Doc. no. TQ1300100-OM101-B

Operation Manual

PRODUCT NAME

Electric Vacuum Gripper

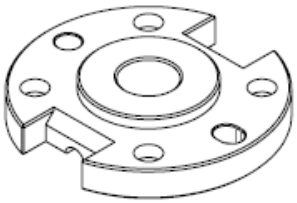
MODEL / Series / Product Number

ZXPE5-P-X100

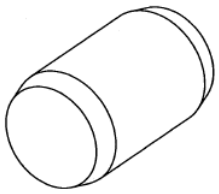
SMC Corporation

Table of Contents

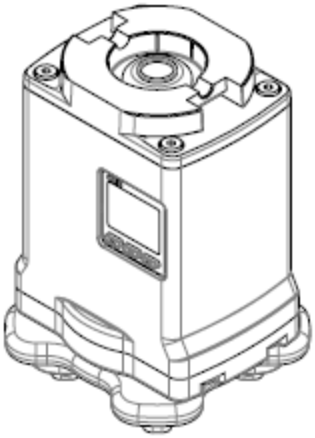
1. Parts included in the package



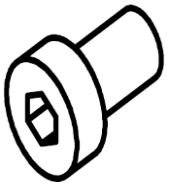
Main plate: 1 pc.



Parallel pin (6x10): 1 pc.

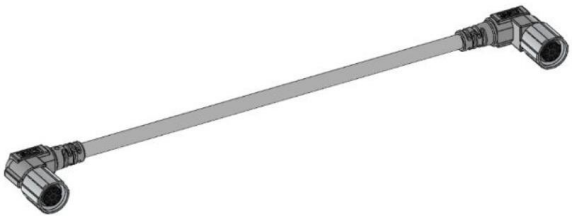


Electric Vacuum Gripper: 1 pc.

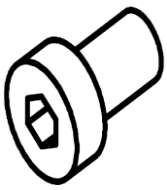


Hexagon socket thin head bolt
(M6 x 10): 4 pc.

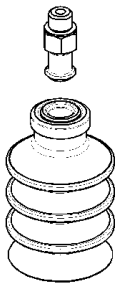
Clamper: 2 pc.



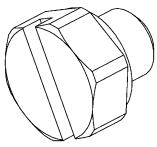
Connector cable: 1 pc.
Part No. RMH-A00-11-A



Hexagon socket head bolt
(M5 x 25): 2 pc.



Suction cup with adapter: 4 pcs.
Part No.: ZP2-TB25JS-AS6

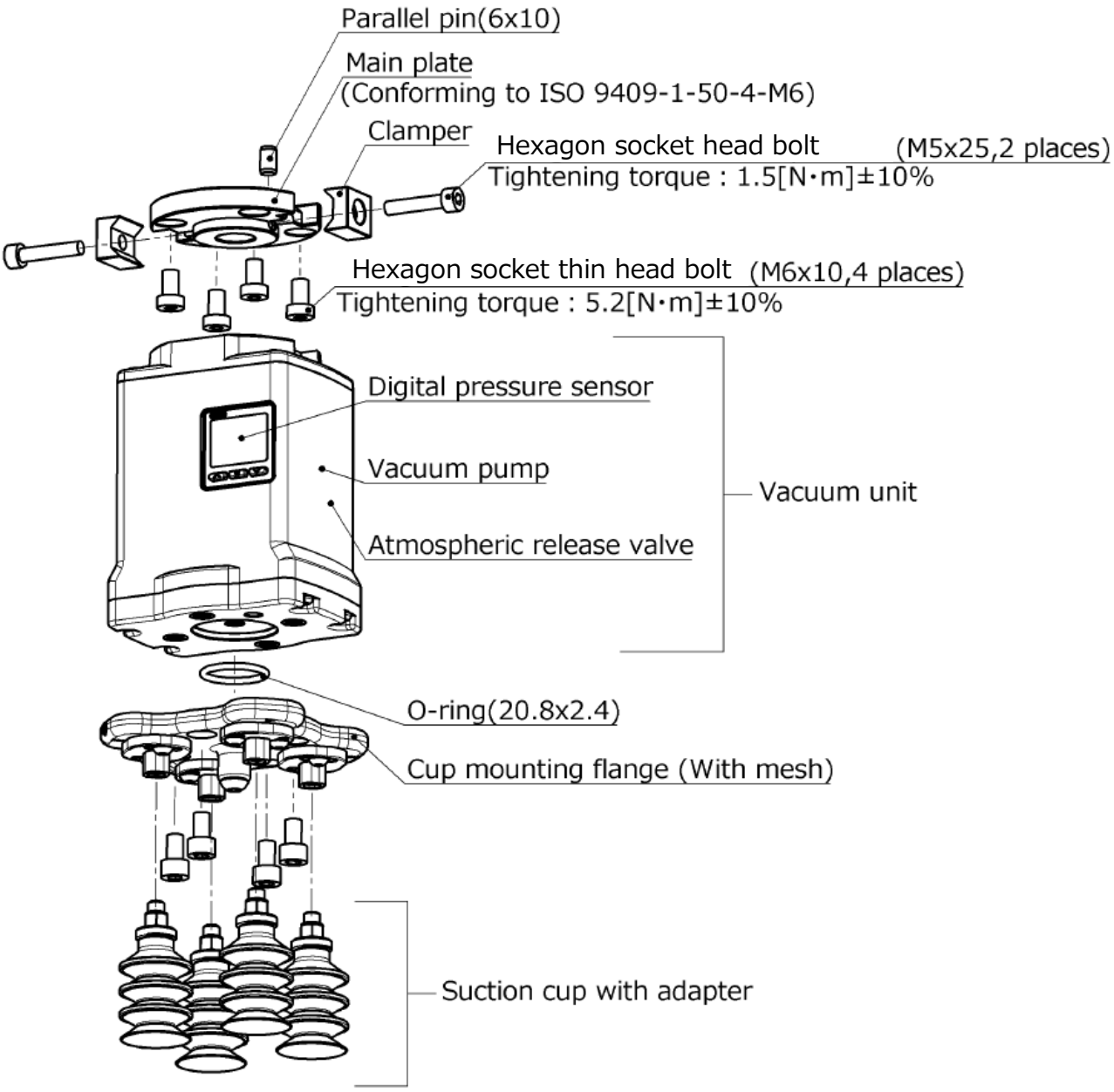


Plug: 4 pcs.
Part No. M-3P
(Used for decreasing the number of suction cups)

* URCap will be sent separately.

2. Names and descriptions of parts

2.1. Names of parts of the product



2.2. Descriptions of parts

Main plate:	Connects the gripper with the robot.
LED:	Indicates the gripper’s status.
DIP switch:	Changes the gripper’s operation mode.
Pressure monitor:	Displays real-time vacuum pressure and the gripper's operation mode and sets parameter threshold values.
Vacuum pump:	Generates vacuum.
Atmospheric release valve:	Releases air to atmosphere upon the release command.
SET/TEST button:	Moves to initial setup or fault diagnostic function or between parameters.
Cup mounting flange:	Connects a cup with the gripper body.
Cup with adapter:	Grips workpieces. Select a cup suitable for the workpiece.

2.3. LED light and status of the gripper

Table 1. LED light and status of the gripper

LED		Gripper status
Color	Status	
-	No light	No supply voltage, Device disabled
Green	Flashing	Idle state
	Light	Grip success
Red	Flashing	Alarm (Refer to “5.3.4. Commissioning Table 6. Alarm list” for details.)
	Flashing x 2	Execute “Factory reset”
	Light	Grip and Release failure, Work drop detection

3. Specifications

3.1. Specifications

■Product specifications

Table 2. Product specifications

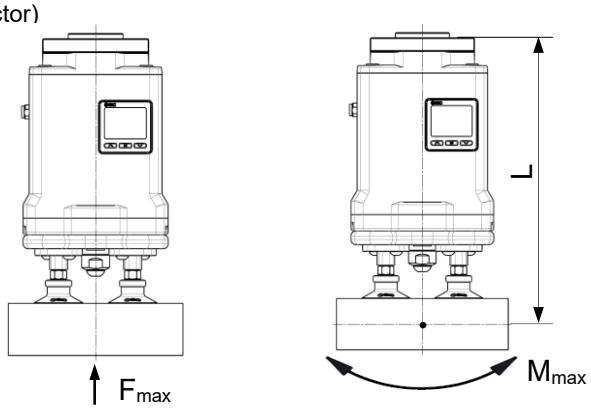
Body specifications	Compatible robot		UR3e, UR5e, UR10e, UR16e (UNIVERSAL ROBOTS)
	Standards		Conforming to “ISO 9409-1-50-4-M6”
	Operating temperature range [°C]		5 to 40
	Connector type		M8 8-pin (Plug)
	Weight [g] excluding cups with adapter 1)		722 (556)
	Max. work load [kg] 2)		5
	Static allowable load F_{max} [N] 3)		150
	Static allowable moment M_{max} [N·m] 3)		1
	Max. vacuum pressure [kPa] 4)		-74
	Max. suction flow rate [L/min(ANR)] 4)		4.5
	Impact / Vibration resistance [m/s²] 5)		150 / 30
	Noise level [dB(A)] 6)		60
Power specifications	Power supply voltage [V]		24 VDC ±10%
	Current consumption [mA] 7)	Max. current 8)	1,400
		Standby current 9)	60
IO communication input specifications	Input type		PNP
	Input ON voltage [V]		15 or more
	Input ON current [mA]		3 or more
	Input OFF voltage [V]		5 or less
	Input OFF current [mA]		0.5 or less
IO communication output specifications	Output type		PNP
	Max. load current [mA]		200
	Protection		Short-circuit protection
Pressure monitor specifications	Rated pressure range [kPa]		0.0 to -101.0
	Display pressure range [kPa]		10.0 to -105.0
	Display/Smallest adjustable increment [kPa]		0.1
	Display accuracy [%]		±2 F.S. ±1 digit (Ambient temperature of 25± 3°C)
	Repeatability [%]		±0.2 F.S. ±1 digit
	Temperature characteristics [%]		±2 F.S. (25°C standard)
Standard			CE / UKCA MARKED

1) The weight in parentheses refers to the weight of the product without a cup mounting flange.

2) The maximum workload is restricted by the cup diameter, mounting orientation and workpieces. Use this product within its maximum workload. Grip or transport of a workpiece exceeding the maximum workload may cause a reduction in vacuum pressure due to air leakage.

3) Limit values of the product itself. If there are other restrictions, such as a robot to be connected, use the ZXPE within these limits. When combining a load and moment such as at the time of transportation, make sure the load factor is 1 or less according to the equation below.

