



# Operation Manual

PRODUCT NAME

Air servo cylinder

MODEL/ Series/ Product Number

IN-777 Series



**SMC Corporation**

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# Safety Instructions

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

\*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.

ISO 4413: Hydraulic fluid power -- General rules relating to systems.

IEC 60204-1: Safety of machinery -- Electrical equipment of machines .(Part 1: General requirements)

ISO 10218: Manipulating industrial robots -Safety.

etc.



## Caution

**Caution** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.



## Warning

**Warning** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.



## Danger

**Danger** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.



## Warning

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

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

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

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

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

The product specified here may become unsafe if handled incorrectly.

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

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

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.

2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.

3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

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

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.

2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.

3. An application which could have negative effects on people, property, or animals requiring special safety analysis.

4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.



# Safety Instructions

## Caution

### **The product is provided for use in manufacturing industries.**

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

## **Limited warranty and Disclaimer/Compliance Requirements**

The product used is subject to the following “Limited warranty and Disclaimer” and “Compliance Requirements”.

Read and accept them before using the product.

### **Limited warranty and Disclaimer**

1. The warranty period of the product is 1 year in service or 1.5 years after the product is delivered, whichever is first.\*2)  
Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.
2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.  
This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.
3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.  
\*2) Vacuum pads are excluded from this 1 year warranty.  
A vacuum pad is a consumable part, so it is warranted for a year after it is delivered.  
Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty.

### **Compliance Requirements**

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



## Caution

### **SMC products are not intended for use as instruments for legal metrology.**

Measurement instruments that SMC manufactures or sells have not been qualified by type approval tests relevant to the metrology (measurement) laws of each country.

Therefore, SMC products cannot be used for business or certification ordained by the metrology (measurement) laws of each country.










## Explanation of Symbols

Symbol	Definition
	Things you must not do. Instructions are provided as a drawing or sentence next to the symbol.
	Things you must do. Instructions are provided as a drawing or sentence next to the symbol.

## Operator

<p>(1) This Operation Manual is intended for those who have knowledge of machinery using pneumatic equipment, and have sufficient knowledge of assembly, operation and maintenance of such equipment. Only those persons are allowed to perform assembly, operation and maintenance.</p> <p>(2) Read and understand this Operation Manual carefully before assembling, operating or providing maintenance to the product.</p>
---

## Safety Instructions


 <b>Warning</b>	
 Disassembly prohibited	Do not disassemble, modify (including the replacement of the circuit board) or repair. Otherwise, an injury or failure can result.
 Do not	Do not operate the product outside of the specifications. Do not use the product with flammable or harmful fluids. Fire, malfunction, or damage to the system can result. Please check the specifications before use.
 Do not	Do not use in an atmosphere containing flammable or explosive gases. Fire or an explosion may result. The product is not designed to be explosion proof.
 Instruction	If using the product in an interlocking circuit: - Provide a double interlocking system, for example a mechanical system. - Check the product for proper operation. Otherwise malfunction can result, causing an accident.
 Instruction	The following instructions must be followed during maintenance: - Turn off the power supply - Stop the air supply, exhaust the residual pressure in piping and verify that the air is released before performing maintenance work. Otherwise an injury can result.
 <b>Caution</b>	
 Instruction	After completing maintenance, perform appropriate functional checks. Stop operation if the equipment does not function properly.
 Connect the grounding cable	Provide grounding to improve the safety and noise resistance of the product. Grounding should be as close as possible to the product and the ground wires should be as short as possible.

## ■ Handling Precautions

Follow the instructions given below for selecting and handling of the air servo cylinder.


- The instructions on design and selection (installation, wiring, environment, adjustment, operation, maintenance, etc.) described below must be followed.

\*Product specifications

 <b>Warning</b>
<ul style="list-style-type: none"><li>- Use the specified voltage. Otherwise failure or malfunction can result.</li><li>- Reserve a space for maintenance. When installing the products, allow access for maintenance.</li><li>- Do not remove the label. This can lead to incorrect maintenance, or misreading of the operation manual, which can cause damage or malfunction to the product. It may also result in nonconformity to safety standards.</li></ul>

## ● Product Handling

\* Precautions for design

 <b>Warning</b>
<ul style="list-style-type: none"><li>- There is a possibility of dangerous sudden action by air cylinders if force is changed due to twisting of sliding parts of machinery. In such cases, human injury may occur; e.g., hands or feet caught in the machinery, or damage to the machinery itself may occur. Therefore, the machine should be designed to operate smoothly and avoid such dangers.</li><li>- A protective cover is recommended to minimize the risk of personal injury. If the driven object or moving parts of the product will pose a hazard to humans, a construction that prevents direct contact with the exposed area must be provided.</li><li>- Securely tighten all stationary parts and connected parts, so that they will not become loose. When the product operates with high frequency or is installed where there is a lot of vibration, ensure that all parts remain secure.</li><li>- Design the system so that an external force exceeding the maximum output is not applied to the product. The product can break, causing a risk of personal injury or damage to equipment.</li><li>- The product generates a large force. Install on a sufficiently rigid mounting base, taking this force into consideration. There is a risk of personal injury or damage to equipment.</li><li>- Consider a possible loss of power source. Measures should be taken to prevent personal injury and damage to equipment in the event that there is a power malfunction to equipment controlled by air pressure, electricity or hydraulics, etc.</li><li>- Consider the action when operation is restarted after an emergency stop or abnormal stop. Design the machinery so that personal injury or damage to equipment will not occur upon restart of operation. When the cylinder has to be reset at the starting position, install safety manual control equipment.</li></ul>

## Caution

- Do not touch the cylinder during high speed and high frequency operation. When the cylinder is operating at high speed and high frequency, the surface temperature of the cylinder tube increases, and may cause injury to personnel.
- Do not use the air cylinder as an air-hydro cylinder.  
If the working fluid of the air cylinder is turbine oil, oil leakage can result.
- The oil adhered to the cylinder is grease oil.
- The base oil of grease may seep out. The base oil of grease in the cylinder may seep out from the tube, cover, or rod sliding part depending on the operating conditions (ambient temperature of 40°C or more, pressurized condition, low frequency operation, etc.). Contact SMC especially if a clean environment is required.

### \* Mounting

## Caution

- Do not drop, hit or apply excessive shock to the product.  
The product will be damaged, leading to failure and malfunction.
- Tighten to the specified tightening torque.  
If the tightening torque is exceeded, the mounting screws can be broken.  
If the screws are tightened to a different torque, IP67 will not be achieved.
- Be sure to connect the piston rod and the load so that their axial centers and movement directions match. If they do not match, stress could be applied to the rod and the cylinder tube, causing wear on the inner surface of the cylinder tube, the bushing, the rod surface, and damage to the seals.
- Do not scratch or dent the sliding parts of the cylinder tube or piston rod, by striking or grasping them with other objects.
- Cylinder bores are manufactured to precise tolerances, even a slight deformation may cause a malfunction. Moreover, scratches or dents, etc. on the piston rod sliding part may lead to damaged seals and cause air leakage.
- Do not apply excessive lateral load to the piston rod.  
Calculation for excessive lateral load:  
Minimum operating pressure value after the device is mounted (MPa) = Cylinder's minimum operating pressure (MPa) + {Load weight (kg) x Guide friction coefficient / Cylinder's cross section (mm<sup>2</sup>)}  
If the product is found to operate smoothly with the calculated pressure, it can be judged that the alignment of the guides have not created additional loading on the cylinder.
- Do not use the product until it has been verified that the equipment can operate properly. After installation or repair, apply compressed air and power supplies to the equipment and perform appropriate functional and leakage inspections to make sure the equipment is mounted properly.
- Do not let foreign matter such as cutting chips get into the product from the supply port. When the product is installed on site, the debris from drilling mounting holes could get in the supply port of the product. Take sufficient care to prevent this.
- Never mount the product in a location that will be used as a footrest.  
The product may be damaged if excessive force is applied by stepping or climbing onto it.

\* Wiring (Including connecting/disconnecting of the connectors)

 **Warning**

- Wire correctly.

Incorrect wiring can cause damage the product.

- Do not perform wiring while the power is on.

Incorrect wiring can damage the air servo cylinder and/or input/output equipment and malfunction can result.

 **Caution**

- Avoid repeatedly bending or stretching the cables, or placing a heavy load on them.

Applying repeated bending and tensile stress to the cable can break the circuit.

- Do not route wires and cables together with power or high voltage cables.

The product can malfunction due to interference of noise and surge voltage from power and high voltage cables to the signal line.

Wiring of the air servo cylinder and the input/output device and the power cable or high voltage cable should be separated from each other.

- Confirm proper insulation of wiring.

Poor insulation (interference with other circuits, poor insulation between terminals etc.) can apply excessive voltage or current to the air servo cylinder and input/output device causing damage to them.

- When an air servo cylinder is installed in machinery/equipment, provide adequate protection against noise by using noise filters, etc. Noise in signal lines may cause malfunction.

\* Operating environment

 **Caution**

- Select the proper type of enclosure according to the operating environment.

IP67 protection class is achieved when the following conditions are met.

Wire the units correctly using a cable and M23 connector compliant with IP67.

If using in an environment that is exposed to water splashes, please take protective measures, such as using a cover.

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

If the product is to be used in an environment containing oils or chemicals such as coolant or cleaning solvent, even for a short time, the pressure switch may be adversely affected (damage, malfunction, etc.).

- Do not use the product in an environment where corrosive gases or fluids can be splashed.

Otherwise damage to the air servo cylinder can result, causing malfunction.

- Do not use in an area where electrical surges are generated.

If there is equipment which generates a large amount of surge (solenoid type lifter, high frequency induction furnace, motor, etc.) close to the air servo cylinder, this may cause deterioration or breakage of the internal circuit of the air servo cylinder. Avoid sources of surge generation and crossed lines.

- The product is CE marked, but not immune to lightning strikes. Take measures against lightning strikes in the system.

- Do not let foreign matter, such as wire debris, get inside the product.

This can damage the product causing failure or malfunction.

- Do not install this product in a location subject to vibration and impact.



Otherwise it can cause damage or malfunction.

- Do not use the product in an environment that is exposed to temperature cycle.

Heat cycles other than ordinary changes in temperature can adversely affect the internal components of the product.

- Do not expose the product to direct sunlight.

If using in a location directly exposed to sunlight, protect the product from the sunlight.

Failure or malfunction may occur.

- Keep within the specified ambient temperature range. Otherwise malfunction can result.

- Do not use in a location where the product is exposed to radiant heat from surrounding heat sources.

Otherwise malfunction can result.

#### \* Air Supply

This product uses a metal seal type air servo valve. A mist separator with a filtration rating of 0.3  $\mu\text{m}$  or less must be used in conjunction with this product. Do not use air containing mist or dust. It will cause a decrease in performance.

Install a dryer (IDF series), air filter (AF/AFF series), or mist separator (AFM/AM series) to obtain clean compressed air (air quality of Class 2.6.3 or higher according to ISO 8573-1: 2010 is recommended for operation).

### Warning

- Type of fluids

Applicable fluid is compressed air.

- When there is a large amount of condensate

Compressed air containing a large amount of condensate can cause the malfunction of pneumatic equipment. An air dryer or mist separator should be installed upstream from the filters.

- Drain flushing

If condensate in the drain bowl is not emptied on a regular basis, the bowl will overflow and this may cause the malfunction of pneumatic equipment. If the drain bowl is difficult to check and remove, installation of a drain bowl with an auto drain option is recommended.

- Types of air

Do not use compressed air which contains chemicals, synthetic oils containing organic solvents, salts or corrosive gases, etc., as this can cause damage or a malfunction.

### Caution

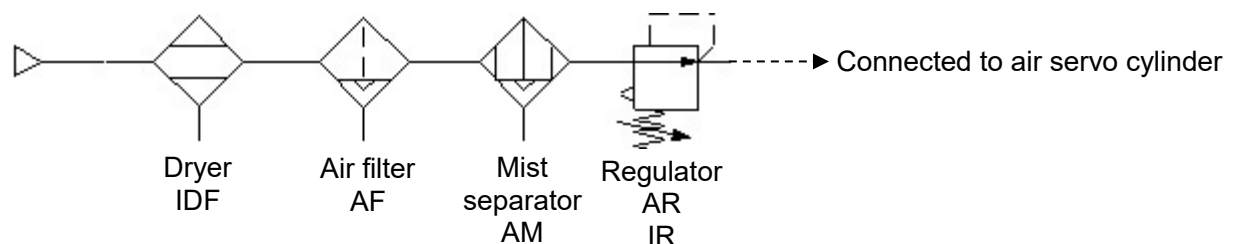
- Install an air filter.

Install an air filter upstream near the valve. Select an air filter with a filtration size of 0.3 $\mu\text{m}$  or smaller.

- Take measures to ensure air quality, such as installing an aftercooler, air dryer, or water separator.

Compressed air that contains excessive foreign material may cause malfunction of valves and other pneumatic equipment. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.

- Recommended pneumatic circuit example



\* Adjustment and Operation

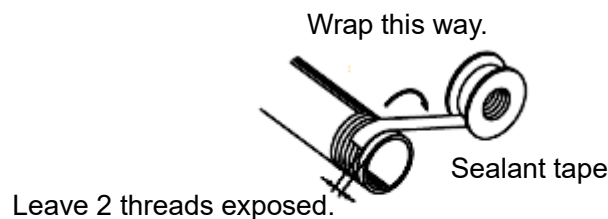
**⚠ Caution**

- Set the switches using a small flat blade screwdriver.  
Using an unsuitable tool may lead to damage to the setting switch.
- Perform settings suitable for the operating conditions.  
Incorrect setting can cause operation failure.  
For details of each setting, refer to 6. Setting of this Operation Manual.

\* Piping

**⚠ Caution**

- Preparation before piping  
Flush the piping enough before connecting piping to the supply port.  
Do not allow water or dust to enter the pressure release port and/or the main exhaust ports when piping. Confirm that the piping is securely connected before supplying compressed air.
- Wrapping of sealant tape  
When installing piping, avoid chips and sealing materials from piping screws entering the inside of equipment. Also, if pipe tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



\* Maintenance

**⚠ Warning**

- Turn off the power supply, stop the air supply, exhaust the residual pressure in the piping and cylinder, and verify the release of air, before performing maintenance. Otherwise, unintended malfunction of system components can result.
- Perform regular maintenance and inspections. There is a risk of unexpected malfunction due to malfunction of the equipment.
- After maintenance is complete, perform appropriate functional inspections. Stop operation if the equipment does not function correctly. Otherwise, unintended malfunction of system components can result.

**⚠ Caution**

- Do not use solvents such as benzene, thinner etc. to clean the product. These can damage the surface of the body and erase the markings on the body. Use a soft cloth to remove stains. For heavy stains, use a cloth soaked with diluted neutral detergent and fully squeezed, then wipe up the stains again with a dry cloth.

- Check items

1. Smooth operation
2. Changes in piston speed and cycle time
3. Abnormal stroke
4. Looseness of the cylinder mounting bolt
5. Looseness of cylinder mounting frame or excessive deflection
6. Internal and external leakage (Change in output)
7. Damage to the piston rod sliding surface
8. Clogging and discharge drainage of the air filter

When any abnormality is found as a result of the inspections shown above, eliminate the causes and take necessary measures such as retightening screws. Contact SMC sales if the cylinder needs to be repaired.

 **Warning**

- Maintenance should be performed according to the items above. Perform additional inspections as necessary. Improper handling can cause damage or malfunction of equipment and machinery.

- Removal of equipment and supply/exhaust of compressed air

When equipment is removed, first confirm that measures are in place to prevent workpiece from dropping and/or equipment running away, etc. Cut the supply pressure and electric power and exhaust all compressed air from the system. Before restarting the equipment, confirm that measures are taken to prevent sudden action.

# 1. Product Overview / Features

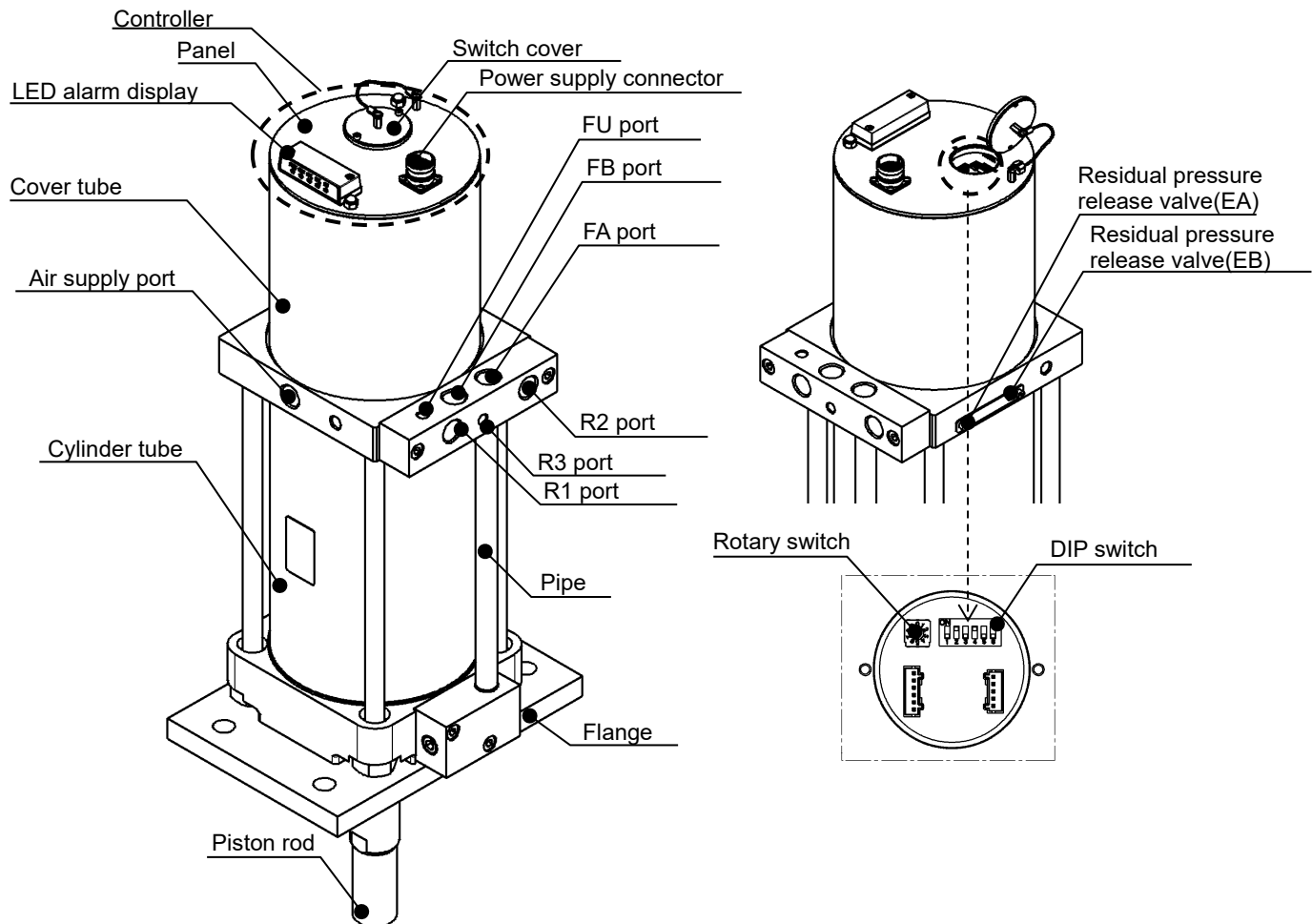
## Product Overview

The positioning operation of this air servo cylinder can be accurately controlled. It can be used for positioning applications which require high thrust. It can be easily set up with simple interface, function and configuration.

## Features

1. Positioning based on a command from the host PLC can be performed (Repeated positioning accuracy: within +/-0.5 mm)
2. Cylinder and controller are integrated
3. Compliant dust and water proof to IP67
4. Piston rod stop position maintained during power failure
5. Alarm LED display (Option)
6. Calibration
7. JOG operation
8. Piston rod position can be provided as an output signal
9. Manual air exhaust

## 2. Names and Functions of Parts



Name	Function
Controller	Controls the drive of the air servo cylinder.
Panel	Forms part of the controller body and protects the cover tube from foreign matter.
Switch cover	For access to the switches in the controller.
LED alarm display	LED display to indicate alarm condition.
Power supply connector	Connector for power supply and input/output signals. (Size:M23)
Cover tube	Protects the internal valve unit and controller assembly.
Air supply port	Port for connecting the air supply
R1, R2 ports	Air exhaust ports for air servo cylinder operation
R3 port	Port for releasing pressure in the cover tube
Cylinder tube	Component for pressure in the cylinder chamber
FA port	When using the optional fail safe air circuit, the piping needs to be connected to these 3 ports. Please refer to the fail-safe air circuit for how to connect piping when the fail-safe air circuit is used.
FB port	
FU port	
Pipe	Flow passage to supply air to the cylinder rod end
Flange	Mounting bracket for installing the product
Piston rod	Driving part of the cylinder
Residual pressure release valve (EA,EB)	Valve for releasing the residual pressure in the cylinder
Rotary switch	Switch for setting the piston rod travel speed
DIP switch	Switch for setting the travel direction and signal operation

### 3. How to Order

#### 3-1. Main Body

(1) Air servo cylinder

IN-777- **160** **TF** - **300** **F** **J** - **H** **L** **S** -

**Bore size**

<b>125</b>	125 mm
<b>160</b>	160 mm
<b>200</b>	200 mm
<b>250</b>	250 mm
<b>320</b>	320 mm

**Port thread type**

<b>TF</b>	G
-----------	---

**Stroke**

Bore size(mm)	Stroke(mm)
<b>125</b>	<b>250</b>
<b>160</b>	<b>200,300</b>
<b>200</b>	<b>200,300</b>
<b>250</b>	<b>350,450</b>
<b>320</b>	<b>200,350,530</b>

Made to order

**Auto start function**

<b>Nil</b>	Without Auto start function
<b>S</b>	With Auto start function

**LED alarm display**

<b>L</b>	With LED alarm display
----------	------------------------

**Communication protocol**

<b>H</b>	4-20mA/HART communication
----------	---------------------------

**Rod boot**

<b>J</b>	Silicone rubber material
<b>A</b>	Nylon tarpaulin
<b>Nil</b>	Without rod boot

**Ambient temperature specifications**

With rod boot of silicone rubber material and without rod boot : -20°C to 60 °C

With rod boot of nylon tarpaulin : -10°C to 60 °C

(No freezing)

**Mounting**

<b>F</b>	Rod flange style
----------	------------------

### Warning

The actions of the piston rod differ between the auto start function enabled and disabled specification. At the time of turning on again of power supply in restoration from power failure, re-input of analogue signal, and normal use, pay attention to a sudden extension or retraction of the piston rod. For details, refer to "6-5. Auto start function" and the items (4) and (5) in "7-11. Operation Examples (Timing Chart)" of this instruction manual.

### 3-2. Spare Parts

#### (1) Controller assembly

IN-777P- **H** **L** **S** -410AS

**Communication protocol**

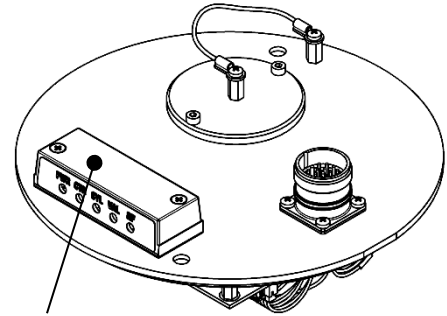
<b>H</b>	4-20mA/HART communication
----------	---------------------------

**LED alarm display**

<b>L</b>	With LED alarm display
----------	------------------------

**Auto start function**

<b>Nil</b>	Without Auto start function
<b>S</b>	With Auto start function

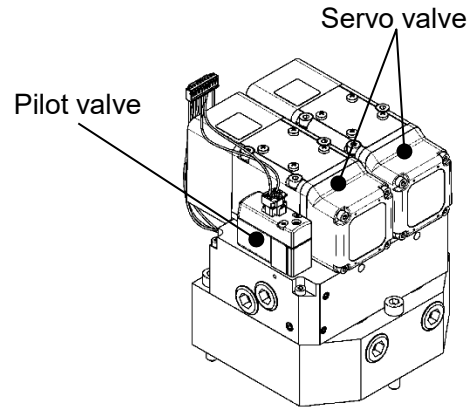


LED alarm display

#### (2) Valve unit

IN-777P-010AS

Valve unit

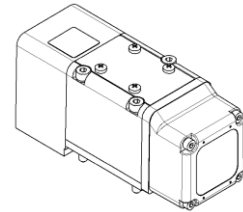


Servo valve

Pilot valve

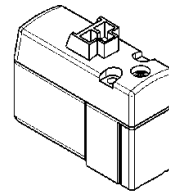
#### (3) Servo valve

XT581-V-C-X001  
(One piece)



#### (4) Pilot valve

V211KT-5LOZ-X48



#### (5) Position sensor unit

IN-777P- **200** -830AS

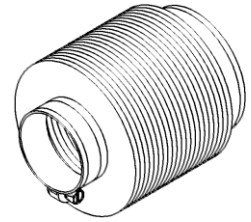
**Cylinder stroke**

<b>200</b>	200 mm
<b>250</b>	250 mm
<b>300</b>	300 mm
<b>350</b>	350 mm
<b>450</b>	450 mm
<b>530</b>	530 mm



(6) Rod boot

Bore size (mm)	Stroke (mm)	Part number	
		Silicone rubber material	Nylon tarpaulin
125	200	C96A2G-1461V-R	C96A2G-0294Y-R
160	200	C95A6G-471AQ-R	CS1-J16-300
	300		
200	200	C95B0G-472AQ-R	C95B0G-0304Y-R
	300		
250	350	C95B5G-533AQ-R	C95B5G-574EQ-R
	450		
320	200	C1SC2G-1468V-R	CS1-J25-200
	350	C1SC2G-1470V-R	CS1-J25-530
	530		



Ambient temperature specifications

With rod boot of silicone rubber material and without rod boot: -20 °C to 60 °C

With rod boot of nylon tarpaulin: -10 °C to 60 °C

(No freezing)

(7) Seal kit

IN-777P- **125** -910AS

Bore size (mm)

125	(13) Tube gasket : 2 pcs, (16) Piston seal : 1 pc, (25) Rod seal : 1 pc, (28) Wear ring : 1 pc, (31) Pipe O-ring : 2 pcs
160	
200	
250	
320	(13) Tube gasket : 2 pcs, (16) Piston seal : 1 pc, (25) Rod seal : 1 pc, (28) Wear ring : 1 pc, (31) Pipe O-ring : 2 pcs, (35) Wiper ring : 1 pc

\*Seal kit includes a grease pack.

\*The numbers in a parenthesis correspond to the component numbers in the cross-section construction drawing on page 25.



## 4. Specification

### 4-1. General Specification

Item	Specification
Action	Double acting, Single rod
Fluid	Air
Filtration of compressed air	0.3 μm or less
Proof pressure	1.2 MPa
Operating pressure range	0.55 MPa to 0.8 MPa
Repeated stop position accuracy	+/-0.5 mm or less *1
Average speed	Refer to "6-4-1 Piston rod moving average speed".
Ambient temperature	-20 °C to 60 °C (With rod boot of silicone rubber material and without rod boot) -10 °C to 60 °C (With rod boot of nylon tarpaulin) (No freezing)
Fluid temperature	-20 °C to 60 °C (No freezing)
Operating humidity	35 % to 85 % (No condensation)
Installation altitude	0 m to 5,000 m
Housing protection	IP67
Standard	CE,UKCA, RoHS compliant
Weight	Refer to Table 1.
Lubrication	Non-lube
Mounting orientation	Vertical downward, Vertical upward
Vibration resistance	Amplitude or acceleration: 1.5 mm or 3 G Frequency: 5 Hz to 100 Hz Direction: X,Y,Z 3 times each Sweep time, sweep cycle: 12 min · 10 cycle (De-energized)
Impact resistance	Acceleration: 15 G Duration of shock pulse, Pulse shape: 11 ms, sinusoidal waveform Direction: X,Y,Z 3 times each (De-energized)
Allowable lateral load at rod end	Refer to Table 2.
Theoretical output · Work load	Refer to Table 3.
Power supply connector (Body)	M23 19 pin male connector

\*1 Based on the SMC's test conditions

Table 1 Weight

Bore size (mm)	Stroke (mm)	Weight (kg)
125	250	24
160	200	37
	300	43
200	200	53
	300	61
250	350	86
	450	97
320	200	100
	350	129
	530	163

Table 2 Allowable lateral load at rod end

Bore size (mm)	Allowable lateral load at rod end (N)
125	70
160	90
200	140
250	160
320	230

Table 3 Theoretical output/Maximum work load

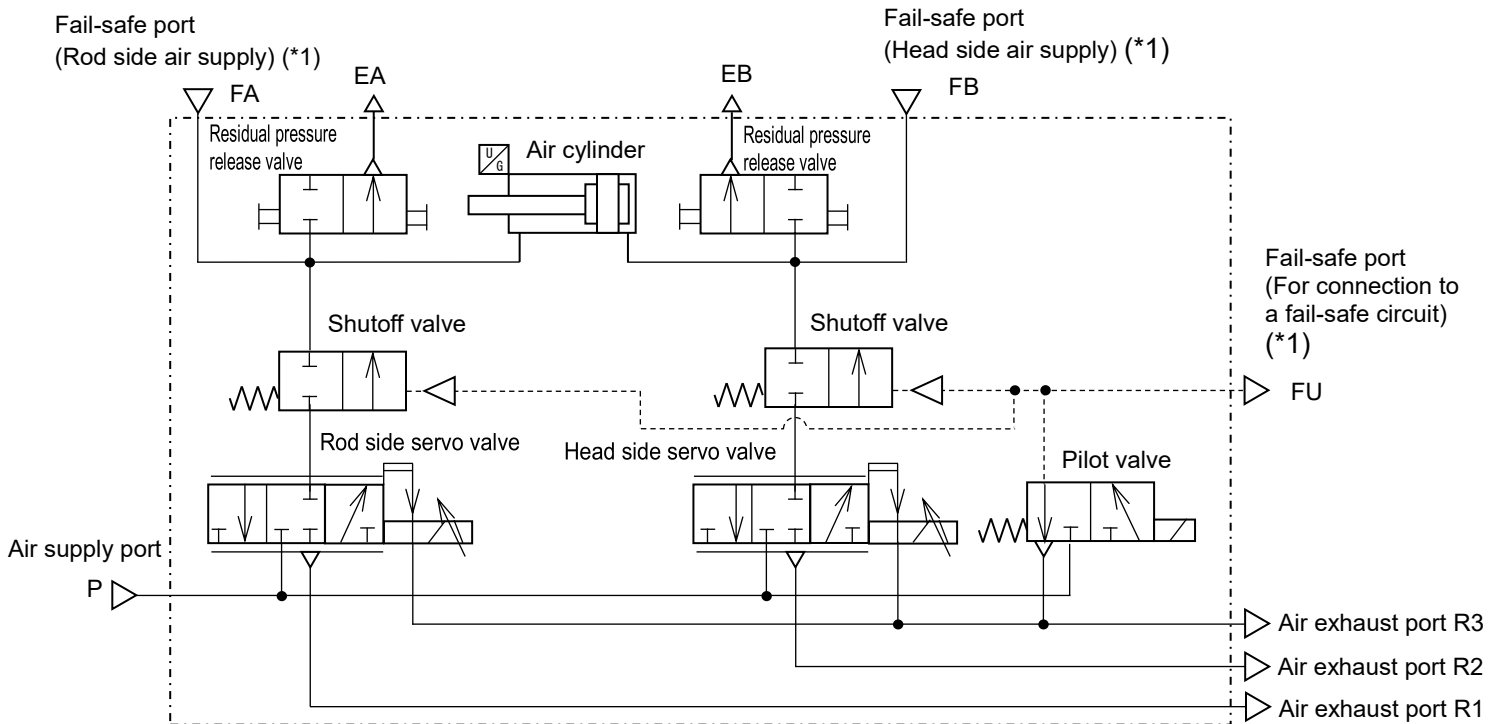
Bore size (mm)	Theoretical output (N)			Maximum work load (kg) *2
	Operating direction	Operating pressure (MPa)		
		0.55	0.8	
125	IN	6,400	9,200	160
	OUT	6,800	9,900	
160	IN	10,400	15,100	240
	OUT	11,100	16,100	
200	IN	16,600	24,200	240
	OUT	17,300	25,200	
250	IN	26,000	37,700	300
	OUT	27,000	39,300	
320	IN	42,700	62,100	300
	OUT	44,300	64,400	

\*2 Based on the SMC's test conditions.

