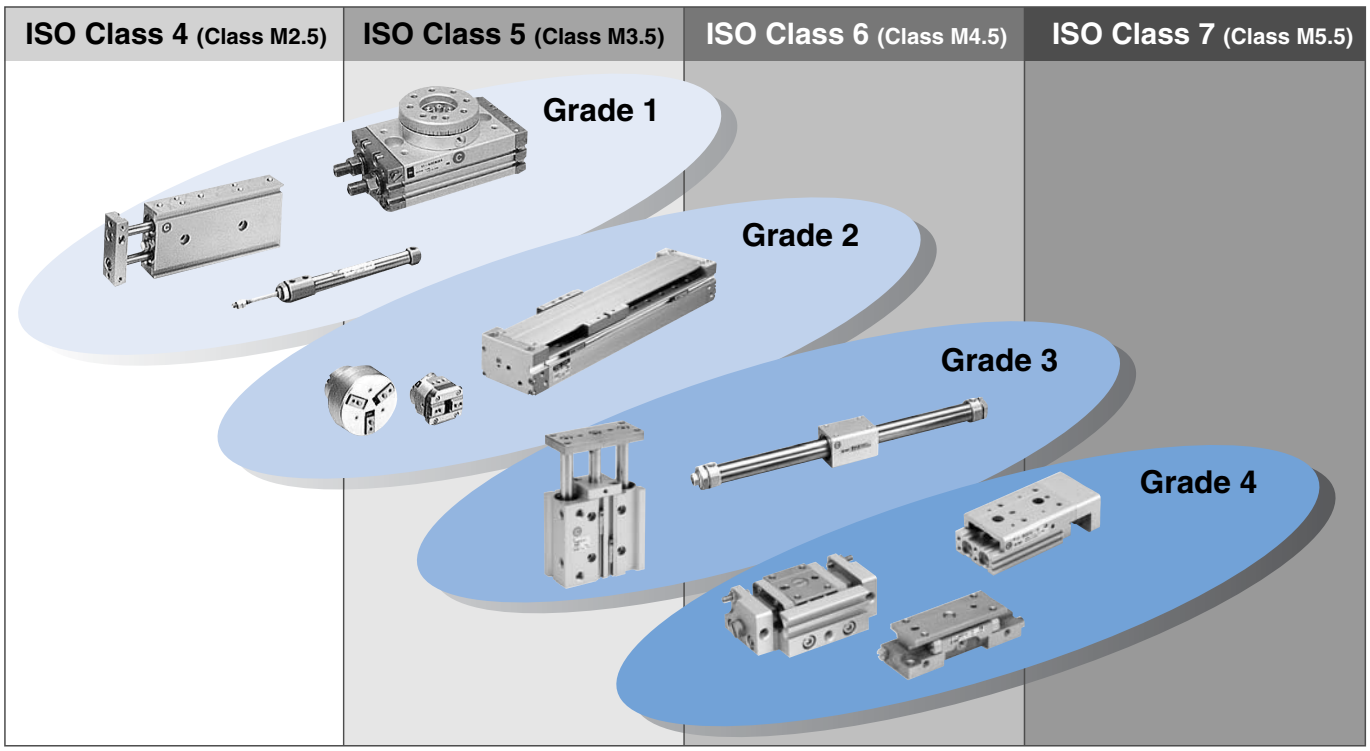
SMC Pneumatics Equipment for Clean Room

SMC pneumatics equipment for clean room undergoes particle generation testing, and is divided into particle generation levels (Grade 1 to 4). Equipment can be selected based on the cleanliness class of the clean room.



The above table is a simulated image only. For details on the particle generation grade of each equipment, refer to back pages 11 through to 20. Figures in parentheses indicate for reference the cleanliness grade according to Fed.Std.209E (abolished in Nov. 2001).

Clean Series *10-/11-/12-/13- series*

Suitable for a clean environment.
Prevents particle generation in a clean room.

Applicable equipment

Actuators (Cylinders, Rotary actuators, Air grippers), Directional control equipment, Flow control equipment, Filters, Pressure control equipment, Fittings/Tubings, Air preparation equipment, Pressure switches

Note) The 11-, 12-, and 13-series are only applicable to actuators.

Special Clean Series

Adheres to an even higher standard of cleanliness than the Clean Series.
The development of this line of products, from structure and materials to assembly environment, are all determined for clean environment use.

Applicable equipment

Clean rodless cylinders, Clean regulators, Clean one-touch fittings, Clean tubings, Clean gas filters, Clean air filters

Copper, Fluorine, Silicon-free, Low-particle Generation *21-/22- series*

Suitable for environments where the presence of copper, fluorine or silicon materials is restricted.
Structures are identical to the Clean Series (Grease and packaging are different from the Clean Series.)

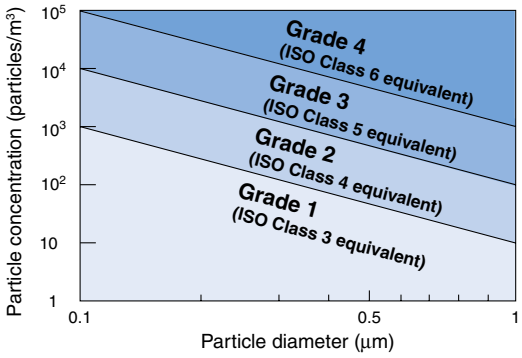
Applicable equipment

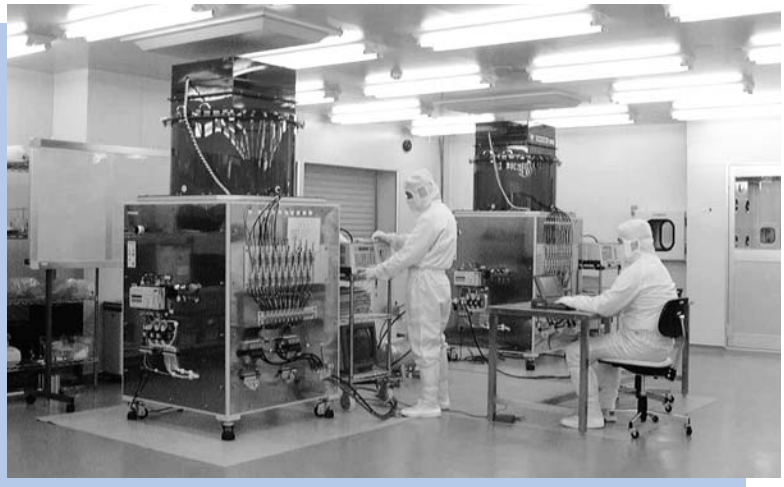
Actuators (Cylinders, Rotary actuators, Air grippers), Directional control valves, Flow control equipment, Pressure control equipment, Fittings

Note) The 22- series is only applicable to actuators.

Back page 4

Particle Generation Grade Classification





Cleanliness Grade (Reference)

SMC	Fed.Std.209E Note) SI unit	ISO 14644-1
Grade 1	M1.5	ISO Class 3
Grade 2	M2.5	ISO Class 4
Grade 3	M3.5	ISO Class 5
Grade 4	M4.5	ISO Class 6
	M5.5	ISO Class 7
	M6.5	ISO Class 8

Note) Fed.Std.209E was abolished in Nov. 2001, so these figures are for reference only.

Grading is based on SMC's original system of designation, with a lower grade number indicating a smaller volume of particle generation.
The information in parentheses indicates the upper limit of concentration for the cleanliness classes based on ISO 14644-1.

(Refer to back page 21 "Particle Generation Measuring Method" and back page 22 "Comparison of Cleanliness Standards".)

Note) In case of the one-touch fitting 10-KQ (that includes built-in one-touch fitting solenoid valve manifolds, and speed controllers with one-touch fittings), changes in internal pressure may cause the collet chuck to slide very slightly. This may result in particle generation, so please avoid using this item in Grade 1 or Grade 2 areas. However, there is no need for similar caution in the case of insert fittings (KF), miniature fittings (M/MS), clean one-touch fittings (KP/KPQ/KPG), or speed controllers with clean one-touch fittings (AS-FPQ/FPG).

