USER MANUAL

RG6

Industrial Robot Gripper

For the Universal Robots

Document version 1.9.2

OnRobot URCap version 1.9.0.

January 2019

Content

1 Preface 5

1.1 Target Audience 5

1.2 Intended Use 5

1.3 Important safety notice 5

1.4 Warning Symbols 6

1.5 Typographic Conventions 7

2 Getting Started 8

2.1 Scope of Delivery 8

2.2 Mounting 8

2.3 Mechanical Dimensions 9

2.4 Load Capacity 9

2.5 Fingers 10

2.6 Gripper Work Range 11

2.6.1 Finger Thickness 12

2.6.2 Gripping Speed 12

2.7 Cable Connections 13

2.7.1 Tool Connections 13

2.7.2 Power Supply 14

2.8 UR Compatibility 14

2.9 URCap Plugin Installation 14

2.10 URCap Plugin Setup 15

2.10.1 Mounting setup 15

2.10.2 Settings 18

2.10.3 About Screen 20

3 Using the URCap Plugin 21

3.1 OnRobot Feedback Variables 21

3.1.1 Single RG6 21

3.1.2 Dual RG6 21

3.2 OnRobot URCap Commands 21

3.3 RG6 Command 21

3.3.1 Width and Force 22

3.3.2 Payload 23

3.3.3 Depth Compensation 24

3.3.4 Feedback and Teaching Buttons 24

3.3.5 Dual Gripper 26
3.4 RG6 TCP Node 27
3.5 Script Function 27
4 List of Acronyms 28
5 Appendix 29
5.1 Technical Specifications 29
5.2 Software Uninstallation 29
5.3 Declarations and Certificates 30
5.3.1 CE/EU Declaration of Incorporation (original) 30
5.4 Editions 31

1 Preface

1.1 Target Audience

This document is intended for integrators who design and install complete robot applications. Personnel working with the gripper are expected to have the following expertise:

A. Basic knowledge of mechanical systems
B. Basic knowledge of electronic and electrical systems
C. Basic knowledge of the robot system

1.2 Intended Use

The gripper is designed for grabbing objects, installed on the end effector of a robot, typically used in pick and place applications. OnRobot is not liable for any damage or injury resulting from misuse.

Misuse includes, but is not limited to:

- Use in potentially explosive environments
- Use in medical and life critical applications
- Use before performing a risk assessment

1.3 Important Safety Notice

The gripper is *partly completed machinery* and a risk assessment is required for each application the gripper is a part of. It is important that all safety instructions herein are followed. The safety instructions are limited to the gripper only and do not cover the safety precautions of a complete application.

Below is listed some potential dangerous situations, that the integrator as a minimum must take to consideration. Please note that there can be other dangerous situations depending on the specific situation.

- Entrapment of limbs between the Grippers finger arms
- Penetration of skin by sharp edges and sharp points on the grabbed object
- Consequences due to incorrect mounting of the Gripper
- Objects falling out of the Gripper, e.g. due to incorrect gripping force or to high acceleration from a robot

The complete application must be designed and installed, in accordance with the safety requirements specified in the standards and regulations of the country where the application is installed.

1.4 Warning Symbols

DANGER:

This indicates a very dangerous situation which, if not avoided, could result in injury or death.

WARNING:

This indicates a potentially hazardous electrical situation which, if not avoided, could result in injury or damage to the equipment.

WARNING:

This indicates a potentially hazardous situation which, if not avoided, could result in injury or major damage to the equipment.

CAUTION:

This indicates a situation which, if not avoided, could result in damage to the equipment.

NOTE:

This indicates additional information such as tips or recommendations.

1.5 Typographic Conventions

The following typographic conventions are used in this document.

Table 1: Conventions

`Courier Text`	File paths and file names, code, user input and computer output.
Italicized text	Citations and marking image callouts in text.
Bold text	UI elements, including text appearing on buttons and menu options.
Bold, blue text	External links, or internal cross-references.
<angle brackets>	Variable names that must be substituted by real values or strings.
1. Numbered lists	Steps of a procedure.
A. Alphabetical lists	Image callout descriptions.

2 Getting Started

2.1 Scope of Delivery

In the Universal Robots OnRobot RG6 Gripper Kit everything required to connect the OnRobot gripper to your UR robot is provided.

OnRobot RG6 Industrial Robot Gripper

- OnRobot RG6 Single Bracket
- OnRobot RG6 Fingertips
- OnRobot USB drive
- T10 Torx key
- T25 Torx key
- T30 Torx key
- plastic bag, containing:
  - M6x8 Torx screws (4 pcs)
  - M5x10 Torx screws (8 pcs)

2.2 Mounting

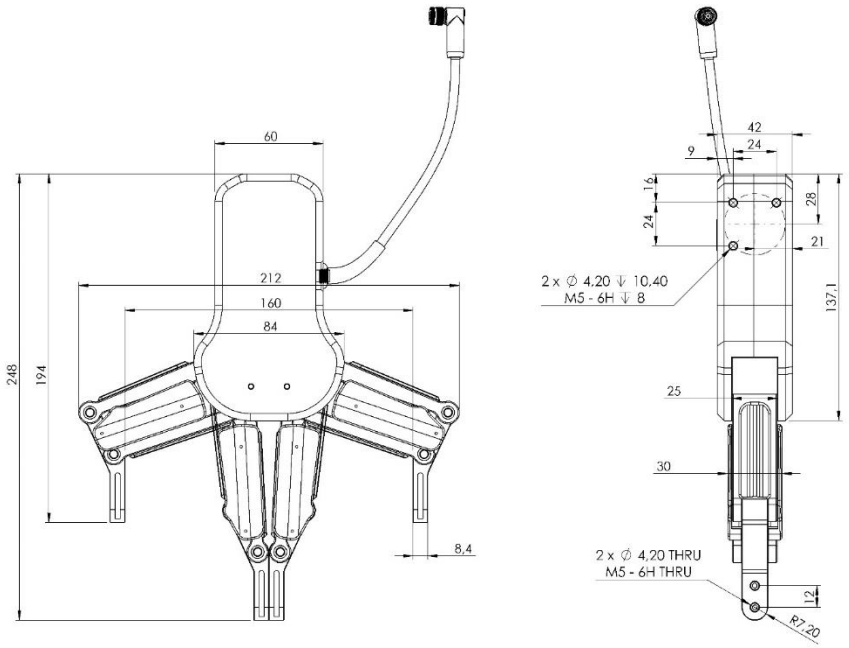
To mount the gripper, follow this process:

1. Fasten the Gripper bracket to the Robot by four Torx T30 M6x8 screws. Use 7 Nm tightening torque. Use the T30 Torx key.
2. Fasten the Gripper to the adapter by four Torx T25 M5x10 screws. Use 2 Nm tightening torque. Use the Torx T25 key.

Use only the screws provided with the gripper. Longer screws could damage the gripper or the robot.

> The design of the standard Gripper bracket means that the angle of the Gripper can be adjusted from 0° to 180° in steps of 90°.

