



# Operation Manual

PRODUCT NAME

*Air cylinder*

MODEL / Series / Product Number

CS2\*125~320-\*\*

**SMC Corporation**

# Contents

1. Safety Instructions	P.2
2. Product specifications	P.4
1) Specifications	P.4
2) Max. stroke	P.5
3) Max. usable stroke by the side load given to the cylinder	P.6
4) The relation between cylinder size and max. stroke by the mounting style	P.8
5) Theoretical output	P.10
6) Kinetic energy absorbed by cushion mechanism	P.10
7) Application of 2nd –class pressure vessel regulation due to operating liquid	P.11
8) How to order	P.11
3. Mounting, Operation	P.12
1) Operating air	P.12
2) Precaution on design	P.12
3) Mounting	P.14
4) Operating environment	P.15
5) Piping	P.16
6) Cushion	P.17
7) Speed control	P.18
8) Direction control	P.19
4. Maintenance	P.20
1) Inspection	P.20
2) Overhaul	P.21
3) Disassembly	P.22
4) Assembly	P.23
5) Expendable supplies	P.24
6) Replacement procedure of seal	P.25
7) Inspection	P.26
5. Troubleshooting	P.27
6. Construction	P.30



# 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.

## 2 Product Specifications

### 1) Specifications

Bore size	ø125,ø140,ø160		ø180,ø200,ø250,ø320	
Fluid	Air			
Max. operating pressure	0.97MPa		0.7MPa	
Proof pressure	1.57MPa		1.2MPa	
Min. operating pressure	0.05MPa			
Piston speed	0.05~0.5m/sec			
Cushion	Air cushion		Air cushion + Bumper	
Ambient and fluid temperature	0~70°C(No freezing)			
Ambient temperature for bellows	J(Nylon tarpaulin) : 0~70°C(No freezing) K(Heat resistant tarpaulin) : 0~110°C(No freezing)			
Thread tolerance	JIS Class 2			
Stroke length tolerance	~ 250mm	+1.0 0 mm	~ 250mm	+2.0 0 mm
	251~1000mm	+1.4 0 mm	251~1000mm	+2.4 0 mm
	1001~1500mm	+1.8 0 mm	1001~1500mm	+2.8 0 mm
	1501~2000mm	+2.2 0 mm	1501~2000mm	+3.2 0 mm
Mounting bracket	Basic, Foot, Rod side flange, Head side flange Single clevis, Double clevis, Center trunnion			



#### Caution

In case of rod boot style, min. stroke is 30 mm or more.



#### Warning

##### 1. Confirm the specifications

This product was designed to use only for the compressed air system for industry.

Operation with pressure or temperature beyond the specifications range could cause breakage or malfunction. (See specifications.)

Contact SMC beforehand when the product is used for non-industrial application or is used with the fluids other than compressed air.

2) Max. stroke

Table 1. Maximum stroke (mm)

Bracket Bore size	Basic Head side flange, Single clevis Double clevis Center trunnion	Foot, Rod side flange
ø125	1000 or less	1600 or less
ø140	1000 or less	1600 or less
ø160	1200 or less	1600 or less
ø180	1200 or less	1569 or less
ø200	998 or less	
ø250	813 or less	
ø320	495 or less	

Note: Air cylinders with a ø180 or more. have the stroke range falling within the scope of the second class pressure vessel regulations in Japan.

For details, refer to subpara.

"7) Application of 2nd class pressure vessel regulation due to operating liquid," page 10.

Remark: Only when the air cylinder is intended for use outside Japan, products with ø180 and ø200 will be available as special order up to the stroke of 1800, and products with ø250 and ø320 will be as special order up to the stroke of 2000.

 Caution

Cylinder should be operated within the max. usable stroke.

Operation at the stroke beyond the max. stroke could cause breakage of piston rod.

Also since there are some cases where piston rod could break at the stroke less than the max. stroke depending on the application, please refer to "4)

The relationship between cylinder size and max. stroke by the mounting style" for the max. usable stroke.

### 3) Max. usable stroke by the lateral load given to the cylinder

The area within the solid line shows the relationship between the specified length stroke cylinder and allowable lateral load. The dotted line in the graph shows the case beyond the long stroke limit.

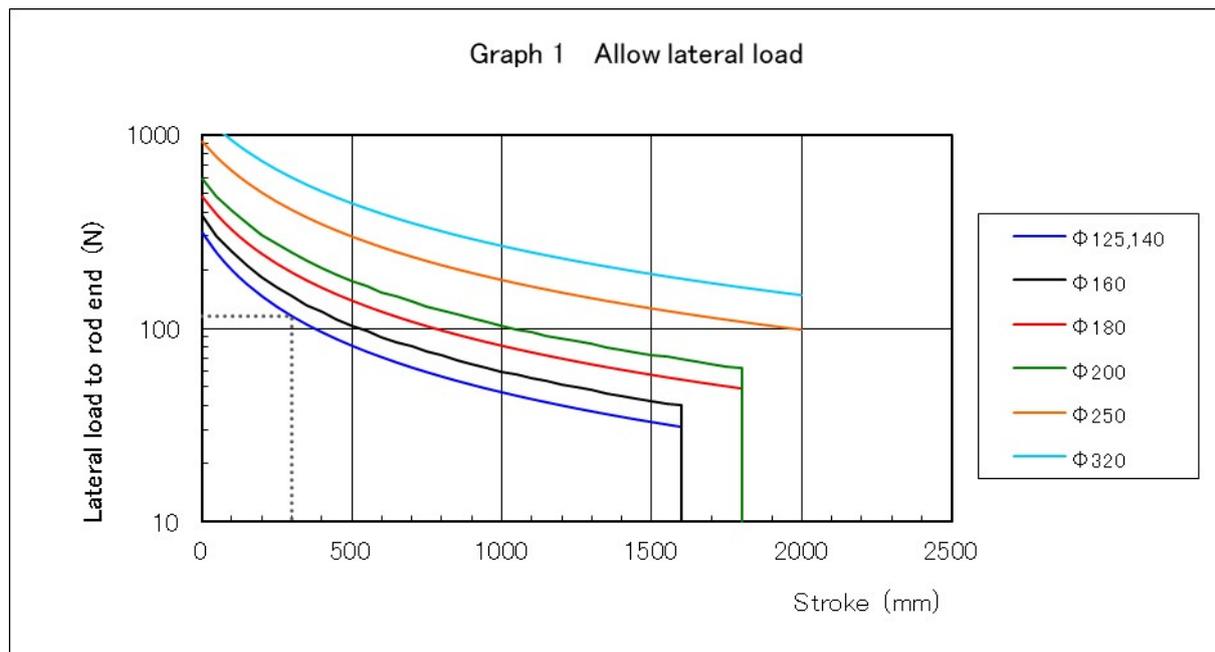
#### i) Judging external lateral load.

It is recommended to use fixed type cylinder so as the lateral load would not apply to the piston rod, however, in case it is not avoidable, it needs to be checked, if the lateral load is within the range of safety.

How to judge: The area within the curb line of graph 1 shows the relationship between the specified length stroke cylinder and allowable lateral load, which applies to piston rod end.

#### Ex.) CS2F125-300

According to the graph 1, nodal point of cylinder stroke 300mm and  $\phi 125$  is 115N. Lateral load to rod end needs to be smaller than this.



#### ii Judging lateral load of dead weight

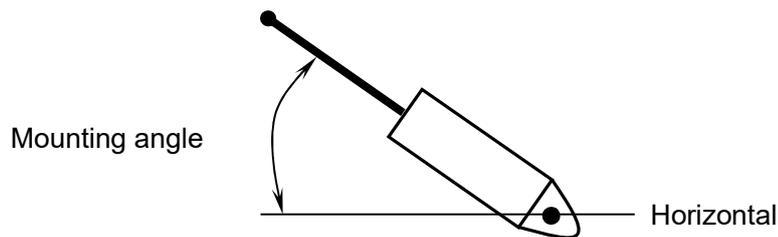
In case of rotating type cylinder, lateral load applies to the piston rod because of dead weight of the cylinder. It needs to be checked, if the lateral load is within the range of safety.

