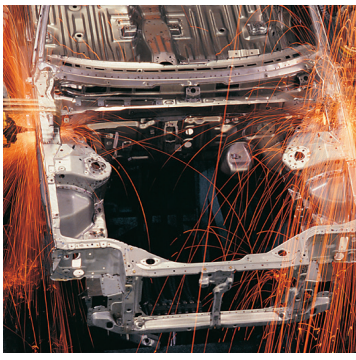
Rod Lock Air Cylinders

Series 2AP & 2ANP



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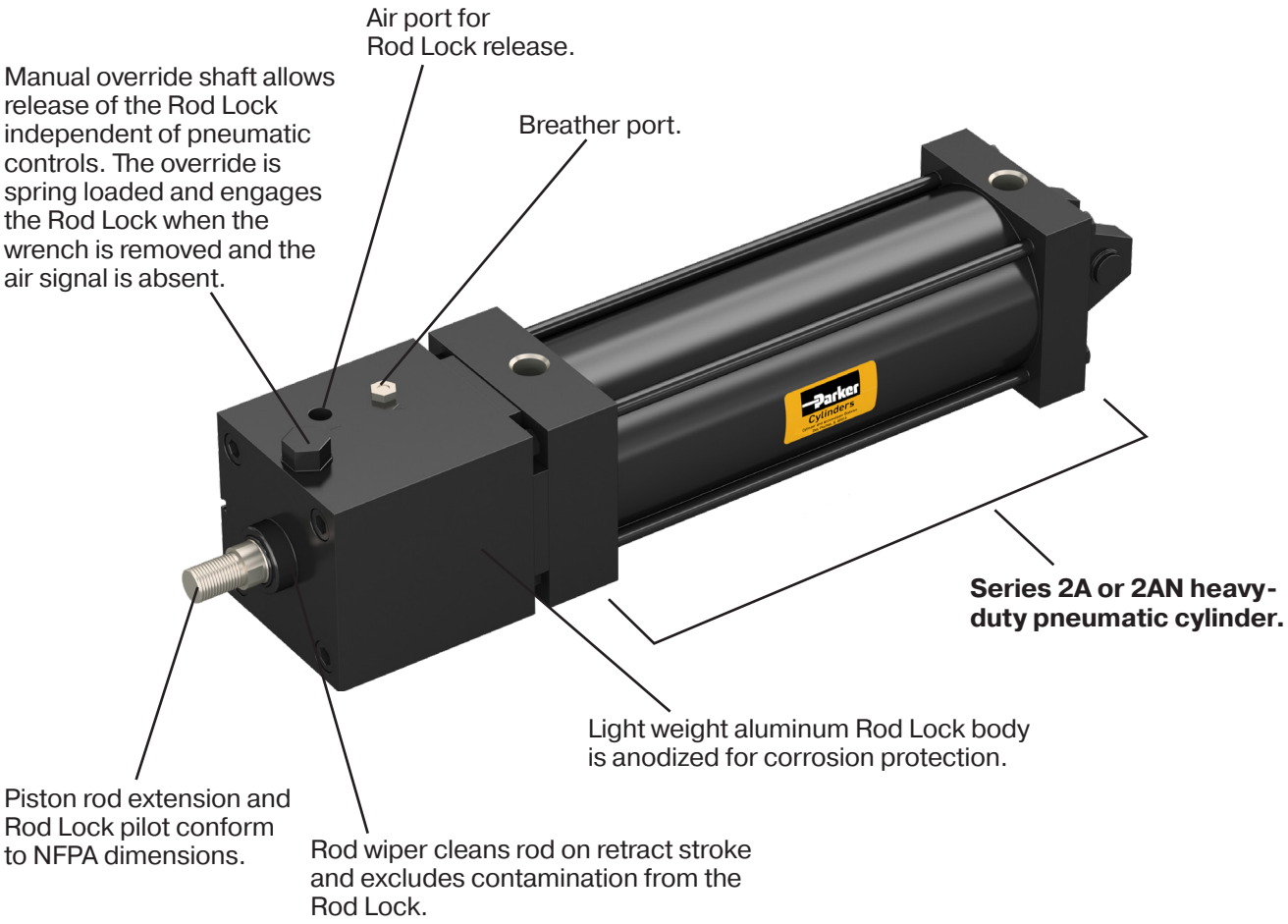
Benefits of using a piston Rod Lock include:

- Prevents rod movement upon release of stored energy
- Eliminates the need for pilot operated check valves for load holding
- Eliminates complicated piping between pilot operated check valves and the cylinder



Rod Lock Features

- **True Bolt-on Modularity** – the cylinder is built and tested as a stand alone unit. The Rod Lock is then assembled and tested at rated holding force.
- **Large Rod Lock Clamping Surface** – provides uniform force to the rod contact area. This allows holding forces to resist 100 psi input on the cylinder cap end for most bore and rod combinations.
- **Spring-engaged, air-released operation** – ensures positive holding in power-off situations with minimal air volume required for release.
- **Manual release is standard** – cam operated release disengages the Rod Lock with a simple turn of a hex bolt. The default-to-lock function springs back to the engaged position when released.
- **Rod Lock is sealed to withstand harsh environments** – NEMA 4X/IP67 rating protects internal components from contamination

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

Parker Hannifin Corporation
Cylinder and Accumulator Division
Des Plaines, Illinois USA

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⚠Warning

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

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How to Select a Series 2AP or 2ANP Cylinder

Step 1 – **Determine the correct cylinder bore size** necessary to achieve required push or pull force using the available operating pressure (up to 100 psi). Follow steps in Theoretical Push and Pull Forces below.

Step 2 – **Select the mounting style** that fits your installation needs. Determine the bore and rod sizes available for the required mounting style and complete the model selection.

Step 3 – **Choose a rod end style** and the desired rod end accessories.

Theoretical Push and Pull Forces

The cylinder output forces are derived from this formula:

$$F = P \times A$$

Where F = Force in pounds.
P = Pressure at the cylinder in pounds per square inch.
A = Effective area of cylinder piston in square inches.

To determine the bore size for the application, follow the steps below.

1. Select the Operating Pressure column closest to that desired.
2. In the same column, identify the force required to move the load (always rounding up). If the piston rod is in compression use the 'Push' row and if the piston rod is in tension use the 'Pull' row.
3. In the row to the left is the bore required. To select the correct rod diameter for the stroke required use the Piston Rod-Stroke Selection Chart on page 7.

If the cylinder envelope dimensions are too large for the application, increase the operating pressure to the maximum pressure in the table below, if possible, and repeat steps 1 - 3.

Push and Pull Force in Pounds

Bore Ø	Rod Ø	Operating Direction	Piston Area (inches²)	Operating Pressure in psi		
				60	80	100
1 1/2	5/8	Push	1.767	106	141	177
		Pull	1.460	88	117	146
2	5/8	Push	3.142	189	251	314
		Pull	2.835	170	227	284
	1	Push	3.142	189	251	–
		Pull	2.357	141	189	–
2 1/2	5/8	Push	4.909	295	393	491
		Pull	4.602	276	368	460
	1	Push	4.909	295	393	491
		Pull	4.124	247	330	412
3 1/4	1	Push	8.296	498	664	830
		Pull	7.511	451	601	751
	1 3/8	Push	8.296	498	664	830
		Pull	6.811	409	545	681
4	1	Push	12.566	754	1005	1257
		Pull	11.781	707	942	1178
	1 3/8	Push	12.566	754	1005	1257
		Pull	11.081	665	886	1108
5	1	Push	19.635	1178	1571	1964
		Pull	18.850	1131	1508	1885
	1 3/8	Push	19.635	1178	1571	1964
		Pull	18.150	1089	1452	1815
6	1 3/8	Push	28.274	1696	2262	2830
		Pull	26.789	1607	2143	2679
	1 3/4	Push	28.274	1696	2264	2830
		Pull	25.869	1552	2070	2587
8	1 3/8	Push	50.265	3016	4021	5027
		Pull	48.780	2927	3902	4878
	1 3/4	Push	50.265	3016	4021	5027
		Pull	47.860	2872	3829	4786

* Maximum Rod Lock operating pressure = 100 PSI

Cylinder Pressure Rating & Rod Lock Holding Force

Bore Ø	1 1/2	2		2 1/2	3 1/4	4	5	6	8
Rod Ø	5/8	5/8	1	5/8, 1	1, 1 3/8	1, 1 3/8	1, 1 3/8	1 3/8, 1 3/4	1 3/8, 1 3/4
Cylinder Pressure Rating (psi)	100	100	80	100	100	100	100	100	100
Rod Lock Holding Force (lb.)	180	314	250	491	830	1256	1963	2830	5026

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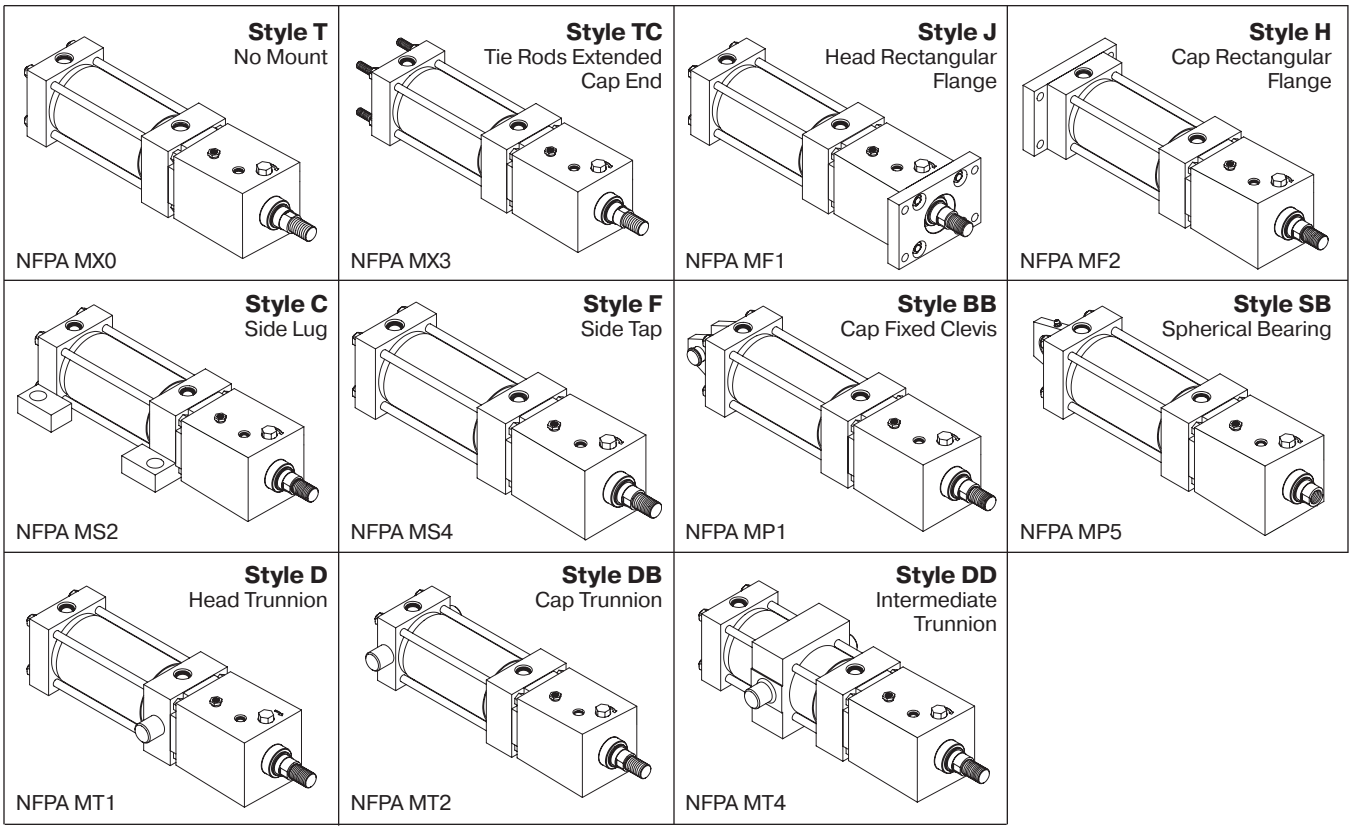
Series 2AP/2ANP Mounting Styles



Standard Specifications

- 11 Standard mounting styles
- Bore sizes – 1½" to 8"
- Strokes – up to 120"
- Piston Rod Diameters – ⅝" to 1¾"
- Working pressure up to 100 psi
- Single and double rod construction available
- Temperature range – -10°F (-23°C) to +165°F (+74°C)

Seal Classes	Typical Fluids	Temperature Range
1 – Standard Nitrile Seals	Dry 50µ filtered air	-10°F (-23°C) to +165°F (+74°C)
5 – Optional (At extra cost) Fluorocarbon Seals	Dry 50µ filtered air	-10°F (-23°C) to +165°F (+74°C)
Note: Class 5 seals do not increase temperature resistance of the cylinder and Rod Lock assembly. Specify Class 5 seals for chemical compatibility.		

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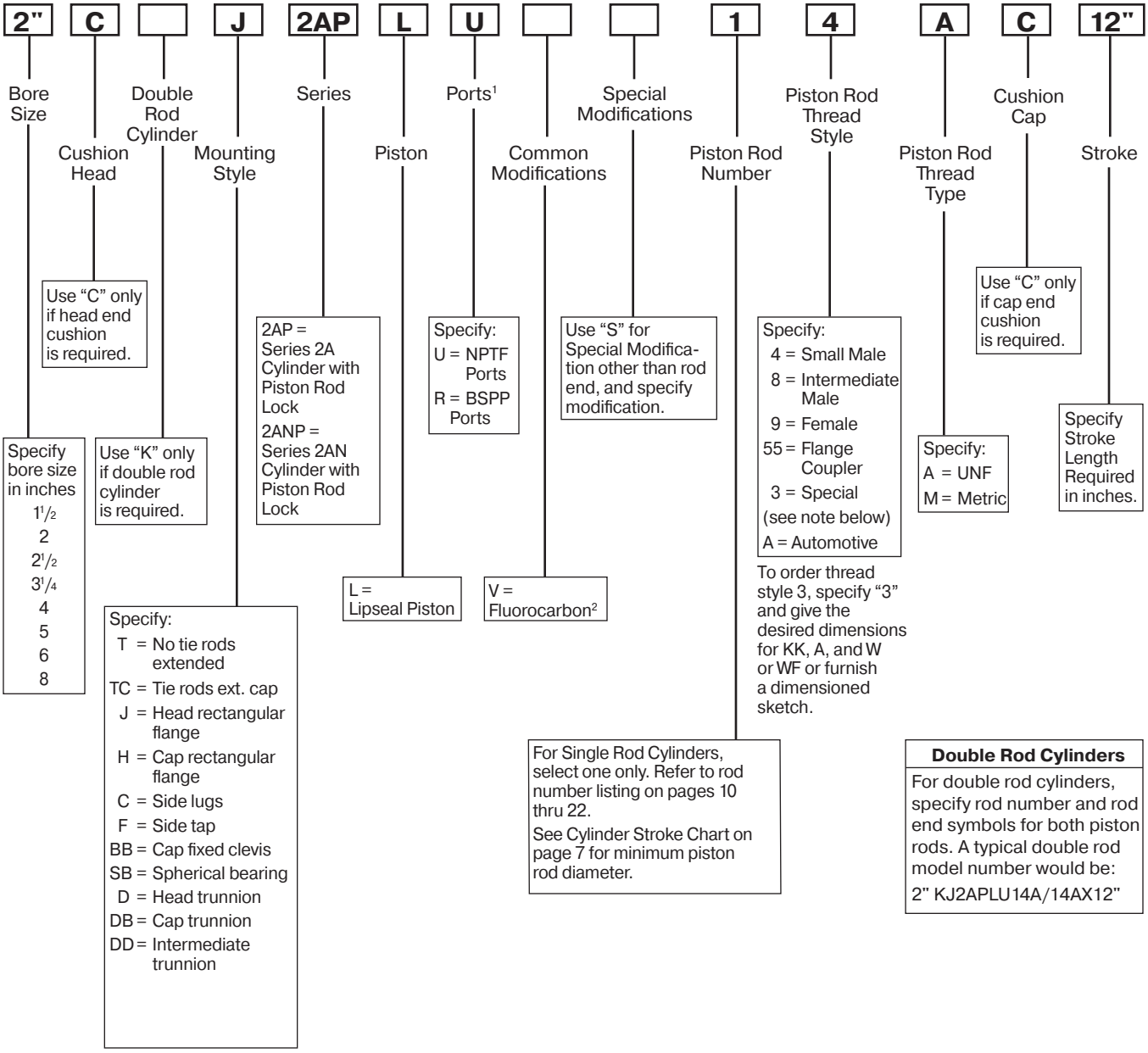
2AP / 2ANP Model Code



[1] Port thread styles for base cylinder only. Standard Rod Lock port is NPTF and cannot be specified with this field entry. If a different Rod Lock port is required, place an 'S' for special in the Special Modification field and indicate the desired Rod Lock port thread style in the item notes.

