User Manual

Universal Robots Integration

Setting up the MIRAI system

Implementing MIRAI skills in PolyScope

VERSION 21.0.0

micropsi industries

Contents

Introduction

Micropsi Industries' robot control system, MIRAI, allows users to automate complex motion tasks in dynamic process environments by manually training robots. MIRAI is a machine learning-based system that generates robot movements based on sensory input and (re-)acts in real-time based on image data.

Today, most automation solutions are programmed in a script language or 'taught' using a teach pendant and its user interface. MIRAI, on the other hand, can train robots to solve complex hand-eye coordination tasks by 'watching' these being performed through a human operator and 'imitating' the actions seen. Key advantages of MIRAI compared to more 'classical' automation approaches are: first, the ease of use in solving and automating complex motion tasks without previous expert knowledge in automation, machine vision or programming. Second, MIRAI's underlying machine learning technology is inherently able to handle different sources of process variances and dynamics within the task and its environment. With this, the MIRAI controller can solve new classes of tasks and problems in automation and robotics that normally required complex and expensive solutions or were impossible to automate before.

To 'train' the robot, the user manually scans the area between the precise target position and the intended starting position(s). These scanned demonstrations are called episodes. For more complex tasks, the user performs and records repeated demonstrations of a task, by guiding the robot from varying starting positions to the target position, in a very precise trajectory. The user manages the camera recording of the respective episodes through our MIRAI Training App for Android tablets. These episodes are then transformed into a vision-based robot motion program by our cloud-based machine learning service, which results in a 'MIRAI skill'. These trained skills ultimately allow the MIRAI controller to imitate the motions and actions it was shown by steering robot movements, dealing with all the dynamics and variances the user trained for in real time (closed loop).

1 Getting Started

1.1 Supported UR models and software versions

MIRAI is compatible with the following UR robot models:

UR CB3 series	UR e-Series
UR 3 UR 5 UR 10	UR 3e UR 5e UR 10e UR 16e (experimental)

MIRAI requires the following minimum software versions:

UR CB3 series	UR e-Series
Version 3.9.0 and above	Version 5.3 Version 5.7 and above Avoid versions *between* 5.3 and 5.7 due to RTDE interface bug

NOTE: MIRAI requires specific minimum software versions because the newer versions provide more registers for the MIRAI controller. Previous versions had only 24 registers, while the later versions support 48 registers. The registers used for writing are `input_double_register_24` to `input_double_register_30`. The following registers are used for reading: `actual_TCP_speed`, `actual_q`, `target_q` and `robot_status_bits`.

The MIRAI controller coexists with Profinet. Other fieldbus standards will be verified in the future.

1.2 MIRAI components

1.2.1 MIRAI kit

The MIRAI Kit contains the following components:

- MIRAI controller: Siemens SIMATIC IPC BX-39A – power supply not included
- Android-based tablet with the MIRAI Training App
- Camera setup:
  - Cameras: USB 3.0 cameras (XIMEA xiQ) or GigE cameras (Baumer VCXG.2-15C.I)
  - Camera lenses (9 mm and 16 mm)
  - Connection cables
  - Ring lights and adapters
  - Camera mount (optional)
- *Only for USB 3.0 camera setups with force/torque sensor:* Ethernet Gigabit switch and cables

1.2.2 Additional components

Some additional components are required to use the MIRAI system, and some components are optional. All additional components must be procured by the customer.

Required components:

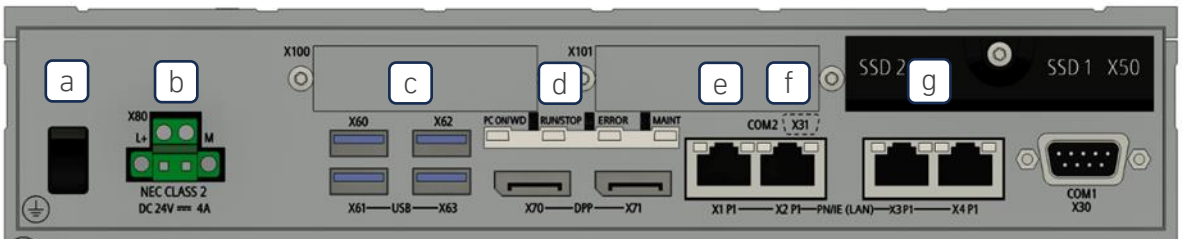
- 24 V power supply to provide power to the MIRAI controller. For other options (230V/110V), contact your account executive.
- *For GigE camera setups only:* Siemens SCALANCE XC208G PoE Switch. For other options, contact your account executive.

Optional components for using the hand-guiding feature:

- One of the following force/torque sensors:
  - OnRobot HEX-E v2
  - OnRobot HEX-QC
  - ATI Axia80-M20 with adapters
  - Any ATI sensor supporting the Network Force/Torque (NET F/T) system (tested with ATI-9105-Net-Gamma)

1.3 MIRAI controller interface description

The MIRAI controller has four preconfigured Ethernet ports: X1P1, X2P1, X3P1, and X4P1. These ports can also be manually configured for specific network needs (see Section 4.2.4).



a. Power on/off
b. Power supply (24 V, not included)
c. 4 USB 3.2 ports
d. RUN/STOP LED
e. Ethernet port X1P1, configured to 192.168.100.5
f. Ethernet port X2P1, for WAN/internet DHCP
g. Link-aggregated Ethernet ports X3P1 and X4P1, configured to 192.168.99.5

1.4 MIRAI controller specifications

- Intel Xeon W-11555MLE (1.9/4.4 GHz, 6C/12T)
- 16GB DDR4-3200 SO-DIMM
- SSD 512 GB Eco
- 24V power supply
- Operating conditions: 0° C to 55° C. Humidity 5% to 80% at 25° C (no condensation)
- Dimensions:
  - Width: 262 mm
  - Height: 139.7 mm
  - Depth: 62.6 mm

2 Set up the MIRAI controller

The MIRAI controller is a compute and control unit. It uses camera images to calculate robot movements in real time.

To set up the MIRAI controller, first assemble the camera and force/torque sensor stack (Section 2.1).

Then connect the MIRAI controller to all system components. Different cameras require specific setups:

- For USB 3.0 cameras, see Section 2.2.
- For GigE cameras, see Section 2.3.

2.1 Assemble the camera and force/torque sensor stack

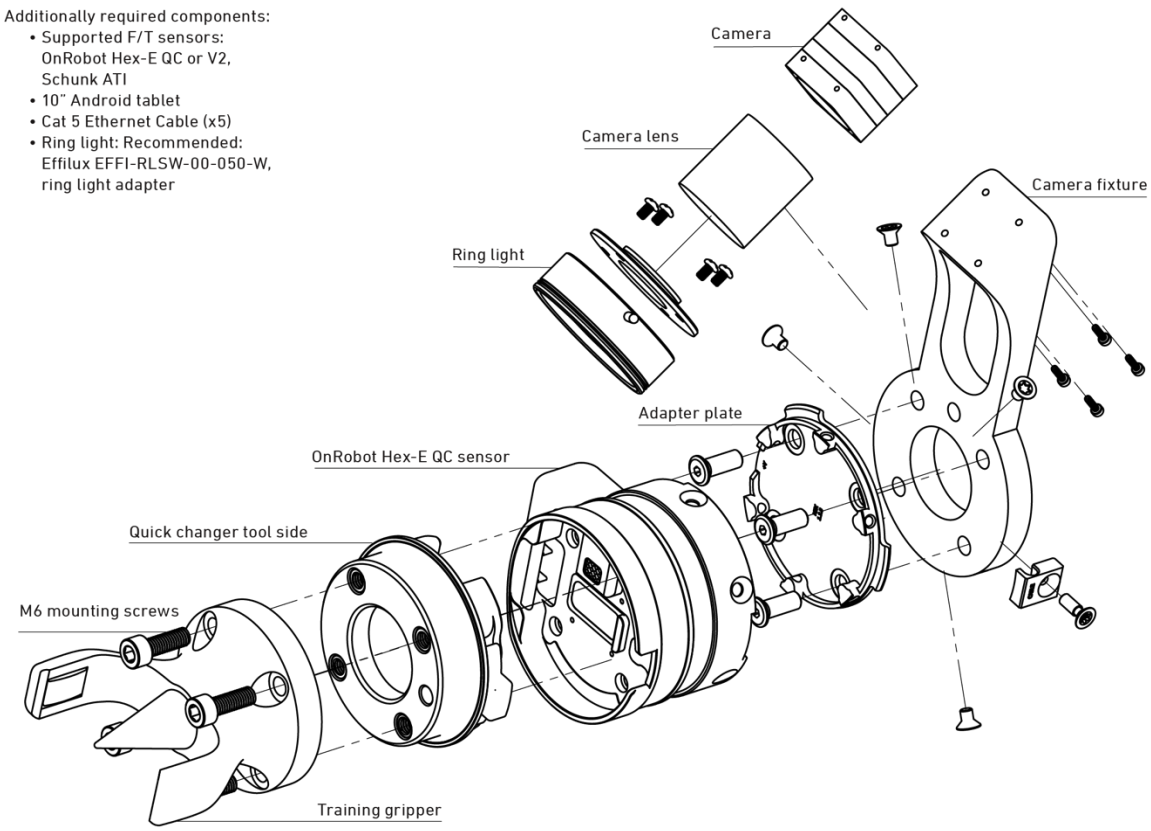


Figure 1: Diagram of the correct order for assembling the camera and force/torque sensor stack.

IMPORTANT: The physical MIRAI setup must be assembled in the order shown above.

To mount cameras and the force/torque sensor on the robot arm, follow these steps:

1. Attach the camera lens to the camera.
2. Screw the ring light adapter and the ring light on to the lens.
3. Mount the camera on the camera fixture with the provided screws.
4. Mount the assembled camera fixture on the robot tool flange using the adapter plate and the provided screws.
5. Attach the force/torque sensor to the adapter plate with the provided screws.
6. Click on the quick changer tool adapter.
7. Attach the training gripper or other end-of-arm tool.
8. Connect the cable with the camera and secure the cable to the robot arm, leaving enough slack to allow the robot arm to move freely.

2.2 USB 3.0 camera setups

2.2.1 MIRAI setup scheme with USB cameras

This schematic diagram of a MIRAI-controlled robot setup shows the components of a MIRAI-based solution. The diagram shows all supported peripherals and how they connect through various interfaces.