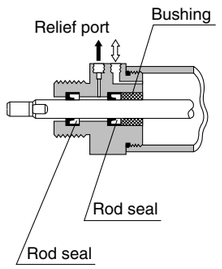
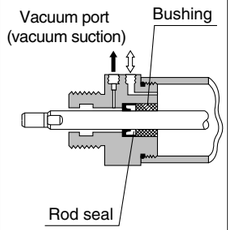
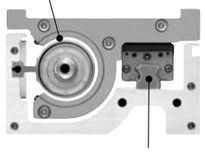
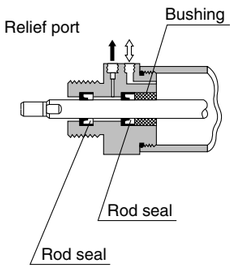
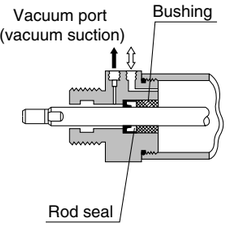
Dust is kept from the clean room.

- **After inspection, the product is blown with high purity air (of ISO Class 5 equivalent clean bench) in a clean environment.**
- **Products are sealed and shipped in anti-static double bags.**

10-/11-/12-/13- (Clean Series)	Assembled item in clean room (Special Clean Series)
Assembly and inspection in a standard workshop ↓ Clean room ISO Class 8 equivalent Surface wiped with alcohol (to remove oil) ↓ Clean room ISO Class 8 equivalent Clean booth ISO Class 5 equivalent Interior packed after blowing surface with clean air (anti-static electricity measures) ↓ Clean room ISO Class 8 equivalent Exterior packed (Double packing) ↓ Shipping	Clean booth ISO Class 5 equivalent Clean bench ISO Class 5 equivalent in Clean room ISO Class 7 equivalent Parts washed ↓ Assembly/Inspection ↓ Double packing ↓ Shipping

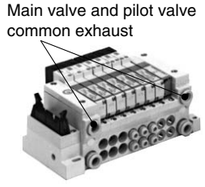
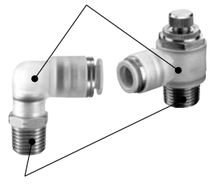
The **21- and 22-series** are given standard packaging (assembly, inspection, packing, and shipping carried out in a standard workshop.) Contact SMC for clean packaging.

Basic Specifications of Actuators

	10-series	11-series	12-series		13-series	Special clean series	21-series	22-series
Construction	· **Double seal type / release to atmosphere**  	· **Single seal type / vacuum suction**  	· **Guide cylinder** · **Dual rod cylinder** Double seal type / release to atmosphere (10-series equivalent) and specially treated Ball bushing guide Linear guide	· **Rodless cylinder** Specially treated cylinder tube exterior Cylinder tube		· **Guide cylinder** · **Air slide table** Single seal type / vacuum suction (11-series equivalent) and specially treated guide Ball bushing guide Linear guide	· **Clean rodless cylinder** No contact between the cylinder tube exterior and the slider interior  Linear guide Special treatment	· **Double seal type / release to atmosphere**  	· **Single seal type / vacuum suction** 
Restricted material	None					None	Copper, fluorine and silicon-free	
Grease	Fluorine grease					Fluorine grease	Lithium soap base grease	
Assembly environment	General environment (assembly and inspection in a workshop)					Parts are washed and assembled in a clean room.	General environment (assembly and inspection in a workshop)	
Packaging	Clean packaging: Products are sealed in antistatic double bags after blow to the surface with clean air.						Standard packaging Note)	

Note) Contact SMC for clean packaging.

Basic Specifications of Other Equipment

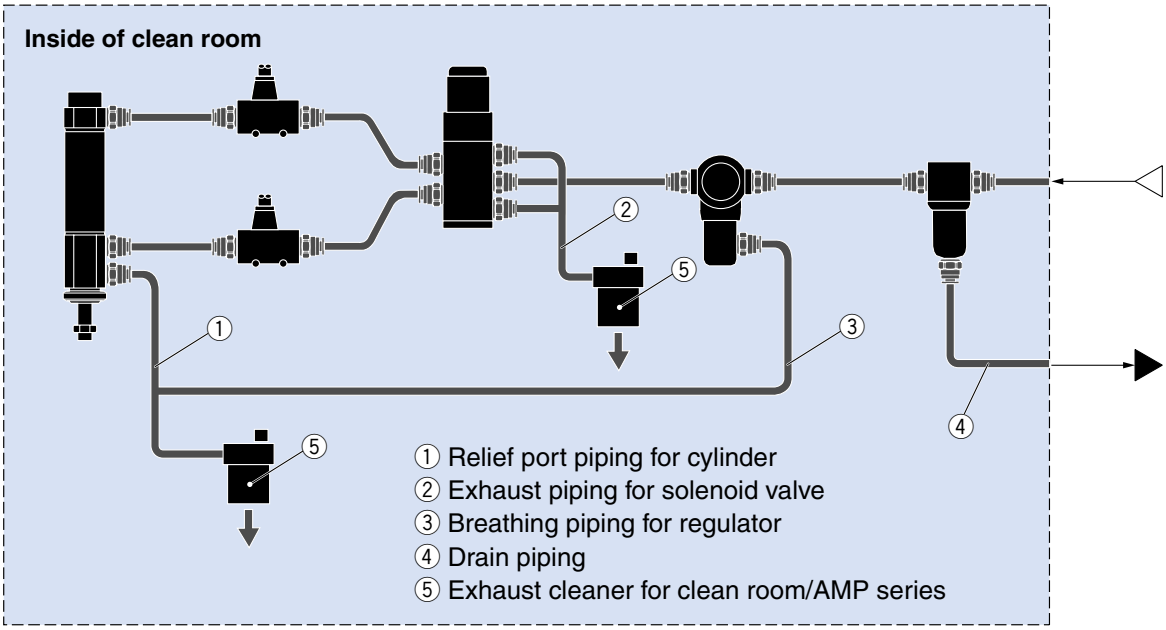
	10-series		Special clean series					21-series	
Construction	· **Directional control valve** Main valve and pilot valve common exhaust  · **Pressure control equipment** Relief port With fitting in bleed port	· **Air filter** Drain guide With female thread Fitting, speed controller, pressure switch, etc. have the same structure as those of standard.	· **Clean regulator** All wetted parts are made of stainless steel, FPM and PTFE, and exterior metal parts are made of anodized aluminum, which provides high corrosion resistance. 	· **Clean one-touch fittings (for blow)** Wetted parts non-metal Polypropylene resin · **Clean tubing** Polyolefin-based resin		· **Clean one-touch fittings** (for driving system air piping) · **Clean speed controller** Polypropylene resin  Metal parts Brass (Electroless nickel plated) or Stainless steel 304	· **Exhaust cleaner for clean room** · **Clean gas filter** **PTFE membrane element** · **Clean air filter** **Polyolefin hollow fiber membrane element** 	· **Directional control valve** · **Pressure control equipment** The same construction as the 10- series	· **Clean one-touch fittings** (for driving system air piping) · **Clean speed controller** No sealant on thread parts * UNI thread is also applicable. (Made to Order)
Restricted material	None					None		Copper, fluorine and silicon-free	
Grease	Fluorine grease		——	——		Fluorine grease	——	Lithium soap base grease	
Assembly environment	General environment (assembly and inspection in a workshop)		Parts are washed and assembled in a clean room.					General environment (assembly and inspection in a workshop)	Parts are washed and assembled in a clean room.
Packaging	Clean packaging: Products are sealed in antistatic double bags after giving blow to the surface with clean air.							Standard packaging Note)	

Note) Contact SMC for clean packaging.

