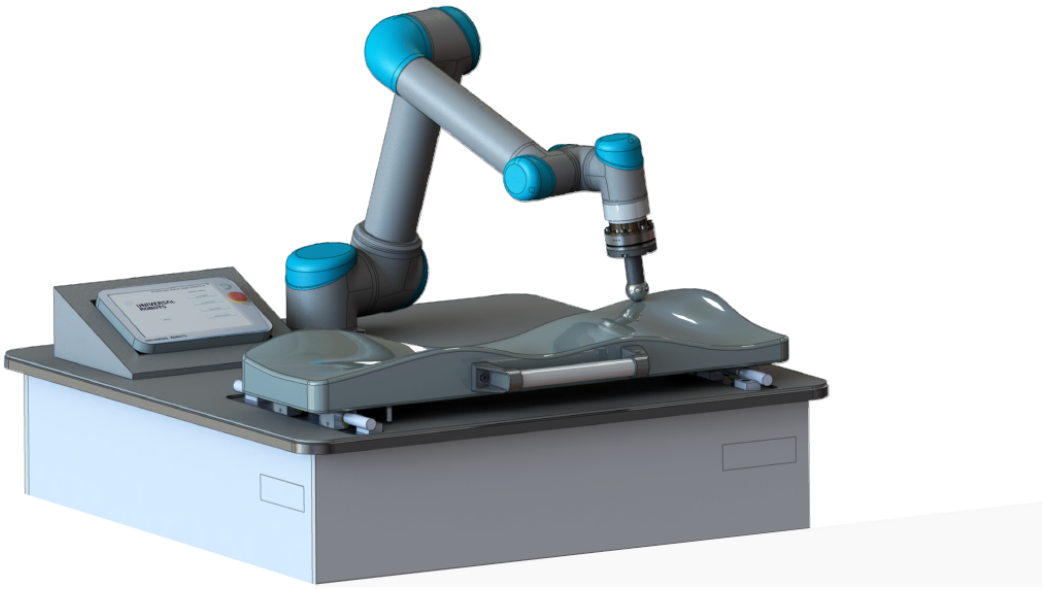
Software Manual

SCHUNK Software Module for URCap

SCHUNK Sensor FT-AXIA 80 Ethernet



Superior Clamping and Gripping

Imprint

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Technical changes:

We reserve the right to make alterations for the purpose of technical improvement.

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Dear Customer,

thank you for trusting our products and our family-owned company, the leading technology supplier of robots and production machines.

Our team is always available to answer any questions on this product and other solutions. Ask us questions and challenge us. We will find a solution!

Best regards,

Your SCHUNK team

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Table of contents

1 About this manual

This manual contains important information for a safe and appropriate use of the product.

This manual is an integral part of the product and must be kept accessible for the personnel at all times.

Before starting work, the personnel must have read and understood this operating manual. Prerequisite for safe working is the observance of all safety instructions in this manual.

Illustrations in this manual are provided for basic understanding and may differ from the actual product design.

In addition to these instructions, the documents listed under Link Mitgeltende Unterlagen are applicable.

1.1 Explanation of Warnings

The warnings included here are specific to the product(s) covered by this manual. It is expected that the user heed all warnings from the robot manufacturer and/or the manufacturers of other components used in the installation.

⚠ DANGER

Danger for persons!

Non-observance will inevitably cause irreversible injury or death.

⚠ CAUTION

Dangers for persons!

Non-observance can cause minor injuries.

⚠ WARNING

Dangers for persons!

Non-observance can lead to irreversible injury and even death.

NOTICE

Material damage!

Information about avoiding material damage.

2 Safety

The safety section describes general safety guidelines to be followed with this product, explanation of the notification found in this manual, and safety precaution that apply to the product. More specific notification are imbedded within the sections of the manual where they apply.

2.1 General Safety Guidelines

The customer should verify that the transducer selected is rated for maximum loads and torques expected during operation. Because static forces are less than the dynamic forces from the acceleration or declaration of the robot, be aware of the dynamic loads caused by the robot.

2.2 Safety Precautions

NOTICE

Material damage due to wrong up setting.

When initially setting up the Demo Programs, position the robot manually in order to avoid damaging parts, especially the sensor cable.

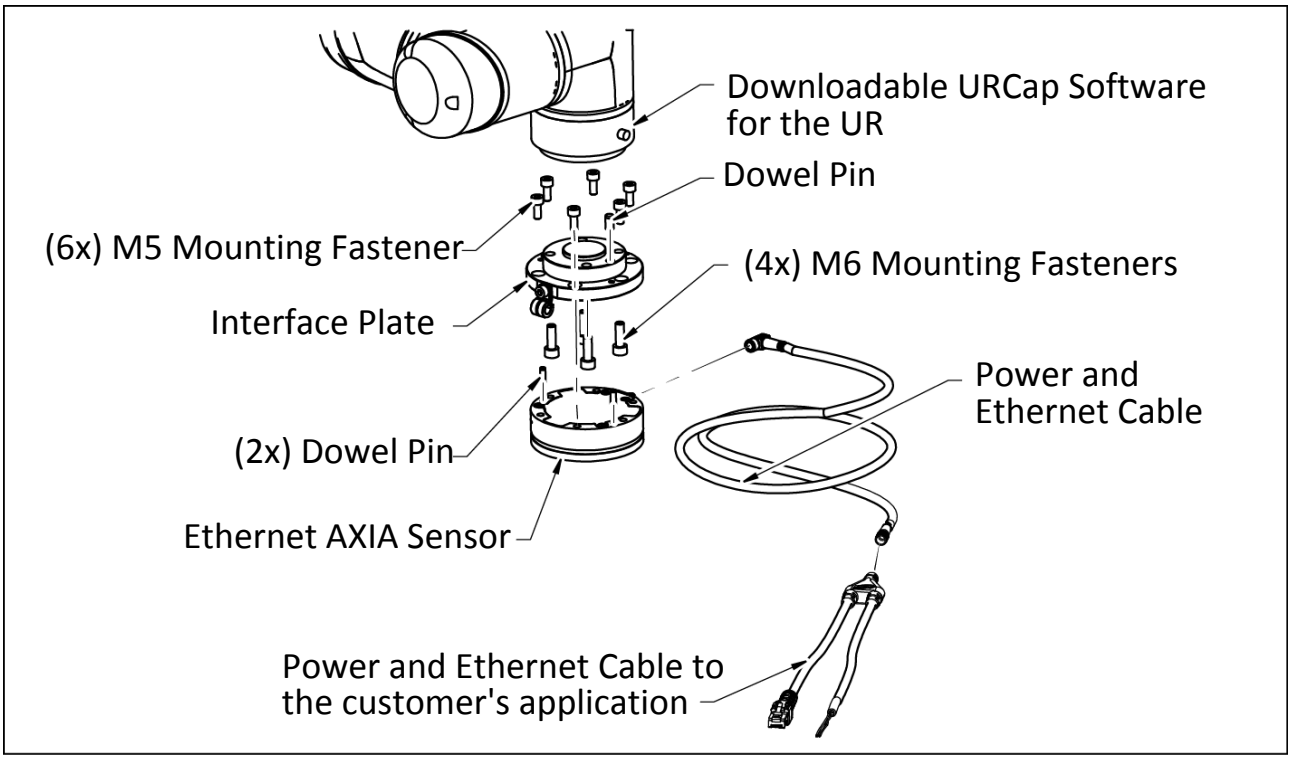
3 Overview

This manual explains how to install and operate the SCHUNK Universal Robot(UR)Cap software and demo programs so that the UR robot can be used with an SCHUNK Force/Torque (F/T) Ethernet sensor rather than the UR robot's calculated F/T readings. The SCHUNK URCap software is compatible with Ethernet protocol only.

F/T sensors convert sensed loads from forces and torques into electrical signals. The F/T sensor provides data to the robot. This data is the six degrees of freedom (DoF): Fx, Fy, Fz, Tx, Ty, and Tz. UR robots have algorithms to use force feedback to control the robot motion. The SCHUNK URCap software provides a way to input data from an SCHUNK sensor into those algorithms by using plugin technology.

For more information on UR robots and the UR user interface, PolyScope, refer to https://www.universal-robots.com/support/. For more information on the SCHUNK F/T Ethernet sensors refer to the Ethernet AXIA manual for the FT-AXIA 80 sensor and Net FT for all other SCHUNK Ethernet sensors.

3.1 UR Kit



SCHUNK provides a bundle that includes the following:

- downloadable URCap software.
- 1x FT-AXIA 80 Ethernet sensor.
- 1x interface plate assembly.
- 1x Ethernet and power cable with a 6-pin connector and 8-pin M12 connector.
- 1x cable with an 8-pin M12 connector that splits to a RJ45 Ethernet connection and an unterminated end for power.

The interface plate assembly includes the following:

- 6x M5-0.8 x 12 mm socket head cap screws.
- 4x M6-1 x 18 mm socket head cap screws.
- 1x clamp loop for routing the cable.
- 1x 4 mm Allen® wrench or hex key.

Refer to the FT-AXIA 80 Ethernet manual for information about the FT-AXIA 80 Ethernet sensor. The FT-AXIA 80 Ethernet manual includes mechanical and electrical specifications.

3.1.1 Unpacking the UR Kit

- Check the shipping container and components for damage that may have occurred during shipping. Report damage to SCHUNK.
- Verify the components from the packing list are included in the UR Kit.
- Refer to UR Kit [▶ 8], for standard components included in the UR Kit.

3.1.2 Installing the Ethernet AXIA Sensor

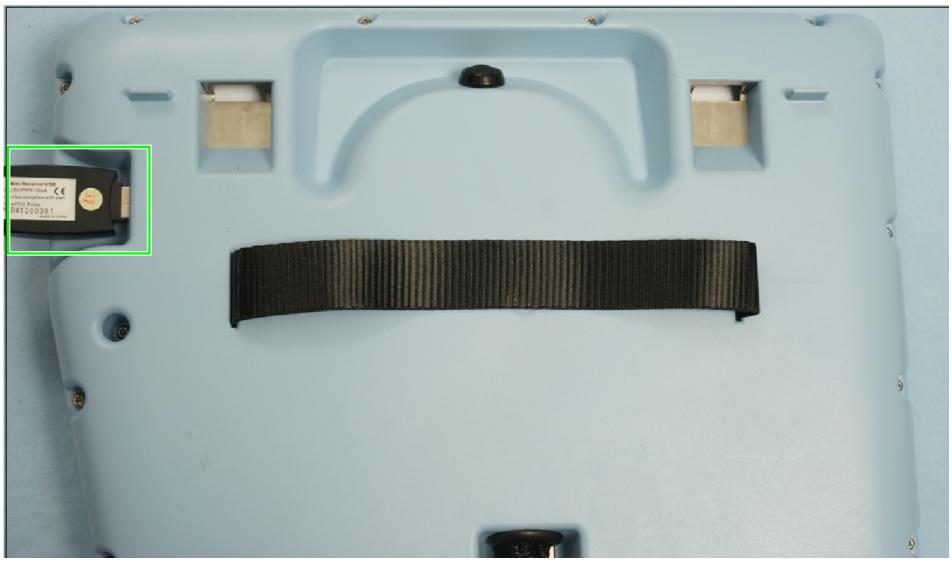
Refer to the Ethernet AXIA manual, for mechanical installation, cable routing, wiring information for the connectors, and electrical specifications.

