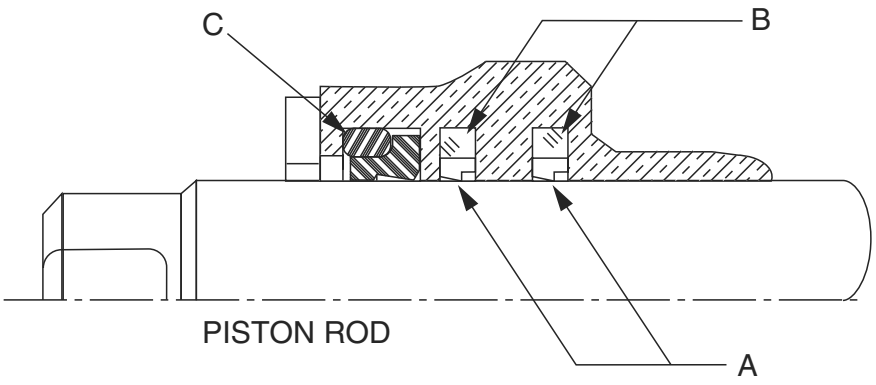
Parker Series 2H/3H Hydraulic Cylinders with Low Friction Seal Option

High Performance Cylinders for Your Demanding Applications

- Smooth-running operation – reduces “slip-stick” or “chatter”
- Ideally suited for use in servo applications
- Bronze-filled PTFE material for low friction, rapid break-in and long service life
- Innovative seal geometry for maximum sealing efficiency

Low Friction Rod Gland



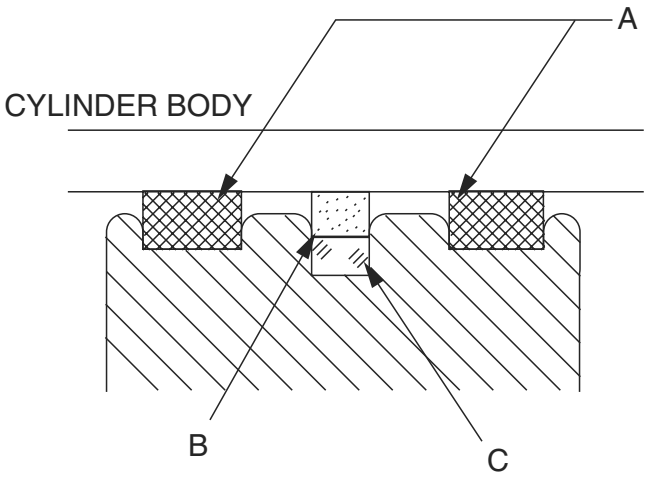
A - Dual step-seal rod seals ensure positive sealing and smooth operation up to 3,000 psi.

B - Square ring elastomer expander for pressure compensation and low pressure effectiveness.

C - Energized filled PTFE wiper keeps contaminants out.

D - Available in 1.000", 1.375", 1.750", 2.000", 2.500", 3.000", 3.500", 4.000", 4.500", 5.000", 5.500" diameter piston rods (1.50" - 8.00" Bore).

Low Friction Piston



A - Dual bronze-filled PTFE piston bearings for high load capacity, low friction and no metal-to-metal contact.

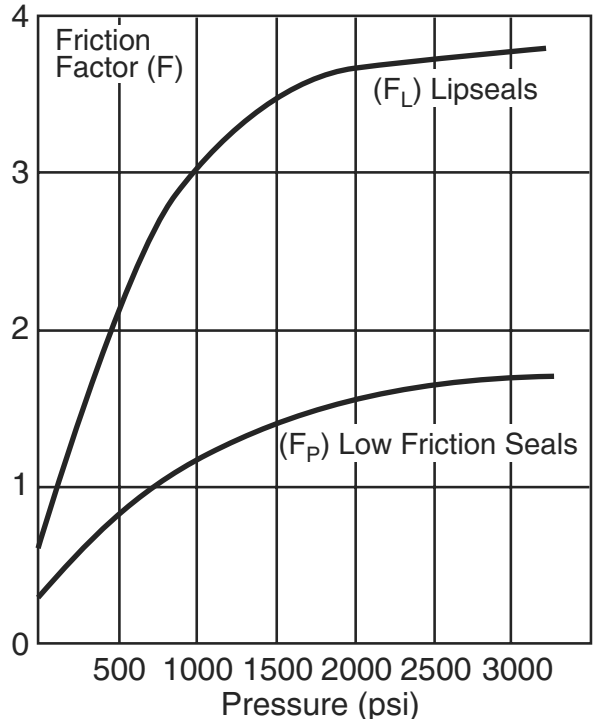
B - Bronze filled PTFE piston seal ensures maximum sealing efficiency.

C - Square-ring elastomer expander for pressure compensation

D - Available in 1.50" - 8.00" bore diameters

Seal Friction:

Seal friction under a given set of working conditions is not easily calculated due to the multiplicity of variables involved. The following graphs are offered as a guide for use in performance calculations, but for critical application measurements should be made under simulated or actual working conditions.



Calculation of Running Friction:

The seal friction attributable to the cylinder is calculated as the sum of the friction due to the individual sealing elements = (wiper seal friction + rod seal friction + piston seal friction), using the following formulae:

Option:	**Formula:**
Lipseal Rod + Piston	$12d + 12 F_Ld + 24 F_LD$
Lipseal Rod w/Low Friction Piston	$12d + 12 F_Ld + 12F_pD$
Low Friction Rod + Piston	$12d + 30 F_pd + 6 F_pD$

Where: d = rod dia. (in.) D = bore dia. (in.)
F_L = friction factor for lipseals (F_L)
F_p = friction factor for PTFE (F_p)

Breakaway Friction:

Breakaway friction may be calculated by applying the following correction factors:

Correction factors:
Lipseals: F_L x 1.5
Low Friction: F_p x 1.0

Sample Calculation:

2HX Cylinder with 3.25 dia. bore + 1.75 dia. piston rod with low friction seals at 1500 psi.

