HOW TO GUIDE

Updated: July 16th, 2021

URCap for Robot Cell Integration (v2.x)

Version 2.xMM1

Contents

Overview

Vention offers Universal Robot Capability (URCap) extension packages enabling simple programming of Vention motion systems from within the UR teach pendant. Once loaded in the UR Polyscope HMI, these URCap applications provide an intuitive environment for seamlessly managing Vention components from the UR pendant. URCap integrations make it simple and cost-effective to create systems combining UR six-axis robot arms with Vention's MachineMotion controlled systems.

This document describes **Vention's URCap for Robot Cell Integration**. This URCap enables equipment comprised of a Vention MachineMotion controller and a UR controller to be seamlessly managed from the UR teach pendant. This integration makes it simple and cost-effective to create systems that unite UR six-axis robot arms with Vention linear axes and rotational indexers. Using the intuitive UR programming environment, it's easy to create applications controlling a combination of UR robot arm, Vention linear axes, and rotational indexers. An example of which is a 7th Axis Range Extender (see Figure 1).

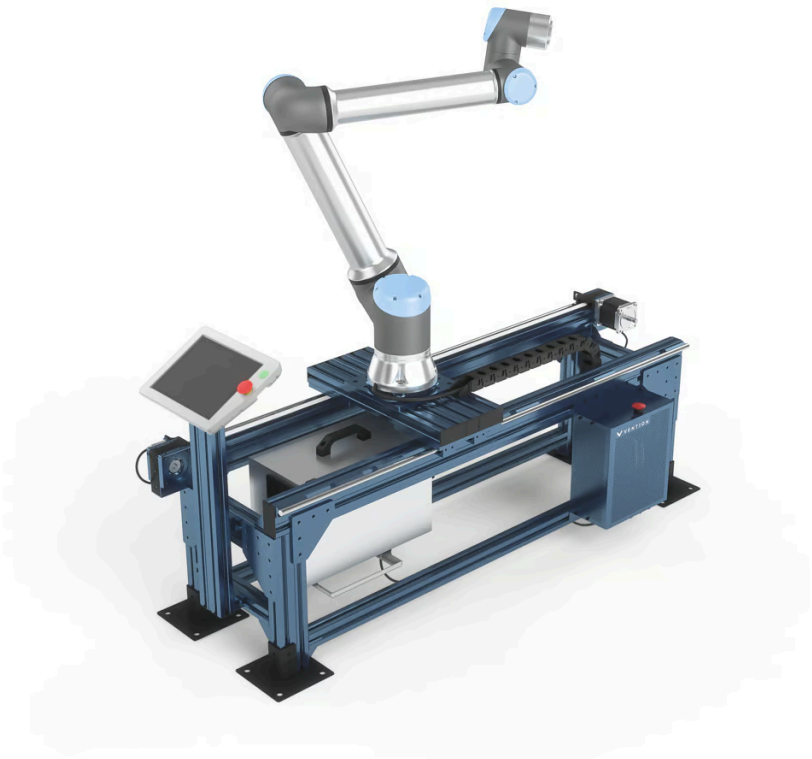

Figure 1: UR10 Mounted on a Vention 7th Axis Range Extender

This guide explains the steps required to:

1. Install the URCap
2. Connect your system
3. Setup the network
4. Configure your system
5. Use the URCap

Install the URCap

The Vention URCap For Robot Cell Integration software is distributed on a USB flash drive and must be installed on the UR teach pendant.

Step 1: Insert USB Stick

Insert the Vention URCap for Robot Cell Integration USB drive into the UR teach pendant's USB port. The USB stick includes the URCap file (*.urcap*) required by the UR setup assistant.

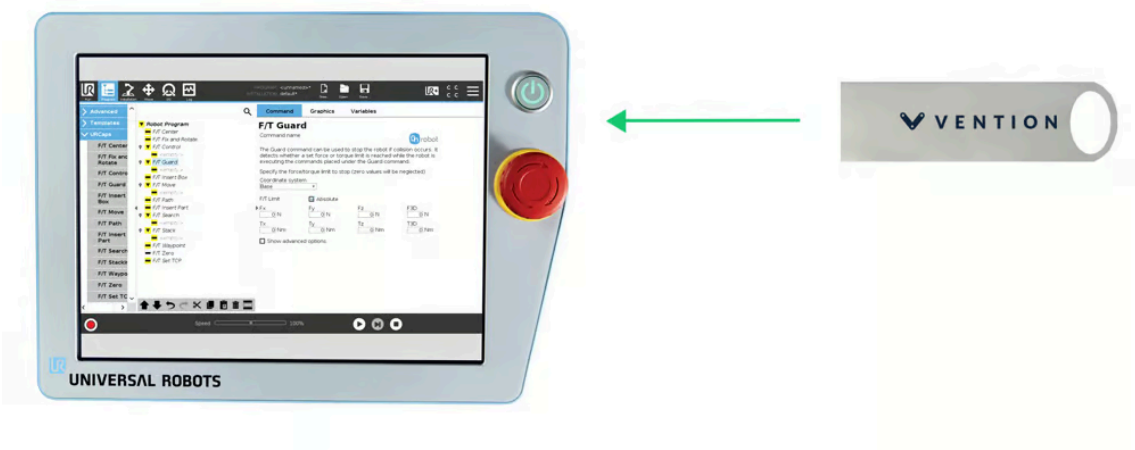

Figure 2: Location of the UR teach pendant's USB port

Step 2: Add the URCap to the UR environment

On the teach pendant home screen, select **Menu** › **Settings** (see Figure 3).

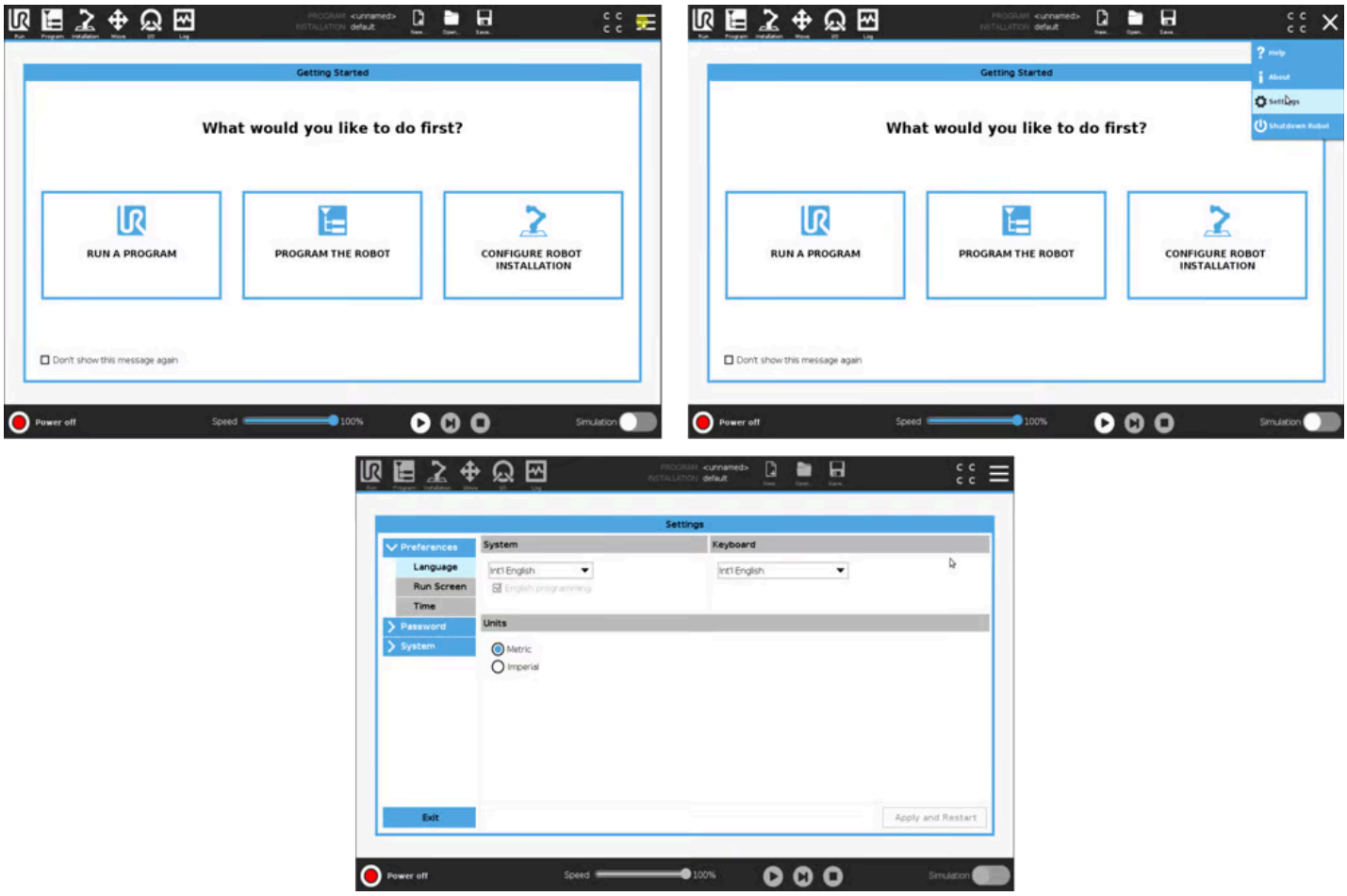

Figure 3: Opening the Settings screen

To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/756/original/urintegration-

teachpendanthomescreensetuprobot.png?1565209701) and here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/757/original/urintegration-teachpendantsetuproboturscript.png?1565209702)

Select **System** › **URCaps**, then click the **+** icon at the bottom of the screen to add a new URCap to the UR teach pendant.

Select the **.urcap** file and click **Open** to install the URCap extension (see Figure 4).

When prompted to do so, restart the UR controller to complete the installation.

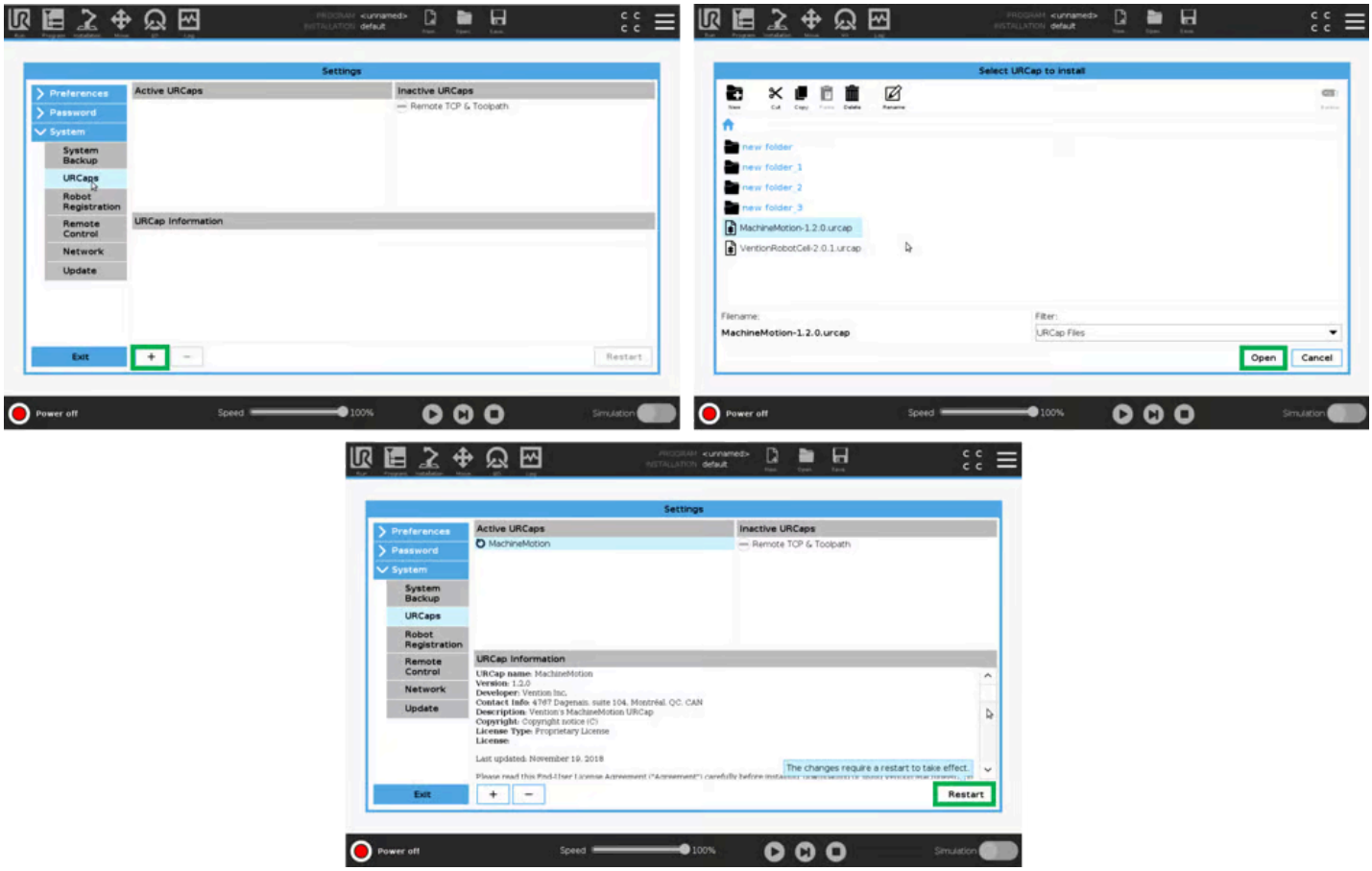

Figure 4: Adding the URCap file and restarting the system
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/761/original/urcapv2-install-urcap-v3.png?1565210046) and here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/762/original/urcapv2-setup-robot-v3.png?1565210047)

After restarting, you are ready to physically connect the controllers, actuators, and sensors.