[2] Fluorocarbon seals for the 2AP or 2ANP are only for chemical compatibility and not for temperature resistance. The maximum rod lock operating temperature is +165°F.

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Rod Lock Connection / Rod Lock Specifications

Connection

The Rod Lock release signal should be taken from the main air supply and must be **60 psi or higher**. Avoid using cylinder lines for the release signal because pressure levels may drop below the specified minimum. A separate quick-venting valve should be used for ON/OFF operation of the Rod Lock.

Caution: Release pressures that fall below 60 psi may result in engagement of the Rod Lock.

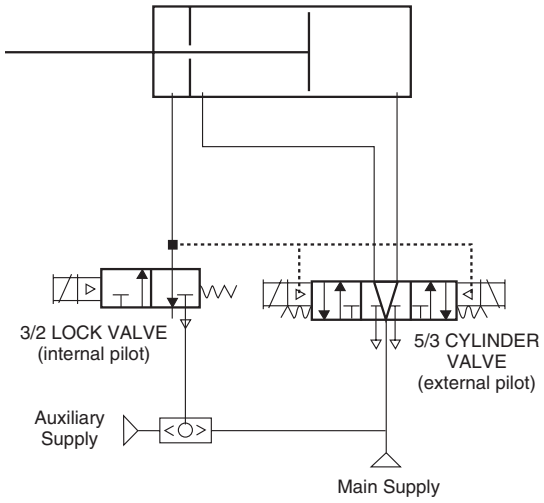
The Rod Lock is not intended to stop a moving load. The piston rod should not be moving when the Rod Lock release signal is removed.

Series 2AP / 2ANP is not intended for use in water service applications, environments with high humidity levels, or when fluids may splash on the cylinder or piston rod.

Other Series 2AP/ 2ANP and Rod Lock Features

- The Rod Lock can be operated in both directions, engaging with the same holding force
- The Series 2AP / 2ANP can be mounted in any orientation. E.g. vertical, horizontal, rod up or down.
- The piston rod must not be rotated when the Rod Lock is engaged. The Rod Lock cannot be used for torsional braking.
- Rated Rod Lock holding force applies only to static load conditions. If the rated load value is exceeded, slippage and other problems (including damage to Rod Lock and piston rod) may occur.
- An unrelated, redundant safety system is recommended to help ensure personal safety.

Sample Pneumatic Circuit



1. The Lock Valve must be energized during cylinder motion. When the Lock Valve is not energized, the Rod Lock is engaged and the Cylinder Valve must be in the mid-position.
2. The Cylinder Valve must be energized during extend or retract. It should also be energized at stroke end until a change of direction is required.
3. The 5/3 Cylinder Valve mid-position may be pressurized outlets if the combination of pressure load on the cylinder and the inertia effects of the attached load do not exceed the holding force rating of the Rod Lock device, including allowance for wear.
4. Do not use cylinder lines for logic functions because pressures can vary significantly.

Rod Lock Specifications

Bore Ø	Rod No.	Rod Ø	Air Chamber Volume (in^3)	Rated Holding Force (lbs)	Minimum Override Torque (ft-lbs applied to hex shaft)	Cylinder Pressure Rating (psi)
1.50	1	0.625	0.25	180	6	100
2.00	1	0.625	0.71	314	16	100
	3	1.000	0.68	250	16	80
2.50	1	0.625	1.26	491	16	100
	3	1.000	1.49	491	16	100
3.25	1	1.000	3.20	830	17	100
	3	1.375	2.11	830	17	100
4.00	1	1.000	6.73	1256	45	100
	3	1.375	4.78	1256	45	100
5.00	1	1.000	11.50	1963	72	100
	3	1.375	9.50	1963	72	100
6.00	1	1.375	14.08	2830	135	100
	3	1.750	12.75	2830	135	100
8.00	1	1.375	22.66	5026	160	100
	3	1.750	23.21	5026	160	100

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Cylinder Weights

To determine the weight of a Series 2AP or 2ANP cylinder, first select the basic zero stroke weight for the mounting required, and then calculate the weight of the cylinder stroke and add the results to the basic weight. For extra rod extension, use piston rod weights per inch in Table B.

Table A – Series 2AP & 2ANP Cylinder Weights in Pounds

Bore Ø	Rod Ø	Single Rod Cylinders Basic Weight - Zero Stroke		Add Per Inch of Stroke	Double Rod Cylinders Basic Weight - Zero Stroke		Add Per Inch of Stroke
		T, TC, F, H, J	C, BB, SB D, DB, DD		KT KF, KJ	KC, KD, KDD	
1 1/2	5/8	6.0	6.6	0.3	6.6	7.2	0.6
2	5/8	8.8	9.2	0.4	9.7	10.1	0.8
	1	9.9	10.4	0.5	10.8	11.3	1.1
2 1/2	5/8	12.9	13.6	0.5	14.2	14.8	0.9
	1	14.8	15.3	0.6	16.1	16.6	1.2
3 1/4	1	25.3	26.3	0.7	27.3	28.2	1.4
	1 3/8	28.2	29.3	0.9	30.2	31.2	1.8
4	1	37.0	41.8	0.8	39.9	44.2	1.6
	1 3/8	37.2	41.9	1.0	40.1	44.4	2.0
5	1	61.2	68.8	1.2	65.5	72.5	2.3
	1 3/8	61.7	69.3	1.4	66.0	73.0	2.7
6	1 3/8	95.7	104.0	1.7	101.7	109.6	3.4
	1 3/4	98.6	107.0	1.9	104.6	112.6	3.9
8	1 3/8	163.6	168.8	2.4	173.9	178.9	4.8
	1 3/4	169.0	174.3	2.7	179.2	184.4	5.4

Table B – Piston Rod Weights in Pounds

Rod Ø	Piston Rod Weight Per Inch
5/8"	0.09
1"	0.22
1 3/8"	0.42
1 3/4"	0.68

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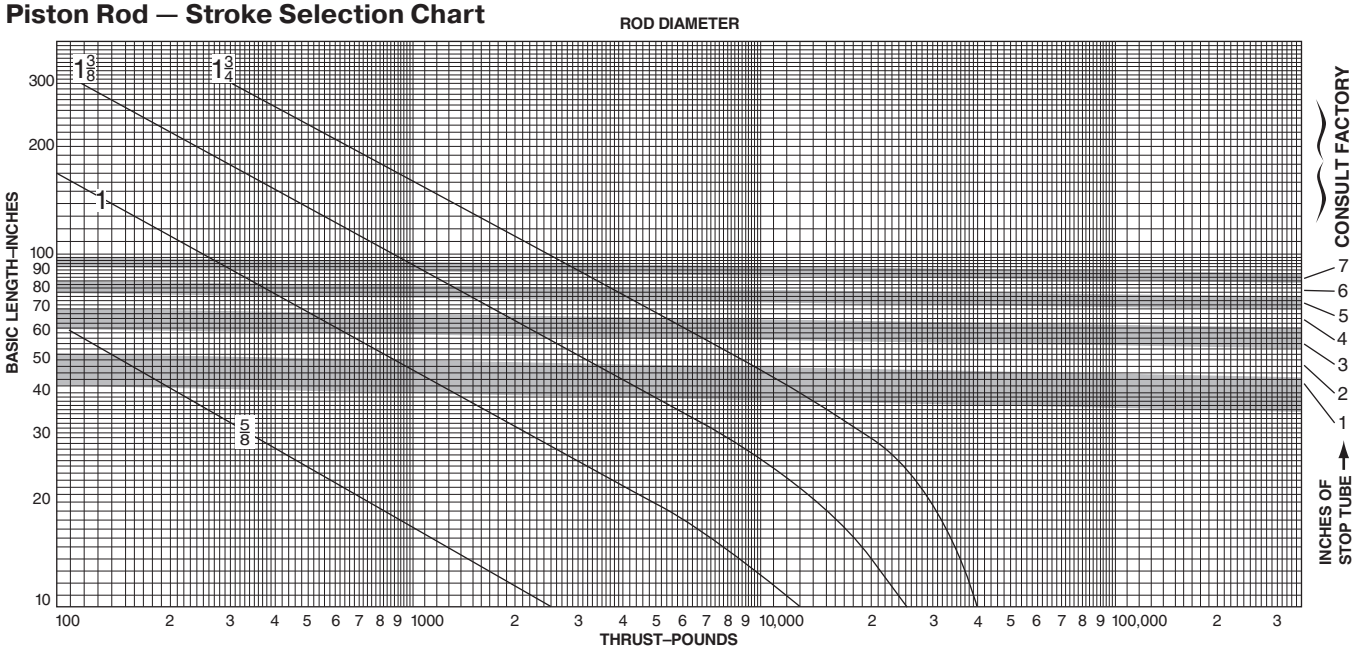
Piston Rod — Stroke Selection Chart



How to Use the Chart

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

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

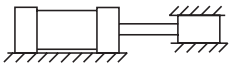
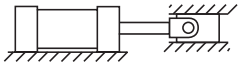
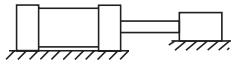
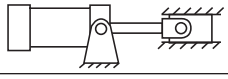
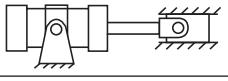
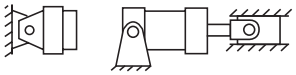
   Basic Length = Actual Stroke x Stroke Factor

   The graph is prepared for standard rod extensions beyond the face of the head. For rod extensions greater than standard, add the increase to the stroke in arriving at the "basic length."
3. Find the load imposed for the thrust application by multiplying the full bore area of the cylinder by the system pressure.
4. Enter the graph along the values of "basic length" and "thrust" as found above and note the point of intersection:
   A) The correct piston rod size is read from the diagonally curved line labeled "Rod Diameter" next above the point of intersection.
   B) The required length of stop tube is read from the right of the graph by following the shaded band in which the point of intersection lies.
   C) If required length of stop tube is in the region labeled "consult factory," submit the following information for an individual analysis:

1) Cylinder mounting style.
2) Rod end connection and method of guiding load.
3) Bore, required stroke, length of rod extension (Dim. "A" and "W") if greater than standard, and series of cylinder used.
4) Mounting position of cylinder. (Note: If at an angle or vertical, specify direction of piston rod.)
5) Operating pressure of cylinder if limited to less than standard pressure for cylinder selected.

Warning

Piston rods are not normally designed to absorb bending moments or loads which are perpendicular to the axis of piston rod motion. These additional loads can cause the piston rod end to fail. If these types of additional loads are expected to be imposed on the piston rods, their magnitude should be made known to our Engineering Department so they may be properly addressed. Additionally, cylinder users should always make sure that the piston rod is securely attached to the machine member.

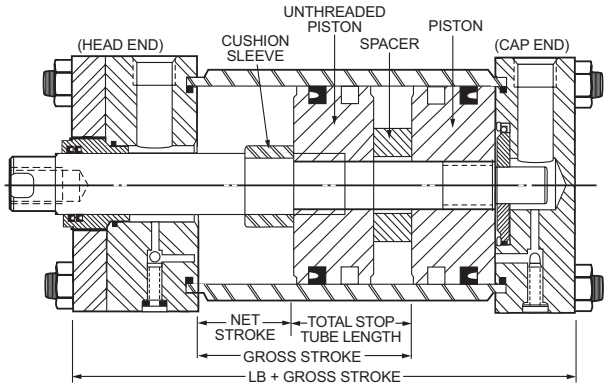
Recommended Mounting Styles for Maximum Stroke and Thrust Loads	Rod End Connection	Case	Stroke Factor
Groups 1 or 3 Long stroke cylinders for thrust loads should be mounted using a heavy-duty mounting style at one end, firmly fixed and aligned to take the principal force. Additional mounting should be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

Stop Tubing

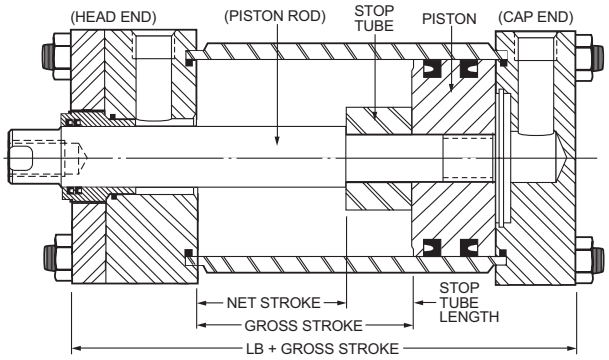
Stop tube is recommended to lengthen the distance between the gland and piston to reduce bearing loads when the cylinder is fully extended. This is especially true of horizontally mounted and long stroke cylinders. Long stroke cylinders achieve additional stability through the use of a stop tube.

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

Refer to piston rod/stroke selection chart to determine stop tube length.



Double piston design is supplied on air cylinders with cushion head end or both ends.



This design is supplied on cushion cap end non cushion
cylinders.

