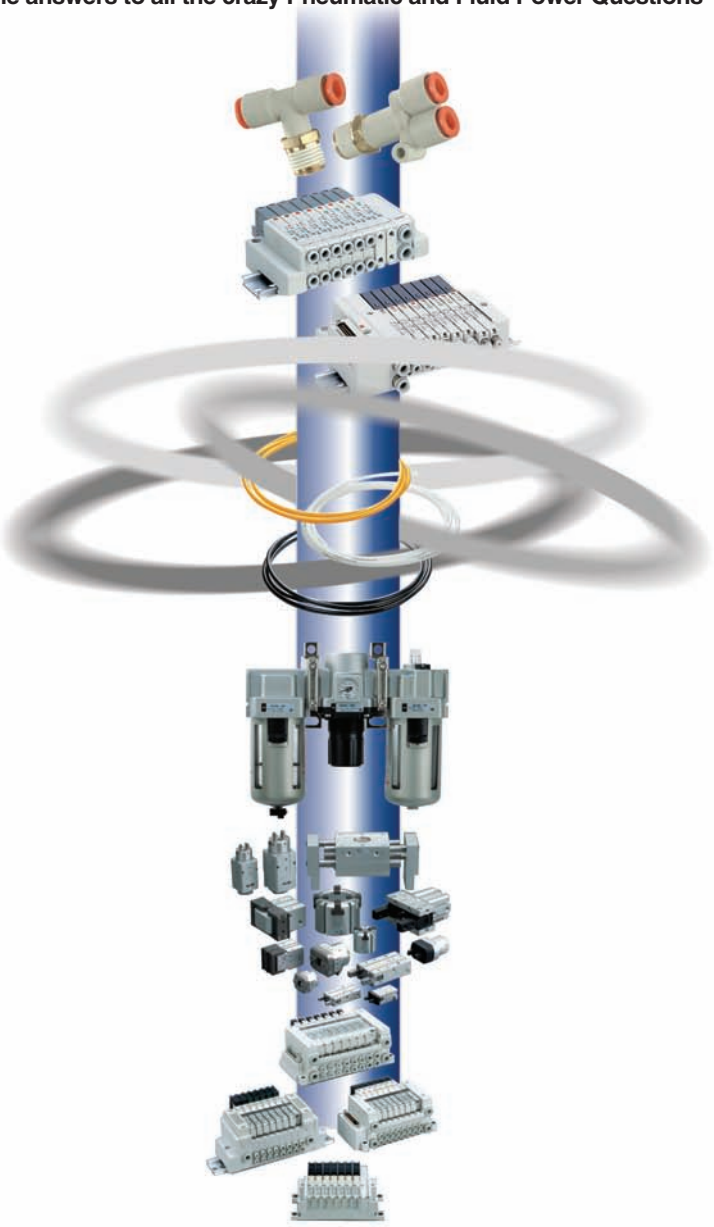
Survival Guide

“The answers to all the crazy Pneumatic and Fluid Power Questions”



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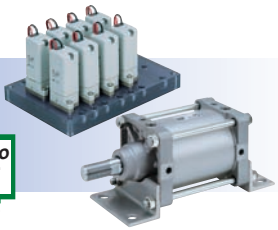


Cost Savings

1. Low Power
2. Energy Saving
3. Space Saving

Largest Choice

10,100 basic models & **600,000** variations.

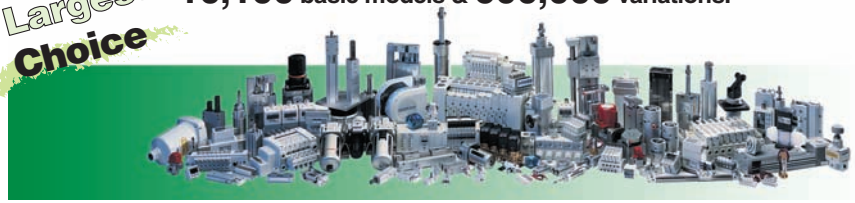


Table of Contents

Unit Conversions

Metric to English

Multiply ∇	By ∇	To Obtain ∇
Length:		
μm	0.0394	mil
mm	0.0394	in
cm	0.3937	in
m	3.2810	ft
Area:		
mm^2	0.0016	in^2
cm^2	0.1550	in^2
m^2	10.764	ft^2
Volume:		
mm^3	6.10×10^{-5}	in^3
cm^3 (cc)	0.0610	in^3
m^3	35.314	ft^3
ℓ	0.0353	ft^3
ℓ	0.2642	gal (US)
Weight:		
g	0.0353	oz
kg	2.2046	lb
Force:		
gf	2.205×10^{-3}	lbf
kgf	2.2046	lbf
N	0.2248	lbf
Torque:		
N·m	0.7375	ft·lb
kg·m	7.223	ft·lb
Pressure:		
mm (H_2O)	0.00142	psi
mm (Hg)	0.0193	psi
torr	0.0193	psi
kPa	0.145	psi
bar	14.5	psi
kgf/cm^2	14.224	psi
MPa	145.0	psi
Energy:		
N·m	0.7375	ft·lb
J	0.7375	ft·lb
MJ	0.2778	kWh
Power:		
W	0.7376	ft·lb/s
kW	1.341	hp
Flow Rate:		
Nℓ/min	0.035	SCFM
Flow Coefficient:		
mm^2	0.0556	Cv