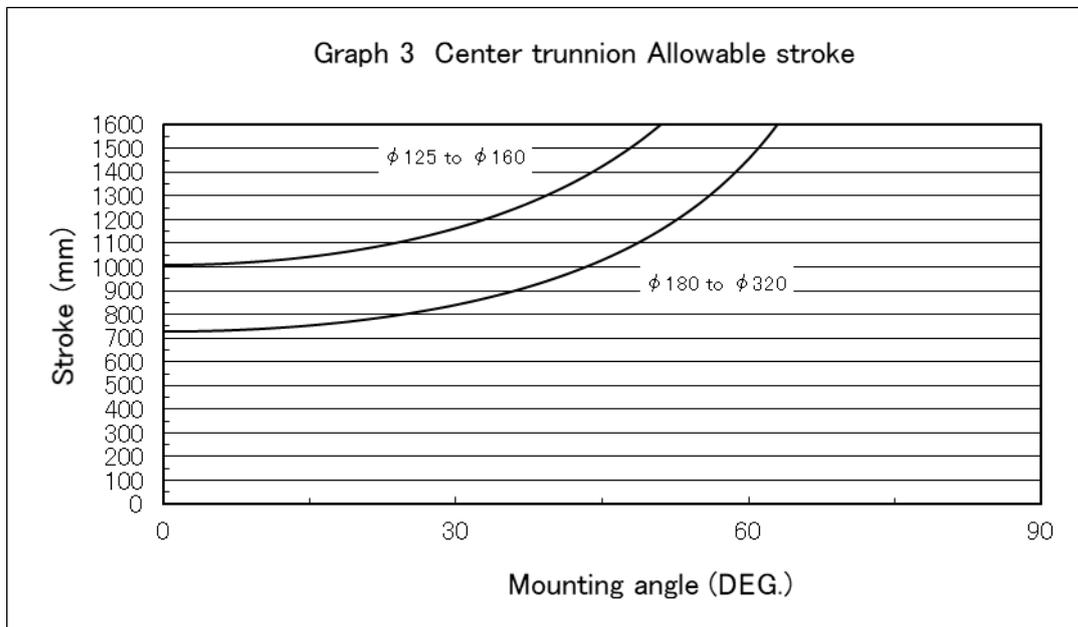
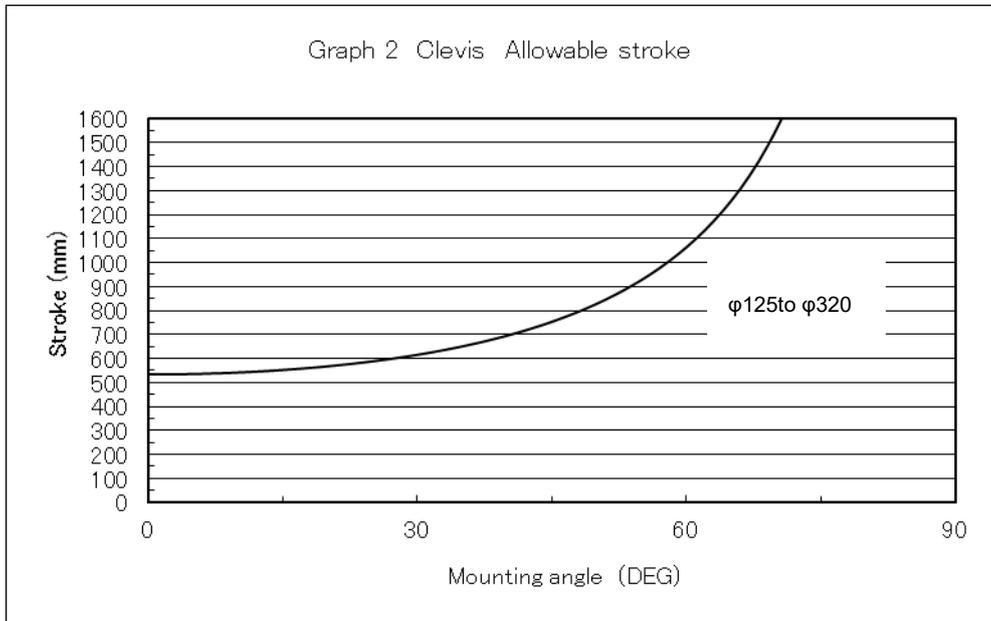
## How to judge

Use graph 2 or 3, either of the one applicable to the mounting bracket and bore size of the cylinder, which are used. Check if the stroke of the cylinder model is smaller than the allowable stroke.

Ex.) CS2D125-450, mounting angle  $0^{\circ}$

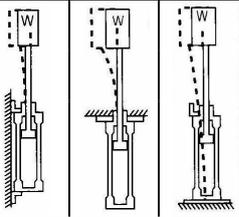
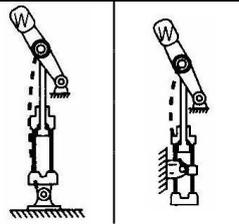
This is clevis type, so use graph 2 and read nodal point of mounting angle  $0^{\circ}$  and curb line, which is stroke approx. 480mm. The cylinder stroke 450mm is smaller than this stroke, therefore it is safe.





- 4) The relation between cylinder size and max. stroke by the mounting style  
 Table 2 shows max. usable stroke found by calculation on the assumption that the force generated by cylinder itself acts on piston rod or piston rod and tube as buckling force.  
 Therefore the max. usable stroke of each cylinder size can be determined according to the relation between high/low of operating pressure and mounting style regardless of load factor.  
 (Reference) Even in the case of light load, when cylinder is stopped by the external stopper on the extended side, max. generated force of cylinder acts on the cylinder itself.

Table 2. Usable stroke by buckling strength

Mounting style			Pressur e (MPa)	Usablestroke by buckling strength (cm)										
Symbol and sketch of bracket		Symbol		ø125	ø140	ø160	ø180	ø200	ø250	ø320				
Foot: L	Rod side Frang e F	Head side flange G	L	0.3	103	92	113	108	124	155	162			
				0.5	79	70	86	81	94	118	122			
			F	0.7	66	58	72	67	78	98	101			
				G	0.3	45	38	47	46	54	67	69		
			0.5		33	27	34	33	39	49	49			
			0.7		26	22	27	26	31	39	39			
						C · D	0.3	96	83	106	102	118	147	152
							0.5	71	61	76	75	88	109	113
T	0.7	59				50	62	61	72	89	92			
	0.3	135				119	147	146	167	208	217			
	0.5	101				89	111	110	127	158	164			
0.7	84	74				91	91	105	131	136				
Foot: L	Rod side Frang e F	Head side flange G	L	0.3	301	267	330	324	370	460	483			
				0.5	231	207	253	248	284	354	371			
			F	0.7	193	172	212	208	239	297	311			
				G	0.3	144	126	156	154	177	220	230		
					0.5	109	94	118	116	134	167	174		
			0.7		90	78	97	96	111	138	144			
Foot: L	Rod side Frang e F	Head side flange G	L	0.3	433	386	476	462	528	655	688			
				0.5	334	297	367	355	406	505	530			
			F	0.7	281	250	309	299	342	425	446			
				G	0.3	210	185	229	223	256	317	332		
					0.5	160	141	175	170	195	242	253		
			0.7		134	117	129	142	163	202	211			

5) Theoretical output



Table 3. Double acting cylinder theoretical output (N)

