Global Pneumatics, Warning, Offer of Sale

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Pneumatic Division
Wadsworth, Ohio
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P1X Series

Compact Rodless Air Cylinders

G

P1X

RC

P1Z

Contents

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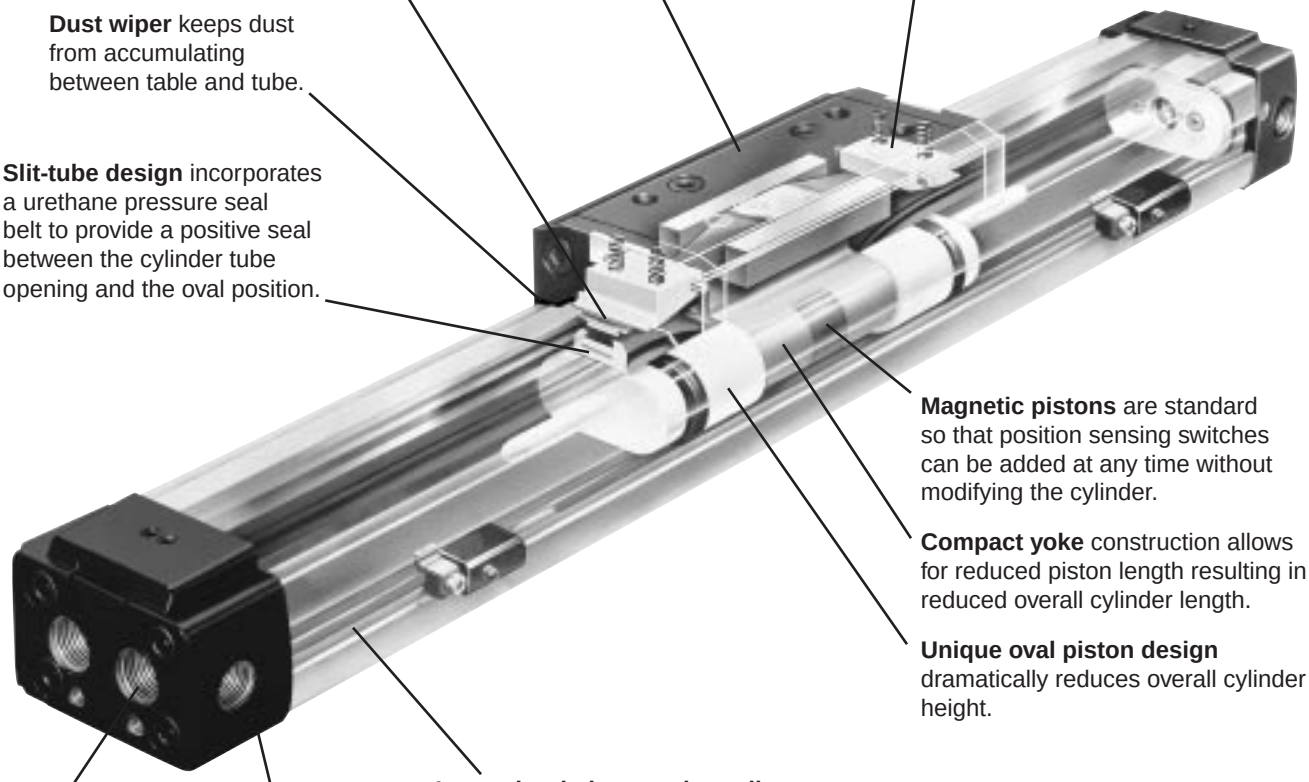
Large carriage with four strategically placed mounting holes ensures a high degree of stability and flexibility.

Spring-loaded tension arms located on the work table maintain constant pressure on the dust seal belt to ensure external sealing protection.

Dust-seal belt located above the pressure seal belt, prevents contamination from entering the cylinder tube.

Dust wiper keeps dust from accumulating between table and tube.

Slit-tube design incorporates a urethane pressure seal belt to provide a positive seal between the cylinder tube opening and the oval position.



Magnetic pistons are standard so that position sensing switches can be added at any time without modifying the cylinder.

Compact yoke construction allows for reduced piston length resulting in reduced overall cylinder length.

Unique oval piston design dramatically reduces overall cylinder height.

Integral switch mounting rail provides convenient mounting location for position sensing switches. Switches available include Solid State and Reed, AC or DC, with or without indicator lights. Bi-Color switches are available with 2 indicators to identify when maximum efficiency of contact is made.

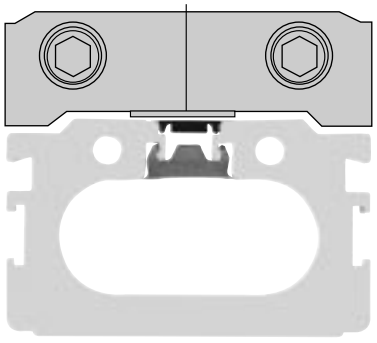
Additional ports in one end cap for optional piping location.

Note: End cap ports shown on this view are for representation only. Actual end ports are at other end of cylinder in relation to standard side ports and end ports are normally furnished plugged.

Adjustable cushions for deceleration at end of stroke are standard.

Oval Piston Design

Oval piston design provides greater load carrying capacity than typical rodless cylinders with round pistons.



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Model Code

P1X	N	016	D	A	N	0500	W	D	N	N	N

Series

Construction

N	Inch
M	Metric

Bore Size

016	16mm
020	20mm
025	25mm
032	32mm
040	40mm
050	50mm
063	63mm

Function

D	Double Acting

Seal Material

N	Standard

Stroke Length

Basic or Options

B†	Basic
W†	With Options
/	Special (for factory use only)

Carriage Mounting Style

Standard	Inverted	Carriage Mounting
D (std)	**J**	Single, Basic Mount
A	**G**	Single, Swivel Mount

Piston Style*

A	Cushions Both Ends (Standard)
R	Cushion Right End Only**
L	Cushion Left End Only**
N	No Cushions or Shock Absorbers
H	Shock Absorber Both Ends
B	Shock Absorber Right End Only**
C	Shock Absorber Left End Only**

* Magnetic piston standard.
** As viewed from port side of cylinder.

Mounting Options

No Foot Mount	End Mount Foot Bracket	Bottom Mount Foot Bracket	Intermediate Supports
N (std)	**F**	**A**††	No Support
H	**M**	**B**††	One Support
K	**P**	**C**††	Two Supports
T	**R**	**D**††	Three Supports

Porting Options

N	NPTF
G	BSPP
Q	BSPT*

* Not available with N Series

Sensors

C	P8S-GPFLX* (Qty 2)
B	P8S-GPFTX* (Qty 2)
S	P8S-GPSHX* (Qty 2)
E	P8S-GPMHX* (Qty 2)
A	P8S-GNFLX* (Qty 2)
F	P8S-GNFTX* (Qty 2)
D	P8S-GNSHX* (Qty 2)
G	P8S-GNMHX* (Qty 2)
H	P8S-GRFLX* (Qty 2)
K	P8S-GRFTX* (Qty 2)
J	P8S-GRSHX* (Qty 2)
M	P8S-GRMHX* (Qty 2)
N	None (standard)

* Includes switch adapter bracket

Essential Information

Optional Features

† When "B" is specified, the remaining digits in the part number are not necessary. If "W" is used, the remaining digits in the part number must be filled out.

†† Not available on 40, 50 and 63mm bore sizes.

Ordering Example #1

25mm bore, 350mm stroke standard cylinder with air cushions both ends, magnetic piston, inch mounting threads and NPTF ports.

Cylinder Part # P1XN025DAN0350B

Ordering Example #2

32mm bore, 1500mm stroke standard cylinder with shock absorbers both ends, magnetic piston, inch mounting threads, single swivel mount carriage, NPTF ports, bottom mounted foot brackets, 2 intermediate supports and 2 P8S-GNFLX sensors with brackets.

Cylinder Part # P1XN032DHN1500WANCA

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Specifications

Model	P1X (Standard w/Switch)			
Operating Medium	Compressed Air			
Maximum Pressure	100 PSI (7 BAR)			
Minimum Pressure	Ø16, Ø20 Bores 29 PSI (2 Bar) Ø25, Ø32, Ø40 Bores 14.5 PSI (1 Bar) Ø50, Ø63 Bores 7 PSI (0.5 Bar)			
Proof Pressure	152 PSI (10.5 Bar)			
Bore Size mm (inch nominal)	16 (5/8)	20 (3/4), 25 (1)	32 (1-1/4), 40 (1-1/2)	50 (2), 63 (21/2)
Port Size – N Series	M5 (10-32)	1/8 NPT	1/4 NPT	3/8 NPT
Port Size – M Series	M5 (10-32)	1/8 Rc	1/4 Rc	3/8 Rc
Ambient Temperature °F (°C)	40 to 140°F (5 to 60°C)			
Stroke Tolerance in.	±0.080 to 39"	±0.100 to 118"	±0.120 to 196"	
Piston Speed, *in./sec.	2-80 IPS with side ports on each end (Ø16 & Ø20 bores 2-40 IPS with single end porting with 39" stroke) (Ø25, Ø32, Ø40, Ø50 & Ø63 bores 2-40 IPS with single end porting with 78" stroke)			
Cushion	Air Cushion Standard			
Lubrication	Not Required (if you choose to lubricate your system, continuing lubrication will be required.)			

***Note:** Actual piston speed with one end ports will vary depending on stroke length.

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Weight & Theoretical Force Characteristics

Bore	Area In²	Weights								Theoretical Force (lbs)				
		Weight at Zero Stroke						Weight per 1" (25.4mm) Stroke		at Pressure (PSI)				
		M00		MLB		MLB1								
		lbs	kg	lbs	kg	lbs	kg	lbs	kg	30	40	60	80	100
16	0.31	0.70	0.3	0.73	0.3	0.77	0.4	0.07	0.03	9	12	19	25	31
20	0.49	1.15	0.5	1.19	0.5	1.28	0.6	0.10	0.04	15	20	29	39	49
25	0.84	2.21	1.0	2.43	1.1	2.43	1.1	0.15	0.07	23	30	46	61	76
32	1.26	3.31	1.5	3.53	1.6	3.75	1.7	0.20	0.09	38	50	69	100	125
40	1.96	5.29	2.4	5.51	2.5	—		0.27	0.12	59	78	117	156	195
50	3.08	7.94	3.6	8.16	3.7			0.40	0.18	91	122	182	243	304
63	4.86	13.67	6.2	14.33	6.5			0.63	0.28	145	193	290	386	483

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Moments

Figure 5 shows the maximum allowable moments for each of the three types of loading: pitch, roll and yaw.