The MIRAI solution includes the following components:

- **MIRAI robot controller:** generates image-based, real-time robot movements based on trained skills
- **MIRAI Training App:** primary user interface for the MIRAI controller; runs on an Android-based tablet and allows users to record training episodes and manage MIRAI skills
- **Micropsi Industries cloud:** calculates MIRAI skills using training episodes
- **MIRAI URCap plugin:** integrates MIRAI skills in UR PolyScope robot program flows

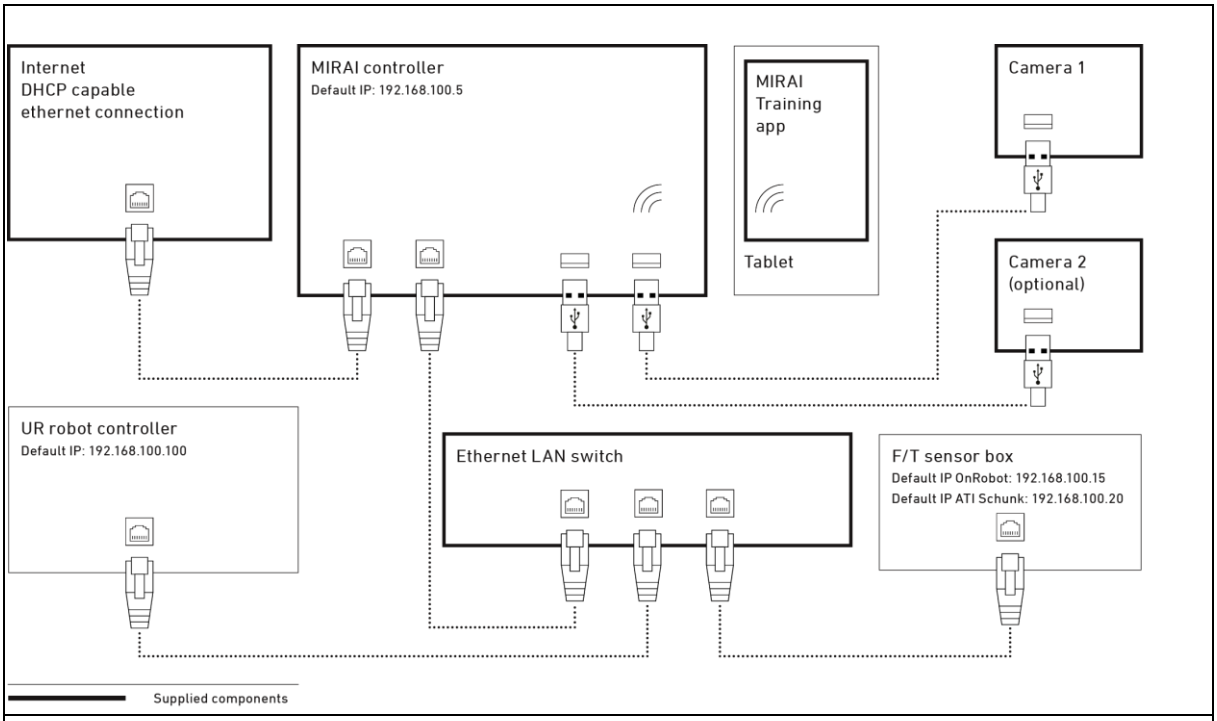


Figure 2: Schematic view of a MIRAI-controlled robot setup for USB cameras.

2.2.2 Connect the MIRAI Controller with a USB camera setup

NOTE: Refer to Section 1.3 for a diagram of the MIRAI controller.

To connect all components in the MIRAI-controlled robot setup, follow these steps:

1. Place the MIRAI controller and the Ethernet LAN switch near the UR robot controller or robot arm. We recommend securing the MIRAI controller to prevent it from falling or shifting.
2. Connect the UR robot controller to the Ethernet LAN switch.
3. Connect the force/torque sensor box to the Ethernet LAN switch.
4. Connect the Ethernet LAN switch to Port X1P1 on the MIRAI controller, creating a local area network (LAN) for the robot control environment.

5. Connect the USB 3.0 cameras to the MIRAI controller's USB ports.

6. Connect the Wi-Fi module to a USB port on the MIRAI controller to link it with the tablet.

7. Connect the Ethernet WAN port (X2P1) on the MIRAI controller to a network with WAN/internet access. Ensure that the connected network offers DHCP service, as the IP address for this port will be assigned automatically through DHCP.
    a. **NOTE:** To use a proxy to connect with the Micropsi cloud, see Connecting to the Micropsi Cloud Using a Proxy Server. For details on the cloud connection and handling of recorded data, see Data FAQ in the MIRAI Training User Manual.

8. Connect a 24 V power supply to the MIRAI controller to turn the controller on. Check the LED RUN/STOP indicator for a green light to confirm successful system boot and started runtime.

2.3 GigE camera setups

2.3.1 MIRAI setup scheme with GigE cameras

These schematic diagrams show MIRAI-controlled robot setups for one GigE camera (*top*) and for two GigE cameras (*bottom*). The diagrams show all supported peripherals and how they connect through various interfaces.

The MIRAI solution includes the following components:

- **MIRAI robot controller:** generates image-based, real-time robot movements based on trained skills
- **MIRAI Training App:** primary user interface for the MIRAI controller; runs on an Android-based tablet and allows users to record training episodes and manage MIRAI skills
- **Micropsi Industries cloud:** calculates MIRAI skills using training episodes
- MIRAI **URCap plugin:** integrates MIRAI skills in UR PolyScope robot program flows

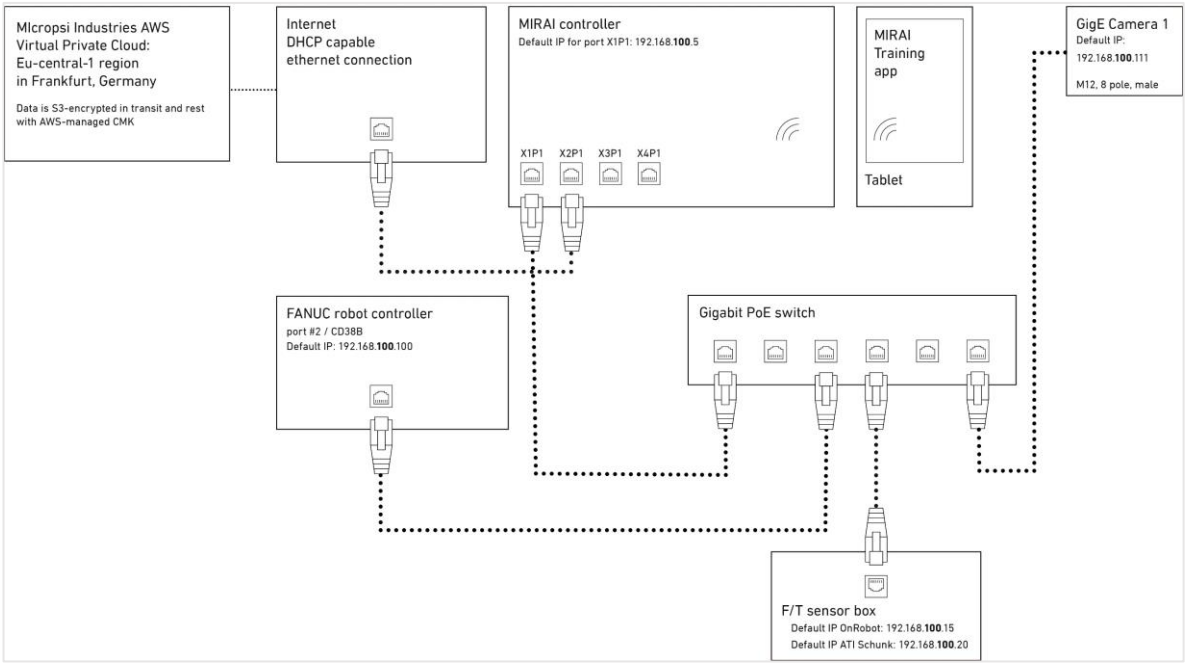


Figure 3: Schematic view of a MIRAI-controlled robot setup with one GigE camera.

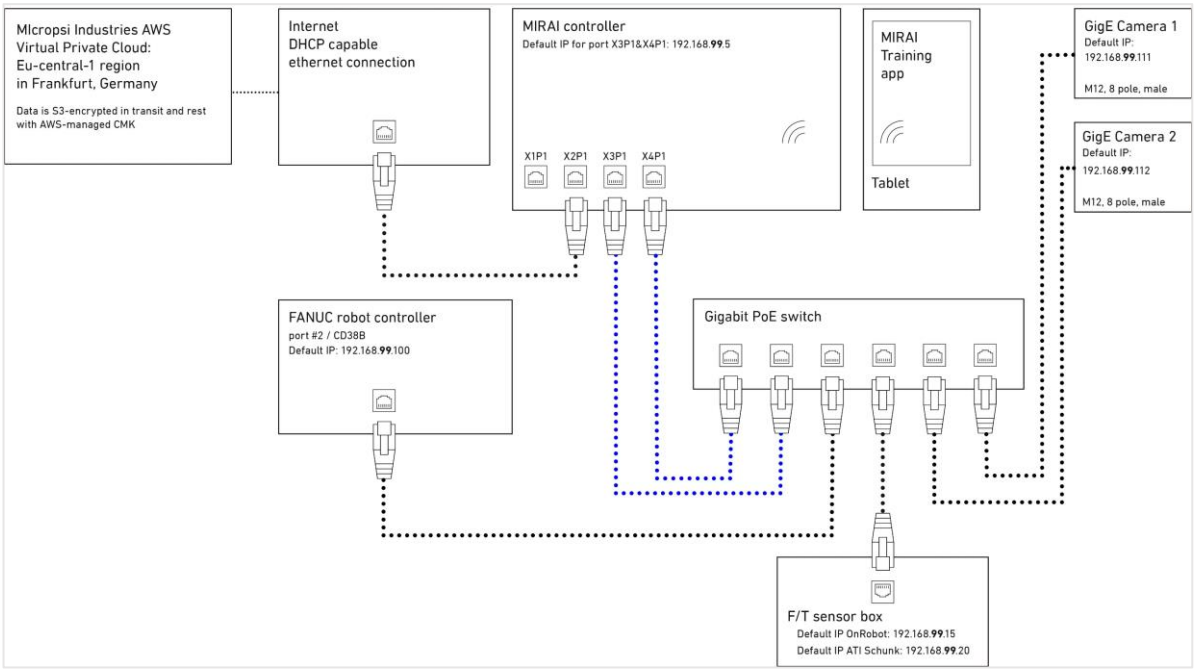


Figure 4: Schematic view of a MIRAI-controlled robot setup with two GigE cameras. Two link-aggregated ports are used to connect the MIRAI controller to the Gigabit Ethernet switch.

2.3.2 Connect the MIRAI controller with GigE cameras

GigE cameras are part of the MIRAI network and have an Ethernet interface. They have an IP address that needs to be configured to the same subnet as the robot, the force/torque sensor, and the MIRAI controller. The MIRAI controller has preconfigured ports for one or two cameras.

Step 5 describes setups using the preconfigured ports on the MIRAI controller. The network can also be configured manually to customize settings, which may use different ports.

NOTE: Refer to Section 1.3 for a diagram of the MIRAI controller.

