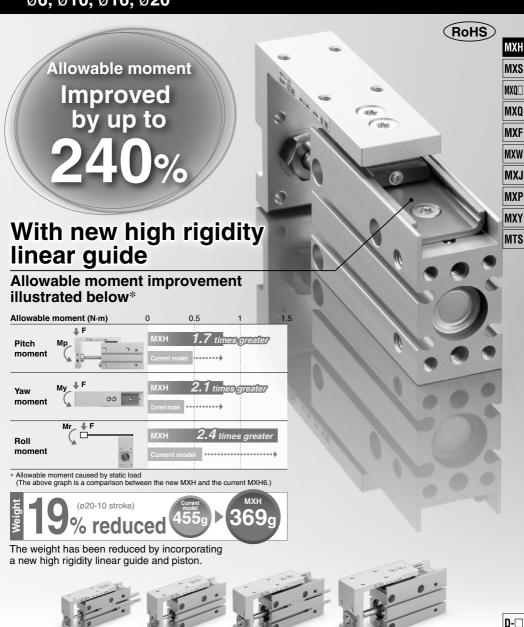
Compact Slide

MXH Series

ø6, ø10, ø16, ø20



-X□

High rigidity achieved with new circulating type linear guide

High allowable moment

Pitch Moment		(N·m)
Bore size (mm)	MXH	MXH existing model
6	0.81	0.47
10	1.69	0.96
16	3.49	1.88
20	5.86	3.14

Yaw Moment		(N·m
Bore size (mm)	MXH	MXH existing model
6	0.81	0.39
10	1.69	0.82
16	3.49	1.59
20	5.86	2.75

Roll Moment		(N⋅m
Bore size (mm)	MXH	MXH existing model
6	1.4	0.59
10	3.19	1.37
16	6.47	2.75
20	11.66	5.49

* Selection of a bore size cannot be made only with above allowable moment. Select a bore size in accordance with "Model Selection" on pages 17 and 18

Traveling parallelism is the same as the existing model.

Deflection at the extended position of the table is the same as the existing model.

Tuescaline	Stroke (mm)						
Traveling parallelism	5 to 30	40 to 60					
	0.05 mm or less	0.1 mm or less					

Values when no load and no pressure applied

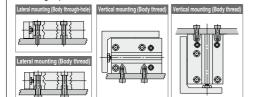
Small auto switches capable

(D-M9□, D-A9□)



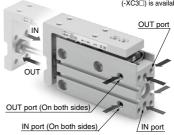
Mounting is completely interchangeable with existing model.

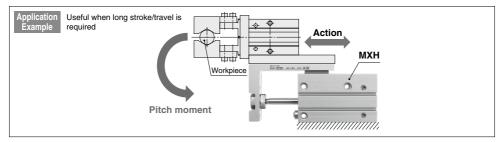
Dimensions including workpiece mounting dimensions and cylinder mounting dimensions are the same as the existing model. Mounting is possible in 4 directions.



Piping is possible in 3 directions.

If changing the port location, "Made to Order" model (-XC3□) is available.





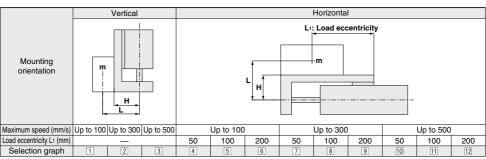
Series Variations

Model			Standard stroke (mm)							Mada As Oudan
Wodei	5	10	15	20	25	30	40	50	60	Made to Order
MXH6	-	-	•	•	•	•	•	•	•	-XC79: Machining tapped hole, drilled hole and pin hole additionally
MXH10	-	-	•	•	-	•	•	•	-	-XB13: Low speed cylinder (5 to 50 mm/s) -XC3□: Special port location
MXH16	-	•	•	•	•	•	•	•	•	-XC19: Intermediate stroke (Spacer type)
MXH20	-	-	•	•	-	-	•	-	-	-XC22: Fluororubber seal
16							C CI	///		

MXH Series Model Selection

⚠ Caution Confirmation of theoretical output is required separately. Refer to "Theoretical Output" on page 20.

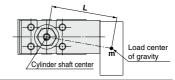
Selection Conditions: Follow the tables below in order to determine selection conditions and choose one selection graph.