Temperature: °F = (1.8 x °C) + 32

English to Metric

Multiply ∇	By ∇	To Obtain ∇
Length:		
mil	25.4	μm
in	25.4	mm
in	2.54	cm
ft	0.3048	m
Area:		
in^2	645.16	mm^2
in^2	6.4516	cm^2
ft^2	0.0929	m^2
Volume:		
in^3	16387	mm^3
in^3	16.387	cm^3 (cc)
ft^3	0.0283	m^3
ft^3	28.329	ℓ
gal (US)	3.785	ℓ
Weight:		
oz	28.349	g
lb	0.4536	kg
Force:		
lbf	453.6	gf
lbf	0.4536	kgf
lbf	4.4482	N
Torque:		
ft·lb	1.3559	N·m
ft·lb	0.1383	kg·m
Pressure:		
in (H_2O)	0.00254	kgf/cm^2
in (Hg)	0.03518	kgf/cm^2
psi	6.8947	kPa
psi	0.06894	bar
psi	0.0703	kgf/cm^2
psi	0.00689	MPa
Energy:		
ft·lb	1.356	N·m
ft·lb	1.356	J
kWh	3.6	MJ
Power:		
ft·lb/s	1.356	W
hp	0.7457	KW
Flow Rate:		
SCFM	28.31685	Nℓ/min
Flow Coefficient:		
Cv	18	mm^2

Temperature: °C=5/9(°F -32)

Fractional / Decimal / Millimeter Conversion Chart

1mm = 0.03937” 0.01” = 0.254mm 1” = 25.4mm

Inch	Decimal	mm
1/64	0.016	0.397
1/32	0.031	0.794
3/64	0.047	1.191
1/16	0.063	1.588
5/64	0.078	1.984
3/32	0.094	2.381
7/64	0.109	2.778
1/8	0.125	3.175
9/64	0.141	3.572
5/32	0.156	3.969
11/64	0.172	4.366
3/16	0.188	4.763
13/64	0.203	5.159
7/32	0.219	5.556
15/64	0.234	5.953
1/4	0.25	6.35
17/64	0.266	6.747
9/32	0.281	7.144
19/64	0.297	7.541
5/16	0.313	7.938
21/64	0.328	8.334

Inch	Decimal	mm
11/32	0.344	8.731
23/64	0.359	9.128
3/8	0.375	9.525
25/64	0.391	9.922
13/32	0.406	10.319
27/64	0.422	10.716
7/16	0.438	11.113
29/64	0.453	11.509
15/32	0.469	11.906
31/64	0.484	12.303
1/2	0.5	12.7
33/64	0.516	13.097
17/32	0.531	13.494
35/64	0.547	13.891
9/16	0.563	14.288
37/64	0.578	14.684
19/32	0.594	15.081
39/64	0.609	15.478
5/8	0.625	15.875
41/64	0.641	16.272
21/32	0.656	16.669

Inch	Decimal	mm
43/64	0.672	17.066
11/16	0.688	17.463
45/64	0.703	17.859
23/32	0.719	18.256
47/64	0.734	18.653
3/4	0.75	19.05
49/64	0.766	19.447
25/32	0.781	19.844
51/64	0.797	20.241
13/16	0.813	20.638
53/64	0.828	21.034
27/32	0.844	21.431
55/64	0.859	21.828
7/8	0.875	22.225
57/64	0.891	22.622
29/32	0.906	23.019
59/64	0.922	23.416
15/16	0.938	23.813
61/64	0.953	24.209
31/32	0.969	24.606
63/34	0.984	25.003

mm	Inch
0.1	0.0039
0.2	0.0079
0.3	0.0118
0.4	0.0157
0.5	0.0197
0.6	0.0236
0.7	0.0276
0.8	0.0315
0.9	0.0354
1	0.0394
2	0.0787
3	0.1181
4	0.1575
5	0.1969
6	0.2362
7	0.2756
8	0.3150

mm	Inch
9	0.3543
10	0.3937
11	0.4331
12	0.4724
13	0.5118
14	0.5512
15	0.5906
16	0.6299
17	0.6693
18	0.7087
19	0.7480
20	0.7874
21	0.8268
22	0.8661
23	0.9055
24	0.9449
25	0.9843

Pressure Conversions

PSI	kgf/cm²	MPa	kPa	bar
5	.35	.03	34	0.34
10	.70	.06	69	0.69
11.6	.82	.08	80	0.80
15	1.0	.10	103	1.03
20	1.4	.13	137	1.37
21.8	1.5	.15	150	1.50
25	1.8	.17	172	1.72
29	2.0	.20	200	2.00
30	2.1	.21	206	2.06
35	2.5	.24	241	2.41
36	2.6	.25	250	2.50
40	2.8	.27	275	2.75
45	3.2	.31	310	3.10
50	3.5	.34	344	3.44
55	3.9	.38	379	3.79
60	4.2	.41	413	4.13
65	4.6	.45	448	4.48
70	4.9	.48	482	4.82
75	5.3	.52	517	5.17
80	5.6	.55	551	5.51
85	6.0	.59	586	5.86
90	6.3	.62	620	6.20
95	6.7	.65	655	6.55
100	7.0	.70	689	6.89
101.5	7.1	.71	700	7.00
105	7.4	.72	724	7.24
110	7.7	.75	758	7.58
115	8.1	.79	758	7.93
120	8.4	.82	827	8.27
125	8.8	.86	861	8.62
130	9.1	.90	896	8.96
135	9.5	.93	930	9.31
140	9.8	.96	965	9.65
145	10.2	1.0	1000	10.00
150	10.5	1.1	1034	10.34
215.6	15.3	1.48	1500	15.00