1. Place the MIRAI controller and the Gigabit Ethernet switch near the UR robot controller or robot arm. We recommend securing the MIRAI controller to prevent it from falling or shifting.
2. Connect the UR robot controller to the Gigabit Ethernet switch.
3. Connect the GigE camera or cameras to the Gigabit Ethernet switch.
4. Connect the force/torque sensor box to the Gigabit Ethernet switch.
5. Connect the Gigabit Ethernet switch to the MIRAI controller using the following ports:
    a. *For one GigE camera*: Connect Ethernet port X1P1 on the MIRAI controller with any port on the Gigabit Ethernet switch.
    b. *For two GigE cameras*: Connect link-aggregated ports X3P1 and X3P4 on the MIRAI controller with two link-aggregated ports on the Gigabit Ethernet switch.
6. Connect port X2P1 on the MIRAI controller to a network with WAN/internet access. Ensure that the connected network offers DHCP service, as the IP address for this port will be assigned automatically through DHCP.

a. **NOTE:** To use a proxy to connect with the Micropsi cloud, see Connecting to the Micropsi Cloud Using a Proxy Server. For information on the cloud connection and handling of recorded data, see Data FAQ in MIRAI Training User Manual.

7. Connect the Wi-Fi module to a USB port on the MIRAI controller to link it with the Android tablet.
8. Connect a 24 V power supply to the MIRAI controller to turn the controller on. Check the LED RUN/STOP indicator for a green light to confirm successful system boot and started runtime.

3 Install and connect the MIRAI Training App

The MIRAI Training App is the primary user interface for the MIRAI solution. It is a mobile application for Android based tablets that allows users to do the following:

- Create and define new MIRAI skills
- Record training episodes to train new or improve available skills
- Create new skill versions using recorded episodes
- Test newly calculated skills to ensure they perform as expected or continue adding training episodes to further improve the behavior of an available skill
- Set, test, and revise end state parameters that allow MIRAI to trigger a successful skill execution
- View and track execution KPIs of skills while they operate in production mode (in development)
- Accelerate and tune skill execution speed to achieve optimal tact time without compromising on precision
- Manage and delete trained skills

3.1 Install the latest MIRAI Training App on the tablet

1. Ensure that the MIRAI controller is set up, powered on and that the Wi-Fi module is connected.
2. Power on your Android tablet and switch on its Wi-Fi network. Go to the Wi-Fi settings of the tablet and choose the network SSID from the MIRAI controller, which should be named "MIRAI-*<ID_number>*." The ID number of the MIRAI controller is indicated on the product sticker. Enter the MIRAI password, also printed on the same sticker.
3. Within the Android settings of your device, navigate to **Settings** > **Security**, and activate the option that reads "Allow install of apps from unknown sources" or has similar wording. Depending on your Android version, this menu item might not be present, and instead the system will ask for permission to install the APK file once trying to open it. In this case, grant the request.
4. Start the internet browser of the tablet and go to http://mirai:6543/mint/apk.
5. Click to confirm downloading the MIRAI Training App installation file, mint.apk. After downloading, tap on the file in the Android file browser to install the app. If a security message requests permission to install the APK file, grant the request.

6. Start the MIRAI Training App. It should show the "Skill training" screen with an overview of the trained skills available on the MIRAI controller. When you use the app for the first time, this list will be empty.

4 Network configuration

4.1 Networks in the MIRAI setup

There are three networks in the standard MIRAI setup: the robot network, the WAN, and the Wi-Fi network. The MIRAI controller uses different ports for each network, ensuring they remain separated and cannot communicate with each other.

1. **Robot Network**: This network includes the MIRAI controller, the robot controller, a force/torque sensor (if used), and the GigE camera or cameras (if used). Each device in this network has a static IP address. The devices are connected through specific ports on the controller, ensuring they operate within an isolated network that cannot communicate with the other networks.
2. **Wide Area Network (WAN)**: This network also includes the controller, but it is connected through a different port preconfigured to expect a DHCP-assigned IP address. The WAN typically includes an HTTP/HTTPS proxy that facilitates communication between the controller and the Micropsi cloud, making it reachable via the internet. This network is logically separated from the robot network.
3. **Wi-Fi Network**: This network is created by the controller and includes a single member, an Android-based tablet. The Wi-Fi network is isolated from both the robot network and the WAN, ensuring that the tablet can only communicate with the controller through this dedicated wireless connection.

The following sections explain how to set up the **robot network**.

The MIRAI controller has four network ports. The ports have the following settings:

Port number	Controller name	MIRAI controller	Subnet
Port 1	X1P1	192.168.100.5	192.168.100.0/24
Port 2	X2P1	set via DHCP	set via DHCP
Port 3	X3P1	192.168.99.5	192.168.99.0/24
Port 4	X4P1	192.168.99.5	192.168.99.0/24

Different ports and network configurations are recommended for different camera setups. Choose one of the following configuration options depending on your camera setup:

- **USB 3.0 cameras**: Refer to Section 4.2.1.
- **One GigE camera**: Use Port 1 or custom settings (see Section 4.2.2)
- **Two GigE cameras**: Use Ports 3 and 4 (see Section 4.2.3)

For **custom network settings**, users can manually configure the ports as desired. Refer to Section 4.2.4.

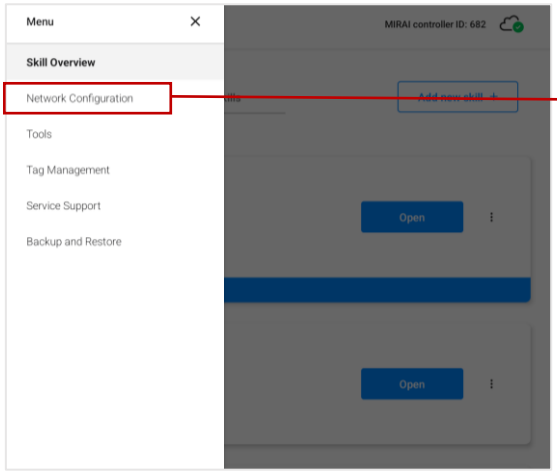
4.2 Network Configuration in the MIRAI Training App

The MIRAI Training App includes a Network Configuration screen. This section guides you through setting up the network for your camera system.

4.2.1 USB 3.0 Cameras

All components in the MIRAI network must be configured to the same subnet. USB 3.0 cameras are not in the MIRAI network and do not require configuration.

To configure the other components in the MIRAI network, use the default settings or choose custom settings:

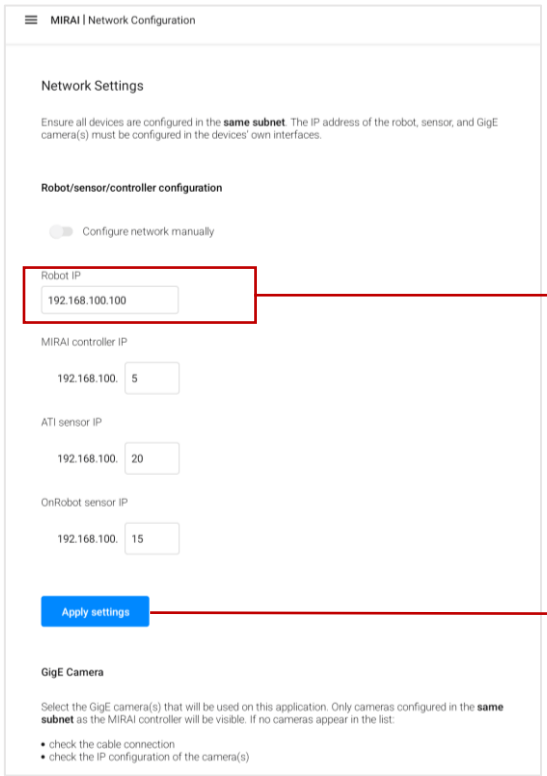


Step 1. Enter the main menu (top left corner) and go to **Network Configuration**.

Default settings

The app settings for Port 1 (X1P1) are preconfigured to the **192.168.100.0/24 subnet**, as shown below.

To use these settings, **no changes are necessary in the app**. Ensure that the robot and force/torque sensor are configured correctly on their respective interfaces.



Custom settings

Step 2. To configure Port 1 (X1P1), enter the IP address of the robot that you are using. The first three IP digit fields will be automatically updated for the MIRAI controller and the relevant force/torque sensor. Assign the remaining fields accordingly.

Step 3. Tap **Apply Settings**.

An error message will appear for the sensor model you are not using.

- Tap **OK.**

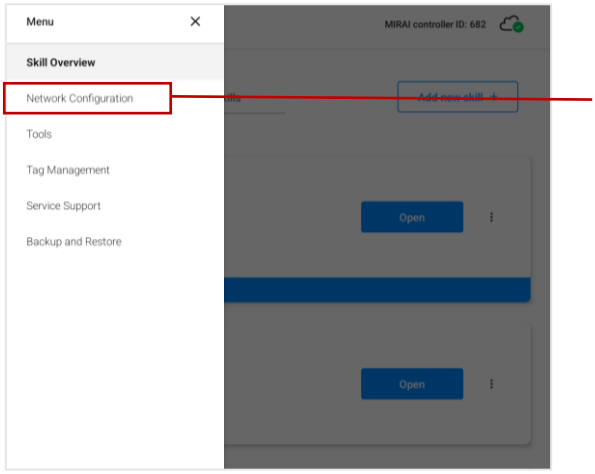
A message to confirm settings will appear.

- Tap **Yes, apply**.

4.2.2 One GigE camera: Use Port 1 (X1P1)

Port 1 is preconfigured to the 192.168.100.0/24 subnet with the MIRAI controller assigned to the IP address 192.168.100.5. If you plan to switch between using one and two GigE cameras, use the 192.168.99.0/24 subnet (see 4.2.3).

To configure the components in the MIRAI network, use the default settings or choose custom settings:

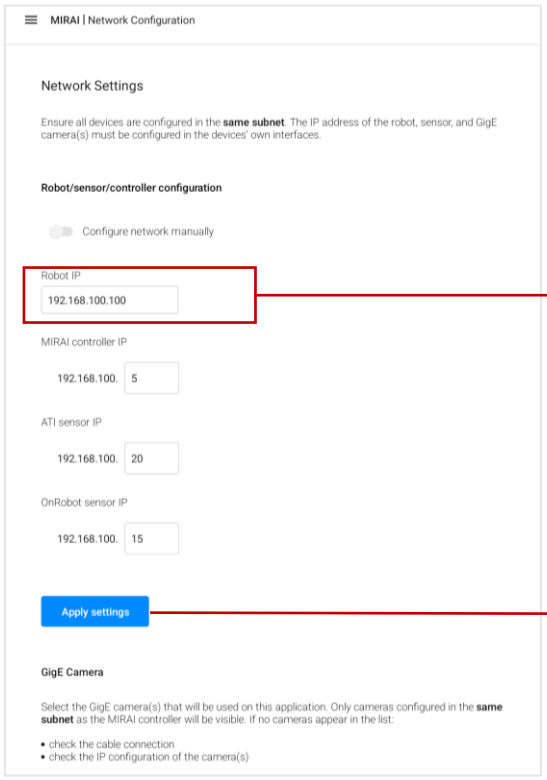


Step 1. Enter the main menu (top left corner) and go to **Network Configuration**.