Mounting Classes

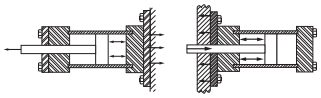
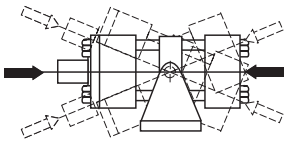
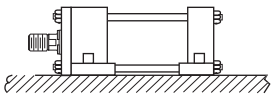
Standard mountings for fluid power cylinders fall into three basic groups. The groups can be summarized as follows:

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

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

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

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

Group 1 FIXED MOUNTS which absorb force on cylinder centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	Mtg. Style TC
Medium -Duty Service For Thrust Loads For Tension Loads	Mtg. Style H Mtg. Style J
Group 2 PIVOT MOUNTS which absorb force on cylinder centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	Mtg. Styles DD, D Mtg. Styles BB, DD, D, DB
Medium-Duty Service For Thrust Loads For Tension Loads	Mtg. Style BB Mtg. Style BB
Group 3 FIXED MOUNTS which do not absorb force on the centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	Mtg. Style C Mtg. Style C
Medium-Duty Service For Thrust Loads For Tension Loads	Mtg. Style F Mts. Style F

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LED Light on Sensor

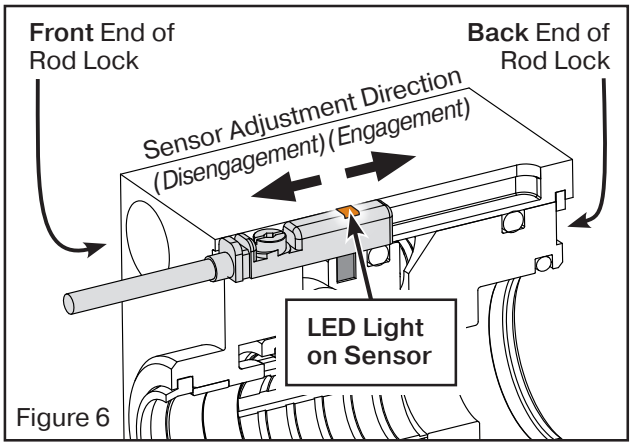

Figure 6

Disengagement Sensor Definition - Sensor is activated when the rated air pressure is applied and the piston moves to a disengaged position.

Engagement Sensor Definition - Sensor is activated when the piston moves out of the disengaged position into a position in which the clamp collar constricts on the rod.

Sensing Disengagement Position:

1. With Rod Lock on rod, supply air pressure to the Rod Lock so it is disengaged.
2. Install sensor as shown in Figure 6. Start with sensor positioned closest to the back of the Rod Lock, past the sensing target. Slide the sensor towards the front end of the Rod Lock until LED is lit. Once the LED is lit, move sensor a small amount further into sensing target.
3. Use a standard flat-head screwdriver or 1.5mm allen wrench to turn the screw and fix the sensor in the t-slot.
4. Cycle air pressure to ensure the LED is lit only when release air pressure is supplied to the Rod Lock.

Sensing Engagement Position:

1. With Rod Lock on rod, remove air pressure to the Rod Lock so it is engaged.
2. Install sensor as shown in Figure 6. Start with sensor positioned closest to the front of the Rod Lock, before the sensing target is reached. Slide the sensor towards the back end of the Rod Lock until LED is lit. Once the LED is lit, move sensor a small amount further into sensing target.
3. Use a standard flat-head screwdriver or 1.5mm allen wrench to turn the screw and fix the sensor in the t-slot.
4. Cycle air pressure to ensure the LED is lit only when air pressure is removed from the Rod Lock.

Operating Mode Sensor

Sensor Type	Magneto-resistive
Supply Voltage	10 to 30 V DC
Operational Current	< 150 mA
Switching Type	Normally Open (PNP or NPN Available)
Ambient Temperature	-25 to 70°C (-13 to +158°F)
Switching Status Indicator	LED, Yellow
Cable Length	7 meters (22.9 feet)
Protection Class	IP68
Circuit Protection	Short Circuit, Wire Breakage, Reverse Polarity

Parker Part Number	Description
966190	RL Sensor NPN NO
966195	RL Sensor PNP NO

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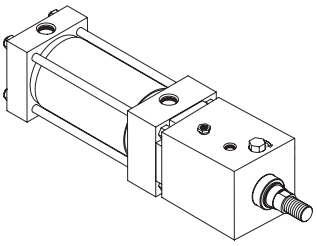
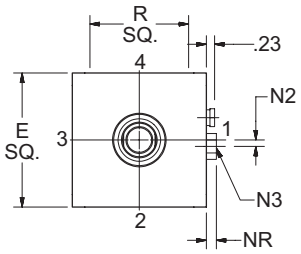
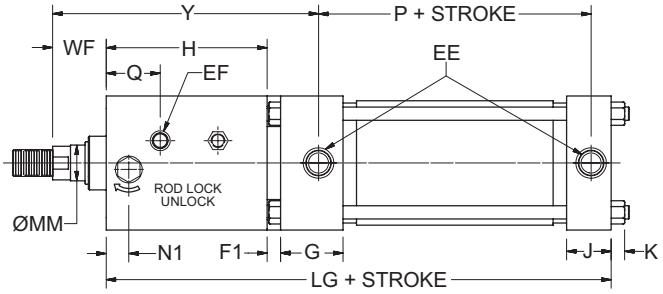
T Mount – Single Rod End

1½" to 8" Bore Size







T Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	E	EE NPTF	EF NPTF	F1	G	J	K	N3 Hex	NR (Max.)	R	P Add Stroke
1.50	2.00	3/8	1/8	0.25	1.50	1.00	0.25	5/16	0.24	1.43	2.25
2.00	2.50	3/8	1/8	0.31	1.50	1.00	0.32	1/2	0.32	1.84	2.25
2.50	3.00	3/8	1/8	0.31	1.50	1.00	0.32	1/2	0.32	2.19	2.38
3.25	3.75	1/2	1/4	0.38	1.75	1.25	0.38	5/8	0.41	2.76	2.63
4.00	4.50	1/2	1/4	0.38	1.75	1.25	0.38	7/8	0.55	3.32	2.63
5.00	5.50	1/2	1/4	0.50	1.75	1.25	0.44	7/8	0.55	4.10	2.88
6.00	6.50	3/4	1/4	0.50	2.00	1.50	0.44	1 5/16	0.81	4.88	3.13
8.00	8.50	3/4	1/4	0.63	2.00	1.50	0.56	1 5/16	0.81	6.44	3.25

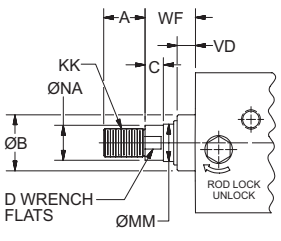
* 8" Bore has exposed tie rod nuts on the Rod Lock end

T Mount Single Rod End – Rod Dimensions

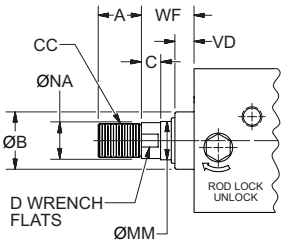
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions													LG Add Stroke
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	H	N1	N2	NA	Q	VD	WF	Y	
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	2.93	0.22	0.14	0.56	0.72	0.38	1.00	5.11	6.80
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	2.88	0.34	0.13	0.56	0.90	0.38	1.00	5.13	6.81
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	3.88	0.34	0.15	0.94	1.07	0.50	1.38	6.50	7.81
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	2.88	0.35	0.15	0.56	0.76	0.50	1.00	5.13	6.94
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	4.00	0.35	0.15	0.94	1.12	0.50	1.38	6.63	8.06
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	4.50	0.63	0.18	0.94	1.51	0.50	1.38	7.31	9.13
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	4.88	0.81	0.25	1.31	1.65	0.63	1.63	7.94	9.50
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	4.88	0.63	0.24	0.94	1.73	0.50	1.38	7.69	9.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	5.13	0.77	0.28	1.31	1.68	0.75	1.63	8.19	9.75
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	5.38	0.72	0.22	0.94	2.00	0.50	1.38	8.31	10.38
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	5.75	0.72	0.22	1.31	2.33	0.75	1.63	8.94	10.75
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	6.38	1.17	0.18	1.31	2.71	0.76	1.63	9.69	11.88
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	6.88	1.50	0.18	1.69	3.07	0.88	1.88	10.44	12.38
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	6.63	1.31	0.18	1.31	2.89	0.76	1.63	10.06	12.38
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	7.13	1.57	0.18	1.69	3.15	0.88	1.88	10.81	12.88

Rod End Dimensions

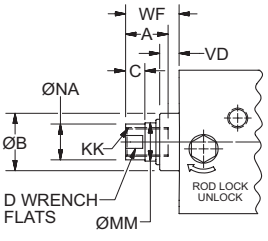
Thread Style 4



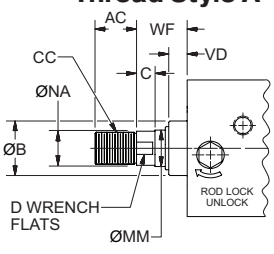
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

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

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

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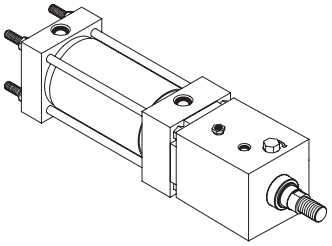
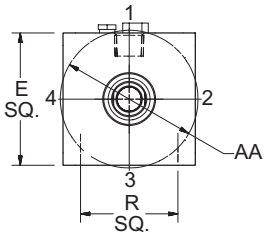
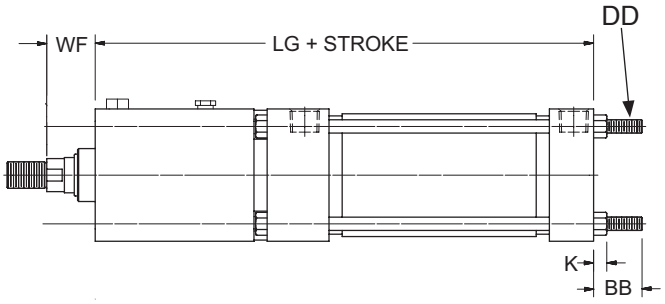
TC Mount – Single Rod End*

1½" to 8" Bore Size







TC Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	AA	BB	DD	E	K	R
1.50	2.02	1.00	1/4-28	2.00	0.25	1.43
2.00	2.60	1.13	5/16-24	2.50	0.31	1.84
2.50	3.10	1.13	5/16-24	3.00	0.31	2.19
3.25	3.90	1.38	3/8-24	3.75	0.38	2.76
4.00	4.70	1.38	3/8-24	4.50	0.38	3.32
5.00	5.80	1.81	1/2-20	5.50	0.44	4.10
6.00	6.90	1.81	1/2-20	6.50	0.44	4.88
8.00	9.10	2.31	5/8-18	8.50	0.56	6.44

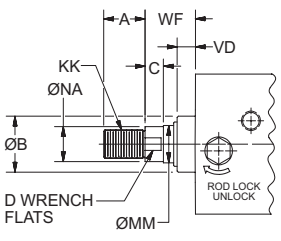
* 8" Bore has exposed tie rod nuts on the Rod Lock end

TC Mount Single Rod End – Rod Dimensions

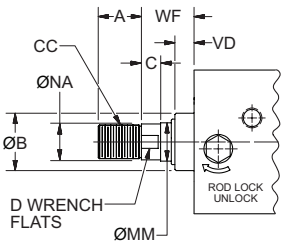
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions								LG Add Stroke
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	VD	WF	
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	6.80
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	6.81
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.81
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.50	1.00	6.94
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	8.06
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.13
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.63	1.63	9.50
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.75
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	10.38
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	10.75
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	11.88
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.88	1.88	12.38
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	12.38
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	0.88	1.88	12.88

Rod End Dimensions

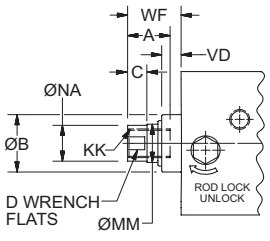
Thread Style 4



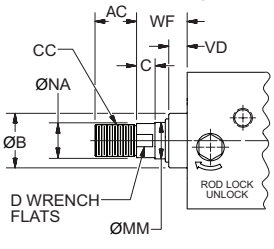
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

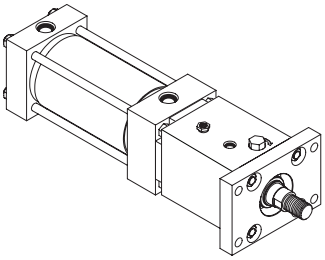
Special thread, extension, rod eye, blank, etc. are also available.

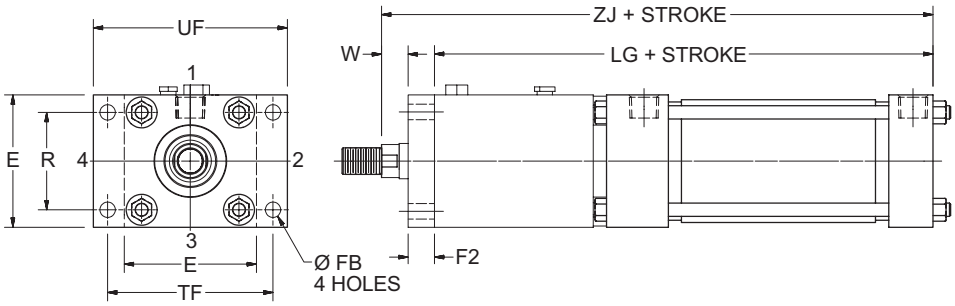
To order, specify "Style 3" and give desired dimensions for KK, A, & WF. If otherwise special furnish dimensional sketch.

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

J Mount – Single Rod End

1½" to 8" Bore Size





J Mount Single Rod End – Envelope and Mounting Dimensions

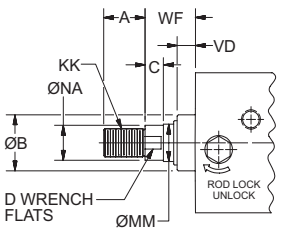
Bore Ø	E	F2	FB (Bolt)	R	TF	UF
1.50	2.00	0.63	0.25	1.43	2.75	3.38
2.00	2.50	0.63	0.31	1.84	3.38	4.13
2.50	3.00	0.63	0.31	2.19	3.88	4.63
3.25	3.75	0.75	0.38	2.76	4.69	5.50
4.00	4.50	0.75	0.38	3.32	5.44	6.25
5.00	5.50	0.75	0.50	4.10	6.63	7.63
6.00	6.50	0.75	0.50	4.88	7.63	8.63
8.00	8.50	1.00	0.63	6.44	9.75	11.00

J Mount Single Rod End – Rod Dimensions

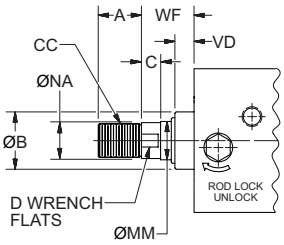
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions								Add Stroke	
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	V	W	LG	ZJ
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	–	0.63	6.80	8.05
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	–	0.63	6.81	8.06
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	–	1.00	7.81	9.44
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	–	0.63	6.94	8.19
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	–	1.00	8.06	9.69
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	–	0.75	9.13	10.63
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	–	1.00	9.50	11.25
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	–	0.75	9.50	11.00
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	–	1.00	9.75	11.50
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	–	0.75	10.38	11.88
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	–	1.00	10.75	12.50
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	–	0.88	11.88	13.50
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.13	1.13	12.38	14.25
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	–	0.88	12.38	14.25
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	–	1.13	12.88	15.00

Rod End Dimensions

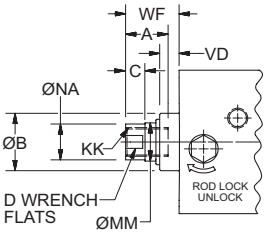
Thread Style 4



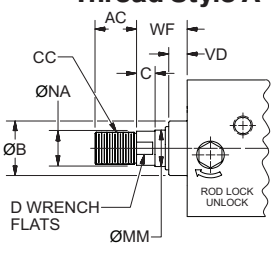
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

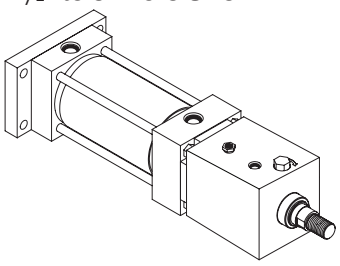
Special thread, extension, rod eye, blank, etc. are also available.

