



Original

# User Manual

*By On Robot ApS*



## RG2

Industrial Robot Gripper

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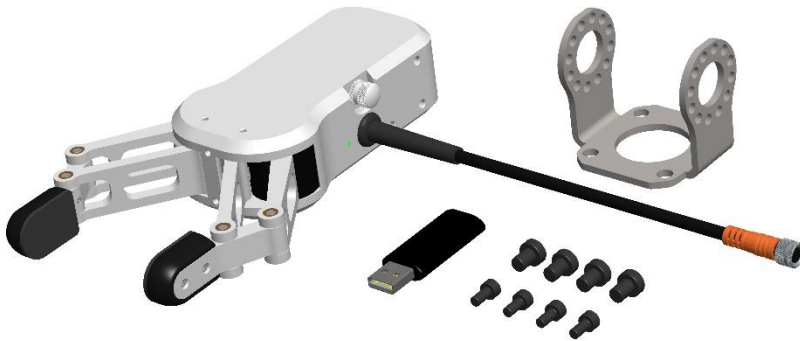
# 1 Preface

Congratulations on your new RG2 Industrial Robot Gripper.

The RG2 is an electrical industrial robot gripper that can handle a variation of different object sizes. Typically for pick and place applications. The gripping force as well as the gripping width can be preset to custom requirements.

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## 1.1 Scope of delivery



- 1x RG2 Industrial Robot Gripper
- 1x RG2 Mounting Coupling
- 2x RG2 Fingertips
- 1x USB Flash Drive
  - Software
  - Manual
- 1x Bag of bolts

The appearance of the delivered components may be different from the images and illustrations in this manual.

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## 1.2 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.

## 2 Introduction

The RG2 is an industrial robot gripper. Designed for grabbing objects, typically used in pick and place applications. Its long stroke allows it to handle a variety of object sizes and the option to adjust the gripping force allows the gripper to handle both delicate and heavy objects. The standard fingers can be used with many different objects, but it is also possible to fit custom fingers. The installation complexity is minimal as the RG2 cable attaches directly onto any supported robot. All configuration of the gripper are controlled in the robot software.

## 3 Safety instructions

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### 3.1 Validity and responsibility

The information in this manual is not a guide to design a complete robotic application. The safety instructions is limited to the RG2 gripper only and does not cover the safety precautions of a complete application. 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.

The application integrators are responsible for ensuring that the applicable safety laws and regulations in the country concerned are observed and that any significant hazards in the complete application are eliminated.

This includes, but is not limited to:

- Making a risk assessment for the complete application.
- Validating that the complete application is designed and installed correctly.

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### 3.2 Limitations of liability

The safety instructions and other information in this manual is not a guarantee that the user wont suffer injury. Even if all instructions are followed.

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### 3.3 Warning symbols in this manual

**DANGER:**

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

**WARNING:**

This indicates a potentially hazardous electrical situation which, if not avoided, could result in injury or major 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.

---

### 3.4 General warnings and cautions

This section contains general warnings and caution.



#### WARNING:

1. Make sure that the Gripper is properly mounted.
2. Make sure the gripper is not collided into obstacles.
3. Never use a damaged Gripper.
4. Make sure not to have any limbs in contact with or between the Gripper fingers and finger arms, when it is operating or in teach mode.
5. Make sure to follow the safety instructions of all equipment in the application.
6. Never modify the Gripper. A modification might cause dangerous situations. On Robot DISCLAIMS ANY LIABILITY IF THE PRODUCT IS CHANGED OR MODIFIED IN ANY WAY.
7. When mounting external equipment such as custom fingers make sure that the safety instructions both herein and in the external manual are followed.
8. If the gripper is used in applications where it is not connected to a UR robot. Make sure the connections resembles the analog input, digital in and outputs and the power connections. Make sure you use a RG2 gripper programming script that are adapted to fit your specific application.  
For more information, please contact your supplier.



#### CAUTION:

1. When the gripper is combined with or working with machines capable of damaging the gripper, then it is highly recommended to test all functions separately outside the potentially hazardous workspace.
2. When the gripper feedback (I/O ready signal) is relied upon for continuing operation and a malfunction will cause damage to the gripper and/or other machines, it is highly recommended to use external sensors in addition to the gripper feedback for insuring correct operations even if a failure should occur. On Robot cannot be held responsible for any damages caused to the gripper or other equipment due to programming errors or malfunctioning of the gripper.
3. Never let the gripper come into contact with corrosive substances, soldering splashes or abrasive powders as they may damage the gripper. Never let personnel or objects stand within the operating range of the gripper. Never operate the gripper if the machine on which it is fitted does not comply with safety laws and standards of your country

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### 3.5 Intended use

The Gripper is industrial equipment and intended as an end effector or tool for industrial robots. It is intended for pick and place operations of a variety of different objects.

The RG2 gripper is intended for use with robots from Universal Robots. The information in this manual about electrical connections, programming and use of the gripper are described only for robots from Universal Robots.

**CAUTION:**

Use without a UR robot is not described in this manual and misuse can cause damage to the gripper or the connected equipment.

Collaborative use of the gripper, where humans are close to or within the work area, is only intended for non-hazardous applications, where the complete application, including the object, is without any significant risks according to the risk assessment of the specific application.

Any use or application deviating from the intended use is deemed to be impermissible misuse. This includes, but is not limited to:

1. Use in potentially explosive environments.
2. Use in medical and life critical applications.
3. Use before performing a risk assessment.

---

### 3.6 Risk assessment

It is important to make a risk assessment. Since the Gripper itself is considered *partly completed machinery*, it is also important to follow the guidelines in the manuals of all additional machines in the application.

It is recommended that the integrator uses guidelines in ISO 12100 and ISO 10218-2 to conduct the risk assessment.

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.

1. Entrapment of limbs between the grippers finger arms.
2. Penetration of skin by sharp edges and sharp points on the object.
3. Consequences due to incorrect mounting of the gripper.
4. Objects falling out of the gripper, e.g. due to incorrect gripping force or to high acceleration from a robot.



## 4 Mechanical interface

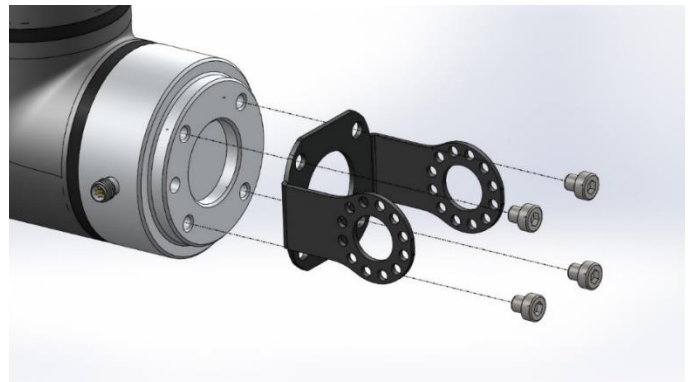
The Gripper is constructed such a way that should a power loss occur, it will maintain the gripping force.

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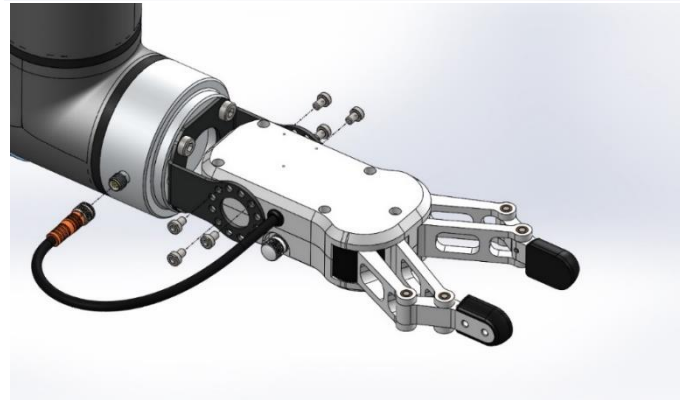
### 4.1 Mounting the gripper

The design of the standard gripper coupling is in such a way, that the angle of the gripper can be adjusted from 0° to 180° in steps of 30°.

