User Manual

FANUC Integration

Setting up the MIRAI system

Implementing MIRAI skills into FANUC Teach Pendant

VERSION 21.0.0

micropsi
industries

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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 About this manual

This manual provides instructions and guidance on integrating MIRAI with FANUC robots, using images and examples from the CRX-10iA/L model. While the CRX-10iA/L is used for illustration, the instructions and menus apply to all supported robot models.

The manual also includes basic guidance on processes specific to FANUC robots, such as accessing certain menus and responding to common FANUC alarms. For detailed information, refer to the FANUC manual for your specific robot model.

1.2 Safety precautions

1.2.1 Robot safety

To ensure safety, follow these precautions:

- Always keep a safe distance from the robot.
- Have the FANUC Teach Pendant with an EMERGENCY STOP button within reach at all times.
- Follow all safety precautions in the FANUC robot safety guidelines.

The latest MIRAI software release 20.0.1 has the following known issues. These are not considered safety issues.

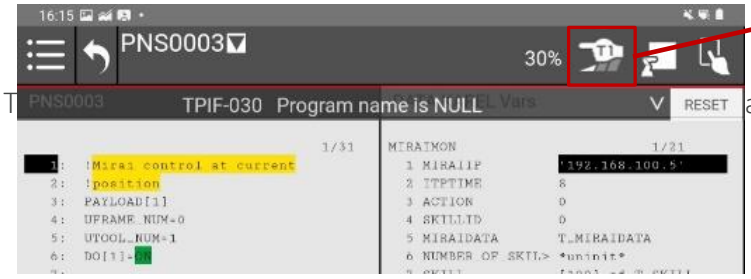
- MIRAI operates within a safety bounding box of 1.5 meters. For motion skills in wide motion, skill execution might stop due to the bounding box.

1.2.2 Set operating mode for MIRAI

⚠ IMPORTANT
For safety reasons, FANUC robots must be in T1 mode when using the MIRAI Training App.

The operation mode must be set to T1 to use the MIRAI Training App. The method for selecting the operation mode (AUTO/T1/T2) depends on your robot and controller model. On the robot controller, use either a key switch or turn-knob. On the FANUC teach pendant, use the Mode Select function. For more details on mode selection, refer to the operator's manual.

After you train a MIRAI skill and add it to the robot program, you can change the operation mode back to T2 or AUTO.



T ach operating mode:

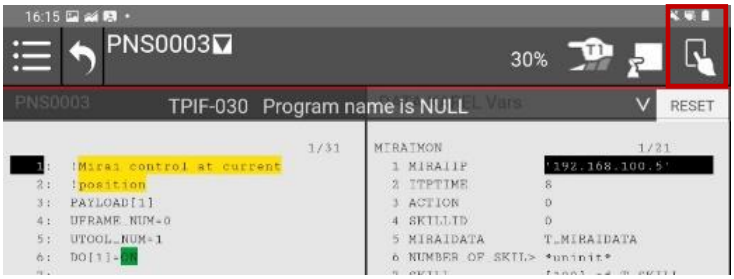
IMPORTANT: Operation mode must be **T1**.

If it is not possible to select T1 mode, refer to Operation Mode Switch (T1, T2, Auto) for Instructions to activate the operation mode via the teach pendant.

System parameters	T1 mode	AUTO mode
Flags [1–3] and F[8]	Off	On
Menu/System/Config: 7. Enable UI signals	False	True
Menu/System/Config: 42. Remote/Local setup	Local	Remote
Teach pendant	Enabled	Disabled

1.2.3 Enable the FANUC teach pendant

The FANUC Teach Pendant must always be enabled when using the MIRAI Training App. Enable the Teach Pendant by tapping the enable button on the status bar of the tablet teach pendant ,or by turning the black knob on the iPendant Touch.



1.2.4 The deadman switch

⚠ IMPORTANT
You must hold the deadman switch while using the MIRAI Training App.

If the deadman switch is released, the following alarms will appear on the Teach Pendant: `SRVO-289 Smooth Stop` and `SRVO-003 Deadman Switch Released`. The MIRAI Training App will display a message and become unusable until the alarms are reset. To reset them, hold the deadman switch in the middle position and press RESET in the Alarm Display below the status bar.

1.3 Back up the FANUC controller

We recommend taking backups ("Image" and "All of above") of the FANUC controller **before and after** installing the MIRAI software package.

- The pre-installation backup allows you to restore previous states.
- The post-installation backups allow Micropsi Industries to debug and provide support, if needed.

Installation of the MIRAI software package requires specific registers, inputs, and outputs, which will be automatically overwritten when executing the SETUP.CM file. MIRAI uses the following I/Os and data registers:

- Digital Outputs: DO[2049–2068]
- Digital Inputs: DI [2053–2068]
- Registers: R[75–92]
- Position Registers: PR[75–78]

1.4 Supported FANUC models

MIRAI is compatible with the following FANUC robot models:

- CRX-10*i*A
- CRX-10*i*A/L
- LR-10*i*A/10
- LR Mate 200*i*D
- LR Mate 200*i*D/4S
- LR Mate 200*i*D/7L
- M-20*i*B/25
- R-2000*i*C/165F
- R-2000*i*C/210F
- R-2000*i*C/270F

The following robots are considered "experimental" and have not been tested on physical hardware:

- ARC Mate 100*i*C/12
- CRX-20*i*A/L
- CRX-30*i*A
- M-20*i*D/25
- M-710*i*C/50

1.5 MIRAI components

1.5.1 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)
- *For USB 3.0 camera setups only:* Ethernet Gigabit switch and cables

1.5.2 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

- a 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 the hand-guiding feature include 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)

1.6 Required FANUC software versions and packages

Specific FANUC software versions and packages are required to support MIRAI. The minimum required FANUC robot control components are:

- **FANUC robot arm and control system:** Minimum software version required is V9.4
- **Teach pendant:** FANUC Tablet Teach Pendant or FANUC iPendant Touch

The required software options for the FANUC robot controller are listed below by region.

Software Packages Required for Collaborative Robots: Regional Availability

Package	Europe	USA
R739 Dyn Path Modifier	Purchase required	Purchase required
R648 User Socket Msg	Purchase required	Purchase required
J742 Customize Support Function	Purchase required	Purchase required
R650 FRA Params	Exclusive to USA	Standard, pre-installed
R651 FRL Params	Standard, pre-installed	Exclusive to Europe
R632 KAREL	Included with R651 FRL Params	Purchase required
R553 HMI Device (SNPX)	Standard, pre-installed	Purchase required

1.6.1 FANUC software releases and implications for MIRAI

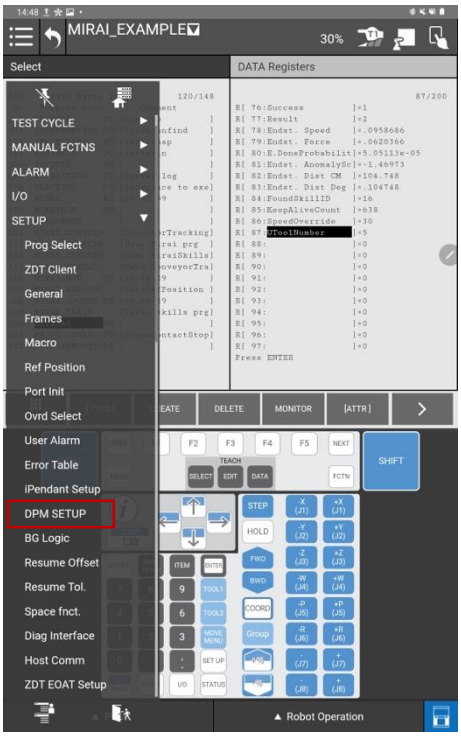
FANUC software version	Improvement	MIRAI implication
min. V9.40P/49	Coexistence between Line Tracking (J512) and DPM	Both programs can now coexist, But **they cannot be used simultaneously**. Only one can be activated at a time.
min. V9.40P/58	DPM rotation bug	When you switch tools in a program, e.g use a different tool than UTOOL_NUM=1, there is a delay of **15 seconds** after skill execution. To avoid this use only the UTOOL_NUM=1 in your program with all values set to 0. For details, see Adding the MIRAI Tool in the Robot Program.
V9.40P/64	DPM rotation bug	Fixed. There is no longer a delay when switching tools.

⚠ IMPORTANT: If you are using FANUC software version **V9.40P/58 and above:**

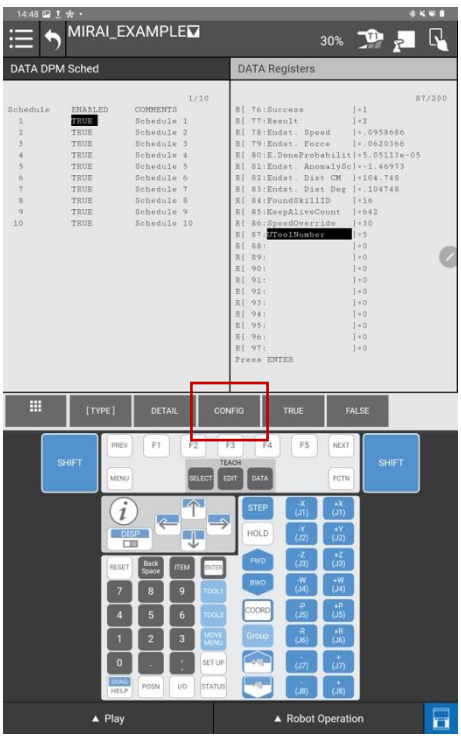
For the R739 Dyn Path Modifier package to function properly, you must set the Orientation frame in the DPM CFG SETUP to **STANDARD**.

Follow these steps:

Step 1 – In the long menu go to **SETUP > DPM SETUP**.

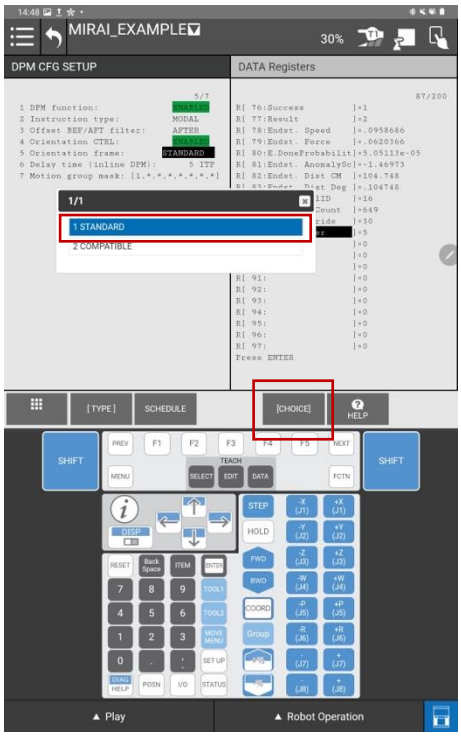


Step 2 – Tap **CONFIG**.



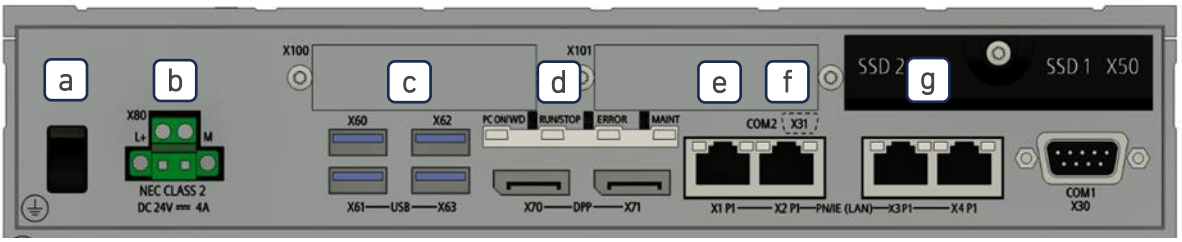
Step 3 – Go to the **5 Orientation frame** argument and tap **ENTER**.