Bore size(m m)	Rod diameter (mm)	Operating direction	Pressurize d area (mm <sup>2</sup> )	Operating pressure(MPa)			
				0.3	0.5	0.7	0.9
125	32	OUT	12300	3690	6150	8610	11100
		IN	11500	3440	5750	8030	10300
140	32	OUT	15400	4620	7700	10200	13900
		IN	14600	4380	7290	10100	13100
160	38	OUT	20100	6030	10100	14100	18100
		IN	19000	5690	9490	13300	17100
180	40	OUT	25400	7620	12700	17800	—
		IN	24200	7260	12100	16940	—
200	45	OUT	31400	9420	15700	22000	—
		IN	29800	8940	14910	20870	—
250	56	OUT	49100	14700	24600	34400	—
		IN	46600	13980	23310	32630	—
320	65	OUT	80400	24120	40200	56280	—
		IN	77100	23130	38550	53970	—

6) Kinetic energy absorbed by cushion mechanism

Table 4. Kinetic energy absorbed

Bore size (mm)	Effective cushion length (mm)	Absorbable kinetic energy (J)
125	21.0	32.3
140	21.0	44.6
160	21.0	58.8
180	21.0	78.4
200	21.0	98.0
250	22.5	147
320	28.5	265

 Warning

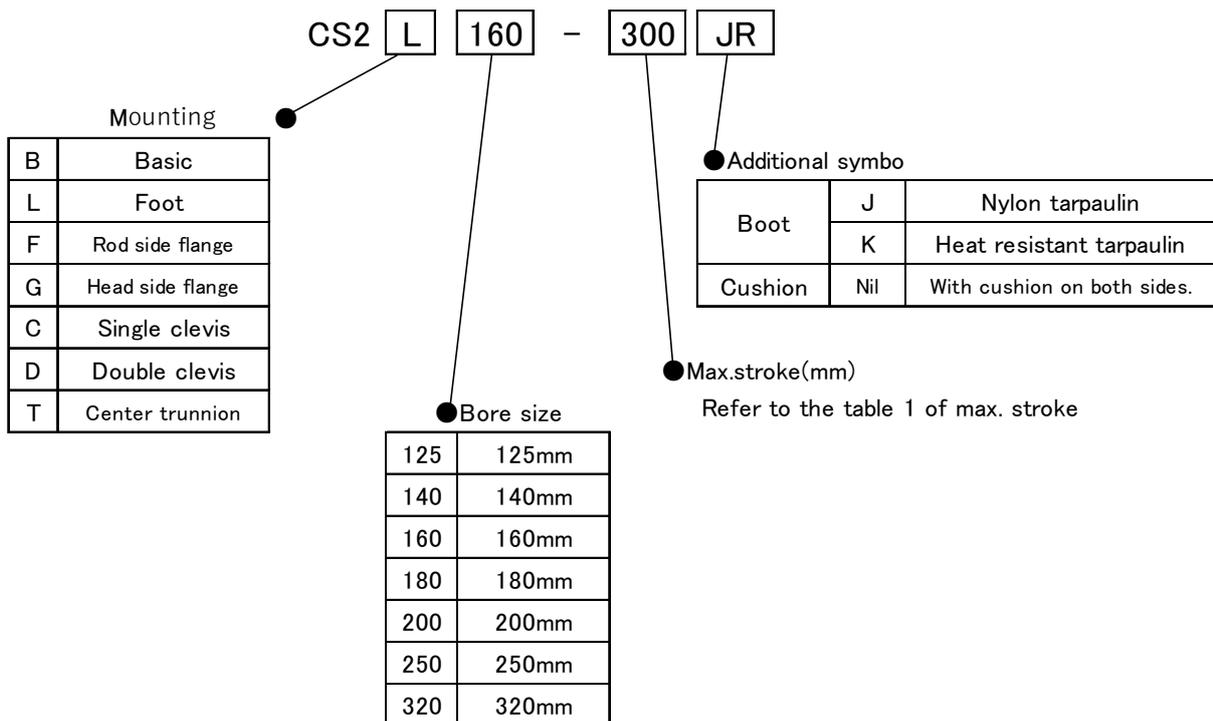
A deceleration circuit or shock absorber may be required. When a driven object is operated at high speed or the load is heavy, a cylinder's cushion will not be sufficient to absorb the shock. Install a deceleration circuit to reduce the speed before cushioning, or install an external shock absorber to relieve the shock. In this case, the rigidity of the machinery should also be examined.

7) Application of 2nd-class pressure vessel regulation due to operating liquid.

Every air cylinder intended for use or mounting in Japan, with the gauge pressure of 0.2 MPa or more and the cylinder internal capacity of 0.04 m<sup>3</sup> and more, or with the cylinder inside diameter of 200 mm dia. or more and the stroke of more than 998 mm falls within the scope of the second class pressure vessel regulations. For air cylinders with a stroke exceeding the values in the table below and falling within the scope of the second class pressure vessel regulations, a product will be available in CS1 series model.

Bore size(mm)	Cylinder stroke(mm)
180	1569
200	998
250	813
320	495

8) How to order



### 3. Mounting · Operation

#### 1) Operating air

Compressed air supplied to the cylinder should be filtered using a SMC filter such as series AF and regulated to the specified set pressure using a regulator such as series AR.

#### Warning

Use clean air.

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

#### Caution

##### 1. Install air filters

Install air filters at the upstream side of valves. The filtration degree should be 5µm or less.

##### 2. Install an air dryer, after cooler, etc.

Air that includes excessive condensate may cause malfunction of valves and of other pneumatic equipment. To prevent this, install an air dryer, after cooler, etc.

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

Take measures to prevent freezing, since moisture in circuits will be frozen under 5°C, and this may cause damage to seals and lead to malfunction. Refer to SMC's "Air Cleaning Equipment" catalog for further details on compressed air quality.

#### 2) Precautions on design

#### Warning

##### 1. There is a possibility of dangerous sudden action by air cylinders if sliding parts of machinery are twisted due to external forces, etc.

In such cases, human injury may occur, e.g., by catching hands or feet in the machinery, or damage to the machinery itself may occur. Therefore, the machine should be designed with consideration to accomplish smooth operation and to prevent damage to human body.

##### 2. Use a protective cover to minimize the risk of personal injury.

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

3. Securely tighten all stationary parts and connected parts so that they will not become loose.  
When a cylinder operates with high frequency or a cylinder is installed where there is a lot of vibration, ensure that all parts remain secure.
4. Don't use a cylinder as an air damper (buffer).  
Compressed air could cause sudden extension or damage the human body or machines.
5. Design a system to prevent a cylinder from being given by the external force exceeding the max. output.  
Otherwise cylinder may break and human body and equipment are damaged.
6. Make sure that a mounting base is rigid enough to withstand large force generated by cylinder.  
Otherwise it may result in human injury or equipment damage.
7. Consider a possible drop in operating pressure due to power outage, etc.  
When a cylinder is used in a clamping mechanism, there is a danger of work dropping if there is a drop in circuit pressure caused by a power outage, etc. Therefore, safety equipment should be installed to prevent damage to machinery and human injury. Suspension mechanisms and lifting devices also require consideration for drop prevention.
8. Consider a possible loss of power source.  
Measures should be taken to protect against human injury and equipment damage in the event that there is a loss of power to equipment controlled by air pressure, electricity or hydraulics, etc.
9. Design circuitry to prevent sudden lurching of driven objects.  
When a cylinder is driven by an exhaust center directional control valve or when starting up after residual pressure is exhausted from the circuit, etc., the piston and its driven object will lurch at high speed if pressure is applied to one side of the cylinder because of the absence of air pressure inside the cylinder. Therefore, equipment should be selected and circuits designed to prevent sudden lurching, because there is a danger of human injury and/or damage to equipment when this occurs.
10. Consider emergency stops.  
Design so that human injury and/or damage to machinery and equipment will not be caused when machinery is stopped by a safety device under abnormal conditions, a power outage or a manual emergency stop.
11. Consider the action when operation is restarted after an emergency stop or abnormal stop.  
Design the machinery so that human injury or equipment damage will not occur upon restart of operation. When the cylinder has to be reset at the starting position, install manual safety equipment.
12. Intermediate stops  
When intermediate stopping of a cylinder piston is performed with a 3 position closed center type directional control valve, it is difficult to achieve stopping positions as accurate and minute as with hydraulic pressure, due to the compressibility of air. Furthermore, since valves and cylinders, etc. are not guaranteed for zero air leakage, it may not be possible to hold a stopped position for an extended period of time. Contact SMC in case it is necessary to hold a stopped position for an extended period.

