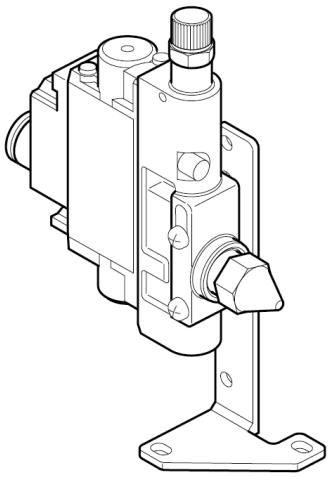
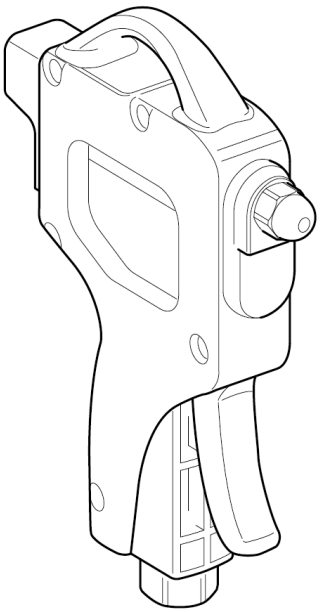
CKD

BNP Series
Pulsed Blow Valve

INSTRUCTION MANUAL

Read this Instruction Manual before using the product.
Read the safety notes carefully.
Keep this Instruction Manual in a safe and convenient place for future reference.





2024-12-13 SM-A92743-A/1

PREFACE

Thank you for purchasing CKD's "BNP Series" pulsed blow valve.

This Instruction Manual contains basic matters related to the operation of this product in order to ensure optimal performance of the product. Please read this Instruction Manual thoroughly and use the product properly.
Keep this Instruction Manual in a safe place and be careful not to lose it.

Product specifications and appearances presented in this Instruction Manual are subject to change without notice.

The product, which uses control valves such as solenoid valves, motor valves, and air operated valves, is intended for users who have basic knowledge about materials, fluids, piping, and electricity. CKD shall not be responsible for accidents caused by persons who selected or used the product without knowledge or sufficient training with respect to control valves.

Since there are a wide variety of customer applications, it is impossible for CKD to be aware of all of them. Depending on the application or usage, the product may not be able to exercise its full performance or an accident may occur due to fluid, piping, or other conditions. It is the responsibility of the customer to check the product specifications and decide how the product shall be used in accordance with the application and usage.

SAFETY INFORMATION

When designing and manufacturing any device incorporating the product, the manufacturer has an obligation to ensure that the device is safe. To that end, make sure that the safety of the machine mechanism of the device, the pneumatic or water control circuit, and the electric system that controls such mechanism is ensured.
To ensure the safety of device design and control, observe organization standards, relevant laws and regulations, which include the following:

- ISO 4414, JIS B 8370, JFPS 2008 (the latest edition of each standard)
- The High Pressure Gas Safety Act, the Industrial Safety and Health Act, other safety rules, organization standards, relevant laws and regulations

In order to use our products safely, it is important to select, use, handle, and maintain the products properly.
Observe the warnings and precautions described in this Instruction Manual to ensure device safety.
Although various safety measures have been adopted in the product, handling that is not described in this Instruction Manual may lead to an accident. Thoroughly read and understand this Instruction Manual before using the product.

To explicitly indicate the severity and likelihood of a potential harm or damage, precautions are classified into three categories: "DANGER", "WARNING", and "CAUTION".

DANGER	Indicates an imminent hazard. Improper handling will cause death or serious injury to people.
WARNING	Indicates a potential hazard. Improper handling may cause death or serious injury to people.
CAUTION	Indicates a potential hazard. Improper handling may cause injury to people or damage to property.

Some statements classified as "CAUTION" may still lead to serious results depending on the situation.
All statements that follow these labels are important and must be observed.

<Types of warning symbols>

	A general mark indicating a prohibited (not permitted) action.		A mark prohibiting people from touching objects or equipment.
	A mark prohibiting people from putting their fingers into openings.		A general mark warning people of dangers such as electric shock and burns.
	A mark warning people of dangers that occur when starting an automatic equipment.		A general mark indicating that a specific course of action must be taken.
	A mark indicating that an instruction manual must be read carefully.		A mark indicating that the earth terminal must be connected to the ground.

In addition, the following icons indicate general precautions.

- Contains useful information such as general precautions, supplementary information, and reference information.

Precautions on Product Use

WARNING

Do not modify the product or perform additional work on the product.

- Modification or additional work may not only pose a risk of fire or electric shock, but it may also cause the product to fail to satisfy the specifications described in this Instruction Manual.

Do not handle the product or install or remove pipes and devices until confirming safety.

- Inspect and service the machines and devices only after confirming that safety of the entire system related to the product is ensured. Also, turn off the energy source (air supply) and power to the relevant equipment, and release compressed air from the system.
- Before starting or restarting a machine or device that incorporates pneumatic components, make sure that a safety measure (such as a pop-out prevention mechanism) is in place and system safety is secured.

Do not point the nozzle at people.

- The air blow pressure is powerful. If air is released toward a person, it may cause bodily harm.

The product must be handled by a qualified person who has extensive knowledge and experience.

- This product is designed and manufactured as a device or part for general industrial machinery and should be handled with care.

Use the product within the specifications.

- The product must not be used beyond its specifications.
- The product is intended for use as a device or part for general industrial machinery. It is not intended for use under the conditions or in environments listed below. Exception is made if the customer consults with CKD prior to use and understands the specifications of the product. However, even in that case, safety measures must be taken to avoid danger in case of a possible failure.
  - ◎ For use under the conditions or in environments other than those specified or outdoors.
  - ◎ In applications for nuclear power, railroad system, aviation, ship, vehicle, medical equipment, and equipment that directly touches beverage or food.
  - ◎ For special applications that require safety including amusement equipment, emergency shut-off circuit, press machine, brake circuit, and safety measures.
  - ◎ For applications where life or properties may be adversely affected and special safety measures are required.