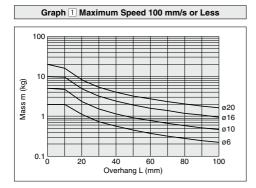
L: Overhang (the distance from the cylinder shaft center to the load center of gravity) The direction of L can also be a diagonal direction. (Refer to the drawing at right.)

* H: Distance from the cylinder center axis to the mounting surface for the table

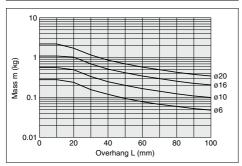
	MXH6	MXH10	MXH16	MXH20
H dimension (mm)	24.5	30.5	34.5	41.5



Selection Graph 1 to 3 (Vertical Mounting)



Graph 2 Maximum Speed 300 mm/s or Less



Selection Example (Vertical Mounting)

Refer to Graph 3 based on vertical mounting and a speed of 500 mm/s.

In Graph $\[\]$, find the intersection of a 40 mm overhang $\]$ and load mass $\]$ of 0.1 kg, which results in a determination

D-

MXH

MX0

MXQ MXF

MXW

MXJ

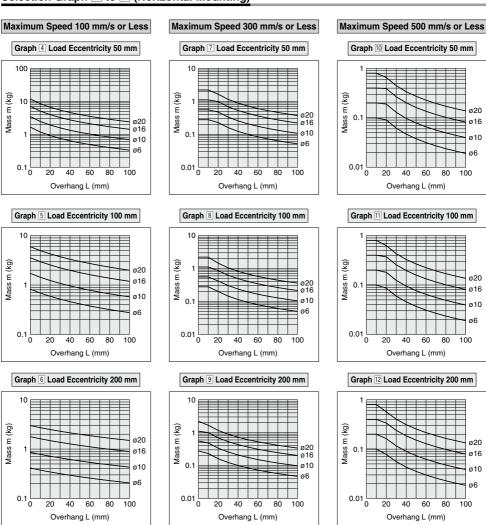
MXP

MXY

MTS



Selection Graph 4 to 12 (Horizontal Mounting)



Selection Example (Horizontal Mounting)

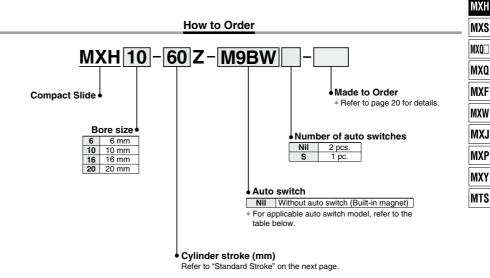
2. Selection conditions | Mounting: Horizontal | Maximum speed: 500 mm/s | Load eccentrity L1: 50 mm | Overhang L: 30 mm | Load mass m: 0.1 kg

Refer to Graph $\boxed{0}$ based on horizontal mounting, a speed of 500 mm/s and load eccentricity L1 of 50 mm. In Graph $\boxed{0}$, find the intersection of a 30 mm overhang L and load mass \mathbf{m} of 0.1 kg, which results in a determination of \emptyset 10.



Compact Slide MXH Series Ø6, Ø10, Ø16, Ø20





Applicable Auto Switches/Refer to pages 1119 to 1245 for further information on auto switches.

