

Aruna Motion URCap for Polyscope e-Series User Manual

3rd Issue
U.S. English

**ARUNA
ROBOTICS**
a division of 3D INFOTECH

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2 Document Conventions

2.1 Highlighted Blocks of Information

	Safety-related content (Red left margin)		Important content (Yellow left margin)
	Summary (Green left margin)		Tips and tricks (Blue left margin)

3 About this Document

3.1 Document Properties

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3.2 Disclaimer



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3.5 Standards



USEFUL INFO

This document has been prepared by following the guidelines described in these documents as applicable:

IEC/IEEE 82079-1:2019 International Standard

3.6 Terms and Definitions

- **Manual**
This document.
- **URCap, Product**
The 'Aruna Motion URCap' plug-in software presented in this Manual.
- **Controlled Hardware**
The device which is controlled by the Product.
- **Customer**
Individual or organization that purchases or receives the Product.
- **Supplier**
The individual or organization that provides the Product.
- **Manufacturer**
The individual or organization that created the Product.
- **Skilled Person**
A person, who has acquired through education, training, qualifications or experience, the required knowledge and skills, enabling that person to perform a specified task.

4 Change History

Issue	Date	Changes	Pages Changed	Document ID
1 st (A)	2021-04-22	None	All	PM21126-AUS
2 nd (B)	2022-05-18	<ul style="list-style-type: none">Anatomy of a Typical programConveyor added	<ul style="list-style-type: none">17-1827-35	PM21126-BUS
3 rd (C)	2022-10-27	<ul style="list-style-type: none">Specified for Universal Robots E-Series	All	PM21126-CUS

5 Product Description

Aruna Motion URCap is a software product to operate devices, like rotary tables and linear rails, which are based on the Astaire firmware and driven by Astaire-compatible motion controller.

Aruna Motion URCap can be installed only on Polyscope, the operating system of robots manufactured by Universal Robots.

Astaire-controlled devices are products of 3D Infotech, Inc.

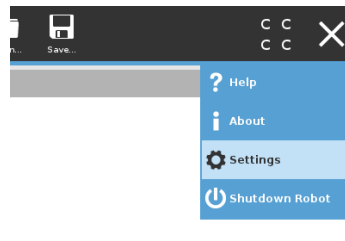
6 Commissioning

6.1 Prerequisites

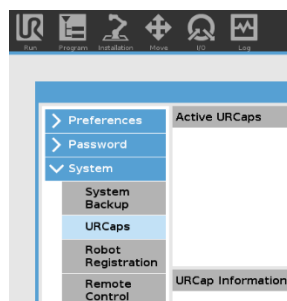
1. Universal Robots UR3, 5, 10 or other, e-Series robot made by Universal Robots
2. Polyscope 5.8 or later installed on robot controller
3. 3D Infotech or Aruna Motion rotary table, controlled by Astaire firmware
4. Astaire firmware 1.3.4 or later installed on the rotary table
5. If relative positioning functions are required, Astaire firmware 4.3.18 or later installed on rotary table
6. Ethernet connection between robot and rotary table on the same LAN

6.2 Install URCap

1. Receive the Aruna Motion URCap file from a 3D Infotech or Aruna Robotics representative
2. Copy the file named "ArunaMotion-1.0.0.urcap" to a portable drive which has USB interface toward hosts (portable USB hard drive or USB stick)
3. Insert the portable drive in the robot's pendant's USB port (top-right corner of the display)
4. On robot pendant, click on the button with the three horizontal lines, at the top-right corner, then click on the "Settings" menu item



5. On the left panel, click on the "System" item, then click on the "URCaps" item



6. At the bottom, click on the "+" button, select the removable drive containing the URCap file
7. Locate and select the URCap file, then click on the "Open" button
8. Restart the robot by clicking on the "Restart" button

- Installation of Aruna Motion URCap is now complete

6.3 Set Up the Rotary Table

6.3.1 Establish Control Connection

- Switch the rotary table ON
- On the top menu, click on the "Installation" button
- On the left panel, click on the "URCaps" item
- Click on the "Accept the End User License Agreement" button, if you accept the terms shown in the document displayed
- The Installation tab shows up. This page is used to manage the connections to the supported hardware device, and to show various parameters when connected.

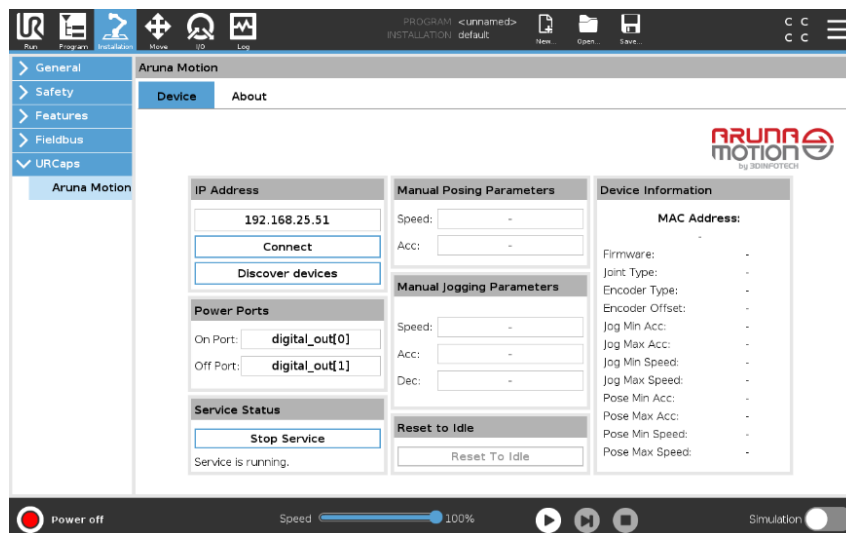


Figure 6-1 Installation tab when device is disconnected

- Click on "Discover devices" button to find any devices supported by URCap, on the network

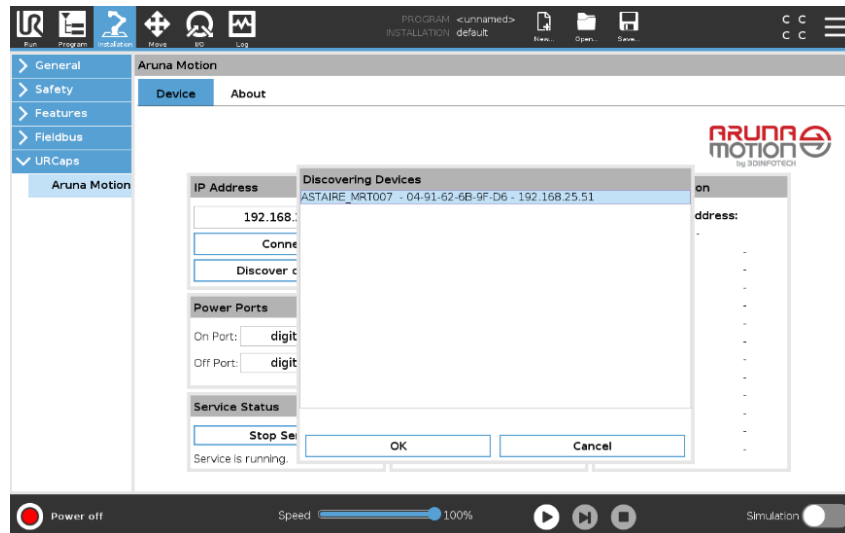


Figure 6-2 Discovering Devices

7. Select the device you want to control with the URCap, then click the "OK" button.
If the proper device does not show up on the list, troubleshoot the Ethernet connections.