The sum total of each of these types of moments, divided by each of the maximum values, determines a Load-Moment Factor (LMF) should be equal to or less than 1.0. On horizontal mountings, the total load (L) should also be divided by the maximum load allowable (Figure 6) and factored into the equation.

Horizontal Mountings:

$$\frac{L}{[L]} + \frac{M}{[M]} + \frac{Ms}{[Ms]} + \frac{Mv}{[Mv]} = LMF \leq 1.0$$

Vertical Mountings:

$$\frac{M}{[M]} + \frac{Ms}{[Ms]} + \frac{Mv}{[Mv]} = LMF \leq 1.0$$

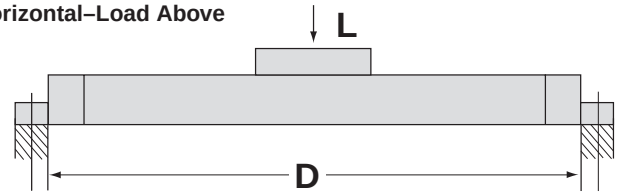
Figure 5

Maximum Allowable Moments N-m (lb-in)						
Bore	[M] Pitch Moment		[Ms] Roll Moment		[Mv] Yaw Moment	
	Std.	Inverted	Std.	Inverted	Std.	Inverted
16	5 (44)	3.5 (31)	1 (9)	0.5 (4)	1 (9)	1 (9)
20	10 (89)	7 (62)	1.5 (13)	0.7 (6)	3 (27)	3 (27)
25	17 (150)	12 (106)	5 (44)	2.5 (22)	10 (89)	10 (89)
32	36 (319)	25 (221)	10 (89)	5 (44)	21 (186)	21 (186)
40	77 (682)	54 (478)	23 (204)	11.5 (102)	26 (230)	26 (230)
50	154 (1363)	108 (956)	32 (283)	16 (142)	42 (372)	42 (372)
63	275 (2434)	193 (1708)	52 (460)	26 (230)	76 (673)	76 (673)

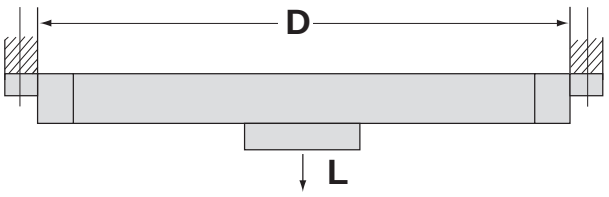
Load and Deflection

Figure 6 shows the maximum load [L] that the cylinder can accept, as well as the maximum length [D] between supports at the maximum load.

Horizontal–Load Above



Horizontal–Load Below



Horizontal–Tube Support

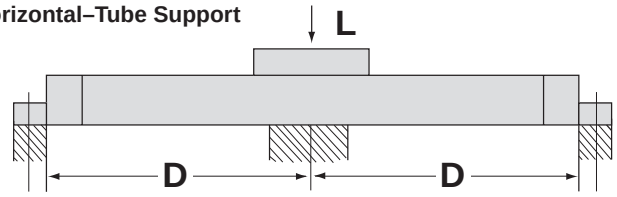
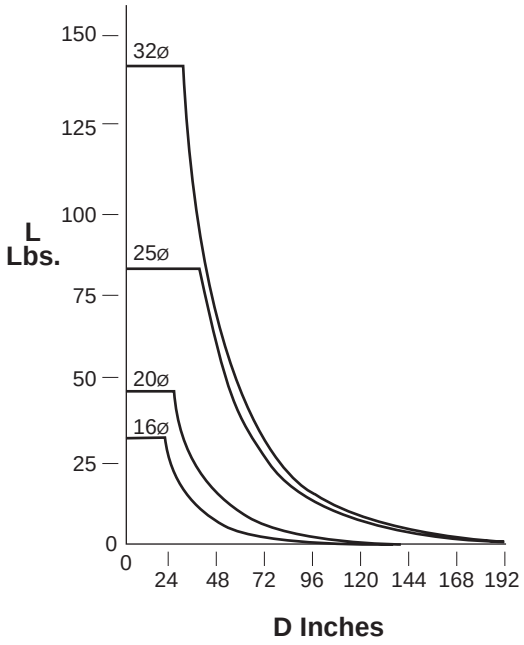


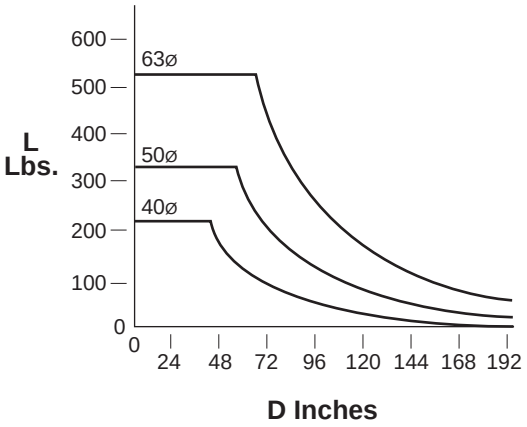
Figure 6

Bore Size	Max. Allowable Load [L] N (lbs)		Max. Unsupported Length mm (in) at Max. Load
	Std.	Inverted	
16	141 (32)	70 (16)	450 (17.7)
20	198 (45)	101 (23)	551 (21.7)
25	356 (81)	180 (41)	899 (35.4)
32	616 (140)	308 (70)	749 (29.5)
40	959 (218)	480 (109)	1000 (39.4)
50	1456 (331)	726 (165)	1300 (51.2)
63	2297 (522)	1148 (261)	1600 (63.0)

Acceptable length and load combinations for the various bore sizes can be determined from the charts in Figure 7.

Figure 7





To determine cylinder deflections under the load (or resistive force perpendicular to the piston table) without mid-support, see the graphs on page G9.

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Inertia Moment Consideration

When the weight is stopped at the end of the stroke by the cylinder cushion, inertial force is created. This inertial force (Fi) can be determined by using the formula:

Fi = LG

L = Load attached to the cylinder carriage (lbs.)

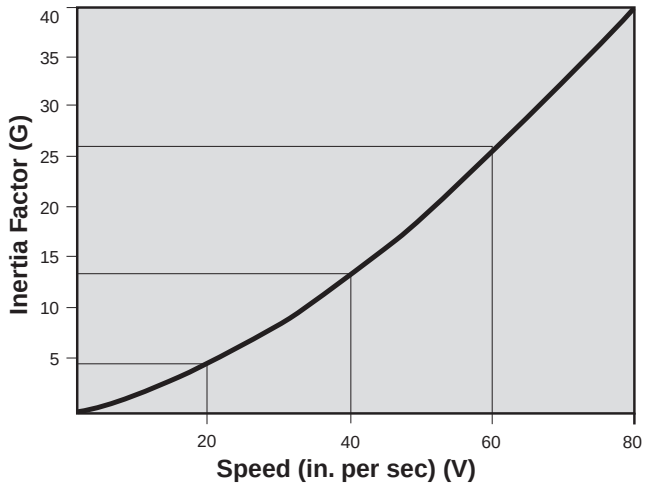
G = Inertia factor (Figure 8)

Example:
A speed of 40 in/sec corresponds to an inertia factor G of 13.

The inertial force calculated would then be multiplied by the distance from the center of gravity of the load to the centerline of the cylinder, and added to the previously calculated M and Mv moments. This will give an M Total and Mv Total. Ensure that the M Total and the Mv Total do not exceed the [M] and [Mv] values shown in Figure 5 (previous page). If they exceed these values, consult the factory.

See pages G18-G9 for additional information on shock absorbers.

Figure 8

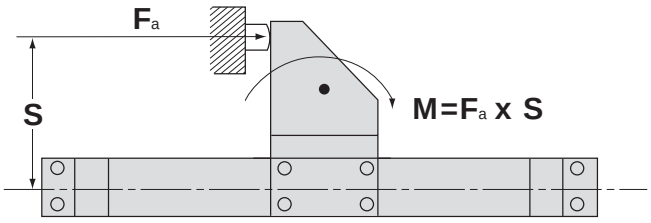


External Stops

When the load attached to the cylinder is stopped externally, it creates an additional moment equal to the cylinder force (Fa) times the distance (S). This additional moment, plus the previously calculated Load-Moment factor, should not exceed the allowable values. See previous page.

When reducing the stroke with external stops, remember that the cushion length and the energy absorption capacity are not directly proportional. Reducing the cushioning distance by 50% corresponds to a reduction of 60-70% in cushion effectiveness.