Default settings

The app settings for Port 1 (X1P1) are preconfigured to the **192.168.100.0/24 subnet**, as shown below left.

To use these settings, go to Step 5. Ensure that the robot and force/torque sensor are configured correctly on their respective interfaces.



Custom settings

Step 2. To configure Port 1 (X1P1), enter the IP address of the robot that you are using. The first three IP digit fields will be automatically updated for the MIRAI controller and the relevant force/torque sensor. Assign the remaining fields accordingly.

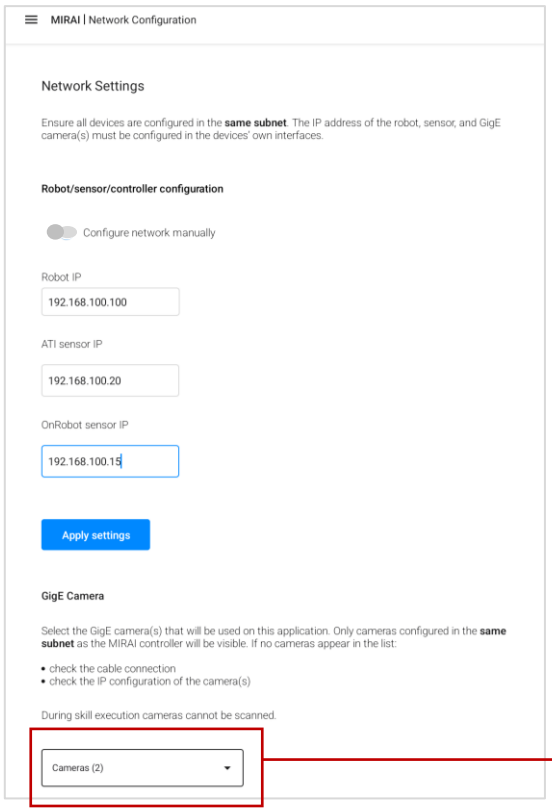
Step 3. Tap **Apply Settings**.

An error message will appear for the sensor model you are not using.

- Tap **OK.**

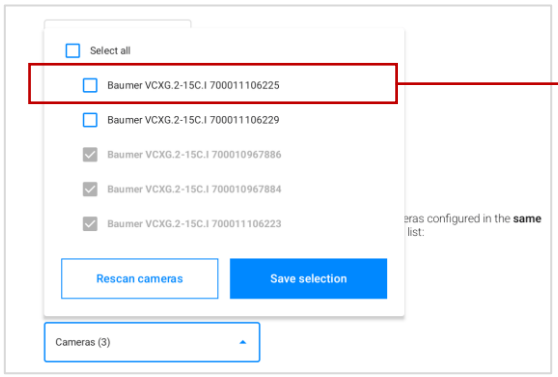
A message to confirm settings will appear.

- Tap **Yes, apply**.

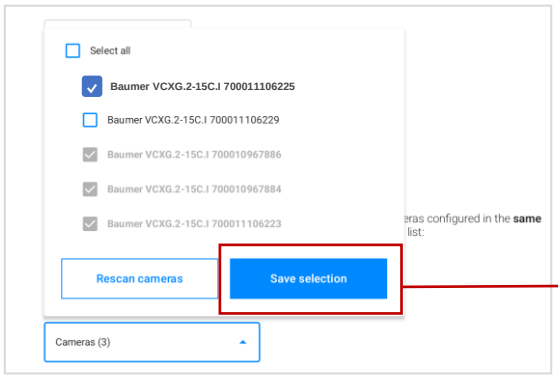


Step 5. Ensure that the GigE camera is connected to the Gigabit Ethernet switch using the correct port, and that the IP address is configured to the right subnet. The camera needs power to be visible in the network.

Step 6. Go to the **Cameras** drop-down menu.



Step 7. Select the configured camera from the **Cameras** drop-down menu.

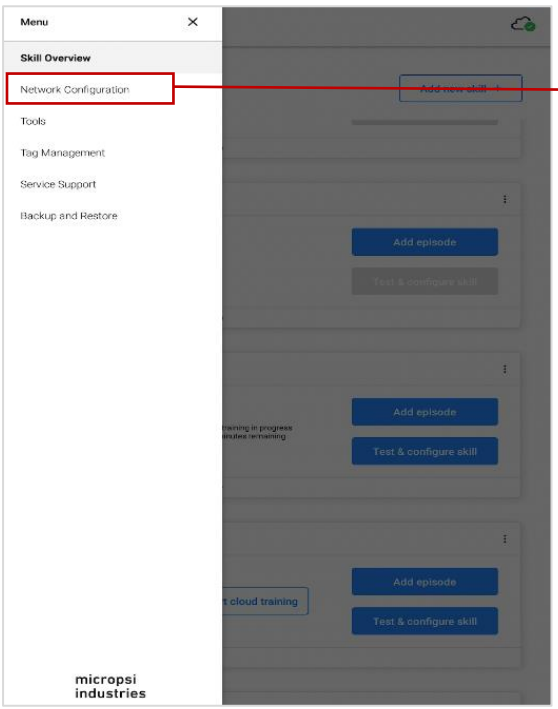


Step 8. Tap **Save selection**. The configured IP address will appear next to the selected camera.

4.2.3 Two GigE cameras: Use preconfigured Ports 3 and 4

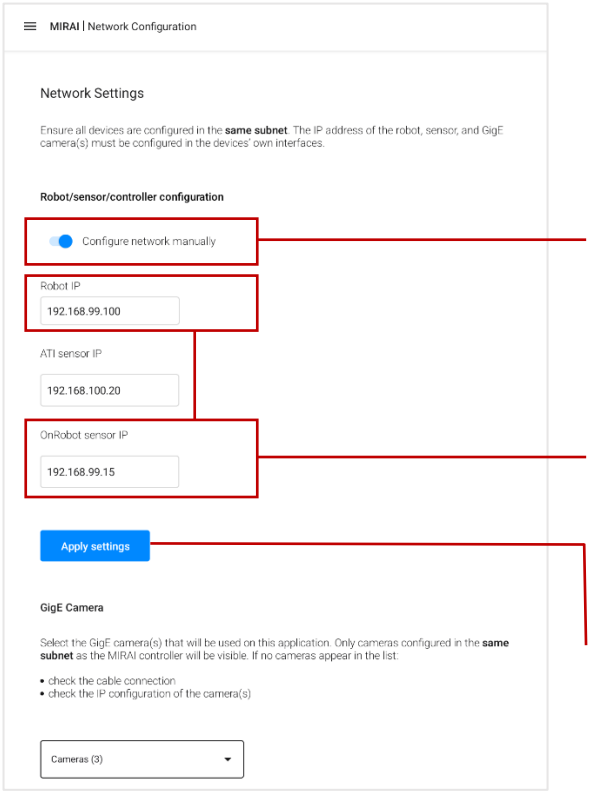
Ports 3 and 4 are link aggregated, functioning as a single logical link to provide increased bandwidth. The ports are preconfigured to the 192.168.99.0/24 subnet, with the MIRAI controller assigned to IP address 192.168.99.5. Note that you can use a single camera on this network as well.

To use these preconfigured settings, follow these steps to enter the IP addresses for the robot and force/torque sensor:



Step 1. Enter the main menu (top left corner) and go to **Network Configuration**.

NOTE: All devices in the MIRAI network must be configured to the 192.168.99.0/24 subnet. Configure the robot, force/torque sensor, and GigE cameras using their respective interfaces.



Step 2. Set the toggle button to **Configure network manually** and tap **Continue**.

Step 3. Enter the IP address for the robot and for the force/torque sensor you are using to train the skill using the 192.168.99.0/24 subnet.

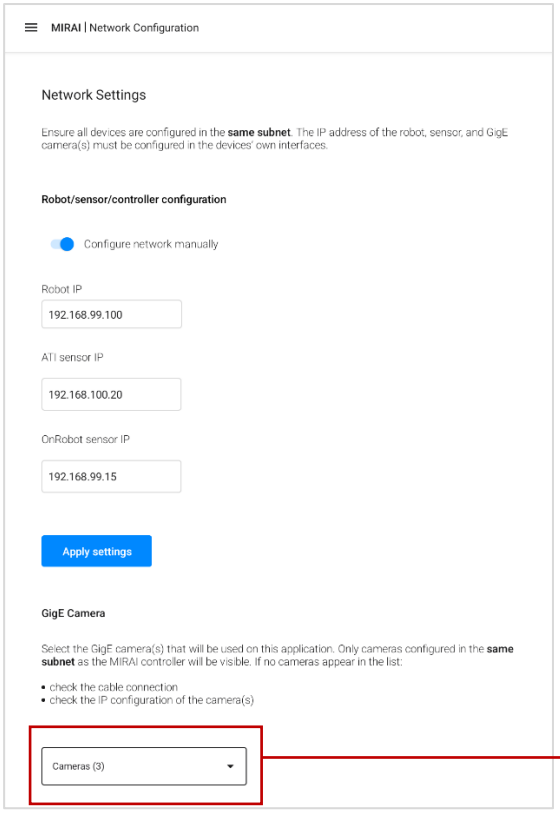
Step 4. Tap **Apply Settings**.

An error message will appear for the sensor model you are not using.

- Tap **OK.**

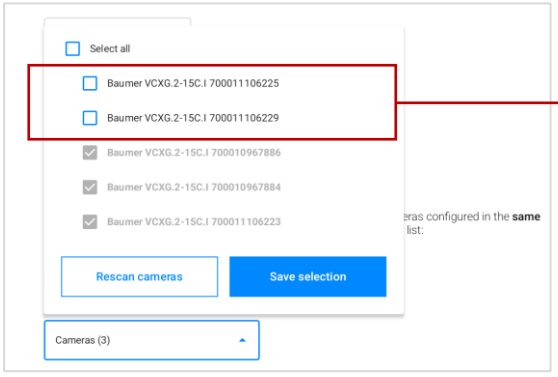
A message to confirm settings will appear.

- Tap **Yes, apply**.

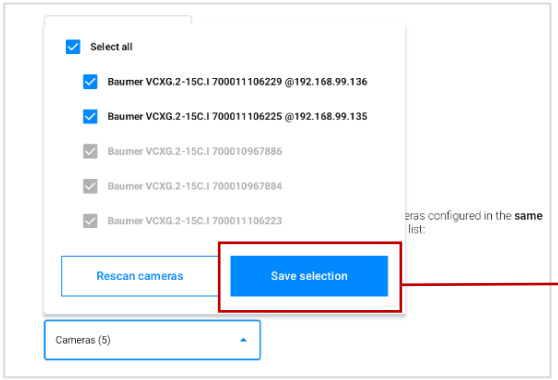


Step 5. Ensure that the GigE cameras are connected to the Gigabit Ethernet switch using the correct ports, and that the IP address is configured to the right subnet. The cameras need power to be visible in the network.

