SIEMENS

Technical Bulletin
Document No. 155-219P25
TB 181
March 2, 2005

Powers™ Controls

Maximum Thrust Ratings of Pneumatic Damper Actuators

Description	Actuator force or thrust is expressed in total net pounds of force available at the actuator shaft. This force can be modulated to an intermediate value to maintain a stabilized position against a known load, or increased to initiate a forward or return thrust to activate the operated device to a new position. The net available force in either direction is always the difference between the spring force at that actuator position and control pressure times the diaphragm area.

The values expressed in the following tables are the maximum forces available at various actuator positions, using either full supply air or the full available force of the actuator spring. Positioning type control devices can use up to the full supply air pressure to stabilize or to initiate a forward movement of the actuator shaft. Return movement depends on the internal spring force exceeding the workload at any actuator position.

Torque Ratings	Rotary force requirements are expressed in terms of torque. Dampers and associated linkages are normally rated in this manner. Torque is usually expressed in terms of pound-inch, pound-foot, or Newton-meter.

Actuator thrust can be converted to torque by the following formulas:

• Multiply pounds force by effective crank radius in inches to obtain pound-inch.

• Multiply pounds force by effective crank radius in feet to obtain pound-foot.

• Multiply Newtons by effective crank radius in meters to obtain Newton-meters.

The effective crank radius is less than the actual crank radius because the effective force exerted by the actuator decreases as the angle between the crank and actuator shaft decreases from 90°. The effective crank radius used for these tables is equal to the crank radius for 90° rotation (See Figure 1) times 0.5 (sine of 30°). This assumes a "worst case" actuator mounting which has the crank at 30° to the actuator shaft when the actuator shaft is fully retracted. The recommended actuator mounting should have the crank at 45° to the actuator shaft when the shaft is fully retracted.

Torque ratings are based on crank radius for 90° damper rotation. For ratings other than 90° rotation, multiply by the ratio of (Crank radius at X° / crank radius at 90°). See Figure 1, to determine crank radius.

Siemens Industry, Inc.

Using This Graph

To find the required stroke when the crank radius is known:

1. Select available crank radius at the left of the graph.

2. Follow the curved line to the intersection with the degree of rotation desired.

3. Follow the vertical line down to read the required actuator stroke.

To find the crank radius when the stroke is known:

1. Select the required actuator stroke at the bottom of the graph.

2. Follow the vertical line up to the intersection with the degree of shaft rotation desired.

3. Follow the curved line to the left to read the required crank radius.

Question:

An application requires the use of the No. 4 actuator (stroke equals 4 inches) to operate a shaft through a rotation of 120°. For what radius should the crank be drilled?
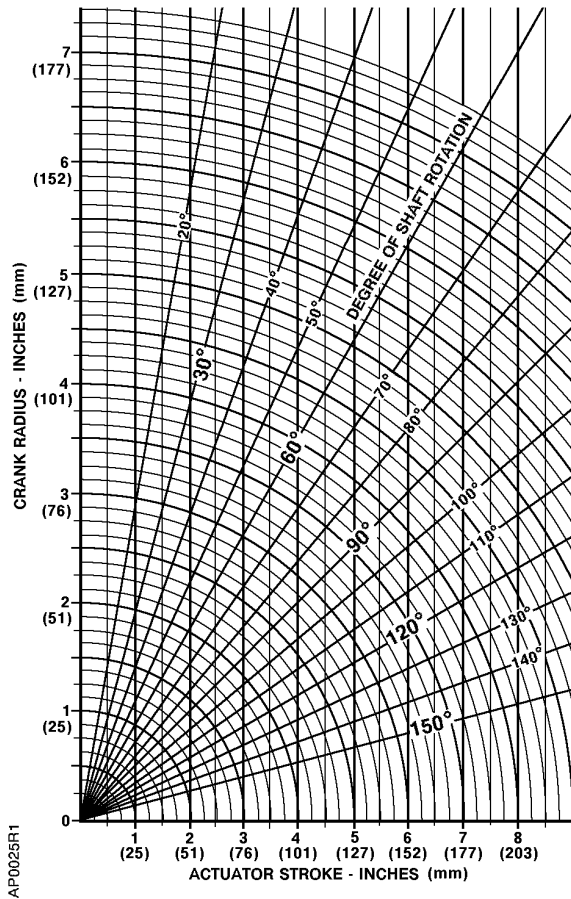
Answer:

2-5/16 inch radius.

Figure 1. Crank Radius/Actuator Stroke Graph.

NOTE: The minimum radius is approximately 1-1/4 inches to avoid interference of the actuator clevis and crank hub.

Formula	**Pc**	= Control air pressure (psi) to actuator
	Fs	= Spring return force (lb of force)
	A	= Effective diaphragm area

$\quad\quad$ = 8 sq. in. (51.5 cm^2) for No. 3 actuator
$\quad\quad$ = 11 sq. in. (71 cm^2) for No. 4 actuator
$\quad\quad$ = 17.9 sq. in. (115 cm^2) for No. 6 actuator

Ff $\quad$ = force forward

Fs $\quad$ The pressure corresponding to the actuator position within the nominal spring range times its diaphragm area.

