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MAD Controller User Manual

www.nutai.com

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Overview

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- 3 Installation
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- 5 Safety
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Introduction


What is MAD Controller?

Multi Axis Drive (MAD) Controller is a URCap software that allows you to control multiple axis from your UR robot using Festo CMMT-AS/ST and CMMP-AS motor controllers.

With this software you can move up to 4 axis to points or positions easily and code-free, without the need for other external components such as PLC/HMI.

Suitable applications:

- Palletizing
- Material handling
- Machine tending
- Material removal
- Quality inspection
- Dispensing

 **Warning:** we are not responsible for any damage caused by misuse of this product.

Introduction

Clarifications

MAD Controller is compatible with Festo CMMT-AS/ST and CMMP-AS motor controllers depending on the URCap software version:

- 2.x.x: compatible with CMMT-AS/ST (new controller)
- 1.x.x: compatible with CMMP-AS (previous controller)

Some of the functionalities described in this user manual are only available for one controller model, indicated in the footer.

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Requirements



Requirements needed to use this URCap satisfactorily:

- Universal Robots e-Series¹ (PolyScope 5.3.0² or higher³)
- Festo CMMT-AS/ST or CMMP-AS motor controller(s)
- Ethernet connection between the robot and motor controller(s)
- USB device (only for installation)

¹ From PolyScope 5.10, for correct operation, check that the *RTDE* service is enabled in *Settings -> Security -> Services*.

² Download and instructions for upgrading PolyScope:

<https://www.universal-robots.com/download>


Requirements

RTDE connection

This software makes use of the Universal Robots *Real-Time Data Exchange* (RTDE) protocol to synchronize information necessary for the operation of the URCap.

Below is a table with the registers in use (default range). You can modify its offset from the [advanced configuration](#) panel of the URCap.

Type	Quantity	Range
Integer	12	24..35
Boolean	8	64..71

 **Warning:** check that no other program or URCap uses the configured RTDE registers to avoid possible interference that may cause the software to function incorrectly.

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This section explains everything related to the installation process at the hardware and software level. It is divided into the following subsections:

1. Mounting

General assembly diagram of the mechanical components.

2. Safety connections

Safety connections between the robot and the axis.

3. Motor controller configuration

Configuration of the motor controller using Festo software.

4. URCap Installation

Installation and licensing of the URCap software on the robot.

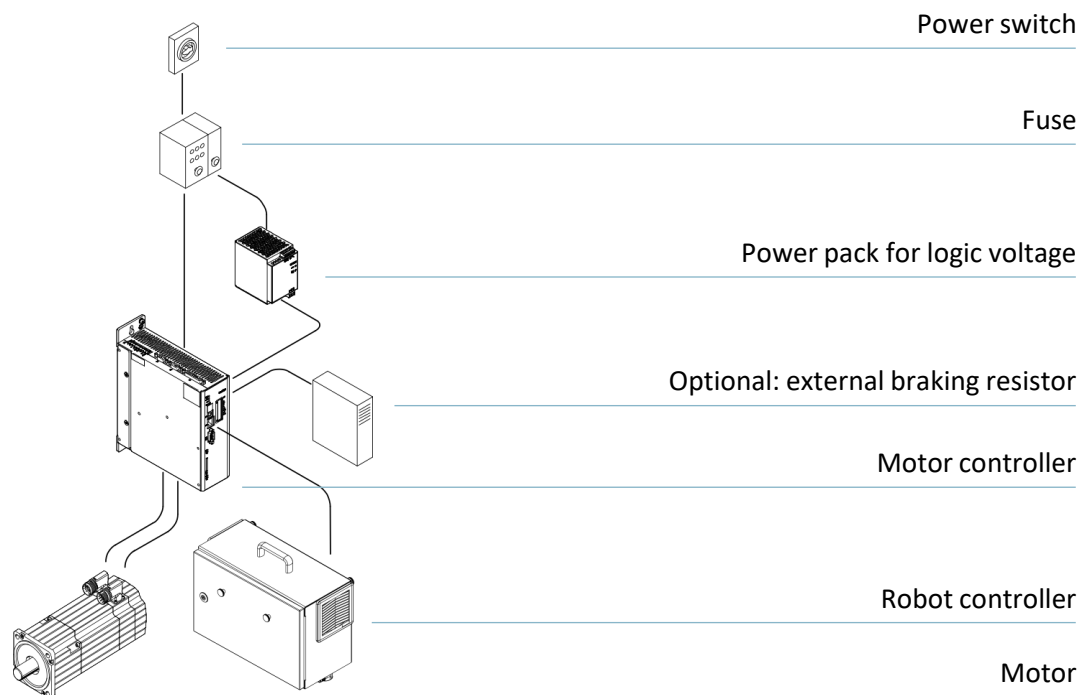
5. First steps

First steps to take to proceed with the use of the product.

1 Mounting

Installation

General assembly diagram¹:



¹ See all mounting details in the manufacturer's manual:

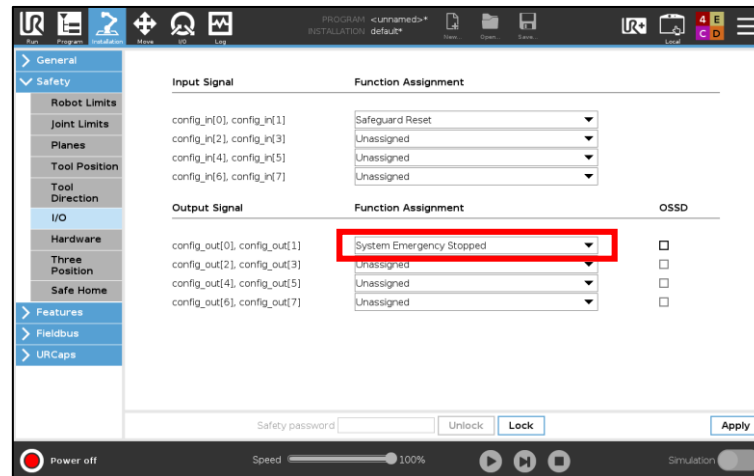
<https://www.festo.com>

2 Safety connections

Installation



- 1 Connect a robot controller double safety output to the *STO* —*Safe Torque Off*— function of the motor controller/s¹.
- 2 Configure that output as *System Emergency Stopped*² from the robot installation panel.

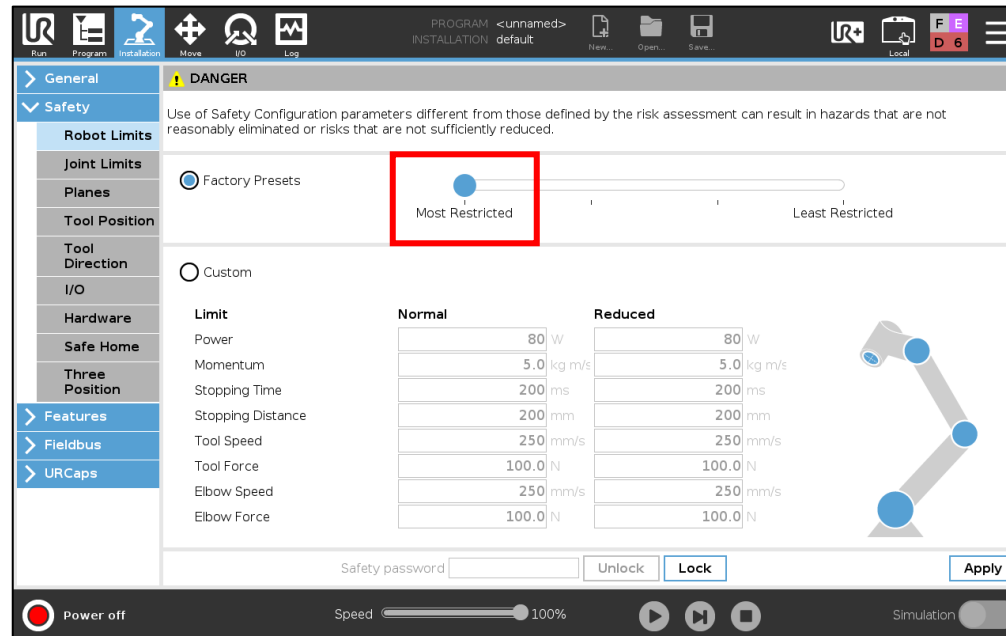


¹ In case of using multiple axis, you must use a safety relay to connect them all.

² This will cause the axis to stop upon collisions, failures or safety stops of the robot.

Installation

- 3 We advise you to select a restrictive safety¹ setting on the robot from the robot installation panel.



¹ See the robot user manual for more details.

3 Motor controller(s) configuration

Once the mounting has been completed and the safety connections between the robot controller and the motor controller/s are connected, it is necessary to configure the latter/s.

If you have purchased the equipment directly from NUTAI, the motor controller/s will already be preconfigured to work correctly with the selected components.

If not, or if reconfiguration is required, it is necessary to connect to the motor controller/s via the Festo parametrization software and configure¹ the necessary components and parameters to function properly with the URCap.

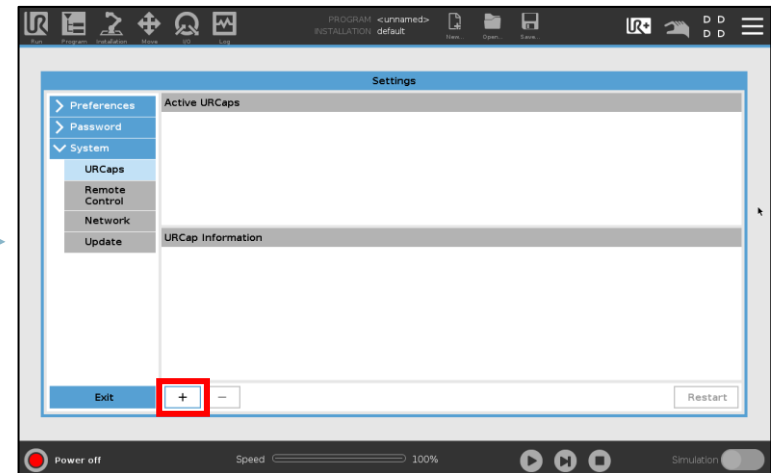
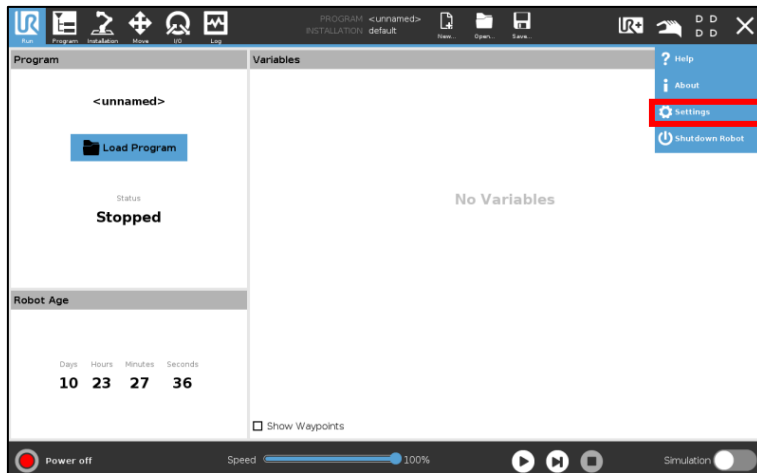
¹ Please refer to NUTAI's document *CMMT-AS/ST* and *CMMP-AS Configuration Manual* and follow the indicated steps to configure the motor controller/s.

