ROBOTIQ

E PICK

Original Notice

Robotiq EPick Vacuum Gripper for TM Robots

Instruction Manual

LEAN ROBOTICS

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Revisions

Robotiq may modify this product without notice, when necessary, due to product improvements, modifications or changes in specifications. If such modification is made, the manual will also be revised, see revision information. See the latest version of this manual online at support.robotiq.com.

2019/08/13

- Update of the latest TMflow 1.72.3500
- Update of the version V_002 of the components

2019/07/02

Initial release

1 General Presentation

The terms “ Gripper” , " EPick Gripper" , " EPick Vacuum Gripper" and " EPick" used in the following manual all refer to the Robotiq EPick Vacuum Gripper. The Robotiq EPick Vacuum Gripper is a robotic peripheral designed for industrial applications. The vacuum is generated with an electric vacuum pump. Its design makes it a unique robotic end-of-arm tool to quickly pick, place and handle a large range of parts of varying sizes and shapes.

Info

The following section presents the key features of the Gripper and must not be considered as appropriate to the operation of the Gripper. Each feature is detailed in the appropriate section.

Info

The following manual uses the metric system. Unless specified, **all dimensions are in millimeters**.

11 Gripper nomenclature

111 EPick Gripper

The EPick Gripper is a vacuum Gripper that generates a vacuum with an electric vacuum pump.. It is equipped with one or multiple suction cups. Each suction cup can be adapted to your application and grasping needs. The EPick Gripper is compatible with the Robotiq standard coupling interface.

Fig. 1-1: Robotiq EPick Gripper

Info

Please refer to the **Scope of Delivery** section subsection and the **Spare Parts, Kits and Accessories** section for details on standard and optional parts.

112. Suction Cup System

A Robotiq Suction Cup System can be installed directly under the Vacuum Gripper. Each Robotiq Suction Cup System includes a bracket, a manifold, air nodes, port plugs, bumpers, tubing and additional suction cups.

Fig. 1-2: Suction cup system

Info

Please refer to the **Installation** section for more information on how to integrate the Suction Cup System to EPick.

Info

Please refer to the **Scope of Delivery** section subsection and the **Spare Parts, Kits and Accessories** section for details on standard and optional parts.

Tip

The owner can use a custom bracket or a mounting plate. The bracket or mounting plate can be installed directly under the manifold.

12. Object picking

The EPick Gripper allows:

1. Main unit suction cup
2. Auxiliary system with multiple suction cups

> **Warning**
>
> Object picking causes the compression of the suction cup(s) , which can result in pinching points between the gripper and the load. Avoid presence of body parts in this zone during operation.

> **Warning**
>
> Before picking any new object or material in autonomous mode, always check that the resulting vacuum level is sufficient to ensure safe gripping, in order to prevent dropping or ejection of the load.

12.1 Main unit suction cup

In order to use only one suction cup, the single cup can be mounted right in the port of the vacuum generator.

12.2. Auxiliary system with multiple suction cups

A standard Suction Cup System can be attached to the EPick Vacuum Gripper. The bracket normally holds two or four suction cups (corresponding to the four ports of the manifold).

Any unused manifold port should be blocked with a mating plug to avoid air leakage.

Other custom mounting options can also be used to benefit from a multiple suction cups solution

> **Caution**
>
> Custom brackets and plates must meet the required technical specifications (refer to the **Technical dimensions** section subsection).

13. Setup and control

The Vacuum Gripper is powered and controlled directly via a single device cable that carries 24 V DC power and Modbus RTU communication over RS-485.

> **Info**
>
> Please refer to the **Electrical Setup** section subsection for wiring information, and to the **Software** section for the control of the Vacuum Gripper.

In order to be used, the EPick Gripper has to be connected to a Gripper coupling which provides both the mechanical and electrical connectivity to the Gripper.

Info

Please refer to the **Mechanical Installation** section for more information on mounting the Vacuum Gripper onto the coupling. Refer to the **Technical dimensions** section for the technical drawing, and refer to the **Spare Parts, Kits and Accessories** section for a list of the available couplings.

The EPick Gripper boasts an embedded object detection feature which uses indirect sensing measurements. The system thus indicates if the workpiece has been dropped or if the Gripper failed to grasp the workpiece.

Info

For more information regarding the object detection feature, please refer to the **Software** section.

2. Safety

Warning

The operator must have read and understood all of the instructions in the following manual before operating the Robotiq Vacuum Gripper.

Caution

The term “ operator” refers to anyone responsible for any of the following operations on the Robotiq Vacuum Gripper:

- Installation
- Control
- Maintenance
- Inspection
- Calibration
- Programming
- Decommissioning

This manual covers the various components of the Robotiq Vacuum Gripper and the general operations regarding the whole life-cycle of the product, from installation to operation and decommissioning.

The drawings and photos in this manual are representative examples. However, discrepancies may be observed between the visual supports and the actual product.

2.1 Warning

Caution

Any use of the Gripper in non-compliance with these warnings is deemed inappropriate and may cause injury or damage.

Warning

- Always use the suction cup system and its components (air nodes, port plug, etc.) with the Robotiq Vacuum Gripper only.
- Never operate the Vacuum Gripper with leaking or worn parts.
- The Vacuum Gripper needs to be properly secured before operating the robot.
- Do not install or operate a Gripper that is damaged or lacking parts.
- Never supply the Gripper with an alternating current source.
- Make sure all cord sets are always secured at both ends—Gripper and robot.
- Always meet the recommended keying for electrical connections.
- Make sure no individuals or assets are in the vicinity of the robot and/or Gripper prior to initializing the robot.
- Always meet the Gripper's payload specifications.
- Set your vacuum level based on your application.
- Keep body parts and clothing away from the Gripper while the device is powered on.
- Do not use the Gripper on people or animals.
- Never stand under suspended loads held by the Vacuum Gripper.

2.11 Risk assessment and final application:

The Robotiq Vacuum Gripper is meant to be used on cobots and industrial robots.

The robot, the Gripper and any other equipment used in the final application must go through a comprehensive risk assessment process before they can be used. Special care must be taken during this step if custom mounting options are used for the suction cups.

Caution

It is the robot integrator's responsibility to ensure that all local safety measures and regulations are met.

The following non-exhaustive list presents risks that must be assessed during the integration process:

- Risk of contact between body parts and suction cups during gripping;
- Risk of load ejection resulting from loss of vacuum;
- Risk of load dropping resulting from loss of vacuum;

- Risk of pinching between the Vacuum Gripper and the part(s) or the environment;
- Risk of damage or breaking if using a custom suction cup bracket that does not meet the technical requirements.

Depending on the application, there may be hazards that require additional protection and/or safety measures. For instance, the workpiece handled by the Gripper could be inherently dangerous to the operator.

Warning

Depending on the supply sources, when an emergency stop (e-Stop) button is pressed, the following consequences may occur. The robot owner has the responsibility to do a risk assessment and choose the appropriate option.

Supply sources	e-Stop consequences
Robot tool supply (tool connector)	Power failure to the Vacuum Gripper. The vacuum level will drop to ambient pressure and the object will be lost.
Robot controller supply (Any 24V pin)	Vacuum Gripper powered ON. • If an object is detected: the vacuum level will continue to be regulated and the object will not be lost. • If no object is detected: the Vacuum Gripper will go into a standby state 2 seconds after the e-Stop button is pressed.

Warning

Loss of vacuum can occur due to power failure.

2.2. Intended Use

The Gripper unit is designed for gripping and temporarily securing or holding objects.

Caution

The Gripper is NOT intended for applying force against objects or surfaces.

The product is intended for installation on a robot or other automated machinery and equipment.

Info

Always comply with local, state, province and/or federal laws, regulation and directives regarding automation safety and general machine safety.

The unit should be used exclusively within the range of its technical data. Any other use of the product is deemed improper and unintended. Robotiq will not be liable for any damages resulting from any improper or unintended use.

3. Installation

The following subsections will guide you through the installation and general setup of your Robotiq Vacuum Gripper.

Warning

Before installing:

- Read and understand the safety instructions related to the Vacuum Gripper.
- Verify your package according to the scope of delivery and your order.
- Make sure to have the required parts, equipment and tools listed in Scope of delivery.

Warning

When installing:

- Meet the recommended environmental conditions.
- Do not operate the Vacuum Gripper, or even turn on the power supply, before the device is firmly anchored and the machine area is cleared. Make sure that the air supply is secured.

3.1 Scope of Delivery

3.1.1 Robotiq EPick Vacuum Gripper Kit

Standard upon delivery:

- **Standard Kit**
  - One (1) electrical vacuum generator
  - Two (2) standard suction cups (two different sizes)
  - One (1) End effector coupling kit
  - One (1) USB stick
  - One (1) USB to RS485 signal converter
  - One (1) RS485 to RS232 Converter
  - One (1) 10-meters communication cable
  - Required hardware

- **2 Suction Cups Kit**
  - One (1) Vacuum generator
  - One (1) suction cup system for 2 suction cups (1 manifold, 1 bracket, tubing, 2 air nodes, 4 suction cups)
  - Four (4) standard suction cups (two different sizes)
  - Four (4) port plugs (two already mounted on the suction cup system)
  - One (1) End effector coupling kit
  - 10-meter communication cable
  - One (1) USB to RS485 signal converter
  - One (1) RS485 to RS232 Converter
  - Required hardware
- **4 Suction Cups Kit**
  - One (1) Vacuum generator
  - One (1) suction cup system for 4 suction cups (1 manifold, 1 bracket, tubing, 4 air nodes, 8 suction cups)
  - Eight (8) standard suction cups (two different sizes)
  - Four (4) port plugs
  - One (1) End effector coupling kit
  - 10-meter communication cable
  - One (1) USB to RS485 signal converter
  - One (1) RS485 to RS232 Converter
  - Required hardware

Info

Please refer to the **Spare Parts, Kits and Accessories** section for a list of available couplings.

Caution

The following are not included in the standard delivery:

- Options such as custom suction cup brackets/plates or couplings for mounting on various industrial robots.
- Hardware required for accessories or fixtures, unless specified.

Info

When purchased as a kit, the EPick Vacuum Gripper will come in a package with the appropriate coupling, suction cups and cabling.

Please refer to the **Spare Parts, Kits and Accessories** section for additional components.

3.2. Required Tools and Equipment

3.2.1 EPick Gripper Add-On

The following tools are required to install the Vacuum Gripper:

- Hex key to mount the coupling onto the robot, according to your coupling
- 4 mm hex key to mount the Vacuum Gripper onto its coupling .

3.2.2. Suction cup system

The following tool is required to install the Suction cup system on the Vacuum Gripper:

- 4 mm hex key to assemble together the suction cup system and the vacuum generator.

3.3. Environmental and Operating Conditions

CONDITION	VALUE
Minimum storage/transit temperature	-30°C [-22°F]
Maximum storage/transit temperature	60°C [140°F]
Minimum operating temperature	5°C [41°F]
Maximum operating temperature	40°C [104°F]
Humidity (non-condensing)	20-80% RH
IP Rating	IP 4X

Table 3-1: Environmental and operating conditions of the EPick Vacuum Gripper

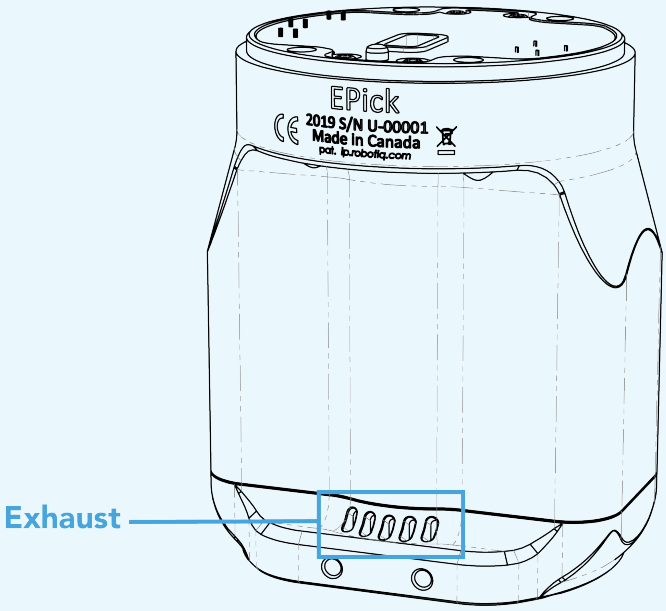
Caution

Use of the Vacuum Gripper is not recommended in presence of chemicals in the environment.

Info

The input filter prevents any dust larger than 200 µm from getting inside the pump. Dry dust will prevent the accumulation on filters or inside the pump. The use of suction cups with integrated filter can be used to reduce dust accumulation.

The exhaust must not be blocked.



3.4. Mechanical Installation

3.4.1 Installing the Vacuum Gripper onto the robot

Single Gripper

For purposes of power and communication, a coupling must be used to attach the Vacuum Gripper to the robot.

Here are the steps to follow to mount the Gripper on the robot arm (exploded view in figure below). Please note that all screws should be secured using medium strength threadlockers.

1. Mount the coupling on the robot wrist using the provided M6 screws and tooth lock washers. Align properly with the dowel pin. The dowel pin is meant to have a tight fit on the robot side and a slip fit on the effector side of the assembly.
2. Fasten the Gripper to the coupling using the provided M5 screws and tooth lock washers.
3. Plug the device cable into the gripper's pigtail and attach the cable along the robot arm using a cable routing system.

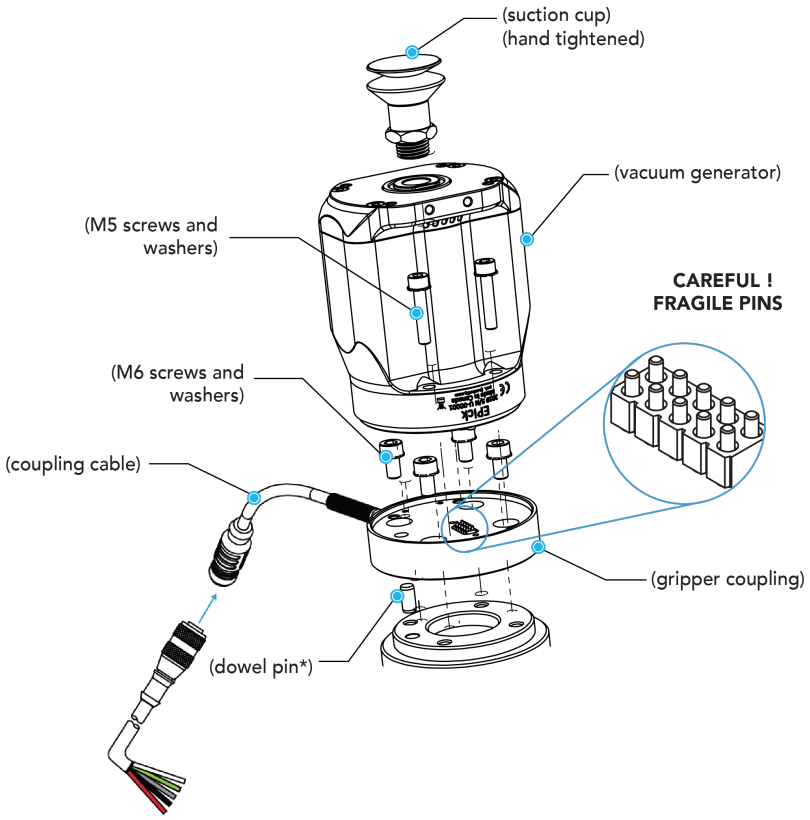


Fig. 3-1: Installing the Vacuum Gripper onto the robot wrist

3.4.2. Air tubing

Connection of the suction cup systems

To ensure vacuum distribution to the suction cups, connect the appropriate manifold ports with the pertaining air nodes using the provided plastic tubing.

> **Info**
>
> To facilitate the assembly of the Robotiq Wrist Camera on the suction cup system, make sure to place the tubing as shown in the figure to be assured that there will be no interference with the camera's field of view while preventing excessive tube bending.

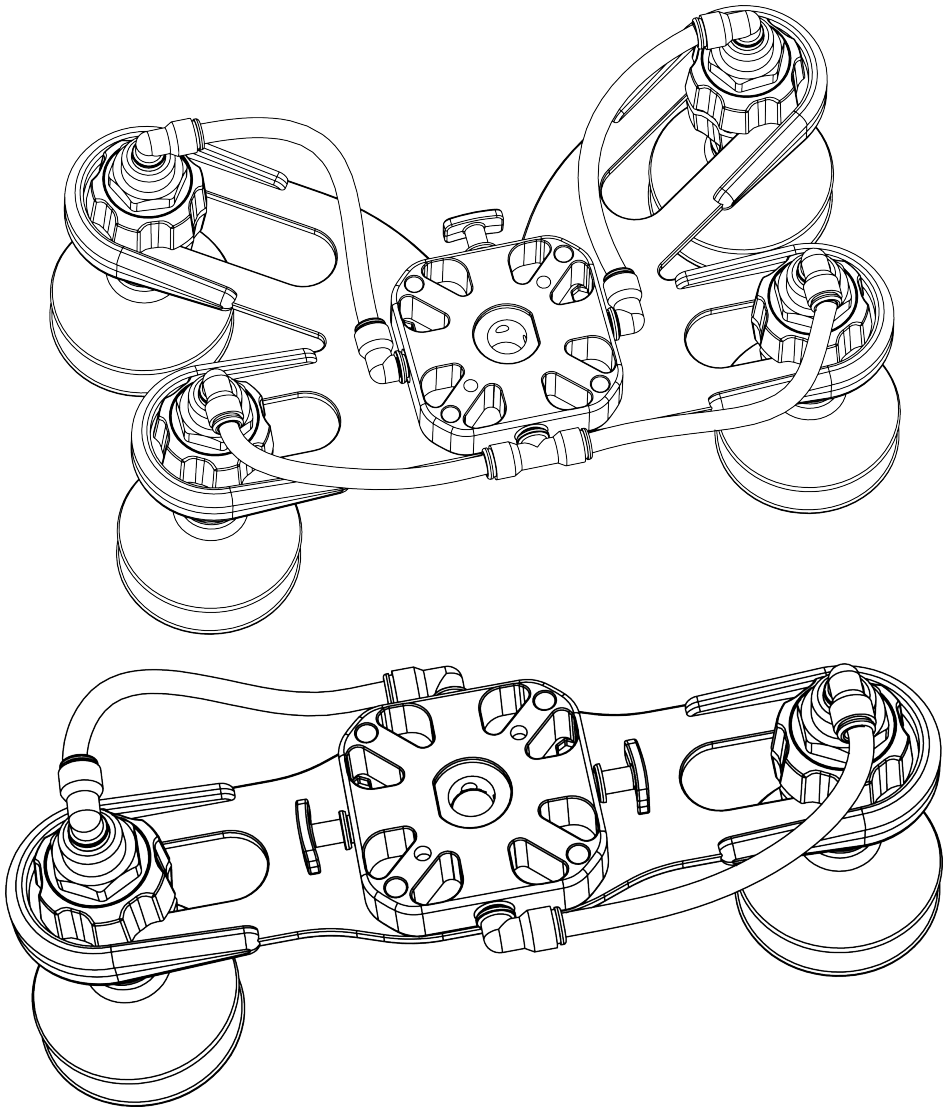


Fig. 3-2: Air tubes alignment

3.4.3. Suction cup system

Manifold and mounting bracket

In order to use the two (2) or the four (4) Suction Cups System, assemble the vacuum generator to the suction cup system, as shown in the figure below, using four (4) M5 socket head cap screws and four (4) M5 toothlock washers.

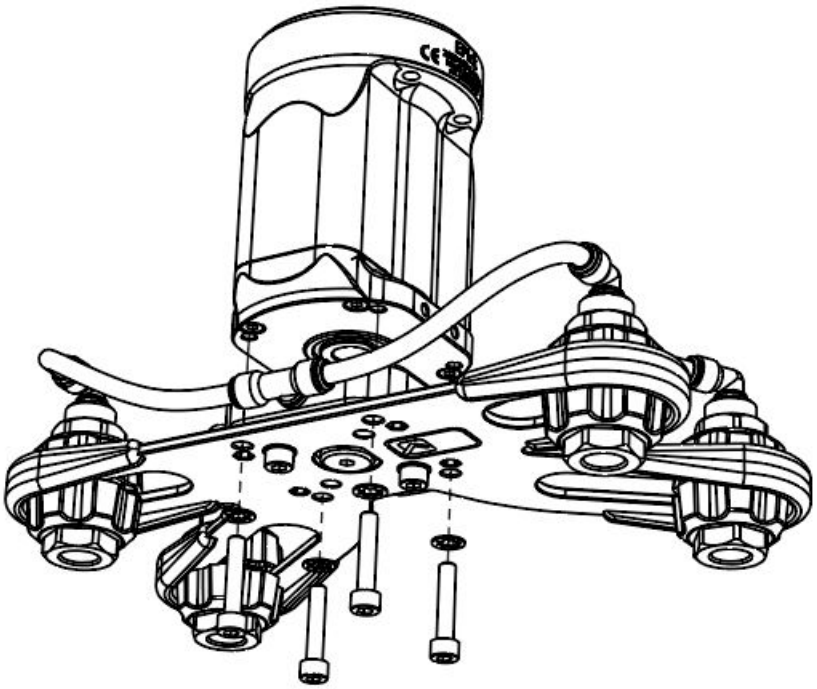


Fig. 3-3: Mounting example of the four suction cups assembly on the vacuum generator

> **Warning**
>
> Any unused manifold port should be covered with a provided port plug to avoid air leakage. For more details, please refer to the **Manifold** section

Suction cups and air nodes

Whether you are using a standard or custom option, air nodes should be used to connect the suction cups and the air tubing, and to prevent air leakage as much as possible. Air nodes are easy to assemble, as shown in the figures below.

1. Screw by hand each provided vacuum cup to an air bolt.

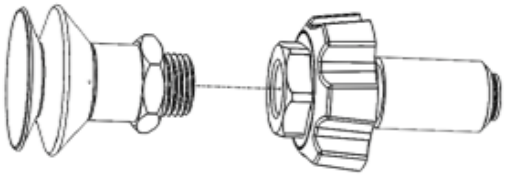


Fig. 3-4: Screwing a vacuum cup and an air bolt

2. Pass each air bolt through the mounting bracket, adjust the position of the node along the bracket side, align with mating air nuts and tighten node by hand.

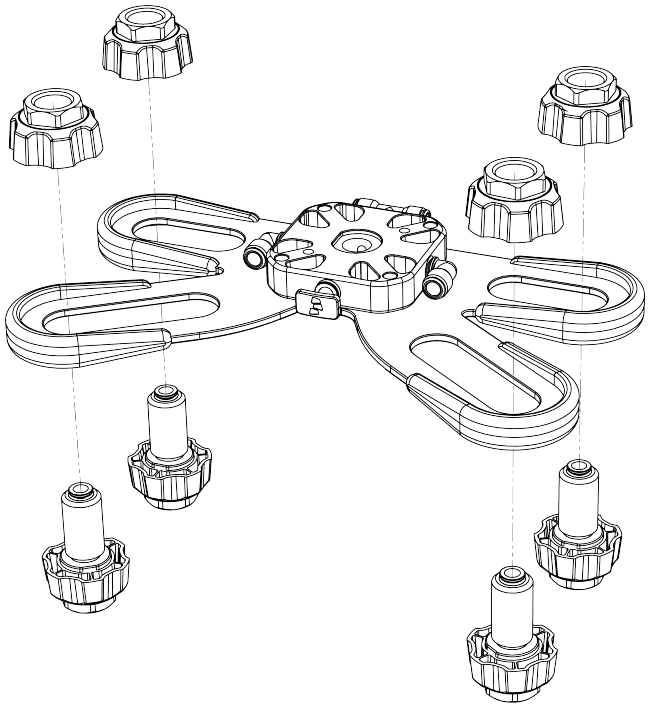


Fig. 3-5: Mounting air nodes (vacuum cups, air bolts, air nuts) on the bracket

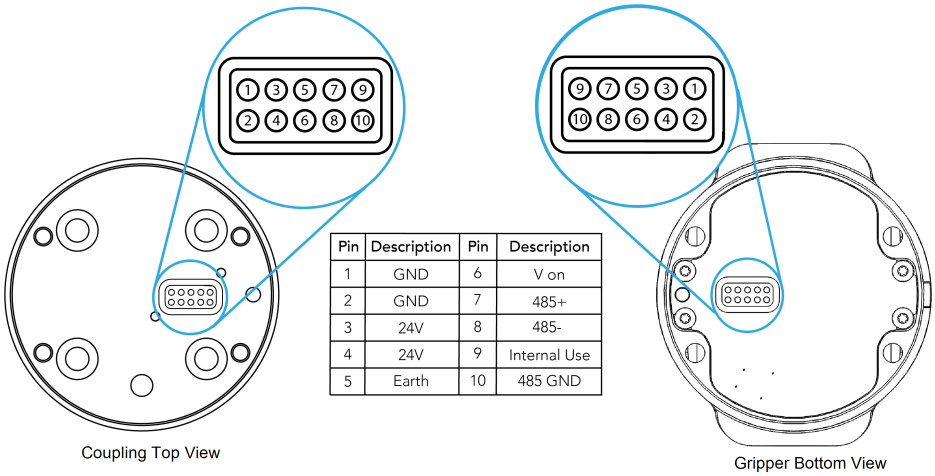
3.5. Electrical Setup

Power and communication are established with the Gripper via a single device cable. The device cable provides a 24 V power supply and enables serial RS-485 communication to the robot controller.

> **Info**
>
> RS-485 signals (485+ , 485- and 485 GND) are isolated from the main 24 V power supply. GND can be connected to any other ground reference as long as the voltage potential between the grounds does not exceed 250 V. Grounding reference is at the user's discretion.

3.5.1 Pinout interface

The Gripper interfaces with its coupling via a 10-spring pin connector located on its outer surface.



Pin	Description	Pin	Description
1	GND	6	V on
2	GND	7	485+
3	24V	8	485-
4	24V	9	Internal Use
5	Earth	10	485 GND

Fig. 3-6: Pinout of the EPick cable-to-wrist coupling.

Info

The coupling used in the figure above is used for reference only and corresponds to bolt pattern ISO 9409-1-50-4-M6.

3.5.2. Coupling to controller

An optional Robotiq Universal Controller may be used between the Gripper and the network/robot controller if fieldbus communication is required.

If a Robotiq Universal Controller is used, please refer to the instruction manual of the Robotiq Universal Controller. The figure below represents the wiring scheme of the Vacuum Gripper with device cable, power supply, fuse (refer to the **Required Tools and Equipment** section) and grounding.

