



# FINISHING *KITS*

Original Notice

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Robotiq Finishing Kits  
Instruction Manual



Instruction Manual

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# Revisions

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

## 2021-08-13

Update of section 3 : Installation

Added section 4.2 : Visible Nodes using Copilot

Update of Section 4.4 : ActiveDrive Toolbar

Update of section 5.3 : Mechanical specifications

Added section 5.4 : Center of mass and tool center point

Update of section 8 : Spare Parts, Kits and Accessories

## 2020-04-16

Update of the Dynabrade finishing tool models compatible with the Finishing Kits.

## 2020-03-02

Initial release: Note that the Sanding Kit instructions are now included in this manual.



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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

## Info

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

## 1.1. Robotiq Finishing Kits

The term " Finishing Kits" used in the following manual, refer to the Robotiq Surface Finishing Kit and the Robotiq Sanding Kit, unless otherwise specified. This Robotiq Kit is compatible with e-Series and CB-Series Universal Robots and with all **Mirka** and **Dynabrade** finishing tools mentioned in this manual. The Kits can fit with an important variety of material surfaces, as wood, plastic, metal, fiberglass, solid surface and carbon fiber and are the only all-in-one hardware and software solution for cobots that allow a quick programming, the generation of complex paths and a part position validation.

### 1.1.1. Surface Finishing Kit

The Surface Finishing Kit is part of the Robotiq Finishing Kits. It includes a **Mirka** and a **Dynabrade** bracket, the Robotiq Finishing Copilot software (in a dongle for e-Series) and a valve accessories kit. CB-Series kits also include an FT 300-S Force Torque Sensor for force and torque data acquisition and in which the software is included. It can fit with Mirka and Dynabrade finishing tools and can be used for finishing applications such as polishing and sanding.

### 1.1.2. Sanding Kit

The Sanding Kit is now part of the Robotiq Finishing Kits. It includes the Robotiq Finishing Copilot software (in a dongle for e-Series), an air control accessories kit and the Dynabrade orbital sander model 56819B and its bracket. CB-Series kits also include an FT 300-S Force Torque Sensor for force and torque data acquisition and in which the software is included. Note that the Sanding Kit can also fit with Dynabrade models 56854B, 56819B, 56830B, 56863B, 57404B, 57814B.

### 1.1.3. Robotiq FT 300-S Force Torque Sensor

The installation of the Finishing kits on CB-Series robots require the preliminary installation of the Robotiq FT 300-S Force Torque Sensor .

## Info

The Robotiq FT 300-S Force Torque Sensor will have to be used if a CB-Series Universal Robot is used.

The terms "Sensor", "Robotiq Sensor", " Force Torque Sensor", " Force Sensor", used in the following manual refer to the Robotiq FT 300-S Force Torque Sensor unless specified. The Robotiq FT 300-S Force Torque Sensor is a robotic peripheral designed for force and torque data acquisition.

## Info

The following section presents key features of the Sensor, and must not be considered as being related to Sensor operation. Every feature is detailed in the applicable section of the manual. Safety guidelines must be read and understood before any operation is attempted with the Sensor.



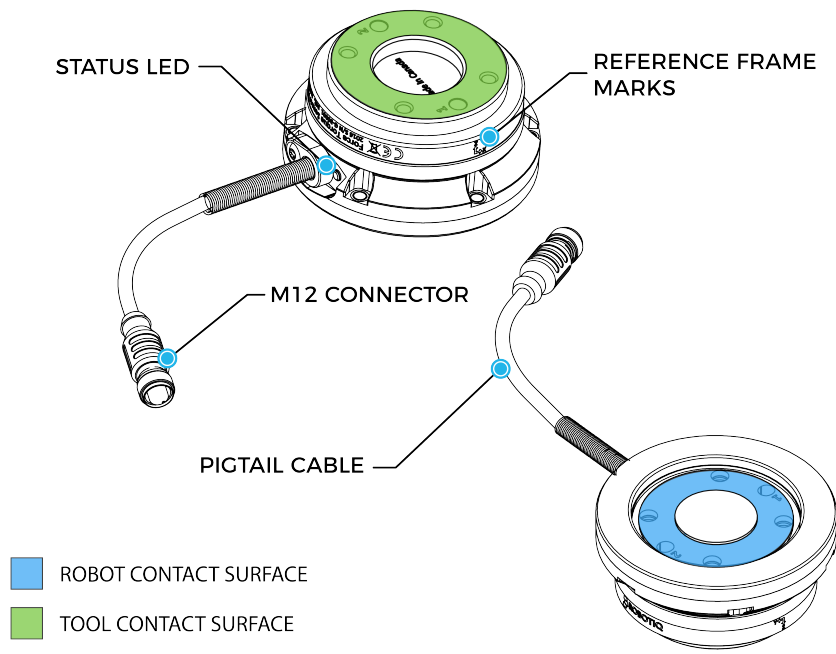


Fig. 1-1: General presentation of the Robotiq Force Torque Sensors with main features.

## Main features

- The end-of-arm tool contact surface (in green) is the only point of contact allowed between the Sensor and the tool to ensure correct force and torque feedback.
- The robot contact surface (in blue) is the only contact point allowed between the Sensor and the robot for fastening the sensor to the robot. Note that the inside ring must not touch the robot.

### Info

Details on the bolt pattern and dowel pin for the tool side and the robot side can be found in the **Specifications** section.

- M12 connector allows for both power and data transfer for the Sensor.
- Status LED provides visual information on the status of the Sensor, see **Status LED section** of the Copilot Instruction Manual for details.



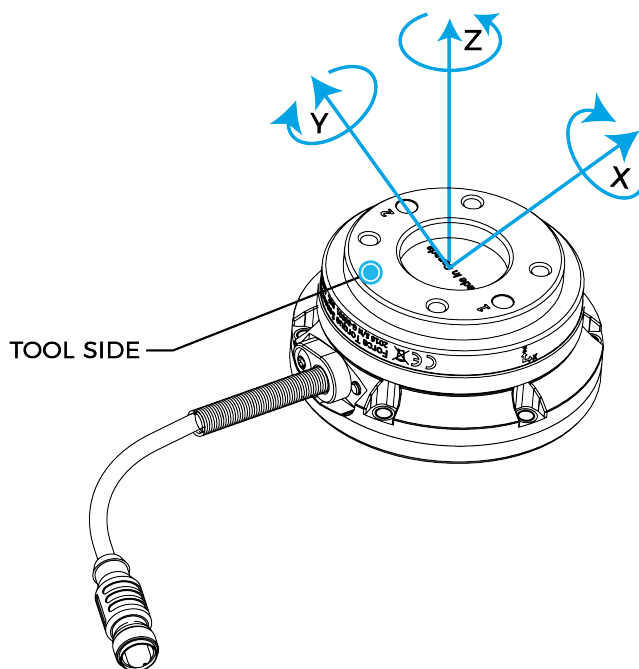


Fig. 1-2: FT 300-S Force Torque Sensor force and torque diagrams.

The figure above represents the various forces and torques that the FT 300-S Force Torque Sensor can measure. Reference frame is centered on the Sensor as shown above and visual inscriptions are also represented on it.

- The Z axis passes through the center of the depression with positive direction in the tool direction.
- The X axis traces a symmetric line centered on the connector; the positive direction points the opposite way away from the connector.
- The Y axis uses the right hand thumb rule according to X-Z.



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## 2. Safety

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### Warning

The operator must have read and understood all the instructions in this manual before handling one of the Robotiq Finishing Kits and using the license mentioned in this manual.

### Info

The term "operator" refers to anyone responsible for any of the following operations, associated robot or tools, with the Robotiq products and license mentioned in this instruction manual:

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

### Info

The drawings and pictures in this documentation are representative examples and differences may exist between them and the delivered product.

## 2.1. Warning

### Info

Any use of the Finishing Kits in noncompliance of these warnings is inappropriate and may cause injury or damage.

### Warning

A force torque sensor used in human-robot collaboration must not be considered a complete safety measure, additional dedicated safety device(s) must be considered. Sensor failure can occur and result in danger for workers or machinery. See local or international safety measure for human-robot collaboration.



### Finishing Kits Warning

- The hardware components of the Finishing Kits need to be properly secured before operating the robot.
- Eye protection must be worn at all times when using finishing tools.
- Keep fingers, clothes and hair away from the sanding tool while the power is on.
- Do not install or operate Finishing Kits that are damaged or have lacking parts.
- Be sure no one is in the robot and/or tooling path before initializing the robot's routine.
- Always meet the Finishing Kits payload specifications.
- Some dust created by sanding contain chemicals. Work in a well ventilated area or wear appropriate protection.
- Do not use the Finishing Kits in potentially explosive atmospheres.
- Make sure no one is in the robot and/or the Finishing Kit's path before initializing the robot's routine.
- Potentially explosive atmospheres can be caused by dust and fumes resulting from sanding or grinding. Always use dust extraction or suppression systems which are suitable for the material being processed.
- All local safety measures and/or laws on robot operation must be applied to all the Robotiq products mentioned in this instruction manual.
- Do not use any of the Robotiq products on people or animals.
- Refer to the finishing tool's instruction manuals for further warnings and safety considerations.

### Sensor Warning

- Never supply the Sensor with an alternative current source.
- Make sure all cord sets are always secured at both ends, at the Sensor and at the robot controller.
- Always meet the recommended keying for electrical connections.



## 2.2. Intended Use

### Info

Always comply with local and/or national laws, regulations and directives on automation safety and general machine safety.

### 2.2.1. Robotiq Finishing Kits

Finishing Kits are designed to perform process-to-part sanding and finishing applications using Universal Robots UR10e/UR10 and UR16/UR16e robots. The software of the Kits was created to teach complex trajectories with only few information and to edit this trajectory rapidly. It was also designed to control the robot so it applies a constant force onto a surface during the sanding or polishing process. Refer to the respective sanding tool's instruction manuals to have more details on its intended use.

The unit may be used only within the range of its technical specifications. 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.

#### 2.2.2. FT 300-S Force Torque Sensor

- The Sensor is designed for data acquisition (force and torque sensing) for an end-of-arm tool on a robot.
- The Sensor is intended for installation on a robot or other automated machinery or equipment.
- The software is used for the implementation of a force torque sensor's operational commands in a user interface.

The unit may be used only within the range of its technical specifications. 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.



## 3. Installation

### 3.1. Scope of delivery

#### 3.1.1. Surface Finishing Kit for UR e-Series

Surface Finishing Kit (SURF-ES-UR-KIT)
1 x Finishing Copilot dongle license (CP-FIN-ES-UR-KIT)
1 x Mounting Kit for Dynabrade Orbital Sanders (SAND-APL-ROS-001)
1 x Mounting Kit for Mirka Orbital Sanders (SAND-APL-ROS-002)
1 x Air Control accessories (ACC-AIR-001)

#### 3.1.2. Surface Finishing Kit for UR CB-Series

Surface Finishing Kit (SURF-FTS-S-CB-UR-KIT)
1 x FT 300-S Force Torque Sensor Kit for UR (FTS-300-S-UR-KIT)
1 x Mounting Kit for Dynabrade Orbital Sanders (SAND-APL-ROS-001)
1 x Mounting Kit for Mirka Orbital Sanders (SAND-APL-ROS-002)
1 x Air Control accessories (ACC-AIR-001)

#### 3.1.3. Sanding Kit for UR e-Series

Sanding Kit (SAND-ES-UR-KIT)
1 x Finishing Copilot dongle license (CP-FIN-ES-UR-KIT)
1 x Air Control accessories (ACC-AIR-001)
1 x Sander & Mounting Kit Dynabrade (SAND-ROS-001)



### 3.1.4. Sanding Kit for UR CB-Series

Sanding Kit (SAND-FTS-S-CB-UR-KIT)
1 x FT 300-S Sensor Kit for UR (FTS-300-S-UR-KIT)
1 x Sander & Mounting Kit Dynabrade (SAND-ROS-001)
1 x Air Control accessories (ACC-AIR-001)

### 3.1.5. Sander models compatible with the Finishing Kits

Mirka Finishing tool	Dynabrade Finishing tool
MR-30, MR-34, MR-350, MR-350CV, MR-35SVG, MR-38CV, MR-5, MR-508, MR-525, MR-5V, MR-6, MR-608, MR-625, MR-6V, MROS-150, MR-150NV, MR-325CV	56854B 56819B 56830B
MROS-325NV, MROS-343CV, MROS-383CV, MROS-525CV, MROS-550CV, MROS-625CV, MROS-650CV	56863B 57404B
MRPS-300CV	57814B

#### Info

Availabilities of the different sanders may change without notice. Please contact the sander's supplier for more information.

## 3.2. Environmental and Operating Conditions

### 3.2.1. Surface Finishing Kit & Sanding Kit

Finishing Kits are designed for industrial applications and can be used in an ambient temperature of 5°C to 40°C.

The Kits must be in an environment free of:

- Corrosive liquids or gases
- Explosive liquids or gases
- Powerful electromagnetic interferences



### 3.2.2. FT 300-S Force Torque Sensor

The FT Sensor is designed for industrial applications. Always respect the following specified storage, transport and operating environmental conditions:

Conditions	Values
Minimum storage / transit temperature	-30°C
Maximum storage / transit temperature	70°C
Minimum operating temperature <sup>1</sup>	5°C
Maximum operating temperature <sup>1</sup>	40°C
Humidity (non-condensing)	20-80% RH
Maximum vibration (storage / transit)	5G
Maximum vibration (operating)	2G
IP rating	IP 652,3
Other	<ul style="list-style-type: none"> <li>• Free from corrosive liquids or gases</li> <li>• Free from explosive liquids or gases</li> <li>• Free from powerful electromagnetic interference</li> </ul>

<sup>1</sup>Refer to the **Signal Specifications** section for details on temperature compensation range.

<sup>2</sup>Dust-tight and protected against water jets.

<sup>3</sup>IP Certification performed on the FT 300-S-UR-KIT, FT 300-S-OMRON-KIT, and FT 300-S-TM-KIT configurations only.

## 3.3. Mechanical installation

Choose the bracket corresponding to your finishing tool brand and align the dowel pin on the robot tool flange.

### 3.3.1. Mounting the Mirka finishing tool on e-Series robots

1. Mount the Robotiq Mirka bracket on the robot tool flange and secure it with the M6 screws and the tooth lock washers.
2. Align the Mirka finishing tool on the bracket.
3. Position the small jaws correctly on the sander and place the Belleville washers (with the convex side upward) and the M4 screws and fasten them loosely. Do not tighten them.
4. Position the large jaw on the sander and fasten the Belleville washers (with the convex side upward) and the M4 screws tightly.



5. Fully tighten the small jaw's M4 screws.
6. Screw the NPT air fitting.

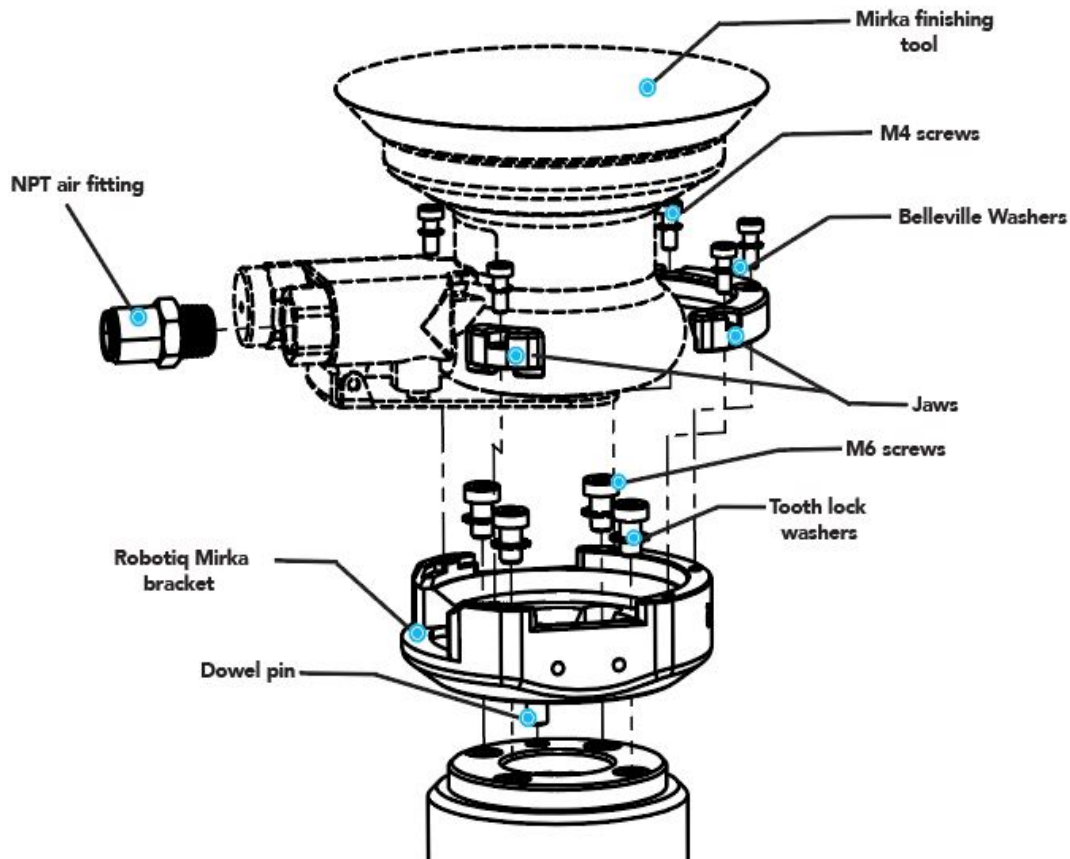


Fig. 3-1: Mechanical installation of the Finishing Kit with the Mirka finishing tool on e-Series robot

### 3.3.2. Mounting the Dynabrade finishing tool on e-Series robots

1. Mount the Robotiq Dynabrade bracket on the robot tool flange and secure it with the M6 screws and the tooth lock washers.
2. Align the Dynabrade finishing tool on the bracket.
3. Fasten the M3 screw.
4. Position the jaw correctly on the finishing tool. Place the tooth lock washers and the M4 screws to fasten them.
5. Fasten the set screw until you feel some resistance, using a 3mm hex key. The screw allows turning on the finishing tool and adjusting the air flow.
6. Screw the NPT air fitting.



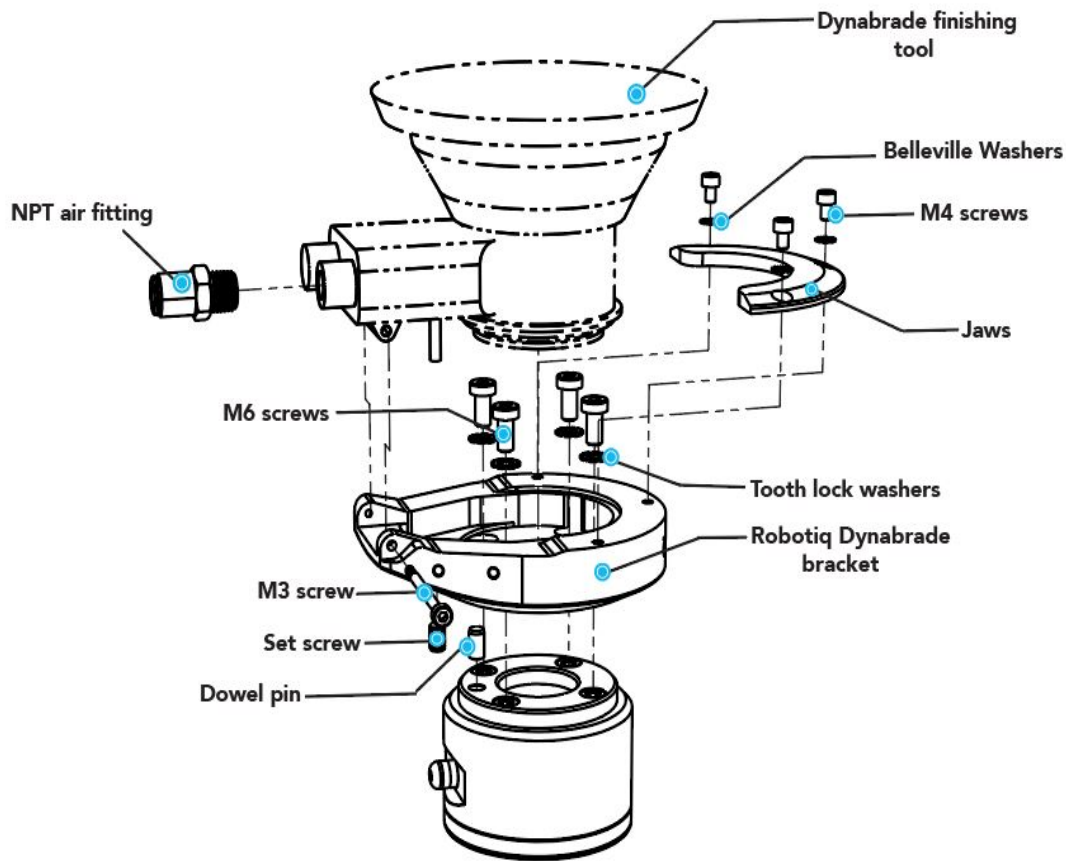


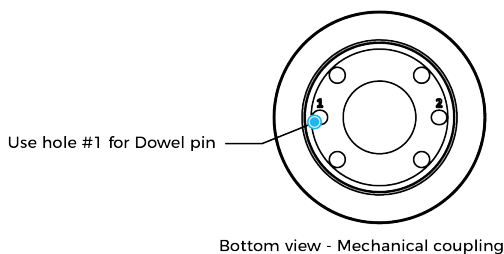
Fig. 3-2: Mechanical installation of the Finishing Kit with the Dynabrade finishing tool on e-Series robot

### 3.3.3. Mounting the Finishing Kits on CB-Series robot

The installation of Finishing kits on a CB-Series robot requires the preliminary installation of a Robotiq FT 300-S Force Torque Sensor. The steps below describe the installation procedure of the Sensor and the kits.

#### Mounting the Mirka finishing tool

1. Place the provided dowel pin in the robot tool flange hole.
2. Mount the mechanical coupling on your robot arm. Align marked hole 1 with the dowel pin.



3. Secure by inserting the M6 screws and tooth lock washers.
4. Mount the Force Torque Sensor on the mechanical coupling.





5. Secure by inserting the M4 screws and the Belleville washers (with the convex side upward) in a cross pattern to properly compress the O-ring.
6. Insert the dowel pin into hole #1 of the Force Torque Sensor and mount the Robotiq Mirka bracket on the FT 300-S Sensor. Secure it with the M6 screws and the tooth lock washers.
7. Align the Mirka finishing tool on the bracket.
8. Position the small jaws correctly on the finishing tool and insert the Belleville washers (with the convex side upward) and the M4 LHCS screws and fasten them loosely. Do not tighten them.
9. Position the large jaw on the finishing tool and fasten the Belleville washers (with the convex side upward) and the M4 LHCS screws tightly.
10. Fully tighten the small jaw's M4 LHCS screws.
11. Screw the NPT air fitting.