4 URCap installation

Installation

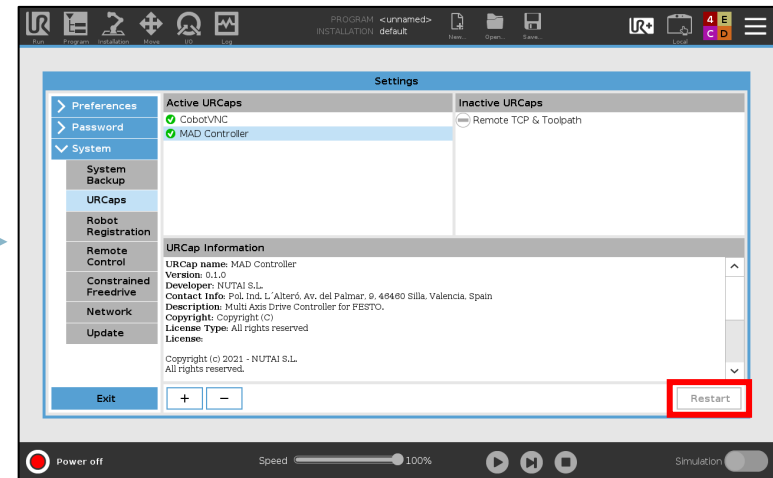
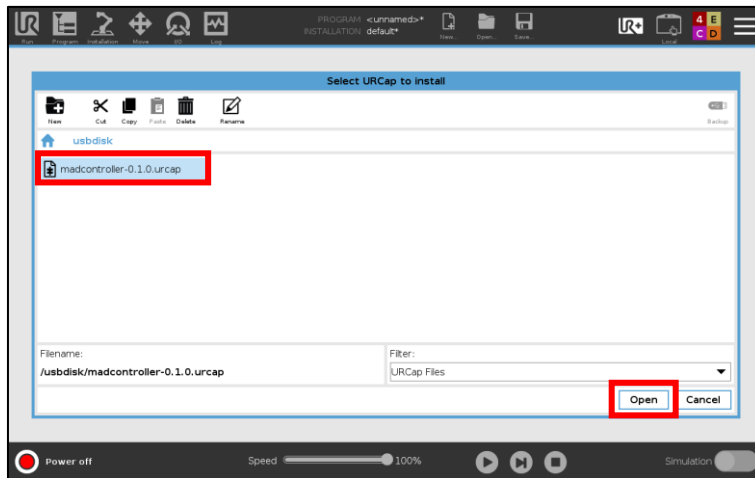


- 1 Copy the installation file `madcontroller-{version}.urcap` into a USB device and plug the USB into your robot's teach pendant.
- 2 Go to *Settings* in the upper right menu, then *System* -> *URCaps* and click on the install button (+).




Installation

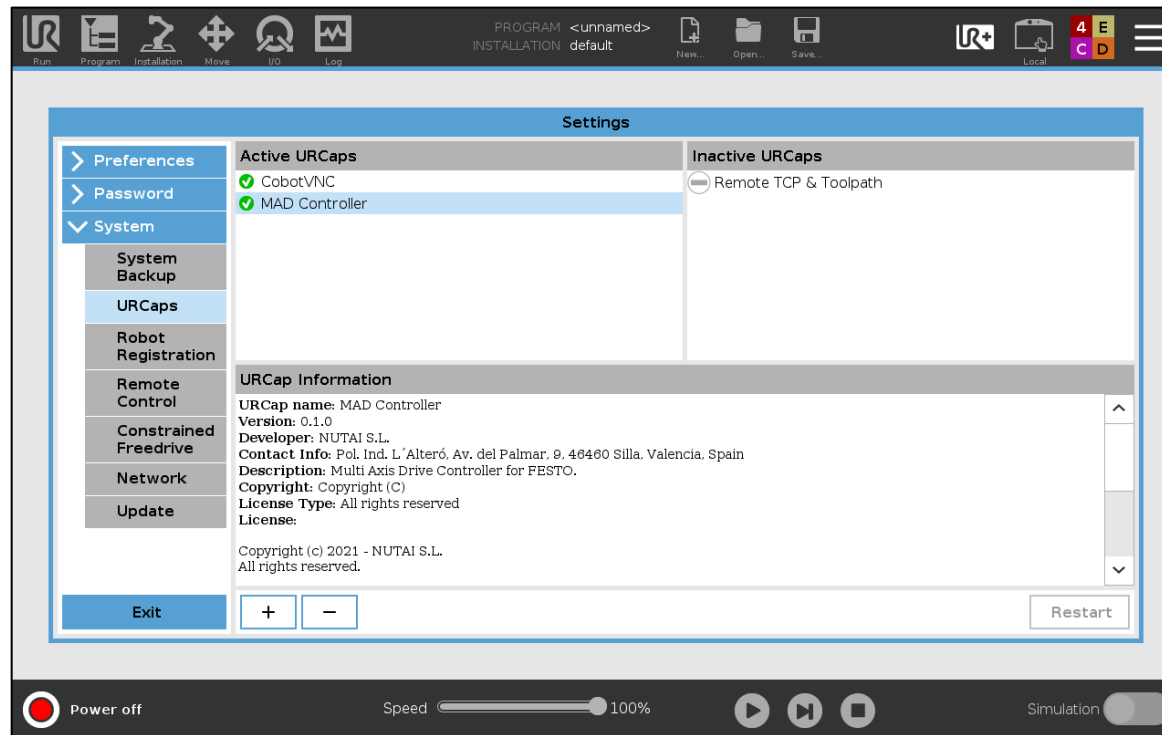
- 3 Navigate through your USB device, select the URCap and click on the *Open* button.
- 4 Click on *Restart* button to apply installation.



Installation

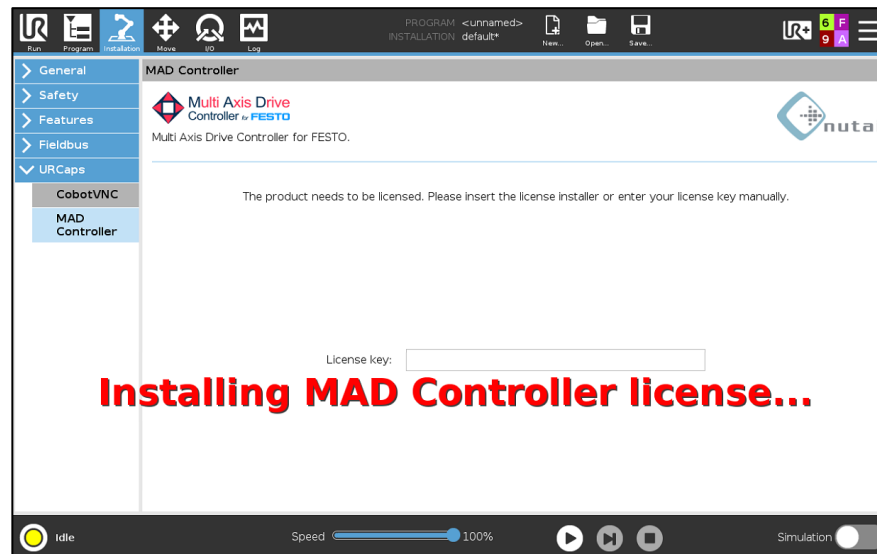


- 5 Once restarted, if it has been successfully installed you should see the URCap along with the  mark.



Installation

- 6 The next step is to license the URCap. To do this, insert the USB with the license installer¹ into the robot's teach pendant. Wait until the green confirmation message is displayed and restart the robot.

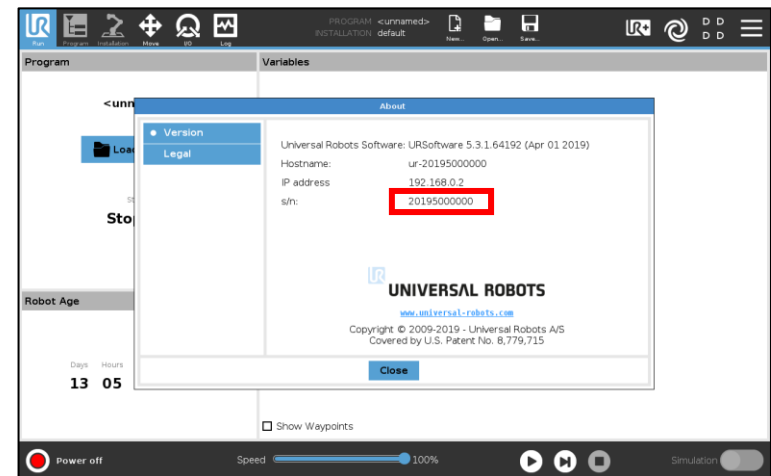
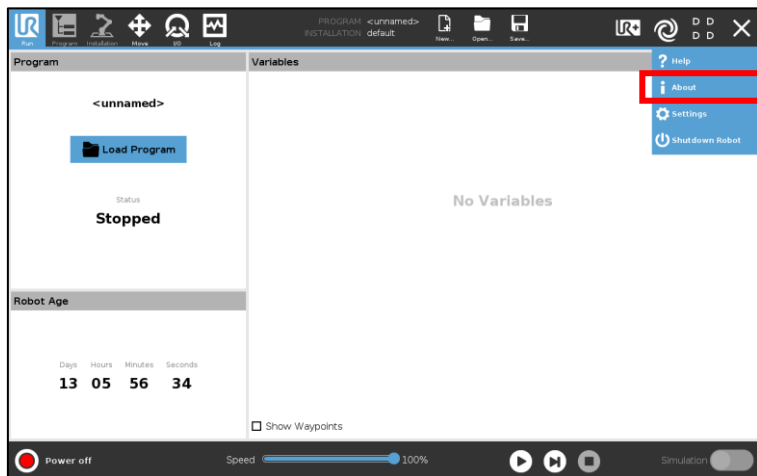


¹ You can also license the product manually by entering your license key.

² Make sure to always keep the robot's system date up-to-date to avoid licensing issues.

Installation

- ❓ How do I request my license key?
Check the serial number¹ of your robot and send it to us by email².



¹ We need the serial number of the robot controller, which can be seen following the steps above. Usually, it is the same as the one shown on the robot arm, but you should check it.

² Contact us at sales@nutai.com

5 First steps¹

¹ For a better understanding, we advise you to complete the reading of this user manual before carrying out the actions indicated in this section.

Once the URCap is installed, you must perform the following configuration from the URCap for each of your axis:

1. [Connect](#) to your axis
2. Perform a [Home](#)¹
3. Configure the new [software position limits](#)²

¹ It is possible that you cannot move the axis due to the software position limits configured by default, so in this case you must previously configure them from the [Parameters](#) tab, setting large values temporarily.

² From the [Parameters](#) tab, select the *Software position limits* option and configure the lower and upper limit, respectively.

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Functionalities

This section explains everything related to the functionalities of the URCap software. It is divided into the following subsections:

1. Installation panel

Configuration of axis parameters and saving of points.

2. Program panel

Axis movement instructions using program nodes and URScript code.

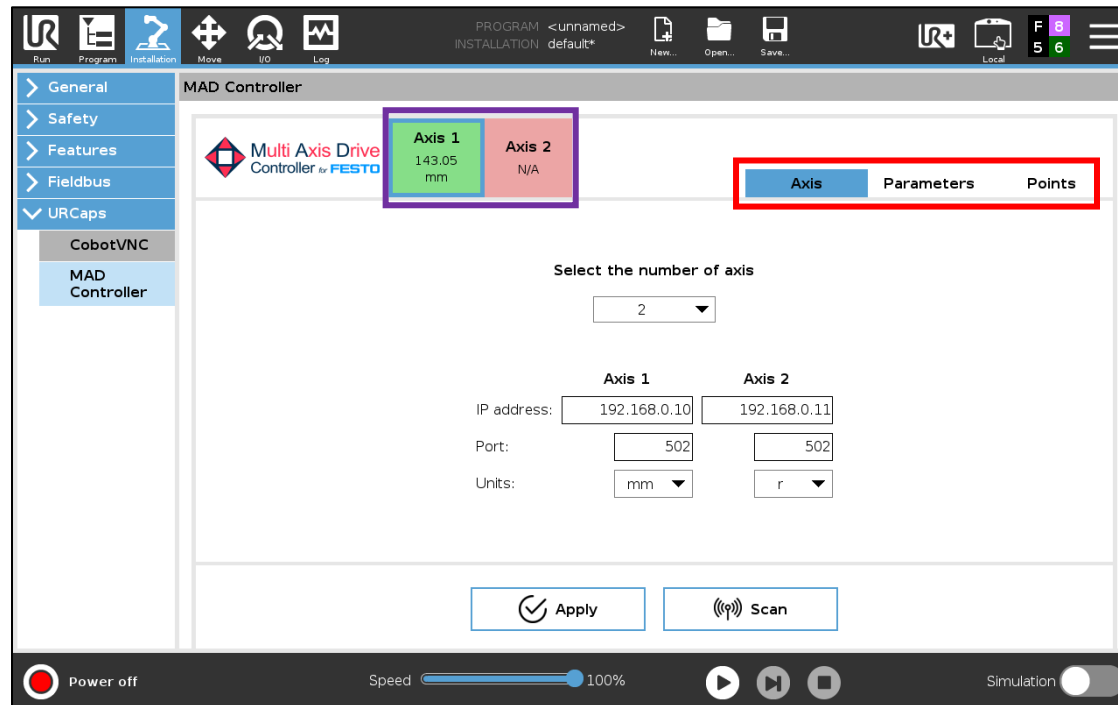
3. Toolbar panel

Diagnosis of the axis and Jog manual movement.