$F/F_{max} + M/M_{max} \leqq 1$ (Load factor)



4) These are the values under SMC measurement conditions when the vacuum pump working continuously and may vary depending on the atmospheric pressure (weather, altitude, etc.) and the measurement method.
5) Impact resistance: The characteristics are satisfied after being tested one time in each of the X, Y and Z directions with energization. (Initial value)
   Vibration resistance: The characteristics are satisfied after being tested a one sweep in each of the X, Y and Z directions at 10 to 500 Hz with energization. (Initial value)
6) Actual values under SMC's measurement conditions (Not guaranteed values)
7) When supply voltage of 24VDC is applied.
8) Including inrush current.
9) The standby current is an average current when the electric vacuum gripper is on standby.

4. Functions

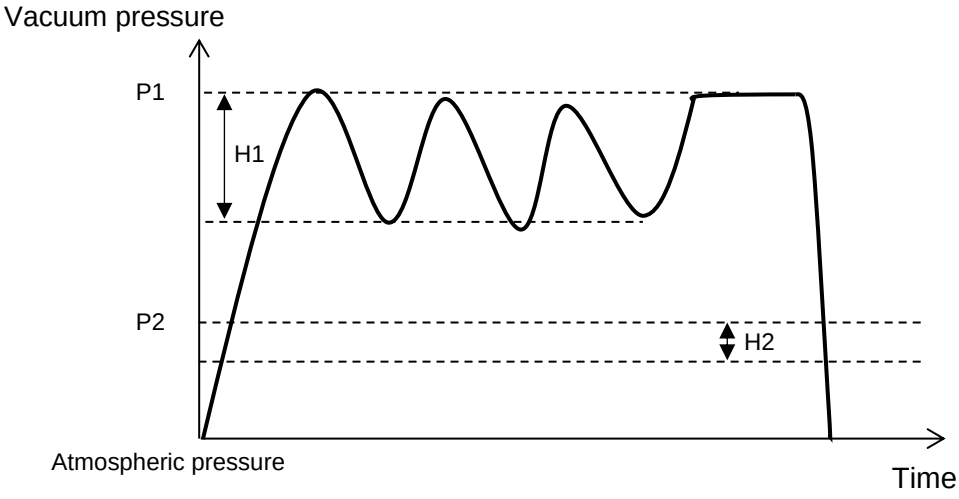
Automatic mode

In automatic mode, the electric vacuum gripper operates in an energy-saving manner, automatically setting a threshold value based on the vacuum pressure at gripping, the maximum vacuum pressure of the product.

Below is the description of the energy-saving operation.

Upon the grip command, the pump engages and starts suctioning. According to the vacuum pressure after suction has started, the gripper performs one of the following five actions:

1. When the vacuum pressure reaches P1, the pump stops. After that, when the vacuum pressure drops by H1, the pump starts again and maintains the vacuum. If the vacuum pressure reaches P1 again, the pump stops, and thereafter it repeats the on and off cycle.
2. When the vacuum pressure reaches P1, the pump stops. When the vacuum pressure drops by H1, the pump starts again. However, if the vacuum pressure does not reach P1, the pump runs continuously.
3. If the vacuum pressure does not increase sufficiently after the start of suction, the pump does not stop and runs continuously.
4. If the vacuum pressure does not reach P2, it indicates that gripping has failed, and the pump stops.
5. If the vacuum pressure drops to P2-H2 during suction, it indicates that a dropped workpiece event has been detected, and the pump stops.



P1: Target vacuum pressure
H1: Energy-saving operation range
P2: Pressure at which gripping is judged to have failed
H2: Hysteresis of P2

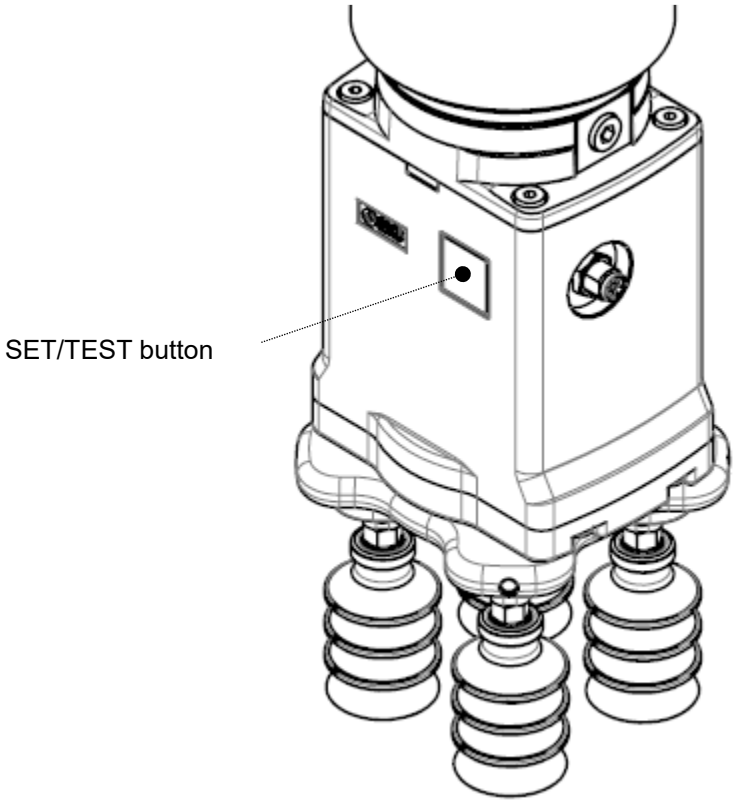
*Vacuum pressure without workpiece means the pressure at which the grip command is given, with no workpiece in place.

■ Factory reset

The gripper can be reset to the factory settings if the current settings are uncertain.

How to reset

1. Press and hold the SET/TEST button for 10 seconds or longer until [RSET] is shown on the left of the sub screen of the pressure monitor, and then release the button. The LED flashes orange twice; the gripper is now reset to the factory settings.



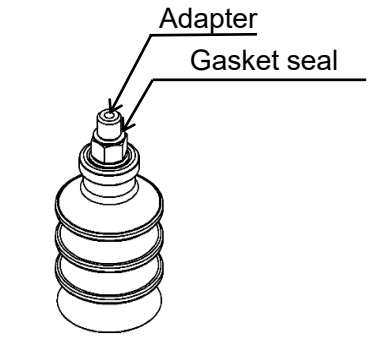
5. Mounting

5.1. Mounting

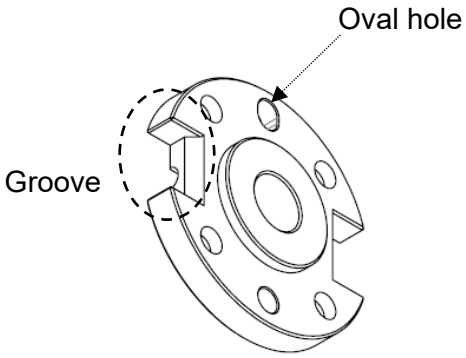
■ Mounting the gripper on the robot

1) Insert the parallel pin into the robot tool flange pin hole.
2) Aligning the parallel pin with the oval hole of the main plate, mount the main plate on the robot with 4 hexagon socket thin head bolts provided, with a tightening torque of 5.2±0.5 N·m.
3) Aligning the grooves of the main plate and the LED cover, insert the clamper into the grooves and mount the gripper by tightening the hexagon socket thin head bolts (M5 X 25) with a tightening torque of 1.5±0.1 N·m.
4) With the gasket seal in place on the adapter, mount 4 cups with adapter on the electric vacuum gripper with a tightening torque of 1 N·m or tighten by 1/4 turn using a spanner after tightening by hand.

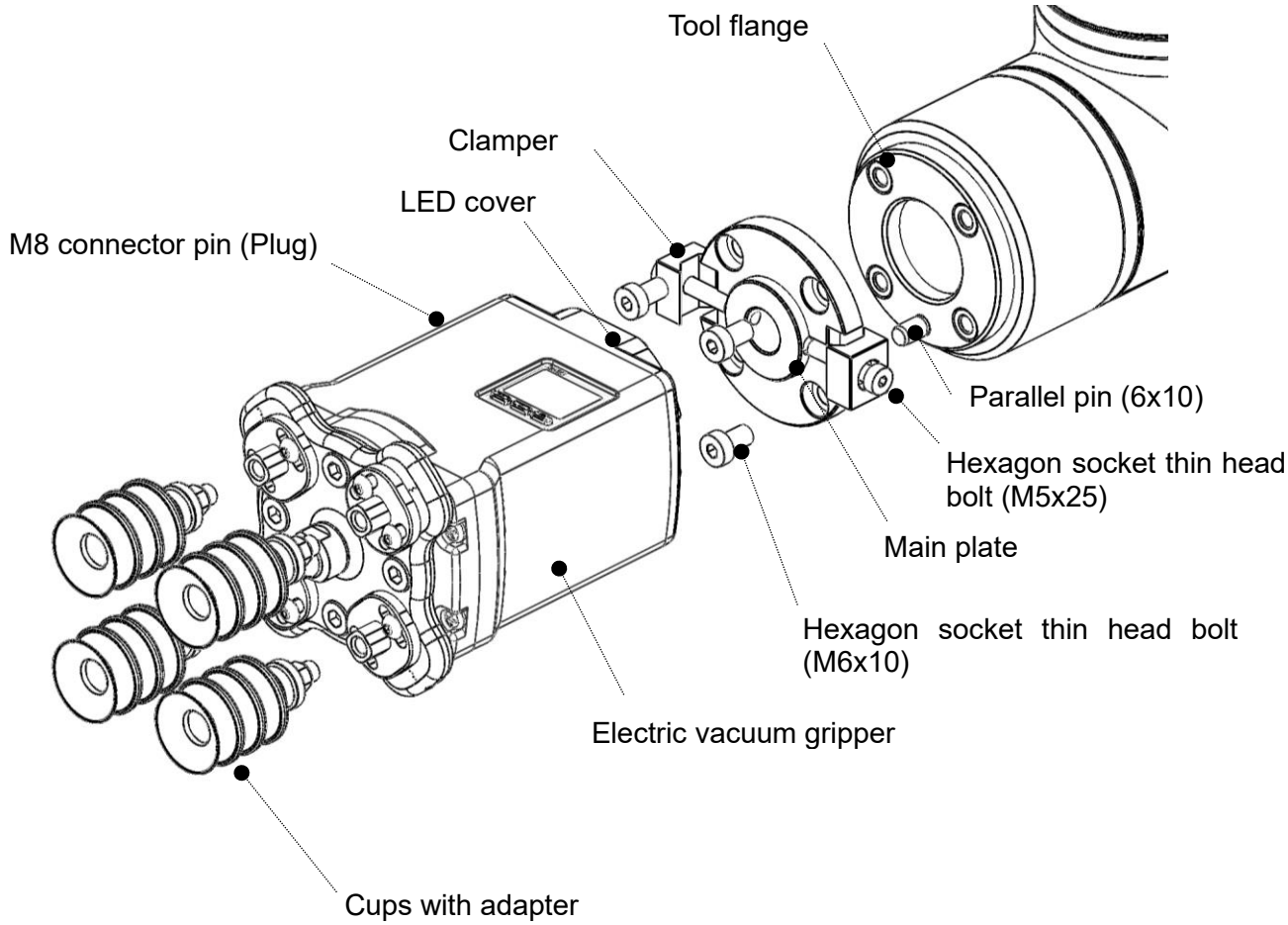
To remove the gripper, follow the mounting procedure in reverse.



