



Slim Small Linear Gripper Instruction Manual

Second Edition



Please Read Before Use

Thank you for purchasing our product.

This Instruction Manual explains how to operate, the configuration of, how to maintain, etc. this product, and specifies the necessary information for the safe use of the product.

Before using this product, be sure to read and understand the Instruction Manual to ensure your safety in the use of the product.

In the CD included with the product, there are Instruction Manuals of our products.

For a use of the products, print out or display on your personal computer the necessary pages of the applicable Instruction Manuals.

After reading the Instruction Manuals, be sure to keep them in a convenient place easily accessible to the personnel using this product.

[Important]

- This Instruction Manual is original.
- This product is not to be used for any other purpose from what is noted in this Instruction Manual. IAI shall not be liable whatsoever for any loss or damage arising from the result of using the product for any other purpose from what is noted in the manual.
- The information contained in this Instruction Manual is subject to change without notice for the purpose of production improvement.
- If you have any question or finding regarding the information contained in this Instruction Manual, contact our customer center or our sales office near you.
- Using or copying all or a part of this Instruction Manual without permission is prohibited.
- The company names, names of products and trademarks of each company shown in the sentences are registered trademarks.

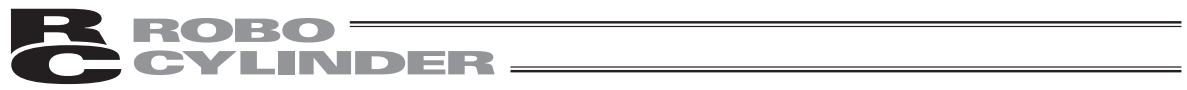


Table of Contents

Safety Guide	1
Precautions in Handling	7
Names of the Parts	9
1. Product Check	10
1.1 Parts	10
1.2 How to read the model plate	10
1.3 How to read the model	10
2. Specifications	11
3. Product Life	12
4. Installation and Storage/Preservation Environment	13
4.1 Installation Environment	13
4.2 Storage and Preservation Environment	13
5. Transportation	14
5.1 Handling of the Packed Product	14
5.2 Handling of the Unpacked Product	14
5.3 Handling in Assembled Condition	14
6. Attachment	15
6.1 Installation of Main Unit	15
6.2 Installation of Finger Attachments	17
6.3 Moving Direction and Attachment Orientation of Unit	18
6.4 Temperature Rises on Main Body and Finger	19
6.4.1 Temperature Rise from Ambient Temperature (Maximum Value)	19
6.4.2 Heat Release Effect by Heat Sink Application	20
7. Driving Circuit	21
8. Operation	22
9. Treatment of Cables	23
10. Allowable Load Condition	26
10.1 Check Holding Force and Allowable Load Conditions	26
11. Cautions During Work Part Travel	30
12. Removal of the Gripped Work Part	32
13. Option	33
13.1 Position Sensor	33

14. Maintenance Inspection	34
14.1 Inspection Items and Inspection Schedule	34
11.2 Exterior cleaning	34
15. Appendix	35
15.1 External Dimensions	35
15.1.1 Normally Closed Type with No Position Sensor	35
15.1.2 Normally Closed Type with Position Sensor (Option)	36
16. Warranty	37
16.1 Warranty Period	37
16.2 Scope of Warranty	37
16.3 Honoring Warranty	37
16.4 Limited Liability	37
16.5 Conditions of Conformance with Applicable Standards/Regulations, Etc. and Applications	38
16.6 Other Items Excluded from Warranty	38
Change History	39

Safety Guide

“Safety Guide” has been written to use the machine safely and so prevent personal injury or property damage beforehand. Make sure to read it before the operation of this product.

Safety Precautions for Our Products

The common safety precautions for the use of any of our robots in each operation.

No.	Operation Description	Description
1	Model Selection	<ul style="list-style-type: none">• This product has not been planned and designed for the application where high level of safety is required, so the guarantee of the protection of human life is impossible. Accordingly, do not use it in any of the following applications.<ol style="list-style-type: none">1) Medical equipment used to maintain, control or otherwise affect human life or physical health.2) Mechanisms and machinery designed for the purpose of moving or transporting people (For vehicle, railway facility or air navigation facility)3) Important safety parts of machinery (Safety device, etc.)• Do not use it in any of the following environments.<ol style="list-style-type: none">1) Location where there is any inflammable gas, inflammable object or explosive2) Place with potential exposure to radiation3) Location with the ambient temperature or relative humidity exceeding the specification range4) Location where radiant heat is added from direct sunlight or other large heat source5) Location where condensation occurs due to abrupt temperature changes6) Location where there is any corrosive gas (sulfuric acid or hydrochloric acid)7) Location exposed to significant amount of dust, salt or iron powder8) Location subject to direct vibration or impact• Do not use the product outside the specifications. Failure to do so may considerably shorten
2	Transportation	<ul style="list-style-type: none">• Consider well so that it is not bumped against anything or dropped during the transportation.• Transport it using an appropriate transportation measure.• Do not step or sit on the package.• Do not put any heavy thing that can deform the package, on it.• When using a crane capable of 1t or more of weight, have an operator who has qualifications for crane operation and sling work.• When using a crane or equivalent equipments, make sure not to hang a load that weighs more than the equipment's capability limit.• Use a hook that is suitable for the load. Consider the safety factor of the hook in such factors as shear strength.• Do not get on the load that is hung on a crane.• Do not leave a load hung up with a crane.• Do not stand under the load that is hung up with a crane.
3	Storage and Preservation	<ul style="list-style-type: none">• The storage and preservation environment conforms to the installation environment. However, especially give consideration to the prevention of condensation.

No.	Operation Description	Description
4	Installation and Start	<p>(1) Installation of Robot Main Body and Controller, etc.</p> <ul style="list-style-type: none"> • Make sure to securely hold and fix the product (including the work part). A fall, drop or abnormal motion of the product may cause a damage or injury. • Do not get on or put anything on the product. Failure to do so may cause an accidental fall, injury or damage to the product due to a drop of anything, malfunction of the product, performance degradation, or shortening of its life. • When using the product in any of the places specified below, provide a sufficient shield. <ul style="list-style-type: none"> 1) Location where electric noise is generated 2) Location where high electrical or magnetic field is present 3) Location with the mains or power lines passing nearby 4) Location where the product may come in contact with water, oil or chemical droplets
		<p>(2) Cable Wiring</p> <ul style="list-style-type: none"> • Use our company's genuine cables for connecting between the actuator and controller, and for the teaching tool. • Do not scratch on the cable. Do not bend it forcibly. Do not pull it. Do not coil it around. Do not insert it. Do not put any heavy thing on it. Failure to do so may cause a fire, electric shock or malfunction due to leakage or continuity error. • Perform the wiring for the product, after turning OFF the power to the unit, so that there is no wiring error. • When the direct current power (+24V) is connected, take the great care of the directions of positive and negative poles. If the connection direction is not correct, it might cause a fire, product breakdown or malfunction. • Connect the cable connector securely so that there is no disconnection or looseness. Failure to do so may cause a fire, electric shock or malfunction of the product. • Never cut and/or reconnect the cables supplied with the product for the purpose of extending or shortening the cable length. Failure to do so may cause the product to malfunction or cause fire.
		<p>(3) Grounding</p> <ul style="list-style-type: none"> • Make sure to perform the grounding of type D (Former Type 3) for the controller. The grounding operation should be performed to prevent an electric shock or electrostatic charge, enhance the noise-resistance ability and control the unnecessary electromagnetic radiation.





No.	Operation Description	Description
4	Installation and Start	<p>(4) Safety Measures</p> <ul style="list-style-type: none"> • When the product is under operation or in the ready mode, take the safety measures (such as the installation of safety and protection fence) so that nobody can enter the area within the robot's movable range. When the robot under operation is touched, it may result in death or serious injury. • Make sure to install the emergency stop circuit so that the unit can be stopped immediately in an emergency during the unit operation. • Take the safety measure not to start up the unit only with the power turning ON. Failure to do so may start up the machine suddenly and cause an injury or damage to the product. • Take the safety measure not to start up the machine only with the emergency stop cancellation or recovery after the power failure. Failure to do so may result in an electric shock or injury due to unexpected power input. • When the installation or adjustment operation is to be performed, give clear warnings such as "Under Operation; Do not turn ON the power!" etc. Sudden power input may cause an electric shock or injury. • Take the measure so that the work part is not dropped in power failure or emergency stop. • Wear protection gloves, goggle or safety shoes, as necessary, to secure safety. • Do not insert a finger or object in the openings in the product. Failure to do so may cause an injury, electric shock, damage to the product or fire. • When releasing the brake on a vertically oriented actuator, exercise precaution not to pinch your hand or damage the work parts with the actuator dropped by gravity.
5	Teaching	<ul style="list-style-type: none"> • Perform the teaching operation from outside the safety protection fence, if possible. In the case that the operation is to be performed unavoidably inside the safety protection fence, prepare the "Stipulations for the Operation" and make sure that all the workers acknowledge and understand them well. • When the operation is to be performed inside the safety protection fence, the worker should have an emergency stop switch at hand with him so that the unit can be stopped any time in an emergency. • When the operation is to be performed inside the safety protection fence, in addition to the workers, arrange a watchman so that the machine can be stopped any time in an emergency. Also, keep watch on the operation so that any third person can not operate the switches carelessly. • Place a sign "Under Operation" at the position easy to see. • When releasing the brake on a vertically oriented actuator, exercise precaution not to pinch your hand or damage the work parts with the actuator dropped by gravity. <p>* Safety protection Fence : In the case that there is no safety protection fence, the movable range should be indicated.</p>

