




Rotary Table Series **MSU** Vane Type/Sizes 1, 3, 7, 20

Peripheral table deflection **0.03** mm or less


Table top deflection **0.03** mm or less

High Precision



Series MSUB

Series MSUA



High precision series MSUA introduced to vane type rotary tables

Rotary Table

Series MSU

Vane type/Sizes 1, 3, 7, 20

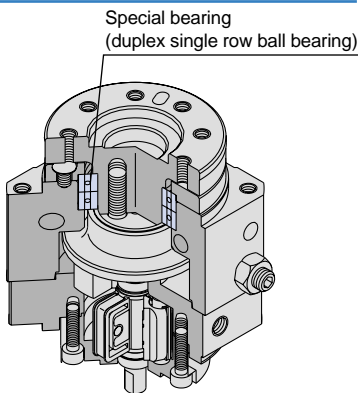


High Precision Type
Sizes 1, 3, 7, 20

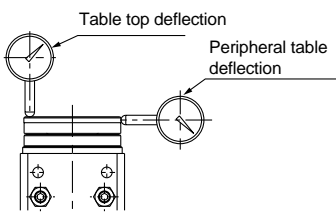
Series MSUA

Improved table deflection accuracy:
0.03mm or less

High precision/High rigidity



Deflection accuracy:
Displacement for 180° rotation



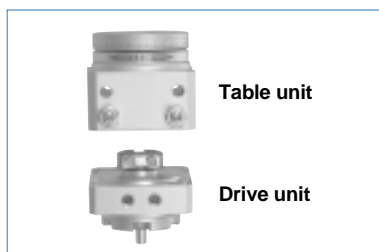
Model	MSUA
Table top deflection	0.03 (0.1 to 0.2)
Peripheral table deflection	0.03 (0.1 to 0.2)

mm

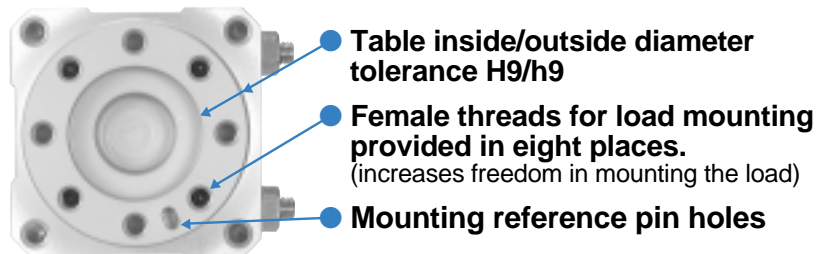
Values inside () are for series MSUB

Disengageable

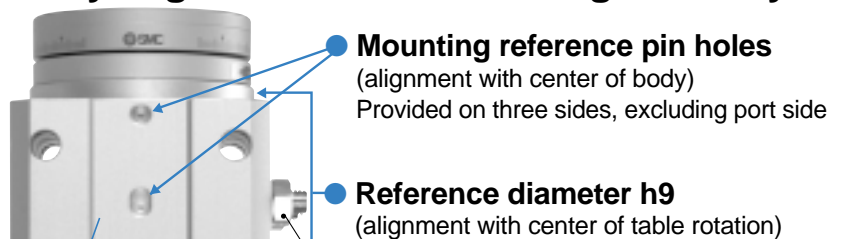
Maintenance work is simplified.
The drive unit can be replaced with the load mounted.



Easy alignment when mounting the load

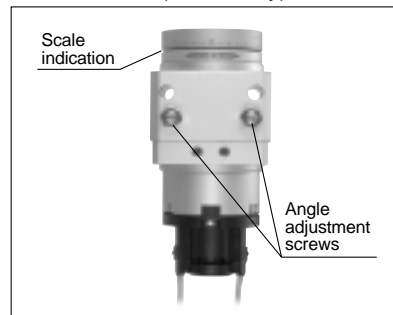


Easy alignment when mounting the body



Angle is adjustable

90°±10°, 180°±10°
Double vane (MSUB only) 90°±5°



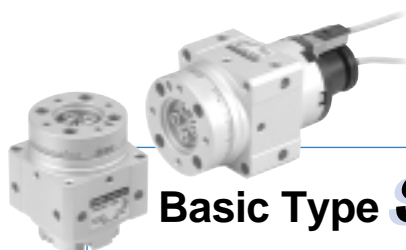
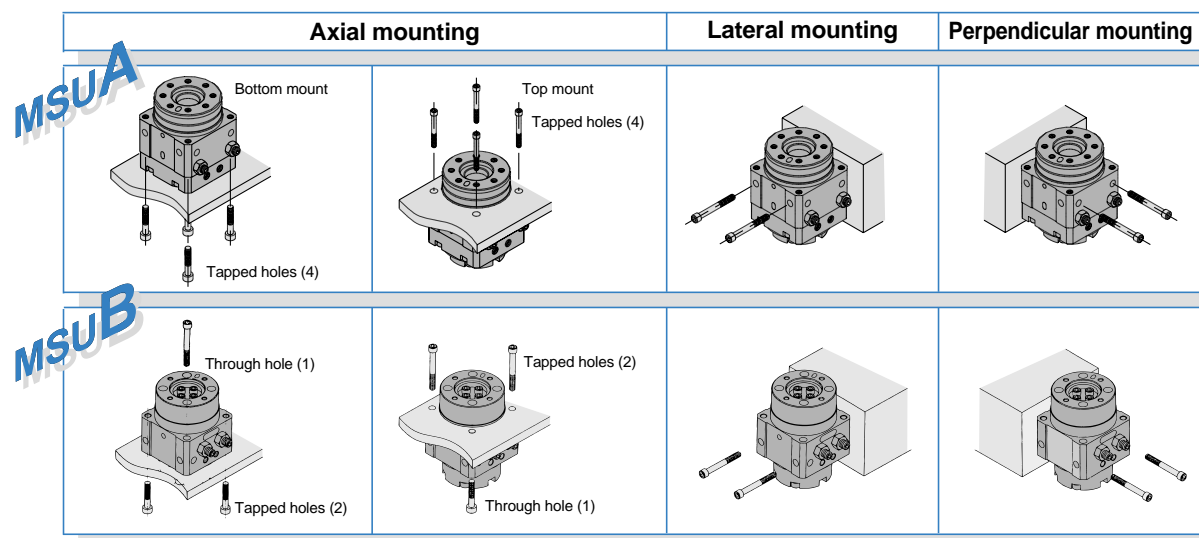
Auto switch capable

Since switches can be moved anywhere on the circumference, they can be mounted at positions which accommodate the specifications.

Rotary actuator with lightweight, compact table for robotic hands

Free-mount type

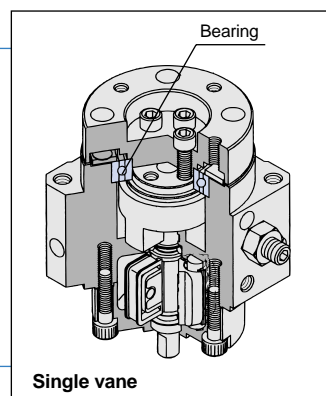
Can be mounted from three directions: axial, lateral, perpendicular



Basic Type **Series MSUB**

Sizes 1, 3, 7, 20

- Single vane and double vane standardized
- Double vane has the same dimensions as single vane (except size 1)



Series variations

Series	Size	Rotation	Vane type	Applicable auto switch
High precision type MSUA	1	90°	Single vane	D-9, D-T99 D-9□A, D-S99, S9P
	3			D-R73, D-T79 D-R80, D-S79, S7P
	7	180°		D-R73, D-T79 D-R80, D-S79, S7P
	20			
MSUB	1	90°	Single vane*	D-9, D-T99 D-9□A, D-S99, S9P
	3		Double vane	D-R73, D-T79 D-R80, D-S79, S7P
	7	180°	Single vane*	D-9, D-T99 D-9□A, D-S99, S9P
	20		Double vane	D-R73, D-T79 D-R80, D-S79, S7P

* Double vane is available with 90° rotation setting only.

Rotary Table/Vane Type: High Precision

Series MSUA

Sizes 1, 3, 7, 20



How to Order

Without Auto Switch Unit
MSUA 20-90 S

With Auto Switch Unit
M D SUA 20-90 S-R73 L

Bearing type

Nil	Side ports
E	Top ports

Available with side ports only, when equipped with switch unit.

Free-mount

Nominal size (torque)

1	MSUA 1
3	MSUA 3
7	MSUA 7
20	MSUA 20

Rotation

Application	Symbol	Rotation
Single vane	90	90°
	180	180°

Rotation adjustment range
Single vane: Both ends ±5° each

Vane type

S	Single vane
---	-------------

Number of auto switches

S	1 pc.*
Nil	2 pcs.

* For 1 piece, a right hand auto switch is installed.

Electrical entry/Lead wire length

Nil	Grommet/lead wire 0.5m
L	Grommet/lead wire 3m
C	Connector/lead wire 0.5m
CL	Connector/lead wire 3m
CN	Connector/without lead wire

* Available only with R73, R80 and T79 type connectors.
** Lead wire with connector part nos.
D-LC05: Lead wire 0.5m
D-LC30: Lead wire 3m
D-LC50: Lead wire 5m

Type of auto switch

Nil	Without auto switch
-----	---------------------

* Select applicable auto switches from the table below.

Applicable auto switches/Refer to pages 26 through 35 for detailed auto switch specifications.

Applicable model	Type	Electrical entry	Indicator light	Wiring (output)	Load voltage		Auto switch part no.	Lead wire type	Lead wire length (m)*				Applicable loads										
					DC	AC			0.5 (Nil)	3 (L)	5 (Z)	None (N)											
MDSUA1 MDSUA3	Reed	Grommet	No	2 wire	24V	5V, 12V	5V, 12V, 24V	90	Parallel cord	●	●	●	—	Relay, PLC									
						5V, 12V, 100V	5V, 12V, 24V, 100V	90A	Heavy duty	●	●	●	—										
						—	100V	93A	Parallel cord	●	●	●	—										
	Solid state					Yes	3 wire (NPN)	24V	12V	—	—	Heavy duty	Heavy duty		●	●	—	—					
															●	●	—	—					
															●	●	—	—					
3 wire (PNP)	5V, 12V	—	—	—	—									—	—	—	●	●	—	—			
																	●	●	—	—			
																	●	●	—	—			
MDSUA7 MDSUA20						Reed	Grommet	Yes	2 wire	24V	—	100V	Heavy duty				Heavy duty	●	●	—	—	Relay, PLC	
																		●	●	●	●		
																		●	●	—	—		
	Connector	No	2 wire	24V	48V, 100V	24V, 48V, 100V								—	—	—		—	●	●	—		—
																			●	●	●		●
																			●	●	●		●
Solid state	Yes						3 wire (NPN)	24V	12V	—	—	—	—				—		●	●	—	—	
																			●	●	—	—	
																			●	●	—	—	
Grommet		3 wire (PNP)	5V, 12V	—	—	—								—	—	—		—	●	●	—	—	
																			●	●	—	—	
																			●	●	—	—	

- Order example: MSUA20 single vane type (connection port side position selected)
- Standard type (without auto switches), rotation 90°, side port position MSUA20-90S
 - With switch unit (without auto switches), rotation 180°, side port position MDSUA20-180S
 - With switch unit + auto switch R73, rotation 180°, side port position MDSUA20-180S-R73

* Lead wire length symbols 0.5m Nil (Example) R73C
3m L (Example) R73CL
5m Z (Example) R73CZ
None N (Example) R73CN

● Operating time — 1.2ms ● Operating temperature range — 5 to 60°C
● Impact resistance — 300m/s² (reed), 1000m/s² (solid state)



Specifications

Model ^{2*}	MSUA1		MSUA3		MSUA7		MSUA20	
Vane type	Single vane		Single vane		Single vane		Single vane	
Rotation ^{1*}	90°±10°	180°±10°	90°±10°	180°±10°	90°±10°	180°±10°	90°±10°	180°±10°
Fluid	Air (unlubricated)							
Proof pressure MPa	1.05					1.5		
Ambient and fluid temperature	5 to 60°C							
Operating pressure range MPa	0.2 to 0.7		0.15 to 0.7			0.15 to 1.0		
Rotation time adjustment range sec/90°	0.07 to 0.3							
Shaft load	Allowable radial load	20N	40N	50N	60N			
	Allowable thrust load	15N	30N	60N	80N			
	Allowable moment	0.3N·m	0.7N·m	0.9N·m	2.9N·m			
Bearing	Special bearings							
Port position	Side ports or Top ports							
Port size	Side ports	M3 x 0.5		M5 x 0.8				
	Top ports	M3 x 0.5			M5 x 0.8			
Deflection accuracy	0.03mm or less							

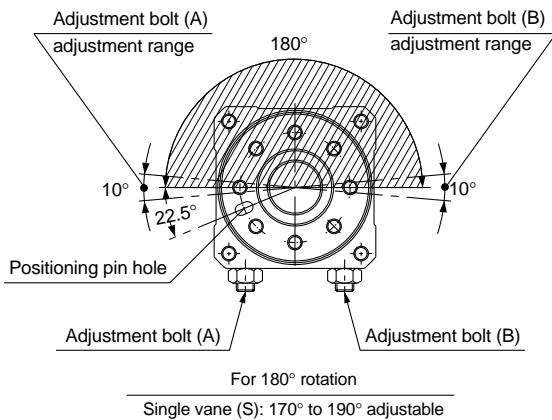
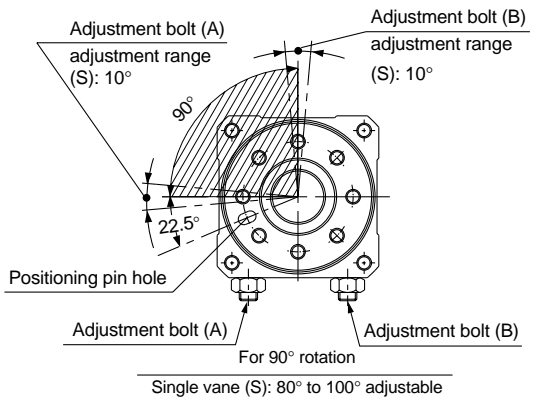
*1. Single vane 90° can be adjusted to 90°±10° (both ends of rotation ±5° each)
 Single vane 180° can be adjusted to 180°±10° (both ends of rotation ±5° each)
 Note) Refer to page 39 for allowable kinetic energy.

*2

Rotary table	Equivalent conventional/ready-to-use
MSUA 1	CRBUW10
MSUA 3	CRBUW15
MSUA 7	CRBUW20
MSUA20	CRBUW30

Table Rotation Range

Angle adjustment is possible as shown in the drawings below using adjustment bolts (A) and (B).



Applicable Auto Switches

Auto switch type	MDSUB1, 3	MDSUB7, 20
Reed switch	D-90/97, D-90A/93A	D-R7, R8
Solid state switch	D-S99, D-T99, D-S9P	D-S7, S7P, T7

Weights

Unit: g

Size	Rotation	Basic weight	Auto switch unit + Auto switch 2 pcs.
		Single vane	
1	90	162	25
	180	161	
3	90	261.5	30
	180	259.5	
7	90	440	50
	180	436	
20	90	675	60
	180	670.5	

Allowable Loads

Do not permit the load and moment applied to the table to exceed the allowable values shown in the table below. (Operation above the allowable values can cause adverse effects on service life, such as play in the table and loss of accuracy.)

Size	Allowable radial load (N)	Allowable thrust load (N)	Allowable moment (N·m)
1	20	15	0.3
3	40	30	0.7
7	50	60	0.9
20	60	80	2.9

Series MSUA

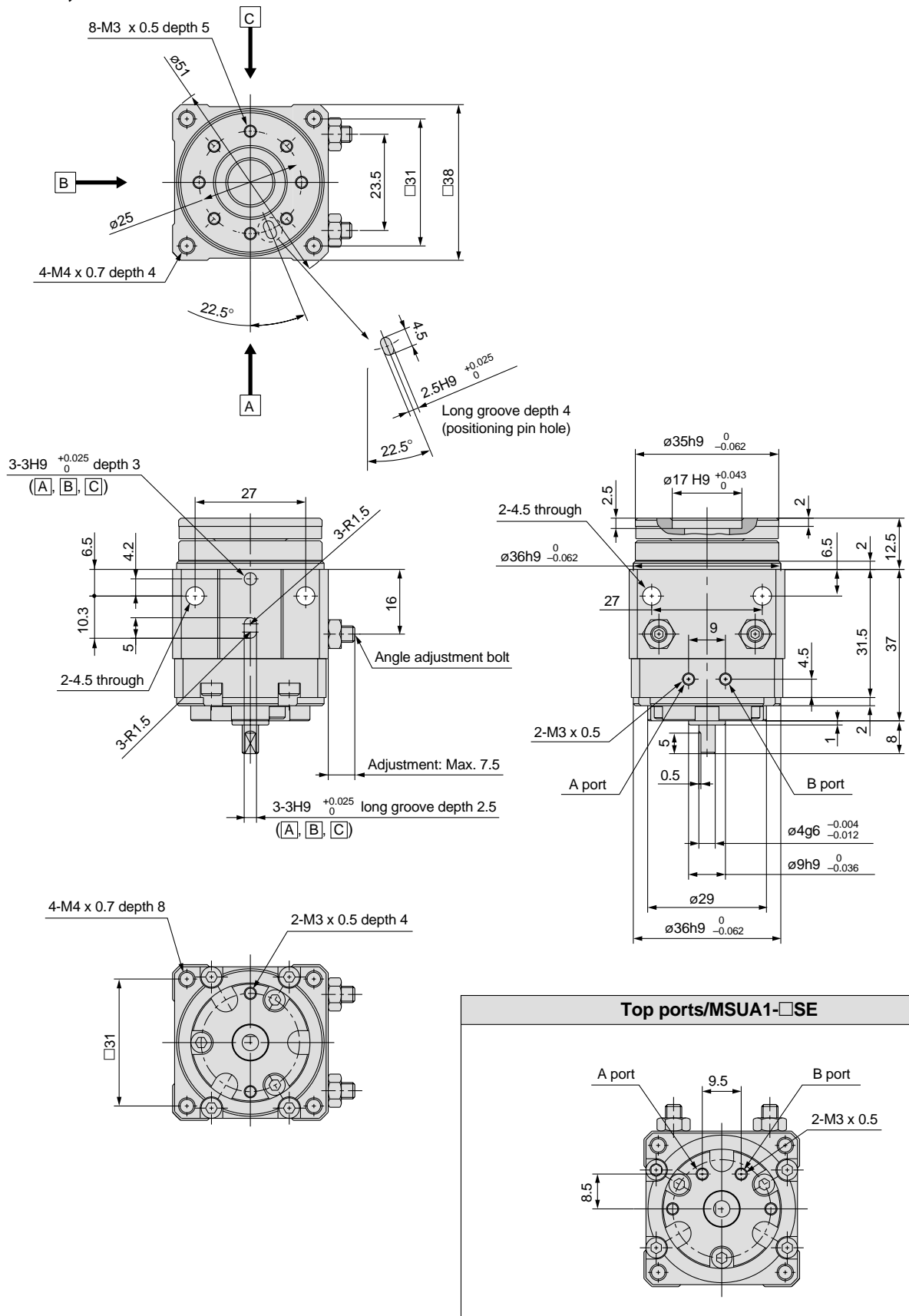
Dimensions

These drawings indicate the condition when the B port is pressurized.

MSUA1

MSUA1-□S, SE

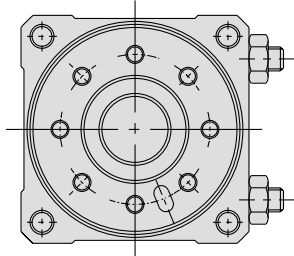
Scale: 70%



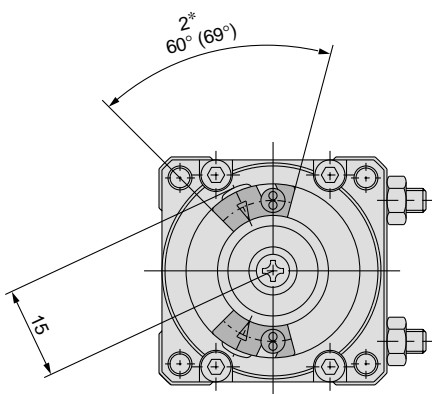
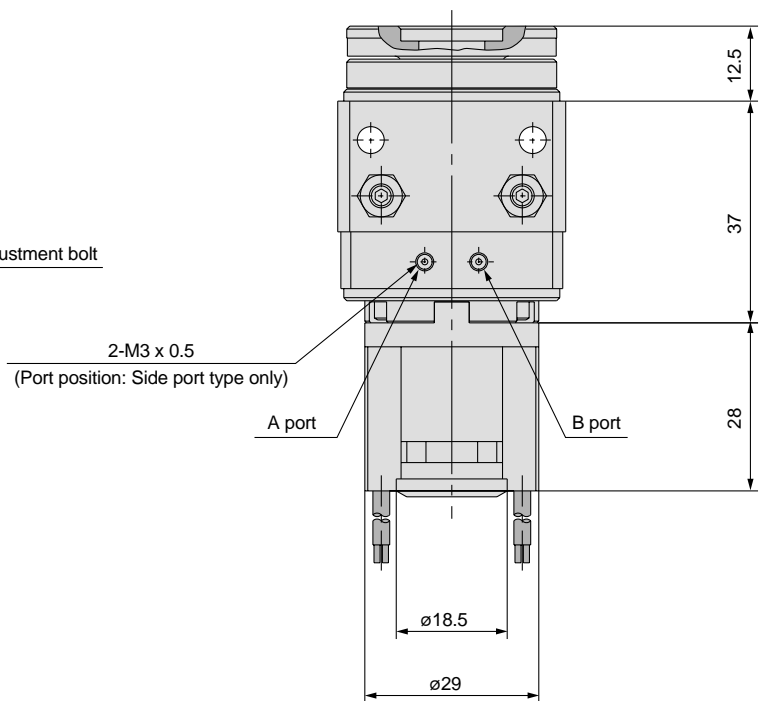
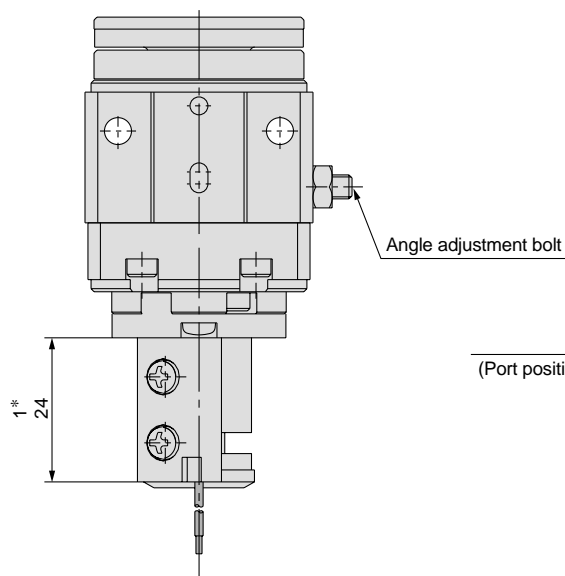
These drawings indicate the condition when the B port is pressurized.

