1, PB2, MP2
	tension	MP2

Group 3	Straight line force transfer with fixed mounting which does not absorb force on the centerline.	
Heavy duty service	thrust	SL
	tension	SL
Medium duty service	thrust	FS
	tension	FS

Stroke Factor

Recommended Mounting Styles for Maximum Stroke and Thrust Loads	ROD END CONNECTION	CASE	STROKE FACTOR
GROUP 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. Consult factory for a guide. Machine mounting pads can be adjustable for support mountings to achieve proper alignment.	Fixed and Rigidly Guided	1 	.50
	Pivoted and Rigidly Guided	2 	.70
	Supported but not Rigidly Guided	3 	2.00
GROUP 2 Trunnion on Head	Pivoted and Rigidly Guided	4 	1.00
Intermediate Trunnion	Pivoted and Rigidly Guided	5 	1.50
Trunnion on Cap or Clevis on Cap	Pivoted and Rigidly Guided	6 	2.00

HOW TO USE CHARTS

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 above and find the "stroke factor" that corresponds to the conditions used.

2. Using this stroke factor, determine the "basic length" from the equation:

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

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

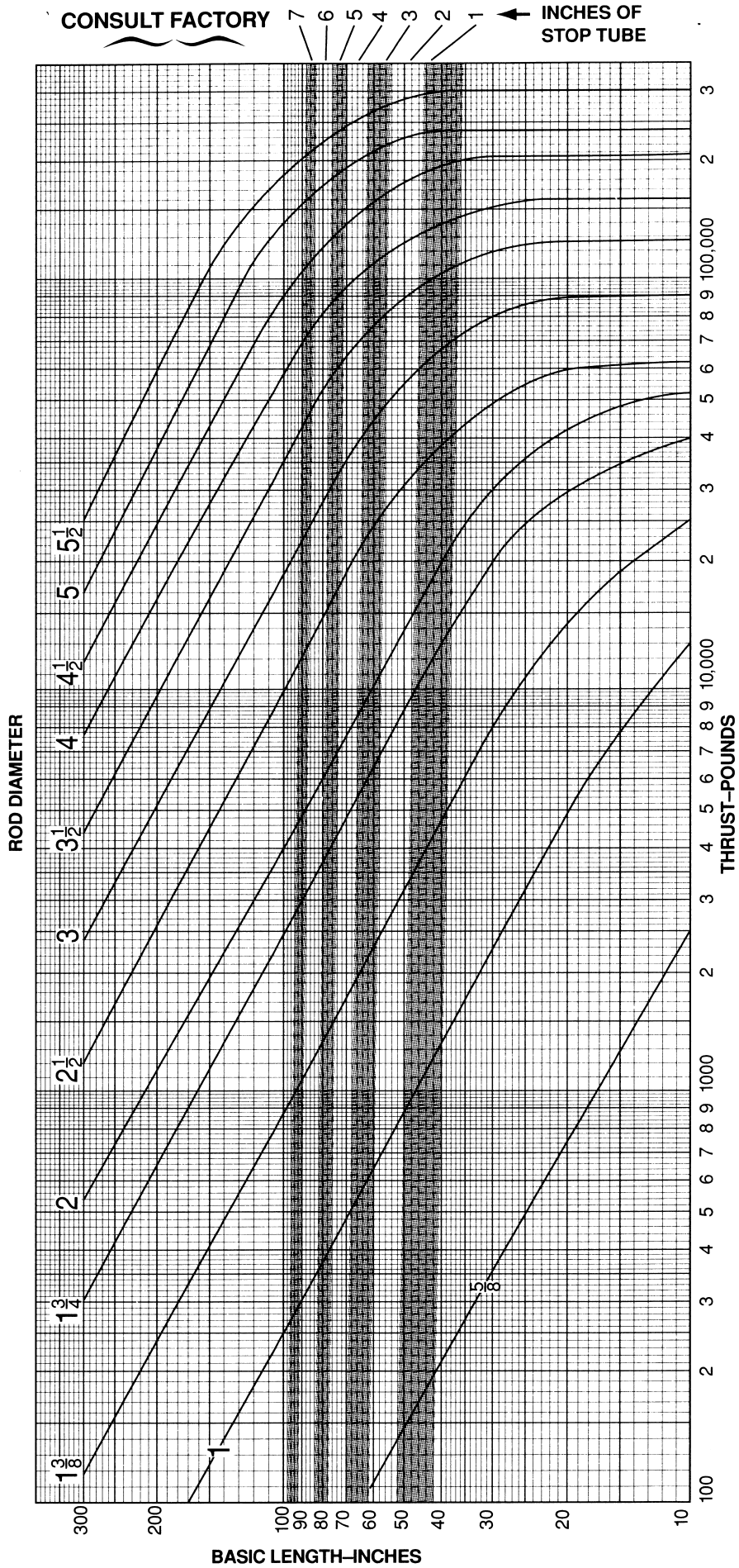
- The correct piston rod size is read from the diagonally curved line labeled "Rod Diameter" next above the point of intersection
- The required length of stop tube is read from the right of the graph by following the shaded band in which the point of intersection lies
- If required length of stop tube is in the region labeled "consult factory" submit the following information for an individual analysis:
 - Cylinder mounting style.
 - Rod end connection and method of guiding load.
 - Bore, required stroke length of rod extension (Dim. "WF") if greater than standard and series of cylinder used.