1 Installation panel

Functionalities

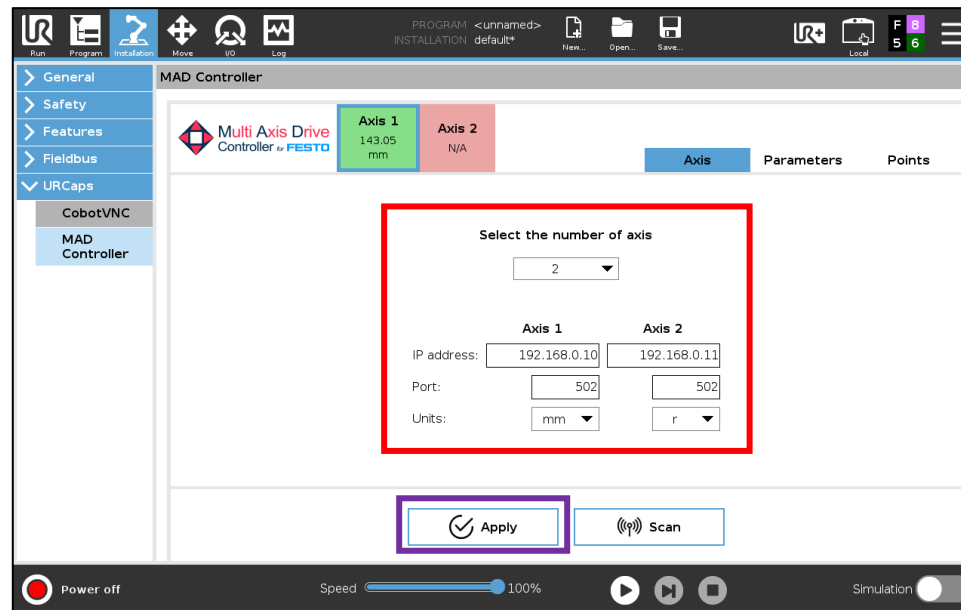
You can configure all the features of the URCap from the installation panel.
This window has 3 tabs (☐): *Axis*, *Parameters* and *Points*:



☐ The information of the configured axis is also displayed: their status and their current position.

Functionalities

From the *Axis* tab you can select the number of axis you want to work with, assigning each one its IP address, port and position units.



□ Once the axis have been specified, press the *Apply* button to connect¹ or reconnect to them.

¹ In case of error, check that there are no other active connections to your axis via PLC or FAS/FCT.

Functionalities


Select the number of axis

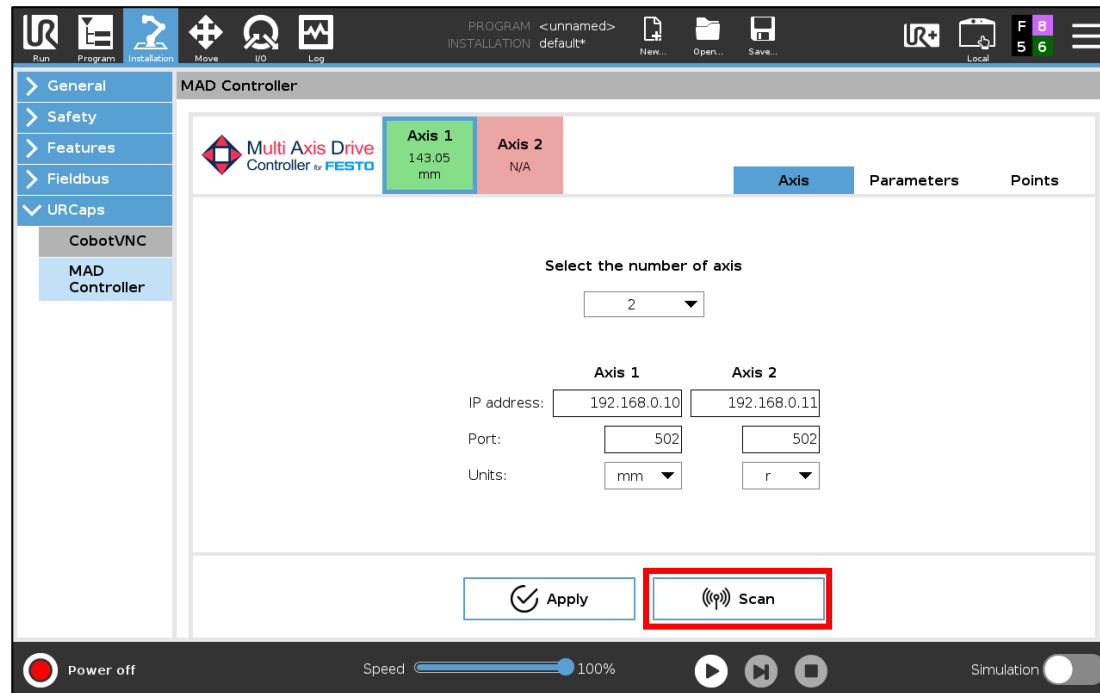
2 ▼

	Axis 1	Axis 2
IP address:	192.168.0.10	192.168.0.11
Port:	502	502
Units:	mm ▼	r ▼

- **Number of axis:** enable the number of selected axis —up to 4 axes, limited according to the license purchased.
- **IP address and port:** connection parameters with the motor controller.
- **Units:** position units, as configured in the motor controller.

Functionalities

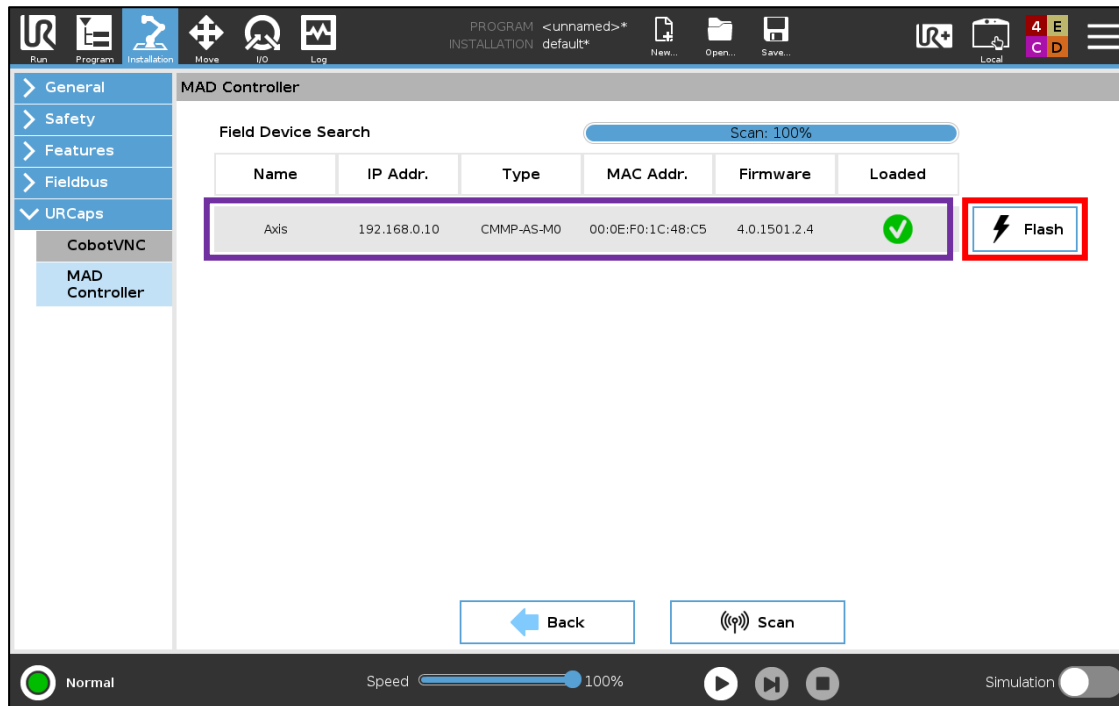
The *Scan* button¹ () will perform a device search and will list them with their main data —IP address, MAC, firmware version, and configuration status.



¹ This functionality is only available for CMMP-AS motor controllers.

Functionalities

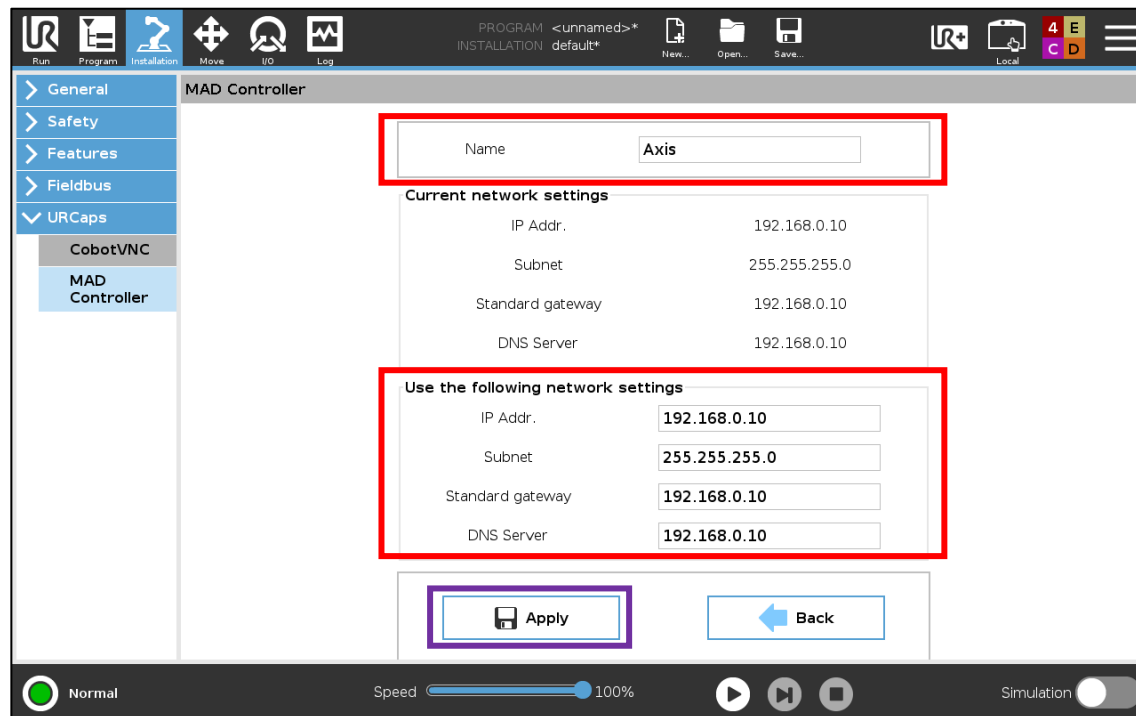
The *Flash* button (⚡) allows you to identify the motor controller. When pressed, the letters HELLO will be displayed on the screen of the selected controller.



It is possible to edit the motor controller network configuration by clicking on it.


Functionalities

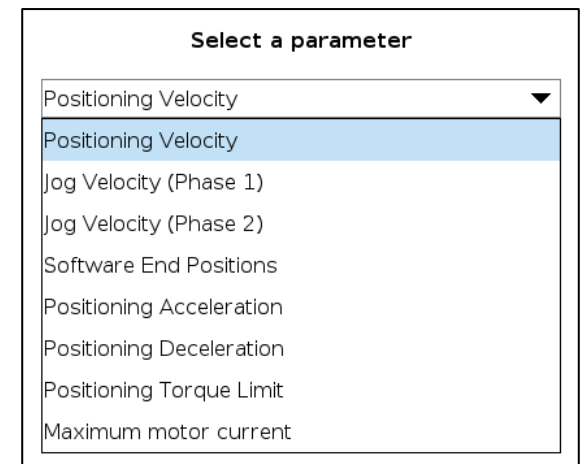
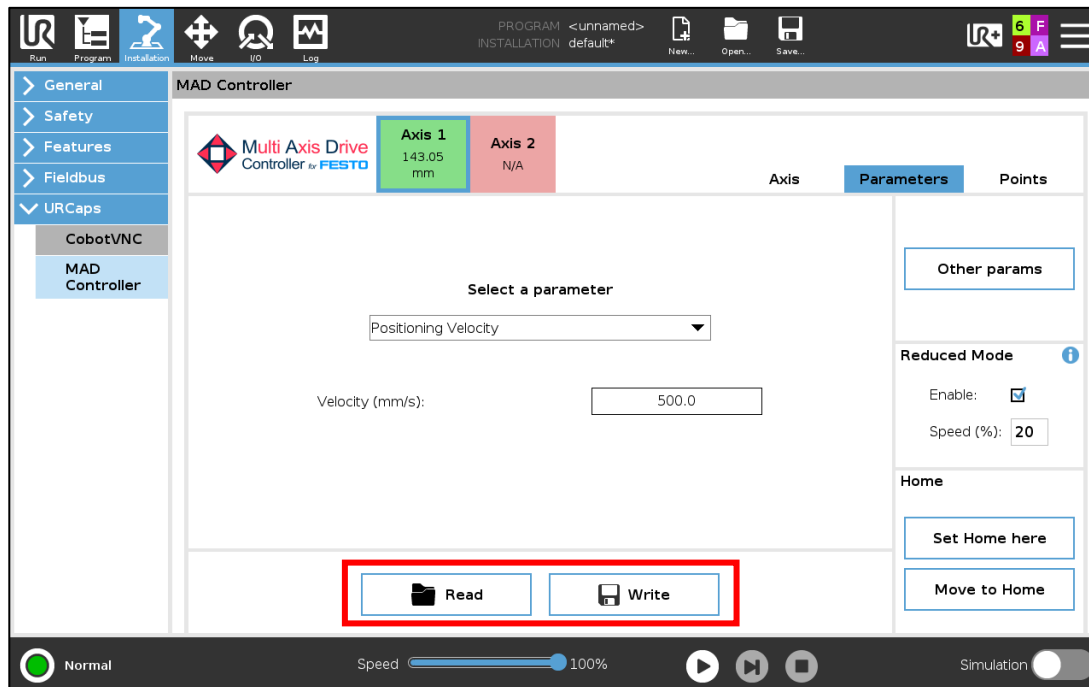
In this window you can configure the name, IP address, subnet mask, gateway and DNS server of the selected motor controller (□).