Running Friction Calculation:

Friction (lbs. force) $\approx 12d + 30F_pd + 6F_pD$

Friction (lbs. force) $\approx$ 12 (1.75) + 30 (1.3 x 1.75) + 6 (1.3 x 3.25)

Friction (lbs. force) $\approx$ 115

Breakaway Friction Calculation:

F_p x 1.0 $\approx F_p$

Based on zero pressure:

Friction (lbs. force) $\approx 12d + 30F_pd + 6F_pD$

Friction (lbs. force) $\approx$ 12 (1.75) + 30 (.3 x 1.75) + 6 (.3 x 3.25)

Friction (lbs. force) $\approx$ 43

Specifications for Low Friction Options:

Operating Pressure: 0 - 3000 psi

Operating Temperature: -10°F to +160°F.
For higher temperatures, consult factory.

Fluid Media: Petroleum based hydraulic oils.
For other fluids, consult factory.

How to Order Low Friction Option for Series 2H/3H Cylinders

When ordering Series 2H or 3H cylinders, place an “F” in the piston field for low friction seals.

Consult factory for availability of gland drain or other options.

D

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

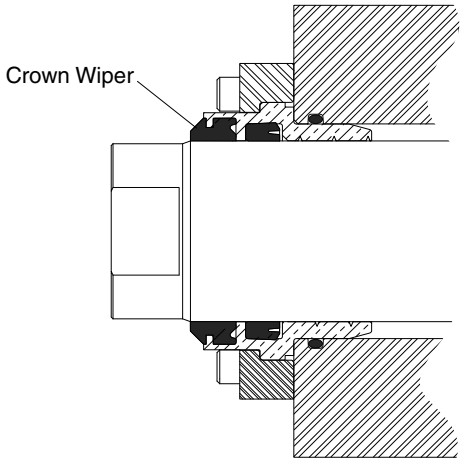
Metallic Rod Wiper

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

Parker Crown Wiper™ for Series 2HD and 7" & 8" bore 3HD

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

Standard Crown Wiper material for Seal Class 1 and 2 service is durable polyurethane. Optional FKM material is available for Class 5 service. The Crown Wiper requires a unique gland but does not change cylinder mounting dimensions



Crown Wiper Rod Gland Kits are available to retrofit existing 2HD & 3HD cylinders. See 2HD/3HD Parts List and Seal Kits page.

Rod End Boots

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

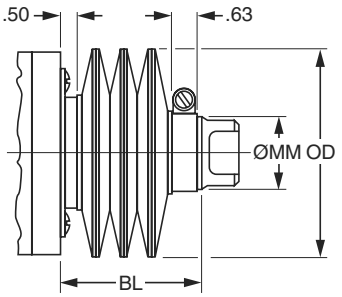
LF	.13	.13	.13	.13	.13	.13	.13	.10	.10	.10	.10	.10
OD	2.25	2.25	2.63	3.00	3.38	3.75	4.38	5.13	5.63	6.25	7.00	7.50
MM	.500	.625	1.000	1.380	1.750	2.000	2.500	3.000	3.500	4.000	5.000	5.500

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

BL = Stroke x LF + 1.13"

BL + Std. W + A = length of piston rod to extend beyond the retainer.

NOTE: Check all Boot O.D’s against std. “E” dimension from catalog. This may be critical on foot mounted cylinders.



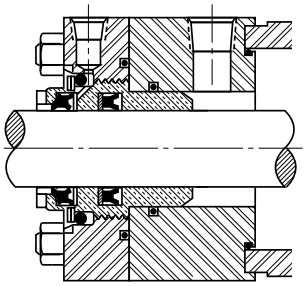
Gland Drain

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

A 1/8" NPTF gland drain port can be provided in the gland retainer. A passage in the gland between the wiperseal and lipseal is provided to drain off any accumulation of fluid between the seals. See drawing below.

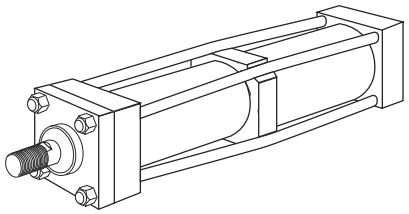
It is recommended that the gland drain port be piped back to the fluid reservoir and that the reservoir be located below the level of the head of the cylinder.

On 1.50" bore with 0.625" rod the drain port is located in the head adjacent to the port. The retainer thickness on 1.50" bore with 1.000" rod and gland drain is increased to 0.63". On 2.00"-8.00" bore sizes the drain port is located in the retainer as shown. On Style JJ with gland drain and 1.000"-4.000" rods the retainer thickness is increased by 0.25".



Air Bleeds

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



Tie Rod Supports

Rigidity of Envelope – The pre-stressed tie rod construction of Parker cylinders has advantages in rigidity within the limits of the cylinder tube to resist buckling. For long stroke cylinders within practical limits. Parker provides exclusive TIE ROD SUPPORTS (see table below) which move the tie rod centerlines radially outward.

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

Number of Supports Required	Bore Ø	Stroke (Inches)											
		36	48	60	72	84	96	108	120	132	144	156	168
	1.00	—	1	1	1	2	Consult Factory						
	1.50	—	—	1	1	1	2	2	2	3	3	3	4
	2.00	—	—	—	1	1	1	1	2	2	2	2	3
	2.50	—	—	—	—	—	1	1	1	1	1	2	2
	3.25	—	—	—	—	—	—	—	1	1	1	1	1
	4.00	—	—	—	—	—	—	—	—	—	1	1	1

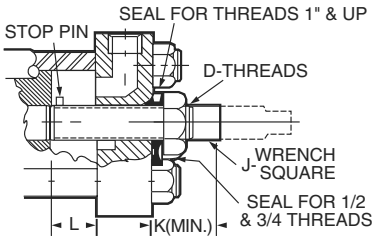
Note: 5.00" through 14.00" bore sizes — no supports required.

Stroke Adjusters

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

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

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



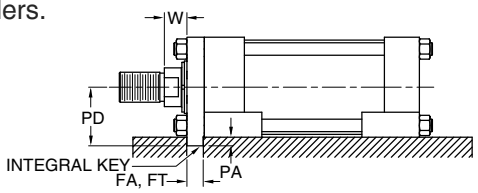
Where frequent adjustment or cushions at the cap end are required, other designs are available according to application needs.

[1] Infrequent is defined by positioning the retract stroke in a couple of attempts at original machine set up. The frequent stroke adjuster is recommended for adjustments required after the original equipment has been adjusted by the original machine manufacturer.

