



SmoothTool version 1.12.0



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1 | Introduction

1.1 About this manual

This manual contains essential information for safe and appropriate use of the product. The manual is an integral part of the product and must be kept accessible for the operator at all times. The operator must have read and understood the operating manual before product usage. Illustrations within the manual are provided for basic understanding and may differ from the actual product design.

This manual explains how to install and operate the SmoothTool URCap software on both CB- and e-series from Universal Robots (UR). For more information about UR robots, the UR user interface, PolyScope etc., please refer to <https://www.universal-robots.com/support/>. Examples throughout this manual will be based on the e-series.

1.2 Purpose of the product

With SmoothTool, any welding robot operator can ‘plug-and-produce’ a new series in less than 30 minutes. The solution uses intuitive programming by demonstration to enhance the operator’s welding know-how with unmatched speed and repetitive accuracy.

The software and hardware are used for easy creation of welding programs, and for enabling communication with different welding power sources.

1.3 Contents of the box

Everything needed to get started with SmoothTool is included in the box (see figure 1.1).

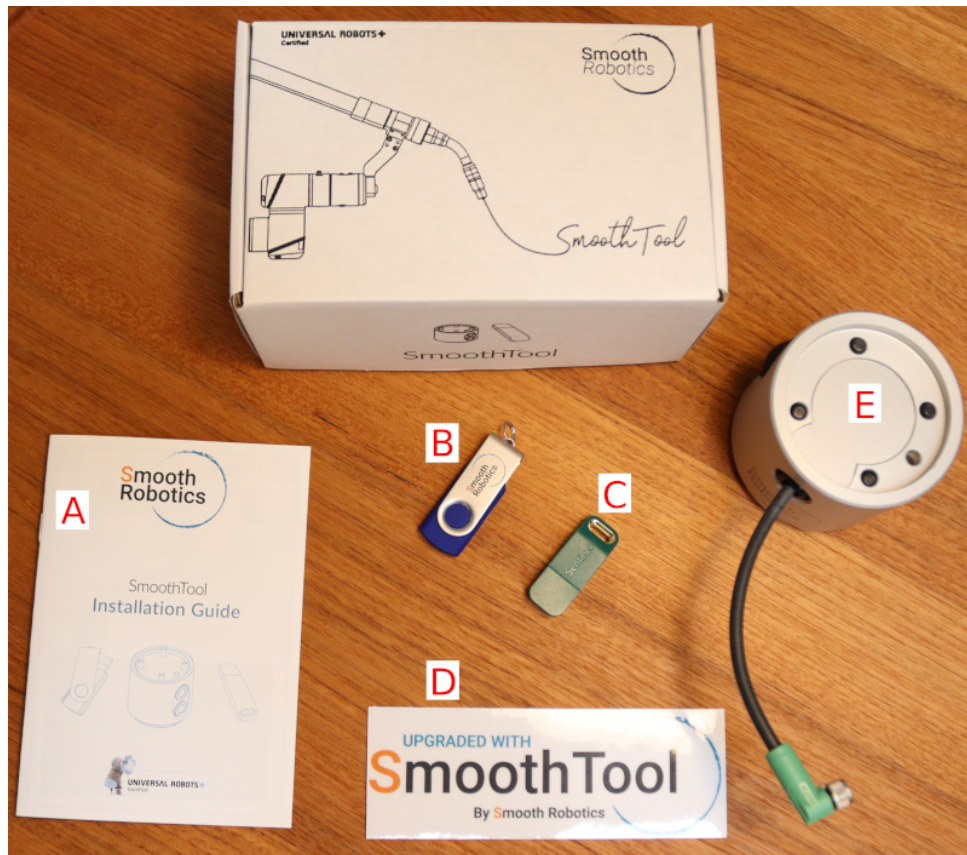


Figure 1.1: The contents of the box.

The content of the box includes:

- (A) An installation quick guide
- (B) A software USB-key containing:
 - The SmoothTool URCap software
 - This user manual
- (C) A license dongle
- (D) A sticker
- (E) A programming flange, including:
 - Two guide pins for the flange

Part I

Installing and setting up the product

2 | Safety

The SmoothTool URCap software is intended for robotic welding applications using a Universal Robots robot arm. The SmoothTool URCap is intended as an add-on or extension to new or existing robot welding cells. Robotic welding is associated with many potential hazards. The user must read, understand and comply with the instructions in this manual, the manuals of the power source, UR-robot, and the manuals of other components in the complete robot system. The integrator must ensure that the complete robot system complies with the laws and regulations of the area in which it is installed. The integrator must perform a risk assessment and take the necessary steps to minimize the risks. The user must comply with the safety regulations set in place by the integrator.

Smooth Robotics ApS does not take responsibility for injuries or damage, resulting from unintended use of the SmoothTool URCap software.

2.1 Unintended use

Unintended use includes but is not necessarily limited to:

- Using the SmoothTool URCap in combination with other URCaps. See warning 2.2.2.
- Executing a program without having completed and verified a dry run of the program first. The 3D universe is a useful feature for visualizing programs, but should not replace dry runs completely.
- Making unintended changes to the SmoothTool program tree (see section 5.1). This includes:
 - Removing the MoveJ node or its child.
 - Inserting a SmoothTool node within the sub-tree of another SmoothTool node.
 - Removing all the *Approach* nodes before a *Weld Start* node.
 - Removing all the *Exit* nodes after a *Weld Start* node.
 - Inserting *Linear* or *Circular* segment outside of a *Weld Start* nodes sub-tree.

2.2 Warnings

2.2.1 Automatic Control of the Power Source

WARNING



The SmoothTool URCap software automatically controls the power source. Care must be taken to ensure that this does not result in personal or material damage. In particular, be aware that the URCap does not enable the user to explicitly define when the arc of the power source is turned on or off using the provided integration. Instead, this information implicitly lies in the program structure.

When connected to a power source that provides the option to control the wire, make sure the area around the welding torch is clear before use, in order to avoid causing harm to people or material.

2.2.2 Use of other URCaps

WARNING



Other URCaps might interfere with the SmoothTool URCap and affect its ability to work correctly. In particular, one should be VERY careful with inserting any nodes other than SmoothTool-nodes in the *Weld Start* sub-tree of the SmoothTool program tree, as this is where the arc is automatically turned on and off. However, in many cases, using SmoothTool with other URCaps should not be an issue.

2.2.3 Using the robot's built in simulation feature

WARNING



If the robot's built in simulation feature is enabled while SmoothTool is not also in simulation mode, the robot will not move from its initial position but will start welding regardless when the program is run. Thus, care must be taken to ensure that the robot's built in simulation feature is never used without SmoothTool also being in simulation mode.

3 | Installation

3.1 Compatibility

The SmoothTool software is compatible with PolyScope 3.9 or higher on CB-series and 5.3.0 or higher on e-series.

3.1.1 Units

The software supports both Metric and Imperial units.

3.1.2 Software languages

- English
- Danish
- Slovak
- French
- Swedish
- Portuguese
- Finnish
- Dutch
- German
- Polish
- Brazilian Portuguese
- Slovene

3.2 USB-key placement

Insert the License dongle in the robot (either via the teach pendant or the control box). As the License dongle must always stay in the robot in order to use the software, it is recommended to put it in the control box (see figure 3.1). Next, insert the Software USB-key in the robot and follow the steps below. The Software USB-key is only needed while installing the URCap. It is therefore recommended to put it in the teach pendant.

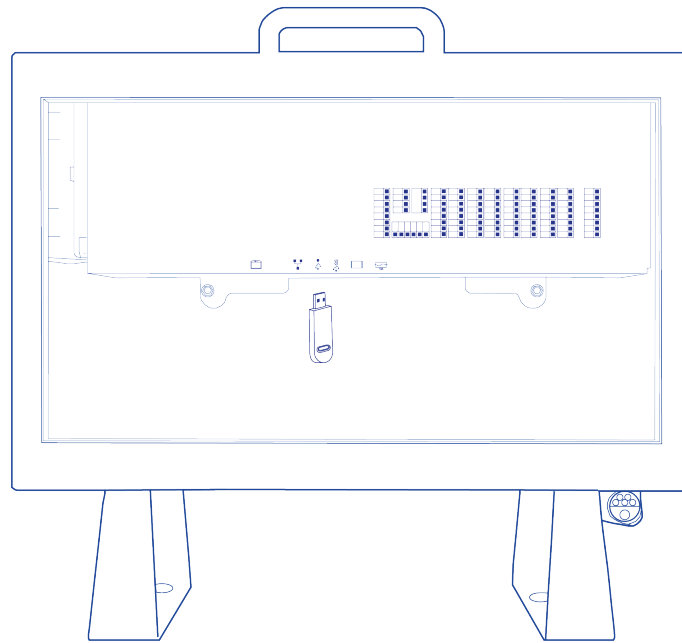


Figure 3.1: The control box.

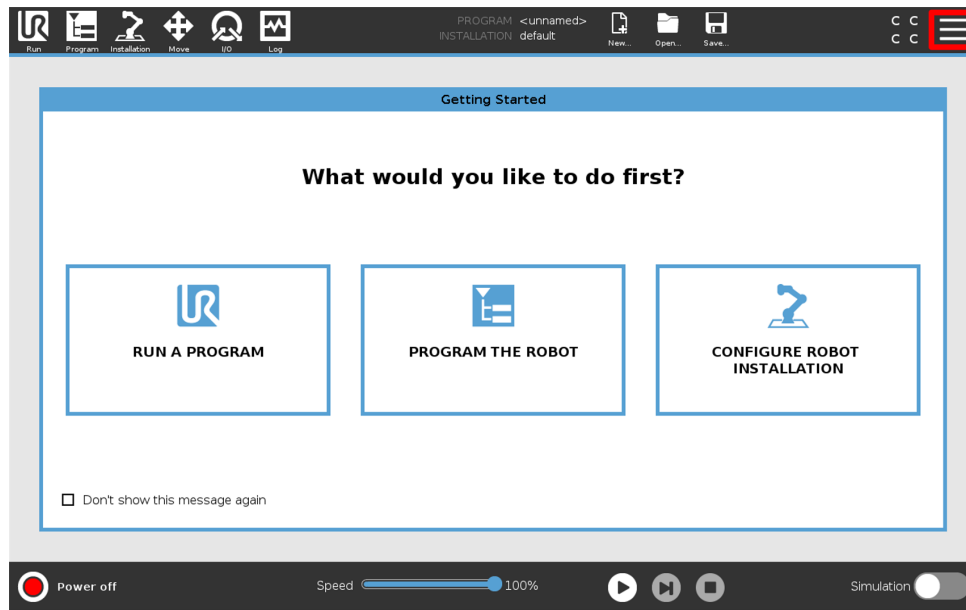
NOTICE

When the License dongle is inserted into a Universal Robot for the first time, it will be locked to that specific robot. Plugging it in other robots afterwards will not grant access to the SmoothTool software.

3.3 e-Series SmoothTool URCap Installation

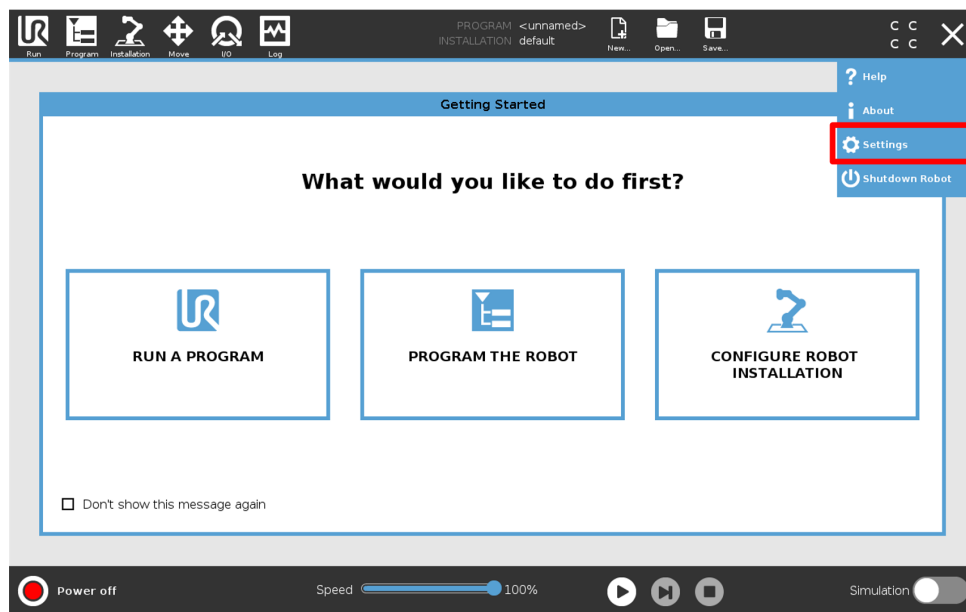
Step 1

1. Make sure the PolyScope version is up to date.
2. Insert the Software USB-key in the UR teach pendant or controller.
3. On the teach pendant, tap the triple-bar icon in the upper-right corner of the screen (see figure below).



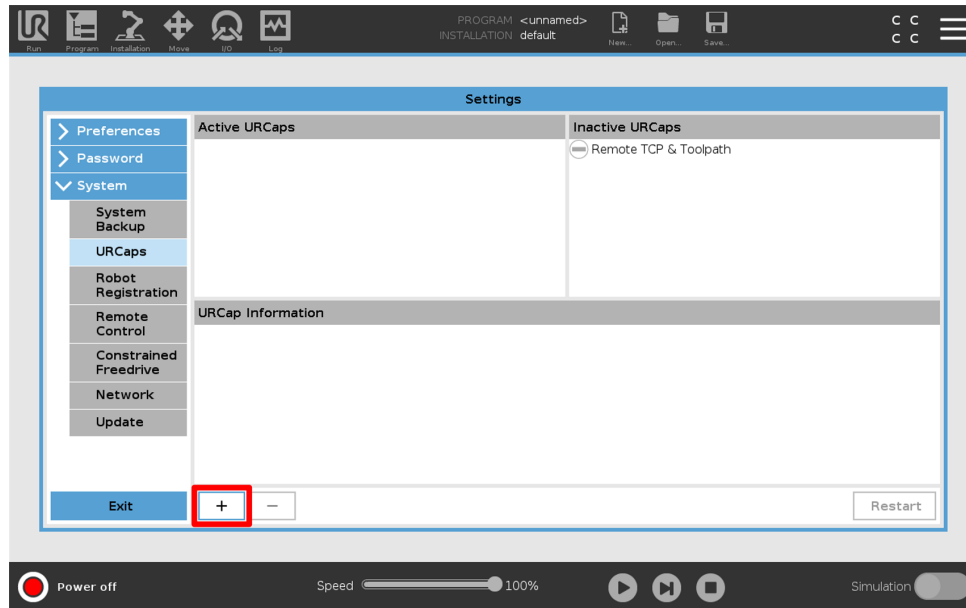
Step 2

1. Tap *Settings*.



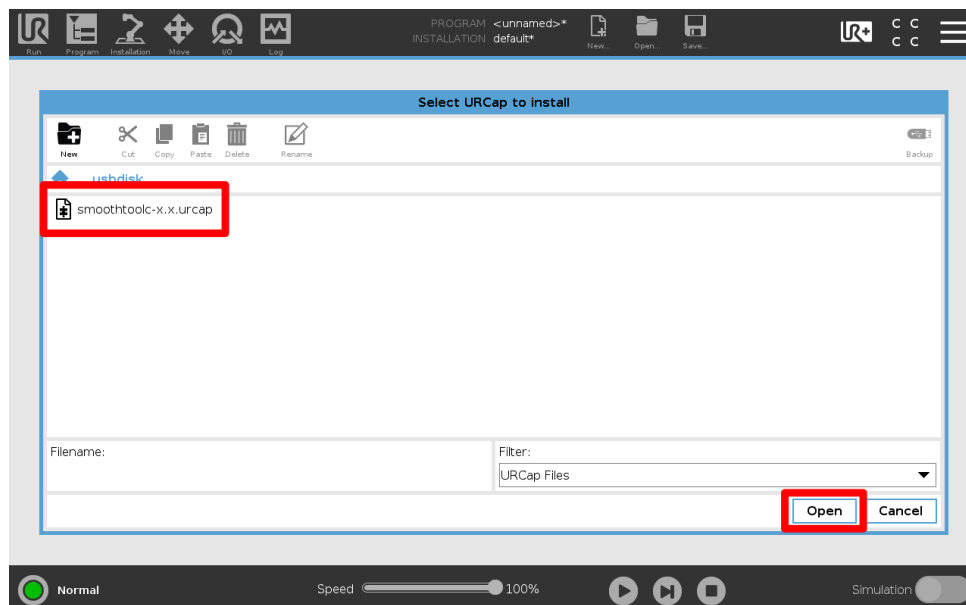
Step 3

1. Navigate to *System* → *URCaps* in the navigation panel to the left.
2. Tap the plus (+) button (see figure below) to display the storage devices (USB key) and navigate to the SmoothTool URCap.



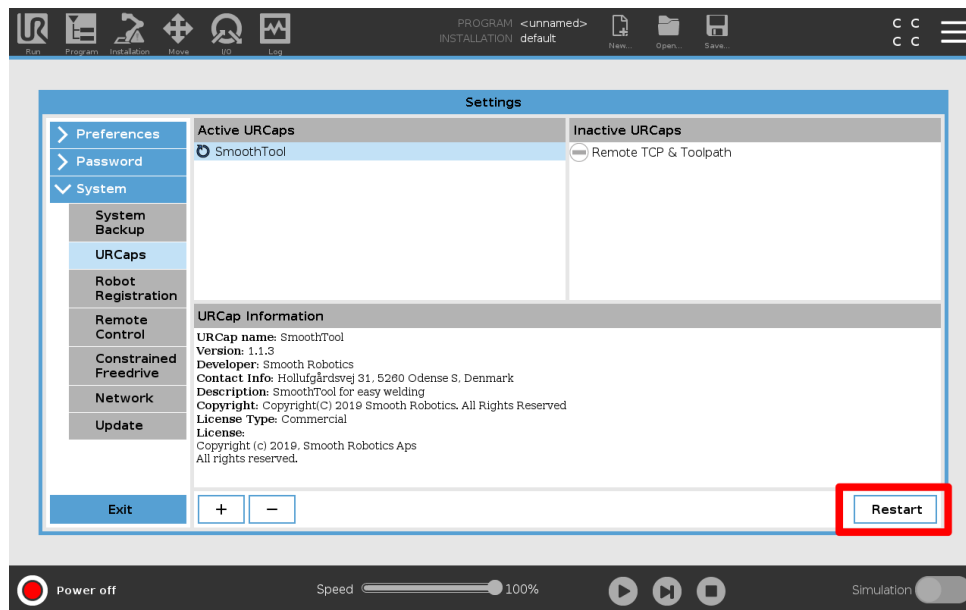
Step 4

1. Select the SmoothTool x.x.x URCap.
2. Once the file is selected tap the *Open* button.



Step 5

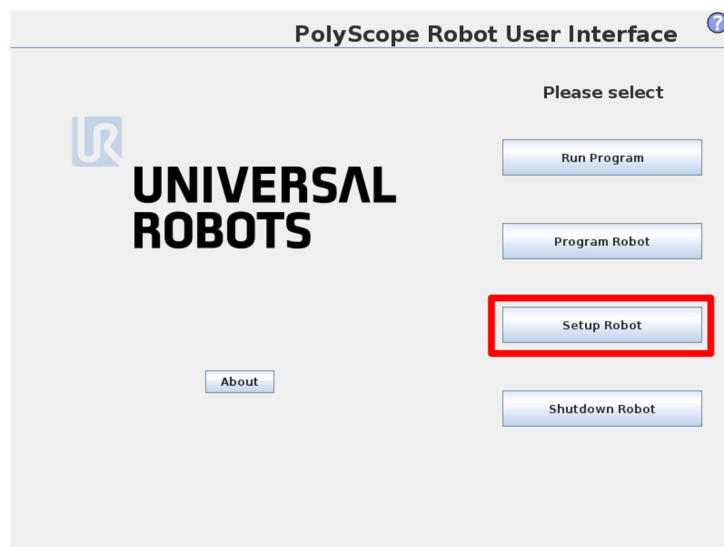
1. Tap the *Restart* button to complete the URCap installation.



3.4 CB-Series SmoothTool URCap Installation

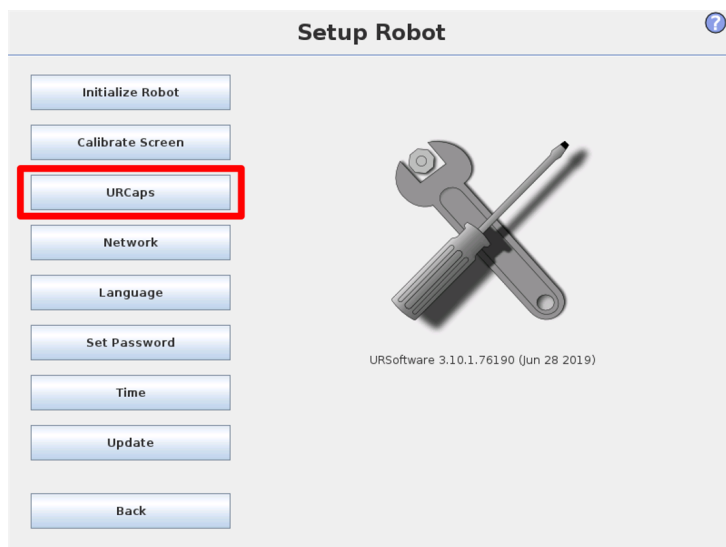
Step 1

1. Make sure the PolyScope version is up to date.
2. Insert the Software USB-key in the UR teach pendant or controller.
3. Tap *Setup Robot*.



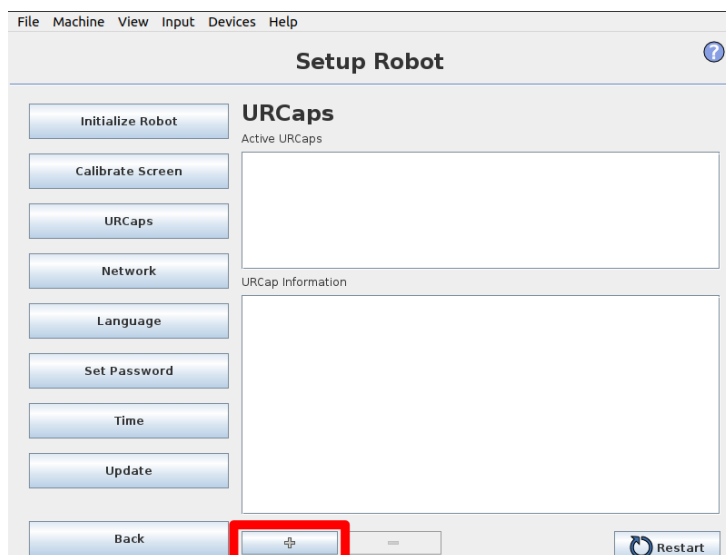
Step 2

1. Tap *URCaps*.



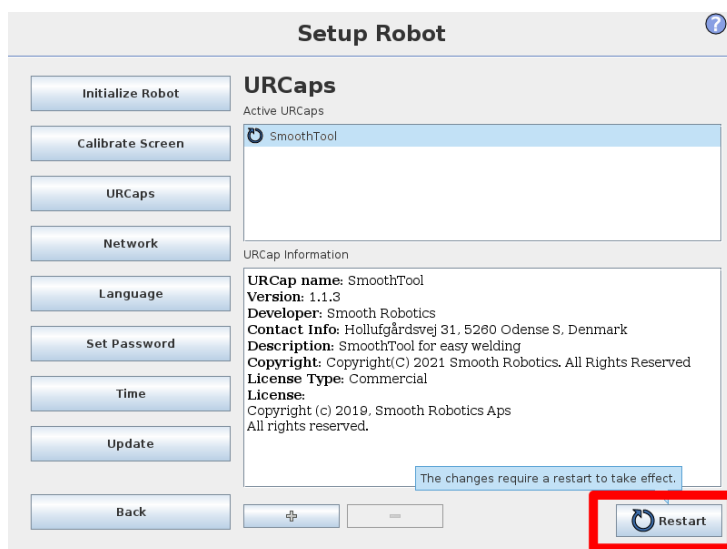
Step 3

1. Tap the plus (+) button (see figure below) to display the storage devices (USB key) and navigate to the SmoothTool URCap.
2. Select the SmoothTool x.x.x URCap.
3. Once the file is selected tap the *Open* button.