□ Press the *Apply* button to save the changes and restart the controller.

Functionalities

From the *Parameters* tab you can consult —*Read* button— and configure —*Write* button— () the most common parameters of the controller.



 **Warning:** modifying the parameters will affect the operation of its components. All the parameters located in this tab (except *Reduced Mode*) are stored in the motor controller and not in the installation file.

Functionalities

Description of the main configuration parameters:

1. **Positioning speed:** base speed for direct —that is, moving to value or point (not Jog).
2. **Jog speed (phase 1)**¹: maximum speed in manual mode (Jog) during initial phase.
3. **Jog speed (phase 2)**²: maximum speed in manual mode (Jog) during final phase.
4. **Software position limits:** minimum and maximum software end position (not limited). Plausibility rule: Lower limit \leq Upper limit.

^{1 2} Parameter only available for CMMP-AS motor controllers.

Functionalities

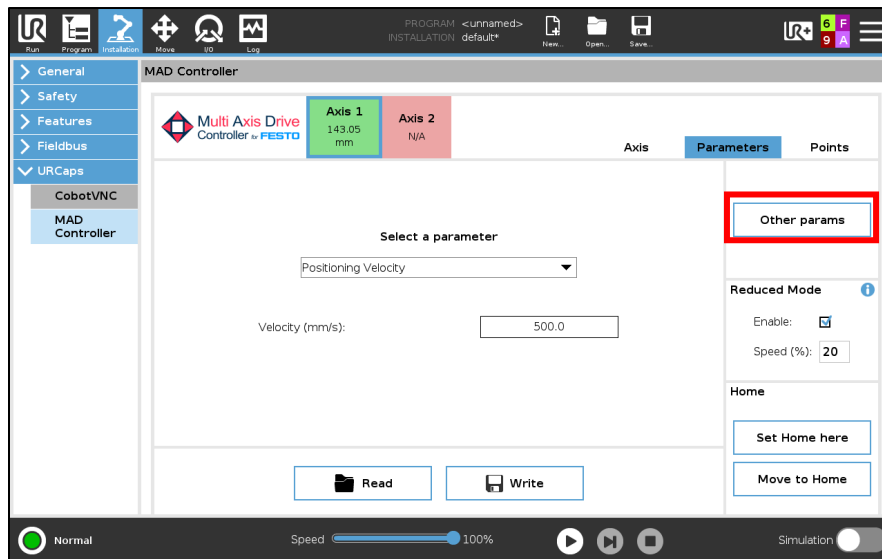
Description of the main configuration parameters:

- 5. **Positioning acceleration:** acceleration for direct mode positioning tasks.
- 6. **Positioning deceleration:** deceleration for direct mode positioning tasks.
- 7. **Positioning torque limit¹:** torque limit in *mNm* (not limited). If the axis exceeds this limit, the fault is activated. The value 0 disables the torque limitation.
- 8. **Maximum motor current:** maximum current in % or Arms of the nominal current of the motor.

¹ Parameter only available for CMMP-AS motor controllers.

Functionalities

If it is required to read or modify any other parameter¹ of the controller², it is possible to do³ so knowing its *PNU* and its *Index* by means of the *Other params* button.



Festo Parameter Channel (FPC)	
PNU:	1014
Index:	1
Value:	1
<div>Read PNU</div> <div>Send PNU</div>	

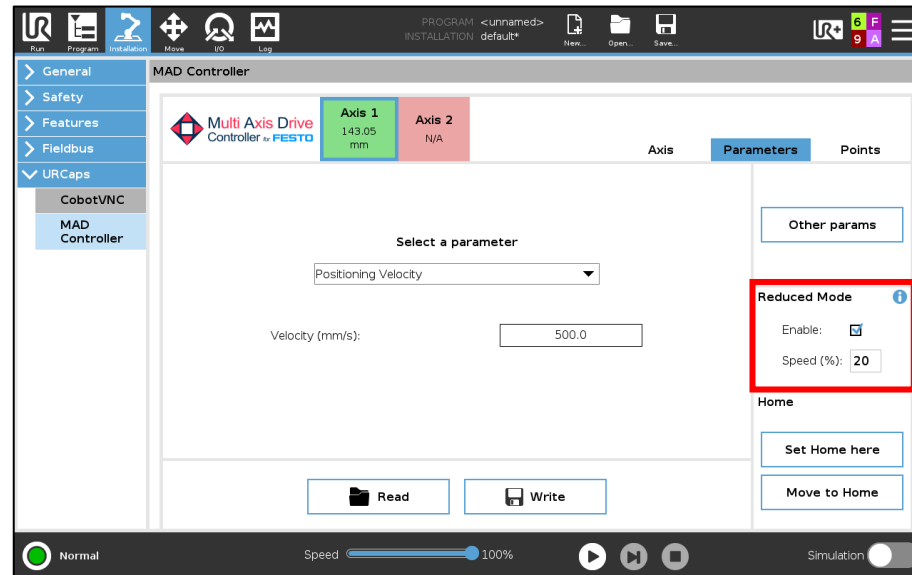
¹ This functionality is only available for CMMP-AS motor controllers.


² See the motor controller manual for the full list of parameters.

³ In case of reading or writing position, speed or acceleration parameters, you will have to consider the exponents previously configured in the motor controller via FCT.

Functionalities

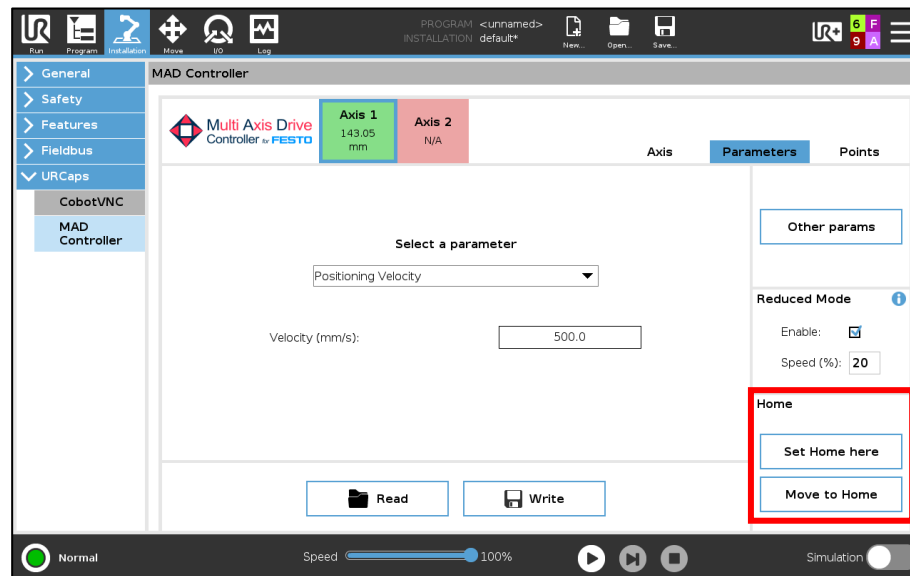
It is possible to enable and configure the axis speed in *Reduced mode* (☐). By enabling this option, if the robot is in Reduced Mode, the maximum positioning velocity of the selected axis will be limited to the configured percentage.



 **Warning:** this software functionality does not replace the SLS (*Safe Limited Speed*, EN 61800-5-2) motor controller safety function, which would require the additional safety hardware module.

Functionalities

You can define the current position as *Home* (□) using the set home button. The Homing¹ procedure is detailed on the next slide.



□ Clicking on *Move to Home* will move the axis to the current zero position.

¹ We recommend using multi-turn absolute encoders to avoid having to perform Homing every time the motor controller is restarted.

Functionalities

❓ What is Homing?

The Homing procedure consists of defining what the zero point of the axis will, that is, the physical position where the axis will indicate zero position. Once the Home is defined, you can move the axis and memorize points based on this reference¹.

❓ How do I perform a Homing?

1. Move the axis by manual movement (Jog²) to the position you want to set as the zero point³
2. Press the set home button and wait for the motor controller to restart

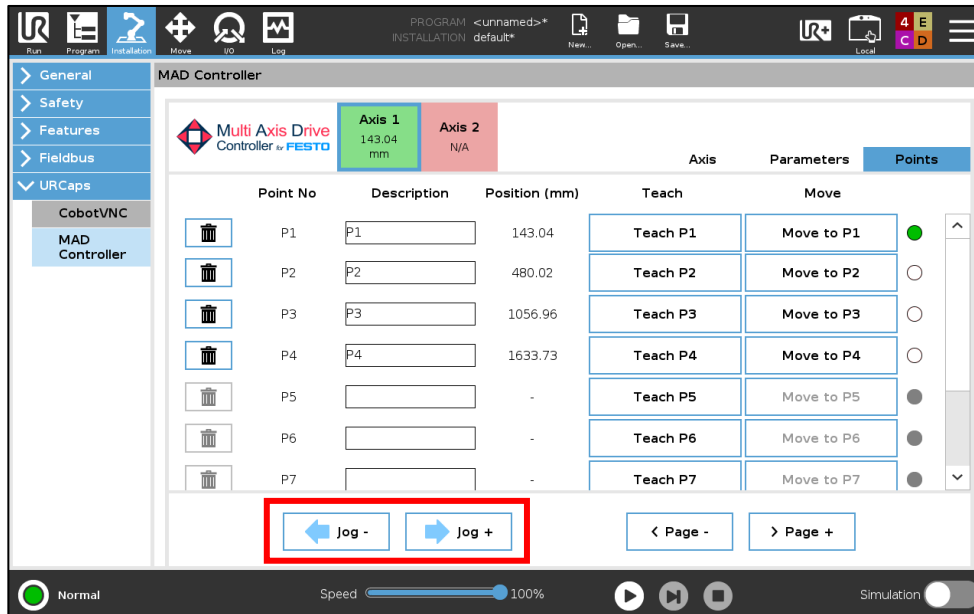
¹ It is advisable to physically mark this point on the axis in case it is necessary to perform another Home later, and thus not lose the reference of the memorized points.

² You can move in Jog from the *Points* tab or from the Toolbar.

³ This operation will set the axis zero point and the project zero point internally in the motor controller as zero at the position where the axis is when homing.

Functionalities

From the *Points* tab you can save —*Teach P_i* button— and move —*Move to P_i*¹ button— to positions to use them during the program, as well as move the selected axis in manual mode with the Jog buttons (□).