Thrust Key Mountings (2H, 3H, 2HD, 3HD)

Thrust key mountings eliminate the need of using fitted bolts or external keys on side mounted cylinders. Parker cylinders in mounting styles CP and FP can be provided with the gland retainer plate extended below the mounting side of the cylinder (see illustration below). This extended retainer plate can then be fitted into a keyway milled into the mounting surface of the machine member. This is referred to as the "P" Modification of any side mounting style.

Note: Please consult factory when replacing HD Series cylinders.



Bore Ø	FA (Series 2HD/3HD)	FT (Series 2H/3H)	PA	PD Mtg. Styles CP & FP
1.50	.361 -.001 +.000	.312 -.002 +.000	0.19	1.44
2.00	.611 -.001 +.000	.562 -.002 +.000	0.31	1.81
2.50	.611 -.001 +.000	.562 -.002 +.000	0.31	2.06
3.25	.736 -.001 +.000	.687 -.003 +.000	0.38	2.63
4.00	.861 -.001 +.000	.812 -.003 +.000	0.44	2.94
5.00	.861 -.001 +.000	.812 -.003 +.000	0.44	3.69
6.00	.986 -.001 +.000	.937 -.003 +.000	0.50	4.25
7.00	.986 -.001 +.000	.937 -.003 +.000	0.50	4.75
8.00	.986 -.001 +.000	.937 -.003 +.000	0.50	5.25

Metric Piston Rod Thread

The table below lists the standard thread supplied when Piston Rod Thread type M is specified in the cylinder model code.

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

D

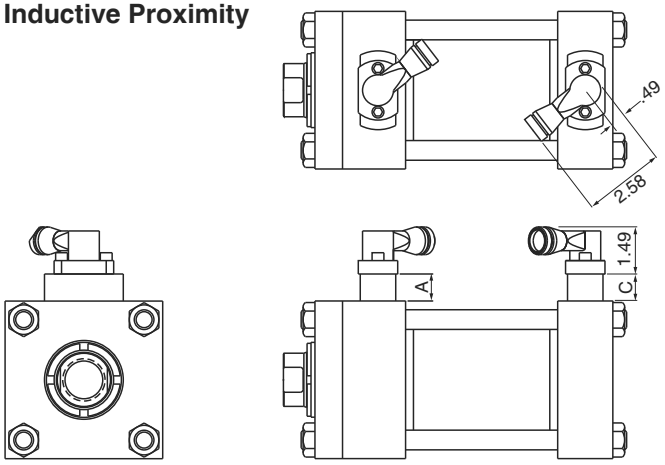
Cylinder End-of-Stroke Proximity Switches

"EPS" Style Inductive Sensors
For General Industrial AC and DC Applications

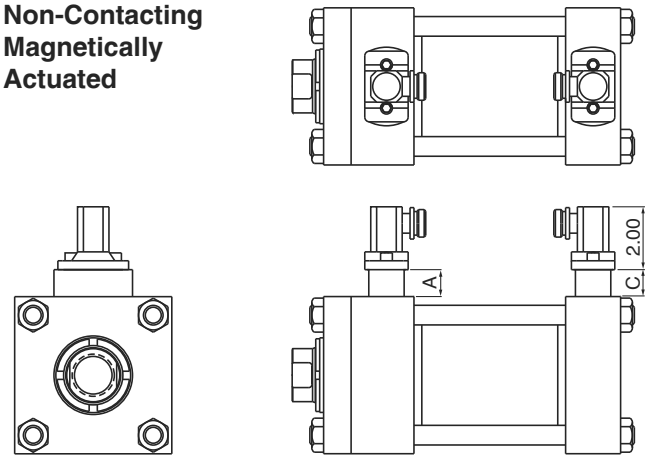
"CLS" Style Magnetic Sensors
Including Extreme Temperature Applications

All Sensors Are:
Non-Contacting
Water Resistant
Weld-Field Immune
Shock and Vibration Resistant
Flange-Mounted to Cylinder End Caps

EPS 7 & 6 Sensors
Inductive Proximity



CLS 1 & 4 Sensors
Non-Contacting
Magnetically
Actuated

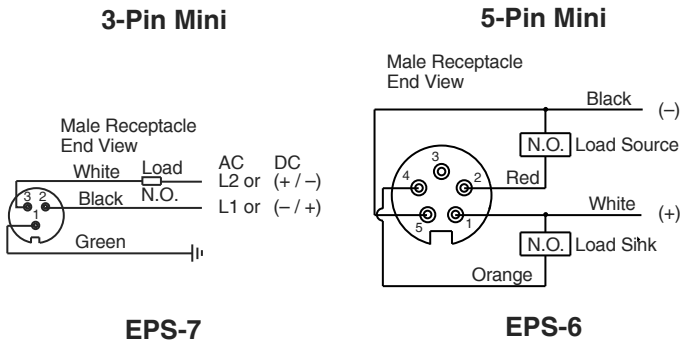


Spacer Height
EPS & CLS Sensors

A max.	C max.
.86	1.75

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

Connector Pin Numbering



Series and Parallel Wiring

When Parker EPS-6 or 7 sensors are used as inputs to programmable controllers the preferred practice is to connect each sensor to a separate input channel of the PLC. Series or parallel operations may then be accomplished by the internal PLC programming.

Parker EPS-6 or 7 sensors may be hard wired for series operation, but the voltage drop through the sensors (see specifications) must not reduce the available voltage below what is needed to actuate the load.

Parker EPS-6 or 7 sensors may also be hard wired for parallel operation. However, the leakage current of each sensor will pass through the load. The total of all leakage currents must not exceed the current required to actuate the load. In most cases, the use of two or more EPS-6 or 7 sensors in parallel will require the use of a bypass (shunt) resistor.

Minimum Stroke

The minimum stroke for EPS-6 or 7 and CLS-1 or 4 sensors, utilizing standard components, is the cushion sleeve or spear length for the cylinder series in which the sensor is installed. See the Cushion Length Chart in this catalog for details. Contact the factory if a shorter stroke is required.