## 4-2. Electrical Specifications

Item	Specification
Power supply	Applied voltage: DC24 V $\pm$ 10% Current consumption: 0.5 A (Maximum 2.5 A)
Control system	Closed loop
Positioning sensor	Absolute
Analog input signal	DC 4 to 20 mA
Analog input impedance	Approx. 250 $\Omega$
Analog output signal	DC 4 to 20 mA
Maximum load impedance (Analog output)	500 $\Omega$
Voltage across terminals	DC12 V (Input impedance worth 600 $\Omega$ at DC20 mA)
Switch input signal	4 points, Connected to DC+24 V $\pm$ 10% Current consumption: 10 mA or less
Switch output signal	5 points, N-type MOSFET Open source output Maximum load current: 100 mA

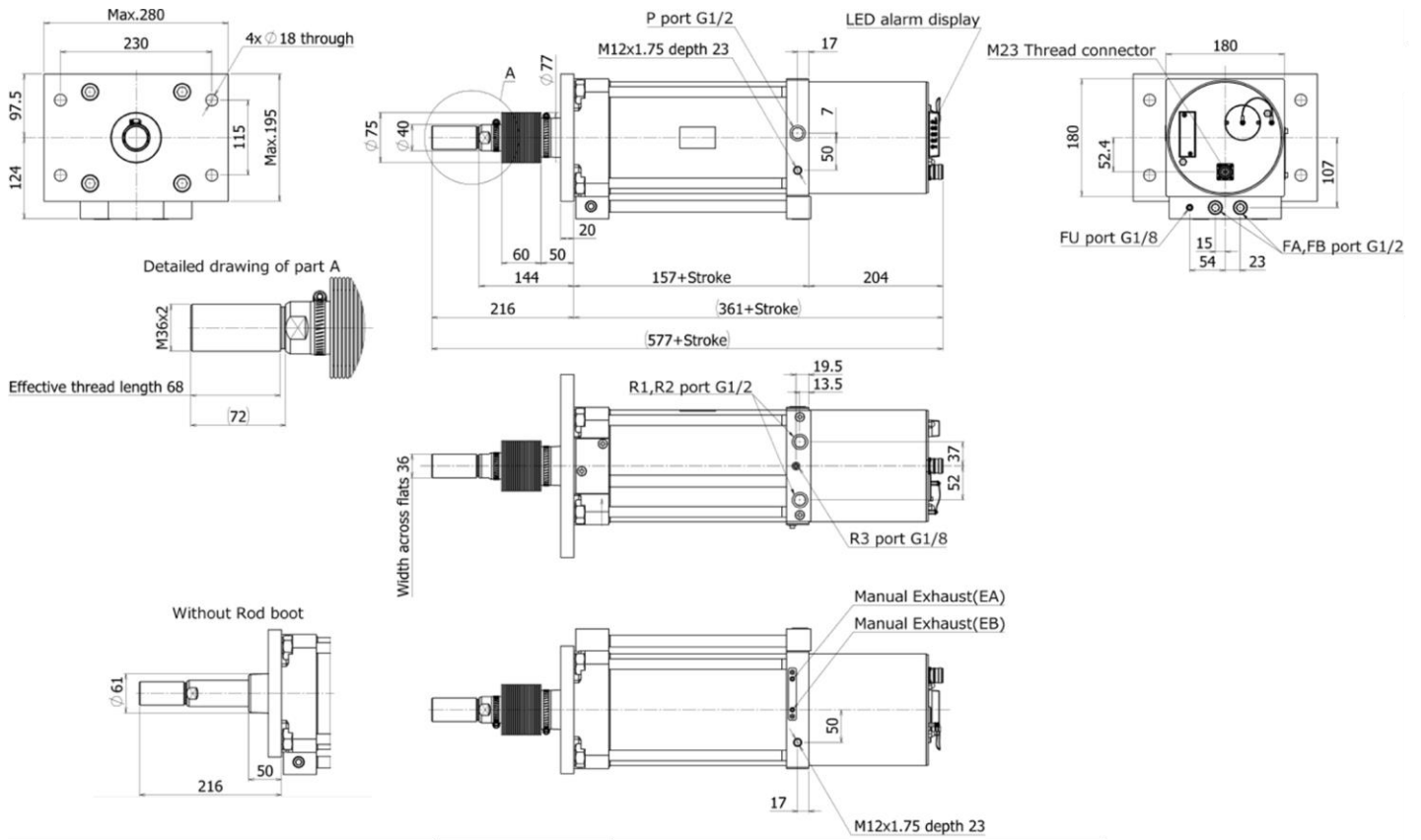
## 4-3. Air Circuit



\*1) IN-777 series can be operated with a fail-safe mode. In order to operate the cylinder with fail-safe mode, FA, FB and FU port piping is necessary. When the fail-safe function is not used, do not remove the plugs from FA, FB and FU ports. Refer to reference document "Example of fail-safe circuit for air servo cylinder IN-777" for the pneumatic circuit to use when the fail-safe function is used.

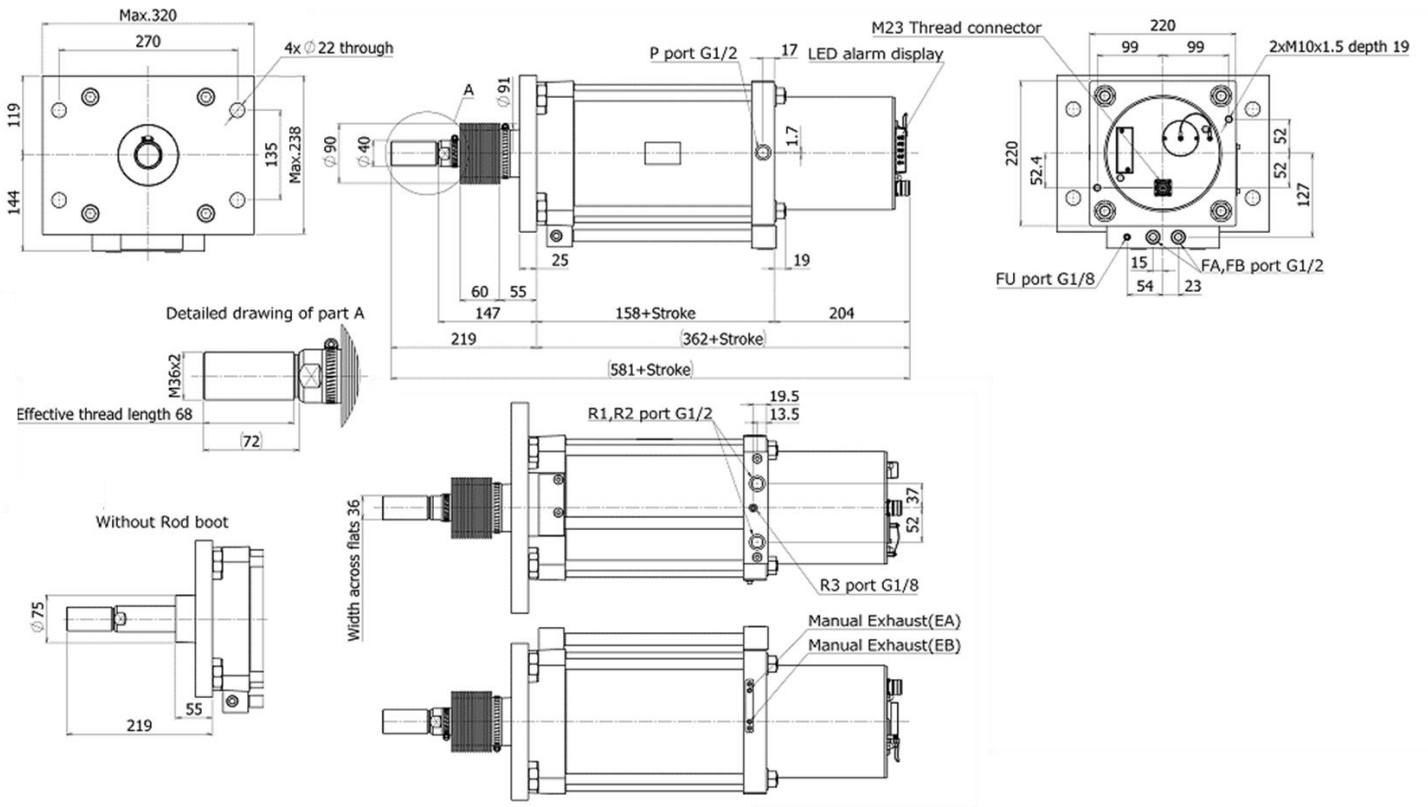


(2) Bore size: Ø160



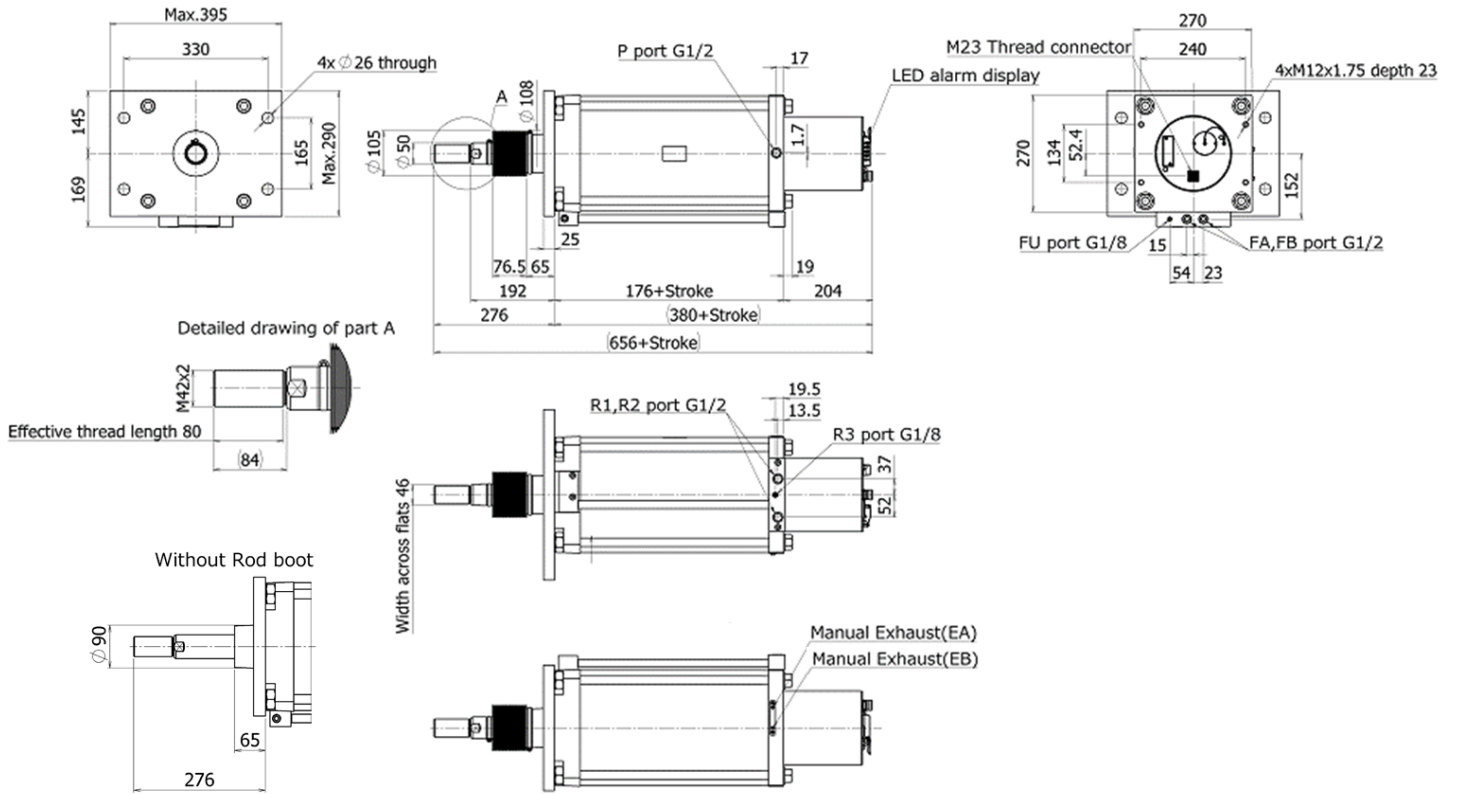
Product number	Bore size (mm)	Stroke (mm)
IN-777-160TF-200F*-HL	160	200
IN-777-160TF-300F*-HL		300

(3) Bore size: Ø200



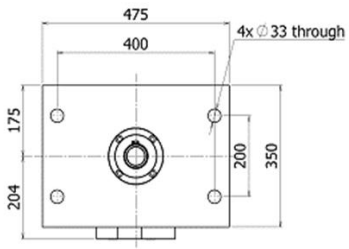
Product number	Bore size (mm)	Stroke (mm)
IN-777-200TF-200F*-HL	200	200
IN-777-200TF-300F*-HL		300

(4) Bore size: Ø250

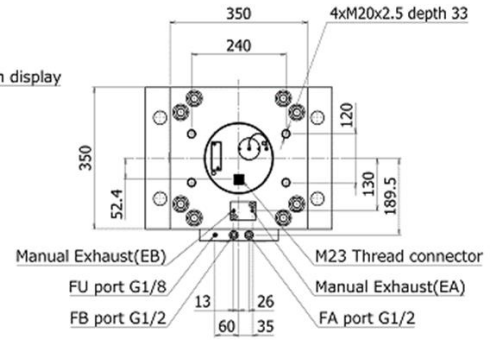
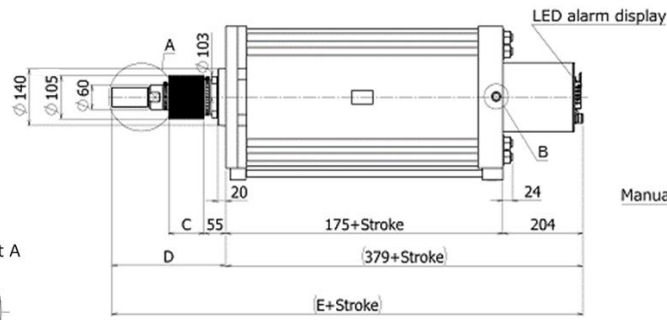
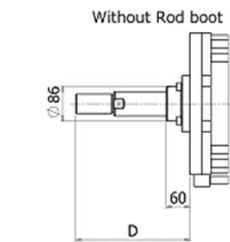
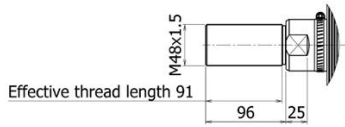


Product number	Bore size (mm)	Stroke (mm)
IN-777-250TF-350F*-HL	250	350
IN-777-250TF-450F*-HL		450

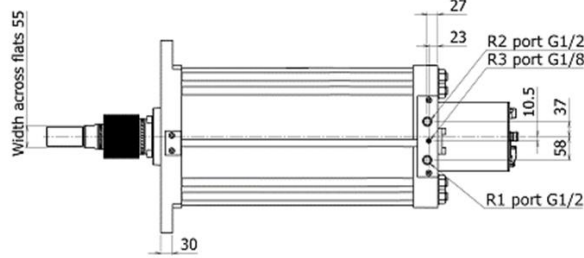
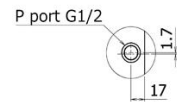
(5) Bore size: Ø320



Detailed drawing of part A



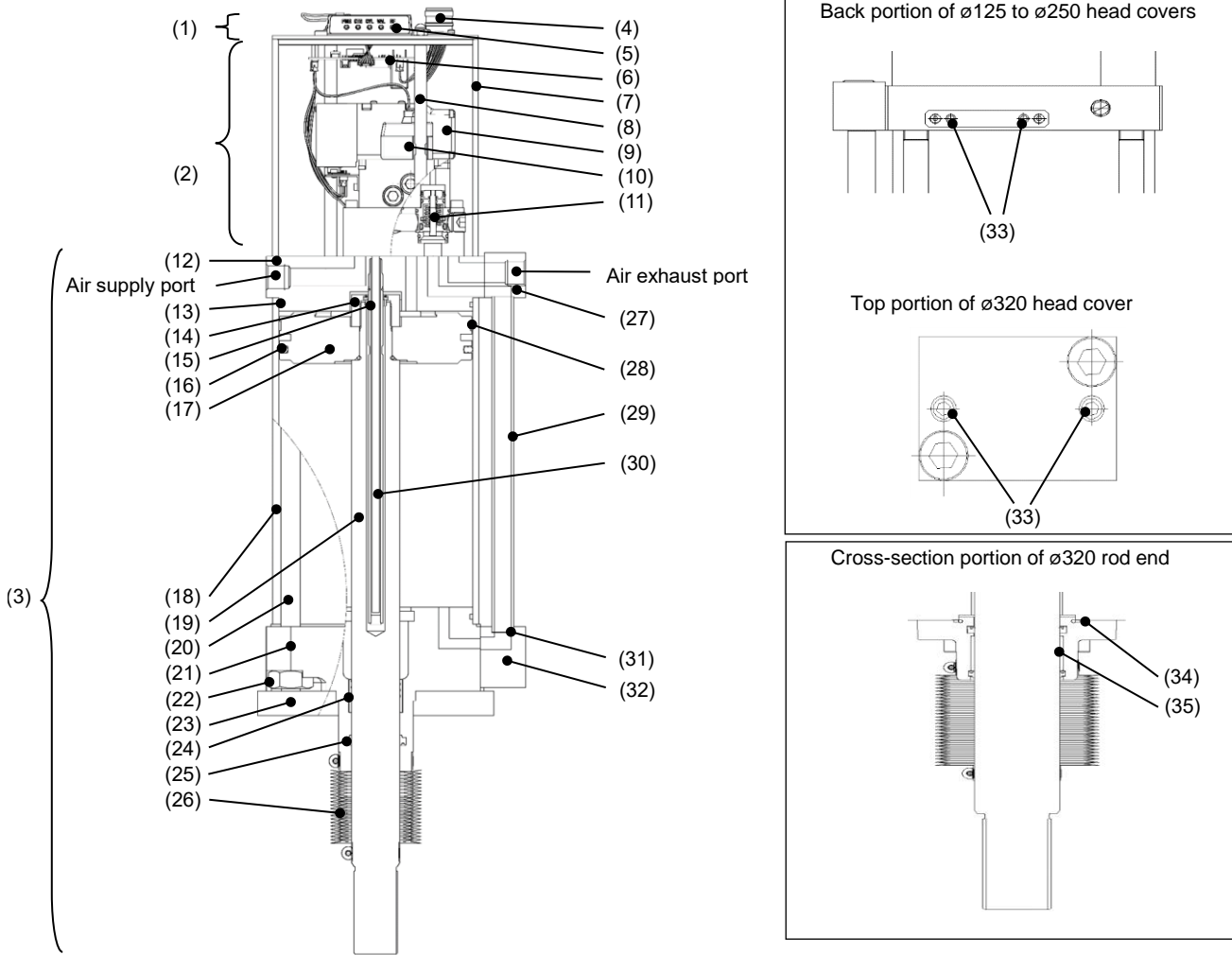
Detailed drawing of part B



Product number	Bore size (mm)	Stroke (mm)	Dimensions (mm)		
			C	D	E
IN-777-320TF-200F*-HL	320	200	34	233.5	612.5
IN-777-320TF-350F*-HL		350	90.5	290	669
IN-777-320TF-530F*-HL		530			



## 4-5. Construction



No.	Name	Material / Surface treatment	No.	Name	Material/ Surface treatment
(1)	Controller assembly	Aluminum alloy / Anodized (Main parts)	(19)	Piston rod	Stainless steel/ Hard chrome plating
(2)	Valve unit	-	(20)	Tie-rod	Stainless steel
(3)	Air cylinder	-	(21)	Rod cover	ø160 to ø250: Aluminum die-cast / Chromated ø125 and ø320: Aluminum alloy / Anodized
(4)	Power supply connector	-	(22)	Tie-rod nut	Stainless steel
(5)	LED alarm display	Aluminum alloy / Painted (Main parts)	(23)	Flange (*2)	Steel / Zinc plating
(6)	Controller	-	(24)	Bushing	Bearing alloy
(7)	Cover tube	Aluminum alloy / Anodized	(25)	Rod seal (*1)	Low-temperature NBR
(8)	Pillar	Aluminum alloy	(26)	Rod boot (Option)(*1)	Silicone rubber material Nylon tarpaulin
(9)	Servo valve	-	(27)	Pipe block (Head side) (*3)	Aluminum alloy / Anodized
(10)	Pilot valve	-	(28)	Wear ring (*1)(*4)	Resin
(11)	Shutoff valve	-	(29)	Pipe	Aluminum alloy / Anodized
(12)	Head cover	Aluminum alloy / Anodized	(30)	Position sensor	-
(13)	Tube gasket (*1)	Low-temperature NBR	(31)	Pipe O-ring (*1)	Low-temperature NBR
(14)	Piston nut	Stainless steel	(32)	Pipe block (Rod side) (*4)	Aluminum alloy / Anodized
(15)	Magnet	-	(33)	Residual pressure manual release port	-
(16)	Piston seal (*1)	Low-temperature NBR	(34)	Retaining plate	Stainless steel
(17)	Piston	Aluminum alloy / Chromated	(35)	Wiper ring(*1)	Low-temperature NBR
(18)	Cylinder tube	ø125 to ø250: Aluminum alloy / Anodized ø320: Carbon steel tube / Painted			

\*1 Refer to 3.2 Spare Parts for maintenance parts and seal kit accessories.

\*2 The rod cover is integrated for sizes ø320.

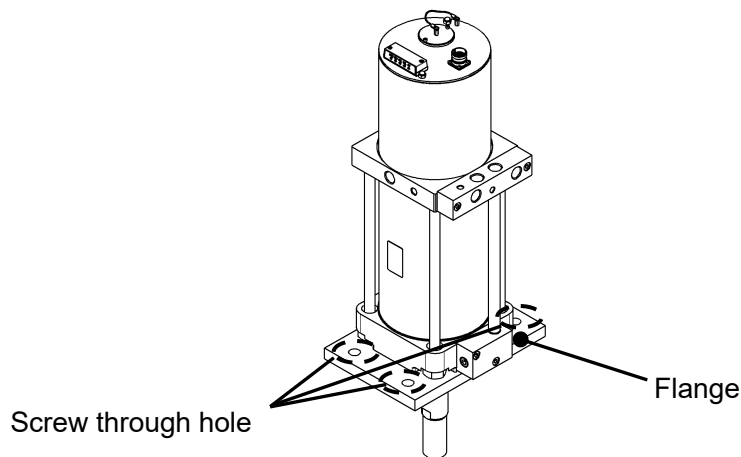
\*3 The head cover is integrated for size ø125.

\*4 The rod cover is integrated for size ø125.

## 5. Installation / Wiring

### 5-1. Installation

Mount the flange on to the base and secure with screws using the screw through holes.

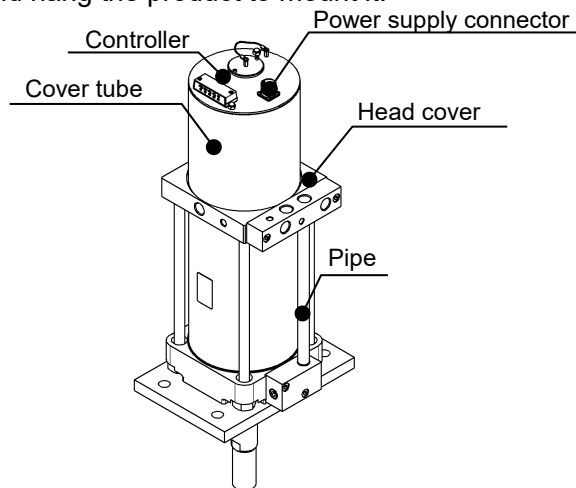


### Caution

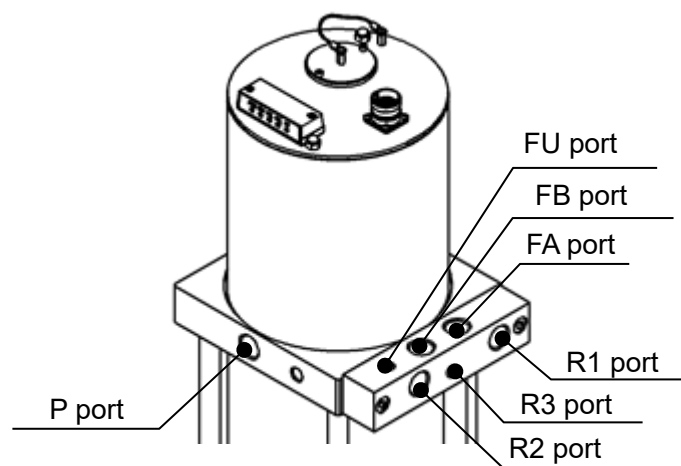
When installing the product, do not apply an excessive external force or impact to the cover tube and pipe. This may damage the controller in the cover tube and the piping tube and power supply connector.

Applying excessive external force to the piping may result in damage to the piping or a malfunction.

As screw holes for installing eye bolts are provided on the head covers of sizes  $\varnothing 160$  and larger, insert the eye bolts into the screw holes and hang the product to mount it.



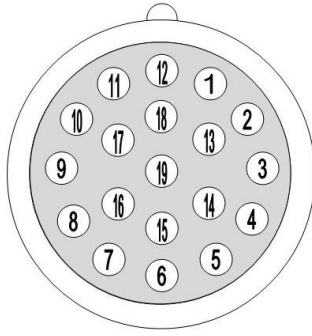
Do not allow foreign matter such as cutting chips inside the cylinder from the ports.



## 5-2. Electrical Wiring Diagram

Perform wiring according to the connector pin numbers and the wiring diagram.