Cup with adapter



Main plate

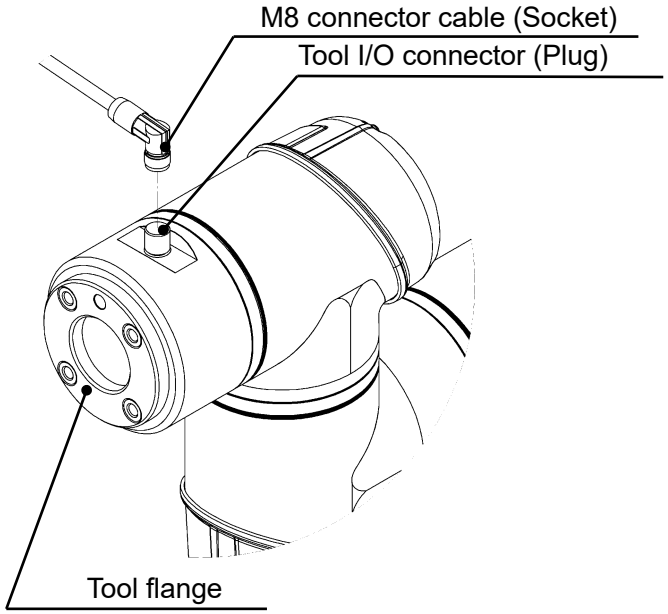


5.2. Wiring

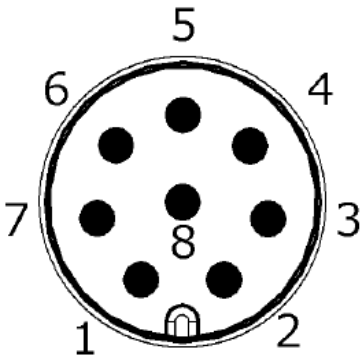
■Mounting the M8 connector cable

Connect the electric vacuum gripper's M8 connector pin (plug) and the tool flange's tool I/O connector (plug) together with the M8 connector cable (socket – socket).

Do not energize while securing the connector.
Check that the connector is not loose.



■M8 Connector pin



M8 connector plug angle

Table 4. M8 connector pin assign

Pin no.	Function
1	RS485+
2	RS485-
3	Digital output 1
4	Digital output 0
5	Power supply voltage (24V)
6	Digital input 1 *
7	Digital input 0 *
8	Power supply voltage (GND)

*Set "Digital output 0" and "Digital output 1" of the robot side tool I/O to sourcing(PNP).

Digital inputs are allocated to the gripper's control signals, and digital outputs are allocated to the status signals.

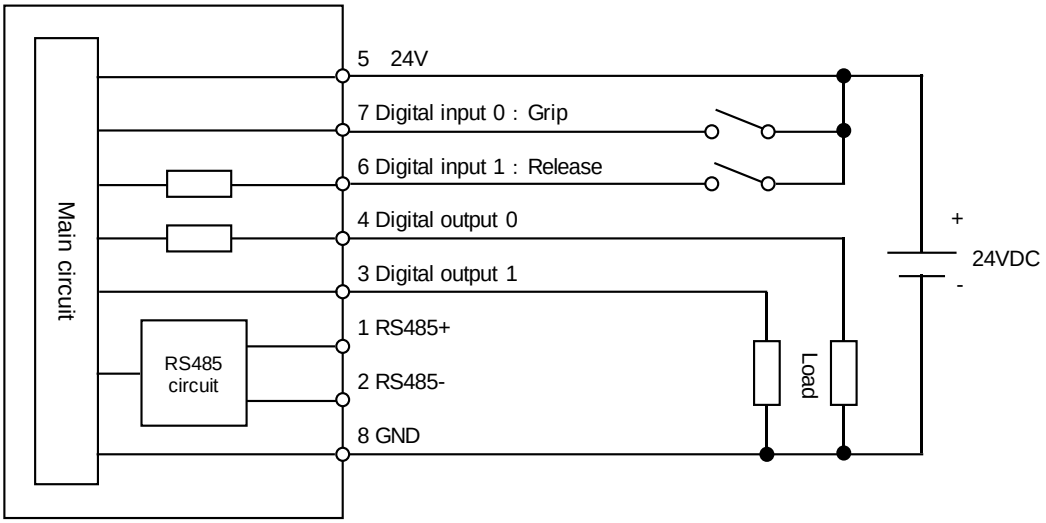
Table 4. Digital inputs (control signals from the robot to the gripper)

Digital input 0	Digital input 1	Status
OFF	OFF	Idle
ON	OFF	Grip command
OFF	ON	Release command
ON	ON	Idle

Table 5. Digital outputs (status signals from the gripper to the robot)

Digital output 0	Digital output1	Status
OFF	OFF	Idle
ON	OFF	Grip/release success
OFF	ON	Grip failed, work drop detection or release failed
ON	ON	Alarm occurred

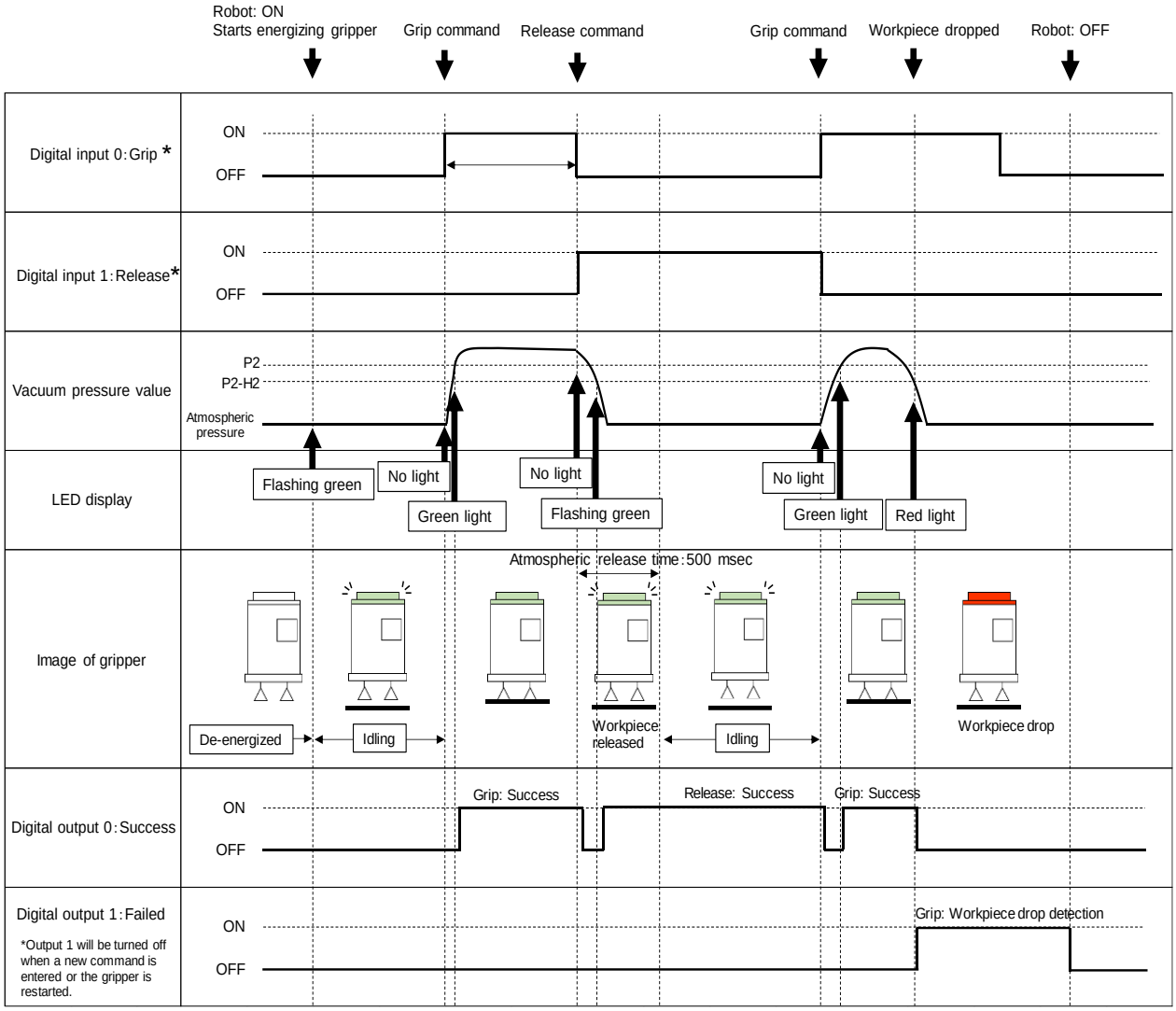
Internal circuit and wiring example



*Set "Digital output 0" and "Digital output 1" of the robot side tool I/O to sourcing(PNP).

