



CNC Machine Tending Kit

Original Notice

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Robotiq CNC Machine Tending Kit
for e-Series Universal Robots

Instruction Manual



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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 Instruction Manual will also be revised: see revision information. See the latest version of this manual online at robotiq.com/support.

Revision 2019/11/12

- Standardized appearance of tables throughout the Instruction Manual.
- Section " Cam Locate Node" :
 - Renamed subsection " Settings" to Camera Locate Settings"
 - Added typical use tips for options under the " Camera Locate Settings" window
 - Added " Auto Pick" subsection
- Section " Scan Code Node" :
 - Added subsection " Guidelines on Reading Codes"
 - Added subsection " Strings Data Stored in CSV Files"
- Section " Object Teaching" : removed all mentions of the " Play" button and " Question Mark" button which were used to access contextual help contents. This contextual help has since been removed from the Wrist Camera URCap.

Revision 2019/10/10

- Official release.



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Information provided by Robotiq in this document is believed to be accurate and reliable. However, no responsibility is assumed by Robotiq for its use. There may be some differences between the manual and the product if the product has been modified after the edition date.

The information contained in this document is subject to change without notice.



1. General Presentation

The CNC Machine Tending Kit is a Robotiq product that bundles two Hand-E grippers, two sets of Fingertips Extender, two sets of 2F-85 Fingertips Conversion Kit and optionally, the Wrist Camera. On the software side, this kit includes the Machine Tending Copilot.

This kit aims to streamline machine tending applications by installing two grippers on a single robot, which reduces cycle time for pick and place operations. Moreover, the CNC Machine Tending Kit leverages Robotiq Copilot software to create robot programs that self-correct their waypoints based on physical feedback, or by using the Wrist Camera for visual feedback. This makes robot programs more robust, and should reduce production stops. It also means that robot programs require fewer adjustments when used for different machines or work environments.

For further details on the Hand-E gripper, on the Wrist Camera, or on Copilot capabilities, please refer to the instruction manual of each product, found on robotiq.com/support. The current instruction manual includes basic information on all previously mentioned devices.

Info

This manual uses the metric system. Unless otherwise specified, **all dimensions are in millimeters**.

Caution

The following section presents the key features of the product, and must not be considered as appropriate to its operation. Product features are detailed in relevant sections of the Instruction Manual.

Read and understand safety guidelines before attempting to use your product.

1.1. Introduction to the Hand-E gripper

1.1.1. Gripper nomenclature

The Hand-E gripper is a parallel gripper. Its two fingers are actuated by a single motor.



Fig. 1-1: Robotiq Hand-E gripper.

Please refer to the and **Spare Parts, Kits and Accessories** for details on standard and optional parts. The Hand-E basic gripper unit includes flat rubber (NBR) overmolded aluminum fingers (NBR overmold is not illustrated in [Figure 1.1: Robotiq Hand-E gripper](#)).

The user can install fingers directly on racks, or fasten fingertips to fingertip holders, which are in turn installed on racks. Refer to the **Mechanical Installation** for more information on how to integrate custom fingers and fingertips to Hand-E.



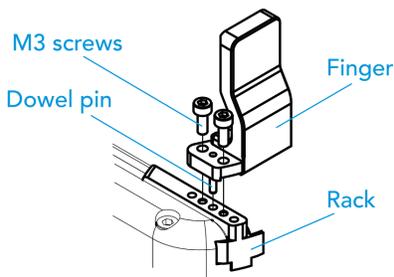


Fig. 1-2: Mounting a finger on a rack.

When Hand-E is ordered as a kit (see **Installation**), a fingertip starting kit is included (see **Spare Parts, Kits and Accessories**). These fingertips should be mounted onto fingertip holders.

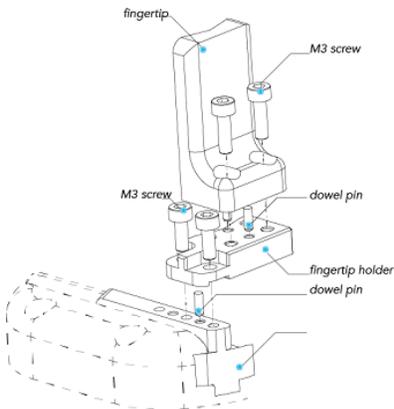


Fig. 1-3: Mounting a fingertip on a fingertip holder (example).

Tip

You can customize fingers and fingertips. Mount custom fingers on racks, and fingertips on fingertip holders.

112. Object picking

The Hand-E gripper has a single actuator for opening and closing the fingers. It also allows internal gripping: fingers can pick hollow parts from inside by applying pressure with the outer surface of the fingers.

See the figure below for a representation and refer to the **Control** for details on available position commands for your gripper.

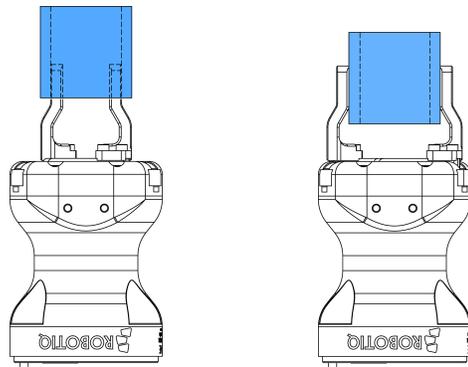


Fig. 1-4: Hand-E gripper internal (left) and external (right) gripping.

11.3. Setup and control

Hand-E is powered and controlled directly via a single device cable that carries a 24V DC supply and Modbus RTU communication over RS-485. See the **Installation** for wiring information and section **Control** for controlling the gripper (software packages are available for control via some types of robot controllers).

A gripper coupling is required to use Hand-E; providing mechanical and electrical connectivity. See the **Installation** to install the coupling, the **Technical dimensions** for technical drawings, and the **Spare Parts, Kits and Accessories** for a list of available couplings.

Hand-E has an embedded object detection feature based on indirect sensing methods. When picking an object with the "go to" command, the gripper status indicates whether or not an object has been picked, using only an object detection bit (0 or 1). When an object is detected, the gripper no longer increases the force exerted on the object. If the object is being dropped, the gripper automatically exerts more force until the object is detected or until the position target from the "go to command" is reached. For details on object detection, see section **Control**.

12. Custom Fingers

The CNC Machine Tending Kit makes your grippers even more versatile than before. With the Fingertips Extender, you can widen the grip to grasp larger objects. The 2F-85 Fingertips Conversion Kit kickstarts the tooling process of your own custom fingers by providing an installation frame, or helps reusing legacy fingers for new applications. In addition, the CNC Machine Tending Kit is bundled with three sets of Hand-E fingers, as well as V-groove fingertips (v4) manufactured for the 2-Finger Adaptive Robot Gripper.

To mount a Fingertips Extender to a gripper rack or to mount fingers/fingertips on the Fingertips Extender, see section **Installation**.

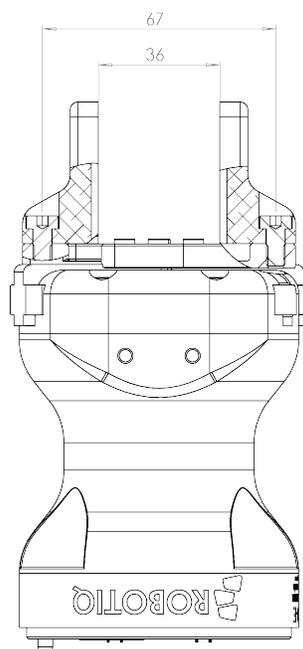


Fig. 1-5: Hand-E fully closed with Fingertips Extender and V-groove fingers.

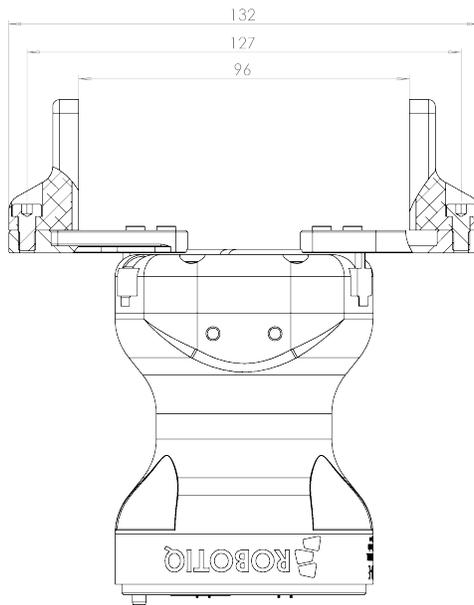


Fig. 1-6: Hand-E fully opened with Fingertips Extender and V-groove fingers.

13. Introduction to the Machine Tending Copilot

Force Copilot is a software package designed to use force and torque values read by a force-torque sensor (FT300), in support to robotic applications. The collected data can then be leveraged for applications such as guiding robot hands, force control, assembly, product testing, and much more. Force Copilot functionalities, such as the Visual Offset (using the optional Wrist Camera) and Contact Offset nodes, help unlock the full potential of the CNC Machine Tending Kit.

Force Copilot requires a product license, which is stored on a license dongle provided with your Kit. The license dongle must remain connected to your robot controller to use Force Copilot functionalities.



Fig. 1-7: Force Copilot license dongle.

14. Introduction to the Wrist Camera

The terms "Camera" and "Wrist Camera" used in the following Instruction Manual all refer to the "Robotiq Wrist Camera", while the term "Vision" and "Vision System" all refer to the "Robotiq Wrist Camera Vision System" for Universal Robots.

The Vision System uses the Robotiq Wrist Camera and the Cam Locate node on Universal Robots to provide you with a simple object teaching interface.

The interface allows you to set up the Vision System so that it can recognize object locations and orientations automatically. The Vision System, using the Cam Locate feature, is only designed to locate on object at a time on a predefined workplane. It gets the object position (x, y) and orientation along the z-axis. You can then operate the robot based on the object location. The Wrist Camera is designed for industrial applications, to be combined with Robotiq adaptive grippers Hand-E, 2F-85 and 2F-140.

14.1 Vision System Components

The figure below describes the various components of the Robotiq Vision System for Universal Robots. This system uses the Robotiq Wrist Camera with any Universal Robots model using a robot controller model CB3.1 and up. For a list of provided components, see the Scope of Delivery section of the Wrist Camera Instruction Manual.



Caution

The Robotiq Vision System is only compatible with Universal Robots models using a controller version of CB3.1 and up, as well as with any e-Series releases. To identify your controller version, contact your Universal Robots representative.

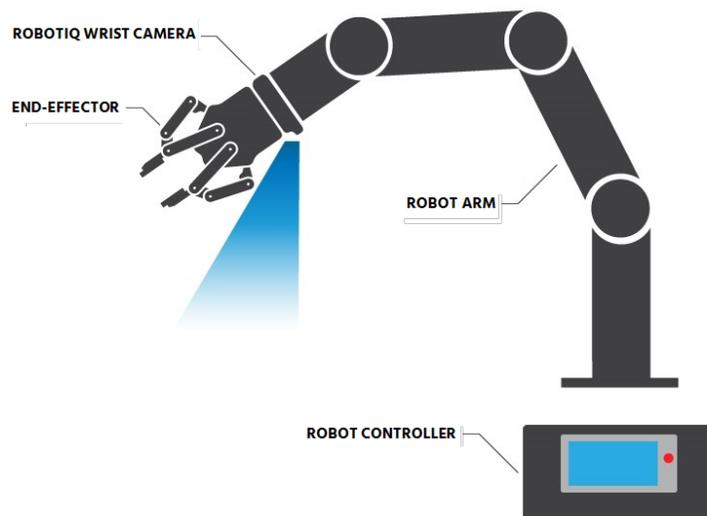


Fig. 1-8: Schematic representation of the Robotiq Wrist Camera Vision System hardware.

More details on the Wrist Camera are available in subsection Wrist Camera, as well as in the product Instruction Manual.

14.2. Snapshot Position and Workspace

The figure below illustrates the various terms used in the following Instruction Manual to describe the Vision System concepts of "snapshot position" and "workspace". The process to locate an object always starts from a snapshot position. That position defines the field of view of the Wrist Camera, what we call the workspace. See the "Snapshot Position" section of the Wrist Camera Instruction Manual on how to teach a snapshot position.

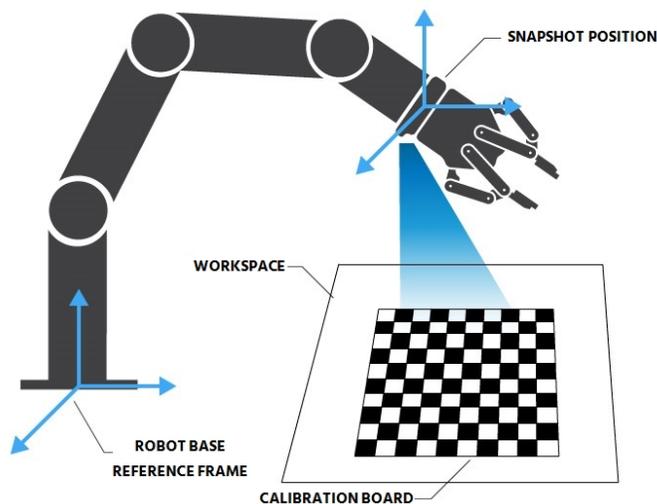


Fig. 1-9: Schematic representation of the Robotiq Vision System concepts of snapshot position and workspace.



And Now, Some Terminology

snapshot position	Robot pose used to take snapshots with the Wrist Camera.
workspace	Area of interest for the Vision System. Fits the field of view of the Wrist Camera.
object	Object to locate using the Vision System.
calibration board	Grid provided with the Wrist Camera. Used in the calibration process of the snapshot position.

14.3. Object Location

The Vision System uses the Cam Locate node to locate an object. The illustration below represents the object location process. For more details, see the Wrist Camera Instruction Manual, section "[Programming with the Camera Locate node](#)".

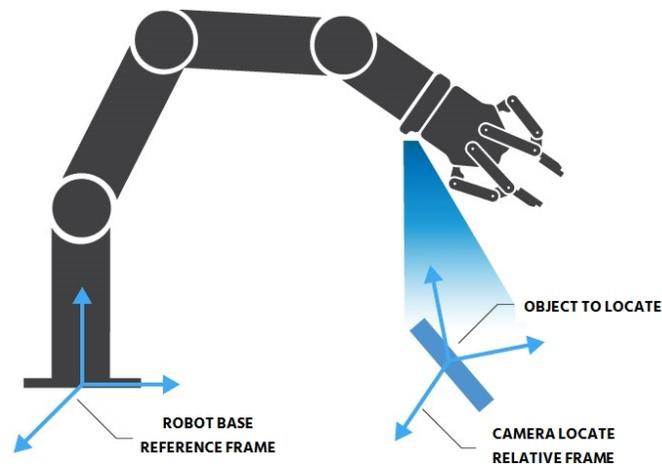


Fig. 1-10: Diagram of the object location process.

And Now, Some Terminology

object to locate	Object to locate using coordinates x , y , and R_z (rotation).
camera locate relative frame	Reference frame as updated by the Vision System to locate an object.
robot base reference frame	Frame coordinates defined as $[0, 0, 0]$.

14.4. Hardware

The hardware at the core of the Vision System is the Wrist Camera, shown in the figure below. To install the Wrist Camera, refer to the **Installation** of the current Instruction Manual.





Fig. 1-11: Wrist Camera hardware.

Here are some hardware specifications of the Wrist Camera:

Hardware	Specifications
CMOS image sensor with liquid lens	<ul style="list-style-type: none"> • Resolution: 0.3 to 5 Mpx • Frame rate: 2 to 30 FPS • Focus: 70mm to ∞
6 LED	<ul style="list-style-type: none"> • Diffuse white light • Automatic control
high-flex 10-meter pigtail cable	<ul style="list-style-type: none"> • USB 2.0 • 24V DC power
tool flange: ISO 9409-1:2004 4 X M6 \varnothing 50mm bolt pattern	<ul style="list-style-type: none"> • Wrist Camera is mounted on the tool flange • Grippers are mounted on the Wrist Camera

Info

The Robotiq Wrist Camera provides a direct mounting interface for grippers, including a mechanical interface, 24V power, and gripper-robot communication capabilities.



2. Safety

Warning

Operators must read and understand all instructions contained in this manual prior to operating the CNC Machine Tending Kit.

Info

"Operator" refers to the person in charge of operating the CNC Machine Tending Kit for the following activities: installation, control, maintenance, inspection, calibration, programming or decommissioning.

The current document covers the various components of the CNC Machine Tending Kit, and its broad applications, considering the product full lifecycle, starting with the installation, then operation, and finally, its decommissioning.

Illustrations shown in the current Instruction Manual are typical examples. However, the products you receive may be slightly different.

2.1. Warning

Info

Please comply with all warnings contained in this Instruction Manual regarding the operation of the CNC Machine Tending Kit and of its components. Other uses may result in injury or damage.

Warning

- Secure the Wrist Camera, the dual adapter, and both Hand-E grippers to the tool flange before operating the robot.
- Do not install/operate devices which are damaged or which have parts missing.
- Do not supply alternative current to devices.
- Secure all cables and cords both at device level, and along the robot arm.
- Follow recommended keying for electrical connections.
- Prior to initializing a robot program, make sure the path of the robot or of its attached devices is free from obstacles.
- Comply with grippers payload specifications.
- Set the gripper force and speed based on your application.
- When the robot is active, keep fingers and clothes at a distance.
- Do not use grippers on people or animals.
- Do not look directly into the LED of theWrist Camera when they are turned on: this might dazzle you.

2.1.1 Risk assessment and final application

The Hand-E gripper is meant to be mounted on industrial or collaborative robots. The robot, gripper, Wrist Camera, and any other equipment used in the final application must undergo a thorough risk assessment. Robot integrators must comply with all local and national safety measures and regulations. Risks may require additional protection/safety measures to be implemented, depending on the application. That could be the case when handling parts inherently dangerous to the operator.



For more details, read eBooks available from www.robotiq.com, or contact our Technical Support department.

2.2. Intended Use

Info

Comply with local and national laws and regulations at all times, including with directives on automation safety, and general machine safety guidelines.

Warning

Use your devices within the range of their technical specifications. Using a device beyond its technical specifications is considered improper and as unforeseen by the manufacturer. Robotiq will not be held liable for any damage resulting from improper or unforeseen uses.

2.2.1 Hand-E grippers

Grippers are designed to temporarily secure or hold objects.

2.2.2. Machine Tending Copilot

The Machine Tending Copilot offers you all the software capabilities needed for your machine tending applications, such as being able to reuse your robot programs on similar production cells at different locations, without reprogramming all waypoints. This is accomplished through the Contact Offset node, which uses force feedback to get real-world data input, and modifies robot programs accordingly.

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

2.2.3. Wrist Camera

The Wrist Camera is designed to locate objects lying flat on a delimited workspace. It can identify and locate various objects, each requiring an independent object teaching process, as explained in the [Object Teaching](#) section of the Wrist Camera Instruction Manual. The Wrist Camera finds an object position (x, y), and its orientation on the Z axis, allowing to carry out operations based on object location. Use the Find Visual Offset node to locate a tag, then execute robot moves based on the position of objects in relation to tag position.

Tip

For recommendations on what workspace to use and to avoid using, see the [Guidelines on snapshot position](#) subsection included in the Wrist Camera Instruction Manual. Section [Object Teaching](#) also contains recommendations about backgrounds, and specifies kinds of objects that can or cannot be located.

Caution

The Wrist Camera is not designed for metrology purposes.



3. Installation

The following subsections will guide you through the installation and general setup of your Robotiq CNC Machine Tending Kit.

Caution

Prior to installation

- Read and understand the safety instructions related to the CNC Machine Tending Kit.
- Verify that your package contains all parts noted in the scope of delivery.
- Have the required parts, equipment and tools listed in the requirements readily available.

Warning

During installation

- Meet the recommended environmental conditions.
- Before operating a gripper or turning on its power supply, secure it to the robot arm. When a gripper is activated, its fingers may move and cause injury or damage.



3.1. Scope of Delivery

3.1.1. Standard upon delivery of CNC-ES-UR-KIT

- Combo of Two Hand-E for UR e-Series [CUR-ES-DUAL-HND]
 - two Hand-E grippers fitted with flat rubber (NBR) overmolded fingers
 - two gripper couplings
 - one 90-degree adapter plate for dual grippers
 - two Hand-E fingertips starting kits [HND-TIP-START-KIT]
 - two sets of Hand-E V-groove fingertips
 - two sets of Hand-E aluminum fingers
 - two sets of fingertip holders
- two sets of V-groove fingers for 2-Finger Adaptive Robot Gripper (v4.0) [AGC-TIP-205-085]
- two sets of Fingertips Extender [HND-TIP-EXT-KIT]
- two sets of 2F-85 Fingertips Conversion Kit [AGC-TIP-CONV-KIT]
- Machine Tending Copilot kit [CP-MT-ES-UR-KIT]
- one USB stick [AGC-USB-16G]

3.1.2. Standard upon delivery of CNC-RWC-ES-UR-KIT

- Combo of two Hand-E for UR e-Series [CUR-ES-DUAL-HND]
 - two Hand-E grippers fitted with flat rubber (NBR) overmolded fingers
 - two gripper couplings
 - one 90-degree adapter plate plate for dual grippers
 - two Hand-E fingertips starting kits [HND-TIP-START-KIT]
 - two sets of Hand-E V-groove fingertips
 - two sets of Hand-E aluminum fingers
 - two sets of fingertip holders
- two sets of V-groove fingers for 2-Finger Adaptive Robot Gripper (v4.0) [AGC-TIP-205-085]
- two sets of Fingertips Extender [HND-TIP-EXT-KIT]
- two sets of 2F-85 Fingertips Conversion Kit [AGC-TIP-CONV-KIT]
- Machine Tending Copilot kit [CP-MT-ES-UR-KIT]
- one USB stick [AGC-USB-16G]
- one Wrist Camera [RWC-CAM-001]
- one tool plate for the Wrist Camera [RWC-TOOL-062]
- one calibration board for Wrist Camera [ACC-CALIB-BOARD]
- one color background for the Wrist Camera Vision System [ACC-TEACH-BACK]
- one 4-port USB hub [ACC-USB-4-HUB]
- one USB dongle loaded with the Vision license [ACC-USB-DONGLE]



3.2. Required Tools and Equipment

The following table lists tools required to assemble parts of the CNC Machine Tending Kit.

Part	Tools required
Hand-E gripper	<ul style="list-style-type: none"> • 4mm hex key (gripper to coupling) • 2.5mm hex key (some fingertips)
Dual Hand-E adapter plate	<ul style="list-style-type: none"> • 4mm hex key (dual plate to tool flange)
Wrist Camera (optional)	<ul style="list-style-type: none"> • 4mm hex key (Wrist Camera to tool flange) • 2mm slotted screwdriver (electrical wiring with a Universal Robots controller)
Force Copilot dongle	<ul style="list-style-type: none"> • None



3.3. Environmental and Operating Conditions

3.3.1 Hand-E

CONDITION	VALUE
Minimum storage temperature	-30°C [-22°F]
Maximum storage temperature	70°C [158°F]
Minimum operating temperature	-10°C [14°F]
Maximum operating temperature	50°C [122°F]
Humidity (non-condensing)	20-80% RH
Maximum vibration (storage/transit)	5G
Maximum vibration (operating)	2G
IP Rating	IP 67

Table 3-1: Environmental and operating conditions of the Hand-E gripper.

3.3.2. Wrist Camera

CONDITION	VALUE
Minimum storage temperature	-30°C [-22°F]
Maximum storage temperature	70°C [158°F]
Minimum operating temperature	0°C [32°F]
Maximum operating temperature	50°C [122°F]
Humidity (non-condensing)	Non-condensing
Maximum vibration (operating)	2G
IP Rating	IP 67



CONDITION	VALUE
Others	<ul style="list-style-type: none">• Lenses must be free from dust, soot, and water.• Environment must be free from powerful electromagnetic interference.• Environment must be free from corrosive or explosive liquids or gases.

Table 3-2: Environmental and operating conditions of the Wrist Camera.



3.4. Mechanical Installation

For easier mounting, move the tool flange to make it point upwards.

For more details on installing your CNC Machine Tending Kit, see figures in this section. If your CNC Machine Tending Kit includes the Wrist Camera, skip to section **Assembling the CNC Machine Tending Kit with the Wrist Camera**. Please note that the terms "finger" and "fingertip" are used interchangeably in this section.

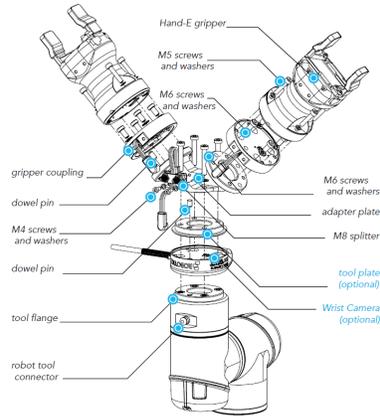


Fig. 3-1: Exploded view of the CNC Machine Tending Kit, Wrist Camera included.

3.4.1 Assembling the CNC Machine Tending Kit without the Wrist Camera

1. Insert a dowel pin under the adapter plate. It should fit tightly.
2. Insert four M6 screws and toothlock washers into the adapter plate, using a 3mm hex key, and secure plate to tool flange.
3. Insert a dowel pin into a socket of the adapter plate.
4. Place a gripper coupling on the socket of the adapter plate. Align using the dowel pin, which should fit loosely in the gripper coupling.
5. Secure the gripper coupling to the adapter plate with four M6 screws and toothlock washers, using a 4mm hex key.
6. Secure the Hand-E gripper to the gripper coupling with four M5 screws and toothlock washers, using a 4mm hex key.
7. Repeat steps 3, 4, 5, and 6 to mount the second Hand-E gripper on the adapter plate.
8. Secure the M8 splitter to the front of the adapter plate with two M4 screws and lock washers, using a 3mm hex key. See **Securing the M8 splitter to the adapter plate**.

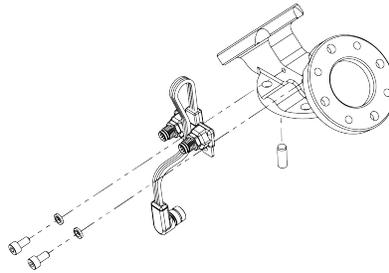


Fig. 3-2: Securing the M8 splitter to the adapter plate.

3.4.2 Assembling the CNC Machine Tending Kit with the Wrist Camera

1. Place the Wrist Camera on the tool flange. Align with the dowel pin already installed on the Wrist Camera.
2. Insert a dowel pin into the top part of the Wrist Camera, then place the tool plate onto the Wrist Camera. Align using dowel pin.
3. Insert a dowel pin into the tool plate, then place the adapter plate onto the tool plate.
4. Insert four M6 screws and toothlock washers into the adapter plate, and secure it to the tool flange.
5. Insert a dowel pin into a socket of the adapter plate. It should fit tightly.
6. Place a gripper coupling on the socket of the adapter plate. Align using the dowel pin, which should fit loosely in the gripper coupling.
7. Secure the gripper coupling to the adapter plate with four M6 screws and toothlock washers, using a 4mm hex key.
8. Secure the Hand-E gripper to the gripper coupling with four M5 screws and toothlock washers, using a 4mm hex key.
9. Repeat steps 6, 7, 8, and 9 to mount the second Hand-E gripper.
10. Secure the M8 splitter to the front of the adapter plate with two M4 screws and lock washers, using a 3mm hex key. See figure **Securing the M8 splitter to the adapter plate**.

Tip

Avoid connecting your grippers to the M8 splitter. This will be done at a later stage, when configuring your grippers on the Teach Pendant.



3.4.3. (optional) Assembling Fingertips Extender and Fingers on a Hand-E Gripper

Note

Only fingers made for the 2F-85 adaptive gripper are compatible with the Fingertips Extender.

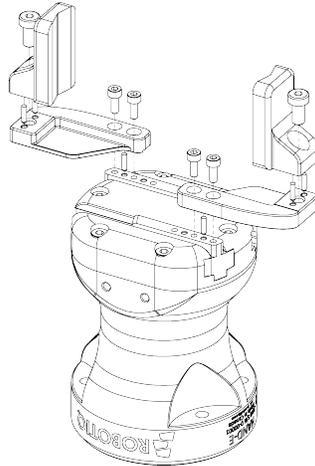


Fig. 3-3: Exploded view of Hand-E with Fingertips Extender and two 2F-85 V-groove fingers.

1. Remove both M3 screws securing a Hand-E finger to the gripper rack, using a 2.5mm hex key.
2. Insert two dowel pins under the finger you wish to mount on the Fingertips Extender.
3. Insert the finger on the outside end of the Fingertips Extender, and secure it with screws that fit the finger you are installing, using the applicable hex key. Align finger using its two dowel pins.
4. Insert two dowel pins under the Fingertips Extender.
5. Secure the Fingertips Extender on a gripper rack with M3 screws, using a 2.5mm hex key. Align Fingertips Extender using its two dowel pins.
6. Repeat procedure to install the second Fingertips Extender on the gripper rack, then install the second finger on the Fingertips Extender.

3.5. Software Installation

3.5.1 Installing URCap files

Robotiq provides you with Universal Robots URCap packages that enable direct serial communication with your robot controller. To operate the CNC Machine Tending Kit to its full potential, install required URCap files for your Hand-E grippers, for your Force Torque Sensor, and optionally, for your Wrist Camera.

To download URCap packages for your Universal Robots controller, go to robotiq.com/support. To ensure compatibility between your Teach Pendant PolyScope and the Machine Tending Copilot URCap, please use the latest PolyScope version.

Prior to installing any URCap on your Teach Pendant, make sure that all devices have been mounted on the robot arm. For more details, read section **Mechanical Installation**, and confirm that your robot controller is compatible with the URCap version. The Teach Pendant PolyScope version must be 3.7 or later to install the Robotiqgripper URCap, or 3.9 and later to install the Wrist Camera URCap.

Caution

To check your PolyScope version, tap  and select About.



To install URCap files for products included in your CNC Machine Tending Kit, follow these instructions:

1. Go to robotiq.com/support.
2. Click or tap Select Product > CNC Machine Tending Kit > Universal Robots > Software > Machine Tending Kit Software > Download ZIP.
3. Decompress the ZIP archive to the root folder of a USB stick. It contains three URCap files and their matching release notes.
4. Insert the USB stick into the Teach Pendant.

From your Teach Pendant interface, select , then Settings > System > URCaps, as shown below.

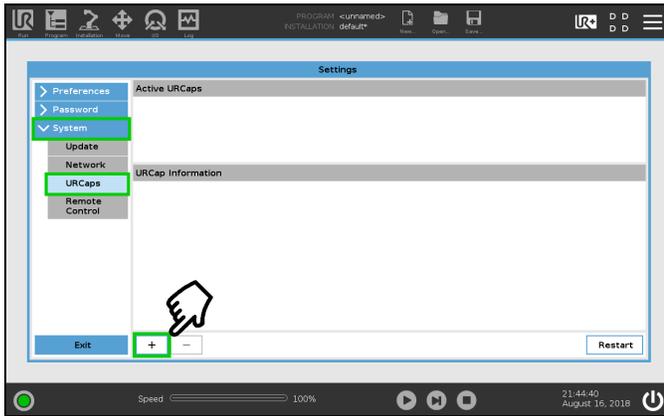


Fig. 3-4: Installing URCap files on your Teach Pendant.

5. Tap the  button.
6. Select either the gripper URCap (**UCG-x.x.x**) or the Force Copilot URCap (**UCS-x.x.x**) to install a URCap on your Teach Pendant, then select Open.
7. Repeat the previous step, and install the second URCap.
8. (optional) Install the Wrist Camera URCap.
9. Once a URCap has been installed, it will be displayed in the Active URCaps section, with the  icon next to indicate the Teach Pendant must restart to use the URCap.
10. After installing all required URCap files for your CNC Machine Tending Kit hardware, tap Restart in the "Settings" window. The Teach Pendant restarts.

Tip

For details on resources included in URCap files, refer to the Instruction Manual of the applicable Robotiq hardware.

3.5.2. Installing Licenses

Connect the 4-port USB hub splitter into the USB port of your robot controller, then insert all provided USB dongles into the splitter ports:

- Vision Server (packaged with the Wrist Camera URCap; copy it to a USB stick)
- Vision license USB dongle
- Machine Tending Copilot License dongle



Tip

Removing a dongle from your robot controller will deactivate its associated functionalities on the Teach Pendant.

3.5.3. Activating Two Hand-E Grippers on PolyScope

Before setting up your Hand-E grippers via the Teach Pendant, make sure only one gripper is connected to the M8 splitter, then follow these instructions.

1. On your Teach Pendant, select Installation in the top ribbon.
2. Select URCaps > Gripper > Dashboard > Scan. This displays connected grippers, each represented with a number inset on a gripper icon. Only one gripper should be shown at this time, as shown below.



Fig. 3-5: Activating a gripper and assigning an ID.

3. Select the "Change ID" dropdown list, then assign any number to your gripper. Note this number somewhere – it will be required for your second gripper –, then select Activate.
4. Disconnect the gripper cable from the M8 splitter.
5. Connect the second gripper to the M8 splitter.
6. Select Scan.
7. Select the "Change ID" dropdown list, then assign a number to your gripper, but make sure it is different from the one assigned to the first gripper. Select Activate.
8. Reconnect the cable of the first gripper to the M8 splitter. Both grippers are shown under the Dashboard.