Discovery function uses the ICMP protocol to find supported devices.

The IP Address of the device can be changed in a web browser, by opening the device's embedded website. Point your browser to the IP Address shown in the "Discovering Devices" dialog

8. Click the "Connect" button. Upon successful connection to the rotary table, the "Operational" blue LED should lit up, and "Device Information" panel should be populated with current parameters of the rotary table.

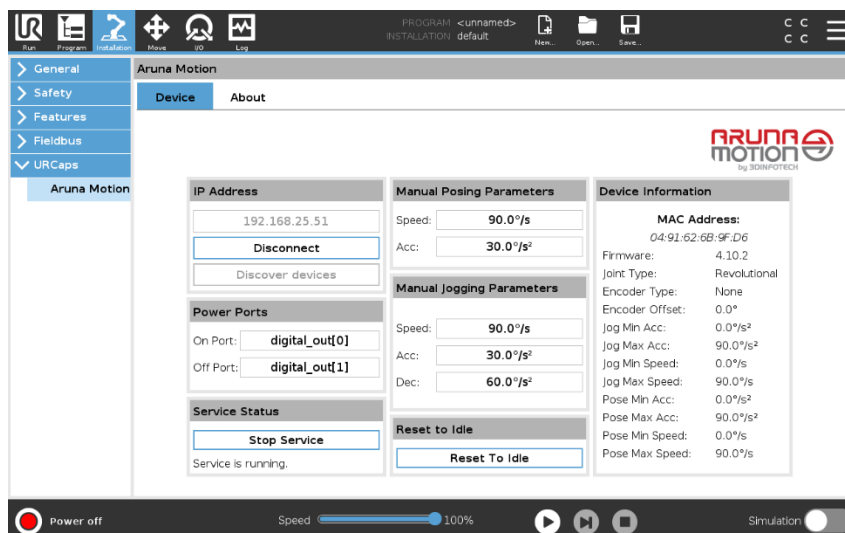


Figure 6-3 Installation tab when device is connected

6.3.2 Set Up Remote Power Control (Optional)

9. If rotary table supports remote power control, the assigned GPIO ports of the robot must be specified. For details on wiring the rotary table and robot to support remote power control, please, refer to the rotary table user manual.

6.3.3 Set Safe Limits

10. Manual posing and jogging functions are available during creation of robot programs. Set a safe limit for those functions on the Installation tab, "Manual Posing Parameters" and "Manual Jogging Parameters" panels. These values cannot be set greater than the similar limits available on the rotary table. "Device Information" panel shows the limits of the rotary table.



Get recommended safe limit values from the workplace's safety officer.

11. Set up of URCap is now complete

7 Programming



It is prohibited to perform operations with URCap, which would cause a safety hazard.

The Programmer and the Operator of Product must read, understand and follow all safety-related information contained in the manuals of the controlled hardware. This chapter assumes that the Skilled Person has the knowledge to write robot programs on the Universal Robot's controller.

Please refer to the controlled hardware user manuals for safety-related hazards.

7.1 Anatomy of a Typical Program

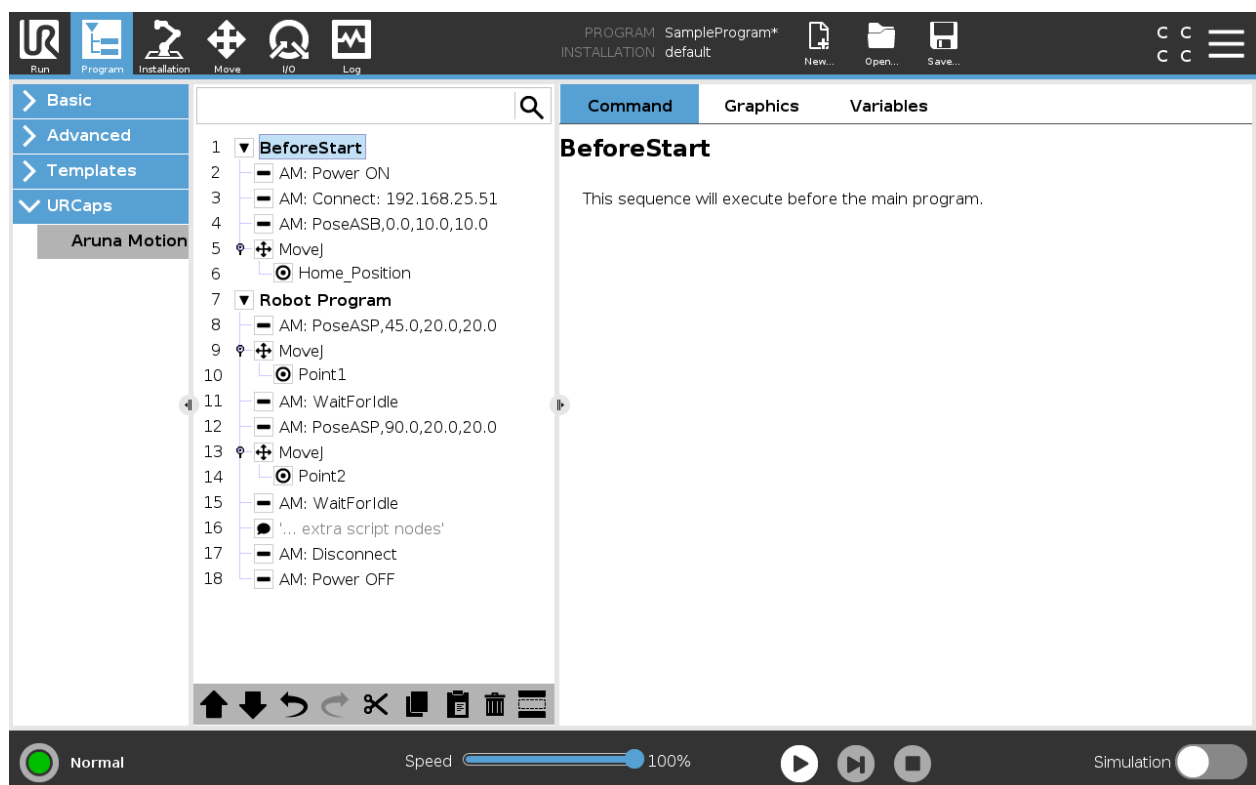


Figure 7-1 Anatomy of a Typical Program

1. BeforeStart

- a. **AM: Power ON - (optional)**
Switches the rotary table ON
- b. **AM: Connect <rotary IP address>**
Program connects to the rotary table
- c. **AM: PoseASB <angle>,<speed>,<acceleration>**
Rotary table moves to target (in this case this is the home position) position (Absolute, Speed-based, blocking)
- d. **MoveJ**