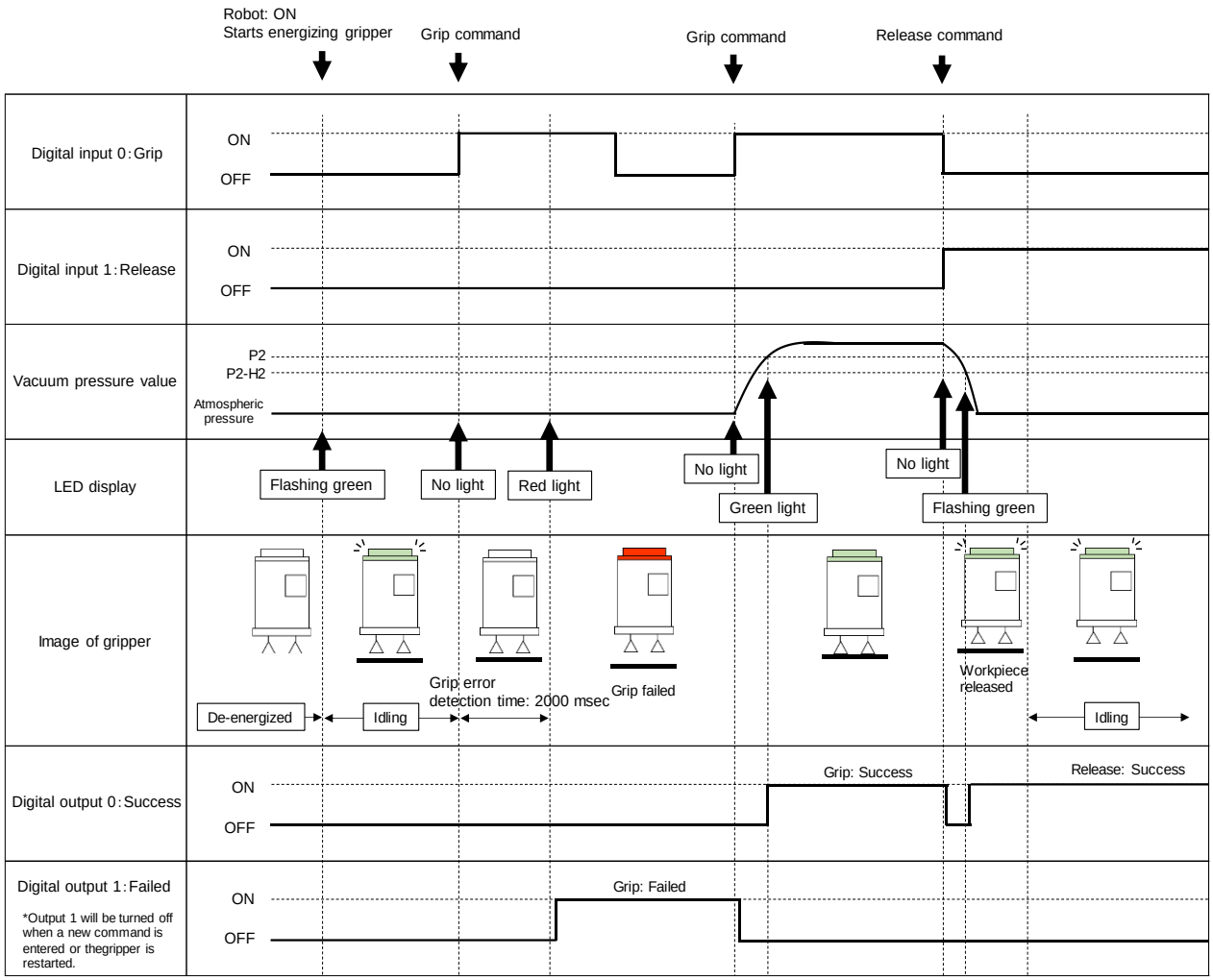
5.3.2. Illustration of the gripper operation via IO communication

Example 1 – Gripping/release motion and work drop detection



*Enter digital input signals for 200 msec or longer.

Example 2 – Gripping failed



5.3. URCap

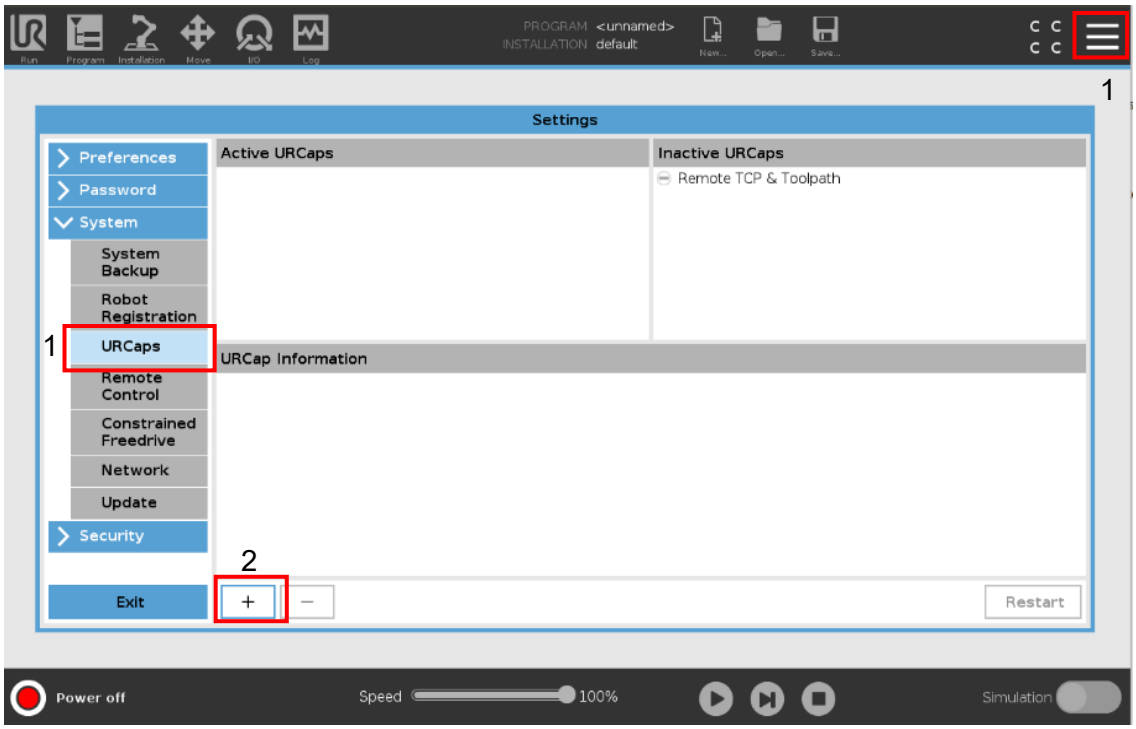
5.3.1. Installation of URCap

Before installation

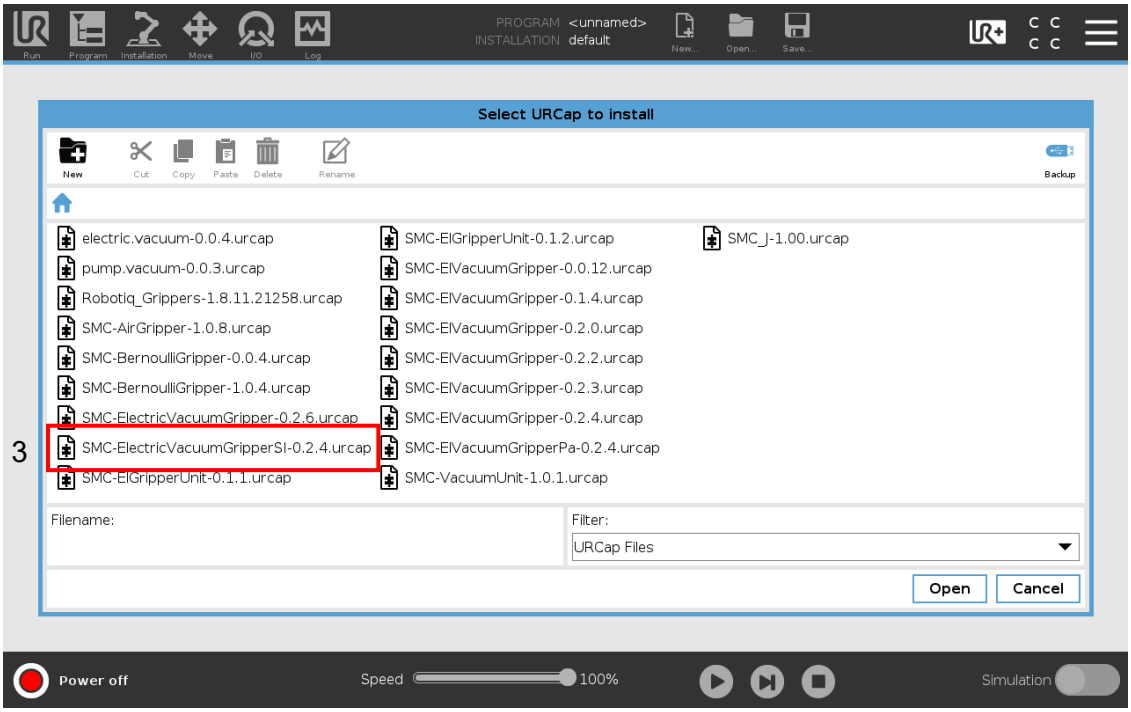
Copy “SMC-ElectricVacuumGripperSI-x.x.x.urcap” to a USB memory.
The plugin software is compatible with a UR robot Polyscope version 5.9.1 or later. Before installing the plugin software, update the Polyscope to the 5.9.1 or later version, if it is prior to 5.9.1.

How to install

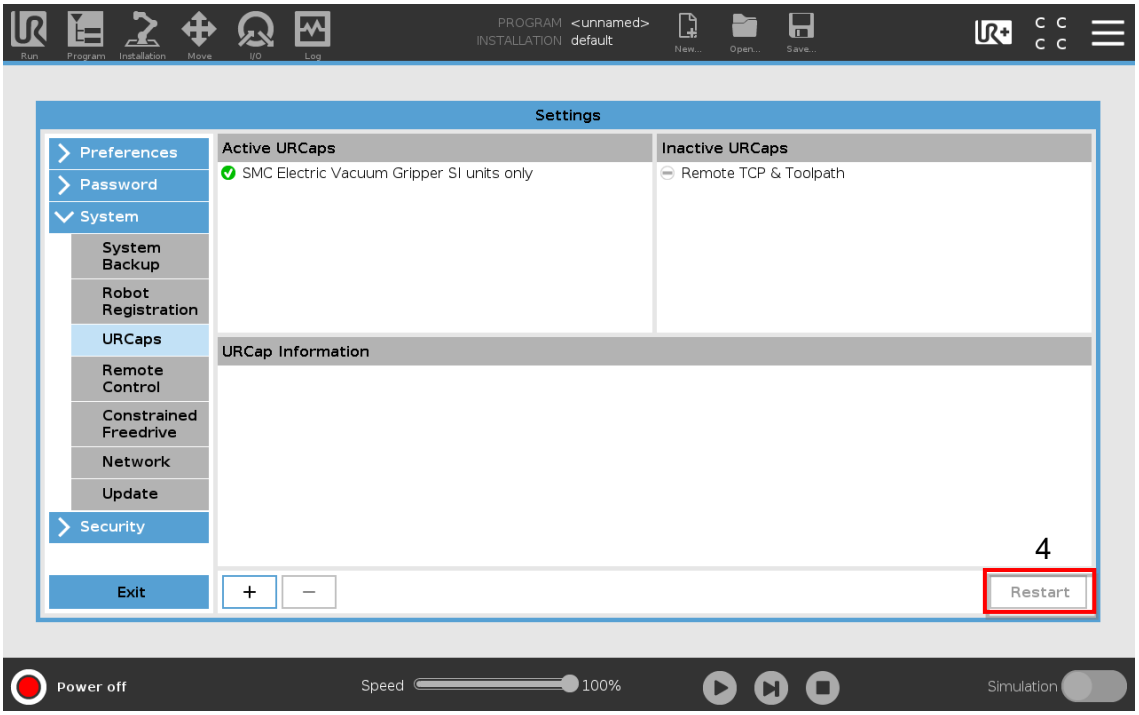
1. Go to “Setting” from the menu on the top right of the screen and tap “URCaps” from “System”.
2. Insert the USB memory with a copy of the URCap into the teaching pad and tap the "+" button.