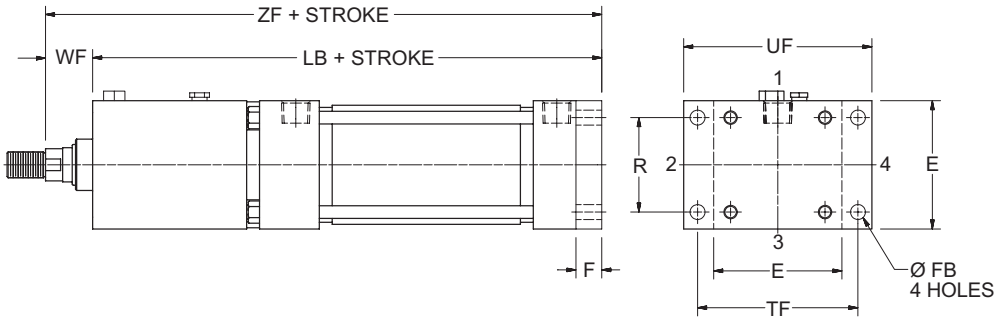
To order, specify "Style 3" and give desired dimensions for KK, A, & WF. If otherwise special furnish dimensional sketch.

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

H Mount – Single Rod End

1½" to 8" Bore Size





H Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	E	F	FB (Bolt)	R	TF	UF
1.50	2.00	0.38	0.25	1.43	2.75	3.38
2.00	2.50	0.38	0.31	1.84	3.38	4.13
2.50	3.00	0.38	0.31	2.19	3.88	4.63
3.25	3.75	0.63	0.38	2.76	4.69	5.50
4.00	4.50	0.63	0.38	3.32	5.44	6.25
5.00	5.50	0.63	0.50	4.10	6.63	7.63
6.00	6.50	0.75	0.50	4.88	7.63	8.63
8.00	8.50	–	0.69*	7.57*	7.57*	8.50*

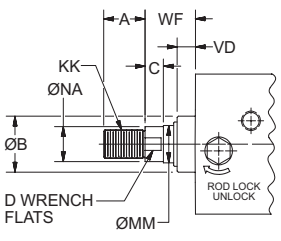
* Style HB Square Cap mount supplied in 8" bore.
*8" Bore has exposed tie rod nuts on the Rod Lock end

H Mount Single Rod End – Rod Dimensions

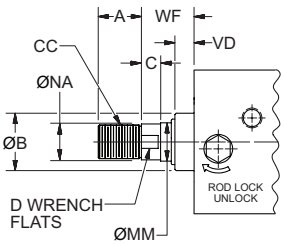
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions								Add Stroke	
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	VD	WF	LB	ZF
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	7.18	8.18
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	7.19	8.19
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	8.19	9.56
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.50	1.00	7.31	8.31
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	8.44	9.81
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.75	11.13
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.63	1.63	10.13	11.75
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	10.13	11.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	10.38	12.00
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	11.00	12.38
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	11.38	13.00
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	12.63	14.25
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.88	1.88	13.13	15.00
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	12.38*	14.00*
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	0.88	1.88	12.88*	14.25*

Rod End Dimensions

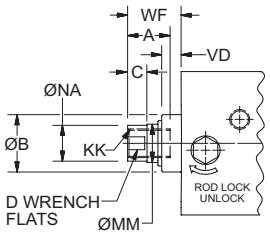
Thread Style 4



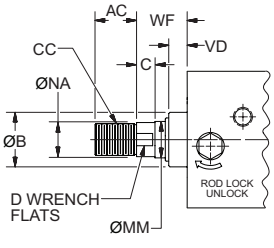
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

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

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

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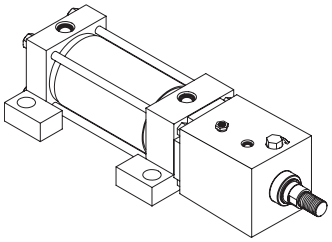
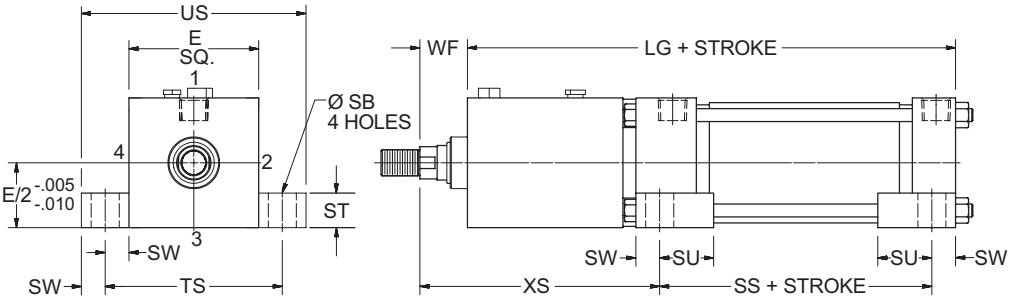
C Mount – Single Rod End

1½" to 8" Bore Size





C Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	E	SB (Bolt)	ST	SU	SW	TS	US	SS Add Stroke
1.50	2.00	0.38	0.50	0.94	0.38	2.75	3.50	2.88
2.00	2.50	0.38	0.50	0.94	0.38	3.25	4.00	2.88
2.50	3.00	0.38	0.50	0.94	0.38	3.75	4.50	3.00
3.25	3.75	0.50	0.75	1.25	0.50	4.75	5.75	3.25
4.00	4.50	0.50	0.75	1.25	0.50	5.50	6.50	3.25
5.00	5.50	0.75	1.00	1.56	0.69	6.88	8.25	3.13
6.00	6.50	0.75	1.00	1.56	0.69	7.88	9.25	3.63
8.00	8.50	0.75	1.00	1.56	0.69	9.88	11.25	3.75

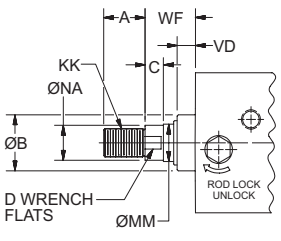
*8" Bore has exposed tie rod nuts on the Rod Lock end

C Mount Single Rod End – Rod Dimensions

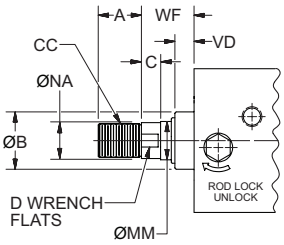
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions									LG Add Stroke
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	VD	WF	XS	
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	4.55	6.80
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	4.56	6.81
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	5.94	7.81
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.50	1.00	4.56	6.94
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	6.06	8.06
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	6.75	9.13
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.63	1.63	7.38	9.50
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.13	9.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	7.63	9.75
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.94	10.38
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	8.56	10.75
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.19	11.88
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.88	1.88	9.94	12.38
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.56	12.38
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	0.88	1.88	10.31	12.88

Rod End Dimensions

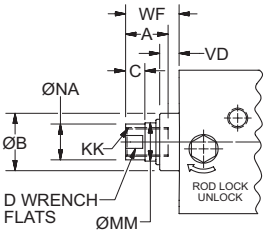
Thread Style 4



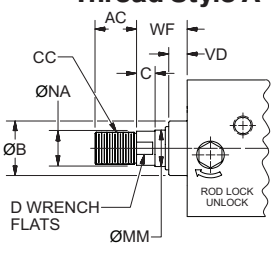
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

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

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

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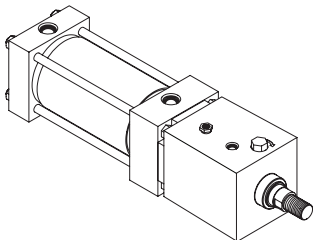
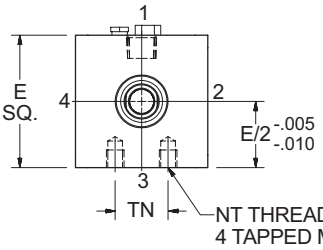
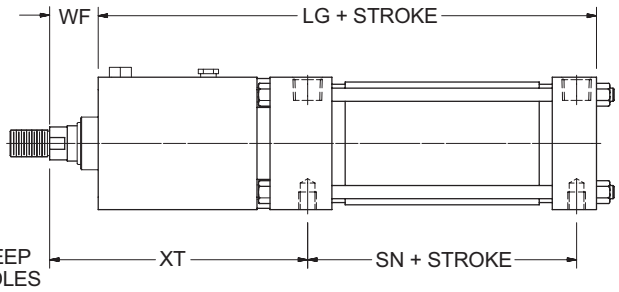
F Mount – Single Rod End

1½" to 8" Bore Size







F Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	E	ND	NT	TN	SN Add Stroke
1.50	2.00	0.31	1/4-20	0.63	2.25
2.00	2.50	0.34	5/16-18	0.88	2.25
2.50	3.00	0.44	3/8-16	1.25	2.38
3.25	3.75	0.50	1/2-13	1.50	2.63
4.00	4.50	0.63	1/2-13	2.06	2.63
5.00	5.50	0.75	5/8-11	2.69	2.88
6.00	6.50	0.88	3/4-10	3.25	3.13
8.00	8.50	1.13	3/4-10	4.25	3.25

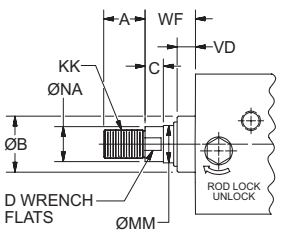
*8" Bore has exposed tie rod nuts on the Rod Lock end

F Mount Single Rod End – Rod Dimensions

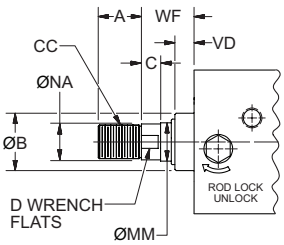
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions									LG Add Stroke
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	VD	WF	XT	
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	5.11	6.80
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	5.13	6.81
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	6.50	7.81
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.50	1.00	5.13	6.94
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	6.63	8.06
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.31	9.13
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.63	1.63	7.94	9.50
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.69	9.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	8.19	9.75
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	8.31	10.38
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	8.94	10.75
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.69	11.88
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.88	1.88	10.44	12.38
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	10.06	12.38
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	0.88	1.88	10.81	12.88

Rod End Dimensions

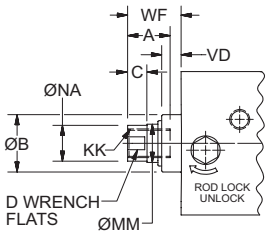
Thread Style 4



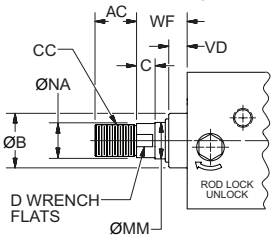
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

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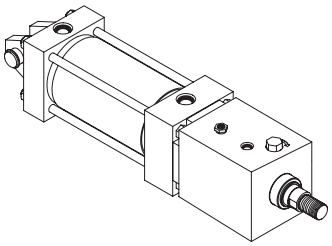
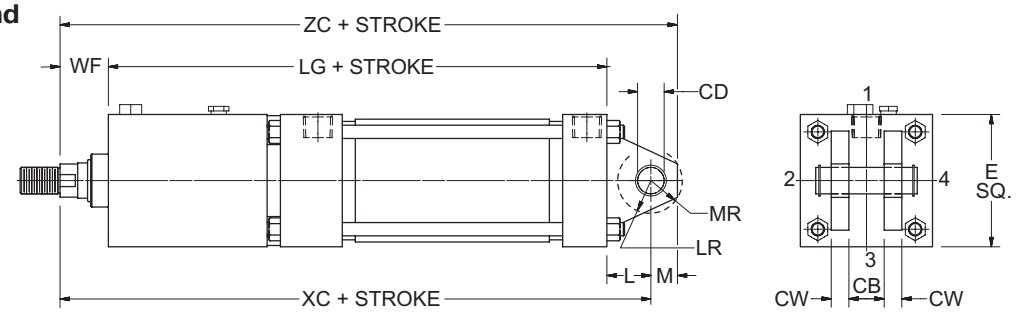
BB Mount – Single Rod End

1½" to 8" Bore Size





BB Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	CB	CD * +.000 –.002	CW	E	L	LR	M	MR
1.50	0.75	0.501	0.50	2.00	0.75	0.75	0.50	0.63
2.00	0.75	0.501	0.50	2.50	0.75	0.75	0.50	0.63
2.50	0.75	0.501	0.50	3.00	0.75	0.75	0.50	0.63
3.25	1.25	0.751	0.63	3.75	1.25	1.00	0.75	0.94
4.00	1.25	0.751	0.63	4.50	1.25	1.00	0.75	0.94
5.00	1.25	0.751	0.63	5.50	1.25	1.00	0.75	0.94
6.00	1.50	1.001	0.75	6.50	1.50	1.25	1.00	1.19
8.00	1.50	1.001	0.75	8.50	1.50	1.25	1.00	1.19

* 8" Bore has exposed tie rod nuts on the Rod Lock end

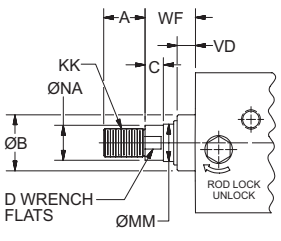
* Dimension CD is pin diameter.