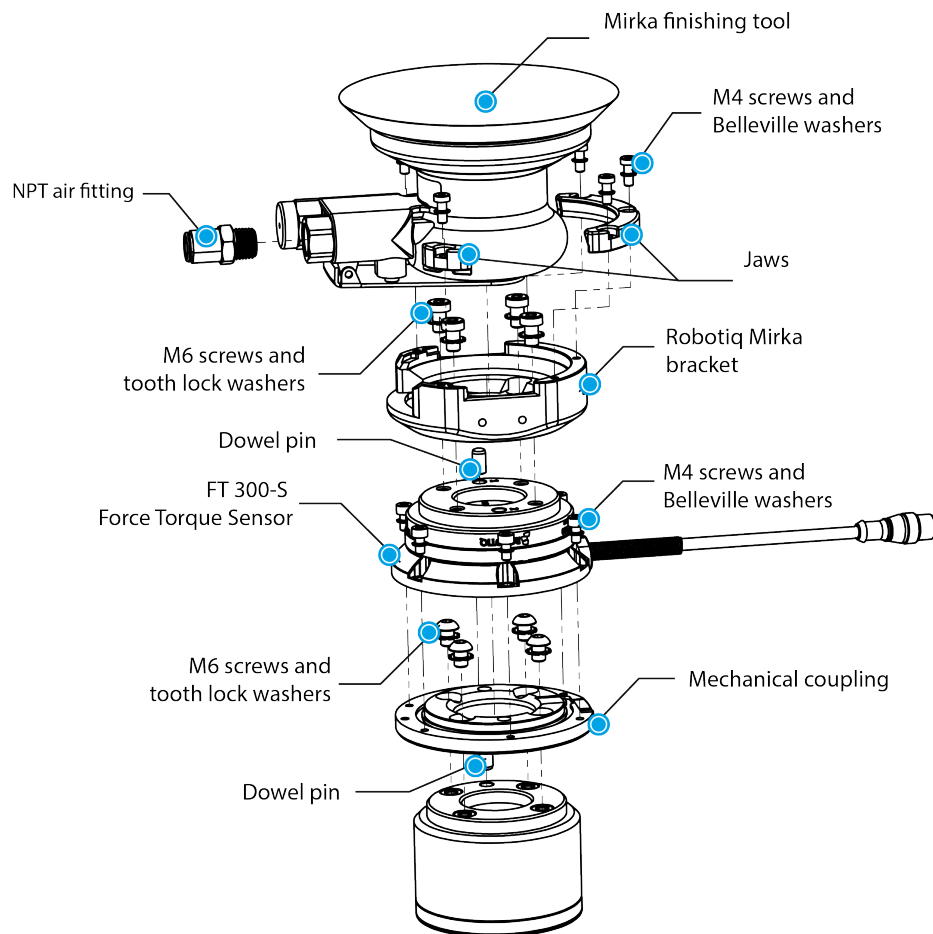
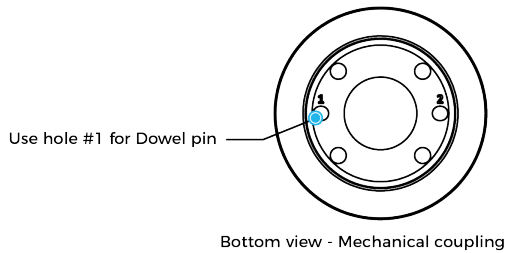


Fig. 3-3: Mechanical installation of the Finishing Kit with the Mirka finishing tool on a CB-Series robot



## Mounting the Dynabrade finishing tool

1. Place the provided dowel pin in the robot tool flange hole.
2. Mount the mechanical coupling on your robot arm. Align marked hole 1 with the dowel pin.



3. Secure by inserting the M6 screws and tooth lock washers.
4. Mount the Force Torque Sensor on the mechanical coupling.
5. Secure by inserting the M4 screws and the Belleville washers (with the convex side upward) in a cross pattern to properly compress the O-ring.
6. Insert the dowel pin into hole #1 of the Force Torque Sensor and align the Robotiq Dynabrade bracket on the FT 300-S Sensor. Secure it with the M6 screws and the tooth lock washers.
7. Align the Dynabrade finishing tool on the bracket.
8. Fasten the M3 screw.
9. Position the jaw correctly on the finishing tool and place the tooth lock washers and the M4 screws and fasten them.
10. Fasten the set screw until you feel some resistance, using a 3mm hex key. The screw allows turning on the finishing tool and adjusting the air flow.
11. Screw the NPT air fitting.



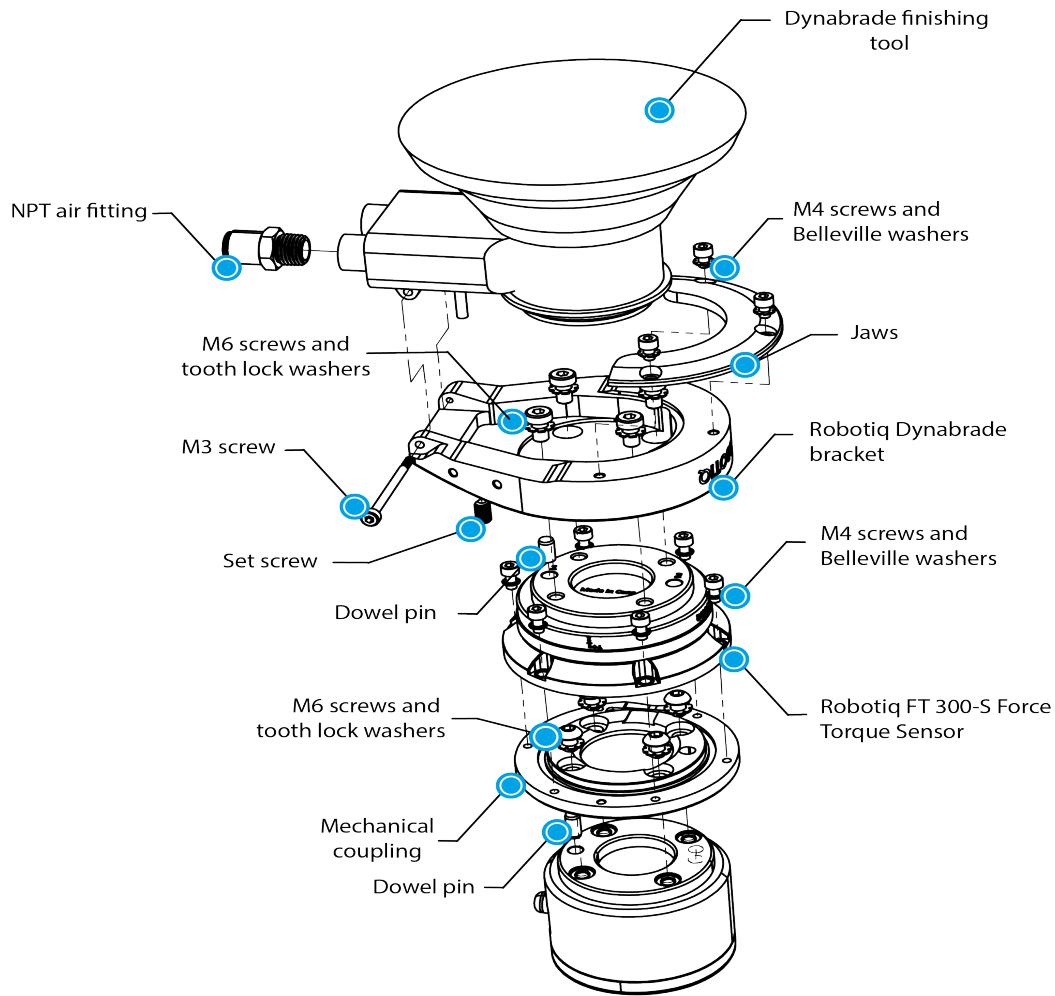


Fig. 3-4: Mechanical installation of the Finishing Kit with the Dynabrade finishing tool on CB-Series robot

### 3.3.4. Supplying air to the valve

1. Push the 3/8 inch air tube into the finishing tool air inlet fitting.
2. Connect your air supply line to port #1.
3. Secure the valve to the controller using the valve magnetic clip.

#### Warning

Strong magnets. Hold the valve bracket firmly when attaching it to a surface to avoid damaging magnets.

4. Plug the black wire in a 0V output of the robot controller.
5. Plug the red wire in a configurable output of the robot controller.



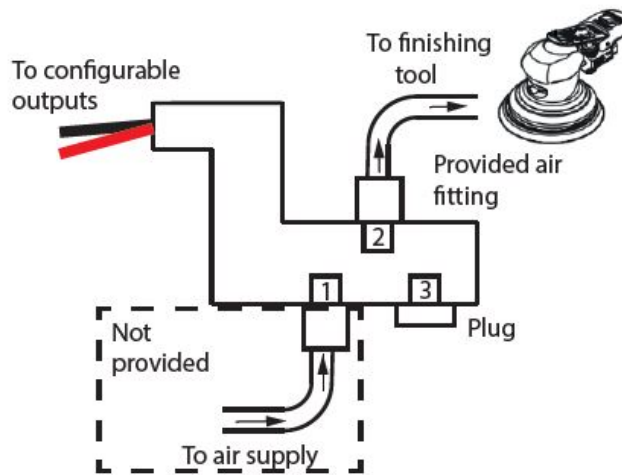


Fig. 3-5: Supplying air to the valve

## Power Supply Specifications of the FT 300-S Force Torque Sensor

The Sensor needs to be supplied by a DC voltage source. This power supply is not included with the Sensor. When installing, use the 24 Volt external source available on the CB-Series controller.

POWER SUPPLY SPECIFICATIONS	VALUE
Output voltage	5 to 24 V DC
Max power consumption	2 W
Overcurrent	1 A Fuse (Phoenix #0916604 (UT6-TMC M 1A))
Overvoltage protection	<div style="border: 1px solid red; padding: 5px;"> <p><b>Warning</b></p> <p>Maximum output voltage tolerance is 10%, exceeding this limit, 26.4 V DC could damage the Sensor.</p> </div>

### Info

Robotiq recommends the use of the following power supply: TDK-Lambda DPP Series, 15W Single Output DIN Rail Mount Power Supply, DPP15-24.

## Wiring the FT 300-S Force Torque Sensor

Power and communications are established with the FT 300-S Force Torque Sensor via a single device cable. The FT 300-S has a pigtail cable. The figure below represents the FT 300-S Force Torque Sensor receptacle (Sensor side) and connector (cable side) with associated pinout. The M12 - 5 pin A-coded connector is used in accordance with IEC 61076-2-101.



### Warning

**Use proper cabling management.** Be sure to have enough forgiveness in the cabling to allow movement of the Finishing Kits along all axes without pulling out the connectors. Always protect the controller side of the cable connection with a strain relief cable clamp.

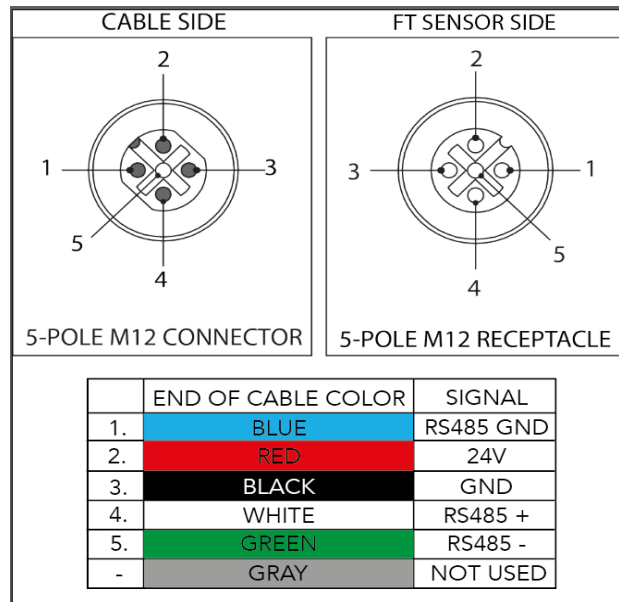


Fig. 3-6: Pinout of the Robotiq Force Torque Sensor FT 300-S and color code for the respective cable type.

### Info

Power pins 2 & 3 are connected to the specified power supply. Do not connect the gray wire.

### Info

RS-485 signal pins 1, 4 & 5 are connected directly, to a RS-485 / USB converter or to a RS-485 / RS-232 converter.

## Wiring with USB to RS485 Converter

When using a RS485 to USB converter, the wiring must respect the figure below and subsequent directions. GND / 0V is wired to Sensor pin #3.

The converter will provide you with a standard USB 2.0 male A connector.

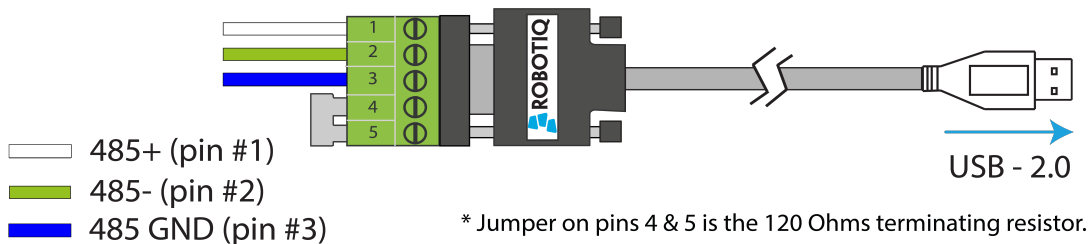


Fig. 3-7: Wiring diagram for the RS485 to USB converter



## Warning

Power is not delivered via the USB, do not plug 24V into the USB.

## 3.4. URCap Package on Universal Robots

### 3.4.1. On e-Series Robots

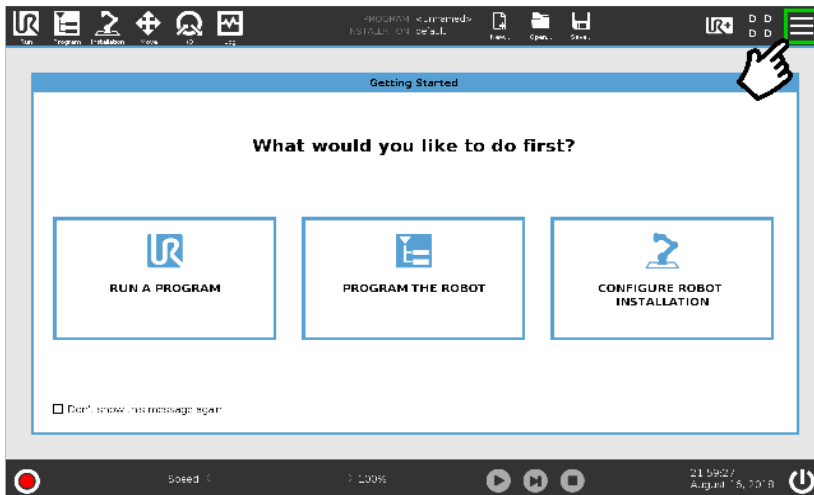
Robotiq provides you with a Universal Robots URCap package that enables direct serial communication to your UR controller.

#### Info

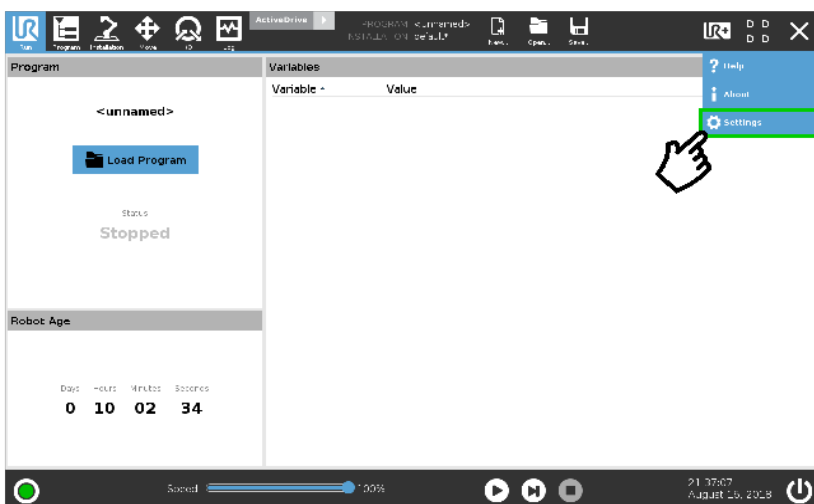
To get the URCap package for your UR controller, browse to [www.support.robotiq.com](http://www.support.robotiq.com).

## URCap package installation

Follow this procedure to install your Copilot URCap package:

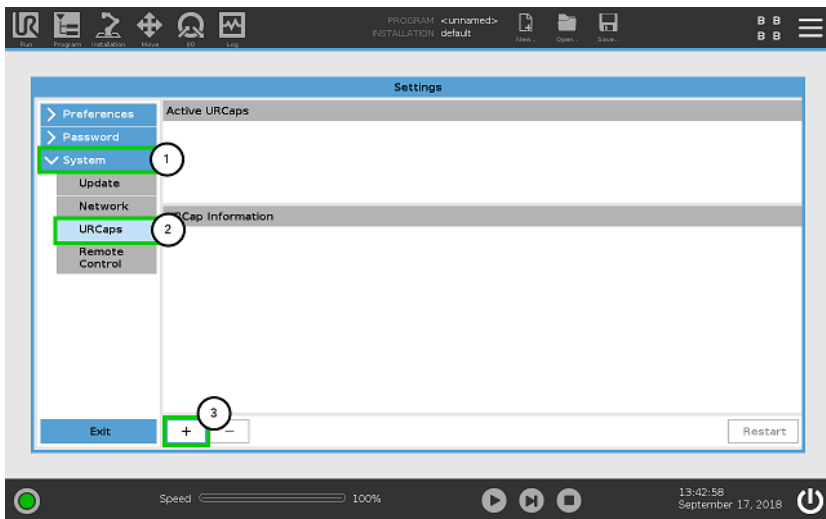


- Make sure that your PolyScope version is up-to-date.
- Go to [www.support.robotiq.com](http://www.support.robotiq.com), select **Browse by product**, click on your **Robotiq product page** and then **Universal Robots**
- Click on **Software** → **Surface Finishing Kit software** → **Copilot**, download the URCap zip and extract it on the root of a blank USB stick.
- Insert the USB stick in the UR teach pendant or controller.
- On the teach pendant, tap the **triple bar icon** in the upper right corner of the screen.

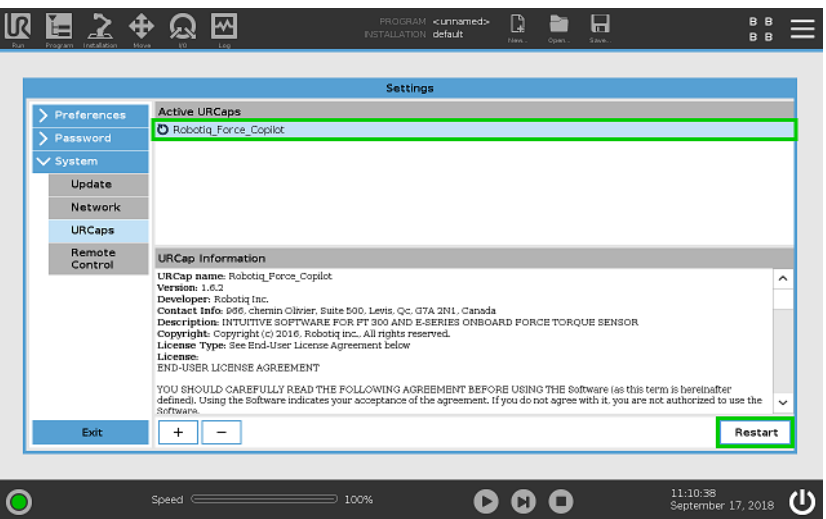


- Tap **Settings**





- Tap **System** in the navigation pane on the left.
- Select the **URCap**
- Tap the Plus (+) button to display the storage devices and browse for the URCap files.
- Once the file is selected, tap the **Open** button.



- Tap the **Restart** button to complete the URCap installation. By doing so, you accept the **License agreement** detailed in the URCap information textbox.

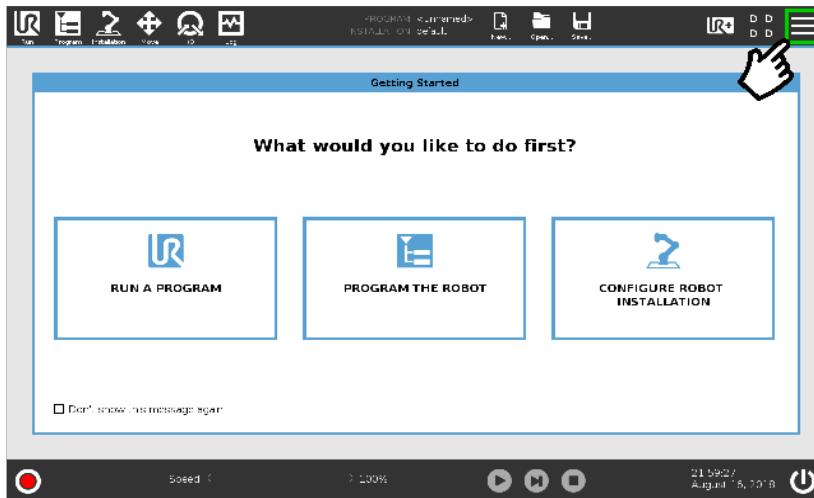
### Info

Note that the license dongle in e-Series Kits must remain plugged in the controller.

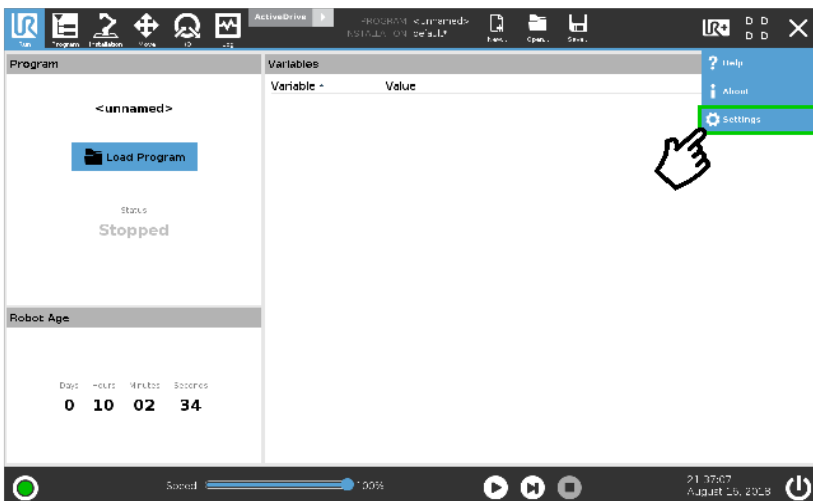


## URCap package uninstallation

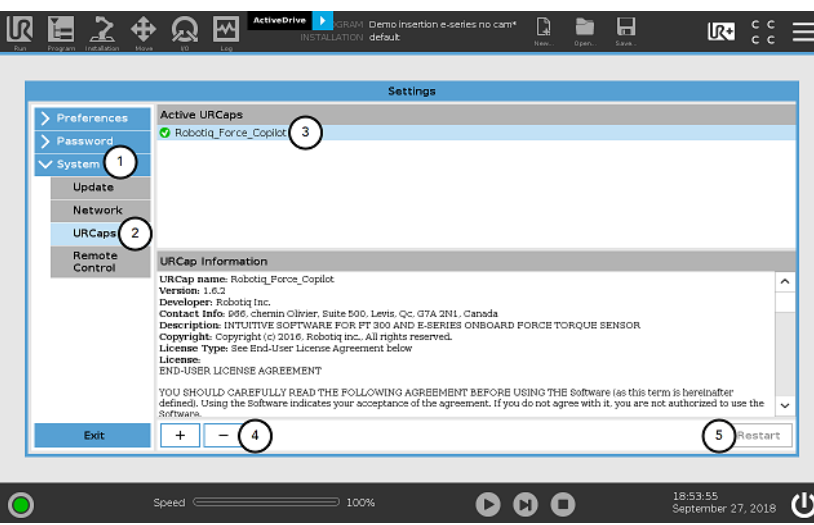
If you wish to uninstall your Copilot URCap, please follow this procedure:



- On the teach pendant, tap the triple bar icon.



- Select Settings



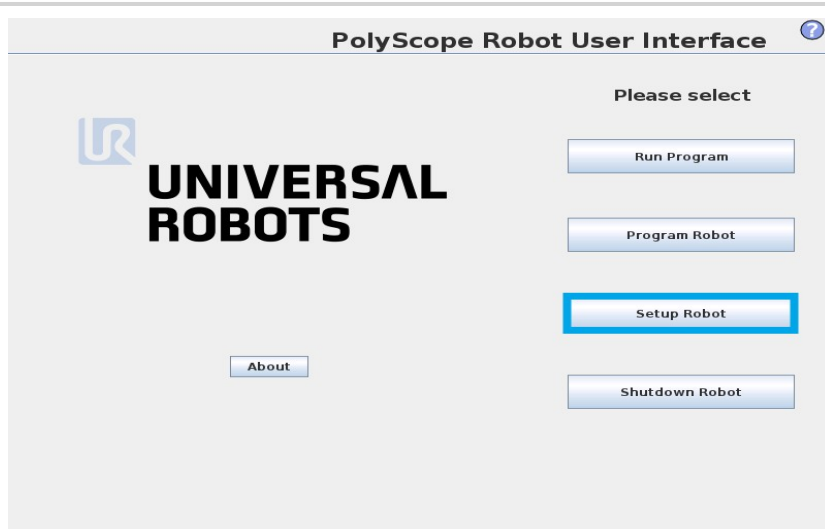
- Select **System** in the navigation pane on the left.
- Select **URCaps**.
- In the Active URCaps box, select the URCap to uninstall.
- Tap the minus (-) button to uninstall the URCap.
- Restart PolyScope to complete the uninstallation process.