No.	Operation Description	Description
6	Trial Operation	<ul style="list-style-type: none"> • After the teaching or programming operation, perform the check operation one step by one step and then shift to the automatic operation. • When the check operation is to be performed inside the safety protection fence, perform the check operation using the previously specified work procedure like the teaching operation. • Make sure to perform the programmed operation check at the safety speed. Failure to do so may result in an accident due to unexpected motion caused by a program error, etc. • Do not touch the terminal block or any of the various setting switches in the power ON mode. Failure to do so may result in an electric shock or malfunction.
7	Automatic Operation	<ul style="list-style-type: none"> • Before the automatic operation is started up, make sure that there is nobody inside the safety protection fence. • Before the automatic operation is started up, make sure that all the related peripheral machines are ready for the automatic operation and there is no error indication. • Make sure to perform the startup operation for the automatic operation, out of the safety protection fence. • In the case that there is any abnormal heating, smoke, offensive smell, or abnormal noise in the product, immediately stop the machine and turn OFF the power switch. Failure to do so may result in a fire or damage to the product. • When a power failure occurs, turn OFF the power switch. Failure to do so may cause an injury or damage to the product, due to a sudden motion of the product in the recovery operation from the power failure.
8	Maintenance and Inspection	<ul style="list-style-type: none"> • Perform the work out of the safety protection fence, if possible. In the case that the operation is to be performed unavoidably inside the safety protection fence, prepare the "Stipulations for the Operation" and make sure that all the workers acknowledge and understand them well. • When the work is to be performed inside the safety protection fence, basically turn OFF the power switch. • When the operation is to be performed inside the safety protection fence, the worker should have an emergency stop switch at hand with him so that the unit can be stopped any time in an emergency. • When the operation is to be performed inside the safety protection fence, in addition to the workers, arrange a watchman so that the machine can be stopped any time in an emergency. Also, keep watch on the operation so that any third person can not operate the switches carelessly. • Place a sign "Under Operation" at the position easy to see. • For the grease for the guide or ball screw, use appropriate grease according to the Instruction Manual for each model. • Do not perform the dielectric strength test. Failure to do so may result in a damage to the product. • When releasing the brake on a vertically oriented actuator, exercise precaution not to pinch your hand or damage the work parts with the actuator dropped by gravity. <p>* Safety protection Fence : In the case that there is no safety protection fence, the movable range should be indicated.</p>

No.	Operation Description	Description
9	Modification	<ul style="list-style-type: none"> • Do not modify, disassemble, assemble or use of maintenance parts not specified based at your own discretion. • In such case, the warranty is not applied.
10	Disposal	<ul style="list-style-type: none"> • When the product becomes no longer usable or necessary, dispose of it properly as an industrial waste. • Do not put the product in a fire when disposing of it. The product may burst or generate toxic gases.

Alert Indication

The safety precautions are divided into “Danger”, “Warning”, “Caution” “Notice” according to the warning level, as follows, and described in the Instruction Manual for each model.

Level	Degree of Danger and Damage	Symbol
Danger	This indicates an imminently hazardous situation which, if the product is not handled correctly, will result in death or serious injury.	 Danger
Warning	This indicates a potentially hazardous situation which, if the product is not handled correctly, could result in death or serious injury.	 Warning
Caution	This indicates a potentially hazardous situation which, if the product is not handled correctly, may result in minor injury or property damage.	 Caution
Notice	This indicates lower possibility for the injury, but should be kept to use this product properly.	 Notice

Precautions in Handling

1. Do not stand close to this product if you use a medical device such as a pacemaker.

There is a high performance rare earth permanent magnet (neodymium magnet) used in the actuator. It may cause an error to the operation of medical devices such as a pacemaker.

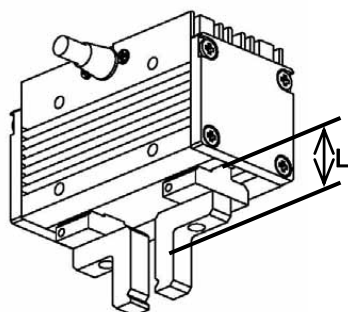
2. Use the unit within the range of specified allowable load moment.

If a load beyond the range is applied, it may shorten the product life.

3. Keep the holding point of the work part at 20mm or less and the overhang at 10mm or less.

If the finger attachments are long and big or the weight is large, the inertial force at open and close of the fingers become large and that may cause a drop of the performance or a malfunction of the guide part.

Also, if the finger attachments are long, moment is applied to the fingers and that may cause a drop of performance or a malfunction of the guide part.



Holding Point (L) ⇒ 20mm or less

4. Install the fingers facing downwards.

Mounting the fingers in an orientation other than downwards may allow foreign object to get in the unit from the openings, which may result in a bad operation of the fingers or malfunction of the unit.

5. Do not have the fingers open continuously for more than 60sec. Use the unit with the duty at 50% or less.

Use of the unit beyond the specified conditions may cause a malfunction of the unit such as difficulty in opening the fingers, breakage or short of the inductors.

6. This product generates heat. The temperature may get high depending on how to install it.

Watch out for a burn or injury.

Make sure to follow the instructions below when installing.

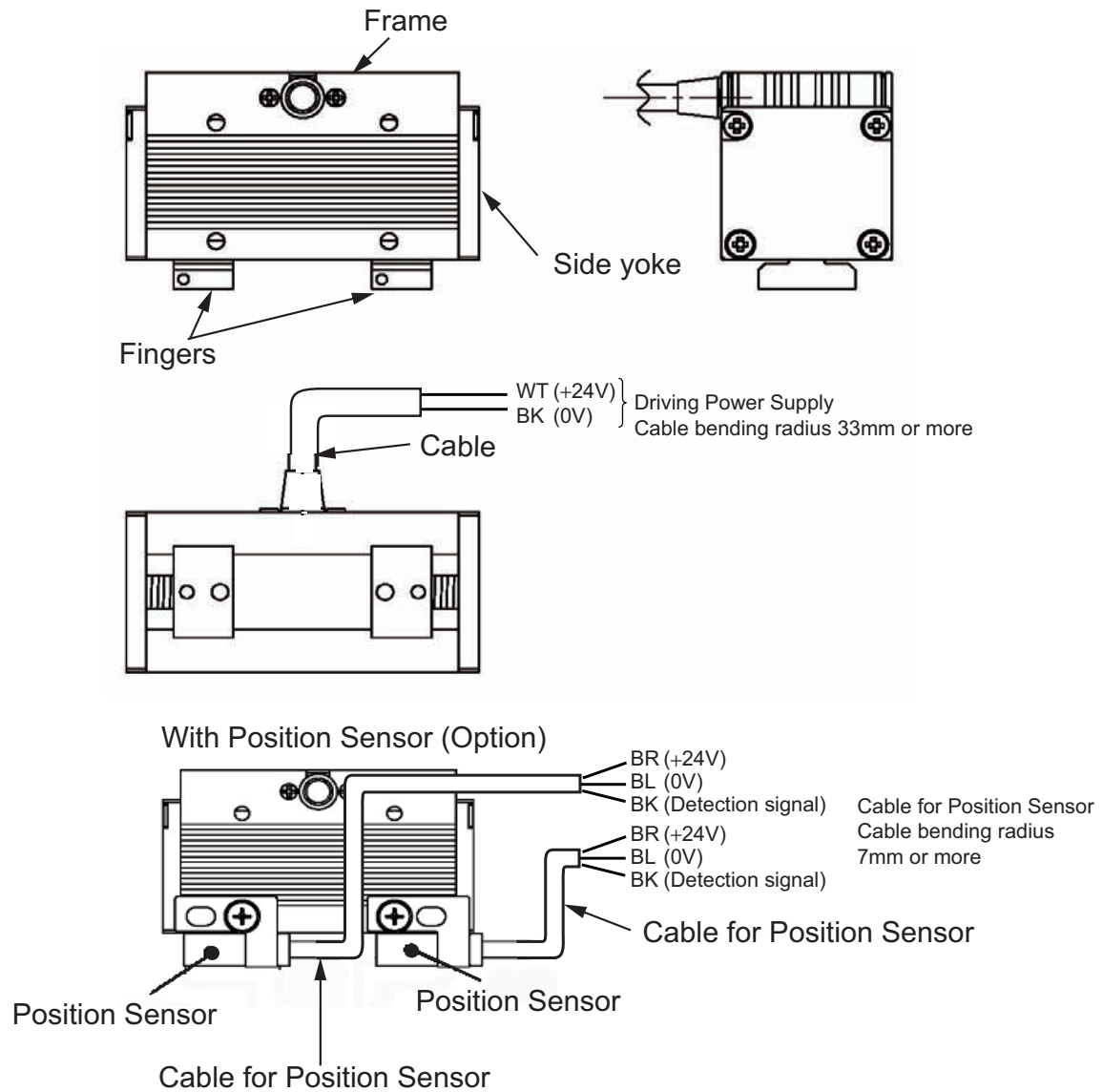
- Install the unit on a material with high heat conductivity.
To prevent a temperature rise on the unit, install it on a material such as metal, which possesses the characteristic of good heat conductivity. Installing the unit on a material with insufficient heat conductivity may cause the unit to raise its temperature and may result in a malfunction.
- Do not use this product under conditions with bad heat radiation, such as fixing the unit body on an insulation material or use the unit in a closed area which would not allow heat to be released. Using this product in a condition with bad heat radiation may cause the unit to raise its temperature and may result in a malfunction.
- To block heat from being conducted to the work part, use a material with low heat conductivity such as polyacetal for the finger attachments.

