milwaukee Cylinder

ISO 9001
REGISTERED

MC105R2

Specials are Our Standard

milwaukee Cylinder

...engineered solutions for hydraulic and pneumatic applications

A long established and recognized supplier of highly engineered cylinder solutions and a manufacturer of a standard range of steel and aluminum NFPA tie-rod cylinders for both hydraulic and pneumatic applications.

Milwaukee Cylinder, a leader and innovator in the hydraulic and pneumatic actuation field since 1956, is now ISO 9001:2008 certified.

Our broad product line offers a solution for virtually every possible cylinder application. We offer our customers years of experience in the design and manufacture of fluid power products with special operating and design requirements.

By working directly with our customers, Milwaukee Cylinder has developed a world-wide reputation for engineering expertise in the manufacture of specialty cylinders. Over the last 50 years, Milwaukee Cylinder has become known as the company where specials are our standard.

At Milwaukee Cylinder, we operate with a spirit of innovation and creativity, dedicated to meeting the needs and challenges of todays most demanding applications. We take pride in being a producer of High-Quality Performance-Tested hydraulic and pneumatic products. Products that have been proven and tested by the worlds leading manufacturers in the harshest environments.

With our on-going commitment to research and development, as well as our worldwide sales and distribution network, we will continue to meet and exceed demanding customer requirements and provide world-class customer service. From initial design to after-sale support, we maintain the same high level of quality that our customers have come to recognize from Milwaukee Cylinder.

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Table 3 Piston Rod End Styles (Series H, LH and A) *See page 105 for Series MN*

ROD MM	A	B -.001 -.003	C	CC	*D	KK_1	$KK_{2\,3\,5}$	NA	AD	AE +.001 -.002	AF diameter	AC
5/8	3/4	1 1/8	3/8	5/8-18	1/2	1/2-20	7/16-20	19/32	5/8	1/4	3/8	1 1/8
1	1 1/8	1 1/2	1/2	1-14	7/8	7/8-14	3/4-16	31/32	15/16	3/8	11/16	1 1/2 (#1)
1 3/8	1 5/8	2	5/8	1 3/8-12	1 1/8	1 1/4-12	1-14	1 11/32	1 1/16	3/8	7/8	1 3/4
1 3/4	2	2 3/8	3/4	1 3/4-12	1 1/2	1 1/2-12	1 1/4-12	1 45/64	1 5/16	1/2	1 1/8	2
2	2 1/4	2 5/8	7/8	2-12	1 11/16	1 3/4-12	1 1/2-12	1 61/64	1 11/16	5/8	1 3/8	2 5/8
2 1/2	3	3 1/8	1	2 1/2-12	2 1/16	2 1/4-12	1 7/8-12	2 29/64	1 15/16	3/4	1 3/4	3 1/4
3	3 1/2	3 3/4	1	3-12	2 5/8	2 3/4-12	2 1/4-12	2 15/16	2 7/16	7/8	2 1/4	3 5/8 (#2)
3 1/2	3 1/2	4 1/4	1	3 1/2-12	3	3 1/4-12	2 1/2-12	3 7/16	2 11/16	1	2 1/2	4 3/8
4	4	4 3/4	1	4-12	3 3/8	3 3/4-12	3-12	3 15/16	2 11/16	1	3	4 1/2
4 1/2	4 1/2	5 1/4	1	4 1/2-12	**	4 1/4-12	3 1/4-12	4 27/64	3 3/16	1 1/2	3 1/2	5 1/4
5	5	5 3/4	1	5-12	**	4 3/4-12	3 1/2-12	4 59/64	3 3/16	1 1/2	3 7/8	5 3/8
5 1/2	5 1/2	6 1/4	1	5 1/2-12	**	5 1/4-12	4-12	5 27/64	3 15/16	1 7/8	4 3/8	6 1/4
7	7	8	1	7-12	**	6 1/2-12	5 1/2-12	6 57/64	4 1/16	2	5 3/4	6 1/2

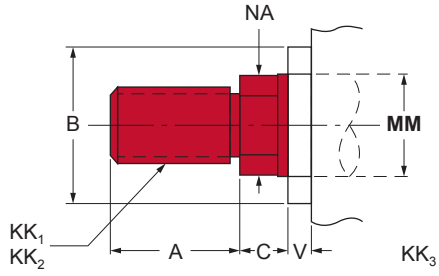
* Distance across wrench flats.

** (4) Spanner holes 33/64″ x 1/2" deep.

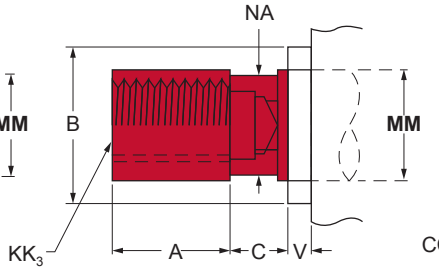
Note: Other rod sizes available. Consult factory.

▲ Rod end style KK_2 is studded as standard for 5/8" and 1" diameter rods. Studded rod end style is available for all rod sizes.

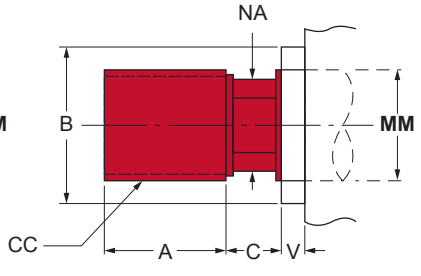
■ See page 105 for Series MN piston rod end styles.



ROD END STYLE
CODE NO. 1 (KK_1)
CODE NO. 2 (▲KK_2)



ROD END STYLE
CODE NO. 3



ROD END STYLE
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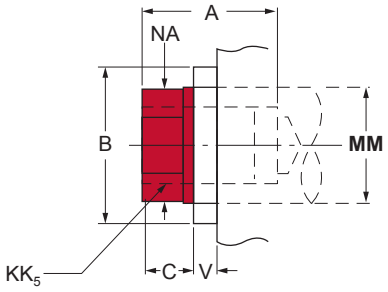
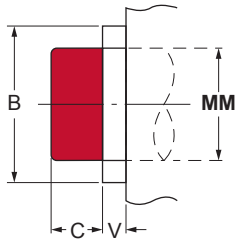
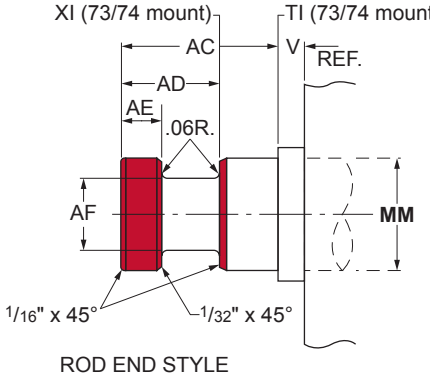


ROD END STYLE
CODE NO. 5



ROD END STYLE
CODE NO. 6



ROD END STYLE
CODE NO. 7

NOTE:
1.) AC = 1 5/8" FOR 1 1/2" BORE CYL.
2.) AC = 3 3/4" FOR 7" BORE CYL.

CAUTION: When ordering replacement cylinders for competitive brands, our Style #1 rod ends may not be interchangeable with other manufacturers' Style #1. Our Style #2 should be used if this applies to your application.

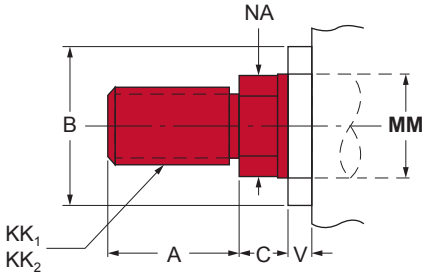
METRIC Piston Rod End Styles (Series MH)

Bore Ø	Rod MM	B	V	C	*D	NA	Rod End Styles KK$_1$	A	KK$_2$	A	KK$_5$	A
25	12	24	6	9	10	11	M10 X 1.25	14	—	—	M8 X 1	14
	18	30			15	17	M14 X 1.5	18	M10 X 1.25	14	M12 X 1.25	18
32	14	26	12	13	12	13	M12 X 1.25	16	—	—	M10 X 1.25	16
	22	34			18	21	M16 X 1.5	22	M12 X 1.25	16	M16 X 1.5	22
40	18	30	6	19	15	17	M14 X 1.5	18	—	—	M12 X 1.25	18
	28	42	12	13	22	26	M20 X 1.5	28	M14 X 1.5	18	M20 X 1.5	28
50	22	34	6	19	18	21	M16 X 1.5	22	—	—	M16 X 1.5	22
	28	42			22	16	M20 X 1.5	28	M16 X 1.5	22	M20 X 1.5	28
	36	50	9	16	30	34	M27 X 2	36	M16 X 1.5	22	M27 X 2	36
63	28	42	6	26	22	26	M20 X 1.5	28	—	—	M20 X 1.5	28
	36	50	9	23	30	34	M27 X 2	36	M20 X 1.5	28	M27 X 2	36
	45	60	13	19	39	43	M33 X 2	45	M20 X 1.5	28	M33 X 2	45
80	36	50	5	26	30	34	M27 X 2	36	—	—	M27 X 2	36
	45	60	9	22	39	43	M33 X 2	45	M27 X 2	36	M33 X 2	45
	56	72			48	54	M42 X 2	56	M27 X 2	36	M42 X 2	56
100	45	60	7	28	39	43	M33 X 2	45	—	—	M33 X 2	45
	56	72			48	54	M42 X 2	56	M33 X 2	45	M42 X 2	56
	70	88	10	25	62	68	M48 X 2	63	M33 X 2	45	M48 X 2	63
125	56	72	7	28	48	54	M42 X 2	56	—	—	M42 X 2	56
	70	88	10	25	62	68	M48 X 2	63	M42 X 2	56	M48 X 2	63
	90	108			80	88	M64 X 3	85	M42 X 2	56	M64 X 3	85
160	70	88	7	25	62	68	M48 X 2	63	—	—	M48 X 2	63
	90	108			80	88	M64 X 3	85	M48 X 2	63	M64 X 3	85
	110	133			**	108	M80 X 3	95	M48 X 2	63	M80 X 3	95
200	90	108	7	25	80	88	M64 X 3	85	—	—	M64 X 3	85
	110	133			**	108	M80 X 3	95	M64 X 3	85	M80 X 3	95
	140	163			**	138	M100 X 3	112	M64 X 3	85	M100 X 3	112

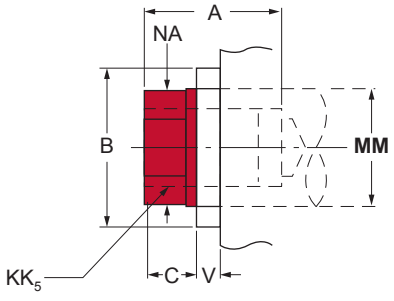
* Distance across wrench flats.

** (4) Spanner holes 13mm x 13mm deep.

Note: Other rod sizes available. Consult factory.



ROD END STYLE
CODE NO. 1 (KK$_1$)
CODE NO. 2 (KK$_2$)



ROD END STYLE
CODE NO. 5 (KK$_5$)

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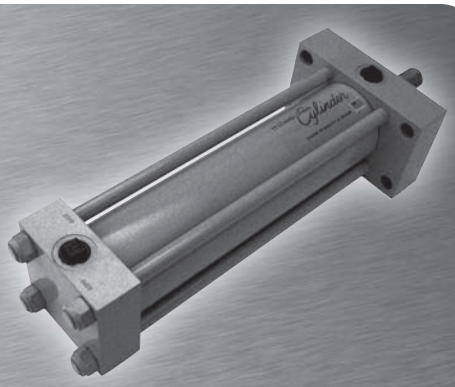
NEW PRODUCTS

METRIC HYDRAULIC CYLINDERS



Series "MH" ISO Metric Tie Rod Cylinders

- ISO standard 6020/2 - 160 bar series
- Working pressure up to 210 bar
- Temperature range 20° C to 150° C
- Cushions available at either or both ends
- Single and Double rod end design

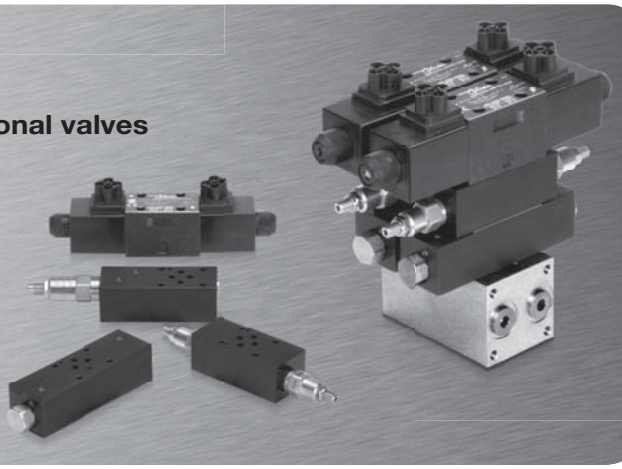
See pages 36-49 for details!

POWER UNITS

- Gear (3000 psi) or Vane (2000 psi) Pump designs
- Vertical, JIC, Low Height or L-shaped reservoirs available
- Available in a wide range of standard and custom configurations

See pages 160-166 for details!

VALVES



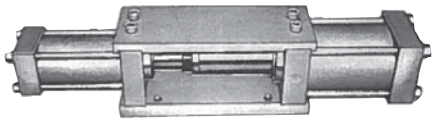
- D03 and D05 spool type directional valves in multiple flow paths
- Working pressure up to 3000 psi (210 bar)
- Temperature range 20° C to 150° C

See pages 167-176 for details!

CUSTOM PRODUCTS

WHEN IT COMES TO SPECIAL CYLINDERS, *Milwaukee Cylinder* is not limited to tie rod constructed cylinders. This cylinder, which incorporated a number of special features, was designed for use on farm equipment. It features a threaded rod bushing for easy removal of the rod and piston seals, a modified NFPA mount MF1 to suit the design requirement of the customer, welded construction and welded half coupling ports were required so that this cylinder would be interchangeable with equipment already in the field.

WE ARE PROUD OF OUR ROLE as a quality supplier of cylinders to many different areas of industry. This cylinder was designed for a foundry application that required a special mounting because of clearance problems with existing equipment. *Milwaukee Cylinder* satisfied the customer's requirements with round end caps to provide the required clearance, multiple tie rods for added strength, and a special mounting to the customer's specifications.



IF STANDARD CYLINDERS WON'T DO THE JOB, we're specialists in engineering cylinders that will perform the functions that you require. This special pumping unit used on marine vessels was designed to separate the shipboard and mast hydraulic fluid systems. Cylinders used on a marine vessel to raise and lower the mast are subject to salt water contamination. To prevent contamination of the shipboard system, an independent hydraulic system is required for the mast. This cylinder acts as a pump operated off of the shipboard system, to provide hydraulic pressure for the mast system on the marine vessel.

SYSTEM SOLUTIONS

***Milwaukee Cylinder* wants to solve your problem!**

We provide many complete solutions to both our OEM customers and end users.

In addition to custom cylinders we often provide plumbing, fittings, valves, mounting hardware, and other accessories to allow a quicker and easier solution.

Ask us to help!

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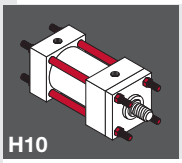
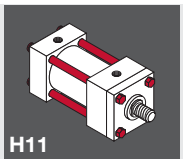
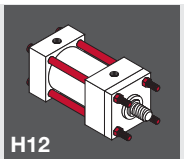
Series H



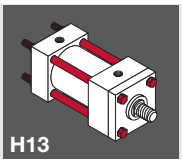
NFPA MX1



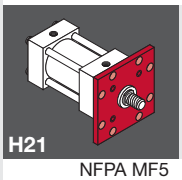
NFPA MX0



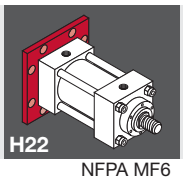
NFPA MX3



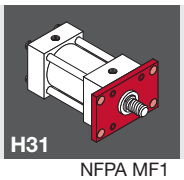
NFPA MX2



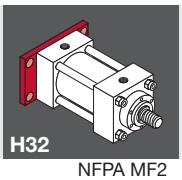
NFPA MF5



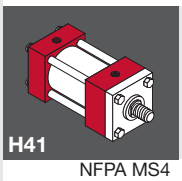
NFPA MF6



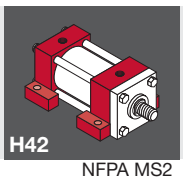
NFPA MF1



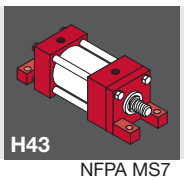
NFPA MF2



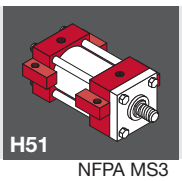
NFPA MS4



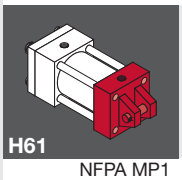
NFPA MS2



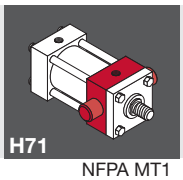
NFPA MS7



NFPA MS3



NFPA MP1



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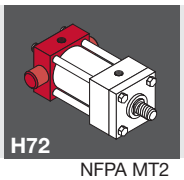
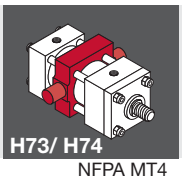
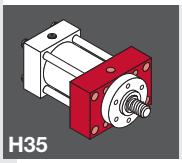


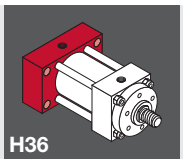
NFPA MT2



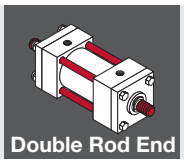
NFPA MT4



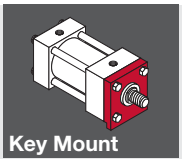
NFPA ME5



NFPA ME6



NFPA MDX



***Milwaukee Cylinder* Series H Hydraulic Cylinders** are built to perform on the toughest applications. Series H is a complete line of NFPA standard hydraulic tie rod cylinders, with maximum operating pressures up to 3000 psi on all standard bore sizes. If your application requires higher operating pressures, consult our engineers. Incorporating a variety of *Milwaukee Cylinder* exclusive advanced features proven through the years, these cylinders will provide a long, maintenance-free service life.

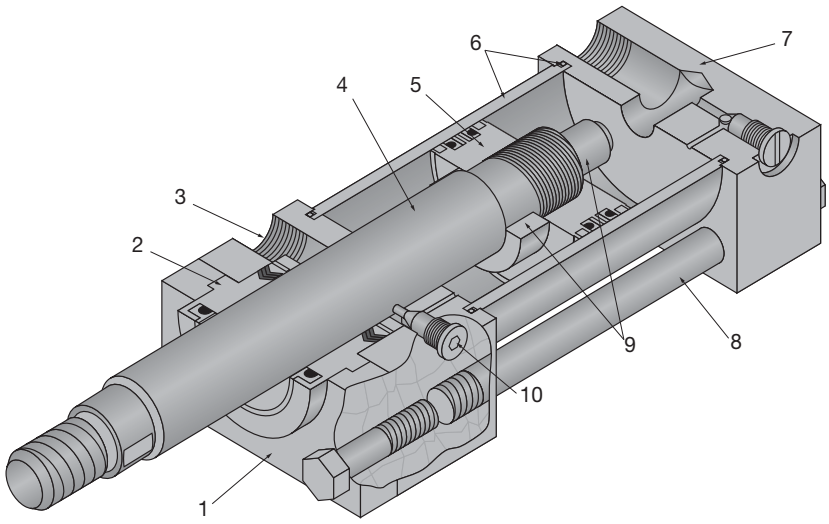
STANDARD SPECIFICATIONS

- Standard construction – square head – tie-rod design
- Nominal pressure – 3000 psi (See info box below for pressures higher than 3000 psi)
- Standard fluid-hydraulic oil
- Standard temperature – -20° F to +200° F
- Standard bore sizes – 1½" To 18"
- Standard piston rod diameters ⅝" thru 7"
- Standard mounting styles– 18 standard styles and custom designs to suit your needs
- Strokes – available in any practical stroke length
- Cushions – available at either end or both ends of stroke
- Standard 7 rod end styles and specials designed to order
- Rod end style KK_2 is studded as standard for ⅝" and 1" diameter rods. Studded rod end style is available for all rod sizes

If your hydraulic operating pressure exceeds 3000 psi, send your application data for engineering evaluation and design recommendations.

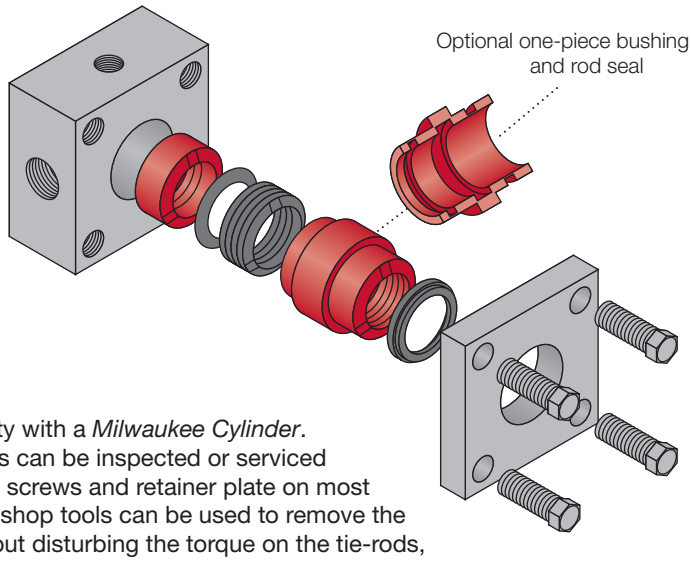
***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.



STANDARD FEATURES

1. **Removable Retainer Plate**
   The retainer plate and rod bushing are externally removable without disassembling the cylinder on most standard models. Four capscrews securely hold and lock the retainer plate in place.
2. **Rod Bushing and Seals**
   A combination of spring loaded multiple lip vee rings with a supporting bronze bushing is standard in *Milwaukee Cylinder* Series H Cylinders.
3. **Ports**
   Large NPTF cylinder ports are standard and can be located to customer requirements. SAE ports optional.
4. **Piston Rod**
   The piston rod is of high strength steel, hardened and plated to resist scoring and corrosion, assuring maximum life.
5. **Piston**
   The piston is of fine grained alloy iron, incorporating a combination of u-cup seals and cast iron rings, ensuring non-leak Hi-Lo pressure performance. The piston is pilot fitted and threaded to the rod.
6. **Cylinder Barrel and Seals**
   The barrel is of steel tubing, honed to a fine finish to assure superior sealing, minimum friction and maximum seal life. It is step cut on the O.D. of both ends for an O-Ring and molded back-up washer. *Milwaukee Cylinder*'s unique non-extrusion barrel seal design provides a positive leak tight seal.
7. **End Caps**
   End caps and mountings are of high quality steel, precision machined for accurate mounting.
8. **Tie-Rods and Nuts**
   The tie-rods are constructed from a high quality medium carbon steel. On most sizes the threads are rolled for rigid engagement of the self-locking nuts.
9. **Cushions**
   Cushions are machined to close tolerance to provide positive, smooth deceleration at the end of stroke. On all bore sizes, we provide the longest cushion possible based on the rod size and blind end caps. Longer cushions are available; for further information, consult factory.
10. **Cushion Needle Adjustment and Ball Check**
    The cushion needle adjustment valve and cushion-check ball retainer screw are specifically designed to provide full cushion adjustment.



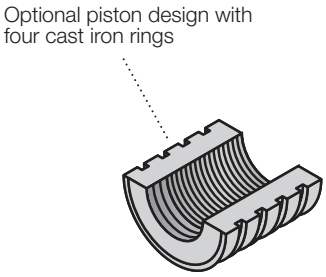
Simple Maintenance…

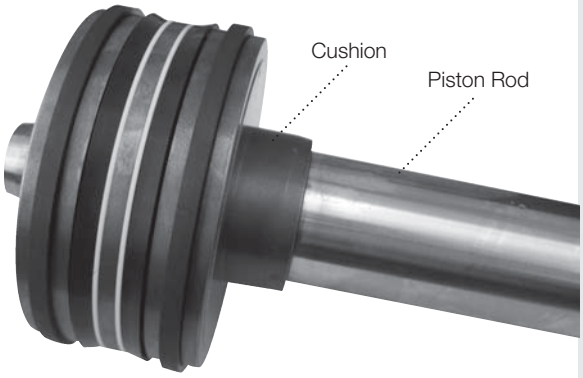
Simple maintenance is reality with a *Milwaukee Cylinder*. The rod bushing or rod seals can be inspected or serviced by merely removing the cap screws and retainer plate on most models. Standard available shop tools can be used to remove the rod bushing and seals without disturbing the torque on the tie-rods, assuring performance quality with maintenance ease.

COMBINATION ROD SEAL DESIGN…

The Series H cylinder combines spring loaded multiple lip vee rings with a supporting bronze bearing ring bushing and a double lip wiper as a secondary seal. This proven rod seal design combination is effective at both high and low pressures. It affords maximum sealing and an extra long bearing support.

As an optional design, a one-piece rod bushing with a double lip u-cup rod seal and a double lip wiper is available. Metallic rod scrapers may be supplied on request, in place of the double lip wiper with either rod bushing design.





Cushions…

The cushion is of a high-grade alloy, precision machined and specially tapered to provide smooth deceleration of the piston at the end of stroke.

A standard manufacturing process at *Milwaukee Cylinder* is to assemble the piston, cushion, and the piston rod; placing the assembly between centers and checking the critical diameters for concentricity.

Piston Rod…

The piston rod is hardened, plated high strength steel, machined and processed to resist scoring and corrosion, assuring maximum life. *Milwaukee Cylinder* offers seven rod end styles as standard. **The style #2 rod end with two wrench flats is furnished as standard** unless otherwise specified. Special rod ends and extra wrench flats are also available. They must be specified at the time of order, giving the dimensional requirements and the location of additional wrench flats.

COMBINATION SEALING ROD

The Series H Cylinder combines two bi-directional sealing cast iron piston rings, with u-cup seals with back-up rings and a fine grained alloy iron piston. This proven piston seal design is effective at both high and low pressures. The design gives the wear and shock absorbing quantities of cast iron and the near zero leakage of the u-cup seals.

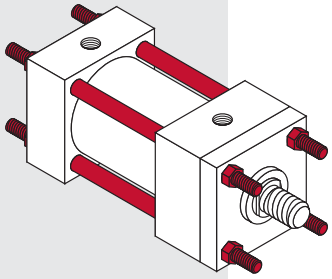
As an optional design, a piston using four low friction cast iron rings is available.

For Package and Mounting Dimension see Tables 1H and 2H.

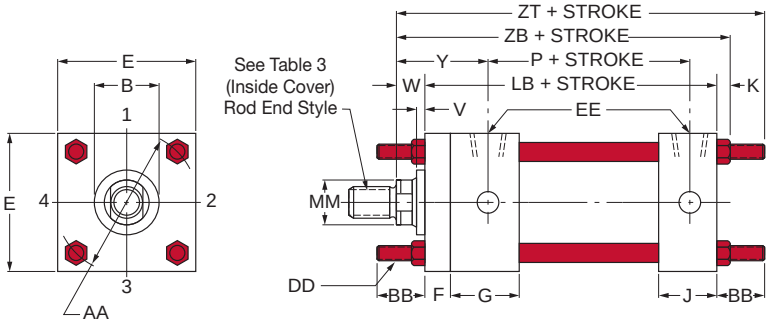
TIE-ROD MOUNTED CYLINERS

Tie-rod mounts are suited for many applications and are similar to flange mounts, but tie-rod mounts are not as rigid as the flange type of mounting. The best use of tie rods extended on the blind end is in a thrust load application. When using tie rods extended on the rod end, the best application is a tension load. When long strokes are required, the free end should be supported to prevent misalignment, sagging or possible binding of the cylinder.

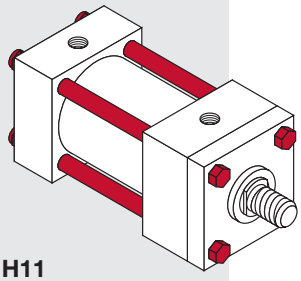
TIE RODS EXTENDED BOTH ENDS



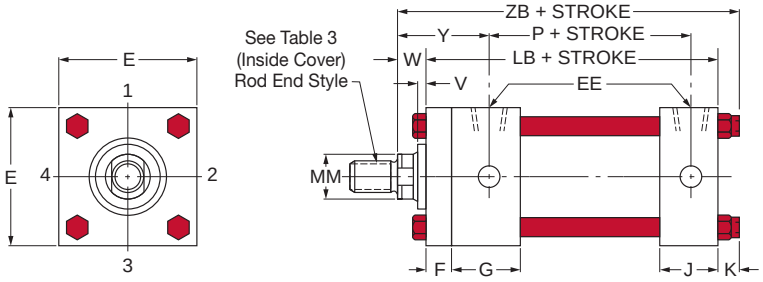
MODEL H10
NFPA STYLE MX1



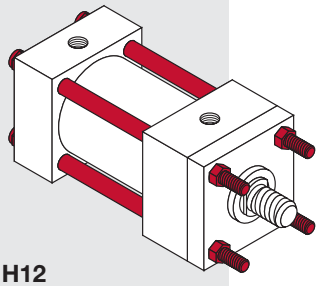
NO TIE ROD EXTENSION



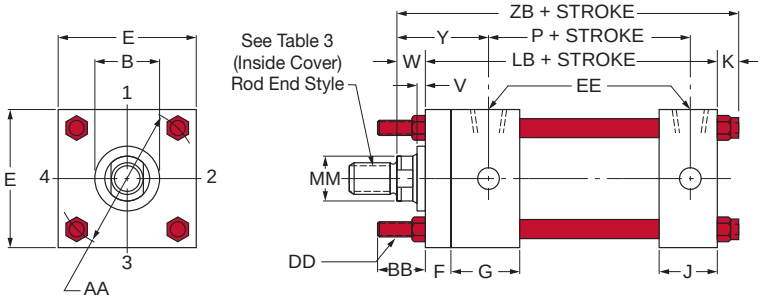
MODEL H11
NFPA STYLE MX0



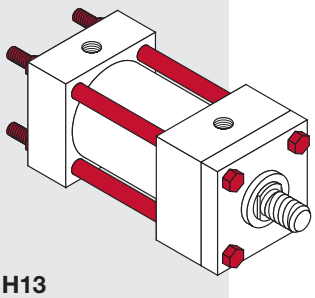
TIE RODS EXTENDED ROD END



MODEL H12
NFPA STYLE MX3



TIE RODS EXTENDED BLIND END



MODEL H13
NFPA STYLE MX2

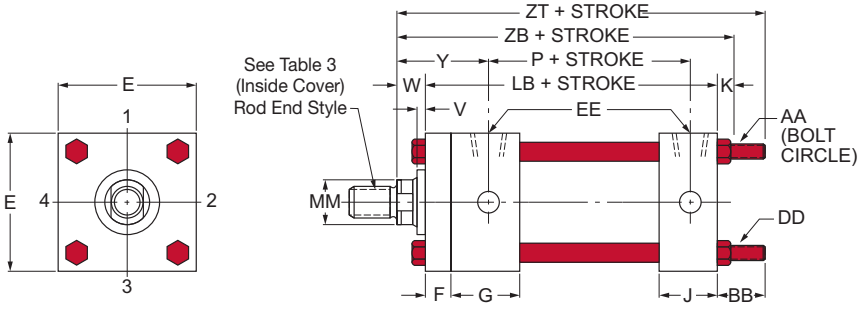


TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	Y	ZB	ZT
1½	5/8	H00151	1 1/8	5	2 7/8	1/4	5/8	2	6 1/8	7
	1	H00152	1 1/2			1/2	1	2 3/8	6 1/2	7 3/8
2	1	H01510	1 1/2	5 1/4	2 7/8	1/4	3/4	2 3/8	6 5/8	7 13/16
	1 3/8	H01511	2			3/8	1	2 5/8	6 7/8	8 1/16
2½	1	H01520	1 1/2	5 3/8	3	1/4	3/4	2 3/8	6 3/4	7 15/16
	1 3/8	H01521	2			3/8	1	2 5/8	7	8 3/16
	1 3/4	H01522	2 3/8			1/2	1 1/4	2 7/8	7 1/4	8 7/16
3¼	1 3/8	H01530	2	6 1/4	3 19/32	1/4	7/8	2 23/32	7 7/8	9 7/16
	1 3/4	H01531	2 3/8			3/8	1 1/8	2 31/32	8 1/8	9 11/16
	2	H01532	2 5/8			3/8	1 1/4	3 3/32	8 1/4	9 13/16
4	1 3/4	H01540	2 3/8	6 5/8	3 7/8	1/4	1	2 15/16	8 3/8	9 15/16
	2	H01541	2 5/8			1/4	1 1/8	3 1/16	8 1/2	10 1/16
	2 1/2	H01542	3 1/8			3/8	1 3/8	3 5/16	8 3/4	10 5/16
5	2	H01550	2 5/8	7 1/8	4 3/8	1/4	1 1/8	3 1/16	9 1/4	11 7/16
	2 1/2	H01551	3 1/8			3/8	1 3/8	3 5/16	9 1/2	11 11/16
	3	H01552	3 3/4			3/8	1 3/8	3 5/16	9 1/2	11 11/16
	3 1/2	H01553	4 1/4			3/8	1 3/8	3 5/16	9 1/2	11 11/16
6	2 1/2	H01560	3 1/8	8 3/8	5	1/4	1 1/4	3 7/16	10 3/4	13 1/4
	3	H01561	3 3/4							
	3 1/2	H01562	4 1/4							
	4	H01563	4 3/4							
7	3	H01570	3 3/4	9 1/2	5 1/2	1/4	1 1/4	3 3/4	12	14 7/8
	3 1/2	H01571	4 1/4							
	4	H01572	4 3/4							
	4 1/2	H01573	5 1/4							
	5	H01574	5 3/4							
8	3 1/2	H01580	4 1/4	10 1/2	6 1/4	1/4	1 1/4	3 7/8	13 1/4	16 1/4
	4	H01581	4 3/4							
	4 1/2	H01582	5 1/4							
	5	H01583	5 3/4							
	5 1/2	H01584	6 1/4							
10	4 1/2	H15100	5 1/4	13 13/16	8 1/2	1/4	1 1/4	4 3/4	16 11/16	21 1/16
	5	H15101	5 3/4			1/2	1 1/2	5	16 15/16	21 5/16
	5 1/2	H15102	6 1/4			1/2	1 1/2	5	16 15/16	21 5/16
12	5 1/2	H15120	6 1/4	16 7/16	9 7/8	1/4	1 1/4	5 1/2	19 9/16	24 11/16
	7	H15121	8							

For bore diameter sizes 14" to 18" see next page.

TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	AA	BB	DD	E	EE NPT	EE SAE	F	G	J	K
1½	2.3	1 3/8	3/8-24	2 1/2	1/2	#10	3/8	1 3/4	1 1/2	1/2
2	2.9	1 13/16	1/2-20	3	1/2	#10	5/8	1 3/4	1 1/2	5/8
2½	3.6	1 13/16	1/2-20	3 1/2	1/2	#10	5/8	1 3/4	1 1/2	5/8
3¼	4.6	2 5/16	5/8-18	4 1/2	3/4	#12	3/4	2	1 3/4	3/4
4	5.4	2 5/16	5/8-18	5	3/4	#12	7/8	2	1 3/4	3/4
5	7.0	3 3/16	7/8-14	6 1/2	3/4	#12	7/8	2	1 3/4	1
6	8.1	3 5/8	1-14	7 1/2	1	#16	1	2 1/4	2 1/4	1 1/8
7	9.3	4 1/8	1 1/8-12	8 1/2	1 1/4	#20	1	2 3/4	2 3/4	1 1/4
8	10.6	4 1/2	1 1/4-12	9 1/2	1 1/2	#24	1	3	3	1 1/2
10	13.62	6	1 3/4-12	12 5/8	2	#24	1 11/16	3 11/16	3 11/16	1 5/8
12	16.25	7	2-12	14 7/8	2 1/2	#32	1 15/16	4 7/16	4 7/16	1 7/8

HOW TO ORDER

For ordering information refer to Page 32.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DH00151. (Refer to page 26.)

Rod End Styles and Dimensions

For rod end styles and dimensions see Table 3 in the inside cover of catalog.

Page ii

***MilCad* Cylinder Configurator**

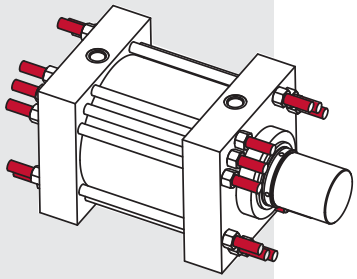
Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

For Package and Mounting Dimension see Tables 1H and 2H.

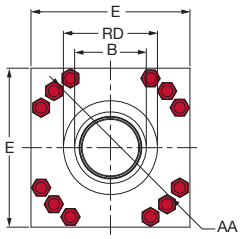
TIE ROD MOUNTED CYLINDERS

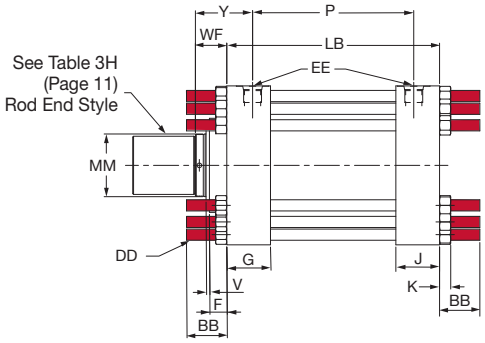
Tie rod mounts are suited for many applications and are similar to flange mounts, but tie-rod mounts are not as rigid as the flange type of mounting. The best use of tie rods extended on the blind end is in a thrust load application. When using tie rod extended on the rod end, the best application is a tension load. When long strokes are required, the free end should be supported to prevent misalignment, sagging or possible binding of the cylinder.

TIE RODS EXTENDED BOTH ENDS

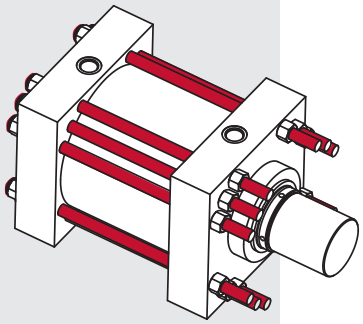


MODEL HM10

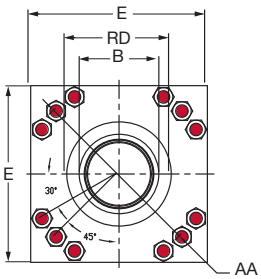


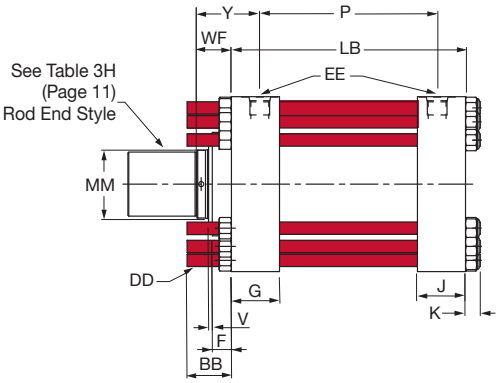


TIE RODS EXTENDED ROD END

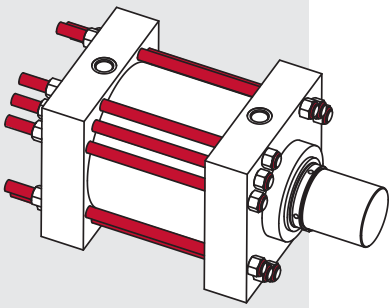


MODEL HM12

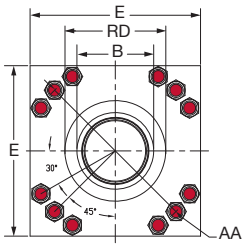


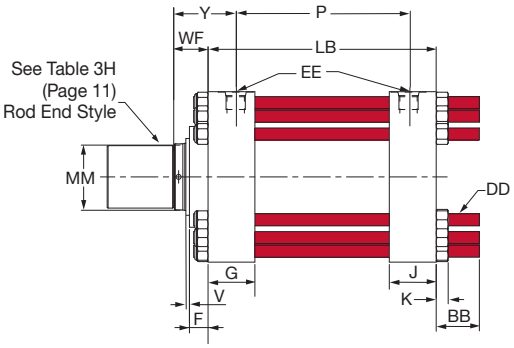


TIE RODS EXTENDED BLIND END



MODEL HM13





▼ TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	WF	Y	RD
14	7	HM15140	8	15⅝	10⅝	¼	3½	6	10½
	8	HM15141	9			¼	4	6½	11½
	10	HM15142	-			-	6	8½	14½
16	8	HM15160	9	18⅝	11⅞	¼	4	7⅜	11½
	9	HM15161	-			-	5⅝	9	13⅞
	10	HM15162	-			-	6	9⅜	14½
18	9	HM15180	-	22	13¾	-	5⅝	9¾	13⅞
	10	HM15181	-			-	6	10⅛	14½

▼ TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	AA	BB	DD	E	EE SAE	G	J	K
14	17.88	4½	1¼-12	17¾	#24	4⅞	4⅞	1½
16	20.25	5	1⅜-12	20¼	#24	5⅞	5⅞	1⅝
18	22.63	5½	1½-12	22¼	#24	6⅞	6⅞	1⅞

LARGE BORE CYLINDERS

NOTE: Large bore Series H cylinders (14", 16" and 18") must use Table 3H for accurate piston rod end dimensions.

▼ TABLE 3H - Piston Rod Ends

Bore Ø	Rod MM	Thread KK	A	B +.000 -.005	F	NA	V	WF
14	7	5½-12	7	8	1 15/16	6⅞	¼	3½
	8	5¾-12	8	9	1 15/16	7⅞	¼	4
	10	7¼-12	10	-	3½	9⅞	-	6
16	8	5¾-12	8	9	1 15/16	7⅞	¼	4
	9	6½-12	9	-	3⅜	8⅞	-	5⅝
	10	7¼-12	10	-	3½	9⅞	-	6
18	9	6½-12	9	-	3⅜	8⅞	-	5⅝
	10	7¼-12	10	-	3½	9⅞	-	6

HOW TO ORDER

For ordering information refer to Page 32.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DHM15140. (Refer to page 26.)

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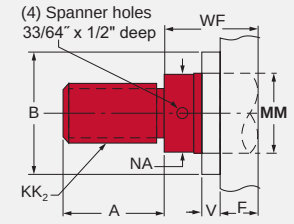
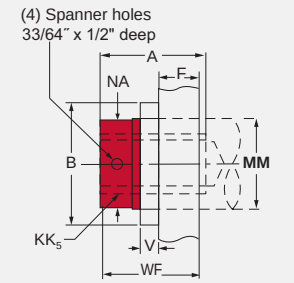
PISTON ROD END STYLES

STYLE KK2



ROD END STYLE CODE NO. 2

STYLE KK5



ROD END STYLE CODE NO. 5

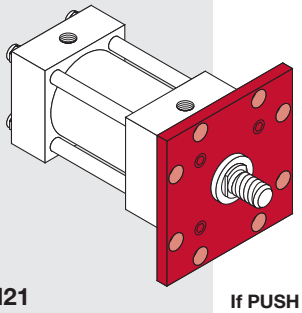
For Package and Mounting Dimension see Tables 1H and 2H.

FLANGE MOUNTED CYLINDERS

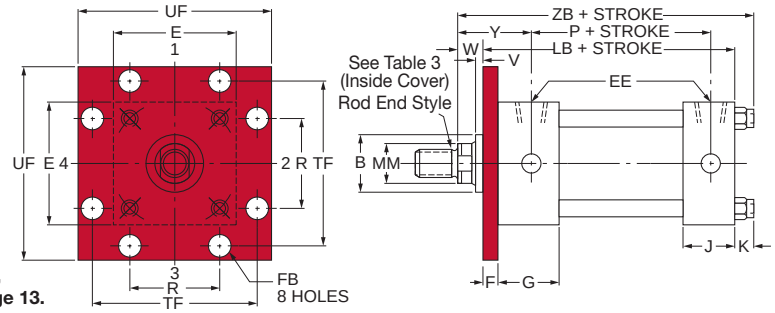
The flange mount is one of the strongest, most rigid methods of mounting. With this type of mount there is little allowance for misalignment, though when long strokes are required, the free end opposite the mounting should be supported to prevent sagging and possible binding of the cylinder. The best use of a blind end flange is in a thrust load application (rod in compression).

Rod end flange mounts are best used in tension applications. If an application exceeds the rectangular flange rating, requiring an extra heavy flange, a solid flange style end cap mount is available for all bore sizes (refer to page 22). When a less rigid mount can be used and the cylinder can be attached to a panel or bulkhead, an extended tie-rod mounting could be considered.

ROD SQUARE FLANGE MOUNTING



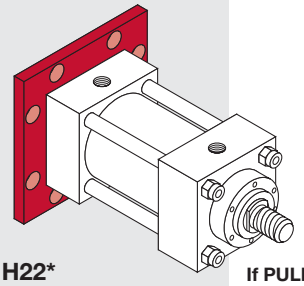
MODEL H21
NFPA STYLE MF5



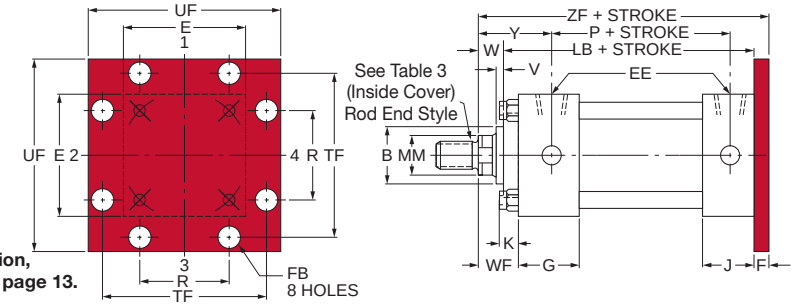
If PUSH application, see Table 3H on page 13.

Shown with circular retainer.
Retainer is square <3¼" bore.

BLIND SQUARE FLANGE MOUNTING

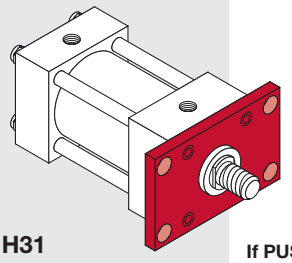


MODEL H22*
NFPA STYLE MF6

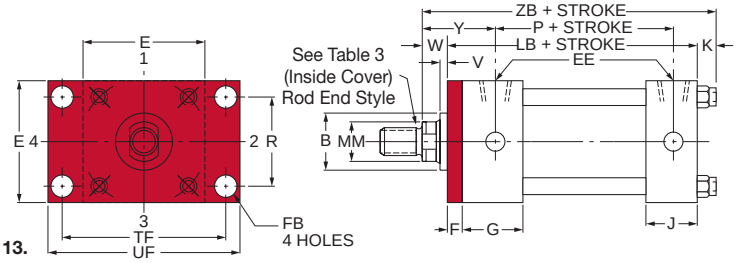


If PULL application, see Table 3H on page 13.

ROD RECTANGULAR FLANGE MOUNTING

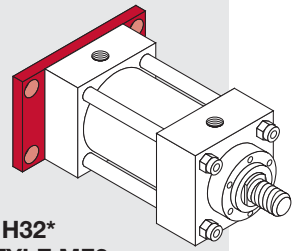


MODEL H31
NFPA STYLE MF1

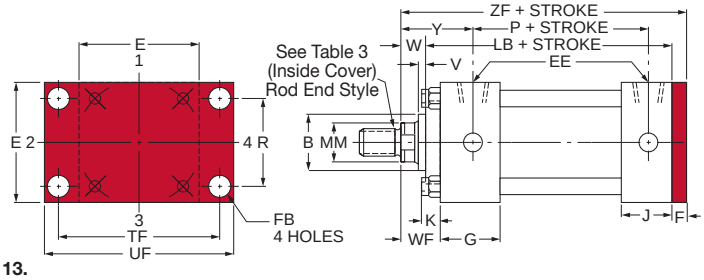


If PUSH application, see Table 3H on page 13.

BLIND RECTANGULAR FLANGE MOUNTING



MODEL H32*
NFPA STYLE MF2



If PULL application, see Table 3H on page 13.

▼ TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	WF	Y	ZB	ZF
1½	5/8	H00151	1 1/8	5	2 7/8	1/4	5/8	–	2	6 1/8	6
	1*	H00152	1½			½	1		2 3/8	6½	6 3/8
2	1	H01510	1½	5 1/4	2 7/8	1/4	3/4	–	2 3/8	6 5/8	6 5/8
	1 3/8*	H01511	2			3/8	1		2 5/8	6 7/8	6 7/8
2½	1	H01520	1½	5 3/8	3	1/4	3/4	–	2 3/8	6 3/4	6 3/4
	1 3/8	H01521	2			3/8	1		2 5/8	7	7
	1 3/4*	H01522	2 3/8			½	1 1/4		2 7/8	7 1/4	7 1/4
3¼	1 3/8	H01530	2	6 1/4	3 19/32	1/4	7/8	1 5/8	2 23/32	7 7/8	7 7/8
	1 3/4	H01531	2 3/8			3/8	1 1/8	1 7/8	2 31/32	8 1/8	8 1/8
	2	H01532	2 5/8			3/8	1 1/4	2	3 3/32	8 1/4	8 1/4
4	1 3/4	H01540	2 3/8	6 5/8	3 7/8	1/4	1	1 7/8	2 15/16	8 3/8	8½
	2	H01541	2 5/8			1/4	1 1/8	2	3 1/16	8½	8 5/8
	2½	H01542	3 1/8			3/8	1 3/8	2 1/4	3 5/16	8 3/4	8 7/8
5	2	H01550	2 5/8	7 1/8	4 3/8	1/4	1 1/8	2	3 1/16	9 1/4	9 1/8
	2½	H01551	3 1/8			3/8	1 3/8	2 1/4	3 5/16	9½	9 3/8
	3	H01552	3 3/4			3/8	1 3/8	2 1/4	3 5/16	9½	9 3/8
	3½	H01553	4 1/4			3/8	1 3/8	2 1/4	3 5/16	9½	9 3/8
6	2½	H01560	3 1/8	8 3/8	5	1/4	1 1/4	2 1/4	3 7/16	10 3/4	10 5/8
	3	H01561	3 3/4								
	3½	H01562	4 1/4								
	4	H01563	4 3/4								
7	3	H01570	3 3/4	9½	5½	1/4	1 1/4	2 1/4	3 3/4	12	11 3/4
	3½	H01571	4 1/4								
	4	H01572	4 3/4								
	4½	H01573	5 1/4								
	5	H01574	5 3/4								
8	3½	H01580	4 1/4	10½	6 1/4	1/4	1 1/4	2 1/4	3 7/8	13 1/4	12 3/4
	4	H01581	4 3/4								
	4½	H01582	5 1/4								
	5	H01583	5 3/4								
	5½	H01584	6 1/4								
10	4½	H15100	5 1/4	13 13/16	8½	1/4	1 1/4	–	4 3/4	16 11/16	16 3/4
	5	H15101	5 3/4			½	1½		5	16 15/16	17
	5½	H15102	6 1/4			½	1½		5	16 15/16	17
12	5½	H15120	6 1/4	16 7/16	9 7/8	1/4	1 1/4	–	5½	19 9/16	19 5/8
	7	H15121	8								

For bore diameter sizes 14" to 18" see pages 24 and 25 (solid end cap mount).

▼ TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	EE NPT	EE SAE	F	FB	G	J	K	R	TF	UF
1½	2½	½	#10	3/8	7/16	1 3/4	1½	½	1.63	3 7/16	4 1/4
2	3	½	#10	5/8	9/16	1 3/4	1½	5/8	2.05	4 1/8	5 1/8
2½	3½	½	#10	5/8	9/16	1 3/4	1½	5/8	2.55	4 5/8	5 5/8
3¼	4½	3/4	#12	3/4	11/16	2	1 3/4	3/4	3.25	5 7/8	7 1/8
4	5	3/4	#12	7/8	11/16	2	1 3/4	3/4	3.82	6 3/8	7 5/8
5	6½	3/4	#12	7/8	15/16	2	1 3/4	1	4.95	8 3/16	9 3/4
6	7½	1	#16	1	1 1/16	2 1/4	2 1/4	1 1/8	5.73	9 7/16	11 1/4
7	8½	1 1/4	#20	1	1 3/16	2 3/4	2 3/4	1 1/4	6.58	10 5/8	12 5/8
8	9½	1½	#24	1	1 5/16	3	3	1½	7.50	11 13/16	14
10	12 5/8	2	#24	1 11/16	1 13/16	3 11/16	3 11/16	1 5/8	9.62	15 7/8	19
12	14 7/8	2½	#32	1 15/16	2 1/16	4 7/16	4 7/16	1 7/8	11.45	18½	22

HOW TO ORDER

For ordering information refer to Page 32.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DH00151. (Refer to page 26.)

* Removable retainer not available for these bore and rod combinations in the H22 and H32 mounting styles.

Rod End Styles and Dimensions

For rod end styles and dimensions see Table 3 in the inside cover of catalog.

Page ii

▼ TABLE 3H

Recommended Pressure Rating

Bore Ø	Standard Flange PSI Rating	3000 PSI Required Flange Thickness
1½-4	3000	Standard
5	2200	1
6	1500	1½
7	1100	1¾
8	800	2
10	1300	2½
12	1000	3

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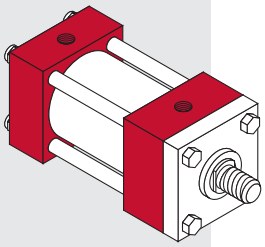
For Package and Mounting Dimension see Tables 1H and 2H.

SIDE OR LUG MOUNTED CYLINDERS

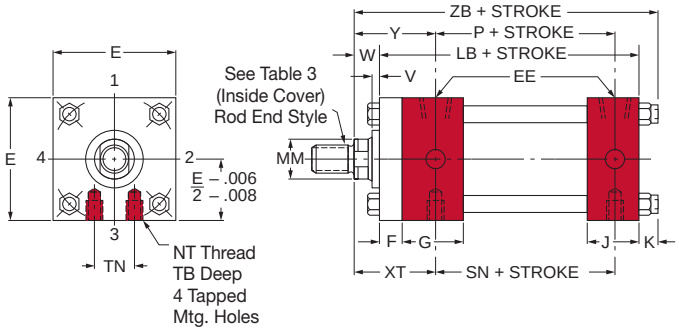
The side or lug mounted cylinder provides a fairly rigid mount. These types of cylinders can tolerate a slight amount of misalignment when the cylinder is at full stroke, but as the piston moves toward the blind end, the tolerance for misalignment decreases. It is important to note that if the cylinder is used properly (without misalignment), the mounting bolts are either in simple shear or tension without any compound stresses.

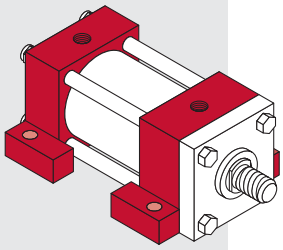
Shown with square retainer. Retainer is circular on bore size 3¼" and larger.



MODEL H41
NFPA STYLE MS4

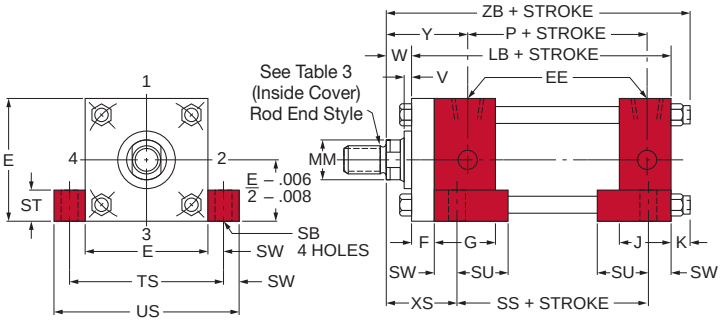
TAPPED HOLES IN CAPS FLUSH MOUNTING



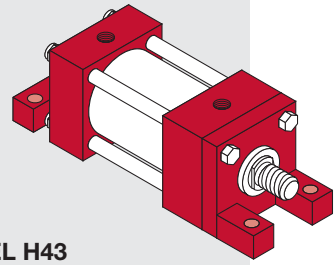


MODEL H42
NFPA STYLE MS2

SIDE LUG MOUNTING

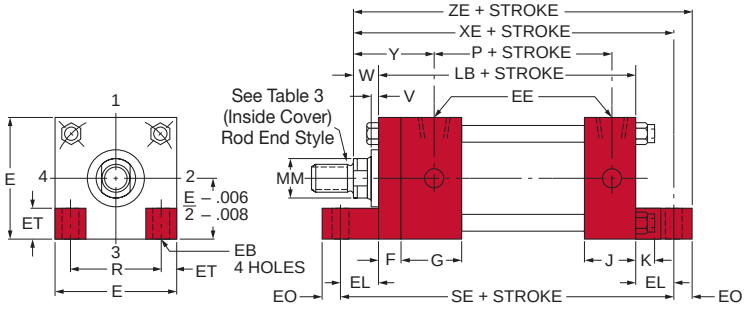


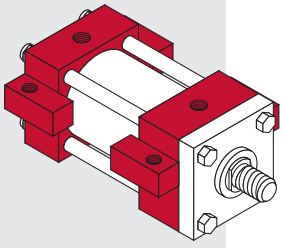
Not Available With Removable Retainers.



MODEL H43
NFPA STYLE MS7

FOOT MOUNTING





MODEL H51
NFPA STYLE MS3

CENTERLINE LUG MOUNTING

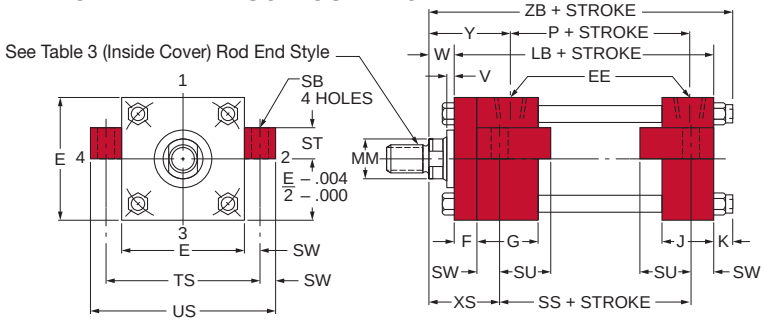


TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	P	LB	SE ▲	SN	SS ■	V	W	XE	XS	XT	Y	ZB	ZE
1½	⅝	H00151	2⅞	5	6¾	2⅞	3⅞	¼	⅝	6½	1⅜	2	2	6⅛	6⅞
	†1*	H00152						½	1	6⅞	1¾	2⅜	2⅜	6½	7¼
2	1	H01510	2⅞	5¼	7⅛	2⅞	3⅝	¼	¾	6 15/16	1⅞	2⅜	2⅜	6⅝	7 7/16
	†1⅜*	H01511						⅜	1	7 3/16	2⅛	2⅝	2⅝	6⅞	7 11/16
2½	1	H01520	3	5⅜	7¼	3	3⅜	¼	¾	7 1/16	2 1/16	2⅜	2⅜	6¾	7 9/16
	1⅜*	H01521						⅜	1	7 15/16	2 5/16	2⅝	2⅝	7	7 13/16
	†1¾*	H01522						½	1¼	7 9/16	2 9/16	2⅞	2⅞	7¼	8 1/16
3¼	1⅜	H01530	3 19/32	6¼	8½	3½	4⅛	¼	⅞	8¼	2 5/16	2¾	2 23/32	7⅞	8⅞
	1¾	H01531						⅜	1⅛	8½	2 9/16	3	2 31/32	8⅛	9⅛
	†2*	H01532						⅜	1¼	8⅝	2 11/16	3⅛	3 3/32	8¼	9¼
4	1¾	H01540	3⅞	6⅝	8⅞	3¾	4	¼	1	8¾	2¾	3	2 15/16	8⅜	9⅜
	2*	H01541						¼	1⅛	8⅞	2⅞	3⅛	3 1/16	8½	9½
	2½*	H01542						⅜	1⅜	9⅛	3⅛	3⅞	3 5/16	8¾	9¾
5	2	H01550	4⅜	7⅛	10⅛	4⅜	4½	¼	1⅛	9¾	2⅞	3⅛	3 1/16	9¼	10½
	2½	H01551						⅜	1⅜	10	3⅛	3⅜	3 5/16	9½	10¾
	3	H01552						⅜	1⅜	10	3⅛	3⅜	3 5/16	9½	10¾
	3½*	H01553						⅜	1⅜	10	3⅛	3⅜	3 5/16	9½	10¾
6	2½	H01560	5	8⅜	10¾	5	5⅛	¼	1¼	11 5/16	3⅜	3½	3 7/16	10¾	12 13/16
	3	H01561													
	3½	H01562													
	4*	H01563													
7	3	H01570	5½	9½	13⅛	5½	5¾	¼	1¼	12 9/16	3⅝	3 13/16	3¾	12	13½
	3½	H01571													
	4	H01572													
	4½*	H01573													
	5*	H01574													
8	3½	H01580	6¼	10½	14½	6¼	6¾	¼	1¼	13¾	3⅝	3 15/16	3⅞	13¼	14⅞
	4	H01581													
	4½	H01582													
	5	H01583													
	5½*	H01584													
10	4½	H15100	8½	13 13/16	–	8½	8⅞	¼	1¼	–	4 9/16	5	4¾	16 11/16	–
	5	H15101						½	1½		4 13/16	5¼	5	16 15/16	
	5½	H15102						½	1½		4 13/16	5¼	5	16 15/16	
12	5½	H15120	9⅞	16 7/16	–	10⅛	10½	¼	1¼	–	5 3/16	5¾	5½	19 9/16	–
	7	H15121													

HOW TO ORDER

For ordering information refer to page 32.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DH00151. (Refer to page 26.)

* Tapped holes on H41 rod end cap have a shallower TB depth in these sizes.

† The standard rod eye or rod clevis will interfere with foot lugs on Model H43. When these rod end accessories are required, use additional rod extension.

▲ For double rod end cylinders from 1½" thru 5" bore, add ¼ + F to this dimension.

■ For double rod end cylinders from 1½" thru 5" bore, add ¼ to this dimension.

Rod End Styles and Dimensions

For rod end styles and dimensions see Table 3 in the inside cover of catalog.

Page ii

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▼ TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

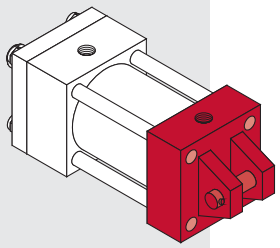
Bore Ø	E	EB	EE NPT	EE SAE	EL	EO	ET	F	G	J	K	NT	R	SB	ST	SU	SW	TB	TN	TS	US
1½	2½	7/16	½	#10	⅞	⅜	¾	⅜	1¾	1½	½	⅜-16	1.63	7/16	½	15/16	⅜	9/16	¾	3¼	4
2	3	9/16	½	#10	15/16	½	⅞	⅝	1¾	1½	⅝	½-13	2.05	9/16	¾	1¼	½	⅝	15/16	4	5
2½	3½	9/16	½	#10	15/16	½	⅞	⅝	1¾	1½	⅝	⅝-11	2.55	13/16	1	1 9/16	1 1/16	⅞	1 5/16	4⅞	6¼
3¼	4½	1 1/16	¾	#12	1⅛	⅝	1⅛	¾	2	1¾	¾	¾-10	3.25	13/16	1	1 9/16	1 1/16	1	1½	5⅞	7¼
4	5	1 1/16	¾	#12	1⅛	⅝	1⅛	⅞	2	1¾	¾	1-8	3.82	1 1/16	1¼	2	⅞	1⅜	2 1/16	6¾	8½
5	6½	15/16	¾	#12	1½	¾	1½	⅞	2	1¾	1	1-8	4.95	1 1/16	1¼	2	⅞	1½	2 15/16	8¼	10
6	7½	1 1/16	1	#16	1 11/16	13/16	1⅝	1	2¼	2¼	1⅛	1¼-7	5.73	1 5/16	1½	2½	1⅛	1¾	3 5/16	9¾	12
7	8½	1 3/16	1¼	#20	1 13/16	15/16	1¾	1	2¾	2¾	1¼	1½-6	6.58	1 9/16	1¾	2⅞	1⅜	1⅞	3¾	11¼	14
8	9½	1 5/16	1½	#24	2	1⅛	2	1	3	3	1½	1½-6	7.50	1 9/16	1¾	2⅞	1⅜	1⅞	4¼	12¼	15
10	12⅝	–	2	#24	–	–	–	1 11/16	3 11/16	3 11/16	1⅝	1½-6	9.62	1 9/16	2¼	3½	1⅝	2¼	5¾	15⅞	19⅛
12	14⅞	–	2½	#32	–	–	–	1 15/16	4 7/16	4 7/16	1⅞	1½-6	11.45	1 9/16	3	4¼	2	2¼	7¼	18⅞	22⅞

For Package and Mounting Dimension see Tables 1H and 2H.

PIN AND TRUNNION MOUNTED CYLINDERS

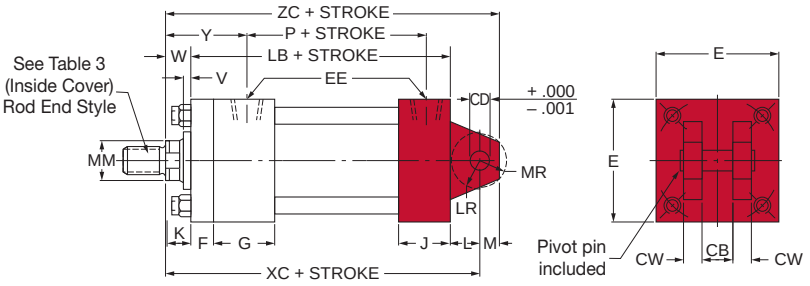
All pin and trunnion cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and the trunnion and pivot pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.

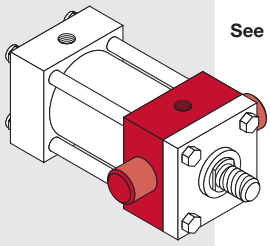
Shown with square retainer.
Retainer is circular on bore sizes of 3¼" and larger.



MODEL H61
NFPA STYLE MP1

CLEVIS MOUNT

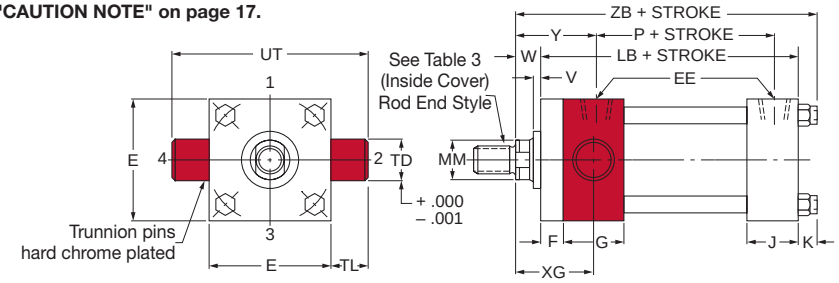


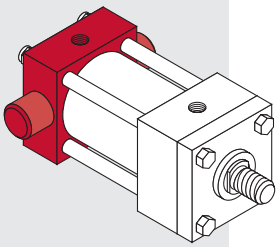


MODEL H71
NFPA STYLE MT1

ROD END TRUNNION MOUNT

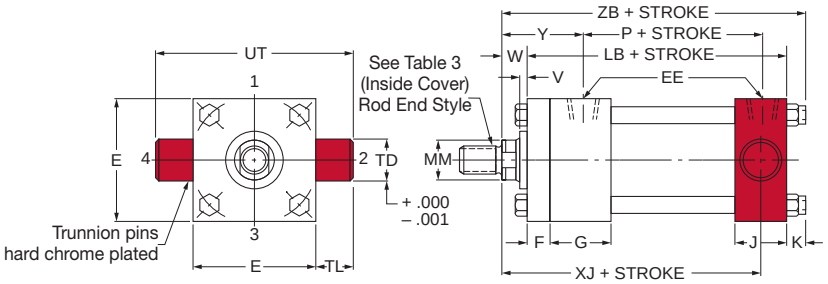
See "CAUTION NOTE" on page 17.

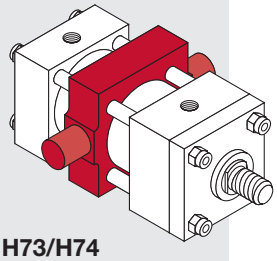




MODEL H72
NFPA STYLE MT2

BLIND END TRUNNION MOUNT

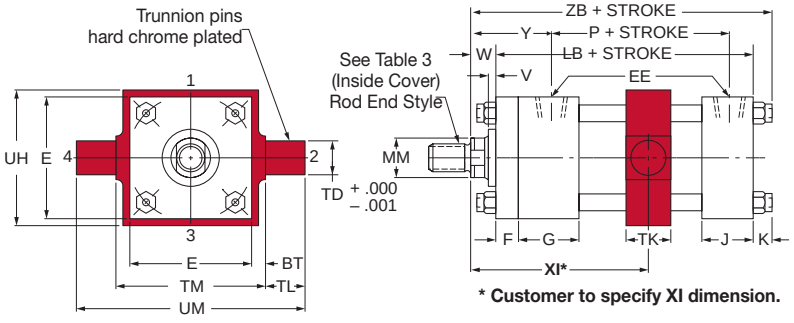




MODEL H73/H74
NFPA STYLE MT4

H73 is an exclusive Milwaukee Cylinder design.
H74 is the Industry "Standard" design.

CENTER TRUNNION MOUNT



*** Customer to specify XI dimension.**

▼ TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	P	LB	V	W	XC	XG	XJ	Y	ZB	ZC
1½	5/8	H00151	2 7/8	5	1/4	5/8	6 3/8	1 7/8	4 7/8	2	6 1/8	6 7/8
	1*	H00152			1/2	1	6 3/4	2 1/4	5 1/4	2 3/8	6 1/2	7 1/4
2	1	H01510	2 7/8	5 1/4	1/4	3/4	7 1/4	2 1/4	5 1/4	2 3/8	6 5/8	8
	1 3/8*	H01511			3/8	1	7 1/2	2 1/2	5 1/2	2 5/8	6 7/8	8 1/4
2½	1	H01520	3	5 3/8	1/4	3/4	7 3/8	2 1/4	5 3/8	2 3/8	6 3/4	8 1/8
	1 3/8	H01521			3/8	1	7 5/8	2 1/2	5 5/8	2 5/8	7	8 3/8
	1 3/4*	H01522			1/2	1 1/4	7 7/8	2 3/4	5 7/8	2 7/8	7 1/4	8 5/8
3¼	1 3/8	H01530	3 19/32	6 1/4	1/4	7/8	8 5/8	2 5/8	6 1/4	2 23/32	7 7/8	9 5/8
	1 3/4	H01531			3/8	1 1/8	8 7/8	2 7/8	6 1/2	2 31/32	8 1/8	9 7/8
	2	H01532			3/8	1 1/4	9	3	6 5/8	3 3/32	8 1/4	10
4	1 3/4	H01540	3 7/8	6 5/8	1/4	1	9 3/4	2 7/8	6 3/4	2 15/16	8 3/8	11 1/8
	2	H01541			1/4	1 1/8	9 7/8	3	6 7/8	3 1/16	8 1/2	11 1/4
	2 1/2	H01542			3/8	1 3/8	10 1/8	3 1/4	7 1/8	3 5/16	8 3/4	11 1/2
5	2	H01550	4 3/8	7 1/8	1/4	1 1/8	10 1/2	3	7 3/8	3 1/16	9 1/4	12 1/8
	2 1/2	H01551			3/8	1 3/8	10 3/4	3 1/4	7 5/8	3 5/16	9 1/2	12 3/8
	3	H01552			3/8	1 3/8	10 3/4	3 1/4	7 5/8	3 5/16	9 1/2	12 3/8
	3 1/2	H01553			3/8	1 3/8	10 3/4	3 1/4	7 5/8	3 5/16	9 1/2	12 3/8
6	2 1/2	H01560	5	8 3/8	1/4	1 1/4	12 1/8	3 3/8	8 3/8	3 7/16	10 3/4	14 1/8
	3	H01561										
	3 1/2	H01562										
	4	H01563										
7	3	H01570	5 1/2	9 1/2	1/4	1 1/4	13 3/4	3 5/8	9 3/8	3 3/4	12	16 1/8
	3 1/2	H01571										
	4	H01572										
	4 1/2	H01573										
	5	H01574										
8	3 1/2	H01580	6 1/4	10 1/2	1/4	1 1/4	15	3 3/4	10 1/4	3 7/8	13 1/4	17 3/4
	4	H01581										
	4 1/2	H01582										
	5	H01583										
	5 1/2	H01584										
10	4 1/2	H15100	8 1/2	13 13/16	1/4	1 1/4	19 1/16	4 3/4	13 1/4	4 3/4	16 11/16	22 9/16
	5	H15101			1/2	1 1/2	19 5/16	5	13 1/2	5	16 15/16	22 13/16
	5 1/2	H15102			1/2	1 1/2	19 5/16	5	13 1/12	5	16 15/16	22 13/16
12	5 1/2	H15120	9 7/8	16 7/16	1/4	1 1/4	22 3/16	5 3/8	15 1/2	5 1/2	19 9/16	26 3/16
	7	H15121										

For bore diameter sizes 14" to 18" see next page.

HOW TO ORDER

For ordering information refer to Page 32.

CAUTION NOTES:

Rod end trunnion mount cylinders in bore sizes 5" through 8" with oversize piston rods, and bore sizes 10" through 18" with all piston rod diameters should not be used over 1500 PSI. If your application requires higher pressure, consult the factory.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DHM00151. (Refer to page 26.) Double rod ends are not available on clevis mount Series H cylinders.

* Removable retainer not available for these bore and rod combinations: H61 and H73/ H74 mounting styles.

Rod End Styles and Dimensions

For rod end styles and dimensions see Table 3 in the inside cover of catalog.

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***MilCad* Cylinder Configurator**

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TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

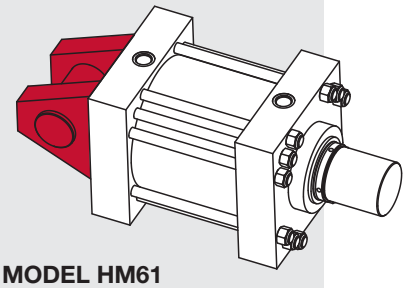
Bore Ø	CB	CD	CW	E	EE NPT	EE SAE	F	G	J	K	L	LR	M	MR	TD	TL	H73 TK	H73 TM	H73 UH	H73 UM	H74 TK	H74 TM	H74 UH	H74 UM	H74 UT
1½	3/4	1/2	1/2	2 1/2	1/2	#10	3/8	1 3/4	1 1/2	1/2	3/4	5/8	1/2	21/32	1	1	1 1/2	4	2 1/2	6	1 1/2	3	3	5	4 1/2
2	1 1/4	3/4	5/8	3	1/2	#10	5/8	1 3/4	1 1/2	5/8	1 1/4	1 1/8	3/4	15/16	1 3/8	1 3/8	2	5	3 3/8	7 3/4	1 3/4	3 1/2	3 1/2	6 1/4	5 3/4
2½	1 1/4	3/4	5/8	3 1/2	1/2	#10	5/8	1 3/4	1 1/2	5/8	1 1/4	1 1/8	3/4	15/16	1 3/8	1 3/8	2	5 1/2	4 1/8	8 1/4	1 3/4	4	4	6 3/4	6 1/4
3¼	1 1/2	1	3/4	4 1/2	3/4	#12	3/4	2	1 3/4	3/4	1 1/2	1 1/4	1	1 3/16	1 3/4	1 3/4	2 1/2	7	5	10 1/2	2 1/4	5	5	8 1/2	8
4	2	1 3/8	1	5	3/4	#12	7/8	2	1 3/4	3/4	2 1/8	1 7/8	1 3/8	1 3/8	1 3/4	1 3/4	2 1/2	7 1/2	6 1/2	11	2 1/4	5 1/2	6 1/2	9	8 1/2
5	2 1/2	1 3/4	1 1/4	6 1/2	3/4	#12	7/8	2	1 3/4	1	2 1/4	2	1 5/8	1 5/8	1 3/4	1 3/4	3	9	7 1/2	12 1/2	3	7	7 1/4	10 1/2	10
6	2 1/2	2	1 1/4	7 1/2	1	#16	1	2 1/4	2 1/4	1 1/8	2 1/2	2 1/16	2	2	2	2	3 1/2	10 1/2	8 3/4	14 1/2	3 1/4	8 1/2	8 3/4	12 1/2	11 1/2
7	3	2 1/2	1 1/2	8 1/2	1 1/4	#20	1	2 3/4	2 3/4	1 1/4	3	2 5/8	2 3/8	2 3/8	2 1/2	2 1/2	4	12	10	17	3 1/2	9 3/4	10	14 3/4	13 1/2
8	3	3	1 1/2	9 1/2	1 1/2	#24	1	3	3	1 1/2	3 1/4	2 7/8	2 3/4	2 3/4	3	3	4 1/2	13	11	19	4	11	11 3/4	17	15 1/2
10	4	3 1/2	2	12 5/8	2	#24	1 11/16	3 11/16	3 11/16	1 5/8	4	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	5	17 1/8	15 1/4	24 1/8	5	14	15 1/4	21	19 5/8
12	4 1/2	4	2 1/4	14 7/8	2 1/2	#32	1 15/16	4 7/16	4 7/16	1 7/8	4 1/2	4	4	4	4	4	5 1/2	20 7/8	19 1/4	28 7/8	5 1/2	16 1/2	19 1/4	24 1/2	22 7/8

For Package and Mounting Dimension see Tables 1H and 2H.

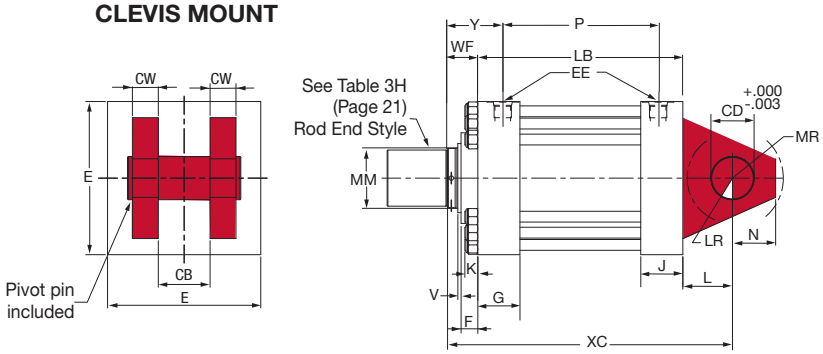
PIN AND TRUNNION MOUNTED CYLINDERS

All pin and trunnion cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and the trunnion and pivot pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.

CLEVIS MOUNT

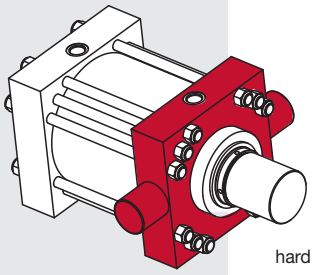


MODEL HM61

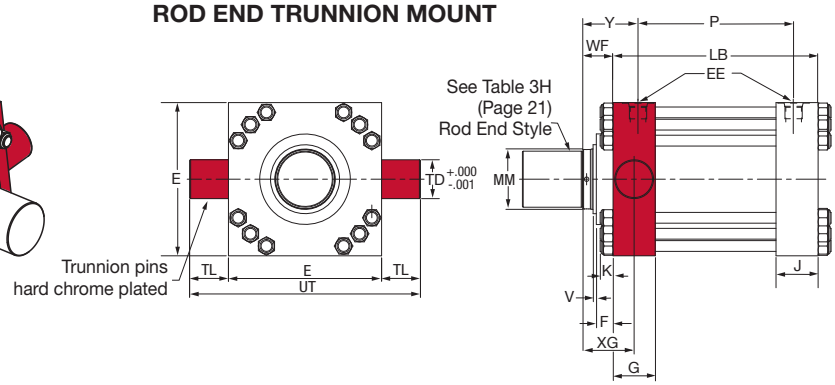


See "CAUTION NOTE" on page 19.

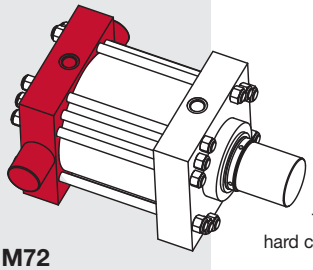
ROD END TRUNNION MOUNT



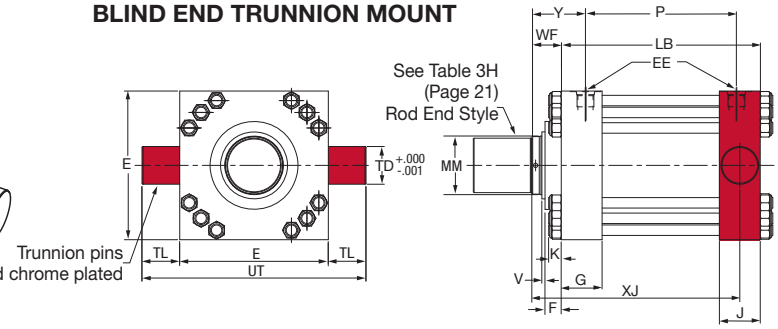
MODEL HM71



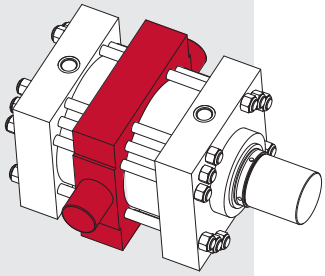
BLIND END TRUNNION MOUNT



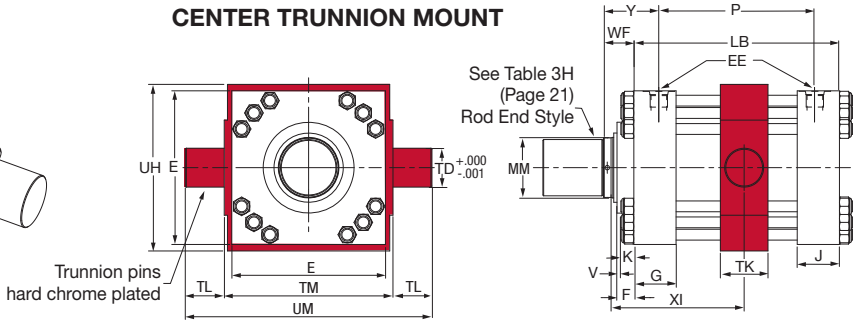
MODEL HM72



CENTER TRUNNION MOUNT



MODEL HM74



▼ TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	WF	Y	XC	XG	XJ
14	7	HM15140	8	15⅝	10⅝	¼	3½	6	24⅞	5 15⁄16	16 1⁄16
	8	HM15141	9			¼	4	6½	25⅜	6 7⁄16	17 3⁄16
	10	HM15142	-			-	6	8½	27⅜	8 7⁄16	19 3⁄16
16	8	HM15160	9	18⅝	11⅞	¼	4	7⅜	29⅝	-	-
	9	HM15161	-			-	5⅝	9	31¼	-	-
	10	HM15162	-			-	6	9⅜	31⅝	-	-
18	9	HM15180	-	22	13¾	-	5⅝	9¾	35¼	-	-
	10	HM15181	-			-	6	10⅛	35⅝	-	-

▼ TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	CB	CD	CW	E	EE SAE	G	J	K	L	LR	M	MR	TD	TL	TK	TM	UH	UM	UT
14	6	5	3	17¾	#24	4⅞	4⅞	1½	5¾	4⅛	5	5 15⁄32	4½	4½	5½	19½	19¼	28½	26⅛
16	7	6	3½	20¼	#24	5⅞	5⅞	1⅝	7	6¼	6	6	-	-	-	-	-	-	-
18	8	6½	4	22¼	#24	6⅞	6⅞	1⅞	7⅝	6¾	6½	6½	-	-	-	-	-	-	-

LARGE BORE CYLINDERS

NOTE: Large bore Series H cylinders (14", 16" and 18") must use Table 3H for accurate piston rod end dimensions.

▼ TABLE 3H - Piston Rod Ends

Bore Ø	Rod MM	Thread KK	A	B +.000 -.005	F	NA	V	WF
14	7	5½-12	7	8	1 15⁄16	6⅞	¼	3½
	8	5¾-12	8	9	1 15⁄16	7⅞	¼	4
	10	7¼-12	10	-	3½	9⅞	-	6
16	8	5¾-12	8	9	1 15⁄16	7⅞	¼	4
	9	6½-12	9	-	3⅜	8⅞	-	5⅝
	10	7¼-12	10	-	3½	9⅞	-	6
18	9	6½-12	9	-	3⅜	8⅞	-	5⅝
	10	7¼-12	10	-	3½	9⅞	-	6

HOW TO ORDER

For ordering information refer to Page 32.

CAUTION NOTES:

Rod end trunnion mount cylinders in bore sizes 5" through 8" with oversize piston rods, and bore sizes 10" through 18" with all piston rod diameters should not be used over 1500 PSI. If your application requires higher pressure, consult the factory.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DHM15140. (Refer to page 26.) Double rod ends are not available on clevis mount Series H cylinders.

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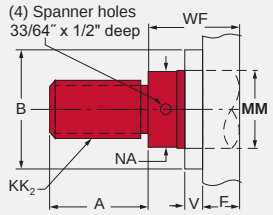
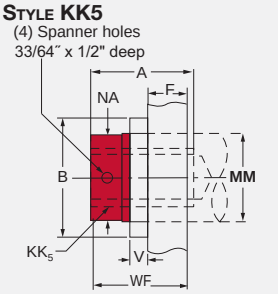
PISTON ROD END STYLES

STYLE KK2



ROD END STYLE CODE NO. 2

STYLE KK5



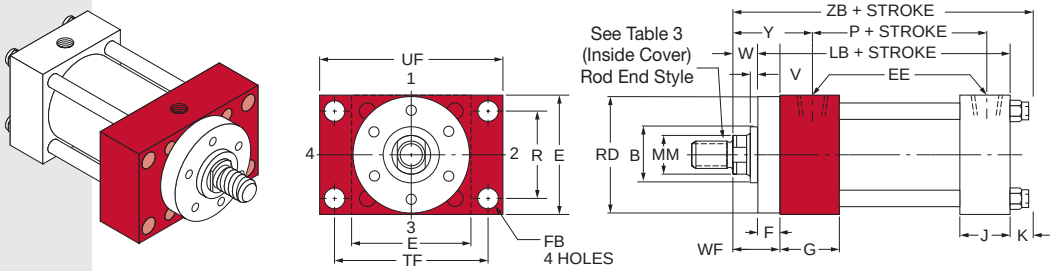
ROD END STYLE CODE NO. 5

For Package and Mounting Dimension see Tables 1H and 2H.

SOLID ROD END CAP MOUNTED CYLINDERS

Milwaukee Cylinder's solid rod end cap mount is one of the strongest, most rigid methods of mounting. This type of mounting is best in a tension application.

Flange rated for 3,000 PSI operation.

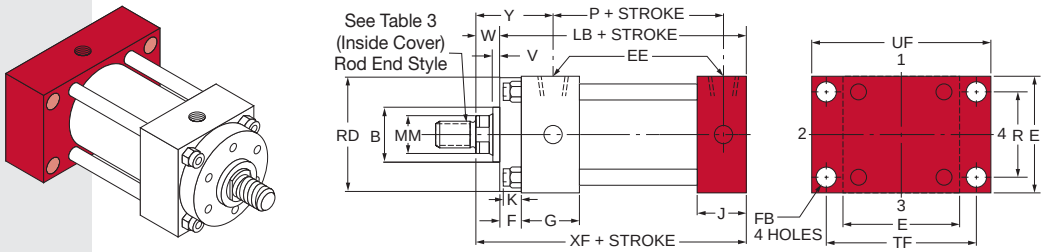


MODEL H35
NFPA STYLE ME5

SOLID BLIND END CAP MOUNTED CYLINDERS

Milwaukee Cylinder's solid blind end cap mount is one of the strongest, most rigid methods of mounting. This type of mounting is best in a thrust load application.

Flange rated for 3,000 PSI operation.



MODEL H36
NFPA STYLE ME6

TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	P	LB	RD	V	W	WF	XF	Y	ZB
1½	5/8	H00151	1 1/8	2 7/8	5	2.38	1/4	5/8	1	5 5/8	2	6 1/8
	1	H00152	1 1/2			2.50	1/2	1	1 3/8	6	2 3/8	6 1/2
2	1	H01510	1 1/2	2 7/8	5 1/4	3.00	1/4	3/4	1 3/8	6	2 3/8	6 5/8
	1 3/8	H01511	2			3.00	3/8	1	1 5/8	6 1/4	2 5/8	6 7/8
2½	1	H01520	1 1/2	3	5 3/8	3.00	1/4	3/4	1 3/8	6 1/8	2 3/8	6 3/4
	1 3/8	H01521	2			3.00	3/8	1	1 5/8	6 3/8	2 5/8	7
	1 3/4	H01522	2 3/8			3.50	1/2	1 1/4	1 7/8	6 5/8	2 7/8	7 1/4
3¼	1 3/8	H01530	2	3 19/32	6 1/4	3.50	1/4	7/8	1 5/8	7 1/8	2 23/32	7 7/8
	1 3/4	H01531	2 3/8			3.50	3/8	1 1/8	1 7/8	7 3/8	2 31/32	8 1/8
	2	H01532	2 5/8			4.00	3/8	1 1/4	2	7 1/2	3 3/32	8 1/4
4	1 3/4	H01540	2 3/8	3 7/8	6 5/8	3.50	1/4	1	1 7/8	7 5/8	2 15/16	8 3/8
	2	H01541	2 5/8			4.00	1/4	1 1/8	2	7 3/4	3 1/16	8 1/2
	2 1/2	H01542	3 1/8			4.50	3/8	1 3/8	2 1/4	8	3 5/16	8 3/4
5	2	H01550	2 5/8	4 3/8	7 1/8	4.00	1/4	1 1/8	2	8 1/4	3 1/16	9 1/4
	2 1/2	H01551	3 1/8			4.50	3/8	1 3/8	2 1/4	8 1/2	3 5/16	9 1/2
	3	H01552	3 3/4			5.12	3/8	1 3/8	2 1/4	8 1/2	3 5/16	9 1/2
	3 1/2	H01553	4 1/4			5.50	3/8	1 3/8	2 1/4	8 1/2	3 5/16	9 1/2
6	2 1/2	H01560	3 1/8	5	8 3/8	4.50	1/4	1 1/4	2 1/4	9 5/8	3 7/16	10 3/4
	3	H01561	3 3/4			5.50						
	3 1/2	H01562	4 1/4			5.88						
	4	H01563	4 3/4			6.38						
7	3	H01570	3 3/4	5 1/2	9 1/2	5.50	1/4	1 1/4	2 1/4	10 3/4	3 3/4	12
	3 1/2	H01571	4 1/4			5.88						
	4	H01572	4 3/4			6.38						
	4 1/2	H01573	5 1/4			6.88						
	5	H01574	5 3/4			7.31						
8	3 1/2	H01580	4 1/4	6 1/4	10 1/2	5.88	1/4	1 1/4	2 1/4	11 3/4	3 7/8	13 1/4
	4	H01581	4 3/4			6.38						
	4 1/2	H01582	5 1/4			6.88						
	5	H01583	5 3/4			7.31						
	5 1/2	H01584	6 1/4			8.43						
10	4 1/2	H15100	5 1/4	8 1/2	13 13/16	6.88	1/4	1 1/4	2 15/16	15 1/16	4 3/4	16 11/16
	5	H15101	5 3/4			7.31	1/2	1 1/2	3 3/16	15 5/16	5	16 15/16
	5 1/2	H15102	6 1/4			8.43	1/2	1 1/2	3 3/16	15 5/16	5	16 15/16
12	5 1/2	H15120	6 1/4	9 7/8	16 7/16	8.43	1/4	1 1/4	3 3/16	17 11/16	5 1/2	19 9/16
	7	H15121	8			10.50						

For bore diameter sizes 14" to 18" see next page.