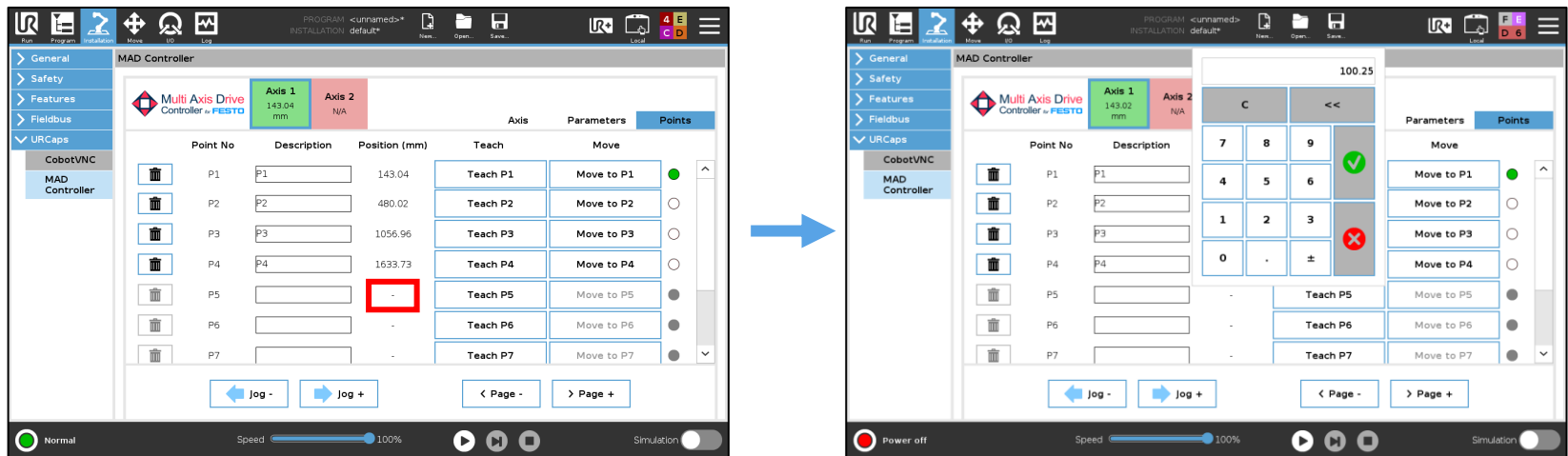


- Not memorized
- Memorized
- Memorized in current position
- Memorized out of SW limits
- Axis controller N/A or not enabled

¹ The axis must be stopped the button is pressed, otherwise it will not move and will display *Wait*.

Functionalities

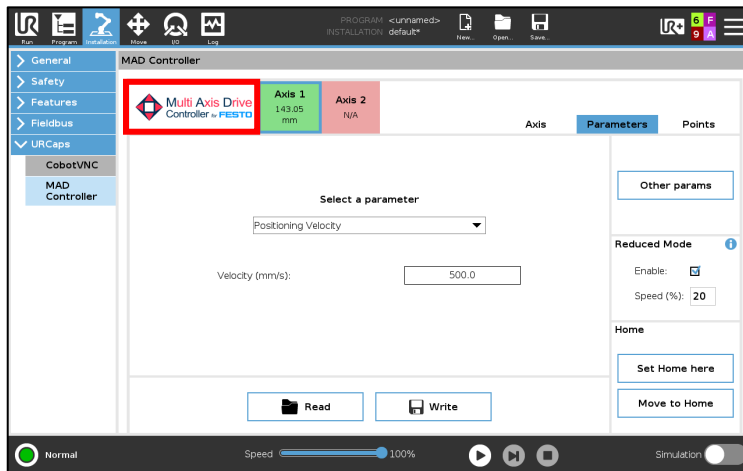
You can also memorize the position of your points manually by clicking on the current position value and entering the new value (□).



Functionalities



Clicking on the upper left logo opens a product information window with the status of the license, the version, possible updates, etc.

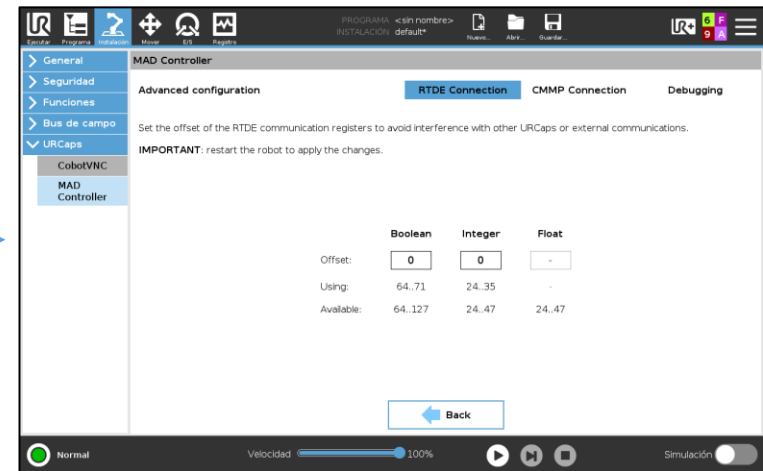
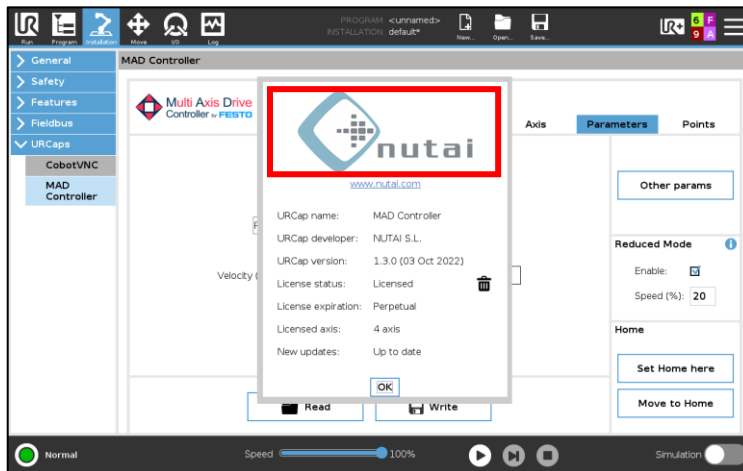


Functionalities



From the URCap information popup you can also access the advanced configuration panel by keeping the NUTAI logo pressed for 3s.

From here you can make additional settings such as the offset of the RTDE registers.

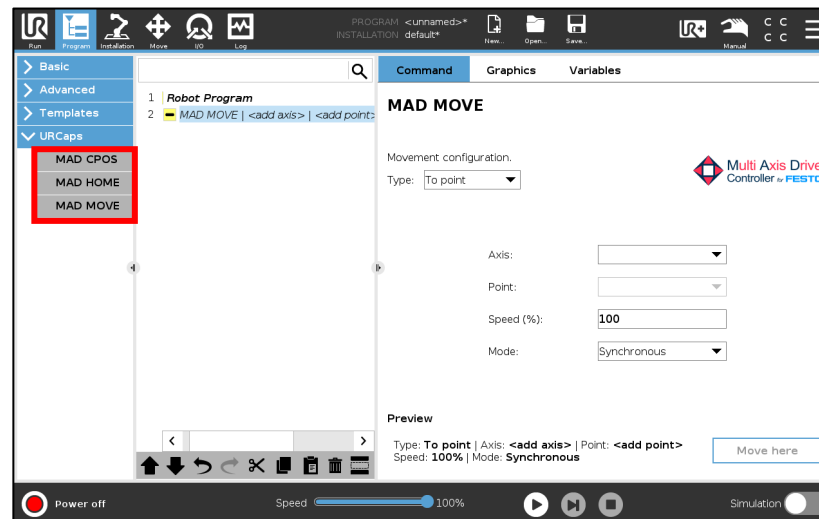


2 Program panel

Functionalities

The URCap has three program nodes:

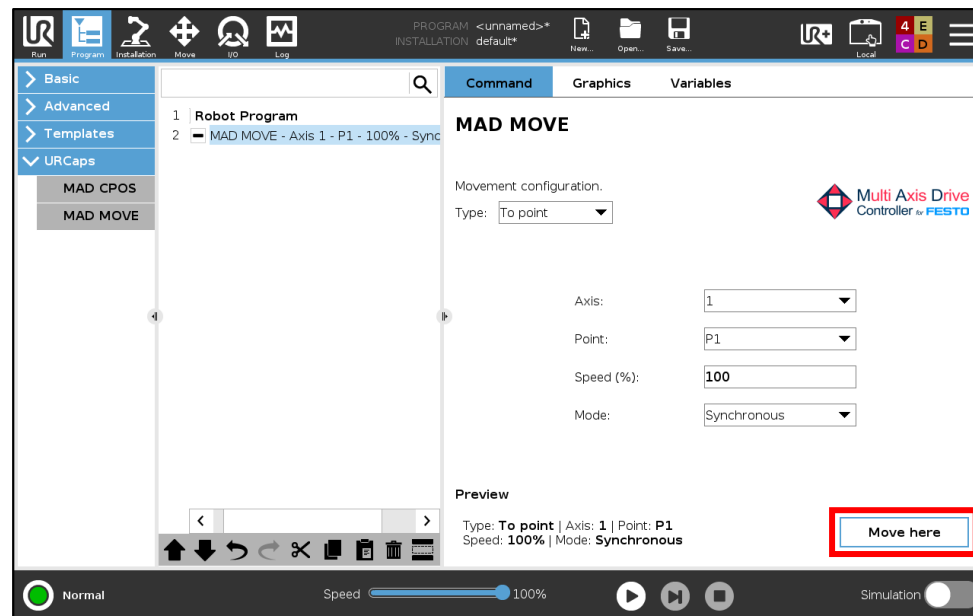
- 1 **MAD MOVE:** move the axis to the desired position
- 2 **MAD CPOS:** wait for the axis to reach a position
- 3 **MAD HOME:** perform homing on the axis



Furthermore, it is possible to make use of URScript functions to interact with the axis through program code, as explained in subsequent slides.

Functionalities

From any of the program nodes, you can move to the configured position using the button in the lower right corner.

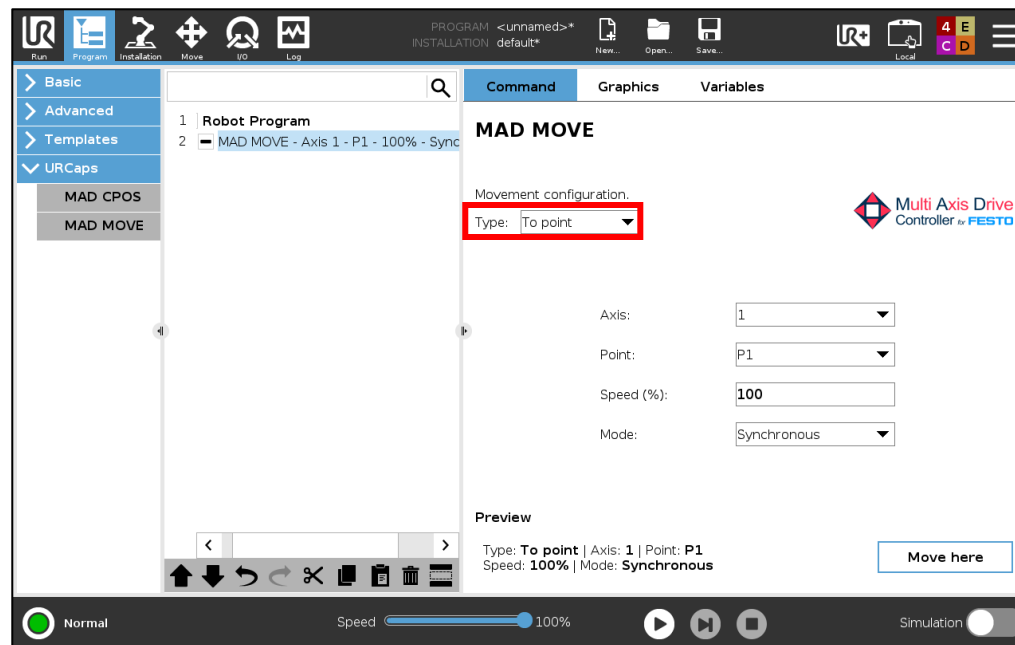


¹ For the button to be enabled, you must complete the configuration of the program node, as well as ensure that the axis is available.

Functionalities

1 **MAD MOVE:** move the axis to the desired position

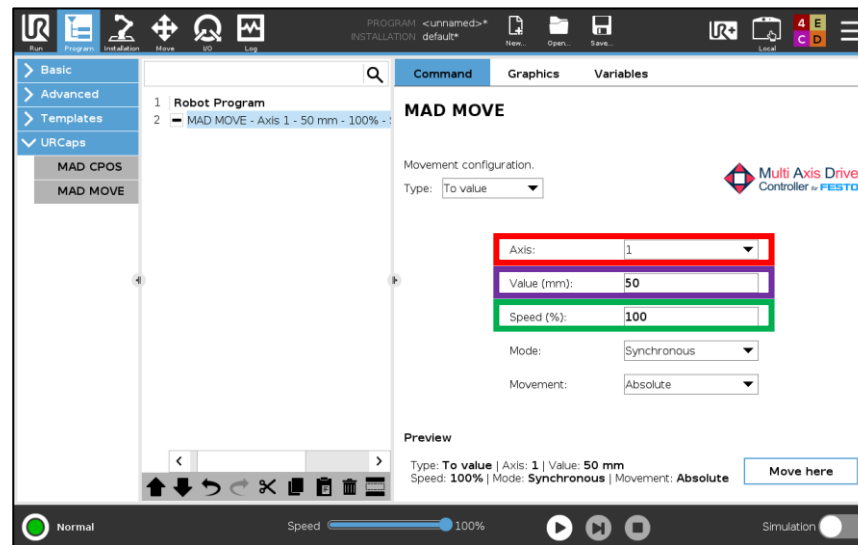
- ❑ In type *To point* the robot will move to positions defined in the installation panel, while in type *To value* it will move to the position indicated manually.