(1) Connector pin numbers (Male side)

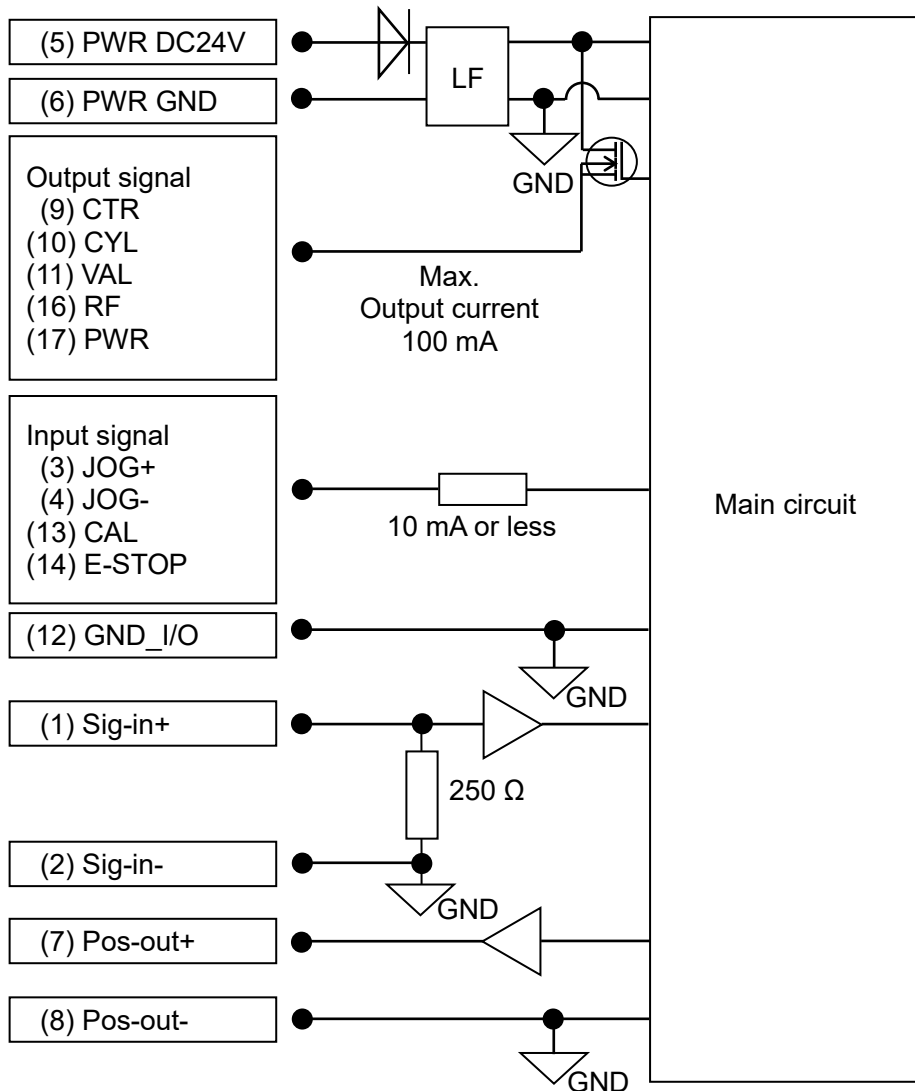


Pin No.	Signal name	Input/output status	Description
1	Sig-in+	Input	4-20 mA analog input signal (+), HART Communication signal
2	Sig-in-	Input	4-20 mA analog input signal (-), HART Communication signal
3	JOG+	Input	JOG operation signal (Move to the extended end direction)
4	JOG-	Input	JOG operation signal (Move to the retracted end direction)
5	PWR_DC24V		DC+24 V Power supply
6	PWR_GND		Power supply GND
7	Pos-out+	Output	4-20 mA analog output signal (+)
8	Pos-out-	Output	4-20 mA analog output signal (-)
9	CTR	Output	Controller normal signal
10	CYL	Output	Positioning sensor error signal
11	VAL	Output	Valve error signal
12	GND_I/O	—	Input/output signal GND
13	CAL	Input	Calibration signal
14	E-STOP	Input	Emergency stop signal (Negative edge triggered *1)
15	-	-	-
16	RF	Output	Piston rod worn error signal
17	PWR	Output	Power supply error signal
18	-	-	-
19	-	-	-

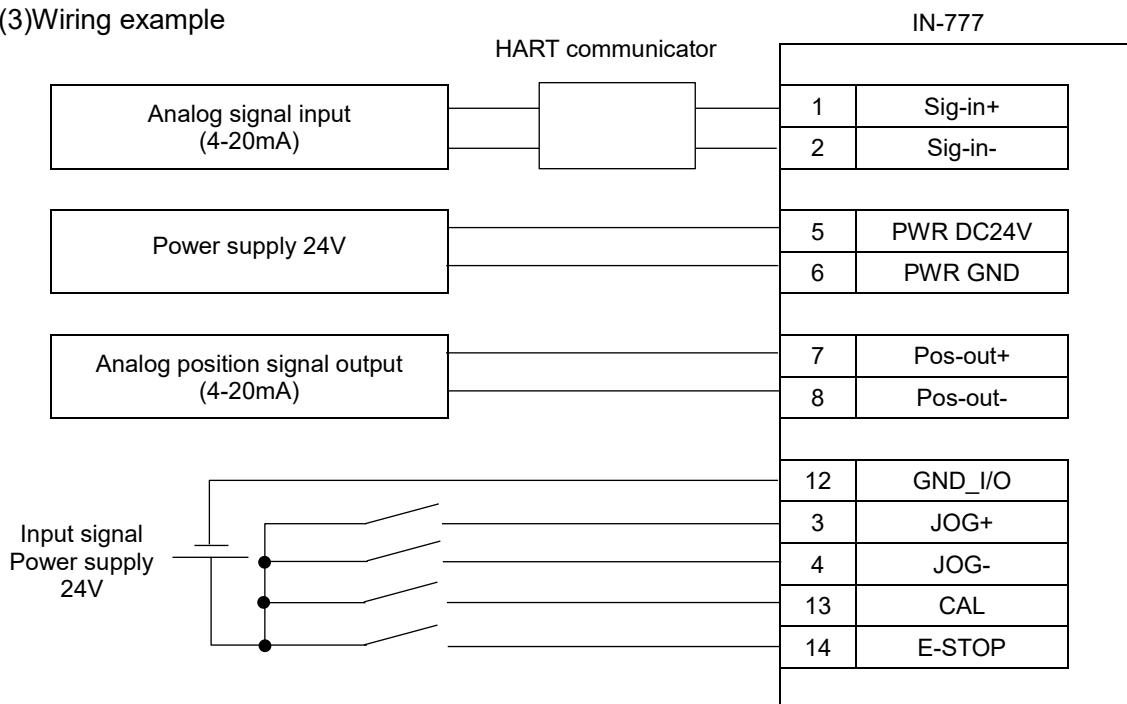
\*1 Emergency stop is performed when signal is OFF.

For detailed description of the signals, refer to the following pages.

(2) Wiring diagram (Numbers in brackets indicates the pin numbers)



(3) Wiring example



\*1 When the air servo cylinder is operated, turn ON the E-STOP signal.

As a feature of safety, if the E-STOP signal is turned OFF, the cylinder will not operate.

\*2 The cable connecting the customer's equipment and the air servo cylinder is not included. Please prepare the cable by the customer.

## 6. Setting

Perform the DIP switch setting for normal/reversed switching of the piston rod travel direction (during target position operation), cylinder bore size, and piston rod operating direction at no signal operation. By performing the rotary switch setting, the piston rod speed during target position operation can be set.

With the power to the air servo cylinder disconnected, remove the hexagon socket head cap screws to remove the switch cover from the panel. Using the DIP switch and rotary switch mounted inside the switch cover, perform setting whilst referring to the procedure below.

### ⚠ Caution

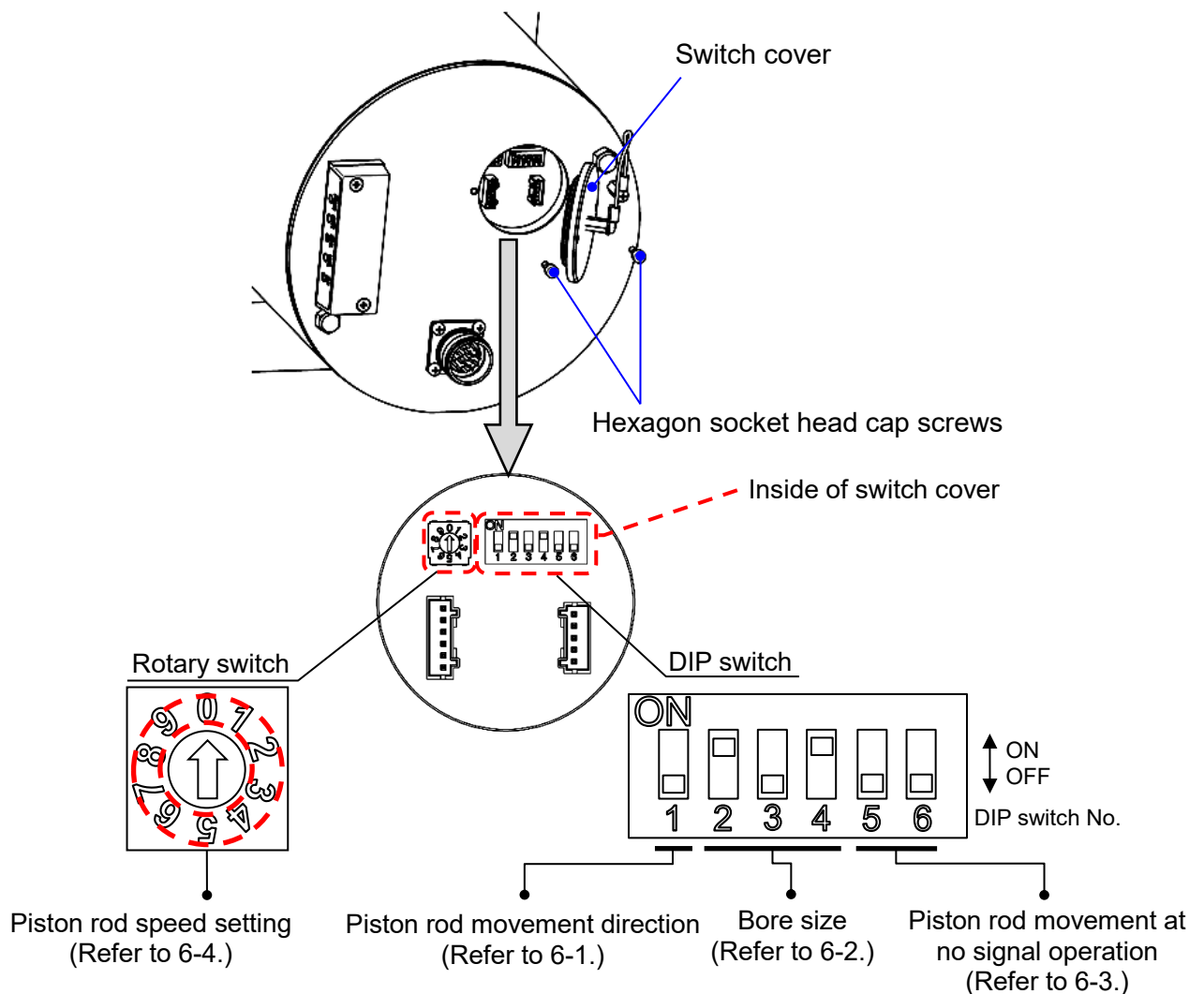
If the settings of the DIP switch and rotary switch are changed while power is supplied, the setting will not become effective. Changes to the DIP switch and rotary switch setting should be performed with no power supplied to the product.

[Set up flow diagram (Example)]

Set the DIP switch (Refer to 6-1, 6-2, and 6-3).

Set the rotary switch (Refer to 6-4).

Supply power



After setting, push the switch cover into the panel hole and replace the 2 hexagon socket head cap screws. (Recommended tightening torque: 0.5 N·m to 0.75 N·m)

### 6-1. Piston Rod Movement Direction (DIP Switch No. 1)

The piston rod movement direction relative to the analogue input signal (4-20 mA) can be set, for when the target position operation is performed.

No. 1	Moving direction	Relationship between the analogue input signal and the piston rod movement direction
OFF (Default)	Standard	<p>20 mA      4 mA</p> <p>Set point (*)   Retracted end   Piston rod</p>
ON	Reverse	<p>4 mA      20 mA</p> <p>Set point (*)   Retracted end   Piston rod</p>

\* Set point: Position set by Calibration. Refer to "7-2. Calibration" for details.

### 6-2. Bore size (DIP Switch No. 2, No. 3, No. 4)

The cylinder bore size has been set when the product is shipped.

No. 2	No. 3	No. 4	Bore size
ON	OFF	OFF	Ø125
OFF	ON	OFF	Ø160
ON	ON	OFF	Ø200
OFF	OFF	ON	Ø250
ON	OFF	ON	Ø320
OFF	ON	ON	Don't use.

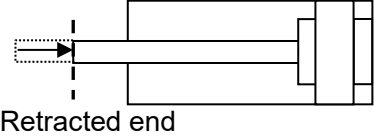
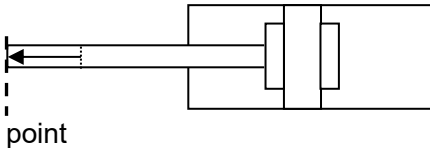
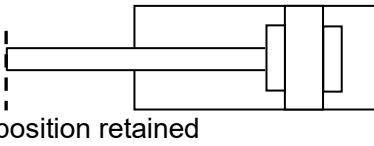
If all switches are set to ON or OFF, a cylinder bore setting error will occur and an alarm will be generated (refer to 9). Change the setting of the DIP switch correctly.

### ⚠ Caution

Please do not change the DIP switch No.2, No.3 or No.4 on the controller mounted on the air servo cylinder. The bore size set to the DIP switch No. 2 to 4 and cylinder bore size must be identical, otherwise vibration, damage and unexpected motion may occur.

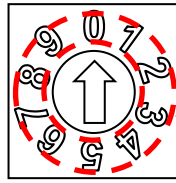
### 6-3. Piston rod Movement at No Signal Operation

Set the piston rod operation at no signal operation (refer to 6-4) using DIP switch No. 5 and No. 6. The piston rod operation setting can be selected from "Stops after moving to the retracted end", "Stops after moving to the set point", or "Current position retained".

No. 5	No. 6	Piston rod operation
OFF (Default)	OFF	Cylinder stops after moving to the retracted end 
ON	OFF	Cylinder stops after moving to the set point 
ON OFF	ON	Cylinder retains current position 

## 6-4. Maximum Piston Rod Speed Setting (Rotary Switch)

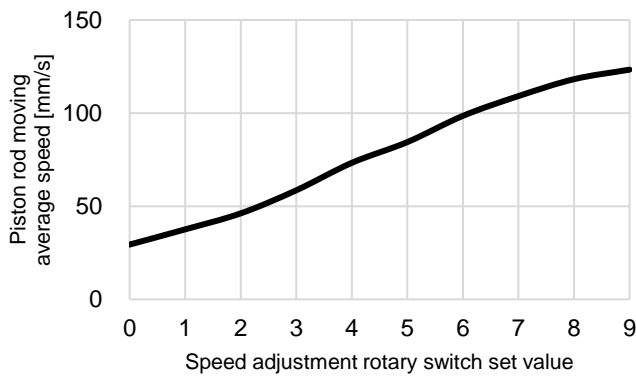
The piston rod speed can be set using the rotary switch. The relation between the switch numbers and speed is shown in the table below.



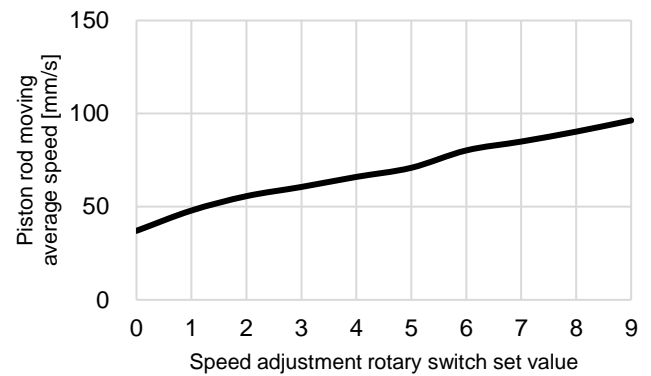
Switch No.									
0 (Default)	1	2	3	4	5	6	7	8	9
Slower	→→(Speeds up gradually.)→→								Faster

### 6-4-1. Piston rod moving average speed (\*1)

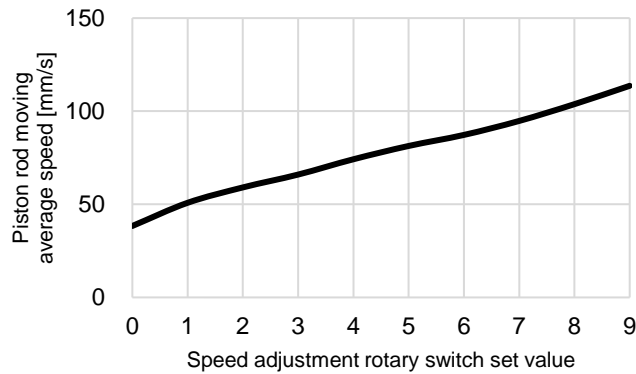
(1) IN-777-125TF-250F\*-HL



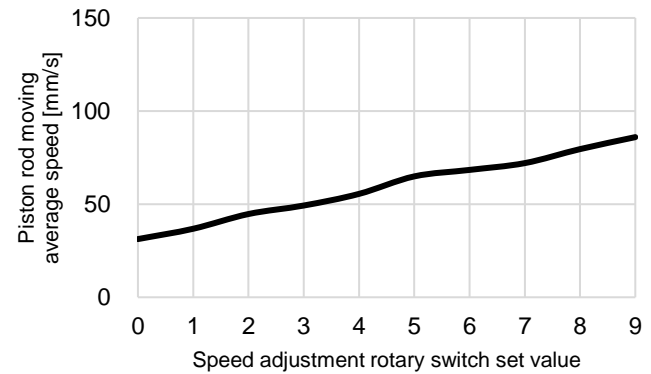
(2) IN-777-160TF-200F\*-HL



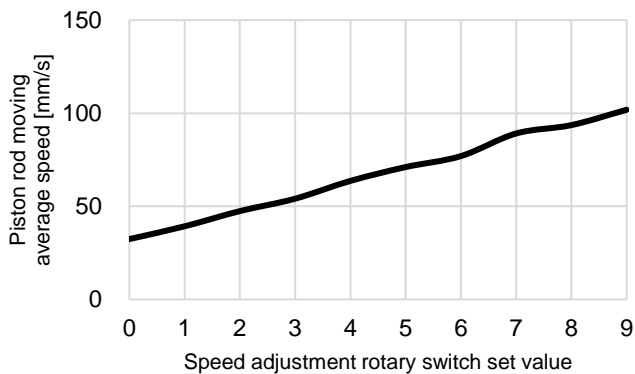
(3) IN-777-160TF-300F\*-HL



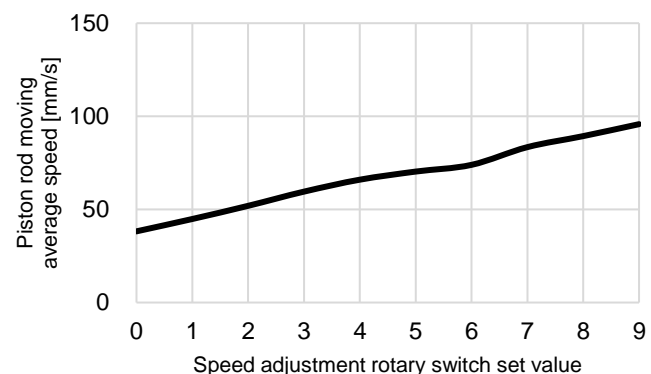
(4) IN-777-200TF-200F\*-HL



(5) IN-777-200TF-300F\*-HL

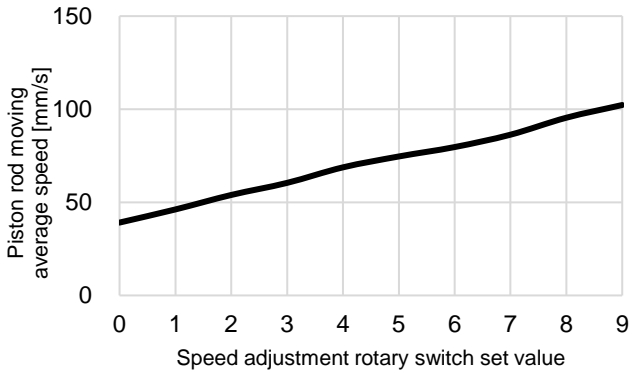


(6) IN-777-250TF-350F\*-HL

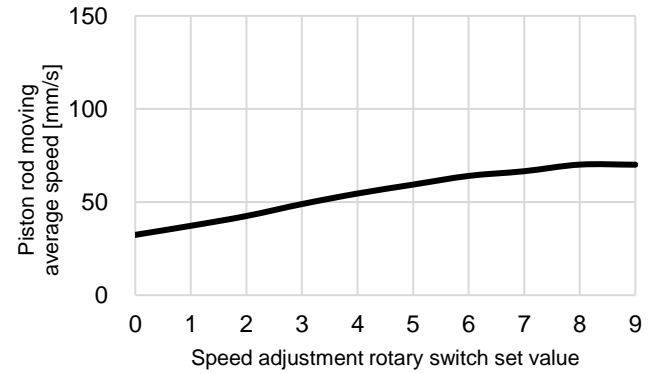




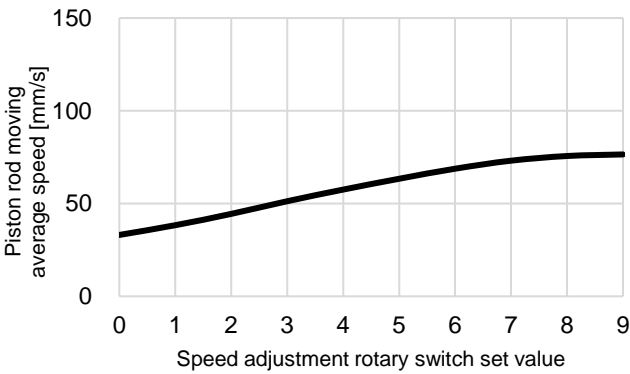
(7) IN-777-250TF-450F\*-HL



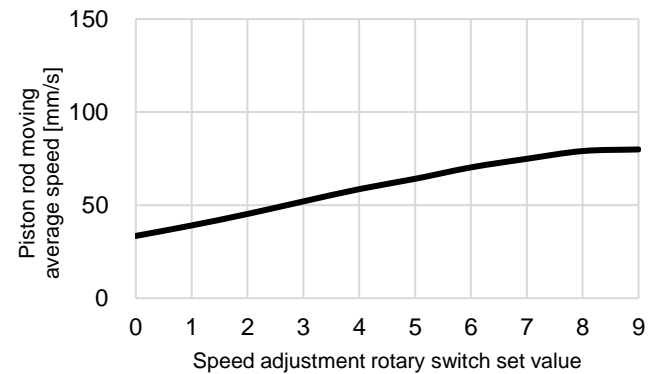
(8) IN-777-320TF-200F\*-HL



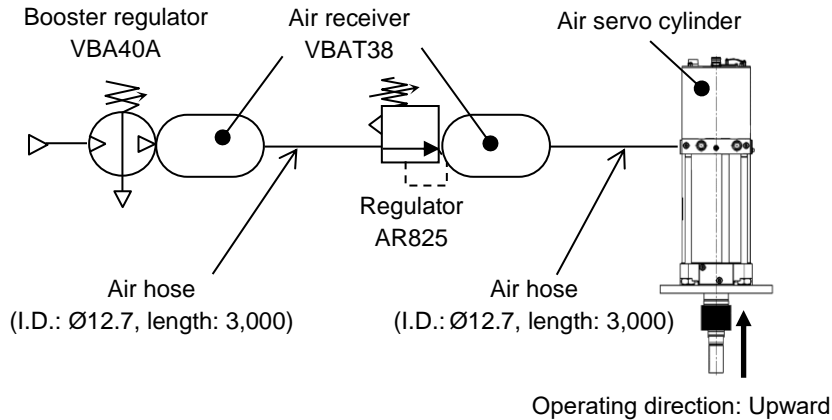
(9) IN-777-320TF-350F\*-HL



(10) IN-777-320TF-530F\*-HL



Circuit



Measurement conditions

- Supply pressure: 0.55MPa
- Mount: Vertical downward mounting
- Load: No load
- Operating direction: Upward

\*1 The average speed value is the stroke divided by the “full stroke time.”

The “full stroke time” refers to the time from when the target position operation signal is input until the piston stops.

The average speed adjustment range of each cylinder size varies according to the operating conditions.

## 6-5. Auto start function

At the purchase of this product, select to enable or disable the auto start function. The actions the piston rod will make when the auto start function is enabled or disabled are as follows.

### (1) Auto start function disabled (when product number: IN-777-\*TF-\*F\*-HL□ is used)

Apply the analogue input current (command current: 4 to 20 mA) to the air servo cylinder before turning on the power supply. The piston rod is driven as per the setting of No Signal Operation ("Stops after moving to the retracted end" or "Stops after moving to the set point" or "Current position retained"). To start the target position operation in this condition, turn OFF the analogue input current once, and then reapply the current.

If the power supply is turned off with the analogue input current kept applied during the target position operation, the piston rod remains in its current position. Then, if the power supply is turned on, the piston rod is driven as per the setting of No Signal Operation ("Stops after moving to the retracted end" or "Stops after moving to the set point" or "Current position retained"). To start the target position operation in this condition, turn OFF the analogue input current once, and then re-apply the current.

### (2) Auto start function enabled (when product number: IN-777-\*TF-\*F\*-HL□ is used)

Apply the analogue input current (command current: 4 to 20 mA) to the air servo cylinder before turning on the power supply. The piston rod starts a target position operation.

If the power supply is turned off with the analogue input current kept applied during the target position operation, the piston rod remains in its current position. When the power supply is turned on, a target position operation is started.

\* When using the product for the first time since its purchase, execute a calibration (refer to 7-2. Calibration). If calibration has not been performed, regardless of whether the auto start function is enabled or disabled, entering analogue input current does not start a target position operation.

\* It is not possible to switch between enabling and disabling of the auto start function. If switching needs to be performed, purchase the appropriate controller assembly (product number: IN-777P-HL\*-410AS) with the corresponding specification, and replace the old controller with it.

## 7. Operation Mode and Functions

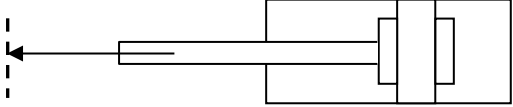
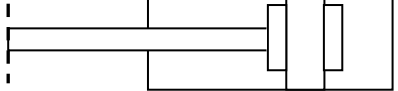
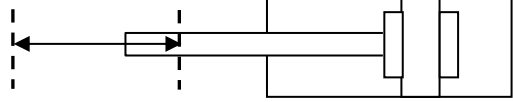
The operation modes for this product include JOG operation, Calibration, Target position operation (4-20mA), No signal operation, and Emergency stop. The functions available during operation are residual pressure release and alarm LED display. This section describes each operation mode and function.

### 7-1. JOG Operation

The piston rod moves at a set speed in response to the JOG signal being input. The range of movement is the length of the cylinder stroke. JOG mode is used to stop the piston rod for positioning before calibration or to move the piston rod to a specified position. The speed of movement during the JOG operation is approximately 50 mm/s (guideline) regardless of the rotary switch speed setting (refer to 6-4).

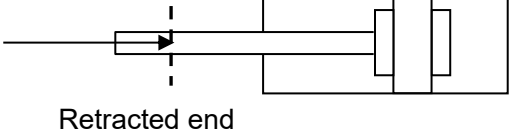
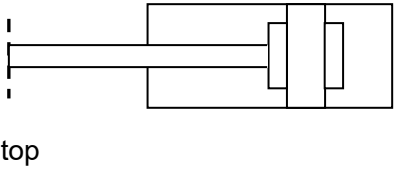
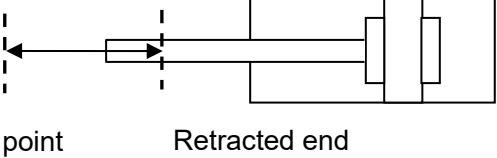
#### (1) Movement to the extended end

When the JOG+ signal (Pin No. 3) is ON, the piston rod moves to the extended end. When the JOG- signal (Pin No. 4) turns ON while the JOG+ signal is ON, the piston rod stops and retains the current position. When the JOG+ signal turns OFF during operation, the operation mode will change from the JOG operation to the Target position operation (refer to 7-3).

JOG+	JOG-	Piston rod operation
ON	OFF	Moves to the extended end direction  Extended end
ON	ON	Stops moving  Stop
OFF	OFF	Target position operation (4-20 mA)  Set point    Retracted end

(2) Movement to the retracted end

When the JOG- signal (Pin No. 4) is ON, the piston rod moves to the retracted end. When the JOG+ signal (Pin No. 3) turns ON while the JOG- signal is ON, the JOG operation is stopped and the piston rod retains the current position. When the JOG- signal turns OFF during operation, the operation mode will change from the JOG operation to the Target position operation (refer to 7-3).

JOG+	JOG-	Piston rod operation
OFF	ON	<p>Moves to the retracted end direction</p>  <p>Retracted end</p>
ON	ON	<p>Stops moving</p>  <p>Stop</p>
OFF	OFF	<p>Target position operation (4-20 mA)</p>  <p>Set point Retracted end</p>

## 7-2. Calibration

The piston rod movement range (set point) can be set when using the Target position operation (refer to 7-3). By performing the Calibration, the relationship between the piston rod position (from the retracted end to the set point) and the current value (4-20 mA) input to Sig-in+ and Sig-in- can be set. Once the Calibration is performed, the set point is stored in the product and will be recorded even when the power supply is OFF.

There are two types of Calibration mode; Automatic and Manual.

The set point is not set when the product is shipped from the factory.

### **Caution**

Perform the Calibration at the initial installation of the product. Otherwise, the cylinder will not operate even when an analog signal is input in the target position operation.

### 7-2-1. Change the mode

#### 7-2-1-1. Automatic mode

Step (1) – Turn the power supply OFF if it is not already. Ensure that all DIP switches are turned to ON position and check that all LEDs are off.

Step (2) – Turn the power supply ON. Ensure that all DIP switches remain in the ON position and check that the LEDs begin to flash at a rate of 0.5 Hz.

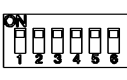
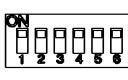
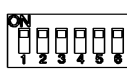
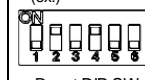
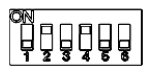
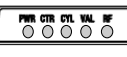


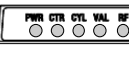
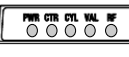


The product will make an emergency stop and JOG operation, target position operation, no signal operation and calibration are not available.

Step (3) – At this stage verify that the LEDs are still flashing at 0.5 Hz; if yes, turn the power supply OFF and check that the LEDs stop flashing. All DIP switches should still be in the ON position.

