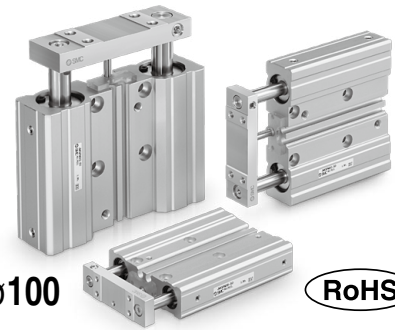


Compact Guide Cylinder

JMGP Series

ø12, ø16, ø20, ø25, ø32, ø40, ø50, ø63, ø80, ø100



How to Order

JMGPM 25 **30** **M9BW**

Bearing type

M	Slide bearing
----------	---------------

Bore size

12	10 mm x 2
16	12 mm x 2
20	16 mm x 2
25	20 mm x 2
32	25 mm x 2
40	32 mm x 2
50	40 mm x 2
63	45 mm x 2
80	56 mm x 2
100	71 mm x 2

Number of auto switches

Nil	2
S	1
n	n

Auto switch

Nil	Without auto switch (Built-in magnet)
------------	---------------------------------------

* For applicable auto switches, refer to the table below.

Cylinder stroke [mm]
Refer to "Standard Strokes" on page 4.

Port thread type

Nil	M thread	ø12 to ø32
	Rc	
TN	NPT	ø40 to ø100
TF	G	

Applicable Auto Switches/Refer to the WEB catalog or Best Pneumatics for further information on auto switches.

Type	Special function	Electrical entry	Indicator light	Wiring (Output)	Load voltage		Auto switch model		Lead wire length [m]				Pre-wired connector	Applicable load		
					DC	AC	Perpendicular	In-line	0.5 (Nil)	1 (M)	3 (L)	5 (Z)				
Solid state auto switch	—	Grommet	Yes	3-wire (NPN)	24 V	—	M9NV	M9N	●	●	●	○	○	IC circuit		
				3-wire (PNP)			M9PV	M9P	●	●	●	○	○			
				2-wire			M9BV	M9B	●	●	●	○	○			
	Diagnostic indication (2-color indicator)			3-wire (NPN)	24 V	—	M9NWV	M9NW	●	●	●	○	○	○	○	IC circuit
				3-wire (PNP)			M9PWV	M9PW	●	●	●	○	○	○		
				2-wire			M9BWV	M9BW	●	●	●	○	○	○		
	Water resistant (2-color indicator)			3-wire (NPN)	24 V	—	M9NAV**	M9NA**	○	○	●	○	○	○	○	IC circuit
				3-wire (PNP)			M9PAV**	M9PA**	○	○	●	○	○	○		
				2-wire			M9BAV**	M9BA**	○	○	●	○	○	○		

** Water resistant type auto switches can be mounted on the above models, but in such case SMC cannot guarantee water resistance. Please contact SMC regarding water resistant types with the above model numbers.

* Lead wire length symbols: 0.5 m..... Nil (Example) M9NW * Solid state auto switches marked with "○" are produced upon receipt of order.
 1 m..... M (Example) M9NWM
 3 m..... L (Example) M9NWL
 5 m..... Z (Example) M9NWZ

* For details about auto switches with pre-wired connector, refer to the WEB catalog or Best Pneumatics.

* Auto switches are shipped together, (but not assembled).



Specifications

Bore size [mm]	ø12 (ø10 x 2)	ø16 (ø12 x 2)	ø20 (ø16 x 2)	ø25 (ø20 x 2)	ø32 (ø25 x 2)	ø40 (ø32 x 2)	ø50 (ø40 x 2)	ø63 (ø45 x 2)	ø80 (ø56 x 2)	ø100 (ø71 x 2)
Action	Double acting									
Fluid	Air									
Proof pressure	1.05 MPa									
Maximum operating pressure	0.7 MPa*1									
Minimum operating pressure	0.15 MPa									
Ambient and fluid temperature	5 to 60°C									
Piston speed (Note)**	50 to 300 mm/s*1								50 to 250 mm/s*1	
Cushion	Rubber bumper on both ends									
Lubrication	Not required (Non-lube)									
Stroke length tolerance	$^{+1.5}_0$ mm									

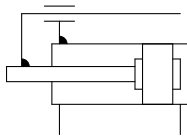
Note) Maximum speed with no load

* Depending on the system configuration selected, the specified speed may not be satisfied.

*1 Maximum operating pressure and piston speed are different from the current product (JMG series).

Symbol

Rubber bumper



Refer to pages 10 and 11 for cylinders with auto switches.

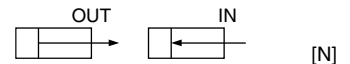
- Auto switch proper mounting position (detection at stroke end) and mounting height
- Minimum stroke for auto switch mounting
- Operating range
- Auto switch mounting

Standard Strokes

Bore size [mm]	Standard stroke [mm]
ø12 (ø10 x 2) ø16 (ø12 x 2)	10, 20, 30, 50, 100
ø20 (ø16 x 2) ø25 (ø20 x 2)	20, 30, 50, 100, 150
ø32 (ø25 x 2) ø40 (ø32 x 2) ø50 (ø40 x 2) ø63 (ø45 x 2) ø80 (ø56 x 2) ø100 (ø71 x 2)	25, 50, 100, 150, 200

* Intermediate strokes are available as a special order.