CONTENTS

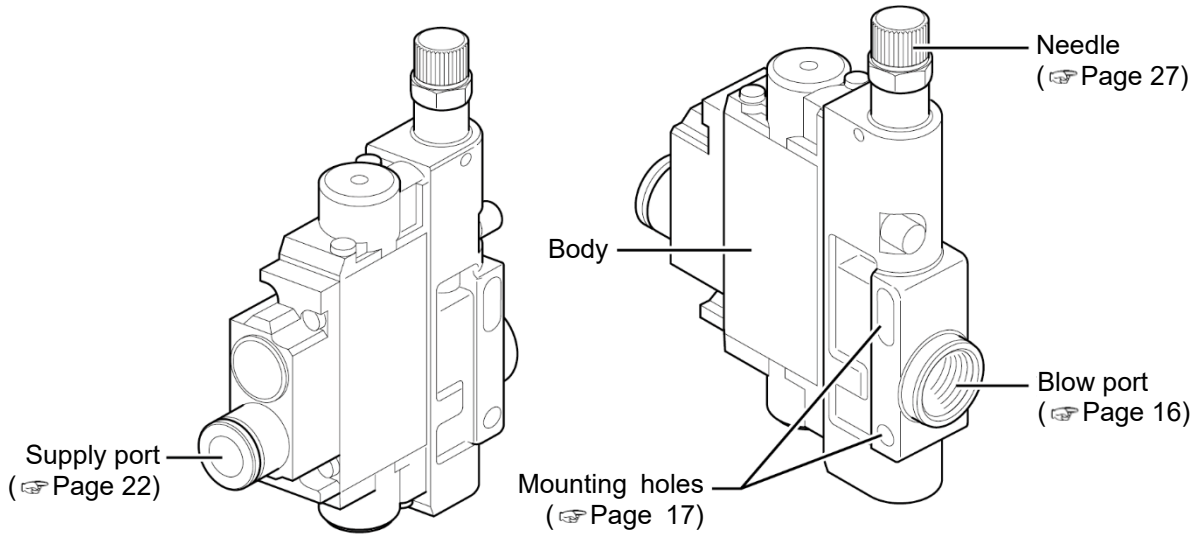
1. PRODUCT OVERVIEW

Refer to the catalog for the model number indication of the product itself.

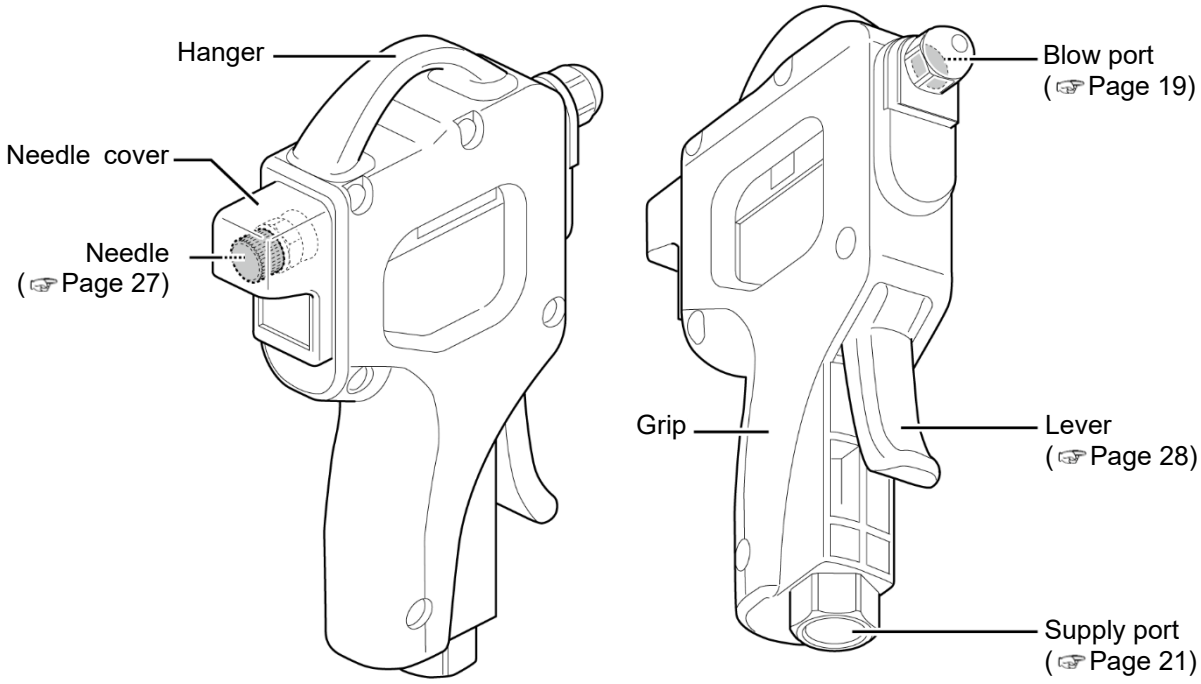
1.1. Names of Parts

Only the main parts are shown here.

■ Unit type



■ Gun type



1.2. Specifications

Below are the general specifications of this product. Refer to the catalog for items not listed below, such as weight and material.

1.2.1. General specifications

Item		BNP-G (Gun type)	BNP-U (Unit type)
Working fluid		Compressed air Note 1	
Working pressure MPa		0.25 to 0.7	
Proof pressure MPa		1.05	
Ambient temperature °C		-5 to 50 (no freezing)	
Fluid temperature °C		5 to 50	
Pulse frequency Hz		5 to 15 Note 2	
Port size	**Supply port**	Rc1/4	Push-in fitting ⌀8
	Blow port	Nozzle attached	Rc1/4
Nozzle hole diameter mm		2.5 (recommended), 3	-
Weight g		250	130

Note 1: Install a dryer, filter, and oil mist filter upstream to remove moisture and oil.
Note 2: This is the performance at a working pressure of 0.5 MPa in our measuring circuit.

1.2.2. Piping conditions

If pressure drop or insufficient flow occurs due to piping conditions on the supply side, operation may become unstable. Refer to the table below to install the supply side piping.

■ Unit type

Nozzle hole diameter	Working pressure	Tube ⌀8		
		1 m	3 m	5 m
⌀2	0.25 MPa	○	○	○
	0.5 MPa	○	○	○
	0.7 MPa	○	○	○
⌀2.5	0.25 MPa	○	○	○
	0.5 MPa	○	○	○
	0.7 MPa	○	○	○

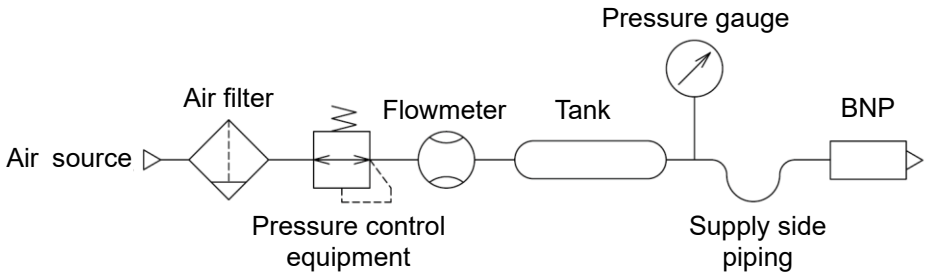
※ ○: Recommended, ×: Not recommended (based on the test conditions below)