3. Select “SMC-ElectricVacuumGripper*-x.x.x.urcap” from ”Files” and tap the "Open" button.



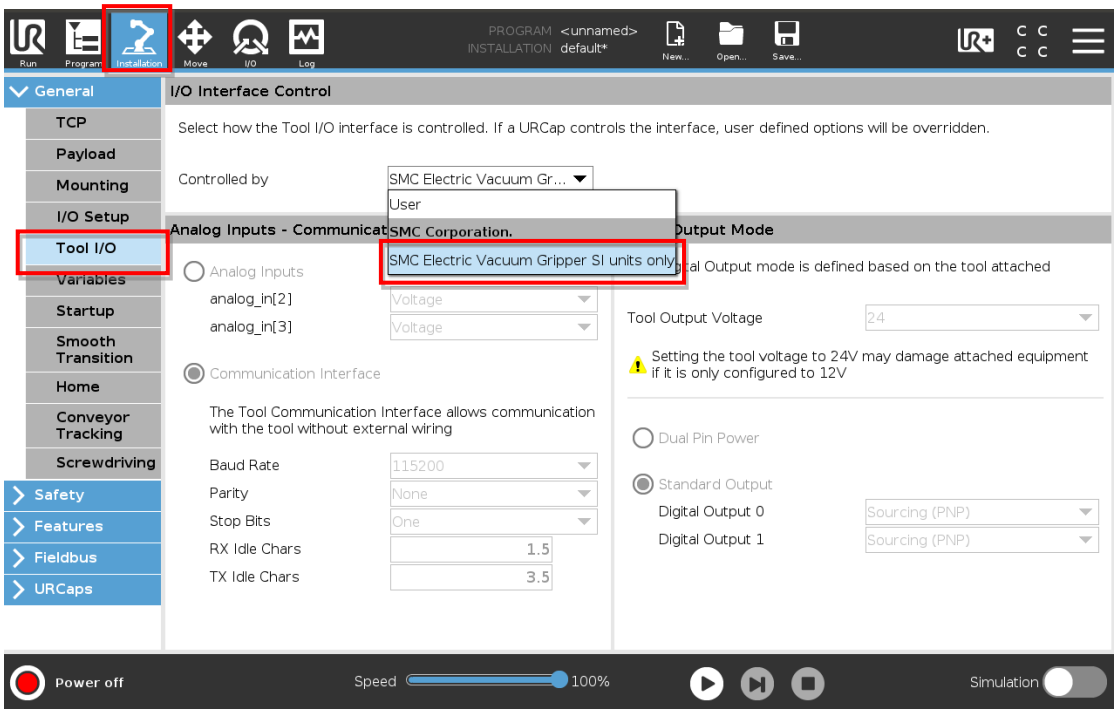
4. Tap the "Restart" button to restart the robot.



5.3.2. Basic settings

Tool I/O

After restarting the robot, press “Installation” to open “Tool/IO” from “General”. Then, select “SMC Electric Vacuum Gripper” from the “Controlled by” drop down list.

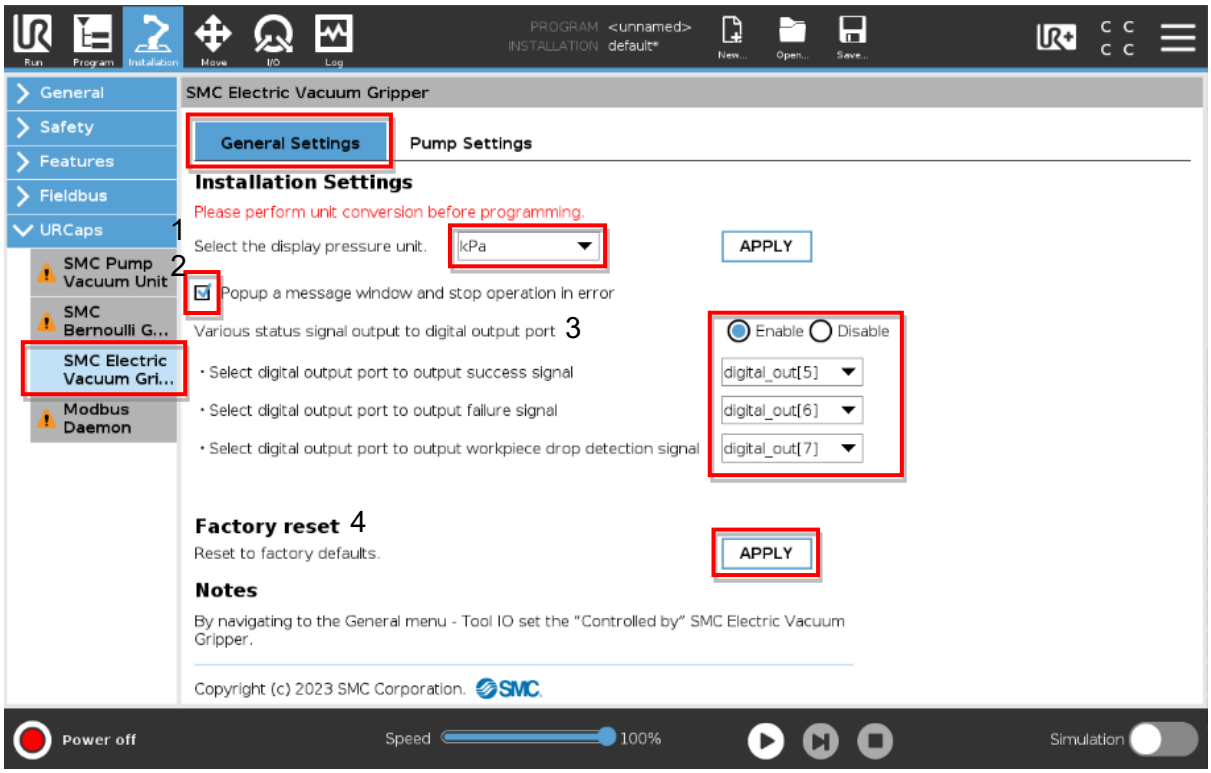


“Analogue Inputs – Communication Interface” and “Digital Output Mode” will be set automatically.

General Settings

Open “General Settings” from the “URCaps” menu in the “Installation” tab.

1. Select the display pressure unit: allows the user to change the measurement unit and set the pressure unit displayed on the URCap as well as the pressure unit displayed on the gripper’s pressure monitor.
   Measurement units available for use: “kPa”, “MPa”
2. Popup a message window and stop operation in error: allows the user to select whether a popup window should appear and the program should be stopped when a failure (gripping or release failure) occurs.
   This option is set to ☑ Popup message window and stop operation in error by default.
3. Various status signal output to digital output port: allows the user to select whether to enable or disable the output ports. When “Enable” is selected, the user can select the output port numbers for the signals for success, failure, and workpiece drop detection. Note that different signals cannot be assigned to one port. When an output port is not used, select “Disable”.
   This option is set to “Enable” by default.
   The default port numbers are as follows:
   success signal - digital_out[5]
   failure signal - digital_out[6]
   workpiece drop detection signal – digital_out[7]
4. Factory reset: Allows the user to reset the gripper to the factory settings if the current settings are uncertain. Tapping “APPLY” opens a window asking whether “Factory reset” is to perform. When “Yes” is selected, the settings of the gripper and on the URCap will be reset to default.



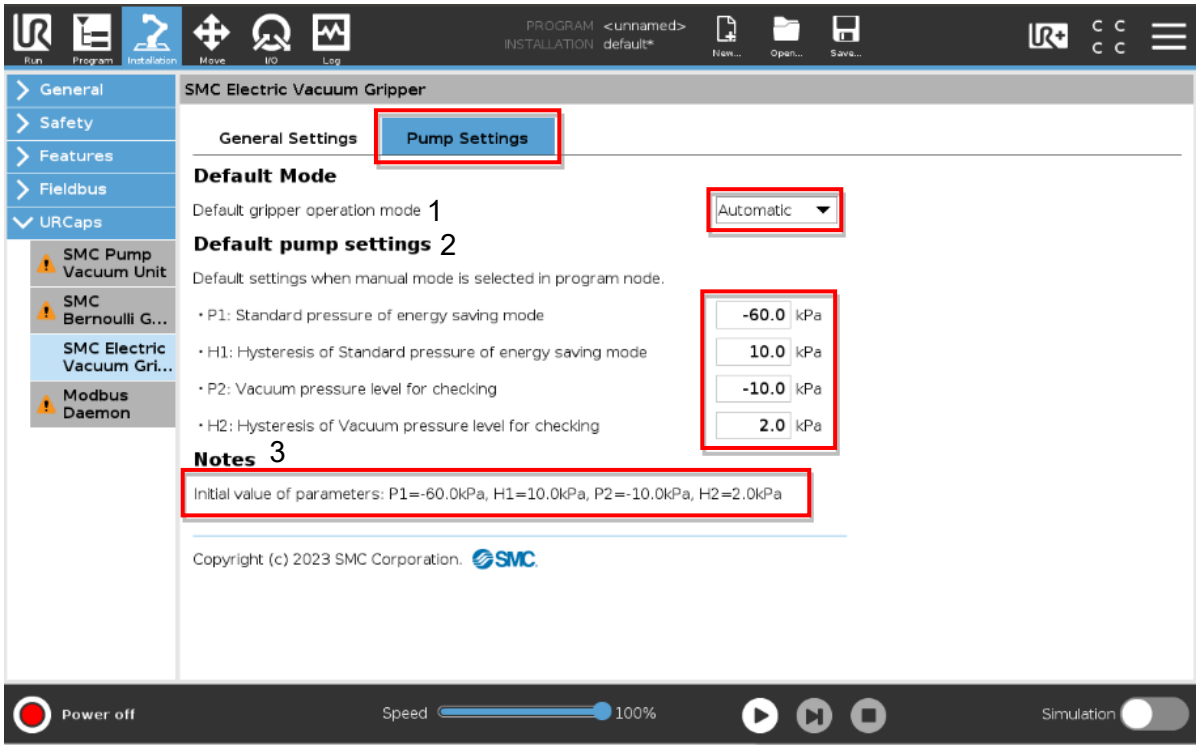
Pump Settings

Open “Pump Settings” from the “URCaps” menu in the “Installation” tab.