4 URCap Software

URCap software is required to bypass the UR robot's calculated F/T readings and program the robot to use a F/T sensor. URCap software is compatible with the FT-AXIA 80 Ethernet sensor and other F/T Ethernet sensors. Contact SCHUNK for help in selecting the proper sensor for your application. Refer to Demo Programs [▶ 34], for information about the simple and standard demo programs available through the URCap software. The demo programs are included in the URCap software package that is downloaded from the website

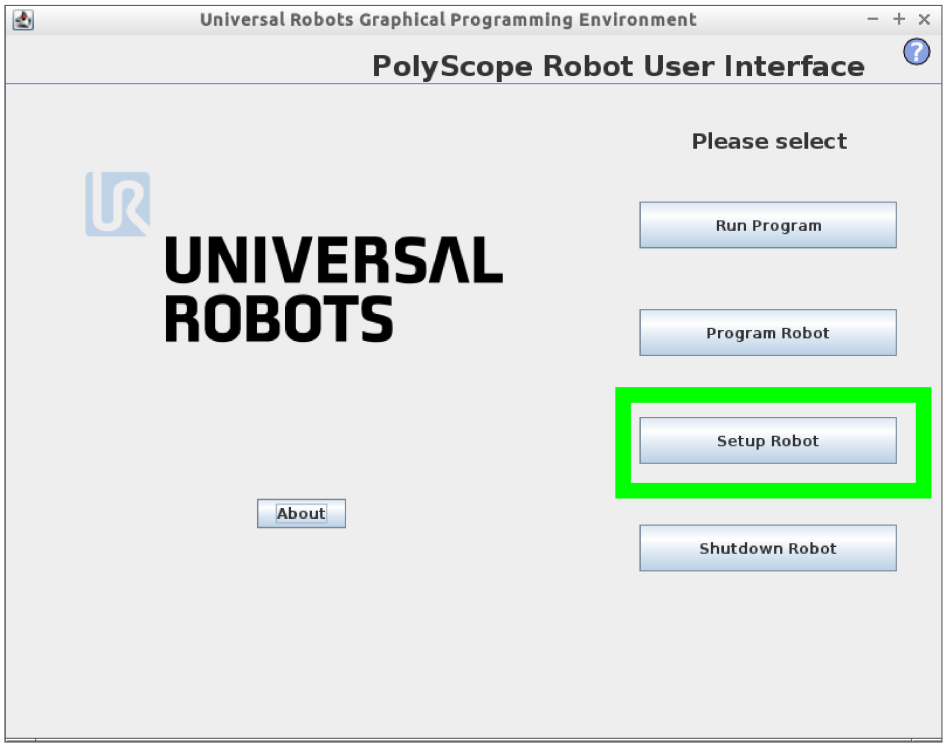
4.1 Installing URCap Software

URCap software is installed onto the UR Teach Pendant using a portable USB drive.

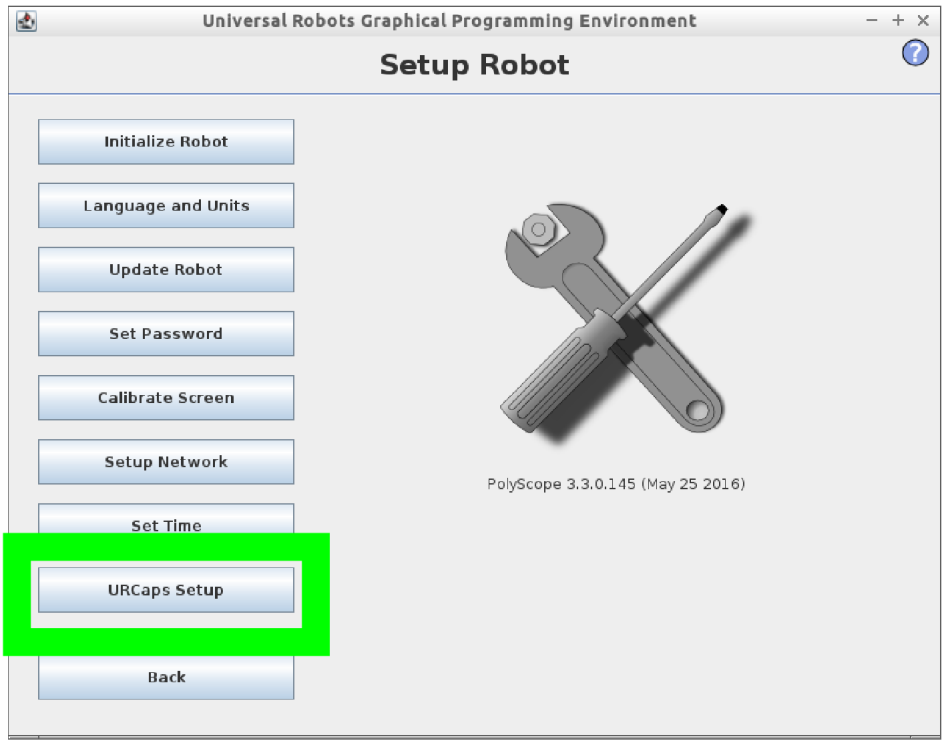


UR Teach Pendant

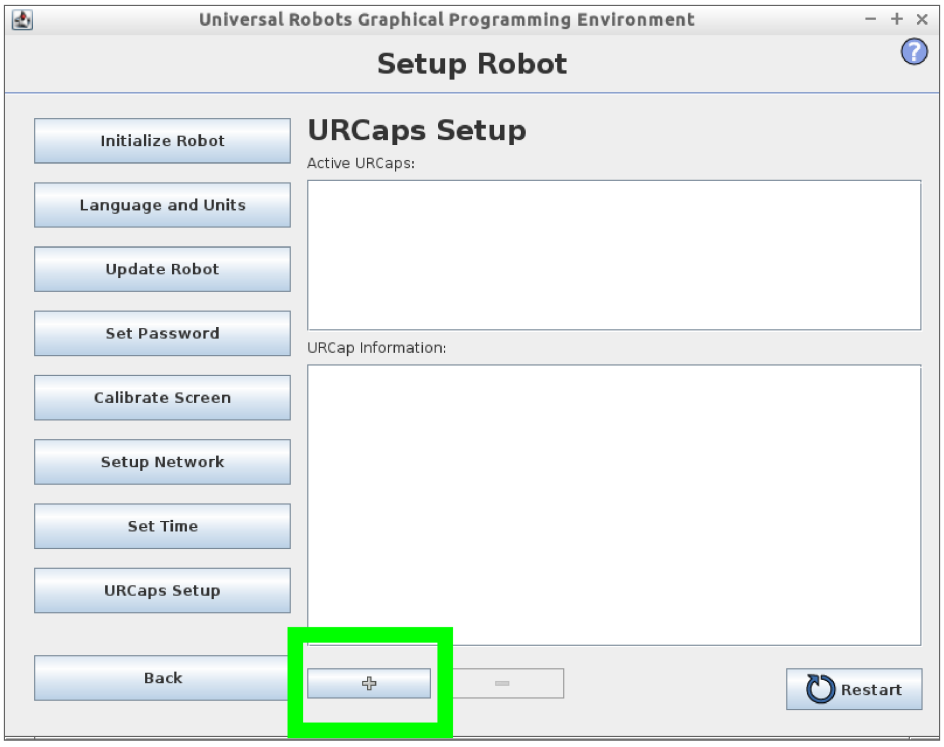
1. Insert a USB drive that contains the URCap package into the USB port on the back of the UR Teach Pendant.



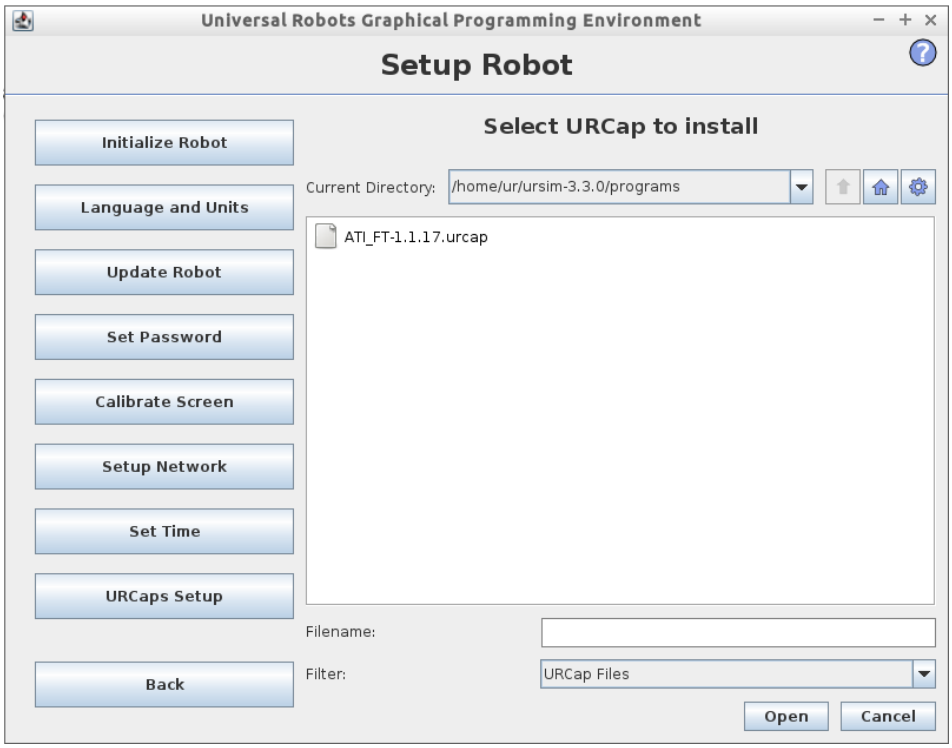
2. On the UR Teach Pendant, “PolyScope Robot User Interface” screen or main menu, click "Setup Robot".



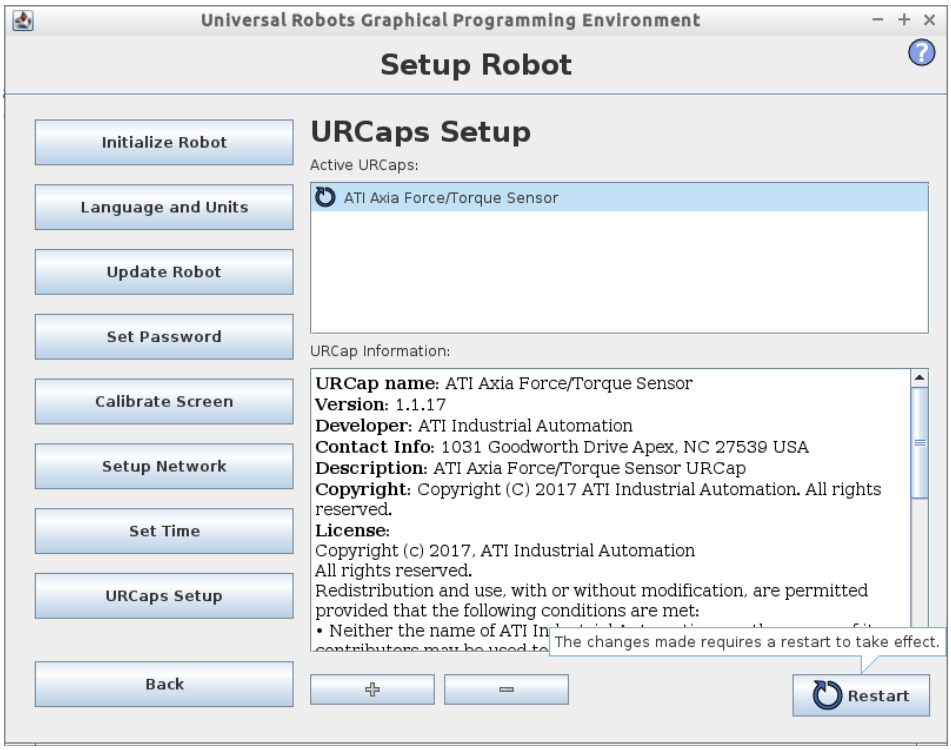
3. On the “Setup Robot” screen, click URCaps Setup.



4. On the “Setup Robot”, “URCaps Setup” screen, click +.



5. Select the latest version of the file: FT-version.urcap. Click Open.

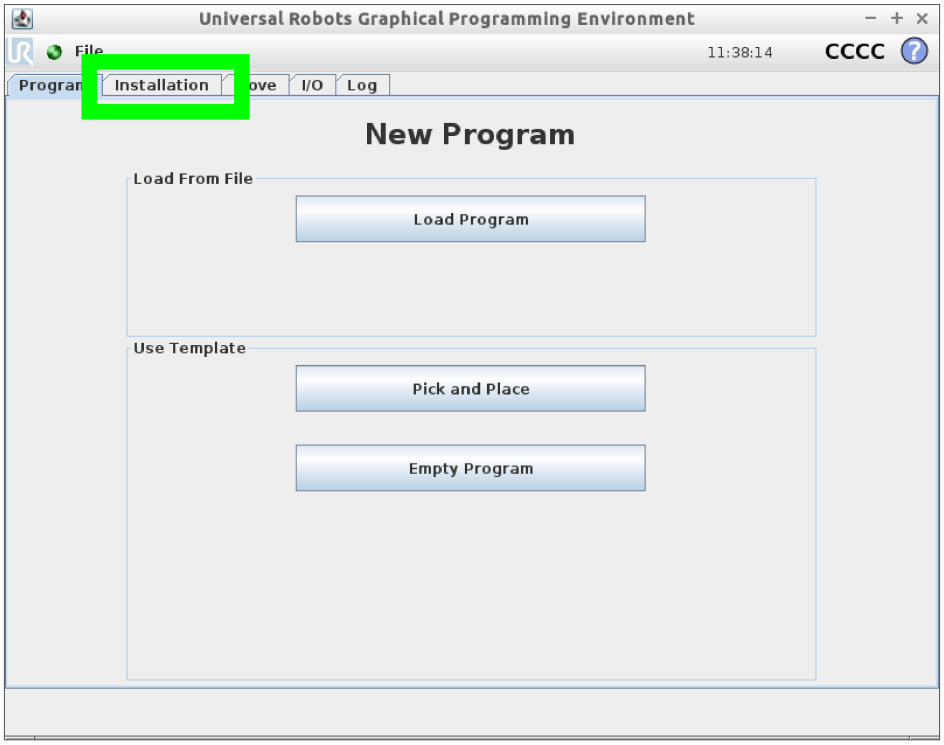


6. On the “Setup Robot”, “URCaps Setup” screen, AXIA Force/ Torque Sensor appears in the “Active URCaps” field. Click Restart.
7. When the installation completes, remove the USB stick.