The heat of the unit is conducted from the fingers to the work part via the finger attachments.
(Reference)

When operated with duty 50%, the temperature rises in approximately 40°C at the unit attachment surface (side surface) and finger attachment surfaces.


[Refer to 6.4 Temperature Rises on Main Body and Finger]

Names of the Parts



1. Product Check

The standard configuration of this product is comprised of the following parts.


 Note : Check packed items with the packing list. If you find any fault with the product you have received, or any missing parts, contact us or our distributor.

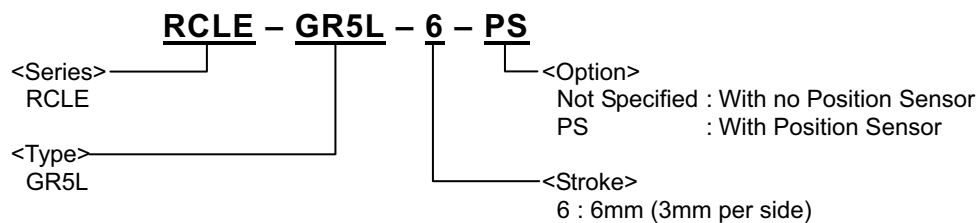
1.1 Parts

No.	Part Name	Model	Reference
1	Actuator Main Body	Refer to “How to read the model plate”, “How to read the model”	
Accessories			
2	Instruction Manual		
3	Safety Guide		

1.2 How to read the model plate



1.3 How to read the model

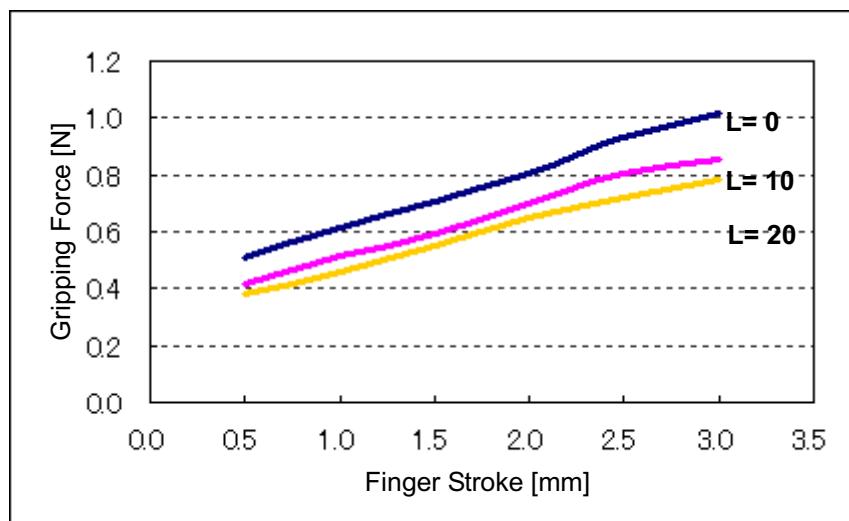


2. Specifications

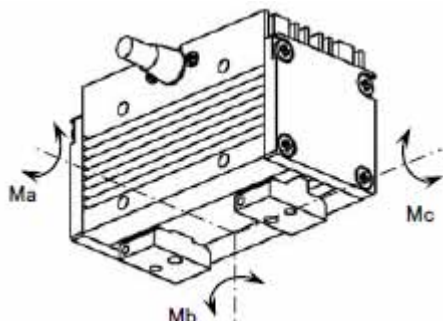
Item	No Position Sensor	With Position Sensor (Option)
Open/Close Stroke	6 (3 per side) mm	
Open/Close Operation	Power is OFF : Close Power is ON : Open	
Maximum Open/Close Frequency	600 cycles/min	
Minimum Open Duration	0.05sec	
Continuous Operation Time	60sec or less	
Maximum Gripping Force ^{*1}	1±0.2N (0.1 ±0.2kgf)	
Positioning Accuracy Repeatability ^{*2}	± 0.1mm	
Static Load Moment ^{*3}	Ma : 0.02N•m Mb : 0.02N•m Mc : 0.04N•m	
Driving Voltage	24V DC ±10%	
Driving Current	0.5A	
Rush Current	0.6A or less	
Back EMF from Power ON to OFF	Counter electromotive voltage : Approx. 40V Counter electromotive current : Approx. 0.1A	
Operational Surrounding Environment	Temperature 0 to 40°C Temperature 20 to 85%RH or less (non-condensing)	
Preservation Environment	Temperature 0 to 40°C Temperature 20 to 85%RH or less (non-condensing)	
Body Weight	0.16kg	0.18kg

- *1 This is the holding force of the finger at 3mm on one side assuming the holding point is 0mm and the overhang is 0mm. The holding force varies depending on the point on the stroke where the fingers hold the work part. (It simply means the holding force varies depending on the width of the work part.) The holding force will vary in ±0.05N after 10,000,000 cycles of open and close operation.


Relation of Finger Stroke and Holding Force (reference)



- *2 It shows the positioning accuracy repeatability at the most closed finger point.
- *3 It shows the static allowable load moment at the most closed finger point. Applying load more than this value will decrease the product life and also may cause a malfunction.



Static Load Moment in M_a , M_b and M_c Directions

 Note : Even though there is a high performance rare earth permanent magnet (neodymium magnet) used in the actuator, the structure of the actuator body is designed not to leak out the magnetic force much on its surface.

Leaked Magnetic Flux Density at Each Part of Actuator (Reference)

Measurement Point		Leaked Magnetic Flux Density [mT]
1	Top Surface of Finger	2 or less
2	Top Surface of Main Unit	3 or less
3	Side Surface of Main Unit	5 or less
4	Bottom Surface of Main Unit	7 or less
5	Surface of Side Yoke	7 or less
6	Side Surface of Side Yoke	7 or less
7	Top Surface of Side Yoke	7 or less

3. Product Life

The product life is 10,000,000 cycles of open and close operation (reference).

4. Installation and Storage/Preservation Environment

4.1 Installation Environment

Do not use this product in the following environment.

It is generally the environment where a worker can work without any protection gear.

Also make sure to keep enough work space necessary for maintenance.

- Location exposed to radiant heat from a huge heat source such as the heat treatment
- Location where the surrounding air temperature exceeds the range of 0 to 40°C
- Location where condensation occurs due to abrupt temperature changes
- Location where relative humidity exceeds 85%RH
- Location exposed to direct sunlight
- Location exposed to corrosive gases or combustible gases
- Location exposed to significant amount of dust, salt or iron powder (Outside of ordinary assembly plant)
- Location where water, oil (includes oil mist and cutting fluid) or chemical is splashed
- Location where the product main body receives vibration or hit impact

When using the product in any of the locations specified below, provide a sufficient shield.

- Location subject to electrostatic noise
- Location where exposed to the influence of strong electric or magnetic field
- Location where exposed to the influence of ultraviolet or radiant rays

4.2 Storage and Preservation Environment

In particular, when the machine is to be stored for a long time, pay close attention to environmental conditions so that no dew condensation forms.

Unless specially specified, moisture absorbency protection is not included in the package when the machine is delivered. In the case that the machine is to be stored and preserved in an environment where dew condensation is anticipated, take the condensation preventive measures from outside of the entire package, or directly after opening the package.

For storage and preservation temperature, the machine withstands temperatures up to 60°C for a short time, but in the case of the storage and preservation period of 1 month or more, control the temperature to 50°C or less.

Storage and preservation should be performed in the horizontal condition. In the case it is stored in the packaged condition, follow the posture instruction if any displayed on the package.

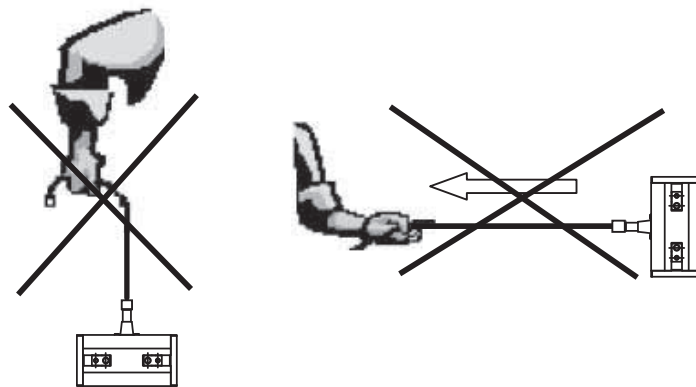
5. Transportation

5.1 Handling of the Packed Product

- Be careful not to hit or drop the product.
- Follow the instruction if there is any for the packaging condition.
- Do not step or sit on the package.
- Do not put any heavy thing that can deform the package, on it.

5.2 Handling of the Unpacked Product

- Grab the body part when holding the actuator. Do not carry the actuator by holding the cable, or do not move it by pulling the cable.



- Be careful not to hit or drop the product when transporting or installing it. Pay attention especially to the fingers.
- Do not give any excessive force to any of the sections in the actuator. Pay attention especially to the fingers and the cable.

5.3 Handling in Assembled Condition

If it is out of the package, cover up the whole unit for protection and do not damage to it.