Cylinder Force Chart

Force = Area x Pressure

Bore	Piston Area (in^2)	Operating Pressure (psi)					
		25 psi	50 psi	75 psi	100 psi	125 psi	150 psi
1/4" (6mm)	0.04	1 lbf	2 lbf	3 lbf	4 lbf	5 lbf	6 lbf
8mm	0.08	2	4	6	8	10	12
3/8" (10mm)	0.12	3	6	9	12	15	18
5/8" (16mm)	0.27	7	14	20	27	34	41
3/4" (20mm)	0.44	11	22	33	44	55	66
1" (25mm)	0.79	20	40	59	79	99	119
1 1/8"	0.99	25	50	74	99	124	149
30mm	1.10	28	55	83	110	138	165
1 ¼" (32mm)	1.23	31	62	92	123	154	185
1 ½" (40mm)	1.77	44	89	133	177	221	266
1 ¾"	2.41	60	121	181	241	301	362
2" (50mm)	3.14	79	157	236	314	393	471
2 ½" (63mm)	4.91	123	246	368	491	614	737
3 ¼ (80mm)	8.3	208	415	623	830	1038	1245
4" (100mm)	12.57	314	629	943	1257	1571	1886
4 ½"	15.9	398	795	1196	1590	1988	2385
5" (125mm)	19.64	491	982	1473	1964	2455	2946
140mm	23.85	596	1193	1789	2385	2981	3576
6"	28.27	707	1414	2120	2827	3534	4241
160mm	31.15	779	1558	2336	3115	3894	4673
7" (180mm)	38.48	962	1924	2886	3848	4810	5772
8" (200mm)	50.27	1256	2514	3770	5027	6284	7541
10" (250mm)	78.54	1963	3927	5891	7854	9818	11781
12"	113.1	2827	5655	8482	11310	14137	16965

Cylinder Speed vs. Flow Chart

Cylinder Bore (inches)

In/sec	1/2	3/4	1	1 1/2	2	2 1/2	3 1/4	4
1	**.0014**	**.0032**	**.0058**	**.013**	**.023**	**.036**	**.061**	**.092**
	.041	.091	.16	.37	.65	1.0	1.73	2.6
2	**.0029**	**.0065**	**.012**	**.026**	**.046**	**.072**	**.12**	**.18**
	.081	.18	.33	.74	1.3	2.0	3.5	5.2
3	**.0043**	**.0097**	**.17**	**.039**	**.11**	**.069**	**.18**	**.276**
	.13	.28	.5	1.1	3.0	2.0	5.2	7.8
4	**.0058**	**.013**	**.023**	**.052**	**.092**	**.14**	**.24**	**.37**
	.16	.37	.65	1.5	2.6	4.0	6.9	10.4
5	**.0069**	**.015**	**.028**	**.065**	**.11**	**.18**	**.3**	**.46**
	.21	.46	.83	1.9	3.3	5.0	8.6	13.0
6	**.0087**	**.020**	**.035**	**.078**	**.14**	**.22**	**.37**	**.55**
	.25	.56	1.0	2.2	4.0	6.1	10.4	15.6
7	**.010**	**.023**	**.04**	**.091**	**.16**	**.25**	**.43**	**.64**
	.28	.44	1.13	2.6	4.5	7.1	12.1	18.2
8	**.011**	**.025**	**.045**	**.10**	**.18**	**.29**	**.49**	**.74**
	.33	.73	1.3	3.0	5.2	8.1	13.8	20.8
9	**.013**	**.030**	**.053**	**.12**	**.21**	**.32**	**.55**	**.83**
	.36	.82	1.45	3.3	5.8	9.1	15.6	23.4
10	**.014**	**.032**	**.058**	**.13**	**.23**	**.36**	**.61**	**.92**
	.36	.91	1.63	3.7	6.5	10.1	17.3	26.0
11	**.016**	**.035**	**.063**	**.14**	**.25**	**.40**	**.67**	**1**
	.44	1.0	1.78	4.1	7.1	11.1	19.0	28.6
12	**.018**	**.039**	**.07**	**.16**	**.28**	**.43**	**.73**	**1.1**
	.49	1.1	1.8	4.4	7.8	12.1	20.8	31.2
13	**.019**	**.042**	**.075**	**.17**	**.30**	**.47**	**.79**	**1.2**
	.53	1.18	2.10	4.8	8.4	13.1	22.5	33.8
14	**.02**	**.045**	**.08**	**.18**	**.32**	**.50**	**.85**	**1.3**
	.57	1.28	2.28	5.2	9.1	14.1	24.2	36.4
15	**.021**	**.048**	**.085**	**.19**	**.34**	**.54**	**.91**	**1.4**
	.61	1.36	2.43	5.6	9.7	15.1	25.9	39.0
16	**.023**	**.052**	**.093**	**.20**	**.37**	**.58**	**.98**	**1.5**
	.65	1.46	2.6	5.9	10.4	16.2	27.7	41.6
17	**.024**	**.055**	**.096**	**.22**	**.39**	**.61**	**1.0**	**1.6**
	.69	1.55	2.75	6.3	11.0	17.2	29.4	44.2
18	**.026**	**.058**	**.103**	**.230**	**.41**	**.65**	**1.1**	**1.7**
	.73	1.65	2.93	6.6	11.7	18.2	31.1	46.8
19	**.028**	**.062**	**.11**	**.25**	**.44**	**.68**	**1.2**	**1.75**
	.77	1.73	3.08	7.0	12.3	19.2	32.8	49.4
20	**.029**	**.065**	**.12**	**.26**	**.46**	**.72**	**1.25**	**1.8**
	.81	1.83	3.25	7.4	13.0	20.2	34.6	52.0
22	**.032**	**.072**	**.13**	**.29**	**.51**	**.79**	**1.3**	**2.0**
	.89	2.01	3.58	8.1	14.3	22.2	38.1	57.2
24	**.034**	**.077**	**.14**	**.31**	**.55**	**.86**	**1.5**	**2.2**
	.98	2.19	3.90	8.9	15.6	24.2	41.5	62.4
26	**.037**	**.084**	**.15**	**.34**	**.60**	**.94**	**1.6**	**2.4**
	1.06	2.38	4.23	9.6	16.9	26.3	45.0	67.6
28	**.04**	**.09**	**.16**	**.36**	**.64**	**1.0**	**1.7**	**2.6**
	1.14	2.56	4.55	10.3	18.2	27.3	48.4	72.8
30	**.069**	**.097**	**.17**	**.39**	**.69**	**1.1**	**1.8**	**2.8**
	1.22	2.74	4.88	11.1	19.5	30.3	51.9	78.0