Step 4 – Tap **CHOICE**, select **1 STANDARD**, and tap **ENTER**.



1.7 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. For more information see Section 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

1.8 MIRAI controller specifications

- Intel Xeon W-11555MLE (1.9/4.4 GHz, 6C/12T)
- 16GB DDR4-3200 SO-DIMM
- SSD 512 GB Eco
- 24 V 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

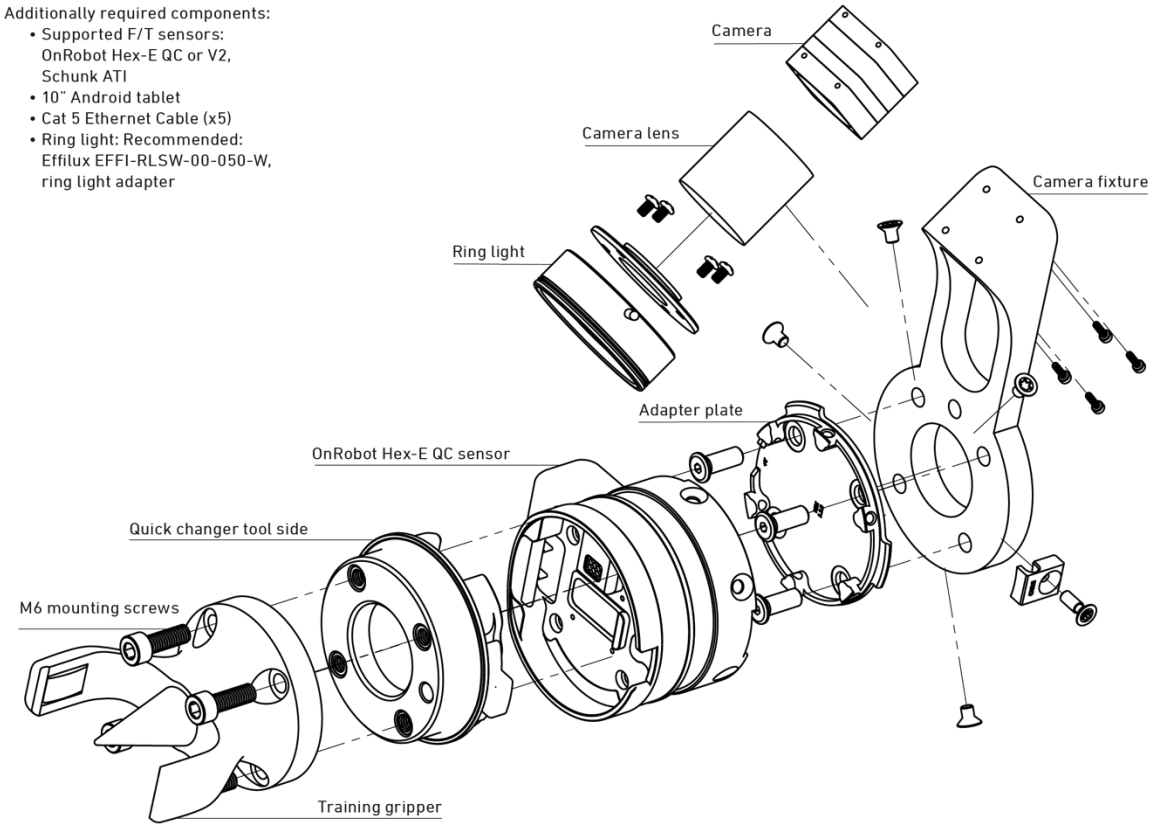
2 Set up the MIRAI controller

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 (see 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.
   - NOTE: On FANUC robots, the tool coordinate system is rotated by 90 degrees.
   - Use the universal camera fixture without a dowel pin to mount it in a "wrong orientation" and align the coordinate system of the robot with the coordinate system of the force/torque sensor.
   - Ensure that the printed symbols on the sensor (such as +Y, -X) line up with the robot flange.
   - Test if the sensor is mounted correctly by ensuring that the robot arm moves in the direction you push it in. If it moves in a different direction, you need to remount.
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 software package: integrates MIRAI skills into robot program flows on the Teach Pendant

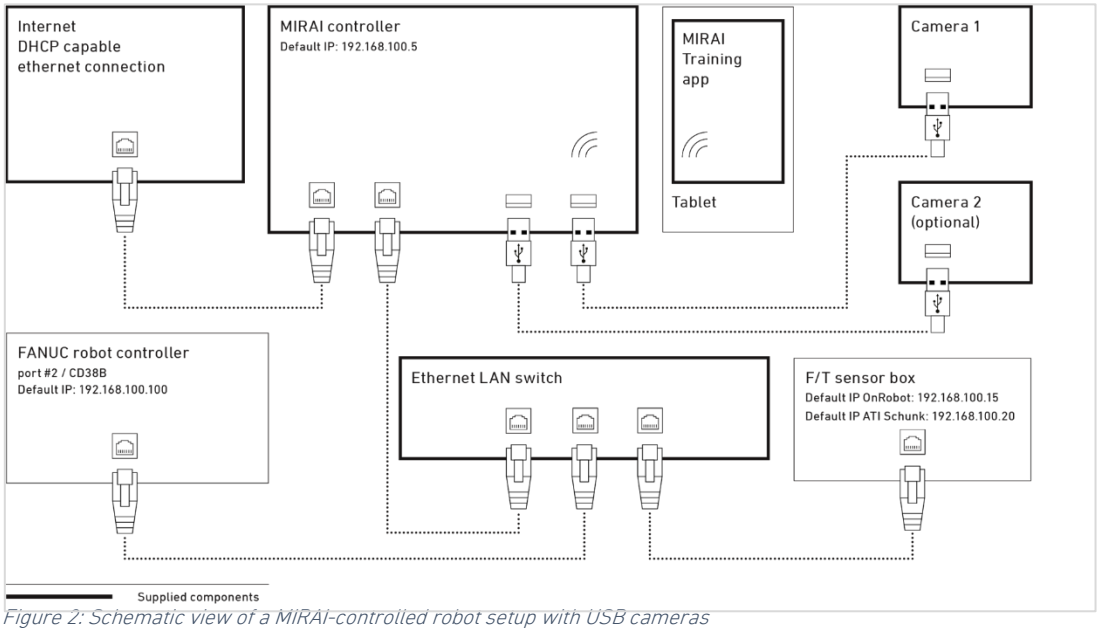


Figure 2: Schematic view of a MIRAI-controlled robot setup with USB cameras

2.2.2 Connect the MIRAI controller with a USB camera setup

NOTE: Refer to Section 1.6 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 FANUC robot controller or robot arm. We recommend securing the MIRAI controller to prevent it from falling or shifting.
2. Connect the FANUC robot controller to the Ethernet LAN switch.
    a. If the FANUC robot controller has **multiple Ethernet RJ45 ports**, use CD38B/port #2.
    b. If the FANUC robot controller has **one Ethernet RJ45 port**, use CD38A.
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, refer to Section 4.4.5. 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
- **The MIRAI software package**: integrates MIRAI skills into robot program flows on the Teach Pendant

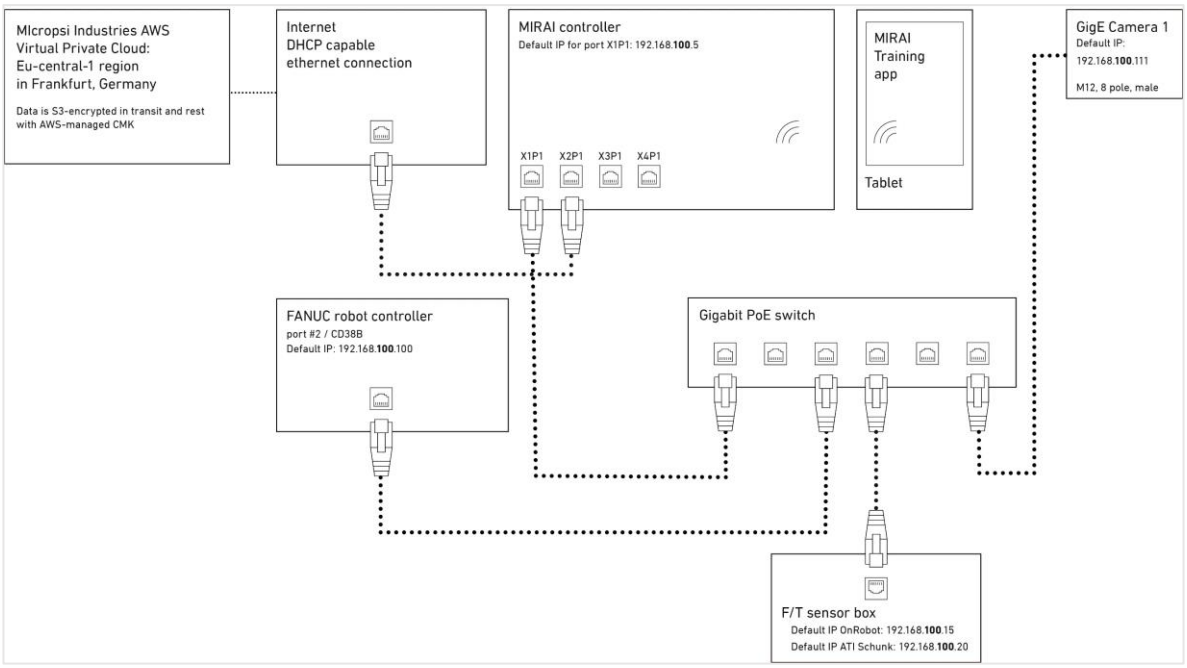


Figure 3: Schematic view of a MIRAI-controlled robot setup with one GigE camera

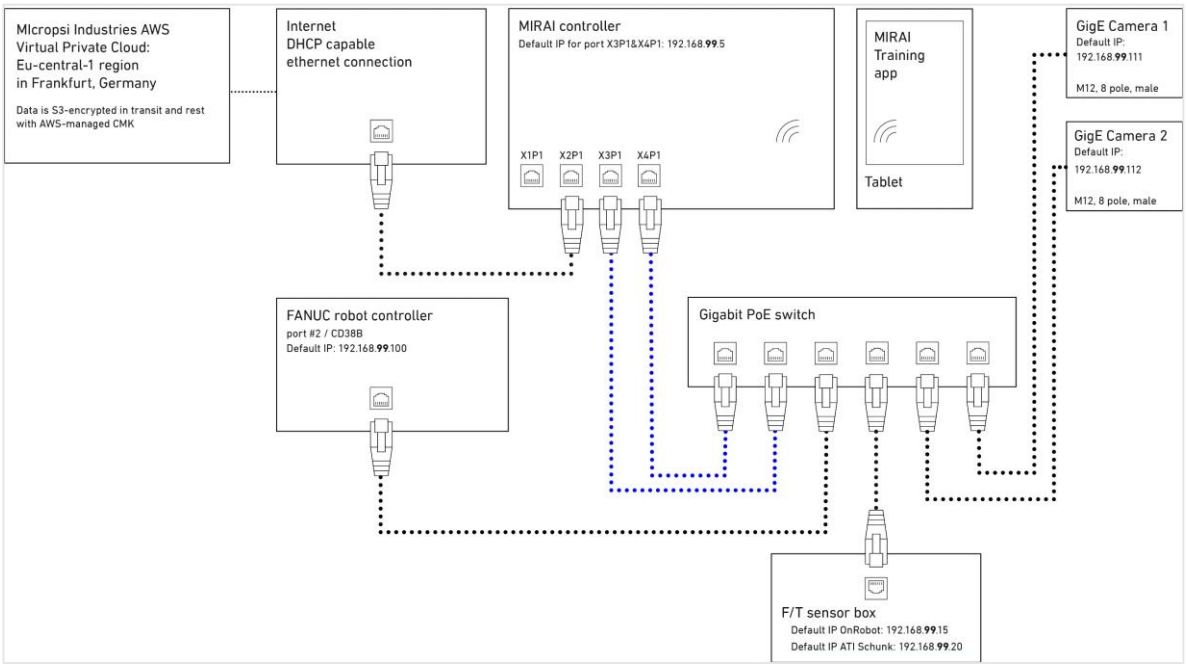


Figure 4: Schematic view of a MIRAI-controlled robot setup with two GigE cameras. Two link-aggregated ports are used to connect the MIRAI controller to the Gigabit Ethernet switch.