▼ TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	EE NPT	EE SAE	F	FB	G	J	K	PA	PD	R	TF	UF
1½	2½	½	#10	3/8	7/16	1 3/4	1½	½	3/16	1 7/16	1.63	3 7/16	4¼
2	3	½	#10	5/8	9/16	1 3/4	1½	5/8	5/16	1 13/16	2.05	4⅛	5⅛
2½	3½	½	#10	5/8	9/16	1 3/4	1½	5/8	5/16	2 1/16	2.55	4⅝	5⅝
3¼	4½	¾	#12	¾	11/16	2	1¾	¾	3/8	2⅝	3.25	5⅞	7⅛
4	5	¾	#12	⅞	11/16	2	1¾	¾	7/16	2 15/16	3.82	6⅜	7⅝
5	6½	¾	#12	⅞	15/16	2	1¾	1	7/16	3 11/16	4.95	8 3/16	9¾
6	7½	1	#16	1	1 1/16	2¼	2¼	1⅛	½	4¼	5.73	9 7/16	11¼
7	8½	1¼	#20	1	1 3/16	2¾	2¾	1¼	½	4¾	6.58	10⅝	12⅝
8	9½	1½	#24	1	1 5/16	3	3	1½	½	5¼	7.50	11 13/16	14
10	12⅝	2	#24	1 11/16	1 13/16	3 11/16	3 11/16	1⅝	13/16	7⅛	9.62	15⅞	19
12	14⅞	2½	#32	1 15/16	2 1/16	4 7/16	4 7/16	1⅞	15/16	8⅜	11.45	18½	22

HOW TO ORDER

For ordering information refer to Page 32.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DH00151. (Refer to page 26.)

Rod End Styles and Dimensions

For rod end styles and dimensions see Table 3 in the inside cover of catalog.

Page ii

***MilCad* Cylinder Configurator**

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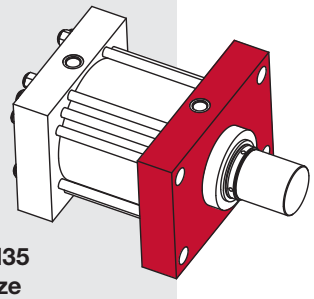
For Package and Mounting Dimension see Tables 1H and 2H.

SOLID END CAP MOUNTED CYLINDERS

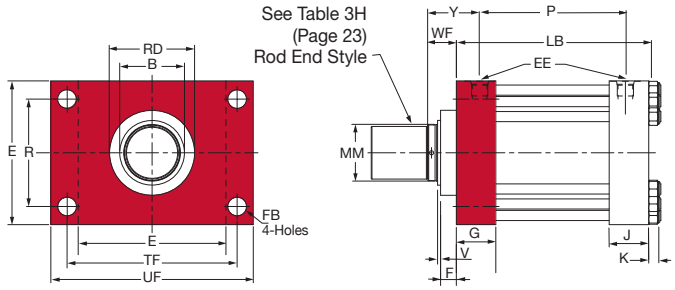
Milwaukee Cylinder's solid end cap mount is one of the strongest, most rigid methods of mounting. This type of rod end cap mounting is best in a tension application. A solid blind end cap mounting is best in a thrust application.

SOLID ROD END CAP MOUNT (14" Bore)

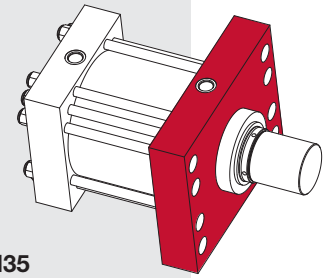
Flange rated for 3,000 PSI operation.



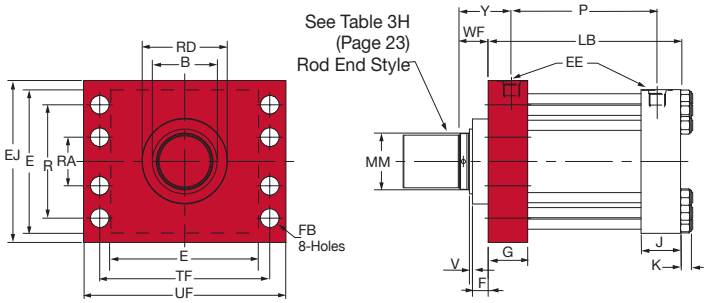
MODEL HM35
14" Bore Size



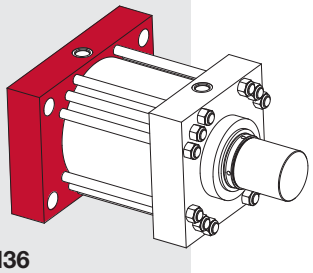
SOLID ROD END CAP MOUNT (16" and 18" Bore)



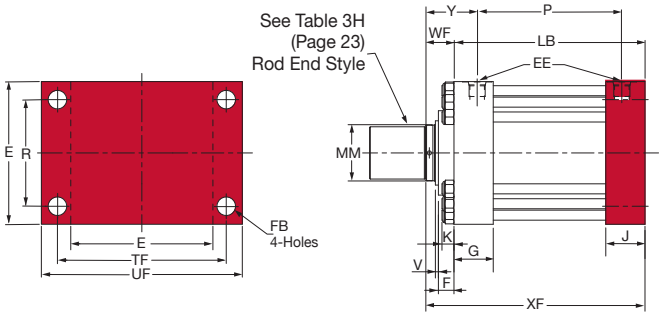
MODEL HM35
16"and 18" Bore Sizes



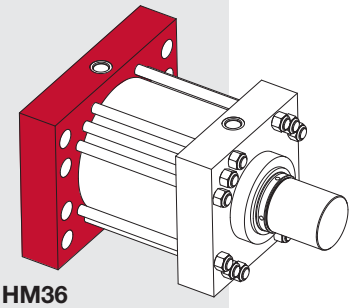
SOLID BLIND END CAP MOUNT (14" BORE)



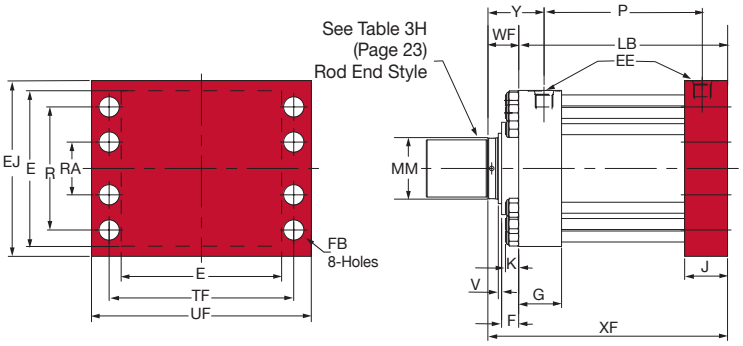
MODEL HM36
14" Bore Size



SOLID BLIND END CAP MOUNT (16" AND 18" BORE)



MODEL HM36
16"and 18" Bore Sizes



▼ TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke. (H21, H22)

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	WF	Y	RD	XF
14	7	HM15140	8	15⅝	10⅝	¼	3½	6	10½	19⅛
	8	HM15141	9			¼	4	6½	11½	19⅝
	10	HM15142	-			-	6	8½	14½	21⅝
16	8	HM15160	9	18⅝	11⅞	¼	4	7⅜	11½	22⅝
	9	HM15161	-			-	5⅝	9	13⅞	24¼
	10	HM15162	-			-	6	9⅜	14½	24⅝
18	9	HM15180	-	22	13¾	-	5⅝	9¾	13⅞	27⅝
	10	HM15181	-			-	6	10⅛	14½	28

TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	EE SAE	EJ	FB	G	J	K	R	RA	TF	UF
14	17¾	#24	-	2 5/16	4⅞	4⅞	1½	13.26	-	21.00	25
16	20¼	#24	20	1 13/16	5⅞	5⅞	1⅝	15.50	8	21.00	24½
18	22¼	#24	23	2 1/16	6⅞	6⅞	1⅞	18.00	7¼	24.25	28¼

LARGE BORE CYLINDERS

NOTE: Large bore Series H cylinders (14", 16" and 18") must use Table 3H for accurate piston rod end dimensions.

▼ TABLE 3H - Piston Rod Ends

Bore Ø	Rod MM	Thread KK	A	B +.000 -.005	F	NA	V	WF
14	7	5½-12	7	8	1 15/16	6⅞	¼	3½
	8	5¾-12	8	9	1 15/16	7⅞	¼	4
	10	7¼-12	10	-	3½	9⅞	-	6
16	8	5¾-12	8	9	1 15/16	7⅞	¼	4
	9	6½-12	9	-	3⅜	8⅞	-	5⅝
	10	7¼-12	10	-	3½	9⅞	-	6
18	9	6½-12	9	-	3⅜	8⅞	-	5⅝
	10	7¼-12	10	-	3½	9⅞	-	6

HOW TO ORDER

For ordering information refer to Page 32.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DHM15140. (Refer to page 26.)

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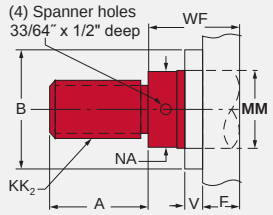
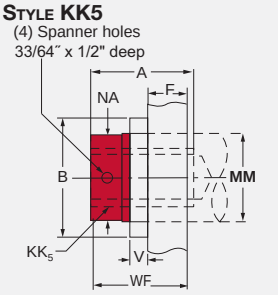
PISTON ROD END STYLES

STYLE KK2



ROD END STYLE CODE NO. 2

STYLE KK5



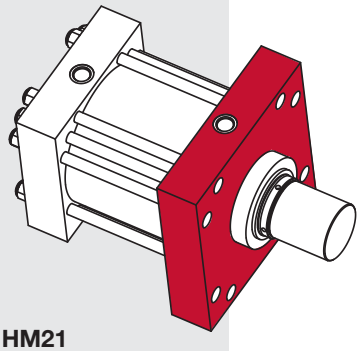
ROD END STYLE CODE NO. 5

For Package and Mounting Dimension see Tables 1H and 2H.

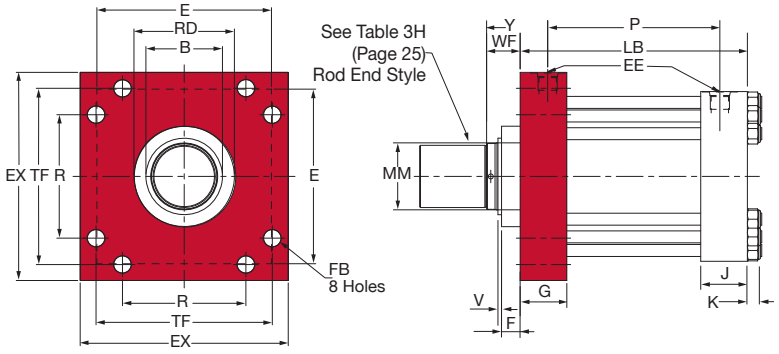
SOLID END CAP MOUNTED CYLINDERS

Milwaukee Cylinder's solid end cap mount is one of the strongest, most rigid methods of mounting. This type of rod end cap mounting is best in a tension application. A solid blind end cap mounting is best in a thrust application.

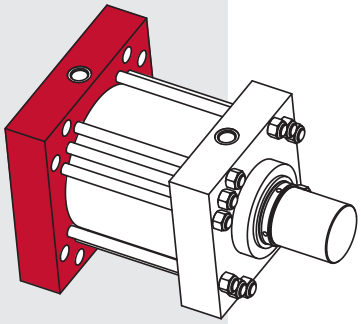
SOLID ROD END CAP SQUARE MOUNTING



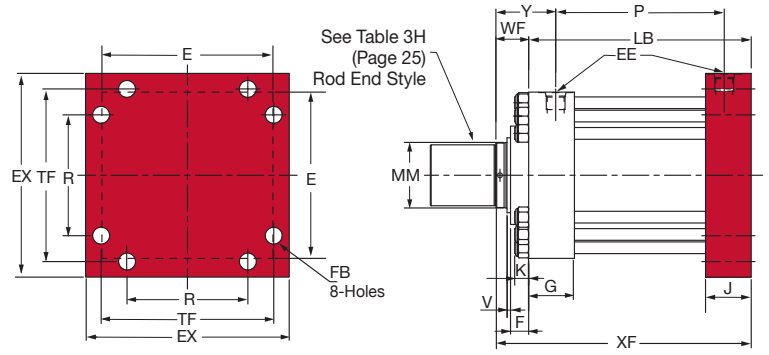
MODEL HM21



SOLID BLIND END CAP SQUARE MOUNTING



MODEL HM22



▼ TABLE 1H

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	WF	Y	RD	XF
14	7	HM15140	8	15⅝	10⅝	¼	3½	6	10½	19⅛
	8	HM15141	9			¼	4	6½	11½	19⅝
	10	HM15142	-			-	6	8½	14½	21⅝
16	8	HM15160	-	18⅝	11⅞	-	4	7⅜	11½	22⅝
	9	HM15161	-			-	5⅝	9	13⅞	24¼
	10	HM15162	-			-	6	9⅜	14½	24⅝
18	9	HM15180	-	22	13¾	-	5⅝	9¾	13⅞	27⅝
	10	HM15181	-			-	6	10⅛	14½	28

▼ TABLE 2H

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	EE SAE	EX	FB	G	J	K	R	TF
14	17¾	#24	21¾	1 13/16	4⅞	4⅞	1½	12.90	18.43
16	20¼	#24	24½	1 13/16	5⅞	5⅞	1⅝	15.28	21.03
18	22¼	#24	26½	2 1/16	6⅞	6⅞	1⅞	16.45	22.65

LARGE BORE CYLINDERS

NOTE: Large bore Series H cylinders (14", 16" and 18") must use Table 3H for accurate piston rod end dimensions.

▼ TABLE 3H - Piston Rod Ends

Bore Ø	Rod MM	Thread KK	A	B +.000 -.005	F	NA	V	WF
14	7	5½-12	7	8	1 15/16	6⅞	¼	3½
	8	5¾-12	8	9	1 15/16	7⅞	¼	4
	10	7¼-12	10	-	3½	9⅞	-	6
16	8	5¾-12	8	9	1 15/16	7⅞	¼	4
	9	6½-12	9	-	3⅜	8⅞	-	5⅝
	10	7¼-12	10	-	3½	9⅞	-	6
18	9	6½-12	9	-	3⅜	8⅞	-	5⅝
	10	7¼-12	10	-	3½	9⅞	-	6

HOW TO ORDER

For ordering information refer to Page 32.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DHM15140. (Refer to page 26.)

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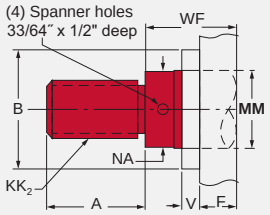
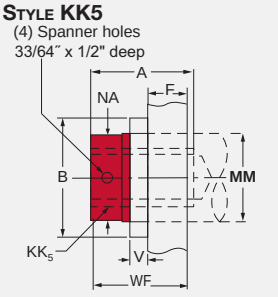
PISTON ROD END STYLES

STYLE KK2

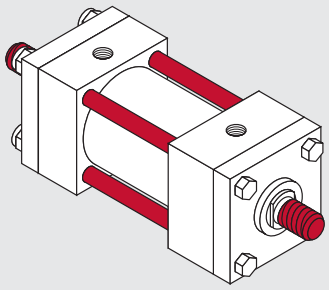


ROD END STYLE CODE NO. 2

STYLE KK5



ROD END STYLE CODE NO. 5



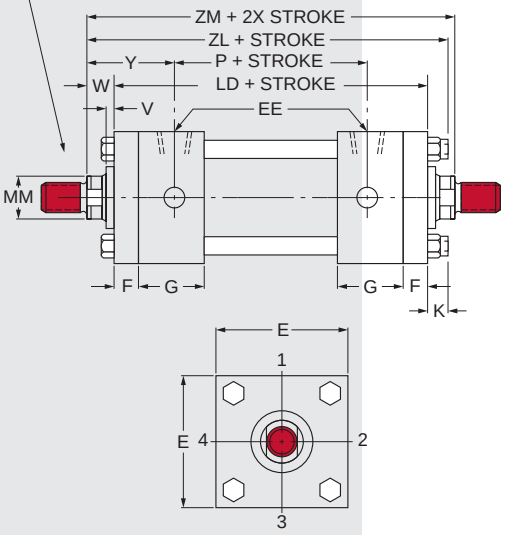
DOUBLE ROD END CYLINDERS

Milwaukee Cylinder's Double Rod End Cylinders are available with all the standard types of Series H mountings, except the clevis mount (H61).

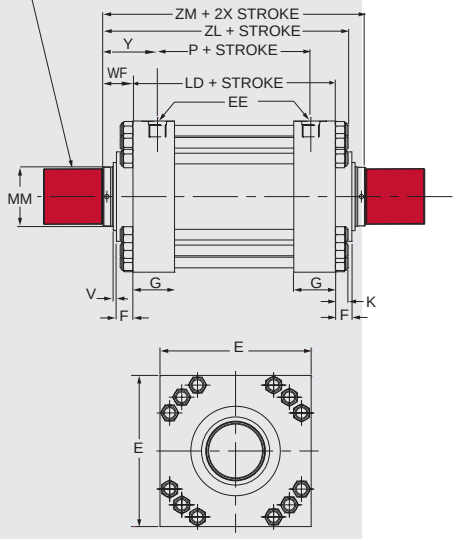
To obtain dimensional information on a double rod end cylinder, first select the desired mounting style and refer to the corresponding single rod end cylinder model shown on the preceding pages. After you have determined all necessary dimensions from the previous page covering the desired mounting, turn back to this page. Supplement those dimensions with additional ones from the drawings below and the table at the right. These added dimensions differ from, or are in addition to, those shown on the preceding pages and provide the additional information needed to completely dimension a double rod end cylinder model.

On a double rod end cylinder where two different rod ends are required, or two different rod sizes are required, or cushions on one end are required, be sure to state clearly which rod is to go at which end of the cylinder. When two types of mounting styles are required, be sure to specify their relationship to the piston rods, if they are not the same.

BORE SIZES 1" to 12".
See Table 3 (Inside cover)
Rod End Styles.



BORE SIZES 14" to 18". See
Table 3H (on previous page)
Rod End Styles.



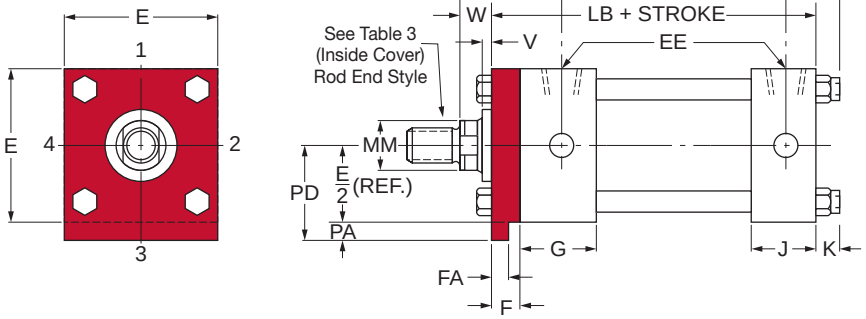
▼ DOUBLE ROD END CYLINDERS

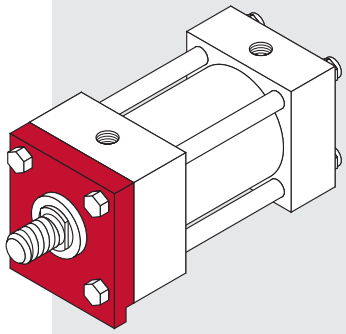
Bore Ø	Rod MM	Cylinder Code	LD*	SE*	SS*	ZL	ZM
1½	⅝	DH00151	5⅝	7⅜	4⅛	6¾	6⅞
	1*	DH00152		7⅜	4⅛	7⅛	7⅝
2	1	DH01510	6⅛	8	3⅞	7½	7⅝
	1⅜*	DH01511		8	3⅞	7¾	8⅛
2½	1	DH01520	6¼	8⅛	3⅝	7⅝	7¾
	1⅜	DH01521		8⅛	3⅝	7⅞	8¼
	1¾*	DH01522		8⅛	3⅜	8⅛	8¾
3¼	1⅜	DH01530	7¼	9½	4⅜	8⅞	9
	1¾	DH01531		9½	4⅜	9⅛	9½
	2	DH01532		9½	4⅜	9¼	9¾
4	1¾	DH01540	7¾	10	4¼	9½	9¾
	2	DH01541		10	4¼	9⅝	10
	2½	DH01542		10	4¼	9⅞	10½
5	2	DH01550	8¼	11¼	4¾	10⅜	10½
	2½	DH01551		11¼	4¾	10⅝	11[8]
	3	DH01552		11¼	4¾	10⅝	11
	3½	DH01553		11¼	4¾	10⅝	11
6	2½	DH01560	9⅜	11¾	5⅛	11¾	11⅞
	3	DH01561		11¾	5⅛		
	3½	DH01562		11¾	5⅛		
	4	DH01563		11¾	5⅛		
7	3	DH01570	10½	13⅛	5¾	13	13
	3½	DH01571		13⅛	5¾		
	4	DH01572		13⅛	5¾		
	4½	DH01573		13⅛	5¾		
	5	DH01574		13⅛	5¾		
8	3½	DH01580	11½	14½	6¾	14¼	14
	4	DH01581		14½	6¾		
	4½	DH01582		14½	6¾		
	5	DH01583		14½	6¾		
	5½	DH01584		14½	6¾		
10	4½	DH15100	15½	—	8⅞	18⅜	18
	5	DH15101		—	8⅞	18⅜	18½
	5½	DH15102		—	8⅞	18⅜	18½
12	5½	DH15120	18⅜	—	10½	21¼	20⅞
	7	DH15121		—	10½		
14	7	DHM15140	15⅝	—		20⅝	22⅝
	8	DHM15141		—	—	21⅛	23⅝
	10	DHM15142		—	—	23⅛	27⅝
16	8	DHM15160	18⅝	—	—	24¼	26⅝
	9	DHM15161		—	—	25⅞	29⅞
	10	DHM15162		—	—	26¼	30⅝
18	9	DHM15180	22	—	—	29½	33¼
	10	DHM15181		—	—	29⅞	34

*Note: These dimensions are to be substituted for the related mounting dimensions given on the preceding pages. All dimensions given on this table are plus stroke.

KEY MOUNT CYLINDERS

The *Milwaukee Cylinder* Key Mount retainer plate is a mounting option designed to add rugged stability to foot and side mount cylinders. The retainer plate is extended below the mounting surface of the cylinder. This extension may be fitted into a milled keyway in your mounting pad, eliminating the need for welded keys or locator pins.





KEY MOUNT CYLINDERS

Bore Ø	E	F	FA	G	PA	PD
1½	2½	⅜	.312/.310	1¾	3/16	1 7/16
2	3	⅝	.562/.560	1¾	5/16	1 13/16
2½	3½	⅝	.562/.560	1¾	5/16	2 1/16
3¼	4½	¾	.687/.684	2	⅜	2⅝
4	5	⅞	.812/.809	2	7/16	2 15/16
5	6½	⅞	.812/.809	2	7/16	3 11/16
6	7½	1	.937/.934	2¼	½	4¼
7	8½	1	.937/.934	2¾	½	4¾
8	9½	1	.937/.934	3	½	5¼
10	12⅝	1 11/16	1.625/1.620	3 11/16	13/16	7⅛
12	14⅞	1 15/16	1.875/1.870	4 7/16	13/16	8⅜

Key Mount is not available on larger bore cylinders.

HOW TO ORDER

For ordering information refer to Page 32.

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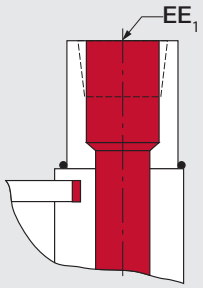
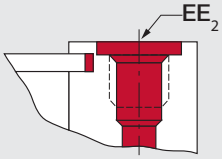
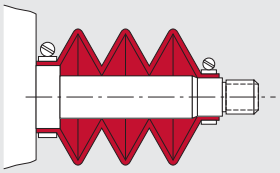
Port Locations



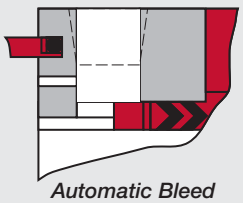
Oversize Port Welded Boss



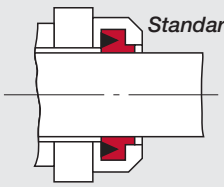
SAE Straight Thread O-ring Port



Rod Boots



Automatic Bleed



Metallic Rod Wipers

DESIGN OPTIONS

Standard Ports

The *Milwaukee Cylinder* Series H cylinders are manufactured as standard, with the largest possible NPTF tapered thread ports that will fit in both the rod and blind ends of a given bore size. Upon request, extra ports can be provided on the sides of the end caps not occupied by mountings or cushion adjusters.

Oversize Ports

On most bore sizes, welded bosses may be provided for oversize NPTF ports. These bosses protrude from the sides of the end caps. For information as to the boss height in relation to your bore and port requirements, contact the factory. Also, special heavier end caps can be provided to accommodate oversize ports without the use of a welded boss.

Straight Thread Ports

On request, an SAE straight thread O-Ring port can be used on the Series H cylinders. In addition to the standard oversize NPTF ports, welded bosses may also be used for oversize SAE straight thread O-Ring ports. For further information contact the factory.

Note: Flange and manifold style ports are available.

Bleeder Ports

Bleeder ports are not regularly furnished with Series H cylinders. Automatic air bleeds are standard on non-cushion cylinders. Bleeder ports are available upon request. They will be placed on either end cap or on the tube.

▼ PORT SIZES

Bore Ø	Standard NPTF Port EE	Oversized NPTF Port EE_1	SAE Straight O-Ring Port	
			EE_2	SAE Standard Thread Series
1½	½	¾	#10	⅞-14
2	½	¾	#10	⅞-14
2½	½	¾	#10	⅞-14
3¼	¾	1	#12	1 1/16-12
4	¾	1	#12	1 1/16-12
5	¾	1	#12	1 1/16-12
6	1	1¼	#16	1 5/16-12
7	1¼	1½	#20	1⅝-12
8	1½	2	#24	1⅞-12
10	2	2½	#24	1⅞-12
12	2½	3	#32	2½-12

▼ 4-Bolt Flange Ports
Heavy-duty Hydraulic Cylinders

Bore Ø	Rod Ø	Nominal Flange Size (in)
3¼	1.38	.75
	1.75	.75
	2.00	.75
4	1.75	.75
	2.00	.75
	2.50	.75
5	2.00	.75
	2.50	.75
	3.00	.75
	3.50	.75
6	2.50	1.00
	3.00	1.00
	3.50	1.00
	4.00	1.00
7	3.00	1.25
	35.00	1.25
	4.00	1.25
	4.50	1.25
	5.00	1.25
8	3.50	1.50
	4.00	1.50
	4.50	1.50
	5.00	1.50
	5.50	1.50

NOTE: Some flange overhang will occur on heads or caps in most cylinder designs. Overhang may interfere with some end mountings.

Rod Boots

When cylinders are used in areas of high contamination or where contaminants have an air hardening property, the exposed piston rod should be covered with a rod boot to protect the rod bearing and seals. A rod boot is simply a collapsible cover. It is of sewn construction made from a neoprene coated fabric. The rod boots are impervious to oil, grease and water.
They will operate effectively from 0° F to +200° F without cracking. For additional details on Rod Boots, please see page 186.

Metallic Rod Wipers

If requested metallic rod wipers will be supplied in place of the standard synthetic rubber wiper. This type of seal is recommended for applications where contaminants would tend to cling to the rod and damage a standard synthetic rubber rod wiper.

DESIGN OPTIONS FOR SPECIAL CYLINDERS

Special Rod Ends

Modifications of standard or entirely special rod ends are available from *Milwaukee Cylinder*. When your requirements call for a special rod end style, your order should include a sketch if it is to be an entirely special rod end or note reference as to which letter dimensions you wish to have modified (see inside cover).

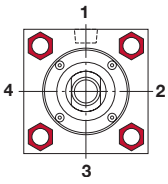
Special Assemblies from Standard Parts

Each style of the various standard cylinder mountings is illustrated, using the commonly recognized cylinder dimensional symbols of the National Fluid Power Association. Each side of the end views are numbered to aid in communication when referring to the relationship between the ports and the mountings. When requesting information or placing an order that requires a dimension other than standard, always make reference to the given dimensional symbol in the catalog and then give your requirements.

Cushion Adjustment Locations

A ball check and a cushion adjustment needle are supplied as standard in position #2 on most models. The cushion needle and ball check are interchangeable as far as location and may be put in any side not occupied by a port or mounting.

Port Locations



Ports are located in position #1 as standard unless otherwise specified. By using the position numbers given with the end views in the dimensional data section of this catalog, ports can be arranged in any one of four 90° positions in relation to the cylinder mounting. When ports are relocated on a cushioned cylinder, the cushion needle and ball check are automatically relocated to hold their relationship to the port as on a standard cylinder, unless otherwise specified at the time of the order.

Removable Trunnion Pins

Removable trunnion pins are available on models H71 and H72 at a nominal extra charge. They can be used on all bore and rod combinations, except on the largest oversize rods offered with each bore size on all model H71 cylinders.

Single-Acting Cylinders

Series H cylinders are designed for either single or double action. When used as a single acting cylinder, hydraulic power drives the piston in one direction, only relying on either the load or an external force to return the piston after the pressure is exhausted.

Single-Acting Spring Cylinders

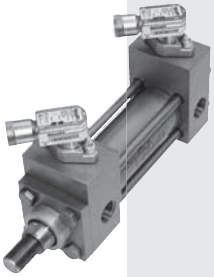
Single-acting spring return cylinders normally have a spring inside of the cylinder to return the piston to its original position. The application load and friction conditions must be specified when placing an order to properly size the spring. Also specify whether the spring is to return or advance the piston. A spring return cylinder is designed with a stop tube to act as spring guide, which prevents binding of the cylinder due to misalignment of the spring. To accurately determine the cylinder length and mounting dimensions for your application, contact your local *Milwaukee Cylinder* representative or the factory.

Water Service Cylinders

Series H cylinders can be used with water as an operating fluid with some standard modifications to the types of material and the manufacturing processes used. These modifications will include, at some additional cost, bronze piston, nickel plated end caps, a hard chrome plated cylinder barrel and a chrome plated piston or stainless steel piston rod at extra cost. Due to the increased factors of corrosion, electrolysis and mineral deposits acting within a water fitted cylinder, *Milwaukee Cylinder* cannot warrant or make any guarantees other than a water service cylinder will be free of defects in workmanship or materials.

Proximity Switches

End of Stroke Limit Switches:

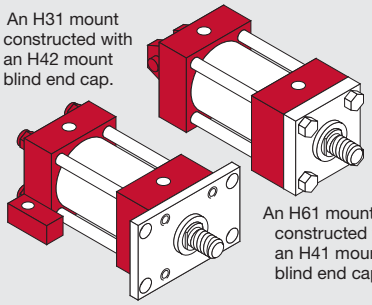


We provide inductive proximity switches for end of stroke sensing. These non-contact switches detect the presence of the spud/ cushion bushing. See page 185 for more information.

Combined Mountings

Standard mountings may be combined when specified by the customer. Some examples of this are:

▼ An H31 mount constructed with an H42 mount blind end cap.



An H61 mount constructed with an H41 mount blind end cap.

These and other combinations can be readily made from standard parts. If you are unsure of a possible combination or if it will suit your particular needs, consult with your local *Milwaukee Cylinder* representative or contact the factory.

Adjustable Stroke Cylinders

When a cylinder application requires stroke adjustment, *Milwaukee Cylinder* offers a number of designs, the most common of which is illustrated below. This particular design is externally adjustable, incorporating a threaded rod (of piston rod quality) with the standard hydraulic rod end multiple lip vee seal and bushing design. This provides a proven-effective high and low pressure seal, affording maximum sealing on the stroke adjustment rod.

Further information concerning design limitations, cushioning or alternate designs can be obtained by contacting the factory.

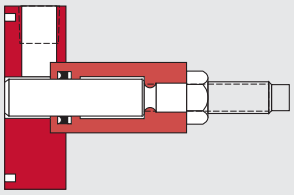
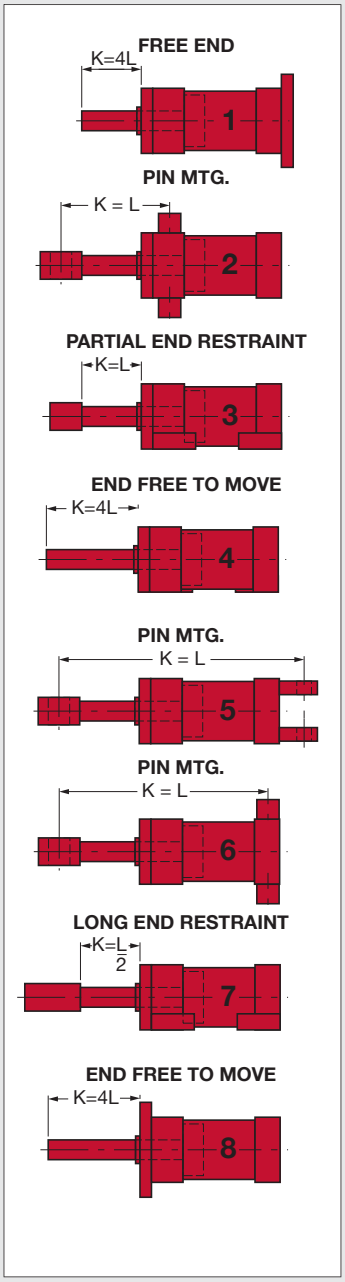


FIGURE 1



Stop Tubes

For more information on Stop Tubes, see page 181 in the Design Engineer's Guide.

STOP TUBES

Stop tubes are used to maintain bearing pressure within acceptable limits and are recommended on cylinders with long strokes or poorly guided rods.

The stop tube is a spacer between the rod end cap and the piston, which provides separation between the piston and the rod bearing. This separation reduces the moment forces developed between the rod bearing and piston when the rod is extended.

To determine if stop tube is necessary for your cylinder requirements, you have to solve for "K" (refer to Figure 1). If your required cylinder has a "K" dimension in excess of 40 inches, stop tube is required. For each 10 inch increment or fraction thereof in excess of 40 inches, one inch of stop tube is recommended. When stop tube is required, the overall length of the cylinder will be increased by the length of the stop tube to be used.

To determine "K" (see to Figure 1)
*Note: W = the rod stick out
(refer to pages 8-27)

Cylinder #1, #4, #8 – see Figure 1

K = 4L= 4 (stroke + W*)

Cylinder #2 - see Figure 1

K = L = (CA or CE) + XG + Stroke

Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XG = mounting dimension page 18

Cylinder #3 – see Figure 1

K = L = W* + Stroke

Cylinder #5 – see Figure 1

K = L = (CA or CE) + XC + (2 x Stroke)

Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XC = mounting dimension page 18

Cylinder #6 – see Figure 1

K = L = (CA or CE) + XJ + (2 x Stroke)

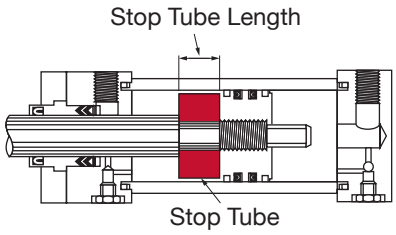
Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XJ = mounting dimension page 18

Cylinder #7 – see Figure 1

K = L/2 =(W* + Stroke)/2

When mounting long stroke cylinders, care should be taken to assure cylinder alignment over the entire length of stroke. The use of external guides or swivel bushings is recommended to reduce side load conditions and prolong the cylinder's service life.

Note: Stop tube length must be added to "K" factor before making final selection of rod size. This is primarily true in No. 5 long stroke applications.



The stop tube is located between the piston and the rod end cap. It limits the extended stroke of the cylinder, providing additional strength for less cost and reduced weight than the use of an oversize rod.

▼ TABLE 1 - VALUE OF "K" IN INCHES

Thrust Force (in-lbs)	Piston Rod Diameter (in)															
	⅝	1	1⅜	1¾	2	2½	3	3½	4	4½	5	5½	7	8	9	10
400	35	84	134	–	–	–	–	–	–	–	–	–	–	–	–	–
700	30	68	119	–	–	–	–	–	–	–	–	–	–	–	–	–
1,000	26	60	105	156	190	–	–	–	–	–	–	–	–	–	–	–
1,400	24	54	93	144	175	244	308	–	–	–	–	–	–	–	–	–
1,800	23	48	84	127	160	230	294	366	–	–	–	–	–	–	–	–
2,400	18	45	75	114	145	214	281	347	–	–	–	–	–	–	–	–
3,200	16	40	68	103	131	196	262	329	398	–	–	–	–	–	–	–
4,000	12	38	63	93	119	174	240	310	373	446	–	–	–	–	–	–
5,000	9	36	60	87	112	163	225	289	359	426	–	–	–	–	–	–
6,000	–	30	56	82	102	152	209	274	342	411	476	–	–	–	–	–
8,000	–	25	51	76	93	136	186	244	310	375	448	–	–	–	–	–
10,000	–	21	45	70	89	125	172	221	279	349	412	–	–	–	–	–
12,000	–	17	41	64	85	117	155	210	270	326	388	455	–	–	–	–
16,000	–	–	35	57	75	110	141	188	233	291	350	421	–	–	–	–
20,000	–	–	28	52	66	103	136	173	218	270	325	385	–	–	–	–
30,000	–	–	–	39	56	87	120	156	190	232	285	330	–	–	–	–
40,000	–	–	–	24	43	75	108	142	177	210	248	293	–	–	–	–
50,000	–	–	–	–	30	66	97	131	165	201	234	268	408	–	–	–
60,000	–	–	–	–	–	57	88	119	154	190	226	256	384	–	–	–
80,000	–	–	–	–	–	36	71	104	136	170	204	240	336	–	–	–
100,000	–	–	–	–	–	–	56	91	120	154	199	224	324	400	–	–
120,000	–	–	–	–	–	–	45	76	108	146	174	207	313	377	–	–
140,000	–	–	–	–	–	–	–	64	98	129	162	194	301	365	–	–
160,000	–	–	–	–	–	–	–	47	87	118	149	182	279	350	421	–
200,000	–	–	–	–	–	–	–	–	65	98	131	160	260	330	402	–
250,000	–	–	–	–	–	–	–	–	–	72	109	143	236	301	375	–
300,000	–	–	–	–	–	–	–	–	–	–	85	120	212	281	351	420
350,000	–	–	–	–	–	–	–	–	–	–	53	100	195	261	328	396
400,000	–	–	–	–	–	–	–	–	–	–	–	72	182	241	309	374
500,000	–	–	–	–	–	–	–	–	–	–	–	–	152	212	274	341
600,000	–	–	–	–	–	–	–	–	–	–	–	–	114	183	247	310
700,000	–	–	–	–	–	–	–	–	–	–	–	–	70	162	221	280

▼ TABLE 2 - DEDUCTIONS FOR PULL STROKE FORCE & DISPLACEMENT

Piston Rod Ø	Piston Rod Area	Cylinder Force in Pounds for Various Pressures							Displacement /in of Stroke
		500 psi	750 psi	1000 psi	1250 psi	1500 psi	2000 psi	3000 psi	Gallons Oil Displaced
⅝	.307	154	230	307	384	461	614	921	.00133
1	.785	393	589	785	981	1178	1570	2355	.00340
1⅜	1.485	743	1114	1485	1856	2228	2970	4455	.00643
1¾	2.405	1203	1804	2405	3006	3608	4810	7215	.01041
2	3.142	1571	2357	3142	3928	4713	6284	9426	.01360
2½	4.909	2455	3682	4909	6137	7364	9818	14730	.02125
3	7.069	3535	5302	7069	8836	10600	14140	21210	.03060
3½	9.621	4811	7216	9621	12026	14430	19240	28860	.04165
4	12.57	6285	9428	12570	15708	18860	25140	37710	.05442
4½	15.90	7950	11920	15900	19880	23850	31800	47700	.06883
5	19.64	9818	14726	19635	24544	29452	39270	58905	.08500
5½	23.76	11880	17820	23760	29698	35640	47520	71280	.10286
7	38.48	19240	28860	38480	–	57720	76920	115400	.1668
8	50.27	25135	37700	50270	–	75400	100500	150810	.2177
9	63.62	31810	47720	63620	–	95430	127200	190860	.2753
10	78.54	39270	58900	78540	–	117810	157100	235620	.3396

▼ TABLE 3 - THRUST FORCE AND DISPLACEMENT

Cylinder Bore Ø	Piston Area	Cylinder Force in Pounds for Various Pressures							Displacement /in of Stroke
		500 psi	750 psi	1000 psi	1250 psi	1500 psi	2000 psi	3000 psi	Gallons Oil Displaced
1½	1.767	884	1325	1767	2209	2651	3534	5301	.00765
2	3.142	1571	2357	3142	3928	4713	6284	9426	.01360
2½	4.909	2455	3682	4909	6137	7364	9818	14730	.02125
3¼	8.296	4148	6222	8296	10370	12440	16590	24890	.03591
4	12.57	6285	9428	12570	15708	18860	25140	37710	.05442
5	19.64	9820	14730	19640	24544	29460	39280	58920	.08502
6	28.27	14140	21200	28270	35342	42400	56540	84810	.12230
7	38.49	19240	28870	38490	48106	57740	76980	115500	.16660
8	50.27	25140	37700	50270	62832	75400	100500	150800	.21760
10	78.54	39270	58900	78540	98175	117800	157100	235600	.34000
12	113.1	56550	84820	113100	141375	169600	226200	339300	.48960
14	153.9	76950	115400	153900	–	230800	307800	461700	.66620
16	201.1	100600	150800	201100	–	301600	402200	603300	.8706
18	254.5	127200	190900	254500	–	381800	509000	763500	1.102
20	314.2	157100	235600	314200	–	471300	628400	942600	1.306

CYLINDER SIZING

The selection of the correct rod size is one of the most important factors in sizing a cylinder. The standard rod for each bore size that *Milwaukee Cylinder* manufactures is sufficient to handle the maximum tension force that the cylinder is capable of producing. It is primarily in compression and long stroke, high thrust applications that the column strength needs to be considered.

The following steps should be used to determine the proper rod size for an application:

1. Select the cylinder bore size required from Table 3 based on the required cylinder thrust force and the operating line pressure at the cylinder.
2. Determine the length between mounting points or "L" as shown on Figure 1, page 30.
3. Based on the distance between mounting points ("L"), determine the value of "K" as shown on Figure 1, page 30.
4. Using the thrust force and the developed "K" dimension, refer to Table 1 to select the proper rod size.
5. If an oversized rod is required, re-check the overall length dimension ("K") in Step 1 and confirm your previous rod size selection.

To determine the cylinder pull (tension), stroke force, or displacement, deduct the force or displacement corresponding to the rod size in Table 2 from the force or displacement corresponding to the bore size shown in Table 3.

Feature	Description	Page Number	Code Number	Example
Double Rod End		26	D	H01541 – 31 – 1 4 – 7 × 14¾
Cylinder Code	Refer to Table 1H	9, 11, 13, 15, 17 19, 21, 23, 25	—	
Mounting Style	Model Number Only	8, 10, 12, 14, 16 18, 20, 22, 24	—	
Rod End Style	Code Number	inside front cover	—	
Cushions	None Rod End Blind End Both Ends	— — — —	1 2 3 4	
Cyllinder Modifications	Special		S	If Standard Leave Blank
Seals	BUNA-N (-20° to 200° F) Viton (-15° to 350° F) Special		7 8 S	*If Special Describe Requirements
Stroke	Specify in Inches Including Fractional Requirements		—	

***NOTE:** Use "S" if any special design features or seals are required, describe in detail on your order.

EXAMPLE: The code for a hydraulic cylinder 4" bore, 2" rod, rod end rectangular flange mounting, Style No. 1 rod end, cushion both ends, standard seals with a 14¾" stroke is: **H01541-31-14-7x14¾.**

DUPLICATE CYLINDERS

Duplicate cylinders can be ordered by giving the serial number from the nameplate of the original cylinder. Factory records supply a quick, positive identification.

HOW TO ORDER

Series H Cylinders

Standard Series H Cylinders can be completely and accurately described by a model number. If your requirements are completely standard, select the alphanumberic codes from above that represent your cylinder and place them in the sequence indicated by the example. Use of the cylinder model number will eliminate untimely delays in handling your order.

General Order Data

1. Bore & Rod Size or the Cylinder Code: (refer to pages 8-27)
2. Mounting Style: (refer to page 8-27)
3. Rod End Style: (refer to inside cover, page ii)
4. Cushion Requirements
5. Length of Stroke

Application Data

1. **Port Requirements**: refer to page 28.
2. **Operating Fluid or Medium:** Series H Cylinders are equipped with seals for use with hydraulic oil. If other than a quality grade hydraulic oil will be used, specify the type of fluid in your order. See page 184 for more details.
3. **Temperature Range:** Series H Hydraulic Cylinders contain seals of Nitrile (Buna-N) suitable to -20° F to +200° F. Specify your operating temperature if your application does not fall within this temperature range.
4. **Operating Pressure:** Series H Cylinders are rated for 3000 PSI. If your requirements are in excess of the rated pressure, describe your application in your order.
5. **Accessories**: Specify any accessories you require, using the part numbers given on the inside back cover.
6. **Special Requirements:** If you require special seals, rod material, stop tube, center support, adjustable stroke or any other special requirements not covered, specify in detail on your order.

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

REPLACEMENT SEALS OR CYLINDER PARTS

For replacement seals or cylinder parts, the serial number of your cylinder, the cylinder model number and the item number of the part you require (below) should appear on your order. To order entire seal kits for your cylinder, simply specify the serial number and the cylinder model number from page 32 on your request for service parts.

HOW TO ORDER COMPLETE SEAL KITS

When ordering complete seal kits, specify the following information on your order:

1. The serial number of the cylinder the seals will be used on.
2. The bore and rod size.
3. If the cylinder is cushioned.

To eliminate untimely delays in the handling of your order, please use the seal kit code as shown in the example below:

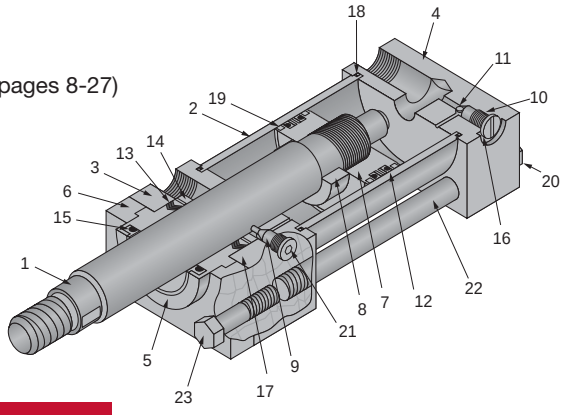
Example:

Buna-N Kit No. XXXXX-7-40

- cylinder code number (refer to pages 8-27)

Viton Kit No. XXXXX-8-40

- cylinder code number (refer to pages 8-27)



▼ STANDARD PARTS LIST

Item No.	Description
1	Piston Rod
2	Cylinder Barrel
3	Head End Cap
4	Cap End Cap
5	Rod Bushing
6	Retainer Plate
7	Piston
8	Cushion Plunger
9	Cushion Adj. Plunger
10	Ball Check Retainer
11	Ball Check
12	U-Cup Seal & Backup Washer for Piston
13	Rod Vee Ring Set
14	Rear Bearing Ring
15	Rod Wiper
16	O-Ring Seal for Ball Check Retainer
17	Wave Spring
18	Cylinder Barrel O-Ring & Backup Washer
19	Cast Iron Piston Ring, Standard
20	Tie Rod Flex Lock Nut
21	O-Ring Seal for Cushion Adj. Needle
22	Tie Rod
23	Self-Locking Cap Screw

Retainer Plate Cap Screw Torques

▼ For Square Retainers

Bore Ø	Torque (Ft-lbs)
1½	10
2	20
2½	20
3¼	40
4	40
5	75
6	100

▼ For Circular Retainers

Bore Ø	Rod	Torque (Ft-lbs)
1½	All	3
2	All	6
2½	1, 1⅜	6
	1¾	10
3¼	All	10
4	All	10
5	All	10
6	2½	10
	3, 3½, 4	30
7	All	30
8	3½ - 5	30
	5½	50
10	4½ - 5	30
12	5½	50
	All	50

Tie-rod Nut Torques

▼ Nut Torque Specifications

Bore Ø	Torque (Ft-lbs)
1½	25
2	45
2½	45
3¼	125
4	125
5	300
6	400
7	600
8	900
10	2500
12	3700

When it is necessary to remove the tie-rod nuts on a cylinder, they must be reassembled to the torque specifications given above. To prevent the tie-rods from twisting when tightened, use a vice grip or locking clamp. Note that the torque specification is based on lubricated threads.

INSTALLATION FOR SERIES H

General Information

Cleanliness

The most important consideration when installing the cylinder. When cylinders are shipped from *Milwaukee Cylinder*, the ports are securely plugged with plastic plugs which should not be removed until the piping is to be installed. All piping should be thoroughly clean, to include the removal of all threading and flaring burrs or chips, before making the connection to the cylinder ports. One chip can cause premature failure of the cylinder or other hydraulic system components.

Alignment

Improper alignment will result in excessive cylinder wear. Check to assure rod alignment between the cylinder and its mating component on your machine in both the extended and retracted positions.

Environment

Cylinders operating in areas where there is weld splatter, fast drying chemicals, paint, excessive heat or other hazardous conditions, should have covers or shields to prevent damage to the rod and rod seals.

Bleeding

Air within the cylinder or system will cause erratic operation of the cylinder. *Milwaukee Cylinders* generally do not require bleed ports if the cylinder ports are mounted in an upright position. Several full strokes of the cylinder will purge air from the cylinder into the circuit piping, where it can be bled off. Bleeder ports are available for applications where the cylinder is the high point of the circuit or where the cylinder does not complete a full stroke during its normal cycle.

MOUNTING RECOMMENDATIONS

Foot Mounted Cylinders

The use of high strength alloy steel mounting bolts 1/16" smaller than the hole size is recommended. After final alignment, foot mounted cylinders should be dowel pinned in place.

Trunnion Mounted Cylinders

Lubricated pillow blocks designed for close tolerance applications should be used. It is important to rigidly mount and align the pillow blocks so that the trunnion pins will not be subjected to any extreme bending moments The rod end should be pivoted with the pivot pin in line and parallel to the axis of the trunnion pins.

Flush Mount Cylinders

The use of high strength alloy steel mounting bolts is recommended. Shear keys should be used to reduce the stress on the mounting bolts created by the normal push and pull forces created by the cylinder cycle.

Flange Mount Cylinders

The controlled diameter rod bushing extension can be used as a pilot to locate the flange mount. Dowel pins should be used after the cylinder is mounted and aligned to prevent shifting.

Clevis Mount Cylinders

This type of cylinder must be pivoted at both ends and the pins must be in line and parallel to each other. After the cylinder is mounted, the customer should check to assure that the cylinder is free to swing through its working arc without interference from other machined parts.

STORAGE

Often times, cylinders are delivered before a customer is prepared to install them and must be stored for a period of time. When storage is required:

1. Select an area indoors for storage, which has dry and non-corrosive atmosphere. Take caution to protect the cylinder from both internal and external corrosion.
2. Cylinders to be stored should be kept in a vertical position (piston rod up) whenever possible.
3. Port protector plugs should be kept in the cylinder ports until the time of installation.

CYLINDER TROUBLE SHOOTING

1. **External leakage**

   If leaking occurs between the end cap and barrel, check tie-rod torque. Do not over torque. If the torque is correct, then replace the barrel seal. When leakage occurs in the rod bushing area, replace the rod seals. If leakage continues or reoccurs in short period of operation, check items 2 thru 5, page 33.

2. **Cylinder misalignment**

   Side load is a common problem which occurs when the cylinder application does not allow the piston rod to work in line during the extend and retract motions of the cylinder. Evidence of this is excessive seal failure, bushing wear or galling of the piston rod. Often, bending of the piston rod or complete failure (breakage) of the rod occurs.

3. **Contamination on the piston rod**

   Dirt and other material is often picked up when the piston rod is extended. When the rod is retracted in an excessive dirty application, it often carries the dirt back into the rod seal cavity of the cylinder, causing damage to the seals. With a slight modification of the cylinder rod end, a rod boot can be added to protect the rod bushing and seals for most applications.

4. **Bad mountings**

   Due to wear of pivot pins or mounting bolts working loose, a cylinder may have side load, even though the rod was in line when the cylinder was first installed. All cylinder mountings should be checked periodically.

5. **Damaged piston rod**

   An extended piston rod can be damaged by the impact of a hard object which could burr the rod. If this occurs, the rod should be checked immediately to prevent seal damage.

6. **Internal leakage**

   Inside the cylinder, leakage past the piston seals can cause sluggish movement or settling of the cylinder under load conditions. This occurs due to leakage of worn piston seals or rings.

7. **Creeping cylinder**

   When a cylinder is stopped in midstroke and it creeps, check for internal leakage. Creeping can also be caused by a worn control valve and this should be checked, even if the cylinder is found to have internal leakage.

8. **Erratic operation**

   When a cylinder is erratic or sluggish in operation, this may be caused by a number of problems. The most common cause of sluggish operation is air in the system. Internal leakage could also be a cause. If the system starts out sluggishly and, as it warms, speeds up, the oil may be of too high viscosity. The whole system should be checked for worn components if after these checks, the cylinder is still operating in a sluggish manner.

CYLINDER MAINTENANCE

Rod Seal Replacement

When changing rod seals, extend the piston rod 3" or more if possible, being sure to support the rod at all times. Remove the retainer plate screws (if tie-rod nuts have to be removed, refer to the nut torque specification on this page when reassembling the cylinder), retainer plate and outer bushing. Using an eye hook or thin screwdriver, pry the vees from the end cap cavity (if low pressure air is applied to the rod end port, this will help to force the vees from the cavity). The new set of vees should be assembled into the cavity separately and lubed with the soft vee in the center. Replace the rod wiper in the bushing and reassemble the cylinder.

Piston Seal Replacement

When changing piston seals, extend the piston rod 3" or more if possible, being sure to support the piston rod and the piston at all times. *Remove the tie-rod nuts, blind end cap, the barrel and then the piston seals. A light grease, compatible with the system fluid, should be used on the rings and block vee seals for smooth assembly. Install the block vee piston seals, scarf cutting on only the back-up washers. Then install the cast iron rings with the joints in opposite directions. To reassemble, start the piston into the tube, compressing the cast iron rings using twine or a ring compressor. When the piston block vee seal is to the edge of the barrel, use a thin rounded blade to start the lip of the block vee, making sure the entire lip is started before moving the piston further into the tube.

***Note:** When a cylinder has been disassembled this far, the barrel seals should at least be inspected, if not replaced.

Barrel Seal Replacement

When replacing barrel seals, use the same method of disassembling the cylinder as used when replacing piston seals. The barrel seal consists of a backup washer and O-Ring, which is assembled on the first step of both ends of the tube, with the backup washer going on first. The outer diameter of the tube groove on the end caps must be checked for nicks or burrs and then greased. Position the end caps squarely on the tube (check to make sure port location is correct) and firmly force or tap the end cap over the tube until it bottoms. Check to make sure the O-Ring did not shear and then finish assembling the cylinder.

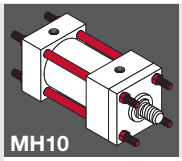
Nut Torque Specifications

Cylinder Bore	Torque (Ft-lbs)
1½	25
2 - 2½	45
3¼ - 4	125
5	300
6	400
8	900
10	2500
12	3700

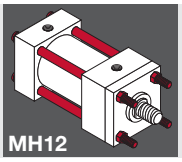
When it is necessary to remove the tie-rod nuts on a cylinder, they must be reassembled to the torque specifications given above. To prevent the tie-rods from twisting when tightened, use a vice grip or locking clamp. Note that the torque specification is based on lubricated threads.

milwaukee Cylinder

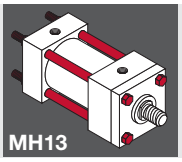
Series MH



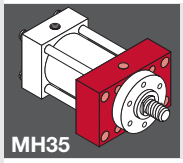
ISO MX1



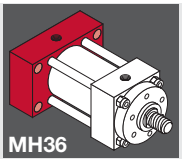
ISO MX3



ISO MX2



ISO ME5



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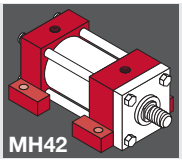
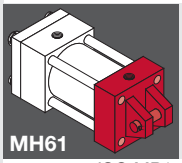
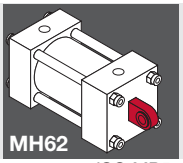


ISO ME2



ISO MP1



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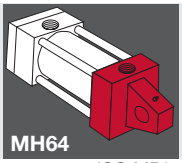
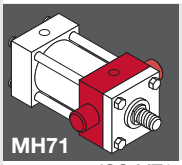
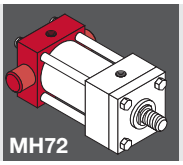


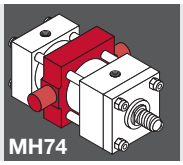
ISO MP3



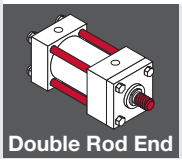
ISO MT1



ISO MT2



ISO MT4



NFPA MDX

***Milwaukee Cylinder* Series MH ISO Metric Hydraulic Cylinders** are built to perform on the toughest applications. Series MH tiered cylinders are built to ISO spec 6020-2, with maximum operating pressures up to 210 bar on all standard bore sizes. If your application requires higher operating pressures, consult our engineers. *Milwaukee Cylinder* helps you solve even more application needs with our expanded ISO Metric Cylinder product line.

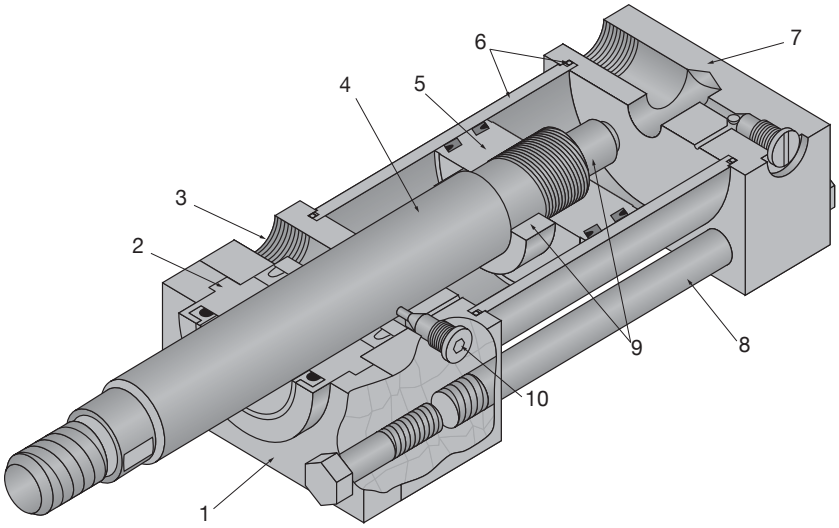
STANDARD SPECIFICATIONS

- Standard construction – square head – tie-rod design
- ISO 6020-2
- Nominal pressure – 210 bar; see info box below
- Standard fluid-hydraulic oil
- Standard temperature – -20° C to +105° C
- Standard bore sizes – 25 mm thru 200 mm
- Standard piston rod diameters 12 mm thru 140 mm
- Standard mounting styles– 12 standard styles and custom designs to suit your needs
- Strokes – available in any practical stroke length
- Cushions – available at either end or both ends of stroke
- Three standard rod end styles and specials designed to order

If your hydraulic operating pressure exceeds 210 bar, send your application data for engineering evaluation and design recommendations.

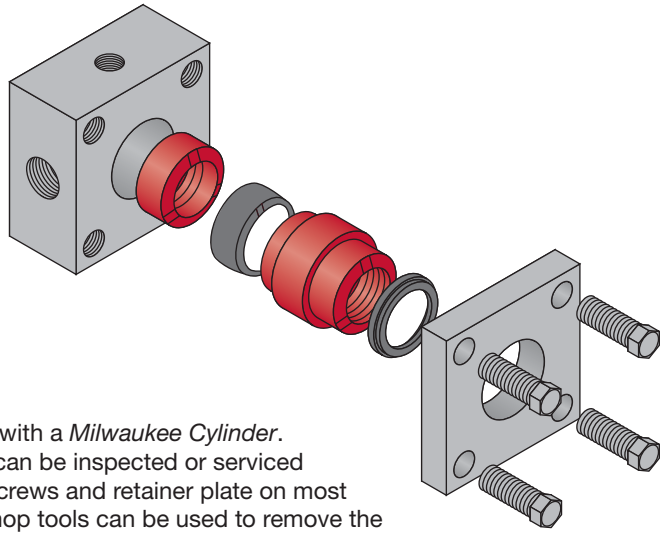
***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.



STANDARD FEATURES

1. **Removable Retainer Plate**
   The retainer plate and rod bushing are externally removable without disassembling the cylinder on most standard models. Four capscrews securely hold and lock the retainer plate in place.
2. **Rod Bushing and Seals**
   A U-cup Rod Seal with a supporting bronze bushing is standard in *Milwaukee Cylinder* Series MH Cylinders.
3. **Ports**
   BSPP/G (ISO 1179-1) cylinder ports are standard and can be located to customer requirements. ISO 6149-1 ports optional.
4. **Piston Rod**
   The piston rod is of high strength steel, hardened and plated to resist scoring and corrosion, assuring maximum life.
5. **Piston**
   The piston is of fine grained alloy iron, incorporating u-cup seals, ensuring non-leak Hi-Lo pressure performance. The piston is pilot fitted and threaded to the rod.
6. **Cylinder Barrel and Seals**
   The barrel is of steel tubing, honed to a fine finish to assure superior sealing, minimum friction and maximum seal life.
7. **End Caps**
   End caps and mountings are of high quality steel, precision machined for accurate mounting.
8. **Tie-Rods and Nuts**
   The tie-rods are constructed from a high quality medium carbon steel. On most sizes the threads are rolled for rigid engagement of the self-locking nuts.
9. **Cushions**
   Cushions are machined to close tolerance to provide positive, smooth deceleration at the end of stroke. On all bore sizes, we provide the longest cushion possible based on the rod size and blind end caps. Longer cushions are available; for further information, consult factory.
10. **Cushion Needle Adjustment and Ball Check**
    The cushion needle adjustment valve and cushion-check ball retainer screw are specifically designed to provide full cushion adjustment.

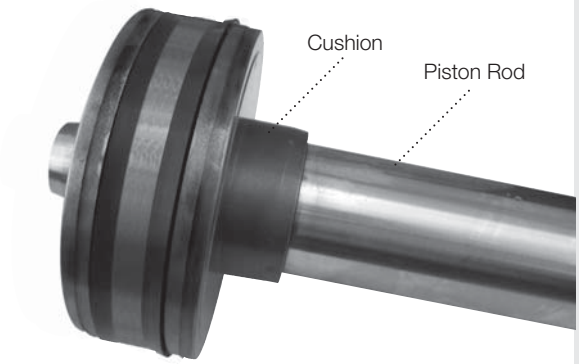


Simple Maintenance…

Simple maintenance is reality with a *Milwaukee Cylinder*. The rod bushing or rod seals can be inspected or serviced by merely removing the cap screws and retainer plate on most models. Standard available shop tools can be used to remove the rod bushing and seals without disturbing the torque on the tie-rods, assuring performance quality with maintenance ease.

COMBINATION ROD SEAL DESIGN…

The Series MH cylinder design is a one-piece rod bushing with a double lip u-cup rod seal, a supporting bearing ring, and a double lip wiper.



COMBINATION SEALING ROD

The Series MH cylinder combines two bi-directional sealing u-cup seals and a fine grained alloy iron piston. This proven piston seal design is effective at both high and low pressures. The design gives the wear and shock absorbing qualities of cast iron and the near zero leakage of the u-cup seals.

Cushions…

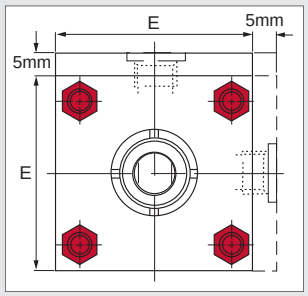
The cushion is of a high-grade alloy, precision machined and specially tapered to provide smooth deceleration of the piston at the end of stroke.

A standard manufacturing process at *Milwaukee Cylinder* is to assemble the piston, cushion, and the piston rod; placing the assembly between centers and checking the critical diameters for concentricity.

Piston Rod…

The piston rod is hardened, plated high strength steel, machined and processed to resist scoring and corrosion, assuring maximum life. *Milwaukee Cylinder* offers three rod end styles as standard. **The style #2 rod end with two wrench flats is furnished as standard** unless otherwise specified. Special rod ends and extra wrench flats are also available. They must be specified at the time of order, giving the dimensional requirements and the location of additional wrench flats.

25 & 32mm Bore Cylinders

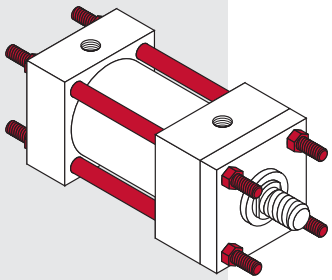


5mm extra height applies to port face at the rod end caps only.

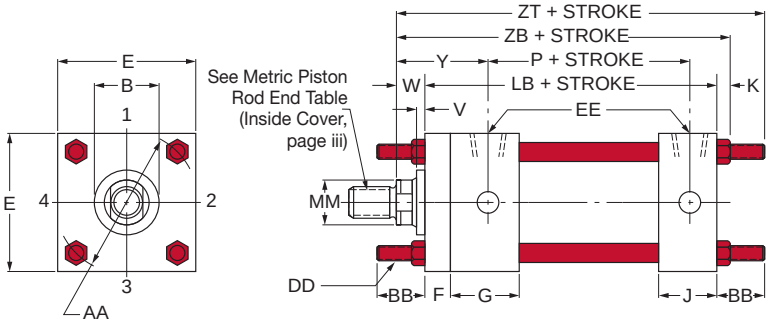
TIE ROD MOUNTED CYLINDERS

The flange and tie-rod mounts are basically the same, except that the cylinder tie-rods are extended and used to mount the cylinder. To prevent misalignment, sagging, or possible binding of the cylinder, when long strokes are required, the free end should be supported. The best use of tie-rods when extending on the blind end is in a thrust load application. When using tie-rods extended on the rod end, the best application is a tension load. Tie rod mounts are suited for many applications, but it should be noted that they are not as rigid as the flange type of mounting.

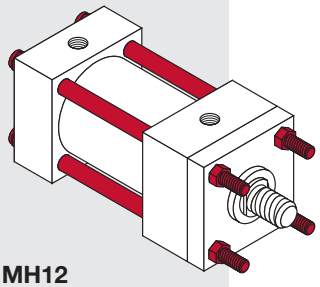
TIE RODS EXTENDED BOTH ENDS



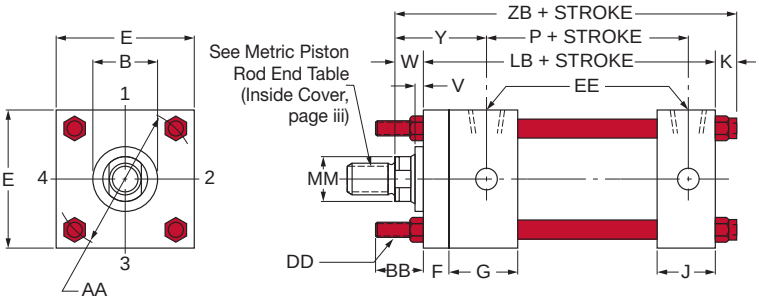
MODEL MH10
ISO STYLE MX1



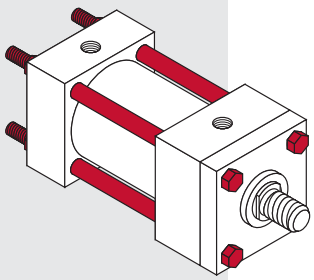
TIE RODS EXTENDED ROD END



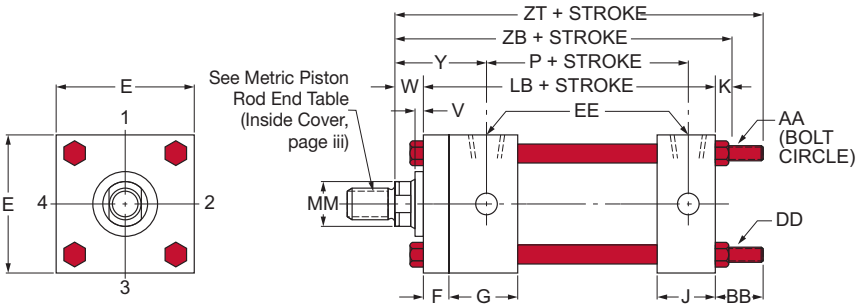
MODEL MH12
ISO STYLE MX3



TIE RODS EXTENDED BLIND END



MODEL MH13
ISO STYLE MX2



▼ TABLE 1MH

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	Y	ZB	ZT
25	12	**MH0151**	24	99	53	6	15	50	121	133
	18△	**MH0152**	30							
32	14	**MH1510**	26	103	56	12	25	60	137	152
	22†	**MH1511**	34							
40	18	**MH1520**	30	128	73	6	25	62	163	188
	28†	**MH1521**	42			12				
50	22	**MH1530**	34	134	74	6	25	67	174	205
	28	**MH1531**	42							
	36†	**MH1532**	50			9				
63	28	**MH1540**	42	136	80	6	32	71	183	214
	36	**MH1541**	50			9				
	45	**MH1542**	60			13				
80	36	**MH1550**	50	159	93	5	31	77	209	249
	45	**MH1551**	60			9				
	56	**MH1552**	72							
100	45	**MH1560**	60	168	101	7	35	82	222	262
	56	**MH1561**	72			10				
	70	**MH1562**	88							
125	56	**MH1570**	72	197	117	10	35	86	258	313
	70	**MH1571**	88							
	90	**MH1572**	108							
160	70	**MH1580**	88	213	130	7	32	86	273	337
	90	**MH1581**	108							
	110	**MH1582**	133							
200	90	**MH1590**	108	267	165	7	32	98	330	414
	110	**MH1591**	133							
	140	**MH1592**	163							

△ Cushions not available on rod end.

† Available with fixed nonadjustable cushions on rod end and standard adjustable cushions on the blind end only.

▼ TABLE 2MH

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	AA	BB	DD	E	EE BSPP	F	G	J	K
25	40	19	**M5 X 0.8**	40	¼	10	40	25	7
32	47	24	**M6 X 1**	45	¼	10	40	25	9
40	59	35	**M8 X 1**	63	⅜	10	45	38	10
50	74	46	**M12 X 1.25**	75	½	16	45	38	15
63	91	46	**M12 X 1.25**	90	½	16	45	38	15
80	117	59	**M16 X 1.5**	115	¾	20	50	45	19
100	137	59	**M16 X 1.5**	130	¾	22	50	45	19
125	178	81	**M22 X 1.5**	165	1	22	58	58	26
160	219	92	**M27 X 2**	205	1	25	58	58	28
200	269	115	**M30 X 2**	245	1¼	25	76	76	31

HOW TO ORDER

For ordering information refer to page 49.

CAUTION NOTES:

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMH0151. (Refer to page 48.)

Rod End Styles and Dimensions

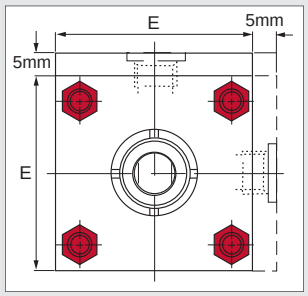
For rod end styles and dimensions see the table in the inside cover of the brochure "METRIC Piston Rod End Styles".

Page iii

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

25 & 32mm Bore Cylinders



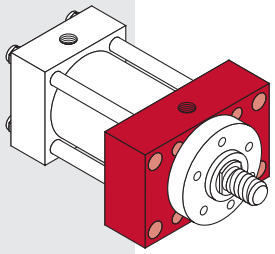
5mm extra height applies to port face at the rod end caps only.

SOLID END CAP MOUNTED CYLINDERS

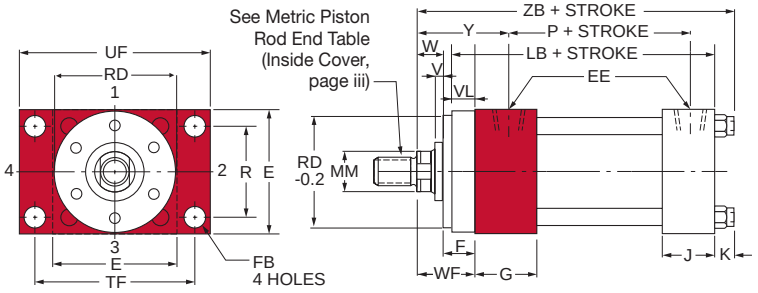
Milwaukee Cylinder's solid end cap mount is one of the strongest, most rigid methods of mounting. This type of rod end cap mounting is best in a tension application.
A solid blind end cap mounting is best in a thrust application.

SOLID ROD END CAP MOUNT

Flange rated for 210 bar operation.

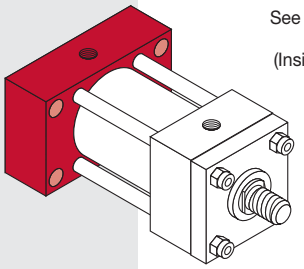


MODEL MH35*
ISO STYLE ME5

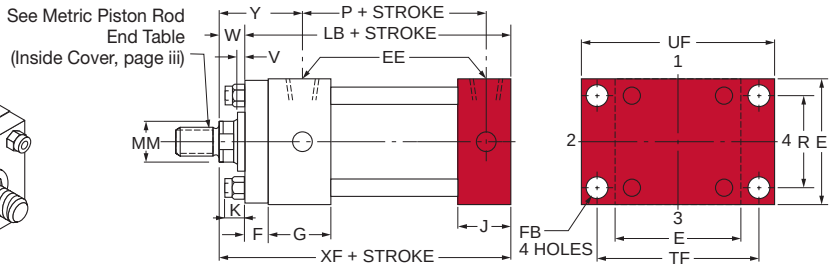


SOLID BLIND END CAP MOUNT

Flange rated for 210 bar operation.



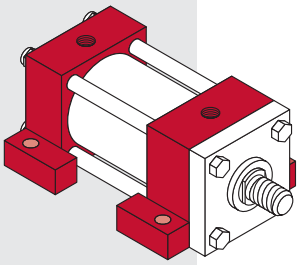
MODEL MH36
ISO STYLE ME6



SIDE OR LUG MOUNTED CYLINDERS

25 mm and 35 mm port at Rod End available in Position #1 only.

The side or lug mounted cylinder provides a fairly rigid mount. These types of cylinders can tolerate a slight amount of misalignment when the cylinder is at full stroke, but as the piston moves toward the blind end, the tolerance for misalignment decreases. It is important to note that if the cylinder is used properly (without misalignment), the mounting bolts are either in simple shear or tension without any compound stresses.



MODEL MH42
ISO STYLE MS2

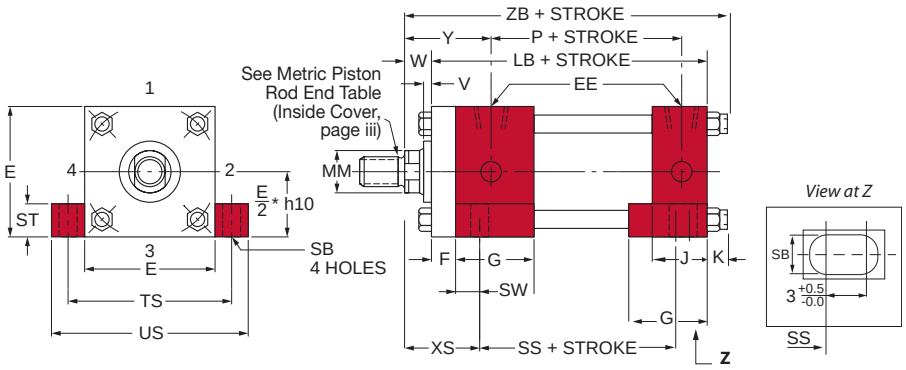


TABLE 1MH

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	RD f8	SS	V	VL min.	W	WF	XF	XS	Y	ZB
25	12	MH0151	24	99	53	38	72	6	3	15	25	114	33	50	121
	18△	MH0152	30												
32	14	MH1510	26	103	56	42	72	12	3	25	35	128	45	60	137
	22†	MH1511	34												
40	18	MH1520	30	128	73	62	97	6	3	25	35	153	45	62	163
	28†	MH1521	42					12							
50	22	MH1530	34	134	74	74	91	6	4	25	41	159	54	67	174
	28	MH1531	42												
	36†	MH1532	50					9							
63	28	MH1540	42	136	80	75	85	6	4	32	48	168	65	71	183
	36	MH1541	50			82		9							
	45	MH1542	60			88		13							
80	36	MH1550	50	159	93	82	104	5	4	31	51	190	68	77	209
	45	MH1551	60			88		9							
	56	MH1552	72			105									
100	45	MH1560	60	168	101	92	101	7	5	35	57	203	79	82	222
	56	MH1561	72			105									
	70	MH1562	88			125		10							
125	56	MH1570	72	197	117	105	130	7	5	35	57	232	79	86	258
	70	MH1571	88			150		10							
	90	MH1572	108												
160	70	MH1580	88	213	130	125	129	7	5	32	57	245	86	86	273
	90	MH1581	108			170									
	110	MH1582	133												
200	90	MH1590	108	267	165	150	171	7	5	32	57	299	92	98	330
	110	MH1591	133			210									
	140	MH1592	163												

△ Cushions not available on rod end.

† Available with fixed nonadjustable cushions on rod end and standard adjustable cushions on the blind end only.

TABLE 2MH

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	EE BSPP	F	FB	G	J	K	R	SB	ST	SW	TS	TF	UF	US
25	40*	¼	10	5.5	40	25	7	27	6.6	8.5	8	54	51	65	72
32	45*	¼	10	6.5	40	25	9	33	9	12.5	10	63	58	70	84
40	63	⅜	10	11	45	38	10	41	11	12.5	10	83	87	110	103
50	75	½	16	14	45	38	15	52	14	19	13	102	105	130	127
63	90	½	16	14	45	38	15	65	18	26	17	124	117	145	161
80	115	¾	20	18	50	45	19	83	18	26	17	149	149	180	186
100	130	¾	22	18	50	45	19	97	26	32	22	172	162	200	216
125	165	1	22	22	58	58	26	126	26	32	22	210	208	250	254
160	205	1	25	26	58	58	28	155	33	38	29	260	253	300	318
200	245	1¼	25	33	76	76	31	190	39	44	35	311	300	360	381

* 25 mm and 35 mm port at rod end available in position #1 only (MH42 only).

HOW TO ORDER

For ordering information refer to page 49.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMH0151. (Refer to page 48.) Double rod ends are not available on clevis mount Series MH cylinders

Rod End Styles and Dimensions

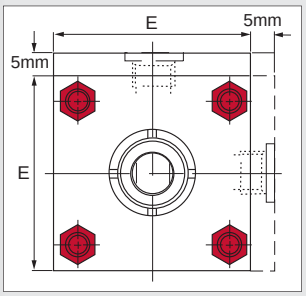
For rod end styles and dimensions see the table in the inside cover of the brochure "METRIC Piston Rod End Styles".

Page iii

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

25 & 32mm Bore Cylinders

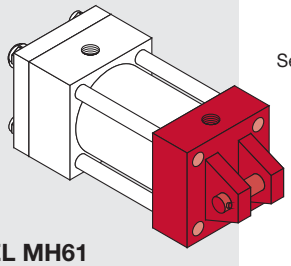


5mm extra height applies to port face at the rod end caps only.

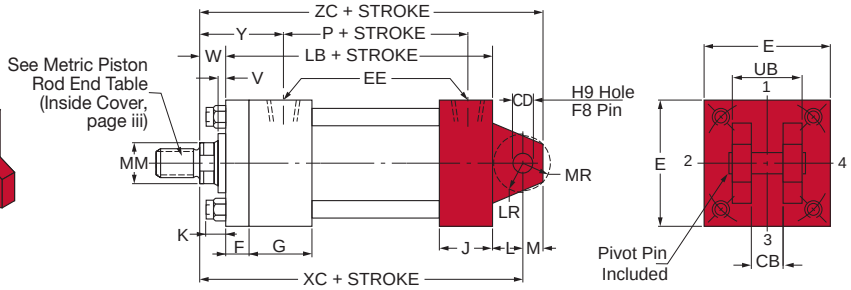
PIN MOUNTED CYLINDERS

All pin cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and pivot pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.

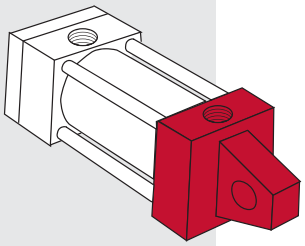
CLEVIS MOUNT



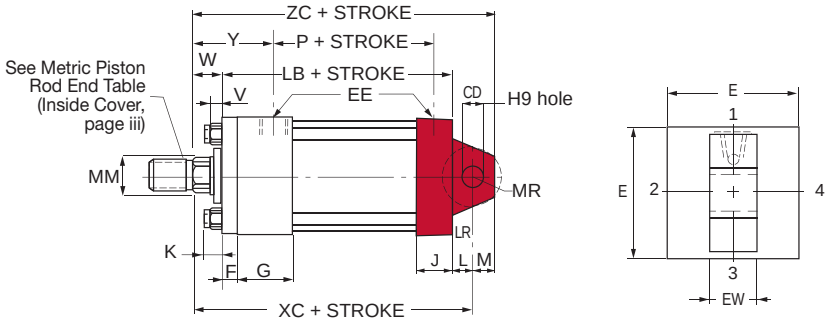
MODEL MH61
ISO STYLE MP1



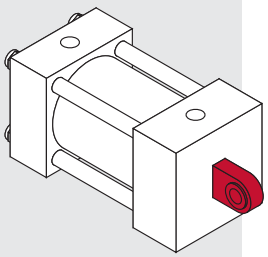
FIXED EYE MOUNT



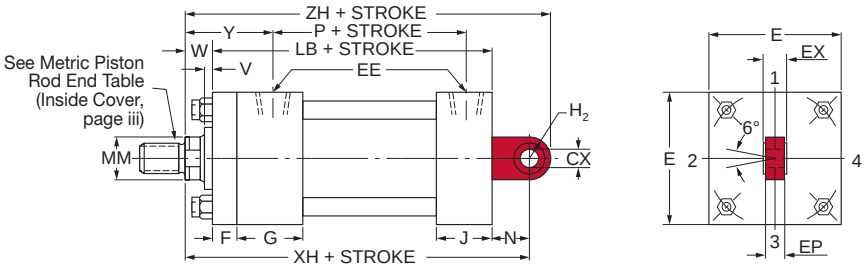
MODEL MH64
ISO STYLE MP3



SPHERICAL EYE MOUNT



MODEL MH62
ISO STYLE MP5



▼ TABLE 1MH

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	XC	XH	Y	ZC	ZH
25	12	**MH0151**	24	99	53	6	15	127	130	50	137	150
	18△	**MH0152**	30									
32	14	**MH1510**	26	103	56	12	25	147	148	60	159	170.5
	22†	**MH1511**	34									
40	18	**MH1520**	30	128	73	6	25	172	178	62	186	207
	28†	**MH1521**	42			12						
50	22	**MH1530**	34	134	74	6	25	191	190	67	211	223
	28	**MH1531**	42									
	36†	**MH1532**	50			9						
63	28	**MH1540**	42	136	80	6	32	200	206	71	220	246
	36	**MH1541**	50			9						
	45	**MH1542**	60			13						
80	36	**MH1550**	50	159	93	5	31	229	238	77	257	288
	45	**MH1551**	60			9						
	56	**MH1552**	72									
100	45	**MH1560**	60	168	101	7	35	257	261	82	295	323
	56	**MH1561**	72									
	70	**MH1562**	88			10						
125	56	**MH1570**	72	197	117	7	35	289	304	86	334	384
	70	**MH1571**	88			10						
	90	**MH1572**	108									
160	70	**MH1580**	88	213	130	7	32	308	337	86	367	437
	90	**MH1581**	108									
	110	**MH1582**	133									
200	90	**MH1590**	108	267	165	7	32	381	415	98	451	535
	110	**MH1591**	133									
	140	**MH1592**	163									

△ Cushions not available on rod end.

† Available with fixed nonadjustable cushions on rod end and standard adjustable cushions on the blind end only.

HOW TO ORDER

For ordering information refer to page 49.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMH0151. (Refer to page 48.) Double rod ends are not available on clevis mount Series MH cylinders.

Rod End Styles and Dimensions

For rod end styles and dimensions see the table in the inside cover of the brochure "METRIC Piston Rod End Styles".

Page iii

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

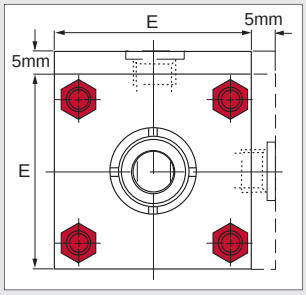
▼ TABLE 2MH

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	CB A16	CD	CX	E	EE BSPP	EP	EW h14	EX	F	G	H2 max.	J	K	L	LR	M	MR	N	UB max.
25	12	10	12 -0.008	40	¼	8	12	10	10	40	20	25	7	13	12	10	12	16	24
32	16	12	16 -0.008	45	¼	11	16	14	10	40	22.5	25	9	19	17	12	15	20	32
40	20	14	20 -0.012	63	⅜	13	20	16	10	45	29	38	10	19	17	14	16	25	40
50	30	20	25 -0.012	75	½	17	30	20	16	45	33	38	15	32	29	20	25	31	60
63	30	20	30 -0.012	90	½	19	30	22	16	45	40	38	15	32	29	20	25	38	60
80	40	28	40 -0.012	115	¾	23	40	28	20	50	50	45	19	39	34	28	34	48	80
100	50	36	50 -0.012	130	¾	30	50	35	22	50	62	45	19	54	50	36	44	58	100
125	60	45	60 -0.015	165	1	38	60	44	22	58	80	58	26	57	53	45	53	72	120
160	70	56	80 -0.015	205	1	47	70	55	25	58	100	58	28	63	59	59	59	92	140
200	80	70	100 -0.020	245	1¼	57	80	70	25	76	120	76	31	82	78	70	76	116	160

For Package and Mounting Dimension see Tables 1MH and 2MH.

25 & 32mm Bore Cylinders



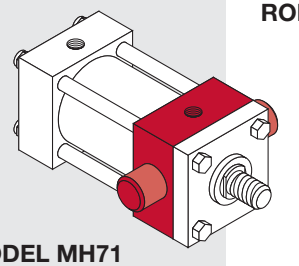
5mm extra height applies to port face at the rod end caps only.

TRUNNION MOUNTED CYLINDERS

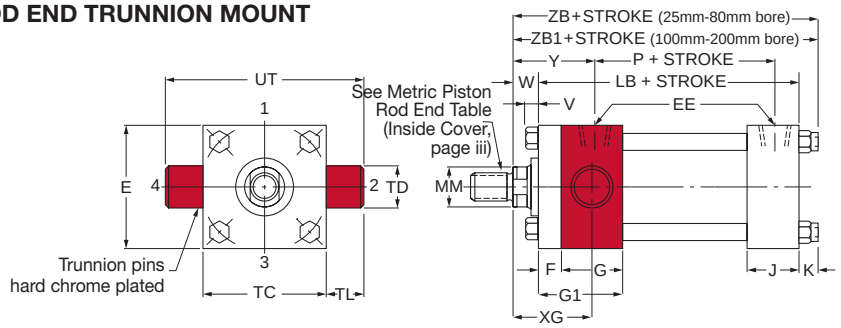
All trunnion cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and the trunnion and pivot pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.

See "CAUTION NOTE on page 47.

ROD END TRUNNION MOUNT

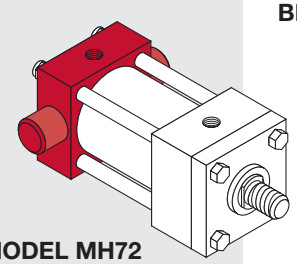


MODEL MH71
ISO STYLE MT1

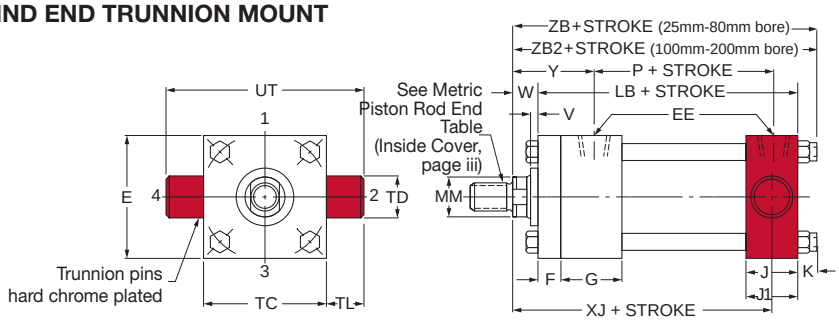


MH71 mount cylinders with bore sized 100mm through 200mm DO NOT have bolts ont the rod end. Tie rods are threaded into the rod end cap. Use **ZB1** and **G1** for this bore size range .

BLIND END TRUNNION MOUNT

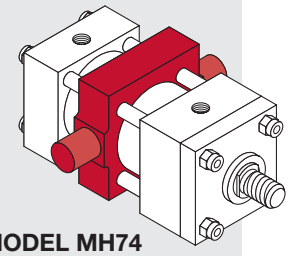


MODEL MH72
ISO STYLE MT2

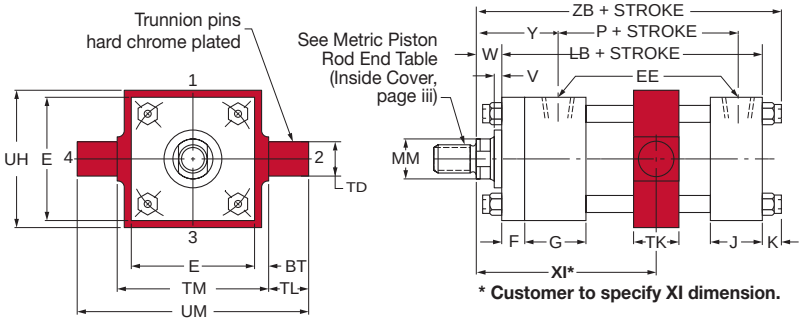


MH72 mount cylinders with bore sized 100mm through 200mm DO NOT have nuts ont the blind end. Tie rods are threaded into the blind end cap, and secured with nuts (K) on the rod end. Use **ZB2** and **J1** for this bore size range .

CENTER TRUNNION MOUNT



MODEL MH74
ISO STYLE MT4



*** Customer to specify XI dimension.**

▼ TABLE 1MH

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	XG	XJ	Y	ZB	ZB1	ZB2
25	12	**MH0151**	24	99	53	6	15	44	101	50	121	-	-
	18△	**MH0152**	30										
32	14	**MH1510**	26	103	56	12	25	54	115	60	137	-	-
	22†	**MH1511**	34										
40	18	**MH1520**	30	128	73	6	25	57	134	62	163	-	-
	28†	**MH1521**	42			12							
50	22	**MH1530**	34	134	74	6	25	64	140	67	174	-	-
	28	**MH1531**	42										
	36†	**MH1532**	50			9							
63	28	**MH1540**	42	136	80	6	32	70	149	71	183	-	-
	36	**MH1541**	50			9							
	45	**MH1542**	60			13							
80	36	**MH1550**	50	159	93	5	31	76	168	77	209	-	-
	45	**MH1551**	60			9							
	56	**MH1552**	72										
100	45	**MH1560**	60	168	101	7	35	71	187	82	222	222*	216**
	56	**MH1561**	72										
	70	**MH1562**	88			10							
125	56	**MH1570**	72	197	117	7	35	75	209	86	258	258*	246**
	70	**MH1571**	88			10							
	90	**MH1572**	108										
160	70	**MH1580**	88	213	130	7	32	75	230	86	273	278*)	275**
	90	**MH1581**	108										
	110	**MH1582**	133										
200	90	**MH1590**	108	267	165	7	32	85	276	98	330	337*)	331**
	110	**MH1591**	133										
	140	**MH1592**	163										

△ Cushions not available on rod end.

† Available with fixed nonadjustable cushions on rod end and standard adjustable cushions on the blind end only.

* Use this dimension for **MH71** mount cylinders with bore sizes 100mm through 200mm.

** Use this dimension for **MH72** mount cylinders with bore sizes 100mm through 200mm.

HOW TO ORDER

For ordering information refer to Page 49.

CAUTION NOTES:

) Rod end trunnion mount cylinders in 160mm bore (all rod sizes) and 200mm bore, (110 and 140 sizes) should not be used over 100 bar. If your application requires higher pressure, consult the factory.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMH0151. (Refer to page 48.) Double rod ends are not available on clevis mount Series MH cylinders.

Rod End Styles and Dimensions

For rod end styles and dimensions see the table in the inside cover of the brochure "METRIC Piston Rod End Styles".