\neg PP	Applicable Auto Switches/Herer to pages 1119 to 1245 for further information on auto switches.																						
	Special function Electrical		٠. tō	Wiring	Load v		ltage	Auto switch model Lead w			wire length (m)			Dro wired									
Туре	Type Special function entry	Indica ligh	(Output)	D	С		Perpendicular		0.5 (Nil)		J	J 3	connector	Applicat	ole load								
5				3-wire (NPN)		5 V,		M9NV	M9N	•	•	•	0	0	IC circuit								
switch	_			3-wire (PNP)		12 V		M9PV	M9P		•	•	0	0	IC CITCUIT								
S				2-wire		12 V		M9BV	M9B	•	•	•	0	0	_]							
anto	Diagnostic indication				3-wire (NPN)		5 V,		M9NWV	M9NW	•	•	•	0	0	IC circuit	Dalau						
		Grommet	Yes	3-wire (PNP)	24 V	24 V 12 V	V —	M9PWV	M9PW		•	•	0	0	IC CITCUIT								
state	(2-color indicator)			2-wire		12		12 V		M9BWV	M9BW	•	•	•	0	0	_	PLC					
ts	Water resistant							1			3-wire (NPN)	ı	5 V,		M9NAV*1	M9NA*1	0	0	•	0	0	IC circuit	
Solid	(2-color indicator)			3-wire (PNP)		12 V	12 V		M9PAV*1	M9PA*1	0	0	•	0	0	ic dicuit							
	(2-color indicator)			2-wire		12 V		M9BAV*1	M9BA*1	0	0	•	0	0									
Reed auto switch	Switch — Grommet	Yes	3-wire (NPN equivalent)	_	5 V	_	A96V	A96	•	_	•	_	_	IC circuit									
a S	_	Gioillilet		2-wire 2		12 V	100 V	A93V*2	A93	•	•	•	•	_	_	Relay,							
ar	art		No	Z-WIIG	24 V	12 V	100 V or less	A90V	A90		_	•	I-	_	IC circuit	PLC							

*1 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 type with the above model numbers.

receipt of order.

* Solid state auto switches marked with "O" are produced upon

- *2 1 m type lead wire is only applicable to D-A93.
- * Lead wire length symbols: 0.5 mNii (Example) M9NW

 1 mM (Example) M9NWM

 3 mL (Example) M9NWL
 - 3 mL (Example) M9NWL 5 mZ (Example) M9NWZ
- * Refer to page 28 for applicable auto switches other than listed above.
- * For details about auto switches with pre-wired connector, refer to pages 1192 and 1193.
- * Auto switches are shipped together, (but not assembled).

D-□

-X□





Symbol Rubber bumper





Made to Order (Refer to pages 1247 to 1440 for details.)

Symbol	Specifications
-XC79	Machining tapped hole, drilled hole and pin hole additionally
-XB13	Low speed cylinder (5 to 50 mm/s)
-хсз	Special port location
-XC19	Intermediate stroke (Spacer type)
-XC22	Fluororubber seal

Specifications

Bore size (mm)	6	10	16	20				
Fluid	Air							
Action		Double	acting					
Piping port size		M5 x	0.8					
Minimum operating pressure	0.15 MPa	0.06 MPa 0.05						
Maximum operating pressure	0.7 MPa							
Proof pressure	1.05 MPa							
Ambient and fluid temperature	Without auto switch: -10 to 70°C (No freezing) With auto switch: -10 to 60°C							
Piston speed		50 to 50	0 mm/s					
Allowable kinetic energy (J)	0.0125	0.025	0.05	0.1				
Lubrication		Non-	lube					
Cushion	ı	Rubber bumpe	r on both ends	S				
Stroke length tolerance		+1						
Auto switch (Option)	Solid	state auto swi Reed auto s		19□W				

Standard Stroke

Bore size (mm)	Standard stroke (mm)
6, 10, 16, 20	5, 10, 15, 20, 25, 30, 40, 50, 60

Note) Intermediate strokes are available with "Made to Order" model (-XC19). (For details, refer to page 1346.)

Theoretical Output

						(N)			
Bore size	Rod size	Operating	Piston area	Operat	Operating pressure (MPa)				
(mm)	(mm)	direction	(mm²)	0.3	0.5	0.7			
6	3	OUT	28	8	14	19			
	3	IN	21	6	10	14			
10	4	OUT	78	23	39	55			
10	4	IN	66	19	33	46			
16	6	OUT	201	60	101	141			
16	О	IN	172	51	86	121			
20	8	OUT	314	94	157	220			
20	ō	IN	264	79	132	185			

Weight

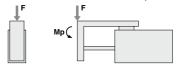
									(g)
Model				St	roke (mi	n)			
	5	10	15	20	25	30	40	50	60
MXH6	61	66	75	80	88	93	107	120	134
MXH10	104	112	125	133	146	153	174	195	216
MXH16	194	204	222	232	250	260	288	316	343
MXH20	352	369	400	417	448	466	514	562	610



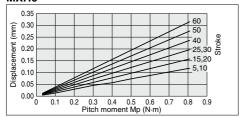
Table Displacement

Table Displacement due to Pitch Moment (Reference)