6. Attachment

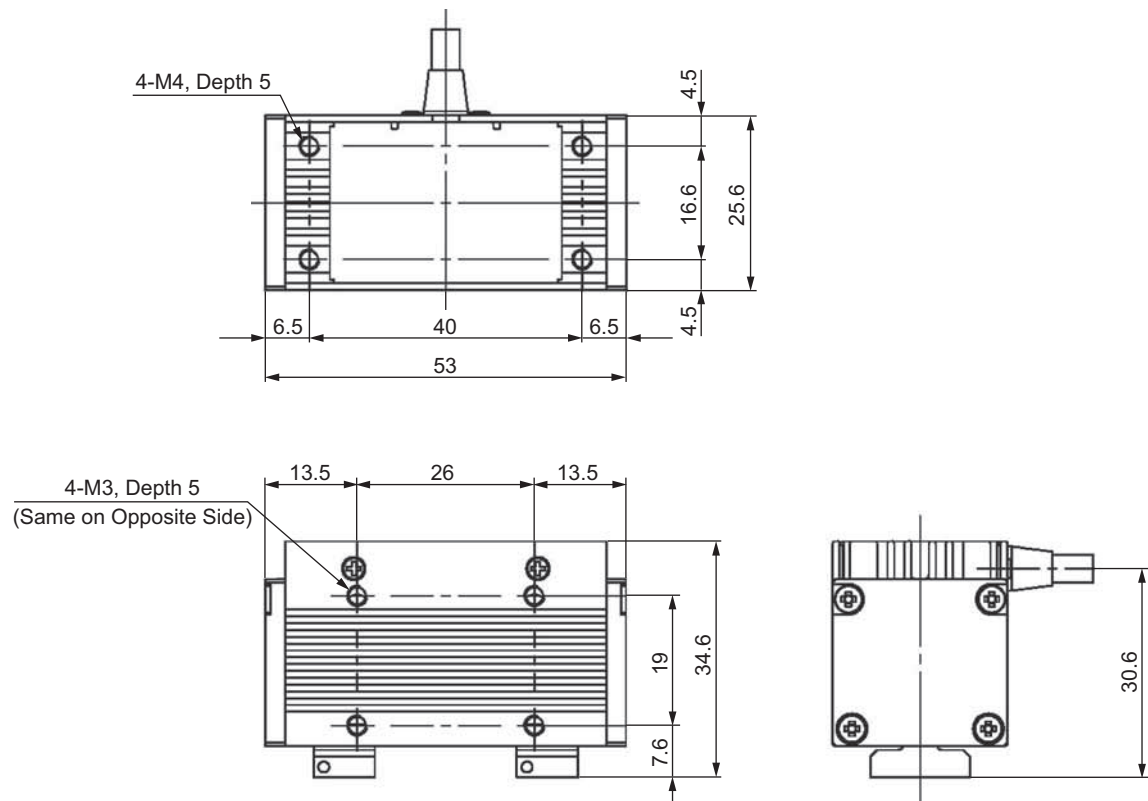
Mount the unit so the fingers comes down at the bottom.

6.1 Installation of Main Unit

There are threaded holes prepared for attachment on the 3 surfaces of the main unit. Choose the suitable ones to install the unit.

The effective thread depths differ for each attachment surface. Refer to the drawing to determine the screw length. For the installation of the unit, make sure that attachment surface is a machined surface or a surface with an equivalent accuracy.

Bolts to be used	Tightening Torque	
	When Attachment Surface is Steel	When Attachment Surface is Aluminum
M3	154N•cm (15.8kgf•cm)	83N•cm (8.47kgf•cm)





Note :

- Some tapped holes for attachment are through holes. Do not attempt to use a long screw with the length more than the effective screw length of the hole. Doing so may damage the mechanical parts or electrical parts inside.
- The temperature of the unit gets very high in a continuous operation. To lessen the temperature rise of the unit, install it on a material such as metal that possesses high heat conductivity performance.

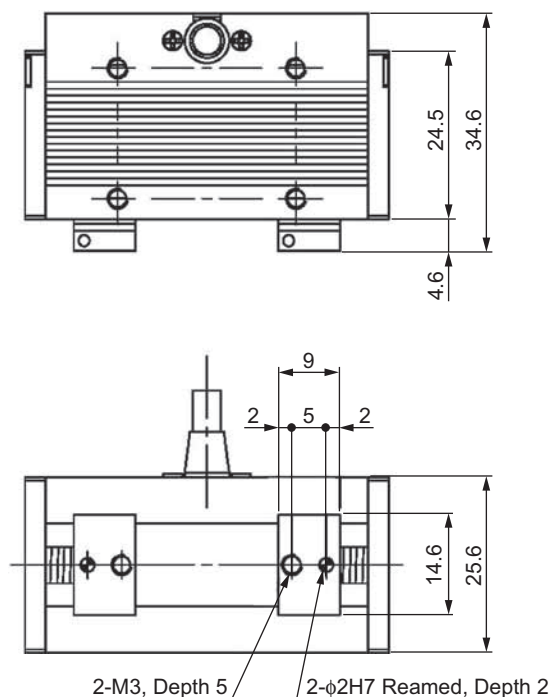
It may cause an extreme temperature rise on the unit, and may end up with a breakdown.
(Reference)

When operated with duty 50%, the temperature rises in approximately 40°C at the unit attachment surface (side surface) and finger attachment surfaces.

[Refer to 6.4 Temperature Rises on Main Body and Finger]

6.2 Installation of Finger Attachments

Bolts to be used	Tightening Torque	
	When Attachment Surface is Steel	When Attachment Surface is Aluminum
M3	154N•cm (15.8kgf•cm)	83N•cm (8.47kgf•cm)



Note :

- When applying or removing the finger attachment to the finger, hold the finger attachment with a tool such as a wrench to support it to tighten the attachment screws to avoid load or stress applied to the guide part.
- The heat of the unit is conducted from the fingers to the work part via the finger attachments. To block heat from being conducted to the work part, use a material with low heat conductivity such as polyacetal for the finger attachment.

(Reference)

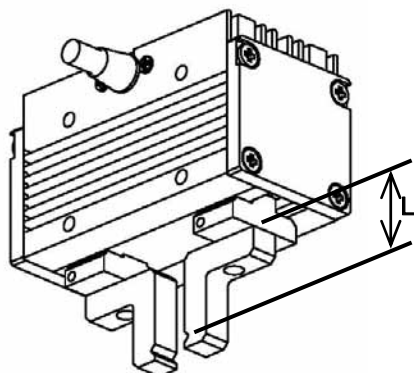
When operated with duty 50%, the temperature rises in approximately 40°C at the unit attachment surface (side surface) and finger attachment surfaces.

[Refer to 6.4 Temperature Rises on Main Body and Finger]



Note :

- Set the distance from the attachment surface of the finger attachment to the holding point (L) equal or less than the value specified below.



Holding Point (L) \Rightarrow 20mm or less

- Attempt to have the finger attachments attached to the unit as small and light as possible. If the finger attachments are long and big or the weight is large, the inertial force and the bending moment at open and close of the fingers may cause a drop of the performance or a malfunction of the guide part.
- Each finger has a play of 1° to all of M_a , M_b and M_c directions.

6.3 Moving Direction and Attachment Orientation of Unit

Pay attention to the movement direction and the attachment orientation of the unit.

In case the moving direction of the unit is the same as the movements of the fingers and if the acceleration is high and the inertial force exceeds the reaction force of the finger springs, the fingers may move.

Reference of Acceleration Exceeding Spring Reaction Force (assuming total weight of left and right finger attachments is 20g and work part is 10g)

Finger Stroke	Acceleration
0mm	0.8G
1mm	1.3G
2mm	1.8G
3mm	2.3G

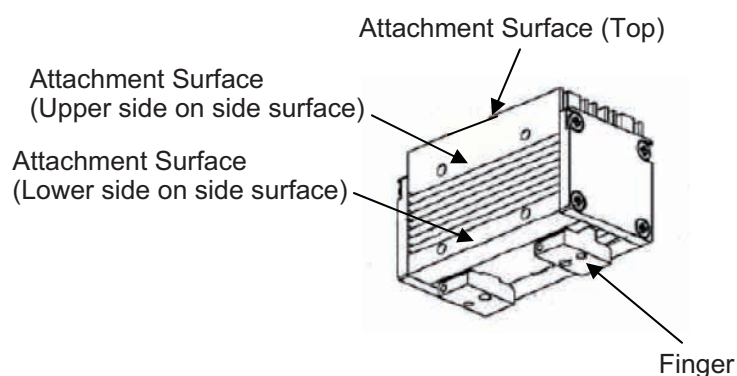
When holding the work part, the acceleration of the finger movements may differ depending on the weight of the finger attachments and that of the work part.