Step 4

1. Tap the *Restart* button to complete the URCap installation.

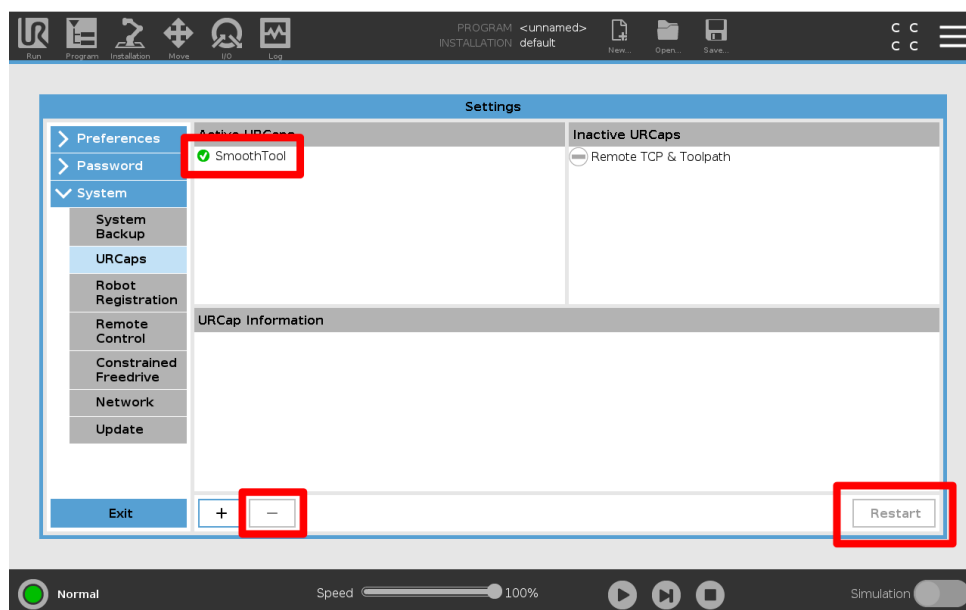


3.5 Updating the SmoothTool URCap Software

To update the SmoothTool URCap software, first uninstall the old version (see section 3.6), and then install the new version (see section 3.3 or 3.4).

3.6 Uninstalling the SmoothTool URCap Software

1. Tap the triple-bar icon in the upper-right corner and navigate to *Settings* → *System* → *URCaps*.
2. Select SmoothTool from the list.
3. Tap (-).
4. Tap *Restart*.



3.7 SmoothTool Programming Flange Installation

NOTICE

Using the Programming flange is optional and not strictly necessary for using the SmoothTool software.

3.7.1 Mounting the flange on the robot

1. Mount the flange by placing it at the end of the robot arm (see figure 3.2).
2. Use a 4 mm hex key to tighten the flange to the robot arm.
3. Connect the flange to the robot by plugging in the cable.

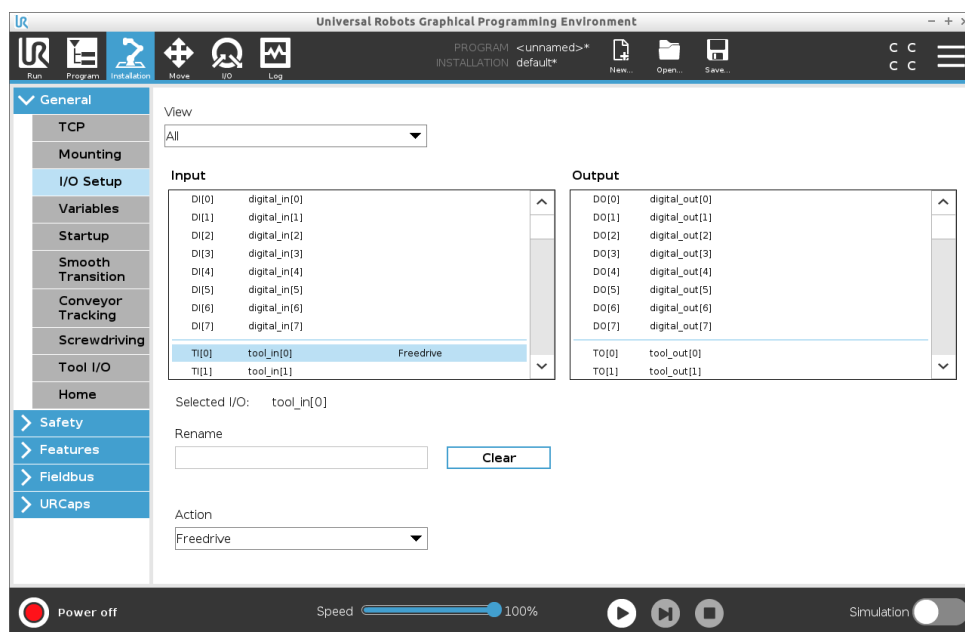


Figure 3.2: Mounting the programming flange.

3.7.2 Configuring the flange on the e-Series

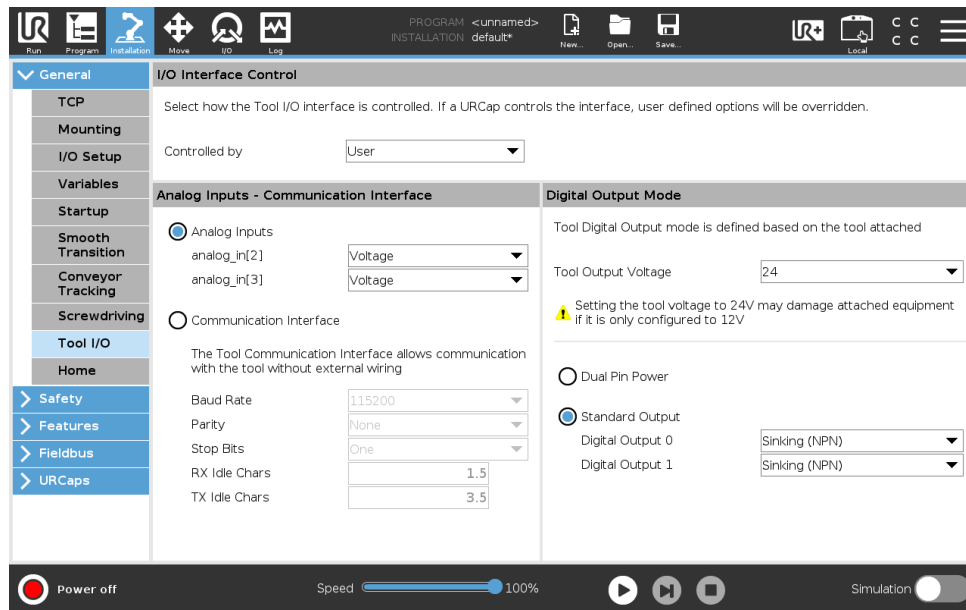
Step 1: Configure the Freedrive Button

1. On the Teach Pendant, go to *Installation* → *General* → *I/O Setup*.
2. Select *TI[0]* in the Input table.
3. In the drop-down menu under *Action*, select *Freedrive*.



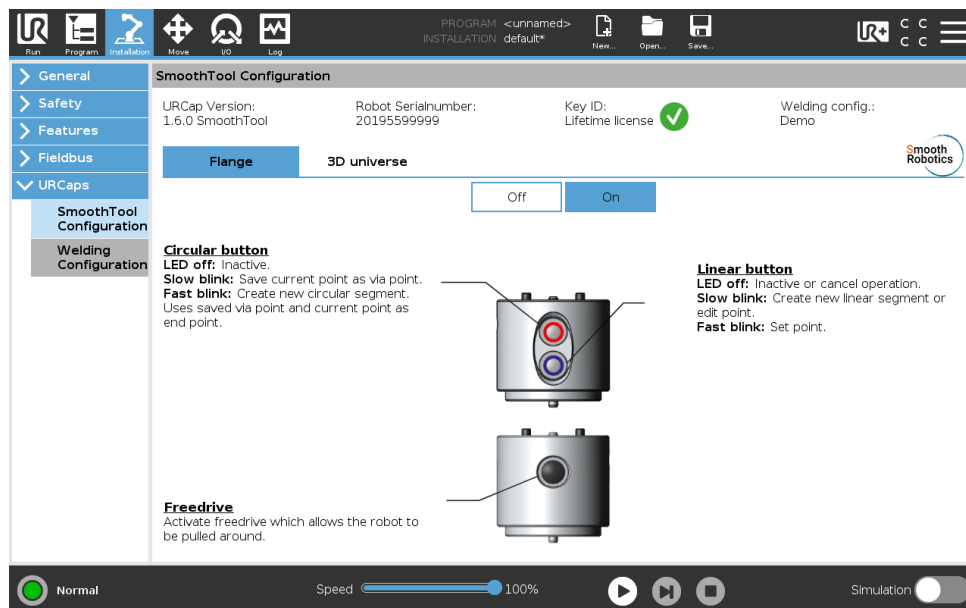
Step 2: Configure the Digital/Analog Inputs/Outputs

1. Go to *Installation* → *General* → *Tool I/O*.
2. Make sure *analog_in[2]* under *Analog Inputs* is set to *Voltage*.
3. Set *Tool Output Voltage* to 24.
4. Set *Digital Output 0* and *Digital Output 1* to *Sinking (NPN)*.



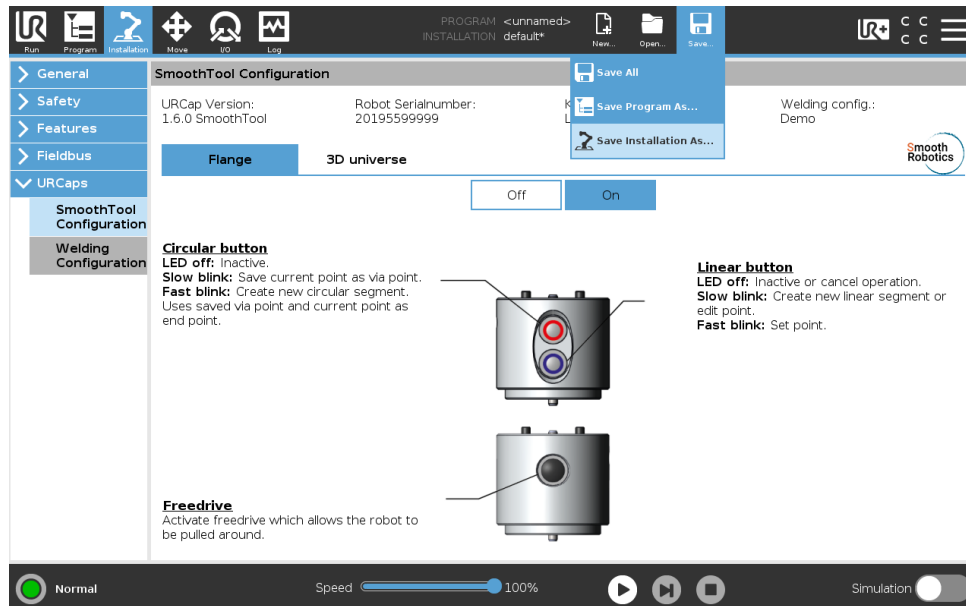
Step 3: Turn on the Flange

1. Go to *Installation* → *URCaps* → *SmoothTool configuration* → *Flange*.
2. Tap *On*.



Step 4: Save the Configuration

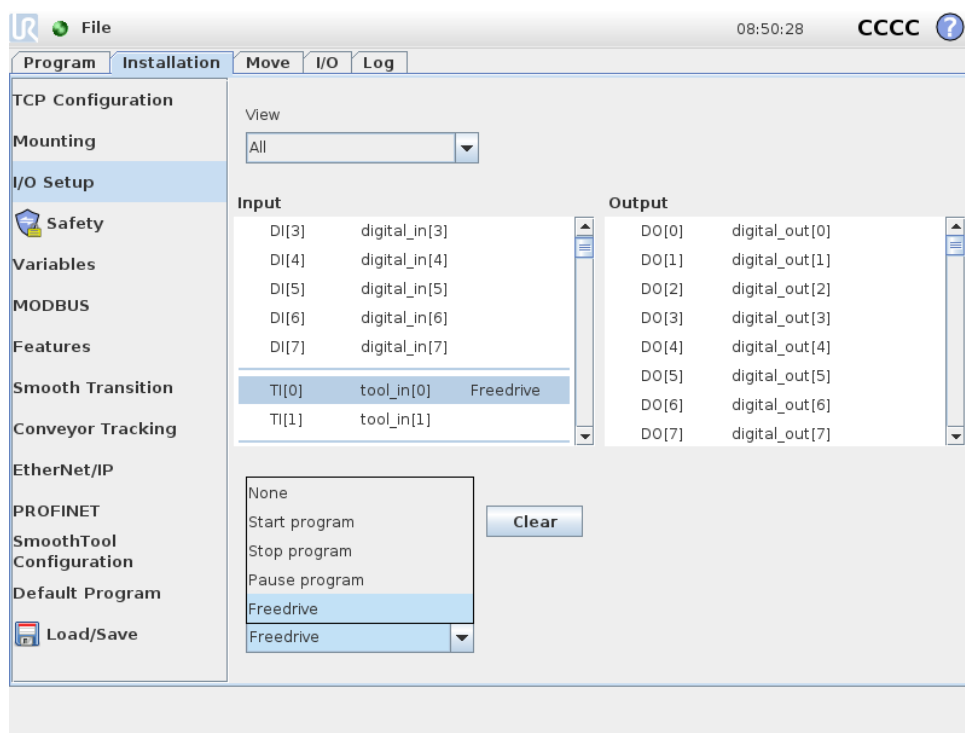
1. Tap *Save* → *Save Installation As....*
2. Select *default.installation* and tap *Save*.
3. Tap *Overwrite File*.



3.7.3 Configuring the flange on the CB-Series

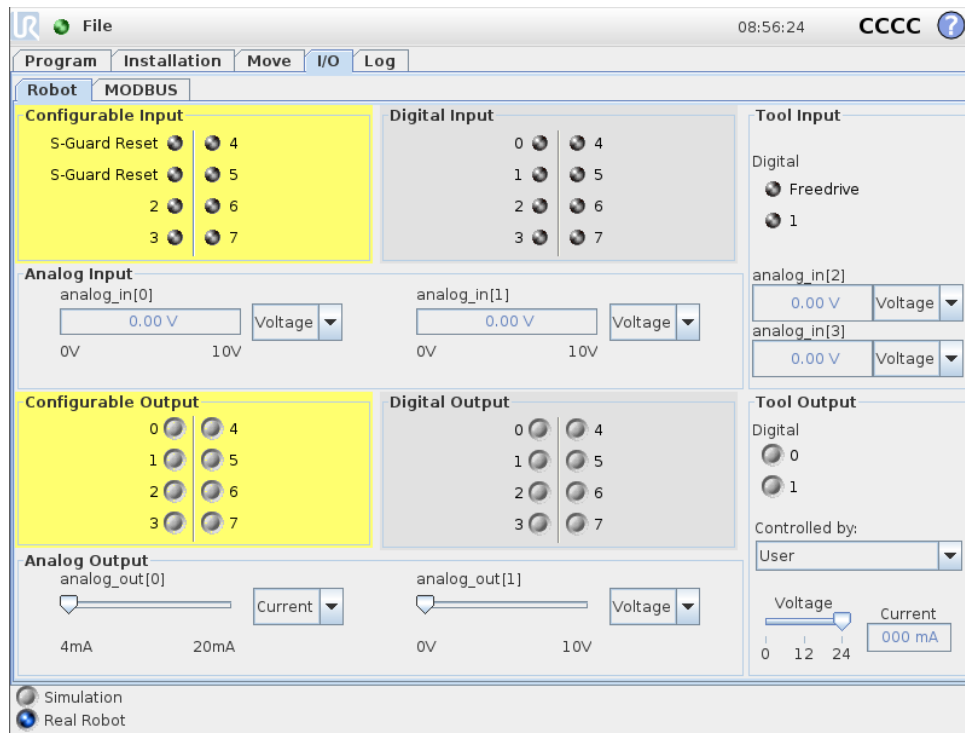
Step 1: Configure the Freedrive Button

1. On the Teach Pendant, go to *Installation* → *I/O Setup*.
2. Select *TI[0]* in the Input table.
3. In the drop-down menu under *Action*, select *Freedrive*.



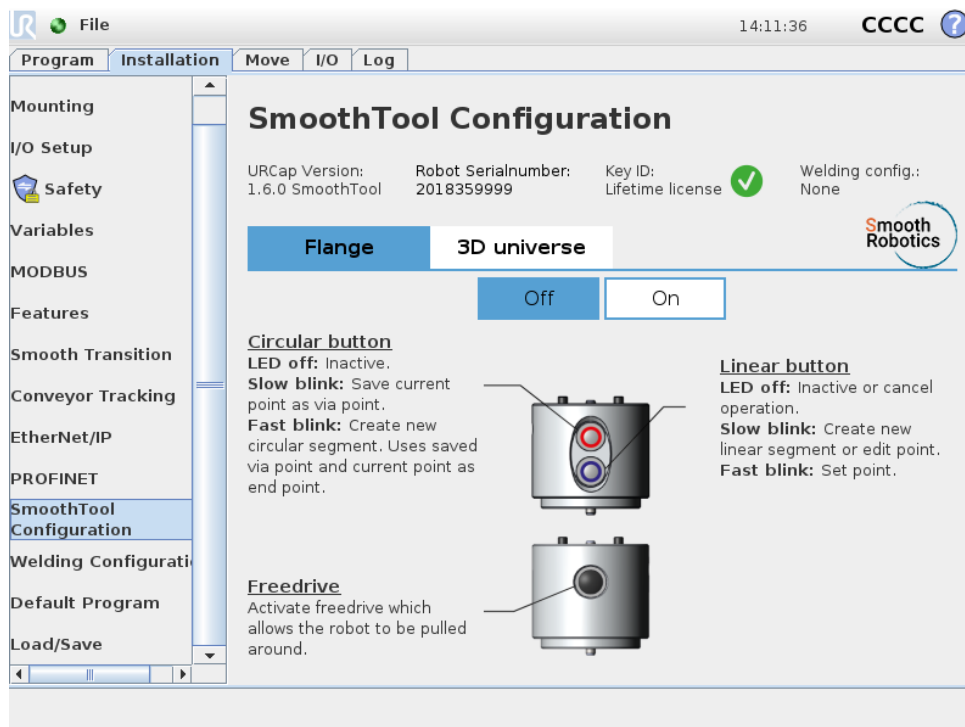
Step 2: Configure the Digital/Analog Inputs/Outputs

1. Go to the *I/O* tab.
2. Make sure *analog_in[2]* under *Analog Inputs* is set to *Voltage*.
3. Set the voltage slider under *Tool Output* to 24.



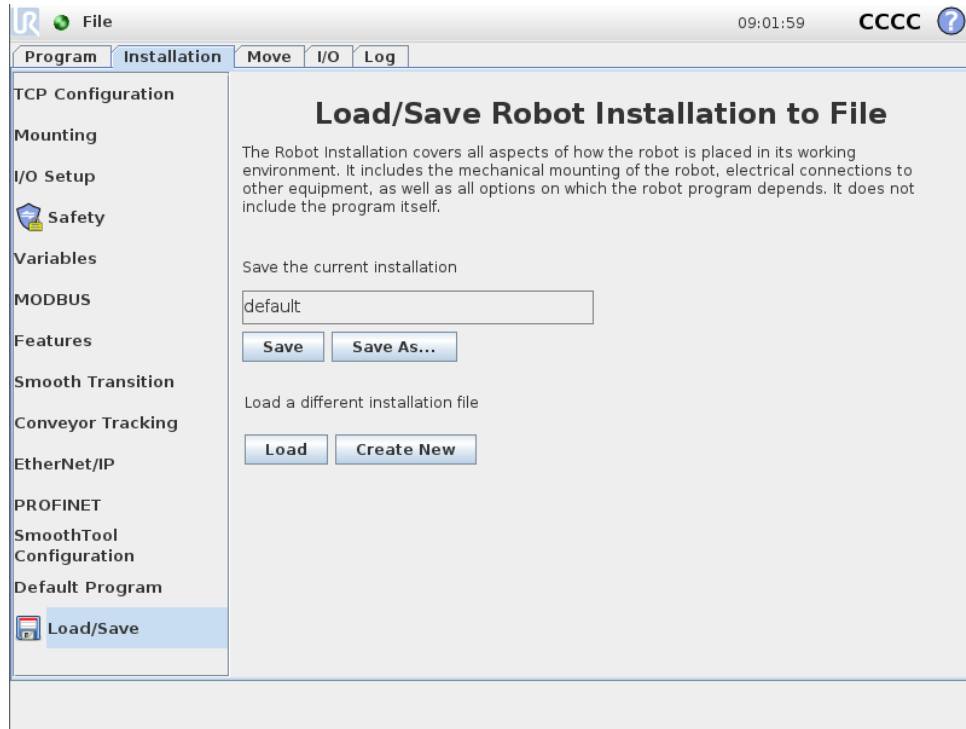
Step 3: Turn on the Flange

1. Go to *Installation* → *SmoothTool configuration* → *Flange*.
2. Tap *On*.



Step 4: Save the Configuration

1. Go to *Installation* → *Load/Save*.
2. Tap *Save*.



4 | Configuration and initial setup

4.1 Configuring the TCP of the UR-arm

WARNING



The instructions in this section should be read and followed carefully, as using SmoothTool with an incorrect TCP will lead to errors. For instance, if the z-axis of the TCP doesn't point directly away from the torch (as shown in figure 4.1), any and all angle calculations will be incorrect and retractions when stitching will not behave as intended. Similarly, errors in the position of the TCP will lead to errors when offsetting and might also make the 3D representation of the path abnormal.

NOTICE

The Tool Center Point (TCP), the payload and the center of gravity must be configured when the Programming Flange and the welding torch have been mounted on the robot arm. This configuration provides the robot with the necessary information about the mounted tool in order to make the calculations accordingly. For a welding torch, the TCP is the point at the tip of the welding wire with a direction of the z-axis pointing directly away from the torch (the directions of the x- and y-axis are insignificant), as shown in figure 4.1.

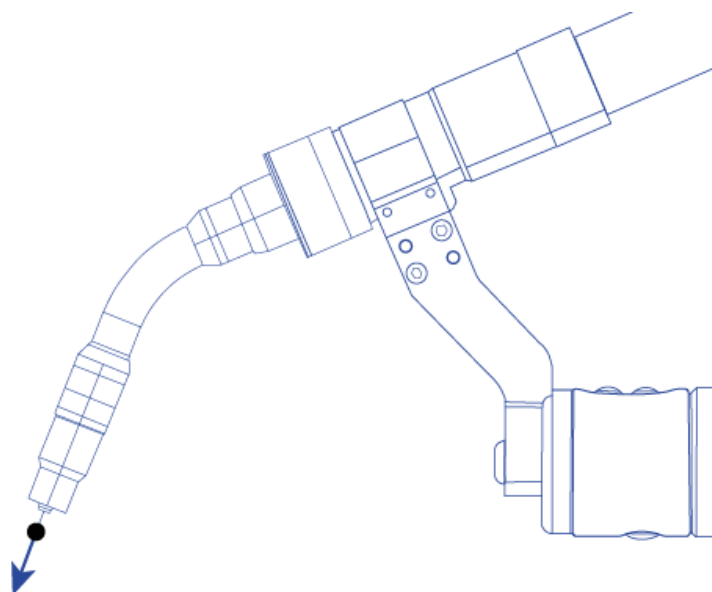


Figure 4.1: Proper configuration of the TCP. The black dot represents the TCP, which is the point at the tip of the welding wire. The z-axis of the TCP should point directly away from the torch, as illustrated by the blue arrow.