## Caution

1. Operate within the limits of the maximum usable stroke.  
Refer to the selection procedures for the air cylinder to be used for the maximum usable stroke.
2. Operate the piston within a range such that collision damage will not occur at the end of the stroke.  
Operate within a range such that damage will not occur when the piston having inertial force stops by striking the cover at the stroke end. Refer to the cylinder type selection procedure for the range within which damage will not occur.
3. Use a speed controller to adjust the cylinder drive speed, gradually increasing from a low speed to the desired speed setting.
4. Provide an intermediate support for a cylinder with a long stroke.  
If the cylinder has a long stroke, provide an intermediate support to prevent the rod from sagging and the tube from flexing, as well as to prevent damage to the rod due to vibrations or external loads.
5. When a clearance between clevis or trunnion and bearing is large, bending load acts on the pin.
6. Prevent foreign matters such as cutting chip from entering inside of cylinder from the suction port.

### 3) Mounting

## Caution

1. Make sure to connect the rod and the load so that their axial center and movement directions match.  
If they do not match, stress could be applied to the rod and the tube, causing the inner surface of the tube, the bushing, the rod surface, and the seals to wear and to become damaged.
2. When an external guide is used, connect the external slider and the load in such a way that there is no interference at any point within the stroke.
3. Do not scratch or gouge the sliding portion of the cylinder tube or the piston rod by striking it with an object, or squeezing it.  
The tube bore is manufactured under precise tolerances. Thus, even a slight deformation could lead to a malfunction. Furthermore, any scratches or gouges on the sliding portion of the piston rod could damage the seals, which could lead to air leakage.
4. Prevent the rotating parts from seizing.  
Apply grease to the rotating parts (such as the pin) to prevent them from seizing.
5. Don't use until you verify that the equipment can operate properly.  
After mounting, repair or modification, etc., connect the air supply and electric power, and then confirm proper mounting by means of appropriate function and leak inspections.

6. Prevent foreign matter such as cutting chips from entering the cylinder through its supply port.

Cutting chips from mounting hole drilling may go into the supply port of a cylinder placed underneath when the cylinder is installed in the job site.

7. When boots is mounted, be careful not to be wrenched.
8. Knuckle joint Mounting

When mounting a knuckle joint to the piston rod end with the rod end nut, consult with SMC first.

9. Refrain from attaching adhesive tape or padding on the painting surface of the mounting brackets.

Keep in mind that the painting on the mounting brackets can sometimes peel when adhesive tape is attached or padding is put on the painted surface, since it has been air-dried.

#### 4) Operating environment

##### Warning

1. Do not use in environments where there is a danger of corrosion.  
Refer to the construction drawings regarding cylinder materials.
2. In dirty areas such as dusty locations or where water, oil, etc. splash on the equipment, take suitable protective measures.  
When cylinder is operated in dusty areas, use a strong scraper (-XC4) type.
3. Do not use in environments or locations where the equipment is exposed to cleaning solvent, etc. and oil film on rod may be washed away.  
Seals may break due to insufficient lubrication, causing air leakage.
4. Do not store cylinders in humid places.  
Humid environment should be avoided when storing cylinders. Before storing cylinder, be sure to retract its piston rod in a low humid place to avoid rust generation.

## 5) Piping

Figure 1 is a basic circuit when operating a cylinder with air filter, regulator, solenoid valve and speed controller.

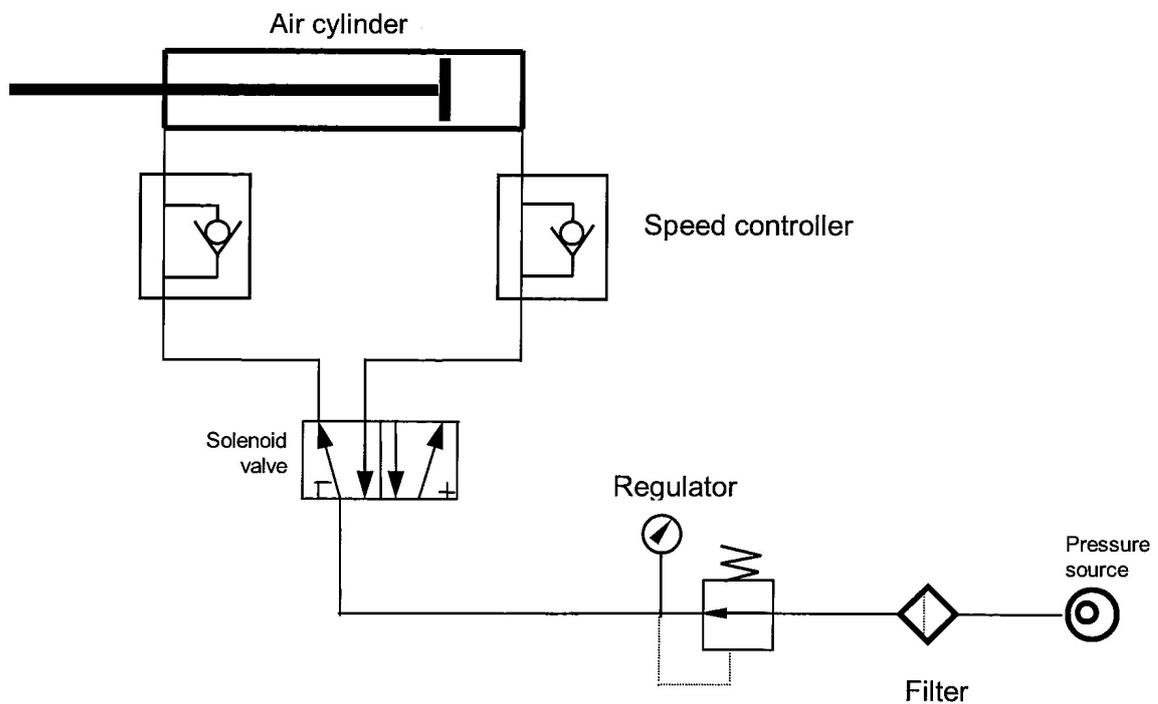


Figure 1

### Caution

#### 1. Precaution before piping

Before piping is connected, it should be thoroughly blown out with air (flushing) or washed to remove cutting chips, cutting oil and other debris from inside the pipe.

#### 2. Wrapping of pipe tape

When connecting pipes and fittings, etc., be certain that cutting chips from the pipe threads and sealing material do not get inside the piping. Also, when pipe tape is used, leave 1.5 to 2 thread ridges exposed at the end of the pipe/ fitting.

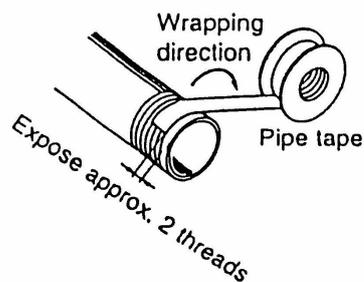


Figure 2

### 3. Screwing of fitting

When screwing the fitting into the port, tighten by the following appropriate torque.