■ Gun type

Nozzle hole diameter	Working pressure	Tube ⌀6			Tube ⌀8		
		1 m	3 m	5 m	1 m	3 m	5 m
⌀2.5	0.25 MPa	○	○	○	○	○	○
	0.5 MPa	○	○	×	○	○	○
	0.7 MPa	○	×	×	○	○	○
⌀3	0.25 MPa	×	×	×	○	○	○
	0.5 MPa	×	×	×	○	○	×
	0.7 MPa	×	×	×	○	○	×

※ ○: Recommended, ×: Not recommended (based on the test conditions below)

■ Test conditions



1.3. Dimensions

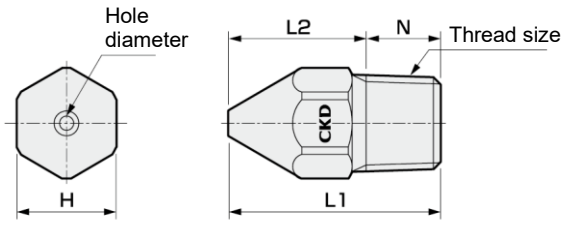
Refer to the catalog for the external dimensions of the product itself.

1.3.1. Air blow nozzle

Refer to the instruction manual or catalog for the nozzle being used for handling instructions, precautions, external dimensions, etc.

■ Unit type: Nozzle not included

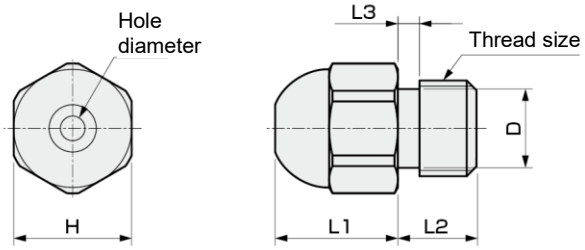
For the unit type, nozzle is not included. However, a standard type nozzle can be attached directly. When using a CKD standard type nozzle (BN series), the recommended nozzle is BN-8S25P.



Model no.	Thread size	L1	L2	H	N	Hole diameter
BN-8S10P	R1/4	30	19.5	14	10.5	1.0
BN-8S15P	R1/4	30	19.5	14	10.5	1.5
BN-8S20P	R1/4	30	19.5	14	10.5	2.0
BN-8S25P	R1/4	30	19.5	14	10.5	2.5

■ Gun type: Round tip nozzle

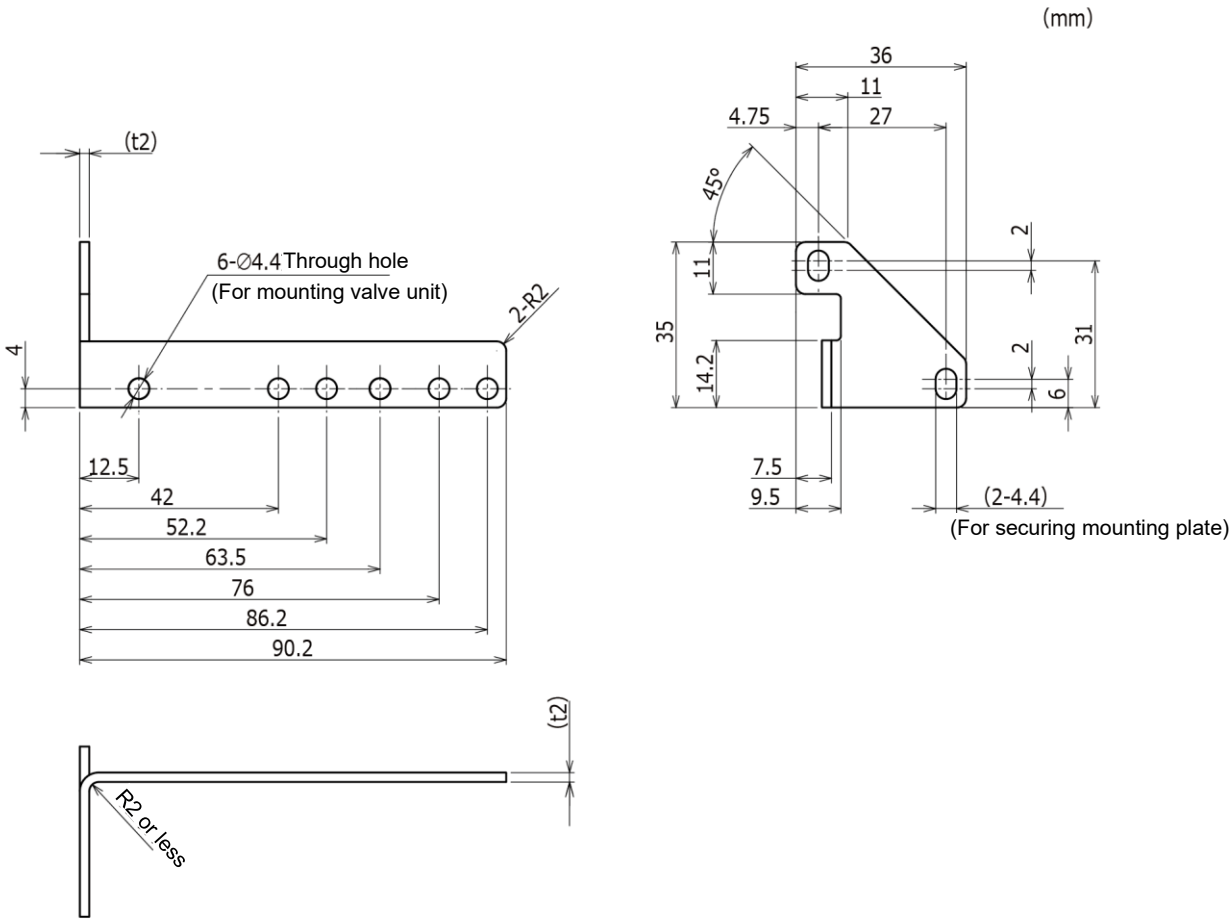
For the gun type, the round tip nozzle for the model number selected is attached prior to shipping. Due to the difference in shape, CKD standard type nozzle (BN series) cannot be attached directly to the gun type.