Connect your System

The MachineMotion controller has two panels with pre-labeled connectors. Depending on the application needed, MachineMotion may connect up to:

- Three (3) motors (Six (6) motors with Y-cable)

- Six (6) end-stop sensors
- Three (3) position encoders
- Twelve (12) digital inputs
- Twelve (12) digital outputs
- One (1) safety input
- One (1) safety output

The motor drive and associated end-stop sensors are arranged in three (3) groups as indicated on the MachineMotion connector panel. The digital I/Os and position encoders can be connected to the auxiliary inputs (AUX) of MachineMotion (see Figure 5).

Figure 5: MachineMotion motor and sensor sonnectors

The safety input / output allows MachineMotion to participate as either a parent or a child in a unified safety solution (see Figure 6). We recommend configuring MachineMotion as a safety child when used with a UR robot cell.

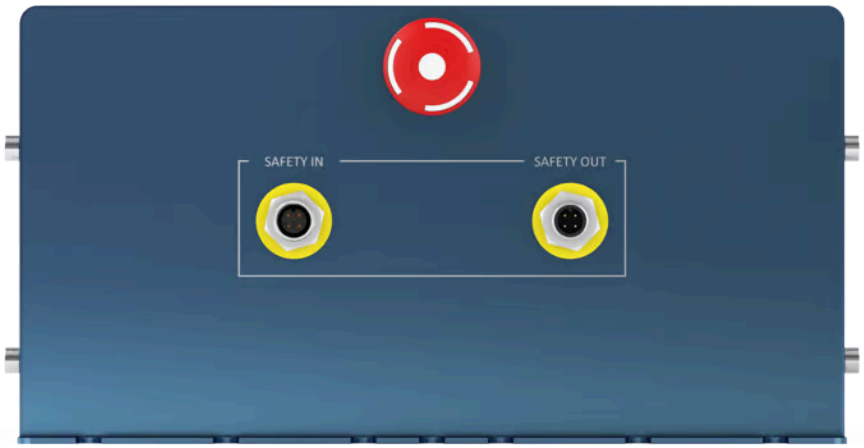

Figure 6: MachineMotion safety connectors

Controller Connections

This section discusses common MachineMotion connections for pairing with a Universal Robot controller. These connections require the following cables (provided with the MachineMotion package):

- AC power cable
- E-stop bypass connector
- Ethernet cable (controller communication)
- Safety e-stop cable

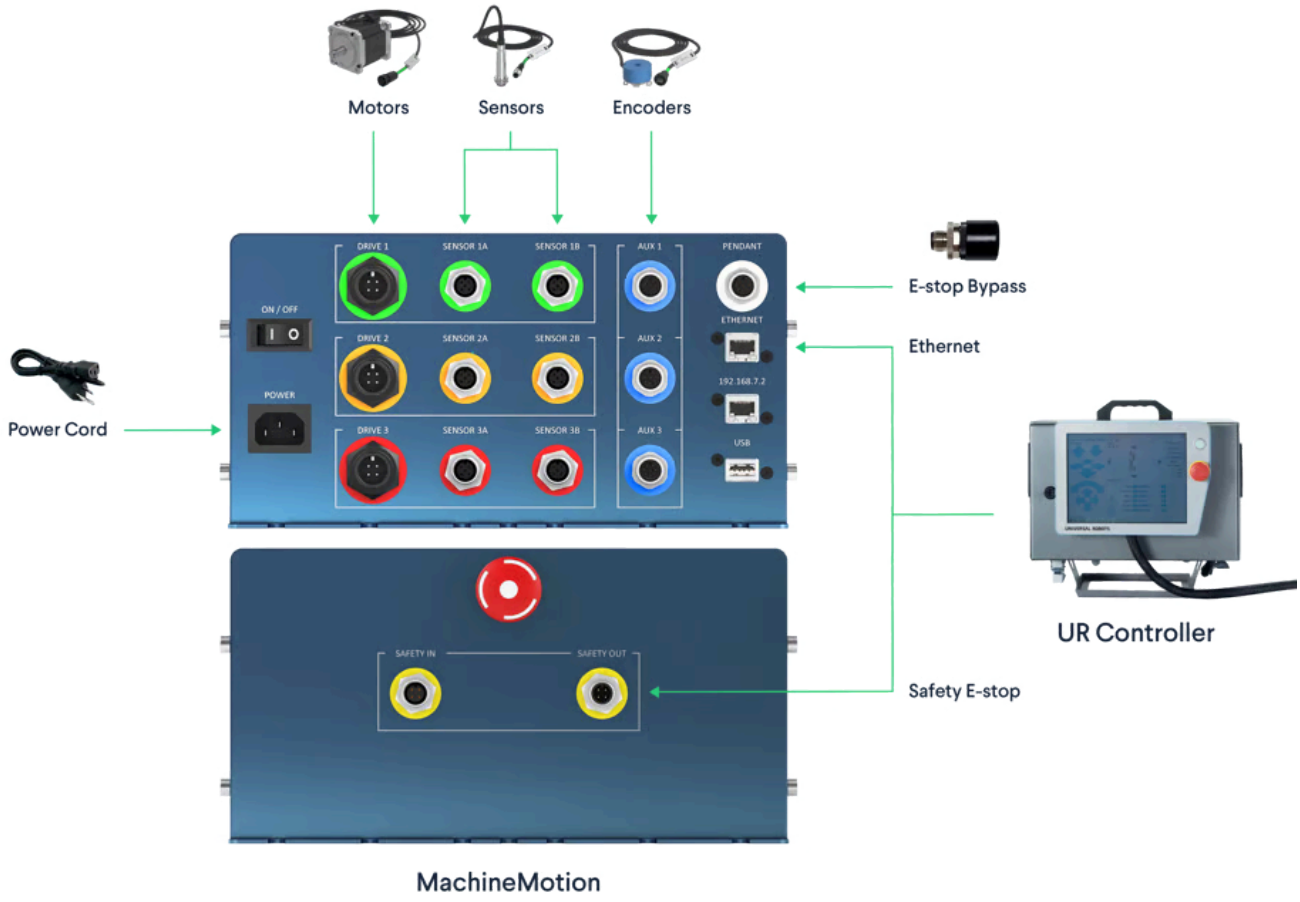

Figure 7: MachineMotion-to-UR controller connections

AC Power Connection

Use the provided power cable to connect the MachineMotion controller to an outlet that provides 110V (of AC power) at 15 amps. Use a standard voltage converter to convert 220 V to 110 V in regions that do not provide 110 V power. An average of 400 watts per actuator must be available to properly power the equipment.

UR and MachineMotion Ethernet

The UR and MachineMotion controllers communicate using TCP/IP sockets on standard Ethernet. We recommend using a point-to-point connection by running an Ethernet cable between the MachineMotion Ethernet port and the UR controller Ethernet port. This direct connection requires that the IP address be statically configured. For a

simplified networking set-up, you can also use a DHCP approach where the IP address is assigned automatically (see Connecting the UR and MachineMotion via Ethernet for more).

E-stop Bypass

The e-stop bypass on the pendant connector must be connected when using the MachineMotion with the UR Controller.

Linear Range Extender Connections

Linear range extenders are available from Vention to extend the robot arm reach in one, two, and three dimensions. When paired with 6-axes robot arms, these range extenders are commonly known as the robot's 7th, 8th, and 9th axis, respectively

Each axis is connected to the MachineMotion controller using:

- One motor drive connection
- Two end-of-travel sensors

The MachineMotion main connector panel clearly identifies each axis with a row of related ports, each with a unique color ring, as listed in Table 1.

Table 1: MachineMotion axes color assignment

Axis Identifier	Axis Color
1st Axis	Green
2nd Axis	Orange
3rd Axis	Red

Figure 8: MachineMotion ports

For each Axis, connect the motor cable to the **Drive** port and the two end-stop sensors to their color-matched **Sensor A** and **Sensor B** connectors.

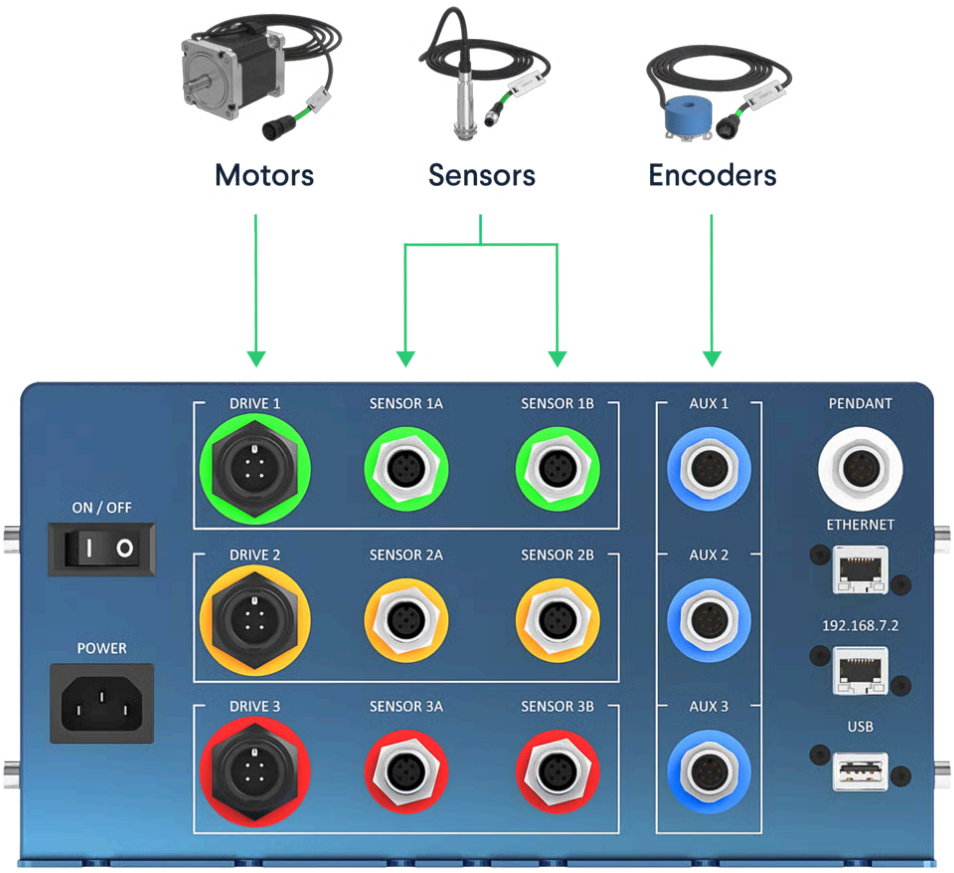

Figure 9: Connection ports for the MachineMotion Linear Axis Range Extender

Note: Depending on the motor rotation and desired home position, the connection for the sensors may need to be swapped.

Rotational Indexer Connections

Starting from URCap for Robot Cell Integration, Vention's Rotary indexer may be controlled from the UR teach pendant, which allows for application like inspection jigs and soldering stations. The Rotary indexer is controlled in terms of angle (degrees) and is connected to MachineMotion as a full axis.

The Rotary indexer connection includes:

- One motor drive connection
- Two end-of-travel sensors

The end-of-travel sensors are used to determine the rotation origin (0 degrees). The end-of-rotation sensors are used to constrain rotational applications (0–360 degrees). End-of-travel sensors are not required for free-form relative Rotary applications.