- Mounting position of cylinder. (Note: if at an angle or vertical, specify direction of piston rod.)
- Operating pressure of cylinder 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.

Piston Rod — Stroke selection Chart



SELECTING THE PROPER SIZE CYLINDER

DETERMINE THE FORCE REQUIRED — To select a cylinder for an application, first determine the maximum push and/or pull force required to do the job. Then use the pressure table to select the cylinder that gives the necessary force for your application. It should be noted that the force requirements derived by formula are only theoretically correct. Other factors must be provided for.

Pressure drop—which means that working pressure at the cylinder port will be somewhat less than system pressure—should be allowed for in such calculations. A margin for overcoming friction in the cylinder likewise must be added.

After selecting the proper size cylinder for the job use the envelope and mounting dimension charts to determine cylinder dimensions.

PRESSURE TABLE

CYL. BORE DIA.	PRESSURE RATINGS		PISTON ROD DIA.	CYL. WORK ACTION	WORK AREA (SQ. IN.)	HYDRAULIC WORKING PRESSURE PSI							FLUID REQUIRED PER IN. OF STROKE	
	HEAVY DUTY SERVICE	4:1 SAFETY FACTOR				350	500	750	1000	1500	2000	3000	GAL.	CU. FT.
1.00	2500	1960	5/8	Push	0.785	275	393	589	785	1178	1570	2355		
				Pull	0.479	168	240	359	479	719	958	1437		
1.50	3000	2530	5/8	Push	1.767	618	884	1325	1767	2651	3534	5301	.00765	.00102
				Pull	1.460	511	730	1095	1460	2190	2920	4380	.00632	.00084
				Pull	.982	344	491	737	982	1473	1964	2946	.00425	.00057
2.00	3000	2950	1	Push	3.141	1099	1571	2356	3141	4712	6282	9423	.01360	.00182
				Pull	2.356	825	1178	1767	2356	3534	4712	7068	.01020	.00136
				Pull	1.656	580	828	1252	1656	2484	3312	4968	.00717	.00096
2.50	3000	2340	1 1/8	Push	4.909	1718	2455	3682	4909	7364	9818	14727	.02125	.00284
				Pull	4.124	1443	2062	3093	4124	6186	8248	12372	.01785	.00239
				Pull	3.424	1198	1712	2568	3424	5136	6848	10272	.01482	.00198
				Pull	2.504	876	1252	1878	2504	3756	5008	7512	.01084	.00145
3.25	3000	2250	1 3/8	Push	8.296	2904	4148	6222	8296	12444	16592	24888	.0359	.00480
				Pull	6.811	2384	3406	5108	6811	10217	13622	20433	.0295	.00394
				Pull	5.891	2062	2946	4418	5891	8837	11782	17673	.0255	.00341
				Pull	5.154	1804	2577	3866	5154	7731	10308	15462	.0223	.00298
4.00	3000	2130	1 3/4	Push	12.566	4398	6283	9425	12566	18849	25132	37698	.0544	.00727
				Pull	10.161	3556	5081	7621	10161	15242	20322	30483	.0440	.00588
				Pull	9.424	3298	4712	7068	9424	14136	18848	28272	.0408	.00545
				Pull	7.657	2680	3829	5743	7657	11486	15314	22971	.0331	.00443
5.00	3000	2170	2	Push	19.635	6872	9818	14726	19635	29453	39270	58905	.0850	.01136
				Pull	16.492	5772	8246	12369	16492	24738	32984	49476	.0714	.00954
				Pull	14.726	5154	7363	11045	14726	22089	29452	44178	.0637	.00852
				Pull	12.566	4398	6283	9425	12566	18849	25132	37698	.0544	.00728
				Pull	10.014	3505	5007	7511	10014	15021	20028	30042	.0433	.00580
6.00	3000	2270	2 1/2	Push	28.274	9896	14137	21206	28274	42411	56548	84822	.1224	.01636
				Pull	23.365	8178	11683	17524	23365	35048	46730	70095	.1011	.01352
				Pull	21.205	7422	10603	15904	21205	31808	42410	63615	.0918	.01227
				Pull	18.653	6529	9327	13990	18653	27980	37306	55959	.0808	.01079
				Pull	15.708	5498	7854	11781	15708	23562	31416	47124	.0680	.00909
7.00	3000	2030	3	Push	38.485	13470	19243	28864	38485	57728	76970	115455	.1666	.02227
				Pull	31.416	10996	15708	23562	31416	47124	62832	94248	.1360	.01818
				Pull	28.864	10102	14432	21648	28864	43296	57728	86592	.1250	.01670
				Pull	25.915	9070	12958	19436	25915	38873	51830	77745	.1122	.01500
				Pull	22.585	7905	11293	16939	22585	33878	45170	67755	.0977	.01307
8.00	3000	2040	3 1/2	Push	50.265	17593	25133	37699	50265	75398	100530	150795	.2176	.02909
				Pull	40.644	14225	20322	30483	40644	60966	81288	121932	.1759	.02352
				Pull	37.699	13195	18850	28274	37699	56549	75398	113097	.1632	.02182
				Pull	34.365	12028	17183	25774	34365	51548	68730	103095	.1488	.01989
				Pull	30.630	10721	15315	22973	30630	45945	61260	91890	.1326	.01772
			5 1/2	Pull	26.507	9277	13254	19880	26507	39761	53014	79521	.1147	.01534