The welding wire should protrude approximately 15-25mm. In order to configure the TCP, go to *Installation* → TCP. Enter the values in the appropriate fields if known beforehand. Otherwise, it is recommended to use the wizards provided by UR. Press on each wand and follow the instructions.

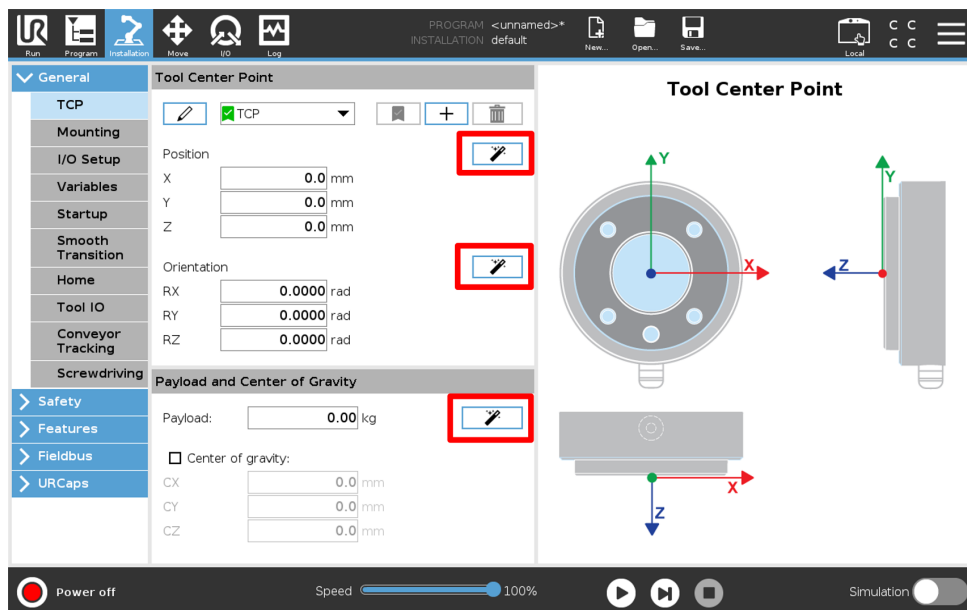


Figure 4.2: Universal Robots' TCP installation page. Follow the wizards accessed by tapping the wands to configure the TCP.

4.2 SmoothTool configuration page

General information about the product and the license is located at the top of the configuration page (see figure 4.4).

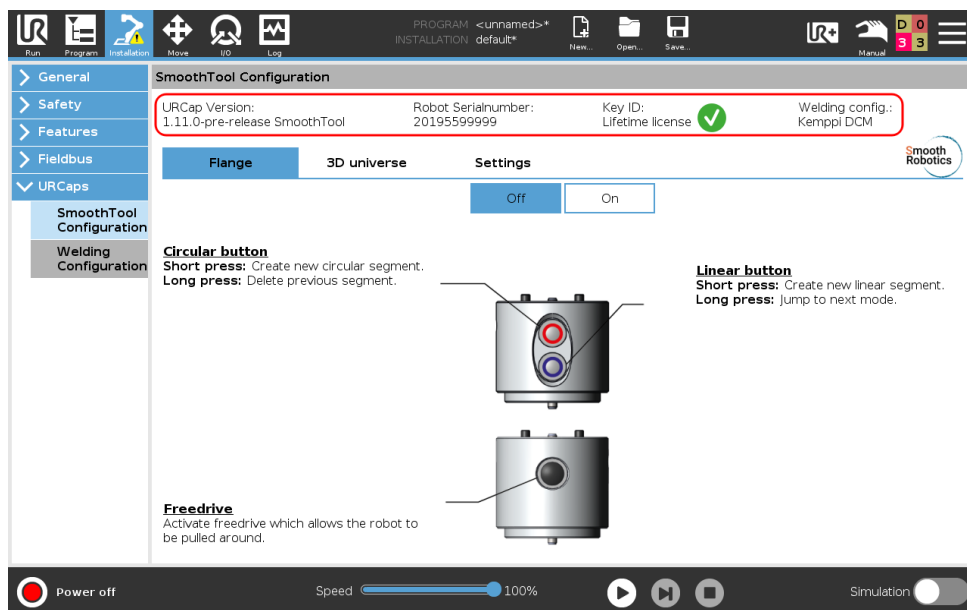


Figure 4.3: General information about the SmoothTool software.

Identifier:	Description:
URCap version	The software version currently in use.
Robot Serial number	The serial number of the robot.
Key ID	The ID of the license dongle and information about the license type. If the license is subscription based this field will also show days left.
Welding Config.:	The currently active welding configuration.
	Indicates an error related to the License dongle. Please contact the local distributor.
	Indicates that the inserted license dongle does not support SmoothTool.
	Indicates a successful installation of SmoothTool and a valid License dongle.
	Indicates absence of the License dongle or no connection found.
	Indicates that the License dongle is already locked to another robot.
	Indicates that the License has expired.

NOTICE

Ensure that the robot time is set to the correct time. After setting the correct time, please remember to restart the robot for the changes to take effect.

General settings related to the software are found in the *Settings* tab.

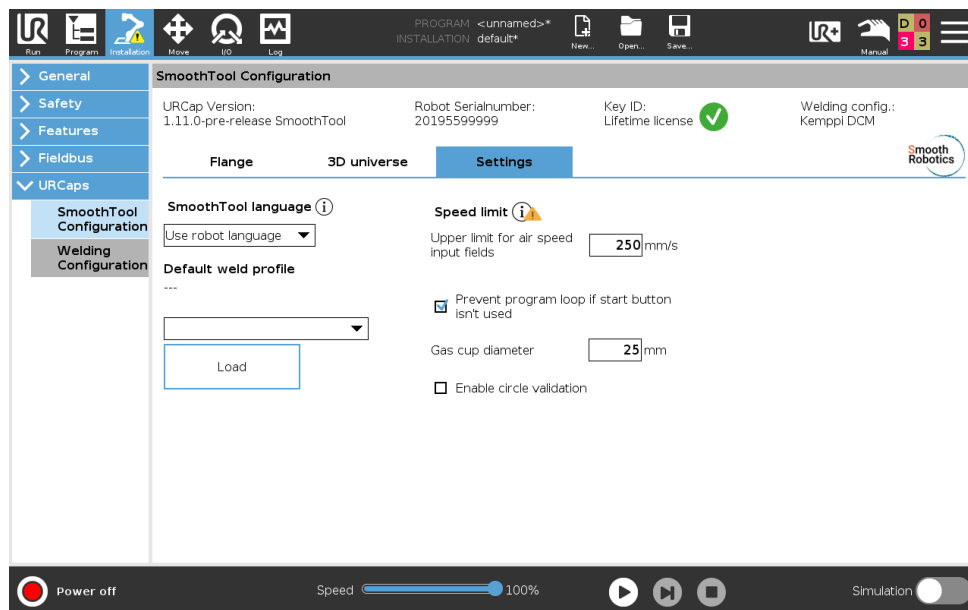


Figure 4.4: General SmoothTool settings.

Identifier:	Description:
SmoothTool language	SmoothTool supports some languages, that are not available in the UR system. These languages can be activated here.
Default weld profile	Sets default profile for welds.
Speed limit	Sets the upper limit for air speed input fields. This setting is NOT safety rated and only used by the software to limit the speed slider and SmoothTool-related air movements. Use UR's Safety settings to ensure the robot does not exceed safety limits.
Prevent program loop if start button isn't used	When enabled, the program execution will be halted when it reaches the end of the program if no start-button is configured, even though the program is set to Loop forever.
Gas cup diameter	Gas cup diameter is used to reduce the calculation error when computing the touch sense offset.
Enable circle validation	When enabled, the software will perform additional computations to check the validity of circles before the program execution starts. It is recommended to enable this feature if the PolyScope version is below 5.14.

4.3 3D universe setup

The 3D universe (described in Chapter 12) is capable of visualizing the robot program in 3D. In order to do so correctly, it must be aware of the robot's physical mount position and angle. Follow section 4.3.1 to configure the robot mount.

Moreover, the operator can optionally configure the dimensions and position of the work table in order to visualize it in the 3D universe. This improves the visualization experience and makes objects and paths more relatable. Follow the steps in section 4.3.2 to configure the work table.

4.3.1 Robot mount configuration

Navigate to *Robot mount* to configure the robot mount position and angles:

- E-series: Tap *Installation* → *URCaps* → *SmoothTool Configuration* → *3D universe* → *Robot mount*.
- CB-series: Tab *Installation* → *SmoothTool Configuration* → *3D universe* → *Robot mount*.

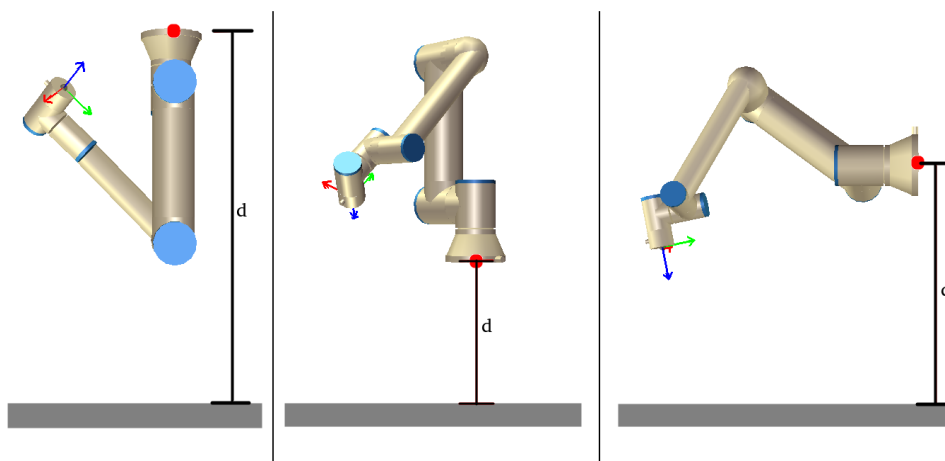


Figure 4.5: The figure describes how to measure the *Distance to ground*. The gray rectangle illustrates the floor. The distance, d , is measured from the floor to the bottom of the robot base (red dot).

Measure the distance from the floor to the robot base as instructed in Figure 4.5 and enter the value in the field *Distance to ground*, see Figure 4.6.

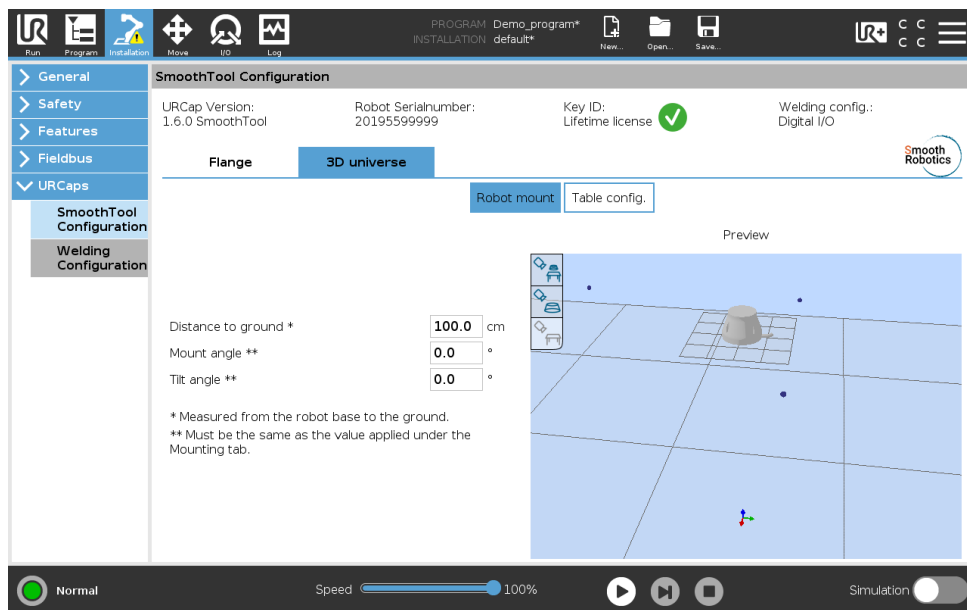


Figure 4.6: Robot mount configuration.

Next, enter the *Mount angle* and *Tilt angle*. These values must be the same as those applied under *General* → *Mounting* (or just *Mounting* on CB-series)¹.

4.3.2 Work table configuration

Navigate to *Table config.* to configure the work table position and dimensions:

- E-series: Tap *Installation* → *URCaps* → *SmoothTool Configuration* → *3D universe* → *Table config.*
- CB-series: Tab *Installation* → *SmoothTool Configuration* → *3D universe* → *Table config.*

Follow the steps below to configure the table:

- **Step 1:** Make sure *Show table* is checked, in order to enable the table.
- **Step 2:** Under *Corner*, specify the position of one of the table corners.
- **Step 3:** Under *Direction 1* specify a corner that shares an edge with *Corner*. If the corner is unreachable, specify any point along the edge.
- **Step 4:** Under *Direction 2* specify the corner that shares the second edge with *Corner*. If the corner is unreachable, specify any point along the edge.

¹See Universal Robots user manual for more information on how to specify the robot mounting angles.

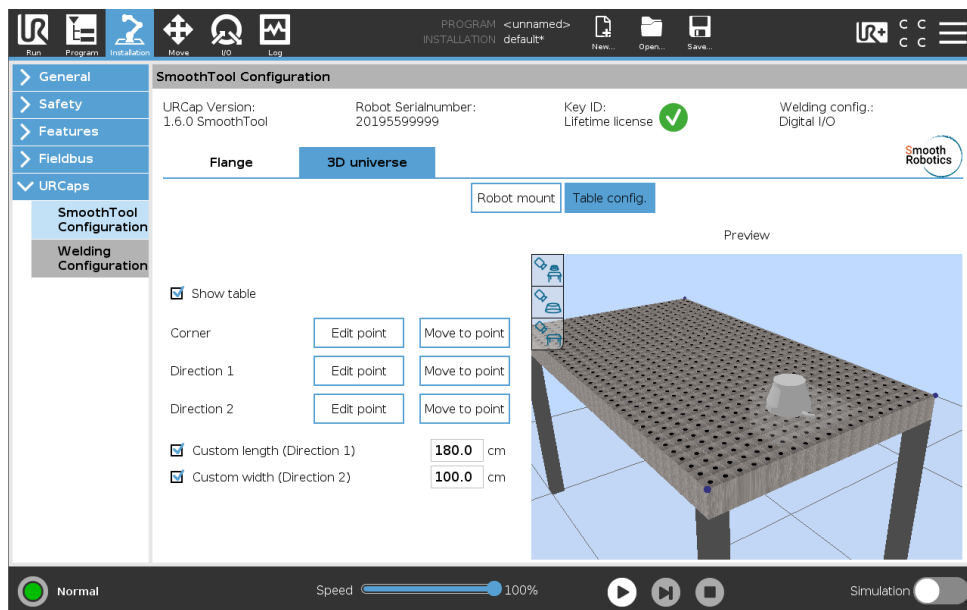


Figure 4.7: Work table configuration.

After completing the steps above, the previewer should display the table. If *Direction 1* and *Direction 2* both specify corners (and not points along an edge), then the table should have the right dimensions and the configuration is thereby done.

If *Direction 1* and/or *Direction 2* specify points along edges, the dimensions of the table should be off. In order to correct them, check *Custom length (Direction 1)* and/or *Custom width (Direction 2)* and enter the correct dimensions.

4.4 Welding configuration page

The *Welding configuration* page contains the following settings:

- Under the *Welding* tab, the desired power source integration can be chosen and configured (see section 4.5).
- Under the *Arc settings* tab, settings related to SmoothTool's general welding behaviour can be found (see section 4.6).

4.5 Welding setup

When a SmoothTool program is executed, the robot will start executing the commands in the program tree. Once it reaches *Weld Start*, SmoothTool will automatically start the arc and start welding until it reaches the last point in the *Weld Start* program branch. The power source management can be set up in the installation node using one of the integrated power sources (subsection 4.5.2), the I/O integration (subsection 4.5.3) or the Callback functions (subsection 4.5.4).

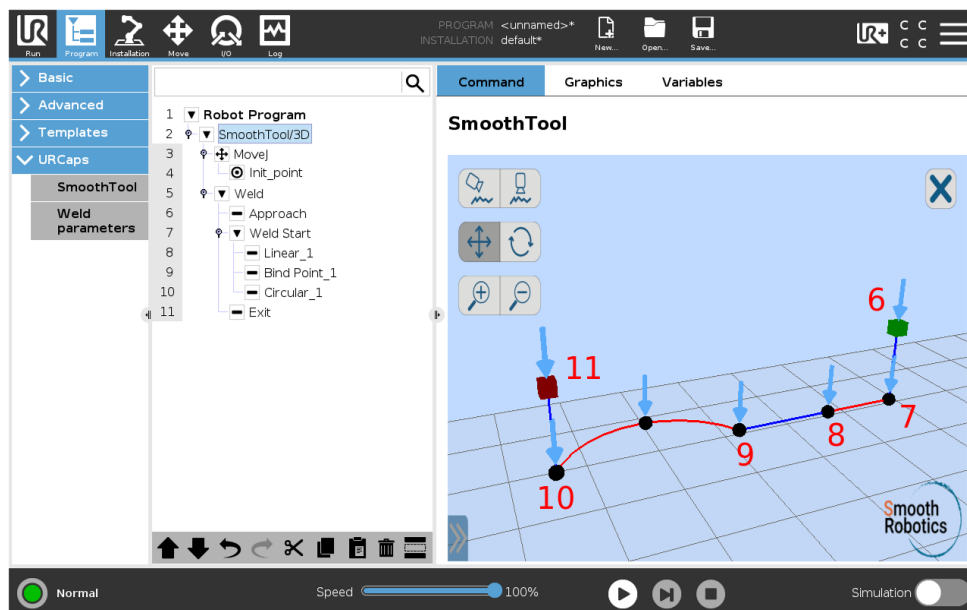


Figure 4.8: The program tree is shown on the left. The actual path is shown on the right. Blue lines are path sections where the robot does not weld and red lines are welding sections. The numbers refer to the corresponding line number in the program tree. The figure illustrates that the robot will be welding from *Weld Start* until the last point in that branch, i.e. *Circular_1*, except on the air point.

4.5.1 Integration selection

Under the *Welding* -tab in the SmoothTool *Welding configuration* installation page, a list of the power source integrations can be found. This list is a subset of the available power source integrations and can be configured by pressing the *Configure* button.

The integrations are divided into three categories:

- Digital I/O
 - This type of integration uses digital or analog signals to control the power source. The integration is usually more direct and less complicated but with fewer features.
- URScript
 - This type of integration uses URScript code to control the power source, meaning any feature made available by UR can be used. The limitation and advantages are described in section 4.5.4
- Integrated power sources (protocol based): Ethernet/IP, MODBUS, XMLRPC
 - These integrations communicate with the power source over a protocol and usually offer more features, functionalities and control options.
Please note that Ethernet/IP integrations do **not** work if the UR Ethernet/IP Adapter is enabled. Make sure to disable it before attempting to connect to a power source.

4.5.2 Integrated power source setup

The automatic control of the arc prerequisites a connection to a power source, which the software must usually take full control of. Currently, SmoothTool supports the following pre-configured integration options:

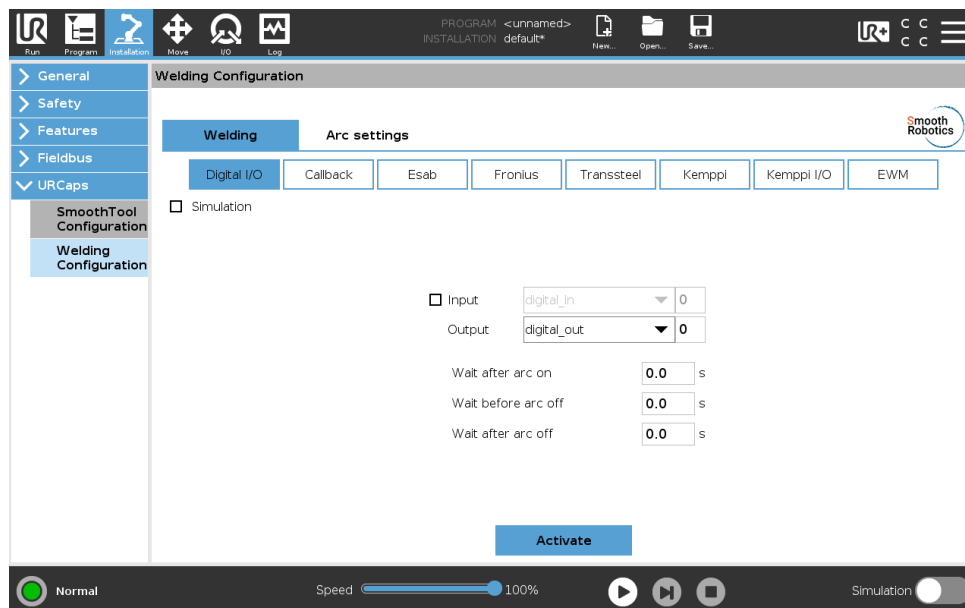
Integration	Model(s)	Integration manual
Abicor Binzel iRob Pulse 400/500	iRob Pulse 400 iRob Pulse 400 Multivoltage iRob Pulse 500	SmoothTool Abicor Binzel iRob Pulse 400/500 integration manual
Fronius TPSi	Fronius TPSi series	SmoothTool Fronius TPSi integration manual
Fronius TransSteel	Fronius TransSteel series	SmoothTool Fronius Transsteel integration manual
ESAB	ESAB Aristo Mig series, ESAB 500ix	SmoothTool ESAB Aristo integration manual
Kemppi A7	Kemppi A7 350 Kemppi A7 450	SmoothTool Kemppi A7 integration manual
Kemppi X8	Kemppi X8 series	SmoothTool Kemppi X8 integration manual
Kemppi X5/MasterM	Kemppi X5 FastMig Kemppi MasterM Kemppi MasterTig	SmoothTool Kemppi X5/MasterM integration manual
Kemppi DCM	Power sources compatible with Kemppi DCM Module (X5 FastMig, MasterM...)	SmoothTool Kemppi DCM integration manual
EWM	EWM Titan XQ puls EWM Phoenix XQ puls EWM Phoenix 355 puls	SmoothTool EWM integration manual
Lorch	Lorch S/P-series Lorch S/P-series XT Lorch Robot-MicorMIG	SmoothTool Lorch integration manual
Weco	WECO DIGITAL	SmoothTool WECO DIGITAL integration manual
Auto-Continuum™	Miller Auto-Continuum™ series	SmoothTool Miller Auto-Continuum™ integration manual
OTC	WB-P402 WB-P402L WB-502L WB-P322E	SmoothTool OTC integration manual

Depending on which of the pre-configured power sources is active, the Weld parameters nodes created (see 5.3) and the Toolbar (see 5.4) will adapt to offer the functionalities available for the specific power source.

Use the corresponding power source installation manuals for more information regarding the integration of the power sources. In addition, SmoothTool offers two generic options for power source integration that must be configured manually. These are I/O setup and Callback functions. In order to use one of these options, go to *Installation* → *Welding configuration* → *Welding*. Tap either *Callback* or *Digital IO*. Tap *Activate*.

4.5.3 Digital I/O Setup

The Digital I/O setup is the most basic welding configuration. It enables SmoothTool to control the power source using a simple user-selected output signal for starting and stopping the arc. An optional input signal can be used to receive information about the actual arc state.