Page iii

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

▼ TABLE 2MH

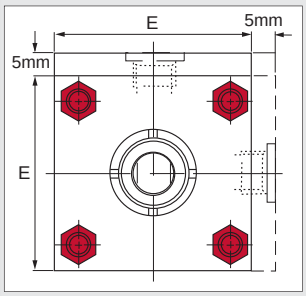
The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	BT	E	EE BSPP	F	G	G1	J	J1	K	TD f8	TC h14	TL	TM h14	TK	UH	UM	UT
25	9	40	¼	10	40	-	25	-	7	12	38	10	48	20	45	68	58
32	11	45	¼	10	40	-	25	-	9	16	44	12	55	25	54	79	68
40	14.5	63	⅜	10	45	-	38	-	10	20	63	16	76	30	76	108	95
50	17	75	½	16	45	-	38	-	15	25	76	20	89	40	89	129	116
63	17.5	90	½	16	45	-	38	-	15	32	89	25	100	40	95	150	139
80	22	115	¾	20	50	-	45	-	19	40	114	32	127	50	127	191	178
100	25	130	¾	22	50	72	45	58	19	50	127	40	140	60	140	220	207
125	31.5	165	1	22	58	80	58	72	26	63	165	50	178	73	178	278	265
160	36.5	205	1	25	58	88	58	88	28	80	203	63	215	90	216	341	329
200	57	245	1¼	25	76	108	76	108	31	100	241	80	279	110	280	439	401

* Use this dimension for **MH71** mount cylinders with bore sizes 100mm through 200mm.

** Use this dimension for **MH72** mount cylinders with bore sizes 100mm through 200mm.

25 & 32mm Bore Cylinders



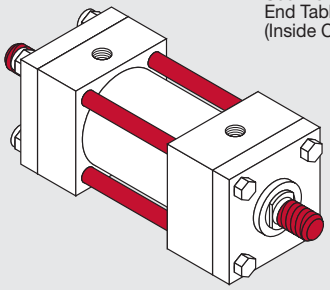
5mm extra height applies to port face at the rod end caps only.

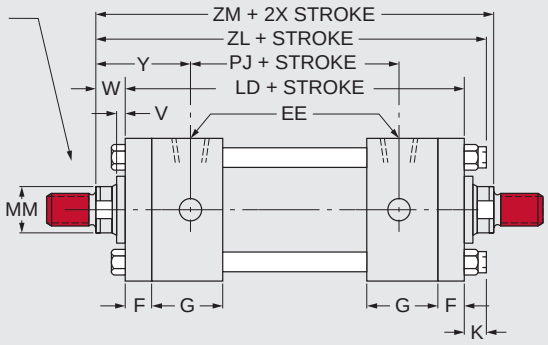
DOUBLE ROD END CYLINDERS

Double rod end styles are available in every mounting style except clevis. On double rod end cylinders where the rod ends are not the same, be sure to specify clearly which rod end is to go at which end of the cylinder in relation to your mounting requirements.

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

On a double rod end cylinder where two different rod ends are required, or two different rod sizes are required, or cushions on one end are required, be sure to state clearly which rod is to go at which end of the cylinder. When two types of mounting styles are required, be sure to specify their relationship to the piston rods, if they are not the same.





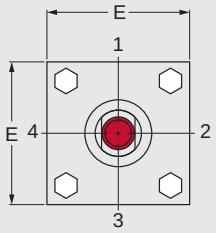


TABLE 2MH

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	F	G	K	EE BSPP
25	40	10	40	7	¼
32	45	10	40	9	¼
40	63	10	45	10	⅜
50	75	16	45	15	½
63	90	16	45	15	½
80	115	20	50	19	¾
100	130	22	50	19	¾
125	165	22	58	26	1
160	205	25	58	28	1
200	245	25	76	31	1¼

DOUBLE ROD END CYLINDERS

Bore Ø	Rod MM	Cylinder Code	B	LD	PJ	V	W	Y	ZL	ZM
25	12	**DMH0151**	24	124	54	6	15	50	146	154
	18	**DMH0152**	30							
32	14	**DMH1510**	26	128	58	12	25	60	162	178
	22	**DMH1511**	34							
40	18	**DMH1520**	30	145	71	6	25	62	180	195
	28	**DMH1521**	42			12				
50	22	**DMH1530**	34	157	73	6	25	67	197	207
	28	**DMH1531**	42							
	36	**DMH1532**	50			9				
63	28	**DMH1540**	42	159	81	6	32	71	206	223
	36	**DMH1541**	50			9				
	45	**DMH1542**	60			13				
80	36	**DMH1550**	50	184	92	5	31	77	234	246
	45	**DMH1551**	60			9				
	56	**DMH1552**	72							
100	45	**DMH1560**	60	195	101	7	35	82	249	265
	56	**DMH1561**	72							
	70	**DMH1562**	88			10				
125	56	**DMH1570**	72	219	117	7	35	86	280	289
	70	**DMH1571**	88			10				
	90	**DMH1572**	108							
160	70	**DMH1580**	88	238	130	7	32	86	298	302
	90	**DMH1581**	108							
	110	**DMH1582**	133							
200	90	**DMH1590**	108	292	160	7	32	98	355	488
	110	**DMH1591**	133							
	140	**DMH1592**	163							

▼ CONFIGURE YOUR CYLINDER (Series MH Metric Cylinder Nomenclature)

	MH1552	- 61	- 2	4	_	- 9	X 425
1	2	3	4	5	6	7	8
Double Rod End	Cylinder Code (*Refer to Table 1MH*)	Mounting Style	Rod End Style	Cushions	Cylinder Modifications *If standard leave blank*	Seal	Stroke

Note:
Use "S" if any special design features are required, describe in detail on your order.

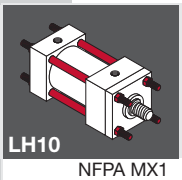
Example:
The code for a MP1 mount metric hydraulic cylinder with an 80mm bore, 56mm rod, Style No. 2 rod end, cushion both ends, standard seals with a 425mm stroke is MH1552-61-24-9 x 425

	Feature	Description	Page No.	Code No.
1	Double Rod End		—	D
2	Cylinder Code	Refer to Table 1MH	7, 9, 11, 13	—
3	Mounting Style	Model Number Only	6, 8, 10, 12	—
4	Rod End Style	Code Number	Inside front cover (iii)	—
5	Cushions	None Rod End Blind End Both Ends	— — — —	1 2 3 4
6	Cylinder Modifications	Special	—	S
7	Seal	Polyurethane (-20° to 200° F)	—	9
8	Stroke	Specify in millimeters	—	—

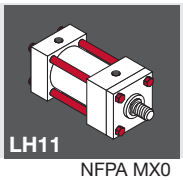
milwaukee *Cylinder*

Series LH

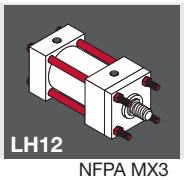
NFPA MP1



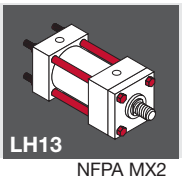
NFPA MP5



NFPA MT1



NFPA MT2



NFPA MT4

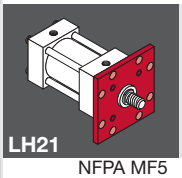
NFPA MDX

NFPA MX1

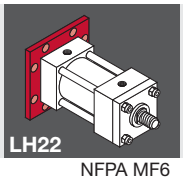
NFPA MX0

NFPA MX3

NFPA MX2



NFPA MF5



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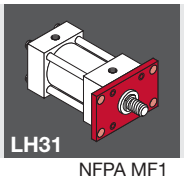
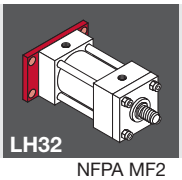
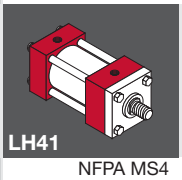


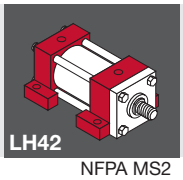
NFPA MF1



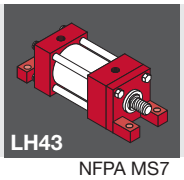
NFPA MF2



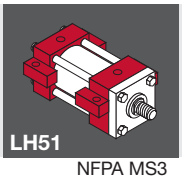
NFPA MS4



NFPA MS2



NFPA MS7

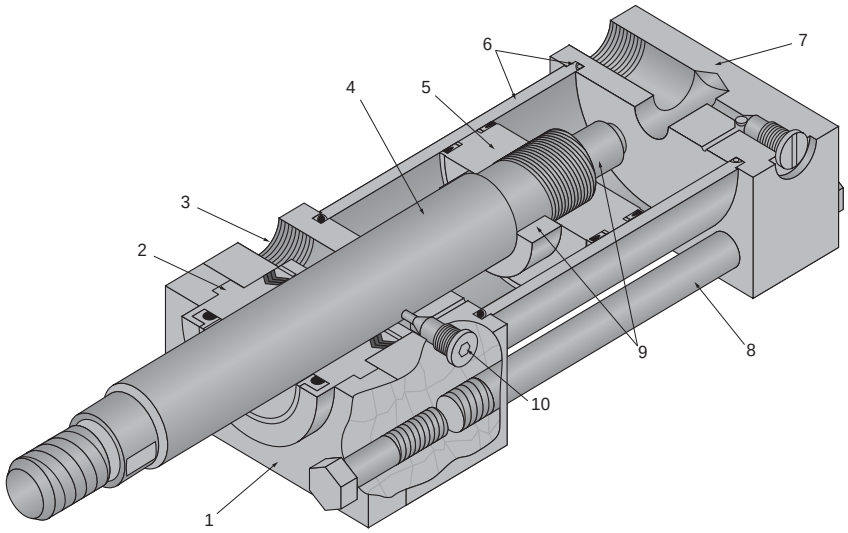


NFPA MS3

***Milwaukee Cylinder* Series LH Low Pressure Hydraulic Cylinders** are built to perform on the toughest applications. The nominal pressure for Series LH ranges from 750 psi to 1500 psi, depending on bore size. Advanced engineering, combined with quality materials and expert workmanship, contribute to the making of a rugged, top quality low-pressure hydraulic cylinder that will provide a long, maintenance-free service life.

STANDARD SPECIFICATIONS

- Standard construction – square head – tie rod design
- Nominal pressure – 750 psi to 1500 psi (range varies by bore size)
- Standard fluid-hydraulic oil
- Standard temperature – -20° F to +200° F
- Standard bore sizes – 1½" to 6"
- Standard piston rod diameters ⅝" thru 4"
- Standard mounting styles – 17 standard styles plus custom designs to suit your needs
- Strokes – available in any practical stroke length
- Cushions – available at either or both ends of stroke
- Standard 7 rod end styles, plus specials designed to order
- Rod end style KK_2 - is studded as standard for ⅝" and 1" diameter rods. Studded rod end style is available for all rod sizes.

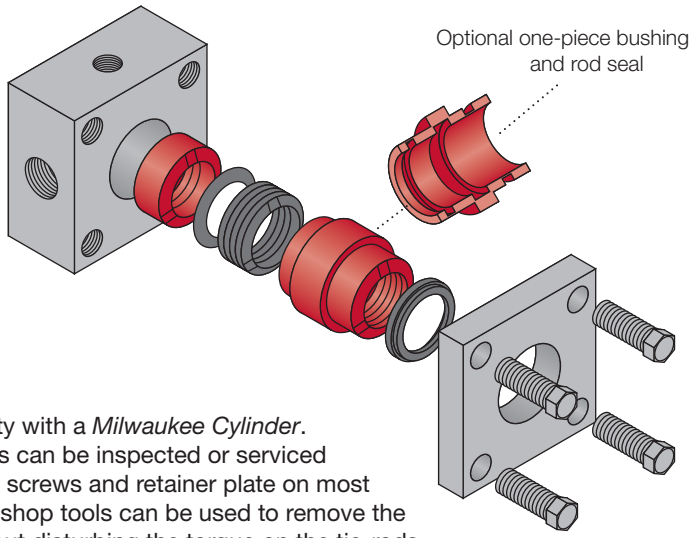


STANDARD FEATURES

1. **Removable Retainer Plate**
   The retainer plate and rod bushing are externally removable without disassembling the cylinder on most standard models. Four capscrews securely hold and lock the retainer plate in place.
2. **Rod Bushing and Seals**
   A combination of spring loaded multiple lip vee rings with a supporting bronze bushing is standard in *Milwaukee Cylinder* Series LH Cylinders.
3. **Ports**
   Large NPTF cylinder ports are standard and can be located to customer requirements. SAE ports available upon request.
4. **Piston Rod**
   The piston rod is of high strength steel, hardened and plated to resist scoring and corrosion to assure maximum seal life.
5. **Piston**
   The Series LH piston is precision machined from fine grained iron alloy. It is pilot fitted and threaded to the piston rod.
6. **Cylinder Barrel and Seals**
   The barrel is of chrome plated steel tubing, honed to a fine finish to assure superior sealing, minimum friction and maximum seal life. It is step cut on the I.D. of both ends for O-ring seals.
7. **End Caps**
   End caps and mountings are of high quality steel, precision machined for accurate mounting.
8. **Tie-Rods**
   The tie rods are constructed from a high quality medium carbon steel. The threads are accurately rolled for rigid engagement of the nuts.
9. **Cushions**
   Cushions are machined to close tolerance to provide positive, smooth deceleration at the end of stroke. On all bore sizes we provide the longest cushion possible, based on the rod size and blind end caps. Longer cushions are available; for further information, consult factory.
10. **Cushion Needle Adjustment and Ball Check**
    The cushion needle adjustment valve and cushion-check ball retainer screw are specifically designed to provide full cushion adjustment.

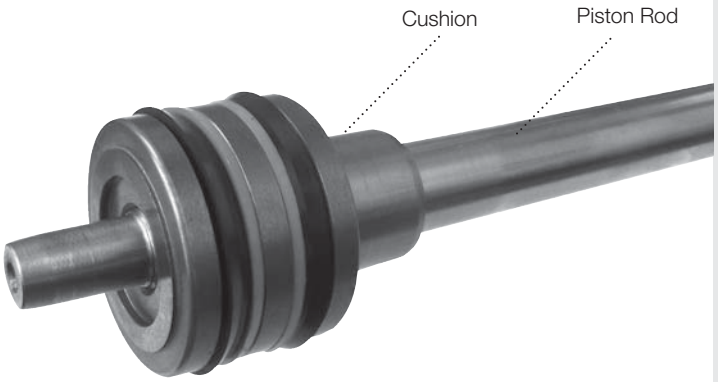
***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.



Simple Maintenance…

Simple maintenance is reality with a *Milwaukee Cylinder*. The rod bushing or rod seals can be inspected or serviced by merely removing the cap screws and retainer plate on most models. Standard available shop tools can be used to remove the rod bushing and seals without disturbing the torque on the tie-rods, assuring performance quality with maintenance ease.



Cushions…

The cushion is of a high grade alloy, precision machined and specially tapered to provide smooth deceleration of the piston at the end of stroke. The rod end cushion bushing is floated with an O-ring to compensate for minor misalignments during normal operation.

Piston Rod…

The piston rod is hardened, plated high strength steel, machined and processed to resist scoring and corrosion, assuring maximum life. *Milwaukee Cylinder* offers seven rod end styles as standard. **The style #2 rod end with two wrench flats is furnished as standard** unless otherwise specified. Special rod ends and extra wrench flats are also available. They must be specified at the time of order, giving the dimensional requirements and the location of additional wrench flats.

COMBINATION ROD SEAL DESIGN…

The *Milwaukee Cylinder* Series LH cylinder combines spring loaded multiple lip vee rings with a supporting bronze bushing and a double lip wiper as a secondary seal. This proven rod seal design combination is effective at both high and low pressures. It affords maximum sealing and an extra long bearing support.

As an optional design, a one-piece rod bushing with a double lip rod seal and a double lip wiper is available. Metallic rod scrapers may be supplied on request, in place of the double lip wiper with either rod bushing design.

The unique versatility of the *Milwaukee Cylinder* Series LH design makes available a selection of seals to meet all types of service conditions.

PISTON AND SEAL COMBINATION

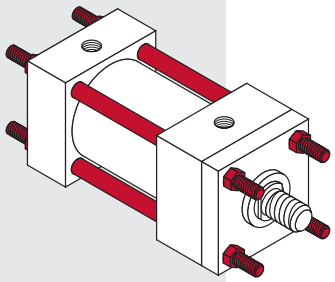
The *Milwaukee Cylinder* Series LH cylinder combines two u-cup seals and a fine grained iron alloy. This proven design combines low friction and smooth break away with the near zero leakage of the block vee seal.

For Package and Mounting Dimension see Tables 1LH and 2LH.

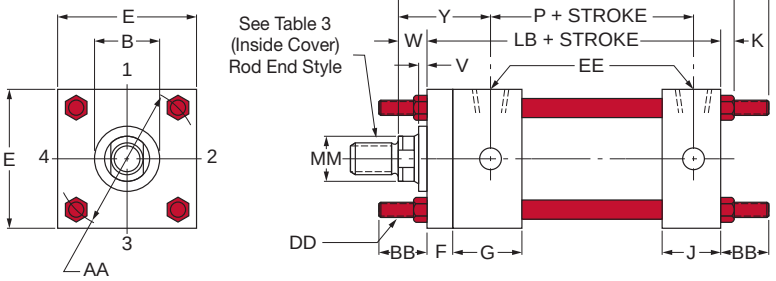
TIE ROD MOUNTED CYLINDERS

Tie-rod mounts are suited for many applications and are similar to flange mounts, but tie-rod mounts are not as rigid as the flange type of mounting. The best use of tie-rods extended on the blind end is in a thrust load application. When using tie-rods extended on the rod end, the best appllication is a tension load. When long strokes are required, the free end should be supported to prevent misalignment, sagging or possible binding of the cylinder.

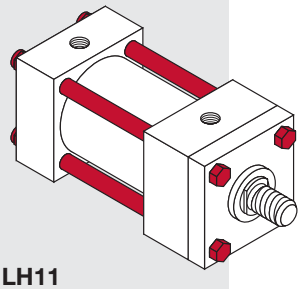
TIE RODS EXTENDED BOTH ENDS



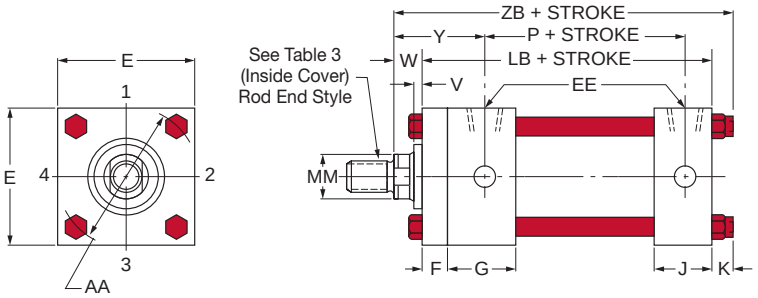
MODEL LH10
NFPA STYLE MX1



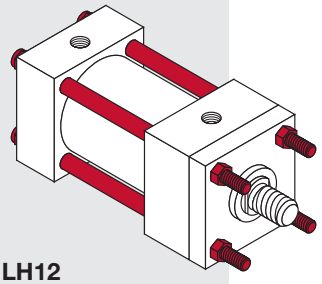
NO TIE ROD EXTENSION



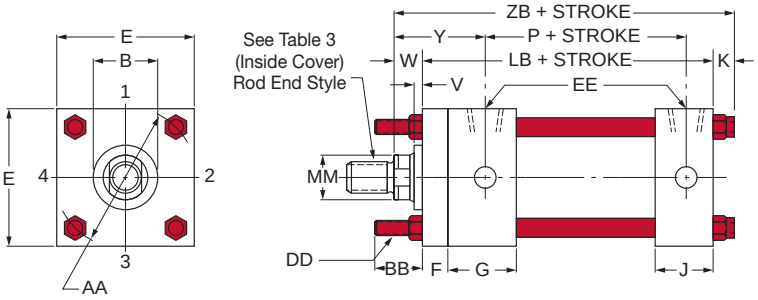
MODEL LH11
NFPA STYLE MX0



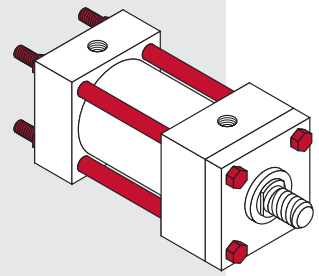
TIE RODS EXTENDED ROD END



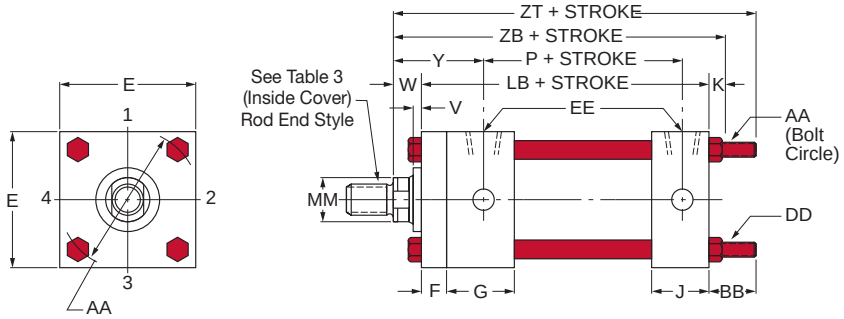
MODEL LH12
NFPA STYLE MX3



TIE RODS EXTENDED BLIND END



MODEL LH13
NFPA STYLE MX2



▼ TABLE 1LH

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	Y	ZB	ZT
1½	⅝	LH0051	1⅛	4	2¼	¼	⅝	1 15/16	5	5⅝
	•1	LH0052	1½			½	1	2 5/16	5⅜	6
2	⅝	LH0510	1⅛	4	2¼	¼	⅝	1 15/16	5 1/16	5¾
	1	LH0511	1½			½	1	2 5/16	5 7/16	6⅛
	•1⅜	LH0512	2			⅝	1¼	2 9/16	5 11/16	6⅜
2½	⅝	LH0520	1⅛	4⅛	2⅜	¼	⅝	1 15/16	5 3/16	5⅞
	1	LH0521	1½			½	1	2 5/16	5 9/16	6¼
	1⅜	LH0522	2			⅝	1¼	2 9/16	5 13/16	6½
	•1¾	LH0523	2⅜			¾	1½	2 13/16	6 1/16	6¾
3¼	1	LH0530	1½	4⅞	2⅝	¼	¾	2 7/16	6⅛	7
	1⅜	LH0531	2			⅜	1	2 11/16	6⅜	7¼
	1¾	LH0532	2⅜			½	1¼	2 15/16	6⅝	7½
	2	LH0533	2⅝			½	1⅜	3 1/16	6¾	7⅝
4	1	LH0540	1½	4⅞	2⅝	¼	¾	2 7/16	6⅛	7
	1⅜	LH0541	2			⅜	1	2 11/16	6⅜	7¼
	1¾	LH0542	2⅜			½	1¼	2 15/16	6⅝	7½
	2	LH0543	2⅝			½	1⅜	3 1/16	6¾	7⅝
	2½	LH0544	3⅛			⅝	1⅝	3 5/16	7	7⅞
5	1	LH0550	1½	5⅛	2⅞	¼	¾	2 7/16	6 7/16	7 11/16
	1⅜	LH0551	2			⅜	1	2 11/16	6 11/16	7 15/16
	1¾	LH0552	2⅜			½	1¼	2 15/16	6 15/16	8 3/16
	2	LH0553	2⅝			½	1⅜	3 1/16	7 1/16	8 5/16
	2½	LH0554	3⅛			⅝	1⅝	3 5/16	7 5/16	8 9/16
	3	LH0555	3¾			⅝	1⅝	3 5/16	7 5/16	8 9/16
	3½	LH0556	4¼			⅝	1⅝	3 5/16	7 5/16	8 9/16
6	1⅜	LH0560	2	5¾	3⅛	¼	⅞	2 13/16	7 3/16	8 7/16
	1¾	LH0561	2⅜			⅜	1⅛	3 1/16	7 7/16	8 11/16
	2	LH0562	2⅝			⅜	1¼	3 3/16	7 9/16	8 13/16
	2½	LH0563	3⅛			½	1½	3 7/16	7 13/16	9 1/16
	3	LH0564	3¾			½	1½	3 7/16	7 13/16	9 1/16
	3½	LH0565	4¼			½	1½	3 7/16	7 13/16	9 1/16
	4	LH0566	4¾			½	1½	3 7/16	7 13/16	9 1/16

▼ TABLE 2LH

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	AA	BB	DD	E	EE NPT	EE SAE	F	G	J	K
1½	2.02	1	¼-28	2	⅜	#6	⅜	1½	1	⅜
2	2.60	1⅛	5/16-24	2½	⅜	#6	⅜	1½	1	7/16
2½	3.10	1⅛	5/16-24	3	⅜	#6	⅜	1½	1	7/16
3¼	3.90	1⅜	⅜-24	3¾	½	#10	⅝	1¾	1¼	½
4	4.70	1⅜	⅜-24	4½	½	#10	⅝	1¾	1¼	½
5	5.80	1 13/16	½-20	5½	½	#10	⅝	1¾	1¼	9/16
6	6.90	1 13/16	½-20	6½	¾	#12	¾	2	1½	9/16

HOW TO ORDER

For ordering information refer to Page 68.

NOTES:

- ♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DLH0051 (Refer to page 62.)
- • Available with fixed-non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

Recommended Pressure Rating

Bore Ø	Pressure Rating (psi)
1½	1500
2	1500
2½	1500*
3¼	1500
4	1000
5	1000*
6	750

***NOTE:**

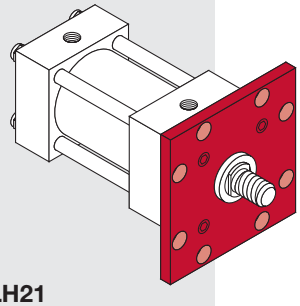
2½" Bore, ⅝" Rod, Rating 1000 psi
5" Bore, 1" Rod, Rating 750 psi

For Package and Mounting Dimension see Tables 1LH and 2LH.

FLANGE MOUNTED CYLINDERS

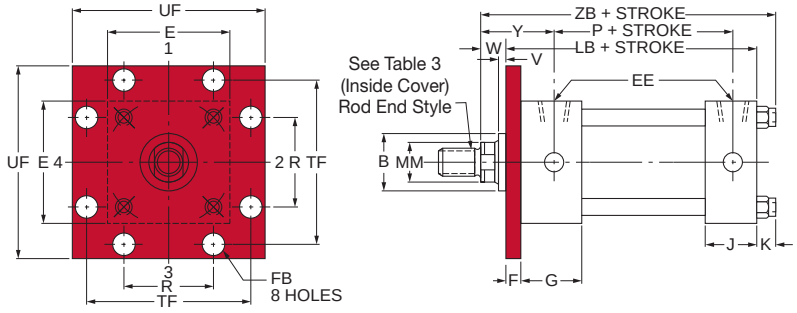
The flange mount is one of the strongest, most rigid methods of mounting. With this type of mount there is little allowance for misalignment, though when long strokes are required, the free end opposite the mounting should be supported to prevent sagging and possible binding of the cylinder.

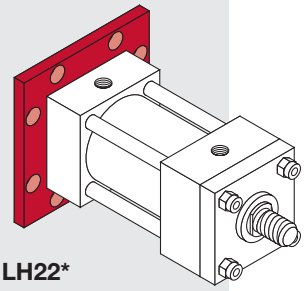
The best use of a blind end flange is in a thrust load application (rod in compression). Rod end flange mounts are best used in tension applications. When a less rigid mount can be used and the cylinder can be attached to a panel or bulkhead, an extended tie-rod mounting could be considered.



MODEL LH21
NFPA STYLE MF5

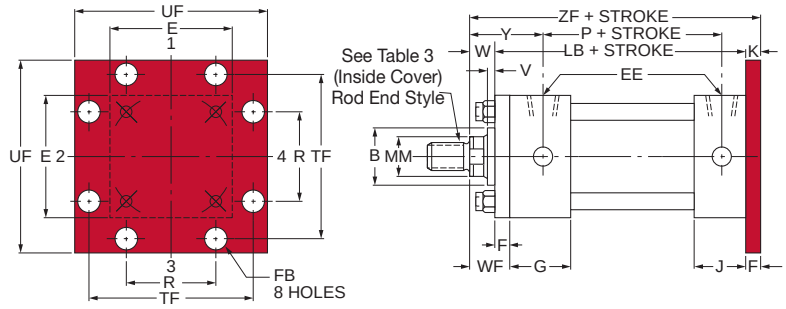
ROD SQUARE FLANGE MOUNTING

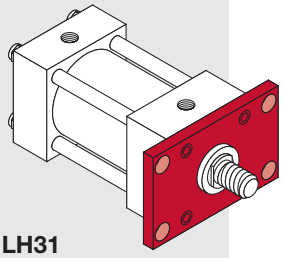




MODEL LH22*
NFPA STYLE MF6

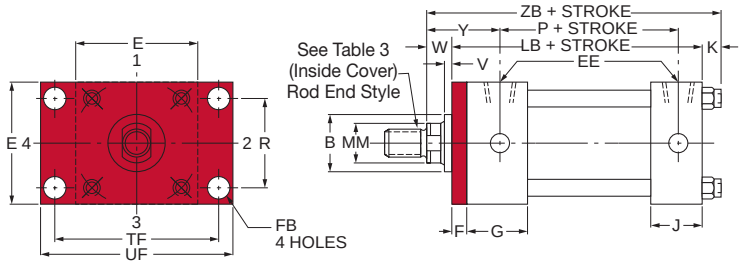
BLIND SQUARE FLANGE MOUNTING

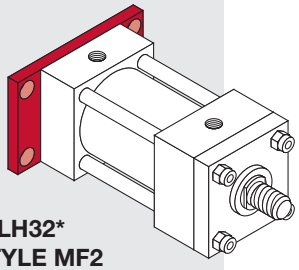




MODEL LH31
NFPA STYLE MF1

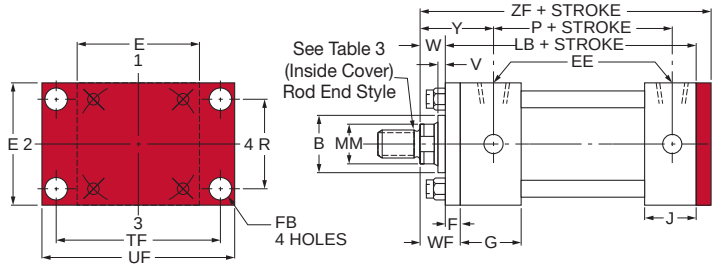
ROD RECTANGULAR FLANGE MOUNTING





MODEL LH32*
NFPA STYLE MF2

BLIND RECTANGULAR FLANGE MOUNTING



▼ TABLE 1LH

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	Y	ZB	ZF
1½	⅝	LH0051	1⅛	4	2¼	¼	⅝	1 15/16	5	5
	•1*	LH0052	1½			½	1	2 5/16	5⅜	5⅜
2	⅝	LH0510	1⅛	4	2¼	¼	⅝	1 15/16	5 1/16	5
	1	LH0511	1½			½	1	2 5/16	5 7/16	5⅜
	•1⅜*	LH0512	2			⅝	1¼	2 9/16	5 11/16	5⅝
2½	⅝	LH0520	1⅛	4⅛	2⅜	¼	⅝	1 15/16	5 3/16	5⅛
	1	LH0521	1½			½	1	2 5/16	5 9/16	5½
	1⅜	LH0522	2			⅝	1¼	2 9/16	5 13/16	5¾
	•1¾*	LH0523	2⅜			¾	1½	2 13/16	6 1/16	6
3¼	1	LH0530	1½	4⅞	2⅝	¼	¾	2 7/16	6⅛	6¼
	1⅜	LH0531	2			⅜	1	2 11/16	6⅜	6½
	1¾	LH0532	2⅜			½	1¼	2 15/16	6⅝	6¾
	2*	LH0533	2⅝			½	1⅜	3 1/16	6¾	6⅞
4	1	LH0540	1½	4⅞	2⅝	¼	¾	2 7/16	6⅛	6¼
	1⅜	LH0541	2			⅜	1	2 11/16	6⅜	6½
	1¾	LH0542	2⅜			½	1¼	2 15/16	6⅝	6¾
	2	LH0543	2⅝			½	1⅜	3 1/16	6¾	6⅞
	2½*	LH0544	3⅛			⅝	1⅝	3 5/16	7	7⅛
5	1	LH0550	1½	5⅛	2⅞	¼	¾	2 7/16	6 7/16	6½
	1⅜	LH0551	2			⅜	1	2 11/16	6 11/16	6¾
	1¾	LH0552	2⅜			½	1¼	2 15/16	6 15/16	7
	2	LH0553	2⅝			½	1⅜	3 1/16	7 1/16	7⅛
	2½	LH0554	3⅛			⅝	1⅝	3 5/16	7 5/16	7⅜
	3	LH0555	3¾			⅝	1⅝	3 5/16	7 5/16	7⅜
	3½*	LH0556	4¼			⅝	1⅝	3 5/16	7 5/16	7⅜
6	1⅜	LH0560	2	5¾	3⅛	¼	⅞	2 13/16	7 3/16	7⅜
	1¾	LH0561	2⅜			⅜	1⅛	3 1/16	7 7/16	7⅝
	2	LH0562	2⅝			⅜	1¼	3 3/16	7 9/16	7¾
	2½	LH0563	3⅛			½	1½	3 7/16	7 13/16	8
	3	LH0564	3¾			½	1½	3 7/16	7 13/16	8
	3½	LH0565	4¼			½	1½	3 7/16	7 13/16	8
	4	LH0566	4¾			½	1½	3 7/16	7 13/16	8

▼ TABLE 2LH

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	EE NPT	EE SAE	F	FB	G	J	K	R	TF	UF
1½	2	⅜	#6	⅜	5/16	1½	1	⅜	1.43	2¾	3⅜
2	2½	⅜	#6	⅜	⅜	1½	1	7/16	1.84	3⅜	4⅛
2½	3	⅜	#6	⅜	⅜	1½	1	7/16	2.19	3⅞	4⅝
3¼	3¾	½	#10	⅝	7/16	1¾	1¼	½	2.76	4 11/16	5½
4	4½	½	#10	⅝	7/16	1¾	1¼	½	3.32	5 7/16	6¼
5	5½	½	#10	⅝	9/16	1¾	1¼	9/16	4.10	6⅝	7⅝
6	6½	¾	#12	¾	9/16	2	1½	9/16	4.88	7⅝	8⅝

HOW TO ORDER

For ordering information refer to Page 68.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DLH0051 (Refer to page 62.)

• Available with fixed-non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

* Removable retainer not available for these bore and rod combinations in the LH22 and LH32 mounting styles.

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

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***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

Recommended Pressure Rating

Bore Ø	Pressure Rating (psi)
1½	1500
2	1500
2½	1500*
3¼	1500
4	1000
5	1000*
6	750

***NOTE:**

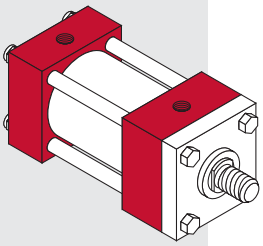
2½" Bore, ⅝" Rod, Rating 1000 psi
5" Bore, 1" Rod, Rating 750 psi

For Package and Mounting Dimension see Tables 1LH and 2LH.

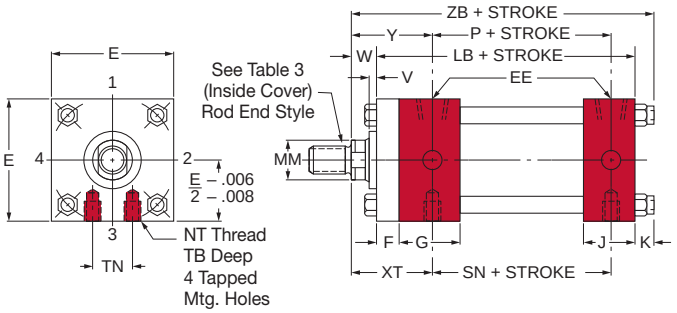
SIDE OR LUG MOUNTED CYLINDERS

The side or lug mounted cylinder provides a fairly rigid mount. These types of cylinders can tolerate a slight amount of misalignment when the cylinder is at full stroke, but as the piston moves toward the blind end, the tolerance for misalignment decreases. It is important to note that if the cylinder is used properly (without misalignment), the mounting bolts are either in simple shear or tension without any compound stresses.

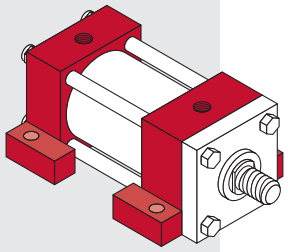
TAPPED HOLES IN CAPS FLUSH MOUNTING



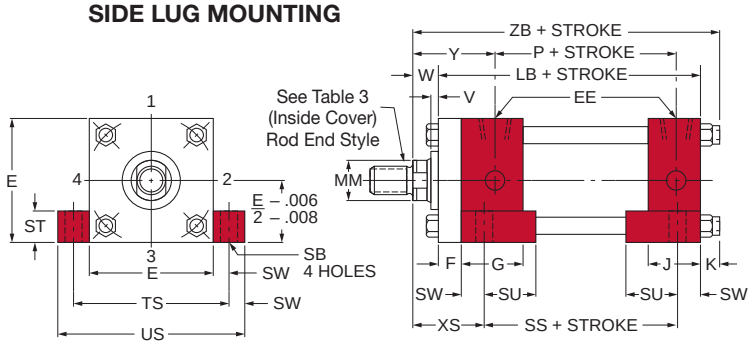
MODEL LH41
NFPA STYLE MS4



SIDE LUG MOUNTING

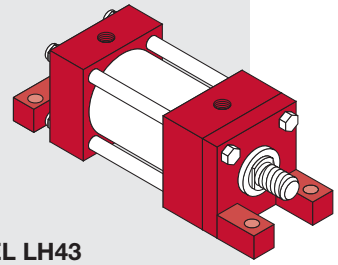


MODEL LH42
NFPA STYLE MS2

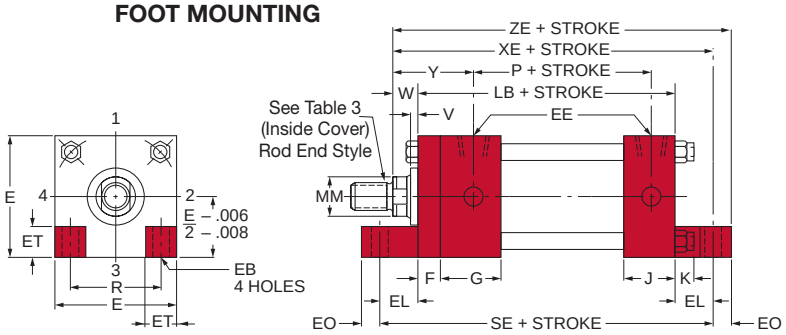


Not Available With Removable Retainers.

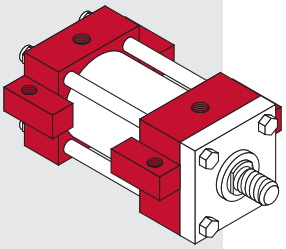
FOOT MOUNTING



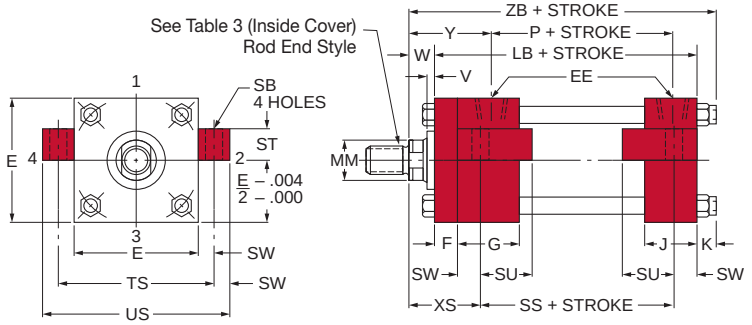
MODEL LH43
NFPA STYLE MS7



CENTERLINE LUG MOUNTING



MODEL LH51
NFPA STYLE MS3



▼ TABLE 1LH

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	LB	P	SE ▲	SN	SS ■	V	W	XE	XS	XT	Y	ZB	ZE
1½	⅝	LH0051	4	2¼	5½	2¼	2⅞	¼	⅝	5⅜	1⅜	1 15/16	1 15/16	5	5⅜
	•1*	LH0052						½	1	5¾	1¾	2 5/16	2 5/16	5⅜	6
2	⅝	LH0510	4	2¼	5⅞	2¼	2⅞	¼	⅝	5 9/16	1⅜	1 15/16	1 15/16	5 1/16	5⅞
	†1*	LH0511						½	1	5 15/16	1¾	2 5/16	2 5/16	5 7/16	6¼
	•1⅜*	LH0512						⅝	1¼	6 3/16	2	2 9/16	2 9/16	5 11/16	6½
2½	⅝	LH0520	4⅛	2⅜	6¼	2⅜	3	¼	⅝	5 13/16	1⅜	1 15/16	1 15/16	5 3/16	6⅛
	1	LH0521						½	1	6 3/16	1¾	2 5/16	2 5/16	5 9/16	6½
	†1⅜*	LH0522						⅝	1¼	6 7/16	2	2 9/16	2 9/16	5 13/16	6¾
	•1¾*	LH0523						¾	1½	6 11/16	2¼	2 13/16	2 13/16	6 1/16	7
3¼	1	LH0530	4⅞	2⅝	6⅝	2⅝	3¼	¼	¾	6½	1⅞	2 7/16	2 7/16	6⅛	6⅞
	1⅜	LH0531						⅜	1	6¾	2⅛	2 11/16	2 11/16	6⅜	7⅛
	1¾*	LH0532						½	1¼	7	2⅜	2 15/16	2 15/16	6⅝	7⅜
	2*	LH0533						½	1⅜	7⅛	2½	3 1/16	3 1/16	6¾	7½
4	1	LH0540	4⅞	2⅝	6⅞	2⅝	3¼	¼	¾	6⅝	1⅞	2 7/16	2 7/16	6⅛	7
	1⅜	LH0541						⅜	1	6⅞	2⅛	2 11/16	2 11/16	6⅜	7¼
	1¾	LH0542						½	1¼	7⅛	2⅜	2 15/16	2 15/16	6⅝	7½
	2	LH0543						½	1⅜	7¼	2½	3 1/16	3 1/16	6¾	7⅝
	2½*	LH0544						⅝	1⅝	7½	2¾	3 5/16	3 5/16	7	7⅞
5	1	LH0550	5⅛	2⅞	7¼	2⅞	3⅛	¼	¾	6 15/16	2 1/16	2 7/16	2 7/16	6 7/16	7 7/16
	1⅜	LH0551						⅜	1	7 3/16	2 5/16	2 11/16	2 11/16	6 11/16	7 11/16
	1¾	LH0552						½	1¼	7 7/16	2 9/16	2 15/16	2 15/16	6 15/16	7 15/16
	2	LH0553						½	1⅜	7 9/16	2 11/16	3 1/16	3 1/16	7 1/16	8 1/16
	2½	LH0554						⅝	1⅝	7 13/16	2 15/16	3 5/16	3 5/16	7 5/16	8 5/16
	3	LH0555						⅝	1⅝	7 13/16	2 15/16	3 5/16	3 5/16	7 5/16	8 5/16
	3½*	LH0556						⅝	1⅝	7 13/16	2 15/16	3 5/16	3 5/16	7 5/16	8 5/16
6	1⅜	LH0560	5¾	3⅛	7¾	3⅛	3⅝	¼	⅞	7⅝	2 5/16	2 13/16	2 13/16	7 3/16	8⅛
	1¾	LH0561						⅜	1⅛	7⅞	2 9/16	3 1/16	3 1/16	7 7/16	8⅜
	2	LH0562						⅜	1¼	8	2 11/16	3 3/16	3 3/16	7 9/16	8½
	2½	LH0563						½	1½	8¼	2 15/16	3 7/16	3 7/16	7 13/16	8¾
	3	LH0564						½	1½	8¼	2 15/16	3 7/16	3 7/16	7 13/16	8¾
	3½	LH0565						½	1½	8¼	2 15/16	3 7/16	3 7/16	7 13/16	8¾
	4*	LH0566						½	1½	8¼	2 15/16	3 7/16	3 7/16	7 13/16	8¾

HOW TO ORDER

For ordering information refer to Page 68.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. (Example: DLH0051 (Refer to page 62.)

* Tapped holes on LH41 rod end cap have a shallower TB depth in these sizes.

† The standard rod eye or rod clevis will interfere with foot lugs on Model LH43. When these rod end accessories are required, use additional rod extension.

▲ For double rod end cylinders from 1½" thru 6" bore, add ½ + F to this dimension.

■ For double rod end cylinders from 1½" thru 6" bore, add ½ to this dimension.

• Available with fixed non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

Recommended Pressure Rating

Bore Ø	Pressure Rating (psi)
1½	1500
2	1500
2½	1500*
3¼	1500
4	1000
5	1000*
6	750

***NOTE:**

2½" Bore, ⅝" Rod, Rating 1000 psi
5" Bore, 1" Rod, Rating 750 psi

▼ TABLE 2LH

The dimensions are constant regardless of rod diameter or stroke.

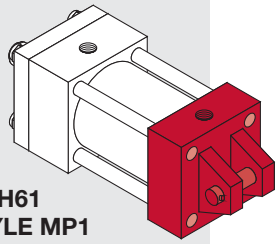
Bore Ø	E	EB	EE NPT	EE SAE	EL	EO	ET	F	G	J	K	NT	R	SB	ST	SU	SW	TB	TN	TS	US
1½	2	5/16	⅜	#6	¾	¼	½	⅜	1½	1	⅜	¼-20	1.43	7/16	½	15/16	⅜	⅜	⅝	2¾	3½
2	2½	⅜	⅜	#6	15/16	5/16	19/32	⅜	1½	1	7/16	5/16-18	1.84	7/16	½	15/16	⅜	9/16	⅞	3¼	4
2½	3	⅜	⅜	#6	1 1/16	5/16	¾	⅜	1½	1	7/16	⅜-16	2.19	7/16	½	15/16	⅜	⅝	1¼	3¾	4½
3¼	3¾	7/16	½	#10	⅞	⅜	29/32	⅝	1¾	1¼	½	½-13	2.76	9/16	¾	1¼	½	¾	1½	4¾	5¾
4	4½	7/16	½	#10	1	⅜	1⅛	⅝	1¾	1¼	½	½-13	3.32	9/16	¾	1¼	½	1	2 1/16	5½	6½
5	5½	9/16	½	#10	1 1/16	½	1 11/32	⅝	1¾	1¼	9/16	⅝-11	4.10	13/16	1	1 9/16	1 1/16	1	2 11/16	6⅞	8¼
6	6½	9/16	¾	#12	1	½	1 9/16	¾	2	1½	9/16	¾-10	4.88	13/16	1	1 9/16	1 1/16	1⅛	3¼	7⅞	9¼

For Package and Mounting Dimension see Tables 1LH and 2LH.

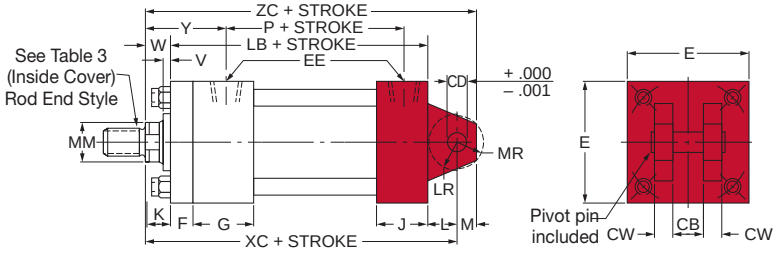
PIN AND TRUNNION MOUNTED CYLINDERS

All pin and trunnion cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and the trunnion and pivot pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.

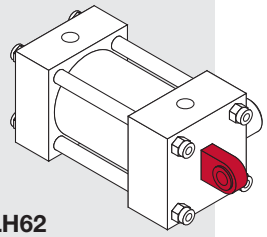
CLEVIS MOUNT



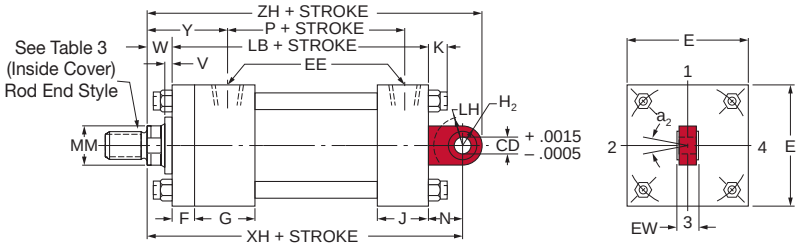
MODEL LH61
NFPA STYLE MP1



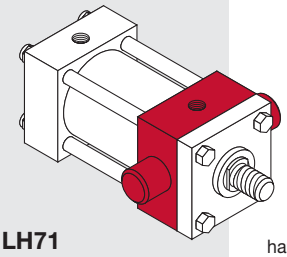
SPHERICAL EYE MOUNT



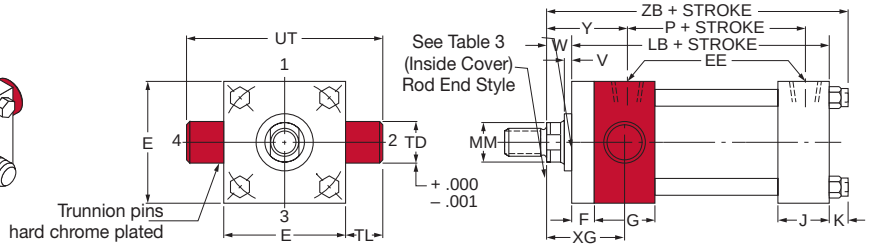
MODEL LH62
NFPA STYLE MP5



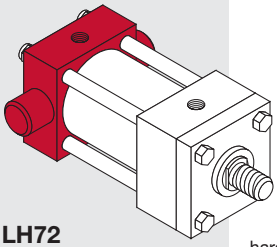
ROD END TRUNNION MOUNT



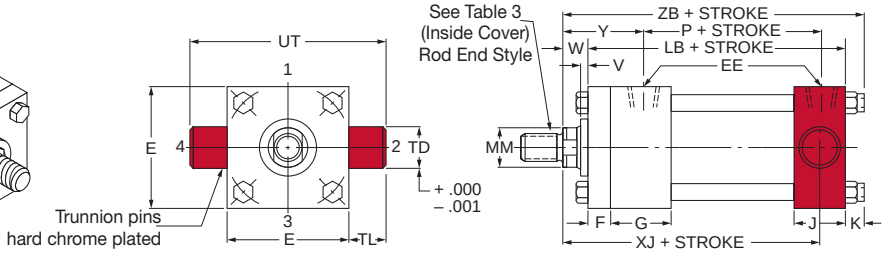
MODEL LH71
NFPA STYLE MT1



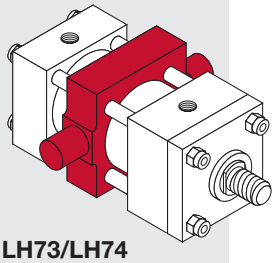
BLIND END TRUNNION MOUNT



MODEL LH72
NFPA STYLE MT2

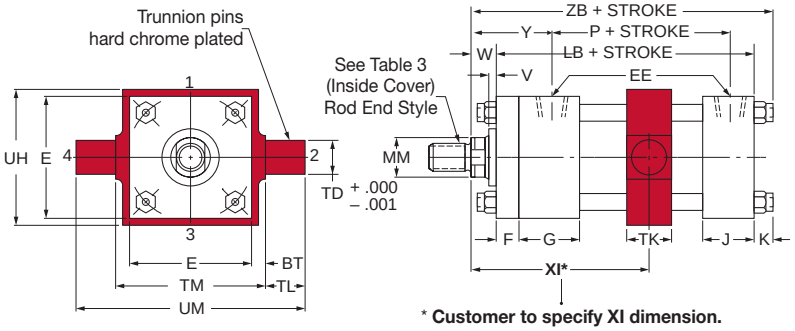


CENTER TRUNNION MOUNT



MODEL LH73/LH74
NFPA STYLE MT4

LH73 is an exclusive Milwaukee Cylinder design.
LH74 is the Industry "Standard" design.



* Customer to specify XI dimension.

▼ TABLE 1LH

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	LB	P	V	W	XC	XG	XH	XJ	Y	ZB	ZC	ZH
1½	5/8	LH0051	4	2¼	¼	5/8	5⅜	1¾	5½	4⅛	1 15/16	5	5⅞	6¼
	•1*	LH0052			½	1	5¾	2⅛	5⅞	4½	2 5/16	5⅜	6¼	6⅝
2	5/8	LH0510	4	2¼	¼	5/8	5⅜	1¾	5½	4⅛	1 15/16	5 1/16	5⅞	6¼
	1*	LH0511			½	1	5¾	2⅛	5⅞	4½	2 5/16	5 7/16	6¼	6⅝
	•1⅜*	LH0512			5/8	1¼	6	2⅜	6⅛	4¾	2 9/16	5 11/16	6½	6⅞
2½	5/8	LH0520	4⅛	2⅜	¼	5/8	5½	1¾	5⅝	4¼	1 15/16	5 3/16	6	6⅜
	1	LH0521			½	1	5⅞	2⅛	6	4⅝	2 5/16	5 9/16	6⅜	6¾
	1⅜	LH0522			5/8	1¼	6⅛	2⅜	6¼	4⅞	2 9/16	5 13/16	6⅝	7
	•1¾*	LH0523			¾	1½	6⅜	2⅝	6⅜	5⅛	2 13/16	6 1/16	6⅞	7⅛
3¼	1	LH0530	4⅞	2⅝	¼	¾	6⅞	2¼	6⅞	5	2 7/16	6⅛	7⅝	8⅛
	1⅜	LH0531			⅜	1	7⅛	2½	7⅛	5¼	2 11/16	6⅜	7⅞	8⅜
	1¾	LH0532			½	1¼	7⅜	2¾	7⅜	5½	2 15/16	6⅝	8⅛	8⅝
	2*	LH0533			½	1⅜	7½	2⅞	7½	5⅝	3 1/16	6¾	8¼	8¾
4	1	LH0540	4⅞	2⅝	¼	¾	6⅞	2¼	6⅞	5	2 7/16	6⅛	7⅝	8⅛
	1⅜	LH0541			⅜	1	7⅛	2½	7⅛	5¼	2 11/16	6⅜	7⅞	8⅜
	1¾	LH0542			½	1¼	7⅜	2¾	7⅜	5½	2 15/16	6⅝	8⅛	8⅝
	2	LH0543			½	1⅜	7½	2⅞	7½	5⅝	3 1/16	6¾	8¼	8¾
	2½*	LH0544			5/8	1⅝	7¾	3⅛	7¾	5⅞	3 5/16	7	8½	9
5	1	LH0550	5⅛	2⅞	¼	¾	7⅛	2¼	7⅛	5¼	2 7/16	6 7/16	7⅞	8⅜
	1⅜	LH0551			⅜	1	7⅜	2½	7⅜	5½	2 11/16	6 11/16	8⅛	8⅝
	1¾	LH0552			½	1¼	7⅝	2¾	7⅝	5¾	2 15/16	6 15/16	8⅜	8⅞
	2	LH0553			½	1⅜	7¾	2⅞	7¾	5⅞	3 1/16	7 1/16	8½	9
	2½	LH0554			5/8	1⅝	8	3⅛	8	6⅛	3 5/16	7 5/16	8¾	9¼
	3	LH0555			5/8	1⅝	8	3⅛	8	6⅛	3 5/16	7 5/16	8¾	9¼
	3½*	LH0556			5/8	1⅝	8	3⅛	8	6⅛	3 5/16	7 5/16	8¾	9¼
6	1⅜	LH0560	5¾	3⅛	¼	⅞	8⅛	2⅝	8¼	5⅞	2 13/16	7 3/16	9⅛	10
	1¾	LH0561			⅜	1⅛	8⅜	2⅞	8½	6⅛	3 1/16	7 7/16	9⅜	10¼
	2	LH0562			⅜	1¼	8½	3	8⅝	6¼	3 3/16	7 9/16	9½	10⅜
	2½	LH0563			½	1½	8¾	3¼	8⅞	6½	3 7/16	7 13/16	9¾	10⅝
	3	LH0564			½	1½	8¾	3¼	8⅞	6½	3 7/16	7 13/16	9¾	10⅝
	3½	LH0565			½	1½	8¾	3¼	8⅞	6½	3 7/16	7 13/16	9¾	10⅝
	4	LH0566			½	1½	8¾	3¼	8⅞	6½	3 7/16	7 13/16	9¾	10⅝

HOW TO ORDER

For ordering information refer to Page 68.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DLH0051 (Refer to page 62.) Double rod ends are not available on LH61 or LH62 mount styles of Series LH cylinders.

• Available with fixed non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

* Removable retainer not available for these bore and rod combinations: LH61 and LH73/LH74 mounting styles.

Rod End Styles and Dimensions

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

Recommended Pressure Rating

Bore Ø	Pressure Rating (psi)
1½	1500
2	1500
2½	1500*
3¼	1500
4	1000
5	1000*
6	750

***NOTE:**

2½" Bore, 5/8" Rod, Rating 1000 psi
5" Bore, 1" Rod, Rating 750 psi

▼ TABLE 2LH

The dimensions are constant regardless of rod diameter or stroke.

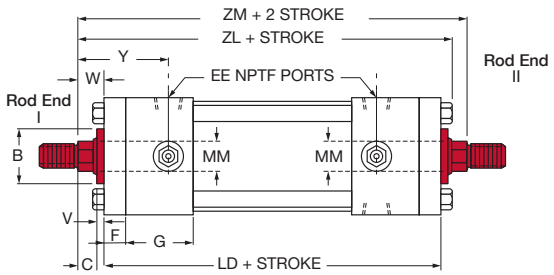
Bore Ø	a_2	BT	CB	CD	CW	E	EE NPT	EE SAE	EW	F	G	H_2	J	K	L	LH	LR	M	MR	N	TD	TL	LH73 TK	LH73 TM	LH73 UH	LH73 UM	LH74 TK	LH74 TM	LH74 UH	LH74 UM	UT
1½	13°	¾	¾	½	½	2	⅜	#6	5/8	⅜	1½	13/16	1	⅜	¾	5/8	5/8	½	21/32	⅞	1	1	1⅛	3½	2⅜	5½	1¼	2½	2½	4½	4
2	13°	¾	¾	½	½	2½	⅜	#6	5/8	⅜	1½	13/16	1	7/16	¾	5/8	5/8	½	11/16	⅞	1	1	1⅛	4	2⅞	6	1½	3	3	5	4½
2½	13°	¾	¾	½	½	3	⅜	#6	5/8	⅜	1½	13/16	1	7/16	¾	5/8	5/8	½	11/16	⅞	1	1	1⅛	4½	3⅜	6½	1½	3½	3½	5½	5
3¼	13°	¾	1¼	¾	5/8	3¾	½	#10	⅞	5/8	1¾	1¼	1¼	½	1¼	1	1 1/16	¾	15/16	1¼	1	1	1¼	5¼	4⅛	7¼	2	4½	4¼	6½	5¾
4	13°	¾	1¼	¾	5/8	4½	½	#10	⅞	5/8	1¾	1¼	1¼	½	1¼	1	1 1/16	¾	15/16	1¼	1	1	1¼	6	5	8	2	5¼	5	7¼	6½
5	13°	¾	1¼	¾	5/8	5½	½	#10	⅞	5/8	1¾	1¼	1¼	9/16	1¼	1	1 1/16	¾	15/16	1¼	1	1	1¼	7	6	9	2	6¼	6	8¼	7½
6	12½°	1	1½	1	¾	6½	¾	#12	1⅜	¾	2	1¾	1½	9/16	1½	1¼	1¼	1	1 3/16	1⅝	1⅜	1⅜	1½	8½	7	11¼	2½	7⅝	7	10⅜	9¼

DOUBLE ROD END CYLINDERS

Milwaukee Cylinder's Double Rod End Cylinders are available with all the standard types of mountings, except LH61 and LH62 mount styles of Series LH cylinders.

To obtain dimensional information on a double rod end cylinder, first select the desired mounting style and refer to the corresponding single rod end cylinder model shown on the preceding pages. After you have determined all necessary dimensions from the previous page covering the desired mounting, turn back to this page. Supplement those dimensions with additional ones from the drawings below and the table at the right. These added dimensions differ from, or are in addition to, those shown on the preceding pages and provide the additional information needed to completely dimension a double rod end cylinder model.

On a double rod end cylinder where two different rod ends are required, or two different rod sizes are required, or cushions on one end are required, be sure to state clearly which rod is to go at which end of the cylinder. When two types of mounting styles are required, be sure to specify their relationship to the piston rods, if they are not the same.



▼ DOUBLE ROD END CYLINDERS

Bore Ø	Rod MM	Cylinder Code	LD*	SE*	SS*	ZL	ZM
1½	⅝	DLH051	4⅞	6⅜	3⅜	5⅞	6⅛
	1	DLH052				6¼	6⅞
2	⅝	DLH510	4⅞	6¾	3⅜	5 15/16	6⅛
	1	DLH511				6 5/16	6⅞
	1⅜	DLH512				6 9/16	7⅜
2½	⅝	DLH520	5	7⅛	3½	6 1/16	6¼
	1	DLH521				6 7/16	7
	1⅜	DLH522				6 11/16	7½
	1¾	DLH523				6 15/16	8
3¼	1	DLH530	6	7¾	3¾	7¼	7½
	1⅜	DLH531				7½	8
	1¾	DLH532				7¾	8½
	2	DLH533				7⅞	8¾
4	1	DLH540	6	8	3¾	7¼	7½
	1⅜	DLH541				7½	8
	1¾	DLH542				7¾	8½
	2	DLH543				7⅞	8¾
	2½	DLH544				8⅛	9¼
5	1	DLH550	6¼	8⅜	3⅝	7 9/16	7¾
	1⅜	DLH551				7 13/16	8¼
	1¾	DLH552				8 1/16	8¾
	2	DLH553				8 3/16	9
	2½	DLH554				8 7/16	9½
	3	DLH555					
	3½	DLH556					
6	1⅜	DLH560	7	8⅞	4⅛	8 7/16	8¾
	1¾	DLH561				9 11/16	9¼
	2	DLH562				8 13/16	9½
	2½	DLH563				9 1/16	10
	3	DLH564					
	3½	DLH565					
	4	DLH566					

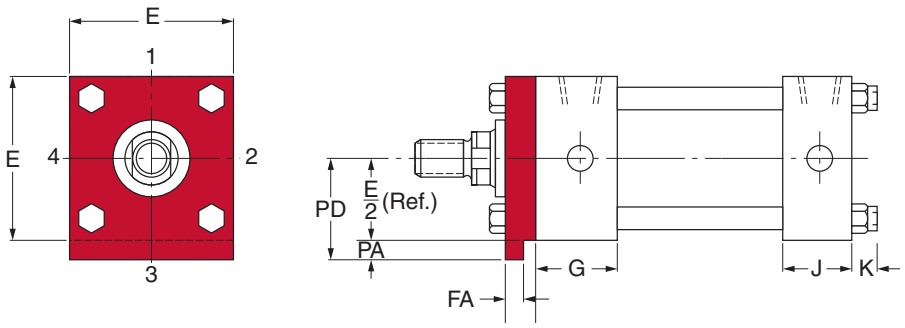
* NOTE: These dimensions are to be substituted for the related mounting dimensions given on the preceding pages. All dimensions given on this table are plus stroke.

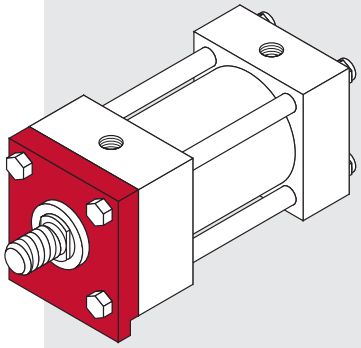
KEY MOUNT CYLINDERS

The *Milwaukee Cylinder* Key Mount retainer plate is a mounting option designed to add rugged stability to foot and side mount cylinders. The retainer plate is extended below the mounting surface of the cylinder. This extension may be fitted into a milled keyway in your mounting pad, eliminating the need for welded keys or locator pins.

HOW TO ORDER

For ordering information refer to Page 68.



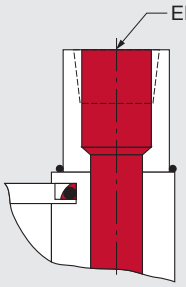


▼ KEY MOUNT CYLINDERS

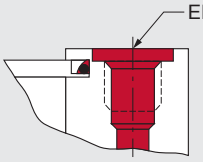
Bore Ø	E	F	FA	G	PA	PD
1½	2	⅜	.312/.310	1½	3/16	1 3/16
2	2½	⅜	.312/.310	1½	3/16	1 7/16
2½	3	⅜	.312/.310	1½	3/16	1 11/16
3¼	3¾	⅝	.562/.560	1¾	5/16	2 3/16
4	4½	⅝	.562/.560	1¾	5/16	2 9/16
5	5½	⅝	.562/.560	1¾	5/16	3 1/16
6	6½	¾	.687/.684	2	⅜	3⅝

***MilCad* Cylinder Configurator**

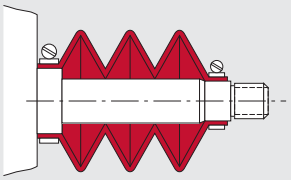
Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.



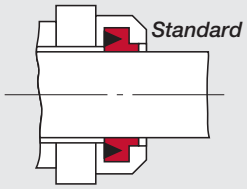
Oversize Port Welded Boss

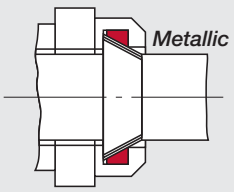


SAE Straight Thread O-ring Port



Rod Boots





Metallic Rod Wipers

STANDARD DESIGN OPTIONS

Standard Ports

The *Milwaukee Cylinder* Series LH Cylinders are manufactured as standard, with the largest NPTF tapered thread ports that will fit in both the rod and blind ends of a given bore size. Upon request, extra ports can be provided on the sides of the end caps not occupied by mountings or cushion adjusters.

Oversize Ports

On most bore sizes, welded bosses may be provided for oversize NPTF ports. These bosses protrude from the sides of the end caps. For information as to the boss height in relation to your bore and port requirements, contact your local *Milwaukee Cylinder* Representative. Also, special heavier end caps can be provided so that oversize ports can be accommodated without the use of a welded boss.

Straight Thread Ports

On request, *Milwaukee Cylinder* will furnish an SAE straight thread O-Ring port on the Series LH Cylinders. In addition to the standard oversize NPTF ports, welded bosses may also be used for oversize SAE straight thread O-Ring ports. For further information on oversize SAE ports, contact the factory.

Note:
Flange and manifold style ports are available from *Milwaukee Cylinder*.

Rod Boots

When cylinders are used in areas of high contamination or where contaminants have an air hardening property, the exposed piston rod should be covered with a rod boot to protect the rod bearing and seals. A rod boot is simply a collapsible cover. It is of sewn construction made from a neoprene coated fabric. The rod boots are impervious to oil, grease and water. They will operate effectively from 0° F to +200° F without cracking. For additional details on Rod Boots, please see page 186.

Metallic Rod Wipers

If requested, metallic rod wipers will be supplied in place of the standard synthetic rubber wiper. This type of seal is recommended for applications where contaminants would tend to cling to the rod and damage a standard synthetic rubber rod wiper.

▼ PORT SIZES

Bore Ø	Standard NPTF Port EE	Oversized NPTF Port EE_1	SAE Straight O-Ring Port	
			EE_2	SAE Standard Thread Series
1½	⅜	½	#6	9/16-18
2	⅜	½	#6	9/16-18
2½	⅜	½	#6	9/16-18
3¼	½	¾	#10	7/8-14
4	½	¾	#10	7/8-14
5	½	¾	#10	7/8-14
6	¾	1	#12	1 1/16-12

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

DESIGN OPTIONS FOR SPECIAL CYLINDERS

Special Rod Ends

Modifications of standard or entirely special rod ends are available from *Milwaukee Cylinder*. When your requirements call for a special rod end style, your order should include a sketch if it is to be an entirely special rod end or note reference as to which letter dimensions you wish to have modified (see inside front cover).

Special Assemblies from Standard Parts

Each style of the various standard cylinder mountings is illustrated, using the commonly recognized cylinder dimensional symbols of the National Fluid Power Association. Each side of the end views are numbered to aid in communication when referring to the relationship between the ports and the mountings. When requesting information or placing an order that requires a dimension other than standard, always make reference to the given dimensional symbol in the catalog and then give your requirements.

Cushion Adjustment Locations

A ball check and a cushion adjustment needle are supplied as standard in position #2 on most models. The cushion needle and ball check are interchangeable as far as location and may be put in any side not occupied by a port or mounting.

Port Locations

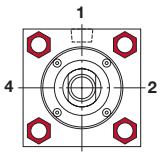
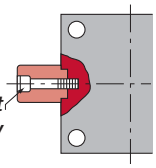


Figure 1

Ports are located in position #1 as standard unless otherwise specified. By using the position numbers given with the end views in the dimensional data section of this catalog, ports can be arranged in any one of four 90° positions in relation to the cylinder mounting. When ports are relocated on a cushioned cylinder, the cushion needle and ball check are automatically relocated to hold their relationship to the port as on a standard cylinder, unless otherwise specified at the time of the order.

Removable Trunnion Pins


Self-Locking Socket Head Capscrew

Removable trunnion pins are available on models LH71 and LH72. They can be used on all bore and rod combinations, except on the largest oversize rods offered with each bore size on all model LH71 cylinders.

Single-Acting Cylinders

The *Milwaukee Cylinder's* Series LH cylinders are designed for either single or double action. When used as a single acting cylinder, hydraulic power drives the piston in one direction, only relying on either the load or an external force to return the piston after the pressure is exhausted.

Single-Acting Spring Cylinders

Single-acting spring return cylinders normally have a spring inside of the cylinder to return the piston to its original position. The application load and friction conditions must be specified when placing an order to properly size the spring. Also specify whether the spring is to return or advance the piston. A spring return cylinder is designed with a stop tube to act as spring guide, which prevents binding of the cylinder due to misalignment of the spring. To accurately determine the cylinder length and mounting dimensions for your application, contact your local *Milwaukee Cylinder* representative or the factory.

Water Service Cylinders

Milwaukee Cylinder's Series LH Cylinders can be used with water as an operating fluid with some standard modifications to the types of material and the manufacturing processes used. These modifications will include, at some additional cost, bronze piston, nickel plated end caps, a hard chrome plated cylinder barrel and a chrome plated piston or stainless steel piston rod at extra cost. Due to the increased factors of corrosion, electrolysis and mineral deposits acting within a water fitted cylinder, *Milwaukee Cylinder* cannot warrant or make any guarantees other than a water service cylinder will be free of defects in workmanship or materials.

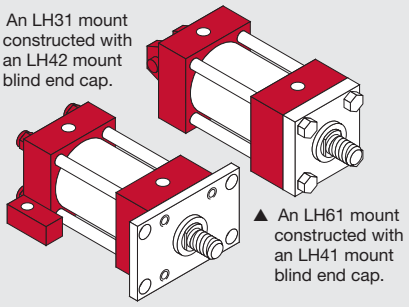
Proximity Switches

End of Stroke Limit Switches:

We provide inductive proximity switches for end of stroke sensing. These non-contact switches detect the presence of the spud/cushion bushing. See page 185 for more information.

Combined Mountings

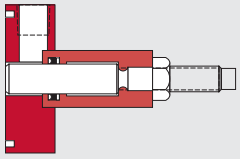
Standard mountings may be combined when specified by the customer. Some examples of this are:


▼ An LH31 mount constructed with an LH42 mount blind end cap.

▲ An LH61 mount constructed with an LH41 mount blind end cap.

These and other combinations can be readily made from standard parts. If you are unsure of a possible combination or if it will suit your particular needs, consult with your local *Milwaukee Cylinder* representative or contact the factory.

Adjustable Stroke Cylinders

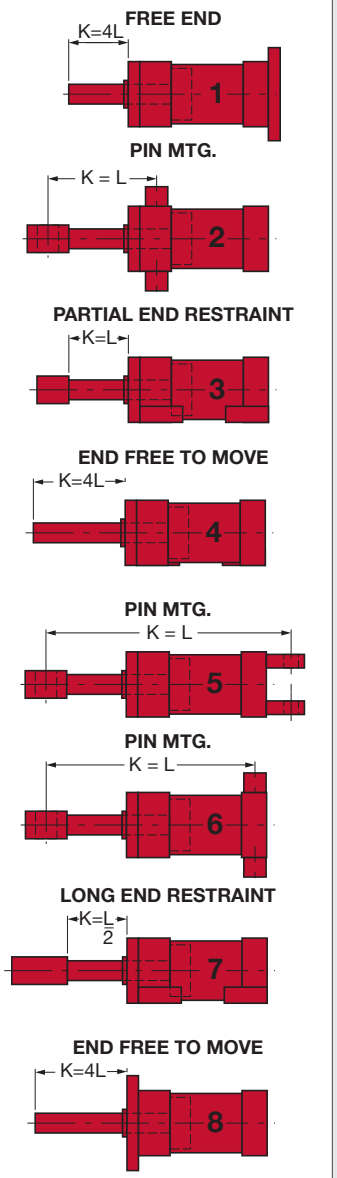


When a cylinder application requires stroke adjustment, *Milwaukee Cylinder* offers a number of designs, the most common of which is illustrated below. This particular design is externally adjustable, incorporating a threaded rod (of piston rod quality) with the standard hydraulic rod end multiple lip vee seal and bushing design. This provides a proven-effective high and low pressure seal, affording maximum sealing on the stroke adjustment rod.

Further information concerning design limitations, cushioning or alternate designs can be obtained by contacting the factory.

CAUTION!
Cylinders with removable trunnion pins will have a reduced pressure rating. Consult the factory.

FIGURE 1



Stop Tubes
For more information on Stop Tubes, see page 181 in the Design Engineer's Guide.

STOP TUBES

Stop tubes are used to maintain bearing pressure within acceptable limits and are recommended on cylinders with long strokes or poorly guided rods.

The stop tube is a spacer between the rod end cap and the piston, which provides separation between the piston and the rod bearing. This separation reduces the moment forces developed between the rod bearing and piston when the rod is extended.

To determine if stop tube is necessary for your cylinder requirements, you have to solve for "K" (refer to Figure 1). If your required cylinder has a "K" dimension in excess of 40 inches, stop tube is required. For each 10 inch increment or fraction thereof in excess of 40 inches, one inch of stop tube is recommended. When stop tube is required, the overall length of the cylinder will be increased by the length of the stop tube to be used.

To determine "K" (see to Figure 1)
*Note: W = the rod stick out
(refer to pages 54-63)

Cylinder #1, #4, #8 – see Figure 1

K = 4L= 4 (stroke + W*)

Cylinder #2 - see Figure 1

K = L = (CA or CE) + XG + Stroke

Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XG = mounting dimension page 60

Cylinder #3 – see Figure 1

K = L = W* + Stroke

Cylinder #5 – see Figure 1

K = L = (CA or CE) + XC + (2 x Stroke)

Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XC = mounting dimension page 60

Cylinder #6 – see Figure 1

K = L = (CA or CE) + XJ + (2 x Stroke)

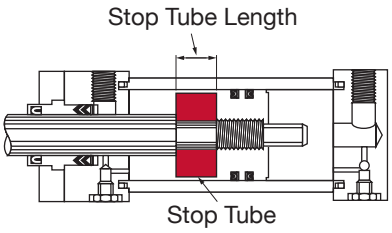
Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XJ = mounting dimension page 60

Cylinder #7 – see Figure 1

K = L/2 =(W* + Stroke)/2

When mounting long stroke cylinders, care should be taken to assure cylinder alignment over the entire length of stroke. The use of external guides or swivel bushings is recommended to reduce side load conditions and prolong the cylinder's service life.

Note: Stop tube length must be added to "K" factor before making final selection of rod size. This is primarily true in No. 5 long stroke applications.



The stop tube is located between the piston and the rod end cap. It limits the extended stroke of the cylinder, providing additional strength for less cost and reduced weight than the use of an oversize rod.

▼ TABLE 1 - VALUE OF "K" IN INCHES

Thrust Force (in-lbs)	Piston Rod Diameter (in)												
	⅝	1	1⅜	1¾	2	2½	3	3½	4	4½	5	5½	7
400	35	84	134	–	–	–	–	–	–	–	–	–	–
700	30	68	119	–	–	–	–	–	–	–	–	–	–
1,000	26	60	105	156	190	–	–	–	–	–	–	–	–
1,400	24	54	93	144	175	244	308	–	–	–	–	–	–
1,800	23	48	84	127	160	230	294	366	–	–	–	–	–
2,400	18	45	75	114	145	214	281	347	–	–	–	–	–
3,200	16	40	68	103	131	196	262	329	398	–	–	–	–
4,000	12	38	63	93	119	174	240	310	373	446	–	–	–
5,000	9	36	60	87	112	163	225	289	359	426	–	–	–
6,000	–	30	56	82	102	152	209	274	342	411	476	–	–
8,000	–	25	51	76	93	136	186	244	310	375	448	–	–
10,000	–	21	45	70	89	125	172	221	279	349	412	–	–
12,000	–	17	41	64	85	117	155	210	270	326	388	455	–
16,000	–	–	35	57	75	110	141	188	233	291	350	421	–
20,000	–	–	28	52	66	103	136	173	218	270	325	385	–
30,000	–	–	–	39	56	87	120	156	190	232	285	330	–
40,000	–	–	–	24	43	75	108	142	177	210	248	293	–
50,000	–	–	–	–	30	66	97	131	165	201	234	268	408
60,000	–	–	–	–	–	57	88	119	154	190	226	256	384
80,000	–	–	–	–	–	36	71	104	136	170	204	240	336
100,000	–	–	–	–	–	–	56	91	120	154	199	224	324
120,000	–	–	–	–	–	–	45	76	108	146	174	207	313
140,000	–	–	–	–	–	–	–	64	98	129	162	194	301
160,000	–	–	–	–	–	–	–	47	87	118	149	182	279
200,000	–	–	–	–	–	–	–	–	65	98	131	160	260
250,000	–	–	–	–	–	–	–	–	–	72	109	143	236
300,000	–	–	–	–	–	–	–	–	–	–	85	120	212
350,000	–	–	–	–	–	–	–	–	–	–	53	100	195
400,000	–	–	–	–	–	–	–	–	–	–	–	72	182
500,000	–	–	–	–	–	–	–	–	–	–	–	–	152
600,000	–	–	–	–	–	–	–	–	–	–	–	–	114
700,000	–	–	–	–	–	–	–	–	–	–	–	–	70

▼ TABLE 2 - DEDUCTIONS FOR PULL STROKE FORCE & DISPLACEMENT

Piston Rod Ø	Piston Rod Area	Cylinder Force in Pounds for Various Pressures								Displacement /in of Stroke
		100 psi	200 psi	250 psi	500 psi	750 psi	1000 psi	1250 psi	1500 psi	Gallons Oil Displaced
⅝	.307	31	61	77	154	230	307	384	461	.00133
1	.785	79	157	196	393	589	785	981	1178	.00340
1⅜	1.485	149	297	371	743	1114	1485	1856	2228	.00643
1¾	2.405	241	481	601	1203	1804	2405	3006	3608	.01041
2	3.142	314	628	786	1571	2357	3142	3928	4713	.01360
2½	4.909	491	982	1227	2455	3682	4909	6137	7364	.02125
3	7.069	707	1414	1767	3535	5302	7069	8836	10600	.03060
3½	9.621	962	1924	2405	4811	7216	9621	12026	14430	.04165
4	12.57	1257	2514	3143	6285	9428	12570	15708	18860	.05442

▼ TABLE 3 - THRUST FORCE AND DISPLACEMENT

Cylinder Bore Ø	Piston Area	Cylinder Force in Pounds for Various Pressures								Displacement /in of Stroke
		100 psi	200 psi	250 psi	500 psi	750 psi	1000 psi	1250 psi	1500 psi	Gallons Oil Displaced
1½	1.767	177	353	442	884	1325	1767	2209	2651	.00765
2	3.142	314	628	786	1571	2357	3142	3928	4713	.01360
2½	4.909	491	982	1227	2455	3682	4909	6137	7364	.02125
3¼	8.296	830	1659	2074	4148	6222	8296	10370	12440	.03591
4	12.57	1257	2514	3143	6285	9428	12570	15708	18860	.05442
5	19.64	1964	3928	4910	9820	14730	19640	24544	29460	.08502
6	28.27	2827	5654	7068	14140	21200	28270	35342	42400	.12230

CYLINDER SIZING

The selection of the correct rod size is one of the most important factors in sizing a cylinder. The standard rod for each bore size that *Milwaukee Cylinder* manufactures is sufficient to handle the maximum tension force that the cylinder is capable of producing. It is primarily in compression and long stroke, high thrust applications that the column strength needs to be considered.

The following steps should be used to determine the proper rod size for an application:

1. Select the cylinder bore size required from Table 3 based on the required cylinder thrust force and the operating line pressure at the cylinder.
2. Determine the length between mounting points or "L" as shown on Figure 1, page 66.
3. Based on the distance between mounting points ("L"), determine the value of "K" as shown on Figure 1, page 66.
4. Using the thrust force and the developed "K" dimension, refer to Table 1 to select the proper rod size.
5. If an oversized rod is required, re-check the overall length dimension ("K") in Step 1 and confirm your previous rod size selection.

To determine the cylinder pull (tension), stroke force, or displacement, deduct the force or displacement corresponding to the rod size in Table 2 from the force or displacement corresponding to the bore size shown in Table 3.

Feature	Description	Page Number	Code Number
Double Rod End		62	D
Cylinder Code	Refer to Table 1LH	55, 57, 59, and 61	—
Mounting Style	Model Number Only	54, 56, 58, and 60	—
Rod End Style	Code Number	inside front cover (ii)	—
Cushions	None Rod End Blind End Both Ends	— — — —	1 2 3 4
Cylinder Modifications	Special		S
Seals	BUNA-N (-20° to 200° F) Viton (-15° to 350° F) Special		7 8 S
Stroke	Specify in Inches Including Fractional Requirements		—

Example: LH0542 – 31 – 1 4 ___ – 7 × 14¾

If Standard Leave Blank

*If Special Describe Requirements

*__NOTE:__ Use “S” if any special design features or seals are required, describe in detail on your order.

__EXAMPLE:__ The code for a hydraulic cylinder 4" bore, rod end rectangular flange mounting, 1¾" rod, style No. 1 rod end, cushion both ends, standard seals with a 14¾" stroke is **LH0542-31-14-7x14¾.**

DUPLICATE CYLINDERS

Duplicate cylinders can be ordered by giving the serial number from the nameplate of the original cylinder. Factory records supply a quick, positive identification.

HOW TO ORDER

Series LH Cylinders

Standard Series LH Cylinders can be completely and accurately described by a model number. If your requirements are completely standard, select the alphanumeric codes from above that represent your cylinder and place them in the sequence indicated by the example. Use of the cylinder model number will eliminate untimely delays in handling your order.

General Order Data

1. Bore & Rod Size or the Cylinder Code: (refer to pages 54-63)
2. Mounting Style: (refer to page 54-63)
3. Rod End Style: (refer to Inside Cover, page ii)
4. Cushion Requirements
5. Length of Stroke

Application Data

1. **Port Requirements**: refer to page 64.
2. **Operating Fluid or Medium:** Series LH Cylinders are equipped with seals for use with hydraulic oil. If other than a quality grade hydraulic oil will be used, specify the type of fluid in your order. See page 184 for more details.
3. **Temperature Range:** Series LH Hydraulic Cylinders contain seals of Nitrile (Buna-N) suitable to -20° F to +200° F. Specify your operating temperature if your application does not fall within this temperature range.
4. **Operating Pressure:** Series LH Cylinders are rated for 750-1500 PSI. If your requirements are in excess of the rated pressure, describe your application in your order.
5. **Accessories**: Specify any accessories you require, using the part numbers given on the inside back cover.
6. **Special Requirements:** If you require special seals, rod material, stop tube, center support, adjustable stroke or any other special requirements not covered, specify in detail on your order.

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

REPLACEMENT SEALS OR CYLINDER PARTS

For replacement seals or cylinder parts, the serial number of your cylinder, the cylinder model number and the item number of the part you require (below) should appear on your order. To order entire seal kits for your cylinder, simply specify the serial number and the cylinder model number from page 68 on your request for service parts.

HOW TO ORDER COMPLETE SEAL KITS

When ordering complete seal kits, specify the following information on your order:

1. The serial number of the cylinder the seals will be used on.
2. The bore and rod size.
3. If the cylinder is cushioned.

To eliminate untimely delays in the handling of your order, please use the seal kit code as shown in the example below:

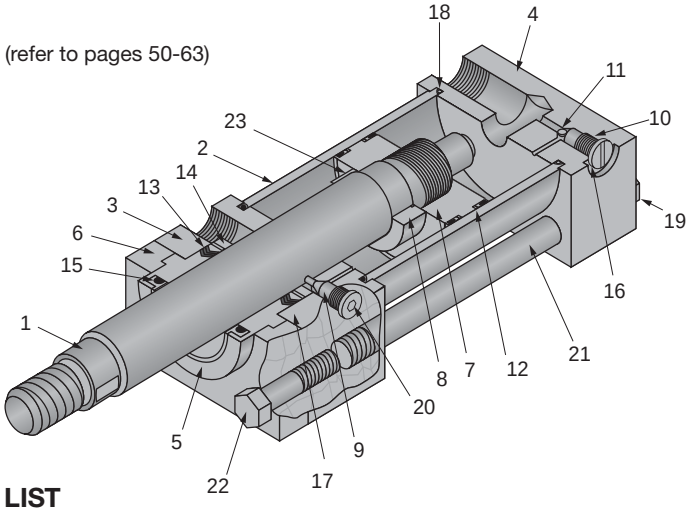
Example:

Buna-N Kit No. XXXXX-7-50

- cylinder code number (refer to pages 50-63)

Viton Kit No. XXXXX-8-50

- cylinder code number (refer to pages 50-63)



▼ STANDARD PARTS LIST

Item No.	Description
1	Piston Rod
2	Cylinder Barrel
3	Head End Cap
4	Cap End Cap
5	Rod Bushing
6	Retainer Plate
7	Piston
8	Cushion Plunger
9	Cushion Adj. Plunger
10	Ball Check Retainer
11	Ball Check
12	U-Cup Seal & Backup Washer for Piston
13	Rod Vee Ring Set
14	Rear Bearing Ring
15	Rod Wiper
16	O-Ring Seal for Ball Check Retainer
17	Wave Spring
18	Cylinder Barrel O-Ring
19	Tie Rod Flex Lock Nut
20	O-Ring Seal for Cushion Adj. Needle
21	Tie Rod
22	Self-Locking Cap Screw
23	O-Ring for Floating Cushion

Retainer Plate Cap Screw Torques

▼ For Square Retainers

Bore Ø	Torque (Ft-lbs)
1½	10
2	20
2½	20
3¼	30
4	30
5	50
6	50

Tie-rod Nut Torques

▼ Nut Torque Specifications

Bore Ø	Torque (Ft-lbs)
1½	8
2	18
2½	18
3¼	35
4	35
5	60
6	60

When it is necessary to remove the tie-rod nuts on a cylinder, they must be reassembled to the torque specifications given above. To prevent the tie-rods from twisting when tightened, use a vice grip or locking clamp. Note that the torque specification is based on lubricated threads.

INSTALLATION FOR SERIES LH

General Information

Cleanliness

The most important consideration when installing the cylinder. When cylinders are shipped from *Milwaukee Cylinder*, the ports are securely plugged with plastic plugs which should not be removed until the piping is to be installed. All piping should be thoroughly clean, to include the removal of all threading and flaring burrs or chips, before making the connection to the cylinder ports. One chip can cause premature failure of the cylinder or other hydraulic system components.

Alignment

Improper alignment will result in excessive cylinder wear. Check to assure rod alignment between the cylinder and its mating component on your machine in both the extended and retracted positions.

Environment

Cylinders operating in areas where there is weld splatter, fast drying chemicals, paint, excessive heat or other hazardous conditions, should have covers or shields to prevent damage to the rod and rod seals.

Bleeding

Air within the cylinder or system will cause erratic operation of the cylinder. Our cylinders generally do not require bleed ports if the cylinder ports are mounted in an upright position. Several full strokes of the cylinder will purge air from the cylinder into the circuit piping, where it can be bled off. Bleeder ports are available for applications where the cylinder is the high point of the circuit or where the cylinder does not complete a full stroke during its normal cycle.

MOUNTING RECOMMENDATIONS

Foot Mounted Cylinders

The use of high strength alloy steel mounting bolts 1/16" smaller than the hole size is recommended. After final alignment, foot mounted cylinders should be dowel pinned in place.

Trunnion Mounted Cylinders

Lubricated pillow blocks designed for close tolerance applications should be used. It is important to rigidly mount and align the pillow blocks so that the trunnion pins will not be subjected to any extreme bending moments The rod end should be pivoted with the pivot pin in line and parallel to the axis of the trunnion pins.

Flush Mount Cylinders

The use of high strength alloy steel mounting bolts is recommended. Shear keys should be used to reduce the stress on the mounting bolts created by the normal push and pull forces created by the cylinder cycle.

Flange Mount Cylinders

The controlled diameter rod bushing extension can be used as a pilot to locate the flange mount. Dowel pins should be used after the cylinder is mounted and aligned to prevent shifting.

Clevis Mount Cylinders

This type of cylinder must be pivoted at both ends and the pins must be in line and parallel to each other. After the cylinder is mounted, the customer should check to assure that the cylinder is free to swing through its working arc without interference from other machined parts.

STORAGE

Often times, cylinders are delivered before a customer is prepared to install them and must be stored for a period of time. When storage is required:

1. Select an area indoors for storage, which has dry and non-corrosive atmosphere. Take caution to protect the cylinder from both internal and external corrosion.
2. Cylinders to be stored should be kept in a vertical position (piston rod up) whenever possible.
3. Port protector plugs should be kept in the cylinder ports until the time of installation.

CYLINDER TROUBLE SHOOTING

1. **External leakage**

   If leaking occurs between the end cap and barrel, check tie-rod torque. Do not over torque. If the torque is correct, then replace the barrel seal. When leakage occurs in the rod bushing area, replace the rod seals. If leakage continues or reoccurs in short period of operation, check items 2 thru 5, page 69.

2. **Cylinder misalignment**

   Side load is a common problem which occurs when the cylinder application does not allow the piston rod to work in line during the extend and retract motions of the cylinder. Evidence of this is excessive seal failure, bushing wear or galling of the piston rod. Often, bending of the piston rod or complete failure (breakage) of the rod occurs.

3. **Contamination on the piston rod**

   Dirt and other material is often picked up when the piston rod is extended. When the rod is retracted in an excessive dirty application, it often carries the dirt back into the rod seal cavity of the cylinder, causing damage to the seals. With a slight modification of the cylinder rod end, a rod boot can be added to protect the rod bushing and seals for most applications.

4. **Bad mountings**

   Due to wear of pivot pins or mounting bolts working loose, a cylinder may have side load, even though the rod was in line when the cylinder was first installed. All cylinder mountings should be checked periodically.

5. **Damaged piston rod**

   An extended piston rod can be damaged by the impact of a hard object which could burr the rod. If this occurs, the rod should be checked immediately to prevent seal damage.

6. **Internal leakage**

   Inside the cylinder, leakage past the piston seals can cause sluggish movement or settling of the cylinder under load conditions. This occurs due to leakage of worn piston seals or rings.

7. **Creeping cylinder**

   When a cylinder is stopped in midstroke and it creeps, check for internal leakage. Creeping can also be caused by a worn control valve and this should be checked, even if the cylinder is found to have internal leakage.

8. **Erratic operation**

   When a cylinder is erratic or sluggish in operation, this may be caused by a number of problems. The most common cause of sluggish operation is air in the system. Internal leakage could also be a cause. If the system starts out sluggishly and, as it warms, speeds up, the oil may be of too high viscosity. The whole system should be checked for worn components if after these checks, the cylinder is still operating in a sluggish manner.

CYLINDER MAINTENANCE

Rod Seal Replacement

When changing rod seals, extend the piston rod 3" or more if possible, being sure to support the rod at all times. Remove the retainer plate screws (if tie-rod nuts have to be removed, refer to the nut torque specification on this page when reassembling the cylinder), retainer plate and outer bushing. Using an eye hook or thin screwdriver, pry the vees from the end cap cavity (if low pressure air is applied to the rod end port, this will help to force the vees from the cavity). The new set of vees should be assembled into the cavity separately and lubed with the soft vee in the center. Replace the rod wiper in the bushing and reassemble the cylinder.

Piston Seal Replacement

When changing piston seals, extend the piston rod 3" or more if possible, being sure to support the piston rod and the piston at all times. *Remove the tie-rod nuts, blind end cap, the barrel and then the piston seals. A light grease, compatible with the system fluid, should be used on the rings and block vee seals for smooth assembly. Install the block vee piston seals, scarf cutting on only the back-up washers. Then install the cast iron rings with the joints in opposite directions. To reassemble, start the piston into the tube, compressing the cast iron rings using twine or a ring compressor. When the piston block vee seal is to the edge of the barrel, use a thin rounded blade to start the lip of the block vee, making sure the entire lip is started before moving the piston further into the tube.