Step 6. Go to the **Cameras** drop-down menu.



Step 7. Select the configured cameras from the **Cameras** drop-down menu.



Step 8. Tap **Save selection**. The configured IP addresses will appear next to the selected cameras.

4.2.4 Manual network configuration

> ⚠ CAUTION
>
> Manual configuration requires Linux command-line skills and a solid understanding of networking principles. Exercise caution, because incorrect configurations can cause network connectivity issues. Users are fully responsible for any changes made to network settings using this method.

This method provides full control and customization of network settings beyond standard configurations.

Set the toggle to **Configure network manually**.

To configure the network setup, access the controller via SSH or a physical terminal, and then use Linux command-line tools.

The username is netadmin. The password is printed on the controller. It is the same password used for the Wi-Fi connection.

Log in to edit **/etc/network/interfaces** and configure each Ethernet interface.

The netadmin user has write access to **/etc/network/interfaces** and to the following commands:

- `sudo ip`
- `sudo ifup`
- `sudo ifdown`
- `sudo reboot`
- `sudo poweroff`
- `sudo systemctl restart micropsi-runtime`
- `gevipconfig`

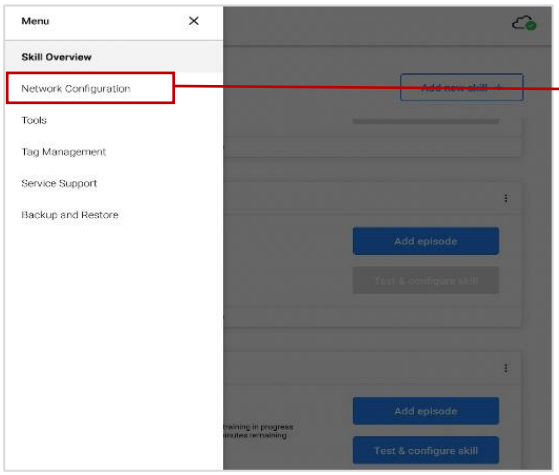
If you misconfigure the network of the MIRAI controller, you can restore the controller's initial state using the following command:

```
mirai-restore-network
```

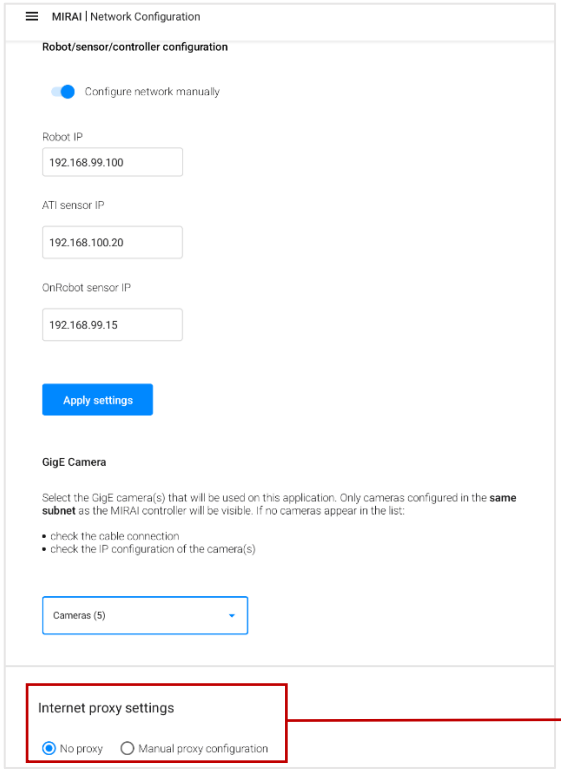
> ⚠ IMPORTANT:
> The MIRAI controller requires a **restart to apply network changes** made by netadmin.

4.2.5 Connect to the Micropsi Cloud using a proxy server

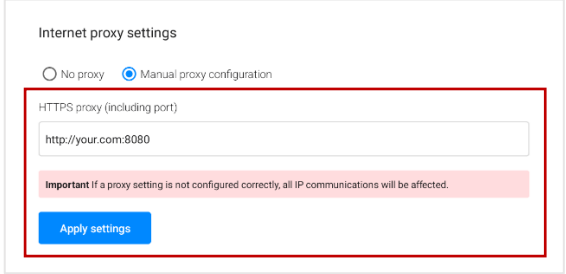
If IT security requires the use of a proxy server to connect the MIRAI controller to the Micropsi cloud, follow these steps:



Step 1. Enter the main menu (top left corner) and go to **Network Configuration**.



Step 2. Under **Internet proxy settings**, select **Manual proxy configuration.**



Step 3. Enter the address and the port in the indicated format. Tap **Apply settings.**

The proxy must allow connections to these sites:

For training:
https://crunch.micropsi-industries.com **(TCP Port 443)**
https://crunch.micropsi.io **(TCP Port 443)**

For support :
mirai-vpn.micropsi-industries.com **(UDP Port 1194)**

For software updates :
https://apt.tools.micropsi.io **(TCP Port 443)**
http://deb.debian.org **(TCP Port 80)**
http://security.debian.org **(TCP Port 80)**

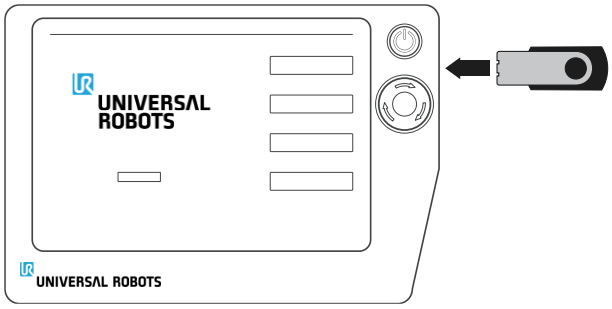
5 Install the MIRAI URCap Plugin

Ensure that the UR robot controller is running the appropriate version of UR PolyScope™:

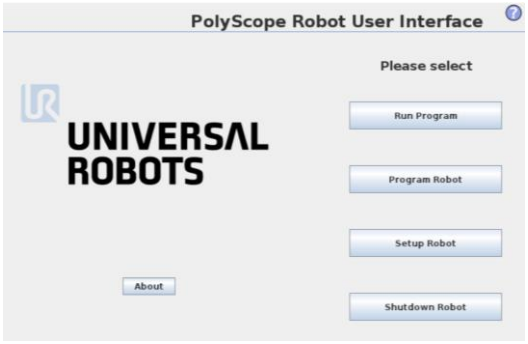
- CB3 Series: 3.9.0 and above
- E-Series:
  - 5.3
  - 5.7 and above
  - NOTE: Avoid versions *between* 5.3 and 5.7 due to RTDE interface bug

5.1 For the UR CB3 series (UR3, UR5, UR10)

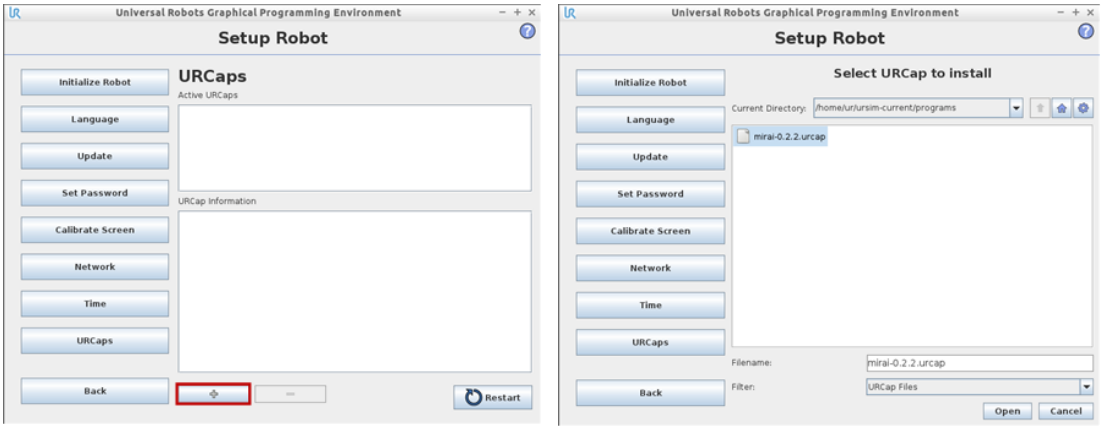
1. Insert the MIRAI USB drive in the USB slot of the UR teach pendant.



2. Access the URCaps installation screen:
   a. On the welcome screen, tap **Setup Robot**.
   b. On the URCaps screen, tap **URCaps**.

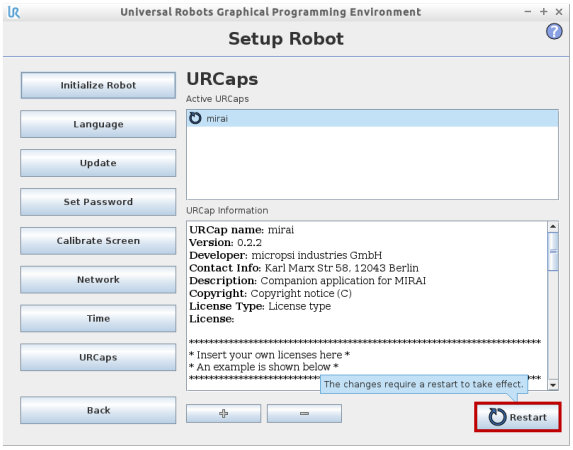


4. Install the MIRAI URCap plugin:
   a. On the URCaps installation screen, tap `+`. **Add** at the bottom to open the file selector.
   b. In the **Current Directory** menu, select the USB drive.
   c. On the USB drive, select the folder named `MIRAI_URCaps` folder.
   d. In the folder, select the `mirai-<version>.urcap` file and tap **Open**.



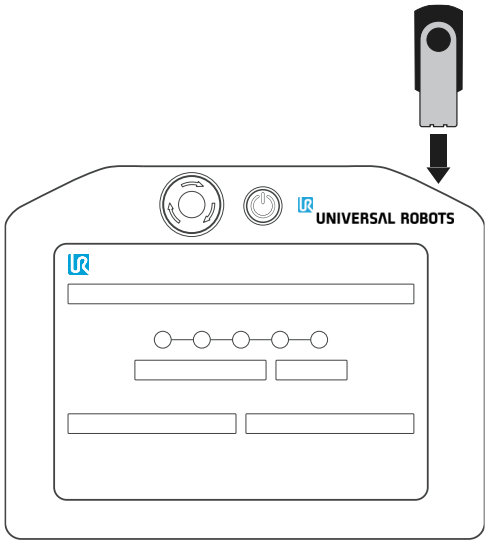
5. The URCaps panel should now show `mirai` in the list of active URCaps and a prompt to restart the robot to initialize the MIRAI URCap plugin. Tap **Restart**.