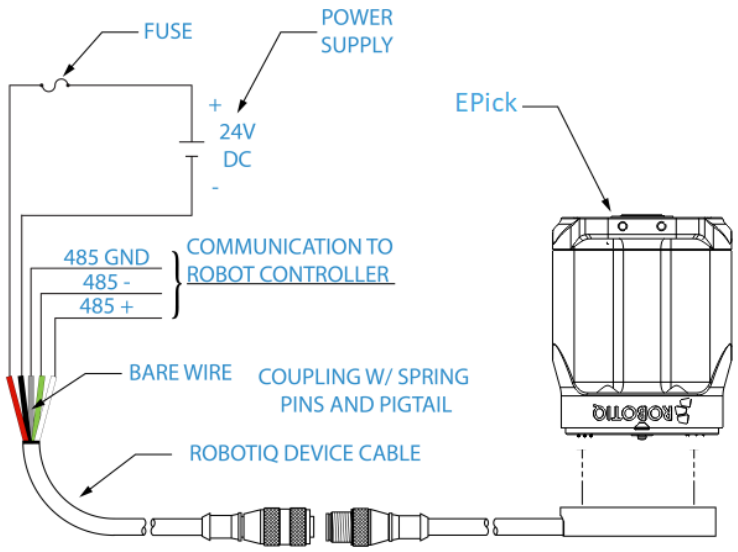
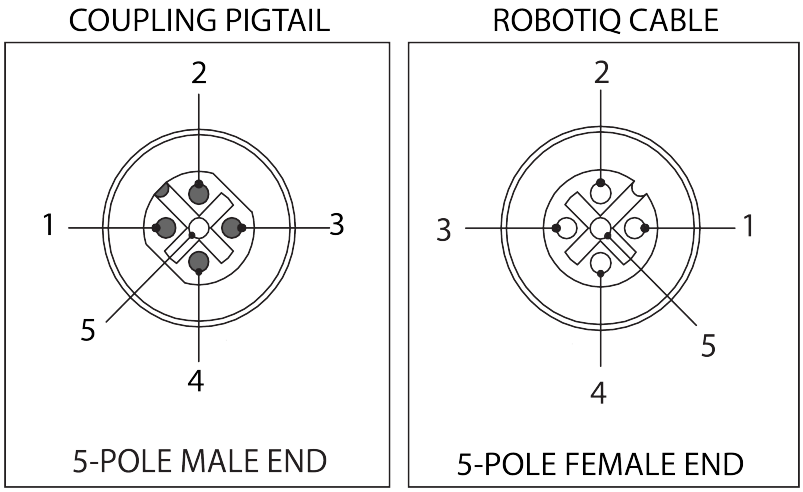


Fig. 3-7: Robotiq Vacuum Gripper with pigtail cable and device cable wiring scheme.

> **Caution**
>
> Use proper cabling management. Make sure to leave enough slack in the cabling to allow movement of the Gripper along all axes without pulling out the connectors. Always protect the controller side (robot side) connector of the cable with a strain relief cable clamp.

The figure below illustrates the Vacuum Gripper pigtail connector from the coupling (GRP-CPL-062 or AGC-CPL-XXX-002), the device cable on the robot side (CBL-COM-2065-10-HF) and their associated pinout.



PIN	END OF CABLE COLOR	SIGNAL
1.	(SHIELD)	RS485 GND
2.	RED	24 V
3.	BLACK	GND
4.	WHITE	RS485 +
5.	GREEN	RS485 -

Fig. 3-8: Pinout of the Vacuum Gripper pigtail and device cable

If additional cables are used, suggested cable specifications are:

Power supply, fusing

- Minimum #22 AWG TEW, 300 V or 600 V

RS485 signal

- Minimum #24 AWG TEW, 300 V or 600 V
- A and B signals must be balanced at 120 Ohms

Single Vacuum Gripper

Connect the white, green and bare wires to the Robotiq RS485 to RS232 signal converter (ACC-ADT-RS232-RS485) as shown in the figure below.

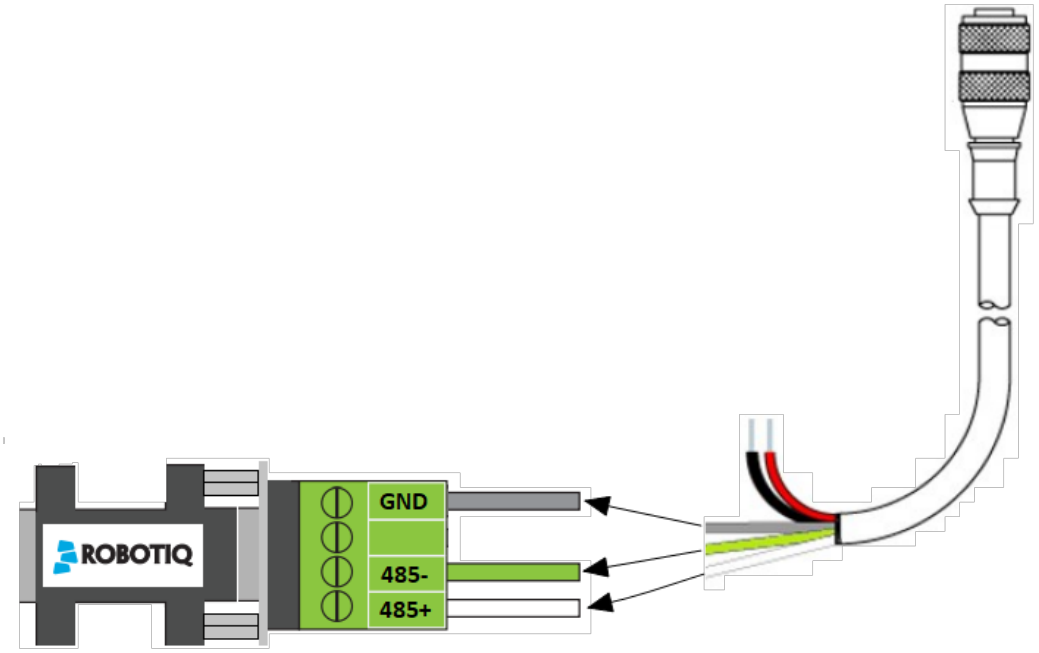


Fig. 3-9: Gripper cable to RS485/RS232 converter

Also connect the red (24V) and black (0V) wires in the controller according to the figure bellow.

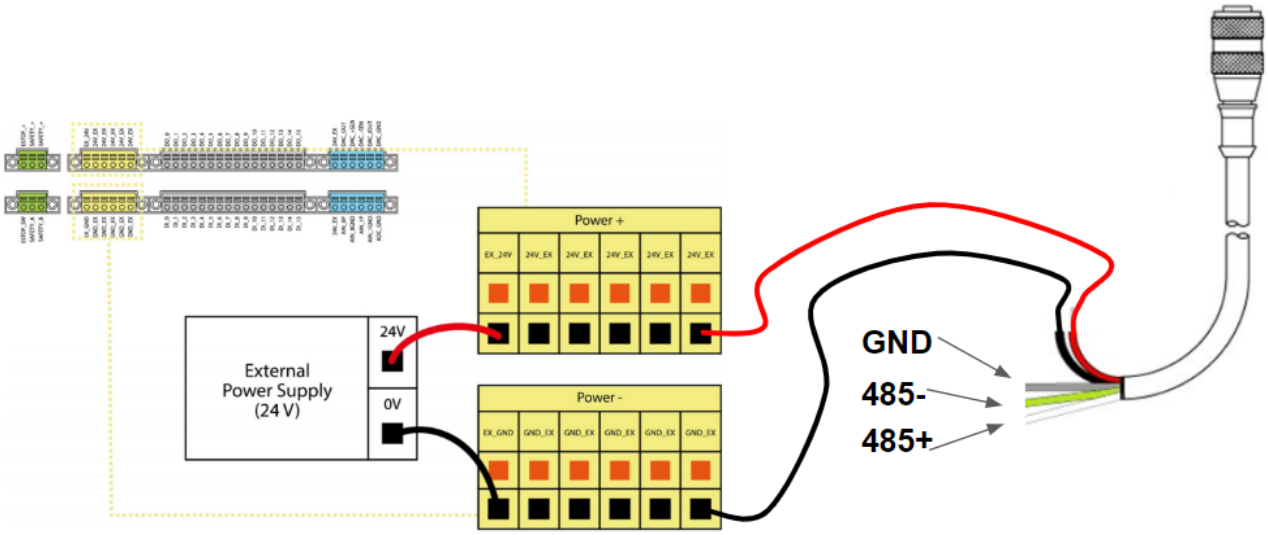
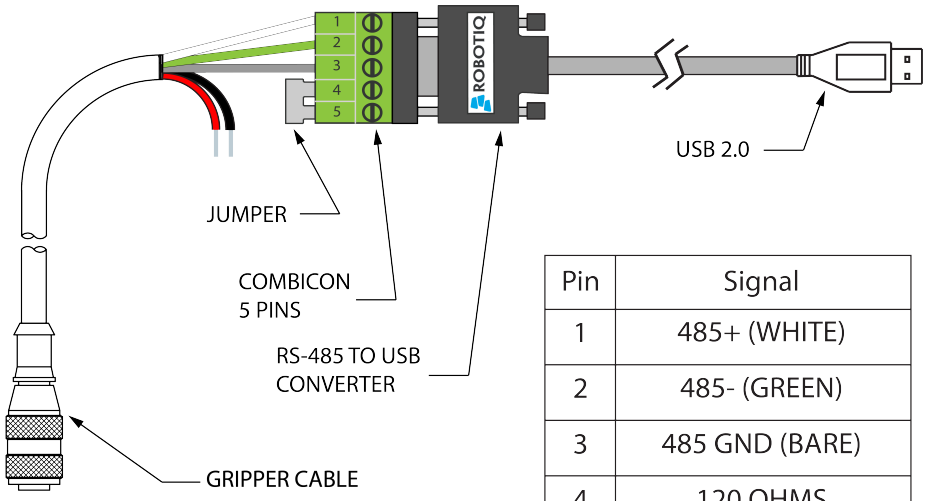


Fig. 3-10: Gripper cable to terminal connector on the controller

3.6. Testing the Gripper with the Robotiq User Interface (RUI)

Once installed and properly secured, your Robotiq Vacuum Gripper should be tested with the Robotiq User Interface test software using the provided USB converter. To do so :



Pin	Signal
1	485+ (WHITE)
2	485- (GREEN)
3	485 GND (BARE)
4	120 OHMS
5	120 OHMS

*24 V AND GND ARE NOT SUPPLIED VIA USB
*120 Ohms resistance JUMPER BETWEEN PINS 4 AND 5

Fig. 3-11: Wiring possibilities of the USB to RS-485 converter.

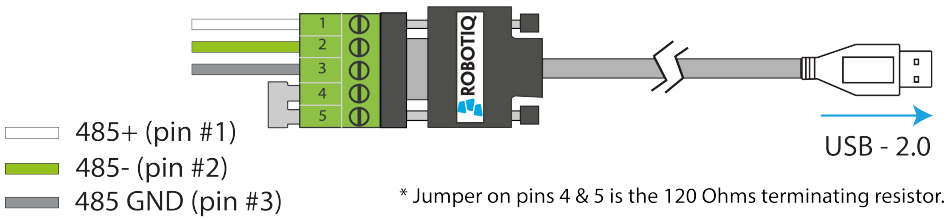


Fig. 3-12: Wiring possibilities of the USB to RS-485 converter.

3.6.1 License Agreement

END-USER LICENSE AGREEMENT

YOU SHOULD CAREFULLY READ THE FOLLOWING AGREEMENT BEFORE USING THE Software (as this term is hereinafter defined). Using the Software indicates your acceptance of the agreement. If you do not agree with it, you are not authorized to use the Software.

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    3. The Licensor's failure to insist upon or enforce strict performance of any provision of this Agreement shall not be construed as a waiver of any provision or right. Neither the course of conduct between the parties nor trade practice shall act to modify any provision of this Agreement.

    4. The Licensor may assign its rights and duties under this Agreement to any party at any time without notice to the End-User. The End-User may not assign this Agreement without the prior written consent of the Licensor.

    5. If any part of this Agreement is null, illegal or non-enforceable, this Agreement shall be interpreted as if this part was never part of this Agreement.

    6. The provisions of this Agreement are for the benefit of the Licensor and its officers, directors, employees, agents, licensors and suppliers. Each of these individuals or entities shall have the right to assert and enforce those provisions directly against the End-User on its own behalf. This Agreement is also for the benefit of, and binds, the End-User and its heirs, successors, legal representatives and permitted assigns.

    7. Any rights not expressly granted herein are reserved.

    8. The parties confirm that they have agreed that this Agreement and all related documents be drafted in English only. Les parties aux présentes confirment qu'elles ont accepté que la présente convention et tous les documents y afférents soient rédigés en anglais seulement.

4. Software

> **Info**
>
> Unless specified, all units in this section are in hexadecimal values.

4.1 Overview

> **Info**
>
> The operator can:
>
> - Control the vacuum level (continuous vacuum when manual mode is set at 100%)
> - Set the minimum vacuum level
> - The automatic mode operation is set by default. The continuous operation mode can also be choose, when checked in the Advanced settings.
> - Benefit from a security mode if air leakage is detected
> - Benefit from energy saving with the automatic mode.
> - Apply a timeout manually (ms) or benefit from an automatic timeout delay

4.11 Control using registers

The Vacuum Gripper has an internal memory that is shared with the robot controller. One part of the memory is for robot output (Gripper functionalities). The other part of the memory is for robot input (Gripper status). Two types of actions can thus be performed by the robot controller:

1. Write in the robot output registers to activate functionalities;
2. Read in the robot input registers to get the status of the Gripper.

The **Vacuum Gripper register mapping** section will map the different registers used to control the Gripper or to read its status. The **Robot output registers & functionalities** section will detail the output (write) register functions. The **Robot input registers & status** section will detail the input (read) register status. The figure below is a representation of the memory and the control logic of the Gripper.

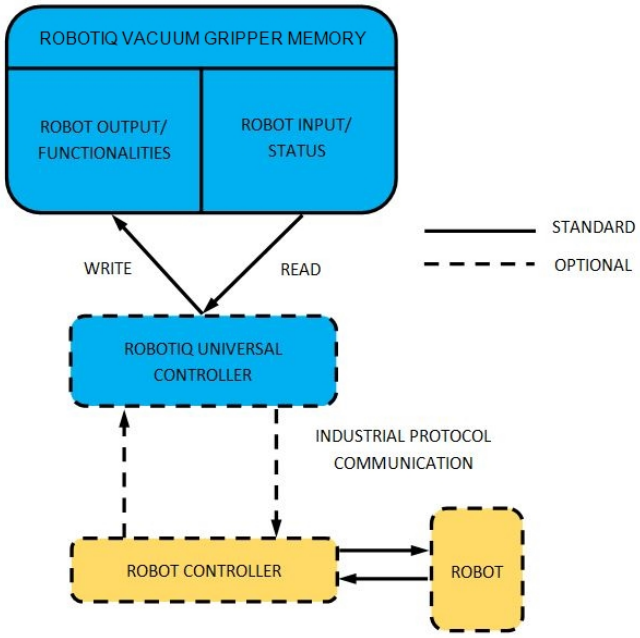


Fig. 4-1: Vacuum Gripper control logic overview

4.2. Vacuum Gripper register mapping

> **Caution**
>
> Byte numbering starts at zero.

Register	Robot Output/Functionality	Robot Input/Status
Byte 0	ACTION REQUEST	GRIPPER STATUS
Byte 1	RESERVED	GRIPPER STATUS
Byte 2	RESERVED	FAULT STATUS
Byte 3	MAX RELATIVE PRESSURE LEVEL REQUEST	MAX RELATIVE PRESSURE LEVEL REQUEST ECHO
Byte 4	GRIP TIMEOUT / RELEASE DELAY	ACTUAL RELATIVE PRESSURE
Byte 5	MINIMUM RELATIVE PRESSURE LEVEL REQUEST	RESERVED
Byte 6 to 15	RESERVED	RESERVED

Table 4-1: Registers of the Vacuum Gripper

4.3. Robot output registers & functionalities

Register: ACTION REQUEST

Address: Byte 0

Bits	7	6	5	4	3	2	1	0
Symbols	Reserved			rATR	rGTO	rMOD		rACT

rACT (Activate)

The rACT bit allows the Gripper to be operational.

- 0b0 - Clear Gripper fault status.
- 0b1 - Gripper is operational. Must stay 0x01 at all time during normal operation of the gripper.

rMOD Gripper mode

The rMOD bits are used to select the gripping mode.

- 0b00 - Automatic mode. The gripper will automatically detect the proper vacuum level, timeout/delay and hysteresis.
- 0b01 - Advanced mode. The user can set the desired minimum and maximum vacuum level and the time-out.
- 0b10 - Reserved
- 0b11 - Reserved

rGTO (Regulate)

The rGTO bit allow gripper to follow the desired vacuum parameters.

- 0b0 - Stop the vacuum generator; valves are in position to hold the workpiece.
- 0b1 - Follow the requested vacuum parameters in real time. When timeout is reached, rGTO must be re-asserted (Set to 0b0 then to 0b1)

rATR (Automatic release)

The rATR bit is used to release the object to ambient pressure (if possible) without any timeout. The rATR bit overrides all other commands excluding the activation bit (rACT). rACT must be at 0b1 during this action.

- 0b0 - Normal operation
- 0b1 - Open the valves without any timeout. After an automatic release, rACT must be re-asserted (rACT=0b0 then rACT=0b1).

Register: RESERVED

Address: Byte 1

Bits	7	6	5	4	3	2	1	0
Symbols	Reserved							

Register: RESERVED

Address: Byte 2

Bits	7	6	5	4	3	2	1	0
Symbols	Reserved							

Register: MAXIMUM VACUUM/PRESSURE REQUEST

Address: Byte 3

Bits	7	6	5	4	3	2	1	0
Symbols	rPR							

rPR (Maximum Vacuum/ Pressure request)

This register is used to set the target vacuum or pressure and is only valid in manual mode (rMOD=0x01).

rPR = 100 + Pmax

Where:

Pmax is the target maximum differential pressure relative to ambient in KPa.

- 0x00 (0d0) - Continuous grip. Vacuum generator always ON.
- 0x16 (0d22) - Grip to 78% of vacuum (Maximum device vacuum).
- 0x5A (0d90) - Grip to 10% of vacuum (Minimum device vacuum).
- 0x64 (0d100) - Passive release. Releasing to ambient pressure.
- 0x65 (0d101) - Active release. Releasing with minimum positive pressure.
- 0xFF (0d255) - Active release. Releasing with maximum positive pressure.

Example:

For a grip with 78% of vacuum level, use Pmax = -78 kPa in the formula.

For a release with 155 kPa of positive air, use Pmax = 155 kPa in the formula.

Register: GRIP TIMEOUT / RELEASE TIME

Address: Byte 4

Bits	7	6	5	4	3	2	1	0
Symbols	rSP							

rSP (Action timeout)

When gripping (rPR <= 0d99), this register is used to set the time window (each integer being 100 milliseconds) prior to a gripping error. The vacuum generator will stop after the timeout period. Only valid if rMOD=0x01.

- 0x00 (0d0) - No timeout.
- 0x0A (0d10) - 1 sec timeout period.
- 0xFF (0d255) - 25.5 sec timeout period.

When releasing (rPR >= 0d100), this register is used to set the time window (each integer being 100 milliseconds) prior to set the vacuum actuators in holding mode. Only valid if rMOD=0x01.

- 0x00 (0d0) - Vacuum holding state set when ambient pressure is detected.
- 0x01 (0d01) - Vacuum holding state set 100 msec after ambient pressure is detected.
- 0x0A (0d10) - Vacuum holding state set 1000 msec after ambient pressure is detected.

Register: MINIMUM VACUUM/PRESSURE REQUEST

Address: Byte 5

Bits	7	6	5	4	3	2	1	0
Symbols	rFR							

rFR (Minimum Vacuum/Pressure request)

This register is used to set the appropriate minimum acceptable vacuum/pressure on the workpiece. When the minimum vacuum level is reached, the object flag (gOBJ) will be set. Once the object is detected, the vacuum generator will keep the vacuum level in between the minimum and maximum vacuum level. Only valid if rMOD=0x01.

rFR = 100 + Pmin.

Where:

P_{min} is the target minimum differential pressure relative to ambient in kPa.

- 0x00 (0d0) - Object will be detected when vacuum level reaches 100% (This is impossible, so avoid using this value)
- 0x1E (0d30) - Object will be detected when vacuum level reaches 70%.
- 0x50 (0d80) - Object will be detected when vacuum level reaches 20%.
- >0x64 (>0d100) - Reserved value

Example:

For a grip with a maximum of 78% vacuum level and an object detection at 20% of vacuum level, use:

Pmax = -78 kPa

Pmin = -20 kPa

rFR = 100 + (-20) = 80

Warning

Setting the pressure tolerance too low might wear the product prematurely resulting in a shorter lifespan than expected.

The warranty of the product is defined as the number of grip/release valve cycles and not in terms of object grip/release cycles.

4.4. Robot input registers & status

Register: GRIPPER STATUS

Address: Byte 0

Bits	7	6	5	4	3	2	1	0
Symbols	gOBJ		gSTA		gGTO	gMOD		gACT

gACT (Activate echo)

The gACT bit is the echo of the rACT bit in the ACTION REQUEST register.

gMOD (Gripper mode echo)

The gMOD bits are the echo of the rMOD bits in the ACTION REQUEST register.

gGTO (Regulate echo)

The gGTO bit is the echo of the rGTO bit in the ACTION REQUEST register. Valid only if the vacuum/pressure is regulated, otherwise it returns 0x0.

gSTA (Activation status)

The rSTA bits indicates the status of the gripper activation sequence.

- 0b00 - Gripper is not activated.
- 0b11 - Gripper is operational.

gOBJ (Object status)

The gOBJ bits indicates the status of the object detection.

- 0b00 - Unknown object detection. Regulating towards requested vacuum/pressure.
- 0b01 - Object detected. Minimum vacuum value reached.
- 0b10 - Object detected. Maximum vacuum value reached.
- 0b11 - No object detected. Object loss, dropped or gripping timeout reached.

Register: GRIPPER STATUS EXTENSION

Address: Byte 1

Bits	7	6	5	4	3	2	1	0
Symbols	Reserved						gVAS	

gVAS (Vacuum actuator status)

The rVAS bits indicates the status of the gripper actuators.

- 0b00 - Standby. Vacuum generator and valves deasserted (OFF).
- 0b01 - Gripping. Vacuum generator ON.
- 0b10 - Passive releasing. Releasing to ambient pressure.
- 0b11 - Active releasing. Releasing with positive pressure.

Register: FAULT STATUS

Address: Byte 2

Bits	7	6	5	4	3	2	1	0
Symbols	kFLT				gFLT			

gFLT (Gripper fault status)

The gFLT bits indicates priority, minor or major fault codes that are useful for troubleshooting.

- **No fault**
  - 0x0 - No fault
- **Priority faults (0x0 < gFLT <= 0x7)**
  - 0x5 - Action delayed
  - 0x3 - Very porous material detected
  - 0x6 - Gripping timeout. rGTO must be re-asserted (rGTO=0 then rGTO=1) or one of the following parameters must be changed (rMOD, rPR, rSP, rFR).
  - 0x7 - The Activation bit not set. Activation bit must be set prior to action (rACT=1).
- **Minor faults (0x8 <= gFLT <= 0x9)**
  - 0x8 - Maximum operating temperature exceeded, wait for cool-down.
  - 0x9 - No communication during at least 1 second. This fault will only be returned once if the next valid communication is a “ read command” of the FAULT STATUS register.
- **Major faults (0xA <= gFLT <= 0xF) - Reset is required (rising edge on activation bit rACT required)**
  - 0xA - Under minimum operating voltage.
  - 0xB - Automatic release in progress (Vacuum/pressure detected).
  - 0xC - Internal fault; contact support@robotiq.com.
  - 0xF - Automatic release completed (Vacuum/pressure not detected)

kFLT

Please refer to the optional Robotiq Controller manual (input registers & status).

Register: MAXIMUM VACUUM/PRESSURE LEVEL REQUEST ECHO

Address: Byte 3

Bits	7	6	5	4	3	2	1	0
Symbols	gPR							

gPR (Vacuum/Pressure request echo)

This register is the echo of the MAXIMUM VACUUM/PRESSURE LEVEL REQUEST register.

Register: ACTUAL VACUUM/PRESSURE

Address: Byte 4

Bits	7	6	5	4	3	2	1	0
Symbols	gPO							

gPO (Actual Vacuum/Pressure)

The gPO is the actual vacuum/pressure measured in the suction cups.

Pdiff = gPO - 100. Where Pdiff is the differential pressure relative to ambient in KPa.

- 0x00 (0d00) - Maximum vacuum (Pdiff <= -100 kPa).
- 0x64 (0d100) - No differential pressure (Pdiff = 0 kPa).
- 0xFF (0d255) - Maximum pressure (Pdiff >= 155 kPa).

4.5. Gripper behavior

Workpiece gripping/releasing is performed by changing the values of the gripper input registers. While the control is very simple, some behaviors deserve a better explanation.

4.5.1 Control modes

The vacuum gripper can work in two different mode: the Automatic and Advanced options.

Automatic mode

The automatic mode is selected when rMOD==0b00. In this mode, the gripper will automatically detect the proper vacuum levels and timeout/delay required to grip or release the workpiece. Behavior of the automatic mode changes depending on the workpiece surface material, the suction cup condition and the firmware revision. This mode should be used when the user wants to make a quick test. If a constant behavior is needed, using the advanced mode is a more suitable option.

When gripping an object in the automatic mode, the Vacuum Gripper will:

1. Try to reach the maximum possible vacuum level for a maximum period of 2 seconds.
2. Automatically determine a desired minimum and maximum vacuum level in order to keep a good grip on the workpiece, if a vacuum level of more than 20% is detected and the level seems constant.
3. Set the object flag.
4. Vacuum generator will keep the vacuum level in between min and max until a release command is received.
5. Object lost/drop flag will be set if the vacuum level drops below 10% or if the vacuum level falls below the minimum vacuum level for more than 2 seconds.

When releasing an object in the automatic mode, the Vacuum Gripper will:

1. Open the release valve.
2. Object drop flag will be set when the vacuum level falls below 0.5%.
3. Release valve will be kept open for 1 second.