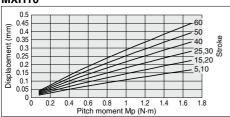
Table displacement (arrow) when a load acts upon the section marked with the arrow at the full stroke of the Compact Slide



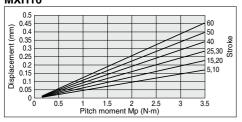
MXH6



MXH₁₀



MXH16



MXH20

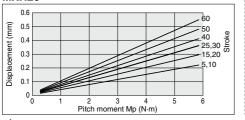
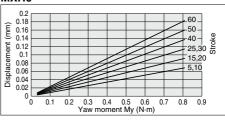


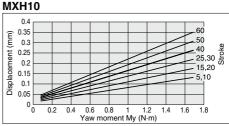
Table Displacement due to Yaw Moment (Reference)

Table displacement (arrow) when a load acts upon the section marked with the arrow at the full stroke of the Compact Slide

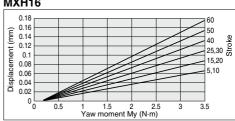


MXH6

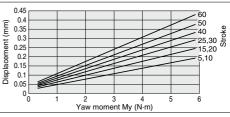




MXH16



MXH20



↑Caution Design

- 1. Selection of a bore size cannot be made only with above graphs. Select a bore size in accordance with "Model Selection" on pages 17 and 18.
- 2. Displacement may increase after an impact load has been applied. When the table is subjected to an impact load, there may be permanent distortion of the guide unit and increased displacement.

MXH

MXS $MXO\square$

MXO

MXF

MXW

MXJ

MXP

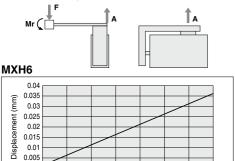
MXY

MTS

Table Displacement

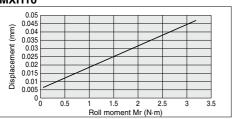
Table Displacement due to Roll Moment (Reference)

Table displacement (at A) when a load acts upon section F at the full stroke of the Compact Slide

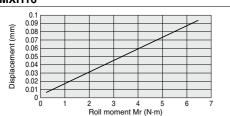


0.4 0.6 0.8 1 Roll moment Mr (N·m) 1.2

MXH10



MXH16



MXH20

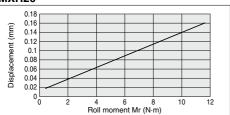


Table Accuracy

	Traveling parallelism	Stroke (mm)				
		5 to 30	40 to 60			
		0.05 mm or less	0.1 mm or less			

^{*} Values when no load and no pressure applied.

Allowable Moment

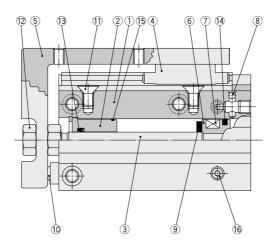
Allowable moment (N·m)							
Model	Pitch moment	Yaw moment	Roll moment				
Iviouei	Мр	Му	Mr				
MXH6	0.81 0.81		1.40				
MXH10	1.69	1.69	3.19				
MXH16	3.49	3.49	6.47				
MXH20	5.86	5.86	11.66				

Design

⚠ Caution

Selection of a bore size cannot be made only with above allowable moment. Select a bore size in accordance with "Model Selection" on pages 17 and 18.

Construction



Component Parts

No.	Description	Material	Note		
1	Cylinder tube	Aluminum alloy	Hard anodized		
2	Rod cover	Aluminum alloy	Hard anodized		
3	Piston rod	Stainless steel			
4	Guide	The main parts are made of stainless steel.			
5	Table	Aluminum alloy	Hard anodized		
6	Piston	Aluminum alloy	Chromated		
7	Magnet	Magnetic material			
8	Steel ball	Carbon steel			
9	Bumper	Urethane			
10	Bumper	Urethane			
11	Countersunk head screw	Carbon steel	Nickel plating		
12	Nut	Brass	Nickel plating		
13	Rod seal	NBR			
14	Piston seal	NBR			
15	Gasket	NBR			
16 Plug		Carbon steel	Zinc chromated		

Note) The MXH series cannot be disassembled.