Mount the gripper coupling with 4 pcs M6x8 bolts.  
Tighten the bolts with minimum 7Nm.



Mount 4-6 pcs M4x8 bolts.  
Tighten the bolts with minimum 2Nm.



#### **DANGER:**

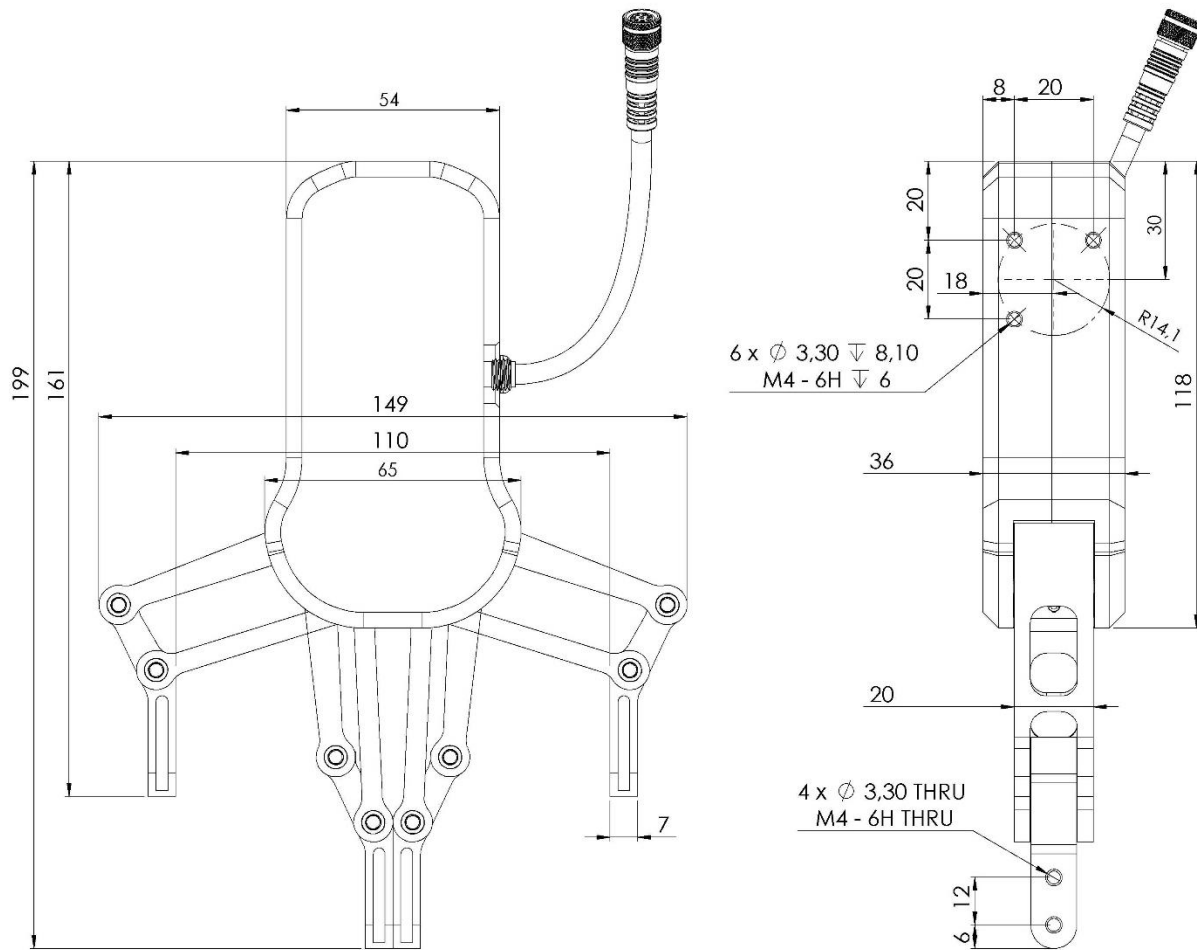
Make sure that the gripper is properly mounted using correct torque to tighten the bolts. Incorrect mounting can result in injury.



#### **CAUTION:**

The M4 threads in the gripper are 6mm deep. Do not exceed this.

## 4.2 Mechanical dimensions



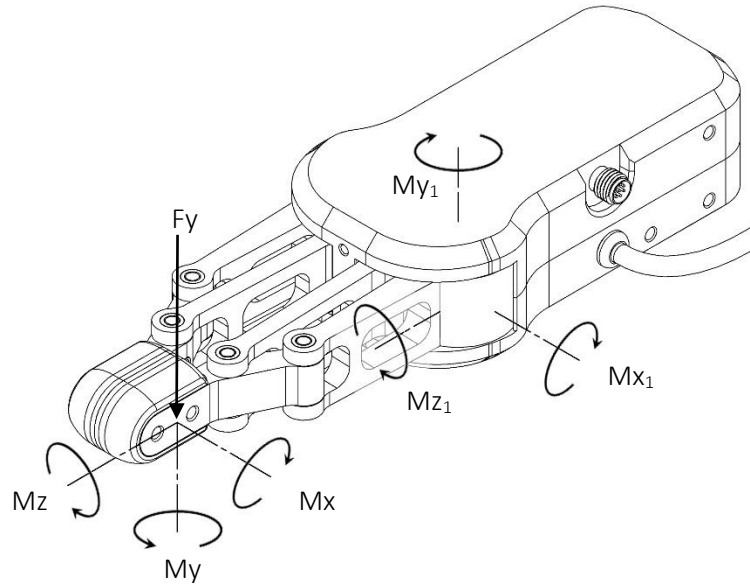
The dimensions are in millimeters

### 4.3 Load capacity

Be aware that when grasping an object, some of the parameters below are not directly applicable. But can be used to calculate the load on the gripper.

Parameter	Static	Unit
$F_y$	362	[N]
$M_x$	7,55	[Nm]
$M_y$	4,1	[Nm]
$M_z$	6,92	[Nm]
$M_{x_1}$	22	[Nm]
$M_{y_1}$	11	[Nm]
$M_{z_1}$	22	[Nm]