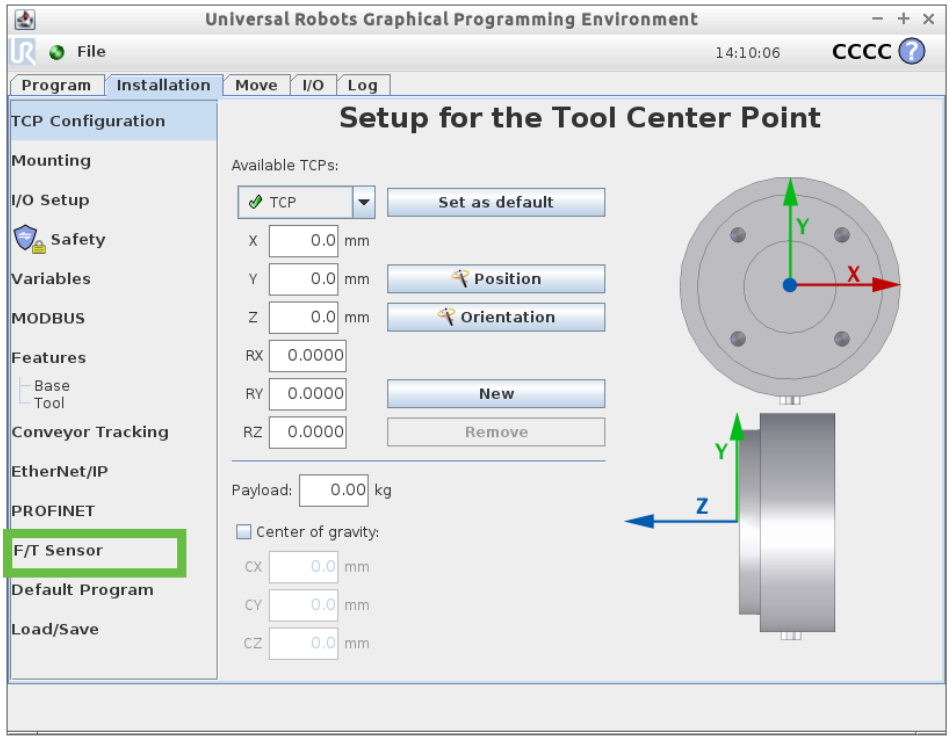
4.2 Setting up URCap Software

Perform the following steps to prepare the URCap software to work with the UR robot and sensor.

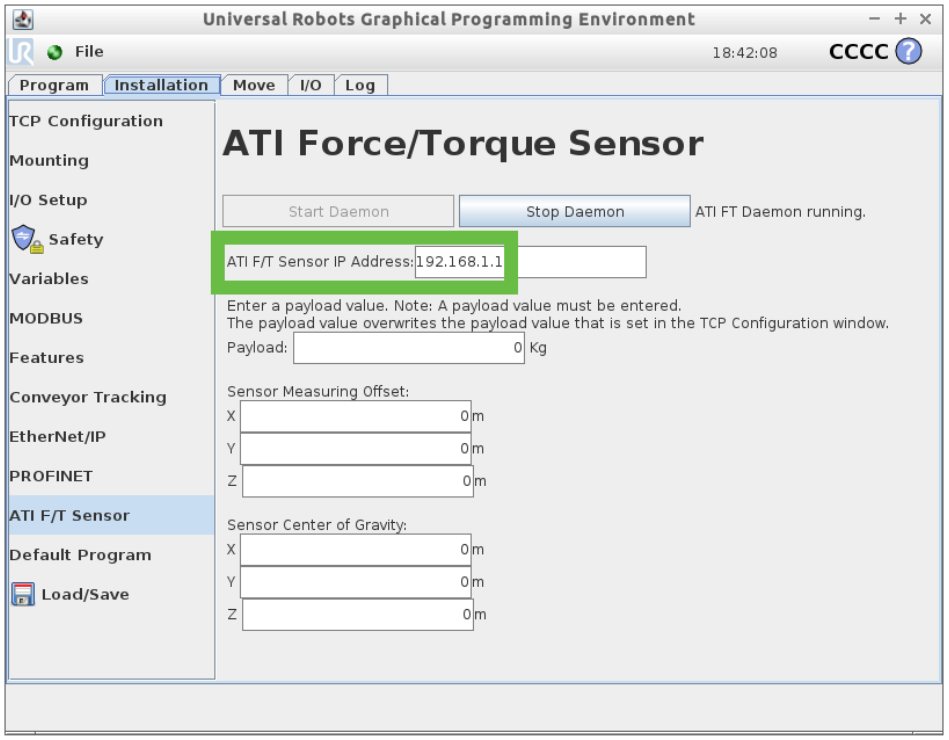
1. On the UR Teach Pendant, “PolyScope Robot User Interface” screen or main menu, click "Program Robot".



2. The “New Program” screen displays. Select the Installation tab.



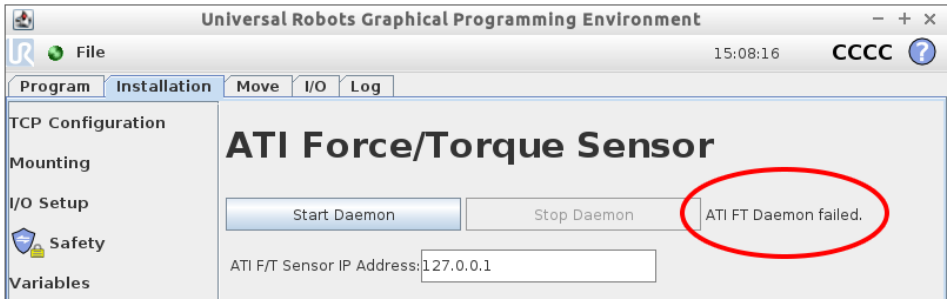
3. The “Setup for the Tool Center Point” screen displays. Refer to Determining the Tooling Mass and Offset [▶ 17] for filling in the fields on the screen. On the sidebar, click F/T Sensor.



4. The “Force/Torque Sensor” screen displays. Enter the sensor’s IP address. The sensor is shipped with a default sensor IP address: “192.168.1.1”.
5. Click Start Daemon. The setup completes.

NOTE

If after clicking Start Daemon and the error message “FT Daemon failed.” appears, verify the IP Address entered is correct. Repeat previous step.



4.3 Determining the Tooling Mass and Offset

NOTICE

Do not enter the following default values into the robot controller without accounting for the tooling mass by using the following equations.

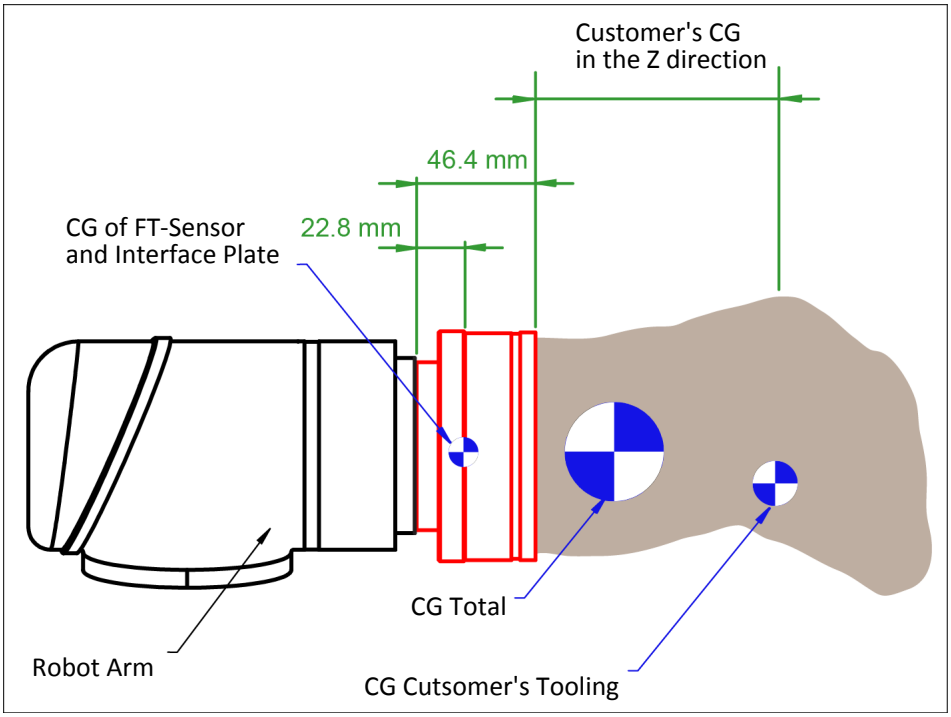
Failure to account for the tooling mass and offset reduces the performance of the UR robot.

- Properly account for the customer tooling, when setting up the tool center point or TCP.

The SCHUNK-provided sensor and interface plate in the UR Kit have the following mass characteristics with no customer tooling installed:

- Mass = 0.558 kg
- Offset to the Center of Gravity in the Z direction = 22.8 mm
- Offset to the Center of Gravity in the X, Y directions = 0 mm
- Total Stack Height or Offset from the robot reference plane to the sensor reference plane = 46.4 mm

When the customer tooling is mounted to the sensor, these default values change to account for both the mass of the tool and the mass of the sensor. Use the following equations to determine the values to enter in the fields of the “Setup for the Tool Center Point” screen; Refer to Figure "Setup for the Tool Center Point". The following diagram can be used as a reference for the equations.



$$\text{Payload (kg)} = 0.558 + \text{Customer´s Tooling Mass}$$

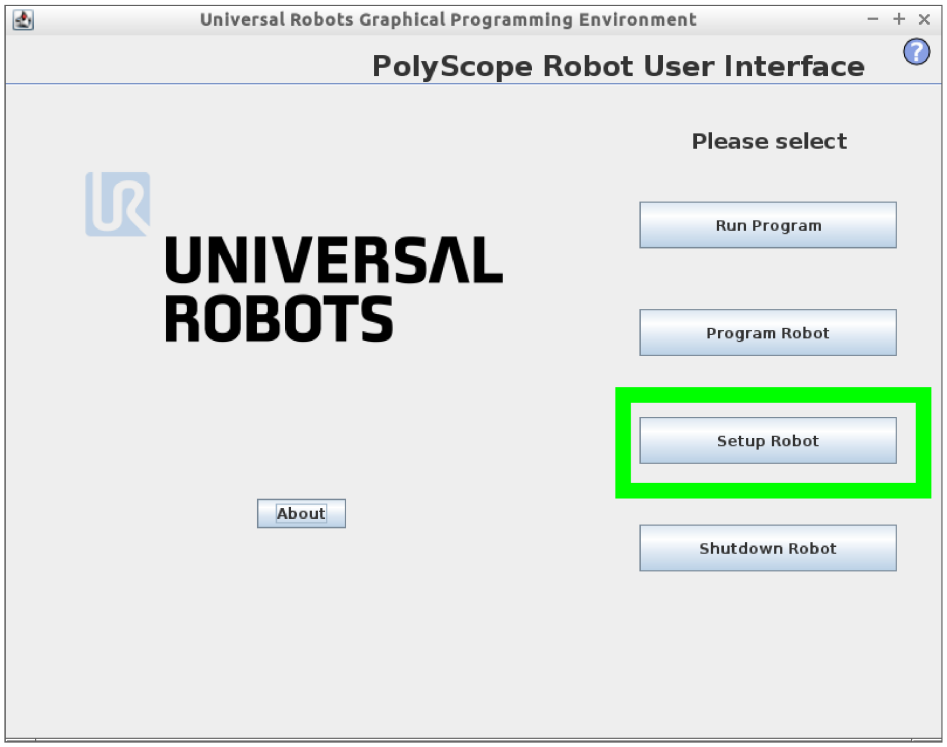
$$\text{Center of Gravity (x, mm)} = \frac{\text{Customer´s Tooling Mass x Customer´s CG in the x direction}}{0.558 + \text{Customer´s Tooling Mass}}$$

$$\text{Center of Gravity (y, mm)} = \frac{\text{Customer´s Tooling Mass x Customer´s CG in the y direction}}{0.558 + \text{Customer´s Tooling Mass}}$$