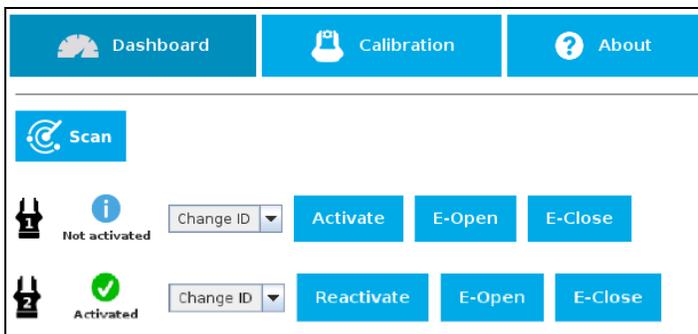


Fig. 3-6: Activating two grippers and assigning each one an ID.

9. To check that both grippers communicate properly with the robot, select the Configuration tab, then select either the Activate or Reactivate buttons located next to each gripper icon.

Caution

All grippers should have a unique ID assigned to them. By default, all grippers have their Gripper ID set to 1. If grippers share an ID, communication issues will arise.



3.5.4. Specifying Payload, Center of Gravity and Tool Center Points

After mounting the CNC Machine Tending Kit hardware on your robot, you need to specify the payload and center of mass into the Teach Pendant.

Note

In this Instruction Manual, "center of gravity" is also referred as "center of mass".

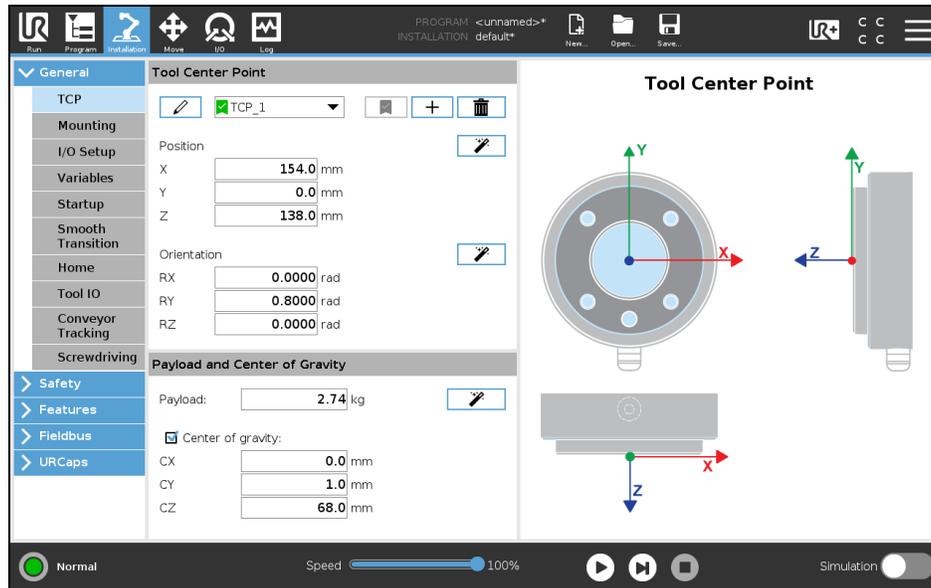


Fig. 3-7: Specify the Payload and Center of gravity for the hardware mounted on your robot.

1. Go to the Installation tab > TCP.
2. Enter values of the payload and center of gravity for your CNC Machine Tending Kit. See table **Values of center of mass, tool center point and mass for kits**.
3. In the dropdown list under the "Tool Center Point" section, select your first gripper. Enter its X, Y, and Z coordinates as specified under "Gripper 1" in the same table as before.
4. Select the dropdown list once again, and select your second gripper from this list. As in the previous step, enter its coordinates as specified under "Gripper 2" in the same table as before.

Kit	Center of mass (mm)			TCP (X, Y, Z in mm; RX, RY, RZ in rad)												Mass (g)
				Gripper 1						Gripper 2						
	X	Y	Z	X	Y	Z	RX	RY	RZ	X	Y	Z	RX	RY	RZ	
CNC Machine Tending Kit without the Wrist Camera	0	0	62	154	0	138	0	0.7854	0	-154	0	138	1.22	0	-2.887	2400
CNC Machine Tending Kit with the Wrist Camera	-0.3	0.4	78.5	154	0	161.5	0	0.7854	0	-154	0	161.5	1.22	0	-2.887	2700

Table 3-3: Values of center of mass, tool center point and mass for kits.



If you install the Fingertips Extender or use custom fingers, payload and center of gravity may differ from those in the table. For more data on hardware setups, see table [6.2.2 Center of mass and tool center point](#) in the Hand-E Instruction Manual.

Info

For details on controlling grippers, see section **Control** on page 32.



3.5.5. License Agreement

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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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1. Definition.

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 - b. “ Software” means any of the Licensor’s softwares provided to its customers for the purposes mentioned in Sub-section 1.4 hereof including their modifications and upgrades and their related materials;
 - c. “ Licensor” means Robotiq inc., a corporation incorporated under the laws of Quebec, having its registered office at 500-966 chemin Olivier, Lévis, Québec, Canada, G7A 2N1, which specializes into the conception, advanced manufacturing and sale of robotic products (the “ Licensor’s Business”);
 - d. “ End-User” means a customer authorized pursuant to this Agreement to install or use the Software in order to make a specific product from the Licensor’s Products compatible and functional with a specific product of the UR’s Product;
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all obligations of the parties under this Agreement due for performance on the date of termination shall survive the termination, and the party terminating shall not be liable to the other party for any damages arising out of the termination.

13. Miscellaneous.

- a. This Agreement constitutes the entire understanding and agreement between the Licensor and the End-User and replaces any prior agreement relating to the same subject matter.
- b. This Agreement shall be governed and construed in accordance with the laws of the province of Quebec and the federal laws of Canada applicable therein. Any legal action or proceeding between the Licensor and the End-User for any purpose concerning this Agreement or the parties' obligations hereunder shall be brought exclusively in a court of competent jurisdiction sitting in the judicial district of Trois-Rivières, Quebec.
- c. 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.
- d. 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.
- e. 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.
- f. 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.
- g. Any rights not expressly granted herein are reserved.
- h. 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. Control

4.1 Overview

This section introduces nodes that have been developed to be used with the CNC Machine Tending Kit. For details on basic nodes developed for the hardware included in the CNC Machine Tending Kit, refer to the applicable Instruction Manual of Hand-E, Force Copilot or the Wrist Camera.

Advanced user can learn more on communicating with Hand-E and controlling it by referring to the device Instruction Manual, section [Control](#). For typical use cases, refer to the current section.

Control using Universal Robots packages

Robotiq provides *Universal Robots* packages to be used with *URCaps* (this requires controller version CB3 or higher).

See section **Control** on page 32 for instructions on how to use the **Gripper** URCap; this method will provide you with a Gripper Toolbar to test and a Gripper node to program via the URCaps tab.

4.2. Controlling your Hand-E grippers

4.2.1 Contents of the URCap

The URCap package contains many features to program and control the gripper:

- The Gripper toolbar is automatically installed with the gripper URCap. It allows jogging and testing of the gripper. It is a great tool to try grasps with the gripper while programming.
- The Gripper node is used to add a gripper command. It can make the gripper move to a specific opening, grasp an object and modify the speed and applied force.

Overview

Single Gripper

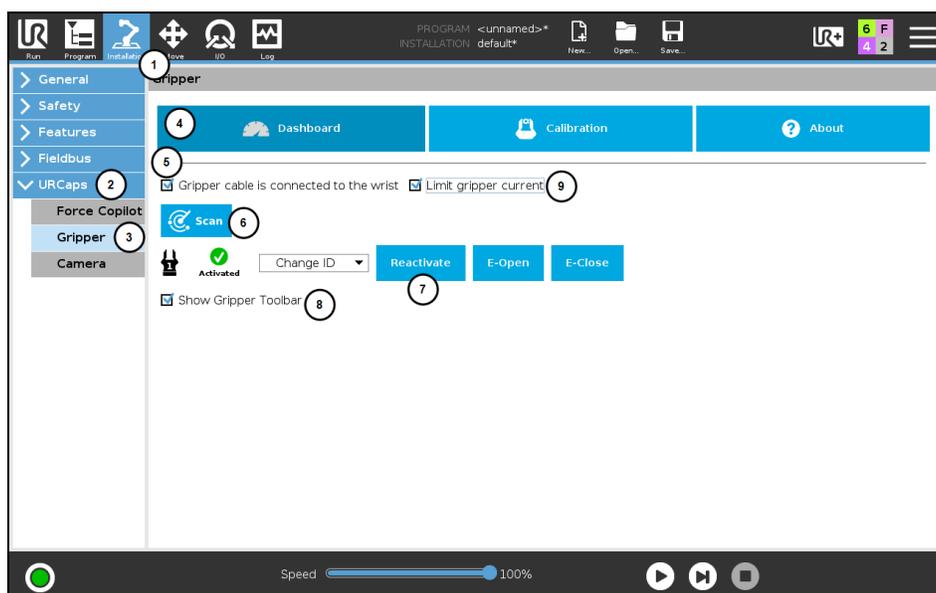


Fig. 4-1: Gripper Dashboard (steps highlighted)



- 1 On the teach pendant, tap the **Installation** button.
- 2 Select **URCaps** in the navigation pane on the left.
- 3 Tap the **Gripper** button.
- 4 Select the **Dashboard** tab.
- 5 If the Gripper is connected to the robot wrist (and not to the robot controller or via a Robotiq Wrist Camera) tick the "**Gripper cable is connected to the wrist**" box.
- 6 If no Gripper is found, tap the **Scan** button to detect any Gripper that might be connected to the robot
- 7 Tap the **Activate/Reactivate** button.
- 8 In order to display the Gripper Toolbar in the UR+ menu in the top ribbon of PolyScope, tick the **Show Gripper Toolbar** box.
- 9 In order to prevent overcurrent conditions (for instance when grasping soft objects or using multiple Grippers at the same time), tick the **Limit gripper current** box.
 - a Limits the current at 600 mA for a single Gripper
 - b Limits the current at 450 mA for each Gripper connected in a multiple Gripper configuration

Info

The default Gripper ID allocated to the first device connected is 1.

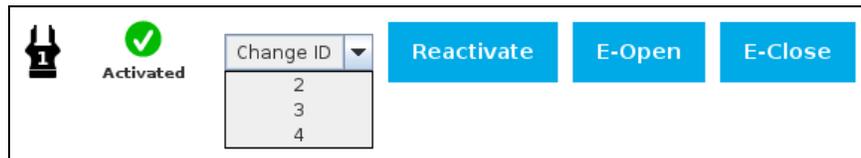


Fig. 4-2: Gripper ID modification in the Gripper Dashboard

Info

The **E-Open** and **E-Close** buttons allow the user to open and close the Gripper even if the latter is not activated. These emergency commands use very low speed and force settings.

Multiple Grippers

Info

The URCap allows the user to connect and control up to **4** Grippers at the same time.

Features

Icon	Functionality Name	Description
	Dashboard	After selecting Gripper in the left pane of the Installation tab, tap this button to access the Gripper Dashboard.
	Activate/Reactivate	The Activate and Reactivate buttons enables the corresponding Gripper.



Icon	Functionality Name	Description
		
 	Not activated/ Activated	Gripper status: One or the other of these icons is displayed next to the corresponding Gripper icon.
	Gripper	Label indicating the Gripper's ID, ranging from 1 to 4.
	Scan	Command allowing for a detection of connected Grippers. After tapping this button, the latter will display in the Gripper Dashboard.
	Change ID	Tap the arrow next to the textbox to expand a list of available Gripper IDs. Selecting an available number will allocate it to the corresponding Gripper.
	E-Open	Tapping this button sends an emergency open command to the corresponding Gripper, whether it is activated or not.
	E-Close	Tapping this button sends an emergency close command to the corresponding Gripper, whether it is activated or not.

4.2.2. Gripper Calibration menu and wizard

Depending on the fingers/fingertips used, the operator will calibrate the Gripper and measure the stroke by defining the fully open and fully closed positions.

Make sure the Gripper is activated.

- 1 On the teach pendant, tap the **Installation** button.
- 2 Select **URCaps** in the navigation pane on the left.
- 3 Tap the **Gripper** button.

Info

A gripper that has not been calibrated will display open and closed values in percentage.



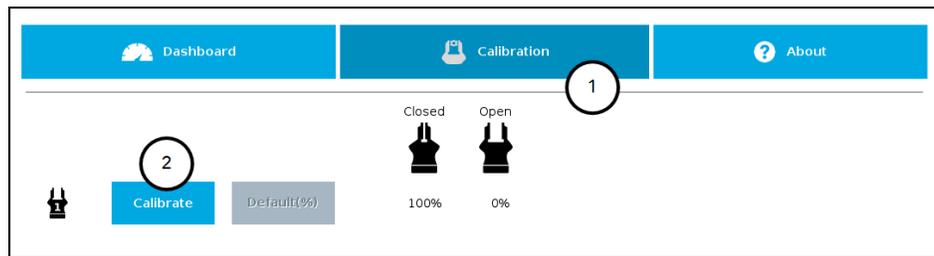


Fig. 4-3: Calibrating grippers.

- 1 Tap the Calibration tab
- 2 Tap Calibrate, and configure the applicable Gripper.

Tapping the Calibrate button from the Calibration menu launches the **Calibration wizard**.

Follow instructions onscreen, and calibrate.

Tip

Depending on the PolyScope settings defined by the user, the units of measurement can either display according to the metric or imperial system.

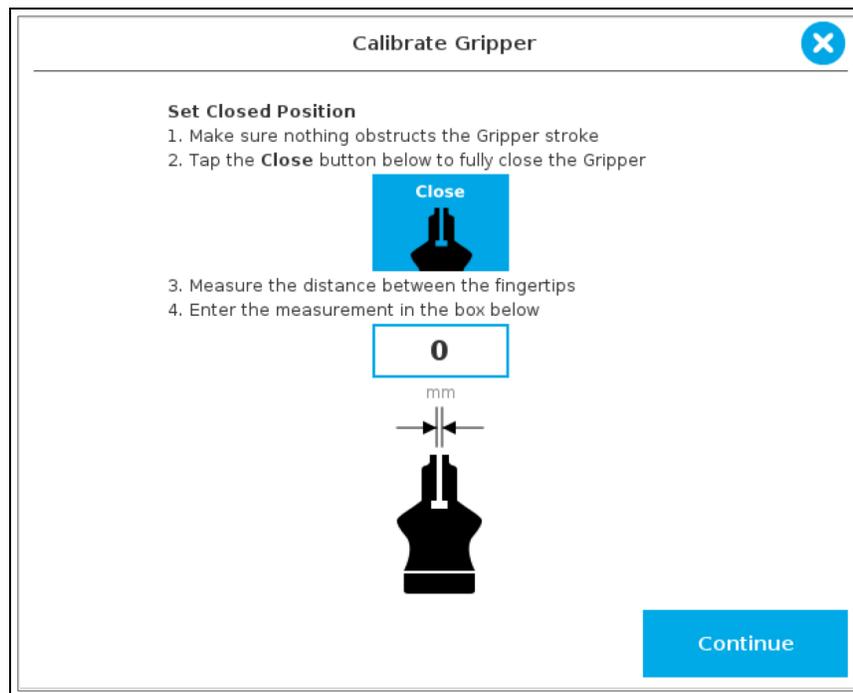


Fig. 4-4: First step of the calibration wizard

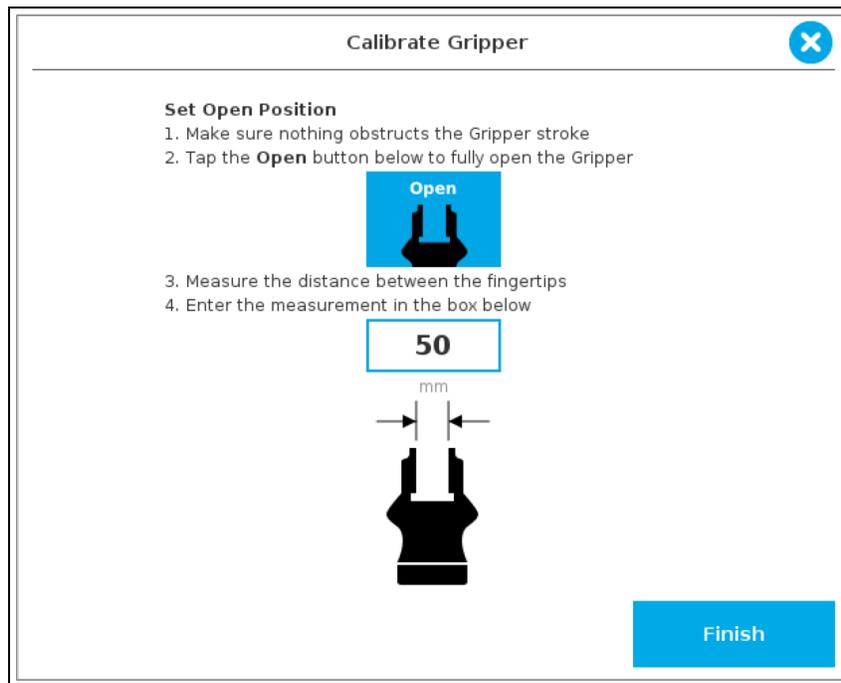


Fig. 4-5: Second step of the calibration wizard

Following their respective calibration, the Grippers will display their actual stroke, from the fully closed to the fully open position.

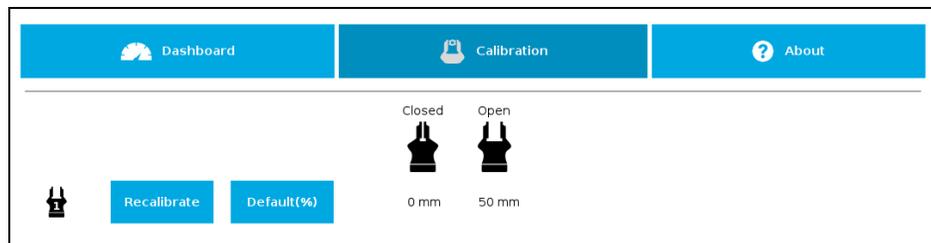
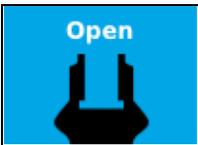
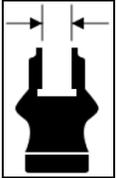


Fig. 4-6: Single Gripper, calibrated

Features

Icon	Functionality Name	Description
 Calibration	Calibration	After selecting the Gripper in the left pane of the Installation tab, tap this button to access the Gripper Calibration menu.
 	Calibrate/Recalibrate	The Calibrate and Recalibrate buttons launch the Gripper Calibration wizard.

Icon	Functionality Name	Description
	Default (%)	Following a calibration, tap this button to reset the calibration and return to the default percentage values. The button is greyed out if no calibration has been performed for the corresponding Gripper.
	Gripper	Label indicating the Gripper's ID , ranging from 1 to 4.
	Fully closed dimension table header	Visual aid above the fully closed dimensions in the Calibration menu.
	Fully open dimension table header	Visual aid above the fully open dimensions in the Calibration menu
	Close	Tap this button to close the Gripper in the Calibration wizard.
	Open	Tap this button to open the Gripper in the Calibration wizard.
	Fully closed	Visual aid for entering the fully closed dimension in the Calibration wizard.
	Fully open	Visual aid for entering the fully open dimension in the Calibration wizard.

Icon	Functionality Name	Description
	Continue	Tap this button at the end of the first step of the Calibration wizard in order to go to the next step.
	Finish	Tap this button at the the end of the Calibration wizard to complete the calibration process for the corresponding Gripper.

4.2.3. Gripper Toolbar

The Gripper Toolbar is generally used to test and jog the gripper, meaning it has no effect on the programming of the robot.

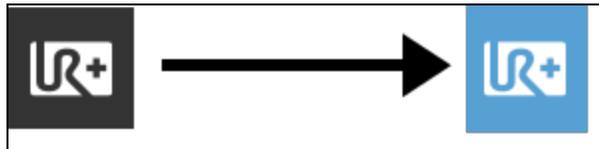
Info

The Gripper URCap package contains the Gripper toolbar. Therefore, the toolbar is automatically installed with the URCap package. The Gripper toolbar can be installed and used without the URCap package (please refer to the **Control** for information on how to install the toolbar and the driver package without the URCap).

Overview

Prior to using the Gripper Toolbar, the user needs to go to the Gripper Dashboard and tick the **Show Gripper Toolbar**. Please refer to the **Control**

Following the proper installation of the Gripper URCap, the user can tap the **UR+** button at the top of the screen to expand the Gripper Toolbar. Please refer to the figure below.



If the user has omitted to tick the Show Gripper Toolbar box in the gripper Dashboard, tapping the UR+ button will display this message:

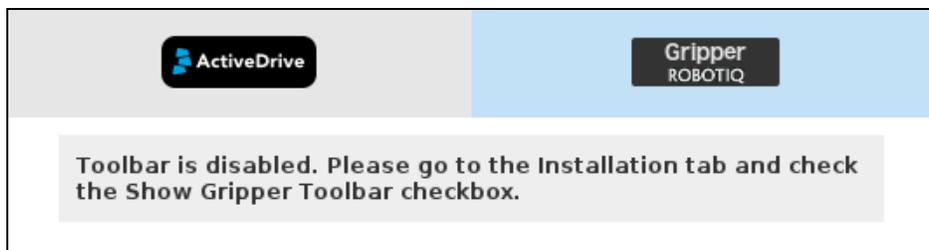


Fig. 4-7: Disabled Gripper Toolbar.

Here is how the Gripper toolbar looks before activating a gripper.



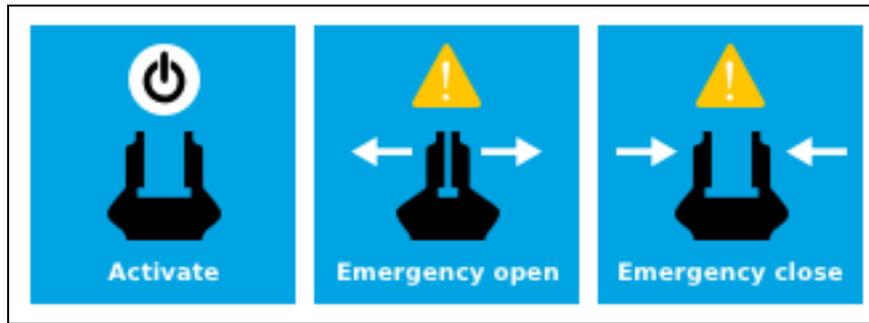


Fig. 4-8: Gripper Toolbar before activation.

Info

The **Emergency open** and **Emergency close** buttons allow the user to open and close the Gripper even if the latter is not activated.

The emergency commands use very low speed and force settings.

- Tap the **Activate** button to enable the Gripper

Single Gripper

Caution

If the Gripper has not been calibrated at this point, the Open and Close values will remain in percentage. Please refer to the **Gripper Calibration menu and wizard** for instructions.

Once the Gripper is activated, the toolbar can be expanded and used to test and jog the Gripper

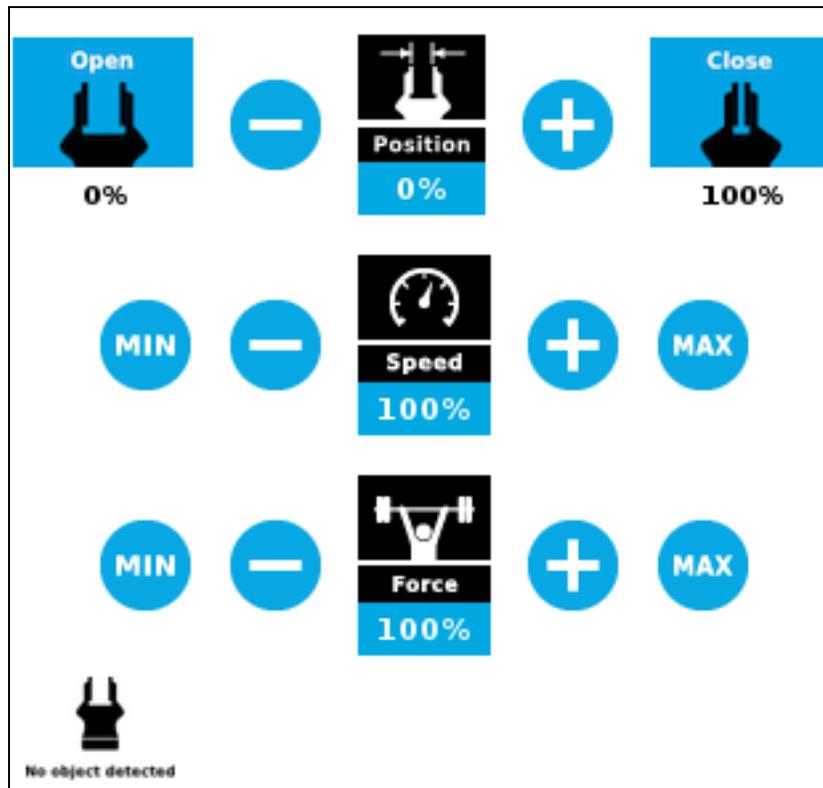
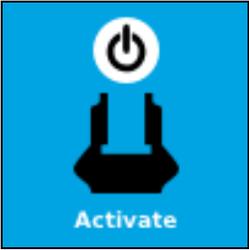
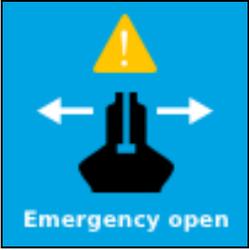


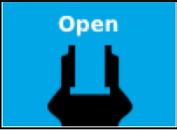
Fig. 4-9: Gripper toolbar after activation.

Features

Gripper activation

Icon	Functionality Name	Description
	Gripper toolbar	Tap to toggle between the expanded and collapsed Gripper toolbar. When greyed out, the functionality is not available.
	UR+ Menu (Gripper Toolbar)	Tap to toggle between the expanded (blue) and collapsed (black) Gripper Toolbar.
	Activate	Tap to activate the Gripper. The Gripper will fully open and close to set the zero of the position value.
	Emergency open	Slowly moves the Gripper to its fully closed position.
	Emergency close	Slowly moves the Gripper to its fully open position.

Gripper operation window

Primary Icon	Functionality Name	Description
	Gripper toolbar	Tap to toggle between expanded and collapsed Gripper toolbar. When greyed out, the functionality is not available.
	UR+ Menu (Gripper Toolbar)	Tap to toggle between the expanded (blue) and collapsed (black) Gripper Toolbar.
	Open	Tap to fully open the Gripper.
	Close	Tap to fully close the Gripper.
	Requested position	Shows the actual position of the Gripper according to the system of units defined in PolyScope (imperial vs. metric). If the Gripper is not calibrated, the values will display in percentage.
	Requested speed	Shows the actual speed set of the Gripper. <ul style="list-style-type: none"> • 0% = minimum speed • 100% = maximum speed
	Requested force	Shows the actual force set of the Gripper: <ul style="list-style-type: none"> • 0% : minimum force, regrasp feature disabled • 1% : minimum force, with regrasp feature enabled • 100% : maximum force, with regrasp feature enabled

Primary Icon	Functionality Name	Description
	Plus	Tap to increase the corresponding parameter.
	Minus	Tap to decrease the corresponding parameter.
	No object detected	Icon shown when no object is detected during a grasp.
	Object detected	The icon shows a green checkmark when an object is detected during a grasp.

4.2.4. Gripper Node

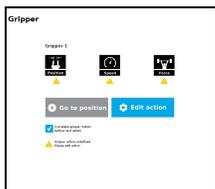
To add and edit a Gripper node inside your robot program, follow the steps below:

- 1 On the teach pendant, at the top of the screen, tap the **New** icon to create a program or the **Open** icon to load a program.
- 2 Select **Program**. The **Program** window will display.
- 3 Tap the **URCaps** menu in the navigation pane on the left.
- 4 Tap the **Gripper** button.
- 5 Select the node in the robot program and tap the **Command** tab.
- 6 Tap the **Edit** action button to edit the node's parameters.

Command window

The Command window shows the requested action parameters for the Gripper node. Depending on the position, speed and force parameters, warning messages may display.

To edit the Gripper node, tap **Edit action** (please refer to the **Edit action screen** for more details).

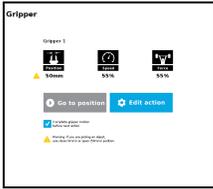


When the node is not defined, the Command window shows warning messages. Tap **Edit action** to modify the Gripper's action.

Caution

Tap the **Go to position** button prior to editing the action. Whereas the command window displays the command that the Gripper should execute in this particular node, the Edit action screen displays the current Gripper position.





When the node requests the Gripper to close/open, the Command window warns that a partial opening/closing should not be performed for picking an object.

- For positioning and partial movement of the hand, moving to a specific position (between the fully open and fully close positions) is suitable.
- To pick an object, use the close (or open) actions along with the object detection feature (please refer to the **Edit action screen**).

Info

When the action is set for multiple Grippers, the header lists the selected Grippers (e.g. Grippers 1,2,3,4)



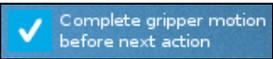
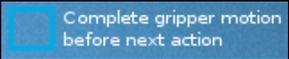
When the Gripper action is set to **close**, a green "Close" icon appears.

When the Gripper action is set to **open**, a green "Open" icon appears.

Features

Icon	Functionality Name	Description
	Requested position	Shows the position requested for the current Gripper node. Read only.
	Requested speed	Shows the speed requested for the selected Gripper node. Read only.
	Requested force	Shows the force requested for the selected Gripper node. Read only.
	Go to position	Sends all node parameters (position, force, speed) to the Gripper. Note: This button is disabled (grey) when the Gripper is already at the node position or when the Gripper is not powered/activated.
	Edit action	Opens the Edit action screen, where you can edit the Gripper's action parameters.



Icon	Functionality Name	Description
	Complete motion	<p>Selected by default.</p> <p>Selected: The Gripper completes its motion before executing the next action on the PolyScope program tree. This is slower but safer.</p>
	Do not complete motion	<p>Selected by default.</p> <p>Unselected: As soon as the Gripper starts moving, PolyScope will execute the next action on the program tree. This allows you to move the Gripper and robot at the same time.</p>
	Warning message section	
	Gripper not activated	<p>“ Warning, the Gripper is not powered or not activated. The Gripper will not move.”</p> <p>Make sure that the Gripper is installed correctly and powered. You need to activate it using the Gripper toolbar before running Gripper commands.</p>
	Gripper action undefined	<p>“ Gripper action undefined! Please edit action.”</p> <p>When creating a new node, all action parameters are undefined. Tap the edit action button to define parameters.</p>
	Object picking warning	<p>“ Warning, if you are picking an object, use close (100%) or open (0%) position.”</p> <p>It is highly recommended to only use 0% or 100% position when trying to pick an object.</p>
	Node name	<p>Node name is automatically set to:</p> <ul style="list-style-type: none"> • Gripper Open, when position = 0% or fully open value as defined in the Calibration wizard • Gripper Close, when position = 100% or fully closed value as defined in the Calibration wizard. • Gripper Move x%/mm/in, when position is between the fully open and fully closed values.
	Open request	When position requested is 0%, or the fully opened value defined in the Calibration wizard.
	Close request	When position request is 100%.

Edit action screen

Tap **Edit action** from the Command window and use the Edit action screen to edit the Gripper's parameters and adjust its position, speed and force. In normal usage conditions, the Gripper will move as soon as you change the position setting. The Gripper will not move if it is not properly powered, connected and activated.

Caution

The Gripper needs to be activated before it can receive a command. To do so, use the `rq_activate_and_wait()` function script at the beginning of the program or activate with the Gripper toolbar. Starting from Gripper URCap version 1.0.2, the gripper activation script command (`rq_activate()` or `rq_activate_and_wait()`) must be preceded by the reset command (`rq_reset()`). This will force the gripper's activation routine. Thus, if the gripper was already activated, it will activate again.