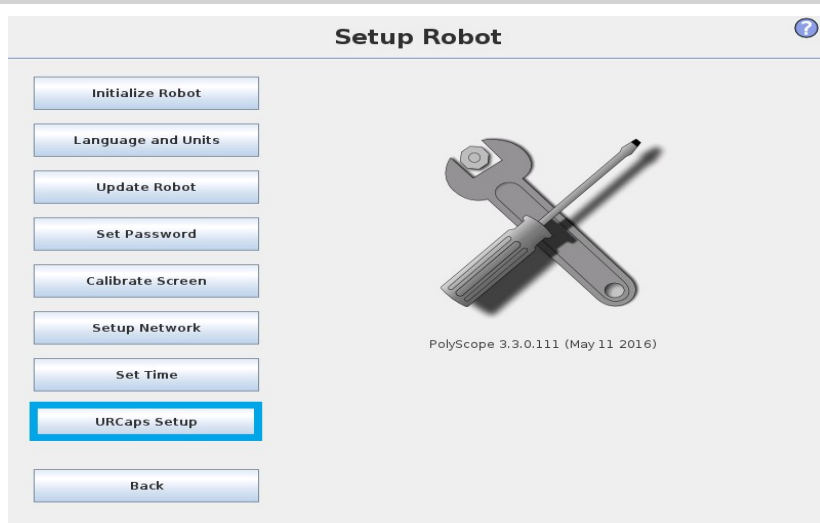


## 3.4.2. On CB-Series Robots

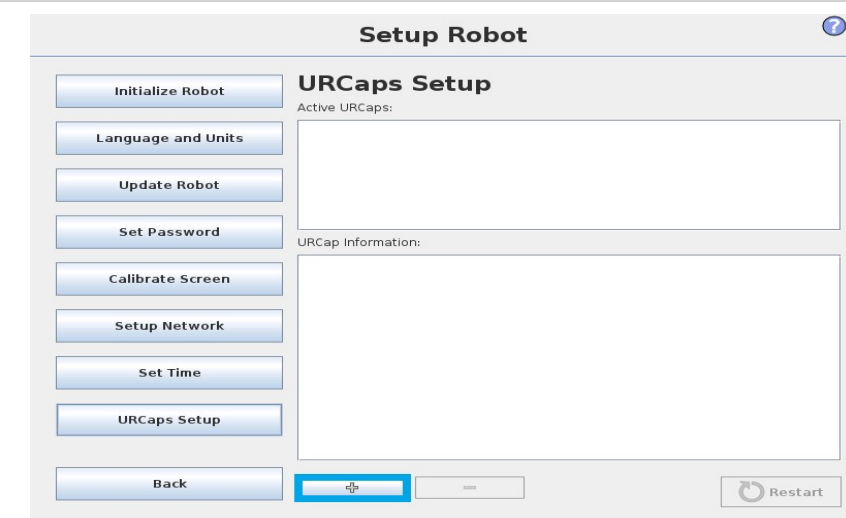
### URCap package installation



- Make sure that your PolyScope version is up-to-date and that your Universal Robots controller is compatible with the Force Copilot URCap package.
- Go to [www.support.robotiq.com](http://www.support.robotiq.com), select **Browse by product**, click on your Robotiq product page and then **Universal Robots**
- Click on **Software** → **Surface Finishing Kit software** → **Copilot**, download the URCap zip and extract it on the root of a blank USB stick.
- Insert the USB stick in the UR teach pendant or controller.
- Go to **Setup Robot**.

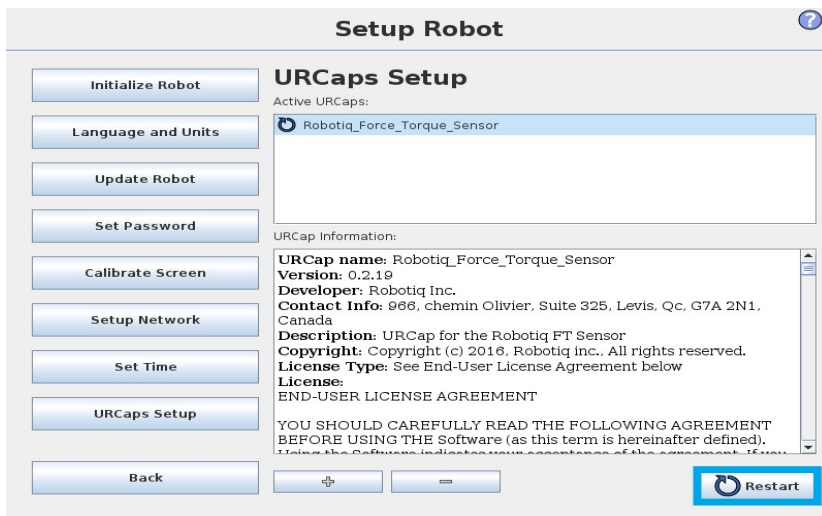


- Tap URCaps Setup.

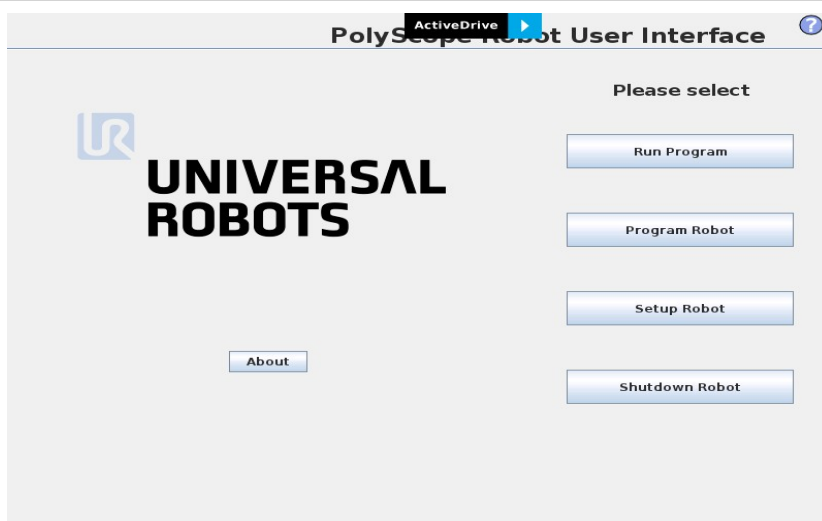


- Tap the **plus** button (+) to add the Sensor's URCaps package.
- Open Robotiq Copilot-X.X.X.urcap.





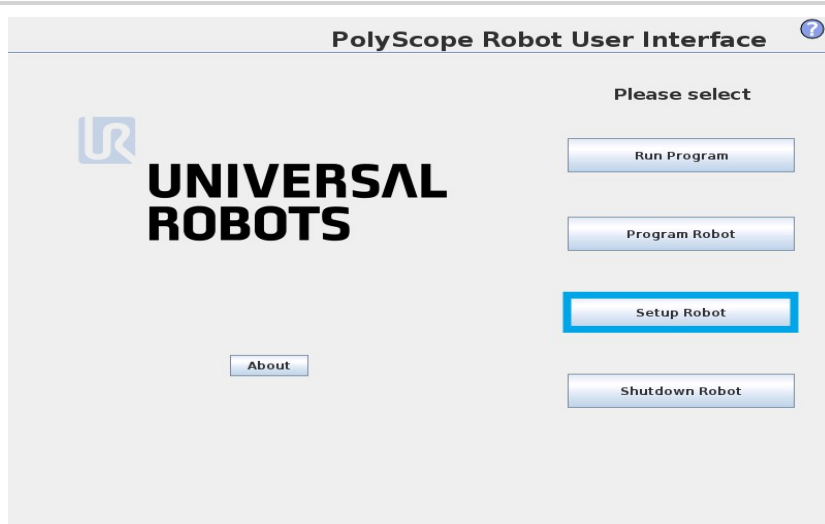
- Restart PolyScope to complete the URCap installation. By doing so, you accept the **License Agreement** that is detailed in the URCap Information text box



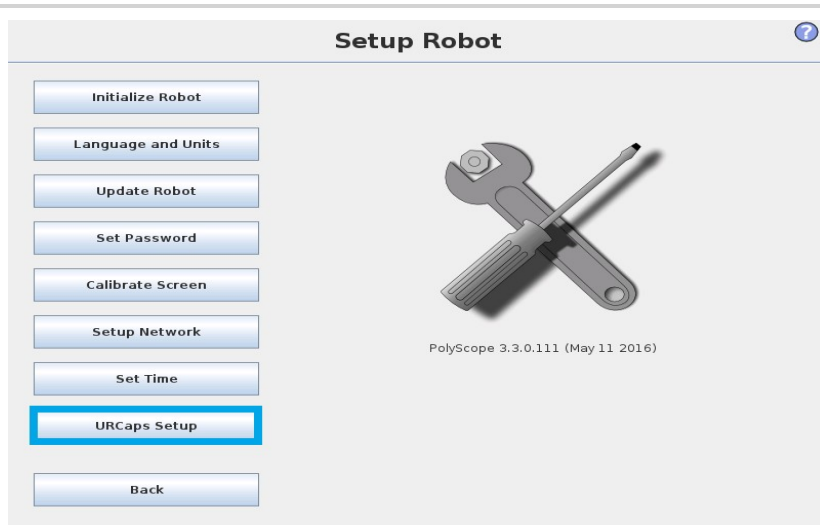
- When PolyScope reopens, the ActiveDrive toolbar will appear on the screen.



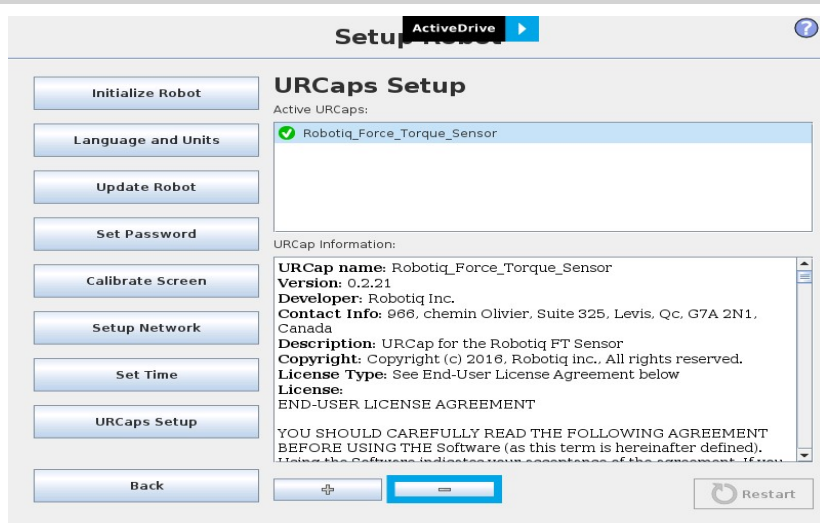
## URCap package uninstallation



- Go to Setup Robot.



- Tap URCaps Setup.



- In the Active URCaps box, select the URCap to uninstall.
- Tap the minus (-) button to uninstall the URCap.
- Restart PolyScope to complete the uninstallation process.



## 4. Software

The following sub-sections provide instructions concerning the installation of your **Copilot software** package and the various parameters of each node.

### 4.1. Copilot control with Universal Robots

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

Table 4-1: Nodes and Features, based on License Type



## 4.2. Visible Nodes using Copilot

Copilot gives the possibility to remove Copilot nodes from the menus in case they are not to be displayed. To do so, go to **Installation > URCaps > Copilot**, select the **Visible Nodes** tab and select the nodes to display. The system must be restarted to apply any change.

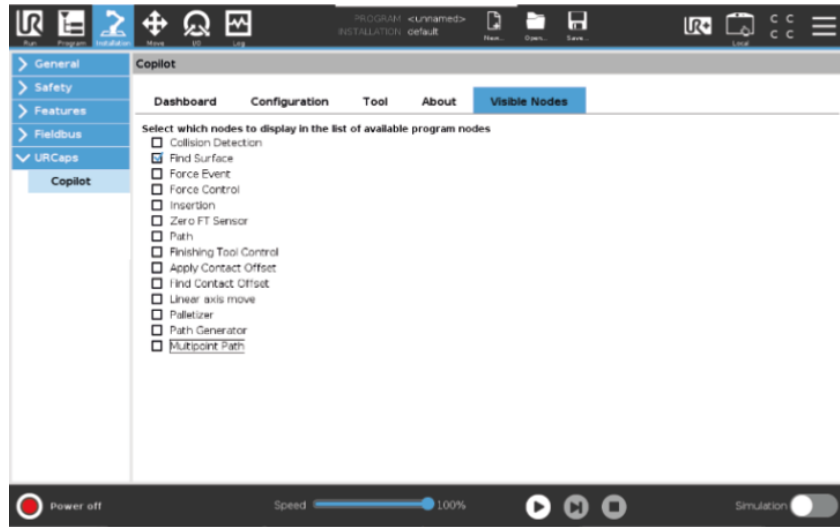


Fig. 4-1: The Find Surface node is selected in the Visible Nodes menu (UR e-Series robot).

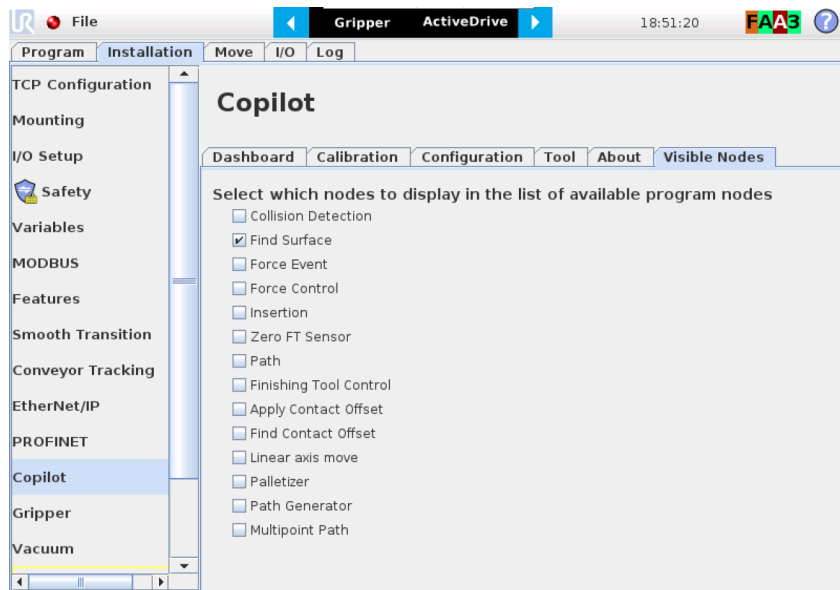


Fig. 4-2: The Find Surface node is selected in the Visible Nodes menu (UR CB-Series robot).



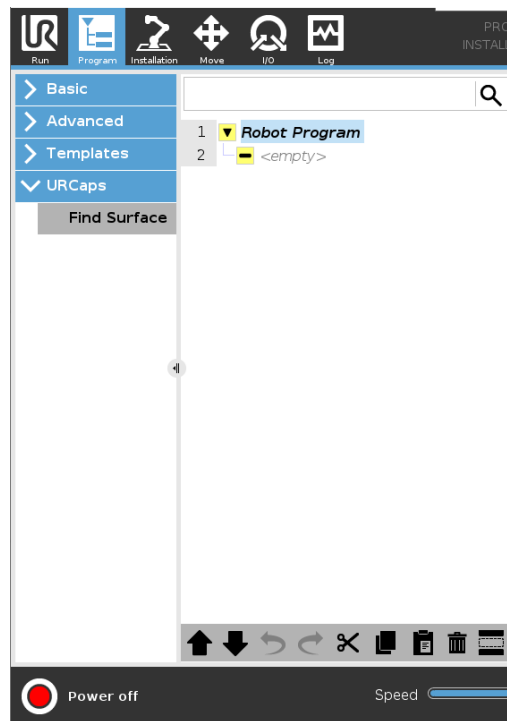


Fig. 4-3: The Find Surface programming node is now part of the URCaps drop-down menu (UR e-Series robot).

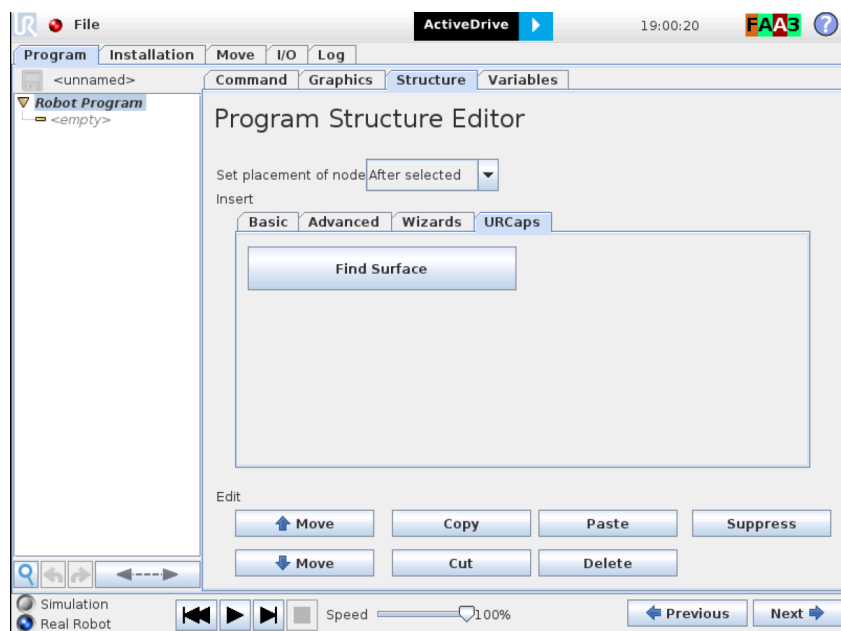


Fig. 4-4: The Find Surface programming node is now part of the URCaps drop-down menu (UR CB-Series robot).

#### Info

An existing robot program containing nodes that are not currently displayed will still be executed without any issue.

#### Info

The Visible Nodes option only applies to the Copilot programming nodes.



## 4.3. Force and torque script functions

Force Torque Sensor functions are made available in the Script 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)

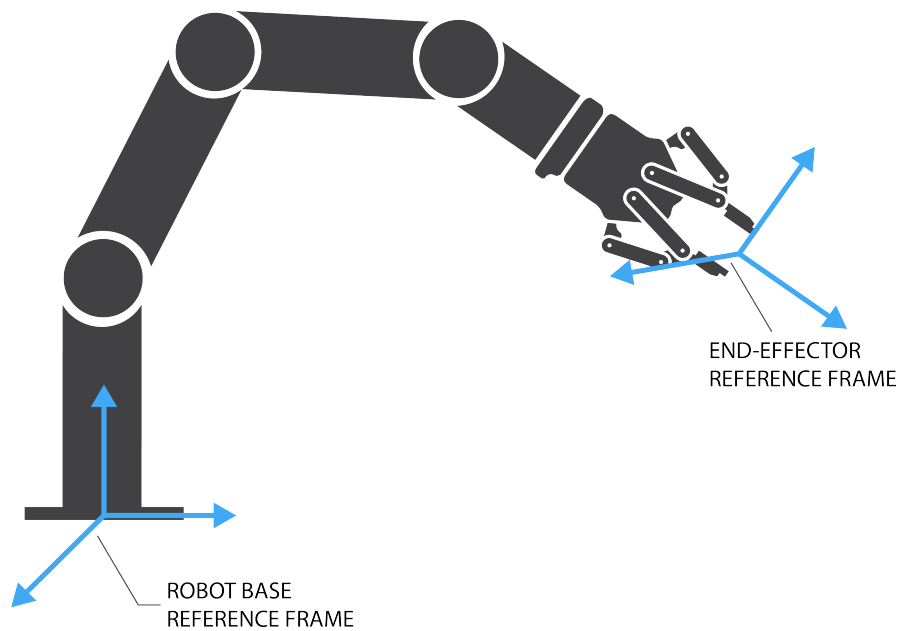


Fig. 4-5: Example of two reference frames for the `express_force_in_frame (<T_from_to>, <wrench_from>)` function

### Info

Although displayed in real time in the Variables tab, the force and torque values can be seen in the Finishing Copilot Dashboard. Note that the force and torque values, in the Installation tab, are those of the tool flange.

## 4.4. ActiveDrive Toolbar

The ActiveDrive Toolbar is automatically installed with the Finishing Copilot software package. 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 node** section, by hand-guiding the robot while recording a path.



### Info

The Finishing Copilot software Package 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. When the ActiveDrive mode is activated, the speed slider is automatically set at 100%. Verify and adjust the speed slider to the desired speed so it has to be greater than 50%.

## 4.4.1. Overview

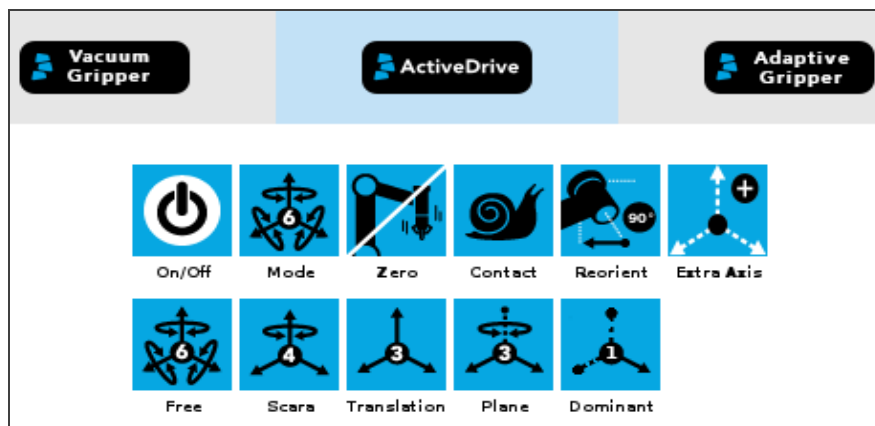
### Toolbar collapsed



Tap the UR+ button to expand the toolbar.

### Toolbar expanded

- Tap the mode selector to get the Toolbar expanded (green rectangle).



## Features



Primary icon	Functionality name	Description
 	ActiveDrive	Tap to toggle between the expanded and collapsed ActiveDrive Toolbar. When greyed out, the functionality is not available. Tap the button to see why it is not available.





Primary icon	Functionality name	Description
	Start / Stop	<p>Tap to start or stop ActiveDrive. ActiveDrive will automatically turn off after 30s of inactivity.</p> <p>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.</p>
	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.
	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).
	Dominant	<ul style="list-style-type: none"> <li>• Works like the Translation mode, but the robot will only move in one direction, X, Y, or Z at a time.</li> <li>• The robot detects the direction the user is trying to move and will lock the movement in that direction.</li> </ul>
	Drift Control	Tap this button to stop the robot from drifting (resets the sensor's offset) and to remove all forces applied on the robot.
	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.

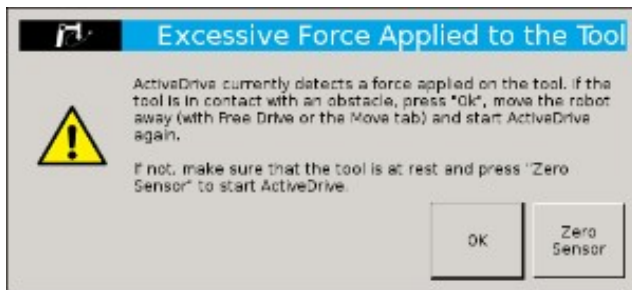


Primary icon	Functionality name	Description
 	Speed	<p>Motion speed control is toggled between fast and slow, allowing precise movement in slow motion.</p> <p>The force torque sensor will switch to slow speed automatically whenever high forces are detected, for example, during an impact with an object.</p>

## 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's home page. Tap **Setup Robot** and go to **Initialize Robot** to start the robot.