4:1 SAFETY FACTOR BASED ON BURST PRESSURE ONLY

RECOMMENDED TIE ROD TORQUE VALUES

BORE	1	1½	2	2½	3¼	4	5	6	7	8
TIE ROD THREAD	# 10 - 24	¾ - 24	½ - 20	½ - 20	⅝ - 18	⅝ - 18	⅞ - 14	1-14	1⅛ -12	1¼ -12
TORQUE FT. LBS.	2	18	45	45	120	131	312	528	800	1168

RECOMMENDED RETAINER SCREW TORQUE VALUES

Screw Size	#10-24 UNC	1/4-20 UNC	3/8-16 UNC
Torque	24 in. lb.	120 in. lb.	240 in. lb.

APPROXIMATE NET WEIGHTS OF ELECTROHYDRAULIC CYLINDERS BASED ON STANDARD ROD DIAMETERS

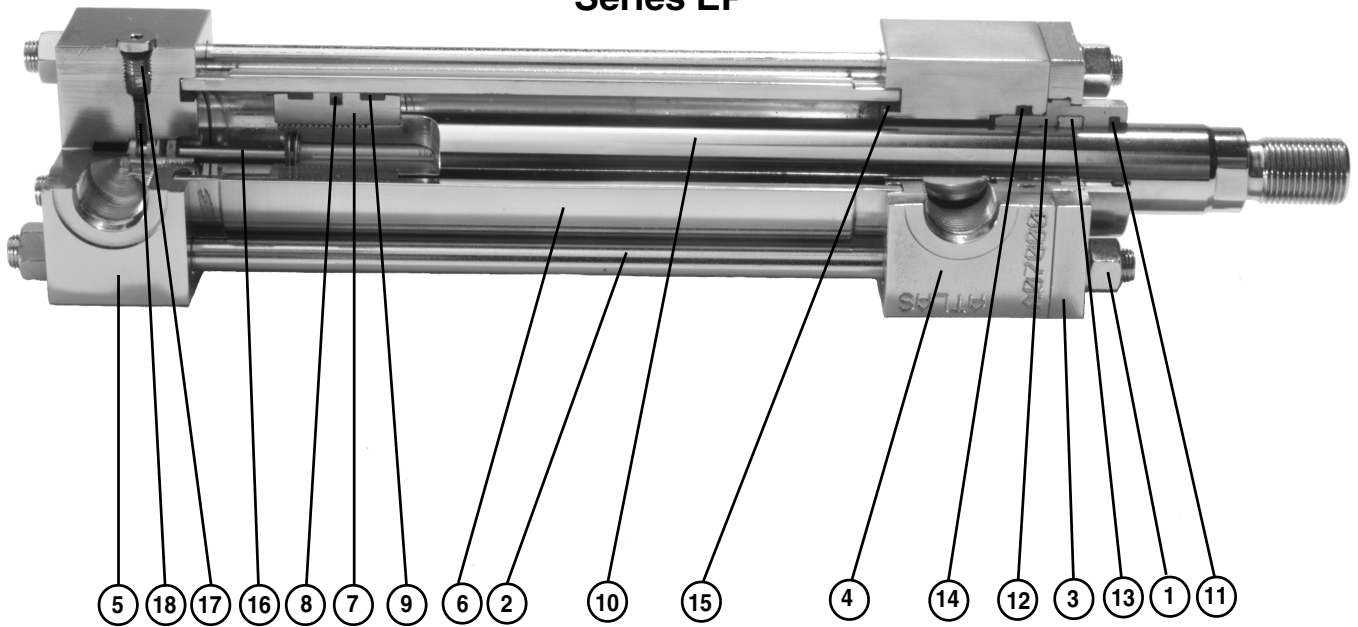
(All weights expressed in lbs.)