$\quad\quad$ Fs = Actuator position pressure $\times$ A

Spring return force (Fs) values appear in Tables 1, 2, and 3.

Ff $\quad$ The control air pressure to the actuator times its effective area less the return force of the spring.

$\quad\quad$ Ff = Pc A - Fs

Forward force (Ff) values appear in Tables 1, 2, and 3.

NOTE: A much higher torque rating or available force, can be obtained by using positioners or two-position operation. In addition, the forward force is maximized by using a low spring range (3 to 7 psi) and the spring return force is maximized by using a high spring range (8 to 13 psi).

Table 1. No. 3 Damper Actuator with 2-3/8 inch Stroke.

Nominal Spring Range (No load)	Position		Maximum Available Force Pounds (N)				Maximum Torque Rating lb-in (N m)		Max.Torque Rating Gradual Operation
	Stroke Inches (mm)	Pressure psi (kPa)	Forward Force (Ff)			Spring Return Force, (Fs)	2-Position or with Positioner		*
			at 15 psi (103 kPa)	at 18 psi (124 kPa)	at 25 psi (172 kPa)		18 psi (124 kPa)	25 psi (172 kPa)	lb-in (N m)
3 to 7 psi (21-48 kPa)	0 (0)	3 (21)	96 (427)	120 (533)	176 (781)	24 (107)	20.2 (2.3)	20.2 (2.3)	10 (1.1)
	5/8 (16)	4 (28)	88 (390)	112 (497)	168 (746)	32 (142)			
	1-1/4 (32)	5 (34)	80 (355)	104 (462)	160 (710)	40 (178)			
	1-3/4 (44)	6 (41)	72 (320)	96 (427)	152 (675)	48 (213)			
	2-3/8 (60)	7 (48)	64 (285)	88 (391)	144 (641)	56 (249)			
5 to 10 psi (35-69 kPa)	0 (0)	5 (35)	80 (355)	104 (462)	160 (710)	40 (178)	33.6 (3.8)	33.6 (3.8)	10 (1.1)
	5/8 (16)	6.25 (43)	70 (311)	94 (417)	150 (666)	50 (222)			
	1-1/4 (32)	7.5 (52)	60 (266)	84 (373)	140 (622)	60 (266)			
	1-3/4 (44)	8.75 (60)	50 (222)	74 (329)	130 (577)	70 (311)			
	2-3/8 (60)	10 (69)	40 (178)	64 (285)	120 (534)	80 (355)			
8 to 13 psi (55-90 kPa)	0 (0)	8 (55)	56 (249)	80 (355)	136 (604)	64 (285)	33.6 (3.8)	53.8 (6.1)	10 (1.1)
	5/8 (16)	9.25 (64)	46 (204)	70 (311)	126 (600)	74 (329)			
	1-1/4 (32)	10.5 (72)	36 (160)	60 (266)	116 (515)	84 (373)			
	1-3/4 (44)	11.75 (81)	26 (115)	50 (222)	106 (471)	94 (417)			
	2-3/8 (60)	13 (90)	16 (71)	40 (178)	96 (427)	104 (462)			

*With maximum hysteresis of 2.5 psi @ 90° rotation.

Table 2. No. 4 Damper Actuator with 4-inch Stroke.