1. Default mode: Allows the user to change the default gripper operation mode on the program and commissioning windows.

   The gripper has three operation modes: “Automatic” (default), “Manual” and “Continuous”.
   “Automatic”: In automatic mode, the electric vacuum gripper operates in an energy-saving manner, automatically setting a threshold value based on the vacuum pressure at gripping.
   “Manual”: In manual mode, threshold values are manually set, and the vacuum gripper operates in an energy-saving manner (which controls the pump’s actions) similarly to automatic mode.
   “Continuous”: In continuous mode, the pump operates continuously while the grip command is valid.

2. Default pump settings: Allows the user to change each of the parameter threshold values if “Manual” has been selected on the program or commissioning window.
3. Notes: Shows the default values of each parameter.



5.3.3. Program settings

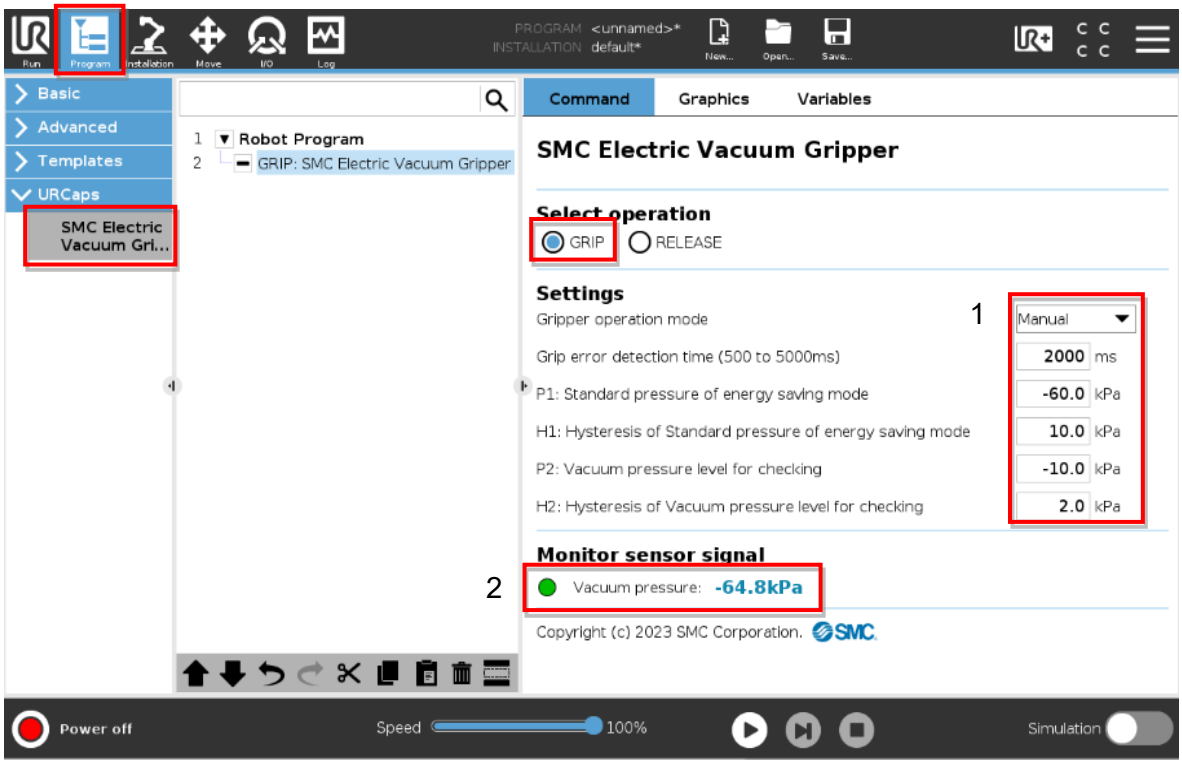
On the “Program” tab, you can create programs and configure their operation.

GRIP

From the “URCaps” menu in the “Program” tab, tap “SMC Electric Vacuum Gripper. Select “Grip” in “Select operation” to add “Grip: SMC Electric Vacuum Gripper” command to the “Robot Program”.

1. Settings: Allows the user to set the parameters for each command.
   Gripper operation mode: Shows the operation mode set according to Pump settings. The user can also change the mode here.
   Grip error detection time: Sets the time to determine that gripping has failed. If, after the start of gripping, the vacuum pressure at which the gripping success signal is sent, is not reached within the set duration of time, the gripping failed signal is sent.
   P1 to H2 (only when manual mode is selected): Shows the values set according Pump settings. The user can also change the values here.
2. Monitor sensor signal: Allows the user to check the status of the gripper and vacuum pressure.
   - Green: Gripping success
   - Red: Gripping failed, workpiece drop detection, or release failed
   - Grey: Idle

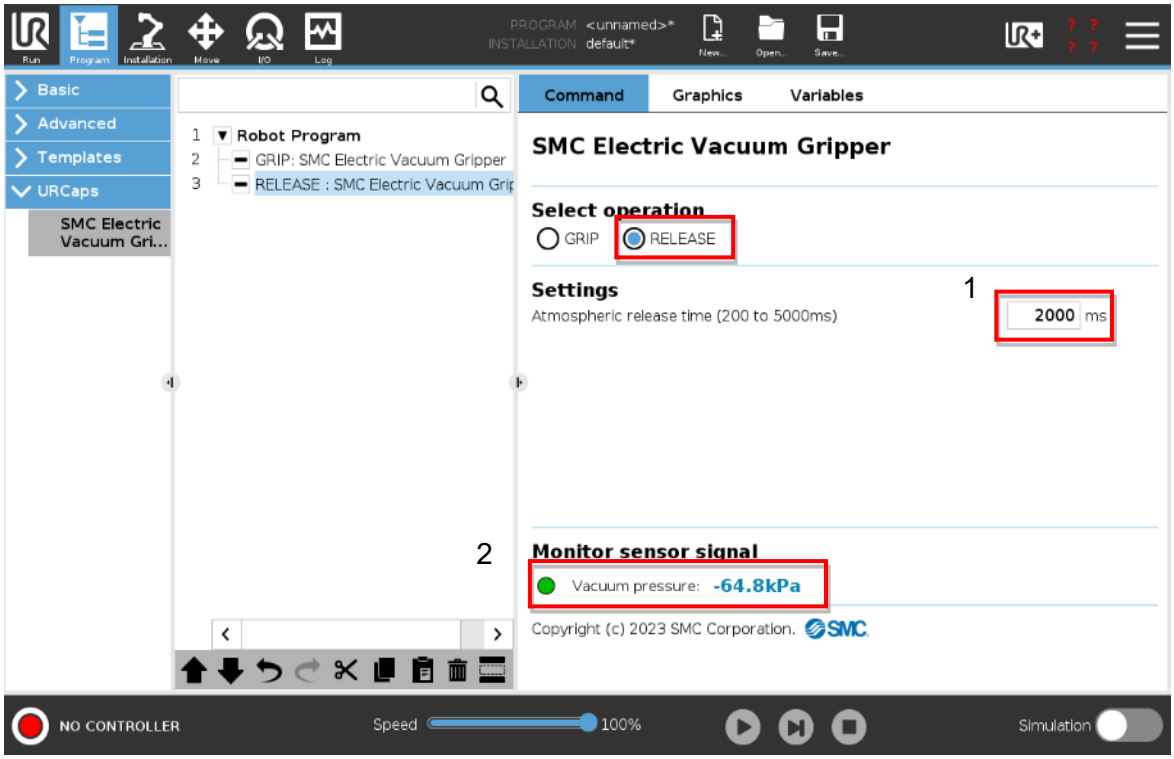
   “-kPa” is shown when no wiring has been made.



RELEASE

From the “URCaps” menu, tap “SMC Electric Vacuum Gripper”. Select “RELEASE” in “Select operation” to add the “Release: SMC Electric Vacuum Gripper” command to the “Robot Program”.

1. Settings: Allows the user to set the parameters for each command.
   Atmospheric release time: Sets the duration of time for a valve to release air to atmosphere.
   The time can be set between 200 to 5000 msec.
2. Monitor sensor signal: Same as the gripping motion.



5.3.4. Commissioning

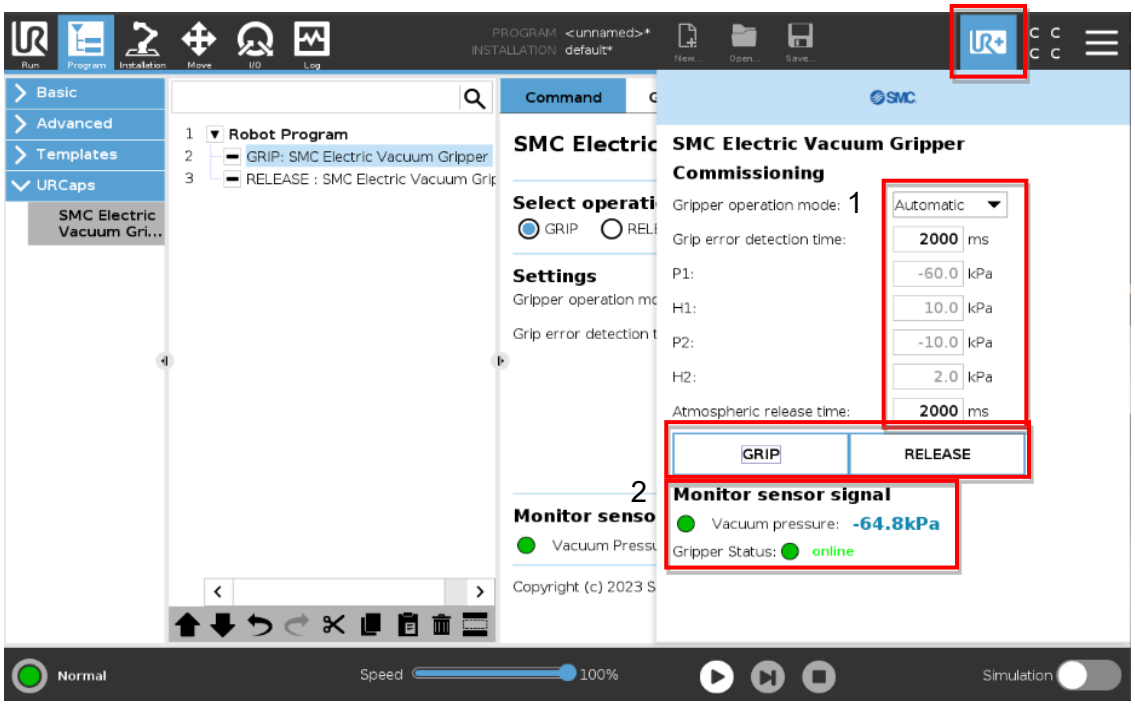
The “UR+” icon on the top right of the interface allows the user to commission the gripper.