Identifier:	Description:
Input	If enabled, the selected digital input is expected to receive the actual arc state. HIGH = arc on, LOW = arc off.
Output	The robot will set and reset this output when it wants to start or stop the arc. HIGH = start arc, LOW = stop arc.
Wait after arc on	Wait time once the arc has been established. Can be used to heat up the weld before the robot starts moving.
Wait before arc off	Time to wait after the robot stops moving and before the stop arc signal is sent (e.i. digital output goes low). Can be used for crater filling.
Wait after arc off	Time to wait after the arc has been turned off. Especially useful to ensure that the arc has actually been turned off, when no input signal is provided.

For more information about inputs and outputs, where they are located and how to use them, please see the Universal Robots user manual: <https://www.universal-robots.com/download/>

4.5.4 Callback Functions Setup

Callback functions allow the integrator to setup the communication between SmoothTool and power sources that are not preconfigured using the URscript language². The integrator must define two functions: One for turning on the arc and one for turning it off. These functions will be called automatically as needed when the Callback method is activated.

Usually, the structure of each callback function will contain two parts:

1. Command for turning on/off the welding arc.
2. Wait for verification signal to ensure that the arc has been turned on/off.

The callback functions are defined in the *Welding configuration* → *Welding* → *Callback* installation node. After writing or loading the Callback functions, remember to save the UR installation setup.

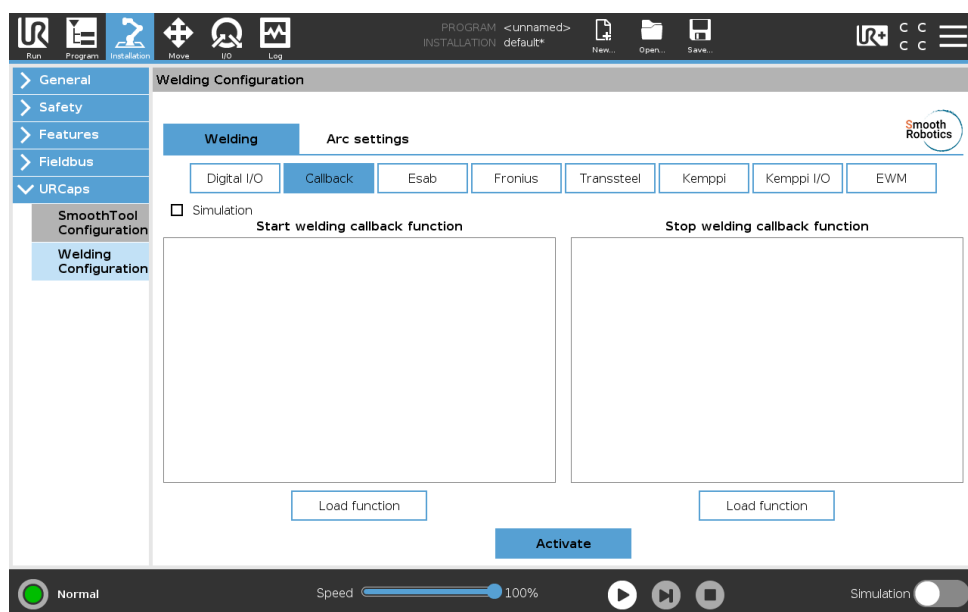


Figure 4.9: *Welding configuration* installation node. Callback functions can be activated under *Welding* → *Callback*.

WARNING



In normal operation, *Start Welding Callback Function* is called when the robot wants to start the arc and *Stop Welding Callback Function* is called when the robot wants to turn off the arc. However, if the program stops while the robot is welding, *Stop Welding Callback Function* will not be called automatically and thus the welding arc will not be turned off. In order to prevent that situation, the integrator must prevent the existence of the arc when the robot program is not running. One way to do this is to configure a digital output on the robot to be set if the program is running and reset otherwise. The integrator can thereby use that signal to turn off the arc if the digital output resets. Such a signal can be configured under *Installation* → *I/O setup*, see figure 4.11.

²The URscript Manual is available here: [https://www.universal-robots.com/download/?query=&type\[\]=98761](https://www.universal-robots.com/download/?query=&type[]=98761)

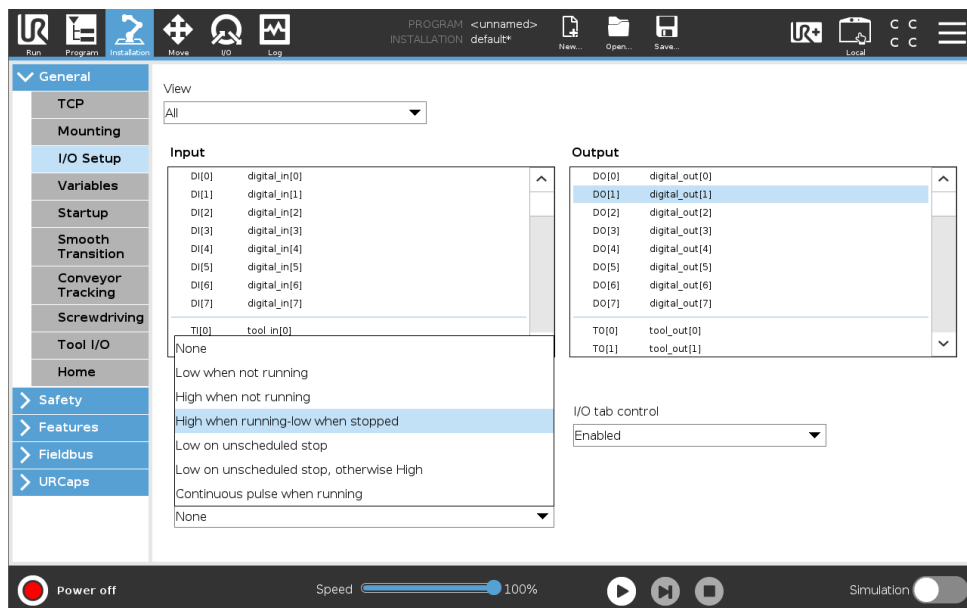


Figure 4.10: Under *Installation* → *I/O Setup* it is possible to configure a digital output to reflect the program status.

4.6 Arc settings

SmoothTool offers a number of settings for customizing the welding behaviour and welding signals during program execution. These settings can be accessed under *Installation* → *URCaps* → *Welding configuration* → *Arc Settings*.

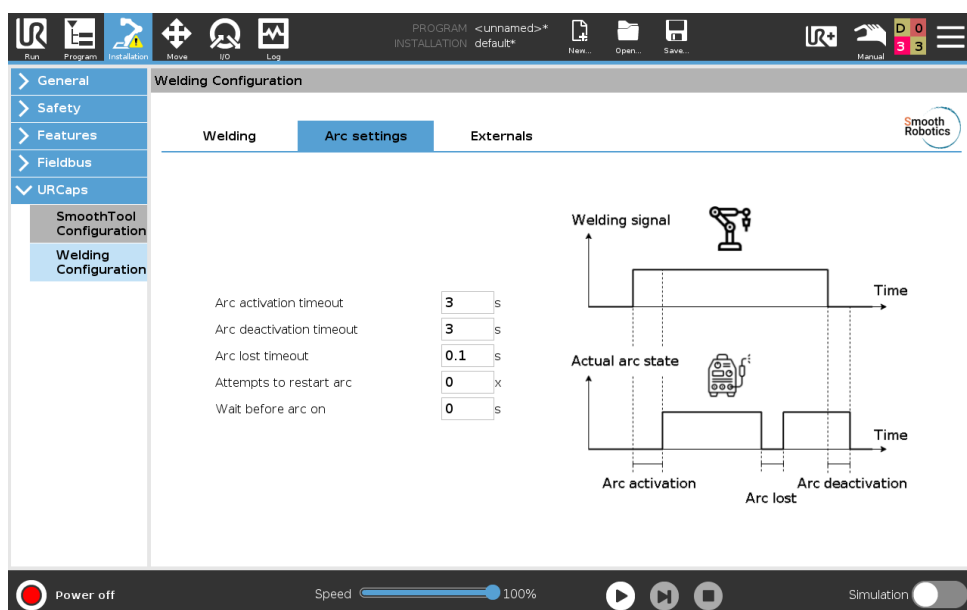


Figure 4.11: Arc settings page.

Identifier:	Description:
Arc activation timeout	Arc activation time is the time delay from when the robot signals to the power source to start welding, to when the power source verifies that the arc has actually been started. If the arc activation time exceeds the specified time the robot will interpret this as failing to initiate welding. The robot will try to restart arc if configured, otherwise safely stop the robot.
Arc deactivation timeout	Arc deactivation time is the time delay from when the robot signals to the power source to stop welding to when the power source verifies that the arc has actually been stopped. If the arc deactivation time exceeds the specified time, the robot will interpret this as an error and safely stop the robot.
Arc lost timeout	Arc lost time is the time where the welding arc is lost unexpectedly. If the arc lost time exceeds the specified time, the robot will interpret this an error. The robot will try to restart arc if configured, otherwise safely stop the robot.
Attempts to restart arc	If the robot fails to start the arc within the specified amount of time or if the arc is lost unexpectedly during a weld, the robot will attempt to restart the arc. Attempts to restart arc specifies how many times the robot should try to restart the arc. If the value is 0, the robot will not attempt to restart the arc.
Wait before arc on	Time delay before starting the arc. If fume extraction is configured (see section 4.7 on how to setup fume extraction), this time delay will allow the fume extractor to start up before the arc is turned on.

4.7 Externals

SmoothTool can be configured to interact with an external control box and/or fume extractor. The configuration settings can be accessed under *Installation* → *URCaps* → *Welding configuration* → *Externals*.

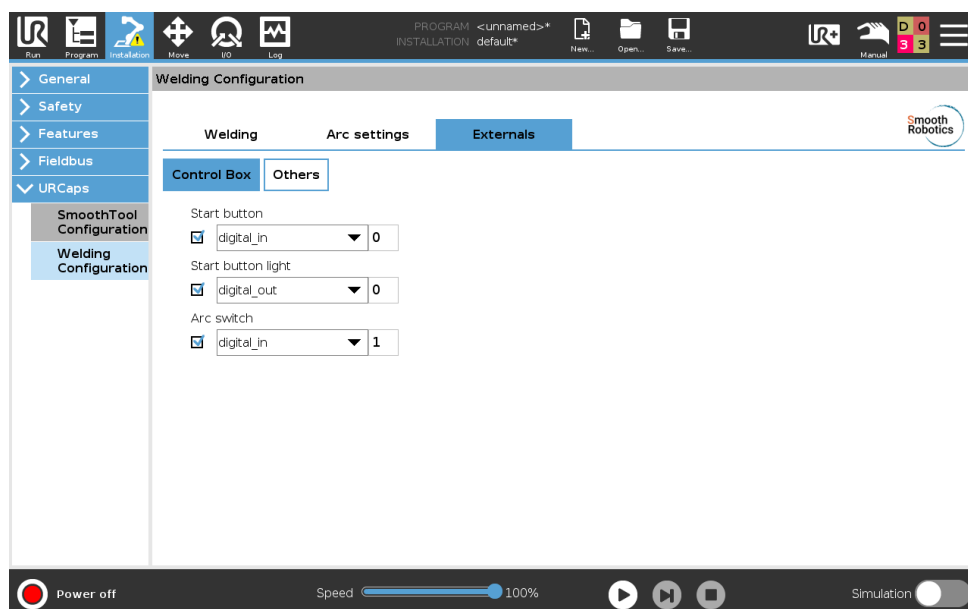


Figure 4.12: Setting up control box

Identifier:	Description:
Start button	The start button is an optional external button used to actually start the program. When enabled and the program is started using the play button on the teach pad, the robot will wait for the button to be pressed (in every loop), before actually starting.
Start button light	Signal indicating that the robot is awaiting the start button to be pressed.
Arc switch	The arc switch is an optional external switch used to enable or disable welding. This switch can be toggled during program execution.

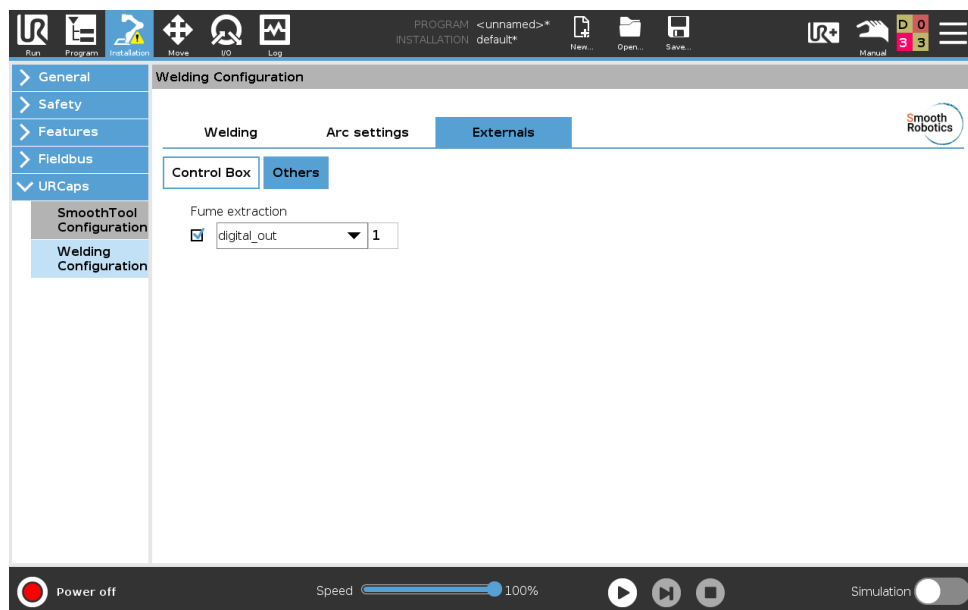


Figure 4.13: Setting up control box

Identifier:	Description:
Fume extraction	Configures an output signal for the fume extractor. HIGH=Robot is about to start welding and fume extractor should start. LOW=Robot finished welding and fume extractor should stop.

Part II

Using the product

5 | Overview of the SmoothTool UR-Cap

This chapter aims to provide an overview of how to use the SmoothTool software. To get started, insert a SmoothTool node:

- On CB-series: Go to *Robot Program* → *Structure* → *URCaps* → *SmoothTool*.
- On e-series: SmoothTool can be found under the menu to the left in the program page (see figure 5.1).

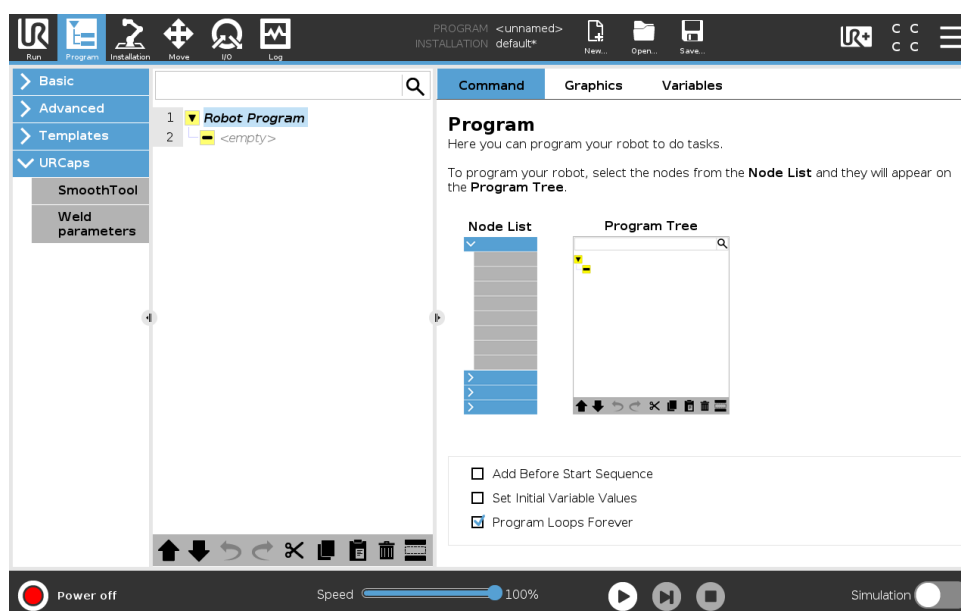


Figure 5.1: View of the programming page on startup.

NOTICE

A Robot Program should only contain a single SmoothTool node. If multiple work-pieces are to be welded in a single program, they should all be added to the same SmoothTool node as different Welds.

5.1 SmoothTool program structure

A SmoothTool program has the following structure:

- SmoothTool node, which is the start page of SmoothTool.
- MoveJ - Init_point (Home position).
- One or more Welds. A Weld is an essential concept in SmoothTool that describes how to approach a weld, how to weld it and how to leave it. Welds come under different names (Weld, Pipe, Pass) but the underlying concept is the same. The weld concept is described in detail in section 6.

In between the nodes of the SmoothTool program, the user can optionally add one or more Weld parameters nodes. These nodes are used to specify the weld parameters to use for the welds. See section 5.3.

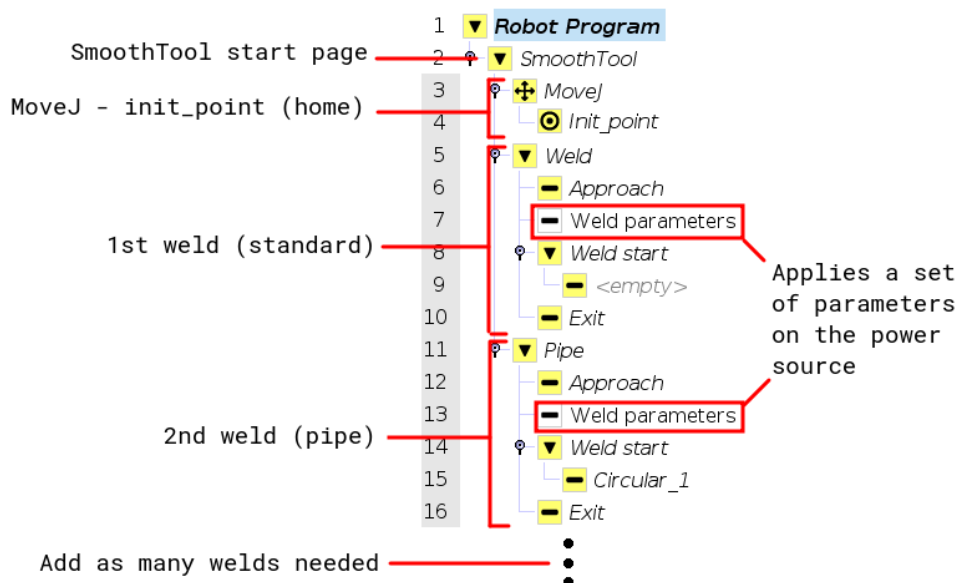


Figure 5.2: General structure of a SmoothTool program

5.1.1 SmoothTool start page

The SmoothTool start page is accessed by tapping the SmoothTool node.

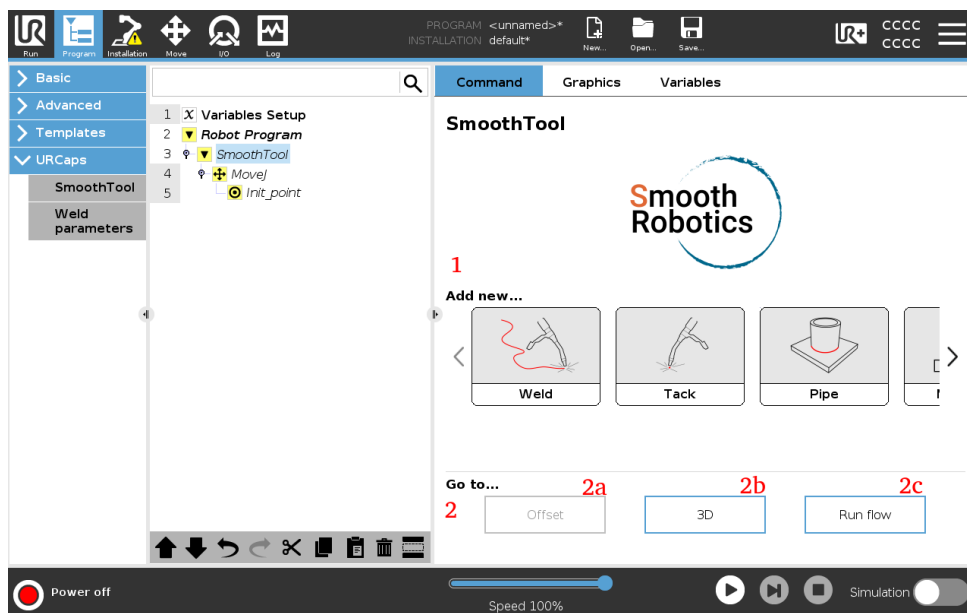


Figure 5.3: The SmoothTool start page.

The functionality of the SmoothTool node illustrated in figure 5.3 is defined as follows:

1. **Add new...** offers templates for creating different types of welds:
 - **Weld:** General purpose welding program template. Usually used for single-pass welds consisting of one or more sequential linear/circular welding segments.

- **Tack:** Creates a new tack node which can be used to tack points on the work-piece. See Chapter 15 for more details.
- **Pipe:** Creates a template for a full-circle pipe weld, but can also be modified to any weld item that contains a pipe.
- **Multipass:** Creates a Multipass template. See Chapter 17.
- **Touch sense:** Creates a new touch sense node to automatically correct the welds that follows. See Chapter 16 for more details.

2. **Go to...** navigates to other sub-pages with essential functionalities:

- Offset:** Offers moving/rotating and/or copying existing weld(s). See chapter ???. Please note that this feature is only active when all points in all welds are set.
- 3D:** Opens the 3D universe of SmoothTool, where all active welds are visualized in 3D. It is also possible to make small adjustments directly from the 3D universe. See chapter 12.
- Run flow:** Control the program execution flow, see more in section 5.2.

5.1.2 MoveJ - Init_point

The *MoveJ - Init_point* functions as the initial point in the program, which is a safe home position for the robot. This is the point where the program starts, and the robot should from there be able to move safely to whatever comes next (usually the approach point of the first active weld).

To define the point, tap *Init_point* in the program tree, and click the *Set Waypoint* button (see figure 5.4).

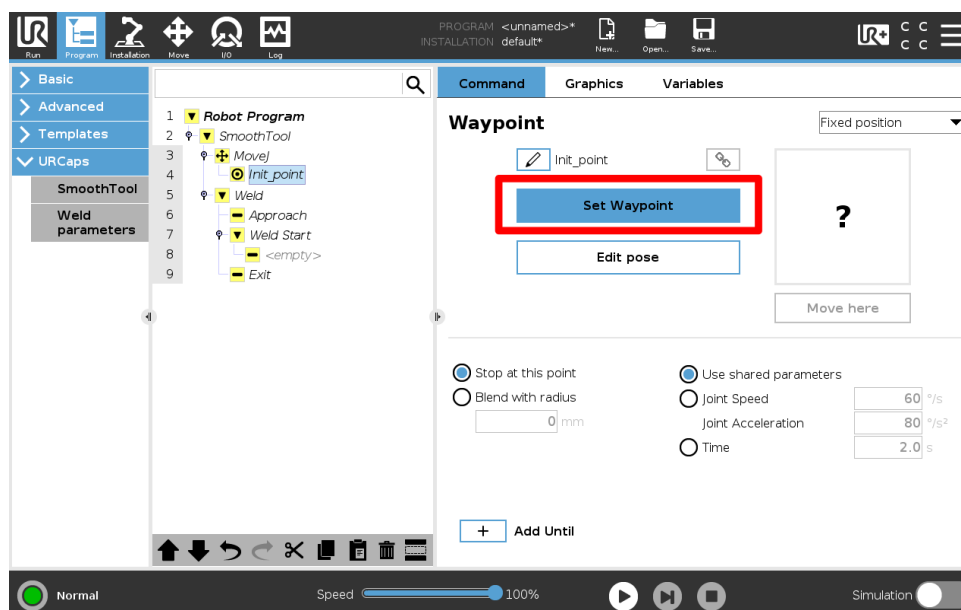


Figure 5.4: The Init_point page.