- i. **Home_Position**

- Robot performs movements to reach starting position

- 2. **Robot Program**

- a. **AM: PoseASP <Angle>,<Speed>,<Acceleration>**

- Rotary table starts to move to **first** target position (Absolute, speed-based, parallel (robot will start moving in the next command immediately))

- b. **MoveJ**

- i. **Point1**

- Robot performs movements to reach **first** target position, at the same time the rotary table started moving in previous command

- c. **AM: Wait for Idle**

- Waits until rotary table has fully stopped

- d. **AM: PoseASP <Angle>,<Speed>,<Acceleration>**

- Rotary table starts to move to **second** target position (Absolute, speed-based, parallel (robot will start moving in the next command immediately))

- e. **MoveJ**

- i. **Point2**

- Robot performs movements to reach **second** target position, at the same time the rotary table started moving in previous command

- f. **AM: Wait for Idle**

- Waits until rotary table has fully stopped

- g. **AM: Disconnect**

- Closes the connection with the device

- h. **AM: Power OFF - (optional)**

- Switches the rotary table OFF

8 URCap Commands

Creating programs for the controlled hardware is performed on the same page, where the robot is programmed.

1. Click on the "Program" tab to open the program page
2. On the left panel, click on "URCaps" then "Aruna Motion" whenever you want to insert a command for performing actions using the Aruna Motion URCap-compatible hardware.

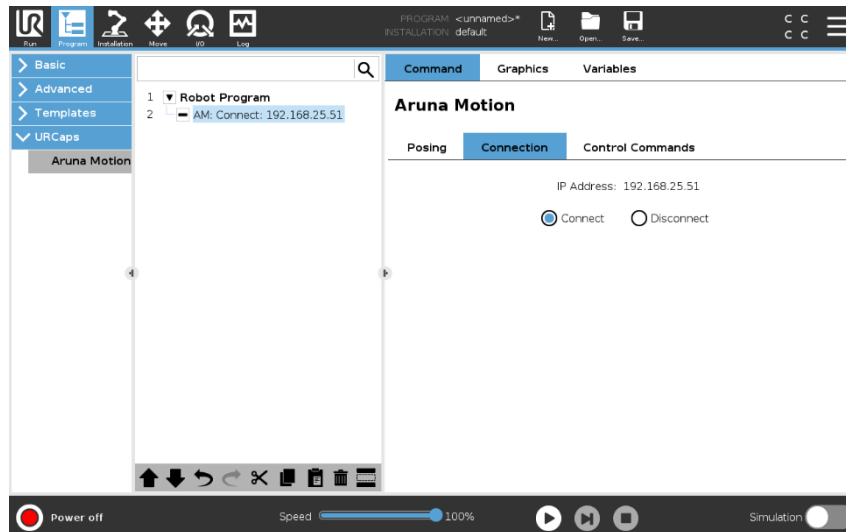


Figure 8-1 Connections

It is recommended to start the program with an "AM: Connect" command, which ensures that the controlled hardware is switched ON.

Whenever the controlled hardware needs to be switched OFF, use the "AM: Disconnect" command.



USEFUL INFO

Not all Aruna Motion URCap-compatible, Astaire firmware-controlled hardware is capable to understand these commands. Please, refer to the controlled hardware's user manual to confirm this capability.

8.1 Posing

Posing commands are the ones used the most frequently. It is important to understand the difference between:

1. Absolute targeting vs. Relative targeting
2. Speed-based vs. Time-based posing
3. Parallel vs. Blocking execution

The name of entry in the robot program is built as follows:

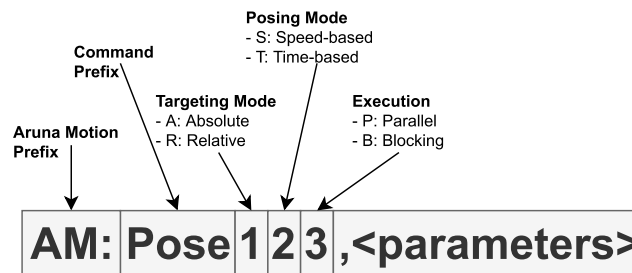


Figure 8-2 Structure of Posing name

8.1.1 Absolute Targeting

When "Absolute target" radio button is selected, the target pose is always the same, absolute value, regardless of the starting pose.

8.1.2 Relative Targeting

When "Relative target" radio button is selected, the target pose depends on the starting pose. The actual target pose is calculated by adding the starting pose and relative target input parameter together.

8.1.3 Speed-Based Posing

In a Speed-Based command, the programmer specifies the target pose, the maximum speed during posing, and the acceleration/deceleration values. The time needed to perform the posing is then calculated based on these inputs.

The maximum allowed speed and acceleration/deceleration values are set in the Astaire motion controller's firmware.

8.1.4 Time-Based Posing

In a Time-Based command the only input parameter is the time period, in which the controlled hardware should perform the posing. This command is useful, when a posing needs to be performed in a certain time period.