System Circuit in Clean Room

Following are the actuator driving system and circuit configuration of blow system employed to reduce particle generation when using pneumatic equipment in a clean room.

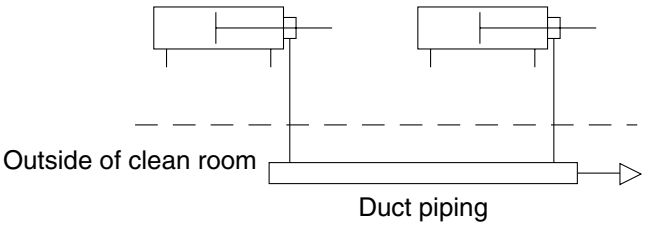
● Actuator Driving System



● Cylinder Relief Port Piping

10-/12-/21-series (Atmospheric release type)

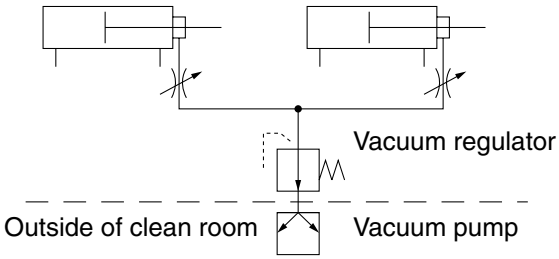
Connect the relief port piping with the dedicated duct piping installed outside the clean room or with the exhaust cleaner for clean room/AMP series.



11-/13-/22-series (Vacuum suction type)

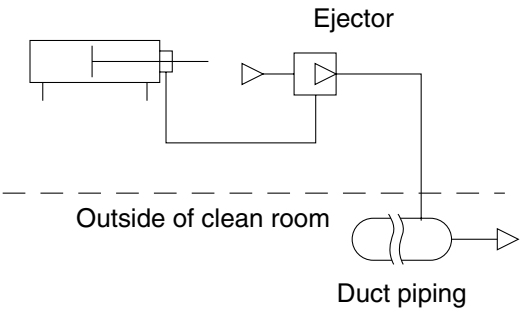
With a vacuum pump

When several air cylinders are used together or a model with high vacuum suction flow is used.



With an ejector

When a few air cylinders are locally used.



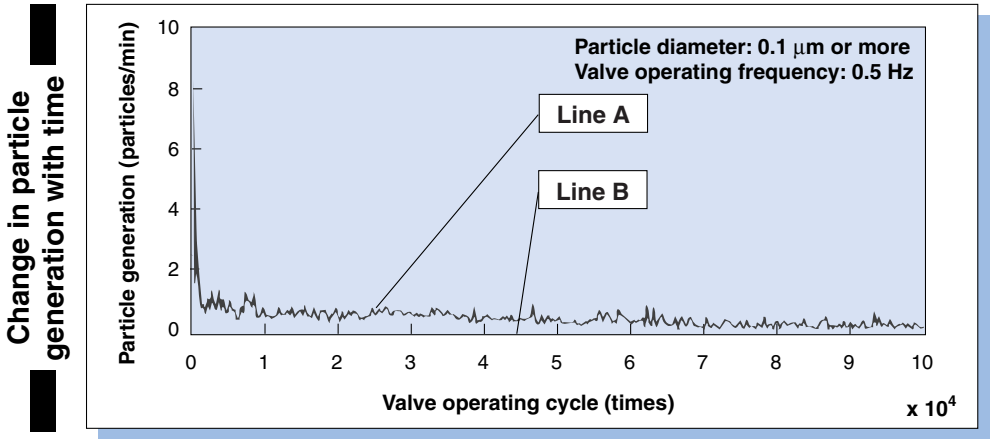
● Clean Blow System

Example of equipment to suit each clean blow grade

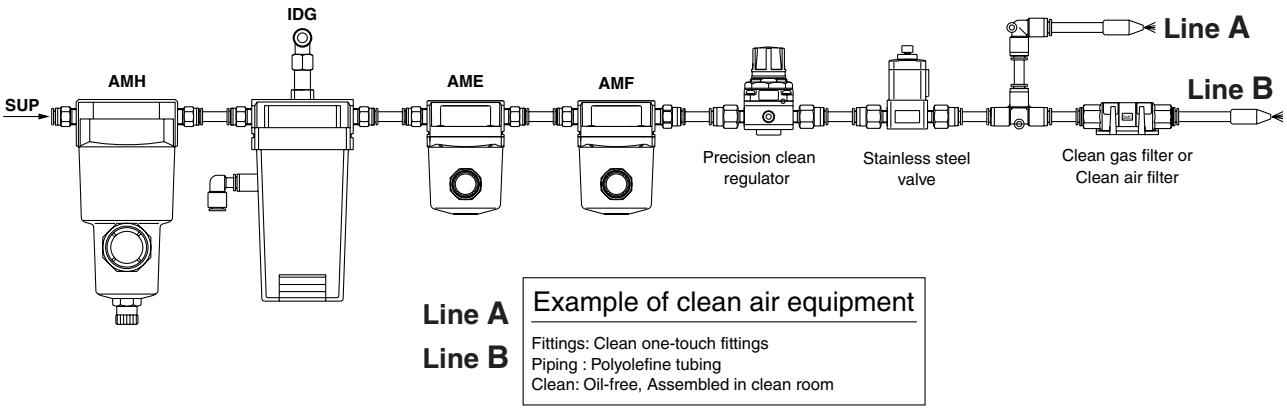
Line A: For clean blow

Line B: For clean blow (with clean gas filter, or with clean air filter)

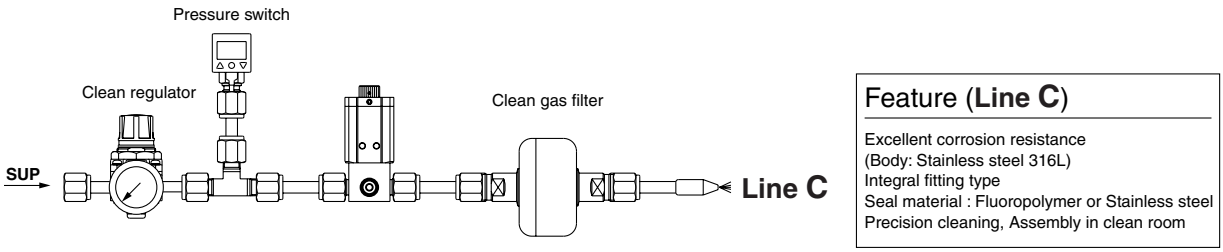
Line C: For N_2 blow



● Example of Air Line Equipment



● Example of N_2 Equipment

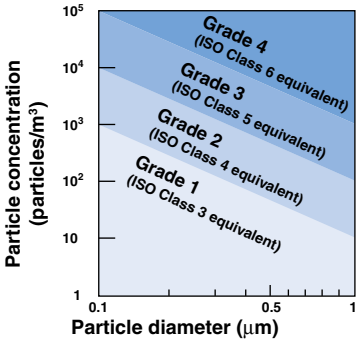


How to Use Clean Series

The position of the pneumatic equipment to the workpiece is determined by the particle generation degree.

Particle generation grade no. of the pneumatic equipment ≦ **Particle concentration grade no. around the workpiece**

Particle Generation Grade Classification



Grading is based on SMC's original system of designation, with a lower grade number indicating a smaller volume of particle generation. The information in parentheses indicates the upper limit of concentration for the cleanliness classes based on ISO 14644-1.

(For further details, refer to back page 21 "Particle Generation Measuring Method" and back page 22 "Comparison of Cleanliness Standards".)