Nominal Spring Range (No load)	Position		Maximum Available Force Pounds (N)				Maximum Torque Rating lb-in (N m)		Max. Torque Rating Gradual Operation* lb-in (N m)
	Stroke Inches (mm)	Pressure psi (kPa)	Forward Force (Ff)			Spring Return Force (Fs)	2-position or with positioner		
			at 15 psi (103 kPa)	at 18 psi (124 kPa)	at 25 psi (172 kPa)		18 psi (124 kPa)	25 psi (172 kPa)	
3 to 7 psi (21-50 kPa)	0 (0)	3 (21)	132 (587)	165 (734)	242 (1074)	33 (147)	46.4 (5.2)	46.4 (5.2)	30.0 (3.4)
	1 (25)	4 (28)	121 (538)	154 (684)	231 (1026)	44 (195)			
	2 (51)	5 (34)	110 (488)	143 (635)	220 (977)	55 (244)			
	3 (76)	6 (41)	99 (440)	132 (586)	209 (928)	66 (294)			
	4 (102)	7 (48)	88 (391)	121 (538)	198 (881)	77 (342)			
3 to 13 (21-90 kPa)	0 (0)	3 (21)	132 (586)	165 (734)	242 (1074)	33 (147)	46.4 (5.2)	46.4 (5.2)	30.0 (3.4)
	1 (25)	5.5 (38)	105 (466)	138 (613)	215 (955)	60 (266)			
	2 (51)	8 (55)	77 (342)	110 (488)	187 (830)	88 (391)			
	3 (76)	10.5 (73)	50 (222)	83 (369)	160 (710)	115 (511)			
	4 (102)	13 (90)	22 (98)	55 (245)	132 (587)	143 (635)			
5 to 10 (35-70 kPa)	0 (0)	5 (35)	110 (488)	143 (635)	220 (977)	55 (245)	77.3 (8.7)	77.3 (8.7)	30.0 (3.4)
	1 (25)	6.25 (43)	97 (431)	130 (577)	207 (919)	68 (302)			
	2 (51)	7.5 (52)	83 (369)	116 (515)	193 (857)	82 (364)			
	3 (76)	8.75 (60)	69 (306)	102 (453)	179 (795)	96 (426)			
	4 (102)	10 (69)	55 (245)	88 (391)	165 (734)	110 (488)			
8 to 13 (55-90 kPa)	0 (0)	8 (55)	77 (342)	110 (488)	187 (830)	88 (391)	77.3 (8.7)	124 (14)	30.0 (3.4)
	1 (25)	9.25 (64)	63 (280)	96 (426)	173 (768)	102 (453)			
	2 (51)	10.5 (72)	50 (222)	83 (369)	160 (710)	116 (515)			
	3 (76)	11.75 (81)	36 (160)	69 (306)	146 (648)	129 (568)			
	4 (102)	13 (90)	22 (98)	55 (245)	132 (587)	143 (635)			
2 to 3, 8 to 13 psi (14-21, 55-90 kPa) Hesitation	0 (0)	2 (14)	143 (635)	176 (781)	253 (1123)	22 (195)	—	—	23.0 (2.6)
	3/4 (20)	3 (21)	132 (586)	165 (733)	242 (1074)	33 (147)			
	3/4 (20)	8 (28)	77 (342)	110 (488)	187 (830)	88 (391)			
	1-1/2 (38)	9.7 (67)	58 (258)	91 (404)	168 (746)	106 (471)			
	2-1/4 (57)	11.3 (78)	40 (178)	73 (324)	150 (666)	124 (551)			
	3 (76)	13 (90)	22 (195)	55 (245)	131 (587)	143 (635)			

* With maximum hysteresis of 2.5 psi @ 90° rotation.

Table 3. No. 6 Damper Actuator with 4-inch Stroke.

Nominal Spring Range (No Load)	Position		Maximum Available Force Pounds (N)				Maximum Torque Rating lb-in (N m)		Max Torque Rating Gradual Operation* lb-in (N m)
	Stroke Inches (mm)	Pressure Psi (kPa)	Forward Force (Ff)			Spring Return Force (Fs)	2-position or with Positioner		
			at 15 psi (103 kPa)	at 18 psi (124 psi)	at 25 psi (172 kPa)		18 psi (124 psi)	25 psi (172 kPa)	
3 to 13 psi (21 to 90 kPa)	0 (0)	3 (21)	215 (955)	268 (1190)	393 (1745)	54 (240)	75 (8.5)	75 (8.5)	50.0 (5.6)
	1 (25)	5.5 (38)	170 (755)	224 (995)	349 (1550)	98 (435)			
	2 (51)	8 (55)	125 (556)	179 (795)	304 (1350)	143 (635)			
	3 (76)	10.5 (73)	81 (360)	134 (595)	259 (1150)	188 (835)			
	4 (102)	13 (90)	36 (160)	89 (396)	214 (952)	233 (1035)			
3 to 8 psi (21 to 55 kPa)	0 (0)	3 (21)	215 (955)	568 (2522)	393 (1745)	54 (240)	75 (8.5)	75 (8.5)	50.0 (5.6)
	1 (25)	4.25 (29)	192 (845)	246 (1092)	371 (1647)	76 (337)			
	2 (51)	5.5 (38)	170 (755)	225 (999)	359 (1594)	98 (435)			
	3 (76)	6.75 (47)	149 (662)	201 (892)	357 (1665)	121 (537)			
	4 (102)	8.0 (55)	125 (556)	179 (796)	304 (1352)	143 (635)			
8 to 13 psi (55 to 90 kPa)	0 (0)	8 (55)	126 (559)	179 (795)	304 (1350)	143 (635)	125 (14.1)	202 (22.8)	50.0 (5.6)
	1 (25)	9.25 (64)	103 (457)	156 (693)	281 (1248)	166 (737)			
	2 (51)	10.5 (72)	81 (360)	134 (595)	259 (1150)	188 (835)			
	3 (76)	11.75 (81)	59 (262)	112 (497)	237 (1052)	210 (932)			
	4 (102)	13 (90)	36 (160)	89 (396)	214 (952)	233 (1035)			

* With maximum hysteresis of 2.5 psi @ 90° rotation.

Siemens Industry, Inc.
Building Technologies Division
1000 Deerfield Parkway
Buffalo Grove, IL 60089
+ 1 847-215-1000

Your feedback is important to us. If you have comments
about this document, please send them to
sbt_technical.editor.us.sbt@siemens.com

Document No. 155-219P25
Printed in the USA
Page 5