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

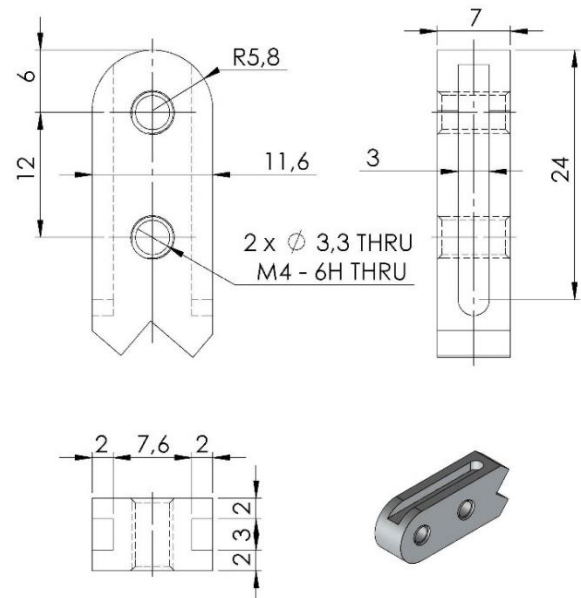


### 4.4 Fingers

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

#### Standard fingers

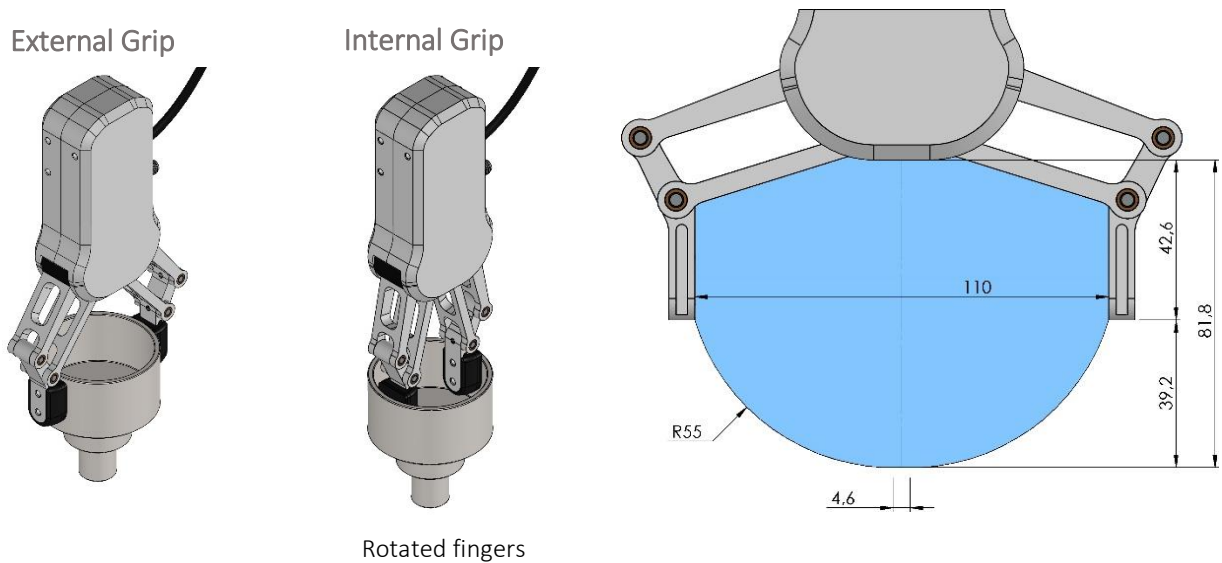
For a variety of workpieces



Dimensions of the gripper aluminum fingertips.  
Dimensions are in millimeters.

## 4.5 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 included before entering values into the gripper settings.



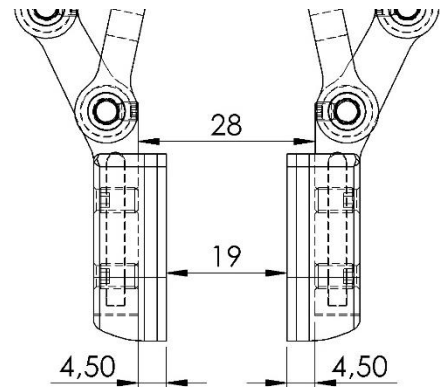
### 4.5.1 Finger thickness

In this example, we want to grip an object of 20mm.

To clear the object before gripping we want to set the gripping width to 28mm in the gripper settings on the robot. Because of the finger thickness, the resulting actual gripper width will be 19mm, which is not enough to clear the object. To calculate the needed setting, you need the finger thickness, which is the offset from the inner aluminum finger to the contact flange of the mounted finger, in this case 4,5mm.

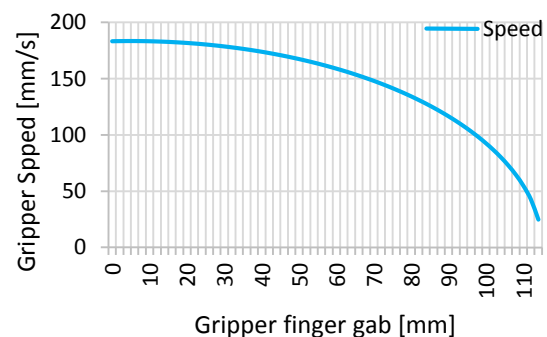
$2 * \text{finger thickness} + \text{clearing gap} + \text{object width} = \text{Actual gripping width}$

In this example:  $2 * 4,5 + 8 + 20 = 37$  type 37 into the gripper settings on the robot.



### 4.5.2 Gripping speed

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

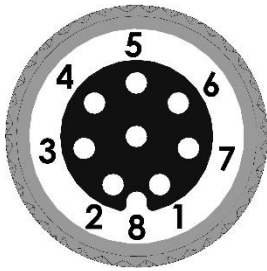


## 5 Electrical interface

This chapter describes all the electrical interfaces of the gripper. The term “I/O” refers to both digital and analog control signals from or to the gripper.

### 5.1 Tool connections

The Gripper cable is intended to fit the tool connector on robots 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

<i>pin</i>	<i>wire</i>	<i>UR tool</i>	<i>UR I/O V3</i>
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 RG2 gripper programming script that are adapted to fit your specific application.  
For more information, please contact your supplier.
2. Do not operate the gripper in a wet environment.

#### 5.1.1 Power supply

The gripper can operate at both 12V and 24V. Please Note that at 12V the forces, speed and some of the function tolerances described in this manual does not apply. It is recommended to use 24V.

## 6 Technical

### 6.1 Technical Specifications

<i>Technical data</i>	<i>Min</i>	<i>Typical</i>	<i>Max</i>	<i>Units</i>
Total stroke (adjustable)	0	-	110	[mm]
Finger position resolution	-	0,1	-	[mm]
Repetition accuracy	-	0,1	0,2	[mm]
Reversing backlash	0,2	0,4	0,6	[mm]
Gripping force (adjustable)	3	-	40	[N]
Gripping force accuracy	±0,05	±1	±2	[N]
Gripping speed*	55	110	184	[mm/s]
Gripping time**	0,04	0,07	0,11	[s]
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	-	0,65	-	[kg]

\* see speed table

\*\* based on 8mm total movement between fingers, see speed table

\*\*\*At 12V the gripper runs at approximately half the normal speed

## 7 Gripper programming

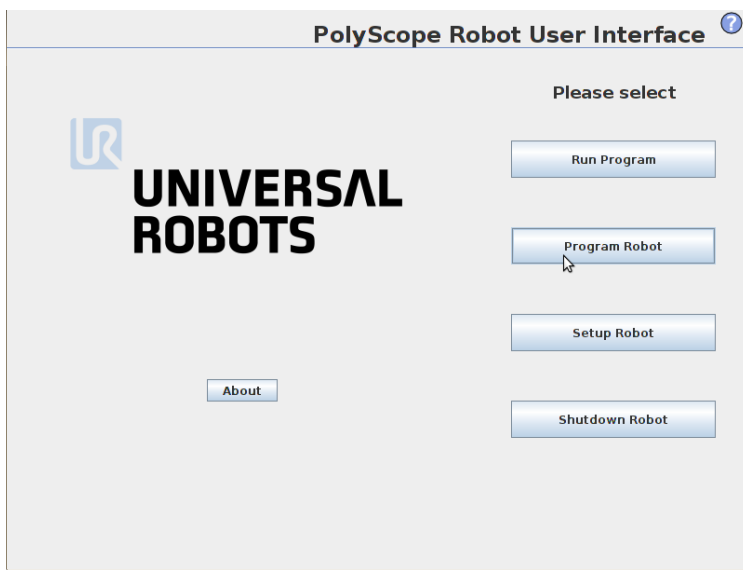
### 7.1 Quick Start

The easiest way to start using the RG2 gripper is by using the **RG2\_Template.urp** file. When done the robot will open and close the gripper. Alternatively the gripper can be used in teach mode, see 7.3.2 Teach Mode