6.4 Temperature Rises on Main Body and Finger

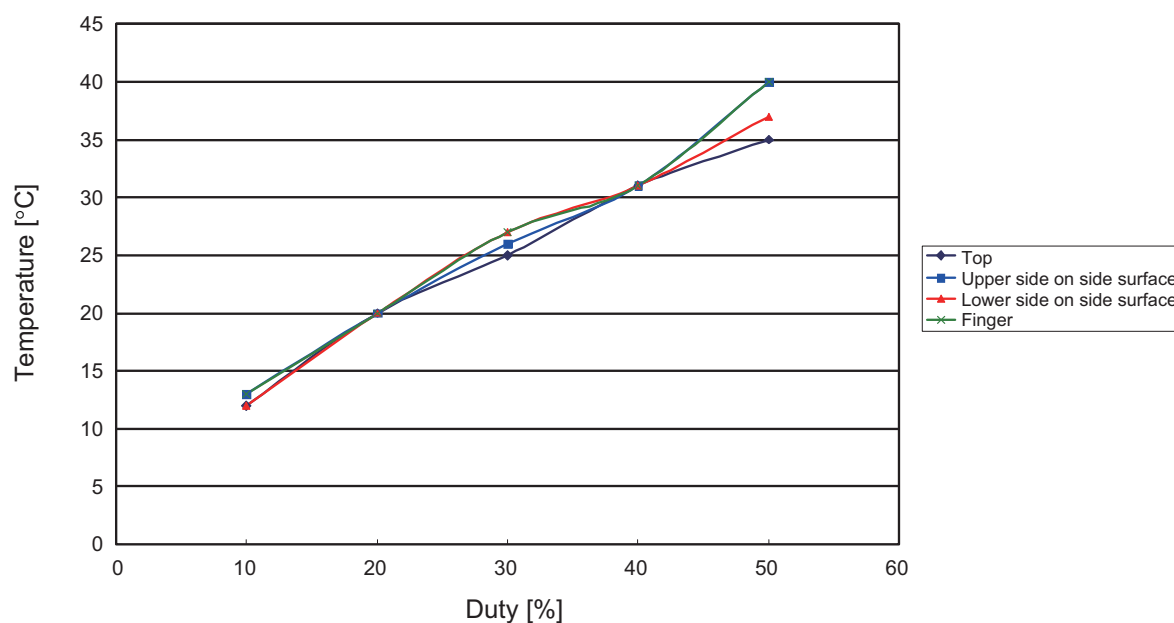
6.4.1 Temperature Rise from Ambient Temperature (Maximum Value)

The graph below shows the temperature rise (maximum value) from the ambient temperature for each duty.

The measured points are as shown below:



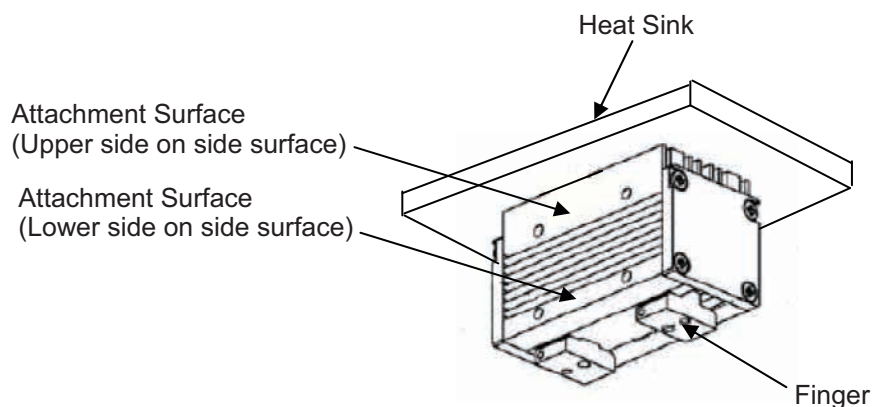
Reference : Temperature Rise from Ambient Temperature (Maximum Value)
Ambient temperature at measurement : Approx. 25°C



⚠ Danger : This product generates heat. The temperature may get high depending on how it is installed. Don't get burned or injured.


6.4.2 Heat Release Effect by Heat Sink Application

The graph below shows the temperature rise (maximum value) from the ambient temperature when the unit is operated with 50% duty with 2 types of heat sinks applied on the attachment surface (top surface).



Reference data : Temperature Rise from Ambient Temperature (Maximum Value)
Ambient temperature at measurement : Approx. 25°C

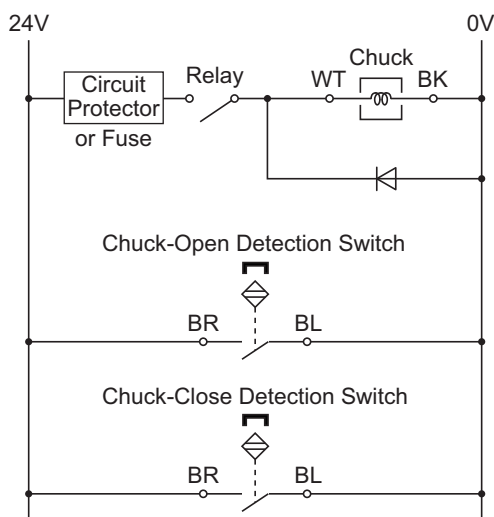
Heat Sink		Heat Sink	Attachment Surface (Upper side on side surface)	Attachment Surface (Lower side on side surface)	Finger
Dimensions	Material				
60 × 60 × 5	Aluminum Anodized Surface	Approx. 22°C	Approx. 26°C	Approx. 25°C	Approx. 36°C
150 × 85 × 10	Aluminum Polished surface	Approx. 17°C	Approx. 23°C	Approx. 22°C	Approx. 34°C

 **Note :** Even if a heat sink is attached on the top of the unit, the temperature on the fingers would not decrease much. To block heat from being conducted to the work part, use a material with low heat conductivity such as polyacetal for the finger attachments. The heat of the unit is conducted from the fingers to the work part via the finger attachments.

7. Driving Circuit

Follow the example of the driver circuit shown below to apply the diode, relay and circuit protector (or fuse) to the cable ends and connect to the 24V DC power supply. To protect the gripper, make sure to apply the circuit protector (or fuse). Please prepare the diode, relay and circuit protector (or fuse) separately from the product.

The cable length should be approximately 1m. It is bare wire on one end.



(1) Selection of the Circuit Protector or Fuse

Select ones with the following performance:

- Rated Current : 2A
- Transient Characteristics : Should cut the power within 3sec at 200% of rated current
Select from a high-speed type or a transient type if a circuit protector is used.

(2) Relay

Select ones that satisfy the following conditions:

- Select solid state relays when open and close operation is frequently conducted.
- Output rated load voltage: 24V DC $\pm 10\%$
- Output load current : 1A or less

(Reference) G3FD-X102SN DC5-24 manufactured by OMRON is available.

(3) Diode

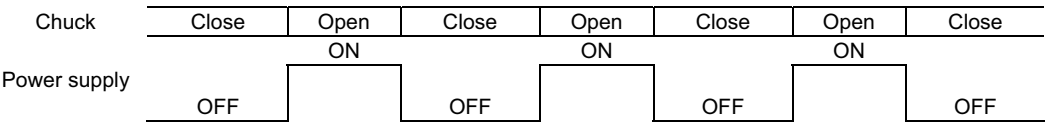
Counter EMF is generated when turning the power OFF from being ON to close the fingers of the gripper from being open. Select a diode that is able to cut the voltage caused by the counter EMF.

- Counter electromotive voltage : Approx. 40V
- Counter electromotive current : Approx. 0.1A

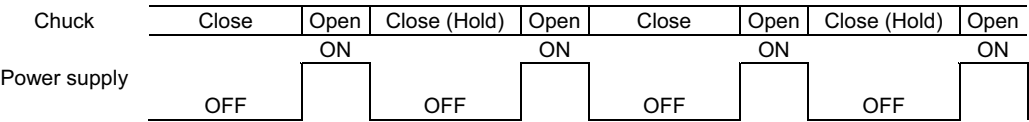
(Reference) D1N60 manufactured by Shindengen Electric Manufacturing is available.

8. Operation

This gripper opens the chuck when the power is ON and closes it with the springs when the power is turned OFF.



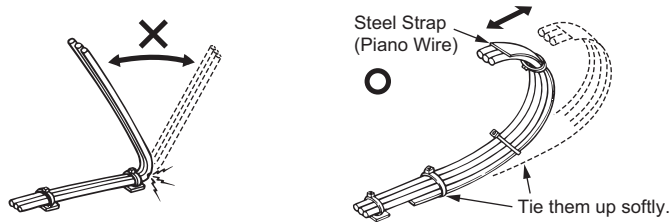
Opening the chuck just before holding the work shortens the time that the power is conducted, thus enables to save the power consumption.
It also prevents the product temperature to rise.



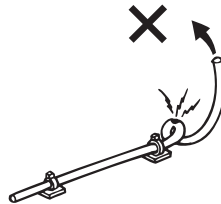
9. Treatment of Cables

When constructing the application system, make sure to lay out each cable and connect them correctly otherwise it may cause unexpected troubles such as cable breakage or contact failure. Described below are the things that are prohibited to be done regarding the treatment of cables.

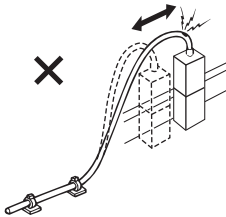
- Do not cut and extend, shorten or rejoin the cables.
- Have a sufficient radius for bending to avoid stress being applied to one place. [For the bending radius, refer to the name of each part.]



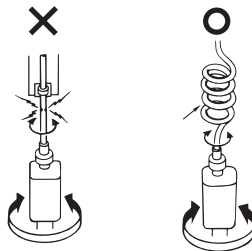
- Do not let the cable bend, kink or twist.



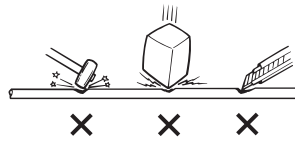
- Do not pull the cable with a strong force.



