Doc. no. CY*S-OM0078P

Operation Manual

PRODUCT NAME

Magnetically Coupled Rodless Cylinder
(Slider Type: Slide Bearing)

MODEL / Series / Product Number

Series CY1S-Z

SMC Corporation

Contents

Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage.
These instructions indicate the level of potential hazard with the labels of “Caution,” “Warning” or “Danger.” They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC)[*1)], and other safety regulations.

*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.
ISO 4413: Hydraulic fluid power -- General rules relating to systems.
IEC 60204-1: Safety of machinery -- Electrical equipment of machines .(Part 1: General requirements)
ISO 10218-1992: Manipulating industrial robots -Safety.
etc.

Caution	**Caution** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
Warning	**Warning** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
Danger	**Danger** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

⚠ Warning

1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results.

The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product.

This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

2. Only personnel with appropriate training should operate machinery and equipment.

The product specified here may become unsafe if handled incorrectly.

The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.
2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.
3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.
2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.
3. An application which could have negative effects on people, property, or animals requiring special safety analysis.
4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.

Safety Instructions

⚠ Caution

1.The product is provided for use in manufacturing industries.
The product herein described is basically provided for peaceful use in manufacturing industries.
If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.
If anything is unclear, contact your nearest sales branch.

Limited warranty and Disclaimer/Compliance Requirements

The product used is subject to the following “Limited warranty and Disclaimer” and “Compliance Requirements”.
Read and accept them before using the product.

Limited warranty and Disclaimer

1.The warranty period of the product is 1 year in service or 1.5 years after the product is delivered, whichever is first.*2)
Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.

2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.
This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.

∗2) Vacuum pads are excluded from this 1 year warranty.
A vacuum pad is a consumable part, so it is warranted for a year after it is delivered.
Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty.

Compliance Requirements

1. **The use of SMC products with production equipment for the manufacture of weapons of mass destruction (WMD) or any other weapon is strictly prohibited.**
2. **The exports of SMC products or technology from one country to another are governed by the relevant security laws and regulations of the countries involved in the transaction. Prior to the shipment of a SMC product to another country, assure that all local rules governing that export are known and followed.**

1. Mounting

⚠ Caution

1-1） Surface for mounting

①Mount the cylinder with the surface which flatness is 0.2mm or less.

When the flatness is more than 0.2mm, two guide shaft will be twisted, increasing sliding resistance, shortening the product life.

②If the required flatness is not available, make adjustment of the gap using a shim.

Make adjustment so that the slide block moves smoothly at the minimum operating pressure [0.18Mpa] for full stroke.

③Make sure that there are no foreign matters including debris on the mounting surface before mounting the cylinder.

If the cylinder is fixed with debris in between the cylinder and the mounting surface, the guide shaft may be twisted and poor performance or short life can result.

④It is recommended to configure the mounting surface for the cylinder with the same material of the cylinder.

If the material of the cylinder and the mounting surface is different, the flatness of the mating surface will be insufficient.

When the materials are different, adjust the flatness at 0.2mm or less using a shim.

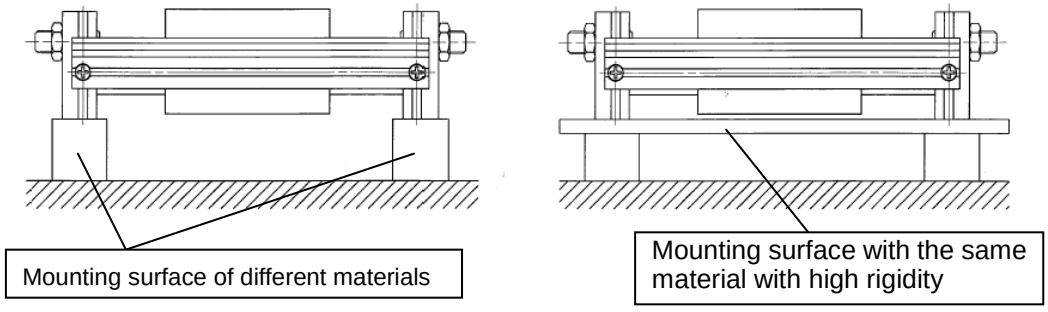


Fig.1 Cylinder mounting surface

⚠ Caution

1-2） Mounting the cylinder

①Mount the cylinder using the plate on both ends.

（Do not mount the cylinder using the slide block (Fig.2).

Otherwise, excessive moment will be applied to the bushing at the stroke, wearing the bushing in early stage of life.

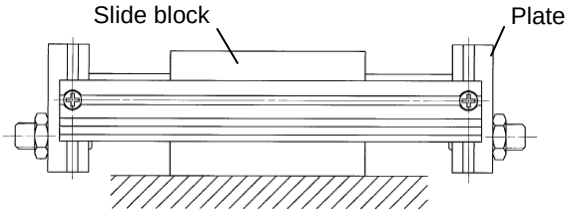


Fig.2 Do not mount the cylinder using the slide block

②Cylinder has to be fixed by screws from the top surface of the plate (surface with countersunk).

If the cylinder needs to be fixed by screws from the bottom, please use made-to-order product [-X2423].

*) -X2423: Mounting surface tapped hole type (Refer to Page 24, Fig.13, Table 14)

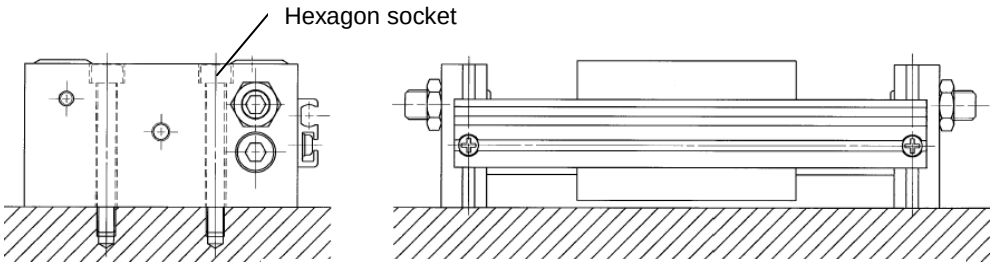
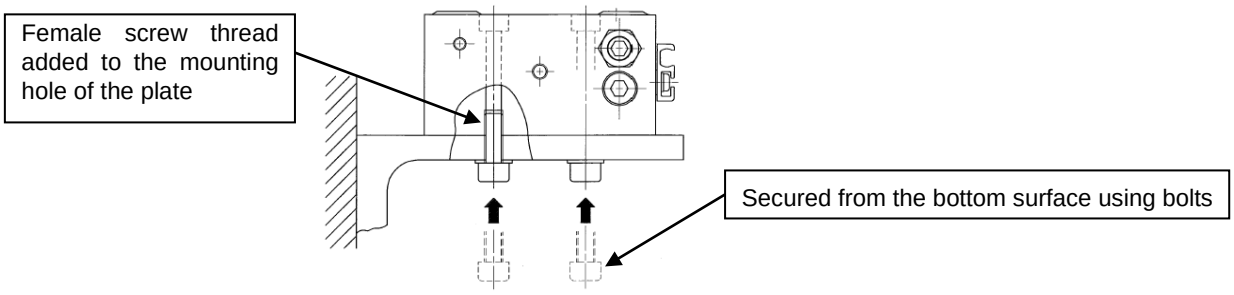


Fig.3 Cylinder mounting method (Standard product)



X2423 (Screw type for the mounting

⚠ Caution

1-3） Minimum necessary space for the installation of the cylinder

Keep adequate space in operating directions of the bumper bolt, shock absorber and thefitting for ease of mounting and replacement.

Table 1 shows the minimum necessary space. Keep more space than is required.

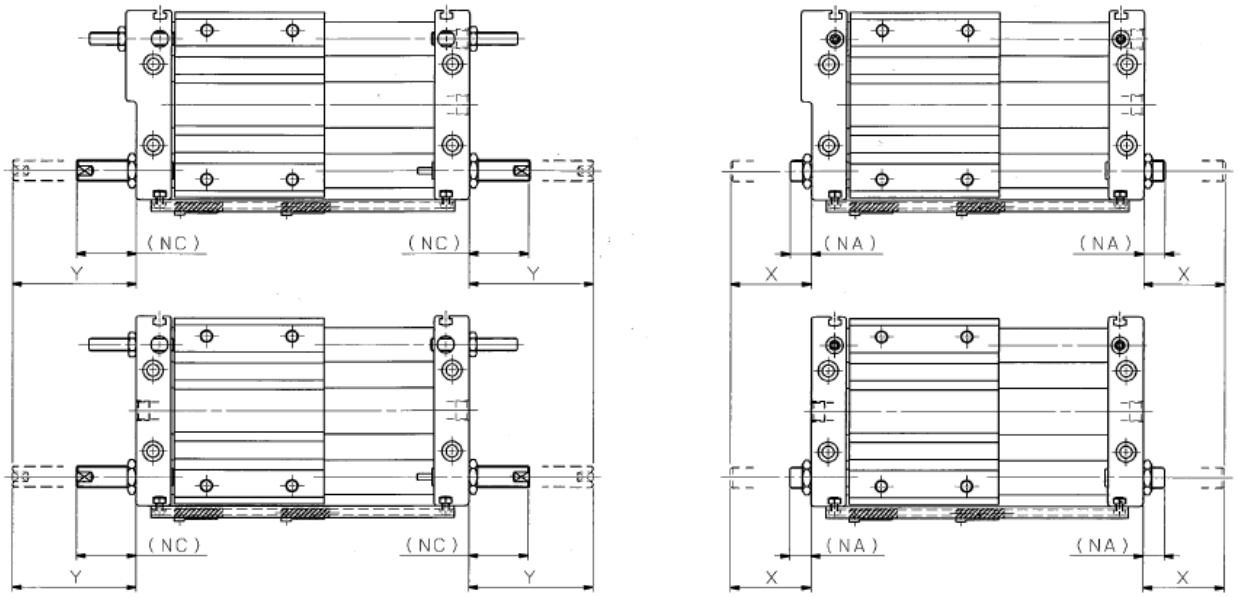


Fig.4 Minimum necessary space

Table 1. Minimum necessary space (Reference)

Tube I.D. (mm)	With shock absorber (mm)		With bumper bolt (mm)	
	(NC)	Y: Minimum necessary space	(NA)	X: Minimum necessary space
6	19	44	11	32
10	28	58	10.5	34
15	28	58	10.5	34
20	28	63	10.5	39
25	49	89	12.5	41
32	52	99	11.5	43
40	51	99	10.5	43

Note) The dimensions above show the minimum necessary space for the replacement of the shock absorber and bumper bolt. (Full length of the stopper + 10mm)

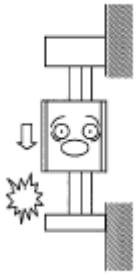
2. Operation

⚠ Warning

① **Do not put your hand between the plate and the slide block during the cylinder operation.**
It is very dangerous.