Figure 9



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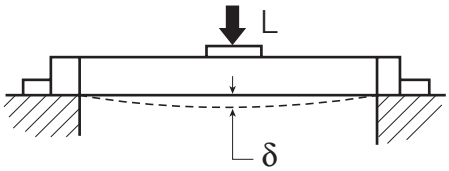
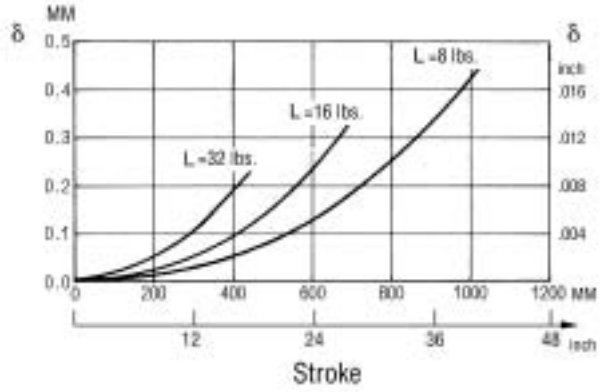
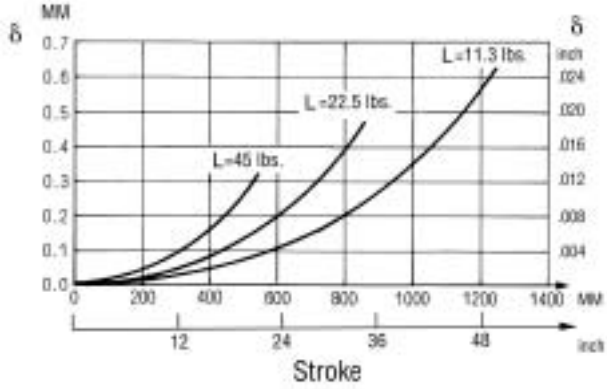


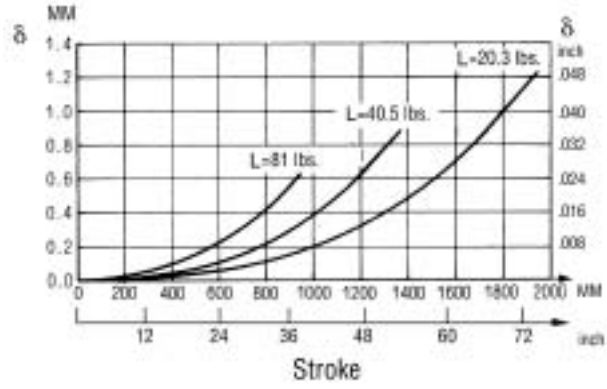
16 mm Bore



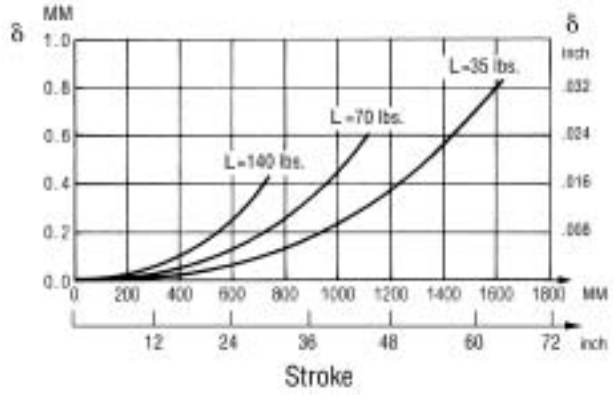
20 mm Bore



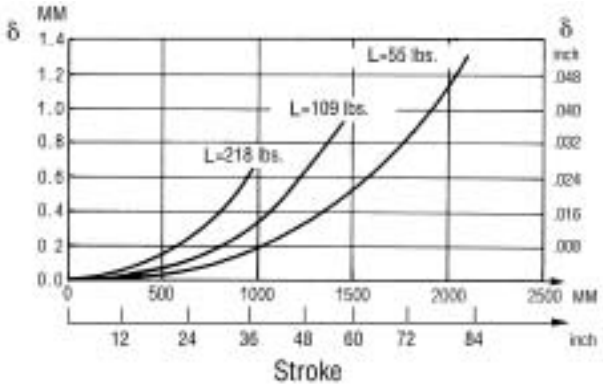
25 mm Bore



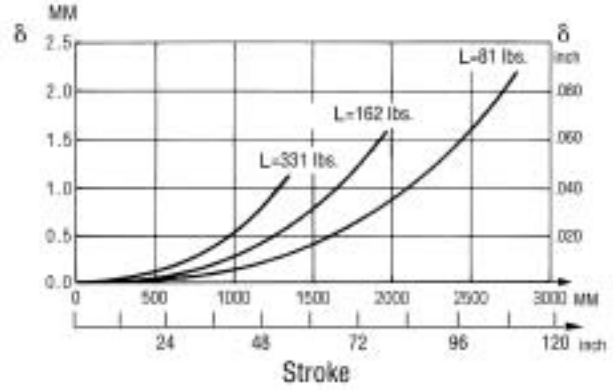
32 mm Bore



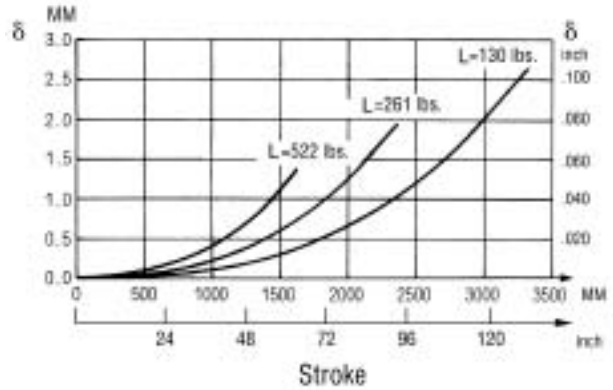
40 mm Bore



50 mm Bore



63 mm Bore



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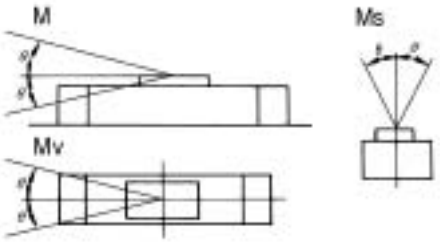
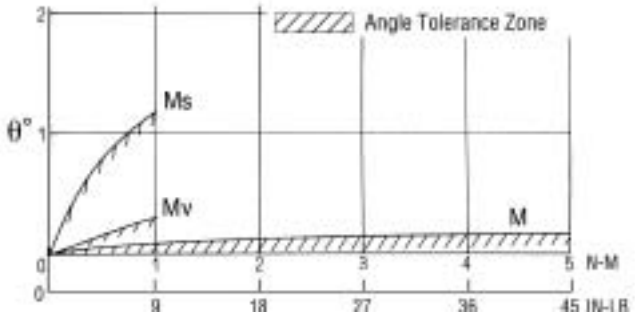
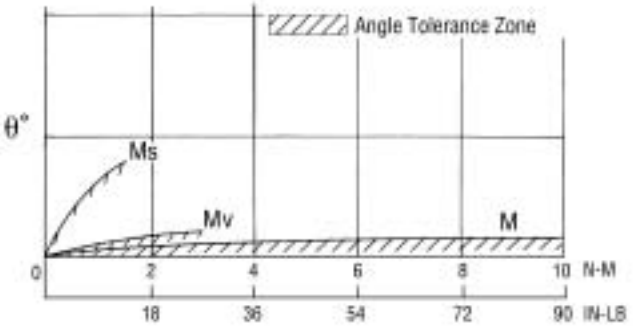
Piston Table Angular Deflection Due To Load Moments Applied