Code	Thread size	L1	L2	L3	D	H	Hole diameter
G25	G1/8	12.5	8	2.2	⌀8	12	2.5
G30	G1/8	12.5	8	2.2	⌀8	12	3

1.3.2. Mounting plate

The mounting plate is optional. It can be used when installing the unit type.



	Model no.	Parts included
Mounting plate kit	BNP-MOUNT-PLATE-KIT	Mounting plate, 2 mounting screws, 2 flat washers, 2 nuts

2. INSTALLATION

WARNING

Consult CKD about the specifications before using the product outside the designated specifications or for a special application.

Prevent water and cutting oil from directly splashing onto the product.

- If water or cutting oil gets on the product, it may cause an operation fault.
- Install this product so that it is not directly exposed to water or dust.
- If there is a possibility that the product may be exposed to spatter during welding, take appropriate protective measures.

CAUTION

Do not paint the product or clean it with water or solvent.

- It may damage the resin parts and cause a failure or malfunction.

Do not apply pressure from the blow port side.

- It may cause a failure.

Do not use the product in cleanrooms.

- This product is not suitable for cleanrooms. Tiny particles may be discharged with the air due to wear on internal parts.

2.1. Installation and Working Environment

WARNING

Do not use the product in the presence of corrosive gas or solvents.
- Do not use the product in an environment where corrosive gases such as sulfur dioxide gas or solvents are present.

Do not use the product in an environment where it may be exposed to water.
- Do not use the product in a water vapor atmosphere or in an environment where there is a risk of contact with chemicals, seawater, or water.

Do not use the product in an explosive gas atmosphere.

CAUTION

Do not use the product in an environment where the valve is subject to vibrations or inertia.

Do not use the product in places where there is a lot of dust, where dust scatters, or where static electricity buildup is likely to cause a problem.
- It may cause an operation fault or failure.

Keep the product away from heat-generating equipment and use it in an environment where it is not exposed to radiant heat.

Use a clean air source.
- If the compressed air contains any of the following, it may cause product damage or operation fault: chemicals, synthetic oils containing organic solvents, salts, corrosive gases, solids, etc.
- Install an air filter with a filtration rating of 5 μm or less upstream near this product.
- If the compressed air contains drain, install an air dryer or drain catcher upstream near this product.

Take measures to prevent the occurrence of condensation and frost caused by blowing air during use.
- Keep the dew point temperature of the compressed air (the air source) below the ambient temperature by passing it through a refrigerated air dryer or aftercooler.

When using the product in cold climates, take appropriate measures against freezing.

Install the product where it is not exposed to direct sunlight, ultraviolet rays, water, and rain.
- The product cannot be used outdoors.

2.2. Unpacking

CAUTION

Do not remove the piping port protector and do not take the product out of the plastic bag until immediately prior to performing piping work.

- If the piping port protector is removed or the product is taken out of the plastic bag before ready to begin piping work, foreign matters may enter from the piping ports and cause a failure or malfunction.

Check that the model number ordered and the model number indicated on the product are the same.
Check the exterior of the product for any damage.

2.3. Mounting (Unit Type)

CAUTION

Hold the unit firmly when handling and mounting the product.
• Do not hang the product by holding the tube as this may cause a failure.
Mount the product so that the tube is not subjected to excessive force or bending.

- Since the unit type does not have a mechanism to stop the air, and to ensure safety in case of air leakage or damage, install a shut-off valve on the supply port side.
- Be careful not to block the exhaust port. Blocking the exhaust port may cause an operation fault. (The exhaust port is located on the blow port side and is equipped with a silencer.)
- Refer to the instruction manual or catalog for the nozzle being used for handling instructions, precautions, external dimensions, etc.

2.3.1. How to attach the nozzle

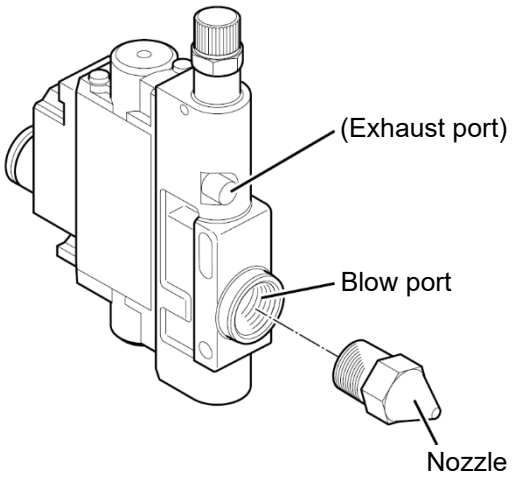
Instructions for attaching the nozzle are given below, using as an example the case where the CKD standard type nozzle (BN series) is used.

1. Apply seal material to the threaded part of the nozzle.

Refer to page 21 for instructions on applying seal material.

2. Attach the nozzle to the blow port (Rc1/4) and tighten the hexagonal nut of the nozzle with a spanner wrench.

Recommended tightening torque: 6 to 8 N·m



2.3.2. How to mount the unit

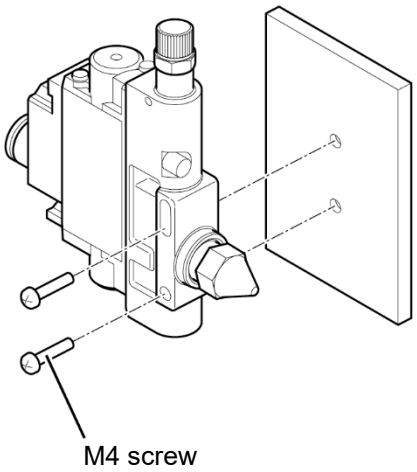
Instructions for mounting the unit are given below, using as examples the case where a panel is used and the case where the optional mounting plate is used.

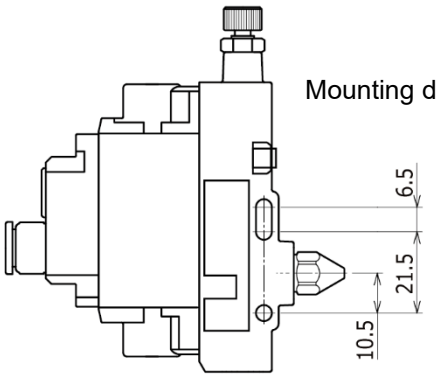
- Secure sufficient space for working safely during maintenance and troubleshooting (see the figure below).
- There is no restriction on the mounting orientation. However, if the unit is mounted with the needle facing down, foreign matters in the fluid may adhere to it and cause an operation fault. Therefore, it is recommended to mount the product in an orientation other than downward.