② **Do not apply the load more than allowable value of the cylinder.**
It will cause malfunction.

③ **Check the supply pressure, and the kinetic energy that the cylinder generates, When performing an intermediate stop.**
Fine stroke end adjustment is considered as an intermediate stop, so the considerations for an intermediate stop must be observed.



[When stopping the external slider in an intermediate position with external stopper]
If the allowable pressure values are exceeded, the stopper position might be displaced or the external slider may become detached from the magnetic coupling and drop.

[When stopping the external slider in an intermediate position in a pneumatic circuit]
If the external kinetic energy of the load on the slider exceeds the allowable values, the stopper position might be displaced or the external slider may become detached from the magnetic coupling and drop.

⚠ Caution

① **Do not use the cylinder in an environment where the cylinder is expose to moisture, adhesive foreign matter, dust or liquid such as water or cutting fluid.**
If the cylinder is used in an environment where the lubrication of the cylinders sliding parts is compromised, contact your SMC sales representative.

3. Functions

3-1) Piping selection

2 types of piping type are available: (1) Bilateral piping type[CY1S] One piping port is located at each end plate, (2) Centralized piping type [CY1SG] Two piping ports are both located at plate A. (Fig. 5-1, Fig. 5-2)

Reference: For the bilateral piping type: The full length of the cylinder is shorter than the centralized piping type: Integrated piping is possible.

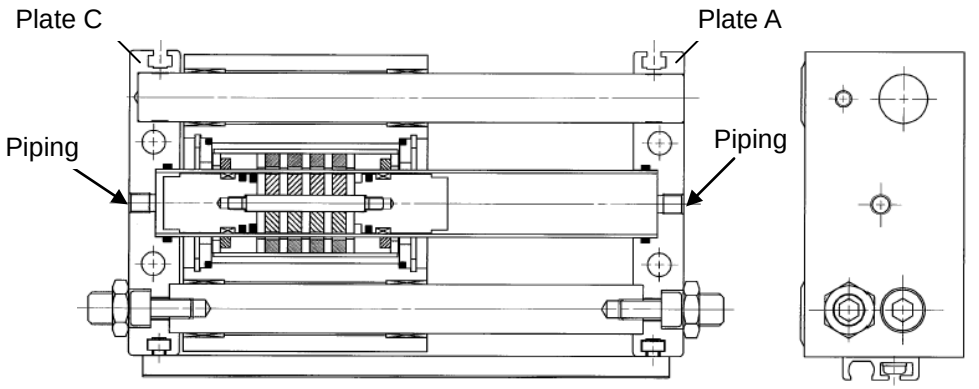
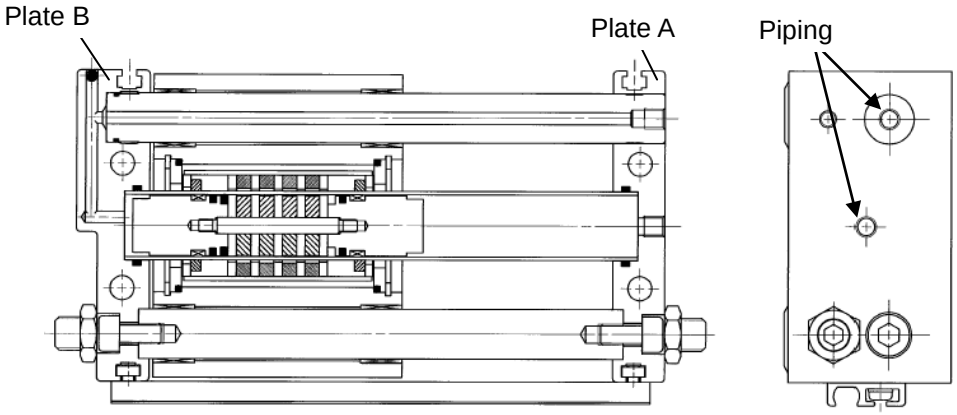


Fig.5-1 Bilateral piping type [CY1S]

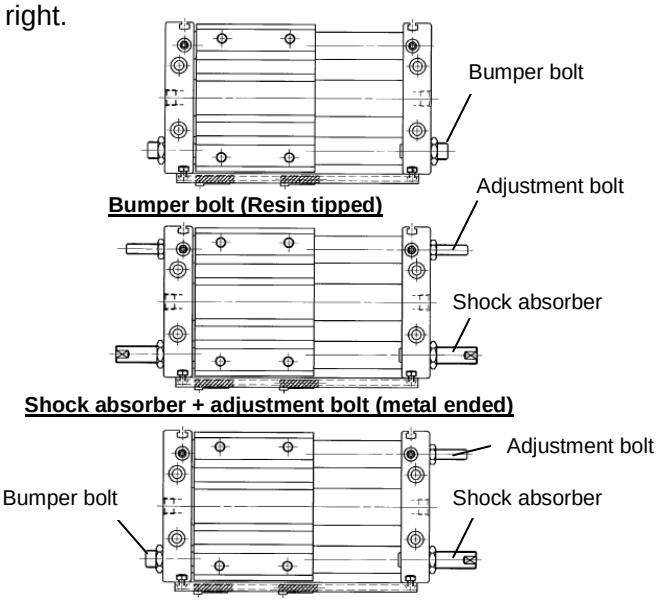


Fig,5-2 Centralized piping type [CY1SG]

3-2) Stopper type

Select the stopper from the three types on the right.

(Fig.6)



Bumper bolt (Resin tipped)

Shock absorber + adjustment bolt (metal ended)

Shock absorber + adjustment bolt (metal ended) on one side

Bumper bolt on one side (Resin tipped)

3-3) Auto switches

3-3-1) Applicable auto switches

Refer to Table 2. Pay attention to the type of auto switches.

Table2. Applicable Auto Switches

Type	Special function	Electrical entry	Indicator light	Wiring (Output)	Load voltage DC		Load voltage AC	Auto switch model Perpendicular	Auto switch model In-line	Lead wire length (m) 0.5 (Nil)	1 (M)	3 (L)	5 (Z)	Pre-wired connector	Applicable load	
Solid state auto switch	——	Grommet	Yes	3-wire (NPN)	24 V	5 V, 12 V	—	M9NV	M9N	●	●	●	○	○	IC circuit	Relay, PLC
				3-wire (PNP)				M9PV	M9P	●	●	●	○	○		
				2-wire		12 V		M9BV	M9B	●	●	●	○	○	—	
	Diagnostic indication (2-color indication)			3-wire (NPN)		5 V, 12 V		M9NWV	M9NW	●	●	●	○	○	IC circuit	
				3-wire (PNP)				M9PWV	M9PW	●	●	●	○	○		
				2-wire		12 V		M9BWV	M9BW	●	●	●	○	○	—	
	Water resistant (2-color indication)			3-wire (NPN)		5 V,12 V		M9NAV**	M9NA**	○	○	●	○	○	IC circuit	
				3-wire (PNP)				M9PAV**	M9PA**	○	○	●	○	○		
				2-wire		12 V		M9BAV**	M9BA**	○	○	●	○	○	—	
Reed auto switch	——	Grommet	Yes	3-wire (NPN equivalent)	—	5 V	—	A96V	A96	●	—	●	—	—	IC circuit	—
			No	2-wire	24 V	12 V	100 V	A93V	A93	●	—	●	●	—	—	Relay, PLC
							100 V or less	A90V	A90	●	—	●	—	—	IC circuit	

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

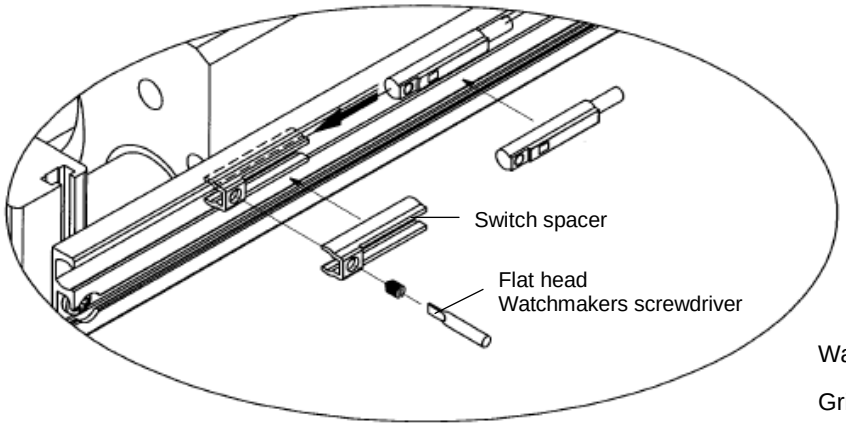
* Lead wire length symbols: 0.5 m ..... Nil (Example) M9NW
1 m ..... M (Example) M9NWM
3 m ..... L (Example) M9NWL
5 m ..... Z (Example) M9NWZ

* Solid state auto switches marked with "○" are produced upon receipt of order.

3-3-2) Mounting of auto switch

As shown in the figure 7, combine the auto switch with the switch spacer (BMY3-016) to secure the auto switch in the mounting groove of the switch rail.

Combine the auto switch with the switch spacer and secure the mounting screw with a flat blade watchmakers screw driver.



Watchmakers screwdriver:

Grip diameter 5 to 6mm

Tightening torque: 0.1 to 0.15Nm

Fig.7 Mounting method of auto switch

3-3-3) Mounting and removal of the switch rail.

Care must be taken when removing the switch rail so that the screws, nuts or washers are not lost.

Refer to the table 3 for mounting the switch rail again or to the opposite side.