Theoretical Output



Bore size [mm]	Rod size [mm]	Operating direction	Piston area [mm ²]	Operating pressure [MPa]					
				0.2	0.3	0.4	0.5	0.6	0.7
ø12 (ø10 x 2)	6	OUT	157	31	47	63	79	94	110
		IN	101	20	30	40	50	60	70
ø16 (ø12 x 2)	6	OUT	226	45	68	90	113	136	158
		IN	170	34	51	68	85	102	119
ø20 (ø16 x 2)	8	OUT	402	80	121	161	201	241	281
		IN	302	60	90	121	151	181	211
ø25 (ø20 x 2)	10	OUT	628	126	188	251	314	377	440
		IN	471	94	141	188	236	283	330
ø32 (ø25 x 2)	12	OUT	982	196	295	393	491	589	687
		IN	756	151	227	302	378	453	529
ø40 (ø32 x 2)	16	OUT	1608	322	483	643	804	965	1126
		IN	1206	241	362	483	603	724	844
ø50 (ø40 x 2)	18	OUT	2513	503	754	1005	1257	1508	1759
		IN	2004	401	601	802	1002	1203	1403
ø63 (ø45 x 2)	20	OUT	3181	636	954	1272	1590	1909	2227
		IN	2553	511	766	1021	1276	1532	1787
ø80 (ø56 x 2)	25	OUT	4926	985	1478	1970	2463	2956	3448
		IN	3944	789	1183	1578	1972	2367	2761
ø100 (ø71 x 2)	30	OUT	7918	1584	2376	3167	3959	4751	5543
		IN	6505	1301	1951	2602	3252	3903	4553

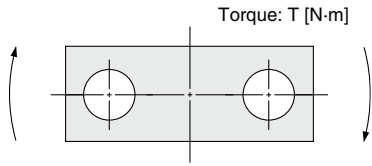
Note) Theoretical output [N] = Pressure [MPa] x Piston area [mm²]

Weight

Bore size [mm]	Stroke [mm]							
	10	20	25	30	50	100	150	200
ø12 (ø10 x 2)	0.09	0.12	—	0.14	0.19	0.30	—	—
ø16 (ø12 x 2)	0.10	0.13	—	0.15	0.20	0.32	—	—
ø20 (ø16 x 2)	—	0.21	—	0.25	0.33	0.53	0.72	—
ø25 (ø20 x 2)	—	0.28	—	0.33	0.43	0.68	0.92	—
ø32 (ø25 x 2)	—	—	0.60	—	0.77	1.11	1.44	1.78
ø40 (ø32 x 2)	—	—	0.80	—	1.07	1.62	2.16	2.70
ø50 (ø40 x 2)	—	—	1.27	—	1.63	2.36	3.09	3.82
ø63 (ø45 x 2)	—	—	1.60	—	2.03	2.89	3.74	4.60
ø80 (ø56 x 2)	—	—	2.81	—	3.47	4.79	6.12	7.44
ø100 (ø71 x 2)	—	—	4.48	—	5.40	7.22	9.05	10.87

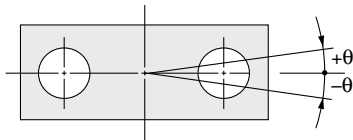
JMGP Series

Allowable Rotational Torque of Plate



Bore size [mm]	Stroke [mm]							
	10	20	25	30	50	100	150	200
ø12 (ø10 x 2)	0.13	0.10	—	0.08	0.06	0.04	—	—
ø16 (ø12 x 2)	0.14	0.11	—	0.09	0.07	0.04	—	—
ø20 (ø16 x 2)	—	0.27	—	0.22	0.16	0.10	0.07	—
ø25 (ø20 x 2)	—	0.54	—	0.45	0.34	0.21	0.15	—
ø32 (ø25 x 2)	—	—	0.93	—	0.66	0.42	0.31	0.24
ø40 (ø32 x 2)	—	—	2.18	—	1.59	1.03	0.77	0.61
ø50 (ø40 x 2)	—	—	3.41	—	2.56	1.70	1.27	1.02
ø63 (ø45 x 2)	—	—	5.09	—	3.86	2.60	1.96	1.57
ø80 (ø56 x 2)	—	—	8.48	—	6.56	4.52	3.45	2.79
ø100 (ø71 x 2)	—	—	13.54	—	10.72	7.56	5.84	4.76

Non-rotating Accuracy of Plate



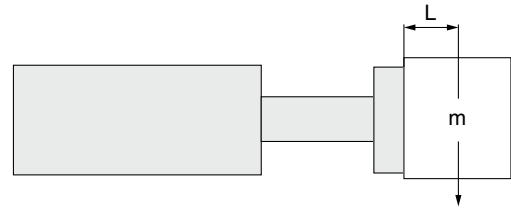
Non-rotating accuracy θ when retracted and when no load is applied should be not more than the values shown in the table.

Bore size [mm]	Non-rotating accuracy θ
ø12 (ø10 x 2)	±0.07°
ø16 (ø12 x 2)	
ø20 (ø16 x 2)	
ø25 (ø20 x 2)	
ø32 (ø25 x 2)	±0.06°
ø40 (ø32 x 2)	
ø50 (ø40 x 2)	±0.05°
ø63 (ø45 x 2)	
ø80 (ø56 x 2)	±0.04°
ø100 (ø71 x 2)	

Allowable Lateral Load

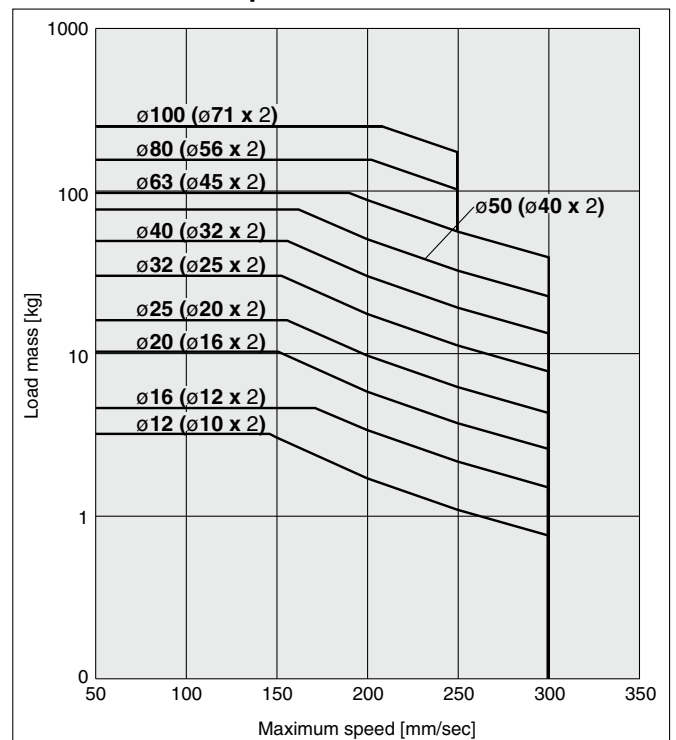
Bore size [mm]	Stroke [mm]							
	10	20	25	30	50	100	150	200
ø12 (ø10 x 2)	0.9	0.7	—	0.5	0.4	0.2	—	—
ø16 (ø12 x 2)	0.9	0.7	—	0.6	0.4	0.2	—	—
ø20 (ø16 x 2)	—	1.3	—	1.0	0.8	0.5	0.3	—
ø25 (ø20 x 2)	—	2.3	—	1.9	1.4	0.9	0.6	—
ø32 (ø25 x 2)	—	—	3.4	—	2.4	1.5	1.1	0.9
ø40 (ø32 x 2)	—	—	7.8	—	5.7	3.7	2.7	2.2
ø50 (ø40 x 2)	—	—	9.6	—	7.2	4.8	3.6	2.9
ø63 (ø45 x 2)	—	—	13.0	—	9.8	6.6	5.0	4.0
ø80 (ø56 x 2)	—	—	18.3	—	14.2	9.8	7.5	6.0
ø100 (ø71 x 2)	—	—	24.5	—	19.4	13.7	10.6	8.6