- Message:



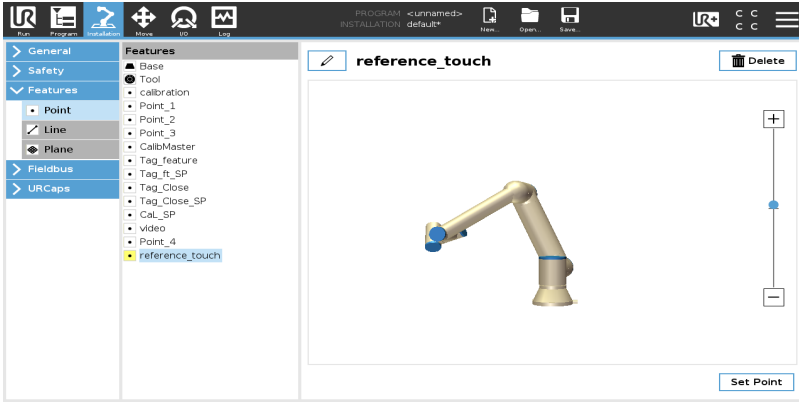
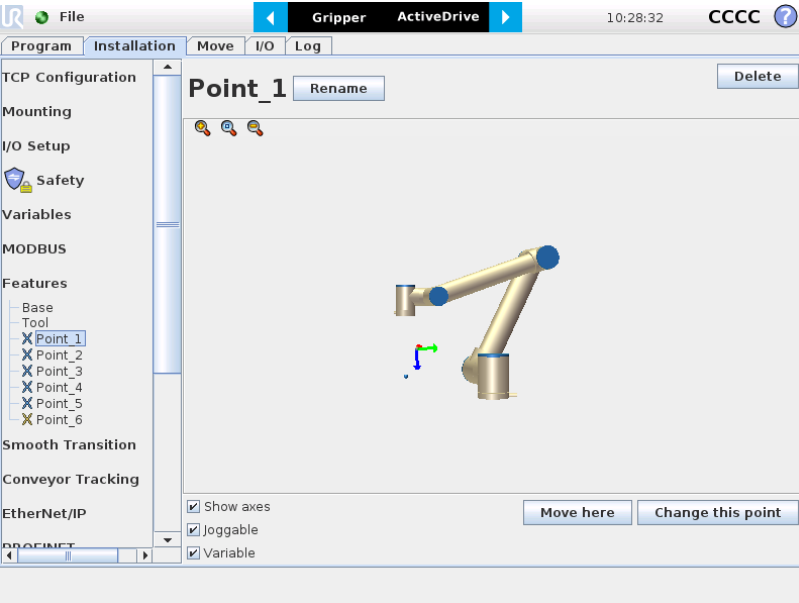
- Solution:

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



## 4.5. Find Contact Offset node

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.

URCaps	Instructions
<p>On e-Series robot:</p> 	<ol style="list-style-type: none"> <li>1. Go to the <b>Installation</b> tab → <b>Features</b> → <b>Point</b>.</li> <li>2. Create a Feature Point, then tap "<b>Set Point</b>".</li> </ol> <div style="border: 2px solid yellow; padding: 10px; margin-top: 10px;"> <p><b>Caution</b></p> <p>The feature point can be located anywhere, as long as the set coordinates remain within the robot reach at all times.</p> </div>
<p>On CB-Series robot:</p> 	



# Find Contact Offset

Teach sequence

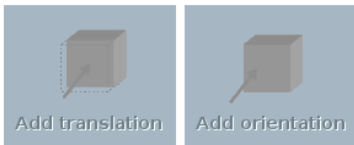
3. Insert a **Find Contact Offset** node.
4. Tap **Teach sequence**.

Command Graphics Variables

## Find Contact offset

Teaching the Touch sequence program

Feature to offset:  




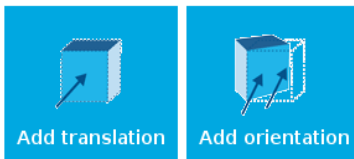
Teach the contact offset reference

5. From the "**Feature to offset**" drop-down list, select the feature point you previously created. For more information, select the help button.

## Find Contact Offset

Teaching sequence

Feature to Offset: Point\_1  



Teach the contact offset reference

6. Select **Add translation** or **Add orientation** to determine by how much the feature has been offset.
7. For more details, see following sections.

### Tip

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



## 4.5.1. Add Translation

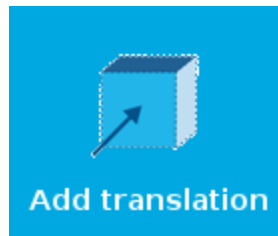


Fig. 4-6: Select this button to insert a *Translation* node.

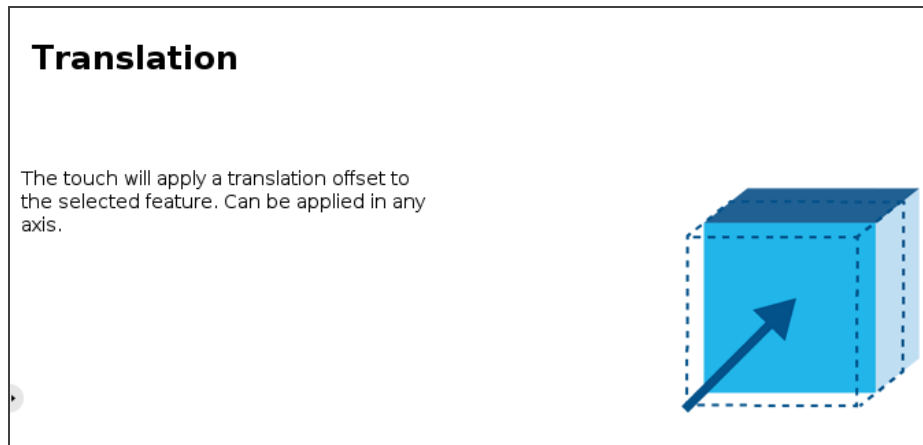


Fig. 4-7: Translation node

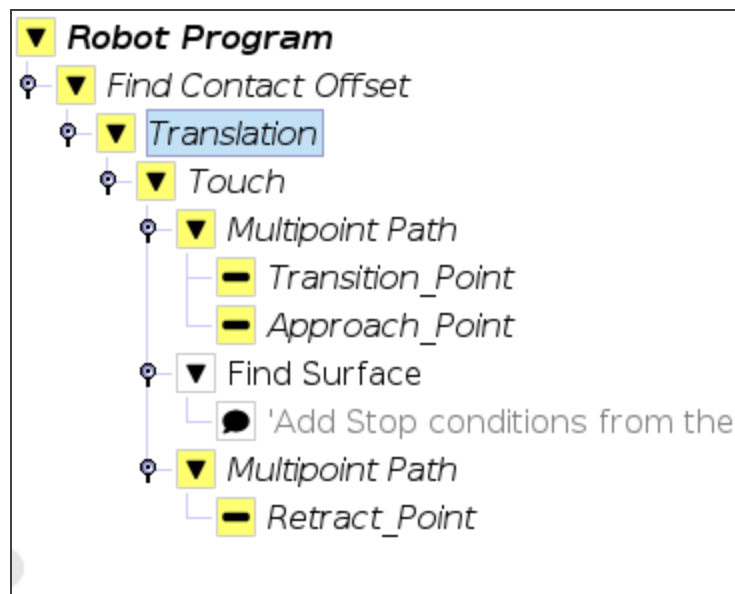



Fig. 4-8: Add Translation program tree

- Follow these steps to setup a Translation node.
  1. Select the **Touch node** from the program tree for detailed instructions.



## Touch

Touch sequence:

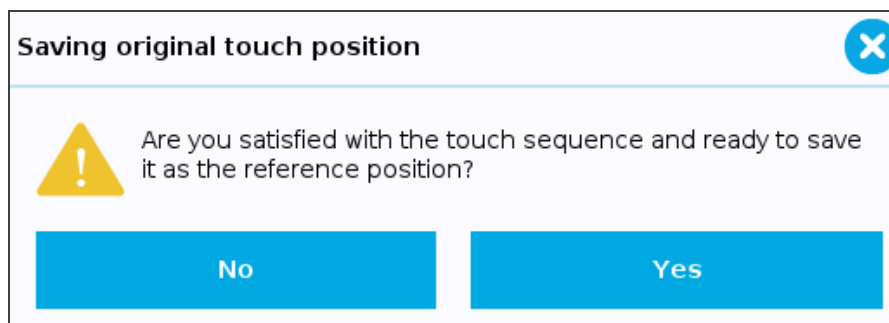
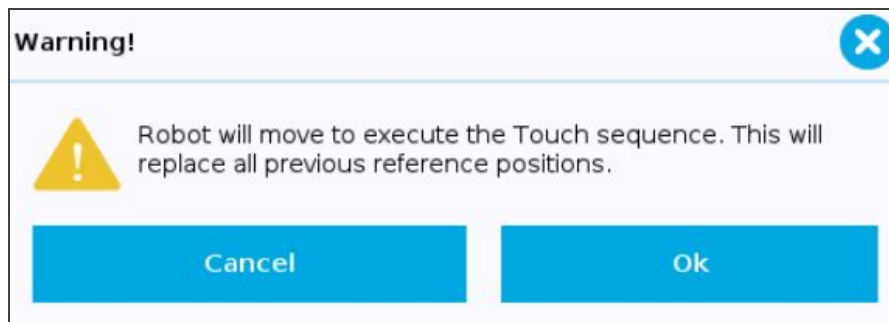
- 1 Bring the robot to a Transition position.
  - 2 Bring the robot to an Approach position.
  - 3 Use the Find Surface node.
  - 4 Bring the robot to a Retract position.
-  Moves under the Touch node must have their path relative to the feature you want to offset.

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 **Find Contact Offset node** section.
5. Tap **Retract\_Point** from the Robot Program, move the robot to the required position, and select **Set waypoint** .
6. Return to the **Find Contact Offset node** in the program tree and tap **Teach the contact offset reference** .
7. The following windows are displayed :



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 Robots Installation 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.

## 4.5.2. Add orientation

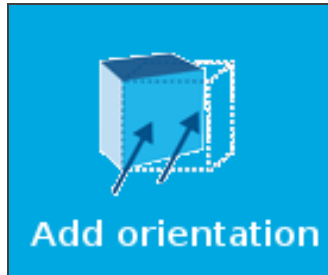


Fig. 4-9: Select this button to insert an **Orientation** node.

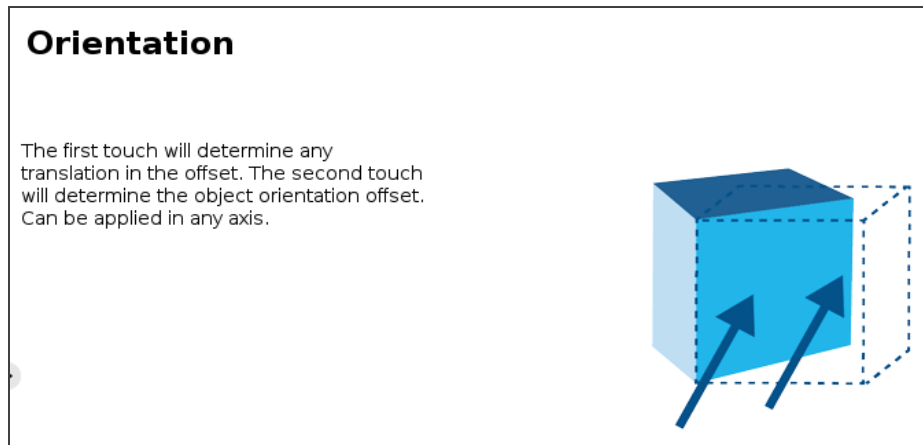


Fig. 4-10: Orientation node



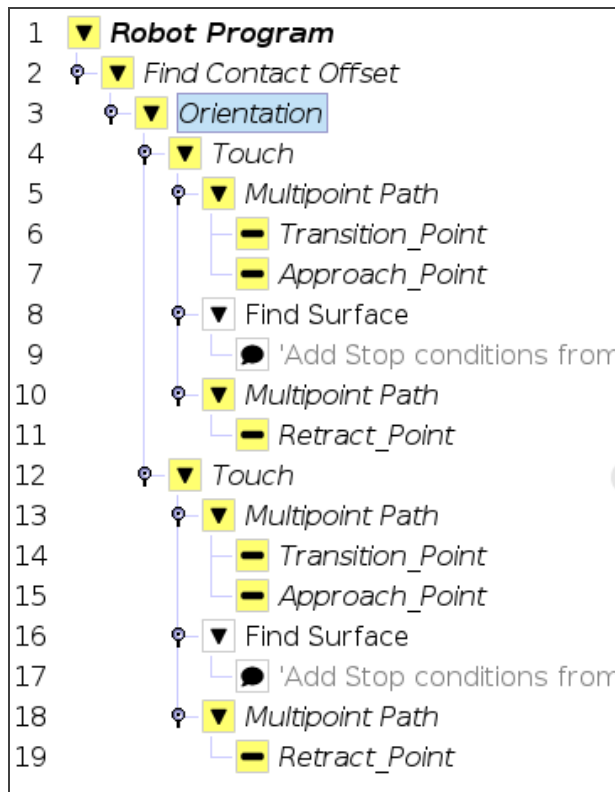


Fig. 4-11: Add Orientation program tree.

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 **Add Translation** section. The two offset values will be used to calculate a rotation angle.



## 4.6. Apply Contact Offset node

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 your 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 check mark is shown, this means that moves will be executed according to the offset value of the Apply Contact Offset node. In order to apply the contact offset to a move, in the **Move** node, select the same **Feature** as in the **Apply Contact Offset** node (e.g. in the case presented above, it would be "Point\_1").
- Create your robot program with children nodes inserted under the Apply Contact Offset node.

### Tip

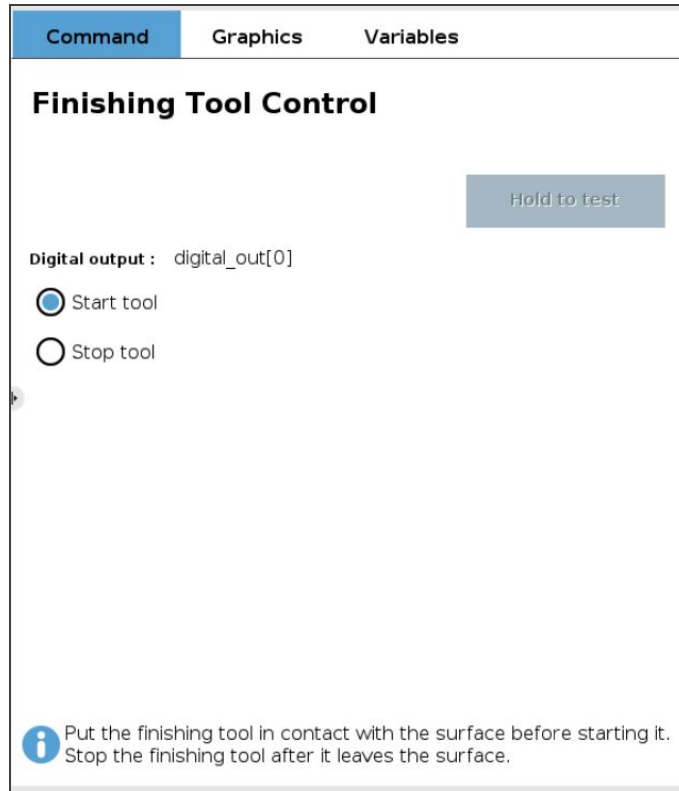
Reduce cycle time by inserting a **Find Contact Offset** node in the "Before\_Start" section of the robot program, or as a sub-program. This strategy will reduce the frequency at which nodes are run in the course of your robot program.



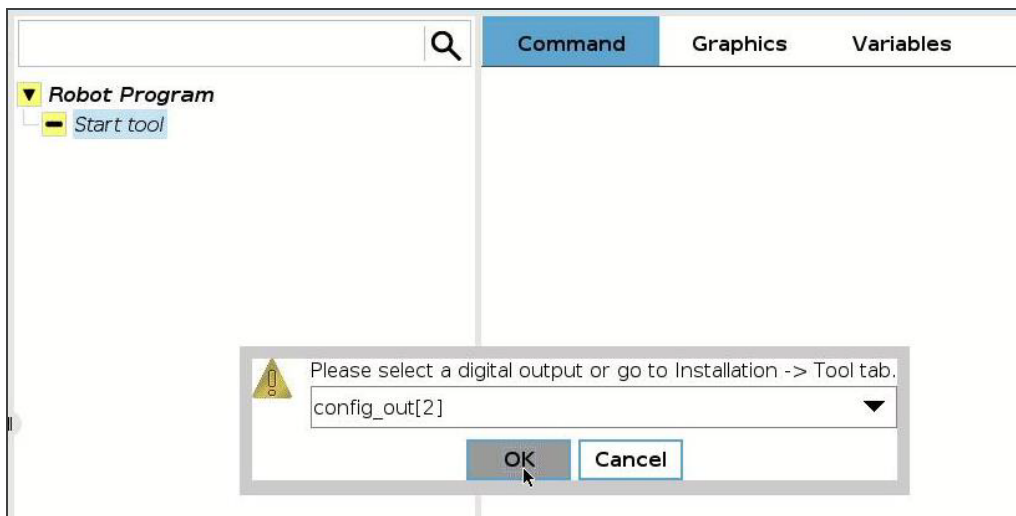
## 4.7. Finishing Tool Control node

When running a program that uses a Robotiq end-effector, you can send a command to either start or stop this tool. The Finishing Tool Control node offers two commands: **Start tool** and **Stop tool**.

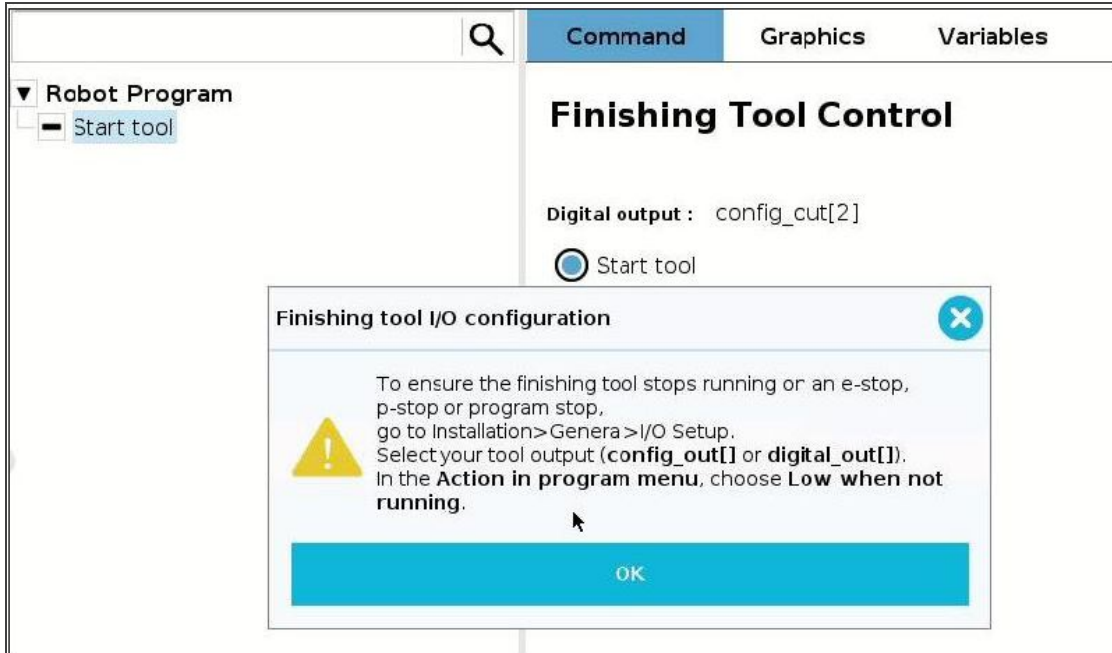
- Select **Start tool** to turn on your tool when it comes into contact with the surface. Select **Stop tool** to turn off your tool, after it is no longer in contact with the surface.



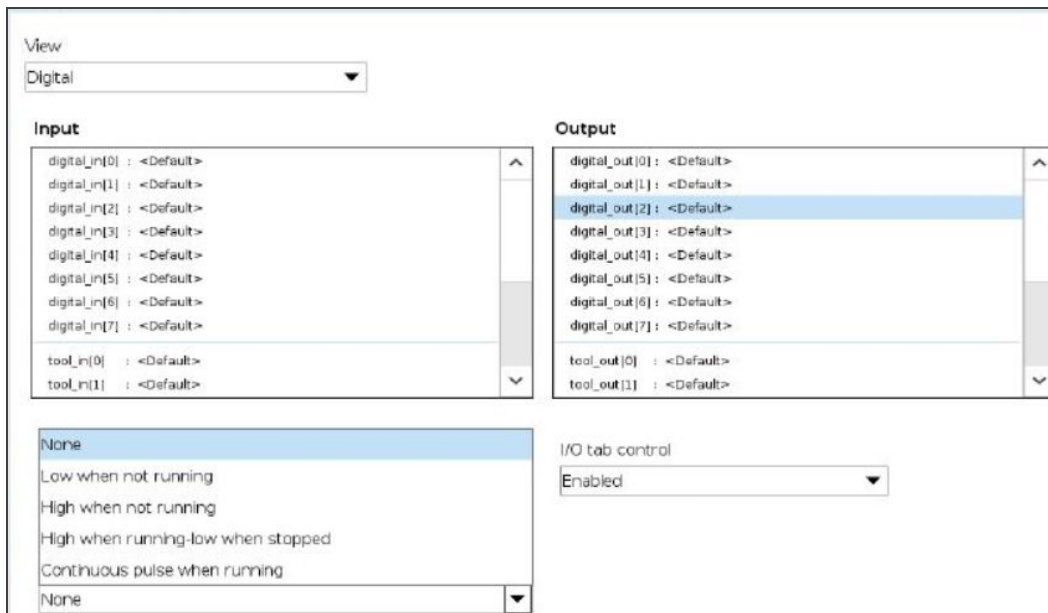
- From the **Program** tab, tap **URCaps** and **Finishing Tool Control**.
- Select the output to which your tool is connected in the robot controller.



In addition, you must ensure that your finishing tool stops running on an emergency stop (e-stop), protective stop (p-stop) or program stop. To do so, follow the instructions displayed in the message window "Finishing tool I/O configuration", or look at the following screenshot for reference.



You can enable e-stops, p-stops and program stops with options from the following window.

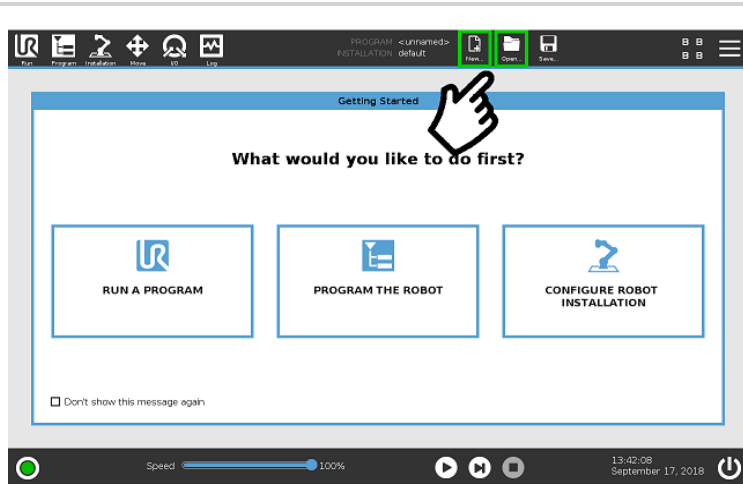


Select the input and output ports to which your tool is wired, then make sure to select **Low when not running** from the dropdown list. Other settings will not enforce stops.