Scale: 80%

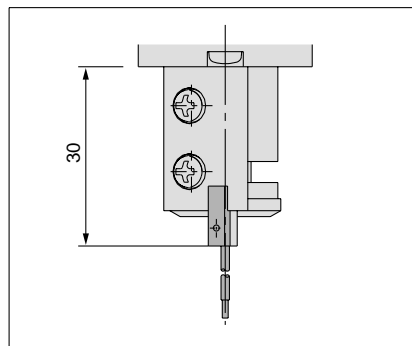
With auto switch: MSUA1-□S



- *1) 24 : When using D-90, 90A, S99, S99V, S9P, S9PV, T99, T99V
30 : When using D-97, 93A
- *2) 60°: When using D-90, 90A, 97, 93A
69°: When using D-S99, S99V, S9P, S9PV, T99, T99V



For D-97, 93A



Series MSUA

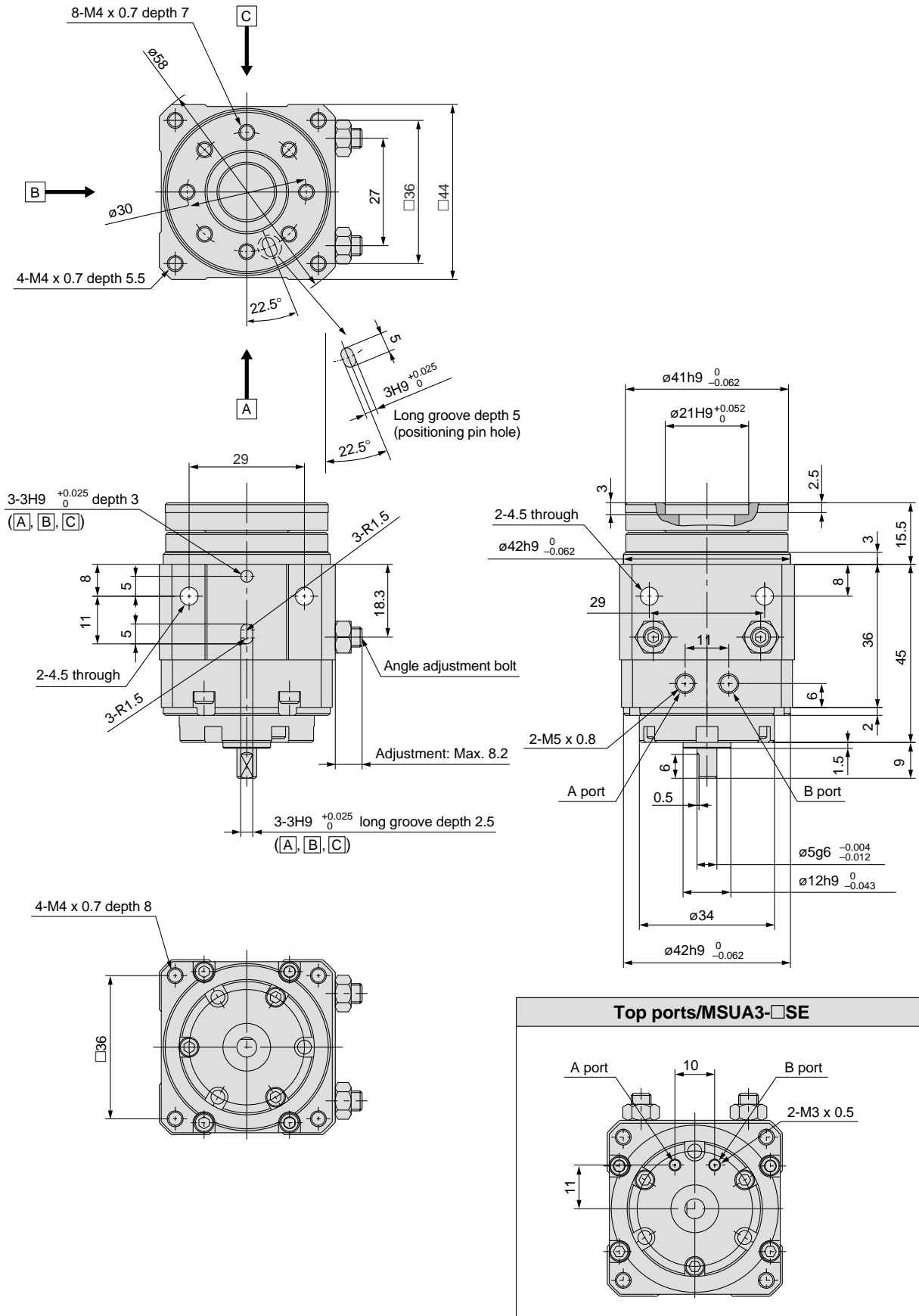
Dimensions

These drawings indicate the condition when the B port is pressurized.

MSUA3

MSUA3-□S, SE

Scale: 70%

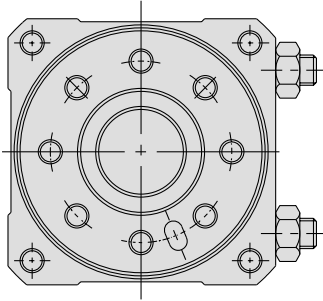


Rotary Table High Precision Type *Series MSUA*

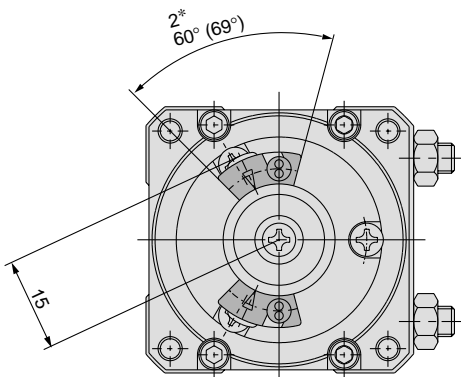
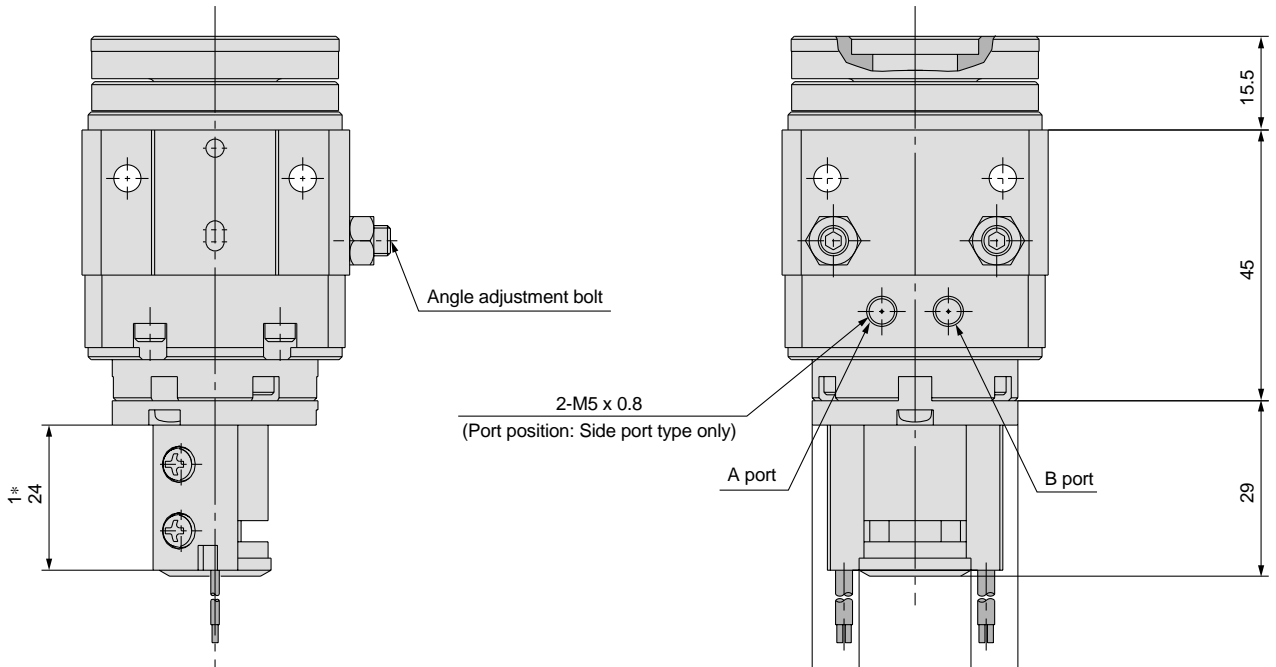
These drawings indicate the condition when the B port is pressurized.

Scale: 80%

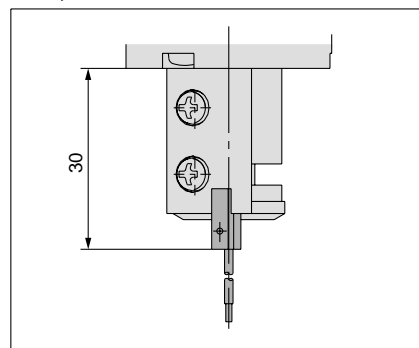
With auto switch: MDSUA3-□S



- *1) 24 : When using D-90, 90A, S99, S99V, S9P, S9PV, T99, T99V
30 : When using D-97, 93A
- *2) 60° : When using D-90, 90A, 97, 93A
69° : When using D-S99, S99V, S9P, S9PV, T99, T99V



D-97, 93A



Series MSUA

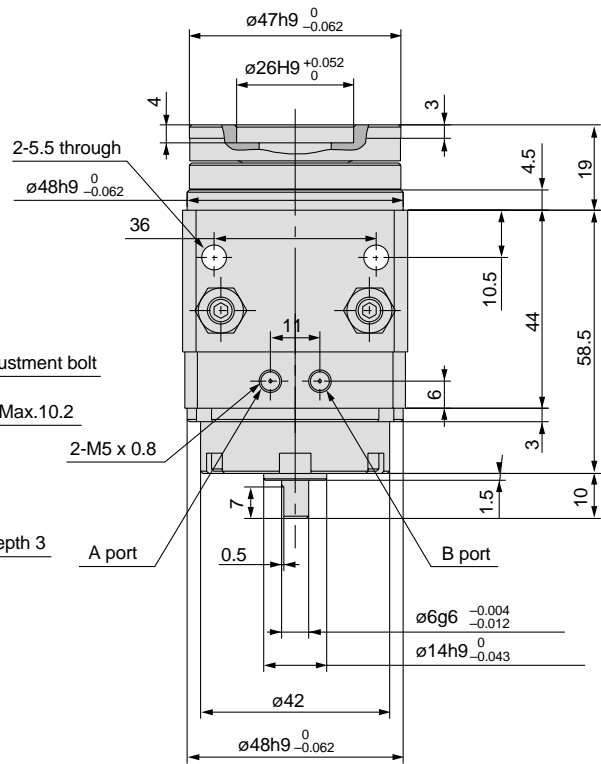
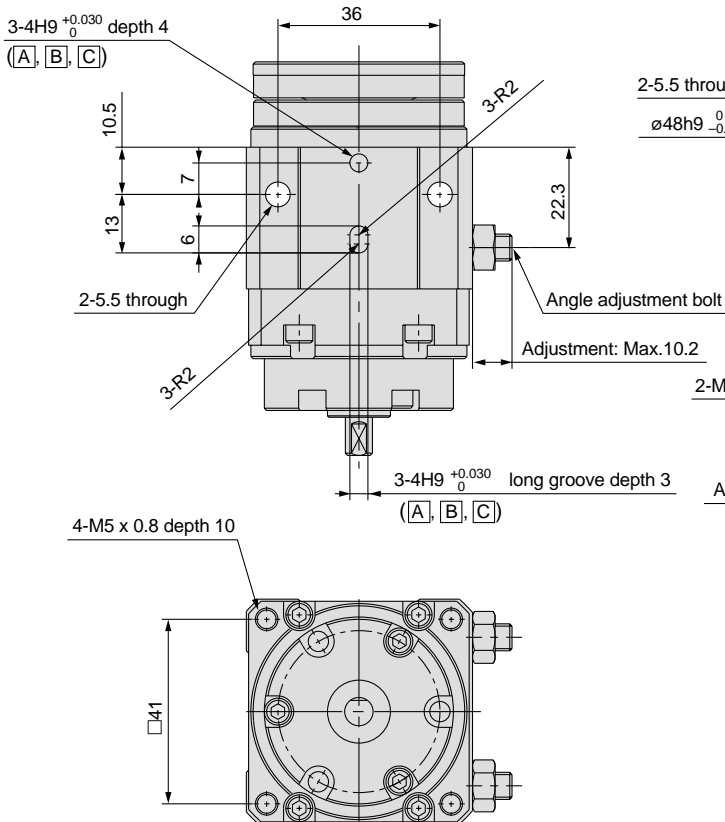
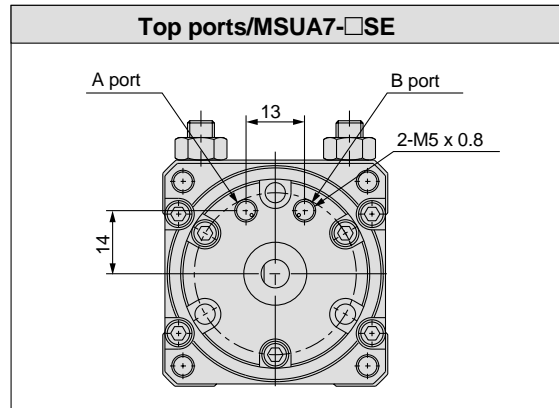
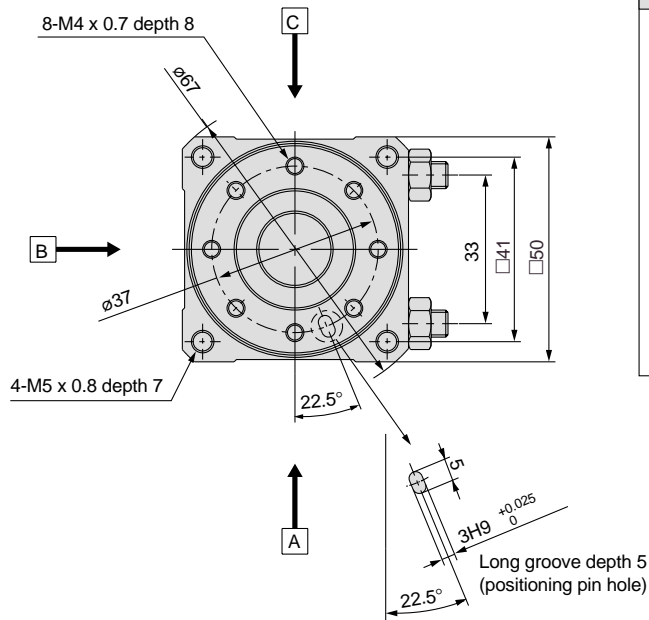
Dimensions

These drawings indicate the condition when the B port is pressurized.

MSUA7

MSUA7-□S, SE

Scale: 60%

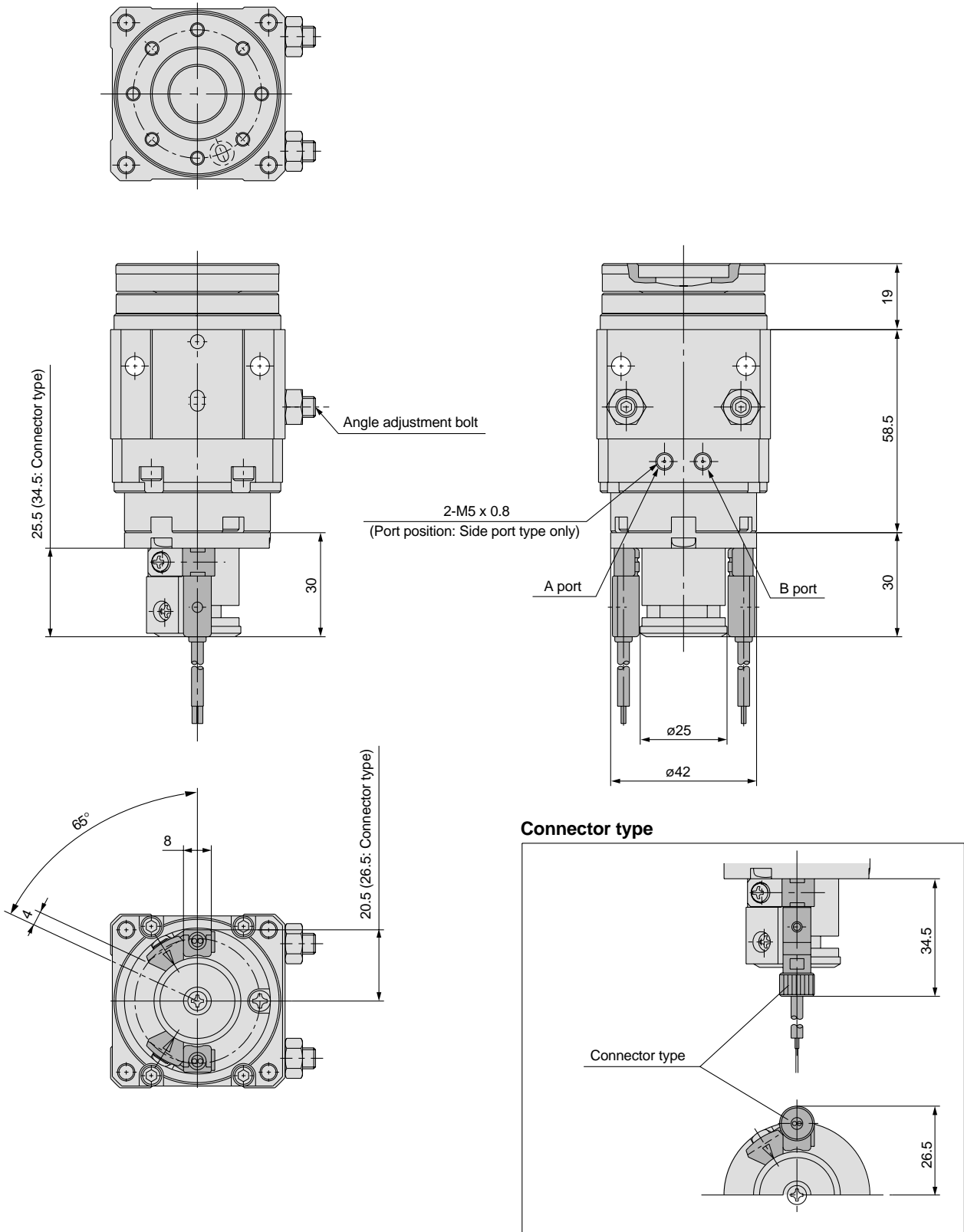


Rotary Table High Precision Type *Series MSUA*

These drawings indicate the condition when the B port is pressurized.

Scale: 60%

With auto switch: MDSUA7-□S



Series MSUA

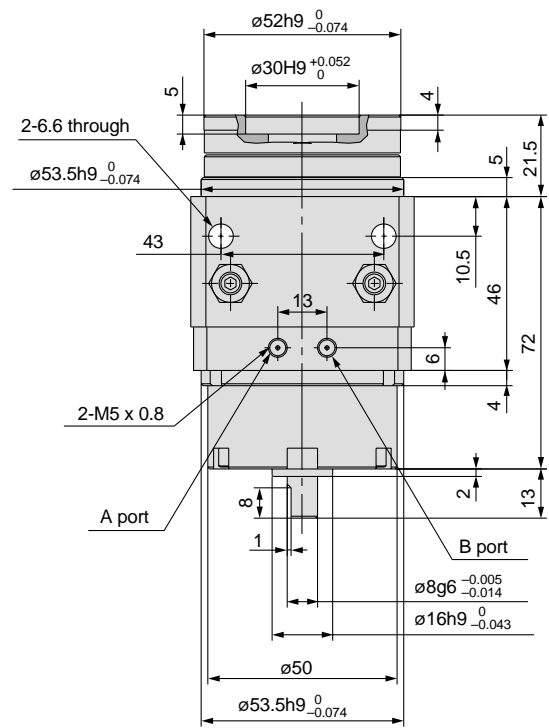
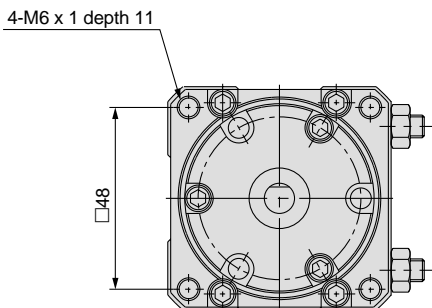
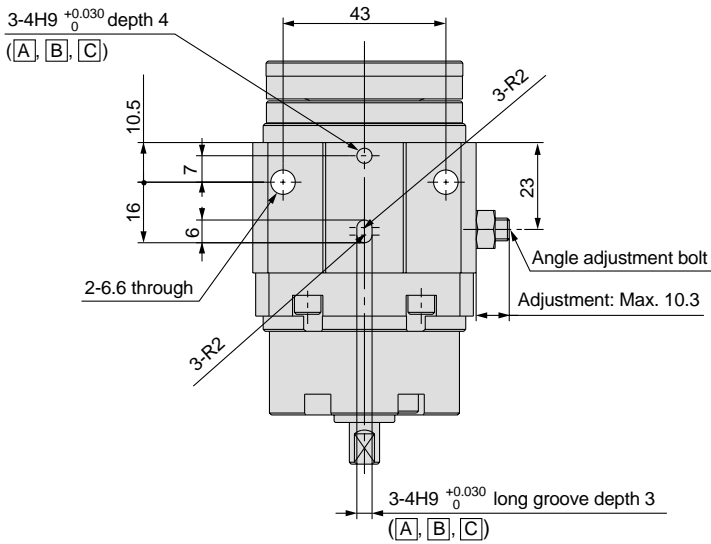
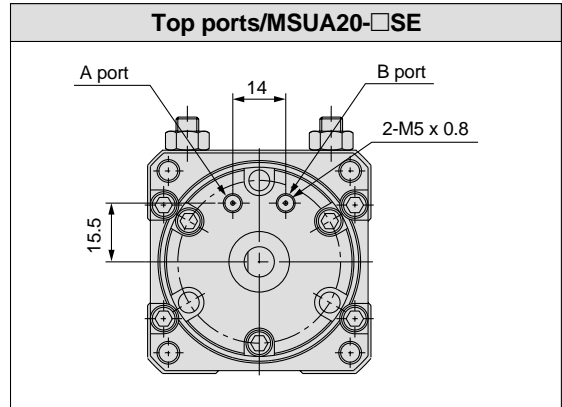
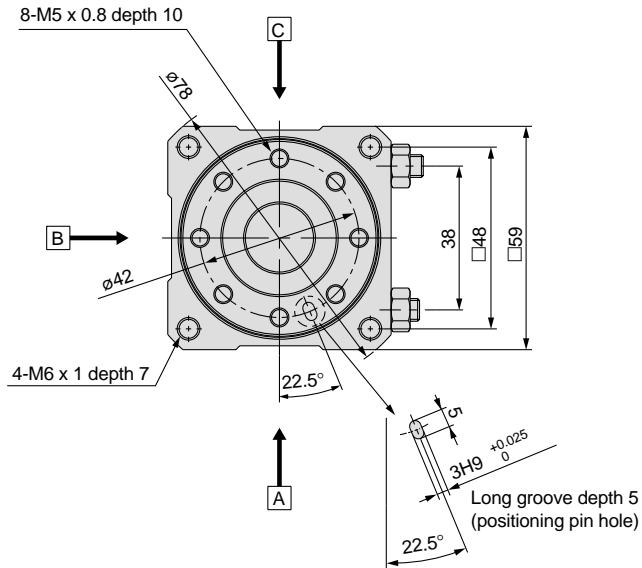
Dimensions

These drawings indicate the condition when the B port is pressurized.

MSUA20

MSUA20-□S, SE

Scale: 50%

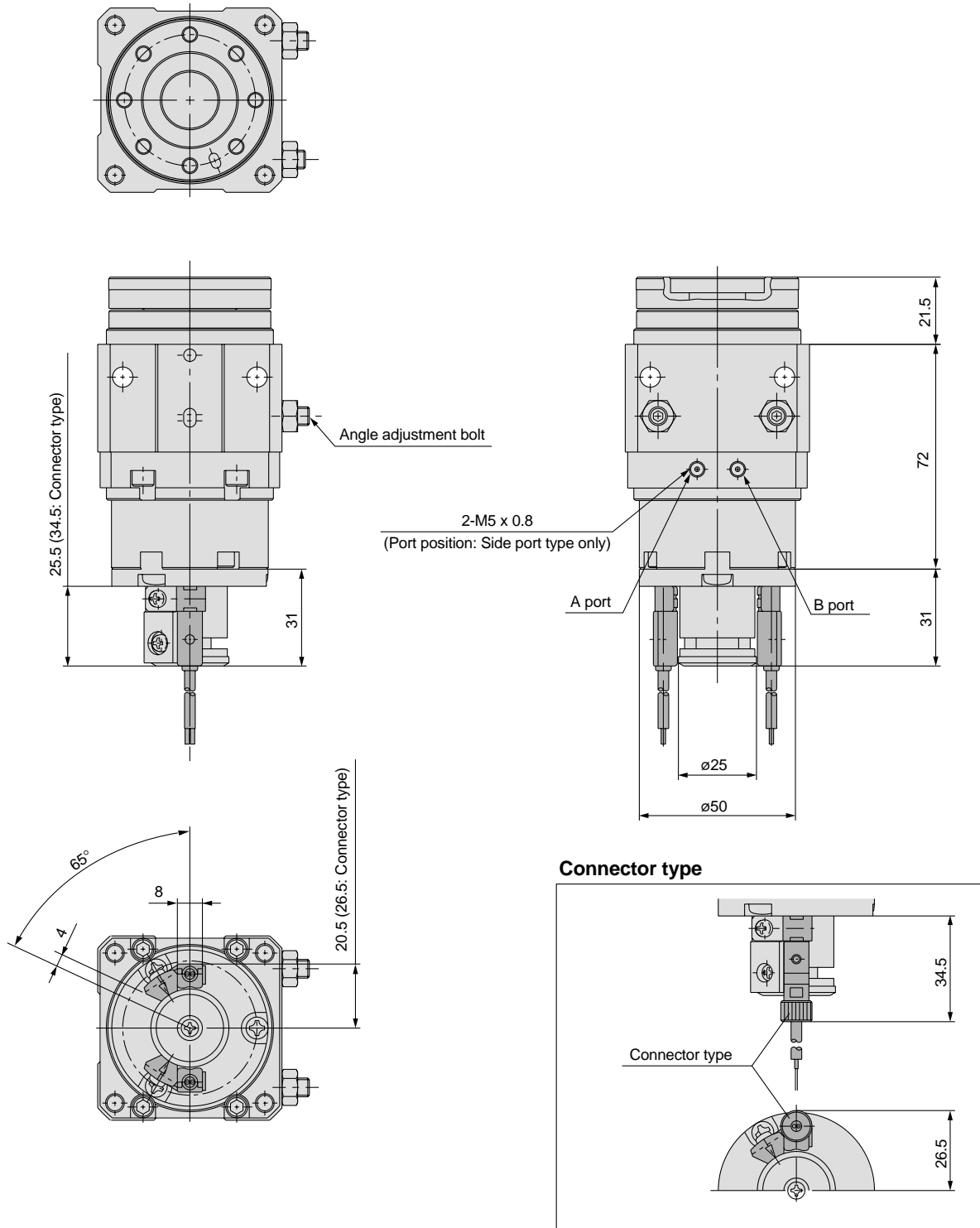


Rotary Table High Precision Type *Series MSUA*

These drawings indicate the condition when the B port is pressurized.