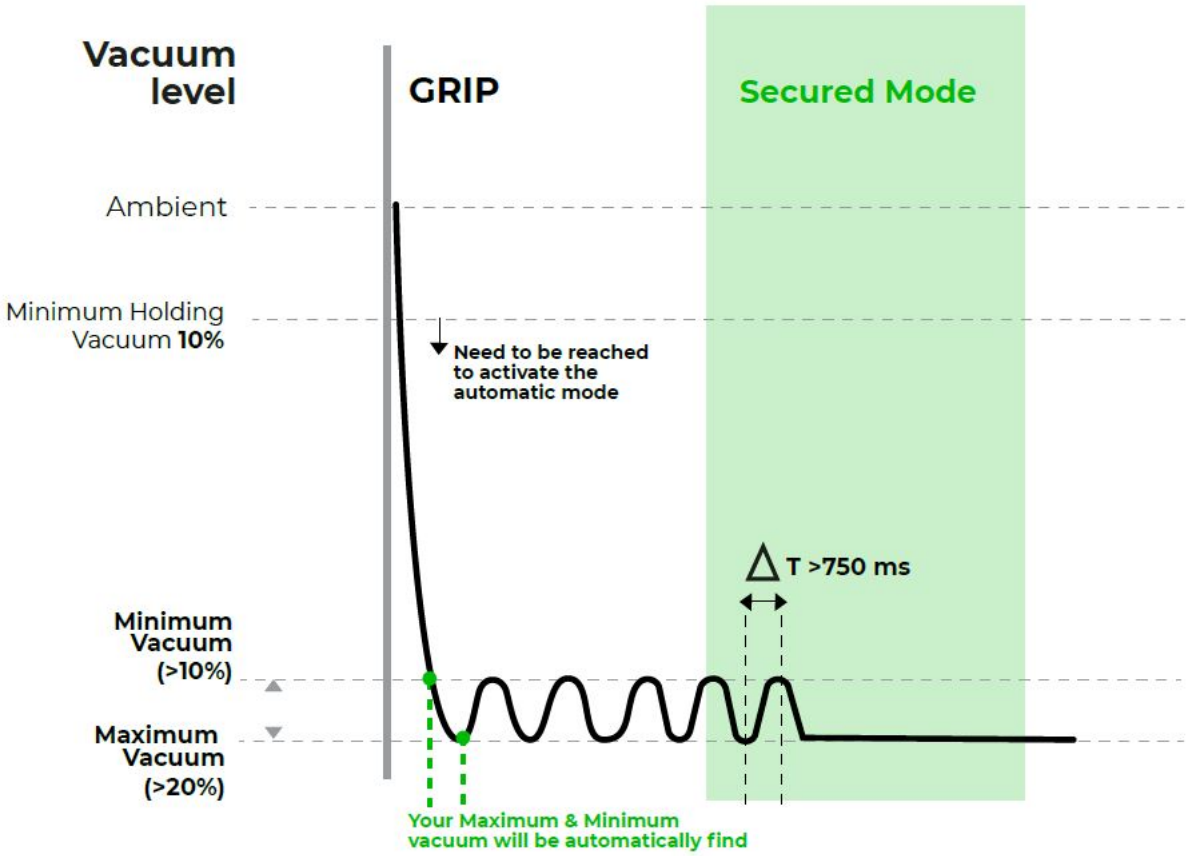


Fig. 4-2: Vacuum level vs time in the automatic mode

Advanced mode

The advanced mode is selected when rMOD==0b01. In this mode, the user can set the desired vacuum levels and timeout/delay required to grip/release the object. Behavior of the manual mode only depends on the maximum vacuum level, minimum vacuum level and the timeout/delay registers. This mode should be used when the user wants to have a constant production behavior.

When gripping an object in the manual mode, with the maximum vacuum level set below 100%, the Vacuum Gripper will:

1. Try to reach the desired maximum vacuum level for a maximum period of the desired timeout value.
2. If the desired maximum vacuum level is reached and the vacuum level is higher than 20%, object flag will be set to (gOBJ=0b10).
3. Vacuum generator will keep the vacuum level in between min and max until a release command is received. Object flag will toggle in between (gOBJ=0b01) and (gOBJ=0b10).
4. Object lost/drop flag will be set if the vacuum level drops below 10% or if the vacuum level falls below the desired minimum vacuum level for more than the desired timeout value.

When gripping an object in the manual mode with the maximum vacuum level set to 100%, the Vacuum Gripper will:

1. Continuously generate a vacuum
2. When the minimum vacuum level is reached, object flag will be set (gOBJ=0b01). Object flag (gOBJ=0b10) will never be set because 100% of vacuum level is impossible to reach.
3. Object lost/drop flag will be set if the vacuum level drops below 10% or if the vacuum level falls below the minimum vacuum level for more than the desired timeout value.

When releasing an object in the manual mode, the Vacuum Gripper will:

1. Open the release valve.
2. Object drop flag will be set when the vacuum level falls below 0.5%.
3. Release valve will be kept open for 1 second.

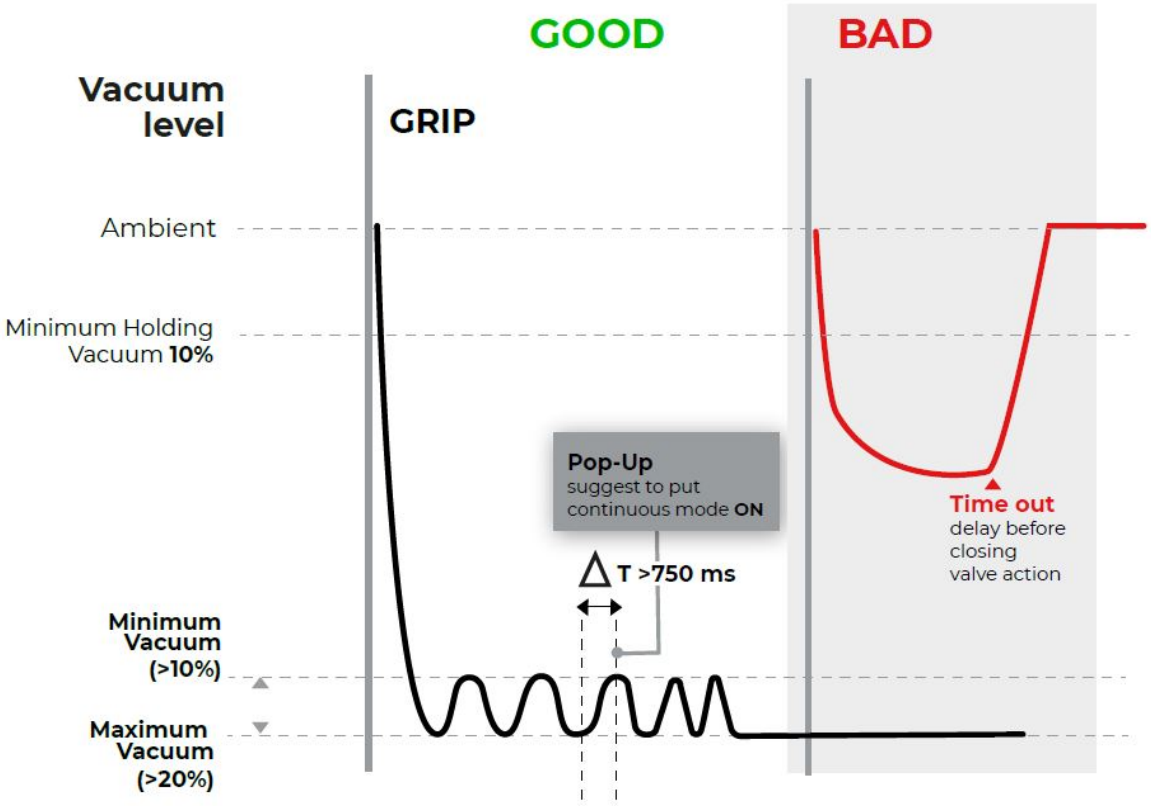


Fig. 4-3: Vacuum level vs time in the Advanced mode

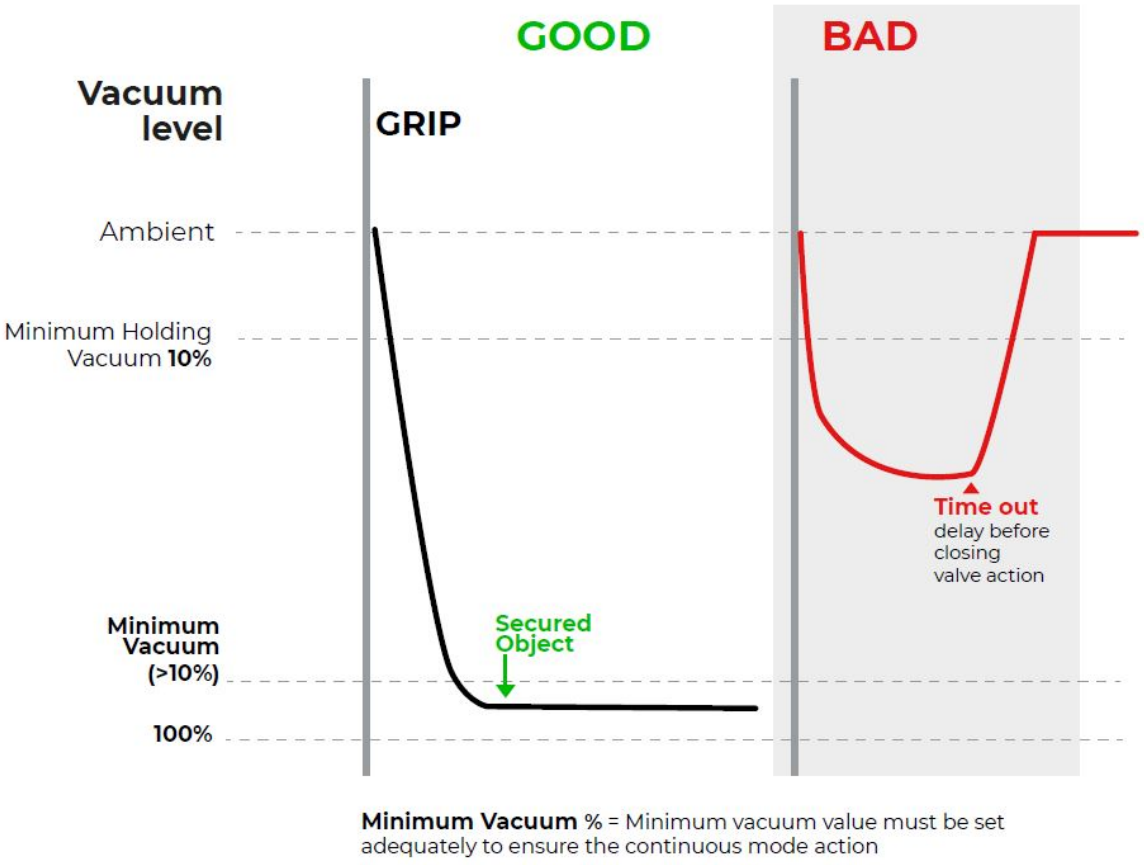


Fig. 4-4: Vacuum level vs time in the continuous mode

Very porous material detection

When a very porous material is detected or when the suction wears out, the Vacuum Gripper will detect it and react according to the gripper mode. When this condition occurs, it is important to find the underlying reason because it will make the vacuum generator start and stop very rapidly. This can lead to a premature wear of the gripper internal mechanics.

- In **automatic mode**, no fault will be set, but the gripper will continuously run the vacuum generator until a release command is received.
- In **advanced mode**, a fault flag will be set (gFLT=0x3) and the gripper will continue to run with the desired settings.

Object lost/ drop behavior

When an object is lost or dropped, the gripper will set an object flag (gOBJ=0b11). This means that the vacuum level has fallen below 10% or below the minimum desired vacuum level for a the desired timeout value.

Object secured behavior

As soon as the grip command is received by the gripper:

1. The unknown object flag will be set (gOBJ=0b00).
2. If the vacuum level reaches the desired maximum vacuum level, the object secure to max flag will be set (gOBJ=0b10).

3. The vacuum generator will stop until the vacuum reach the desired minimum vacuum level.
4. The object secured to min flag will be set (gOBJ=0b01) and the vacuum generator will try to reach the maximum vacuum again.

Object not detected behavior

When a grip command is received, the gripper will use the desired timeout value as a maximum period of time to detect an object. When no object is detected after the timeout value, the timeout flag will be set (gFLT=0x6). To retry the same grip command, the regulate bit needs to be re-asserted (rGTO=0b0, then rGTO=0b1). If new gripping settings are received (rMOD, rPR, rFR, rSP), there is no need to re-assert the regulate bit.

Object release delay

When the release command is received, the vacuum gripper will open the release valve in order to let air enter the suction cups. Once the pressure inside the suction cup is equal or greater than the ambient pressure, the gripper will set the no object flag (gOBJ=0b11). The robot will then move away from the workpiece. Depending on the suction type, this motion might create a new vacuum inside the suction cups. Therefore, the user can set the distance for the robot to move away from the workpiece. Once this distance is reached, the Vacuum Gripper valve will close.

Emergency stop behavior

Depending on the robot, the behavior might be different when pushing an emergency stop. If the user wants to ensure a good grip even in emergency stop, the vacuum gripper must be connected to a supply source that will not drop when pushing the emergency stop. As long as the gripper is supplied, it will always try to keep the workpiece, even if the communication is stopped with the robot.

4.6. Control logic

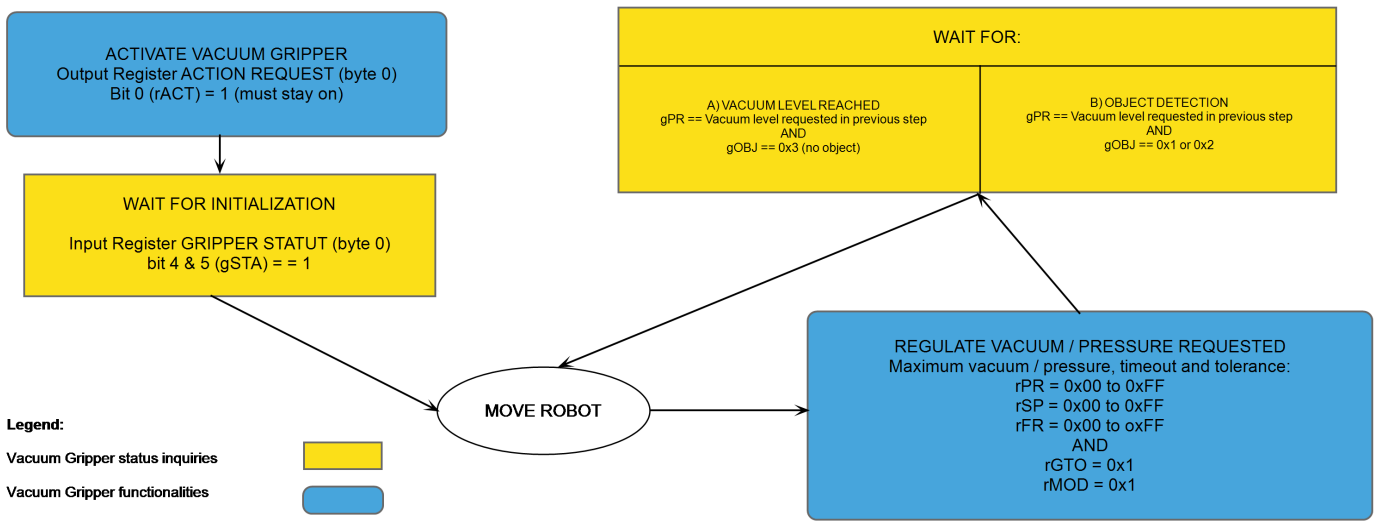


Fig. 4-5: Example of the Vacuum Gripper control logic with associated registers.

4.7. Modbus RTU communication

The Vacuum Gripper can be controlled by Modbus RTU over RS485. This section is intended to provide guidelines for setting up a Modbus master that will adequately communicate with the Gripper.

For a general introduction to Modbus RTU and for details regarding the CRC algorithm, the reader is invited to read the Modbus over serial line specification and implementation guide available at: http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf.

For debugging purposes, the reader is also invited to download one of many free Modbus master such as the CAS Modbus Scanner from Chipkin Automation Systems available at: http://www.store.chipkin.com/products/tools/cas-modbus-scanner.

Info

Modbus RTU is a communication protocol based on a Big Endian byte order. Therefore, the 16-bit register addresses are transmitted with the most significant byte first. However, the data port is, in the case of Robotiq products, based on the Little Endian byte order. As such, the data parts of Modbus RTU messages are sent with the less significant byte first.

Tip

Modbus RTU specifications and details can be found at www.modbus.org.

4.7.1 Connection setup

The following table describes the connection requirements for controlling the Gripper using the Modbus RTU protocol.

Proprieties	Value
Physical interface	RS-485
Baud rate	1.2KBps to 10500KBps; **Default:115.2 KBps**
Data bits	8 bits
Parity	None, Odd, Even; **Default: None**
Stop bit	1 or 2 bit; **Default: 1 bit**
Other Modbus functions	FC3, FC4, FC6, FC16, FC23,
Exception responses	0x03 (Illegal Data Value)
Slave ID	1 to 9: **Default: 9**
Robot output/Gripper input registers	1000 to 1007
Robot input/Gripper output registers	2000 to 2007

Table 4-2: Modbus RTU connection setup for the Vacuum Gripper

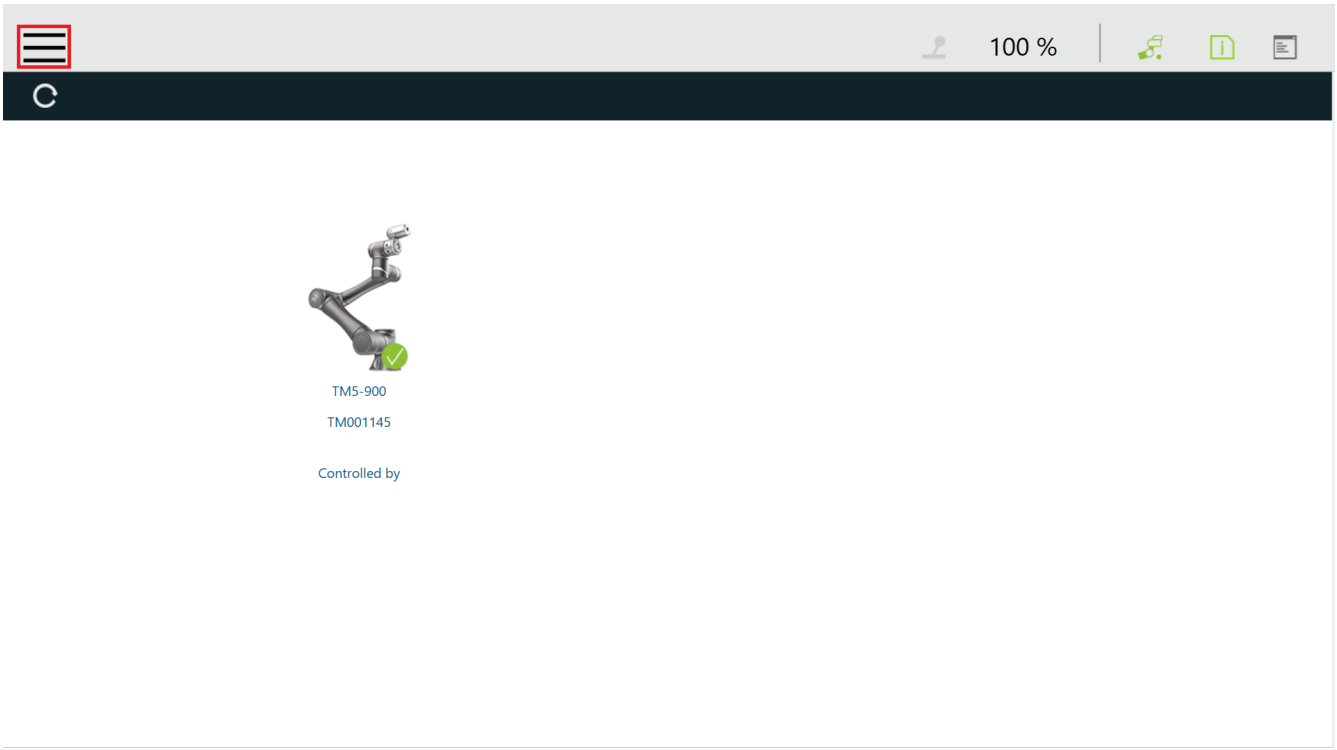
4.8. Control over TM

4.8.1 TM Robots compatibility with Robotiq Vacuum Grippers

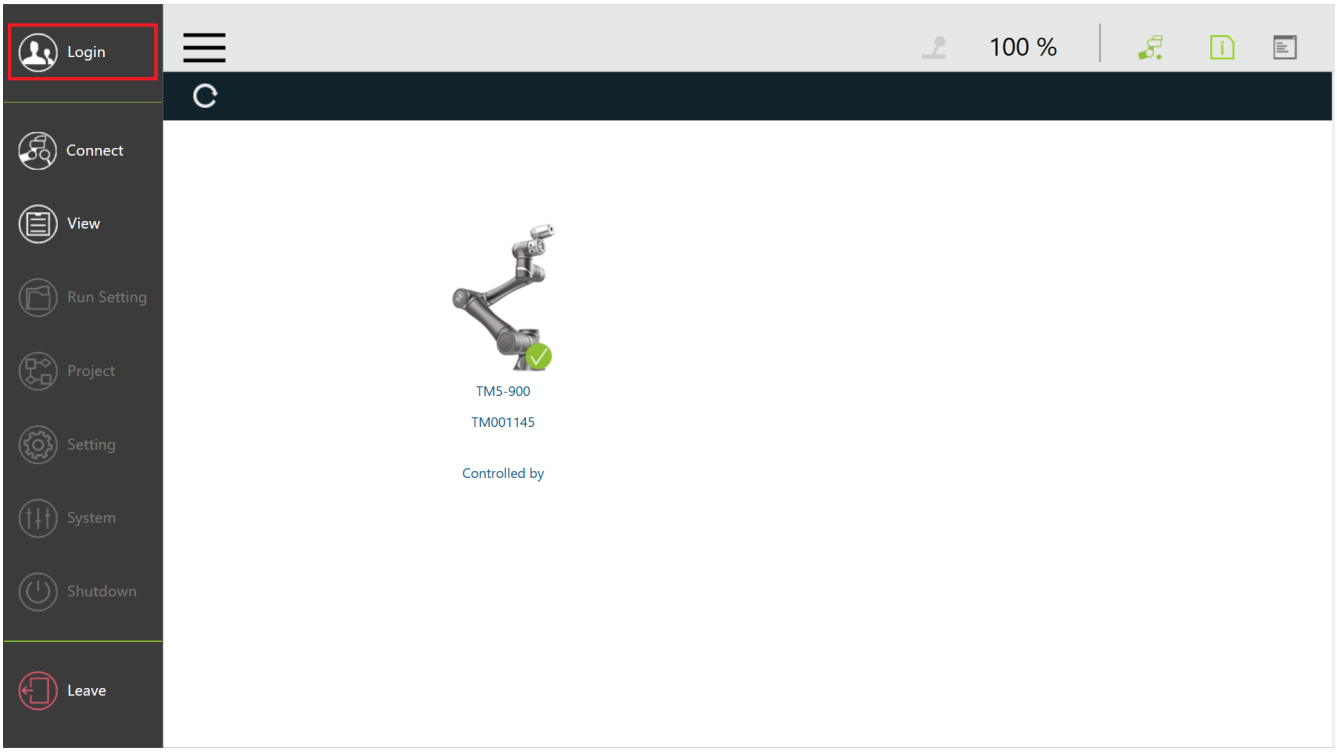
Hardware Version	TM Flow Version	TM Gripper Component	Robotiq RS232 Converter
HW1, HW2, HW3	1.68 and later	VAC_V002_XXX	Compatible

4.8.2. Getting Started

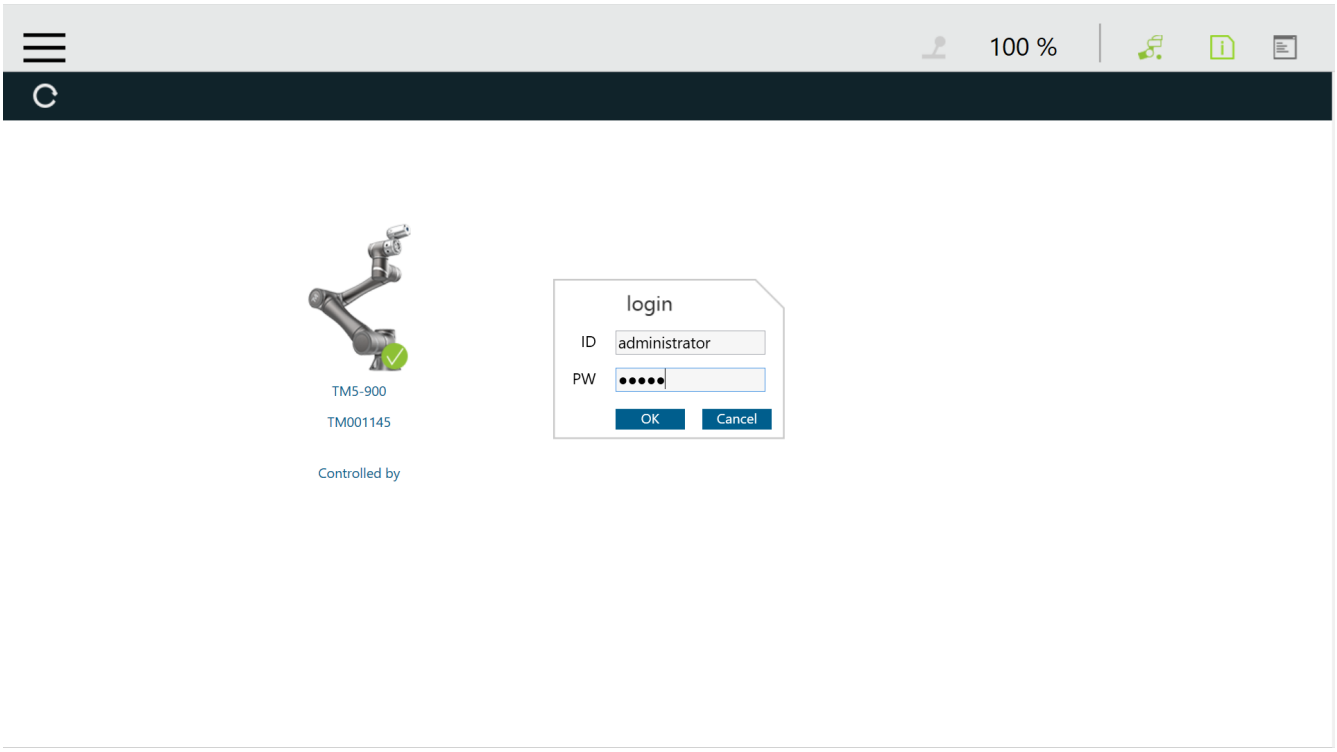
1. Power ON the robot
2. Tap the triple bar icon in the upper left corner of the screen