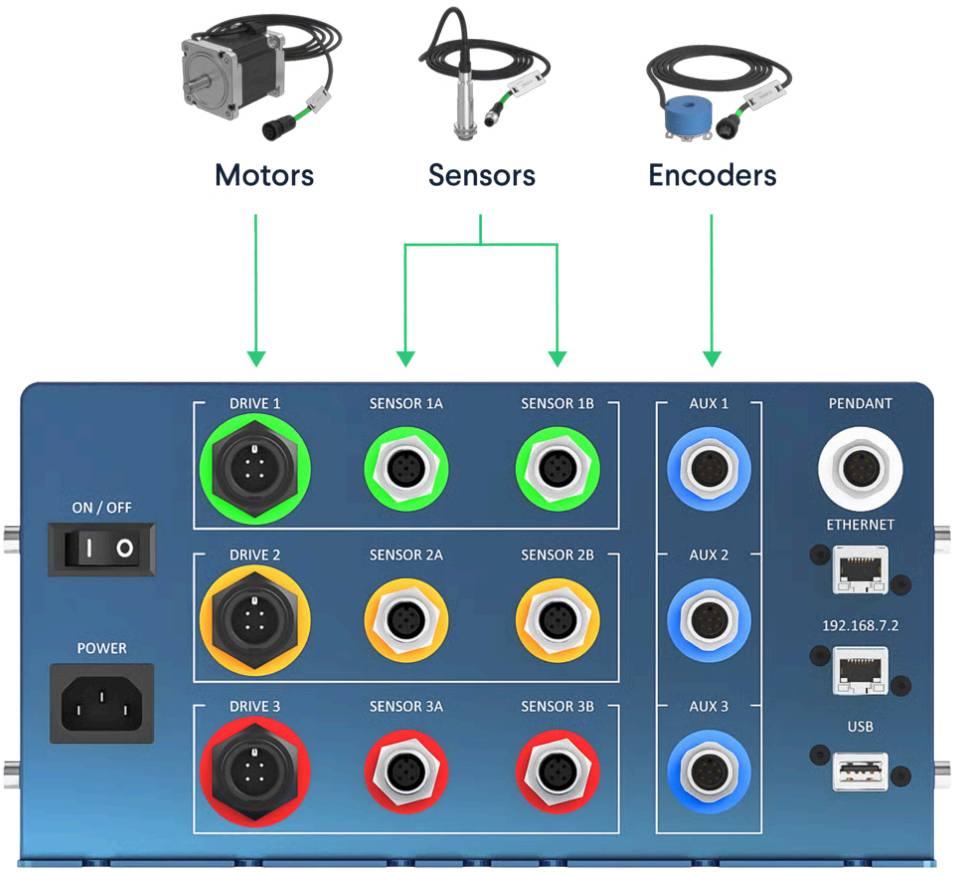

Figure 10: Connection ports for the MachineMotion Rotary Indexer

Connecting the UR and MachineMotion via Ethernet

The UR and MachineMotion controllers communicate using TCP/IP sockets on standard Ethernet. We recommend using a point-to-point connection by running an Ethernet cable between the MachineMotion Ethernet port and the UR controller Ethernet port.

The UR controller has an Ethernet port available on its bottom panel, and the MachineMotion controller has one on its connector panel. For the standard connection, connect the UR controller to the ETHERNET port on the MachineMotion controller using an Ethernet cable as indicated in Figure 11. See **Static Address Method** in **Setup the Network** below for more details.

For a simplified networking approach, you can connect the UR controller to the 192.168.7.2 port (also labelled DEFAULT ETHERNET on older versions). This provides a faster way to configure your system and start testing. See **DHCP Method** in **Setup the Network** below for more details.

Figure 11: Example MachineMotion system with Ethernet peer-to-peer connection to a UR controller

Important: Make sure to add jumpers to the pendant port and to the SAFETY IN port if you are not using these ports.

Setup the Network

There are two ways to setup your network: the DHCP method and the Static Address method. The following sections describe both.

DHCP Method

The simplest way to connect the UR controller and the MachineMotion controller is to use the DHCP approach. With the DHCP approach, there is no configuration to be done on the MachineMotion controller. However, this networking method does not support multiple MachineMotion controllers connected to a UR controller. Also, you will need to disconnect the UR Controller to connect a computer to the MachineMotion controlling when accessing ControlCenter.

On the UR teach pendant home screen, select **Menu** › **Settings** › **System** › **Network**. Select DHCP as your network method (see Figure 12).
You can continue your configuration by jumping to the section **Configure your System**.

Important: To use the DHCP approach make sure your Ethernet cable is connected to the 192.168.7.2 port (also labelled DEFAULT ETHERNET on older models) NOT to the ETHERNET port

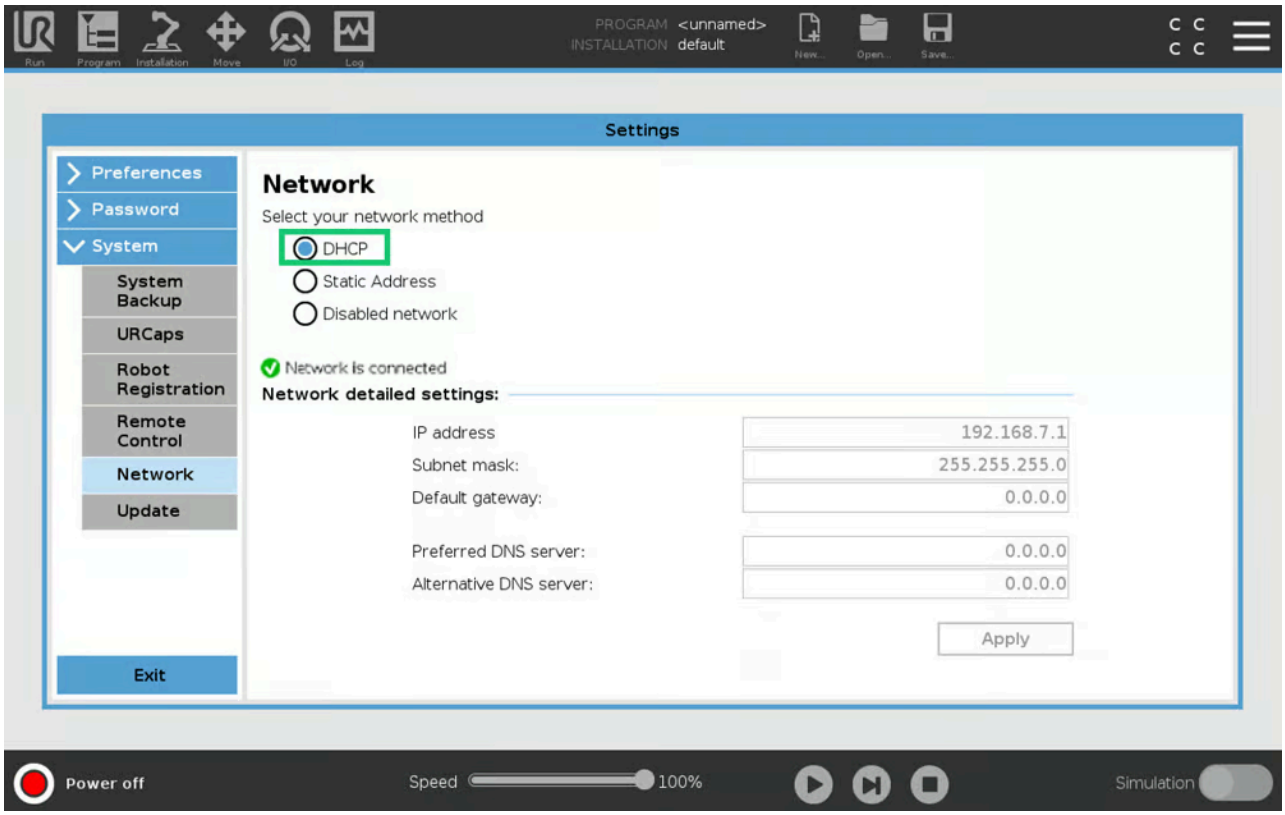

Figure 12: DHCP configuration
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/003/521/original/mm-urcap-dhcp-polyscope3.png?1591217940)

Static Address Method

Communication between the UR controller and MachineMotion uses Ethernet. This configuration is peer-to-peer. In order for the Ethernet communication to function, both devices must be properly configured. In this system, the UR controller is the controlling entity. It runs the application-level program and sends commands and queries to the MachineMotion controller.

Configuring the MachineMotion Network

1. Connect MachineMotion to a 120 V power source via the power cable and POWER connector
2. Connect a computer that has Google Chrome installed to MachineMotion via the provided Ethernet cable to the port labelled 192.168.7.2 (also labelled DEFAULT ETHERNET on some versions of the MachineMotion controller). If using a computer that does not have an Ethernet port a USB to Ethernet adapter can be utilized.
3. Turn on the MachineMotion system using the rocker switch.
4. **Wait at least 90 seconds for the system to complete its booting sequence.**
5. Using the Google Chrome browser on your computer, navigate to: 192.168.7.2 (http://192.168.7.2)

The MachineMotion main menu (see Figure 13) will be displayed.

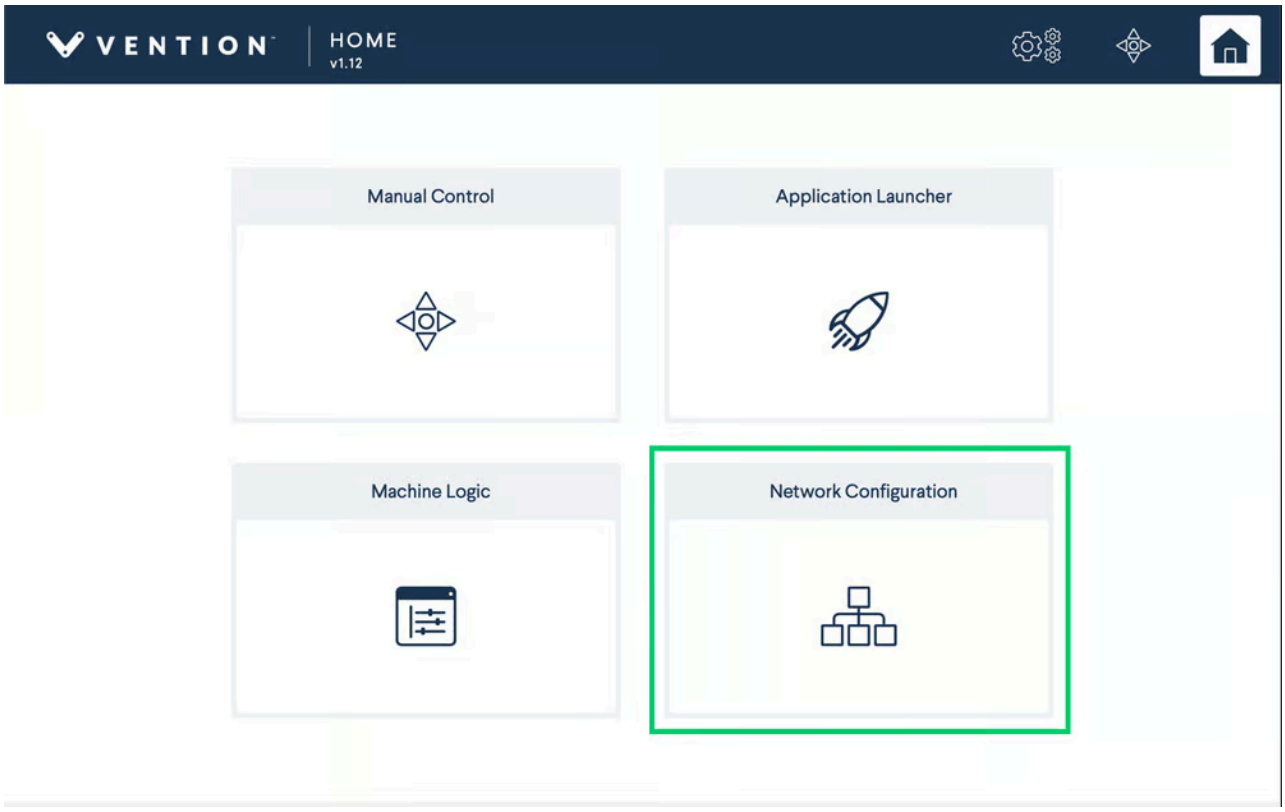

Figure 13: MachineMotion main menu

6. From the main menu, select **Network Configuration**
7. Modify the IP address of the MachineMotion controller, if desired. The default network configuration for MachineMotion connected to a UR controller is as follows:
    - IP address: 192.168.0.2
    - Netmask: 255.255.255.0
    - Gateway: 192.168.0.1
8. If you have modified any of the fields, select **Use Static Mode** to save your changes