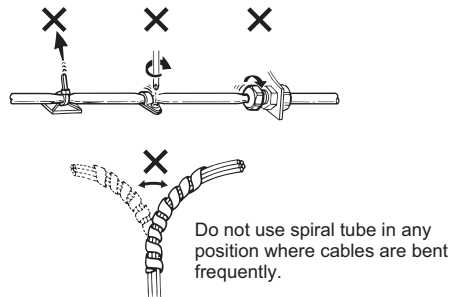
- Do not let the cable receive a turning force at a single point.



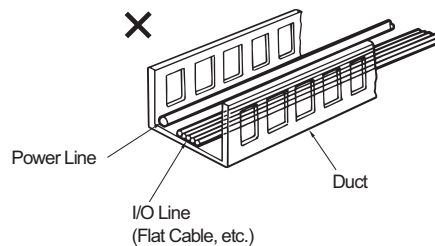
- Do not pinch, drop a heavy object onto or cut the cable.



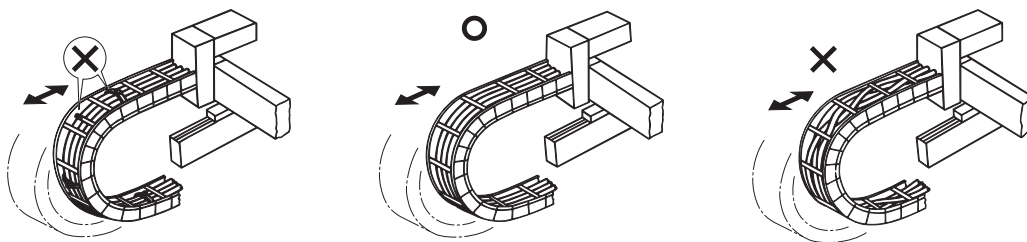
- When fixing the cable, provide a moderate slack and do not tension it too tight.



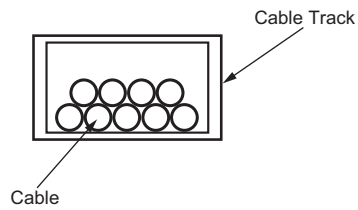
- Separate the I/O line, communication line and power line from each other. Do not put them in the same duct.



- If using a cable track, make sure to use robot cables so the cables do not get twisted or entangled inside the cable track or flexible tube, and also make the cables free to avoid the cables getting tied. (Make sure the cables do not get pulled when being bent.) [For the bending radius, refer to the name of each part.]



- The occupied volume rate for the cables, etc., inside the cable track should be 60% or less.



Warning :

- When the cable is connected or disconnected, make sure to turn OFF the power to the controller. When the cable is connected or disconnected with the controller power turned ON, it might cause a malfunction of the actuator and result in a serious injury or damage to the machinery.
- When the connector connection is not correct, it would be dangerous because of a malfunction of the actuator. Make sure to confirm that the connector is connected correctly.

10. Allowable Load Condition

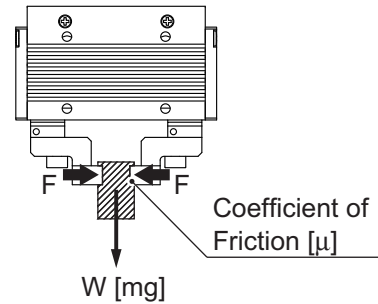
10.1 Check Holding Force and Allowable Load Conditions

Follow the steps below:

Step 1: Check the necessary holding force and the weight of the work part

Step 2: Check the allowable vertical load of the fingers and allowable moment

Step 1: Check the necessary holding force and the weight of the work part



In ordinary work part movement

Necessary holding force \Rightarrow 10 to 20 times the weight of the work part

Work part weight \Rightarrow 1/10 to 1/20 or less of the holding force

As the calculation below shows, the weight of the work part capable to hold gets bigger as the coefficient of friction gets larger. However, for safety reasons, have the holding force 10 to 20 times more than the work part weight regardless of the coefficient of friction.

(Calculation Example) Here, figure out the necessary holding force when gripping the work part with the friction force.

(1) In ordinary travel

F : Gripping Force [N].....Total value of the pressing force of each finger

W : Work part weight [kgf]

μ : Coefficient of static friction between finger attachments and work part

m : Work part mass [kg]

g : Acceleration of gravity [= 9.8m/s²]

The condition when the work part is held firmly and work part would not drop is:

$$F\mu > \frac{W}{g}$$

$$F > \frac{mg}{\mu g}$$

The necessary holding force in ordinary travel considering a recommended safety factor of 2 is:

$$F > \frac{m}{\mu} \times 2 \text{ (Safety Margin)}$$

Assuming the coefficient of friction μ is 0.1 to 0.2:

$$F > \frac{m}{0.1 \text{ to } 0.2} \times 2 = (10 \text{ to } 20) \times m$$

(2) When large acceleration or impact is applied during work part movement.

It will apply bigger inertial forces to the work part as well as gravity. In such a case, consider more holding force and a larger safety factor.

When large acceleration/deceleration or impact is applied

Necessary holding force \Rightarrow 30 to 50 times the weight of the work part

Work part weight \Rightarrow 1/30 to 1/50 or less of the holding force

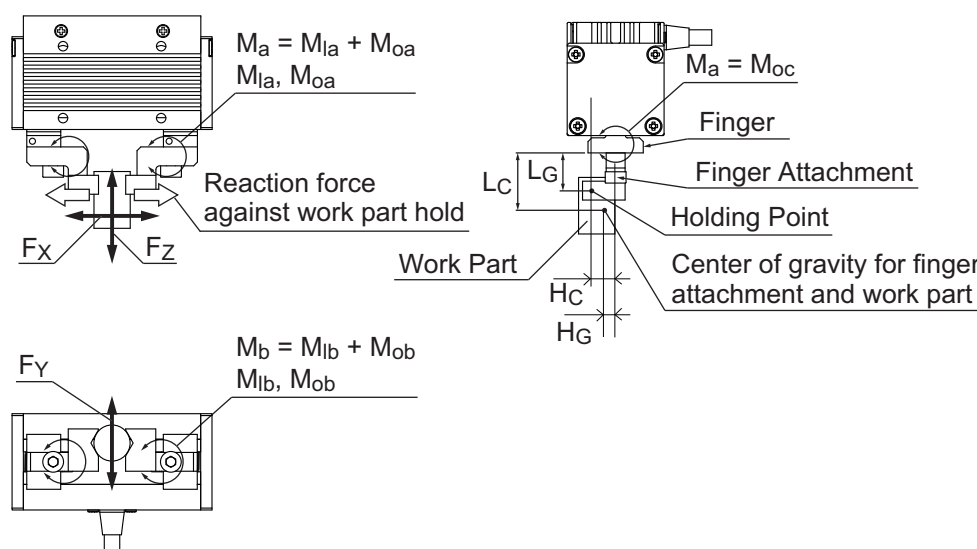
Step 2: Check the allowable vertical load of the fingers and allowable moment

Table 1. Allowable load and allowable moment on the fingers

Allowable load in the vertical direction [N] F_{zmax}	Allowable Load Moment [Nm]		
	M_{amax}	M_{bmax}	M_{cmax}
12	0.02	0.02	0.04

Check the vertical load and the load moments applied to the fingers. Do not exceed the allowable range of F_z , M_a , M_b and M_c .

The values shown are the static allowable load and static allowable load moments that may be applied to each finger. Also, the allowable moment is the value the load is applied only in one direction. If the load is applied in two directions, divide the specified values in half.

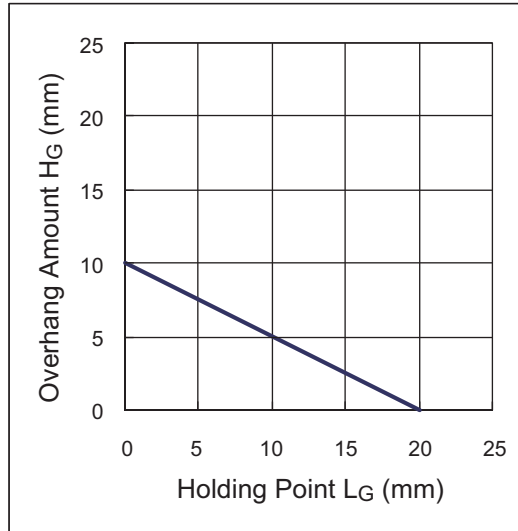


F_x : External force in X direction applied to finger attachment [N]
 F_y : External force in Y direction applied to finger attachment [N]
 F_z : External force in Z direction applied to finger attachment [N]
 L_G : Distance from finger attachment surface to holding point (holding point) [m]
 H_G : Distance from finger center to holding point (overhang) [m]
 L_C : Distance from finger attachment surface to center of finger attachment gravity [m]
 H_C : Distance from finger center to center of finger attachment gravity [m]

M_{la} : Moment in M_a direction generated on fingers by holding force [Nm]
 M_{lb} : Moment in M_b direction generated on fingers by holding force [Nm]
 M_{Oa} : Moment in M_a direction generated on fingers by external force [Nm]
 M_{Ob} : Moment in M_b direction generated on fingers by external force [Nm]
 M_{Oc} : Moment in M_c direction generated on fingers by external force [Nm]
 M_a : All the moments in M_a direction generated on fingers [Nm]
 M_b : All the moments in M_b direction generated on fingers [Nm]
 M_c : All the moments in M_c direction generated on fingers [Nm]

Consider the value shown below as the upper limit for $L_G H_G$. Use beyond the limited range will give extreme moment to the finger slide part and internal mechanism, which could badly influence to the product life.