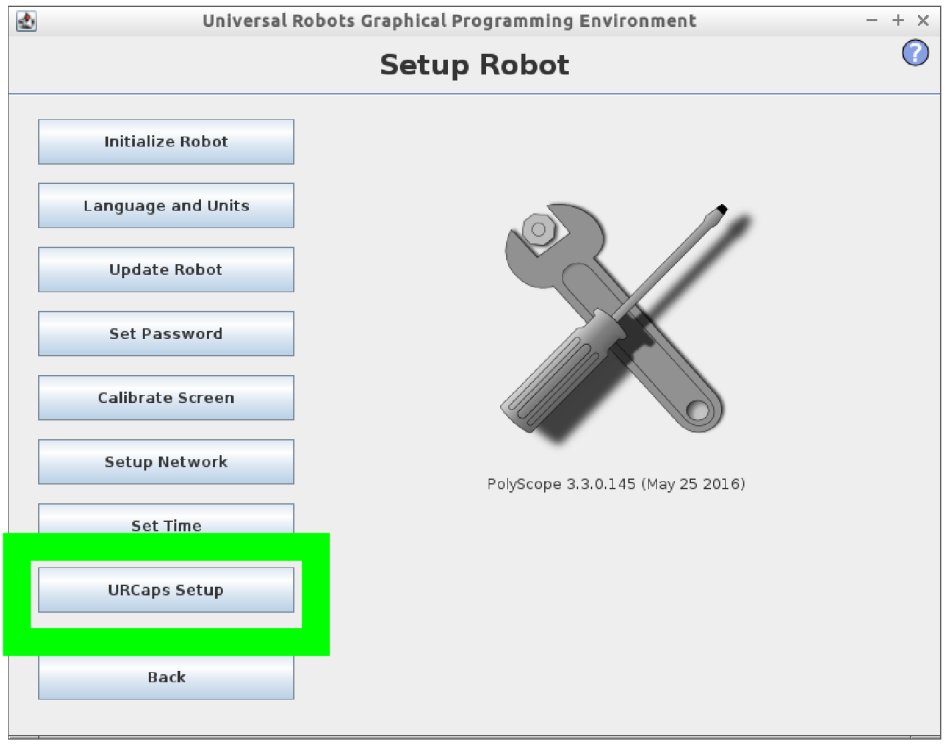
$$\text{Center of Gravity (y, mm)} = \frac{12.7224 + \text{Customer´s Tooling Mass x (Customer´s CG in the z direction+46.4)}}{0.558 + \text{Customer´s Tooling Mass}}$$

Center of Gravity (CG)	The point of a mass around which the resultant torque from gravity forces is zero.
Customer's Center of Gravity in the X, Y, Z Direction	The distance in mm from the F/T sensor's sensing reference frame origin (refer to the customer drawing) to the center of gravity of the customer's tooling. This should include the mass and location of all customer-provided fasteners and not SCHUNK-provided parts. The location of a center of gravity can be found in most CAD packages used to design robot tooling.
Customer's Tooling Mass	The mass of the customer's tooling that includes all fasteners not provided by SCHUNK, in kilograms.
F/T Mass	The mass of the F/T sensor including the interface plate and all hardware required to connect the F/T sensor to the robot. The F/T mass does not include any hardware the customer uses to mount their tooling to the F/T sensor.

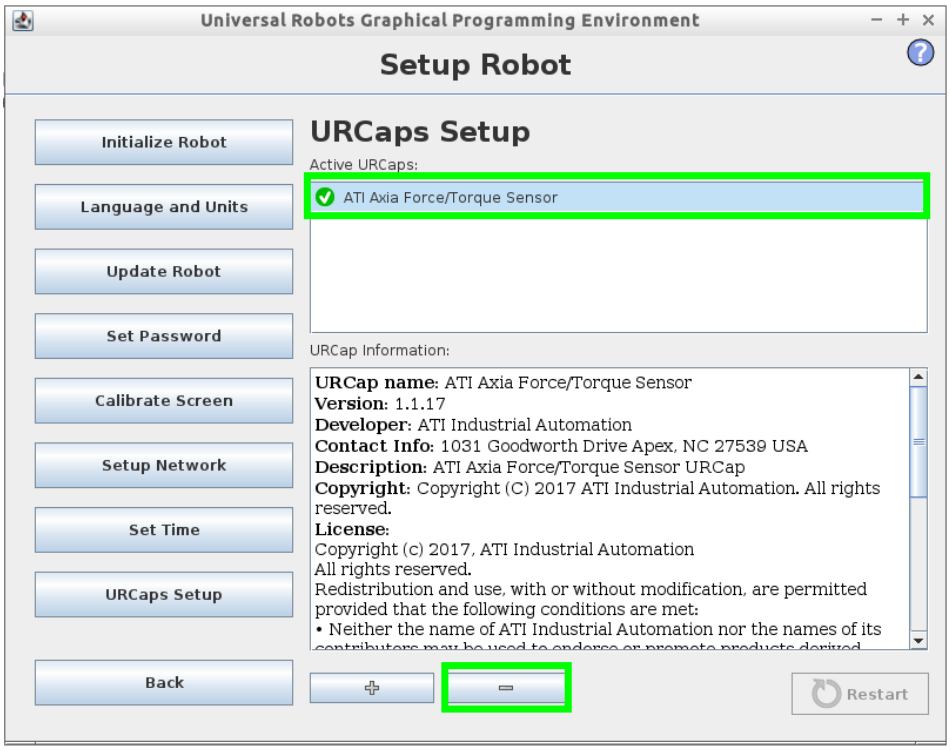
4.4 Uninstalling URCap Software



1. On the UR Teach Pendant, “PolyScope Robot User Interface” screen or main menu, click Setup Robot.



2. On the “Setup Robot” screen, click URCaps Setup.



3. On the “Setup Robot” “URCaps” screen, select AXIA Force/ Torque Sensor.
4. Click -. AXIA Force/Torque Sensor is removed from the “Active URCaps” field.
5. Click Restart. The changes require a restart for the uninstallation to be complete.

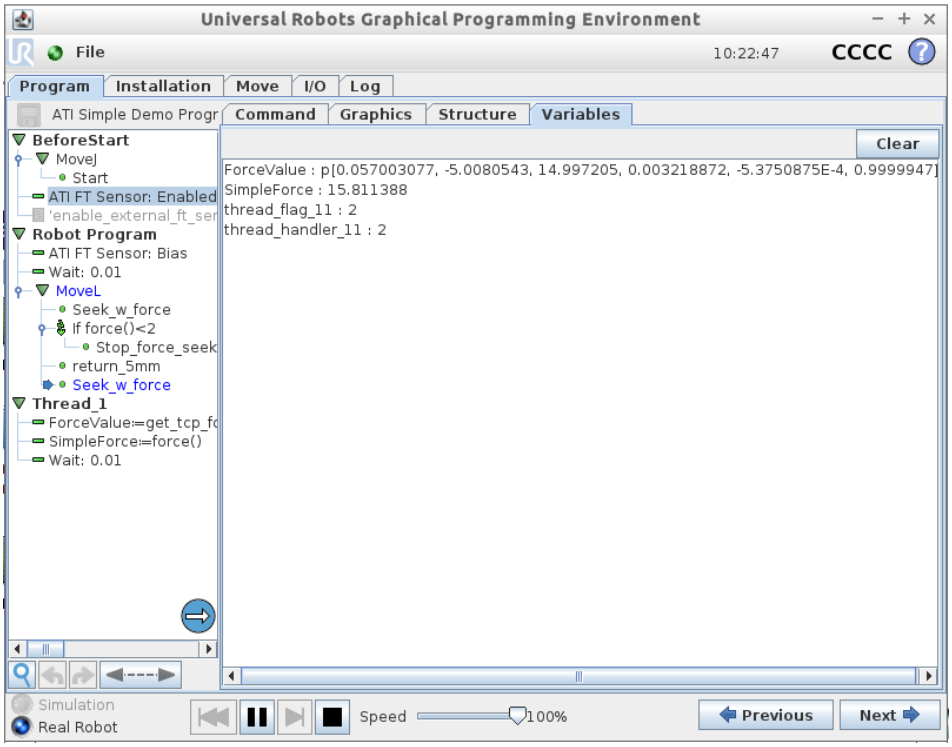
5 Operation of the URCap Software

The following section provides information required when using the URCap software, during operation of the robot and sensor. Communicating with the sensor and UR robot, requires a knowledge of Ethernet standards and operation and UR interface, Polyscope. For more information about UR, refer to https://www.universal-robots.com.

5.1 Sample Rate

The power-on default sample rate for UR robots is 125 Hz.

5.2 View Force and Torque Readings



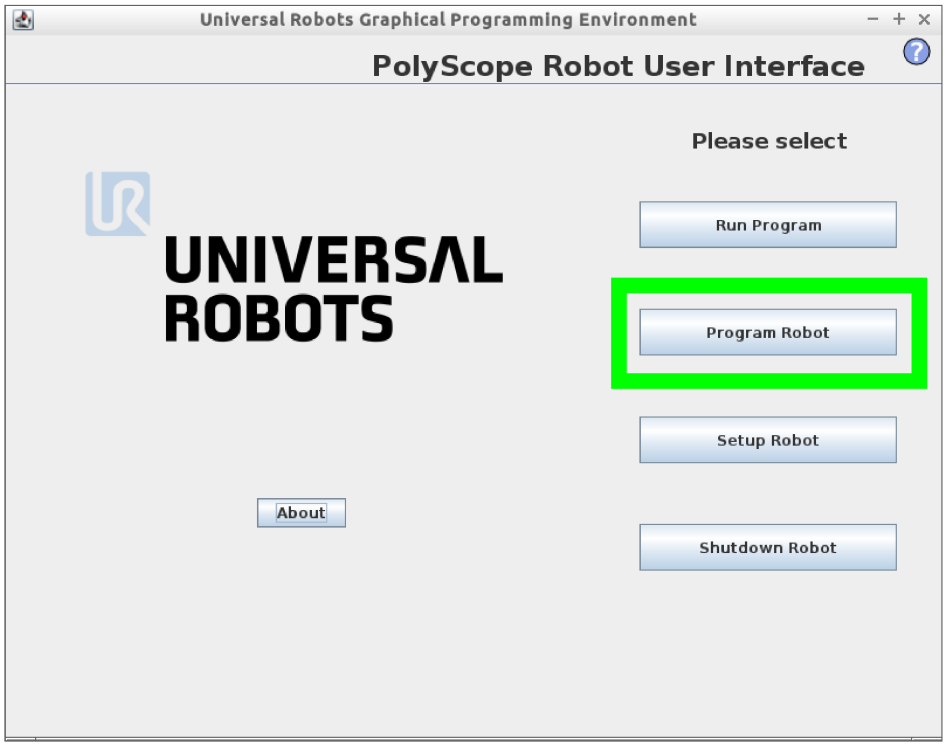
While the program is operating, the user can view the force and torque readings. Select the “Variables” tab. The values are labeled “ForceValue” and are in the order [Fx, Fy, Fz, Tx, Ty, Tz] in N/Nm.