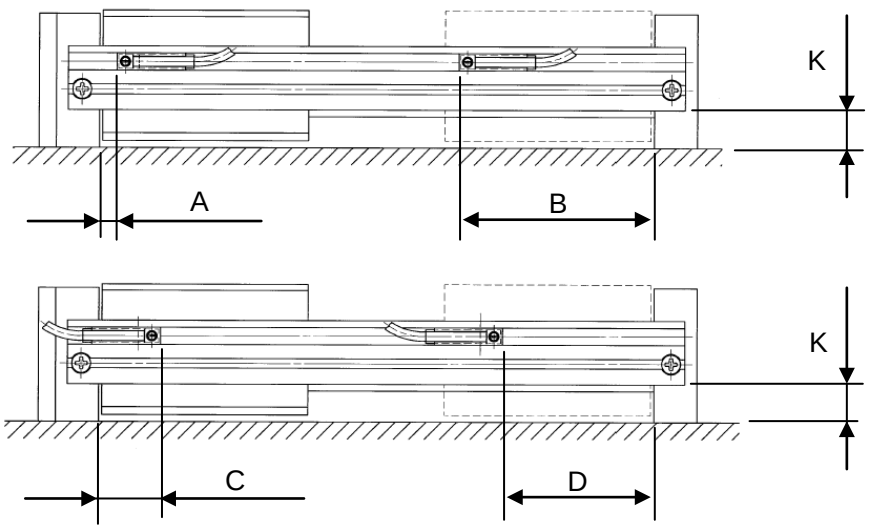


Fig. 8 Auto Switch Proper Mounting Position

Table3. Auto Switch Proper Mounting Position

Auto switch model / Bore size	K dimension (Switch rail height)	A		B		C		D	
		D-M9□ D-M9□V D-M9□W D-M9□WV D-M9□A D-M9□AV	D-A9□ D-A9□V	D-M9□ D-M9□V D-M9□W D-M9□WV D-M9□A D-M9□AV	D-A9□ D-A9□V	D-M9□ D-M9□V D-M9□W D-M9□WV D-M9□A D-M9□AV	D-A9□ D-A9□V	D-M9□ D-M9□V D-M9□W D-M9□WV D-M9□A D-M9□AV	D-A9□ D-A9□V
6	3	5.5	1.5	36.5	40.5	17.5	21.5	24.5	20.5
10	6	5.5	1.5	41.5	45.5	17.5	21.5	29.5	25.5
15	11	5.5	1.5	56.5	60.5	17.5	21.5	44.5	40.5
20	16	6	2	67	71	18	22	55	51
25	20	6	2	67	71	18	22	55	51
32	26	7.5	3.5	83.5	87.5	19.5	23.5	71.5	67.5
40	28	6.5	2.5	92.5	96.5	18.5	22.5	80.5	76.5

3-3-4) Groove for the switch rail lead wire.

Switch rail has a groove for the lead wire.(Fig. 9)

When the groove is used, do not deform the switch rail.

3-3-5) Switch response at intermediate positions of the stroke.

It is possible to install an auto switch at an intermediate position of the stroke, but the maximum speed of the cylinder, which can be detected by the switch, will be limited due to the load relay response.

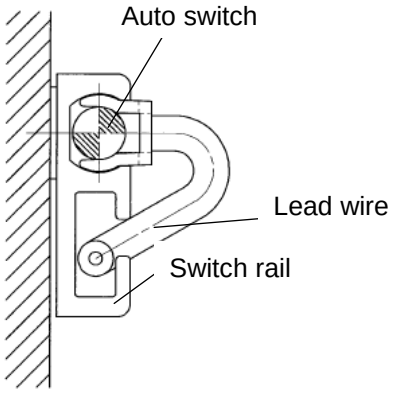
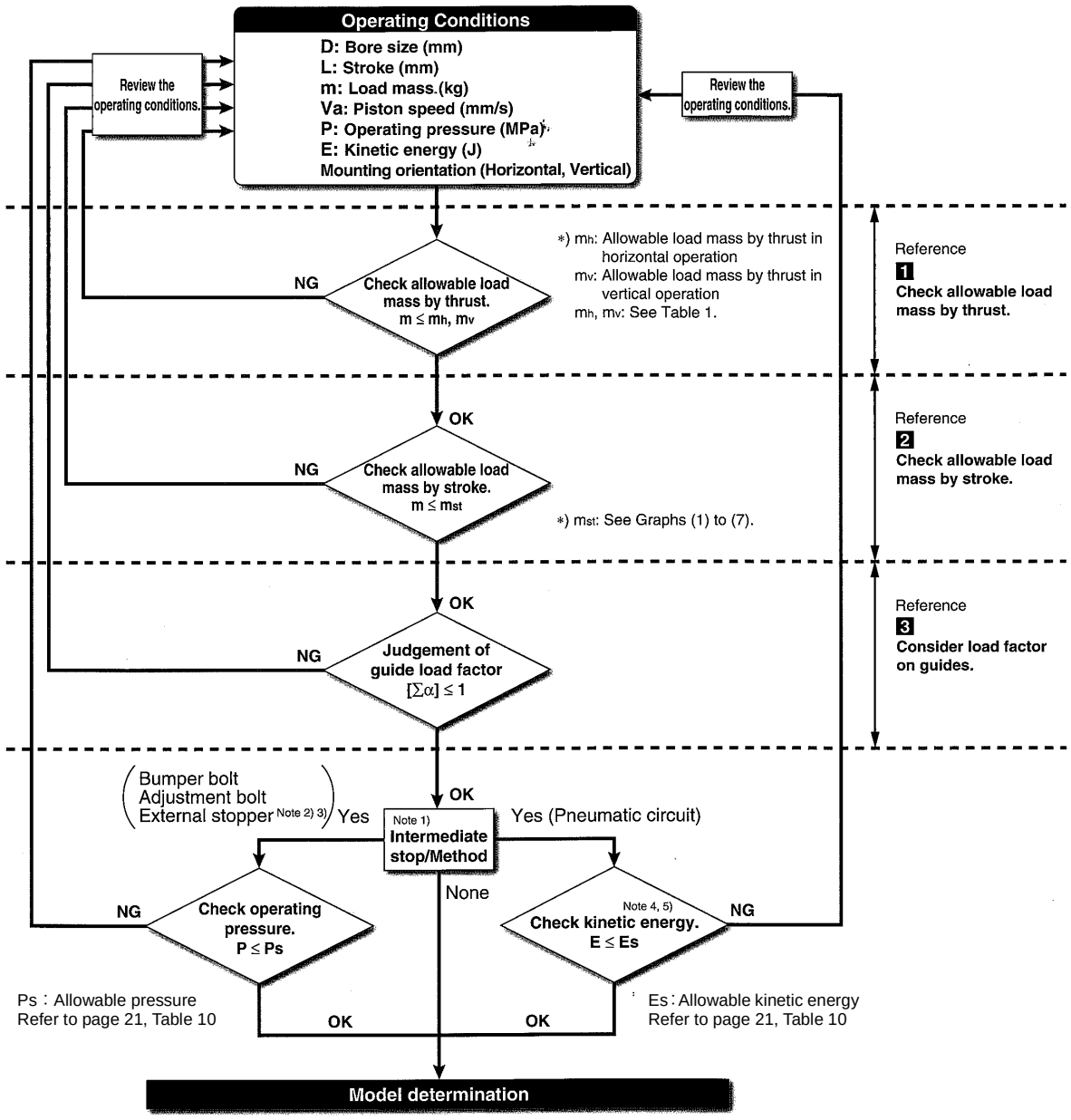


Fig. 9 Switch rail

4. Model selection

Selection Flow Chart



Note 1) Stroke adjustment with either a bumper bolt or adjustment bolt is considered as an intermediate stop.
Note 2) When an intermediate stop is performed with an external stopper, consider the dynamic load as shown below.
- Bumper bolt: δ = 4/100
- Shock absorber and air cushion: δ = 1/100

In addition to this, check the judgement results of the guide load factor. (δ: Bumper coefficient)
Note 3) When an external stopper is used in conjunction with a shock absorber, check the model selection of shock absorber separately.
Note 4) This cylinder cannot perform an intermediate stop with the pneumatic circuit in vertical operation.
The intermediate stop is only performed with a bumper bolt, adjustment bolt or external stopper.
Note 5) When an intermediate stop is performed with the pneumatic circuit, the stopping accuracy may vary significantly.
If accuracy is required, be sure to perform the intermediate stop with a bumper bolt, adjustment bolt or external stopper.

1 Check allowable load mass by thrust.

In this series, the work load and the maximum operating pressure are restricted to prevent the magnetic coupling from being separated. Ensure that the work load mass and operating pressure are within the values in Table 4.

Table4. Allowable load mass by thrust and maximum operating pressure

Bore size (mm)	Horizontal operation m_h [kg]	Horizontal operation Max. operating pressure P_h [MPa] Note)	Vertical operation m_v [kg]	Vertical operation Max. operating pressure P_v [MPa]
6	1.8	0.70	1.0	0.55
10	3.0		2.7	
15	7.0		7.0	0.65
20	12		11	
25	20		18.5	
32	30		30	
40	50		47	

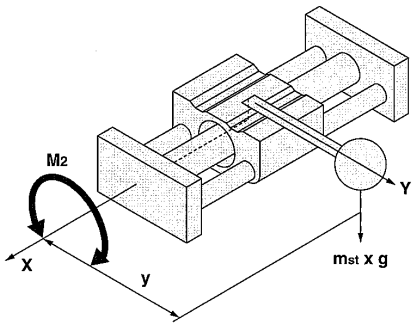
Note) Without stroke adjustment

When stroke adjustment is performed with bumper bolt, adjustment bolt, or intermediate stop is performed with an external stopper, the maximum operating pressure should be as shown in the page 22, Table 10.

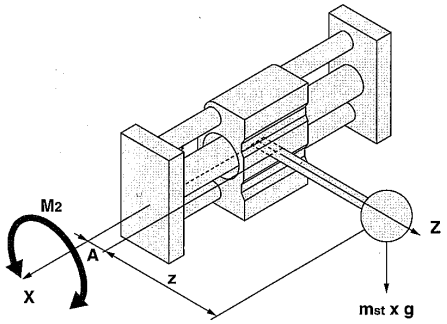
2 Check allowable load mass by stroke.

In this series, guide shafts are assembled to support the load.
Deflection of the guide shaft increases due to work load mass and rolling moment (M_2), so the work load mass and stroke is restricted. Check that the load mass is within the allowable load mass by stroke: m_{st} from Graphs (1) to (7) for each bore size.

[Horizontal mounting and Ceiling mounting]
The allowable load mass by stroke range varies depending on the y direction of the loads center of gravity.



[Wall mounting]
The allowable load mass by stroke range varies depending on the z direction of the loads center of gravity.



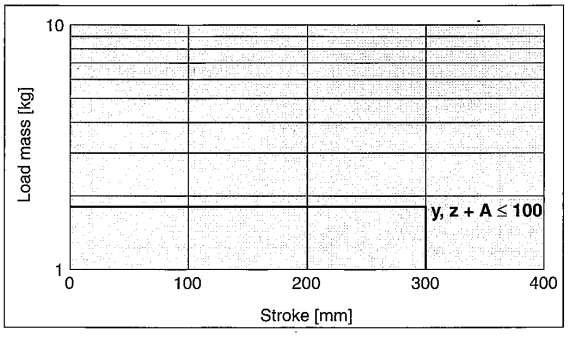
[Vertical mounting]
Load mass is not restricted by stroke.