***Note:** When a cylinder has been disassembled this far, the barrel seals should at least be inspected, if not replaced.

Barrel Seal Replacement

When replacing barrel seals, use the same method of disassembling the cylinder as used when replacing piston seals. The barrel seal consists of a backup washer and O-Ring, which is assembled on the first step of both ends of the tube, with the backup washer going on first. The outer diameter of the tube groove on the end caps must be checked for nicks or burrs and then greased. Position the end caps squarely on the tube (check to make sure port location is correct) and firmly force or tap the end cap over the tube until it bottoms. Check to make sure the O-Ring did not shear and then finish assembling the cylinder.

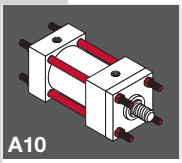
▼ Nut Torque Specifications

Bore Ø	Torque (Ft-lbs)
1½	8
2	18
2½	18
3¼	35
4	35
5	60
6	60

When it is necessary to remove the tie-rod nuts on a cylinder, they must be reassembled to the torque specifications given above. To prevent the tie-rods from twisting when tightened, use a vice grip or locking clamp. Note that the torque specification is based on lubricated threads.

milwaukee *Cylinder*

Series A



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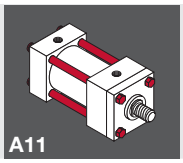

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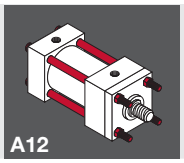

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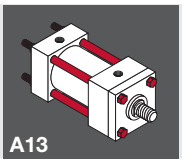

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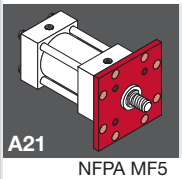

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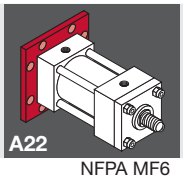

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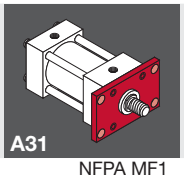

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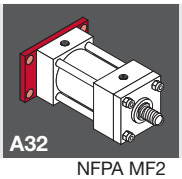

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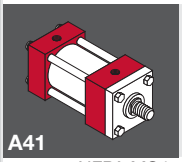

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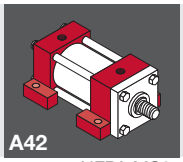

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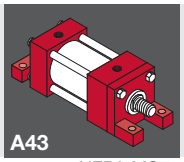

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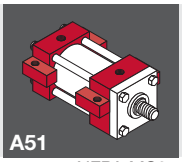

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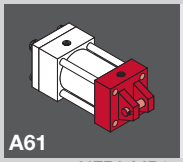

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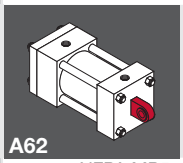

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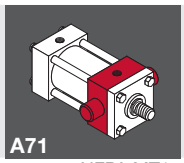

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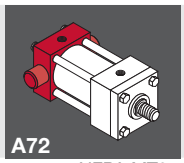

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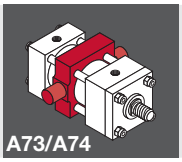

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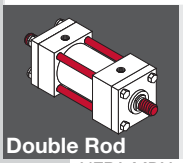
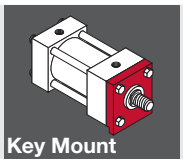


NFPA MDX



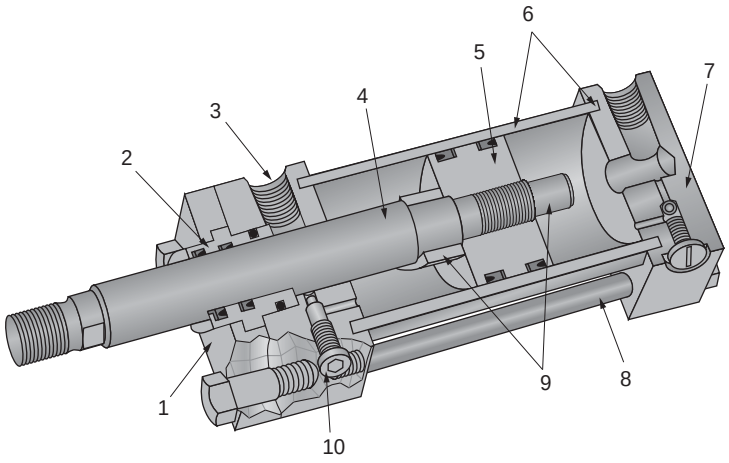
NOTE: End cap design differs on cylinders 8" bore and larger.

See the following pages for details.

***Milwaukee Cylinder* Series A Pneumatic Cylinders** are built to perform on the toughest applications. This heavy-duty air cylinder is designed for 250 psi operation at temperatures between -20° F and +200° F, but can be used at higher temperatures with special seals. *Milwaukee Cylinder's* advanced engineering and quality workmanship ensure you years of maintenance-free service life.

STANDARD SPECIFICATIONS

- Standard construction – square head – tie rod design
- Nominal pressure – 250 psi air service
- Standard fluid-filtered air
- Standard temperature – -20° F to +200° F
- Standard bore sizes – 1½" to 16"
- Standard piston rod diameters ⅝" thru 5½"
- Standard mounting styles – 17 standard styles plus custom designs to suit your needs
- Strokes – available in any practical stroke length
- Cushions – available at either end or both ends of stroke
- Standard 7 rod end styles, plus specials designed to order
- Rod end style KK_2 - is studded as standard for ⅝" and 1" diameter rods. Studded rod end style is available for all rod sizes.



STANDARD FEATURES

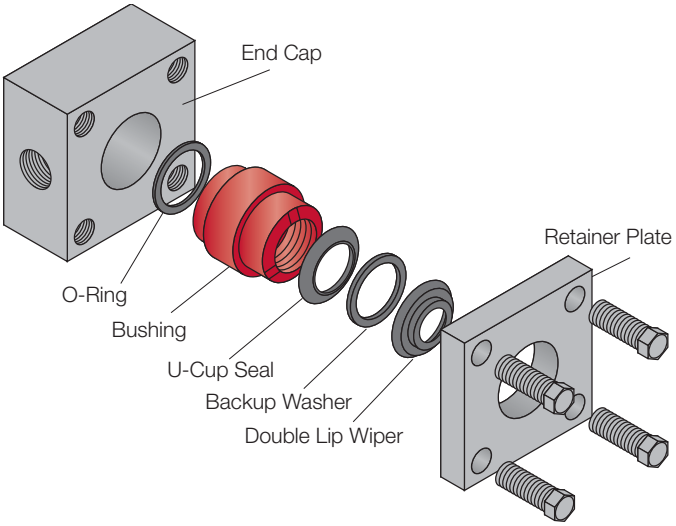
1. **Removable Retainer Plate**
   The retainer plate and rod bushing are externally removable. On most models, total disassembly of the cylinder is not necessary. Four capscrews securely hold and lock the retainer plate in place.
2. **Rod Bushing and Seals**
   The rod bushing is accurately machined from solid bearing bronze. It is piloted and retained in the end cap to provide positive rod support, and designed for maximum bearing area.
   Buna-N seals are supplied as standard with *Milwaukee Cylinder* Series A cylinder. They are suitable for use with air or petroleum base fluids up to a temperature of 200°F. For high temperature or synthetic petroleum base fluids, seals of Viton and Teflon are also available.
3. **Ports**
   Large NPTF cylinder ports are standard and can be located to customer requirements. SAE ports optional.
4. **Piston Rod**
   The piston rod is of high strength steel, hardened and plated to resist scoring and corrosion, assuring maximum life.
5. **Piston**
   An iron piston is precision machined from fine grained iron alloy. The piston is pilot fitted and threaded to the rod.
6. **Cylinder Barrel**
   The barrel is honed and hard chrome plated. This provides superior sealing power, with the minimum of friction, to assure long seal life. Composite barrel is standard for 10" diameter and larger.
7. **End Caps**
   End caps and mountings are of high quality steel, precision machined for accurate mounting.
8. **Tie-Rods**
   The tie-rods are constructed from a high quality medium carbon steel. The threads are accurately rolled for rigid engagement of the nuts.
9. **Cushions**
   Cushions are machined to close tolerance to provide positive, smooth deceleration at the end of stroke. On all bore sizes, we provide the longest cushion possible, based on the rod size and blind end caps. Longer cushions are available; for further information, consult factory.
10. **Cushion Needle Adjustment and Ball Check**
    The cushion needle adjustment valve and cushion-check ball retainer screw are specifically designed to provide full cushion adjustment.

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

Combination Rod Seal Design…

The *Milwaukee Cylinder* Series A Cylinder combines a u-cup seal with a double lip wiper as a secondary seal. It is piloted and retained in the end cap to provide positive rod support and maximum bearing area.



***MilCad* Cylinder Configurator**

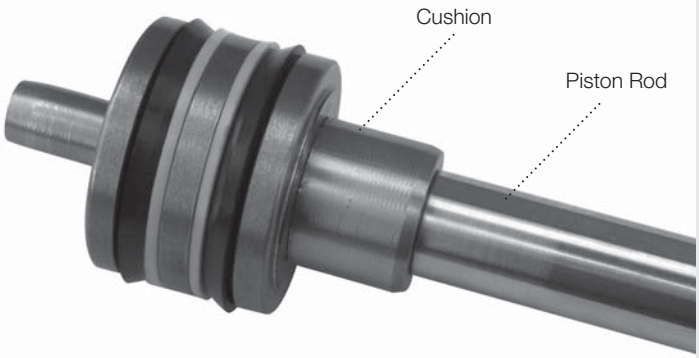
Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

Simple Maintenance…

Simple maintenance is reality with a *Milwaukee Cylinder*. The rod bushing or rod seals can be inspected or serviced by merely removing the cap screws and retainer plate on most models. Standard available shop tools can be used to remove the rod bushing and seals without disturbing the torque on the tie-rods, assuring performance quality with maintenance ease.

Piston…

The *Milwaukee Cylinder* Series A cylinder uses two u-cup seals with back-up rings and a fine grained iron alloy piston. This proven piston seal design combines low friction and smooth break away with the near zero leakage of the u-cup seals.



Cushions…

The cushion is of a high grade alloy, precision machined and specially tapered to provide smooth deceleration of the piston at the end of stroke. The rod end cushion bushing is floated with an O-ring to compensate for minor misalignments during normal operation. This is to assure that our customers receive the total quality of performance that is designed into a *Milwaukee Cylinder* cylinder.

Piston Rod…

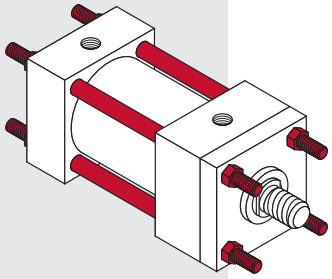
The piston rod is hardened, plated high strength steel, machined and processed to resist scoring and corrosion, assuring maximum life. *Milwaukee Cylinder* offers seven rod end styles as standard. **The style #2 rod end with two wrench flats is furnished as standard**, unless otherwise specified. Special rod ends and extra wrench flats are also available. They must be specified at the time of order, giving the dimensional requirements and the location of additional wrench flats.

For Package and Mounting Dimension see Tables 1A and 2A.

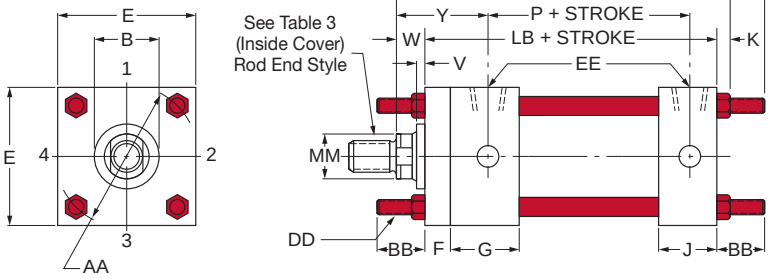
TIE ROD MOUNTED CYLINDERS

Tie-rod mounts are suited for many applications and are similar to flange mounts, but tie-rod mounts are not as rigid as the flange type of mounting. The best use of tie-rods extended on the blind end is in a thrust load application. When using tie-rods extended on the rod end, the best application is a tension load. When long strokes are required, the free end should be supported to prevent misalignment, sagging or possible binding of the cylinder.

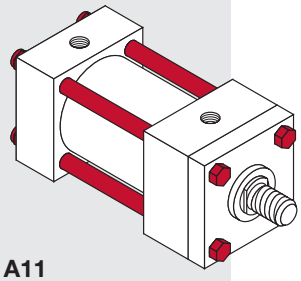
TIE RODS EXTENDED BOTH ENDS



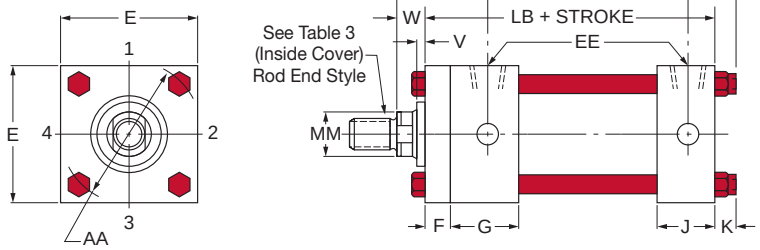
MODEL A10
NFPA STYLE MX1



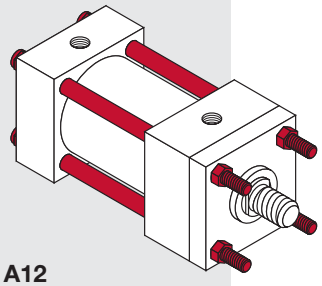
NO TIE ROD EXTENSION



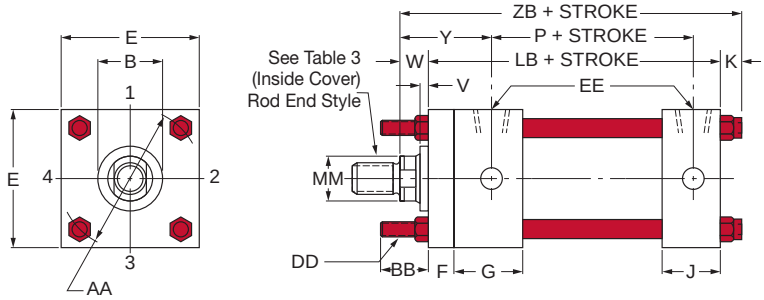
MODEL A11
NFPA STYLE MX0



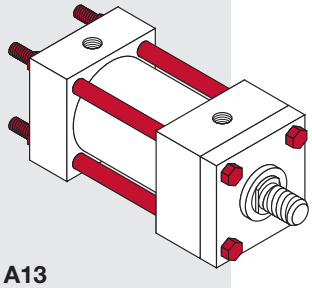
TIE RODS EXTENDED ROD END



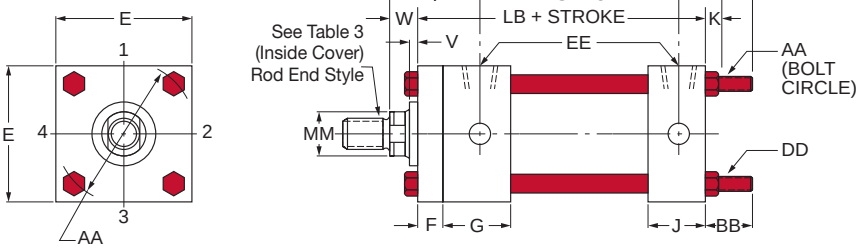
MODEL A12
NFPA STYLE MX3



TIE RODS EXTENDED BLIND END



MODEL A13
NFPA STYLE MX2



▼ TABLE 1A

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	Y	ZB	ZT
1½	⅝	A0011	1⅛	4	2¼	¼	⅝	1 15/16	4⅞	5⅝
	•1	A0012	1½			½	1	2 5/16	5¼	6
2	⅝	A0110	1⅛	4	2¼	¼	⅝	1 15/16	4 15/16	5¾
	1	A0111	1½			½	1	2 5/16	5 5/16	6⅛
	•1⅜	A0112	2			⅝	1¼	2 9/16	5 9/16	6⅜
2½	⅝	A0120	1⅛	4⅛	2⅜	¼	⅝	1 15/16	5 1/16	5⅞
	1	A0121	1½			½	1	2 5/16	5 7/16	6¼
	1⅜	A0122	2			⅝	1¼	2 9/16	5 11/16	6½
	•1¾	A0123	2⅜			¾	1½	2 13/16	5 15/16	6¾
3¼	1	A0130	1½	4⅞	2⅝	¼	¾	2 7/16	6	7
	1⅜	A0131	2			⅜	1	2 11/16	6¼	7¼
	1¾	A0132	2⅜			½	1¼	2 15/16	6½	7½
	2	A0133	2⅝			½	1⅜	3 1/16	6⅝	7⅝
4	1	A0140	1½	4⅞	2⅝	¼	¾	2 7/16	6	7
	1⅜	A0141	2			⅜	1	2 11/16	6¼	7¼
	1¾	A0142	2⅜			½	1¼	2 15/16	6½	7½
	2	A0143	2⅝			½	1⅜	3 1/16	6⅝	7⅝
	2½	A0144	3⅛			⅝	1⅝	3 5/16	6⅞	7⅞
5	1	A1X50	1½	5⅛	2⅞	¼	¾	2 7/16	6 5/16	7 11/16
	1⅜	A1X51	2			⅜	1	2 11/16	6 9/16	7 15/16
	1¾	A1X52	2⅜			½	1¼	2 15/16	6 13/16	8 3/16
	2	A0153	2⅝			½	1⅜	3 1/16	6 15/16	8 5/16
	2½	A0154	3⅛			⅝	1⅝	3 5/16	7 3/16	8 9/16
	3	A0155	3¾			⅝	1⅝	3 5/16	7 3/16	8 9/16
	3½	A0156	4¼			⅝	1⅝	3 5/16	7 3/16	8 9/16
6	1⅜	A0160	2	5¾	3⅛	¼	⅞	2 13/16	7 1/16	8 7/16
	1¾	A0161	2⅜			⅜	1⅛	3 1/16	7 5/16	8 11/16
	2	A0162	2⅝			⅜	1¼	3 3/16	7 7/16	8 13/16
	2½	A0163	3⅛			½	1½	3 7/16	7 11/16	9 1/16
	3	A0164	3¾			½	1½	3 7/16	7 11/16	9 1/16
	3½	A0165	4¼			½	1½	3 7/16	7 11/16	9 1/16
	4	A0166	4¾			½	1½	3 7/16	7 11/16	9 1/16

For bore diameter sizes 8" to 16" see next page.

▼ TABLE 2A

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	AA	BB	DD	E	EE	F	G	J	K
1½	2.02	1	¼-28	2	⅜	⅜	1½	1	¼
2	2.60	1⅛	5/16-24	2½	⅜	⅜	1½	1	5/16
2½	3.10	1⅛	5/16-24	3	⅜	⅜	1½	1	5/16
3¼	3.90	1⅜	⅜-24	3¾	½	⅝	1¾	1¼	⅜
4	4.70	1⅜	⅜-24	4½	½	⅝	1¾	1¼	⅜
5	5.80	1 13/16	½-20	5½	½	⅝	1¾	1¼	7/16
6	6.90	1 13/16	½-20	6½	¾	¾	2	1½	7/16

HOW TO ORDER

For ordering information refer to page 98.

NOTES:

- ♦ For double rod end cylinders add prefix letter "D" to cylinder code. Example: DA0011. (Refer to page 92.)
- • Available with fixed-non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

***MilCad* Cylinder Configurator**

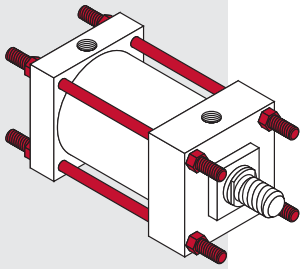
Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

For Package and Mounting Dimension see Tables 1A and 2A.

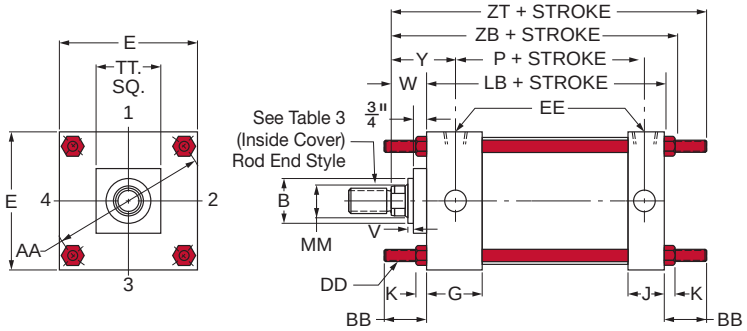
TIE ROD MOUNTED CYLINDERS

The flange and tie-rod mounts are basically the same, except that the cylinder tie-rods are extended and used to mount the cylinder. To prevent misalignment, sagging or possible binding of the cylinder, when long strokes are required, the free end should be supported. The best use of tie-rods when extending on the blind end is in a thrust load application. When using tie-rods extended on the rod end, the best application is a tension load. Tie-rod mounts are suited for many applications, but it should be noted that they are not as rigid as the flange type of mounting.

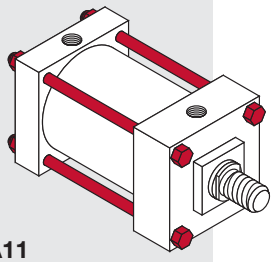
TIE RODS EXTENDED BOTH ENDS



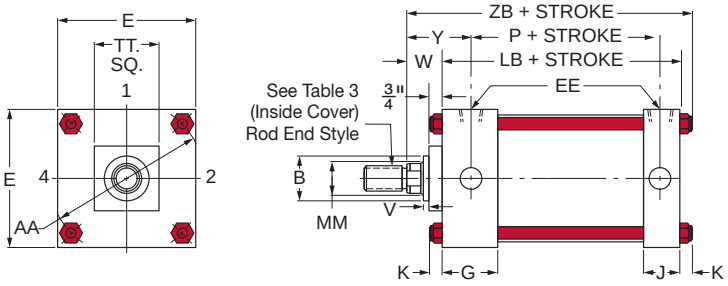
MODEL A10
NFPA STYLE MX1



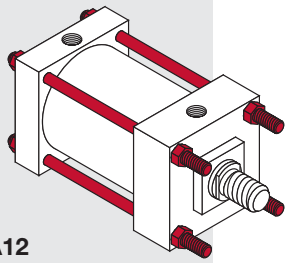
NO TIE ROD EXTENSION



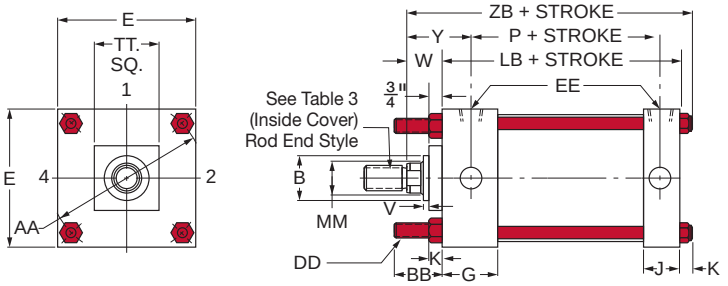
MODEL A11
NFPA STYLE MX



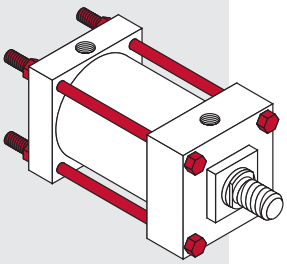
TIE RODS EXTENDED ROD END



MODEL A12
NFPA STYLE MX3



TIE RODS EXTENDED BLIND END



MODEL A13
NFPA STYLE MX2

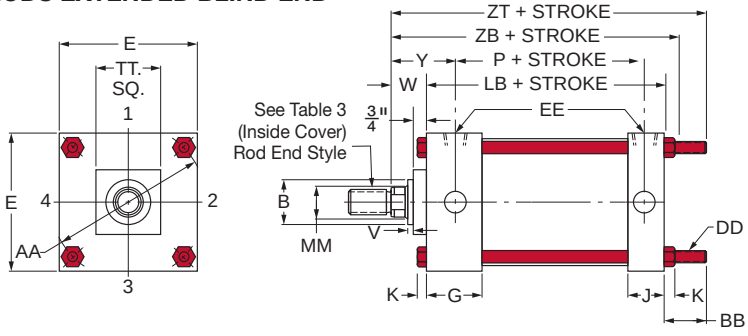


TABLE 1A

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	TT	V	W	Y	ZB	ZT
8	1⅜	A0180	2	5⅛	3¼	4	¼	1⅝	2 13/16	7 5/16	9 1/16
	1¾	A0181	2⅜			4	⅜	1⅞	3 1/16	7 9/16	9 5/16
	2	A0182	2⅝			4	⅜	2	3 3/16	7 11/16	9 7/16
	2½	A0183	3⅛			4	½	2¼	3 7/16	7 15/16	9 11/16
	3	A0184	3¾			5½					
	3½	A0185	4¼			5½					
	4	A0186	4¾			5½					
	4½	A0187	5¼			7					
	5	A0188	5¾			7					
	5½	A0189	6¼			7					
10	1¾	A1100	2⅜	6⅜	4⅛	4	⅜	1⅞	3⅛	8 15/16	10 15/16
	2	A1101	2⅝			4	⅜	2	3¼	9 1/16	11 1/16
	2½	A1102	3⅛			4	½	2¼	3½	9 5/16	11 5/16
	3	A1103	3¾			5½					
	3½	A1104	4¼			5½					
	4	A1105	4¾			5½					
	4½	A1106	5¼			7					
	5	A1107	5¾			7					
	5½	A1108	6¼			7					
12	2	A1120	2⅝	6⅞	4⅝	4	⅜	2	3¼	9 9/16	11 9/16
	2½	A1121	3⅛			4	½	2¼	3½	9 13/16	11 13/16
	3	A1122	3¾			5½					
	3½	A1123	4¼			5½					
	4	A1124	4¾			5½					
	4½	A1125	5¼			7					
	5	A1126	5¾			7					
	5½	A1127	6¼			7					
14	2½	A1140	3⅛	8⅛	5½	4	½	2¼	3 13/16	11 13/16	13 9/16
	3	A1141	3¾			5½					
	3½	A1142	4¼			5½					
	4	A1143	4¾			5½					
	4½	A1144	5¼			7					
	5	A1145	5¾			7					
	5½	A1146	6¼			7					
16	2½	A1160	3⅛	8⅛	5⅝	4	½	2¼	3¾	11 13/16	13 9/16
	3	A1161	3¾			5½					
	3½	A1162	4¼			5½					
	4	A1163	4¾			5½					
	4½	A1164	5¼			7					
	5	A1165	5¾			7					
	5½	A1166	6¼			7					

TABLE 2A

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	AA	BB	DD	E	EE	G	J	K
8	9.10	2 5/16	⅝-18	8½	¾	2	1½	9/16
10	11.20	2 11/16	¾-16	10⅝	1	2¼	2	11/16
12	13.30	2 11/16	¾-16	12¾	1	2¼	2	11/16
14	15.40	3 3/16	⅞-14	14¾	1¼	2¾	2¼	13/16
16	17.90	3 3/16	⅞-14	17	1¼	2¾	2¼	13/16

HOW TO ORDER

For ordering information refer to page 98.

NOTES:

♦ For double rod end cylinders add prefix letter "D" to cylinder code. Example: DA0180. (Refer to page 92.)

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

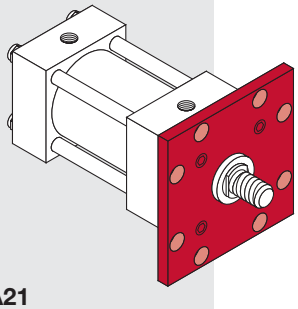
***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

For Package and Mounting Dimension see Tables 1A and 2A.

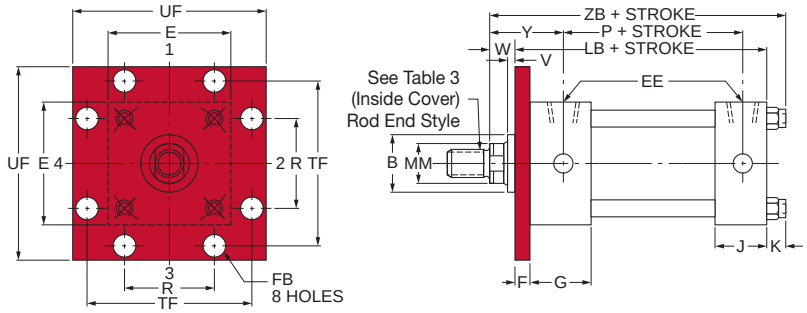
FLANGE MOUNTED CYLINDERS

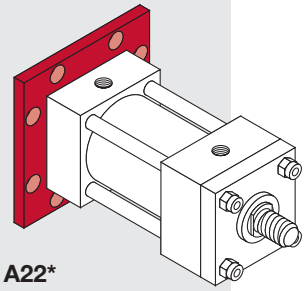
The flange mount is one of the strongest, most rigid methods of mounting. With this type of mount there is little allowance for misalignment, though when long strokes are required, the free end opposite the mounting should be supported to prevent sagging and possible binding of the cylinder. The best use of a blind end flange is in a thrust load application (rod in compression). Rod end flange mounts are best used in tension applications. When a less rigid mount can be used and the cylinder can be attached to a panel or bulkhead, an extended tie-rod mounting could be considered.



MODEL A21
NFPA STYLE MF5

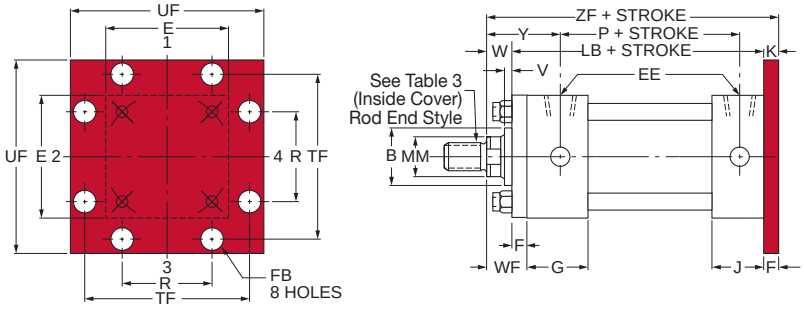
ROD SQUARE FLANGE MOUNTING

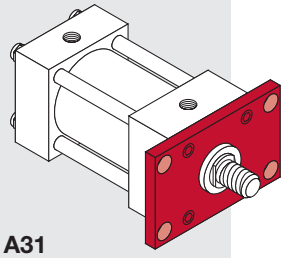




MODEL A22*
NFPA STYLE MF6

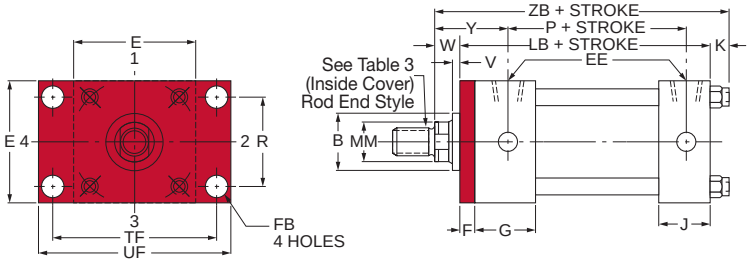
BLIND SQUARE FLANGE MOUNTING

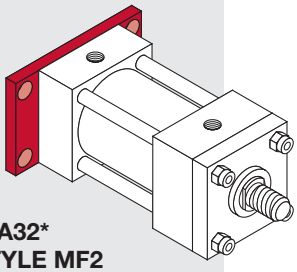




MODEL A31
NFPA STYLE MF1

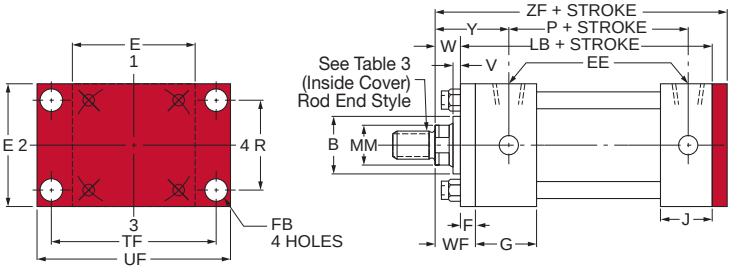
ROD RECTANGULAR FLANGE MOUNTING





MODEL A32*
NFPA STYLE MF2

BLIND RECTANGULAR FLANGE MOUNTING



▼ TABLE 1A

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	V	W	Y	ZB	ZF
1½	⅝	A0011	1⅛	4	2¼	¼	⅝	1 15/16	4⅞	5
	•1*	A0012	1½			½	1	2 5/16	5¼	5⅜
2	⅝	A0110	1⅛	4	2¼	¼	⅝	1 15/16	4 15/16	5
	1	A0111	1½			½	1	2 5/16	5 5/16	5⅜
	•1⅜*	A0112	2			⅝	1¼	2 9/16	5 9/16	5⅝
2½	⅝	A0120	1⅛	4⅛	2⅜	¼	⅝	1 15/16	5 1/16	5⅛
	1	A0121	1½			½	1	2 5/16	5 7/16	5½
	1⅜	A0122	2			⅝	1¼	2 9/16	5 11/16	5¾
	•1¾*	A0123	2⅜			¾	1½	2 13/16	5 15/16	6
3¼	1	A0130	1½	4⅞	2⅝	¼	¾	2 7/16	6	6¼
	1⅜	A0131	2			⅜	1	2 11/16	6¼	6½
	1¾	A0132	2⅜			½	1¼	2 15/16	6½	6¾
	2*	A0133	2⅝			½	1⅜	3 1/16	6⅝	6⅞
4	1	A0140	1½	4⅞	2⅝	¼	¾	2 7/16	6	6¼
	1⅜	A0141	2			⅜	1	2 11/16	6¼	6½
	1¾	A0142	2⅜			½	1¼	2 15/16	6½	6¾
	2	A0143	2⅝			½	1⅜	3 1/16	6⅝	6⅞
	2½*	A0144	3⅛			⅝	1⅝	3 5/16	6⅞	7⅛
5	1	A1x50	1½	5⅛	2⅞	¼	¾	2 7/16	6 5/16	6½
	1⅜	A1x51	2			⅜	1	2 11/16	6 9/16	6¾
	1¾	A1x52	2⅜			½	1¼	2 15/16	6 13/16	7
	2	A0153	2⅝			½	1⅜	3 1/16	6 15/16	7⅛
	2½	A0154	3⅛			⅝	1⅝	3 5/16	7 3/16	7⅜
	3	A0155	3¾			⅝	1⅝	3 5/16	7 3/16	7⅜
	3½*	A0156	4¼			⅝	1⅝	3 5/16	7 3/16	7⅜
6	1⅜	A0160	2	5¾	3⅛	¼	⅞	2 13/16	7 1/16	7⅜
	1¾	A0161	2⅜			⅜	1⅛	3 1/16	7 5/16	7⅝
	2	A0162	2⅝			⅜	1¼	3 3/16	7 7/16	7¾
	2½	A0163	3⅛			½	1½	3 7/16	7 11/16	8
	3	A0164	3¾			½	1½	3 7/16	7 11/16	8
	3½	A0165	4¼			½	1½	3 7/16	7 11/16	8
	4	A0166	4¾			½	1½	3 7/16	7 11/16	8

For bore diameter sizes 8" to 16" see next page.

▼ TABLE 2A

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	EE	F	FB	G	J	K	R	TF	UF
1½	2	⅜	⅜	5/16	1½	1	¼	1.43	2¾	3⅜
2	2½	⅜	⅜	⅜	1½	1	5/16	1.84	3⅜	4⅛
2½	3	⅜	⅜	⅜	1½	1	5/16	2.19	3⅞	4⅝
3¼	3¾	½	⅝	7/16	1¾	1¼	⅜	2.76	4 11/16	5½
4	4½	½	⅝	7/16	1¾	1¼	⅜	3.32	5 7/16	6¼
5	5½	½	⅝	9/16	1¾	1¼	7/16	4.10	6⅝	7⅝
6	6½	¾	¾	9/16	2	1½	7/16	4.88	7⅝	8⅝

HOW TO ORDER

For ordering information refer to Page 98.

NOTES:

♦ For double rod end cylinders add prefix letter "D" to cylinder code. Example: DA0011. (Refer to page 92.)

• Available with fixed-non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

* Removable retainer not available for these bore and rod combinations in the A22 and A32 mounting styles.

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

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***MilCad* Cylinder Configurator**

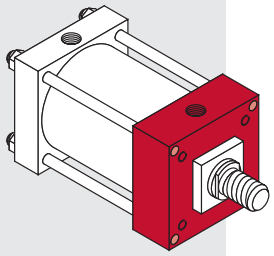
Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

For Package and Mounting Dimension see Tables 1A and 2A.

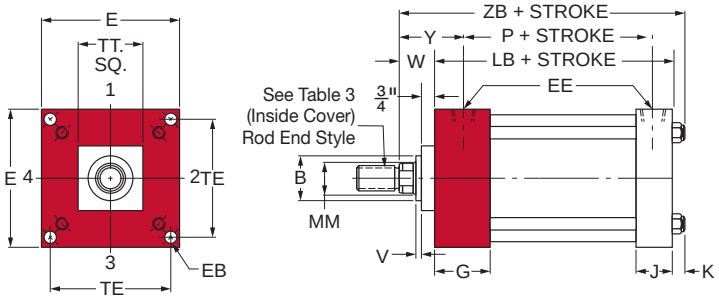
SOLID ROD END CAP MOUNTED CYLINDERS

Milwaukee Cylinder's solid end cap mount is one of the strongest, most rigid methods of mounting. This type of rod end cap mounting is best in a tension application. A solid blind end cap mounting is best in a thrust application.

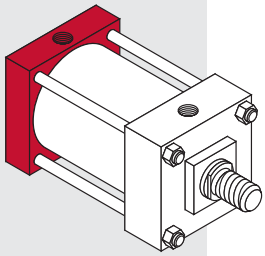
SOLID ROD END CAP SQUARE MOUNTING



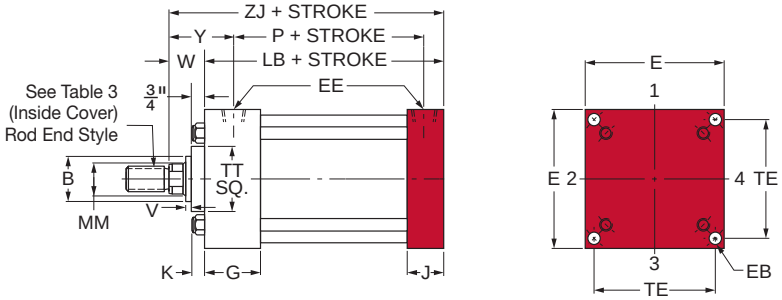
MODEL A21
NFPA STYLE ME3



SOLID BLIND END CAP SQUARE MOUNTING



MODEL A22
NFPA STYLE ME4



▼ TABLE 1A

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	B	LB	P	TT	V	W	Y	ZB	ZJ
8	1⅜	A0180	2	5⅛	3¼	4	¼	1⅝	2 13/16	7 5/16	6¾
	1¾	A0181	2⅜			4	⅜	1⅞	3 1/16	7 9/16	7
	2	A0182	2⅝			4	⅜	2	3 3/16	7 11/16	7⅛
	2½	A0183	3⅛			4	½	2¼	3 7/16	7 15/16	7⅜
	3	A0184	3¾			5½					
	3½	A0185	4¼			5½					
	4	A0186	4¾			5½					
	4½	A0187	5¼			7					
	5	A0188	5¾			7					
	5½	A0189	6¼			7					
10	1¾	A1100	2⅜	6⅜	4⅛	4	⅜	1⅞	3⅛	8 15/16	8¼
	2	A1101	2⅝			4	⅜	2	3¼	9 1/16	8⅜
	2½	A1102	3⅛			4	½	2¼	3½	9 5/16	8⅝
	3	A1103	3¾			5½					
	3½	A1104	4¼			5½					
	4	A1105	4¾			5½					
	4½	A1106	5¼			7					
	5	A1107	5¾			7					
	5½	A1108	6¼			7					
12	2	A1120	2⅝	6⅞	4⅝	4	⅜	2	3¼	9 9/16	8⅞
	2½	A1121	3⅛			4	½	2¼	3½	9 13/16	9⅛
	3	A1122	3¾			5½					
	3½	A1123	4¼			5½					
	4	A1124	4¾			5½					
	4½	A1125	5¼			7					
	5	A1126	5¾			7					
	5½	A1127	6¼			7					
14	2½	A1140	3⅛	8⅛	5½	4	½	2¼	3 13/16	11 3/16	10⅜
	3	A1141	3¾			5½					
	3½	A1142	4¼			5½					
	4	A1143	4¾			5½					
	4½	A1144	5¼			7					
	5	A1145	5¾			7					
	5½	A1146	6¼			7					
16	2½	A1160	3⅛	8⅛	5⅝	4	½	2¼	3¾	11 3/16	10⅜
	3	A1161	3¾			5½					
	3½	A1162	4¼			5½					
	4	A1163	4¾			5½					
	4½	A1164	5¼			7					
	5	A1165	5¾			7					
	5½	A1166	6¼			7					

HOW TO ORDER

For ordering information refer to page 98.

NOTES:

♦ For double rod end cylinders add prefix letter "D" to cylinder code. Example: DA0180. (Refer to page 92.)

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

▼ TABLE 2A

The dimensions are constant regardless of rod diameter or stroke.

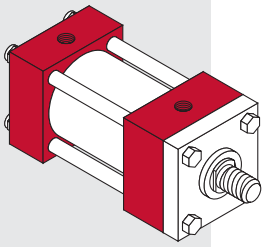
Bore Ø	E	EB	EE	R	G	J	K	R	TE
8	8½	1 1/16	¾	–	2	1½	9/16	6.44	7.57
10	10⅝	13/16	1	–	2¼	2	1 1/16	7.92	9.40
12	12¾	13/16	1	–	2¼	2	1 1/16	9.40	11.10
14	14¾	15/16	1¼	–	2¾	2¼	13/16	10.90	12.87
16	17	1 1/16	1¼	–	2¾	2¼	13/16	12.65	14.85

For Package and Mounting Dimension see Tables 1A and 2A.

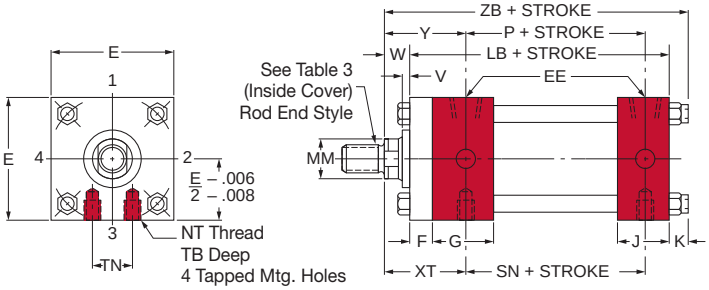
SIDE OR LUG MOUNTED CYLINDERS

The side or lug mounted cylinder provides a fairly rigid mount. These types of cylinders can tolerate a slight amount of misalignment when the cylinder is at full stroke, but as the piston moves toward the blind end, the tolerance for misalignment decreases. It is important to note that if the cylinder is used properly (without misalignment), the mounting bolts are either in simple shear or tension without any compound stresses.

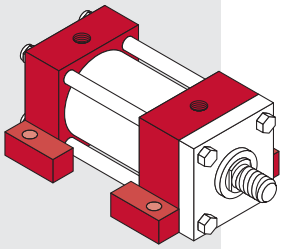
TAPPED HOLES IN CAPS FLUSH MOUNTING



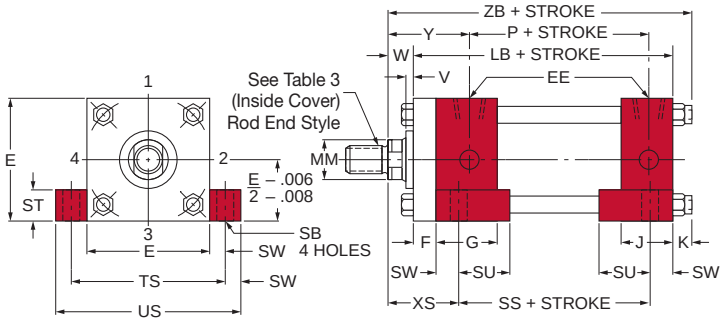
MODEL A41
NFPA STYLE MS4



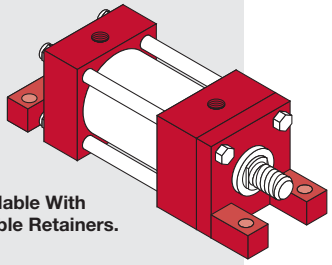
SIDE LUG MOUNTING



MODEL A42
NFPA STYLE MS2

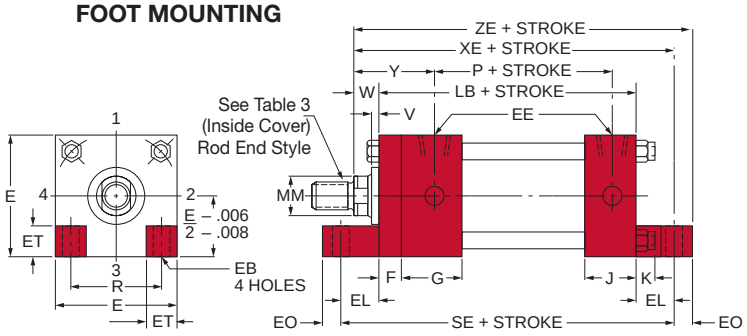


FOOT MOUNTING

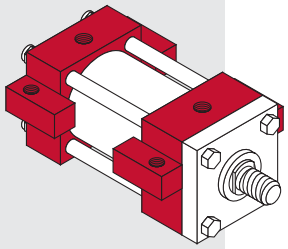


Not Available With Removable Retainers.

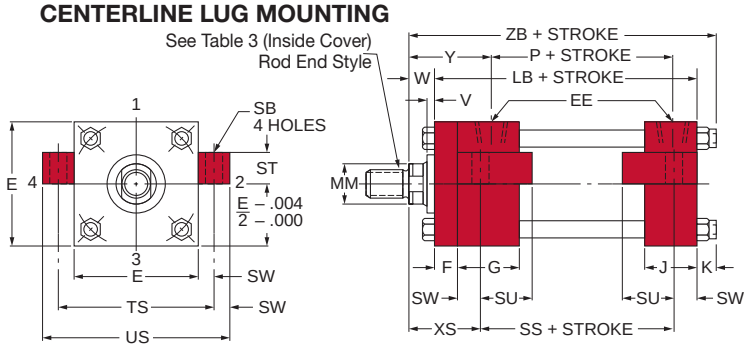
MODEL A43
NFPA STYLE MS7



CENTERLINE LUG MOUNTING



MODEL A51
NFPA STYLE MS3



▼ TABLE 1A

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	LB	P	SE ▲	SN	SS ■	V	W	XE	XS	XT	Y	ZB	ZE
1½	⅝	A0011	4	2¼	5½	2¼	2⅞	¼	⅝	5⅜	1⅜	1 15/16	1 15/16	4⅞	5⅜
	•1*	A0012						½	1	5¾	1¾	2 5/16	2 5/16	5¼	6
2	⅝	A0110	4	2¼	5⅞	2¼	2⅞	¼	⅝	5 9/16	1⅜	1 15/16	1 15/16	4 15/16	5⅞
	†1*	A0111						½	1	5 15/16	1¾	2 5/16	2 5/16	5 5/16	6¼
	•1⅜*	A0112						⅝	1¼	6 3/16	2	2 9/16	2 9/16	5 9/16	6½
2½	⅝	A0120	4⅛	2⅜	6¼	2⅜	3	¼	⅝	5 13/16	1⅜	1 15/16	1 15/16	5 1/16	6⅛
	1	A0121						½	1	6 3/16	1¾	2 5/16	2 5/16	5 7/16	6½
	†1⅜*	A0122						⅝	1¼	6 7/16	2	2 9/16	2 9/16	5 11/16	6¾
	•1¾*	A0123						¾	1½	6 11/16	2¼	2 13/16	2 13/16	6 15/16	7
3¼	1	A0130	4⅞	2⅝	6⅝	2⅝	3¼	¼	¾	6½	1⅞	2 7/16	2 7/16	6	6⅞
	1⅜	A0131						⅜	1	6¾	2⅛	2 11/16	2 11/16	6¼	7⅛
	1¾*	A0132						½	1¼	7	2⅜	2 15/16	2 15/16	6½	7⅜
	2*	A0133						½	1⅜	7⅛	2½	3 1/16	3 1/16	6⅝	7½
4	1	A0140	4⅞	2⅝	6⅞	2⅝	3¼	¼	¾	6⅝	1⅞	2 7/16	2 7/16	6	7
	1⅜	A0141						⅜	1	6⅞	2⅛	2 11/16	2 11/16	6¼	7¼
	1¾	A0142						½	1¼	7⅛	2⅜	2 15/16	2 15/16	6½	7½
	2	A0143						½	1⅜	7¼	2½	3 1/16	3 1/16	6⅝	7⅝
	2½*	A0144						⅝	1⅝	7½	2¾	3 5/16	3 5/16	6⅞	7⅞
5	1	A1x50	5⅛	2⅞	7¼	2⅞	3⅛	¼	¾	6 15/16	2 1/16	2 7/16	2 7/16	6 5/16	7 7/16
	1⅜	A1x51						⅜	1	7 3/16	2 5/16	2 11/16	2 11/16	6 9/16	7 11/16
	1¾	A1x52						½	1¼	7 7/16	2 9/16	2 15/16	2 15/16	6 13/16	7 15/16
	2	A0153						½	1⅜	7 9/16	2 11/16	3 1/16	3 1/16	6 15/16	8 1/16
	2½	A0154						⅝	1⅝	7 13/16	2 15/16	3 5/16	3 5/16	7 3/16	8 5/16
	3	A0155						⅝	1⅝	7 13/16	2 15/16	3 5/16	3 5/16	7 3/16	8 5/16
	3½*	A0156						⅝	1⅝	7 13/16	2 15/16	3 5/16	3 5/16	7 3/16	8 5/16
6	1⅜	A0160	5¾	3⅛	7¾	3⅛	3⅝	¼	⅞	7⅝	2 5/16	2 13/16	2 13/16	7 1/16	8⅛
	1¾	A0161						⅜	1⅛	7⅞	2 9/16	3 1/16	3 1/16	7 5/16	8⅜
	2	A0162						⅜	1¼	8	2 11/16	3 3/16	3 3/16	7 7/16	8½
	2½	A0163						½	1½	8¼	2 15/16	3 7/16	3 7/16	7 11/16	8¾
	3	A0164						½	1½	8¼	2 15/16	3 7/16	3 7/16	7 11/16	8¾
	3½	A0165						½	1½	8¼	2 15/16	3 7/16	3 7/16	7 11/16	8¾
	4*	A0166						½	1½	8¼	2 15/16	3 7/16	3 7/16	7 11/16	8¾

For bore diameter sizes 8" to 16" see next page.

HOW TO ORDER

For ordering information refer to Page 98.

NOTES:

♦ For double rod end cylinders add prefix letter "D" to cylinder code. Example: DA0011. (Refer to page 92.)

* Tapped holes on A41 rod end cap have a shallower TB depth in these sizes.

† **The standard rod eye or rod clevis will interfere with foot lugs on Model A43. When these rod end accessories are required, use additional rod extension.**

▲ For double rod end cylinders from 1½" thru 6" bore, add ½ + F to this dimension.

■ For double rod end cylinders from 1½" thru 6" bore, add ½ to this dimension.

• Available with fixed non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

▼ TABLE 2A

The dimensions are constant regardless of rod diameter or stroke.

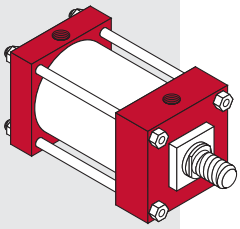
Bore Ø	E	EB	EE	EL	EO	ET	F	G	J	K	NT	R	SB	ST	SU	SW	TB	TN	TS	US
1½	2	5/16	⅜	¾	¼	½	⅜	1½	1	¼	¼-20	1.43	7/16	½	15/16	⅜	⅜	⅝	2¾	3½
2	2½	⅜	⅜	15/16	5/16	19/32	⅜	1½	1	5/16	5/16-18	1.84	7/16	½	15/16	⅜	9/16	⅞	3¼	4
2½	3	⅜	⅜	1 1/16	5/16	¾	⅜	1½	1	5/16	⅜-16	2.19	7/16	½	15/16	⅜	⅝	1¼	3¾	4½
3¼	3¾	7/16	½	⅞	⅜	29/32	⅝	1¾	1¼	⅜	½-13	2.76	9/16	¾	1¼	½	¾	1½	4¾	5¾
4	4½	7/16	½	1	⅜	1⅛	⅝	1¾	1¼	⅜	½-13	3.32	9/16	¾	1¼	½	1	2 1/16	5½	6½
5	5½	9/16	½	1 1/16	½	1 11/32	⅝	1¾	1¼	7/16	⅝-11	4.10	13/16	1	1 9/16	1 1/16	1	2 11/16	6⅞	8¼
6	6½	9/16	¾	1	½	1 9/16	¾	2	1½	7/16	¾-10	4.88	13/16	1	1 9/16	1 1/16	1⅛	3¼	7⅞	9¼

For Package and Mounting Dimension see Tables 1A and 2A.

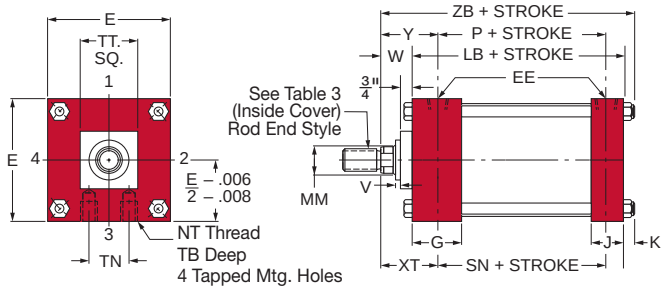
SIDE OR LUG MOUNTED CYLINDERS

The side or lug mounted cylinder provides a fairly rigid mount. These types of cylinders can tolerate a slight amount of misalignment when the cylinder is at full stroke, but as the piston moves toward the blind end, the tolerance for misalignment decreases. It is important to note that if the cylinder is used properly (without misalignment), the mounting bolts are either in simple shear or tension without any compound stresses.

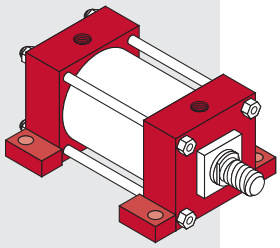
TAPPED HOLES IN CAPS FLUSH MOUNTING



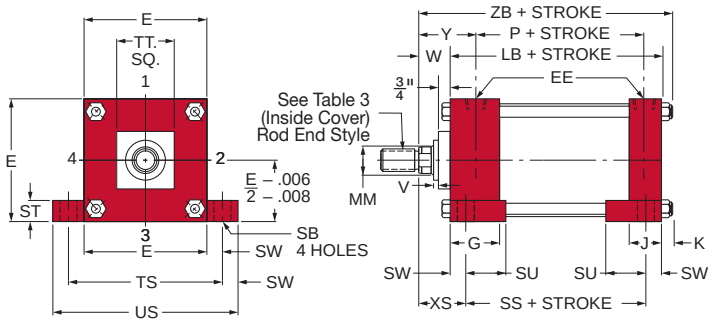
MODEL A41
NFPA STYLE MS4



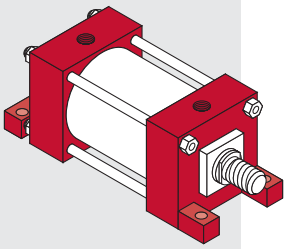
SIDE LUG MOUNTING



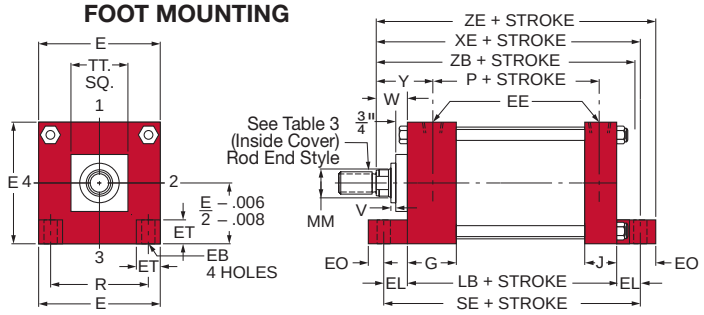
MODEL A42
NFPA STYLE MS2



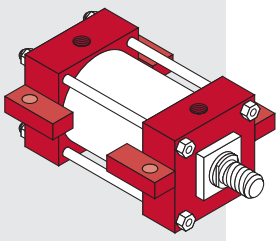
FOOT MOUNTING



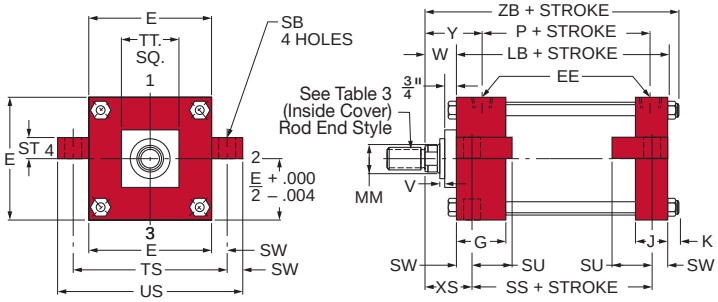
MODEL A43
NFPA STYLE MS7



CENTERLINE LUG MOUNTING



MODEL A51
NFPA STYLE MS3



▼ TABLE 1A

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	LB	P	SE ■	SN	SS ■	TT	V	W	XE	XS	XT	Y	ZB	ZE
8	1 3/8	A0180	5 1/8	3 1/4	7 3/8	3 1/4	3 3/4	4	1/4	1 5/8	7 7/8	2 5/16	2 13/16	2 13/16	7 5/16	8 1/2
	1 3/4	A0181						4	3/8	1 7/8	8 1/8	2 9/16	3 1/16	3 1/16	7 9/16	8 3/4
	2	A0182						4	3/8	2	8 1/4	2 11/16	3 3/16	3 3/16	7 11/16	8 7/8
	2 1/2	A0183						4								
	3*	A0184						5 1/2								
	3 1/2*	A0185						5 1/2								
	4*	A0186						5 1/2	1/2	2 1/4	8 1/2	2 15/16	3 7/16	3 7/16	7 15/16	9 1/8
	4 1/2*	A0187						7								
	5*	A0188						7								
	5 1/2*	A0189						7								
10	1 3/4	A1100	6 3/8	4 1/8	9	4 1/8	4 5/8	4	3/8	1 7/8	9 9/16	2 3/4	3 1/8	3 1/8	8 15/16	10 3/16
	2	A1101						4	3/8	2	9 11/16	2 7/8	3 1/4	3 1/4	9 1/16	10 5/16
	2 1/2	A1102						4								
	3*	A1103						5 1/2								
	3 1/2*	A1104						5 1/2								
	4*	A1105						5 1/2	1/2	2 1/4	9 15/16	3 1/8	3 1/2	3 1/2	9 5/16	10 9/16
	4 1/2*	A1106						7								
	5*	A1107						7								
	5 1/2*	A1108						7								
12	2	A1120	6 7/8	4 5/8	9 1/2	4 5/8	5 1/8	4	3/8	2	10 3/16	2 7/8	3 1/4	3 1/4	9 9/16	10 13/16
	2 1/2	A1121						4								
	3	A1122						5 1/2								
	3 1/2	A1123						5 1/2								
	4	A1124						5 1/2	1/2	2 1/4	10 7/16	3 1/8	3 1/2	3 1/2	9 13/16	11 1/16
	4 1/2*	A1125						7								
	5*	A1126						7								
	5 1/2*	A1127						7								
14	2 1/2*	A1140	8 1/8	5 1/2	11 1/8	5 1/2	5 7/8	4	1/2	2 1/4	11 7/16	3 3/8	3 13/16	3 13/16	11 3/16	13 5/8
	3*	A1141						5 1/2								
	3 1/2*	A1142						5 1/2								
	4*	A1143						5 1/2								
	4 1/2*	A1144						7								
	5*	A1145						7								
	5 1/2*	A1146						7								
16	2 1/2*	A1160	8 1/8	5 5/8	12 1/8	5 1/2	5 7/8	4	1/2	2 1/4	11 7/16	3 3/8	3 13/16	3 3/4	11 3/16	13 1/2
	3*	A1161						5 1/2								
	3 1/2*	A1162						5 1/2								
	4*	A1163						5 1/2								
	4 1/2*	A1164						7								
	5*	A1165						7								
	5 1/2*	A1166						7								

HOW TO ORDER

For ordering information refer to page 98.

NOTES:

♦ For double rod end cylinders add prefix letter "D" to cylinder code. Example: DA0180. (Refer to page 92.)

* Model A43 is not available in these sizes.

■ For double rod end cylinders from 8" thru 16" bore, add ½" to this dimension (except 10" and 12"; add ¼").

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

***MilCad* Cylinder Configurator**

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▼ TABLE 2A

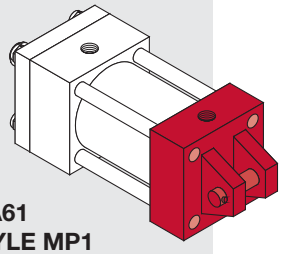
The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	E	EB	EE	EL	EO	ET	F	G	J	K	NT	R	SB	ST	SU	SW	TB	TN	TS	US
8	8 1/2	1 1/16	3/4	1 1/8	5/8	2	–	2	1 1/2	9/16	3/4-10	6.44	13/16	1	1 9/16	1 1/16	1 1/8	4 1/2	9 7/8	11 1/4
10	10 5/8	13/16	1	1 5/16	5/8	2 5/8	–	2 1/4	2	1 1/16	1-8	7.92	1 1/16	1 1/4	2	7/8	1 5/8	5 1/2	12 3/8	14 1/8
12	12 3/4	13/16	1	1 5/16	5/8	3 9/32	–	2 1/4	2	1 1/16	1-8	9.40	1 1/16	1 1/4	2	7/8	1 5/8	7 1/4	14 1/2	16 1/4
14	14 3/4	15/16	1 1/4	1 1/2	3/4	3 25/32	–	2 3/4	2 1/4	13/16	1 1/4-7	10.90	1 5/16	1 1/2	2 1/2	1 1/8	2 1/4	8 3/8	17	19 1/4
16	17	1 1/16	1 1/4	2	1 1/8	3 5/8	–	2 3/4	2 1/4	13/16	1 3/8-6	12.65	1 5/16	1 1/2	2 1/2	1 1/8	2 1/2	9 3/4	19 1/4	21 1/2

For Package and Mounting Dimension see Tables 1A and 2A.

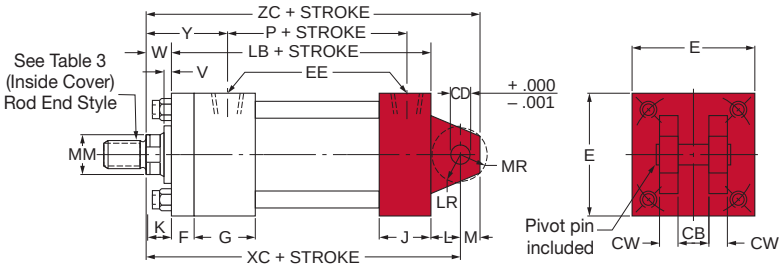
PIN AND TRUNNION MOUNTED CYLINDERS

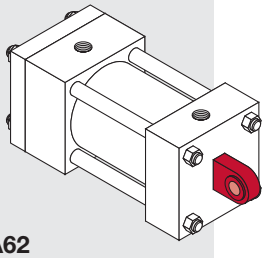
All pin and trunnion cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and the trunnion and pivot pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.



MODEL A61
NFPA STYLE MP1

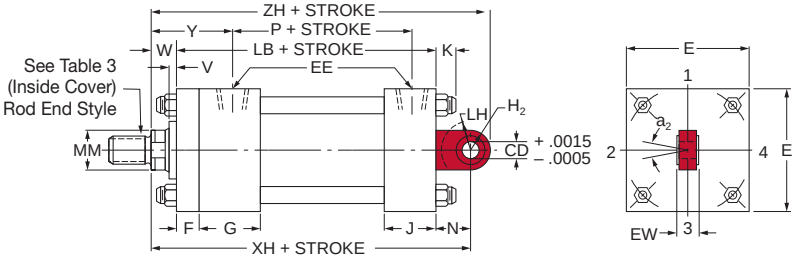
CLEVIS MOUNT

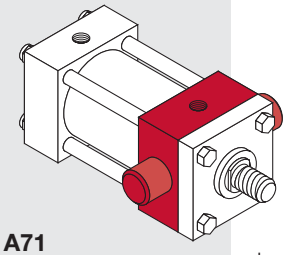




MODEL A62
NFPA STYLE MP5

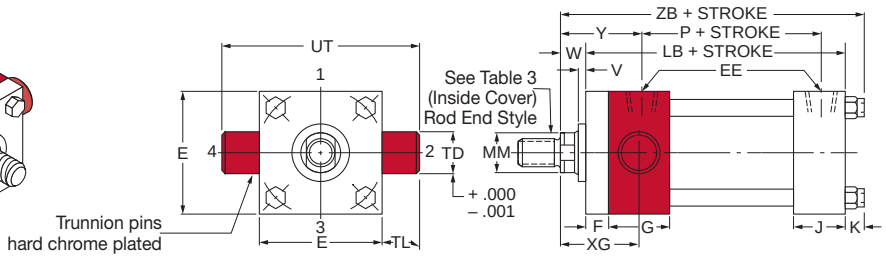
SPHERICAL EYE MOUNT

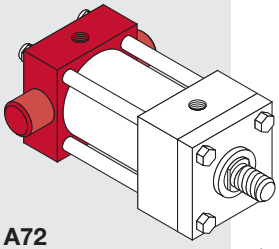




MODEL A71
NFPA STYLE MT1

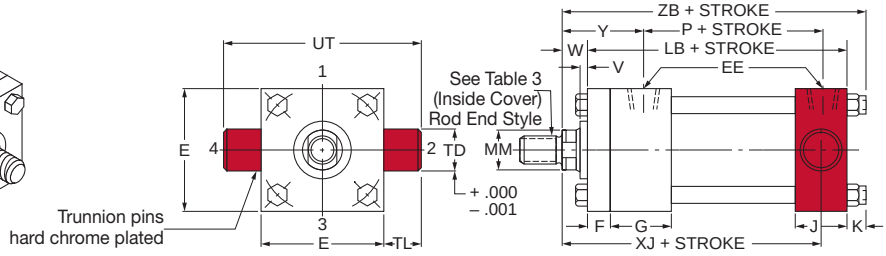
ROD END TRUNNION MOUNT

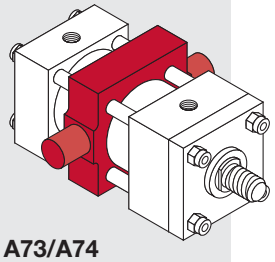




MODEL A72
NFPA STYLE MT2

BLIND END TRUNNION MOUNT

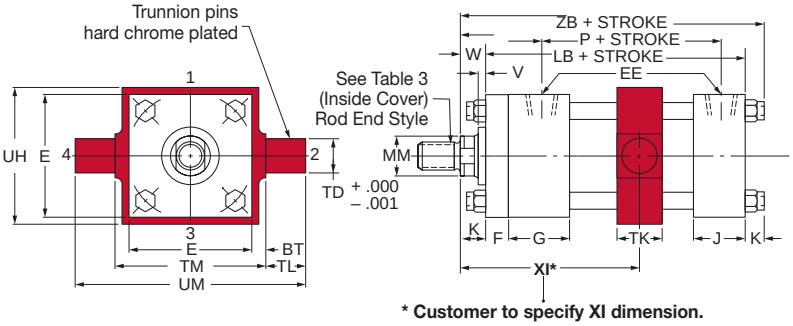




MODEL A73/A74
NFPA STYLE MT4

A73 is an exclusive *Milwaukee Cylinder* design.
A74 is the Industry "Standard" design.

CENTER TRUNNION MOUNT



*** Customer to specify XI dimension.**

▼ TABLE 1A

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	LB	P	V	W	XC	XG	XH	XJ	Y	ZB	ZC	ZH
1½	⅝	A0011	4	2¼	¼	⅝	5⅜	1¾	5½	4⅛	1 15/16	4⅞	5⅞	6¼
	•1*	A0012			½	1	5¾	2⅛	5⅞	4½	2 5/16	5¼	6¼	6⅝
2	⅝	A0110	4	2¼	¼	⅝	5⅜	1¾	5½	4⅛	1 15/16	4 15/16	5⅞	6¼
	1*	A0111			½	1	5¾	2⅛	5⅞	4½	2 5/16	5 5/16	6¼	6⅝
	•1⅜*	A0112			⅝	1¼	6	2⅜	6⅛	4¾	2 9/16	5 9/16	6½	6⅞
2½	⅝	A0120	4⅛	2⅜	¼	⅝	5½	1¾	5⅝	4¼	1 15/16	5 1/16	6	6⅜
	1	A0121			½	1	5⅞	2⅛	6	4⅝	2 5/16	5 7/16	6⅜	6¾
	1⅜	A0122			⅝	1¼	6⅛	2⅜	6¼	4⅞	2 9/16	5 11/16	6⅝	7
	•1¾*	A0123			¾	1½	6⅜	2⅝	6⅜	5⅛	2 13/16	5 15/16	6⅞	7⅛
3¼	1	A0130	4⅞	2⅝	¼	¾	6⅞	2¼	6⅞	5	2 7/16	6	7⅝	8⅛
	1⅜	A0131			⅜	1	7⅛	2½	7⅛	5¼	2 11/16	6¼	7⅞	8⅜
	1¾	A0132			½	1¼	7⅜	2¾	7⅜	5½	2 15/16	6½	8⅛	8⅝
	2*	A0133			½	1⅜	7½	2⅞	7½	5⅝	3 1/16	6⅝	8¼	8¾
4	1	A0140	4⅞	2⅝	¼	¾	6⅞	2¼	6⅞	5	2 7/16	6	7⅝	8⅛
	1⅜	A0141			⅜	1	7⅛	2½	7⅛	5¼	2 11/16	6¼	7⅞	8⅜
	1¾	A0142			½	1¼	7⅜	2¾	7⅜	5½	2 15/16	6½	8⅛	8⅝
	2	A0143			½	1⅜	7½	2⅞	7½	5⅝	3 1/16	6⅝	8¼	8¾
	2½*	A0144			⅝	1⅝	7¾	3⅛	7¾	5⅞	3 5/16	6⅞	8½	9
5	1	A1x50	5⅛	2⅞	¼	¾	7⅛	2¼	7⅛	5¼	2 7/16	6 5/16	7⅞	8⅜
	1⅜	A1x51			⅜	1	7⅜	2½	7⅜	5½	2 11/16	6 9/16	8⅛	8⅝
	1¾	A1x52			½	1¼	7⅝	2¾	7⅝	5¾	2 15/16	6 13/16	8⅜	8⅞
	2	A0153			½	1⅜	7¾	2⅞	7¾	5⅞	3 1/16	6 15/16	8½	9
	2½	A0154			⅝	1⅝	8	3⅛	8	6⅛	3 5/16	7 3/16	8¾	9¼
	3	A0155			⅝	1⅝	8	3⅛	8	6⅛	3 5/16	7 3/16	8¾	9¼
	3½*	A0156			⅝	1⅝	8	3⅛	8	6⅛	3 5/16	7 3/16	8¾	9¼
6	1⅜	A0160	5¾	3⅛	¼	⅞	8⅛	2⅝	8¼	5⅞	2 13/16	7 1/16	9⅛	10
	1¾	A0161			⅜	1⅛	8⅜	2⅞	8½	6⅛	3 1/16	7 5/16	9⅜	10¼
	2	A0162			⅜	1¼	8½	3	8⅝	6¼	3 3/16	7 7/16	9½	10⅜
	2½	A0163			½	1½	8¾	3¼	8⅞	6½	3 7/16	7 11/16	9¾	10⅝
	3	A0164			½	1½	8¾	3¼	8⅞	6½	3 7/16	7 11/16	9¾	10⅝
	3½	A0165			½	1½	8¾	3¼	8⅞	6½	3 7/16	7 11/16	9¾	10⅝
	4	A0166			½	1½	8¾	3¼	8⅞	6½	3 7/16	7 11/16	9¾	10⅝

For bore diameter sizes 8" to 16" see next page.

HOW TO ORDER

For ordering information refer to page 98.

NOTES:

♦ For double rod end cylinders add prefix letter "D" to cylinder code. Example: DA0011. (Refer to page 92.) Double rod ends are not available on clevis mount Series A cylinders.

• Available with fixed non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

* Removable retainer not available for these bore and rod combinations: A61 and A73 mounting styles.

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

***MilCad* Cylinder Configurator**

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▼ TABLE 2A

The dimensions are constant regardless of rod diameter or stroke.

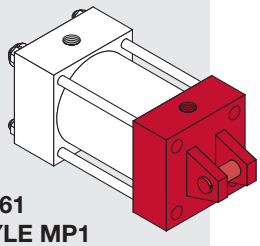
																					A73				A74				
Bore Ø	a_2	BT	CB	CD	CW	E	EE	EW	F	G	H_2	J	K	L	LH	LR	M	MR	N	TD	TL	TK	TM	UH	UM	TK	TM	UH	UM	UT
1½	13°	¾	¾	½	½	2	⅜	⅝	⅜	1½	13/16	1	¼	¾	⅝	⅝	½	21/32	⅞	1	1	1⅛	3½	2⅜	5½	1¼	2½	2½	4½	4
2	13°	¾	¾	½	½	2½	⅜	⅝	⅜	1½	13/16	1	5/16	¾	⅝	⅝	½	11/16	⅞	1	1	1⅛	4	2⅞	6	1½	3	3	5	4½
2½	13°	¾	¾	½	½	3	⅜	⅝	⅜	1½	13/16	1	5/16	¾	⅝	⅝	½	11/16	⅞	1	1	1⅛	4½	3⅜	6½	1½	3½	3½	5½	5
3¼	14°	¾	1¼	¾	⅝	3¾	½	⅞	⅝	1¾	1¼	1¼	⅜	1¼	1	1 1/16	¾	15/16	1¼	1	1	1¼	5¼	4⅛	7¼	2	4½	4¼	6½	5¾
4	14°	¾	1¼	¾	⅝	4½	½	⅞	⅝	1¾	1¼	1¼	⅜	1¼	1	1 1/16	¾	15/16	1¼	1	1	1¼	6	5	8	2	5¼	5	7¼	6½
5	14°	¾	1¼	¾	⅝	5½	½	⅞	⅝	1¾	1¼	1¼	7/16	1¼	1	1 1/16	¾	15/16	1¼	1	1	1¼	7	6	9	2	6¼	6	8¼	7½
6	12½°	1	1½	1	¾	6½	¾	1⅜	¾	2	1¾	1½	7/16	1½	1¼	1¼	1	1 3/16	1⅝	1⅜	1⅜	1½	8½	7	11¼	2½	7⅝	7	10⅜	9¼

For Package and Mounting Dimension see Tables 1A and 2A.

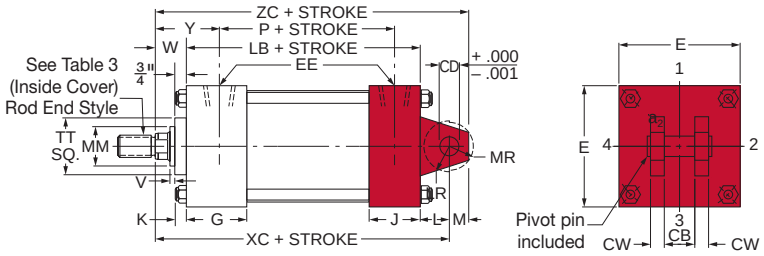
PIN AND TRUNNION CYLINDERS

All pin and trunnion cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and the trunnion and pivot pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.

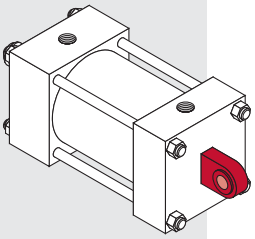
CLEVIS MOUNT



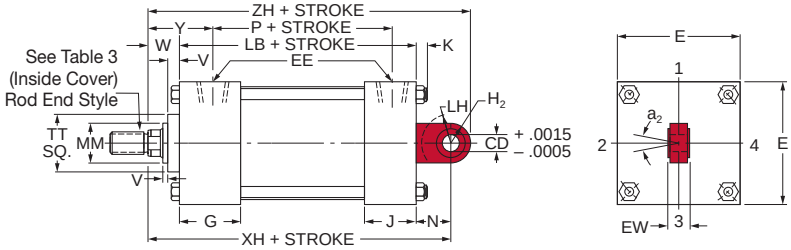
MODEL A61
NFPA STYLE MP1



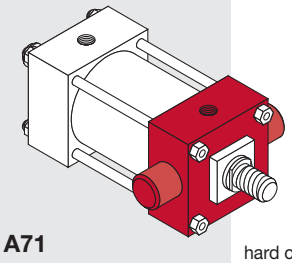
SPHERICAL EYE MOUNT



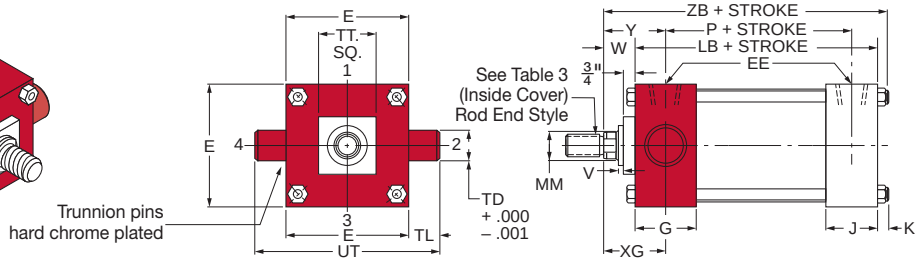
MODEL A62



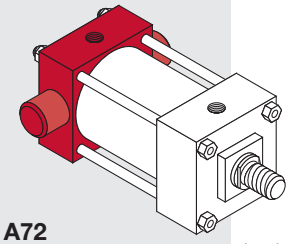
ROD END TRUNNION MOUNT



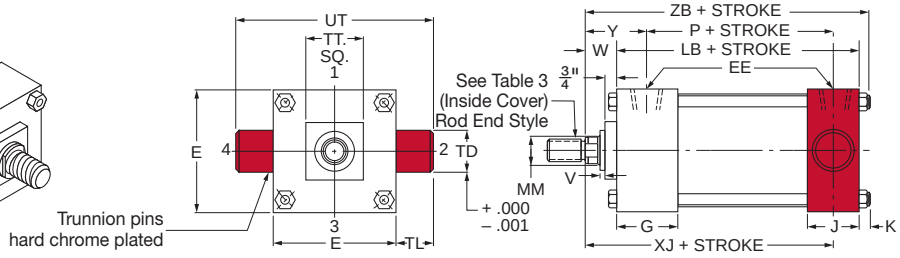
MODEL A71
NFPA STYLE MT1



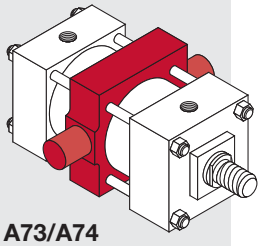
BLIND END TRUNNION MOUNT



MODEL A72
NFPA STYLE MT2

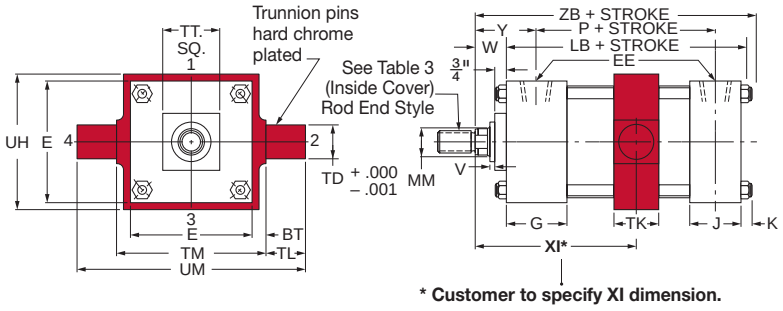


CENTER TRUNNION MOUNT



MODEL A73/A74
NFPA STYLE MT4

A73 is an exclusive Milwaukee Cylinder design.
A74 is the Industry "Standard" design.



*** Customer to specify XI dimension.**

▼ TABLE 1A

The dimensions given on this table are affected by the piston rod diameter and the stroke.

Bore Ø	Rod MM	Cylinder Code ♦	LB	P	TT	V	W	XC	XG	XH	XJ	Y	ZB	ZC	ZH
8	1⅜	A0180	5⅛	3¼	4	¼	1⅝	8¼	2⅝	8⅜	6	2 13/16	7 5/16	9¼	10⅛
	1¾	A0181			4	⅜	1⅞	8½	2⅞	8⅝	6¼	3 1/16	7 9/16	9½	10⅜
	2	A0182			4	⅜	2	8⅝	3	8¾	6⅜	3 3/16	7 11/16	9⅝	10½
	2½	A0183			4										
	3	A0184			5½										
	3½	A0185			5½										
	4	A0186			5½	½	2¼	8⅞	3¼	9	6⅝	3 7/16	7 15/16	9⅞	10¾
	4½	A0187			7										
	5	A0188			7										
	5½	A0189			7										
10	1¾	A1100	6⅜	4⅛	4	⅜	1⅞	10⅜	3	–	7¼	3⅛	8 15/16	11¾	–
	2	A1101			4	⅜	2	10½	3⅛	–	7⅜	3¼	9 1/16	11⅞	–
	2½	A1102			4										
	3	A1103			5½										
	3½	A1104			5½										
	4	A1105			5½	½	2¼	10¾	3⅜	–	7⅝	3½	9 5/16	12⅛	–
	4½	A1106			7										
	5	A1107			7										
	5½	A1108			7										
12	2	A1120	6⅞	4⅝	4	⅜	2	11⅛	3⅛	–	7⅞	3¼	9 9/16	12⅞	–
	2½	A1121			4										
	3	A1122			5½										
	3½	A1123			5½										
	4	A1124			5½	½	2¼	11⅜	3⅜	–	8⅛	3½	9 13/16	13⅛	–
	4½	A1125			7										
	5	A1126			7										
	5½	A1127			7										
14	2½	A1140	8⅛	5½	4	½	2¼	12⅞	3⅝	–	9¼	3 13/16	11 13/16	14⅞	–
	3	A1141			5½										
	3½	A1142			5½										
	4	A1143			5½										
	4½	A1144			7										
	5	A1145			7										
	5½	A1146			7										
16	2½	A1160	8⅛	5⅝	4	½	2¼	14⅜	3⅝	–	9¼	3¾	11 13/16	16⅞	–
	3	A1161			5½										
	3½	A1162			5½										
	4	A1163			5½										
	4½	A1164			7										
	5	A1165			7										
	5½	A1166			7										

HOW TO ORDER

For ordering information refer to page 98.

NOTES:

♦ For double rod end cylinders add prefix letter "D" to cylinder code. Example: DA0180. (Refer to page 92.) Double rod ends are not available on clevis mount Series A cylinders.

Rod End Styles and Dimensions

For rod end styles and dimensions see the Table 3 in the inside cover of the catalog.

Page ii

***MilCad* Cylinder Configurator**

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▼ TABLE 2A

The dimensions are constant regardless of rod diameter or stroke.

Bore Ø	a_2	BT	CB	CD	CW	E	EE	EW	G	H_2	J	K	L	LH	LR	M	MR	N	TD	TL	A73 TK	A73 TM	A73 UH	A73 UM	A74 TK	A74 TM	A74 UH	A74 UM	UT
8	12½°	1	1½	1	¾	8½	¾	1⅜	2	1¾	1½	9/16	1½	1¼	1¼	1	1 3/16	1⅝	1⅜	1⅜	1½	10½	9	13¼	2½	9¾	9½	12½	11¼
10	–	1¼	2	1⅜	1	10⅝	1	–	2¼	–	2	1 1/16	2⅛	–	2⅞	1⅜	1⅜	–	1¾	1¾	2	13⅛	11	16⅝	3	12	11¾	15½	14⅛
12	–	1¼	2½	1¾	1¼	12¾	1	–	2¼	–	2	1 1/16	2¼	–	2	1¾	1¾	–	1¾	1¾	2	15¼	13⅜	18¾	3	14	17½	18¾	16¼
14	–	1½	2½	2	1¼	14¾	1¼	–	2¾	–	2¼	13/16	2½	–	2¼	2	2	–	2	2	2¼	17¾	15⅜	21¾	3½	16¼	16	20¼	18¾
16	–	1½	3	2	1¼	17	1¼	–	2¾	–	2¼	13/16	4	–	3⅝	2½	3	–	2	2	2¼	20	18	24	–	–	–	–	–

DOUBLE ROD END CYLINDERS

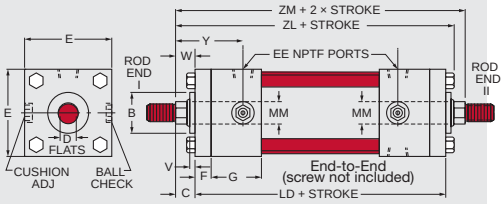
Milwaukee Cylinder's Double Rod End Cylinders are available with all the standard types of mountings, except 61 and 62.

To obtain dimensioning information on a double rod end cylinder, first select the desired mounting style and refer to the corresponding single rod end cylinder model shown on the preceding pages. After you have determined all necessary dimensions from the previous page covering the desired mounting, turn back to this page.

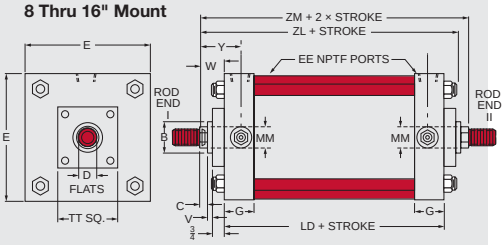
Supplement those dimensions with additional ones from the drawings below and the table on the right. These added dimensions differ from, or are in addition to, those shown on the preceding pages and provide the additional information needed to completely dimension a double rod end cylinder model.

On a double rod end cylinder where two different rod ends are required, or two different rod sizes are required, or cushions on one end are required, be sure to state clearly which rod is to go at which end of the cylinder. When two types of mounting styles are required, be sure to specify their relationship to the piston rods if they are not the same.

1½ Thru 6" Mount



8 Thru 16" Mount

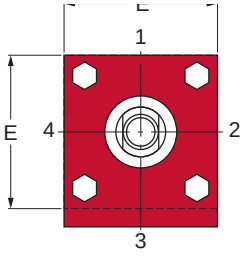


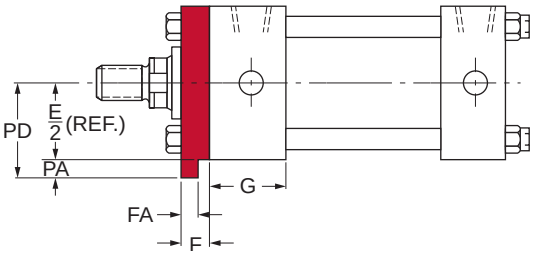
Bore Ø	Rod MM	Cylinder Code	LD*	SE*	SS*	ZL	ZM
1½	⅝	DA0011	4⅞	6⅜	3⅜	5¾	6⅛
	1	DA0012				6⅛	6⅞
2	⅝	DA0110	4⅞	6¾	3⅜	5 13/16	6⅛
	1	DA0111				6 3/16	6⅞
	1⅜	DA0112				6 7/16	7⅜
2½	⅝	DA0120	5	7⅛	3½	5 15/16	6¼
	1	DA0121				6 5/16	7
	1⅜	DA0122				6 9/16	7½
	1¾	DA0123				6 13/16	8
3¼	1	DA0130	6	7¾	3¾	7⅛	7½
	1⅜	DA0131				7⅜	8
	1¾	DA0132				7⅝	8½
	2	DA0133				7¾	8¾
4	1	DA0140	6	8	3¾	7⅛	7½
	1⅜	DA0141				7⅜	8
	1¾	DA0142				7⅝	8½
	2	DA0143				7¾	8¾
	2½	DA0144				8	9¼
5	1	DA1x50	6¼	8⅜	3⅝	7 7/16	7¾
	1⅜	DA1x51				7 11/16	8¼
	1¾	DA1x52				7 15/16	8¾
	2	DA0153				8 1/16	9
	2½	DA0154				8 5/16	9½
	3	DA0155					
	3½	DA0156					
6	1⅜	DA0160	7	8⅞	4⅛	8 5/16	8¾
	1¾	DA0161				8 9/16	9¼
	2	DA0162				8 11/16	9½
	2½	DA0163				8 15/16	10
	3	DA0164					
	3½	DA0165					
	4	DA0166					
8	1⅜	DA0180	5⅝	7⅞	4¼	7 13/16	8⅞
	1¾	DA0181				8 1/16	9⅜
	2	DA0182				8 3/16	9⅝
	2½	DA0183					
	3	DA0184					
	3½	DA0185					
	4	DA0186				8 7/16	10⅛
	4½	DA0187					
	5	DA0188					
	5½	DA0189					
10	1¾	DA1100	6⅝	9¼	4⅞	9 3/16	10⅜
	2	DA1101				9 5/16	10⅝
	2½	DA1102				9 9/16	11⅛
	3	DA1103					
	3½	DA1104					
	4	DA1105					
	4½	DA1106					
	5	DA1107					
	5½	DA1108					
12	2	DA1120	7⅛	9¾	5⅜	9 3/16	11⅛
	2½	DA1121				10 1/16	11⅝
	3	DA1122					
	3½	DA1123					
	4	DA1124					
	4½	DA1125					
	5	DA1126					
	5½	DA1127					
14	2½	DA1140	8⅝	11⅝	6⅛	11 11/16	13⅛
	3	DA1141					
	3½	DA1142					
	4	DA1143					
	4½	DA1144					
	5	DA1145					
	5½	DA1146					
16	2½	DA1160	8⅝	11¾	6⅛	11 11/16	13⅛
	3	DA1161					
	3½	DA1162					
	4	DA1163					
	4½	DA1164					
	5	DA1165					
	5½	DA1166					

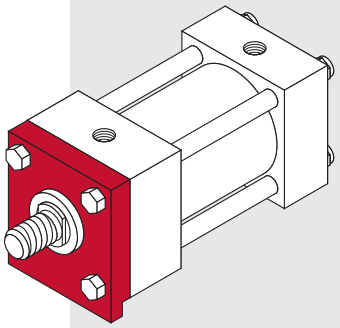
*Note: These dimensions are to be substituted for the related mounting dimensions given on the preceding pages. All dimensions given on this table are plus stroke.

KEY MOUNT CYLINDERS

The *Milwaukee Cylinder* Key Mount retainer plate is a mounting option designed to add rugged stability to foot and side mount cylinders. The retainer plate is extended below the mounting surface of the cylinder. This extension may be fitted into a milled keyway in your mounting pad, eliminating the need for welded keys or locator pins.





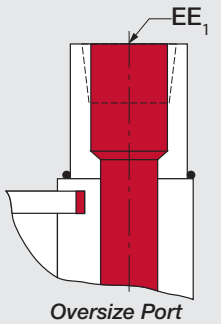


HOW TO ORDER

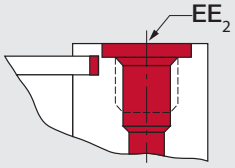
For ordering information refer to page 98.

▼ KEY MOUNT CYLINDERS

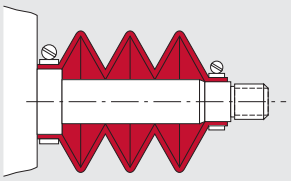
Bore Ø	E	F	FA	G	PA	PD
1½	2	⅜	.312/.310	1½	3/16	1 3/16
2	2½	⅜	.312/.310	1½	3/16	1 7/16
2½	3	⅜	.312/.310	1½	3/16	1 11/16
3¼	3¾	⅝	.562/.560	1¾	5/16	2 3/16
4	4½	⅝	.562/.560	1¾	5/16	2 9/16
5	5½	⅝	.562/.560	1¾	5/16	3 1/16
6	6½	¾	.687/.684	2	⅜	3⅝



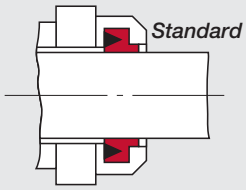
Oversize Port Welded Boss

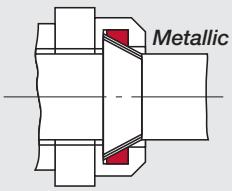


SAE Straight Thread O-ring Port



Rod Boots





Metallic Rod Wipers

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

DESIGN OPTIONS

Standard Ports

The *Milwaukee Cylinder* Series A Cylinders are manufactured as standard, the largest NPTF tapered thread ports that will fit in both the rod and blind ends of a given bore size. Upon request, extra ports can be provided on the sides of the end caps not occupied by mountings or cushion adjusters.