Step (4) – While the power supply is still OFF, refer to sections 6-1, 6-2 and 6-3 and set all DIP switches to the desired positions for the operation required. All LEDs should remain OFF.

Step (5) – Turn the power supply ON once all DIP switches have been set to the desired positions and immediately follow step (6)

Step (6) – When power supply has been turned ON, all LEDs should flash once. Following this, PWR and CTR lights should remain ON and CYL, VAL and RF should be OFF. Automatic mode calibration has now been performed and JOG operation, target positioning, and no signal operation are available.

STEP	(1)	(2)	(3)	(4)	(5) and(6)
POWER SUPPLY (24V)	24V 0V Power supply turn off.	24V 0V Power supply turn on.	24V 0V Power supply turn off.	24V 0V Power supply turn on.	24V 0V Power supply turn on.
DIP SW	 DIP SW turn ON all.			(ex.)  Reset DIP SW as 6-1,6-2,6-3.	
LEDs	 All LEDs turn off.	 All LEDs flash(0.5Hz).	Check  →  All LEDs turn off.	 All LEDs turn off.	 →  All LEDs flash once. PWR and CTR LEDs are ON.

### 7-2-1-2. Manual mode

Step (1) – Turn the power supply OFF if it is not already. Ensure that all DIP switches are turned to OFF position and check that all LEDs are off.

Step (2) – Turn the power supply ON. Ensure that all DIP switches remain in the OFF position and check that the LEDs begin to flash at a rate of 0.5 Hz.

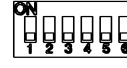

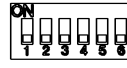
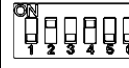
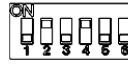







The product will make an emergency stop and JOG operation, target position operation, no signal operation and calibration are not available.

Step (3) – At this stage verify that the LEDs are still flashing at 0.5 Hz; if yes, turn the power supply OFF and check that the LEDs stop flashing. All DIP switches should still be in the OFF position.

Step (4) – While the power supply is still OFF, refer to sections 6-1, 6-2 and 6-3 and set all DIP switches to the desired positions for the operation required. All LEDs should remain OFF.

Step (5) – Turn the power supply ON once all DIP switches have been set to the desired positions and immediately follow step (6)

Step (6) – When power supply has been turned ON, all LEDs should flash twice. Following this, PWR and CTR lights should remain ON and CYL, VAL and RF should be OFF. Manual mode calibration has now been performed and JOG operation, target positioning, and no signal operation are now available.

STEP	(1)	(2)	(3)	(4)	(5) and(6)
POWER SUPPLY (24V)	24V 0V Power supply turn off.	24V 0V Power supply turn on.	24V 0V Power supply turn off.	24V 0V	24V 0V Power supply turn on.
DIP SW	 DIP SW turn OFF all.			(ex.)  Reset DIP SW as 6-1,6-2,6-3.	
LEDs	 All LEDs turn off.	 All LEDs flash(0.5Hz).	Check  →  All LEDs flash(0.5Hz). All LEDs turn off.	 All LEDs turn off.	 →  All LEDs flash twice. PWR and CTR LEDs are ON.

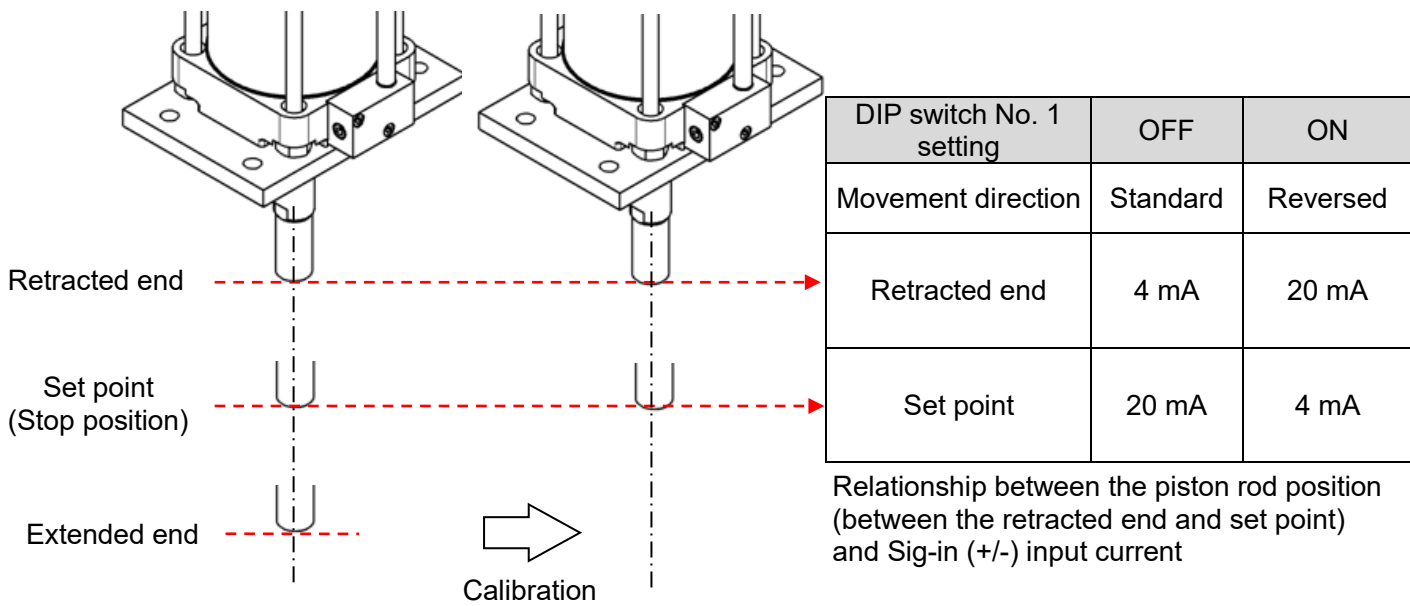
### 7-2-2. Perform calibration

#### 7-2-2-1. Automatic calibration procedure

While the automatic calibration signal (CAL) is ON the automatic calibration will be performed, and the piston rod will move in the extended end direction. The position at which the piston rod must stop for 1 second, due to an external stopper or cylinder extended end, is set as a set point. When the calibration signal is turned OFF, the operation mode will change to the target position operation. The piston rod speed during auto calibration is approximately 50 mm/s (guideline).

#### 7-2-2-2. Manual calibration procedure

Perform JOG operation or target position operation (\*1) to move the piston rod to the required stop position (example: position where an external stopper is located). When the calibration signal (CAL) is input for 100ms or longer, the position where the piston rod stops is set as a set point. When the setting of the set point is completed and the calibration signal is turned OFF, the operation mode will change to the target position operation.



(\*1) If calibration is never performed after receiving the product from SMC, the set point is set to the retracted end. Therefore, even if current (4-20mA) is input at the target position operation, the piston stays at the retracted end.

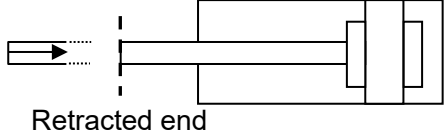
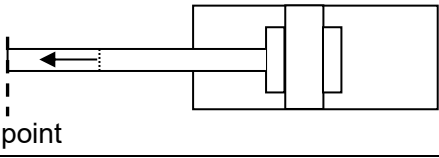

### 7-3. Target Position Operation (4-20 mA)

By inputting an analog signal, the piston rod moves to the target position which corresponds to the input current (between 4 mA and 20 mA) from the retracted end to the set point.

No. 1	Movement direction	Relationship between the analog input signal and the piston rod movement direction	Relationship between the analog input current and the target position
OFF (Default)	Standard		<p>Extended end direction</p>
ON	Reversed		<p>Extended end direction</p>

### 7-4. No Signal Operation

When an analog input signal of 3.9 mA or less is input, the piston rod operates according to the No signal operation setting set beforehand. The operation can be selected from 3 types of operation by switching the DIP switch No. 5 and No. 6 (refer to "6-3. DIP Switch Setting"). The speed of movement can be set using the rotary switch.

No. 5	No. 6	Piston rod operation
OFF (Default)	OFF	Stops after moving to the retracted end (Default setting) 
ON	OFF	Stops after moving to the set point 
Both ON and OFF	ON	Current position retained 

### 7-5. Emergency Stop

The piston rod will stop operating when the E-STOP signal (pin No. 14) is turned OFF during JOG operation, Calibration, Target position operation, or No signal operation. When the E-STOP signal is turned ON again, it will return to the previous operation mode.

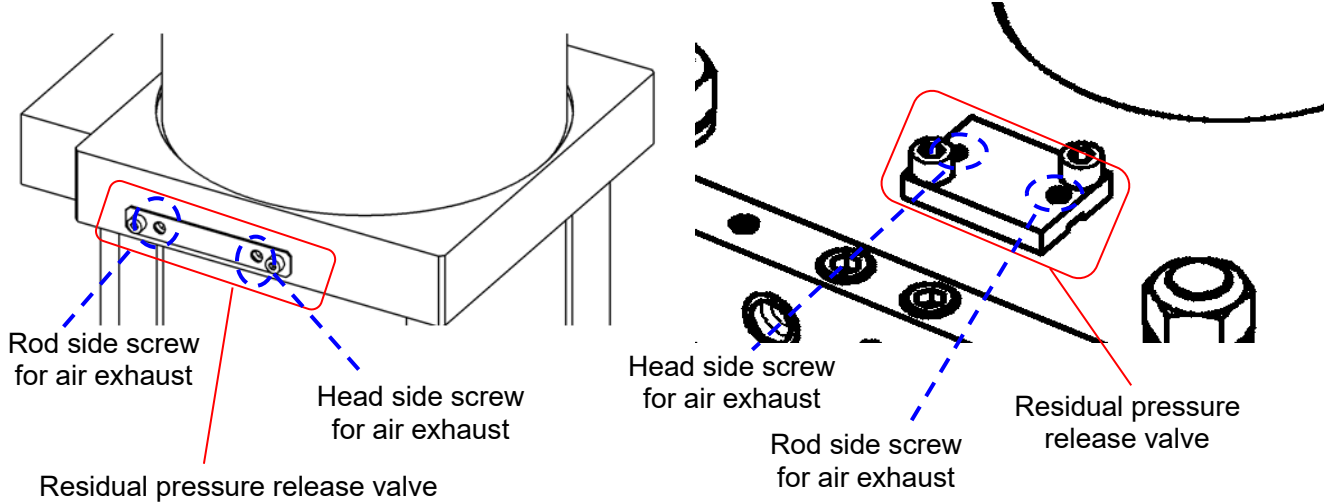


## 7-6. Residual Pressure Release

The pressure on the head side and rod side of the air cylinder can be released from the residual pressure release valve in the head cover of the product. Rotate the exhaust screw (hexagon socket head cap screw) in the counterclockwise direction to release the valve and exhaust the air. Exhaust the air only after disconnecting the power supply and air supply. Be cautious of a sudden extension or retraction of the rod during the air exhaust operation. When tightening the air exhaust screw, use a tightening torque of 5.0 N·m to 7.4 N·m.

• Bore size :  $\varnothing 125$  to  $\varnothing 250$

• Bore size :  $\varnothing 320$

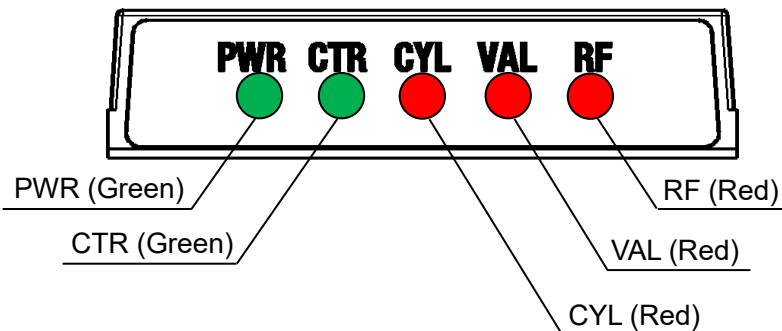


### **Warning**

Take care that a sudden extension or retraction of the piston rod will occur when returning from emergency stop or switching the operation mode.

### 7-7. Functions of LED Alarm Display

The names and functions of the LED alarm display are shown in the figure and table below.



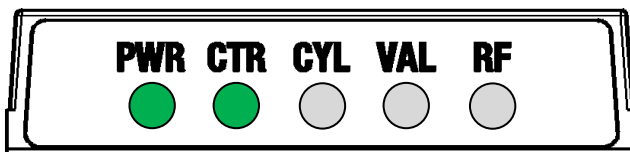
LED Alarm display	LED name	LED condition	Description (*1)
PWR	Power supply indicator	Green LED is ON	Power supply is ON.
		Green LED flashing (1 Hz)	Power supply error (Outside of 24 V +/-10%)
		OFF	Power supply is OFF or incorrect power supply (17 V or less)
CTR	Controller indicator	Green LED is ON	Power supply is ON (Normal control)
		Green LED flashing (0.5 Hz)	Incorrect cylinder bore size setting
		Green LED flashing (2 Hz)	Setting the set point in auto calibration mode
CYL	Positioning sensor error indicator	Red LED is ON	Over current to the positioning sensor
		Red LED flashing (1 Hz)	Incorrect positioning sensor
		Red LED flashing (0.5 Hz)	Incorrect positioning sensor connection
VAL	Valve error indicator	Red LED is ON	Over current to the emergency stop valve
		Red LED is ON	Over current to the servo valve
		Red LED flashing (0.5 Hz)	Incorrect servo valve connection
RF	Piston rod worn error indicator	Red LED is ON	Piston rod is worn-out

LED Alarm display	LED condition	Description
PWR,CTR,CYL,VAL,RF(All LEDs)	All LEDs flashing (0.5Hz)	Calibration setting mode (Automatic and manual mode)
	All LEDs flashing once (0.5Hz)	Selecting calibration automatic mode(*2)
	All LEDs flashing twice (0.5Hz)	Selecting calibration manual mode(*2)

\*1: Refer to "9. Alarms" for further details.

\*2: Immediately after turning on the power supply in the normal operation mode.

<LED condition when the operation is normal (no errors generated)>



## 7-8. Priority of Operation Mode

The priority of the operation modes is shown in the table below. To change the operation mode to a high priority mode while the required operation mode is being performed, it can be changed by turning ON the signal for the next operation mode (turning OFF the signal for the emergency stop operation) without stopping (signal OFF) the current operation mode.

To change the operation mode to a low priority mode, stop (turn OFF the signal/turn ON the signal for emergency stop) the current operation mode before turning ON the signal for the operation mode in the next step.

Priority	Operation mode
High 1	Emergency stop
2	Calibration
3	JOG Operation
Low 4	Target position operation (4-20 mA), No signal operation

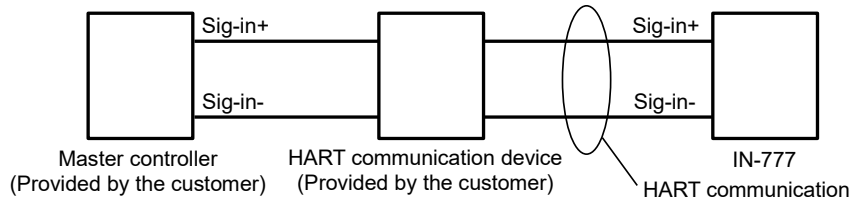
## 7-9. Fail-safe function

The IN-777 series can be operated with a fail-safe function.

Refer to "Example of fail-safe circuit for air servo cylinder IN-777"(Document No.K35-OMX0069) for the pneumatic circuit to use when the fail-safe function is used.

## 7-10. HART Communication protocol

HART (Highway Addressable Remote Transducer) communication function is available for IN-777 series when H: 4-20mA/HART communication is selected as communication protocol (see How to order). HART communication is a technology in which digital signals are sent over the same cable for 4-20mA analogue signals using the HART communicator.



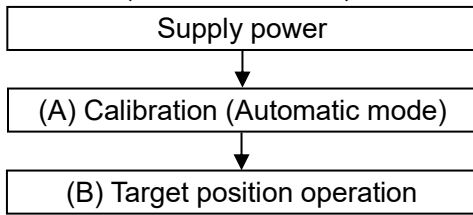
### Available operations

1. Checking and changing of the equipment information
2. Checking and changing of the HART communication setting
3. Setting and checking of the cylinder parameter
4. Calibration
5. Setting and checking of the operation mode
6. JOG operation
7. Checking of the operating conditions

Please refer to HART communication operation manual for how to use the HART communication function (K35-OMW0031).

## 7-11. Operation Examples (Timing Chart)

### (1) Calibration (Automatic mode)

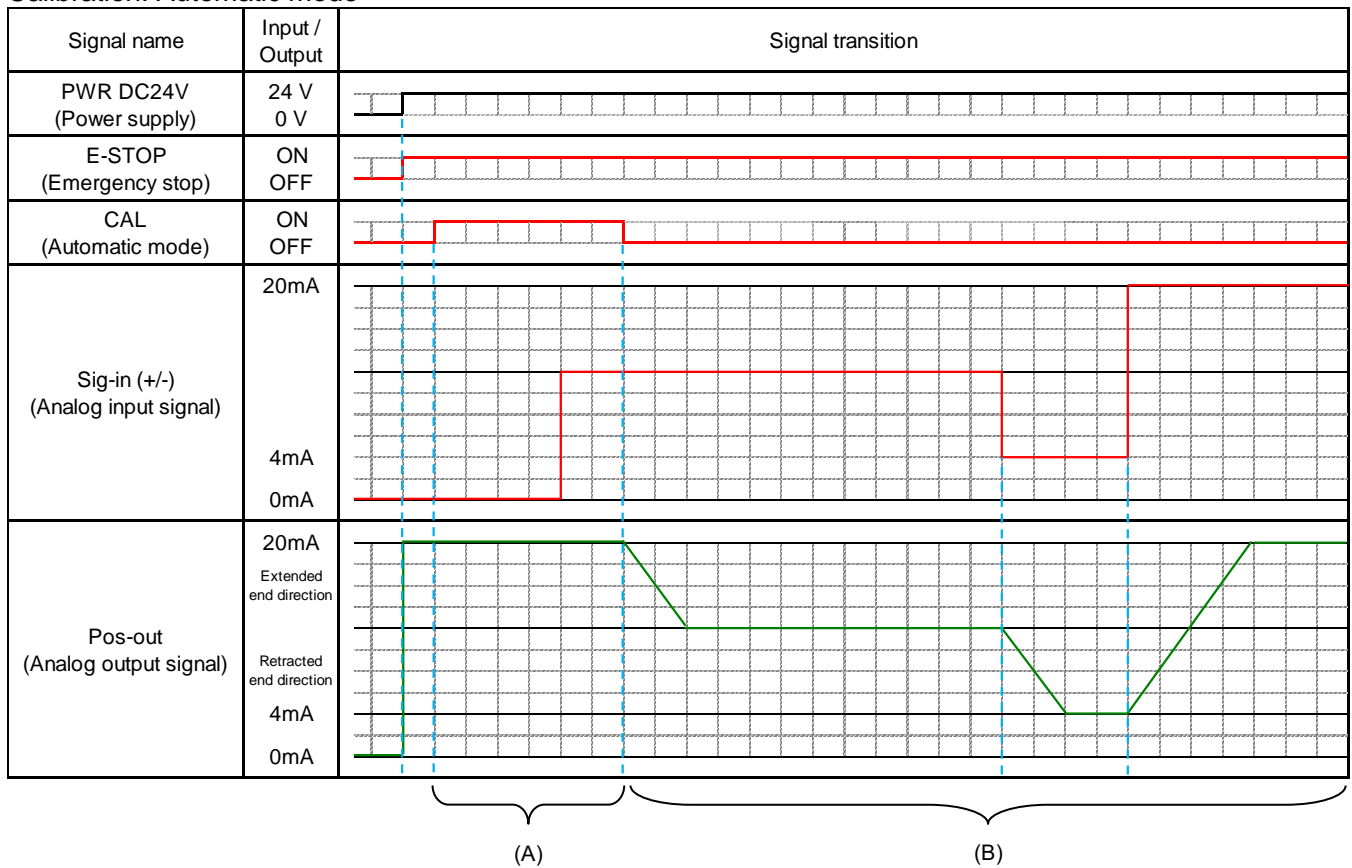


Setting when power is supplied.

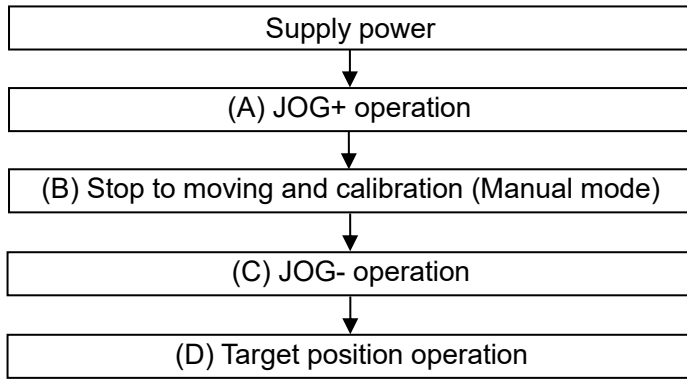
Piston rod movement direction: Standard

Set point: Not set

Calibration: Automatic mode



(2) Calibration (Manual mode)

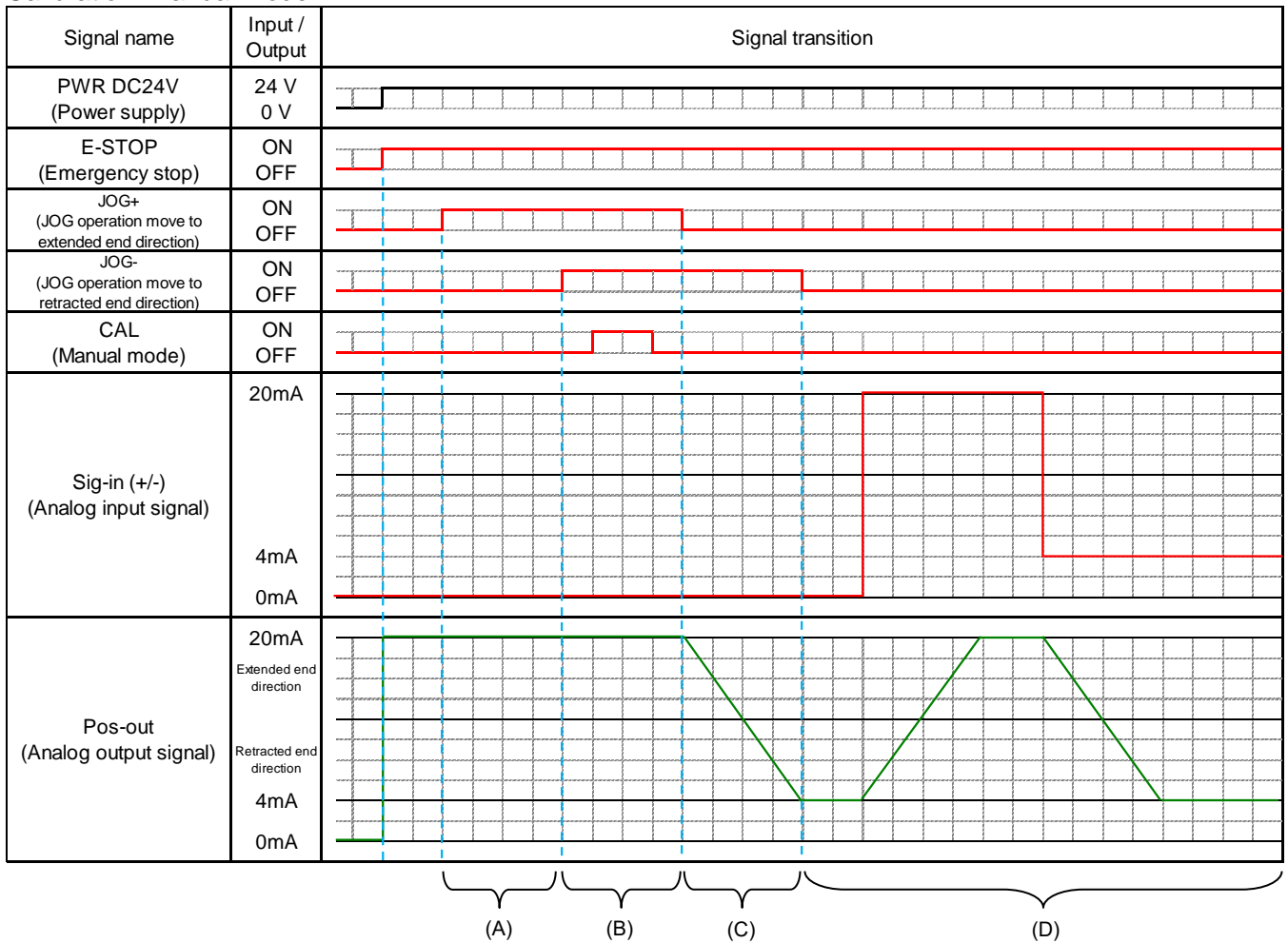


Setting when power is supplied.

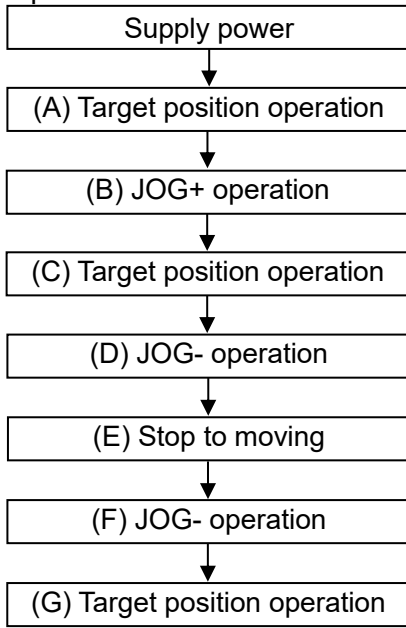
Piston rod movement direction: Standard

Set point: Not set

Calibration: Manual mode



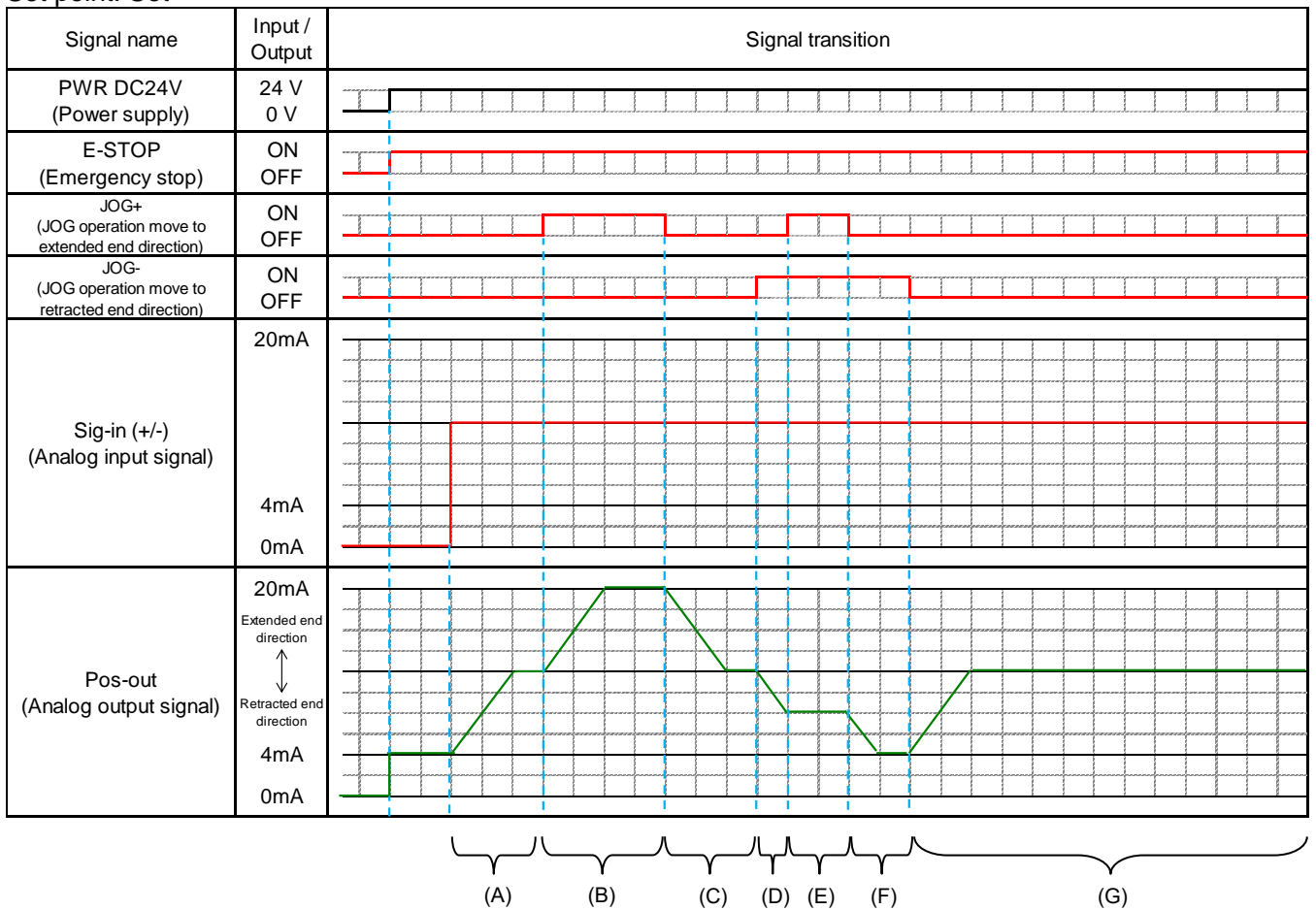
(3) JOG Operation



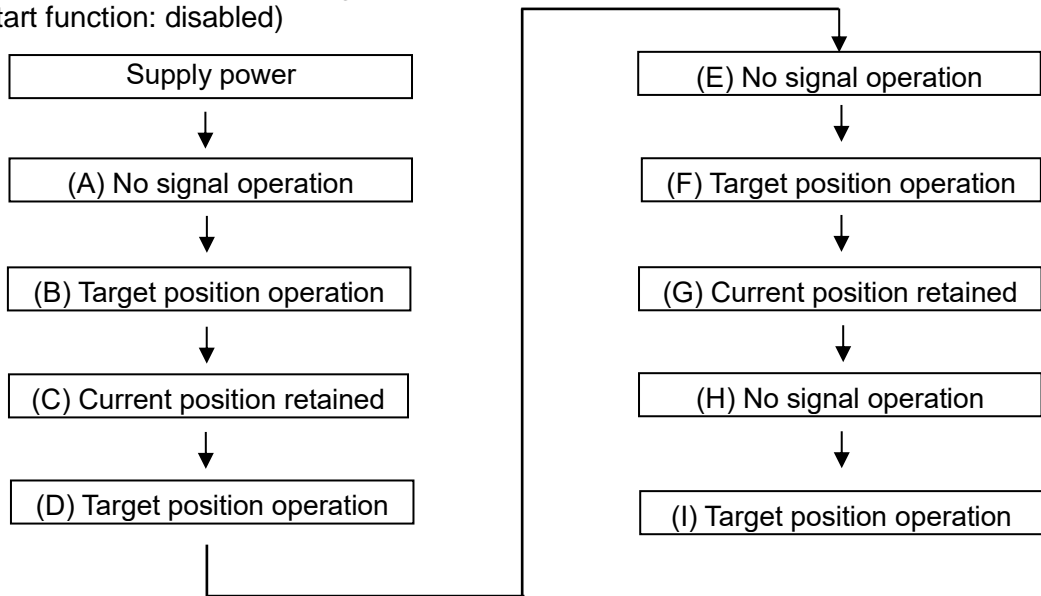
Setting when power is supplied.