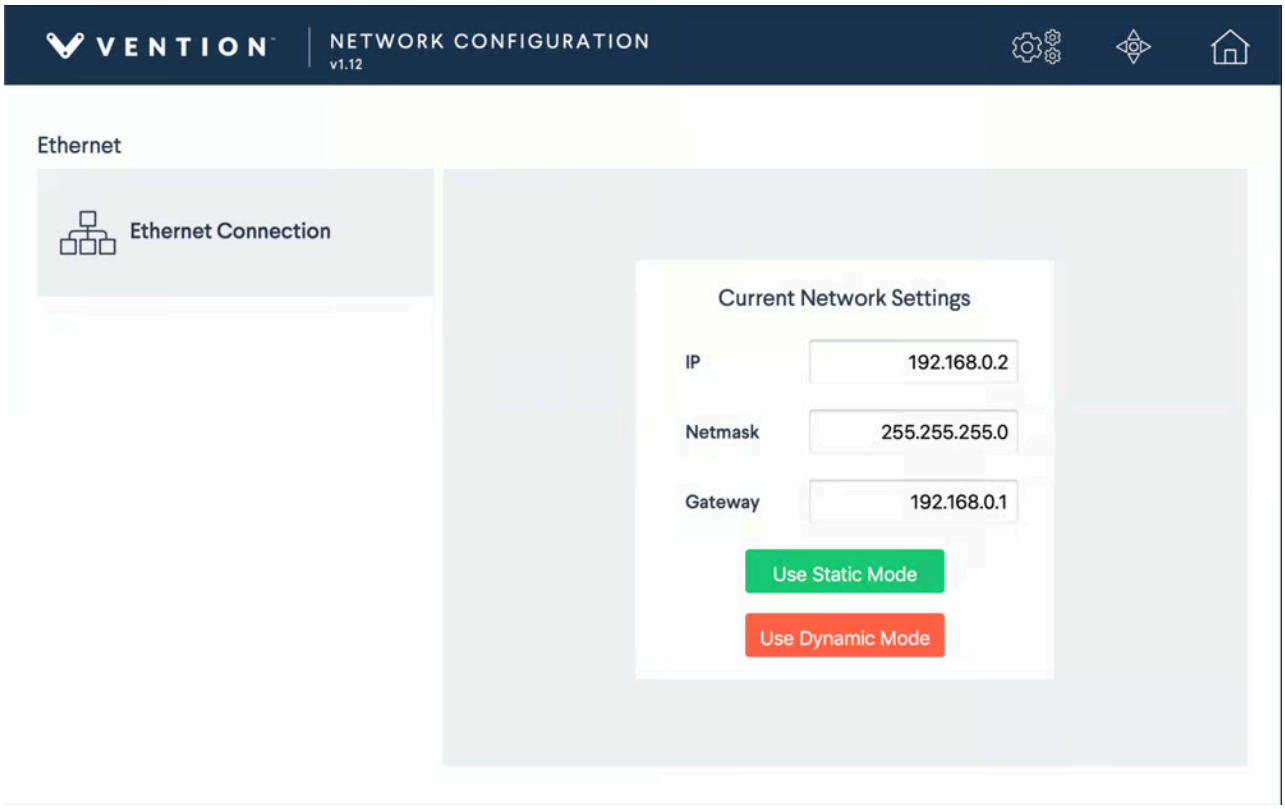

Figure 14: Default MachineMotion network configuration settings when connected to a UR controller

MachineMotion IP Addresses

The MachineMotion controller has two different network interfaces: ETHERNET and 192.168.7.2 (also labelled DEFAULT ETHERNET on earlier units). These two interfaces are distinct, and consequently can be configured differently. They also have different IP addresses. The table below highlights the differences between the two interfaces.

Table 2: Network adapter details

Physical Port	IP Address	Configurable	Default Gateway
ETHERNET	192.168.0.2 (default)	Yes	192.168.0.1
DEFAULT ETHERNET (192.168.7.2)	192.168.7.2	No	192.168.7.1

MachineMotion IP Ports

The MachineMotion controller serves multiple ports, as detailed below.

Table 3: MachineMotion server's IP ports

Service Port	applications
80	MachineMotion UX/UI

8888	Communication setup and basic machine apps
9999	Communication with UR controller

Configuring the UR Controller Network

On the UR teach pendant home screen, select **Menu** › **Settings** › **System** › **Network** (see Figure 15).

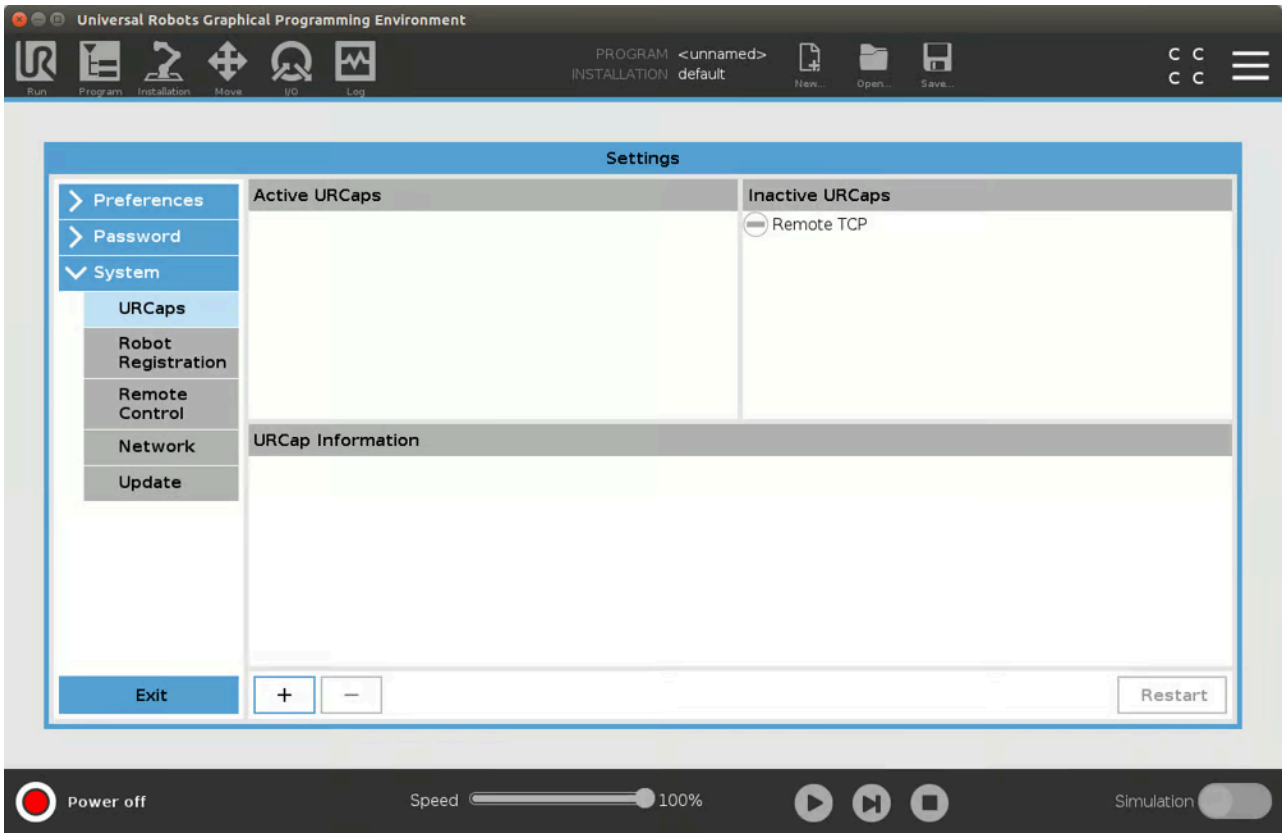

Figure 15: Polyscope (UR teach pendant) main menu
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/756/original/urintegration-teachpendanthomescreensetuprobot.png?1565209701)

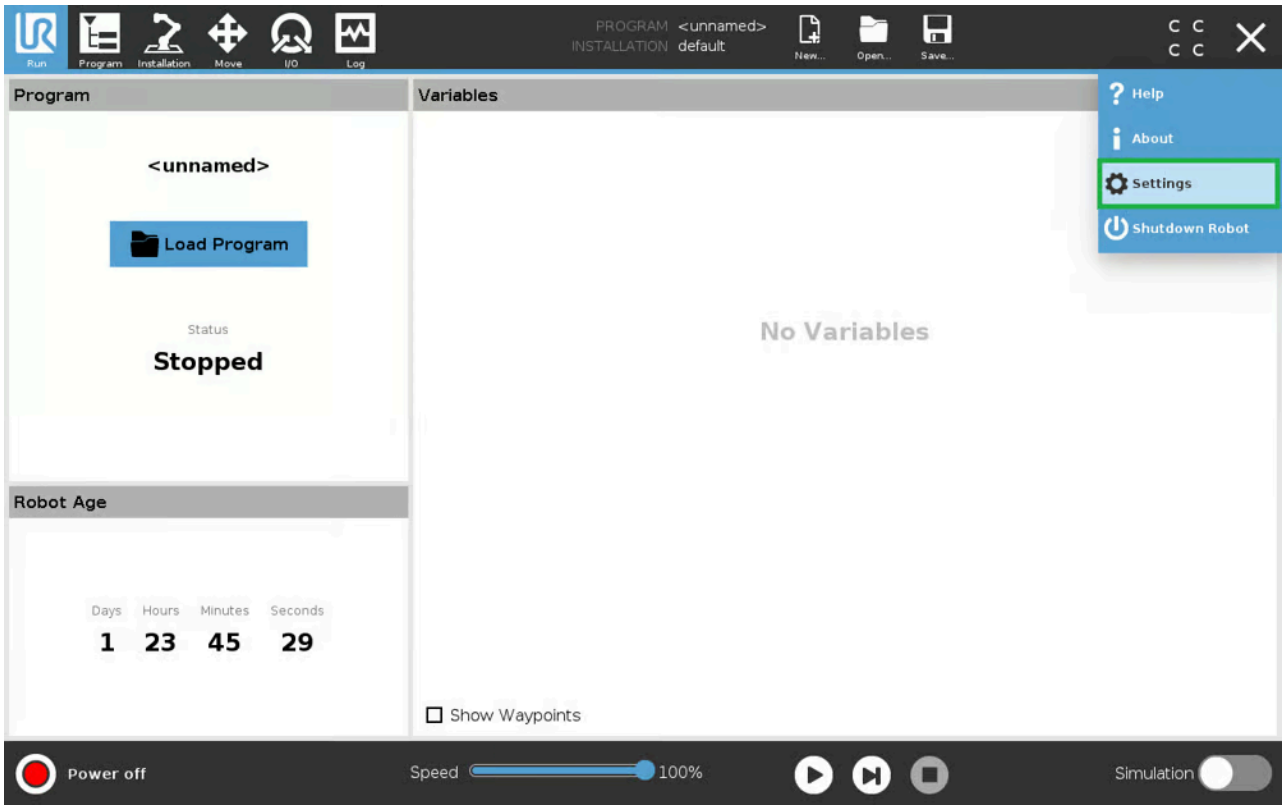

Figure 16: Setup robot menu
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/776/original/ur-v3-network.png?1565211293)

Enter the parameters as shown in Figure 17. Note that here, the UR controller IP address is **192.168.0.3**, and the MachineMotion controller IP address is **192.168.0.2**. Any address in the **192.168.0.xxx** subnetwork is acceptable. The other parameters should be configured as shown in Figure 19. Click **Apply** to save your settings.

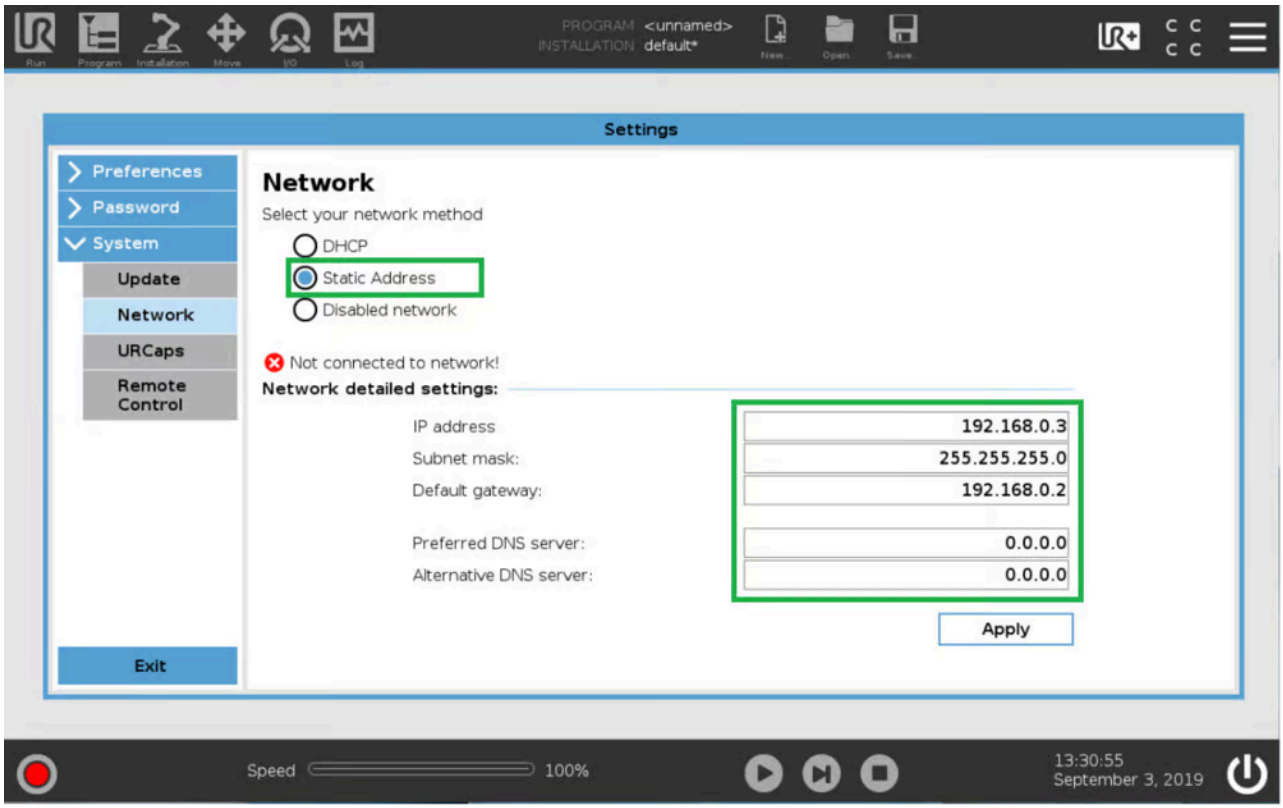

Figure 17: Network parameters setup
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/002/479/original/cbseries-network-parameters.png?1579618269)

The network status line should display **Network is connected** after a few seconds. If it does, the network setup is complete.