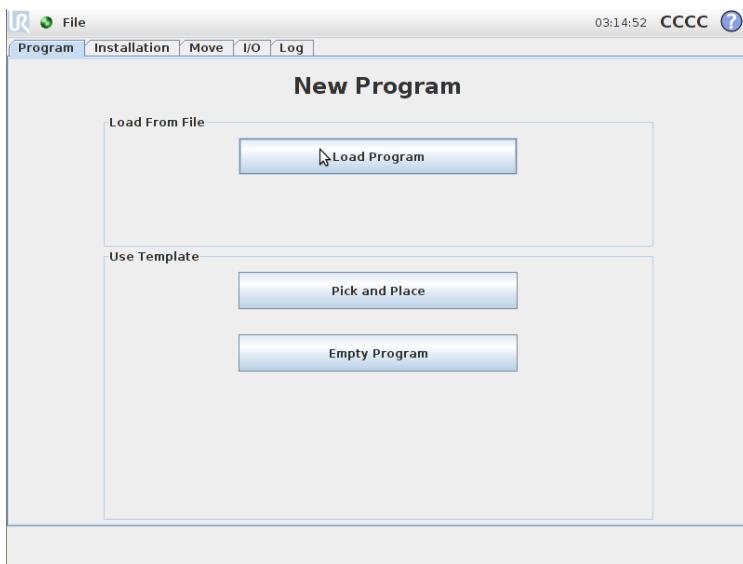
Mount and connect the gripper and turn on the robot.

Insert the included **USB Flash Drive**

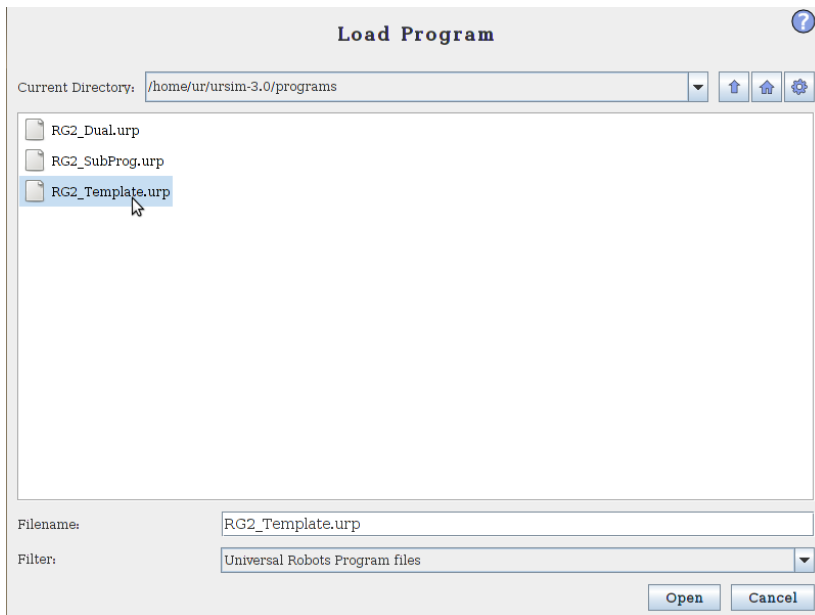
Select **Program Robot**



Select **Load Program**

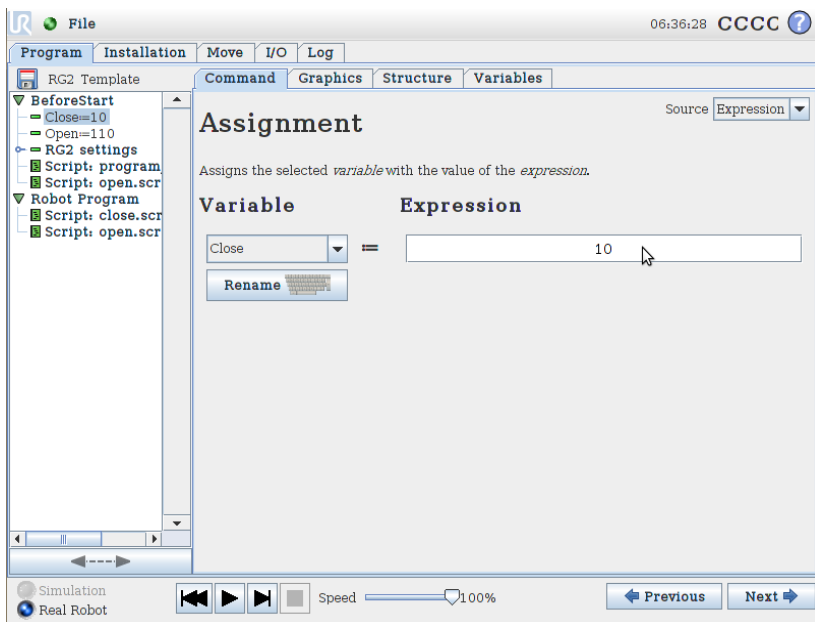


Select **RG2\_Template.urp**

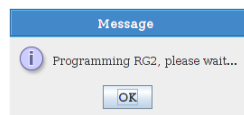


Click **Open**

Set **Close** to the distance in millimeters that should be between the aluminum fingers, when the gripper is closed. Repeat for the same with the **Open** variable.



Press **Play**  The popup



will appear. After approximately 3 seconds, the gripper will

If the gripping force needs to be adjusted, or another set of open and close width needs to be added, the **RG2 settings** folder can be unfolded. The variable **Force\_** controls the gripping force for **Open** and **Close** width, the unit



is in Newton. The variables **Force2**, **Open2** and **Close2** holds the settings for the script/functions **close\_2()** and **open\_2()**, see 7.3.1 Control variables.

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## 7.2 Programming introduction

When the RG2 gripper is powered on, it will receive its programming parameters. These parameters are stored in the control variables; **Close**, **Open**, **Force\_**, **Close2**, **Open2**, **Force2** and they are transferred by the **program\_RG2.script** (see 7.3.1 Control variables). If the gripper does not receive the programming parameters within 5 seconds, it selects its default parameters. This state of the gripper is called teach mode and is indicated by the green flashing LED (see 7.3.2 Teach Mode).

When the programming parameters is determent, the gripper detects if a second gripper is connected. If that is the case, the programming parameters are transferred to the connected gripper (see 7.5 Two Grippers).

The gripper is basically controlled through **tool\_out[0]** and **tool\_out[1]** and gives feedback through **tool\_in[0]**, **tool\_out[1]**, **analog\_in[2]** and **analog\_in[3]**. The gripper can be controlled directly by **tool\_out[0]** and **tool\_out[1]** (see 7.3.4 Control outputs signals), or the scripts/functions delivered by On Robot (see 7.3.3 Control script/functions) can be used. The gripper feedback can be read directly from **tool\_in[0]**, **tool\_out[1]**, **analog\_in[2]** and **analog\_in[3]** (7.4.2 Feedback input signals), or by reading the feedback values (see 7.4.1 Feedback variables). The script that transfers the programming parameters to the gripper is included in the following robot programs delivered by On Robot: **RG2\_Template.URP** (see section 7.17.1 Quick Start), **RG2\_Dual.URP** (see 7.5 Two Grippers) and **RG2\_SubP.URP** (see 7.6 Add RG2 to existing robot program).

## 7.3 Gripper control

### 7.3.1 Control variables

The control variables **Close**, **Open**, **Force\_**, **Close2**, **Open2** and **Force2** holds the programming parameters that are transferred to the gripper in the **program\_RG2.script**.