Piston rod movement direction: Standard

Set point: Set



(4) Target position operation and No signal operation  
(Auto start function: disabled)

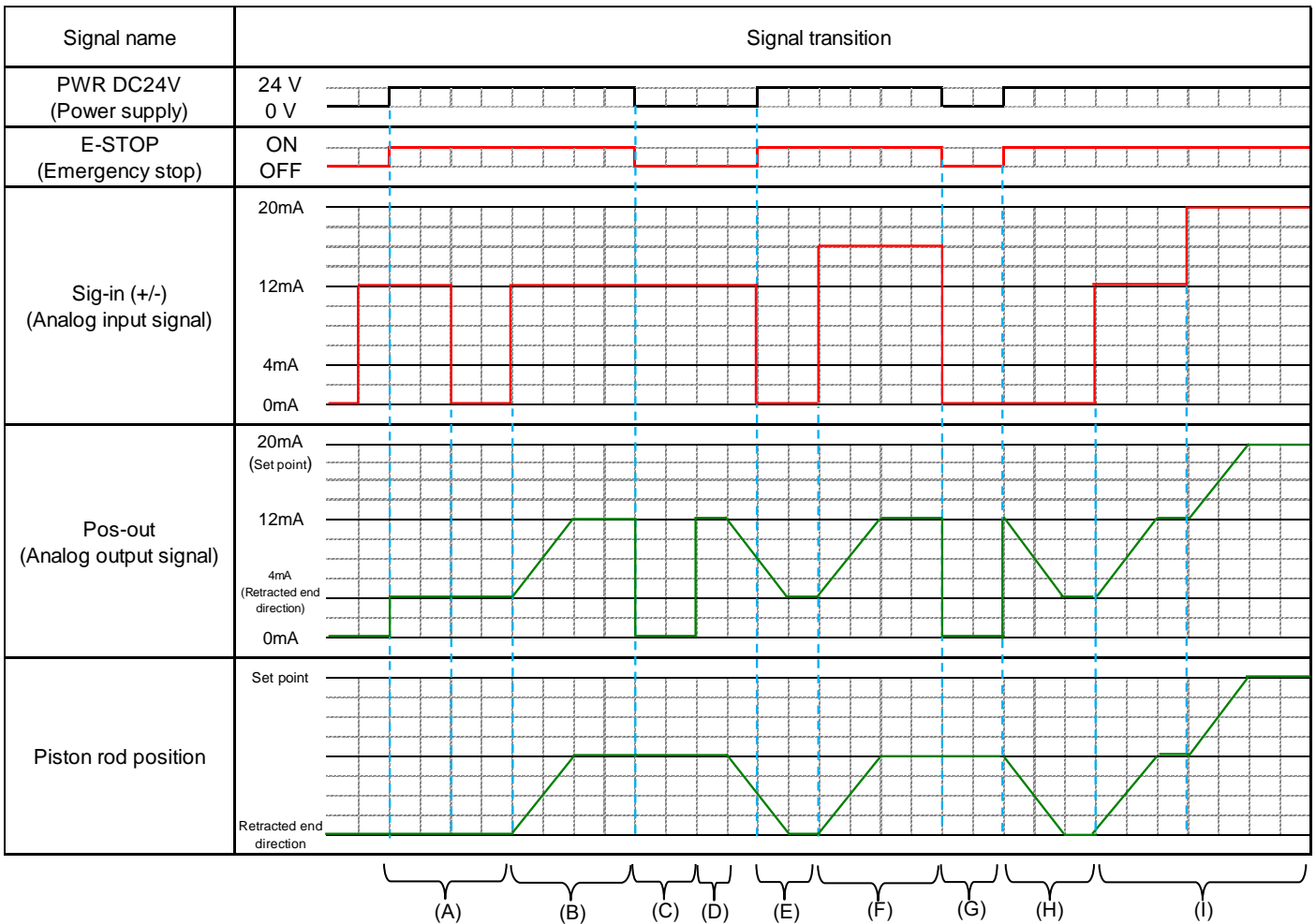


Setting when power is supplied.

Piston rod movement direction: Standard

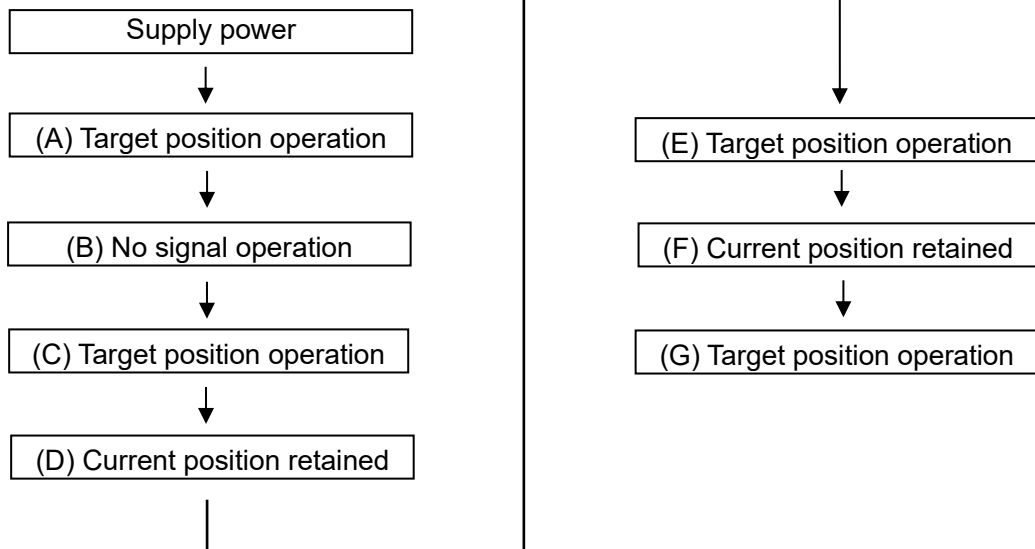
No signal operation: Stops after moving to the retracted end

Set point: Set





(5) Target position operation and No signal operation  
(Auto start function: enabled)

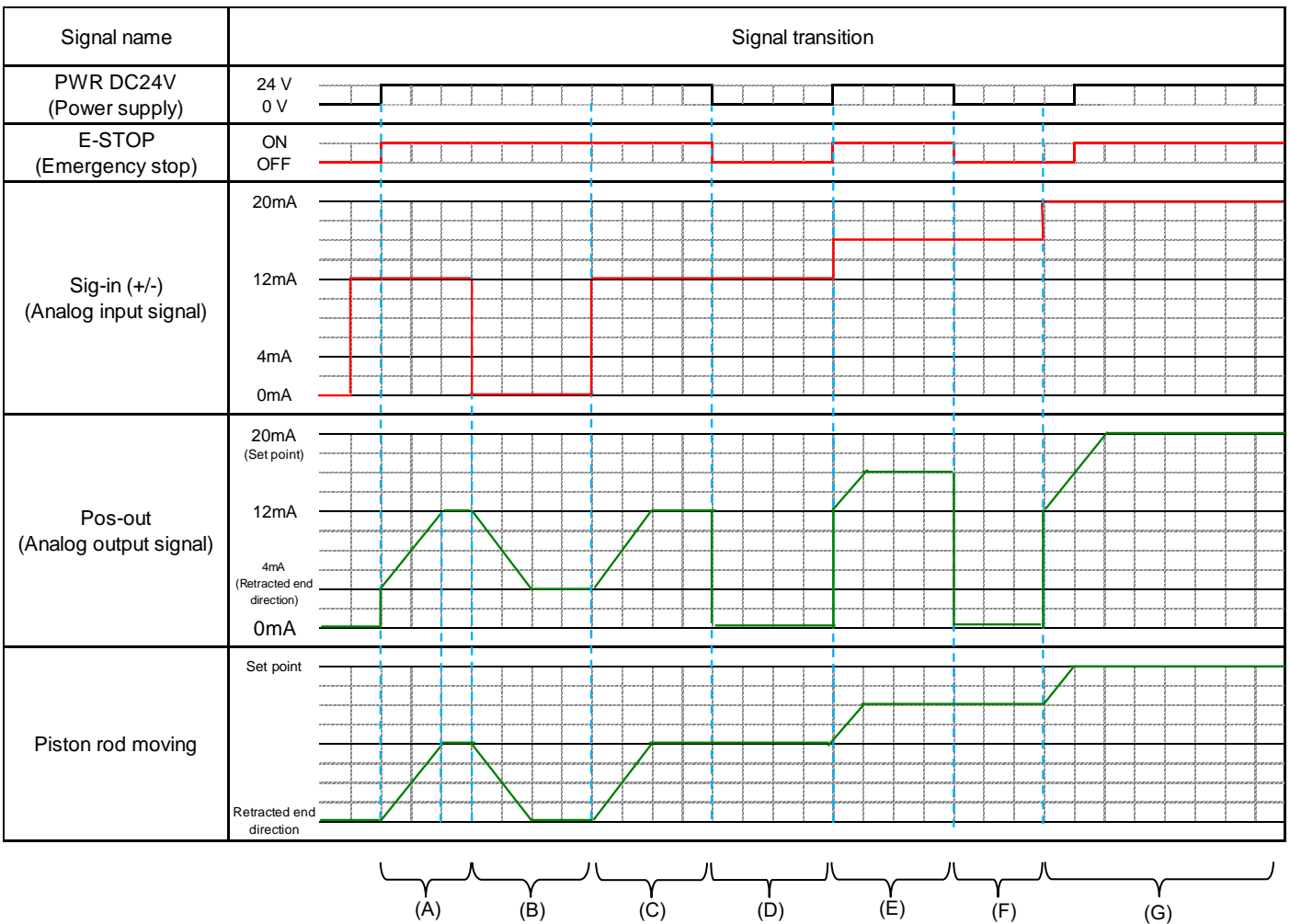


Setting when power is supplied.

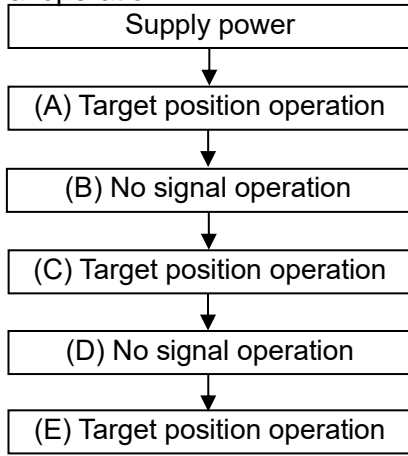
Piston rod movement direction: Standard

No signal operation: Stops after moving to the retracted end

Set point: Set



(6) No signal operation

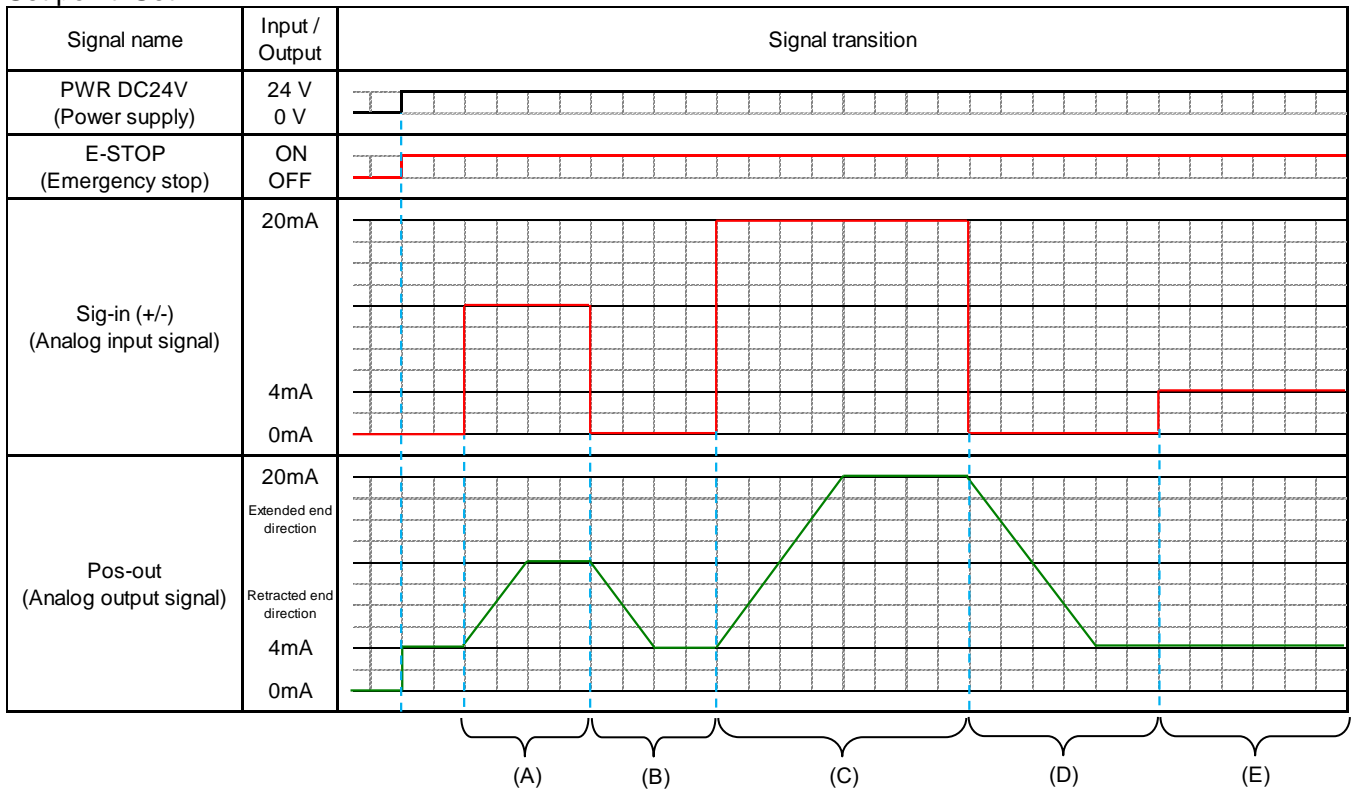


Setting when power is supplied.

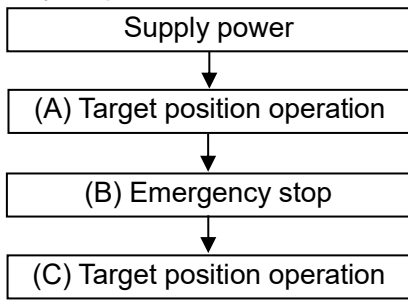
Piston rod movement direction: Standard

No signal operation: Piston rod moves to the retracted end

Set point: Set



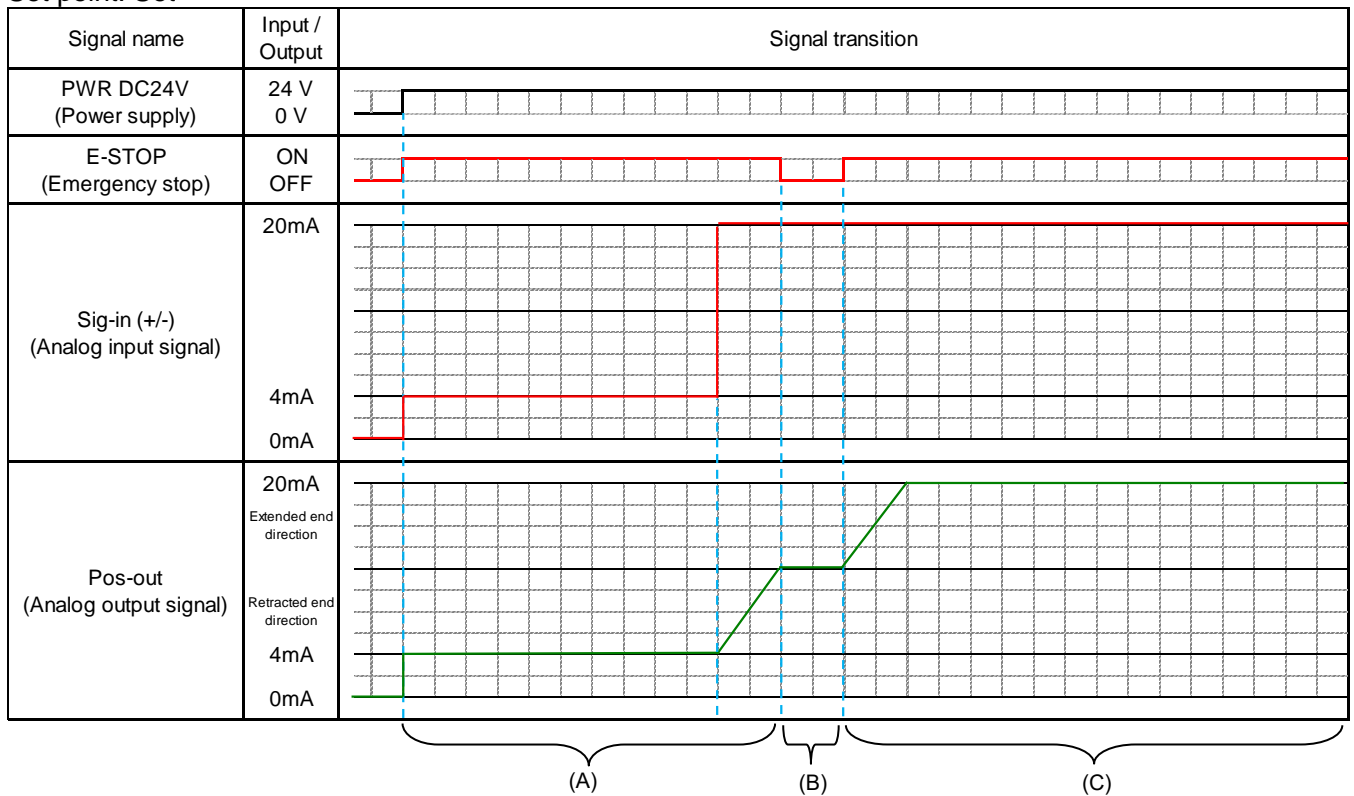
(7) Emergency stop



Setting when power is supplied.

Piston rod movement direction: Standard

Set point: Set



## 8. Replacement of parts

### Caution

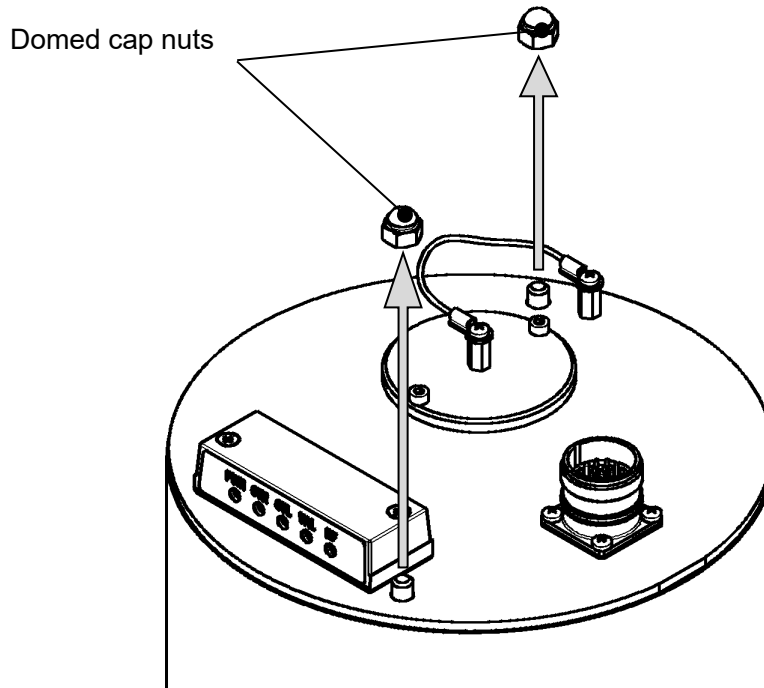
Release the residual pressure release valve (Chapter 7.6) to exhaust the residual pressure in the product.

Disassembly of the cylinder should be performed in an open, dust free area.

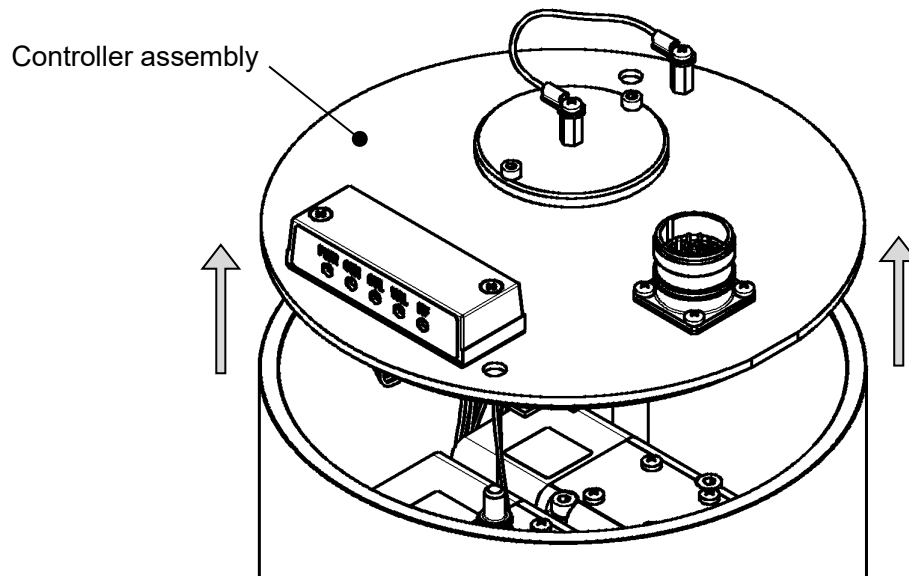
After removing the servo cylinder from the device, be sure to protect the end of the piping port and rubber hose device side with a clean cloth to prevent dust entering.

#### 8-1-1. Disassembly of the controller assembly

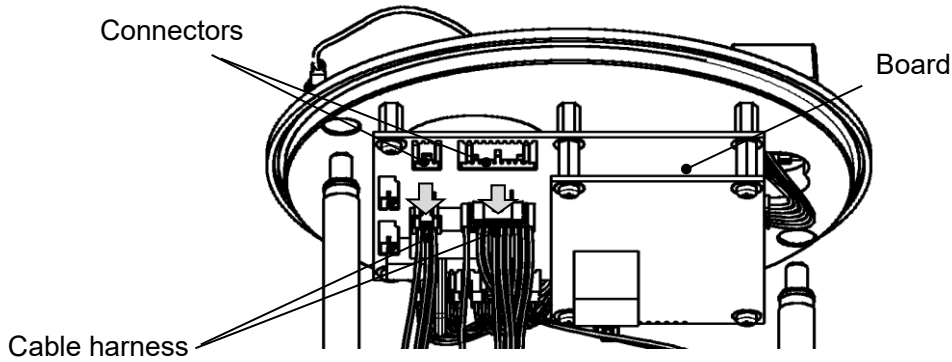
(1) Remove the domed cap nuts (2 pcs.) from the upper surface of the product.



(2) Pull out the controller assembly in the arrow direction.



- (3) Remove the cable harness from the two connectors on the board mounted on the bottom surface of the controller assembly to remove the controller assembly.

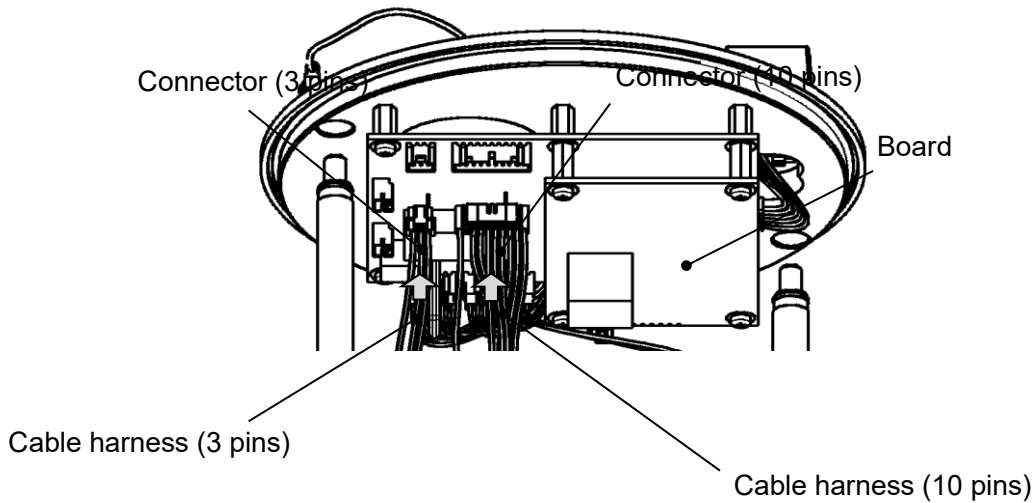


**⚠ Caution**

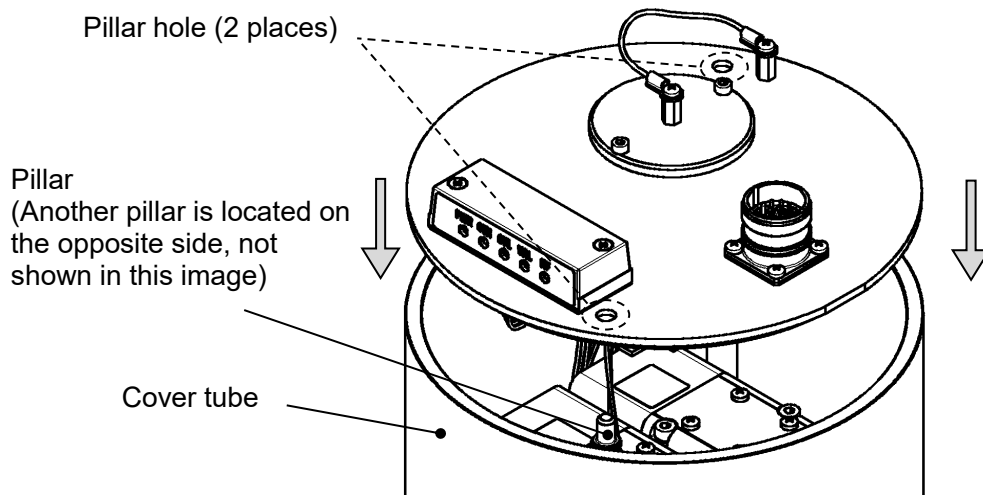
Never touch the board with bare hand.

**8-1-2. Assembly of the controller assembly**

- (1) Connect the connectors of the cable harness to the controller assembly. Be careful with the cable harness and the number and orientation of the pins. The connector will not be connected correctly if the pin orientation and number are incorrect.



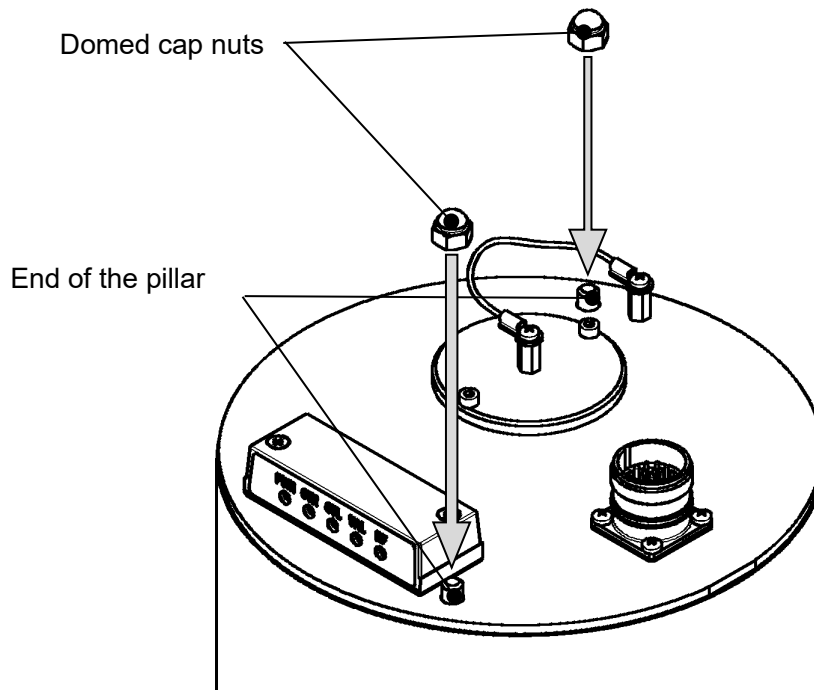
- (2) Lower the controller assembly down over the pillars. Ensure the pillar aligns with the pillar holes, (2 places) before fully lowering until there is no gap between the controller and cover tube.