Single Gripper

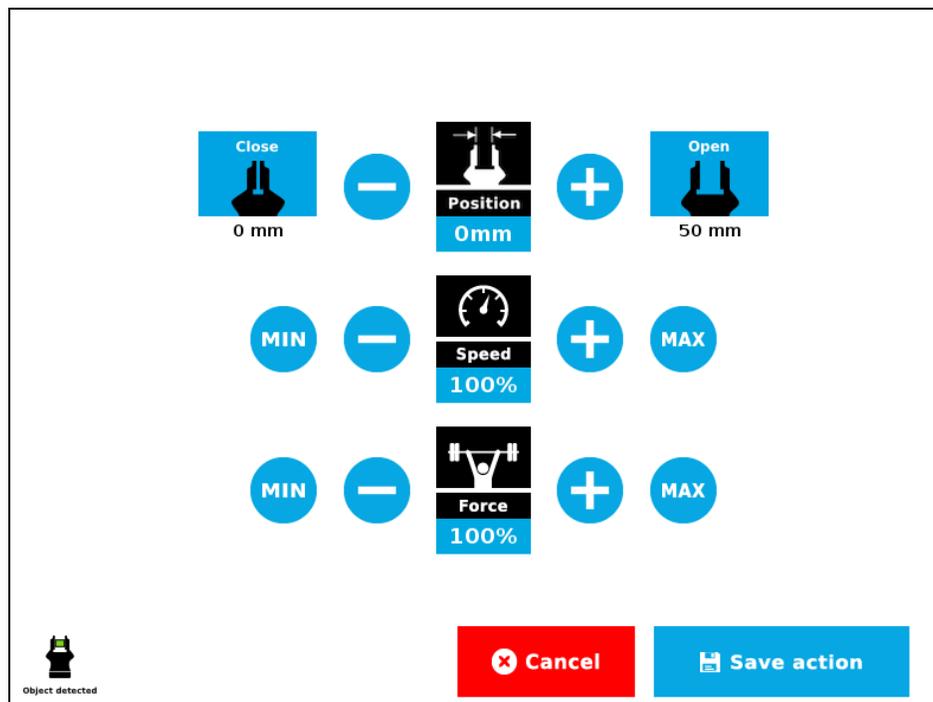
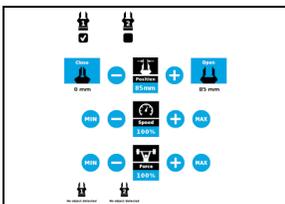
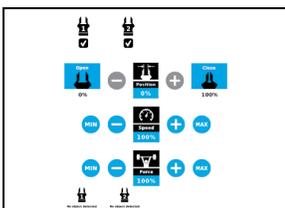


Fig. 4-10: Edit action screen

Multiple Grippers

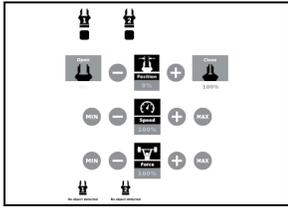


- When selecting one gripper, all buttons are available. The action will apply to the selected gripper.
- When jogging the position, the selected gripper will move automatically.
- It is possible to jog the position (%).



- When selecting two or more grippers, it is not possible to jog the position.
- To jog the position, select only one gripper, jog the position and then select all grippers. The second gripper will move to the requested position.





- When no grippers are selected, the action cannot be edited.

Features

Primary Icon	Functionality Name	Description
	Open	Tap to fully open the Gripper. Use this when you want to grip an object (internal grip), for example.
	Close	Tap to fully close the Gripper. Use this when you want to grip an object (external grip), for example.
	Requested position	Shows the position request for the selected Gripper node.
	Requested speed	Shows the speed requested for the selected Gripper node. Use the Plus and Minus icons to modify.
	Requested force	Shows the force requested for the selected Gripper node. Use the Plus and Minus icons to modify.
	Plus	Tap to increase the corresponding parameter.
	Minus	Tap to decrease the corresponding parameter.
	Cancel	Cancels modifications and brings back the Gripper node command screen.
	Save action	Saves settings into the selected Gripper node and brings back the Gripper node command screen. Note: This functionality is not available (grey) when the Gripper has the same



Primary Icon	Functionality Name	Description
		action parameters as the selected Gripper node.
	No object detected	Icon shown when no object is detected during a grasp.
	Object detected	Icon shows a green checkmark when an object is detected during a grasp.

Warning

If the Gripper is powered and activated, it will move as soon as a change to the parameter is made (position, speed, force).

Tip

Change speed and force when grasping fragile objects or other specific parts. In all other cases, it is recommended to use maximum speed and force.

Grip Check node

In order to add and edit a Grip Check node:

- 1 On the teach pendant, at the top of the screen, tap the **New** icon to create a program or the **Open** icon to load a program.
- 2 Select **Program**. The Program window will display.
- 3 Tap the **URCaps** menu in the navigation pane on the left.
- 4 Tap the **Grip Check** button.
- 5 Select the node in the robot program to edit it.

The Grip Check node is pre-packaged as an If statement that prompts the user to select between if the object *is* detected and if the object *is not* detected.

Selecting the former option allows the user to check a box and choose whether or not the grasp should be validated according to the object's dimension (in percentage if the Gripper is not calibrated, or in mm/in if the Gripper is calibrated—depending on the PolyScope configuration).

Grip Check

Gripper ID 1
Check if object is...

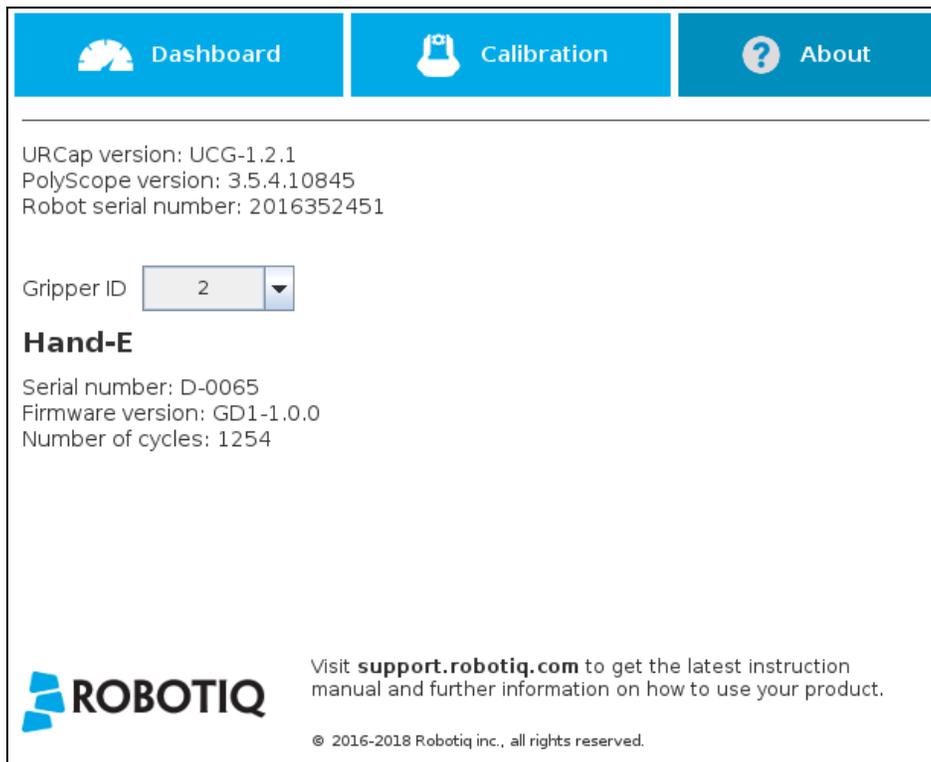
Detected Not detected

and...

Validate grip with dimension

Fig. 4-11: Grip Check node interface





Error messages overview

If a program is running without the Gripper being activated, the program will stop at the execution of a Gripper node and the following message will be displayed in a popup. Tap **Stop Program** and activate the gripper with the toolbar to continue or add an activation command in the program (please refer to the **Control**).



Caution

Starting from Gripper URCap version 1.0.2, the Gripper activation command (`rq_activate()` or `rq_activate_and_wait()`) must be preceded by the reset command (`rq_reset()`). This will force the gripper's activation routine. Thus, if the gripper was already activated, it will activate again.

Gripper Program Template

A program template is bundled with the gripper URCap when installing it. You can find this template in the program folder of PolyScope. It contains comments and pop up windows that explain gripper nodes and advanced functions.

Load and open the gripper_tutorial.urp program located in the root program folder. Make sure the Gripper is well connected to the UR controller. Run the program. You will see pop up windows with comments on the Gripper nodes and advanced functions.



Tip

Use the `gripper_tutorial.urp` to learn how to program the Gripper using nodes and advanced functions. You can copy the tutorial and start a new program based on it.



5. Machine Tending Copilot Functionalities

The following table shows which Copilot functionalities are bundled in the Machine Tending Copilot. The letter "X" indicates that a functionality is available to the license type shown in the table header.

Nodes/Features	CB-Series Universal Robots	e-Series Universal Robots		
	License Type			
	FT 300 Force Torque Sensor	Force Copilot	Machine Tending Copilot	Finishing Copilot
Collision Detection	X	X	X	X
Find Surface	X	X	X	X
Finishing Tool Control	X			X
Force Event	X	X	X	X
Force Control	X	X	X	X
Insertion node	X	X	X	X
Find Contact Offset	X		X	X
Apply Contact Offset	X		X	X
Path Generator	X			X
Multipoint Path	X	X	X	X
Multipoint Path (with External TCP option)	X			X
Path	X	X	X	X
Path (with External TCP option)	X			X



Zero FT Sensor	X	X	X	X
Active Drive	X	X	X	X

Table 5-1: Available Copilot Nodes and capabilities, per license.

Two Copilot nodes are introduced with the Machine Tending Copilot:

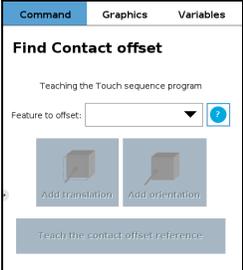
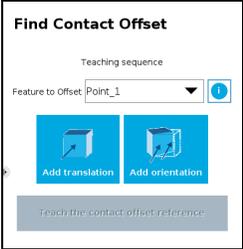
- Find Contact Offset
- Apply Contact Offset

The Find Contact Offset and Apply Contact Offset nodes integrate the Multipoint Path and Find Surface nodes as part of Touch sequences. The current Instruction Manual first introduces these nodes that are instrumental to machine tending applications. Other Copilot nodes are described following this.



5.1 Find Contact Offset

When using Contact Offset capabilities, run this node before the Apply Contact Offset node. This node finds by how much a reference feature has been offset, and stores this value, which will be used by the Apply Contact Offset node.

	<ol style="list-style-type: none"> 1. Go to the Installation tab > Features > Point. 2. Create a Feature Point, then tap " Set Point" . <div style="border: 1px solid yellow; padding: 10px; margin-top: 10px;"> <p>Caution</p> <p>The feature point can be located anywhere, as long as its coordinates remain within the robot reach at all times.</p> </div>
	<ol style="list-style-type: none"> 3. Insert a Find Contact Offset node. 4. Tap Teach the Touch sequence program.
	<ol style="list-style-type: none"> 5. From the " Feature to offset" dropdown list, select the feature point you previously created. For more information, select the help button.
	<ol style="list-style-type: none"> 6. Select Add translation or Add orientation to determine by how much the feature has been offset. 7. For more details, see sections Add translation and Add orientation.

Tip

Reduce cycle time by inserting a Find Contact Offset node in the " BeforeStart" section of the robot program, or alternatively, as a sub-program. This strategy will reduce the frequency at which Find Contact Offset nodes are run in the course of your robot program.



5.11 Add translation



Fig. 5-1: Select this button to insert a Translation node.



Fig. 5-2: The Translation node.

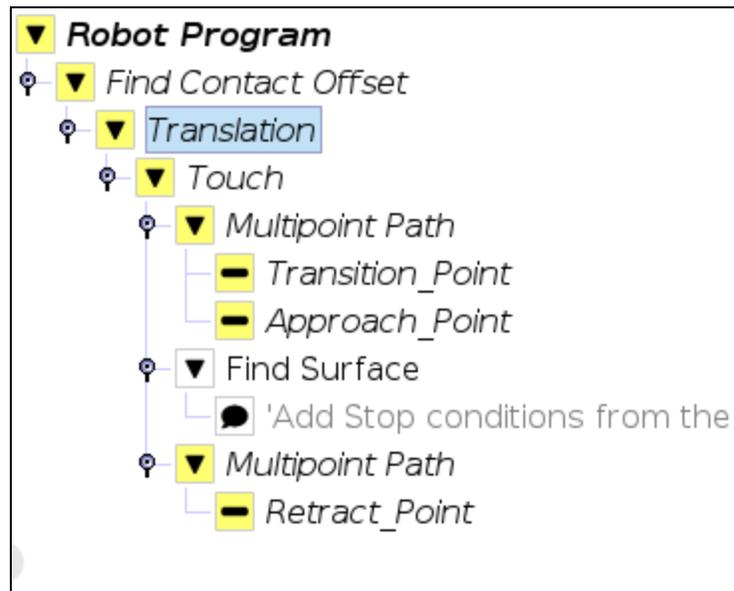


Fig. 5-3: Add Translation program tree.

Follow these steps to setup a Translation node.

1. Select the Touch node from the program tree for detailed instructions.

Touch

Touch sequence:

- 1 Bring the robot to a Transition position.
- 2 Bring the robot to an Approach position.
- 3 Use the Find Surface node.
- 4 Bring the robot to a Retract position.

Moves under the Touch node must have their path relative to the feature you want to offset.

2. Tap Transition_Point from the Robot Program, move the robot to the required position, and select Set waypoint.

Info

Transition Point: feature point used to move between waypoints without colliding with the object.

3. Repeat for Approach_Point.
4. Setup the Find Surface node. For more details, see section **Find Surface**
5. Tap Retract_Point from the Robot Program, move the robot to the required position, and select Set waypoint.
6. Tap **Teach the contact offset reference**.
7. The following window is displayed.

Saving original touch position
X

Are you satisfied with the touch sequence and ready to save it as the reference position?

No

Yes

8. Select Yes to save the offset value as the reference position, which can then be used for programs under the Apply Contact Offset node. Select No if you want to set up different waypoints for the Touch sequence.
9. Proceed by inserting an Apply Contact Offset node.

Info

The offset value is stored under the Universal RobotsInstallation tab. As such, this value can be reused either in the same robot program where it was first calculated, or in a different robot program altogether.



5.12. Add orientation



Fig. 5-4: Select this button to insert an Orientation node.

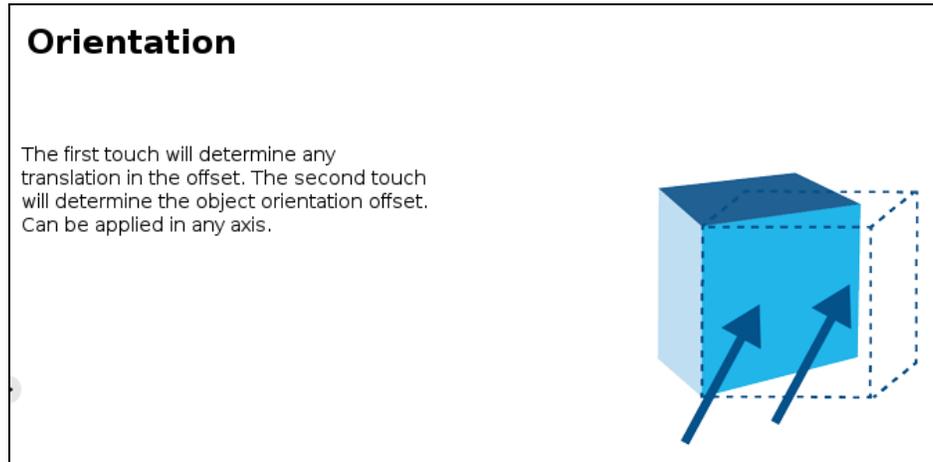


Fig. 5-5: The Orientation node.

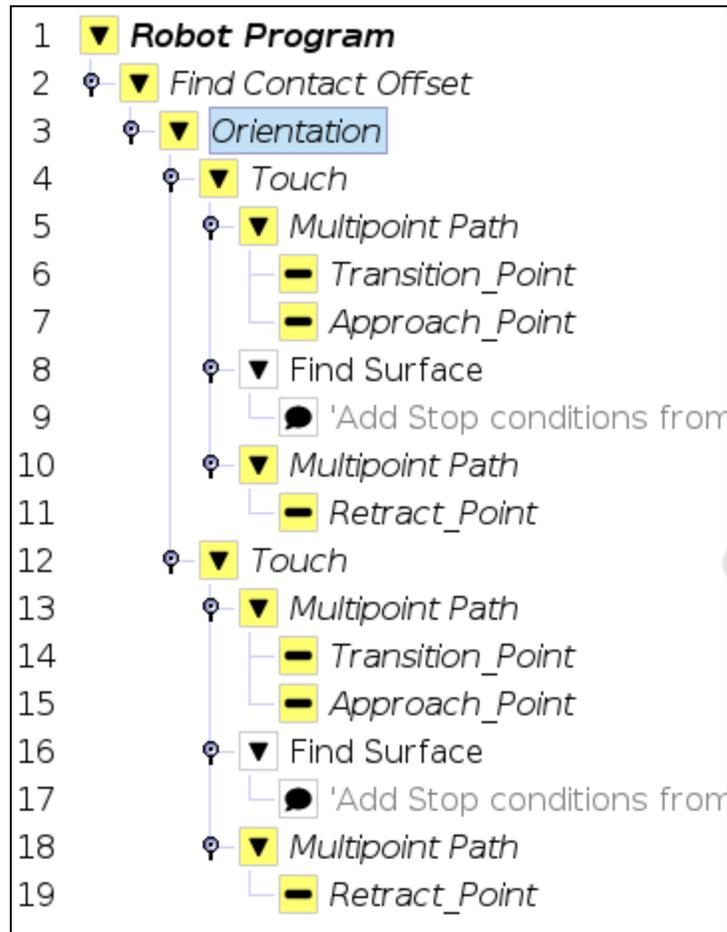


Fig. 5-6: Add Orientation program tree.

The Orientation node can be set up in the same way as a Translation node. However, the Orientation node contains two Touch nodes. Configure each node as described in section **Add translation**. The two offset values will be used to calculate a rotation angle.

5.2. Apply Contact Offset

Insert an Apply Contact Offset node, then select a feature to offset. This feature must be the same as the one used by the Find Contact Offset node you previously executed.

Apply Contact Offset

Apply the last Contact Offset calculated from any other Robot Program using the same Installation file.

Select Feature to Offset

Apply Contact Offset

Apply the last Contact Offset calculated from any other Robot Program using the same Installation file.

Select Feature to Offset



Children nodes are safe to modify and moves relatives to this feature will move to the expected positions.

UR Actual Feature position
=
last calculated feature position based on touch program execution

- When you select a feature point to offset and a green checkmark is shown, this means that moves will be executed according to the offset value of the Apply Contact Offset node.
- Create your robot program with children nodes inserted under the Apply Contact Offset node.

Tip

Nodes must be inserted under the Apply Contact Offset node to be affected by the offset value.

5.3. Multipoint Path

The Multipoint Path node is an advanced version of the Path node, combining complex trajectory recording and point-to-point teaching, with the option to define each segment as a line or as a curve.



5.3.1 Adding a Multipoint Path Node

1. On the Teach Pendant, tap New to create a program or Open to load a program.
2. From the left navigation pane, tap URCaps > Multipoint Path.
3. Tap the Multipoint Path node in the Robot Program to edit it.

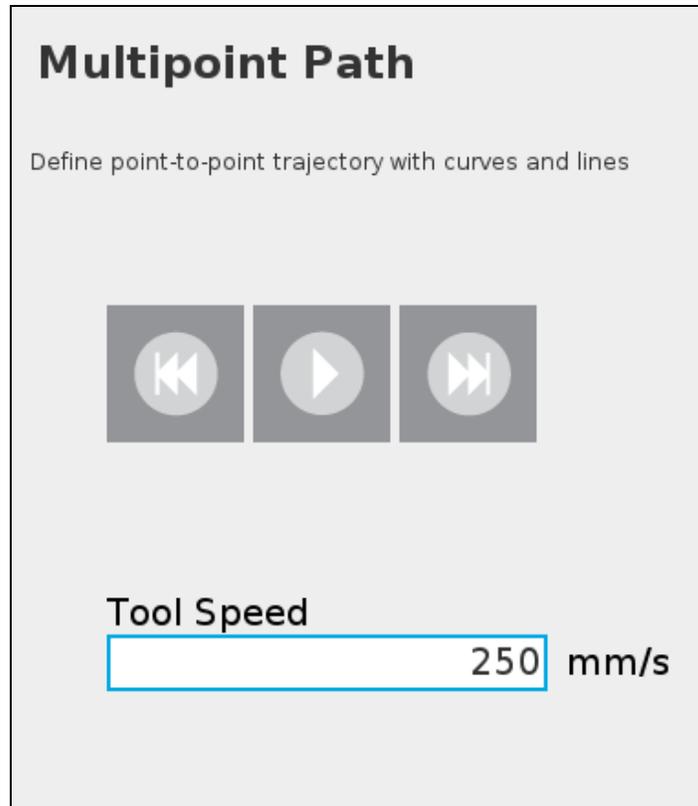


Fig. 5-7: Multipoint Path node (empty).

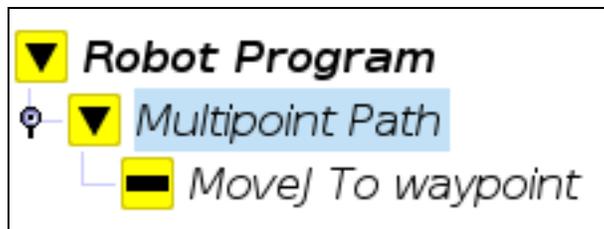


Fig. 5-8: A Multipoint Path parent node is always followed by a MoveJ command leading to the initial waypoint of the path sequence.

5.3.2. Setting Up a Multipoint Path

Creating the Initial Waypoint

1. In the Robot Program tree, select MoveJ To waypoint, as shown in **Fig. 5-8**.
2. A menu is displayed in the Command tab.
3. Using the Freedrive mode or the Universal Robots Move menu, move the robot arm to starting point of your Multipoint Path.
4. Tap Set waypoint. The UR waypoint interface will pop up and ask you to define the waypoint.
5. Adjust the position as required, then press OK.
6. Tap Edit waypoint (see 1) to open the UR waypoint interface, and adjust the robot position. This affects all waypoints of the Multipoint Path.

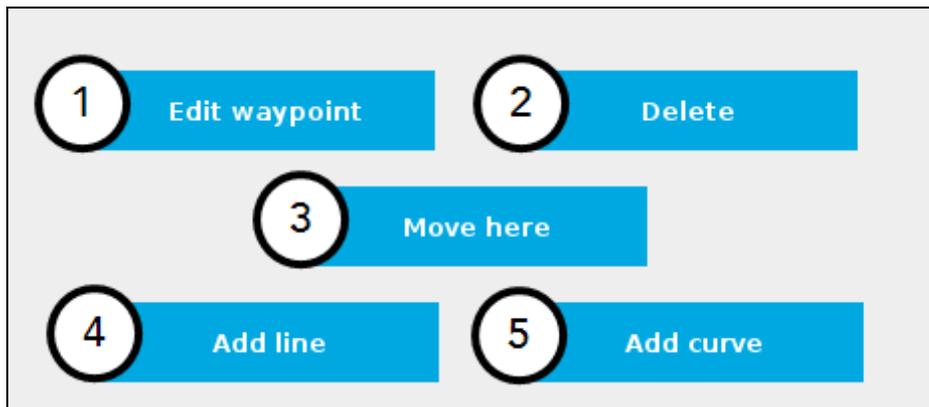


Fig. 5-9: Available options when setting up a Multipoint Path.

7. Tap Delete (see 2) to delete the waypoint. Deleting the starting waypoint unassigns it.
8. Tap and hold Move here (see 3) to move the robot to a waypoint.
9. Tap Add line (see 4) to link current waypoint to the next waypoint via a straight line.
10. Tap Add curve (see 5) to link current waypoint to the next waypoint via a curve.

Important

Although paths can be made of straight lines, curves or a mix of both, they move from waypoint to waypoint, as set by the user.

Important

Curves are not generated and/or represented according to a spline model; they are rather based on **Bézier curves**.

Info

For describing the continuity of the curves used in the Multipoint Path node, control points are generated on the bisector of each waypoint junction (angle). Curves are therefore tangent to those bisectors.

Creating More Waypoints

1. Using the Freedrive mode or the Universal Robots Move menu, move to the next position.
2. To add a waypoint to the program tree, tap Add line or Add curve.



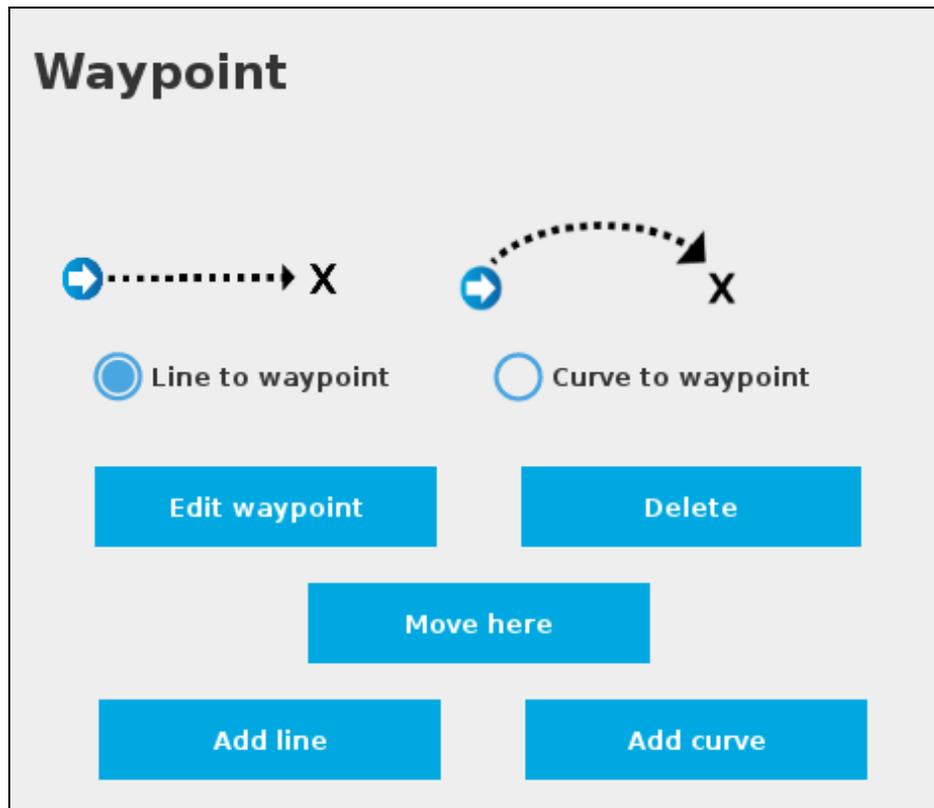


Fig. 5-10: Multipoint Path interface to add a Line or a Curve waypoint.

Caution

Adding several waypoints (lines or curves) without moving the robot between each, generates identical waypoints. Fix this by editing each created waypoint, and adjust its position.

Tip

You can toggle at any time between the Line to waypoint and Curve to waypoint options. Select the waypoint in the program tree, and tap the appropriate radio button in the Command tab.

Repeat this step until you complete your Multipoint Path.

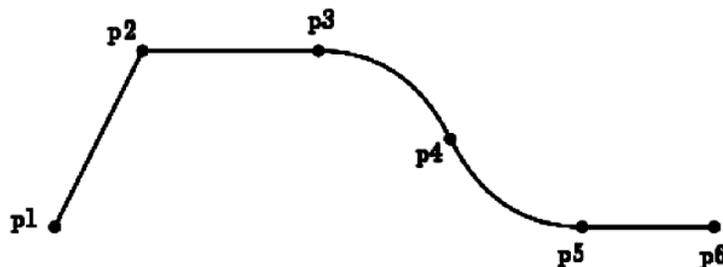


Fig. 5-11: Representation of a six-waypoint Multipoint Path that combines curves and straight lines.



5.4. Find Surface

Force Copilot includes the Find Surface node, which is a great tool for machine tending and various other applications that require repeated, accurate positioning of objects.

The default parameters of the function allow for a versatile demo or a quick test of the features while the advanced parameters make it a more customizable asset.

5.4.1 Adding a Find Surface Node

1. On the Teach Pendant, tap New to create a program or the Open button to load a program
2. Tap the URcaps button in the left navigation pane.
3. Tap Find Surface.
4. Tap the Find Surface node in the robot program to edit it.

Find Surface

Use the Force Torque Sensor's data to detect a surface during a robot motion in a given tool axis.

Motion

Direction relative to the tool (A) 1 Z+ ▼

2 Zero Sensor Before Execution

3 Advanced parameters

Motion speed 4 mm/s

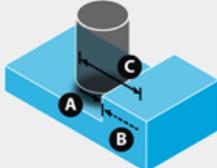
Stop condition

Maximum distance traveled (C) 6 mm

5 Insert a program instruction if this condition occurs.

Force threshold (B) 8 N

7 Insert a program instruction if this condition occurs.



- 1 Direction relative to the tool** dropdown menu: Menu used to select the direction of the linear motion, relative to the tool
- 2 Zero Sensor Before Execution** box: Box that inserts a Zero FT Sensor command right before the Find Surface instructions
- 3 Advanced parameters** box: Box that expands the advanced parameters menu when ticked
- 4 Motion speed** parameter: Textbox for the user to enter a speed value for the approach motion towards the destination
- 5 Maximum distance traveled** (Stop condition): Textbox for the user to enter the maximum distance value which, upon being reached, means the force threshold has never been reached in the linear motion
- 6 Insert instruction textbox**: Checkbox that inserts the corresponding stop condition in the robot program when ticked; its main function is to facilitate the programming and improve the user experience
- 7 Force threshold** (Stop condition): Textbox for the user to enter a force threshold value that completes the linear motion
- 8 Insert instruction textbox**: Checkbox that inserts the corresponding stop condition in the robot program when ticked; its main function is to facilitate the programming and improve the user experience



Parameter	Unit of measurement	Default value
Direction relative to the tool	N/A	Z+
Motion speed	mm/s	5
Maximum distance traveled (Stop condition)	mm	100
Force threshold (Stop condition)	N	10

Find Surface

Use the Force Torque Sensor's data to detect a surface during a robot motion in a given tool axis.

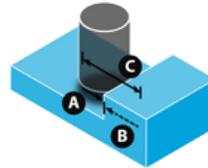
Motion

Direction relative to the tool (A)

Zero Sensor Before Execution

Advanced parameters

Motion speed mm/s



Stop condition

Maximum distance traveled (C) mm

Insert a program instruction if this condition occurs.

Force threshold (B) N

Insert a program instruction if this condition occurs.

Find Surface

Use the Force Torque Sensor's data to detect a surface during a robot motion in a given tool axis.

Motion

Direction relative to the tool (A)

Zero Sensor Before Execution

Advanced parameters

Motion speed mm/s

Stop condition

Maximum distance traveled (C) mm

Insert a program instruction if this condition occurs.

Force threshold (B) N

Insert a program instruction if this condition occurs.

Fig. 5-12: This Find Surface node includes stop condition(s).



5.5. ActiveDrive Toolbar

The ActiveDrive Toolbar is automatically installed with the Force CopilotURCap. It enhances the guiding mode on Universal Robots by allowing the robot to be hand-guided smoothly and easily towards a waypoint. The ActiveDrive feature is a great way to assist the Path recording described in the **Path Recording**, by hand-guiding the robot while recording a path.

Info

The Force CopilotURCap contains the ActiveDrive Toolbar. Therefore, the toolbar is automatically installed with the URCap Package.

The robot speed set with the Speed slider will affect the speed at which the robot moves in the ActiveDrive mode. Verify and adjust the speed slider to the desired speed. It has to be greater than 50%.

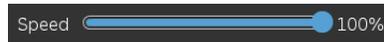


Fig. 5-13: The speed slider.

5.5.1 Overview

Toolbar collapsed

Tap  to expand the toolbars menu.

Tap  to expand the ActiveDrive mode selector toolbar.

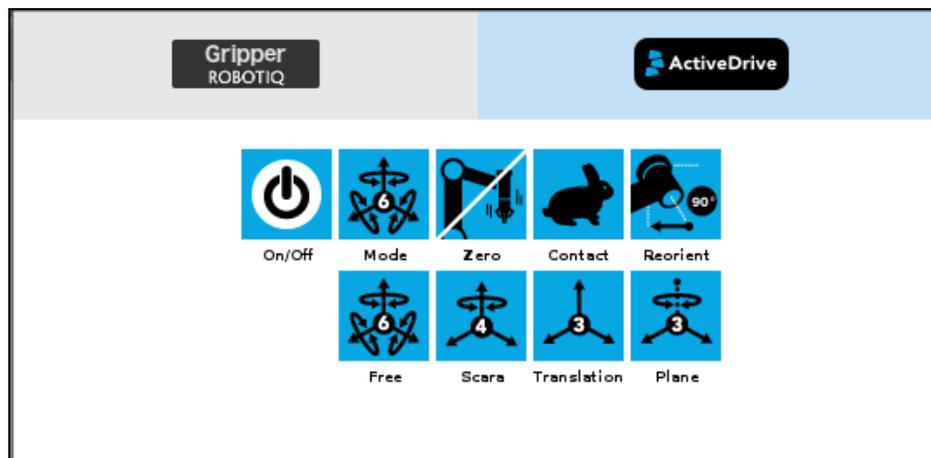


Fig. 5-14: Select an ActiveDrive mode.



5.5.2. Features

Primary icon	Functionality name	Description
	ActiveDrive	Tap to toggle between the expanded and collapsed ActiveDrive Toolbar. When grey, the functionality is not available. Tap the button to see why it is not available.
	Start / Stop	Tap to start or stop ActiveDrive. ActiveDrive will automatically turn off after 30s of inactivity. When started, ActiveDrive allows you to move the robot freely by applying forces on robot's end-effector. This is different from the Free Drive feature on the robot, where you can move the robot arm.
	Modes	Shows the current ActiveDrive mode. When tapping the icon, the available modes will appear and you can change to a different mode. ActiveDrive modes allow you to restrain the robot to specific movements.
	Free	Free motion: all translations and rotations are allowed.
	Scara	SCARA-style motion: all translations and horizontal rotation (twist) are allowed.