### 6) Cushion

#### Warning

1. A deceleration circuit or shock absorber, etc., may be required.

When a driven object is operated at high speeds or the load is heavy, a cylinder's cushion will not be sufficient to absorb the shock. Install a deceleration circuit to reduce the speed before cushioning, or install an external shock absorber to relieve the shock. In this case, the rigidity of the machinery should also be examined.

2. Do not turn the cushion valve to a position beyond the allowable rotation limit.

The cushion valve has been retained by a retaining ring or staking to prevent falling off. However, never turn the cushion valve to a position beyond the allowable rotation limit.

If air is supplied for operation with a wrongly turned valve not found out, the cushion valve can suddenly pop out from beneath the cover.

The allowable rotation limit is the number of rotation of the cushion valve required to move the valve from the position where the orifice is fully closed to where it is fully opened.

No. of allowable rotation

Bore size(mm)	No. of allowable rotation
125, 140, 160	5 turns
180, 200, 250, 320	6 turns

3. Ensure to use an air cushion at cylinder stroke end.

Table 5 Tighten torque of piping

Port size	Tightening torque N.m
Rc 1/2,NPT 1/2	28~30
Rc3/4,NPT3/4	28~30
Rc1,NPT1	36~38

## Caution

### 1. Readjust with the cushion needle.

The cushion has been adjusted at the time of shipment. However, before operating the actuator, readjust the cushion needle that is provided on the cover, according to the size of the load and the operating speed. Turn the cushion needle clockwise to restrict the flow, which increases the cushioning effect. Occasional readjustment is required as the cushion seal gets worn and the function becomes dull after operating a long period of time.

### 2. Do not operate the actuator with the cushion needle fully closed.

This could damage the seals (excluding the cushion).

### 3. If the cushion valve is fully closed throughout operation, the piston may bounce at the stroke end, not move full stroke, or the cushion seal may be damaged due to excessive pressure. Therefore, do not use the cushion cover in such manner.

### 4. Use hexagon wrench key to adjust the cushion valve. Size of width across flats is 4 which is standard by JIS B 4648.

## 7) Speed control

When controlling the cylinder speed, install SMC's speed controller, Series AS, on the position near to the supply port for air and control the cylinder speed to the specified speed. When using a speed controller to control the speed, there are two cases such as restricting the air supplied to the cylinder and restricting the air exhausted from the cylinder. Usually, a speed controller is used for the latter case.

## Caution

Use a speed controller to adjust the cylinder drive speed, gradually increasing from a low speed to the desired speed setting.

## 8) Direction control

When changing the operating direction of cylinder, choose the most suitable solenoid valve among SMC's solenoid valve variation.

### Warning

1. Design circuitry to prevent sudden lurching of driven objects.

When a cylinder is driven by an exhaust center type directional control valve or when starting up after residual pressure is exhausted from the circuit, etc., the piston and its driven object will lurch at high speed if pressure is applied to one side of the cylinder because of the absence of air pressure inside the cylinder. Therefore, equipment should be selected and circuits designed to prevent sudden lurching, because there is a danger of human injury and/or damage to equipment when this occurs.

2. Intermediate stops

When intermediate stopping of a cylinder piston is performed with a 3 position closed center type directional control valve, it is difficult to achieve stopping positions as accurate and minute as with hydraulic pressure, due to the compressibility of air. Furthermore, since valves and cylinders, etc. are not guaranteed for zero air leakage, it may not be possible to hold a stopped position for an extended period of time. Contact SMC in case it is necessary to hold a stopped position for an extended period.

## 4. Maintenance

### 1) Inspection

#### Daily inspection

1. Check the cylinder for smooth operation.
2. Check the cylinder for change of piston speed and cycle time.
3. Check the cylinder for abnormal stroke

#### Regular inspection

1. Check the cylinder mounting bolt and nut for loose.
2. Check the cylinder mounting flange for loose or abnormal deflection.
3. Check the cylinder for smooth operation.
4. Check the cylinder for change of piston speed and cycle time.
5. External leakage
6. Check the rod end bracket, tie rod, bolt for loose.
7. Check the cylinder for abnormal stroke.
8. Check the rod for damage
9. Check the air filter for implementation of periodic drain.

If you find any abnormalities after above checks, give additional tightening and take corrective action.

#### Warning

1. Maintenance should be done according to the procedure indicated in the operating manual. If handled improperly, malfunction and damage of machinery or equipment may occur.
2. Machine maintenance, and supply and exhaust of compressed air. when machinery is serviced, first check measures to prevent dropping of driven objects and run-away of equipment, etc. Then cut off the supply pressure and electric power, and exhaust all compressed air from the system. When machinery is restarted, check that operation is normal with actuators in the proper positions.
3. Use full care not to get your fingers smashed between parts during disassembly and reassembly since the machine body and each of its parts are very heavy.

## 2) Overhaul

When abnormality is found by regular inspection, following portions should be inspected and take corrective action. However, seal kits should be replaced.

Table 6. Portion to be inspected, abnormality and corrective action

Portion to be inspected	Abnormality	Corrective action
1. Inside surface of tube  Sliding face of rod	Shallow scratches caused by sliding	No problem with operation. Rub them with paper, etc. slightly.
	Deep scratches Caused by sliding	Replace it with new one when it can't be repaired.
	Scratches caused by seizing	Replace with new one.
	Stripping	Replace with new one.
2. Inside surface of bushing	Shallow scratches caused by sliding	No problem with operation. Rub them with paper, etc. slightly.
	Partial thickness : 0.2 mm or more	Replace the rod cover assembly with new one. Check for abnormal partial thickness and if you find it, remove it.
	Crack in bushing	Same as above.
3. Piston surface	Shallow scratches caused by sliding	No problem for operation. Rub them with paper, etc. slightly.
	Deep flaws or scratches	Replace the piston rod assembly with new one when it can't be repaired. Check the inside of cylinder and piping for existence of foreign matters.
	Crack in piston	Replace the piston rod assembly with new one.
	Abnormal abrasion in piston	Check the piston rod for abnormal side load and remove the factor. Replace the piston rod assembly with new one.
4. Connection between piston and rod	Looseness	Replace the piston rod assembly with new one.
	Crack	Check the portion for a large inertia force and remove the factor. Replace the piston rod assembly with new one.
5. Others		Check the flame and the mounting portion for welding crack, abnormal abrasion, etc. If abnormality is found, replace the portion.

### Caution

For  $\Phi 180$  to  $\Phi 250$ , the construction of the piston rod and rod end thread does not allow for the product to be reassembled if the piston rod is completely removed from the rod cover.

If the rod cover is removed, or if the rod cover assembly or piston rod assembly needs to be replaced, it will be repaired at SMC factory.

When the piston rod diameter and rod end thread are different, then the rod seal can be replaced along with the other seals at the customer site, please refer to Table 9 for confirmation of what seals are included in the seal kits for each bore size.

### 3) Disassembly

1. Disassembly should be done in a wide space containing little dust.
2. After removing the cylinder, be sure to protect the end of piping port and rubber hose on the machine side with clean waste to prevent dust from entering.
3. Disassemble the unit with care to prevent damage to the sliding portion.
4. Check the double chamfered portion at the rod end for burrs to prevent damage to the seal and the bushing when removing the cover (push plate) from the piston rod. If burrs are found, remove them with a "file".
5. Loose either of nuts for tie rod with "ratchet handle for socket wrench", "T-type slide handle for socket wrench" or "spinner handle for socket wrench", etc. and remove it from the tie rod. Please refer to the table 7 for "socket for socket wrench".