<i>Control variable</i>	<i>min</i>	<i>max</i>	<i>unit</i>	<i>resolution</i>
<i>Open</i>	0	110	[mm]	0.1
Close	0	110	[mm]	0.1
Force_	3	40	[N]	1
Open2	0	110	[mm]	0.1
Close2	0	110	[mm]	0.1
Force2	3	40	[N]	1

Changing the variable does not affect the gripper before the **program\_RG2.script** is executed.

### 7.3.2 Teach Mode

When the robot is turned on, the gripper can be used without programming it first. Use the tool output I/O's. The table to the right shows the preset configuration.

- 1) Go to the I/O screen on the teach pendant
- 2) Turn on 24V in the tool section, wait 5 seconds
- 3) Use tool output 0 to move the gripper
- 4) And tool output 1 to select High or Low Force

#### *Teach Mode*

<i>Tool Outputs</i>	<b>0</b>	<b>1</b>
Open Gripper (110mm)	Off	-
Close Gripper (0mm)	On	-
High Force (40N)	-	Off
Low Force (5N)	-	On

### 7.3.3 Control script/functions

The RG2 gripper can be controlled directly through **tool\_out[0]** and **tool\_out[1]** (see 7.3.4 Control outputs signals). The typical use case is that the robot should wait until the gripper is done with operation. That functionality is implemented in a couple of script functions delivered by On Robot.

A table with the control script/functions for single gripper operation is shown in the below table:

<i>Script</i>	<i>Function</i>	<i>Width</i>	<i>Force</i>
<i>open.script</i>	open()	Open	Force_
close.script	close()	Close	Force_
open2.script	open2()	Open2	Force2
close2.script	close2()	Close2	Force2

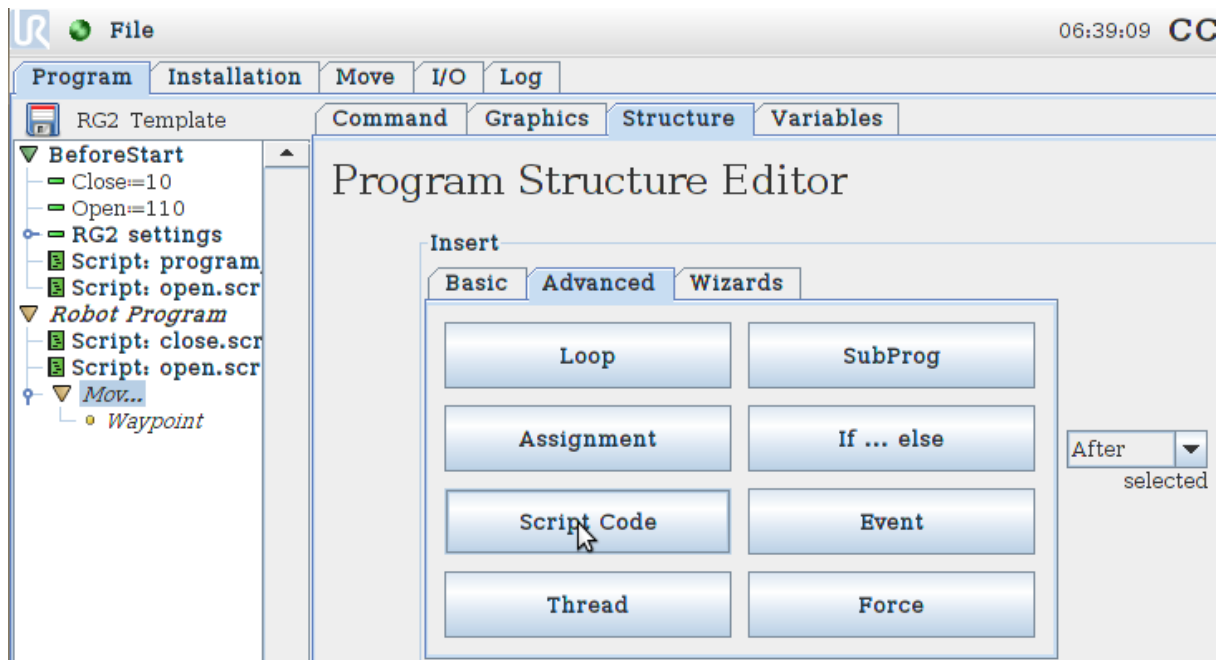
The script **open.script** implements exactly the same functionality as the function **open()**, but there are small differences by adding the script files vs. the functions. The functions can be tracked in the program tree while executing, but it cannot be single stepped. The script files cannot be tracked in the program tree while executing, but it can be single stepped.

#### 7.3.3.1 Adding a script file

Select the place in the **Robot Program** in the program tree where you want the gripper to perform an action.

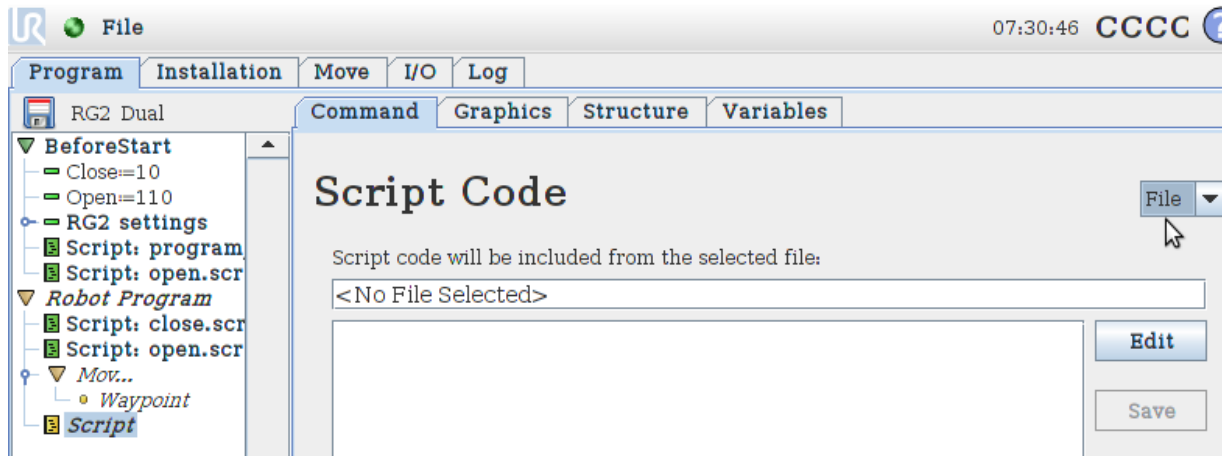
Go to the **Structure** tab and then to **Advanced**.

Select **Script Code**.

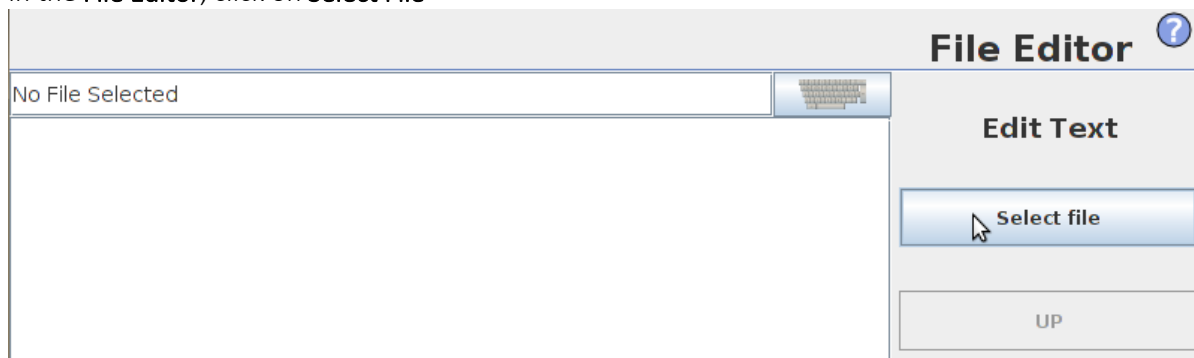


With the new Script highlighted, go to the **Command** tap, click on the **Dropdown menu** in the upper right corner and select **File**.