Note) In case of the one-touch fitting 10-KQ (that includes built-in one-touch fitting solenoid valve manifolds, and speed controllers with one-touch fittings), changes in internal pressure may cause the collet chuck to slide very slightly. This may result in particle generation, so please avoid using this item in Grade 1 or Grade 2 areas. However, there is no need for similar caution in the case of insert fittings (KF), miniature fittings (M/MS), clean one-touch fittings (KP/KPQ/KPG), or speed controllers with clean one-touch fittings (AS-FPQ/FPG).

Cleanliness Grade (Reference)

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Grade 1	M1.5	ISO Class 3
Grade 2	M2.5	ISO Class 4
Grade 3	M3.5	ISO Class 5
Grade 4	M4.5	ISO Class 6
—	M5.5	ISO Class 7
—	M6.5	ISO Class 8

Note) Fed.Std.209E was abolished in Nov. 2001, so these figures are for reference only.

Selection Procedure

① Required clean room cleanliness? ····· ISO Class 4 or ISO Class 5 or ISO Class 6?

↓

② Air flow to the workpiece? (Refer to Diagram 1.) ····· Diagram 1: Air flow

↓

③ Where is the pneumatic equipment located? (Refer to Diagram 2.)

↓

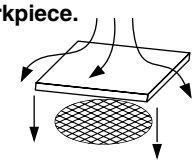
④ Determine the particle concentration grade no. around the workpiece based on above ① to ③. (Refer to Table 1.)

↓

⑤ Select the equipment to be used. (Refer to back pages 11 through to 20.)

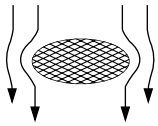
Diagram 1: Air flow

Workpiece A
The air flow is blocked before it reaches the workpiece.



Workpiece B
Convection currents are frequently generated around the workpiece.

Workpiece C
The air flows freely.



Workpiece D
The air is sucked under the workpiece.

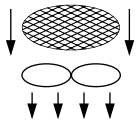


Diagram 2: Installation location of equipment

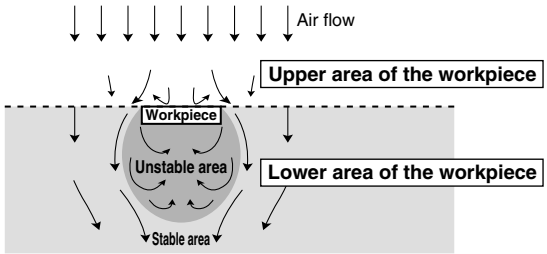


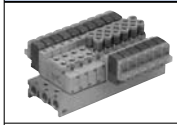
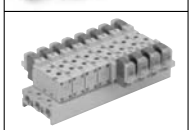
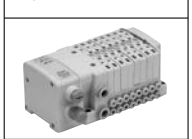
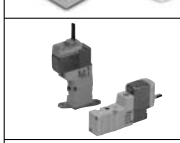
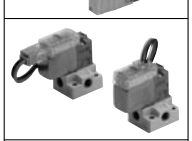
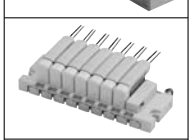
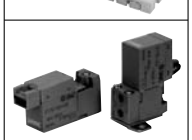
Table 1: Particle Concentration Grade around the Workpiece

② Workpiece		A, B			C			D		
③ Position of the equipment to be used		Upper area of the workpiece	Lower area of the workpiece: Unstable area	Lower area of the workpiece: Stable area	Upper area of the workpiece	Lower area of the workpiece: Unstable area	Lower area of the workpiece: Stable area	Upper area of the workpiece	Lower area of the workpiece: Unstable area	Lower area of the workpiece: Stable area
① Cleanliness	ISO Class 4				Grade 1		Grade 2	Grade 1	Grade 2	
	ISO Class 5					Grade 2	Grade 3			Grade 3
	ISO Class 6	Grade 1	Grade 2	Grade 3	Grade 2	Grade 3	Grade 4	Grade 2	Grade 3	Grade 4

▨: ISO Class 4 and 5 levels of cleanliness cannot be achieved in area due to dust accumulation or flotation.

Particle Generation Grade

Directional Control Valves

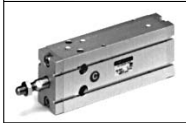
Description		Series	Particle generation grade by series		
			Standard	10-	21-
	5 port solenoid valve	10-SY3000/5000/7000/9000	3	1	
		10-SV1000/2000/3000/4000	3	1	
		10-SYJ3000/5000/7000	3	1	
		10-SZ3000	3	1	
		10-/21-S0700	3	1	1
		10-/21-VQ1000/2000	3	1	1
		10-/21-SQ1000/2000	3	1	1
		10-VQD1000	3	1	
	3 port solenoid valve	10-SYJ300/500/700	3	1	
		10-V100	3	1	
		10-/21-S070	3	1	1
		10-SY100	3	1	
		10-/21-VQ100	3	1	1

Note) Particle generation grades apply to threaded port connection type.
Different grades apply to the one-touch fittings. For details, refer to back page 10.

Values in ▒ show grades.
No grade applies to blanks.

Particle Generation Grade

Cylinders

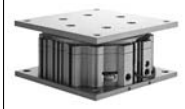
Description			Series	Particle generation grade by series						
				Standard	10-	11-	12-	13-	21-	22-
	Air cylinder	Standard	10-/11-/21-/22- CJ2	3	2	1			2	1
		Double rod	10-/11-/21-/22- CJ2W							
		Direct mount type	10-/11-/21-/22- CJ2RA							
	Air cylinder	Standard	10-/11-/21-/22- CM2	3	2	1			3	1
		Double rod	10-/11-/21-/22- CM2W							
		Direct mount type	10-/11-/21-/22- CM2R							
		End lock (Except rod side)	10-/11-/21-/22- CBM2							
	Air cylinder	Standard	10-/11-/21-/22- CG1	3	2	1			3	1
		Double rod	10-/11-/21-/22- CG1W							
		Direct mount type	10-/11-/21-/22- CG1R							
	Air cylinder Standard		10-/11-/21-/22- CA2	3	2	1			3	1
	Mini free mount cylinder		10-/11- CUJ	3	2	1				
	Free mount cylinder		10-/11-/21-/22- CDU	3	2	1			3	1
	Compact cylinder		10-/11-/21-/22- CQS	3	2	1			2	1
			10-/11-/21-/22- CQ2	3	2	1			2	1
	Low speed cylinder		10-/11- CQSX	3	2	1				
			10-/11- CQ2X	3	2	1				
			10-/11- CM2X	3	2	1				
	Rodless cylinder Basic type		12-CY3B	4			3			

Values in ▒ show grades.
No grade applies to blanks.

ⓑ Back page 12

Particle Generation Grade

Cylinders

Description		Series	Particle generation grade by series						
			Standard	10-	11-	12-	13-	21-	22-
	Rodless cylinder Direct mount type	12-CY3R	4			3			
	Clean rodless cylinder	CYP	2						
	Air slide table	13- 22- MXS	—				Note 1) 3,4		Note 1) 3,4
		13- 22- MXQ							
	Air slide table	11- 22- MXJ	—		Note 1) 3, 4				Note 1) 3,4
	Air slide table	11- 22- MXP	—		Note 1) 1, 2, 4				Note 1) 1,2,4
		11- 22- MXPJ6	—		1				1
	Compact guide cylinder	12-/13- 21-/22- MGPL	4			3	2	4	3
	Guide table	10-MGF	4	2					
	Dual rod cylinder	11-/12- 21-/22- CXSJ	3, 4		1	Note 2) 2		Note 2) 3	Note 2) 1
		10-/11-/12- 21-/22- CXS	3, 4	2	1	Note 2) 2		Note 2) 3	Note 2) 1
	Sine rodless cylinder	12-REA	4			3			
	Sine cylinder	10- 11- REC	3	2	1				

Note 1) The grade is different depending on the type of the adjuster option.
Note 2) The 12-, 21-, 22-series are only available for ball bushing bearing (CXSL/CXSJL).

Values in ▒ show grades.
No grade applies to blanks.