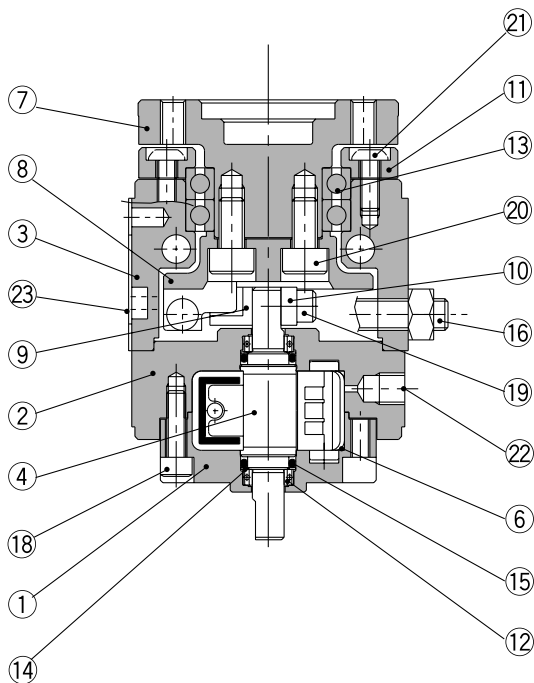
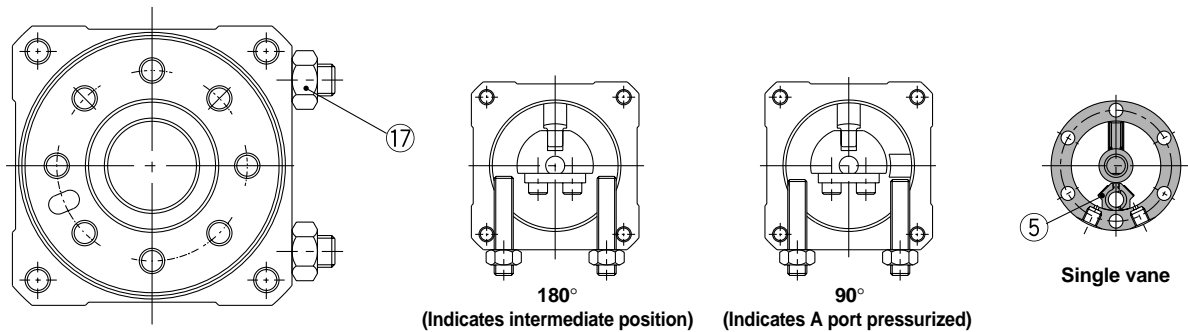
Scale: 50%

With auto switch: MDSUA20-□S



Series MSUA

Construction

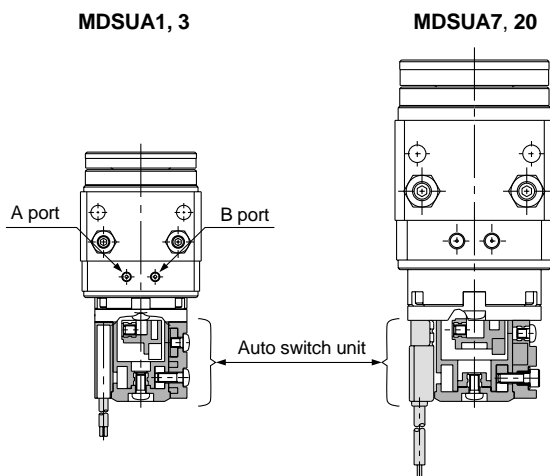


Parts list

No.	Description	Material	Note
1	Body A	Aluminum alloy	Light gray color
2	Body B	Aluminum alloy	Light gray color
3	Body C	Aluminum alloy	Light gray color
4	Vane shaft	Stainless steel (MSUA20 is carbon steel)	Single vane
5	Stopper	Resin	Single vane
6	Stopper seal	NBR	
7	Table	Aluminum alloy	Light gray color
8	Stopper lever	Carbon steel	
9	Stopper guide	Stainless steel	
10	Lever retainer	Carbon steel	
11	Bearing retainer	Aluminum alloy	Light gray color
12	Bearing	High carbon chrome bearing steel	
13	Special bearing	High carbon chrome bearing steel	
14	Back-up ring	Stainless steel	
15	O-ring	NBR	
16	Adjustment bolt	Carbon steel	
17	Hexagon nut	Carbon steel	
18	Hexagon socket head cap screw	Stainless steel	
19	Hexagon socket head cap screw	Stainless steel	
20	Hexagon socket head cap screw	Carbon steel	
21	Button bolt	Carbon steel	
22	Hexagon socket head set screw	Stainless steel	SE type only
23	Label		

* The plug 22 is used only when the connection port is type SE.

Internal construction with auto switch



Model	Auto switch unit part number
MDSUA 1	P211070-1
MDSUA 3	P211090-1
MDSUA 7	P211060-1
MDSUA20	P211080-1

* Auto switches are not included with switch units.

Auto switch block unit		
MDSUA1, 3		MDSUA7, 20
Right-handed	Left-handed	Combination left & right-handed
Part no.: P211070-8	Part no.: P211070-9	Part no.: P211060-8

* A switch block unit is the assembly required to mount one auto switch on a switch unit.

Rotary Table/Vane Type: Basic

Series **MSUB**

Sizes 1, 3, 7, 20



How to Order

Bearing type

B	Basic type
---	------------

Free-mount

Connection port position

Nil	Side ports
E	Top ports

Available with side ports only, when equipped with switch unit.

Without Auto Switch Unit

MSUB 20-90-S

With Auto Switch Unit

M D SUB 20-90-S-R73-L

Number of auto switches

S	1 pc.*
Nil	2 pcs.

* For 1 piece, a right hand auto switch is installed.

Electrical entry/Lead wire length

Nil	Grommet/lead wire 0.5m
L	Grommet/lead wire 3m
C	Connector/lead wire 0.5m
CL	Connector/lead wire 3m
CN	Connector/without lead wire

* Available only with R73, R80 and T79 type connectors.
** Lead wire with connector part nos.
D-LC05: Lead wire 0.5m
D-LC30: Lead wire 3m
D-LC50: Lead wire 5m

Type of auto switch

Nil	Without auto switch
-----	---------------------

* Select applicable auto switches from the table below.

Nominal size (torque)

1	MSUB 1
3	MSUB 3
7	MSUB 7
20	MSUB 20

Rotation

Application	Symbol	Rotation
Single vane	90	90°
	180	180°
Double vane	90	90°

Rotation adjustment range
Single vane: Both ends ±5° each
Double vane: Both ends ±2.5° each

Vane type

S	Single vane
D	Double vane

Applicable auto switches/Refer to pages 26 through 35 for detailed auto switch specifications.

Applicable model	Type	Electrical entry	Indicator light	Wiring (output)	Load voltage		Auto switch part no.	Lead wire type	Lead wire length (m)*				Applicable loads		
					DC	AC			0.5 (Nil)	3 (L)	5 (Z)	None (N)			
MDSUB1 MDSUB3	Reed	Grommet	No	2 wire	24V	5V, 12V	5V, 12V, 24V	90	Parallel cord	●	●	●	—	Relay, PLC	
						5V, 12V, 100V	5V, 12V, 24V, 100V	90A	Heavy duty	●	●	●	—		
						—	100V	93A	Parallel cord	●	●	●	—		
	Solid state					Yes	3 wire (NPN)	5V, 12V	T99	Heavy duty	●	●	—		—
									T99V		●	●	—		—
									S99		●	●	—		—
3 wire (PNP)	S99V	●	●	—	—										
	S9P	●	●	—	—										
	S9PV	●	●	—	—										
MDSUB7 MDSUB20	Reed	Grommet	Yes	2 wire	24V	—	100V	R73	Heavy duty	●	●	—	—	Relay, PLC	
						—	100V	R73C		●	●	●	●		
						48V, 100V	24V, 48V, 100V	R80		●	●	—	—		
	Solid state					No	Grommet	12V		R80C	●	●	●		●
										T79	●	●	—		—
										T79C	●	●	●		●
Grommet	Yes	3 wire (NPN)	5V, 12V	S79	●		●	—	—						
				S7P	●		●	—	—						
				—	—		—	—	—						

- Order example: MSUA20 single vane type (connection port side position selected)
- Standard type (without auto switches), rotation 90°, side port position MSUB20-90S
 - With switch unit (without auto switches), rotation 180°, side port position MDSUB20-180S
 - With switch unit + auto switch R73, rotation 180°, side port position MDSUB20-180S-R73

* Lead wire length symbols 0.5m Nil (Example) R73C ● Operating time — 1.2ms ● Operating temperature range — 5 to 60°C
 3m L (Example) R73CL ● Impact resistance — 300m/s² (reed), 1000m/s² (solid state)
 5m Z (Example) R73CZ
 None N (Example) R73CN

Specifications

Model ^{3*}		MSUB1			MSUB3			MSUB7			MSUB20		
Vane type		Single vane		Double vane	Single vane		Double vane	Single vane		Double vane	Single vane		Double vane
Rotation ^{1*}		90°±10°		180°±10°	90°±5°		180°±10°	90°±5°		180°±10°	90°±5°		180°±10°
Fluid		Air (unlubricated)											
Proof pressure MPa		1.05						1.5					
Ambient and fluid temperature		5 to 60°C											
Operating pressure range MPa		0.2 to 0.7			0.15 to 0.7						0.15 to 1.0		
Rotation time adjustment range sec/90°		0.07 to 0.3											
Shaft load	Allowable radial load	20N			40N			50N			60N		
	Allowable thrust load ^{2*}	15N			30N			60N			80N		
	Allowable moment	10N			15N			30N			40N		
Bearing		Bearings											
Port position		Side ports or Top ports											
Port size	Side ports	M3 x 0.5			M5 x 0.8								
	Top ports	M3 x 0.5						M5 x 0.8					

*1. Single vane 90° type can be adjusted to 90°±10° (both ends of rotation ±5° each)
 Single vane 180° type can be adjusted to 180°±10° (both ends of rotation ±5° each)
 Double vane 90° type can be adjusted to 90°±5° (both ends of rotation ±2.5° each)
 • Rotation angles other than 90° and 180° (single vane) are available by special order.

*2. The allowable thrust load is directional. For details refer to the allowable load table below.

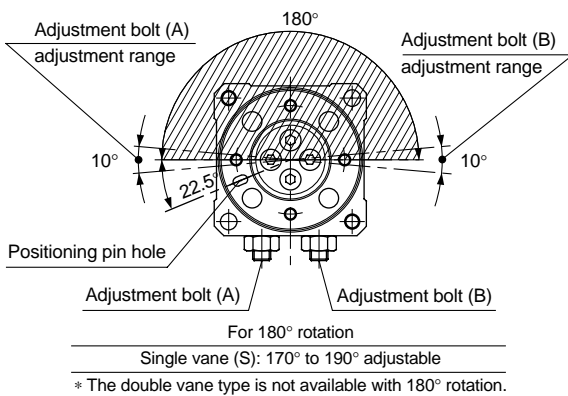
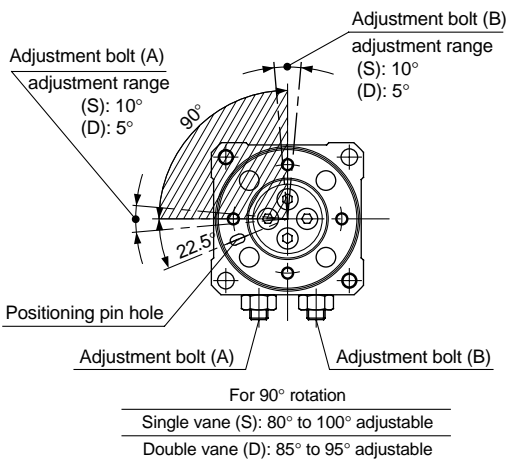
(Note) Refer to page 39 for allowable kinetic energy.

*3. Correspondence to equivalent conventional free-mount types

Rotary table	Free-mount rotary actuator
MSUB 1	CRBUW10
MSUB 3	CRBUW15
MSUB 7	CRBUW20
MSUB20	CRBUW30

Table Rotation Range

Angle adjustment is possible as shown in the drawings below using adjustment bolts (A) and (B).



Applicable Auto Switches

Auto switch type	MDSUB1, 3	MDSUB7, 20
Reed switch	D-90/97, D-90A/93A	D-R7, R8
Solid state switch	D-S99, D-T99, D-S9P	D-S7, D-S7P, T7

Weights

Unit: g

Size	Rotation	Basic weight		Auto switch unit + Auto switch 2 pcs.
		Single vane	Double vane	
1	90	145	150	25
	180	140	—	
3	90	230	240	30
	180	225	—	
7	90	360	375	50
	180	355	—	
20	90	510	580	60
	180	505	—	

Allowable Loads

Do not permit the load and moment applied to the table to exceed the allowable values shown in the table below. (Operation above the allowable values can cause adverse effects on service life, such as play in the table and loss of accuracy.)

Size	Allowable radial load (N)	Allowable thrust load (N)		Allowable moment (N·m)
1	20	(A) 15	(B) 10	0.3
3	40	30	15	0.7
7	50	60	30	0.9
20	60	80	40	2.9

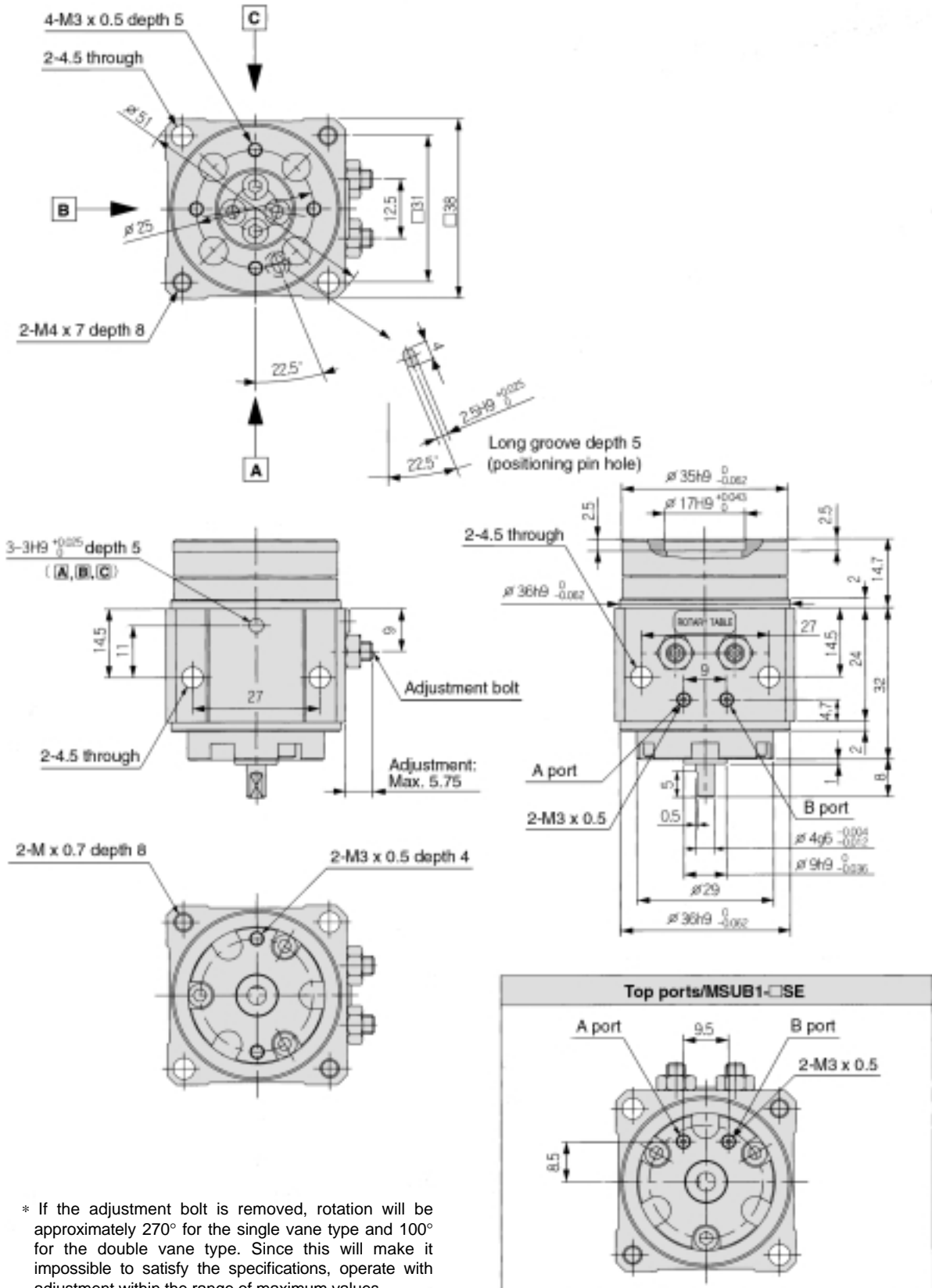
Series MSUB

Dimensions

These drawings indicate the condition when the B port is pressurized.

MSUB1 (Single vane)

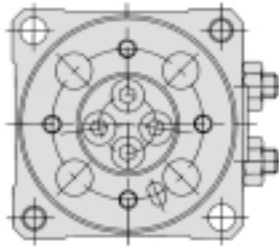
MSUB1-□S, SE



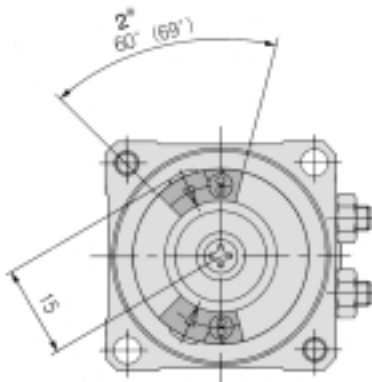
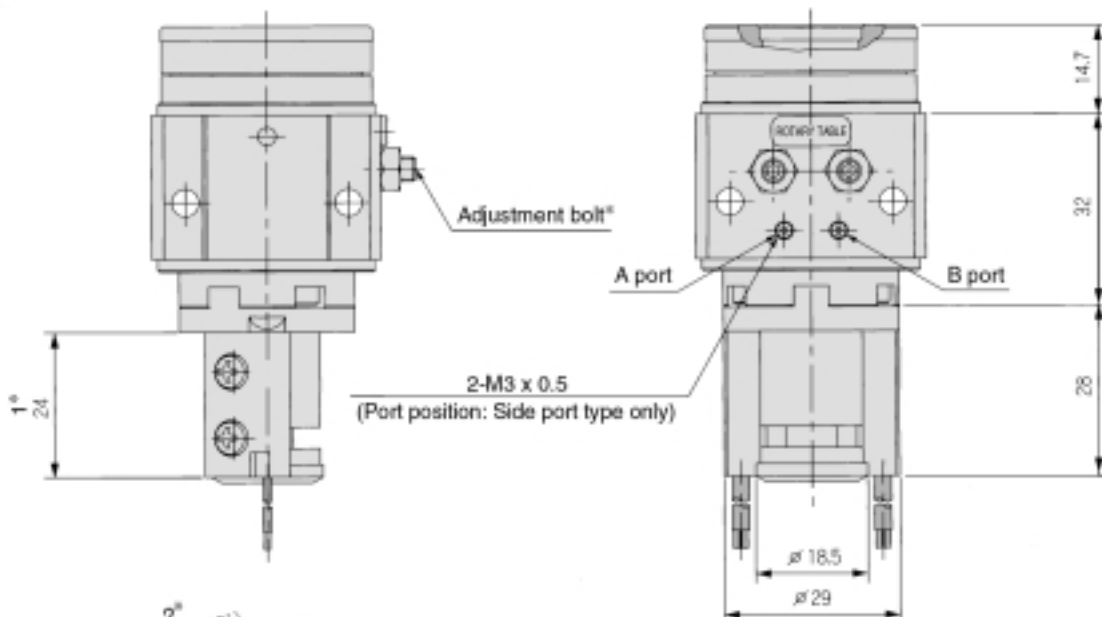
* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.

These drawings indicate the condition when the B port is pressurized.

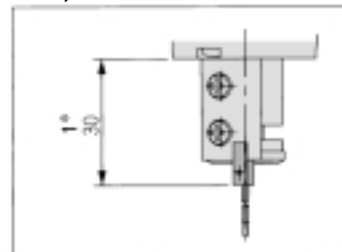
With auto switch: MDSUB1-□S



- *1) When using 24 : D-90, 90A, S99(V), T99(V), S9P(V)
When using 30 : D-97, 93A
- *2) When using 60° : D-90, 90A, 97, 93A
When using 69° : D-S99(V), T99(V), S9P(V)



D-97, 93A



* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.

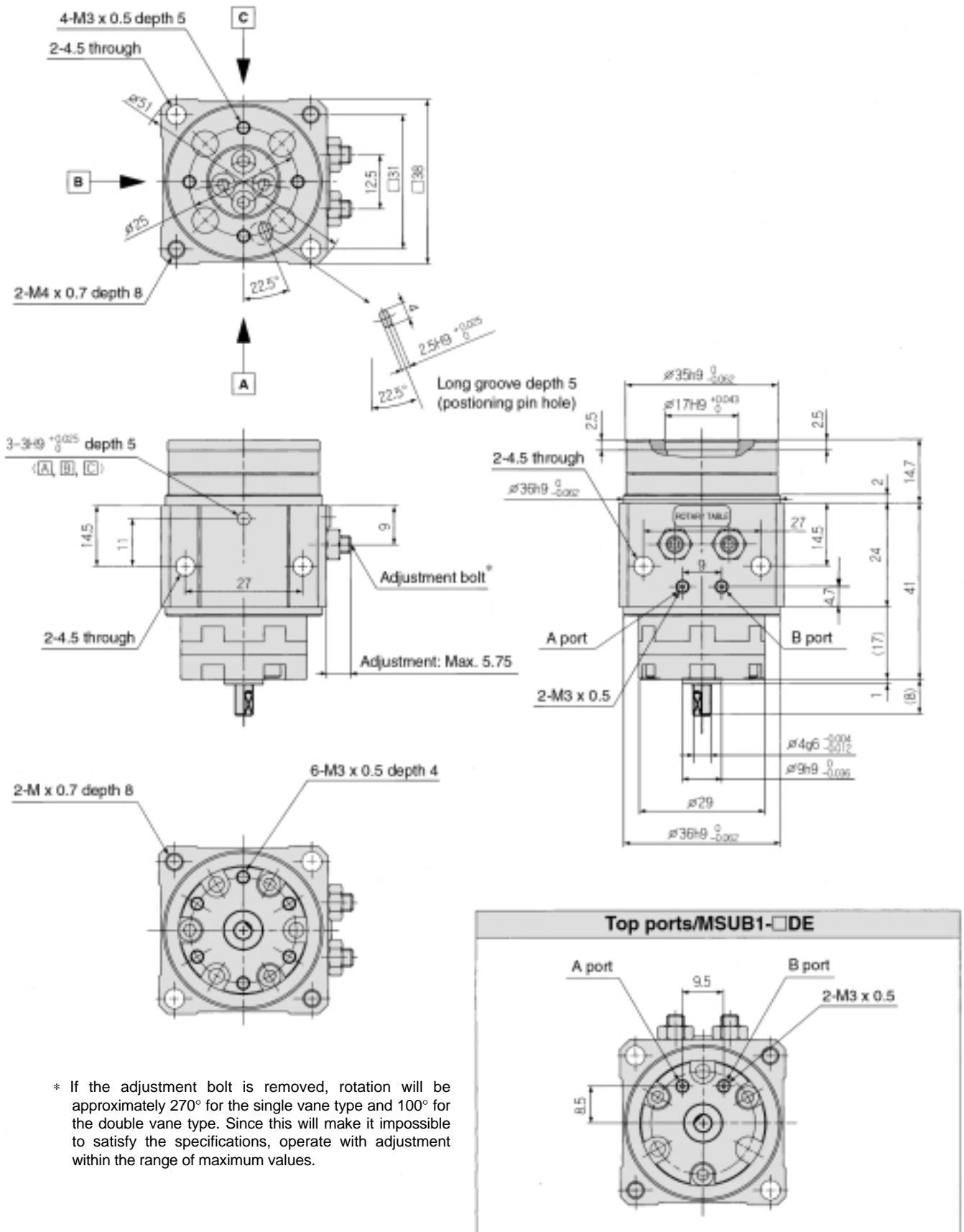
Series MSUB

Dimensions

These drawings indicate the condition when the B port is pressurized.