BORE SIZE	ROD DIA.	SINGLE ROD CYLINDERS BASIC WEIGHT AT ZERO STROKE		
		FS, BEF2, REF2, REF1 NM1, NM2, NM3	PB2, PB1, SL, TM1, TM2 TM3, ME5, ME6	ADD PER INCH OF STROKE
1	5/8	3.4	3.3	0.3
1.5	5/8	7.8	9.0	0.5
	1	8.4	9.3	0.6
2	1	11.6	13.2	0.8
	1 3/8	13.5	17.1	1.0
2.5	1	17.0	19.5	1.1
	1 3/4	22.5	25.5	1.5
3.25	1 3/8	32.0	41.0	1.8
	2	37.0	46.0	2.2
4	1 3/4	48.0	53.0	2.5
	2 1/2	52.0	58.0	3.2
5	2	76.0	82.0	3.4
	3 1/2	88.0	86.0	5.2
6	2 1/2	125.0	133.0	5.2
	4	133.0	140.0	7.3
7	3	233.0	242.0	6.7
	5	240.0	253.0	10.3
8	3 1/2	262.0	276.0	9.0
	5 1/2	300.0	309.0	13.0

WEIGHT ADDERS ADD TO THE WEIGHT IF YOU HAVE:			
BORE	SMALL VALVE A,B,C,G	LARGE VALVE D,E,F,H	FALSE STAGE
1.5	8.3	-	3.0
2	9.4	-	4.4
2.5	11.6	19.6	6.8
3.25	17.5	30.4	11.2
4	19.6	34.0	14.6
5	30.2	54.4	25.0
6	30.9	62.0	39.3
7	29.8	69.5	63.1
8	28.3	76.7	83.5

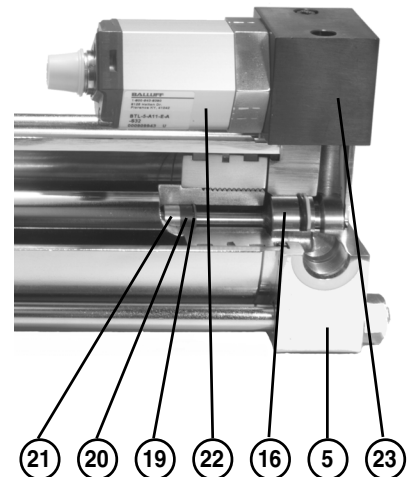
WEIGHT ADDER SUB-PLATE	
GROUP	WEIGHT
A	8.7
D	14.3
G	6.4
H	9.9
J	17.7
K	21.3
M	35.7

Series EP



- | | |
|------------------------|---------------------------------------|
| 01. Tie Rod Nut | 13. Rod Seal |
| 02. Tie Rod | 14. Cartridge O.D. Seal |
| 03. Cartridge Retainer | 15. Barrel Seal (15A Cap Barrel Seal) |
| 04. Rod Head | 16. Transducer |
| 05. Cap Head | 17. Lock Screw Plug |
| 06. Cylinder Barrel | 18. Lock Screw |
| 07. Piston | 19. Magnet Retainer |
| 08. Piston O.D. Seal | 20. Magnet |
| 09. Wear Ring | 21. Magnet Spacer |
| 10. Piston Rod | 22. Electronic Module |
| 11. Rod Wiper | 23. Electronic Module Mount |
| 12. Rod Cartridge | 24. Plumbing Assembly |

Series EM



Cylinder Repair Kit Contents

Cartridge Kit

Items 11, 12, 13, 14

Rod Seal Kit

Items 11, 13, 14

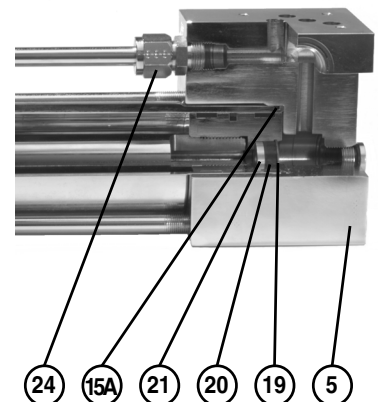
Piston Seal Kit

Items 8, 9, 15, 15A

To speed the handling of orders for parts or Repair kits, please specify:

1. Cylinder serial number
2. Cylinder bore diameter
3. Stroke
4. Piston rod diameter
5. Operating medium

Series ES



Storage, Installation, Troubleshooting

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.