MXQ

Option	13-	22-
Without adjuster	3	
Rubber stopper		
Metal stopper	4	

MXP

Option	11-	22-
Without adjuster	1	
Rubber stopper	2	
Metal stopper	4	

The MXP6 without adjuster is not available.

MXJ

Option	11-	22-
Without adjuster	3	
Metal stopper	4	

CXSJ

Model	Bearing type	Standard
CXSJL	Ball bushing bearing	3
CXSJM	Slide bearing	4

CXS

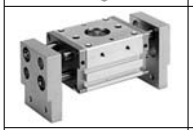
Model	Bearing type	Standard
CXSL	Ball bushing bearing	3
CXSM	Slide bearing	4

Particle Generation Grade

Rotary Actuators

Description			Series	Particle generation grade by series						
				Standard	10-	11-	12-	13-	21-	22-
	Rotary actuator	Vane	10-, 21- CRB1	4	2				2	
		Rack & pinion	11-CRA1	3		2				
	Rotary table		11-, 22- MSQ	3		1				1

Air Grippers

Description			Series	Particle generation grade by series						
				Standard	10-	11-	12-	13-	21-	22-
	Air gripper 2 fingers		11-, 22- MHZ2	—		2				2
	Wide opening parallel type air gripper 2 fingers		11-, 22- MHL2	—		2				2
	Rotary actuated air gripper	2 fingers	11-, 22- MHR2	—		1				1
		3 fingers	11-, 22- MHR3	—		1				1

Values in ▒ show grades.
☐ No grade applies to blanks.

Particle Generation Grade

Air Preparation Equipment

Description		Series	Particle generation grade	
			Standard	10-
	Membrane air dryer	10-IDG1	3	1
		10-IDG3 to 100	3	1
		10-IDG3H to 100H	3	1
		10-IDG30L to 100L	3	1
		10-IDG60S to 100S	3	1
	Main line filter	10-AFF2C to 22C 10-AFF37B, 75B	3	1
	Mist separator	10-AM150C to 550C 10-AM650, 850	3	1
	Micro mist separator	10-AMD150C to 550C 10-AMD650, 850	3	1
	Micro mist separator with pre-filter	10-AMH150C to 550C 10-AMH650, 850	3	1
	Super mist separator	10-AME150C to 550C 10-AME650, 850	3	1
	Odor removal filter	10-AMF150C to 550C 10-AMF650, 850	3	1
	Exhaust cleaner for clean room	AMP220 to 420	1	—

Values in ▒ show grades.
No grade applies to blanks.

Particle Generation Grade

Clean Gas Filters

Description		Series	Particle generation grade
			Standard
	Clean gas filter Cartridge type	**SFA100/200/300**	**1**
	Clean gas filter Cartridge type	**SFB100**	**1**
	Clean gas strainer Cartridge type	**SFB200**	**1**
	Clean gas filter Disposable type	**SFB300**	**1**
	Clean gas filter Disposable type	**SFC100**	**1**

Clean Air Filters

Description		Series	Particle generation grade
			Standard
	Clean air filter Disposable type	**SFD100**	**1**
	Clean air filter Cartridge type	**SFD101/102**	**1**
	Clean air filter Cartridge type	**SFD200**	**1**

Values in ▒ show grades.

Particle Generation Grade

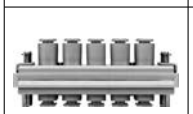
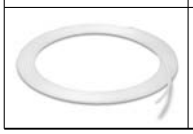
Filters and Pressure Control Equipment

Description		Series	Particle generation grade by series		
			Standard	10-	21-
	Air filter	10-/21- AF20 to 60	3	1	1
	Mist separator	10-/21- AFM20 to 40	3	1	1
	Micro mist separator	10-/21- AFD20 to 40	3	1	1
	Regulator	10-/21- AR20 to 60	3	1	1
	Regulator with back flow mechanism	10-/21- AR20K to 60K	3	1	1
	Filter regulator	10-/21- AW20 to 60	3	1	1
	Filter regulator with back flow mechanism	10-/21- AW20K to 60K	3	1	1
	Mist separator regulator	10-/21- AWM20 to 40	3	1	1
	Micro mist separator regulator	10-/21- AWD20 to 40	3	1	1
	Direct operated precision regulator	10-/21- ARP20 to 40	3	1	1
	Direct operated precision regulator with backflow function	10-/21- ARP20K to 40K	3	1	1
	Precision regulator	10-IR1000 to 3000	—	—	
	Vacuum regulator	10-IRV10, 20	—	1	
	Clean regulator	SRH3000/4000	1		
	Precision clean regulator	SRP1000	3		

Values in ▒ show grades.
No grade applies to blanks.

Particle Generation Grade

Fittings & Tubing

Description			Series	Particle generation grade by series		
				Standard	10-	21-
	One-touch mini		10-KJ	4	3	
	One-touch fittings		10-KQ	4	3	
	Insert fittings		10-KF	3	1	
	Miniature fittings		10-M	3	1	
	Rectangular multi-connector		10-KDM	4	3	
	Stainless steel one-touch fittings		10-KG	4	3	
	Stainless steel miniature fittings		10-MS	3	1	
	Clean one-touch fittings	For blow	KP	1		
		For driving system air piping	(21-)KPQ	1		1
			(21-)KPG	1		1
	Polyurethane tubing		10-TU	3	1	
	Polyurethane coil tubing		10-TCU	3	1	
	Polyurethane flat tubing		10-TFU	3	1	
	Clean tubing	Polyolefin	TPH	1		
		Soft polyolefin	TPS	1		

Values in ▒ show grades.
□ No grade applies to blanks.

Particle Generation Grade

Flow Control Equipment

Description		Series	Particle generation grade by series		
			Standard	10-	21-
	Speed controller Elbow type/Universal type	**10-AS-F**	4	3	
	Speed controller In-line type	**10-AS-F**	4	3	
	Dual speed controller	**10-ASD**	4	3	
	Stainless steel speed controller Elbow type/Universal type	**10-AS-FG**	4	3	
	Stainless steel speed controller In-line type	**10-AS-FG**	4	3	
	Stainless steel dual speed controller	**10-ASD-FG**	4	3	
	Clean speed controller	**(21-)AS-FPQ**	1		1
		(21-)AS-FPG	1		1
	Speed controller for low speed operation Elbow type/Universal type	**10-AS-FM**	4	3	
	Speed controller for low speed operation In-line type	**10-AS-FM**	4	3	
	Dual speed controller for low speed operation	**10-ASD-FM**	4	3	
	Metal body speed controller Elbow type	**10-AS12□0 to 42□0**	3	1	
	Metal body speed controller In-line type	**10-AS1000 to 5000**	3	1	

Values in ▒ show grades.
☐ No grade applies to blanks.

Particle Generation Grade

Pressure Switches

Description			Series	Particle generation grade	
				Standard	10-
	2-color display high-precision digital pressure switch		10-ZSE/ISE30	3	2
	High-precision digital pressure switch		10-ZSE/ISE40	3	2
	High-precision digital pressure switch for general fluids		10-ZSE/ISE50	3	2
			10-ZSE/ISE60	3	2
	Remote type pressure sensor	For compact pneumatics	10-PSE530	3	2
		For compact pneumatics	10-PSE540	3	2
		For low differential pressure	10-PSE550	3	2
		For general fluids	10-PSE560	3	2
	Remote type digital pressure sensor controller/ Multi-channel		10-PSE200	1	1
	Remote type 2-color display digital pressure sensor controller		10-PSE300	1	1

Values in ▒ show grades.
☐ No grade applies to blanks.