2.3.2 Connect the MIRAI controller with GigE camera setups

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 1.6 for a diagram of the MIRAI controller.

1. Place the MIRAI controller and the Gigabit Ethernet switch near the FANUC robot controller or robot arm. We recommend securing the MIRAI controller to prevent it from falling or shifting.
2. Connect the FANUC robot controller to the Gigabit Ethernet switch.
    a. If the FANUC robot controller has **multiple Ethernet RJ45 ports**, use CD38B/port #2.
    b. If the FANUC robot controller has **one Ethernet RJ45 port**, use CD38A.
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 version 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, which 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. In 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** on the FANUC Teach Pendant (see Section 4.2) and in the MIRAI Training App (see Section 4.3).

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 4.3.1.
- **One GigE camera**: Use Port 1 or custom settings (see section 4.3.2)
- **Two GigE cameras**: Use Ports 3 and 4 (see section 4.3.3)

For **custom network settings**, users can manually configure the ports as desired. Refer to section 4.3.4.

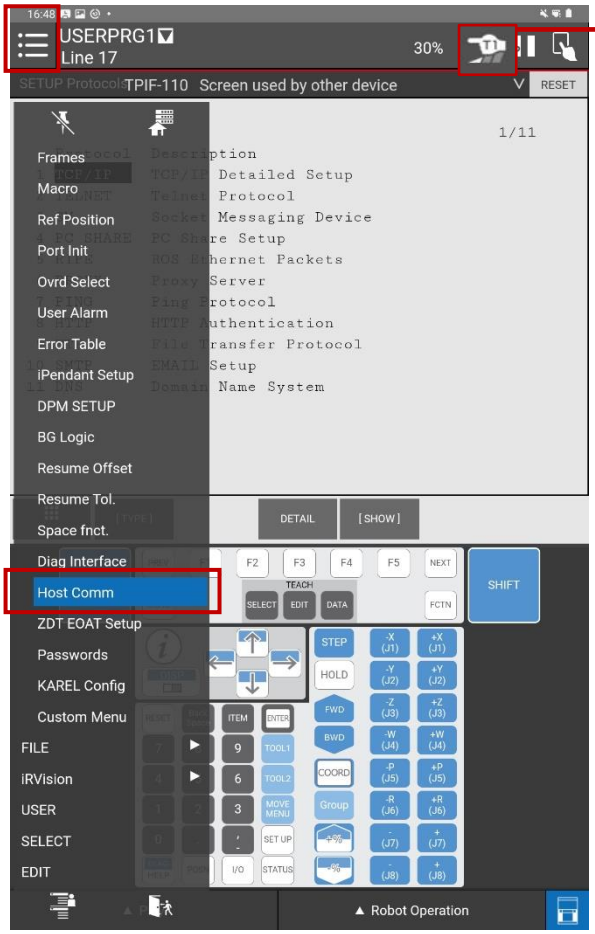
4.2 Network configuration on the FANUC teach pendant

> ⚠ **NOTE:** The following steps show the settings for the default configuration for MIRAI controller Port#1 (X1P1) on the 192.168.100.0/24 subnet. The MIRAI controller is assigned to the IP address 192.168.100.5. If you are using a different subnet, use that (Steps 6 and 7).

If you are using the default MIRAI IP address (192.168.100.5), follow these steps to configure the network on the FANUC Teach Pendant.

Step 1. Expand the **Menu** at top left.

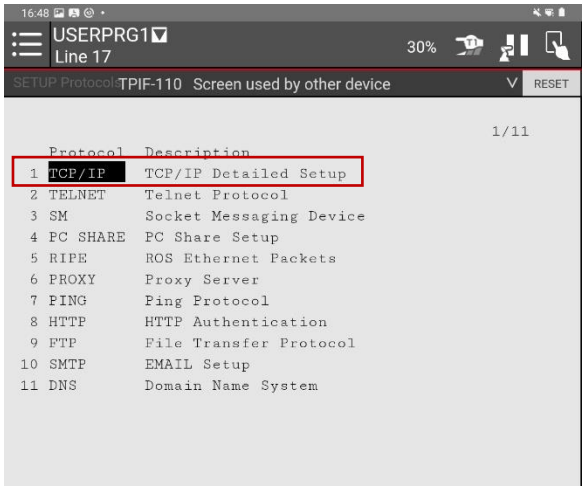
Step 2. Tap **Setup** and then **Host Comm.**



Remember: Operation mode must be **T1**.

If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.

Step 3. Select `TCP/IP` and tap **ENTER.**



⚠ NOTE: The FANUC robot controller may have one or more Ethernet RJ45 ports.

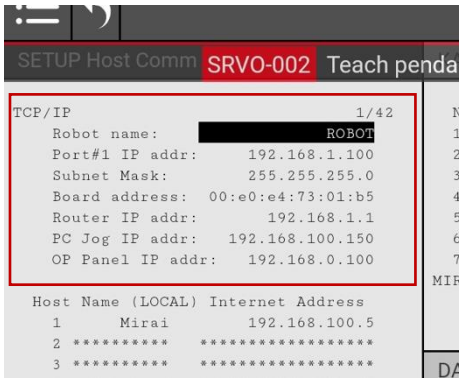
- Port#1 in the FANUC TP corresponds to port CD38A on the main board of the controller.
- Port#2 in the FANUC TP corresponds to port CD38B on the main board of the controller.

If your FANUC software only detects Port#1, connect the MIRAI controller to the Ethernet RJ45 port labelled CD38A on the FANUC controller. In Step 4, different IP addresses will be entered depending on the port you use.

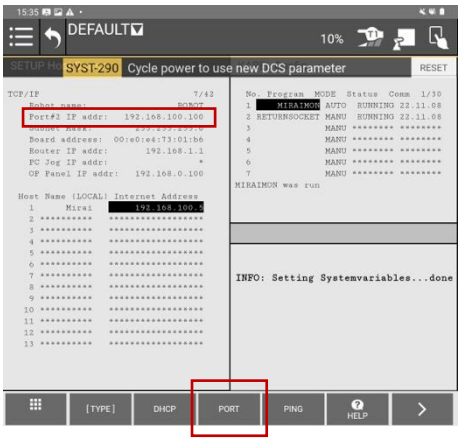
If using port CD38A (Port#1), skip Steps 5 and 6.

Step. 4. Enter the following IP addresses as shown in the screen below:

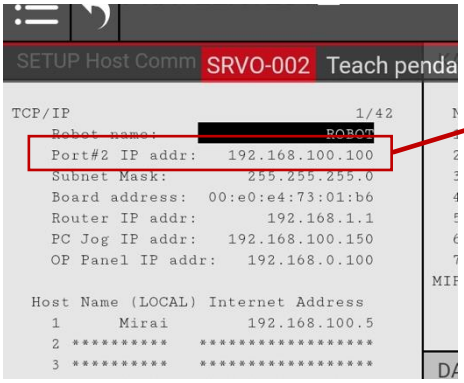
- Port#1 IP address:
  - If using port CD38B: 192.168.1.100
  - If using port CD38A: 192.168.100.100
- Subnet Mask: 255.255.255.0
- Router IP address: 192.168.1.1
- If applicable: PC Jog IP address: 192.168.100.150
- If applicable: OP Panel IP address: 192.168.0.100



Step 5 – only for port CD38B. If the MIRAI controller is connected to port CD38B of the FANUC controller, you must also configure the IP address of Port#2 to communicate with the robot. Port#1 must be in a different subnet. To open the Port#2 settings tap on [port #1] and then on [PORT]

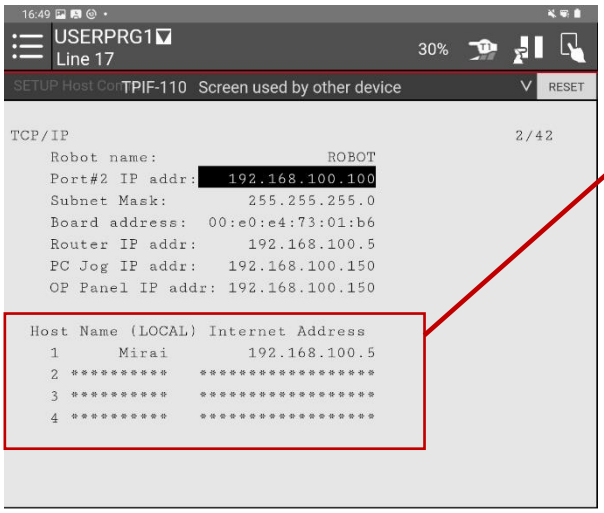


Step 6 – only for port CD38B. For the Port#2 IP address enter 192.168.100.100



If you are working in a different subnet:
Enter the robot IP address according to the respective subnet here, for example, 192.168.99.100 or according to your manually configured subnet.

Step 7. Enter Mirai as the Host Name (LOCAL). Enter the IP address of the MIRAI controller. The IP address for the standard configuration is 192.168.100.5.



If you are working in a different subnet:
Enter the MIRAI controller IP address according to the respective subnet here, e.g 192.168.99.100 or according to your manually configured subnet.

Step 8. Configure the force/torque sensor.

- For the OnRobot F/T sensor, use 192.168.100.15. For more information, see section 11.1.
- For the ATI sensor, use 192.168.100.20). For more information, see section 11.2.

⚠ NOTE: After changing the IP settings in the FANUC Teach Pendant you must cycle the power of the controller to apply the new settings. Skipping this step may result in reduced MIRAI functionality.

You can also cycle the power twice after completing all steps to install the MIRAI software package (see section 5) and skip the power cycle in this step.

If you are connected to port 1 (X1P1), you can customize the MIRAI controller's IP address to connect to a different subnet. After installing the software package on the FANUC Teach Pendant, go to the MIRAI Training App (Main Menu > Network Configuration) and enter the robot's IP address. Ensure the IP address matches the correct port: port #1 for Ethernet RJ45 port CD38A, or port #2 for port CD38B. After the robot's IP address is entered in the MIRAI Training App, the first three IP digit-fields for the MIRAI controller and force/torque sensor will update automatically. You can then assign the final field as needed. For more details on network configuration, refer to Section 4.3.

4.3 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.