D

Specifications

Style:	EPS-7	EPS-6	CLS-1	CLS-4
Code Designator:	H	D	F	B
Description:	Economical, General Purpose, 2 wire device, primarily for AC applications. (Not suitable for 3 wire 24 volt Sinking or Sourcing applications.) Also for automotive industry applications.	Economical, General Purpose, 3 wire, DC sensor, dual output: sinking and sourcing	Functional replacement for AB (Mechanical) Limit Switches in many applications, or where customer needs NC contacts, zero leakage, zero voltage drop, higher or lower load current than EPS-style	Functional replacement for AB (Mechanical) Limit Switches in many High Temperature applications, or where customer needs NC contacts, zero leakage, zero voltage drop, higher or lower load current than EPS-style.
Supply Voltage:	20 to 250 VAC/DC	10 to 30 VDC	24 to 240 VAC/DC	24 to 240 VAC/DC
Load Current, min:	8 mA	N/A	NA	NA
Load Current, max:	300 mA	200 mA	4 AMPS @ 120 VAC 3 AMPS @ 24VDC	4 AMPS @ 120 VAC 3 AMPS @ 24 VDC
Leakage Current:	1.7 mA, max.	10 micro amps max	–	–
Voltage Drop:	7 V, max.	2 VDC max.	N/A	NA
Operating Temperature:	-14° to +158° F	-14° to +158°F	-40°F to +221°F	-40°F to +400°F
Sensor Type:	Inductive proximity	Inductive proximity	non-contacting magnetically actuated	non-contacting magnetically actuated
Part Number:	148897[1]	148896[1]	148275[1]	149109[1]
Part Number Suffix[1]:	[1]**4-digit suffix indicates probe length: 0125=1.25", 0206=2.06", 0288=2.875", 0456=4.562"**			
Connection:	3 pin mini	5 pin mini	3 pin mini	144" PTFE Coated Flying Leads with 1/2" conduit hub
Enclosure Rating:	IEC IP67	IEC IP67	NEMA 1, 2, 3, 4, 4x, 5, 6, 6P, 11, 12, 12K, 13	NEMA 1, 2, 3, 4, 4x, 5
LED indication:	Yes	Yes	Yes	No
Short Circuit Protection:	Yes	Yes	No	No
Weld Field Immunity:	Yes	Yes	Yes	Yes
Output:	2 wire, Normally Open with leakage current	Dual Output: DC Sinking and DC Sourcing, user selectable via wiring	SPDT (Single Pole Double Throw), Normally Open/Normally Closed, Form C	SPDT (Single Pole Double Throw), Normally Open/Normally Closed, Form C
Approvals/Marks:	CE, UL, CSA	CE, UL, CSA	UL or CSA[2]	UL or CSA[2]
Make/Break Location:	**0.13" from end of stroke, typical. Tolerance is +0/-0.13"**			
Wiring Instructions:	Pin 1: AC Ground (Green) Pin 2: Output (Black) Pin 3: AC Line (White)	Pin 1) +10 to 30 VDC (White) Pin 2) Sourcing Output (Red) Pin 3) Grounded (not connected or required) Pin 4) Sinking Output (Orange) Pin 5) DC Common (Black)	Pin 1: Common (Green) Pin 2: Normally Closed (Black) Pin 3: Normally Open (White)	Common: (Black) Normally Open: (Blue) Normally Closed: (Red)
Cable: 6'	0853550006	0859170006	0853550006	–
Cable: 12'	0853550012	0859170012	0853550012	–
Cable: 6', Right Angle	0875470006	–	0875470006	–

[2]CSA available upon request – contact factory.

How to Specify EPS Proximity Switches

Parker EPS proximity switches may be ordered on Series 2H & 3H cylinders as follows:

1) Complete the basic cylinder model number.

2) Place an "S" in the model number to denote switches and/or special features.

3) Mounting styles D, DB, JJ, J, or H should be used with caution because of possible mounting interferences. Consult bulletin 0840-G-E1 for additional information.

4) Special modifications to cylinders other than switches must have a written description.

5) Specify letter prefix "H" for EPS-7, "D" for EPS-6, and "F" for CLS-1, or "B" for CLS-4, then fill in the four blanks specifying port location, switch orientation and actuation point for both head and cap. If only one switch is used, place "XXXX" in the unused blanks.

Example = H13CGG-XXXX denotes a switch on the head end only, EPS-7

Example = XXXX-B42BGG denotes a switch on the cap end only, CLS-4

Head End

H	1	3	A	GG
Specify: "H" = EPS-7 "D" = EPS-6 "F" = CLS-1[1] "B" = CLS-4[1] "N" = Prep for EPS-6 and EPS-7 switches "P" = Prep for CLS-1 and CLS-4 switches "T" = Prep for CLS-2 switch	Port Location See Figure 1.	Switch Location See Figure 1.	Switch Orientation See Figure 2 for EPS-7, EPS-6, CLS-1 and CLS-4.	Actuation Point GG = End of Stroke FF = Stroke to Go; See Bulletins 0840-G-E1, 2 or 3 for stroke remaining.

Cap End

H	4	2	A	GG
Specify: "H" = EPS-7 "D" = EPS-6 "F" = CLS-1[1] "B" = CLS-4[1] "N" = Prep for EPS-6 and EPS-7 switches "P" = Prep for CLS-1 and CLS-4 switches "T" = Prep for CLS-2 switch	Port Location See Figure 1.	Switch Location See Figure 1.	Switch Orientation See Figure 2 for EPS-7, EPS-6, CLS-1 and CLS-4.	Actuation Point GG = End of Stroke FF = Stroke to Go; See Bulletins 0840-G-E1, 2 or 3 for stroke remaining.

Note: All specified switch and port locations are as seen from rod end of cylinder.

[1] CLS-1 and CLS-4 proximity switches are not available on the head end of 1.50" bore with 1.00" rod and 2.00" bore with 1.375" rod

Figure 1

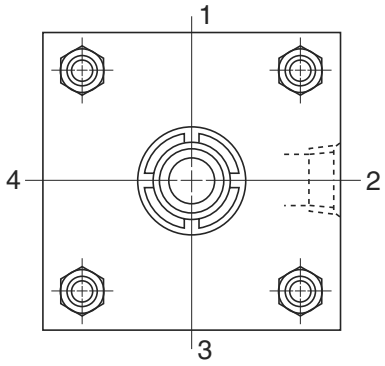
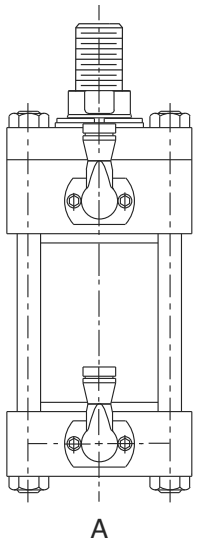


Figure 2



D

Notes

Section E

Series 2H / 3H Engineering Data

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E

Theoretical Push Forces for Hydraulic Cylinders — Push Force

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

General Formula

The cylinder output forces are derived from the formula:

$$F = P \times A$$

Where F = Force in pounds.