Configure your System

In order to have the UR controller communicate with the MachineMotion controller, you have to configure your Vention system within the Polyscope environment.

On the teach pendant home screen, select **Installation** › **UR Caps** › **Vention Robot Cell Integration**, to navigate to the Vention system configuration screen

The Vention URCap configuration screen has two main windows:

1) Upper Window

The upper window of the Vention URCap is used to define a MachineMotion controller instance (see Figure 18). Note that multi-controller systems can be created by adding more than one controller.

- **Controller Name:** Name assigned to the MachineMotion controller
- **IP Address:** IP address of the MachineMotion controller. In Figure 18, IP address **192.168.0.2** is used for the MachineMotion controller

To add a controller, select the **+** icon.

You can edit the controller name by clicking on the default "MachineMotion" name.

Important: If you are using the DHCP networking approach, you have to overwrite the IP address value with **192.168.7.2**. See Figure 19.

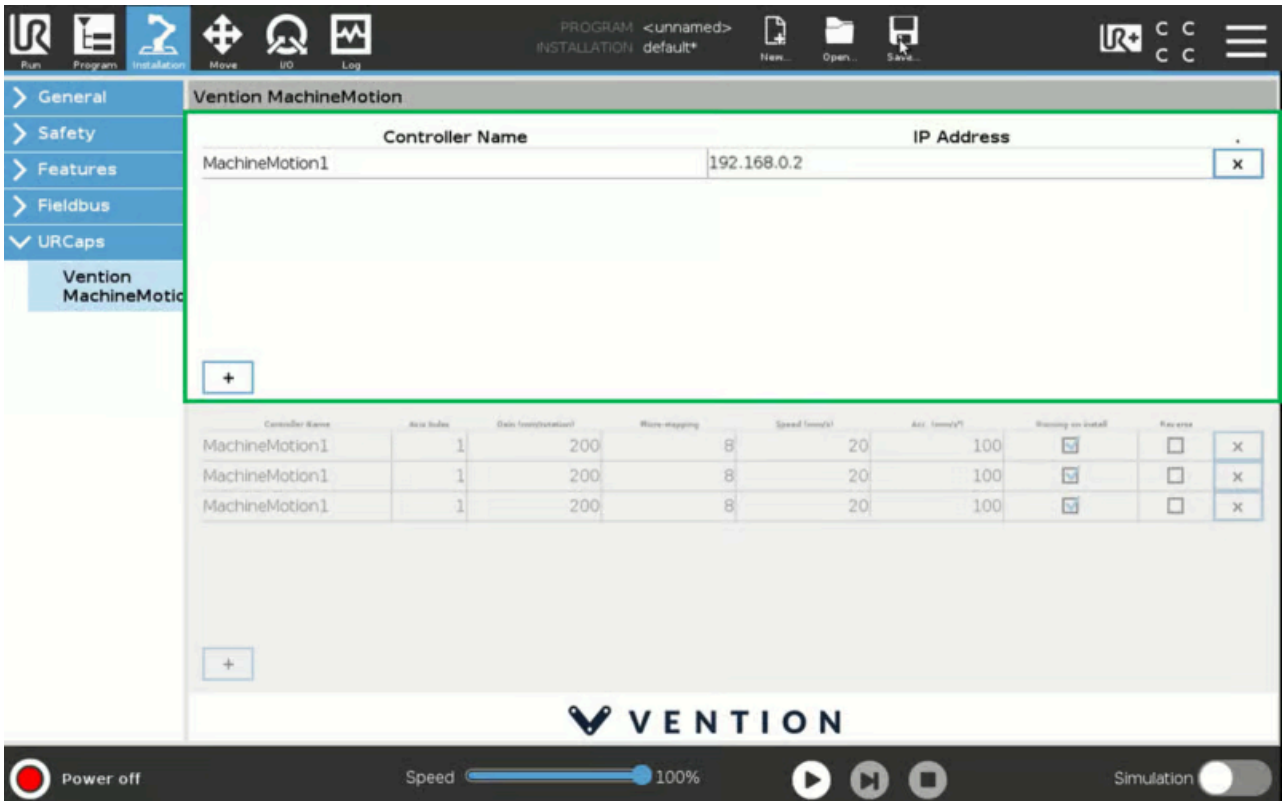

Figure 18: Upper window of the Vention URCap configuration screen

Figure 19: For the DHCP netwtworking method, the IP address needs to be set to 192.168.7.2
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/003/525/original/mm-urcap-simplifiednetworking-polyscope3.png?1591217945)

2) Lower Window

The lower window of the Vention URCap defines actuators for linear axes of motion (see Figure 20). For example, the system shown in Figure 20 has three actuators linked to the controller, which is called **MachineMotion1**. These actuators are plugged into drive ports one, two, and three of the controller, hence the (1), (2), (3) appearing under the **Drive #** setting.

- **Controller:** Name of the controller on which the axis is plugged
- **Drive Index:** Indicates which port the axis is connected to on the MachineMotion controller
- **Type:** Indicates the type of actuator. Setting the type will populate the **Gain, Micro-stepping, Speed, and Acceleration** fields with default values, but you can still edit them if you wish to
- **Gain:** Mechanical gain of the mechanical system in mm or degrees per motor turn
- **Micro-stepping:** These settings must match the micro-stepping setup of the drives inside the MachineMotion controller (8 is the default)
- **Speed:** Default axis displacement speed in mm/s, if none is specified in the program
- **Acceleration:** Default axis displacement acceleration in mm/s^2, if none is specified in the program
- **Start with home:** Indicates whether the MachineMotion axis should perform a homing sequence before the start of each program
- **Counterclockwise:** Select this to reverse the direction of motor rotation for the axis
- **Gear box:** Select this if you are using a 5:1 gear box so the system can automatically adjust your gain

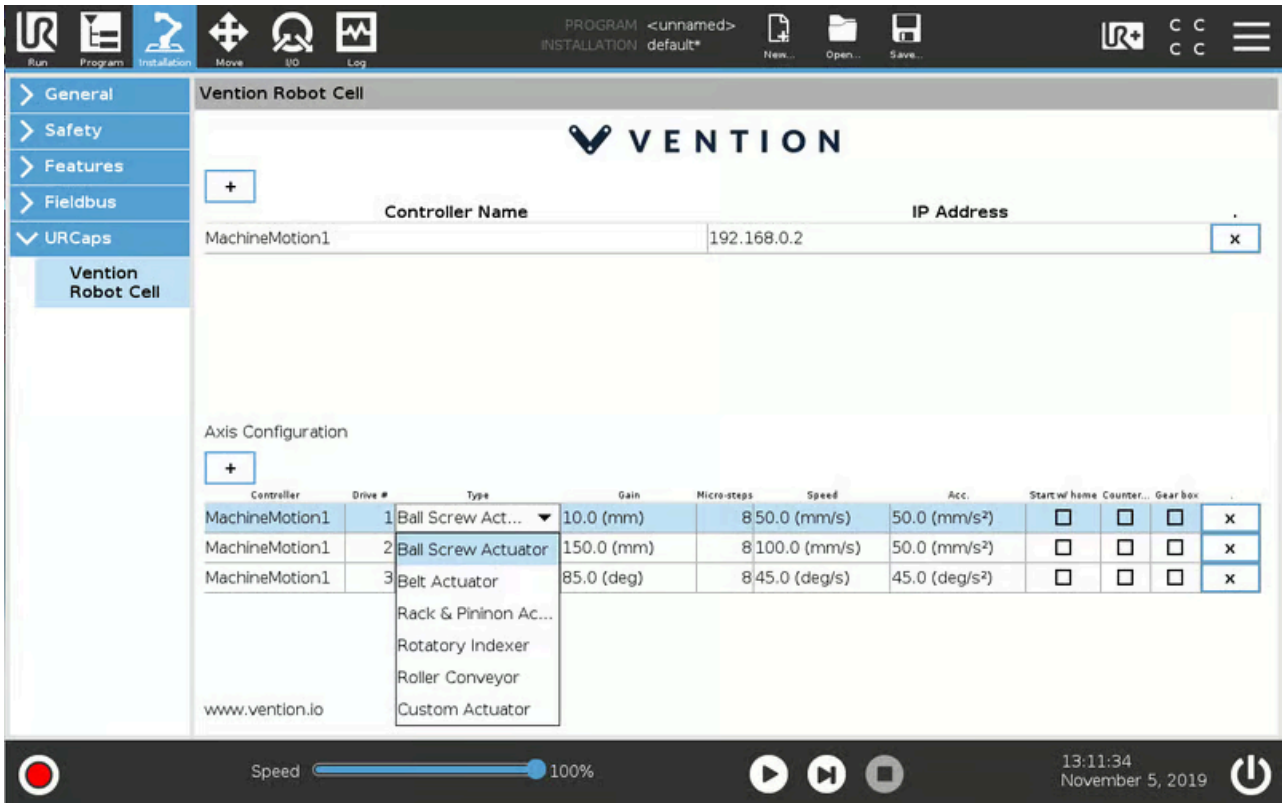

Figure 20: Vention URCap configuration screen
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/772/original/urcapv2-installation-v3.png?1565211038)

After configuring the installation in both windows, click **Save** at the top of the screen to complete.

Important: Optional homing configuration
You can configure the MachineMotion axis to automatically home its axes upon system startup. The homing process executes as follows:

1. The axis slowly moves in the negative direction
2. End-stop sensors are triggered
3. Movement stops, and the **home** location is now calibrated

Important: Save and run active installations upon start-up
When controlling the MachineMotion controller via the teach pendant and its URCap, the appropriate installation must be saved and run upon start-up of the robot program. If the MachineMotion controller is removed from the system, it is important to replace the installation file with one that does not contain MachineMotion-specific commands. Not doing so could cause the robot program to misbehave on start-up.

Use the URCap

The Vention URCap adds the following instructions for controlling the Vention actuators from a UR teach pendant program:

- Actuator ON/OFF
- Safety reset
- Safety status
- Home a single axis
- Move axes
- Get axes positions/rotations from the controller and encoders
- Set axes position/rotation references for the controller and/or encoders
- Start a parallel move
- Wait for a parallel move to complete

Control Screen

When creating a robot program, the Vention URCap can be found in the **Structure/URCaps** tab, as shown in Figure 21.

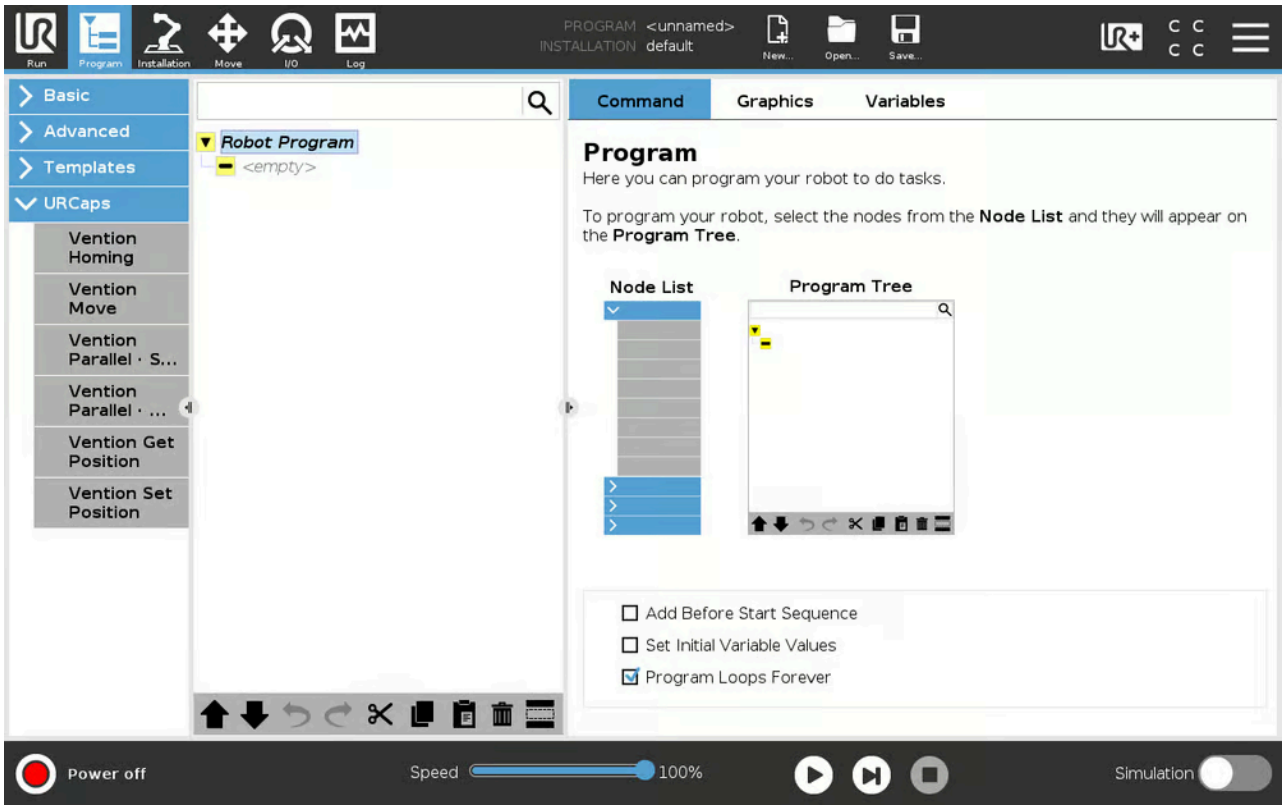

Figure 21: Vention URCap in the program structure editor
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/773/original/urcapv2-control-screen-v3.png?1565211084)

Actuator ON/OFF

Set this command field to OFF to de-energize all actuators connected to a MachineMotion Controller. Set the field to ON to restore actuators connected to the controller.