Oversize Ports

On most bore sizes, welded bosses may be provided for oversize NPTF ports. These bosses protrude from the sides of the end caps. For information as to the boss height in relation to your bore and port requirements, contact your local *Milwaukee Cylinder* Representative. Also, special heavier end caps can be provided so that oversize ports can be accommodated without the use of a welded boss.

Straight Thread Ports

On request, *Milwaukee Cylinder* will furnish an SAE straight thread O-Ring port on the Series A Cylinders. In addition to the standard oversize NPTF ports, welded bosses may also be used for oversize SAE straight thread O-Ring ports. For further information on oversize SAE ports, contact the factory.

Note: Flange and manifold syle ports are available from *Milwaukee Cylinder*.

Rod Boots

When cylinders are used in areas of high contamination or where contaminants have an air hardening property, the exposed piston rod should be covered with a rod boot to protect the rod bearing and seals. A rod boot is simply a collapsible cover. It is of sewn construction made from a neoprene coated fabric. The rod boots are impervious to oil, grease and water. They will operate effectively from 0°F to +200°F without cracking. For additional details on Rod Boots, please see page 186.

Metallic Rod Wipers

If requested, metallic rod wipers will be supplied in place of the standard synthetic rubber wiper. This type of seal is recommended for applications where contaminants would tend to cling to the rod and damage a standard synthetic rubber rod wiper.

▼ PORT SIZES

Bore Ø	Standard NPTF Port EE	Oversized NPTF Port EE_1	SAE Straight O-Ring Port	
			EE_2	SAE Standard Thread Series
1½	⅜	½	#6	9/16-18
2	⅜	½	#6	9/16-18
2½	⅜	½	#6	9/16-18
3¼	½	¾	#10	⅞-14
4	½	¾	#10	⅞-14
5	½	¾	#10	⅞-14
6	¾	1	#12	1 1/16-12
8	¾	1	#12	1 1/16-12
10	1	1¼	#16	1 5/16-12
12	1	1¼	#16	1 5/16-12
14	1¼	1½	#20	1⅝-12
16	1¼	1½	#20	1⅝-12

DESIGN OPTIONS FOR SPECIAL CYLINDERS

Special Rod Ends

Modifications of standard or entirely special rod ends are available from *Milwaukee Cylinder*. When your requirements call for a special rod end style, your order should include a sketch if it is to be an entirely special rod end or note reference as to which letter dimensions you wish to have modified (see inside front cover).

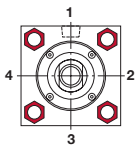
Special Assemblies from Standard Parts

Each style of the various standard cylinder mountings is illustrated, using the commonly recognized cylinder dimensional symbols of the National Fluid Power Association. Each side of the end views are numbered to aid in communication when referring to the relationship between the ports and the mountings. When requesting information or placing an order that requires a dimension other than standard, always make reference to the given dimensional symbol in the catalog and then give your requirements.

Cushion Adjustment Locations

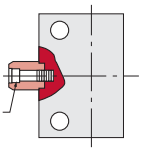
A ball check is supplied as standard in position #2 and a cushion adjustment needle is supplied **as standard in position #2 on most models.** The cushion needle and ball check are interchangeable as far as location and may be put in any side not occupied by a port or mounting.

Port Locations



Ports are located in position #1 as standard unless otherwise specified. By using the position numbers given with the end views in the dimensional data section of this catalog, ports can be arranged in any one of four 90° positions in relation to the cylinder mounting. When ports are relocated on a cushioned cylinder, the cushion needle and ball check are automatically relocated to hold their relationship to the port as on a standard cylinder, unless otherwise specified at the time of the order.

Removable Trunnion Pins



Removable trunnion pins are available on models A71 and A72. They can be used on all bore and rod combinations, except on the largest oversize rods offered with each bore size on all model A71 cylinders.

Single-Acting Cylinders

The *Milwaukee Cylinder* Series A Cylinders are designed for either single- or double action. When used as a single-acting cylinder, pneumatic power drives the piston in one direction, only relying on either the load or an external force to return the piston after the pressure is exhausted.

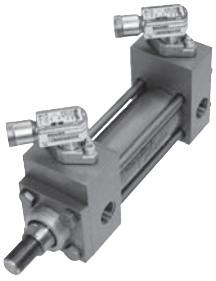
Single-Acting Spring Cylinders

Single-acting spring return cylinders normally have a spring inside of the cylinder to return the piston to its original position. The application load and friction conditions must be specified when placing an order to properly size the spring. Also specify whether the spring is to return or advance the piston. A spring return cylinder is designed with a stop tube to act as spring guide, which prevents binding of the cylinder due to misalignment of the spring. To accurately determine the cylinder length and mounting dimensions for your application, contact your local *Milwaukee Cylinder* representative or the factory.

Proximity Switches

End of Stroke Limit Switches:

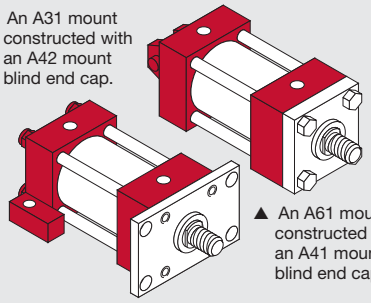
We provide inductive proximity switches for end of stroke sensing. These non-contact switches detect the presence of the spud/cushion bushing. See page 185 for more information.



Combined Mountings

Standard mountings may be combined when specified by the customer. Some examples of this are:

▼ An A31 mount constructed with an A42 mount blind end cap.

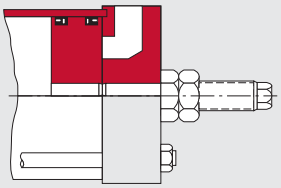


▲ An A61 mount constructed with an A41 mount blind end cap.

These and other combinations can be readily made from standard parts. If you are unsure of a possible combination or if it will suit your particular needs, consult with your local *Milwaukee Cylinder* representative or contact the factory.

Adjustable Stroke Cylinders

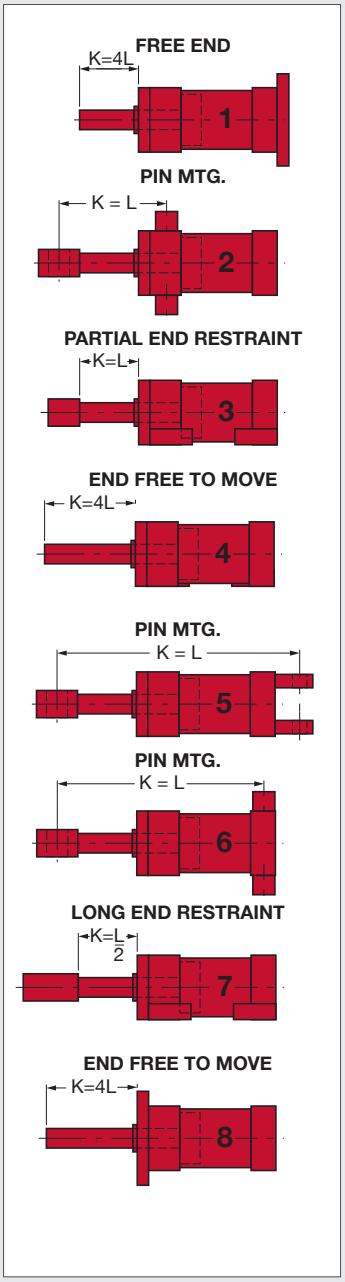
When a cylinder application requires stroke adjustment, *Milwaukee Cylinder* offers a number of designs. This particular design is externally adjustable, incorporating a threaded rod (of piston rod quality) with a seal nut. This provides a proven-effective, high and low pressure seal, affording maximum sealing on the stroke adjustment rod.



Further information concerning design limitations, cushioning or alternate designs can be obtained by contacting *Milwaukee Cylinder*.

CAUTION!
Cylinders with removable trunnion pins will have a reduced pressure rating. Consult the factory.

▼ FIGURE 1



Stop Tubes
For more information on Stop Tubes, see page 181 in the Design Engineer's Guide.

STOP TUBES

Stop tubes are used to maintain bearing pressure within acceptable limits and are recommended on cylinders with long strokes or poorly guided rods.

The stop tube is a spacer between the rod end cap and the piston, which provides separation between the piston and the rod bearing. This separation reduces the moment forces developed between the rod bearing and piston when the rod is extended.

Depending on the type of air cylinder you require, *Milwaukee Cylinder* offers two stop tube designs. When an air cylinder cushioned on the rod end requires stop tube, an additional piston and spacer is used (refer to Figure A). If an air cylinder requiring stop tube is not cushioned, only a spacer is used (refer to Figure B).

To determine if stop tube is necessary for your cylinder requirements, you have to solve for "K" (refer to Figure 1). If your required cylinder has a "K" dimension in excess of 40 inches, stop tube is required. For each 10 inch increment or fraction thereof in excess of 40 inches, one inch of stop tube is recommended. When stop tube is required, the overall length of the cylinder will be increased by the length of the stop tube to be used.

To determine "K" (see Figure 1)
*Note: W = the rod stick out
(refer to pages 74-93)

K = 4L= 4 (stroke + W*)

Cylinder #2 - see Figure 1

K = L = (CA or CE) + XG + Stroke

Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XG = mounting dimension page 88 or 90

Cylinder #3 – see Figure 1

K = L = W* + Stroke

Cylinder #5 – see Figure 1

K = L = (CA or CE) + XC + (2 x Stroke)

Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XC = mounting dimension page 88 or 90

Cylinder #6 – see Figure 1

K = L = (CA or CE) + XJ + (2 x Stroke)

Note:
CA = rod eye dimension (back inside cover)
CE = rod clevis dimension (back inside cover)
XJ = mounting dimension page 88 or 90

Cylinder #7 – see Figure 1

K = L/2 =(W* + Stroke)/2

When mounting long stroke cylinders, care should be taken to assure cylinder alignment over the entire length of stroke. The use of external guides or swivel bushings is recommended to reduce side load conditions and prolong the cylinder's service life.

Note: Stop tube length must be added to "K" factor before making final selection of rod size. This is primarily true in No. 5 long stroke applications.

Figure A

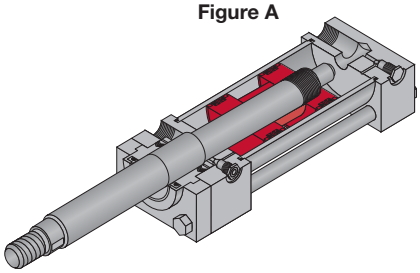
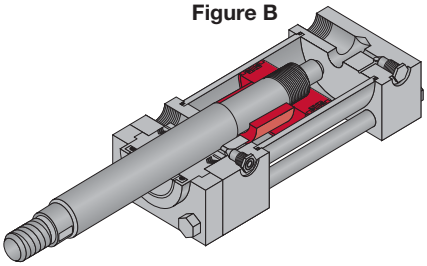


Figure B



The stop tube is located between the piston and the rod end cap. It limits the extended stroke of the cylinder, providing additional strength for less cost and reduced weight than the use of an oversize rod.

▼ TABLE 1 - VALUE OF "K" IN INCHES

Thrust Force (in-lbs)	Piston Rod Diameter (in)												
	⅝	1	1⅜	1¾	2	2½	3	3½	4	4½	5	5½	7
400	35	84	134	–	–	–	–	–	–	–	–	–	–
700	30	68	119	–	–	–	–	–	–	–	–	–	–
1,000	26	60	105	156	190	–	–	–	–	–	–	–	–
1,400	24	54	93	144	175	244	308	–	–	–	–	–	–
1,800	23	48	84	127	160	230	294	366	–	–	–	–	–
2,400	18	45	75	114	145	214	281	347	–	–	–	–	–
3,200	16	40	68	103	131	196	262	329	398	–	–	–	–
4,000	12	38	63	93	119	174	240	310	373	446	–	–	–
5,000	9	36	60	87	112	163	225	289	359	426	–	–	–
6,000	–	30	56	82	102	152	209	274	342	411	476	–	–
8,000	–	25	51	76	93	136	186	244	310	375	448	–	–
10,000	–	21	45	70	89	125	172	221	279	349	412	–	–
12,000	–	17	41	64	85	117	155	210	270	326	388	455	–
16,000	–	–	35	57	75	110	141	188	233	291	350	421	–
20,000	–	–	28	52	66	103	136	173	218	270	325	385	–
30,000	–	–	–	39	56	87	120	156	190	232	285	330	–
40,000	–	–	–	24	43	75	108	142	177	210	248	293	–
50,000	–	–	–	–	30	66	97	131	165	201	234	268	408
60,000	–	–	–	–	–	57	88	119	154	190	226	256	384
80,000	–	–	–	–	–	36	71	104	136	170	204	240	336
100,000	–	–	–	–	–	–	56	91	120	154	199	224	324
120,000	–	–	–	–	–	–	45	76	108	146	174	207	313
140,000	–	–	–	–	–	–	–	64	98	129	162	194	301
160,000	–	–	–	–	–	–	–	47	87	118	149	182	279
200,000	–	–	–	–	–	–	–	–	65	98	131	160	260
250,000	–	–	–	–	–	–	–	–	–	72	109	143	236
300,000	–	–	–	–	–	–	–	–	–	–	85	120	212
350,000	–	–	–	–	–	–	–	–	–	–	53	100	195
400,000	–	–	–	–	–	–	–	–	–	–	–	72	182
500,000	–	–	–	–	–	–	–	–	–	–	–		152
600,000	–	–	–	–	–	–	–	–	–	–	–	–	114
700,000	–	–	–	–	–	–	–	–	–	–	–	–	70

▼ TABLE 2 - DEDUCTIONS FOR PULL STROKE FORCE & DISPLACEMENT

Bore Ø	Piston Rod Area	Piston Rod Force in Pounds for Various Pressures								Displacement per inch of Stroke	
		30 psi	50 psi	80 psi	100 psi	125 psi	150 psi	200 psi	250 psi	Pressure Air Cubic Ft. Displaced	Free Air Cubic Ft. @ 80 psi
⅝	.307	9	15	25	31	38	46	62	77	.00018	.00116
1	.785	23	39	63	79	98	118	158	197	.00045	.00290
1⅜	1.4895	44	74	119	149	186	223	298	372	.00086	.00554
1¾	2.405	72	120	192	241	300	261	482	601	.00139	.00895
2	3.142	94	157	251	314	392	471	628	785	.00182	.01172
2½	4.909	147	245	393	491	613	736	982	1227	.00284	.01829
3	7.069	212	353	566	707	883	1060	1414	1767	.00409	.02635
3½	9.621	288	481	770	962	1202	1443	1924	2405	.00557	.03588
4	12.566	377	628	1006	1257	1571	1885	2514	3142	.00727	.04683
4½	15.904	477	795	1272	1590	1987	2385	3180	3975	.00920	.05926
5	19.635	589	982	1571	1964	2455	2946	3928	4910	.01137	.07324
5½	23.758	712	1188	1901	2376	2970	3564	4752	5940	.01375	.08857

▼ TABLE 3 - THRUST FORCE AND DISPLACEMENT

Piston Ø	Piston Rod Area	Cylinder Force in Pounds for Various Pressures								Displacement per inch of Stroke	
		30 psi	50 psi	80 psi	100 psi	125 psi	150 psi	200 psi	250 psi	Pressure Air Cubic Ft. Displaced	Free Air Cubic Ft. @ 80 psi
1½	1.77	53	88	141	177	221	265	354	442	.00102	.00657
2	3.14	94	157	251	314	392	471	628	785	.00182	.01185
2½	4.91	147	245	393	491	613	736	982	1227	.00284	.01829
3¼	8.30	249	415	664	830	1037	1245	1660	2075	.00480	.03091
4	12.57	377	628	1006	1257	1571	1885	2514	3142	.00727	.04682
5	19.64	589	982	1571	1964	2455	2946	3928	4910	.01137	.07324
6	28.27	848	1413	2262	2827	3533	4240	5654	7067	.01636	.10538
8	50.27	1508	2513	4022	5027	6283	7540	10054	12567	.02909	.18740
10	78.54	2356	3927	6283	7854	9817	11781	15708	19635	.04545	.29279
12	113.10	3393	5655	9048	11310	14137	16965	22620	28275	.06545	.42160
14	153.90	4617	7695	12312	15390	19237	23085	30780	38475	.08906	.57367
16	201.10	6030	10050	16080	20100	25125	30150	40200	50250	.11620	.74900

CYLINDER SIZING

The selection of the correct rod size is one of the most important factors in sizing a cylinder. The standard rod for each bore size that *Milwaukee Cylinder* manufactures is sufficient to handle the maximum tension force that the cylinder is capable of producing. It is primarily in compression and long stroke, high thrust applications that the column strength needs to be considered.

The following steps should be used to determine the proper rod size for an application:

1. Select the cylinder bore size required from Table 3 based on the required cylinder thrust force and the operating line pressure at the cylinder.
2. Determine the length between mounting points or "L" as shown on Figure 1, page 96.
3. Based on the distance between mounting points ("L"), determine the value of "K" as shown on Figure 1, page 96.
4. Using the thrust force and the developed "K" dimension, refer to Table 1 to select the proper rod size.
5. If an oversized rod is required, re-check the overall length dimension ("K") in Step 1 and confirm your previous rod size selection.

To determine the cylinder pull (tension), stroke force, or displacement, deduct the force or displacement corresponding to the rod size in Table 2 from the force or displacement corresponding to the bore size shown in Table 3.

Feature	Description	Page Number	Code Number
Double Rod End		92	D
Cylinder Code	Refer to TABLE 1A	77, 79, 81, 83, 85, 87, 89, 91	—
Mounting Style	Model Number Only	76, 78, 80, 82, 84, 86, 88, 90	—
Rod End Style	Code Number	inside front cover (ii)	—
Cushions	None Rod End Blind End Both Ends	— — — —	1 2 3 4
Cylinder Modifications	Special		S
Seals	Buna-N (-20° to 200° F) Viton (-15° to 350° F) Special		7 8 S
Stroke	Specify in Inches Including Fractional Requirements		—

Example: A143 – 31 – 1 4 ___ – 7 × 14¾

If Standard Leave Blank

*If Special Describe Requirements

*__NOTE:__ Use “S” if any special design features or seals are required, describe in detail on your order.

__EXAMPLE:__ The code for a pneumatic cylinder 4" bore, rod end rectangular flange mounting, 1¾" rod, Style No. 1 rod end, cushion both ends, standard seals with a 14¾" stroke is **A142-31-14-7x14¾.**

DUPLICATE CYLINDERS

Duplicate cylinders can be ordered by giving the serial number from the nameplate of the original cylinder. Factory records supply a quick, positive identification.

HOW TO ORDER

Series A Cylinders

Standard Series A Cylinders can be completely and accurately described by a model number. If your requirements are completely standard, select the alphanumeric codes from above that represent your cylinder and place them in the sequence indicated by the example. Use of the cylinder model number will eliminate untimely delays in handling your order.

General Order Data

(covered by the cylinder code)

1. Bore & Rod Size or the Cylinder Code: (refer to pages 76-93)
2. Mounting Style: (refer to page 76-93)
3. Rod End Style: (refer to Inside Cover, page ii)
4. Cushion Requirements
5. Length of Stroke

Application Data

1. **Port Requirements**: refer to page 94.
2. **Operating Fluid or Medium:** Series A Cylinders are equipped with seals for use with shop air or petroleum base fluids. Specify on your order if any other type of operating medium is to be used.
3. **Temperature Range:** Series A pneumatic cylinders contain seals of Nitrile (Buna-N) suitable to -20° F to +200° F. Specify your operating temperature if your application does not fall within this temperature range.
4. **Operating Pressure:** Series A Cylinders are rated for 250 psi. If your requirements are in excess of the rated pressure, describe your application in your order.
5. **Accessories**: Specify any accessories you require, using the part numbers given on the inside back cover.
6. **Special Requirements:** If you require special seals, rod material, stop tube, center support, adjustable stroke or any other special requirements not covered, specify in detail on your order.

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

REPLACEMENT SEALS OR CYLINDER PARTS

For replacement seals or cylinder parts, the serial number of your cylinder, the cylinder model number and the item number of the part you require (below) should appear on your order. To order entire seal kits for your cylinder, simply specify the serial number and the cylinder model number from page 84 on your request for service parts.

HOW TO ORDER COMPLETE SEAL KITS

When ordering complete seal kits, specify the following information on your order:

1. The serial number of the cylinder the seals will be used on.
2. The bore and rod size.
3. If the cylinder is cushioned.

To eliminate untimely delays in the handling of your order, please use the seal kit code as shown in the example below:

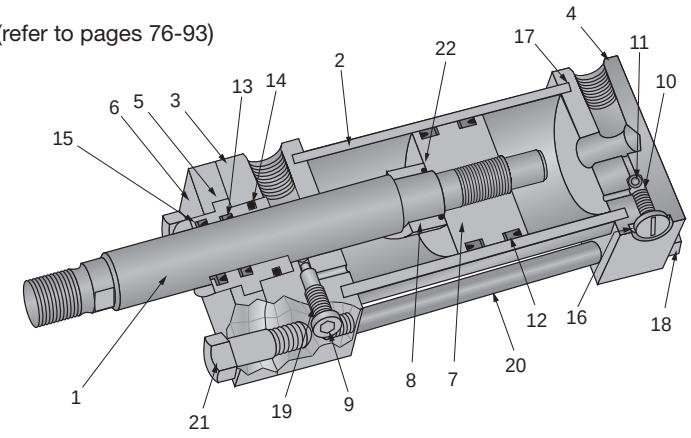
Example:

Buna-N Kit No. XXXXX-7-50

- cylinder code number (refer to pages 76-93)

Viton Kit No. XXXXX-8-50

- cylinder code number (refer to pages 76-93)



Item No.	Description
1	Piston Rod
2	Cylinder Barrel
3	Head End Cap
4	Cap End Cap
5	Rod Bushing
6	Retainer Plate
7	Piston
8	Cushion Plunger
9	Cushion Adj. Needle
10	Ball Check Retainer
11	Ball Check
12	U-Cup Seal & Backup Washer for Piston
13	Rod Seal & Backup Washer for Rod Bushing
14	O-Ring Seal for Rod Bushing
15	Rod Wiper
16	O-Ring Seal for Ball Check Retainer
17	Gasket
18	Tie Rod Nut
19	O-Ring Seal for Cushion Adj. Needle
20	Tie Rod
21	Self-Locking Cap Screw
22	O-Ring for Floating Cushion

Retainer Plate Cap Screw Torques

▼ **For Square Retainers**

Bore Ø	Torque (Ft-lbs)
1½	10
2	20
2½	20
3¼	30
4	30
5	50
6	50

Tie-rod Nut Torques

▼ **Nut Torque Specifications**

Bore Ø	Torque (Ft-lbs)	
	Steel	Composite
1½	5	3
2-2½	12	6
3¼-4	30	15
5 - 6	50	25
8	100	50
10	160	95
12	160	135
14	250	220
16	250	250

When it is necessary to remove the tie-rod nuts on a cylinder, they must be reassembled to the torque specifications given above. To prevent the tie-rods from twisting when tightened, use a vice grip or locking clamp. Note that the torque specification is based on lubricated threads.

INSTALLATION FOR SERIES A

General Information

Cleanliness

Cleanliness is the most important consideration when installing the cylinder. When cylinders are shipped from *Milwaukee Cylinder*, the ports are securely plugged with plastic plugs which should not be removed until the piping is to be installed. All piping should be thoroughly clean, to include the removal of all threading and flaring burrs or chips, before making the connection to the cylinder ports. One chip can cause premature failure of the cylinder or other system components.

Alignment

Improper alignment will result in excessive cylinder wear. Check to assure rod alignment between the cylinder and its mating component on your machine in both the extended and retracted positions.

Environment

Cylinders operating in areas where there is weld splatter, fast drying chemicals, paint, excessive heat or other hazardous conditions, should have covers or shields to prevent damage to the rod and rod seals.

MOUNTING RECOMMENDATIONS

Foot Mounted Cylinders

The use of high-strength alloy steel mounting bolts 1/16" smaller than the hole size is recommended. After final alignment, foot mounted cylinders should be dowel pinned in place.

Trunnion Mounted Cylinders

Lubricated pillow blocks designed for close tolerance applications should be used. It is important to rigidly mount and align the pillow blocks so that the trunnion pins will not be subjected to any extreme bending moments The rod end should be pivoted with the pivot pin in line and parallel to the axis of the trunnion pins.

Flush Mount Cylinders

The use of high strength alloy steel mounting bolts is recommended. Shear keys should be used to reduce the stress on the mounting bolts created by the normal push and pull forces created by the cylinder cycle.

Flange Mount Cylinders

The controlled diameter rod bushing extension can be used as a pilot to locate the flange mount. Dowel pins should be used after the cylinder is mounted and aligned to prevent shifting.

Clevis Mount Cylinders

This type of cylinder must be pivoted at both ends and the pins must be in line and parallel to each other. After the cylinder is mounted, the customer should check to assure that the cylinder is free to swing through its working arc without interference from other machined parts.

STORAGE

Often times, cylinders are delivered before a customer is prepared to install them and must be stored for a period of time. When storage is required:

1. Select an area indoors for storage, which has dry and non-corrosive atmosphere. Take caution to protect the cylinder from both internal and external corrosion.
2. Cylinders to be stored should be kept in a vertical position (piston rod up) whenever possible.
3. Port protector plugs should be kept in the cylinder ports until the time of installation.

CYLINDER TROUBLE SHOOTING

External leakage

If leaking occurs between the end cap and barrel, check tie-rod torque. Do not over torque. If the torque is correct, then replace the barrel seal. When leakage occurs in the rod bushing area, replace the rod seals. If leakage continues or reoccurs in short period of operation, check items 2 thru 5, page 99.

Cylinder misalignment

Side load is a common problem which occurs when the cylinder application does not allow the piston rod to work in line during the extend and retract motions of the cylinder. Evidence of this is excessive seal failure, bushing wear or galling of the piston rod. Often, bending of the piston rod or complete failure (breakage) of the rod occurs.

Contamination on the piston rod

Dirt and other material is often picked up when the piston rod is extended. When the rod is retracted in an excessive dirty application, it often carries the dirt back into the rod seal cavity of the cylinder, causing damage to the seals. With a slight modification of the cylinder rod end, a rod boot can be added to protect the rod bushing and seals for most applications.

Bad mountings

Due to wear of pivot pins or mounting bolts working loose, a cylinder may have side load, even though the rod was in line when the cylinder was first installed. All cylinder mountings should be checked periodically.

Damaged piston rod

An extended piston rod can be damaged by the impact of a hard object which could burr the rod. If this occurs, the rod should be checked immediately to prevent seal damage.

Internal leakage

Inside the cylinder, leakage past the piston seals can cause sluggish movement or settling of the cylinder under load conditions. This occurs due to leakage of worn piston seals or rings.

Creeping cylinder

When a cylinder is stopped in midstroke and it creeps, check for internal leakage. Creeping can also be caused by a worn control valve and this should be checked, even if the cylinder is found to have internal leakage.

CYLINDER MAINTENANCE

Rod Seal Replacement

When changing rod seals, extend the piston rod 3" or more if possible, being sure to support the rod at all times. Remove the retainer plate screws (if tie-rod nuts have to be removed, refer to the nut torque specification on this page when reassembling the cylinder), retainer plate and outer bushing. Using an eye hook or thin screwdriver, pry the vees from the end cap cavity (if low pressure air is applied to the rod end port, this will help to force the vees from the cavity). The new set of vees should be assembled into the cavity separately and lubed with the soft vee in the center. Replace the rod wiper in the bushing and reassemble the cylinder.

Piston Seal Replacement

When changing piston seals, extend the piston rod 3" or more if possible, being sure to support the piston rod and the piston at all times. *Remove the tie-rod nuts, blind end cap, the barrel and then the piston seals. A light grease, compatible with the system fluid, should be used on the rings and u-cup seals for smooth assembly. Install the u-cup piston seals, scarf cutting on only the back-up washers. Then install the cast iron rings with the joints in opposite directions. To reassemble, start the piston into the tube, compressing the cast iron rings using twine or a ring compressor. When the piston u-cup seal is to the edge of the barrel, use a thin rounded blade to start the lip of the u-cup, making sure the entire lip is started before moving the piston further into the tube.

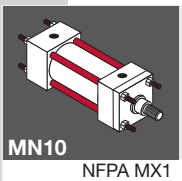
***Note:** When a cylinder has been disassembled this far, the barrel seals should at least be inspected, if not replaced.

Barrel Seal Replacement

When replacing barrel seals, use the same method of disassembling the cylinder as used when replacing piston seals. The barrel seal is a gasket which is layed into the end cap tube groove first. Then position the end caps squarely on the tube (check to make sure port location is correct), and firmly force or tap the end cap over the tube until it bottoms. Check to make sure the gasket did not move and then finish assembling the cylinder.

milwaukee Cylinder

Series MN



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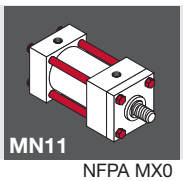

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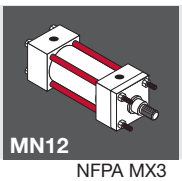

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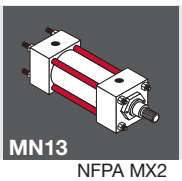

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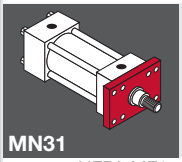

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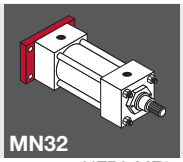

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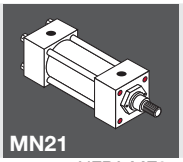

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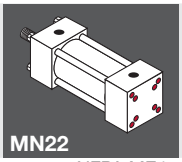

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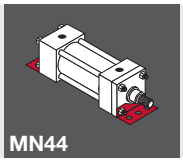

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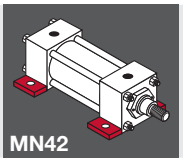

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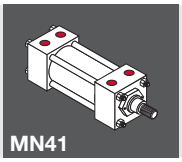

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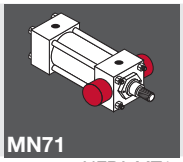

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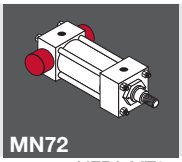

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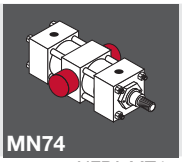

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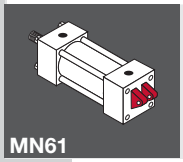

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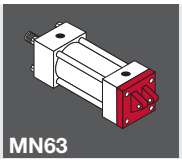

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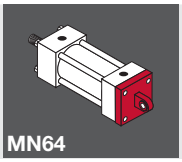

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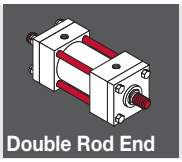


NFPA MDX

***Milwaukee Cylinder* Series MN Aluminum Cylinders** are of heavy duty construction in ten bore sizes (1-1/2" up to 12"). Pneumatic operation up to 250 PSI is standard, and 400 PSI hydraulic non-shock operation is available. These high-alloy aluminum pneumatic cylinders are made to order, allowing you to meet the needs of your custom application. Series MN Cylinders are recognized for their durability and long-lasting performance.

Max. Operating Pressure:
250 psi

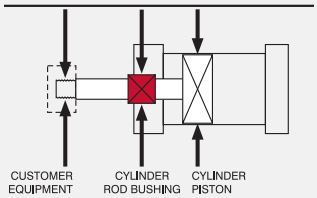
Operating Temperature, **Buna-N**:
-20° F to 200° F

Operating Temperature, **Viton**:
-15° F to 350° F

FLOATING ROD BUSHING

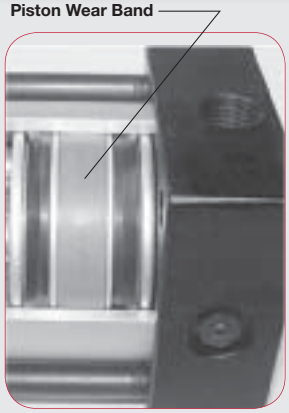
Self Alignment Feature

Rod Bushing is designed to float .002", improving bearing surface alignment.



- Reduces cylinder drag and erractic operation
- Reduces cylinder wear
- Provides a minimum of 25% longer life than "fixed" Rod Bushing designs

Piston Wear Band



***MilCad* Cylinder Configurator**

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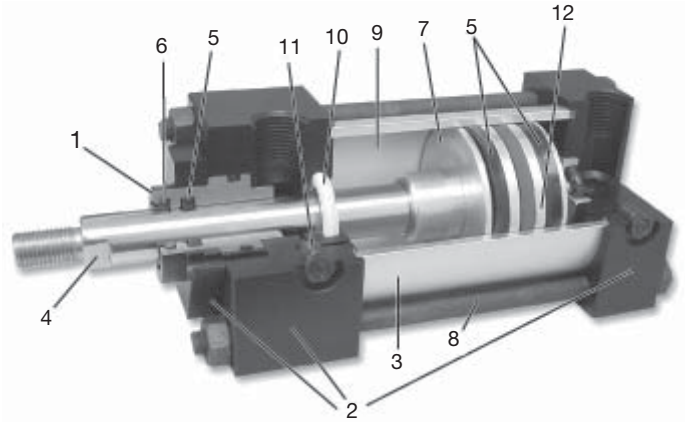


STANDARD FEATURES

1. **Floating Rod Bushing**
   Precision machined from 150,000 psi rated graphite filled cast iron and PTFE coated to reduce friction and extend cycle life. Bushing design "traps" lubrication in effective bearing area.
2. **Head, Cap & Retainer**
   Precision machined from high strength 6061-T6 aluminum alloy. Black anodized for corrosion resistance.
3. **Cylinder Tube**
   Precision machined from 6063-T6832 high tensile aluminum alloy and hard coat to 60 Rc for wear resistance and extended cycle life.
4. **Piston Rod**
   Precision machined from high yield, polished and hard chrome plated steel.
5. **Piston & Rod Seals**
   Heavy lip design Buna-N Nitrile construction. Seals are pressure activated and wear compensating with PTFE piston wear band for long life. (Self lubricating material).
6. **Rod Wiper**
   Abrasion resistant urethane provides aggressive wiping action in all environments. External lip design prevents debris from entering cylinder.
7. **Piston**
   Precision machined from 6061-T651 alloy aluminum, provides an excellent bearing surface for extended cylinder life.
8. **Tie Rods**
   Prestressed high carbon steel tie rod construction eliminates axial loading of cylinder tube and maintains compression on tube and end seals.
9. **Permanent Lubrication**
   Permanently lubricated with PTFE based grease on all internal components. This is a non-migratory type high performance grease providing outstanding service life. No additional lubrication is required.
10. **Cushions**
    (Options H & C) Floating cushion seal designed for maximum cushion performance, quick return stroke break-away and extended life.
11. **Cushion Adjustment Needle**
    Adjustable steel needle design has fine thread metering and is positively captured to prevent needle ejection during adjustment.
12. **Piston Magnet**
    (Option MPR/MPH - see page 120) for *Milwaukee Cylinder* magnetically operated Reed and Solid State switches (refer to pages 127-133).

PERFORMANCE OPTIONS

ST – Stop Tubes are used to reduce rod bearing and piston stress (refer to page 108 for cylinder design guidance).

MA – Micro-Adjust provides a precision adjustment on the cylinder extend stroke, providing quick and accurate cylinder positioning, reducing set-up time.

SSA – Stainless Steel Piston Rod, Tie Rods, Nuts, and Fasteners provide corrosion resistance in outdoor applications and wet environments.

LF – Low Friction Seals reduce breakaway and running friction. Effective at all operating pressures.

NR – Non-Rotating option incorporates (2) internal guide rods preventing rod rotation (NFPA dimensions).

ABOUT ROD END STYLES

Style KK1 Male Rod End is STANDARD. (If no rod style is specified, it will be supplied with KK1). Other NFPA Styles can be specified (See Chart).

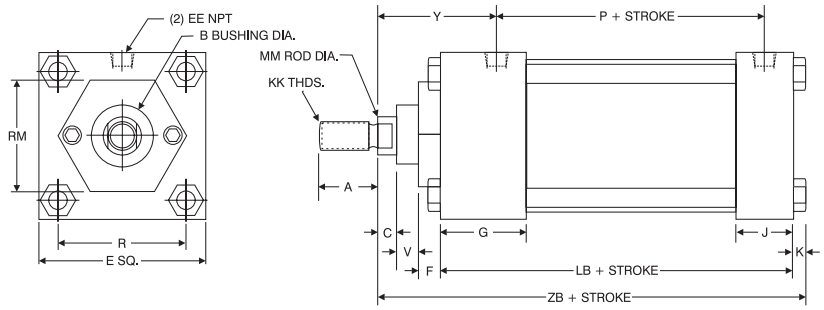
Need a rod end not listed? NO PROBLEM! Each Piston Rod is made to order and does not delay shipment. Coarse (UNC) threads, metric threads or just plain rod ends are common. Thread lengths are also made to order (Specify: "A"= Length).

NEED SOMETHING NOT LISTED? Contact the factory to discuss your custom requirements.

BORE	ROD MM	STANDARD KK1	A	OPTIONAL KK2	A	OPTIONAL KK3	A	OPTIONAL KK4	A	OPTIONAL KK5	C	V
1½, 2, 2½	⅝ 1	7/16-20 ¾-16	¾ 1⅛	½-20 ⅞-14	¾ 1⅛	7/16-20 ¾-16	¾ 1⅛	⅝-18 1-14	¾ 1⅛	No Threads	⅜ ½	¼ ½
3¼, 4, 5	1 1⅜	¾-16 1-14	1⅛ 1⅝	⅞-14 1¼-12	1⅛ 1⅝	¾-16 1-14	1⅛ 1⅝	1-14 1⅜-12	1⅛ 1⅝	No Threads	½ ⅝	¼ ⅜
6 & 8	1⅜ 1¾	1-14 1¼-12	1⅝ 2	1¼-12 1½-12	1⅝ 2	1-14 1¼-12	1⅝ 2	1⅜-12 1¾-12	1⅝ 2	No Threads	⅝ ¾	⅜ ½
10	1¾ 2	1¼-12 1½-12	2 2¼	1½-12 1¾-12	2 2¼	1¼-12 1½-12	2 2¼	1¾-12 2-12	2 2¼	No Threads	¾ ⅞	½ ⅜
12	2 2½	1½-12 1⅞-12	2¼ 3	1¾-12 2¼-12	2¼ 3	1½-12 1⅞-12	2¼ 3	2-12 2½-12	2¼ 3	No Threads	⅞ 1	⅜ ½

BASIC CYLINDER

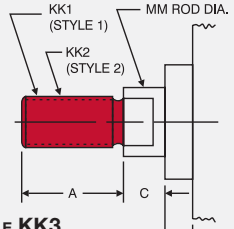
MODEL MN11
NFPA STYLE MX0 (No mount)



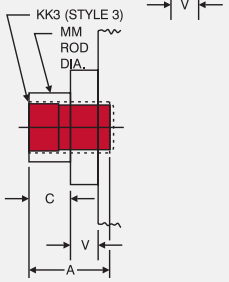
Bore Ø	Rod MM	Cylinder Code	A	B	C	E	EE	F	G	J	K	KK	LB	P	R	RM	V	Y	ZB
1½	⅝	MN00611	¾	1⅛	⅜	2	⅜	⅜	1½	1	¼	7/16-20	3⅝	2⅜	1.43	2 Sq.	¼	1⅞	4⅞
	1	MN00612	1⅛	1½	½							¾-16					½	2¼	5¼
2	⅝	MN06110	¾	1⅛	⅜	2½	⅜	⅜	1½	1	5/16	7/16-20	3⅝	2⅜	1.84	1¾ Hex	¼	1⅞	4 15/16
	1	MN06111	1⅛	1½	½							¾-16				2½ Sq.	½	2¼	5 5/16
2½	⅝	MN06120	¾	1⅛	⅜	3	⅜	⅜	1½	1	5/16	7/16-20	3¾	2½	2.19	1¾ Hex	¼	1⅞	5 1/16
	1	MN06121	1⅛	1½	½							¾-16				3 Sq.	½	2¼	5 7/16
3¼	1	MN06130	1⅛	1½	½	3¾	½	⅝	1¾	1¼	⅜	¾-16	4¼	2¾	2.76	2¾ Dia.	¼	2⅜	6
	1⅜	MN06131	1⅝	2	⅝							1-14				3¾ Sq.	⅜	2⅝	6¼
4	1	MN06140	1⅛	1½	½	4½	½	⅝	1¾	1¼	⅜	¾-16	4¼	2¾	3.32	2¾ Dia.	¼	2⅜	6
	1⅜	MN06141	1⅝	2	⅝							1-14				3½ Dia.	⅜	2⅝	6¼
5	1	MN06150	1⅛	1½	½	5½	½	⅝	1¾	1¼	7/16	¾-16	4½	3	4.10	2¾ Dia.	¼	2⅜	6 5/16
	1⅜	MN06151	1⅝	2	⅝							1-14				3½ Dia.	⅜	2⅝	6 9/16
6	1⅜	MN06160	1⅝	2	⅝	6½	¾	⅝	2	1½	7/16	1-14	5	3¼	4.88	3½ Dia.	⅜	2¾	7 1/16
	1¾	MN06161	2	2⅜	¾							1¼-12					½	3	7 5/16
8	1⅜	MN06180	1⅝	2	⅝	8½	¾	⅝	2	1½	9/16	1-14	5⅛	3⅜	6.44	3½ Dia.	⅜	2¾	7 5/16
	1¾	MN06181	2	2⅜	¾							1¼-12					½	3	7 9/16
10	1¾	MN61100	2	2⅜	¾	10⅝	1	⅝	2¼	2	11/16	1¼-12	6⅜	4 5/16	7.92	3½ Dia.	½	3 1/16	8 15/16
	2	MN61101	2¼	2⅝	⅞			¾				1½-12				5 Dia.	⅜	3 3/16	9 1/16
12	2	MN61200	2¼	2⅝	⅞	12¾	1	¾	2¼	2	11/16	1½-12	6⅞	4 13/16	9.40	5 Dia.	⅜	3 3/16	9 9/16
	2½	MN61201	3	3⅛	1							1⅞-12					½	3 7/16	9 13/16

PISTON ROD END STYLES

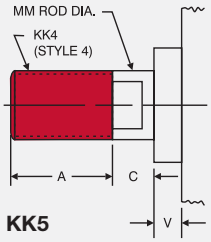
STYLE KK1 & KK2



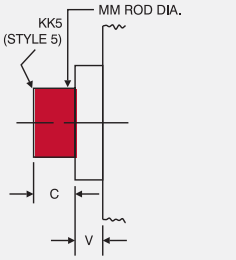
STYLE KK3



STYLE KK4



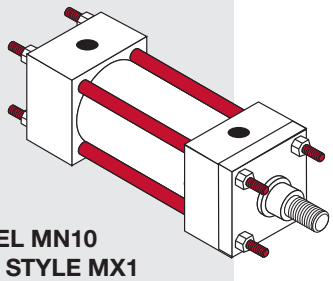
STYLE KK5



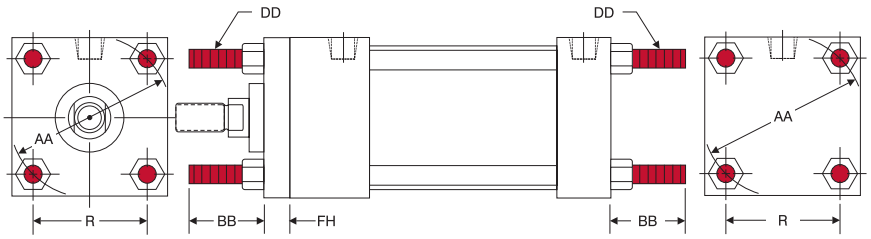
TIE ROD MOUNTED CYLINDERS

Tie-rod mounts are suited for many applications and are similar to flange mounts, but tie-rod mounts are not as rigid as the flange type of mounting. The best use of tie-rods extended on the blind end is in a thrust load application. When using tie-rod extended on the rod end, the best application is a tension load. When long strokes are required, the free end should be supported to prevent misalignment, sagging or possible binding of the cylinder.

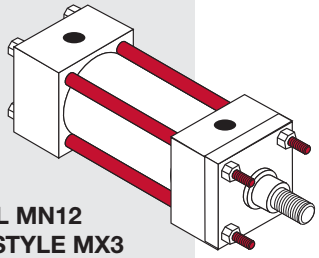
TIE RODS EXTENDED BOTH END



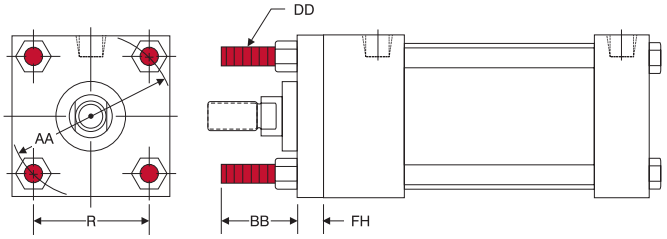
MODEL MN10
NFPA STYLE MX1



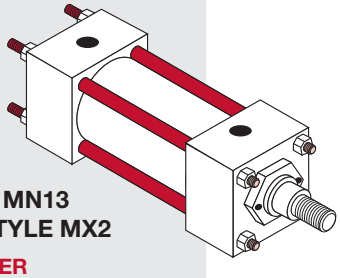
TIE RODS EXTENDED ROD END



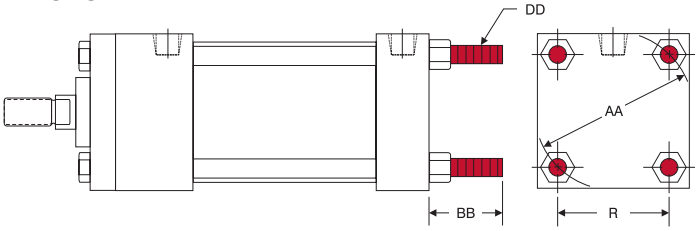
MODEL MN12
NFPA STYLE MX3



TIE RODS EXTENDED BLIND END



MODEL MN13
NFPA STYLE MX2



HOW TO ORDER

For ordering information refer to Page 134.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMN00611. (Refer to page 112.)

Rod End Styles and Dimensions

For rod end styles and dimensions see:

Page 105

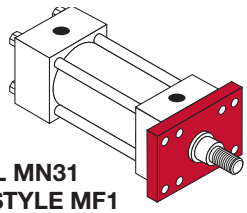
***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

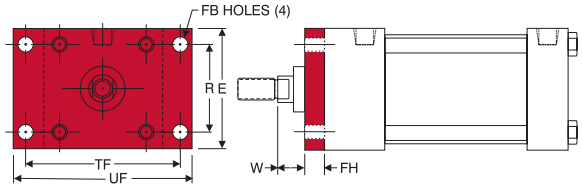
TIE ROD EXTENDED 'MN10', 'MN12, 'MN13' MOUNT DIMENSIONS							
Bore Ø	Rod MM	Cylinder Code ♦	AA	BB	DD	FH	R
1½	⅝	MN00611	2.02	1	¼-28	⅜	1.43
	1	MN00612					
2	⅝	MN06110	2.6	1⅛	5/16-24	⅜	1.84
	1	MN06111					
2½	⅝	MN06120	3.1	1⅛	5/16-24	⅜	2.19
	1	MN06121					
3¼	1	MN06130	3.9	1⅜	⅜-24	⅝	2.76
	1⅜	MN06131					
4	1	MN06140	4.7	1⅜	⅜-24	⅝	3.32
	1⅜	MN06141					
5	1	MN06150	5.8	1 13/16	½-20	⅝	4.10
	1⅜	MN06151					
6	1⅜	MN06160	6.9	1 13/16	½-20	¾	4.88
	1¾	MN06161					
8	1⅜	MN06180	9.1	**2 5/16	⅝-18	*⅝	6.44
	1¾	MN06181					
10	1¾	MN61100	11.2	**2 11/16	¾-16	*⅝	7.92
	2	MN61101				*¾	
12	2	MN61200	13.3	**2 11/16	¾-16	*¾	9.40
	2½	MN61201					

* MX1 and MX3 have full square bushing retainer on 1½" - 6" bores, round retainers on 8"-12" bores.
** BB dimensions from face of head. For dimensions not shown, see page 105.

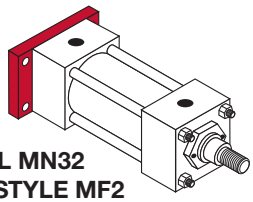
ROD RECTANGULAR FLANGE MOUNTING
(1½" - 6" bore only)



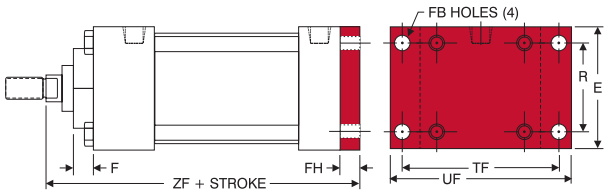
MODEL MN31
NFPA STYLE MF1



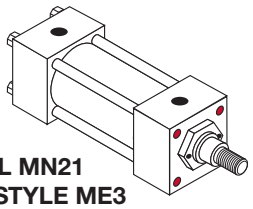
BLIND RECTANGULAR FLANGE MOUNTING
(1½" - 6" bore only)



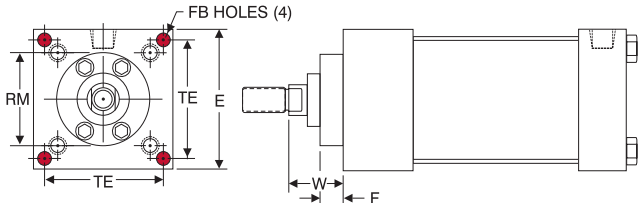
MODEL MN32
NFPA STYLE MF2



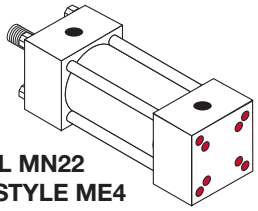
ROD SQUARE FLANGE MOUNTING
(8" - 12" bore only)



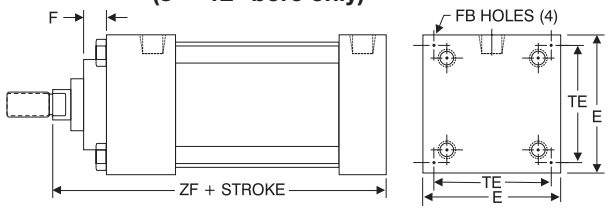
MODEL MN21
NFPA STYLE ME3



BLIND SQUARE FLANGE MOUNTING
(8" - 12" bore only)



MODEL MN22
NFPA STYLE ME4



'MN31', 'MN32' FLANGE MOUNT & 'MN21', 'MN22' CAP MOUNT DIMENSIONS

Bore Ø	Rod MM	Cylinder Code ♦	E	F	FB	FH	R	RM	TE	TF	UF	W	ZF
1½	5/8**	MN00611	2	3/8	5/16	3/8	1.43	—	—	2 3/4	3 3/8	5/8	5
	1**	MN00612										1	5 3/8
2	5/8**	MN06110	2 1/2	3/8	3/8	3/8	1.84	—	—	3 3/8	4 1/8	5/8	5
	1**	MN06111										1	5 3/8
2 1/2	5/8**	MN06120	3	3/8	3/8	3/8	2.19	—	—	3 7/8	4 5/8	5/8	5 1/8
	1**	MN06121										1	5 1/2
3 1/4	1**	MN06130	3 3/4	5/8	7/16	5/8	2.76	—	—	4 11/16	5 1/2	3/4	6 1/4
	1 3/8**	MN06131										1	6 1/2
4	1**	MN06140	4 1/2	5/8	7/16	5/8	3.32	—	—	5 7/16	6 1/4	3/4	6 1/4
	1 3/8**	MN06141										1	6 1/2
5	1**	MN06150	5 1/2	5/8	9/16	5/8	4.10	—	—	6 5/8	7 5/8	3/4	6 1/2
	1 3/8**	MN06151										1	6 3/4
6	1 3/8**	MN06160	6 1/2	5/8	9/16	3/4	4.88	—	—	7 5/8	8 5/8	7/8	7 3/8
	1 3/4**	MN06161										1 1/8	7 5/8
8	1 3/8*	MN06180	8 1/2	5/8	11/16	N/A	N/A	3 1/2	7.57	N/A	N/A	1 5/8	6 3/4
	1 3/4*	MN06181										1 7/8	7
10	1 3/4*	MN61100	10 5/8	5/8	13/16	N/A	N/A	3 1/2	9.40	N/A	N/A	1 7/8	8 1/4
	2*	MN61101		3/4				5				2	8 3/8
12	2*	MN61200	12 3/4	3/4	13/16	N/A	N/A	5	11.1	N/A	N/A	2	8 7/8
	2 1/2*	MN61201										2 1/4	9 1/8

For dimensions not shown, see page 105.

FLANGE MOUNTED CYLINDERS

The flange mount is one of the strongest, most rigid methods of mounting. With this type of mount there is little allowance for misalignment, though when long strokes are required, the free end opposite the mounting should be supported to prevent sagging and possible binding of the cylinder. The best use of a blind end flange is in a thrust load application (rod in compression).

Rod end flange mounts are best used in tension applications.

When a less rigid mount can be used and the cylinder can be attached to a panel or bulkheard, an extended tie-rod mounting could be considered.

HOW TO ORDER

For ordering information refer to Page 134.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMN00611. (Refer to page 112.)

***** Models MN31 and MN32 not available in these sizes.

****** Models MN21 and MN22 not available in these sizes.

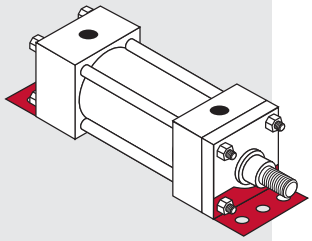
Rod End Styles and Dimensions
For rod end styles and dimensions see:
Page 105

HOW TO ORDER

For ordering information refer to Page 134.

NOTES:

♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMN00611. (Refer to page 112.)

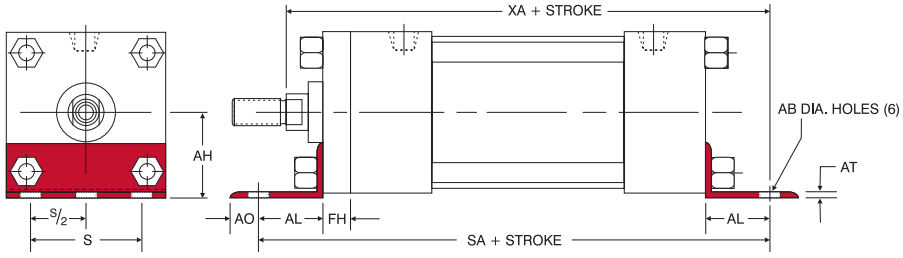


MODEL MN44
NFPA STYLE MS1

SIDE OR LUG MOUNTED CYLINDERS

The side or lug mounted cylinder provides a fairly rigid mount. These types of cylinders can tolerate a slight amount of misalignment when the cylinder is at full stroke, but as the piston moves toward the blind end, the tolerance for misalignment decreases. It is important to note that if the cylinder is used properly (without misalignment), the mounting bolts are either in simple shear or tension without any compound stresses.

ANGLE MOUNTING



'MN44' ANGLE MOUNT DIMENSIONS											
Bore Ø	Rod MM	Cylinder Code ♦	AB	AH	AL	AO	AT	FH	S	Add Stroke SA▲	Add Stroke XA
1½	⅝	MN00611	7/16	1 3/16	1	⅜	⅛	⅜	1¼	6	5⅝
	1	MN00612									6
2	⅝	MN06110	7/16	1 7/16	1	⅜	⅛	⅜	1¾	6	5⅝
	1	MN06111									6
2½	⅝	MN06120	7/16	1⅝	1	⅜	⅛	⅜	2¼	6⅛	5¾
	1	MN06121									6⅛
3¼	1	MN06130	9/16	1 15/16	1¼	½	⅛	⅝	2¾	7⅜	6⅞
	1⅜	MN06131									7⅛
4	1	MN06140	9/16	2¼	1¼	½	⅛	⅝	3½	7⅜	6⅞
	1⅜	MN06141									7⅛
5	1	MN06150	11/16	2¾	1⅜	⅝	3/16	⅝	4¼	7⅞	7¼
	1⅜	MN06151									7½
6	1⅜	MN06160	13/16	3¼	1⅜	⅝	3/16	¾	5¼	8½	8
	1¾	MN06161									8¼
8	1⅜	MN06180	13/16	4¼	1 13/16	11/16	¼	⅝*	7⅛	8¾	8 9/16
	1¾	MN06181									8 13/16

*3½" diameter round retainer on 8" bore. **(MA1 bracket bolted directly to head)**
For dimensions not shown, see page 105.

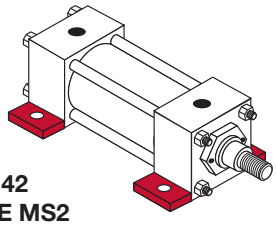
▲ For Double Rod End, add 1/2" + FH to this dimension.

Rod End Styles and Dimensions
For rod end styles and dimensions see:
Page 105

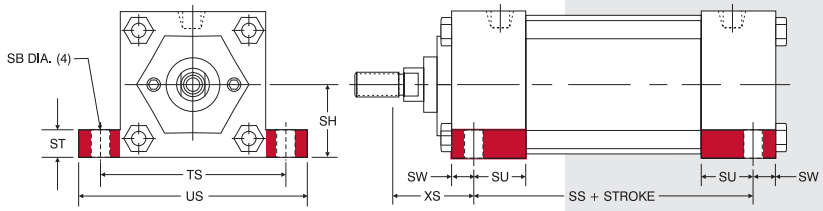
***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

SIDE LUG MOUNTING



MODEL MN42
NFPA STYLE MS2



'MN42' SIDE LUG MOUNT DIMENSIONS												
Bore Ø	Rod MM	Cylinder Code ♦	SB	SH	ST	SU	SW	SZ	TS	US	XS	Add Stroke SS*
1½	⅝	MN00611	7/16	1	½	1⅛	⅜	⅝	2¾	3½	1⅜	2⅞
	1	MN00612									1¾	
2	⅝	MN06110	7/16	1¼	½	1⅛	⅜	⅝	3¼	4	1⅜	2⅞
	1	MN06111									1¾	
2½	⅝	MN06120	7/16	1½	½	1⅛	⅜	⅝	3¾	4½	1⅜	3
	1	MN06121									1¾	
3¼	1	MN06130	9/16	1⅞	¾	1¼	½	¾	4¾	5¾	1⅞	3¼
	1⅜	MN06131									2⅛	
4	1	MN06140	9/16	2¼	¾	1¼	½	¾	5½	6½	1⅞	3¼
	1⅜	MN06141									2⅛	
5	1	MN06150	13/16	2¾	1	1 1/16	1 1/16	9/16	6⅞	8¼	2 1/16	3⅛
	1⅜	MN06151									2 5/16	
6	1⅜	MN06160	13/16	3¼	1	1 5/16	1 1/16	13/16	7⅞	9¼	2 5/16	3⅝
	1¾	MN06161									2 9/16	
8	1⅜	MN06180	13/16	4¼	1	1 5/16	1 1/16	13/16	9⅞	11¼	2 5/16	3¾
	1¾	MN06181									2 9/16	

For dimensions not shown, see page 105.

HOW TO ORDER

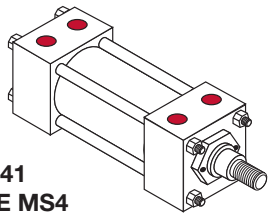
For ordering information refer to Page 134.

NOTES:

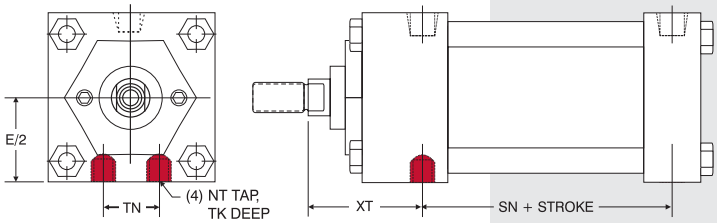
♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMN00611. (Refer to page 112.) Double rod ends are not available on clevis mount Series MN cylinders.

* For Double Rod End Cylinders add 1/2" to this dimension.

TAPPED HOLES IN CAPS FLUSH MOUNTING



MODEL MN41
NFPA STYLE MS4



'MN41' TAPPED HOLE MOUNT DIMENSIONS								
Bore Ø	Rod MM	Cylinder Code ♦	E/2	NT	TK	TN	XT	Add Stroke SN
1½	⅝	MN00611	1	¼-20	⅜	⅝	1 15/16	2¼
	1	MN00612					2 5/16	
2	⅝	MN06110	1¼	5/16-18	½	⅞	1 15/16	2¼
	1	MN06111					2 5/16	
2½	⅝	MN06120	1½	⅜-16	⅝	1¼	1 15/16	2⅜
	1	MN06121					2 5/16	
3¼	1	MN06130	1⅞	½-13	¾	1½	2 7/16	2⅝
	1⅜	MN06131					2 11/16	
4	1	MN06140	2¼	½-13	¾	2 1/16	2 7/16	2⅝
	1⅜	MN06141					2 11/16	
5	1	MN06150	2¾	⅝-11	1	2 11/16	2 7/16	2⅞
	1⅜	MN06151					2 11/16	
6	1⅜	MN06160	3¼	¾-10	1⅛	3¼	2 13/16	3⅛
	1¾	MN06161					3 1/16	
8	1⅜	MN06180	4¼	¾-10	1⅛	4½	2 13/16	3¼
	1¾	MN06181					3 1/16	
10	1¾	MN61100	5 5/16	1-8	1½	5½	3⅛	4⅛
	2	MN61101					3¼	
12	2	MN61200	6⅜	1-8	1½	7¼	3¼	4⅝
	2½	MN61201					3½	

For dimensions not shown, see page 105.

Rod End Styles and Dimensions
For rod end styles and dimensions see:
Page 105

***MilCad* Cylinder Configurator**

Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

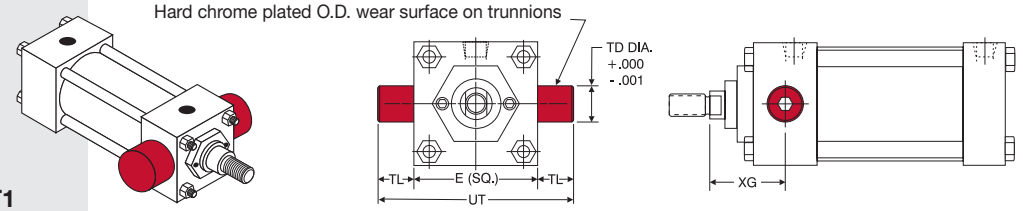
NOTE:
MT1 and MT2 trunnions are bolt on, non-removable design.

TRUNNION CYLINDERS

All trunnion cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and the trunnion pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.

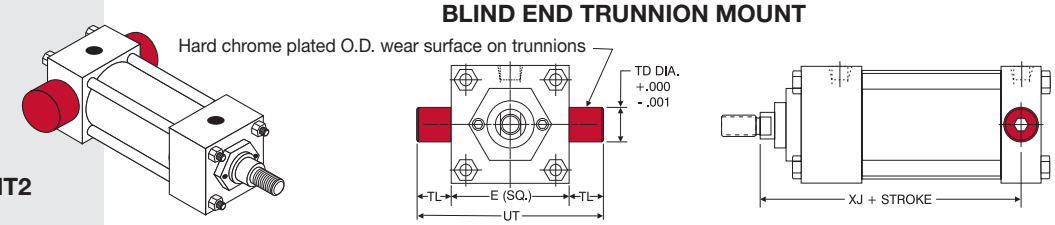
ROD END TRUNNION MOUNT

MODEL MN71
NFPA STYLE MT1



BLIND END TRUNNION MOUNT

MODEL MN72
NFPA STYLE MT2



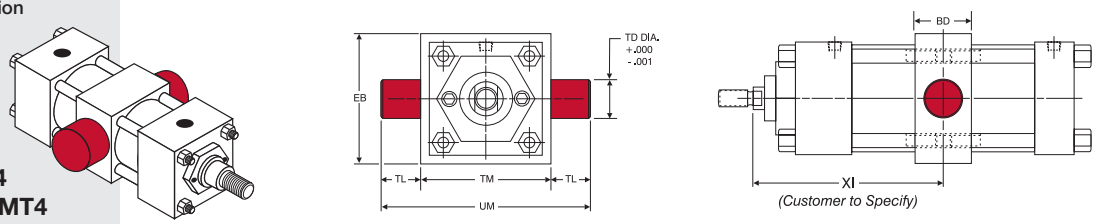
'MN71' AND 'MN72' TRUNNION MOUNT DIMENSIONS									ACCESSORIES (see pages 110-111 for dimensions)		
Bore Ø	Rod MM	Cylinder Code ♦	E	TD	TL	UT	XG	Add Stroke XJ	Rod Clevis	Rod Eye	Clevis Pin
1½*	⅝	MN00611	2	1	1	4	1¾	4⅛	RC437	RE437	CP500
	1	MN00612					N/A*	4½	RC750	RE750	CP750
2	⅝	MN06110	2½	1	1	4½	1¾	4⅛	RC437	RE437	CP500
	1	MN06111					2⅛	4½	RC750	RE750	CP750
2½	⅝	MN06120	3	1	1	5	1¾	4¼	RC437	RE437	CP500
	1	MN06121					2⅛	4⅝	RC750	RE750	CP750
3¼	1	MN06130	3¾	1	1	5¾	2¼	5	RC750	RE750	CP750
	1⅜	MN06131					2½	5¼	RC1000	RE1000	CP1000
4	1	MN06140	4½	1	1	6½	2¼	5	RC750	RE750	CP750
	1⅜	MN06141					2½	5¼	RC1000	RE1000	CP1000
5	1	MN06150	5½	1	1	7½	2¼	5¼	RC750	RE750	CP750
	1⅜	MN06151					2½	5½	RC1000	RE1000	CP1000
6	1⅜	MN06160	6½	1⅜	1⅜	9¼	2⅝	5⅞	RC1000	RE1000	CP1000
	1¾	MN06161					2⅞	6⅛	RC1250	RE1250	CP1375
8	1⅜	MN06180	8½	1⅜	1⅜	11¼	2⅝	6	RC1000	RE1000	CP1000
	1¾	MN06181					2⅞	6¼	RC12505	RE1250	CP1375

*No oversize rod available on 1½" bore MT1. For dimensions not shown, see page 105.

NOTE: MT4 Trunnions and Intermediate section are one-piece steel construction.

CENTER TRUNNION MOUNT

MODEL MN74
NFPA STYLE MT4



'MN74' CENTER TRUNNION MOUNT DIMENSIONS							
Bore Ø	BD	EB	TD	TL	TM	UM	X1
1½	1¼	2½	1	1	2½	4½	CUSTOMER TO SPECIFY
2	1½	3	1	1	3	5	
2½	1½	3½	1	1	3½	5½	
3¼	2	4¼	1	1	4½	6½	
4	2	5	1	1	5¼	7¼	
5	2	6	1	1	6¼	8¼	
6	2	7	1⅜	1⅜	7⅝	10⅜	
8	2½	9½	1⅜	1⅜	9¾	12½	

HOW TO ORDER

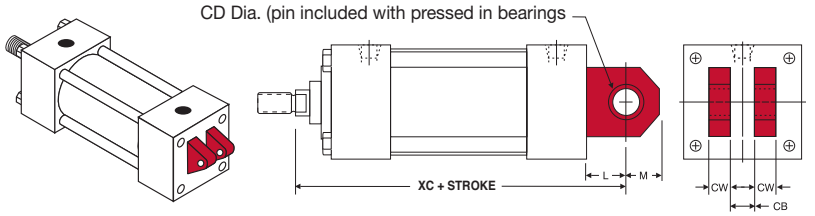
For ordering information refer to Page 134.

NOTES:

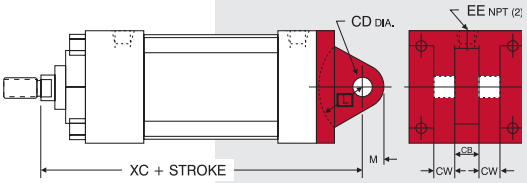
♦ For double rod end cylinders, add prefix letter D to cylinder code. Example: DMN00611. (Refer to page 112.)

CLEVIS MOUNT

Extruded MP1 Mount
(Extruded: 1½" - 8" Bores, Weldment: 10" & 12" Bores)



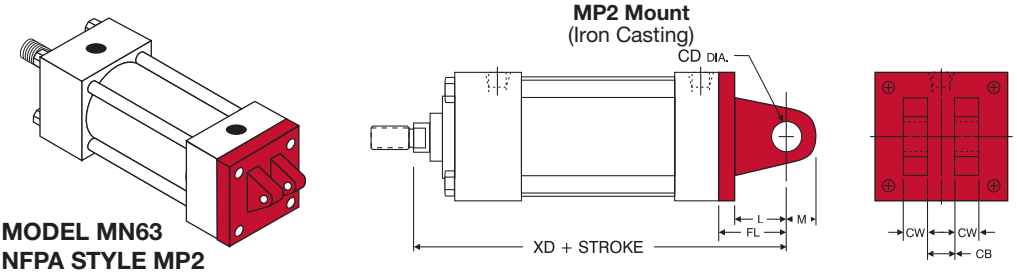
Iron Casting MP1 Mount
(Optional)**



MODEL MN61
NFPA STYLE MP1

REMOVABLE CLEVIS MOUNT

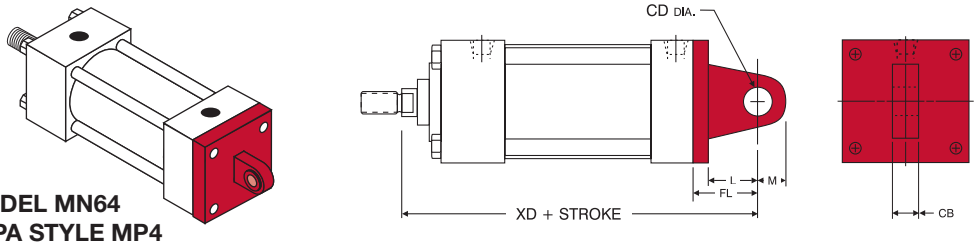
MP2 Mount
(Iron Casting)



MODEL MN63
NFPA STYLE MP2

REMOVABLE FIXED EYE MOUNT

MP4 Mount
(Iron Casting: 1½" - 4" Bores, Weldment: 5" & 6" Bores)



MODEL MN64
NFPA STYLE MP4

See pages 124-125 for dimensions.

HOW TO ORDER

For ordering information refer to Page134.

NOTES:

- For double rod end cylinders, add prefix letter D to cylinder code. Example: DMN00611. (Refer to page 112.)

Rod End Styles and Dimensions
For rod end styles and dimensions see:
Page 105

***MilCad* Cylinder Configurator**
Visit **milwaukeecylinder.com** to configure and download CAD files of your cylinders.

'MN61', 'MN63' CLEVIS AND 'MN64' EYE MOUNT DIMENSIONS (in)											ACCESSORIES (see pages 110-111 for dimensions)				
Bore Ø	Rod MM	Cylinder Code ♦	CB	CD	CW	FL	L	M	XC	XD	Rod Clevis	Rod Eye	Clevis Pin	Eye Bracket (for MP1)	Clevis Bracket (for MP4)
1½	⅝	MN00611	¾	½	½	1⅛	¾	⅝	5⅜	5¾	RC437	RE437	CP500	EB500	CB500
	1	MN00612							5¾	6⅛	RC750	RE750	CP750		
2	⅝	MN06110	¾	½	½	1⅛	¾	⅝	5⅜	5¾	RC437	RE437	CP500		
	1	MN06111							5¾	6⅛	RC750	RE750	CP750		
2½	⅝	MN06120	¾	½	½	1⅛	¾	⅝	5½	5⅞	RC437	RE437	CP500		
	1	MN06121							5⅞	6¼	RC750	RE750	CP750		
3¼	1	MN06130	1¼	¾	⅝	1⅞	1¼	⅞	6⅞	7½	RC750	RE750	CP750	EB750	CB750
	1⅜	MN06131							7⅛	7¾	RC1000	RE1000	CP1000		
4	1	MN06140	1¼	¾	⅝	1⅞	1¼	⅞	6⅞	7½	RC750	RE750	CP750		
	1⅜	MN06141							7⅛	7¾	RC1000	RE1000	CP1000		
5	1	MN06150	1¼	¾	⅝	1⅞	1¼	⅞	7⅛	7¾	RC750	RE750	CP750		
	1⅜	MN06151							7⅜	8	RC1000	RE1000	CP1000		
6	1⅜	MN06160	1½	1	¾	2¼	1½	1	8⅛	8⅞	RC1000	RE1000	CP1000	EB1000	CB1000
	1¾	MN06161							8⅜	9⅛	RC1250	RE1250	CP1375		
8	1⅜	MN06180	1½	1	¾	N/A	1½	1	8¼	N/A	RC1000	RE1000	CP1000		
	1¾	MN06181							8½		RC1250	RE1250	CP1375		
10	1¾	MN61100	2	1⅜	1	N/A	2⅛	1⅜	10⅜	N/A	RC1250	RE1250	CP1375	EB1375	CB1375
	2	MN61101							10½		RC1500	RE1500	CP1750	EB1750	CB1750
12	2	MN61200	2½	1¾	1¼	N/A	2¼	1¾	11⅛	N/A	RC1500	RE1500	CP1750		
	2½	MN61201							11⅜		RC1875	N/A	CP2000		

Clevis pins are provided with pivot mounts.
For dimensions not shown, see page 105.

**Extruded MP1 mounts are standard (1½" - 8" bores). Cast Iron removable mounts are optional, and must be requested when ordering (1½" - 6" bores). Specify "CAST MP1" when ordering.

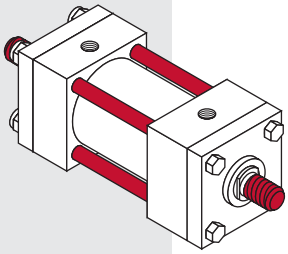
Rod End Styles and Dimensions

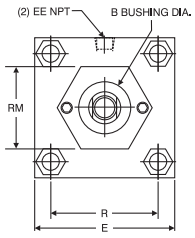
For rod end styles and dimensions see:

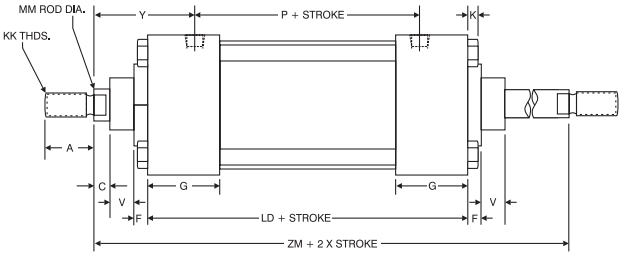
Page 105

DOUBLE ROD END CYLINDERS

- Standard and oversize piston rods available
- Full range of standard options
- Durable design. Full rod bearing at each end of cylinder
- Can be provided with hollow piston rods (gun-drilled through, to your size requirements)
- Can be used in adjustable extend stroke applications (by adding a stop collar on one rod end, or option "MA" - Refer to page 119).







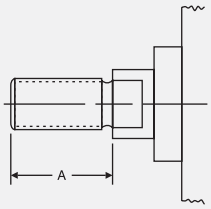
Bore Ø	Rod MM	Cylinder Code	A	B	C	E	EE	F	G	K	KK	LD	P	R	RM	V	Y	ZM
1½	⅝	DMN00611	¾	1⅛	⅜	2	⅜	⅜	1½	¼	7/16-20	4⅛	2⅜	1.43	2 Sq.	¼	1⅞	6⅛
	1	DMN00612	1⅛	1½	½						¾-16					½	2¼	6⅞
2	⅝	DMN06110	¾	1⅛	⅜	2½	⅜	⅜	1½	5/16	7/16-20	4⅛	2⅜	1.84	1¾ Hex	¼	1⅞	6⅛
	1	DMN06111	1⅛	1½	½						¾-16				2½ Sq.	½	2¼	6⅞
2½	⅝	DMN06120	¾	1⅛	⅜	3	⅜	⅜	1½	5/16	7/16-20	4¼	2½	2.19	1¾ Hex	¼	1⅞	6¼
	1	DMN06121	1⅛	1½	½						¾-16				3 Sq.	½	2¼	7
3¼	1	DMN06130	1⅛	1½	½	3¾	½	⅝	1¾	⅜	¾-16	4¾	2¾	2.76	2¾ Dia.	¼	2⅜	7½
	1⅜	DMN06131	1⅝	2	⅝						1-14				3¾ Sq.	⅜	2⅝	8
4	1	DMN06140	1⅛	1½	½	4½	½	⅝	1¾	⅜	¾-16	4¾	2¾	3.32	2¾ Dia.	¼	2⅜	7½
	1⅜	DMN06141	1⅝	2	⅝						1-14				3½ Dia.	⅜	2⅝	8
5	1	DMN06150	1⅛	1½	½	5½	½	⅝	1¾	7/16	¾-16	5	3	4.10	2¾ Dia.	¼	2⅜	7¾
	1⅜	DMN06151	1⅝	2	⅝						1-14				3½ Dia.	⅜	2⅝	8¼
6	1⅜	DMN06160	1⅝	2	⅝	6½	¾	⅝	2	7/16	1-14	5½	3¼	4.88	3½ Dia.	⅜	2¾	8¾
	1¾	DMN06161	2	2⅜	¾						1¼-12					½	3	9¼
8	1⅜	DMN06180	1⅝	2	⅝	8½	¾	⅝	2	9/16	1-14	5⅝	3⅜	6.44	3½ Dia.	⅜	2¾	8⅞
	1¾	DMN06181	2	2⅜	¾						1¼-12					½	3	9⅜
10	1¾	DMN61100	2	2⅜	¾	10⅝	1	⅝	2¼	11/16	1¼-12	6⅝	4⅝16	7.92	3½ Dia.	½	3 1/16	10⅜
	2	DMN61101	2¼	2⅝	⅞			¾			1½-12				5 Dia.	⅜	3 3/16	10⅝
12	2	DMN61200	2¼	2⅝	⅞	12¾	1	¾	2¼	11/16	1½-12	7⅛	4 13/16	9.40	5 Dia.	⅜	3 3/16	11⅛
	2½	DMN61201	3	3⅛	1						1⅞-12					½	3 7/16	11⅝

▼ Double Rod End Stroke Adders

Bore Ø	Rod MM	MS1D SAD	MS1D XAD	MS2D SSD
1½	⅝	6⅞	6½	3⅜
	1		6⅞	
2	⅝	6⅞	6½	3⅜
	1		6⅞	
2½	⅝	7	6⅝	3½
	1		7	
3¼	1	8½	8	3¾
	1⅜		8¼	
4	1	8½	8	3¾
	1⅜		8¼	
5	1	9	8⅜	3⅝
	1⅜		8⅝	
6	1⅜	9¾	9¼	4⅛
	1¾		9½	
8	1⅜	9¼	9 1/16	4¼
	1¾		9 5/16	

Index to Basic Options

A=



EXTENDED PISTON ROD THREAD

"A=" Refers to the length of piston rod thread

Shorter than standard lengths can be furnished at no charge. Longer than standard lengths can be furnished at nominal price adder.

Special length threads available.

A/O

AIR/OIL PISTON

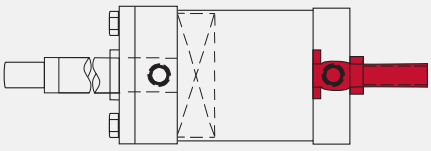
Air/Oil pistons allow for the combination of pneumatic supply air with the precise control of oil.

The basic A/O piston is designed for oil on the cylinder cap end, and a "meter out" flow control (not provided) for precise return stroke control.

For applications that require the oil to be on the cylinder rod end, specify the TH option.

NOTE: Due to the nature of oil to remain in the tubing finish recesses, a condition called "collaring" will allow oil to seep past the A/O seal over time, escaping in the air valve exhaust.

AS

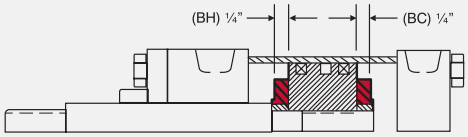


ADJUSTABLE STROKE (RETRACT)

Consists of a threaded rod in the cylinder cap, non-removable. Provides an adjustable positive stop on the cylinder retract.

To order, specify "AS" and length of adjustment (Example: AS=3").

B, BC, BH



BUMPERS

Urethane impact dampening bumpers, used when cylinder speeds do not allow for standard cushions.

BC = Cap Bumper **BH** = Head Bumper **B** = Head and Cap Bumper

(NOTE: Each bumper adds 1/4" to cylinder length).

BP

BUMPER PISTON SEALS

***Milwaukee Cylinder*'s Bumper Piston Seal**, when used with our advanced cushion design, decelerates the cylinder at end of stroke — reducing noise and extending cylinder life.

1½" Bore Shown

Available on 1½" - 8" Bore

BENEFITS

- **Reduces cycle rates**
  Higher piston velocities can be achieved due to rapid deceleration feature increasing productivity
- **Provides maximum impacf dampening**
  Reduces machine vibration
- **Reduces cylinder end-of-stroke noise**
- **Available in Viton Seals**
  (1½" to 8" bore)

DESIGN TIPS

- Use cushions to achieve quick performace on longer strokes (Options HC & BP)
- Use the BP Seals without cushions on short strokes requiring fast cycles
- Due to compressibility, BP Seals are not recommended for applications that require 100% repeatable stroke increments

Standard Material: Buna-N
Optional Material: Viton

Operating Temperature:
-20° F to 200° F

Operating Temperature:
-150° F to 350° F

Operating Pressure:
250 PSI Air

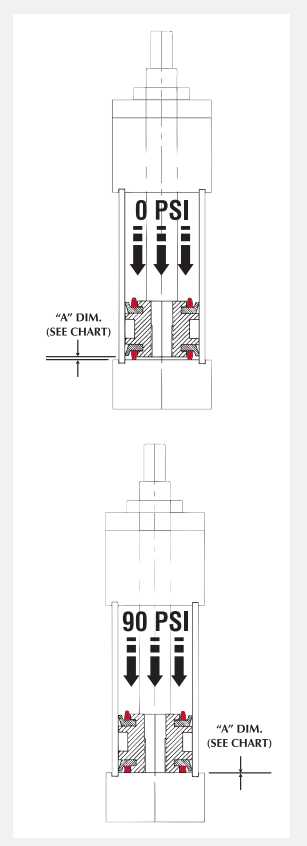
Bumper Piston Seals will shorten the cylinder stroke when operated at less than 90 PSI supply air. The charts below show the approximate (average) stroke reduction, at various pressure (for new cylinders). As the cylinders are cycled, the seals will take a slight set. Tests have shown that after 1,500,000 cycles, the seals will have between .001" and .008" compression set per seal. After that, there is no noticeable compression set.

TOTAL STROKE REDUCTION ("A" Dimension X 2) (in inches)

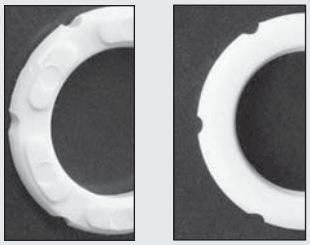
Bore Ø	0 PSI	10 PSI	30 PSI	50 PSI	70 PSI	90 PSI
1½	.10	.09	.07	.06	.04	.00
2	.14	.11	.07	.04	.01	.00
2½	.18	.14	.08	.05	.02	.00
3¼	.14	.12	.08	.04	.01	.00
4	.17	.14	.09	.05	.02	.00
5	.18	.14	.07	.03	.01	.00
6	.23	.18	.10	.05	.01	.00
8	.31	.26	.15	.07	.03	.00

PER END STROKE REDUCTION ("A" Dimension) (in inches)

Bore Ø	0 PSI	10 PSI	30 PSI	50 PSI	70 PSI	90 PSI
1½	.048	.043	.035	.028	.021	.00
2	.069	.056	.037	.020	.010	.00
2½	.091	.070	.042	.024	.008	.00
3¼	.071	.059	.039	.020	.002	.00
4	.087	.069	.045	.026	.009	.00
5	.092	.072	.036	.013	.005	.00
6	.113	.091	.051	.023	.003	.00
8	.154	.132	.076	.037	.016	.00



Seal Design



Front Side | Back Side

HEAD AND CAP CUSHIONS

Milwaukee Cylinder's advanced cushion design features a unique, one piece seal that is allowed to float in a precision machined groove.

This type of seal design provides consistent cushion performance and maximum seal life. Oversized flow paths molded in the periphery of the seal provide "full flow" on the return stroke without the use of ball checks.

HEAD CUSHIONS

H	**STANDARD LENGTH HEAD CUSHION**
LH	**LONG HEAD CUSHION**
ELH	**EXTRA LONG HEAD CUSHION***

* Extra Long Head add length to cylinder.
Refer to page 117 for details.*

CAP CUSHIONS

C	**STANDARD LENGTH CAP CUSHION**
LC	**LONG CAP CUSHION**
ELC	**EXTRA LONG CAP CUSHION***

* Extra Long Head add length to cylinder.
Refer to page 117 for details.*

HOW TO SIZE CUSHIONS FOR YOUR APPLICATION

Cylinders with air cushions provide a possible solution to destructive energies. The air cushion traps a small amount of exhaust air at the end of stroke, providing an air pocket that decelerates the load. This reduces the potentially destructive energy being transmitted to the cylinder and other components. The following is a brief explanation on how to determine the energy level of your application and determine if an air cushion can provide adequate energy absorption. Air cushions do not build heat since the heat generated is dissipated with the exhausted air flow.

STEP 1: Determine the total load to be stopped by the cylinder. Include the piston rod weight (see piston rod weight chart below).

STEP 2: Determine the velocity (in feet per second) at which the load impacts the cylinder end caps.

STEP 3: Use the following formula to calculate the energy the cylinder generates.

STEP 4: Using the table below, select the proper cushion length. Note: You can choose a larger bore size to increase cushion capacities.

Design Tips

- **Cushions Adjustment screws can be ordered on same side as ports.** Refer to page 121 for details.
- **BP** Seals provide additional impact dampening and noise reduction. (Refer to page 145 for details).

CUSHION SIZING FORMULA

Milwaukee Cylinder's advanced cushion design features a unique, one piece seal that is allowed to float in a precision machined groove.

$$\text{energy} = \left(\frac{w}{64} \times v^2\right) + (p \times k)$$

W = Total weight of load in pounds (including piston rod)
V = Velocity (in feet per second)
P = Driving pressure in PSI (usually the air line pressure)
K = Bore constant value (see chart below for "K" values)

Sizing Example:

How to figure the energy for a 2½" bore cylinder, 10" stroke, 5/8" piston rod, moving a 25 lb. load at 6 feet per second with 80 psi air.

P = 80 psi W = 26.25 lbs. V = 6 FPS. K = .17

Energy = (26.25/64) X (62) or (36) + (80 X .17)
Energy = 28.36 ft/lbs.

The Maximum Energy Data Chart indicates that the "Long" Cushion at 38.6 maximum energy value would be the right choice for this application.

Piston Rod Weight Chart

Rod MM	Piston Rod Weight*
⅝	.35 lb. + .09 lb/in of stroke
1	1.1 lb. + .22 lb/in of stroke
1⅜	2.3 lb. + .42 lb/in of stroke
1¾	5.0 lb. + .68 lb/in of stroke
2	6.1 lb. + .88 lb/in of stroke
2½	10.4 lb. + 1.39 lb/in of stroke

* Double weight for double rod end cylinders.

MAXIMUM ENERGY DATA

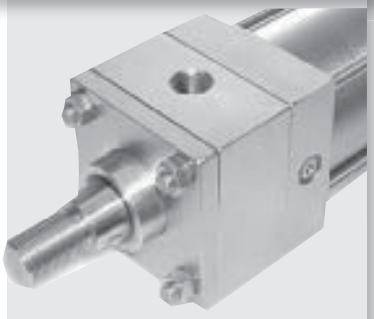
Bore Ø	K	H OR C Standard Cushion Series Max Energy (ft-lbs)	LH OR LC Long Cushion Series Max Energy (ft-lbs)	ELH OR ELC Extra-Long Cushion Series Max Energy (ft-lbs)
1½	.06	8.2	12.8	26.9
2	.11	13.8	21.7	45.8
2½	.17	24.6	38.6	81.5
3¼	.25	45.7	83.6	172.2
4	.38	57.3	137.1	282.6
5	.59	94.6	226.0	465.8
6	1.37	225.5	334.4	767.6
8	2.43	411.3	609.8	1399.8
10	3.79	379.4	621.4	1620.9
12	5.47	554.8	908.8	2370.6

EXTRA LONG CUSHIONS

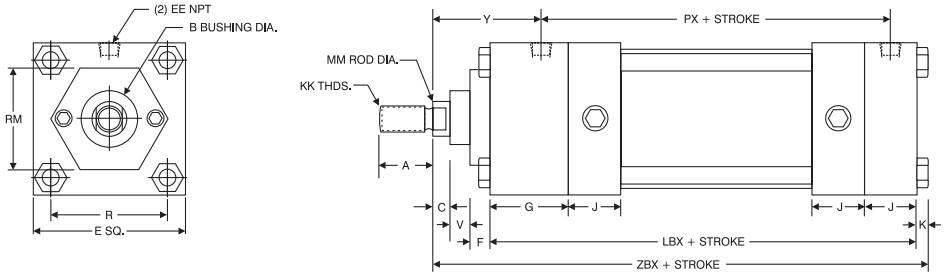
Milwaukee Cylinder's "ELH" Extra-Long Head Cushions and "ELC" Extra-Long Cap Cushions add length to the cylinder. Refer to the chart for dimensions.

ELH EXTRA LONG HEAD CUSHION

ELC EXTRA LONG CAP CUSHION



(MN41-1½" X 6" ELH - EN) Shown

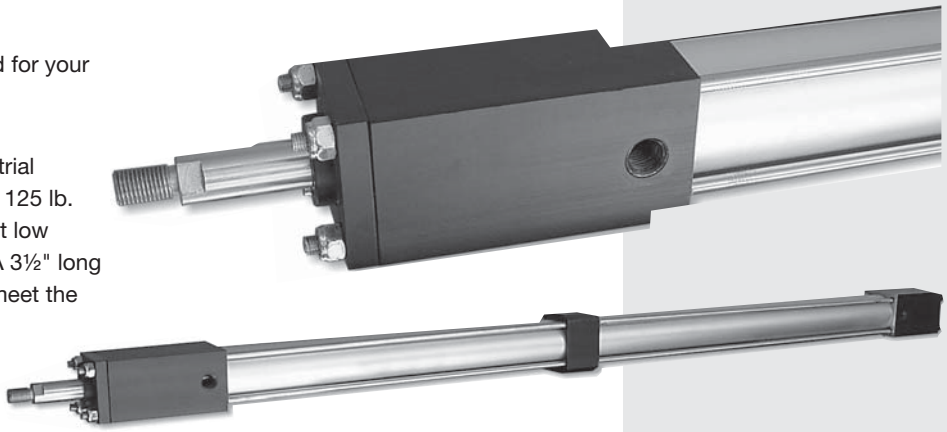


Bore Ø	Rod MM	Cylinder Code	A	B	C	E	EE	F	G	J	K	KK	LBX	PX	R	RM	V	Y	ZBX
1½	⅝	DMN00611	¾	1⅛	⅜	2	⅜	⅜	1½	1	¼	7/16-20	5⅝	4⅜	1.43	2 Sq.	¼	1⅞	6⅞
	N/A	DMN00612	N/A	N/A	N/A							N/A					N/A	N/A	N/A
2	⅝	DMN06110	¾	1⅛	⅜	2½	⅜	⅜	1½	1	5/16	7/16-20	5⅝	4⅜	1.84	1¾ Hex	¼	1⅞	6 15/16
	1	DMN06111	1⅛	1½	½							¾-16				2½ Sq.	½	2¼	7 5/16
2½	⅝	DMN06120	¾	1⅛	⅜	3	⅜	⅜	1½	1	5/16	7/16-20	5¾	4½	2.19	1¾ Hex	¼	1⅞	7 1/16
	1	DMN06121	1⅛	1½	½							¾-16				3 Sq.	½	2¼	7 7/16
3¼	1	DMN06130	1⅛	1½	½	3¾	½	⅝	1¾	1¼	⅜	¾-16	6¾	5¼	2.76	2¾ Dia.	¼	2⅜	8½
	1⅜	DMN06131	1⅝	2	⅝							1-14				3¾ Sq.	⅜	2⅝	8¾
4	1	DMN06140	1⅛	1½	½	4½	½	⅝	1¾	1¼	⅜	¾-16	6¾	5¼	3.32	2¾ Dia.	¼	2⅜	8½
	1⅜	DMN06141	1⅝	2	⅝							1-14				3½ Dia.	⅜	2⅝	8¾
5	1	DMN06150	1⅛	1½	½	5½	½	⅝	1¾	1¼	7/16	¾-16	7	5½	4.10	2¾ Dia.	¼	2⅜	8 13/16
	1⅜	DMN06151	1⅝	2	⅝							1-14				3½ Dia.	⅜	2⅝	9 1/16
6	1⅜	DMN06160	1⅝	2	⅝	6½	¾	⅝	2	1½	7/16	1-14	8	6¼	4.88	3½ Dia.	⅜	2¾	10 1/16
	1¾	DMN06161	2	2⅜	¾							1¼-12					½	3	10 5/16
8	1⅜	DMN06180	1⅝	2	⅝	8½	¾	⅝	2	1½	9/16	1-14	8⅛	6⅜	6.44	3½ Dia.	⅜	2¾	10 5/16
	1¾	DMN06181	2	2⅜	¾							1¼-12					½	3	10 9/16
10	1¾	DMN61100	2	2⅜	¾	10⅝	1	⅝	2¼	2	11/16	1¼-12	10⅜	8 5/16	7.92	3½ Dia.	½	3 1/16	12 15/16
	2	DMN61101	2¼	2⅝	⅞			¾				1½-12				5 Dia.	⅜	3 3/16	13 1/16
12	2	DMN61200	2¼	2⅝	⅞	12¾	1	¾	2¼	2	11/16	1½-12	10⅞	8 13/16	9.40	5 Dia.	⅜	3 3/16	13 9/16
	2½	DMN61201	3	3⅛	1							1⅞-12					½	3 7/16	10 13/16

EXTRA LONG CUSHIONS

Custom length cushions can be designed for your application. Contact *Milwaukee Cylinder* for details!