Table.7 Socket

Tube bore size	Nut	Applicable socket
125·140	Class1, M14×1.5	JISB4636 Dodecagon 22
160	Class1, M16×1.5	JISB4636 Dodecagon 24
180	Class1, M18×1.5	JISB4636 Dodecagon 27
200	Class1, M20×1.5	JISB4636 Dodecagon 30
250	Class1, M24×1.5	JISB4636 Dodecagon 36
320	Class1, M30×1.5	JISB4636 Dodecagon 46

6. Remove 4 tie rods from cover.
7. Remove the push plate (rod cover) from the piston rod with care to prevent damage to the seal and bushing.
8. Pull the piston rod and pull out the piston from the cylinder tube.
9. Remove the cylinder tube from the head cover.
10. Disassembly of the rod cover (For the head cover, it should also be in accordance with this procedure.)
  - a. Remove the cylinder tube gasket. When excessive deformation or cut is found with the gasket, replace it.
  - b. Pick out the rod seal with a small flat blade driver carefully not to damage seal and rod cover.
  - c. Remove the cushion seal from the cover by using a small flat blade driver carefully not to damage seal and rod cover. ( $\Phi$  125 to  $\Phi$  200 only)  
※  $\phi$  180 and  $\phi$  200 can be replaced only on the head cover side.
  - d. The bushing or cushion packing ( $\phi$ 250, $\phi$ 320) is hard to remove since it has been press-fitted into the rod cover or the head cover. Even if it is removed, the interference required for reassembly will become diminished in it. When it should be replaced with a new one, replace the rod cover assembly or the head cover assembly as a unit.

※The rod cover assembly for  $\phi 180$  to  $\phi 250$  are not replaceable.

If you want to replace the rod cover assembly, return it to the factory for repair.

#### 4) Assembly

1. Before assembling cylinder, be sure to clean each part to remove dust.
2. Before assembling, apply rod, bushing, tube and seal with enough grease.
3. For rusty part, remove the rust completely.
4. Assembly should be done in a clean place with care to prevent foreign matters from entering.
5. Mount seal with care to prevent damage to it.
6. Insert piston into tube or rod into bushing with care to prevent damage to each seal.
7. When trunnion bracket is used, mount so that rod cover and trunnion becomes parallel.
8. When foot bracket is used, mount it so that the distance between the bottom face of the foot bracket and the center of the piston rod becomes minimum. (See the figure 3.)

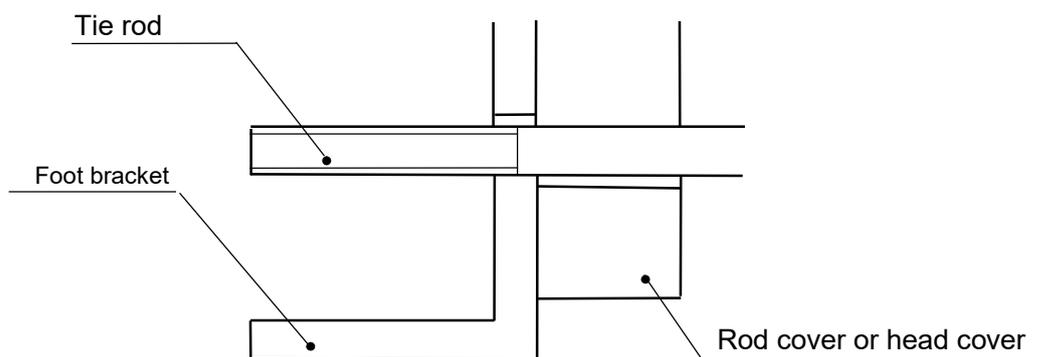


Figure 3

9. Tighten tie rod and bolt with appropriate torque shown in the table 8.

Table 8. Tightening torque (N·m)

Bore size	$\phi 125$	$\phi 140$	$\phi 160$	$\phi 180$	$\phi 200$	$\phi 250$	$\phi 320$
Tightening torque	39.2		62.8	85.0	118.0	165.0	405.0



#### Warning

Take care not to deform the cushion ring during disassembly and reassembly. When the cushion ring is hit against something during disassembly and reassembly, the air cushion will not function well.

5) Expendable supplies

1. Part No. and seal kits are as follows.

**CS2-**  **A-PS**

\_\_\_\_\_ Tube bore size

Table 9. Seal kits

Name	Qty			
	ø125,140,160	ø180,200	ø250	ø320
Rod seal	1	-	-	1
Piston seal	1	1	1	1
Cylinder tube gasket	2	2	2	2
Cushion seal	2	1	-	-
Scraper	-	-	-	1
Grease pack (10g)	-	1	-	-
Grease pack (20g)	2	2	3	3

Seal kits or individual seal unit supplied from SMC is not packed in sealed up condition. Therefore it should be used within one year. When it is needed to be stored for a long period of time, it should be sealed up following the method shown below;

Sealed up condition: A condition which kits are sealed up with a polyethylene bag, then put into a box.

2. Store method of seal

- a. Seal kits should be packed in sealed up condition and stored.
- b. When removing a part of the seal kits, pack the remained items again so that the package condition will be restored to its former state as much as possible with care to protect them from foreign matters. Don't store the remained items without sealing.
- c. Store seal kits in environment in low temperature and low humid avoiding direct sunlight.
- d. Install seal kits isolating from the equipment generating heat, radiation and ozone and protect them so that they are not affected by them.
- e. Don't pile up many seal units or put heavy thing on it to prevent them from being deformed or being damaged.
- f. White powder generated on rubber material in storage does not influence the sealing performance.

## 6) Replacement procedure of seal

### 1. Dismantling of seal

Please refer to “3) Disassembly” for dismantling of rod seal, cushion seal and tube gasket.

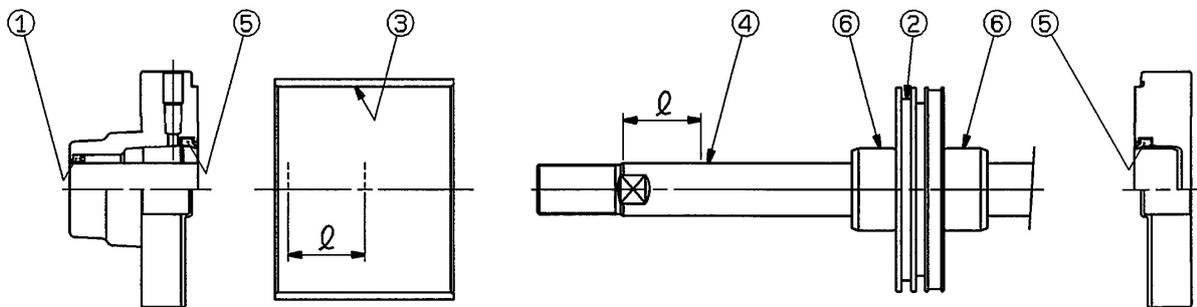
Since piston seal has a deep groove for sealing, use your hand (not a screw driver) and push from one side of seal and pull it out when it lifts off.

### 2. Grease

a. Seal kits : Apply thin coat of grease.

b. Cylinder component

Apply grease to the individual component, shown in the table 10. The following amount is needed per one 100 stroke cylinder.



$$l = \frac{\text{STROKE}}{2} \text{ or } 100\text{mm and more}$$

Table 10. Grease apply amount( g )

	ø125	ø140	ø160	ø180	ø200	ø250	ø320	Portion to apply
100st	15~17	20~22	24~26	27~29	30~32	33~35	36~38	①~⑥
50st Up	3	3	3	4	4	5	5	③④

For grease, use lithium soap group grease JIS #2

### 3. Mounting seal

a. Cushion seal/Rod seal /Scraper

Mount in correct direction. N

b. Seal kits (O-ring) other than Rod seal , Cushion seal and scraper

After mounting seal kit, apply grease on inside diameter surfaces of bushing (rubbing grease into surface).