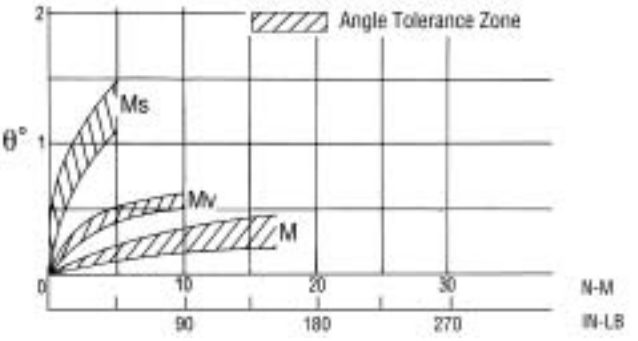
16 mm Bore



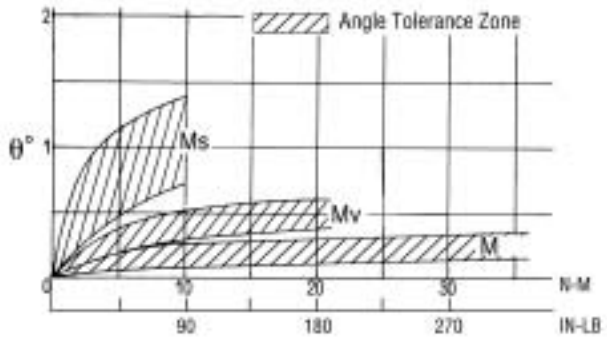
20 mm Bore



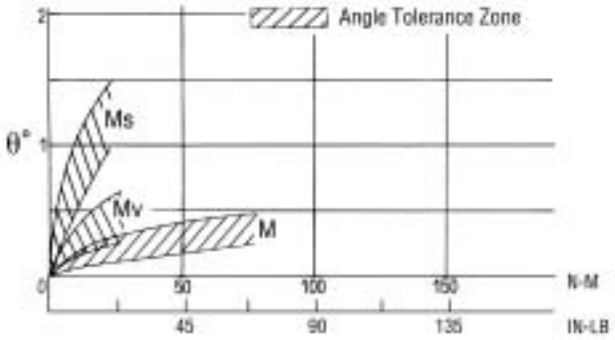
25 mm Bore



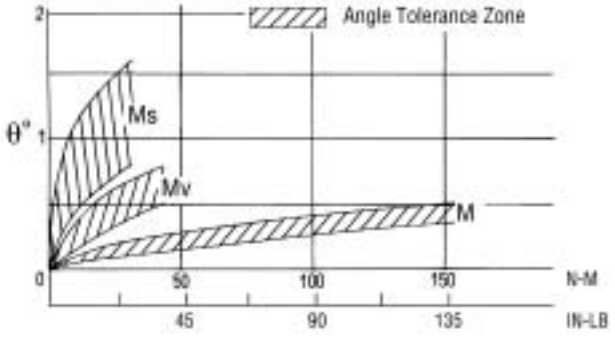
32 mm Bore



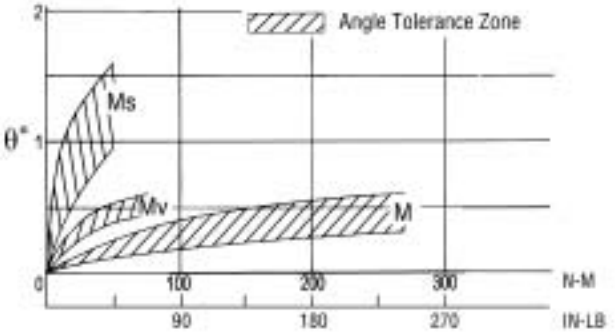
40 mm Bore



50 mm Bore



63 mm Bore



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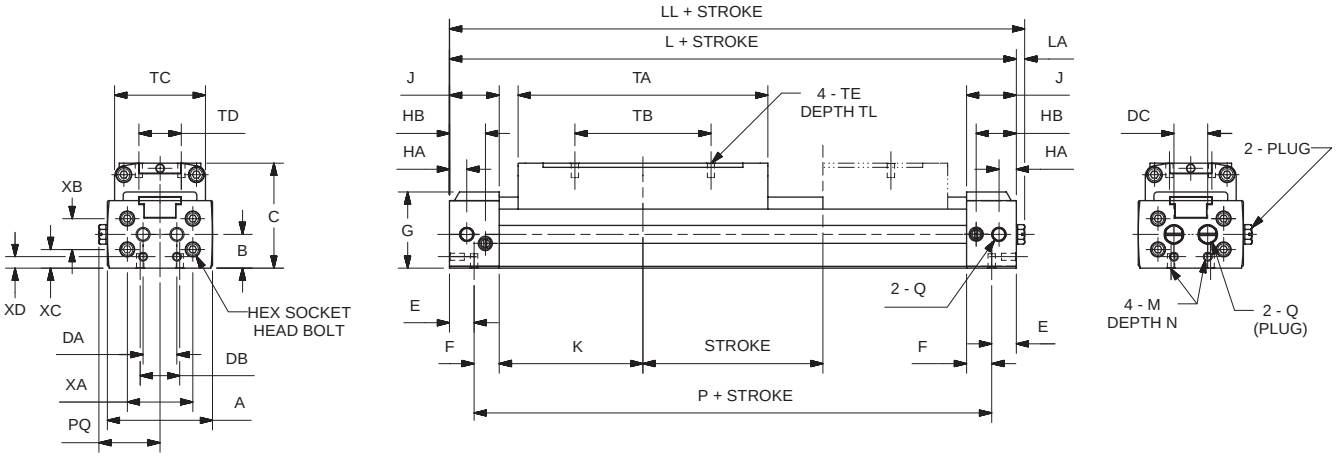
Basic Cylinder

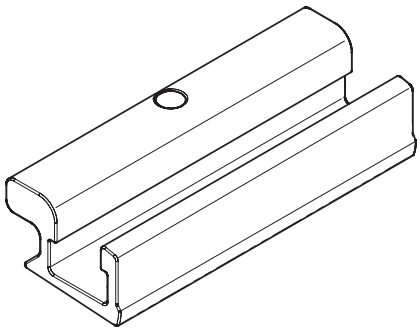


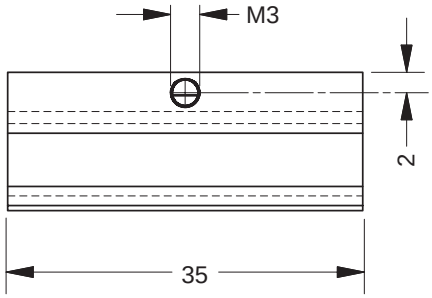
Bore (mm)		A	B	C	DA	DB	DC	E	F	G	HA	HB	J	K	L	LL	LA	M	N
16	inches	1.46	0.47	1.46	0.47	0.55	0.47	0.34	0.35	1.06	0.24	0.55	0.69	2.24	5.87	5.98	0.12	5-40	0.20
	mm	37	12	37	12	14	12	8.5	9	27	6	14	17.5	57	149	152	3	M3	5
20	inches	1.73	0.55	1.65	0.55	0.63	0.63	0.41	0.45	1.22	0.34	0.73	0.87	2.46	6.65	6.75	0.10	8-32	0.26
	mm	44	14	42	14	16	16	10.5	11.5	31	8.5	18.5	22	62.5	169	171.5	2.5	M4	6.5

Bore (mm)		P	PQ	Q	TA	TB	TC	TD	TE	TL	XA	XB	XC	XD
16	inches	5.20	0.83	10-32 NPT	3.47	1.89	1.26	0.59	5-40	0.20	0.91	0.43	0.26	0.16
	mm	132	21	M5	88	48	32	15	M3	5	23	11	6.5	4
20	inches	5.83	0.97	1/8 NPT	3.94	2.36	1.50	0.71	8-32	0.24	1.10	0.63	0.24	0.20
	mm	148	24.5	1/8 Rc	100	60	38	18	M4	6	28	16	6	5

Sensor Adapter Bracket

Part Number P8S-TMA0Y
(Shown larger than actual size)





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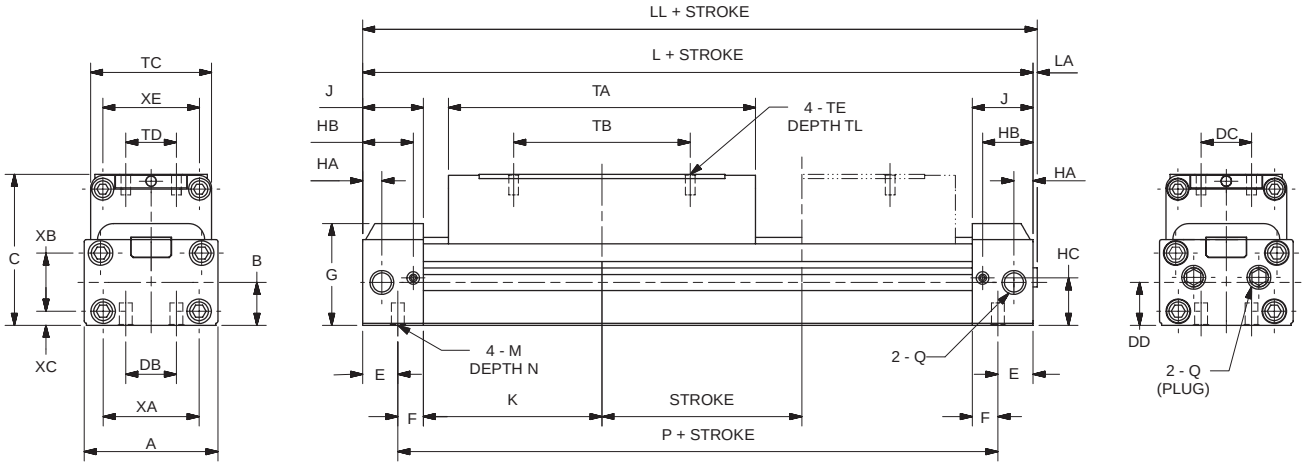
Basic Cylinder



G

Bore (mm)		A	B	C	DB	DC	DD	E	F	G	HA	HB	HC	J	K	L	LL	LA	M	N
25	inches	2.09	0.67	2.09	0.79	1.02	0.75	0.55	0.39	1.59	0.30	0.79	0.74	0.95	2.80	7.48	7.56	0.08	1/4-20	0.35
	mm	53	17	53	20	26	19	14	10	40.5	7.5	20	18.9	24	71	190	192	2	M6	9
32	inches	2.60	0.73	2.24	1.26	1.06	0.83	0.59	0.51	1.71	0.39	0.93	0.85	1.10	3.35	8.90	9.00	0.10	1/4-20	0.35
	mm	66	18.5	57	32	27	21	15	13	43.5	10	23.5	21.5	28	85	226	228.5	2.5	M6	9
40	inches	3.15	0.87	2.64	1.42	1.38	1.10	0.67	0.55	2.03	0.51	1.02	1.06	1.22	3.58	9.61	9.71	0.10	5/16-18	0.47
	mm	80	22	67	36	35	28	17	14	51.5	13	26	27	31	91	244	246.5	2.5	M8	12
50	inches	3.78	1.10	3.23	1.77	1.38	1.38	0.91	0.63	2.40	0.59	1.30	1.39	1.54	3.54	10.16	10.26	0.10	5/16-18	0.47
	mm	96	28	82	45	35	35	23	16	61	15	33	35.3	39	90	258	260.5	2.5	M8	12
63	inches	4.65	1.38	3.74	1.97	1.54	1.65	0.75	0.79	2.91	0.59	1.26	1.69	1.54	4.29	11.65	11.75	0.10	3/8-16	0.59
	mm	118	35	95	50	39	42	19	20	74	15	32	43	39	109	296	298.5	2.5	M10	15

Bore (mm)		P	Q	TA	TB	TC	TD	TE	TL	XA	XB	XC	XE
25	inches	6.38	1/8 NPT	4.80	2.76	1.89	0.79	10-24	0.32	1.50	0.91	0.22	1.58
	mm	162	1/8 Rc	122	70	48	20	M5	8	38	23	5.5	40
32	inches	7.72	1/4 NPT	5.28	3.15	2.21	0.79	1/4-20	0.35	1.89	0.98	0.24	1.85
	mm	196	1/4 Rc	134	80	56	20	M6	9	48	25	6	47
40	inches	8.27	1/4 NPT	5.83	3.54	2.68	1.18	1/4-20	0.43	2.36	1.18	0.28	2.28
	mm	210	1/4 Rc	148	90	68	30	M6	11	60	30	7	58
50	inches	8.35	3/8 NPT	5.98	3.94	3.15	1.18	5/16-18	0.51	2.91	1.42	0.39	2.76
	mm	212	3/8 Rc	152	100	80	30	M8	13	74	36	10	70
63	inches	10.16	3/8 NPT	6.61	4.33	4.02	1.58	5/16-18	0.51	3.78	1.65	0.55	3.54
	mm	258	3/8 Rc	168	110	102	40	M8	13	96	42	14	90