Example: An OEM manufacturer of industrial equipment needed a cylinder to shuttle a 125 lb. rolling (and guided) fixture 36" of travel, at low airline pressure to avoid operator injury. A 3½" long head and cap cushion was designed to meet the operating specifications.



BSPT

BRITISH STANDARD PIPE TAPER

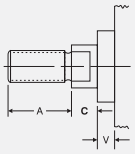
British Standard Pipe Taper (**BSPT**) threads have the same taper as American NPT tapered threads, but use a 55° Whitworth thread form and different diameters. *(Not interchangeable with NPT)*

BSPP

BRITISH STANDARD PIPE PARALLEL

British Standard Pipe Parallel (**BSPP**) also refered to as BSP "Straight" Thread. *(Not interchangeable with NPT)*

C=



EXTENDED PISTON ROD

"**C=**" is commonly referred to as Piston Rod Extension. Piston rods can be extended to any length up to 120" total piston rod length, including stroke portion. Cylinders with long "C" lengths can be mounted away from obstacles or outside hazardous environments.

EN

EN CYLINDER SPECIFICATIONS

En Plated Parts:

Tube, Head, Cap, Bushing Retainer, Mounts (excluding MT1/MT2 which is hard chrome plated stainless steel).

Other Components:

303/304 Stainless Steel: Tie Rods & Nuts, Retainer Screws, Piston Rod (hard chrome plated), Rod Bushing with PTFE Wear Band and Rod Wiper. (Optional: SAE 660 Bronze Rod Bushing)

EN PLATING SPECIFICATIONS:

High Phosphorus (highest corrosion resistant Electroless Nickel plating available)

Composition: 87-90% Nickel, 10-13% Phosphorus

Hardness: Rc 46-48

Thickness: .0005"-.0007"

Lubricity: Excellent (Similar to chrome)

Coefficent Of Friction: Low

Finish: Bright and very smooth

Other types of EN plating are available. Contact *Milwaukee Cylinder* with your specifications for a prompt quote.

ELECTROLESS NICKEL

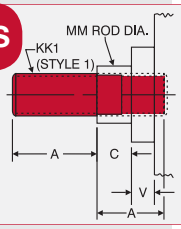
"**EN"** or Electroless Nickel plating was invented in 1946, and has gained worldwide commercial usage since 1964. Common usages include aircraft landing gear, automotive brake cylinder and components, fuel injector parts, gas turbine parts, spray nozzles for chemical applications and many electronic devises including hard drives.

The properties of Electroless Nickel contribute to the multitude of uses. The coating provides an attractive finish, while exhibiting high abrasion and corrosion resistance. Its ability to uniformly coat blind holes, threads, internal surfaces and sharp edges contributes to its effectiveness. It has a very high bonding strength to the base metal (100,000-200,000 psi), so much so that gas turbines use electroless nickel plating as a base to braze broken blades to.

COMMON USAGES:

- Food Processing — EN plating has been used to handle such diverse products as sodium hydroxide, food grade acids and fish oils. Excellent resistance to mild sanitizing caustics, chlorine, and chlorides in general. The natural smooth finish ensures cleanliness in food processing equipment.
- Petroleum And Chemical — The petroleum and chemical industry are large users of electroless nickel plating for corrosion protection. Design tip: Submit the list of chemicals and concentration levels to *Milwaukee Cylinder* for evaluation and recommendations. In some instances, Stainless Steel cylinders provide the best value and long cylinder life.
- Medical and Pharmaceutical — The medical industry uses EN plated cylinders in clean-rooms, on equipment used to make plasma or IV bags, since it is critical that cylinder components need to be sterilized and particle “flake free”. The pharmaceutical industry typically can be harsh on equipment, even abusive – but the equipment must remain completely reliable. EN cylinders provide the most reliable and cost effective choice.

KK3S



STUDDED PISTON ROD

KK3S option combines the KK3 female threaded rod end design and a stud, with permanent Loctite. When assembled, the KK3S has the same dimensions as a KK1 rod end.

This option is useful in applications that typically break standard KK1 rod ends due to high load impacting.

LF

Material: Carboxilated Nitrile
Operating Temp.: -20°F to 200°F
Operating Pressure: 250 psi Air

LOW FRICTION

“**LF**” Low Friction option incorporates the use of round-lip, extremely low friction carboxilated nitrile seals. Round-lip seals “hydroplane” on opposed sealing surfaces, and have a lower running and break-away friction. • *Material: Carboxilated Nitrile* • *Operating Temperature: -20°F to 200°F (-25°C to 90°C)* • *Operating Pressure: 250 psi air (17 bar)*

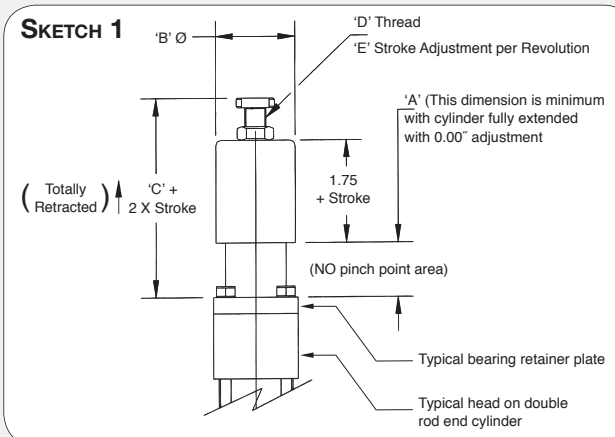
MA

MICRO-ADJUST

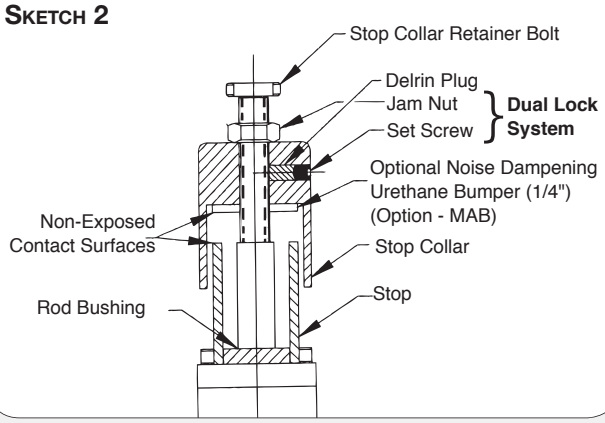
- Allows precise adjustment of cylinder extend stroke
- Easy to read precision scale (.001" calibration)
- Enclosed, no “pinch point” design
- Available on all cylinder models with “D” Double Rod End option
- Up to 6" stroke and adjustment*

* Note: The adjustment range is throughout entire stroke. Consult factory for longer stroke requirements or modifications not listed.

SKETCH 1



SKETCH 2



MICRO-ADJUST Set-up Instructions

1) Set actuator to desired stroke
2) Turn stop ollar until it makes contact with stop
3) Tighten set screw
4) Tighten jam nut for positive lock of stop collar

MICRO-ADJUST DIMENSIONS

Bore Ø	A	B	C	D	E
1½	1.00	1.88	3.71	½-20	.050
2	1.00	1.88	3.71	½-20	.050
2½	1.00	1.88	3.71	½-20	.050
3¼	1.00	2.81	3.71	¾-16	.063
4	.75	2.81	3.47	¾-16	.063
5	.75	2.81	3.47	¾-16	.063
6	.75	3.75	3.47	¾-16	.063
8	.75	3.75	3.47	¾-16	.063

MAB

MICRO-ADJUST WITH URETHANE BUMPER

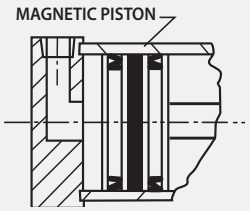
A noise dampening urethane bumper is added between the metal contact points, minimizing noise. See Sketch 2 above.

MPR/MPH

MAGNETIC PISTON

MPR Magnetic Pistons are used in conjunction with *Milwaukee Cylinder's* R10, R10P, RAC Reed and MSS Solid State Switches. *(See pages 127-133 for switches)*

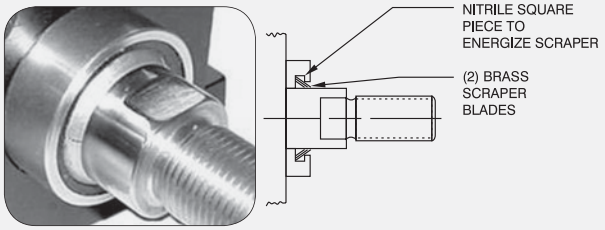
MPH Magnetic Pistons are used with *Milwaukee Cylinder's* "Old Style" HE011, HE03SK and HE04SC Hall Effect Switches.



MS

METALLIC ROD SCRAPER

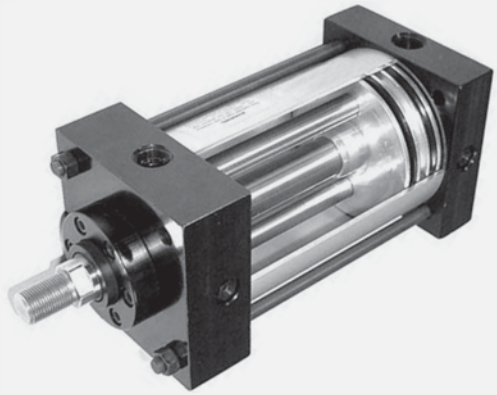
Aggressively scrapes the piston rod, removing foreign material such as spatter, sprays and powders. *(Brass contruction)*



NR

NON-ROTATING (NFPA) CYLINDERS

2" through 12" bore 200 psi air, 400 psi hydraulic (non-shock)



Benefits:

- Two internal guide rods throughout stroke
- High repeatability at each end of stroke (+/- 1 degree)
- All external dimensions are the same as standard cylinder (no additional length or width required)
- Standard Diameter Guide Rod Seals & Bronze Bearings for long life and reliable operation
- Available in Double Rod End Models

Advantages

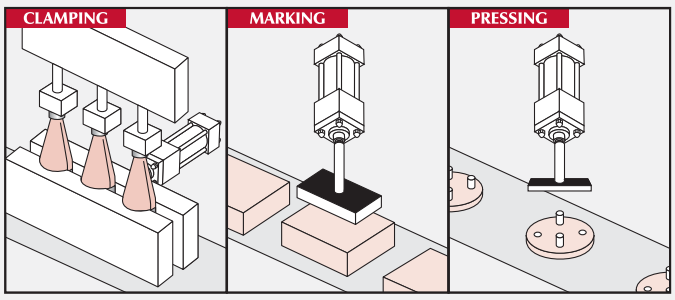
- Eliminates the need for external guide shafts in many positioning applications
- Guide rods are internal, self-cleaning, not subjected to harsh cleaners
- Compact design saves space, no larger than standard NFPA cylinders!
- Durable, self-contained construction

Note: "NR" option not available in combination with "BP" bumper piston seal option.

'NR' GUIDE ROD SIZES AND MAX. STROKE

Bore Ø	Rod MM	Cushions	Guide Rod Ø	Max. Stroke (inches)
2	⅝	Cap only	0.250	10
2½	⅝	Cap only	0.312	12
	1	N/A	0.312	12
3¼	1	Available	0.375	18
	1⅜	Cap only	0.375	18
4	1	Available	0.625	30
	1⅜		0.625	30
5	1	Available	0.625	30
	1⅜		0.625	30
6	1⅜	Available	0.625	30
	1¾		0.625	30
8	1⅜	Available	1.000	40
	1¾		1.000	40
10	1¾	Available	1.000	40
	2		1.000	40
12	2	Available	1.000	40
	2½		1.000	40

APPLICATION POSSIBILITIES:



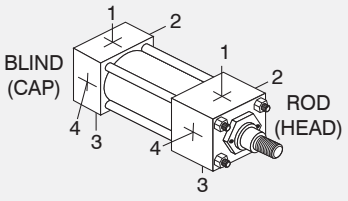
OP

OPTIONAL PORT LOCATION

Optional port locations can be ordered simply by calling out the location numbers:

Note: When optional port locations are ordered, specify both port locations, even if one port is in the standard location.

- Standard port positions at 1
- Standard cushion positions at 2
- Specify non-standard locations when ordering



OPTIONAL PORT AND CUSHION AT SAME LOCATION

Now available, the ability to specify Ports and Cushions on the same cylinder side!

Note: When optional port and cushion locations are ordered, specify both port and cushion locations, even if a port or cushion is in the standard location.

BASIC DIMENSIONS:

HEAD VIEWS **CAP VIEWS**

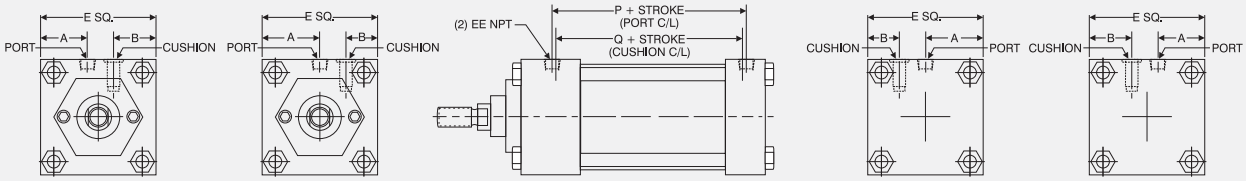


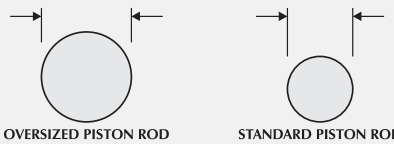
FIGURE #1 FIGURE #2 FIGURE #2 FIGURE #1

Bore Ø	Rod MM	Figure	A	B	E	EE	P	Q
1½	⅝	1	¾	⅝	2	¼	2⅜	2⅛
	1	N/A	N/A	N/A	N/A			
2	⅝	1	⅞	15⁄16	2½	⅜	2⅜	2⅛
	1	1	1	¾	2½			
2½	⅝	1	1⅛	1⅛	3	⅜	2½	2¼
	1	1	1⅛	1	3			
3¼	1	1	1½	1⅜	3¾	½	2¾	2½
	1⅜	2	1⅞	1	3¾			
4	1	2	2¼	1¼	4½	½	2¾	2½
	1⅜	2	2¼	1⅛	4½			
5	1	2	2¾	1¾	5½	½	3	3
	1⅜	2	2¾	1⅝	5½			
6	1⅜	2	3¼	1⅞	6½	¾	3¼	3
	1¾	2	3¼	1⅞	6½			
8	1⅜	2	4¼	2¾	8½	¾	3⅜	3⅛
	1¾	2	4¼	2¾	8½			
10	1¾	2	5 5⁄16	3 11⁄16	10⅝	1	4 5⁄16	4⅛
	2	2	5 5⁄16	3 11⁄16	10⅝			
12	2	2	6⅜	4¾	12¾	1	4 13⁄16	4⅝
	2½	2	6⅜	4¾	12¾			

OS

OVERSIZE ROD

Applications requiring long strokes may require oversize piston rod diameters to prevent sagging or buckling. To determine the recommended rod diameter, refer to Chart 3 on page 122.



SAE

SAE "O"-RING BOSS PORTS (SAE J514)

SAE ports can be ordered in place of NPT ports. Order by SAE number. (Example SAE#10)

Recommended SAE Port Size by Cylinder Bore			
Bore Ø	SAE#	Bore Ø	SAE#
1½	#4 (7⁄16-20)	5	#6 (9⁄16-18)
2	#4 (7⁄16-20)	6	#8 (¾-16)
2½	#4 (7⁄16-20)	8	#8 (¾-16)
3¼	#6 (9⁄16-18)	10	#10 (⅞-14)
4	#6 (9⁄16-18)	12	#10 (⅞-14)

STAINLESS STEEL

Stainless Steel, when used in conjunction with Anodized Aluminum Heads, Caps and Tube, provide corrosion resistance in outdoor applications and wet environments.

Customize your cylinder by choosing from Stainless Steel Fasteners, Piston Rod, or Tie Rods and Nuts.

SSA **STAINLESS STEEL "ALL"**
Stainless Steel Piston Rod (Hard-Chrome Plated), Stainless Steel Fasteners, Stainless Steel Tie Rods and Nuts

SSF **STAINLESS STEEL FASTENERS**
Stainless Steel Fasteners (Bushing Retainer Screws)

SSR **STAINLESS STEEL PISTON ROD**
Stainless Steel Piston Rod (Hard-Chrome Plated)

SST **STAINLESS STEEL TIE RODS & NUTS**
Stainless Steel Tie Rods and Nuts

ST **STOP TUBE**

Stop Tubes are designed to reduce the piston rod bushing stress to within the designed range of the bearing material. This will insure proper cylinder performance, in any given application. Stop Tubes lower the cylinder bearing stress by adding length to the piston, which increases the overall length of the cylinder. (Note: *Milwaukee Cylinder* uses a double piston design for 2-inch and longer stop tubes.)

Stop Tube Selection

To determine the proper amount of stop tube for your application, you must first find the value of "D", which represents the *"stroke, adjusted for mounting condition"*. Each mounting condition creates different levels of bushing stress, which have direct impact on the amount of stop tube required. (See Chart 1)

Once the value of "D" is known, refer to Chart 2 for the recommended amount of stop tube.

To order a Stop Tube, add the stop tube prefix "ST=" and the length, to the end of your cylinder model number.

As noted, the working stroke must be included when ordering.

Chart 1

Find the value of "D" for your application

"D" = Stroke, adjusted for mounting condition "T" = Axial thrust (refer to Chart 3)
"S" = Actual cylinder stroke

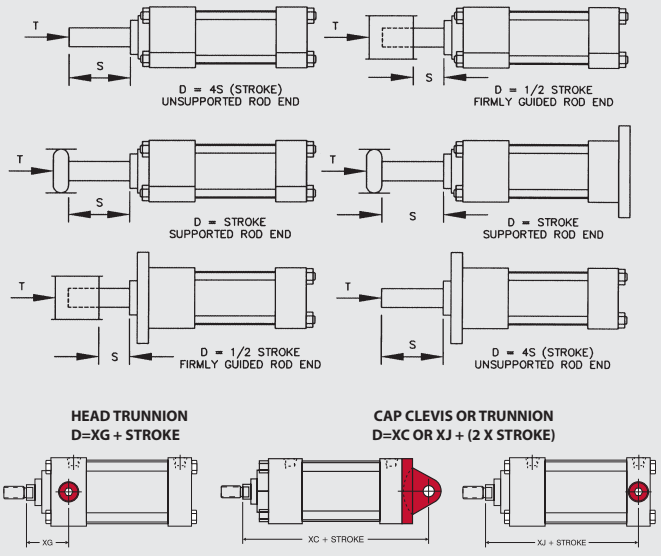


Chart 2

Using the value of "D", find the recommended amount of stop tube

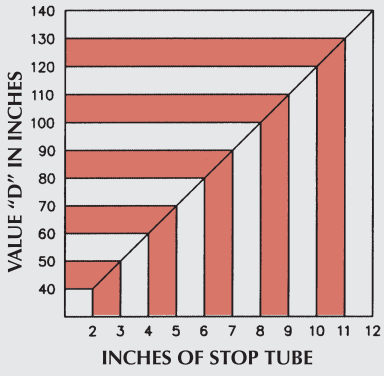
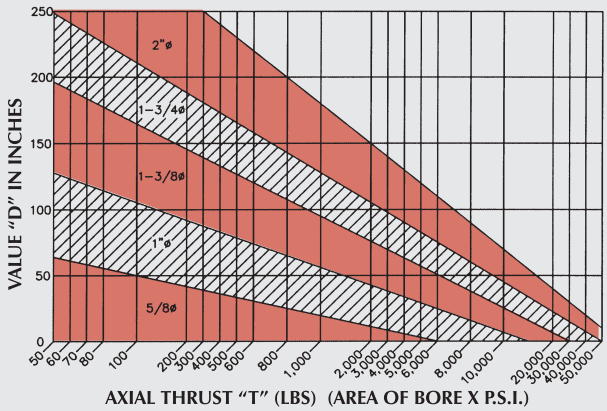


Chart 3

ROD SIZE SELECTION



TH

400 PSI HYDRAULIC (NON-SHOCK)

"MN" Series can be ordered with the "TH" option.

RATING: 400 PSI Hydraulic, Non-Shock

SEALS:

- Piston Seals - (1) POLY-PAK, (1) square-lip
- Rod Seal - POLY-PAK

VS

VITON SEALS

Benefits of VITON Seals:

- Higher temperature performance (0° F to 350° F [-20° C to 200° C])
- Higher chemical resistance (Resists most wash down solutions)

Many other seal materials are available. Contact *Milwaukee Cylinder* for proper seal material selection in tough applications or environments

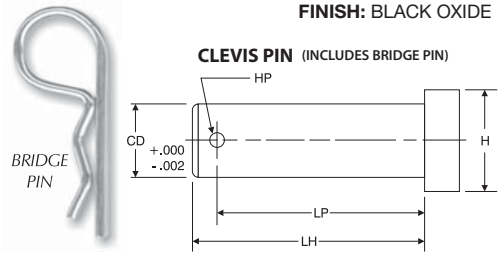
▼ ACCESSORIES CROSS REFERENCE CHART

CYLINDER MODEL					ACCESSORIES				
Bore Ø	Rod MM	Rod Style (KK)		Rod Thread	Rod Clevis	Rod Eye	Clevis Pin	Clevis Bracket	Eye Bracket
1½, 2, 2½	⅝	(Standard)	KK1	7/16-20	RC437	RE437	CP500	CB500	EB500
			KK2	½-20	RC500	RE500	CP500		
	1	(Standard-Oversized)	KK1	¾-16	RC750	RE750	CP750		
			KK4	1-14	RC1000	RE1000	CP1000		
3¼, 4, 5	1	(Standard)	KK1	¾-16	RC750	RE750	CP750	CB750	EB750
			KK4	1-14	RC1000	RE1000	CP1000		
	1⅜	(Standard-Oversized)	KK1	1-14	RC1000	RE1000	CP1000		
			KK2	1¼-12	RC1250	N/A	CP1375		
6 and 8	1⅜	(Standard)	KK1	1-14	RC1000	RE1000	CP1000	CB1000	EB1000
			KK2	1¼-12	RC1250	N/A	CP1375		
	1¾	(Standard-Oversized)	KK1	1¼-12	RC1250	N/A	CP1375		
			KK2	1½-12	RC1500	N/A	CP1750		
10	1¾	(Standard)	KK1	1¼-12	RC1250	RE1250	CP1375	CB1375	EB1375
			KK2	1½-12	RC1500	RE1500	CP1750	CB1750	EB1750
	2	(Standard)	KK1	1½-12	RC1500	RE1500	CP1750	CB1750	EB1750
12	2	(Standard)	KK1	1½-12	RC1500	RE1500	CP1750	CB1750	EB1750

CLEVIS PIN (with Bridge Pin - Standard)

Part No.	CD	H	HP	LH	LP
CP500	½	⅝	5/32	2¼	2 3/32
CP750	¾	15/16	5/32	3	2 27/32
CP1000	1	1 3/16	13/64	3½	3 5/16
CP1375	1⅜	1¾	¼	5	4½
CP1750	1¾	2 9/64	¼	6	5½

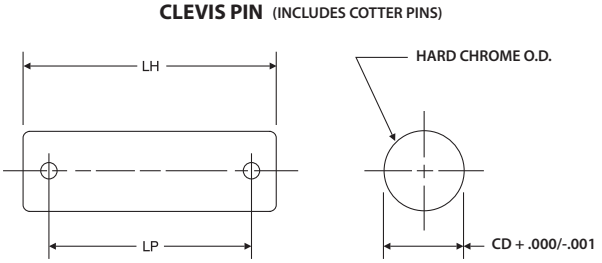
MATERIAL: 1018 CRS
FINISH: BLACK OXIDE



CLEVIS PIN (with Cotter Pin)

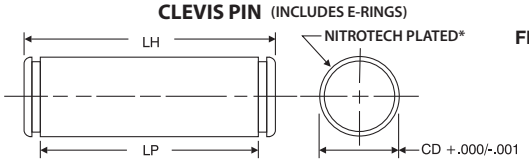
Part No.	CD	LH	LP
CP500C	½	2¼	1 15/16
CP750C	¾	3	2 23/32
CP1000C	1	3½	3 7/32
CP1375C	1⅜	5	4¼
CP1750C	1¾	6	5½
CP2000C	2	6	5½

MATERIAL: 1045 CRS
FINISH: CHROME PLATED O.D.



CLEVIS PIN (with E-Ring)

Part No.	CD	LH	LP
CP500E	½	2⅛	1⅞
CP750E	¾	2 15/16	2⅝
CP1000E	1	3 7/16	3⅛



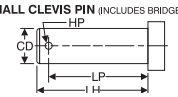
*Hard chrome plated O.D. available

MATERIAL: 1045 CRS
FINISH: NITROTECH PLATED*

SMALL CLEVIS PIN (with Bridge Pin)

Part No.	CD	HP	LH	LP
CP500CCS	½	5/32	1⅜	1¼
CP750CCS	¾	5/32	2	1⅞

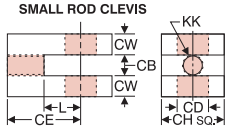
MATERIAL: 1018 CRS
FINISH: BLACK OXIDE



SMALL ROD CLEVIS

Part No.	CB	CD	CE	CH	CW	KK1	KK2	L
RC437CCS	½	½	1⅜	1	¼	7/16-20	—	¾
RC500CCS	½	½	1⅜	1	¼	—	½-20	¾
RC750CCS	¾	¾	1¾	1½	⅜	¾-16	—	1

MATERIAL: 1018 CRS
FINISH: BLACK OXIDE

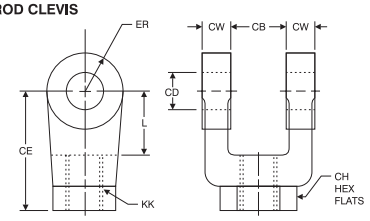


ROD CLEVIS

Part No.	CB	CD	CE	CH	CW	ER	KK	L
RC437	¾	½	1½	1	½	½	7/16-20	¾
RC500	¾	½	1½	1	½	½	½-20	¾
RC750	1¼	¾	2⅜	1¼	⅝	¾	¾-16	1¼
RC1000	1½	1	3⅛	1½	¾	1	1-14	1½
RC1250	2	1⅜	4⅛	2	1	1⅜	1¼-12	2⅛
RC1375	2	1⅜	4⅛	2	1	1⅜	1⅜-12	2⅛
RC1500	2½	1¾	4½	2⅜	1¼	1¾	1½-12	2¼
RC1750	2½	1¾	4½	2⅜	1¼	1¾	1¾-12	2¼
RC1875	2½	2	5½	3	1¼	2	1⅞-12	2½

MATERIAL: CAST STEEL
FINISH: BLACK OXIDE

ROD CLEVIS



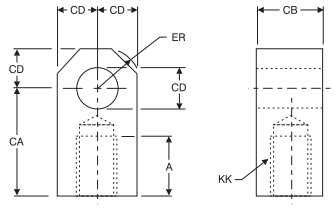
(Clevis Pins sold separately from Rod Clevises)

ROD EYE

Part No.	A	CA	CB	CD	ER	KK
RE437	¾	1½	¾	½	⅝	7/16-20
RE500	¾	1½	¾	½	⅝	½-20
RE750	1⅛	2 1/16	1¼	¾	⅞	¾-16
RE1000	1⅝	2 13/16	1½	1	1 3/16	1-14
RE1250	2	3 7/16	2	1⅜	1 9/16	1¼-12
RE1500	2¼	4	2½	1¾	2	1½-12

MATERIAL: 1018 CRS
FINISH: BLACK OXIDE

ROD EYE



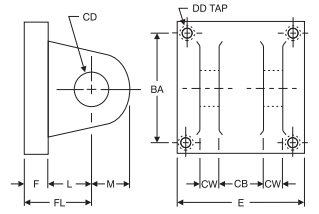
(Clevis Pins sold separately from Rod Eyes)

CLEVIS BRACKET

Part No.	BA	CB	CD	CW	DD	E	F	FL	L	M
CB500	1⅝	¾	½	½	⅜-24	2½	⅜	1⅛	¾	⅝
CB750	2 9/16	1¼	¾	⅝	½-20	3½	⅝	1⅞	1¼	¾
CB1000	3¼	1½	1	¾	⅝-18	4½	¾	2¼	1½	1
CB1375	3 13/16	2	1⅜	1	⅝-18	5	⅞	3	2⅛	1⅜
CB1750	4 15/16	2½	1¾	1¼	⅞-14	6½	⅞	3⅛	2¼	1¾

MATERIAL: CAST STEEL
FINISH: BLACK OXIDE

CLEVIS BRACKET



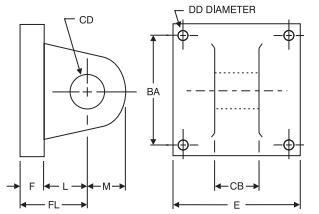
(Clevis Pins sold separately from Clevis Brackets)

EYE BRACKET

Part No.	BA	CB	CD	DD	E	F	FL	L	M
EB500	1⅝	¾	½	13/32	2½	⅜	1⅛	¾	½
EB750	2 9/16	1¼	¾	17/32	3½	⅝	1⅞	1¼	¾
EB1000	3¼	1½	1	21/32	4½	¾	2¼	1½	1
EB1375	3 13/16	2	1⅜	21/32	5	⅞	3	2⅛	1⅜
EB1750	4.95	2½	1¾	29/32	6½	⅞	3⅛	2¼	1¾

MATERIAL: CAST STEEL
FINISH: BLACK OXIDE

EYE BRACKET



(Clevis Pins sold separately from Eye Brackets)

▼ STAINLESS STEEL ACCESSORIES CROSS REFERENCE CHART

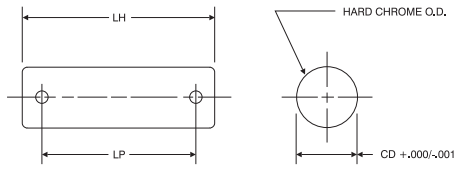
CYLINDER MODEL					ACCESSORIES				
Bore Ø	Rod MM	Rod Style (KK)		Rod Thread	Rod Clevis	Rod Eye	Clevis Pin	Clevis Bracket	Eye Bracket
1½, 2, 2½	⅝	(Standard)	KK1	7/16-20	SS-RC437	SS-RE437	SS-CP500	SS-CB500	SS-EB500
			KK2	½-20	SS-RC500	SS-RE500	SS-CP500		
	1	(Standard-Oversized)	KK1	¾-16	SS-RC750	SS-RE750	SS-CP750		
			KK4	1-14	SS-RC1000	SS-RE1000	SS-CP1000		
3¼, 4, 5	1	(Standard)	KK1	¾-16	SS-RC750	SS-RE750	SS-CP750	SS-CB750	SS-EB750
			KK4	1-14	SS-RC1000	SS-RE1000	SS-CP1000		
	1⅜	(Standard-Oversized)	KK1	1-14	SS-RC1000	SS-RE1000	SS-CP1000		
			KK2	1¼-12	SS-RC1250	N/A	SS-CP1375		
6 and 8	1⅜	(Standard)	KK1	1-14	SS-RC1000	SS-RE1000	SS-CP1000	SS-CB1000	SS-EB1000
			KK2	1¼-12	SS-RC1250	N/A	SS-CP1375		
	1¾	(Standard-Oversized)	KK1	1¼-12	SS-RC1250	N/A	SS-CP1375		
			KK2	1½-12	SS-RC1500	N/A	SS-CP1750		

▼ ACCESSORIES (303 Stainless Steel)

CLEVIS PIN (with Cotter Pins)

Part No.	CD	LH	LP
SS-CP500	½	2¼	1 15/16
SS-CP750	¾	3	2 23/32
SS-CP1000	1	3½	3 7/32
SS-CP1375	1⅜	5	4¼
SS-CP1750	1¾	6	5½

CLEVIS PIN (INCLUDES COTTER PINS)

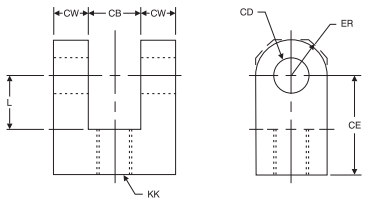


(Clevis Pins sold with (2) S.S. Cotter Pins)

ROD CLEVIS

Part No.	CB	CD	CE	CW	ER	KK	L
SS-RC437	¾	½	1½	½	½	7/16-20	¾
SS-RC500	¾	½	1½	½	½	½-20	¾
SS-RC750	1¼	¾	2⅜	⅝	¾	¾-16	1¼
SS-RC1000	1½	1	3⅛	¼	1	1-14	1½
SS-RC1250	2	1⅜	4⅛	1	1⅜	1¼-12	2⅛
SS-RC1500	2½	1¾	4½	1¼	1¾	1½-12	2¼

ROD CLEVIS

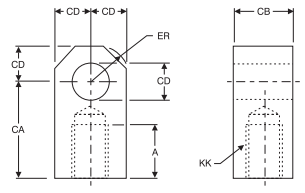


(Clevis Pins sold separately from Rod Clevis)

ROD EYE

Part No.	A	CA	CB	CD	ER	KK
SS-RE437	¾	1½	¾	½	⅝	7/16-20
SS-RE500	¾	1½	¾	½	⅝	½-20
SS-RE750	1⅛	2 1/16	1¼	¾	⅞	¾-16
SS-RE1000	1⅝	2 13/16	1½	1	1 3/16	1-14
SS-RE1250	2	3 7/16	2	1⅜	1 9/16	1¼-12
SS-RE1500	2¼	4	2½	1¾	2	1½-12

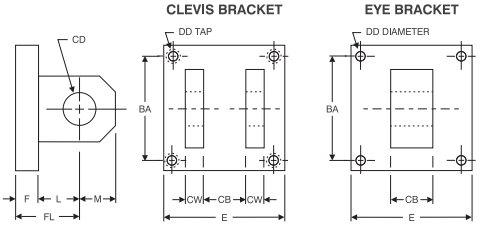
ROD EYE



(Clevis Pins sold separately from Rod Eyes)

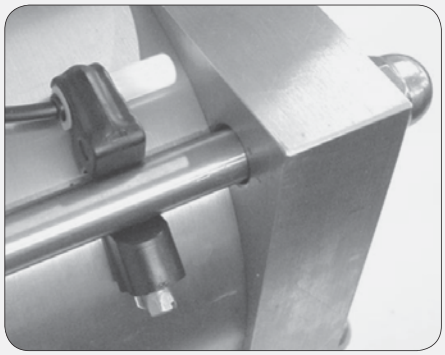
CLEVIS BRACKETS AND EYE BRACKETS

	Part No.	BA	CB	CD	CW	DD	E	F	FL	L	M
Clevis Brackets	SS-CB500	1⅝	¾	½	½	⅜-24	2½	⅜	1⅛	¾	⅝
	SS-CB750	2 9/16	1¼	¾	⅝	½-20	3½	⅝	1⅞	1¼	¾
	SS-CB1000	3¼	1½	1	¾	⅝-18	4½	¾	2¼	1½	1
Eye Brackets	SS-EB500	1⅝	¾	½	N/A	13/32	2½	⅜	1⅛	¾	½
	SS-EB750	2 9/16	1¼	¾		17/32	3½	⅝	1⅞	1¼	¾
	SS-EB1000	3¼	1½	1		21/32	4½	¾	2¼	1½	1



(Clevis Pins sold separately from Clevis & Eye Brackets)

Milwaukee Cylinder **offers Reed, High Power AC Reed, DC Solid State and Reed Switches with built-in circuit protection to meet a wide variety of customer needs.**



SWITCHES

- Miniature AC/DC Reed
- High Power AC Reed
- CE RoHS
- Miniature AC/DC Reed with built-in Circuit Protection
- Extended Temperature Range Reed
- Miniature DC Solid State

Advantages:

- Compact low profile switch/bracket assembly
- Switches and brackets are nylon and stainless steel hardware construction – suitable for wash down or corrosive environments (IP67)
- Quick, simple set-up: Requires standard (slotted) screw driver only
- High visibility LED can be seen up to 20 feet
- Optional quick connect threaded coupling on low current model
- Magnetically operated, can be located anywhere in the actuator stroke range
- Can be used with the MN Series *Milwaukee Cylinder* aluminum actuators, electroless nickel plated series, and stainless steel

(Note: Specify "MPR" option when ordering actuator)

- Suitable for all bore sizes (1½" to 12")
- One magnet (MPR) for all switch models

Benefits of REED Switch:

- Internal circuit protection
- Lower cost
- Low or high current models available, AC or DC, and TRIAC type switch for inductive loads
- High visibility red LED (on low current models)
- Choice of lead lengths available on all models
- Optional quick connect threaded coupling on low current model

Benefits of SOLID STATE Switch:

- Faster signal speeds
- Solid State Reliability – No moving parts means long life, no contact bounce or wear
- Reverse Polarity and Over Voltage Protection
- High Visibility Red LED (all models)
- Choice of lead lengths available or Quick Connect Threaded Coupling

R10 Minature REED Switch

- 5-120 Volts AC, 5-110 Volts DC, 400 mA current rating (max.)
- Cable options include 24" or 120" plain cable leads, and 8mm threaded quick connect
- High visibility LED

RAC High Power AC REED Switch

- 12-240 Volts AC, 800 mA current rating, TRIAC output
- Cable options include 24" or 120" plain cable leads

R10P Miniature AC/DC REED Switch with built-in Circuit Protection

- 5-120 Volts AC, 5-110 Volts DC, 150 mA current rating (max.)
- Cable options include 24" or 120" plain cable leads
- High visibility LED
- Circuit protection consisting of varistor/choke arrangement that will protect switch from transients, voltage spikes and inrush currents usually associated with long cable runs (particularly at higher voltages) and unprotected inductive loads such as relays, solenoids, motors, and motor starters and some PLC's

MSS Minature SOLID STATE Switch

- 10-30 Volts DC, 4-300 mA current rating
- Can be wired current sinking (NPN) or current sourcing (PNP)
- Cable options include 24" or 120" plain cable leads, and 8mm threaded quick connect
- High visibility LED

▼ SWITCH APPLICATION SELECTION GUIDE

For selecting the right switch for your application

Switch Model	Programmable Controllers	Relays	Solenoids	Indicator Lights		Motors	Time Counters
				Bulbs	Solid State		
R10 Reed	Yes	<10VA*	<10VA*	<10VA*	Yes	<10VA*	<10VA*
RAC High Powered Reed**	No	Yes	Yes	Yes	No	Yes	Yes
R10P Reed	Yes	<10VA	<10VA	<10VA	No	<10VA	<10VA
MSS Solid State	Yes	<300mA	No	<300mA	Yes	No	<300mA

*Use resistor-capacitor protection

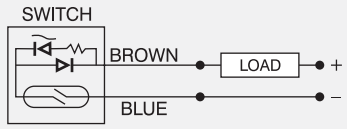
**Minimum current = 80mA

R10 / R10X

MINATURE REED SWITCH, CABLE TYPE, (Two Wire Switch)

R10: Miniature Reed Switch, 24" Plain Cable Lead, (2 wire Switch)
R10X: Miniature Reed Switch, 120" Plain Cable Lead, (2 wire Switch)

Contacts:	SPST Form A (Normally Open)
Contact Rating:	10 Watts Max.
Input Voltage:	5-120 Volts Max. AC, 5-110 Volts Max. DC
Maximum Load Current:	400 mA Max. (Resistive) @ 25° C (77° F) 150 mA Max. (Resistive) @ 70° C (158° F)
Actuating Time Average:	1.0 millisecond
LED Indicator:	High Luminescence Housing
Temperature Range:	-20° C to 70° C (-4° F to 158° F)
Protection Rating:	IP67



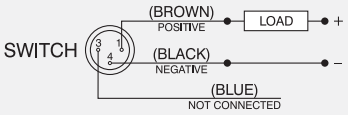
Input Voltage:	110 Volts Max. DC, 120 Volts Max. AC
Maximum Load Current:	400 mA Max. (Resistive) @ 25° C (77° F) 150 mA Max. (Resistive) @ 70° C (158° F)

R10Q

MINATURE REED SWITCH, 8mm MALE QUICK CONNECT, (Two Wire Switch)

R10Q: Miniature Reed Switch, 8mm Male Quick Connect, (2 wire Switch)

Contacts:	SPST Form A (Normally Open)
Contact Rating:	10 Watts Max.
Input Voltage:	60 Volts Max. AC or DC
Maximum Load Current:	400 mA Max. (Resistive) @ 25° C (77° F) 150 mA Max. (Resistive) @ 70° C (158° F)
Actuating Time Average:	1.0 millisecond
LED Indicator:	High Luminescence Housing
Temperature Range:	-20° C to 70° C (-4° F to 158° F)
Protection Rating:	IP67



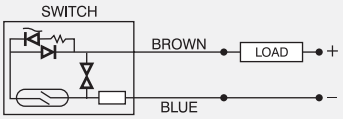
Input Voltage:	60 Volts Max. AC or DC
Maximum Load Current:	400 mA Max. (Resistive) @ 25° C (77° F) 150 mA Max. (Resistive) @ 70° C (158° F)

R10P/R10PX

MINIATURE REED SWITCH, 24" PLAIN CABLE LEAD, CIRCUIT PROTECTION, (Two Wire Switch)

R10P: Miniature Reed Switch, 24" Plain Cable Lead, Circuit Protection (2 wire Switch)
R10PX: Miniature Reed Switch, 120" Plain Cable Lead, Circuit Protection (2 wire Switch)

Contacts:	SPST Form A (Normally Open)
Contact Rating:	10 Watts Max.
Input Voltage:	5-120 Volts Max. AC, 110 Volts Max. DC
Maximum Load Current:	150 mA Max. (Resistive)
Actuating Time Average:	1.0 millisecond
LED Indicator:	High Luminescence Housing
Temperature Range:	-20° C to 70° C (-4° F to 158° F)
Protection Rating:	IP67



Input Voltage:	120 Volts Max. AC, 110 Volts Max. DC
Maximum Load Current:	150 mA Max.

Circuit Protection

Varistor:	138 Volts
Choke:	680 µH

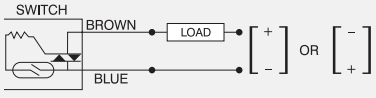
Note: The circuit protection consists of a Varistor and Choke arrangement. The Varistor will take transient and voltage spikes out of the line and is mounted in parallel with the switch. The Choke will disperse inrush currents (normally caused by long cable runs) and is mounted in series with the switch.

RAC / RACX

HIGH POWER AC REED SWITCH, CABLE TYPE, (Two Wire Switch)

RAC: High Power AC Reed Switch, 24" Plain Cable Lead, (2 wire Switch)
RACX: High Power AC Reed Switch, 120" Plain Cable Lead, (2 wire Switch)

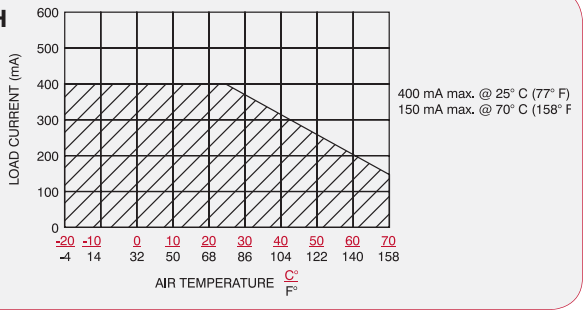
Contacts:	TRIAC Output
Contact Rating:	200 Watts Max.
Input Voltage:	12 to 240 Volts (AC only)
Minimum Load Current:	80 mA
Maximum Load Current:	800 mA
Actuating Time Average:	2.0 milliseconds
LED Indicator:	Not Available
Temperature Range:	-20° C to 70° C (-4° F to 158° F)
Protection Rating:	IP67



Contact Rating	200 Watts Max.
Input Voltage	12 to 240 Volts (AC only)
Minimum Load Current	80 mA
Maximum Load Current	800 mA

LOAD CURRENT DE-RATING GRAPH

R10 / R10X / R10Q
(R10PX: 150 mA MAX., -20°C to 70°C)

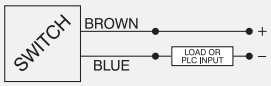


MSS / MSSX

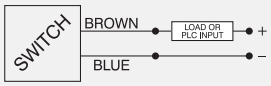
MINATURE SOLID STATE SWITCH, CABLE TYPE, (Two Wire Switch)

MSS: Miniature Solid State Switch, 24" Plain Cable Lead, (2 wire Switch)
MSSX: Miniature Solid State Switch,120" Plain Cable Lead, (2 wire Switch)

*Output Type:	Current Sinking or Current Sourcing
Input Voltage:	10 to 30 Volts DC
Current Consumption (not sensing):	1mA
Minimum Load Current:	4 mA
Maximum Load Current:	300 mA
"ON" Voltage Drop:	3 Volts @ 4 mA 4 Volts @ 300 mA
LED Indicator:	High Luminescence Housing
Temperature Range:	-20° C to 70° C (-4° F to 158° F)
Actuating Time Average:	2.0 Microseconds
Protection Rating:	IP67
Reverse Polarity Protected:	Yes
Transient (over voltage) Protected:	Yes



Typical Current Sourcing (PNP) Configuration



Typical Current Sinking (NPN) Configuration

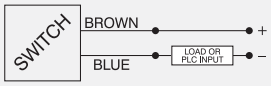
***NOTE:** This is a (2) wire switch used in series with the load. Therefore, this switch can be used with devices requiring either a current sinking (NPN) output or a current sourcing (PNP) output from the solid state switch.

MSSQ

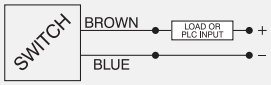
MINIATURE SOLID STATE SWITCH, 8mm MALE QUICK CONNECT, (Two Wire Switch)

MSSQ: Miniature Solid State Switch,
8mm Male Quick Connect
(2 wire Switch)

*Output Type:	Current Sinking or Current Sourcing
Input Voltage:	10 to 30 Volts DC
Current Consumption (not sensing):	1mA
Minimum Load Current:	4 mA
Maximum Load Current:	300 mA
"ON" Voltage Drop:	3 Volts @ 4 mA 4 Volts @ 300 mA
LED Indicator:	High Luminescence Housing
Temperature Range:	-20° C to 70° C (-4° F to 158° F)
Actuating Time Average:	2.0 Microseconds
Protection Rating:	IP67
Reverse Polarity Protected:	Yes
Transient (over voltage) Protected:	Yes



Typical Current Sourcing (PNP) Configuration

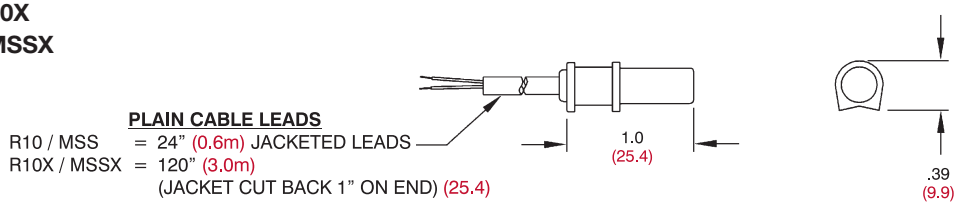


Typical Current Sinking (NPN) Configuration

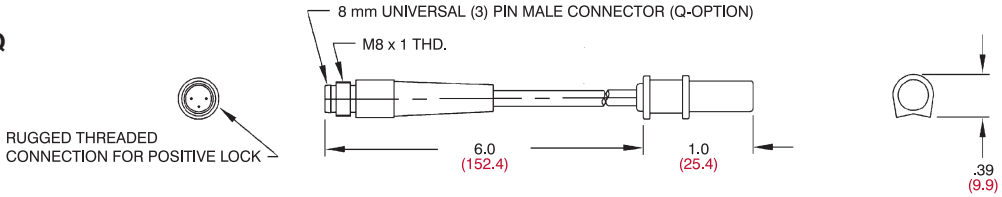
***NOTE:** This is a (2) wire switch used in series with the load. Therefore, this switch can be used with devices requiring either a current sinking (NPN) output or a current sourcing (PNP) output from the solid state switch.

SWITCHES

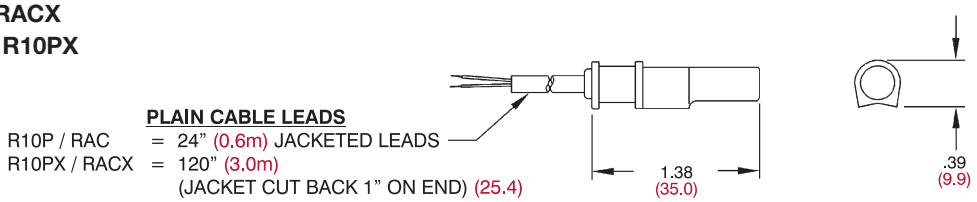
R10 / R10X
MSS / MSSX



R10Q
MSSQ



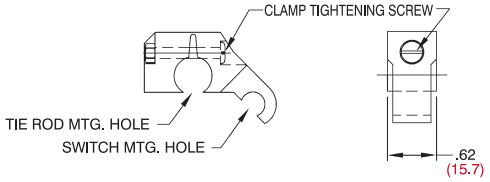
RAC / RACX
R10P / R10PX



SWITCH BRACKETS

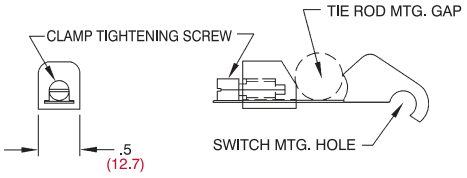
SB15 (For 1½ " Through 2½" Bore Cylinders)

Bracket Construction:
Molded Nylon 6 (Black) and
Stainless Steel Hardware



SB32 (For 3¼ " Through 12" Bore Cylinders)

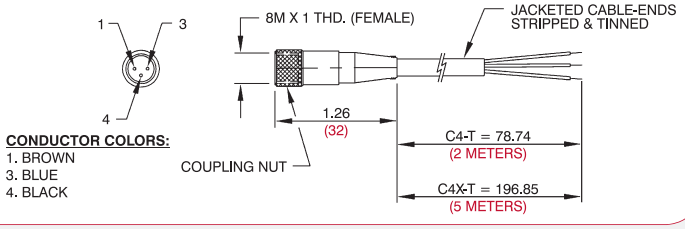
Bracket Construction:
Molded Nylon 6 (Black) and
Stainless Steel Hardware



QUICK CONNECT CORD SET

(Used with "Q" Type Switch Leads)

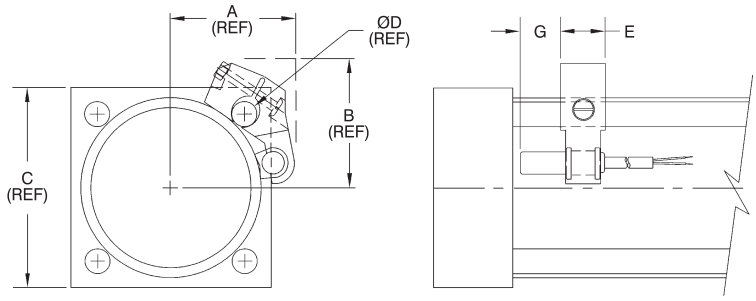
FOR CABLES:
C4-T (2 METER CABLE LENGTH)
C4X-T (5 METER CABLE LENGTH)



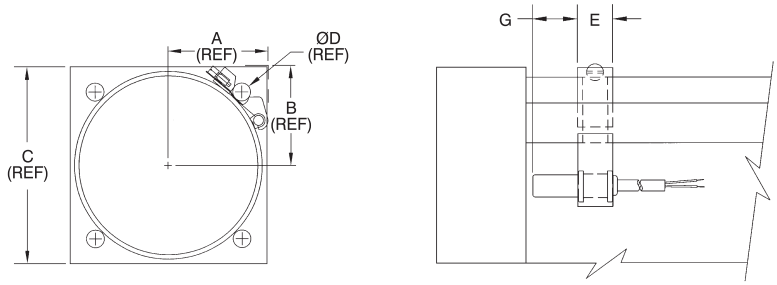
All dimensions are in inches (metric in parentheses)

SB15 / SB32

SB15



SB32



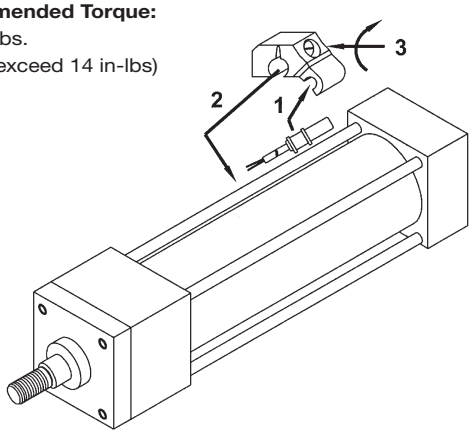
▼ SWITCH BORE DIMENSIONAL TABLE

Part #	Bore Ø	A	B	C	D	E	G
SB15	1½	1⅜	1 13/32	2	¼	⅝	½
	2	1⅝	1 21/32	2½	5/16	⅝	½
	2½	1⅞	1⅞	3	5/16	⅝	½
SB32	3¼	2⅛	2⅛	3¾	⅜	½	9/16
	4	2 7/16	2⅜	4½	⅜	½	9/16
	5	2⅞	2¾*	5½	½	½	9/16
	6	3¼*	3¼*	6½	½	½	9/16
	8	4¼*	4¼*	8½	⅝	½	9/16
	10	5 5/16*	5 5/16*	10⅝	¾	½	9/16
	12	6⅜*	6⅜*	12¾	¾	½	9/16

* These dimensions are 1/2 of the 'C' dimension. The switch barcket **does not** protrude beyond standard head/cap.

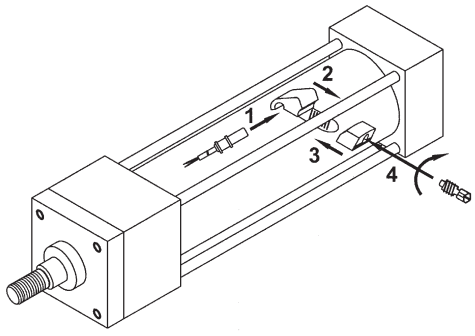
▼ HOW TO ASSEMBLE SWITCH AND BRACKETS

Recommended Torque:
6-10 in-lbs.
(Do not exceed 14 in-lbs)



SB15 SWITCH BRACKET (MOUNTING ILLUSTRATION)

Recommended Torque:
8-12 in-lbs.
(Do not exceed 14 in-lbs)



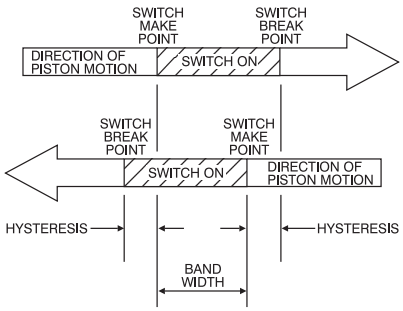
SB32 SWITCH BRACKET (MOUNTING ILLUSTRATION)

HYSTERESIS:

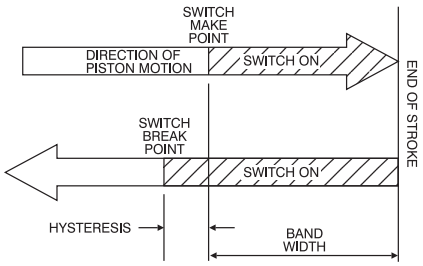
The distance between the switch break point moving in one direction, and the switch make point moving in the opposite direction.

BAND WIDTH:

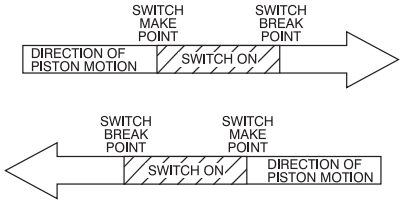
Distance the piston moves while the switch is made (in either direction), less the hysteresis.



MID STROKE OPERATION

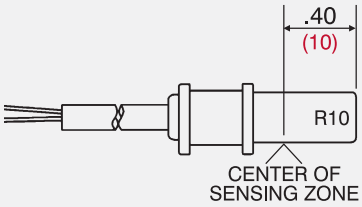


END OF STROKE OPERATION



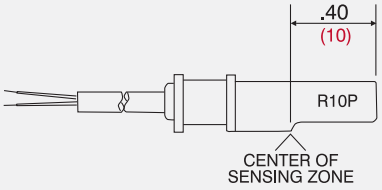
TERMINOLOGY ILLUSTRATION

R10 / R10X / R10Q



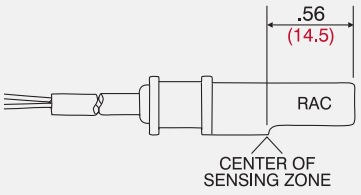
Repeatability	Hysteresis (Maximum)	Band Width (Minimum)
±.010" (±,25 mm)	.040" (1 mm)	.200" (5 mm)

R10P / R10PX



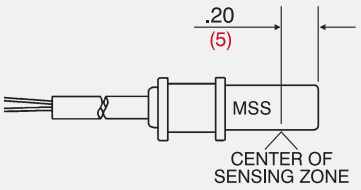
Repeatability	Hysteresis (Maximum)	Band Width (Minimum)
±.010" (±0,25 mm)	.040" (1 mm)	.200" (5 mm)

RAC / RACX



Repeatability	Hysteresis (Maximum)	Band Width (Minimum)
±.010" (±0,25 mm)	.085" (2,1 mm)	.345" (8,8 mm)

MSS / MSSX / MSSQ



Repeatability	Hysteresis (Maximum)	Band Width (Minimum)
±.010" (±0,25 mm)	.075" (1,9 mm)	.315" (8 mm)

NOTE: Dimensions are in inches, (metric in parentheses). Results are based upon *Milwaukee Cylinder's* piston and magnet assemblies. Results may vary if used with other manufacturers cylinder products.

▼ CONFIGURE YOUR SWITCH PART NUMBER

TO ORDER, SPECIFY:
Switch Model, Lead Type, and Bracket Size

R10 (Switch Model) **X** (Switch Lead Type) **-** **SB15** (Switch Bracket Size)

Switch Model		
R10	=	AC/DC Reed
RAC	=	High Power AC Reed
MSS	=	Solid State
R10P	=	AC/DC Reed with Circuit Protection

Switch Lead Type		
(leave blank)	=	24" Plain Cable
X	=	120" Plain Cable
Q	=	8mm Quick Connect (not available on RAC or R10P)

Switch Bracket Size		
SB15	=	1½" to 2½" Bore
SB32	=	3¼" to 12" Bore
(leave blank for switch only)		

▼ SWITCH ACCESSORIES

Quick Connect Cord Sets	
Model	**Description**
C4-T	8mm Straight Quick Connect Cord X 2 Meter (78")
C4X-T	8mm Straight Quick Connect Cord X 5 Meter (196")

ABOUT OUR SWITCHES

Our switches are different! The most common complaint in the market is the unreliability of magnetically operated switches. Most cylinder piston magnets have about 10-30% more power than required to operate the switch. This results in erractic operation, a nuisance for maintenance and lowering overall plant productivity.

Milwaukee Cylinder's magnets have 50-100% more power than required to operate our switch! The combination of *Milwaukee Cylinder's* R10, R10P, RAC and MSS Switches and our Cylinders, raises the reliability of switch operation comparable to that of many mechanically operated limit switches.

APPLICATION RECOMMENDATIONS AND PRECAUTIONS

- Noise suppression — Motors and valve solenoids will produce high pulses throughout an electrical system. Therefore, primary and control circuit wiring should not be mixed in the same conduit. Separate power supplies for both logic level signals (Microprocessor, P.C., CPU, Input Devices) and Output Field Devices (Motors, Valve Solenoids) is recommended.
- Never connect R10, R10P or MSS type switches without a load present. The switch will be destroyed.
- Some electrical loads may be capacitive. Capacitive loading may occur due to distributed capacity in cable runs over 25 feet. Use switch model RAC whenever capacitive loading may occur.
- To obtain optimum performace and long life, switches should not be subjected to strong magnetic fields, extreme temperatures (outside of specifications), or excessive ferrous filings or chip buildup.
- Improper wiring may damage or destroy the switch. Therefore, the wiring diagrams along with the listed power ratings, should be carefully observed before connecting power to the switch.

Following these tips can save time and provide trouble free installations!

Other switches available:

- **12mm Quick Connect**
- **Pulse Extension Switch**
- **Special Length Cable**
- **Change Over Switch (SPDT)**
- **Weld Immune Switch**
- **High Temp. Switch**

(Consult factory for details.)

▼ CONFIGURE YOUR CYLINDER (Series MN cylinder)

	MN06130	- 31	- HC	- KK2	- 7	x 14¾
1 Double Rod End add "D"	2 Cylinder Code	3 NFPA Mounts	4 Cushions	5 Options	6 Seals	7 Stroke

Part Number System
Example: A 3¼" Bore, 1" rod, MF1 mount, cushion both ends, Style KK2 rod end, standard seals with a 14¾" stroke.
Part Number:
MN06130-31-HC-KK2-7 x 14¾

2 CYLINDER CODE

Bore Ø	Rod Ø	Cylinder Code
1½	⅝	MN00611
	1	MN00612
2	⅝	MN06110
	1	MN06111
2½	⅝	MN06120
	1	MN06121
3¼	1	MN06130
	1⅜	MN06131
4	1	MN06140
	1⅜	MN06141
5	1	MN06150
	1⅜	MN06151
6	1⅜	MN06160
	1¾	MN06161
8	1⅜	MN06180
	1¾	MN06181
10	1¾	MN61100
	2	MN61101
12	2	MN61200
	2½	MN61201

3 NFPA MOUNTS

		Description
31	MF1	Front Flange (1½"-6" Bore)
32	MF2	Rear Flange (1½"-6" Bore)
21	ME3	Front Mounting Holes (8"-12" Bore)
22	ME4	Rear Mounting Holes (8"-12" Bore)
61	MP1	Rear Pivot Clevis (1½"-12" Bore)
63	MP2	Rear Pivot Clevis, Removable (1½"-6" Bore)
64	MP4	Rear Fixed Eye Mount, Removable (1½"-6" Bore)
44	MS1	Front & Rear End Angle (1½"-8" Bore)
42	MS2	Side Lug (1½"-8" Bore)
41	MS4	Bottom Tapped Holes (1½ -12" Bore)
71	MT1	Front Trunnion (1½"-8" Bore)
72	MT2	Rear Trunnion (1½"-8" Bore)
74	MT4	Intermediate Trunnion (1½"-8" Bore)
11	MX0	No Mount (1½"-12" Bore)
10	MX1	Extended Tie Rods - Head & Cap (1½"-12" Bore)
13	MX2	Extended Tie Rods (Cap) (1½"-12" Bore)
12	MX3	Extended Tie Rods (Head) (1½"-12" Bore)

4 CUSHIONS

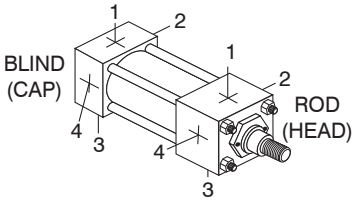
	Description
H	Head Cushion Position 2 is Standard Specify for Positions: 1, 3 & 4
LH	**Long** Head Cushion Position 2 is Standard Specify For Positions: 1, 3 & 4
* ELH	**Extra Long** Head Cushion Position 2 is Standard Specify for Positions: 1, 3 & 4
C	**Cap** Cushion Position 2 is Standard Specify for Positions: 1, 3 & 4
LC	**Long** Cap Cushion Position 2 is Standard Specify for Positions: 1, 3 & 4
* ELC	**Extra Long** Cap Cushion Position 2 is Standard Specify for Positions: 1, 3 & 4
NC	**No** Cushion

6 SEALS

7	BUNA (-30° to 250° F)
8	VITON (-15° to 350° F)
S	SPECIAL

7 STROKE

0" to 120" / Made to order.



5 OPTIONS

	Add length to cylinder - See "Option Length Adder" Chart Below
KK1	Standard
A =	Extended piston rod thread (Example: A = 2")
AS	Adjustable stroke - retract (specify length, example: AS = 4")
A/O	Air / oil piston
*B	¼" Urethane bumper both ends
*BC	¼" Urethane bumper cap only
*BH	¼" Urethane bumper head only
BP	Bumper piston seals (1½" - 8" bore)
BSPP	BSPP ports (specify size, example: BSPP = ¼")
BSPT	BSPT ports (specify size, example: BSPT = ¼")
C =	Extended piston rod (example: C = 3")
EN	Electroless nickel plated (see page 118 for specifications)
KK2	Large male rod thread
KK3	Female rod thread
KK3S	Studded piston rod (KK3 with stud, loctite in place)
KK4	Full diameter male rod thread
KK5	Blank rod end (no threads, "A" = 0")
LF	Low friction seals (see page 118 for specifications)
MA	Micro-adjust (6" max. stroke) available on double rod end models
MAB	Micro-adjust with sound dampening bumper (6" max. stroke)
MPR	Magnetic piston for Reed or Solid State switches R10, RAC, and MSS (see pages 127-133 for selection)
MPH	Magnetic piston for hall switches
MS	Metallic rod scraper (brass construction)
NR	Non-rotating (see page120 for specifications)
OP	Optional port location (example: ports at 2 and 3)
OS	Oversize rod diameter (specify size, example: OS = 1⅜")
SAE	Sae ports (specify size, example: SAE #10)
SE	Spring extend (1½, 2, 2½ inch bore)
SR	Spring return (1½, 2, 2½ inch bore)
SSA	Stainless steel piston rod, tie rods & nuts, and fasteners
SSF	Stainless steel fasteners
SSR	Stainless steel piston rod
SST	Stainless steel tie rods & nuts
*ST	Stop tube (specify stop tube length and effective stroke) (example: MN MS4 2 x 24" effective stroke-ST=3)
Steel tube	Steel cylinder tube, black epoxy paint finish
TH	400 psi hydraulic non-shock (see page 123 for specifications)
XX	Special variation (specify)

* Add length to cylinder - See "Options Length Adder" chart below

OPTIONS LENGTH ADDER
(add to catalog basic overall length dimensions.

Bore Ø	OPTION					ST* (Stop Tube) Example: ST=2
	B	BC	BH	ELC	ELH	
1½	½	¼	¼	1	1	2
2	½	¼	¼	1	1	2
2½	½	¼	¼	1	1	2
3¼	½	¼	¼	1¼	1¼	2
4	½	¼	¼	1¼	1¼	2
5	½	¼	¼	1¼	1¼	2
6	½	¼	¼	1½	1½	2
8	½	¼	¼	1½	1½	2
10	½	¼	¼	2	2	2
12	½	¼	¼	2	2	2

Standard Port and Cushion Adjustment Positions

- Ports - Position 1
- Cushion adjustment - Position 2
- Specify non-standard positions when ordering

milwaukee Cylinder

Hydraulic-Pneumatic Devices

Pressure Boosters
Air Oil Tanks
Accumulators

Milwaukee Cylinder offers additional products to help complete your system needs. **Pressure Boosters** are ideal for limited operation applications requiring intermittent high pressure when you only have low-pressure air. **Air Oil Tanks** supplement a booster system by providing a source of low pressure oil, while also providing an outlet for entrapped air. **Accumulators** can improve overall system efficiency.

Example of How a Booster Works

1. Low pressure air enters the input section of the booster. It pushes against a large area piston. For example, if a 100 PSI air supply pushes against a 4" diameter piston, it is working against an area of approximately 12.6 square inches, for a total force of 1,260 pounds.
2. This total force is exerted by means of the piston rod, or ram, to the output section of the booster. The output section contains a hydraulic fluid. Just the end of the rod applies pressure to this fluid.
3. Let's say that the rod end has a 1" diameter. Its area is about .8 square inches. Divide the .8 square inches into the total applied force of the 1,260 pounds and the result is 1,590 pounds per square inch. We have transformed 100 PSI into 1,600 PSI, or a ratio of 16 to 1.

HOW A BOOSTER WORKS

A booster, or pressure intensifier, is a device that amplifies available line pressure in order to perform work requiring much higher pressure. It operates a hydraulic cylinder without the need for a hydraulic power unit. A booster is basically a cylinder and is similar in internal design, except that the rod end of the piston does not extend outside. The rod becomes a ram for hydraulic fluid. A booster is equivalent to a transformer, or pulley system, in that it changes the ratio of pressure input to pressure output but does not amplify power. Low pressure air, as found in most plants or shops, is connected to the large cylinder. Pressures are typically 80 to 100 PSI. This low pressure is converted by the booster to a much higher hydraulic pressure on the output side. This discharge has an amplified pressure potential equal to the product of the supply pressure and the booster ratio. Total power is not changed, as the low pressure input air must operate against a large area piston in order to produce high pressure from a much smaller surface area.

Standard boosters are available in ratios running from approximately 2:1 up to 36:1. In the selection of a particular booster (for details, see page 143), not only does the ratio have to be taken into account, but also the output volume has to be matched to the cylinder which the booster will drive.

What does the working cylinder see?

In our example above, we have an output of 1600 PSI hydraulic pressure. When this 1600 PSI is fed to a cylinder, the total area of the piston in the cylinder is now under a pressure of 1600 PSI! Therefore, instead of an air cylinder which would have to work under 100 PSI air pressure, we can now have a cylinder working under 1600 PSI hydraulic pressure. True, this cylinder will only perform work at this pressure through a volume of fluid in the cylinder that is equal to the same volume displacement in the booster, but for many operations, this volume displacement at such increased pressures is completely satisfactory.

Operating power

In the example above, shop air is used as the power source, as this is the most common way boosters are used. It is, however, quite possible to use oil as the operating power source, particularly for extremely high pressure applications. For example, if you need to develop 40,000 PSI and had a choice of 80 PSI air or 3,000 PSI oil, the air booster ratio would be 500:1 and the oil only about 13:1. It's obvious that using an oil to oil booster system would be far less expensive. Standard boosters are air to oil only.

When should boosters be used?

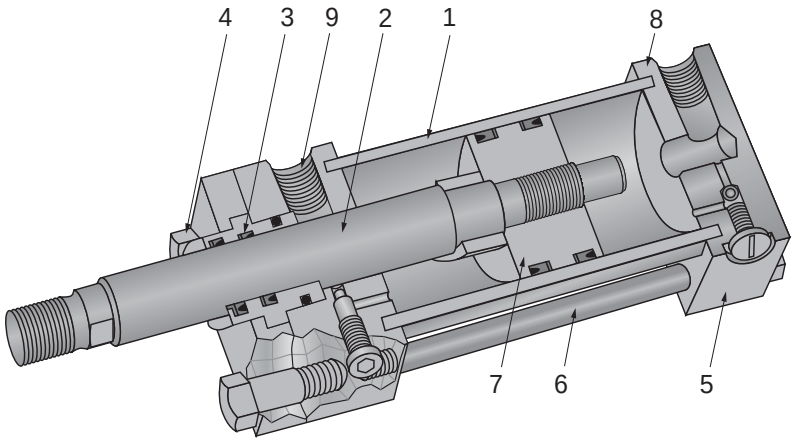
Typical applications for boosters are shown on page 128. Without going into a list of such applications, let's see when you are better off using a booster rather than a complete hydraulic system. Keep in mind that boosters will never replace the pump-cylinder method of work ability…nor are they intended to do so. Therefore, as a general statement, you use a booster *when intermittent high pressure is required in a limited operation, and all you have is low pressure air.* In all of the published applications, there is really no exception to this general rule. The reason for this is that boosters and cylinder combinations are not intended for rapid cycling with high pressures: i.e., their total power is limited.

Now that we've eliminated the negative, let's take the positive approach. You need to clamp a fixture into position for a work application. You have 100 psi shop air. An air cylinder operating under 100 psi will simply not hold the fixture in position in the intended application. Here's an ideal spot for a booster and hydraulic cylinder. As a plus, remember that the hydraulic cylinder can be controlled in its clamping action better than an air cylinder. By using a Dual Pressure Booster (Model BA), the clamping cylinder will travel rapidly toward the fixture, under light pressure, and then will, at the end of its travel, exert high pressure just as it clamps.

Cost Ratio. Another reason for using boosters is the cost ratio of a booster system vs. pump system. You have a machine which requires a linear actuator pressure of 5,000 PSI. If you were to design in a complete 5,000 PSI hydraulic system into this one machine, it could cost you many times a booster system! Again, remember that we are talking about one machine requiring intermittent high pressure.

Long Holding Times. Another case is where you want to exert a high pressure for a long time, such as maintaining pressures on printing rolls. A booster-cylinder system will maintain a continuous pressure with very little power input. In a pump-cylinder system, the pump must be kept in continual operation. (In order to achieve such holding pressure, there must be a relief valve inserted in the system.)

Extreme High Pressures. Pressures over 10,000 PSI can be obtained with special boosters while virtually impossible with ordinary rotary pumps. When you require an inexpensive way of achieving high pressure, even up to 50,000 PSI, the booster is the answer.



BOOSTER FEATURES

1. Booster Barrel

The barrel is of steel tubing, honed to a fine finish and hard chrome plated. This provides superior sealing power, minimum friction and maximum seal life.

2. Rod

Made of high strength steel, induction hardened. It is grounded and polished to a low micro finish, and then chrome plated to resist scoring and corrosion, for maximum life.

3. Rod Seals

Rod seals are of *Milwaukee Cylinder's* high quality, stacked vee construction. They are specifically designed for high pressure hydraulic use, and their performance record has proven their long lasting, low leakage capability.

4. Nozzles

Steel nozzles are externally removable for replacing seals without disturbing booster assembly or tie-rod torque. Four self-locking nuts require only a standard shop wrench for removal.

5. End Caps

Heavy duty end caps are machined from solid, durable steel. All mountings are rigidly attached by either threading or welding. All mountings are expertly machined to provide accurate alignment on matched beds or mounting surfaces.

6. Tie Rods and Nuts

Tie rods are constructed from medium carbon steel, with a yield strength of 125,000 PSI. Threads are accurately machined for rigid engagement of the nuts. Nuts are high strength, self-locking type.

7. Piston

Precision machined from high strength iron alloy. The piston is pilot fitted and threaded to the rod. “U” cup seals are supported by back-up washers.

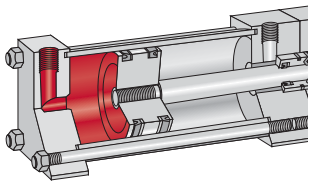
8. End Cap Seals

The barrel is sealed to the end caps with a high temperature, compression type gasket that seals over the entire face of the tube end.

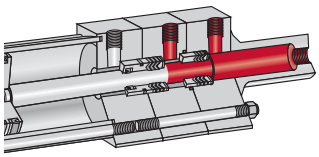
9. Ports

Large, unrestricted ports conforming to NFPA standards are provided. They can be rotated to any 90° position in relation to each other and the booster mounting. Dry seal, national pipe threads are standard with SAE straight thread ports, oversized ports and metric ports available upon request.

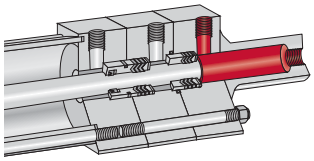
How a Dual Pressure Booster Works



1. Low pressure air is applied to the large surface piston during the entire work stroke. The input pressure of BA Boosters is rated at 250 PSI air.



2. The rod advances through hydraulic fluid that is not yet contained under pressure. The rod is traveling under the same pressure as the air supply.



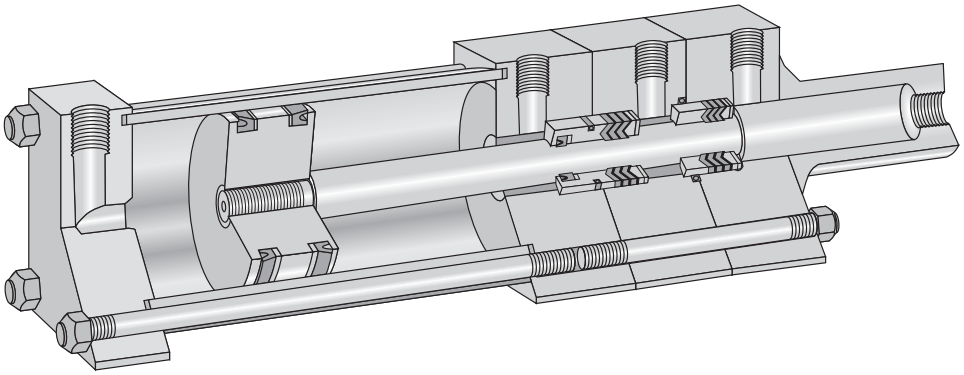
3. When the ram enters the high pressure seal, it immediately boosts the hydraulic pressure up to the rated value. Because of the extra ram seal assembly, the output pressure of this model is limited to 3,000 PSI.

4-Inch Minimum Stroke

Series BA Boosters must have a minimum of 4-inches of stroke.

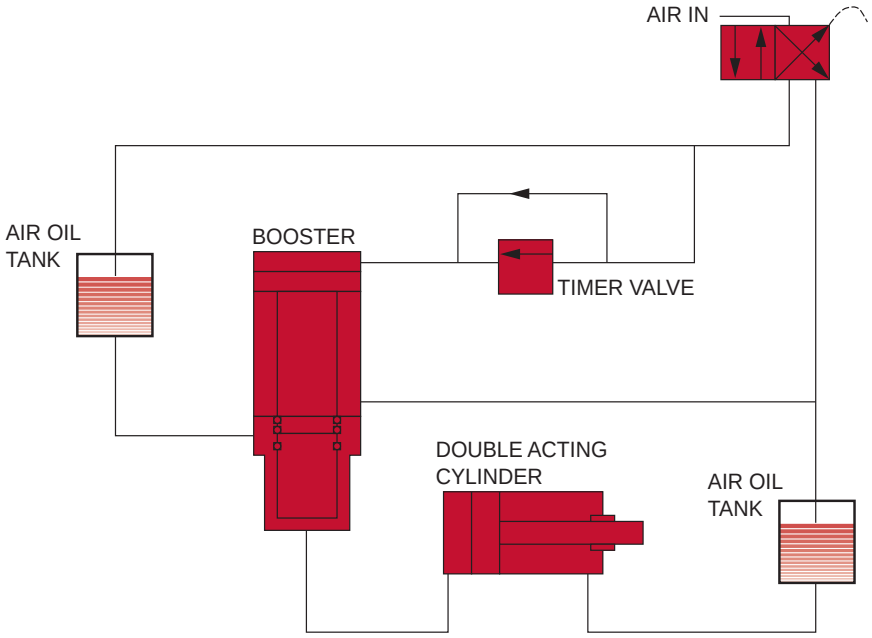
DUAL PRESSURE BOOSTERS

In *Milwaukee Cylinder's* Model BA Booster, the high pressure output is applied only after the ram has entered the secondary, or high pressure seal. This allows a low pressure approach stroke and a high pressure work stroke where the working ram travels only a short distance under high pressure, as when a part needs to be clamped in position for another operation. Model BA boosters are self bleeding and an external valve in the inlet is not required.



RAPID TRAVERSE, AUTOMATIC SEQUENCING WITH BA BOOSTER

Below the circuit shows the use of a double-acting cylinder with rapid traverse at low pressure and sequencing to high pressure when the load is picked up. When the air valve is shifted, the left air-oil tank forces oil through the booster and extends the cylinder. When the load is picked up, the timer valve ports air to the booster for a high pressure output to the cylinder. On the return stroke, the right air-oil tank retracts the cylinder.

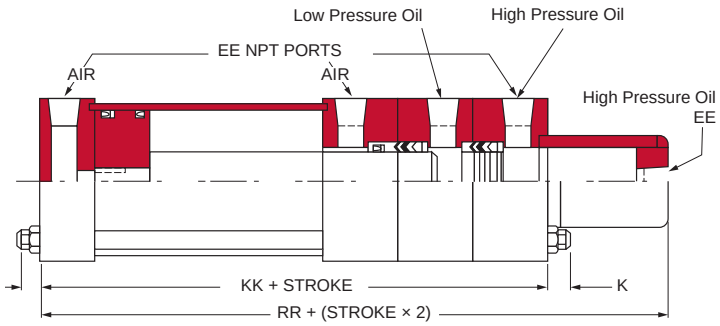


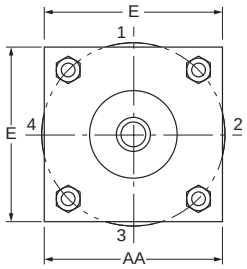
Pressure Limitation Rated Output:
3000 psi

Pressure Limitation Rated Input:
250 psi

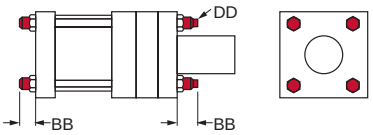
Over 3000 psi, contact factory for information on HBA Series.

MODEL BA 11 - No Tie Rod Extension

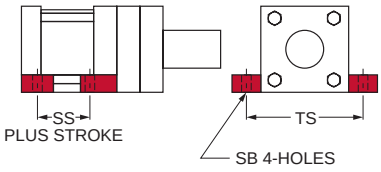




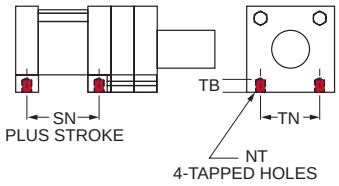
MODEL BA 10 - Tie Rod Extended Both Ends
MODEL BA 12 - Tie Rod Extended Rod End
MODEL BA 13 - Tie Rod Extended Blind End



MODEL BA 42 - Side Lug Mounting



MODEL BA 41 - Tapped Holes in Caps Flush Mounting

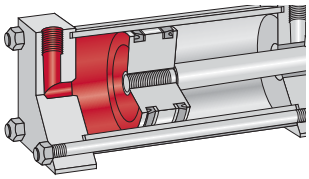


OTHER MOUNTING STYLES AVAILABLE UPON REQUEST
ADD 2" TO REQUIRED STROKE FOR BA BOOSTERS

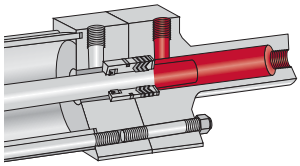
▼ TABLE BA

Bore Ø	E	K	AA	BB	DD	EE	KK	NT	RR max.	SB	SN	SS	TB	TN	TS
2½	3	7/16	3.10	1⅛	5/16-24	⅜	6¾	⅜-16	5¾	7/16	2⅜	3	⅝	1¼	3¾
3¼	3¾	½	3.90	1⅜	⅜-24	½	7¾	½-13	6¾	9/16	2⅝	3¼	¾	1½	4¾
4	4½	½	4.70	1⅜	⅜-24	½	7¾	½-13	6¾	9/16	2⅝	3¼	1	2 1/16	5½
5	5½	⅝	5.80	1 13/16	½-20	½	8	⅝-11	7	13/16	2⅞	3⅛	1	2 11/16	6⅞
6	6½	⅝	6.90	1 13/16	½-20	¾	9	¾-10	8	13/16	3⅛	3⅝	1⅛	3¼	7⅞
8	8½	¾	9.10	2 5/16	⅝-18	¾	9⅛	¾-10	8⅛	13/16	3¼	3¾	1⅛	4½	9⅞
10	10⅝	⅞	11.20	2 11/16	¾-16	1	10⅞	1-8	9⅞	1 1/16	4⅛	4⅝	1⅝	5½	12⅜
12	12¾	⅞	13.30	2 11/16	¾-16	1	11⅜	1-8	10⅜	1 1/16	4⅝	5⅛	1½	7½	14½
14	14¾	1	15.40	3 3/16	⅞-14	1¼	13⅝	1¼-7	12⅝	1 5/16	5½	5⅞	2¼	8⅜	17

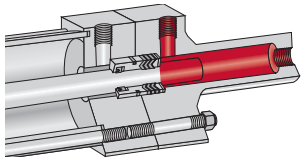
How a Single Pressure Booster Works



1. Low pressure air is applied to the large surface piston during the entire work stroke. The input pressure of BD Boosters is rated at 250 PSI air.



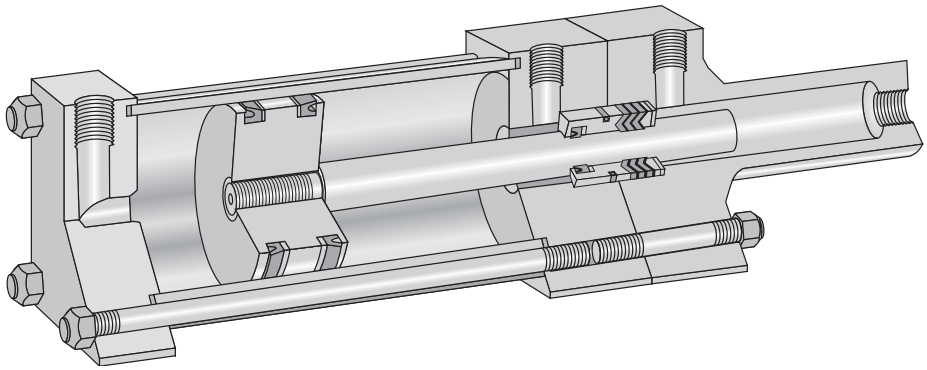
2. The rod of the BD booster is constantly under high pressure throughout the entire work stroke. It has but a single seal assembly.



3. Oil flows out, and back in, the same port on the high pressure end of the BD booster. Make up oil is provided through an external check valve or needle valve.

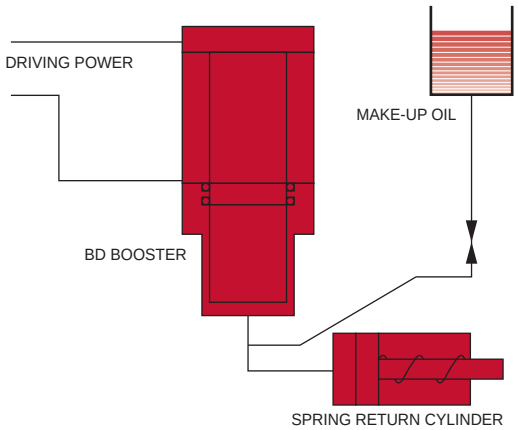
SINGLE PRESSURE BOOSTERS

Milwaukee Cylinder's Model BD Boosters are used where high pressure output is required during the entire work stroke of the cylinder. This design is used for all output pressures and exclusively with special boosters where pressures are above the normal 3,000 PSI. Its single rod seal assembly constantly surrounds the rod. Because of its simpler design, model BD is not self bleeding and more care must be taken in bleeding out air when installing.

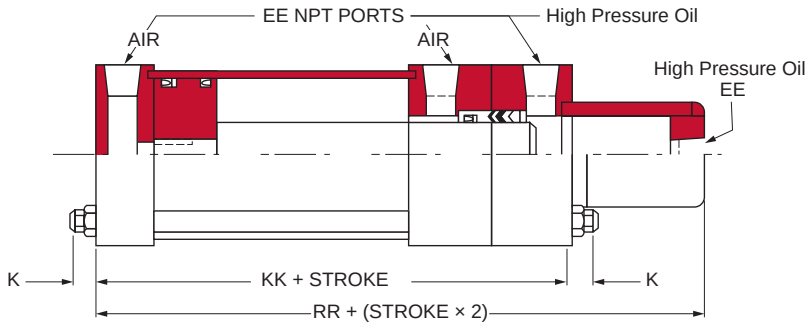


BD BOOSTER WITH SINGLE-ACTING CLAMPING CYLINDER

The circuit shows a BD booster powering a short stroke, spring return cylinder. A simple valve on the input line to the booster can be either manually or automatically operated. Input to the booster is kept on as long as the clamping action of the cylinder is required.
Once removed, the internal spring in the cylinder returns the cylinder piston which, in turn, returns the oil to the booster port.



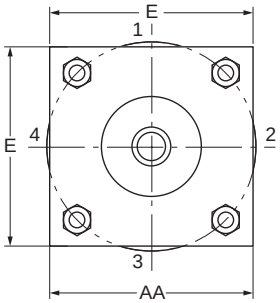
MODEL BD 11 - No Tie Rod Extension



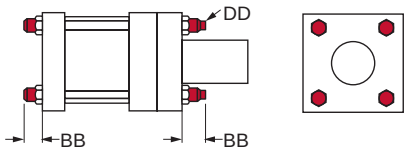
Pressure Limitation Rated Output:
3000 psi

Pressure Limitation Rated Input:
250 psi

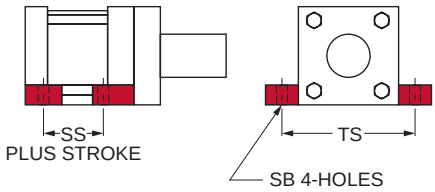
Over 3000 psi, contact factory for information on HBD Series.



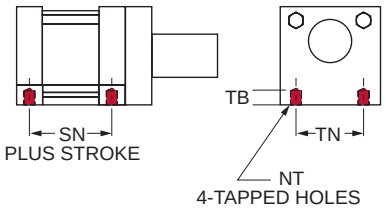
MODEL BD 10 - Tie Rod Extended Both Ends
MODEL BD 12 - Tie Rod Extended Rod End
MODEL BD 13 - Tie Rod Extended Blind End



MODEL BD 42 - Side Lug Mounting



MODEL BD 41 - Tapped Holes in Caps Flush Mounting



OTHER MOUNTING STYLES AVAILABLE UPON REQUEST

▼ TABLE BD

Bore Ø	E	K	AA	BB	DD	EE	KK	NT	RR max.	SB	SN	SS	TB	TN	TS
2½	3	7/16	3.10	1⅛	5/16-24	⅜	5¼	⅜-16	6	7/16	2⅜	3	⅝	1¼	3¾
3¼	3¾	½	3.90	1⅜	⅜-24	½	6	½-13	6½	9/16	2⅝	3¼	¾	1½	4¾
4	4½	½	4.70	1⅜	⅜-24	½	6	½-13	7 1/16	9/16	2⅝	3¼	1	2 1/16	5½
5	5½	⅝	5.80	1 13/16	½-20	½	6¼	⅝-11	7⅜	13/16	2⅞	3⅛	1	2 11/16	6⅞
6	6½	⅝	6.90	1 13/16	½-20	¾	7	¾-10	8⅛	13/16	3⅛	3⅝	1⅛	3¼	7⅞
8	8½	¾	9.10	2 5/16	⅝-18	¾	7⅛	¾-10	8⅛	13/16	3¼	3¾	1⅛	4½	9⅞
10	10⅝	⅞	11.20	2 11/16	¾-16	1	8⅝	1-8	9⅜	1 1/16	4⅛	4⅝	1⅝	5½	12⅜
12	12¾	⅞	13.30	2 11/16	¾-16	1	9⅛	1-8	9⅞	1 1/16	4⅝	5⅛	1½	7¼	14½
14	14¾	1	15.40	3 3/16	⅞-14	1¼	10⅞	1¼-7	11⅛	1 5/16	5½	5⅞	2¼	8⅜	17

Save Space and Weight

In many applications, booster driven cylinders can replace an extremely large, low pressure air cylinder with a small, efficient, high pressure hydraulic cylinder. Coupled with reduced circuitry, the overall weight of a machine can be reduced , as well as the total space required.