A: Distance between the center of the guide shaft and the upper surface of the slide block

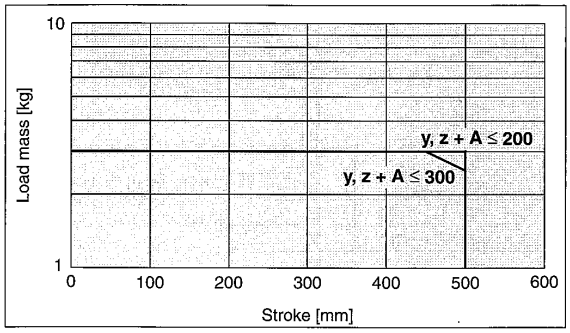
2 Check allowable load mass by stroke.

Selection Graph

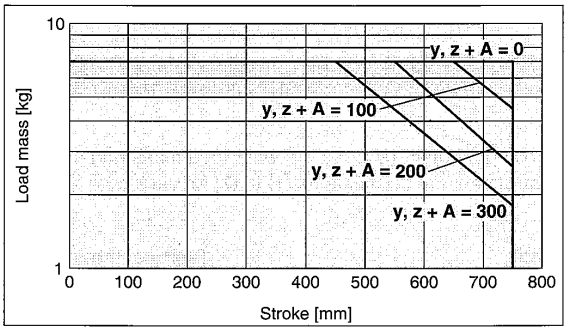
[Graph 1] Allowable load mass by stroke ø6



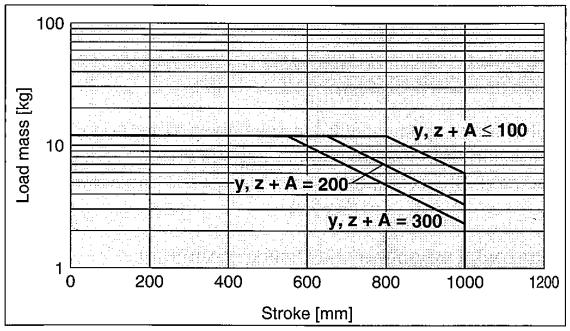
[Graph 2] Allowable load mass by stroke ø10



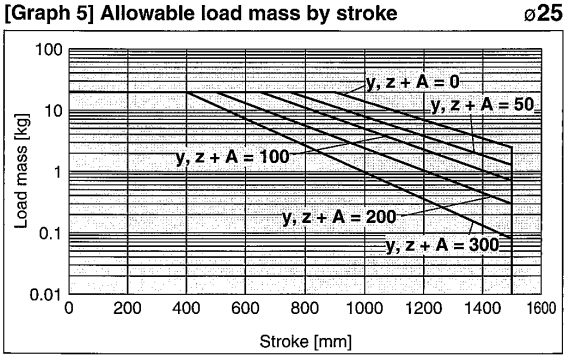
[Graph 3] Allowable load mass by stroke ø15



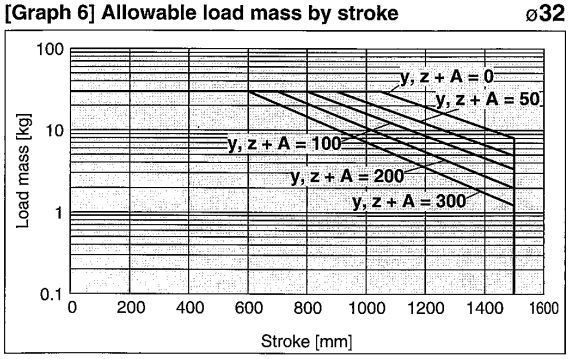
[Graph 4] Allowable load mass by stroke ø20



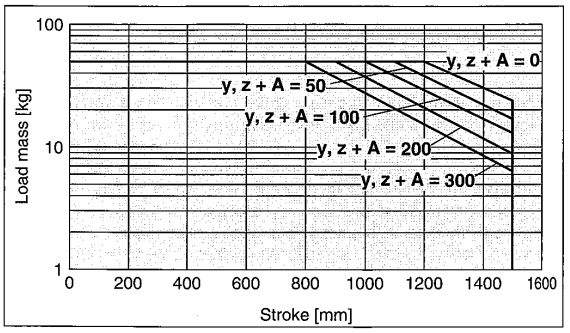
[Graph 5] Allowable load mass by stroke ø25



[Graph 6] Allowable load mass by stroke ø32



[Graph 7] Allowable load mass by stroke ø40



* If load center of gravity exceeds the value of y, z + A on the graph, please consult SMC.

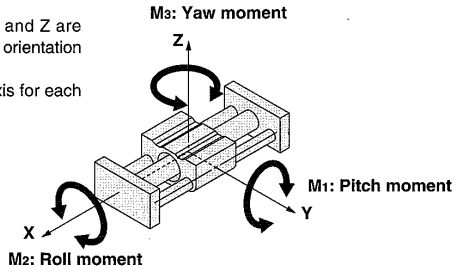
3 Consider load factor on guides.

3—① Types of moment applied to rodless cylinders

Multiple moments may be generated depending on the mounting orientation, load, and position of the center of gravity.

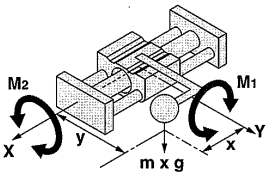
Coordinates and Moments

* The direction of the axis, X, Y and Z are based on the cylinder mounting orientation shown on the right.
Consider the direction of the axis for each mounting direction.

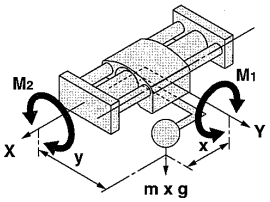


Static moment calculation by mounting style

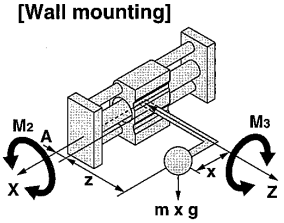
[Horizontal mounting]



[Ceiling mounting]



[Wall mounting]



[Vertical mounting]

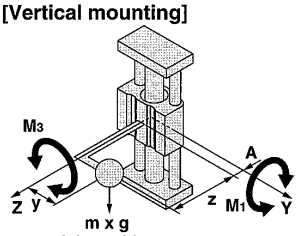


Table5. Mounting orientation and static moment

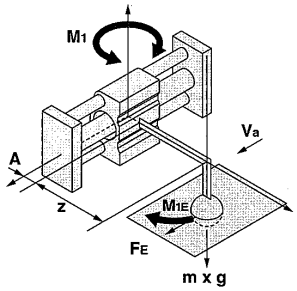
Mounting orientation		Horizontal mounting	Ceiling mounting	Wall mounting	Vertical mounting
Static load		m			
Static moment	M_1	m x g x x	m x g x x	—	m x g x (z + A)
	M_2	m x g x y	m x g x y	m x g x (z + A)	—
	M_3	—	—	m x g x x	m x g x y

* A: Distance between the center of the guide shaft and the upper surface of the slide block (See the table on the right.)

Table6. Dimension from the center of the guide to the upper surface of the slide block

Bore size (mm)	A [mm]
6	19
10	21
15	25
20	27
25	33
32	40
40	49

Dynamic moment calculation by mounting style



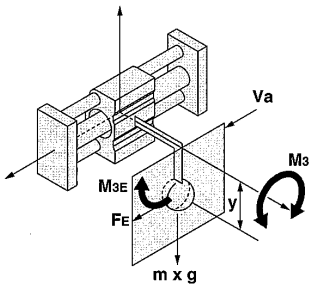


Table7. Mounting orientation and static moment

Mounting orientation		Horizontal mounting	Ceiling mounting	Wall mounting	Vertical mounting
Dynamic load F_E		δ x 1.4 x Va x m x g		Bumper bolt: δ = 4/100 Shock absorber: δ = 1/100	
Static moment	M_{1E}	1/3 x F_E x (z + A)			
	M_{2E}	Dynamic moment does not occur.			
	M_{3E}	1/3 x F_E x y			

Regardless of the mounting orientation, dynamic moment is calculated with the formulas above.

3 Consider load factor on guides.

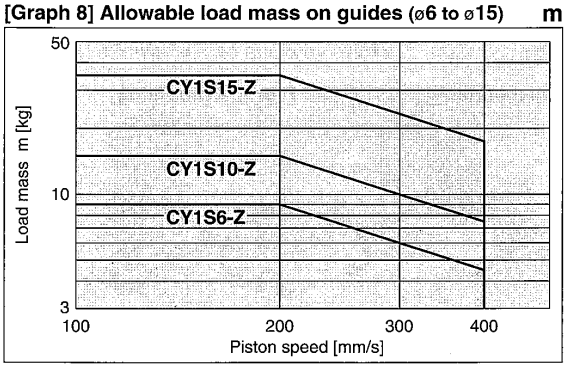
3—② Allowable load mass on guides/Allowable moment

Table8. Allowable load mass on guides and moment

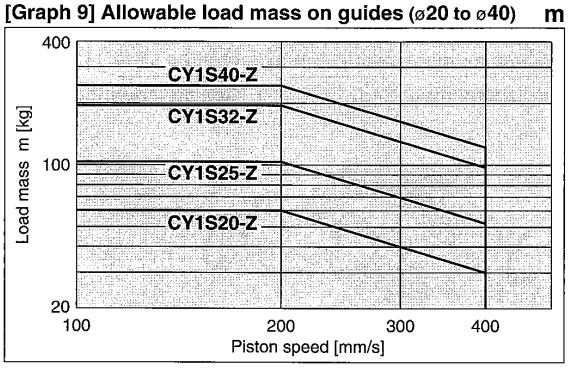
Bore size (mm)	Allowable load mass on guides m [kg]	Allowable moment [N·m]		
		M_1	M_2	M_3
6	9	1.3	1.4	1.3
10	15	2.6	2.9	2.6
15	35	8.6	8.9	8.6
20	60	17	18	17
25	104	30	35	30
32	195	67	82	67
40	244	96	124	96

The table above indicates the maximum performance of the guide, but does not show the actual allowable work load mass. Refer to Graphs (8) to (13) for correct allowable mass by piston speed.