5.2 Run flow

Run flow provides some shortcuts to change the program execution behaviour.

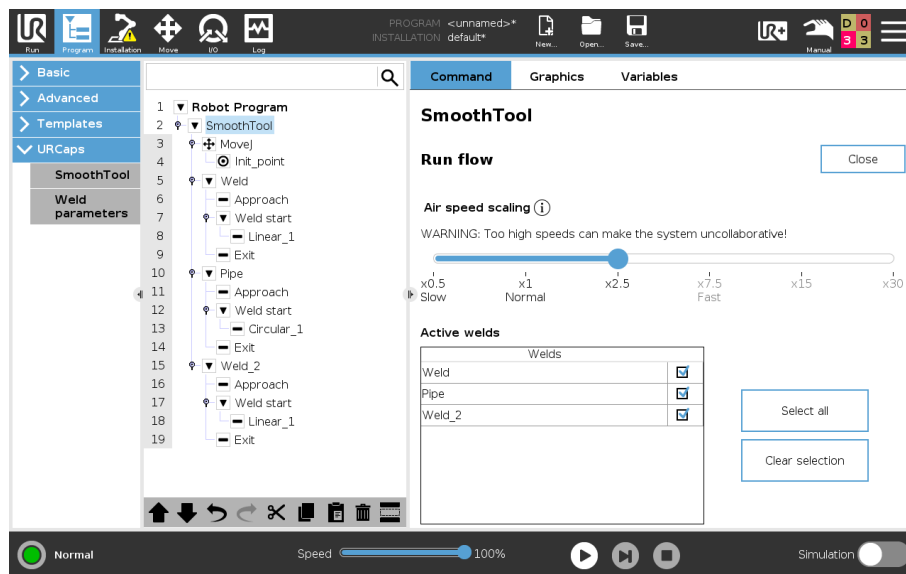


Figure 5.5: Run flow page.

Identifier:	Description:
Air speed scaling	NOTICE: See warning 5.2 before using this feature. This slider applies a scaling factor on all air movements in the program. It is a shortcut to improve the cycle time, without affecting the welding. The speed slider limit can be adjusted in <i>Installation -> SmoothTool configuration -> Settings</i> .
Active welds	This table provides an overview of the welds in the program. Unselected welds will be skipped during the program execution. They will not appear in the 3D universe either.

Table 5.1: Description of run flow functionalities

WARNING 5.2



Increasing the speed will also raise the potential damage in case of a failure.
Please ensure that the robot's safety speed limits are configured properly using UR's safety speed limits before utilizing this feature.

5.3 Weld Parameters

The *Weld parameters* node can be added anywhere in the program tree the same way the *SmoothTool* node is added. However, it is recommended to place weld parameters within welds. The program can contain any number of these nodes.

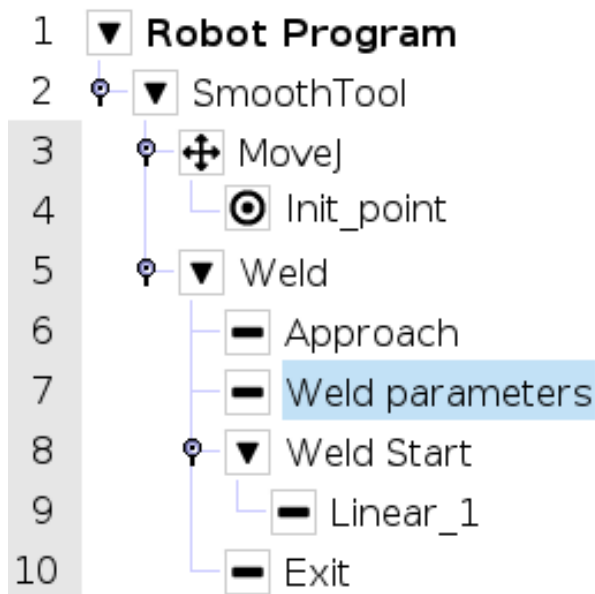


Figure 5.6: In this example, a *Weld parameters* node has been inserted in a weld right before welding starts.

The *Weld parameters* node contains the parameters supported by the installed power source if it is one of the preconfigured power sources. Once the program reaches the node, the parameters will be applied to the power source and the welds that follow will be welded with these parameters.

For more information about a specific Weld parameters page, see the manual corresponding to the power source. References are provided in section 4.5.

NOTICE

When a preconfigured power source is active and the *Weld parameters* node is added, the actual node will automatically be named according to the power source brand, e.g., if Fronius 320i is active, the *Weld parameters* node in the tree will be named *Fronius*. If no power source is active or if it is not pre-configured, the *Weld parameters* node can not be used.

5.4 Toolbar

NOTICE

The toolbar is only available on the Universal Robot e-series. CB-series users can find the toolbar functionality in the Welding configuration or Weld parameters pages.

To show or hide the toolbar, press the UR+ icon in the top right corner of the screen (see figure 5.7). The toolbar can be accessed from anywhere when programming the robot.

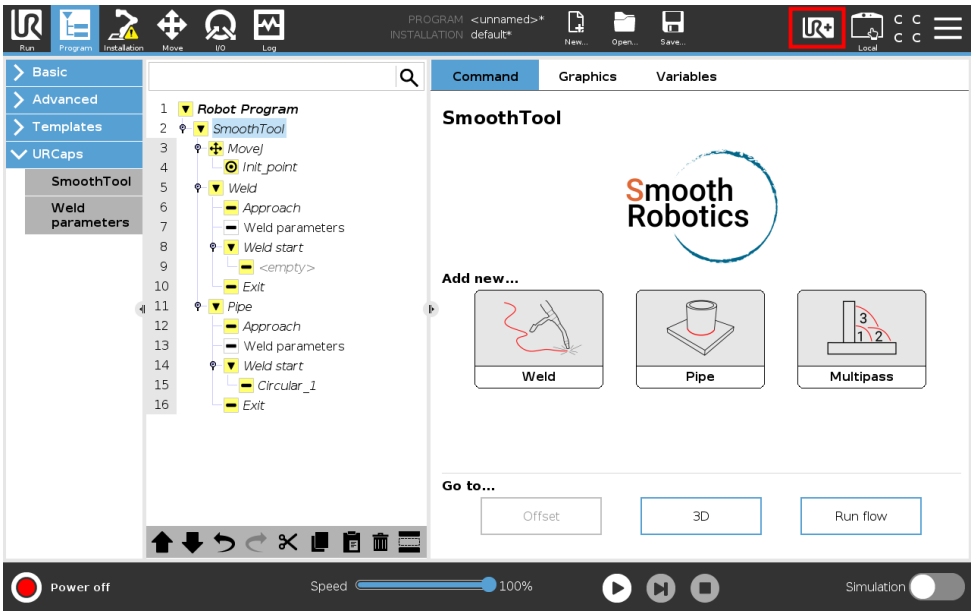


Figure 5.7: Highlight of the UR+ button.

The Toolbar offers quick access to a number of power source related control options. Depending on the active power source, the Toolbar may change behavior, appearance and options offered.

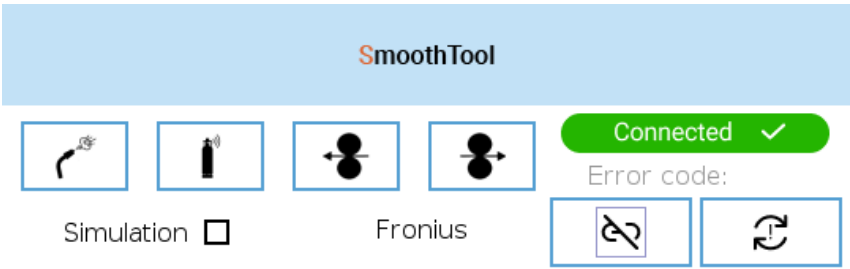


Figure 5.8: In this example of the toolbar, the Fronius integration is active and connected.

Identifier:	Description:
	Air blow: If enabled and setup on the power source, the button will pulse the valve to let pressurized air run through the torch, thereby cleaning it.

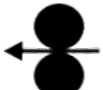
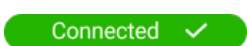
	Gas test: If enabled, the button will turn on the gas for a preset amount of time depending on the power source.
	Wire retract: If enabled, the button will start reversing the wire.
	Wire inch: If enabled, the button will start inching the wire.
Simulation checkbox	The checkbox determines if simulation is used. The checkbox will also send the state to the power source if connected.
Active welding configuration	Reflects that actual active welding configuration.
	Describes the connection to the activated power source. Connected.
	Describes the connection to the activated power source. Disconnected.
	Connect: If visible and enabled, will try to connect to the active power source using the IP defined on the installation page.
	Disconnect: If visible and enabled, will disconnect the active power source.
	Error reset: If visible and enabled, will send a reset error signal to the active power source.
	If shown an error has occurred on the power source please consult the specific power source manual for more information on the shown error. This may be reset using the error reset.

Table 5.2: Description of the icons in the toolbar

WARNING



When connected to a power source that provides the option to control the wire: Do not use the functions without ensuring no harm can come to people or material. Make sure the area around the welding torch is clear before use.

5.5 Using the SmoothTool Programming Flange

The SmoothTool Programming Flange is a tool that allows the operator to teach the welding path on the fly. It provides an alternative way of constructing the welding program. When the flange is installed correctly and the robot is in Normal mode i.e., ready to move, the freedrive button (black button on the back) will be ready to use. Push the black button on the back of the flange (see figure 5.9) and the freedrive will be activated, i.e., the robot will move when pushed or pulled.

Circular button

Short press: Create new circular segment.
Long press: Delete previous segment.

Linear button

Short press: Create new linear segment.
Long press: Jump to next mode.

Freedrive

Activate freedrive which allows the robot to be pulled around.

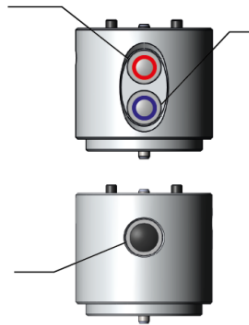


Figure 5.9: SmoothTool Programming Flange front (upper part) and back (lower part).

6 | Welds

A Weld (and its children) is a description of the path, which the robot must follow, to create a single weld. Create a weld by tapping *Weld* in the SmoothTool start page, see Figure 5.3.

A Weld consists of the following nodes:

- **Weld node:** The weld node contains overall settings for the weld.
- **Approach node(s):** One or more nodes describing how to approach the weld.
- **Weld start node:** The point where the welding starts.
- **Weld path:** One or more nodes describing the actual welding path.
- **Exit node(s):** One or more nodes describing how to leave the weld once done.

6.1 Creating a weld using only the flange

Navigate to the How-to page of the Weld node (in the programming tree) that should be programmed (see figure 6.1). The flange can be in one of four states:

1. Setting Approach points
2. Setting the Weld start point
3. Building the welding path
4. Setting Exit points

The boxes on this page illustrate the states highlighting the active one (see figure 6.1). In order to jump to next state, make a long press on the blue button. Alternatively, tap one of the boxes to go to that state.

In all states, a short press of the blue button will set a linear point. A long press of the red button will delete the last node. Additionally, when in the Weld path state, a short press of the red button will record the via point of a circular segment. Another short press of the red button sets the end point and creates the circular segment in the program tree.

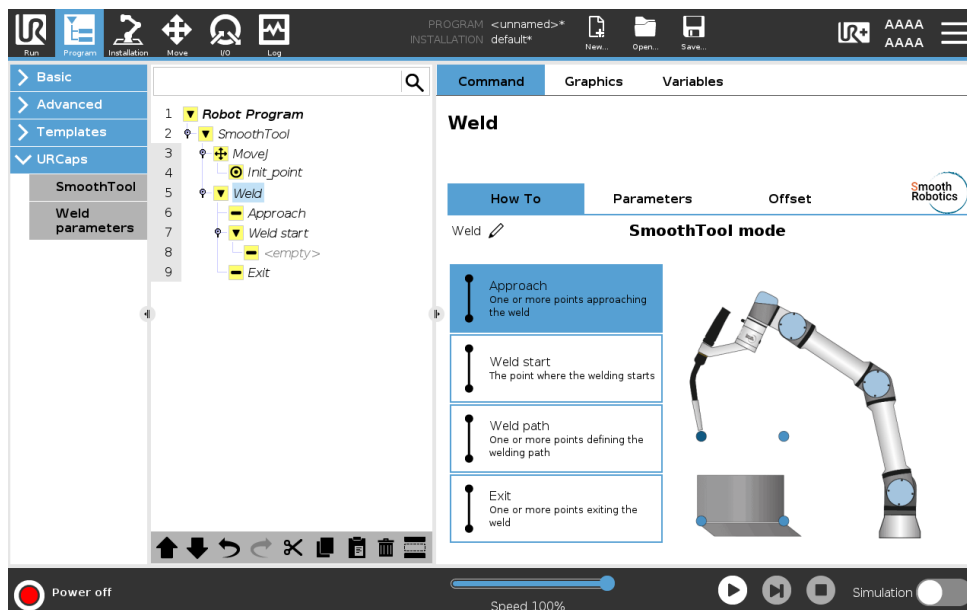


Figure 6.1: The weld How-to page

6.2 Description of the Weld node

On the Weld node page, there are 3 tabs: *How-To*, *Parameters* and *Points*.

How-To shows 4 simple steps that sum up how the weld is supposed to be built. Have in mind that many linear segments, air points and circular segments can be added within a single *Weld Start*. By tapping the pen icon (✎), it is possible to customize the name of the Weld.

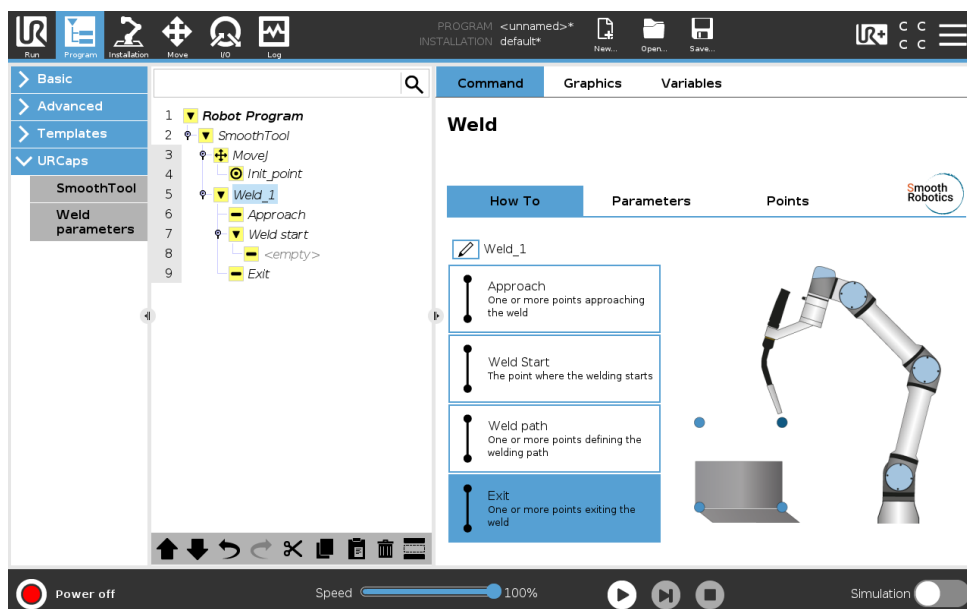


Figure 6.2: The How To tab of the Weld node

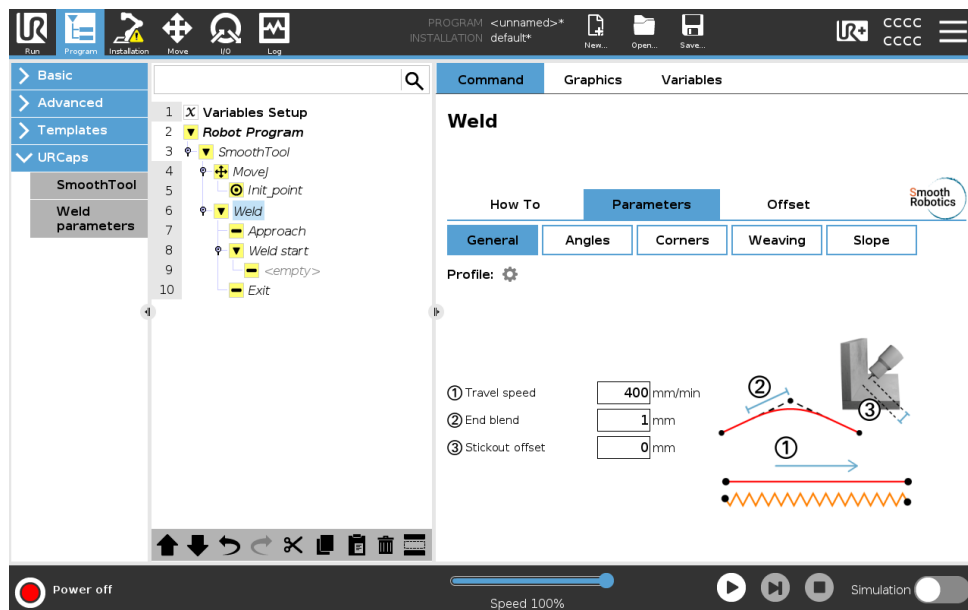


Figure 6.3: The Parameters tab of the Weld node

The *Parameters* tab (see figure 6.3) contains the shared parameters that will be used in this weld unless the parameters have been overridden in specific segments. The parameters are contained in the following sub-tabs:

- **General:** Travel speed and end blend parameters, see table below.
- **Angles:** Parameters related to the Angle System, which help set and maintain a travel angle and work angle during the weld. By default, the angle system is off. Learn how to use this powerful tool in Chapter 8.
- **Corners:** Parameters related to automatic corner handling. See chapter 9 for more information.
- **Weaving:** Parameters related to the weaving pattern and stitch. See Chapter 7.
- **Slope:** Parameters related to sloping down at the end of welding. See chapter 10.

The table below provides an explanation of the parameters under the *General* tab.

Identifier:	Description:
Travel Speed	Defines the speed of the TCP in the welding direction [mm/min], i.e. the welding speed. It is worth mentioning that even if a weaving pattern is applied, the robot will still aim to maintain this speed throughout the weld.
End Blend	Smooths out the transition between path segments, allowing the robot to move continuously. This field specifies when to start the smoothing operation. The larger the blend value is, the smoother the curve will become. If the specified blend is too large to be executed, the underlying <i>Automatic blend reduction</i> -system will catch it and reduce it to the largest possible value to execute. See section ?? for more information.
Stickout offset	The length of how much the stickout should be offset from the point that has been set in [mm]. The stickout offset can be negative and positive values.

The last tab in the *Weld* node is the *Offset*. See section ?? for more information.

6.3 Description of the sub-nodes

6.3.1 Approach

A weld must have one or more *Approach* points describing the path which the robot should follow to reach the *Weld Start* point.

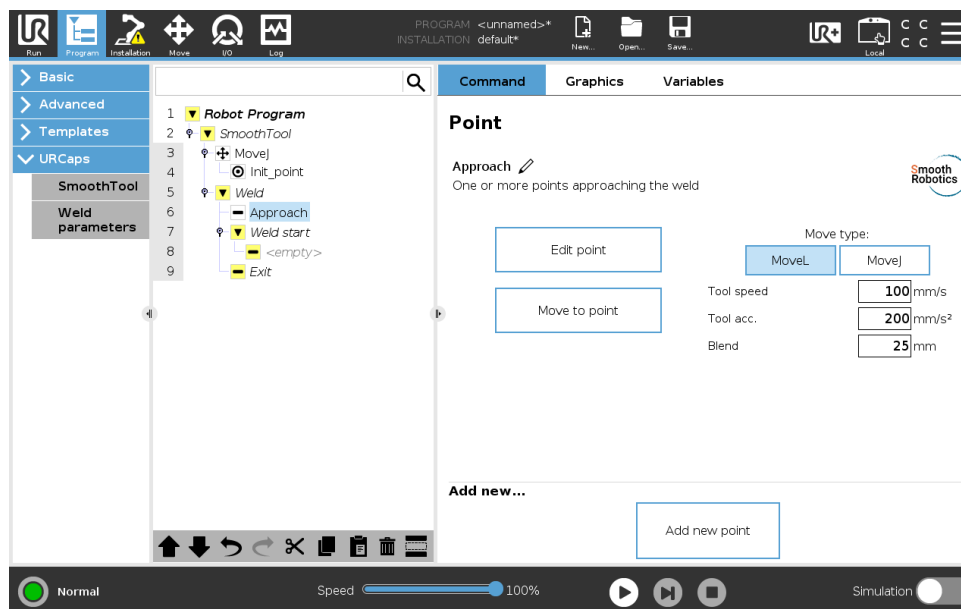


Figure 6.4: The Approach point page.

Identifier:	Description:
Set point/Edit point	Sets the point either by using the controls on the teach pendant or using the freedrive functionality. Freedrive can be activated either by pressing the black button on the SmoothTool Programming Flange or by pressing the freedrive button on the back of the teach pendant.
Move to point	Moves the robot to the point set for the node.
Add new point	Adds an <i>Approach</i> point in the program tree below the selected point.
MoveL/MoveJ	MoveL moves the TCP linearly between waypoints. MoveJ makes movements that are calculated in the robot arm joint space. In general, MoveL gives predictable movements but is a bit slower, whereas MoveJ is faster but may produce unpredictable movements.
Tool Speed	The speed $[mm/s]$ of the TCP if MoveL is selected.
Tool Acceleration	The acceleration of the TCP $[mm/s^2]$ if MoveL is selected.
Blend	Smooths out the transition between path segments, allowing the robot to move continuously. This field specifies when to start the smoothing operation. The larger the blend value is, the smoother the curve will become. If the specified blend is too large to be executed, the underlying <i>Automatic blend reduction</i> -system will catch it and reduce it to the largest possible value to execute. See section ?? for more information.
Joint speed	The speed of the joints $[^\circ/s]$ if MoveJ is selected.
Joint acceleration	The acceleration of the joints $[^\circ/s^2]$ if MoveJ is selected.

6.3.2 Weld Start

Weld Start is the start point of your welding path. When the robot reaches this point, it will turn on the welding arc.

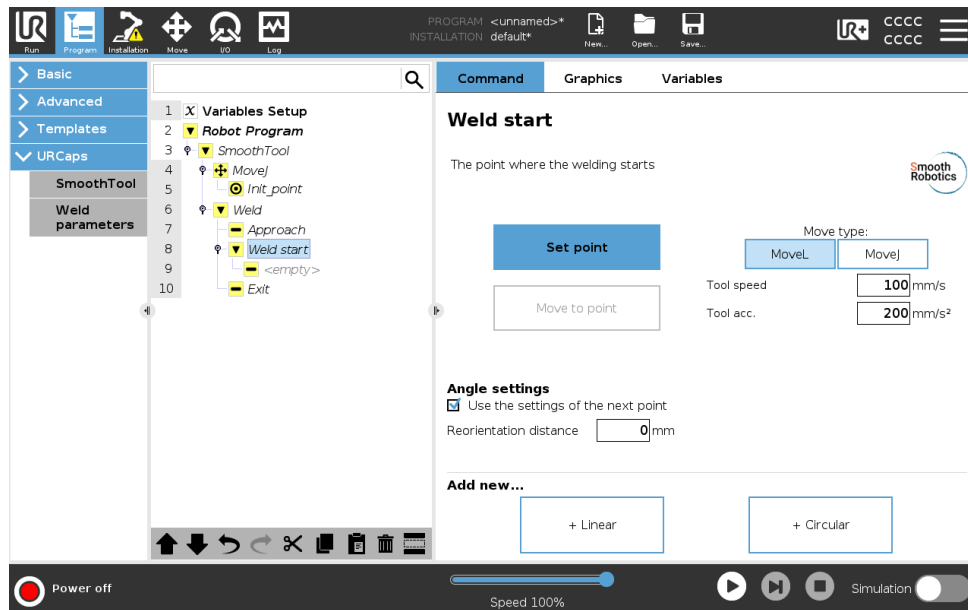


Figure 6.5: The Weld start page.