Then click on **Edit**, right under the **dropdown menu**.



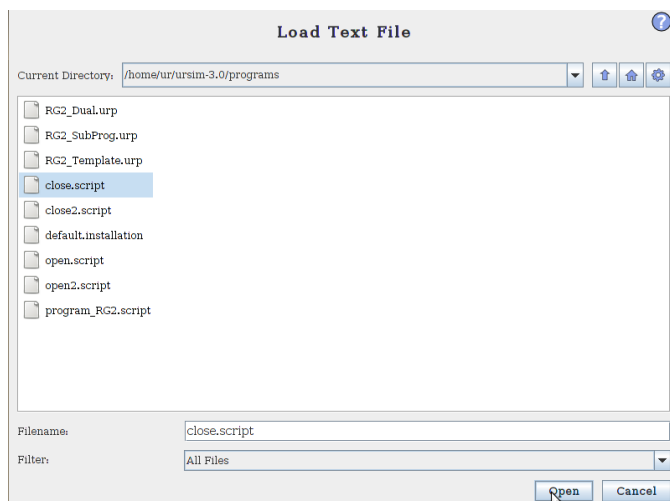
In the **File Editor**, click on **Select File**



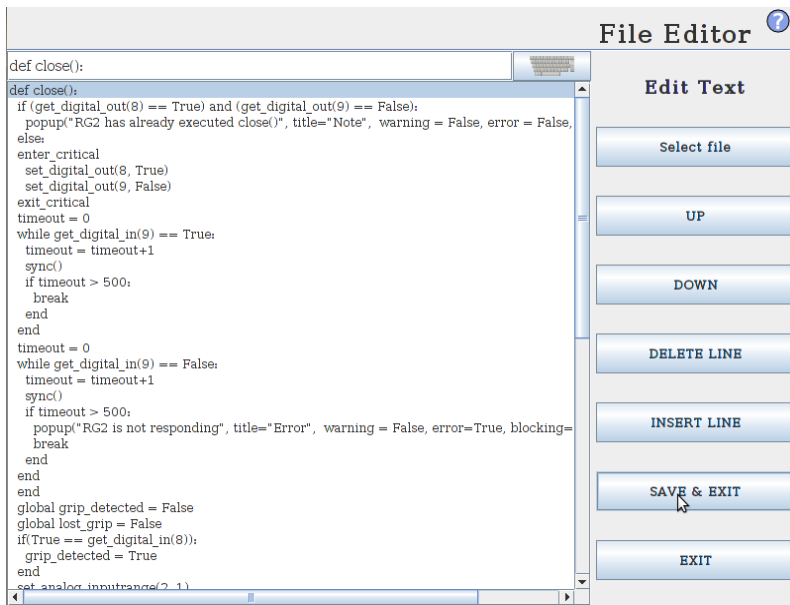
In the **Load Text File** window click on the bottom **dropdown menu** and select **All Files**.

Then the .script files should appear.

Select the text file named **close.script** and click open.



Click **SAVE & EXIT** in the **File Editor**,



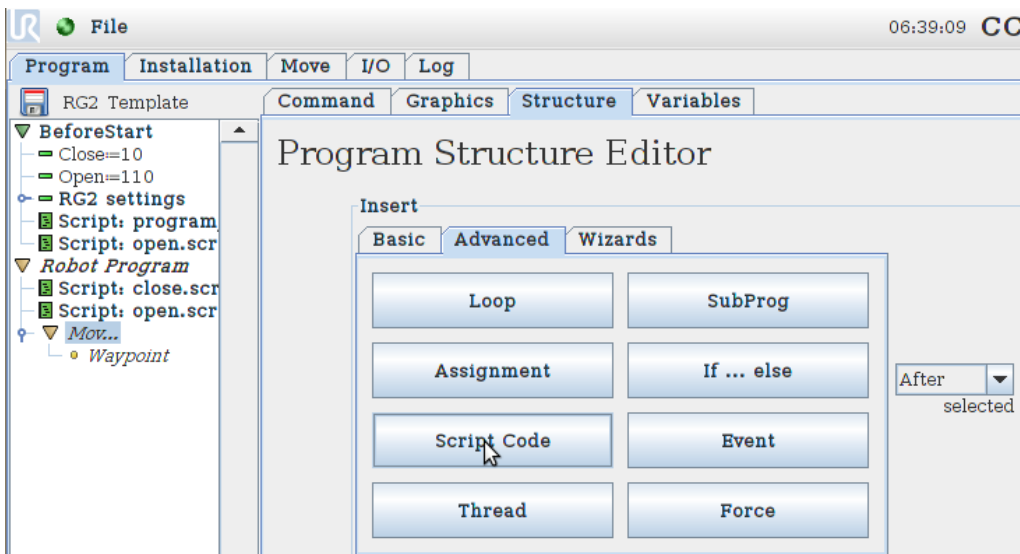
Press **Step**  to execute the added script file.

### 7.3.3.2 Adding a function

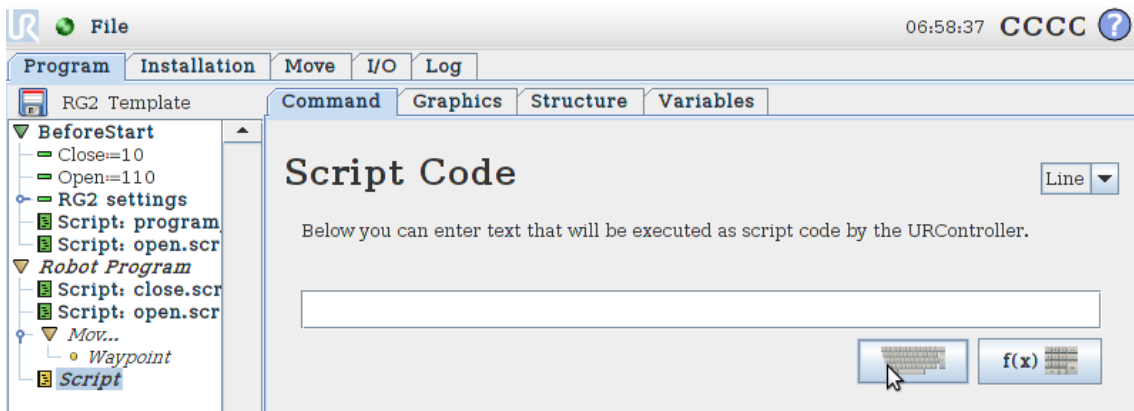
Select the place in the **Robot Program** in the program tree where you want the gripper to perform an action.


Go to the **Structure** tab and then to **Advanced**.

Select **Script Code**.



With the new Script highlighted, go to the **Command** tap, click on the keyboard icon.



When the keyboard appear type "close()" or "open()". Press **Play**  to execute the robot program. When the robot execute the added function, the RG2 will open or close.