Functionalities

1 **MAD MOVE:** move the axis to the desired position.

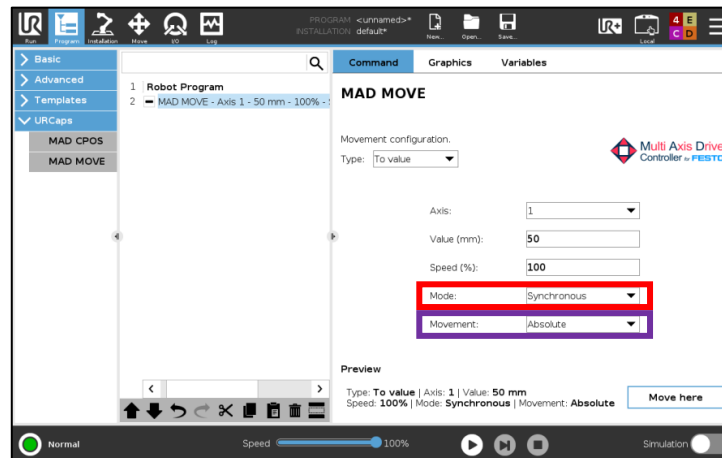
- ❑ Selection of the axis on which to carry out the movement
- ❑ Value or destination point to which you want to move the axis
- ❑ Percentage of speed over the set positioning speed




Functionalities

1 **MAD MOVE:** move the axis to the desired position.

- ❑ In *Synchronous* mode the instruction waits for the completion of the movement, while in *Asynchronous* mode the execution starts the movement and continues.
- ❑ The movement can be *Absolute* —referenced to *Home*— or *Relative* —referenced to the position in which it is at the moment of execution.

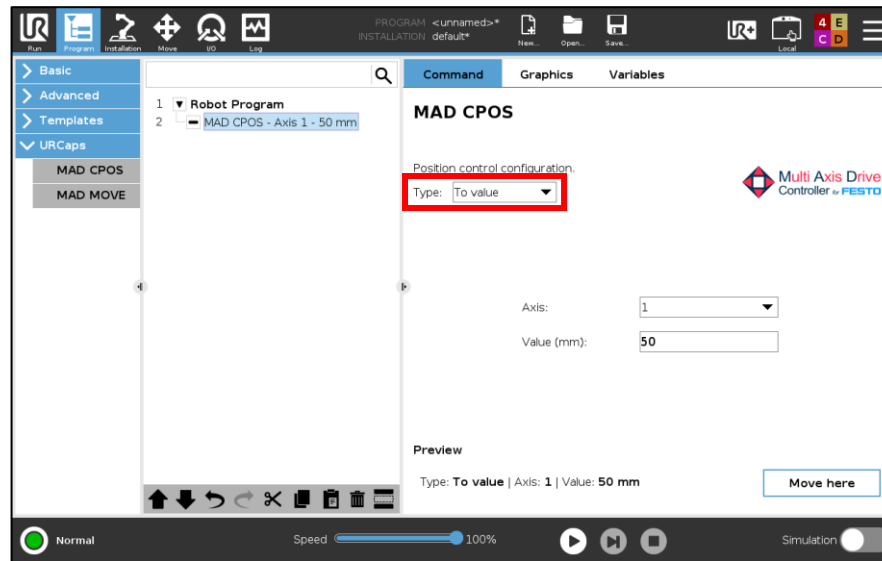


 **Warning:** when using asynchronous mode, be sure to avoid any possible collisions. Note that when resuming a program paused during an asynchronous movement, it can be completed in a different duration.

Functionalities

2 **MAD CPOS:** wait for the axis to reach¹ a position to continue execution.

- ❑ In type *To point* it will wait in a point defined in the [Points](#) tab, while in type *To value* it will wait in the position indicated manually.

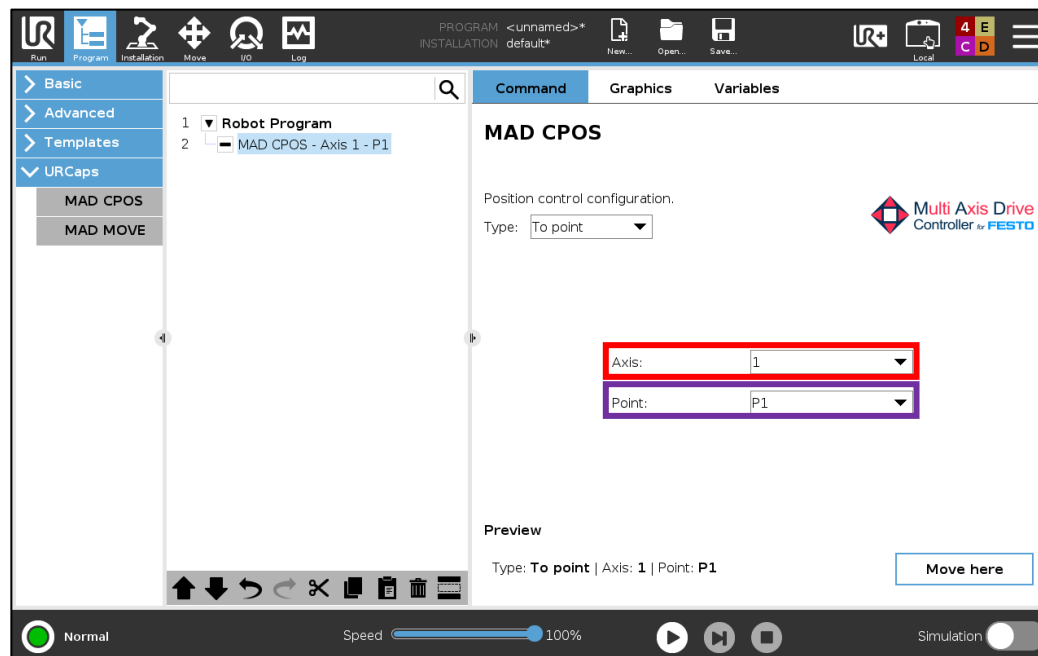


¹ This command is especially useful for waiting at a point or value after an asynchronous move.

Functionalities

2 **MAD CPOS:** wait for the axis to reach a position to continue execution.

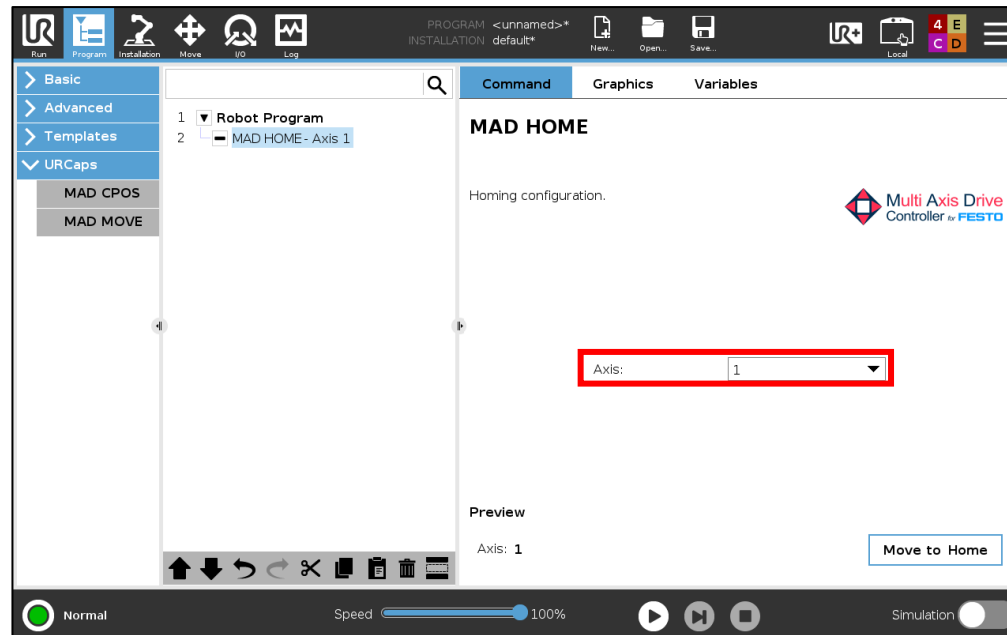
- ❑ Selecting the axis to wait on
- ❑ Value or destination point where to wait



Functionalities

3 MAD HOME: perform homing on the axis

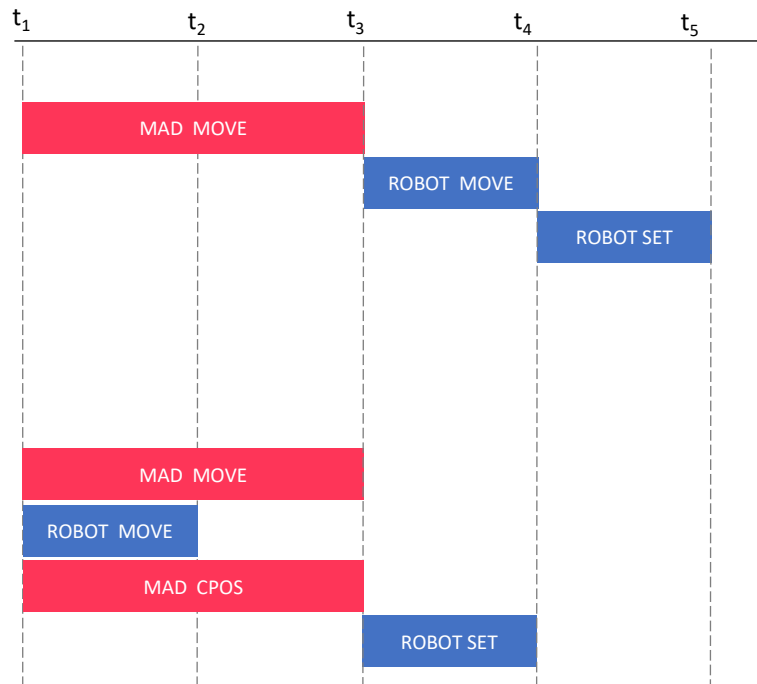
- ❑ Selecting the axis on which to perform homing



¹ This functionality is only available for CMMT-AS/ST motor controllers.

Functionalities

Comparison between synchronous and asynchronous movements:



SYNCHRONOUS

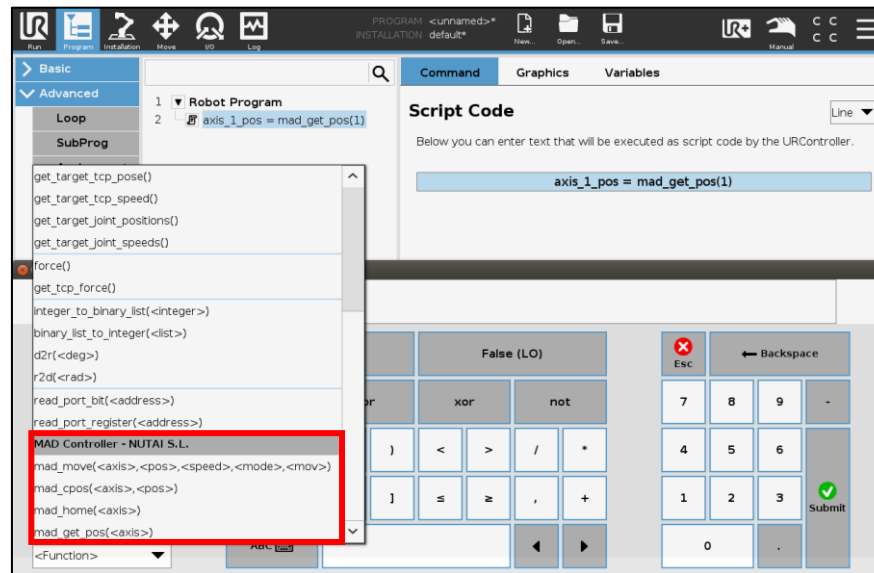
MAD MOVE (P1, SYNC)
ROBOT MOVE
ROBOT SET

ASYNCHRONOUS

MAD MOVE (P1, ASYNC)
ROBOT MOVE
MAD CPOS (P1)
ROBOT SET

Functionalities

In addition to the program nodes, it is possible to use **URScript functions** to interact with the axis from the robot code and even integrate them into other URCaps.