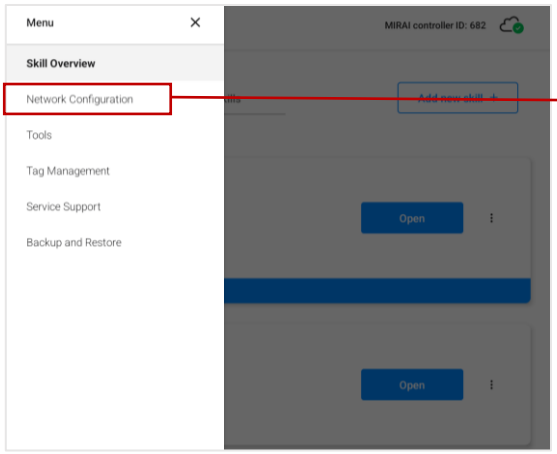
- **USB 3.0 cameras**: Refer to section 4.3.1.
- **One GigE camera**: Use Port 1 or custom settings (see section 4.3.2)
- **Two GigE cameras**: Use Ports 3 and 4 (see section 4.3.3)

For **custom network settings**, users can manually configure the ports as desired. Refer to section 4.3.4.

4.3.1 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 custom settings:

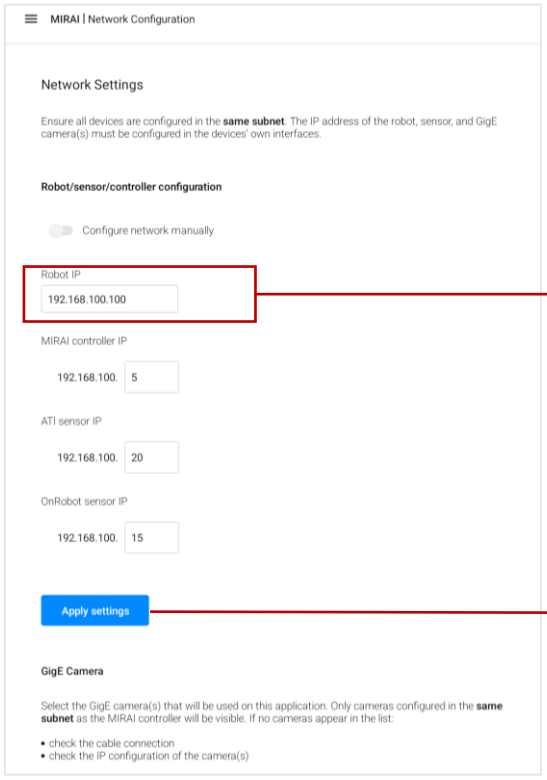


Step 1. Enter the main menu (top left corner) and go to **Network Configuration**.

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.**

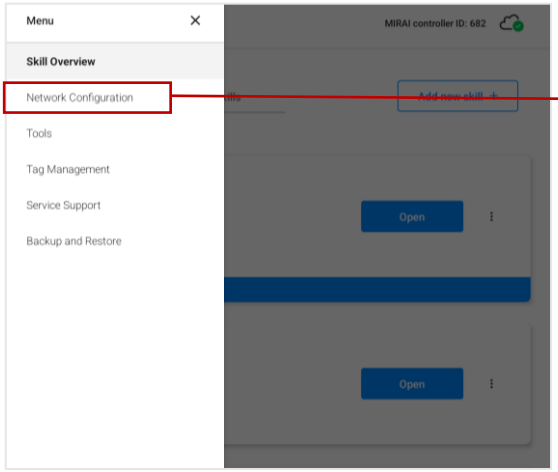
A message to confirm settings will appear.

- Tap **Yes, apply**.

4.3.2 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 4.3.3).

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

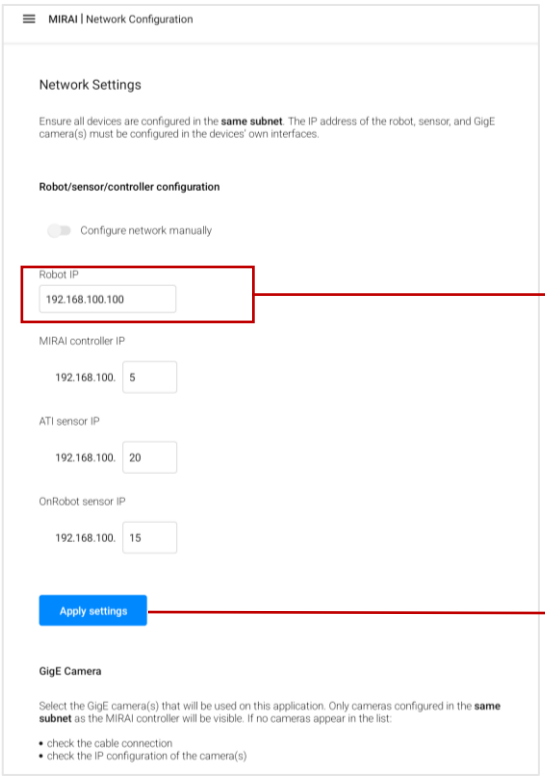


Step 1. Enter the main menu (top left corner) and go to **Network Configuration**.

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.

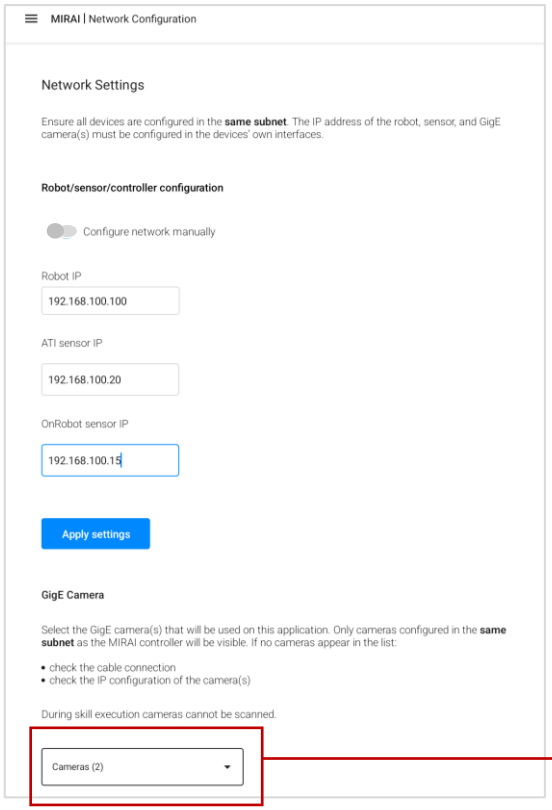
Step 3. Tap **Apply Settings**.

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

- Tap **OK.**

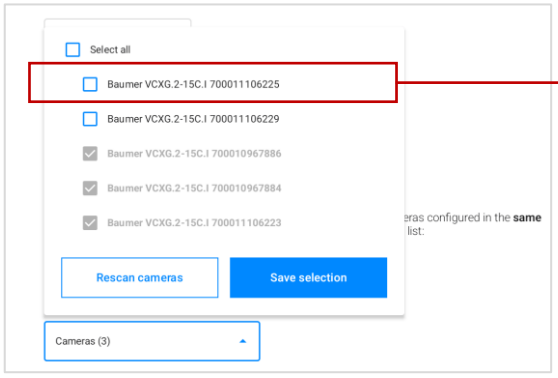
A message to confirm settings will appear.

- Tap **Yes, apply**.

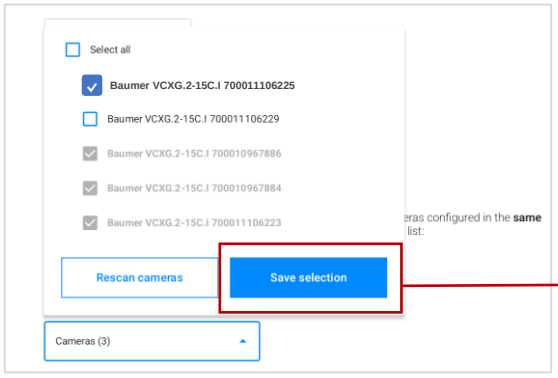


Step 5. Ensure that the GigE camera is connected to the Gigabit Ethernet switch using the correct port, and that the IP address is configured to the right subnet. The camera needs power to be visible in the network.

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



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

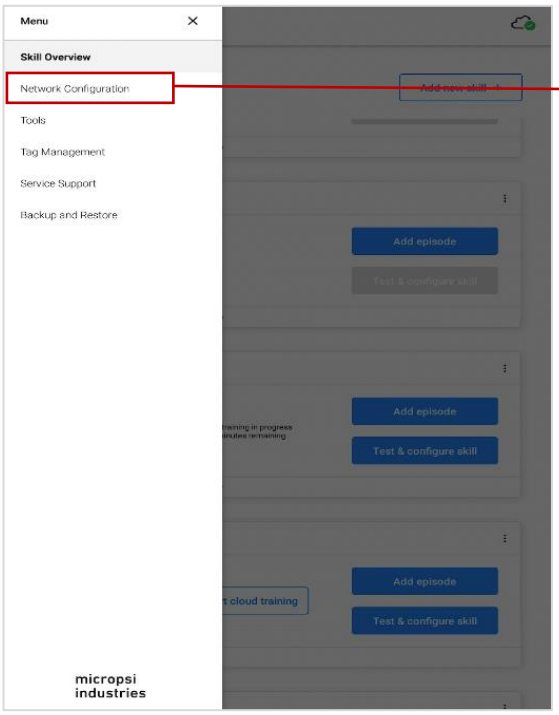


Step 8. Tap **Save selection**. The configured IP address will appear next to the selected camera.

4.3.3 Two GigE cameras: Use preconfigured Ports 3 and 4

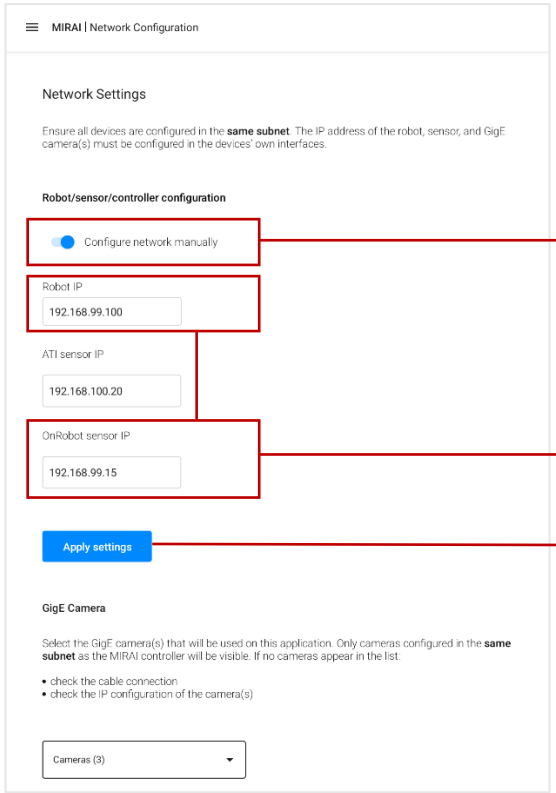
Ports 3 and 4 are link aggregated, functioning as a single logical link to provide increased bandwidth. The ports are preconfigured to the 192.168.99.0/24 subnet, with the MIRAI controller assigned to IP address 192.168.99.5. Note that you can use a single camera on this network as well.