5.3 Program Node Commands and Options

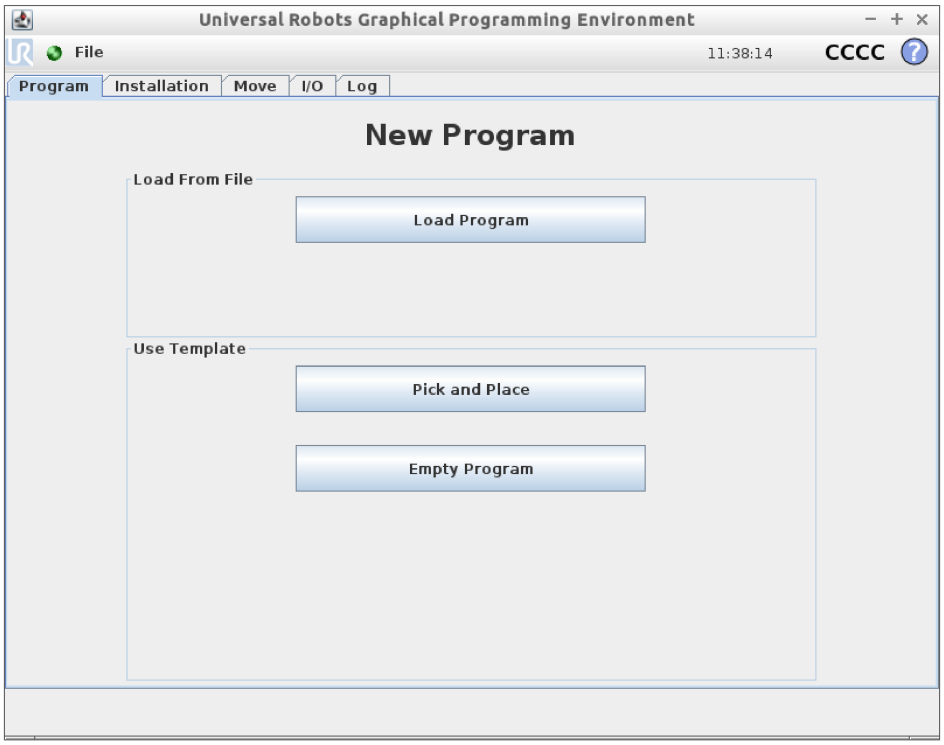
There are (5) commands that the user can issue, during operation of the robot. These 5 commands are divided into 2 Program Nodes: Program Node Command and Program Node Options. Refer to the following table for a list of commands associated with each Program Node.

Program Node	Command	Reference
Program Node Command	Enable	Enable Command [▶ 27]
	Disable	Disable Command [▶ 27]
	Bias	Bias Command [▶ 27]
Program Node Options	Logging Level	Logging Level [▶ 29]
	Acceptable Status Conditions	Acceptable Status Conditions [▶ 32]

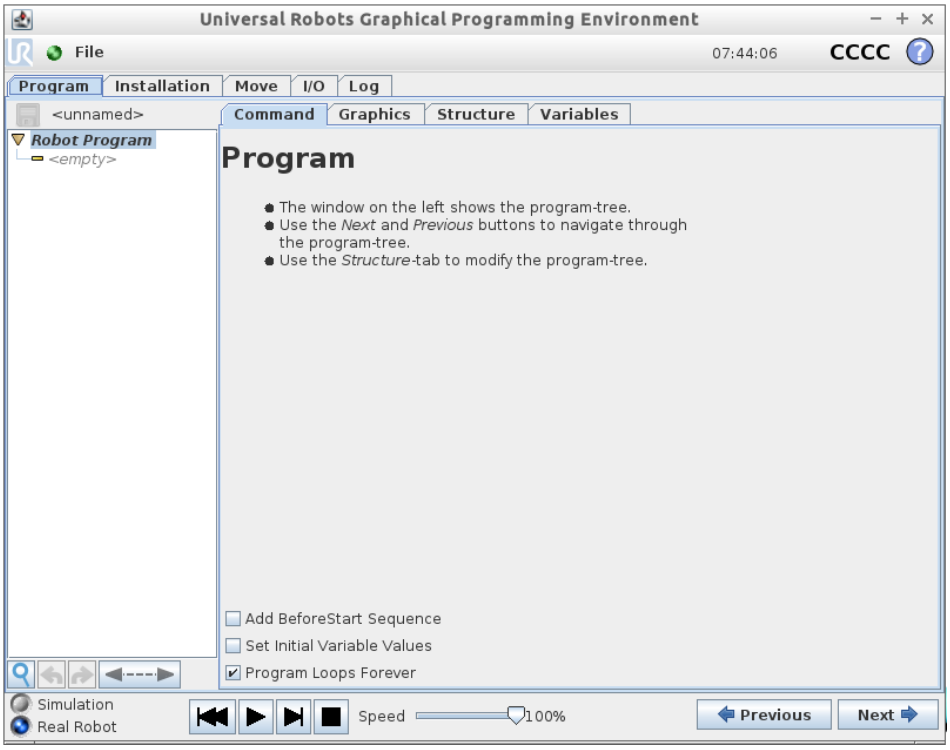
In order to access the commands, the user must complete the following steps:



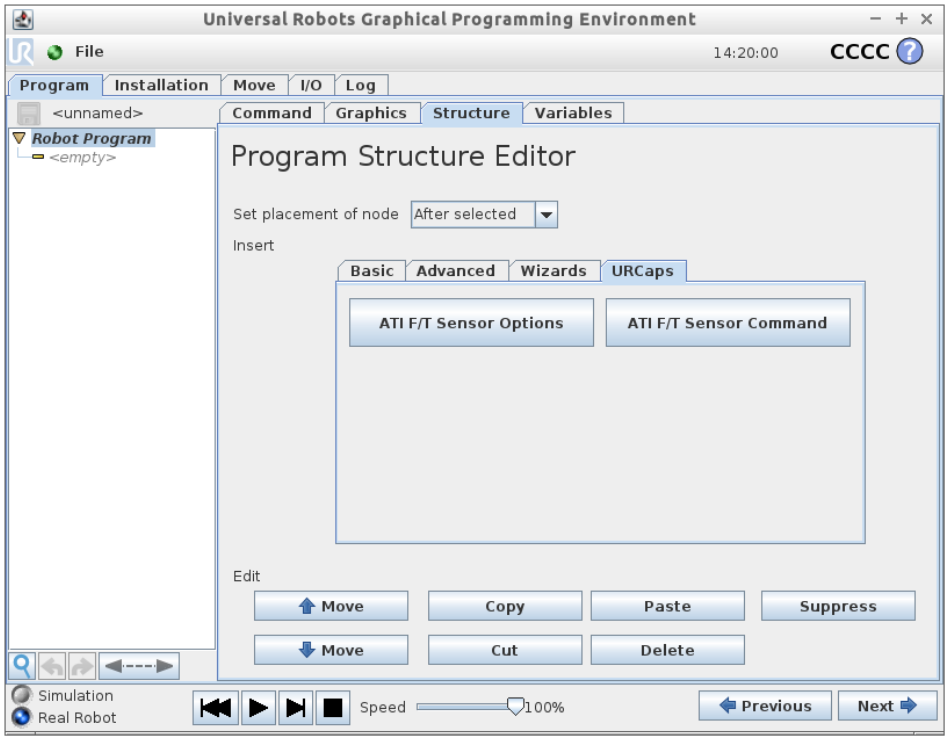
1. On the UR Teach Pendant, “PolyScope Robot User Interface” screen or main menu, click Program Robot.



2. The “New Program” screen displays. Click the "Empty Program" button.

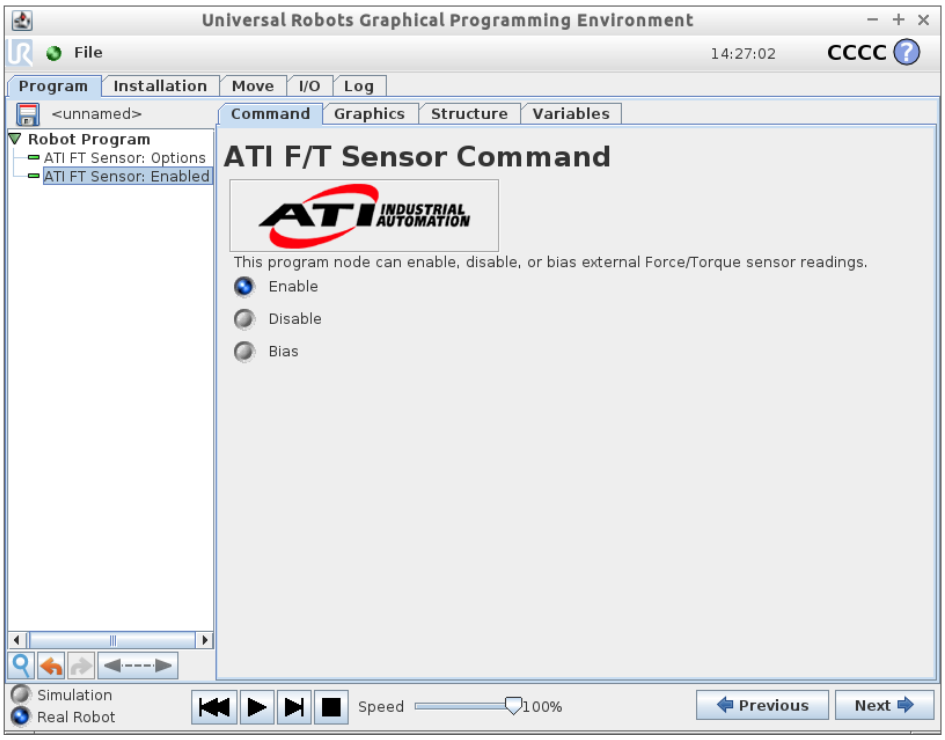


3. The “Program” screen appears. Click the Structure tab.



4. The “Program Structure Editor” screen appears.
   Click the URCaps tab.
5. Click the Program Node.
   - To access the Program Node Command, click the SCHUNK F/T Sensor Command button.
     i. Refer to Section Program Node Commands [▶ 26]
   - To access the Program Node Operations, click the SCHUNK F/T Sensor Options button.
     i. Refer to Section Program Node Options [▶ 28]

5.3.1 Program Node Commands



There are three Program Node Commands that the user can select by clicking on the radio button on the “F/T Sensor Command” screen.

5.3.1.1 Enable Command

The Enable command completes the following operations:

- streaming F/T data over the RDT interface on the sensor.
- forwarding the F/T data to the UR robot over the UR RTDE interface.
- using the F/T data in the UR program force feedback controls.

5.3.1.2 Disable Command

The Disable command completes the following operations:

- stops using F/T data from an F/T sensor.
- starts using the internal force sensing of the UR robot.

5.3.1.3 Bias Command

Biasing is useful for eliminating the effects of gravity (tool weight) or other acting forces from the force/torque data that is provided by the F/T sensor.

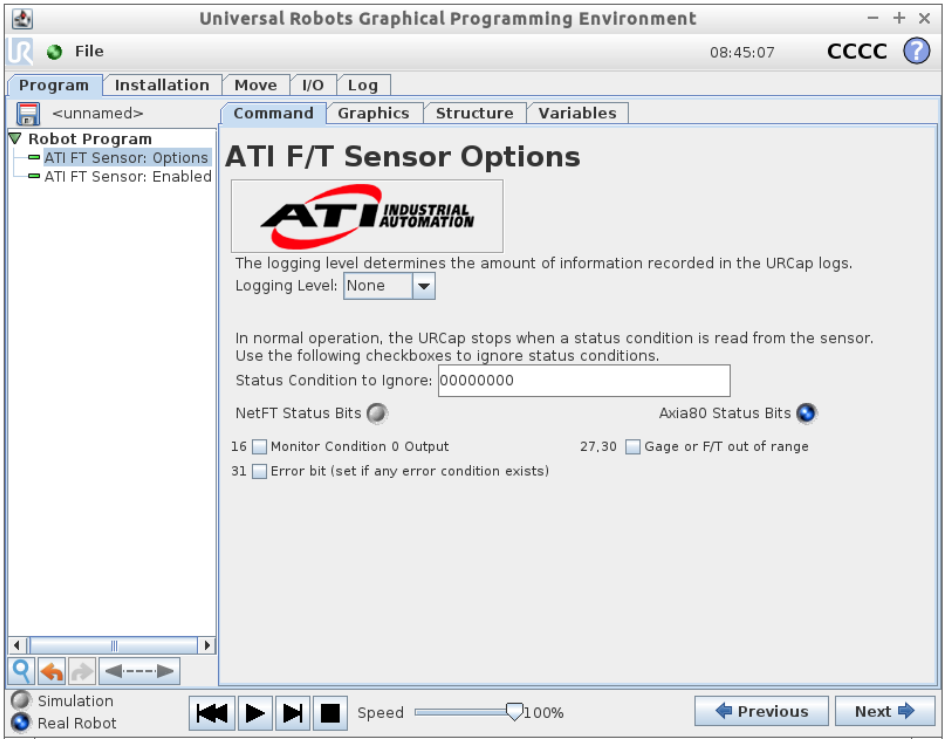
The bias command completes the following operations:

- data collection for the forces and torques, which are currently acting on the sensor.
- use collected data as a reference for future data.
- future data has this reference subtracted, before the values are transmitted.