MXH

MXQ

MXQ

MXF

MXW

MXJ

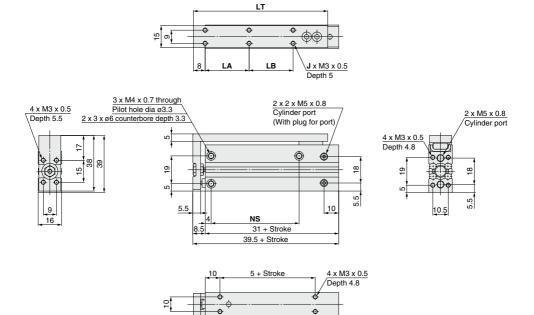
MXP

MXY

MTS



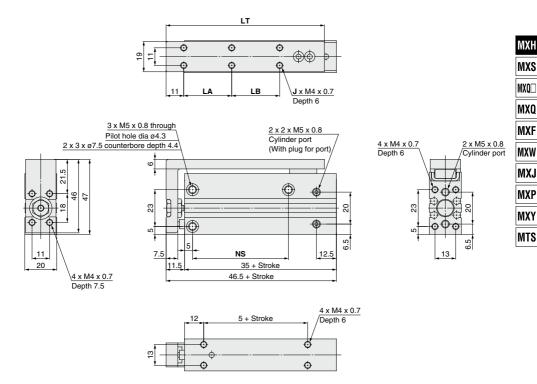
Dimensions: Ø6



Note 1) Refer to "Specific Product Precautions" for mounting of the Compact Slide and a workpiece. Note 2) When changing the port location, please order a new port plug: MXH-P (2 pcs.)

Stroke (mm)	J	LA	LB	LT	NS
5	4	10	_	42	14
10	4	10	_	42	14
15	4	20	_	52	24
20	4	20	_	52	24
25	4	30	_	62	30
30	4	30	_	62	30
40	6	20	20	72	45
50	6	25	25	82	55
60	6	30	30	92	60

Dimensions: Ø10

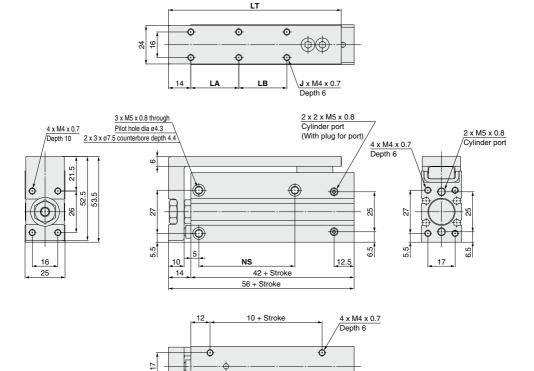


Note 1) Refer to "Specific Product Precautions" for mounting of the Compact Slide and a workpiece. Note 2) When changing the port location, please order a new port plug: MXH-P (2 pcs.)

Stroke (mm)	J	LA	LB	LT	NS
5	4	10	_	49	14
10	4	10	_	49	14
15	4	20	_	59	24
20	4	20	_	59	24
25	4	30	_	69	30
30	4	30	_	69	30
40	6	20	20	79	45
50	6	25	25	89	55
60	6	30	30	99	60



Dimensions: Ø16

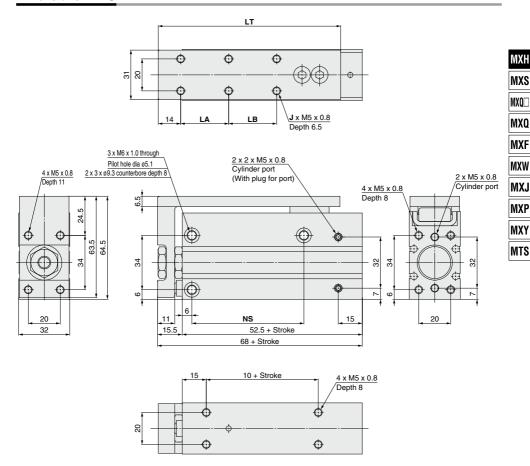


Note 1) Refer to "Specific Product Precautions" for mounting of the Compact Slide and a workpiece. Note 2) When changing the port location, please order a new port plug: MXH-P (2 pcs.)