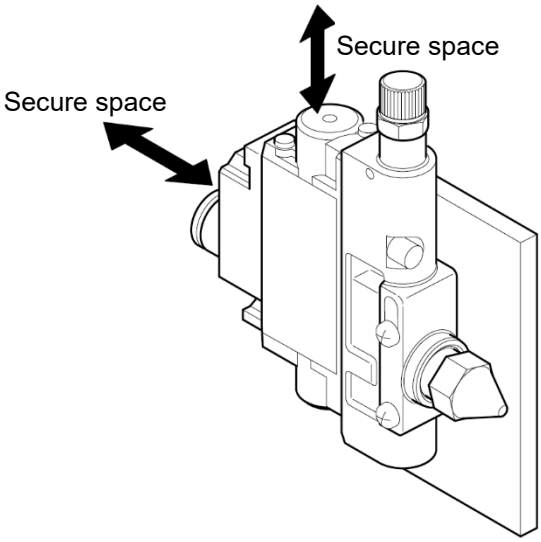
■ How to mount the unit when using a panel

1. Ensure sufficient space and secure the unit.

After making sure that there will be enough space for the unit when it is mounted, secure the unit with two M4 screws using the mounting holes in the base.





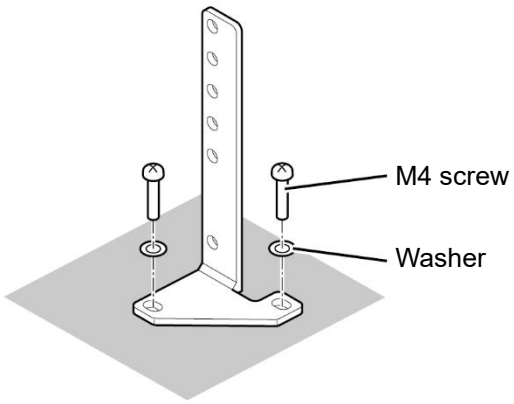


■ How to mount the unit when using the optional mounting plate

- For mounting plate dimensions and mounting hole locations, refer to "1.3.2 Mounting plate".
- When using the optional mounting plate, make sure that vibration is not applied in the direction of the thickness of the plate surface on which the unit is mounted.

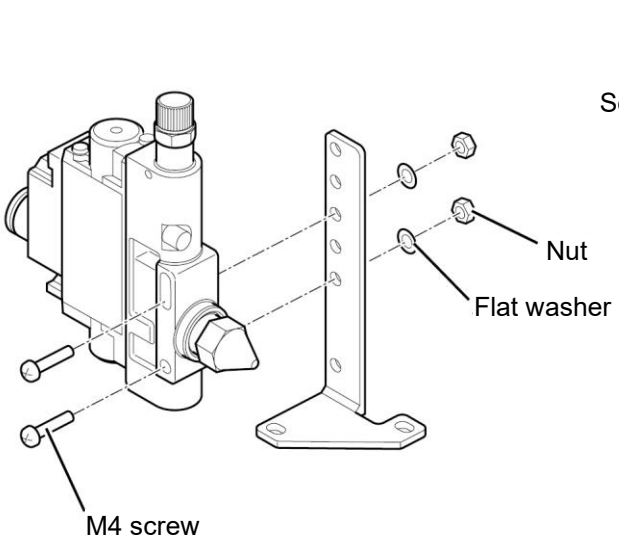
1. Secure the optional mounting plate.

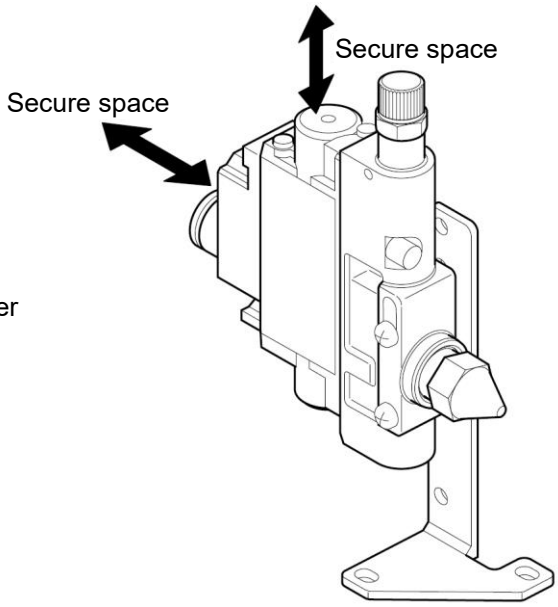
After making sure that there will be enough space for the unit when it is mounted, secure the optional mounting plate with two M4 screws.



2. Ensure sufficient space and secure the unit.

Secure the unit with two M4 screws using the mounting holes in the base.





2.4. Mounting (Gun Type)

CAUTION

Hold the unit firmly when handling and mounting the product.
• Do not hang the product by holding the tube as this may cause a failure.
Mount the product so that the tube is not subjected to excessive force or bending.

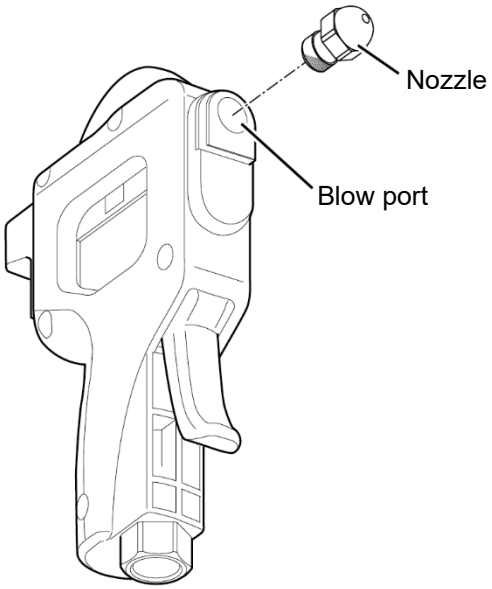
- To ensure safety in case of air leakage or damage, install a shut-off valve on the supply port side.
- Refer to the instruction manual or catalog for the nozzle being used for handling instructions, precautions, external dimensions, etc.

2.4.1. How to attach the nozzle

The nozzle is attached prior to shipping. When replacing the nozzle, remove the old one and follow the procedure below to install the new one.

1. Attach the nozzle to the blow port (G1/8) and tighten the hexagonal nut of the nozzle with a spanner wrench.

Recommended tightening torque: 0.5 to 0.6 N·m



2.5. Piping

CAUTION

Be careful not to use the wrong supply port or connect to the wrong piping destination.

- If a wrong supply port or piping destination is used, it may lead to a malfunction or accident.