These functions allow the user to move the axis, check positions, perform homing or get the current position. The following slides detail each of the available functions.

Functionalities

- **Name of the function:** `mad_move()`
- **Description:** move the axis (equivalent to [MAD MOVE](#) node)
- **Arguments:**
 - `axis`: axis to move [1..LICENSED_AXIS]
 - `pos`: target position or increment (depending on `mov` argument)
 - `speed`: relative speed [1..100]
 - `mode`: synchronous or asynchronous mode [0 | 1]
 - `mov`: absolute or relative movement [0 | 1]
- **Return:** True if the execution is successful, False if the execution failed
- **Example:** `mad_move(2, 1565.50, 80, 1, 0) --> True`

Functionalities

- **Name of the function:** `mad_cpos()`
- **Description:** check the axis position (equivalent to [MAD CPOS](#) node)
- **Arguments:**
 - `axis`: axis to move [1..LICENSED_AXIS]
 - `pos`: target position to check
- **Return:** True if the execution is successful, False if the execution failed
- **Note:** this function is especially useful for waiting at a position value after launching an asynchronous move
- **Example:** `mad_cpos(2, 1565.50) --> True`

Functionalities

- **Name of the function:** `mad_home()`¹
- **Description:** perform a homing on the axis (equivalent to [MAD HOME](#) node)
- **Arguments:**
 - `axis`: axis to move [1..LICENSED_AXIS]
- **Return:** True if the execution is successful, False if the execution failed
- **Note:** The homing method to be executed will be the one configured in the controller
- **Example:** `mad_home(1)` --> True

¹ This functionality is only available for CMMT-AS/ST motor controllers.

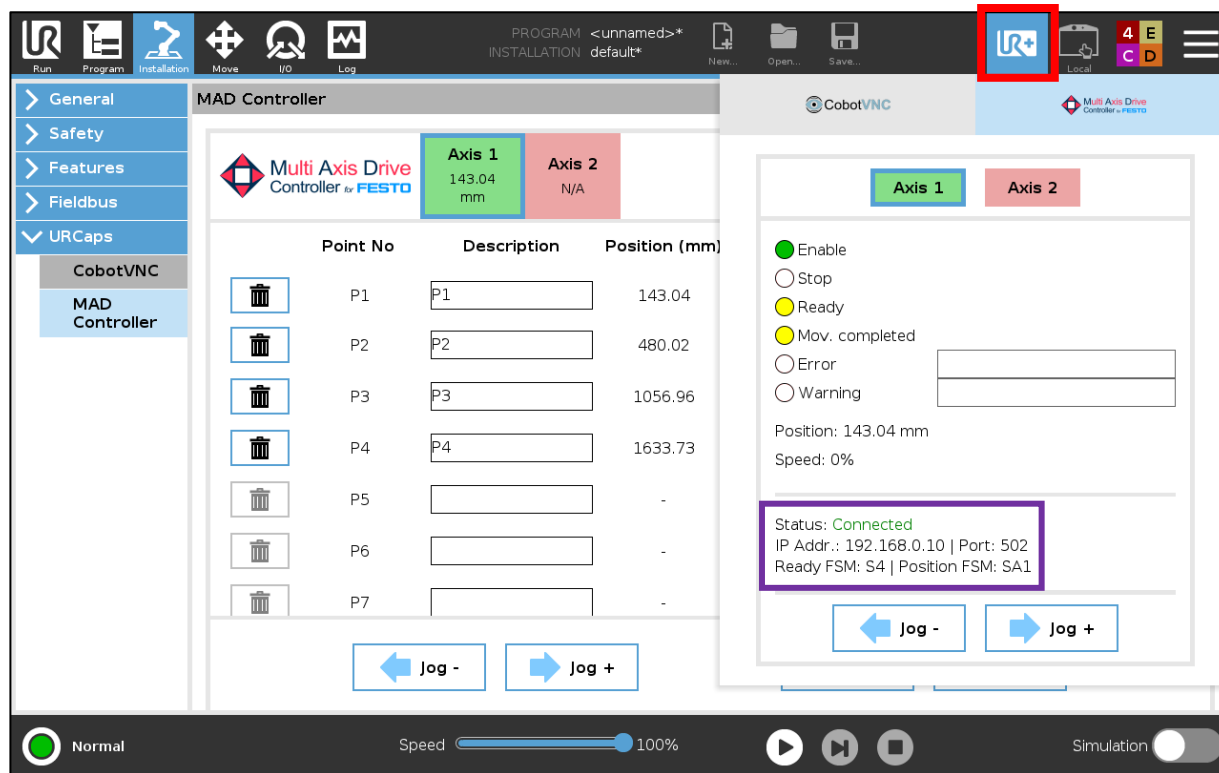
Functionalities

- **Name of the function:** `mad_get_pos()`
- **Description:** get current axis position
- **Arguments:**
 - `axis`: axis to get position[1..LICENSED_AXIS]
- **Return:** current axis position, -1,000,000 in case of axis N/A or any other type of error
- **Note:** this function can be useful to execute other actions in parallel when verifying that an axis exceeds a certain position, for example
- **Example:** `mad_get_pos(2) --> 1565.50`

3 Toolbar panel

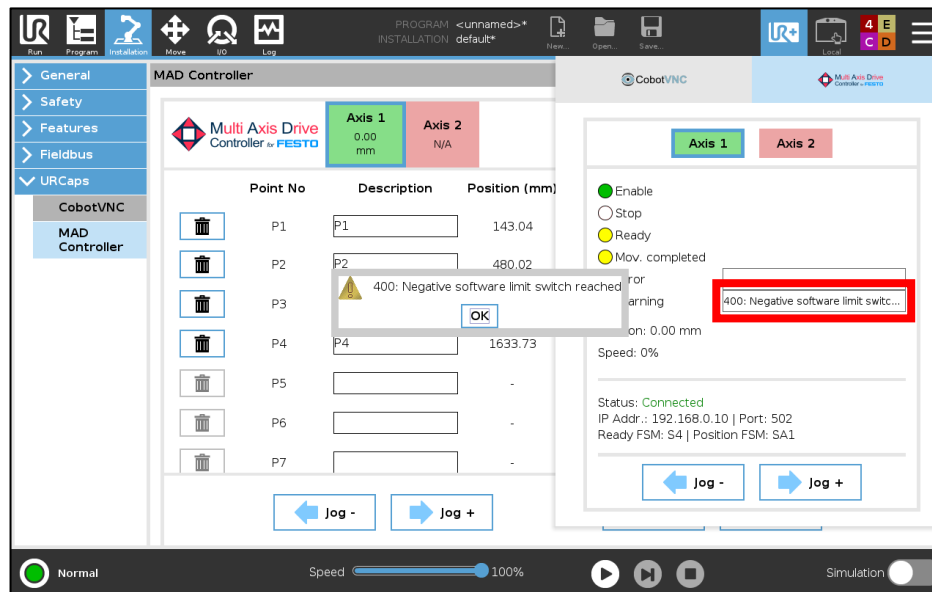
Functionalities

You can access the URCap toolbar from any window (□) to check the status of the controller and move the axis manually using *Jog* (□).



Functionalities

In case of displaying¹ an error or warning message, you can check the complete message by clicking on it².



¹ The error and warning messages disappear after a few seconds.

¹ For more information on the error or warning and its possible solutions, see the motor controller manual.

Overview

- 1 Introduction
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This section explains everything related to safety aspects. It is divided into the following subsections:

1. Essential recommendations

Basic aspects of the connection and configuration of the axis.

2. Integration recommendations

Advanced aspects on the integration of the product in the final solution.

1 Essential recommendations

- **Connect the safety** between the robot and the motor controller/s as indicated in [Installation](#) section
- Correctly configure your motor controller/s **software position limits** from the [Parameters](#) tab
- In an emergency, press the robot **emergency push button** to immediately stop the robot and axis
- When moving an axis to any point or value, the **relative speed of the robot** (slider) will be applied over the configured positioning speed

2 Integration recommendations

Here are some recommended integration schemes according to the level of safety required in the final integration of the product:

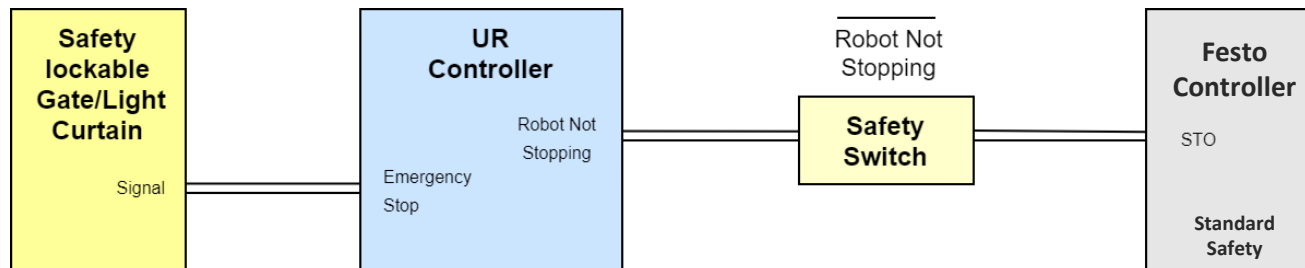
1. **Basic level:** the robot and the axis are in a fenced area. Both stop if the operator enters the fence.
2. **Medium level:** the robot and the axis are NOT in a fenced area. The robot stops/reduces, and the axis stops if the operator enters the operating area.
3. **Advanced level:** the robot and the axis are NOT in a fenced area. The robot and the axis reduce their speed if the operator enters the operating area.

The following slides detail each of these safety levels.




Warning: these slides are only safety tips. We are not responsible for damages caused by misuse or incorrect integration of this product in the customer's final solution.

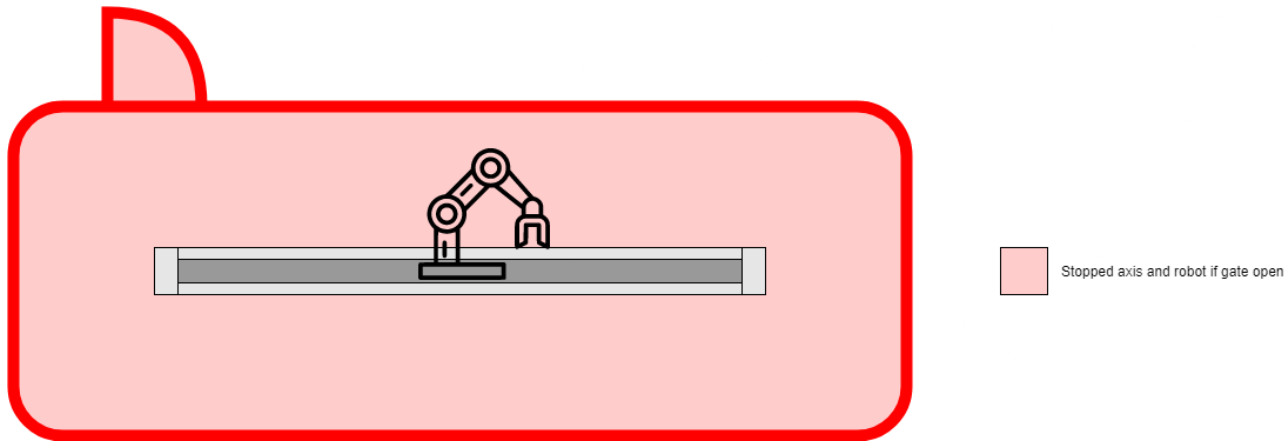
1. **Basic level:** the robot and the axis are in a fenced area. Both stop if the operator enters the fence.