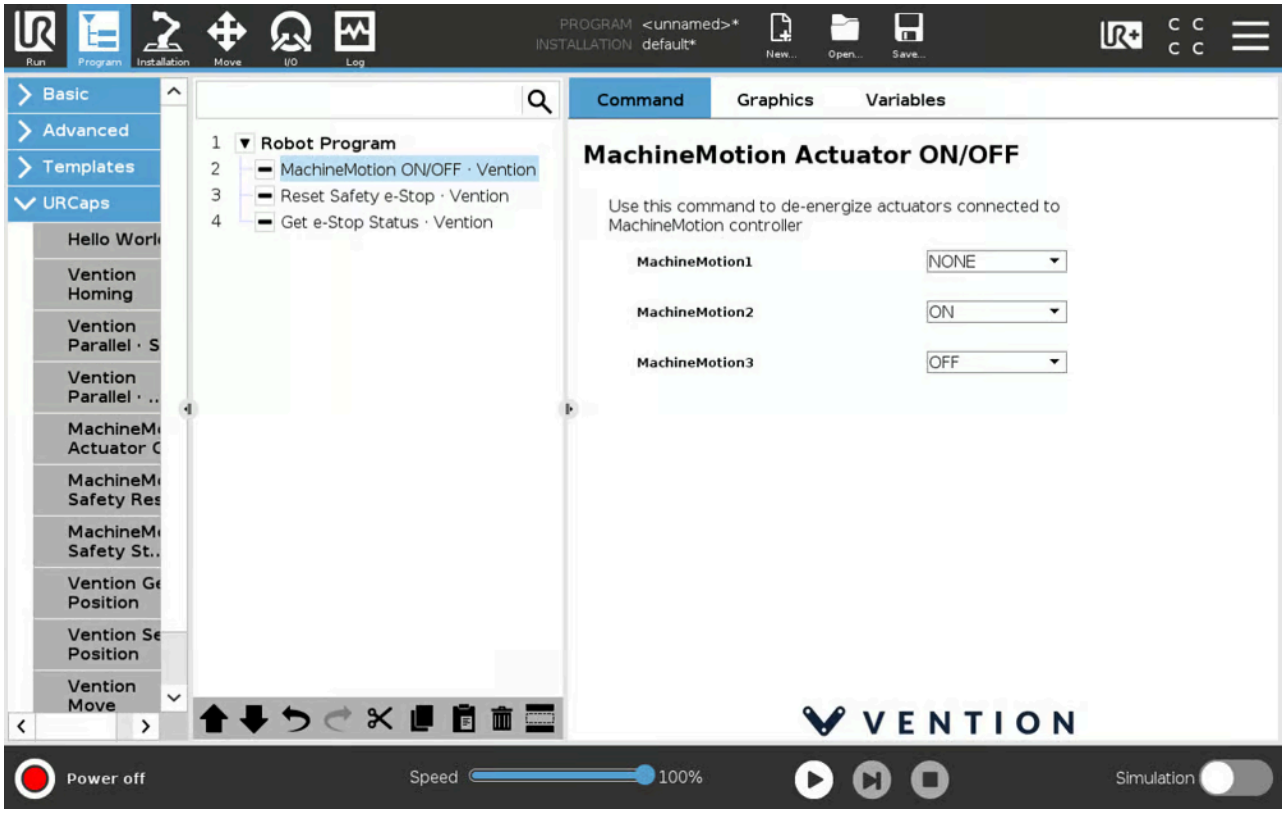

Figure 22: Vention URCap actuator ON/OFF details

Safety Reset

MachineMotion e-stop feature is explained in MachineMotion: User Manual (https://www.vention.io/docs/guides/machine-motion-user-manual-v1e-82).

To release the MachineMotion system from a manual e-stop:

- Release the physical e-stop button on the controller before proceeding.
- Checkmark the “Reset Safety E-stop” command when you’re ready to operate the machine. The status LED on the controller should display green once this step is completed.

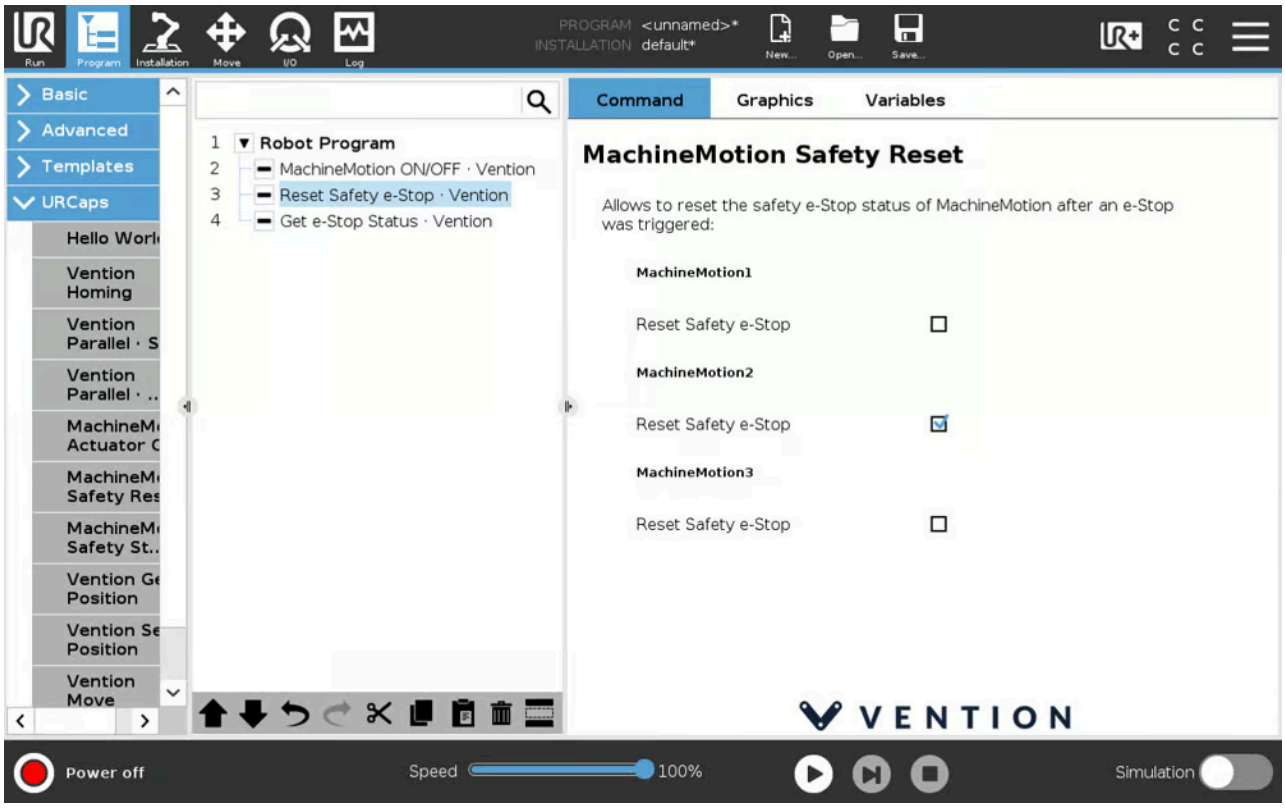

Figure 23: Vention URCap safety reset details

Safety Status

The safety e-stop status(es) can be input as UR teach pendant variable(s) using the Get E-stop Status command.

- Use the drop-down menu to select a variable to store a MachineMotion controller status
- '+': Adds a new variable to hold a status
- 'pencil icon': Edits the name of a variable created in this command
- 'trash icon': Deletes the selected variable

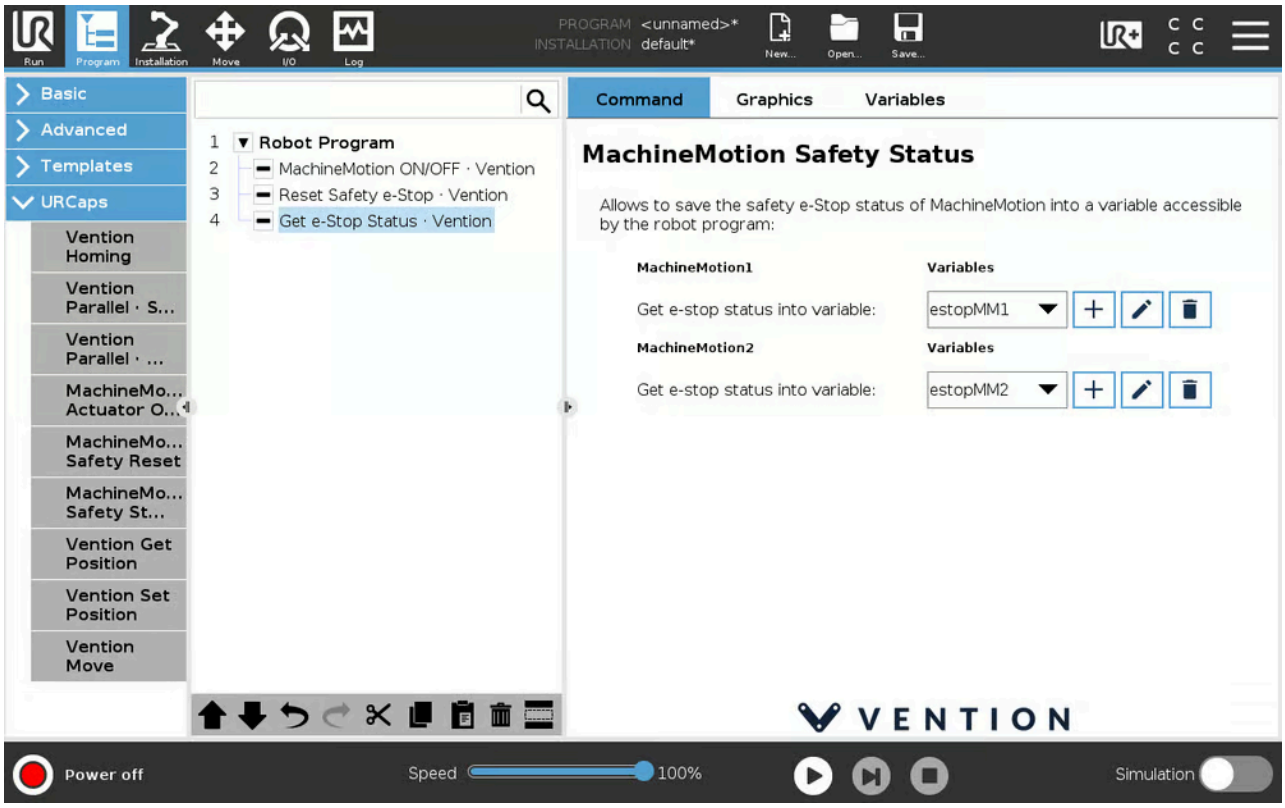

Figure 24: Vention URCap safety status details

Homing an Axis

This instruction moves the axis in the negative direction until the end-of-travel (home) sensor is triggered. Once the axis has been homed, the position is reset to zero (0).