MSUB1 (Double vane)

MSUB1-□D



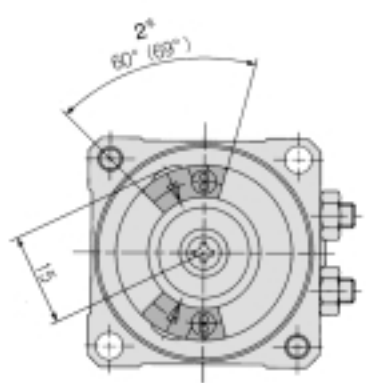
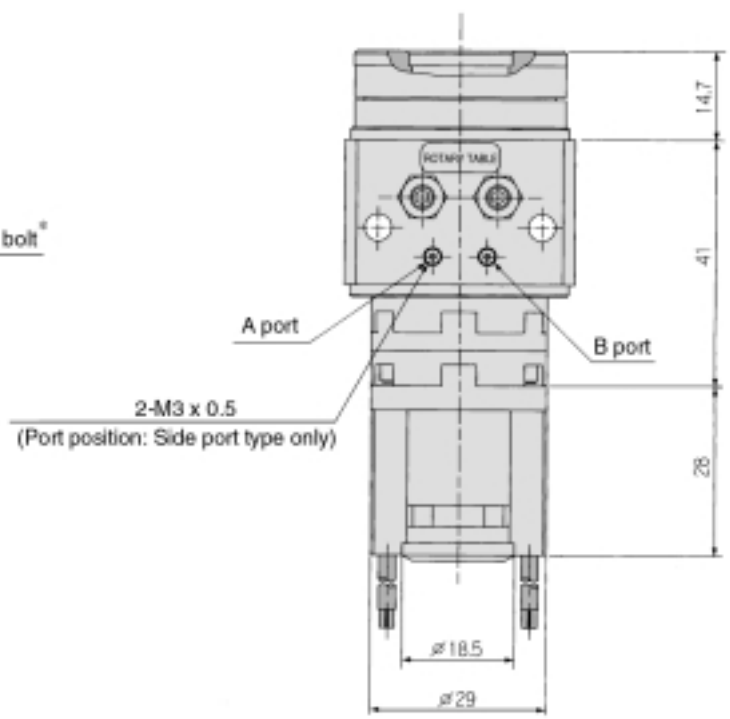
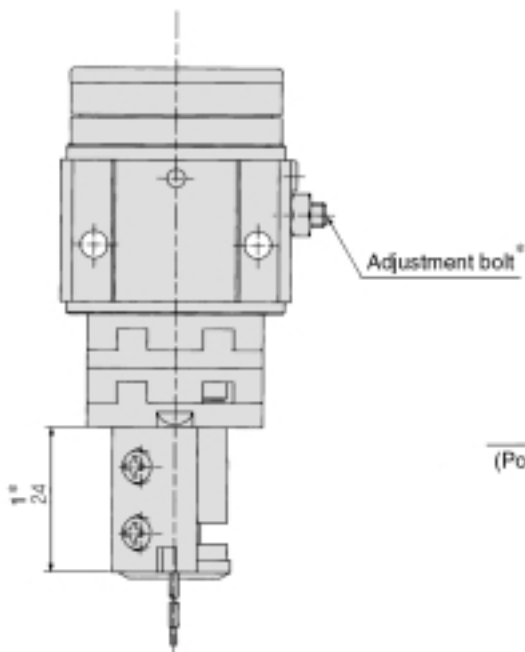
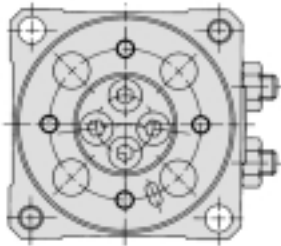
* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.

These drawings indicate the condition when the B port is pressurized.

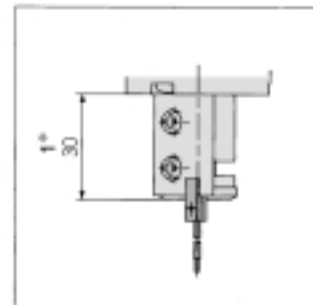
With auto switch: MDSUB1-□D

*1) When using 24 : D-90, 90A, S99(V), T99(V), S9P(V)
When using 30 : D-97, 93A

*2) When using 60° : D-90, 90A, 97, 93A
When using 69° : D-S99(V), T99(V), S9P(V)



D-97, 93A

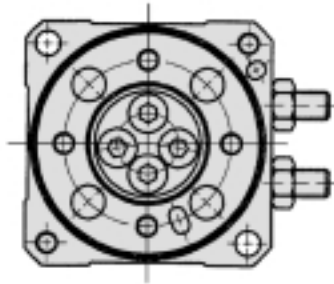


* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.

Rotary Table *Series MSUB*

These drawings indicate the condition when the B port is pressurized.

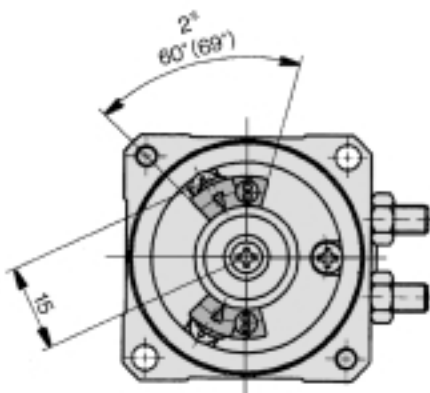
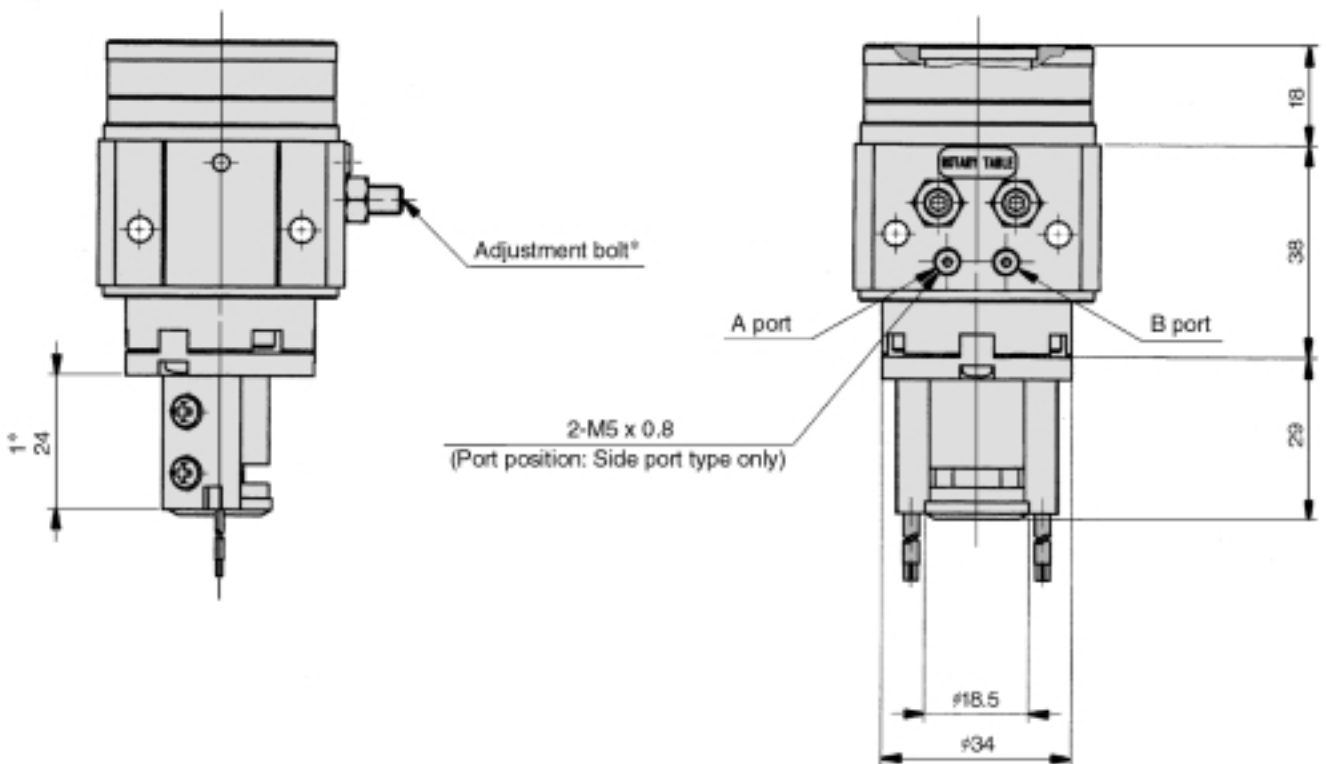
With auto switch: MDSUB3



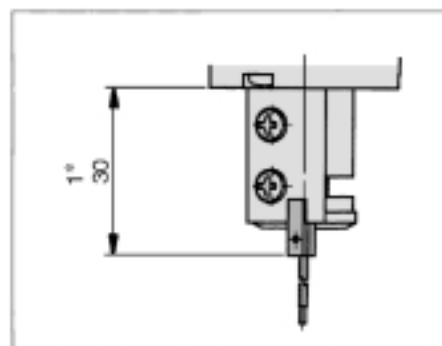
*1) When using 24 : D-90, 90A, S99(V), T99(V), S9P(V)
When using 30 : D-97, 93A

*2) When using 60° : D-90, 90A, 97, 93A
When using 69° : D-S99(V), T99(V), S9P(V)

* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.



D-97, 93A



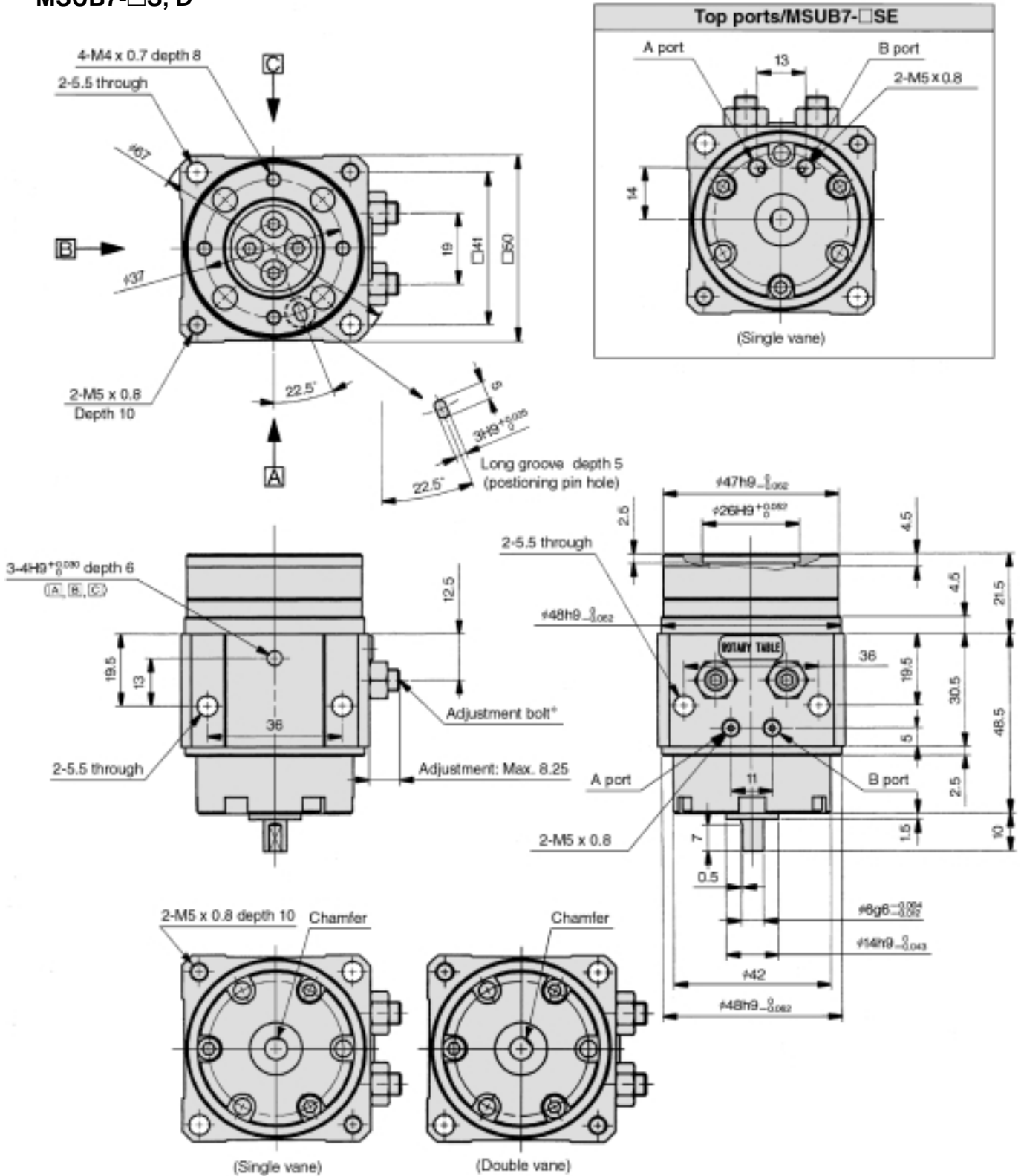
Series MSUB

Dimensions

These drawings indicate the condition when the B port is pressurized.

MSUB7 (Single vane, Double vane)

MSUB7-□S, D



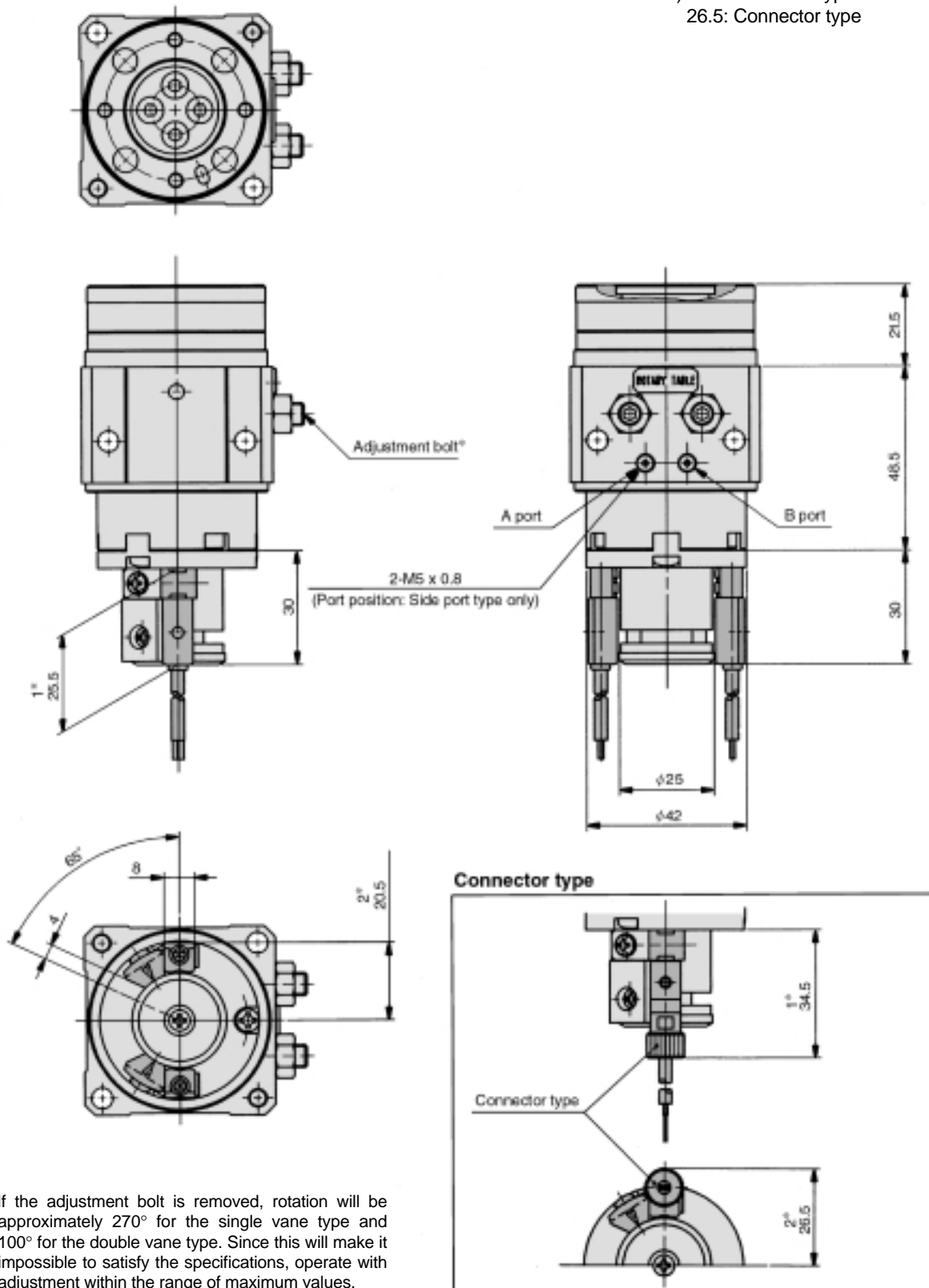
The outside drawings show the single vane type, but only the position of the chamfered sections shown in the above drawings differs for single and double vane.

* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.

These drawings indicate the condition when the B port is pressurized.

With auto switch: MDSUB7

- *1) 25.5: Grommet type
34.5: Connector type
- *2) 20.5: Grommet type
26.5: Connector type



* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.

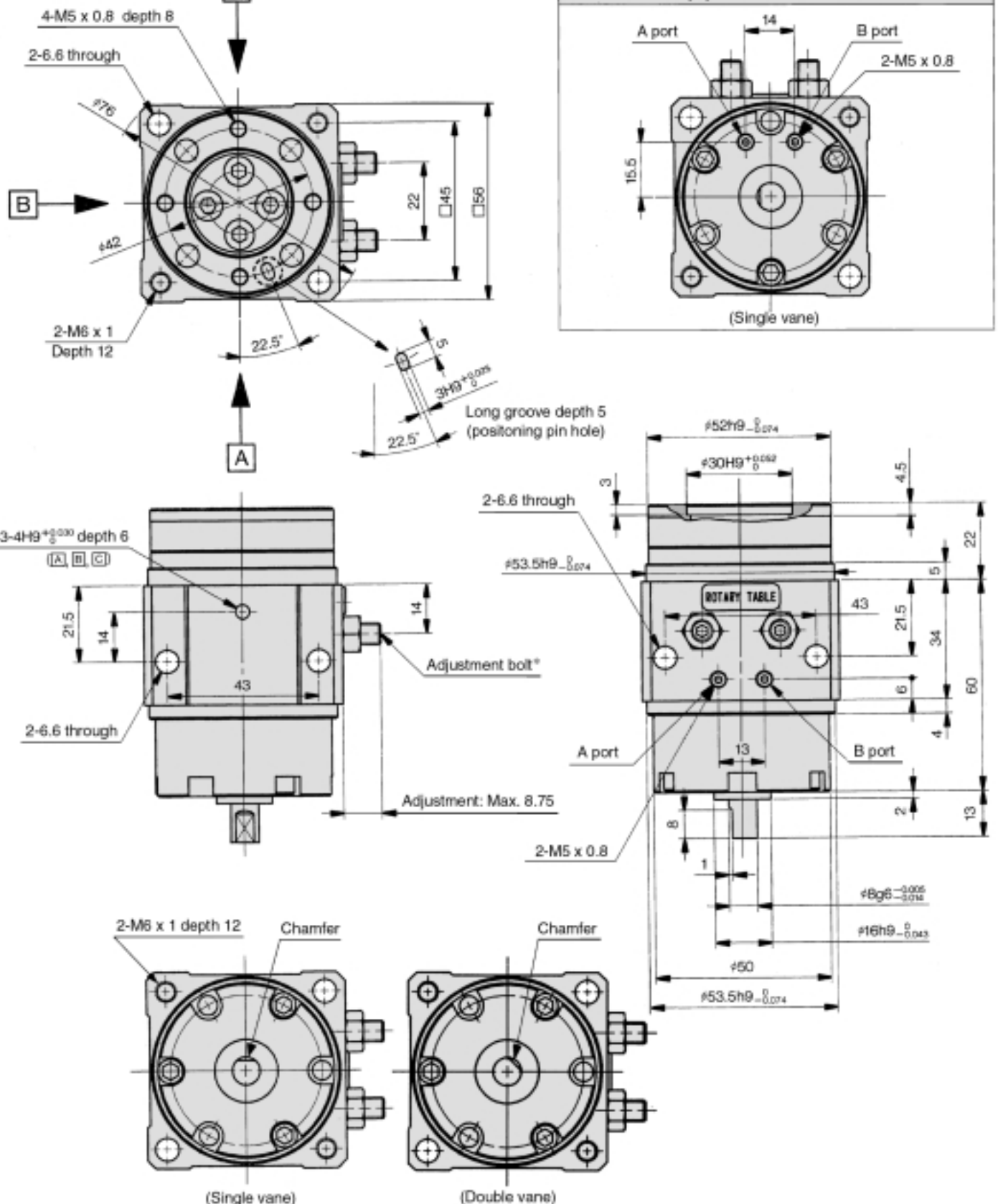
Series MSUB

Dimensions

These drawings indicate the condition when the B port is pressurized.

MSUB20 (Single vane, Double vane)

MSUB20-□S, D



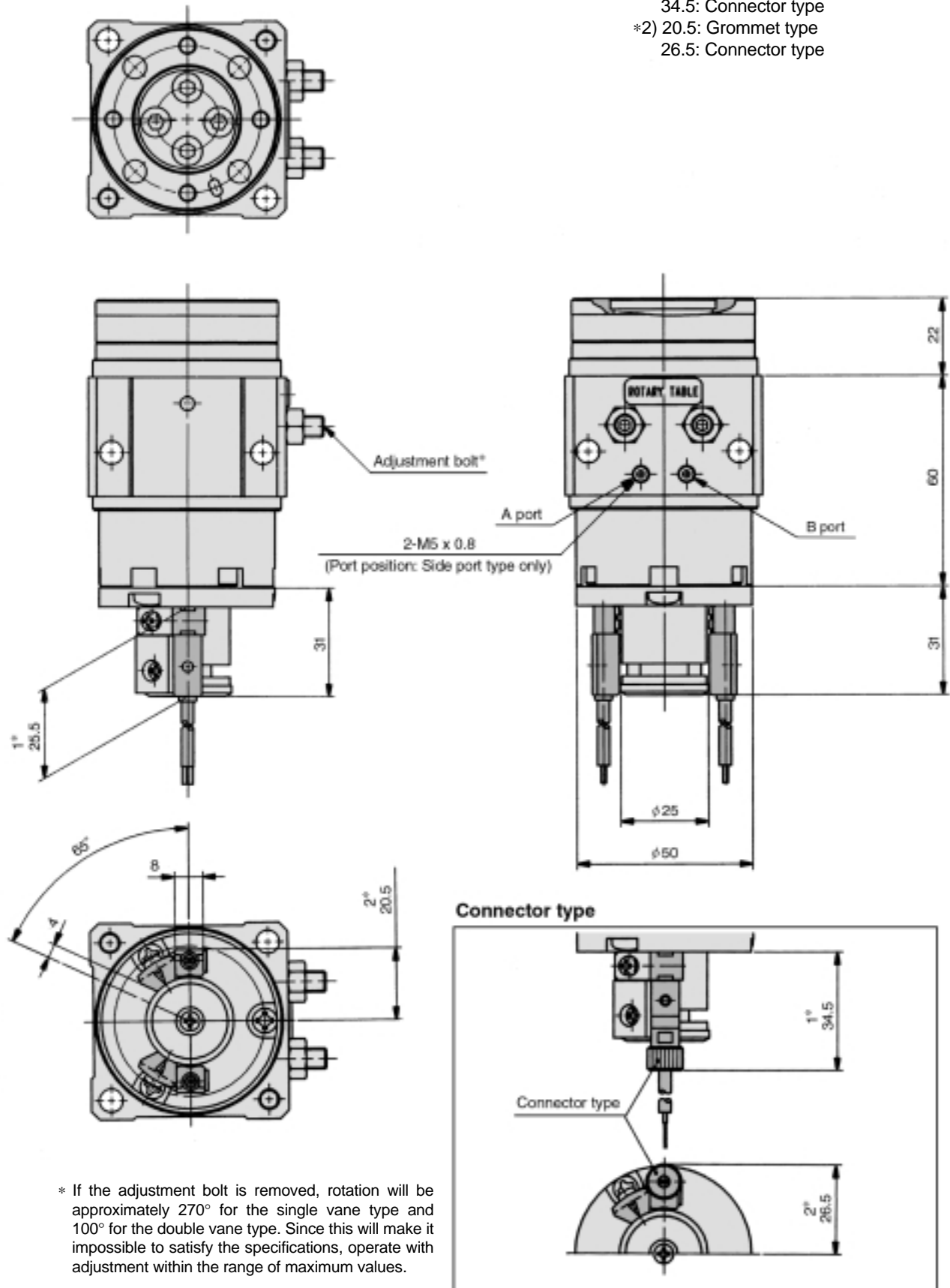
The outside drawings show the single vane type, but only the position of the chamfered sections shown in the above drawings differs for single and double vane.

* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.

These drawings indicate the condition when the B port is pressurized.

With auto switch: MDSUB20

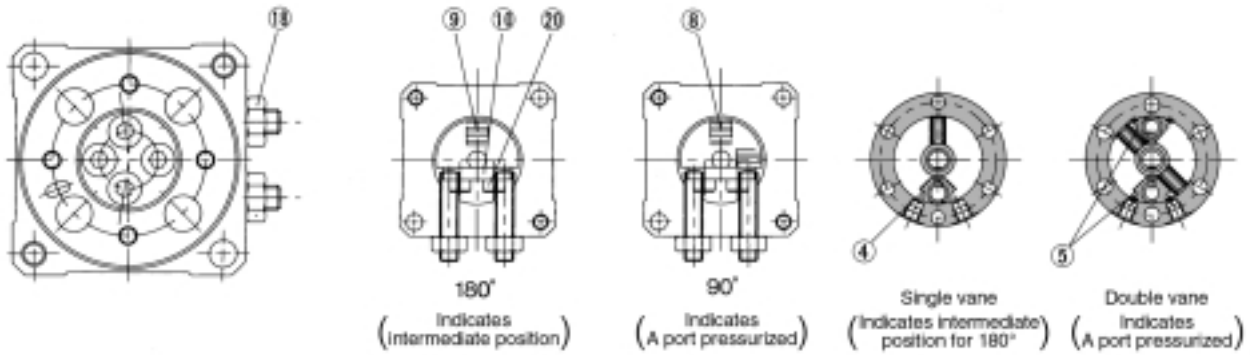
- *1) 25.5: Grommet type
34.5: Connector type
- *2) 20.5: Grommet type
26.5: Connector type



* If the adjustment bolt is removed, rotation will be approximately 270° for the single vane type and 100° for the double vane type. Since this will make it impossible to satisfy the specifications, operate with adjustment within the range of maximum values.

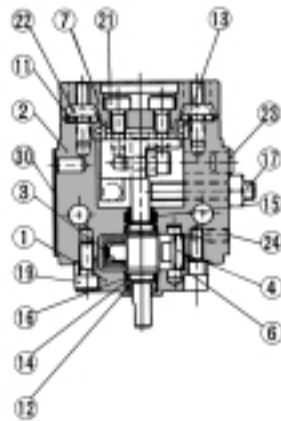
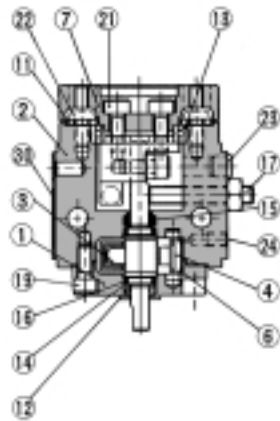
Series MSUB

Construction/Parts List



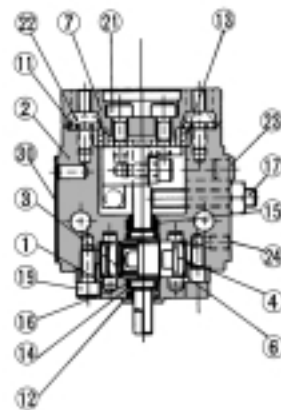
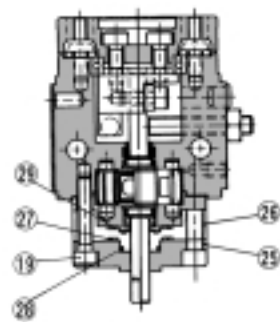
Single vane: Size 1

Single vane: Sizes 3, 7, 20



Double vane: Size 1

Double vane: Sizes 3, 7, 20



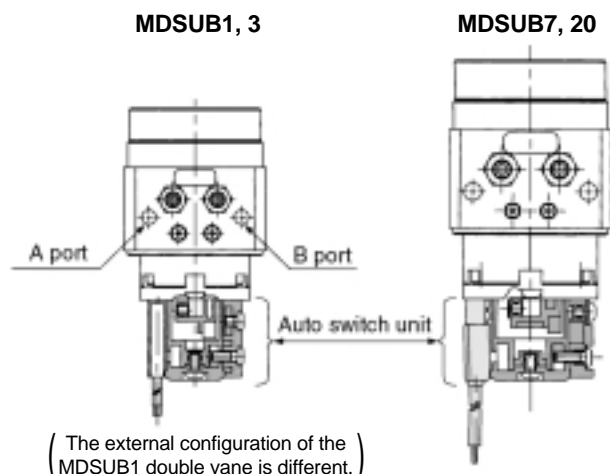
Parts list

No.	Description	Material	Note
1	Body (A)	Aluminum alloy	Light gray color
2	Body (B)	Aluminum alloy	Light gray color
3	Vane shaft	Stainless steel (MSUB20: Carbon steel)	Single vane
		Carbon steel	Double vane
4	Stopper	Resin	Single vane
5	Stopper	Stainless steel	Double vane
6	Stopper seal	NBR	
7	Table	Aluminum alloy	Light gray color
8	Stopper lever (D)	Carbon steel	
9	Stopper lever (S)	Carbon steel	
10	Lever retainer	Carbon steel	
11	Ring collar	Carbon steel	
12	Bearing	High carbon chrome bearing steel	
13	Bearing	High carbon chrome bearing steel	
14	Back-up ring	Stainless steel	
15	Scraper	NBR	
16	O-ring	NBR	
17	Adjustment bolt	Carbon steel	
18	Hexagon nut	Stainless steel	
19	Hexagon socket head cap screw	Stainless steel	
20	Hexagon socket head cap screw	Stainless steel	
21	Hexagon socket head cap screw	Stainless steel	
22	Button bolt	Carbon steel	
23	Rubber cap	NBR	
24	Hexagon socket head set screw	Stainless steel	
25	Cover	Aluminum alloy	SE type only
26	Plate	Resin	
27	Gasket	NBR	
28	O-ring	NBR	
29	O-ring	NBR	
30	Label		

* The plug number 24 is used only when the connection port is type SE.

Internal construction with auto switch

Units are common for both single and double vane.



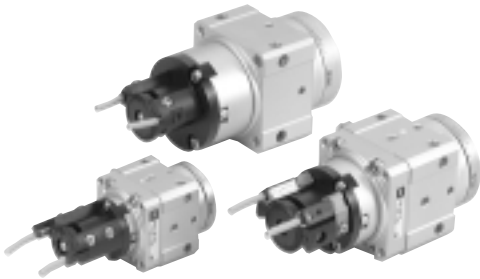
Model	Auto switch unit part no.
MDSUB 1	P211070-1
MDSUB 3	P211090-1
MDSUB 7	P211060-1
MDSUB20	P211080-1

* Auto switches are not included with switch units.

Auto switch block unit		
For MDSUB1, 3		For MDSUB7, 20
Right-handed	Left-handed	Combination left & right-handed
Part no.: P211070-8	Part no.: P211070-9	Part no.: P211060-8

* A switch block unit is the assembly required to mount one auto switch on a switch unit.

Series MSU Auto Switch Specifications



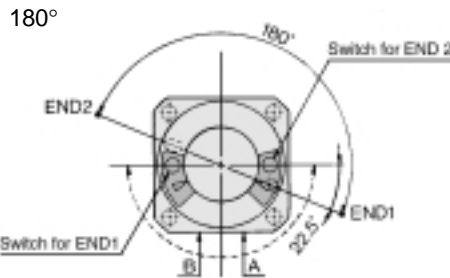
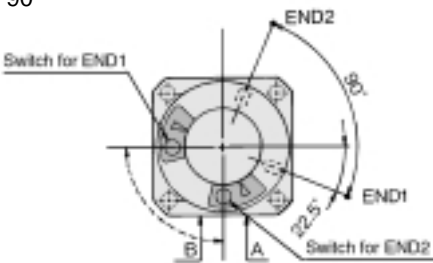
Applicable auto switches

Applicable series	Auto switch model		Electrical entry
MDSU□1 MDSU□3	Reed switch	D-90, 90A	Grommet (2 wire)
		D-97, 93A	Grommet (2 wire)
	Solid state switch	D-S99, S99V	Grommet (3 wire)
		D-S9P, S9PV	Grommet (3 wire) PNP
D-T99, T99V		Grommet (2 wire)	
MDSU□7 MDSU□20	Reed switch	D-R73	Grommet (2 wire)
		D-R80	Grommet (2 wire), Connector (2 wire)
	Solid state switch	D-S79	Grommet (3 wire)
		D-S7P	Grommet (3 wire) PNP
		D-T79	Grommet (2 wire), Connector (2 wire)

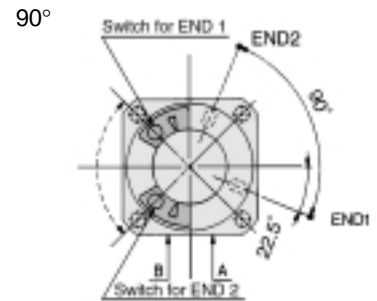
Table Positioning Pin Hole Rotation Range and Auto Switch Mounting Position

MSU□1, 3

Single vane type
90°

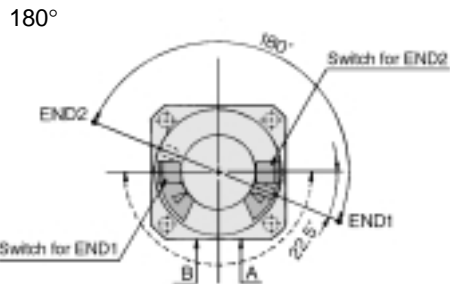
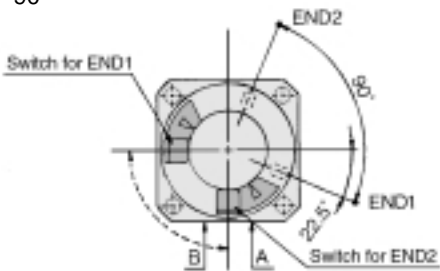


Double vane type (MSUB only)

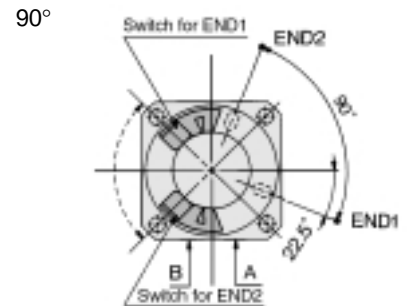


MSU□7, 20

Single vane type
90°



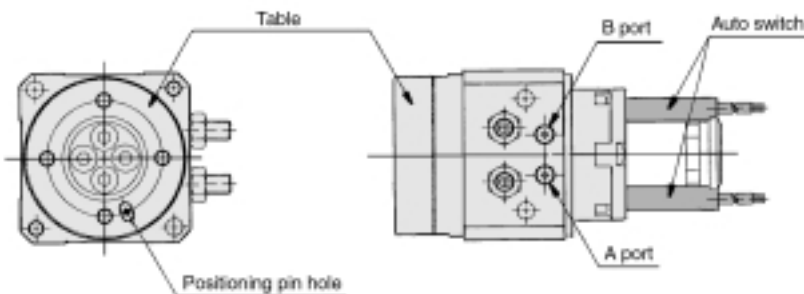
Double vane type (MSUB only)



- In drawings that show the rotation range, the arrows on the solid line 90° (180°) indicate the rotation range of the positioning pin holes on the table surface. When the pin hole is at END1, the END1 switch operates, and when the pin hole is at END2, the END2 switch operates.
- The arrows on the broken line indicate the rotation range of the internal magnet. The rotation range of each switch can be reduced by moving the END1 switch clockwise and the END2 switch counterclockwise.

Auto switch rotation and actuation ranges

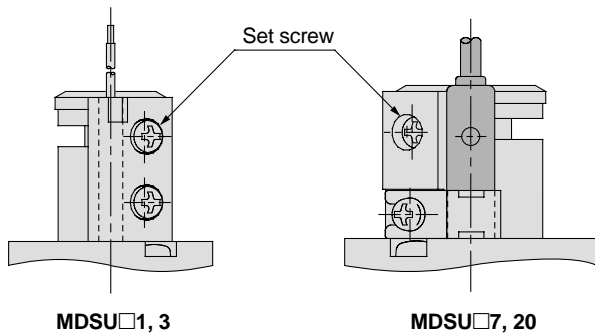
Model	Rotation range	Actuation range
MDSU□1, 3	110°	10°
MDSU□7, 20	90°	



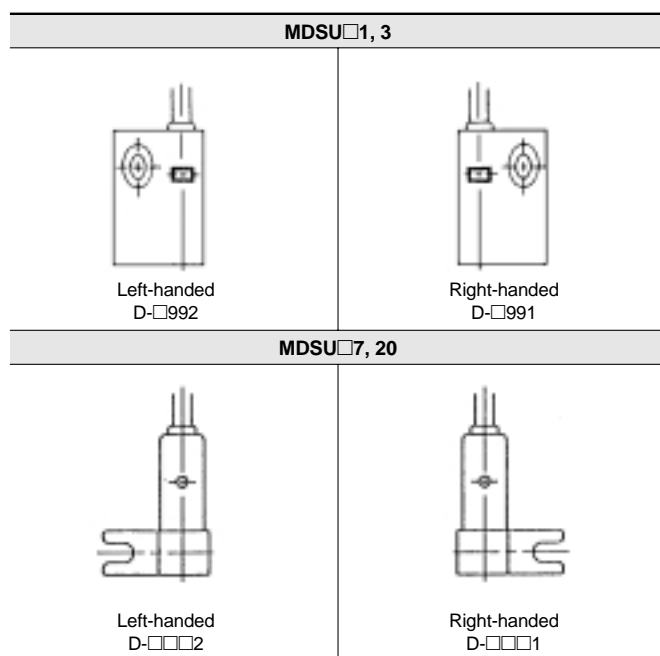
Series MSU Auto Switch Specifications

How to change Auto switch Detecting Positions

To set a new detection position, slightly loosen the set screw, move the switch to the desired position and retighten the screw. Over-tightening can damage the screw making it impossible to hold the position. Use a tightening torque of about 0.5N·m.



Auto Switch Mounting Classifications



Auto Switch Units



Auto switch unit part numbers

Model	Unit part number
MDSU□ 1	P211070-1
MDSU□ 3	P211090-1
MDSU□ 7	P211060-1
MDSU□20	P211080-1

*The magnet lever is included.

Auto switch block units

MDSU□1, 3		MDSU□7, 20
Right-handed	Left-handed	Combination left & right-handed
Part no.: P211070-8	Part no.: P211070-9	Part no.: P211060-8

* A switch block unit is the assembly required to mount one switch on a switch unit.

⚠ Caution

Be sure to read before handling.
Refer to pages 45 through 47
before using auto switches.

Auto Switch Common Specifications

Type	Reed switch	Solid state switch
Leakage current	None	3 wire: 100μA or less, 2 wire: 0.8mA or less
Operating time	1.2ms	1ms or less
Impact resistance	300m/s ²	1000m/s ²
Insulation resistance	50MΩ or more at 500VDC (between lead wire and case)	
Withstand voltage	1500VAC for 1 min.*1) (between lead wire and case)	1000VAC for 1 min. (between lead wire and case)
Ambient temperature	-10 to 60°C	
Enclosure	IEC529 standard IP67, JISC0920 watertight construction	

*1) Electrical entry: Connector type (R73C, R80C) and D-9, 9□A, A9 and A9□V are 1000VAC for 1 min. (between lead wire and case)

Lead Wire Length

Lead wire length indication

(Example) **D-90A L**

Lead wire length

Nil	0.5m
L	3m
Z	5m
N*	None

* Applicable only for connector type switch D-□□C.

Note 1) Lead wire length Z: 5m applicable auto switches

Reed: D-90/97/90A/93A, D-R73C/R80C

Solid state: All types are produced upon receipt of order (standard availability).

Lead wire with connector part number

(applicable only for connector type)

Model	Lead wire length
D-LC05	0.5m
D-LC30	3m
D-LC50	5m

Contact Protection Boxes/CD-P11, CD-P12

<Applicable switches>

D-R73(C)/R80(C), D-9, 9□A

The above auto switches do not have internal contact protection circuits.

1. The operating load is an induction load.

2. The length of wiring to the load is 5m or more.

3. The load voltage is 100 or 200VAC.

Use a contact protection box in any of the above situations.

The life of the contacts may otherwise be reduced. (They may stay ON all the time.)

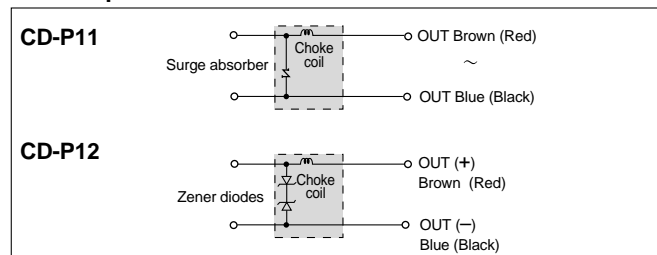
Contact protection box specifications

Part number	CD-P11		CD-P12
Load voltage	100VAC	200VAC	24VDC
Maximum load current	25mA	12.5mA	50mA

* Lead wire length— Switch connection side 0.5m
Load connection side 0.5m

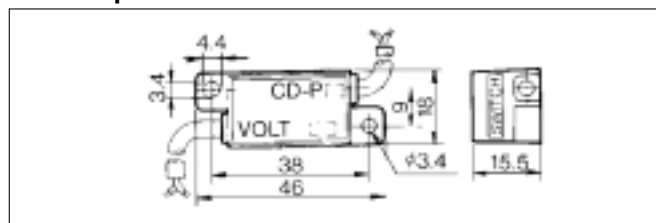


Contact protection box internal circuits



Lead wire colors inside () are those prior to conformity with IEC standards.

Contact protection box/Dimensions

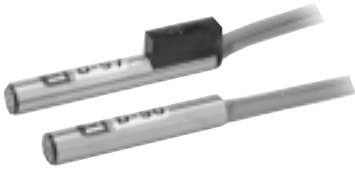


Contact protection box/Connection

To connect a switch to a contact protection box, connect the lead wire from the side of the contact protection box marked SWITCH to the lead wire coming out of the switch. Furthermore, the switch unit should be kept as close as possible to the contact protection box, with a lead wire length of no more than 1 meter between them.

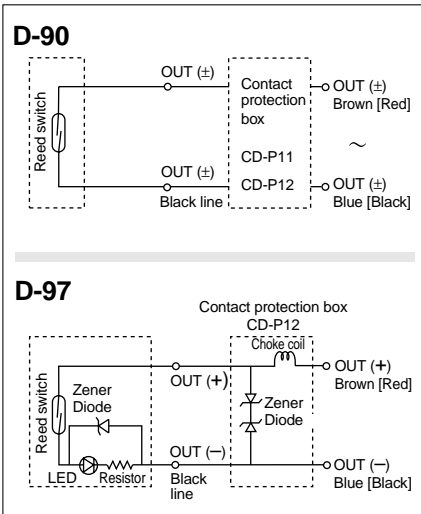
Reed Switches/Direct Mount Type D-90, D97

Grommet
Lead wire: Parallel cord



Auto switch internal circuits

Lead wire colors inside () are those prior to conformity with IEC standards.



Note) 1. The load is an induction load
2. The lead wire length to the load is 5m or more
Use a contact protection box in either of the above situations, as the life of the contacts may otherwise be reduced. (Refer to page 28 for details regarding contact protection boxes.)

Auto Switch Specifications

D-90 (without indicator light)

Auto switch part no.	D-90		
Application	Relay, IC circuit, PLC		
Load voltage	5V ^{AC} DC	12V ^{AC} DC	24V ^{AC} DC
Maximum load current	50mA		
Internal resistance	1Ω or less (including lead wire length of 3m)		

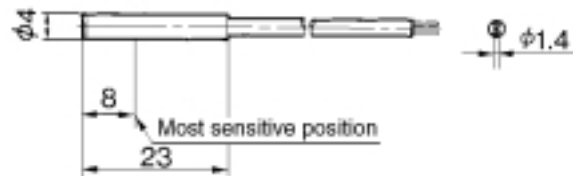
D-97 (with indicator light)

Auto switch part no.	D-97		
Application	Relay, PLC		
Load voltage	24VDC		
Load current range	5 to 40mA		
Internal voltage drop	2.4V or less		

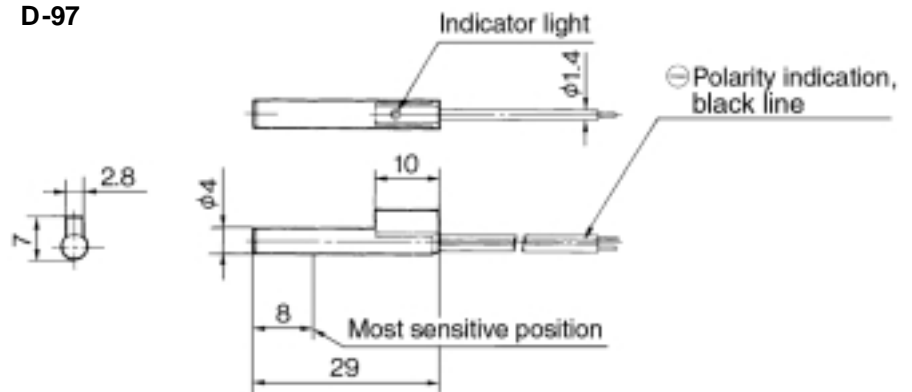
• Lead wire — Vinyl parallel cord, 0.2mm², 2 wire, 0.5m
Note 1) Refer to page 28 for auto switch common specifications
Note 2) Refer to page 28 for lead wire length.

Dimensions

D-90



D-97



Reed Switches/Direct Mount Type

D-90A, D-93A

Grommet
Lead wire: Heavy duty cord



Auto Switch Specifications

D-90A (without indicator light)

Auto switch part no.	D-90A			
Applicable load	Relay, IC circuit, PLC			
Load voltage	5V ^{AC} _{DC}	12V ^{AC} _{DC}	24V ^{AC} _{DC}	100V ^{AC} _{DC}
Maximum load current	50mA			20mA
Internal resistance	1Ω or less (including lead wire length of 3m)			

D-93A (with indicator light)

Auto switch part no.	D-93A	
Application	Relay, PLC	
Load voltage	24VDC	100VAC
Load current range	5 to 40mA	5 to 20mA
Internal voltage drop	2.4V or less	
Indicator light	Red LED lights up when ON	

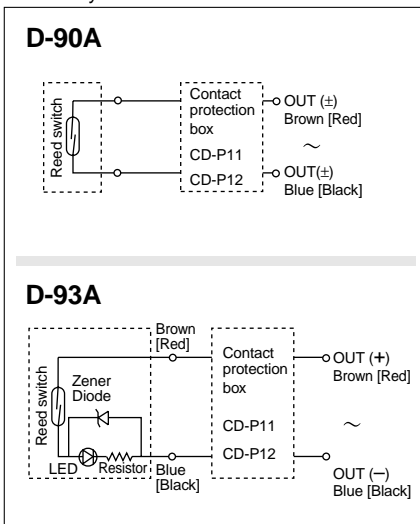
• Lead wires — Oil resistant vinyl heavy duty cord, 0.2mm², 2 wire [Brown, Blue (Red, Black)], 0.5m

Note 1) Refer to page 28 for reed switch common specifications.

Note 2) Refer to page 28 for lead wire length.

Auto switch internal circuits

Lead wire colors inside () are those prior to conformity with IEC standards.