* Lateral load above is the value when eccentric distance $L = 0$ mm.



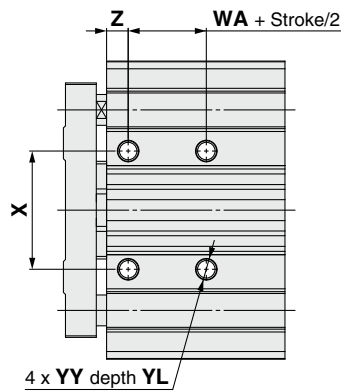
Allowable Kinetic Energy

With Rubber Bumper

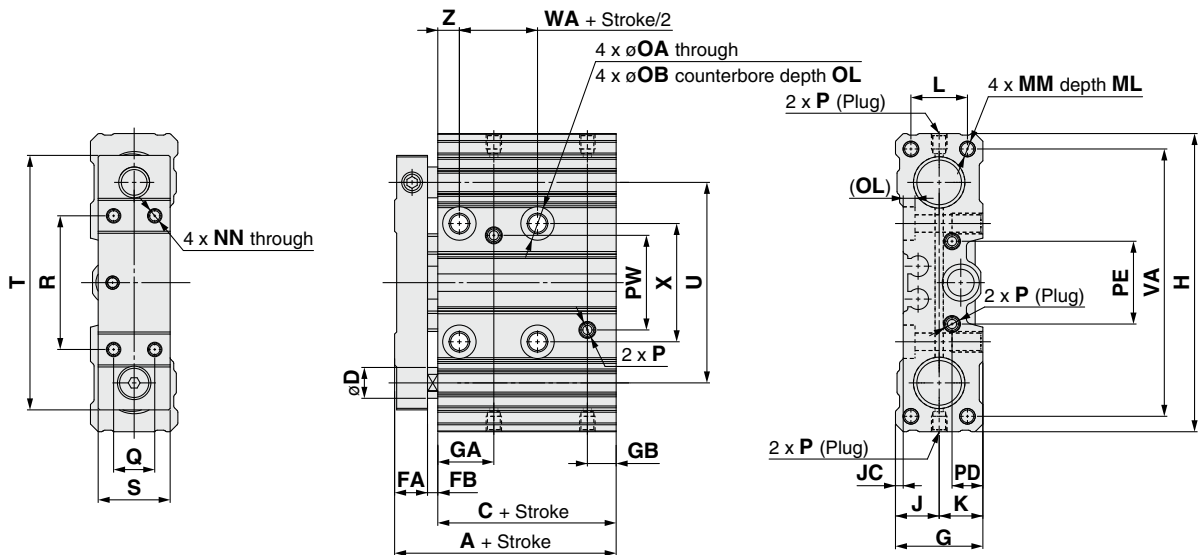


Bore Size $\varnothing 12$ ($\varnothing 10 \times 2$), $\varnothing 16$ ($\varnothing 12 \times 2$)

Standard: JMGP



Bottom view



[mm]