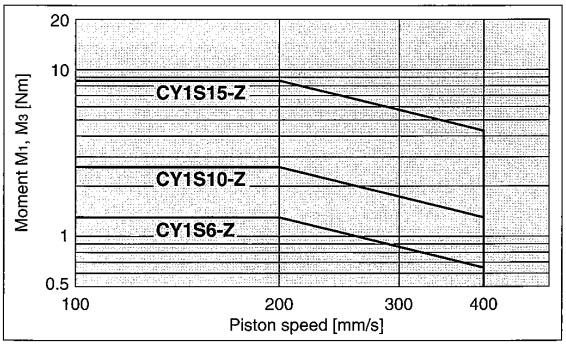
[Graph 8] Allowable load mass on guides (ø6 to ø15) m



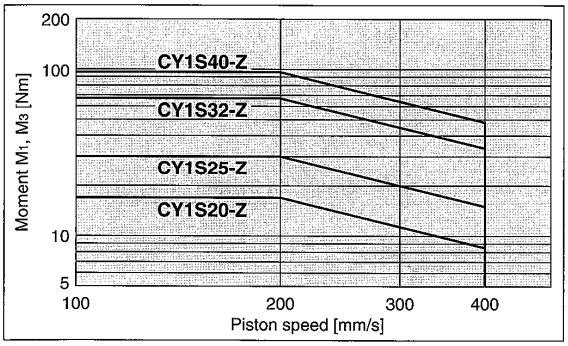
[Graph 9] Allowable load mass on guides (ø20 to ø40) m



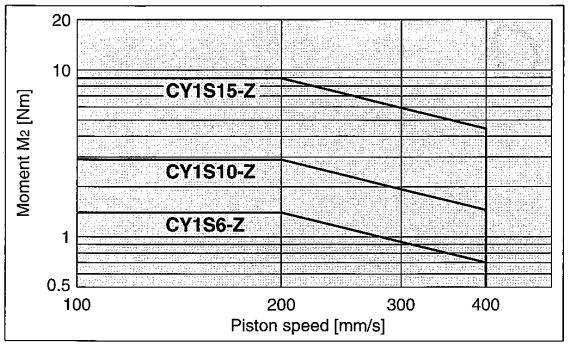
[Graph 10] Allowable moment (ø6 to ø15) M_1, M_3



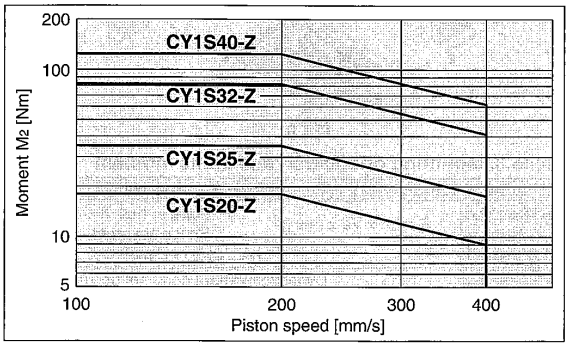
[Graph 11] Allowable moment (ø20 to ø40) M_1, M_3



[Graph 12] Allowable moment (ø6 to ø15) M_2



[Graph 13] Allowable moment (ø20 to ø40) M_2



3—③ Consideration of guide load factor

Work load mass and allowable moment varies depending on the load mounting method, stroke, cylinder mounting orientation and piston speed.

Whether the cylinder is suitable or not is decided by the allowable load mass on guides in the graphs.

The selection calculation is shown below.

It is necessary to consider i) allowable load mass on guides, ii) static moment and iii) dynamic moment (when the slide block collides with the stopper).

* i)・ii) is calculated with Va (average speed) and iii) is calculated with V (collision speed V = 1.4Va).
Calculate m_{max} of i) from the allowable load mass on guides in Graphs (8) and (9),
and calculate Mmax of ii) and iii) from the allowable moment (M_1, M_2, M_3) in Graphs (10), (11), (12) and (13).

Sum of guide load factors

$$\Sigma\alpha = \frac{\text{Load mass (m)}}{\text{Allowable load mass on guides } (m_{max})} + \frac{\text{Static moment (M)}^{\text{Note 1)}}}{\text{Allowable static moment } (M_{max})} + \frac{\text{Dynamic moment } (M_E)^{\text{Note 2)}}}{\text{Allowable dynamic moment } (M_{Emax})} \leq 1$$

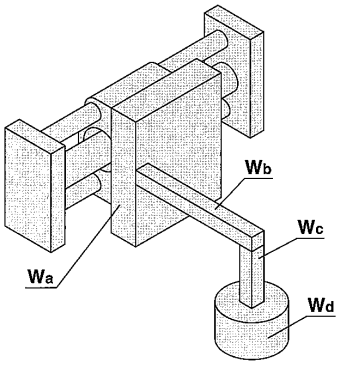
Note 1) Moment caused by the load etc., with cylinder in resting condition

Note 2) Moment caused by the load equivalent to impact at the stroke end (at the time of impact with stopper)

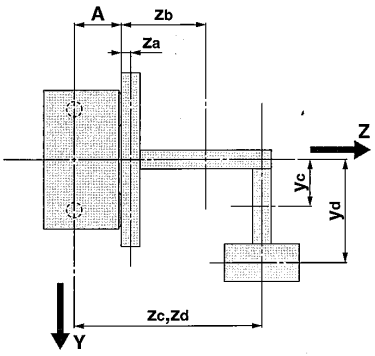
Note 3) Several moments might be generated depending on the cylinder mounting orientation or the load center of gravity, so the sum of the allowable load mass on guides, allowable static moment and allowable dynamic moment will be the sum of all these guide load factors.

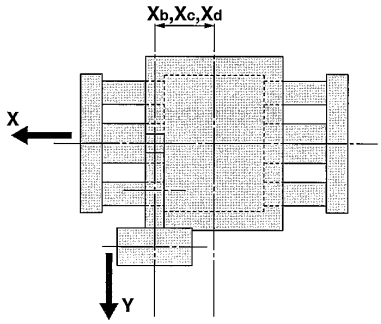
Calculation method to determine the center of gravity when several loads are mounted on the cylinder

When several loads are mounted on the cylinder, it is difficult to calculate the center of gravity.
As shown in the figure below, the center of gravity of the load is calculated from the total load mass and of center of gravity for all the loads.



■ **Load Blocking**





Mass and center of gravity of the load

Load No. Wn	Mass mn	Center of gravity X-axis xn	Y-axis yn	Z-axis zn
Wa	ma	xa	ya	za
Wb	mb	xb	yb	zb
Wc	mc	xc	yc	zc
Wd	md	xd	yd	zd

■ **Calculation for Overall Center of Gravity**

$$m_t = \Sigma m_n \quad \ldots①$$

$$X = \frac{1}{m_t} \times \Sigma (m_n \times x_n) \quad \ldots\ldots②$$

$$Y = \frac{1}{m_t} \times \Sigma (m_n \times y_n) \quad \ldots\ldots③$$

$$Z = \frac{1}{m_t} \times \Sigma \{m_n \times (A + z_n)\} \quad \ldots④$$

$$(n = a,b,c,d)$$

Refer to the following sections 1 to 4 to calculate the center of gravity and the total load.

Calculation of Guide Load Factor

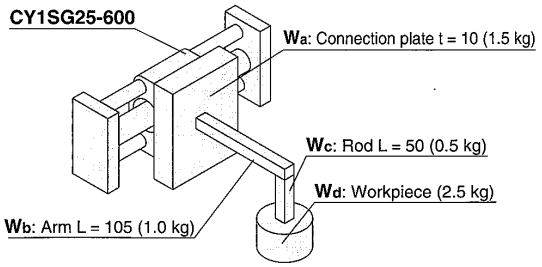
The selection calculation finds the load factors (αn) of the items below, where the total does not exceed 1.

Item	Load factor αn	Note
1: Maximum load mass	$\alpha_1 = m/m_{max}$	Examine m. m_{max} is the max. load mass for Va.
2: Static moment	$\alpha_2 = M/M_{max}$	Examine M_1, M_2, M_3. Mmax is the allowable moment for Va.
3: Dynamic moment	$\alpha_3 = M_E/M_{Emax}$	Examine M_{1E}, M_{3E}. M_{Emax} is the allowable moment for V.

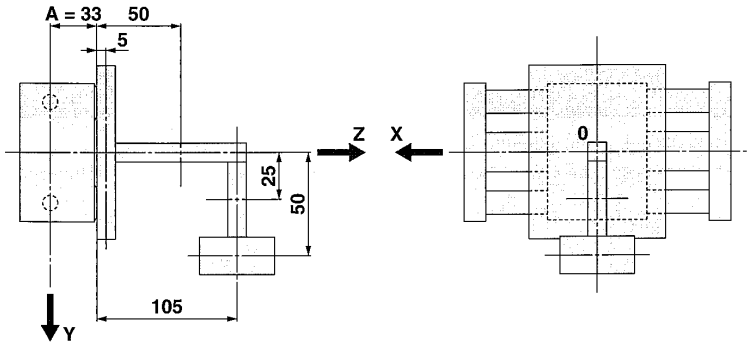
Calculation example 1 Mounting on horizontal wall

[1] Operating Conditions

Cylinder: **CY1SG25-600**
Cushion: Shock absorber
Mounting: Horizontal wall mounting
Speed: Va = 250 [mm/s]



[2] Load Blocking



Mass and center of gravity of the load

Load no. W_n	Mass m_n	Center of gravity		
		X-axis x_n	Y-axis y_n	Z-axis z_n
Wa	1.5 kg	0 mm	0 mm	5 mm
Wb	1.0 kg	0 mm	0 mm	50 mm
Wc	0.5 kg	0 mm	25 mm	105 mm
Wd	2.5 kg	0 mm	50 mm	105 mm

n = a,b,c,d

[3] Calculation for Overall Center of Gravity

$$m_t = \Sigma m_n$$
$$= 1.5 + 1.0 + 0.5 + 2.5$$
$$= 5.5 \text{ kg}$$
$$X = 0 \text{ mm}$$

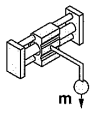
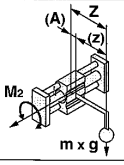
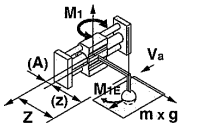
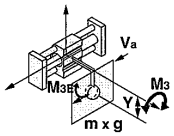
(The center of gravity in the x direction of all work pieces is 0, so X = 0 mm.)

$$Y = \frac{1}{m_t} \times \Sigma (m_n \times y_n)$$
$$= \frac{1}{5.5} \times (1.5 \times 0 + 1.0 \times 0 + 0.5 \times 25 + 2.5 \times 50)$$
$$= 25 \text{ mm}$$
$$Z = \frac{1}{m_t} \times \Sigma \{m_n \times (A + z_n)\}$$
$$= \frac{1}{5.5} \times \{1.5 \times (33 + 5) + 1.0 \times (33 + 50) + 0.5 \times (33 + 105) + 2.5 \times (33 + 105)\}$$
$$= 100 \text{ mm}$$

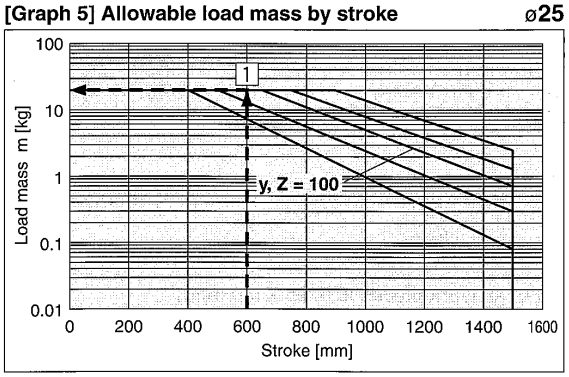
[4] Check the allowable load.