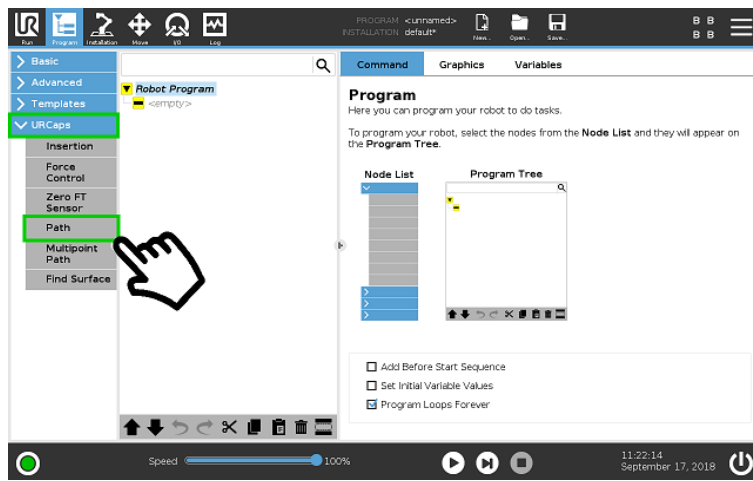


## 4.8. Path Recording node

The Finishing Copilot software package adds a Path feature 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. Two options are available with the Path Recording node: **Tool on robot** or **External tooling**. The following table explains the steps to follow.



- 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.



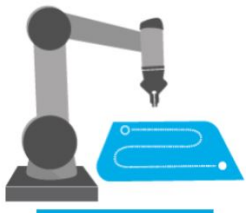
- Select the **URCaps** menu.
- Tap the **Path** button.




Command Graphics Variables

## Path

Select an option, then setup your Robot Program for the Path



Tool on robot






External tooling

- In the **Command** tab, select the required option for the desired Path:
  - **Tool on robot** :
    - i. Normal path
    - ii. Relative path
    - iii. Path relative to a feature
  - **External tooling**:
    - i. Path relative to an external tool center point (TCP)

Command Graphics Variables

## Path


Tool Speed

X

Reverse path     Constant speed





Path relative to a feature  

When the Tool on robot is selected:

- Check the *Path relative to a feature* box to choose between the **Actual pose** of the robot or go configure a Feature point in **Installation** tab → **Features** → **Point**.

Command Graphics Variables


## Path


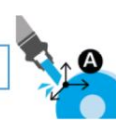





Tool Speed

mm/s

Reverse path

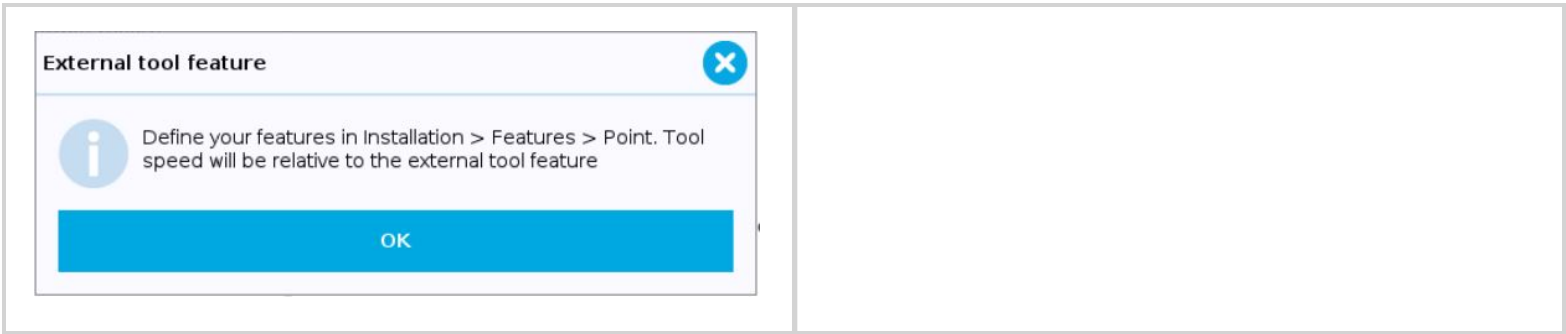
 Warning! Selected options change the speed of the original path recording.

**A** External tool feature   

When the External Tooling is selected:

- Configure the position and the orientation of your Tool Center Point (TCP) in **Installation** tab → **Features** → **Point**










## Overview

	Path recording and visualization.
<p><b>Tool Speed</b></p> <input type="text" value="1"/> X	Path speed box.
<input type="checkbox"/> Reverse path <input type="checkbox"/> Constant speed <input type="checkbox"/> Path relative to a feature <input type="text" value=""/>	Path options.
<b>Warning!</b> Selected options change the speed of the original path recording.	Warning section. Displayed whenever a setting results in a duration different than the original path duration.

### 4.8.1. Features\*

Primary icon	Description
	Starts and stops the path recording.



	<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 in order to move the robot to the path's start and play the path as it will be executed in the program.</p>
	<p>Displayed whenever a setting results in a duration different than the original path duration.</p>
<input type="checkbox"/> Reverse path	<p>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.</p>
<input type="checkbox"/> Constant speed	<p>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.</p>
<input type="checkbox"/> Path relative to a feature <input type="text"/> 	<p>If selected, the path will be played relative to the actual robot position or to a feature (previously set in the <b>Installation tab</b>) when the program enters the path instruction.</p> <p>This effectively offsets all the recorded path.</p>

\* When an icon is greyed, it means it is unavailable.

#### Tip

If you tap the record button when a path is already recorded in a node, a warning pop-up will ask if you want to overwrite the path (tap **OK**) or keep the previously recorded path (tap **Cancel**).





## 4.9. Multipoint path node

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 **straight line** or as a **curve**.

### Tip

Try inserting a Multipoint Path node in a Robotiq Force Control node. The former will perform the movements that were taught while taking into consideration the parameters set in the latter.

### How to add a Multipoint Path 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 **Multipoint Path**
- Tap the **Multipoint Path** node in the robot program to edit it.
- You can configure your **Multipoint Path** by selecting the **Tool on robot** or the **External Tooling** options.

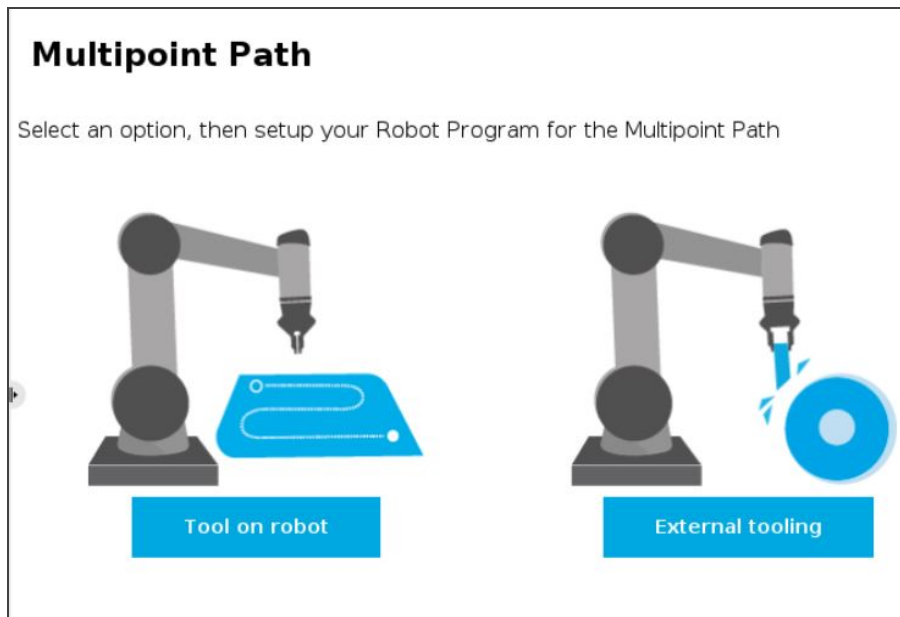


Fig. 4-12: Multipoint Path options

- If the **Tool on robot** option is selected, check the **Path relative to a feature** option and choose in the dropdown list the required position. You can select **Actual pose** to continue with the actual position of the robot or you can create a feature point in **Installation** tab → **Features** → **Point**.



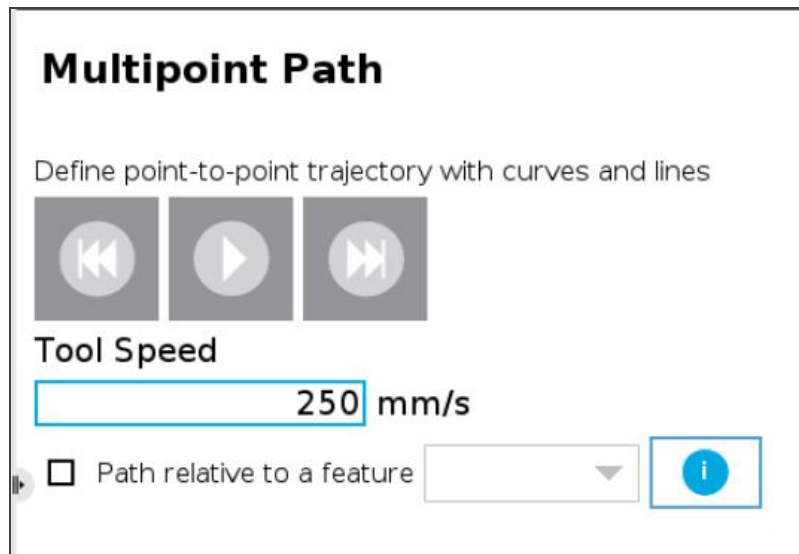


Fig. 4-13: Multipoint Path node *Tool on robot* option

- If the **External Tooling** option is selected, you will have to create a feature point in **Installation** tab → **Features** → **Point**.

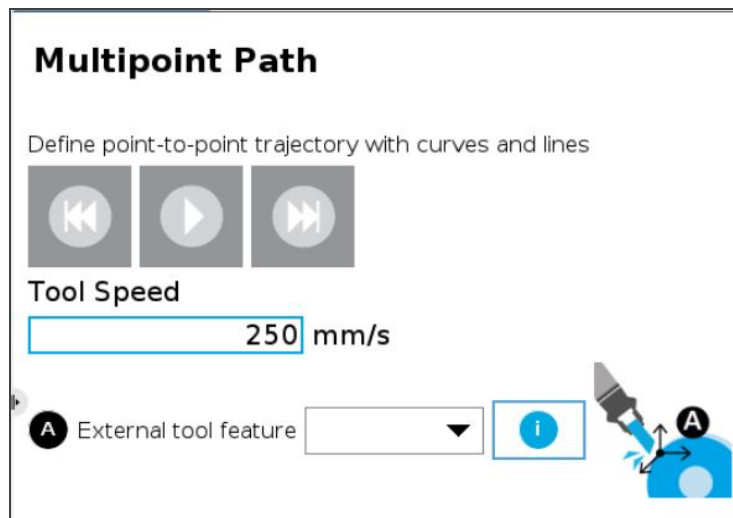
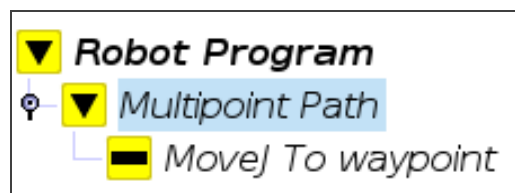


Fig. 4-14: Multipoint Path node *External tooling* option

#### Info

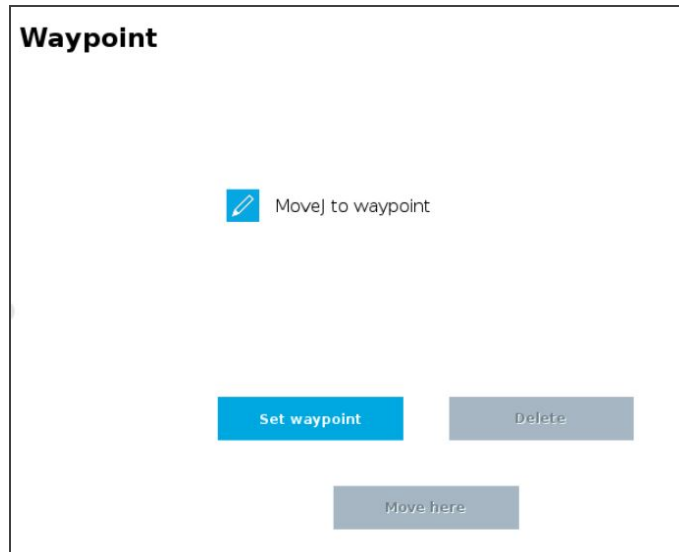
Please note that a Multipoint Path parent node is always followed by a *MoveJ* command leading to the starting waypoint of the path sequence.



## 4.9.1. How to set up a Multipoint Path

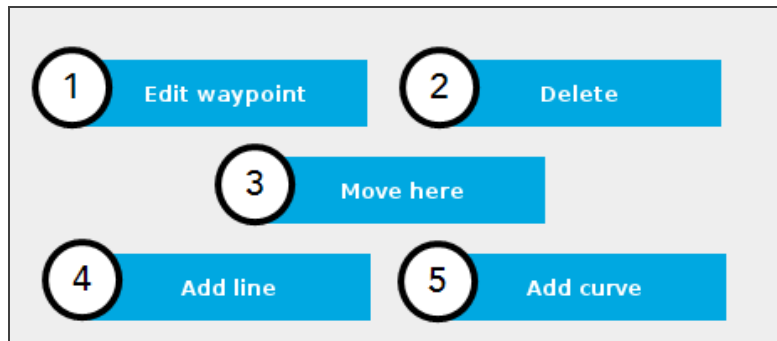
### Step 1

- Select the **MoveJ To waypoint** child node in the program tree.
- A menu will display in the **Command** tab.
- Using the Freedrive mode or the UR Move menu, move the robot arm to the position you want to be the starting point of your Multipoint Path.



- Tap the **Set waypoint** button. The UR waypoint interface will pop up and ask you to define the waypoint.
- Adjust the position if needed, then press **OK**.

At this point, the interface will look like this:



- 1 Tap the **Edit** button to open the UR waypoint interface and adjust the position of the robot arm (this works for every waypoint of the Multipoint Path)
- 2 Tap the **Delete** button to cancel the waypoint (deleting the starting waypoint will turn it to unassigned)
- 3 Tap and hold the **Move here** button to make the robot arm travel to the corresponding waypoint
- 4 Tap the **Add line** button to let the system know that a **straight line** will be linking the current waypoint and the next waypoint
- 5 Tap the **Add curve** button to let the system know that a **curve** will be linking the current waypoint and the next waypoint



**Important**

Whether the path is made of straight lines, curves or a mix of both, it inevitably passes through each waypoint set by the user.

**Important**

The curve segments 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.

**Step 2**

- Using the Freedrive mode or the UR Move menu, move the robot arm to the next desired position.
- Add another waypoint in the program tree by tapping the **Add line** or **Add curve** button.

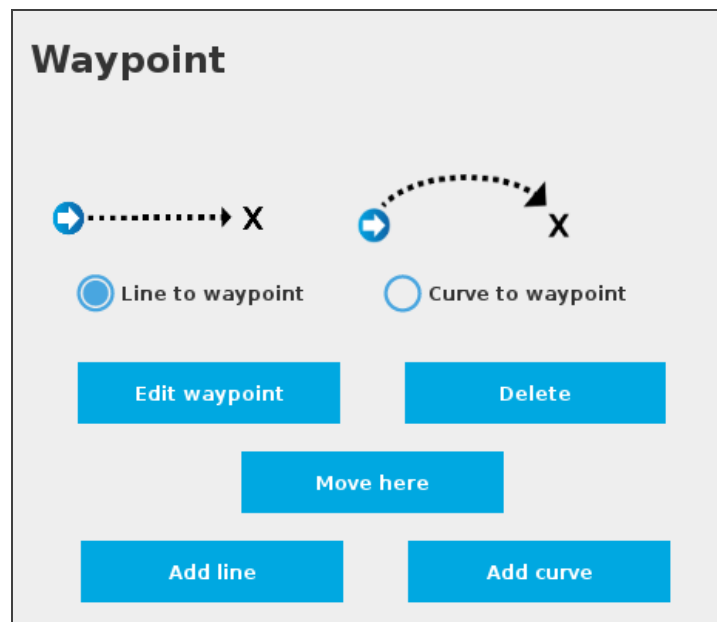


Fig. 4-15: Multipoint Path interface with Line/Curve options.

**Caution**

Adding several waypoints (lines or curves) without moving the robot in between them will result in the generation of identical waypoints. In order to remedy this situation, the user can edit each waypoint created 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 step 2 until you complete your Multipoint Path.

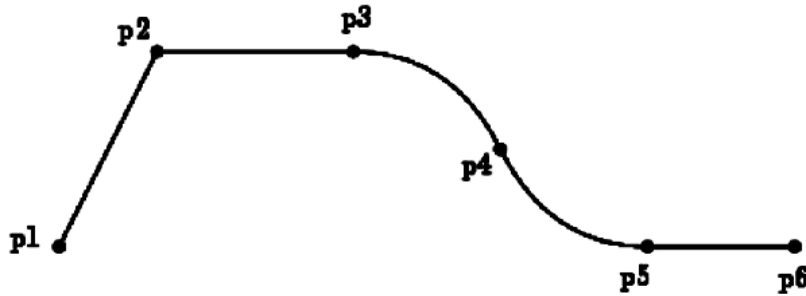
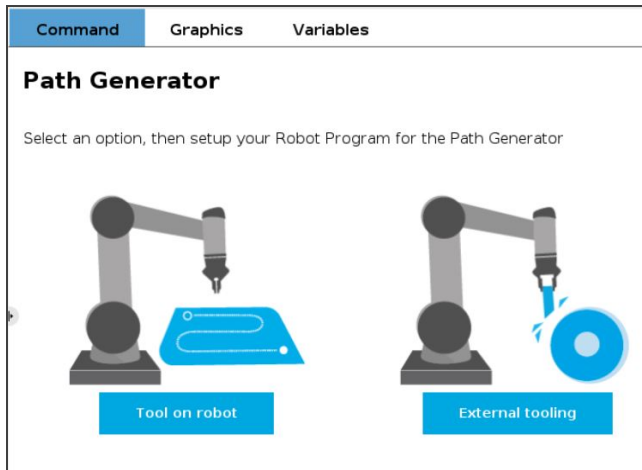


Fig. 4-16: Representation of a six-waypoint Multipoint Path with both curves and straight lines.

## 4.10. Path Generator node

The Path Generator node allows you to program and edit complex trajectory in a matter of minutes. You can put the Path Generator node within a Force Control node to make sure your robot applies a constant force along the process.

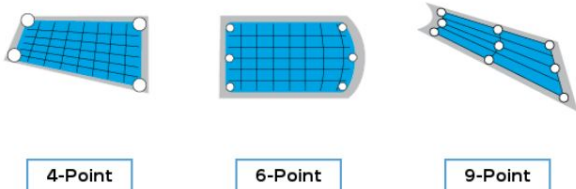


- To add a **Path Generator** node, open the **URCaps** menu from your program.
  1. Choose **Path Generator**.
  2. On the **command** tab, select the **Tool on robot** or the **External Tooling** option.

*Tool on robot option:*

- Check the **Path relative to a feature** box to choose between the **Actual pose** of the robot or go configure a **Feature point** in **Installation** tab → **Features** → **Point**.

### Path Generator

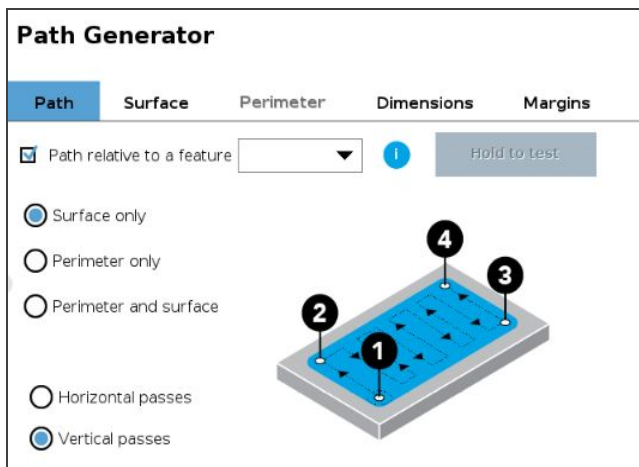
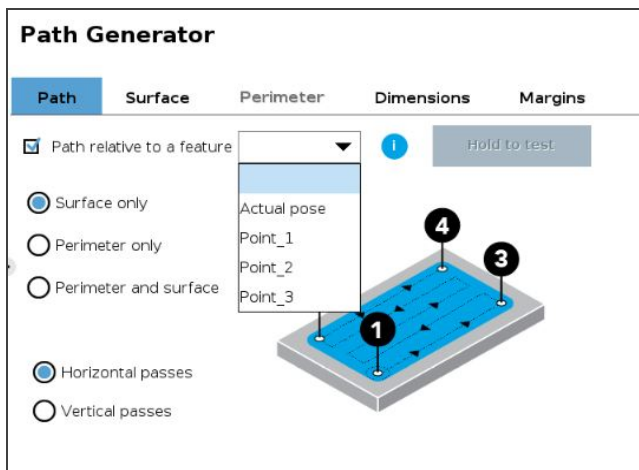
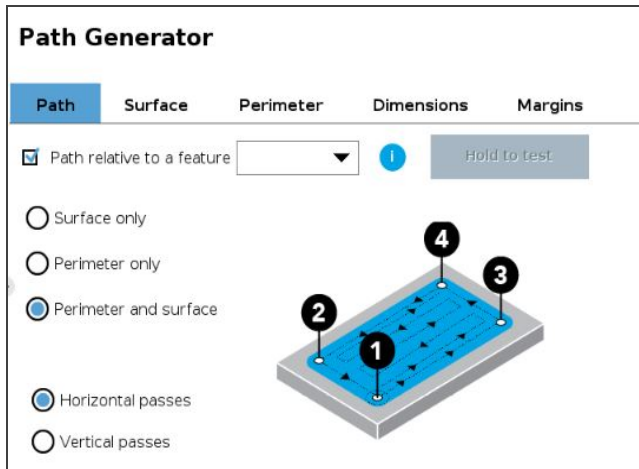


- Select the required path depending on your surface :
  - **4-point**: for a surface between two lines
  - **6-point**: for a surface between two arcs
  - **9-point** : for a surface between four arcs
- Follow the steps bellow.



## 4-Point Path

## Tool on robot option



Once you choose the *Tool on robot* option, you may have up to five (5) tabs to configure, depending on the desired path.

### 1 Path

- In this tab, you have to choose the generated path that your finishing tool will follow. Three options are available:
  - Surface only
  - Perimeter only
  - Perimeter and surface
- These options can be done either with **Horizontal** or **Vertical** passes.
- You can also check the *Path relative to a feature* box to choose between the **Actual pose** of the robot or go configure a Feature point in **Installation** tab → **Features** → **Point**.