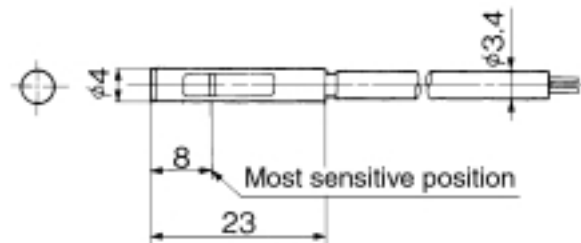


- Note) 1. The load is an induction load
2. The lead wire length to the load is 5m or more
3. The load voltage is 100VAC

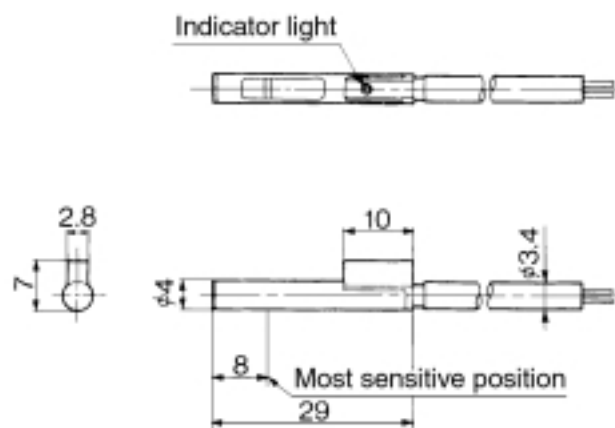
Use a contact protection box in any of the above situations, as the life of the contacts may otherwise be reduced. (Refer to page 28 for details regarding contact protection boxes.)

Dimensions

D-90A



D-93A



Reed Switches/Direct Mount Type

D-R73, D-R80

Grommet
Electrical entry direction: In-line



Auto Switch Specifications

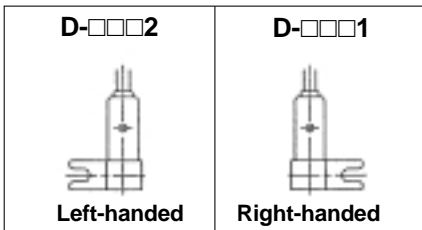
D-R73□ (with indicator light)

Auto switch part no.	D-R73C, D-R73Z	
Applicable load	Relay, PLC	
Load voltage	100VAC	24VDC
Maximum load current and load current range	5 to 20mA	5 to 40mA
Contact protection circuit	None	
Internal voltage drop	2.4V or less	
Indicator light	Red LED lights up when ON	

D-R80□ (without indicator light)

Auto switch part no.	D-R801, D-R802		
Applicable loads	Relay, IC circuit, PLC		
Load voltage	24V ^{AC} _{DC} or less	48V ^{AC} _{DC}	100V ^{AC} _{DC}
Maximum load current and load current range	50mA	40mA	20mA
Contact protection circuit	None		
Internal voltage drops	0		
Indicator light	None		

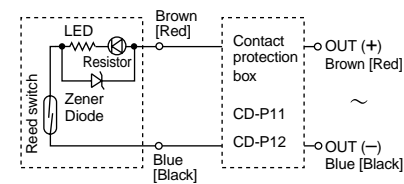
• Lead wires — Oil resistant vinyl heavy duty cord, 0.2mm², 2 wire [Brown, Blue (Red, Black)], 0.5m
 Note 1) Refer to page 28 for reed switch common specifications.
 Note 2) Refer to page 28 for lead wire length.



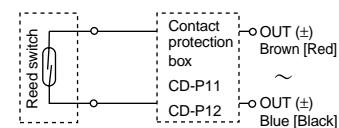
Auto switch internal circuits

Lead wire colors inside () are those prior to conformity with IEC standards.

D-R731, R732

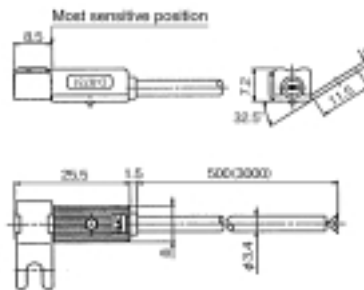


D-R801, R802

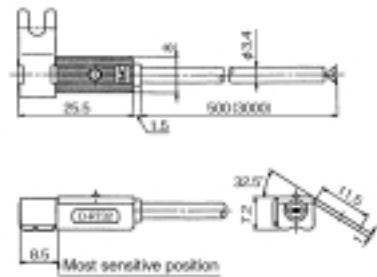


Dimensions

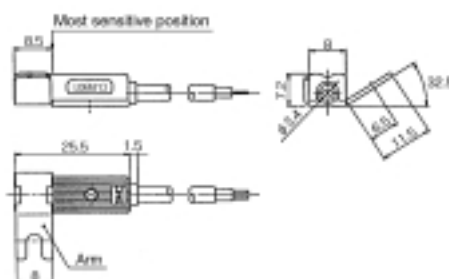
D-R731: Right-handed



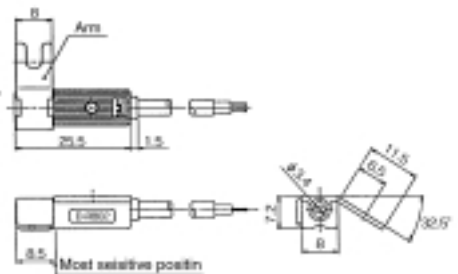
D-R732: Left-handed



D-R801: Right-handed



D-R802: Left-handed



Reed Switches/Direct Mount Type

D-R73□C, D-R80□C

Connector
Electrical entry direction: In-line



Auto Switch Specifications

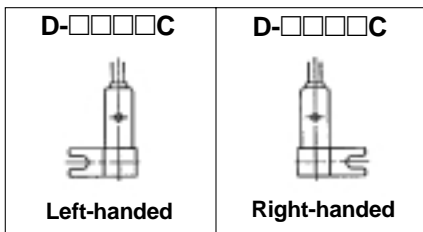
D-R73□C (with indicator light)

Auto switch part no.	D-R731C, D-R732C
Applicable load	Relay, PLC
Load voltage	24VDC
Load current range	5 to 40mA
Contact protection circuit	None
Internal voltage drop	2.4V or less
Indicator light	Red LED lights up when ON

D-R80□C (without indicator light)

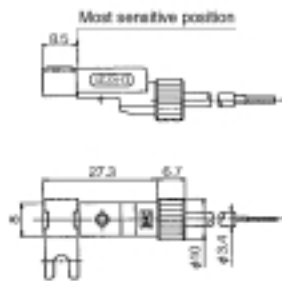
Auto switch part no.	D-R801C, D-R802C
Applicable load	Relay, PLC
Load voltage	24V ^{AC} or less
Load current range	50mA
Contact protection circuits	None
Internal voltage drops	0
Indicator light	None

• Lead wires — Oil resistant vinyl heavy duty cord, $\phi 3.4$, 0.2mm²
 Note 1) Refer to page 28 for reed switch common specifications.
 Note 2) Refer to page 28 for lead wire length.

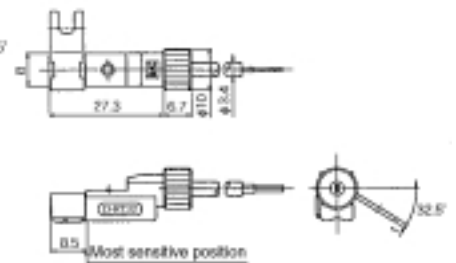


Dimensions

D-R731C: Right-handed



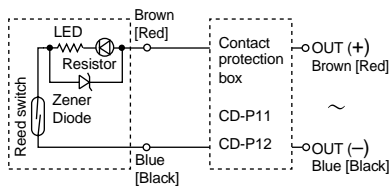
D-R732C: Left-handed



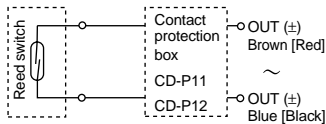
Auto switch internal circuits

Lead wire colors inside () are those prior to conformity with IEC standards.

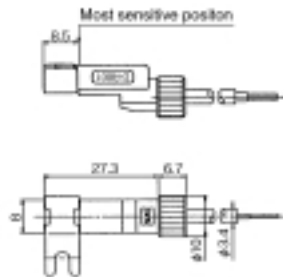
D-R731, R732



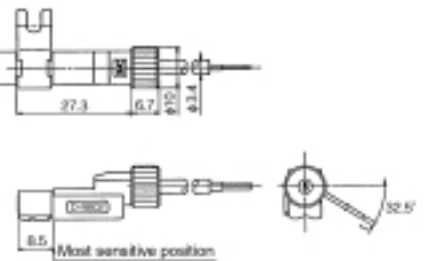
D-R801, R802



D-R801C: Right-handed

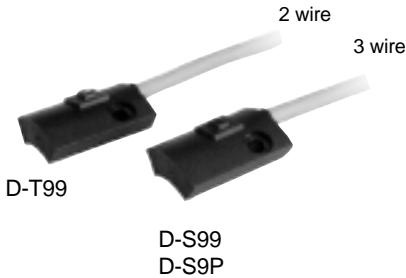


D-R802C: Left-handed



Solid State Switches/Direct Mount Type D-S99(V), D-S9P(V), D-T99(V)

Grommet



Auto Switch Specifications

D-S99 (V), D-S9P (V), D-T99 (V) (with indicator light)

Auto switch model no.	D-S991 D-S992	D-S99V1 D-S99V2	D-S9P1 D-S9P2	D-S9PV1 D-S9PV2	D-T991 D-T992	D-T99V1 D-T99V2
Electrical entry direction	In-line	Perpendicular	In-line	Perpendicular	In-line	Perpendicular
Wiring type	3 wire			2 wire		
Output type	NPN		PNP		—	
Applicable load	IC circuit, Relay, PLC				24VDC Relay, PLC	
Power supply voltage	5, 12, 24VDC (4.5 to 28VDC)					—
Current consumption	10mA or less					—
Load voltage	28VDC or less		—		24VDC (10 to 28VDC)	
Load current	40mA or less		80mA or less		5 to 40mA	
Internal voltage drop	1.5V or less (0.8V or less at 10mA load current)		0.8V or less		4V or less	
Leakage current	100μA or less at 24VDC					0.8mA or less at 24VDC
Indicator light	Red LED lights up when ON					

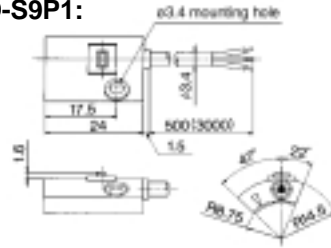
• Lead wires — Oil resistant, vinyl heavy duty cord, $\phi 3.4$, 0.2mm², 3 wire [Brown, Black, Blue (Red, White, Black)], 2 wire [Brown, Blue (Red, Black)], 0.5m

Note 1) Refer to page 28 for solid state switch common specifications.
Note 2) Refer to page 28 for lead wire length.

Dimensions

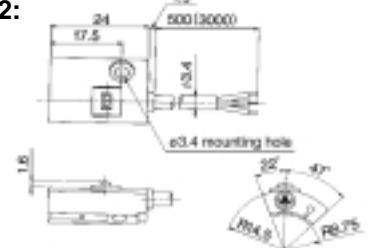
D-S991: Right-handed

D-S9P1:

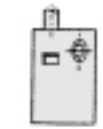


D-S992: Left-handed

D-S9P2:



D-□991



Right-handed

D-□992



Left-handed

D-□99V1



Right-handed

D-□99V2

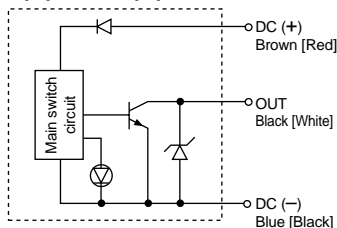


Left-handed

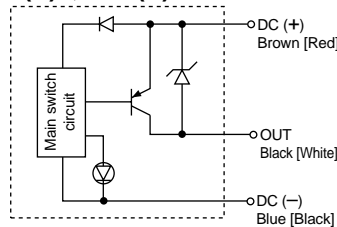
Auto switch internal circuits

Lead wire colors inside () are those prior to conformity with IEC standards.

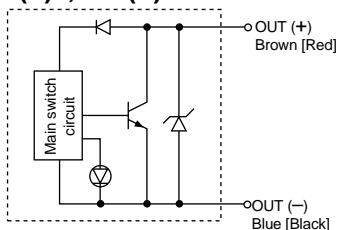
D-S99(V)1, S99(V)2



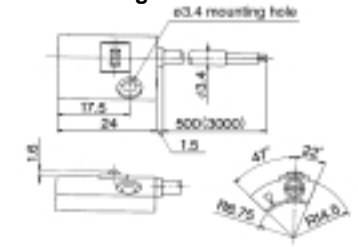
D-S9P(V)1, S9P(V)2



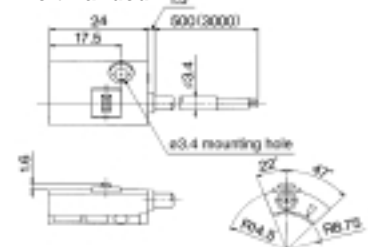
D-T99(V)1, T99(V)2



D-T991: Right-handed

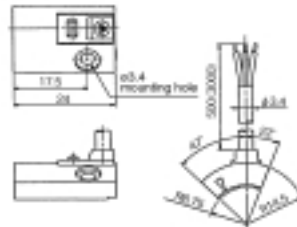


D-T992: Left-handed



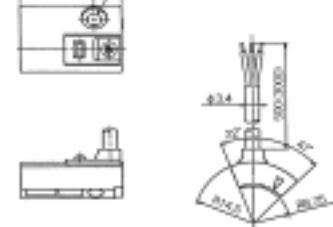
D-S99V1: Right-handed

D-S9PV1:

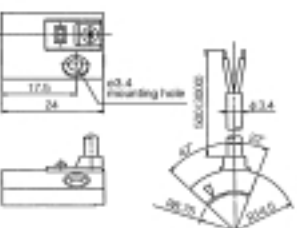


D-S99V2: Left-handed

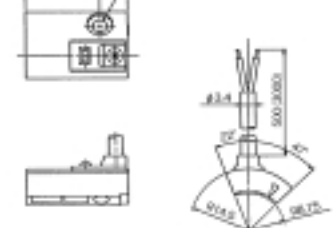
D-S9PV2:



D-T99V1: Right-handed

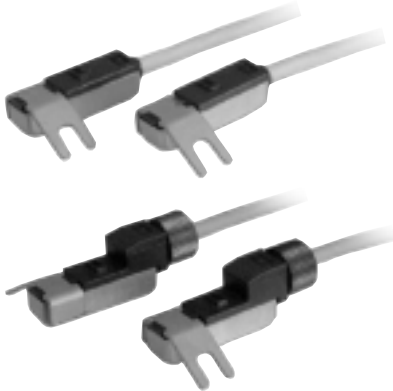


D-T99V2: Left-handed



Solid State Switches/Direct Mount Type D-S79, D-S7P, D-T79(C)

Grommet, Connector
Electrical entry direction: In-line



Auto Switch Specifications

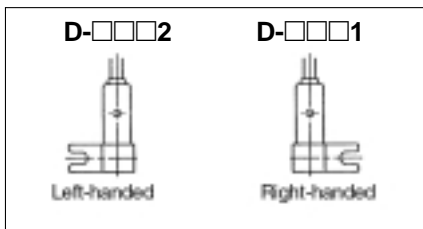
D-S79, D-T79 (with indicator light)

Auto switch model no.	D-S791, D-S792	D-S7P1, D-S7P2	D-T791, D-T792, D-T791C, D-T792C
Wiring type	3 wire		2 wire
Output type	NPN	PNP	—
Applicable load	IC circuit, Relay, PLC		24VDC relay, PLC
Power supply voltage	5, 12, 24VDC (4.5 to 28VDC)		—
Current consumption	10mA or less		—
Load voltage	28VDC or less	—	24VDC (10 to 28VDC)
Load current	40mA or less	80mA or less	5 to 40mA
Internal voltage drop	1.5V or less (0.8V or less at 10mA load current)	0.8V or less	4V or less
Leakage current	100μA or less at 24VDC		0.8mA or less at 24VDC
Indicator light	Red LED lights up when ON		

• Lead wires — Oil resistant, vinyl heavy duty cord, ø3.4, 0.2mm², 3 wire [Brown, Black, Blue (Red, White, Black)], 2 wire [Brown, Blue (Red, Black)], 0.5m

Note 1) Refer to page 28 for solid state switch common specifications.

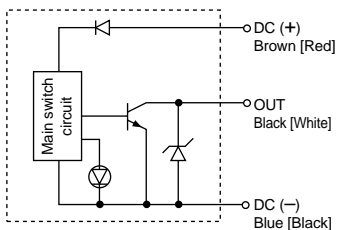
Note 2) Refer to page 28 for lead wire length.



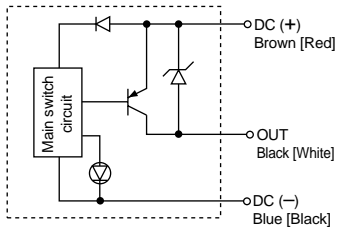
Auto switch internal circuits

Lead wire colors inside () are those prior to conformity with IEC standards.

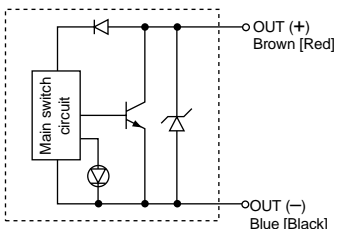
D-S791, S792



D-S7P1, S7P2



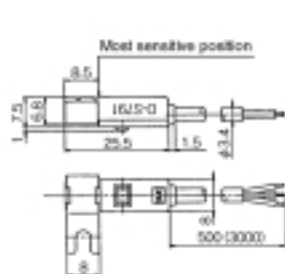
D-T791(C), T792(C)



Dimensions

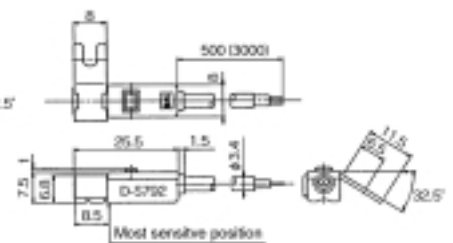
D-S791: Right-handed

D-S7P1:

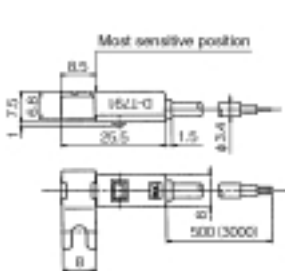


D-S792: Left-handed

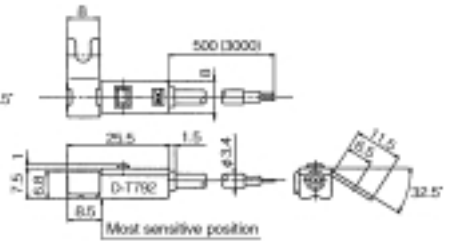
D-S7P2:



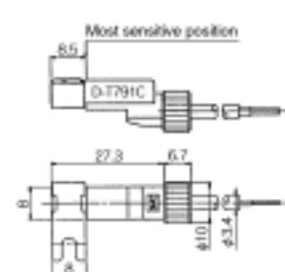
D-T791: Right-handed



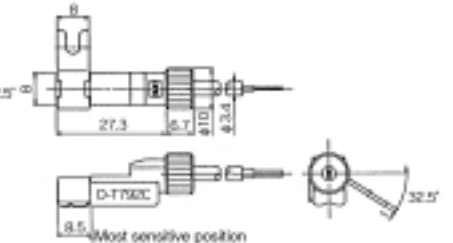
D-T792: Left-handed



D-T791C: Right-handed



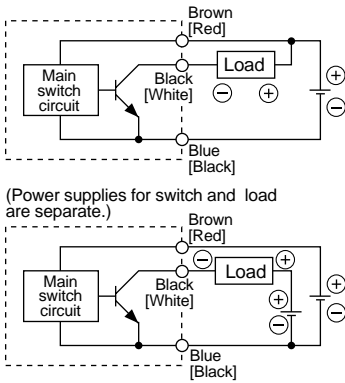
D-T792C: Left-handed



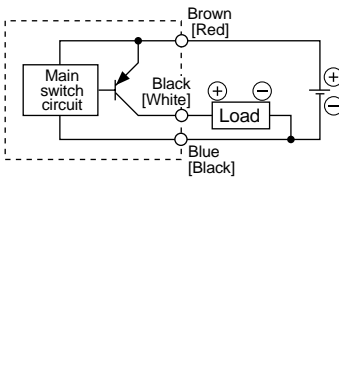
Auto Switch Connections and Examples

Basic Wiring

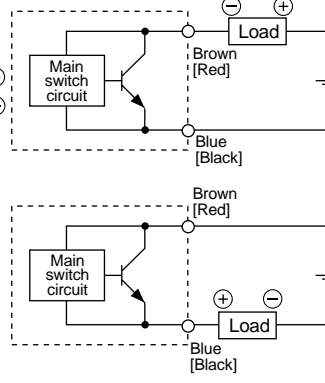
Solid state 3 wire, NPN



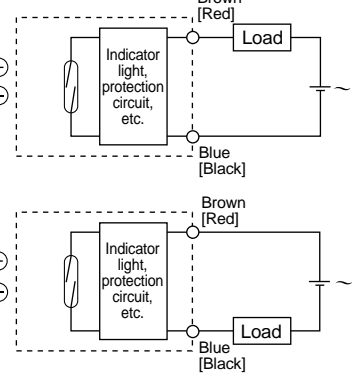
Solid state 3 wire, PNP



2 wire <Solid state>

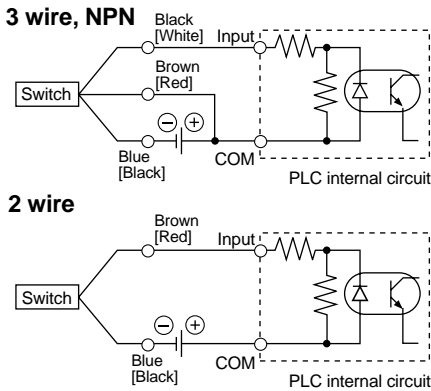


2 wire <Reed switch>

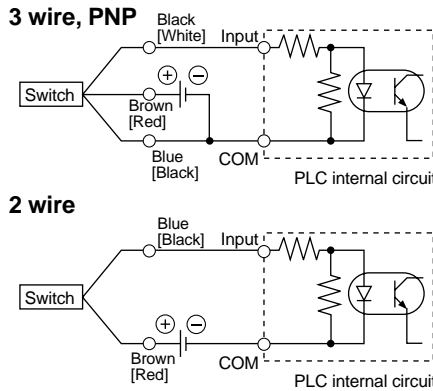


Examples of Connection to PLC

Sink input specifications



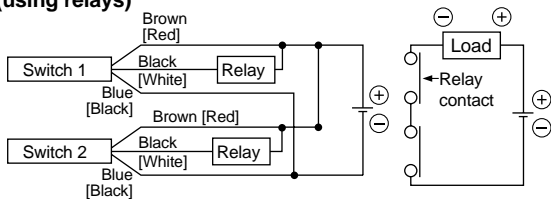
Source input specifications



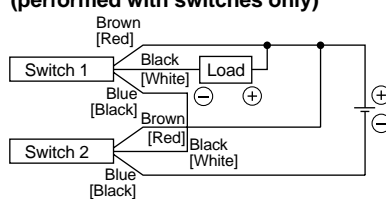
Connect according to the applicable PLC input specifications, as the connection method will vary depending on the PLC input specifications.

Connection Examples for AND (Series) and OR (Parallel)

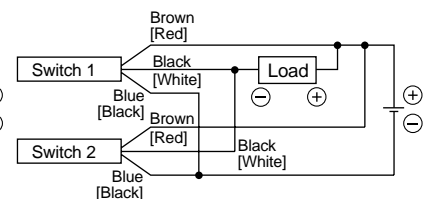
3 wire AND connection for NPN output (using relays)



AND connection for NPN output (performed with switches only)

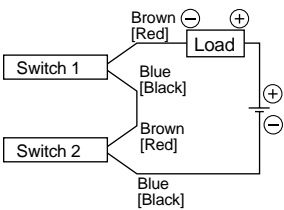


OR connection for NPN output



The indicator lights will light up when both switches are turned ON.

2 wire with 2 switch AND connection

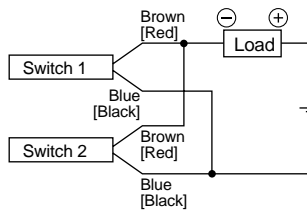


When two switches are connected in series, a load may malfunction because the load voltage will decline when in the ON state. The indicator lights will light up if both of the switches are in the ON state.