Item	Result	Note
(1) Check allowable load mass by thrust.	Work load is 5.5 kg < 20 kg. OK	Check allowable load by thrust. The bore size is ø25, so the allowable load by thrust will be 20 kg.
(2) Allowable load by stroke	Work load is 5.5 kg < 20 kg. OK	The load is restricted to 20 kg when the stroke is 600 mm and Z = 100 mm taken from Graph (5) 1 (See the next page).

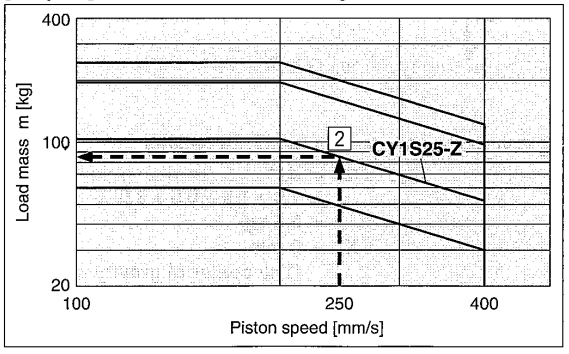
[5] Judgement of Guide Load Factor

Item	Load factor αn	Note
1 Load mass 	$\alpha_1 = m/m_{max}$ $= 5.5/83.2$ $= 0.07$	Examine m. Find the value of m_{max} when Va = 250 mm/s from Graph (9) 2.
2 Static moment 	$M_2 = m \times g \times Z$ $= 5.5 \times 9.8 \times 100/1000$ $= 5.4$ [N·m] $\alpha_2 = M_2/M_{2max}$ $= 5.4/28.0$ $= 0.19$	Examine M_2. M_1, M_3 values do not apply to this example. Refer to [3] Calculation for Overall Center of Gravity in the Z-axis on front matter 7. Find the value M_{2max} when Va = 250 mm/s from Graph (13) 3.
3 Dynamic moment  	$F_E = 1.4 \times Va \times m \times g \times \delta$ $= 1.4 \times 250 \times 5.5 \times 9.8 \times 1/100$ $= 188.7$ [N] $M_{1E} = 1/3 \times F_E \times Z$ $= 1/3 \times 188.7 \times 100/1000$ $= 6.3$ [N·m] $\alpha_{3A} = M_{1E}/M_{1max}$ $= 6.3/17.1$ $= 0.37$	Calculate for the impact load. Since the impact is absorbed by shock absorber, the bumper coefficient $\delta = 1/100$ Examine M_{1E}. Calculate the collision speed V. $V = 1.4 \times Va$ $V = 1.4 \times 250$ $V = 350$ mm/s Find the value M_{1Emax} when Va = 350 mm/s from Graph (11) 4.
	$M_{3E} = 1/3 \times F_E \times Y$ $= 1/3 \times 188.7 \times 25/1000$ $= 1.6$ [N·m] $\alpha_{3B} = M_{3E}/M_{3max}$ $= 1.6/17.1$ $= 0.09$	Examine M_{3E}. Refer to [3] Calculation for Overall Center of Gravity in the Y-axis on front matter 7. From the results above, Find the value M_{3Emax} when Va = 350 mm/s from Graph (11) 5.
4 Judgement	$\Sigma\alpha_n = \alpha_1 + \alpha_2 + \alpha_{3A} + \alpha_{3B}$ $= 0.07 + 0.19 + 0.37 + 0.09$ $= 0.72$	$\Sigma\alpha_n = 0.72 \leq 1$, so the cylinder can be used.

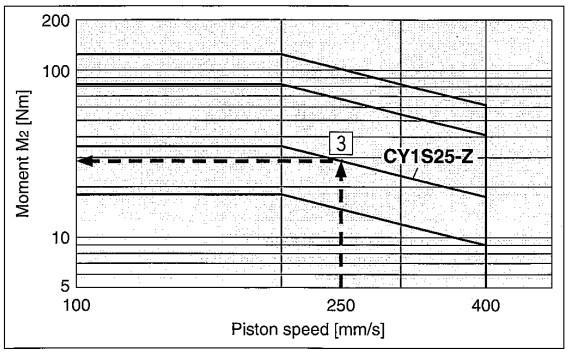
[Graph 5] Allowable load mass by stroke **ø25**



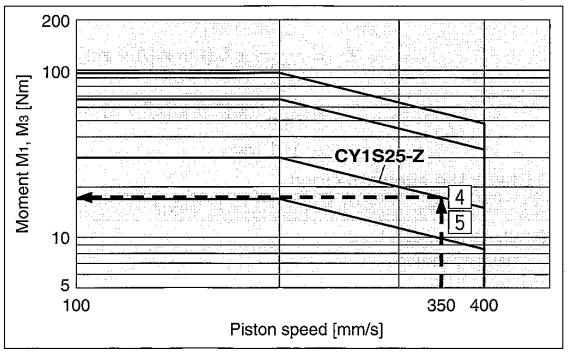
[Graph 9] Allowable load mass on guides **m**



[Graph 13] Allowable moment **M2**



[Graph 11] Allowable moment **M1, M3**

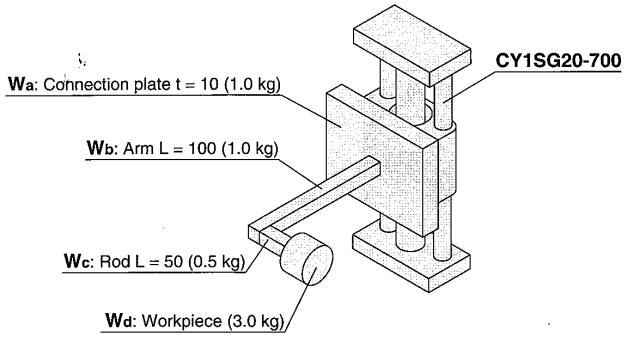


Calculation of Guide Load Factor

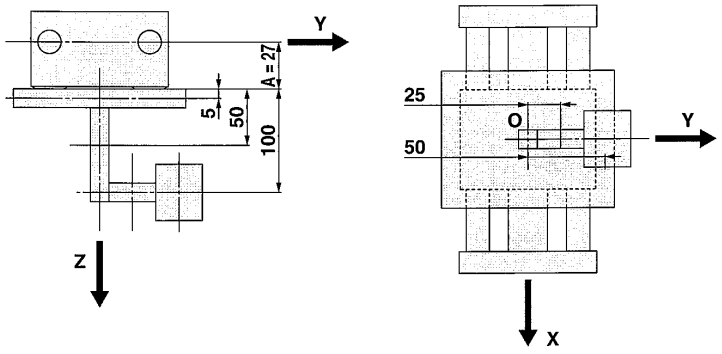
Calculation example 2 Vertical mounting

[1] Operating Conditions

Cylinder: **CY1SG20-700**
Cushion: Shock absorber
Mounting: Vertical mounting
Speed: Va = 200 [mm/s]



[2] Load Blocking



Mass and center of gravity of the load

Load no. W_n	Mass m_n	Center of gravity		
		X-axis x_n	Y-axis y_n	Z-axis z_n
Wa	1.0 kg	0 mm	0 mm	5 mm
Wb	1.0 kg	0 mm	0 mm	50 mm
Wc	0.5 kg	0 mm	25 mm	100 mm
Wd	3.0 kg	0 mm	50 mm	100 mm

n = a, b, c, d

[3] Calculation for Overall Center of Gravity

$$m_t = \Sigma m_n$$
$$= 1.0 + 1.0 + 0.5 + 3.0$$
$$= 5.5 \text{ kg}$$
$$X = 0 \text{ mm}$$

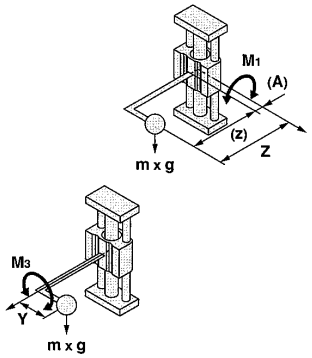
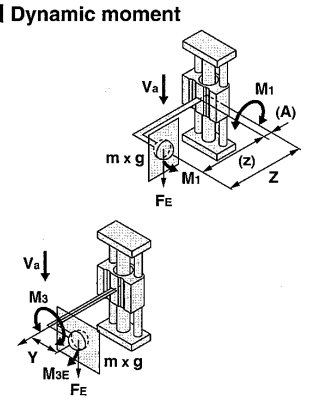
(The center of gravity in the x direction of all work pieces is 0, so X = 0 mm.)

$$Y = \frac{1}{m_t} \times \Sigma (m_n \times y_n)$$
$$= \frac{1}{5.5} \times (1.0 \times 0 + 1.0 \times 0 + 0.5 \times 25 + 3.0 \times 50)$$
$$= 30 \text{ mm}$$
$$Z = \frac{1}{m_t} \times \Sigma \{m_n \times (A + z_n)\}$$
$$= \frac{1}{5.5} \times \{1.0 \times (27 + 5) + 1.0 \times (27 + 50) + 0.5 \times (27 + 100) + 3.0 \times (27 + 100)\}$$
$$= 101 \text{ mm}$$

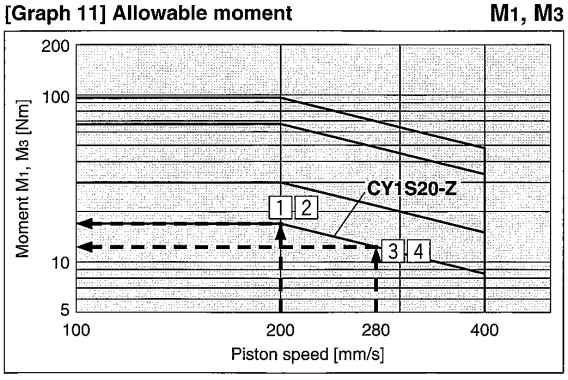
[4] Check the allowable load.

Item	Result	Note
(1) Check allowable load mass by thrust.	Work load is 5.5 kg < 11 kg. OK	Check the allowable load for vertical mounting. The bore size is ø20, so the maximum load for vertical mounting will be 11 kg.
(2) Allowable load by stroke	No restriction	The cylinder is mounted in the vertical direction, and the load generates no rolling moment, so there is not restriction.