Identifier:	Description:
+ Linear	Adds a new linear segment under <i>Weld Start</i> in the program tree.
+ Circular	Adds a new circular segment under <i>Weld Start</i> in the program tree.

For a description of the rest of the *Weld start*-nodes parameters and buttons, see previous section 6.3.1.

6.3.3 Line segment

A linear segment describes a linear sub-part of the weld.

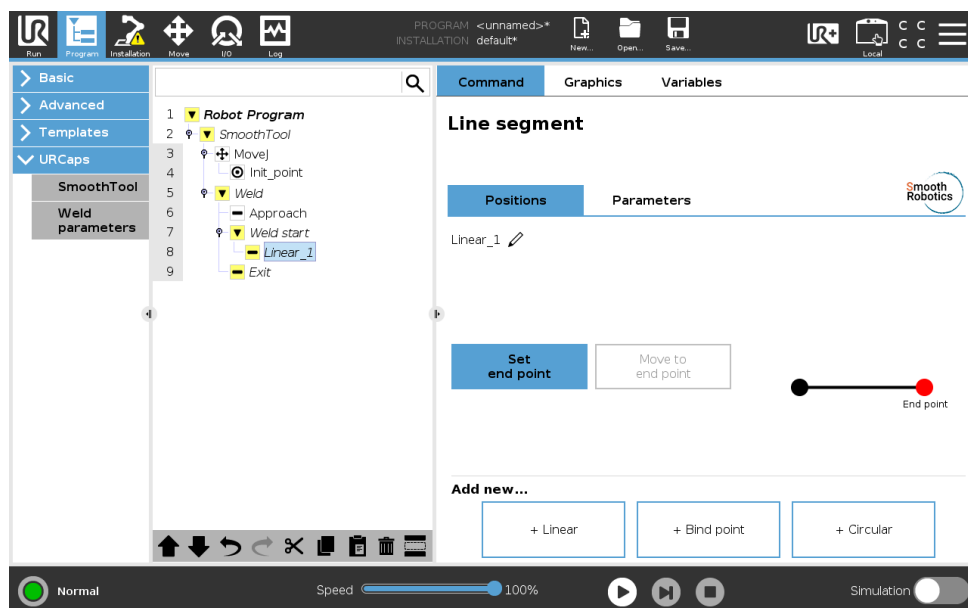


Figure 6.6: The Linear segment page.

A linear segment is simply configured by defining its end point using the *Set end point* button.

The *Parameters* tab contains the same parameters as those mentioned earlier in section 6. However, parameters applied on this level, will only apply on this segment.

The "+"-buttons at the bottom of the page add new segments in the program tree, right below the selected node. The Air points and Circular segments are described in the following sections.

6.3.4 Circular segment

A circular segment describes a circular sub-part of the weld.

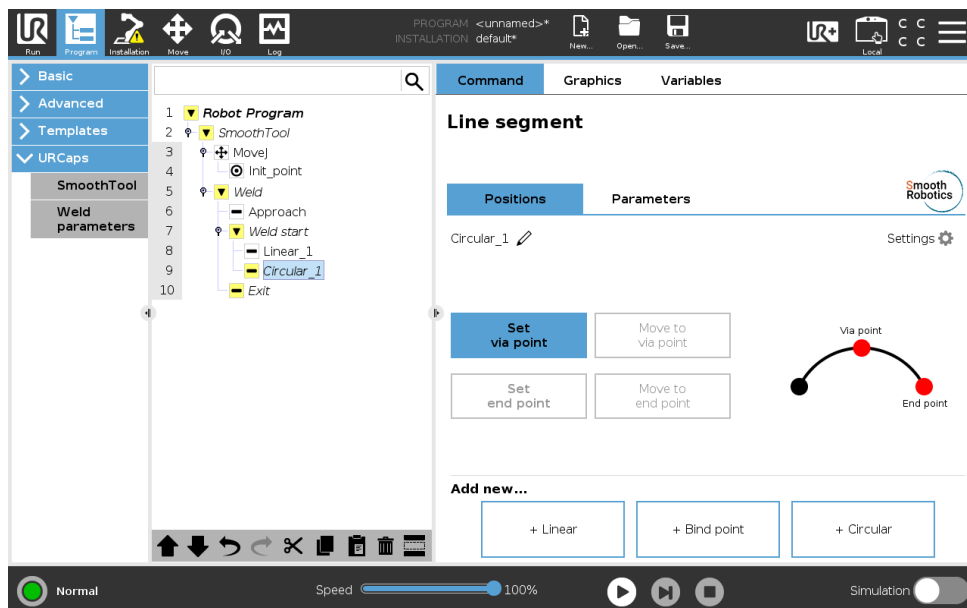


Figure 6.7: The Circular segment page

A circular segment is simply configured by defining its via and end points using the *Set via point* and *set end point* buttons.

It is possible to extend or trim the circular segment to an exact angle, by entering the angle in the (Settings ⚙️) page.

6.3.5 Air Point

Air points are used to connect the path without welding, i.e. to reorient the welding gun or move it to another location on the work piece.

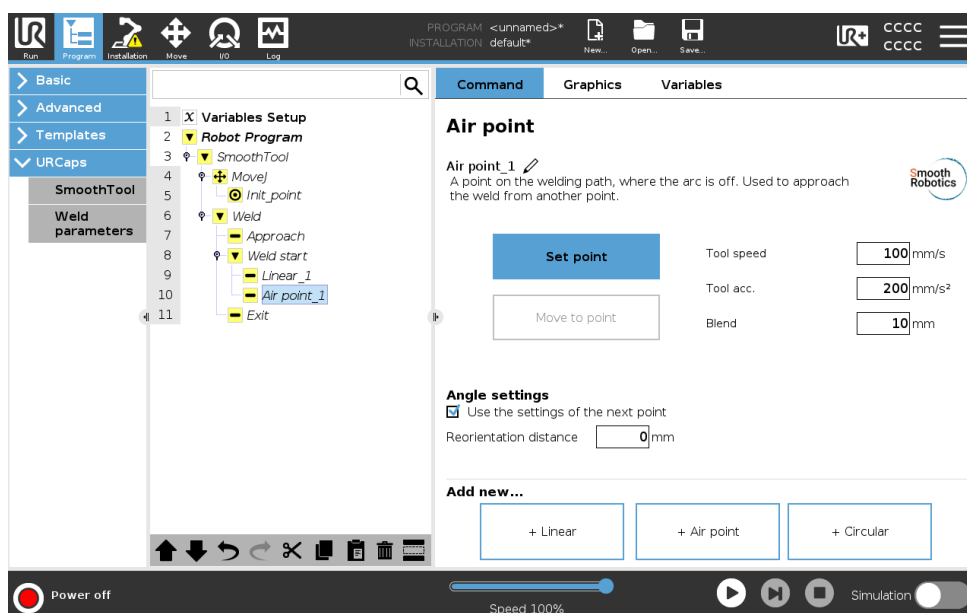


Figure 6.8: The Air point page.

6.3.6 Exit

A weld must have one or more *Exit* points describing the path which the robot should follow when leaving the work piece. It is recommended to set the last *Exit* point near the *Approach* of the next *Weld*.

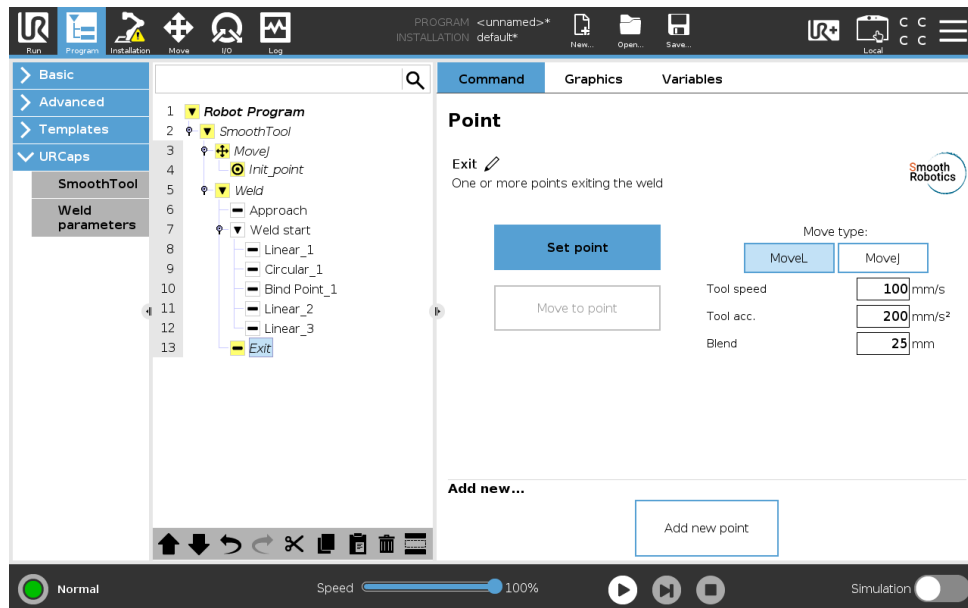


Figure 6.9: The Exit node page.

7 | Weaving and stitch

Weaving and Stitch can be applied on either a linear or circular segment (see subsections 6.3.3 and 6.3.4 for more information about these segments). It is also possible to combine them together. In order to use the features, create a linear or circular segment and activate the desired features in their respective tab. The visible parameters on the weaving and stitch tabs are explained in subsections 7.2 and 7.3. If weaving and stitch are turned off, the produced weld will be a standard single seam weld.

7.1 Configure weaving

SmoothTool has six different weaving patterns described in the following sections. By default only three of the six weaving patterns are visible on the weaving parameter page. In order to enable the other weaving patterns use the *Configure* page, by clicking the *Configure*  button.

7.2 Weaving

7.2.1 Zig zag

Zig Zag is a flexible general purpose weaving pattern that can be used for normal weaving, as well as hard-facing / cladding and PF-welding.

Identifier:	Description:
Shared parameters 	Locked: Use shared parameters for this weld on this weld. Unlocked: Specify specific parameters for this segment.
1: Amplitude	The height of a weave period peak [mm].
2: Period	The period of the periodic weave pattern [mm].
3: Angle	The angle at the center point, meaning if the angle is 180° the weave will be leveled. If the angle is eg. 90° the peak and the bottom points elevate corresponding to the angle at the center of the weave. Changing this angle from 180° is mostly done when PF welding and the angle should be 180° when welding normally.
4: Dwell left	The time spent in the left weave period peak [s].
5: Dwell center	The time spent in the center of the weave [s].
6: Dwell right	The time spent in the right weave period bottom [s].

7.2.2 Crescent

Identifier:	Description:
Shared parameters 	Locked: Use shared parameters for this weld on this weld. Unlocked: Specify specific parameters for this segment.
1: Amplitude	The height of a weave period peak $[mm]$.
2: Period	The period of the periodic weave pattern $[mm]$.
3: Arc depth	This parameter determines the shape of the pattern. If set to 0, the resulting pattern will effectively be zig zag. If set to a positive value, the pattern will curve forward relative to the welding direction. If set to a negative value, the pattern will curve backwards relative to the welding direction. The parameter is a percentage, and all values from -100 to 100 are possible.
4: Dwell left	The time spent in the left weave period peak $[s]$.
5: Dwell right	The time spent in the right weave period bottom $[s]$.

7.2.3 Circles

Identifier:	Description:
Shared parameters 	Use the shared parameters defined under the weld node in the program tree (see subsection 6).
1: Amplitude	The height of a weave period peak $[mm]$.
2: Period	The distance between the loops $[mm]$.
3: Width	The width of a single loop $[mm]$.
4: Orientation	This parameter determines if the pattern is oriented left or right.

7.2.4 Trapezoid

NOTICE

The Trapezoid pattern is hard to use and made obsolete by the Crescent pattern. We recommend using that instead.

Identifier:	Description:
Shared parameters 	Locked: Use shared parameters for this weld on this weld. Unlocked: Specify specific parameters for this segment.
1: Frequency	The number of weave periods per second $[Hz]$.
2: Amplitude	The height of a weave period peak $[mm]$.
3: Dwell left	The time spent in the left weave period peak $[s]$.
4: Dwell right	The time spent in the right weave period bottom $[s]$.
5: Blend	The blend radius at the corners of the zigzag-pattern $[mm]$. If not 0, the weaving pattern will be smoothed out at the corners allowing the robot to move continuously. This distance specifies the start of the smoothing operation. Using a non-zero blend can result in the actual travel speed being different than the specified value!

7.2.5 Back and forth

Identifier:	Description:
Shared parameters 	Locked: Use shared parameters for this weld on this weld. Unlocked: Specify specific parameters for this segment
1: Step forward	The length of the step forward [mm].
2: Step backward	The length of the step backward [mm].
3: Dwell	The time spent after the step forward [s].

7.3 Stitch

Identifier:	Description:
Shared parameters 	Use the shared parameters defined under the weld node in the program tree (see subsection 6).
Weld end	Determines if the last part of the path should be welded or not.
Manual separation	If Manual separation is disabled the weld uses <i>Number of welds</i> as seen in figure ???. If it is enabled it uses <i>Separation</i> as seen in figure ??.
Start offset	If this value is larger than 0, an air movement with this length will be inserted at the beginning of the stitch pattern. This is often used when welding both sides of an object, where the weld of the second side has a start offset to avoid the welds from being in the same positions. To calculate the start offset of the second side: $(weldlength + separation)/2$.
Weld length	The length of each weld segment [mm].
Number of welds	The number of weld segments between the start and end points.
Separation	The distance between each weld segment [mm].
Air speed	The speed between the air points in [mm/s].
Retraction	The length the TCP retracts from the object after a weld in [mm].
Allow merge	If allow merge is enabled, all the linear and circular segments are merged into one, and the stitch parameters will be applied as if it was one segment. If allow merge is disabled, the parameters will be applied to each of the segments in the weld.

8 | Managing torch angles

Identifier:	Description:
Use angles	If checked, the angle system is enabled and the torch orientations in the welding path will be modified. If not checked, the angle system is disabled, and the robot will use the manually defined torch orientations.
Side	The side parameter should be set to either left or right, depending on if the torch should be on the left or right side of the weld, relative to the welding direction.
Work	The work angle defines how much the torch should be angled relative to the horizontal in the selected plane.
Travel	The travel angle defines how the torch should be angled relative to the welding direction.
Plane	The z-axis of the selected plane defines which direction is considered up, and thus influences all the coordinates. By default, the plane is set to Base, which should be appropriate as long as the welding item lies in a plane parallel to the robots base plane. If the default plane is not appropriate, a new plane must be defined in the robots installation, after which it can be selected in the drop down menu.

9 | Handling corners automatically

NOTICE

The angle system must be enabled for the corner system to be available.

NOTICE

The corner system is intended to be used for weld items with sharp corners. If the corners are rounded, the corner system will not perform optimally.

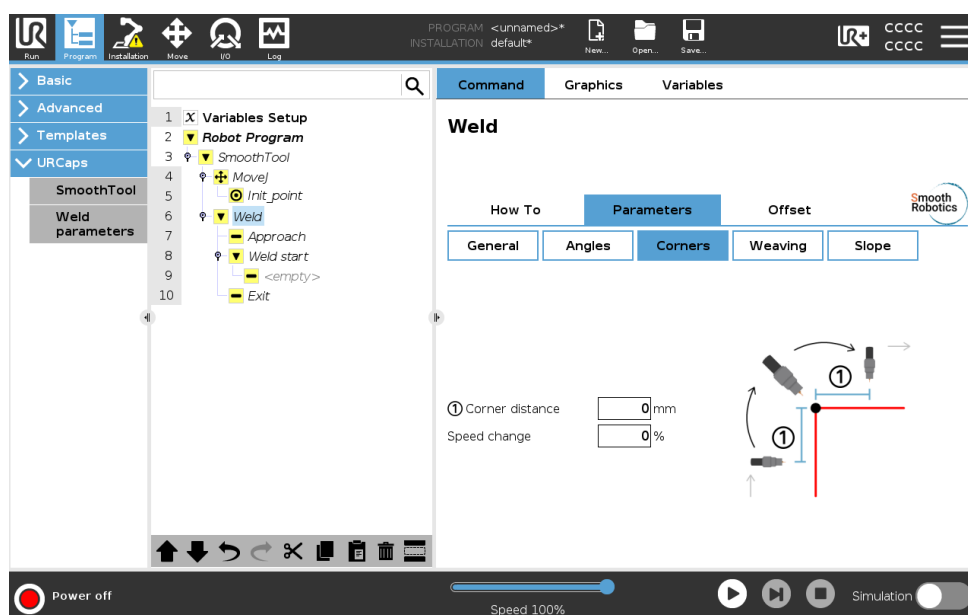


Figure 9.1: The corners page.

Identifier:	Description:
Corner distance	This parameter defines the distance before and after the corner that the robot can use for reorienting the torch. Larger values give a slower reorientation. A value of 0 means that the corner system is turned off.
Speed change	This parameter can be used to slow or increase the travel speed in the corner by some percentage if this is required to achieve a higher quality weld.

10 | Slope down at the end of welding

10.1 Introduction to slope

The slope parameters are used to control the robot's behaviour right before it finishes a weld. There are two parameters which can be configured in the slope parameters, *Time* and *Type*.

10.2 Explanation of the parameters

- Time
 - The time parameter is usually configured to match the slope down time of the power source. The robot will send arc off signal X seconds before it reaches the end destination.
- Type - There are two types *No Weaving - sudden stop* and *Continue weaving*.
 - If *No Weaving - sudden stop* is enabled the weaving will stop while the slope down is happening see figure 10.1.
 - If *Continue weaving* is enabled weaving will continue while the slope down is happening see figure 10.2.

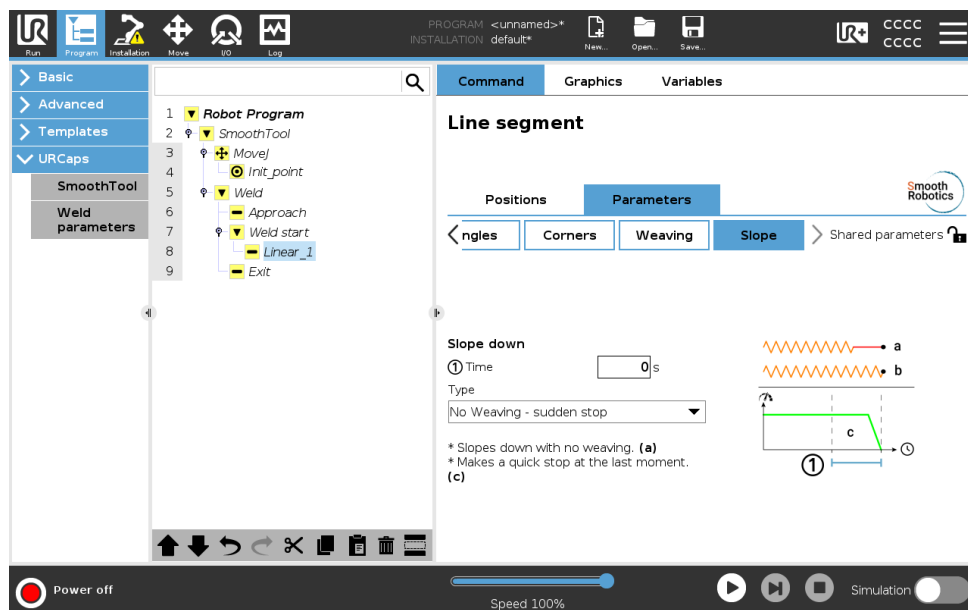


Figure 10.1: The slope parameters no weaving

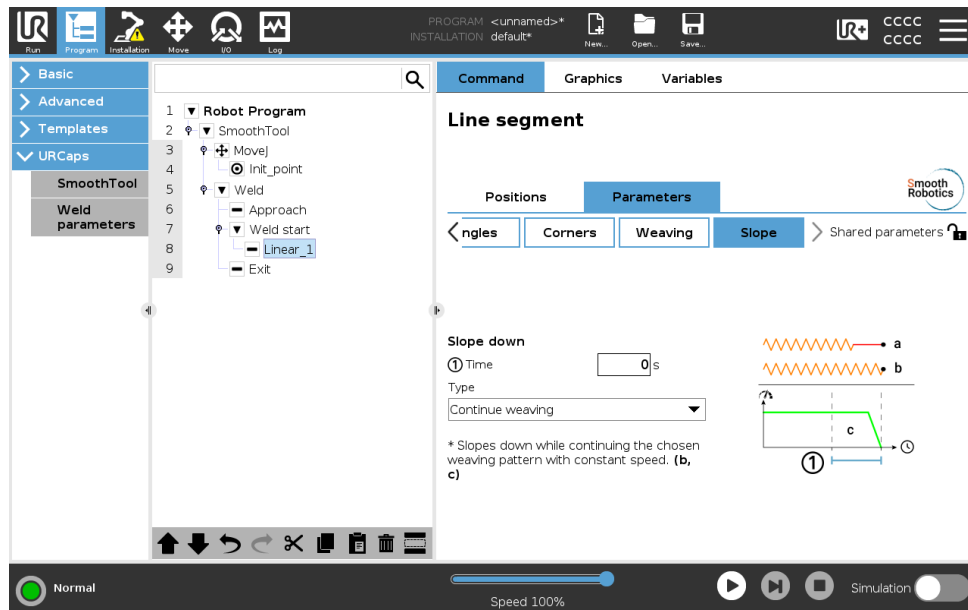


Figure 10.2: The slope parameters with weaving

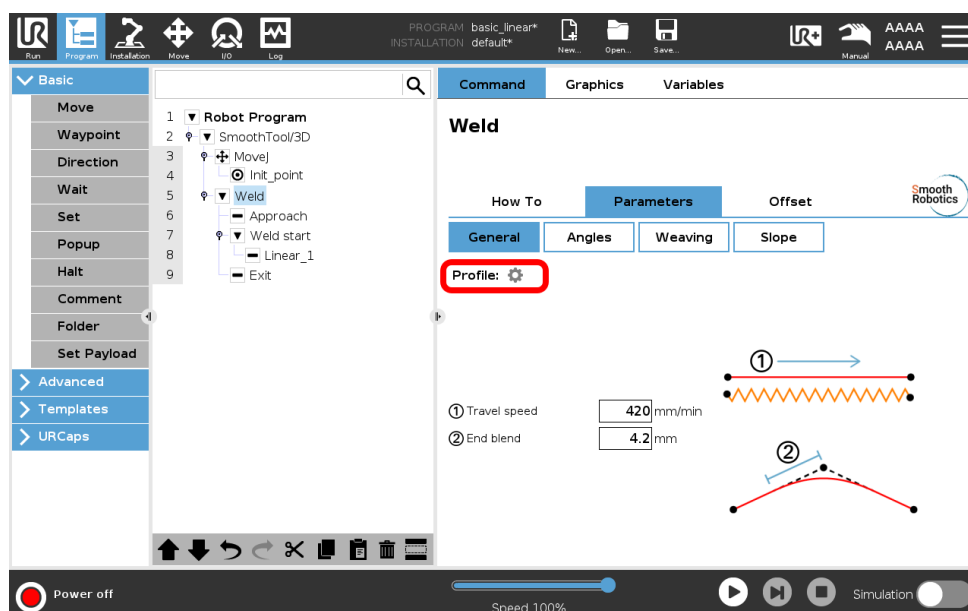
11 | Saving and using Weld settings

11.1 Introduction to weld profiles

Weld profiles allow saving the weld parameters and using them on new or old welds. Weld profiles ensure that the welds using the same profile will have the same parameters. The next sections will explain how weld profiles can be utilized.