Tap GRIP or RELEASE to see the gripper’s grip or release operation, status, and vacuum pressure.

1. Commissioning: Sets the gripper’s operation mode and threshold values of each parameter during commissioning.
2. Monitor sensor signal
   - Vacuum pressure: Same as the program window
   - Gripper status: Displays the status of the gripper.
     - Online (green): The gripper is connected with the robot and operating normally.
     - Offline (yellow): The gripper is not connected with the robot.
     - Error (red): An alarm has occurred.

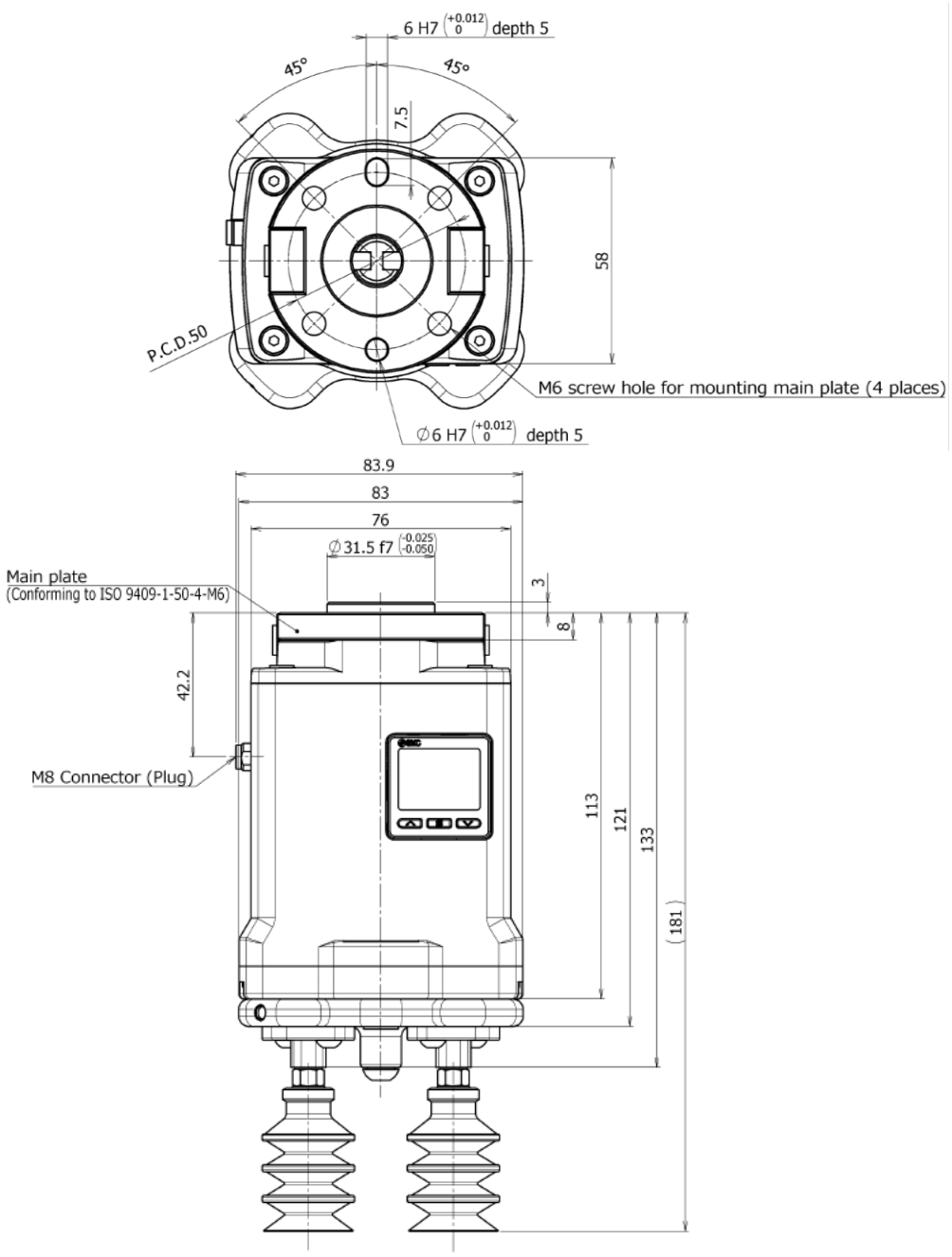
Table 6. Alarm list

Error text	Gripper status
Over current error pump	Internal pump overcurrent error
Over current error valve	Internal valve overcurrent error
Over current error pressure monitor	Internal pressure monitor overcurrent error
Over current error MCU out0	OUT0 of internal circuit overcurrent error
Over current error MCU out1	OUT1 of internal circuit overcurrent error
Pressure monitor internal error	Pressure monitor internal error
Pressure monitor communication error	Communication error



6. Dimensions

6.1. Electric Vacuum Gripper



*Movable range: 25 to 35 (In case of the cup mounting on the center part.)

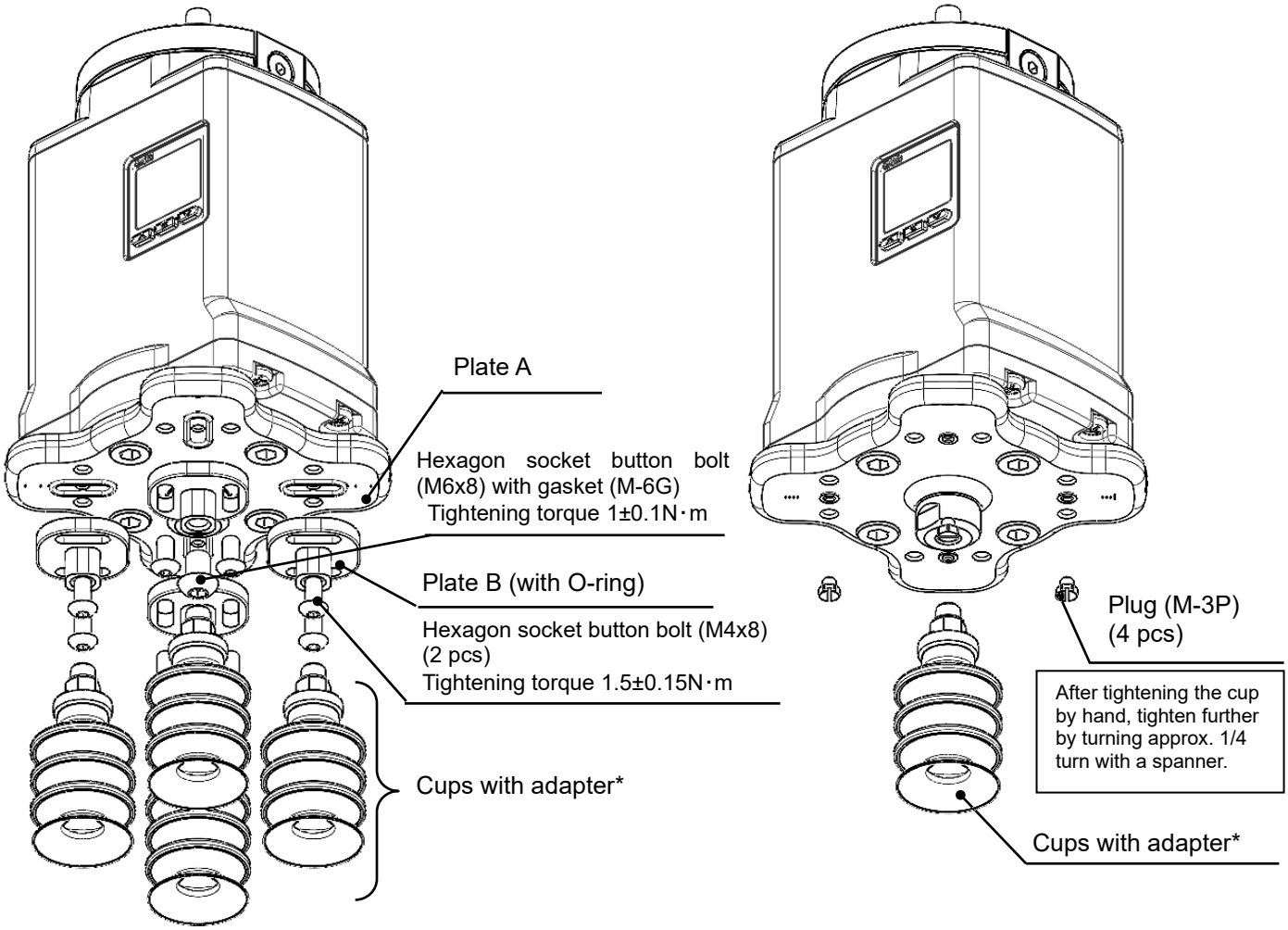
7. How to change the number of cups

7.1. Change to 1 cup (with flange)

1. Removal of the cup
   (1) Remove the suction cup with adapter from Plate B using a spanner.
   (2) Loosen the bolt (M4x8) to remove Plate B from Plate A.
   Be careful not to lose the O-ring.
   (3) Loosen the bolt for sealing (M6x8) to remove the cup from Plate A.

2. Mounting of the plug and suction cup with adapter
   (1) After making sure that each of the plugs provided has a gasket seal inside it, mount the plugs to Plate A. (4 places)
   (2) After making sure that the adapter has a gasket seal inside it, mount the suction cup with adapter removed in the step (1) to Plate A.

To reassemble the parts, follow these steps in reverse with the specified tightening torque.



(1) Removal of the suction cup

(2) Mounting of plugs and a suction cup with adapter

⚠ Caution

* Tightening torque: 1 N·m (As reference, tighten the cup by turning 1/4 turn using a spanner after tightening by hand) If tightened excessively, the thread may be damaged and gasket may be deformed. This will cause air leakage. Insufficient tightening may loosen the thread or cause air leakage.

8. Maintenance

Perform the maintenance and inspection shown below in order to use the electric vacuum gripper in a safe and appropriate manner for a long time.