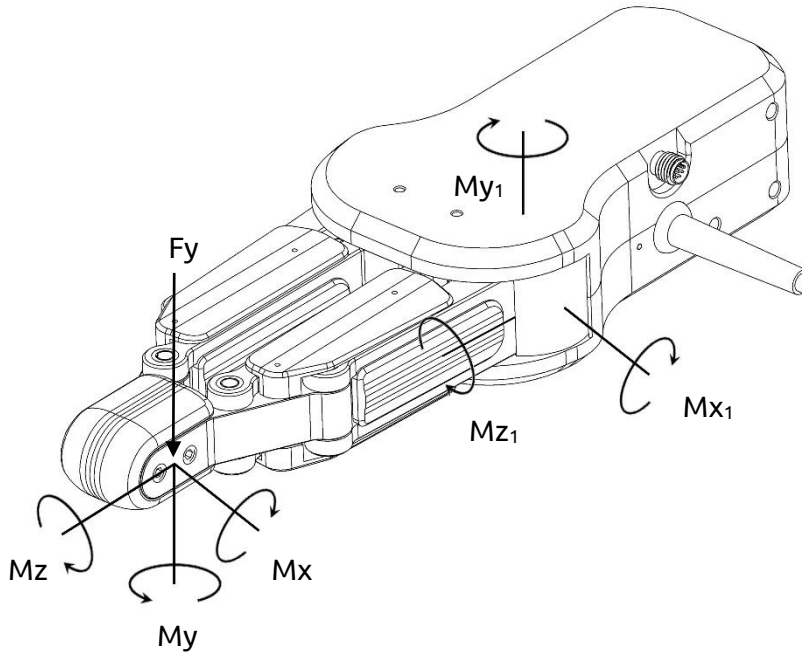
2.3 Mechanical Dimensions



The dimensions are in millimeters (the cable may differ from above drawing).

2.4 Load Capacity

Be aware that when grapping an object, some of the parameters below are not directly aplicative, but can be used to calculate the load on the Gripper.



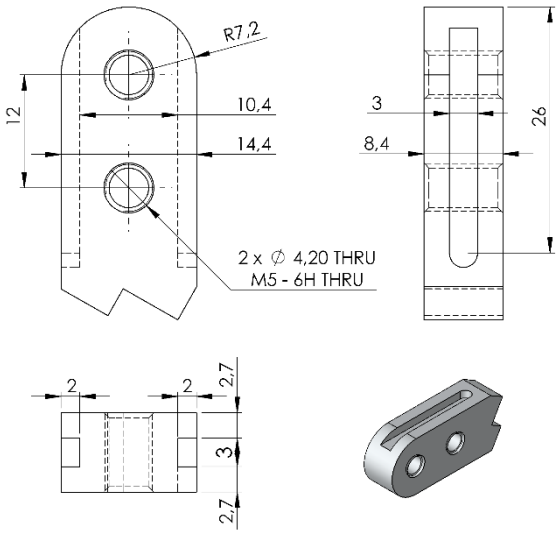
Parameter	Static	Unit
Fy	1890	[N]
Mx	38	[Nm]
My	20	[Nm]
Mz	35	[Nm]
Mx_1	120	[Nm]
My_1	56	[Nm]
Mz_1	120	[Nm]

The parameters in the fingertips are calculated at the shown position and will change in relation to the finger positions.

2.5 Fingertips

The standard fingertips can be used for many different workpieces. If custom fingertips are required, they can be made to fit the Gripper fingers.

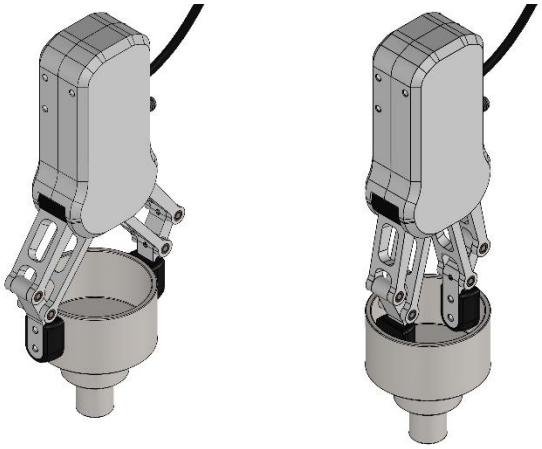
Dimensions of the Grippers aluminum fingers, in millimeters.



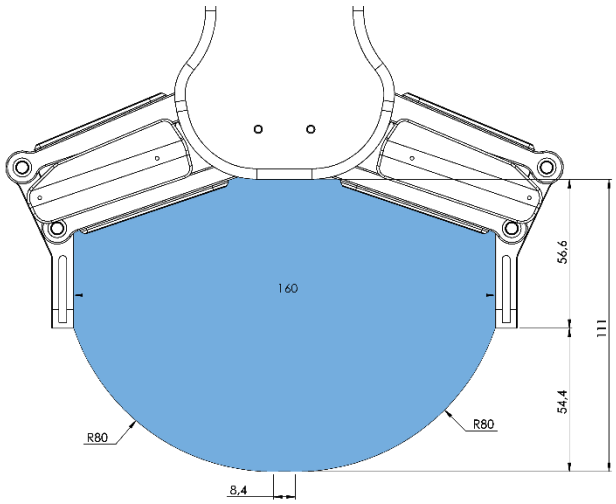
2.6 Gripper Work Range

The work range is measured between the aluminum fingers. The Gripper can be used for both internal and external grip, e.g. by rotating the fingers. Make sure that the offset is adjusted before entering values into the Gripper settings.

See the figure below, for external grip, and internal grip with rotated fingers.



See the figure below, for the gripper work range.



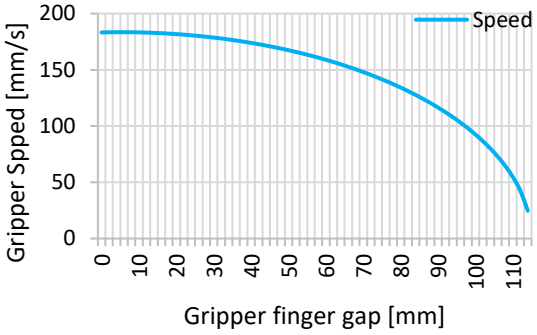
2.6.1 Finger Thickness

The finger thickness is used to specify the distance from the inside of the RG6 aluminum fingertip to the reference point on the attached fingertip.
When removing or changing the fingertips, the thickness of the fingertips have to be adjusted in the RG6' configurations.

For more information, see section **Settings**.

2.6.2 Gripping Speed

Speed table illustrating the difference in speed relative to the Gripper finger position.



2.7 Cable Connections

To connect the gripper, follow this process:

1. Connect the 8 pin M8 cable of the gripper to the Tool I/O connector on the robot arm.

2.7.1 Tool Connections

The Gripper cable is intended to fit the tool connector OnRobots from Universal Robots. The connections are described below. The output tool connector on the Gripper shares the same connections as the input cable described below.