Φ

Stroke (mm)	J	LA	LB	LT	NS
5	4	10	_	58	20
10	4	10	_	58	20
15	4	20	_	68	30
20	4	20	_	68	30
25	4	30	_	78	40
30	4	30	_	78	40
40	6	20	20	88	50
50	6	25	25	98	60
60	6	30	30	108	60

Dimensions: Ø20



Note 1) Refer to "Specific Product Precautions" for mounting of the Compact Slide and a workpiece. Note 2) When changing the port location, please order a new port plug: MXH-P (2 pcs.)

Stroke (mm)	J	LA	LB	LT	NS
5	4	10	_	64	20
10	4	10	_	64	20
15	4	20	_	74	25
20	4	20	_	74	25
25	4	30	_	84	40
30	4	30	_	84	40
40	6	20	20	94	50
50	6	25	25	104	70
60	6	30	30	114	70



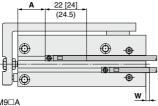
Auto Switch Mounting

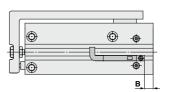
Minimum Stroke for Auto Switch Mounting

			(mm)			
Noveles of substantials	Applicable auto switch model					
Number of auto switches mounted	D-M9□, M9□V	D-M9□W, M9□WV D-M9□A, M9□AV	D-A9□, A9□V			
1 pc.	5	5	5			
2 pcs.	5	10	10			

Auto Switch Proper Mounting Position (Detection at Stroke End) and Its Mounting Height

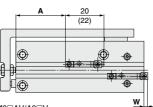


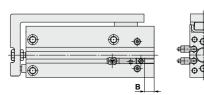




- []: Value of the D-M9□A
- (): Value of the D-A90/A93







(): Value of the D-M9□AV/A9□V

(mm)

Bore size	Bore size D-M9□W, D-M9□		D-M9	D-M9□WV, D-M9□V		D-M9□A		D-M9□AV		D-A9□, D-A9□V					
(mm)	Α	W	В	Α	W	В	Α	W	В	Α	W	В	Α	W	В
6	16.5	7.5	2.5	16.5	5.5	2.5	16.5	9.5	2.5	16.5	7.5	2.5	12.5	3.5 (6)	_
10	15.0	2.0	7.5	15.0	0	7.5	15.0	4.0	7.5	15.0	2.0	7.5	11.0	-2.0 (0.5)	3.5
16	22.0	2.0	8.0	22.0	0	8.0	22.0	4.0	8.0	22.0	2.0	8.0	18.0	-2.0 (0.5)	4.0
20	30.0	-0.5	10.5	30.0	-2.5	10.5	30.0	1.5	10.5	30.0	-0.5	10.5	26.0	-4.5 (-2)	6.5

Note 1) Negative figures in the table W indicate that an auto switch is mounted inward from the edge of the cylinder body.

Note 2) In the case of models with 5 and 10 strokes, the auto switch may not turn off due to operating range or two auto switches may turn on simultaneously. Fix auto switches outside 1 to 4 mm further than the values in the table above. (If one auto switch is used, make sure that it turns ON and OFF properly; If two auto switches are used, make sure that both auto switches turn ON.)

Note 3) () in column W denotes the D-A90/A93 dimensions.

Operating Range				(mm)			
Auto switch model		Bore size					
Auto Switch model	6	10	16	20			
D-M9□, M9□V D-M9□W, M9□WV D-M9□A, M9□AV	3	3.5	5	6			
D-A9□. A9□V	5	6	9	11			

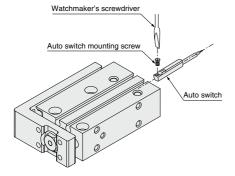
^{*} Values which include hysteresis are for guideline purposes only, they are not a guarantee (assuming approximately ±30% dispersion) and may change substantially depending on the ambient environment.

Other than the applicable auto switches listed in "How to Order", the following auto switches can be mounted.

■ * Normally closed (NC = b contact) solid state auto switches (D-F9G/F9H) are also available. Refer to page 1137 for details.