Cv Top / SCFM Lower: Cv based on 70 psi inlet and 10 psi pressure drop

Formulas

Area (in²) = diameter² x 0.7854 or πr^2

Circumference = $\pi D = 2\pi r$

Pressure = Force/ Area

Force = Pressure • Area

Cylinder Volume (Head end) = Piston Area • Stroke

Cylinder Volume (Rod end) = (Piston Area - Rod Area) • Stroke

Compression Ratio = (psig + 14.7)/ 14.7

Consumption (ft³) = Area•Stroke • compression Ration/1728

Air Demand (scfm) = 60 • Area • Piston Speed • C.R./1728

Peak Air Flow (Q) = Volume/ Time • C.R.

Torque = Force• Perpendicular distance from shaft

Water Weight = Pounds= Gallons x 8.3453

π = 3.14, D = Diameter, r = Radius

Valve Sizing

Use the formula below with the cylinder force chart above and the Compression and pressure drop factor chart below to calculate the required Cv for a valve.

$$C_V = \frac{\text{Piston Area (in2) x Stroke (in) x Compression Factor}}{\text{Pressure Drop Factor x Cycle Time (sec) x 29}}$$

Inlet Pressure	Compression Factor	Pressure Drop Factors for Various Pressure Drops				
		2 psi	5 psi	10 psi	15 psi	20 psi
10	1.7	6.5				
20	2.4	7.8	11.8			
30	3.0	8.9	13.6	18.0		
40	3.7	9.9	15.3	20.5	23.6	
50	4.4	10.8	16.7	22.6	26.4	29.0
60	5.1	11.7	18.1	24.6	29.0	32.0
70	5.8	12.5	19.3	26.5	31.3	34.8
80	6.4	13.2	20.5	28.2	33.5	37.4
90	7.1	13.9	21.6	29.8	35.5	39.9
100	7.8	14.5	22.7	31.3	37.4	42.1
110	8.5	15.2	23.7	32.8	39.3	44.3
120	9.2	15.8	24.7	34.2	41.0	46.4
130	9.8	16.4	25.6	35.5	42.7	48.4
140	10.5	16.9	26.5	36.8	44.3	50.3

Note: Pressure drop factor is based on the inlet pressure of the valve and the allowable pressure drop across the valve. For average conditions use a 70 psi inlet pressure and a 10 psi pressure drop

Vacuum Cup Sizing

Use the theoretical lift force (Ft) table below to determine what size vacuum cup to use for an application. Practical lift force (Fp) should be calculated with the following formula. Use the safety factors (t) from the table.

$$F_p = F_t \times 1/t$$

PLANE OF CUP CONTACT	STATIC LOAD	DYNAMIC LOAD
Horizontal	t μ 2	t μ 4
Vertical	t μ 4	t μ 8

F_t (lbf)		Vacuum Pressure (InHg)							
Cup ø (mm)	Area (mm^2)	26"	24"	22"	20"	18"	16"	14"	12"
2	.031	.062	.057	.05	.049	.042	.037	.033	.029
4	.126	.245	.225	.207	.187	.170	.150	.132	.112
6	.283	.551	.509	.465	.423	.381	.340	.298	.254
8	.503	.979	.904	.829	.754	.677	.602	.527	.452
10	.785	1.53	1.41	1.29	1.18	1.06	.941	.825	.705
13	1.33	2.58	2.38	2.18	1.98	1.79	1.59	1.39	1.19
16	2.01	3.90	3.62	3.31	3.02	2.71	2.40	2.12	1.81
20	3.14	6.13	5.64	5.16	4.70	4.23	3.77	3.31	2.82
25	4.91	9.57	8.82	8.09	7.36	6.61	5.89	5.14	4.41
32	8.04	15.7	14.5	13.3	12.1	10.8	9.63	8.44	7.23
40	12.6	24.5	22.5	20.6	18.8	16.9	15.1	13.2	11.3
50	19.6	38.1	35.3	32.4	29.3	26.5	23.6	20.6	17.7

Note: If several cups are used simply add up the forces for each cup

Ejector Sizing (No Leakage)

Once you have your cups sized, you can start to figure out what size ejector you will need in order to adsorb the part in the amount of time required by the application. In applications where there is a good seal between to work and the pad, and the material is non-porous, you can assume no leakage. Use the formula below to determine the needed ejector flow:

$$Q_1 = V \times 60/T_1$$

Q_1= mean suction flow (Nℓ/min)

V = volume of tubing to cups (liters)
(need inside ø and length of tube)

T_1 = time to reach 63% of target vacuum level (seconds)
(time to reach 95% adsorption = 3 times T_1)

(See reference catalog "Vacuum Equipment" P-E06-7A.)

Pipe Thread Quick Reference

Tapered pipe threads seal at the points where the crests of the threads meet the roots of the mating threads. Standard pipe threads, NPT, PT, and BSPT require sealant to prevent the development of a spiral leak path. NPTF threads are designed to crush the points of the crests into the roots of the mating threads to achieve the same purpose, however, use of a lubricant or sealant to prevent galling of the threads is preferred where not functionally prohibited.