P = Pressure at the cylinder in pounds per square inch, gauge.

A = Effective area of cylinder piston in square inches.

Theoretical Pull Forces for Hydraulic Cylinders

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

E

The weights shown below are for standard Series 2H and 3H hydraulic cylinders equipped with various diameter piston rods. To determine the net weights of a cylinder, first select the proper basic weight for zero stroke, then calculate the weight of the cylinder stroke and add the result to the basic weight. For extra rod extension use piston rod weights per inch shown in Table C. Weights of cylinders with intermediate rods may be estimated from table below by taking the difference between the piston rod weights per inch and adding it to the Code 1 weight for the cylinder bore size involved.

Table A Cylinder Weights, in pounds, for Series 2H, 3H (7.00" & 8.00") hydraulic cylinders

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

Table B Cylinder Weights, in pounds, for Series 3H large bore hydraulic cylinders

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

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

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

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

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

Standard Seals (class 1)
Class 1 seals are what is normally provided in a cylinder unless otherwise specified. They are intended for use with fluids such as: air, nitrogen, mineral base hydraulic oil or MIL-H-5606 within the temperature range of -10°F (-23°C) to +165°F (+74°C). Generally they are nitrile except for piston rod seals in hydraulic cylinders. However the individual seals may be nitrile (Buna-N) enhanced polyurethane, polymyte, PTFE or filled PTFE

Water Base Fluid Seals (class 2)
Generally class 2 seals are intended for use with water base fluids within the temperature of -10°F (-23°C) to +165°F (+74°C) except for High Water Content Fluids (HWCF) in which case Class 6 seals should be used. Typical water base fluids are: Water, Water-Glycol, Water-in Emulsion, Houghto-Safe 27, 620, 5040, Mobil Pyrogard D, Shell Irus 905, Ucon Hydrolube J-4. These seals are nitrile. Lipseal will have polymyte or PTFE back-up washer when required. O-rings will have nitrile back-up washers when required.

Ethylene Propylene (EPR) Seals (class 3)
Class 3 seals are intended for use with some Phosphate Ester Fluids between the temperatures of -10°F (-23°C) to +130°F (+54°C). Typical fluids compatible with EPR seals are Skydrol 500 and 700. EPR are Ethylene Propylene. Lipseals will have a PTFE back-up washer when required. O-rings will have EPR back-up washers when required. Note: EPR seals are not compatible with mineral base hydraulic oil or greases. Even limited exposure to these fluids will cause severe swelling. PTFE back-up washer may not be suitable when used in a radiation environment.

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

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

HWCF Seals (class 6)
Class 6 seals are intended for High Water Content Fluids (HWCF) such as Houghton, Hydrolubric 120B and Sonsol Lubrizol within the temperature range of +40°F (+4°C) to +120°F (+49°C). Class 6 seals are special nitrile compound dynamic seals. Lipseals will have PTFE and or polymyte back-up washers when required. O-rings will have nitrile back-up washers when required. Because of the viscosity of these fluids, cylinders specified with class 6 seals, will also be modified to have lip seal piston seals and straight cushions.

Energized PTFE Seals (class 8)
Class 8 seals consist of PTFE piston lipseals, rod seal and wiperseal. Piston seals have an internal stainless steel spring to energize both the static and dynamic sealing lips. They are intended for high temperature applications, to 400° F (204° C), where longer seal life and improved high temperature sealing performance is required. Minimum operating temperature is -15°F (-26°C). Body and gland o-ring seals will be fluorocarbon. Fluid resistance is comparable to Class 5. Cylinders incorporating Class 8 Seals will not have studded piston rods.

Warning ⚠
The piston rod stud and the piston rod to piston threaded connections are secured with an anaerobic adhesive which is temperature sensitive. Cylinders are assembled with anaerobic adhesive having a maximum temperature rating of +250°F (+121°C) . Cylinders specified with all other seal compounds (built before 1997) were assembled with anaerobic adhesive having a maximum operating temperature rating +165°F (+74°C). These temperature limitations are necessary to prevent the possible loosening of the threaded connections. Cylinders originally manufactured (before 1997) with class 1 seals (Nitrile) that will be exposed to ambient temperatures above +165°F (+74°C) must be modified for higher temperature service. Contact the factory immediately and arrange for the piston to rod and the stud to piston rod connections to be properly re-assembled to withstand the higher temperature service.

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

Lipseal Pistons
Under most conditions lipseals provide the best all around service for pneumatic applications. Lipseals with a back-up washer are often used for hydraulic applications when virtually zero static leakage is required. Lipseals will function properly in these applications when used in conjunction with moderate hydraulic pressures. A high load piston option is recommended when operating at high pressures and especially with large bore hydraulic cylinders.

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

Cast Iron Piston Rings
Cast iron rings are the standard piston seals for Series 2H cylinders. They offer the widest operating conditions by tolerating high operating pressures, wide temperature range and are compatible with most fluids. The only drawback of cast iron rings is that they allow a small amount of leakage. The leakage for a 4" bore cylinder, operating at 2000 psi, with mineral base hydraulic fluid will be less than 10in^3/min. Leakage will increase as pressure, bore size and viscosity of the operating hydraulic fluid increases. For these reasons cast iron rings are not recommended when using water or (HWCF) fluids.

Water Service
Series 2H cylinders can be modified to make them more suitable for use with water as the operating medium. The modifications include chrome-plated cylinder bore; electroless nickel-plated head, cap and piston; chrome-plated 17-4 stainless steel piston rod; chrome plated cushion sleeve or cushion spear.

Modified cylinders may also be used for higher operating pressures, up to 2000 psi, depending on bore size. See pressure rating for Hydraulic Cylinders on the next page. Series 2H and 3H hydraulic cylinders can also be modified for water operation and supplied with chrome-plated cylinder bore; electroless nickel-plated head, cap and piston; chrome-plated precipitation hardened stainless steel piston rod, chrome-plated cushion sleeve or cushion spear. When high water base fluids are the operating medium, hydraulic cylinders are usually supplied with high water base rod wiper and seals. Water and high water base fluid operated cylinders are best used on short stroke applications or where high pressure is applied only to clamp the load.