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

Example: Power supply is 24VDC
Voltage decline in switch is 4V

2 wire with 2 switch OR connection



<Solid state>

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

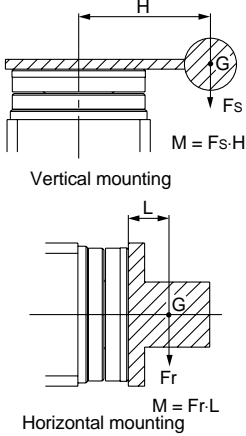
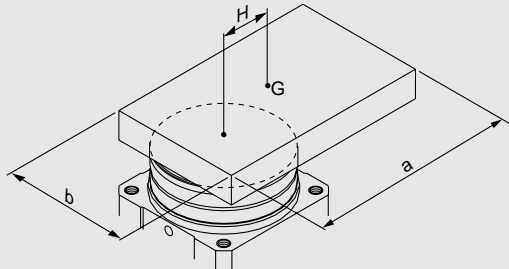
<Reed switch>

Because there is no current leakage, the load voltage will not increase when turned OFF. However, depending on the number of switches in the ON state, the indicator lights may sometimes get dark or not light up, because of dispersion and reduction of the current flowing to the 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 3kΩ
Leakage current from switch is 1mA

Series MSU Model Selection

Selection Procedure	Formulae	Selection Example
<p>1 Operating conditions</p> <p>Enumerate the operating conditions according to the mounting position.</p>  <p>Vertical mounting $M = F_s \cdot H$</p> <p>Horizontal mounting $M = F_r \cdot L$</p>	<ul style="list-style-type: none"> • Model used • Operating pressure • Mounting position • Load type <ul style="list-style-type: none"> Ts (N·m) Tf (N·m) Ta (N·m) • Load configuration • Rotation time t (s) • Rotation • Load mass m (kg) • Distance between central axis and center of gravity H (mm) • Mass point distance L (mm) 	 <p>Rotary table: MSUA7-90S, Pressure: 0.5MPa Mounting position: Vertical, Type of load: Inertial load Ta Load configuration: 60mm x 40mm (rectangular plate) Rotation time (t): 0.2s, Rotation (θ): 90° Load mass (m): 0.15kg, Distance between central axis and center of gravity (H): 30mm</p>
<p>2 Required torque</p> <p>Confirm the type of load as shown below, and select an actuator that satisfies the required torque.</p> <ul style="list-style-type: none"> • Static load: Ts • Resistance load: Tf Load types • Inertial load: Ta 	<p>Effective torque $\geq T_s$ Effective torque $\geq (3 \text{ to } 5) \cdot T_f$ Effective torque $\geq 10 \cdot T_a$</p> <p>Effective torque</p>	<p>Inertial load $10 \times T_a = 10 \times I \times \dot{\omega} = 10 \times 0.0002 \times \pi / 0.2^2$ $= 0.157 \text{N}\cdot\text{m} < \text{Effective torque OK}$</p> <p>Note) I substitutes for ⊕ the value for moment of inertia $\dot{\omega} = \frac{2\theta}{t^2}$ ($\dot{\omega}$: Angular acceleration)</p>
<p>3 Rotation time</p> <p>Confirm that it is within the adjustable range of rotation time.</p>	<p>0.07 to 0.3s/90°</p>	<p>0.2s/90° OK</p>
<p>4 Allowable load</p> <p>Confirm that the radial load, thrust load and moment are within the allowable ranges.</p>	<p>Thrust load: $m \times 9.8 \leq \text{Allowable load}$ Moment: $m \times 9.8 \times H \leq \text{Allowable moment}$</p> <p>Allowable load</p>	<p>$0.15 \times 9.8 \times 1.47 \text{N} < \text{Allowable load OK}$ $0.15 \times 9.8 \times 0.03 = 0.044 \text{N}\cdot\text{m}$ $0.044 \text{N}\cdot\text{m} < \text{Allowable moment OK}$</p>
<p>5 Moment of inertia</p> <p>Find the load's moment of inertia "I" for the energy calculation.</p>	<p>$I = m \times (a^2 + b^2) / 12 + m \times H^2$</p> <p>Moment of inertia</p>	<p>$I = 0.15 \times (0.06^2 + 0.04^2) / 12 + 0.15 \times 0.03^2$ $= 0.0002 \text{kg}\cdot\text{m}^2$</p>
<p>6 Kinetic energy</p> <p>Confirm that the load's kinetic energy is within the allowable value.</p> <p>Note) Table's moment of inertia = I_0</p>	<p>$1/2 \times (I + I_0) \times \dot{\omega}^2 < \text{Allowable energy}$ $\dot{\omega} = 2\theta / t$ ($\dot{\omega}$: Terminal angular velocity) θ: Rotation angle (rad) t: Rotation time (s)</p> <p>Allowable kinetic energy/Rotation time</p>	<p>$1/2 \times (0.0002 + 0.000028) \times (2 \times (\pi/2) / 0.2)^2$ $0.028 \text{J} < \text{Allowable energy OK}$</p>

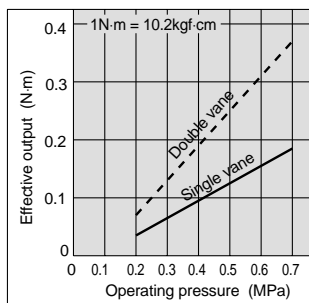
Series MSU Model Selection

Effective torque

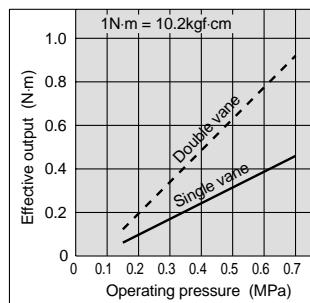
Unit: N·m

Vane type	Size	Operating pressure (MPa)										
		0.1	0.15	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Single vane	MSU□ 1	—	—	0.03	0.06	0.09	0.11	0.14	0.17	—	—	—
	MSU□ 3	—	0.05	0.09	0.16	0.23	0.31	0.38	0.45	—	—	—
	MSU□ 7	—	0.14	0.21	0.37	0.52	0.69	0.83	0.98	—	—	—
	MSU□ 20	—	0.40	0.58	0.99	1.38	1.78	2.19	2.58	2.99	3.39	3.73
Double vane	MSUB 1	—	—	0.06	0.12	0.18	0.23	0.29	0.35	—	—	—
	MSUB 3	—	0.11	0.18	0.32	0.46	0.62	0.77	0.91	—	—	—
	MSUB 7	—	0.29	0.44	0.78	1.10	1.42	1.74	2.04	—	—	—
	MSUB20	—	0.86	1.22	2.04	2.82	3.63	4.43	5.22	6.04	6.83	7.49

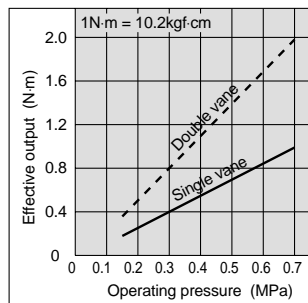
MSU□1



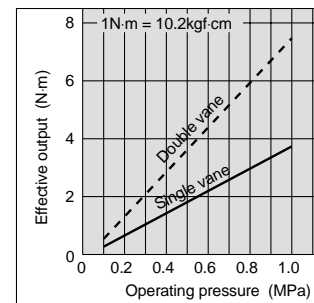
MSU□3



MSU□7



MSU□20



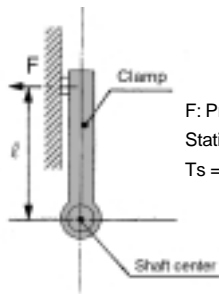
Load Types

• Static load: Ts

A load as represented by the clamp which requires pressing force only

(During examination if it is decided to consider the mass of the clamp itself in the drawing below, it should be regarded as an inertial load.)

(Example)



F: Pressing force (N)
Static torque calculation
 $T_s = F \times l$ (N·m)

• Resistance load: Tf

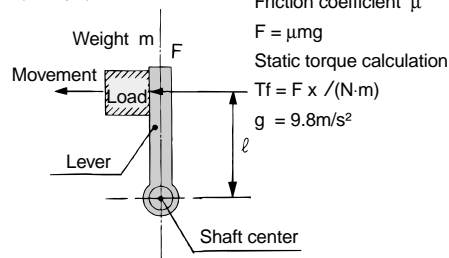
A load that is affected by external forces such as friction or gravity

Since the object is to move the load, and speed adjustment is necessary, allow an extra margin of 3 to 5 times in the effective torque.

* Actuator effective torque \geq (3 to 5) Tf

(During examination if it is decided to consider the mass of the lever itself in the drawing below, it should be regarded as an inertial load.)

(Example)

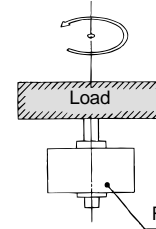


• Inertial load: Ta

The load which must be rotated by the actuator. Since the object is to rotate the load, and speed adjustment is necessary, allow an extra margin of 10 times or more in the effective torque.

* Actuator effective torque \leq S-Ta
(S is 10 times or more)

Accelerating torque calculation



$T_a = I \cdot \dot{\omega}$ (N·m)
I: Moment of inertia
Refer to page 38.
 $\dot{\omega}$: Angular acceleration
 $\dot{\omega} = \frac{2\theta}{t^2}$ (rad/s²)
 θ : Rotation angle (rad)
t: Rotation time (S)

Allowable Load

Do not permit the load and moment applied to the table to exceed the allowable values shown in the table at the right. (Operation above the allowable values can cause adverse effects on service life, such as play in the table and loss of accuracy.)

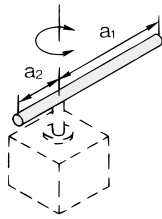
Size	Allowable radial load (N)	Allowable thrust load (N)		Allowable moment (N·m)
		(A)	(B)	
1	20	15	(A) 15 (B) 10	0.3
3	40	30	30 15	0.7
7	50	60	60 30	0.9
20	60	80	80 40	2.9

Moment of Inertia

I: Moment of Inertia kg m², m: Load mass kg

1. Thin shaft

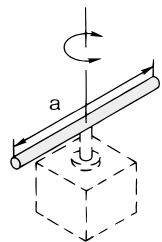
Position of rotational axis: Perpendicular to the shaft through one end



$$I = m_1 \cdot \frac{a_1^2}{3} + m_2 \cdot \frac{a_2^2}{3}$$

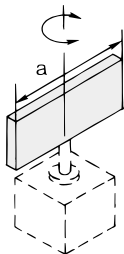
2. Thin shaft

Position of rotational axis: Through the shaft's center of gravity



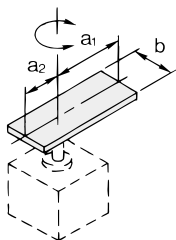
$$I = m \cdot \frac{a^2}{12}$$

3. Thin rectangular plate (rectangular parallelepiped) Position of rotational axis: Through the plate's center of gravity



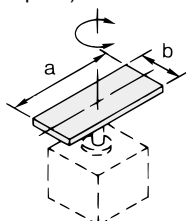
$$I = m \cdot \frac{a^2}{12}$$

4. Thin rectangular plate (rectangular parallelepiped) Position of rotational axis: Perpendicular to the plate through one end (also the same in case of a thicker plate)



$$I = m_1 \cdot \frac{4a_1^2 + b^2}{12} + m_2 \cdot \frac{4a_2^2 + b^2}{12}$$

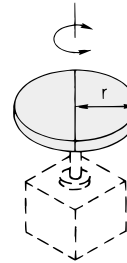
5. Thin rectangular plate (rectangular parallelepiped) Position of rotational axis: Through the center of gravity and perpendicular to the plate (also the same in case of a thicker plate)



$$I = m \cdot \frac{a^2 + b^2}{12}$$

6. Column (including thin round plate)

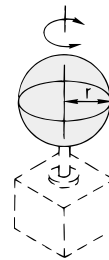
Position of rotational axis: Central axis



$$I = m \cdot \frac{r^2}{2}$$

7. Solid sphere

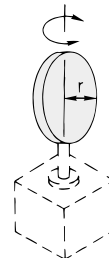
Position of rotational axis: Diameter



$$I = m \cdot \frac{2r^2}{5}$$

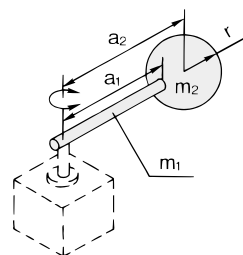
8. Thin round plate

Position of rotational axis: Diameter



$$I = m \cdot \frac{r^2}{4}$$

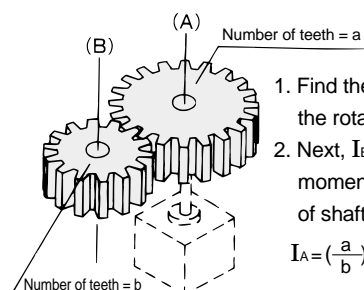
9. Load at end of lever



$$I = m_1 \cdot \frac{a_1^2}{3} + m_2 \cdot a_2^2 + K$$

(Example) When shape of m₂ is a sphere refer to 7, and $K = m_2 \cdot \frac{2r^2}{5}$

10. Gear transmission



1. Find the moment of inertia I_B for the rotation of shaft (B).
2. Next, I_B is entered to find I_A the moment of inertia for the rotation of shaft (A) as

$$I_A = \left(\frac{a}{b}\right)^2 \cdot I_B$$

Series MSU Model Selection

Kinetic Energy/Rotation Time

Even in cases where the torque required for rotation of the load is small, damage to internal parts may result from the inertial force of the load.

Select models giving consideration to the load's moment of inertia, kinetic energy and rotation time during operation. (The moment of inertia and rotation time charts can be used for your convenience in making model selections.)

1. Allowable kinetic energy and rotation time adjustment range

From the table below, set the rotation time within the adjustment range for stable operation. Note that operation beyond the upper limit of the low speed range, 0.3S/90°, may lead to sticking or stopping of operation.

MSUA/Sizes 1 to 20

Size	Allowable kinetic energy J	Rotation time adjustment range for stable operation S/90°
MSUA 1	0.0065	0.07 to 0.3
MSUA 3	0.017	
MSUA 7	0.042	
MSUA20	0.073	

MSUB/Sizes 1 to 20

Size	Allowable kinetic energy J	Rotation time adjustment range for stable operation S/90°
MSUB 1	0.005	0.07 to 0.3
MSUB 3	0.013	
MSUB 7	0.032	
MSUB20	0.056	

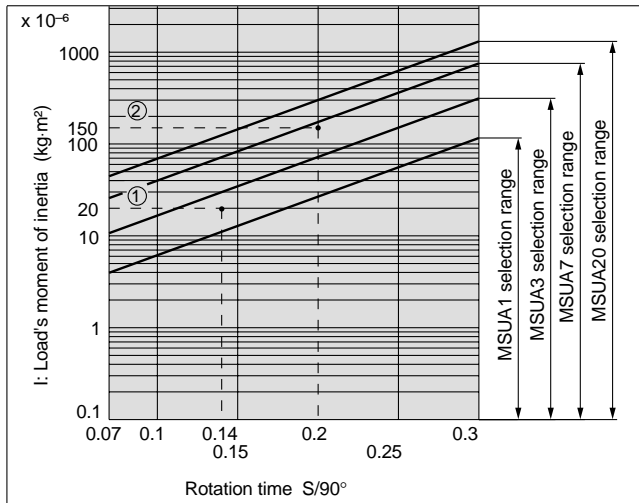
2. Moment of inertia calculation

Since the formulae for moment of inertia differ depending on the configuration of the load, refer to the moment of inertia calculation formulae on page 38.

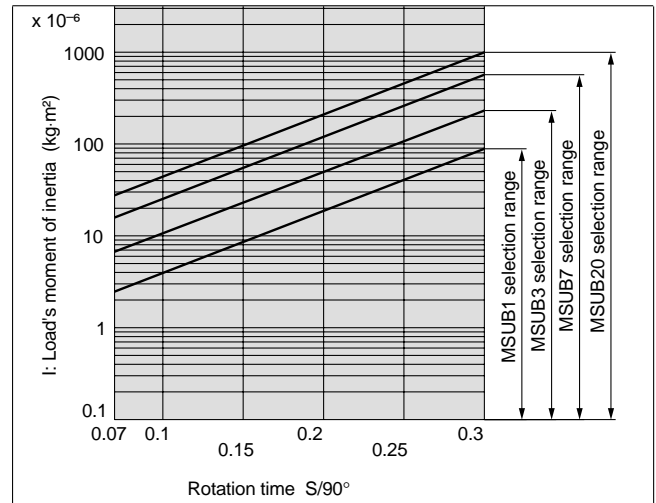
3. Model selection

Select models by applying the moment of inertia and rotation time which have been found to the charts below.

MSUA/Sizes 1 to 20



MSUB/Sizes 1 to 20



1. <Viewing the charts>

- Moment of inertia 20 x 10⁻⁶ kg·m²
 - Rotation time 0.14S/90°
- MSUA3 or MSUA7, 20 is selected for the above.

2. <Example calculation>

Load configuration: A cylinder of radius 0.05m and mass 0.12kg
Rotation time: 0.2S/90°

$$I = 0.12 \times \frac{0.05^2}{2} = 150 \times 10^{-6} \text{ kg}\cdot\text{m}^2$$

In the moment of inertia and rotation time chart, find the intersection of the lines extended from the points corresponding to 150 x 10⁻⁶kg·m² on the vertical axis (moment of inertia) and 0.2S/90° on the horizontal axis (rotation time). Since the resulting intersection point lies within the MSUA7 selection range, MSUA7 or MSUA20 can be selected.

Load energy calculation method

$$E = \frac{1}{2} (I + I_0) \omega^2, \quad \omega = \frac{2\theta}{t}$$

E: Kinetic energy ... (J)

I: Load's moment of inertia (kg·m²)

I₀: Table's moment of inertia ... (kg·m²)

Size	I ₀
MSU□ 1	2.5 x 10 ⁻⁶
MSU□ 3	6.2 x 10 ⁻⁶
MSU□ 7	16.0 x 10 ⁻⁶
MSU□20	28.0 x 10 ⁻⁶

* ω: Angular velocity ... (rad/s)

θ: Rotation (rad)

$$180^\circ = 3.14 \text{ rad}$$

t: Rotation time (s)

* The "ω" which is sought here is the terminal angular velocity for an equivalent angular acceleration.

Series MSU

Air Consumption/Required Air Capacity

Air consumption is the volume of air which is expended by the rotary actuator's reciprocal operation inside the actuator and in the piping between the actuator and the switching valve, etc. This is necessary for selection of a compressor and for calculation of its running cost.

* The air consumption (Q_{CR}) required for one reciprocation of the rotary actuator alone is shown in the table below, and can be used to simplify the calculation.

Formulae

Q_{CR}: Since the internal volume of a rotary table is different when the A and B ports are pressurized, use formula (1).

$$Q_{CR} = V \times \left(\frac{P + 0.1013}{0.1013} \right) \times 10^{-3} \dots \dots \dots \text{Formula (1)}$$

$$Q_{CR} = 2V \times \left(\frac{P + 0.1013}{0.1013} \right) \times 10^{-3} \dots \dots \dots \text{Formula (2)}$$

$$Q_{CP} = 2 \times a \times \text{Length} \times \frac{P}{0.1013} \times 10^{-6} \dots \dots \dots (3)$$

$$Q_C = Q_{CR} + Q_{CP} \dots \dots \dots (4)$$

- Q_{CR} = Air consumption of rotary actuator [/(ANR)]
- Q_{CP} = Air consumption of tubing or piping [/(ANR)]
- V = Internal volume of rotary actuator [cm³]
- P = Operating pressure [MPa]
- / = Length of piping [mm]
- a = Internal cross section of piping [mm²]
- Q_C = Air consumption required for one reciprocation of rotary actuator [/(ANR)]

When selecting a compressor, it is necessary to choose one which has sufficient reserve for the total air consumption of all pneumatic actuators downstream. This is affected by factors such as leakage in piping, consumption by drain valves and pilot valves, etc., and reduction of air volume due to drops in temperature.

Formula

$$Q_{C2} = Q_C \times n \times \text{Number of actuators} \times \text{Reserve factor}$$

- Q_{C2} = Compressor discharge flow rate
- n = Actuator reciprocations per minute

Internal cross section of tubing and steel piping

Nominal size	O.D. (mm)	I.D. (mm)	Internal cross section a (mm ²)
T□ 0425	4	2.5	4.9
T□ 0604	6	4	12.6
TU 0805	8	5	19.6
T□ 0806	8	6	28.3
1/8B	—	6.5	33.2
T□ 1075	10	7.5	44.2
TU 1208	12	8	50.3
T□ 1209	12	9	63.6
1/4B	—	9.2	66.5
TS 1612	16	12	113
3/8B	—	12.7	127
T□ 1613	16	13	133
1/2B	—	16.1	204
3/4B	—	21.6	366
1B	—	27.6	598

Air Consumption

Unit: /min (ANR)

Vane type	Size	Rotation angle (°)	Internal volume (cm ³)		Operating pressure (MPa)									
			V1 port	V2 port	0.15	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Single vane	MSU□ 1	90	0.8	1.3	—	0.006	0.008	0.010	0.012	0.015	0.017	—	—	—
		180	1.3	1.3	—	0.008	0.010	0.013	0.015	0.018	0.021	—	—	—
	MSU□ 3	90	1.9	3.1	0.012	0.015	0.020	0.024	0.029	0.034	0.039	—	—	—
		180	3.1	3.1	0.015	0.018	0.025	0.031	0.037	0.043	0.049	—	—	—
	MSU□ 7	90	4.0	6.6	0.026	0.031	0.042	0.052	0.063	0.073	0.083	—	—	—
		180	6.6	6.6	0.033	0.039	0.052	0.065	0.078	0.091	0.104	—	—	—
	MSU□ 20	90	10.1	16.8	0.067	0.080	0.107	0.133	0.160	0.186	0.213	0.239	0.266	0.292
		180	16.8	16.8	0.083	0.100	0.133	0.166	0.199	0.233	0.266	0.299	0.332	0.365
Double vane	MSUB 1	90	1.1	1.1	—	0.007	0.009	0.011	0.013	0.015	0.017	—	—	—
	MSUB 3	90	2.7	2.7	0.013	0.016	0.021	0.027	0.032	0.037	0.043	—	—	—
	MSUB 7	90	5.7	5.7	0.028	0.034	0.045	0.056	0.068	0.079	0.090	—	—	—
	MSUB 20	90	14.5	14.5	0.072	0.086	0.115	0.144	0.172	0.201	0.229	0.258	0.287	0.32

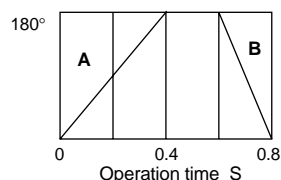
Required Air Capacity

The required air capacity is the air capacity which is necessary for operation at a prescribed speed, and is needed for selection of F.R.L equipment and piping sizes, etc.

Required air capacity of rotary actuator = 0.06 x V x (P/0.1013)/t /min (ANR)

- V: Internal volume = cm³
- P: Absolute pressure = {Operating pressure (MPa) + 0.1013}
- t: Operation time = S

Example Find the required air capacity for use with the following operation chart
Model: MSUB7, Rotation: 180°, Operating pressure: 0.5MPa





Find the required air capacity for A and B.
A = 0.06 x 6.6 x {(0.5+0.1013)/0.1013}/0.4 = 5.9 /min (ANR)
B = 0.06 x 6.6 x {(0.5+0.1013)/0.1013}/0.2 = 11.8 /min (ANR)




Series MSU Safety Instructions

These safety instructions are intended to prevent a hazardous situation and/or equipment damage. These instructions indicate the level of potential hazard by a label of "**Caution**", "**Warning**" or "**Danger**". To ensure safety, be sure to observe ISO 4414 Note 1), JIS B 8370 Note 2) and other safety practices.

 **Caution** : Operator error could result in injury or equipment damage.

 **Warning** : Operator error could result in serious injury or loss of life.

 **Danger** : In extreme conditions, there is a possible result of serious injury or loss of life.

Note 1) ISO 4414: Pneumatic fluid power – Recommendations for the application of equipment to transmission and control systems

Note 2) JIS B 8370: General Rules for Pneumatic Equipment

Warning

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

Since the products specified here are used in various operating conditions, their compatibility for the specific pneumatic system must be based on specifications or after analysis and/or tests to meet your specific requirements.

2. Only trained personnel should operate pneumatically operated machinery and equipment.

Compressed air can be dangerous if handled incorrectly. Assembly, handling or repair of pneumatic systems should be performed by trained and experienced operators.

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

1. Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.
2. When equipment is to be removed, confirm the safety process as mentioned above. Cut the supply pressure for this equipment and exhaust all residual compressed air in the system.
3. Before machinery/equipment is restarted, take measures to prevent shooting-out of cylinder piston rod, etc. (Bleed air into the system gradually to create back pressure.)