BB Mount Single Rod End – Rod Dimensions

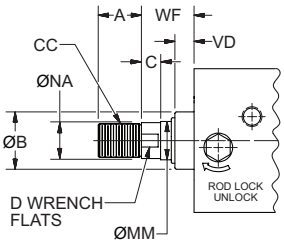
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions								Add Stroke		
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	VD	WF	LG	XC	ZC
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	6.80	8.55	9.05
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	6.81	8.56	9.06
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.81	9.94	10.44
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.50	1.00	6.94	8.69	9.19
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	8.06	10.19	10.69
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.13	11.75	12.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.63	1.63	9.50	12.38	13.13
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.50	12.13	12.88
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.75	12.63	13.38
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	10.38	13.00	13.75
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	10.75	13.63	14.38
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	11.88	15.00	16.00
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.88	1.88	12.38	15.75	16.75
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	12.38	15.50	16.50
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	0.88	1.88	12.88	16.25	17.25

Rod End Dimensions

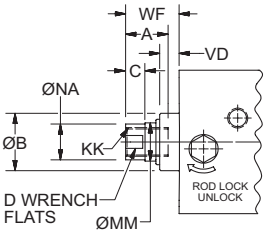
Thread Style 4



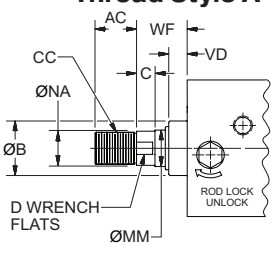
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

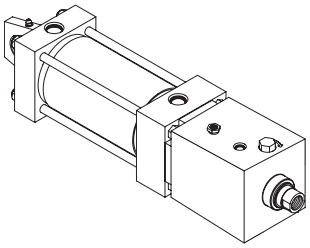
Special thread, extension, rod eye, blank, etc. are also available.

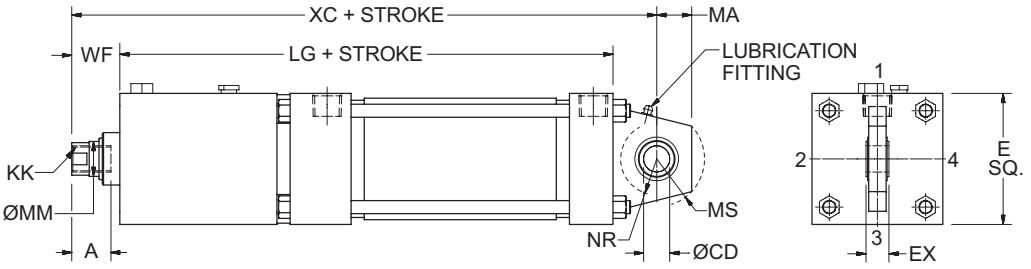
To order, specify "Style 3" and give desired dimensions for KK, A, & WF. If otherwise special furnish dimensional sketch.

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

SB Mount – Single Rod End

1½" to 8" Bore Size





SB Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	CD * +.0000 –.0005	E	EX	MA	MS	NR
1.50	0.5000	2.00	0.44	0.75	0.94	0.63
2.00	0.5000	2.50	0.44	0.75	0.94	0.63
2.50	0.5000	3.00	0.44	0.75	0.94	0.63
3.25	0.7500	3.75	0.66	1.00	1.38	1.00
4.00	0.7500	4.50	0.66	1.00	1.38	1.00
5.00	0.7500	5.50	0.66	1.00	1.38	1.00
6.00	1.0000	6.50	0.88	1.25	1.69	1.25
8.00	1.0000	8.50	0.88	1.25	1.69	1.25

* 8" Bore has exposed tie rod nuts on the Rod Lock end

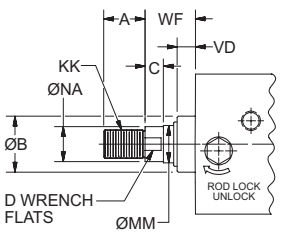
* Dimension CD is hole diameter.

SB Mount Single Rod End – Rod Dimensions

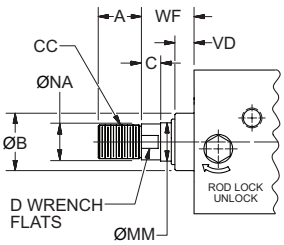
Bore Ø	Rod No.	MM Rod Ø	Thread		A	AC	WF	Add Stroke	
			KK Style 9	KK Style 7				LG	XC
1.50	1	0.625	7/16-20	–	0.75	1.13	1.00	6.80	8.55
2.00	1	0.625	7/16-20	–	0.75	1.13	1.00	6.81	8.56
	3	1.000	–	7/16-20	1.13	1.88	1.38	7.81	9.94
2.50	1	0.625	7/16-20	–	0.75	1.13	1.00	6.94	8.69
	3	1.000	–	7/16-20	1.13	1.88	1.38	8.06	10.19
3.25	1	1.000	3/4-16	–	1.13	1.88	1.38	9.13	11.75
	3	1.375	–	3/4-16	1.63	2.50	1.63	9.50	12.38
4.00	1	1.000	3/4-16	–	1.13	1.88	1.38	9.50	12.13
	3	1.375	–	3/4-16	1.63	2.50	1.63	9.75	12.63
5.00	1	1.000	3/4-16	–	1.13	1.88	1.38	10.38	13.00
	3	1.375	–	3/4-16	1.63	2.50	1.63	10.75	13.63
6.00	1	1.375	1-14	–	1.63	2.50	1.63	11.88	15.00
	3	1.750	–	1-14	2.00	3.00	1.88	12.38	15.75
8.00	1	1.375	1-14	–	1.63	2.50	1.63	12.38	15.50
	3	1.750	–	1-14	2.00	3.50	1.88	12.88	16.25

Rod End Dimensions

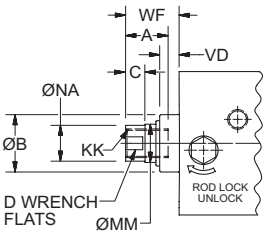
Thread Style 4



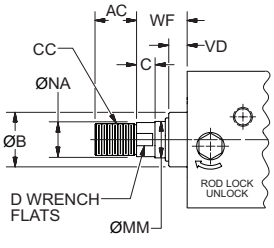
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

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

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

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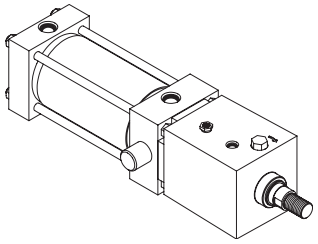
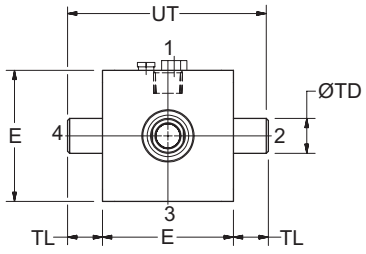
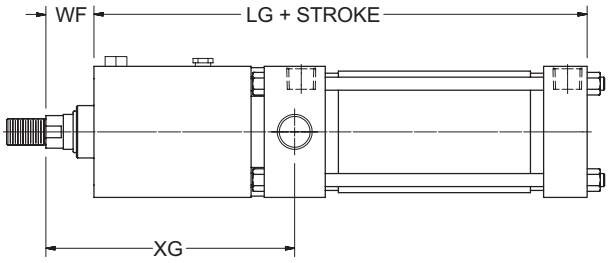
D Mount – Single Rod End

1½" to 8" Bore Size







D Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	E	TD +.000 –.001	TL	UT
1.50	2.00	1.000	1.00	4.00
2.00	2.50	1.000	1.00	4.50
2.50	3.00	1.000	1.00	5.00
3.25	3.75	1.000	1.00	5.75
4.00	4.50	1.000	1.00	6.50
5.00	5.50	1.000	1.00	7.50
6.00	6.50	1.375	1.38	9.25
8.00	8.50	1.375	1.38	11.25

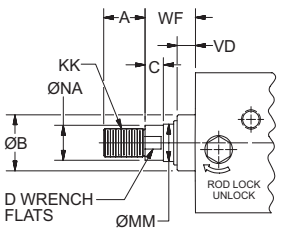
* 8" Bore has exposed tie rod nuts on the Rod Lock end

D Mount Single Rod End – Rod Dimensions

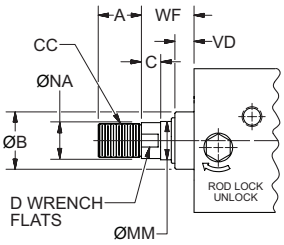
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions									LG Add Stroke
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	VD	WF	XG	
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	4.9	6.8
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	4.94	6.81
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	6.31	7.81
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.50	1.00	4.94	6.94
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	6.44	8.06
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.13	9.13
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.63	1.63	7.75	9.50
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.50	9.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	8.00	9.75
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	8.13	10.38
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	8.75	10.75
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.50	11.88
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.88	1.88	10.25	12.38
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.88	12.38
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	0.88	1.88	10.63	12.88

Rod End Dimensions

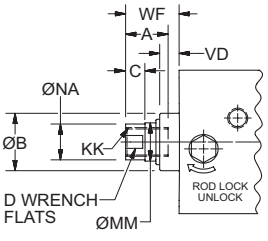
Thread Style 4



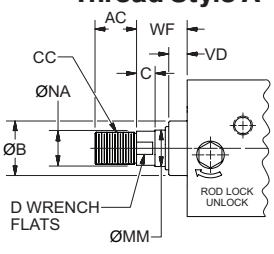
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

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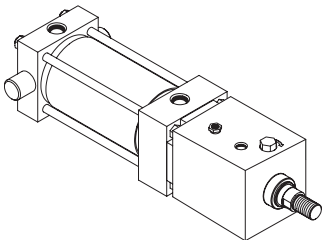
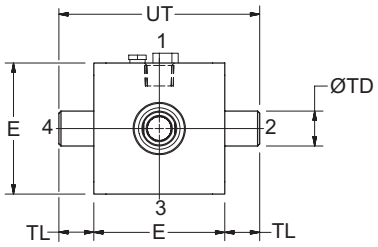
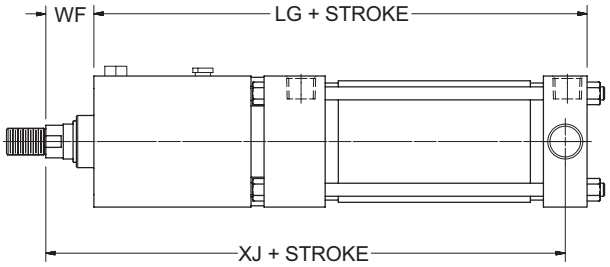
DB Mount – Single Rod End

1½" to 8" Bore Size







DB Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	E	TD +.000 –.001	TL	UT
1.50	2.00	1.000	1.00	4.00
2.00	2.50	1.000	1.00	4.50
2.50	3.00	1.000	1.00	5.00
3.25	3.75	1.000	1.00	5.75
4.00	4.50	1.000	1.00	6.50
5.00	5.50	1.000	1.00	7.50
6.00	6.50	1.375	1.38	9.25
8.00	8.50	1.375	1.38	11.25

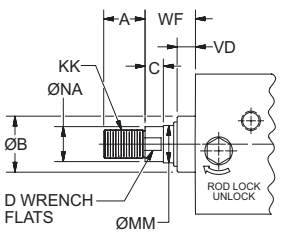
* 8" Bore has exposed tie rod nuts on the Rod Lock end

DB Mount Single Rod End – Rod Dimensions

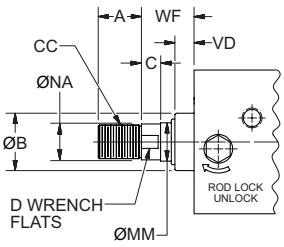
Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions								Add Stroke	
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	VD	WF	LG	XJ
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	6.80	7.30
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	6.81	7.31
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.81	8.69
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.50	1.00	6.94	7.44
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	8.06	8.94
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.13	9.88
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.63	1.63	9.50	10.50
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.50	10.25
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.75	10.75
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	10.38	11.13
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	10.75	11.75
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	11.88	12.75
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.88	1.88	12.38	13.50
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	12.38	13.25
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	0.88	1.88	12.88	14.00

Rod End Dimensions

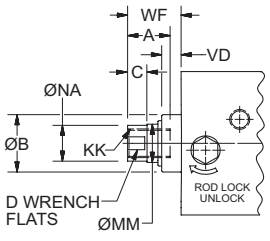
Thread Style 4



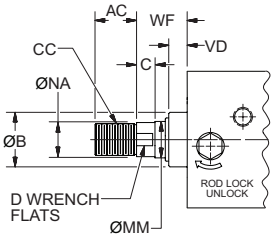
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

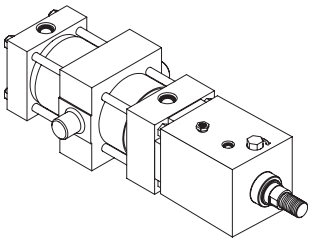
Special thread, extension, rod eye, blank, etc. are also available.

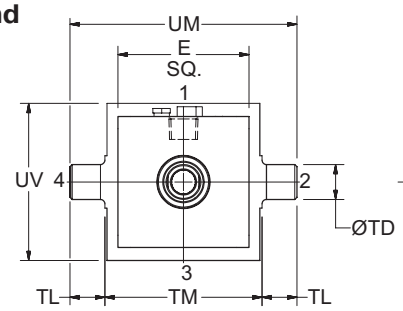
To order, specify "Style 3" and give desired dimensions for KK, A, & WF. If otherwise special furnish dimensional sketch.

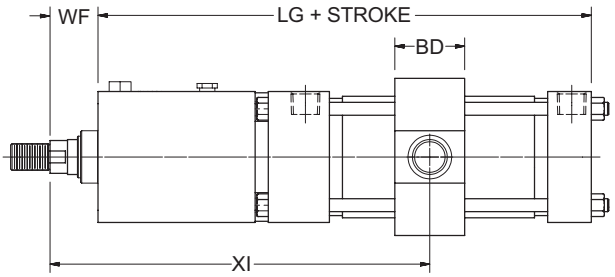
⚠ PROP 65 WARNING **WARNING:** This product can expose you to chemicals including Lead and Lead Compounds which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

DD Mount – Single Rod End

1½" to 8" Bore Size







DD Mount Single Rod End – Envelope and Mounting Dimensions

Bore Ø	E	TD +.000 –.001	TL	TM	UM	UV	Style DD Minimum Stroke
1.50	2.00	1.000	1.00	2.50	4.50	2.50	3.25
2.00	2.50	1.000	1.00	3.00	5.00	3.00	4.00
2.50	3.00	1.000	1.00	3.50	5.50	3.50	3.88
3.25	3.75	1.000	1.00	4.50	6.50	4.25	4.38
4.00	4.50	1.000	1.00	5.25	7.25	5.00	4.88
5.00	5.50	1.000	1.00	6.25	8.25	6.00	5.13
6.00	6.50	1.375	1.38	7.63	10.38	7.00	6.13
8.00	8.50	1.375	1.38	9.75	12.50	9.50	11.75

* 8" Bore has exposed tie rod nuts on the Rod Lock end

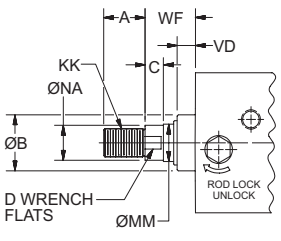
DD Mount Single Rod End – Rod Dimensions

Bore Ø	Rod No.	MM Rod Ø	Thread		Rod Extensions and Pilot Dimensions								LG Add Stroke	XI* Minimum
			CC Style 8	KK Style 4 & 9	A	AC	B +.000 -.002	C	D	NA	VD	WF		
1.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	6.80	9.30
2.00	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.38	1.00	6.81	9.94
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	7.81	11.31
2.50	1	0.625	1/2-20	7/16-20	0.75	1.13	1.124	0.38	0.50	0.56	0.50	1.00	6.94	9.94
	3	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	8.06	11.44
3.25	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.13	12.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.63	1.63	9.50	13.13
4.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	9.50	13.38
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	9.75	13.88
5.00	1	1.000	7/8-14	3/4-16	1.13	1.88	1.499	0.50	0.88	0.94	0.50	1.38	10.38	14.50
	3	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	10.75	15.13
6.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	11.88	16.75
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.00	2.374	0.75	1.50	1.69	0.88	1.88	12.38	17.50
8.00	1	1.375	1 1/4-12	1-14	1.63	2.50	1.999	0.63	1.13	1.31	0.75	1.63	12.38	23.00
	3	1.750	1 1/2-12	1 1/4-12	2.00	3.50	2.374	0.75	1.50	1.69	0.88	1.88	12.88	23.75

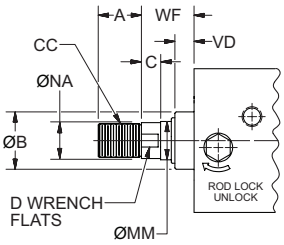
* Dimension XI to be specified by customer. If a shorter than minimum XI is required, the D Mount on page 18 may be suitable.