To use these preconfigured settings, follow these steps to enter the 192.168.99.0/24 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

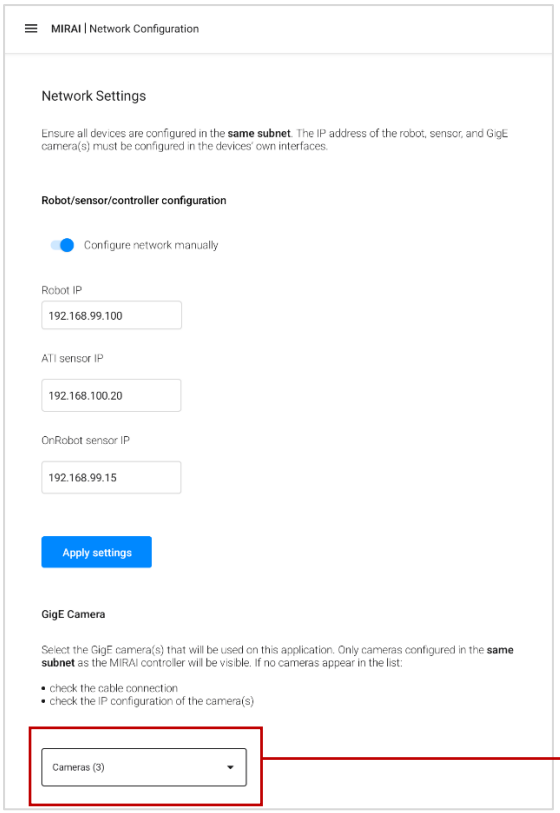
Step 4. Tap **Apply Settings**.

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

- Tap **OK.**

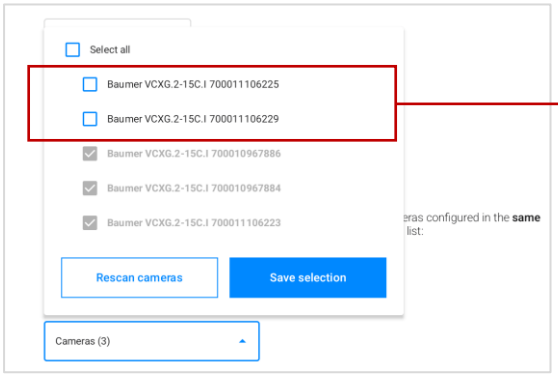
A message to confirm settings will appear.

- Tap **Yes, apply**.

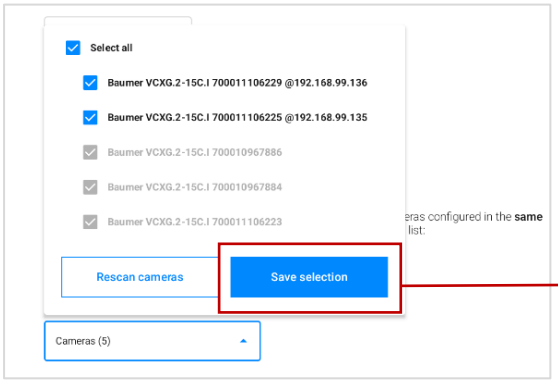


Step 5. Ensure that the GigE cameras are connected to the Gigabit Ethernet switch using the correct ports, and that the IP address is configured to the right subnet. The cameras need power to be visible in the network.

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.

4.3.4 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 sudo commands:

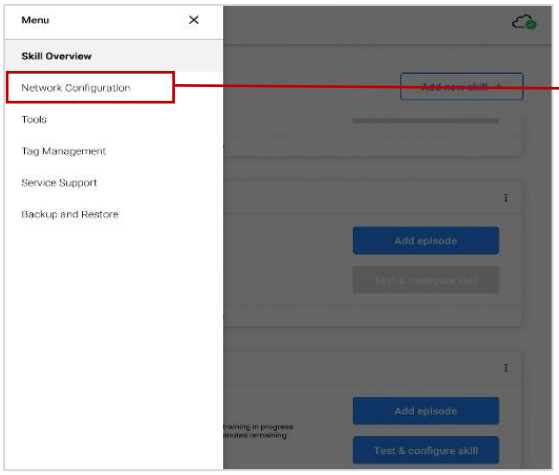
- `sudo ip`
- `sudo ifup`
- `sudo ifdown`
- `sudo reboot`
- `sudo poweroff`
- `sudo systemctl restart micropsi-runtime`
- `gevipconfig`

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

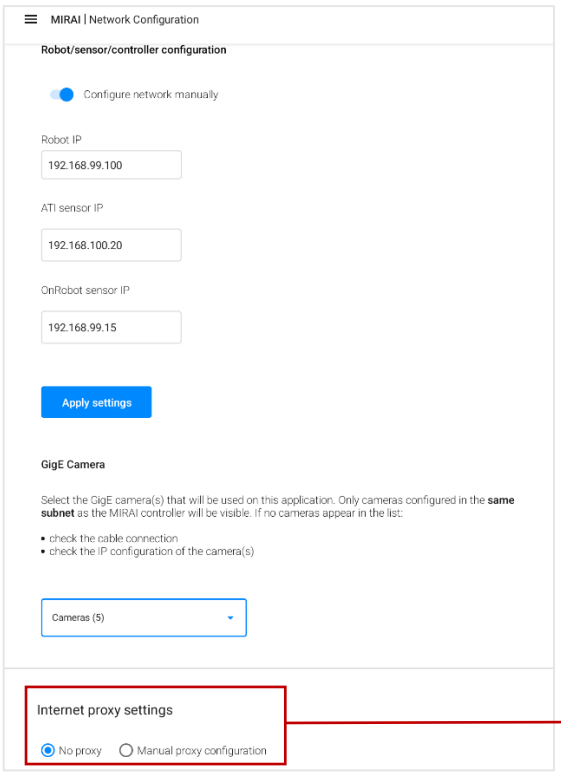
> ⚠ IMPORTANT:
> The MIRAI controller requires a **restart to apply network changes** made by netadmin.

4.3.5 Connect to the Micropsi Cloud using a proxy server

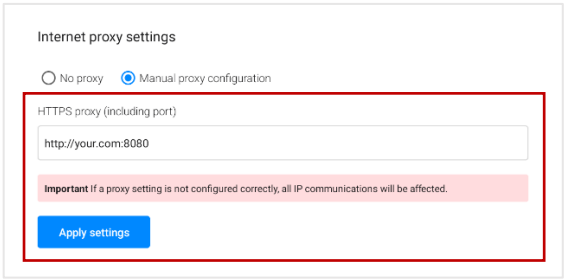
If IT security requires the use of a proxy server to connect the MIRAI controller to the Micropsi cloud, follow these steps:



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 FANUC collaborative robots – CRX series

Collaborative robots are designed to work alongside people. To ensure operator safety, these robots have safety features. The following features are relevant for MIRAI training:

- FANUC Internal Force Sensor: Detects contact with humans and immediately slows or stops the robot
- Visual indicators: The LED color on the robot's base indicates the robot's status:

LED color	Robot status
Green	Collaborative mode
Flash green	Direct teaching
Yellow	High speed mode
Red	Alarm occurrence

This section outlines how to check and change collaborative mode status and force limit sensitivity.

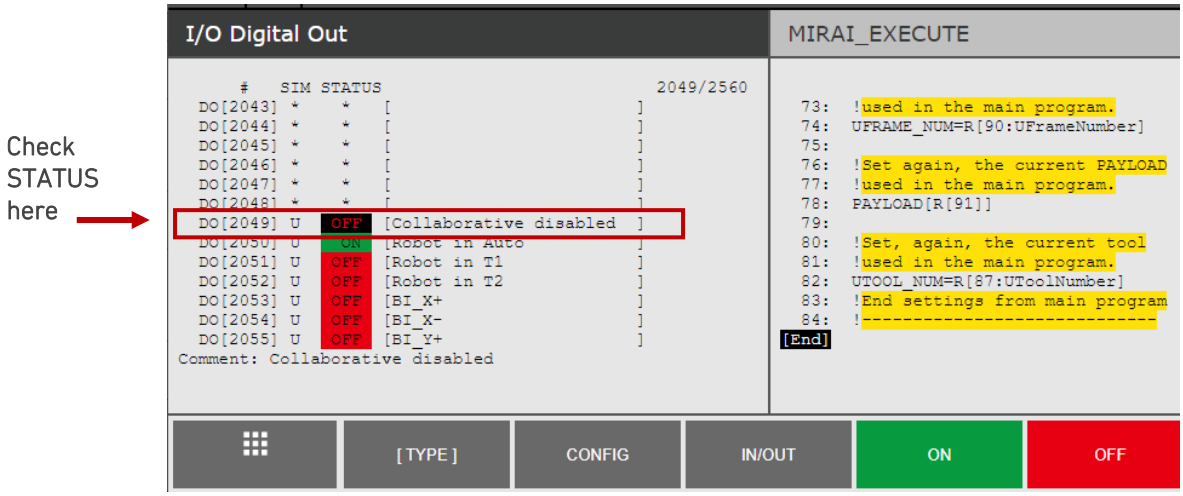
5.1 Check status of collaborative mode

FANUC collaborative robots typically operate in collaborative mode by default. This mode can be disabled for certain tasks, but a full risk assessment must be conducted first to ensure operator safety. After MIRAI files are installed on the robot controller, an option will be added to the Digital Output Menu to check robot's collaborative status using the following steps:

1. Navigate to the Digital Output Menu:
   a. Go to `MENU` > `I/O` > `Digital`.
   b. Select `DO`.

2. Check collaborative status:
   - Search for `DO[2049: Collaborative disabled]`.
     - If STATUS is set to `OFF`, collaborative mode is enabled.
     - If STATUS is set to `ON`, collaborative mode is disabled.

NOTE: The logic is negative – when "Collaborative disabled" is set to OFF, it means that collaborative mode is enabled. In the example below, collaborative mode is enabled.



5.2 Disable collaborative mode

> ⚠ WARNING
>
> When the contact stop is disabled, the collaborative robot will not stop even if external force limits are exceeded, potentially causing serious injury. Always conduct a thorough risk assessment of the entire robot system before disabling the contact stop.
>
> **Micropsi Industries is not responsible for the operator disabling collaborative mode.**

Some tasks require collaborative mode to be disabled. After MIRAI files are installed on the robot controller, an option will be added to the Digital Output Menu to disable collaborative mode following these steps:

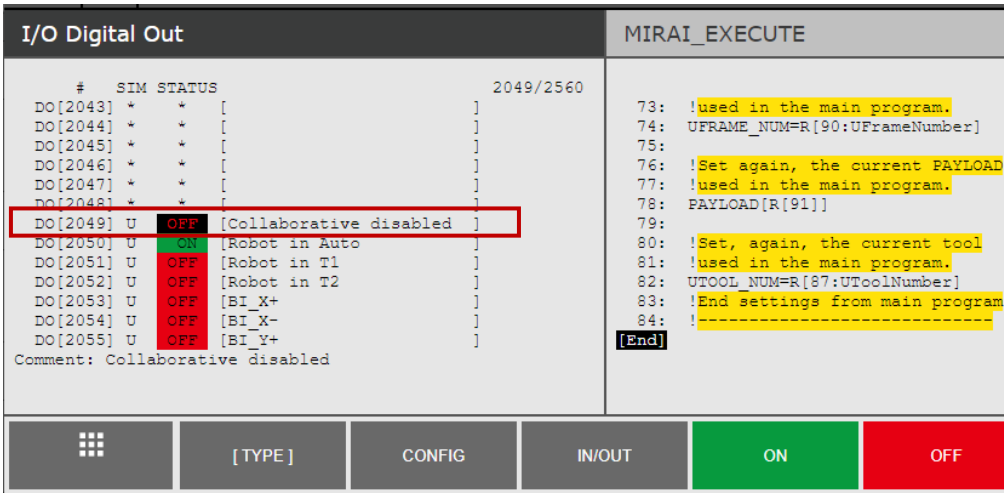
1. **Navigate to the Digital Output Menu**:
   a. Go to `MENU` > `I/O` > `Digital` .
   b. Select `DO` .