[5] Judgement of Guide Load Factor

Item	Load factor αn	Note
1 Load mass	$\alpha_1 = 0$	In case of vertical mounting, no static load is applied.
2 Static moment 	$M_1 = m \times g \times Z$ $= 5.5 \times 9.8 \times 101/1000$ $= 5.4$ [N·m] $\alpha_{2A} = M_1/M_{1max}$ $= 5.4/17.0$ $= 0.32$	Examine M_1. Refer to [3] Calculation for Overall Center of Gravity in the Z-axis on front matter 7. Find the value of M_{1max} when Va = 200 mm/s from Graph (11) 1.
	$M_3 = m \times g \times Y$ $= 5.5 \times 9.8 \times 30/1000$ $= 1.6$ [N·m] $\alpha_{2B} = M_3/M_{3max}$ $= 1.6/17.0$ $= 0.10$	Examine M_3. Refer to [3] Calculation for Overall Center of Gravity in the Y-axis on front matter 7. Find the value of M_{3max} when Va = 200 mm/s from Graph (11) 2. M_2 value does not apply to this example.
3 Dynamic moment 	$F_E = 1.4 \times Va \times m \times g \times \delta$ $= 1.4 \times 200 \times 5.5 \times 9.8 \times 1/100$ $= 150.9$ [N] $M_{1E} = 1/3 \times F_E \times Z$ $= 1/3 \times 150.9 \times 101/1000$ $= 5.1$ [N·m] $\alpha_{3A} = M_{1E}/M_{1max}$ $= 5.1/12.1$ $= 0.42$	Calculate the impact load. Since the impact is absorbed by shock absorber, the bumper coefficient $\delta = 1/100$ Examine M_{1E}. Calculate the collision speed V. $V = 1.4 \times Va$ $V = 1.4 \times 200$ $V = 280$ mm/s Find the value of M_{1Emax} when Va = 280 mm/s from Graph (11) 3.
	$M_{3E} = 1/3 \times F_E \times Y$ $= 1/3 \times 150.9 \times 30/1000$ $= 1.5$ [N·m] $\alpha_{3B} = M_{3E}/M_{3max}$ $= 1.5/12.1$ $= 0.12$	Examine M_{3E}. From the results above, Find the value of M_{3Emax} when Va = 280 mm/s from Graph (11) 4.
4 Judgement	$\Sigma\alpha_n = \alpha_1 + \alpha_{2A} + \alpha_{2B} + \alpha_{3A} + \alpha_{3B}$ $= 0 + 0.32 + 0.10 + 0.42 + 0.12$ $= 0.96$	$\Sigma\alpha_n = 0.96 \leq 1$, so the cylinder can be used.

[Graph 11] Allowable moment **M1, M3**



Load factors on the guides can be calculated with the SMC Pneumatic CAD system.

5. Vertical operation and intermediate stop

5-1) Vertical operation

When operating, it should be operated within limits of the allowable load mass and maximum operating pressures as shown in table 9.

Operating the cylinder above the specified values may lead to the load dropping.

If an accurate stopping position is required, consider using a metal-ended external stopper.

Table 9 Allowable load weight and pressure for vertical operation

Bore size (mm)	Allowable load weight (mv) (kg)	Allowable pressure (Pv) (MPa)
6	1.0	0.55
10	2.7	
15	7.0	0.65
20	11.0	
25	18.5	
32	30.0	
40	47.0	

5-2) Intermediate stop

Fine stroke adjustment is considered as an intermediate stop, so the considerations for an intermediate stop must be observed.

Consider the following points.

Table 10 Allowable pressure for intermediate stops with an external stopper

Bore size (mm)	Maximum operating pressure limit for intermediate stop with an external stopper (Ps) (MPa)
6	0.55
10	
15	0.65
20	
25	
32	
40	

① **Stop the slide block using the external stopper**

When stopping a load in mid-stroke using an external stopper, adjustment bolt or bumper bolt, operate within the operating pressure limits shown in the table 10. Use caution, as operating the cylinder above these pressures may lead to the breaking of the magnetic coupling.

(The piston speed should be the allowable value or less.)

Table 11 Allowable kinetic energy for stopping at the piston side

Bore size (mm)	Allowable kinetic energy for the intermediate stop with pneumatic circuit (Es) (J)
6	0.007
10	0.03
15	0.13
20	0.24
25	0.45
32	0.88
40	1.53

② **When stopping the internal slider with a pneumatic circuit**

When an intermediate stop is performed with a pneumatic circuit with a 3-position solenoid valve, the kinetic energy should be equal to or less than the values in the table 11.

（Piston speed has to be less than the allowable value）

6. Stopper

6-1) Stroke setting

With bumper bolt

Loosen the hexagon nut, and move the bumper bolt to the set stroke end position with a hexagon wrench or by hand. Tighten the hexagon nut to the torque values shown in the table 12.

With shock absorber

The cylinder stroke is controlled by the position of the adjustment bolt.

Parallel pins of similar size to the rod diameter of the shock absorber are mounted on the slide block, these pins collide with the adjustment bolt and shock absorber. Therefore, the stopper of the shock absorber should not come into contact with the slide block directly. Mount the shock absorber stopper approximately 0.2mm shorter than the adjustment bolt.

Table 12. Stopper tightening torque

Bore size (mm)	Nut for bumper bolt		Nut for shock absorber		Nut for adjustment bolt	
	Thread size	Tightening torque(N· m)	Thread size	Tightening torque(N· m)	Thread size	Tightening torque(N· m)
6	M6x0.75	5.2	M6x0.75	0.85	M4x0.7	1.5
10	M8x1	12.5	M8x1	1.67		
15						
20	M10x1	24.5	M10x1	3.14	M6x1	5.2
25	M14x1.5	68.0	M14x1.5	10.80		
32	M20x1.5	204.0	M20x1.5	23.50	M8x1.25	12.5
40						

Fig. 10 Stopper

6-2) Caution when replacing shock absorber

A Cylinder with shock absorber has an adjuster bolt for adjusting the stopping position of the cylinder stroke. Do not change the adjustment bolt position when replacing the shock absorber without changing the stopping position of the cylinder stroke.

7. Cautions for disassembly and maintenance

⚠ Warning

① **The attraction force of the magnet is very strong.**

Be careful so that your hand is not caught when removing the external and piston slider from the cylinder tube during maintenance.

The external slider and the piston slider may be attracted to each other by magnetic force. Use caution when handling.

⚠ Caution

① **Disengage the magnetic attraction of the internal and external slider when removing the sliders from the cylinder tube.**

Dislocate the magnetic position of the magnet coupling between the internal and external slider before removing the external slider or piston slider separately from the cylinder tube.

If the internal and external slider are removed from the cylinder tube while they are attracted to each other, they will be attracted directly and become impossible to separate.

② **If the slider is disassembled for maintenance, do not disassemble the magnet.**

As the holding force of the magnet will decrease or result in operational failure.

③ **Refer to the maintenance procedure for the replacement of the seals.**

④ **The set screws in the figure below are for securing the guide shaft, so do not loosen them except for the purposes of replacing the seals.**

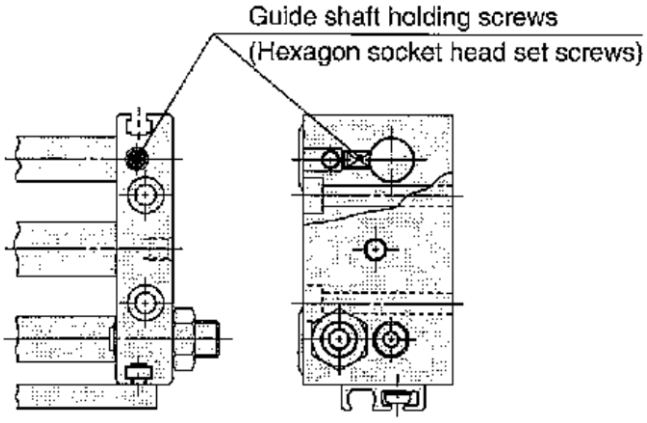


Fig.11 Guide shaft holding screws

⑤ **Make sure the external slider is in the correct direction.**

The internal and external sliders for ø6 and ø10 have a correct assembly orientation. Disassemble and reassemble with the correct orientation referring to the drawing below

(Cylinders larger than ø15 do not have the orientation).

If assembled incorrectly, remove and rotate the piston slider by 180°C, then re-insert into the correct the position.

If th direction is not correct, it will be impossible to obtain the specified holding force.

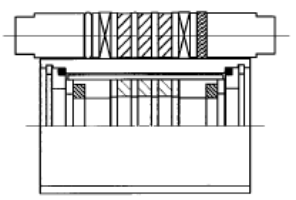


Fig. 12-1 Correct position

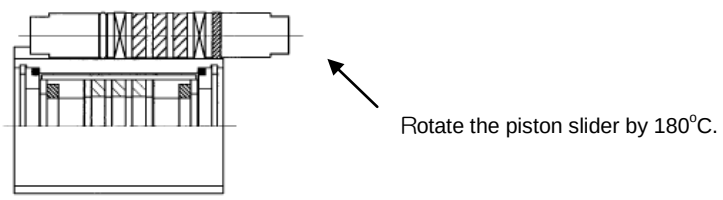


Fig. 12-2 Incorrect position

8. Made to order product

A wide range of made-to-order products are prepared depending on operating environment and conditions.

Refer to Table 13 for made-to-order products. (Product number in the table is added to the end of the standard product number)

(Life of the products below may be shorter than standard products in ordinary environments)

If cylinders are used in an ordinary environment, use standard products as much as possible.)

Table 13 Table for Made to Order products

Product no. Symbol	Description	Note) Recommended operating environment and conditions	Applicable tube I.D.
-XB9	Low speed type (15 to 50mm/s)	When low speed operation (15 to 50mm/s) is necessary	ø6～ø40
-XB13	Very low speed type (7 to 50mm/s)	When very low speed operation (7 to 50mm/s) is necessary	ø6～ø40
-X116	Air-hydro type	Suitable for precise low speed feeding, intermediate stop and skip feeding.	ø25～ø40
-X168	Helical thread type	Strengthen the mounting threads for the workpiece mouting on the slide block.	ø20 to ø40
-X210	Non-lube for the outside (Without dust seal)	Humid place. Environments where products are exposed to splashing water or cutting fluid. Outside of the cylinder: Grease free	ø6～ø40
-X322	Cylinder tube outer surface hard chrome plated	Enhance the hardness of the cylinder tube outer surface to reduce the wearing of the outer bearing.	ø15 to ø40
-X324	Non-lube for the outside (With dust seal)	Humid place. Environments where products are exposed to splashing water or cutting fluid. Outside of the cylinder: Grease free	ø10～ø40
-X431	Switch rail can be mounted from both sides (2 rails)	Necessary switches cannot be mounted by one switch rail because the stroke is short.	ø6～ø40
-X2423	Mounting surface tapped hole type	Fix the cylinder from the plate bottom surface using bolts. (Fig. 13, table 14 for details of dimensions)	ø6 to ø40
20-	Copper-free Specifications	For copper-free environment	ø6 to ø40

Note) Recommended environments and conditions are for your reference.