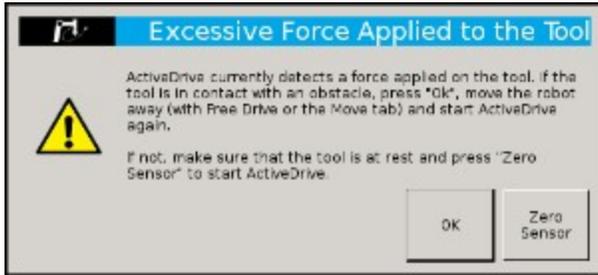
Primary icon	Functionality name	Description
	Translation	Translation motion: only translations are allowed. No rotation of the robot is possible in this mode.
	Plane	Plane motion: horizontal translations and horizontal rotations (twist) are allowed (no vertical motions are allowed).
	Drift Control	Tap this button to stop the robot from drifting (resets the sensor's offset).
	Speed	Motion speed control is toggled between fast and slow, allowing precise movement in slow motion. The force torque sensor will switch to slow speed automatically whenever high forces are detected, for example, during an impact with an object.
	Square robot	Aligns the tool center point (TCP) orientation with the robot base. Tap and hold this button to automatically move the end-effector to the closest orthogonal orientation of the base axis system.



5.5.3. Error Messages Overview

The ActiveDrive Toolbar will be automatically collapsed and be grayed whenever one of the following situations occurs. In such cases, by tapping the ActiveDrive button, the following messages will appear:

- Message:



- Solution:

- Starting ActiveDrive while an excessive force is applied to the tool:
 - Determine if an external force is applied to the end-effector. If it is the case, tap **OK** and move the robot away from the obstacle (with Free Drive or Move tab), or remove any external forces and start ActiveDrive again.
 - If no external forces are applied, tap **Zero Sensor**.

- Message:



- Solution:

- The robot is not initialized: Tap **OK** and go to PolyScope home page. Tap **Setup Robot** and go to **Initialize Robot** to start the robot.

- Message:



- Solution:

- A program is already running: The ActiveDrive Toolbar cannot be used while a program is running. Stop the program to enable the ActiveDrive feature.

- Message:



- Solution:

- The speed setting of the robot is lower than 50%: The robot's speed setting should be greater than 50%. Modify the speed setting in the robot program using the slider.



- Message:



- Solution:

- If the Freedrive button is pressed: The ActiveDrive mode cannot be used when the Free Drive mode is ON. Make sure you are not pressing on the teach pendant's Teach button when trying to use the ActiveDrive toolbar.

5.5.4. Using Force and Torque Values

Force Torque Sensor functions are made available in the Universal Robots functions drop-down menu.

- The `rq_zero_sensor()` function can be called at any point in a robot program to zero the force and torque values of the Force Torque Sensor.
- The `get_sensor_Fx()`, `get_sensor_Fy()`, `get_sensor_Fz()`, `get_sensor_Mx()`, `get_sensor_My()`, `get_sensor_Mz()` functions allow the user to assign the sensor values to any variable.
- The `get_applied_tcp_force(<index>)` function returns the current wrench (force and torque vector) value currently applied at the tool center point (TCP).
- The `get_applied_base_force(<index>)` function returns the current wrench (force and torque vector) value applied at the robot arm base.
- The `express_force_in_frame(<T_from_to>,<wrench_from>)` function is used to convert the wrench (force and torque vector) reading in a given reference frame into another (end-effector to robot base, and vice-versa, for example).
 - `T_from_to` = relative pose of the reference frame into which the wrench reading is converted
 - `wrench_from` = wrench to transform in pose or list format (Fx, Fy, Fz, Mx, My, Mz)



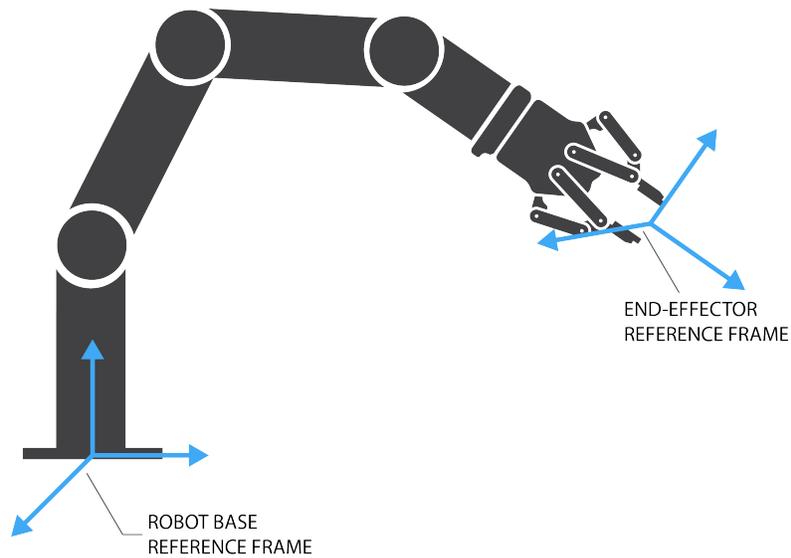


Fig. 5-15: Example of two reference frames for the `express_force_in_frame(<T_from_to>,<wrench_from>)` function

Info

Although displayed in realtime in the Variables tab, the force and torque values are also displayed in the Force Copilot dashboard.

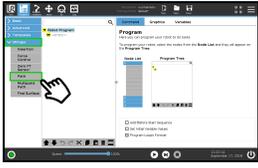
Force Values		Moment Values	
Fx =	-0.6 N	Mx =	0.00 Nm
Fy =	-2.2 N	My =	-0.06 Nm
Fz =	-1.3 N	Mz =	0.06 Nm

Fig. 5-16: The Force Copilot dashboard displays force and torque values in real time.

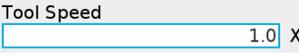
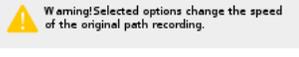
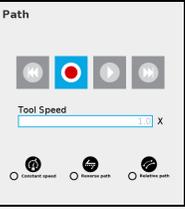
5.6. Path Recording

The Force CopilotURCap adds a Pathnode in PolyScope which can be used to record paths directly by moving the robot. The ActiveDrive Toolbar is a great tool to use while recording a path, as it is an easy way to hand guide the robot end-effector. Path recording can be used for specific processes requiring complex paths (polishing, gluing, etc.) or more generally, for any task otherwise requiring programming many waypoints. The Path node offers options to modify the recorded path to change its speed and play the path backwards or relative to a variable starting position.

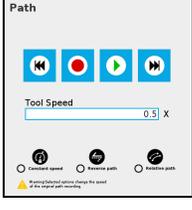
How to add and record a path

	<ul style="list-style-type: none"> In the ribbon at the top of the PolyScope interface, tap the New button to create a program or tap the Open button to load an existing program.
	<ul style="list-style-type: none"> Select the URCaps menu. Tap the Path button.

5.6.1 Overview

Primary Icon	Description
	Path recording and visualization.
	Path speed box.
	Path options.
	Warning section. Displayed whenever a setting results in a duration different than the original path duration.
	When a Path node is empty (no path recorded), the only available button is the record button.



 <p>The screenshot shows the 'Path' control panel with four buttons: Stop (red square), Play (green triangle), Previous (left double arrow), and Next (right double arrow). The 'Tool Speed' slider is set to 1.0 X. Below the slider are three radio buttons: 'Constant speed', 'Reverse path', and 'Reverse path'.</p>	<p>While recording a path, the only available button is the Stop button.</p>
 <p>The screenshot shows the 'Path' control panel with the 'Play' button highlighted in green. The 'Tool Speed' slider is set to 0.5 X. A warning message is displayed at the bottom: 'Warning! When you change the speed the speed will be updated.' Below the slider are three radio buttons: 'Constant speed', 'Reverse path', and 'Reverse path'.</p>	<p>When the speed of the original recording is modified using the speed slider, a warning message appears and the path time and speed information is updated.</p>

5.6.2. Features

Primary icon	Description
 	<p>Starts and stops the path recording.</p>
	<p>Press and hold in order to move the robot at the path's start.</p>
	<p>Press and hold in order to move the robot at the path's end.</p>
	<p>Press and hold to move the robot to starting point, and play the path as run in the program.</p>

Primary icon	Description
 Constant speed	If selected, the path is modified to play at a constant tool speed (linear speed at the tool center point). With this option, all pauses and hesitations (dead times) in the path will be removed.
 Reverse path	If selected, the recorded path will be played backwards in the program. It can be useful if a path is copied and played backwards, resulting in a path played back and forth.
 Relative path	If selected, the path will be played relative to the current robot position when the program enters the path instruction. This effectively offsets all the recorded path.
	Displayed whenever a setting results in a duration different than the original path duration.

Note

Buttons which are greyed out cannot be selected.

If you tap  when a path is already recorded in a node, you will be prompted to overwrite the path. Tap **OK**, or keep the previously recorded path by tapping **Cancel**.

5.7. Insertion Node

The Force CopilotURCap includes Insertion nodes, which can be used to perform spiral, rotational and linear movements to insert objects in holes or bores, or to make contact with a surface. It is an essential integration resource for streamlining robot programs in the framework of precise assembly applications.

When the task is performed by a human operator, the operator's fingers provide valuable feedback through the sense of touch, thus allowing the human to detect any resistance when trying to insert a pin in a hole, for instance. To a certain extent, Force Copilot gives that kind of sensitivity to the end-effector.

5.7.1. Adding an Insertion Node

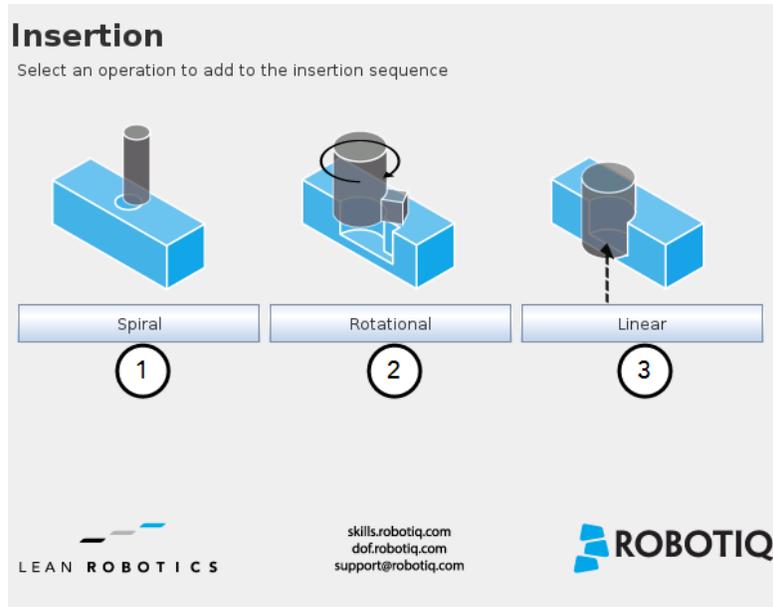
- On the Teach Pendant, tap the **New** button to create a program or the **Open** button to load a program.
- Tap the **URCaps** button in the navigation pane on the left.
- Select **Insertion**.
- Tap the **Insertion** node in the robot program to edit it.

Info

The parent **Insertion** node is automatically followed by a **Zero Sensor** child node.



5.7.2. Insertion Children Nodes



- 1 **Spiral** button to insert a **Spiral** child node
- 2 **Rotational** button to insert a **Rotational** child node
- 3 **Linear** button to insert a **Linear** child node

Spiral

Following a contact established between the object grasped by the end effector (or the end effector itself) and the corresponding mating part or surface, a spiral motion is engaged on a specific plane to find the path of least resistance according to the direction, speed, force, radius increment per turn and maximum radius parameters set by the user.

Rotational

Following a contact established between the object grasped by the end-effector (or the effector itself) and the corresponding mating part or surface, a rotational motion is engaged on a specific plane to find the path of least resistance, according to the direction, speed, force, maximum torque and maximum rotation angle parameters set by the user.

Linear

Following the successful spiral, rotational or fortuitous location of a mating hole or bore, a linear motion is engaged at a certain speed until the force threshold or maximum travel distance is reached.

Spiral Insertion

The Spiral child node is packaged with an **On error** condition line to be populated with a program instruction when/if the error condition occurs. The potential sequence after the Spiral instruction is followed by a program halt, by default.



Spiral

Function used to insert an object in a hole and to perform a spiral search if an obstacle is found.

Motion

Destination (A) 1

Direction (B) 2 3

Advanced parameters

4 **Speed (C)** mm/s 5

Force initiating spiral move (D) N 6

Force initiating insertion (G) N 7

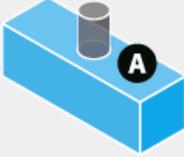
Radius increment per turn (E) mm 8

Enable peck mode

9 **Tool retraction between points of contact**

Error condition

Maximum radius (F) mm 10



- 1 **Teach position** button (Destination): Tapping this button saves the object's destination as a waypoint in the robot program
- 2 **Reference frame** dropdown menu (Direction): Menu used to select the frame according to which the tool will move in space
- 3 **Axis** dropdown menu (Direction): Menu used to select the direction in which the tool will go to reach the destination
- 4 **Advanced parameters** box: Box that expands the advanced parameters menu when ticked
- 5 **Speed** parameter: Textbox for the user to enter a speed value
- 6 **Force initiating spiral move** parameter: Textbox for the user to enter a force threshold value that triggers the spiral move, after the part/tool has established contact with the mating part/surface
- 7 **Force initiating insertion** parameter: Textbox for the user to enter a force drop value indicating that the part/tool has found the path of least resistance, prior to completing the insertion process
- 8 **Radius increment per turn** parameter: Textbox for the user to enter the distance between each spiral turn on the spiral radius
- 9 **Enable peck mode** box: Box that enables the retraction of the tool between points of contact
- 10 **Maximum radius** (Error condition): Textbox for the user to enter the maximum radius of the spiral, considering that no path of least resistance has been found

Parameter	Unit of measurement	Default value
Reference frame (Direction)	N/A	Tool
Axis (Direction)	N/A	Z+
Speed	mm/s	5
Force initiating spiral move	N	10
Force initiating insertion	N	3



Parameter	Unit of measurement	Default value
Radius increment per turn	mm	0.7
Maximum radius (Error condition)	mm	5

Table 5-2: Default values and units of measurement.

Rotational Insertion

Rotational

Function used to insert an object in a hole and to rotate on a given tool axis if an obstacle is found.

Motion

Destination (A) Teach position 1

Direction (B) Tool Z+ 2 3

Advanced parameters 4

Linear speed (C) 5 mm/s 5

Force initiating rotation (D) 10 N 6

Rotation speed 5 °/s 7

Maximum torque 1 Nm 8

Enable peck mode

9 **Enable peck mode** Tool retraction between points of contact

Error condition

Maximum rotation angle (E) 45 ° 10

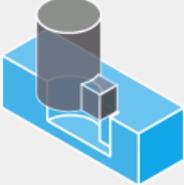


Table 5-3: Describing options available to the Rotational insertion.

- 1 Teach position** button (Destination): Tapping this button saves the object's destination as a waypoint in the robot program
- 2 Reference frame** dropdown menu (Direction): Menu used to select the frame according to which the tool will move in space
- 3 Axis** dropdown menu (Direction): Menu used to select the direction in which the tool will go to reach the destination
- 4 Advanced parameters** box: Box that expands the advanced parameters menu when ticked
- 5 Linear speed** parameter: Textbox for the user to enter a speed value for the approach motion towards the destination
- 6 Force initiating rotation** parameter: Textbox for the user to enter a force threshold value that triggers the rotation move, after the part/tool has established contact with the mating part/surface
- 7 Rotation speed** parameter: Textbox for the user to enter a speed value for the rotational (indexing) motion
- 8 Maximum torque** parameter: Textbox for the user to enter a torque threshold value used to prevent potential collision with objects during the rotational motion
- 9 Enable peck mode** box: Box that enables the retraction of the tool between points of contact
- 10 Maximum rotation angle** (Error condition): Textbox for the user to enter the maximum angle of the rotation motion, considering that no path of least resistance has been found



Parameter	Unit of measurement	Default value
Reference frame (Direction)	N/A	Tool
Axis (Direction)	N/A	Z+
Linear speed	mm/s	5
Force initiating rotation	N	10
Rotation speed	°/s	5
Maximum torque	Nm	1
Maximum rotation angle (Error condition)	°	45

Table 5-4: Default values and units of measurement.

Linear Insertion

Linear

Function used to reach the bottom of a hole by travelling in a linear manner

Motion

Direction (A) Tool Z+

Advanced parameters

Speed (B) 5 mm/s

Force threshold (C) 10 N

Error condition

Maximum travel distance (D) 100 mm

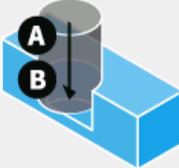


Table 5-5: Describing options available to the Linear insertion.

- 1 **Reference frame** dropdown menu (Direction): Menu used to select the frame according to which the tool will move in space
- 2 **Axis** dropdown menu (Direction): Menu used to select the direction in which the tool will go to reach the destination
- 3 **Advanced parameters** box: Box that expands the advanced parameters menu when ticked
- 4 **Speed** parameter: Textbox for the user to enter a speed value for the approach motion towards the destination



- 5 **Force threshold** parameter: Textbox for the user to enter a force threshold value that completes the linear motion
- 6 **Maximum travel distance** (Error condition): Textbox for the user to enter the maximum distance value which, upon being reached, means the force threshold has never been reached in the linear motion

Parameter	Unit of measurement	Default value
Reference frame (Direction)	N/A	Tool
Axis (Direction)	N/A	Z+
Speed	mm/s	5
Force threshold	N	10
Maximum travel distance (Error condition)	mm	100

5.8. Force Control Node

The Force Control node is used to apply force and torque values along and around axes.

5.8.1. Adding a Force Control Node

- On the Teach Pendant, tap the **New** button to create a program or the **Open** button to load a program
- Tap the **URCaps** button in the navigation pane on the left
- Select **Force Control**
- Tap the **Force Control** node in the robot program to edit it

Warning

UR Move nodes (MoveL, MoveJ, MoveP) and Force nodes cannot be executed as children of the Robotiq Force Control node.

Tip

Where a UR Move node would normally be used, the user shall record a Robotiq Path emulating the desired Move.

In a situation where the user wants to make contact with a surface in accordance with the user-defined settings, a Wait instruction can be inserted as child of the Robotiq Force Control.

The Force Control node is primarily meant to be used with a Robotiq Path node.

With the various user-defined settings available, operators can use a force torque sensor to apply force/torque and thus follow irregular shapes and/or surfaces for applications such as polishing, deburring, finishing, dispensing, etc.

Reference frame

The user can select a reference frame from a dropdown menu, as shown in **Fig. 5-17**.

The **Tool** reference frame uses the X, Y and Z axes of the **end-effector** to apply force and torque values in the appropriate direction.

On the other hand, the Base reference frame takes into consideration the X, Y and Z axes of the **robot arm base**.



Command		Graphics		Variables	
Force Control					
Feature Motion		<input type="checkbox"/> Zero Sen...		Test	
Enable control		Torque		Stiffness	
<div style="border: 1px solid black; padding: 2px;"> Base Tool Motion </div>					
x	<input type="checkbox"/>		0 N	100 %	-100 100 mm
y	<input type="checkbox"/>	Fy	0 N	100 %	-100 100 mm
z	<input type="checkbox"/>	Fz	0 N	100 %	-100 100 mm

Fig. 5-17: Force Control node, highlighting the Feature dropdown list.

Parameters

Force Control							
Feature Tool				Test			
<div style="border: 1px solid green; padding: 2px;"> Enable control x <input checked="" type="checkbox"/> y <input type="checkbox"/> z <input type="checkbox"/> Rx <input checked="" type="checkbox"/> Ry <input type="checkbox"/> Rz <input type="checkbox"/> </div>		<div style="border: 1px solid green; padding: 2px;"> Force/Torque a <input type="text" value="5"/> N Fy <input type="text" value="0"/> N Fz <input type="text" value="0"/> N b <input type="text" value="10"/> Nm Mx <input type="text" value="0"/> Nm My <input type="text" value="0"/> Nm Mz <input type="text" value="0"/> Nm </div>		<div style="border: 1px solid green; padding: 2px;"> Stiffness 3 <input type="text" value="80"/> % <input type="text" value="100"/> % <input type="text" value="100"/> % <input type="text" value="60"/> % <input type="text" value="100"/> % <input type="text" value="100"/> % </div>		<div style="border: 1px solid green; padding: 2px;"> Deviation range 4 a <input type="text" value="-100"/> <input type="text" value="100"/> mm <input type="text" value="-100"/> <input type="text" value="100"/> mm <input type="text" value="-100"/> <input type="text" value="100"/> mm 4 b <input type="text" value="-20"/> <input type="text" value="20"/> ° <input type="text" value="-20"/> <input type="text" value="20"/> ° <input type="text" value="-20"/> <input type="text" value="20"/> ° </div>	
5 <input type="checkbox"/> Enable adaptive stiffness							
		<small>skills.robotiq.com dof.robotiq.com support@robotiq.com</small>					

- 1 **Enable control:** each checkbox corresponds to the enablement of force feeding along an axis (upper three options) or torque feeding around an axis (lower three options)
- 2 **Force/Torque:** depending on which options were checked at step 1, the corresponding textboxes here should be filled with the desired force/torque values
 - a Force values applied are in newtons (N) – the range allowed goes from -150 to +150 N
 - b Torque values applied are in newton-metre (Nm) – the range allowed goes from -50 to +50 N.

Info

Tapping the text boxes brings up a numpad used to enter the values.

- 3 **Stiffness:** the stiffness settings act directly on the Sensor's directional compliance depending on the orientation of the end-effector and the axes selected at step 1.
 - a A stiffness value closer to 0% will provide greater compliance along/around the corresponding axis
 - b A stiffness value of 100% offers no compliance along/around the corresponding axis



4 Deviation range: the deviation range limits the flexibility allowed along/around the corresponding axis.

- a** The deviation range **along** the X, Y and Z axes is measured in **millimeters (mm)** – the negative range allowed goes from -1000 mm to 0 mm while the positive range allowed goes from 0 mm to 1000 mm.
- b** The deviation range **around** the X, Y and Z axes is measured in **degrees (°)** – the negative range allowed goes from -179° to 0° while the positive range allowed goes from 0° to 179°.

Example

In a situation where **10 N** are applied exclusively along the **Z-axis**, with **20% stiffness** along the X and Y axes, and a deviation range that goes from **-50 mm to +50 mm** along all axes...

- The end-effector will systematically point towards its Z-axis
- The end-effector will not rotate around Rx, Ry and Rz (no torque feeding)
- The end-effector will be moderately flexible to move along the X and Y axes
- The movements along the X, Y and Z axes will be limited to -50 mm and +50 mm from the command position

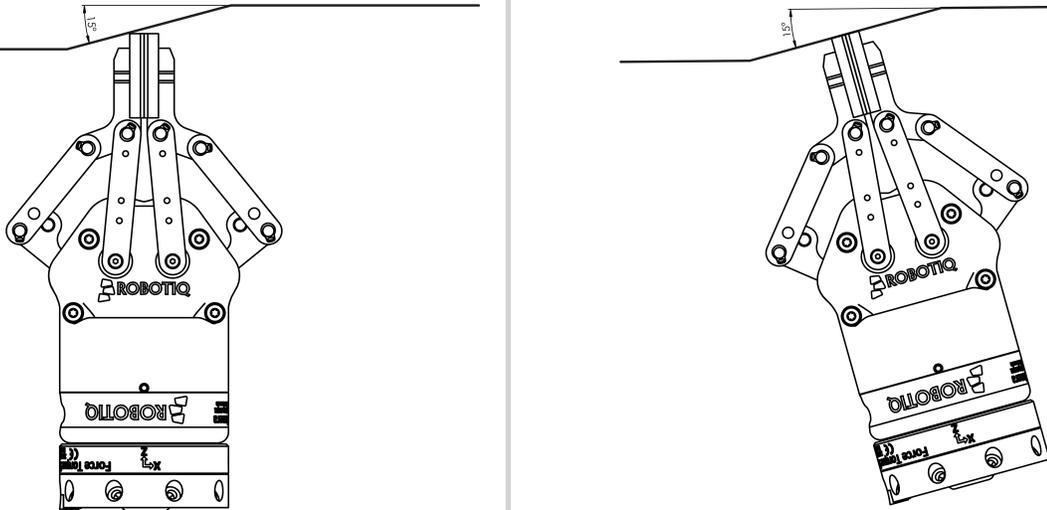


Fig. 5-18: Deviation range - On the left, no deviation range has been entered. On the right, a deviation range of at least 15 degrees has been entered around the corresponding axis.

5 Enable adaptive stiffness: this checkbox greys out the stiffness values in the boxes at step 3 since the Force Control calculates the rigidity of the surface/object with which the end-effector comes in contact. Thus, constant force/torque values are applied to surfaces with variable rigidity (e.g.: long, bent, bending or folded sheets or parts).

When entering into contact with a surface for the first time, the end-effector will pull back for it has reached the force/torque value entered at steps 2a and/or 2b. It will then go back to the surface and apply the same force/torque values while pulling back less and less over time.

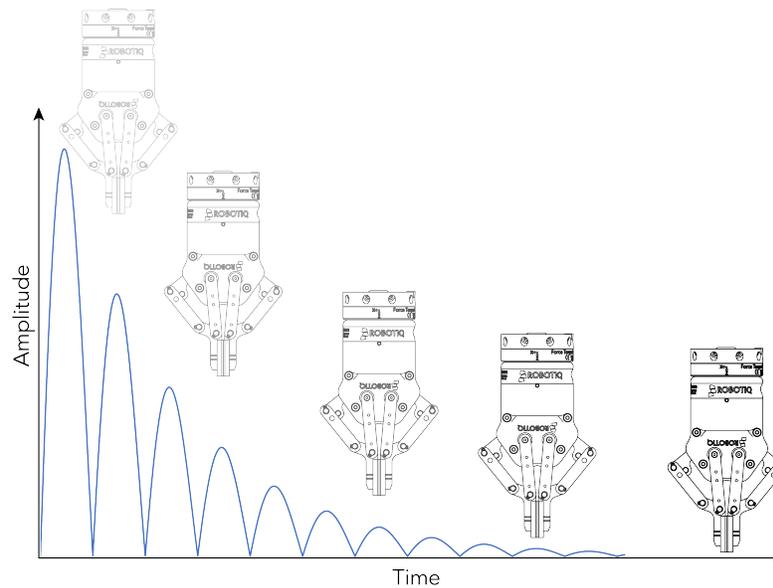


Fig. 5-19: An end-effector meets adaptive stiffness upon repeated contacts with a surface.

Current Position and Targeted Position

From the Force Control node, you can choose to either:

- Apply force based on a Targeted position
- Apply force at the Current position

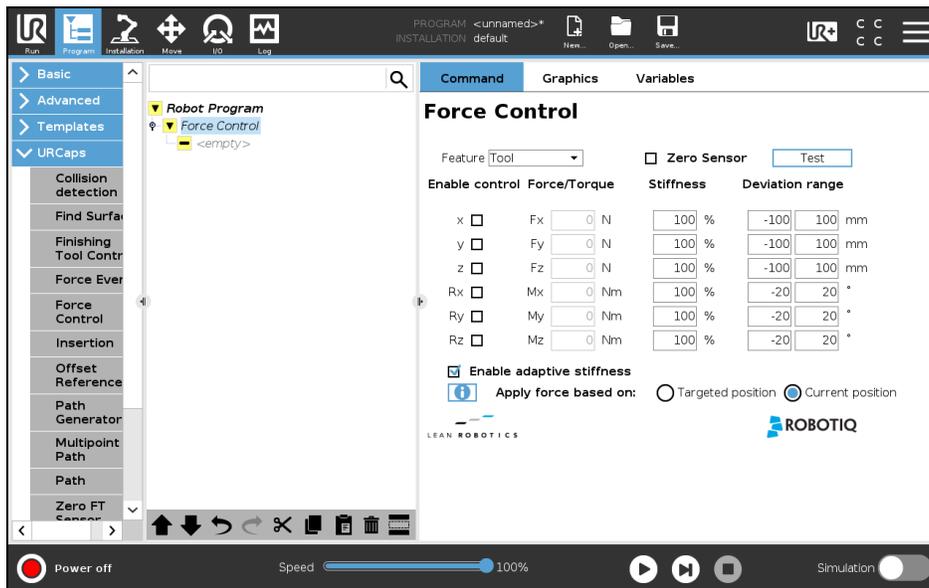


Fig. 5-20: Force Control for e-Series.



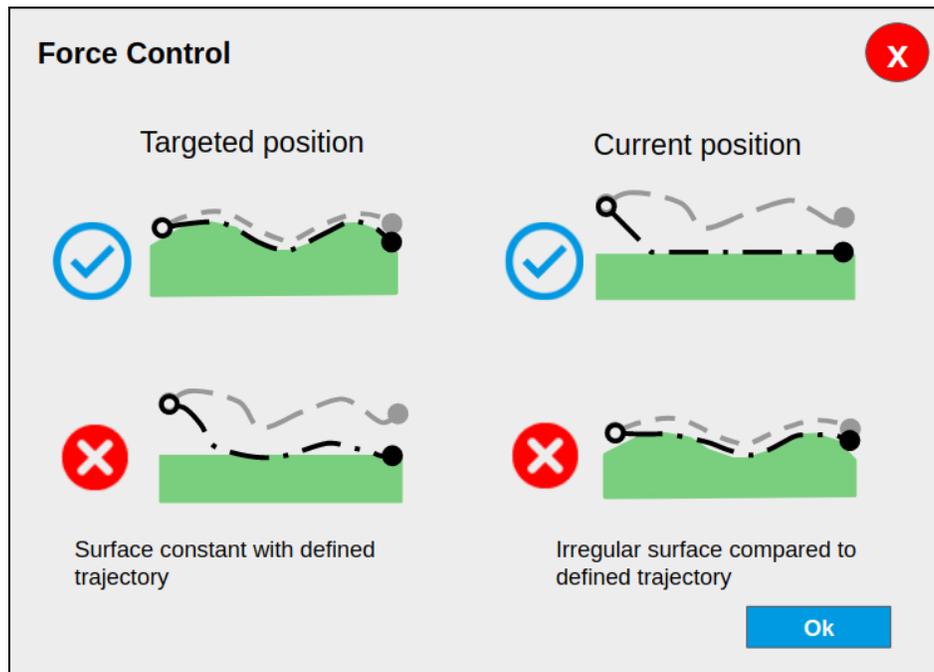


Fig. 5-21: Tooltip illustrating when to use a type of position, and when to avoid using it.

Tip

- Use the targeted position option when your defined trajectory is close to the actual part that will be processed within the Force Control node.
- Use the current position option when your defined trajectory may not resemble to the actual part that is being processed.

Motion Frame

From the Force Control node, it is possible to choose your feature among:

- Tool
- Base
- Motion Frame

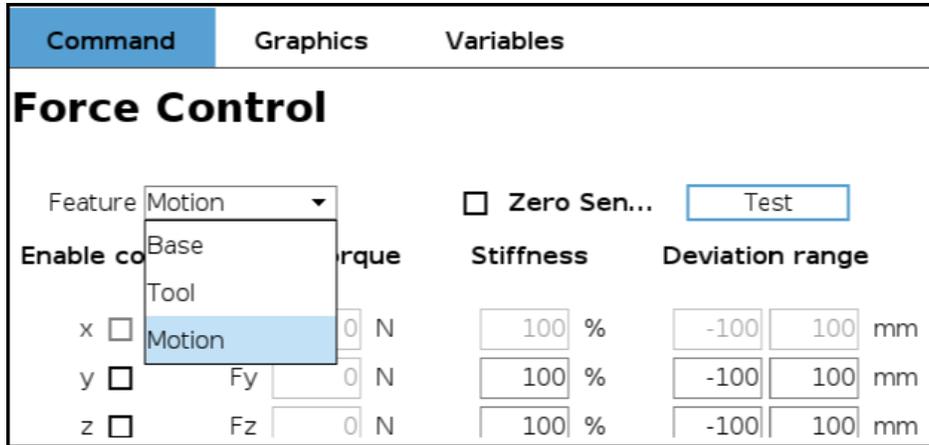


Fig. 5-22: Motion Frame.

The motion frame option allows to apply constant forces and torques along a path. The X axis represents the motion direction, the Z axis is perpendicular to the X axis and is close to the robot Z axis.

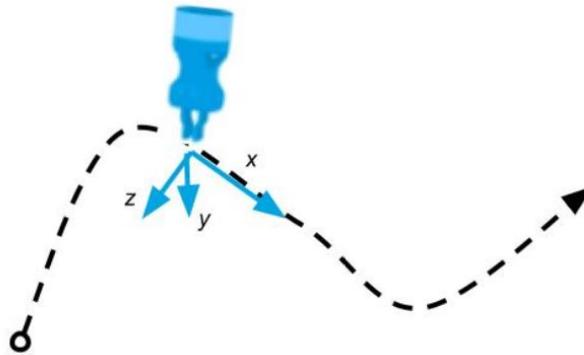


Fig. 5-23: Path example.