2. **Locate the Collaborative Mode setting**:
   a. Search for `DO[2049: Collaborative disabled]` .

3. **Change the status**:
   a. Use the Function key area on the tablet teach pendant to set the collaborative status:
      i. To disable collaborative mode, set STATUS to `ON` .
      ii. To enable collaborative mode, set STATUS to `OFF` .

NOTE: The logic is negative – when "Collaborative disabled" is set to "OFF," it means that collaborative mode is enabled. In the example below, collaborative mode is enabled.

Disable collaborative mode here



5.3 Check force limit sensitivity before MIRAI training

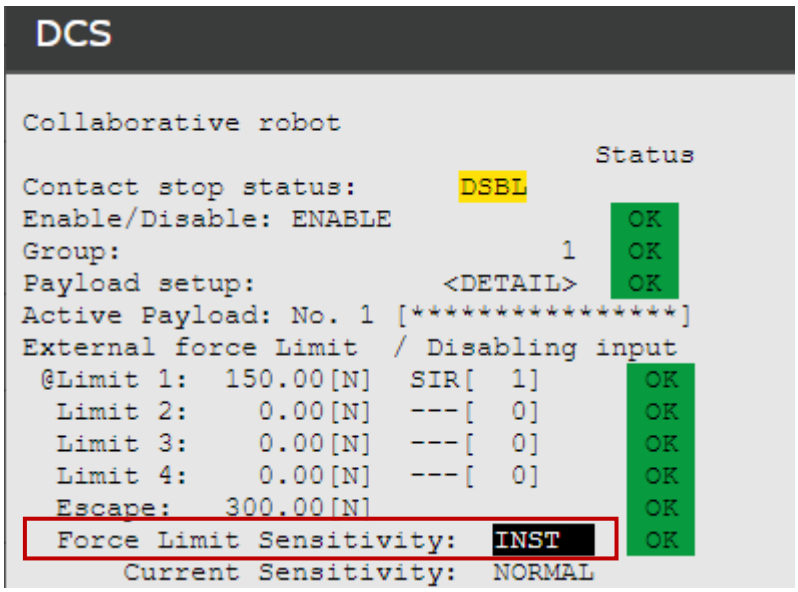
Force limit sensitivity must be set to `INST` before force-applying applications, such as hand-guiding the robot to create MIRAI skills. CRX robots are typically set to `INST` by default.

To check the force limit sensitivity settings, follow these steps:

a. Navigate to the Dual Check Safety Menu:
   a. Go to `MENU` > `System` > `DCS` .

b. Select `Collaborative robot` .
   a. Ensure that `Force Limit Sensitivity` is set to `INST` .
   The available options are INST, Normal, and Low.

Check Force Limit Sensitivity here



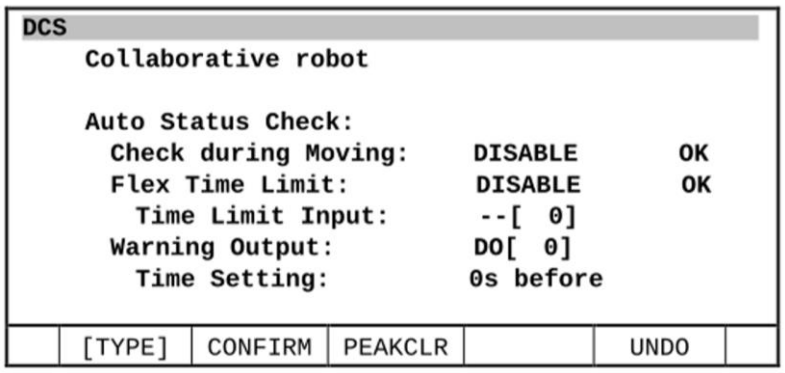
NOTE: During skill execution in AUTO mode, switch to LOW sensitivity to prevent the robot from stopping from excessive-force alarms. For details, refer to Section 6.8.1 and Section 12.6.

5.4 Adjust time limit settings to record training episodes

Training episodes can be recorded for up to 3 minutes (180 seconds) in the MIRAI Training App. However, in collaborative mode, continuous robot movement for more than 90 seconds triggers `alarm SYST-322 Auto status check time out`, stopping the robot and preventing the episode from being recorded. This occurs because FANUC collaborative robots have a safety confirmation system that periodically performs an Auto Status Check, stopping any continuous movement longer than 90 seconds.

To record episodes of more than 1.5 minutes (up to 3 minutes) in collaborative mode, follow these steps to increase the Auto Status Check Time Limit:

1. **Open the Menu on the teach pendant**: Navigate to **MENU** > **SYSTEM** > **DCS** > **Collaborative Robot**.



2. **Scroll to the Auto Status Check section and enable Flex Time Limit.**
3. **Set the Time Limit Input**:
   - Select **R** as the variable type.
   - Enter the register number you will use for your new time limit.
   - We use Register data R[94] as a default, but you can select any empty register.
4. **Apply the changes**:
   - Use the **PREV** button on the FANUC Teach Pendant to go back.
   - Apply DCS parameters, enter the confirmation code, and hit **OK** to confirm.
5. **Restart the robot controller**:
   - Cycle power to the robot controller.
   - After rebooting, enter your new time limit in the selected numeric register.
     - The maximum value is 10000s. If you input a value outside the range of 1-10000, the default value (10000s) will be used.
     - We recommend the maximum value of 10000s.

Your settings should look like this:

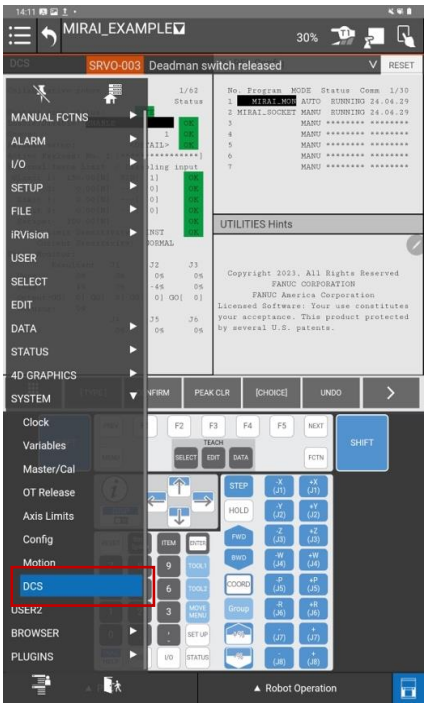
Auto Status Check:		
Check during Moving	[Disable]	OK
Flex Time Limit	[Enabled]	OK
Time Limit Input	R[94]	
Warning Output:	DO[0]	
Time Setting:	10000s	

5.5 Apply DCS Settings

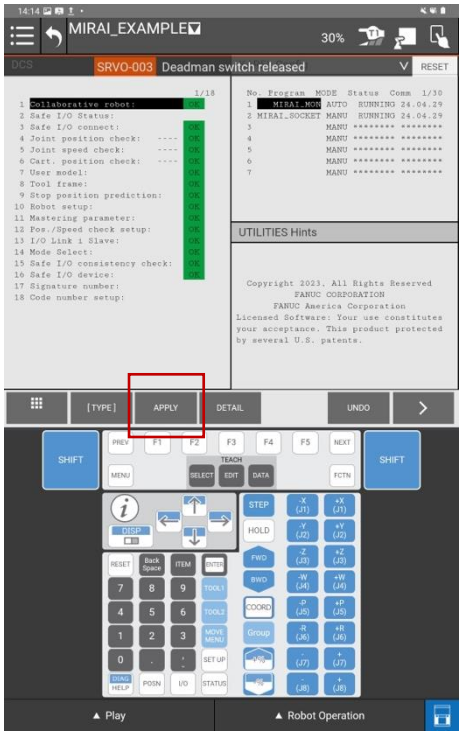
To enable the settings installed with SETUP.CM you must apply the Dual Check Safety (DCS) parameters.

Step 1 – Expand the long menu.

Step 2 – Tap **DCS** to open the DCS parameter overview



Step 3 – Tap **Apply.** You must tap apply to confirm the setting even if all the status messages say "OK."



6 Set up the FANUC robot controller

Ensure that the FANUC robot controller system has software version No. **V9.4** or above installed.

To use MIRAI follow the of the steps below on the FANUC Teach Pendant. The required files are found on the included USB drive.

1. Execute: **SETUP.CM** (see section 5.1)
2. Apply the DCS settings (see section 5.2)
3. Restart the monitoring programs (see section 5.3)

⚠ **NOTE:** After following the steps above cycle the power of the robot controller **twice** to enable all installed settings. Make sure you have also done the network configuration (see section 4). If you fail to do so, full MIRAI functionality cannot be ensured.

6.1 Execute SETUP.CM

NOTE: Remember to take backups (Image and All of Above) of the FANUC controller before installing the MIRAI software package.
The following registers, inputs and outputs are needed for the MIRAI programs.

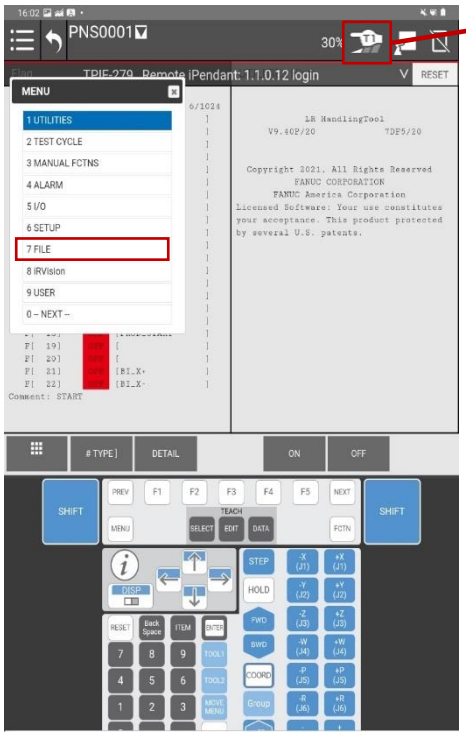
- Digital Outputs: DO[2049–2068]
- Digital Inputs: DI [2053–2068]
- Registers: R[75–91]
- Position Registers: PR[75–78]

These will be overwritten automatically when executing the SETUP.CM file.

Step 1. Insert the USB drive in the FANUC controller port.

Step 2. Tap the **MENU** button.