NOTE

When biasing, ensure the force and torque readings are steadystate. Biasing while the sensor is vibrating, accelerating, or decelerating can provide a poor reference for the user's application.

5.3.2 Program Node Options



Under the Command tab and on the “F/T Sensor Options” screen, the user selects the Logging Level and Acceptable Status Conditions.

5.3.2.1 Logging Level

The Logging Level sets the type of information that the URCap software records in the log file on the UR controller and in the Polyscope Log tab. In Figure 4.7, when the user clicks on the down arrow, a drop down menu with all the logging levels appears. From the menu, the user can select the Logging Level. Refer to the following table for each of the (4) Logging Levels.

Level	Definition
None	No information will be recorded in the log file.
Error	Record information of errors that could cause the URCap to fail.
Warning	Record information of errors and warnings that could degrade the URCap performance.
Info	Record errors, warnings, and additional information about the URCap operation.

5.3.2.2 Logging File

The log file is located in GUI/felix-cache/bundleXX/data/com/ur/urcap/SCHUNK_FT/impl/ daemon/URlog.txt. Where bundleXX is the latest installation bundle. To view the log file, it is possible to SSH into the UR Controller. To copy the log file to another location, it is possible to SFTP to the UR Controller.

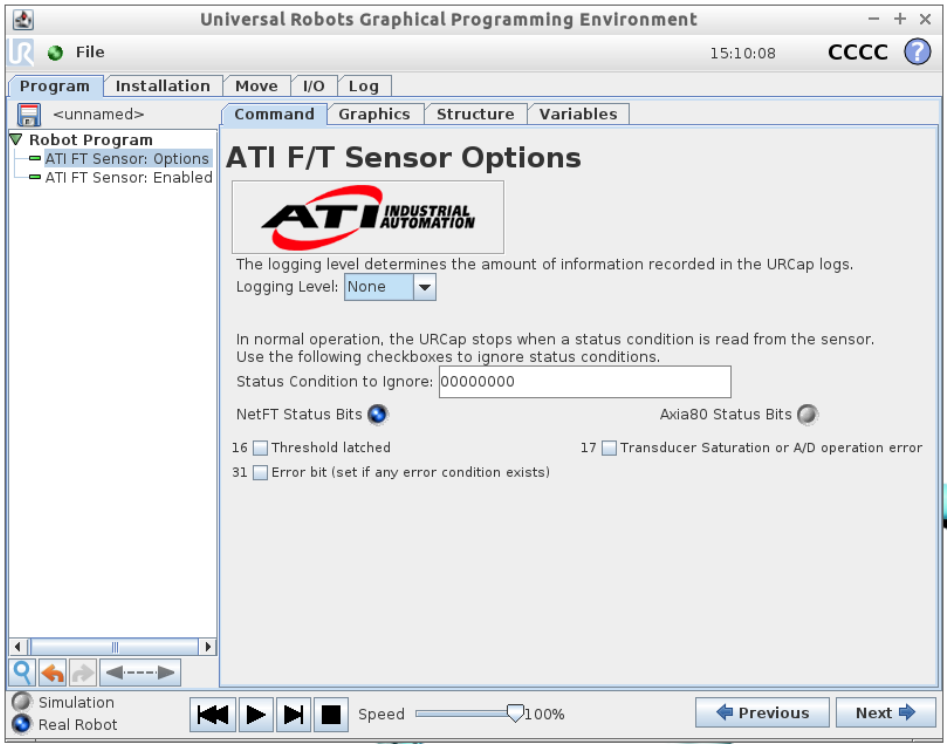
Table 4.3 lists messages written in the log for the applicable Logging Level.

Logging Level	Message	Description
Error	Unable to negotiate RTDE protocol version.	Universal Robots software version is less than 3.3.X and needs to be upgraded to 3.3.X or greater.
	Detected RTDE Setup Error.	Communication problem with UR controller.
	Detected RTDE Loop Error.	
	RTDE missed too many updates.	Communication problem with F/T sensor. The cable connections may not be secure or power is not supplied to the sensor.
	Detected F/T Setup Error.	
	Detected F/T Loop Error.	
	Invalid status condition: #.	F/T sensor has a status condition that is not ignored in F/T Sensor: Options. Reference the sensor manual for status codes or conditions.
Warning	RTDE protocol V2 not supported. Downgrading to RTDE protocol V1.	Universal Robots software version is 3.3.X and needs to be upgraded to 3.4.X or better.
	F/T data not updated since last check. previous sequence: #. current sequence: #.	Communications between F/T sensor and UR Controller are not perfectly synchronous.
	Long RTDE packet: #. RTDE Packet count: #.	Communication with UR Controller took longer than expected.
	New longest period between RTDE packets: #.	This is the longest period of time gone without communication with the UR controller.
	Connection Reset at #. Connection Reestablished at #. Time taken to Re-establish connection: #.	UR Controller reset the RTDE connection.
	Long packet: #. Packet count: #.	Communication with F/T sensor took longer than expected.
	New longest period between packets: #.	This is the longest period of time gone without communication with the F/T sensor.

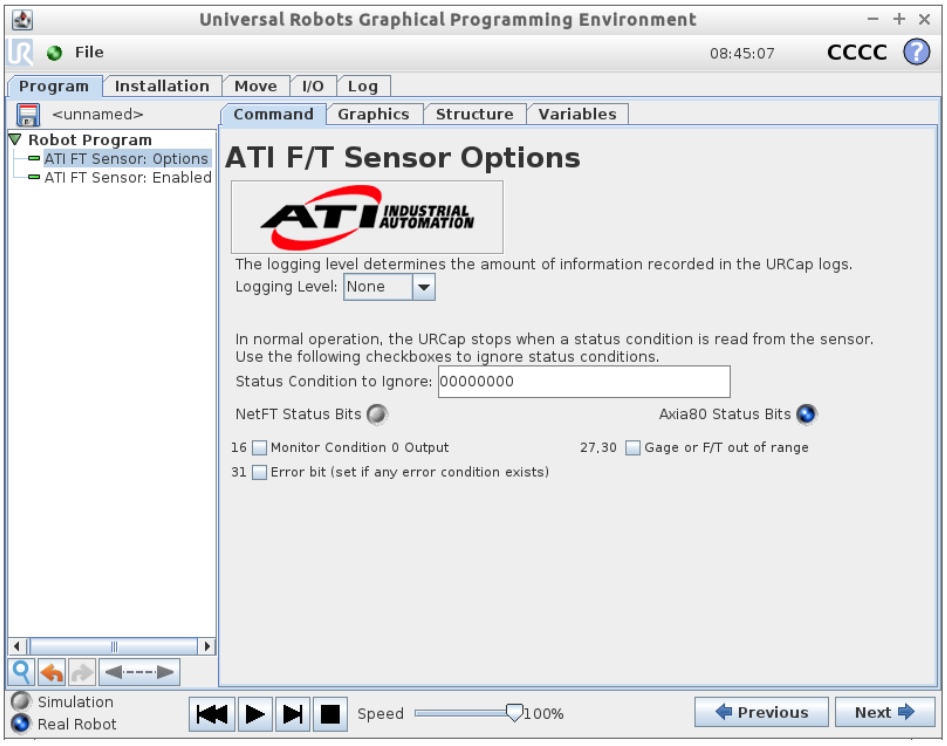
Logging Level	Message	Description
Info	RTDE Setup completed, entering F/T forwarding loop	The RTDE interface was successfully configured. Starting F/T communications.
	RTDE Thread safely closed. Time run: #.	URCap successfully stopped.
	F/T Setup completed, entering F/T forwarding loop.	The F/T sensor was successfully configured. Starting F/T communications.
	Time run: #. Loop iterations: #. Rate: #.	URCap operating information. Generated roughly every 10 seconds. Rate should be around 125 Hz.
	F/T Thread safely closed. Time run: #. Loop iterations: #.	URCap successfully stopped.

5.3.2.3 Acceptable Status Conditions

SCHUNK F/T sensors provide status conditions, status bits, to the UR robot, during operation. The user can set Acceptable Status Conditions so that the URCap software ignores the status condition and continues operation. The user sets Acceptable Status Conditions using the following steps:



Net F/T Status Bits



AXIA 80 Sensor Bits

- Under the Logging Level, click on the radio dial button for either Net F/T Status Bits or AXIA 80 Status Bits. Depending upon, the sensor selected, certain status conditions appear on the screen. Refer to the following figures.
- To turn the status bits to an Acceptable Status Condition, select the boxes for the status bits. For an explanation of the status bits refer the Ethernet AXIA manual for the AXIA 80 sensor and the Net FT for all other SCHUNK Ethernet sensors.

5.3.3 Protective Stop Error

Whenever communication between the sensor and the URCap software is lost, the error “Protective Stop C207A0: Fieldbus Disconnected” appears. Clicking on the Enable Robot button, attempts to re-estabilish communication. Verify that all cables are connected, and the sensor is powered.

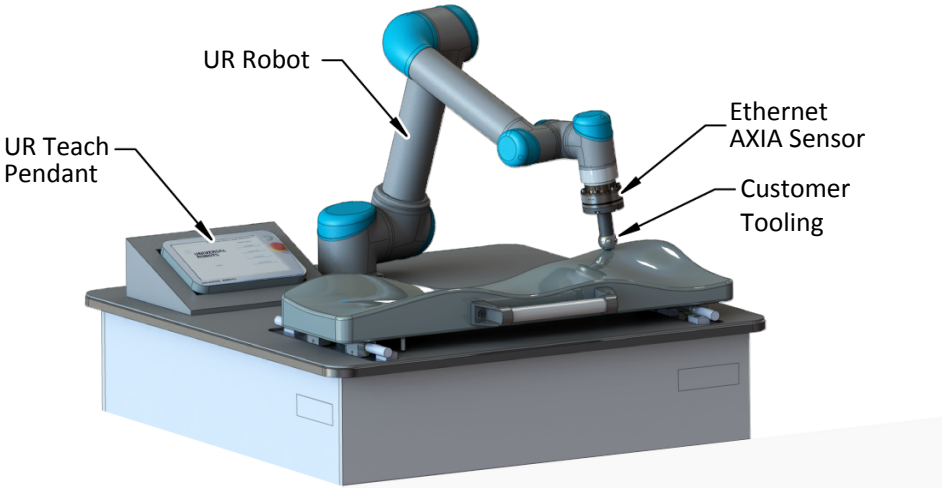
If one or both of the acceptable status conditions from Section Acceptable Status Conditions [▶ 32] are selected, then those status condition will be ignored and the UR robot does not stop with the following error message.

Protective Stop Error Message

6 Demo Programs

SCHUNK provides the following 2 demo program options for use with UR robots:

- a standard demo, which moves the robot and customer tooling across an uneven surface based on feedback from the SCHUNK F/T sensor. The file name is “SCHUNK Demo Program.urp”.
- a simple demo, which moves the robot down until attached customer tooling contacts a surface or a force greater than 2 N. The file name is “SCHUNK Simple Demo Program.urp”.



Demo featuring the AXIA 80 UR F/T System Components

The Demo consists of a robot, a sensor, a program loaded from a USB drive, a customer supplied tool, and an uneven surface.

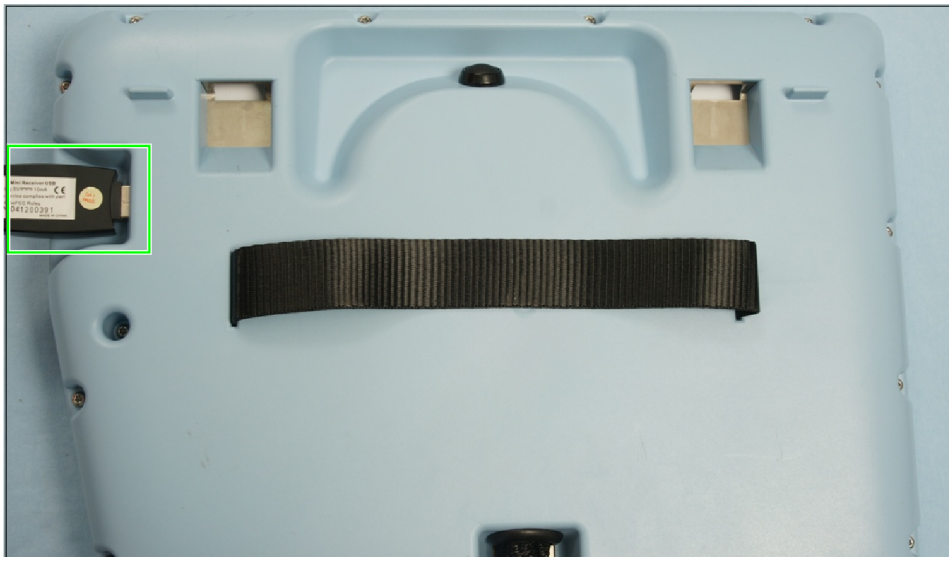
The following sections includes information on downloading, installing, and operating the demo programs.