**⚠ Caution**

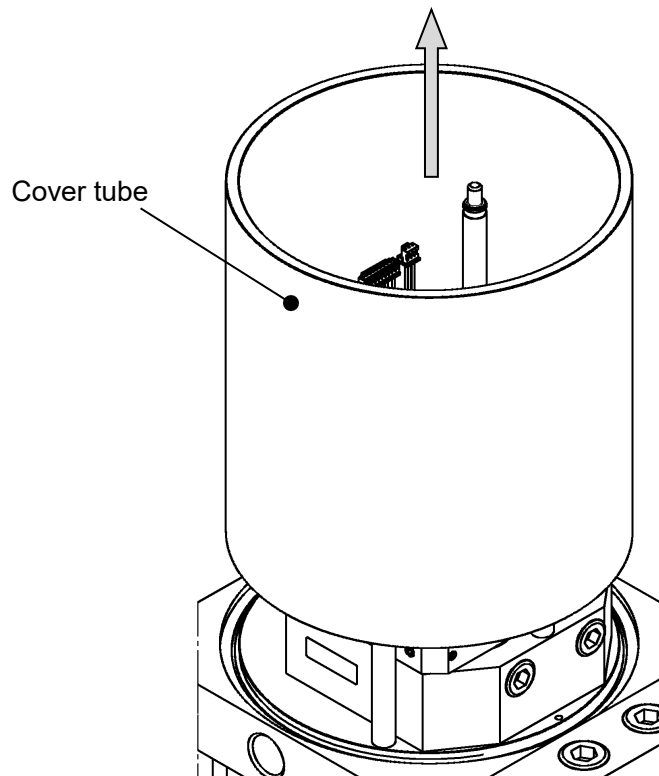
Take care that the cable harness is not caught between the controller and the cover tube.

- (3) Tighten the cap nut (x 2) to the end of the pillar. (Tightening torque: 2.1 N·m to 3.2 N·m)



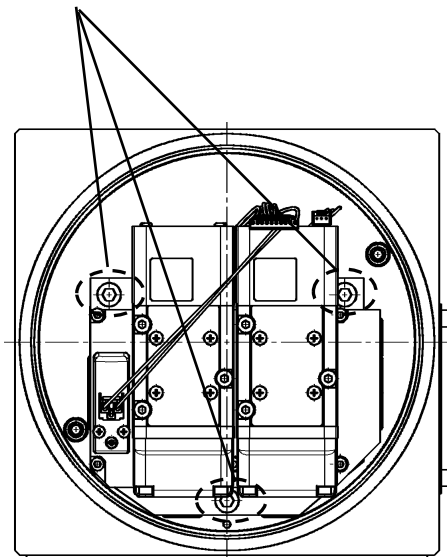
### 8-2-1. Disassembly of the valve unit

- (1) Remove the controller assembly. (Refer to 8-1-1.)
- (2) Remove the cover tube in the arrow direction.

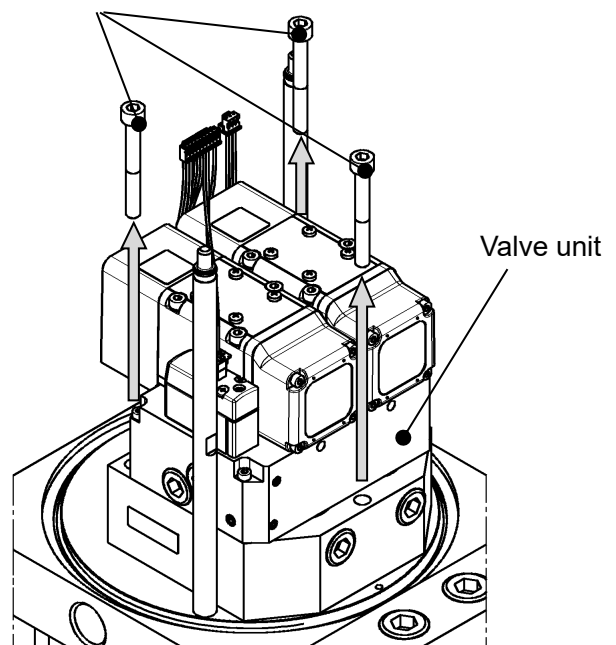


- (3) Remove the hexagon socket head cap screws (3 pcs.).

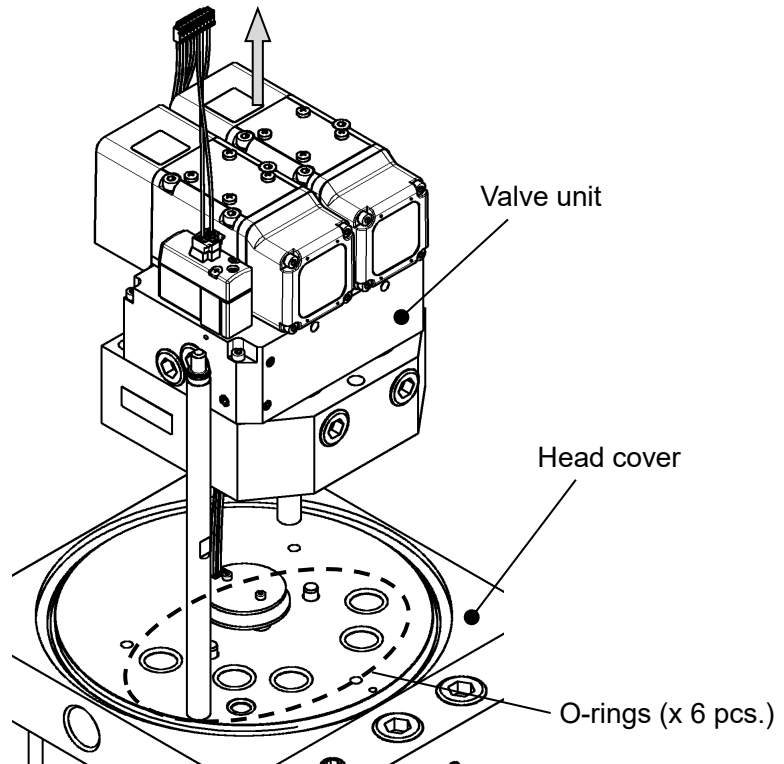
Position of Hexagon socket head cap screw (3 pcs.)



Hexagon socket head cap screw



(4) Remove the valve unit. Be careful not to lose or damage the head cover O-rings (x 6 places).

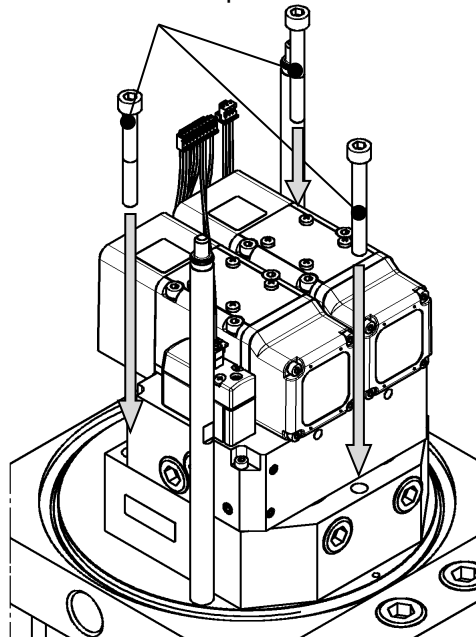


#### 8-2-2. Assembly of the valve unit

(1) Mount the valve unit and tighten the hexagon socket head cap screws (3 pcs.).

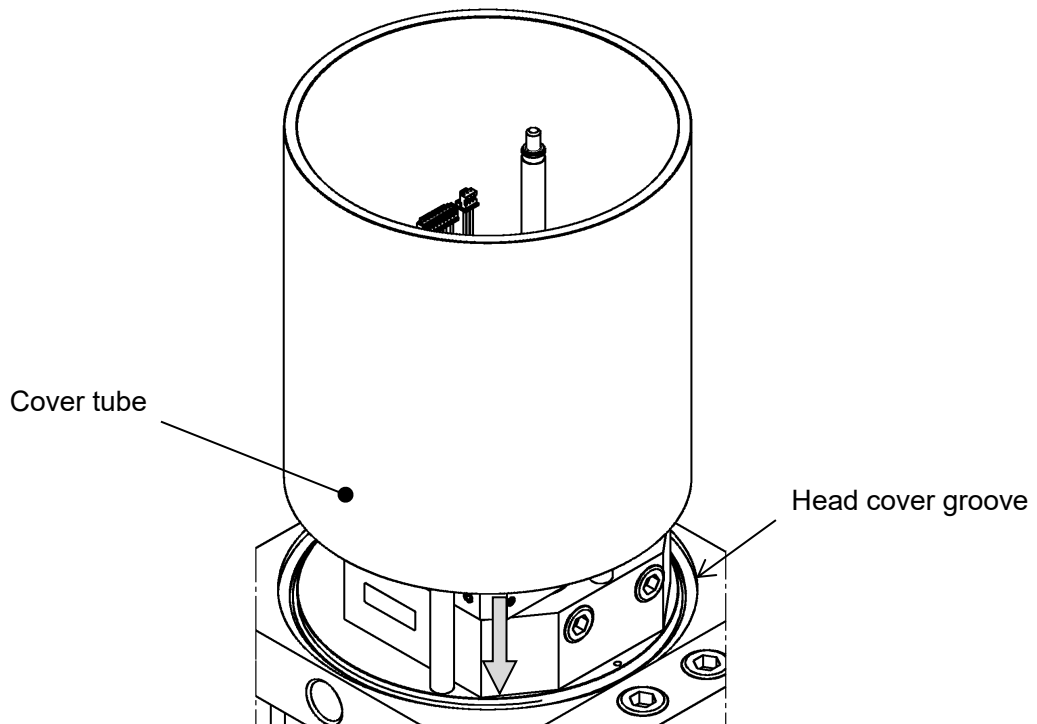
(Tightening torque: 4.2 N·m to 6.2 N·m)

Hexagon socket head cap screw





(2) Mount to the cover tube. (Mounting direction is not specified.) Be careful to ensure that the O-ring located in the head cover groove remains in place and doesn't become twisted.

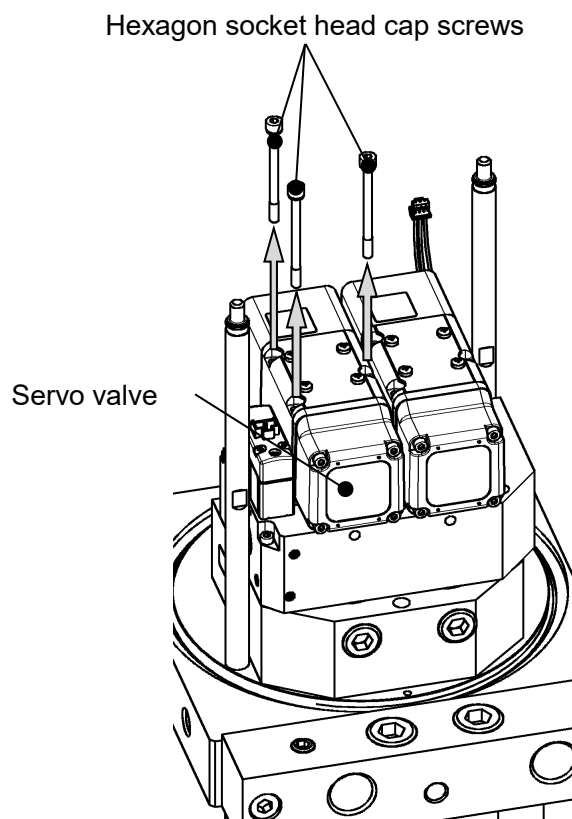


(3) Mount the controller assembly. (Refer to 8.1.2.)

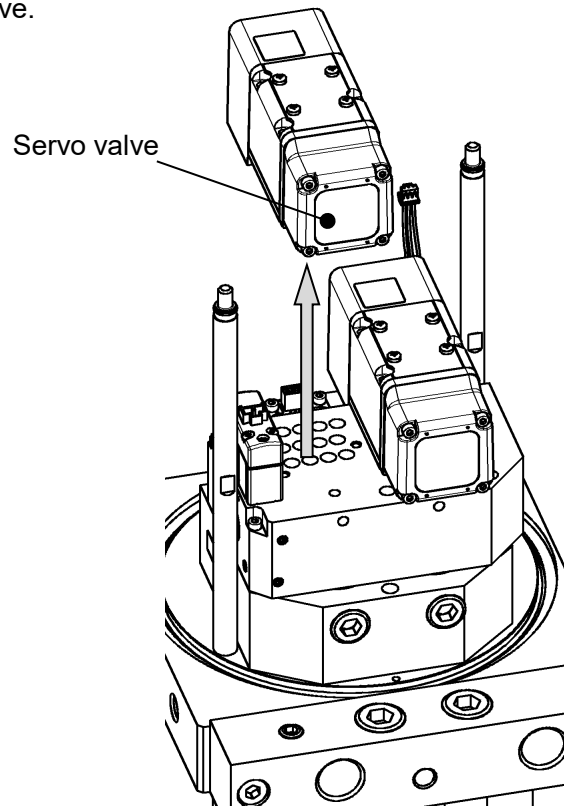
### 8-3-1. Disassembly of the servo valve

(1) Remove the controller assembly and cover tube. (Refer to 8-2-1 (1) to (2).)

(2) Remove the hexagon socket head cap screws (3 pcs.)



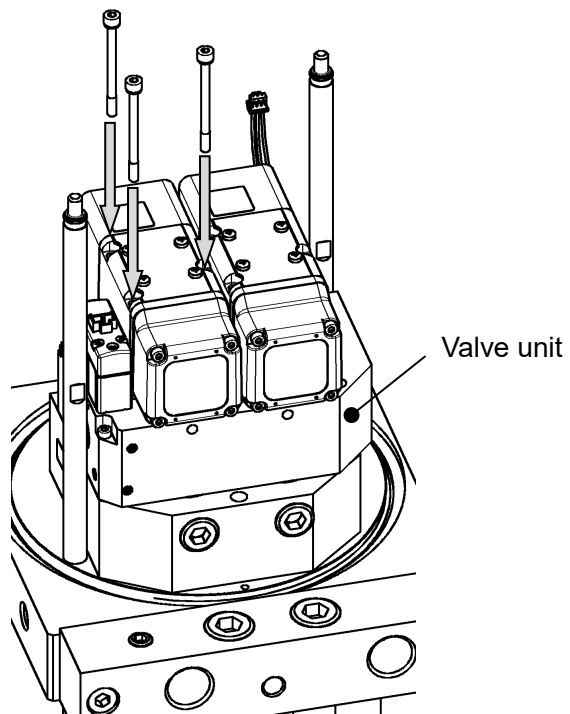
(3) Remove the servo valve.



### 8-3-2. Assembly of the servo valve

(1) Mount the servo valve to the valve unit and tighten the hexagon socket head cap screws (3 pcs.).

(Tightening torque: 1.2 N·m to 1.8 N·m)

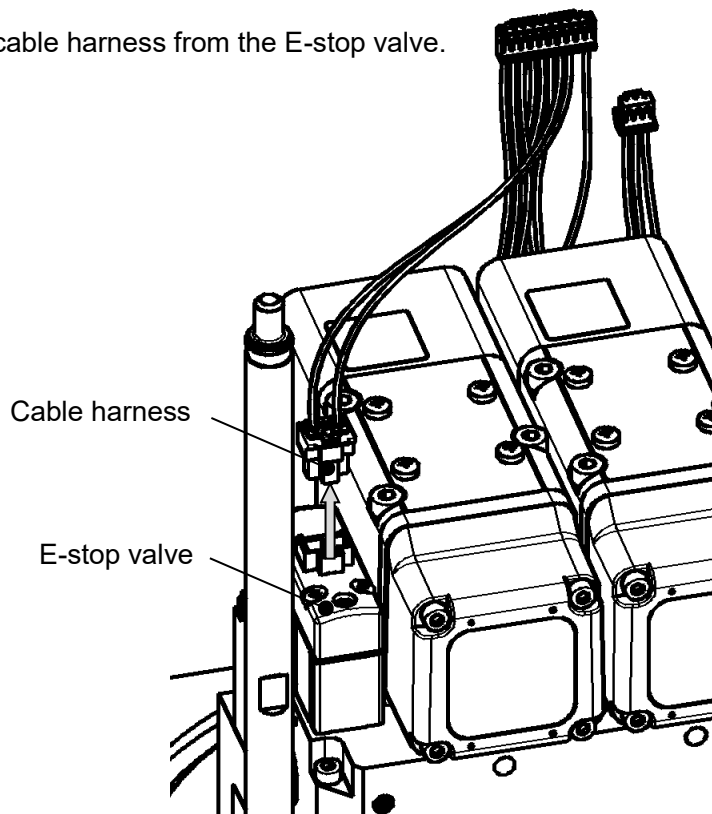


(2) Mount the cover tube and controller assembly. (Refer to 8-2-2(2) and 8-1-2.)

### 8-4-1. Disassembly of the E-stop valve

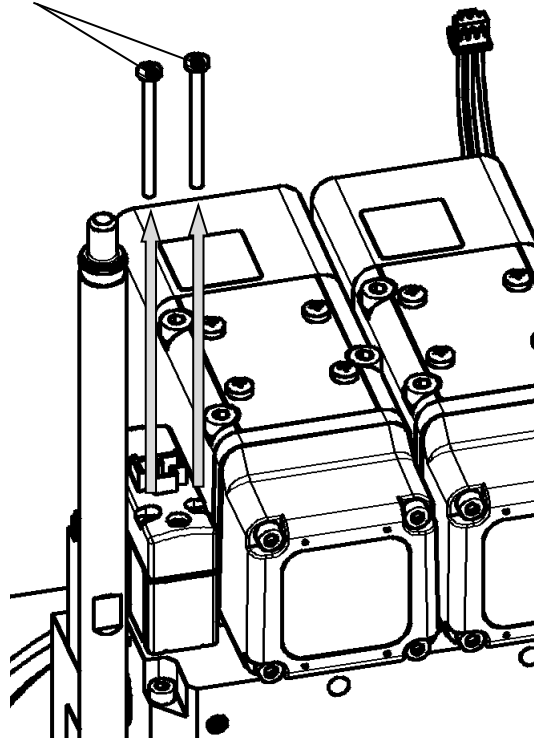
(1) Remove the controller assembly and the cover tube. (Refer to 8-2-1(1) to (2).)

(2) Remove the cable harness from the E-stop valve.

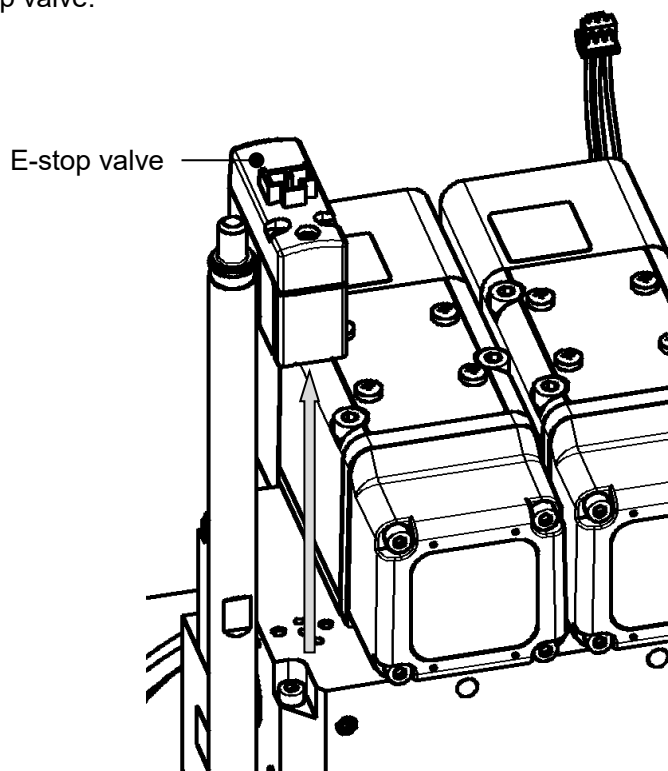


(3) Remove the round head combination screw.

Round head combination screw



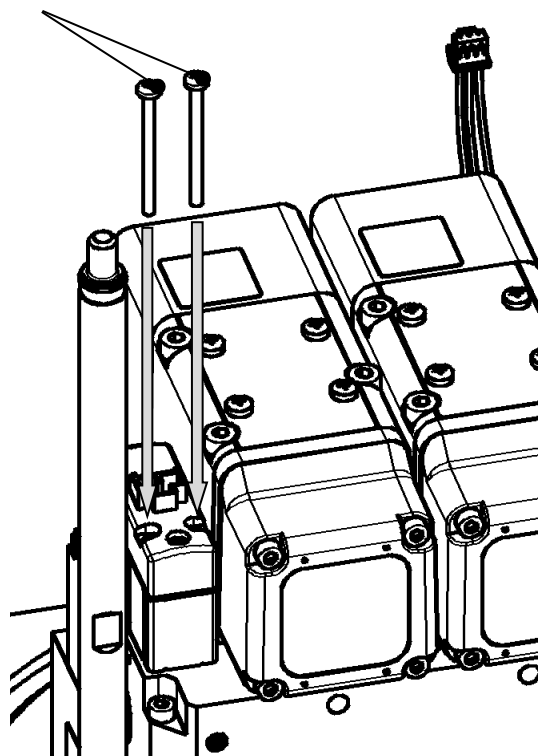
(4) Remove the E-stop valve.



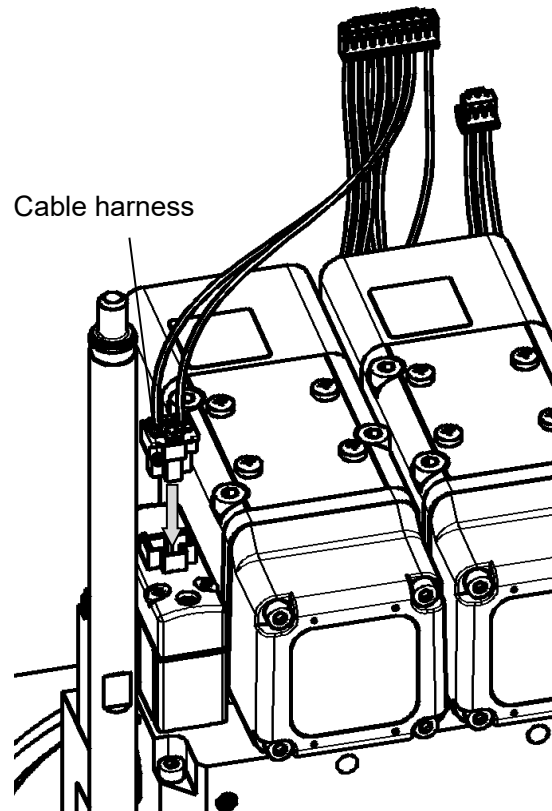
#### 8-4-2. Assembly of the E-stop valve

- (1) Mount the E-stop valve to the valve unit and tighten round head combination screw.  
(Tightening torque: 0.24 N·m to 0.36 N·m)

Round head combination screw



(2) Connect the connectors of the cable harness to the E-stop valve.

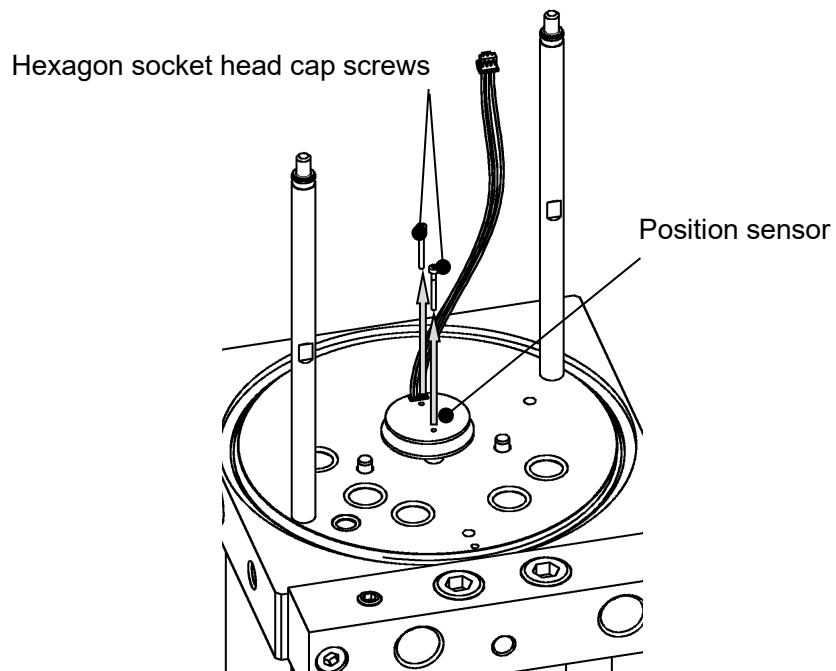


(3) Mount the cover tube and the controller assembly. (Refer to 8-2-2(2) and 8.1.2.)

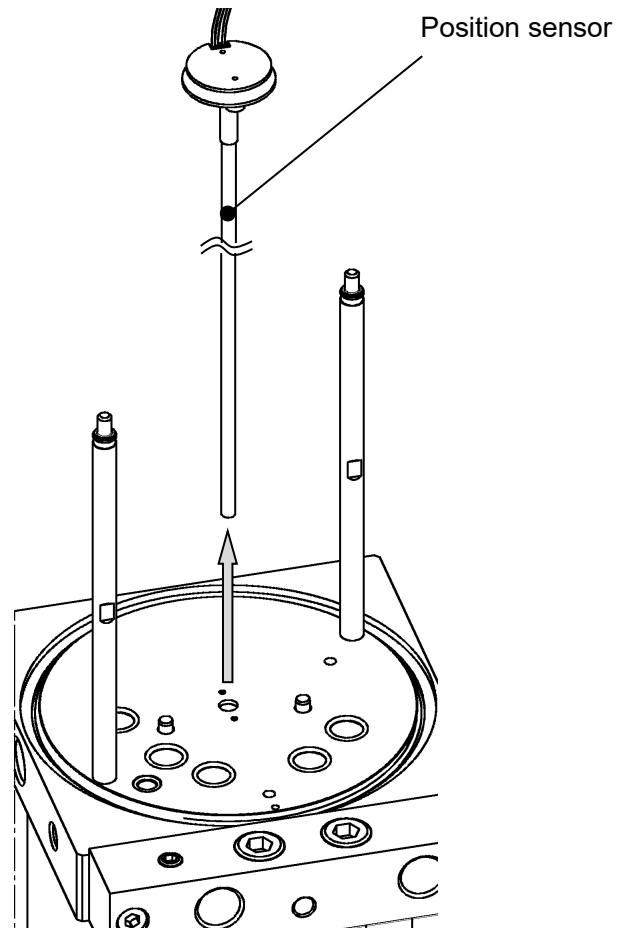
### 8-5-1. Disassembly the position sensor

(1) Remove the controller assembly and cover tube and valve unit. (Refer to 8-3-1(1) to (2).)

(2) Remove the hexagon socket head cap screws (2 pcs.)



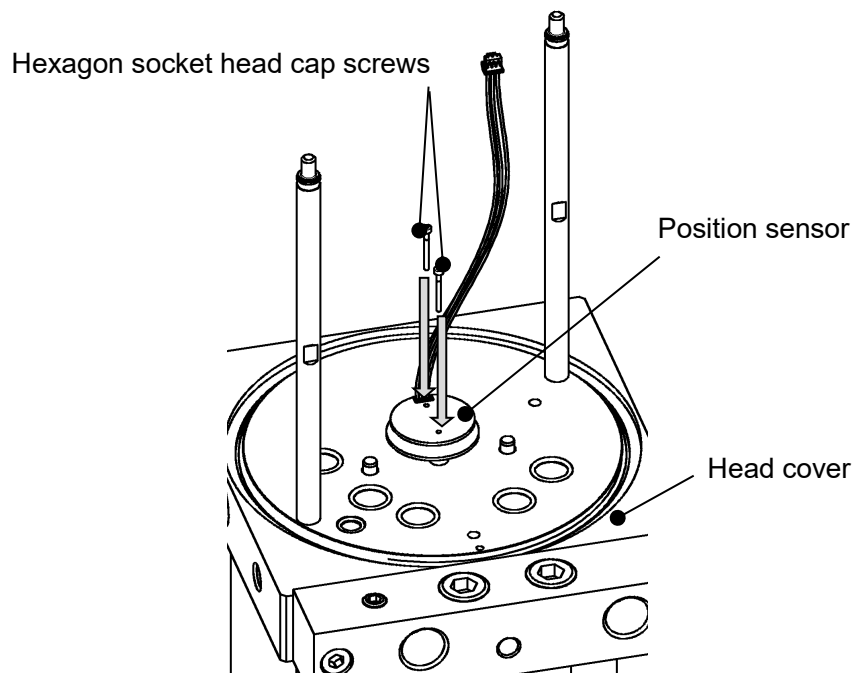
(3) Remove the position sensor.



### 8-5-2. Assembly of the position sensor

(1) Mount position sensor to the head cover and tighten the hexagon socket head cap screws (2 pcs.).

(Tightening torque: 0.09 N·m to 0.12 N·m)



(2) Mount the valve unit, the cover tube and the controller assembly. (Refer to 8-2-2(1) to (2) and 8-1-2.)