## 7) Inspection

1. Follow the procedure of the table 11 for inspection after assembly.

Table 11. Inspection items

Items to be inspected		Criteria and test method	Criteria	Remarks
1	Dimension	Measure dimensions of main parts	As per drawing, catalog and specifications.	
2	Appearance	1.Finish of each part should be good. Check each part for harmful scratches, cracks and other defects. 2.Each part should be painted and coated completely. Check each part for stripping.	No defect shall be observed by view.	
3	Airtight test	Supply air pressure of 0.7~0.7Mpa and 0.05MPa from head side and rod side by turns and hold for 20 sec.	Shall not have any deformation and leakage should be $6.42 \times 10^{-4} \text{m}^3/\text{h}$ (ANR) or less.	
4	Operation test under no load state	After performing running-in 1~2 times, install cylinder horizontally in no load state and supply air pressure of 0.05MPa from head side and rod side of cylinder by turns and repeat full stroke process more than 1 time.	Piston shall move smoothly without stopping during the process.	For cylinders with a built in cushion mechanism, perform this process in the full open state of cushion valve.
5	Cushion test	Fully open cushion valve in no load state and supply air pressure of 0.7MPa and 0.05MPa from head side and rod side of cylinder by turns.	Shall not operate cushion valve within 3 sec.	
6	Internal Leakage test	Leave cylinder in a static state and supply air pressure of 0.7MPa and 0.05MPa from head side and rod side by turns.	Leakage from port shall be $38.52 \times 10^{-4} \text{m}^3/\text{h}$ (ANR) or less.	
7	Indication	Label	No defects shall be observed by view.	

## 5. Troubleshooting

Table 12. Troubleshooting

Failure	Main cause	Measure
1. Operation is not smooth.	1. Improper lubrication	<ul style="list-style-type: none"> <li>● Disassemble and apply applicable grease (lithiumsoap group grease JIS #2 )</li> </ul>
	2. Rod deformation	<ul style="list-style-type: none"> <li>● Rod deformation is caused by offset load, side load, over load, abnormal displacement of mounting position, etc.</li> <li>Replace the piston rod assembly and correct the abnormal load, position, etc.</li> </ul>
	3. Insufficient air pressure	<ul style="list-style-type: none"> <li>● Supply appropriate pressure.</li> </ul>
	4. Too slow operation	<ul style="list-style-type: none"> <li>● Even a little change of external condition may influence the speed in low speed operation. In such case, please consider to use air hydro or hydro checker.</li> <li>● Change the cylinder to the one with larger bore size.</li> </ul>
2. Output is decreasing.	1. Abrasion and damage in piston seal	<ul style="list-style-type: none"> <li>● Replace the seal.</li> </ul>
	2. Decrease in air pressure	<ul style="list-style-type: none"> <li>● Check the pressure and the capacity of the pressure source.</li> </ul>
	3. Insufficient air flow	<ul style="list-style-type: none"> <li>● Resistance in passage might be increased due to deformation of air flow passage and mixing of foreign matters. Repair and clean it.</li> </ul>
	4. Improper mounting position of cylinder	<ul style="list-style-type: none"> <li>● Mount the cylinder on a proper position.</li> </ul>
	5. Deformation of cylinder moving part	<ul style="list-style-type: none"> <li>● Cylinder is deformed by abnormal load, which increases sliding resistance. Overhaul should be performed and the piston rod assembly should be replaced.</li> </ul>
	6. Improper lubrication	<ul style="list-style-type: none"> <li>● Disassemble and apply applicable grease (lithiumsoap group grease JIS #2 )</li> </ul>
3. Piston operates too fast.	1. Speed controller is not used.	<ul style="list-style-type: none"> <li>● Use a speed controller which is suitable to the cylinder size.</li> </ul>
	2. Incapability of fine adjustment with the speed controller	<ul style="list-style-type: none"> <li>● Select a speed controller adequate to secure the required operating speed by referring to the flow characteristics curves.</li> </ul>
	3. Meter-in speed controller is used.	<ul style="list-style-type: none"> <li>● To obtain stable speed even if load fluctuates, use meter-out speed controller.</li> </ul>

Failure	Main cause	Measure
4. Piston operates too slow.	1. Directional control valve size of too small.	●Use larger valve.
	2. Resistance of the equipment used for piping is too large.	● Use appropriate size valve and other equipment. Pay extreme attention to the size of piping material and fitting. ● Use appropriate size equipment and piping on the exhaust side.
5. Cylinder stops operating occasionally.	1. Due to crawling operation	● Crawling operation may create a condition generating little pressure difference between supply side and exhaust side inside the cylinder, which lowers the seal effect, causing malfunction. Be sure to operate the cylinder within the operating speed range.
	2. Defective equipment other than cylinder	●Inspect each portion of all system one by one.
6. The length of cylinder stroke is changing.	1. Abnormal air cushion	● There are some cases where exhaust can't be performed due to foreign matters clogged in needle, So disassemble and clean it.
	2. Piston is filled with drain and lubricant.	Disassemble, clean and apply applicable grease (lithiumsoap group grease JIS #2 )
7. Cylinder stops operating.	1. Defective connection between piston and piston rod	● Replace the piston rod assembly.
	2. Breakage of piston seal	● This failure can be noticed by constant exhaust from exhausting port of valve. In this case, replace the piston seal.
	3. Defective equipment other than cylinder	●Inspect each portion of all system one by one.
	4. Insufficient air pressure	●Supply appropriate air pressure.
	5. Insufficient lubricant	●Refer to 1-1(Operation is not smooth.) (Disassemble and apply applicable grease.)
8. Cushion does not work.	1. Speed is too fast.	● Operation at high speed lowers the pressure on the exhaust side of cylinder, causing insufficient cushion performance. Cylinder should be operated within the high speed limit range.
	2. Load is too large.	● Operate the cylinder within the range allowing the cushion to absorb the kinetic energy of moving object. Or provide external cushion mechanism separately.

Failure	Main cause	Measure
9. Deformation and breakage of piston rod	1. Speed is too fast.	● Operation at high speed may deform or damage the piston rod due to impact force. Operate the cylinder within the high speed limit range.
	2. Unadjusted cushion	● Generation of impulsive sound at the stroke end should be avoided. In such case, adjust the cushion.
	3. Abnormal external force	● Mechanism interference, offset load and over load may deform or damage the cylinder. Eliminate these factors.
	4. Buckling	● Insufficient buckling of cylinder may cause buckling of rod. Appropriate cylinder should be selected.
10. Cylinder speed can not be controlled by speed controller	1. Unappropriate speed controller was elected.	● Use an appropriate speed controller whose size is suitable to the desired speed.
	2. Defective speed controller	● Replace it.
11. Cylinder in operation sticks and slips.	1. Cylinder speed is too slow.	● Use air hydro, hydro checker, etc. when using cylinder at less than the operating speed limit range.
	2. No cylinder force is left.	● Even a little change in external force may influence the speed and smooth operation can not be obtained. Provide extra cylinder force.
	3. Meter-out circuit is not used.	● Since meter-in circuit may cause unstable operation when the cylinder is operated at low pressure and low speed, adjust the speed with meter-out circuit.
12. Cylinder operates suddenly after stopping its operation for a long period of time.	1. There is a difference in the pressure remained in the cylinder between continuous operation and operation after stopping long period of time.	● When cylinder is stopped in halfway of stroke with center close type 3 position valve, it is normal that a little amount of air leaks outside from the inside of cylinder. Although there will be no large difference in pressure remained inside the cylinder when the cylinder is restarted in a short period of time, the cylinder operates suddenly after stopping a long period of time due to decrease in pressure remained inside the cylinder, which eliminates the operation resistance. In this case, consider to use a valve which prevents sudden extension of cylinder .