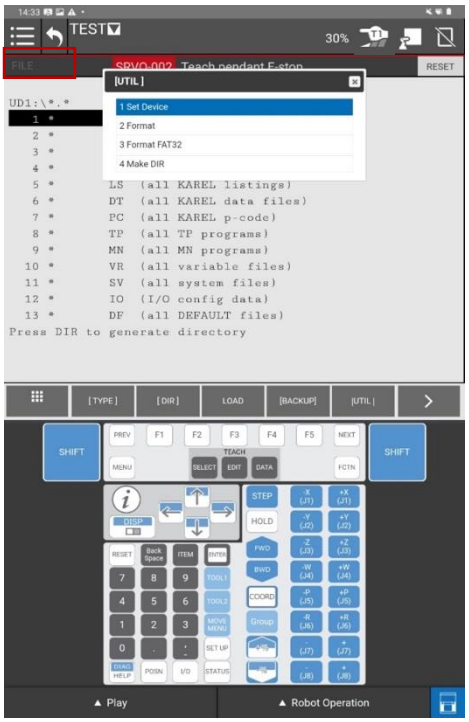
Step 3. Select **FILE.**

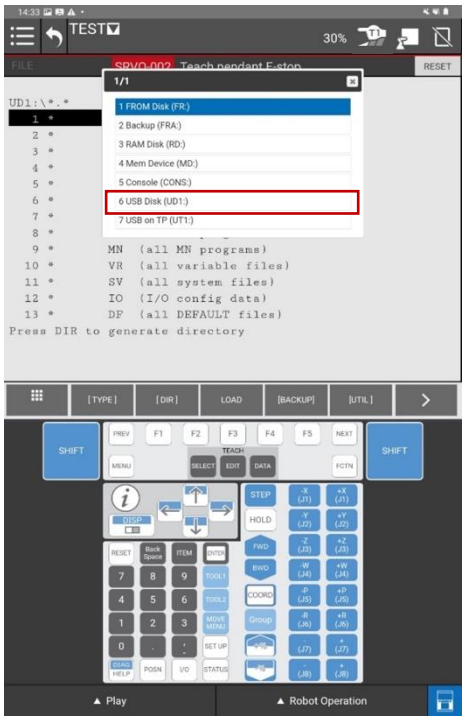


Remember: Operation mode must be **T1**.

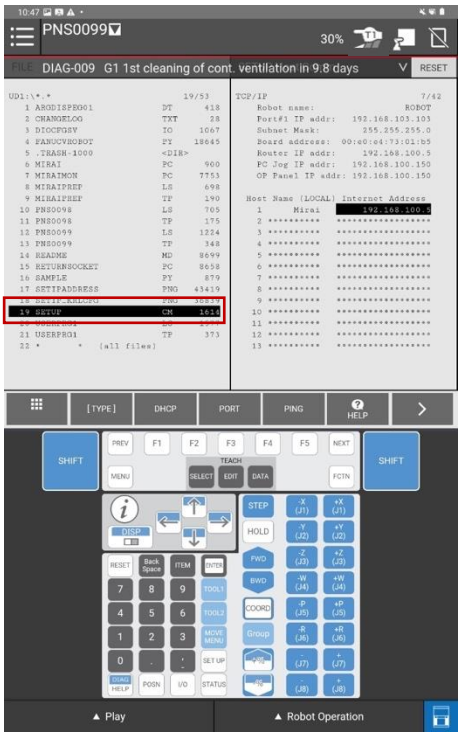
If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.

Step 4. Verify that you are in directory **[UD1:*.*].** Select all files and tap **ENTER.** If you are not in directory [UD1:*.*], tap **UTIL.** Select **1 Set Device** and then **6 USB Disk (UD1:)**.





Step 5. Select the file **SETUP**.



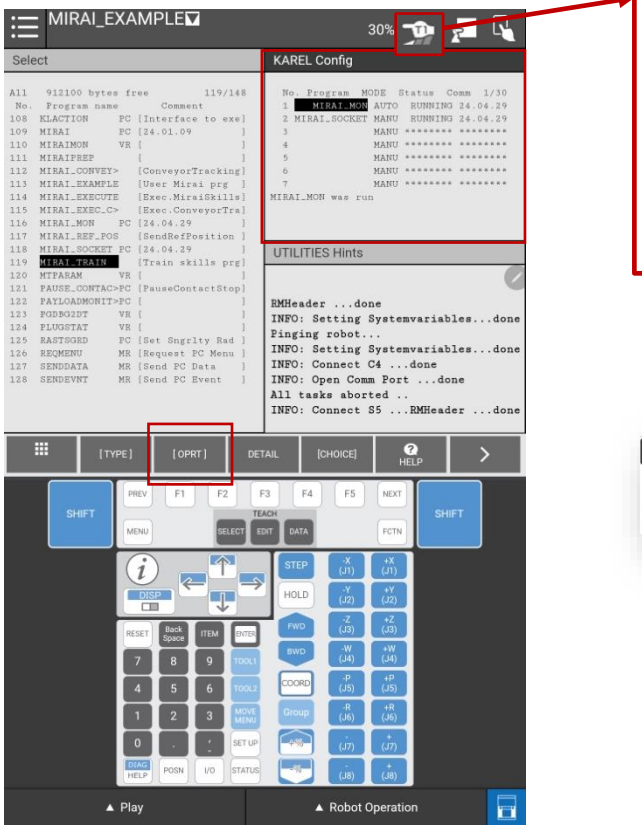
Step 6. Tap **ENTER**.

Step 7. Tap **YES** when the prompt **Execute SETUP.CM?** is displayed.

6.2 Restart the monitoring programs

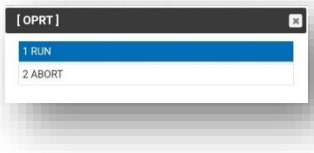
To enable the settings installed with SETUP.CM restart both monitoring (background) programs (MIRAI_MON and MIRAI_SOCKET). Navigate to **MENU** > **Setup** >**KAREL Config**. The **OPRT** option will allow you to either **1 RUN** or **2 ABORT** the program in the KAREL Configs.

Step 1 – Select MIRAI_MON and tap **OPRT**, then select **2 ABORT**. Confirm with **YES.** Do the same for MIRAI_SOCKET.
Step 2 - Select MIRAI_MON and tap **OPRT**, then select **1 RUN**. Confirm with **YES.** MIRAI_MON will automatically restart the MIRAI_SOCKET program.
MIRAI_MON should be in AUTO mode, and MIRAI_SOCKET in MANU (manual) mode.



Remember: Operation mode must be **T1**.

If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.



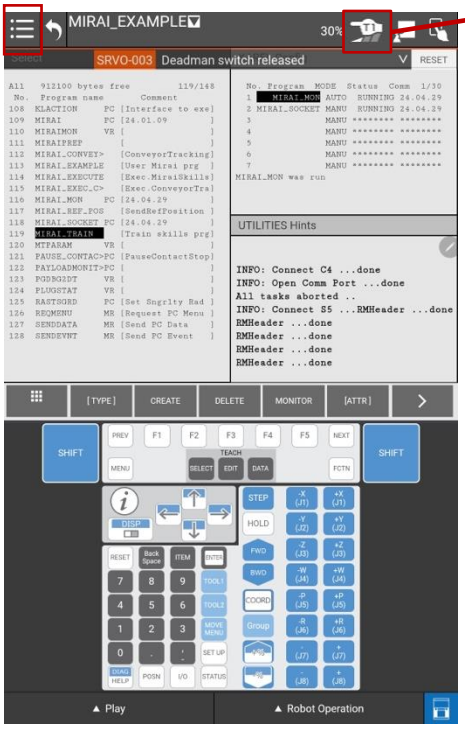
6.3 Check communication status

After the SETUP.CM file has been executed on the FANUC teach pendant, check the communication status between MIRAI and the robot by opening three panels. Hold the **SHIFT** key and tap **DISP**, then select **3 Triple.** The left panel will show the selected or created robot program. We recommend using the two panels on the right as follows:

- Top panel for **KAREL Config**: Displays the status of MIRAI monitoring (background) programs MIRAI_MON and MIRAI_SOCKET
- Bottom panel for **USER**: Displays the communication status between the robot and MIRAI

To select the **KAREL Config** panel, activate the top right window and follow the steps below:

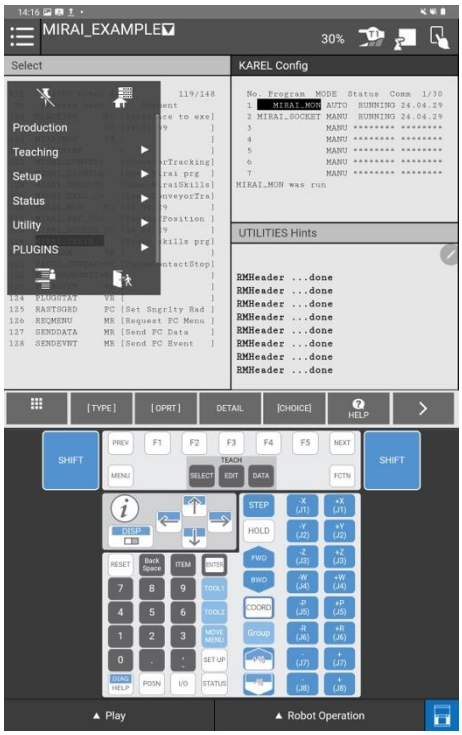
Step 1. Open the Display Menu.



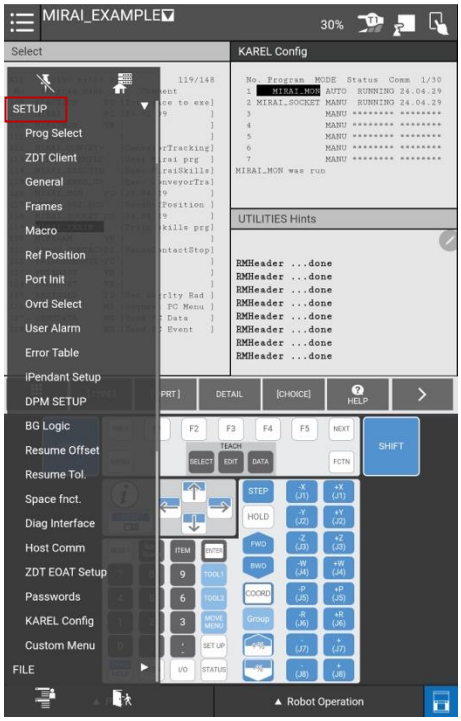
Remember: Operation mode must be **T1**.

If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.

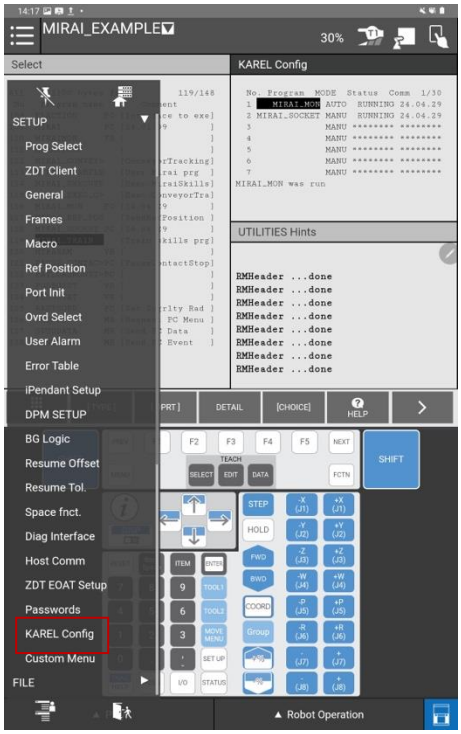
Step 2. Extend the menu.



Step 3. Tap **SETUP**.

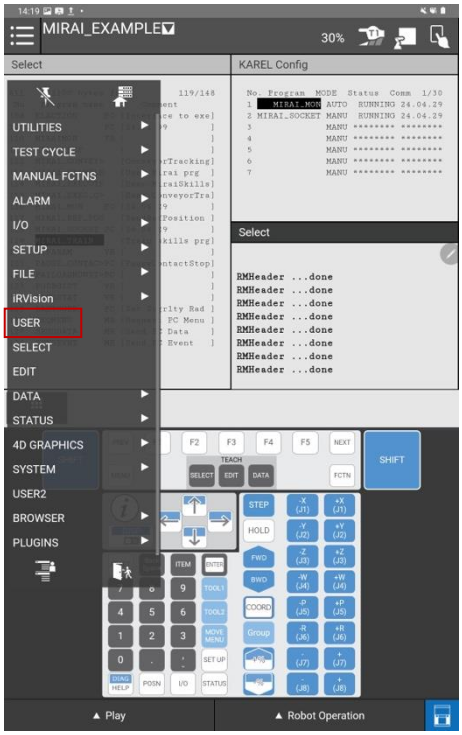


Step 4. Select **KAREL Config** from the list.