Rod End Dimensions

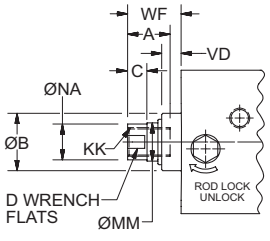
Thread Style 4



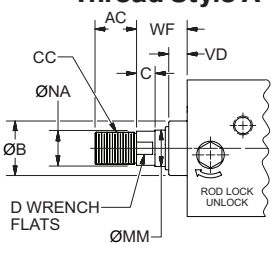
Thread Style 8



Thread Style 9



Thread Style A



"Special" Thread Style 3

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

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

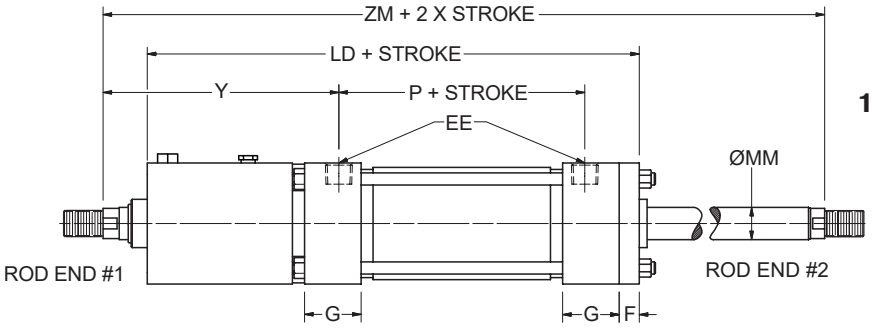
⚠ PROP 65 WARNING **WARNING:** This product can expose you to chemicals including Lead and Lead Compounds which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

How to Use Double Rod Cylinder Dimension Drawings

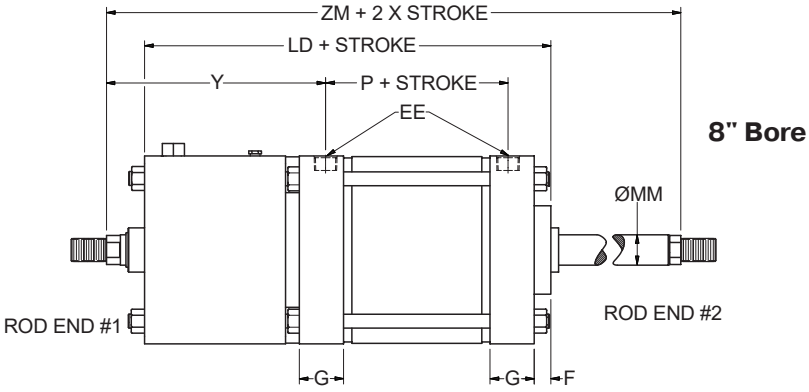
To determine dimensions for a double rod cylinder, first refer to the desired single rod mounting style cylinder shown on preceding pages of this catalog. After selecting necessary dimensions from that drawing, return to this page and supplement the single rod dimensions with those shown in the drawings and dimension table below. Note that double rod cylinders have a head (Dim. G) at both ends and that dimension LD replaces LG.

The double rod dimensions differ from, or are in addition to those for single rod cylinders shown on preceding pages and provide the information needed to completely dimension a double rod cylinder.

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



1½" to 6" Bores



8" Bore

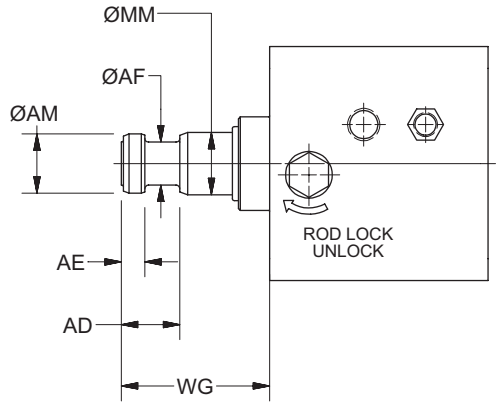
Mounting Styles for Single Rod Models	Corresponding Mounting Styles for Double Rod Models
T	KT
J	KJ
C	KC
F	KF
D	KD
DD	KDD

Bore Ø	Rod No.	MM Rod Ø	EE NPTF	F	G	P	Y	Add Stroke		Add 2X Stroke
								LD	SSK	ZM
1.50	1	0.625	3/8	0.38	1.50	2.25	5.11	7.30	2.88	9.30
2.00	1	0.625	3/8	0.38	1.50	2.25	5.13	7.31	2.88	9.31
	3	1.000	3/8	0.38	1.50	2.25	6.50	8.31	2.88	11.06
2.50	1	0.625	3/8	0.38	1.50	2.38	5.13	7.44	3.00	9.44
	3	1.000	3/8	0.38	1.50	2.38	6.63	8.56	3.00	11.31
3.25	1	1.000	1/2	0.63	1.75	2.63	7.31	9.63	3.25	12.38
	3	1.375	1/2	0.63	1.75	2.63	7.94	10.00	3.25	13.25
4.00	1	1.000	1/2	0.63	1.75	2.63	7.69	10.00	3.25	12.75
	3	1.375	1/2	0.63	1.75	2.63	8.19	10.25	3.25	13.50
5.00	1	1.000	1/2	0.63	1.75	2.88	8.31	10.88	3.13	13.63
	3	1.375	1/2	0.63	1.75	2.88	8.94	11.25	3.13	14.50
6.00	1	1.375	3/4	0.75	2.00	3.13	9.69	12.38	3.63	15.63
	3	1.750	3/4	0.75	2.00	3.13	10.44	12.88	3.63	16.63
8.00	1	1.375	3/4	0.75	2.00	3.25	10.06	13.63	3.75	16.13
	3	1.750	3/4	0.75	2.00	3.25	10.81	14.13	3.75	17.13

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

Parker Style "55" Flange Coupling Piston Rod End

- Simplifies alignment
- Reduces assembly time
- Allows full rated pneumatic pressure in push and pull directions
- Available 5/8" through 1 3/4" piston rod diameters



How to Order

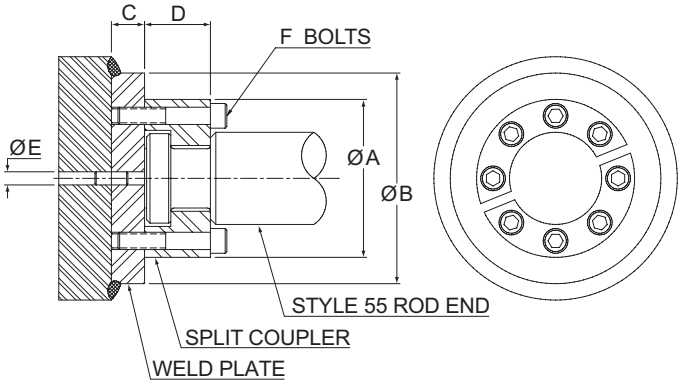
When preparing the Model Code enter a 55 in the Piston Rod Thread Style position.

Example: 2.50 2APLU1**55** X 8.00

Style 55 Rod End Dimensions

MM Rod Ø	AD	AE	AF	AM	WG
0.625	0.63	0.25	0.38	0.57	1.75
1.000	0.94	0.38	0.69	0.95	2.38
1.375	1.06	0.38	0.88	1.32	2.75
1.750	1.31	0.50	1.13	1.70	3.13

Split Couplers and Weld Plates



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

Dimensions and Part Numbers

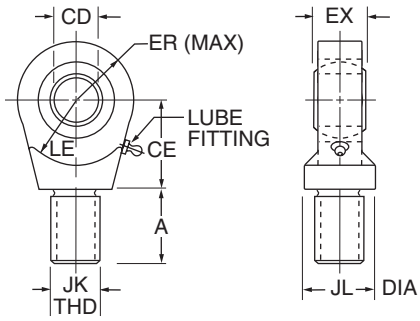
MM Rod Ø	A	B	C	D	E	F	Bolt Size	Bolt Circle	Split Coupler Part Number	Weld Plate Part Number
0.625	1.50	2.00	0.50	0.56	0.25	4	#10-24 x 0.94 LG	1.13	1472340062	1481740062
1.000	2.00	2.50	0.50	0.88	0.25	6	1/4-20 x 1.25 LG	1.50	1472340100	1481740100
1.375	2.50	3.00	0.63	1.00	0.25	6	5/16-18 x 1.50 LG	2.00	1472340138	1481740138
1.750	3.00	4.00	0.63	1.25	0.25	8	5/16-18 x 1.75 LG	2.38	1472340175	1481740175

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

Accessories for Mounting Style SB

Accessories for mounting SB include Rod Eye, Pivot Pin and Clevis Bracket. To select the proper part number for any desired accessory refer to the charts below.

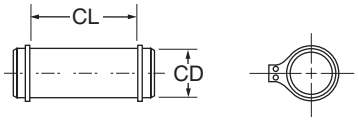
Spherical Rod Eye



Order to fit Piston Rod Thread Size.

Bore Size	Series 2AP	1 1/2, 2 & 2 1/2	3 1/4, 4 & 5	6 & 8
Rod Eye	Part No.	1322900000	1322910000	1322920000
	CD	.5000 -.0005	.7500 -.0005	1.0000 -.0005
	A	11/16	1	1 1/2
	CE	7/8	1 1/4	1 7/8
	EX	7/16	21/32	7/8
	ER	13/16	1 1/8	1 1/4
	LE	3/4	1 1/16	1 7/16
	JK	7/16-20	3/4-16	1-14
	JL	7/8	1 5/16	1 1/2
	LOAD CAPACITY LBS.	2644	9441	16860

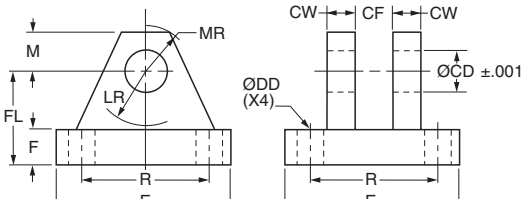
Pivot Pin



Pivot Pins are furnished with (2) Retainer Rings.

Bore Size	Series 2AP	1 1/2, 2 & 2 1/2	3 1/4, 4 & 5	6 & 8
Pivot Pin	Part No.	0839620000	0839630000	0839640000
	CD	.4997 -.0004	.7497 -.0005	.9997 -.0005
	CL	1 9/16	2 1/32	2 1/2
	LOAD CAPACITY LBS.	8600	19300	34300

Clevis Bracket



Order to fit Mounting Plate or Rod Eye.

Bore Size	Series 2AP	1 1/2, 2 & 2 1/2	3 1/4, 4 & 5	6 & 8
Clevis Bracket	Part No.	0959450000	0959300000	0959310000
	CD	1/2	3/4	1
	CF	7/16	21/32	7/8
	CW	1/2	5/8	3/4
	DD	13/32	17/32	17/32
	E	3	3 3/4	5 1/2
	F	1/2	5/8	3/4
	FL	1 1/2	2	2 1/2
	LR	15/16	1 3/8	1 11/16
	M	1/2	7/8	1
	MR	5/8	1	1 3/16
	R	2.05	2.76	4.10
	LOAD CAPACITY LBS.	5770	9450	14300

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Cylinder Accessories

Parker offers mounting accessories to provide you a complete cylinder mounting package. An Eye Bracket is available for Mounting Style BB. Select the Eye Bracket in the row to the right of the bore size cylinder required.

Rod End Accessories

Accessories offered for the rod end of the cylinder include Rod Clevis, Eye Bracket, Knuckle, Clevis Bracket and Pivot Pin. To select the proper part number for any desired accessory, refer to the table below or on the opposite page and look in the row to the right of the rod thread in the first column. For economical accessory selection, it is recommended that rod end style 4 be specified on your cylinder order

Accessory Load Capacity

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

Rod End Accessories

Thread Size	Pin Ø	Rod Clevis		Mounting Plate or Eye Bracket		Pivot Pin	
		Part Number	Load Capacity (lb)	Forged Steel or Cast Ductile Iron		Part Number	Shear Capacity (lb)
				Part Number	Load Capacity (lb)		
5/16-24	0.312	0512210000[1]	2600	0959810031	1850	–	–
7/16-20	0.500	0509400000	4250	0959810050[2]	4620	0683680000	8600
1/2-20	0.500	0509410000	4900	0959810050[2]	4620	0683680000	8600
3/4-16	0.750	0509420000	11200	0959810075[2]	12370	0683690000	19300
3/4-16	0.750	1332840000	11200	0959810075[2]	12370	0683690000	19300
7/8-14	1.000	0509430000	18800	0959810100[2]	20450	0683700000	34300
1-14	1.000	0509440000	19500	0959810100[2]	20450	0683700000	34300
1-14	1.000	1332850000	19500	0959810100[2]	20450	0683700000	34300
1 1/4-12	1.375	0509450000	33500	0959810138	33500	0683710000	65000
1 1/4-12	1.375	1332860000	33500	0959810138	33500	0683710000	65000
1 1/2-12	1.750	0509460000	45600	0959810175	49480	0683720000	105200

Rod End Accessories

Thread Size	Pin Ø	Knuckle		Clevis Bracket				Pivot Pin	
		Part Number	Load Capacity (lb)	Forged Steel or Cast Ductile Iron		Fabricated Steel		Part Number	Shear Capacity (lb)
				Part Number	Load Capacity (lb)	Part Number	Load Capacity (lb)		
5/16-24	0.438	0740750000	3300	0960160044	2830	0740760000	3600	0740780000	6600
7/16-20	0.500	0690890000	5000	0960160050	7740	0692050000	7300	0683680000	8600
1/2-20	0.500	0690900000	5700	0960160050	7740	0692050000	7300	0683680000	8600
3/4-16	0.750	0690910000	12100	0960160075	13600	0692060000	10880	0683690000	19300
7/8-14	1.000	0690920000	13000	0960160100	23000	0692070000	15180	0683700000	34300
1-14	1.000	0690930000	21700	0960160100	23000	0692070000	15180	0683700000	34300
1 1/4-12	1.375	0690940000	33500	0960160138	39500	0692080000	23560	0683710000	65000
1 1/2-12	1.750	0690950000	45000	0960160175	49480	0692090000	21520	0683720000	105200