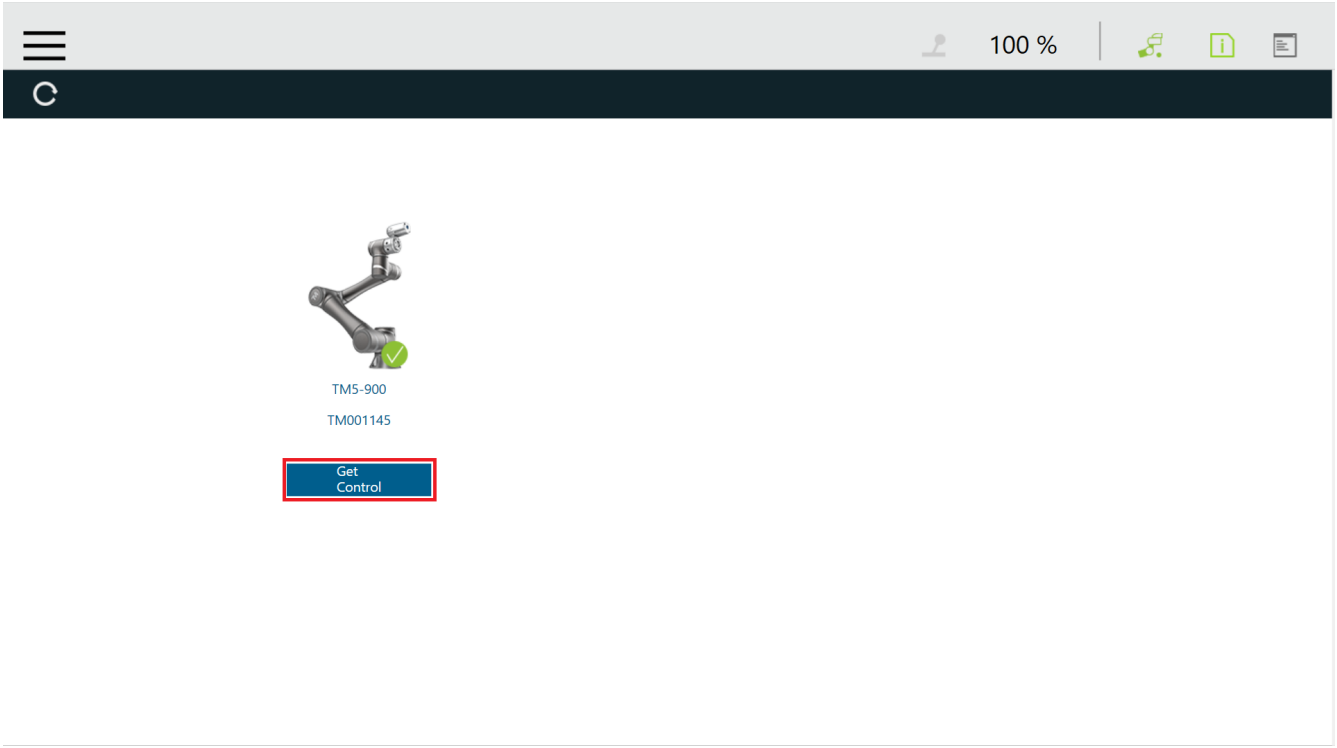
3. Click on the **Login** icon in the navigation pane on the left



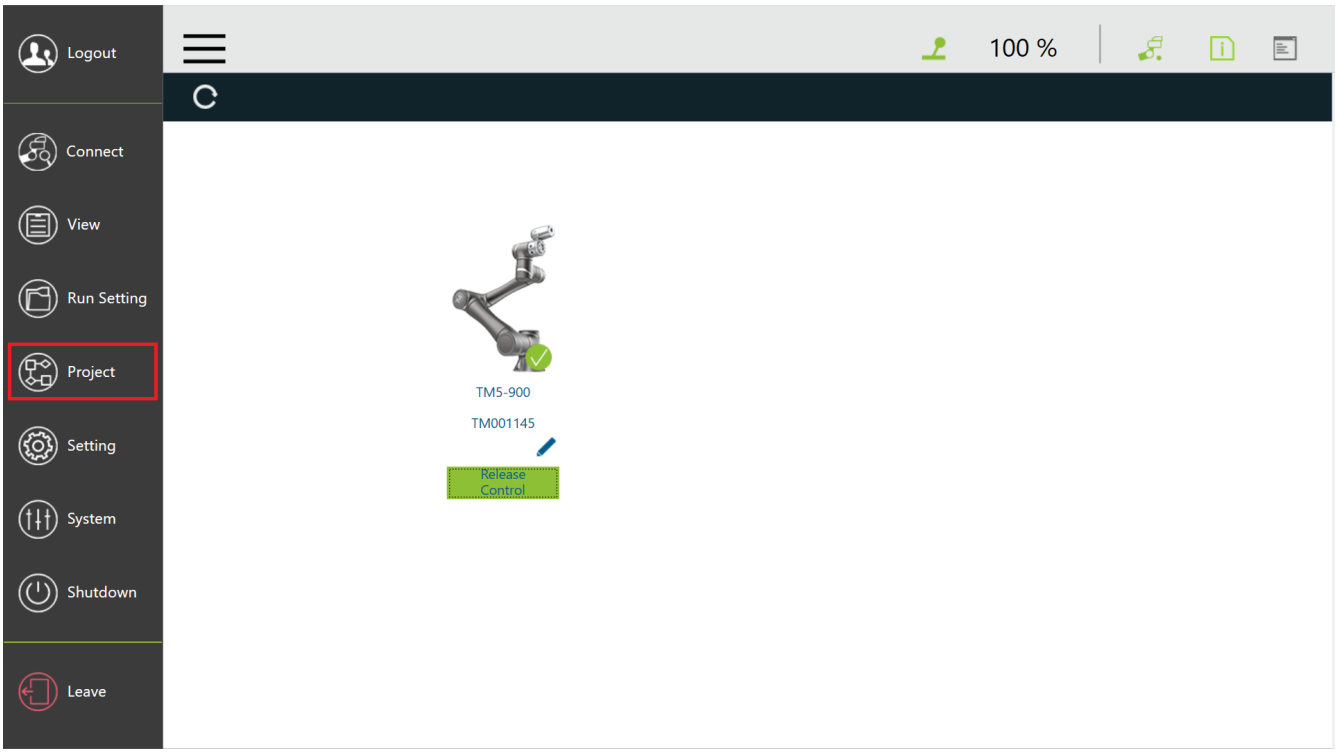
4 Enter your login credentials and click on **OK**



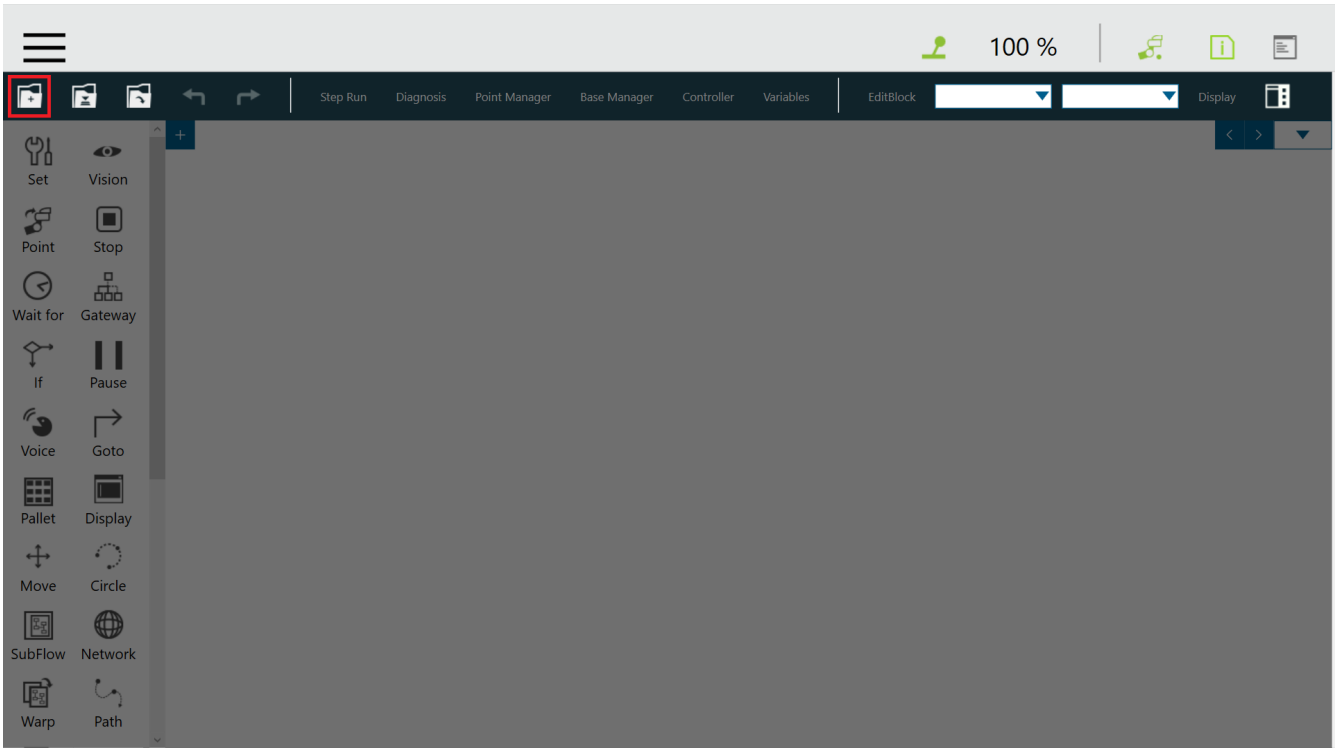
5 Click on **Get Control**



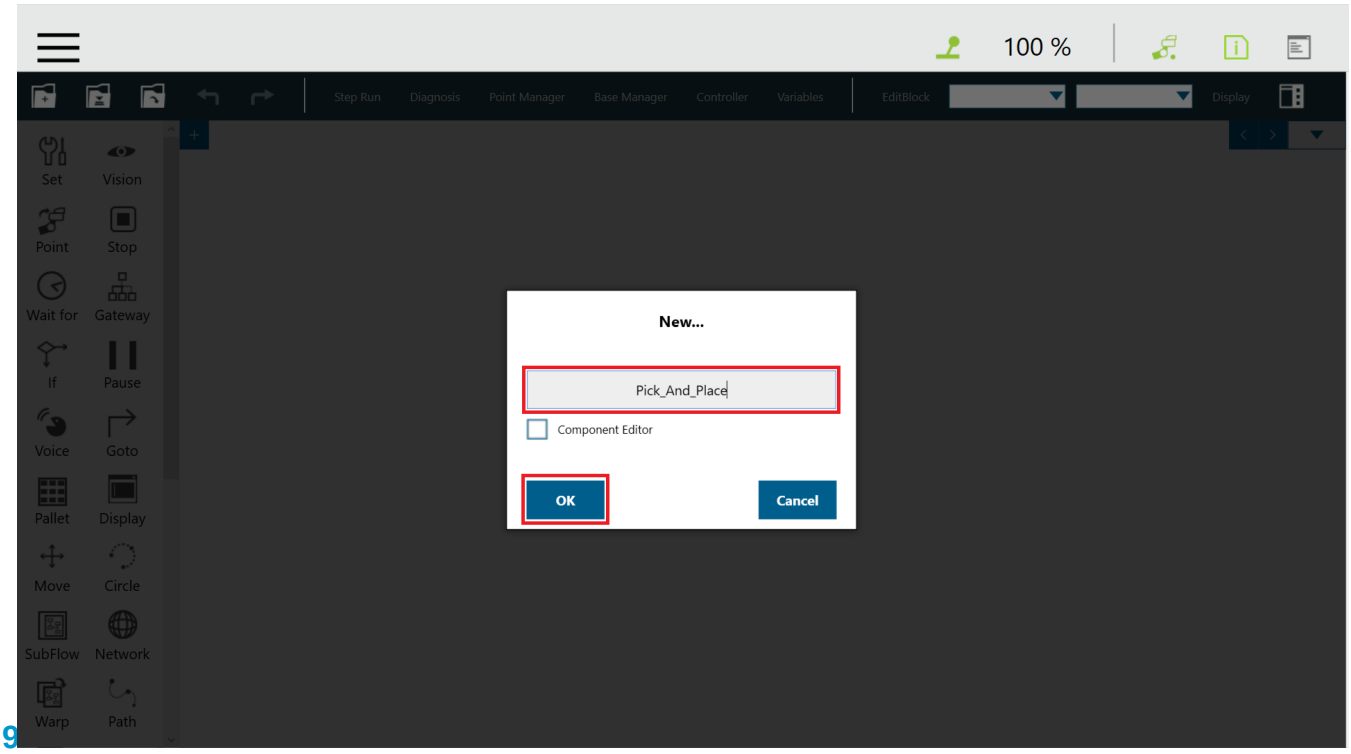
6 Click on the **triple bar icon** in the upper left corner of the screen and select **Project**



7 Click on the **New Project** icon in the upper left corner of the screen



8 Enter a name for your program and click on the **OK** button



9

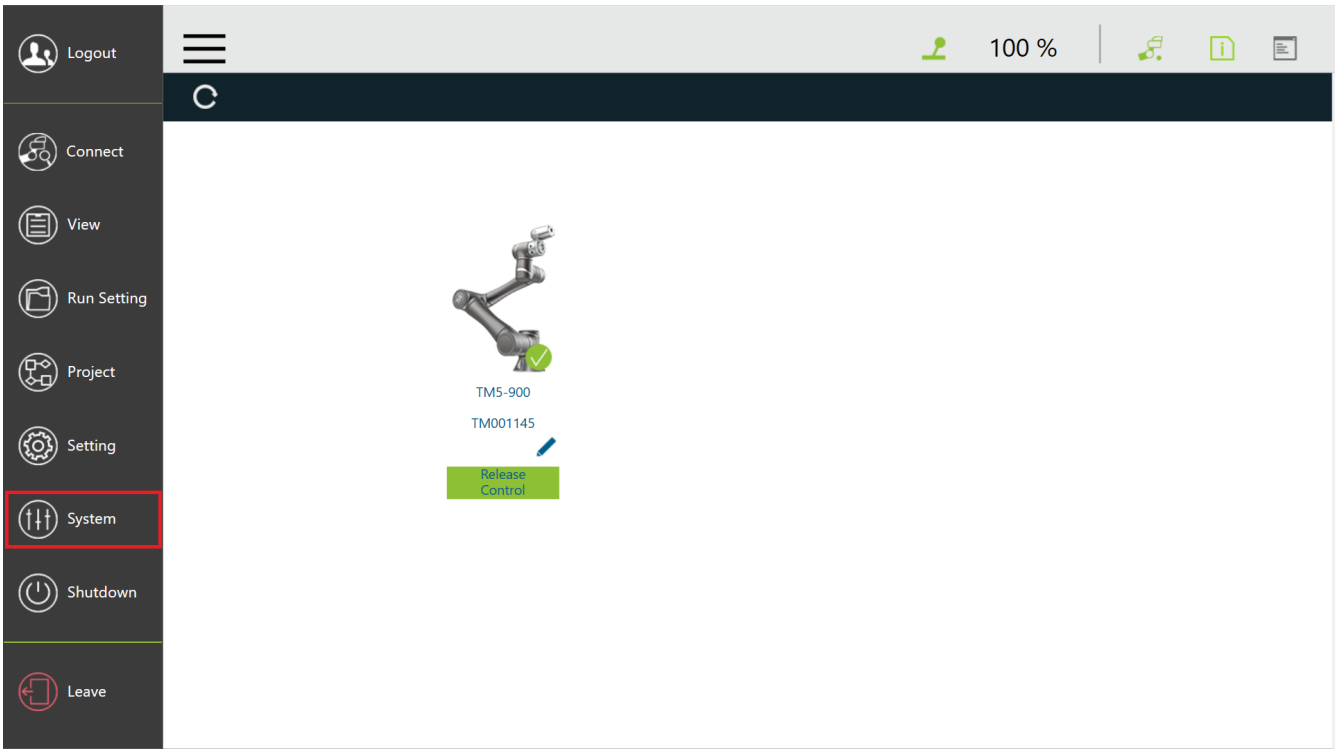
4.8.3. TM Vacuum Gripper Components

Here is the list of the current Robotiq Gripper TM Components to install on TM Robots:

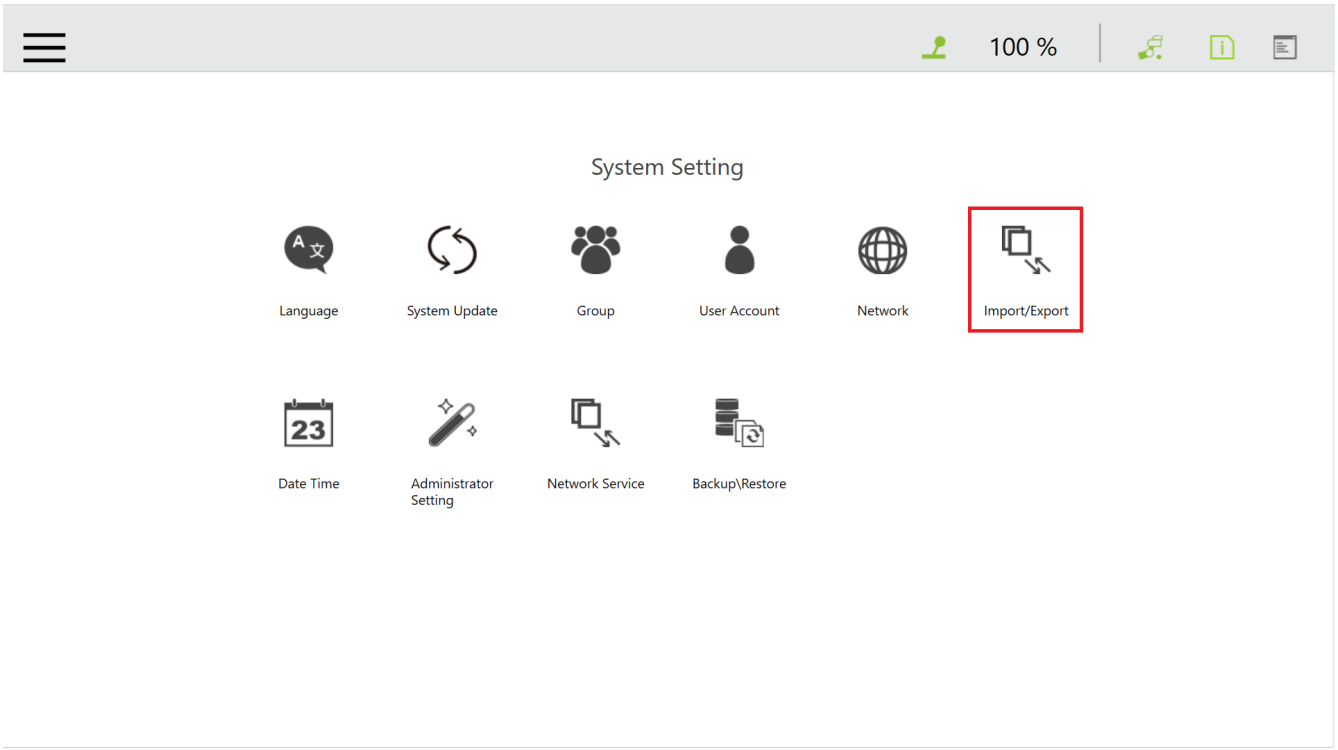
- GRIPPER_ROBOTIQ_VAC_V002_SET.Component = SET the Vacuum Gripper (Advanced mode, Vacuum Levels, Timeout)
- GRIPPER_ROBOTIQ_VAC_V002_GRIP.Component = Grip a part (Action)
- GRIPPER_ROBOTIQ_VAC_V002_RELEASE.Component = Release a part (Action)
- GRIPPER_ROBOTIQ_VAC_V002_SELECTID.Component = Select the slave ID of the gripper when using a dual gripper setup

Installation

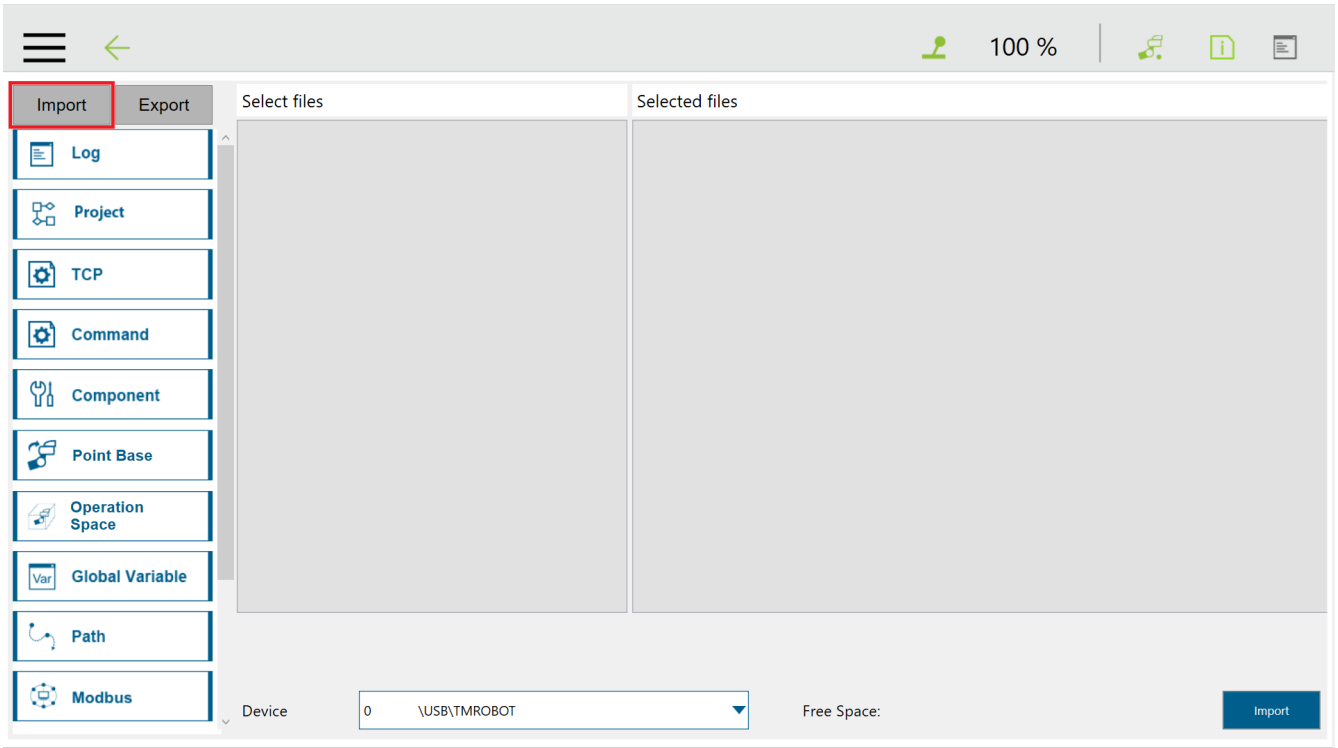
1. Download the TM Plug & Play Software Package compression files on the official website
2. Rename the USB storage device "TMROBOT". Make sure the drive format is **NTFS**.
3. Place the zipped component files in the USB with the folder directory **TMROBOT:\TM_Export\TMComponent\ComponentObject**.
4. Insert the USB storage device in the robot controller
5. In TM Flow (robot software), tap the **triple bar** icon and select **System**