### Path Generator

Path **Surface** Perimeter Dimensions Margins

Tool speed **A** 60 mm/s

Spacing ~ **B** 30 mm

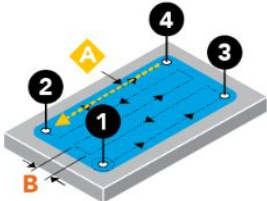
End path on:

Point 4

Point 3

Spacing best fit **1**

Add circular weaving



### Path Generator

Path **Surface** Perimeter Dimensions Margins

Tool speed **A** 60 mm/s

Spacing ~ **B** 30 mm

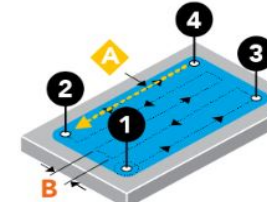
End path on:

Point 4

Point 3

Spacing best fit **1**

Add circular weaving



### Path Generator

Path **Surface** Perimeter Dimensions Margins

Feed **A** 60 mm/s

Spacing ~ **B** 30 mm

End path on:

Point 4

Point 3

Spacing best fit **1**

Add circular weaving

Weaving speed ~ **C** 450 deg/s

Weaving radius **D** 20 mm

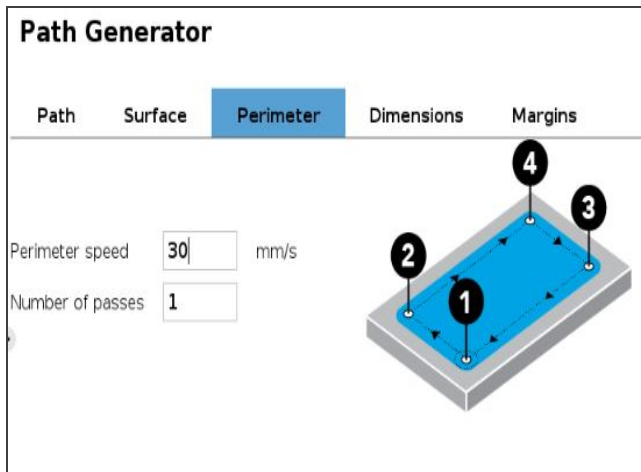
Weaving margin **E** 0 mm



## 2 Surface

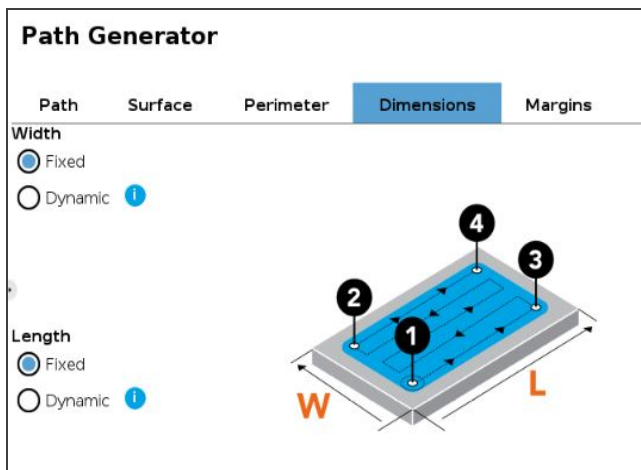
- If you have selected the **Surface only** or **Perimeter and Surface** options, you have to configure the Surface tab.
- The *Tool Speed (A)* and the *Spacing (B)* are respectively preset at 60 mm/s and 30 mm but you can set your own parameters in function of your objectives.
- End path on:** determines the last point in which the finishing tool will end its trajectory. It can end on:
  - Point 4**
  - Point 3**
  - Spacing best fit:** in this case, the Path generator algorithm will determine the number of passes necessary to keep the space as close as possible to the setted *Spacing value (B)*. With this option, the path will end on **Point 2 or 4**.
- Add circular weaving:** this option enable the finishing tool to do circular weaving during the programmed trajectory. The *speed*, *radius* and *margin* values are default settings and you can adjust them in function of the desired finishing result.





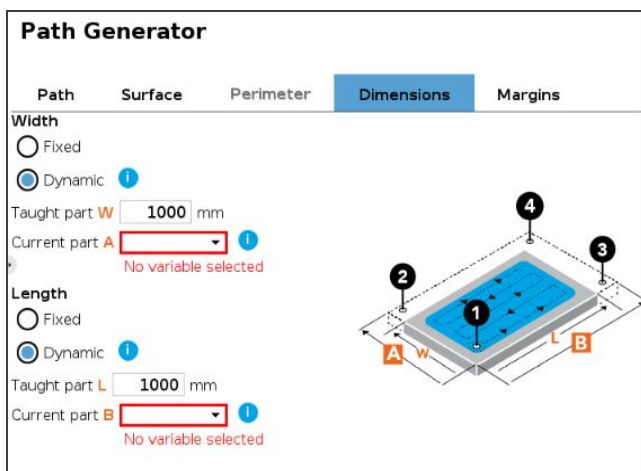
### 3 Perimeter

- If you have selected the **Perimeter only** or **Perimeter and Surface** options, you have to configure the Perimeter tab. You have to determine:
  - The **perimeter speed**: a value is presetted by default but you can change it according to your needs.
  - Number of passes**



### 4 Dimensions

- The **Width** and the **Length** of the piece to be finished can be *Fixed* or *Dynamic*.
- Dynamic**: this option allows to have variant size parts without any recalibration.
  - The **Point 1** is the only one to be fixed at the same position.
  - Points 2, 3 and 4** can be dynamically adjusted to the part dimensions. Please refer to the pop-up information to follow the steps.
  - You can also **create UR variables**: Program > Advanced > Assignment.



#### Tip

To optimize your configuration, start your teach with the biggest part so you can minimize the errors when an adjustment of the dimensions is necessary.





**Path Generator**

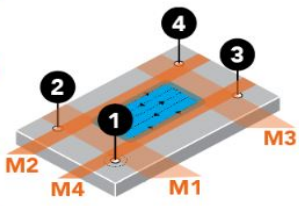
Path Surface Perimeter Dimensions **Margins**

M1  0 mm  
 set with  ⓘ

M2  0 mm  
 set with  ⓘ

M3  0 mm  
 set with  ⓘ

M4  0 mm  
 set with  ⓘ



**Variable Usage Information** ⓘ

ⓘ Create UR variables by going to **Program > Advanced > Assignment**

OK

## 5 Margins

- A **Margin** is the distance between the runtime finishing tool center and the taught **Point 1, 2, 3 or 4**.
- You can configure the four (4) margins by either:
  1. Enter a value manually according to the desired results.
  2. Set with **UR variables** by going to **Program > Advanced > Assignment**.

## External Tooling option

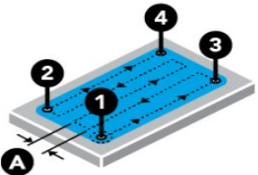
**Path Generator**

External tool feature  ⓘ

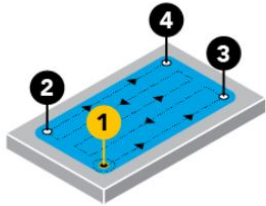
Tool Speed  mm/s

Spacing ~  mm

End path on:  Point 4  
 Point 2



**Point**



Configure the position and the orientation of your **Tool Center Point (TCP)** in **Installation tab → Features → Point**

1. Define the four points that represent the corners of your surface.
2. Each point has its own node. Choose **Set Waypoint** to define your waypoint (bring the robot to where your corner is).
3. Make sure the corner you are teaching fits the corners' sequence on the illustration.
4. When it is defined, you can always move to the point (click on **move here** button that will be available) or change the waypoint (click on **set waypoint**).
5. Perform the same procedure for all four points. Make sure the corner you are teaching fits the corners' sequence on the illustration.
6. When all corners have been defined, go back to 4-Point.
7. You can edit parameters (speed and spacing between passes).



8. You can also choose the final point of your trajectory.
  - **Note:** the spacing you enter will not be applied exactly, it will be rounded to fit the final point you decided.
9. Tap and hold the **Hold to test** button (that will be available) to try out and execute the trajectory without having to run the entire program.
  - **Note:** this will make your robot move, make sure its workspace is clear.

### Tip

To finish complex shapes, it is possible to put one path generator node after the other. If the first one's end point is the second one's starting point, both paths will be followed by the robot without interruption.



## 6-Point Path

## Path Generator

Path relative to a feature i Hold to test

Tool Speed  mm/s

Spacing ~ **A**  mm

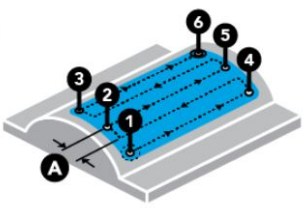
End path on:

Point 6

Point 3

Linear passes

Curved passes



## Path Generator

External tool feature i Hold to test

Tool Speed  mm/s

Spacing ~ **A**  mm

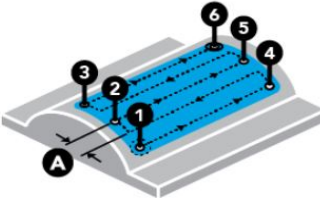
End path on:

Point 6

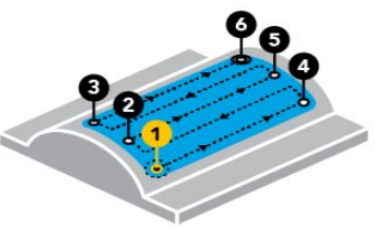
Point 3

Linear passes

Curved passes



## Point



Set waypoint

Move here

1. Define the six points that represent your surface.
2. Each point has its own node.
3. Choose **Set Waypoint** to define your waypoint (bring the robot to where your corner is).
4. Make sure the point you are teaching fits the point sequence on the illustration.
5. When it is defined, you can always move to the point (click on **move here**) or change the waypoint (click on **Set waypoint**).
6. Perform the same procedure for all six points. Make sure the corner you are teaching fits the corners' sequence on the illustration.
7. When all corners have been defined, go back to 6-Point.
8. You can edit parameters (speed and distance between passes).
9. You can also choose the final point of your trajectory.
  - o **Note:** the spacing you enter will not be applied exactly, it will be rounded to fit the final point you decided.
10. Tap and hold the **Hold to test** button (that will be available) to try out and execute the trajectory without having to run the entire program.
  - **Note:** this will make your robot move, make sure its workspace is clear.

You can decide if you want to do linear or curved passes. The illustration will show you the one you selected.



## 9-Point Path

## Path Generator

Path relative to a feature 1 Hold to test

Tool Speed  mm/s

Spacing ~ A  mm

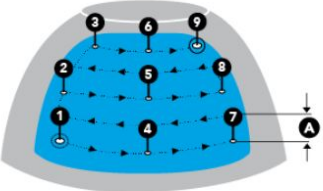
End path on:

Point 9

Point 3

Vertical passes

Horizontal passes



## Path Generator

External tool feature 1 Hold to test

Tool Speed  mm/s

Spacing ~ A  mm

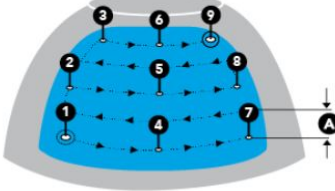
End path on:

Point 9

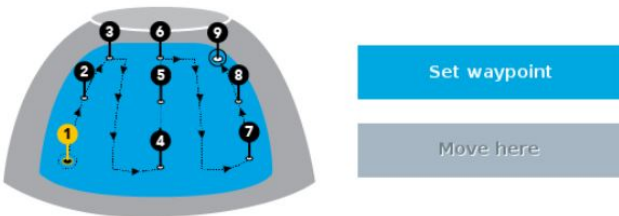
Point 3

Vertical passes

Horizontal passes



## Point



Set waypoint

Move here

1. Define the nine points that represent your surface.
2. Each point has its own node.
3. Choose **Set Waypoint** to define your waypoint (bring the robot to where your corner is).
4. Make sure the point you are teaching fits the point sequence on the illustration.
5. When it is defined, you can always move to the point (click on **move here**) or change the waypoint (click on **Set waypoint**).
6. Perform the same procedure for all nine points. Make sure the corner you are teaching fits the corners' sequence on the illustration.
7. When all corners have been defined, go back to 9-Point.
8. You can edit parameters (speed and distance between passes).
9. You can also choose the final point of your trajectory.

o **Note:** the spacing you enter will not be applied exactly, it will be rounded to fit the final point you decided.

10. Tap and hold the **Hold to test** button (that will be available) to try out and execute the trajectory without having to run the entire program.

- **Note:** this will make your robot move, make sure its workspace is clear.

You can decide if you want to do vertical or horizontal passes. The illustration will show you the one you selected.



## 4.11. Insertion nodes

The Copilot software Package 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, Copilot gives that kind of sensitivity to the end effector.

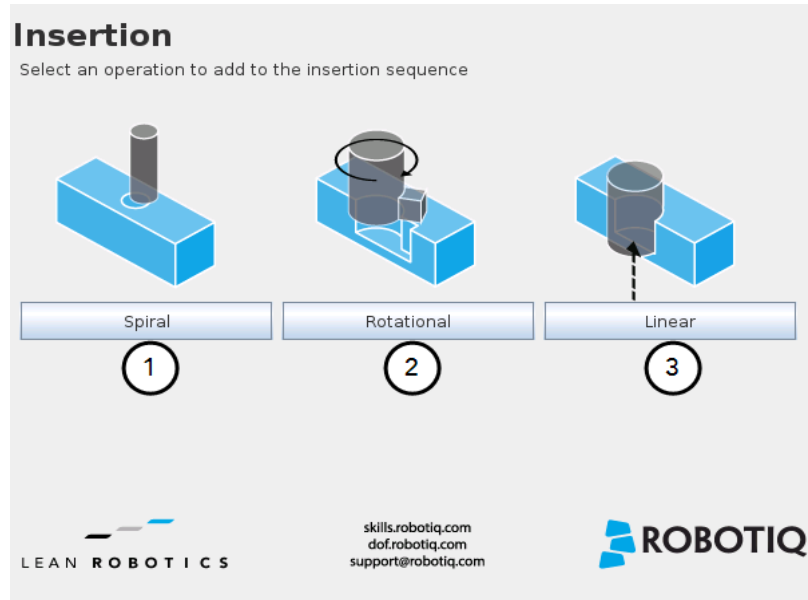
How to add an Insertion node

- On the teach pendant, tap the **New** button to create a program or the **Open** button to load a program
- Tap **Program**→ **URCaps**
- 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.

### 4.11.1. Child 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.

## Features (Spiral)

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)**

**Direction (B)**

**Advanced parameters**

**Speed (C)**

**Force initiating spiral move (D)**

**Force initiating insertion (G)**

**Radius increment per turn (E)**

**Enable peck mode**

**Maximum radius (F)**

Teach position 1

Tool 2 Z+ 3

5 mm/s 5

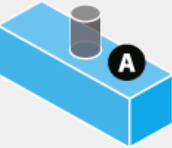
1.0 N 6

3 N 7

0.7 mm 8

9 Tool retraction between points of contact

5 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

### Default values and units of measurement

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
Radius increment per turn	mm	0.7
Maximum radius (Error condition)	mm	5

## Features (Rotational)

### 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 2 Z+ 3

**Advanced parameters**

4 **Linear speed (C)** 5 mm/s 5

**Force initiating rotation (D)** 10 N 6

**Rotation speed** 5 °/s 7

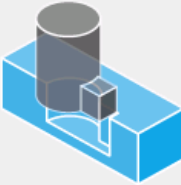
**Maximum torque** 1 Nm 8

**Enable peck mode**

9 **Tool retraction between points of contact**

Error condition

**Maximum rotation angle (E)** 45 ° 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 **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

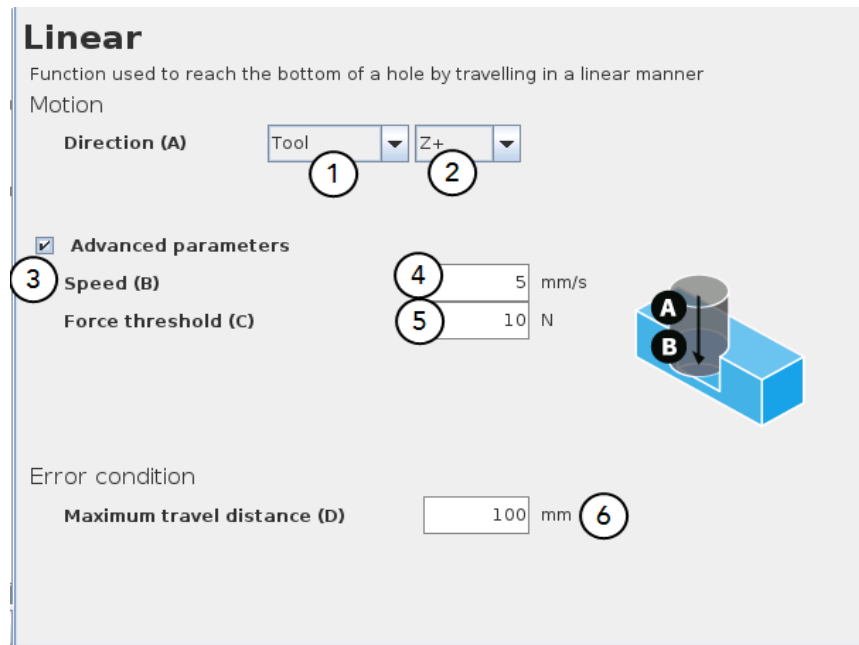
#### Default values and units of measurement

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)	°	360





## Features (Linear)



- 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

## 4.12. Find Surface Node

The Copilot software package 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.

### How to add a Find Surface 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 **Find Surface**
- 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.

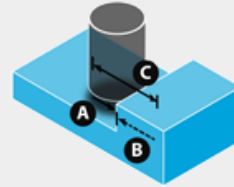
### Motion

Direction relative to the tool (A) **1** Z+ ▾

**2**  Zero Sensor Before Execution

**3**  Advanced parameters

Motion speed **4** 5 mm/s



### Stop condition

Maximum distance traveled (C) **6** 100 mm

**5**  Insert a program instruction if this condition occurs.

Force threshold (B) **8** 10 N

**7**  Insert a program instruction if this condition occurs.

- 1** Direction relative to the tool drop-down 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** 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
- 6** 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
- 7** 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
- 8** Force threshold (Stop condition): Textbox for the user to enter a force threshold value that completes the linear motion

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.

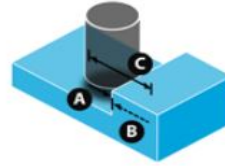
Motion

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.

Fig. 4-17: Find Surface node with stop condition(s)



## 4.13. Force Control node

### Info

The force and torque values, in the pop-up message box, are those applied on the TCP.

### 4.13.1. Overview

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

#### How to add 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 child 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.

### 4.13.2. Features

#### Reference frame

The user can select a reference frame from a drop-down menu, as shown below.

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  Zero Sen... Test

Enable control Force/Torque Stiffness Deviation range

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. 4-18: Force Control node with Reference Feature drop-down highlighted.

## Parameters

## Force Control

Feature Tool Test

Enable control		Force/Torque		Stiffness		Deviation range			
1	x <input checked="" type="checkbox"/>	2 a	5 N	3	80 %	4 a	-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
	Rx <input checked="" type="checkbox"/>	2 b	10 Nm		60 %	4 b	-20	20	°
	Ry <input type="checkbox"/>		My 0 Nm		100 %		-20	20	°
	Rz <input type="checkbox"/>		Mz 0 Nm		100 %		-20	20	°

5  Enable adaptive stiffness

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- 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 stiffness value closer to 0% will provide greater compliance along/around the corresponding axis
  - 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.
- 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.
  - 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

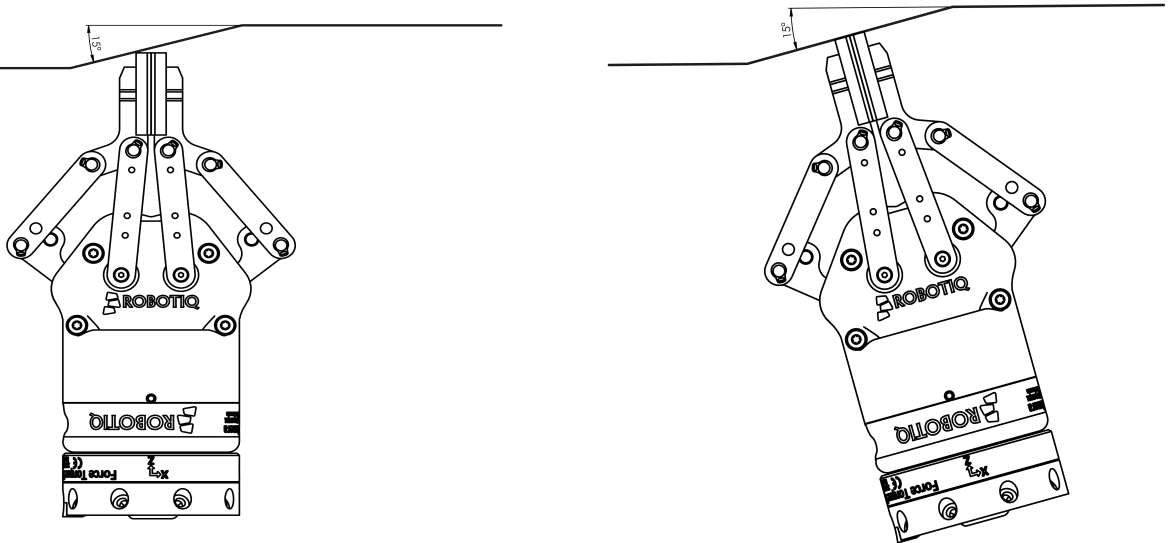


Fig. 4-19: Deviation range - On the left, no deviation range has been entered. On the right, a deviation range of at least 15 degrees has been entered around the corresponding axis.

- 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.