Testing a Path

The Test button (see figure **Motion Frame**. applies user-defined settings of the Force Control node to the sensor, therefore moving along/around the corresponding axes, if the control had been enabled for the latter, regardless of other instructions entered before or after the Force Control node in the robot program.



5.9. Force Event

The Force CopilotURCap includes the Force Event node, which can be used to perform a click detection or to wait for a specific force or torque.

5.9.1. Adding a Force Event Node

1. On the teach pendant, tap the **New** button to create a program or the **Open** button to load a program
2. Tap the **URCaps** button in the navigation pane on the left
3. Select **Force Event**
4. Tap the **Force Event** node in the robot program to edit it
5. Select an operation to add to the **Force Event** sequence

Force Event

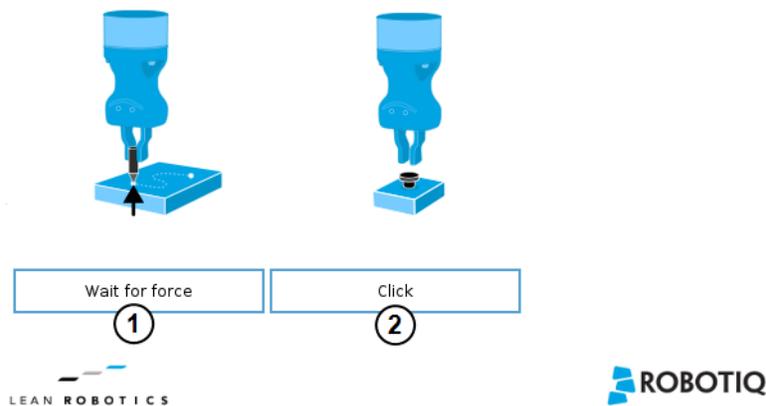


Fig. 5-24: Interface of the Force Event node.

- 1 **Wait for force** function
- 2 **Click** detection function

Wait for force

The Wait for force feature is used to detect a specific force or torque inside a Force Control node.

Click Detection

The Click Detection feature is used to detect a drop that is followed by a rise of a force or a torque.

5.9.2. Click Detection

The Click Detection feature monitors forces and torques throughout the nodes placed within it. This feature senses if a drop in the force or torque is then followed by a sudden rise, thus making a "click". If a click is detected within the Click detection node, the program then skips the remaining instruction lines that are included in the Click detection node. The program automatically goes to the following instruction.

A program instruction can be added if no click is detected.



Force Event

Click

Use the force torque sensor data to detect a drop in force (click) when inserting a connector, pushing a button, etc.

Force drop : N

Torque drop : Nm

Insert a program instruction if no click were detected.



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Tip

To perform a click button action, add a Find Surface node under a Click detection node.

5.9.3. Wait for Force

The Wait for Force feature is used to detect a specific force or torque inside a Force Control node. The program waits until the force or torque is reached prior to the program continuation. The values are defined by the Force Control's force and torque parameters. To be sure the program is not incessantly running, a Timeout option is available.

Force Event

Wait for force

Wait until force and torque are reached.

Timeout sec.

Force/Torque

Fx	<input type="text" value="0"/> N
Fy	<input type="text" value="0"/> N
Fz	<input type="text" value="25"/> N
Mx	<input type="text" value="0"/> Nm
My	<input type="text" value="0"/> Nm
Mz	<input type="text" value="0"/> Nm



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5.10. Collision Detection

The Collision Detection feature is used to stop a program when the forces and the torques, monitored by the embedded e-Series sensor, exceed the defined limits. By default, the program does not monitor forces and torques.



5.10.1. Adding a Collision Detection Node

- On the Teach Pendant, tap the **New** button to create a program or the **Open** button to load a program
- From the **Installation** tab:
 1. Go to the **Installation** tab and tap the **URCaps** submenu
 2. Select **Force Copilot**.
 3. Tap the **Configuration** tab to edit it

- From the **Program** tab:
 1. Tap the **URCaps** button in the navigation pane on the left
 2. Select **Collision Detection**
 3. Tap the **Collision Detection** node to edit it

You can either choose to halt (stop) or suspend (pause) the program when a collision is detected. The forces and torques monitored in the collision detection node are the ones measured by the embedded sensor. Thus, any forces or torques applied to the robot arm will not be detected. Only those applied to the end-of-arm tooling are monitored.

The Collision Detection feature in the Installation tab can be configured to start the monitoring upon every robot program start. On the other hand, the Collision Detection node in the Program tab starts a thread that runs in parallel with the rest of the robot program. If the **Stop monitoring** option is selected in the Collision Detection node, the thread stops and the program continues without monitoring the force or the torque.



6. Machine Tending with the Wrist Camera

Many features of the Wrist CameraURCap can be used for machine tending applications. For details, see section **Cam Locate Node** on page 85, section **Find Visual Offset and Apply Visual Offset Nodes, and Defining Tags** on page 109, section **Save Image Node** on page 114, and section **Scan Code Node** on page 105. Comprehensive information on teaching model objects is also included in the Instruction Manual of the Wrist Camera, available from robotiq.com/support.

6.1 Cam Locate Node

The Cam Locate node is used to teach objects. Once an object is taught through the Cam Locate node, you can use it to detect the object on a work plane, and to interact with it. See section **Object Teaching** on page 1 for a walkthrough.

Programming

The first thing to do after completing the object teaching is to add a Move node to the snapshot position. When you exit the object teaching wizard, the robot arm is already in the Snapshot position location. You can simply add a MoveJ command before the Cam Locate node and set it to the location the robot arm is at (see `Snapshot_pos_1` from the next figure).

Caution

Make sure the robot arm is moved to the snapshot position before executing the Cam Locatenode in the robot program.

The Cam Locate node acts as an "if" statement. If the taught object is detected by the camera, the robot program enters in the Cam Locate node and executes all command lines within it.

After teaching the object within the Cam Locate node, you may continue the programming by using either a linear move (MoveL) with the snapshot position variable as feature or the `object_location` pose. It is also possible to edit the detection threshold or the saved object position after the Teach Object wizard.

- See section **Linear Move with Feature** on page 87 to program a robot motion with a linear move (MoveL) with the snapshot position variable as feature. This allows to perform robot moves relative to the object detected at runtime.
- See section **object_location pose** on page 89 to use an `object_location` pose with robot moves. For advanced users.
- See section **Edit Detection Threshold and Object Location** on page 92 to edit the detection threshold and/or the saved object position.

Cycle Time

The Cam Locate node cycle time is influenced by background complexity, object complexity, and how many objects are on the work plane.

To reduce the Cam Locate cycle time, consider the following at runtime:

- Put fewer objects on the work plane.
- Limit number of object types.
- If your object has many detailed features, you can teach a drawing of it with simplified features or teach only one area of the object.
- Use diffuse lighting, avoiding high light intensity spots on the work plane.

Enabling Fast Cycle Time

If ambient lighting is stable at runtime, you can enable the fast cycle time configuration. Go to the Installation tab > Camera > Configurations, and select Enable fast cycle time.



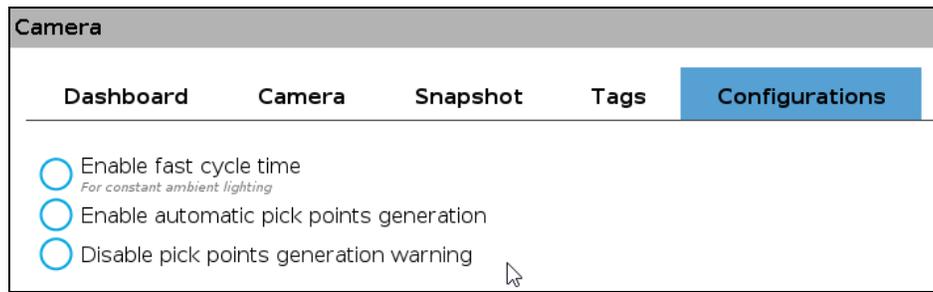


Fig. 6-1: To enable fast cycle time, ambient lighting must be constant.

By enabling the fast cycle time configuration, the camera exposure will be set the first time the program enters a Cam Locate node – at runtime. For others Cam Locate nodes, the Vision System retains exposure settings used in the first run. Enabling this option halves cycle time.

Fast cycle time	Behaviour of the Vision System	Which to choose
Enabled	Exposure is set once for a first run, and reused in following runs.	Halves cycle time. Ambient lighting must be stable.
Disabled	Exposure must be set at every run.	More robust part detection under variable lighting conditions.

Table 6-1: Fast cycle time configuration.

Fast Cycle Time

Enable the fast cycle time configuration **only if the external ambient lighting is stable.**

6.11 Programming a Cam Locate Loop

When you insert a Cam Locate node, it automatically insert If/Else nodes, labelled as "For object(s) found)" and "If no object found" in your robot program.

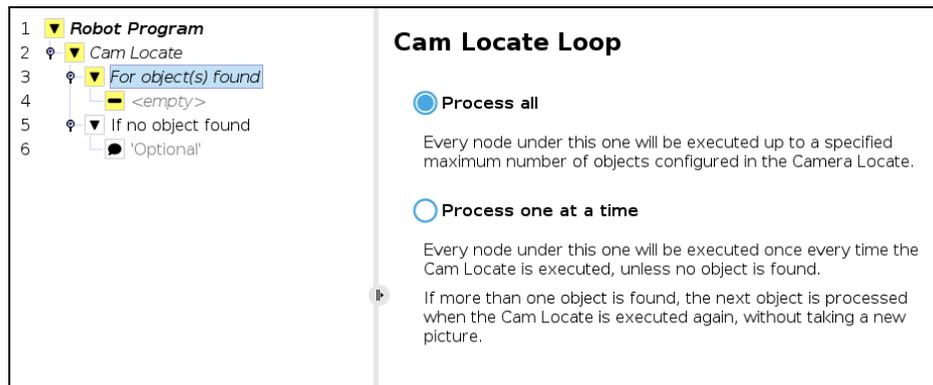


Fig. 6-2: Cam Locate Loop, "Process all" mode.

If you select the radio button Process one at a time from the "Cam Locate Loop" window, the node "For object(s) found" is renamed to "For next object".



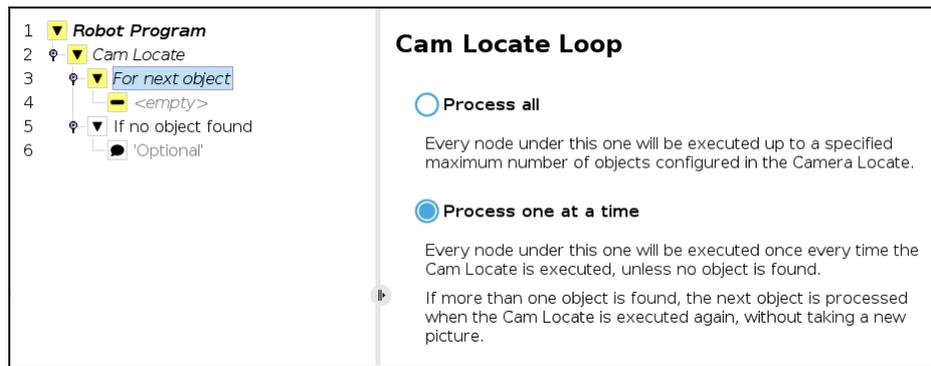


Fig. 6-3: Cam Locate Loop, "Process one at a time" mode.

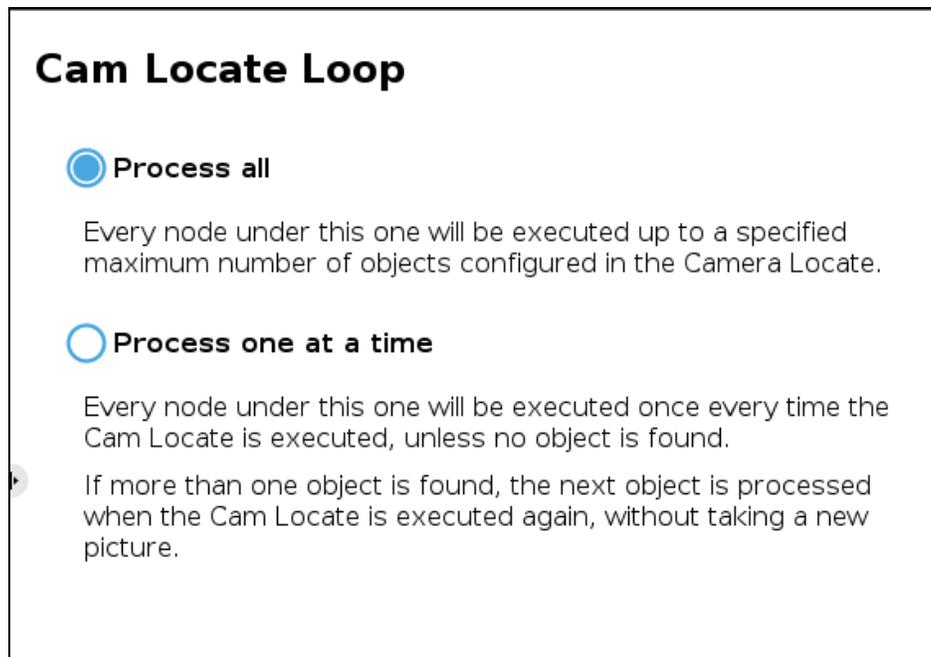


Fig. 6-4: The Cam Locate loop can operate on two different modes.

Process all

When this option is selected, the Wrist Camera takes one picture, and finds objects (their number can be changed when teaching the object). Then, the robot program will carry out instructions under "For object(s) found" for all objects that have been found, and finally, the Cam Locate Loop will be exited.

Process one at a time

When this option is selected, the Wrist Camera takes one picture, and finds objects (their number can be changed when teaching the object). Instructions under "For next object" are carried out only once, the robot program exits the loop, and continues. When the Cam Locate node is run once again, the robot program re-enters the loop, locating an object by using the picture that was first taken. When all objects from the picture have been processed, the Cam Locate instruction takes a new picture to find new objects.

6.12. Linear Move with Feature

Once the Teach Object wizard is completed, you saved the last position of your object. The object position variable, named after the snapshot position, now contains the reference frame of the object in this saved position. Each time the Camera Locate node localizes an object, it updates that feature variable's frame with the new detected object's position and orientation. That feature is named according to the feature name you chose during the snapshot position definition.



Saved position

The saved object position from the Teach Object wizard or the Test/Save wizard is the position of the object to be used for the relative robot motion programming. Once the position is saved, do not move the object to ensure proper robot motion programming within the Camera Locate node.

You can use that reference feature inside the Camera Locate node within Move commands of the robot. To do so:

- Insert a Move node.
- In that node, go to the Command tab.
- Select MoveL.
- Select the appropriate feature (your Snapshot Position / Feature name).

Every waypoint inserted within that MoveL node will be relative to the feature updated by the Cam Locate

Move MoveL ▼

Specify how the robot will move between waypoints.

The values below apply to all child waypoints and depend on the selected movement type.

Set TCP: Use active TCP ▼

Tool Speed: 250 mm/s

Feature: **Snap_FullBoard_var** ▼

Tool Acceleration: 1200 mm/s²

Fig. 6-5: Inserting a Move node with Universal Robots, CB-Series models .

Move MoveL ▼

Specify how the robot will move between waypoints.

The values below apply to all child waypoints and depend on the selected movement type.

Set TCP: Use active TCP ▼

Tool Speed: 250 mm/s

Feature: **view_14x11** ▼

Tool Acceleration: 1200 mm/s²

Use joint angles

Fig. 6-6: Inserting a Move node with Universal Robots, e-Series models .

6.13. object_location pose

Once a snapshot position is defined, the work plane used for the calibration gets its own coordinate system, regardless of its orientation. This coordinate system is shown in the figure below.

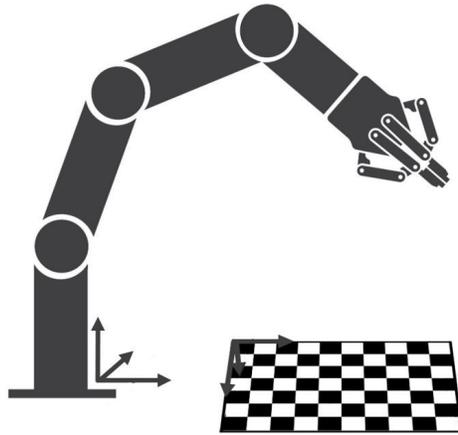


Fig. 6-7: Work plane reference frame.

The Wrist Camera detects an object on the workplane and find its X-Y position, as well as its Z-orientation in the work plane coordinates system (see Fig. 6-8). Thus, a detected object is always laid flat (parallel) to the work plane. It is possible to use the `object_location` pose, which is a variable containing the detected object pose [positions X, Y, Z, and rotations Rx, Ry, Rz] in the robot base reference frame. This variable is updated each time the program goes within a Cam Locate node, thus every time an object is detected, regardless of how many Cam Locate nodes are in the program. The `object_location` pose is relative to the robot base frame.

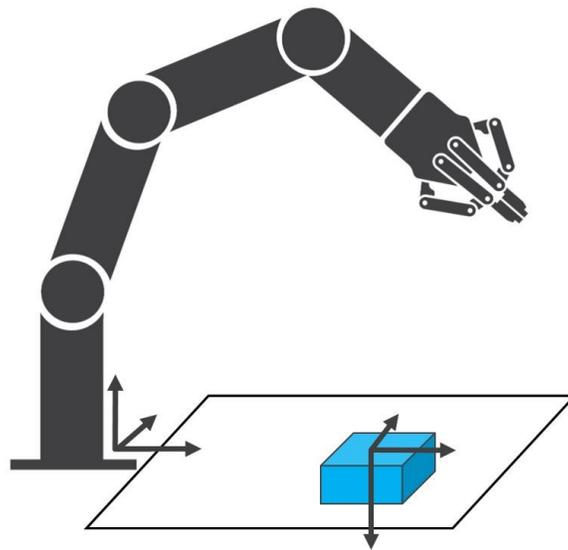


Fig. 6-8: `object_location` pose on the workplane used for the calibration.

object_location is a variable with the pose structure (x, y, z, x rotation, y rotation, z rotation):

x: x position of the object detected, relative to the robot's base reference frame.

y: y position of the object detected, relative to the robot's base reference frame.

z: z position of the object detected, relative to the robot's base reference frame.

x rotation: x rotation from the robot's base frame to the detected object feature reference frame. The object's X axis is parallel to the workplane on which the calibration has been performed.



y rotation: y rotation from the robot's base frame to the detected object feature reference frame. The object's Y axis is parallel to the workplane on which the calibration has been performed.

z rotation: z rotation from the robot's base frame to the detected object feature reference frame. The object's Z axis is normal to the workplane on which the calibration has been performed, points downwards from it, into the workplane.

Object_location pose and TCP

If you move the robot's TCP to the object_location pose, the TCP will go and point the object on the workplane. The height value of the object on the workplane should not be taken into account - the TCP might be directly on the object when moving it to the object_location pose.

Program Example

The program examples below show how to use the object_location pose variable. The first one simply moves the robot so that the TCP goes directly on the detected object. Make sure the TCP is set properly to avoid collisions.

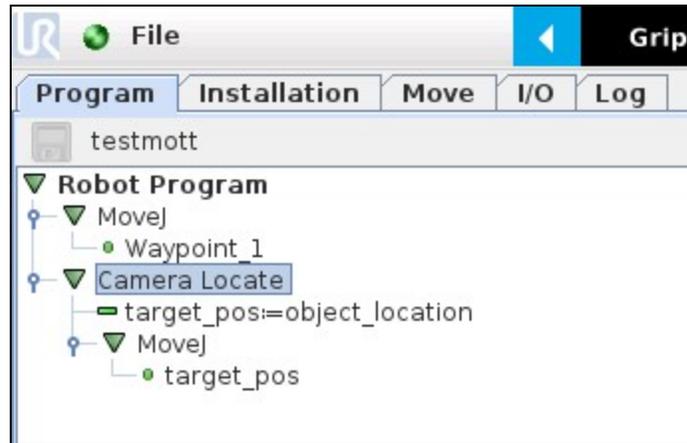


Fig. 6-9: Program example - place the TCP on the detected object. CB-Series robot program is illustrated.

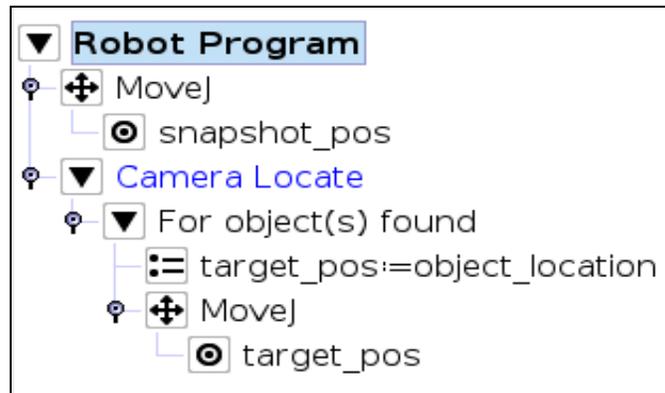


Fig. 6-10: Program example - place the TCP on the detected object. e-Series robot program is illustrated.

The second example moves the robot so that the TCP goes 20 cm above the detected object. This is in the case of an horizontal plane.

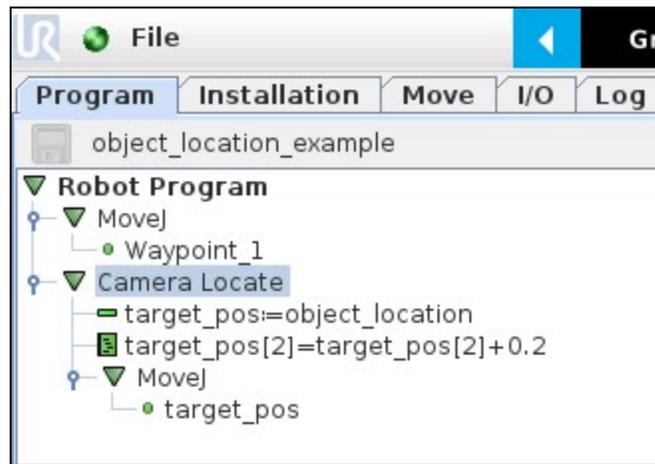


Fig. 6-11: Program example – Place the TCP 20 cm above the detected object, in case of an horizontal plane. CB-Seriesrobot program is illustrated.

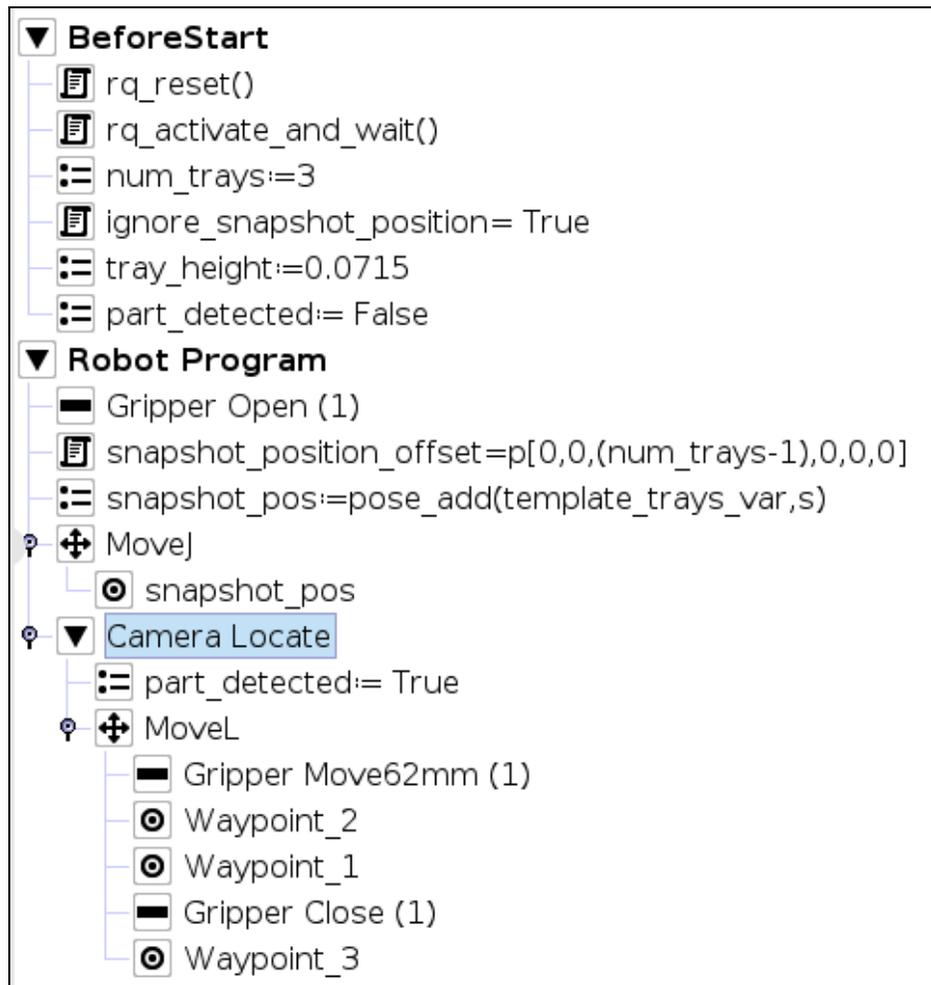


Fig. 6-12: Program example – Place the TCP 20 cm above the detected object, in case of an horizontal plane. e-Seriesrobot program is illustrated.

Info

A statement, called `If no object found` is also present to determine the action to do when Cam Locate does not find any object.

|



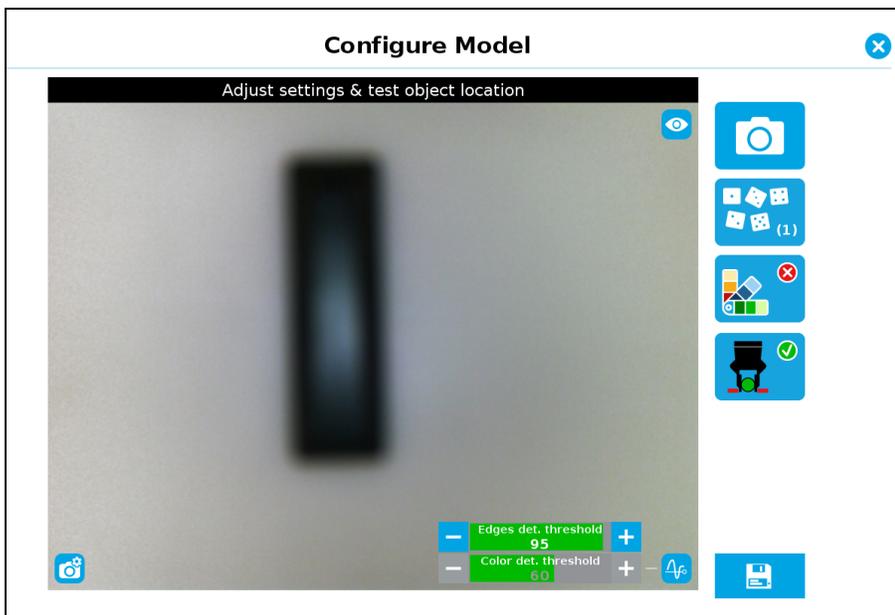
6.14. Edit Detection Threshold and Object Location

It is possible to edit both the detection threshold and the object location after the Teach object wizard has been completed. Tap Cam Locate > Command > Test/Modify (see Fig. 6-13).



Fig. 6-13: The taught object model can be viewed from the "Command" tab of a Cam Locate node.

- Objects can be retaught. To do so, tap . The "Configure Model" window is displayed.

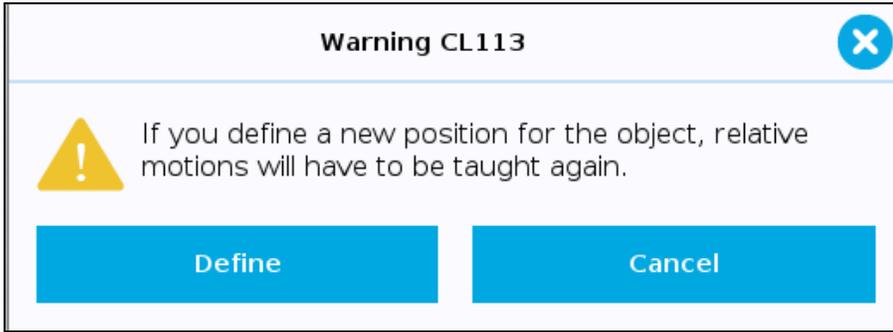


- Object position can be modified. To do so, tap . The "Modify Model Position" window is displayed.

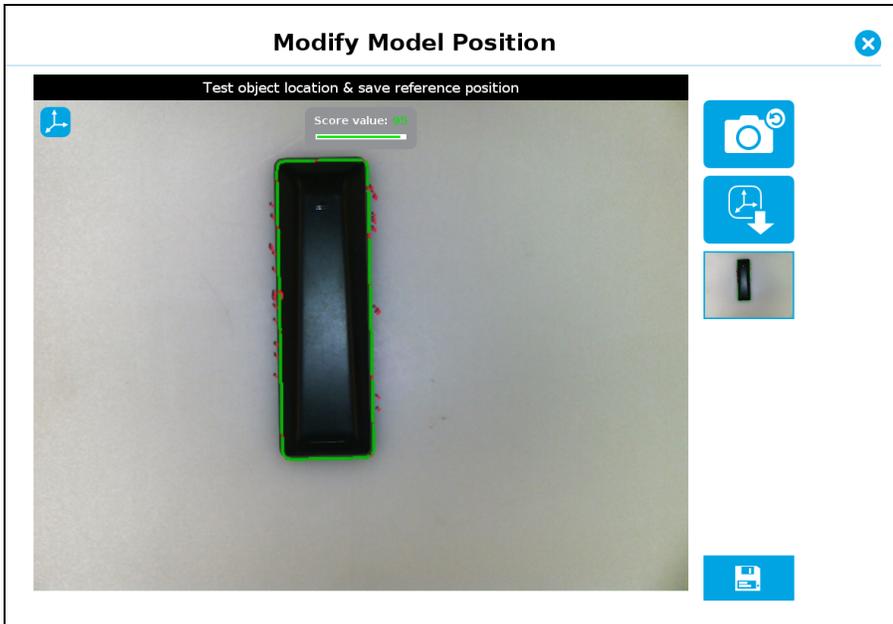
Move object to its new position. To take the new picture, tap . To confirm this new position, tap . A warning message is



displayed to prompt you to confirm this new position. To confirm, tap Define.



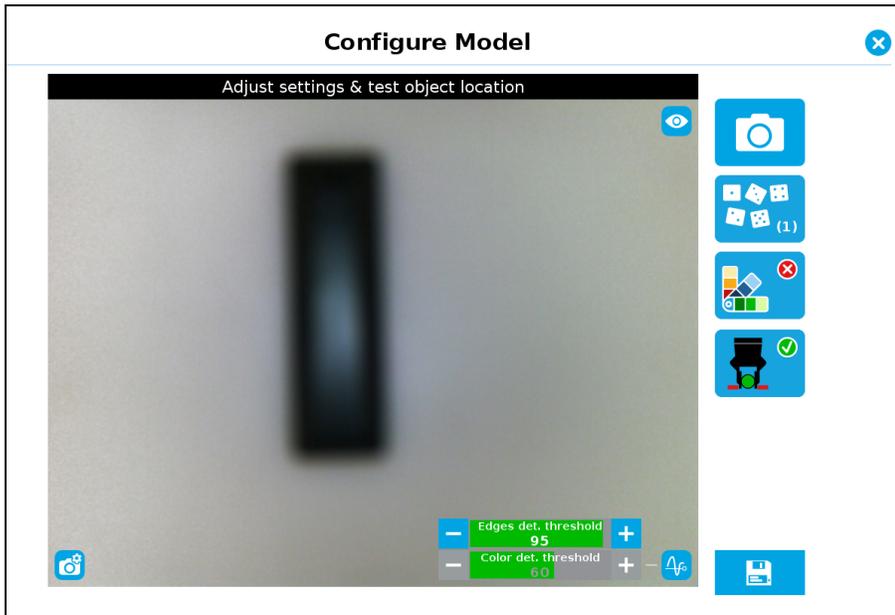
A thumbnail of the object appears under .



Tap  to exit the wizard.



- To modify only the detection threshold, modify it and test it.



Once it is at the required value, tap . This does not modify the object position previously saved.

- To modify both the threshold and the object location, adjust the threshold, place the object in the desired position and test it with the Test locating object button. Once in the desired position, tap Define new position. The position is saved. Tap  to save the threshold.

6.15. Using a Variable Snapshot Position

During a robot program, the robot must be at the snapshot position before entering the Cam Locate node. If it is not in the right position, a pop-up will appear, preventing the camera from taking a snapshot from the wrong position. This is to ensure good precision since the workplane has been previously calibrated for this snapshot position.

In some cases, it is helpful to move the robot to a variable position to enter a Camera Locate node. For instance, it can also be used to teach only one snapshot position and object to manage parts in stacked trays. In order to do so, allow the robot to be in a different position than the original snapshot position by entering the script command:

```
ignore_snapshot_position = True
```

You also need to edit the `snapshot_position_offset` pose variable. This variable contains the pose offset between the original saved snapshot position and the one used in the program.