Particle Generation Measuring Method

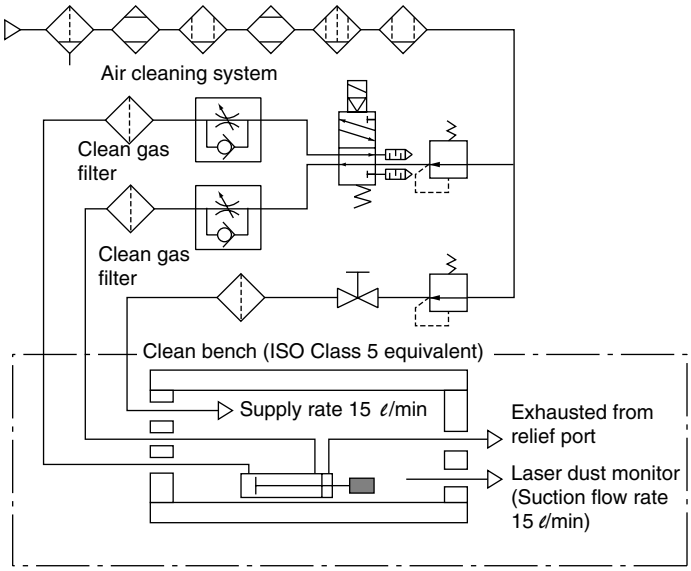
The particle generation data for SMC Clean Series are measured in the following test method.

Test Method (Example)

Place the specimen in the acrylic resin chamber and operate it while supplying the same flow rate of clean air as the suction flow rate of the measuring instrument (15 ℓ/min). Measure the changes of the particle concentration over time until the number of cycles reaches the specified point. The chamber is placed in an ISO Class 5 equivalent clean bench.

Measuring Conditions

Chamber	Internal volume	15 ℓ
	Supply air quality	Same quality as the supply air for driving
Measuring instrument	Description	Laser dust monitor (Automatic particle counter by light-scattering method)
	Model no.	TS-1500
	Minimum measurable particle diameter	0.17 μm
	Suction flow rate	15 ℓ/min
	Manufacturer	Hitachi Electronics Engineering Co. Ltd.
Setting conditions	Sampling time	5 min
	Interval time	55 min
	Sampling air flow	75 ℓ



Particle generation measuring circuit

Evaluation Method

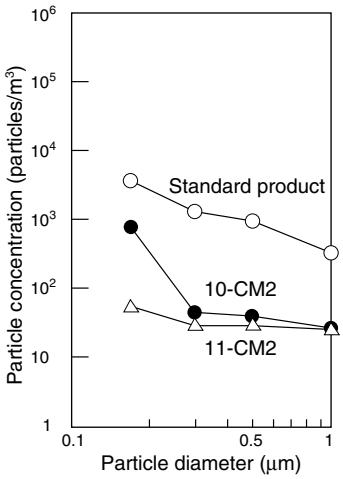
To obtain the measured values of particle concentration, the accumulated value Note 1) of particles captured every 5 minutes, by the laser dust monitor, is converted into the particle concentration in every 1 m^3.

When determining particle generation grades, the 95% upper confidence limit of the average particle concentration (average value), when each specimen is operated at a specified number of cycles Note 2) is considered.

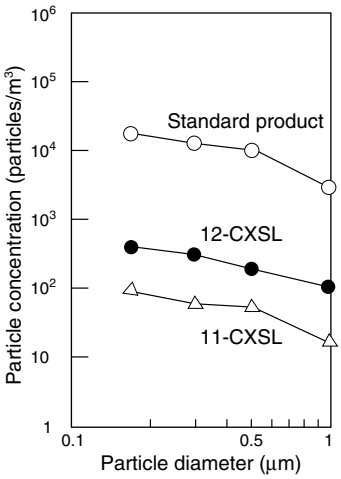
The plots in the graphs indicate the 95% upper confidence limit of the average particle concentration of particles with a diameter within the horizontal axis range.

Note 1) Sampling air flow rate: Number of particles contained in 75 ℓ of air
Note 2) Actuator: 1 million cycles
Solenoid valve: 2 million cycles

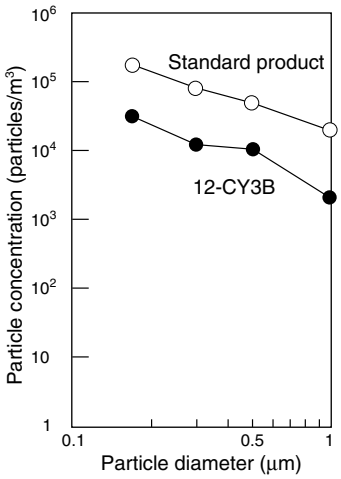
Particle generation characteristics of CM2



Particle generation characteristics of CXSL



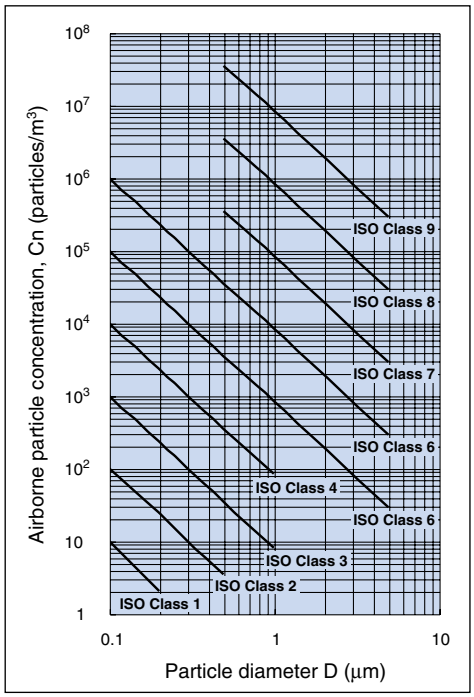
Particle generation characteristics of CY3B



Comparison of Cleanliness Standards (Reference)

Standard		Fed.Std.209E Note)		ISO 14644-1
Cleanliness class		British unit: Class 1 to 100.000 SI unit: Class M1 to M7 U descriptor: Particle diameter less than 0.1 µm		ISO Class 1 to 9 Intermediate class available U descriptor: Particle diameter less than 0.1 µm M descriptor: Particle diameter exceeding 5.0 µm
	Corresponding class indication	(British unit)	(SI unit)	
				ISO Class 1
				ISO Class 2
		1	M1.5	ISO Class 3
		10	M2.5	ISO Class 4
		100	M3.5	ISO Class 5
		1000	M4.5	ISO Class 6
		10000	M5.5	ISO Class 7
		100000	M6.5	ISO Class 8
				ISO Class 9
Cleanliness class indication		The number of particles with diameter 0.5 µm or larger in an air volume of 1 m^3 is expressed in 10 M or coefficient Nc. Cleanliness class: Nc or M		The number of particles with diameter 0.1 µm or larger in an air volume of 1 m^3 is expressed in 10^N. ISO Class N: Occupancy state: Sampling particle diameter
Calculation of the maximum permitted concentration of particulate cleanliness classes		British unit: Number of particles/ft^3 = N_c x $(0.5/D)^{2.2}$ SI unit: Number of particles/m^3 = 10 M x $(0.5/D)^{2.2}$		$C_n = 10^N \times (0.1/D)^{2.08}$
Evaluation method using a simple sampling		① Number of sampling locations: 2 to 9 95% UCL of the mean and the mean of the averages ② Number of sampling locations: 10 or more The mean		① Number of sampling locations: 2 to 9 95% UCL of the mean and the mean of the averages ② Number of sampling locations: 1, or 10 or more The mean
Number of sampling locations		① Non-unidirectional airflow: at least two locations $N_L = A \times 64/(10\ M)^{0.5}$ ② Unidirectional airflow: at least two locations Smaller value between $N_L = A/2.32$, $N_L = A \times 64/(10\ M)^{0.5}$		Derive it from the area of the clean room or clean air controlled space. Number of sampling locations $N_L = (A)^{0.5}$ At least one location
Min. sampling air flow volume		2 litters or a sufficient volume of air that a minimum of 20 particles could be counted if the particle concentration were at the class limit.		2 litters or a sufficient volume of air that a minimum of 20 particles could be counted if the particle concentration were at the class limit. Min. sampling time: 1 minute
Number of samplings		Total number of samplings in each clean zone: 5 times or more		Where only one sampling location is required, take a minimum of three single sample volumes at that location.
Sampling method		5.0 µm or larger: Constant velocity and suction in the same direction of the air flow 0.5 to 5 µm: Correction possible when it is sucked at a nonconstant velocity		Suction in the same direction as the airflow If the direction of the airflow is not predictable, the inlet of the sampling probe shall be directed vertically upward.