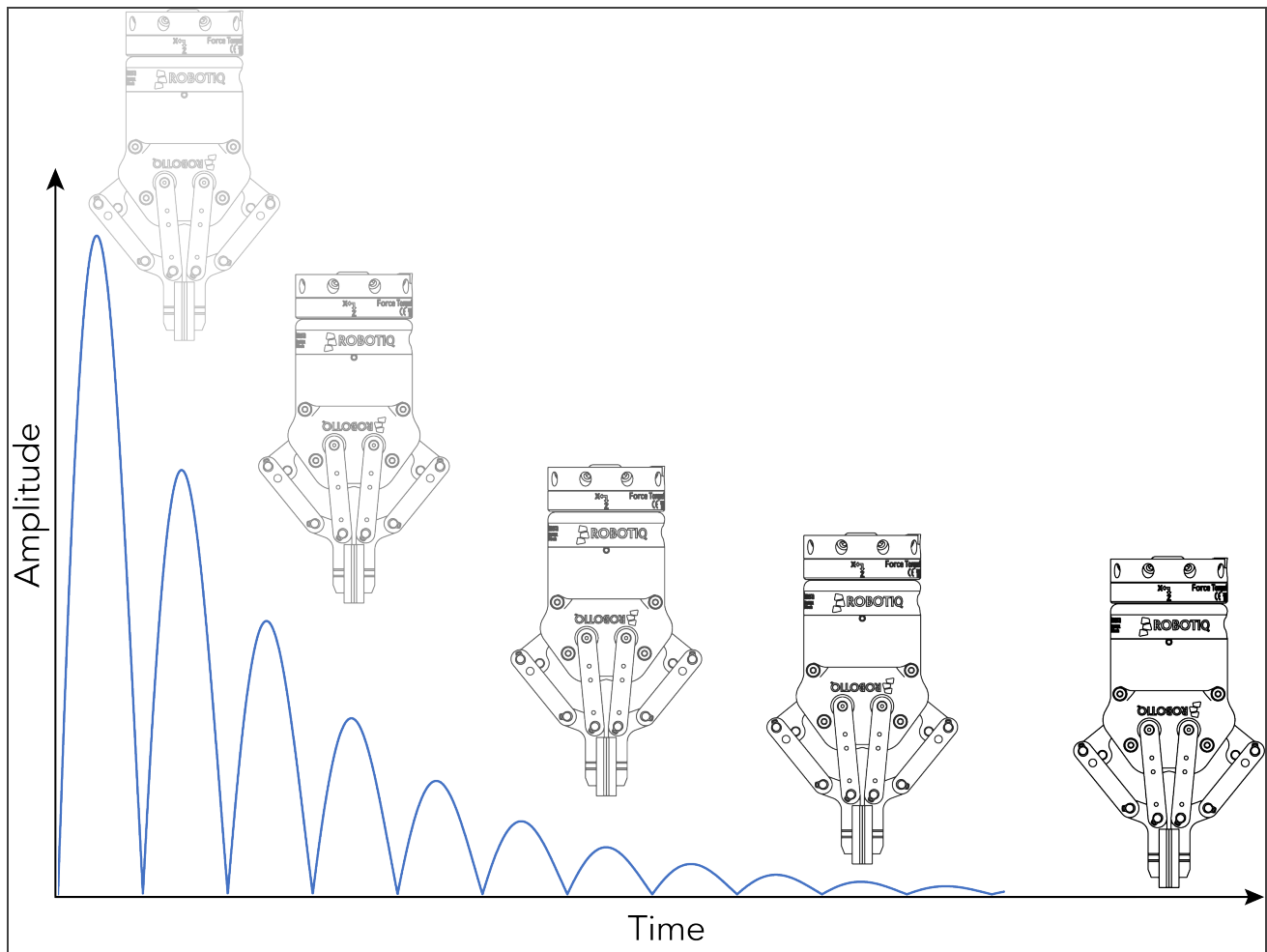


Fig. 4-20: End-effector experiencing adaptive stiffness upon repeated contact with a surface on CB-Series

## Current vs targeted position

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

- Apply force at the current position
- Apply force based on a targeted position



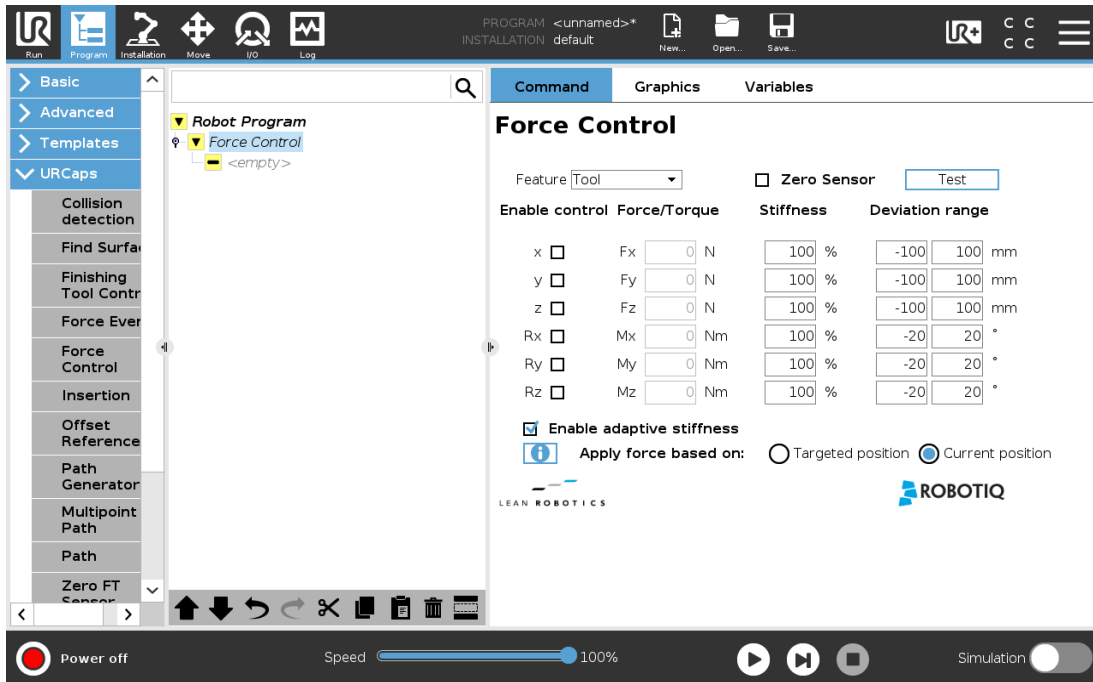


Fig. 4-21: Force control for e-Series

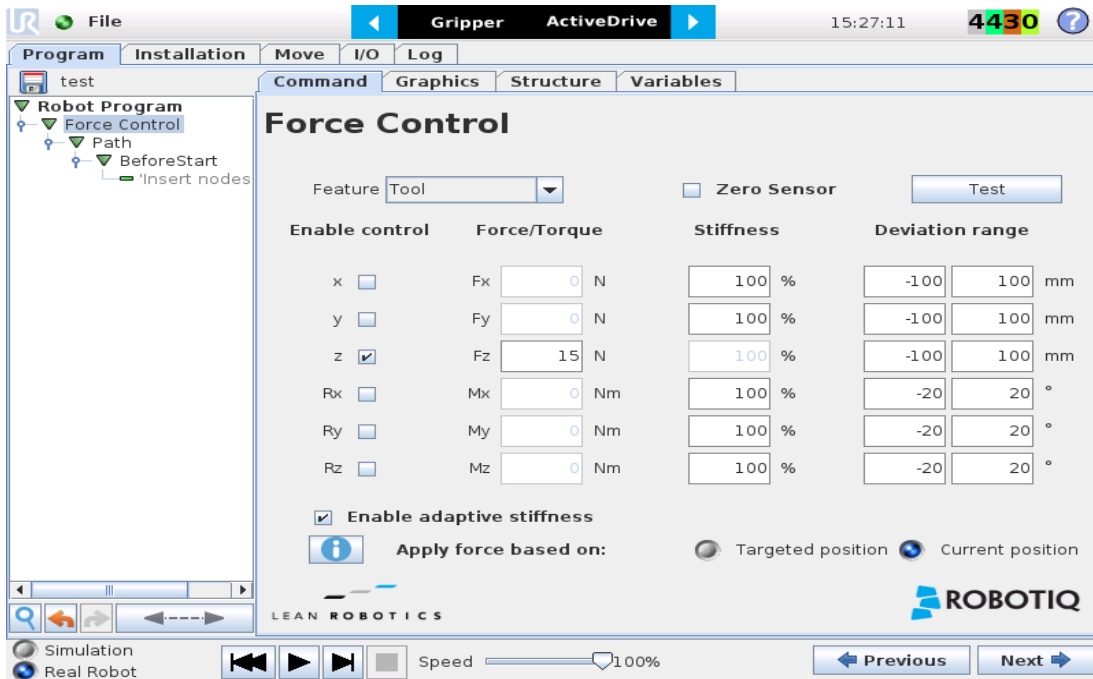
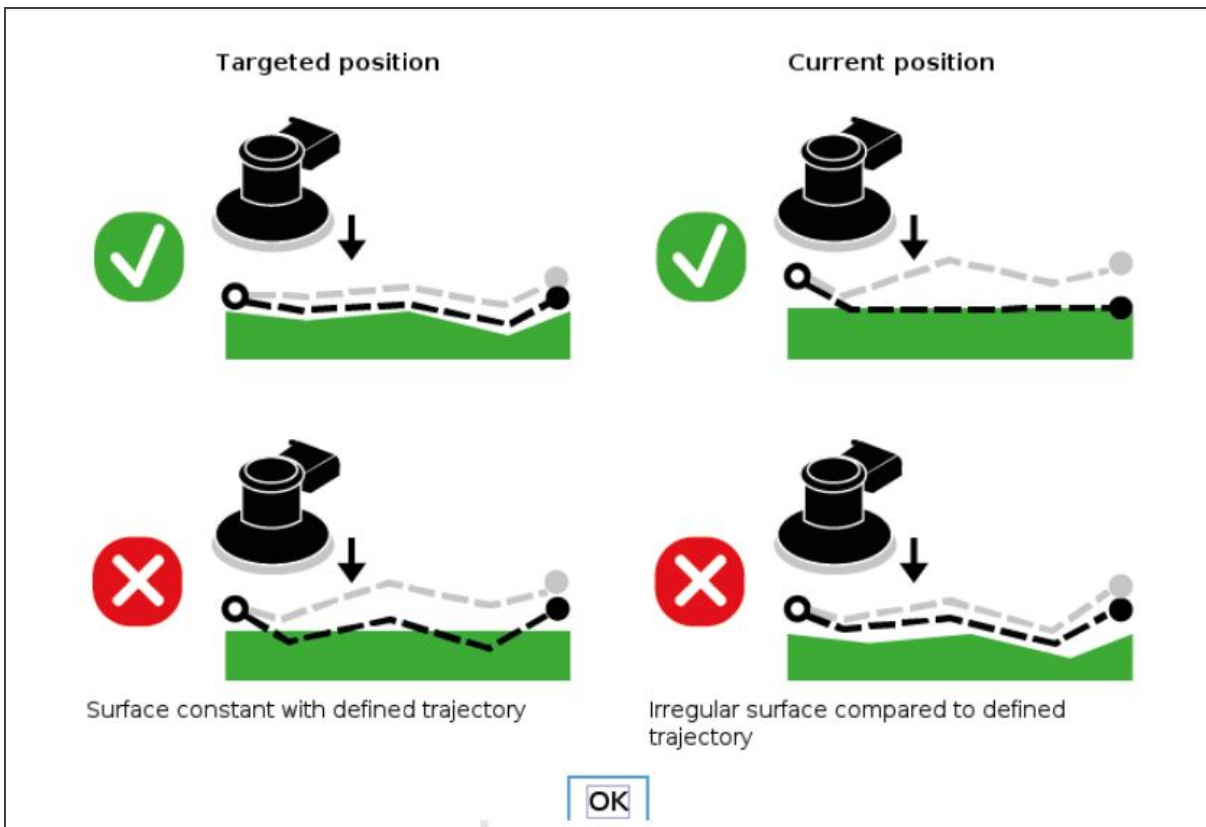


Fig. 4-22: Force control for CB-Series







### 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



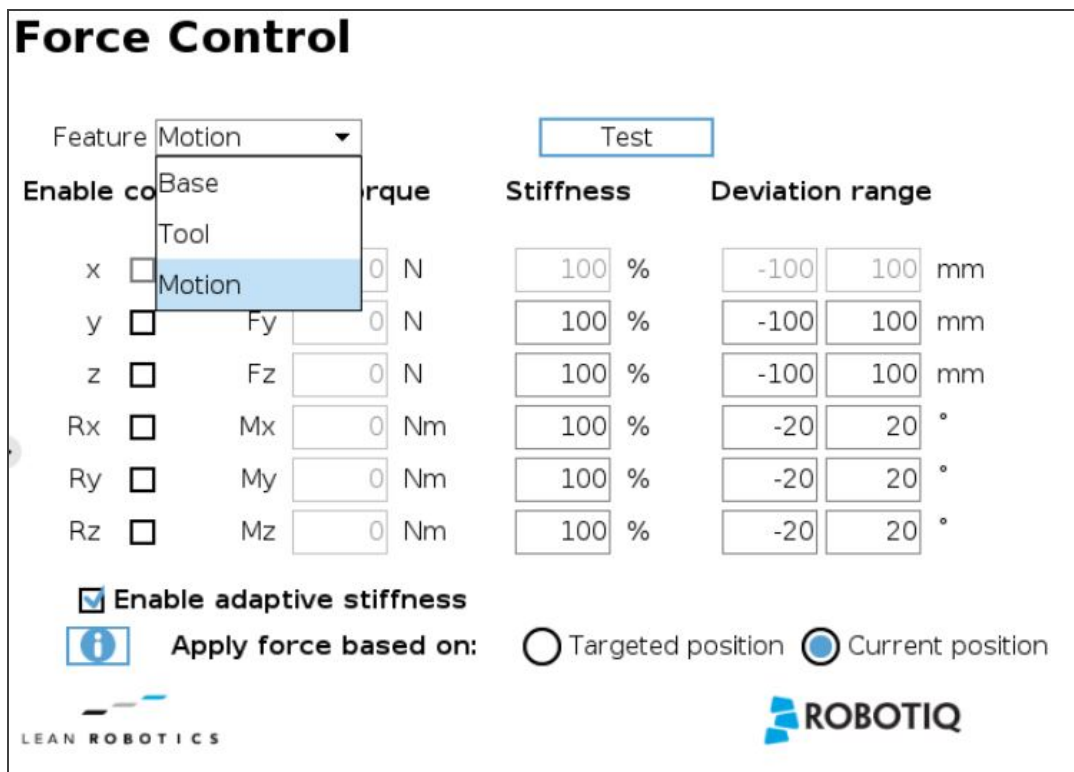
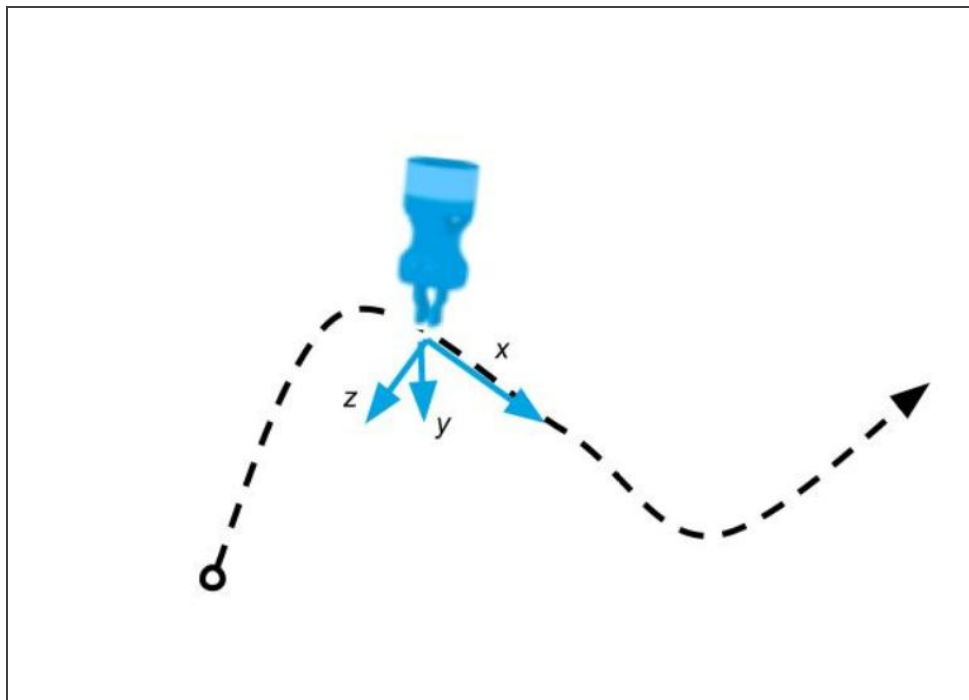


Fig. 4-23: Motion Frame

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's Z axis.



## Test

The Test button applies the 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 program tree.



## Force Control

Feature

	Enable control	Force/Torque	Stiffness	Deviation range
x	<input type="checkbox"/>	Fx <input type="text" value="0"/> N	<input type="text" value="100"/> %	<input type="text" value="-100"/> <input type="text" value="100"/> mm
y	<input type="checkbox"/>	Fy <input type="text" value="0"/> N	<input type="text" value="100"/> %	<input type="text" value="-100"/> <input type="text" value="100"/> mm
z	<input type="checkbox"/>	Fz <input type="text" value="0"/> N	<input type="text" value="100"/> %	<input type="text" value="-100"/> <input type="text" value="100"/> mm
Rx	<input type="checkbox"/>	Mx <input type="text" value="0"/> Nm	<input type="text" value="100"/> %	<input type="text" value="-20"/> <input type="text" value="20"/> °
Ry	<input type="checkbox"/>	My <input type="text" value="0"/> Nm	<input type="text" value="100"/> %	<input type="text" value="-20"/> <input type="text" value="20"/> °
Rz	<input type="checkbox"/>	Mz <input type="text" value="0"/> Nm	<input type="text" value="100"/> %	<input type="text" value="-20"/> <input type="text" value="20"/> °

Enable adaptive stiffness

Apply force based on:  Targeted position  Current position

- You can also test in real time your preset values by holding the **Test** button for the **Tool** and the **Base** features.

## Force Control

Feature

	Enable control	Force Values	Moment Values	Stiffness	Deviation range
x	<input type="checkbox"/>	Fx = -1.0 N	Mx = 0.50 Nm	<input type="text" value="100"/> %	<input type="text" value="-100"/> <input type="text" value="100"/> mm
y	<input type="checkbox"/>	Fy = 2.5 N	My = 0.18 Nm	<input type="text" value="100"/> %	<input type="text" value="-100"/> <input type="text" value="100"/> mm
z	<input type="checkbox"/>	Fz = 12.9 N	Mz = 0.03 Nm	<input type="text" value="100"/> %	<input type="text" value="-100"/> <input type="text" value="100"/> mm
Rx	<input type="checkbox"/>	Mx <input type="text" value="0"/> Nm		<input type="text" value="100"/> %	<input type="text" value="-20"/> <input type="text" value="20"/> °
Ry	<input type="checkbox"/>	My <input type="text" value="0"/> Nm		<input type="text" value="100"/> %	<input type="text" value="-20"/> <input type="text" value="20"/> °
Rz	<input type="checkbox"/>	Mz <input type="text" value="0"/> Nm		<input type="text" value="100"/> %	<input type="text" value="-20"/> <input type="text" value="20"/> °

Enable adaptive stiffness

Apply force based on:  Targeted position  Current position

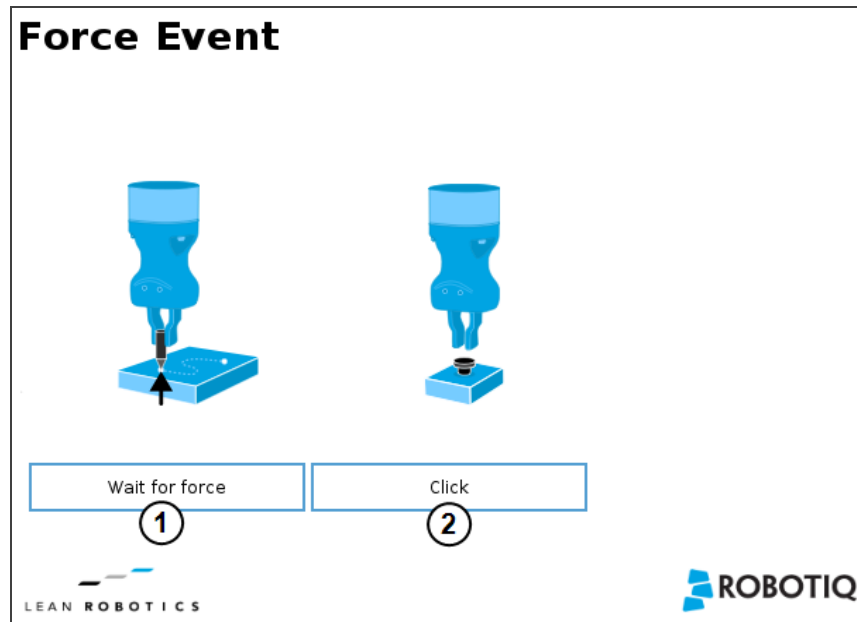


## 4.14. Force Event node

The Force Event node can be used to perform a click detection or to wait for a specific force or torque.

### How to add a Force Event function

- 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 Event**.
- Tap the **Force Event** node in the robot program to edit it.
- Select an operation to add to the **Force Event** sequence.



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.

### 4.14.1. Features (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 instructions.

Indeed, 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, as shown by the animated GIF, a Find Surface function has to be added up in the Click detection node.

## 4.14.2. Features (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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## 4.15. Collision Detection node

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

### How to add a Collision Detection

- **On CB-Series:** From the PolyScope home page, tap **Program Robot** and create or load a robot program
- **On e-Series:** 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 **Copilot**
    3. Tap the **Configuration** tab to edit it.

- From the **Program** tab:
  - Tap the **URCaps** button in the navigation pane on the left
  - Select **Collision Detection**
  - 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 e-Series sensor or the FT Sensor for CB-Series robot. 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.



## Collision detection

Causes a program to stop when the forces and torques monitored by the FT sensor exceed the defined limits.

- Start monitoring
- Stop monitoring
- Halt on collision detection
- Suspend on collision detection

**Force limit**  N

**Torque limit**  Nm

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.



## 5. Specifications

The following sections provide data on the various specifications of the Robotiq Force Torque Sensor.

- Section 5.1 details the technical dimensions of the Dynabrade and Mirka's brackets of the Finishing Kits.
- Section 5.2 details the technical dimensions of the sensor.
- Section 5.3 details the mechanical specifications.
- Section 5.4 specifies the center of mass and tool center point.
- Section 5.5 covers signal specifications (data acquisition).
- Section 5.6 specifies electrical rating.

### Info

Reminder: Measures are in millimeters.