Info

Please note that the arguments of the `snapshot_position_offset` parameter are expressed in the robot base reference frame.

The example shows a program using a Cam Locate node to manage parts in stacked trays.

- The script command in the BeforeStart section allows the camera not to be in the exact snapshot position when entering a Cam Locate node.
- The pose at which the robot enters the Cam Locate node is calculated knowing how many trays are stacked.
- The `snapshot_position_offset` is calculated accordingly for the Wrist Camera to consider the pose offset from the original snapshot position.



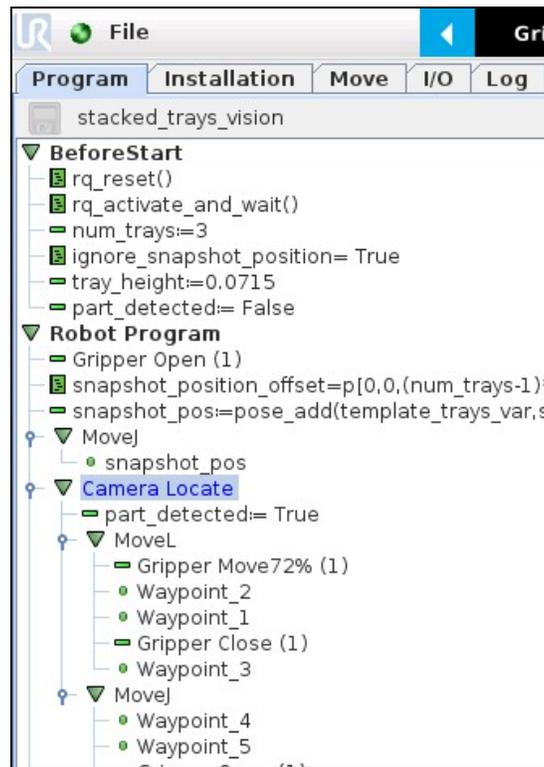


Fig. 6-14: Program example, using Universal RobotsCB-Series models.

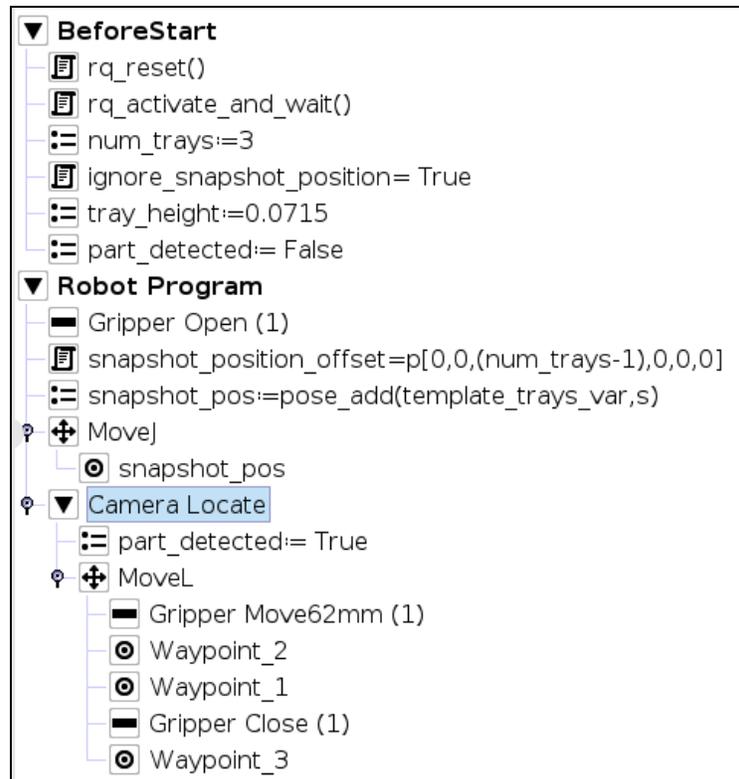


Fig. 6-15: Program example, using Universal Robotse-Series models.



```
ignore_snapshot_position = True
```

When using this method, make sure the workplane has the same orientation and distance regarding the position of the camera before a Cam Locate node. Using a variable and relative snapshot position may decrease the precision, as the workplane can be slightly different depending on where the calibration has been performed. Be aware of this when programming a Cam Locate node relative to another one.

6.16. Auto Pick

The Auto Pick functionality is available after teaching an object with the Parametric method, and is used to accelerate adding pick instructions.

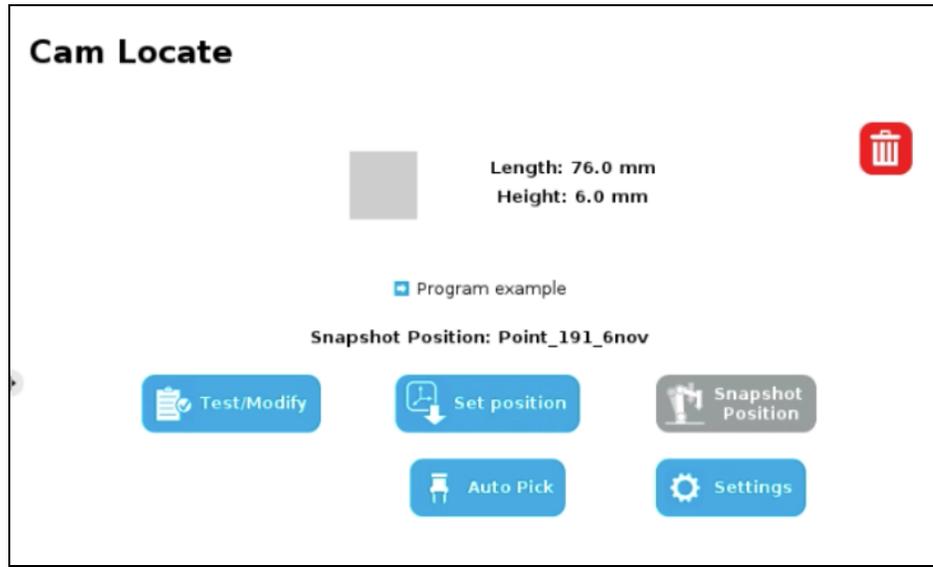


Fig. 6-16: The Auto Pick functionality becomes available after using an object using the Parametric method.

When you tap  **Auto Pick**, some nodes are inserted in your robot program under a MoveL node, as in the structure shown below:

- MoveL
 - Approach Point
 - Pick Point
 - Comment (" Insert pick action")
 - Retract Point

Basically, Auto Pick inserts a MoveL node based on the values you entered in the Parametric method when teaching the object. The values of "Approach Point" and "Retract Point" are automatically inserted, and based on the values entered when teaching the object. However, these two nodes have independent values.

The approach point added via the Auto Pick button will be located over the object at its exact center. The distance between approach point and object center is calculated based on the TCP value entered in the Teach Pendant for your hardware setup.

Here is a general view of the Auto Pick functionality, and how it can be used in a robot program.



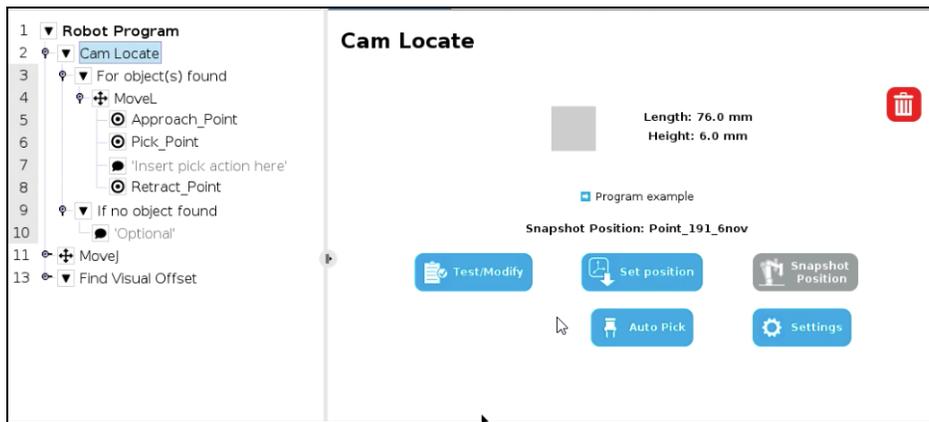
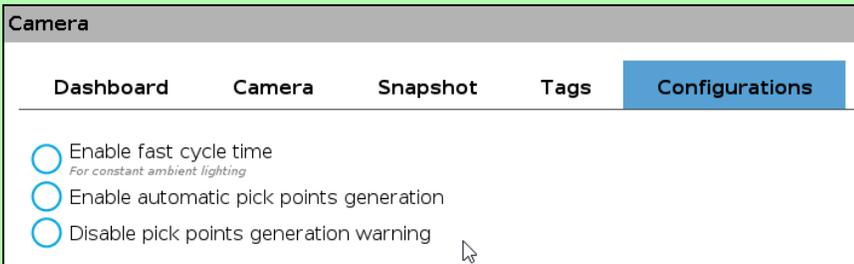


Fig. 6-17: This MoveL node was inserted using the Auto Pick button.

Tip

For a smoother experience using Auto Pick, modify Teach Pendant options under Installation > URCaps > Camera > Configurations. Check the following radio buttons:

- "Enable automatic pick points generation"
- "Disable pick points generation warning"



6.17. Camera Locate Settings

You can configure a Cam Locate node using these options:

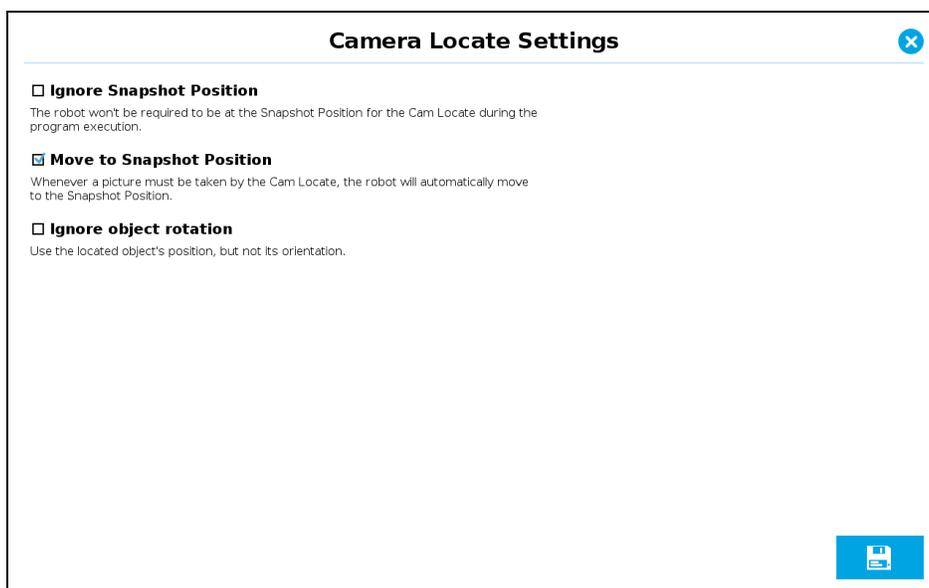


Fig. 6-18: Cam Locate node settings.



Option	Description
Ignore Snapshot Position	The robot won't be required to be at the Snapshot Position for the Cam Locate during the program execution.
Move to Snapshot Position	Whenever a picture must be taken by the Cam Locate, the robot will automatically move to the snapshot position.
Ignore object rotation	Use the located object's position, but not its orientation.

Fig. 6-19: These options can be used to reduce cycle time or to improve part detection.

Tips

- Ignore Snapshot Position can reduce cycle time.
- Move to Snapshot Position can improve part detection.
- Ignore object rotation can reduce cycle time for round objects.
- Ignore Snapshot Position and Move to Snapshot Position are mutually exclusive.

Fast Cycle Time

Enable the fast cycle time configuration **only if the external ambient lighting is constant.**

Programming

The first thing to do after completing the object teaching is to add a Move node to the Snapshot position. When you exit the object teaching wizard, the robot arm is already in the Snapshot position location. You can simply add a MoveJ command before the Cam Locate node and set it to the location the robot arm is at (see Snapshot_pos_1 from the next figure).

Caution

Make sure the robot arm is moved to the snapshot position before the Camera Locate node in the robot program.

The Cam Locatenode acts as an "if" statement. If the taught object is detected by the camera, the robot program will enter in the Cam Locatenode and execute all the command lines within it.

After teaching the object within the Cam Locate node, you may continue the programming by using either a linear move (MoveL) with the snapshot position's variable as feature or the object_location pose. It is also possible to edit the detection threshold or the saved object position after the Teach Object wizard.

- Refer to Section 6.1 to program a robot motion with a linear move (MoveL) with the snapshot position's variable as feature. This allows to perform robot motion relative to the object detected at run time.
- Refer to Section 6.2 to use the object_location pose to program the robot motion - for advanced use.
- Refer to Section 6.3 to edit the detection threshold and/or the saved object position.



Cycle Time

The Cam Locate node cycle time is influenced by the background complexity, the object's features complexity and the number of objects on the workplane.

To accelerate the Cam Locate cycle time, consider the following:

- Have the least possible objects and object types on your workplane at run time.
- If your object has many detailed features, you can teach a drawing of it with simplified features or teach only one area of the object.
- Have a diffuse ambient lighting, avoiding high light intensity spots on the workplane.

Programming a Cam Locate Loop

A Cam Locate node can be used in one of two ways:

- Process all
- Process one at a time

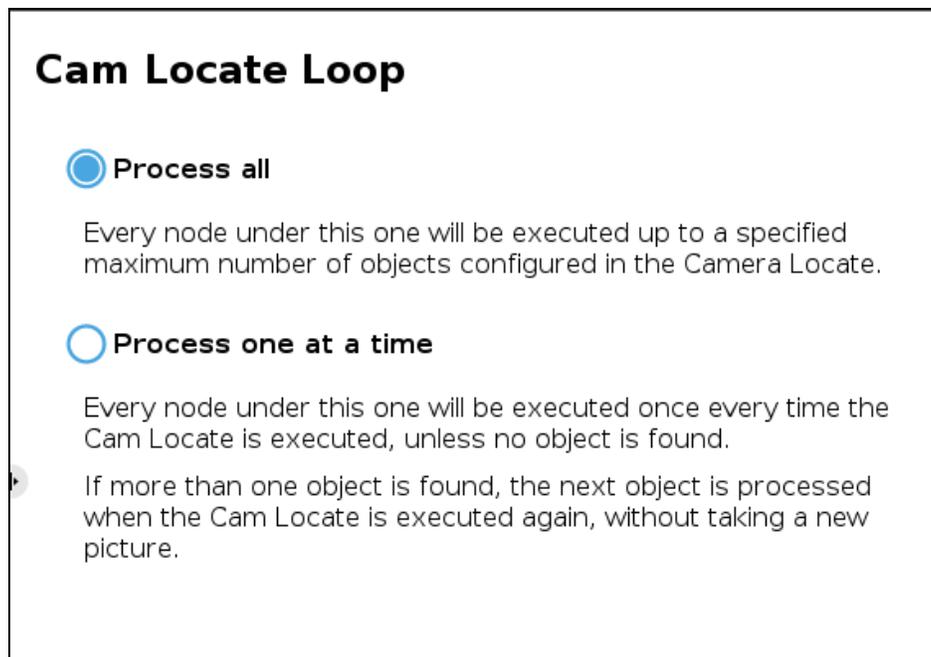


Fig. 6-20: The Cam Locate loop can operate on two different modes.

Process all

When this option is selected, the Wrist Camera takes one picture, and finds objects (their number can be changed when teaching the object). Then, the robot program will carry out instructions under "For object(s) found" for all objects that have been found, and finally, the Cam Locate Loop will be exited.

Process one at a time

When this option is selected, the Wrist Camera takes one picture, and finds objects (their number can be changed when teaching the object). Instructions under "For next object" are carried out only once, the robot program exits the loop, and continues. When the Cam Locate node is run once again, the robot program will re-enter the loop once more, locating an object by using the picture that was first taken. When all objects from the picture have been processed, the Cam Locate instruction will take a new picture to find new objects.



Linear Move with Feature

Once the Teach Object wizard is completed, you saved the last position of your object. The object position variable, named after the snapshot position, now contains the reference frame of the object in this saved position. Each time the Camera Locate node localizes an object, it updates that feature variable's frame with the new detected object's position and orientation. That feature is named according to the feature name you chose during the snapshot position definition.

Saved position

The saved object position from the Teach Object wizard or the Test/Save wizard is the position of the object to be used for the relative robot motion programming. Once the position is saved, do not move the object to ensure proper robot motion programming within the Cam Locate node.

You can use that reference feature inside the Cam Locate node within Move commands of the robot. To do so:

- Insert a Move node.
- In that node, go to the Command tab.
- Select MoveL.
- Select the appropriate feature (your Snapshot Position / Feature name).

Every waypoint inserted within that MoveL node will be relative to the feature updated by the Camera Locate.

Move MoveL

Specify how the robot will move between waypoints.

The values below apply to all child waypoints and depend on the selected movement type.

Set TCP: Use active TCP

Tool Speed: 250 mm/s

Feature: view_14x11

Tool Acceleration: 1200 mm/s²

Use joint angles

Reset

Fig. 6-21: This MoveL is relative to feature "view_14x11".

object_location pose

Once a snapshot position is defined, the workplane used for the calibration gets its own coordinate system, regardless of its orientation. This coordinate system is shown in the figure below.



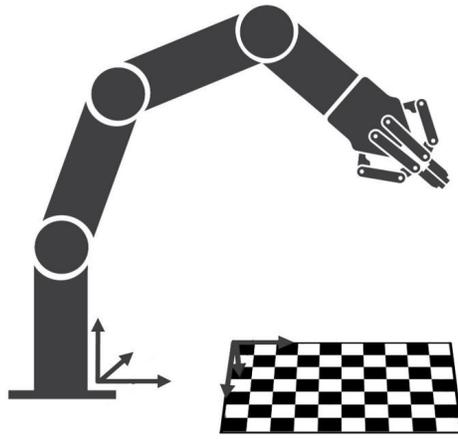


Fig. 6-22: Workplane reference frame.

The camera will detect an object on the workplane and find its X-Y position, as well as its Z-orientation in the workplane's coordinate system (see figure below). Thus, a detected object is always laid flat (parallel) to the workplane. It is possible to use the **object_location** pose, which is a variable containing the detected object's pose ($p[x, y, z, x \text{ rotation}, y \text{ rotation}, z \text{ rotation}]$) in the robot's base reference frame. This variable is updated each time the program goes within a Camera Locate node, thus every time an object is detected, regardless of how many Camera Locate nodes are in the program. The **object_location** pose is relative to the robot's base frame.

Info

object_location is a variable containing the detected object's position and orientation relative to the base reference frame. The orientation is always parallel to the workplane on which the calibration has been performed. Thus, the object's X and Y axes are always parallel to the workplane. The Z axis is always normal to the workplane and points downwards from it, into the workplane (refer to the figure below).

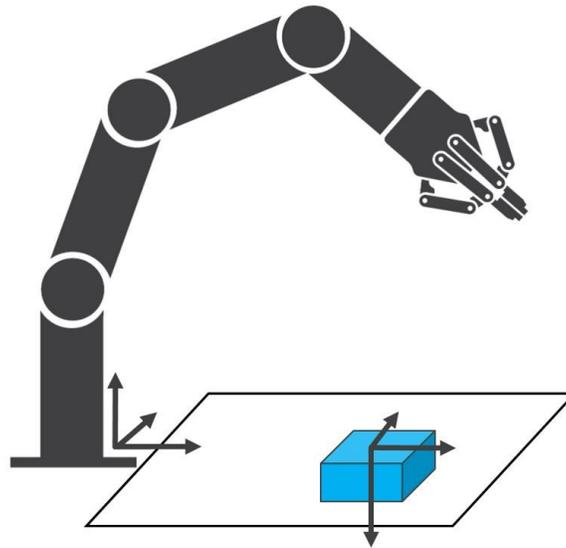


Fig. 6-23: **object_location** pose on the workplane used for the calibration.

object_location is a variable with the pose structure (x, y, z, x rotation, y rotation, z rotation):

x: x position of the object detected, relative to the robot's base reference frame.

y: y position of the object detected, relative to the robot's base reference frame.

z: z position of the object detected, relative to the robot's base reference frame.



x rotation: x rotation from the robot's base frame to the detected object feature reference frame. The object's X axis is parallel to the workplane on which the calibration has been performed.

y rotation: y rotation from the robot's base frame to the detected object feature reference frame. The object's Y axis is parallel to the workplane on which the calibration has been performed.

z rotation: z rotation from the robot's base frame to the detected object feature reference frame. The object's Z axis is normal to the workplane on which the calibration has been performed, points downwards from it, into the workplane.

Info

If you move the robot's TCP to the `object_location` pose, the TCP will go and point the object on the workplane. The height value of the object on the workplane should not be taken into account - the TCP might be directly on the object when moving it to the `object_location` pose.

Program Example

The program examples below show how to use the `object_location` pose variable. The first one simply moves the robot so that the TCP goes directly on the detected object. Make sure the TCP is set properly to avoid collisions.

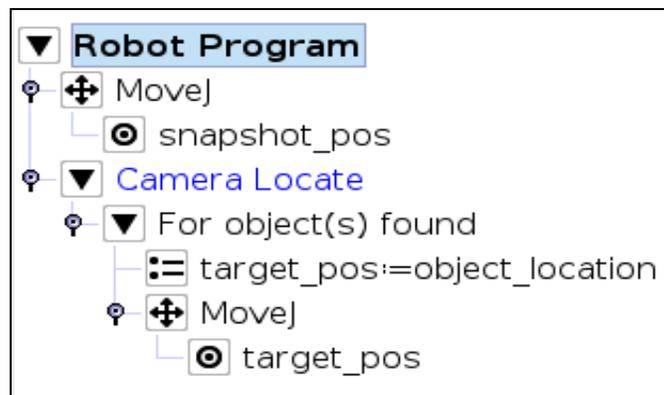


Fig. 6-24: Program example: place the TCP on the detected object.

The second example moves the robot so that the TCP goes 20 cm above the detected object. This is in the case of an horizontal plane.

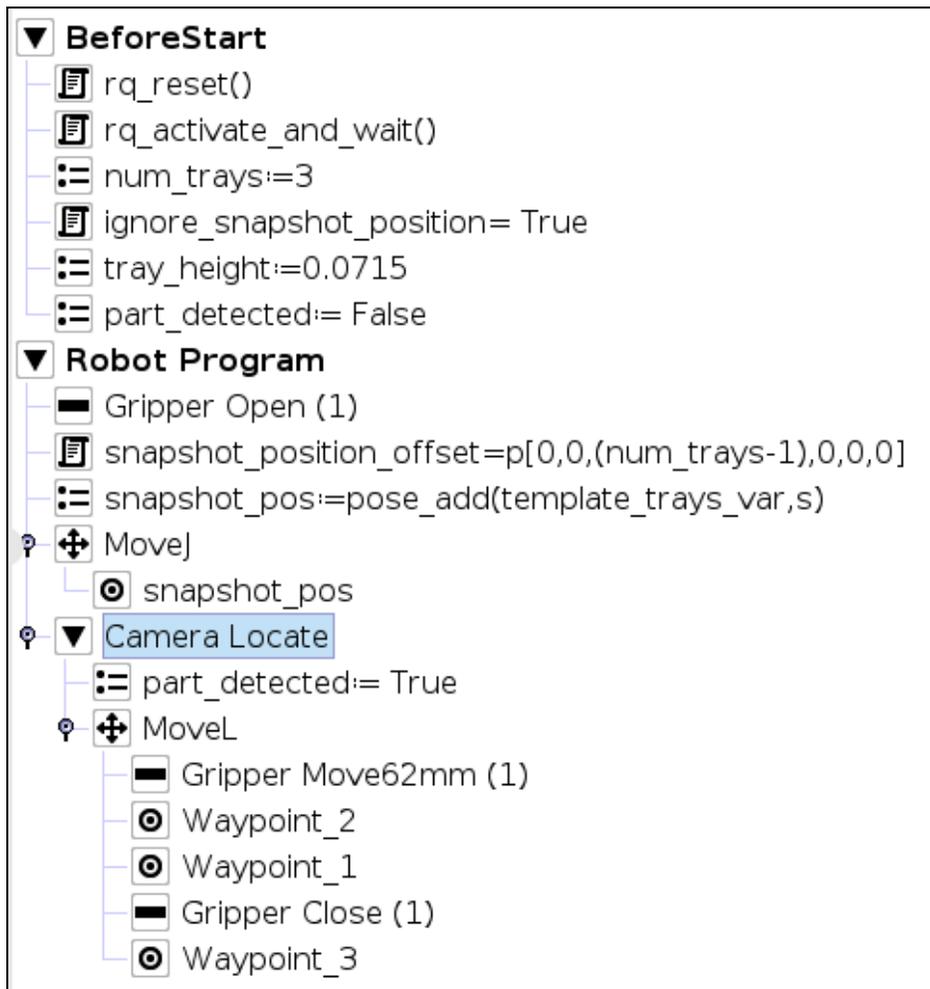


Fig. 6-25: Program example: place TCP 20 cm above the detected object, in case of an horizontal plane.

Info

A statement, called **If no object found**, is also present to determine the action to do when no object is found by the Wrist Camera.



Edit Detection Threshold and Object Location

It is possible to edit both the detection threshold and the object location after the Teach object wizard has been completed. To do so, select the Cam Locate node, go to the Command tab and tap Test/Modify.

- To modify the saved object position, place the object in the desired position. Test is with the Test locating object button and, when in the desired position, tap Define new position. The position is saved. Tap Save & close to exit the wizard. This also saves the threshold.
- To modify only the detection threshold, modify it and test it. Once it is at the required value, tap Save & close. This does not modify the object position previously saved.
- To modify both the threshold and the object location, adjust the threshold, place the object in the desired position and test is with the Test locating object button. Once in the desired position, tap Define new position. The position is saved. Tap Save & close to save the threshold.



Cam Locate Node at a Variable Snapshot Position

During a robot program, the robot must be at the snapshot position before entering the Cam Locate node. If it is not in the right position, a pop-up will appear, preventing the camera from taking a snapshot from the wrong position. This is to ensure good precision since the workplane has been previously calibrated for this snapshot position.

In some cases, it is helpful to move the robot to a variable position to enter a Camera Locate node. For instance, it can also be used to teach only one snapshot position and object to manage parts in stacked trays. In order to do so, allow the robot to be in a different position than the original snapshot position by entering the script command:

ignore_snapshot_position = True

You also need to edit the **snapshot_position_offset** pose variable. This variable contains the pose offset between the original saved snapshot position and the one used in the program .

Info

Please note that the arguments of the **snapshot_position_offset** parameter are expressed in the robot base reference frame.

The example shows a program using a Cam Locate node to manage parts in stacked trays.

- The script command in the BeforeStart section allows the camera not to be in the exact snapshot position when entering a Cam Locate node.
- The pose at which the robot enters the Cam Locate node is calculated knowing how many trays are stacked.
- The **snapshot_position_offset** is calculated accordingly in order for the Wrist Camera to consider the pose offset from the original snapshot position.

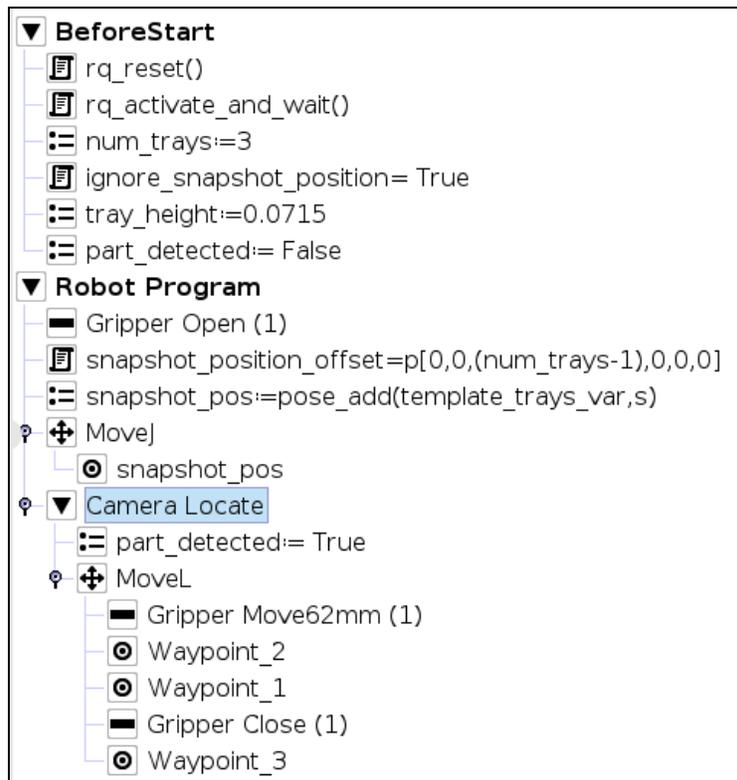


Fig. 6-26: Program example.



`ignore_snapshot_position = True`

When using this method, make sure the workplane has the same orientation and distance regarding the position of the camera before a Cam Locate node. Using a variable and relative snapshot position may decrease the precision, as the workplane can be slightly different depending on where the calibration has been performed. Be aware of this when programming a Cam Locate node relative to another one.

Settings

You can configure your Cam Locate node using these options:

- Ignore Snapshot Position
- Move to Snapshot Position
- Ignore object rotation

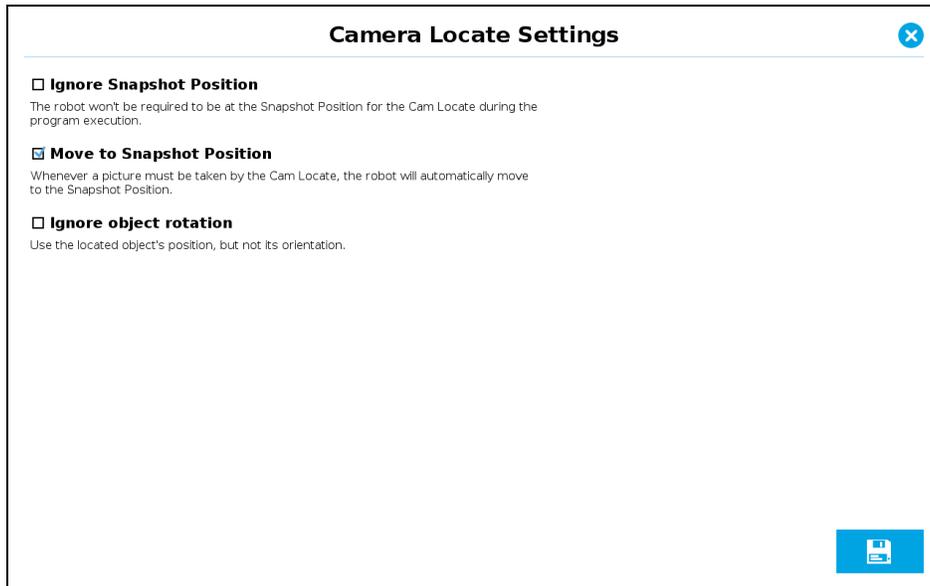


Fig. 6-27: Cam Locate node settings.

6.2. Scan Code Node

6.2.1 Supported Types of Codes

The Scan Code node is used to read various types of barcodes and 2D codes (QR, Datamatrix, PDF417).

Code Image	Type
	Datamat rix
	QR



	PDF-417
	Code 93
	EAN-8
 0 123456 789012	EAN-13
 1234567890	ITF-14
 0 123456 5	UPC-E
 1 23456 78901 2	UPC-A
	Code 39
	Code 128

6.2.2. Guidelines on Reading Codes

Tips

Follow these recommendations to improve codes readings.

- Code must be entirely visible in the field of view of the Wrist Camera.
- However, code should not fill the field of view entirely. Some whitespace must be left around its edges. Moving the Wrist Camera away from the code should increase its field of view and provide an adequate amount of whitespace.
- Background must contrast the code to read.