### 7.3.4 Control outputs signals

The RG2 gripper can be controlled directly through **tool\_out[0]** and **tool\_out[1]**. How the gripper will response to the output **tool\_out[0]** and **tool\_out[1]**, is determent by the control variables **Close**, **Open**, **Force\_**, **Close2**, **Open2** and **Force2**:

<i>Tool outputs</i>		<i>Gripper response</i>	
0	1	Width	Force
False	False	Open	Force_
True	False	Close	Force_
False	True	Open2	Force2
True	True	Close2	Force2

If the gripper is controlled directly through **tool\_out[0]** and **tool\_out[1]**. The robot will execute the next command in the program tree before the gripper has moved. If the robot should not continue executing, the control script/functions could be used (see 7.3.3 Control script/functions).

## 7.4 Gripper feedback

As with the control of the RG2 gripper, the feedback can be read directly from the input signals **tool\_in[0]**, **tool\_out[1]**, **analog\_in[2]** and **analog\_in[3]**, but the feedback could also be read from the feedback variables **grip\_detected**, **lost\_grip** and **measure\_width**.

### 7.4.1 Feedback variables

<i>Feedback variable</i>	<i>Unit</i>	<i>Description</i>
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

### 7.4.2 Feedback input signals

The RG2 feedback can be read directly from the input signals **tool\_in[0]**, **tool\_out[1]**, **analog\_in[2]** **analog\_in[3]**. Digital feedback cover the functionality of tool\_in[0], tool\_out[1]. And Analog feedback covers analog\_in[2] and analog\_in[3].

#### 7.4.2.1 Digital feedback

Use DI8 to detect if the gripper grabbed a work piece or stopped at a given position.

DI9 will go LO (Busy) when the gripper is receiving programming parameters, moving or changing force.

<i>Digital status Feedback</i>	<i>Tool Inputs</i>	
	0	1
Position Reached	LO	-
Force Reached	HI	-
Gripper Busy	-	LO
Gripper Ready	-	HI

#### 7.4.2.2 Analog feedback

AI2 outputs a voltage corresponding to the gripper width.

#### *Analog Feedback*

\* Due to the gripper analog output resistance (10kΩ), the analog feedback voltage will be affected by the robot input resistance. For the robots from Universal Robots, the input resistance is 15kΩ @ 0V:10V, that result in a maximum input voltage of  $5V \cdot \frac{15k\Omega}{10k\Omega + 15k\Omega} = 3.0V @ 0V: 10V$  which correspond to the maximum width of 110mm.






	UR Input	Voltage	Width
Actual Width @ 0V:10V	AI2	0...3.0V*	0...110mm

The actual width can be calculated by  $\frac{\text{voltage}}{\text{maximum input voltage}} \cdot 110\text{mm}$ .

#### *LED feedback*

### 7.4.3 LED feedback

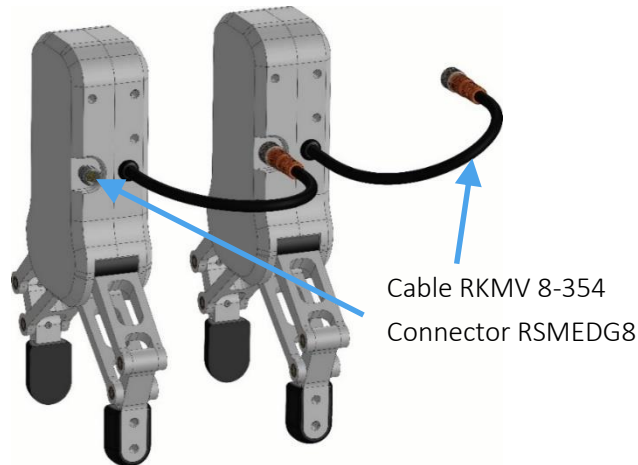
The LED light on the gripper is used for status indication.

	LED status	Gripper status
	Constant red	Initializing
	Flashing green	Teach mode (ready)
	Constant green	Programmed (ready)
	Constant orange	Busy
	Flashing red/green	Error code

## 7.5 Two Grippers

When one gripper is connected to another via the gripper output connector. The first gripper in the chain (from the robot) becomes master and the second slave. This makes it possible to use both grippers individually using only two digital outputs from the robot.

For using two grippers open the robot program **RG2\_Dual.urp**



### CAUTION:

1. When using two grippers, both cannot be turned on from the I/O screen as it is with one gripper. When trying to turn on two grippers at the same time the robot will show the warning **I/O over current**. This is avoided by programming the grippers first and then they can be used from the I/O screen.
2. Do NOT connect more than two grippers in a chain. Connecting more than two can cause damage to the equipment.

The master gripper can be controlled with the scrips `open_master.script/close_master.script`, the functions `open_master()/close_master()` or by toggling **tool\_out[0]**. The slave gripper can be controlled with the scrips `open_slave.script/close_slave.script`, the functions `open_slave()/close_slave()` or by toggling **tool\_out[1]**.

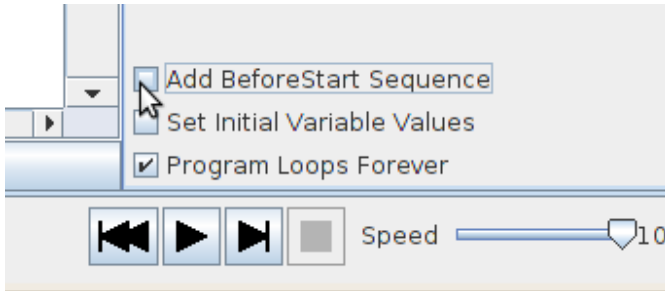
The master is using the parameters defined in **Close, Open, Force\_**, while the slave is using those stored in **Close2, Open2 and Force2**.



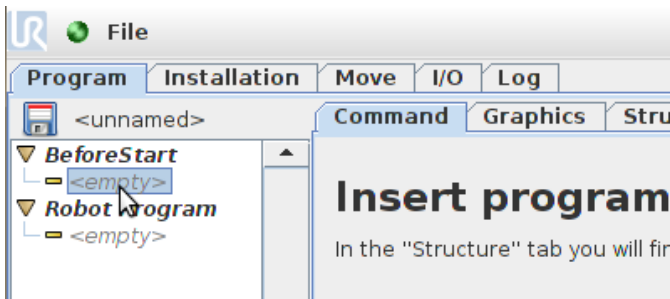
## 7.6 Add RG2 to existing robot program

If you want to add the RG2 functionality to an existing robot program, open the program you want to modify and follow the below steps.

Check the box **Add BeforeStart Sequence**. (if not already checked)



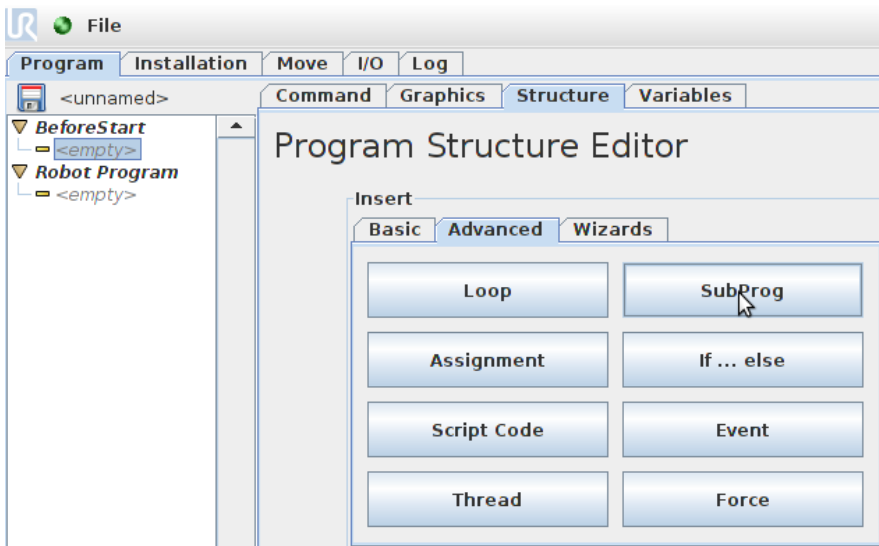
Mark the “empty” field under **BeforeStart** in the program tree.