8.1. Maintenance for electric vacuum gripper

⚠ Caution

1） **Inspection before and after maintenance**
When removing the product from the robot, ensure that the power supply is turned off and the vacuum pressure inside the product is released. When returning the product on the robot after maintenance, connect to the power.and check if it functions properly.

2） **Maintenance should be performed according to the procedure stated in the Operation Manual.**
Improper handling can cause damage and malfunction of equipment and machinery.

3） **Do not disassemble or modify the product, other than replacement of the parts specified in this manual.**

8.2. Maintenance for suction cup

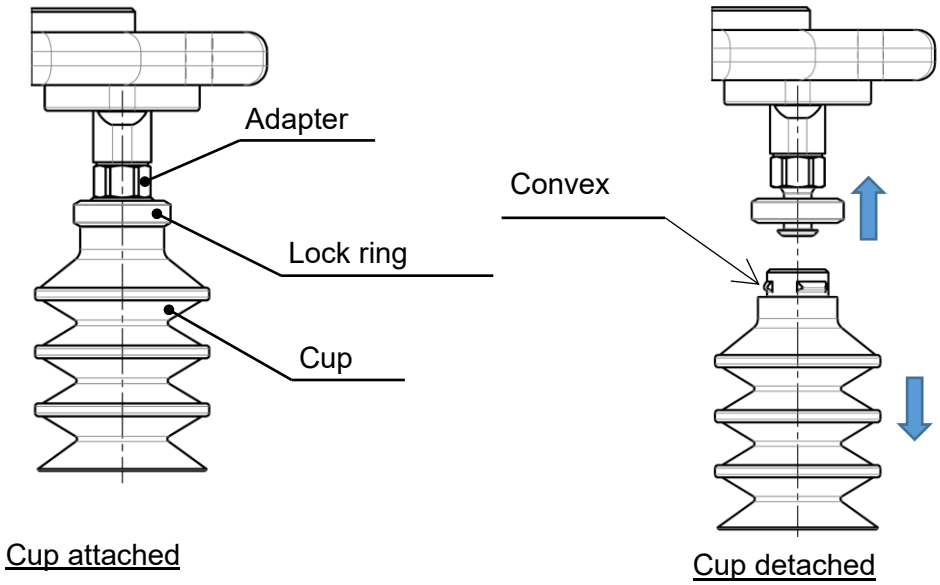
⚠ Caution

1） **Suction cups are consumables. Replace them on a regular basis.**
Continued use of suction cups will cause wear and tear on the gripping surface, and the exterior dimensions will be gradually reduced, which can lead to a reduction in lifting force, whilst gripping will remain possible.
It is extremely difficult to predict when a suction cup should be replaced. This is because there are numerous factors at work, including surface roughness, operating environment (temperature, humidity, ozone, solvents, etc.), and operating conditions (vacuum pressure, workpiece weight, pressing force of the suction cups on the workpieces, presence or absence of a buffer, etc.).
(With the bellow type cup, weakened bents, wear, or sticking of rubber parts may occur.)
The customer is required to decide when suction cups should be replaced, based on their operating condition at the time of initial use.
The bolts may become loose depending on the operating conditions and environment. Be sure to perform regular maintenance.

How to replace the suction cup

- Pull the lock ring upward, and, after lifting it up to the adapter, remove the old cup by pulling it downward.
- While holding the lock ring in the raised position place a new cup onto the adapter.
- Confirm that the cup is securely in place, and then return the lock ring to its original position.

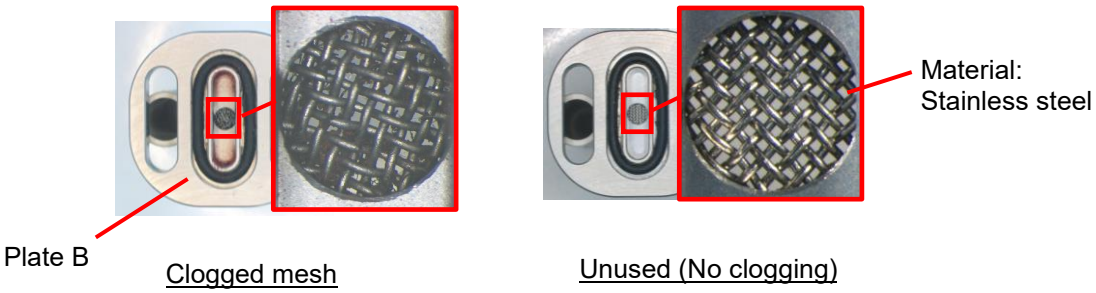
＊The cup without lock ring should be inserted to the end of the adapter.



2) **Mesh**

If the mesh is used in such a way that foreign matter is absorbed from the air or the workpiece, it may become clogged, which will cause a reduction in the ejector performance. Clean the mesh periodically as necessary by washing, air blow and so on. If mesh clogging cannot be resolved by cleaning, replace Plate B.

Plate B spare part number: ZXPE5-APL6-A



Clogged mesh

Unused (No clogging)

9. Precautions

9.1. Electric vacuum gripper precautions

■Designing

⚠**Warning**

If power or air supply is shutdown, vacuum pressure may decrease and this product may drop a workpiece during gripping.

It is necessary to take measures such as drop prevention so that injury and damage to machinery or equipment can be prevented.

■Mounting

⚠**Warning**

1) **Tighten to the specified tightening torque.**
If the tightening torque is exceeded, the body and the mounting screws may break. However, insufficient torque may cause displacement of the body and loosening of the mounting screws.
2) **Hold the product itself when handling.**
Do not pull the M8 connector cable strongly or lift up the product by holding this cable. It can cause the malfunction of the product.

■Wiring

⚠**Warning**

1) Do not wire while energizing the product. Doing so may result in damage to the internal parts of the solenoid valve or pressure sensor. In some cases, this damage may result in a malfunction.
2) Do not disassemble the M8 connector cable or make any modifications, including additional machining. Doing so may cause human injury and/or an accident.

⚠**Caution**

Avoid repeatedly bending or stretching the M8 connector cable as well as applying force to it.

■Workpiece

⚠**Caution**

Do not use the product for workpieces with water or dust attached.

If water or dust adheres to the surface of a workpiece, they may enter the inside of the product, causing a decline in vacuum performance. If the workpiece is permeable, the gripper may not generate sufficient lifting force. Assess the suitability of the gripper with the workpiece before the equipment is put into service.

9.2. Suction cup precautions

■Design

⚠**Warning**

In cases where the workpieces are heavy or dangerous objects, etc., take measures to address a possible loss of gripping force (installation of a drop prevention guide, etc.).

In the case of transportation by vacuum gripping using suction cups, the gripping force is lost when there is a drop in vacuum pressure. Furthermore, since vacuum pressure can also deteriorate due to the wear and cracking of cups, vacuum leakage from piping, etc., be certain to perform maintenance on vacuum equipment.

■Selection

⚠**Caution**

1) **The cup materials which can be used differ depending upon the operating environment.**
An appropriate cup material should be selected. Furthermore, since suction cups are manufactured for use with industrial products, they should not come into direct contact with medicines, food products, etc.

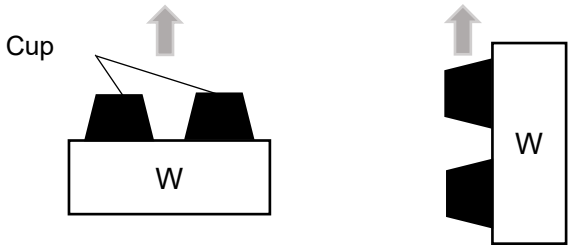
2) **Depending upon the weight and shape of the workpieces, the diameter, quantity, and shape of cups suitable for use will vary.**
The selectable cups will differ based upon conditions other than the above, such as the condition of the workpiece surface (presence or absence of oil or water), the workpiece material, and its gas permeability. Confirmation is necessary by actually performing vacuum gripping on the subject workpieces.

3) **Do not apply an impact or large force to a cup when gripping a workpiece.**
This will cause the deformation, cracking, and wear of the cup to be accelerated. The stiffening ribs, etc., should touch lightly, while staying within the cup skirt's deformation range. Positioning should be performed accurately, especially in the case of small-diameter cups.

4) **When transporting vertically, factors such as acceleration, wind pressure, and impact force must be considered in addition to the workpiece weight.**
Use caution particularly when lifting items such as glass plates and circuit boards because a large force will be applied by wind pressure. When a workpiece which is oriented vertically is transported horizontally, large forces are applied by acceleration when movement is started and stopped. Furthermore, in cases where the cup and workpiece can slip easily, accelerations and decelerations of horizontal movement should be kept to a minimum.

5) **When transporting flat shaped workpieces that have large surface areas using multiple cups, care must be taken in arranging the cups, so that the workpieces are evenly gripped.**

6) **Use caution since the workpiece could rotate during transfer.**
Use of more than one cup for each workpiece is recommended.



Horizontal lifting

Vertical lifting
(This type of application should generally be avoided.)

■Storage

⚠Caution

It is recommended to store vacuum pads in the environment shown in the table below.
Storing in an environment other than that recommended below may lead to changes in properties (deformation, discoloration, cracking, increased adhesiveness, etc.).

Temperature	15 to 25 °C
Humidity	50[%] or less, No condensation
Other	Location that is shaded from direct sunlight or fluorescent light Location without the presence of ozone (For NBR and conductive NBR)

10.Troubleshooting

Problem	Cause	Countermeasure
Initial gripping problem (During commissioning)	Gripping area is small. (Lifting force is lower than the workpiece mass.)	Recheck the relationship between workpiece mass and lifting force. - Use a suction cup with a large gripping area. - Increase the quantity of suction cups.
	Vacuum pressure is low. (Leakage from gripping surface) (Air permeable workpiece)	Eliminate (reduce) leakage from gripping surface. - Reconsider the shape of a suction cup. Check the relationship between suction flow rate and arrival pressure of vacuum ejector. - Increase gripping area.
Slow response	High P2 set value (pressure at which suction is judged to have failed)	Set a suitable pressure for the workpiece and cup conditions.
Gripping problem over time (Gripping is normal during trial operation.)	Clogging of the mesh	Clean the mesh periodically as necessary by washing, air blow and so on or replacing plate B. Refer to 8.2. Maintenance for suction cup
	Cup (rubber) deterioration, cracking, etc.	Replace cups. Check the compatibility of vacuum cup material and workpiece.
Workpiece is not released.	The increase of stickiness due to the wearing of the cup (rubber).	Replace cups. Check the compatibility of the cup material and workpiece.
	Insufficiently short atmospheric release time	Set an adequate atmospheric release time on the plugin software.

Revision history
A : Firmware update (From Date Code CP) [Feb 2024]
B : Add to specifications [Apr 2024]