Warranty
Parker Hannifin will warrant cylinders modified for water or high water content fluid service to be free of defects in materials or workmanship, but cannot accept responsibility to premature failure due to excessive wear due to lack of lubricity or where failure is caused by corrosion, electrolysis or mineral deposits within the cylinder.

Fluids and Temperature Range

Class No.	Typical Fluids	Temperature Range
1 (Standard) (Nitrile Polyurethane)	Air, Nitrogen Hydraulic Oil, Mil-H-5606 Oil	-10°F (-23°C) to +165°F (+74°C)
2 Optional Water Base Fluid Seal	Water, Water-Glycol, HWCF — See Class 6 below. Water-in-Oil Emulsion Houghto-Safe, 271, 620, 5040. Mobil Pyrogard D, Shell Irus 905. Ucon Hydrolube J-4	-10°F (-23°C) to +165°F (+74°C)
3 Special (EPR) (at extra cost)	Some Phosphate Ester Fluids Skydrol 500, 7000	-10°F (-23°C) to +130°F (+54°C)
Note: (EPR) seals are not compatible with Hydraulic Oil		
4 Special (Nitrile) (at extra cost)	Low Temperature Air or Hydraulic Oil	-50°F (-46°C) to +150°F (+66°C)
5 Optional (at extra cost) (Fluorocarbon Seals)	High Temperature Houghto-Safe 1010, 1055, 1120 Fyrquel 150, 220, 300, 550 Mobil Pyrogard 42,43,53,55	See paragraph on Fluorocarbon seals for recommended temperature range.
Note: Fluorocarbon seals are not suitable for use with Skydrol fluid, but can be used with hydraulic oil if desired.		
6 Optional (HWCF) (at extra cost)	Houghton, Hydrolubric 120B Sonsol Lubrizol, for other HWCF — consult factory.	+40°F (+4°C) to +120°F (+49°C)
8 Optional (at extra cost) Energized PTFE	See Class 5 Seals	-15°F (-26°C) to +400°F (+204°C)

Application Data

The proper application of a fluid power cylinder requires consideration of the operating pressure, the fluid medium, the mounting style, the length of stroke, the type of piston rod connection to the load, thrust or tension loading on the rod, mounting attitude, the speed of stroke, and how the load in motion will be stopped. Information given here provides pressure rating data for pneumatic and hydraulic cylinders.

Pressure Ratings

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

Series 2H and 3H hydraulic cylinders are recommended for pressures to 3000 psi for heavy-duty service with hydraulic oil. The 4:1 design factor ratings shown are based on tensile strength of material and are for standard rod diameter only. The rating is conservative for continuous severe applications. Design factors at other pressures can be calculated from this rating. In addition, mounting styles, stroke, etc., should be considered because of the limiting effect they may have on these ratings.

Series 2H & 3H Hydraulic Cylinders
Maximum Pressure Ratings

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

[1] Applies to all mountings except Styles J, JB, H, D, DB, DD.

Ports

Series 2H and 3H cylinders can be supplied with SAE straight O-ring ports or NPTF pipe thread ports. If specified on your order, extra ports can be provided on the sides of heads or caps that are not occupied by mountings or cushion valve.

Standard port location is position 1 as shown on line drawings in product catalog and Figure 1 below. Cushion adjustment needle and check valves are at positions 2 and 4 (or 3), depending on mounting style. Heads or caps which do not have an integral mounting can be rotated and assembled with ports at 90° or 180° from standard position. Mounting styles on which head or cap can be rotated at no extra charge are shown in Table A below. To order, specify by position number. In such assemblies the cushion adjustment needle and check valve rotate accordingly since their relationship with port position does not change.

Figure 1

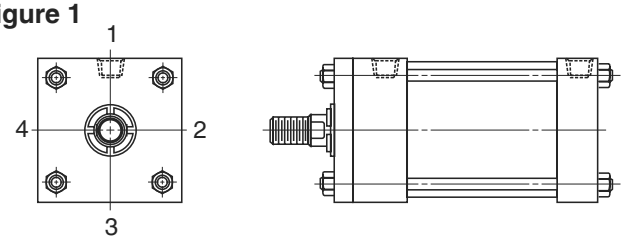


Table A

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

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

Straight Thread Ports

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

Table B

SAE Straight Thread O-Ring Ports

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

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

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

International Ports

Other port configurations to meet international requirements are available at extra cost. Parker Series 2H and 3H cylinders can be supplied, on request, with British standard taper port (BSPT). Such port has a taper of 1 in 16 measured on the diameter ($^1/_{16}$" per inch). The thread form is Whitworth System, and size and number of threads per inch are as follows:

Table C

British Standard Pipe Threads

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

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

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

Table D – Standard Port Sizes

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

[1]Available with 1.000 inch rod diameter only.

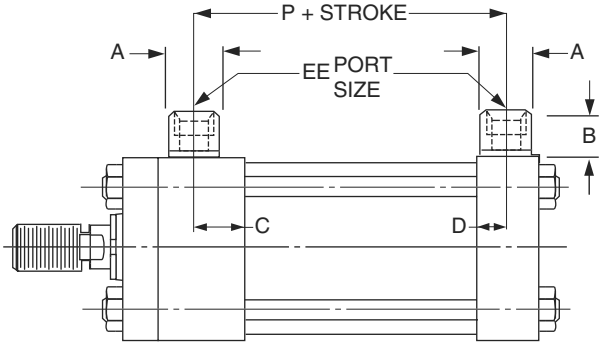
Oversize Ports

Oversize NPTF or SAE straight thread ports can be provided, at an extra charge. For ports one size larger than standard, welded port bosses which protrude from the side of the head or cap are supplied. For dimensions, see drawings and tables below. Series 2H and 3H cylinders equipped with cushions at the cylinder cap end can sustain damage to the cushion check valve (cushion bushing) if excessive oil flow enters the cylinder from the cap end port. Cylinders which are equipped with cap end cushions and ordered with one size oversize ports having hydraulic fluid flow exceeding 25 ft./sec. in the line entering the cap end of the cylinder should be ordered with a "solid cushion" at cap end. All cylinders ordered with double oversize ports should always be ordered with a "solid cushion" at cap end.