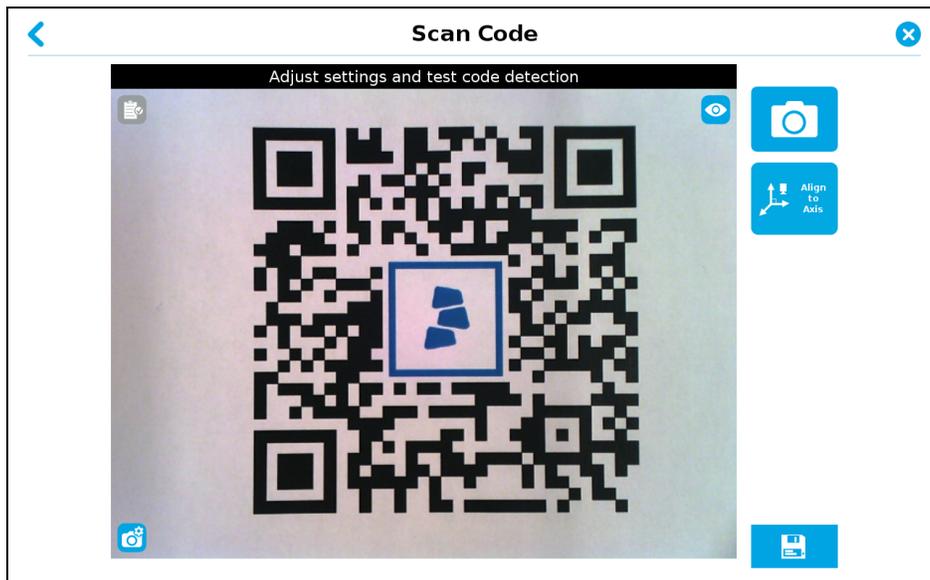
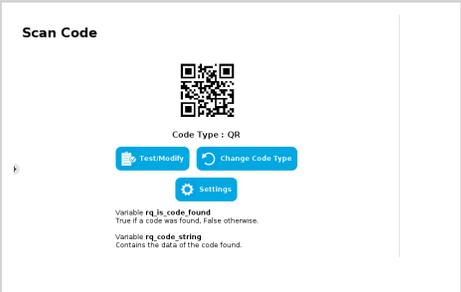
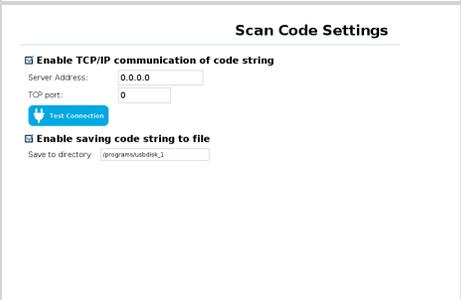


Fig. 6-28: This code cannot be read because there is not enough whitespace around its edges.

6.2.3. Using the Scan Code Node

<p>Scan Code</p> 	<ol style="list-style-type: none"> 1. Tap Program > URCaps > Scan Code.
	<ol style="list-style-type: none"> 2. Tap .
<p>Select Code Type</p> 	<ol style="list-style-type: none"> 3. The window "Select Code Type" is displayed. Tap the applicable code type. To navigate pages for additional code types, use  and .
	<ol style="list-style-type: none"> 4. Put code on workplane, then tap , or retry by tapping  if you are not satisfied with the result. Save your code by tapping . <div style="border: 2px solid green; padding: 10px; margin-top: 10px;"> <p>Tip</p> <p>You can tap  to display the string that was read from the code. This is useful when testing if your codes are read properly under your specific operating conditions.</p> </div>



	<p>5. To save your readings, tap . The "Scan Code Settings" window is displayed.</p>
	<p>6. To save collected strings to a file, check either box, or both. If you choose to save your data locally, you can use a USB stick to do so. The data will be stored in a .CSV file.</p> <p>You can also use the string value during a program. Its value is stored in variable <code>rq_code_string</code>, found in the Variables tab.</p>

6.2.4. Strings Data Stored in CSV files

	A	B	C	D	E	F
1	TimeStamp, CodeType, CodeData					
2	2019-11-01T15:53:22.892892,	QRCODE,	https://robotiq.com/			
3	2019-11-01T15:53:29.949949,	QRCODE,	https://robotiq.com/			
4	2019-11-01T15:53:37.03030,	QRCODE,	https://robotiq.com/			
5	2019-11-01T15:53:44.07474,	QRCODE,	https://robotiq.com/			
6	2019-11-01T15:53:51.09999,	QRCODE,	https://robotiq.com/			
7	2019-11-01T15:53:58.226226,	QRCODE,	https://robotiq.com/			
8	2019-11-01T15:54:05.229229,	QRCODE,	https://robotiq.com/			
9						
10						
11						
12						

Fig. 6-29: Each line represents one code that was read.

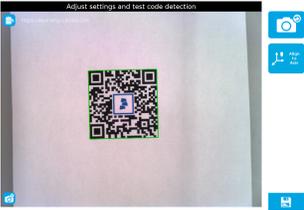
Data is presented in the following order: TimeStamp, CodeType, CodeData. Data elements are separated by commas.

Data Element	Description
TimeStamp	Records the year, month, date, hour, minutes, seconds, and seconds decimals at which the code was read.
CodeType	Records which type of code was read.
CodeData	Records a string read from a code.

6.2.5. Using the Scan Code Node

--	--



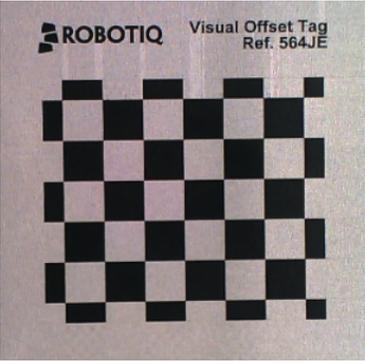
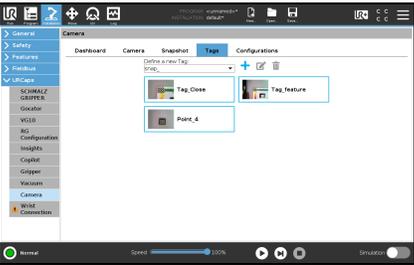
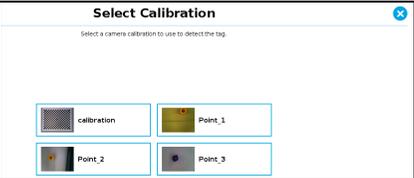
<p>Scan Code</p> 	<p>1. Tap Program > URCaps > Scan Code.</p>
	<p>2. Tap .</p>
<p>Select Code Type</p> 	<p>3. The window "Select Code Type" is displayed. Tap the applicable code type. To navigate pages for additional code types, use  and .</p>
	<p>4. Put code on workplane, then tap , or retry by tapping  if you are not satisfied with the result. Save your code by tapping </p> <div style="border: 2px solid green; padding: 10px; margin: 10px 0;"> <p>You can tap  to display the string that was read from the code. This is useful when testing if your codes are read properly under your specific operating conditions.</p> </div>
<p>Scan Code</p> 	<p>5. To save your readings, tap . The "Scan Code Settings" window is displayed.</p>
<p>Scan Code Settings</p> <p><input checked="" type="checkbox"/> Enable TCP/IP communication of code string</p> <p>Server Address: <input type="text" value="0.0.0.0"/></p> <p>TCP port: <input type="text" value="0"/></p> <p><input checked="" type="checkbox"/> Enable saving code string to file</p> <p>Save to directory: <input type="text" value="/programs/abdrn_1"/></p>	<p>6. To save collected strings to a file, check either box, or both. If you choose to save your data locally, you can use a USB stick to do so. The data will be stored in a .CSV file.</p> <p>You can also use the string value during a program. Its value is stored in variable <code>rq_code_string</code>, found in the Variables tab.</p>

6.3. Find Visual Offset and Apply Visual Offset Nodes, and Defining Tags

The Wrist Camera Visual Offset capabilities are based on two nodes: Find Visual Offset and Apply Visual Offset. By attaching a Robotiq tag to a fixture (a tray, for instance), you can teach robot moves which are relative to this tag position. In other words, you can first teach the tag position, then teach moves, and even if your tray was moved, your robot program will compensate its move commands, first by finding out by how much the tray was displaced (using the node Find Visual Offset). This value is stored, then applied to moves under the node Apply Visual Offset subprogram.



6.3.1 Defining a Tag

	<ol style="list-style-type: none"> 1. Attach a tag to any surface. It is a reference feature for your robot program. The back of the tag has adhesive bands to help attach it.
	<ol style="list-style-type: none"> 2. Move your robot to a position from which the Wrist Camera can fully see the tag, then create a feature Point at this location.
	<ol style="list-style-type: none"> 3. Go to Installation > URCaps > Camera > Tags. 4. From the dropdown list, select the feature Point you previously created, then tap .
	<ol style="list-style-type: none"> 5. The "Select Calibration" window is displayed. Select the camera calibration to use to detect the tag.
	<ol style="list-style-type: none"> 6. The "Define A New Tag" window is displayed. You can tap capture to use default settings and try to read the tag right away.





7. The "Verify Tag" window is displayed. The half-squares must be outside of the green-bordered area shown on your tag. All fully formed squares must be inside the green-bordered area. If these two conditions are met, tap . Otherwise, tap . You will go back to the "Define A New Tag" window. Tap , then adjust parameters from the "Configure Camera" window in the following ways to enhance tag definition.
- Turn off LED lighting.
 - Increase Exposure Sensitivity to 6EV.
 - Manually focus your Wrist Camera to obtain a crisp tag image.
 - To know exactly what your Wrist Camera sees, toggle the vision mode (default mode is ) to . This should make the tag squares stand out. If they are blurry or incomplete, adjust the Wrist Camera parameters until their shapes are all fully displayed on the Teach Pendant.
 - When you are satisfied with the image onscreen, tap . Proceed as previously instructed to attempt to define your tag.

6.3.2. Using a Tag in a Robot Program

Once a tag has been defined, you can start creating your robot program. The tag can serve as a reference point for moves in your program. Even if the tag moves (i.e. it is "offset"), the Wrist Camera can find its new location (see section **Find Visual Offset and Apply Visual Offset Nodes, and Defining Tags**), and quickly adjust your moves based on the value of the offset (see section **Find Visual Offset and Apply Visual Offset Nodes, and Defining Tags**).

Here is an example of a robot program using a tag and the nodes Find Visual Offset and Apply Visual Offset.



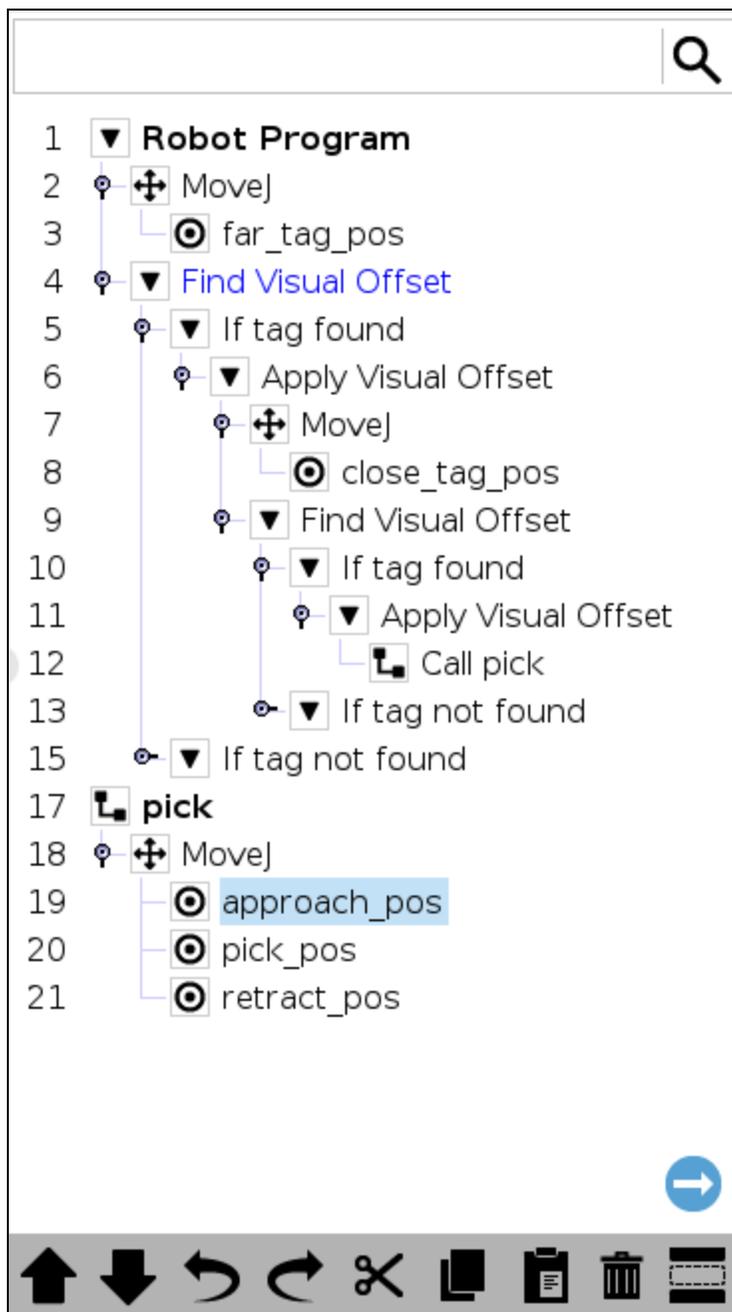


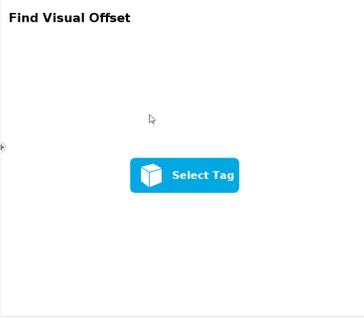
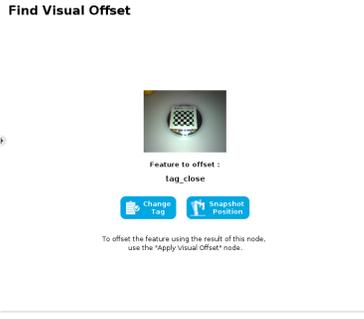
Fig. 6-30: This robot program detects a tag, then uses nodes Find Visual Offset and Apply Visual Offset .

6.3.3. Find Visual Offset Node

This node is used to calculate by how much a tag was moved, in reference to its value as calibrated previously. The value of the offset found by this Find Visual Offset node is temporarily saved, and you can reapply it in a Apply Visual Offset node. In the program shown in **Fig. 6-30**, the condition " If tag found" is under the Find Visual Offset node. If no tag is found, no visual offset is applied to the robot program. If a tag is found, a visual offset is applied, and the robot moves to take a closer picture (" close_tag_pos"). A Find Visual Offset node is run again at a close distance (recommended distance is 15 cm max). Then, the value of the offset found at this step is used by an Apply Visual Offset node, which applies it to the " Call pick" routine (see lines 17-21 in the robot program shown in **Fig. 6-30**).

Here is how to use the Find Visual Offset node.

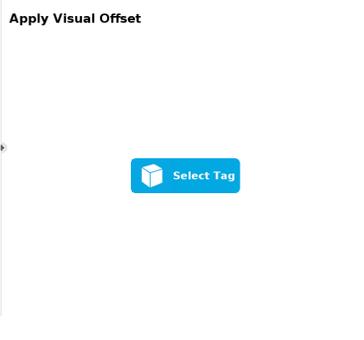


	<ol style="list-style-type: none"> 1. Select the node Find Visual Offset from the left navigation pane. 2. Tap .
	<ol style="list-style-type: none"> 3. The " Select Tag For Visual Offset" window is displayed. Tap the tag you wish to use for your Find Visual Offset node.
	<ol style="list-style-type: none"> 4. A tag is selected for the Find Visual Offset node.

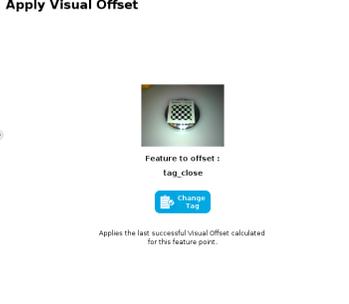
6.3.4. Apply Visual Offset Node

The Apply Visual Offset takes the value by which a tag has been offset, and modifies robot moves that are under this Apply Visual Offset node in the program. As a best practice, this node should be preceded by the condition " If tag found" . Otherwise, if no tag is found with the Find Visual Offset node, the Apply Visual Offset may use a value found at a different time, which may not reflect the current offset value.

Here is how to use the Apply Visual Offset node.

	<ol style="list-style-type: none"> 1. Select the node Apply Visual Offset from the left navigation pane. 2. Tap .
------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------



	<p>3. The " Select Tag For Visual Offset" window is displayed. Tap the tag you wish to use for your Apply Visual Offset node.</p>
	<p>4. A tag is selected for the Apply Visual Offset node.</p>

After inserting this node into your robot program, create the rest of your program under the Apply Visual Offset node. All robot moves will be adjusted based on the value injected by this node.

6.4. Save Image Node

You can take pictures with the Wrist Camera in the course of a robot program, and save them to a USB stick. This node is complementary to the Wrist Camera URCap nodes.

Since saving an image can take up to five seconds for high-definition images, this node might slow down your cycle time. We recommend using the Save Image node under "if_not_found" conditions. The picture taken can then be used either as an alternative means to collect data (e.g. for barcodes that could not be read or when no object is detected using a Cam Locate node), or as a quality assurance tool to document difficulties, and improve your process in the future. Those uses are but suggestions. Please use the Save Image node as it best suits your needs.



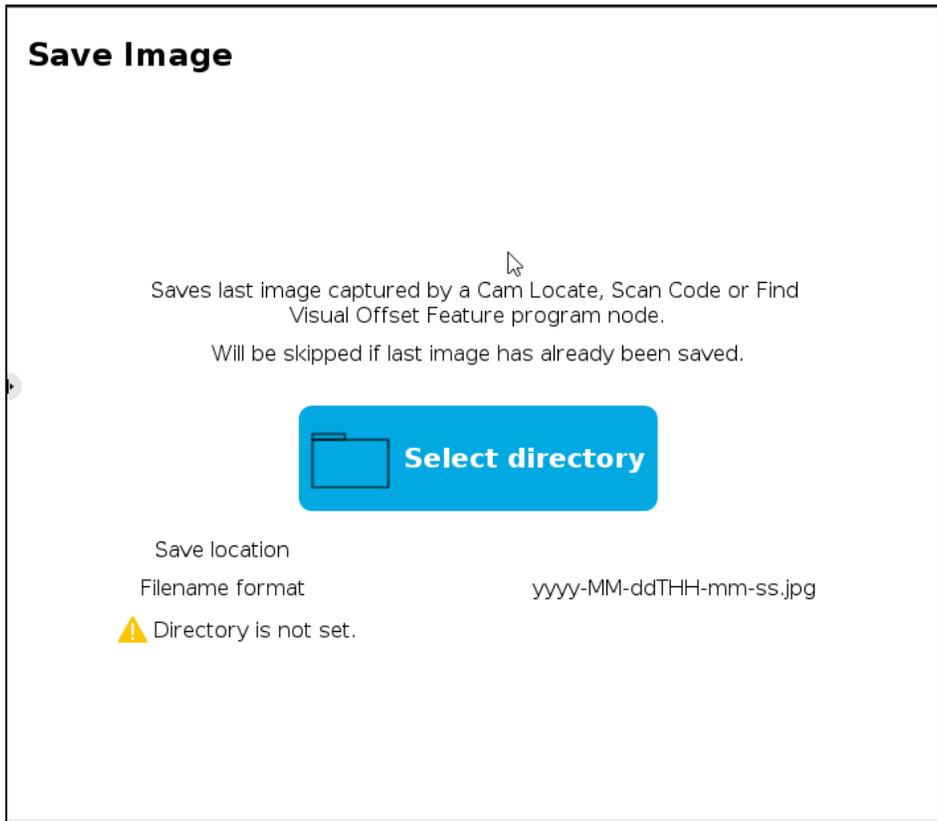


Fig. 6-31: The Save Image node.

To save images to a USB stick, tap .

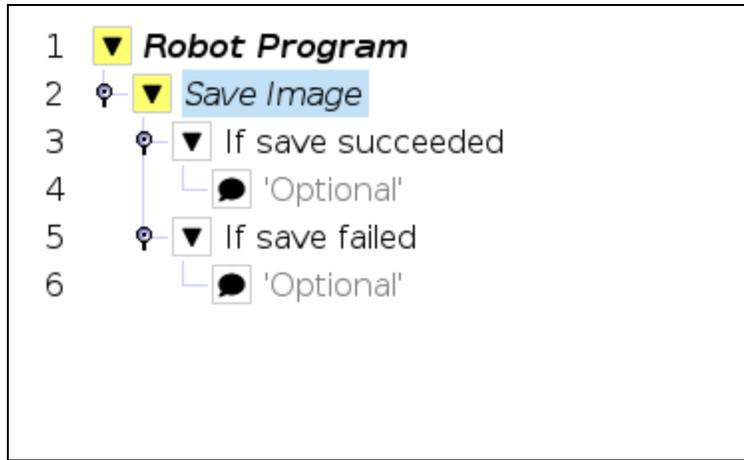


Fig. 6-32: The Save Image node in a robot program.

You can add different instructions following the Save Image node, based on its success or failure. Before adding those instructions, you will need to select the directory where images are saved.

Each image is saved in a separate .jpg file, and named as per this format: yyyy-MM-ddtHH-mm-ss.jpg.



7. User Interface

Visit the product page of the CNC Machine Tending Kit on robotiq.com/support to get the latest installer of the Robotiq User Interface along with appropriate documentation.

You can access the Robotiq User Interface Instruction Manual via robotiq.com/support. Select Browse by product > Hand-E Adaptive Gripper > Universal Robots > Robotiq User Interface, and either download the Instruction Manual, or view it online.



8. Specifications

Info

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

This section contains basic specification for your products. For more detailed data, see the Instruction Manual of the specific hardware bundled in the CNC Machine Tending Kit. These documents contain information on the mechanical specifications and electrical specifications of your hardware.

- Hand-E Instruction Manual, section [Specifications](#);
- Wrist Camera Instruction Manual, section [Specifications](#) (also covers the Vision System).

8.1 Technical dimensions

8.1.1 Dimensions of the Hand-E Gripper

The figure below represents the gripper dimensions with axes X, Y, Z, and origin referenced for finger motion.

Info

All technical drawings in the current section depict aluminum fingers.



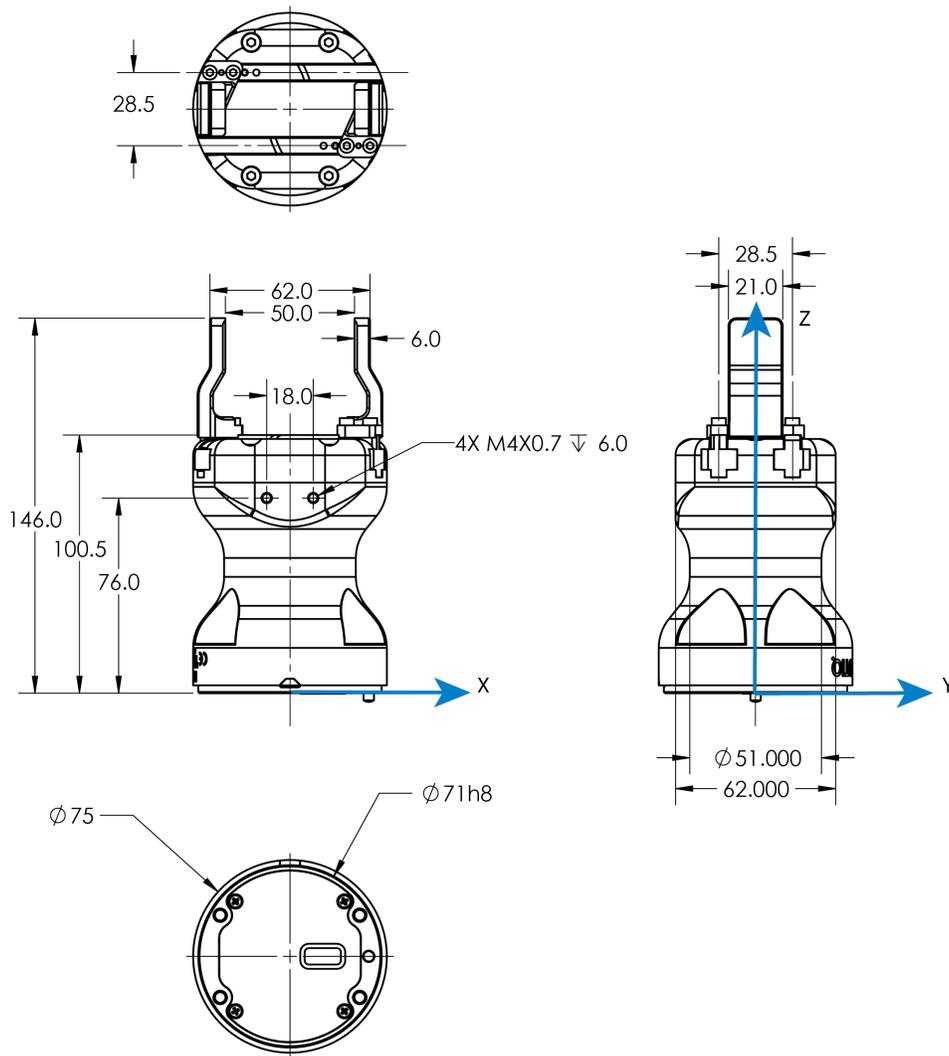


Fig. 8-1: General dimensions of Hand-E (open).

Couplings

Hand-E requires a coupling provided by Robotiq to operate. The coupling is mandatory since it integrates electronics and electrical contacts.

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

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

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



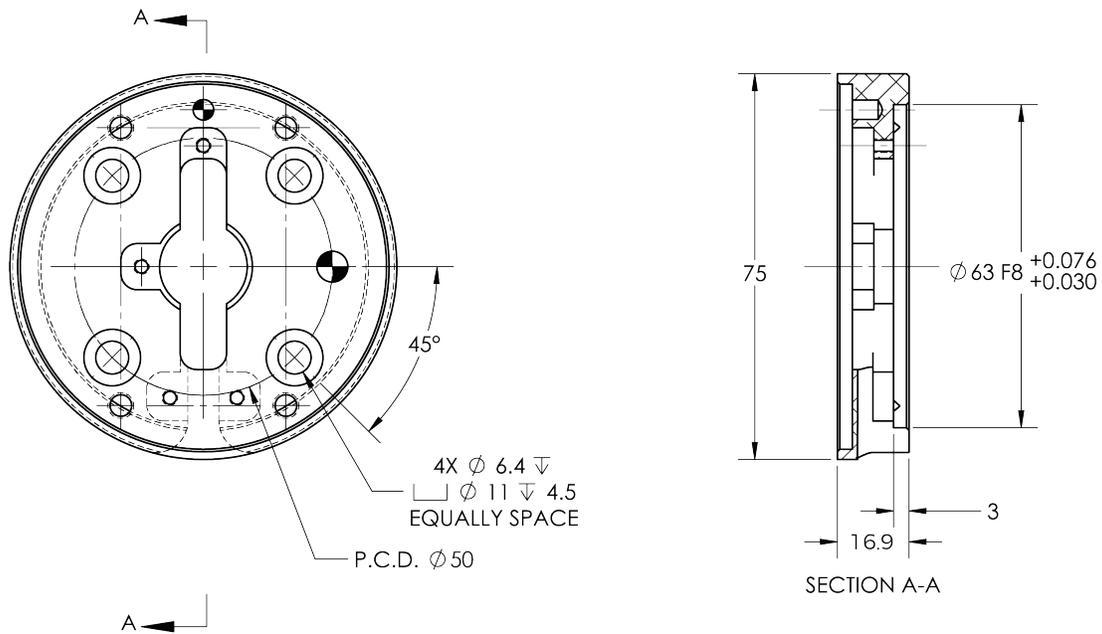


Fig. 8-2: Coupling for ISO 9409-1-50-4-M6.

Fingers and fingertips

The contact grip points for Hand-E are its two fingertip pads.

Different fingertips are available from Robotiq (see section **Spare Parts, Kits and Accessories**). Users can also create custom fingertips, as mentioned in section **Custom Fingers**. Custom fingertips must meet the following specifications:

- Forces exerted at the end of the fingertips must not exceed 100 N, regardless of the direction. See section **Moment and force limits** for more details.

Warning

The following limits must be respected at all times. Calculation of maximum moment and force should include robot acceleration and safety factors.

- See section **Mechanical specifications** to evaluate the grip force for your fingertip design.

Info

You can install custom fingertips directly on the rack or on the fingertip holder.

Tip

Fingertips can be mounted directly on racks or fingertip holders.

Racks

Fingers are installed directly on a rack, and this includes custom fingers. Flat rubber (NBR) overmolded fingers are mounted directly onto it.



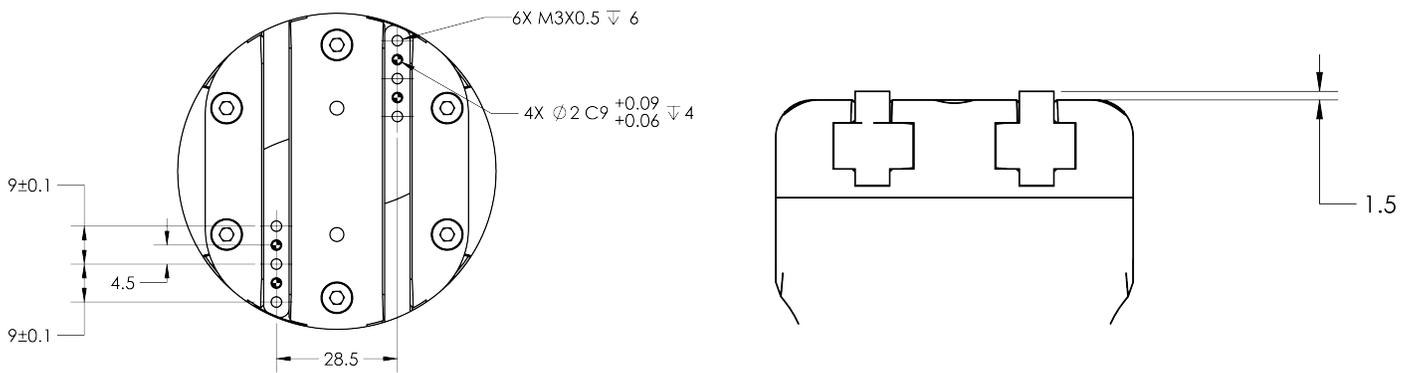


Fig. 8-3: Racks in rack housing.

Flat Rubber (NBR) Overmolded Fingers

The figure below represents flat rubber (NBR) overmolded fingers. For more details, see section **Spare Parts, Kits and Accessories**. This finger allows a 0-50 mm stroke.

Info

The stroke changes when installing the Fingertips Extender. See **Fig. 1-5** and **Fig. 1-6** for details on dimensions of the Fingertips Extender.

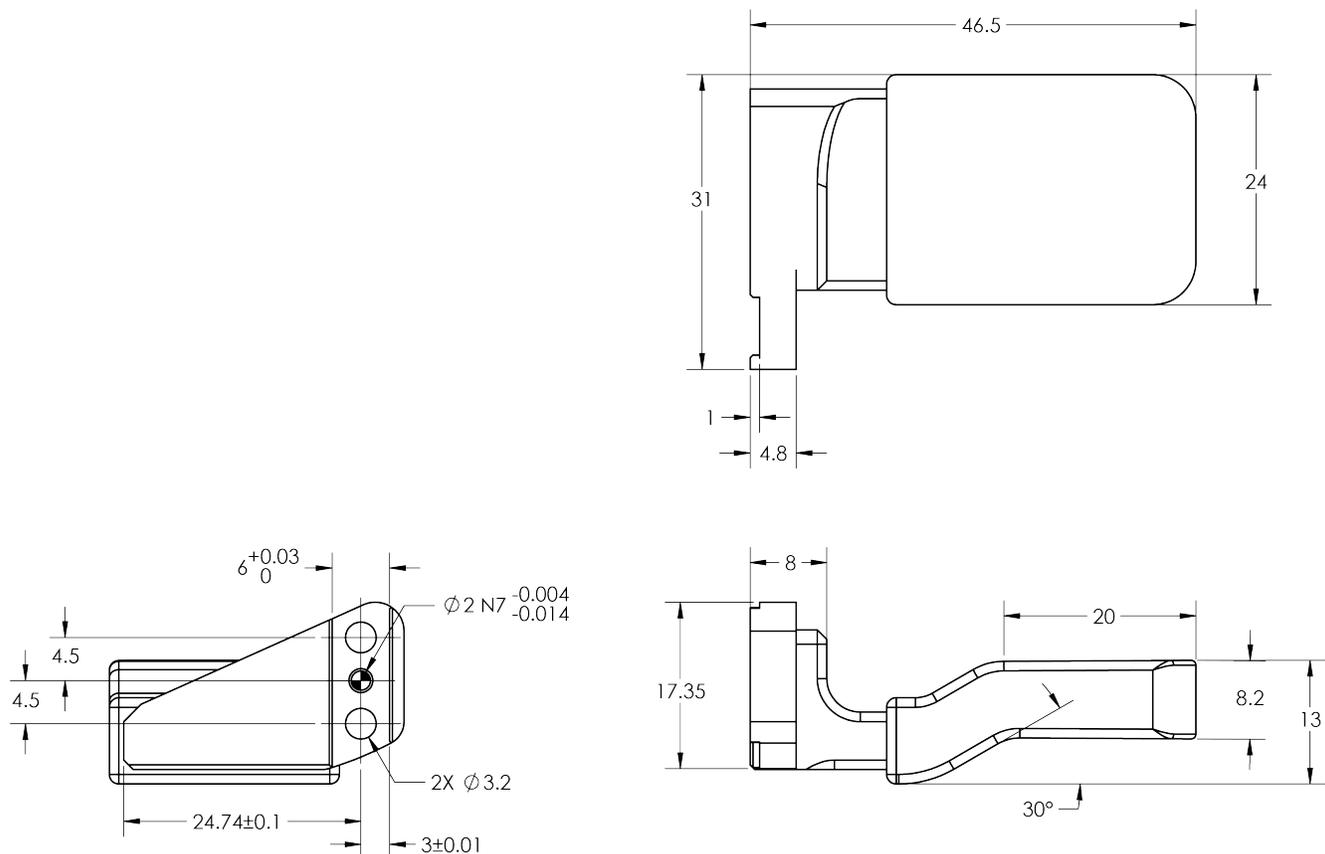


Fig. 8-4: Flat NBR overmolded finger is mounted on Hand-E by default.