Go to the **Structure** tap.

Go to the **Advanced** tap in the Program Structure Editor.

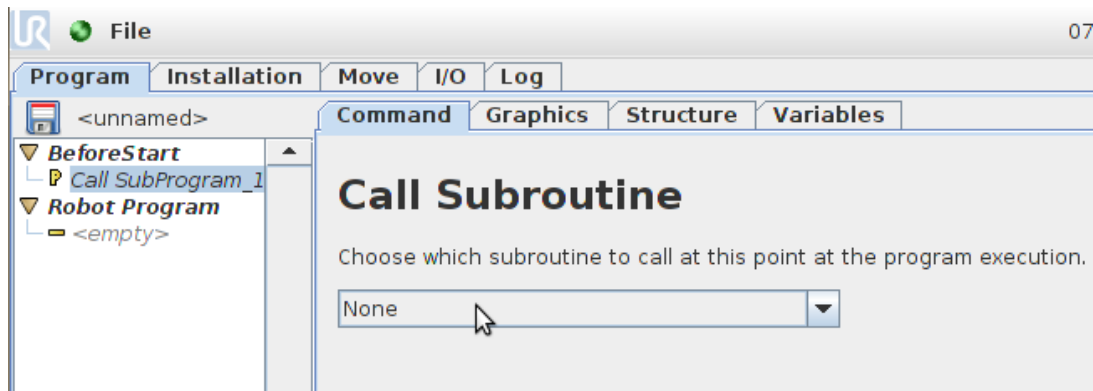
Select **SubProg**



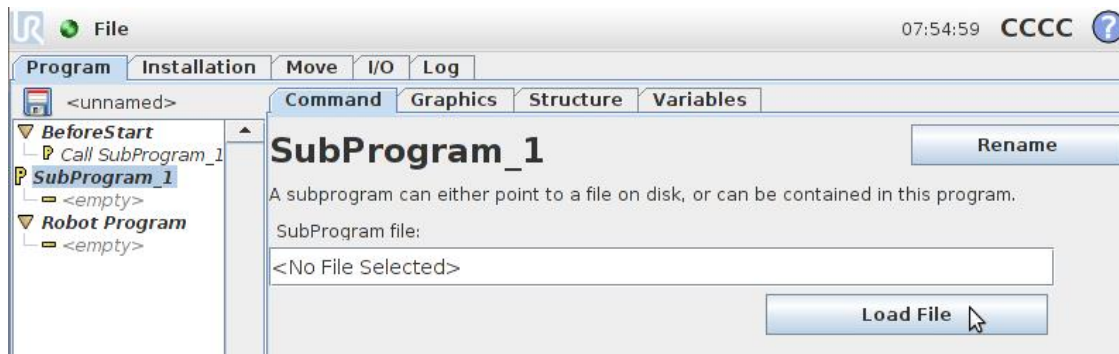
With **Call** marked.

Go to the **command** tap.

Select **Create New** from the **dropdown** menu.

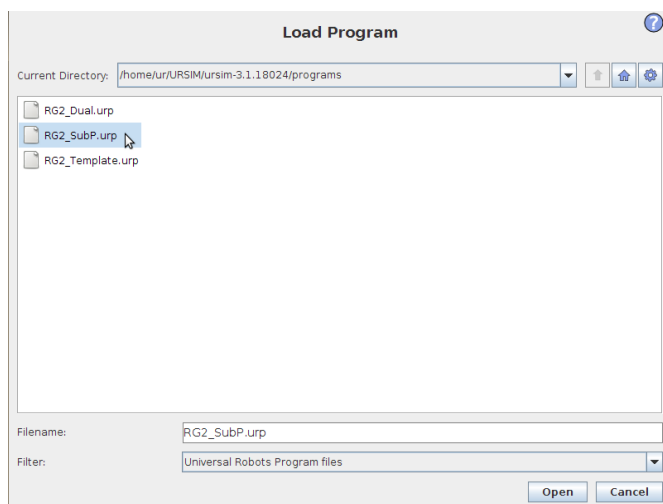


Select **Load File**



Make sure the gripper software is available, the software is on the included USB flash.

Select and open **RG2\_SubProg.urp**

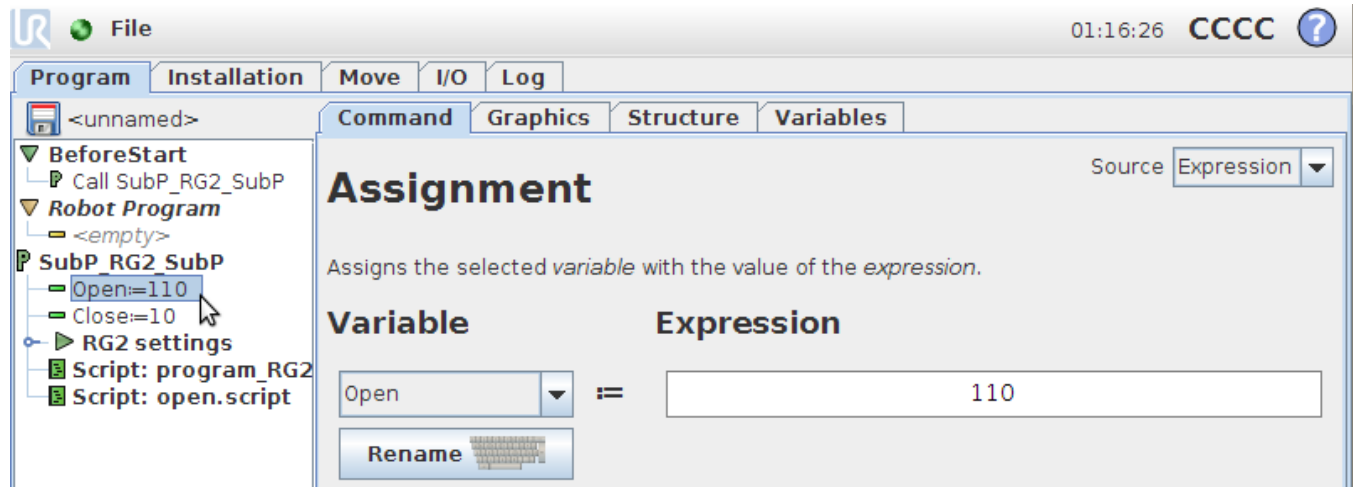


Select the variables that need to change. In this case the first one **Open:=110**

Go to the **Command** tap

Click on the **Expression (on “110”)** box on the right to change the variables.

Repeat this for the other variables (see 7.3.1 Control variables).



This is the end of the subprogram construction.

The gripper can be controlled either with script files/functions (see 7.3.3 Control script/functions) or directly by the output signals (see 7.3.4 Control outputs signals) from the robot.

## 8 Declarations and certificates

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### 8.1 CE/EU Declaration of Incorporation (original)

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

The manufacturer:

On Robot ApS  
Havnegade 100 A  
5000 Odense C  
Denmark  
+45 4094 3348

declares that this product:

Type: Industrial Robot Gripper  
Model: RG2  
Serial number: RG2-10260-16 to RG2-19999-17

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 RG2 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)



Bilge Jacob Christiansen  
CEO & founder  
Odense, April 20<sup>th</sup>, 2016