There is a possibility that the posing cannot be performed in the specified time period. In this case an error message pops up, displaying the problem with the desired operation, and the actual minimum time required to perform the posing, based on the parameters and limits set:

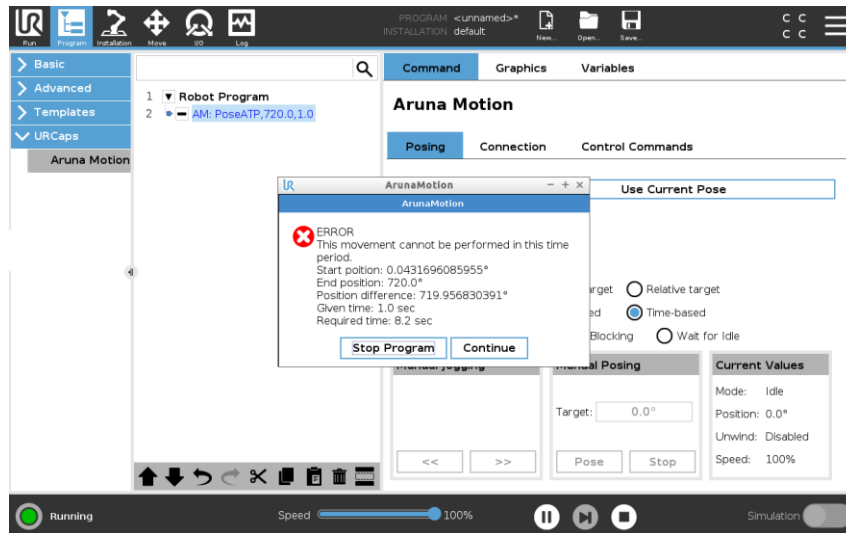


Figure 8-3 Error Message

8.1.5 Parallel Execution

This execution mode allows the robot and controlled hardware perform posing at the same, in parallel.

Using this mode makes the posing to start on the controlled hardware, and script continues to perform the next commands immediately (posing the robot, for example, in the same time period, which was set for the controlled hardware)

For safety reason, it is strongly recommended to add a "Wait for Idle" command after the posing commands of the controlled hardware and the robot, to ensure, that both devices have stopped, before continuing program execution.

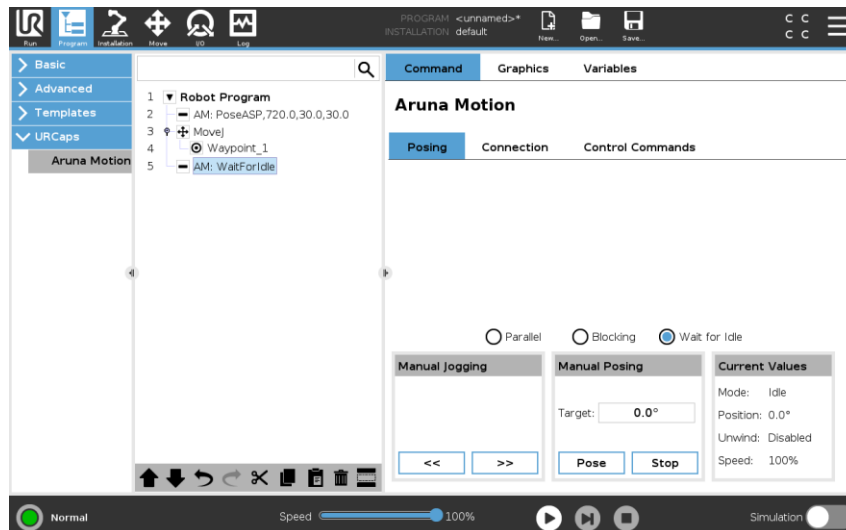


Figure 8-4 Typical commands for parallel execution

8.1.6 Blocking Execution

This execution mode makes the command wait until the controlled hardware is done with the posing operation.

8.1.7 Wait for Idle

This command waits until the controlled hardware stops completely.

8.2 Manual Functions

These functions are helping to make programming easier.

8.2.1 Manual Jogging

Keep one of the two jog buttons down to start and keep posing the controlled hardware in a direction.

8.2.2 Manual Posing

Enter the desired target value and click on the "Pose" button to start posing the controlled hardware. Press the "Stop" button if there is a potential hazard during this posing, or when the desired pose has been reached or overshoot.

8.3 Control Commands

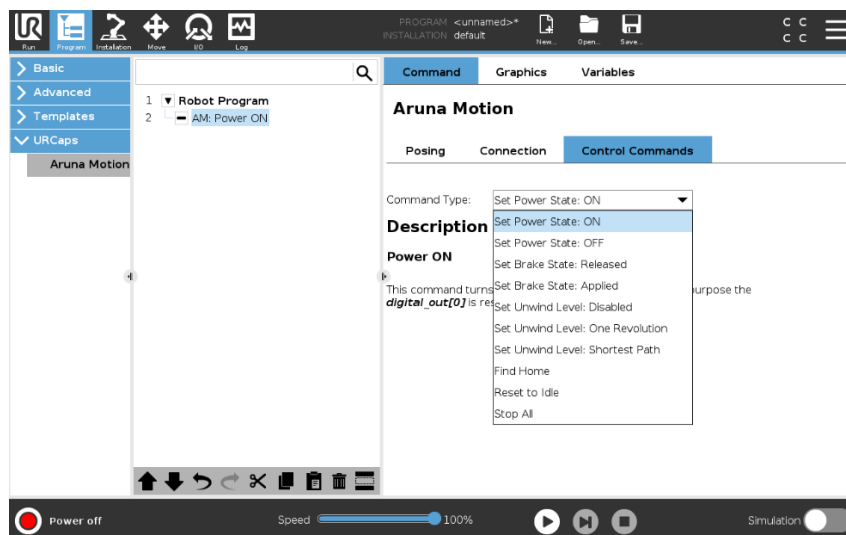


Figure 8-5 Command Types

8.3.1 Set Power State: ON

If controlled hardware has remote power ON/OFF capability, and the proper electrical connections are established, this command switches the controlled hardware ON.

8.3.2 Set Power State: OFF

If controlled hardware has remote power ON/OFF capability, and the proper electrical connections are established, this command switches the controlled hardware OFF.

8.3.3 Set Brake State: Released

If controlled hardware is equipped with built-in brake, this command releases (disengages) that brake.

8.3.4 Set Brake State: Applied

If controlled hardware is equipped with built-in brake, this command applies (engages) that brake. While the brake is applied, no posing operation can be performed on the controlled hardware.

8.3.5 Set Unwind Level

- **Disabled**
Posing is performed without any optimization. For example, posing from 0 deg to 800 deg causes a rotary table to turn two full revolutions plus 80 deg in CCW direction.
- **One Revolution**
The actual rotation is always less than 360 deg. For example, posing from 0 deg to 800 deg causes a rotary table to turn 80 deg in CCW direction, skipping two full revolutions.
- **Shortest Path**
The actual rotation is always less than 180 deg. For example, posing from 0 deg to 630 deg causes a rotary table to turn 90 deg in CW direction, skipping one full revolution.



This mode's direction depends on which is the shorter path to reach the target pose. In this case the target is closer in CW direction than in CCW direction, so CW direction is used.

8.3.6 Find Home

If the controlled hardware is not equipped with an absolute encoder, this command should be executed after every power cycle. In that case it is recommended to use this command in the "Before Start" section of the robot program.