Connection diagram

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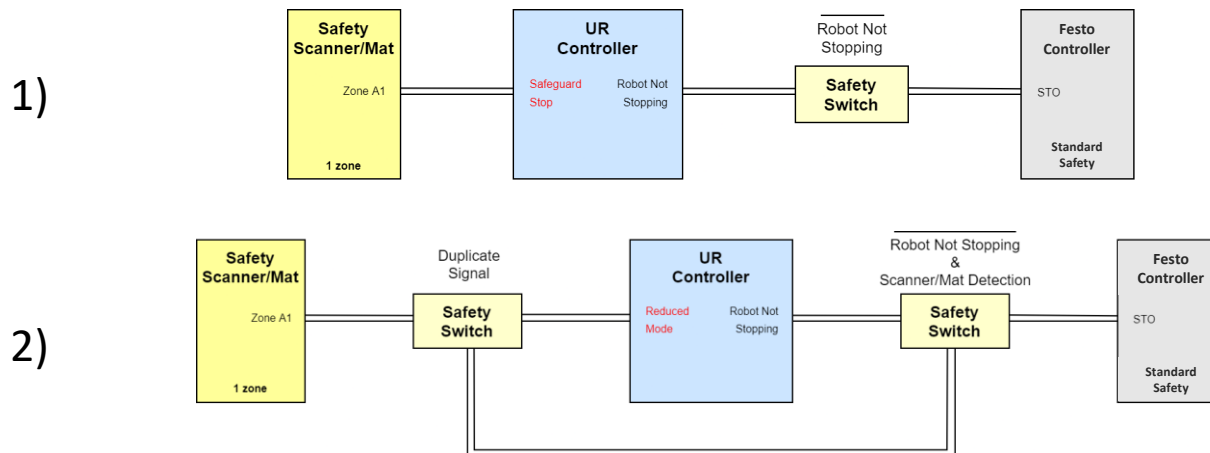
1. **Basic level:** the robot and the axis are in a fenced area. Both stop if the operator enters the fence.



Integration diagram

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2. **Medium level:** the robot and the axis are NOT in a fenced area. The robot stops/reduces, and the axis stops if the operator enters the operating area.



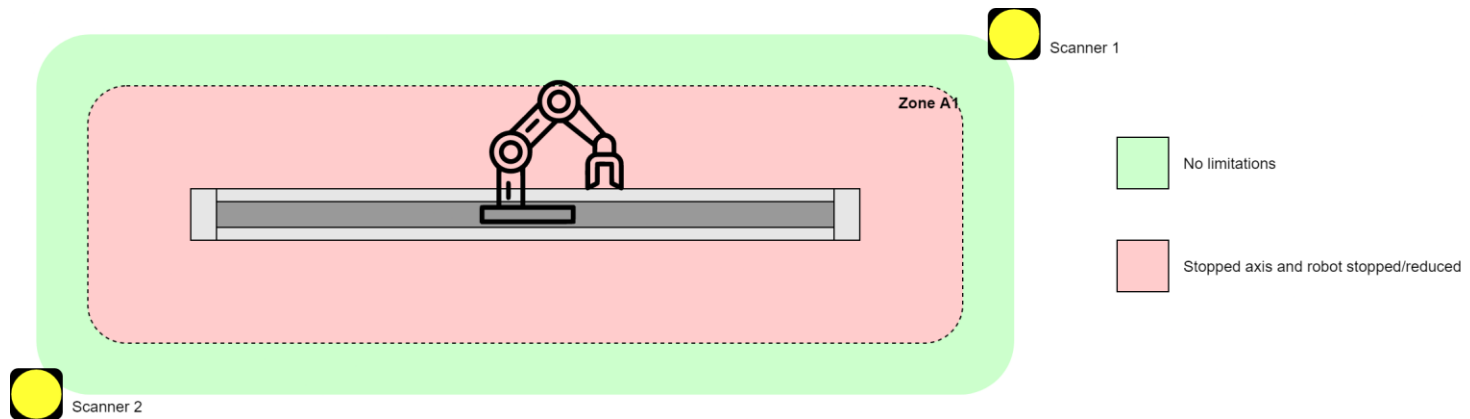
Connection diagram

1) robot and axis stop; 2) robot reduces and axis stops




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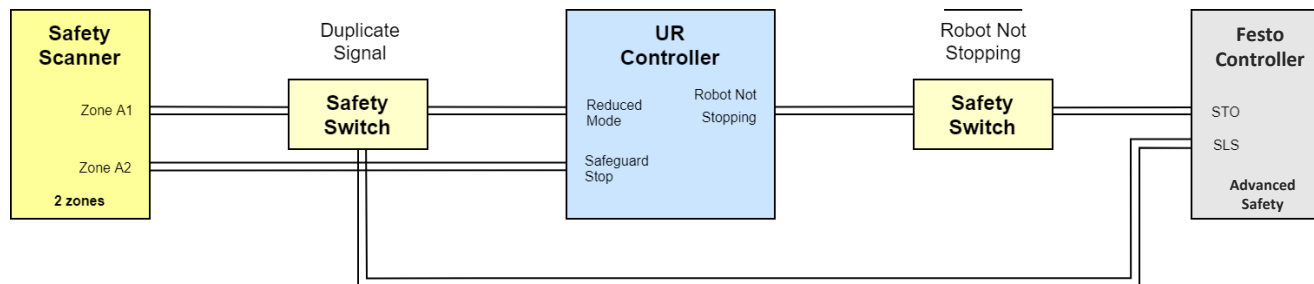
2. **Medium level:** the robot and the axis are NOT in a fenced area. The robot stops/reduces, and the axis stops if the operator enters the operating area.



Integration diagram

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3. **Advanced level:** the robot and the axis are NOT in a fenced area. The robot and the axis reduce their speed if the operator enters the operating area.

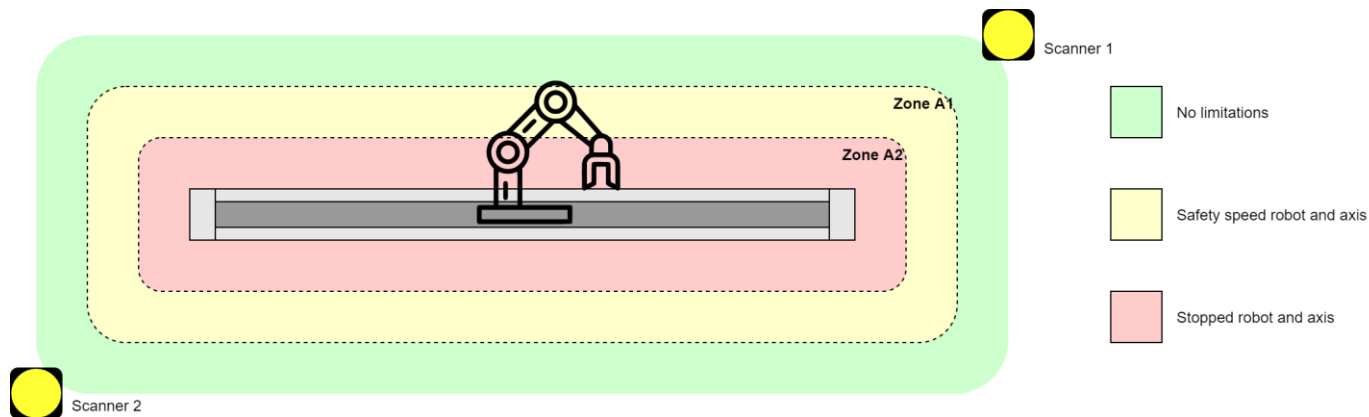


Connection diagram




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3. **Advanced level:** the robot and the axis are NOT in a fenced area. The robot and the axis reduce their speed if the operator enters the operating area.



Integration diagram

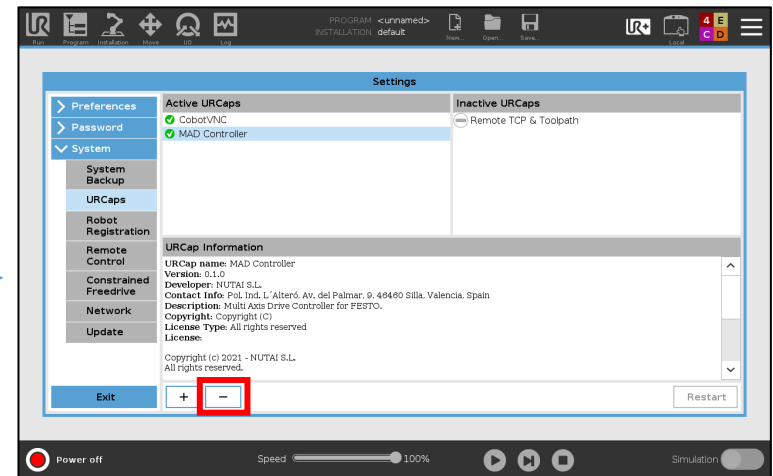
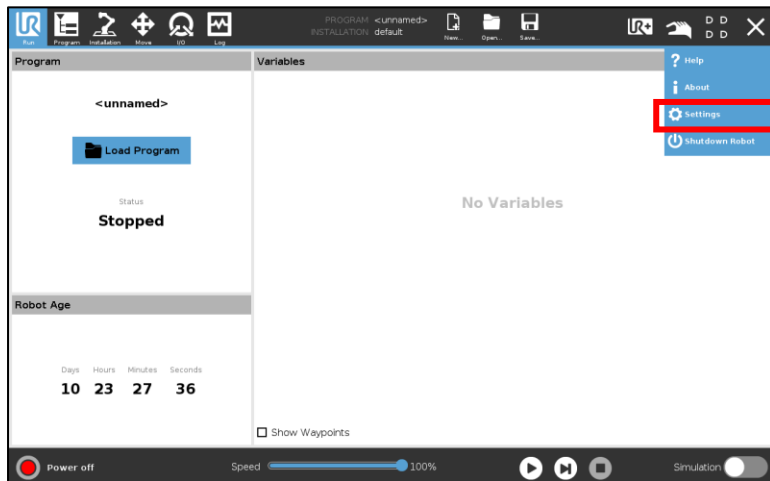
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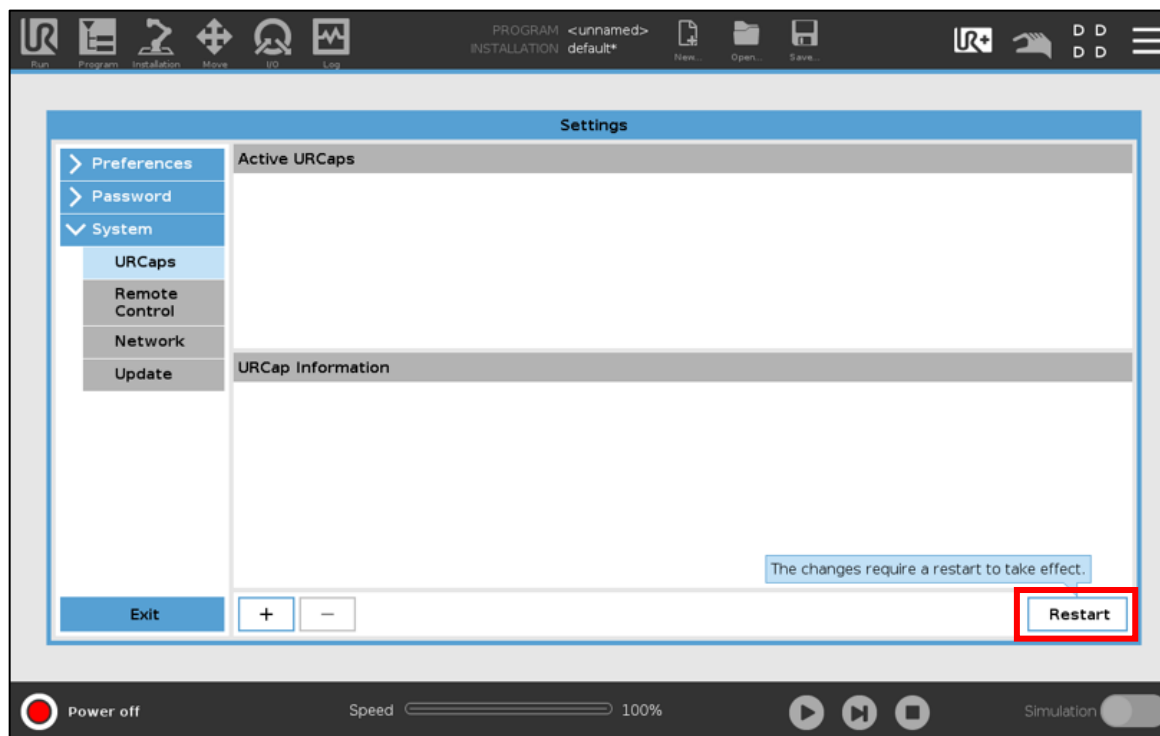
Uninstallation

- 1 Go to *Settings* in the upper right menu, then *System* -> *URCaps*
- 2 Select *MAD Controller* and click the uninstall button (-)



Uninstallation

- 3 Finally, click on the *Restart* button to apply the uninstall



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Best practices

 **We advise you to follow the following recommendations:**

- Before making any movement, check that there are no risks of collision
- The components must only be manipulated by qualified technical personnel
- If you replace any components, perform a *Home* and check the saved points
- Perform proper periodic maintenance of your mechanical components¹
- If you mount your robot on one or more axis, use flexible cabling (*High-Flex*)

¹ See all the information on the manufacturer's website:

<https://www.festo.com>

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