## 8-6-1. Disassembly of the air cylinder parts

### **Caution**

Open the residual pressure release valve (refer to 7-6) to exhaust the residual pressure in the cylinder. Be careful not to scratch or dent the inner surface of the cylinder or sliding surfaces of the piston rod during assembly.

Eliminate all burrs and foreign matter from the piston surface before removing the piston rod from the rod cover so that the seals and bushing are not damaged.

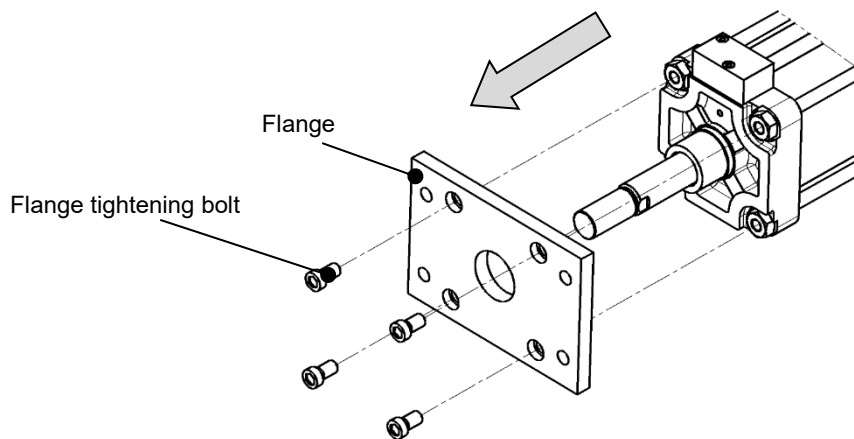
#### (1) Removal of the flange

- Ø125 to Ø250

Remove the flange tightening bolts and remove the flange.

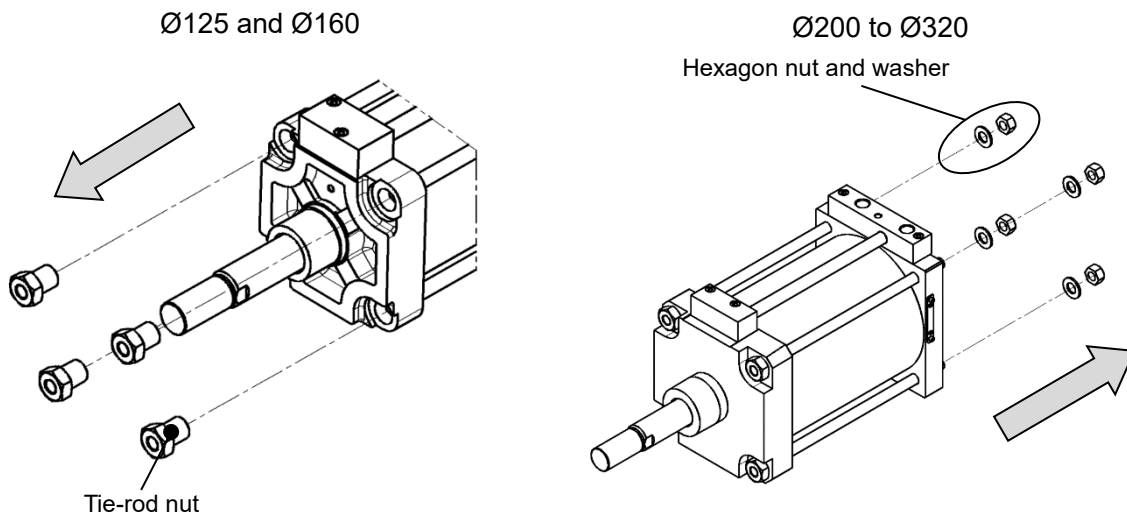
- Ø320

This step is skipped as the flange and rod cover are in one piece.

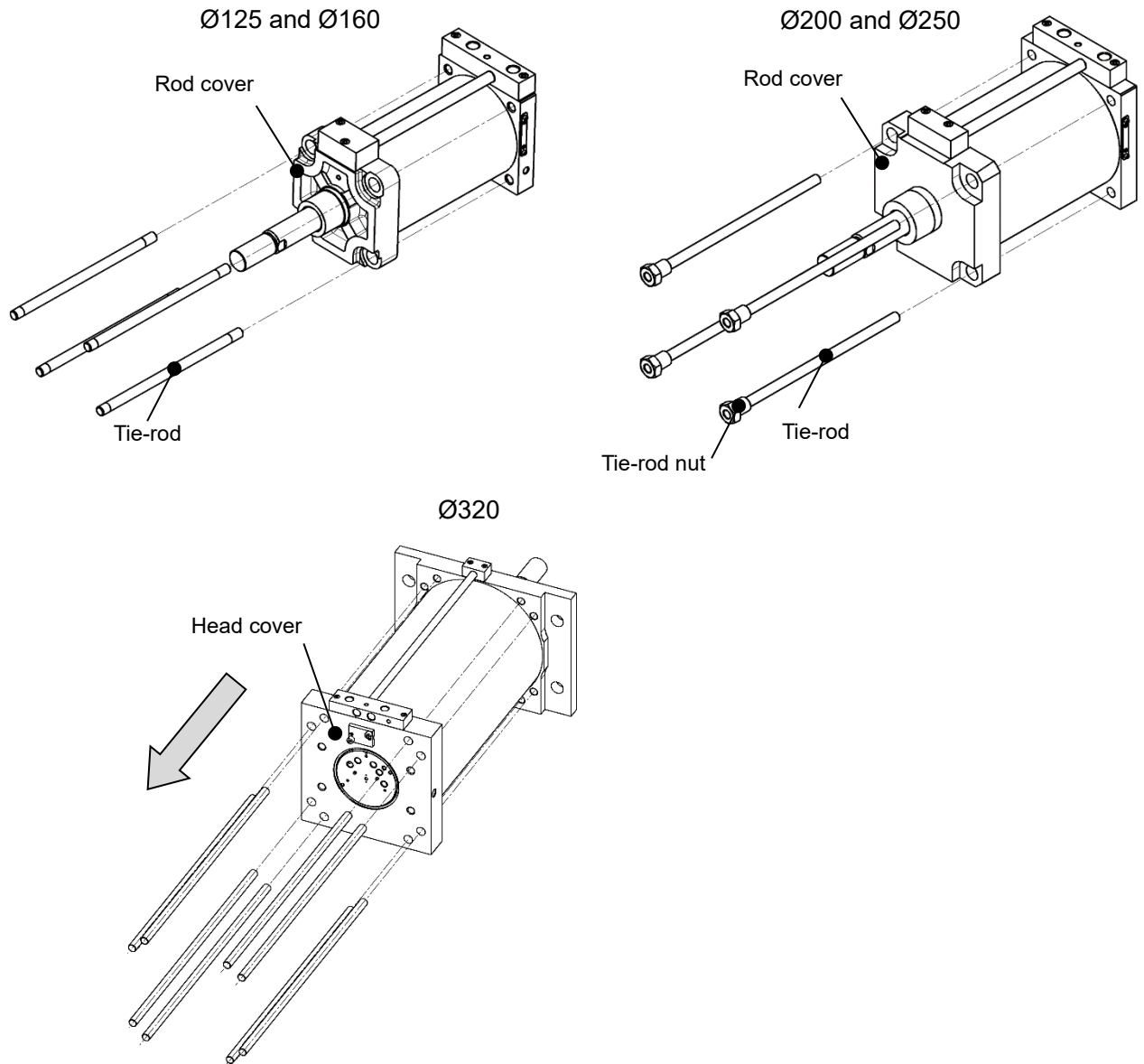


#### (2) Loosen the tie-rod nut (Ø125 and Ø160) or hexagon nut and washer (Ø200 to Ø320) and remove them.

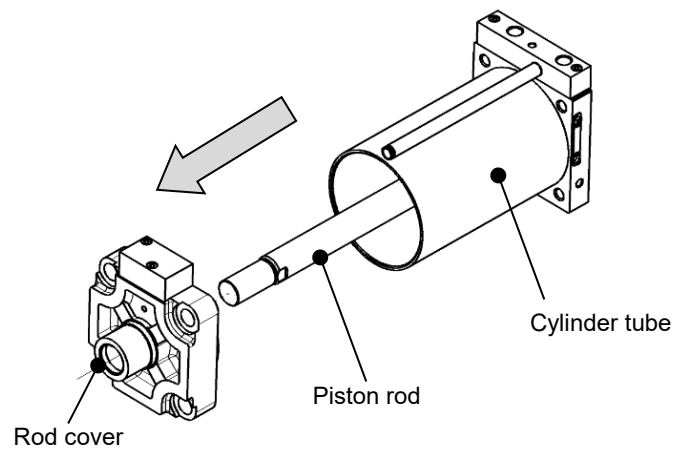
Tie-rod nut (Ø125 and Ø160) is on the rod cover side and hexagon nut and washer (Ø200 to Ø320) is on the head cover side.



(3) Remove the tie-rod from the cover. For  $\text{Ø}200$  to  $\text{Ø}320$ , do not remove the tie-rod nut from the tie-rod.



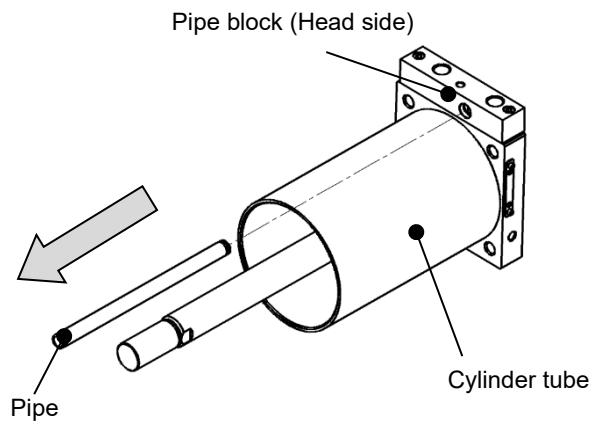
(4) Remove the rod cover from the cylinder tube and piston rod.



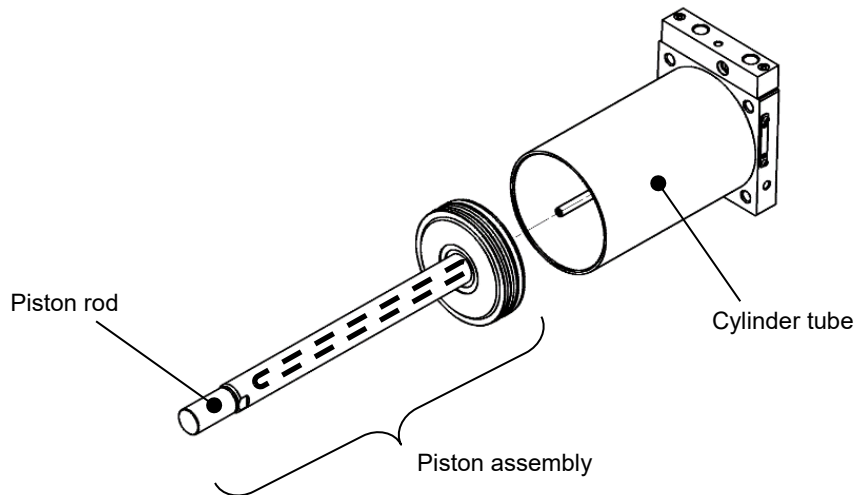


(5) Remove the pipe from the pipe block (head side).

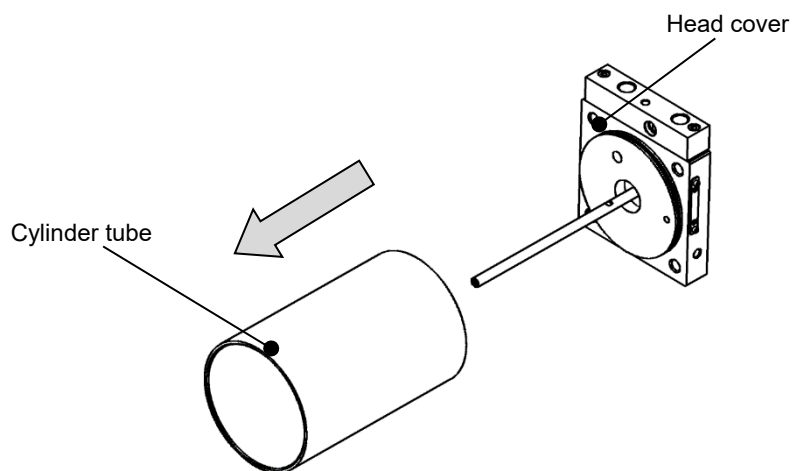
(For  $\varnothing 160$  to  $\varnothing 320$ . For  $\varnothing 125$ , remove the piping from the head cover.



(6) Hold the piston rod and remove the piston assembly from the cylinder tube.

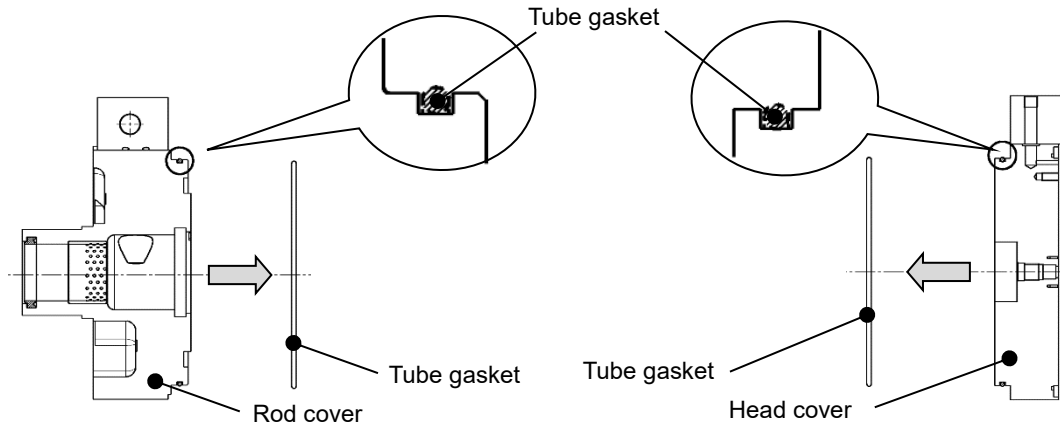


(7) Remove the cylinder tube from the head cover.

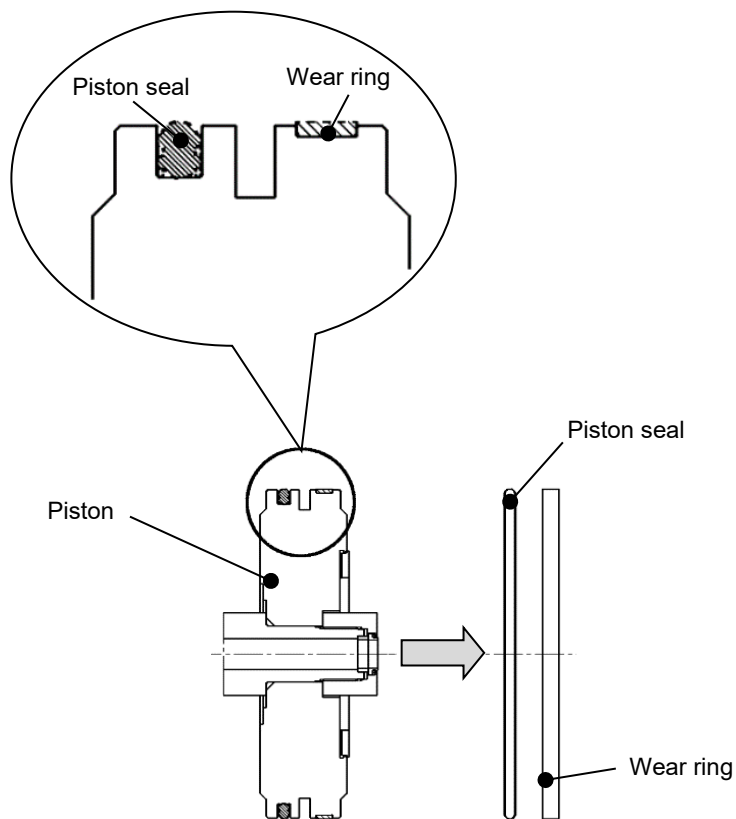


## 8-6-2. Disassembly the O-ring and the Packing

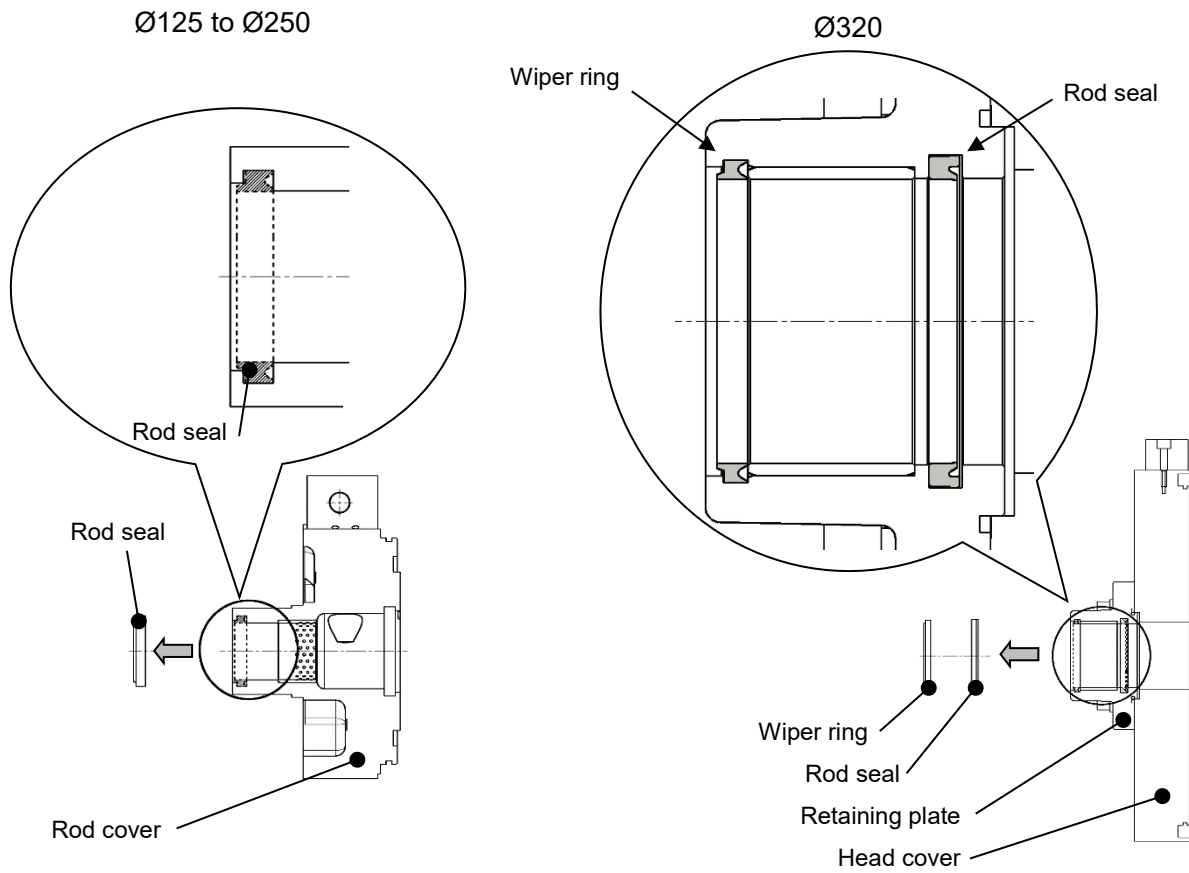
(1) Remove the tube gasket from the head and rod cover.



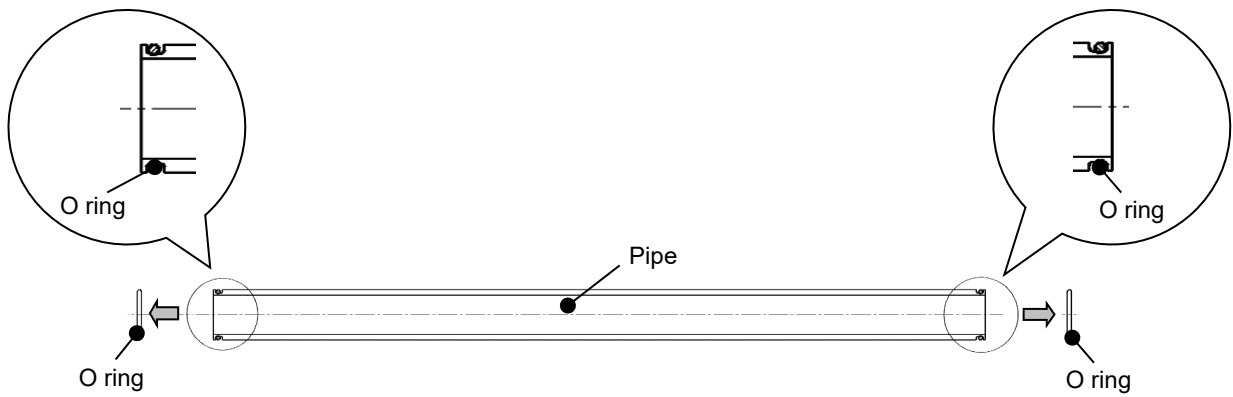
(2) Remove the piston seal and wear ring from the piston. The piston seal groove is deep. Do not use a precision screwdriver. Pinch the piston seal on both sides on opposing sides of the seal diameter so that a portion seal using the raised part of the seal.



(3) Remove the rod seal from the rod cover. Remove the rod seal using a flat blade screwdriver. Take care not to scratch the seal surface or bushing when removing.



(4) Remove the pipe O-ring from the pipe.

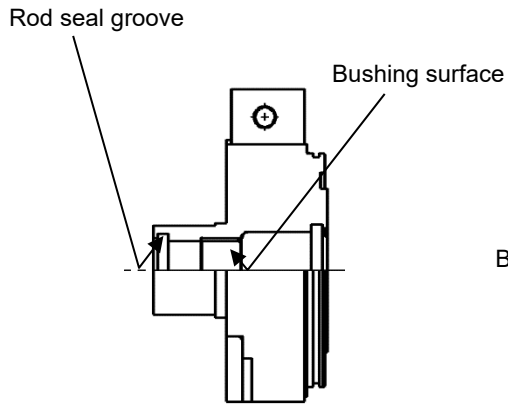


### 8-6-3. Greasing for Packing, O-ring and parts

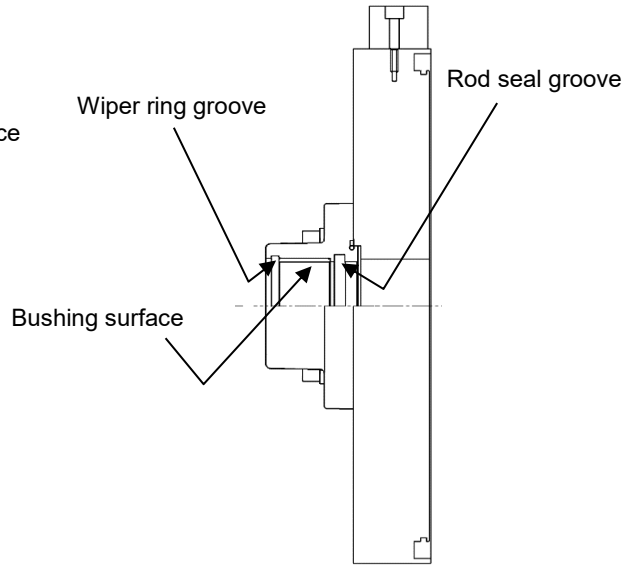
(1) Thinly apply grease to the surface of the seals, O-rings and wear ring.

(2) Apply grease to each part as shown below. \* See Table 1 for guidelines for the amount of grease.

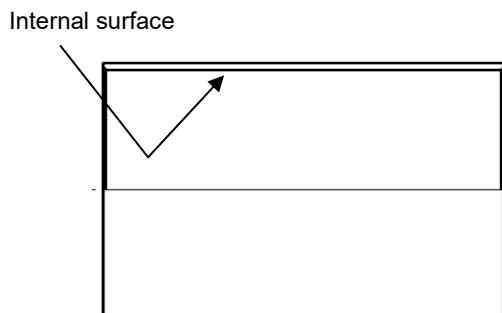
(a-1) Inside of the rod cover (Ø125 to Ø250)



(a-2) Inside of the rod cover (Ø320)



(b) Cylinder tube



(c) Piston assembly

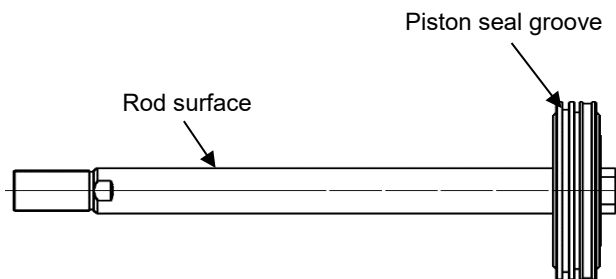
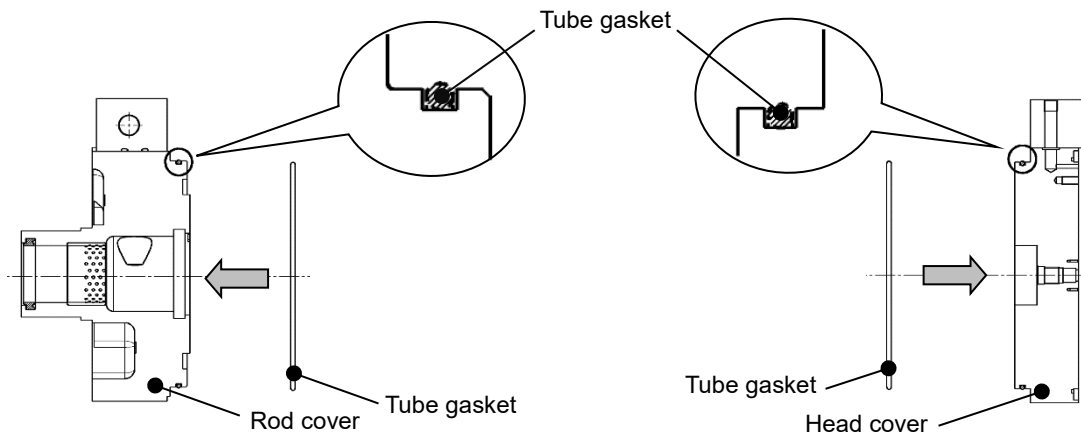


Table 1 Grease application amount

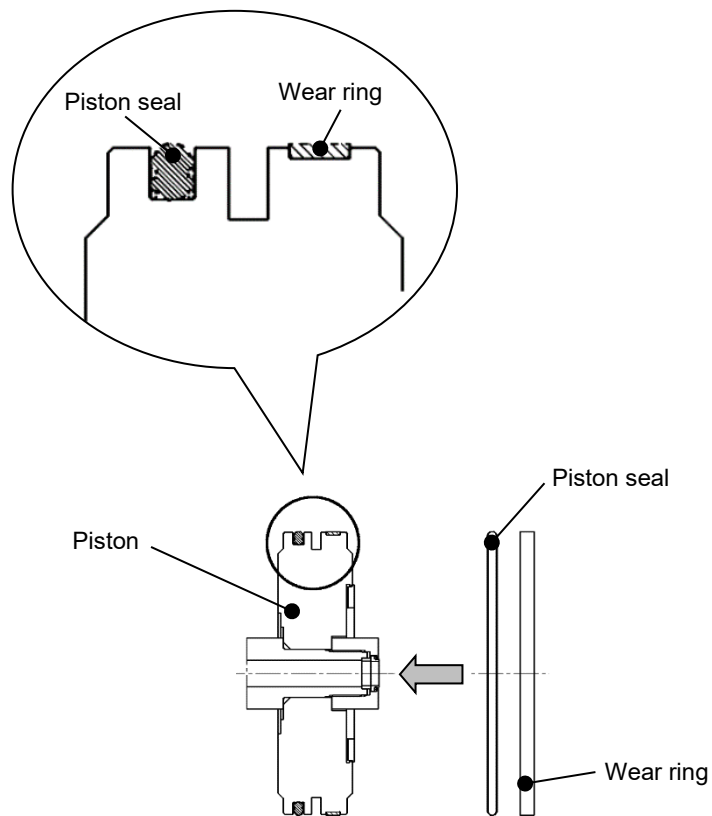
Bore size (mm)	Stroke (mm)	Grease application amount (cm <sup>3</sup> )
125	250	10
160	200	10
	300	15
200	200	10
	300	15
250	350	20
	450	30
320	200	15
	350	30
	530	40

### 8-6-4. Assembly of the Packing and O-ring

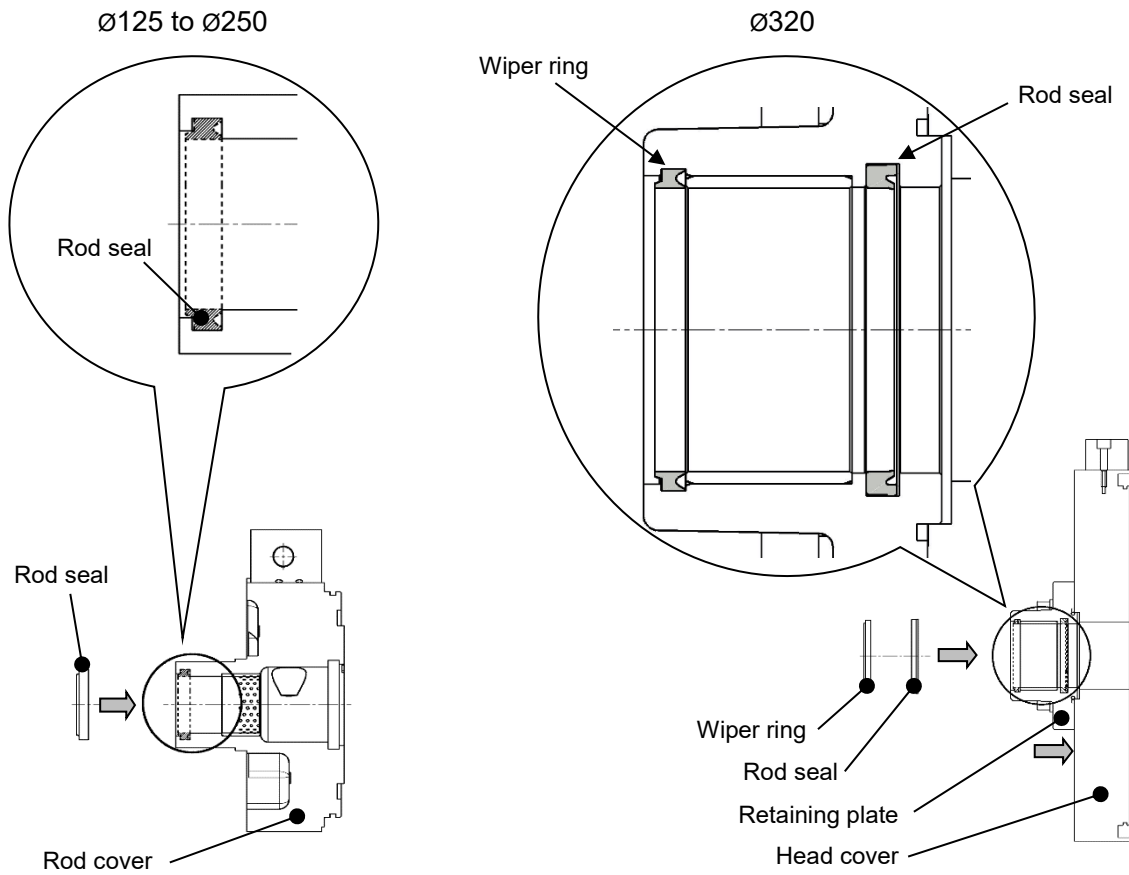
(1) Mount the tube gasket into the groove of the head cover and rod cover.