Note) Fed.Std.209E was abolished in Nov. 2001, so these figures are for reference only.



Cleanliness class (N)		Maximum concentration limit (particles/m^3) Sampling particle diameter (µm)					
		0.1	0.2	0.3	0.5	1	5
ISO Class	1	10	2				
	2	100	24	10	4		
	3	1000	237	102	35	8	
	4	10000	2370	1020	352	83	
	5	100000	23700	10200	3520	832	29
	6	1000000	237000	102000	35200	8320	293
	7				352000	83200	2930
	8				3520000	832000	29300
	9				35200000	8320000	293000

Note) Concentration data with no more than three significant figures be used in determining the classification level.

$$C_n = 10^N \times (0.1/D)^{2.08}$$

C_n: The maximum permitted concentration of airborne particles that are equal to or larger than the sampling particle diameter (D). C_n is rounded down to the nearest whole number, using no more than three significant figures.

N: Class No. (1 to 9), Intermediate class (1.1 to 8.9)

D: Sampling particle diameter (µm)

0.1: Constant number (µm)

Clean Series Precautions 1

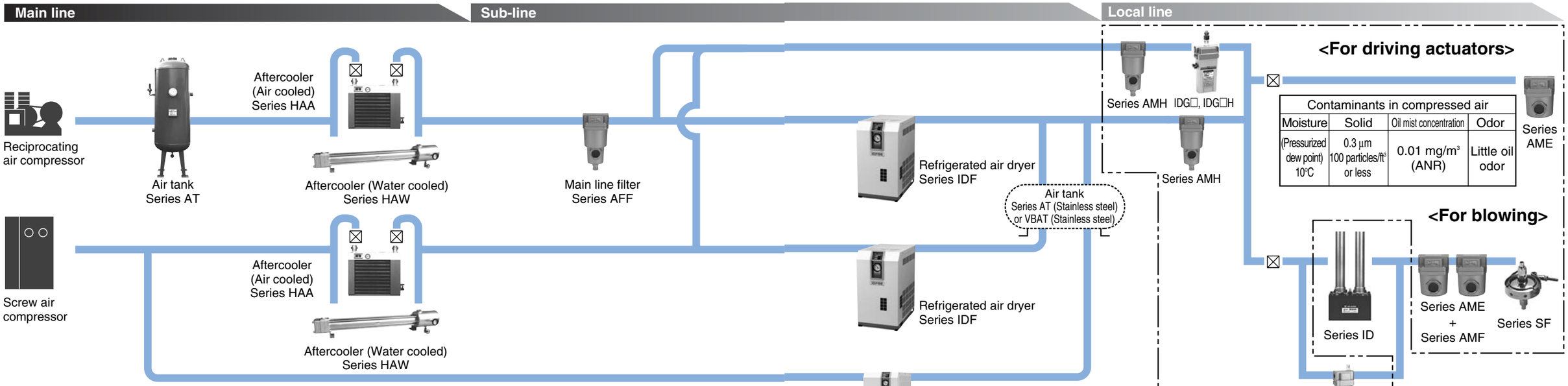
Be sure to read before handling.
Refer to the main text for detailed precautions for every series.

Air Supply

⚠Caution

System Configuration

Refer to the "Air Preparation System" below for the quality of compressed air before configuring the system.

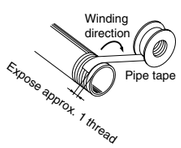


Contaminants in compressed air			
Moisture	Solid	Oil mist concentration	Odor
(Pressurized dew point) 10°C	0.3 µm 100 particles/ft³ or less	0.01 mg/m³ (ANR)	Little oil odor

Contaminants in compressed air			
Moisture	Solid	Oil mist concentration	Odor
Atmospheric pressure dew point – 50°C or less	0.01 µm 1 particle/ft³ or less	0.004 mg/m³ (ANR)	No oil odor

Piping

1. Provide an inclination of 1cm per meter in the direction of the air flow to the main piping.
2. If there is a line branching from the main piping, provide an outlet of compressed air on top using a tee so that drainage accumulated in the piping will not flow out.
3. Provide a drainage mechanism at every recessed point or dead end to prevent drain accumulation.
4. For future piping extensions, plug the end of the piping with a tee.
5. Before piping
   Before piping, the piping should be thoroughly blown out with air (flushed) or washed to remove chips, cutting oil and other debris from inside the pipe.
6. Wrapping of pipe tape
   When screwing piping or fittings into ports, ensure that chips from the pipe threads or sealing material do not get inside the valve.
   Also, when pipe tape is used, leave approx. 1 thread ridges exposed at the end of the threads.



7. After piping
   After piping, the piping should be thoroughly blown out with air (flushed), and dust generated when piping should be removed.
8. If air with a low dew point (–40°C or less) is required, do not use nylon tube or resin fitting (except for fluorine resin) for the outlet side of the membrane air dryer or heatless air dryer. Nylon tubing could be affected by the ambient air and it thus might not be possible to achieve the prescribed low dew point at the end of the tube. Therefore, for low dew point air, use stainless steel or fluorine tube and fittings.

Maintenance

1. If the heatless air dryer Series ID is left unused for a long period, the absorbent may be moistened. Prior to use, close the valve on the outlet side of the dryer for regeneration and drying.

Caution on Design

Employ a safe design, so that the following unexpected conditions will not occur.

⚠Warning

1. **Provide a design that prevents high-temperature compressed air from flowing into the outlet side of the cooling equipment.**
   If the flow of the coolant water in a water-cooled aftercooler is stopped or if the fan motor of an air cooled aftercooler is stopped, the high-temperature compressed air will flow to the outlet side of the cooling equipment, causing the equipment on the outlet side (such as the AFF, AM, AD, or IDF series) to be damaged or to malfunction.
2. **Provide a design in which interruptions in the supply of compressed air are taken into consideration.**
   There are cases in which compressed air cannot flow due to the freezing of the refrigerated air dryer or a malfunction (heatless dryer) in the switching valve.

⚠Caution

3. **Design a layout in which the leakage of the coolant water and the dripping of condensation are taken into consideration.**
   A water-cooled aftercooler that uses coolant water could lead to water leakage due to freezing. Depending on the operating conditions, the refrigerated air dryer and its downstream pipes could create a dripping of water droplets due to condensation formed by supercooling.
4. **Provide a design that prevents back pressure and backflow.**
   The generation of back pressure and backflow could lead to equipment damage.
   Take appropriate safety measures, including the proper installation methods.
5. **When super dry air is used as the fluid, equipment reliability (service life) may be affected adversely due to deteriorating lubrication properties inside the equipment.**
   Please consult with SMC in such cases.
6. **Blowing system**
   Even a small amount of dust can be a problem for blowing systems.
   Install Clean Gas Filter or Clean Air Filter Series SF to the end of the blowing line.

Clean Series Precautions 2

Be sure to read before handling.
Refer to the main text for detailed precautions for every series.

Piping: Inside of Clean Room

⚠ Caution

1. **Do not make the piping for the air cylinder relief port and regulator breathing vent piping common with solenoid valve exhaust piping.**
   This can cause malfunctions in the air cylinder or regulator pressure change.
   Do not apply pressure to the air cylinder relief port.