8.3.7 Reset to Idle

This command performs an immediate stop, if controlled device was posing. This command puts a considerably large amount of stress on the controlled hardware, the fixture and the mounted part. It is recommended to check that the fixture and part were not moved away from the desired locations after this command was executed.

8.3.8 Stop All

This command performs a controlled stop. The current acceleration / deceleration settings are used in this operation.

9 Reference

9.1 Installation - Device Tab

9.1.1 IP Address Panel

- **"IP Address" textbox**
Shows the currently controlled hardware's IP Address.
- **"Connect" / "Disconnect" button**
Connects or disconnects the hardware at IP Address shown.
- **"Discover devices" button**
Shows a dialog box with list of devices, which are reachable on the network and can be controlled with the URCap.

9.1.2 Power Ports Panel

If the controlled hardware supports remote power ON/OFF signals and it has been wired to robot controller properly, you can set the robot's GPIO signals here.

- **"On Port" textbox**
Select the robot's GPIO pin which switches the controlled hardware ON.
- **"Off Port" textbox**
Select the robot's GPIO pin which switches the controlled hardware OFF.

9.1.3 Service Status Panel

A service must be running in order to be able to control the compatible hardware

- **"Start Service" / "Stop Service" button**
Use this button to start or stop the service.
- **Service status label**
Shows the status of service

9.1.4 Manual Posing Parameters Panel

- **"Speed" textbox**
Set the speed here, which will be used during programming, when manual posing buttons are used.
- **"Acc" textbox**
Set the acceleration / deceleration here, which will be used during programming, when manual posing buttons are used.

9.1.5 Manual Jogging Parameters Panel

- **"Speed" textbox**
Set the speed here, which will be used during programming, when manual jog buttons are used.
- **"Acc" textbox**
Set the acceleration here, which will be used during programming, when manual jog buttons are used.
- **"Dec" textbox**
Set the deceleration here, which will be used during programming, when manual jog buttons are used.

9.1.6 Reset to Idle Panel

- **"Reset to Idle" button**
Press this button to stop the controlled device immediately (if posing), and to clear any errors.

9.1.7 Device Information Panel

These values are read from the connected controlled hardware. You can change many of these values by opening the IP Address of controlled hardware in a web browser. Please, refer to Astaire User Manual for further details.

- **"MAC Address" label**
Displays the globally unique network address of the controlled hardware.
- **"Firmware" label**
Displays the version of Astaire firmware of the controlled hardware.
- **"Joint Type" label**
Displays the type of joint on the controlled hardware.
- **"Encoder Type" label**
Displays the type of the encoder, which provides positional data for the controlled hardware.
- **"Encoder Offset" label**
Factory-set value to calibrate the built-in encoder.
- **"Jog Min Acc" label**
Minimum acceleration / deceleration limit for jogging.
- **"Jog Max Acc" label**
Maximum acceleration / deceleration limit for jogging.
- **"Jog Min Speed" label**
Minimum speed limit for jogging.
- **"Jog Max Speed" label**
Maximum speed limit for jogging.
- **"Pose Min Acc" label**
Minimum acceleration / deceleration limit for posing.
- **"Pose Max Acc" label**
Maximum acceleration / deceleration limit for posing.

- **"Pose Min Speed" label**
Minimum speed limit for posing.
- **"Pose Max Speed" label**
Maximum speed limit for posing.

9.2 Installation – Conveyor Settings

Aruna Motion device supports PolyScope's Conveyor tracking function as a circular conveyor. For using this, the rotary table has to be calibrated for the accurate position and orientation.



Before using this function, make sure that the right installation is loaded with the correct calibration parameters.

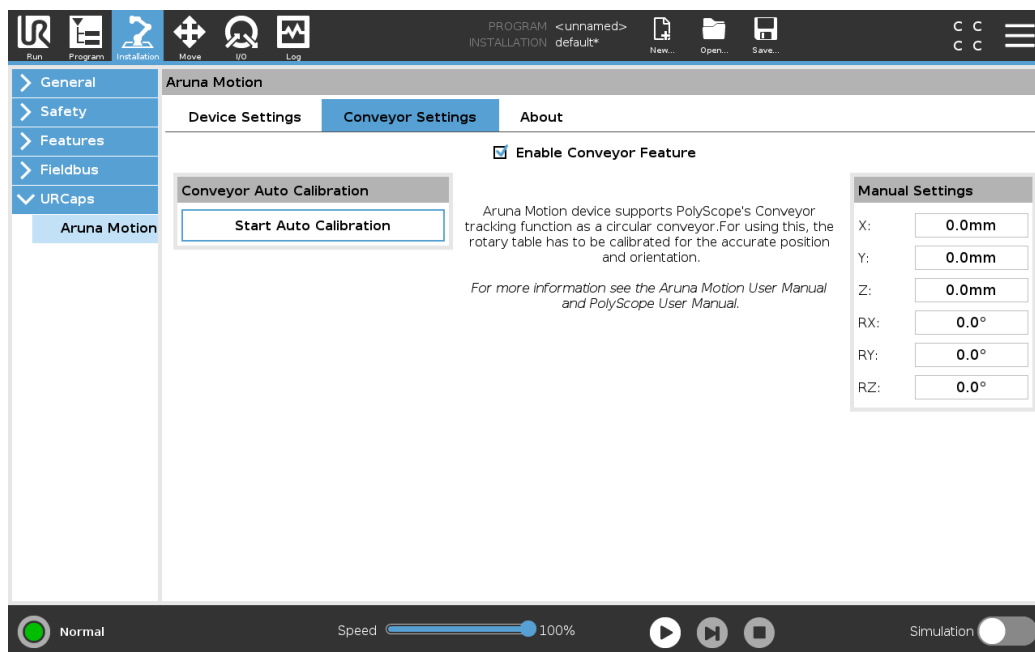


Figure 9-1 Conveyor Settings Tab

9.2.1 Enable Conveyor Feature

This option can enable or disable this feature. When this is enabled, a new feature appears under the Features tab called "AMConveyor". This feature represents the rotary plate's center point and orientation as well. The X and Y axes are parallel to the rotary table and the Z axis is perpendicular and leads inside the plate. This is shown in the GUI by a blue arrow. The parameters of this feature are stored in the installation. For saving and restoring the installation please see the PolyScope User Manual. Disabling will remove this feature from the installation.

9.2.2 Conveyor Auto Calibration

This group is responsible for Auto Calibrating. For more information see the related chapter.

9.2.3 Manual Settings

When the rotary table's relative position and orientation to the robot's base are known information than the Auto Calibration process is unnecessary. In this case the X, Y, Z parameters are used for offsetting the coordinate system of the rotary table from the robot's base point. The RX, RY, RZ parameters are rotation vectors, and they represent the orientation of the rotary plate. Aruna Motion URCap supports every orientation that can be performed by these parameters.