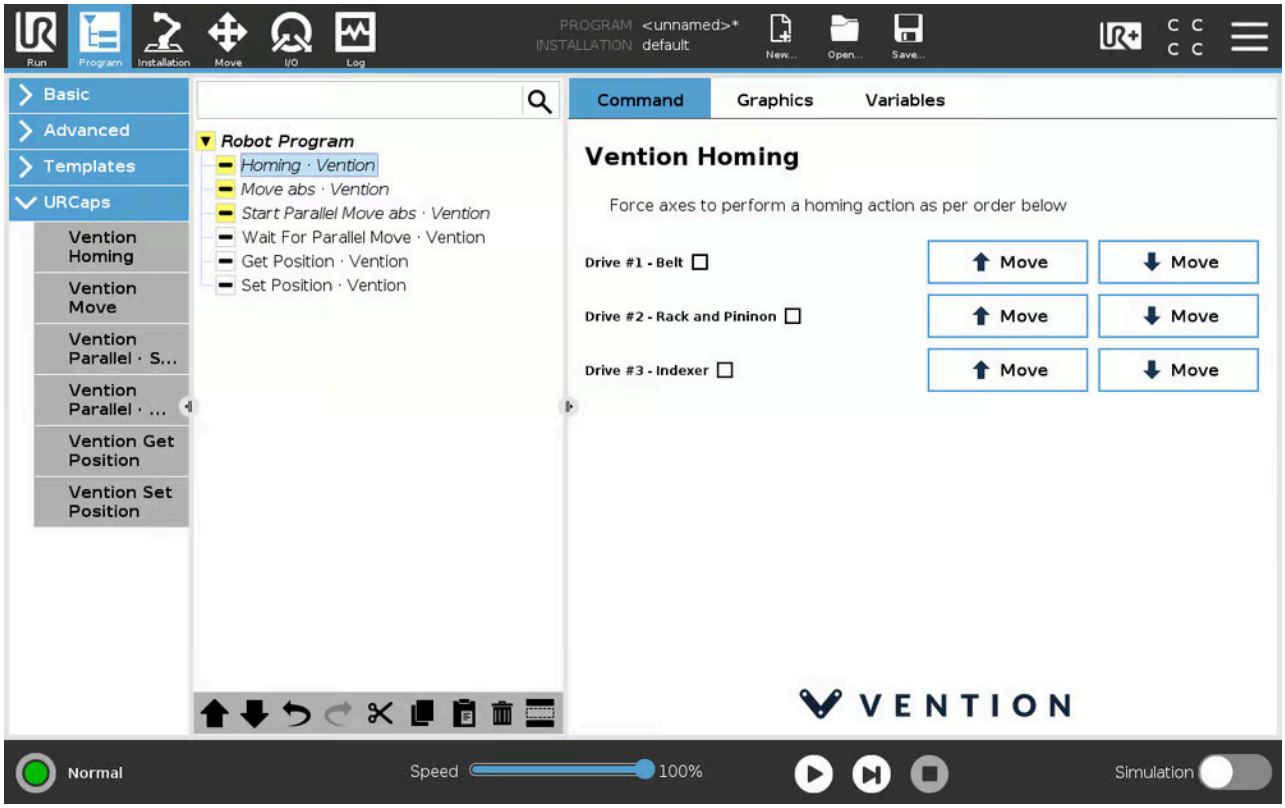

Figure 25: Vention URCap homing instruction details
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/779/original/urcapv2-home-v3.png?1565211499)

Move Axes

The **move axes** instruction enables the movement of one to three axes simultaneously. Two types of movement are supported:

- **Absolute:** Move to an absolute position or rotation
- **Relative:** Move a specified distance relative to the current position or rotation

The units of movement depend on the type of actuator and are as follows:

- **Linear axis:** millimeters
- **Rotary indexer:** degrees

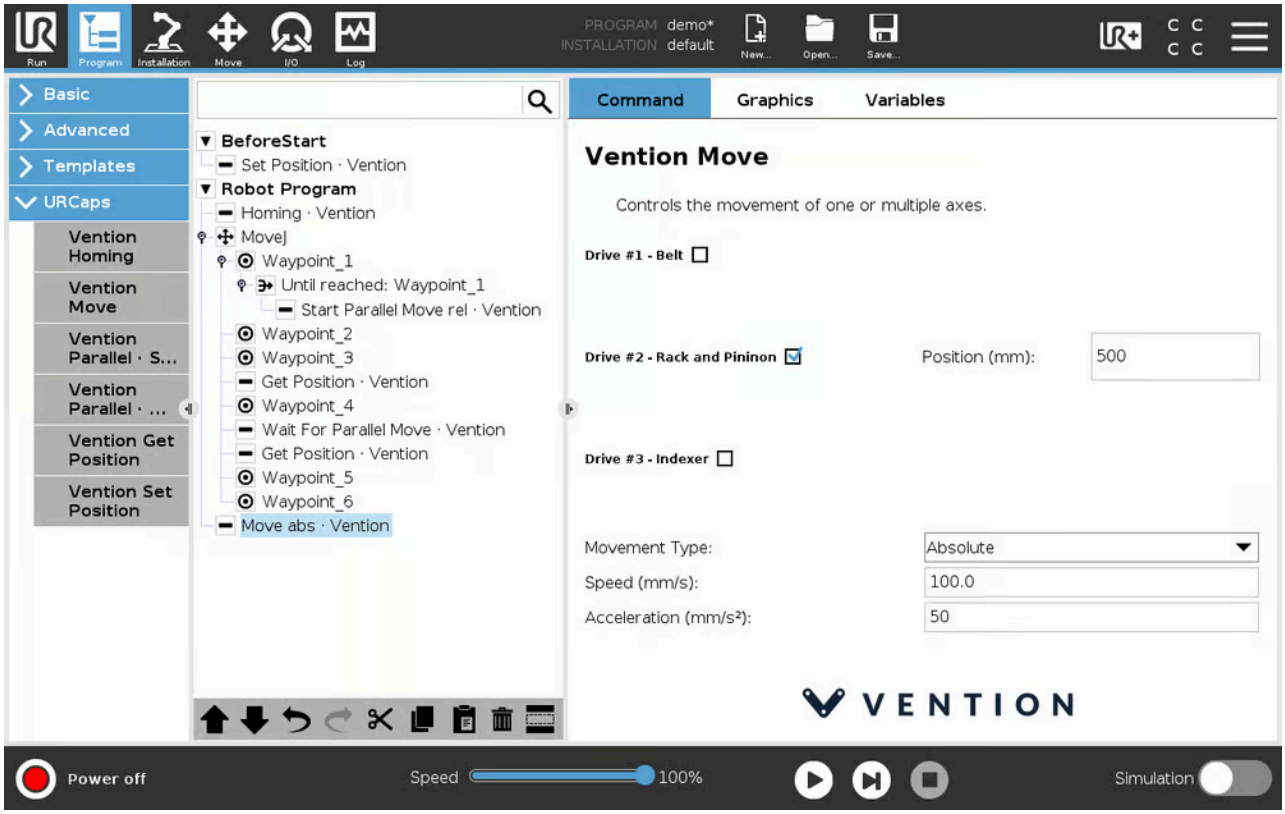

Figure 26: Vention URCap Move instruction details
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/780/original/urcapv2-move-v3.png?1565211500)

You may modify the parameters of the Move instruction from the **Command** tab of the **Program window**.

Position

This is the position, given in millimeters or degrees, to which the linear or Rotary axis will move.

Movement Type

If the **Movement Type** is set to **Absolute**, all positions are with respect to the home location (0 mm). For example, a position of 200 mm will result in the linear axis moving 200 mm away from the home location. If the linear axis is already positioned at 200 mm on the linear axis, then it will simply remain in place and not move.

If the **Movement Type** is set to **Relative**, position commands are relative to the current position of the linear axis. For example, a position of 200 mm will result in the linear axis moving 200 mm away from its current location. If the linear axis is already positioned at 200 mm on the linear axis, then it will move 200 mm away in the positive direction, and its final absolute position will be 400 mm.

Speed

Coasting speed of the linear axis in millimeters or degrees per second depending on your actuator's type. The system utilizes a trapezoidal speed profile which contains an acceleration period, a coasting period and a final deceleration period. The speed increases linearly until coasting speed is reached, and finally decreases linearly until speed reaches zero. The Speed setting configures the coasting speed.

Acceleration

Acceleration of the linear axis in millimeters or degrees / second^2 depending on your actuator's type. This parameter controls the acceleration and deceleration of the trapezoidal speed profile. The acceleration and deceleration are equal.

Get Axes Position

The positions and rotations of up to three (3) axes can be input as UR teach pendant variables using the **get axes position** instruction. Empty fields will be ignored. For example, if you only want to get axis number one's position as a variable, fill in only that field.

Two types of positions are available from Vention axes:

- **Controller position:** The position the motor is being driven to (motor commands)
- **Encoder position:** The position read from the encoder on the shaft of the motor (if installed)

In normal operation (without stalls and skips), the position of the controller and encoder for a given axis should correspond with each other. Discrepancies between these positions indicates that the movement has not been completed according to the program.

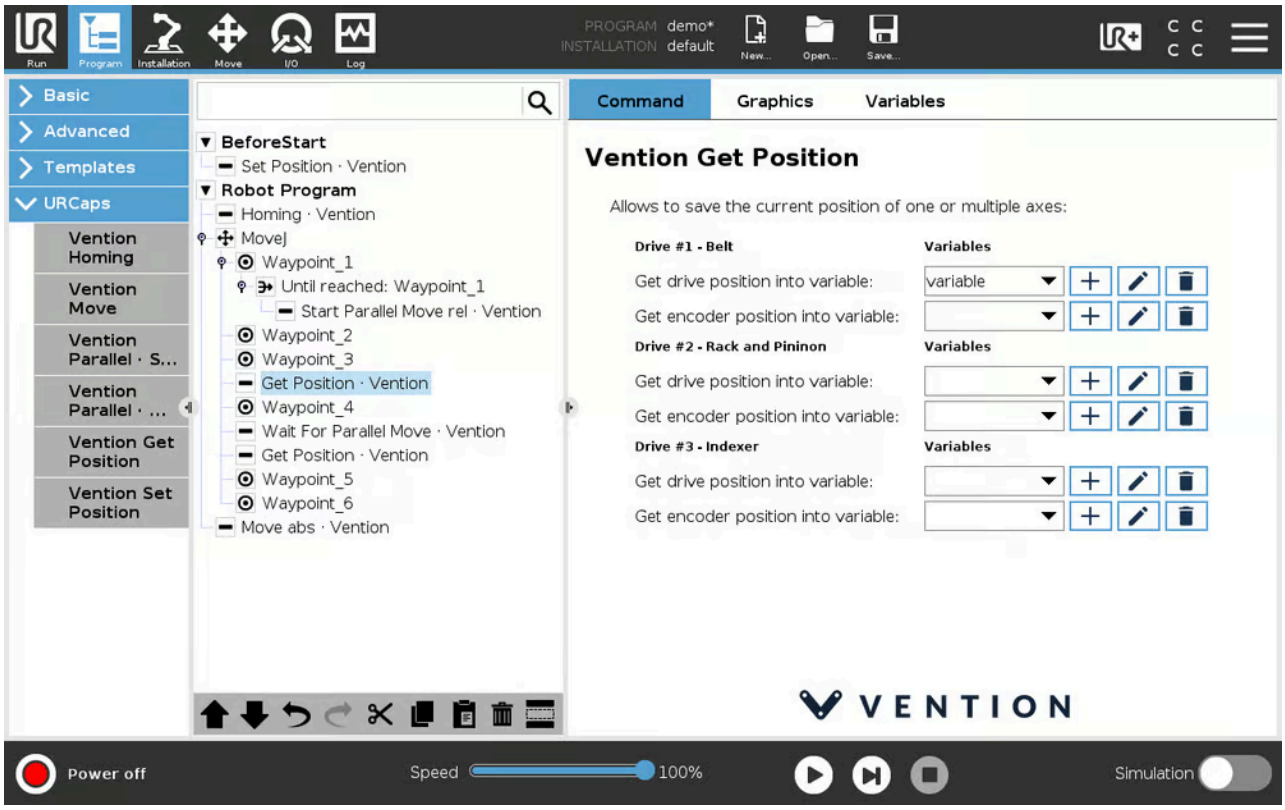

Figure 27: Vention URCap Get Position details
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/783/original/urcapv2-get-position-v3.png?1565211620)

Set Axes Reference Position

The position reported by the axis can be overridden using the **set axes reference position** instruction. Empty fields will be ignored. For example, if you only want to set axis number one's position, fill in only that field.

This instruction can be used to:

- Create a local coordinate system for a series of movements
- Realign the controller position using the encoder position after a stall or a skipped step
- Set a reference point for free-form Rotary applications

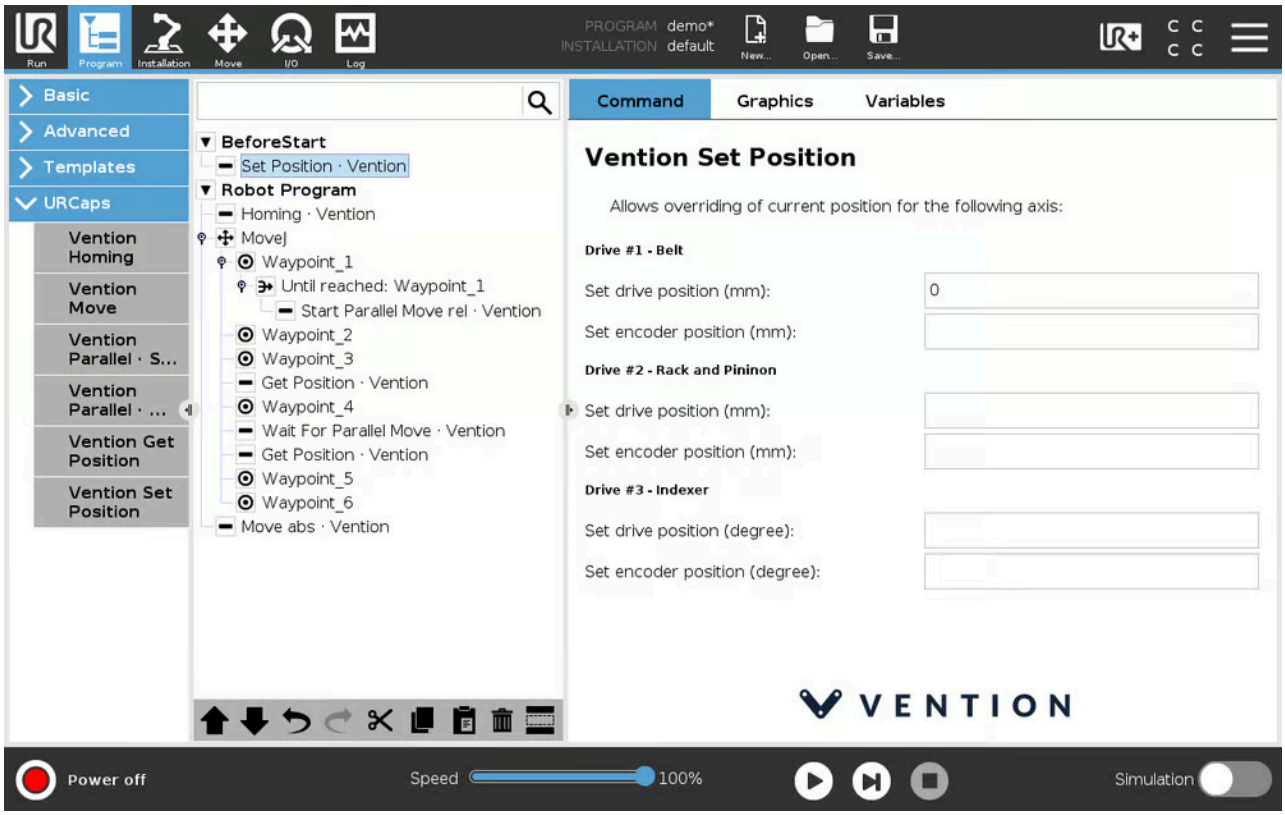

Figure 28: Vention URCap set reference position instruction details
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/784/original/urcapv2-set-position-v3.png?1565211621)

Parallel Move Start

The **parallel move start** instruction can be used to simultaneously move the Vention axes and the UR robot arm. As for the standard sequential move, the parallel move may target one to three Vention axes.