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

Oversize NPTF Port Boss Dimensions

Bore Ø	EE (NPTF)	A Ø	B	C	D	P
1.50	3/4	1.38	1.00	0.75	0.78	2.91
2.00	3/4	1.38	1.00	0.75	0.78	2.91
2.50	3/4	1.38	1.00	0.75	0.78	3.03
3.25	1	1.75	1.19	0.91	0.88	3.53
4.00	1	1.75	1.19	0.91	0.88	3.78
5.00	1	1.75	1.19	0.91	0.88	4.28
6.00	1 1/4	2.25	1.31	1.13	1.13	5.13
7.00	1 1/2	2.50	1.56	1.38	1.38	5.75
8.00	2	3.00	1.69	1.50	1.50	6.50



Oversize SAE Straight Thread Port Boss Dimensions

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

[1] Port tapped directly in head with code 1 rod these bores.

[2] Port tapped directly in head (all rod codes) and cap these bores.

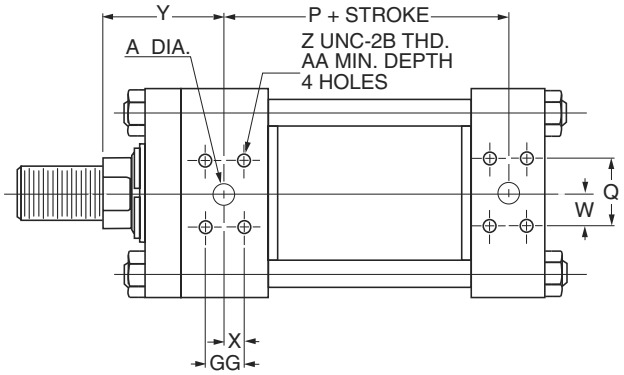
[3] Port tapped directly in cap this bore.

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

Bore Ø	Rod No.	SAE Dash No.	A Ø	AA	GG	P	Q	W	X	Y	Z
2.50[4,5]	1	8	.50	.81	.69	2.97	1.50	.75	.34	2.38	5/16 - 18
3.25[4]	1	12	.75	.75	.87	3.47	1.87	.94	.44	2.75	3/8 - 16
	2									3.13	
	3									3.00	
4.00[4]	1	12	.75	.75	.87	3.72	1.87	.94	.44	3.00	3/8 - 16
	2									3.38	
	3									3.13	
5.00[4]	1	12	.75	.75	.87	4.22	1.87	.94	.44	3.13	3/8 - 16
	2									3.38	
	3									3.38	
	4									3.38	
6.00	All	16	1.00	.87	1.03	4.85	2.06	1.03	.52	3,50	3/8 - 16
7.00	All	20	1.25	1.00	1.19	5.47	2.31	1.16	.59	3.75	7/16 - 14
8.00	All	24	1.50	1.06	1.41	6.19	2.75	1.37	.70	3.88	1/2 - 13

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

[5] 2.50" bore head flange port available with 1.000" rod only.



Stroke Data

Parker cylinders are available in any practical stroke length. The following information should prove helpful to you in selecting the proper stroke for your cylinder application.

Stroke Tolerances

Stroke length tolerances are required due to buildup of tolerances of piston, head, cap and cylinder tube. Standard production of stroke tolerances run +.031" to -.015" up to 20" stroke, +.031" to -.020" for 21" to 60" and +.031" to -.031" for greater than 60" stroke. For closer tolerances on stroke length, it is necessary to specify the required tolerance plus the pressure and temperature at which the cylinder will operate. Stroke tolerances smaller than .015" are not generally practical due to elasticity of cylinders. If machine design requires such close tolerances, use of a stroke adjuster may achieve the desire result.

Mounting Groups

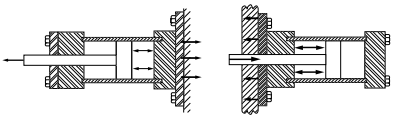
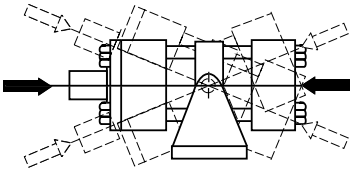
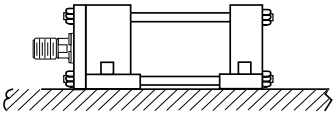
Standard mountings for fluid power cylinders fall into three basic groups. The groups can be summarized as follows:

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

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

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

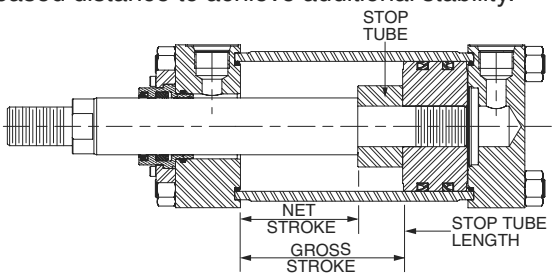
Because a cylinder's mounting directly affects the maximum pressure at which the cylinder can be used, the chart below should be helpful in selection of the proper mounting combination for your application. Stroke length, piston rod connection to load, extra piston rod length over standard, etc., should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

Group 1 FIXED MOUNTS which absorb force on cylinder centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	Styles HB, HH, TC Styles JB, JJ, TB
Medium-Duty Service For Thrust Loads For Tension Loads	Styles H, HB Styles J, JB
Light-Duty Service For Thrust Loads For Tension Loads	Style H Style J
Group 2 PIVOT MOUNTS which absorb force on cylinder centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	Styles DD, D, DE Styles BB, DD, D, DB, DE
Medium-Duty Service For Thrust Loads For Tension Loads	Styles BB, SB Styles BB, SB
Group 3 FIXED MOUNTS which do not absorb force on the centerline.	
	
Heavy-Duty Service For Thrust Loads For Tension Loads	Styles C, CP Styles C, CP
Medium-Duty Service For Thrust Loads For Tension Loads	Styles F, FP Styles F, FP

E

Stop Tubing

Stop tube is recommended to lengthen the distance between the rod bearing and piston bearing to reduce bearing loads on long push stroke cylinders when the cylinder is fully extended. This is especially true of horizontally mounted cylinders. As part of the piston assembly and positioned between the piston and head, a stop tube restricts the extended position of the rod using the increased distance to achieve additional stability.