11.2 Making and using weld profiles

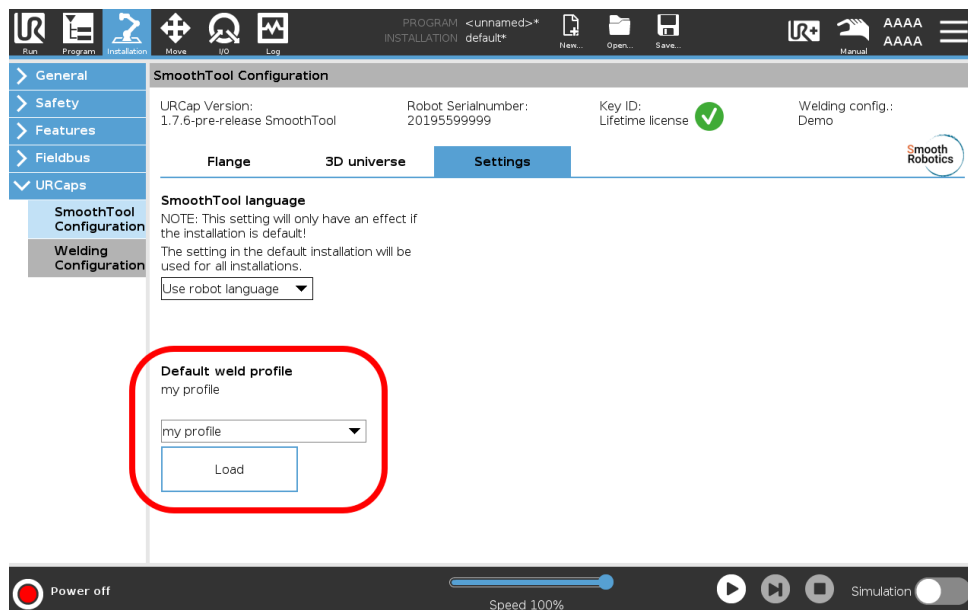
If some optimal Weld node settings (General, Angles, Weaving, Slope, ...) have been found, they can be saved as a profile. Press the profile button to navigate to the profile page:



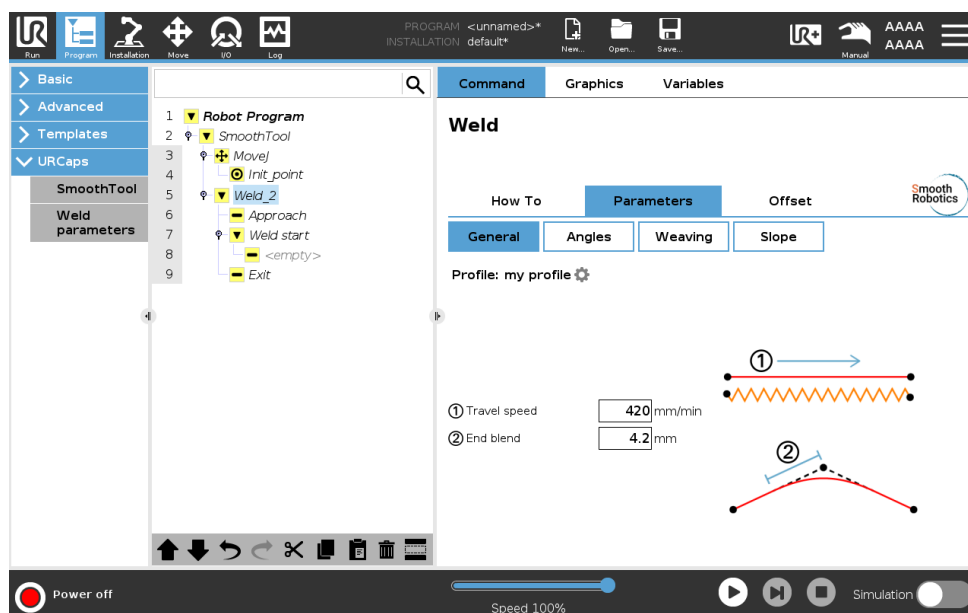
From the profile page, some comments can optionally be made about the profile, and otherwise the profile can be named and saved. When a profile has been saved, it can at any time, even in new programs, be loaded. Navigate to the profile page, select the desired profile in the load drop down, and press the load button. The weld profiles can also be deleted or renamed. To delete or rename press the *Delete/Rename* button.

11.3 Setting a profile as default

In the installation, a profile can be set as the default for that installation. Select the desired profile in the drop down, press the load button and save the installation:



When a profile has been set as default, all new welds (including pipe welds and multipass passes), will start with that profile loaded:



11.4 Detecting changes

If a profile has been loaded and either the profile gets updated or changes are made to the Welds parameters, the software will detect and indicate the change by displaying * next to the profile name.

11.5 Sharing profiles between robots

The weld profiles get saved as special .wprof -files in the weld_profiles folder in the robot's programs folder. This makes it possible to copy profiles and move them from one robot to another. If the robot belongs to an e-series, this can be done by loading the files on to a USB_drive.

12 | 3D universe

The SmoothTool 3D universe produces a visual and tweakable representation of the taught path in a virtual environment.

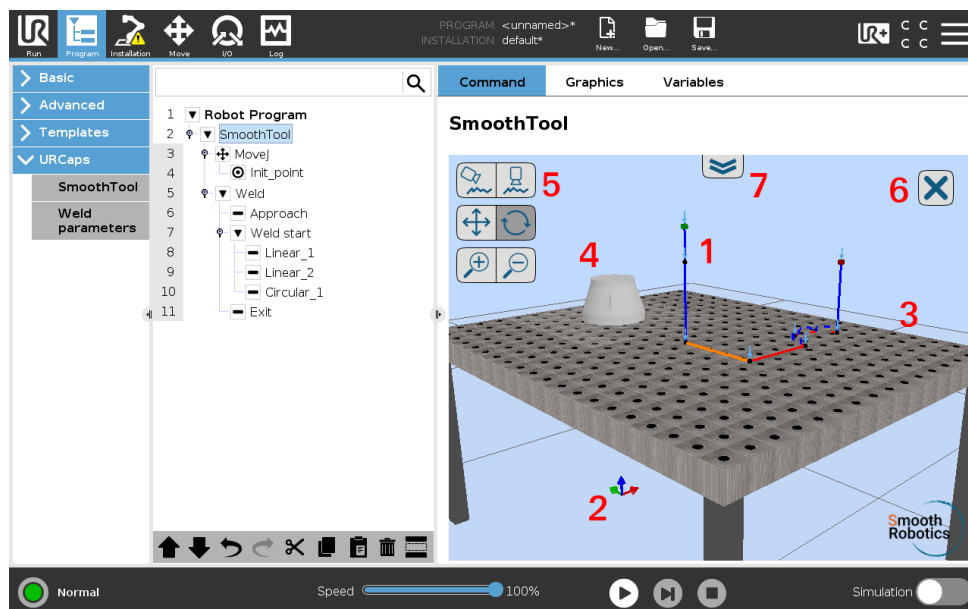


Figure 12.1: The 3D universe.

The 3D universe mainly consists of seven elements (see figure 12.1):

1. Welding path (see section 12.1)
2. World frame
3. Work table
4. Robot base
5. Camera control menu (see section 12.3)

Use this to move the camera and change the view of the scene

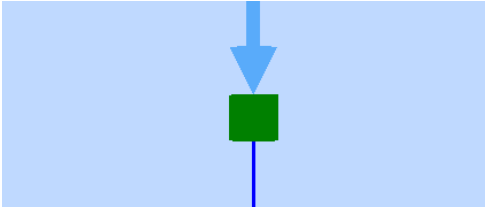
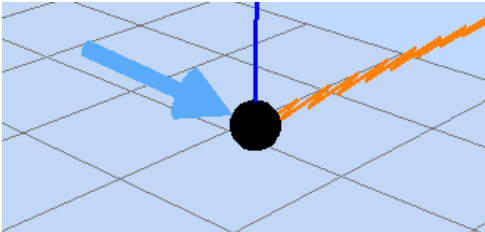
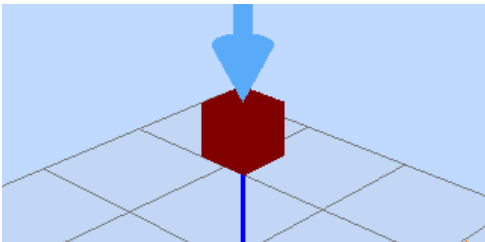
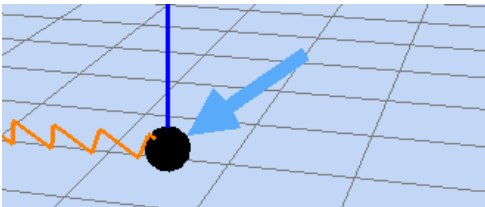
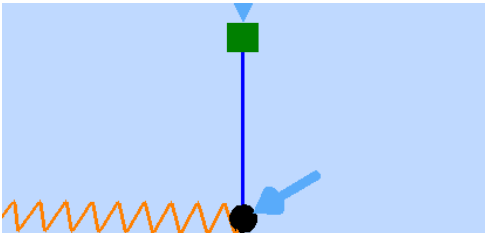
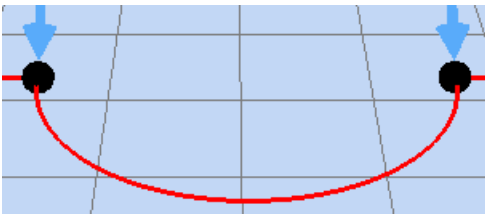
6. Close button

Closes the 3D universe

7. Visibility menu (see section 12.4)

12.1 Welding Path

The welding path is the core of the 3D universe. Table 12.1 explains the illustrated details of the path.

Identifier:	Description:
	The green cube illustrates the first point in the path, usually <i>Init_point</i> .
	The black spheres represent the taught points in the welding path.
	The red cube illustrates the last point in the path, usually <i>Exit</i> .
	The arrows illustrate the orientation of the welding gun.
	The blue lines/arcs represent air movements (Arc off).
	The red lines/arcs represent welding segments (Arc on).

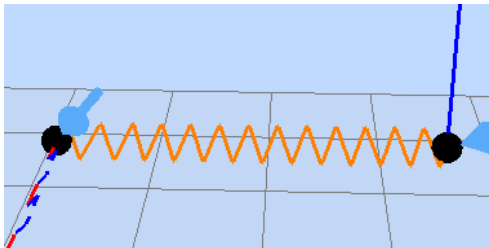
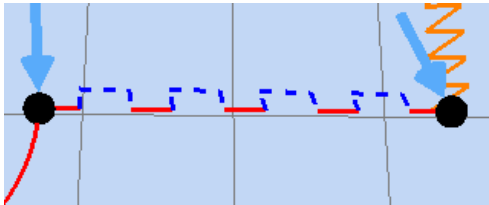
	The orange lines/arcs represent weaving segments (Arc on).
	Stitch segments are represented as either welding or weaving fragments combined with dashed blue lines. The dashed blue lines illustrate the air movements related to the stitch.

Table 12.1: Components of a welding path

The operator can tap the taught points to view the following additional information: Point name, parent weld name, translation (coordinates relative to the robot base), and orientation, see figure 12.2. In order to hide the information, tap anywhere in the 3D universe.

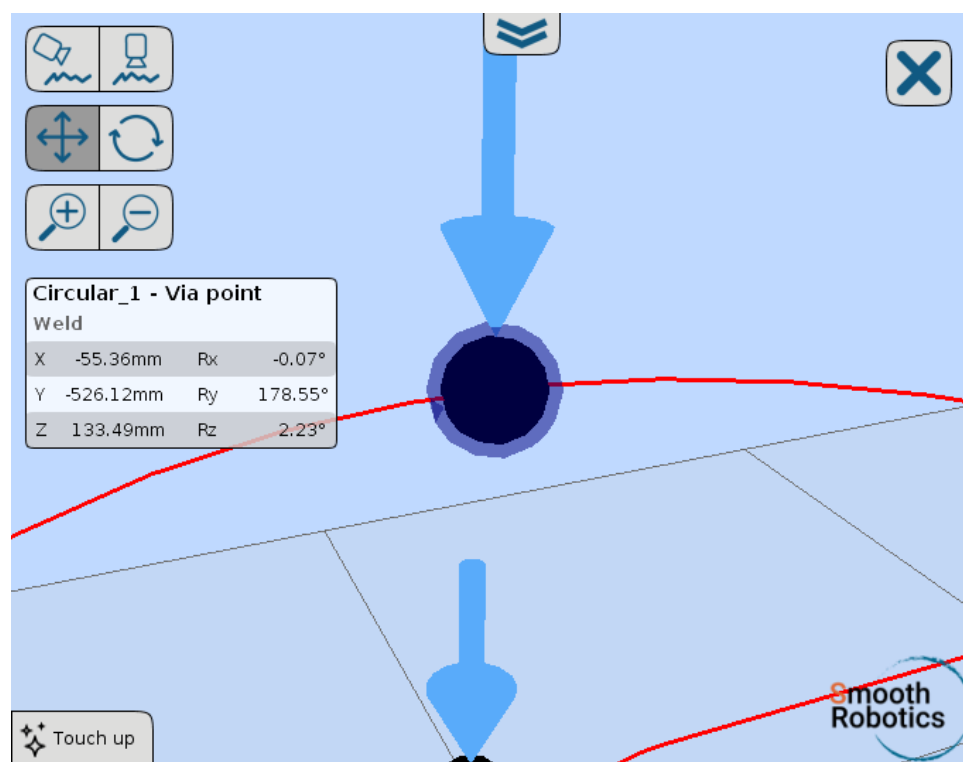


Figure 12.2: A point selected in the 3D universe

12.2 Point tweaking

Regular points (black spheres) can be tweaked directly in the 3D universe. Tap a point, then tap *Touch up* to open the tweaking menu, see Figure 12.3.

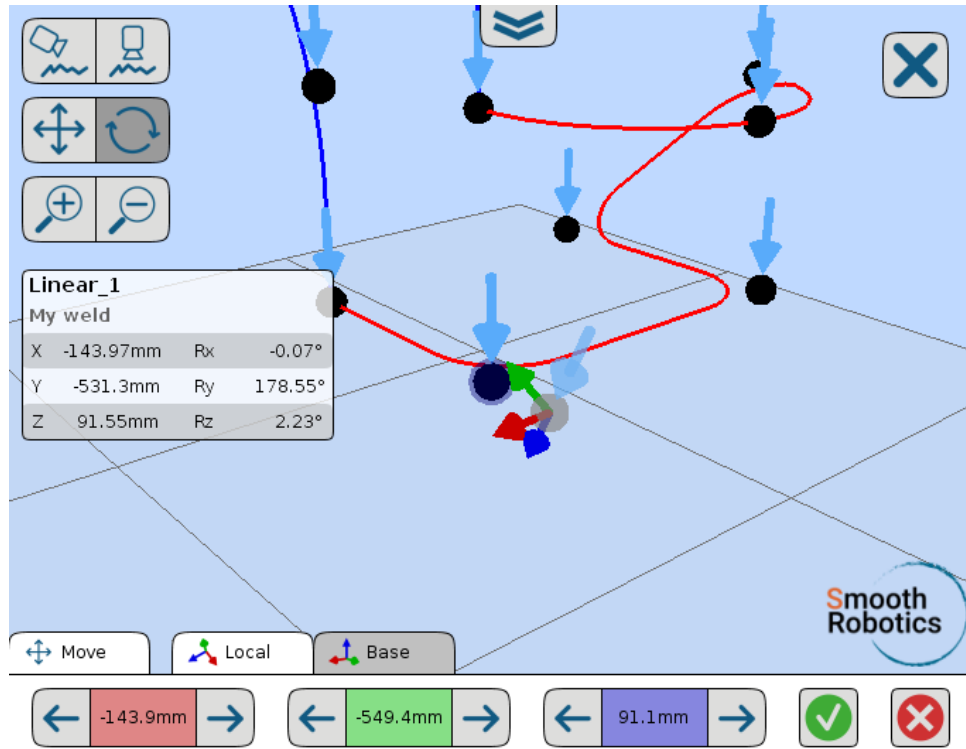


Figure 12.3: 3D universe tweaking menu.

Select *Local* or *Base* to tweak the point relative to itself or relative to the robot base frame. Use the arrows to tweak the point. Changes will be previewed live but not applied until the green checkmark button is tapped. Press the red cross button to discard changes.

12.3 Camera Control Menu

The camera control menu consists of three pairs of buttons.

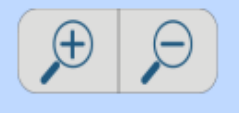
Identifier:	Description:
	The first button pair moves the camera to predefined positions. The left button provides a side view of the path. The right button provides a top view of the path (birds-eye view).
	The second button pair determines how the camera reacts to finger slides. If the left button is active (as shown in the image) a finger slide will translate the view. If the right button is active a finger slide will rotate the view.
	The third and last button pair is used for zooming in and out.

Table 12.2: Components of the Camera control menu

12.4 Visibility Menu

The visibility menu is used to view or hide objects or path-elements in the 3D universe. To open the visibility menu, tap the arrows in the top center of the 3D universe.

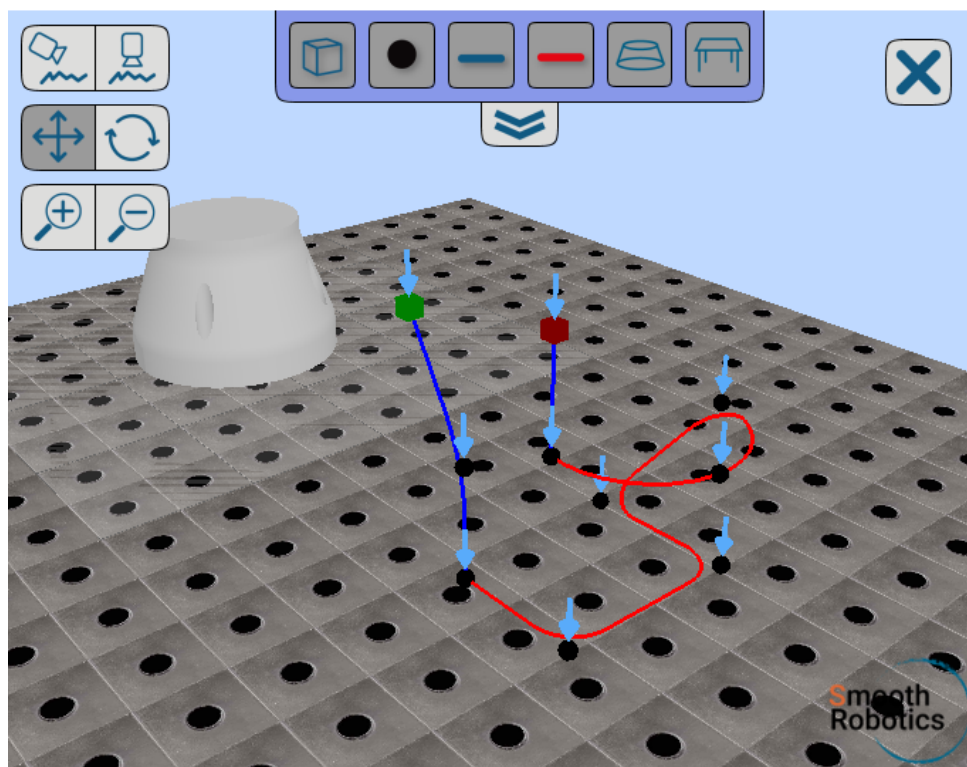


Figure 12.4: The visibility menu in the 3D universe

Identifier:	Description:
	Toggles the visibility of the first and last points.
	Toggles the visibility of the points in the path.
	Toggles the visibility of air movements.
	Toggles the visibility of all welding segments.
	Toggles the visibility of the robot base.
	Toggles the visibility of the work table. If the work table is not enabled or not configured in the SmoothTool configuration page, this button will be disabled.

Table 12.3: Components of the visibility menu

13 | Start from anywhere in the program

The *Start here* feature allows for picking a point in the 3D viewer and making it the new start point of the program. In order to use the *Start here* feature on a weld, click the 3D button in the *SmoothTool* node, click on the point which needs to be the new start point and press *Start here*, see figure 13.1.

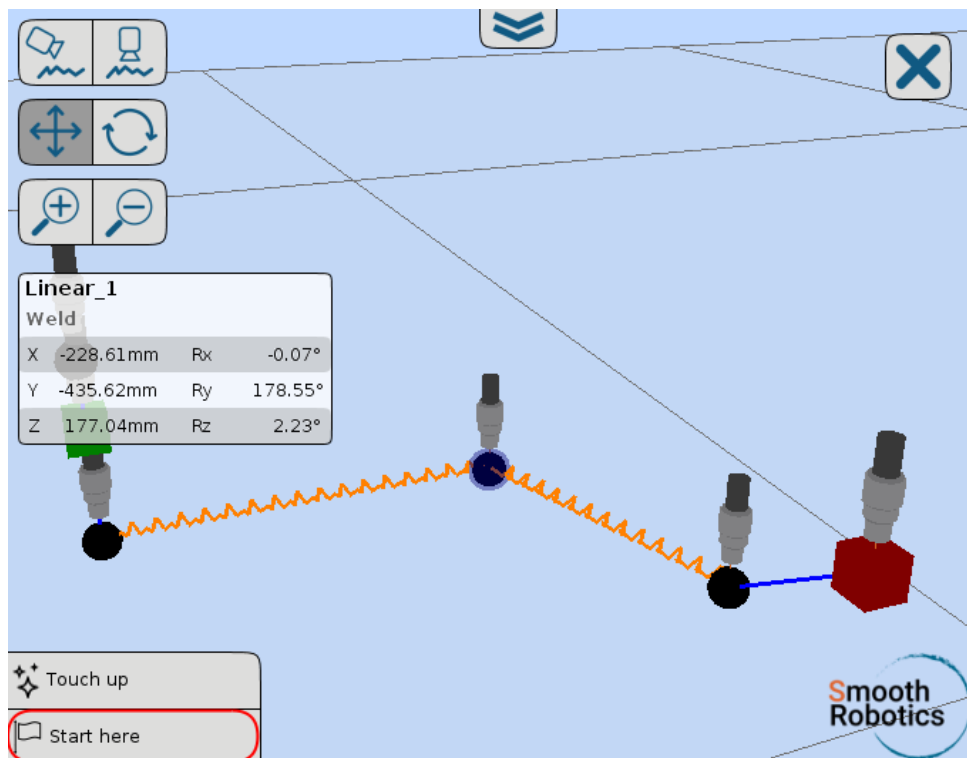


Figure 13.1: Start here button

This moves the start weld to that point and disables everything before that point as seen in figure 13.2.

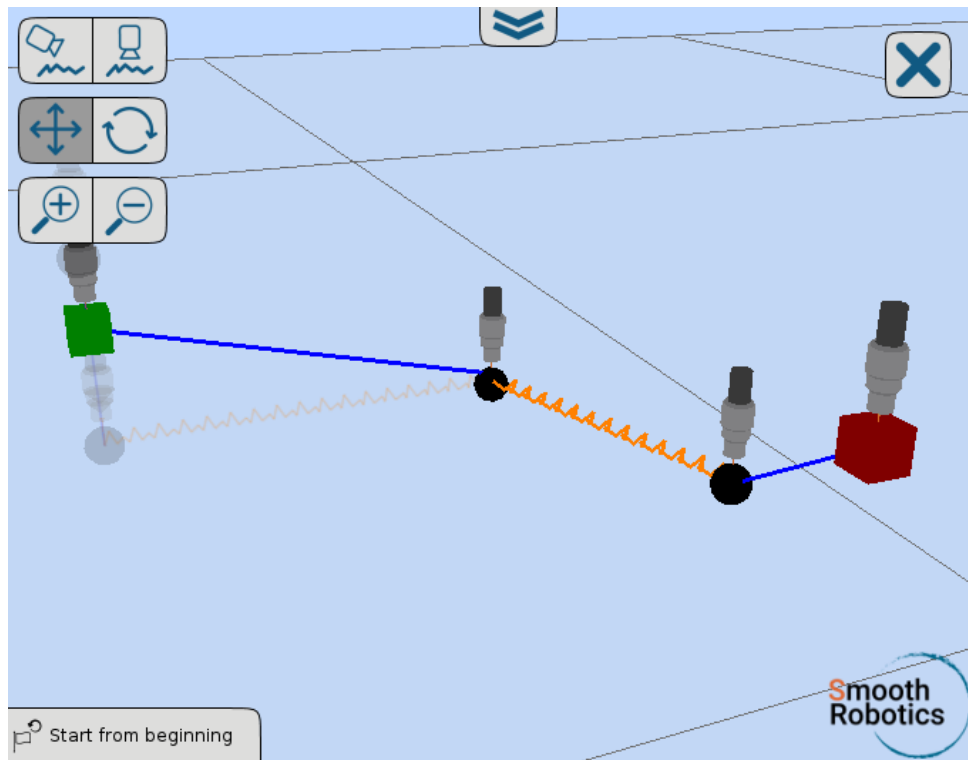


Figure 13.2: Start here after button pressed

It is possible to revert back to the old start weld point, by pressing the button *Start from beginning*.