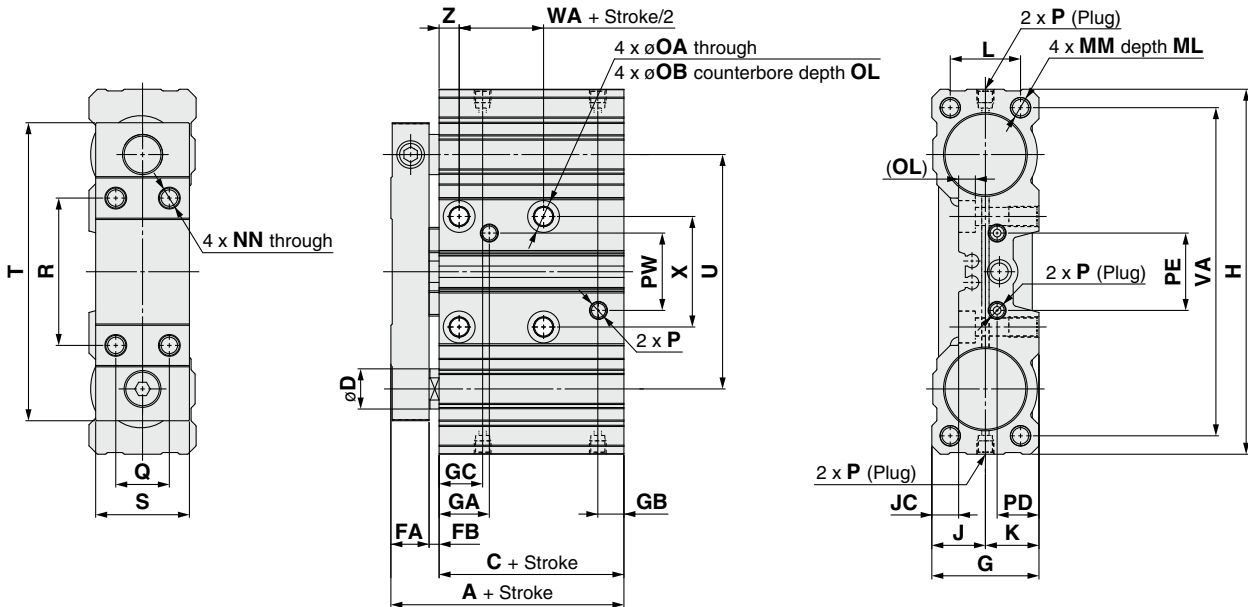
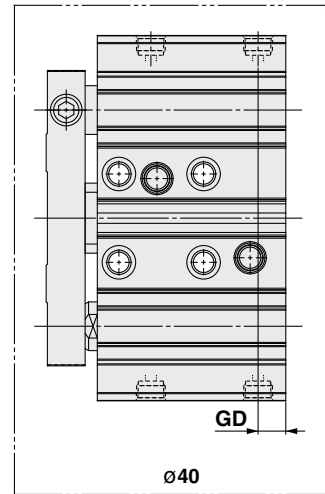
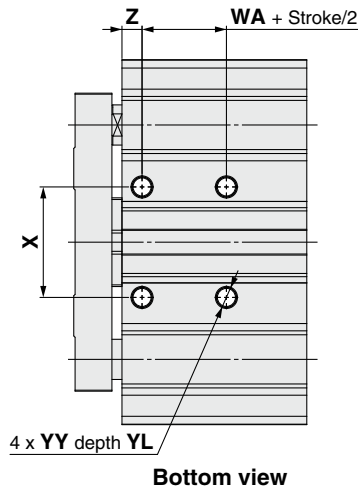
Bore size	Standard stroke	A	C	D	FA	FB	G	GA	GB	H	J	JC	K	L	MM	ML	NN
$\varnothing 12$ ($\varnothing 10 \times 2$)	10, 20, 30, 50, 100	33	24.5	6	6.5	2	17	11	5.5	58	8.5	1.5	8.5	11	M3 x 0.5	7.5	M2.5 x 0.45
$\varnothing 16$ ($\varnothing 12 \times 2$)		33	24.5	6	6.5	2	18	11	5.5	64	9	3	9	11	M4 x 0.7	10	M3 x 0.5

Bore size	OA	OB	OL	P	PD	PE	PW	Q	R	S	T	U	VA	WA	X	YY	YL	Z
$\varnothing 12$ ($\varnothing 10 \times 2$)	3.4	6.5	2.5	M3 x 0.5	6	16	18.5	8	26	14	49.5	39	52	10.2	23	M4 x 0.7	6	4.2
$\varnothing 16$ ($\varnothing 12 \times 2$)	3.4	6.5	2	M3 x 0.5	6.5	16	18.5	8	28	14	53	42	57	10.2	24	M4 x 0.7	6	4.3

JMGP Series

Bore Size $\varnothing 20$ ($\varnothing 16 \times 2$) to $\varnothing 40$ ($\varnothing 32 \times 2$)

Standard: JMGP



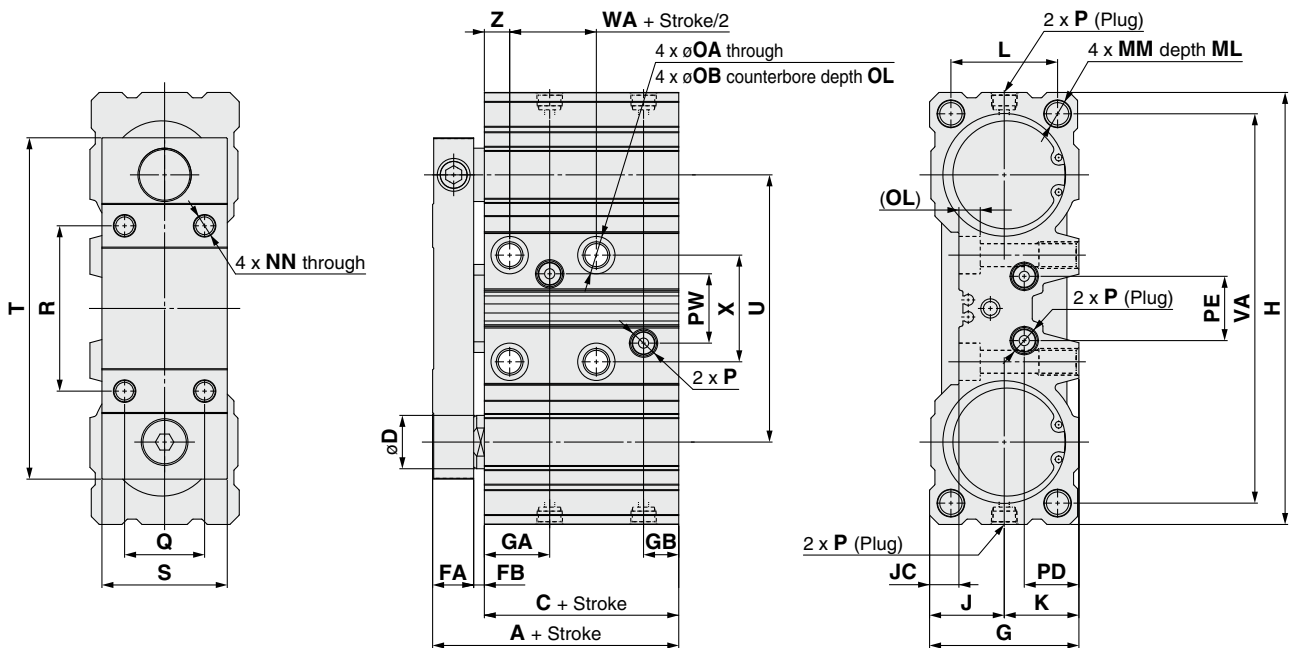
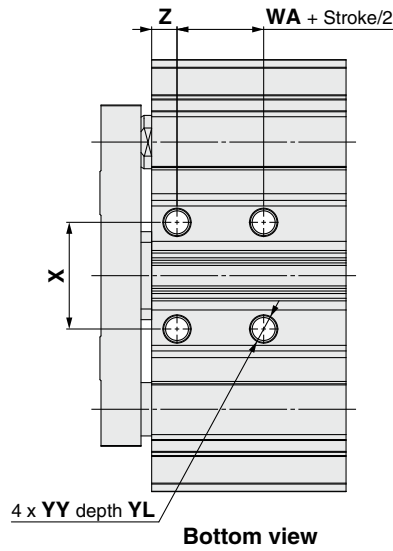
[mm]