To avoid unexpected incidents, it is recommended to test the product with your operating conditions.

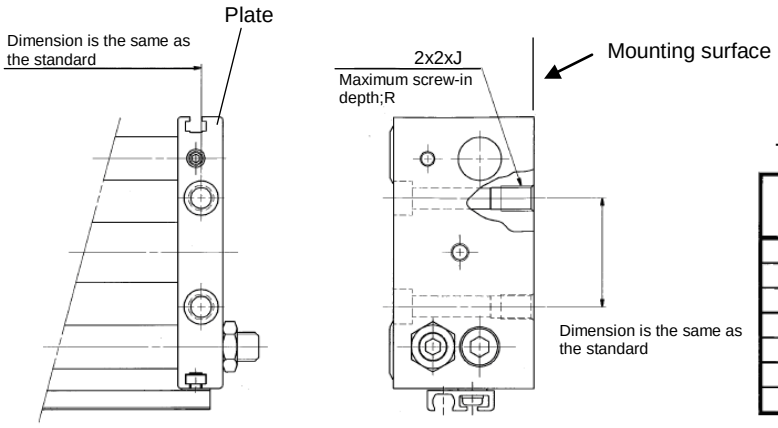


Table 14. Details of thread

Bore size (mm)	J (Thread size)	R (Maximum screw-in depth)
6	M4x0.7	6.5
10	M5x0.8	9.5
15	M6x1	9.5
20	M6x1	9.5
25	M8x1.25	10
32	M10x1.5	15
40	M10x1.5	15

Fig. 13. X2423

9. Internal construction and component

CY1S／Bilateral piping type

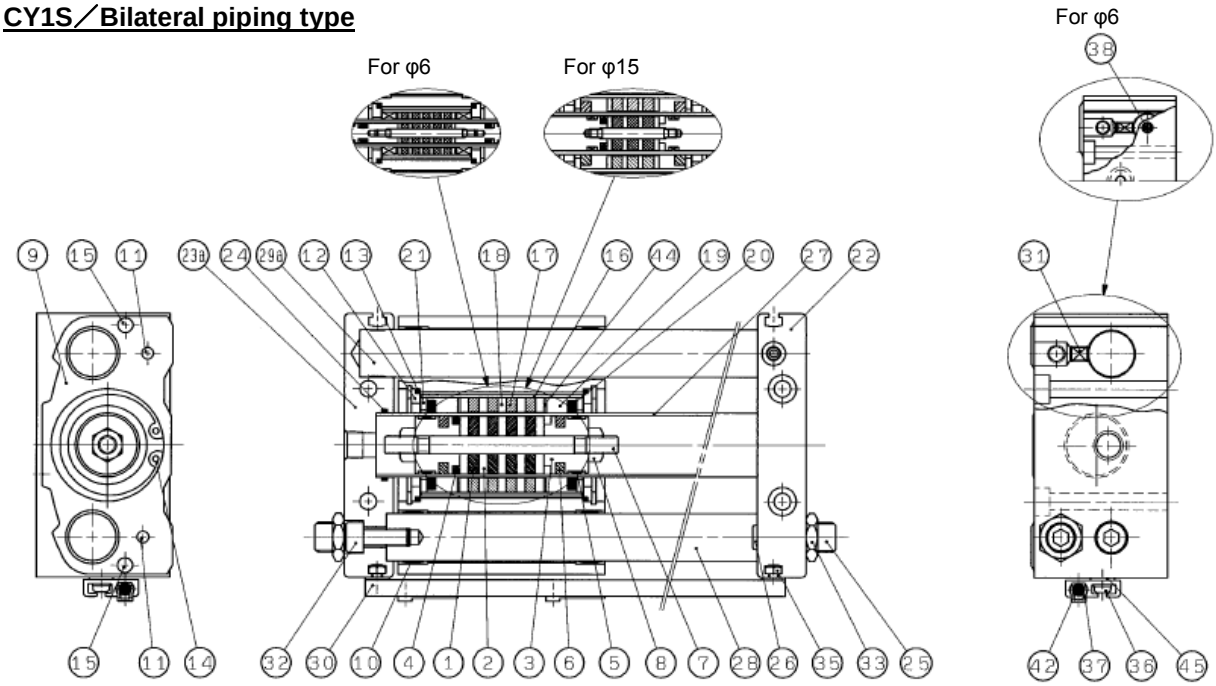


Fig.14-1. Bilateral piping type

CY1SG／Centralized piping type

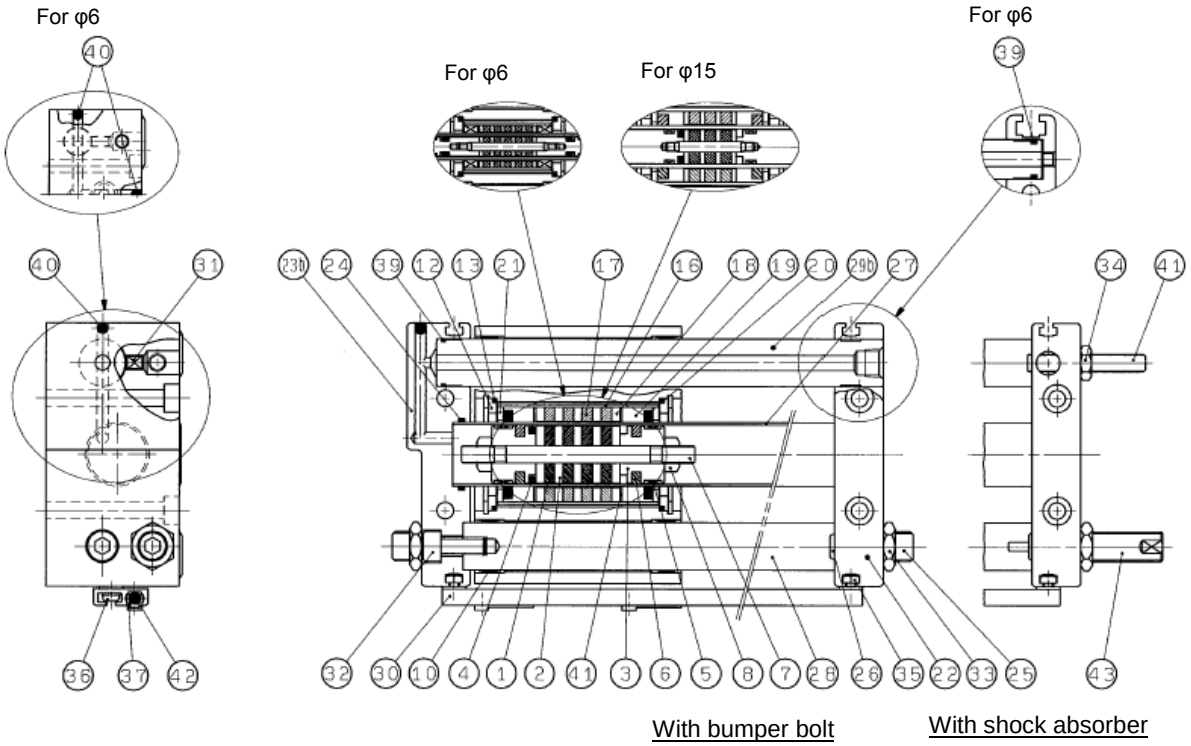


Fig.14-2. Centralized piping type

Table15. Component Parts

No.	Description	Note
1	Magnet A	
2	Piston side yoke	
3	Piston	
4*	Piston seal	
5*	Wear ring A	
6*	Lub-retainer A	Except ø6, ø10
7	Shaft	
8	Piston nut	Except ø6 to ø15
9	Slide block	
10	Bushing	
11	Parallel pin	
12	Slider spacer	
13*	Slider gasket	
14	Retaining ring	
15	Magnet for switch	
16	External slider tube	
17	Magnet B	
18	External slider side yoke	
19*	Wear ring B	
20*	Lub-retainer B	Except ø6
21	Spacer	Except ø6
22	Plate A	
23a	Plate C	Bilateral piping
23b	Plate B	Centralized piping

No.	Description	Note
24*	Cylinder tube gasket	
25	Bumper bolt	
26	Bumper	
27	Cylinder tube	
28	Guide shaft B	
29a	Guide shaft C	Bilateral piping
29b	Guide shaft A	Centralized piping
30	Switch rail	
31	Hexagon socket head set screw	
32	Hexagon socket head cap screw	
33	Hexagon nut	
34	Hexagon nut	
35	Square nut	
36	Cross-recessed head machine screw with SW	
37	Switch spacer	
38	Port plug	ø6, Bilateral piping only
39*	Guide shaft gasket	Centralized piping
40	Steel ball	Centralized piping
41	Adjustment bolt	
42	Auto switch	
43	Shock absorber	
44	Liner	
45	Washer	

Note 1) * denotes parts that are included in the seal kit.
Note 2) Auto switch and switch spacer are shipped together With the product, but not assembled.

Table16. Replacement Parts/Seal Kit

Bore size (mm)	Seal kit		Bumper bolt assembly		Switch spacer	
	Kit no.	Contents	Kit no.	Contents	Kit no.	Contents
6	CY1S6-Z-PS	Set of the nos. 4, 5, 13, 19, 24, 39	CYS06-37-AJ024-R	Set of the nos. 25, 26, 33	BMY3-016	Set of the nos. 37
10	CY1S10-Z-PS	Set of the nos. 4, 13, 19, 20, 24, 39	CYS10-37-AJ025-R			
15	CY1S15-Z-PS	Set of the nos. 4, 5, 6, 13, 19, 20, 24, 39				
20	CY1S20-Z-PS		CYS20-37-AJ027-R			
25	CY1S25-Z-PS		CYS25-37-AJ028-R			
32	CY1S32-Z-PS		CYS32-37-AJ029-R			
40	CY1S40-Z-PS					

Note 1) Seal kit includes a grease pack (10 g).
Order with the following part number when only the grease pack is needed.
Grease pack part number : GR-S-010
Note 2) A switch spacer, as specified in the table above will be required if an auto switch is mounted afterward.
Refer to “Auto Switch Mounting” on page 10 3-3-2 for details.

Revision history

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