Cable RKMV 8-354

Pin	Wire	UR Tool	UR I/O V3
1	White	AI2	Tool analog input 2
2	Brown	AI3	Tool analog input 3
3	Green	DI9	Tool input 1
4	Yellow	DI8	Tool input 0
5	Gray	Power	24V DC
6	Pink	DO9	Tool output 1
7	Blue	DO8	Tool output 0
8	Red	GND	0V DC

CAUTION:

1. If the Gripper is used in applications where it is not connected to a UR robot.
    i. Make sure the connections resemble the analog input, digital in and outputs
    and the power connections.
    ii. Make sure you use a RG6 Gripper programming script that is adapted to fit your specific application. For more information, please contact your supplier.
2. Do not operate the Gripper in a wet environment.

2.7.2 Power Supply

The Gripper can operate at both 12V and 24V.
At 12V the forces, speed and some of the function tolerances described in this manual do not apply. It is recommended to use 24V.

2.8 UR Compatibility

If the UR version is 3.0 <= and >= 3.3. It is recommended to upgrade the robot to the newest available UR software and install the URCap plugin that is installed in this manual. If the robot is < 3.0 the OnRobot USB pen will detect it and install the templates needed for your robot version. In such case please see the User Manual version 1.44 placed on the USB in the folder "\ON\CLASSIC\Technical support".

Compatibility overview:

RG2 Robot program	RG2 firmware < 1.5	RG2 firmware >= 1.5	Robot SW < 1.6	Robot SW < 3.3	Robot SW >= 3.3
Retro URP files	✓	✓	✓	✓	✓
Classic URP files	✓	✓	X	✓	✓
Cap plugin	✓	✓	X	✓	✓

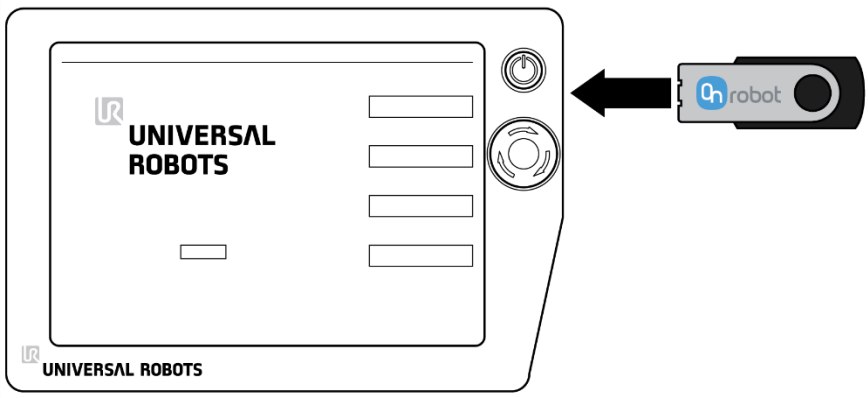
✓ Fully compatible
✓ Upgrade needs to be done
X Not compatible

If the firmware version is too low, the URCap will automatically guide you to update the firmware.

2.9 URCap Plugin Installation

To install the OnRobot URCap plugin, follow this process:

1. Insert the OnRobot USB drive in the USB slot on the right side of the Teach Pendant. A progress bar appears, indicating the upload is in progress.

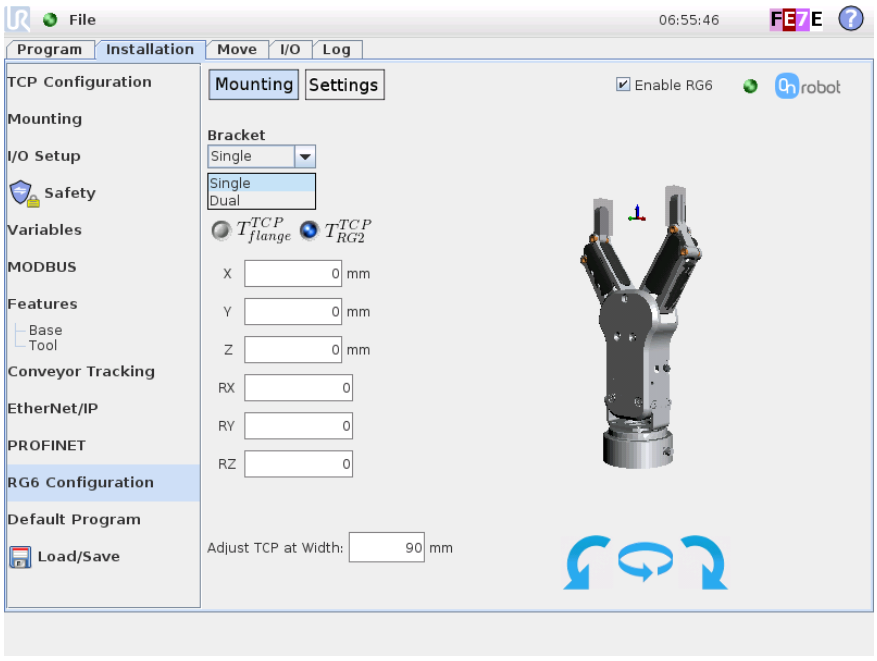


2. Wait for the Robot to reboot.
3. Initialize the robot.

Continue with **URCap Plugin Setup**.

2.10 URCap Plugin Setup

2.10.1 Mounting setup



2.10.1.1 Bracket

Select the bracket that is used for mounting the RG6(s) on the robot.
The options are: “Single”, “Precision” or “Dual”.
The “Dual” bracket is used in case of a dual RG6 setup.
The “Precision” bracket offers an accurate remount of the RG6 with the rotation options of 90° steps. With the “Single” and “Dual” brackets, the RG6(s) can be rotated at 90° steps.

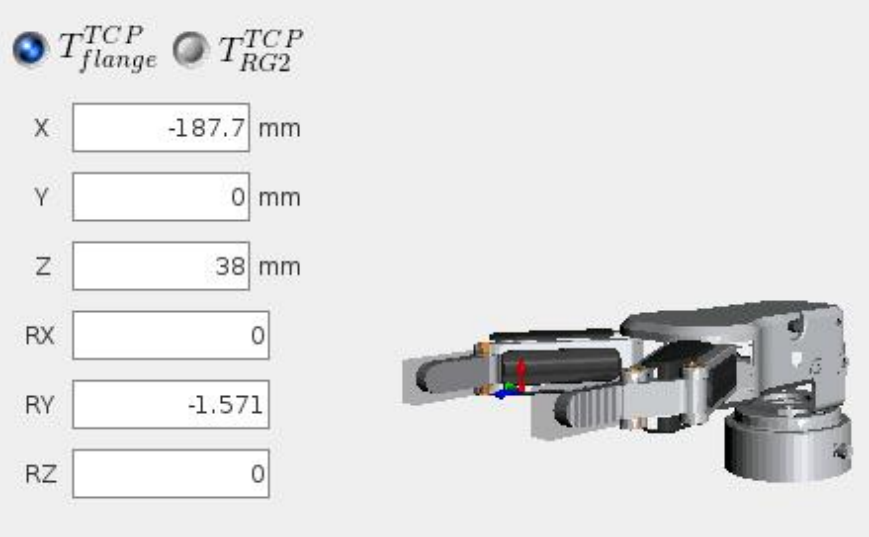
2.10.1.2 Rotation Buttons

Button marked 'b' will rotate the bracket 90° counter clockwise around the z-axis of the tool flange

Buttons marked 'a' will rotate the selected RG6 +/- the step size (30°/90° depending on bracket).