4. Contact SMC if the product is to be used in any of the following conditions:

1. Conditions and environments beyond the given specifications, or if product is used outdoors.
2. Installation on equipment in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverages, recreation equipment, emergency stop circuits, press applications, or safety equipment.
3. An application which has the possibility of having negative effects on people, property, or animals, requiring special safety analysis.



Series MSU Rotary Actuator Precautions 1

Be sure to read before handling.

Precautions on design

⚠ Warning

1. **In case of load variations, lifting/lowering operations or changes in frictional resistance, employ a safety design which allows for these factors.**

Increases in operating speed can cause human injury as well as damage to equipment and machinery.

2. **A protective cover is recommended to minimize the risk of human injury.**

If a stationary object and moving parts of a cylinder are in close proximity, human injury may occur. Design the structure to avoid contact with the human body.

3. **Make secure connections so that stationary parts and connecting parts do not become loose.**

Particularly when operation frequency is high or a rotary actuator is used in a location with excessive vibration, employ a secure method of connection.

4. **Shock absorber may be required.**

When a driven object is operated at high speed or the load is heavy, there is a danger of exceeding the allowable kinetic energy of the rotary actuator. Therefore, install an external shock absorber to relieve the impact before the end of rotation is reached. In this case, the rigidity of the machinery should also be examined.

5. **Consider a possible drop in operating pressure due to a power outage, etc.**

When a cylinder is used in a clamping mechanism, there is a danger of work pieces dropping if there is a decrease in clamping force due to a drop in circuit pressure caused by a power outage, etc. Therefore, safety equipment should be installed to prevent damage to machinery and/or human injury.

6. **Consider a possible loss of power source.**

Measures should be taken to protect against human injury and equipment damage in the event that there is a loss of power to equipment controlled by air pressure, electricity or hydraulics, etc.

7. **When a speed controller is mounted on an exhaust throttle, employ a safety design which considers residual pressure.**

If the air supply side is pressurized when there is no residual pressure on the exhaust side, operation will be abnormally fast and this can cause human injury as well as damage to equipment and machinery.

8. **Consider emergency stops.**

Design so that human injury and/or damage to machinery and equipment will not be caused by operation of a rotary actuator when machinery is stopped by a manual emergency stop or by a safety device under abnormal conditions, such as a power outage.

9. **Consider the action when operation is restarted after an emergency stop or abnormal stop.**

Design the machinery so that human injury or equipment damage will not occur upon restart of operation. When the rotary actuator has to be reset at the starting position, install safe manual control equipment.

Precautions on design

⚠ Warning

10. **Do not use the product as a shock absorbing mechanism.**

If abnormal pressure or leakage occurs, there may be a drastic loss of deceleration effectiveness, leading to a danger of human injury as well as damage to equipment and machinery.

Selection

⚠ Warning

1. **Keep the speed setting within the product's allowable energy value.**

Operation with the kinetic energy of the load exceeding the allowable value can cause damage to the product, leading to human injury as well as damage to equipment and machinery.

2. **Provide a shock absorbing mechanism when kinetic energy applied to the product exceeds the allowable value.**

Operation exceeding the allowable kinetic energy can cause damage to the product and lead to human injury and damage to equipment and machinery.

3. **Do not perform stops or holding operations by containing air pressure inside the product.**

If intermediate stops are performed by containing air with a directional control valve when the product does not have an external stopping mechanism, the stopping position may not be held due to leakage, etc. This can cause human injury and damage to equipment and machinery.

⚠ Caution

1. **Do not operate the product at low speeds which are below the prescribed speed adjustment range.**

If operated at low speeds below the speed adjustment range, this may cause sticking and slipping or stopping of operation.

2. **Do not apply external torque which exceeds the product's rated output.**

If external force is applied which exceeds the product's rated output, the product can be damaged.

3. **When repeatability of the rotation angle is required, the load should be directly stopped externally.**

The initial rotation angle may vary even in products equipped with angle adjustment.

4. **Avoid operation with oil hydraulics.**

Operation with oil hydraulics can cause damage to the product.



Series MSU Rotary Actuator Precautions 2

Be sure to read before handling.

Mounting

Warning

1. **When angle adjustment is performed while applying pressure, make advance preparations to keep equipment from rotating any more than necessary.**

When adjustment is performed with pressure applied, there is a possibility of rotation and dropping during adjustment depending on the mounting position of the equipment, etc. This can cause human injury and damage to equipment and machinery.

2. **Do not loosen the angle adjustment screw above the adjustment range.**

If the angle adjustment screw is loosened above the adjustment range, it may come out causing human injury and damage to equipment and machinery.

3. **Do not allow external magnetism close to the product.**

Since the auto switches used are types sensitive to magnetism, external magnetism in close proximity to the product can cause malfunction leading to human injury and damage to equipment and machinery.

4. **Do not perform additional machining on the product.**

Additional machining of the product can result in insufficient strength and cause damage leading to human injury and damage to equipment and machinery.

5. **Do not enlarge the fixed throttle on the piping port by reworking, etc.**

If the bore is enlarged, rotation speed and impact force will increase, which can cause damage to the product leading to human injury and damage to equipment and machinery.

6. **When using a shaft coupling, use one with a sufficient degree of freedom.**

If a shaft coupling is used which does not have a sufficient degree of freedom, twisting will occur due to eccentricity, and this can cause malfunction and product damage leading to human injury and damage to equipment and machinery.

7. **Do not apply loads to the shaft exceeding the values shown on page 37.**

If loads exceeding the allowable values are applied to the product, this can cause malfunction and product damage leading to human injury and damage to equipment and machinery.

8. **Attach external stoppers away from the axis of rotation.**

If the stopper is installed close to the axis of rotation, the reactive force operating on the stopper due to torque generated by the product itself will be applied to the shaft. This can cause damage to the shaft and bearing, leading to human injury and damage to equipment and machinery.

Precautions when using external stoppers

When the kinetic energy generated by the load exceeds the limit value of the actuator, an external shock absorbing mechanism must be provided to absorb the energy. The correct method for mounting external stoppers is explained in the figure below.

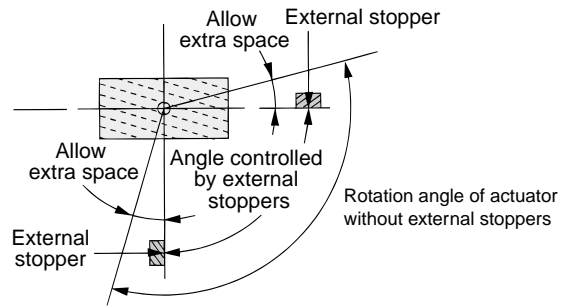
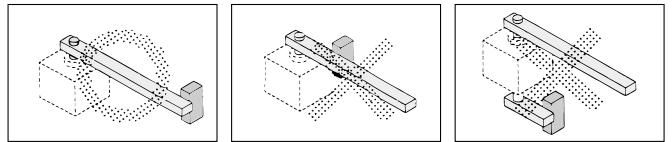


Figure 10.



External stopper becomes a fulcrum, and load's inertial force is applied to shaft as bending moment.

If external stopper is installed on shaft side opposite to load, inertial force generated by load is applied directly to shaft.

Caution

1. **Do not wipe the model indications on labels, etc., with solutions such as organic solvents.**

This will remove the indications.

2. **Do not secure the body and strike the shaft, or secure the shaft and strike the body, etc.**

This can bend the shaft and cause damage to the bearing. When installing a load, etc., on the shaft, secure the shaft.

3. **Do not step directly on the shaft or the equipment installed on the shaft.**

Stepping directly on the shaft can cause damage to the shaft and bearing, etc.



Series MSU Rotary Actuator Precautions 3

Be sure to read before handling.

Air Supply

Warning

1. Use clean air.

If compressed air includes chemicals, synthetic oils containing organic solvents, salt or corrosive gases, etc., it can cause damage or malfunction.

Caution

1. Install air filters.

Install air filters at the upstream side of valves. The rated filtration should be 5 μ m or finer.

2. Install an after cooler, air dryer or water separator, etc.

Air that includes excessive drainage may cause malfunction of rotary actuators and other pneumatic equipment. To prevent this, install an after cooler air dryer or water separator, etc.

3. Use the product within the specified range of fluid and ambient temperature.

Take measures to prevent freezing, since moisture in circuits may be frozen under 5°C, and this can cause damage to seals and lead to malfunction.

Refer to SMC's "Air Cleaning Equipment" catalog for further details on compressed air quality.

Operating Environment

Warning

1. Do not use in environments where there is a danger of corrosion.

Refer to the construction drawings regarding rotary actuator materials.

2. Do not use in dusty locations or where water and oil, etc., splash on the equipment.

Speed Adjustment

Warning

1. Perform speed adjustment gradually from the low speed side.

Speed adjustment from the high speed side can cause product damage leading to human injury and damage to equipment and machinery.

Lubrication

Caution

1. Use this product without lubrication. It can be used with lubrication also, but this can cause problems such as sticking and slipping.

Maintenance

Warning

1. Maintenance should be performed according to the procedure indicated in the instruction manual. Improper handling can cause damage and malfunction of equipment and machinery.

2. During maintenance, do not disassemble while the electric power and supply air are turned ON.

3. Conduct suitable function tests after the product has been disassembled for maintenance.

Failure to test functions can result in inability to satisfy the product specifications.

Caution

1. For lubrication use the grease specified for each product.

Use of a lubricant other than that specified can cause damage to seals, etc.



Series MSU Auto Switch Precautions 1

Be sure to read before handling.

Design & Selection

Warning

1. Confirm the specifications.

Read the specifications carefully and use this product appropriately. The product may be damaged or malfunction if it is used outside the range of specifications of current load, voltage, temperature or impact.

2. Take precautions when actuators are used close together.

When multiple auto switch actuators are used in close proximity, magnetic field interference may cause the switches to malfunction. Maintain a minimum actuator separation of 10mm. (When the allowable separation is indicated for each actuator series, use the specified value.)

3. Keep wiring as short as possible.

<Reed switch>

As the length of the wiring to a load gets longer, the rush current at switching ON becomes greater, and this may shorten the product's life. (The switch will stay ON all the time.)

- 1) For an auto switch without a contact protection circuit, use a contact protection box when the wire length is 5m or longer.
- 2) Even if an auto switch has a built-in contact protection circuit, when the wiring is more than 30m long, it is not able to adequately absorb the rush current and its life may be reduced. It is again necessary to connect a contact protection box in order to extend its life. Please contact SMC in this case.

<Solid state switch>

- 3) Although wire length should not affect switch function, use wiring 100m or shorter.

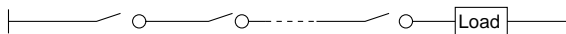
4. Take precautions for the internal voltage drop of the switch.

<Reed switch>

- 1) Switches with an indicator light
 - If auto switches are connected in series as shown below, take note that there will be a large voltage drop because of internal resistance in the light emitting diodes. (Refer to internal voltage drop in the auto switch specifications.)

[The voltage drop will be "n" times larger when "n" auto switches are connected.]

Even though an auto switch operates normally, the load may not operate.



- In the same way, when operating at or below a specified voltage, although an auto switch may operate normally, the load may not operate. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

$$\text{Supply voltage} - \text{Internal voltage drop of switch} > \text{Minimum operating voltage of load}$$

Warning

- 2) If the internal resistance of a light emitting diode causes a problem, select a switch without an indicator light.

<Solid state switch>

- 3) Generally, the internal voltage drop will be greater with a 2 wire solid state auto switch than with a reed switch. Take the same precautions as in 1).

Also, note that a 12VDC relay is not applicable.

5. Pay attention to leakage current.

<Solid state switch>

With a 2 wire solid state auto switch, current (leakage current) flows to the load to operate the internal circuit even when in the OFF state.

$$\text{Operating current of load (OFF condition)} > \text{Leakage current}$$

If the criteria given in the above formula are not met, it will not reset correctly (stays ON). Use a 3 wire switch if this specification will not be satisfied.

Moreover, leakage current flow to the load will be "n" times larger when "n" auto switches are connected in parallel.

6. Do not use a load that generates surge voltage.

<Reed switch>

When driving a load such as a relay that generates a surge voltage, use a switch with a built-in contact protection circuit or use a contact protection box.

<Solid state switch>

Although a zener diode for surge protection is connected at the output side of a solid state auto switch, damage may still occur if the surge is applied repeatedly. When a load, such as a relay or solenoid, which generates surge is directly driven, use a type of switch with a built-in surge absorbing element.

7. Cautions for use in an interlock circuit

When an auto switch is used for an interlock signal requiring high reliability, devise a double interlock system to avoid trouble by providing a mechanical protection function, or by also using another switch (sensor) together with the auto switch. Also perform periodic maintenance and confirm proper operation.

8. Ensure sufficient clearance for maintenance activities.

When designing an application, be sure to allow sufficient clearance for maintenance and inspections.



Series MSU Auto Switch Precautions 2

Be sure to read before handling.

Mounting & Adjustment

Warning

1. Do not drop or bump.

Do not drop, bump or apply excessive impacts (300m/s² or more for reed switches and 1000m/s² or more for solid state switches) while handling. Although the body of the switch may not be damaged, the inside of the switch could be damaged and cause a malfunction.

2. Do not carry a rotary table by the auto switch lead wires.

Never carry a rotary table by its lead wires, as this may not only cause broken lead wires, but it may cause internal elements of the switch to be damaged by the stress.

3. Mount switches using the proper tightening torque.

When a switch is tightened beyond the range of tightening torque, the mounting screws, mounting bracket or switch may be damaged. On the other hand, tightening below the range of tightening torque may allow the switch to slip out of position.

4. Mount a switch at the center of the operating range.

Adjust the mounting position of an auto switch so that the piston stops at the center of the operating range (the range in which a switch is ON). (The mounting positions shown in the catalog indicate the optimum positions at stroke end.) If mounted at the end of the operating range (around the borderline of ON and OFF), operation may be unstable.

Wiring

Warning

1. Avoid repeatedly bending or stretching lead wires.

Broken lead wires will result from repeatedly applying bending stress or stretching force to the lead wires.

2. Be sure to connect the load before power is applied.

<2 wire type>

If the power is turned ON when an auto switch is not connected to a load, the switch will be instantly damaged because of excess current.

3. Confirm proper insulation of wiring.

Be certain that there is no faulty wiring insulation (contact with other circuits, ground fault, improper insulation between terminals, etc.). Damage may occur due to excess current flow into a switch.

4. Do not wire with power lines or high voltage lines.

Wire separately from power lines or high voltage lines, avoiding parallel wiring or wiring in the same conduit with these lines. Control circuits containing auto switches may malfunction due to noise from these other lines.

Wiring

Warning

5. Do not allow short circuit of loads.

<Reed switch>

If the power is turned ON with a load in a short circuit condition, the switch will be instantly damaged because of excess current flow into the switch.

<Solid state switch>

Model D-F9□(V), D-F9□W(V) and all models of PNP output type switches do not have built-in short circuit protection circuits. As in the case of reed switches, if loads are short circuited, the switches will be instantly damaged.

Take special care to avoid reverse wiring with the brown (red) power supply line and the black (white) output line on 3 wire type switches.

6. Avoid incorrect wiring.

<Reed switch>

A 24VDC switch with indicator light has polarity. The brown (red) lead wire or terminal 1 is (+), and the blue (black) lead wire or terminal 2 is (-).

- 1) If connections are reversed, a switch will operate, however, the light emitting diode will not light up.

Also note that a current greater than that specified will damage a light emitting diode and it will no longer operate.

<Solid state switch>

- 1) If connections are reversed on a 2 wire type switch, the switch will not be damaged if protected by a protection circuit, but the switch will be in a normally ON state. However, it is still necessary to avoid reversed connections, since the switch could be damaged by a load short circuit in this condition.
- 2) If connections are reversed (power supply line + and power supply line -) on a 3 wire type switch, the switch will be protected by a protection circuit. However, if the power supply line (+) is connected to the blue (black) wire and the power supply line (-) is connected to the black (white) wire, the switch will be damaged.

* Lead wire color changes

Lead wire colors of SMC switches have been changed as shown below in order to meet NECA Standard 0402 for production beginning September, 1996 and thereafter.

Special care should be taken regarding wire polarity during the time that the old colors still coexist with the new colors.

2 wire			3 wire		
	Old	New		Old	New
Output (+)	Red	Brown	Power supply	Red	Brown
Output (-)	Black	Blue	GND	Black	Blue
			Output	White	Black



Series MSU Auto Switch Precautions 3

Be sure to read before handling.

Operating Environment

Warning

1. Never use in an atmosphere of explosive gases.

The construction of auto switches is not intended to prevent explosion. Never use in an atmosphere with an explosive gas since this may cause a serious explosion.

2. Do not use in an area where a magnetic field is generated.

Auto switches will malfunction or magnets inside actuators will become demagnetized. (Consult SMC regarding the availability of a magnetic field resistant auto switch.)

3. Do not use in an environment where the auto switch will be continually exposed to water.

Although switches, except some models, satisfy IEC standard IP67 construction (JIS C 0920: water tight construction), do not use switches in applications where continually exposed to water splash or spray. Poor insulation or swelling of the potting resin inside switches may cause malfunction.

4. Do not use in an environment with oil or chemicals.

Consult SMC if auto switches will be used in an environment with coolant, cleaning solvent, various oils or chemicals. If auto switches are used under these conditions for even a short time, they may be adversely affected by improper insulation, malfunction due to swelling of the potting resin, or hardening of the lead wires.

5. Do not use in an environment with temperature cycles.

Consult SMC if switches are used where there are temperature cycles other than normal temperature changes, as they may be adversely affected internally.

6. Do not use in an environment where there is excessive impact shock.

<Reed switch>

When excessive impact (300m/s² or more) is applied to a reed switch during operation, the contact point will malfunction and generate or cut off a signal momentarily (1ms or less). Consult SMC regarding the need to use a solid state switch depending upon the environment.

7. Do not use in an area where surges are generated.

<Solid state switch>

When there are units (solenoid type lifter, high frequency induction furnace, motor, etc.) which generate a large amount of surge in the area around actuators with solid state auto switches, this may cause deterioration or damage to the internal circuit elements of the switches. Avoid sources of surge generation and disorganized lines.

8. Avoid accumulation of iron debris or close contact with magnetic substances.

When a large amount of ferrous debris such as machining chips or welding spatter is accumulated, or a magnetic substance (something attracted by a magnet) is brought into close proximity to actuators with auto switches, it may cause the auto switches to malfunction due to a loss of the magnetic force inside the actuator.

Maintenance

Warning

1. Perform the following maintenance periodically in order to prevent possible danger due to unexpected auto switch malfunction.

1) Securely tighten switch mounting screws.

If screws become loose or the mounting position is dislocated, retighten them after readjusting the mounting position.

2) Confirm that there is no damage to lead wires.

To prevent faulty insulation, replace switches or repair lead wires, etc., if damage is discovered.

Other

Warning

1. Consult SMC concerning water resistance, elasticity of lead wires and usage at welding sites, etc.



Series MSU Specific Product Specifications 1

Be sure to read before handling. Refer to pages 41 through 47 for safety instructions, actuator precautions, and auto switch precautions.

Selection

⚠ Warning

1. Keep the load energy within the product's allowable energy value.

Operation with a load kinetic energy exceeding the allowable value can cause human injury and/or damage to equipment or machinery. (Refer to model section procedures in this catalog.)

⚠ Caution

1. When there are load fluctuations, allow a sufficient margin in the actuator torque.

In case of horizontal mounting (operation with product facing sideways), malfunction may occur due to load fluctuations.

Mounting

⚠ Caution

1. Adjust the rotation angle within the prescribed ranges. ($90^\circ \pm 10^\circ$, $180^\circ \pm 10^\circ$) ($\pm 5^\circ$ at end of rotation)

Adjustment outside the prescribed ranges may cause malfunction of the product or failure of switches to operate.

2. Adjust the rotation time within the prescribed values using a speed controller, etc. (0.07 to 0.3s/90°)

The product is provided with a fixed throttle and is designed not to operate faster than 0.07s/90°. However, in cases such as a large load inertia, it can exceed the allowable energy causing damage to equipment. (Refer to the model selection procedures in this catalog.)

Furthermore, adjustment to a speed slower than 0.3s/90° can cause sticking and slipping or stopping of operation.

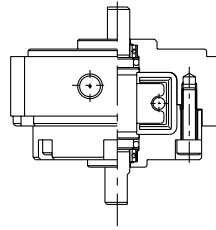
Maintenance

⚠ Caution

<High precision type/MSUA>

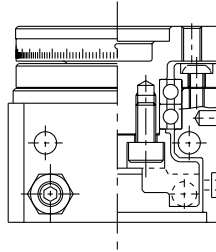
In case a rotary unit and table unit are required for maintenance, order with the unit part numbers shown below.

Rotary unit



Model	Unit part no.
MSUA 1-□S	P402070-2A
MSUA 1-□SE	P402070-2B
MSUA 3-□S	P402090-2A
MSUA 3-□SE	P402090-2B
MSUA 7-□S	P402060-2A
MSUA 7-□SE	P402060-2B
MSUA20-□S	P402080-2A
MSUA20-□SE	P402080-2B

Table unit



Model	Unit part no.
MSUA 1- 90□	P402070-3A
MSUA 1-180□	P402070-3B
MSUA 3- 90□	P402090-3A
MSUA 3-180□	P402090-3B
MSUA 7- 90□	P402060-3A
MSUA 7-180□	P402060-3B
MSUA20- 90□	P402080-3A
MSUA20-180□	P402080-3B

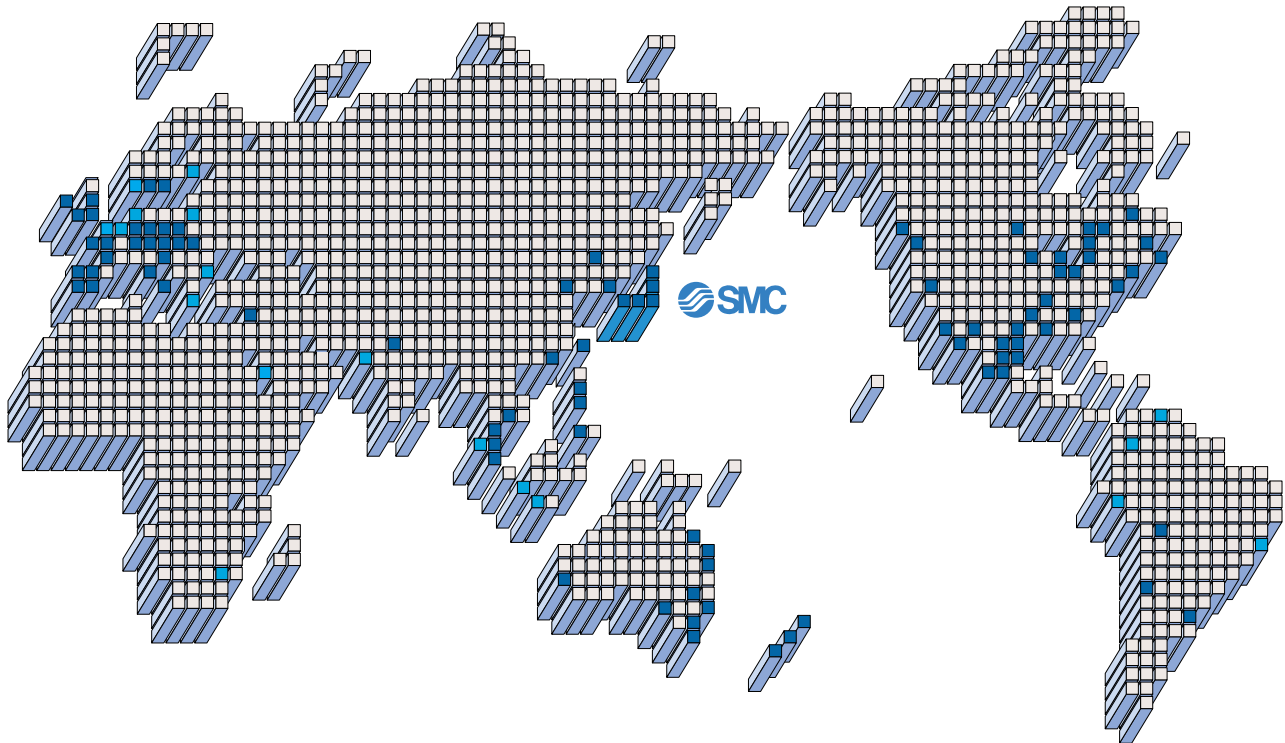
Note 1) Note that the rotation angle should not be changed even though the rotary unit has been changed.

For maintenance, order units with a part number suitable for the model being used.

Note 2) Due to the integral construction of the MSUB series, the rotary and table units cannot be ordered separately.



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