BSPT – British Standard Taper Pipe Threads

PT – Japanese Industrial Standard Taper Pipe Threads

{R (PT) – Taper external threads}

{Rc (PT) –Taper internal threads}

NPT – American National Standard Taper Pipe Threads
*All of the above are designed to be used with sealant to provide a pressure tight joint.

NPTF – American National Standard Dryseal Pipe Threads
*Designed to provide a pressure tight joint without the use of sealant.

PF – Japanese Industrial Standard Parallel Pipe Threads
*Straight threads use a gasket or O-ring to produce a pressure tight joint.

Basic Dimensions

Port Size	PT & BSPT				NPT & NPTF			
	Threads per inch	Pitch	Major Dia.	Thread form angle	Threads per inch	Pitch	Major Dia.	Thread form angle
1/16	28	.03571	.304	55°	27	.030704	.313	60°
1/8	28	.03571	.383	55°	27	.030704	.404	60°
1/4	19	.05262	.518	55°	18	.05556	.540	60°
3/8	19	.05262	.656	55°	18	.05556	.675	60°
1/2	14	.07142	.825	55°	14	.07143	.840	60°
3/4	14	.07142	1.041	55°	14	.07143	1.050	60°

Compatibility between the above male and female is outlined below. SMC Corporation, however, has unique solution to all this perplexity. The Uni-Fit will screw into all main thread variations.

		Female								
		Parallel				Taper			American	
		BSP	Rp	PF	G	BSPT	Rc	PT	NPT	NPTF
Male	BSP	Y	Y	Y	Y	N	N	N	N	N
	BSPT	Y	Y	Y	Y	Y	Y	Y	N	N
	G	Y	Y	Y	Y	N	N	N	N	N
	NPT	N	N	N	N	N	N	N	Y	N
	NPTF	N	N	N	N	N	N	N	N	Y
	PF	Y	Y	Y	Y	N	N	N	N	N
	PT	Y	Y	Y	Y	Y	Y	Y	N	N
	R	Y	Y	Y	Y	Y	Y	Y	N	N
	UNI	Y	Y	Y	Y	Y	Y	Y	Y	Y

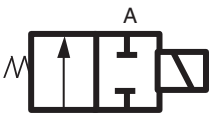
Miniature threads, **M5x0.8** and **10/32 UNF**, will only mate as follows: **10/32** male will fit into and **M5** female, **M5** male will NOT fit into a **10/32** female. Both of these threads use a gasket to produce a pressure tight fit.

"Standard port call out"

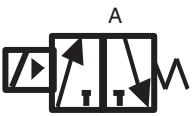
Port ID	Description of Function
P	Inlet – Supply Pressure
A	Output – Normally Closed at rest (Unless specified in a 2 or 3 port valve) (A → EA)
B	Output – Normally Open at rest (P → B)
EA & EB	Exhaust ports
X	External Pilot Supply (Used to supply pilot for low pressure or vacuum applications)
EX	Pilot Exhaust (Never plug. Leave open or use a silencer)

From time to time different manufactures use different call outs listed is the most recognized call outs. (Read across)

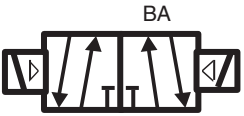
Supply	NC Output	NO Output	Exhaust Of NC	Exhaust Of NO	Pilot For NC	Pilot For NO
P	A	B	R	S	Z	Y
P	A	B	R1	R2	Z	Y
P	A	B	EA	EB	PA	PB
P	A	B	EA	EB	X	X2
1	2	4	3	5	12	14



2 Port/ 2 Position
Normally Closed



3 Port/ 2 Position



5 Port/ 2 Position

Each square represents a position or state that the valve will perform. The square that has the call outs will always show the valve at rest.

At Rest Action

2 port NC	P → Blocked	A → Blocked	
2 port NO	P → A		
3 Port NC	P → Blocked	A → E	
3 Port NO	P → A	E → Blocked	
5 Port / 2 Position	P → B	A → EA	EB → Blocked
5 Port / 3 Pos – Closed	P, B & A → Blocked	EA & EB → Blocked	
5 Port / 3 Pos – Exhaust	P → Blocked	B → EB	A → EA
5 Port / 3 Pos – Open	P → B & A	EA & EB → Blocked	

Cylinder Order Sheet

- Style? _____
- Bore? _____
- Stroke? _____
- Single or Double Acting?
- Spring return or spring extend?

Mounting? _____

Inch or Metric?

Auto -Switch Capable? Y or N

- Number of Switches? _____
- Reed or Solid State? NPN or PNP
- What Voltage? _____
- Standard or Long Leads?
- Prewired lead connector?

Options

- Oversize rod
- Cushions? Air or Urethane?
- Non–rotating rod
- Rod boot? Nylon or Neoprene
- Low or High Temp application
- Low Friction
- Stainless Steel Rod
- Adjustable Stroke? Extend or Retract
- Dual Stroke? Single or Double Rod
- Extended rod? Inch or Metric?
- Extended rod threads? Inch or Metric?
- Special Rod threads?