Manually typed in values are not checked for target reachability. For false parameters that represents an unreachable position the robot can make unpredictable movements!

9.3 Installation – About Tab

9.3.1 About Panel

- **"Version" label**
Displays the version of the URCap installed on the robot controller.
- **"Type" label**
Displays the type of the URCap installed. For production, only use the URCap, which shows "Stable" here.

10 Conveyor Calibration Processes

10.1 Pre Requirements

10.1.1 Conveyor Tracking Setup

This feature uses the PolyScope's Conveyor tracking function. This function has some parameters that has to be set before getting started. After enabling the Conveyor Feature, set the following parameters for the appropriate operation.

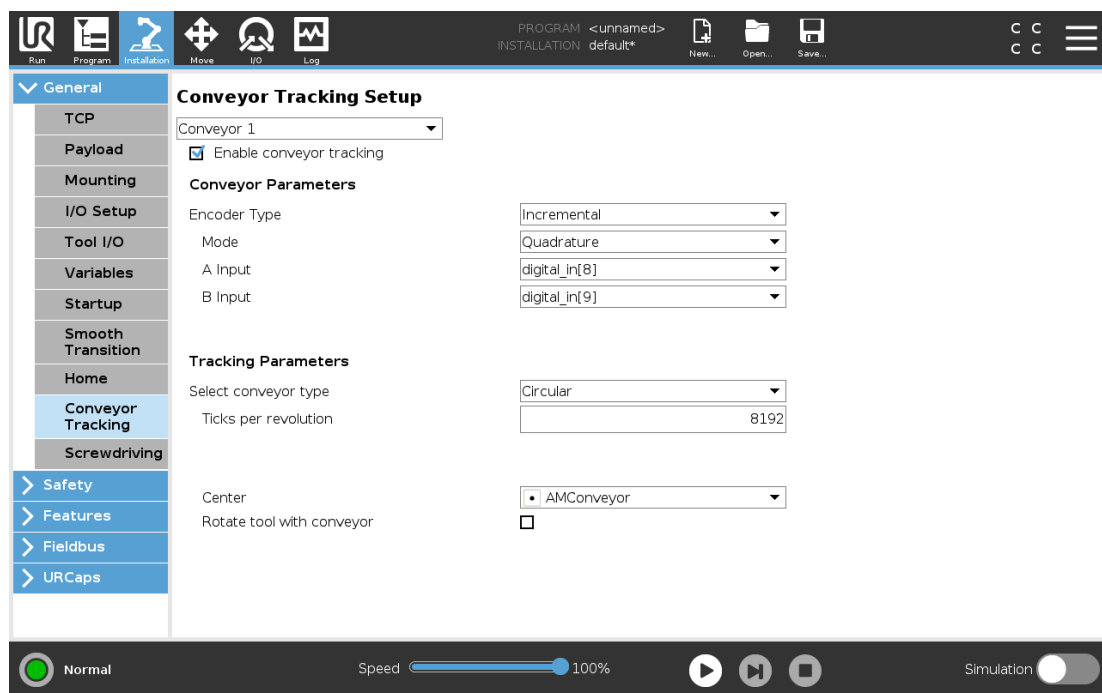


Figure 10-1 Conveyor Tracking parameters

- Encoder Type: Incremental
- Mode: Quadrature
- A input: The A Input wire that is connected to the robot controller. For more information see the wiring diagram.
- B input: The B Input wire that is connected to the robot controller. For more information see the wiring diagram.
- Conveyor Type: Circular
- Ticks per revolution: 8192
This means that the minimum rotating distance is ~0.04 degree that can be followed by the robot.
- Center: AMConveyor
This feature represents the rotary table in the coordinate system.

- Rotate tool with conveyor: optional

These parameters are also stored in the installation file.

For more information about the Conveyor function read the PolyScope User Manual.

10.1.2 TCP

The automatic calibration process requires a special pointer. Before installing this tool to the robot please read the safety instructions in the robot's user manual.

After the tool is mounted to the robot the Tool Center Point (TCP) has to be set.

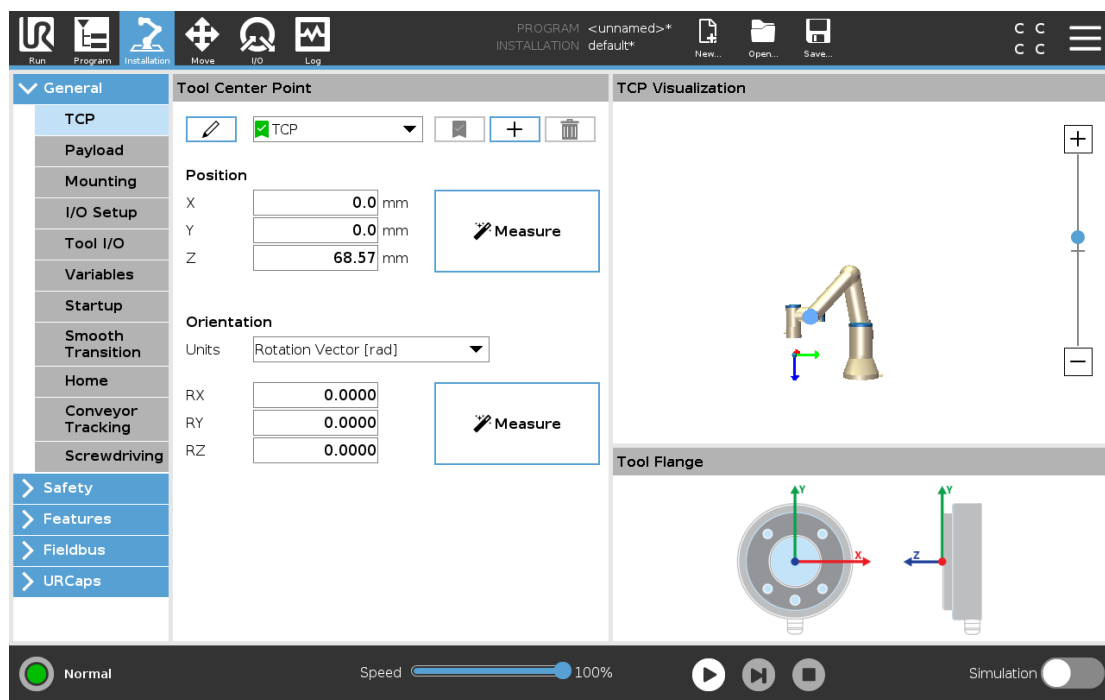


Figure 10-2 TCP settings

The pointer's TCP parameters:

- X: 0mm
- Y: 0mm
- Z: 68.57 mm
- RX: 0 rad [rotation vector]
- RY: 0 rad [rotation vector]
- RZ: 0 rad [rotation vector]

10.2 Manual Calibration

When the rotary table's relative position and orientation to the robot's base are known information than the Auto Calibration process is unnecessary. In this case the X, Y, Z parameters are used for offsetting the coordinate system of the rotary table from the robot's base point. The RX, RY, RZ parameters are rotation vectors, and they represent the orientation of the rotary plate. Aruna Motion URCap supports every orientation that can be performed by these parameters. These 6 parameters give a feature with a specific position and orientation. In the default orientation the X and Y axes are parallel to the rotary table and the Z axis is perpendicular, this acts as the surface normal vector. The surface normal heads to the bottom of the rotary table, through the rotary plate.