This move instruction initiates the movement of Vention axes and then immediately continues with the following URScript instruction, allowing the robot arm to move in parallel.

Note: You must use the parallel wait instruction in conjunction with parallel move start, in order to resynchronize the Vention Axes and Universal Robots movements.

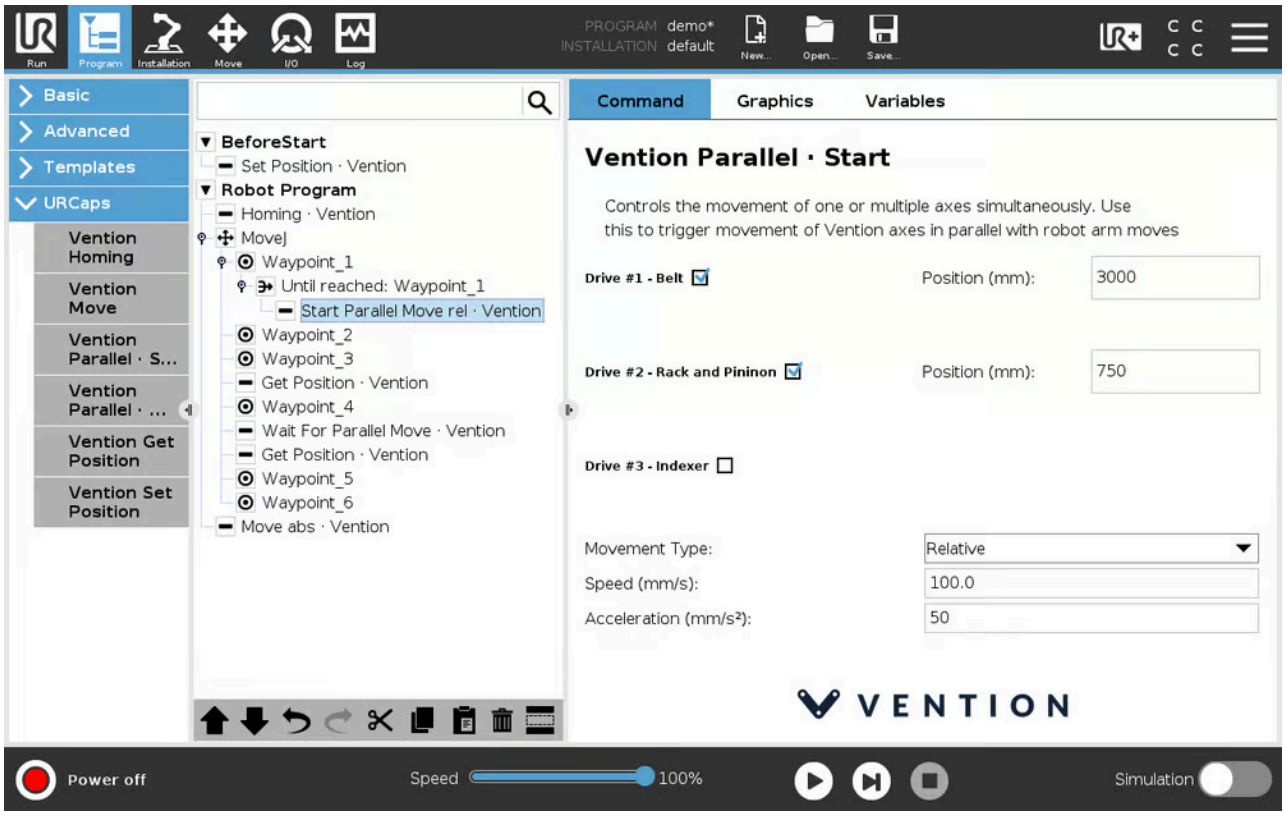

Figure 29: Vention URCap start parallel move instruction details
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/787/original/urcapv2-parallel-start-v3.png?1565211765)

Vention Parallel Move Wait

The **parallel move wait** instruction is used to await the completion of a previously started Vention parallel move before resuming a sequential execution flow. Position this instruction in your program where you need to resynchronize the Vention and robot arm movement.

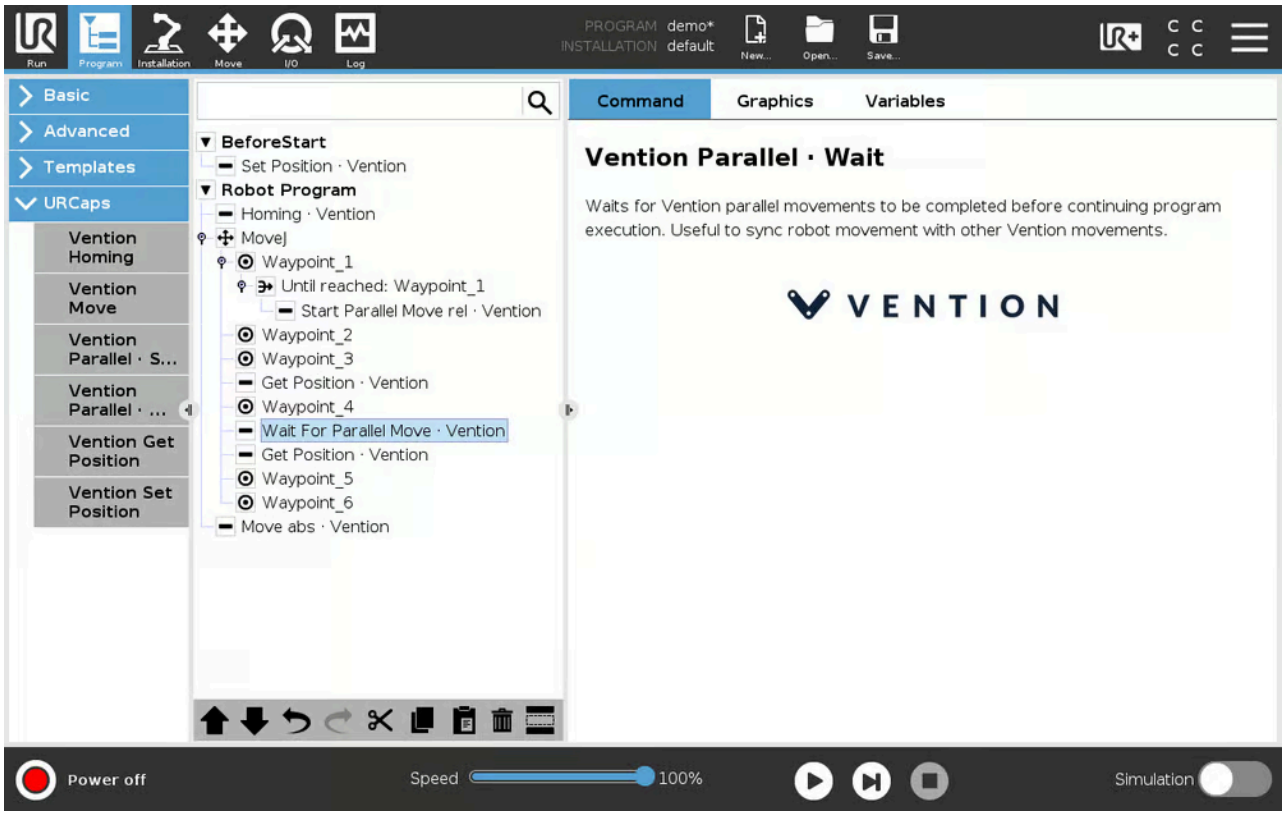

Figure 30: Vention URCap wait for parallel move instruction details
To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/788/original/urcapv2-parallel-wait-v3.png?1565211765)

Example: Vention Parallel Move

The following URScript shows an example of starting a Vention parallel move after the first robot waypoint is reached (*Waypoint_1*). The program will wait for the Vention parallel move to be completed before it executes the **Get Position** instruction.

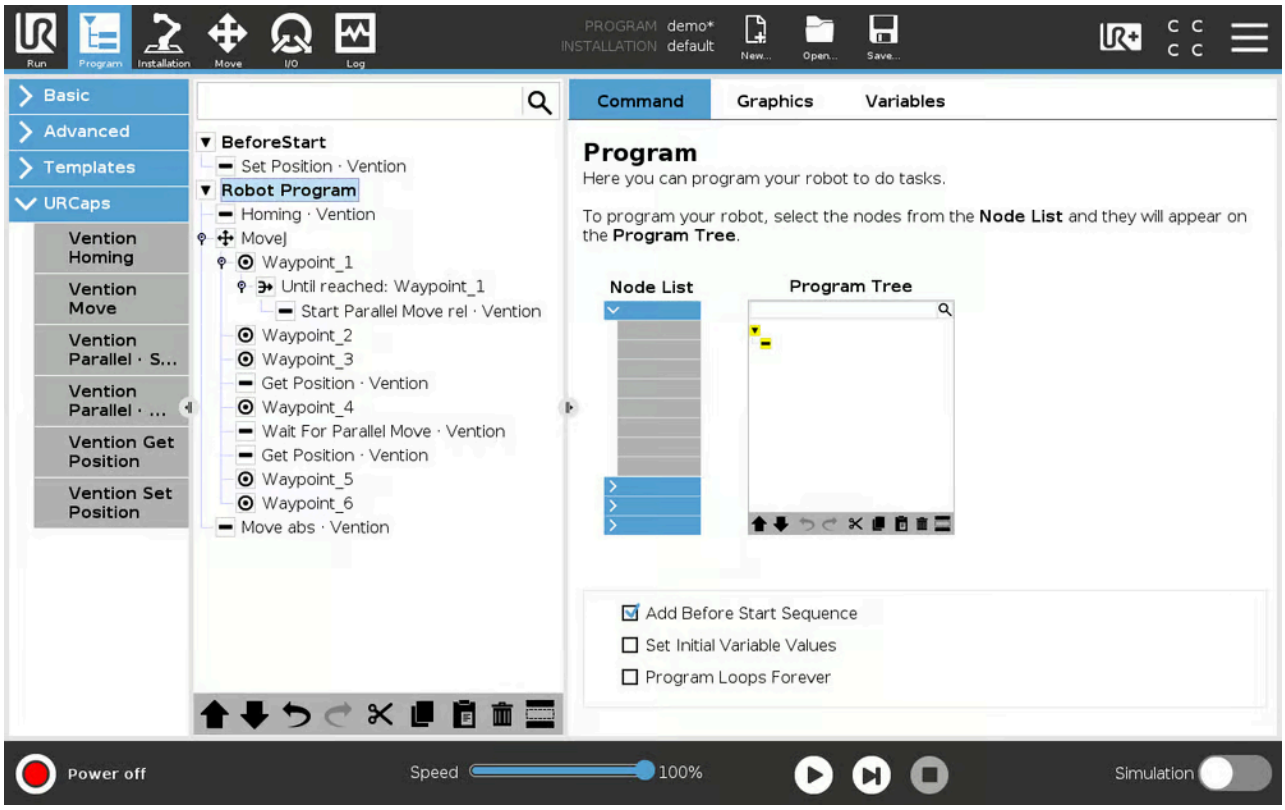

Figure 31: Example of a Vention parallel move instruction

To view UR Interface v3 click here (https://vention.io/cdn-cgi/image/format=auto,width=1000/https://assets.vention.io/images/000/001/791/original/urcapv2-example-v3.png?1565211903)