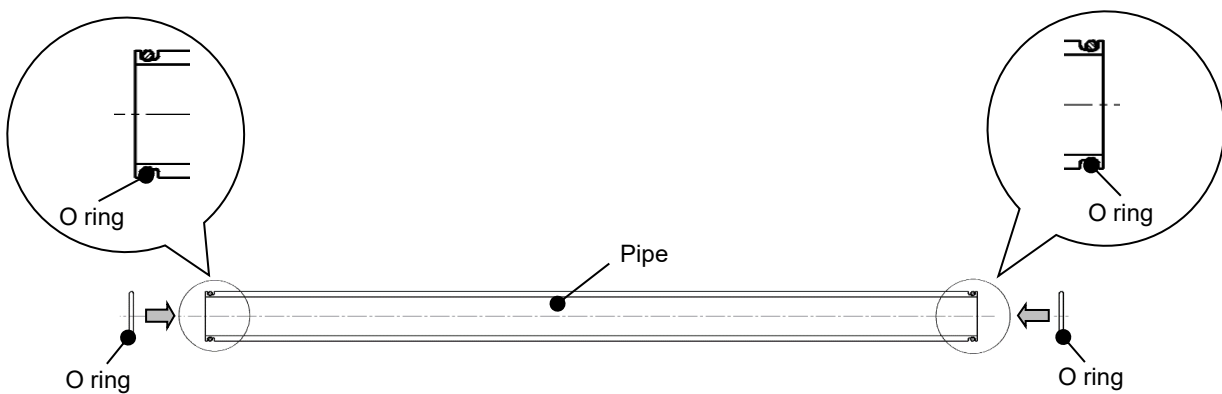
(2) Mount the piston seal and wear ring to the piston groove.



(3) Mount the rod seal to the rod cover groove. Make sure that the mounting direction is correct as shown.

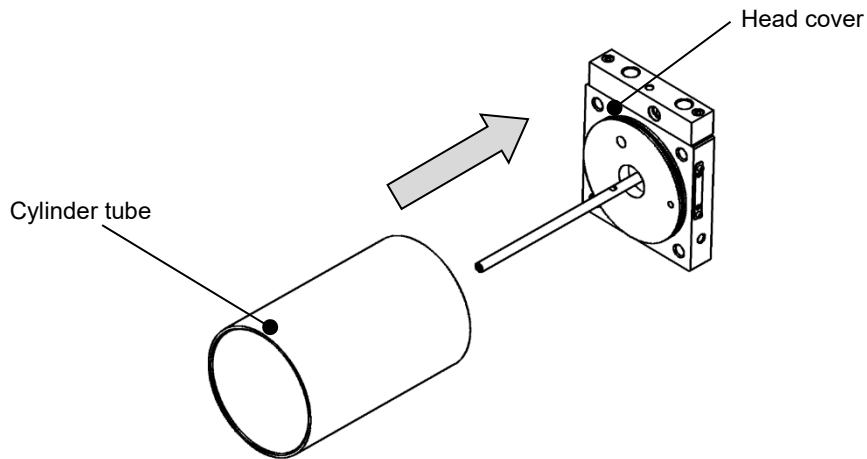


(4) Mount 2 pipe O-rings to the groove at the end of the pipe.

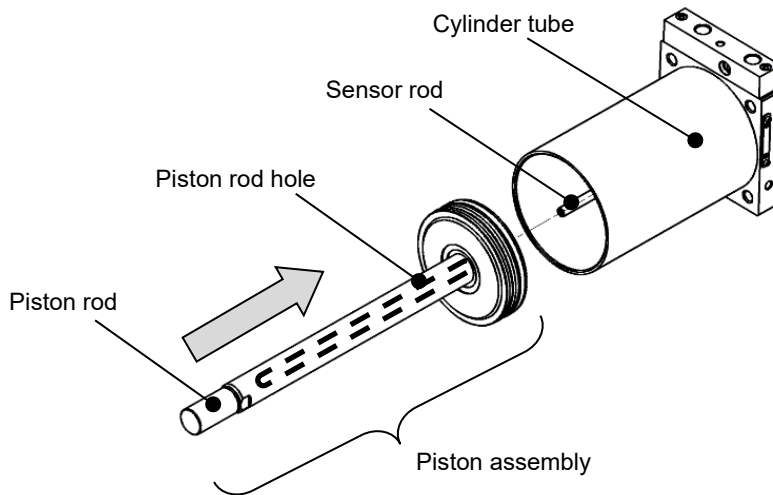


### 8-6-5. Assembly of the Air cylinder parts

(1) Mount the head cover to the cylinder tube.

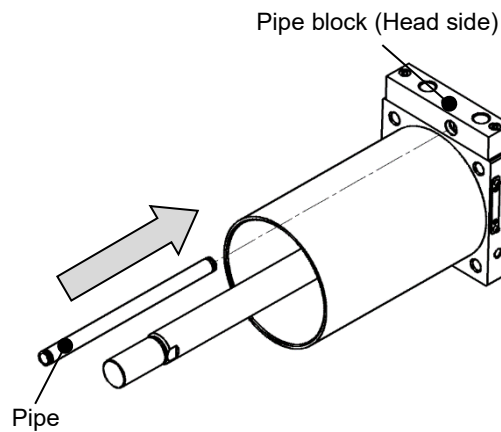


(2) Mount the piston assembly to the cylinder tube. Mount the sensor rod inserting it to the piston rod hole. Be careful not to bend or hit the sensor rod. Take care not to scratch the piston seal during mounting.

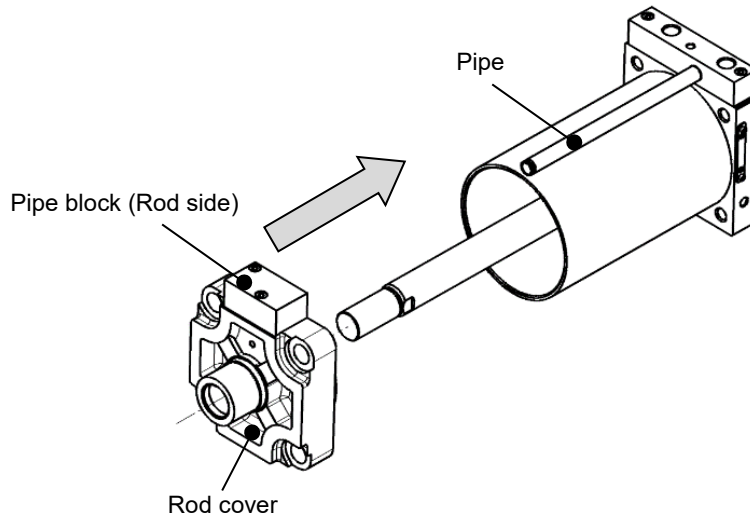


(3) Mount the pipe to the pipe block (head cover side).

(For  $\varnothing 160$  to  $\varnothing 320$ . For  $\varnothing 125$ , mount to the head cover hole).

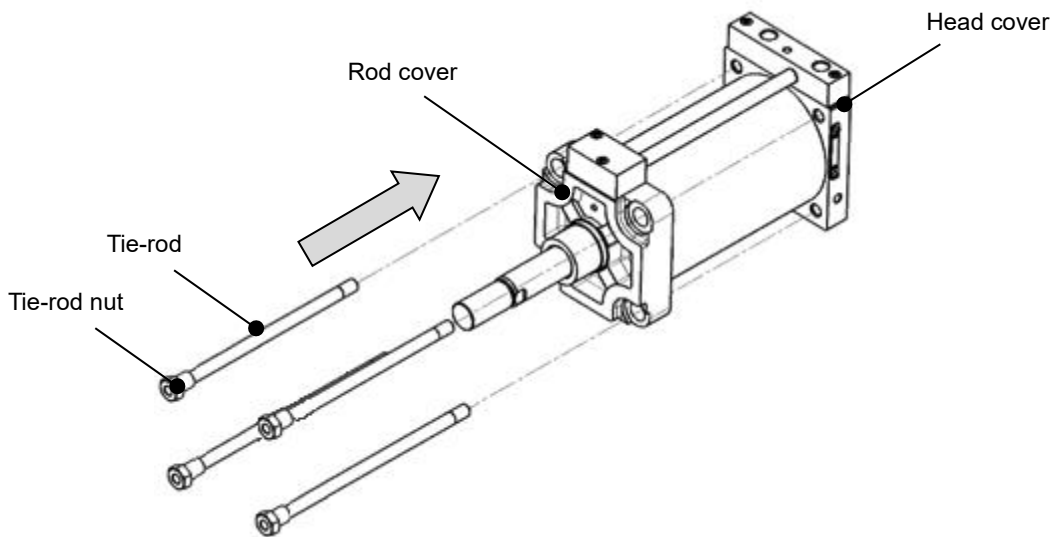


(4) Mount the rod cover to the cylinder tube. Mount the pipe to the pipe block (rod side). Take care not to scratch the rod seal, wiper ring and bushing.



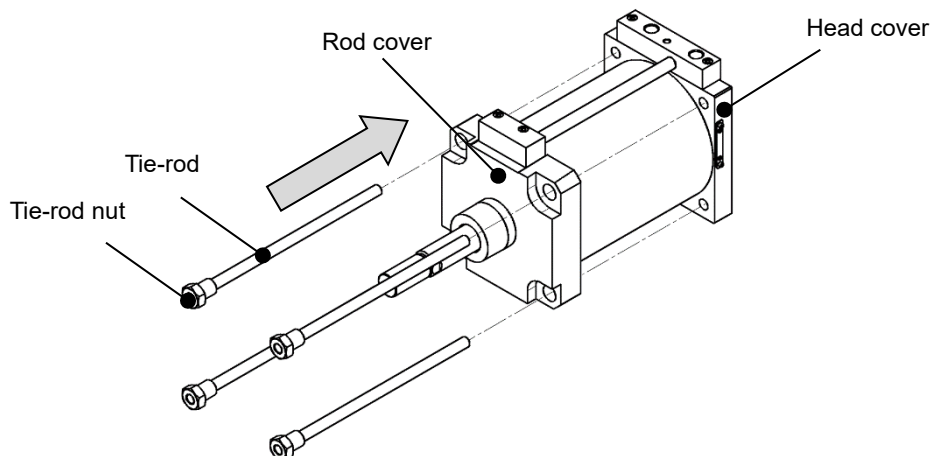
(5) Mount the tie-rod.  
- Ø125 and Ø160

Tighten the tie rod nut to the tie rod on the side which male thread is shorter. Insert the tie rod from the rod cover side through the tie rod through hole and tighten it to the head cover female thread.



-Ø200 and Ø250

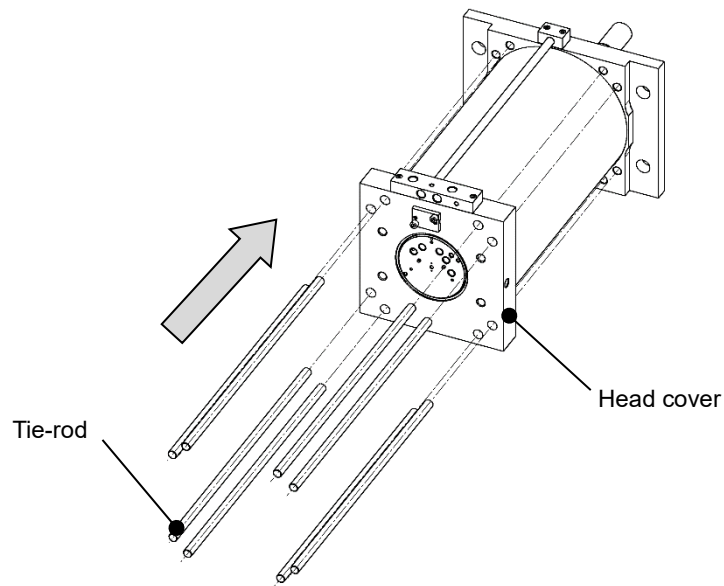
Insert the tie rod with tie rod nut through the tie rod through hole and the head cover tie rod through hole.





-Ø320

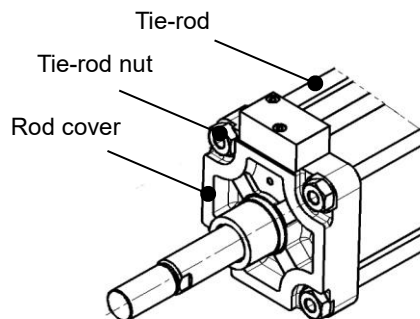
Insert the tie rod from the head cover through the tie rod through hole. Tie rod does not have orientation for insertion. Tighten the tie rod male thread part into the rod cover female thread part.



(6) Tightening of tie-rod nut and hexagon nut

- Ø125 and Ø160

Tighten the tie rod nuts to the tie rod from the rod cover side so that the tie rod tension becomes even.  
(See Table 2 for the tightening torque)



- Ø200 to Ø320

Mount the washer to the tie rod from the head cover side. Tighten the hexagon nuts so that the tension of the tie rod becomes even. (See Table 2 for the tightening torque)

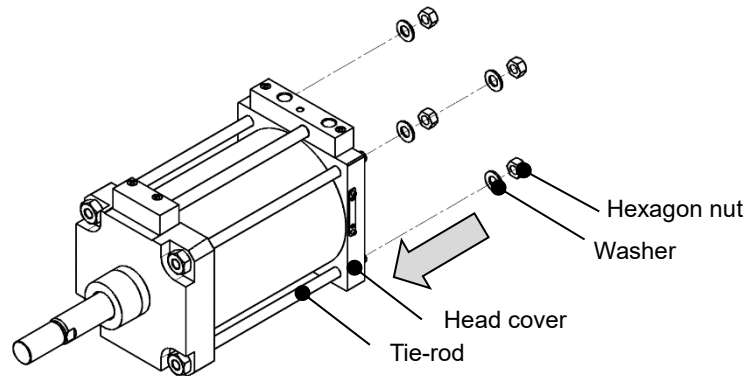


Table 2 Tightening torque

Bore size (mm)	Tightening torque (N·m)
125	23.9 to 33.1
160	89.1 to 108.9
200	89.1 to 108.9
250	174.15 to 212.85
320	147

(7) Mounting of flange

- Ø125 to Ø250

Mount to the rod cover using the tightening bolt for the flange.

- Ø320

This step is skipped as the flange and rod cover are in one piece.

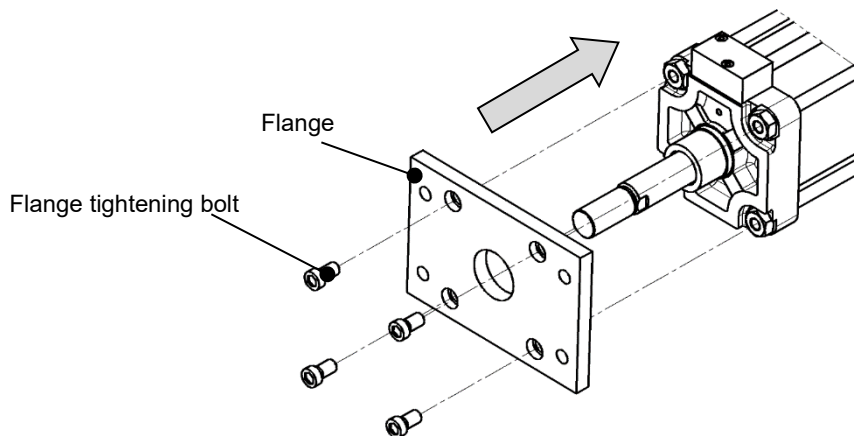
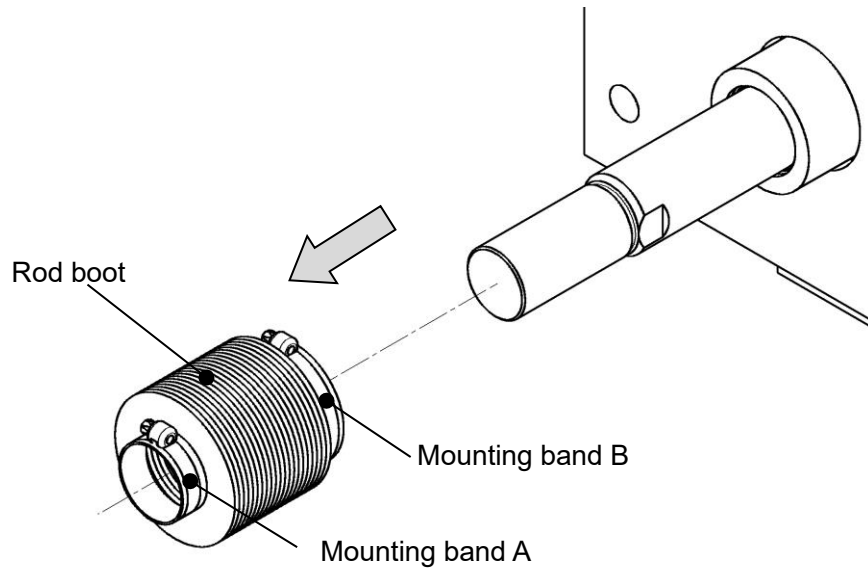


Table 3 Tightening torque

Bore size (mm)	Tightening torque (N·m)
125	30.1
160	99
200	99
250	193.5

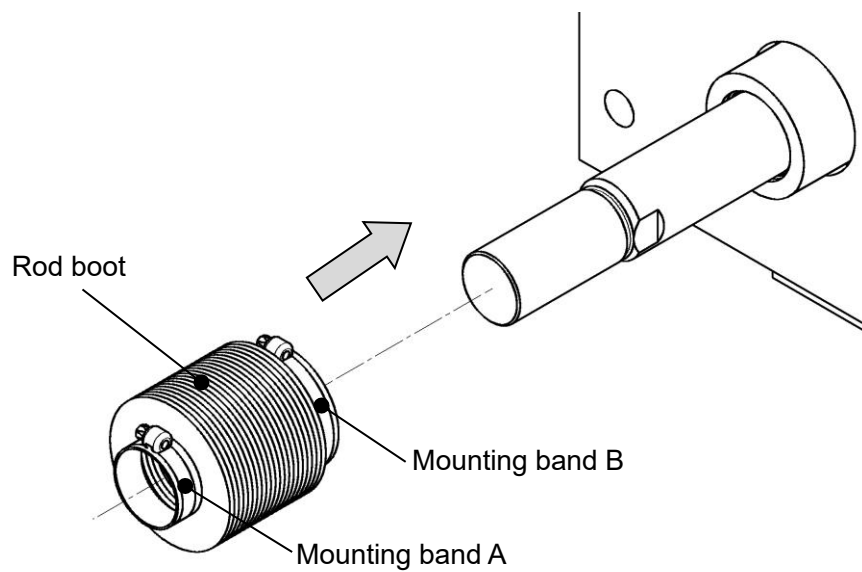
### 8-7-1. Disassembly of the rod boot

- (1) Loosen the mounting screw for rod boot mounting band A and B.
- (2) Remove the rod boot.



### 8-7-2. Assembly of the rod boot

- (1) Mount the rod boot to the cylinder.
- (2) Tighten the screw for the rod boot mounting band A and B.  
Tightening torque:  $5.2 \text{ N}\cdot\text{m} \pm 30\%$  <Common for all sizes>



## 9. Alarm

If errors occur during operation of the air servo cylinder, alarms will be output. Alarm names and the descriptions are shown below.

No	Error name	Possible causes	Countermeasures	Alarm type		Target position operation and JOG operation
				Output signal	LED alarm display (Option) (Refer to 7-7.)	
1	Power supply error (Outside of 24 V +/-10%)	The power supply voltage between the power supply terminal PWR_24V and PWR_GND is outside of DC24 V +/-10%.	Use a power supply voltage of DC24 V +/-10%.	PWR signal: OFF	PWR LED: Green flashing (Cycle: 1 Hz)	Continue
2	Power supply error (Below 17 V)	The power supply voltage between the power supply terminal PWR_24V and PWR_GND is below 17 V.	Use a power supply voltage of DC24 V +/-10%.	PWR signal: OFF	PWR LED: OFF	Stop
3	Incorrect cylinder bore size setting	All DIP switches No. 2, 3 and 4 are ON or OFF, which is an incorrect setting.	Change the setting of the DIP switch correctly. (Refer to 6-2.)	CTR signal: OFF	CTR LED: Green flashing (Cycle: 1 Hz)	Stop
4	Over current to the positioning sensor	Over current flowed to the positioning sensor.	Replace the positioning sensor unit. (Refer to *1.)	CYL signal: OFF	CYL LED: Red ON	Stop
5	Incorrect positioning sensor signal	Non-conformance occurred in the connection of the positioning sensor and controller or on the positioning sensor signal.		CYL signal: OFF	CYL LED: Red flashing (Cycle: 1 Hz)	Stop
6	Incorrect positioning sensor connection	Non-conformance occurred in the connection of the positioning sensor and controller.	Remove the controller to confirm that the connector of the sensor harness which connects the controller board and the positioning sensor is mounted correctly.	CYL signal: OFF	CYL LED: Red flashing (Cycle: 0.5 Hz)	Stop
7	Over current to the emergency stop valve	Over current flowed to the emergency stop pilot valve (E-STOP valve).	Replace the emergency stop pilot valve. (Refer to *1.)	VAL signal: OFF	VAL LED: Red ON	Stop
8	Over current to the servo valve	Over current flowed to the servo valve.	Replace the servo valve. (Refer to *1.)	VAL signal: OFF	VAL LED: Red ON	Stop
9	Incorrect servo valve connection	Non-conformance occurred in the connection of the servo valve and controller.	Check if the servo valve is correctly connected.	VAL signal: OFF	VAL LED: Red flashing (Cycle: 0.5 Hz)	Stop
10	Piston rod wear-out	Malfunction occurred in the piston rod.	Check the condition of the rod, and remove unbalanced load and/or foreign matter as necessary.	RF signal: OFF	RF LED: Red ON	Continue

\*1 Contact your SMC sales representative.

## 10. Trouble Shooting

Refer to the table below for troubleshooting. When none of the causes in the troubleshooting can be confirmed, it is presumed that the product is faulty and normal operation can only be recovered by the replacement of a part. It is possible that this product may be damaged due to the operating conditions (applications). Please contact SMC to discuss appropriate measures.

Problem	Possible causes	Investigation method and location of possible causes	Countermeasures
Does not operate at all.	Power Supply failure	Is there power supplied? Are the PWR LED and CTR LED on the controller LED alarm display (option) ON green?	Check the voltage and current of the power supplied to the product, and use a power supply which satisfies the specification.
	External equipment failure	Does the PLC which controls the product operate correctly?	Check the PLC condition, and recover the problems such as program or wiring.
	Wiring failure	Is the wiring connected correctly?	Perform wiring correctly if a broken wire, short circuit, or incorrect wiring was found.
	Alarm generated	Check the alarm output signals or the LED condition on the LED alarm display.	Refer to "9. Alarm" on page 26 of this manual for the possible causes and countermeasures against the alarm.
	Excessive load	Does the load exceed the maximum load of this product? Is an excessive lateral load applied to the product?	Review the operating condition so that the load and lateral load in the operating condition do not exceed the maximum load.
	Misaligned axial center	Are the axial centers in the moving direction of the piston rod and the load aligned?	Make sure to connect the piston rod and the load so that their axial centers and moving directions match.
	Calibration is not performed.	Is the calibration performed?	Perform the calibration at the initial installation of the product. Refer to "7-2 Calibration".
Operation stops intermittently	Alarm generated	Check the alarm output signals or the LED condition on the LED alarm display.	Refer to "9. Alarm" of this manual for the possible causes and countermeasures against the alarm.
	Wiring failure	Is the wiring connected correctly?	Perform wiring correctly if a broken wire, short circuit, or incorrect wiring was found.
	Noise	Does the power supply cable pick up interference from cables for other equipment? Is there a noise source (RF generation equipment) close to the unit?	Install all noise sources (RF generation equipment) away from the unit. Please check the wiring condition of the power supply cable to avoid making contact with cables that contain surge such as power cables or high voltage cables.
	Voltage drop	Check for a temporary voltage drop in the power supply?	There is a possibility of a momentary voltage drop due to an inadequate power supply capacity or an inrush-current limited type power supply. Make sure to use a power supply which satisfies the specification.
	Misaligned axial center	Are the axial centers in the moving direction of the piston rod and the load aligned?	Make sure to connect the piston rod and the load so that their axial centers and moving directions match.

The product vibrates. (Knocking)	Over pressure	Does the supply pressure exceed the specified value (0.8 MPa)?	Make sure to supply pressure within the product specification.
	Excessive load	Does the load exceed the upper limit of the maximum load of this product?	Review the operating condition so that the load in the operating condition does not exceed the maximum load of this product.
	External equipment failure	Is there an unintentional signal input from the PLC which controls the product?	Check the PLC condition, and recover the non-conformance.
	Sliding resistance failure	Is the grease run out due to drainage in the supply air or adhesion of water to the rod?	To prevent drainage from entering, install a mist separator on the air piping. If the product is used in an environment where water adheres to the rod, review the operating condition and consider using a cylinder with bellows.
	Misaligned axial center	Are the axial centers in the moving direction of the piston rod and the load aligned?	Make sure to connect the piston rod and the load so that their axial centers and moving directions match.
Piston rod movement speed is slow.	Reduced pressure	Is the supply pressure below the lower limit of the specified value (0.55 MPa)?	Make sure to supply pressure within the product specification.
	Excessive load	Does the load exceed the upper limit of the maximum load of this product?	Review the operating condition so that the load in the operating condition does not exceed the upper limit of the maximum load of this product.
	Misaligned axial center	Are the axial centers in the moving direction of the piston rod and the load aligned?	Make sure to connect the piston rod and the load so that their axial centers and moving directions match.
Positioning repeatability accuracy is bad.	Pressure increase or decrease	Is the supply pressure within the specified value (0.55 MPa to 0.8 MPa)?	Make sure to supply pressure within the product specification.
	Excessive load	Does the load exceed the upper limit of the maximum load of this product?	Review the operating condition so that the load and lateral load in the operating condition do not exceed the upper limit of the specified value.
	Misaligned axial center	Are the axial centers in the moving direction of the piston rod and the load aligned?	Make sure to connect the piston rod and the load so that their axial centers and moving directions match.

## 11. Limitations of Use

### 11-1. Mounting



#### Caution

- (1) Vibration may occur due to positioning control depending on the operating environment, load, conditions, etc.  
Be sure to inspect the actual machine for sufficient strength retention in regard to the amount of cylinder vibration that occurs.
- (2) Mount so that a lateral load which exceeds the allowable lateral load is not applied to the piston rod.  
If a lateral load which exceeds the allowable lateral load is applied, the positioning repeatability during the target position operation will decline, which may lead to piston rod malfunction.  
In addition, if the seals, cylinder tubing, etc., come into direct contact with the metal parts of the piston, air leakage due to uneven wear or reduced service life due to accelerated wear of the bearing may result. Refer to Table 2 on page 18 for the allowable lateral load.
- (3) When a workpiece is mounted on the piston rod end, connect them by aligning the axial center of the piston rod and that of the workpiece.  
If they are off-center, a lateral load will be generated and the phenomena mentioned in item 2 may occur.

### 11-2. Operating



#### Caution

- (1) When powering-up the product, restarting after an emergency stop, or switching the operating mode, be careful as the piston rod may suddenly extend or retract according to the settings.
- (2) Avoid use in environments where condensation is generated.  
When moving the product to a location at room temperature after operating it in low-temperature conditions, the temperature will rise suddenly and condensation will be generated. If water droplets from the generated condensation adhere to the internal substrate, an electric short-circuit may occur, resulting in a malfunction.

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## Revision history

1<sup>st</sup> edition: March 2019  
Rev. A: October 2019 (Partial correction)  
Rev. B: January 2021 (Add Variation of rod boot)  
Rev. C: May 2022 (Add auto start function)

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NOTE: Specifications are subject to change without prior notice and any obligation on the part of the manufacturer.  
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