### 5.1. Technical Dimensions of the Finishing Kits

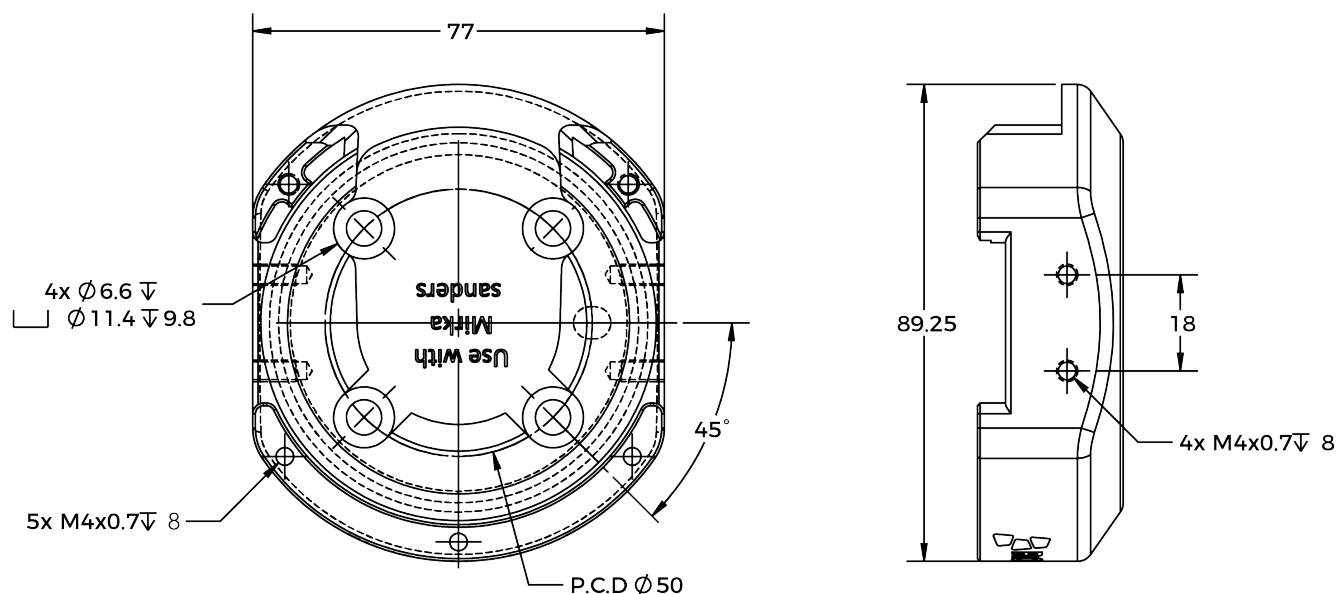


Fig. 5-1: Technical dimensions of Mirka's bracket





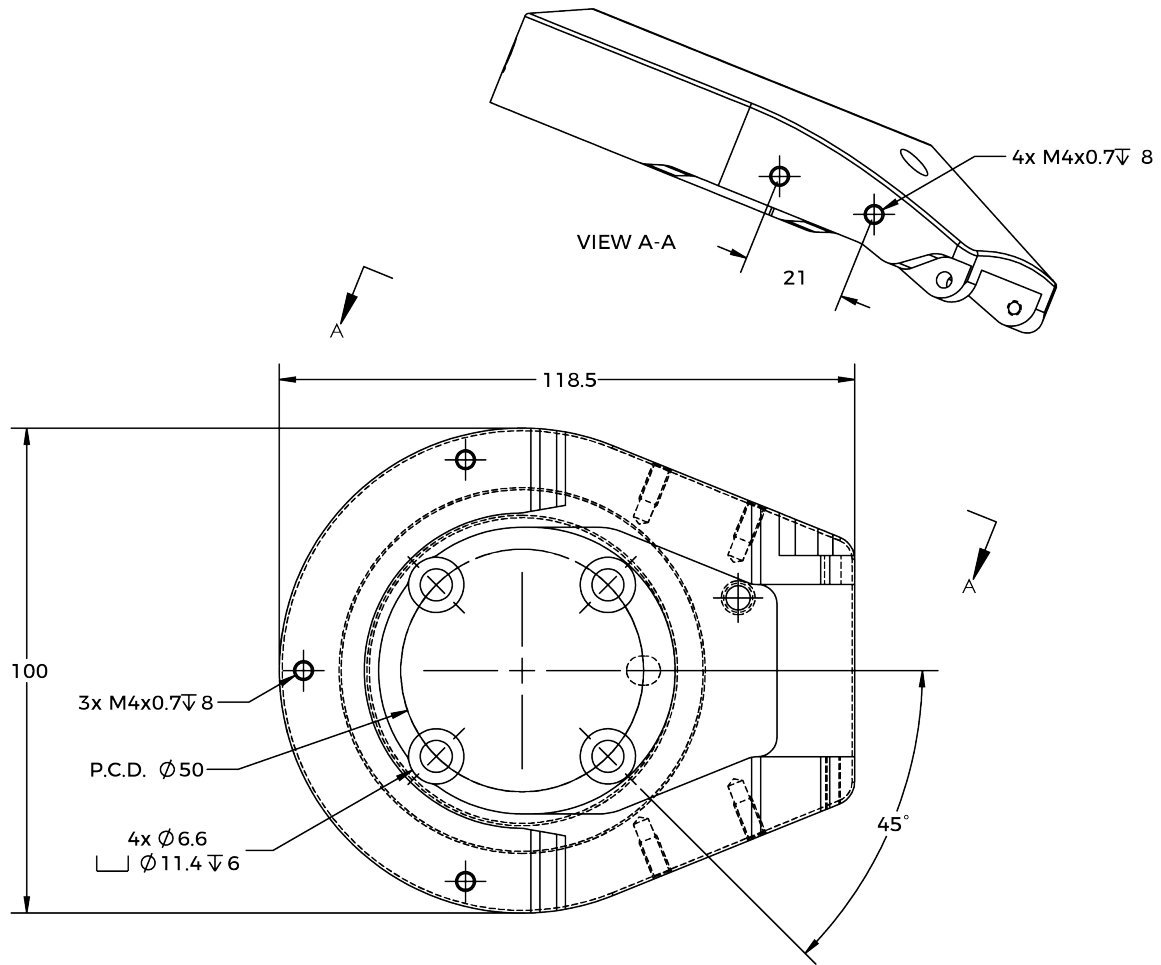


Fig. 5-2: Technical dimensions of Dynabrade's bracket



## 5.2. Technical Dimensions of the FT 300-S Force Torque Sensor

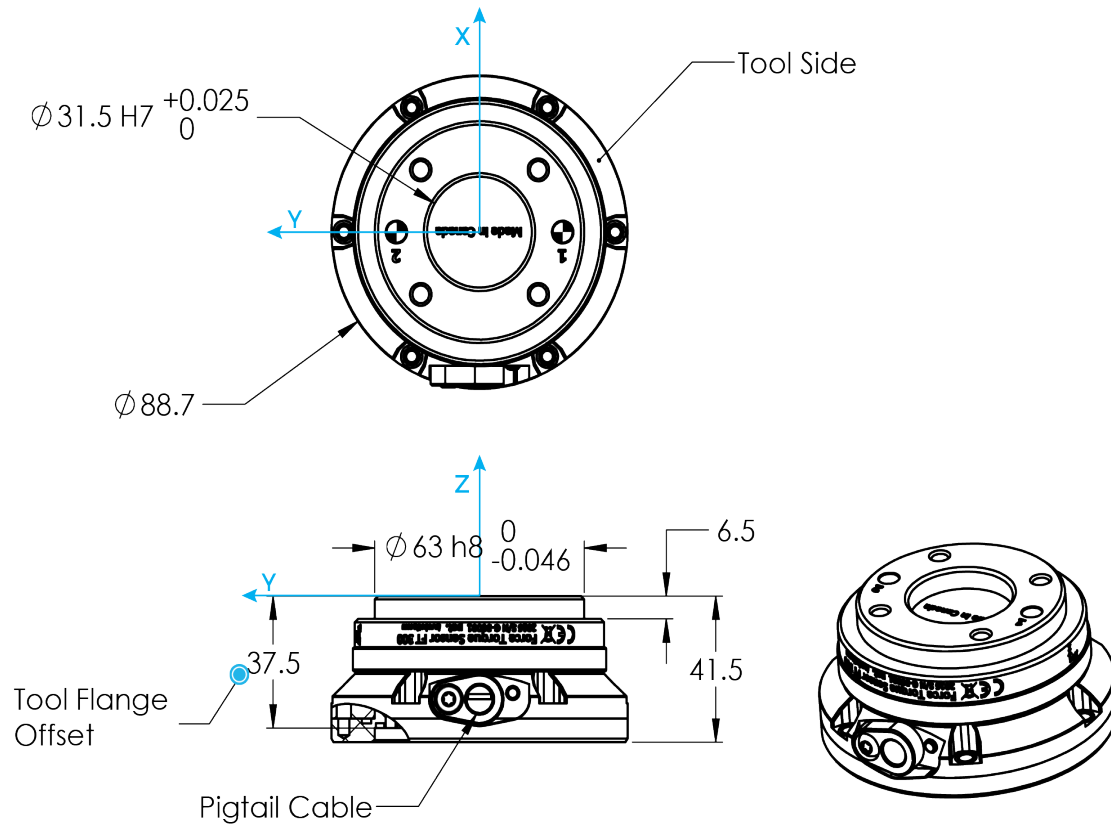


Fig. 5-3: Robotiq FT 300-S Sensor general technical dimensions.



## 5.3. Mechanical Specifications

### 5.3.1. Mechanical Specifications of the Brackets for the Mirka and Dynabrade Sanders

SPECIFICATION	MIRKA BRACKET		DYNABRADE BRACKET	
	Metric	Imperial	Metric	Imperial
External envelope dimensions without sander	[77 89 37] mm	[3.0 3.5 1.5] in.	[100 119 31] mm	[3.9 4.7 1.2] in.
Added height	7 mm	0.28 in.	9 mm	0.35 in.
Product weight without sander	0.221 kg	0.50 lb	0.420 kg	0.93 lb

### 5.3.2. Mechanical Specifications of the FT 300-S Force Torque Sensor

#### Info

Reminder: all units are within the metric measurement system.

SPECIFICATION		VALUE
Approximate weight		442 g
Overload capacity		A combined load exceeding 500% of the measuring range will permanently damage the Force Torque Sensor ( $F_x/300 + F_y/300 + F_z/300 + M_x/30 + M_y/30 + M_z/30 < 500\%$ )
Outside diameter		Ø 89 mm (Robot side) Ø 75 mm (Tool side)
Thickness		41.5 mm (Overall) 37.5 mm (From robot flange)
Stiffness	$F_x, F_y$	35 X 10 <sup>6</sup> N/m
	$F_z$	30 X 10 <sup>6</sup> N/m
	$M_x, M_y$	10,000 Nm/rad
	$M_z$	20,000 Nm/rad



### 5.3.3. Overload Capacity of the FT 300-S Force Torque Sensor

The FT 300-S sensors have overload capacities, the overload capacity specification includes load and torque values in all 3 axes.

#### Info

For loads between the measuring range and the overload capacity, the signal will be saturated. The sensor will not undergo permanent damage if the overload capacity is not reached.

#### Warning

Exceeding the overload capacity will permanently damage the sensor.

Sensor	Measuring range	Overload capacity <sup>1</sup>
FT 300-S	+/- 300 N	1500 N (500%) <sup>2</sup>

<sup>1</sup>Overload capacity with all axes combined.

<sup>2</sup>Maximum load expressed in % of measuring range.

The overload capacity given includes forces and torques in all 3 axes. To get an approximation of the total load, these formulas must be used:

- For the FT 300-S

$$F_x/300 + F_y/300 + F_z/300 + M_x/30 + M_y/30 + M_z/30 < 500\%$$

### 5.4. Center of mass and tool center point

Product	Center of mass (mm)			TCP (mm)			Mass (g)
	X	Y	Z	X	Y	Z	
Finishing kit (SAND-FTS-S-CB-UR-KIT)	1.0	-7.0	60.0	0.0	0.0	138.0	1775
Finishing kit (SAND-ES-UR-KIT)	3.0	-9.0	37.0	0.0	0.0	100.0	1335



## 5.5. Signal Specifications

SPECIFICATION		FT 300 (prior to 10/2017)	FT 300-S
Measuring range	Force	±300 N	
	Torque	± 30 Nm	
Signal noise <sup>1</sup>	F <sub>x</sub> , F <sub>y</sub>	1.2 N	0.1 N
	F <sub>z</sub>	0.5 N	0.1 N
	M <sub>x</sub> , M <sub>y</sub>	0.02 Nm	0.005 Nm
	M <sub>z</sub>	0.03 Nm	0.003 Nm
Recommended threshold when mounted on a robot	F <sub>x</sub> , F <sub>y</sub>	5 N	1 N
	F <sub>z</sub>	2 N	1 N
	M <sub>x</sub> , M <sub>y</sub>	0.08 Nm	0.02 Nm
	M <sub>z</sub>	0.12 Nm	0.01 Nm
External noise sensitivity <sup>2</sup>		Immune	
Data output rate		100 Hz	
Temperature compensation <sup>3</sup>		15 to 35 °C	

<sup>1</sup>Signal noise is the standard deviation of the signal measured over a period of one (1) second

<sup>2</sup>Under normal operating conditions.

<sup>3</sup>Specifications included in the **Signal Specifications** section may vary outside of the temperature compensation range.

Table 5-1: Signal Specifications

### Warning

Sensor data may be slightly affected by strong electromagnetic fields.



**Caution**

For more details on minimum/maximum operating temperatures, please refer to the **Environmental and Operating Conditions** section.

**Caution**

The recommended threshold represents the smallest variations that can be detected by the sensor.

The signal noise is the limiting factor for the Sensor's precision. For the FT 300-S, the signal noise defined in the signal specifications is the standard deviation of each data (Fx, Fy, Fz, Mx, My, Mz) over 1 second. In order to use that signal noise information, three times the standard deviation given must be used. According to the normal distribution, three times the standard deviation will cover almost all values possible (99.7%).

**Info**

Noise is an unwanted and unpredictable alteration to a signal. It may come from electrical or electromagnetic sources and degrades the quality of the Sensor's signal.

## 5.6. Electrical Ratings

SPECIFICATION	VALUE
Input voltage	5 to 24 V DC $\pm$ 10%
Max power consumption	2 W
Communication electrical interface	RS-485
Recommended fuse	Phoenix #0916604 (UT6-TMC M 1 A)
Recommended power supply	TDK-Lambda DPP Series 15W Single Output DIN Rail Mount Power Supply, DPP15-24



## 6. Maintenance

### 6.1. Robotiq Finishing Kits

Refer to the air sanding tools instruction manuals (Mirka or Dynabrade), for information on maintenance specific to the sanding tool.

### 6.2. FT 300-S Force Torque Sensor

The Robotiq Force Torque Sensor requires only external maintenance with limited downtime.

Maintenance of the Sensor is required after specified usage, measured in time (normal 40h week). Respecting the maintenance interval will ensure:

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

#### Warning

Unless otherwise specified, any repairs done on the FT 300-S Force Torque Sensor will be done by Robotiq.

#### 6.2.1. Maintenance Intervals

Operation	Daily	Weekly	Semiannually
Zero calibration	X1		
Sensor cleaning	Dirty conditions	Normal conditions	
Periodic inspection			X2

<sup>1</sup>Zero calibration should be integrated into the program routine. This will compensate for the tool weight (for its current orientation), the effect of the attachment mechanisms on the Sensor and any other factors which could affect the readings. It is recommended to add this instruction when the robot is not applying force on its environment and when the tool is in the same orientation as when the readings will be used (for example at the beginning of the program or just before picking up an object or applying force).

<sup>2</sup>If there is any visible damage to the Sensor, contact [support@robotiq.com](mailto:support@robotiq.com).



## 7. Spare Parts, Kits and Accessories

### 7.1. Surface Finishing Kits

Item	Description	Ordering Number
Surface Finishing kit for UR e-Series	<ul style="list-style-type: none"> <li>• Finishing Copilot software dongle license (CP-FIN-ES-UR-KIT)</li> <li>• Mounting kit for Dynabrade Orbital Sanders (SAND-APL-ROS-001)</li> <li>• Mounting kit for Mirka Orbital Sanders (SAND-APL-ROS-002)</li> <li>• Air control accessories (ACC-AIR-001)</li> </ul>	SURF-ES-UR-KIT
Surface Finishing kit for UR CB-Series	<ul style="list-style-type: none"> <li>• FT 300-S Sensor kit for UR (FTS-300-S-UR-KIT)</li> <li>• Mounting kit for Dynabrade Orbital Sanders (SAND-APL-ROS-001)</li> <li>• Mounting kit for Mirka Orbital Sanders (SAND-APL-ROS-002)</li> <li>• Air control accessories (ACC-AIR-001)</li> </ul>	SURF-FTS-S-CB-UR-KIT

### 7.2. Sanding Kits

Item	Description	Ordering Number
Sanding kit for UR e-Series	<ul style="list-style-type: none"> <li>• 1 x Finishing Copilot dongle license (CP-FIN-ES-UR-KIT)</li> <li>• 1 x Air Control accessories (ACC-AIR-001)</li> <li>• 1 x Sander &amp; Mounting Kit Dynabrade (SAND-ROS-001)</li> </ul>	SAND-ES-UR-KIT
Sanding kit for UR CB-Series	<ul style="list-style-type: none"> <li>• 1 x FT 300-S Sensor Kit for UR (FTS-300-S-UR-KIT)</li> <li>• 1 x Air Control accessories (ACC-AIR-001)</li> <li>• 1 x Sander &amp; Mounting Kit Dynabrade (SAND-ROS-001)</li> </ul>	SAND-FTS-S-CB-UR-KIT





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## 8. Troubleshooting

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The following are some common troubleshooting hints, if you need further assistance please contact [support@robotiq.com](mailto:support@robotiq.com).

### 8.1. Monitoring the Sensor state (Surface Finishing and Sanding Kits)

In order to view the sensor status and verify the force and torque values:

- 1 Tap the **Installation** button in the ribbon at the top of the screen
- 2 Select the **URCaps** menu in the navigation pane on the left
- 3 Tap **Copilot**.
- 4 Tap the **Dashboard** tab.

#### Info

If needed, the user can tap the About tab to get further information regarding the force torque sensor.

Refer to the sanding tool's manuals, for troubleshooting regarding the sander.

#### Info

For FT 300-S Force Torque Sensor troubleshooting instructions, please refer to the Copilot Instruction Manual at [support.robotiq.com](http://support.robotiq.com).



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## 9. Warranty

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### 9.1. Surface Finishing Kit and Sanding Kit

Refer to your orbital sander's instruction manual for information on the sanding tool's warranty. Robotiq warrants the Kits hardware and the Copilot software package against defects in material and workmanship for a period of one year from the date of reception, when utilized as intended.

### 9.2. FT 300-S Force Torque Sensor

Robotiq warrants the FT 300-S Force Torque Sensor against defects in material and workmanship for a period of one year from the date of reception when utilized as intended with the specified maintenance. Robotiq also warrants that this equipment will meet applicable specifications under normal use.

#### Info

For more details about the FT 300-S Force Torque Sensor warranty, please refer to the Copilot Instruction Manual at [support.robotiq.com](https://support.robotiq.com).

### 9.3. Exclusions

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

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 product or other factors beyond Robotiq's control. It also excludes all consumable parts and their normal wear.



# 10. License Agreement

## END-USER LICENSE AGREEMENT

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

**IMPORTANT, READ CAREFULLY:** This End-User License Agreement (the "Agreement") is a legal agreement between you and the Licensor (as this term is hereinafter defined), the licensor of the Software. This Agreement covers the Software. The Software includes any "on-line" or electronic documentation and all modifications and upgrades related thereto. By downloading, installing, or otherwise using the Software, you agree to be bound by the terms of this Agreement. If you do not agree to the terms of this Agreement, the Licensor cannot and does not license the Software to you. In such event, you must not download, use or install the Software.

### 1. Definition.

1. "**UR**" means Universal Robots A/S, a corporation incorporated under the laws of Denmark, having its registered office at Energivej 25, DK-5260 Odense S, which specializes into the conception, advanced manufacturing and sale of robotic products (the "UR's Business");
2. "**Software**" means any of the Licensor's software provided to its customers for the purposes mentioned in sub-section 2.2 hereof including their modifications and upgrades and their related materials;
3. "**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");
4. "**End-User**" means a customer authorized pursuant to this Agreement to install or use the Software with a specific product of the UR's Products;
5. "**Licensor's Products**" means those robotic products developed by the Licensor in the course of the Licensor's Business;
6. "**UR's Products**" means those products developed by UR in the course of the UR's Business;
7. "**Licensor's Authorized Representatives**" means and includes the Licensor and Licensor's authorized vendors, resellers, distributors and licensors;
8. "**Designated Equipment**" means a personal computer that has a functional USB port and an operating system that is an equivalent or a more recent version of one of the following:
  - Windows 7;
  - Mac OSX;
  - Linux Ubuntu 16.
9. "**Purchase Agreement**" means an agreement between the End-User and the Licensor pursuant to which the End-User purchased one or more of the Licensor's Products;
10. "**Trial Period**" means the limited period during which the Software may be installed on the UR's Product and used without any charge by the End-User in order to be used without a Licensor's Product.



## 2. License and Object of the Agreement.

- **License.** Subject to the terms and conditions hereof, the Licensor grants to the End-User a personal, temporary, non-exclusive, non-assignable and non-transferable and revocable license to use the Software in accordance with the terms and conditions hereof.
- **Object of the Agreement.** The object of this Agreement is the grant of a license for the use of software that enables control functionalities of UR's Products devices or Licensor's Products (the "Purpose").

## 3. Software and Documentation.

- **Download.** The Software shall be downloaded from the Licensor's website or provided to the End-User through a USB flash drive, according to the instructions set forth in the order summary sent to the End-User by email or by other means of communication, as decided by the Licensor (the "Order Summary"). The download of the Software shall be made with the End-User's Designated Equipment.
  - **Installation.** The installation on the UR's Product shall be done with a USB flash drive inserted into the UR's Product. If the Software was downloaded from the Licensor's website, it shall be uploaded on a USB flash drive device for the purpose of installation on the UR's Product.
  - **Utilisation.** Two scenarios are possible according to the modalities set forth in the Order Summary:
    - a) The use of the Software is made with a Licensor's Product. In this case, the End-User may start using the Software upon completed installation.
    - b) The use of the Software is made without a Licensor's product. In this case, a Trial Period is granted to the End-User. At the end of the Trial Period, which shall be set forth in the Order Summary, the use of the Software requires the software protection dongle (the "Dongle"). The Dongle will be provided to the End-User for a fee as per section 5 of this Agreement, either by the Licensor or by a Licensor's Authorized Representative.
  - **Documentation.** The Licensor may provide, if applicable, all documentation containing the detailed specifications for operation and use of the Software, which Software shall be used in accordance with such documentation. This documentation, if applicable, will be provided, wholly or in part, within (i) this Agreement, (ii) the Licensor's Web site <http://robotiq.com/> (iii) the Licensor's Products and the Purchase Agreement therewith, or (iv) any other agreement, document, support, whatsoever decided by the Licensor.
4. **Modifications and Upgrades.** The Licensor shall be under no obligation to provide any upgrade, modification or patch to the Software. However, the End-User shall be entitled to receive free of charge the upgrades and patches of the Software provided by the Licensor if, at such time, the End-User is not in default in respect of any of its obligations contained herein. Modifications that create new functionalities may be offered to the End-User at a price set by the Licensor at its sole discretion.
- Such modifications, upgrades and patches of the Software shall be installed by the End-User itself by consulting the Licensor's website <http://robotiq.com/> where a link to proceed to such installation will be made available thereof.
5. **Fees.** The End-User shall pay the Licensor for using the software as per the Order Summary. The fees shall cover upgrades and patches of the Software provided by the Licensor if, at the time of the upgrade or patch, the End-User is not in default in respect of any of its obligations contained herein.
- New End-Users not using the Licensor's Products will be entitled to a Trial Period, which shall begin on the date of the first installation on the UR's Product and which shall end after the Trial Period as determined in the Order Summary.
6. **Maintenance.** During the term of this Agreement, the Licensor will maintain the Software in an operable condition and will make available any corrections and improvements as are generally incorporated in the Software by the Licensor without additional charge to the End-User.
7. **Title to Software.** The licensed Software is composed of confidential data and trade secrets and is proprietary to and constitutes trade secret information and intellectual property of the Licensor. Title and ownership rights to the Software, including the intellectual property rights related thereto, shall remain with the Licensor. The End-User agrees to maintain the confidential nature of the source code and libraries.



- The license granted herein does not include the right to sublicense to others, and may not be assigned to others, in whole or in part, without the prior written consent of the Licensor. The End-User may not or allow others to modify or prepare derivative works, copy (except for normal backups for recovery purposes), reproduce, republish, reverse engineer, upload, post, transmit, or distribute, in any manner, the Software.
8. **Restricted Use.** The Software shall be used solely and exclusively by the End-User and its employees for the Purpose mentioned in sub-section 2.2 hereof. Any other use of the Software, including resell derivative modifications or extensions, is expressly prohibited.
  9. **Audit.** During the term of this Agreement and for six (6) months after the termination, the Licensor shall have the right, during normal business hours and upon reasonable advance notice to the End-User, to visit the End-User's premises for the purpose of auditing the End-User's use of the Software to confirm that such use is in accordance with this Agreement or to confirm that the End-User has ceased the use of the Software after the termination of the Agreement. The costs of such audit shall be borne by the Licensor unless it determines that the End-User has underpaid it for any twelve-month period by five per cent (5%) or more or that the use of the Software is not in accordance with the Agreement; in such case, the End-User shall pay the costs of the audit and such underpayment.
  10. **Exclusion of Warranty on Software.** The End-User expressly acknowledges and agrees that use of the Software is at the End-User sole risk. The Software is provided "as is". The Licensor warrants that, during the term of this Agreement and except if modified by the End-User, the Software will meet in all material respects the specifications provided for in the Licensor's website.
  11. **Limitation of liability.** To the maximum extent permitted by law, the Licensor and Licensor's Authorized Representatives shall not be liable for any indirect, incidental or consequential damages for breach of any express or implied warranty, breach of contract, negligence, strict liability or any other legal theory related to the Software. Such damages include, but are not limited to, loss of profits, loss of revenue, loss of data, loss of use of the product or any associated equipment, down time and user's time, even if the Licensor has been advised of the possibility of such damages. In any case, the Licensor's entire liability under any provision of this agreement shall be limited to the amount actually paid in respect of the Licensor's products purchased by the end-user pursuant to a purchase agreement.
  12. **Indemnification.** The End-User shall indemnify and hold the Licensor harmless from any liability, loss, claim and from any judgment, damage and cost (including, without limitation, the costs and fees of a dispute and reasonable legal fees), fine, penalty and interest whatsoever arising from any defence, dispute, compensation, claim or counterclaim as a result of the use of the Software by any third party authorized by the End-User.
  13. **Training, Maintenance and Support.** There is no entitlement to training, maintenance and support under this license unless otherwise specified in the Purchase Agreement or any other written agreement between the End-User and the Licensor. The End-User may provide the Licensor with details regarding any bug, defect or failure in the Software promptly and with no delay from such event; the End-User shall comply with the Licensor's request for information regarding bugs, defects or failures and furnish him with information, screenshots and try to reproduce such bugs, defects or failures upon Licensor's demand.
  14. **Expiration and Termination.** The Licensor may terminate this Agreement for default by the End-User by sending a ten (10) day notice to the End-User.
- Upon the termination of this Agreement for any reason, the End-User shall promptly uninstall the Software on any UR's Products and Licensor's Products, computer, or server on which it has been installed, deliver to the Licensor all CDs, DVDs, USB flash drives, and other tangible items and materials embodying the Software, and return to the Licensor all copies thereof or destroy such copies and warrant in writing that all copies thereof have been destroyed or deleted. In the event of the termination of this Agreement, 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.
15. **Miscellaneous.**
    - 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.
    - 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 Québec, Québec.

- 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.
- 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.
- 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.
- 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.
- The Licensor hereby confirms that there is no relationship of agency between the Licensor and UR, and that they are independent contractors.
- Any rights not expressly granted herein are reserved.
- 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.



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# 11. Contact

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[www.robotiq.com](http://www.robotiq.com)

Contact Us

**Phone**

1-888-ROBOTIQ (762-6847)  
(01) 418-380-2788 Outside US and Canada

**Technical support and engineering**

option 3

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option 2

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

[dof.robotiq.com](http://dof.robotiq.com)