.

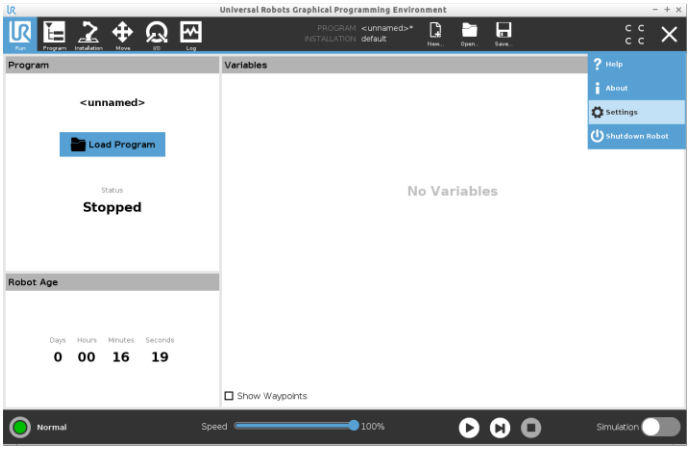


5.2 For the UR e-Series (UR3e, UR5e, UR10e, 16e)

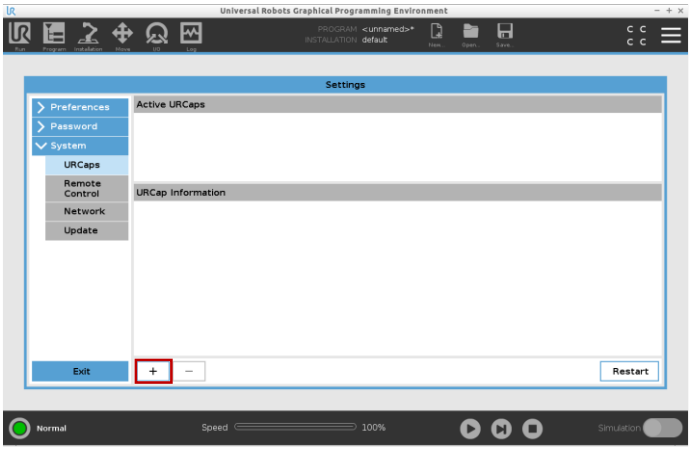
1. Insert the MIRAI USB drive in the USB slot of the UR teach pendant.



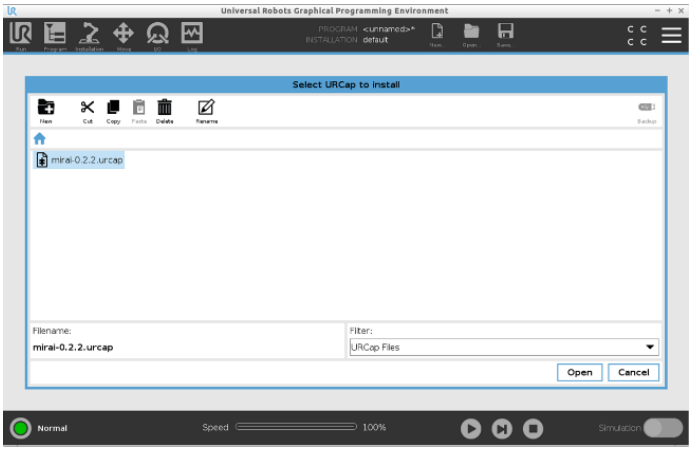
2. Access the URCaps installation screen:
   a. On the top menu bar, tap Menu.
   b. In the menu, tap Settings.



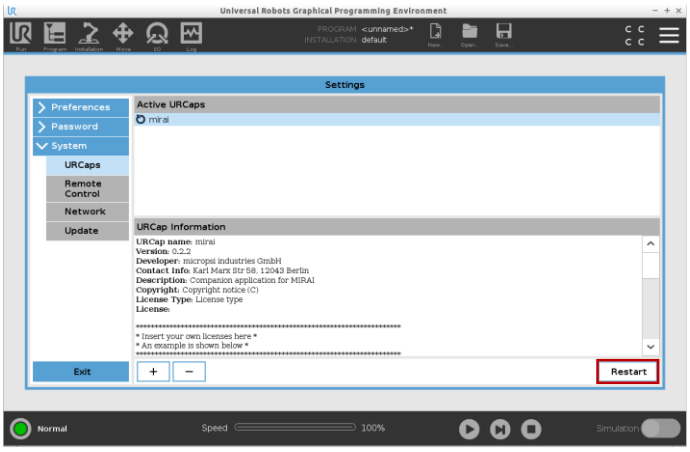
c. In the left sidebar on the Settings screen, expand the **System** options and select **URCaps**.



3. **Install the MIRAI URCap plugin:**
   a. On the URCaps installation screen, tap + **Add** at the bottom to open the file selector.
   b. On the USB drive, select the `mirai-<version>.urcap` file and tap **Open**.



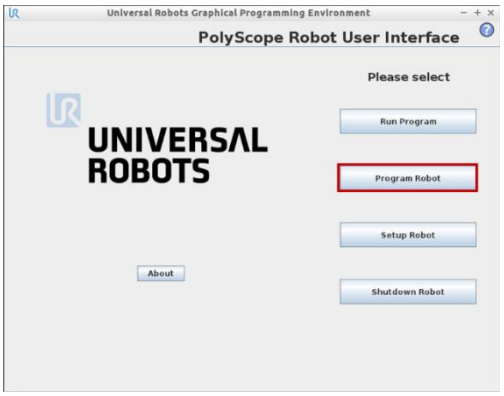
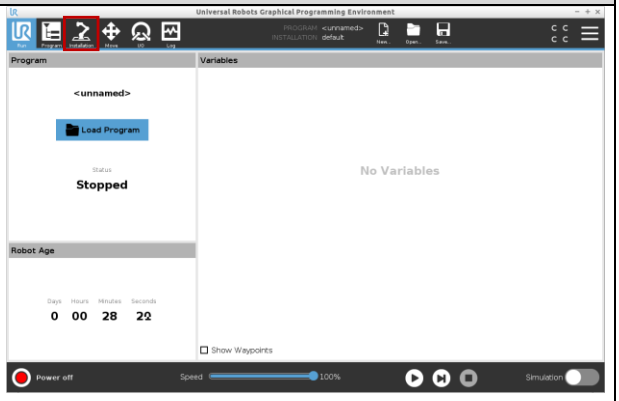
4. The URCaps panel should now show `mirai` in the list of active URCaps and a prompt to restart the robot to initialize the MIRAI URCap plugin. Tap **Restart**.



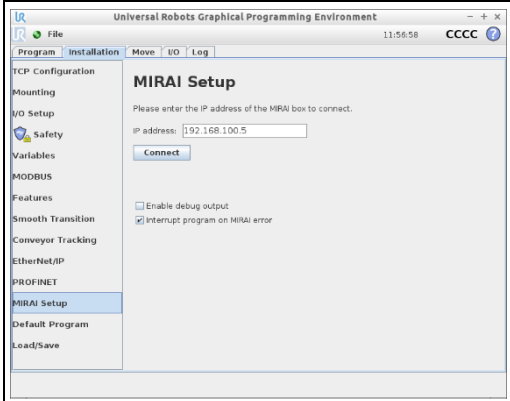
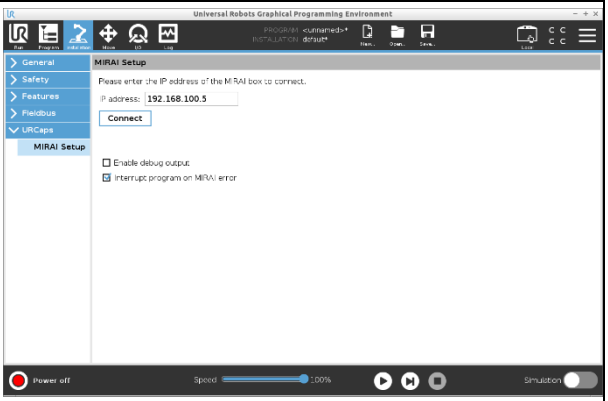
5.3 MIRAI URCap plugin settings

The MIRAI URCap plugin requires initial setup. This section outlines setup for CB3 Series and e-Series robots.

1. Access the Installation screen:
   - CB3 series: From the welcome screen, tap **Program Robot**.
   - e-Series: On the top menu bar, tap **Installation**.

CB3 Series	e-Series
	

2. Enter the IP address of the MIRAI controller:
   - CB3 series:
     a. The IP address field is prefilled with either the default MIRAI controller IP address (192.168.100.5) or the last entered IP address. Change the IP address if necessary.
     b. Tap **Connect**.
   - e-Series:
     a. In the left sidebar, select **MIRAI Setup**.
     b. The IP address field is prefilled with either the default MIRAI controller IP address (192.168.100.5) or the last entered IP address. Change the IP address if necessary.
     c. Tap **Connect**.

CB3 Series	e-Series
	

If you encounter an error message while connecting, check the following conditions and retry:

1. Ensure the MIRAI controller and the UR Robot Controller are connected to the same LAN
2. Verify that the IP address entered is correct.
3. Confirm that the URCap plugin for the OnRobot HEX-E force/torque sensor is not installed. The OnRobot and MIRAI URCap plugins are currently incompatible.

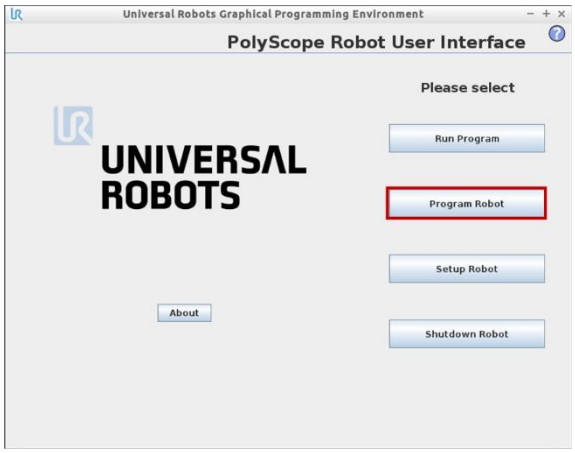
6 Add MIRAI skills to PolyScope programs

These sections outline how to add MIRAI skills to Robot Programs in PolyScope.

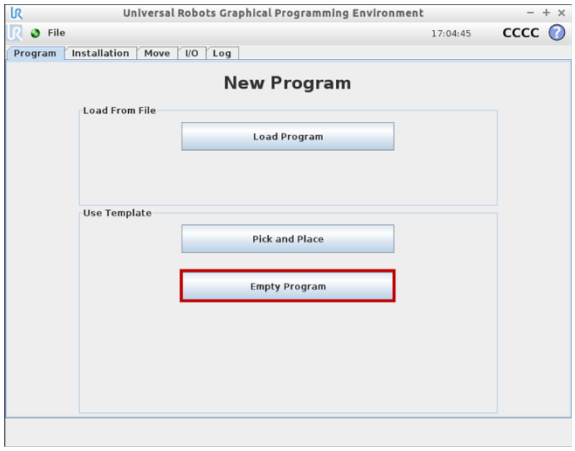
- For CB3 Series robots, refer to Section 6.1.
- For e-Series robots, refer to Section 6.2.