Figure 2. Upper Limit of 2-Finger Gripper Holding Point L_G and Overhang H_G



(1) Moment generated on fingers by holding force

1) Moment in M_a direction [M_{la}]

$$M_{la} = L_G \frac{1.5F_G}{2}$$

2) Moment in M_b direction [M_{lb}]

$$M_{lb} = H_G \frac{1.5F_G}{2}$$


The maximum holding force is 1 + 0.2N described in “2. Performance”. The maximum holding force is indicated at the finger when the holding point is 0mm and overhang distance is 0mm. Holding force varies depending on the stroke. [Refer to 2. Performance]

- (2) Moment generated on fingers by external force
When applying the gripper to Orthogonal, Articulated or other actuator and moving straight or turning, there is an external force other than holding force applied to the work part and finger attachments.
- ◆ External force applied to the work part and finger attachments [F_x , F_y and F_z]
Calculate the external force below for the three directions X, Y and Z applied to the work part and finger attachments based on the usage condition and sum up the numbers.
 - a) Weights of the work part and finger attachments
 $F = mg$ m : Weights of the work part and finger attachments,
 g : Gravitational acceleration
 - b) Inertial force when gripper is moving straight
 $F = ma$ a : Acceleration when moving
 - c) Centrifugal force when gripper is turned
 $F = m\omega^2 r$ r : Radius of turn, ω : Angular velocity

Make sure that F_z is below F_{zmax} , the allowable load in vertical direction shown in Table 1.

- ◆ Moment generated on the fingers by an external force
Calculate the moment in each direction by the external forces F_x , F_y and F_z .
 - 1) Moment in M_a direction [M_{Oa}]
 $M_{Oa} = L_c F_x$
 - 2) Moment in M_b direction [M_{Ob}]
 $M_{Ob} = H_c F_x$
 - 3) Moment in M_c direction [M_{Oc}]
 $M_{Oc} = L_c F_y + H_c F_z$
- (3) All the moments in each direction applied to the fingers
 $M_a = M_{la} + M_{Oa}$, $M_b = M_{lb} + M_{Ob}$, $M_c = M_{Oc}$

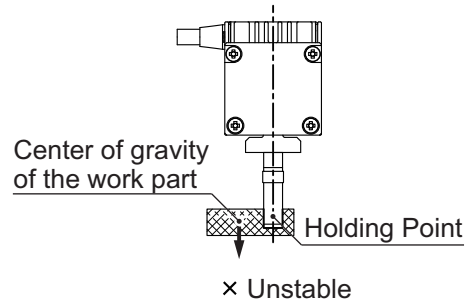
Confirm the calculated number is below the value for the allowable load moment shown in Table 1.

 **Note :** Even if the finger attachments are within the allowable range, attempt to have them as small and light as possible. If the fingers are long and large or the weight is high, it may cause a drop in performance or badly influence the guide part due to the moment caused by the impact due to gripping the work part.

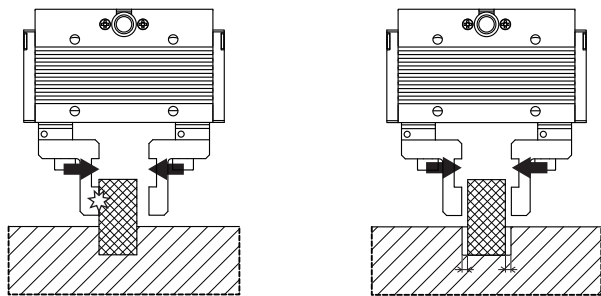
11. Cautions During Work Part Travel

By applying a strong force or impact other than the holding force to the fingers during a work part travel, it may cause the fingers to be off the correct position, to be loosened or malfunction. Please be careful not to apply force or impact during travel.

- Set the holding point as close as possible to the center of gravity of the work part. If it is far, the moment due to gravity may make the work part orientation unstable.

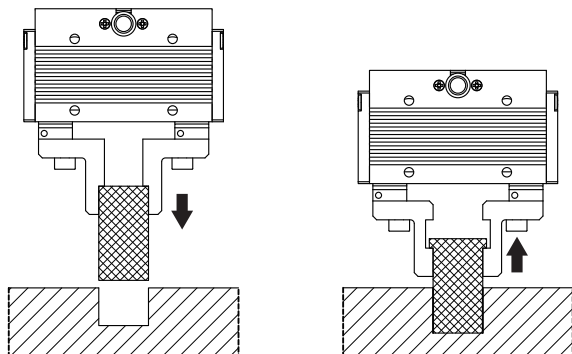


- Keep clearance to the work part in the directions it gets gripped. Also, have enough adjustment so the work part is gripped at the center and the load cannot be focused only on one finger.



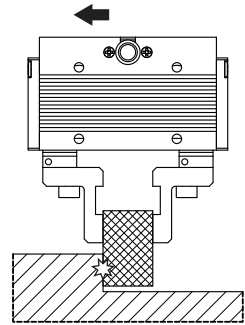
× No clearance, load not balanced ○ With sufficient clearance

- Do not attempt to have such operations that insert the work part into a pocket or pull it out from a pocket while the work part is being held with the gripper.



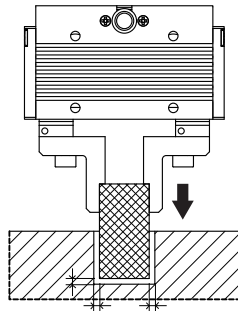
× Press-fitting not permitted × Pulling out press-fitted work part not permitted

- Do not attempt to push the work part to the side while it is held with the gripper.

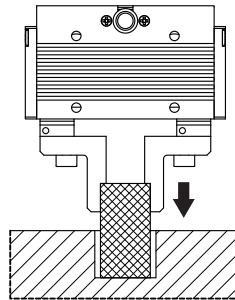


× Pushing not permitted

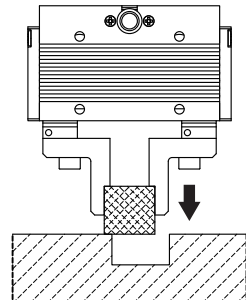
- When inserting the work part into a pocket, have enough clearance considering variants in the position. Also have enough adjustment to center the work part. (Be careful not to hit the work part during the inserting operation.)



○ With sufficient clearance



× No clearance,
load to be impacted



× Not centered

12. Removal of the Gripped Work Part

This gripper possesses a structure to keep the work part holding force with springs even when the power is shutdown.

When the held work part is necessary to be removed while the power is OFF, move the fingers to the opening direction and remove the work part.



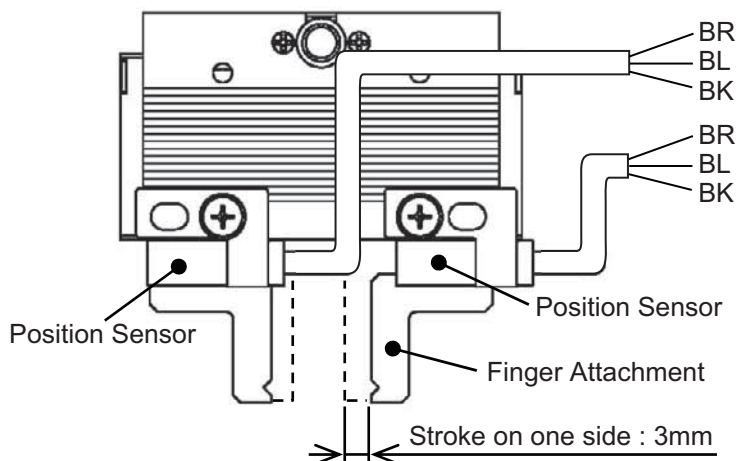
Note :

- When the held work part is necessary to be removed while the power is off, move the fingers to the opening direction and remove the work part. Pulling off the work part forcefully may cause damage to the gripper unit.
- Remove the work part when the machine is kept being stopped for a long while. Leaving it for a long time while holding the work part may badly influence the gripper such as a drop in the performance.

13. Option

13.1 Position Sensor

- Example of using the position sensor



- Sensor Wiring List

Wire Color	Signal Name
BR	+24V
BL	0V
BK	Detection Signal

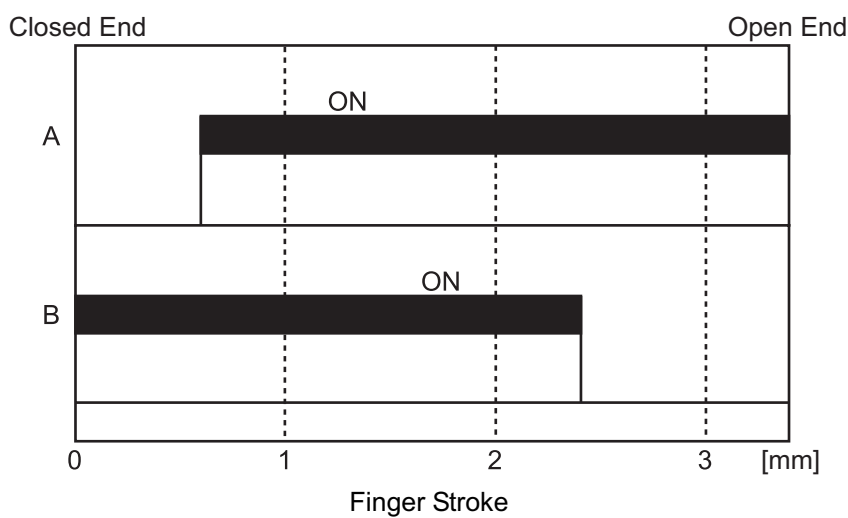
* Since there are 2 sensor units to be used, there will be 2 codes for each signal in the harness.