Lower Cost

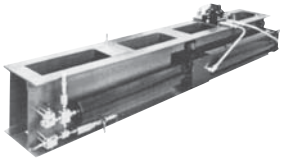
A booster system is less expensive than an overall hydraulic system with its pump-motor requirements. They also require only a fraction of the air of a direct cylinder installation. Hydraulic requirements are also much smaller to operate a given function.

Smoother Power

Compared to air, boosters provide work cylinders with the smooth, efficient power of a hydraulic installation. When such power is required, and installations are limited to smaller volumes, boosters are ideal.

Points of Consideration

1. Plant air distribution system must be capable of maintaining the required pressure to the booster.
2. Regulators should be the relieving type. A leaky poppet could result in a dangerous pressure rise.
3. Directional control valves and air conditioners should have ports at least as large as the booster.
4. Always bleed air from the hydraulic circuit when installing booster systems. Type BA boosters are self bleeding.



A *Milwaukee Cylinder* designed special booster featuring a 10" bore, 60" stroke and a 5½" rod. This booster, mounted on the side of a steel "I" beam, converts a 3,000 psi oil input to an 8,000 PSI output of an ethylene-glycol solution with a total high pressure displacement of 1,400 cubic inches. The booster also had to be designed to operate over a temperature range from -65° to +100° F.

APPLICATIONS FOR BOOSTERS

High Pressure From Shop Air

One of the principle applications for boosters is in the conversion of low pressure shop air to high pressure hydraulic operation for a specific function where a hydraulic cylinder is required. Many operations require the smooth power inherent in a hydraulic cylinder, yet do not require the expenditure for a complete hydraulic installation. The small, yet powerful movement of a booster driven hydraulic cylinder can be used to hold a piece for riveting, as a spot welding clamp, for punching, piercing, forming, crimping, bending, stamping, shearing, marking, etc. The complete installation of booster, air-oil tank and cylinder can be mounted directly on the equipment itself.

Testing

Testing of manufactured parts for physical strength, leaks or burst rating can easily be accomplished with a booster-cylinder combination or a booster alone. A hydraulic cylinder will give a precise, high pressure force for mechanical testing, and a booster can be linked up directly, to a die casting, for instance, to test for leaks.

Fluid Transfer

Fluids that are difficult or impossible to transfer with a conventional pump can be fed through a valve-booster combination. Depending on the type of fluid, boosters can be produced with special metals, such as stainless steel.

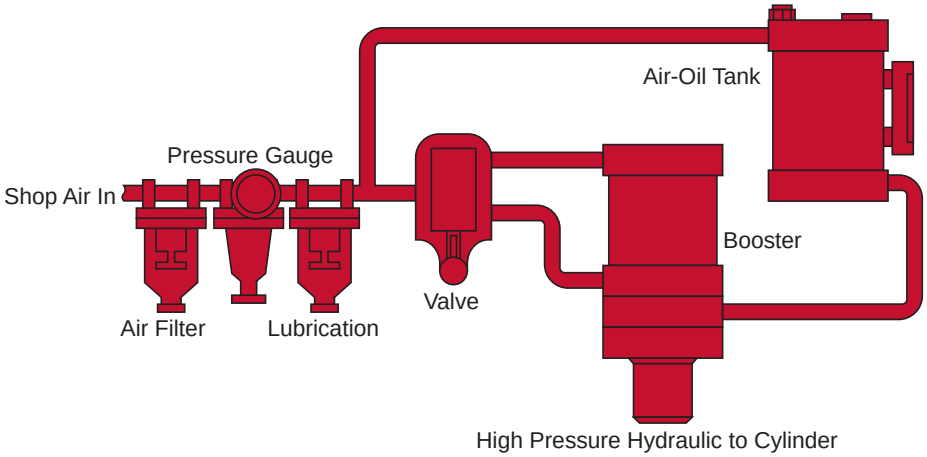
Liquid Injection

High pressure injection of liquids are readily handled with a booster. Such liquids, injected into high pressure gas lines or containers, might include lubricants, antifreeze or odorants.

Holding Pressures

Long holding pressures required in vulcanizing, laminating, bonding or curing can be readily maintained without drawing power or generating heat, except for making up any leakage loss.
A booster can maintain accurate pressure levels under such static conditions for an indefinite time.

High Pressures
Extremely high pressure, up to 50,000 psi, have been achieved with special boosters. Such high pressures would be impossible with an ordinary hydraulic rotary pump.



DETERMINING CORRECT BOOSTER SIZE

Booster size is determined by the high pressure load of the cylinder. In a single pressure system (Model BD), the entire cylinder stroke is the load cycle. In a dual system (Model BA), only the power stroke of the cylinder is considered in the booster calculation.

1. Based on load requirements, select a cylinder bore size that will provide an adequate safety margin.

   Example: Load: 4500 lbs. From the cylinder selector chart, choose a thrust of 4909 lbs. Cylinder bore is therefore 2½", and input pressure is 1,000 PSI.

2. Knowing the stroke required for the cylinder, calculate the volume of oil required for full extension under load pressure. This is the piston area times cylinder stroke. It is important to note that the required volume should not be underestimated. Therefore, add a minimum of 25% to the calculated volume as a safety factor.

   From the cylinder chart, area is 4.909 in^2. (You require a 2" stroke.)

   Volume = 4.91 x 2 x1.25 = 12.25 in^3

3. Divide the hydraulic system pressure by the available shop air pressure to determine booster ratio.

   Booster Ratio = 1000/80 = 12.5

4. From the booster ratio chart, select the required booster bore and rod sizes that will safely handle the booster ratio.

   A booster ratio of 13.22 adequately covers the 12.5 ratio requirement.

   This gives the booster with a bore of 5" and a rod with a diameter of 1⅜". Reading down on the chart, the volume per in. of stroke is 1.49.

5. To determine the booster stroke, divide the calculated high pressure oil volume (from section 2) by the vol/in of stroke. Add 2" for a BA booster.

   Stroke = 12.28/1.49 + 2 = 10.24"

From the above, you specify a cylinder with a bore of 2½" and a stroke of 2". You specify a booster with a 5" bore, a 1⅜" rod and a 10¼" stroke. From this information, you can determine specific mounting dimensions for BA boosters on page 139. (Other bore and rod combinations will also do the job.)

▼ Cylinder Requirements

Push stroke force in pounds
Pressures of operating medium

Cylinder Bore Ø	Piston Area Sq In.	50 PSI	60 PSI	80 PSI	100 PSI	200 PSI	250 PSI	500 PSI	750 PSI	1000 PSI	1500 PSI	2000 PSI	3000 PSI
1½	1.767	88	106	141	177	353	442	884	1,325	1,767	2,651	3,534	5,301
2	3.142	157	189	251	314	628	786	1,571	2,357	3,142	4,713	6,283	9,426
2½	4.909	245	295	393	491	982	1,227	2,455	3,682	4,909	7,364	9,818	14,727
3¼	8.296	415	498	664	830	1,659	2,074	4,148	6,222	8,296	12,444	16,592	24,888
4	12.566	628	754	1005	1,257	2,513	3,141	6,283	9,425	12,566	18,849	25,132	37,698
5	19.635	982	1,178	1,571	1,964	3,927	4,909	9,818	14,726	19,635	29,453	39,270	58,905
6	28.274	1414	1,696	2,262	2,827	5,657	7,071	14,137	21,205	28,274	42,411	56,548	84,822
7	38.485	1,924	2,309	3,079	3,849	7,697	9,621	19,242	28,864	38,485	57,728	76,970	115,455
8	50.265	2513	3,016	4,021	5,027	10,053	12,566	25,133	37,699	50,265	75,398	100,530	150,795
10	78.54	3,927	4,712	6,283	7,854	15710	19,635	–	–	–	–	–	–
12	113.10	5655	6,786	9,048	11,310	22,620	28,275	–	–	–	–	–	–
14	153.94	7697	9,236	12,315	15,394	30,790	38,435	–	–	–	–	–	–
16	201.60	10,053	12,064	16,085	20,106	40,210	–	–	–	–	–	–	–
18	254.47	12,723	15,268	20,358	25,447	50,890	–	–	–	–	–	–	–
20	314.16	15,708	18,850	25,133	31,416	62,830	–	–	–	–	–	–	–

▼ Booster Selection

Booster Ratios
(Condensed Selector Chart for input pressures of 100 psi on page 144.)

Booster Bore Ø	Ram Sizes											
	⅝	1	1⅜	1¾	2	2½	3	3½	4	4½	5	5½
2½	16.00	6.25	–	–	–	–	–	–	–	–	–	–
3¼	–	10.56	5.59	3.45*	2.64*	–	–	–	–	–	–	–
4	–	16.00	8.46	5.22	4.00	2.56	–	–	–	–	–	–
5	–	25.00	13.22	8.16	6.25	4.00	2.78	2.04		–		–
6	–	–	19.04	11.76	9.00	5.76	4.00	2.94	2.25*	–		–
8	–	–	33.85	20.90	16.00	10.24	7.11	5.22	4.00	3.16	2.56	2.12
10	–	–	–	32.65	25.00	16.00	11.11	8.16	6.25	4.94	4.00	3.31
12	–	–	–	–	36.00	23.04	16.00	11.75	9.00	7.11	5.76	4.76
14	–	–	–	–	–	31.36	21.78	16.00	12.25	9.68	7.84	6.48
Vol. Output /in stroke	**.31**	**.78**	**1.49**	**2.40**	**3.14**	**4.91**	**7.07**	**9.62**	**12.57**	**15.90**	**19.63**	**23.76**

*Not available in BA41 or BD41 mount.

BOOSTER BORE & ROD DIAMETERS

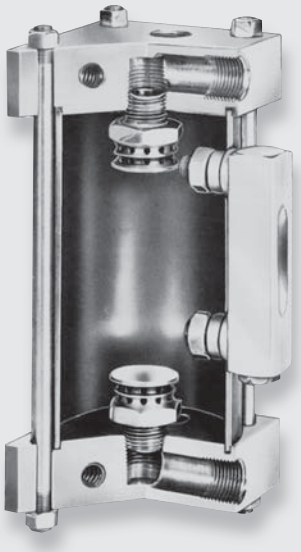
The following chart quickly provides booster bore and rod diameters for basic discharge pressures when the input pressure is 100 PSI. Example: if required pressure to cylinder is 1500 PSI, read down column and select any rod and bore diameter desired, such as a 3" rod and a 12" bore. The left column shows that a displacement of 7.07 in^3 per inch of stroke will result. Other combinations can, of course, be chosen at a glance for the most economical booster or for a booster that fits the installation requirements.

▼ BOOSTER SELECTION CHART (at input pressure of 100 psi)

Displacement per inch of Stroke (in^3)	Minimum Discharge Pressure				Rod Ø
	500	1000	1500	3000	
.31	–	–	2½	–	⅝
.78	2½	3¼	4	–	1
1.49	3¼	5	6	8	1⅜
2.40	4	6	–	10	1¾
3.14	5	–	8	12	2
4.91	6	8	10	14	2½
7.07	8	10	12	–	3
9.62	8	12	14	–	3½
12.57	10	–	–	–	4
15.90	12	–	–	–	4½
19.63	12	–	–	–	5
23.76	14	–	–	–	5½
	Bore Size				

Maximum Pressure:
250 psi

Max. Hydraulic Fluid Temerature:
400° F (205° C)



MILWAUKEE CYLINDER AIR OIL TANKS

Air-Oil Tanks serve several purposes in a booster system:

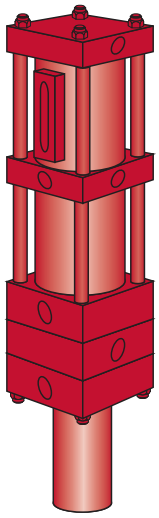
- They are used as a source of oil to compensate for any loss in the hydraulic system
- They can provide hydraulic pressure to return the cylinder to its starting position
- They provide an outlet for entrapped air in the hydraulic system.

The Air-Oil Tank literally contains air on top of oil. The air is under line pressure from the same source as the air used to operate the booster. A sight-gauge is mounted on the side of *Milwaukee Cylinder* Air-Oil Tanks so that the level of oil in reserve can be readily observed. When required, hydraulic fluid may be added through a port in the top of the tank after shutting off air pressure.

Features: *Milwaukee Cylinder* Air-Oil Tanks are manufactured with the same care and high quality materials as are all *Milwaukee Cylinder*'s Boosters and Cylinders. Maximum pressure for these tanks is 250 psi. They are suitable for all hydraulic fluids up to 200° F (93° C). *Milwaukee Cylinder* Air-Oil Tanks incorporate the following high quality features:

- High strength, solid steel end caps with large fill and drain plugs for fast circuit filling
- Steel tubing sealed to each end cap with compression type gaskets
- Replaceable sight gauge enclosed in aluminum shield for maximum gauge protection
- A unique baffle system, inside both end caps, assures rapid intake and discharge with a minimum of churning, foaming and aeration.

Booster & Air-Oil Combination



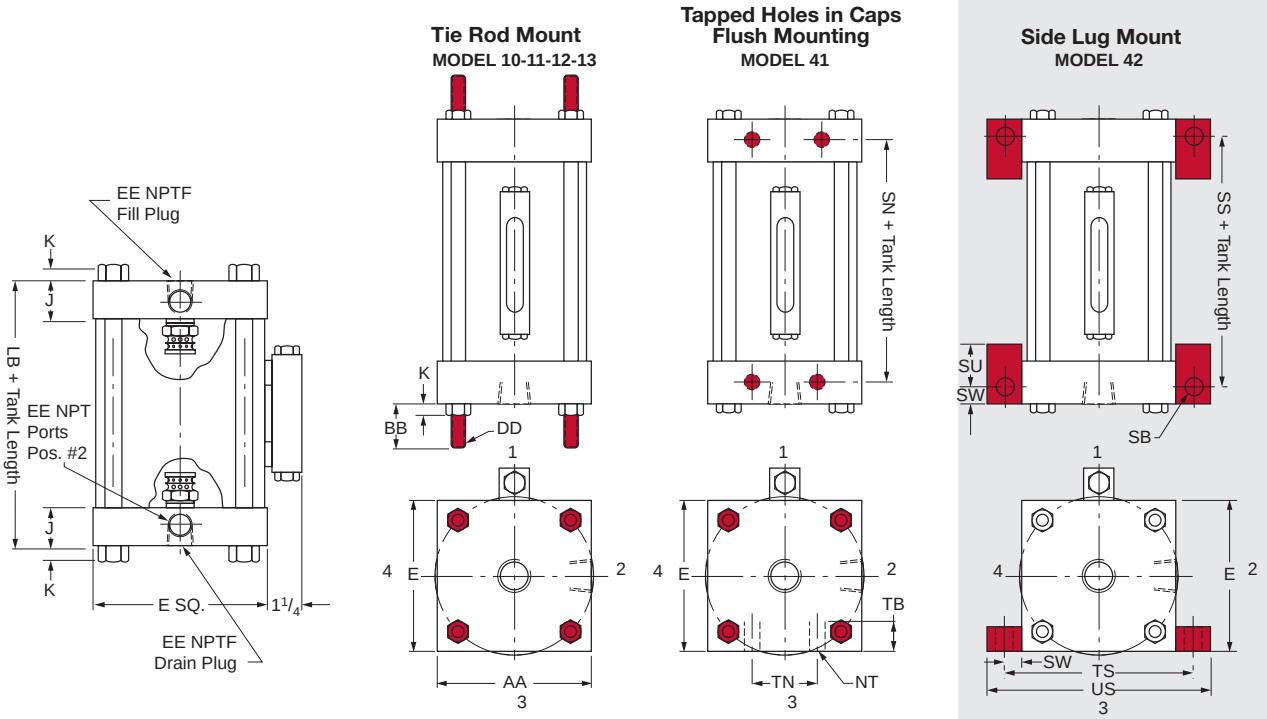
By specifying a combination of a booster and air-oil tank, savings are obtained in space, cost and installation time. Tanks are mounted directly on the booster, using a common end plate and tie-rods. Due to the fact that air-oil tanks must always be used vertically, this combination is limited to a vertically mounted installation. When ordering this combination, specify BAT or BDT depending upon whether a BA or BD booster is used. Tanks are selected with the same size bore as the booster. When determining length, subtract one “J” length from the overall combined length of the individual booster and tank lengths.

SELECTING A TANK SIZE

If the tank is used as a source of pressure to return the cylinder, its size must be in excess of the total cylinder displacement, otherwise, oil will be injected into the air line. Tanks should also be large enough to replenish any hydraulic losses without the necessity of adding fluid too frequently. In the chart below, always select a tank volume equal to or slightly greater than the cylinder volume. After the cylinder volume is determined, it can be located on the chart. Note that a selection may be made with varying tank diameters and lengths. (If a booster-tank combination is required, select the tank diameter to match the booster diameter.)

▼ AIR OIL TANK SELECTION CHART

Tank Bore Ø (in)		Tank Length (in)																		
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
3¼	Usable oil volume in³	26	32	37	44	51	59	66	73	80	88	95	102	109	117	124	131	139	146	153
4		39	48	56	67	78	89	100	111	122	133	144	155	166	177	188	199	210	221	232
5		61	76	88	105	122	139	157	174	191	208	225	243	260	277	294	311	328	346	363
6		88	109	127	152	176	201	226	250	275	300	325	349	374	399	424	448	473	498	523
8		157	195	226	270	314	358	402	446	490	534	578	622	666	710	754	798	841	885	929
10		245	304	353	422	490	559	628	697	765	834	903	971	1040	1109	1178	1246	1315	1384	1453
12		353	438	509	607	706	805	904	1003	1102	1201	1300	1399	1498	1597	1696	1795	1894	1993	2092
14		481	597	692	827	962	1096	1231	1366	1500	1635	1770	1905	2039	2174	2309	2443	2578	2713	2847
Fluid Working Height (in)		3⅛	3⅞	4½	5⅜	6¼	7⅛	8	8⅞	9¾	10⅝	11½	12⅜	13¼	14⅛	15	15⅞	16¾	17⅝	18½



▼ AIR OIL TANK DIMENSIONAL CHART

Tank Bore Ø (in)	E	J	K	AA	BB	DD	EE (NPTF)	LB	NT	SB	SN	SS	ST	SU	SW	TB	TN	TS	US
3¼	3¾	1¼	⅜	3.90	1⅜	⅜-24	½	2½	½-13	9⁄16	1⅜	1½	¾	1¼	½	¾	1½	4¾	5¾
4	4½	1¼	⅜	4.70	1⅜	⅜-24	½	2½	½-13	9⁄16	1⅜	1½	¾	1¼	½	1	2 1⁄16	5½	6½
5	5½	1¼	7⁄16	5.80	1 13⁄16	½-20	½	2½	5⁄8-11	13⁄16	1⅜	1⅛	1	1 9⁄16	1 1⁄16	1	2 11⁄16	6⅞	8¼
6	6½	1½	7⁄16	6.90	1 13⁄16	½-20	¾	3	¾-10	13⁄16	1⅝	1⅝	1	1 9⁄16	1 1⁄16	1⅛	3¼	7⅞	9¼
8	8½	1½	9⁄16	9.10	2 5⁄16	5⁄8-18	¾	3	¾-10	13⁄16	1⅝	1⅝	1	1 9⁄16	1 1⁄16	1⅛	4½	9⅞	11¼
10	10⅝	2	1 1⁄16	11.20	2 11⁄16	¾-16	1	4	1-8	1 1⁄16	2	2¼	1¼	2	⅞	1⅝	5½	12⅜	14⅛
12	12¾	2	1 1⁄16	13.30	2 11⁄16	¾-16	1	4	1-8	1 1⁄16	2	2¼	1¼	2	⅞	1½	7¼	14½	16¼
14	14¾	2¼	13⁄16	15.40	3 3⁄16	⅞-14	1¼	4½	1¼-7	1 5⁄16	2⅜	2¼	1½	2½	1⅛	2¼	8⅜	17	19¼

Operating Pressure:
3000 psi

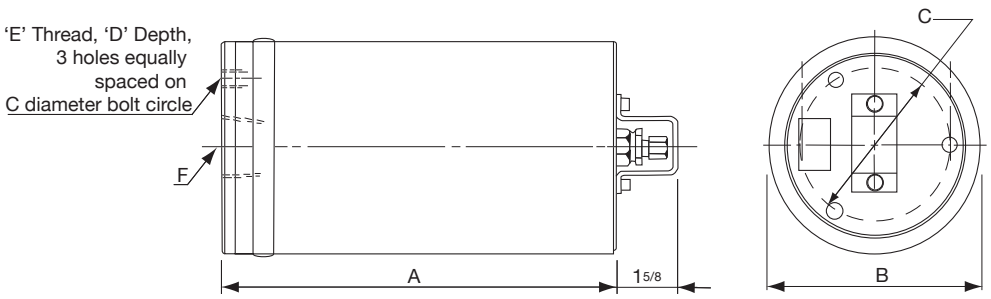
Proof Pressure:
6000 psi

Operating Temperature:
-20°F to +250°F

NA SERIES ACCUMULATORS

Nitrogen-over-oil Accumulators are designed for use over a wide range of industrial applications. Built to the same high quality standards maintained on *Milwaukee Cylinder* Air and Hydraulic Cylinders, Series NA Accumulator can be applied to:

- Simplify hydraulic circuit design
- Lower the hydraulic circuit horsepower requirements
- Improve hydraulic system operation
- Provide exceptionally fast cycle operation when in operation



▼ Dimensional Data & Repair Kits

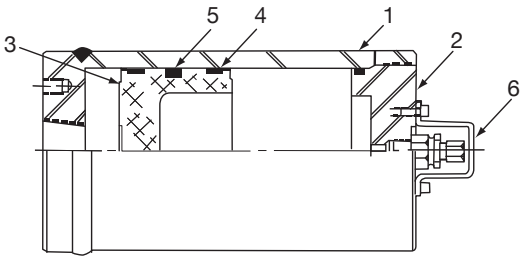
Cylinder Code	Model No.	Size	Oil Capacity in³	Gas Capacity in³	Length A	Ø B	Ø C	Thread Hole Depth D	Thread E	Port *F NPT	Seal Kit Code
3502-1005	**NA2 - 05**	½ Pint	14.5	16.2	8	2⅜	–	–	–	¾	3502-0-40
3502-1001	**NA2 - 1**	Pint	29	30.7	12¾						
3502-1002	**NA2 - 2**	Quart	58	59.7	22						
3504-1002	**NA4 - 2**	Quart	58	70	9⅞	4¾	3¼	½	½ - 20	1¼	3504-0-40
3504-1004	**NA4 - 4**	½ Gal	116	128	14½						
3504-1008	**NA4 - 8**	1 Gal	231	243	23⅝						
3504-1012	**NA4 - 12**	1½ Gal	347	359	32¾						
3504-1016	**NA4 - 16**	2 Gal	462	474	41¾						
3506-1008	**NA6 - 8**	1 Gal	231	273	15 3/16	7	4⅜	¾	⅝ - 18	1½	3506-0-40
3506-1012	**NA6 - 12**	1½ Gal	347	388	19¼						
3506-1016	**NA6 - 16**	2 Gal	462	503	23 5/16						
3506-1020	**NA6 - 20**	2½ Gal	578	619	27½						
3506-1032	**NA6 - 32**	4 Gal	924	965	39⅝						
3506-1040	**NA6 - 40**	5 Gal	1155	1196	47⅞						
3508-1040	**NA8 - 40**	5 Gal	1155	1226	33⅛	9½	5¾	1	¾ - 16	2	3508-0-40
3508-1062	**NA8 - 62**	7½ Gal	1730	1801	44						
3508-1080	**NA8 - 80**	10 Gal	2310	2381	55⅝						

* Available with SAE straight thread; O-Ring port at no additional cost.

NA SERIES PISTON-TYPE ACCUMULATORS

DESIGN FEATURES

Milwaukee Cylinder's Series NA Piston-Type Accumulators are of a sturdy, compact, cylindrical design, built to provide dependable performance at long service life. Series NA features:



1. Honed steel barrel, welded to the hydraulic steel end cap.
2. Solid steel gas end cap, screwed in place for easy removal and seated with O-ring and back-up washer.
3. Lightweight, low inertia aluminum piston, reducing bounce, over travel, and shock when in operation.
4. Non-metallic wear rings provide piston to wall contact. Non-scoring, low frictional drag, these scarf cut rings also stop shock waves from reaching primary seal. The wear rings also provide a wiper type action, thus protecting the primary seal.
5. Proven O-ring balanced seal design with double back-up anti-extrusion rings.
6. Protected gas fill valve. This valve also incorporates a release valve for quick exhausting of the pre charge gas.

APPLICATION

Milwaukee Cylinder's Series NA Piston-Type Accumulators have a wide range of applications such as:

- Cushioning peak loads
- Shock absorbtion
- Compensating for circuit leakage
- Maintaining constant loading on holding circuits
- Performing extremely fast cylinder cycles
- Reducing pump size and circuit horsepower
- A safety device–in case of pump failure–Hydraulic power is available to activate brakes or other locking devices.

Determination of the usable volume of oil obtained from a specific size Accumulator, under specific operating conditions, can be computed by using the formula $P_1V_1 = P_2V_2$ *(Isothermal)* where:

P_1 = absolute precharge pressure (Gauge + 14.7) psia

V_1 = Initial gas volume cubic inch

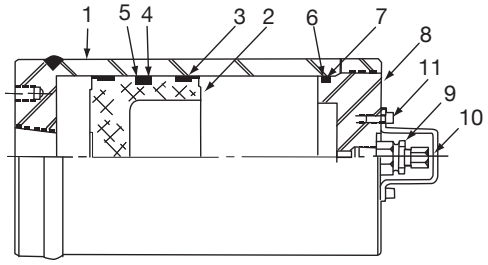
P_2 = Final pressure psia

V_2 = Final gas volume cubic inch

Compute V_2 volume for both maximum and minimum operating pressure, (P_2). Subtracting the V_2 volume from the Accumulator total gas volume will result in the Accumulator oil volujes at both operating pressure limits. The difference between the two resulting oil volumes, is the usable volume of Accumulator oil.

PART LIST

When ordering parts specify Model No., Part No., Description, Serial No. and Quantity.



Part No.	Description	Qty.
1	Accumulator Shell	1
2	Piston	1
3	Wear Ring	2
4	O-Ring (Piston)	1
5	Backup Washer	2
6	O-Ring (End Cap)	1
7	Backup Washer	1
8	End Cap	1
9	Gas Valve	1
10	Bracket	1
11	Cap Screws	2

EXAMPLE FOR NA 4-4

Gas Capacity: 128 cubic inches
Operating Pressure Range:
1500 to 2200 psi
Pre-charge Pressure: 800 psi

@ 2200 psi

$P_1 V_1 , = P_2 V_2$
$814.7 \times 128 = 2214.7 \times V_2$
$V_2 = 47.2$ cu.in. gas
$V_1 - V_2 = 81.2$ cu.in. oil

@ 1500 psi

$814.7 \times 128 = 1514.7 \times V_2$
$V_2 = 68.5$ cu.in. gas
$V_1 - V_2 = 59.5$ cu.in. oil

Usable Oil Volume

81.2 — 59.5 = 21.7 cu.in.
(Based on Isothermal performance)

SPECIAL UNITS

Milwaukee Cylinder can supply you an Accumulator to do your job.

Accumulators for:

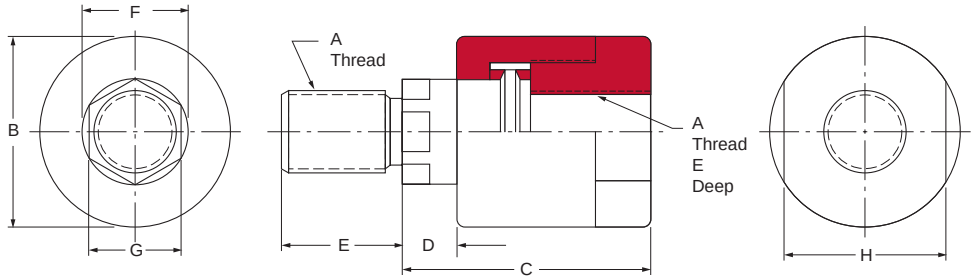
1. Fire-resistant fluids
2. Water operation
3. High pressure
4. High and low temperature operation
5. Special flange mounts for direct connection to check valves or manifold mounts.

These are some of the special applications which are available. Contact your local *Milwaukee Cylinder* representative or the factory direct with you requirements.

milwaukee Cylinder

Cylinder Accessories

Milwaukee Cylinder provides various cylinder accessories to maximize your cylinder's potential. **Linear Alignment Couplers** prevent binding and erratic movement caused by misalignment. **Amlok® Rod Clamps** hold position securely after motion has stopped. Additional accessories are detailed in this section, and also on the inside back cover of this catalog.



Linear Alignment Coupler Dimensional Chart

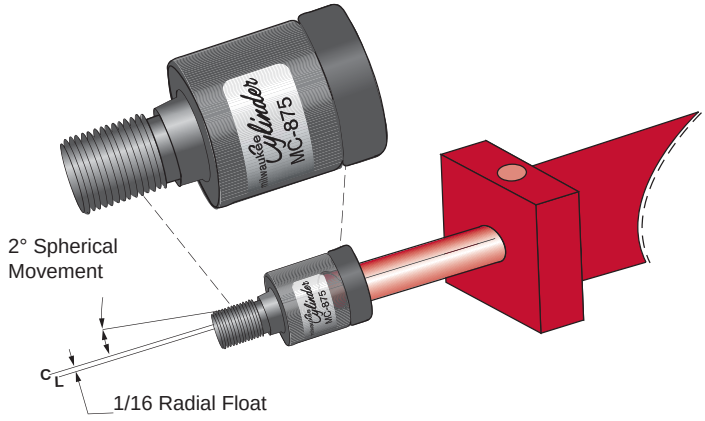
Model No.	A Thread	B Body Ø	C Body Length	D Shank Length	E Thread Length	F Shank Ø	G Flats	H Flats	Max. Rated Load (lbs)	Max. Load @ Yield (lbs)
MC-312	5/16-24	7/8	1 1/4	1/4	5/8	5/16	1/4	3/4	2075	8300
MC-375	3/8-24	7/8	1 1/4	1/4	5/8	5/16	5/16	3/4	2075	8300
MC-437	7/16-20	1 1/4	2	1/2	3/4	5/8	1/2	1	2500	10,000
MC-500	1/2-20	1 1/4	2	1/2	3/4	5/8	1/2	1	3500	14,000
MC-625	5/8-18	1 1/4	2	1/2	3/4	5/8	1/2	1	4750	19,000
MC-750	3/4-16	1 3/4	2 5/16	1/2	1 1/8	31/32	7/8	1 1/2	8500	34,000
MC-875	7/8-14	1 3/4	2 5/16	1/2	1 1/8	31/32	7/8	1 1/2	9750	39,000
MC-1000	1-14	2 1/2	2 15/16	1/2	1 5/8	1 3/8	1 5/32	2 1/4	16,000	64,000
MC-1250	1 1/4-12	2 1/2	2 15/16	1/2	1 5/8	1 3/8	1 5/32	2 1/4	19,500	78,000
MC-1500	1 1/2-12	3 1/4	4 3/8	13/16	2 1/4	1 3/4	1 1/2	3	33,500	134,000
MC-1750	1 3/4-12	3 1/4	4 3/8	13/16	2 1/4	1 3/4	1 1/2	3	33,500	134,000
MC-1875	1 7/8-12	3 3/4	5 7/16	7/8	3	2	1 7/8	3 1/2	60,000	240,000
MC-2000	2-12	3 3/4	5 7/16	7/8	3	2	1 7/8	3 1/2	60,000	240,000

NOTES:
All dimensions are subject to change by manufacturer.
Larger sizes, special designs and metric versions are available. Consult factory.
Use jam nut to lock coupler to rod when used with full diameter threads.
Use "Max. Rated Load" for 4:1 safety factor.

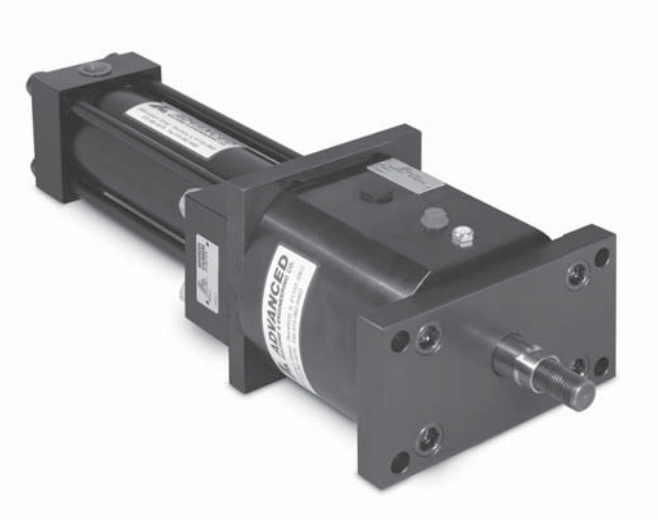
Eliminate Alignment Problems. Install a Linear Alignment Coupler.

Features...

- Reduces rod seal and bearing wear
- Prevents binding and erratic movement caused by misalignment
- Permits a greater tolerance between cylinder centerline and mating member
- Works equally well in “push” or “pull” applications



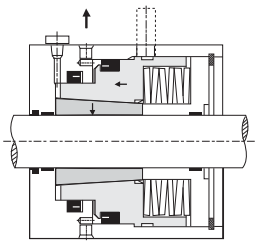
Contact your *Milwaukee Cylinder* representative for product selection assistance.



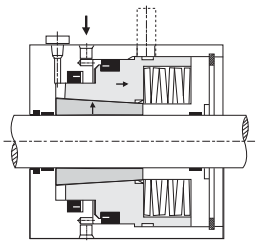
AMLOK® TYPE RCH ROD CLAMP

- Provides power-off clamping of rods and shafts
- Clamps are actuated by a spring/collet mechanism and unclamped by hydraulic pressure
- Designed to clamp components after the motion has stopped and to hold the position securely as long as the forces do not exceed the table values

▼ HOW AMLOK® TYPE RCH ROD CLAMP WORKS



CLAMPED
- Hydraulic pressure off
- Zero back pressure



UNCLAMPED
- Hydraulic pressure at minimum
- Release pressure not to exceed 3000 psi

Optional Accessories

- **Proximity Switch** – to indicate an "unlocked" condition.
- **Air Bleed** - It is important that all the air be bled from the AMLOK® piston area. It is recommended to install an automatic air bleed valve between the AMLOK® and the oil reservoir.

▼ HOW TO ORDER

Example: RCH - XXX XXX - 075 / 100 / 150 X

Rod Size - X.XX (inches)

Cylinder Bore Size - X.XX (inches)

Release Pressure - (psi divided by 10)

Select Options:
P - Proximity Switch (indicates unclamped postion)
N - No Proximity Switch

Example: RCH - 100 250 - 150 N

1.00" Rod - 2.50" Cylinder Bore
1500 psi Release Pressure
No Proximity Switch

Movement in Load A directionis zero.

Movement in Load B direction is .012" maximum when clamp is fully locked

Rod Dia. [1]	Rod Dia. Tolerance [2]	Cyl Bore	AMLOK® Part No. RCH –	Min. Release Pressure psi [3]	Max. Holding Force [4]	D ± .03	L ± .03	E ± .015	R ± .005	TF ± .005	FB ± .015	B ± .015	A ± .015	K ± .015	C ± .03	F ± .03	G ± .03	J ± .03	M ± .03	Port
.625	+.000 - .003	1.50	**062 150-075** **062 150-100** **062 150-150**	750 1000 1500	1100 1800 2250	4.37	3.55	1.63	1.625	3.437	.44	1.25	2.48	.23	.38	2.13	.75	.79	.78	SAE 4
1.000	+.000 - .003	1.50	**100 150-075** **100 150-100** **100 150-150**	750 1000 1500	1200 2000 2300	4.37	3.45	1.75	1.625	3.437	.44	1.63	2.76	.23	.50	1.88	.87	.79	.78	SAE 4
1.000	+.000 - .003	2.00	**100 200-075** **100 200-100** **100 200-150**	750 1000 1500	2900 5200 5600	5.37	4.37	2.25	2.050	4.125	.56	1.63	3.74	.23	.35	2.90	.85	1.00	0	SAE 4
1.000	+.000 - .003	2.50	**100 250-075** **100 250-100** **100 250-150**	750 1000 1500	2900 5200 6000	5.98	5.12	2.50	2.550	4.625	.56	1.63	4.13	.23	.50	3.40	1.00	1.50	0	SAE 4
1.375	+.000 - .003	2.00	**137 200-075** **137 200-100** **137 200-150**	750 1000 1500	2700 2700 5200	5.37	4.65	2.25	2.050	4.125	.56	2.13	3.74	.23	.50	3.00	1.00	1.50	0	SAE 4
1.375	+.000 - .003	2.50	**137 250-075** **137 250-100** **137 250-150**	750 1000 1500	2700 5200 6000	5.98	5.12	2.50	2.550	4.625	.56	2.13	4.13	.23	.50	3.50	.90	1.50	0	SAE 4
1.375	+.000 - .003	3.25	**137 325-075** **137 325-100** **137 325-150**	750 1000 1500	8200 11500 16000	7.75	6.50	3.25	3.250	5.875	.69	2.13	5.70	.28	.45	4.50	1.10	2.60	0	SAE 4
1.750	+.000 - .003	2.50	**175 250-075** **175 250-100** **175 250-150**	750 1200 2000	3500 5700 7500	6.00	5.91	2.50	2.55	4.630	.56	2.38	4.33	.32	.70	3.90	.96	2.44	.78	SAE 4
1.750	+.000 - .003	3.25	**175 325-075** **175 325-100** **175 325-150**	750 1000 1500	8200 11500 16000	7.75	6.50	3.25	3.250	5.875	.69	2.50	5.70	.30	.63	4.67	.93	2.60	0	SAE 4
1.750	+.000 - .003	4.00	**175 400-075** **175 400-100** **175 400-150**	750 1000 1500	8200 12000 17000	8.38	6.50	3.50	3.820	6.375	.69	2.50	6.10	.34	.50	4.375	1.225	2.20	0	SAE 4
2.000	+.000 - .003	3.25	**200 325-075** **200 325-100** **200 325-150**	750 1000 1500	8200 11500 16000	7.75	6.50	3.25	3.250	5.875	.69	2.68	5.70	.29	.58	4.50	1.10	2.60	0	SAE 4
2.000	+.000 - .003	5.00	**200 500-075** **200 500-100** **200 500-150**	750 1000 1500	8200 12000 17000	11.25	6.50	3.50	4.950	8.187	.94	2.75	6.10	.34	.50	4.375	1.225	2.20	0	SAE 4
2.500	+.000 - .003	4.00	**250 400-075** **250 400-100** **250 400-150**	750 1000 1500	6000 8000 15000	7.68	7.10	3.50	3.813	6.375	.69	3.14	6.10	.35	.56	4.77	1.23	3.00	.91	SAE 4
2.500	+.000 - .003	6.00	**250 600-075** **250 600-100** **250 600-150**	750 1000 1500	30000 36000 50000	12.75	9.00	5.00	5.730	9.437	1.06	3.25	8.85	.38	.75	3.625	1.125	3.00	0	SAE 4
3.000	+.000 - .003	6.00	**300 600-075** **300 600-100**	750 1000	17000 22500	12.75	9.00	5.00	5.730	9.437	1.06	3.88	_	_	.38	4.88	1.1	3.11	0	SAE 8
3.000	+.000 - .003	7.00	**300 700-075** **300 700-100** **300 700-150**	750 1000 1500	30000 36000 50000	14.75	10.00	6.50	6.580	10.625	1.19	3.88	_	_	.75	7.325	1.375	4.73	0	SAE 8
3.500	+.000 - .003	8.00	**350 800-075** **350 800-100** **350 800-150**	750 1000 1500	40000 55000 80000	16.14	11.50	7.00	7.500	11.812	1.31	4.38	_	_	.90	8.93	1.32	5.35	0	SAE 10
4.000	+.000 - .005	8.00	**400 800-075** **400 800-100** **400 800-150**	750 1000 1500	40000 55000 80000	16.14	11.50	7.00	7.500	11.812	1.31	4.88	_	_	.90	8.875	1.365	5.35	0	SAE 10

[1] Other sizes available upon request.

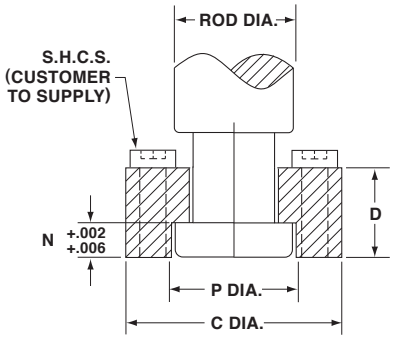
[2] Rod tolerances that exceed these limits will affect the holding force.

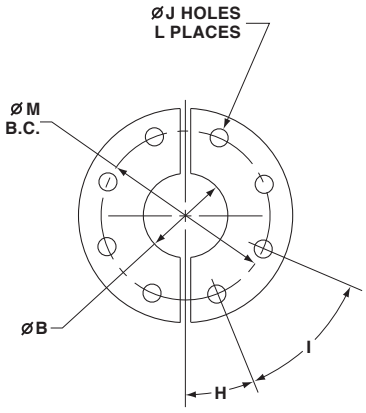
[3] Maximum Hydraulic Release Pressure: 3000 psi

[4] Holding forces are based on dry or mineral-oil lubricated shafts.

Dimensions are subject to change without notice.

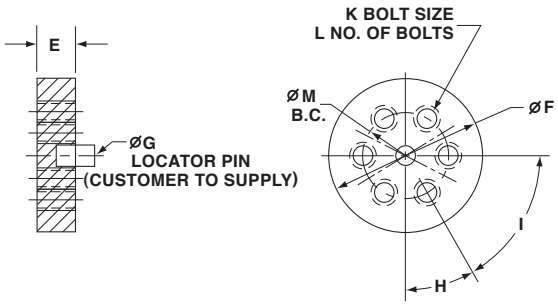
▼ FLANGE COUPLERS





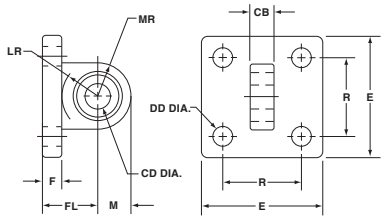
PART#	ROD DIA.	B	C	D	H	I	J	L	M	N	P	MATERIAL
ACFC-062	.625	.406	1.500	.562	45°	90°	.218	4	1.125	.250	.656	AISI 1144 CD
ACFC-100	1.000	.750	2.000	.875	30°	60°	.281	6	1.500	.375	1.063	AISI 1144 CD
ACFC-137	1.375	.938	2.500	1.000	30°	60°	.343	6	2.000	.375	1.438	AISI 1018 CD
ACFC-175	1.750	1.187	3.000	1.250	22.5°	45°	.343	8	2.375	.500	1.813	AISI 1018 CD
ACFC-200	2.000	1.438	3.500	1.625	15°	30°	.406	12	2.688	.625	2.063	AISI 1018 CD
ACFC-250	2.500	1.875	4.000	1.875	15°	30°	.406	12	3.188	.750	2.625	AISI 1018 CD
ACFC-300	3.000	2.375	5.000	2.375	15°	30°	.531	12	4.000	.875	3.125	AISI 1018 CD
ACFC-350	3.500	2.625	5.875	2.625	15°	30°	.656	12	4.688	1.000	3.625	C1119 MOD
ACFC-400	4.000	3.125	6.375	2.625	15°	30°	.656	12	5.188	1.000	4.125	C1119 MOD
ACFC-450	4.500	3.625	6.875	3.125	15°	30°	.656	12	5.688	1.500	4.625	C1119 MOD
ACFC-500	5.000	4.000	7.375	3.125	15°	30°	.656	12	6.188	1.500	5.125	C1119 MOD
ACFC-550	5.500	4.500	8.250	3.875	15°	30°	.781	12	6.875	1.875	5.625	C1119 MOD

▼ WELD PLATES



PART#	SIZE	E	F	G	H	I	K	L	M	MATERIAL
ACWP-062	.625	.500	2.000	.250	45°	90°	10 - 24	4	1.125	CD 1018
ACWP-100	1.000	.500	2.500	.250	30°	60°	1/4 - 20	6	1.500	CD 1018
ACWP-137	1.375	.625	3.000	.250	30°	60°	5/16 - 18	6	2.000	CD 1018
ACWP-175	1.750	.625	4.000	.250	22.5°	45°	5/16 - 18	8	2.375	CD 1018
ACWP-200	2.000	.750	4.000	.375	15°	30°	3/8 - 16	12	2.688	CD 1018
ACWP-250	2.500	.750	4.500	.375	15°	30°	3/8 - 16	12	3.188	CD 1018
ACWP-300	3.000	1.000	5.500	.375	15°	30°	1/2 - 13	12	4.000	CD 1018
ACWP-350	3.500	1.000	7.000	.375	15°	30°	5/8 - 11	12	4.688	A 36 HRS
ACWP-400	4.000	1.000	7.000	.375	15°	30°	5/8 - 11	12	5.188	A 36 HRS
ACWP-450	4.500	1.000	8.000	.375	15°	30°	5/8 - 11	12	5.688	A 36 HRS
ACWP-500	5.000	1.000	8.000	.375	15°	30°	5/8 - 11	12	6.188	A 36 HRS
ACWP-550	5.500	1.250	9.000	.375	15°	30°	3/4 - 10	12	6.875	A 36 HRS

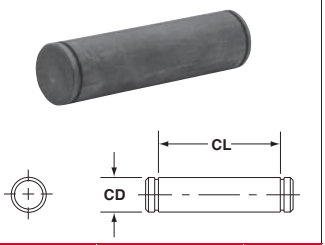
▼ SPHERICAL EYE BRACKETS



PART#	CB	CD - .0005	DD	E	F	FL	LR	M	MR	R
ACEB-05	1/2	.5000	13/32	2 1/2	3/8	1 1/8	3/4	11/16	11/16	1.62
ACEB-07	3/4	.7500	17/32	3 1/2	5/8	1 7/8	1 1/4	1 3/16	1 3/16	2.56
ACEB-10	1	1.0000	21/32	4 1/2	3/4	2 1/4	1 1/2	1 3/8	1 3/8	3.25
ACEB-13	1 3/8	1.3750	21/32	5	7/8	3	2 1/8	2	2	3.81
ACEB-17	1 1/2	1.7500	29/32	6 1/2	7/8	3 1/8	2 1/4	2 1/8	2 1/8	4.94
ACEB-20	1 3/4	2.0000	1 1/32	7 1/2	1	3 1/2	2 1/2	2 3/8	2 3/8	5.75

MATERIAL: 05 thru 10, 1144 Steel Forging; 13 thru 20, Steel Weldment

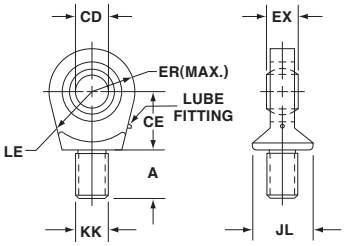
▼ PIVOT PINS FOR SPHERICAL CLEVIS BRACKETS



PART#	CD	CL
ACPP-05	.4997-.0004	1 9/16
ACPP-07	.7497-.0005	2 1/32
ACPP-10	.9997-.0005	2 1/2
ACPP-13	1.3746-.0006	3 5/16
ACPP-17	1.7496-.0006	4 7/32
ACPP-20	1.9996-.0007	4 15/16

MATERIAL: CD1144 **HEAT TREATMENT:** Nitrotec

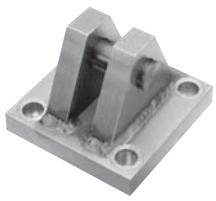
▼ SPHERICAL ROD EYES

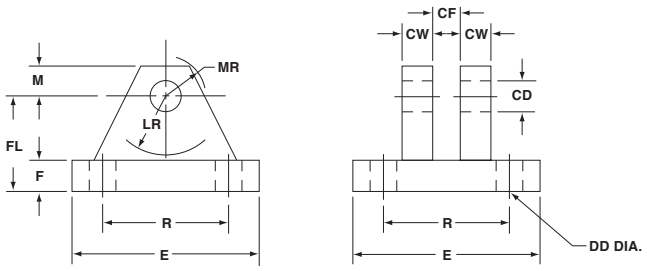


PART#	CD - .0005	A	CE	EX	ER	LE	KK	JL
ACRE-05	.5000	11/16	7/8	7/16	7/8	3/4	7/16 – 20	7/8
ACRE-07	.7500	1	1 1/4	21/32	1 1/4	1 1/16	3/4 – 16	1 5/16
ACRE-10	1.0000	1 1/2	1 7/8	7/8	1 3/8	1 7/16	1 – 14	1 1/2
ACRE-13	1.3750	2	2 1/8	1 3/16	1 13/16	1 7/8	1 1/4 – 12	2
ACRE-17	1.7500	2 1/8	2 1/2	1 17/32	2 3/16	2 1/8	1 1/2 – 12	2 1/4
ACRE-20	2.0000	2 7/8	2 3/4	1 3/4	2 5/8	2 1/2	1 7/8 – 12	2 3/4

MATERIAL: Ductile Iron Casting

▼ SPHERICAL CLEVIS BRACKETS



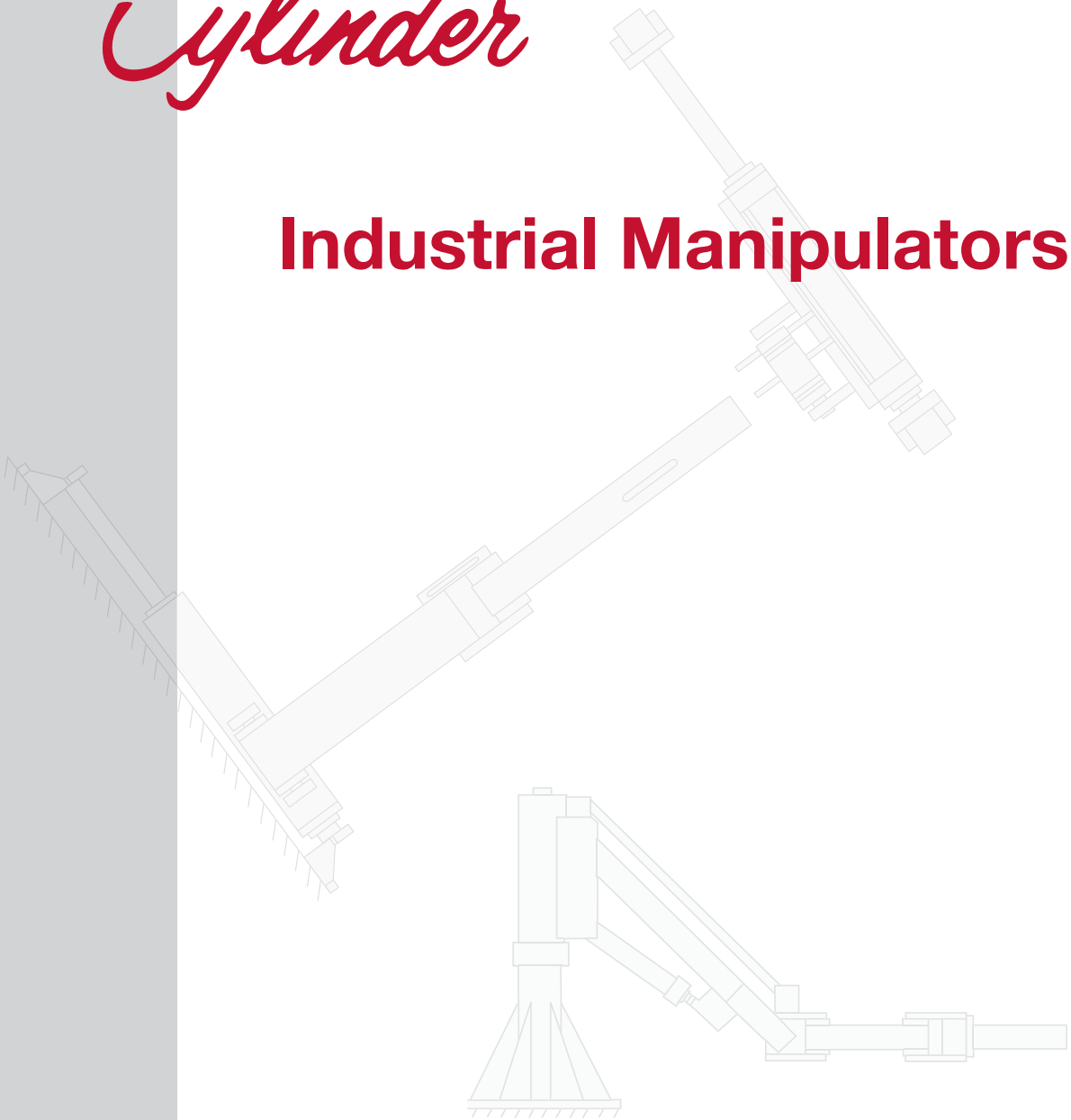


PART#	E	F	M	R	CD	CF	CW	DD	FL	LR	MR
ACCB-05	3.00	.50	.50	2.05	.500	.44	.50	.41	1.50	.94	.62
ACCB-07	3.75	.62	.88	2.76	.750	.66	.62	.53	2.00	1.38	1.00
ACCB-10	5.50	.75	1.00	4.10	1.000	.88	.75	.53	2.50	1.69	1.19
ACCB-13	6.50	.88	1.38	4.95	1.375	1.19	1.00	.66	3.50	2.44	1.62
ACCB-17	8.50	1.25	1.75	6.58	1.750	1.53	1.25	.91	4.50	2.88	2.06
ACCB-20	10.62	1.50	2.00	7.92	2.000	1.75	1.50	.91	5.00	3.31	2.38

MATERIAL: Steel Weldment

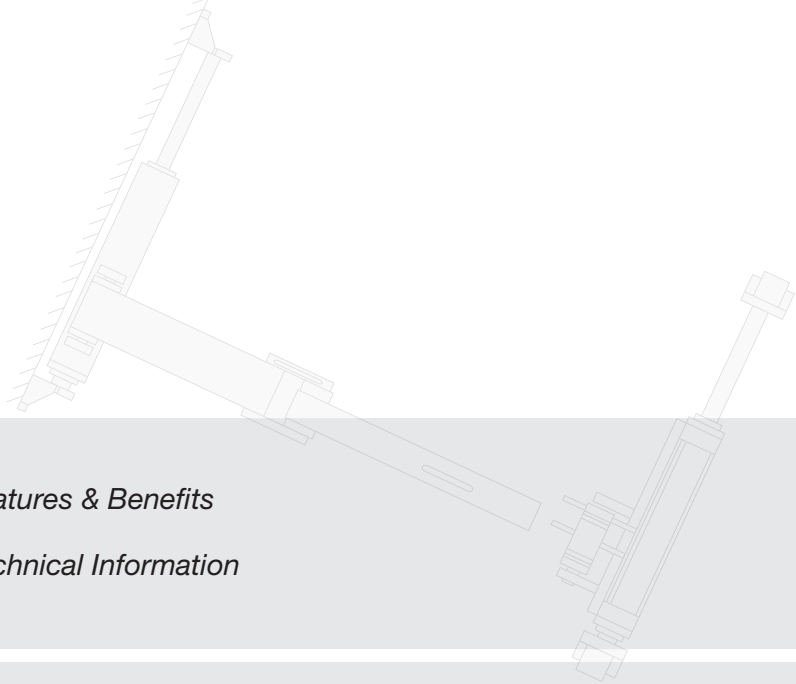
milwaukee Cylinder

Industrial Manipulators



Pow'r Arm™ and Pow'r Reach™ Industrial Manipulators

from *Milwaukee Cylinder* provide safe and efficient means to lift and locate loads up to 2,000 lbs. They use hydraulic power to lift, and manual operator movement to locate the load. Pow'r Arm™ units are typically mounted to a vertical surface at a machine or press to aid the operator in loading heavy tooling, dies or work pieces of up to 2000 lbs. Pow'r Reach™ provides greater vertical travel and reach for loads up to 750 lbs. Mounting options include floor mount, dolly mount, and overhead mount.

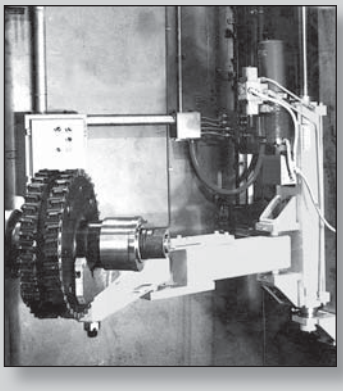


Safe, convenient positioning of loads up to 2,000 lbs.

- **Quick, easy lifting and positioning of heavy dies, tooling and parts**
- **One-man control — saves time and labor**
- **Mounts directly on machine, I-beam or vertical surface**
- **Vertical travel is easily controlled with 8.0 ft remote pendant push-button control**
- **Articulated arm simplifies positioning of load, folds away for convenient storage**
- **Metering orifice slows downward motion**
- **2-speed control permits fast movement and precise positioning of load**

Features

- Hydraulic power to lift, operator movement to locate the load
- 12 inch and 24 inch vertical travel
- Electric powered, self-contained, stand-alone hydraulic power unit controls vertical travel with manual horizontal positioning of the load by the operator
- Lift speeds of 22 in/min. to 117 in/min.



Large and complex cutters are often impossible to handle without some mechanical assistance. The Pow'r Arm™ was adapted for this specific application.

In automated forging processes, hot metal blanks are fed automatically into a progressive die. Each die segment may weigh several hundred pounds and must be handled quickly, easily and safely.

Large shear blades are used to cut steel bars and billets. When these blades become worn the Pow'r Arm™ performs speedy removal and replacement of the blades safely with minimal disruption to the process.

POWER SUPPLY

Pow'r Arm™ includes a complete, self-contained, stand-alone power supply. It consists of a pump, motor, coupling, coupling adapter, hydraulic reservoir and controls.

The electric-hydraulic units have a pre-set relief valve to prevent overloads and a check valve which retards descent of the load if the power fails. Pressure settings for relief valves are set as shown in the "Hydraulic Specifications" table to the right.

▼ Hydraulic Specifications

Model Number	Pressure Rating (psi)	System Fluid Capacity (gal)	Vertical Travel Speed (in/min)
MPA-25	300	2.0	117
MPA-50	300	2.0	54
MPA-100	300	2.0	37
MPA-200	300	2.0	22

▼ Electrical Specifications

AC Voltage	AC Hz	Phase	Amps
115*	60/50	1	9
220	60/50	1	7
440	60/50	3	3.5

* STD. - Unless otherwise specified.

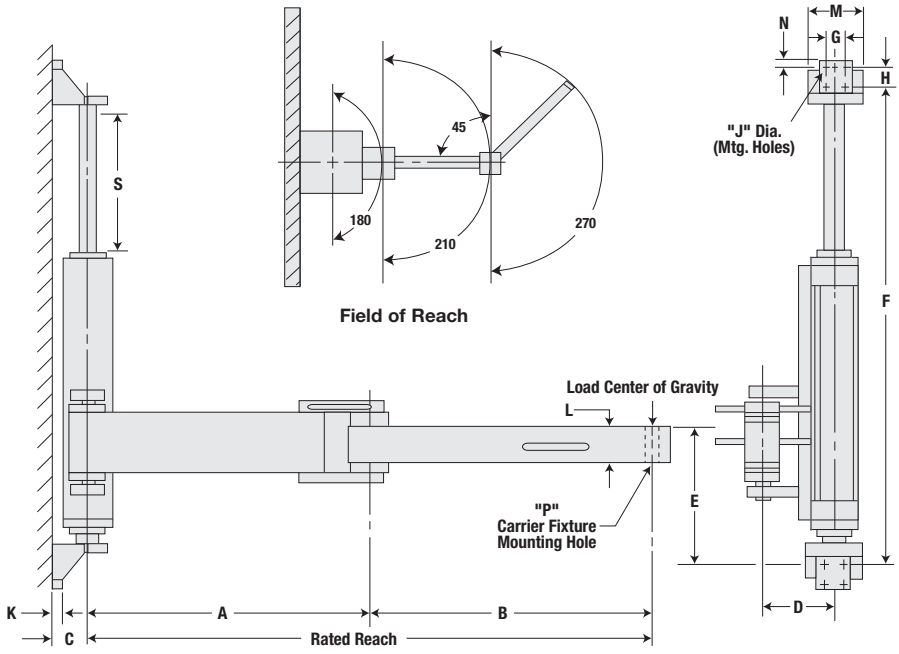
▼ HOW TO ORDER

Example: MPA - 25 - 12 - 24/24 - 7 - SH - S

- Model No. & Load Capacity
- Vertical Travel ("S" from dim. chart below)
- Rated Reach ("A" and "B" from dim. chart below)
- Seals
  - Buna (standard) - 7 ; Viton (optional) - 8
- Power Unit (SH = Electric-Hydraulic)
- Modification from Standard - S
  (If Applicable)

Operating Specs. - Model MPA

Rated Load:	250-2000 lbs.
Working Radius:	24-36 in.
Pump:	1.5 GPM, 3450 RPM
Pressure Rating:	300 psi
Motor:	0.5 hp, 3450 RPM, C Frame
Reservoir Capacity:	2.0 gal.
Lowering Power:	Gravity (Controlled by Needle Valve)
Operating Controls:	2-button Up/Down Pendant
Electrical Requirements:	20 Amps, 115V / 60 Hz
Down Speed:	Adjustable with Needle Valve
Total Weigh: 560 lbs.	275-1600 lbs.



Safety Relief Valve

Relief valves are pre-set at the factory to prevent overloading of the cylinder arm assembly.

Dual Speed Control

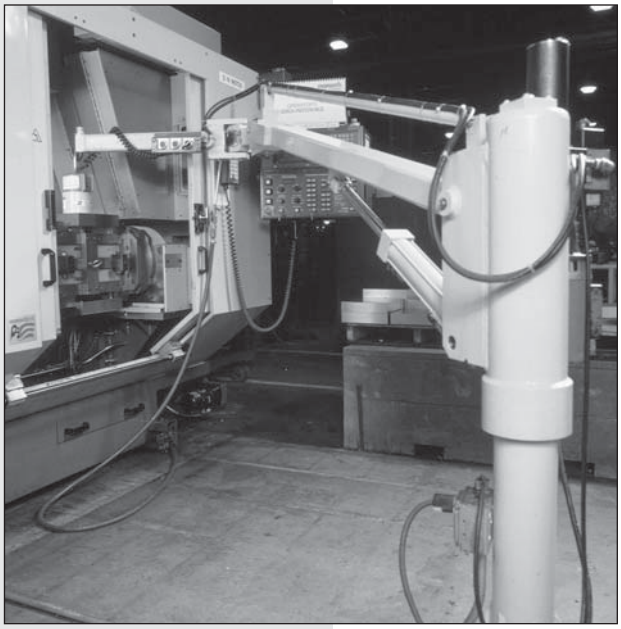
The vertical travel is controlled by a hand held push-button pendant, connected to the hydraulic power unit. Dual speed provides maximum performance and control.

Integrated Hydraulic Controls

All hydraulic controls are integrated into compact manifold packages to minimize space and system hydraulic connections. Controls are designed to provide positive load holding.

▼ DIMENSIONAL CHART

Load Cap. (lbs)	Model No.	Dimensions (in)															Wt.
		A	B	C	D	E	F	G	H	J	K	L	M	N	P	S	
250	MPA-25	24.00	24.00	3.75	5.88	11.25	39.38	1.75	1.75	.43	.50	3.00	3.75	.50	.753/.755	12.00	275
500	MPA-50	24.00	24.00	4.50	7.25	17.43	77.38	4.00	2.00	.56	1.00	4.00	8.00	1.00	1.003/1.005	24.00	750
1000	MPA-100	30.00	30.00	5.50	8.50	19.15	75.81	4.50	3.50	.68	1.25	5.00	8.00	1.00	1.503/1.505	24.00	975
2000	MPA-200	36.00	36.00	6.50	10.75	22.75	78.12	6.00	4.00	.81	1.50	6.00	10.00	.75	1.503/1.505	24.00	1600

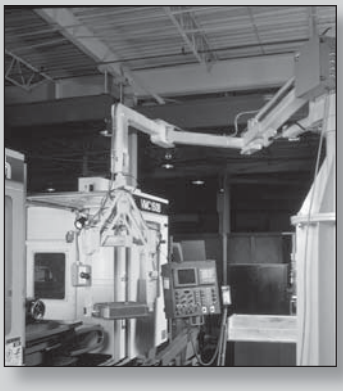


For fast, easy lifting and precise positioning of tombstones, vises and materials

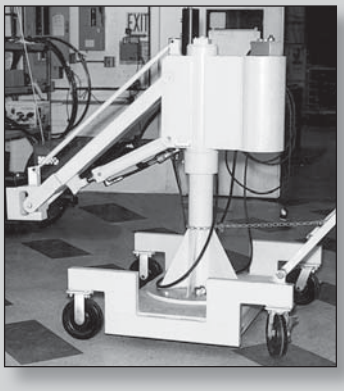
- **Available in 250 lbs or 750 lbs capacity**
- **58-inch vertical travel, 8.5 foot reach, 350 degree rotation**
- **One-person control – saves time and labor**
- **Low column profile for maneuverability**
- **Two-speed pendant control permits fast movement and precise positioning**
- **Special bearings prevent drifting of load**

Standard Features

- 58" vertical travel
- Self-contained hydraulic power unit for lifting with manual horizontal power
- Rapid up speed - Full 58 inches travel in 15 seconds
- Vented reservoir with sintered metal breather filter
- Buna cylinder seals are standard; Viton seals available upon request



Parts are selected from pallets and moved to working stations. The smooth, positive hydraulic control of the Pow'r Reach™ permits picking and positioning of expensive parts safely and precisely.



Portable dolly-mounted Pow'r Reach™ provides flexibility to accommodate a wide variety of applications. For stability, a counterweight is welded to the column of these models.

A Pow'r Reach™ is used to position parts in machining centers. It is useful and effective because of the ease and convenience with which the heavy parts are handled.

POWER SUPPLY

All Pow'r Reach™ units include a complete self-contained electric-hydraulic power supply mounted on the column. The standard power supply is driven by a single-phase electric motor. Standard voltages, frequencies and motor specifications are in the table below. Custom configurations are available upon request.

▼ HOW TO ORDER

Example: MPR - 25 - SH - 7 - S

- Model No. & Load Capacity
- Power Supply
  - SH - Electric / Hydraulic (standard)
- Seals
  - Buna (standard) -7 Viton (optional) -8
- Modification from standard -S (if applicable)

Operating Specifications	Model MPR-25	Model MPR-75
Rated Load:	250 lbs.	750 lbs
Working Radius:	102.00 in.	103.50 in.
Pump:	1.5 GPM, 3450 RPM	2.8 GPM, 1750 RPM
Pressure Rating:	600 psi	600 psi
Motor:	0.5 hp, 3450 RPM, C Frame	1.5 hp, 1750 RPM, C Frame
Reservoir Capacity:	2.0 gal.	3.0 gal.
Lowering Power:	Gravity, Controlled by Needle Valve	Hydraulic Power Unit
Operating Controls:	2-button Up & Down Pendant Control	Joystick, Variable Speed Control Proportional Valve
Electrical Requirements:	20 Amps, 115V / 60 Hz	30 Amps, 220V / 60 Hz
Down Speed:	Adjustable with Needle Valve	Joystick Variable Speed Control
Mounting Data		
Mounting Bolt-Pull-Out Force:	4000 lbs. Minimum	7000 lbs. Minimum
Total Weight, Floor-Mounted Pow'r Reach:	560 lbs.	1183 lbs.

Safety Relief Valve

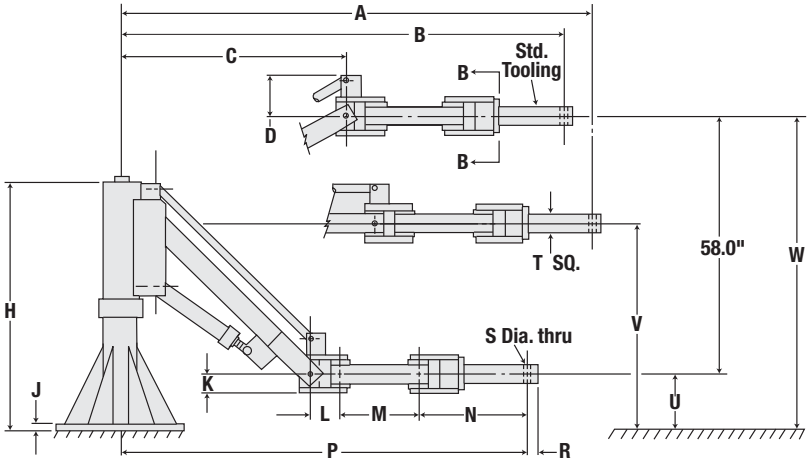
Relief valves are pre-set at the factory to prevent overloading of the cylinder arm assembly.

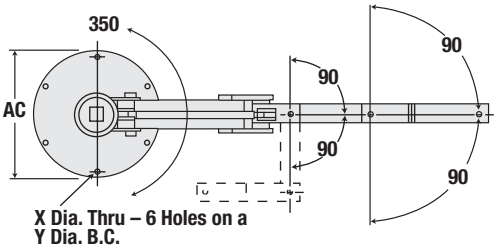
Dual Speed Control

Standard on the MPR-25 for maximum performance and control. Variable speed proportional control is standard on the MPR-75 and optional on the MPR-25.

Integrated Hydraulic Controls

All hydraulic controls are integrated into compact manifold packages to minimize space and system hydraulic connections. Controls are designed to provide positive load holding.





▼ DIMENSIONAL CHART

Load Cap. (lbs)	Model No.	Dimensions (in) A	B	C	D	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	AC
250	MPR-25	102.00	95.50	47.50	7.50	53.00	.75	3.50	5.00	19.00	24.00	88.00	1.62	.755/.753	3.00	12.50	46.50	70.50	.56	18.00	22.00
750	MPR-75	103.50	97.06	49.06	8.75	55.50	1.00	4.00	6.50	17.50	24.00	89.50	2.00	1.005/1.003	4.00	12.50	46.50	70.50	.84	26.00	28.00

milwaukee Cylinder

Power Units and Valves

Milwaukee Cylinder **Vertical Power Units** are powerful performers for your general hydraulic power unit needs. Available in either Gear Pump (3000 psi) or Vane Pump (2000 psi) designs, these units really deliver with standard features and options needed to do the job right. These units are fully featured to give you the performance and value that you need. Available options and directional valves help you to customize the power unit for your application.

STANDARD FEATURES

Vertical Steel Reservoir with Sight Glass and In-tank Filter

- Return filter / breather with indicator gauge
- Locating the pump inside of the reservoir reduces noise

TEFC Motor

- Quality motor with fan cooling for durable performance

Pump Mounted Manifold

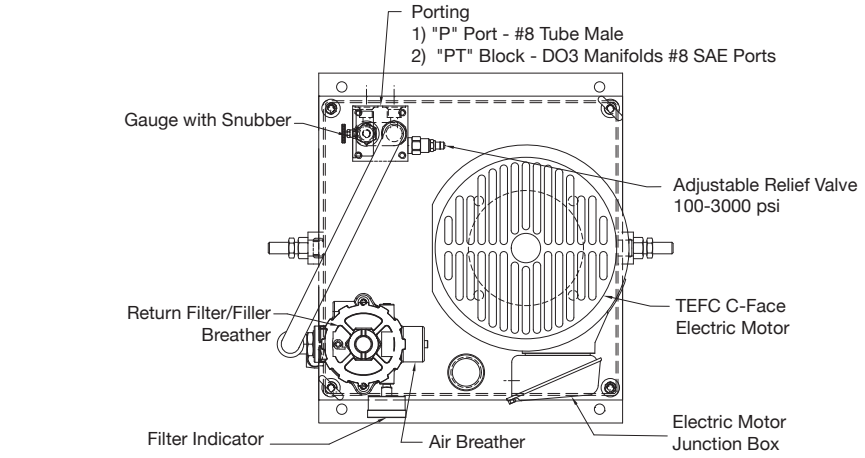
- P & T manifold for use with remote mounted valves
- D03 valve manifolds: 1, 2 or 4 station
- Manifold mounted gauge and snubber

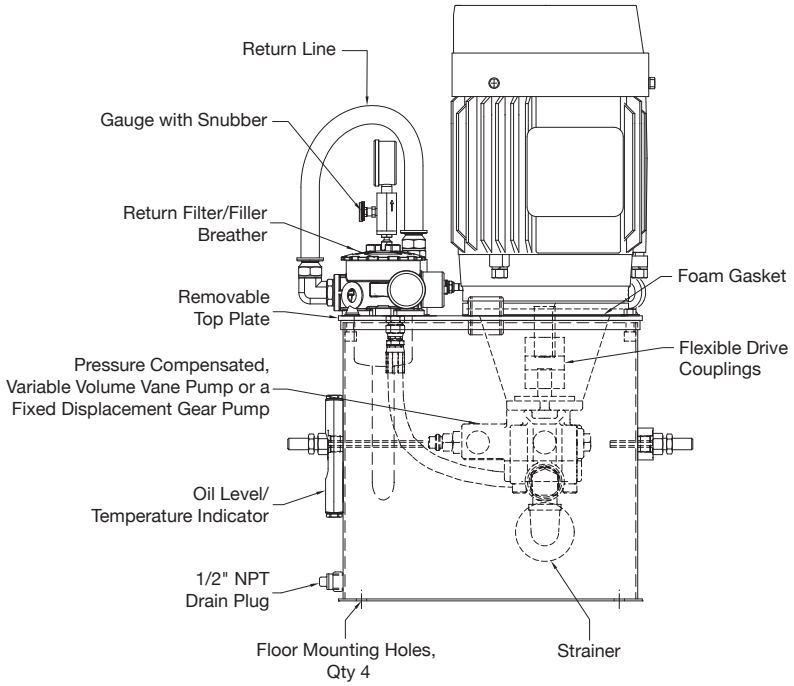
Pressure Control

- Gear Pump Units have a relief valve in the valve manifold
- Vane Pumps Units have tank mounted pressure and volume controls

POPULAR OPTIONS

- Low oil level switch with high temperature (140˚ F)
- Heat exchanger





GEAR PUMPS

Maximum Pressure:
3000 psi

Flow Rates:
.545-10.00 gpm

Reservoir Capacities:
10-30 gallons

Standard Motor:
TEFC 1725 rpm

VANE PUMPS

Maximum Pressure:
2000 psi

Flow Rates:
4-8 gpm

Reservoir Capacities:
20 gallons

Standard Motor:
TEFC 1725 rpm

Due to manufacturing processes and product improvements, please check website for the latest updates of products.

Max. Operating Pressure:
3000 psi

Flow Rates:
.545-10.00 gpm

Reservoir Capacities:
10-30 gallons

Standard Motor:
1725 rpm

For additional details on gear pump and vane pump designs see:.
Page 190

VERTICAL GEAR PUMP POWER UNITS

A **Vertical Gear Pump Power Unit** from *Milwaukee Cylinder* provides an effective solution for your production requirements. With a pressure range up to 3000 psi, these units serve as powerful partners for our H Series tie rod cylinders. Available flow ranges are .5 gpm, 1 gpm, 2 gpm, 5 gpm and 10 gpm. Other models with higher flow are available upon request (see Power Unit Matrix, page 166).

▼ SINGLE-STAGE GEAR PUMP POWER UNITS

* Model Number	HP	Electrical	GPM	Reservoir (gal)	Valve Manifold -Relief valve standard - #8 SAE porting standard
MCVEG-15-1-.5-10-PT	1.5	120/240/1/60	0.545	10	P & T
MCVEG-15-3-.5-10-PT	1.5	208/230/460/3/60	0.545	10	P & T
MCVEG-15-1-.5-10-D31	1.5	120/240/1/60	0.545	10	Single Station D03
MCVEG-15-3-.5-10-D31	1.5	208/230/460/3/60	0.545	10	Single Station D03
MCVEG-15-1-.5-10-D32	1.5	120/240/1/60	0.545	10	Two Station D03
MCVEG-15-3-.5-10-D32	1.5	208/230/460/3/60	0.545	10	Two Station D03
MCVEG-15-1-.5-10-D34	1.5	120/240/1/60	0.545	10	Four Station D03
MCVEG-15-3-.5-10-D34	1.5	208/230/460/3/60	0.545	10	Four Station D03
MCVEG-30-3-1-10-PT	3	208/230/460/3/60	1.14	10	P & T
MCVEG-30-3-1-10-D31	3	208/230/460/3/60	1.14	10	Single Station D03
MCVEG-30-3-1-10-D32	3	208/230/460/3/60	1.14	10	Two Station D03
MCVEG-30-3-1-10-D34	3	208/230/460/3/60	1.14	10	Four Station D03
MCVEG-50-3-2-10-PT	5	208/230/460/3/60	1.96	10	P & T
MCVEG-50-3-2-10-D31	5	208/230/460/3/60	1.96	10	Single Station D03
MCVEG-50-3-2-10-D32	5	208/230/460/3/60	1.96	10	Two Station D03
MCVEG-50-3-2-10-D34	5	208/230/460/3/60	1.96	10	Four Station D03
MCVEG-100-3-5-20-PT	10	208/230/460/3/60	5.01	20	P & T
MCVEG-100-3-5-20-D31	10	208/230/460/3/60	5.01	20	Single Station D03
MCVEG-100-3-5-20-D32	10	208/230/460/3/60	5.01	20	Two Station D03
MCVEG-100-3-5-20-D34	10	208/230/460/3/60	5.01	20	Four Station D03
MCVEG-200-3-10-30-PT	20	208/230/460/3/60	10.02	20	P & T
MCVEG-200-3-10-30-D31	20	208/230/460/3/60	10.02	20	Single Station D03
MCVEG-200-3-10-30-D32	20	208/230/460/3/60	10.02	20	Two Station D03
MCVEG-200-3-10-30-D34	20	208/230/460/3/60	10.02	20	Four Station D03

*Please refer to Power Unit Matrix, page 166, for non catalog configurations.
Available Options (add option code to the end of the power unit model number):
HEG Heat Exchanger for Gear Style Pump
LOL Low Oil Level Switch with High Temperature (140˚ F)
MS Motor Starter (specify voltage)

VERTICAL VANE PUMP POWER UNITS

A Vertical Vane Pump Power Unit from *Milwaukee Cylinder* provides a flexible solution for your hydraulic power unit needs.

When the system is at pressure and the volume requirement falls to zero, the pump automatically adjusts the output volume –

- Less heat
- Less wear and tear on the pump

Set Your Pressure!

- Pressure Compensated Pump
- Pump can be adjusted to provide the pressure that your system requires
  - Externally accessible user adjustable pressure setting
  - Maximum pressure 2000 psi

Set Your Flow!

- Variable Displacement Pump
- Pump can be adjusted to provide the flow that your system requires
  - Externally accessible user adjustable flow volume setting

Max. Operating Pressure:
2000 psi

Flow Rates:
4-8 gpm

Reservoir Capacities:
20 gallons

Standard Motor:
1725 rpm

For additional details on gear pump and vane pump designs see: Page 190

▼ SINGLE-STAGE VANE PUMP POWER UNITS

* Model Number	HP	Electrical	GPM	Reservoir (gal)	Valve Manifold - Relief valve standard - #8 SAE porting standard
MCVEV-50-3-4-20-PT	5	208/230/460/3/60	4	20	P & T
MCVEV-50-3-4-20-D31	5	208/230/460/3/60	4	20	Single Station D03
MCVEV-50-3-4-20-D32	5	208/230/460/3/60	4	20	Two Station D03
MCVEV-50-3-4-20-D33	5	208/230/460/3/60	4	20	Four Station D03
MCVEV-75-3-6-20-PT	7.5	208/230/460/3/60	6	20	P & T
MCVEV-75-3-6-20-D31	7.5	208/230/460/3/60	6	20	Single Station D03
MCVEV-75-3-6-20-D32	7.5	208/230/460/3/60	6	20	Two Station D03
MCVEV-75-3-6-20-D34	7.5	208/230/460/3/60	6	20	Four Station D03
MCVEV-100-3-8-20-PT	10	208/230/460/3/60	8	20	P & T
MCVEV-100-3-8-20-D31	10	208/230/460/3/60	8	20	Single Station D03
MCVEV-100-3-8-20-D32	10	208/230/460/3/60	8	20	Two Station D03
MCVEV-100-3-8-20-D34	10	208/230/460/3/60	8	20	Four Station D03

*Please refer to Power Unit Matrix, page 166, for non catalog configurations.
Available Options (add option code to the end of the power unit model number):
HEV Heat Exchanger for Vane Style Pump
LOL Low Oil Level Switch with High Temperature (140˚ F)
MS Motor Starter (specify voltage)

GEAR PUMP

Max. Operating Pressure:
3000 psi

Flow Rates:
.545-10.00 gpm

Reservoir Capacities:
10-30 gallons

Standard Motor:
1725 rpm

VANE PUMP

Max. Operating Pressure:
2000 psi

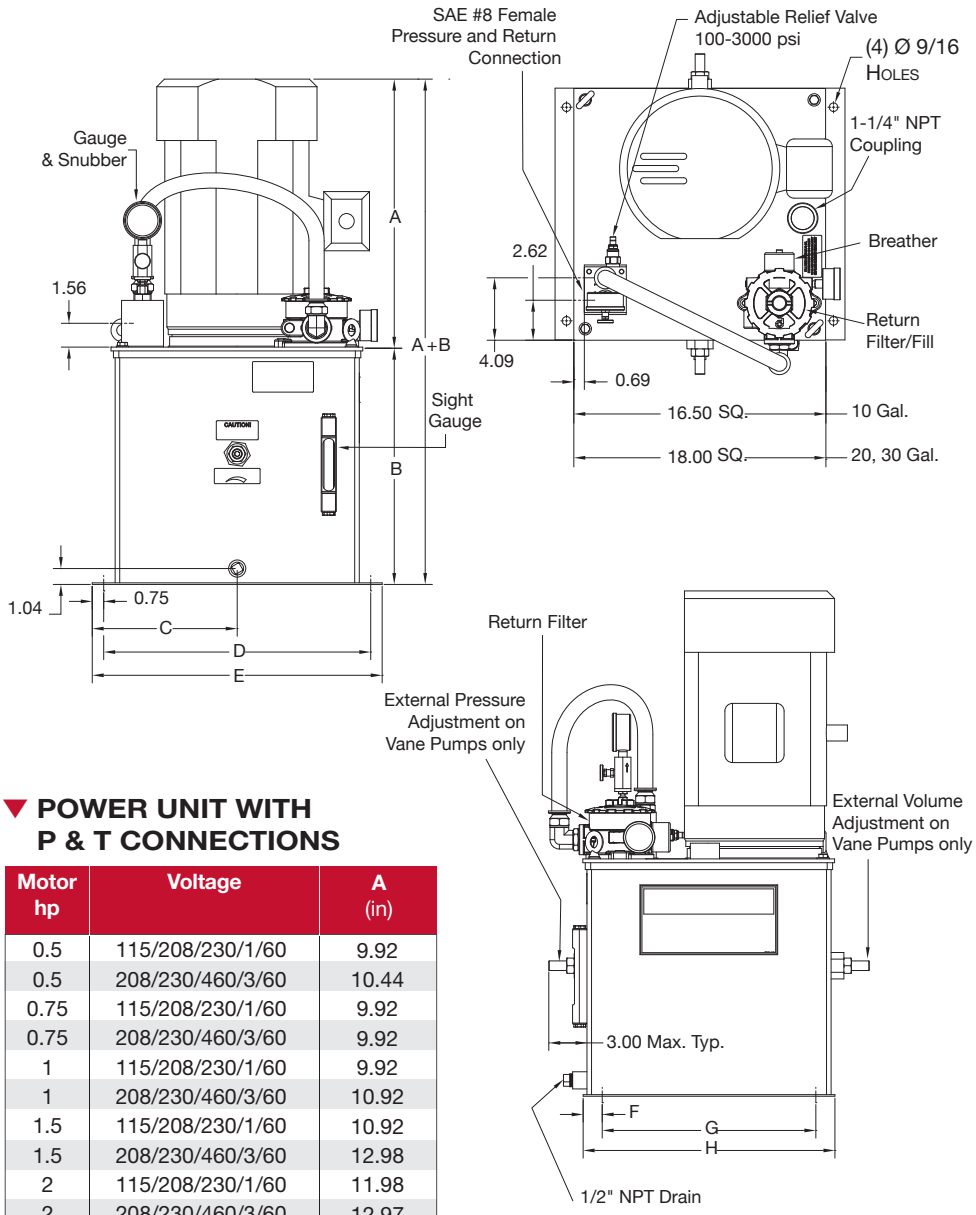
Flow Rates:
4-8 gpm

Reservoir Capacities:
20 gallons

Standard Motor:
1725 rpm

POWER UNIT WITH P & T MANIFOLDS

For use with remote mounted valves.



POWER UNIT WITH P & T CONNECTIONS

Motor hp	Voltage	A (in)
0.5	115/208/230/1/60	9.92
0.5	208/230/460/3/60	10.44
0.75	115/208/230/1/60	9.92
0.75	208/230/460/3/60	9.92
1	115/208/230/1/60	9.92
1	208/230/460/3/60	10.92
1.5	115/208/230/1/60	10.92
1.5	208/230/460/3/60	12.98
2	115/208/230/1/60	11.98
2	208/230/460/3/60	12.97
3	115/208/230/1/60	13.37
3	208/230/460/3/60	14.43
5	208/230/460/3/60	15.06
7.5	208/230/460/3/60	17.56
10	208/230/460/3/60	17.56
15	230/460/3/60	23.03
20	230/460/3/60	23.03

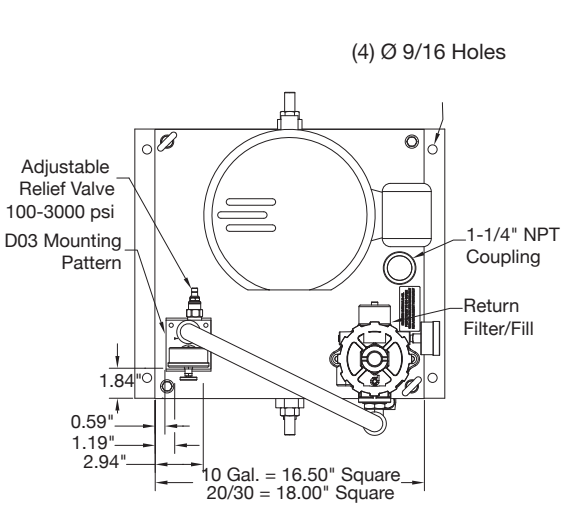
POWER UNIT RESERVOIRS

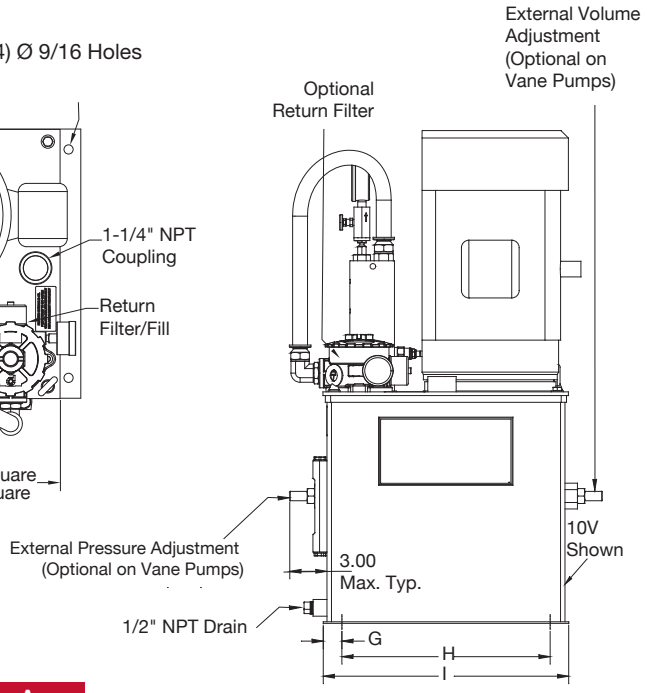
Reservoir Size (gal)	B (in)	C (in)	D (in)	E (in)	F (in)	G (in)	H (in)
10	15.44	9.50	17.50	19.00	1.25	14.00	16.50
20	18.44	10.25	19.00	20.50	1.50	15.00	18.00
30	26.44	10.25	19.00	20.50	1.50	15.00	18.00

Due to manufacturing processes and product improvements, please check website for the latest updates of products.

POWER UNIT WITH D03 MANIFOLD

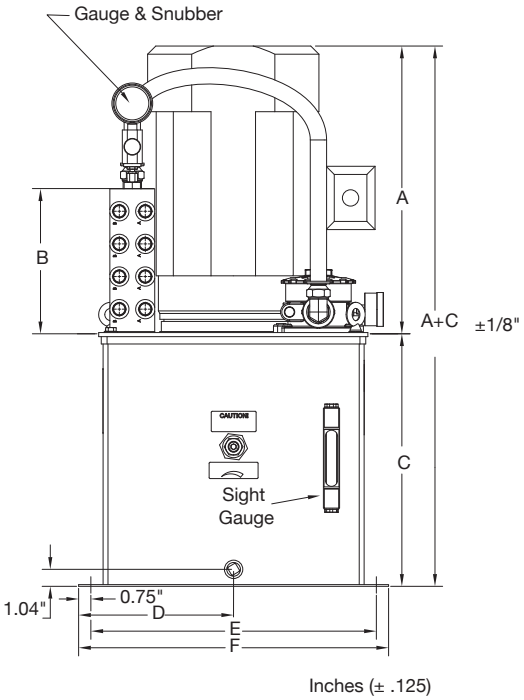
For use with 1, 2, or 4 station.





POWER UNIT WITH P & T CONNECTIONS

Motor hp	Voltage	A (in)
0.5	115/208/230/1/60	9.92
0.5	208/230/460/3/60	10.44
0.75	115/208/230/1/60	9.92
0.75	208/230/460/3/60	9.92
1	115/208/230/1/60	9.92
1	208/230/460/3/60	10.92
1.5	115/208/230/1/60	10.92
1.5	208/230/460/3/60	12.98
2	115/208/230/1/60	11.98
2	208/230/460/3/60	12.97
3	115/208/230/1/60	13.37
3	208/230/460/3/60	14.43
5	208/230/460/3/60	15.06
7.5	208/230/460/3/60	17.56
10	208/230/460/3/60	17.56
15	230/460/3/60	23.03
20	230/460/3/60	23.03



Inches (± .125)

D03 MANIFOLD

No. of Stations	B (in)
1	10.25
2	12.38
4	16.63

POWER UNIT RESERVOIRS

Reservoir Size (gal)	C (in)	D (in)	E (in)	F (in)	G (in)	H (in)	I (in)
10	15.44	9.50	17.50	19.00	1.25	14.00	16.50
20	18.44	10.25	19.00	20.50	1.50	15.00	18.00
30	26.44	10.25	19.00	20.50	1.50	15.00	18.00

Due to manufacturing processes and product improvements, please check website for the latest updates of products.
www.milwaukeecylinder.com

GEAR PUMP

Max. Operating Pressure:
3000 psi

Flow Rates:
.545-10.00 gpm

Reservoir Capacities:
10-30 gallons

Standard Motor:
1725 rpm

VANE PUMP

Max. Operating Pressure:
2000 psi

Flow Rates:
4-8 gpm

Reservoir Capacities:
20 gallons

Standard Motor:
1725 rpm

▼ CONFIGURE YOUR POWER UNIT

MCV	E	V	-	75	-	3	-	4	-	20	-	PT	-	-
Reservoir Style	Driver	Pump Type		Motor hp		Motor Phase		Flow Rate (nominal) gpm		Reservoir Size (gal)		Valve Manifold Type		Options

RESERVOIR STYLE	DRIVER	PUMP TYPE	MOTOR HP	MOTOR PHASE	FLOW RATE (NOMINAL) GPM	RESERVOIR SIZE (GAL)	VALVE MANIFOLD TYPE	OPTIONS
MCV = Vertical **MCH** = NFPA/JIC (Horizontal) **MCLP** = Low Profile **MCL** = L-shaped	**E** = Electric **D** = Diesel **G** = Gas	**G** = Gear **V** = Vane **P** = Piston	**05** = .5 **075** = .75 **10** = 1.0 **15** = 1.5 **20** = 2.0 **30** = 3.0 **50** = 5.0 **75** = 7.5 **100** = 10 **150** = 15 **200** = 20 **250** = 25 **300** = 30 **400** = 40 **500** = 50 **600** = 60 **750** = 75 **1000** = 100 **1250** = 125	**1** = Single (.5-3.0 hp) **3** = Three	**.5** = .545 **0.75** = .769 **1**= 1.14 **1.5** = 1.59 **2** = 1.96 **2.25** = 2.28 **3** = 2.87 **3.5** = 3.44 **3.75** = 3.78 •**4** = 4.0 **5** = 5.01 •**6** = 6.0 **7** = 6.83 •**8** = 8.0 **8.5** = 8.65 **10** = 10.0 **12** = 11.84	**03** **05** **10** **20** **30** **35**◆ **40** **50** **60** **75** **100** **125**	**PT** = Pressure and Tank Connections **D31** = D03 Single Station **D32** = D03 Two Station **D34** = D03 Four Station **D51** = D05 Single Station **D52** = D05 Two Station **D54** = D05 Four Station	**HEG** = Heat Exchanger for Gear Stye Pump **HEV** = Heat Exchanger for Vane Stye Pump **LOL** = Low Oil Level Switch with High Temp **MS** = (Voltage) – Motor Starter (specify voltage)

* Not all configuration combinations are possible with every reservoir style. Other configurations also available. Please consult factory for assistance.
• Available on vane pumps only.
◆ Avaliable on gear pumps only.