Auto Switch Mounting **MXH** Series

Auto Switch Mounting



 When tightening the auto switch mounting screw, use a watchmaker's screwdriver with a handle 5 to 6 mm in diameter.

watchmaker's screworiver with a handle 5 to 6 mm in diameter

Tightening Torque of Auto Switch Mounting Screw							
Auto switch model	Tightening torque						
D-A9□(V)	0.10 to 0.20						
D-M9□(V) D-M9□W(V) D-M9□A(V)	0.05 to 0.15						

Note) When used with side ported type, it is not possible to mount the D-A9□V/M9□V type on the side to which the piping is connected.

MXH

MXS

MXQ ...

MXF

MXW

MXJ MXP

MXY

MTS





Specific Product Precautions 1

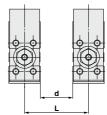
Be sure to read this before handling the products. Refer to back page 50 for Safety Instructions and pages 3 to 12 for Actuator and Auto Switch Precautions.

Auto Switch Mounting

When installing in close proximity to each other

1. When the Compact Slide with the D-A9□ or D-M9□ auto switch is used, the auto switches could activate unintentionally if the installed distance is less than the dimension shown in Table (1). Therefore, make sure to provide at least this much clearance. Due to unavoidable circumstances, if they must be used with less distance than the dimensions given in the table below the cylinders must be shielded. Therefore, affix a steel plate or a magnetic shielding plate (MU-S025) to the area on the cylinder that corresponds to the adjacent auto switch. (Please contact SMC for details.) The auto switch could activate unintentionally if a shielding plate is not used.

Table (1)	(mm			
Bore size (mm)	d	٦		
MXH6	5	21		
MXH10	5	25		
MXH16	10	35		
MXH20	15	47		



Dimensions of a shielding plate (MU-S025) that is sold separately are indicated as reference.



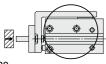
Material: Ferrite stainless steel, Thickness: 0.3 mm Since the back side is treated with adhesive, it is possible to attach to the cylinder.

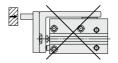
Operating Precautions

Be aware that smoking cigarettes etc., after your hands have come into contact with the grease used in this cylinder can create a gas that is hazardous to humans.

⚠ Caution

- Do not place your fingers in the clearance between the non-rotating plate and the cylinder tube. Your fingers could get caught between the table and the cylinder tube when the piston rod retracts.
 - If fingers are caught in a cylinder, there is a danger of injury due to the strong cylinder output, and therefore, caution must be exercised.
- In terms of the work load and moment, operate the cylinder below the maximum work load and allowable moment.
 If the compact Slide is applied disastly to the
- If the output of the Compact Slide is applied directly to the table, make sure it is applied along the rod axial line. (Refer to the figure below.)





Operating Precautions

- Make sure to connect a speed controller and adjust it to a speed of 500 mm/s or less to operate the cylinder.
- 5. If the vibration of the workpiece due to cylinder operation is clearly noticeable, recheck the operating conditions. Even when the moment applied to the product is under the allowable moment, the vibration width may be increased if a large amount of eccentric load is applied.

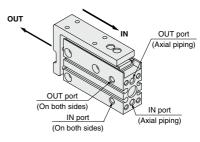
Operating Direction with Different Pressure Ports

∧ Caution

1. The Compact Slide can be piped in 3 directions.

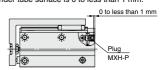
Check the pressure port and the operating direction. (Refer to the figure below.)

Change the plug location depending on the application. Confirm that there is no air leakage after changing the plug location. If there is slight leakage, remove the plug, check the seat surface and reassemble.



When changing the port location, please order the following plug. Replacement port plug part number: MXH-P (2 pcs.)

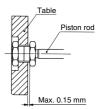
2. If the plug is tightened excessively when attaching it to the axial piping of MXH6, it may be in contact with the internal steel ball, causing air leakage. As for the plug tightening guide, make the adjustment so that the plug sunk dimension from the cylinder tube surface is 0 to less than 1 mm.



Backlash in the Stroke Direction

⚠ Caution

 Since the connection between the piston rod and table is a floating mechanism, the table has backlash of 0.15 mm or less in the stroke direction. (Refer to the figure on the right.)