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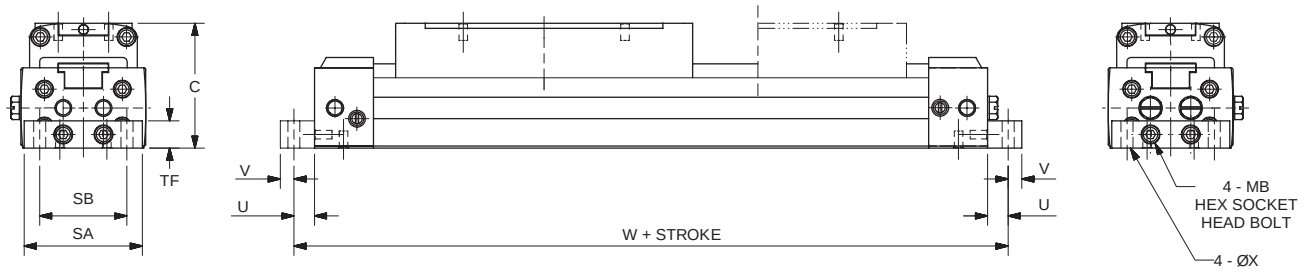
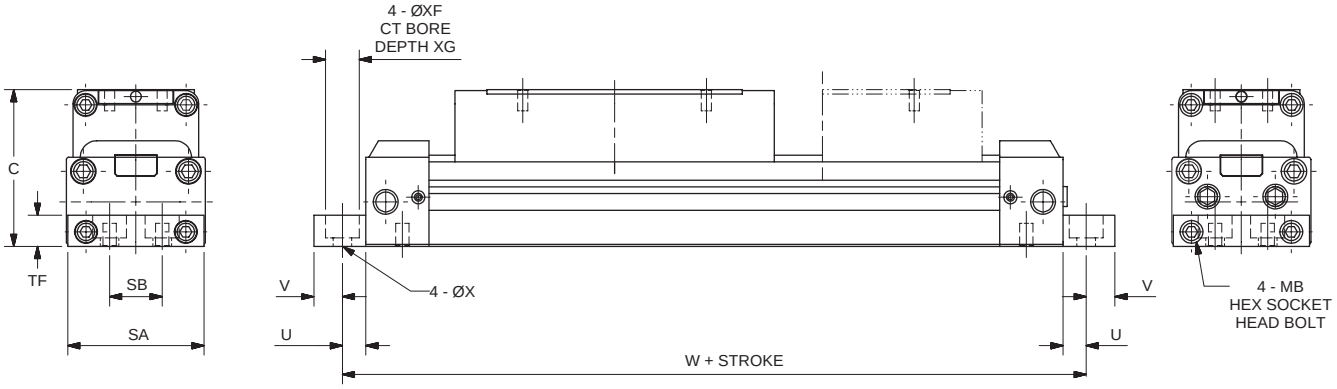
16-32 mm Bore Sizes



See page G17 for end port usage.

40-63 mm Bore Sizes



See page G17 for end port usage.

Bore (mm)		C	SA	SB	TF	U	V	W	X	XF	XG	MB
16	inches	1.46	1.38	1.02	0.32	0.24	0.16	6.34	0.14	—		–
	mm	37	35	26	8	6	4	161	3.6			M3x10
20	inches	1.65	1.69	1.30	0.39	0.24	0.24	7.13	0.19			–
	mm	42	43	33	10	6	6	181	4.7			M4x12
25	inches	2.09	2.05	0.79	0.47	0.35	0.43	8.19	0.28			
	mm	53	52	20	12	9	11	208	7			M5x50
32	inches	2.24	2.52	1.26	0.47	0.35	0.43	9.61	0.28			
	mm	57	64	32	12	9	11	244	7			M5x50
40	inches	2.64	3.15	1.42	0.59	0.43	0.35	10.47	0.35	0.51	0.34	
	mm	67	80	30	15	12.5	11.5	269	9	13	8.7	M6x55
50	inches	3.23	3.70	1.77	0.79	0.43	0.35	11.02	0.35	0.51	0.34	
	mm	82	94	40	20	12.5	11.5	283	9	13	8.7	M8x65
63	inches	3.74	4.57	1.97	0.98	0.51	0.47	12.68	0.43	0.61	0.41	
	mm	95	116	48	25	15	15	326	11	15.5	10.5	M8x70

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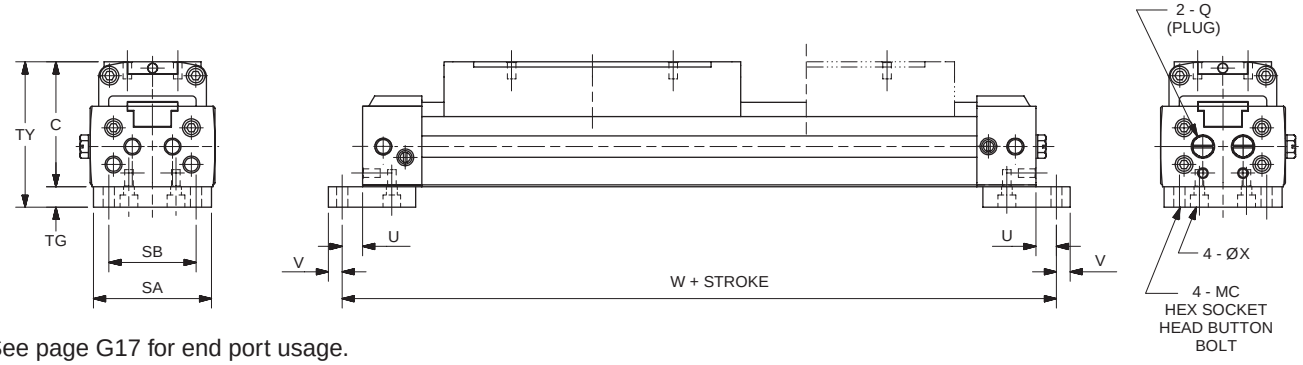
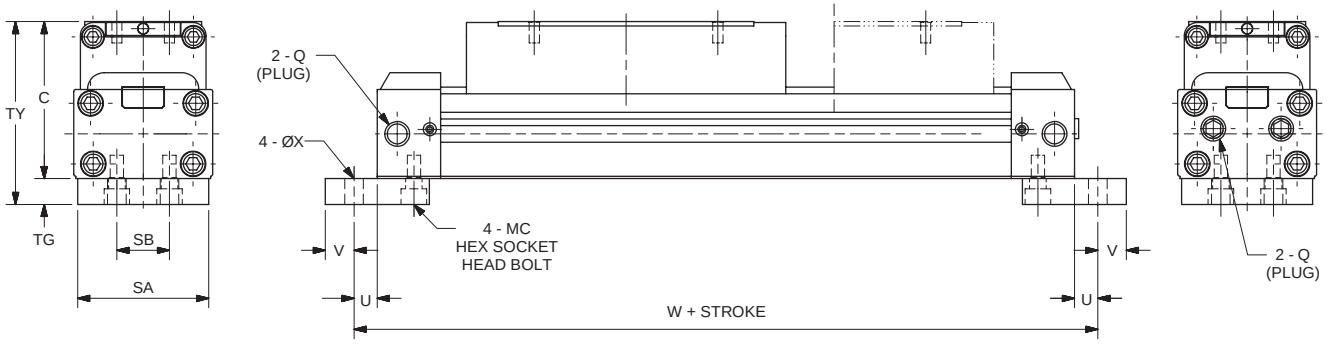
16-20 mm Bore Sizes



See page G17 for end port usage.

25-32 mm Bore Sizes



See page G17 for end port usage.

Bore (mm)		C	Q	SA	SB	TG	TY	U	V	W	X	MC
16	inches	1.46	10-32	1.38	1.02	0.24	1.69	0.24	0.16	6.34	0.13	5-40, 1/4 LG
	mm	37	M5	35	26	6	43	6	4	161	3.4	
20	inches	1.65	1/8 NPT	1.69	1.30	0.32	1.97	0.24	0.24	7.13	0.18	8-32, 3/8 LG
	mm	42	1/8 Rc	43	33	8	50	6	6	181	4.5	
25	inches	2.09	1/8 NPT	1.97	0.79	0.39	2.48	0.35	0.43	8.19	0.28	1/4-20 x 1/2 LG
	mm	53	1/8 Rc	50	20	10	63	9	11	208	7	
32	inches	2.24	1/4 NPT	2.52	1.26	0.39	2.64	0.35	0.43	9.61	0.28	1/4-20 x 1/2 LG
	mm	57	1/4 Rc	64	32	10	67	9	11	244	7	
40	inches	2.64	1/4 NPT	—								
	mm	67	1/4 Rc									
50	inches	3.23	3/8 NPT									
	mm	82	3/8 Rc									
63	inches	3.74	3/8 NPT									
	mm	95	3/8 Rc									

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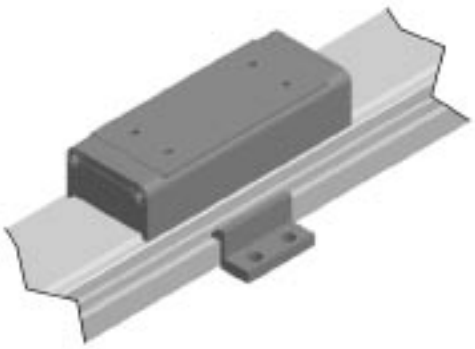
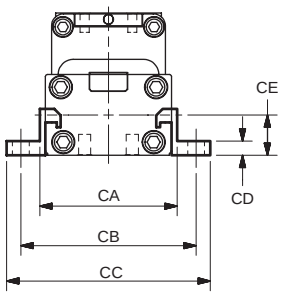
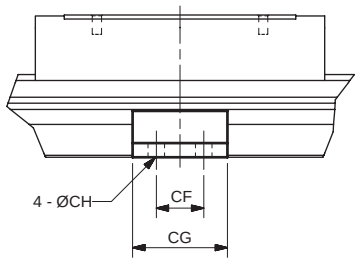
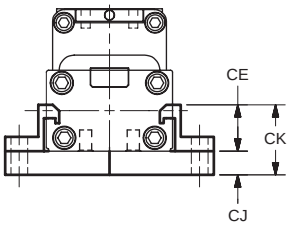
Intermediate Support Brackets

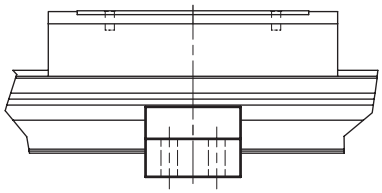
End Mount











Intermediate Support Brackets (2 per kit)