Bore size	Standard stroke	A	C	D	FA	FB	G	GA			GB	GC	GD	H	J	JC	K	L	MM	ML	NN
								Nil	TN	TF											
$\varnothing 20$ ($\varnothing 16 \times 2$)	20, 30, 50 100, 150	38	27.5	8	7.5	3	22	12.5	—	—	7.5	11	—	83	11	3	11	14	M4 x 0.7	10	M4 x 0.7
$\varnothing 25$ ($\varnothing 20 \times 2$)		39.5	28	10	8.5	3	26	12	—	—	7.5	11	—	93	13	4.5	13	17	M5 x 0.8	12.5	M5 x 0.8
$\varnothing 32$ ($\varnothing 25 \times 2$)	25, 50, 100 150, 200	44.5	30	12	11.5	3	32	15	—	—	7.5	13	—	109	16	8	16	21	M6 x 1	15	M6 x 1
$\varnothing 40$ ($\varnothing 32 \times 2$)		54	37	16	13	4	41	19.5	21	12	17.5	9	120	20.5	4	20.5	27	M8 x 1.25	20	M6 x 1	

Bore size	OA	OB	OL	P			PD	PE	PW			Q	R	S	T	U	VA	WA	X	YY	YL	Z
				Nil	TN	TF			Nil	TN	TF											
$\varnothing 20$ ($\varnothing 16 \times 2$)	4.3	8	3.5	M5 x 0.8	—	—	7.5	19	21	—	—	10	36	18	66	54	75	15.9	29	M5 x 0.8	7.5	4.5
$\varnothing 25$ ($\varnothing 20 \times 2$)	4.3	8	4	M5 x 0.8	—	—	9.5	22	22	—	—	12	38	22	75	60	84	12.7	31	M5 x 0.8	7.5	4.5
$\varnothing 32$ ($\varnothing 25 \times 2$)	5.4	9.5	5	M5 x 0.8	—	—	12.5	23	23	—	—	16	44	28	89	70	98	12.7	33	M6 x 1	9	6
$\varnothing 40$ ($\varnothing 32 \times 2$)	6.7	11	6	Rc1/8	NPT1/8	G1/8	13	16.5	26	27.5	20	43	33	97	71	107	15.3	29	M8 x 1.25	10	7.1	

Bore Size $\varnothing 50$ ($\varnothing 40 \times 2$), $\varnothing 63$ ($\varnothing 45 \times 2$)

Standard: JMGP



[mm]

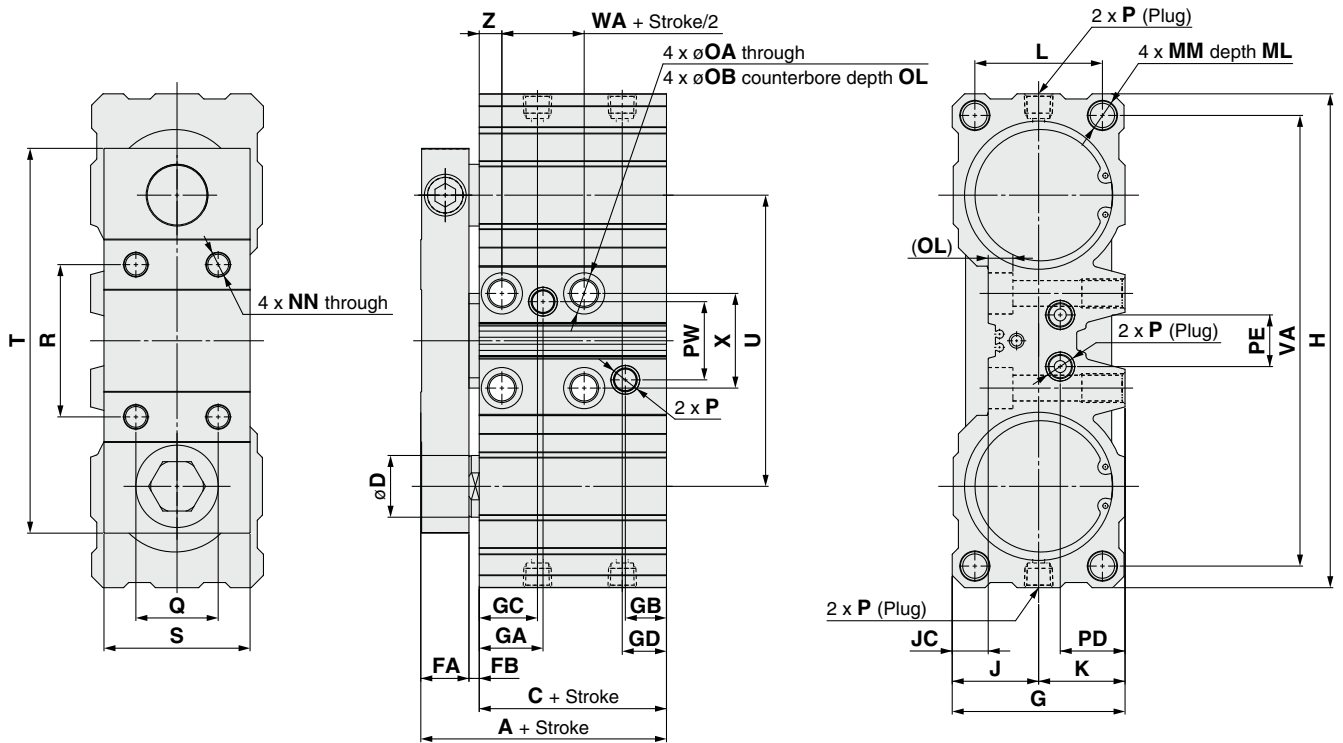
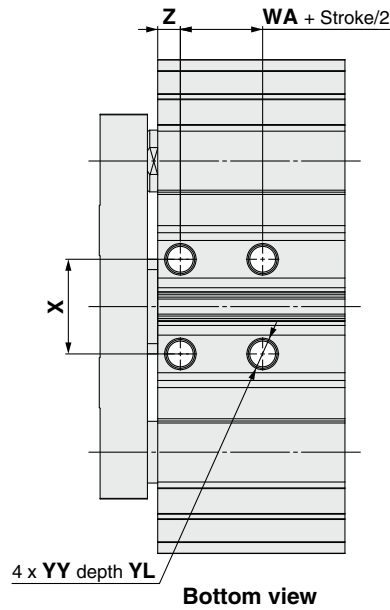
Bore size	Standard stroke	A	C	D	FA	FB	G	GA	GB	H	J	JC	K	L	MM	ML	NN
$\varnothing 50$ ($\varnothing 40 \times 2$)	25, 50, 100, 150, 200	63	43.5	18	15.5	4	51	20.5	12.5	148	25.5	9	25.5	37	M8 x 1.25	20	M8 x 1.25
$\varnothing 63$ ($\varnothing 45 \times 2$)		67.5	48	20	15.5	4	56	24.5	13.5	162	28	11	28	40	M10 x 1.5	25	M8 x 1.25