<Detection of Close, Hold and Open>

B sensor turns ON while the power is OFF (fingers are closed) and A turns ON when the power is ON (fingers are fully open).

Both sensors A and B are ON while the work part is being held.

Thus, only the B sensor turns ON when a failure occurs in holding the work part.



Combinations of signals

Finger Position	Sensor Output	
	A	B
Closed End	OFF	ON
Middle	ON	ON
Open End	ON	OFF

14. Maintenance Inspection

To use the actuator in a good condition for a long term, it is recommended to have daily inspections and also regular inspections.


14.1 Inspection Items and Inspection Schedule

The standard maintenance inspection schedule is as described below.
The calculation is conducted under the condition that there are 8 working hours per day. Have inspections more frequently if the operation frequency is high for night and day continuous operation, etc.

	Visual inspection
At startup inspection	○
1 month after start of operation	○
6 months after start of operation	○
1 year after start of operation	○
Every 6 months thereafter	○
Every year thereafter	○

For the visual inspection, check the appearance following items.

Main Body	Looseness of attachment screws
Cables	Existence of damage and condition of cable connections
Overall	Abnormal noise, vibration

 **Note :** Do not dismantle the unit or cut the cables. Please contact us if it is considered necessary to dismantle the unit for such reasons as a failure in operation.
The warranty to the operation and failure will be voided if a dismantlement or cable cut is confirmed on the unit.

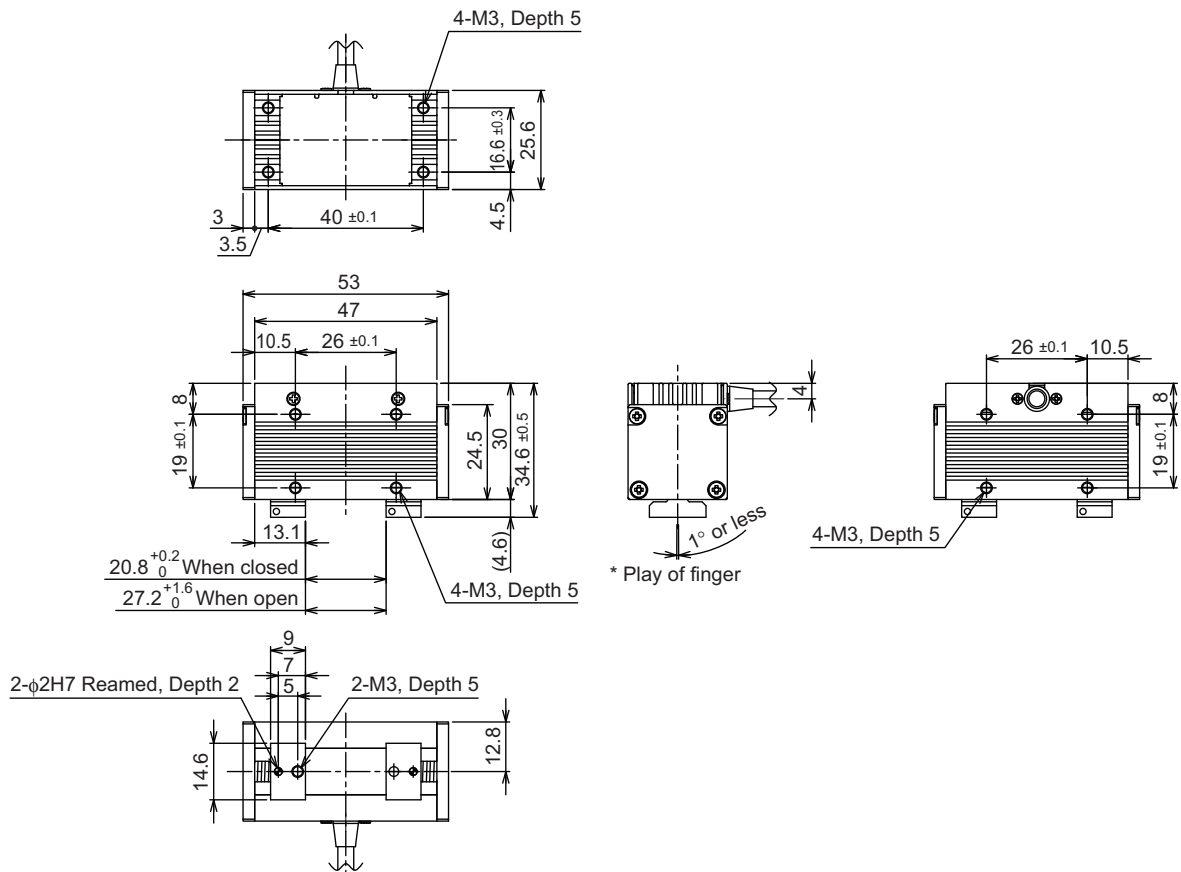
14.2 Exterior cleaning

- Please have cleaning of the external body at any time.
- When cleaning, wipe with a soft cloth to remove dust and dirt.
- To avoid dust getting inside the unit from small gaps, do not attempt to have compressed air blown on the unit body.
- Do not apply petroleum solvent since it may damage the resin or painted surfaces.
- When it is extremely dirty, have neutral detergent applied on a soft cloth, and wipe off the dirt firmly.

15. Appendix

15.1 External Dimensions

15.1.1 Normally Closed Type with No Position Sensor



16. Warranty

16.1 Warranty Period

One of the following periods, whichever is shorter:

- 18 months after shipment from our factory
- 12 months after delivery to a specified location
- 2,500 operational hours

16.2 Scope of Warranty

Our products are covered by warranty when all of the following conditions are met. Faulty products covered by warranty will be replaced or repaired free of charge:

- (1) The breakdown or problem in question pertains to our product as delivered by us or our authorized dealer.
- (2) The breakdown or problem in question occurred during the warranty period.
- (3) The breakdown or problem in question occurred while the product was in use for an appropriate purpose under the conditions and environment of use specified in the instruction manual and catalog.
- (4) The breakdown or problem in question was caused by a specification defect or problem, or by the poor quality of our product.

Note that breakdowns due to any of the following reasons are excluded from the scope of warranty:

- [1] Anything other than our product
- [2] Modification or repair performed by a party other than us (unless we have approved such modification or repair)
- [3] Anything that could not be easily predicted with the level of science and technology available at the time of shipment from our company
- [4] A natural disaster, man-made disaster, incident or accident for which we are not liable
- [5] Natural fading of paint or other symptoms of aging
- [6] Wear, depletion or other expected result of use
- [7] Operation noise, vibration or other subjective sensation not affecting function or maintenance

Note that the warranty only covers our product as delivered and that any secondary loss arising from a breakdown of our product is excluded from the scope of warranty.

16.3 Honoring Warranty

As a rule, the product must be brought to us for repair under warranty.

16.4 Limited Liability

- [1] We shall assume no liability for any special damage, consequential loss or passive loss such as a loss of expected profit arising from or in connection with our product.
- [2] We shall not be liable for any program or control method created by the customer to operate our product or for the result of such program or control method.

16.5 Conditions of Conformance with Applicable Standards/Regulations, Etc., and Applications

- (1) If our product is combined with another product or any system, device, etc., used by the customer, the customer must first check the applicable standards, regulations and/or rules. The customer is also responsible for confirming that such combination with our product conforms to the applicable standards, etc. In such a case we will not be liable for the conformance of our product with the applicable standards, etc.
- (2) Our product is for general industrial use. It is not intended or designed for the applications specified below, which require a high level of safety. Accordingly, as a rule our product cannot be used in these applications. Contact us if you must use our product for any of these applications:
 - [1] Medical equipment pertaining to maintenance or management of human life or health
 - [2] A mechanism or mechanical equipment intended to move or transport people (such as a vehicle, railway facility or aviation facility)
 - [3] Important safety parts of mechanical equipment (such as safety devices)
 - [4] Equipment used to handle cultural assets, art or other irreplaceable items
- (3) Contact us at the earliest opportunity if our product is to be used in any condition or environment that differs from what is specified in the catalog or instruction manual.

16.6 Other Items Excluded from Warranty

The price of the product delivered to you does not include expenses associated with programming, the dispatch of engineers, etc. Accordingly, a separate fee will be charged in the following cases even during the warranty period:

- [1] Guidance for installation/adjustment and witnessing of test operation
- [2] Maintenance and inspection
- [3] Technical guidance and education on operating/wiring methods, etc.
- [4] Technical guidance and education on programming and other items related to programs

Change History

Revision Date	Description of Revision
2011.08	First edition
2011.09	Second edition <ul style="list-style-type: none"> • “Caution” changed to “Caution in Handling” • P.12 Specifications Open/Close Operation Normally closed, open when it is ON → Power is OFF : Close Power is ON : Open • P.23 8. Control Logic → 8. Operation Change in stated contents • P.20 6.4 Temperature Rises on Main Body and Finger Attachments → 6.4 Temperature Rises on Main Body and Finger



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