Bore		CA	CB	CC	CD	CE	CF	CG	CH
16 mm	inches	1.654	2.205	2.52	0.118	0.472	0.787	1.378	0.157
	mm	42	56	64	3	12	20	35	4
20 mm	inches	1.929	2.52	2.953	0.157	0.551	0.787	1.496	0.197
	mm	49	64	75	4	14	20	38	5
25 mm	inches	2.362	2.992	3.465	0.236	0.768	0.787	1.575	0.276
	mm	60	76	88	6	19.5	20	40	7
32 mm	inches	2.913	3.465	3.937	0.236	0.846	0.787	1.575	0.276
	mm	74	88	100	6	21.5	20	40	7
40 mm	inches	3.543	4.252	4.882	0.236	0.965	1.181	2.362	0.354
	mm	90	108	124	6	24.5	30	60	9
50 mm	inches	4.173	4.882	5.512	0.315	1.201	1.181	2.362	0.354
	mm	106	124	140	8	30.5	30	60	9
63 mm	inches	5.118	5.984	6.772	0.394	1.516	1.969	3.543	0.433
	mm	130	152	172	10	38.5	50	90	11

Bore		CJ	CK	Kit Part Number	
				End Mount or No Mount	Bottom Mount
16 mm	inches	0.236	0.709	L078940016	L078950016
	mm	6	18		
20 mm	inches	0.315	0.866	L078940020	L078950020
	mm	8	22		
25 mm	inches	0.394	1.161	L078940025	L078950025
	mm	10	29.5		
32 mm	inches	0.394	1.24	L078940032	L078950032
	mm	10	31.5		
40 mm	inches	—		L078940040	—
	mm				
50 mm	inches			L078940050	
	mm				
63 mm	inches			L078940063	
	mm				

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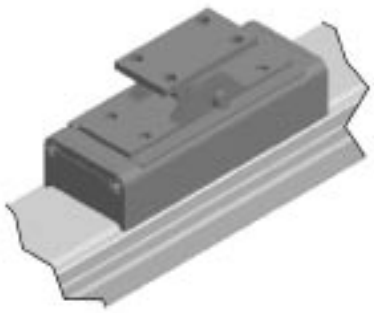
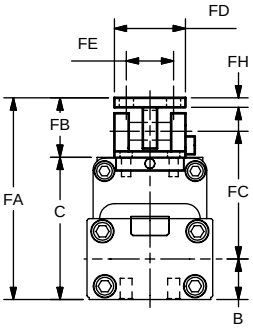
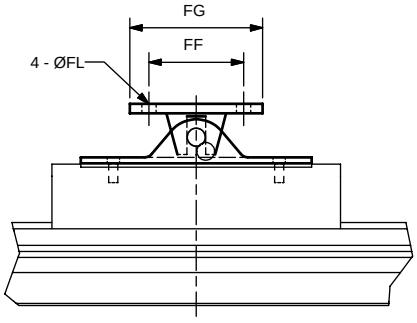
Swivel Mount

Absorbs misalignment between cylinder and load





FJ dimension is the maximum horizontal float



FK dimension is the maximum vertical float

Swivel Mounts

Bore		FA	FB	FC	FD	FE	FF	FG	FH
16 mm	inches	2.238	0.827	1.339	0.945	0.673	1.181	1.575	0.118
	mm	58	21	34	24	16	30	40	3
20 mm	inches	2.638	0.984	1.535	1.181	0.787	1.575	2.205	0.157
	mm	67	25	39	30	20	40	56	4
25 mm	inches	3.071	0.984	1.85	1.181	0.787	1.575	2.205	0.157
	mm	78	25	47	30	20	40	56	4
32 mm	inches	3.74	1.496	2.185	1.772	1.181	1.969	2.756	0.236
	mm	95	38	55.5	45	30	50	70	6
40 mm	inches	4.134	1.496	2.441	1.772	1.181	1.969	2.756	0.236
	mm	105	38	62	45	30	50	70	6
50 mm	inches	4.961	1.732	2.874	2.362	1.575	2.756	3.543	0.315
	mm	126	44	73	60	40	70	90	8
63 mm	inches	5.472	1.732	3.11	2.362	1.575	2.756	3.543	0.315
	mm	139	44	79	60	40	70	90	8

Bore		FI	FJ	FK	B	C	Part Number
16 mm	inches	0.134	0.118	0.118	0.472	1.457	L078930016
	mm	3.4	3	3	12	37	
20 mm	inches	0.177	0.118	0.118	0.551	1.654	L078930020
	mm	4.5	3	3	14	42	
25 mm	inches	0.236	0.118	0.118	0.669	2.087	L078930025
	mm	6	3	3	17	53	
32 mm	inches	0.276	0.197	0.197	0.728	2.244	L078930032
	mm	7	5	5	18.5	57	
40 mm	inches	0.276	0.197	0.197	0.866	2.638	L078930040
	mm	7	5	5	22	67	
50 mm	inches	0.354	0.197	0.197	1.102	3.228	L078930050
	mm	9	5	5	28	82	
63 mm	inches	0.354	0.197	0.197	1.378	3.74	L078930063
	mm	9	5	5	35	95	

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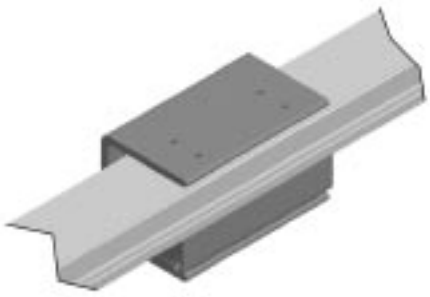
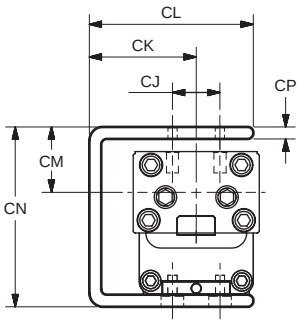
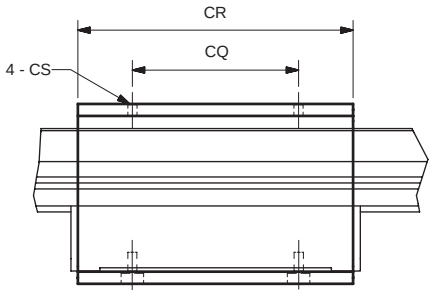
Inverted Mount

Provides mounting surface 180° from carriage







Inverted Mounts*

Bore		CJ	CK	CL	CM	CN	CP	CQ	CR	CS	Part Number**
16 mm	inches	0.591	1.398	1.969	1.142	2.362	0.236	1.89	3.465	5-40	L078960016
	mm	15	35.5	50	29	60	6	48	88		
20 mm	inches	0.709	1.28	1.969	1.024	2.362	0.236	2.362	3.937	8-32	L078960020
	mm	18	32.5	50	26	60	6	60	100		
25 mm	inches	0.787	1.772	2.717	1.102	2.795	0.197	2.756	4.567	10-24	L078960025
	mm	20	45	69	28	71	5	70	116		
32 mm	inches	0.787	2.126	3.209	1.319	3.15	0.276	3.15	5.039	1/4-20	L078960032
	mm	20	54	81.5	33.5	80	7	80	128		
40 mm	inches	1.181	2.48	3.76	1.496	3.602	0.315	3.543	5.433	1/4-20	L078960040
	mm	30	63	95.5	38	91.5	8	90	138		
50 mm	inches	1.181	2.913	4.449	1.89	4.429	0.394	3.937	5.591	5/16-18	L078960050
	mm	30	74	113	48	112.5	10	100	142		
63 mm	inches	1.575	3.465	5.433	2.283	5.157	0.512	4.331	6.22	5/16-18	L078960063
	mm	40	88	138	58	131	13	110	158		

*Inverted mounts not available with adjustable stroke, shock absorber or tube center support bracket.

**Use this part number when ordering as a separate part. When ordering with cylinder, use “C” option as part of cylinder part number.

End Port Piping

Refer to Figure 10 to determine when end port piping can be used with various types of mountings relative to fitting clearance.

On all bore sizes with foot mounting, the end port pipe fittings will obstruct the mounting holes. To avoid this problem, mount the cylinder first and tighten the mounting bolts and then attach the pipe fittings to the cylinder ports.

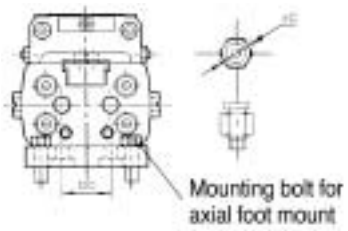


Figure 10

Bore Size (mm)	øC [O.D. of fittings - mm (in.)]		
	No Mount	End Mount	Bottom Mount
16	12 (0.472)	End Port Piping Not Available	12 (0.472)
20	16 (0.630)		16 (0.630)
25	26 (1.024)		26 (1.024)
32	27 (1.065)		27 (1.063)
40	35 (1.378)	26 (1.024)	
50	35 (1.378)	30 (1.181)	
63	39 (1.535)	34 (1.339)	

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Selection Criteria

The Shock Absorber Advantage

- Increase equipment throughput
- Smoother deceleration of loads
- Adjustable end of stroke positioning
- Prevents impact damage
- Minimize shock loads on equipment
- Improves product performance

Four Steps to Great Performance

Step 1. Gather the Application Parameters

- Total load weight (pounds)
- Final velocity at impact (inches/second)*
- Cycle rate (cycles per hour)

Step 2. Verify Shock Absorber Performance

- See charts on the following pages
- Determine that shock absorber will do the job

Step 3. Verify the Cycle Rate

- See shock specifications below and verify application is within cycle rate

Step 4. Choose the Appropriate Option in Model Code

*If final velocity cannot be easily calculated, double the average velocity.