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.
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.
3. Port protector plugs should be left in the cylinder until the time of installation.

Installation

1. Cleanliness is an important consideration, and Atlas 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.
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. 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.

Mounting Recommendations

1. The use of high tensile alloy steel socket head screws 1/16" smaller than the mounting hole size is recommended for all mounting styles.
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. Tie Rod Mounting – Cylinders with tie rod mountings are recommended for applications where mounting space is limited. The standard tie rod extension is shown as BB in dimension tables. Longer or shorter extensions can be supplied.
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.
5. 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 should also be pivoted with the pivot pin in line and parallel to axis of the trunnion pins.
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.

Cylinder Trouble Shooting

External Leakage

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

Rod seal leakage could also be traced to gland bearing wear. If clearance is excessive, replace rod gland and seal.

Rod seal leakage can also be traced to seal deterioration. If seals are soft or gummy, check compatibility of seal material with lubricant used if air cylinder, or operating fluid if hydraulic cylinder. Replace with a seal material which is compatible with the lubricant or operating fluid. 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.

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

Excessive pressure can also result in cylinder body seal leak. Determine maximum pressure to rated limits. Replace seals and retorquer tie rods as in paragraph above.

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

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

Soft or gummy seals are evidence of exposure to fluid with which they are not compatible. Hard seals or seals which have lost their elasticity are a symptom of exposure to excessive temperature. Replace seals as per paragraph above.

Internal Leakage

1. Piston seal leak (by-pass) 1 to 3 cubic inches per minute leakage is considered normal for piston ring construction. Virtually no 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.
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.
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.

Cylinder Fails to Move the Load

1. Pneumatic or hydraulic pressure is too low. Check the pressure at the cylinder to make sure it is to circuit requirements.
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.
3. Cylinder is undersized for the load – Replace cylinder with one of a larger bore size.
4. Piston rod broken at piston end – Disassemble cylinder and replace piston rod.

Erratic or Chatter Operation

1. Excessive friction at gland or piston bearing due to load misalignment – Correct cylinder-to-load alignment.
2. Cylinder sized too close to load requirements – Reduce load or install larger cylinder.
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.

Safety Guidelines

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

WARNING: ⚠ FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF CYLINDERS AND THEIR RELATED ACCESSORIES CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

Before selecting or using Atlas (the Company) cylinders or related accessories, it is important that you read, understand and follow the following safety information.

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 publication are designed to the Company's design guide lines and do not necessarily meet the design guide lines 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.

Seals

Part of the process of choosing a cylinder is the selection of seal compounds. Before making this selection read the Operating Fluids and Seals information in this publication or in the Application Engineering section of the publication covering the series of cylinders of interest, or contact our engineering department.

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.

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 recommendation for the maximum cylinder stroke found in this publication or in the Application Engineering section of the publication covering 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. Cylinder 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.

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.

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.

Port Fittings

Hydraulic cylinders applied with meter out or deceleration circuits are subject to intensified pressure at piston rod end.

The rod end pressure is approximately equal to:

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

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

Cylinder Modifications or Repairs

Cylinders as shipped from the factory are not to be disassembled and or modified. If cylinders require modifications, these modifications must be done at the company locations or by the Company certified facilities. 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 or descriptions provided by The Company, its subsidiaries and its authorized distributors are hereby offered for sale at prices to be established by The Company, its subsidiaries and its authorized distributors. This offer and its acceptance by any customer ("Buyer") shall be governed by all of the following Terms and Conditions. Buyer's order for any such item, when communicated to The Company, its subsidiary or an authorized distributor ("Seller") verbally or in writing, shall constitute acceptance of this offer.

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

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

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

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

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

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

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

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

have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

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

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

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

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

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

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

ATLAS **CYLINDERS**

500 S. Wolf Rd.
Des Plaines, IL 60016 USA
Tel.: (847) 298-2400
Fax.: (800) 892-1008
Web Site: www.atlascylinders.com

8485 Parkhill Drive
Milton, Ontario
Canada L9T 5E9
Tel.: (905) 693-3000
Fax.: (905) 876-1958