To prevent the product from malfunctioning or being damaged, observe the following.

- Use a clean air source.
- Use a tube that is free of scratches on the outer surface.
- For the unit type, be careful not to bend the tube forcibly when piping.
- For the gun type, secure the product when retightening or reconnecting the piping.

Do not apply high pressure suddenly when supplying air for the first time after connecting the pipes.

- If the pipes are not secured properly, it may lead to accidents such as disconnection of piping or leakage of compressed air.

- A characteristic of pulsed blow is that it causes fluctuations in the upstream pressure, which significantly reduces the life of the upstream regulator. As a countermeasure, place something that resists fluctuations, such as a large-volume tank, between the regulator and this product.

■ Pipe cleaning

Before piping, perform flushing with air of more than 0.3 MPa to remove foreign matters such as dust, metal powder, rust, and seal tape.

■ Removal of foreign matters

Remove foreign matters such as dusts in the compressed air to prevent causing an operation fault or leakage.
Install an air filter with a filtration rating of 5 μm or less upstream near this product.

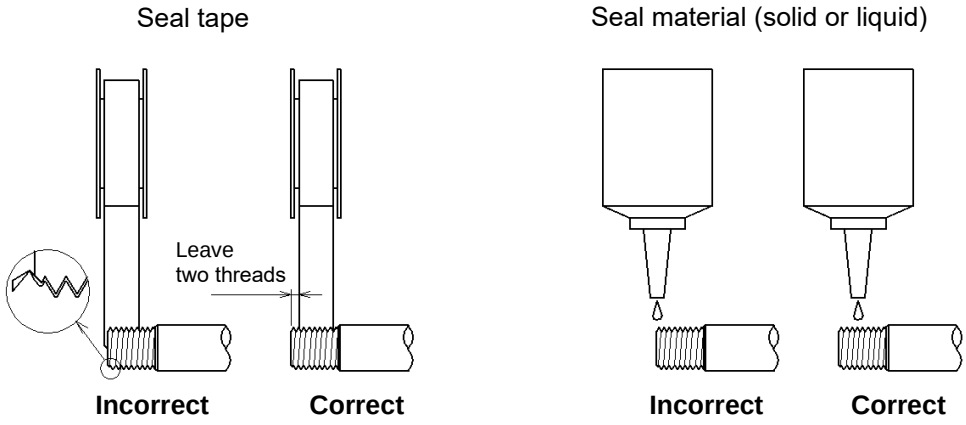
■ Lubrication

Do not lubricate the product. Lubrication may cause contamination of, or damage to, the object being air blown.

■ Seal material

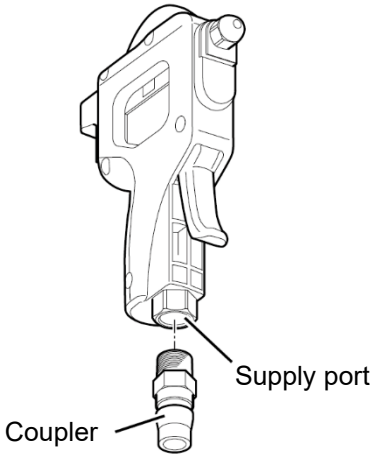
Apply a seal tape or seal material to the screw threads leaving one or two threads at the pipe end uncovered or uncoated.
If the pipe end is fully covered or coated, a shred of seal tape or residue of seal material may enter inside of the valve and cause a failure.

- When using a seal tape, wind it around the screw threads in the direction opposite from the screw threads and press it down with your fingers to attach it firmly.
- When using a liquid seal material, be careful not to apply it to resin parts.
  It may damage the resin parts and cause a failure or malfunction. Also, do not use the seal material excessively or apply it to the internal threads.



■ Installing the fitting (gun type)

Use a seal material on the coupler or fitting (required for connecting the tube) before attaching the coupler or fitting to the supply port (Rc1/4).



■ Tightening (unit type)

Refer to the following table for tightening torques for fittings.

<Recommended tightening torques for fittings>

Port size	Recommended tightening torque (N·m)
Rc1/4	6 to 8

■ Tightening (gun type)

Refer to the following table for tightening torques for couplings and fittings.

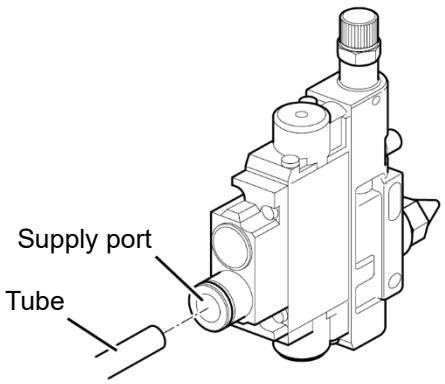
- Since the supply port spins freely, apply a spanner wrench to the supply port to hold it while tightening the coupler or fitting.

<Recommended tightening torques for couplings and fittings>

Port size	Recommended tightening torque (N·m)
Rc1/4	6 to 8

■ Tube connection (unit type)

Be sure to securely insert the tube (outer diameter: ⌀8) all the way into the supply port (push-in fitting).



■ Tube connection (gun type)

Be sure to securely connect the tube to the coupler or fitting attached to the supply port.

3. USAGE

WARNING

Since this product is not a play or cleaning tool, observe the following.

- Do not point the nozzle at people.
- Do not use the product for the purpose of disturbing public order or public health.
- Do not use the product for the purpose of cleaning up hazardous substances.

Before use, make sure that the blowing pressure or objects scattered by blowing will not cause harm to people, the object being air blown, or equipment.

- Failure to check may result in an accident.

CAUTION

Use the compressed air temperature, ambient temperature, working pressure, and flow rate within the specified range.

- Use compressed air as specified in the catalogue.

3.1. Checks to Make Before Use (Checks Made After Mounting)

WARNING

Make sure to exhaust the compressed air in the piping before performing checks.
- Failure to do so may result in an injury.

■ Appearance check

Check the following:
- For the unit type, check that this product is securely fixed by pressing it by hand.
- Check that the threaded parts such as bolts, nuts, and screws, the nozzle, and the fitting are not loose.
- Check that the piping is installed correctly and that the piping connection is not loose.
- Check that the tube is not damaged, deteriorated, hardened, kinked, or crushed.

■ Leakage check

Apply pressure to check for leakage from the piping connection.
- For the unit type, apply pressure after closing the shut-off valve upstream of this product and check for leakage from the piping connection up to the shut-off valve.
- It is recommended to check for leakage by supplying compressed air (0.3 MPa to 0.5 MPa) and applying soapy water to see if bubbles form.