G

Shock Absorber Specifications

Figure 11 Specifications

Cylinder	16mm	20mm	25mm	32mm	40mm	50, 63mm
Shock Absorber No.	**0887790016**	**0887790020**	**0887790025**	**0887790032**	**0887790040**	**0887790050**
Max. Energy Absorption - in-lbs (kgf·m)	26.0 (0.3)	60.8 (0.7)	104.2 (1.2)	226 (2.6)	608 (7.0)	1042 (12)
Stroke - inches	0.236	0.315	0.394	0.590	0.787	0.984
Energy Absorption/hour - in.-lbs/hour	54,700	109,380	187,510	338,560	729,200	750,000
Max. Impact Velocity - in./sec.	59	59	78.7	78.7	98.4	118.1
Max. Cycle Rate per Hour	2100	1800	1800	1500	1200	720
Ambient Temperature - °F (°C)	41-140 (5-60)					
Spring Return Force - lb. Extended Compressed	0.65 1.01	0.45 0.97	0.65 1.33	1.33 2.65	2.20 4.86	3.60 7.49
Return Time - Sec.	0.3	0.3	0.3	0.3	0.4	0.4

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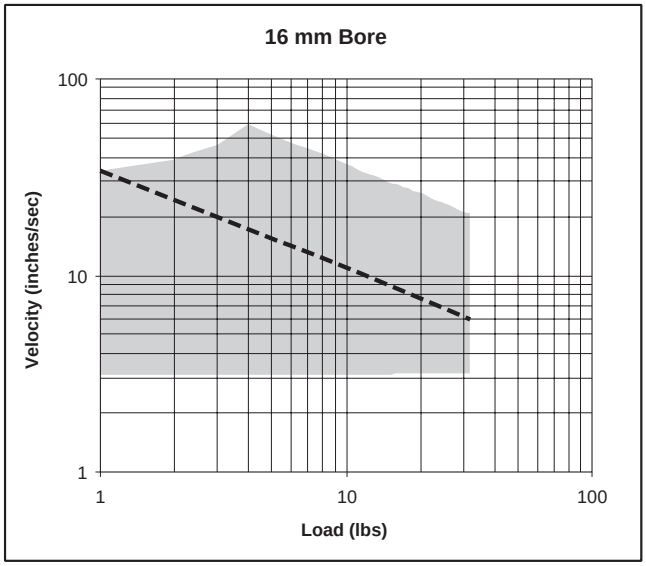
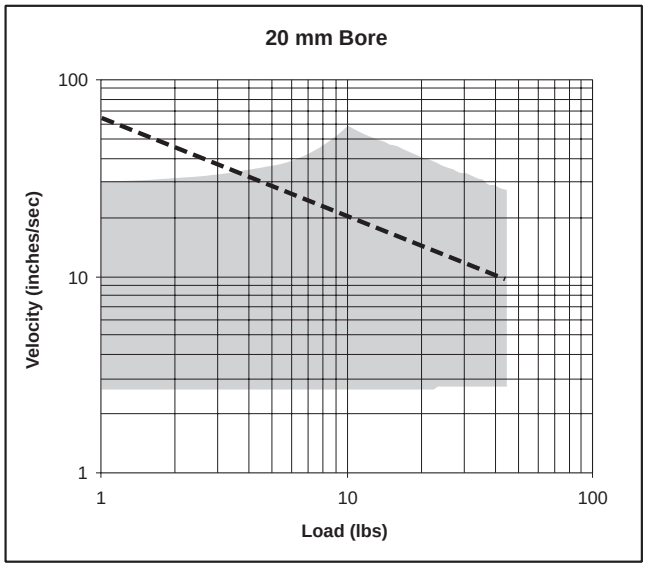
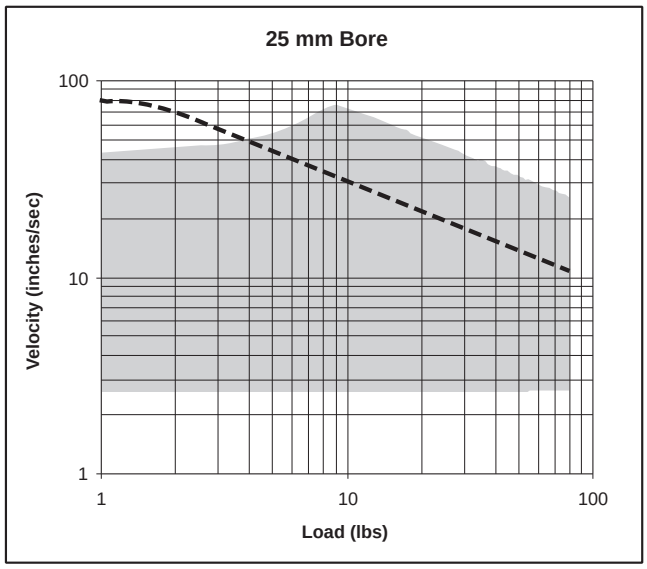
Performance Data (16 - 32mm Bores)

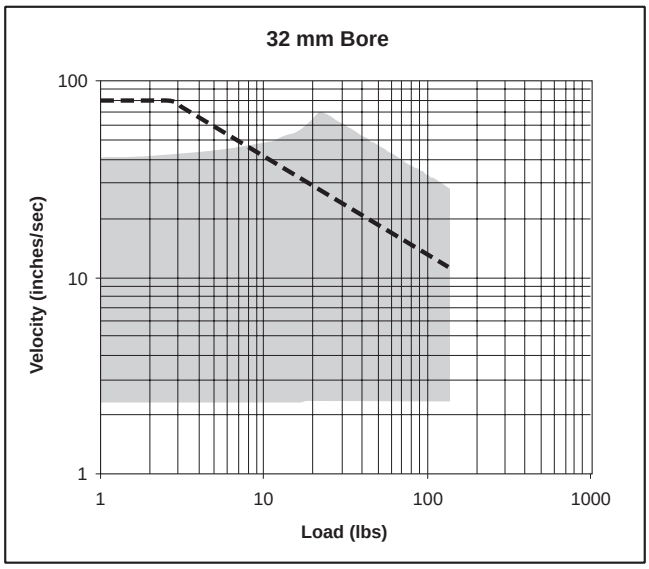
Air Cushion w/back pressure (flow controls or other meter out device)

Shock Absorber









Notes: 1. If the cylinder is vertical in orientation, double the total load for bottom shock absorber.

2. Use the total load that is being moved by shock absorber. If a weight transfer application, this would include La.

3. If final velocity cannot be easily determined, use two times the stroke divided by the stroke time.

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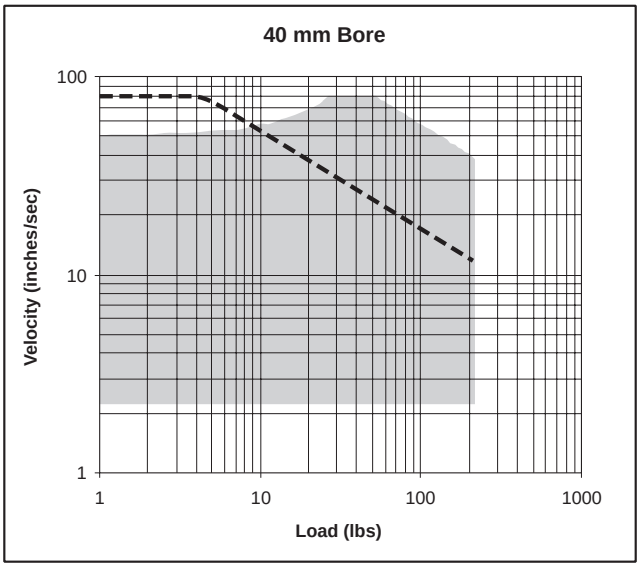
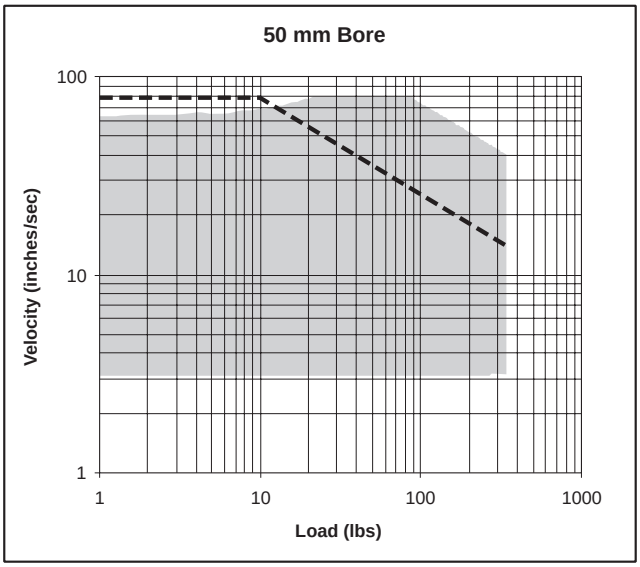
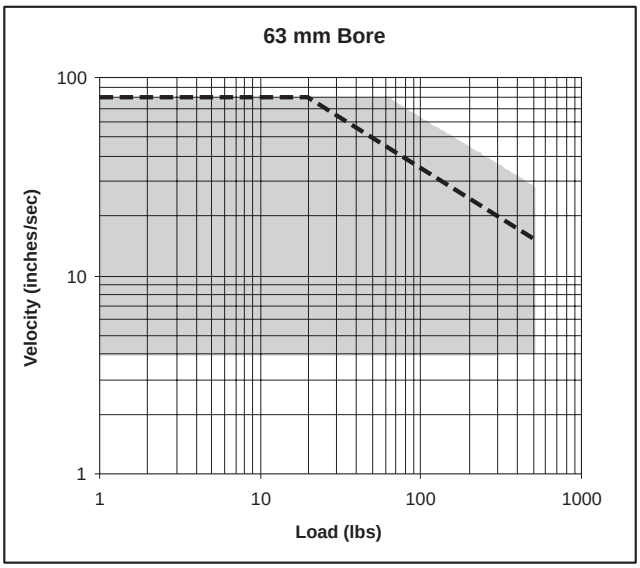
Performance Data (40 - 63mm Bores)

Air Cushion w/back pressure (flow controls or other meter out device)

Shock Absorber







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Notes: 1. If the cylinder is vertical in orientation, double the total load for bottom shock absorber.