6.1 CB3 Series: Add MIRAI calls to PolyScope programs

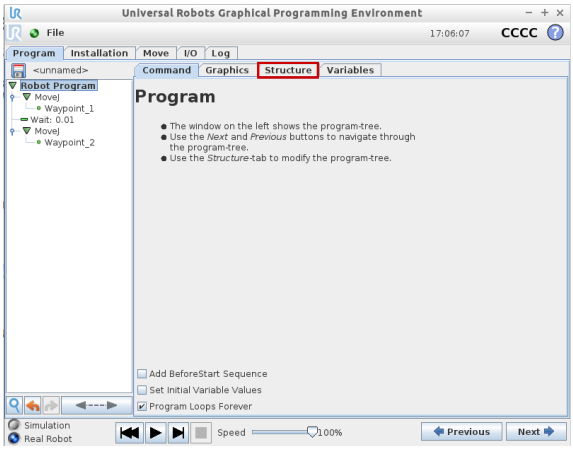
1. On the welcome screen, tap **Program Robot.**



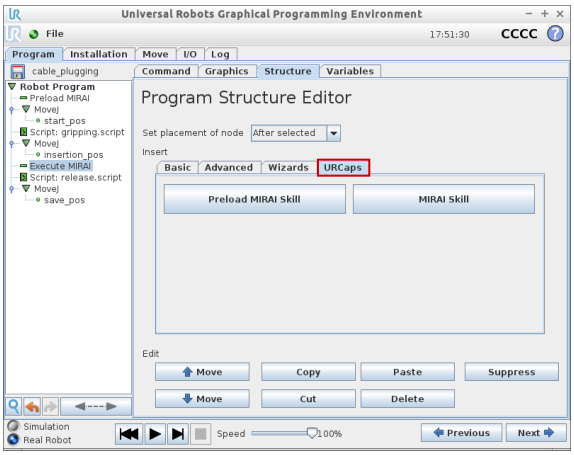
2. Access the robot program:
   - To write a new program, tap **Empty Program.**
   - To open an existing program, tap **Load Program**.



3. To add a MIRAI skill to the robot program, select the **Structure** tab in the **Program** panel.

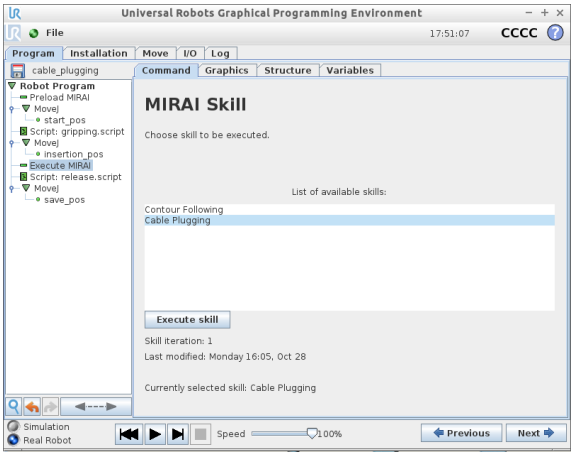


4. In the **Program Structure Editor** panel, select the **URCaps** tab.



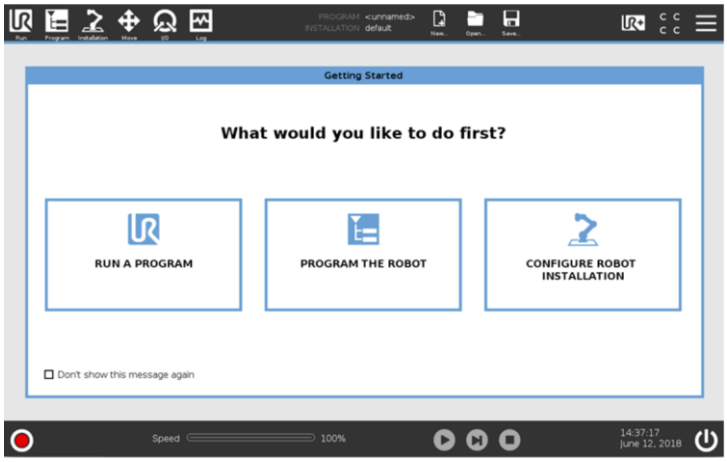
5. In the left panel, select the `Preload MIRAI` node in the robot program. In the right panel, select the skill to be executed and click **Preload skill**. NOTE: Preloading a skill shortens initialization time for the subsequent skill execution node.

6. In the left panel, select the `Execute MIRAI` node in the robot program. In the right panel, select the same skill that was preloaded and tap **Execute skill**. The node symbol next to `Execute MIRAI.` in the Robot Program should change from yellow to green.

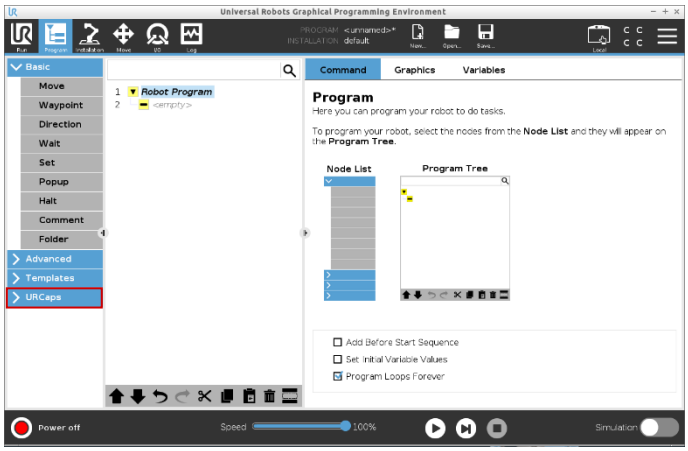


6.2 e-Series: Add MIRAI Calls to PolyScope Programs

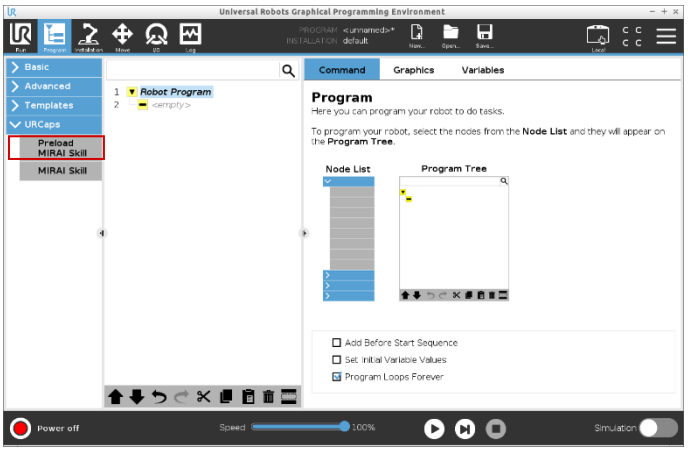
1. From the start screen, tap **PROGRAM THE ROBOT**.



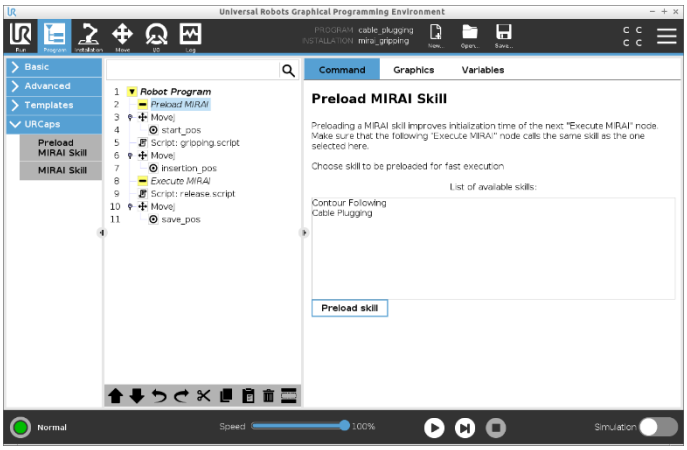
2. On the top menu bar, tap **Program**, and then expand the **URCaps** options.



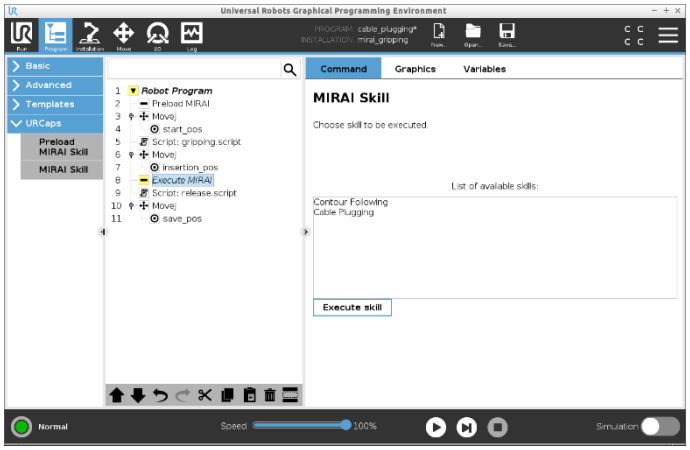
3. Select **Preload MIRAI Skill** from the **URCaps** options. This action will populate the Robot Program with a sub-tree of program nodes in the left panel and display a list of skills in the right panel.



4. In the left panel, select the `Preload MIRAI` node. In the right panel, select the skill to be executed and click **Preload skill**. NOTE: Preloading a skill shortens initialization time for the skill execution node in the program.



5. In the left panel, select the `Execute MIRAI` node. In the right panel, select the same skill that was preloaded and click **Execute skill**.

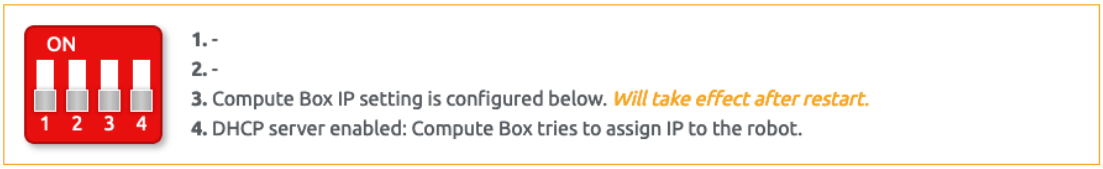


7 Appendix

7.1 Configure the OnRobot Compute Box

NOTE: The IP addresses given here are for our default configuration for USB cameras or one GigE camera. If you are using two GigE cameras or a manual network configuration, enter the appropriate IP address.