Connecting part of piston rod and table



MXH Series Specific Product Precautions 2

Be sure to read this before handling the products. Refer to back page 50 for Safety Instructions and pages 3 to 12 for Actuator and Auto Switch Precautions.

Mounting

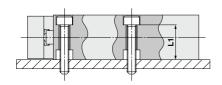
∧ Caution

1. When tightening threads for the Compact Slide, properly tighten within the specified torque.

How to Mount the Compact Slide

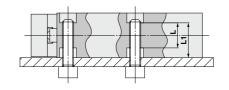
The Compact Slide can be mounted in 4 directions. Make a selection suitable for the applicable machinery and work pieces, etc.

Lateral Mounting (Body through-hole)



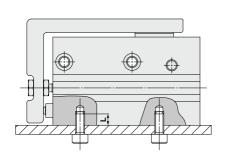
Model	Bolt	Maximum tightening torque (N·m)	L1
MXH6	M3 x 0.5	1.1	12.7
MXH10	M4 x 0.7	2.5	15.6
MXH16	M4 x 0.7	2.5	20.6
MXH20	M5 x 0.8	5.1	24.0

Lateral Mounting (Body thread)



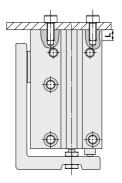
Model	Bolt	Maximum tightening torque (N·m)	L1	L
MXH6	M4 x 0.7	2.5	12.7	9.4
MXH10	M5 x 0.8	5.1	15.6	11.2
MXH16	M5 x 0.8	5.1	20.6	16.2
MXH20	M6 x 1	8.1	24.0	16.0

Vertical Mounting (Body thread)



Model	Bolt	Maximum tightening torque (N·m)	L
MXH6	M3 x 0.5	1.1	4.8
MXH10	M4 x 0.7	2.5	6
MXH16	M4 x 0.7	2.5	6
MXH20	M5 x 0.8	5.1	8

Axial Mounting (Body thread)



Model	Bolt	Maximum tightening torque (N·m)	L
MXH6	M3 x 0.5	1.1	4.8
MXH10	M4 x 0.7	2.5	6
MXH16	M4 x 0.7	2.5	6
MXH20	M5 x 0.8	5.1	8

D-□

MXH

MXS

 $MXQ\square$

MXQ MXF

MXW MXJ MXP MXY MTS

-**X**□





MXH Series Specific Product Precautions 3

Be sure to read this before handling the products. Refer to back page 50 for Safety Instructions and pages 3 to 12 for Actuator and Auto Switch Precautions.

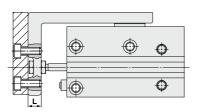
Mounting

- 1. When tightening threads for the Compact Slide, properly tighten within the specified torque.
- 2. When mounting a workpiece on the top of the table, do not screw a bolt in more deeper than the below table L dimension.
- If screwing a bolt in more deeper than the L dimension, the edge of the bolt could reach the linear guide and might damage the linear guide.

How to Mount a Workpiece

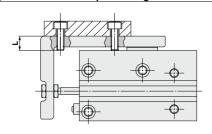
Work pieces can be mounted on 2 surfaces of the Compact Slide.

Front Mounting



Model	Bolt	Maximum tightening torque (N·m)	L
MXH6	M3 x 0.5	1.1	5.5
MXH10	M4 x 0.7	2.5	7.5
MXH16	M4 x 0.7	2.5	10
MXH20	M5 x 0 8	5.1	11

Top Mounting



Model	Bolt	Maximum tightening torque (N·m)	L
MXH6	M3 x 0.5	1.1	6.5
MXH10	M4 x 0.7	2.5	8
MXH16	M4 x 0.7	2.5	9
MXH20	M5 x 0.8	5.1	9.5

How to Mount a Workpiece

Work pieces can be mounted on 2 surfaces of the Compact Slide.

- Since the table is supported by the linear guide, take care not to apply strong impact or large moment, etc., when mounting work pieces.
- Hold the table when fastening work pieces to it with bolts etc. If the body is held while tightening bolts etc., the guide section will be subjected to a large moment, and there may be a loss of precision.





- For connection with a load having an external support/guide mechanism, select an appropriate connection method and perform careful alignment.
- Use caution, as scratches or nicks, etc., on the sliding parts of the piston rod can cause a malfunction and air leakage.