6.1 Downloading Demo Programs

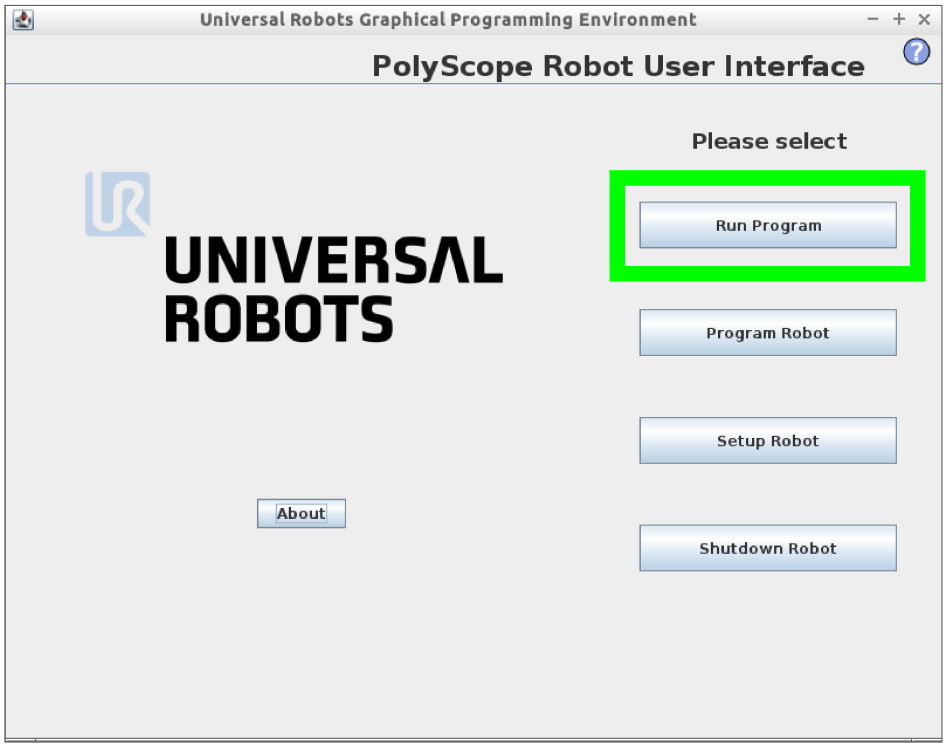
The Demo Program is included in the same package file that contains the URCap software.

6.2 Installing Demo Programs and Setting a Start Position

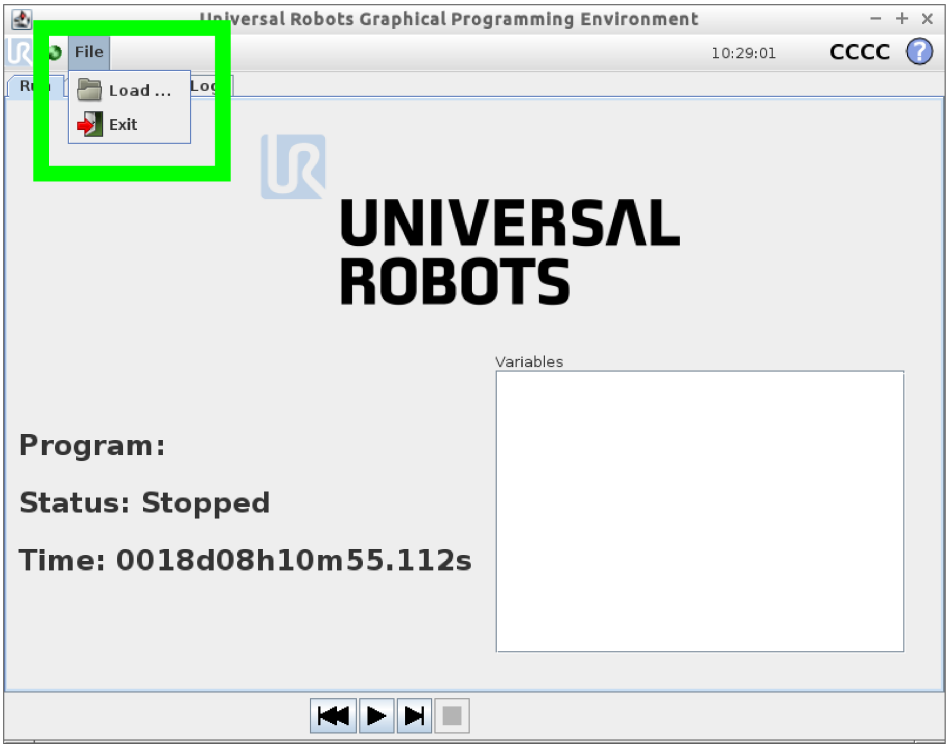
The Demo Programs are installed onto the UR Teach Pendent. The robot must be taught a Start position before operating the Demo Programs.



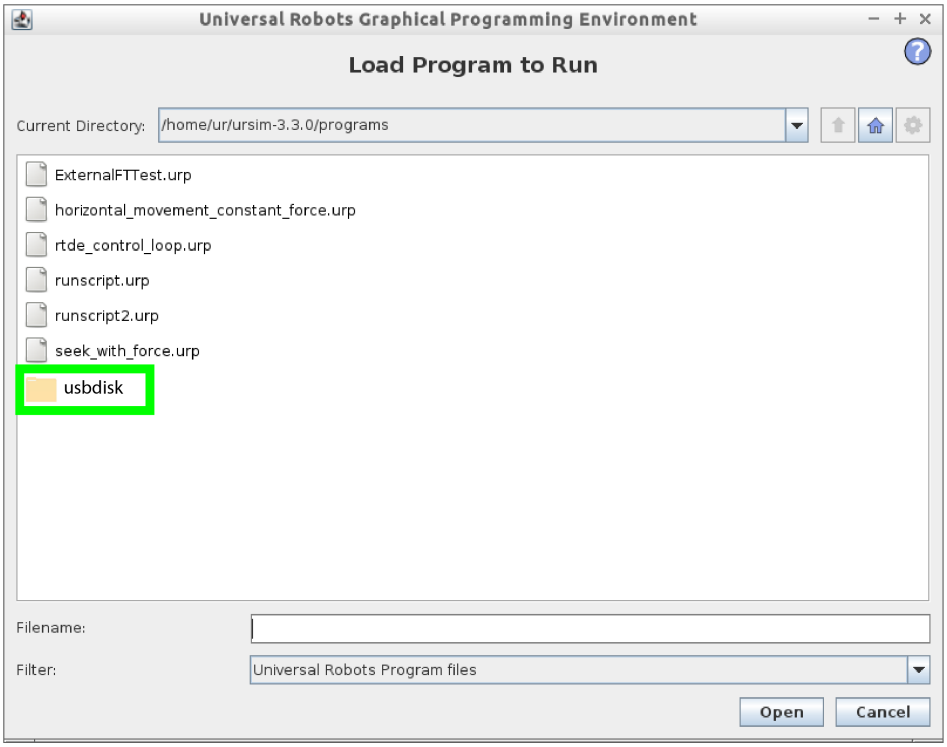
➢ Insert a USB stick that contains the Demo package into the USB port on the UR Teach Pendant.



➢ On the UR Teach Pendant, “PolyScope Robot User Interface” screen or the main menu, select "Run Program".



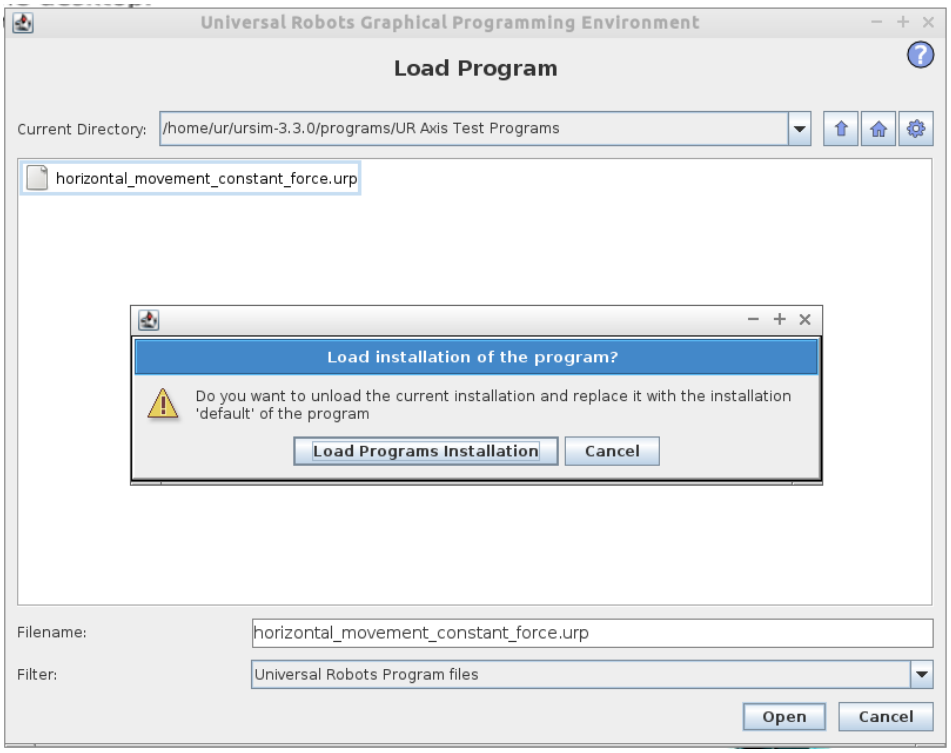
➢ On the Universal Robots Run Program Screen in the following figure, select File > Load.



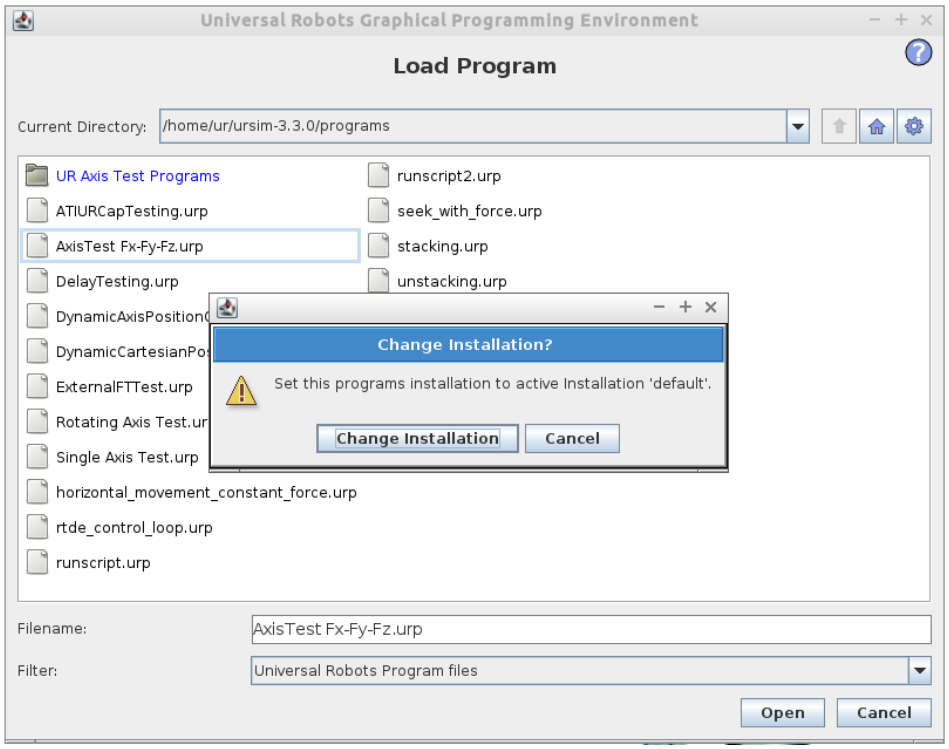
➢ Select the folder usbdisk.