Accessories

- Rod Eye
- Double Rod Clevis
- Flange (Head or Rear)
- Single Rod Clevis
- Foot Bracket
- Trunnion

Speed_____ Load_____ Mounting Direction _____

Temperature _____ Environment_____

Moments: X _____ Y_____ Z _____

Crossing Over a Cylinder

Bore _____ Stroke _____ Inch or Metric Port Size _____

Thread Size _____ Mounting Style _____

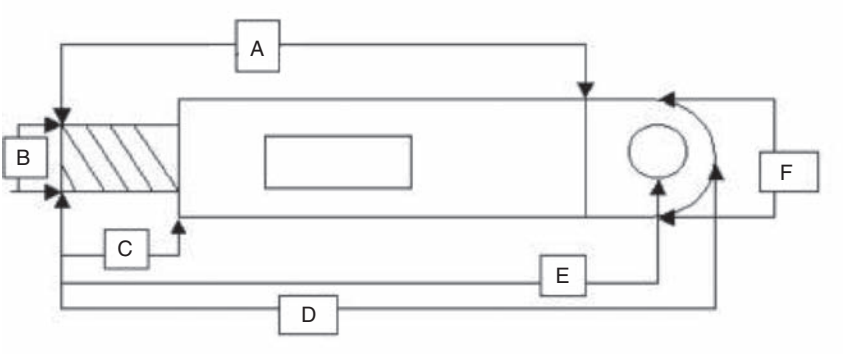
Line Pressure _____ Load _____

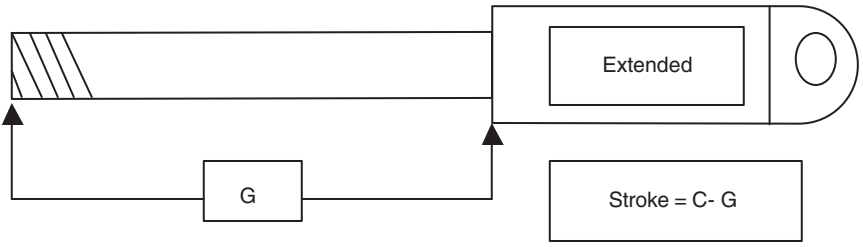
Vertical or Horizontal Lift _____ Switches _____ Style _____

Dimensions:

A _____ B _____ C _____ D _____

E _____ F _____ G _____





Valve Order Sheet

- How Many Port? _____
- How Many Positions? _____
- Flow? _____
- Rubber or Metal Seal? _____
- What is the application? _____

  Cylinder bore? _____ Stroke? _____ _____

  Speed? _____ Blow off? _____

- Single or Double Solenoid? _____
- Voltage? _____
- Style of Connector? _____

  Plug – In, Din or Grommet?

  Serial or Discrete?

- Body Ported, Sub plate or Manifold?
- Foot bracket, Mounting holes or Din Rail?
- Port Size? _____ Threaded or One Touch Fitting
- How Many Stations? _____
- Operating Pressure? _____
- Temperature? _____
- Environment? _____

Vacuum Order Sheet

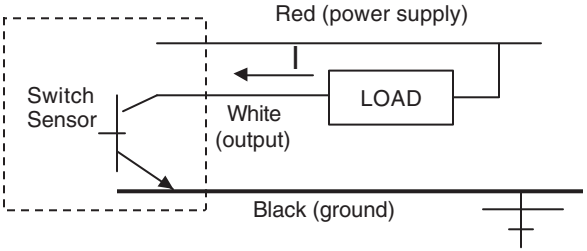
- Ejector - Single, Double or 3 Stage nozzle?
- Port size? _____
- Flow? _____
- Application:
    - Horizontal or Vertical Lift?
    - Load Material? _____
    - Weight of Load? _____
    - Number of Pads? _____
    - Surface Material? _____
    - Pad Diameter? _____
        - Flat, Flat w/ Ribs, Deep or Bellows?
        - Material? _____
        - Connection – Vertical or Horizontal Vacuum entry?
        - Buffer or Non – Buffer?
        - Female Fitting, Barb or One-Touch?
        - Vacuum Pressure? _____
- Suction Filter? _____
- Solenoid Valves for Supply and/or Blow off?
    - Voltage? _____
    - Type of connector, Grommet, L type, M type?
- Individual or Manifold?
- Vacuum Switch or Adsorption Conformation?

PNP or NPN?

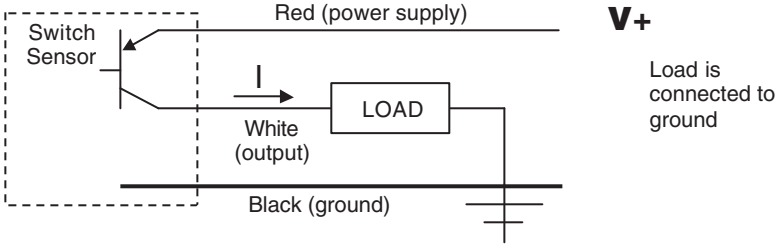
REED SWITCHES: A thin metal contact is drawn closed by the magnetic field of the piston magnet. Since this is a mechanical switch it will wear out over time and is susceptible to vibration and shock. Their advantage is that they are inexpensive and can be used with AC voltages.

SOLID– STATE SWITCHES: The magnetic field generated by the piston magnet causes a current flow inside the switch. Since there are no moving parts, the switch life is much longer than a reed switch and they are less prone to vibration and shock. They are more expensive, can only be used with DC voltages and you need to know whether you need a sinking or sourcing switch.

Current Sinking (NPN) –The switch sensor "sinks" current from the load through the sensor to ground. The load is connected between the positive voltage supply and the output lead of the sensor.



Current Sourcing (PNP) – The switch sensor "Sources" current through load to ground. The load is connected between the output lead of the sensor and the negative "ground" lead of the supply.