8.12. Dimensions of the Wrist Camera

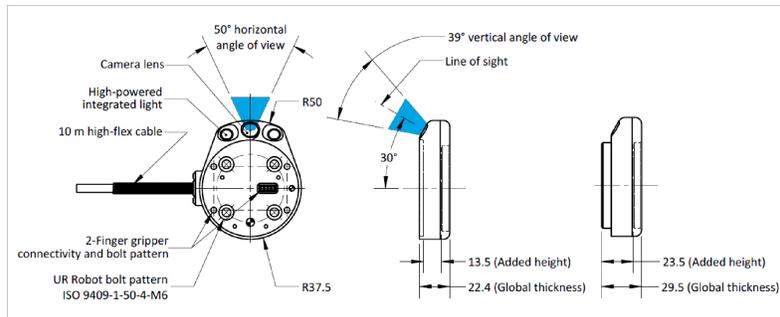


Fig. 8-5: Hardware of the Wrist Camera.

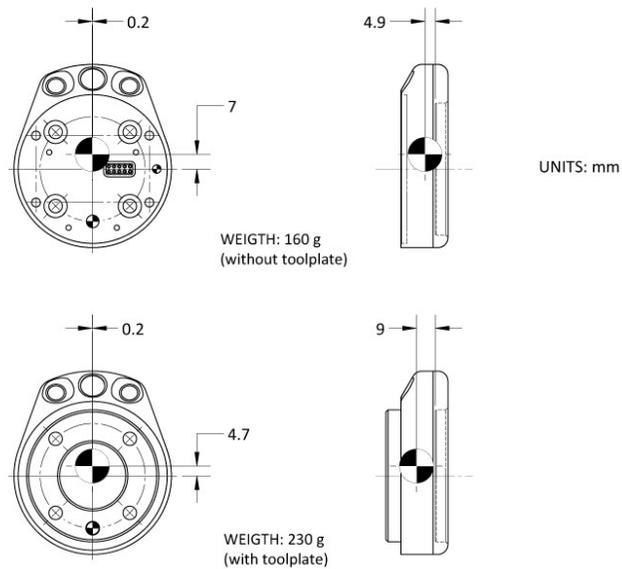


Fig. 8-6: Dimensions and weight of the Wrist Camera.

Specification	Value	
Maximum load	10 kg	40 Nm
Weight (without tool plate)	160 g	
Weight (with tool plate)	230 g	
Added height (without tool plate, for use with 2-Finger Gripper)	135 mm	
Global thickness (without tool plate)	224 mm	
Added height (with tool plate)	235 mm	
Global thickness (with tool plate)	295 mm	



8.2. Mechanical specifications

8.2.1 Hand-E Gripper Specifications

Specification	Metric Units	Imperial Units
Gripper opening	0 - 50 mm	0 - 1.97 in.
Maximum recommended payload, Form-fit grasp	5 kg	11 lbs
Maximum recommended payload, Friction grasp	3 kg	6.6 lbs
Gripper height (without fingertips)	100.5 mm	3.94 in
Gripper diameter	75 mm	2.95 in
Gripper weight (including coupling)	1070 g	2.3 lbs
Grip force	20 N- 130 N	4.5 lbf - 27 lbf
Finger speed	20 to 150 mm/s	0.8 to 5.9 in/s

Info

All specs are measured with coupling GRP-CPL-062 and aluminum fingertips.

Payload and force

Actuation force model used to calculate the recommended friction payload (W):

$$W = \frac{2FC_f}{S_f}$$

For advanced mathematics contents, refer to section [Mechanical Specifications](#) in the Hand-E Instruction Manual. Current section introduces you to basic or important concepts relative to designing custom fingers.

Warning

You must consider the **robot acceleration** in your payload calculations.
Robot emergency stops will lead to major deceleration velocities.

Maximum payload/External force vs. Custom finger design

The maximum payload force recommended depends on the distance on the Z-axis at which the force/payload (F) is applied when using custom fingers on the Hand-E gripper.



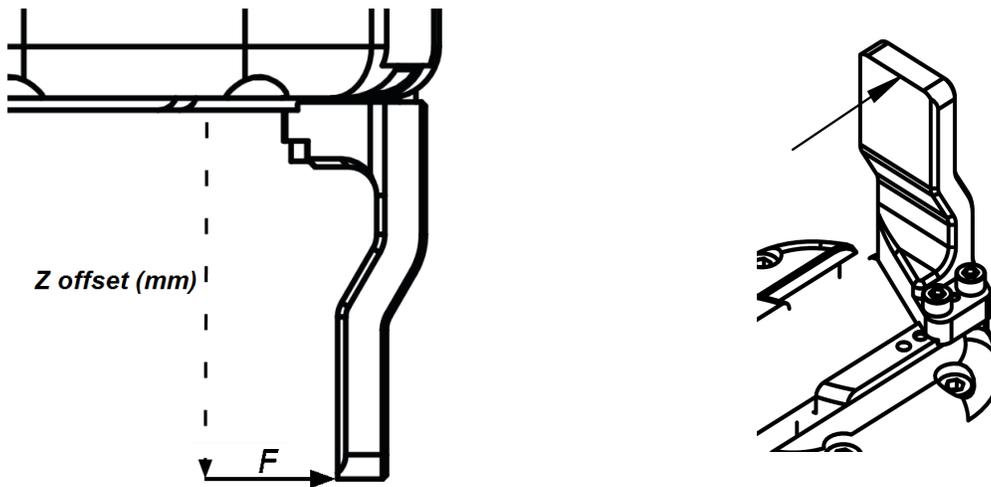


Fig. 8-7: Z-axis offset at which force/payload is applied (tip of the finger, in the middle of the inner surface)

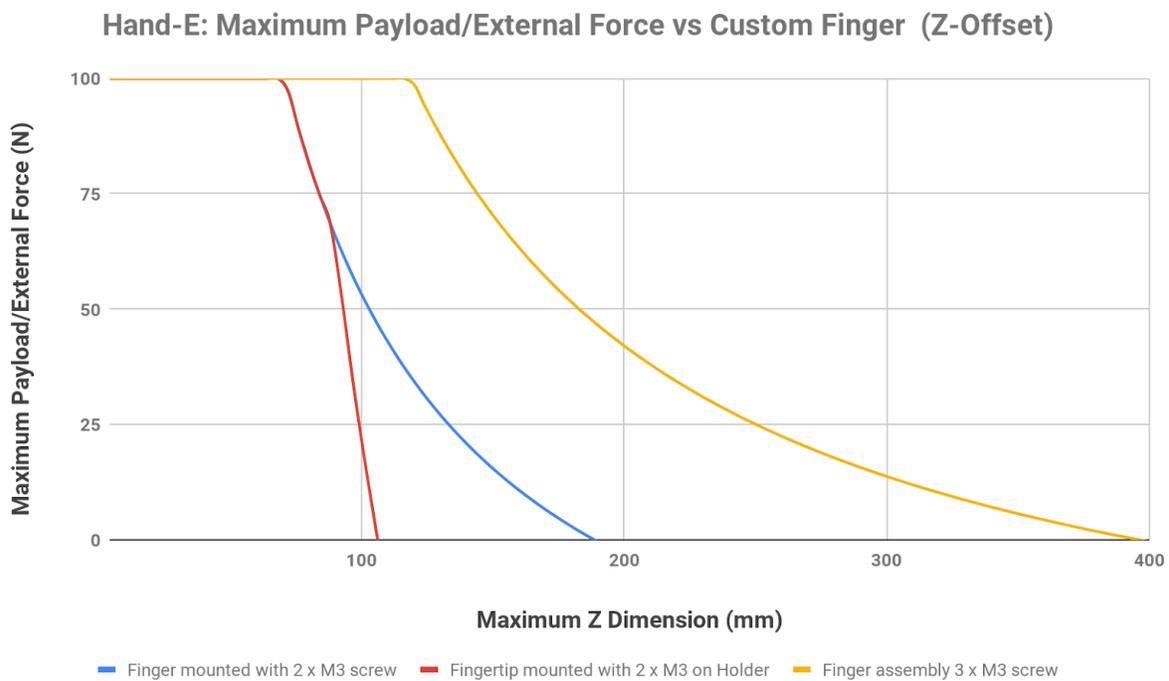


Fig. 8-8: Graph illustrating Maximum Payload/External Force vs. Z-Offset on Custom finger

- The **blue curve** in the graph represents the maximum force/payload (F) recommended at given Z offset for a custom finger design **mounted directly on the rack with two (2) M3 screws**.
- The **red curve** in the graph represents the maximum force/payload (F) recommended at given Z offset for a custom finger design **mounted on a fingertip holder with two (2) M3 screws**.
- The **yellow curve** in the graph represents the maximum force/payload (F) recommended at given Z offset for a custom finger design **mounted directly on the rack with three (3) M3 screws**.



Friction grasp and form-fit grasp

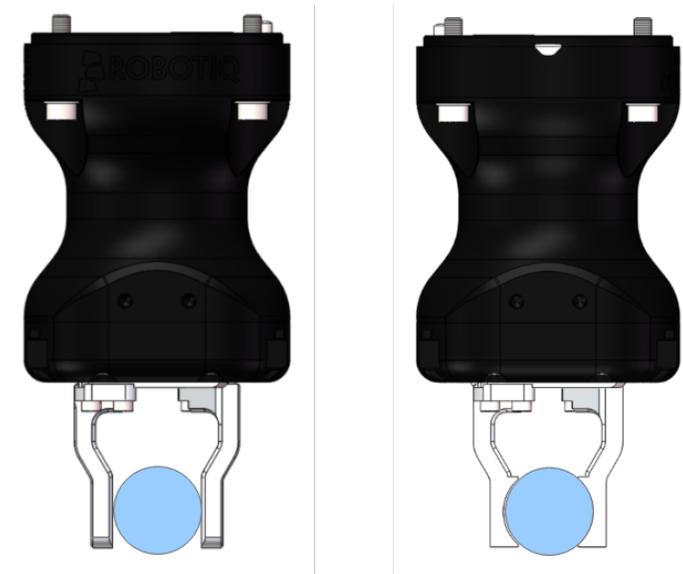


Fig. 8-9: Left: friction grasp; right: form-fit grasp.

Grasp Type	Maximum Payload
Friction grasp	3 kg
Form-fit grasp	5 kg

Table 8-1: Maximum payload by grasp type.

8.2.2. Center of mass and tool center point

Details are available for this CNC Machine Tending Kit in table **Values of center of mass, tool center point and mass for kits**.

8.2.3. Moment and force limits

Hand-E has limits for moment and force values. The maximum moment and force values are independent of the grasp force applied by the Gripper on its payload. For payload calculation, see section **Payload and force**. Moments in x and y are calculated from the base of the fingers.

8.3. Electrical specifications

8.3.1 Hand-E Electrical Specifications

SPECIFICATION	VALUE
Operating supply voltage	24 V DC $\pm 10\%$
Quiescent power (minimum power con-	1W



SPECIFICATION	VALUE
sumption)	
Peak current	11A

8.3.2. Wrist Camera Electrical Specifications

Robotiq recommends you supply the Wrist Camera via the Universal Robots robot controller. If you cannot do so, here are the electrical specifications of the Wrist Camera.

Specification	Value
Operating supply voltage	24 V DC \pm 20%
Quiescent power (minimum power consumption)	1W
Maximum power	22 W
Communication interface	USB 2.0

8.4. Image Specifications

8.4.1. For the Wrist Camera

Specification	Value
Maximum resolution	5 Mpx at 2 fps (2560 X 1920)
Maximum frame rate	30 fps at 0.3Mpx (640 X 480)
Active array size	2592 X 1944
Focus range	70 mm to ∞
Integrated lighting	6 LED diffuse white light
Autofocus technology	Liquid lens

8.4.2. For the Vision System

See section [Vision System Specifications](#) in the Wrist Camera Instruction Manual for detailed information on the following topics:

- Accuracy
- Calibration board position



- Field of view
- Part dimensions
- Background contrast



9. Maintenance

Hand-E requires only external maintenance with limited downtime.

Maintenance is required after specified usage, measured in cycles (open and close motion of the gripper).

Complying with the maintenance interval will ensure the following:

- Correct functioning of your gripper.
- Validity of your warranty.
- Proper lifetime for your gripper.

Warning

Unless otherwise indicated, any repairs done on the gripper will be performed by Robotiq.

Info

A cycle is defined as a go to requested position command that results in grip force being applied (picking an object while opening or closing or closing the fingers on themselves).

Operation	Daily	Weekly	1 M cycles	2 M cycles
Gripper Cleaning	Dirty conditions	Normal conditions		
Periodic Inspection			X	
Rack and pinion mechanism cleaning				X

Table 9-1: Maintenance Intervals for Hand-E grippers.

Maintenance guidelines are developed for an average use of Hand-E. However, it is necessary to take some environmental conditions into account:

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



9.1 Gripper Maintenance

Maintenance Interval	Required Tools	Parts You Need
Weekly Daily for dirty environments	<ul style="list-style-type: none"> • 4 mm hex key • Dry tissue or towel • Medium strength threadlocker 	None (unless damage is detected)

Info

Always turn off the robot and the gripper power supply before performing any maintenance operations.

Caution

The maintenance operator must be grounded to prevent electrostatic discharge that could damage gripper electronics.

1. Remove the gripper from its coupling using the 4 mm hex key to unscrew the four (4) M5-0.8 x 35mm socket head cap screws. Note that each screw uses a tooth lock washer; do not lose these.
2. Clean the gripper with a dry towel: remove all debris, dirt and dust from its surface, clean its pads, dry thoroughly.
3. Clean the coupling with a dry towel, paying attention to the electrical contact.
4. Visually inspect the gripper and look for any visible damage.
5. Put the coupling back on, and secure it with four (4) M5-0.8 x 35mm socket head cap screws. Use the tooth lock washers, and apply medium strength threadlocker to the M5 screws.

When cleaning grippers, check that fingers or fingertips are still intact. When you see wear, you can replace fingers or fingertips with those provided by Robotiq, or with custom fingers. See section Spare parts and accessories to order Hand-E replacement parts.

9.1.1 Replacing Fingers

1. Remove the worn finger by removing the M3 screws.
2. Clean the rack and dry thoroughly.
3. Insert the new finger on the rack.
4. Secure the finger using the provided M3 screws, apply low strength threadlocker to the M3 screw threads.
5. Repeat for other finger.

9.1.2 Replacing Fingertips

1. Remove the worn fingertip by removing the M3 screws.
2. Clean the fingertip holder and dry thoroughly.
3. Insert the new fingertip in the fingertip holder.
4. Secure fingertip to rack.
5. Secure the fingertip using the provided M3 screws, apply low strength threadlocker to the M3 screw threads.
6. Repeat for other fingertip.



9.2. Routine Inspection

Maintenance Interval	Required Tools	Parts You Need
Monthly	<ul style="list-style-type: none">• 4 mm hex key• Dry tissue or towel• Medium strength threadlocker	None (unless damage is detected)

Info

Always turn off the robot and the gripper power supply before performing any maintenance operations.

9.2.1 Monthly Routine Inspection

1. Remove and clean the gripper as described in section **Gripper Maintenance**.
2. Inspect gripper by checking the following elements.
 - Finger or fingertip wear must not affect gripping, if wear is visible and affects movement, change accordingly (refer to the **Gripper Maintenance**)
 - Check for any collision damage. If damage is visible, contact support@robotiq.com
 - Check for any sign of wear on the Gripper chassis; if wear is present and may affect the gripper, contact support@robotiq.com
3. Put back in place according to the instructions from section **Gripper Maintenance**.

9.3. Cleaning Racks and Pinion Mechanisms

Maintenance Interval	Required Tools	Parts You Need
Every 2M cycles or more frequently in dirty operating conditions	<ul style="list-style-type: none">• 4 mm hex key• Dry tissue or towel• Medium strength threadlocker	<ul style="list-style-type: none">• Grease (Mobilith SHC1500 or equivalent)• Degreaser

Info

Always turn off the robot and the gripper power supply before performing any maintenance operations.

9.3.1 Cleaning Procedure

1. Open the Gripper to an intermediate position, so you do not hide the six M5 screws holding the rack housing in place.
2. Remove the Gripper from its coupling using the 4 mm hex key to unscrew the four (4) M5-0.8 x 25mm screws. Note that each screw uses a toothlock washer; do not lose them.
3. Remove six M5 screws holding the rack housing.
4. Gently pull the rack housing away from the body of the Gripper.
5. Remove the pinion and key from the drive shaft, make sure you keep them in a safe space.



6. The finger's racks will slide off freely from the rack housing. Clean the rack housing, the racks and the pinion using a degreaser. Dry thoroughly. Clean the fingers (plus finger holders and fingertips, when applicable) with a dry towel. Remove all debris, dirt and dust.
7. Clean gripper itself with a dry towel. Dry thoroughly.
8. Clean gripper coupling with a dry towel, paying attention to the electrical contact.
9. Proceed as described in section **Gripper Maintenance**.
10. Visually inspect the gripper, and check for visible damage.
11. Grease up racks. Apply on all surfaces except the face with the tapped holes.

Info

Use Mobilith SHC1500 grease or an equivalent.

12. Insert the pinion with the key in the keyhole on the shaft.
13. Slide the racks back in the rack housing.
14. Reinsert the rack housing with racks on the Gripper. Make sure the racks go in symmetrically compared to the center of the gripper.
15. Secure the rack housing using six M5 screws.
16. Put the gripper back on the coupling, and secure it with four (4) M5-0.8 x 25mm screws. Use toothlock washers, and apply medium strength threadlocker to the M5 screws.



10. Spare Parts, Kits and Accessories

For spare parts, kits, and accessories available for purchase, see the Instruction Manual of the applicable Robotiq product. The current section only describes hardware provided as part of CNC Machine Tending Kits.

Info

Unless specified, screws, dowel pins and other hardware are only included for grippers, and not for robots.

Item	Description	Ordering Number
Hand-E Basic Gripper Unit	<ul style="list-style-type: none">• Hand-E basic gripper unit• Flat rubber (NBR) overmolded fingertips	HND-GRP-001
Hand-E Flat Rubber (NBR) Overmolded Fingers Kit	<ul style="list-style-type: none">• 2 x flat rubber (NBR) overmolded finger kits• Screws	HND-FIN-MLD-KIT
Aluminum Finger Kit	<ul style="list-style-type: none">• 2 x aluminum fingers• Screws	HND-FIN-ALU-KIT
Fingertip Starting Kit	<ul style="list-style-type: none">• 1 x Fingertips Holder Kit• 1 x V-Groove Fingertips Kit• 1 x Aluminum Fingertips Kit• 1 x hex key	HND-TIP-START-KIT
Hand-E V-Groove Fingertips Kit	<ul style="list-style-type: none">• 2 x V-groove aluminum fingertip• Screws <div data-bbox="545 1409 1242 1572" style="border: 2px solid green; padding: 5px;"><p>Tip V-Groove fingertips must be mounted on fingertip holders (HND-TIP-HLD-KIT).</p></div>	HND-TIP-VGR-KIT
Gripper coupling kit for e-Series without connector protector	<ul style="list-style-type: none">• Mechanical coupling• Screws	VAC-ES-CPL-062
Hand-E Fingertips Extender Kit	<ul style="list-style-type: none">• 2 x Fingertips Extender• Screws	HND-TIP-EXT-KIT



Item	Description	Ordering Number
2F-85 Fingertips Conversion Kit	<ul style="list-style-type: none"> • 2 x Fingertip adapters • Screws 	AGC-TIP-CONV-KIT
Machine Tending Copilot license dongle	<ul style="list-style-type: none"> • 1 x USB license dongle • 1 x Teach Pendant stylus • 1 x UR wrist axis sticker 	CP-MT-ES-UR-KIT
M8 splitter for dual coupling on URe-Series	<ul style="list-style-type: none"> • Male to 2 female, with 1:1 wiring • Screws 	ACC-SPLIT-M8-2:1
Adapter plate for dual- gripper	<ul style="list-style-type: none"> • 1 x 90-degree adapter plate (bolt pattern: ISO 9409-1:2004 4 X M6 ø 50mm) 	AGC-APL-159-002
Replacement Wrist Camera	<ul style="list-style-type: none"> • 1 x 10-m high flex cable • Screws 	RWC-CAM-001
Replacement calibration board for Wrist Camera	1x calibration board	ACC-CALIB-BOARD
Color background for Wrist Camera Vision System	1x colored background	ACC-TEACH-BACK
4-port USB hub splitter	1x 4-port USB hub splitter	ACC-USB-4-HUB
Replacement software license USB dongle for Wrist Camera	1x USB dongle	ACC-USB-DONGLE



11. Troubleshooting

11.1. Troubleshooting Grippers Using LED Colors

LED integrated on the Hand-E gripper provide information on the product status. See following table for more information on how to interpret colors and flashing/solid/unlit types of lighting.

LED status	Description	Solutions
Off	Gripper not powered.	Check gripper power supply and electrical set up.
Solid blue and solid red	Gripper is in fault.	<ul style="list-style-type: none">• Disconnect the communication and power cycle the Gripper. LED should turn solid red when powered.• While powered with red LED, connect the communication, LED should turn solid blue when connection is established.
Blinking blue and blinking red	Gripper is in fault.	<ul style="list-style-type: none">• Gripper may be in auto-release. Wait for auto-release to complete, then turn off auto-release, and initialize the gripper.• Gripper may have a major fault. Check the error from fault status and contact support.
Solid blue	Communicating.	<ul style="list-style-type: none">• If you can control the gripper from the Teach Pendant, check your robot program.• If you cannot control the gripper via the Teach Pendant, contact support@robotiq.com.
Solid red	Not communicating.	Contact support@robotiq.com .

11.2. Troubleshooting Grippers Using the Teach Pendant

1. Check that the latest version of the gripper URCap is installed. See section **Installing URCap files** for details.
2. If the version is up-to-date, but gripper cannot be controlled, check the following.
 - a. If gripper LED is not blue, see section **Troubleshooting Grippers Using LED Colors**
 - b. If gripper LED is blue, the installed URCap is up-to-date, please contact support@robotiq.com

11.3. Troubleshooting the Wrist Camera Using LED Colors

LED status	Description	Solutions
Off	Wrist Camera not powered.	Check Wrist Camera power supply and electrical set up.



LED status	Description	Solutions
Solid blue and solid red	In fault or booting.	<ul style="list-style-type: none"> • Wait for the booting sequence to complete. • If the LED remains solid blue and solid red after the booting sequence, follow these instructions: <ol style="list-style-type: none"> 1. Disconnect the USB cable from the Wrist Camera. 2. Reconnect the USB cable to the Wrist Camera, and power it on. 3. The red LED should be solid red. Reconnect the USB cable to the Wrist Camera. 4. When the Wrist Camera successfully communicates with the Vision Server, the LED should turn solid blue. 5. Go to the Installation tab , and tap Start camera.
Solid red	Not communicating.	<ul style="list-style-type: none"> • Check if the Vision Server is started. <ul style="list-style-type: none"> • If not, start it. • If it already is started, stop it, then restart it. <p>Follow these instructions to start the Vision Server.</p> <ol style="list-style-type: none"> 1. Go to the Installation tab > Camera > Camera tab. 2. Tap Start camera to start the Vision Server. The output image is shown on the Teach Pendant, and the Wrist Camera LED turns blue. <ul style="list-style-type: none"> • Check if the USB cable is properly connected. • Check if the Wrist Camera URCap is up-to-date.
Blinking blue and blinking red	Major fault: a) input voltage to the Wrist Camera is not sufficient or b) the Wrist Camera temperature is over 70°C.	<ul style="list-style-type: none"> • Confirm that power supply is 24V DC, $\pm 10\%$. • The Wrist Camera should not operate over 50°C.
Solid blue	Communicating.	If you cannot control the Wrist Camera via the Teach Pendant, contact support@robotiq.com .



12. Hand-E Warranty and Patent

Robotiq warrants Hand-E 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.

The warranty applies under the following conditions:

- Usage respects the operating and storage conditions specified in the **Installation**
- Proper installation of the Gripper specified in the **Installation** and following subsections.
- Until a 2 000 000 cycle count¹ has been reached.
- Usage respects maintenance specified in the **Maintenance**.
- Usage respects recommended payload and forces specified in the **Mechanical specifications**.

Info

Cycle count: One (1) cycle is defined as an object picking attempt, successful or not (open or closing onto an object, or closing on itself). It is calculated in the internal memory of the Hand-E and can be seen on the Teach Pendant when using with Universal Robots or with the Robotiq User Interface.

During the warranty period, Robotiq will repair or replace any defective Hand-E, as well as verify and adjust the 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 Gripper fingers cannot close or open;
- The Gripper feedback necessary for the robot program is not accessible.

Parts that come into contact with the work piece and wearing parts such as the finger and fingertips are 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.
- The warranty sticker has been removed.
- The screws, other than as explained in this guide, have been removed.
- The 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 Hand-E, nor shall Robotiq be responsible for any failure in the performance of other items to which Hand-E is connected or the operation of any system of which the Gripper may be a part.



13. Hand-E Harmonized Standards, Declarations and Certificates

13.1. Translation of original EC declaration of incorporation



Translation of Original Declaration of Incorporation

In terms of the Directive 2006/42/EC, Annex II, part B of the European Parliament and of the Council on machinery, we, the manufacturer,

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

hereby declares that the following product:

Robotiq Hand-E Gripper

meets the applicable requirements of the **Machinery Directive 2006/42/EC** of the European Parliament and of the Council. The incomplete machine may not be operated until the machine in which it is integrated has been declared compliant with the relevant provisions of the 2006/42/CE Machinery Directive.

The manufacturer agrees to forward upon request of national competent authorities the relevant technical documents specified by Annex VII, part B, within the required time.

Additionally, the product declares in conformity with the following directives, according to which the product is CE marked:

2011/65/EU Restriction of the use of certain hazardous substances (RoHS)

Person responsible for documentation: Annick Mottard, Jr. Eng., address: see manufacturer address

Lévis, May 2018

Jean-Philippe Jobin
Vice President Research and Development
Robotiq Inc.

The following standards have been applied:

NF EN ISO 12100	2010	Safety of machinery — General principles for design — Risk assessment and risk reduction
CEI 60204-1 Ed6.0	2016	Safety of machinery — Electrical equipment of machines — Part 1: General requirements
NF EN ISO 14539	2000	Manipulating industrial robots — Object handling with grasp-type grippers — Vocabulary and presentation of characteristics





13.2. Applied standards

This section describes all applied harmonized standards for the design and production of the Robotiq CNC Machine Tending Kit. Standards are applied where applicable, some points may not be applied if not applicable to this specific product. Conformity is not enforced by any laws, it is self-applied and the aim is to define normal safety and performance requirements for similar products.

Caution

Conformity of the product is only met if all instructions of this manual are followed. Among others: installation, safety measures and normal usage must be met.

The following standards have been applied:

NF EN ISO 12100	2010	Safety of machinery — General principles for design — Risk assessment and risk reduction
CEI 60204-1 Ed6.0	2016	Safety of machinery — Electrical equipment of machines — Part 1: General requirements
NF EN ISO 14539	2000	Manipulating industrial robots — Object handling with grasp-type grippers — Vocabulary and presentation of characteristics
NF EN ISO 9409-1 2004	2004	Manipulating industrial robots — Mechanical interfaces — Part 1: Plates



13.3. Ingress Protection Certificate



October 12th 2018

Purpose: Ingress Protection (IP67) – Hand-E Test Certificate

To whom it may concern,

This certificate is to attest that Ingress Protection (IP) tests were carried out by NTS Canada in the months of June and July 2018 on Hand-E units manufactured by Robotiq. No ingress of dust or water was observed inside the units after the tests. No insertion of the rod or induced damage was observed. No functional anomaly was noticed or reported by the Robotiq engineering representative on-site during the tests. This test certificate does not supersede the test report FTR0201898 Rev 00 issued by NTS Canada.

The acceptance status for the units tested is "PASS" for the following tests;

- Ingress protection against access to hazardous parts – Rod (code IP6X)
- Ingress protection against solid foreign objects - Dust (code IP6X)
- Ingress protection against immersion in water (code IPX7)

Sincerely yours,

**Jean-Pierre
Rioux**

Digitally signed by Jean-Pierre
Rioux
DN: cn=Jean-Pierre Rioux, o,
ou=NTS Canada Inc.,
email=Jean-
Pierre.Rioux@NTS.com, c=CA
Date: 2018.10.12 11:31:11 -0400

Jean-Pierre Rioux, P. Eng.
Lab Manager
National Technical Systems Canada inc.
2425 Industrial Blvd
Chambly, Quebec
J3L 4W3 Canada



14. Wrist Camera Warranty and Patent

Robotiq warrants the Wrist Camera and Vision System 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.

Warranty applies under the following conditions:

- Usage respects the operating and storage conditions specified in the **Installation**.
- Proper installation of the Wrist Camera specified in the **Installation** and the following subsections.
- Usage under normal one-shift operation (40 h a week)
- Usage respects maintenance specified in the Maintenance section.
- Usage respects recommended payload and forces specified in the Mechanical Specifications of Wrist Camera section.

During the warranty period, Robotiq will repair or replace any defective Wrist Camera, as well as verify and adjust the Camera 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 Camera does not output any image;
- The Camera feedback necessary for the robot program is not accessible;
- The Vision System USB memory, USB hub or USB dongle are inoperable;

Caution

The warranty will become null and void if the :

- Unit has been tampered with, repaired or worked on by unauthorized individuals.
- Warranty sticker has been removed.
- Screws, other than as explained in this guide, have been removed.
- Unit has been opened.
- 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 Robotiq Wrist Camera or Robotiq Vision System, nor shall Robotiq be responsible for any failure in the performance of other items to which the Wrist Camera is connected or the operation of any system of which the Vision System 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 Wrist Camera, the Vision System 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.



15. Wrist Camera Harmonized Standards, Declarations and Certificates

15.1 Declaration of Incorporation



Translation of Original Declaration of Incorporation

In terms of the Directive 2006/42/EC, Annex II, part B of the European Parliament and of the Council on machinery, we, the manufacturer,

Robotiq Inc.
966, Chemin Olivier, suite 325
Lévis, Québec, Canada, G7A 2N1

hereby declare that the following product:

Robotiq Vision System

meets the applicable requirements of the **Machinery Directive 2006/42/EC** of the European Parliament and of the Council. The incomplete machine may not be operated until the machine in which it is integrated is declared compliant with the relevant provisions of the 2006/42/CE Machinery Directive.

The manufacturer agrees to forward, upon request of national competent authorities, the relevant technical documents specified by Annex VII, part B, within the prescribed time.

Additionally, the product declares in conformity with the following directives, according to which the product is CE marked:

2014/30/EU	Electromagnetic Compatibility Directive (EMC)
2011/65/EU	Restriction of the use of certain hazardous substances (RoHS)

Person responsible for documentation: Annick Mottard, Jr. Eng., address: see manufacturer address

Lévis, November 2017

Jean-Philippe Jobin
Vice President Research and Development

Robotiq Inc.

The following standards have been applied:

NF EN ISO 12100	2010	Safety of machinery — General principles for design — Risk assessment and risk reduction
CEI 60204-1 Ed6.0	2016	Safety of machinery — Electrical equipment of machines — Part 1: General requirements



15.2. Ingress Protection Certificate



October 12th 2018

Purpose: Ingress Protection (IP67) – Wrist Camera Test Certificate

To whom it may concern,

This certificate is to attest that Ingress Protection (IP) tests were carried out by NTS Canada in the months of June and July 2018 on Wrist Cameras manufactured by Robotiq. No ingress of dust or water was observed inside the units after the tests. No insertion of the rod or induced damage was observed. No functional anomaly was noticed or reported by the Robotiq engineering representative on-site during the tests. This test certificate does not supersede the test report FTR0201898 Rev 00 issued by NTS Canada.

The acceptance status for the units tested is "PASS" for the following tests;

- Ingress protection against access to hazardous parts – Rod (code IP6X)
- Ingress protection against solid foreign objects - Dust (code IP6X)
- Ingress protection against immersion in water (code IPX7)

Sincerely yours,

**Jean-Pierre
Rioux**

Digitally signed by Jean-Pierre
Rioux
DN: cn=Jean-Pierre Rioux, o,
ou=NTS Canada Inc.,
email=Jean-
Pierre.Rioux@NTS.com, c=CA
Date: 2018.10.12 11:32:13
-0400'

Jean-Pierre Rioux, P. Eng.
Lab Manager
National Technical Systems Canada inc.
2425 Industrial Blvd
Chambly, Quebec
J3L 4W3 Canada



16. Contact

www.robotiq.com

Contact Us

Phone

1-888-ROBOTIQ (762-6847)
(+ 1) 418-380-2788 Outside US and Canada

Fax

1-418-800-0046

Technical support

Extension 3

Sales

Extension 2

Head office

Robotiq
966 chemin Olivier
Suite 500
Lévis, Québec
G7A 2N1
Canada



Where automation Pros come to share their know-how and get answers.

dof.robotiq.com