14 | Pipe welds

A Pipe is used for welding pipes on plates or joining pipes together at the ends. Create a pipe by tapping *Pipe* in the SmoothTool start page, see Figure 5.3.

The pipe node consists of the same nodes as the Weld node, except it is pre-modified with a circular segment that is extended to a full 360 degree circle (see section 6.3.4). Section 6 includes a description of the Weld node, approach and how to create a weld using the flange. This is also applicable for the Pipe node and is highly recommended to read before using the Pipe node.

Note that when teaching a pipe, the user only has to set a via and end point that defines a part of the circle, and the software will then automatically complete the full circle as shown in figure 14.1. Because of this the exit point will have to be set above the Weld start point, and not above the actual taught end point.

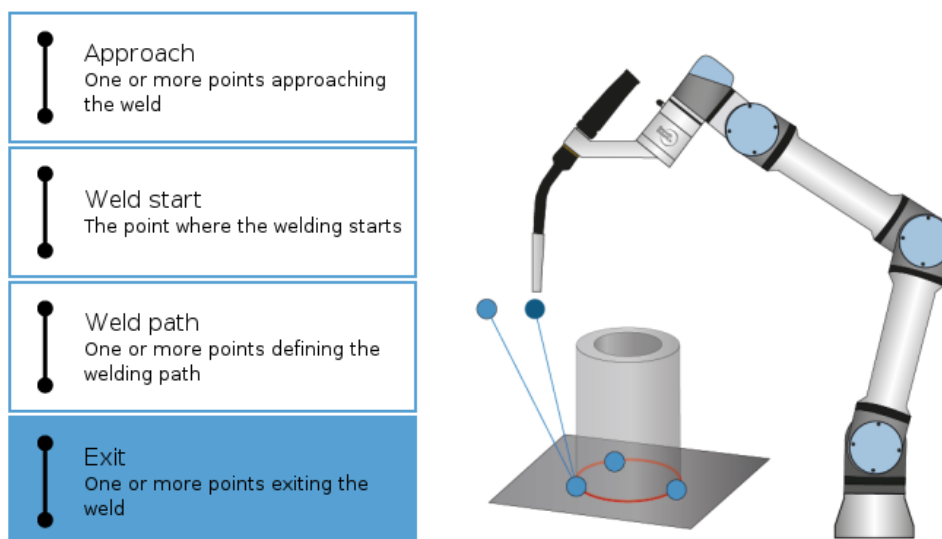


Figure 14.1: Pipe exit.

15 | Tacking

15.1 Introduction

The Tack node is used for quickly setting tack points on the work-pieces that are going to be welded. A Tack consists of the following nodes:

- **Tack:** The tack node contains overall settings for the weld.
- **Tack point:** The point where the tack point is sat.
- **Air point(Optional):** One or more nodes describing how to approach or exit the weld.

15.2 Tack node

On the Tack node page, there are 2 tabs: *How To* and *Parameters*. *How To* (see figure 15.1) shows how to set tack points and air points using the flange.

By tapping the pen icon (✎) it is possible to rename the node. At the bottom of all the tack nodes is a section called *Add new...*, which allows for adding a Tack point or an Air point. The Tack nodes automatically set air points to approach tack points and exit tack points.

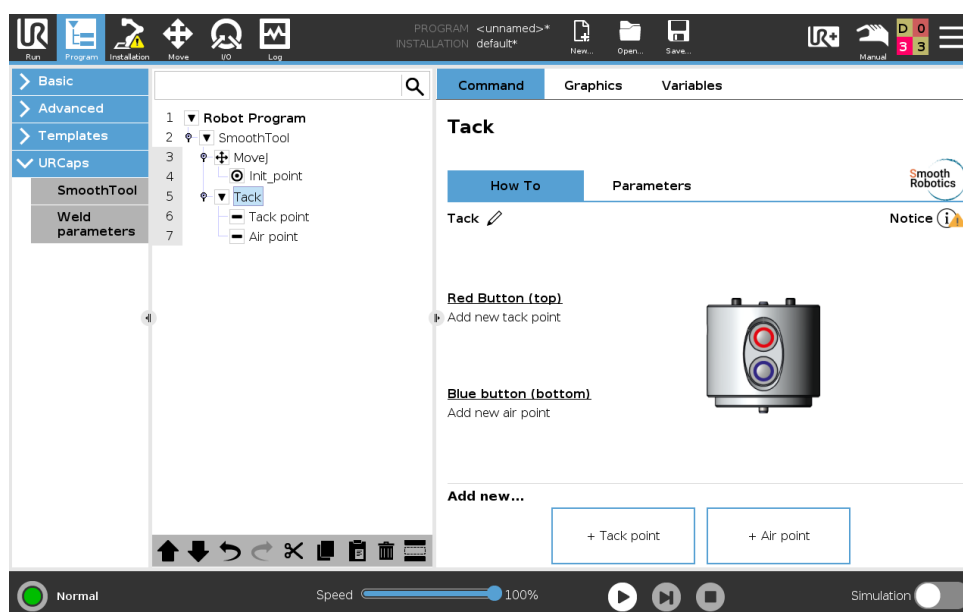


Figure 15.1: The How To tab of the Tack node.

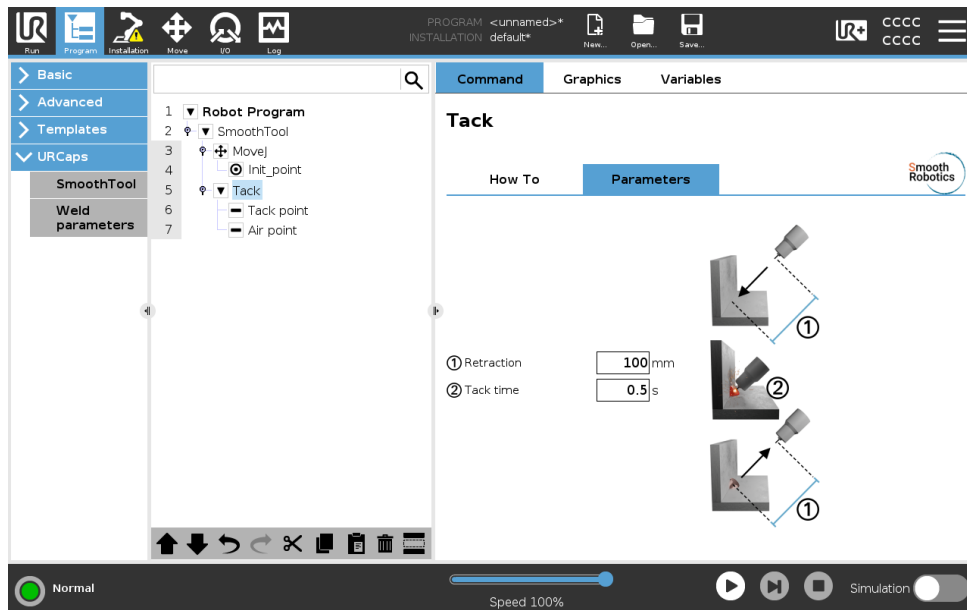


Figure 15.2: The parameters tab of the Tack node.

The *Parameters* tab (see figure 15.2) contains the shared parameters that will be used in this tack unless the parameters have been overridden in specific segments.

Table 15.2 provides an explanation of the tack nodes parameters.

Identifier:	Description:
Retraction	The length of how far the TCP retracts from the element [mm].
Tack time	How long the Tack welds before it retracts [s].

15.3 Tack point

Tack point is the point where the tack is set. When the robot reaches this point, it will turn on the welding arc for how long the parameter *Tack time* is set to.

Tack point has two tabs: *Positions* and *Parameters*.

Positions is seen on figure 15.3 and is described in the table 15.3.

The *Parameters* for Tack points are the same parameters as the Tack parameters which are shown in table 15.2. The Tack points parameters use the shared Tack parameters unless *shared parameters* are disabled. If the shared parameters option is disabled the Tack point will use its own parameters.

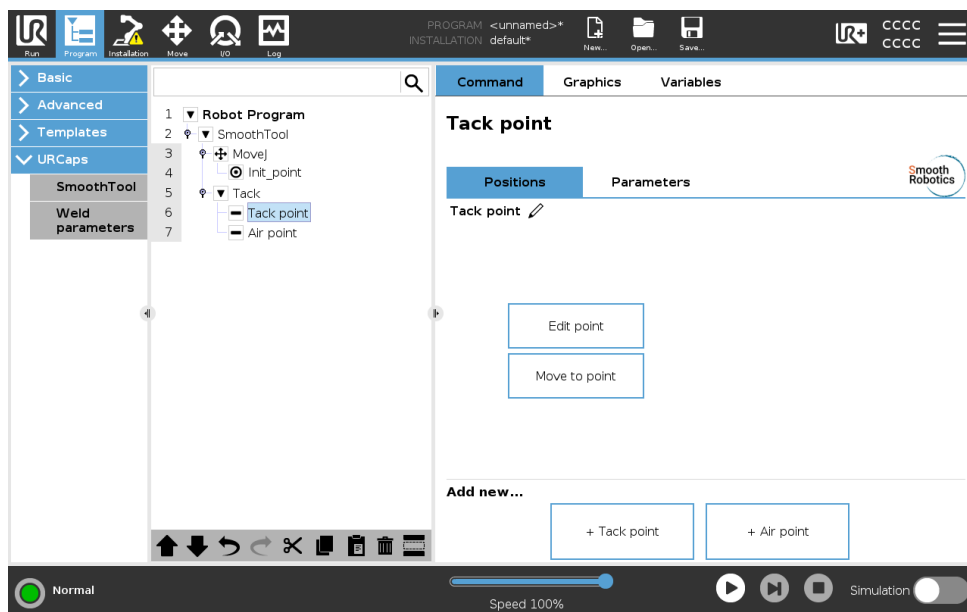


Figure 15.3: The Tack point node.

Identifier:	Description:
Set point/Edit point	Sets the point either by using the controls on the teach pendant or using the freedrive functionality. Freedrive can be activated either by pressing the black button on the SmoothTool Programming Flange or by pressing the freedrive button on the back of the teach pendant.
Move to point	Moves the robot to the point set for the node.

15.4 Air point

As mentioned in 15.2 the Tack node automatically sets air points for approaching the tack and for exiting the tack. Therefore the Air point node is used for making additional points for approaching or exiting the tack, if the TCP needs to follow a certain path.

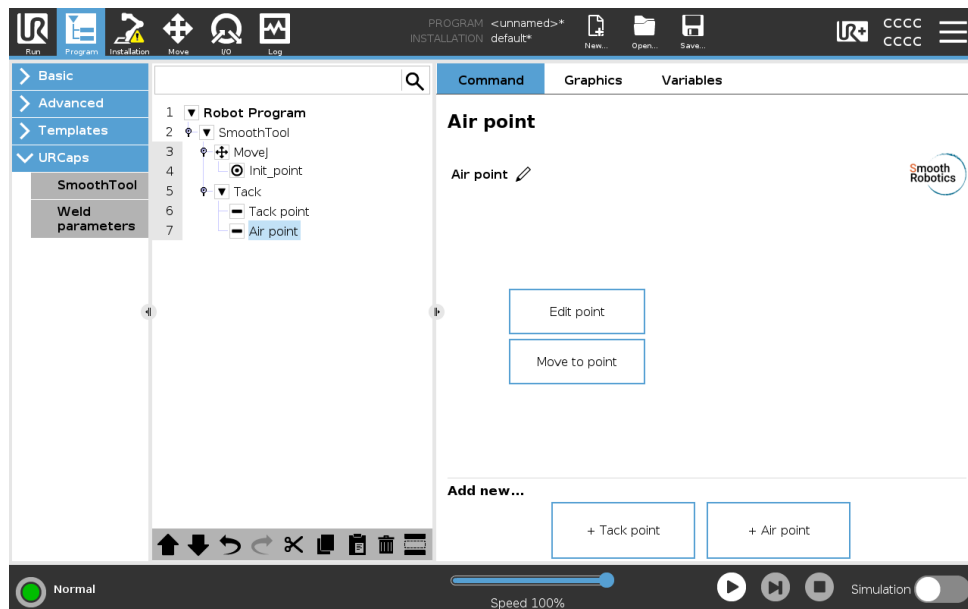


Figure 15.4: The Tack point node.

The Air point node is able to *Set point/Edit* and *Move to point*, which works the same way as Tack point and is described in table 15.3.

16 | Touch sense

16.1 Introduction

Touch sense is a force-based auto offset feature. By teaching the robot points on the work-piece, it will create a search routine, that can utilize the obtained information to accommodate for minor deviations in the displacement of the work-piece. Touch sense can also be used in combination with offset (see chapter ??) to achieve a better result and make that process easier.

Touch sense nodes can be added from the SmoothTool front page.

The touch sense node functionality can either be a search routine or an offset clearer. Search routine touch sense nodes compute and apply an offset on all welds/pipes/passes/tack points etc. that come after it. When another search routine touch sense node in the program is reached, the later offset will override the first one.

Clear offset touch sense nodes mark where the effect of the previous search routine touch sense nodes stop.

16.2 Touch sense node

Create a Touch sense node and select its functionality:

- Quick search: Touches up the work-piece twice to accommodate for deviations.
- Thorough search: Touches up the work-piece three times to accommodate more accurately for deviations.
- Clear offset: Clears the touch sense auto offset.

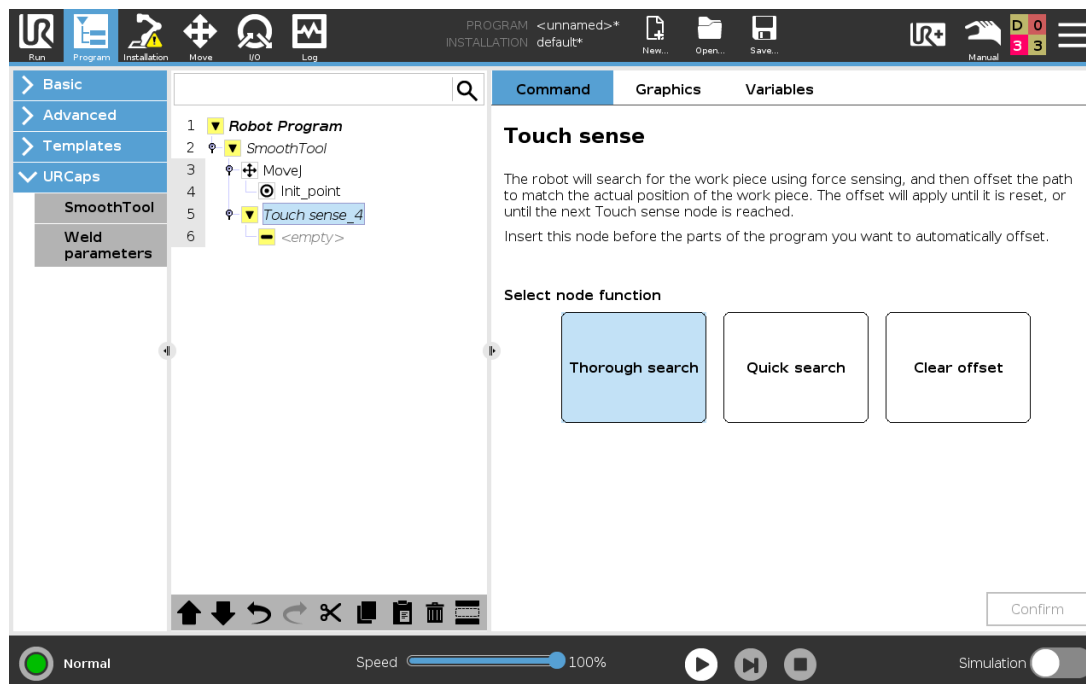


Figure 16.1: Touch sense node function selection.

Touch sense utilizes the gas cup diameter to improve its offset calculations. Make sure the gas cup diameter is set correctly in *Installation -> SmoothTool Configuration -> Settings -> Gas cup diameter*. Save the installation to make the applied cup diameter persistent.

17 | Multipass

17.1 Introduction

Multipass is a feature used for making welds, where several passes need to be layered on top of each other. To use the Multipass feature, navigate to the SmoothTool-node and press the New multipass -button. This will insert a new multipass node in the program.

The multipass node functions as an umbrella for a number of passes, where each pass is a standard weld (as described in subsection 6). The idea here is that the multipass system can be used to generate new passes automatically (more on this in section 17.2), but if the results are unsatisfactory, each individual pass can still be edited in any way. When one or more passes have been made, the table-view can be used to get an overview of the passes, make adjustments and administrate which passes should be welded (see section 17.3).

NOTICE

Please note that the multipass system has the following limitations:

- The system functions as intended only if the welding paths lie in a plane (see section ?? for more information).
- The system cannot offset internal corners or shrink circular segments well. Sometimes such path elements might be offset correctly, but other times the results might be wrong.

17.2 Making new passes

When making a new pass, it must be generated automatically from a previous reference pass lying in a plane. The new pass will be a copy of the reference with all its parameters, but moved some amount out and some amount up. Additionally, the specified work and travel angles of the torch will be used throughout the new pass. For an explanation of the angles, see chapter 8.

17.3 The passes overview

On the overview page (see figure 17.1) a table providing a summary of all the passes under the multipass node can be found.

Multipass

How To
Passes
Offset

Smooth Robotics

⑥ Plane:Base ⚙

	Up [mm]	Out [mm]	WA [°]	TA [°]	SO [mm]	EO [mm]	Wait [s]	Weld ☒
Pass 1	0	-0	88.6	1.4	0	0	0	☒
Pass 2	0	-0	45	10	0	0	0	☒

Welding side
<
>
Save / Load
New pass

Figure 17.1: The multipass table

It is possible to change the values in the table (see figure 17.2). If changes are made, the Apply and Discard buttons become active. Press the Apply button to save the changed values and update the relevant passes, or press Discard to throw away the changes.

Multipass

How To
Passes
Offset

Smooth Robotics

⑥ Plane:Base ⚙

	Up [mm]	Out [mm]	WA [°]	TA [°]	SO [mm]	EO [mm]	Wait [s]	Weld ☒
Pass 1	0	-0	60	1.4	0	0	0	☒
Pass 2	0	-0	45	10	0	0	0	☒

Welding side
<
>
Discard
Apply

Figure 17.2: Edits to passes made in the table

17.3.1 Explanation of the columns in the multipass table.

Identifier:	Description:
Up	Up in the selected plane [mm].
Out	Out relative to the chosen side [mm].
WA(Work)	Angle up from horizontal [°].
TA(Travel)	Push (+) or pull (-) angle
SO(Start offset)	The offset at the start of the pass. If the value is negative, the pass will be extended backwards relative to the welding direction. If the value is positive, the pass will be cropped in the forwards direction.
EO(End offset)	The offset at the end of the pass. If the value is negative, the pass will be cropped backwards relative to the welding direction. If the value is positive, the pass will be extended in the forwards direction.
Wait	Wait time for cool down [s].
Weld	Weld the pass or do not weld the pass.

Appendices

A | Examples

In this appendix we will go through some examples that illuminate how SmoothTool is used in practical cases.

A.1 Configuring welding with callback functions

A.1.1 Example 1 (Digital I/O)

In this example, it is assumed that the welding arc is controlled by the robot's *standard digital output 0* and the actual state of the arc is reflected on the robot's *standard digital input 0*. In order to use that setup with SmoothTool, the following Callback Functions must be defined (see figure A.1).

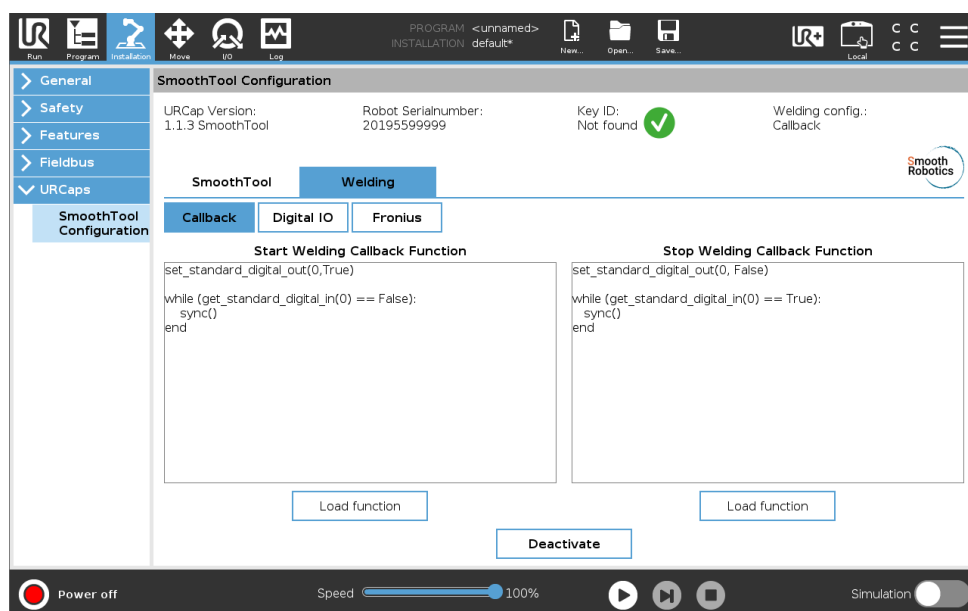


Figure A.1

Start Welding Callback Function

```
1 set_standard_digital_out(0, True)
2
3 while (get_standard_digital_in(0) == False):
4     sync()
5 end
```

Stop Welding Callback Function

```
1 set_standard_digital_out(0, False)
2
3 while (get_standard_digital_in(0) == True):
4     sync()
5 end
```

The *Start Welding Callback Function* sets *standard digital output 0*. Afterwards, it waits until the *standard digital input 0* is set in order to verify that the actual state of the welding arc matches the command

issued.

The *Stop Welding Callback Function* resets *standard digital output 0*. Afterwards, it waits until the *standard digital input 0* is also reset in order to verify that the actual state of the welding arc matches the command issued.

A.1.2 Example 2 (PROFINET)

In this example, it is assumed that the robot communicates with the power source over PROFINET. The *output boolean register 0* is used to turn on/off the welding arc and the *input boolean register 0* reflects the actual state of the welding arc. The *input integer register 0* reflects the state of the power source and the robot is only allowed to write to the power source when its state is 0.

Start Welding Callback Function

```
1 while (read_input_integer_register(0) != 0):
2     sync()
3 end
4 write_output_boolean_register(0, True)
5 while (read_input_boolean_register(0) == False):
6     sync()
7 end
```

Stop Welding Callback Function

```
1 while (read_input_integer_register(0) != 0):
2     sync()
3 end
4 write_output_boolean_register(0, False)
5 while (read_input_boolean_register(0) == True):
6     sync()
7 end
```

The first three lines in *Start Welding Callback Function* signify a wait until the power source is ready to receive the next command. Line four sets *output boolean register 0*. Lines 5-7 signify wait for the power source to verify that the arc has been turned on.

The first three lines in *Stop Welding Callback Function* signify a wait until the power source is ready to receive the next command. Line four resets *output boolean register 0*. Lines 5-7 signify a wait for the power source to verify that the arc has been turned off.