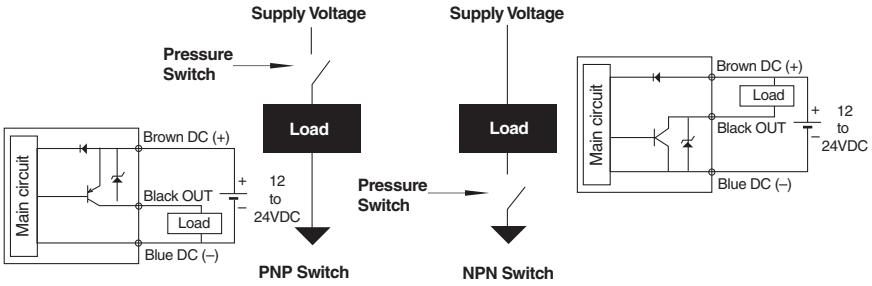


Three wire DC sensors include one wire that provides voltage to the sensor, an output signal wire and a ground wire. Most electro–mechanical loads (relays, counters, solenoids etc.) can use either a sink or source type switch provided it is wired properly. The proper sensor type must be chosen when used with solid-state load and programmable controllers due to the fact that some of these loads must be grounded.

Wire Colors: SMC has changed the wire colors on all of our switch products. This was done to conform to European standards that are being adopted worldwide.

Positive	Red	} (old colors)	Brown	} (new colors)
Negative	Black		Blue	
Output	White		Black	

Pressure Switches and Their Simplified Operation



Sourcing – PNP is often referred to as Sourcing, because the switch closes and provides the source voltage to the load

Sinking – NPN is often referred to as Sinking, because the switch closes and sinks the current to ground

Normally Open – Does not pass signal until the set point is reached

Normally Closed – Passes up to the set point but not beyond

FS or Full Scale – The maximum set unit minus the minimum set unit.

Ex. ITV1050 0.9MPa – 0.005MPa = 0.895 MPa Full Scale

Linearity – The nearness with which the plot of a signal, or variable, plotted against a prescribed linear scale approximates a straight line. Output error to reference value

Repeatability – The ability of the instrument to provide the same output every time for the same input. Usually given as a % of the FS value

Sensitivity – Often described as the minimum change of input to which the system is capable of responding. Usually expressed in % of Full Scale

Hysteresis – The difference in output when the measured value is first approached with increasing and then decreasing values. Expressed in % of Full Scale

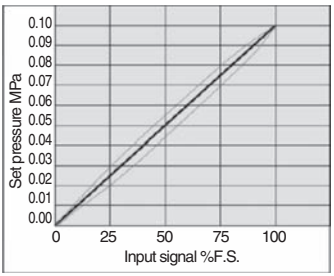
Impedance – Resistance of a load that hinders the flow.

Current Consumption – The amount of current needed for normal operation, does not include load current.

Watts (W) and Volt Amps (VA) – Both of these units are used to express electrical power.

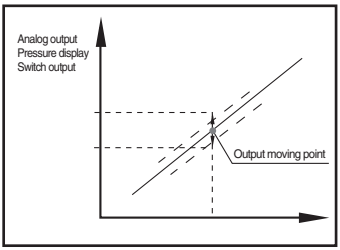
Watts is for DC voltage and Volt Amps is for AC voltage.

If you have any questions on basic electronics there is an entry in the Product Application Database that explains basic electronics.

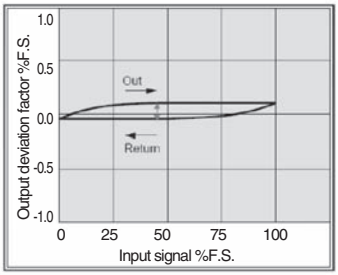


Linearity

This graph shows the repeatability of an analog output, pressure display and a switch (ON-OFF) output's moving point. The pressure is increased or decreased under normal temperature (25°C).



Repeatability



Hysteresis

NEMA Ratings (Electrical Enclosures)

An enclosure is a surrounding case constructed to provide a degree of protection to personnel against accidental contact with the enclosed equipment and to provide a degree of protection to the enclosed equipment against specified environmental conditions. These are the more common classifications as they pertain to pneumatic components such as valves.

NEMA 1 Intended for Indoor use primarily to provide a degree of protection against contact with enclosed equipment.

NEMA 2 Intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.

NEMA 3 Intended for outdoor use to provide a degree of protection against windblown dust, rain, sleet and external ice formation.

NEMA 3R Intended for outdoor use to provide a degree of protection against falling rain, sleet and external ice formation.

NEMA 3S Intended for outdoor use to provide a degree of protection against windblown dust, rain, sleet and provide for operation of external mechanisms when ice laden.

NEMA 4 Intended for indoor and outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water and hose directed water.

NEMA 4X Intended for indoor and outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water and hose directed water.

NEMA 6 Intended for indoor or outdoor use primarily to provide a degree of protection against entry of water during occasional submersion to a limited depth.

IP Ratings (Electrical Enclosures)

1st Numeral: Degree of protection with respect to persons and solid objects		2nd Numeral: Degree of protection with respect to harmful ingress of water								
		Non protected	Dripping water	Dripping water +/- 15°	Spraying water +/- 60°	Splashing water 360°	Water jets	Heavy seas	Immersion	Submersion
Not protected	0	IP00	IP01	IP02						
Solid objects > ø50mm	1	IP10	IP11	IP12	IP13					
Solid objects > ø12mm	2	IP20	IP21	IP22	IP23					
Solid objects > ø2.5mm	3	IP30	IP31	IP32	IP33	IP34				
Solid objects > ø1.0mm	4	IP40	IP41	IP42	IP43	IP44	IP 45	IP 46		
Dust pro tected	5					IP54	IP 55	IP 56		
Dust tight	6						IP 65	IP 66	IP 67	IP 68

Note: find IP rating and follow across and up to find degree of combined protection. IP65 and NEMA 4 are roughly equivalent