Calculating hp Requirement

$$hp = \frac{\text{Pressure (psi) x Flow (gpm)}}{1457}$$

Recommended Reservoir Size

Gal = Flow rate (gal) X 3

Example:

$$hp = \frac{2500 \text{ (psi) x } 10 \text{ (gpm)}}{1457}$$

Example:

10 gpm X 3 = 30 gallon reservoir

$$hp = \frac{2500}{1457}$$

Motor size recommendation:
20 hp

hp = 17.16

Contact *Milwaukee Cylinder* for a quote on the power unit configuration that meets your application.


Vertical


NFPA/JIC Style


Low Profile


L-Shaped

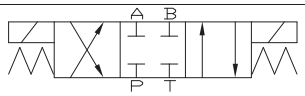
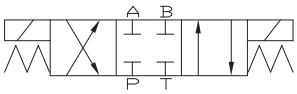
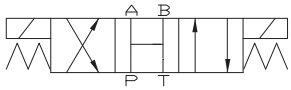
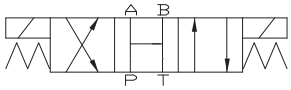
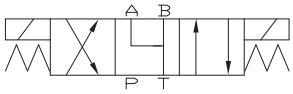
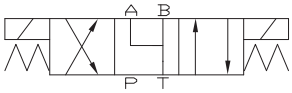
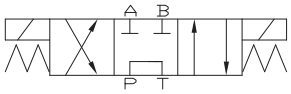
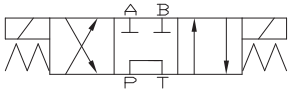
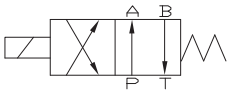
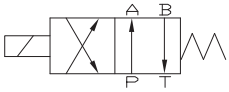
D03 VALVES

For a complete Power Unit solution, use *Milwaukee Cylinder* D03 spool valves and accessory valves. Choose the valve style required for each circuit and add the accessory valves required to control flow rate, circuit pressure or hold pressure in a circuit.

- Mounting Pattern: **D03**
- Solenoid Connection: **DIN**

For additional details on D03 and D05 valves see: Page 191

D03 VALVES

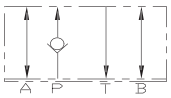
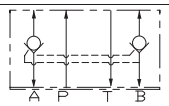
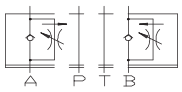
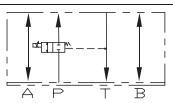
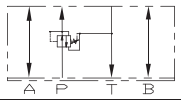
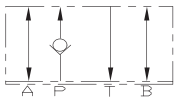
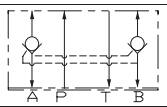
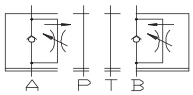
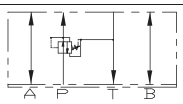
MODEL NUMBER	MAXIMUM PRESSURE	FUNCTION	SCHEMATIC SYMBOL	ELECTRICAL REQUIREMENTS
MCSV3-43C-24	5000	4 Way, 3 Position, Closed Center		24 VDC
MCSV3-43C-120	5000	4 Way, 3 Position, Closed Center		120 VAC
MCSV3-43O-24	5000	4 Way, 3 Position, Open Center		24 VDC
MCSV3-43O-120	5000	4 Way, 3 Position, Open Center		120 VAC
MCSV3-43F-24	5000	4 Way, 3 Position, Float Center		24 VDC
MCSV3-43F-120	5000	4 Way, 3 Position, Float Center		120 VAC
MCSV3-43T-24	5000	4 Way, 3 Position, Tandem Center		24 VDC
MCSV3-43T-120	5000	4 Way, 3 Position, Tandem Center		120 VAC
MCSV3-42-24	5000	4 Way, 2 Position		24 VDC
MCSV3-42-120	5000	4 Way, 2 Position		120 VAC

D03 ACCESSORY VALVES

Add accessory valves to your valve stack to:

- Control flow
- Reduce pressure in a valve circuit
- Lock pressure in a valve circuit
- Aluminum body rated to 3000 psi maximum
- Ductile body rated to 5000 psi maximum

D03 ACCESSORY VALVES

MODEL NUMBER	MAXIMUM PRESSURE	FUNCTION	SCHEMATIC SYMBOL
ALUMINUM			
MCCV3-P-A	3000	Pressure Port Check Valve	
MCCV3-AB-A	3000	Dual Pilot Operated Check Valve	
MCFC3-AB-A	3000	Dual Flow Control Valve (A & B ports) Pressure Compensated with Reverse Check Valve	
MCFCP3-P-A	3000	Proportional Flow Control (solenoid operated, P port)	
MCRRV3-P4003-A	3000	Reducing/Relieving Valve on Pressure Port (400-3000 psi)	
DUCTILE			
MCCV3-P-D	5000	Pressure Port Check Valve	
MCCV3-AB-D	5000	Dual Pilot Operated Check Valve	
MCFC3-AB-D	5000	Dual Flow Control Valve (A & B ports) Pressure Compensated with Reverse Check Valve	
MCRRV3-P4003-D	5000	Reducing/Relieving Valve on Pressure Port (400-3000 psi)	

D03 MOUNTING KITS AND MANIFOLDS

MODEL NUMBER	DESCRIPTION
MCSV3-BK100	Valve Mounting Kit, 1.00"
MCSV3-BK250	Valve Mounting Kit, 2.50"
MCSV3-BK300	Valve Mounting Kit, 3.00"
MCSV3-BK4125	Valve Mounting Kit, 4.125"
MCSV3-BK450	Valve Mounting Kit, 4.50"
MCSV3-BK575	Valve Mounting Kit, 5.75"
ALUMINUM MANIFOLD, 3000 PSI MAXIMUM	
MCVM3-01A	D03 Parallel Valve Manifold, One Station, Aluminum, SAE ports (#10 P & T, #8 A & B), 3000 psi Max.
MCVM3-02A	D03 Parallel Valve Manifold, Two Station, Aluminum, SAE ports (#10 P & T, #8 A & B), 3000 psi Max.
MCVM3-03A	D03 Parallel Valve Manifold, Three Station, Aluminum, SAE ports (#10 P & T, #8 A & B), 3000 psi Max.
MCVM3-04A	D03 Parallel Valve Manifold, Four Station, Aluminum, SAE ports (#10 P & T, #8 A & B), 3000 psi Max.
MCVM3-05A	D03 Parallel Valve Manifold, Five Station, Aluminum, SAE ports (#10 P & T, #8 A & B), 3000 psi Max.
MCVM3-06A	D03 Parallel Valve Manifold, Six Station, Aluminum, SAE ports (#10 P & T, #8 A & B), 3000 psi Max.
MCVM3-COPA	D03 Cross-over Cover Plate, Aluminum (P to A, T to B)
MCVM3-CPA	D03 Parallel Maniold Cover Plate, Aluminum, 3000 psi Max.
DUCTILE MANIFOLD, 5000 PSI MAXIMUM	
MCVM3-01D	D03 Parallel Valve Manifold, One Station, Ductile, SAE ports (#10 P & T, #8 A & B), 5000 psi Max.
MCVM3-02D	D03 Parallel Valve Manifold, Two Station, Ductile, SAE ports (#10 P & T, #8 A & B), 5000 psi Max.
MCVM3-03D	D03 Parallel Valve Manifold, Three Station, Ductile, SAE ports (#10 P & T, #8 A & B), 5000 psi Max.
MCVM3-04D	D03 Parallel Valve Manifold, Four Station, Ductile, SAE ports (#10 P & T, #8 A & B), 5000 psi Max.
MCVM3-05D	D03 Parallel Valve Manifold, Five Station, Ductile, SAE ports (#10 P & T, #8 A & B), 5000 psi Max.
MCVM3-06D	D03 Parallel Valve Manifold, Six Station, Ductile, SAE ports (#10 P & T, #8 A & B), 5000 psi Max.
MCVM3-CPD	D03 Parallel Manifold Cover Plate, Ductile, 5000 psi Max.

D03 VALVE MOUNTING KITS

Select the proper valve mounting kit from the chart below. Combine the directional and sandwich valves to determine the required kit. Using these kits simplifies the installation of the valve stack components onto the manifold, whether pump or remote mounted.

▼ D03 VALVE MOUNTING KIT SELECTION CHART

D03 DIRECTIONAL VALVES AND ACCESSORY VALVES

RECOMMENDED MOUNTING KIT	MCCV3-P-A-P PORT CHECK	MCCV3-AB-D DUAL P.O. CHECK	MCFC3-AB-A DUAL FLOW CONTROL	MCFCP3-P-A PROPORTIONAL FLOW CONTROL	MCRRV3-P1530-A REDUCING/ RELIEVING VALVE	MCRRV3-P0415-A REDUCING/ RELIEVING VALVE
MCSV3-BK100*						
MCSV3-BK250	■					
MCSV3-BK250		■				
MCSV3-BK250			■			
MCSV3-BK317				■		
MCSV3-BK250					■	
MCSV3-BK250						■
MCSV3-BK4125	■		■			
MCSV3-BK575	■		■		■	
MCSV3-BK575	■		■			■
MCSV3-BK460	■			■		
MCSV3-BK4125		■	■			
MCSV3-BK575		■	■		■	
MCSV3-BK575		■	■			■
MCSV3-BK460		■		■		
MCSV3-BK4125			■		■	
MCSV3-BK4125			■			■
MCSV3-BK460				■	■	
MCSV3-BK460				■		■

EXAMPLE: D03 Spool Valve with Dual P.O. Check (MCCV3-AB-D) and Dual Flow Control (MCFC3-AB-A)= MCSV3-BK4125 Mounting Kit

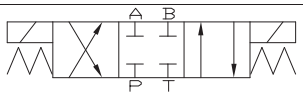
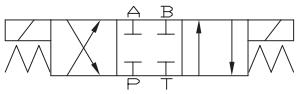
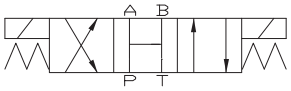
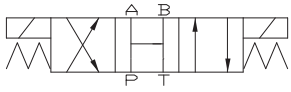
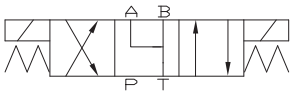
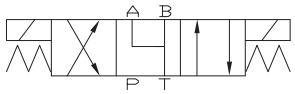
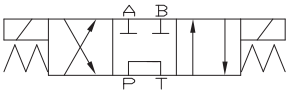
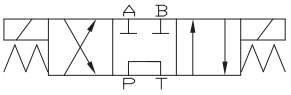
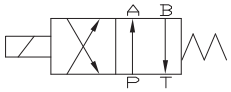
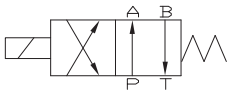
* Mounting kit included with D03 directional valve.

D05 VALVES

For a complete Power Unit solution for higher flow systems, use *Milwaukee Cylinder* D05 spool valves and accessory valves. Choose the valve style required for each circuit and add the accessory valves required to control flow rate, circuit pressure or hold pressure in a circuit.

- Mounting Pattern: **D05**
- Solenoid Connection: **DIN**

For additional details on D03 and D05 valves see: Page 191

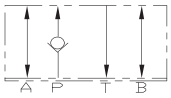
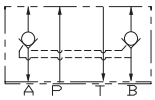
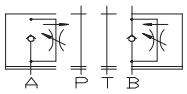
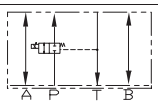
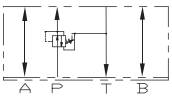
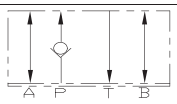
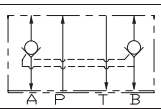
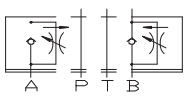
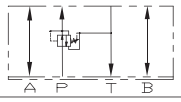
D05 VALVES				
MODEL NUMBER	MAXIMUM PRESSURE	FUNCTION	SCHEMATIC SYMBOL	ELECTRICAL REQUIREMENTS
MCSV5-43C-24	4600	4 Way, 3 Position, Closed Center		24 VDC
MCSV5-43C-120	4600	4 Way, 3 Position, Closed Center		120 VAC
MCSV5-43O-24	4600	4 Way, 3 Position, Open Center		24 VDC
MCSV5-43O-120	4600	4 Way, 3 Position, Open Center		120 VAC
MCSV5-43F-24	4600	4 Way, 3 Position, Float Center		24 VDC
MCSV5-43F-120	4600	4 Way, 3 Position, Float Center		120 VAC
MCSV5-43T-24	4600	4 Way, 3 Position, Tandem Center		24 VDC
MCSV5-43T-120	4600	4 Way, 3 Position, Tandem Center		120 VAC
MCSV5-42-24	4600	4 Way, 2 Position		24 VDC
MCSV5-42-120	4600	4 Way, 2 Position		120 VAC

D05 ACCESSORY VALVES

Add accessory valves to your valve stack to:

- Control flow
- Reduce pressure in a valve circuit
- Lock pressure in a valve circuit
- Aluminum body rated to 3000 psi maximum
- Ductile body rated to 5000 psi maximum

D05 ACCESSORY VALVES

MODEL NUMBER	MOUNT	MAX PRESSURE	FUNCTION	SCHEMATIC SYMBOL
ALUMINUM				
MCCV5-P-A	D05	3000	Pressure Port Check Valve	
MCCV5-AB-A	D05	3000	Dual Pilot Operated Check Valve	
MCFC5-AB-A	D05	3000	Dual Flow Control Valve (A & B ports) Pressure Compensated with Reverse Check Valve	
MCFCP5-P-A	D05	3000	Proportional Flow Control (solenoid operated, P port)	
MCRRV5-P1753-A	D05	3000	Reducing/Relieving Valve on Pressure Port (175-3000 psi)	
DUCTILE				
MCCV5-P-D	D05	5000	Pressure Port Check Valve	
MCCV5-AB-D	D05	5000	Dual Pilot Operated Check Valve	
MCFC5-AB-D	D05	5000	Dual Flow Control Valve (A & B ports) Pressure Compensated with Reverse Check Valve	
MCRRV5-P1753-D	D05	5000	Reducing/Relieving Valve on Pressure Port (175-3000 psi)	

D05 MOUNTING KITS & MANIFOLDS

When using accessory valves with your *Milwaukee Cylinder* D05 directional valves, use the proper mounting kits for each valve stack. For remote mounted valve applications at 3000 psi maximum pressure, choose an aluminum manifold with the number of valve stations required. For pressures up to 5000 psi maximum pressure, use the ductile iron manifolds.

D05 MOUNTING KITS & MANIFOLDS

MODEL NUMBER	DESCRIPTION
MCSV5-BK175	Valve Mounting Kit, 1.75"
MCSV5-BK4.00	Valve Mounting Kit, 4.00"
MCSV5-BK6125	Valve Mounting Kit, 6.125"
MCSV5-BK825	Valve Mounting Kit, 8.25"
ALUMINUM MANIFOLD, 3000 PSI MAXIMUM	
MCVM5-01A	D05 Parallel Valve Manifold, One Station, Aluminum, SAE ports (#12 P & T, #8 A & B), 3000 psi Max.
MCVM5-02A	D05 Parallel Valve Manifold, Two Station, Aluminum, SAE ports (#12 P & T, #8 A & B), 3000 psi Max.
MCVM5-03A	D05 Parallel Valve Manifold, Three Station, Aluminum, SAE ports (#12 P & T, #8 A & B), 3000 psi Max.
MCVM5-04A	D05 Parallel Valve Manifold, Four Station, Aluminum, SAE ports (#12 P & T, #8 A & B), 3000 psi Max.
MCVM5-05A	D05 Parallel Valve Manifold, Five Station, Aluminum, SAE ports (#12 P & T, #8 A & B), 3000 psi Max.
MCVM5-06A	D05 Parallel Valve Manifold, Six Station, Aluminum, SAE ports (#12 P & T, #8 A & B), 3000 psi Max.
MCVM5-COPA	D05 Cross-over Cover Plate, Aluminum (P to A, T to B)
MCVM5-CPA	D05 Parallel Manifold Cover Plate, Aluminum, 3000 psi Max.
DUCTILE MANIFOLD, 5000 PSI MAXIMUM	
MCVM5-01D	D05 Parallel Valve Manifold, One Station, Ductile Iron, SAE ports (#12 P & T, #8 A & B), 5000 psi Max.
MCVM5-02D	D05 Parallel Valve Manifold, Two Station, Ductile Iron, SAE ports (#12 P & T, #8 A & B), 5000 psi Max.
MCVM5-03D	D05 Parallel Valve Manifold, Three Station, Ductile Iron, SAE ports (#12 P & T, #8 A & B), 5000 psi Max.
MCVM5-04D	D05 Parallel Valve Manifold, Four Station, Ductile Iron, SAE ports (#12 P & T, #8 A & B), 5000 psi Max.
MCVM5-05D	D05 Parallel Valve Manifold, Five Station, Ductile Iron, SAE ports (#12 P & T, #8 A & B), 5000 psi Max.
MCVM5-06D	D05 Parallel Valve Manifold, Six Station, Ductile Iron, SAE ports (#12 P & T, #8 A & B), 5000 psi Max.
MCVM5-CPD	D05 Parallel Manifold Cover Plate, Ductile, 5000 psi Max.

D05 VALVE MOUNTING KITS

Select the proper valve mounting stud kit from the chart below. Combine the directional and sandwich valves to determine the required kit. Using these kits simplifies the installation of the valve stack components onto the manifold, whether pump or remote mounted.

▼ D05 Valve Mounting Kit Selection Chart

D05 DIRECTIONAL VALVES AND ACCESSORY VALVES						
RECOMMENDED MOUNTING KIT	MCCV5-P-A-P PORT CHECK	MCCV5-AB-D DUAL P.O. CHECK	MCFC5-AB-A DUAL FLOW CONTROL	MCFCP5-P-A PROPORTIONAL FLOW CONTROL	MCRRV5-P1530-A REDUCING/RELIEVING VALVE	MCRRV5-P0415-A REDUCING/RELIEVING VALVE
MCSV5-BK175						
MCSV5-BK400	■					
MCSV5-BK400		■				
MCSV5-BK400			■			
MCSV5-BK400				■		
MCSV5-BK400					■	
MCSV5-BK400						■
MCSV5-BK6125	■		■			
MCSV5-BK825	■		■		■	
MCSV5-BK825	■		■			■
MCSV5-BK6125		■	■			
MCSV5-BK825		■	■		■	
MCSV5-BK825		■	■			■
MCSV5-BK6125		■		■		
MCSV5-BK825		■		■	■	
MCSV5-BK825		■		■		■
MCSV5-BK6125			■		■	
MCSV5-BK6125			■			■
MCSV5-BK6125				■	■	
MCSV5-BK6125				■		■

EXAMPLE: D03 Spool Valve with Dual P.O. Check (MCCV5-AB-D) and Dual Flow Control (MCFC5-AB-A)= MCSV5-BK6125 Mounting Kit

* Mounting kit included with D05 directional valve.

▼ CONFIGURE YOUR VALVE*

MCSV	3	-	43		C	-	24
Valve Type Series	Size		Function	Adjustment Range (for MCRRV only)	Center Function or Body Material		Solenoid Voltage

VALVE TYPE	SERIES	SIZE	FUNCTION	ADJUSTMENT RANGE	CENTER FUNCTION OR BODY MATERIAL	SOLENOID VOLTAGE
Directional Valve	**MCSV** = Solenoid Valve **MCMV** = Manual Valve **MCAV** = Air Pilot Operated	**3** = D03 **5** = D05	**43** = 4 Way/3 Pos. **42** = 4 Way/2 Pos.	**N/A**	**Center Function** **C** = Closed **O** = Open **F** = Float **T** = Tandem	**24** = 24 VDC Solenoid **120** = 120 VAC Solenoid **24D** = 24 VDC Detented Solenoid **120D** = 120 VAC Detented Solenoid **SC** = Spring to Center (Manual Valve or Air PO) **DSC** = Detented/Spring to Center (Manual Valve or Air PO)
Check Valve	**MCCV** = Check Valve	**3** = D03 **5** = D05	**P** = P Port (inlet) **AB** = A & B Ports (dual PO)	**N/A**	**Body Material** **A** = Aluminum (3000 psi max) **D** = Ductile Iron (5000 psi max)	**N/A**
Flow Control Valve	**MCFC** = Flow Control **MCFCP** = Flow Control Proportional	**3** = D03 **5** = D05	**P** = P Port (inlet) **AB** = A & B Ports	**N/A**	**A** = Aluminum **D** = Ductile Iron (not available with MCFCP)	**N/A** **24** = 24 VDC Solenoid
Reducing / Relieving Valve	**MCRRV** = Reducing / Relieving	**3** = D03 **5** = D05	**P** = P Port	4003 = 400-3000 psi 1753 = 175-3000 psi	**A** = Aluminum (3000 psi max) **D** = Ductile Iron (5000 psi max)	**N/A**

* For additional valve needs please contact the factory.

▼ CONFIGURE YOUR MANIFOLD (Remote Mount)

MCVM	3	01	-	A
Manifold Series	Size	Function		Body Material

SERIES	SIZE	FUNCTION	BODY MATERIAL
MCVM = Valve Manifold	**3** - D03 **5** - D05	**01** = Single Station **02** = Two Station **03** = Three Station **04** = Four Station **05** = Five Station **06** = Six Station	**A** - Aluminum **D** - Ductile Iron

MILWAUKEE CYLINDER POWER UNIT WORKSHEET

(PLEASE REFER TO MATRIX PAGES AS AN EXAMPLE OF HOW THE UNIT IS BUILT)

COMPLETE THE FOLLOWING INFORMATION TO CHOOSE THE RIGHT UNIT

Date:	Project Title:
Requestor:	Customer Drawing #:
Distributor:	User:
Distributor Contact:	User Contact:
Phone #:	User Phone#:
Email:	User Email:

CHOOSE YOUR POWER UNIT

BASIC POWER UNIT SPECIFICATIONS

Reservoir Style: Pressure: Load:

Driver: Fluid to be Used:

Pump Type: Space Dimensions:

Motor hp:

Motor Electrical: Volts: Phase: Hz:

OPTIONS OR SPECIAL FEATURES:

Flow Rate (nominal) GPM:

Reservoir Size (gal):

Valve Manifold Type (if pump mount):

Email: sales@milwaukeecylinder.com Fax: 414-769-0157

CHOOSE YOUR VALVE STACKS

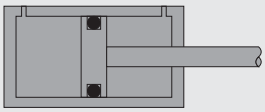
	VALVE STACK #	MC MODEL NUMBER	FUNCTION
	Manifold Model # (if remote mount):		
VALVE STACK #1	Directional Valve:		
	Module #1:		
	Module #2:		
	Module #3:		
	Bolt Kit:		
VALVE STACK #2	Directional Valve:		
	Module #1:		
	Module #2:		
	Module #3:		
	Bolt Kit:		
VALVE STACK #3	Directional Valve:		
	Module #1:		
	Module #2:		
	Module #3:		
	Bolt Kit:		
VALVE STACK #4	Directional Valve:		
	Module #1:		
	Module #2:		
	Module #3:		
	Bolt Kit:		

milwaukee Cylinder

Design Engineering Guide

BASIC CYLINDER OPERATING PRINCIPLES

Cylinders are used to convert fluid power into mechanical motion. A cylinder consists of a cylindrical body, closures at each end, movable piston, and a rod attached to the piston.



When fluid pressure acts on the piston, the pressure is transmitted to the piston rod, resulting in linear motion. The piston rod thrust force developed by the fluid pressure acting on the piston is easily determined by multiplying the line pressure by the piston area.

FORCE = PRESSURE x AREA or F = PA

EXAMPLE: Find the thrust force of a 4" diameter piston operating with a line pressure of 100 psi.

The piston area has to be determined first to solve this problem. The area of a circular surface is πr^2, where "r" is the radius. In the case of a 4" diameter piston, the area equals 12.57 square inches (πr^2). Since a pressure of 100 psi acts on each square inch, the total thrust force will be 100 x 12.57 or 1257 lbs.

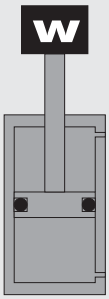
When calculating the pull force of a cylinder, the area covered by the piston rod must be subtracted from the total area of the piston. The pressure does not act on the area covered by the piston rod.

Tables are provided on pages 182-183 (as well as within each Series' Section) to save mathematical calculations for determining thrust force, pull force, and cylinder speed. See page 31, Series H; page 67, Series LH; and page 97, Series A and Series MN.

TYPES OF CYLINDERS

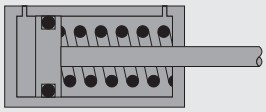
Standard cylinders have been designed to meet the wide range of applications. The following types of cylinders provide an overview of what is available.

■ SINGLE-ACTING CYLINDER



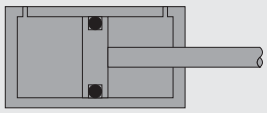
The single-acting cylinder is pressurized at one end only, with the opposite end vented to atmosphere through a breather filter (air cylinder) or vented to a reservoir (hydraulic cylinder). The return stroke of the cylinder is accomplished by some external means.

■ SPRING RETURN CYLINDER



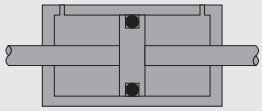
The spring return cylinder is normally considered a single acting cylinder. The operation of this type of cylinder is the same as a single acting cylinder, except that a spring is used to accomplish the return stroke.

■ DOUBLE-ACTING CYLINDER



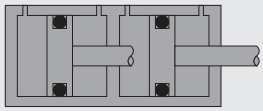
The most familiar double acting cylinder is the single rod end. This type of cylinder provides power in both directions, with a pressure port at either end. Single rod end cylinders exert greater forces when extending than when retracting, since the piston area on the blind end is larger than the piston area on the rod end (due to the area covered by the piston rod).

■ DOUBLE ROD END CYLINDER



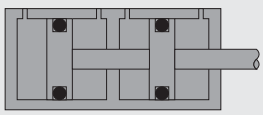
The double rod end cylinder is used when it is necessary for the cylinder to exert equal force and operate at equal speed in both directions. It also can be used to operate limit valves or switches.

■ POSITIONAL OR DUPLEX CYLINDER



Duplex cylinders are similar to tandem cylinders in that both are cylinders connected in line, but the pistons of a duplex cylinder are not physically connected; the rod of one cylinder protrudes into the non-rod end of the second, and so forth. A duplex cylinder may be more than two in-line cylinders and the stroke lengths of the individual cylinders may vary. This results in a component that can achieve a number of different fixed stroke lengths depending on which of the cylinders and on which end the cylinders are pressurized.

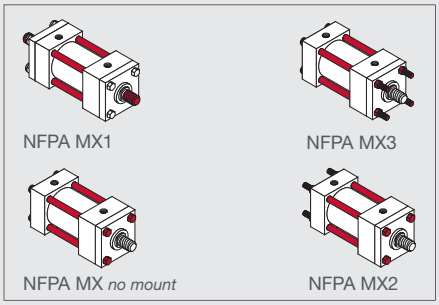
■ TANDEM CYLINDER



A tandem cylinder consists of two cylinders mounted in line with the pistons, connected by a common piston rod. The main advantage of this cylinder is the multiplication of force, during the entire stroke, without requiring higher operating pressures or larger bores.

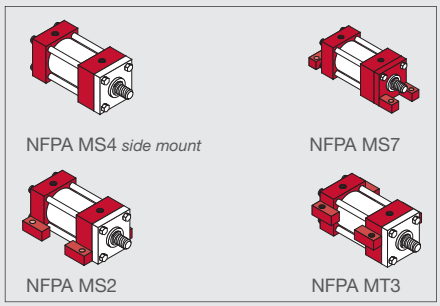
DESIGN INFORMATION

■ TIE ROD MOUNT



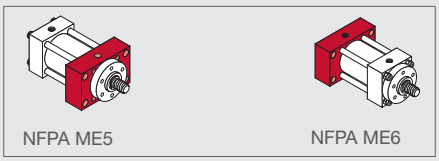
When using tie rods extended on the rod end, the best application is a tension load. For a thrust load application, the tie rods should be extended on the blind end of the cylinder. Tie rod mounts are suited for many applications, but it should be noted that they are not as rigid as flange mounted cylinders and often require additional support for long stroke applications.

■ SIDE AND LUG MOUNTS



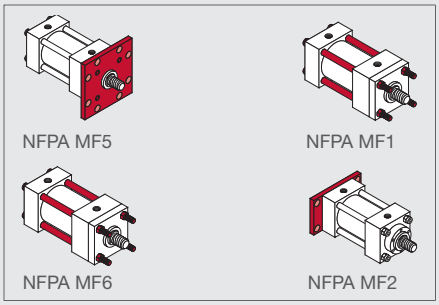
The side or lug mounted cylinder provides a fairly rigid mount. This type of mount can tolerate a slight amount of misalignment when the cylinder is fully extended, but as the piston moves toward the blind end, the tolerance for misalignment decreases. It is important to note that if the cylinder is used properly (without misalignment), the mounting bolts are either in simple shear or tension without compound stresses.

■ SOLID FLANGE MOUNT



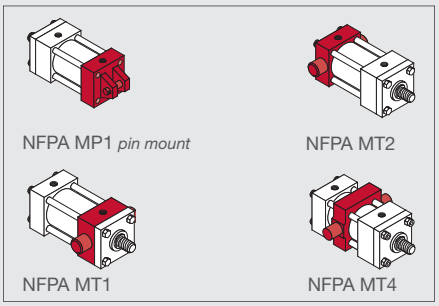
The solid flange mount is the strongest, most rigid method of mounting a cylinder. Industry standards for this type of mounting only cover 1½" through 8" bore cylinders. *Milwaukee Cylinder,* however, offers this mount on cylinders up to 12" bore.

■ FLANGE MOUNT



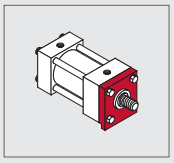
The flange mount is one of the strongest, most rigid methods of mounting. With this type of mount, there is little allowance for misalignment. When long strokes are required, the free end opposite the mounting should be supported to prevent sagging and possible binding of the cylinder. When the cylinder is used in a thrust load application, a blind end flange should be used. For tension applications, rod end flange mounts should be used.

■ PIN AND TRUNNION MOUNT

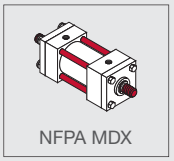


All pin and trunnion mounted cylinders need a provision on both ends for pivoting. This type of mounting is designed to carry shear loads and requires that the trunnion or pivot pins are rigidly held by closely fit bearings for the entire pin length.

■ KEY MOUNT



The key mount retainer plate is a mounting option designed to add stability to foot and side mounted cylinders. The retainer plate is extended below the mounting surface of the cylinder. This extension may be fit into a milled keyway, eliminating the need for welded keys or locator pins.

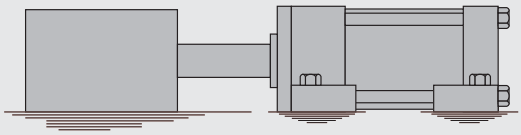


■ DOUBLE ROD END CYLINDERS

Double rod end cylinders are available in every mounting style except the clevis mount (61) and fixed eye mount (62). It should be noted by the designer that when a double flange mount is required, there will be tie rod nuts protruding on one end.

MOVING LOAD

■ SLIDING LOAD

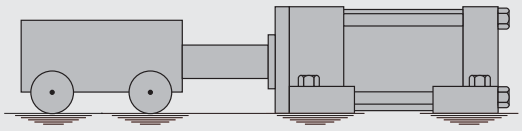


Cylinders perform a wide variety of applications and are often used in place of larger, more expensive mechanical systems. One such application is when a cylinder is used to move a high friction sliding load. Some examples of this are: machine slides, pallet shuttle systems on automated machinery, milling machine tables, and grinder tables.

There are a number of things to consider when sizing a cylinder for a sliding load application. These include the unit weight (load), lubrication, and required speed. For applications where there is light lubrication, the cylinder should provide a thrust force capable of moving a load equal to 50% to 75% of the actual load. Once in motion, a thrust force capable of moving 20% of the actual load weight is adequate.

Because air is a compressible medium, air cylinders should not be used for slow or controlled feed or motion in a sliding load application. The designer should be aware that a jerky motion will result if an air cylinder is used to perform this type of work. Because oil is non-compressible, a hydraulic cylinder with a metered out speed control would be more effective. For indexing applications, from one positive stop to another, air cylinders usually provide better response and more rapid action than hydraulic cylinders.

■ ROLLING LOAD



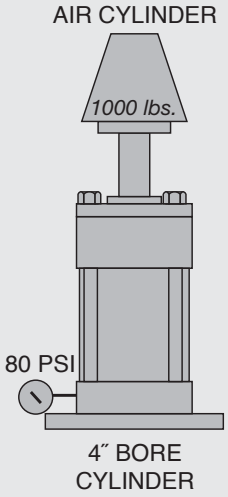
Cylinders can be used to move rolling loads or loads which are moved on low friction bearings. For this type of application, the cylinder should have a thrust force capable of moving a load equal to 10% of the actual load. When using a cylinder to move a rolling load, some means of deceleration at the end of the cylinder stroke should be used to prevent the momentum of the load from damaging either the cylinder or the machine.

CYLINDERS FOR LIFTING

■ VERTICAL LIFTING

Air cylinders must be sized to have more force than needed to just balance the load it must move. The more the cylinder is oversized, with respect to the load, the faster it can move the load (this is not true of hydraulic cylinders).

In the figure at the right, the cylinder has enough upward force to just balance the weight of the load. It cannot move the load upward, it can only hold it from dropping. To start the load in motion, it will have to have additional force. This can be provided by increasing the air pressure to more than 80 psi or by use of a larger bore cylinder.

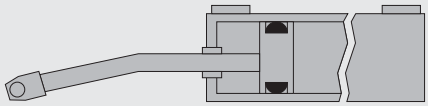


The exact speed of an air cylinder cannot be calculated. Air cylinder sizing depends on the degree of overpowering to move the load, valving, piping, and other factors which usually are unknown and cannot be measured. For further information on air cylinder sizing and speed, refer to page 100.

An air cylinder should not be used for a platform or hoist lift application. If the lift is stopped in mid stroke, it will have a tendency to drift due to the compressibility of air. A hydraulic system or air over oil system should be used in these types of applications, since force applied to a confined liquid exhibits about the same effect of rigidity as a solid.

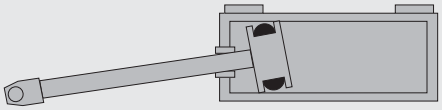
ROD SIZE

■ ROD BUCKLING



Correct rod size selection is an important factor in sizing a cylinder for an application. If the piston rod diameter is too small in relation to the load column, failure or rod buckling is likely to occur.

The standard rod for each bore size that *Milwaukee Cylinder* manufactures is sufficient to carry the maximum tension force that the cylinder is capable of producing. It is in compression applications that the column strength needs to be considered. For proper rod size selection in compression applications, refer to Table 1 on page 31, Series H; page 67, Series LH; and page 97, Series A and Series MN.



■ ROD BEARING FAILURE

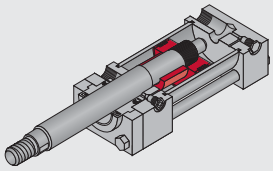
Side load is the most common cause of rod bearing failure. *Milwaukee Cylinder* has designed its standard line of cylinders to operate with a minimum amount of side load. When mounting a cylinder, it is critical that the alignment is checked both in the extended and the retracted positions. When the rod is fully extended, extensive leverage can be developed. If a side load condition exists, it will cause the piston to score the barrel and rapidly reduce the effective life of the rod bushing.

The designer has three methods which can be used to either eliminate or reduce the effects of side load. The first is to use a pin or trunnion mounted cylinder so as to move with the side load. The second is to guide the load and the piston rod, which will eliminate the side load condition. The third solution is to use a cylinder with more stroke than necessary to perform the function. This will increase the distance between the two bearing areas of the cylinder (the piston and rod bushing), reducing the overall effect of the side load condition.

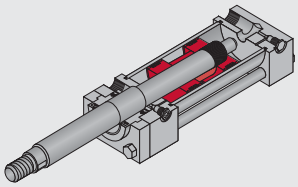
■ STOP TUBE

The use of a stop tube is the preferred method for reducing piston and bearing loads on long stroke cylinders. It is also used to prevent jack-knifing or buckling of horizontally mounted cylinders used in long stroke compression applications.

For reducing bearing loads on the rod, a stop tube is more effective, less costly, and lighter weight than an oversized piston rod. A stop tube is placed between the piston and rod end cap to restrict the extension of the rod. This space between the two bearing areas provides additional strength and support for the extended rod.



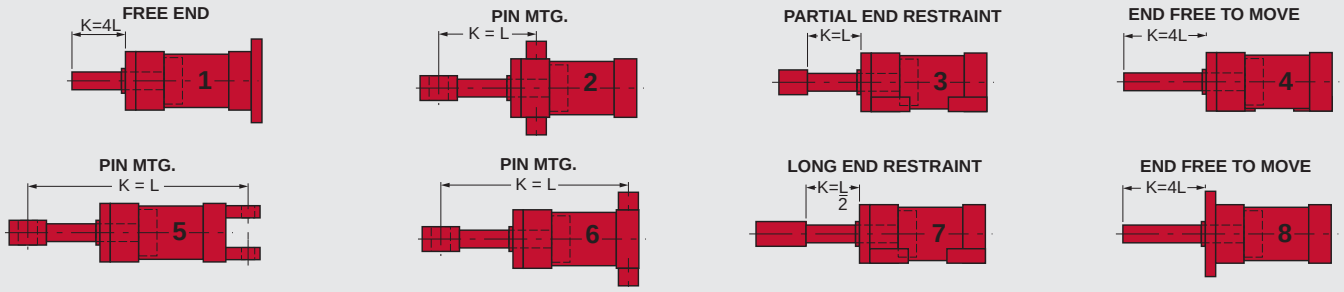
At *Milwaukee Cylinder,* we offer two stop tube designs. The single piston stop tube design is common to all cylinders except cushion rod end air cylinders. A stop tube will increase the overall length of the cylinder and will alter the mounting dimensions on most models by the length of the stop tube.



The second stop tube design is the double piston stop tube. This stop tube is primarily used for cushion rod end air cylinders. Unlike the single piston stop tube design, the double piston stop tube provides additional strength for excessive side loading and adds additional bearing area to the cylinder.

To determine if a stop tube is necessary for a cylinder application, the value of “K” has to be determined (refer to Figure 1). If the required cylinder has a “K” value in excess of 40," a stop tube is required. For each 10" increment or fraction thereof in excess of 40", one inch of stop tube is recommended.

Figure 1 – STROKE TO MOUNTING RELATIONSHIP

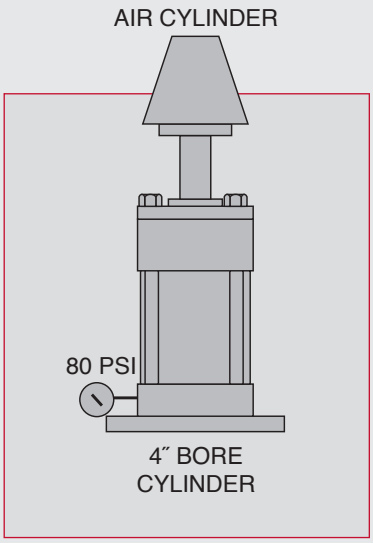


When mounting long stroke cylinders, care should be taken to assure cylinder alignment over the entire length of stroke.
The use of external guides or swivel bushings is recommended to reduce side load conditions and prolong the cylinder’s service life.

■ AIR CYLINDER FORCE

An air cylinder must be oversized to move a load. As illustrated, a 4" bore air cylinder will balance a 1000 pound load with 80 psi of air pressure. To move this load at a slow rate of speed, the cylinder must be oversized.

The designer should remember that when calculating cylinder force on the return (pull) stroke, the rod area must be deducted from the piston area. When a double rod end cylinder is used, deduct for both directions of stroke when calculating the thrust force.



■ AIR CYLINDER SPEED

The exact speed of an air cylinder cannot be calculated.

Air cylinder sizing depends on the degree of overpowering required to move the load at the desired speed, valving, piping, and other factors which usually are unknown and cannot be measured.

When a fast speed is required, the bore size and line pressure should be twice that which is needed to balance the load resistance. The lines to the valve and cylinder should be as short as possible. When selecting the directional valve to be used in an air application, the orifice of the valve should be equal to the cylinder port size. The air cylinder speed chart shows the proper port size under average conditions.

Note: *This Air Cylinder Speed Chart is based on average conditions. Conditions where the cylinder is operating at twice the thrust force required and a line pressure of 80 to 100 psi.*

▼ AIR CYLINDER SPEED CHART

ACTUAL VALVE ORIFICE SIZE								
BORE DIA	1/32	1/16	1/8	1/4	3/8	1/2	3/4	1
1⅛	5	12	28	85	–	–	–	–
1½	3	7	16	50	125	–	–	–
2	1	4	9	28	70	112	–	–
2½	–	2	6	18	45	72	155	–
3¼	–	–	3	9	22	36	78	165
4	–	–	2	7	17	28	60	130
5	–	–	1	4	11	18	40	82
6	–	–	–	3	7	12	26	55
8	–	–	–	1	4	7	15	32
4	–	–	–	–	2	4	9	20
12	–	–	–	–	1	3	6	14

Above figures are in inches per second.

■ HYDRAULIC CYLINDER FORCE

Table 3 on page 31 or 67 shows the thrust force developed by various bore diameters when working at various pressures. These figures do not include a factor covering a reduction in force due to seal or packing friction in the cylinder. This type of friction is estimated to affect the cylinder thrust force by 10%. Additional pressure must be developed by the pump, not only to overcome frictional loss, but also flow losses in the circuitry. The engineer should realize that the usable pressure in the cylinder may be from 10% to 25% less than the pump and relief valve gauge reading.

This type of friction is estimated to affect the cylinder thrust force by 10%. Additional pressure must be developed by the pump, not only to overcome frictional loss, but also flow losses in the circuitry. The engineer should realize that the usable pressure in the cylinder may be from 10% to 25% less than the pump and relief valve gauge reading.

■ HYDRAULIC CYLINDER SPEED

Figures shown in the body of this chart are cylinder rod travel speeds in inches per minute. The extension speeds represent the net piston area for the various rod diameters shown.

HYDRAULIC CYLINDER SPEEDS (inches per minute)

PISTON DIA	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	–	–	–	–	–	–	–	–
	⅝	158	476	792	1265	–	–	–	–	–	–	–	–
	1	235	706	1176	1880	–	–	–	–	–	–	–	–
2	none	73	221	368	588	883	1120	–	–	–	–	–	–
	1	97	294	490	782	1175	1465	–	–	–	–	–	–
	1⅜	139	418	697	1115	1673	2090	–	–	–	–	–	–
2½	none	47	131	235	376	565	675	940	1175	–	–	–	–
	1	56	168	280	448	672	840	1120	1400	–	–	–	–
	1⅜	67	203	339	542	813	1015	1355	1695	–	–	–	–
	1¾	92	277	463	740	1110	1385	1850	2310	–	–	–	–
3¼	none	28	83	139	223	334	417	557	696	836	1115	–	–
	1⅜	34	102	170	271	407	510	680	850	1020	1360	–	–
	1¾	39	118	196	313	472	588	784	980	1176	1568	–	–
	2	44	134	224	358	537	672	896	1120	1344	1792	–	–
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	–
	2½	30	90	150	241	362	450	600	750	900	1200	1500	–
5	none	12	35	58	94	141	174	232	290	348	464	580	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
	3	18	55	92	147	220	275	365	460	550	730	920	1380
	3½	22	66	111	178	266	333	444	555	665	888	1110	1665
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	206	270	325	435	545	810
	3½	12	37	62	99	148	185	245	310	370	495	615	830
	4	15	44	73	117	176	220	295	365	440	585	735	1095
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
	4	9	27	45	71	107	135	180	225	270	360	445	675
	4½	10	31	51	82	122	153	205	255	305	410	515	765
	5	12	37	61	98	147	185	245	305	370	490	615	915
8	none	4	14	23	36	55	69	92	115	135	185	230	345
	3½	5½	17	28	45	68	85	115	140	170	230	285	420
	4	6	18	30	49	73	90	122	150	180	240	305	450
	4½	6½	20	33	53	80	100	135	165	200	265	335	495
	5	7½	22	38	60	90	114	150	185	225	300	375	555
	5½	8½	26	43	70	104	129	172	215	255	345	430	645
10	none	3	9	15	23	35	44	60	73	88	115	145	220
	4½	3½	11	18	29	44	55	75	92	111	150	185	275
	5	4	12	20	31	47	60	80	100	120	155	195	300
	5½	4½	13	21	34	50	63	84	105	132	165	210	315
	7	5½	17	29	46	69	87	115	145	174	230	285	435

■ FLUIDS

Hydraulic fluid heats, cools, lubricates, and sometimes corrodes mechanical components, picks up and releases gases, and sweeps sludge into supposedly free clearances. The fluid is just as important as any other part of the hydraulic system. In fact, a major portion of hydraulic problems stem from the use of improper types of fluids or fluids containing dirt and other contaminants.

To understand the fluids used in today's industry, you have to divide them into two general areas: petroleum fluids and fire resistant fluids. These in turn break down into a number of different types with different properties. Not all fluids are compatible with the standard seal combinations offered by cylinder manufacturers.

In the chart below is a small sample of the fluids available and the seals with which they are compatible. Specific information on seal compatibility is available from either the fluid supplier or the component manufacturer.

■ SEALS

BUNA N SEAL This type of seal is excellent with petroleum products. The seal is rated for a temperature range from -20°F to +200°F, but when used for low temperatures, it is necessary to sacrifice some low temperature resistance. It is a superior material for compression set, cold flow, tear and abrasion resistance. This seal is generally recommended for petroleum, water, diester and water-glycol.

POLYURETHANE SEAL The polyurethane seal provides excellent mechanical and physical properties. Polyurethane does not provide a good low pressure seal, due to its poor compression and permanent set properties. This seal is generally recommended for petroleum, water/oil, and phosphate ester.

ETHYLENE PROPYLENE This seal is excellent when used with Skydrol 500 and Phosphate Ester Fluids. The seal is rated for a temperature range from -65° F to +350° F. This seal is generally recommended for phosphate ester, steam (to 400° F), water, and ketones.

VITON SEAL Viton seals are compatible with a wide range of fluids. This seal is rated for a temperature range from -15° F to +350°F. This seal is generally recommended for petroleum, silicate ester, diester, halogenated hydrocarbons, and most phosphate esters.

SEAL COMPATIBILITY with COMMON FLUIDS

FLUID NAME	MILITARY SPECIFICATION	TRADE NAME/NUMBER	BUNA-N	POLYURETHANE	EP	VITON FLUROCARBON
Water Glycol	MIL-H22072	Houghto-Safe 600 Series	Recommended	Unsatisfactory	Recommended	Satisfactory
		Houghto-Safe 500 Series	Recommended	Unsatisfactory	Recommended	Insufficient data
		Houghto-Safe 271 Series	Recommended	Unsatisfactory	Recommended	Satisfactory
		Ucon Hydrolube	Recommended	Unsatisfactory	Recommended	Recommended
		Celluguard	Recommended	Unsatisfactory	Recommended	Recommended
Water Oil/Emulsion		Houghto-Safe 5040 Series	Recommended	Unsatisfactory	Unsatisfactory	Recommended
		Gulf FR	Recommended	Recommended	Unsatisfactory	Recommended
Water Soluble Oil			Recommended	Insufficient data	Recommended	Insufficient data
Water, Fresh			Recommended	Unsatisfactory	Recommended	Satisfactory
Water, Salt			Recommended	Unsatisfactory	Recommended	Satisfactory
Phosphate Ester	MIL-19547B	Houghto-Safe 1000 Series	Unsatisfactory	Insufficient data	Recommended	Recommended
		Houghto-Safe 1120 Series	Unsatisfactory	Unsatisfactory	Recommended	Recommended
		Pyrogard 42, 43, 53, 55	Unsatisfactory	Unsatisfactory	Recommended	Recommended
		Skydrol 500 Type 2	Unsatisfactory	Unsatisfactory	Recommended	Unsatisfactory
		Skydrol 7000 Type 2	Unsatisfactory	Unsatisfactory	Recommended	Unsatisfactory
Diester	MIL-H-7808	Lube Oil Aircraft	Satisfactory	Unsatisfactory	Unsatisfactory	Satisfactory
Silicate Ester	MIL-H-8446B	Brayco 846	Satisfactory	Recommended	Unsatisfactory	Recommended
Kerosene			Recommended	Recommended	Unsatisfactory	Recommended
Jet Fuel	MIL-J-5624	JP-3, 4, 5 (RP-1)	Recommended	Satisfactory	Unsatisfactory	Recommended
Diesel Fuel			Recommended	Marginal	Unsatisfactory	Recommended
Gasoline			Recommended	Satisfactory	Unsatisfactory	Recommended
Petroleum Base	MIL-H-6383	Preservative Oil	Recommended	Recommended	Unsatisfactory	Recommended
	MIL-H-5606	Aircraft Hyd. Fluid	Recommended	Satisfactory	Unsatisfactory	Recommended

Note: This chart is for general information and should not be taken as warranty or representation for which legal responsibility is assumed. The chart and the information on this page is offered only for your convenience, consideration, investigation and verification.

MOUNTING MODIFICATIONS

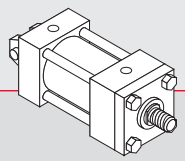
SPECIAL CYLINDER MOUNTINGS

The standard NFPA (National Fuid Power Association) mountings satisfy a wide range of mounting applications and can be easily modified to suit specific design requirements. As a machine or equipment designer, you may encounter various situations where a standard or a modified standard mounting will not satisfy your design requirements. *Milwaukee Cylinder* specializes in meeting your needs in this area by providing cylinders custom designed to suit your specific applications.

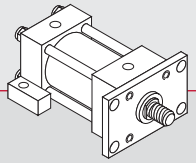
For information on what data is required by *Milwaukee Cylinder* to develop a design to suit your specific requirements, contact either your local *Milwaukee Cylinder* Distributor or the factory.

COMBINED MOUNTINGS

Milwaukee Cylinder offers the designer the ability to combine standard mountings to meet special design requirements. Some examples of this are:



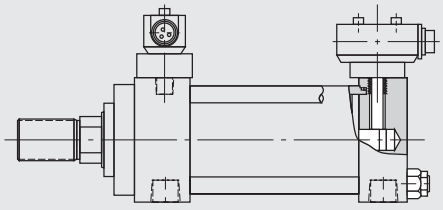
An MF1 mount constructed with an MS2 mount blind end cap.



An MP1 mount constructed with an MS4 mount rod end cap.

These and other combinations can be readily made from standard parts. If you are unsure of a possible combination or its suitability to your application, consult your local *Milwaukee Cylinder* Distributor or the factory.

SOLID STATE END OF STROKE LIMIT SWITCHES



Design compatible with major brands.

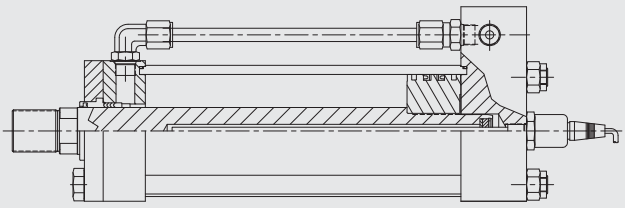
FEATURES:

- End of stroke indication for all sizes of cylinders
- Pneumatic or hydraulic operation (3000 psi)
- Choice of rod end, cap end or both ends
- Cushioned or non-cushioned cylinders available
- Switches are permanently set at factory – no adjustments necessary
- No special filtration required – any cylinder operating fluid acceptable
- Operating point repeatable to.002"
- Quick Response
- Operating temperature range of -4°F to +158°F
- Sensing range .08"
- Short circuit protected
- Immunity to weld field noise
- Typical switching range: 20 to 250 volts AC/DC

OPTIONS:

- Low profile, 1⅜" high above surface (for certain cylinder sizes)
- Mini or micro connections
- Reduced switching voltage available to 10 vdc
- Supplied with or without switches

TRANSDUCERS



FEATURES:

- High immunity to shock and vibration
- Non-contacting design, no wear
- 3000 psi operating pressure
- 24 VDC operating voltage
- Analog or digital output
- Strokes up to 200 inches

Other styles and configurations of cylinders modified for embedded or external transducers are available. Contact your local *Milwaukee Cylinder* Distributor or the factory.

Standard Material:
Neoprene Nylon

Special Material:
Consult Factory

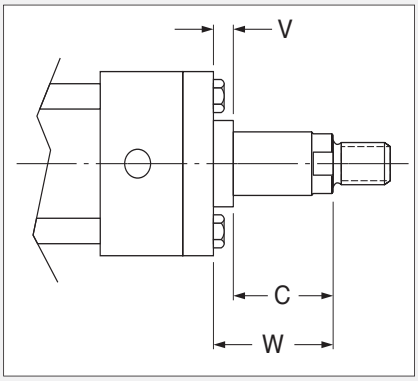
ROD BOOTS

When cylinders are used in areas of high contamination or where contaminants have an air hardening property, the exposed piston rod should be covered with a rod boot to protect the rod bearing and seals. A rod boot is simply a collapsible cover. It is of sewn construction made from a neoprene coated fabric. The rod boots are impervious to oil, grease and water. They will operate effectively from 0°F to +200°F without cracking.

ROD BOOT DATA CHART

ROD DIA. (in)	COVER I.D	COVER O.D	ROD BOOT STYLE	MINIMUM LENGTH FACTOR
⅝	¾	3	**RA-15**	.07
1	1⅛	3⅜	**RB-15**	.07
1⅜	1½	3¾	**RC-15**	.07
1¾	1⅞	4⅛	**RD-15**	.07
2	2⅜	4⅝	**RE-15**	.07
2½	2⅞	5⅛	**RF-15**	.07
3	3⅜	7	Consult Factory	
3½	3⅞	7½	Consult Factory	
4	4½	8¼	Consult Factory	
4½	5	8⅜	Consult Factory	
5	5¼	9	Consult Factory	
5½	5¾	9½	Consult Factory	

NOTE: ROD EXTENSION MUST BE INCREASED TO ACCOMMODATE BOOT

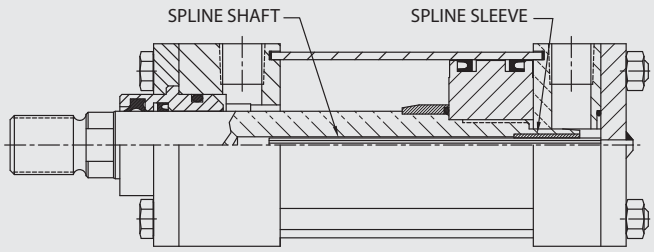


To Compute: W = (Stroke x Min. Length Factor) + 1⅜"
Round up to the nearest ⅛"

Example: A61, 3¼" bore x 12" stroke x 1" rod
W = (12 x 0.07) + 1.375 = (.84) + 1.375 = 2.22"
Round up to the neareset ⅛"

W = 2.25"

SPLINE SHAFT

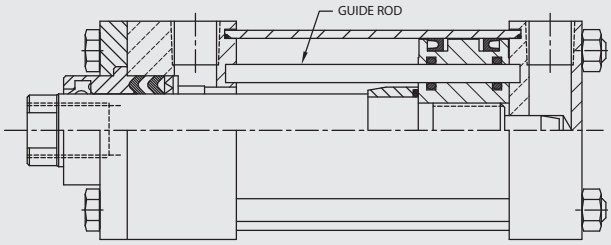


FEATURES:

- All cylinder series
- Cushioned or non-cushioned cylinders
- All bore and rod combinations except ⅝" diameter rod
- Spline shaft and mating sleeve prevent natural rotation of piston rod during stroke
- Mounting styles 11, 21, 31, 35, 41, 42, 43, 71, 72, 73, 74. Consult factory for other mounting styles
- Engineering dimensional drawing provided with each cylinder ordered

NOTE: Not available in double rod end cylinders or with stroke lengths over 45 inches. Rotational limits or torsional load information must be supplied to factory.

GUIDE ROD



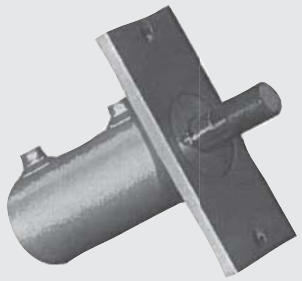
FEATURES:

- All cylinder series
- Cushioned or non-cushioned cylinders
- All mounting styles
- Double rod end cylinders
- All bore and rod combinations 8-inch bore and larger
- Guide rod design through piston prevents natural rotation of piston rod
- Engineering dimensional drawing provided with each cylinder ordered

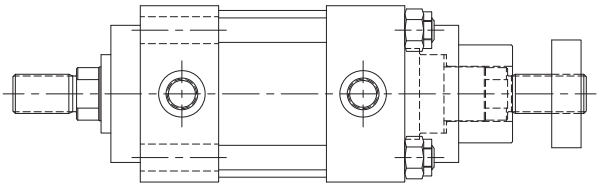
NOTE: Rotational limits or torsional load information must be supplied to factory.

BORE DIA.	ROD DIA.	AVAILABILITY
1½	⅝	N/A
	1	N/A
2	⅝	N/A
	1	N/A
	1⅜	N/A
2½	⅝	Yes
	1	N/A
	1⅜	N/A
	1¾	N/A
3½	1	Yes
	1⅜	N/A
	1¾	N/A
	2	N/A
4	1	Yes
	1⅜	Yes
	1¾	Yes
	2	N/A
	2½	N/A
5	1	Yes
	1⅜	Yes
	1¾	Yes
	2	Yes
	2½	Yes
	3	N/A
	3½	N/A
6	1⅜	Yes
	1¾	Yes
	2	Yes
	2½	Yes
	3	Yes
	3½	Yes
	4	N/A
7	3	Yes
	3½	Yes
	4	Yes
	4½	Yes
	5	N/A

Contact Milwaukee Cylinder for all your Custom Cylinder needs.

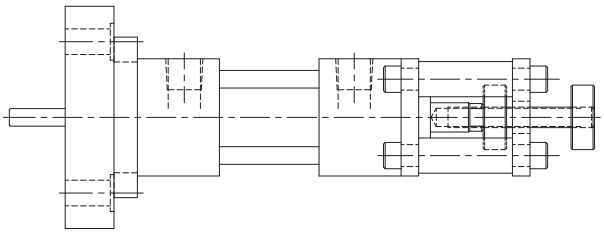


Milwaukee Cylinder *has two basic identities as a cylinder producer. The first is a supplier of standard Hydraulic and Air Cylinders. The second is as a specialist in the design and manufacture of totally unique cylinders. For information on what data is required to develop a design to suit your needs, contact either your local* ***Milwaukee Cylinder*** *representative, or the factory.*



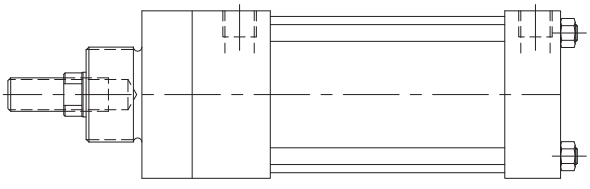
ADJUSTABLE STROKE CYLINDER

In this application, the extend cycle of the cylinder had to be adjustable for different lengths. *Milwaukee Cylinder* attached a special, welded stop around one of the double rod ends. The rod end going through the stop has an easily adjustable nut that will precisely set the length of the extend cycle.



ADJUSTABLE STOP CYLINDER

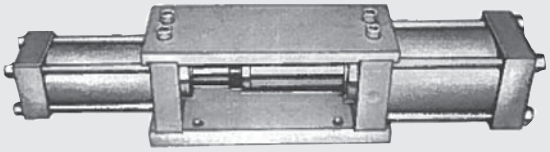
Like the cylinder above, this one does not require special valving to achieve an adjustable stroke length. But unlike the other cylinder, the length of the stroke had to be adjustable in both directions. In this case, the blind end flange had an extension added through which one of the double rod ends passed. Around the rod were attached two, threaded, locking collars for quick and easy adjustment of the rod travel in either direction.



NOSE MOUNTED CYLINDER

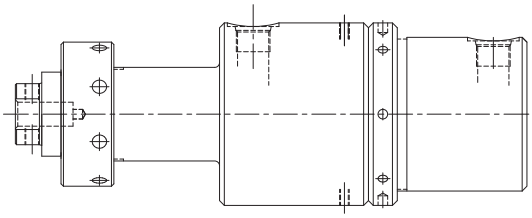
Quite often, cylinders designed and manufactured overseas do not conform to NFPA specifications. *Milwaukee Cylinder* is able to design a replacement non-NFPA cylinder. This particular cylinder was designed to replace a cylinder built in Europe. A special threaded nozzle was required for mounting purposes.

Whether you require a different material, seals, mounting, other modification or a completely unique custom product, ***Milwaukee Cylinder*** *has the resources to meet your needs. We also offer* ***mechanical locking, position sensing, non-rotating*** *and other specialty cylinder types.*



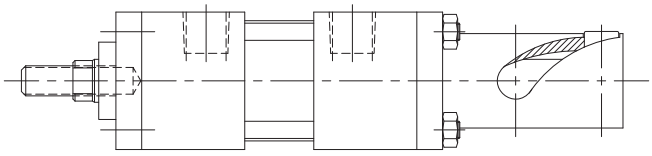
HEAVY-DUTY CYLINDER

The Series HD cylinder is a heavy-duty, non-tie rod design rated for continuous 5,000-psi operation. It has been designed specifically for punching and piercing operations in thick metal requiring tonnage ratings from 17-1/2 to 100 tons.



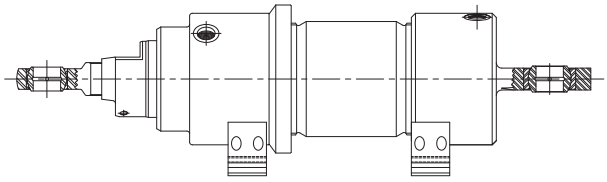
CONTROLLED ROTATING CYLINDER

Sand shell cores for casting turbine rotors required a large cam roll and three men to turn the cope. Due to the curved blades on the rotor, the cope of the pattern had to be rotated as it was being removed. *Milwaukee Cylinder* engineered a precision cylinder in which the rod would rotate during the first two inches of upward travel and then travel straight up for eleven more inches. This controlled rotation released the blades in the pattern from the sand core without incurring breakage.



TILT SYSTEM CYLINDER

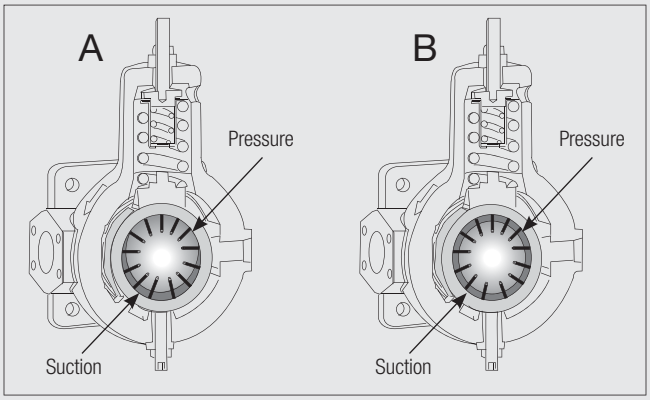
Milwaukee Cylinder was chosen to design and manufacture a custom hydraulic cylinder functioning as the tilting mechanism. We developed a cylinder that could extend and retract a precise distance, allowing a specific degree of tilt in either direction.



Hydraulic Power Units from *Milwaukee Cylinder* are available in Gear Pump and Vane Pump designs.

HOW A VANE PUMP WORKS

The MCVEV series uses a vane style pump element that has both volume adjustment and maximum pressure adjustment. The output flow and pressure are determined by the position of the cam ring and the vane rotor.

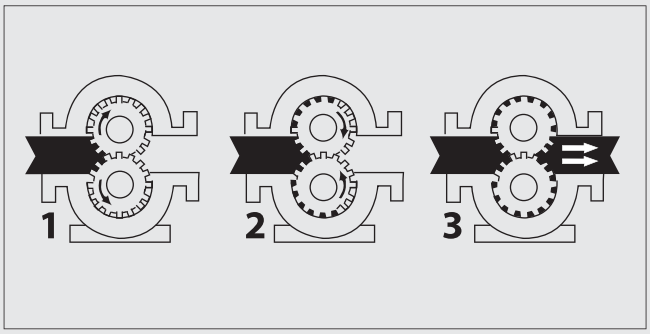


A. To adjust the volume output, the position of the cam ring is moved to reduce the clearance between the vane rotor and the cam ring.

B. To adjust the maximum output pressure, the spring adjustment is set so the internal pressure in the cam ring centers the cam ring around the rotor.

HOW A GEAR PUMP WORKS

The MCVEG series uses a gear style pump element. The driven gear is coupled to the motor. The idler gear is driven by the rotation of the driven gear. Oil is pulled into the suction port, carried in the gap between the gear teeth, and comes out of the pressure port. Adjustment of the system pressure requires a relief valve in the circuit.



Calculating System Requirements

- Cylinder Area (in)* = πr^2
- Cylinder Volume = (in^3) = Cylinder Area x Stroke
- Flow Requirement (gpm) =

$$\frac{\text{Cylinder Volume x \# of Cylinders x (60} \div \text{Speed Required}^{**})}{231\ in^3\ \text{per gal}}$$

* Alternate formula: (Bore Diameter)^2 x 0.7854

** In seconds

Example:

Cylinder Bore: 4.00" Stroke Length: 12"
Number of Cylinders: 4 Speed Required = 6 sec.

Cylinder Radius (r) = 4" bore diameter ÷ 2 = 2" radius

Cylinder Area = π x 2" x 2" = 3.14 x 4 in^2 = 12.56 in^2

Cylinder Volume = 12.56 in^2 x 12" = 150.72 in^3

$$\text{Flow Requirement} = \frac{150.72\ in^3 \times 4 \times (60 \div 6\ \text{sec})}{231\ in^3\ \text{per gal}}$$

$$= \frac{602.88\ in^3 \times 10}{231\ in^3\ \text{per gal}} = \frac{6028.8\ in^3}{231\ in^3\ \text{per gal}}$$

= 26 gpm

Calculating Reservoir Size

The oil capacity of the reservoir used in a hydraulic power unit (HPU) provides the oil volume required to operate the cylinders and other devices in a system, and also absorbs and radiates the heat produced during the operation of the HPU. Using a small reservoir may result in an overheated system. The guideline for sizing the reservoir is 3 to 4 times the flow rate of the pump (gpm).

For example, a 5 gpm HPU should use a 15-20 gallon reservoir. Further reduction of heat buildup in the reservoir may require the use of a heat exchanger. A low oil level and high temperature switch in the reservoir can be used to shut the system down if the oil level in the reservoir falls below a usable level or if the oil temperature rises to a unsafe temperature.

D03 AND D05 DIRECTIONAL VALVES

Spool type valves are typically used with a hydraulic power unit (HPU) where the system provides continuous flow. This helps to compensate for losses due to internal leakage in the valves. *Milwaukee Cylinder* offers spool valves in two industry standard sizes:

D03: Flow rates of 12-17 gpm

D05: Flow rates of 25 gpm

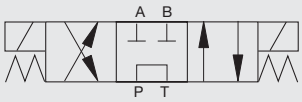
The operation of a valve is described by the flow paths to the circuit ("way"), the number of valve operating positions ("position") and the type of flow path in the center position ("center"). Other characteristics used in describing a valve describe the type of operator used: solenoid, manual lever, cam, air, and operator options such as spring centered and detented.

Common valve configurations are:

4 way / 3 position / TANDEM Center

CENTER POSITION: Pessure to Tank

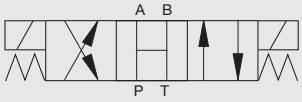
USES: Idles pump in the center position



4 way / 3 position / OPEN Center

CENTER POSITION: All ports to Tank

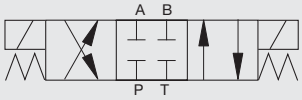
USES: Idles pump in the center position
commonly used with pilot operated check valve



4 way / 3 position / CLOSED Center

CENTER POSITION: All ports blocked

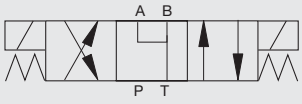
USES: Used in system with multiple valves



4 way / 3 position / FLOAT Center

CENTER POSITION: A & B to to Tank, P blocked

USES: Used in system with mulitple valves with pilot operated check valves



4 way / 2 position

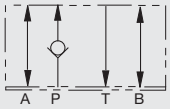
NO CENTER POSITION

USES: Used in systems where cylinders are always either advanced or retracted

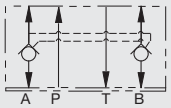
ACCESSORY VALVES

In many circuits, accessory valves are used with the directional valve to provide additional control of the flow in the system:

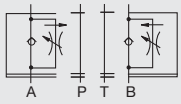
Holding:
Check valve on the pressure port



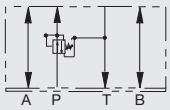
Dual pilot operated check valves on "A" and "B"



Control of flow rate:



Control of pressure (on pressure port)



Manifolds

Manifolds are available for D03 and D05 size valves as either pump mounted or remote mounted. They are available in single and multiple valve models. For systems operating up to 3000 psi, choose an aluminum manifold. The pump mounted manifolds used on the *Milwaukee Cylinder* power units are aluminum, as these units operate at 3000 psi or below.

For applications using higher pressure power units, up to 5000 psi, select the remote mount ductile iron manifolds.

Porting:
D03:
P and T: #10 SAE
A and B: #8 SAE

D05:
P and T: #12 SAE
A and B: #8 SAE

FORMULA	WORD FORMULA	LETTER FORMULA
FLUID PRESSURE *(pounds per square inch)*	PRESSURE = force *(pounds)* / unit area *(square inches)*	$P = \frac{F}{A}$ *or* psi = $\frac{F}{A}$
CYLINDER AREA *(square inches)*	AREA = π x radius^2 *(inches)*	$A = \pi r^2$
	= $\pi/4$ x diameter^2 *(inches)*	$A = \frac{\pi D^2}{4}$ *or* $A = .785d^2$
CYLINDER FORCE *(pounds, push or pull)*	FORCE = pressure *(psi)* x net area *(square inches)*	F = psi x A *or* F = PA
CYLINDER VELOCITY or SPEED *(feet per second)*	VELOCITY = 231 x flow rate *(GPM)* / 12 x 60 x net area *(square inches)*	$v = \frac{231Q}{720A}$ *or* $v = \frac{.3208Q}{A}$
CYLINDER VOLUME CAPACITY *(gallons of fluid)*	VOLUME = π x radius^2 *(inches)* x stroke *(inches)* / 231	$v = \frac{\pi r^2 L}{231}$
	= net area *(inches)* x stroke *(inches)* / 231	$v = \frac{AL}{231}$ L = *length of stroke*
CYLINDER FLOW RATE *(GPM)*	FLOW RATE = 12 x 60 x velocity *(feet/second)* x net area *(square inches)* / 231	$Q = \frac{720vA}{231}$ *or* Q = 3.117vA
FLUID MOTOR TORQUE *(inch pounds)*	TORQUE = pressure *(psi)* x f.m. displacement *(cu. in./rev.)* / 2π	$T = \frac{psi\ d}{2\pi}$ *or* $T = \frac{Pd}{2\pi}$
	= horsepower x 63025 / rpm	$T = \frac{63025\ HP}{n}$
	= flow rate *(gpm)* x pressure *(psi)* x 36.77 / rpm	$T = \frac{36.77QP}{n}$ *or* $T = \frac{36.77psi}{n}$
FLUID MOTOR TORQUE /100 psi *(inch pounds)*	TORQUE = f.m. displacement *(cu. in./rev.)* / .0628 *(cu. in./rev.)*	$T_{100psi} = \frac{d}{.0628}$
FLUID MOTOR SPEED *(revolutions per minute)*	SPEED = 231 x flow rate *(gpm)* / f.m. displacement	$n = \frac{231Q}{d}$
FLUID MOTOR POWER *(horsepower output)*	HORSEPOWER = torque output *(inch pounds)* x rpm / 63025	$HP = \frac{Tn}{63025}$
PUMP OUTLET FLOW *(gallons per minute)*	FLOW = rpm x pump displacement *(cu. in./rev.)* / 231	$Q = \frac{nD}{231}$
PUMP INPUT POWER *(horsepower required)*	HORSEPOWER INPUT = flow rate output *(gpm)* x pressure *(psi)* / 1714 x efficiency *(overall)*	$HP_{IN} = \frac{QP}{1714Eff}$ *or* $\frac{GPM\ x\ psi}{1714Eff}$
FLOW RATE through PIPING *(additional required oil to reach pressure)*	ADDITIONAL VOLUME = pressure *(psi)* x volume of oil under pressure / 250,000	$V_A = \frac{PV}{250,000}$ *Approx. ½% per 1000 psi*

GAS LAWS for ACCUMULATOR SIZING: Where "P" = **psia** (absolute) = **psig** (gauge pressure) + **14.7 psi**

FORMULA	WORD FORMULA	LETTER FORMULA
PRESSURE or VOLUME *(W/Constant "T") Temperature*	Original Pressure x Original Volume = Final Pressure x Final Volume	P1V1 = P2V2 [isothermic]
PRESSURE or TEMPERATURE *(W/Constant "V") Volume*	Original Pressure x Final Temperature = Final Pressure x Original Temperature	P1T2 = P2V1 [isochoric]
VOLUME or TEMPERATURE *(W/Constant "P") Pressure*	Original Volume x Final Temperature = Final Volume x Original Temperature	V1T2 = V2T1 [isobaric]
PRESSURE or VOLUME *(W/Temperature change due to heat of compression*	Original Temperature x Final Volume^n = Final Pressure x Final Volume^n	P1V1^n = P2V2^n
	Final Temperature / Original Temperature = $\left(\frac{\text{Original Volume}}{\text{Final Volume}}\right)^{n-1}$ = $\left(\frac{\text{Final Pressure}}{\text{Original Pressure}}\right)^{n-1/n}$	$\frac{T2}{T1} = \left(\frac{V1}{V2}\right)^{n-1} = \left(\frac{P2}{V1}\right)^{n-1/n}$

For Nitrogen in the Exponent:
"n" = 1.4 For full adiabatic conditions i.e., the "FULL HEATING" theoretical condition
"n" = 1.3 For rapid cycling (most heating normally experienced)
"n" = 1.1 For "NORMAL" cycling
"n" = 1.0 Where gas time to return to normal temperature before discharge or recharge

A

ACCUMULATOR a container in which fluid is stored under pressure as a source of fluid power.

AIR, COMPRESSED air at any pressure greater than atmospheric pressure.

B

BLEEDER, AIR a device for the removal of air from an oil system.

BREATHER, AIR a device permitting air movement between the atmosphere and the component in which it is installed, while preventing contaminations from entering the component.

C

CAP, BLIND END a cylinder end closure which completely covers the bore area.

CAP, ROD END the cylinder and enclosure which covers the differential area between the bore area and the piston rod area.

CAVITATION a localized gaseous condition within a liquid stream which occurs where the pressure is reduced to the vapor pressure.

CLEVIS a "U" shaped mounting device which contains a common pin hole at right angle or normal to the axis of symmetry through each extension.

COMPRESSIBILITY the change in volume of a unit of volume of a fluid when subjected to a unit change of pressure.

CUSHION a device which provides controlled resistance to motion.

CUSHION, CYLINDER a cushion built into the cylinder to restrict flow at the outlet port, thereby arresting the motion of the piston rod.

CYCLE a single complete operation consisting of progressive phases, starting and ending at the neutral position.

CYLINDER a device which converts fluid power into linear mechanical force and motion.

CYLINDER, ADJUSTABLE STROKE a cylinder in which fluid force can be applied to the moveable element in either direction.

CYLINDER, NON-ROTATING a cylinder in which the relative rotation of the cylinder housing and the piston and piston rod, plunger or ram, is fixed.

CYLINDER, SINGLE ACTING a cylinder in which the fluid force can be applied to the moveable element in only one direction.

CYLINDER, TANDEM two or more cylinders with interconnected piston assemblies.

D

DUROMETER HARDNESS a measure of elastomer hardness by use of a durometer.

F

FILTER a device whose primary function is the retention by porous media of insoluble contaminants from a liquid.

FITTING a connector or closure for fluid power lines and passages.

FLOW, LAMINAR a flow situation in which fluid moves in parallel laminar or layers.
Flow Rate – the volume, mass, or weight of a fluid passing through any conductor, per unit of time.

FLOW, TURBULENT a flow situation in which fluid particles move in a random manner.

FLUID FRICTION friction due to the viscosity of fluids.

FLUID STABILITY resistance of a fluid to permanent changes in properties.

G

GAGE an instrument or device for measuring, indicating, or comparing a physical characteristic, such as pressure or volume.

H

HYDRAULIC PUMP a device which converts mechanical force and motion into fluid power.

I

INTENSIFIER a device which converts low pressure fluid power into high pressure fluid power; also called a booster.

L

LUBRICATOR a device which adds controlled or metered amounts of lubricant into an air system.

M

MANIFOLD a conductor which provides multiple connection ports.

MUFFLER a device for reducing gas flow noise.

P

PACKING a sealing device consisting of bulk deformable material or one or more mating deformable elements, reshaped by manually adjustable compression to obtain and maintain effectiveness. It usually uses axial compression to obtain radial sealing.

PORT an internal or external terminus of a passage in a component.

PORT BLEED a port which provides a passage for the purging of gas from a system or component.

PORT, CYLINDER a port which provides a passage to or from an actuator.

PORT, EXHAUST a port which provides a passage to the atmosphere.

PRESSURE force per unit area, usually expressed in pounds per square inch.

PRESSURE, BURST the pressure which creates loss of fluid thru the component envelope, resulting from failure.

PRESSURE, CRACKING the pressure at which a pressure operated valve begins to pass fluid.

PRESSURE, OPERATING the pressure at which a system is operated.

PRESSURE, PEAK the maximum pressure encountered in the operation of a component.

PRESSURE, RATED the qualified operating pressure which is recommended for a component or a system by the manufacturer.

PRESSURE, SHOCK the pressure existing in a wave moving at sonic velocity.

PRESSURE, STATIC the pressure in a fluid at rest.

PRESSURE, SURGE the pressure existing from surge conditions.

PRESSURE, WORKING the pressure at which the working device normally operates.

PRESSURE VESSEL a container which holds fluid under pressure.

R

RESERVOIR a container for the storage of liquid in a fluid power system.

RESTRICTOR a device which reduces the cross-sectional flow area.

REYN the standard unit of absolute viscosity in the English system. It is expressed in pound-seconds per square inch.

S

SERVOVALVE a valve which modulates output as a function of an input command.
Silencer – a device for reducing gas flow noise. Noise is decreased by tuned resonant control of gas expansion.

SUBPLATE an auxiliary ported plate for mounting components.

SURGE a transient rise of pressure or flow.

T

TUBE a line whose size is its outside diameter. Tube is available in varied wall thicknesses.

V

VALVE a device which controls fluid flow direction, pressure, or flow rate.

VALVE, DIRECTIONAL CONTROL a valve whose primary function is to direct or prevent flow through selected passages.

VALVE, FLOW CONTROL a valve whose primary function is to control flow rate.

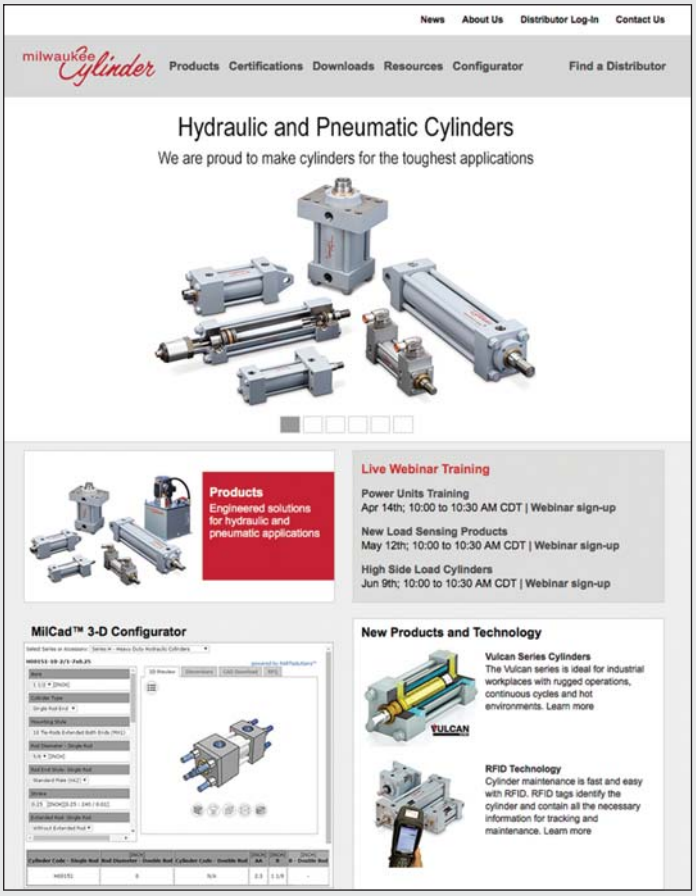
VALVE, SEQUENCE a valve whose primary function is to direct flow in a predetermined sequence.

VALVE POSITION, DETENT a predetermined position maintained by a holding device, acting on the flow-directing elements of a directional control valve.

VALVE POSITION, NORMAL the valve position when signal or actuating force is not being applied.

VISCOSITY a measure of internal friction or the resistance of a fluid to flow.

Terms and definitions are extracted from ANSI Glossary of Terms for Fluid Power with permission of the publisher, National Fluid Power Association, Milwaukee, Wisconsin 53222.



Website Highlights

- "MilCad" software
- Product specifications
- Product literature
- Online quote request
- Distributor locator
- Design Engineering Guide to assist with product application selection

www.milwaukeecylinder.com

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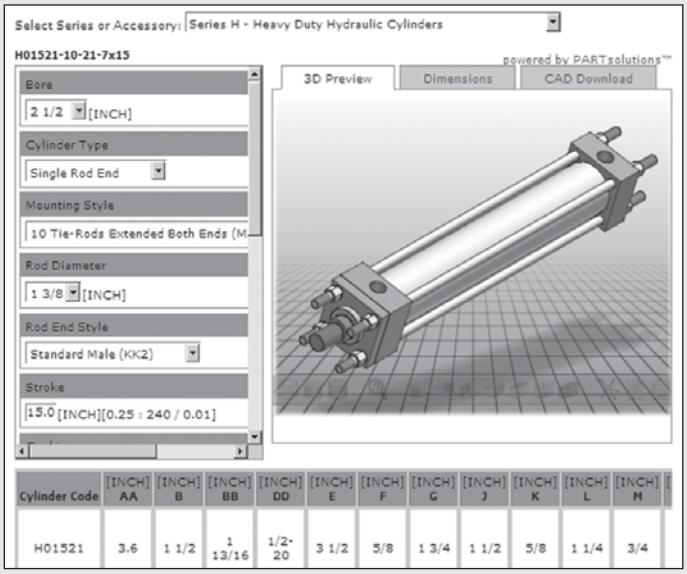
  - Hydraulic and pneumatic
  - NFPA and ISO
  - Accessories
- Download your selections
  - Over forty 3D formats
  - Twenty-five 2D formats
- One-time registration required



WARRANTY

Seller warrants the goods sold hereunder to be free from defects in material and workmanship for a period of twelve months after the date of shipment from Seller's plant. If the goods are in accordance with or in reference to an engineering drawing specified by or furnished to the customer, the specifications and information on the drawing shall be applicable in determining such correct use, operation and application.

When claiming a breach of the above warranty, Buyer must notify Seller promptly in writing, whereupon Seller will either examine the goods at their site or issue shipping instructions for return to Seller.

When any goods sold hereunder are proved not as warranted, Seller's sole obligation under this warranty shall be to repair or replace the goods, not including installation or any other charges, at its option, without charge to Buyer.

THIS WARRANTY COMPRISES SELLER'S SOLE AND ENTIRE WARRANTY OBLIGATION AND LIABILITY TO BUYER, ITS CUSTOMERS AND ASSIGNS IN CONNECTION WITH GOODS SOLD HEREUNDER. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS, ARE EXPRESSLY EXCLUDED.

CONSEQUENTIAL DAMAGES: In no event shall Seller be liable for consequential or special damages arising out of a delay in or failure of delivery, defects in material or workmanship, or arising out of a breach by Seller of any other term or obligation of Seller under this contract.

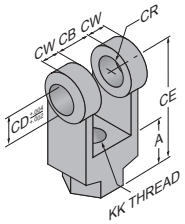
Notes

Notes

Dimensional Data Clevis/Brackets/Pins/Rod Eyes

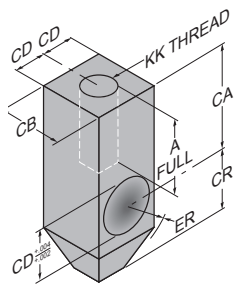
ROD CLEVIS

Part #	Code	Max. Load (tension) (lbs)	Thread Size KK	A	CA	CB	CD	CE	CR	CW	ER
15-72-1001	C101	4,380	7/16-20	3/4	1 1/2	3/4	1/2	1 1/2	1/2	1/2	9/16
15-72-1002	C102	12,372	3/4-16	1 1/8	2 1/16	1 1/4	3/4	2 3/8	3/4	5/8	15/16
15-72-1003	C103	20,433	1-14	1 5/8	2 13/16	1 1/2	1	3 1/8	1	3/4	1 1/8
15-72-1004	C104	30,483	1 1/4-12	2	3 7/16	2	1 3/8	4 1/8	1 3/8	1	1 9/16
15-72-1005	C105	49,479	1 1/2-12	2 1/4	4	2 1/2	1 3/4	4 1/2	1 3/4	1 1/4	2
15-72-1006	C106	70,095	1 7/8-12	3	5	2 1/2	2	5 1/2	2	1 1/4	2 1/2
15-72-1007	C107	94,248	2 1/4-12	3 1/2	5 13/16	3	2 1/2	6 1/2	2 1/2	1 1/2	2 13/16
15-72-1008	C108	121,932	2 1/2-12	3 1/2	6 1/8	3	3	6 3/4	2 3/4	1 1/2	3 1/4
15-72-1009	C109	187,908	3 1/4-12	4 1/2	7 5/8	4	3 1/2	8 1/2	3 1/2	2	3 7/8
15-72-1010	C110	268,026	4-12	5 1/2	9 1/8	4 1/2	4	10	4	2 1/4	4 7/16



ROD EYE

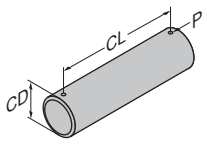
Part #	Code
15-73-1001	C301
15-73-1002	C302
15-73-1003	C303
15-73-1004	C304
15-73-1005	C305
15-73-1006	C306
15-73-1007	C307
15-73-1008	C308
15-73-1009	C309
15-73-1010	C310



NOTE: The Rod Clevis and Rod Eyes are designed for use with the standard *Milwaukee Cylinder* Style No. 2 Rod End.
When ordering these accessories, be sure to match the thread size of the Style No. 2 Rod End of the rod size you ordered to the thread size of the accessory you require.

PIVOT PIN

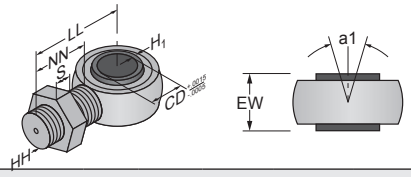
Part #	Code	CD	CL	P
15-76-1001	P101	1/2	1.94	7/64
15-76-1002	P102	3/4	2.72	9/64
15-76-1003	P103	1	3.22	9/64
15-76-1004	P104	1 3/8	4.25	11/64
15-76-1005	P105	1 3/4	5.25	11/64
15-76-1006	P106	2	5.28	13/64
15-76-1007	P107	2 1/2	6.19	Groove width .086 to .091
15-76-1008	P108	3	6.25	Groove width .103 to .108
15-76-1009	P109	3 1/2	8.13	Groove width .120 to .125
15-76-1010	P110	4	9.13	Groove width .120 to .125



1) Pivot pins are furnished with clevis mounted cylinders as standard.
2) Pivot pins for 1½"- 6" bore are furnished with cotter pins.
Pivot pins for 7" thru 12" bore are furnished with snap rings.
3) Pivot pins are not furnished as standard and must be ordered separately for use with accessories.

SPHERICAL ROD EYE (WITH NUT)

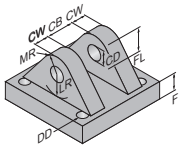
Part #	Max. Load (tension) (lbs)	a1	CD	EW	H_1	HH	LL	NN	S
HS-301	1,665	12°	1/2	5/8	11/16	7/16-20	2 7/16	1 15/32	1/4
HS-302	7,020	13 1/2°	3/4	7/8	29/32	3/4-16	2 27/32	1 23/32	7/16
HS-303	19,050	14°	1	1 3/8	1 13/32	1-14	4 3/32	2 3/32	9/16
S-301	1,450	12°	1/2	5/8	11/16	7/16-20	2 7/16	1 15/32	1/4
S-302	2,880	13 1/2°	3/4	7/8	29/32	3/4-16	2 27/32	1 23/32	7/16
S-303	10,885	14°	1	1 3/8	1 13/32	1-14	4 3/32	2 3/32	9/16

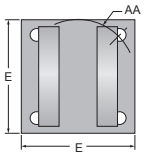


NOTE: The Spherical Rod Eye is used with Style 3 and 5 rod ends.

CLEVIS BRACKET

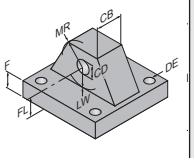
Part # Code	Max. Load (tension) (lbs)*	Max. Press. (psi)*	AA	CB	CD	CW	Thrd. Size DD	DE	E	Clevis F	Eye F	Clevis FL	Eye FL	LR	LW	MR
15-74-2001 B101	7,510	3,000	2.3	3/4	1/2	1/2	3/8-24	13/32	2 1/2	3/8	3/8	1 1/8	1 1/8	13/16	11/16	1/2
15-74-2002 B122	20,082	3,000	2.9	1 1/4	3/4	5/8	1/2-20	17/32	3	5/8	5/8	1 7/8	1 7/8	1 3/16	1 1/4	3/4
15-74-2003 B102	20,082	3,000	3.6	1 1/4	3/4	5/8	1/2-20	17/32	3 1/2	5/8	5/8	1 7/8	1 7/8	1 5/16	1 3/16	3/4
15-74-2004 B103	27,684	3,000	4.6	1 1/2	1	3/4	5/8-18	21/32	4 1/2	3/4	3/4	2 1/4	2 1/4	1 3/8	1 3/8	1
15-74-2005 B104	20,685	3,000	5.4	2	1 3/8	1	5/8-18	21/32	5	7/8	7/8	3	3	1 7/8	1 7/8	1 3/8
15-74-2006 B105	55,000	3,000	7.0	2 1/2	1 3/4	1 1/4	7/8-14	29/32	6 1/2	7/8	1 1/8	3 1/8	3 3/8	2	2 1/32	1 5/8
15-74-2007 B106	80,000	3,000	8.1	2 1/2	2	1 1/4	1-14	1 1/32	7 1/2	1	1 1/2	3 1/2	4	2 1/16	2 1/16	2
15-74-2008 B107	115,000	3,000	9.3	3	2 1/2	1 1/2	1 1/8-12	1 5/32	8 1/2	1	1 3/4	4	4 3/4	2 5/8	2 21/32	2 3/8
15-74-2009 B108	125,000	3,000	10.6	3	3	1 1/2	1 1/4-12	1 9/32	9 1/2	1	2	4 1/4	5 1/4	2 7/8	2 7/8	2 3/4

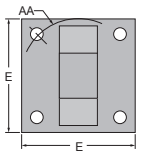




EYE BRACKET

Part # Code
15-75-2001 B401
15-75-2002 B422
15-75-2003 B402
15-75-2004 B403
15-75-2005 B404
15-75-2006A B405A
15-75-2007A B406A
15-75-2008A B407A
15-75-2009A B408A





* Eye Bracket only. Eye Brackets with suffix letter "A" reflect revised NFPA standards for F and FL dimensions.

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