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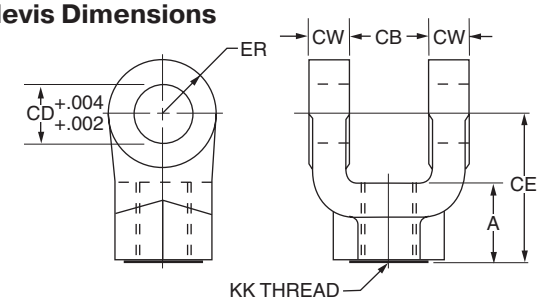
Cylinder Accessories

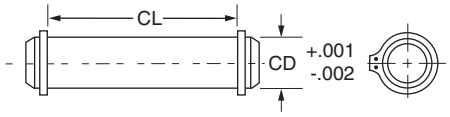
Cast or Forged[5] Part Number	Pin Ø	CB	CD Ø	DD Ø	E (As Cast)	F	FL	LR	M (As Cast)	R
0959810031	0.312	0.31	0.314	0.27	2.25	0.38	1.00	0.59	0.38	1.75
0959810050	0.500	0.75	0.503	0.41	2.50	0.38	1.13	0.69	0.50	1.63
0959810075	0.750	1.25	0.753	0.53	3.50	0.63	1.88	1.13	0.75	2.55
0959810100	1.000	1.50	1.003	0.66	4.50	0.88	2.38	1.37	1.00	3.25
0959810138	1.375	2.00	1.378	0.66	5.00	1.00[4]	3.00	1.88	1.38	3.82
0959810175	1.750	2.50	1.753	0.91	6.50	1.25[4]	3.38	2.13	1.75	4.95
0959810200	2.000	2.50	2.003	1.06	7.50	1.50	4.00	2.38	2.00	5.73
0959810250	2.500	3.00	2.503	1.19	8.50	1.75	4.75	2.88	2.50	6.58
0959810300	3.000	3.00	3.003	1.31	9.50	2.00	5.25	3.13	3.00	7.50
0959810350	3.500	4.00	3.503	1.81	12.63	2.50[6]	6.50[6]	3.88	3.50	9.62
0959810400	4.000	4.50	4.003	2.06	14.88	3.00[6]	7.50[6]	4.38	4.06	11.45

Rod Clevis Dimensions



Part Number	A	CB	CD	CE	CW	ER	KK
0509400000	3/4	3/4	1/2	1 1/2	1/2	1/2	7/16-20
0509410000	3/4	3/4	1/2	1 1/2	1/2	1/2	1/2-20
0509420000	1 1/8	1 1/4	3/4	2 1/8	5/8	3/4	3/4-16
1332840000	1 1/8	1 1/4	3/4	2 3/8	5/8	3/4	3/4-16
0509430000	1 5/8	1 1/2	1	2 15/16	3/4	1	7/8-14
0509440000	1 5/8	1 1/2	1	2 15/16	3/4	1	1-14
1332850000	1 5/8	1 1/2	1	3 1/8	3/4	1	1-14
0509450000	1 7/8	2	1 3/8	3 3/4	1	1 3/8	1 1/4-12
1332860000	2	2	1 3/8	4 1/8	1	1 3/8	1 1/4-12
0509460000	2 1/4	2 1/2	1 3/4	4 1/2	1 1/4	1 3/4	1 1/2-12

Pivot Pin Dimensions



Part Number	CD	CL
0683680000	1/2	1 7/8
0683690000	3/4	2 5/8
0683700000	1	3 1/8
0683710000	1 3/8	4 1/8
0683720000	1 3/4	5 3/16

1. Pivot Pins are furnished with (2) retainer rings.
2. Pivot Pins must be ordered as a separate item if to be used with Rod Clevises or Clevis Brackets.

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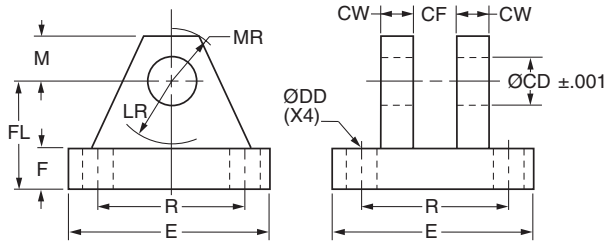
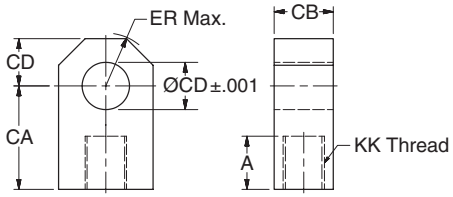
Eye Bracket Dimensions



Cast or Forged[5] Part Number	Pin Ø	CB	CD Ø	DD Ø	E (As Cast)	F	FL	LR	M (As Cast)	R
0959810031	0.312	0.31	0.314	0.27	2.25	0.38	1.00	0.59	0.38	1.75
0959810050	0.500	0.75	0.503	0.41	2.50	0.38	1.13	0.69	0.50	1.63
0959810075	0.750	1.25	0.753	0.53	3.50	0.63	1.88	1.13	0.75	2.55
0959810100	1.000	1.50	1.003	0.66	4.50	0.88	2.38	1.37	1.00	3.25
0959810138	1.375	2.00	1.378	0.66	5.00	1.00[4]	3.00	1.88	1.38	3.82
0959810175	1.750	2.50	1.753	0.91	6.50	1.25[4]	3.38	2.13	1.75	4.95
0959810200	2.000	2.50	2.003	1.06	7.50	1.50	4.00	2.38	2.00	5.73
0959810250	2.500	3.00	2.503	1.19	8.50	1.75	4.75	2.88	2.50	6.58
0959810300	3.000	3.00	3.003	1.31	9.50	2.00	5.25	3.13	3.00	7.50
0959810350	3.500	4.00	3.503	1.81	12.63	2.50[6]	6.50[6]	3.88	3.50	9.62
0959810400	4.000	4.50	4.003	2.06	14.88	3.00[6]	7.50[6]	4.38	4.06	11.45

Knuckle Dimensions



Part Number	A	CA	CB
0690890000	3/4	1 1/2	3/4
0690900000	3/4	1 1/2	3/4
0690910000	1 1/8	2 1/16	1 1/4
0690920000	1 1/8	2 3/8	1 1/2
0690930000	1 5/8	2 13/16	1 1/2
0690940000	2	3 7/16	2
0690950000	2 1/4	4	2 1/2

Part Number	CD	ER	KK
0690890000	1/2	23/32	7/16-20
0690900000	1/2	23/32	1/2-20
0690910000	3/4	1 1/16	3/4-16
0690920000	1	1 7/16	7/8-14
0690930000	1	1 7/16	1-14
0690940000	1 3/8	1 31/32	1 1/4-12
0690950000	1 3/4	2 1/2	1 1/2-12

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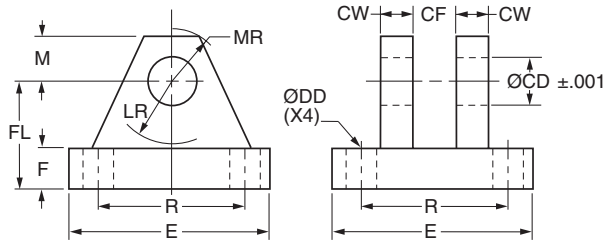
Clevis Bracket Dimensions



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

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Rod Lock Removal

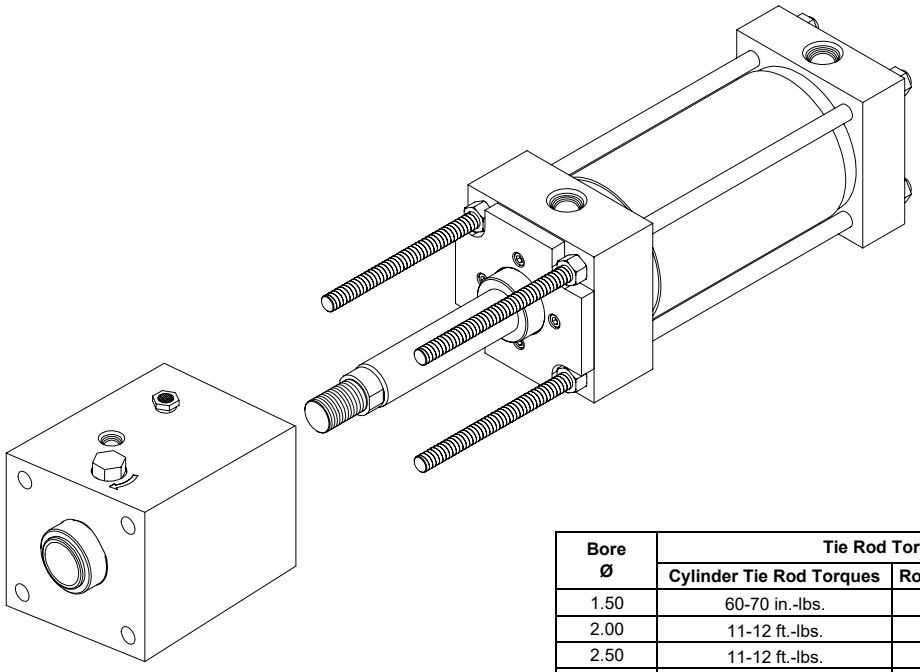
To service the base 2AP or 2ANP cylinder the Rod Lock must first be removed.

Note: The Rod Lock cannot be serviced nor is it considered a service item. The 2AP or 2ANP cylinder must be returned to the factory for Rod Lock service.

1. Using a corner-to-corner sequence, remove the four hex tie rod nuts at the face of the Rod Lock.
2. Apply a minimum of 60 psi to the Rod Lock release port, or apply the appropriate torque to the manual override shaft to disengage the Rod Lock from the piston rod.
3. Carefully slide the Rod Lock off the cylinder. The Rod Lock is piloted and sealed to the gland OD which may necessitate carefully prying the unit from the gland retainer.
4. The 2AP or 2ANP cylinder can now be serviced per normal practice. See the following page for cylinder service kits.

Rod Lock Installation

1. Ensure that the mating surfaces of the Rod Lock and cylinder are free of dirt and debris.
2. Apply a minimum of 60 psi to the Rod Lock release port, or apply the appropriate torque to the manual override shaft to disengage the Rod Lock from the piston rod.
3. Carefully slide the Rod Lock onto the piston rod toward the base cylinder. Because the Rod Lock is sealed to the gland some force may be required to bring it in contact with the gland retainer. Take care not to damage the Rod Lock-to-gland o-ring seal.
4. Torque the hex tie rod nuts that secure the Rod Lock to the values in the table below. Be sure to reuse nuts supplied with the cylinder. Torque the nuts gradually, starting at one corner and work in a diagonal pattern to ensure evenness of tightening. **DO NOT TORQUE ONE NUT COMPLETELY AND THEN THE OTHERS.**
5. Remove air pressure from the Rod Lock release port or torque from the manual override release shaft to engage the Rod Lock.



Barrel Nuts

Barrel nuts are used on 1 1/2" through 6" bore cylinders. 8" bore cylinders have exposed hex nuts.

Bore Ø	Tie Rod Torques	
	Cylinder Tie Rod Torques	Rod Lock Tie Rod Torques
1.50	60-70 in.-lbs.	32-36 in.-lbs
2.00	11-12 ft.-lbs.	6 - 6.8 ft.-lbs.
2.50	11-12 ft.-lbs.	6 - 6.8 ft.-lbs.
3.25	25-26 ft.-lbs.	18-19 ft.-lbs.
4.00	25-26 ft.-lbs.	18-19 ft.-lbs.
5.00	60-64 ft.-lbs.	30-31 ft.-lbs.
6.00	60-64 ft.-lbs.	35-36 ft.-lbs.
8.00	110-114 ft.-lbs.	80-81 ft.-lbs.

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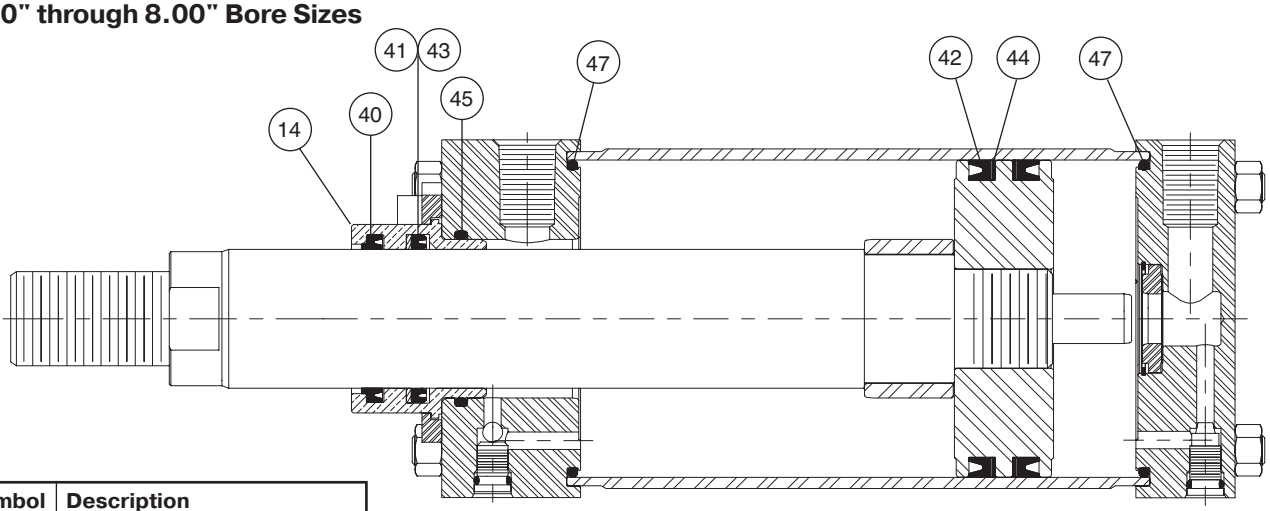
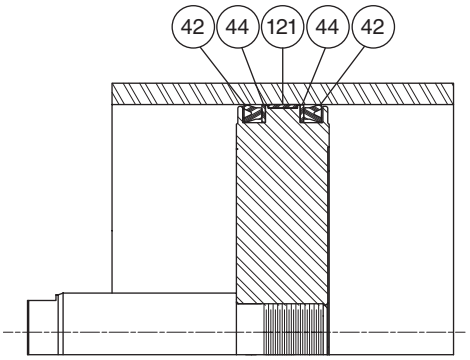
1.50" through 8.00" Bore Sizes



Symbol	Description
14	Rod Gland
40	Rod Wiper
41	Rod Seal
42	Piston Lipseal
43*	Rod Seal Back-up Washer
44*	Piston Seal Back-up Washer
45	Gland to Head O-ring
47	End Seal O-ring
121	Piston Wear Ring

*Item not required in Series 2ANP



Lipseal Piston with Wear Ring
8" Bore

Rod Gland & Rod Seal Kits

Rod Ø	Series 2AP		Series 2ANP	
	Class 1		Class 1	
	Gland Cartridge Kits (Contains: 1 Each Sym. # 14, 40, 41, 43, & 45)	**Rod Seal Kits** (Contains: 1 Each Sym. # 40, 41, 43, & 45)	**Gland Cartridge Kits** (Contains: 1 Each Sym. # 14, 40, 41, & 45)	**Rod Seal Kits** (Contains: 1 Each Sym. # 40, 41, & 45)
0.625	RG2AJ00061	RK2AJ00061	RG2ANJ0061	RK2ANJ0061
1.000	RG2AJ00101	RK2AJ00101	RG2ANJ0101	RK2ANJ0101
1.375	RG2AJ00131	RK2AJ00131	RG2ANJ0131	RK2ANJ0131
1.750	RG2AJ00171	RK2AJ00171	RG2ANJ0171	RK2AN00171

Piston Seal Kits

Bore Ø	Series 2AP	Series 2ANP
	Piston Seal Kits (Contains: 2 Each Sym. # 42, 44 & 47)	**Piston Seal Kits** (Contains: 2 Each Sym. # 42 & 47)
	Class 1	Class 1
1.500	PK1502A001	PK1502AN01
2.000	PK2002A001	PK2002AN01
2.500	PK2502A001	PK2502AN01
3.250	PK3202A001	PK3202AN01
4.000	PK4002A001	PK4002AN01
5.000	PK5002A001	PK5002AN01
6.000	PK6002A001	PK6002AN01
8.000	PK8002A001*	PK8002AN01*

*Kit also includes one each item #121.