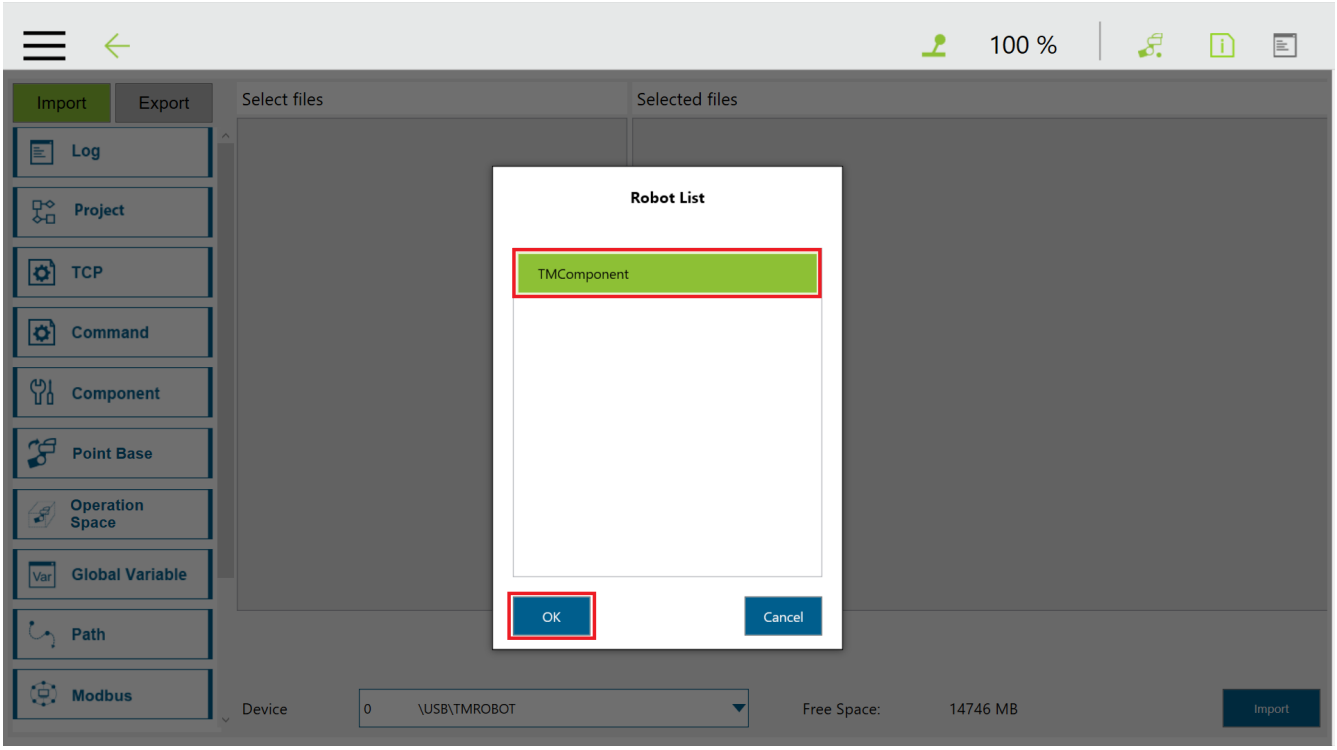
6. Select **Import/Export**



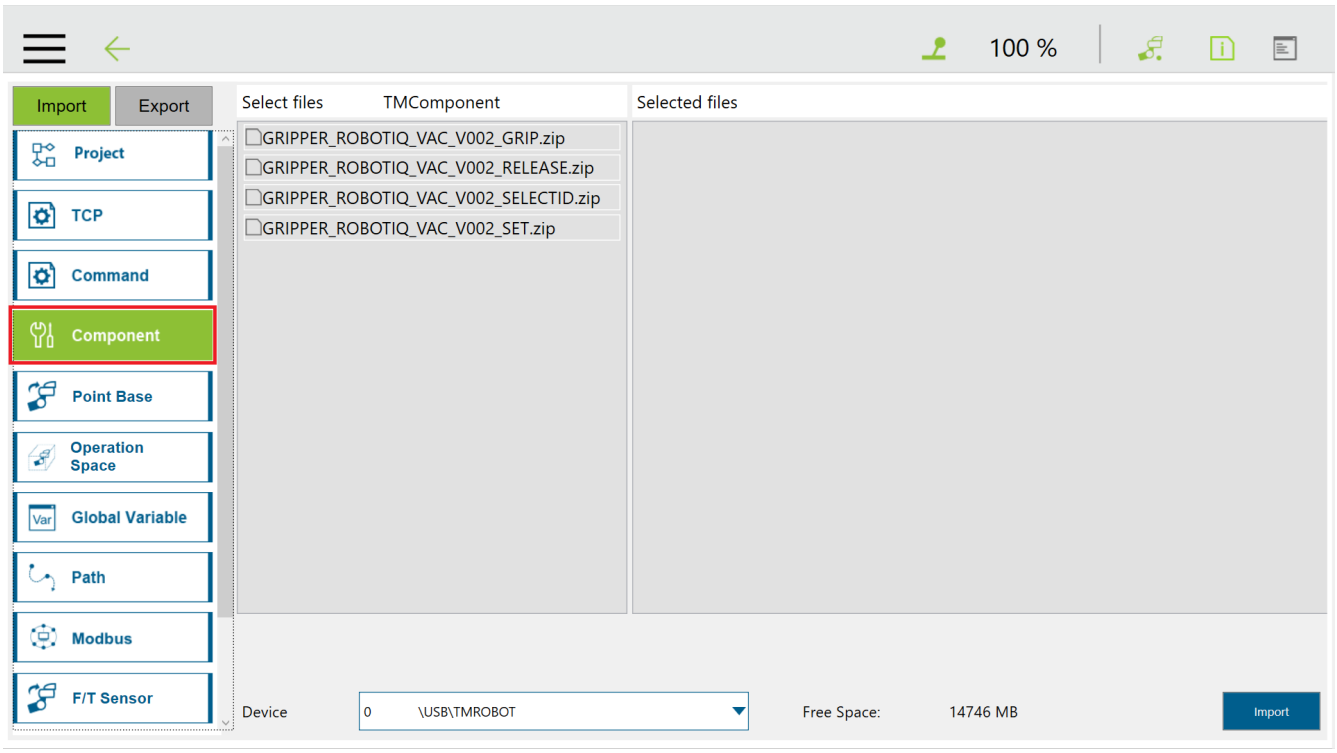
7 Click the **Import** button



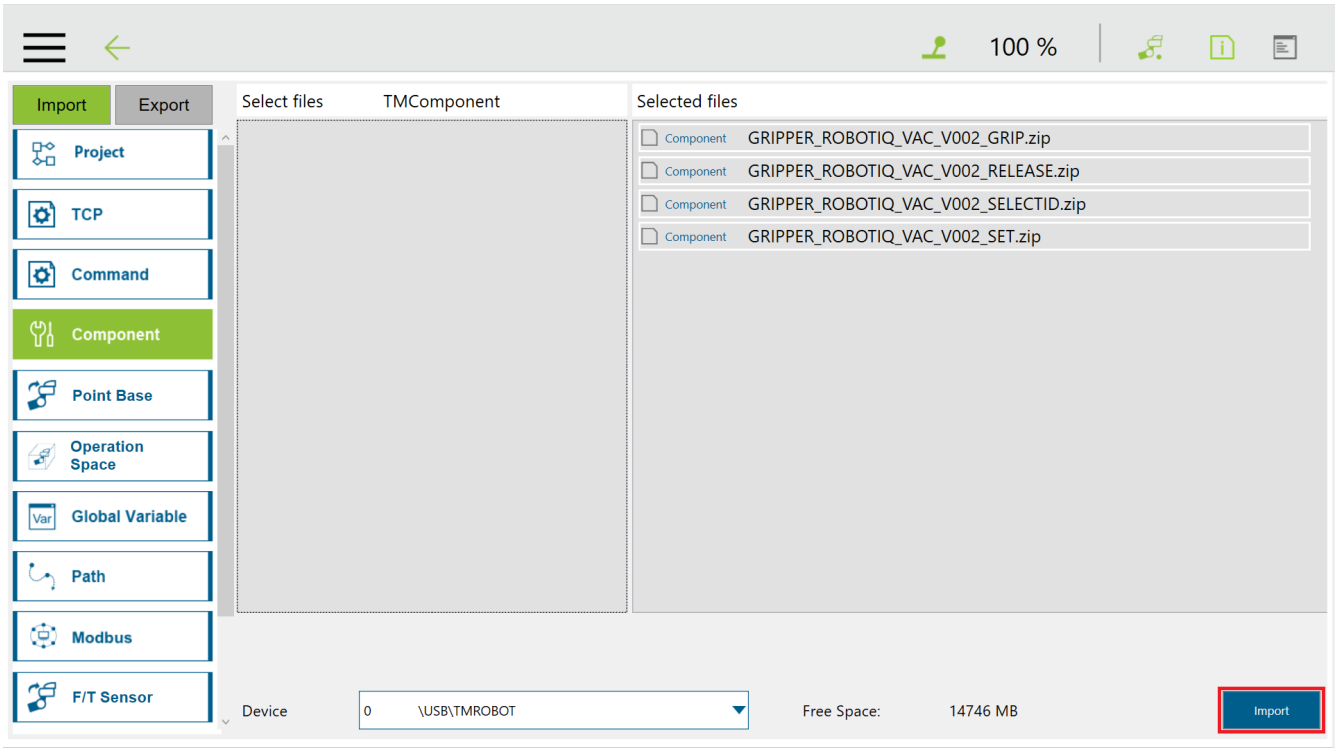
8 Click on **TM Component** in the Robot List window and click on **OK**



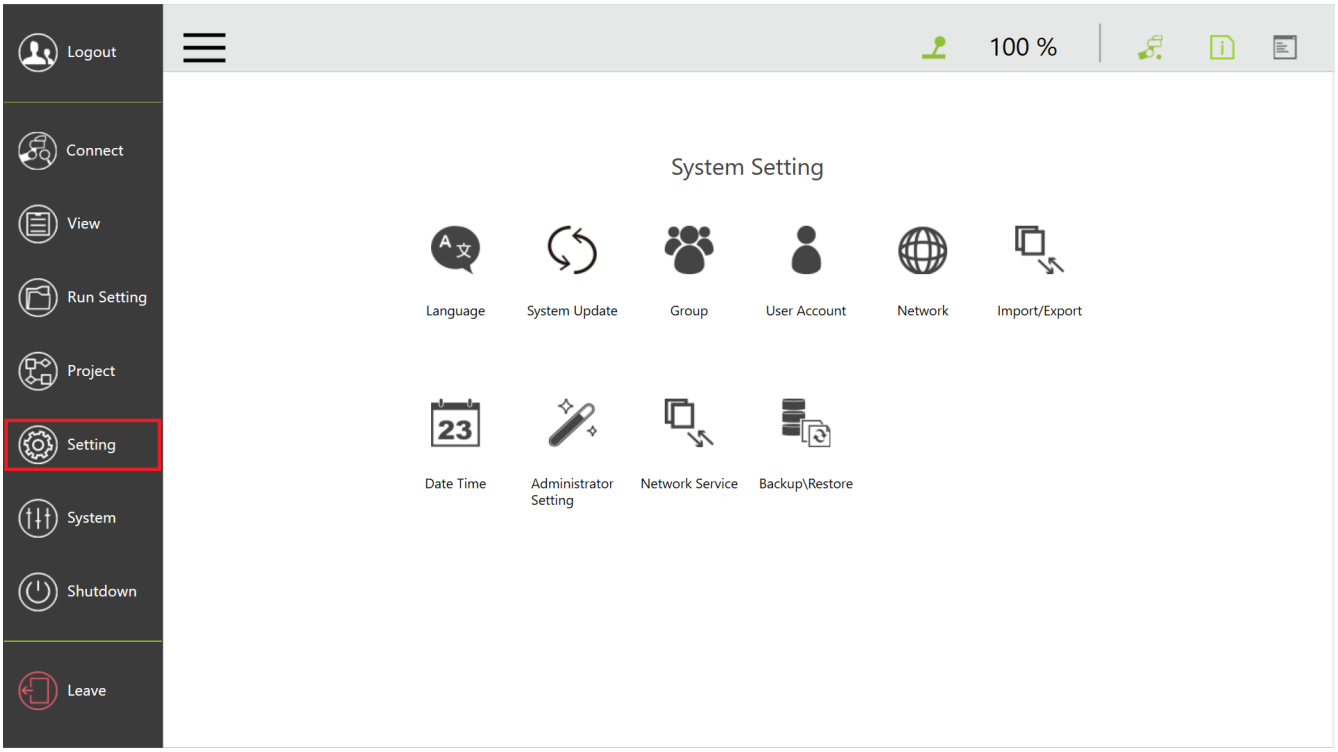
9 Click on the **Component** button of the **Import** navigation pane



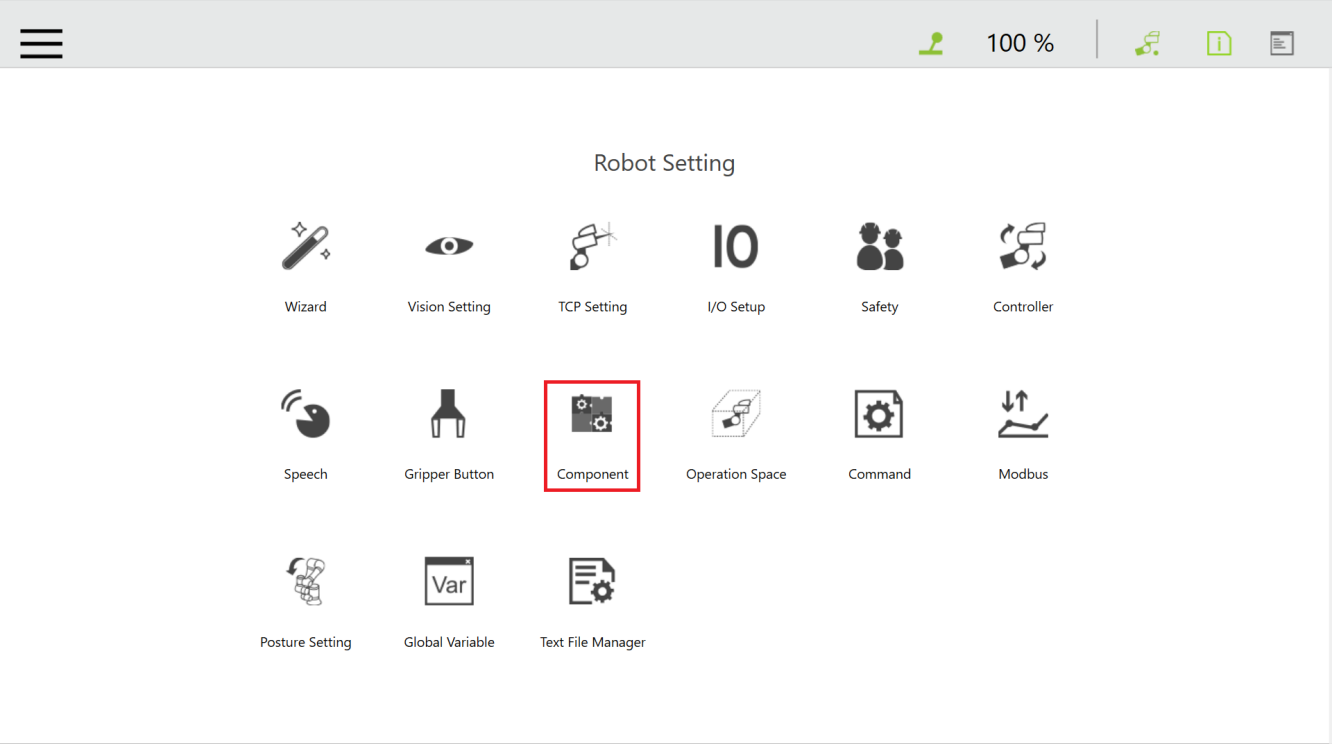
10 Select the Components you want to import and click on the **Import** button



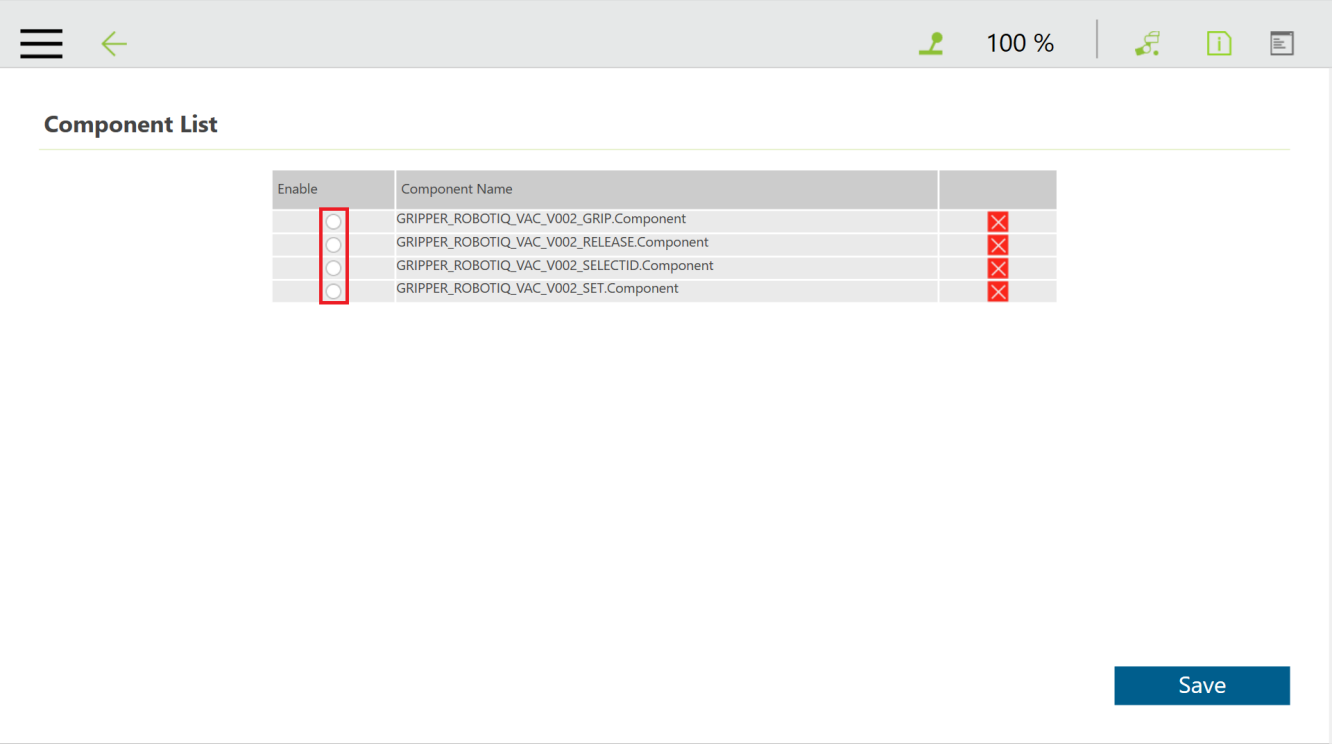
11 Tap the **triple bar icon** and select **Setting** to display the **Robot Setting** window



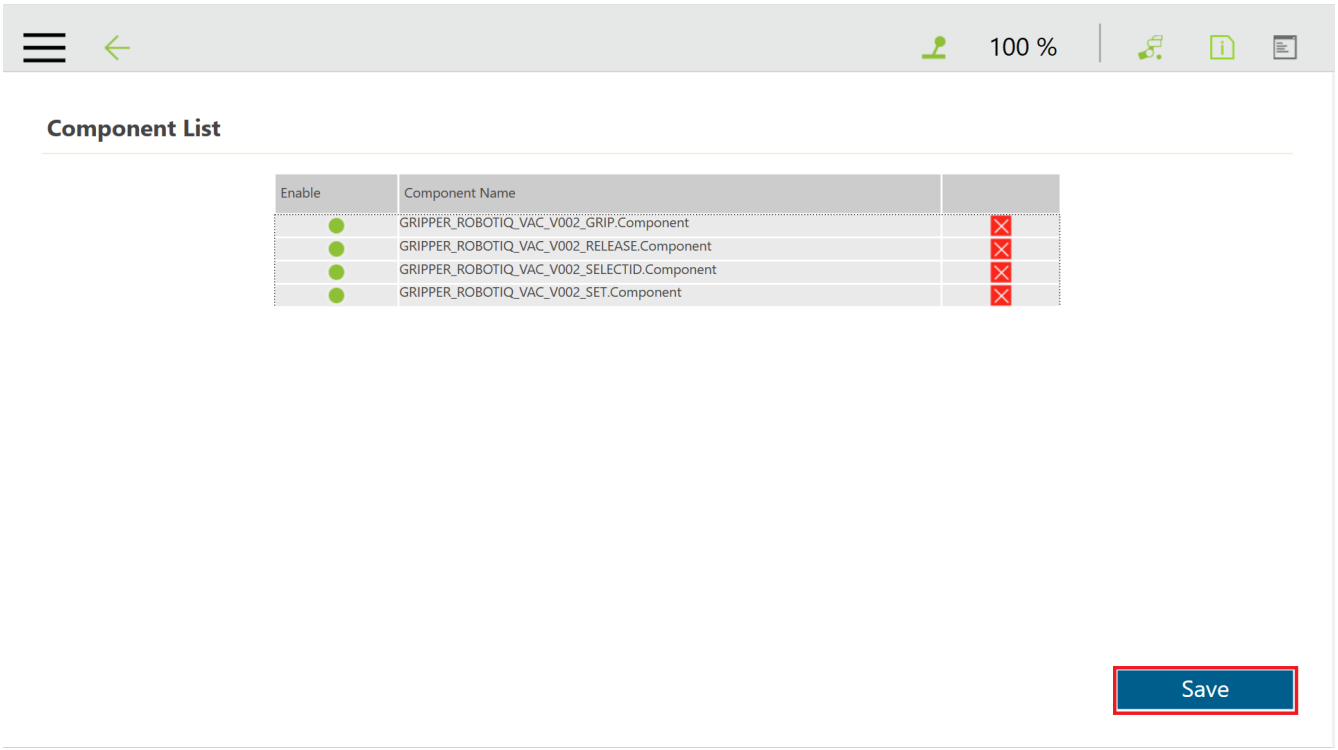
12 Click on the **Component** icon



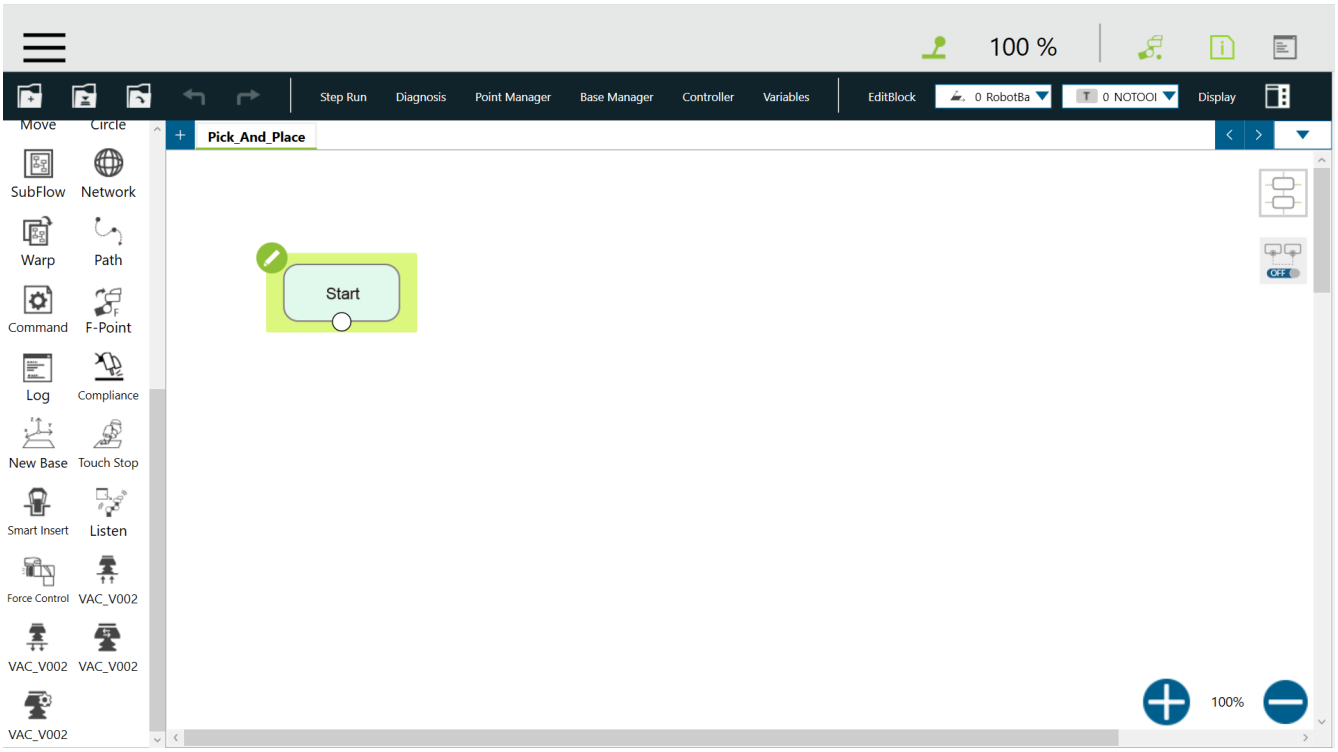
13 Enable required **Components** in the Components list by ticking the radio button beside each of them



14 A Component that is enabled displays a green radio button; once the Components are enabled, click on the **Save** button



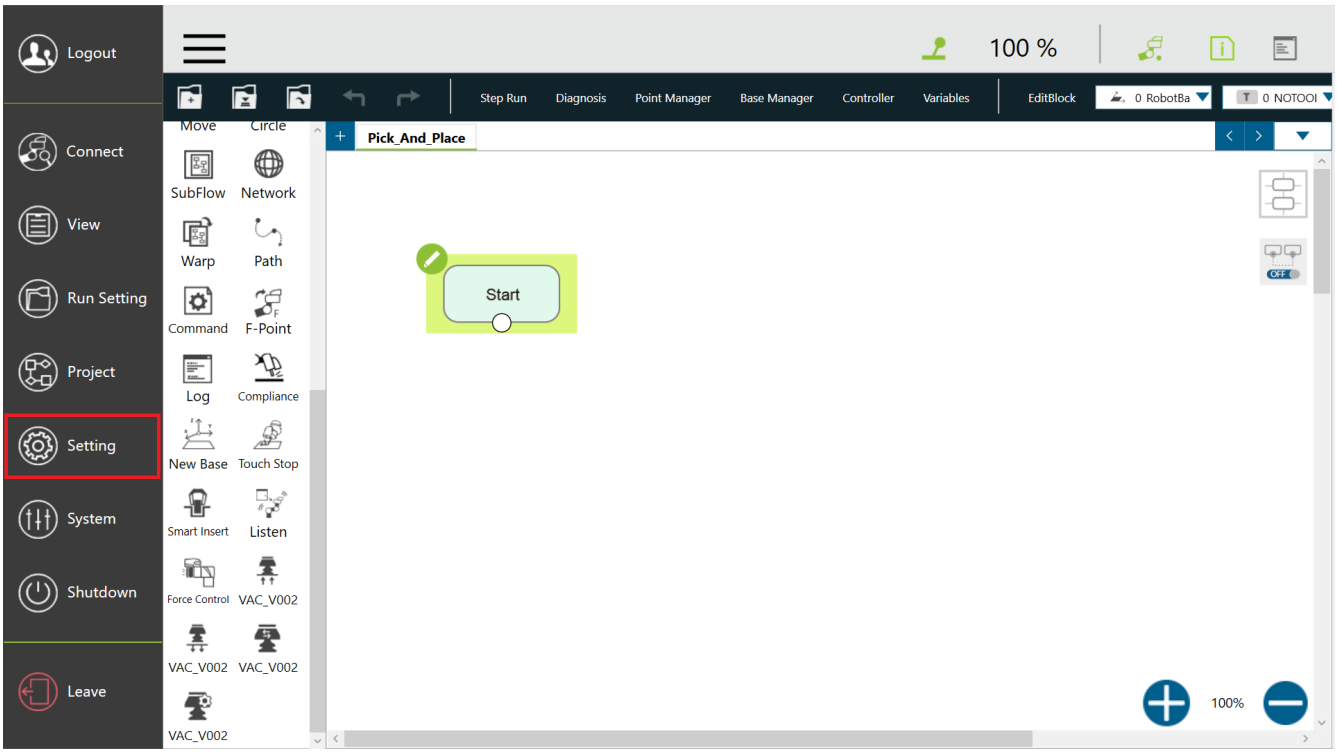
15 Create a new project or open an existing project, and locate the Gripper components in the navigation pane



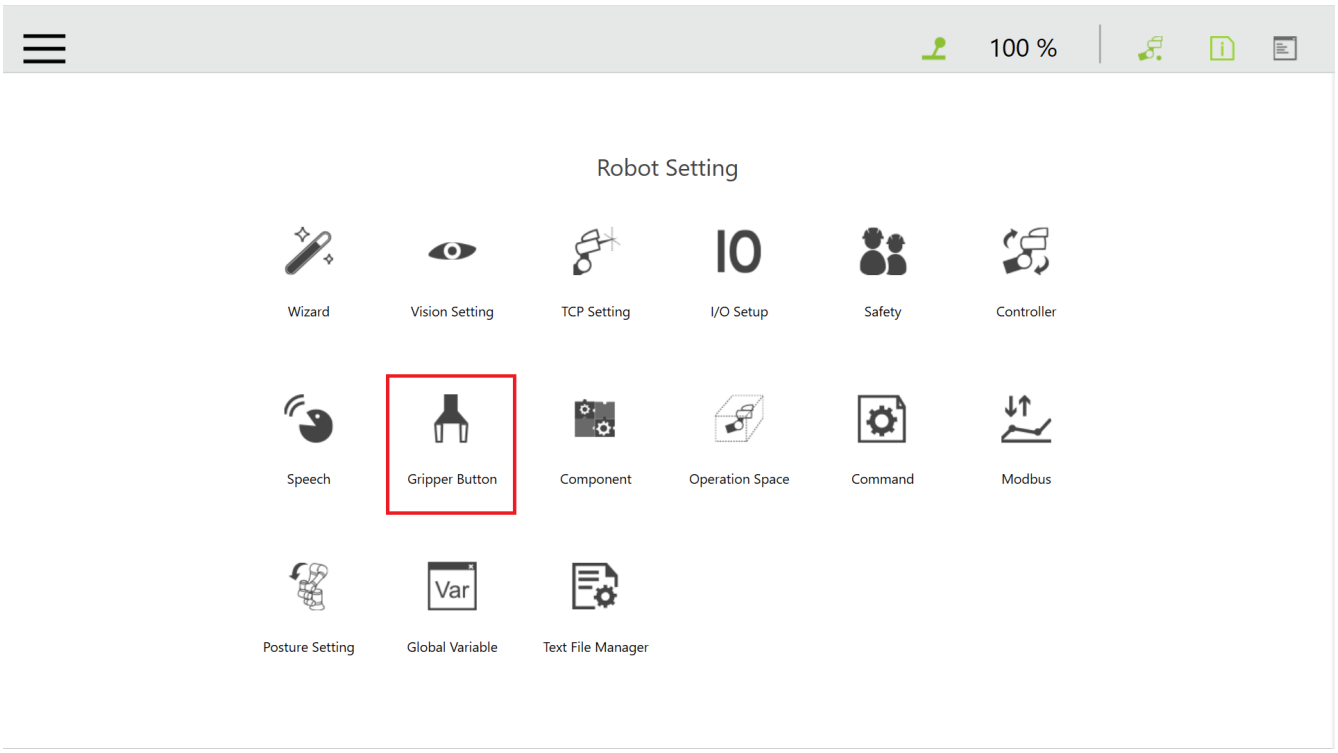
Gripper Button

The user can assign Gripper Components to the Gripper button and use the latter to open and close the fingers of the Robotiq Gripper.