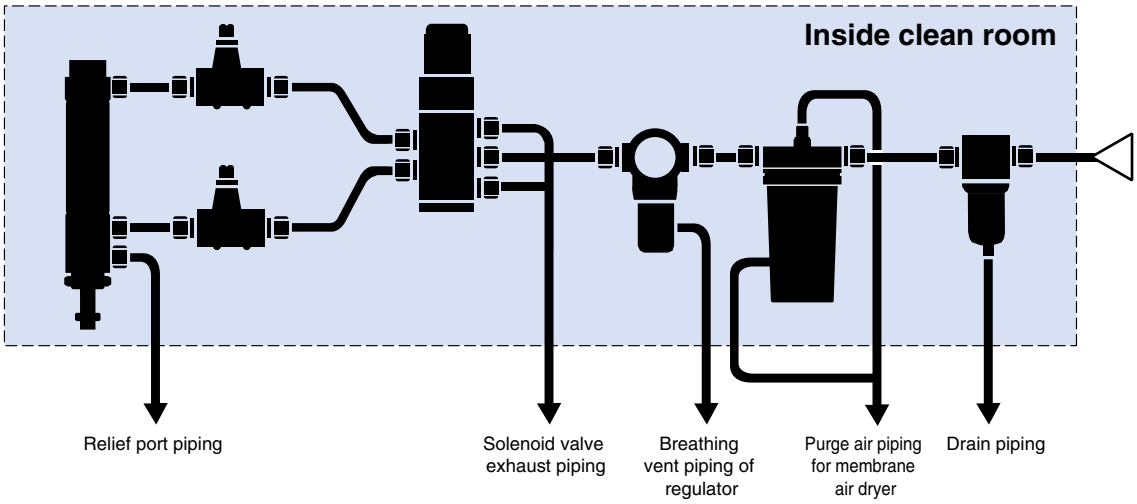
2. **Arrange the piping so that the exhaust air of the solenoid valves is exhausted outside of the clean room.**

3. **Air filter drain piping**
   Exhaust drainage outside the clean room through piping from the drain guide of the air filter.

4. **Arrange the membrane dryer air purge piping using a standard size tubing so that air is exhausted outside the clean room.**

5. **Take precautions so that the threaded portion of the piping connection or the tubing connection will not be loosened.**
   Take sufficient precautions against the piping shaking along with the vibration of the equipment.

6. **Use polyurethane tubing containing no plasticizer.**



Handling

⚠ Caution

1. **The inner bag of a double-packed clean series package should be opened in a clean room or clean environment.**

2. **When standard pneumatic equipment is brought into a clean room, spray high-purity air upon it and remove dust thoroughly by wiping the external surfaces of the cylinder tube, solenoid valves and air line equipment with alcohol.**

3. **To replace parts or disassemble the product in a clean room, first exhaust the compressed air inside the piping to the outside of the clean room before the work.**

4. **Do not use rotation type mounting brackets such as clevises, trunnions, etc.. They will generate a considerable amount of particulate matter due to the sliding friction between the metal parts.**

Lubrication / In the Case of Actuator

⚠ Warning

Be sure to wash your hands after handling fluororesin grease.
The grease itself is not hazardous but it can produce a hazardous gas at temperatures exceeding 260°C.

Lubrication / In the Case of Actuator

⚠ Caution

1. **Do not use any greases but those specified by SMC.**
   Use of greases not specified will cause malfunctions or particle generation.

2. **Do not lubricate the products since they are of a nonlubricant type.**
   As the clean series actuators are lubricated at the factory with fluororesin grease, the product specifications may not be satisfied if turbine oil or other such lubricants are applied.

Piston Speed

⚠ Caution

The air cylinder speed upper limit that retains the particle generation grade is 400 mm/s. When the maximum operating speed for the standard type is 400 mm/s or slower, operate the series within the operating speed range.

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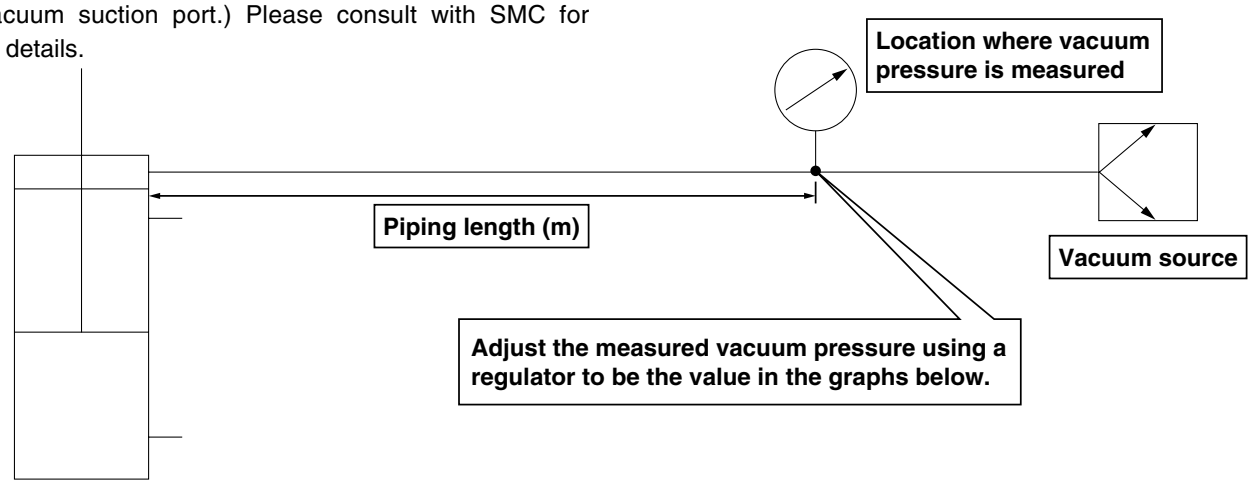
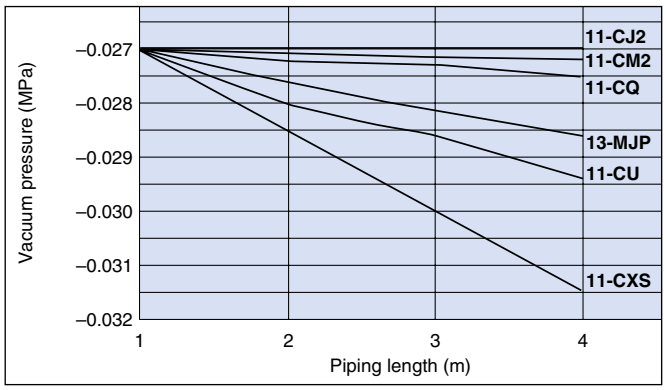
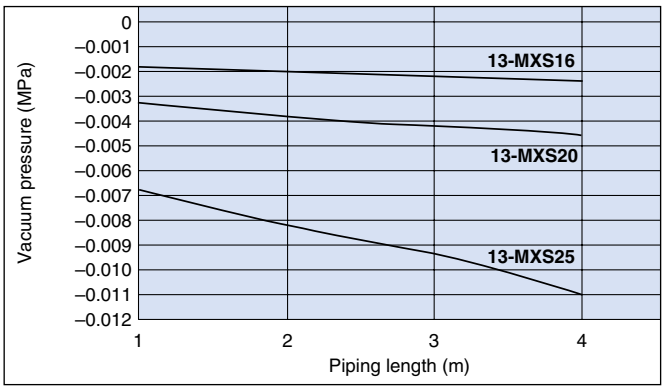
Clean Series Precautions 3

Be sure to read before handling.
Refer to the main text for detailed precautions for every series.

Suction Flow Rate of Vacuum Suction Types

⚠ Caution

For the vacuum suction types (11-/13-/22- Series), perform vacuum suction at the vacuum port to retain the particle generation grade.

The optimum suction flow rate varies depending on series and sizes. Refer to "Suction flow rate of vacuum suction type (Reference values)" for each series. (The vacuum pressure will be approximately –27 kPa at around 1 m from the vacuum suction port.) Please consult with SMC for further details.