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

WARNING: ⚠ FAILURE OF THE CYLINDER, ITS PARTS, ITS MOUNTING, ITS CONNECTIONS TO OTHER OBJECTS, OR ITS CONTROLS CAN RESULT IN:

- **Unanticipated or uncontrolled movement of the cylinder or objects connected to it.**
- **Falling of the cylinder or objects held up by it.**
- **Fluid escaping from the cylinder, potentially at high velocity.**

THESE EVENTS COULD CAUSE DEATH OR PERSONAL INJURY BY, FOR EXAMPLE, PERSONS FALLING FROM HIGH LOCATIONS, BEING CRUSHED OR STRUCK BY HEAVY OR FAST MOVING OBJECTS, BEING PUSHED INTO DANGEROUS EQUIPMENT OR SITUATIONS, OR SLIPPING ON ESCAPED FLUID.

Before selecting or using Parker Hannifin Corporation (the Company) cylinders or related accessories, it is important that you read, understand and follow the following safety information. Training is advised before selecting and using the Company's products.

1.0 General Instructions

1.1 Scope – This safety guide provides instructions for selecting and using (including assembling, installing, and maintaining) cylinder products. This safety guide is a supplement to and is to be used with the specific Company publications for the specific cylinder products that are being considered for use.

1.2 Fail Safe – Cylinder products can and do fail without warning for many reasons. All systems and equipment should be designed in a fail-safe mode so that if the failure of a cylinder product occurs people and property won't be endangered.

1.3 Distribution – Provide a free copy of this safety guide to each person responsible for selecting or using cylinder products. Do not select or use the Company's cylinders without thoroughly reading and understanding this safety guide as well as the specific Company publications for the products considered or selected.

1.4 User Responsibility – Due to very wide variety of cylinder applications and cylinder operating conditions, the Company does not warrant that any particular cylinder is suitable for any specific application. This safety guide does not analyze all technical parameters that must be considered in selecting a product. The hydraulic and pneumatic cylinders outlined in this catalog are designed to the Company's design guidelines and do not necessarily meet the design guideline of other agencies such as American Bureau of Shipping, ASME Pressure Vessel Code etc. The user, through its own
analysis and testing, is solely responsible for:

- Making the final selection of the cylinders and related accessories.
- Determining if the cylinders are required to meet specific design requirements as required by the Agency(s) or industry standards covering the design of the user's equipment.
- Assuring that the user's requirements are met, OSHA requirements are met, and safety guidelines from the applicable agencies such as but not limited to ANSI are followed and that the use presents no health or safety hazards.
- Providing all appropriate health and safety warnings on the equipment on which the cylinders are used.

1.5 Additional Questions – Call the appropriate Company technical service department if you have any questions or require any additional information. See the Company publication for the product being considered or used, or call 1-847-298-2400, or go to www.parker.com, for telephone numbers of the appropriate technical service department.

2.0 Cylinder and Accessories Selection

2.1 Seals – Part of the process of selecting a cylinder is the selection of seal compounds. Before making this selection, consult the "seal information page(s)" of the publication for the series of cylinders of interest.

The application of cylinders may allow fluids such as cutting fluids, wash down fluids etc. to come in contact with the external area of the cylinder. These fluids may attack the piston rod wiper and or the primary seal and must be taken into account when selecting and specifying seal compounds.

Dynamic seals will wear. The rate of wear will depend on many operating factors. Wear can be rapid if a cylinder is mis-aligned or if the cylinder has been improperly serviced. The user must take seal wear into consideration in the application of cylinders.

2.2 Piston Rods – Possible consequences of piston rod failure or separation of the piston rod from the piston include, but are not limited to are:

- Piston rod and or attached load thrown off at high speed.
- High velocity fluid discharge.
- Piston rod extending when pressure is applied in the piston retract mode.

Piston rods or machine members attached to the piston rod may move suddenly and without warning as a consequence of other conditions occurring to the machine such as, but not limited to:

- Unexpected detachment of the machine member from the piston rod.
- Failure of the pressurized fluid delivery system (hoses, fittings, valves, pumps, compressors) which maintain cylinder position.
- Catastrophic cylinder seal failure leading to sudden loss of pressurized fluid.
- Failure of the machine control system.

Follow the recommendations of the "Piston Rod Selection Chart and Data" in the publication for the series of cylinders of interest. The suggested piston rod diameter in these charts must be followed in order to avoid piston rod buckling.

Piston rods are not normally designed to absorb bending moments or loads which are perpendicular to the axis of piston rod motion. These additional loads can cause the piston rod to fail. If these types of additional loads are expected to be imposed on the piston rod, their magnitude should be made known to our engineering department.

The cylinder user should always make sure that the piston rod is securely attached to the machine member.

On occasion cylinders are ordered with double rods (a piston rod extended from both ends of the cylinder). In some cases a stop is threaded on to one of the piston rods and used as an external stroke adjuster. On occasions spacers are attached to the machine member connected to the piston rod and also used as a stroke adjuster. In both cases the stops will create a pinch point and the user should consider appropriate use of guards. If these
external stops are not perpendicular to the mating contact surface, or if debris is trapped between the contact surfaces, a bending moment will be placed on the piston rod, which can lead to piston rod failure. An external stop will also negate the effect of cushioning and will subject the piston rod to impact loading. Those two (2) conditions can cause piston rod failure. Internal stroke adjusters are available with and without cushions. The use of external stroke adjusters should be reviewed with our engineering department.

The piston rod to piston and the stud to piston rod threaded connections are secured with an anaerobic adhesive. The strength of the adhesive decreases with increasing temperature. Cylinders which can be exposed to temperatures above +250°F (+121°C) are to be ordered with a non studded piston rod and a pinned piston to rod joint.

2.3 Cushions – Cushions should be considered for cylinder applications when the piston velocity is expected to be over 4 inches/second.

Cylinder cushions are normally designed to absorb the energy of a linear applied load. A rotating mass has considerably more energy than the same mass moving in a linear mode. Cushioning for a rotating mass application should be reviewed by our engineering department.

2.4 Cylinder Mountings – Some cylinder mounting configurations may have certain limitations such as but not limited to minimum stroke for side or foot mounting cylinders or pressure de-ratings for certain mounts. Carefully review the catalog for these types of restrictions.

Always mount cylinders using the largest possible high tensile alloy steel socket head cap screws that can fit in the cylinder mounting holes and torque them to the manufacturer's recommendations for their size.

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

The rod end pressure is approximately equal to:

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

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

3.0 Cylinder and Accessories Installation and Mounting

3.1 Installation

3.1.1 – Cleanliness is an important consideration, and cylinders are shipped with the ports plugged to protect them from contaminants entering the ports. These plugs should not be removed until the piping is to be installed. Before making the connection to the cylinder ports, piping should be thoroughly cleaned to remove all chips or burrs which might have resulted from threading or flaring operations.

3.1.2 – Cylinders operating in an environment where air drying materials are present such as fast-drying chemicals, paint, or weld splatter, or other hazardous conditions such as excessive heat, should have shields installed to prevent damage to the piston rod and piston rod seals.

3.1.3 – Proper alignment of the cylinder piston rod and its mating component on the machine should be checked in both the extended and retracted positions. Improper alignment will result in excessive rod gland and/or cylinder bore wear. On fixed mounting cylinders attaching the piston rod while the rod is retracted will help in achieving proper alignment.

3.1.4 – Sometimes it may be necessary to rotate the piston rod in order to thread the piston rod into the machine member. This operation must always be done with zero pressure being applied to either side of the piston. Failure to follow this procedure may result in loosening the piston to rod-threaded connection. In some rare cases the turning of the piston rod may rotate a threaded piston rod gland and loosen it from the
cylinder head. Confirm that this condition is not occurring. If it does, re-tighten the piston rod gland firmly against the cylinder head.

For double rod cylinders it is also important that when attaching or detaching the piston rod from the machine member that the torque be applied to the piston rod end of the cylinder that is directly attaching to the machine member with the opposite end unrestrained. If the design of the machine is such that only the rod end of the cylinder opposite to where the rod attaches to the machine member can be rotated, consult the factory for further instructions.

3.2 Mounting Recommendations

3.2.1 – Always mount cylinders using the largest possible high tensile alloy steel socket head screws that can fit in the cylinder mounting holes and torque them to the manufacturer's recommendations for their size.

3.2.2 – Side-Mounted Cylinders – In addition to the mounting bolts, cylinders of this type should be equipped with thrust keys or dowel pins located so as to resist the major load.

3.2.3 – Tie Rod Mounting – Cylinders with tie rod mountings are recommended for applications where mounting space is limited. The standard tie rod extension is shown as BB in dimension tables. Longer or shorter extensions can be supplied. Nuts used for this mounting style should be torqued to the same value as the tie rods for that bore size.

3.2.4 – Flange Mount Cylinders – The controlled diameter of the rod gland extension on head end flange mount cylinders can be used as a pilot to locate the cylinders in relation to the machine. After alignment has been obtained, the flanges may be drilled for pins or dowels to prevent shifting.

3.2.5 – Trunnion Mountings – Cylinders require lubricated bearing blocks with minimum bearing clearances. Bearing blocks should be carefully aligned and rigidly mounted so the trunnions will not be subjected to bending moments. The rod end should also be pivoted with the pivot pin in line and parallel to axis of the trunnion pins.

3.2.6 – Clevis Mountings – Cylinders should be pivoted at both ends with centerline of pins parallel to each other. After cylinder is mounted, be sure to check to assure that the cylinder is free to swing through its working arc without interference from other machine parts.

4.0 Cylinder and Accessories Maintenance, Troubleshooting and Replacement

4.1 Storage – At times cylinders are delivered before a customer is ready to install them and must be stored for a period of time. When storage is required the following procedures are recommended.

4.1.1 – Store the cylinders in an indoor area which has a dry, clean and noncorrosive atmosphere. Take care to protect the cylinder from both internal corrosion and external damage.

4.1.2 – Whenever possible cylinders should be stored in a vertical position (piston rod up). This will minimize corrosion due to possible condensation which could occur inside the cylinder. This will also minimize seal damage.

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

4.1.4 – If a cylinder is stored full of hydraulic fluid, expansion of the fluid due to temperature changes must be considered. Installing a check valve with free flow out of the cylinder is one method.

4.1.5 – When cylinders are mounted on equipment that is stored outside for extended periods, exposed unpainted surfaces, e.g. piston rod, must be coated with a rust-inhibiting compound to prevent corrosion.

4.2 Cylinder Trouble Shooting

4.2.1 – **External Leakage**

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

Rod seal leakage could also be traced to gland wear. If clearance is excessive, replace rod bushing and seal. Rod seal leakage can also be traced to seal deterioration. If seals are soft or gummy or brittle, check compatibility of seal material with lubricant used if air cylinder, or operating fluid if hydraulic cylinder. Replace with seal material, which is compatible with these fluids. If the seals are hard or have lost elasticity, it is usually due to exposure to temperatures in excess of 165°F. (+74°C). Shield the cylinder from the heat source to limit temperature to 350°F. (+177°C.) and replace with fluorocarbon seals.

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

Excessive pressure can also result in cylinder body seal leak. Determine maximum pressure to rated limits. Replace seals and retorque tie rods as in paragraph above. Excessive pressure can also result in cylinder body seal leak. Determine if the pressure rating of the cylinder has been exceeded. If so, bring the operating pressure down to the rating of the cylinder and have the tie rods replaced.

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

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

4.2.2 – **Internal Leakage**

4.2.2.1 – Piston seal leak (by-pass) 1 to 3 cubic inches per minute leakage is considered normal for piston ring construction. Virtually no static leak with lipseal type seals on piston should be expected. Piston seal wear is a usual cause of piston seal leakage. Replace seals as required.

4.2.2.2 – With lipseal type piston seals excessive back pressure due to over-adjustment of speed control valves could be a direct cause of rapid seal wear. Contamination in a hydraulic system can result in a scored cylinder bore, resulting in rapid seal wear. In either case, replace piston seals as required.

4.2.2.3 – What appears to be piston seal leak, evidenced by the fact that the cylinder drifts, is not always traceable to the piston. To make sure, it is suggested that one side of the cylinder piston be pressurized and the fluid line at the opposite port be disconnected. Observe leakage. If none is evident, seek the cause of cylinder drift in other component parts in the circuit.

4.2.3 – **Cylinder Fails to Move the Load**

4.2.3.1 – Pneumatic or hydraulic pressure is too low. Check the pressure at the cylinder to make sure it is to circuit requirements.

4.2.3.2 – Piston Seal Leak – Operate the valve to cycle the cylinder and observe fluid flow at valve exhaust ports at end of cylinder stroke. Replace piston seals if flow is excessive.

4.2.3.3 – Cylinder is undersized for the load – Replace cylinder with one of a larger bore size.

4.3 Erratic or Chatter Operation

4.3.1 – Excessive friction at rod gland or piston bearing due to load misalignment – Correct cylinder-to-load alignment.

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

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

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

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

NOTES

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

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

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

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

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

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

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

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

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

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

10. Security Interest. To secure payment of all sums due from Buyer, Seller retains a security interest in all Products delivered to Buyer and, Buyer's acceptance of these Terms is deemed to be a Security Agreement under the Uniform Commercial Code. Buyer authorizes Seller as its attorney to execute and file on Buyer's behalf all documents Seller deems necessary to perfect Seller's security interest.

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

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

13. Cancellations and Changes. Buyer may not cancel or modify, including but not limited to movement of delivery dates for the Products, any order for any reason except with Seller's written consent and upon terms that will indemnify, defend and hold Seller harmless against all direct, incidental and consequential loss or damage and any additional expense. Seller, at any time, may change features, specifications, designs and availability of Products.

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

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

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

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

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

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

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

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

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

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

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

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