This feature is stored in the installation. For saving and restoring it read the PolyScope User Manual.

10.3 Auto Calibration



Before doing auto calibration, make sure that the TCP are set for the special pointer.

Auto Calibration process consists of 3 steps. After the process, the AMConveyor feature will be updated to the new parameters.

For the Auto Calibration an established connection to the Aruna Motion device is a requirement like the powered-on robot as well. During the process the robot needs to be moved to specific positions. These movements can be produced by freedrive or manual jogging. **In case of choosing freedrive mode the process requires 2 people, one for handling the teach-pendant and one for moving the robot.**

Auto calibration process can be start by clicking to the *"Start Auto Calibration"* button.

10.3.1 Defining the center point of the rotary plate.

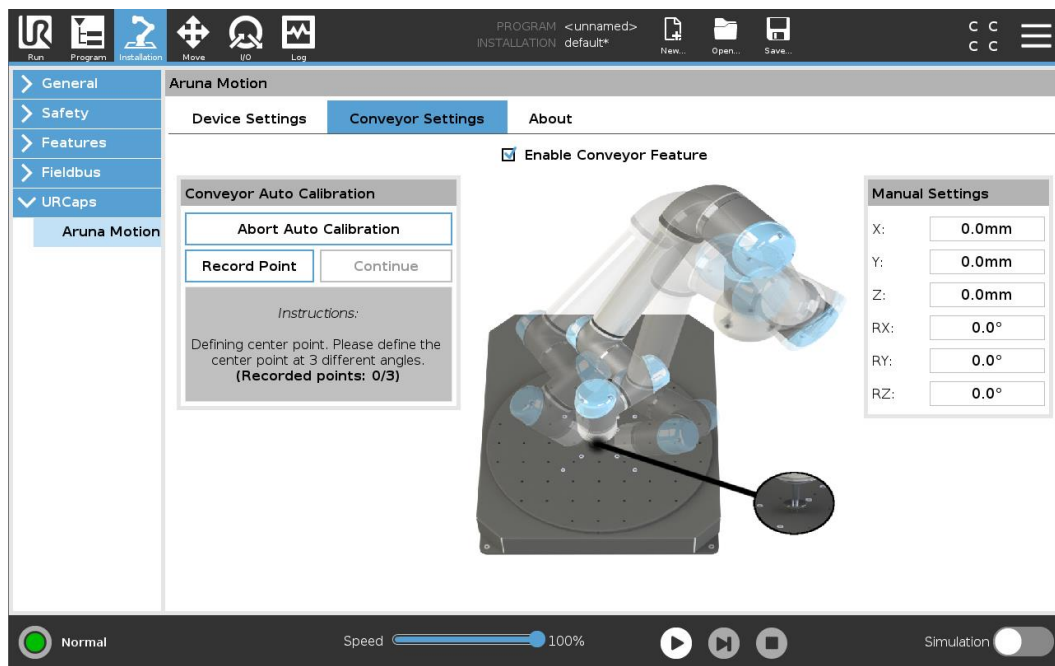


Figure 10-3 Defining center point

The first step in the process is defining the center point. The algorithm needs 3 recorded points from 3 different angles to calculate the accurate center point of the table. 2 recorded points are the same until at least 2 joint angles are not changed. When the position is similar to the previous ones the record button will be disabled until a new angle is not set on the robot.

- Move the robot to the center point and place the ball into the center hole.

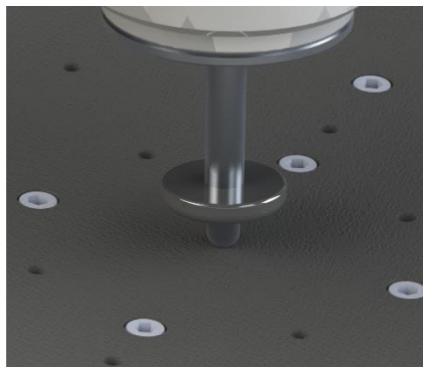


Figure 10-4 Pointer position on the center hole

- Click to the "Record Point" button to save the position.
- Repeat the previous steps until 3 points are not recorded.

10.3.2 Defining the orientation of the rotary plate

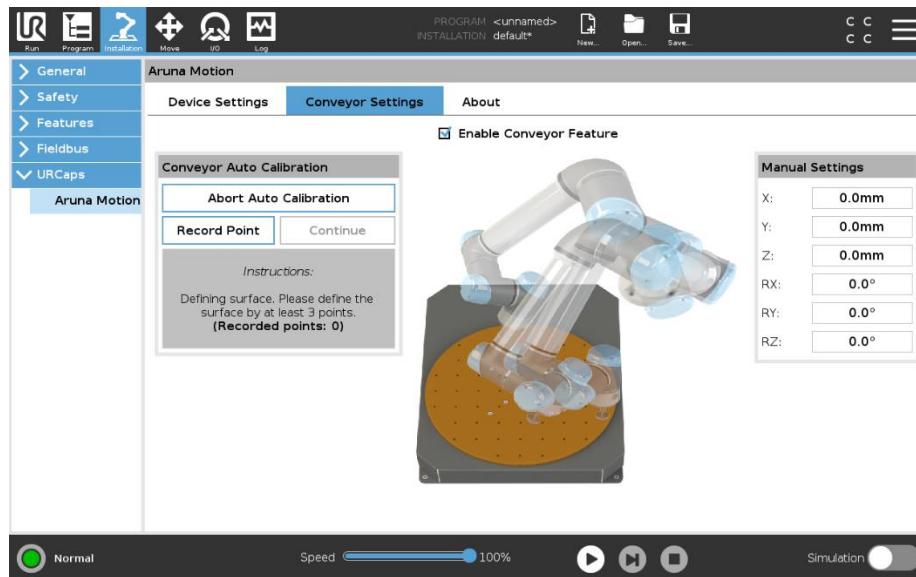


Figure 10-5 Surface orientation

Aruna Motion rotary tables support more mounting states. The second step of the calibration process is defining the current orientation of the rotary plate. For this the software needs at least 3 recorded points on the top of the rotary table's surface. **The more points the better accuracy.** When two positions are similar to each other the record button will be disabled until a new position is not set on the robot. (There is no restriction or rule for the place of these points. Our recommendation is that the points should be as far from each other as they can be.) **There is no exact position of these points. These points figure cannot be a straight line. Our recommendation is that the points should be as far from each other as they can be**

- Define a point by moving the robot to such a position that the pointer's end contacts the rotary table's top surface.
- Click to the "Record Point" button to save the position.
- Repeat the previous steps until at least 3 points are not recorded. There is no maximum limit for the points. **The more points the better accuracy.**

When sufficient quantity of the points is available the "Continue" button enables. This leads to the next step of the process.