3.2. Safety Instructions

WARNING

Do not look into the nozzle.
- It may cause an injury or accident.

Before use, check that the nozzle is not loose.
- If the nozzle is loose, it may come off during use and cause injury, accident, or damage to property.

CAUTION

Do not step on or put a heavy object on this product.
- It may cause an injury, accident, or damage to the solenoid valve.

If this product is not going to be used for a long period of time, keep it packaged in its individual package box.
- Storing the product out of its individual package box may cause foreign matters to enter the valve.

- For the gun type, be careful not to drop it. It may cause damage.
- If the product is not used for a month or more, the packing attached to the spool may stick to the body, resulting in a delay in the initial response time.
- When an abnormality is found, refer to "5 TROUBLESHOOTING".

3.3. Adjusting the Pulse Frequency

CAUTION

Do not slide the needle cover on the gun type with excessive force.
- Using excessive force may cause damage.

Do not turn the needle more than necessary.
- The adjustment range of the needle is approximately one turn. When the needle is turned, it will stop at the end position; however, if the needle is turned forcefully beyond this point, it may cause damage.

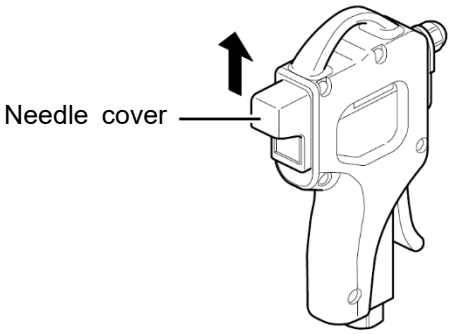
Adjust carefully so as not to blow away surrounding objects.
- If the flow rate is increased excessively, it may cause an accident.

After adjustment, be sure to tighten the lock nut.
- Failure to tighten the lock nut may result in performance changes due to external shock.

- Shut off the air supply before turning the needle. For information on the relationship between needle rotation and pulse frequency, refer to "7.1 Frequency Response Graph".
- Adjust the pulse frequency after attaching the nozzle to the blow port (or on the secondary side for the unit type). Note that the unit type is shipped without a nozzle.

1. For the gun type, slide the needle cover.

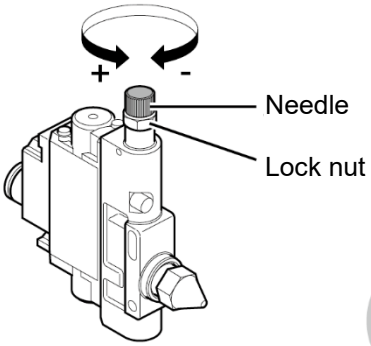
Slide the needle cover in the direction of the arrow shown in the figure below.



2. Loosen the lock nut and turn the needle to adjust the frequency.

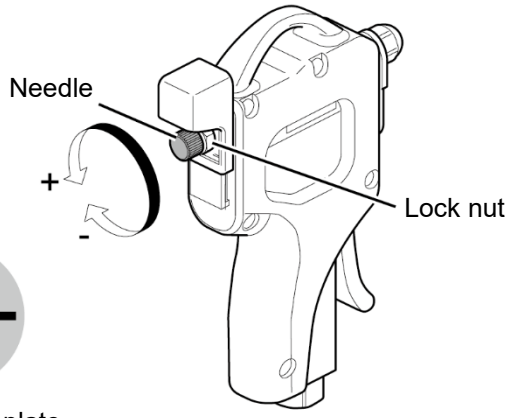
The adjustment range is approximately one turn.
Turning the needle in the - direction (clockwise) decreases the frequency.
Turning the needle in the + direction (counterclockwise) increases the frequency.

<Unit type>



Needle nameplate

<Gun type>



3. Tighten the lock nut to secure the needle in place.

4. For the gun type, slide the needle cover back to its original position.

3.4. Operating the Product (Gun Type)

WARNING

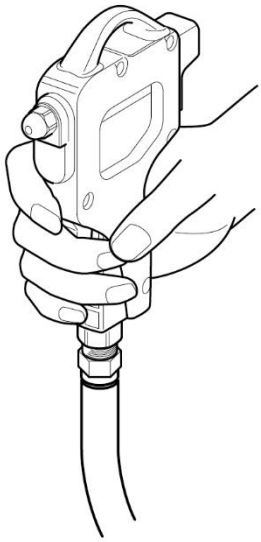
When using the product, observe the following.
- Wear a dust mask and safety glasses to prevent foreign matters blown up by the air blow from being inhaled or getting into your eyes. Also, wear earplugs to protect your ears.
- Do not point the nozzle at people.

CAUTION

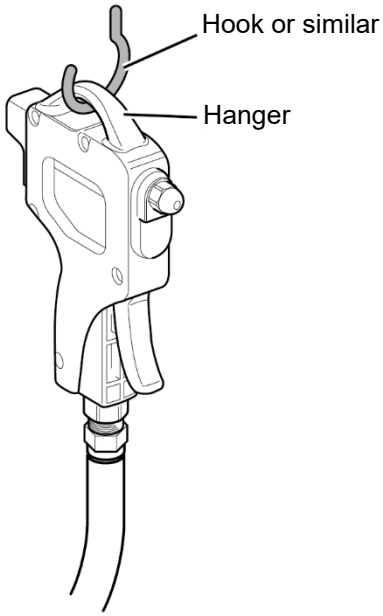
When using the product, observe the following.
- Do not drop the product or carry it by the tube.
- Use the product in such a way that the coupler or fitting between the tube and the supply port is not subjected to stress and the tube is not twisted or bent.

1. Point the nozzle at the point where the air is to be released and pull the lever all the way.

Pulling the lever releases the air.



2. After use, hang the product on a hook or similar using the hanger provided on the product.



CAUTION

After use, be sure to hang the product on a hook or similar using the hanger provided on the product for safekeeping.

- Hanging the product by any part other than the hanger may cause the product to fall or result in damage or operation fault.

4. MAINTENANCE AND INSPECTION

WARNING

Make sure to shut off the air source and exhaust any residual pressure in the piping before performing maintenance.
• Failure to do so may result in an injury.

4.1. Maintenance Parts

Maintenance Parts	General rule for when to make replacements
Nozzle	Replace the nozzle when the nozzle hole is clogged or when changing the nozzle hole diameter. If the frequency used is high, the nozzle hole tends to clog easily. For information on replacing the nozzle, refer to "2.4.1 How to attach the nozzle".