Use the following steps to determine the need for stop tube and, if required, how long it should be.

1. Examine the groups of cylinder illustrations below and determine which mounting and rod guiding group type match the required cylinder application.
2. Establish the Basic Length (L), with the piston rod fully extended, for the selected illustration by using the dimensional tables on previous pages of this catalog. For pivot mounted cylinders, the pin-to-pin dimension with the piston rod fully extended must be used. Regardless of mounting style, be sure to include any extended piston rod length beyond the catalog standard.
3. In the Stop Tube Table select the column for the appropriate mounting style and rod end guiding type. In the Basic Length (L) column, find the row with the range that includes the value calculated in Step 2. The next respective column to the right has the required length of stop tube.

Note: Mounting Styles BB, DB, H, HB, HH and SB that are mounted horizontally should also be checked for turning moments and loads between the rod bearing and piston to ensure they are not excessive. Weight of oil must be included in determining bearing loads.

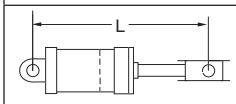
When specifying cylinders with stop tube be sure to call out the net stroke and the length of the stop tube. Machine design can be continued without delay by laying in a cylinder equivalent in length to the NET STROKE PLUS STOP TUBE LENGTH, which is referred to as GROSS STROKE.

Stop Tube Length vs Basic Length (L)

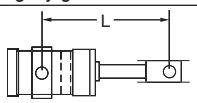
Pivot Mounts (BB, D, DB, DD, DE and SB)		Fixed Mounts (C, F, H, HB, HH, J, JB, JJ, TB, TC, TD)					
Pivoted and Rigidly Guided Rod End		Fixed & Rigidly Guided Rod End		Pivoted & Rigidly Guided Rod End		Unguided Rod End	
Basic Length (L)	Stop Tube Length	Basic Length (L)	Stop Tube Length	Basic Length (L)	Stop Tube Length	Basic Length (L)	Stop Tube Length
0 - 40	0	0 - 80	0	0 - 57	0	0 - 20	0
41 - 50	1	81 - 100	1	58 - 71	1	21 - 25	1
51 - 60	2	101 - 120	2	72 - 86	2	26 - 30	2
61 - 70	3	121 - 140	3	87 - 100	3	31 - 35	3
71 - 80	4	141 - 160	4	101 - 114	4	36 - 40	4
81 - 90	5	161 - 180	5	115 - 129	5	41 - 45	5
91 - 100	6	181 - 200	6	130 - 143	6	46 - 50	6
101 - 110	7	201 - 220	7	144 - 157	7	51 - 55	7
111 - 120	8	221 - 240	8	158 - 171	8	56 - 60	8
121 - 130	9	241 - 260	9	172 - 186	9	61 - 65	9
131 - 140	10	261 - 280	10	187 - 200	10	66 - 70	10
141 - 150	11	281 - 300	11	201 - 214	11	71 - 75	11
151 - 160	12	Consult Factory		215 - 229	12	76 - 80	12
161 - 170	13			230 - 243	13	81 - 85	13
171 - 180	14			244 - 257	14	86 - 90	14
181 - 190	15			258 - 271	15	91 - 95	15
191 - 200	16			272 - 286	16	96 - 100	16
201 - 210	17			287 - 300	17	101 - 105	17
211 - 220	18			Consult Factory		106 - 110	18
221 - 230	19					111 - 115	19
231 - 240	20					116 - 120	20
241 - 250	21					121 - 125	21
251 - 260	22					126 - 130	22
261 - 270	23					131 - 135	23
271 - 280	24					136 - 140	24
281 - 290	25					141 - 145	25
291 - 300	26					146 - 150	26
Consult Factory						Consult Factory	

Cylinder Mounting and Rod Guiding Groups

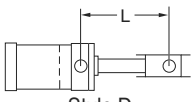
Pivot Mount – Pivoted and rigidly guided rod end



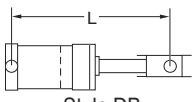
Styles BB, SB



Styles DD, DE

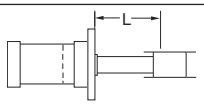


Style D

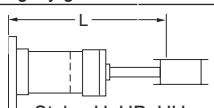


Style DB

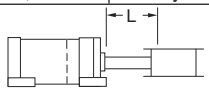
Fixed Mount – Fixed and rigidly guided rod end



Styles J, JB, JJ

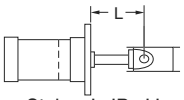


Styles H, HB, HH

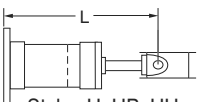


Styles C, F

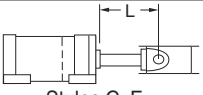
Fixed Mount – Pivoted and rigidly guided rod end



Styles J, JB, JJ

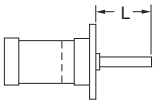


Styles H, HB, HH

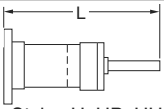


Styles C, F

Fixed Mount – Unguided rod end



Styles J, JB, JJ



Styles H, HB, HH

Piston Rod Diameter Selection

Long stroke cylinders that work on push with the piston rod loaded in compression should be checked, using the following steps, to ensure an appropriate piston rod diameter is specified.

1. First, determine whether stop tubing is required as described on the previous page.
2. Use the Basic Length (L) that was established for determining the stop tube length and then add the required stop tube length to the Basic Length to obtain an Adjusted Basic Length (L_A).
3. In the table below, for the mounting style and rod end guiding condition that will be used, find the row for the Bore and Rod combination that is required.
4. Follow the Bore and Rod row to the right and find the Operating Pressure column that is closest, but exceeds the system pressure. The intersection of the Bore and Rod row and Operating Pressure column displays the maximum allowable L_A. If L_A in the table is greater than or equal to the calculated L_A, the rod diameter selected is satisfactory for the application.
5. If L_A in the table is less than the calculated Adjusted Basic Length move down the column to a rod diameter with an L_A that exceeds the requirement.
6. If the L_A specifies a rod diameter in a larger bore then restart the process of sizing the stop tube and re-check the rod diameter. Contact the factory if L_A exceeds 300 inches.

Note: Data in these tables assume standard rod extension (W dimension) and standard rod end accessories. If different, consult factory.

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

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

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

E

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

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

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