10.3.3 Go to Center Point

When the process reaches this point the algorithm calculates the position and the orientation of the rotary table. These values are written in the manual setting's textboxes as well. It is saved to the installation file. The next step is checking the accuracy of the parameters. The software guides the user through a moving process where the robot will move above the center point. Here the user has to check if the position and the orientation is appropriate. The process is successful when the robot stops above the center point and the pointer is perpendicular to the rotary plate.

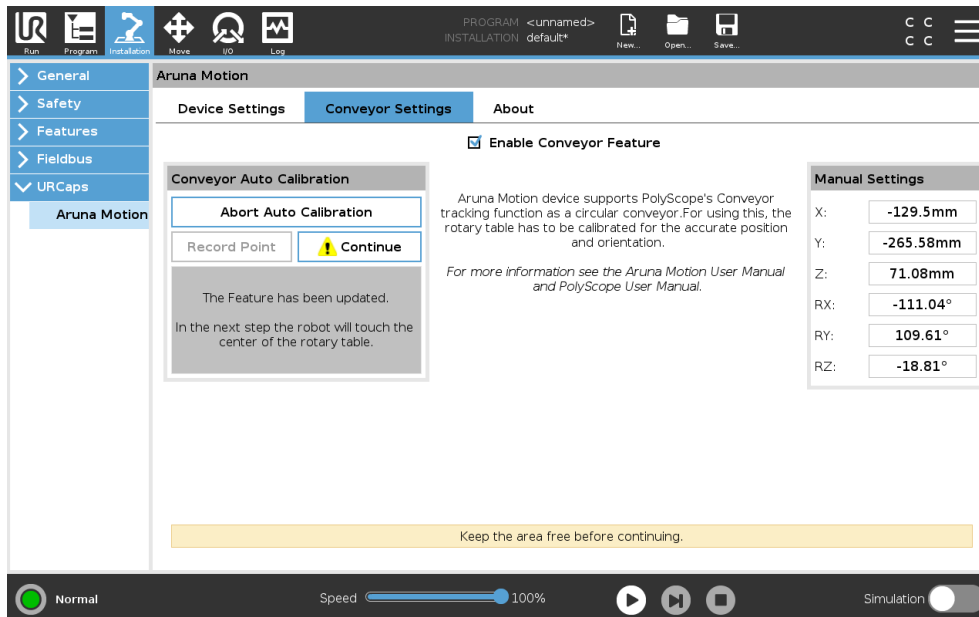


Figure 10-6 End of calibration



Stay the area free while the robot is moving.

If the position or the orientation is not enough appropriate for the purpose, start a new Auto Calibration process and try to record better accuracy points or more surface defining points.

10.3.4 Defining the rotating directions

After a successful Auto Calibration process the right rotating directions has to be defined. At a default system where the robot is next to the rotary table the default wiring diagram operates well, but at a specific system they might be changed.

For checking it a new program has to be created.

- Move the robot from the center point to any point above the rotary plate. Our recommendation is that the pointer should be moved approximately 5cm from the center point parallel to the plate. (In radial direction)
- Create a new program. Our template program can be seen below.

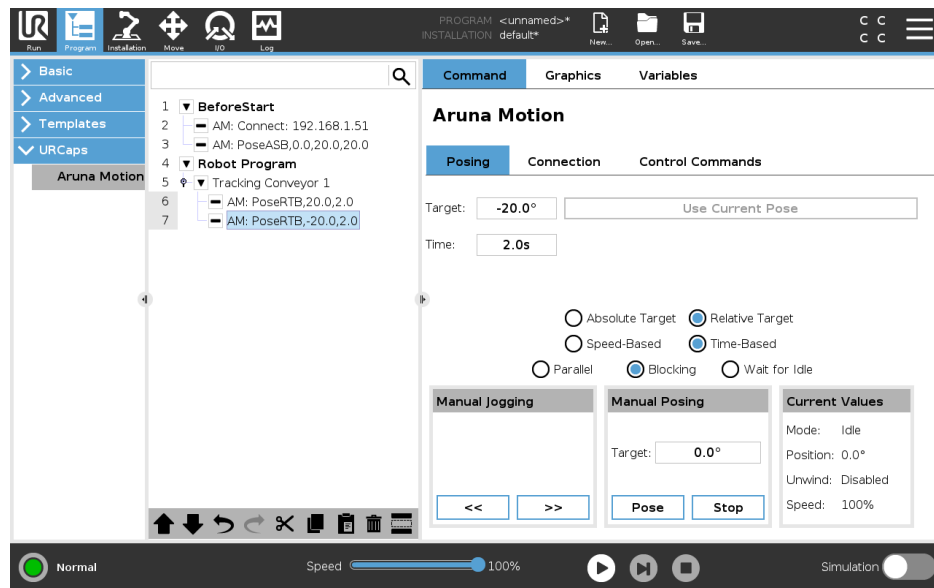


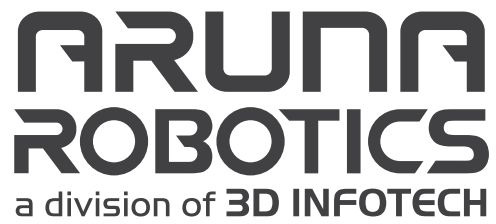
Figure 10-7 Template program

- Before Start
 - Connect to the Aruna Motion device
 - Pose to the zero position
- Robot program
 - Tracking Conveyor
 - Relative posing by 20 degrees and it takes 2 seconds.
 - Relative posing by -20 degrees and it takes 2 seconds.

The nodes that are placed under the “Tracking Conveyor” element are tracked by the robot. In this example there is no move command for the robot, but after starting the program we can see that the robot keeps the original position relative to the rotary table.

Check if the rotating direction of the rotary table and the robot is the same. If they are the opposite of each other than the input A and B have to be replaced in the conveyor settings.

11 Contact Information



www.arunarobotics.com