2. Use the total load that is being moved by shock absorber. If a weight transfer application, this would include La.

3. If final velocity cannot be easily determined, use two times the stroke divided by the stroke time.

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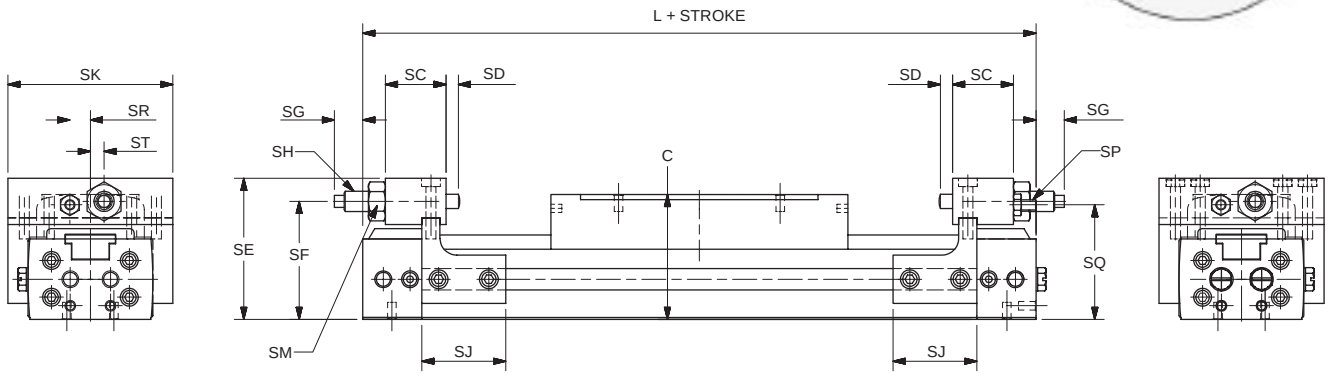
Stroke Adjustment and Shock Absorber Dimensions

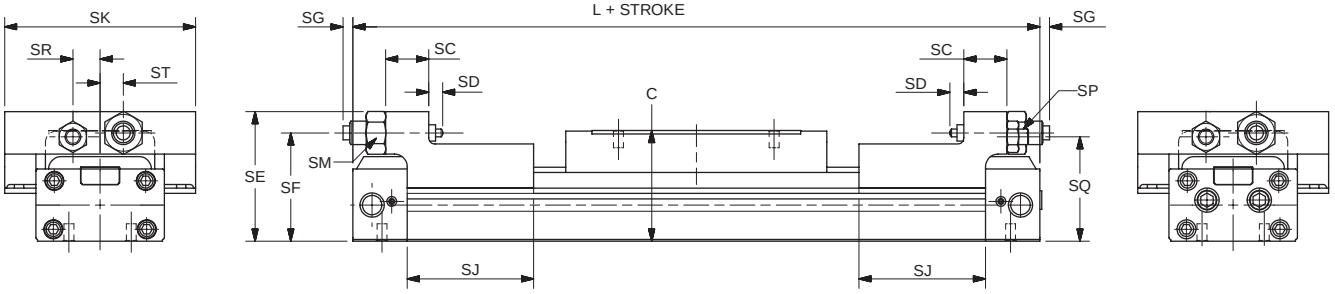
16-25 mm Bore Sizes



Bore (mm)		SC	SD	SE	SF	SG Max	SG Min	SH in-lbs	SJ	SK	SP	SQ	SR	ST	C	L
16	in.	0.71	0.16	1.65	1.38	0.57	0.18	26	0.98	1.93	M3	1.34	0.24	0.16	1.46	5.87
	mm	18	4	42	35	14.5	4.5		25	49		34	6	4	37	149
20	in.	0.89	0.14	1.89	1.57	0.57	0.18	61	1.54	2.24	M4	1.50	0.32	0.20	1.65	6.65
	mm	22.5	3.5	48	40	14.5	4.5		39	57		38	8	5	42	169
25	in.	0.79	0.10	2.46	2.03	0.57	0.18	104	1.97	3.03	M6	1.97	0.47	0.39	2.09	7.48
	mm	20	2.5	62.5	51.5	14.5	4.5		50	77		50	12	10	53	190

SH = max. energy absorption

32-63 mm Bore Sizes



Bore (mm)		SC	SD	SE	SF	SG Max	SG Min	SH in-lbs	SJ	SK	SP	SQ	SR	ST	C	L
32	in.	0.87	0.28	2.62	2.19	1.06	0.67	226	2.56	3.86	M8	2.11	0.55	0.47	2.24	8.90
	mm	22	7	66.5	55.5	27	17		65	98		53.5	14	12	57	226
40	in.	1.26	0.28	3.09	2.58	1.34	0.94	608	2.56	4.41	M10	2.50	0.67	0.47	2.64	9.61
	mm	32	7	78.5	65.5	34	24		65	112		63.5	17	12	67	244
50	in.	1.50	0.32	3.90	3.15	2.17	1.77	1042	2.76	5.35	M12	3.05	0.87	0.67	3.23	10.16
	mm	38	8	99	80	55	45		70	136		77.5	22	17	82	258
63	in.	1.50	0.32	4.41	3.68	1.73	1.34	1042	2.76	6.22	M16	3.50	0.98	0.79	3.74	11.65
	mm	38	8	112	93.5	44	34		70	158		89	25	20	95	296

SH = max. energy absorption

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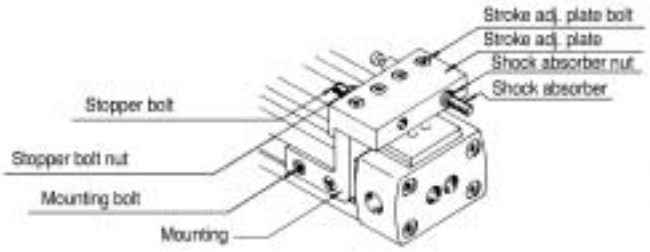
Positioning of Stroke Adjustment Unit



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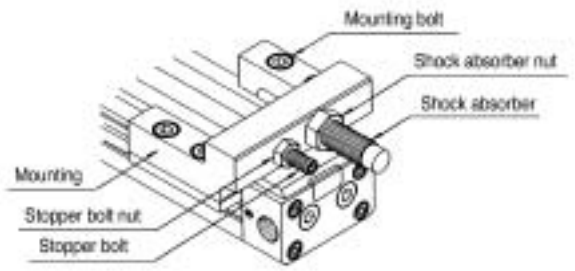

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(1) Moving the stroke adjustment unit.
The stroke adjustment unit can be moved by loosening the mounting bolts.

(2) Locking of stroke adjustment unit.
After moving the stroke adjustment unit to the appropriate position, lock it there by tightening the mounting bolts to the torque values shown in Figure 12. Insufficient torque may cause the stroke adjustment unit to slip out of position.

Figure 12

Torque values for tightening stroke adjustment unit.

Bore Size	Tightening Torque	
	Mounting Bolt (lb-in)	Stroke Adj. Plate Bolt (lb-in)
16mm	9-11	4-6
20mm	22-24	
25mm	46-50	22-24
32mm	195-213	–
40mm	390-415	–
50, 63mm	682-735	–

(3) Stroke adjustment using the stopper bolt.
Adjust the stroke by loosening the stopper bolt nut and turning the stopper bolt. After adjusting the stroke, tighten the stopper bolt nut to the torque values shown in Figure 12a. When adjusting the 16-25 mm cylinders, due to the small amount of clearance between the table and the stroke adjustment plate, adjust the stroke by moving the complete stroke adjustment unit.

Figure 12a

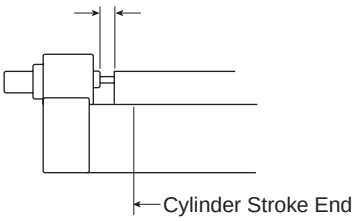
Torque values for tightening stopper bolt nut and shock absorber nut.

Bore Size	Tightening Torque	
	Stopper Bolt Nut (lb-in)	Shock Absorber Nut (lb-in)
16mm	10-11	12-16
20mm	22-24	26-35
25mm	73-84	40-53
32mm	195-213	66-89
40mm	390-425	195-266
50mm	682-735	487-620
63mm	1772-1914	487-620

(4) Adjustment of shock absorber.
Adjust the absorption energy of the shock absorber by changing the operating stroke of the shock absorber. This is done by loosening the shock absorber nut and turning the unit. When adjustment is complete, tighten the shock absorber nut to the torque values shown in Figure 12a.

(5) Notes on usage.
The shock absorber absorbs rated energy with rated stroke. The factory setting allows a small amount of shock absorber stroke before it bottoms out. Readjust the location of the shock absorber so that the complete stroke of the absorber is utilized.

Absorption energy as set at factory:
Small margin with stroke of shock absorber.



Adjust the position of the shock absorber until the plunger of the shock absorber is fully depressed.

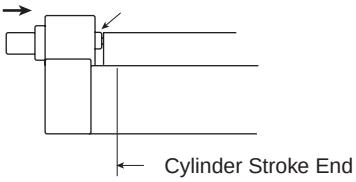


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Table 2. Replacement Seal Kit Part Numbers

Bore Size	16mm	20mm	25mm	32mm	40mm	50mm	63mm
Kit No. / Parts In Kit	L079020016	L079020020	L079020025	L079020032	L079020040	L079020050	L079020063
Pressure Seal Belt	L079030016	L079030020	L079030025	L079030032	L079030040	L079030050	L079030063
Dust Seal Belt	L079040016	L079040020	L079040025	L079040032	L079040040	L079040050	L079040063
Cushion Seal	109358	109359	142367	142384	142401	109347	109348
Piston Seal	109411	109412	109413	109414	109415	109416	109417
Cylinder Body Seal	109380	109381	142724	142741	142758	142775	142792

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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 (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 1-800-CPARKER, 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 review by our engineering department.

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

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

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

The rod end pressure is approximately equal to:

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

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

3.0 Cylinder and Accessories Installation and Mounting

3.1 Installation

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

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

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

3.1.4 – Sometimes it may be necessary to rotate the piston rod in order to thread the piston rod into the machine member. This operation must always be done with zero pressure being applied to either side of the piston. Failure to follow this procedure may result in loosening the piston to rod-threaded connection. In some rare cases the turning of the piston rod may rotate a threaded 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.

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Offer of Sale

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

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

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

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

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

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

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

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

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

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

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

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

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

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