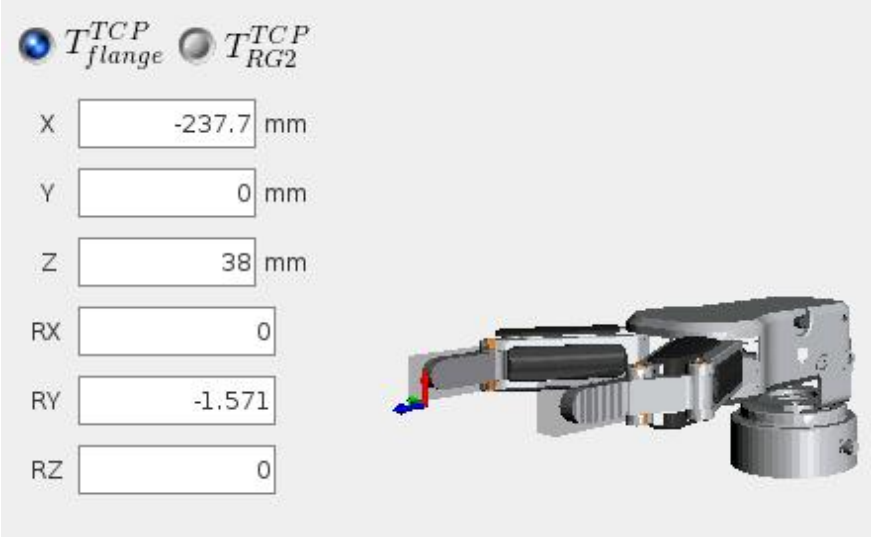
2.10.1.3 TCP Radio Buttons and Values

The radio button will change, if the values represent the transformation from the tool flange to the actual TCP T_{flange}^{TCP},or the transformation for the point in between the fingers of the RG6 to the actual TCP T_{RG2}^{TCP}. The default values of T_{RG2}^{TCP} will always be [0,0,0,0,0,0] while T_{flange}^{TCP} is dependent on bracket and RG6 rotation.



The example above illustrates the difference between how T_{RG2}^{TCP} and T_{flange}^{TCP} is calculated.

The fields [X,Y,Z,RX,RY,RZ], both serve as input and output. When T_{flange}^{TCP} is selected, the values will be affected by pressing the Rotation buttons and entering a new TCP width. The values of [X,Y,Z,RX,RY,RZ] can always be overwritten. If a reset is wanted, the TCP radio button should be set to T_{RG2}^{TCP} and [0,0,0,0,0,0] should be filled in in the rotation vectors [X,Y,Z,RX,RY,RZ].



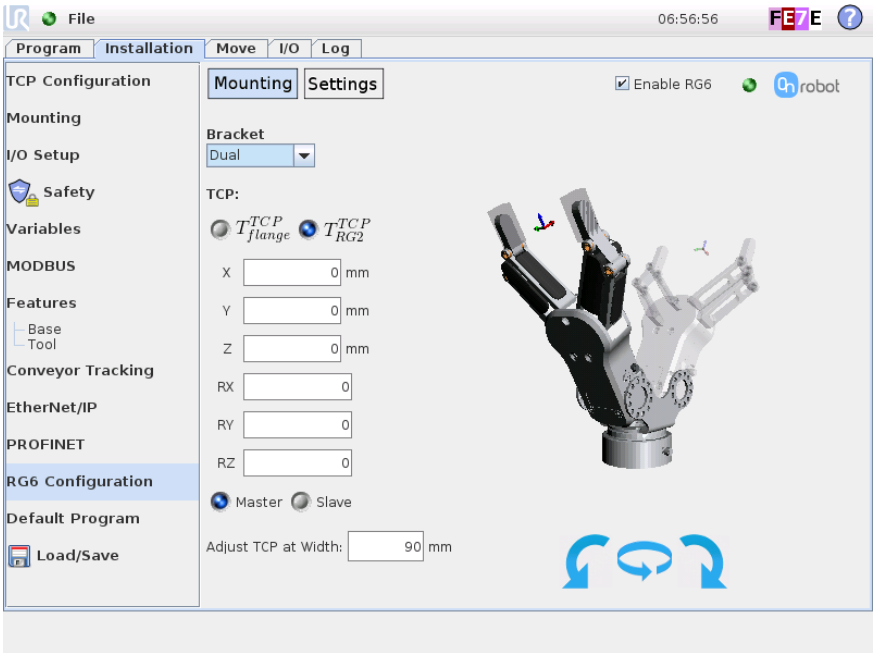
The example shown above, illustrates what to take into account, if you extend the RG6 fingers by 50 mm.

2.10.1.4 TCP Width

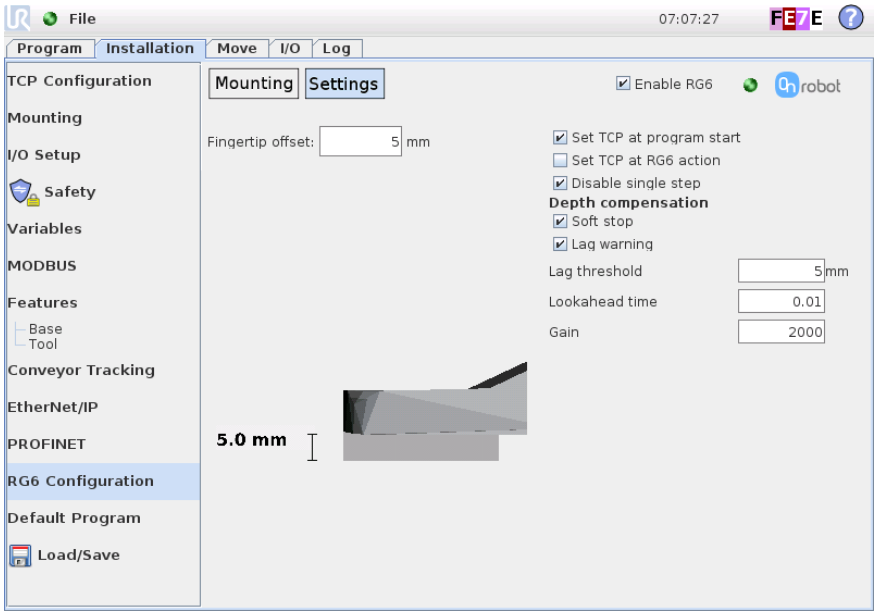
It defines the reference width for the point in between the fingers. A low width will increase the displacement from the bracket to the point in between the fingers, while a higher width will decrease the displacement.