Bore size	OA	OB	OL	P			PD	PE	PW			Q	R	S	T	U	VA	WA	X	YY	YL	Z
				Nil	TN	TF			Nil	TF	TN											
$\varnothing 50$ ($\varnothing 40 \times 2$)	6.7	11	6	Rc1/8	NPT1/8	G1/8	18	27		27	30	24	54	39	119	91	135	18.1	40	M8 x 1.25	12	7.6
$\varnothing 63$ ($\varnothing 45 \times 2$)	8.6	14	8	Rc1/8	NPT1/8	G1/8	20.5	24		26	30	30	62	47	128	100	146	20	40	M10 x 1.5	15	9.5

JMGP Series

Bore Size $\varnothing 80$ ($\varnothing 56 \times 2$), $\varnothing 100$ ($\varnothing 71 \times 2$)

Standard: JMGP



[mm]

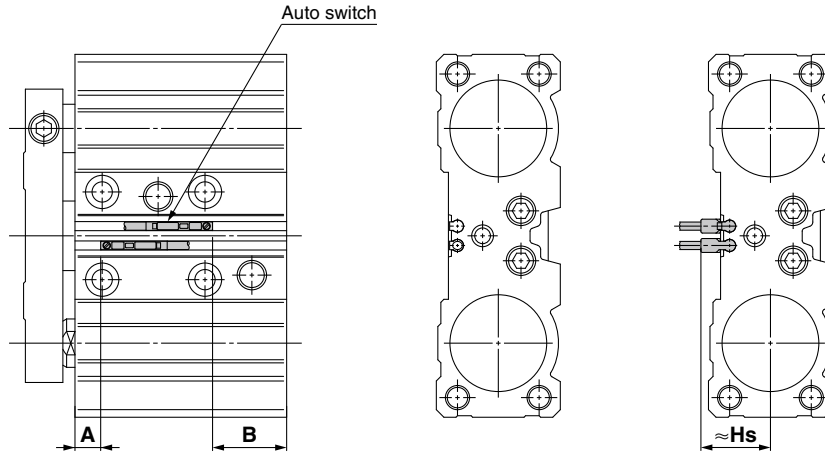
Bore size	Standard stroke	A	C	D	FA	FB	G	GA	GB	GC	GD	H	J	JC	K	L	MM	ML	NN
$\varnothing 80$ ($\varnothing 56 \times 2$)	25, 50, 100 150, 200	85.5	62	25	19.5	4	69	28.5	20.5	25	22	202	34.5	15.5	34.5	50	M12 x 1.75	30	M10 x 1.5
$\varnothing 100$ ($\varnothing 71 \times 2$)		94.5	66	30	23.5	5	84	31	20	28.5	21.5	240	42	17.5	42	62	M14 x 2	35	M12 x 1.75

Bore size	OA	OB	OL	P			PD	PE	PW	Q	R	S	T	U	VA	WA	X	YY	YL	Z
				Nil	TN	TF														
$\varnothing 80$ ($\varnothing 56 \times 2$)	10.6	17.5	10	Rc1/4	NPT1/4	G1/4	24.5	23	37	38	64	55	155	118	184	25.5	42	M12 x 1.75	18	9.5
$\varnothing 100$ ($\varnothing 71 \times 2$)	12.5	20	12	Rc1/4	NPT1/4	G1/4	31.5	25	38	40	74	71	187	141.5	219	27.5	46	M14 x 2	21	11

JMGP Series Auto Switch Mounting

Auto Switch Proper Mounting Position (Detection at stroke end) and Mounting Height

D-M9□/M9□V
D-M9□W/M9□WV
D-M9□A/M9□AV



Auto Switch Proper Mounting Position [mm]

Auto switch model	D-M9□ D-M9□V D-M9□W D-M9□WV D-M9□A D-M9□AV	
	A	B
∅12 (∅10 x 2)	10.0	2.5
∅16 (∅12 x 2)	10.0	2.5
∅20 (∅16 x 2)	9.5	6.0
∅25 (∅20 x 2)	9.5	6.5
∅32 (∅25 x 2)	9.5	8.5
∅40 (∅32 x 2)	8.5	16.5
∅50 (∅40 x 2)	8.5	23.0
∅63 (∅45 x 2)	8.5	27.5
∅80 (∅56 x 2)	8.5	41.5
∅100 (∅71 x 2)	7.5	46.5

Note) Adjust the auto switch after confirming the operating condition in the actual setting.