➢ Double click the program or select the program > Open

✓ The Universal Robots Home screen, with program control buttons displays. The demo includes the SCHUNK default safety settings.

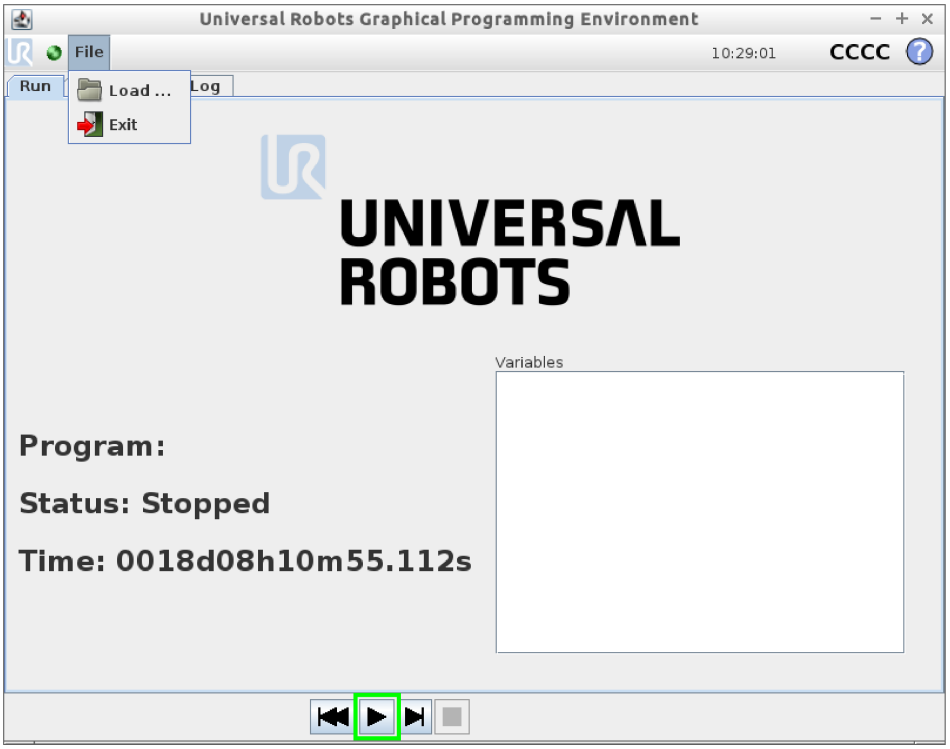


- If the customer's UR robot has different safety settings, the user is prompted to either load the default settings or keep the current safety settings.
  To use the SCHUNK default safety settings, click Load Programs Installation.
  To use current safety settings installed on the UR robot, click Cancel.
- If the user selects to not load the default settings, the following message appears.



✓ If the user selects Cancel, the user will be prompted to Load Programs Installation the next time the demo program is run.

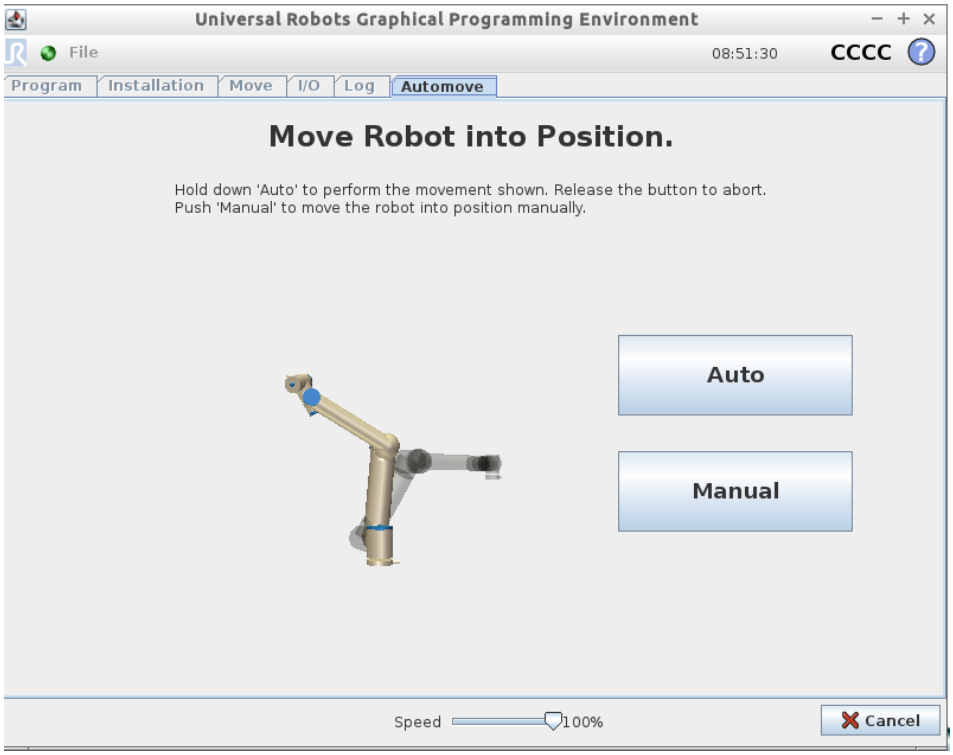
✓ If the user selects Change Installation, the default safety settings are not installed, and the user will not be prompted to Load Programs Installation the next time the demo program is run.



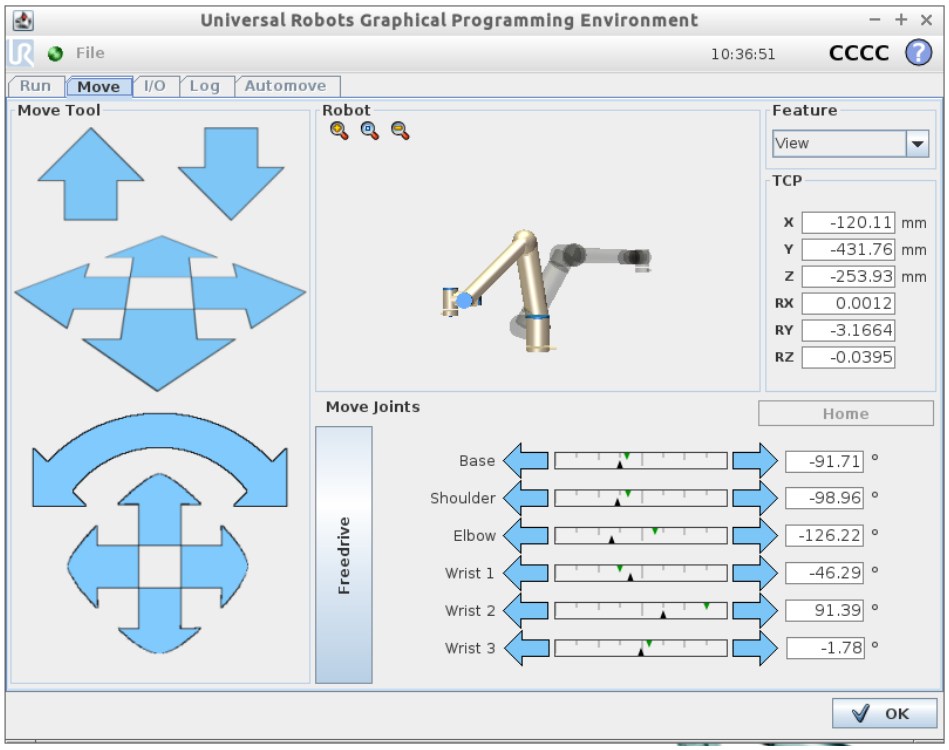
➢ The Universal Robots Run Program control screen displays. Click the Play button. The robot moves to a Start position.

NOTE

When the user plays the demo program, the robot will move to a Start Position. The user is prompted by the screen in the followig figure to either use the default Start Position or edit the demo program to teach the robot a new Start Position. Refer to the following step.



- Move the robot to a Start Position. The user can either use the default Start Position or edit the demo program to teach the robot a Start Position.**CAUTION When initially setting up the Demo Program, the user should move the robot manually in order to avoid damaging parts, especially the sensor cable**
- To use the default Start Position, click and hold "Auto" button.
  - ✓ The robot moves to the default Start Position and the Auto button becomes grayed out.
- To edit the demo program to teach the robot a Start Position, click "Manual".



- Under the Move tab, use the manual controls to move the robot to the Start Position. Click "Ok".
- After the robot moves to a Start Position, the Universal Robots Home Screen appears. Click "Play".

7 Operation

The following sections explain the operation of the Standard and Simple Demo Programs.

7.1 Standard Demo Program

The Demo program consists of the following steps:

- The robot arm is moved to its start position above the surface. **NOTICE! Steps 2 and 3 are the only commands created by the URCap Software plugin. All other steps are standard UR programming commands.**
- The F/T sensor starts sending force/torque data to the UR program.
- The program waits 1 second for the tool to settle, then biases the F/T sensor.
  CAUTION Steps 4 to 6, can use either the UR built-in F/T sensor data or the SCHUNK URCap data. The Demo Program uses the SCHUNK URCap data through the Enable command. The Demo Program does not use the Disable command. Refer to section Program Node Commands [▶ 26] for more information on the Enable, Disable, and Bias commands.
- The tool is moved straight down, until the sensor measures a force greater than 2 N or the tool touches the surface.
- The tool is pressed against the surface with 10 N of force and moved from the left side of the surface to the right. The robot adjusts the tool up and down to maintain 10 N of force as it travels across the surface.
- When the tool reaches the right side of the surface, it stops and then moves up to its checkpoint position.
- The process repeats in reverse. The tool moves down until it touches the surface, travels from the right side of the surface to the left at 10 N, and lifting up.
- This program loops until stopped.

NOTE

SCHUNK F/T Sensors provide status conditions to the robot. Refer to Acceptable Status Conditions [▶ 32] for Acceptable Status Conditions that the user can set the URCap software to ignore so that the UR robot continuously operates.

7.2 Simple Demo

The Simple Demo consists of the following steps:

- The Simple Demo Program moves the end of the robot arm straight up and down.
- If the sensor detects the force of the robot arm moving down onto an object, the robot arm stops and moves upwards again. **NOTICE! The Simple Demo Program stops when the sensor detects a force greater than 2 N**.
- This motion repeats until the program is stopped.

8 Troubleshooting

This section includes answers to some issues that might arise when setting up and using the SCHUNK UPCap software. The question or problem is listed followed by its probable answer or solution. They are categorized for easy reference.

The information in this section should answer many questions that might arise in the field. Customer service is available to users who have problems or questions addressed in the manuals.

NOTE

Please read the manual before calling customer service. Before calling, have the following information available:

1. Serial number (e.g., FT01234)
2. Transducer model (e.g., AXIA, etc.)
3. Calibration (e.g., US-15-50, SI-65-6, etc.)
4. Accurate and complete description of the question or problem
5. Computer and software information. Operating system, PC type, drivers, application software, and other relevant information about your configuration.

If possible, be near the F/T system when calling.

8.1 Errors with the URCap Software

Question/Problem	Answer/Solution
After clicking Start Daemon on the “SCHUNK Force/Torque Sensor screen “during the URCap Software Setup, an error message “SCHUNK FT Daemon failed” appears.	The SCHUNK F/T Sensor IP Address entered may be incorrect. Verify the IP address and reenter Setting up URCap Software [▶ 14].
During operation, a “Protective Stop” error message appears.	There has been a loss of communication between the sensor and the URCap software. Verify that all cables are connected, and the sensor is powered. Select the Enable Robot button on the error message to re-establish communication Protective Stop Error [▶ 33].
The UR is not using data from an SCHUNK F/T sensor that the user installed on the robot arm.	Verify that the Enable command is selected Program Node Commands [▶ 26].
The URCap software is malfunctioning.	Another method to review the activity of the URCap software is to make sure a Logging Level is set and reference the logging file for details Logging Level [▶ 29] and Section 4.3.2.2—Logging File [▶ 29].
The SCHUNK F/T AXIA 80 sensor is malfunctioning.	Refer to the Ethernet AXIA manual.
The SCHUNK NET F/T sensor is malfunctioning.	Refer to the NET FT manual.