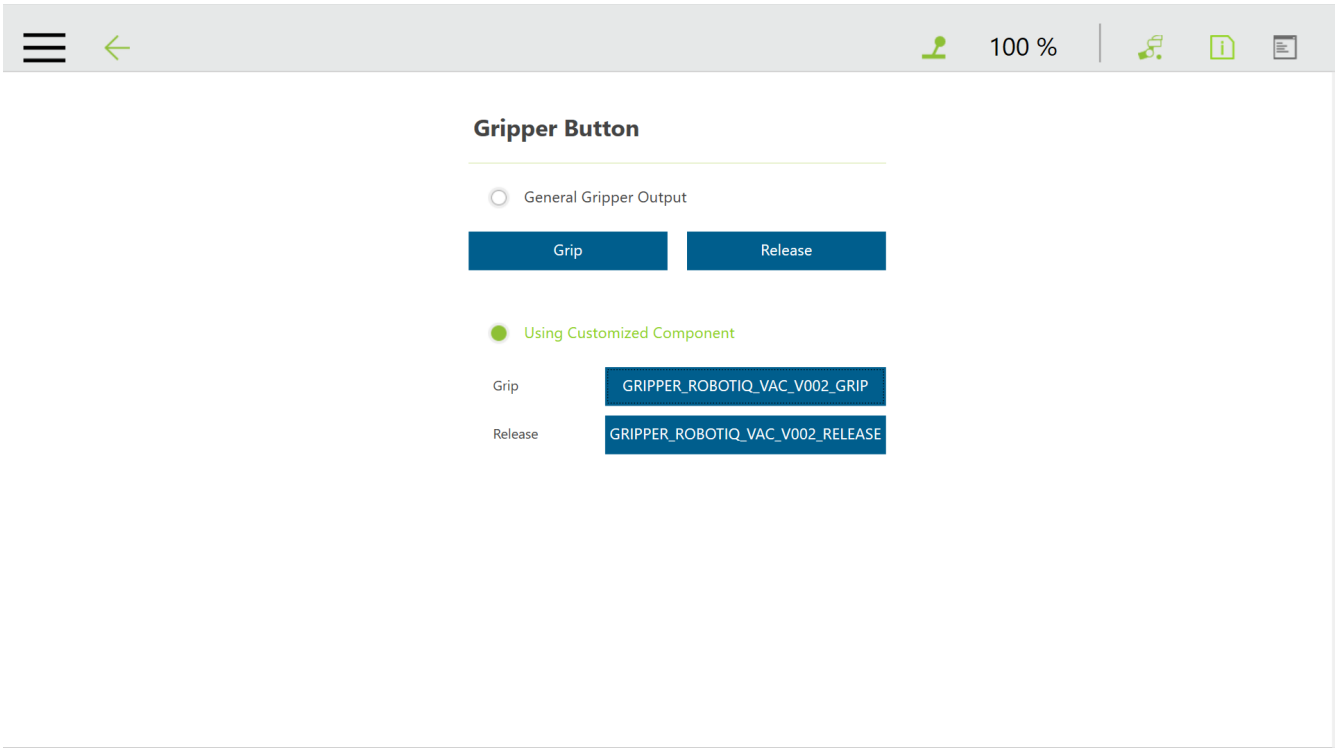
1 From the TM Flow homepage, tap the **triple bar icon** and select the **Setting** icon



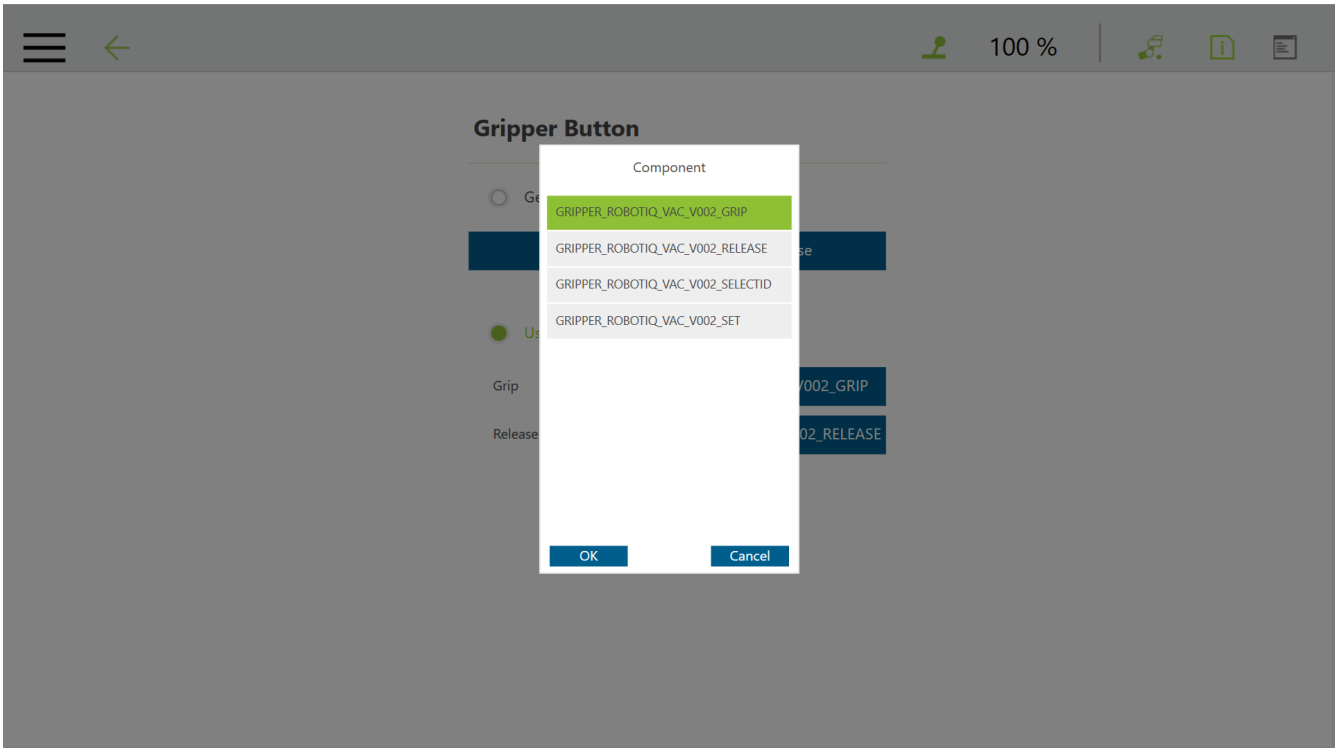
2 Click on **Gripper Button**



3 In the **Gripper Button** window, tick the **Using Customized Component** radio button and select the Component you want to assign to either one of the Gripper actions

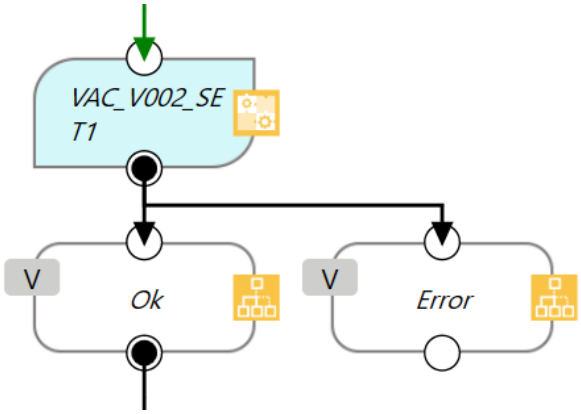


4 In the pop-up window, select or change the Component you wish to assign to the Gripper action/button, and click **OK**



Programming

SET Component

Component Icon	Component Node
	

1. Drag and drop the SET Component icon after a program Gateway to place a SET program node (VAC_V002_SET1)
2. Tap the SET node to highlight it and click on the pencil to edit the settings

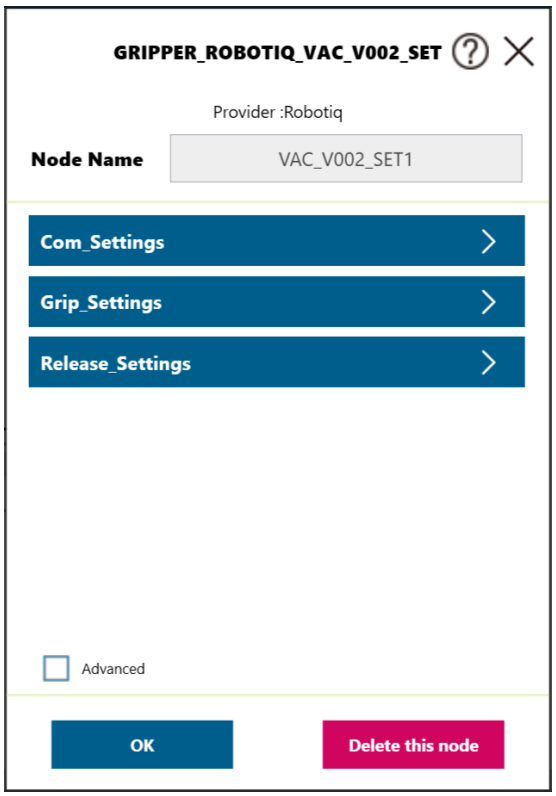


Fig. 4-6: SET Node Settings Menu

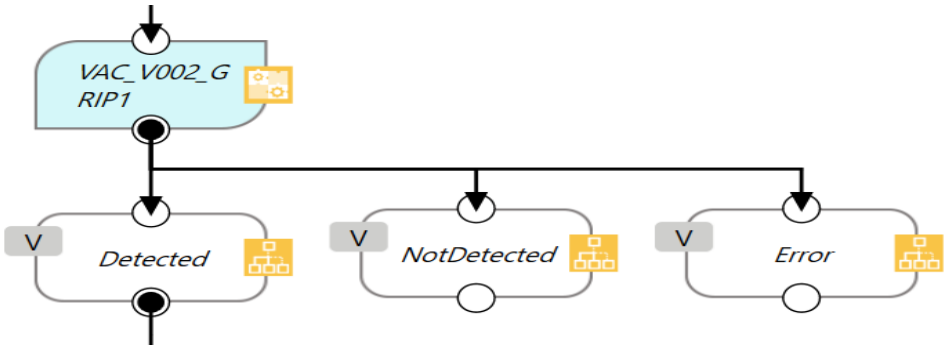
Settings	Variable	Type	Default	Description
Grip_Settings	var_grip_advanced_mode	bool	False	Set to **true** to use the Advanced mode of the gripper
	var_grip_max_vacuum	byte	60	20~100 which represents the vacuum percentage
	var_grip_min_vacuum	byte	40	10~max which represents the vacuum percentage
	var_grip_timeout	int	3000	Time in millisecond (ms) until no part is detected
	var_grip_wait_for_oject_detected	bool	True	When set to **true**, the program will wait for an object detection before exiting the component
Release_Settings	var_release_advanced_mode	bool	False	Set to **true** to use the Advanced mode of the gripper
	var_release_shutoff_time	int	1000	**EPick** Time for the valve to shut off
	var_release_wait_for_object_released	bool	True	When set to **true**, the program will wait for an object detection before exiting the component
	var_slave_id	int	9	The slave ID of the gripper used for modbus communication
	var_com_port	byte	1	The number of the COM port on which the gripper is connected

Table 4-3: SET Component Variables

Advanced Mode

The Advanced mode is set to **false** by default, which means that the vacuum values and the timers are set automatically. When the Advanced mode is set to **true**, the gripper will use the vacuum level parameters and the timer set by the user to grip and release.

GRIP Component

Component Icon	Component Node
	

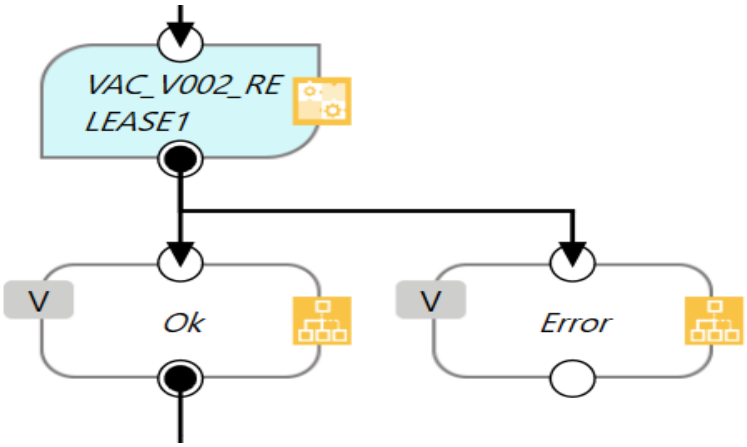
The grip component is used to activate the gripper suction and to pick an object. The grip component has three possible exits:

1. **Detected**: When an object is detected by the gripper
2. **Not Detected**: When no object is detected by the gripper
3. **Error:** When a gripper error occurs

1 Drag and drop the GRIP Component icon after a program Gateway to place a GRIP program node (VAC_V002_GRIP1)

2 Tap the GRIP node to highlight it and click on the pencil to edit the settings

RELEASE Component

Component Icon	Component Node
	

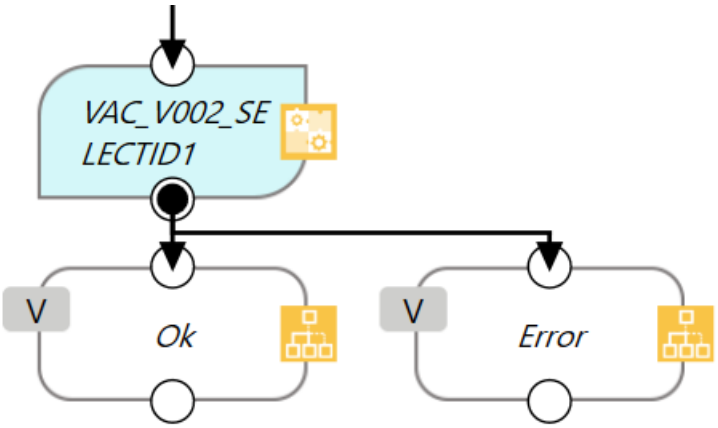
The **Release component** is used to release the part by opening a valve.The **Release component** has two possible exits:

1. **Ok**: the object has been released
2. **Error**: communication error

1. Drag and drop the RELEASE Component icon after a program Gateway to place a RELEASE program node (VAC_V002_GRIP1)
2. Tap the RELEASE node to highlight it and click on the pencil to edit the settings

SelectID Component

The SelectID component is used to change the Slave ID for the modbus communication when using a dual gripper setup.

Component Icon	Component Node
	

Info

Use the Robotiq User Interface to change the Modbus Slave ID Address of the second Vacuum Gripper when using a dual gripper (Default = 9).

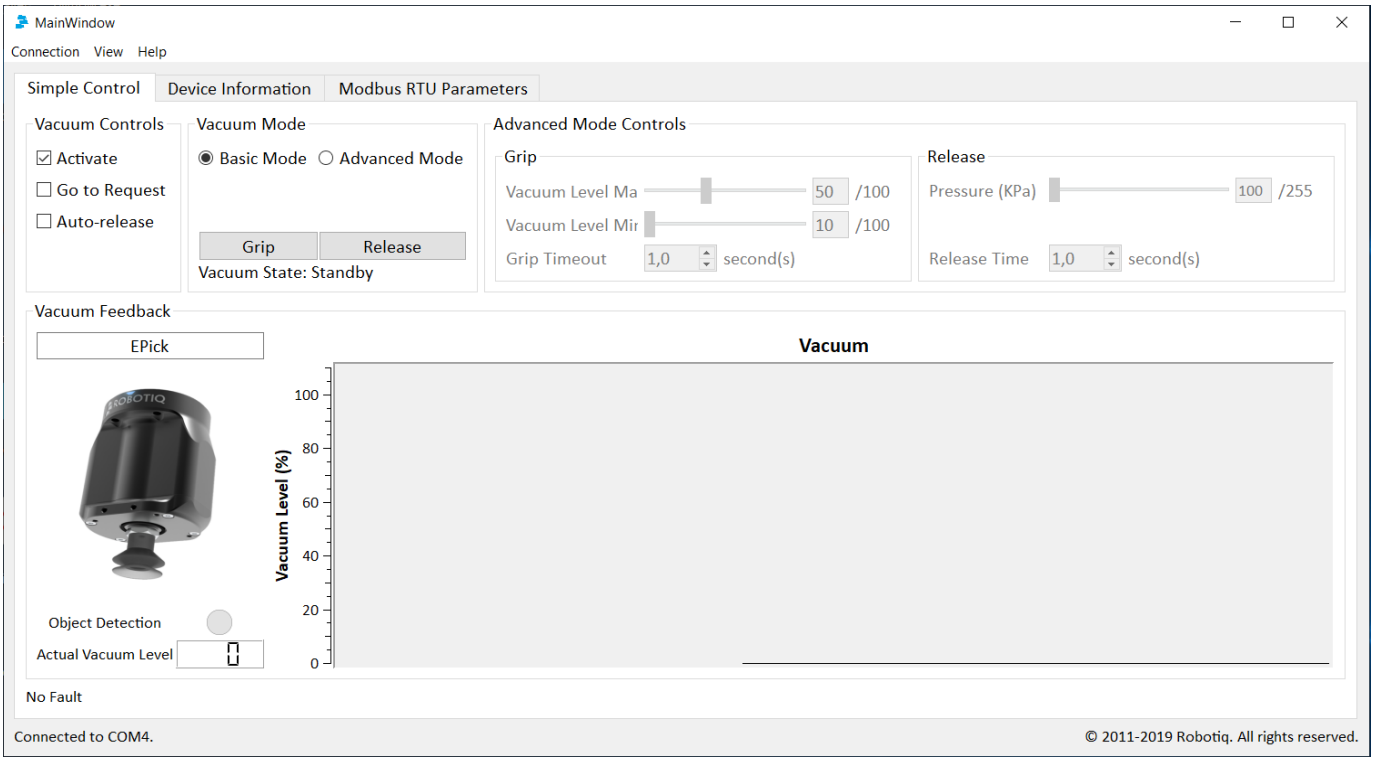
Changing the Modbus Slave ID

The user can change the Modbus Slave ID of a Robotiq Vacuum Gripper via the Robotiq User Interface.

Installer

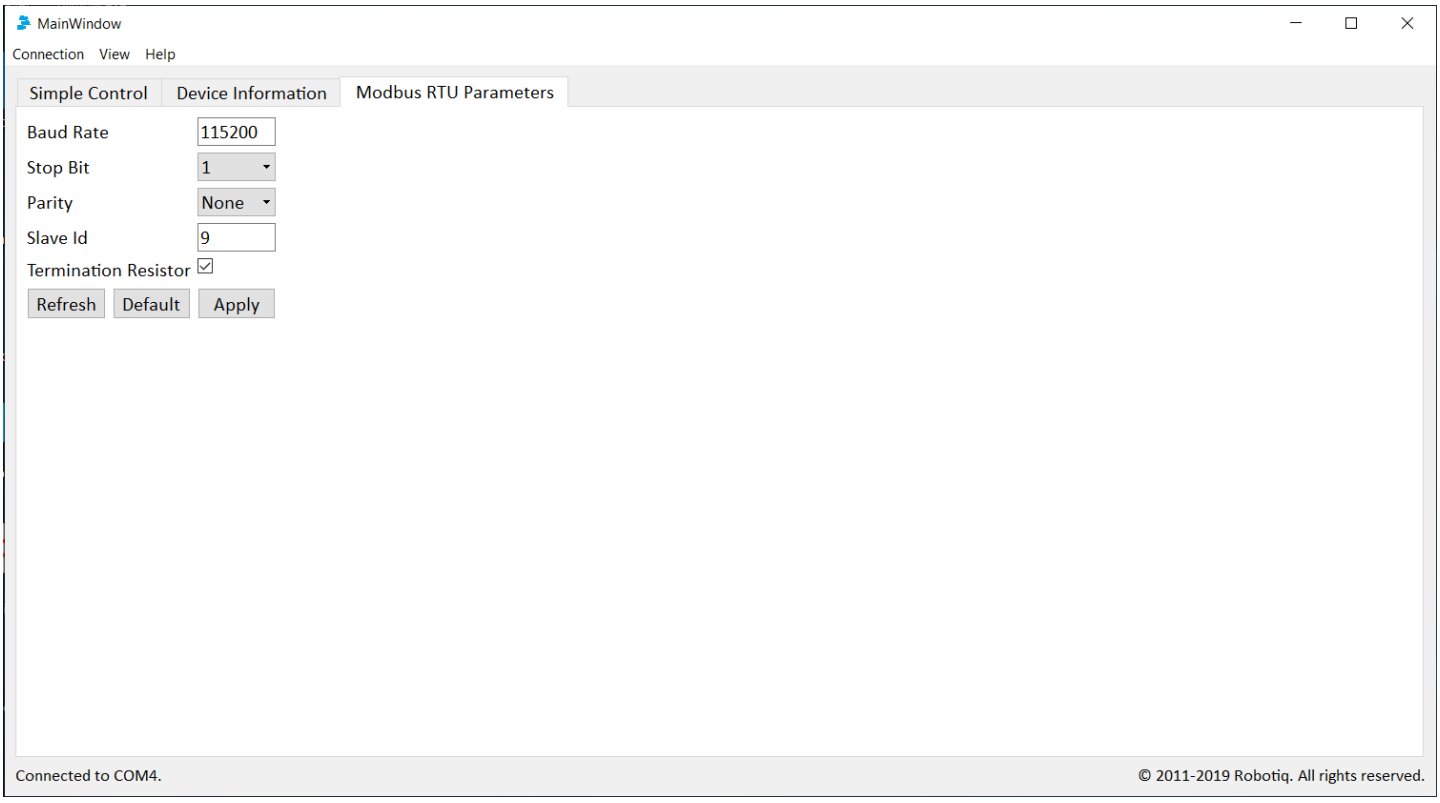
Browse to the support page of the Gripper in the Software section to download the RUI installer (.exe).

1. First, click on the Modbus RTU Parameters tab



2 Change the Slave ID of the Vacuum Gripper by typing in the corresponding box

3 Click on the Apply button



4 Perform a power cycle (24 V) while the USB device remains connected

5. User Interface

Visit support.robotiq.com to get the latest installer of the Robotiq User Interface along with appropriate documentation.

See the instruction manual of the Robotiq User Interface for more details.

6. Specifications

> **Caution**
>
> This manual uses the metric system, unless specified, **all dimensions are in millimeters**.

The following subsections provide data on the various specifications for the Robotiq EPick Gripper.

- Section 6.1 lists the technical dimensions of the Gripper
  - Dimensions for custom (blank) coupling
  - Dimensions of all available couplings
- Section 6.2 presents the mechanical specifications of the Gripper.
- Section 6.3 gives electrical specifications for the Gripper.

6.1 Technical dimensions

6.11 Gripper

The figure below represents the Gripper's dimensions.

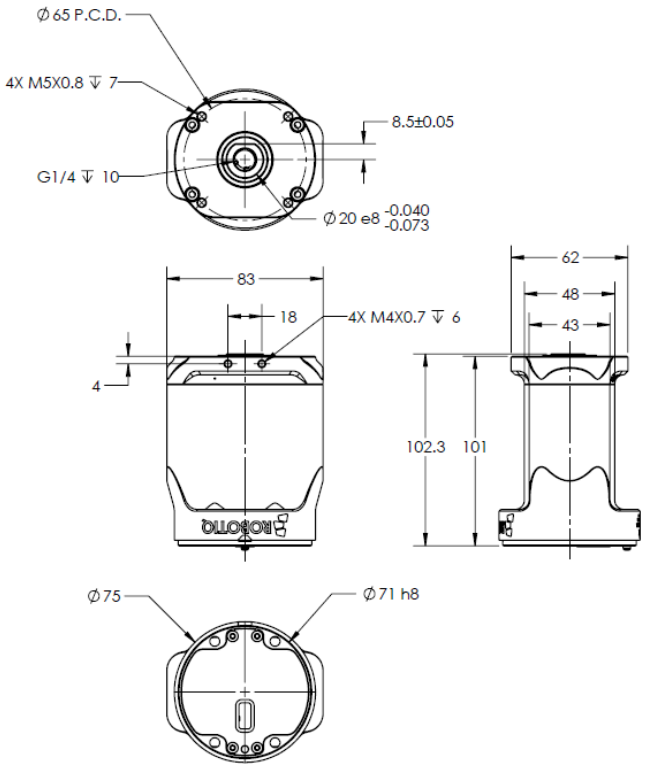


Fig. 6-1: EPick general dimensions

6.12. Suction Cup System

The figures below represent the dimensions of the components of the suction cup systems.