4.2. Periodic Inspection

In order to use the product under optimum conditions, perform periodic inspections every six months.
For the inspection details, refer to "3.1 Checks to Make Before Use (Checks Made After Mounting)" in this Instruction Manual.

4.3. Precautions on Product Disposal

CAUTION

When disposing of the product, comply with local laws and regulations pertaining to disposal and cleaning of wastes and have an industrial waste disposal company dispose of the product.

5. TROUBLESHOOTING

5.1. Problems, Causes, and Solutions

If the product does not operate as intended, check the table below for a possible solution.

- If the problem is not resolved even after conducting inspections and taking corrective actions, contact your nearest CKD sales office or distributor.

Problem	Cause	Solution
Air does not come out.	Air source pressure is low.	Adjust it to be within the specified range.
	Air source flow is insufficient.	Supply a sufficient amount of air.
	Shut-off valve upstream of this product is closed.	Open the shut-off valve.
	Nozzle is clogged.	Clean or replace the nozzle.
	Foreign matters are stuck inside.	Replace the product.
	There is internal wear and tear.	Replace the product.
Air does not change when needle is turned.	Air source pressure is low.	Adjust it to be within the specified range.
	Air source flow is insufficient.	Supply a sufficient amount of air.
	There is internal wear and tear.	Replace the product.
There is external leakage.	Air source pressure is high.	Adjust it to be within the specified range.
	There is internal wear and tear.	Replace the product.
There is internal leakage.	Foreign matters are stuck inside.	Replace the product.
	There is internal wear and tear.	Replace the product.

5.2. Frequently Asked Questions

Question	Answer
Tell me about pulsed blow.	Pulsed blow removes dust more efficiently than continuous air blow by intermittently blowing air at the object to be dusted. As a result, the same effect as continuous air blow can be obtained even if the amount of air blown is reduced, which leads to energy savings.
Is a power supply required?	This product does not require a power supply. Pulsed air is generated by operating the internal spool with compressed air.
What are some examples of use?	It can be used to remove deposits that are in dry conditions and to assist in the transport of workpieces. For removal of moisture and oil, check their condition before use.

6. WARRANTY PROVISIONS

6.1. Warranty Conditions

■ Warranty coverage

If the product specified herein fails for reasons attributable to CKD within the warranty period specified below, CKD will promptly provide a replacement for the faulty product or a part thereof or repair the faulty product at one of CKD's facilities free of charge. However, following failures are excluded from this warranty:

- Failure caused by handling or use of the product under conditions and in environments not conforming to those stated in the catalog, the Specifications, or this Instruction Manual.
- Failure caused by use of the product exceeding its durability (cycles, distance, time, etc.) or caused by consumable parts.
- Failure not caused by the product.
- Failure caused by use not intended for the product.
- Failure caused by modifications/alterations or repairs not carried out by CKD.
- Failure caused by reasons unforeseen at the level of technology available at the time of delivery.
- Failure caused by acts of nature and disasters beyond control of CKD.

The warranty stated herein covers only the delivered product itself. Any loss or damage induced by failure of the delivered product is excluded from this warranty.

■ Confirmation of product compatibility

It is the responsibility of the customer to confirm compatibility of the product with any system, machinery, or device used by the customer.

■ Others

The terms and conditions of this warranty stipulate basic matters.
When the terms and conditions of the warranty described in individual specification drawings or the Specifications are different from those of this warranty, the specification drawings or the Specifications shall have a higher priority.

6.2. Warranty Period

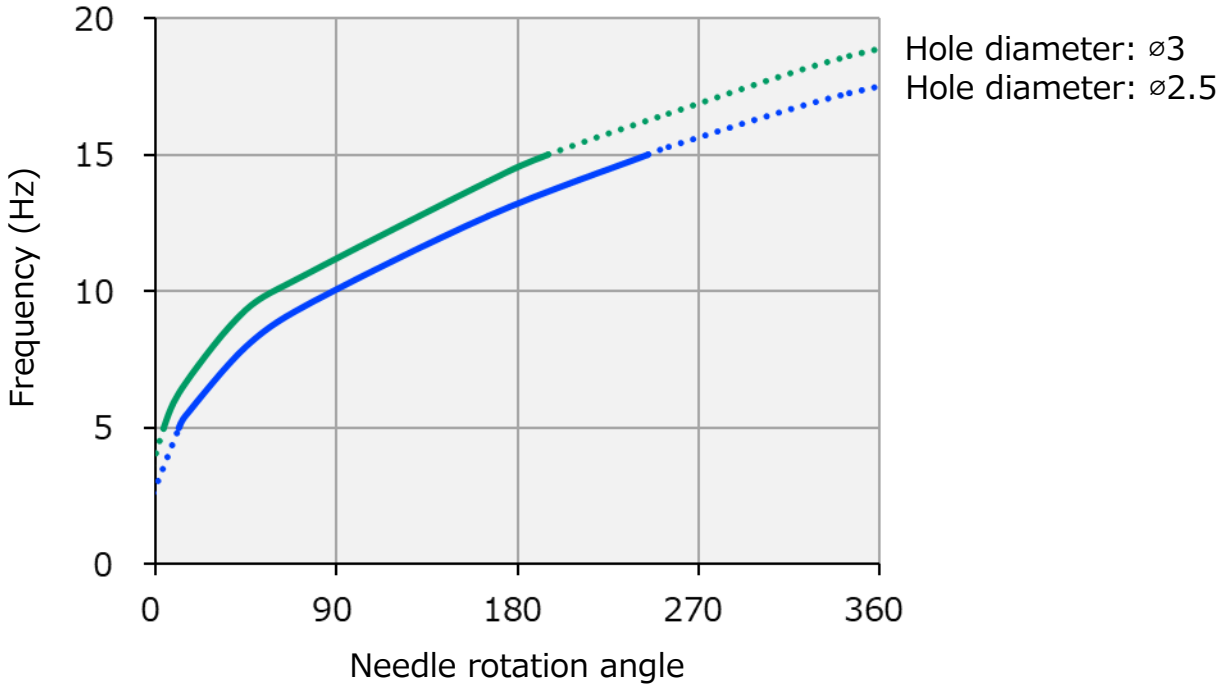
The product specified herein is warranted for one (1) year from the date of delivery to the location specified by the customer.

7. REFERENCE INFORMATION

7.1. Frequency Response Graph

These are reference values based on our testing conditions and are not guaranteed values. The values also vary depending on piping conditions, etc.
For the piping conditions, refer to "1.2.2 Piping conditions".

■ Frequency response relative to needle rotation angle



■ ON-Duty ratio characteristics relative to frequency