2.10.1.5 RG6 Dual Setup

If the dual bracket is selected, the radio buttons “Master” and “Slave” will appear. They control the rotation of the two RG6 Grippers. The Master/Slave radio buttons will select if it is the Master or the Slave RG6 that should perform the action.

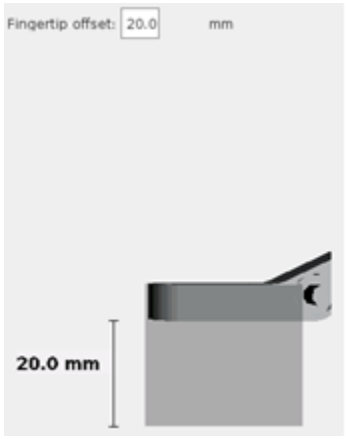


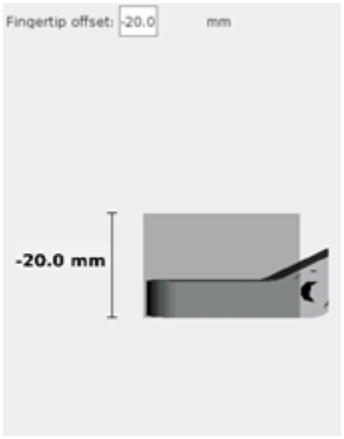
2.10.2 Settings



2.10.2.1 Fingertip Offset

The fingertip offset is used to specify the distance from the inside of the RG6 aluminum fingertip to the reference point on the attached fingertip.





The examples above, shows how the URCap uses the specified offset.

2.10.2.2 TCP Settings

The option to make the URCap plugin set the TCP [X,Y,Z,RX,RY,RZ] rotation vectors at program start and/or every time the RG6 performs an action, is available at the top right corner.

If the TCP is controlled manually and the “Depth Compensation” is not used, it is recommended to disable both check marks. If the TCP is changed dynamically (during a program) and the “Depth Compensation” is used, it is recommended to enable “set TCP at RG6 action”.

2.10.2.3 Disable Single Step

If “Disable single step” is selected, the robot program can be started fast and is not dependent on the number of RG6 nodes, but in this case, it is not possible to single step the RG6 nodes. If it is deselected, the case is the opposite. This option is also located in the top right corner.

2.10.2.4 Depth Compensation Settings

All the “Depth compensation” settings are used for controlling how the Depth compensation should behave, when a RG6 node is set to enable Depth compensation.

“Soft stop” will reduce all robot joint accelerations at the end of the compensation and minimize the integrated compensation error but will make a small increase of the node execution time.

If the “Lag warning” is enabled the robot will give a warning if the robot movement lags the RG6 above the specified threshold. The reason for lag can be a low value of the speed slider, low gain, high lookahead time, strict safety settings, robot kinematic, fast RG6 movements (high force) and full RG6 stroke.

The “Lag threshold” is the threshold that will trigger a warning message if the lag warning is enabled.

The “Gain” is the gain used for the **servoj** function used in the depth compensation. See the UR script manual.

The “Lookahead time” is the lookahead time used for the **servoj** function used in the depth compensation. See the UR script manual.

2.10.3 About Screen

When pressing the Onrobot logo in the top right corner, the above window will appear. From this window it is possible to update the RG6 firmware and to see which version of the URCap is installed.

3 Using the URCap Plugin

3.1 OnRobot Feedback Variables

3.1.1 Single RG6

Feedback Variable	*Unit*	*Description*
grip_detected	True/False	True if Gripper has detected a work piece
lost_grip	True/False	True if Gripper has dropped a work piece
measure_width	[mm]	Width between the fingers of the Gripper

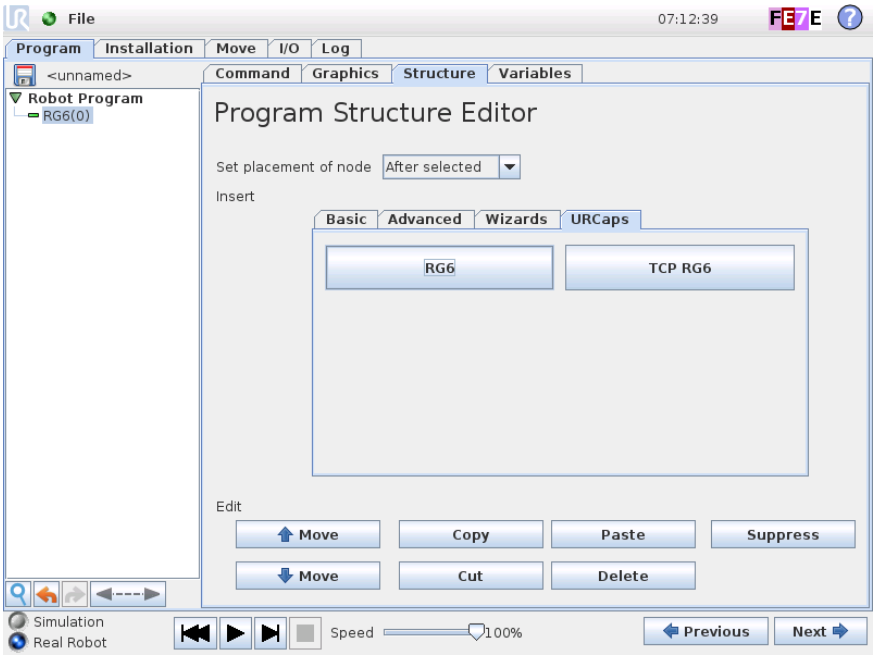
3.1.2 Dual RG6

Feedback Variable	*Unit*	*Description*
master_grip_detected	True/False	True if master has detected a work piece
master_lost_grip	True/False	True if master has dropped a work piece
master_measure_width	[mm]	Width between the fingers of the master
slave_grip_detected	True/False	True if slave has detected a work piece
slave_lost_grip	True/False	True if slave has dropped a work piece
slave_measure_width	[mm]	Width between the fingers of the slave