1. Set the DIP Switch 3 to ON to enable static IP.
2. Power on the compute box, and wait 30 seconds.
3. Set your PC's Ethernet network to use DHCP.
4. Connect the Compute Box to your PC via Ethernet. You PC should automatically receive an IP address from the Compute Box in the subnet 192.168.1.0/24.
5. Open your web browser and type: http://192.168.1.1.
6. The administration page will open. Select "Compute Box."
7. Go to the configuration tab.
8. Set the DIP Switch 3 to OFF to disable static IP.
9. Verify that you see the following image:



10. Set the Network Mode to "Static IP."
11. Enter the IP address 192.168.100.15 (or one that matches your network configuration).
12. Select **Save**.
13. Restart the Compute Box by turning it off and on again.

Steps to verify successful configuration:

1. Configure your PC's network adapter to a static IP address, such as 192.168.100.155, with a subnet mask of 255.255.255.0.
2. Disconnect and then reconnect the Ethernet connection to the Compute box.
3. Open in a web browser and type: http://192.168.100.15 (or the IP address entered in Step 11 above).
4. You should see the sensor's configuration page if everything is set up correctly.

7.2 Configure the ATI sensors

1. Connect the Ethernet cable from the force/torque sensor or Net F/T Box to your computer's ethernet port.
2. Power on the sensor and wait 30 seconds.
3. Open your web browser and navigate to: http://192.168.1.1 to access the ATI Net F/T homepage.
4. Set the IP address to a static IP, such as 192.168.100.20. If you are on a different subnet, enter the appropriate IP address instead.
5. Apply the settings and reboot the sensor.

IMPORTANT
The ATI force/torque sensors are temperature sensitive, especially the Axia80 series. To reduce output drift, warm up the sensor for one hour before use.

7.3 Shut down the MIRAI controller remotely

For MIRAI controllers with power buttons, use the button to shut down the controller before disconnecting power to ensure the integrity and longevity of the controller. If there is no power button, or if the power button is not accessible due to hardware integration, you can shut down the controller over Ethernet, such as from a PLC.

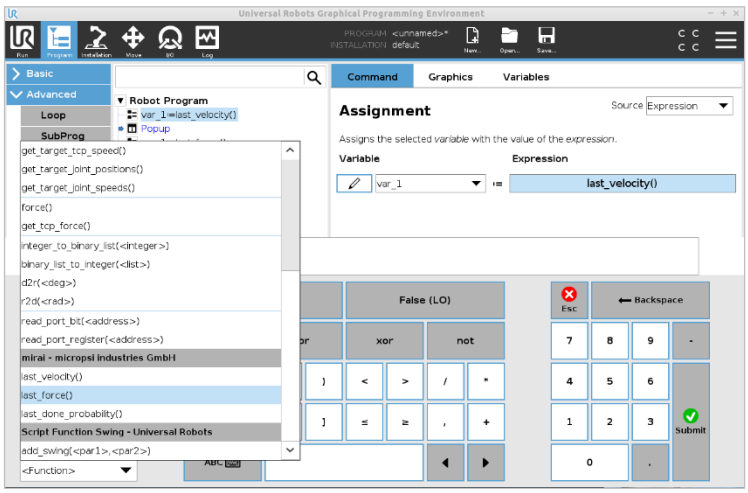
To shut down the MIRAI controller, use a remote procedure call (RPC) protocol encoded in XML using a cURL -X POST command. An example command for a MIRAI controller with IP address 192.168.100.5 and controller number 6543 would be:

```
curl -X POST http://192.168.100.5:6543/skills/xmlrpc -d '<?xml version="1.0"?>
<methodCall><methodName>shutdown_mirai</methodName><params></params>
</methodCall>' -H 'Content-Type:text/xml'
```

7.4 Polyscope functions and variables

The return values of the MIRAI functions called during skill execution can be displayed using the functions below. The function `get_last_endstate` function helps identify which end state caused the skill to stop. For details on configuring skill end states, refer to the MIRAI User Manual.

Functions	Description
`last_done_probability`	Returns the confidence threshold value for a visual end state.
`last_force`	Returns the last force measured at the tool center point (end effector). The end state is reached when force crosses (above or below) a certain threshold.
`last_velocity`	Returns the last velocity measured at the tool center point (end effector). The end state is reached when velocity crosses (above or below) a certain threshold.
`get_last_endstate`	This function offers you an easier way of keeping track of the end states that trigger your skills.
Variable	
`mirai_endstate_x`	Each program node has a variable, denoted as `x`, which contains an integer indicating what caused the node to terminate. The possible integer values are: 0 – none 1 – speed-based end state 2 – force-based end state 3 – visual end state 4 – timeout 5 – position-based end state 6 – anomaly-based end state 7 – proximity-based end state



7.5 Android tablets supporting the MIRAI Training App

To run the MIRAI Training App on Android tablets/mobile devices, follow these recommended minimum configurations:

- Android 8.1 (Oreo) or higher: The app may run on older Android versions, but they are not fully tested.
- Processor: Quad-core (ARM Cortex-A53 or higher), 1.6GHz. Less powerful processors may result in slower app performance and user interface response.
- Memory: 3GB or more recommended.
- Screen size: 10" recommended; 8" supported but not extensively used.
- Screen resolution: HD (1200 x 800) minimum; FHD (1920 x 1080) recommended.
- Wi-Fi: 802.11b/g/n minimum; 802.11a/ac recommended.

If purchasing a new tablet for the MIRAI Training App, consider the following models, which have been tested. However, any tablet meeting the above requirements should run the app effectively.

- Lenovo Yoga Tab 3 Plus (10.1" display, 3GB RAM, 32GB eMMC, Wi-Fi, Android 6.0+)
- Lenovo Tab4 10 Plus (10.1" display, 3GB RAM, 16GB eMMC, Wi-Fi, Android 7.0+)
- Lenovo Tab M10 (10.3" display, 4GB RAM, 64GB eMMC, Wi-Fi, Android 9.0+)
- Samsung Galaxy Tab S2 (9.7" display, 3GB RAM, 32GB eMMC, Wi-Fi, Android 6.0+)
- Samsung Galaxy Tab A 10.1 (10.1" display, 2GB RAM, 32GB eMMC, Wi-Fi, Android 7.0+)

7.6 Certificates and declarations – MIRAI controller

CE

spo-comm

EG Konformitätserklärung
Declaration of Conformity

spo-comm GmbH
Beethovenstraße 22
D-91207 Lauf a.d. Pegnitz
Germany

erklärt, dass das Produkt
declares that the product

spo-comm Mini-PC **spo-book QUADRO P1000**
*spo-comm Mini-PC **spo-book QUADRO P1000***

mit den Vorschriften folgender Europäischer Richtlinien übereinstimmt:
complies with the requirements of the European Directives:

2014/30/EU *2004/108/EG*	Elektromagnetische Verträglichkeit (EMV) *electromagnetic compatibility*
2011/65/EU *2011/65/EU*	Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten (RoHS) *RoHs*

Zutreffende Normen // *Applicable Standards*

EN60950-1:2006+A11:2009+A1:2010+A12:2011+A2:2013	**EN50663** **EN301 489-1 V2.2.0** **EN301 489-3 V2.1.1** **EN301 489-17 V3.2.0** **EN 300 328 V2.1.1** **EN 300 328 V2.1.1** **EN 300 440 V2.2.1**

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften im rechtlichen Sinne.
This declaration certifies conformance with the above mentioned Directives. Affirmation of attributes in a legal sense is not included.

Michael Sporrer, Geschäftsführer spo-comm GmbH
Michael Sporrer, CEO spo-comm GmbH

spo-comm

Konformitätserklärung
Declaration of Conformity

Die

spo-comm GmbH
Beethovenstraße 22
D-91207 Lauf a.d. Pegnitz
Germany

erklärt, dass das Produkt
declares that the product

spo-comm Mini-PC spo-book QUADRO P1000
spo-comm Mini-PC spo-book **QUADRO P1000**

mit den Vorschriften folgender Richtlinien übereinstimmt:
complies with the requirements of the following specifications:

FCC Rules and Regulation under 47 CFR Part 15 Subpart B and ANSI C63.4 (2014)

FCC Part 15.107
FCC Part 15.109

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften im rechtlichen Sinne.
This declaration certifies conformance with the above mentioned Directives. Affirmation of attributes in a legal sense is not included.

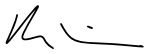
Michael Sporrer, Geschäftsführer spo-comm GmbH
Michael Sporrer, CEO spo-comm GmbH

MICROPSI INDUSTRIES

EU Declaration of Incorporation *(in accordance with Machinery Directive 2006/42/EC Annex II, part B)*

Manufacturer:	Person Authorized to Compile the Technical File:
micropsi industries GmbH Möckernstrasse 120, 10963 Berlin, GERMANY	Naaimah Saghir VP Product micropsi industries
Description and Identification of the Partly Completed Machine(s)	
Product and Function:	Vision-based motion control system for industrial robot systems that enables such robot systems to solve automation problems with high variance in position, shape, or background and lighting conditions. The final function is determined by the completed machine (i.e., robot system, robot cell or robot application with intended use).
Model:	MIRAI Software version 14.0.0 onwards
Incorporation:	The MIRAI vision-based motion control system shall only be put into operation upon being integrated into a final completed machine, which conforms with the provisions of the Machinery Directive and other applicable directives.
It is declared that the above product, for what is supplied, fulfils the directives as detailed below: When this partly completed machinery is integrated and becomes a final machinery, the integrator is responsible for determining that the final machinery fulfils all applicable Directives and providing the Declaration of Conformity.	
(I) Machinery Directive 2006/42/EC	The following essential health and safety requirements were fulfilled: Annex IV, clause 1.1.2, 1.1.3, 1.1.5, 1.2.2, 1.2.3, 1.5.1, 1.5.2, 1.7.1, 1.7.2, 1.7.4 It is declared that the relevant technical documentation was compiled in accordance with Annex VII, Part B The following Harmonized Standard were used (where applicable): EN 60204-1:2019
(II) Low-Voltage Directive 2014/35/EU	The following Harmonized Standard were used (where applicable): EN IEC 60320-1:2023
(III) Radio Equipment Directive 2014/53/EU	The following standards were used: Article 3.1a): EN60950-1:2006+A11:2009+A1:2010 +A12:2011+A2:2013; EN 50663: 2017 Article 3.1b): Draft EN 301 489-1 V2.2.0; final draft EN 301 489-3 V2.1.1; Draft EN 301 489-17 V3.2.0 Article 3.2): EN 300 328 V2.1.1; ETSI EN 301 893 V2.1.1; ETSI EN 300 440 V2.2.1
(IV) Other directives	All applicable directives and harmonized standards have been followed by the component suppliers and can be provided upon request.
Reference to Other Technical Standards and Specifications Used:	
EN ISO 10218-2:2011, ISO/TS 15066:2016	
The manufacturer, or his authorized representative, shall transmit relevant information about the partly completed machinery in response to a reasoned request by the national authorities.	

Berlin, Germany, 15 February 2024



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