## 6. Construction

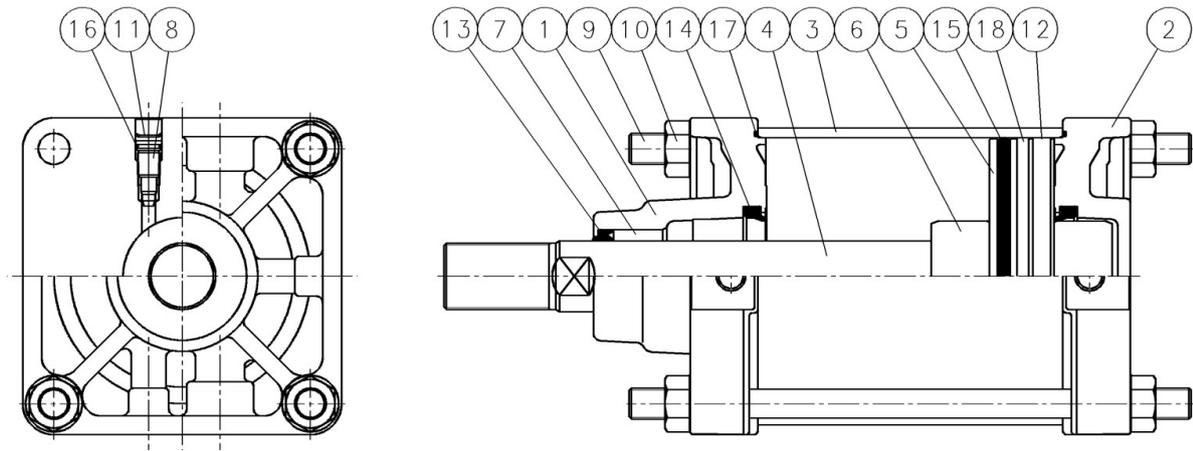


Figure-4  $\varnothing 125$  to  $\varnothing 160$

Table. 13 Parts list

No.	Name	Qty
1	Rod cover	1
2	Head cover	1
3	Cylinder tube	1
4	Piston rod	1
5	Piston	1
6	Cushion ring	2
7	Bushing	1
8	Cushion valve	2
9	Tie rod	4
10	Tie rod nut	4
11	Snap ring	2
12	Wear ring	1
13	Rod seal	1
14	Cushion seal	2
15	Piston seal	1
16	Cushion valve seal	2
17	Cylinder tube gasket	2
18	Magnet	(1)

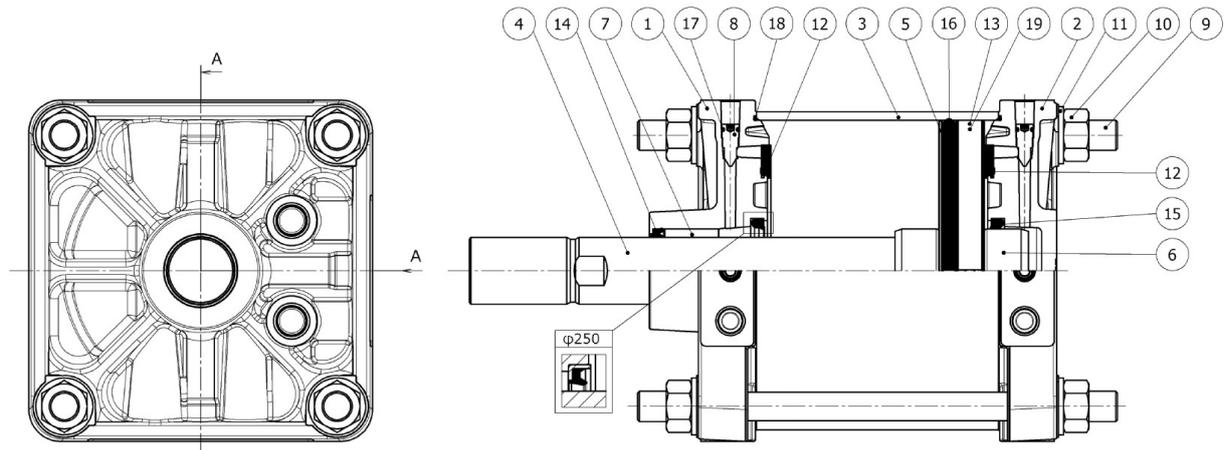


Figure-5  $\varnothing 180$  to  $\varnothing 250$

Table.14 Parts list

No.	Name	Qty
1	Rod cover	1
2	Head cover	1
3	Cylinder tube	1
4	Piston rod	1
5	Piston	1
6	Cushion ring	2
7	Bushing	1
8	Cushion valve	2
9	Tie rod	4
10	Hexagon nut	8
11	Plain washer	8
12	Bumper	2
13	Wear ring	1
14	Rod seal	1
15	Cushion seal	2
16	Piston seal	1
17	Cushion valve seal	2
18	Cylinder tube gasket	2
19	Magnet	(1)

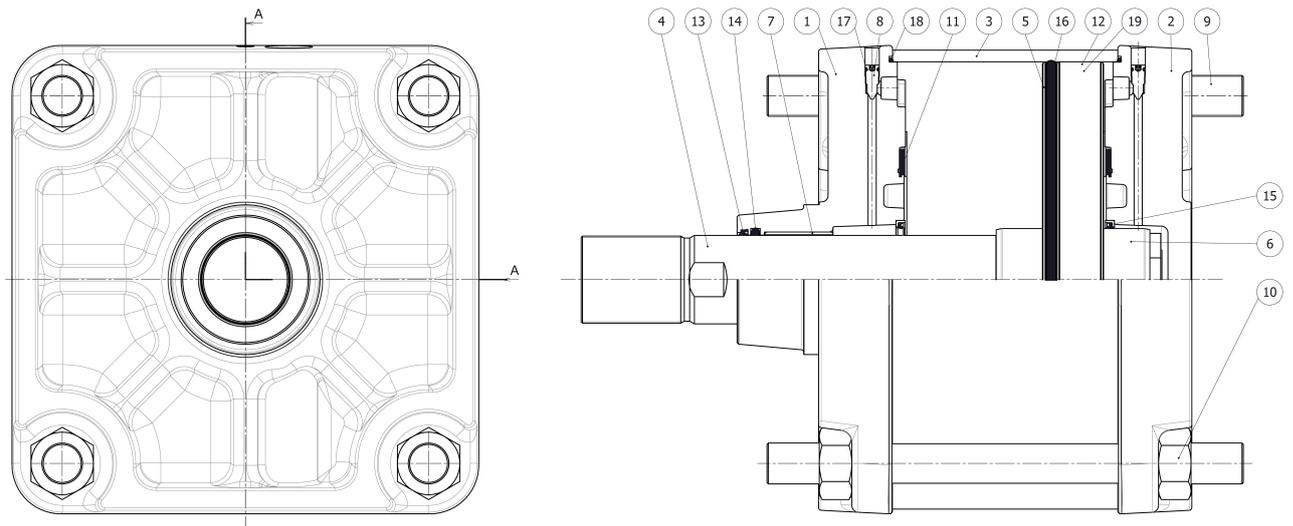


Figure-6 ø320

Table.15 Parts list

No.	Name	Qty
1	Rod cover	1
2	Head cover	1
3	Cylinder tube	1
4	Piston rod	1
5	Piston	1
6	Cushion ring	2
7	Bushing	1
8	Cushion valve	2
9	Tie rod	4
10	Hexagon nut	8
11	Bumper	2
12	Wear ring	1
13	Scraper	1
14	Rod seal	1
15	Cushion seal	2
16	Piston seal	1
17	Cushion valve seal	2
18	Cylinder tube gasket	2
19	Magnet	(1)

#### Revision history

- B** Revise by adding  $\phi$  180 to  $\phi$  320.
- C** 4.2) Added note to overhaul.
- D** Content of seal kit are changed.

## SMC Corporation

4-14-1, Sotokanda, Chiyoda-ku, Tokyo 101-0021 JAPAN

Tel: + 81 3 5207 8249 Fax: +81 3 5298 5362

URL <https://www.smcworld.com>