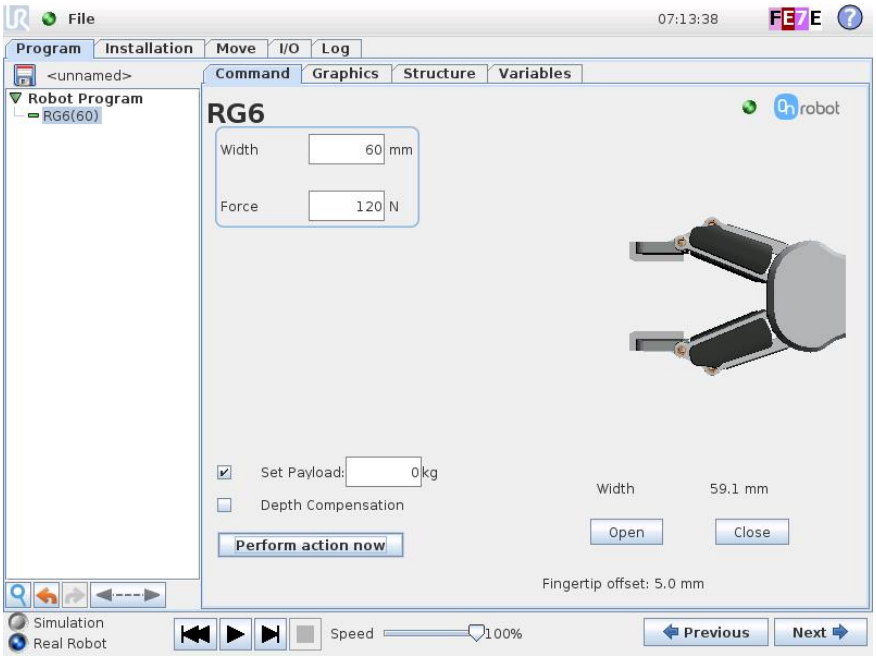
3.2 OnRobot URCap Commands

3.3 RG6 Command

To add a RG6 node, go to the **Program** tab select **Structure** and then the **URCaps** tab. Press the **RG6** button to add the node.



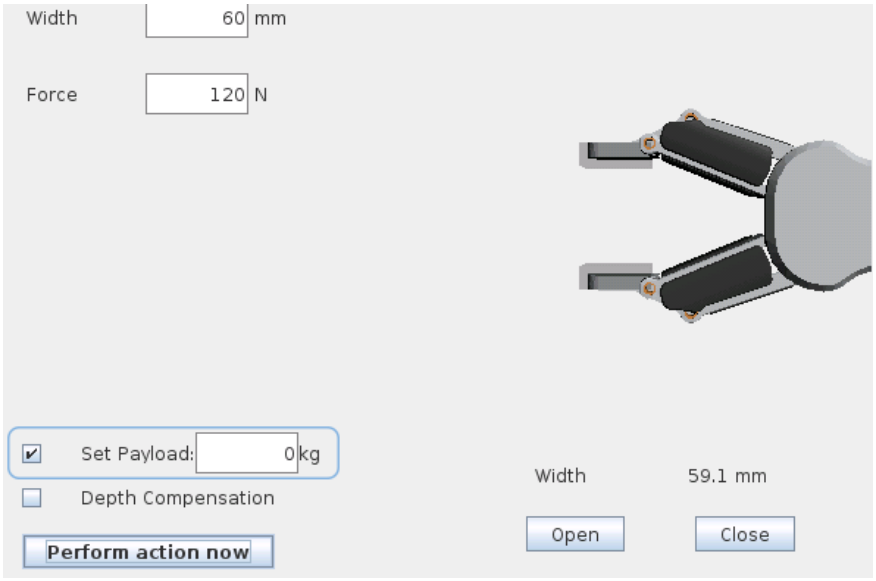
3.3.1 Width and Force



“Width” is the target width that the RG6 will try to reach. If the specified force is achieved, the RG6 will stop at a width that differs from the target width.

“Force” is the target force that the RG6 will try to achieve. If the target width is reached before the target force, the RG6 will stop moving and the target force may not be achieved at the anticipated width.

3.3.2 Payload



When the “Set Payload” calculation is selected, the object weight must be entered in the Payload field. The URCap plugin will then perform the calculation of the resulting payload mass (sum of bracket, RG6(s) and object). The center of mass for the object is assumed to be in the TCP. The object for the active Gripper is only taken into the calculations if an object is grabbed.

The math behind the calculations:

$$M = \sum_{i=1}^{n} m_i$$

$$\boldsymbol{R} = \frac{1}{M} \sum_{i=1}^{n} m_i \boldsymbol{r}_i$$

n: number of present components

i: bracket, RG6_master, RG6_slave, master_object, slave_object

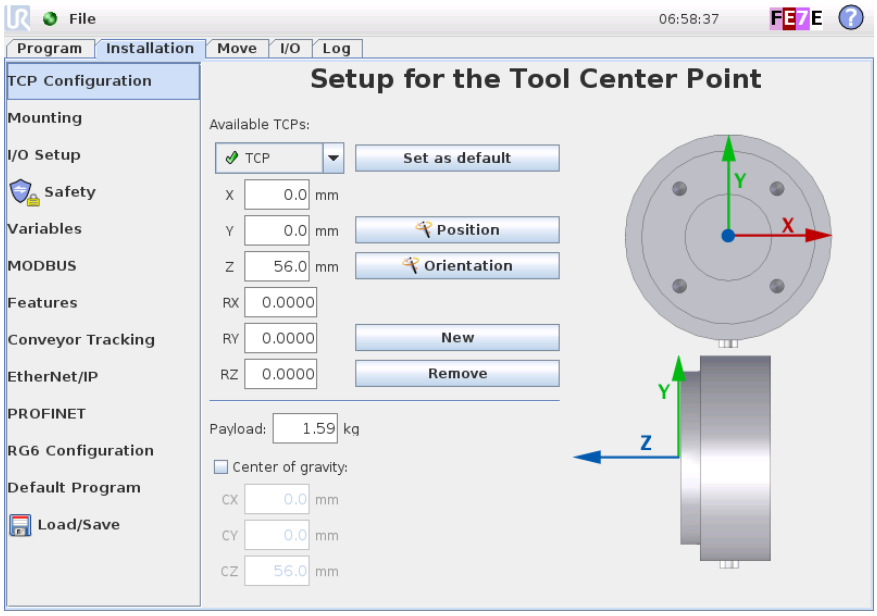
m: mass for each component

r: center of mass vector for each component

M: resulting mass send to UR controller (payload)

R: resulting center of mass vector (CX=Rx, CY=Ry, CZ=Rz)

The above formulas correlate with the TCP configuration setup, which is shown below for reference. To make it simple, when the “Set Payload” is selected, it is only necessary to take the weight of the object handled into account.



Two examples of what the URCap will calculate in the case the RG6 will pick a workpiece with the mass of 0.5Kg

Single mount bracket:

Robot payload = 0.09kg(bracket) + 1.0kg(RG6) + 0.5kg (work piece) = 1.59kg

Dual mount bracket:

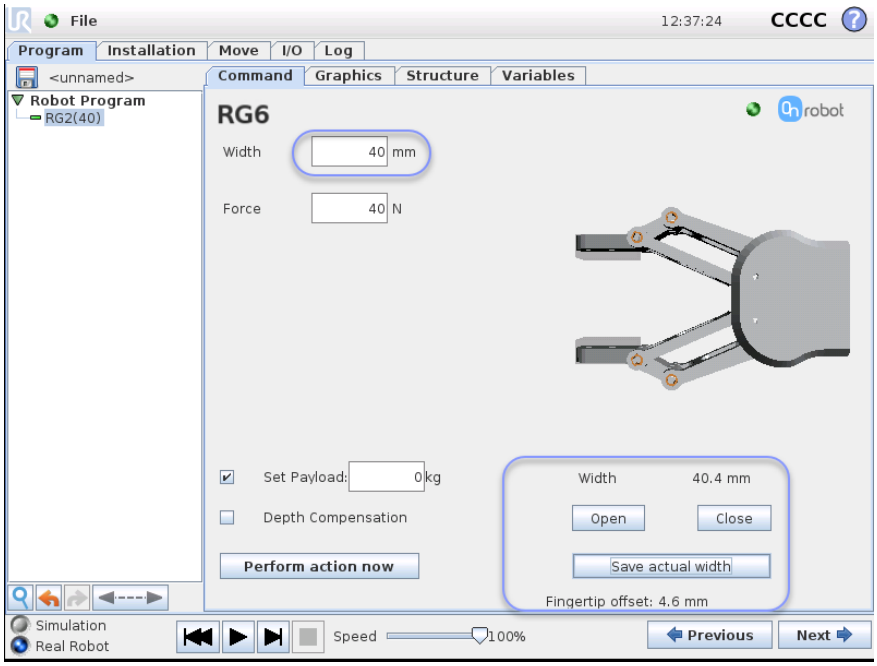
Robot payload = 0.18kg (dual bracket) + 1.0kg (RG6 master) + 1.0kg(RG6 slave) + 0.5kg(work piece) = 2.68Kg

3.3.3 Depth Compensation

When “Depth Compensation” is enabled, the robot arm will try to make a movement that compensates for the circular movement of the finger arms. There will be a small lag between the RG6 and robot arm movement. This lag will be dependent on the settings set in the installation, see **Depth Compensation Settings**. The compensation is done along the z-axis, so any manual change that will change the orientation of the z-axis will affect the compensation.

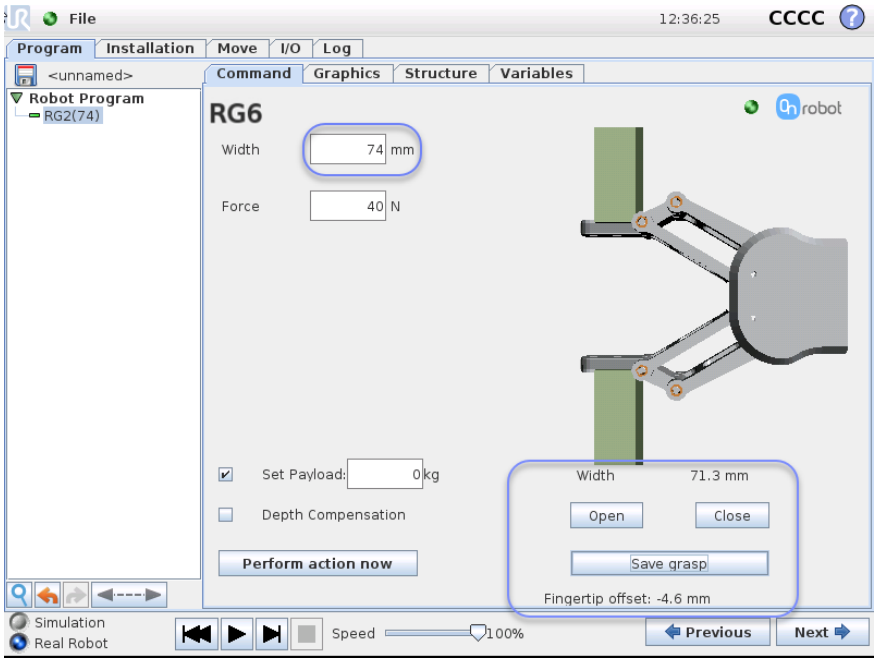
3.3.4 Feedback and Teaching Buttons

3.3.4.1 Gripping No Workpiece



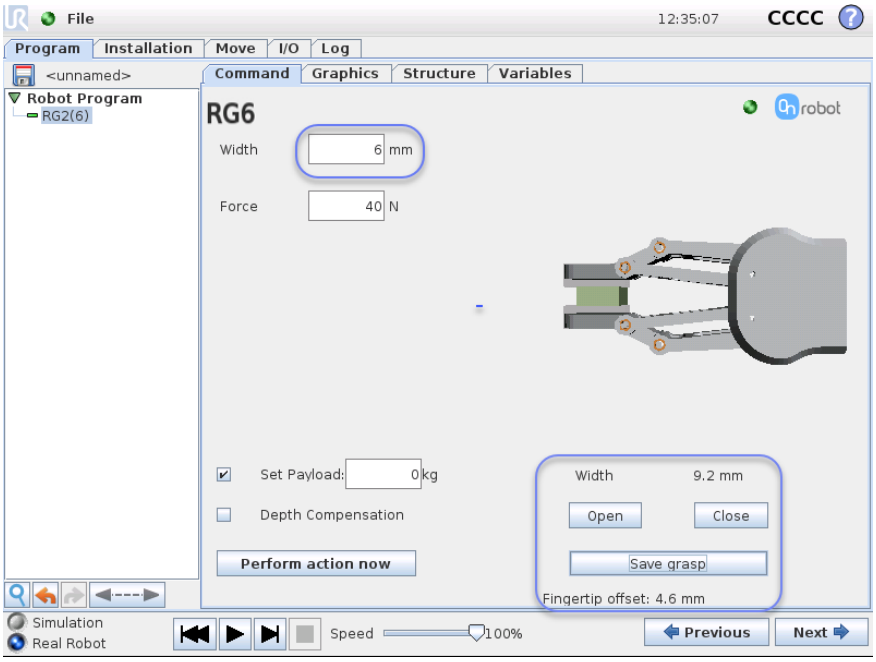
The “Open” and “Close” buttons are “hold to run” buttons, that will open and close the (selected) RG6.
The illustration above shows how the width text will give feedback about the actual width and if a work piece is grabbed and “Save actual width”, is pressed the current width is set at the node.

3.3.4.2 Gripping Workpiece Internally



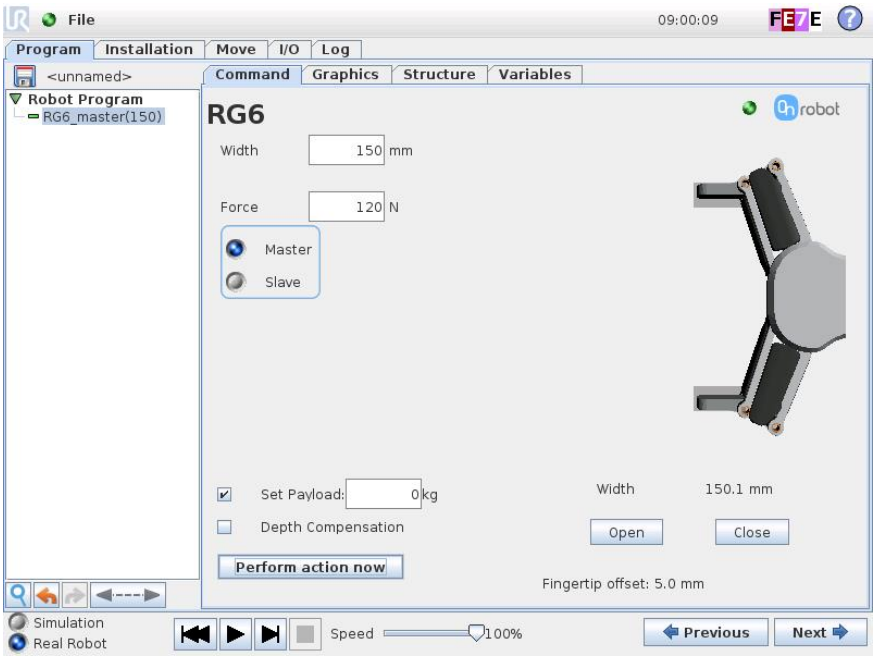
The illustration above shows how the width text will give feedback about the actual width and a work piece is grabbed internally. When “Save grasp”, is pressed the current width +3mm is set at the node.