Auto Switch Mounting Height [mm]

Auto switch model	D-M9□V D-M9□WV D-M9□AV	
	Hs	
∅12 (∅10 x 2)	14.0	
∅16 (∅12 x 2)	14.0	
∅20 (∅16 x 2)	14.0	
∅25 (∅20 x 2)	14.0	
∅32 (∅25 x 2)	—	
∅40 (∅32 x 2)	23.5	
∅50 (∅40 x 2)	—	
∅63 (∅45 x 2)	—	
∅80 (∅56 x 2)	—	
∅100 (∅71 x 2)	—	

Minimum Stroke for Auto Switch Mounting

Auto switch model	Number of auto switches	Bore size [mm]									
		∅12 (∅10 x 2)	∅16 (∅12 x 2)	∅20 (∅16 x 2)	∅25 (∅20 x 2)	∅32 (∅25 x 2)	∅40 (∅32 x 2)	∅50 (∅40 x 2)	∅63 (∅45 x 2)	∅80 (∅56 x 2)	∅100 (∅71 x 2)
D-M9□V	1	5									
	2	5									
D-M9□	1	5 Note 1)					5				
	2	10 Note 1)	10								
D-M9□W	1	5 Note 2)									
	2	10 Note 2)	10								
D-M9□WV D-M9□AV	1	5 Note 2)									
	2	10									
D-M9□A	1	5 Note 2)									
	2	10 Note 2)									

Note 1) Confirm that it is possible to secure the minimum bending radius of 10 mm of the auto switch lead wire before use.

Note 2) Confirm that it is possible to securely set the auto switch(es) within the range of indicator green light ON range before use.

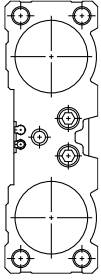
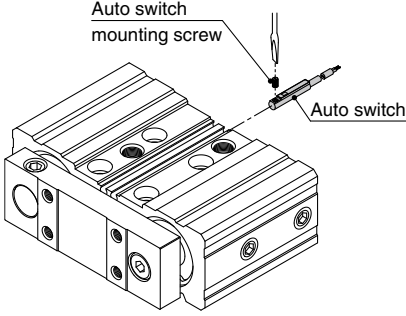
For in-line entry type, also consider Note 1) shown above.

Operating Range

Auto switch model	Bore size [mm]									
	∅12 (∅10 x 2)	∅16 (∅12 x 2)	∅20 (∅16 x 2)	∅25 (∅20 x 2)	∅32 (∅25 x 2)	∅40 (∅32 x 2)	∅50 (∅40 x 2)	∅63 (∅45 x 2)	∅80 (∅56 x 2)	∅100 (∅71 x 2)
D-M9□/M9□V D-M9□W/M9□WV D-M9□A/M9□AV	3.5	3	4	4	4	4	4	4	4	4

* Values which include hysteresis are for guideline purposes only, they are not a guarantee (assuming approximately ±30% dispersion) and may change substantially depending on the ambient environment.

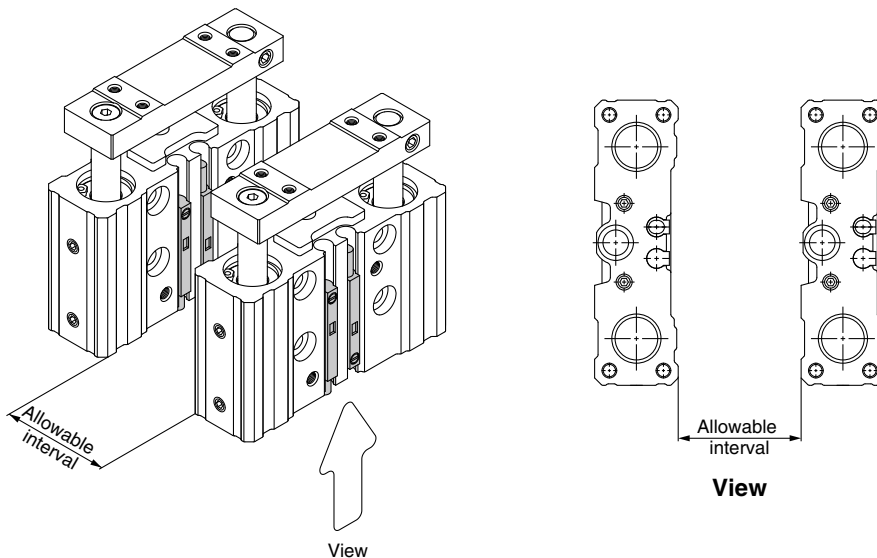
Auto Switch Mounting

Applicable auto switches	D-M9□/M9□V D-M9□W/M9□WV D-M9□A/M9□AV				
Bore size	ø12 (ø10 x 2) to ø100 (ø71 x 2)				
Auto switch mounting surfaces	Surfaces with auto switch mounting slot 				
Mounting of auto switch	 <ul style="list-style-type: none"> When tightening the auto switch mounting screw, use a watchmakers' screwdriver with a handle 5 to 6 mm in diameter. <p>Tightening Torque for Auto Switch Mounting Screw [N·m]</p> <table border="1"> <thead> <tr> <th>Auto switch model</th> <th>Tightening torque</th> </tr> </thead> <tbody> <tr> <td>D-M9□(V) D-M9□W(V) D-M9□A(V)</td> <td>0.05 to 0.15</td> </tr> </tbody> </table>	Auto switch model	Tightening torque	D-M9□(V) D-M9□W(V) D-M9□A(V)	0.05 to 0.15
Auto switch model	Tightening torque				
D-M9□(V) D-M9□W(V) D-M9□A(V)	0.05 to 0.15				

Caution on Proximity Installation

When cylinders are adjacent to one another as shown in the figure below, provide a space between them of at least, the amount shown in the tables below.

If the space is not sufficient, the magnets in adjacent cylinders may cause the auto switches to malfunction.