Manifold

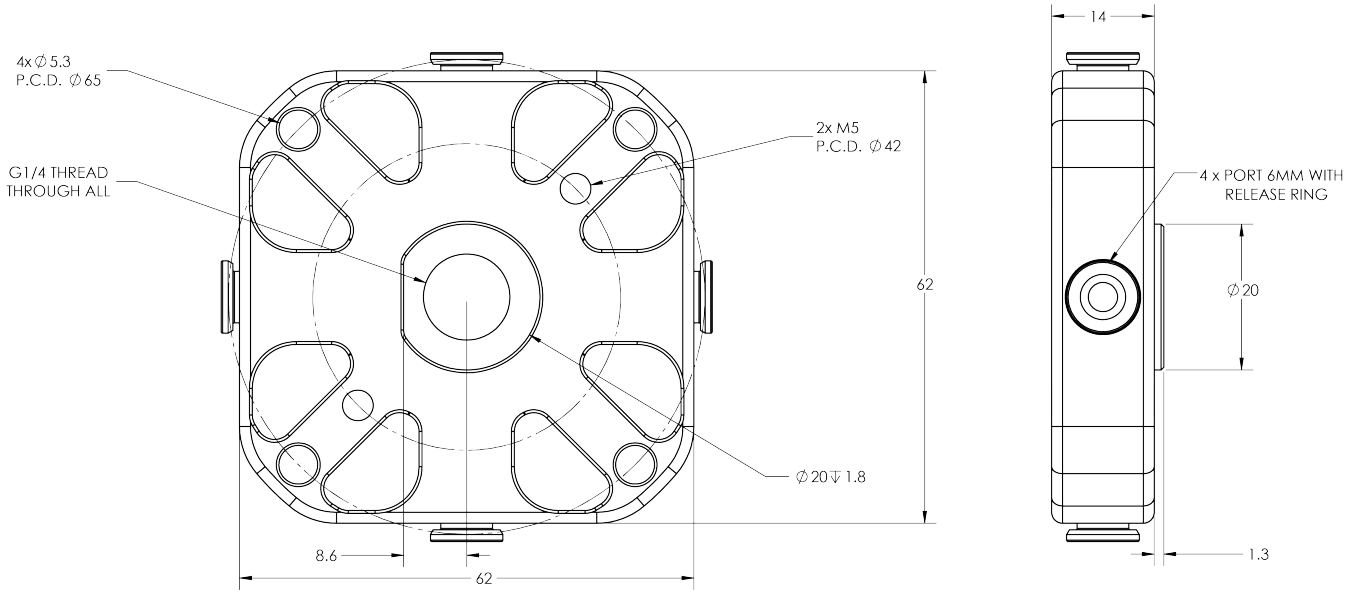
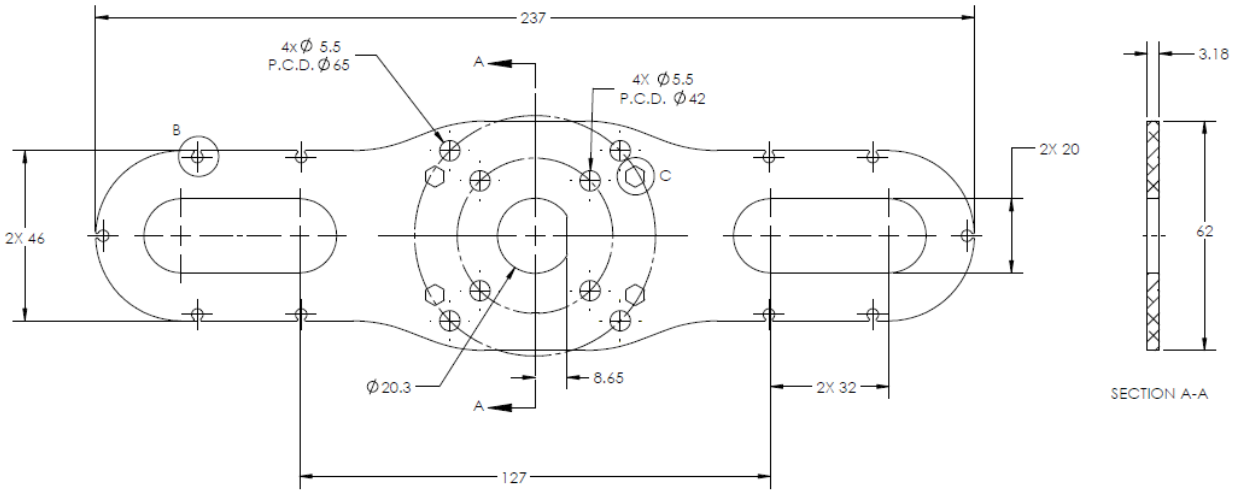


Fig. 6-2: Manifold general dimensions

Bracket for 2 suction cups



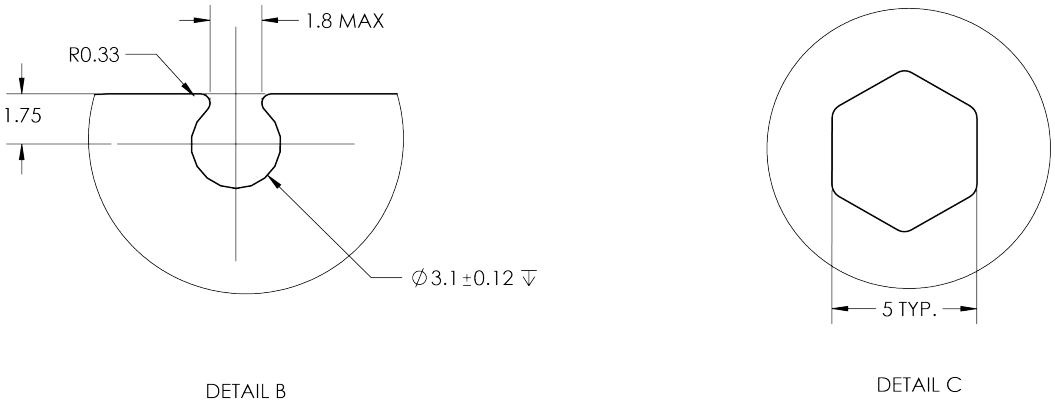


Fig. 6-3: Two air nodes bracket's dimensions

Bracket for 4 suction cups

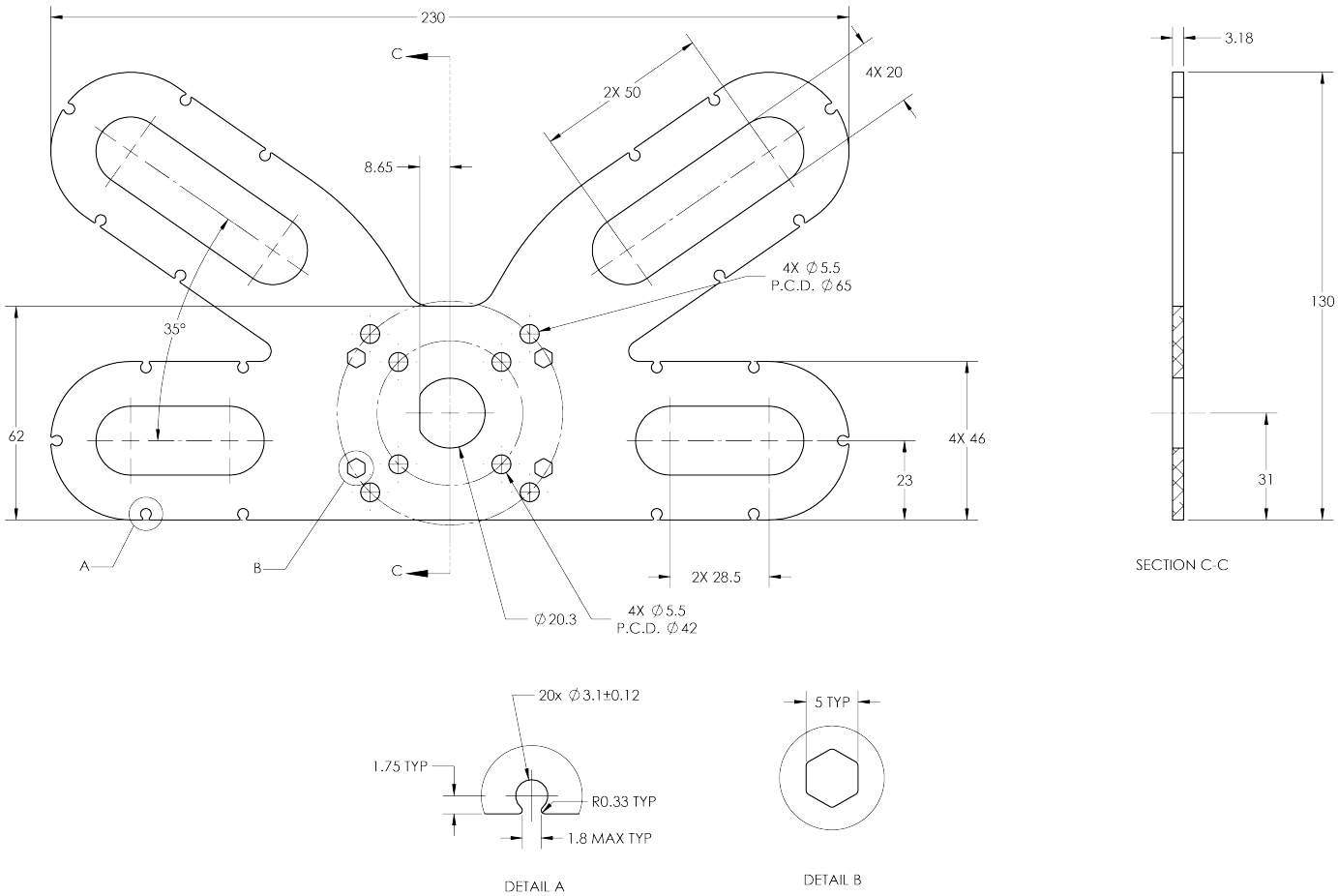


Fig. 6-4: Four air nodes bracket's dimensions

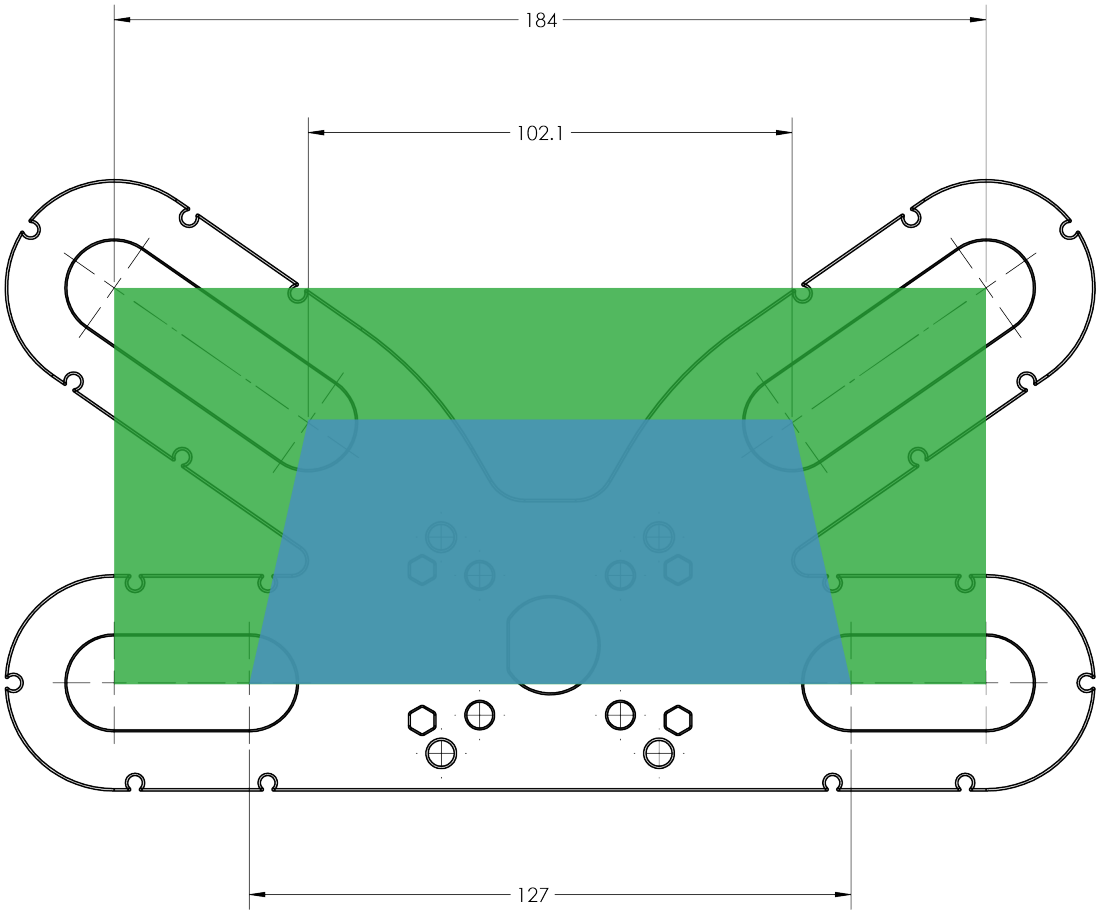


Fig. 6-5: Minimum and maximum arrangement possibilities of the air nodes position.

6.13. Air nodes

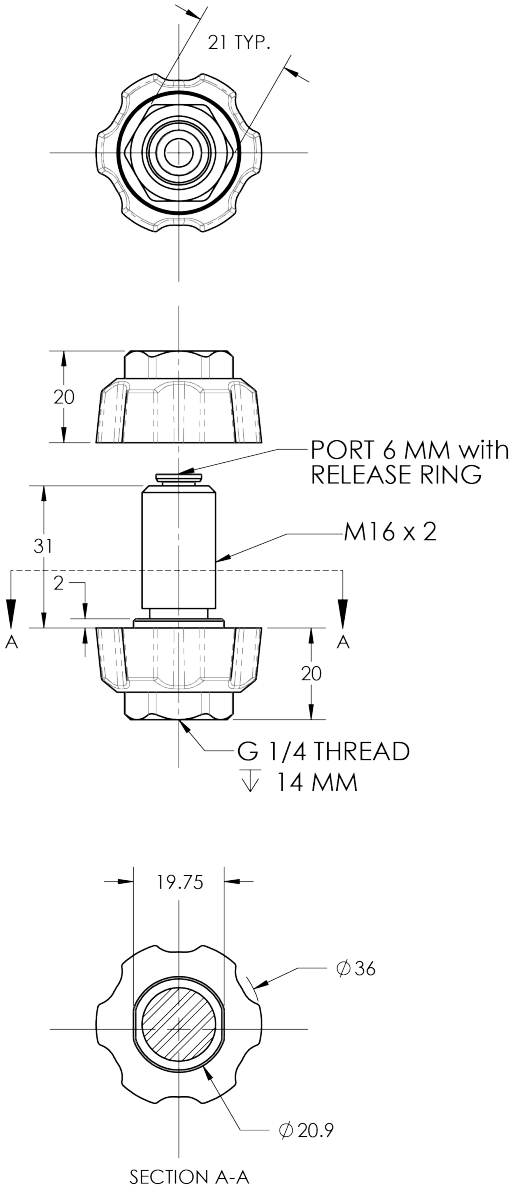


Fig. 6-6: Air nodes dimensions

6.14. Couplings

Operating the Vacuum Gripper requires a coupling provided by Robotiq. The coupling is mandatory since it integrates electronics and electrical contacts.

Blank coupling

Below are the dimensions of the blank coupling, **AGC-CPL-BLANK-002** (refer to the **Spare Parts, Kits and Accessories** section), available to create a custom bolt pattern. Blue section can be fully customized (holes can be place in any part of this section) while the grey section can only be worked to a depth of 3 mm.

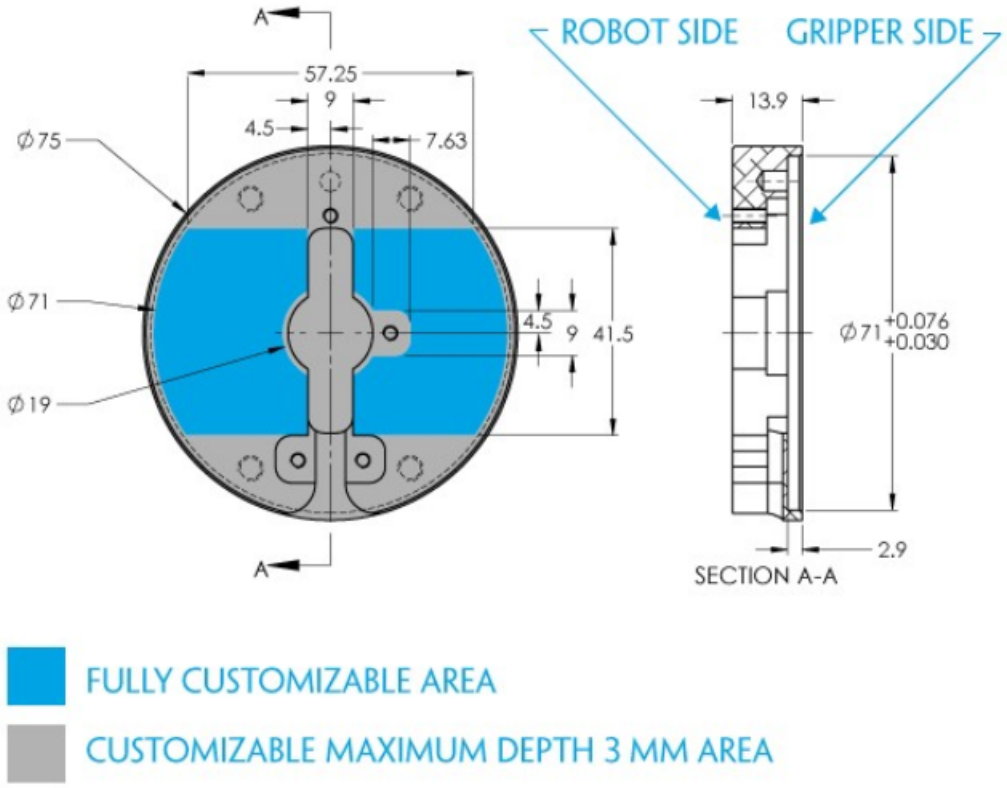


Fig. 6-7: Workable area dimensions of blank coupling AGC-CPL-BLANK-002

Coupling for ISO 9409-1-50-4-M6

Bolt pattern for coupling **GRP-CPL-062** (refer to the **Spare Parts, Kits and Accessories** section) is compatible with :

- 50 mm pitch circle diameter :
  - (4) M6-1.0 low head socket cap screw clearance
  - (1) M6 indexing pin
  - ISO 9409-1 standard 50-4-M6

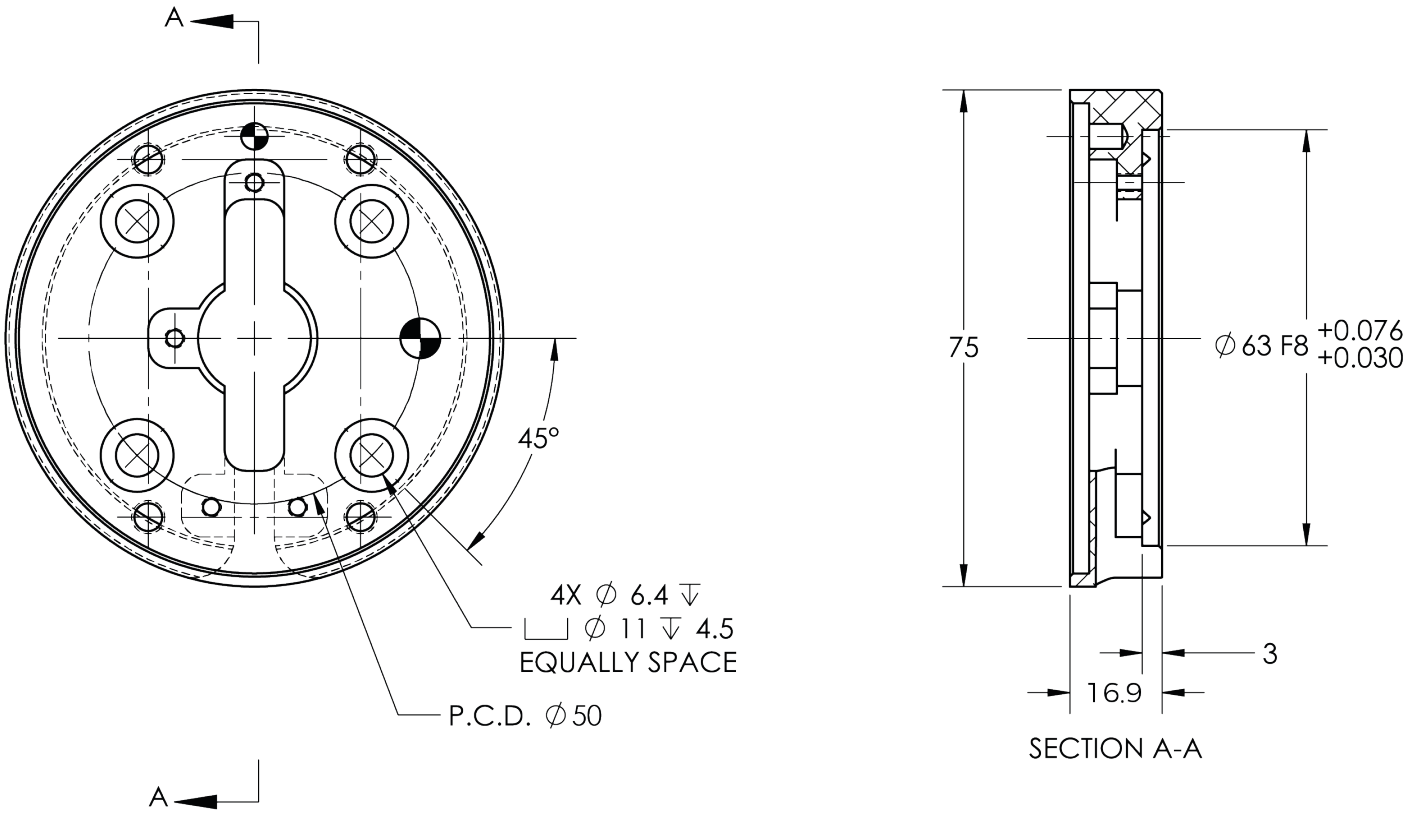


Fig. 6-8: Coupling for ISO 9409-1-50-4-M6.

6.2. Mechanical specifications

Specifications	EPick Vacuum Gripper	
	Metric Units	Imperial Units
Energy source	Electricity	
Gripper mass (including coupling)	720 g	1.58 lbs
Maximum vacuum level	80 %	
Maximum mean flow	12L/min	3.17 gal/min
Payload range[1]	0-10 kg	0-22 lbs
Gripping time[2]	150 ms	
Release time[2]	180 ms	
Noise level	64 dBa	
Maximum torque permissible by custom suction cup bracket	150 Nm / 110 lbf-ft	

[1] The payload range is for a non-porous surface with four suction cups of 55 mm diameter at 80% of vacuum level.

[2] The Gripping and Release time is the time for one suction cup of 40 mm and can vary according to the suction cups configuration and vacuum level.

Table 6-1: Specifications of the EPick Gripper

Info

All specifications are measured with coupling **GRP-CPL-062**.

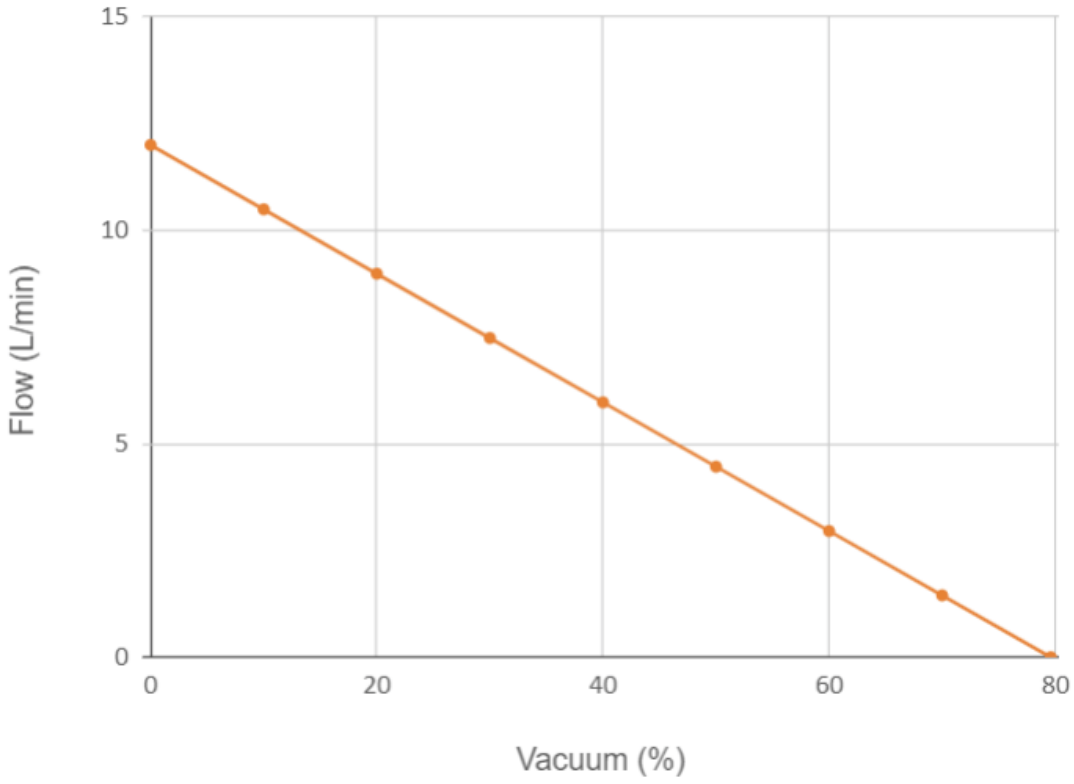


Chart 6-2: Flow (L/min) vs Vacuum (%)

6.2.1 Payload and force

When a load is to be picked by a Vacuum Gripper, several factors have to be considered. One of them is the vacuum level percentage selected. This value represents the pressure difference between the inside of the system and the ambient pressure. This table is valid for a nominal atmospheric pressure of 101,3 kPa.

Vacuum level (%)	Pressure difference (kPa)
0	0
10	10.1
20	20.3
30	30.4
40	40.5
50	50.7
60	60.8

70	70.9
80	81.1
90	91.2
100	101.3

Table 6-3: Conversion of absolute pressure to vacuum level

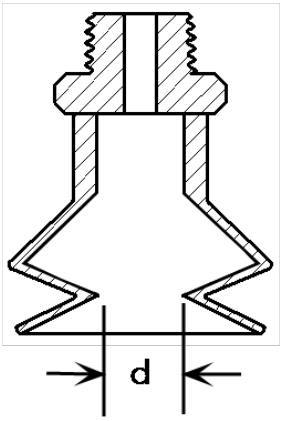


Fig. 6-9: Suction cup with inside diameter

Depending on the selected suction cup, the maximum grip strength can be determined with the following equation:

$$F_p(N) = \frac{A \times P \times n}{1000}$$

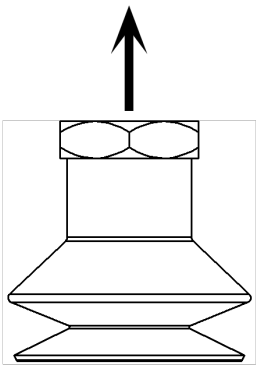
Where:

- A= Suction cups internal surface (mm^2)
- P= Vacuum Level (kPa)
- n= Quantity of suction cups to lift-off

For more details, please refer to the specifications provided by the suction cup manufacturer.

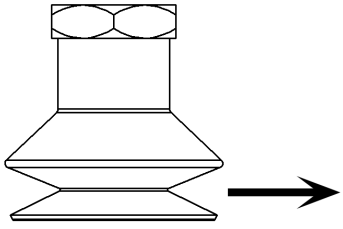
The payload is the mass to be lifted according to an acceleration and an applied safety factor. There are three main types of load application that are represented in the following cases. Note that the arrows represent the robot movement.