3.3.4.3 Gripping Workpiece Externally



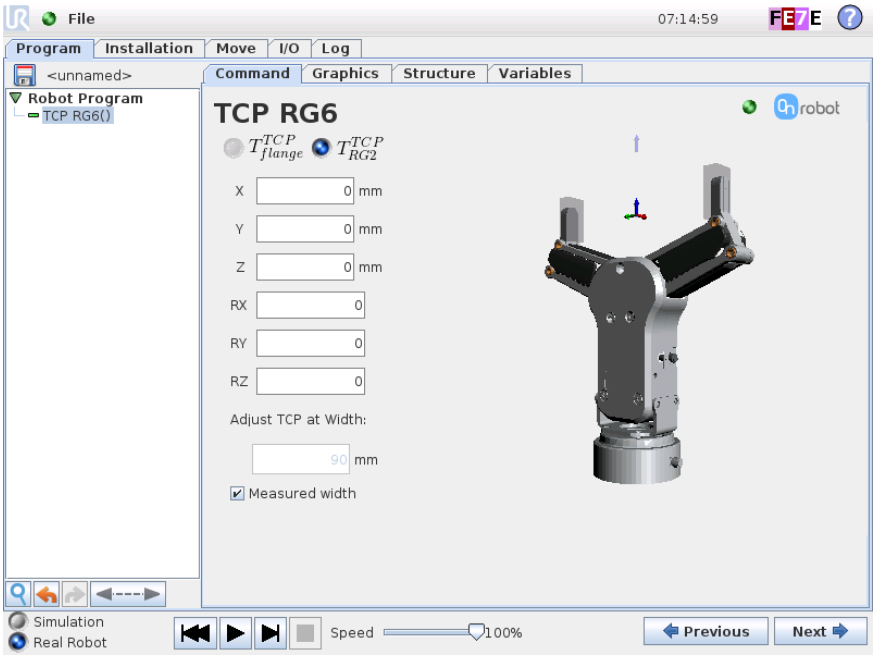
The illustration above shows how the width text will give feedback about the actual width and a work piece is grabbed externally. When “Save grasp”, is pressed the current width -3mm is set at the node.

3.3.5 Dual Gripper



The Master/Slave buttons, selects if it is the master or slave Gripper, that should perform the action.

3.4 RG6 TCP Node



The RG6 TCP node can be inserted to set the current TCP for the robot. The view and the controls are similar to the Mounting setup screen. The “TCP radio buttons & values” and “TCP width” is identical to the settings from the Installation, except that they only affect the single node and not the installation. For explanation, please see **TCP Radio Buttons and Values** and **TCP Width** (if dual Grippers are installed see **RG6 Dual Setup** and **Dual Gripper**).

3.5 Script Function

When the OnRobot URCap is enabled, there will be a defined RG6 script function:

RG6(target_width=110, target_force=40, payload=0.0, set_payload=False, depth_compensation=False, slave=False)

All the input arguments are the same as the ones used by the RG6 node. The script function is useful for parameterized programming. For example, a relative movement for quickly releasing a workpiece can be done as follows:

RG6(measure_width+5, 40)

That will open the Gripper 5mm with the target force set to 40N.

If a soft/compliant work piece needs to be marked with a certain depth(2mm) it could be done with:

RG6(target_width=0, target_force=3, depth_compensation=True)

RG6(target_width=measure_width-2, target_force=40, depth_compensation=True)

4 List of Acronyms

Acronym	Expansion
I/O	Input/Output
TCP	Tool Center Point
UR	Universal Robots
URCap	Universal Robots Capabilities
USB	Universal Serial Bus

5 Appendix

5.1 Technical Specifications

Technical data	*Min*	*Typical*	*Max*	*Units*
IP Class		*54*		
Total stroke (adjustable)	0	-	160	[mm]
Finger position resolution	-	0,15	-	[mm]
Repetition accuracy	-	0,15	0,3	[mm]
Reversing backlash	0,4	0,7	1	[mm]
Gripping force (adjustable)	25	-	120	[N]
Gripping force accuracy	±2	±5	±10	[N]
Operating voltage*	10	24	26	[V DC]
Power consumption	1,9	-	14,4	[W]
Maximum Current	25	-	600	[mA]
Ambient operating temperature	5	-	50	[°C]
Storage temperature	0	-	60	[°C]
Product weight	-	0,1	-	[kg]

*At 12V the Gripper runs at approximately half the normal speed

5.2 Software Uninstallation

To uninstall the URCap plugin, follow this process:

1. Go to the Welcome screen of the PolyScope.
2. Click **Setup Robot**.
3. Click on **URCaps Setup** and locate the `RG – OnRobot` in the list of active URCaps.
4. Click on the **-** sign at the bottom to uninstall it.
5. Restart the robot.

5.3 Declarations and Certificates

5.3.1 CE/EU Declaration of Incorporation (original)

According to European Machinery Directive 2006/42/EC annex II 1.B.

The manufacturer:

OnRobot A/S
Teglvaerksvej 47H
5220 Odense SØ
Denmark
+45 53 53 57 37

declares that this product:

Type: Industrial Robot Gripper
Model: RG6
Serial number from: RG6-1020017

is partly completed machinery according to 2006/42/EC. The product must not be put into service before the complete machine is in full compliance with all essential requirements of 2006/42/EC. A comprehensive risk assessment must be carried out for each application as part of ensuring that all essential requirements are fulfilled. All essential requirements must be assessed. Instructions and guidance provided in the RG6 user manual must be followed.

Technical documentation compiled according to 2006/42/EC annex VII part B is available to national authorities upon request.

The product is in conformity with, and CE marked according to, the following directives:

2014/30/EU — Electromagnetic Compatibility Directive (EMC)
2011/65/EU — Restriction of the use of certain hazardous substances (RoHS)
2014/35/EU — Low Voltage Directive (LVD)

Niels Degn
CTO
Odense, January 2nd, 2019

5.4 Editions

Edition	Comment
Edition 2	Document restructured. List of Acronyms added. Appendix added. Target Audience added. Typographic Conventions added.