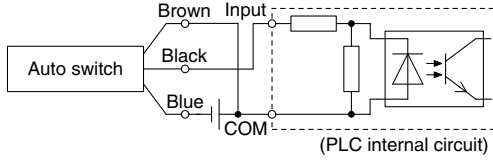
Bore size	Allowable interval [mm]
ø12 (ø10 x 2)	15
ø16 (ø12 x 2)	15
ø20 (ø16 x 2)	15
ø25 (ø20 x 2)	10
ø32 (ø25 x 2)	5
ø40 (ø32 x 2)	0
ø50 (ø40 x 2)	0
ø63 (ø45 x 2)	0
ø80 (ø56 x 2)	0
ø100 (ø71 x 2)	0

Prior to Use

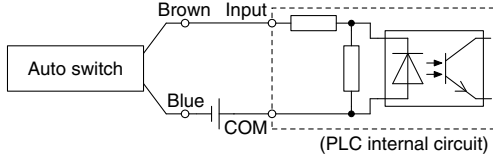
Auto Switch Connection and Example

Sink Input Specifications

3-wire, NPN

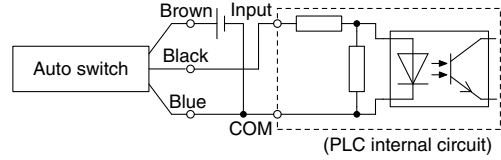


2-wire

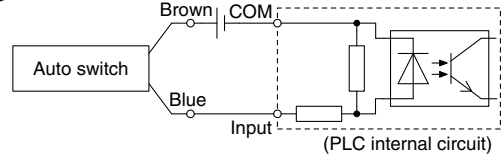


Source Input Specifications

3-wire, PNP



2-wire

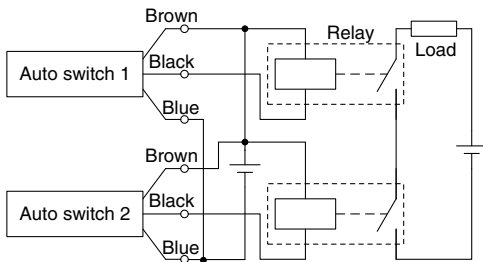


Connect according to the applicable PLC input specifications, as the connection method will vary depending on the PLC input specifications.

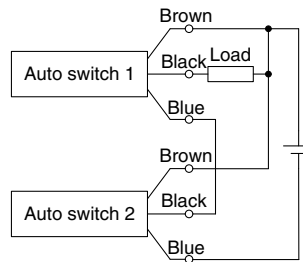
Example of AND (Series) and OR (Parallel) Connection

* When using solid state auto switches, ensure the application is set up so the signals for the first 50 ms are invalid.

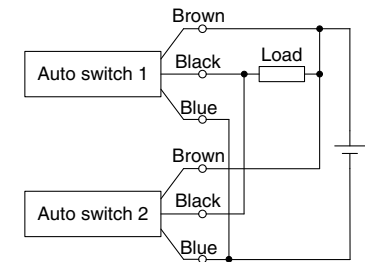
3-wire AND connection for NPN output (Using relays)



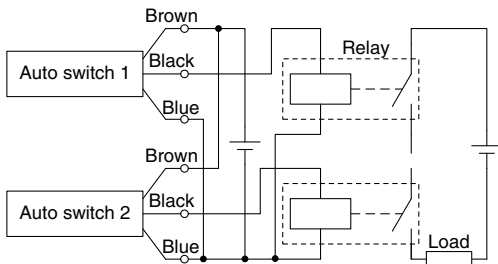
(Performed with auto switches only)



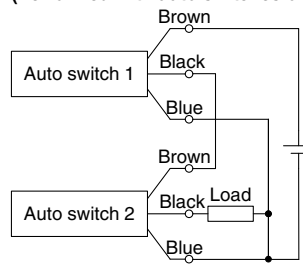
3-wire OR connection for NPN output



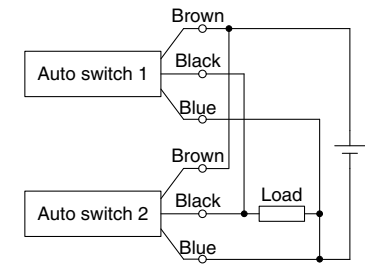
3-wire AND connection for PNP output (Using relays)



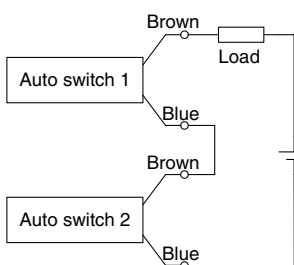
(Performed with auto switches only)



3-wire OR connection for PNP output



2-wire AND connection

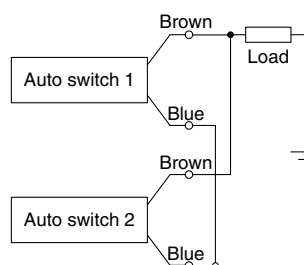


When two auto switches are connected in series, a load may malfunction because the load voltage will decline when in the ON state. The indicator lights will light up when both of the auto switches are in the ON state. Auto switches with load voltage less than 20 V cannot be used.

$$\begin{aligned} \text{Load voltage at ON} &= \text{Power supply voltage} - \text{Residual voltage} \times 2 \text{ pcs.} \\ &= 24 \text{ V} - 4 \text{ V} \times 2 \text{ pcs.} \\ &= 16 \text{ V} \end{aligned}$$

Example: Power supply is 24 VDC
Internal voltage drop in auto switch is 4 V.

2-wire OR connection



(Solid state)
When two auto switches are connected in parallel, malfunction may occur because the load voltage will increase when in the OFF state.

(Reed)
Because there is no current leakage, the load voltage will not increase when turned OFF. However, depending on the number of auto switches in the ON state, the indicator lights may sometimes grow dim or not light up, due to the dispersion and reduction of the current flowing to the auto switches.

$$\begin{aligned} \text{Load voltage at OFF} &= \text{Leakage current} \times 2 \text{ pcs.} \times \text{Load impedance} \\ &= 1 \text{ mA} \times 2 \text{ pcs.} \times 3 \text{ k}\Omega \\ &= 6 \text{ V} \end{aligned}$$

Example: Load impedance is 3 k Ω .
Leakage current from auto switch is 1 mA.