Case #1



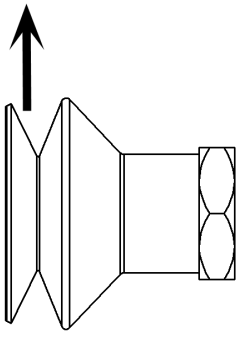
$$F_c = m \times (g + a) \times S$$

Case #2



$$F_c = m \times \left(g + \frac{a}{\mu}\right) \times S$$

Case #3



$$F_c = \frac{m}{\mu} \times (g + a) \times S$$

Where:

- M = mass (kg)
- G = gravitational acceleration (m/s^2)
- A = robot acceleration (m/s^2)
- μ = friction coefficient
- S = safety factor

The maximum grip strength of the suction cup must always be bigger than the payload ($F_p > F_c$) to guarantee the good grip of the piece. Robotiq recommends a minimum security factor of 2 in every case. However, a factor 4 is recommended for the next situations:

- Low friction coefficient
- Important robot acceleration
- Non-uniform surface
- Porous surface
- Unequal distribution of the payload in regards to the suction cups

Two categories of material can be lifted by the vacuum gripper: porous and non-porous. A non-porous material is defined as a material where air leakages are negligible and where it is possible to precisely attain a vacuum percentage between 10 and 80%.

Example 1: Non-porous material

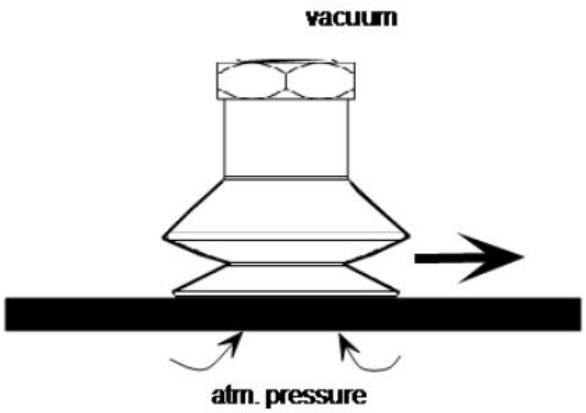


Fig. 6-10: Non-porous material

Initial data:

- Material type: non-porous
- Application type: Case #2
- Suction cup diameter (d): 40 mm (r=20 mm)
- Percentage of vacuum: 60% (which is equivalent to 60.8 kPa, according to the conversion table above)
- Mass: 2 kg
- Acceleration: 1.2 m/s^2
- n = 4

$$F_p(N) = \frac{A \times P \times n}{1000}$$

$$A = \pi \times r^2$$

$$A = 1256{,}6\ mm^2$$

$$F_p(N) = \frac{1256{,}6 \times 60{,}8 \times 4}{1000}$$

$$F_p(N) = 305{,}6\ N$$

Case #2

- m = 2 kg
- g = 9.81 m/s^2
- a = 1.2 m/s^2
- S= 4 (recommended)
- µ = 0.5

$$F_c = m \times \left(g + \frac{a}{\mu}\right) \times S$$

$$F_c = 2 \times \left(9{,}81 + \frac{1{,}2}{0{,}5}\right) \times 4$$

$$F_c = 97{,}7\ N$$

Validation that $F_p > F_c$: 305.6 N > 97.7N
Since 305.6 N > 97.7 N , the rule is respected and we can ensure the good grip of the part.

Example 2: Porous material

For porous material, non-negligible air leakages can be observed. Therefore, the use of the EPick is not recommended. Considering that, the Vacuum Gripper will work in a continuous mode to compensate leakages and the reached vacuum will depend on 4 main factors:

1. Pump flow rate
2. The model of suction cups
3. Porosity of materials
4. Payload to lift

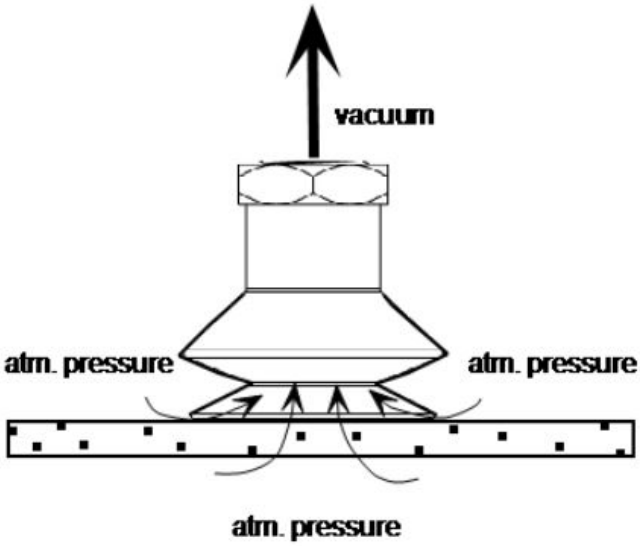
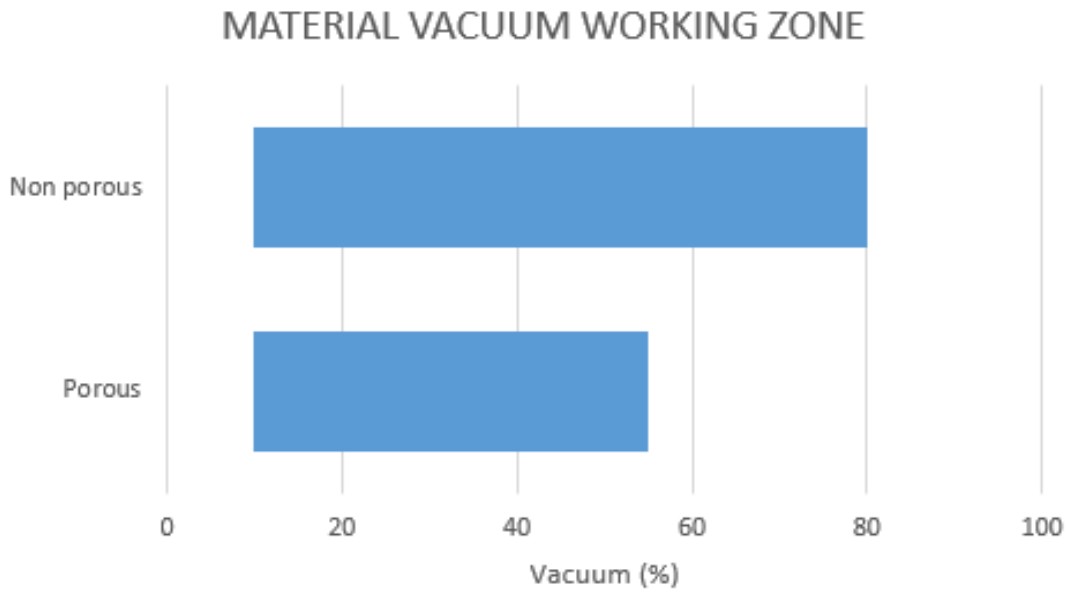


Fig. 6-11: Porous material



Info

Robotiq recommends to do some tests to determine the maximum grip strength of the suction cup, depending on the selected material to lift. It is not recommended to operate the robot with vacuum levels lower than 10%.

Initial data:

- Material type: porous
- Application type: Case #1

Case #1

$$F_c = m \times (g + a) \times S$$

- m = 0.2 Kg
- g = 9.81 m/s^2
- a = 1.2 m/s^2
- S= 4 (recommended)

$$F_c = 0{,}2 \times (9{,}81 + 1{,}2) \times 4$$

$$F_c = 8{,}8\ N$$

A test has been made with this material and it was statistically possible (without any acceleration) to pick a mass of 1 kg.

$$F_p = 1 \times 9{,}81\ m/s^2$$

$$F_p = 9{,}81\ N$$

Since, $F_p > F_c$ (9.81N > 8.8 N), it is possible to lift a mass of 0.2 kg, as required.

6.2.2. Center of mass and tool center point

Couplings are included in the calculations when Vacuum Grippers are not mounted on the Robotiq Wrist Camera. Dual Gripper adapter plates are included where appropriate

Products	Center of mass (mm)			TCP (mm)			Mass (g)
	X	Y	Z	X	Y	Z	
FT Sensor	-3.0	0.0	15.7	0.0	0.0	37.5	300.0
Camera	-4.0	6.0	5.0	0.0	0.0	23.5	230.0
E-pick (without suction cups)	0.0	0.0	51.0	0.0	0.0	113.0	720.0
E-pick (with one suction cup)	0.0	0.0	54.5	0.0	0.0	145.0	745.0
E-pick (with 2 suction cups)	0.0	0.0	40.2	0.0	0.0	196.0	1130.0
E-pick (with 4 suction cups)	0.0	0.0	91.3	0.0	0.0	196.0	1355.0
FT Sensor + E-Pick	-0.9	0.0	65.6	0.0	0.0	150.5	1050.0
FT Sensor + E-Pick (with one suction cup)	-0.9	0.0	68.8	0.0	0.0	182.5	1085.0
FT Sensor + E-Pick (with 2 suction cups)	-0.7	0.0	95.4	0.0	0.0	233.5	1460.0
FT Sensor + E-Pick (with 4 suction cups)	-0.6	0.0	106.7	0.0	0.0	233.5	1685.0
Camera + E-Pick	-0.9	1.3	42.0	0.0	0.0	115.5	915.0
Camera + E-Pick (with one suction cup)	-0.9	1.4	52.2	0.0	0.0	147.5	825.0
Camera + E-Pick (with 2 suction cups)	-0.7	1.0	78.8	0.0	0.0	198.5	1200.0
Camera + E-Pick (with 4 suction cups)	-0.5	0.8	89.2	0.0	0.0	198.5	1425.0
FT Sensor + Camera + E-Pick	-1.6	1.0	65.4	0.0	0.0	153.0	1120.0
FT Sensor + Camera + E-Pick (with one suction cup)	-1.5	1.0	68.6	0.0	0.0	185.0	1155.0
FT Sensor + Camera + E-Pick (with 2 suction cups)	-1.2	0.8	94.6	0.0	0.0	236.0	1530.0
FT Sensor + Camera + E-Pick (with 4 suction cups)	-1.0	0.7	105.8	0.0	0.0	236.0	1755.0

Fig. 6-12: Center of mass and tool center point matrix.

The coordinate system used to calculate the moment of inertia and center of mass of the Vacuum Gripper is shown in the figure below.

$$I = \begin{bmatrix} I_{XX} & I_{XY} & I_{XZ} \\ I_{YX} & I_{YY} & I_{YZ} \\ I_{ZX} & I_{ZX} & I_{ZZ} \end{bmatrix} = \begin{bmatrix} 3084 & 0 & 0 \\ 0 & 2999 & 0 \\ 0 & 0 & 546 \end{bmatrix} = \begin{bmatrix} 10.5 & 0 & 0 \\ 0 & 10.2 & 0 \\ 0 & 0 & 1.6 \end{bmatrix}$$

$kg * mm^2$ $lb * in^2$

Fig. 6-13: Inertia matrix for EPick Gripper.

6.2.3. Moment Limitation

The Vacuum Gripper has a maximum moment. The listed moment is independent to the force applied by the Gripper itself on it's payload. For payload calculation, refer to the **Mechanical specifications** section.

Warning

The following limits must be respected at all time. Calculation of maximum moment should include the robot acceleration and a safety factor.

Parameters	Maximum Value
Total moment	150 Nm

Table 6-4: Moment limitation of the Vacuum Gripper

6.3. Electrical specifications

SPECIFICATION	VALUE
Operating supply voltage	24 VDC ± 10%
Quiescent power (minimum power consumption)	1 W
Peak current	1.8 A for 80 ms when vacuum pump starts

Table 6-5: Vacuum Gripper electrical specifications

7. Maintenance

The Vacuum Gripper only requires external maintenance with limited downtime.
Maintenance is required after specified usage, measured in cycles (workpiece pick-up and release) or use time (hours).

Following the maintenance interval will ensure :

- Correct functioning of the Vacuum Gripper.
- Validity of the warranty.
- Proper lifetime of the Vacuum Gripper.

Warning

Unless specified, any **repairs** done on the Vacuum Gripper will be done by Robotiq.

Operation	Daily	Monthly	1 M cycles or 1000 hours
Gripper Cleaning	Dirty conditions	Normal conditions	
Periodic Inspection			X

Table 7-1: Vacuum Gripper maintenance intervals

Caution

Maintenance operations are for the average normal usage of the Vacuum Gripper, the maintenance intervals must be adjusted according to the environmental conditions such as:

- Operating temperature
- Humidity
- Presence of chemical(s)
- Presence of physical objects (debris, scraps, dust, grease etc.)
- Interaction with operated parts (sharp or rough)
- Dynamics of the operation (accelerations)

7.1 Vacuum Gripper cleaning

Maintenance Interval	Tools you need	Parts you need
Monthly (or daily in dirty operating conditions)	• 4 mm hex key • Dry tissue or towel • Medium strength thread locker • Retaining ring plier	Replacement filter (if required)

Table 7-2: Vacuum Gripper cleaning intervals

Caution

The EPick Vacuum Gripper is not waterproof or water resistant without additional protection, only clean the Gripper with a dry towel.

Caution

Always turn off the robot, the Vacuum Gripper power supply before performing any maintenance operation on it.

Caution

Maintenance operator must be grounded to prevent electrostatic discharge that could damage the Vacuum Gripper electronics.

Caution

Do not use compressed air to clean the Vacuum Gripper. Doing so can result in a damage to the check valve or the release valve.

1. Remove the Vacuum Gripper from its coupling using the 4 mm hex key to unscrew the four (4) M5-0.8 x 25 mm socket head cap screws. Note that each screw uses a tooth lock washer, do not discard.
2. Clean the Vacuum Gripper with a dry towel, remove all debris, dirt and dust from its surface. Clean all suction cups. Dry thoroughly. Inspect the input filter to determine if it needs to be changed or not.
3. If the input filter needs to be changed, follow the steps:
    i. Remove the retaining ring.
    ii. Remove the old input filter.
    iii. Install the new one and put back the retaining ring.

Tip

If the input filter needs to be changed, we recommend you to get a retaining ring plier for internal retaining rings of 0.038'' tip diameter to help you replace it.

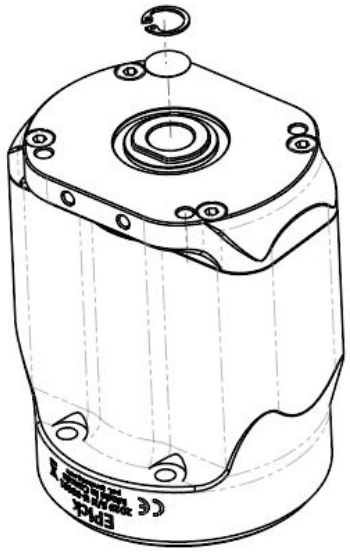


Fig. 7-1: EPick input filter change

4. Clean the coupling with a dry towel and pay a particular attention to the electrical contact.
5. Visually inspect the Vacuum Gripper and pay attention to any visible damage.
6. Put the coupling back on and secure using the four (4) M5-0.8 x 25 mm socket head cap screws. Use the tooth lock washers. Apply medium strength thread locker to the M5 screws.

When cleaning the Vacuum Gripper verify the wear of the suction cup. If wear is visible, change the suction cup. Please refer to the **Spare Parts, Kits and Accessories** section to order EPick replacement parts.

7.2. Periodic inspection

Maintenance Interval	Tools You Need	Parts You Need
Monthly	• Flat head precision 2 mm screwdriver • Dry tissue or towel • Medium strength thread locker	None (unless damage is detected)

Table 7-3: EPick Gripper inspection intervals.

Info

> Always turn off the robot and the Vacuum Gripper power supply before performing any maintenance operations.

1. Remove and clean the Vacuum Gripper following instructions in the **Vacuum Gripper cleaning** section.
2. Inspect the Vacuum Gripper :
   a. Check for any collision damage. If damage is visible, contact support@robotiq.com.
   b. Check for any sign of wear on the Vacuum Gripper chassis. If wear is present and may affect the Vacuum Gripper, contact support@robotiq.com.
3. Put the Vacuum Gripper back in place according to the instructions from the **Vacuum Gripper cleaning** section.

Suction cups and air nodes

Depending on your setup, mount the appropriate number of vacuum cups to their mating air bolts. If you need more information about the suction cups installation, please refer to **Suction cup system** section.

> **Warning**
>
> Any unused manifold port should be covered with a provided port plug to avoid air leakage.

8. Spare Parts, Kits and Accessories

Info

The following list is up to date at print time and is subject to change, check online for updates.

Info

Unless specified, screws, dowel pins and other hardware are included only for the Gripper side, never for the robot side.

Spare parts, kits and accessories list:

Item	Description	Ordering Number (1 Cup)	Ordering Number (2 Cups)	Ordering Number (4 Cups)
Kit for *TM Robot*	EPick Kit for TM	VAC-TM-EPICK-KIT1	VAC-TM-EPICK-KIT2	VAC-TM-EPICK-KIT4
Kit for Omron-TM	EPick Kit for Omron-TM	VAC-OMRON-EPICK-KIT1	VAC-OMRON-EPICK-KIT2	VAC-OMRON-EPICK-KIT4
Kit 2 Suction Cup System	Kit 4 Suction Cup System - 2 Suction Cups	VAC-SCS-KIT2		
Kit 4 Suction Cup System	Kit 4 Suction Cup System - 4 Suction Cups	VAC-SCS-KIT4		
Suction cup configuration - Screwing Kit	Suction cup configuration - Screwing Kit	VAC-SCS-SCREW-KIT		
Vacuum Suction Cup plate for 2 cups	Vacuum Suction Cup plate for 2 cups	VAC-SCS-PLATE-2		
Vacuum Suction Cup plate for 4 cups	Vacuum Suction Cup plate for 4 cups	VAC-SCS-PLATE-4		

Item	Description	Ordering Number (1 Cup)	Ordering Number (2 Cups)	Ordering Number (4 Cups)
Air node Plug and Play	Air node Plug and Play	VAC-SCS-NODE		
Vacuum Cup 1.5 Bellow 40 mm	Vacuum Cup 1.5 Bellow 40 mm	VAC-SCS-CUP40-2		
Vacuum Cup 1.5 Bellow 55mm	Vacuum Cup 1.5 Bellow 55 mm	VAC-SCS-CUP55-2		
Replacement filter	Filter for vacuum generator	VAC-SCS-FILTER		
ISO 9409-1-50-4-M6 coupling (coupling to controller)	ISO 9409-1-50-4-M6 coupling for 2-Finger Robot Grippers, with screws for Gripper fixation and 1 m pigtail cable	GRP-CPL-062		
ISO 9409-1-31.5-4-M5 coupling	ISO 9409-1-31.5-4-M5 coupling for Adaptive Robot Gripper 2-Finger, with screws for Gripper fixation and 1 m pigtail cable	GRP-CPL-063		
ISO 9409-1-40-4-M6 coupling	ISO 9409-1-40-4-M6 coupling for Adaptive Robot Gripper Gripper 2-Finger, with screws for Gripper fixation and 1 m pigtail cable	GRP-CPL-064		
56-8M4-1D4 coupling	Coupling for 56 mm PCD[1] with (8) M4 and (1) 4 mm indexing pin, with screws for 2-F Gripper fixation and 1 m pigtail cable	AGC-CPL-065-002		
56-6M4-1D6 coupling	Coupling for 56 mm PCD[1] with (6) M4 and (1) 6 mm indexing pin, with screws for 2-F Gripper fixation and 1 m pigtail cable	AGC-CPL-066-002		
60-4Ø5-1D5 coupling	Coupling for 60 mm PCD[1] with (4) M5 thread and (1) 5 mm indexing pin, with screws for 2-F Gripper fixation and 1 m pigtail cable	AGC-CPL-067-002		
63-6M6-2D6 coupling	Coupling for 63 mm PCD[1] with (6) M6 and (2) 6mm indexing pins, with screws for 2-F Gripper fixation and 1 m pigtail cable	AGC-CPL-068-002		
40-4M5-1D3 coupling	Coupling for 40 mm PCD[1] with (4) M5 and (1) 3mm indexing pins, with screws for 2-F Gripper fixation and 1 m pigtail cable	AGC-CPL-070-002		

Item	Description	Ordering Number (1 Cup)	Ordering Number (2 Cups)	Ordering Number (4 Cups)
31.5-4M4 coupling	Coupling for 31.5 mm PCD[1] with (4) M4, with screws for 2-F Gripper fixation and 1 m pigtail cable	AGC-CPL-071-002		
Adapter plate to 63-4M6-71-2D3	Wrist adapter plate for use with AGC-CPL-064-002. Interface to 63 mm PCD[1] with (4) M6 screws and 71 mm PCD[1] with (2) M3 indexing pins	AGC-APL-151-002		
Adapter plate to 63-4M6-61_4-2D6	Wrist adapter plate for use with AGC-CPL-064-002. Interface to 63 mm PCD[1] with (4) M6 screws and 61.4 mm PCD 1 with (2) M6 indexing pins	AGC-APL-152-002		
Adapter plate to 80-6M8-2D82D8	Wrist adapter plate for use with AGC-CPL-064-002. Interface to 80 mm PCD[1] with (6) M8 screws and (2) M8 indexing pins	AGC-APL-153-002		

9. Troubleshooting

9.1 Vacuum Gripper verification

If you are not able to attain the desired vacuum level or if a diminution of the vacuum level occurs, verify:

- The suction cups status
- That the air path is clean and not obstructed (including the manifold)
- If a filter cleaning is necessary

10. Warranty

Robotiq warrants the EPick Gripper against defects in material and workmanship for a period of one year from the date of reception when utilized as intended. Robotiq also warrants that this equipment will meet applicable specifications under normal use.

Warning

Warranty applies under the following conditions:

- Usage respects the operating and storage conditions specified in **Environmental and Operating Conditions** section.
- Proper installation of the Vacuum Gripper specified in **Installation** section and the following subsections.
- Until one of these condition is reached:
  - 1 year
  - 2 000 000 cycle count[1]
- Usage respects maintenance specified in the **Maintenance** section.
- Usage respects recommended payload and force specified in the **Mechanical specifications** section.

[1]Cycle count: One (1) cycle is defined as a successful object gripping attempt. It is calculated in the internal memory of the EPick Gripper and can be seen on the robot teach pendant when using with the Robotiq User Interface.

During the warranty period, Robotiq will repair or replace any defective EPick Gripper, as well as verify and adjust the Vacuum Gripper free of charge if the equipment should need to be repaired or if the original adjustment is erroneous. If the equipment is sent back for verification during the warranty period and found to meet all published specifications, Robotiq will charge standard verification fees.

The unit is considered defective when at least one of the following conditions occurs:

- The Vacuum Gripper feedback necessary for the robot program is not accessible.
- Wear of the Vacuum Gripper components due to direct contact with the workpiece or obstacles is not covered by the warranty.

Caution

The warranty will become null and void if the :

- Unit has been tampered with, repaired or worked on by unauthorized individuals.
- Screws, other than as explained in this guide, have been removed.
- Unit has been opened other than as explained in this guide.
- Unit serial number has been altered, erased, or removed.
- Unit has been misused, neglected, or damaged by accident.

This warranty is in lieu of all other warranties expressed, implied, or statutory, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. In no event shall Robotiq be liable for special, incidental, or consequential damages.

Robotiq shall not be liable for damages resulting from the use of the EPick Gripper, nor shall Robotiq be responsible for any failure in the performance of other items to which the EPick Gripper is connected or the operation of any system of which the Vacuum Gripper may be a part.

Exclusions

This warranty excludes failure resulting from: improper use or installation, normal wear and tear, accident, abuse, neglect, fire, water, lightning or other acts of nature, causes external to the Vacuum Gripper or other factors beyond Robotiq's control.

Robotiq reserves the right to make changes in the design or construction of any of its products at any time without incurring any obligation to make any changes whatsoever on units already purchased.

11. Harmonized Standards, Declarations and Certificates

11.1. Original EC declaration of incorporation

ROBOTIQ

EC Declaration of Incorporation (original)

In accordance with the EC Machinery Directive 2006/42/EC, Annex II, 1., Section B.

The manufacturer:

Robotiq Inc.
966 Chemin Olivier, Suite 500
Lévis, Québec, Canada, G7A 2N1

hereby declares, under sole responsibility, that the product:

EPick / EPick Vacuum Gripper
All S/N
(and accessories)

complies with the following essential requirements of the European Directive 2006/42/EC on machinery:

1.1.2, 1.1.3, 1.1.5, 1.3.2, 1.3.4, 1.5.1, 1.5.2, 1.5.4, 1.5.8, 1.5.10, 1.5.11, 1.7.2.

Name and address of the person authorised to compile the relevant technical documentation:

Nicolas Tremblay, CEP, see manufacturer address.

The product is considered as partly completed machinery and has been evaluated in accordance with the following harmonised standard:

ISO 12100:2010 *Safety of machinery – General principles for design – Risk assessment and risk reduction*

The product must not be put into service until the final machinery into which it is to be incorporated has been been declared in conformity with the provisions of the Directive 2006/42/EC, including amendments.

The manufacturer declares that the product complies with the following European Directives and harmonised standards:

- **2014/30/EU** Directive on the harmonisation of the laws of the Member States relating to electromagnetic compatibility
  - *IEC 61000-6-2:2016* *Electromagnetic compatibility (EMC) - Part 6-2: Generic standards – Immunity standard for industrial environments*
  - *IEC 61000-6-4:2018* *Electromagnetic compatibility (EMC) - Part 6-4: Generic standards – Emission standard for industrial environments*
- **2011/65/EU and amendment 2015/863** Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment
  - *EN 50581:2012* *Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances*
- **2012/19/EU** Directive on waste electrical and electronic equipment (WEEE)

The manufacturer also declares the use of these other technical standards, as far as applicable:

ISO 9409-1:2004 *Manipulating industrial robots – Mechanical interfaces – Part 1: Plates*

The relevant technical documentation is compiled in accordance with part B of Annex VII of Directive 2006/42/EC and will be presented electronically by the manufacturer to competent national authorities, if required with a substantiated reason.

Signed in Lévis on June 14th, 2019

Jean-Philippe Jobin, Eng., M.Sc
Chief Technical Officer

112. Applied standards

This section describes all applied harmonized standards for the design and production of the EPick Vacuum Gripper. Conformity of the product is only met if all instructions of the current user manual are followed. Among others; proper installation, safety measures and normal usage must be respected. A risk assessment specific to the user's final application must also be carried out.

> **Caution**
>
> Conformity of the product is only met if all instructions of the following manual are followed. Among others; installation, safety measure and normal usage must be respected.

The following standards have been applied:

ISO 12100	**2010**	Safety of machinery — General principles for design — Risk assessment and risk reduction
ISO 9409-1	**2004**	Manipulating industrial robots – Mechanical interfaces – Part 1: Plates
ISO 4414	**2010**	Pneumatic fluid power – General rules and safety requirements for systems and their components
IEC 61000-6-2	**2016**	Generic standards – Immunity standard for industrial environments
IEC 61000-6-4	**2018**	Generic standards – Emission standard for industrial environments
EN 50581	**2012**	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

12. Contact

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