One-Touch Fittings
Series KQ2

KQ2 H 01 - 35 S - X2

Compact slide table

Prefix	Description
H	Male connector
	Straight union
	Different dia. straight union
K	45° Male elbow
L	Male elbow
	Union elbow
	Plug-in elbow
	Reducer elbow
LE	Bulkhead elbow
LF	Female elbow
LU	Branch union elbow
	Branch elbow
C	Tube cap
	Color cap
D	Delta
	Delta union
E	Bulkhead union
	Bulkhead female union
F	Female connector
N	Nipple
	Different dia. nipple
N	Adaptor
P	Plug
R	Plug-in reducer
S	Hex. socket head male connector
T	Branch tee
TW	Union cross
U	Union "Y"
	Branch "Y"
UD	Double branch
	Different dia. double union "Y"
V	Universal male elbow
VD	Double universal male elbow
VF	Universal female elbow
VS	Hex. socket head universal elbow
VT	Triple universal male elbow
W	Extended male elbow
	Extended plug-in elbow
X	Different dia. branch "Y"
XD	Double branch "Y"
Y	Male run tee
Z	Double branch universal elbow
ZD	Branch universal elbow
ZF	Branch universal female elbow
ZT	Triple branch universal elbow

Tube O.D.

Inch

01	1/8"
03	5/32"
05	3/16"
07	1/4"
09	5/16"
11	3/8"
13	1/2"

Metric

23	3.2mm
04	4mm
06	6mm
08	8mm
10	10mm
12	12mm
16	16mm

Options

Nil	None
X2	Electroless nickel plating
X13*	Series SUS (inch size only)

* Use Series KG for metric SUS.

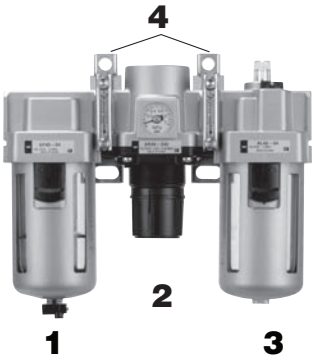
Sealant

Nil	Without sealant
S	With sealant (male thread only, except M5)

Connections

Type	"XX"	Description	Prefix
Tube unions	00	Tubing of equal O.D. diameter	H, L, T, U, E
Plug-in	99	Fitting plug-in to fitting of equal O.D.	L, U
Reducer plug-in	03	5/32"	L, R
	05	3/16"	
	07	1/4"	
	09	5/16"	
	11	3/8"	
Tube (rod) Different dia. tube (reducer)	13	1/2"	H, T, U, X, N
	06	6mm	
	08	8mm	
	10	10mm	
	12	12mm	
	16	16mm	
Threaded pipe	32	10-32 UNF Thread	H, L, W T, Y, U, E
	33	1/16" NPT	
	34	1/8" NPT	
	35	1/4" NPT	
	36	3/8" NPT	
	37	1/2" NPT	
Thread	M5	M5 x 0.8	
	M6	M6 x 1.0	
	01	PT1/8	
	02	PT1/4	
	03	PT3/8	
	04	PT1/2	

FRL Cheat Sheet



1. Filter

Port Size	Part No. W/ Manual Drain	Part No. W/Auto Drain
1/8" NPT	AF20-N01-CZ	AF20-N01C-CZ
1/4" NPT	AF20-N02-CZ	AF20-N02C-CZ
3/8" NPT	AF30-N03-Z	AF30-N03D-Z
1/2" NPT	AF40-N02-Z	AF40-N04D-Z
3/4" NPT	AF50-N06-Z	AF50-N06D-Z
1" NPT	AF60-N10-Z	AF60-N10D-Z

2. Regulator

Port Size	Part Number W/O gauge	Part Number W/gauge
1/8" NPT	AR20-N01H-Z	AR20-N01GH-Z
1/4" NPT	AR20-N02H-Z	AR20-N02GH-Z
3/8" NPT	AR30-N03H-Z	AR30-N03GH-Z
1/2" NPT	AR40-N04H-Z	AR40-N04GH-Z
3/4" NPT	AR50-N06H-Z	AR50-N06GH-Z
1" NPT	AR60-N10H-Z	AR60-N10GH-Z

3. Lubricator

Port Size	Part Number
1/8" NPT	AL20-N01-3CZ
1/4" NPT	AL20-N02-3CZ
3/8" NPT	AL30-N03-3Z
1/2" NPT	AL40-N04-3Z
3/4" NPT	AL50-N06-3Z
1" NPT	AL60-N10-3Z

4. Brackets

Air Prep Unit Port Size	Spacer	Spacer-T
1/8" NPT (AC20 Series)	Y200	Y200T
1/4" NPT (AC20 Series)	Y200	Y200T
3/8" NPT (AC30 Series)	Y300	Y300T
1/2" NPT (AC40 Series)	Y400	Y400T
3/4" NPT (AC50 Series)	Y500	Y500T
1" NPT (AC60 Series)	Y600	Y600T

Notes

- Download CAD files
- Configure part numbers
- Save and e-mail part lists
- Millions of part numbers available

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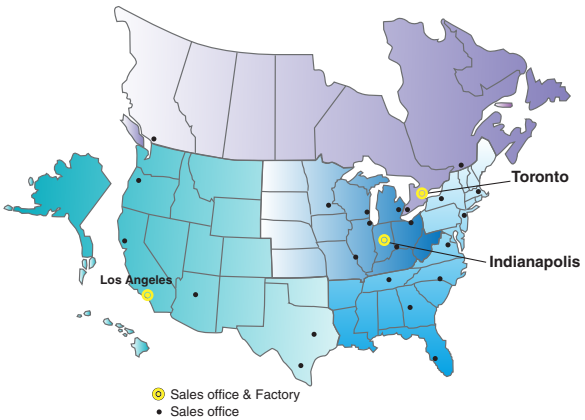

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