To open the **USER** display follow Step 1 and Step 2 described above and then continue below:

Step 3. Select **USER** from the list.



6.4 Enable the FANUC teach pendant

The FANUC Teach Pendant always needs to be enabled while using the MIRAI Training App. Enable the FANUC Teach Pendant by tapping **TP enable** in the top right corner on the tablet teach pendant or by turning the black turn-knob on the iPendant Touch.

6.5 Set the robot to T1 mode

For FANUC CRX, the selection of operation mode (AUTO/T1/T2) is done in the top right corner of the tablet teach pendant.

For other FANUC models, selecting the operation mode will either be done via a key switch or turn-knob on the controller or via the mode select function on your FANUC Teach Pendant. Please refer to the respective operator's manual for more details on mode selection or to the section Operation Mode Switch (T1, T2, Auto).

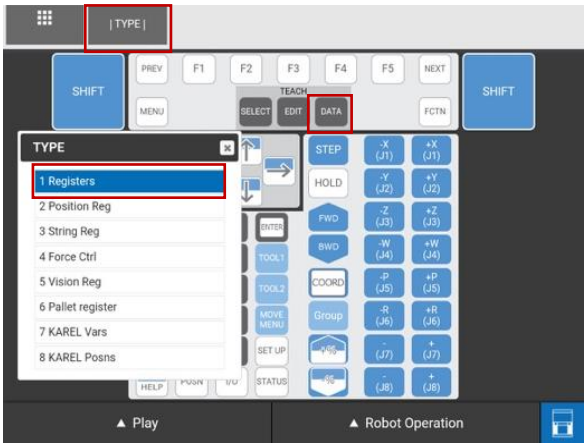
6.6 Set the payload

The robot's payload must be configured in the robot controller through the teach pendant. To set the payload, follow these steps:

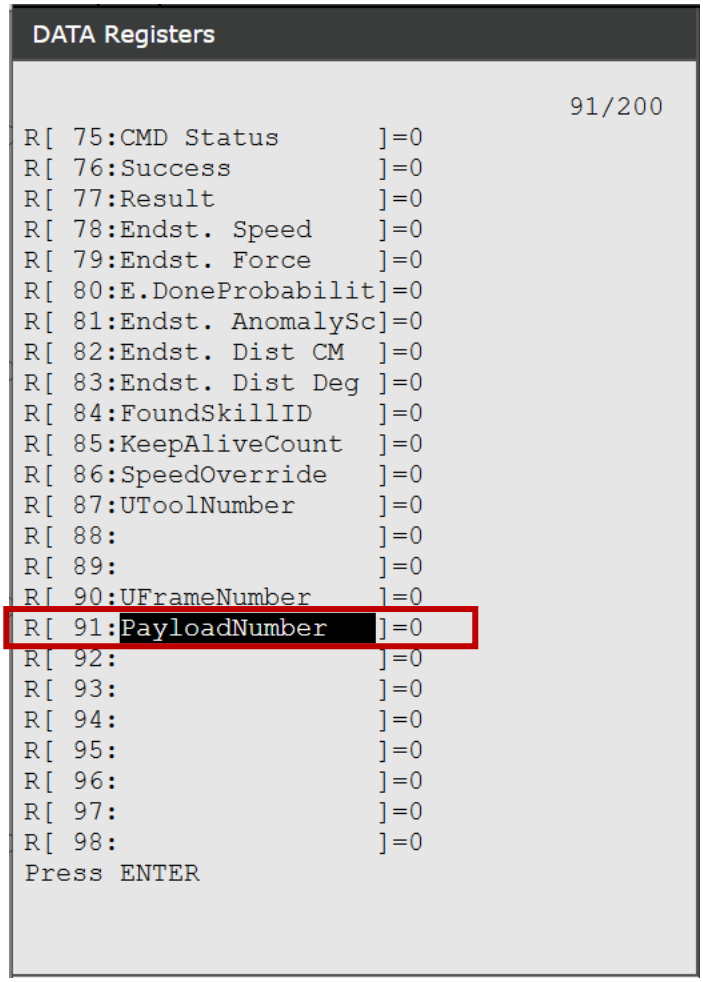
1. Enter payload values manually or by using FANUC's Payload Estimation tool:
   - **To enter values manually**, select a Payload Schedule Number, tap `DETAIL`, and enter the payload information.
   - **Menu > setup > Payload settings**
   - **Select a schedule number and enter the payload value.**
     1. **Popup: Path and Cycletime will change.** Tap **Yes.** Then tap **Apply DCS.** Follow instructions and confirm changes.
     2. Cycle power.
   - **To use FANUC's Payload Estimation** tool, select a Payload Schedule Number, tap `IDENT`, and follow the wizard's instructions. The Payload Ident (J669) software package is typically included in CRX models.
   - **Menu > Setup> UTool Payload Setup**
   - **Follow the steps in the wizard**
   - **Select Schedule number**
2. Save the Payload Schedule Number in Data Register R[91]:
   - Go to `DATA` > `[Type]` > `1 Registers`.
   - Save the payload schedule number in **R[91]**. This step enables the MIRAI_EXECUTE program to restore the main program's payload after skill execution.

Open the **DATA Register:**

DATA > [TYPE] > 1 Registers



Save the Payload Schedule Number in **R[91]** →



6.7 Allow hand-guiding for MIRAI skill training

Hand-guiding to record MIRAI episodes requires low sensitivity, which is set for collaborative robots in the MIRAI_TRAIN program. This setting does not exist for industrial robots, so two lines in the MIRAI_TRAIN program must be remarked before creating MIRAI skills. This section outlines the settings for each type of robot.

NOTE: If you are using a force/torque sensor and hand-guiding the robot when recording episodes, the FANUC Teach Pendant may display these alarms/warnings: `SYST-325 Payload error` and `SYST-348 Payload Monitor (Force)` warning. No action is required. These messages occur because hand-guiding exceeds force thresholds.

6.7.1 Collaborative robot settings

The MIRAI_TRAIN program contains the instruction to "Switch to Low Sensitivity" so the robot can be manually guided when recording episodes. This requires Force Limit Sensitivity to be set to `INST` before training. To check the configuration, refer to Section 5.3.

NOTE: During skill execution using the FANUC Teach Pendant, it might be advisable to switch to LOW sensitivity to prevent alarms that cause the robot to stop. At LOW sensitivity, the alarm won't stop the robot unless a collision occurs. For more information, refer to Section 12.6.

6.7.2 Industrial robot settings: Required remarks in MIRAI_TRAIN

One section of the MIRAI_TRAIN program is wrapped by a function that switches to low sensitivity to enable hand-guiding while recording episodes. Because industrial robots do not have the Switch to Low Sensitivity function, the MIRAI_TRAIN program must be modified to avoid errors.

To create MIRAI skills with industrial robots, remark these lines:

- Line 41 (CALL -INST_INSTSENS_START(1,0,0,0,0)
- Line 54 (CALL -INST_INSTSENS_END(1,0,0,0,0)

The comments highlighted in yellow before and after these lines provide instructions on which lines to remark for industrial robots.

NOTE: If the instruction is not remarked, the errors will be displayed in the user window (Run MIRAI_TRAIN failed with 7004, Starting Prog 99 failed) and on the Teach Pendant (INTP-222 (MIRAI_TRAIN, 43) call program failed, MEMO-073 Program does not exist)

MIRAI_TRAIN

```
                                    1/62
   1:  !Program to train a skill via
   2:  ! MIRAI Training App.
   3:
   4:  !Wait for T1 Mode
   5:  WAIT (DO[2051:Robot in T1]=ON)
    :
   6:
   7:  !MIRAI control at current
   8:  ! position
   9:  !-----------------------------
  10:  !Initial settings for current
  11:  ! program
  12:
  13:  !Payload from main program
  14:  PAYLOAD[R[91]]
  15:  !UFRAME must be Zero
  16:  ! when training an episode
  17:  UFRAME_NUM=0
  18:  !UTOOL must be Mechanical tool.
  19:  ! Please, do not change it.
  20:  UTOOL_NUM=0
  21:  !Keep speed from previous setup
  22:  R[86:SpeedOverride]=(
    :  $MCR.$GENOVERRIDE)
  23:  OVERRIDE=R[86:SpeedOverride]
  24:  !End settings for current
  25:  ! program
  26:  !-----------------------------
  27:
  28:  !Wait to update before getting
  29:  ! the current position
  30:  WAIT    .40(sec)
  31:  !Store current position
  32:  PR[75:Curpos]=LPOS
  33:  PR[76:OffsetPos]=PR[75:Curpos]
    :
  34:  !add small offset
  35:  PR[76,3:OffsetPos]=
    :  PR[76,3:OffsetPos]+.5
  36:
  37:  !Start 'Switch to Low
  38:  ! Sensitivity' INST for  Cobots.
  39:  ! Remark the following
  40:  ! line for industrial robots:
  41:  CALL -INST_INSTSENS_START(1,0,0,
    :  0,0)
```

MIRAI_TRAIN

```
                                   62/62
  25:  ! program
  26:  !-----------------------------
  27:
  28:  !Wait to update before getting
  29:  ! the current position
  30:  WAIT    .40(sec)
  31:  !Store current position
  32:  PR[75:Curpos]=LPOS
  33:  PR[76:OffsetPos]=PR[75:Curpos]
    :
  34:  !add small offset
  35:  PR[76,3:OffsetPos]=
    :  PR[76,3:OffsetPos]+.5
  36:
  37:  !Start 'Switch to Low
  38:  ! Sensitivity' INST for  Cobots.
  39:  ! Remark the following
  40:  ! line for industrial robots:
  41:  CALL -INST_INSTSENS_START(1,0,0,
    :  0,0)
  42:J @PR[76:OffsetPos] 10% FINE
  43:  Track DPM[1]
  44:
  45:  !Main loop
  46:  LBL[1]
  47:  PR[76:OffsetPos]=PR[75:Curpos]
    :
  48:  !add small offset
  49:  PR[76,3:OffsetPos]=
    :  PR[76,3:OffsetPos]+1
  50:  DO[2065:End Stationary]=(OFF)
  51:  DO[2066:End Tracking]=(OFF)
  52:L @PR[76:OffsetPos] 100mm/sec
    :  CNT50
  53:L @PR[75:Curpos] 100mm/sec FINE
  54:  CALL -INST_INSTSENS_END(1,0,0,0,
    :  0)
  55:  !End 'Switch to Low Sensitivity'
  56:  ! INST. Remark previous line
  57:  ! when using industrial robots.
  58:
  59:  IF (DI[2065:End Stationary]=OFF),
    :  JMP LBL[1]
  60:  Track End
  61:
[End]
```

7 Adjust hand-guiding speed in the MIRAI Training App

When hand-guiding the robot under MIRAI control, the jogging speed set on the FANUC teach pendant will apply. To adjust the speed in the MIRAI Training App, modify the guiding sensitivity from the bottom bar in the training loop. For details, refer to the "Guiding Sensitivity" section in the User Manual for MIRAI Training.

This adjustment is useful if you have set a very low jogging speed on the teach pendant and encounter a threshold force that must be overcome to move the robot initially. Note that this issue does not affect all robot models.

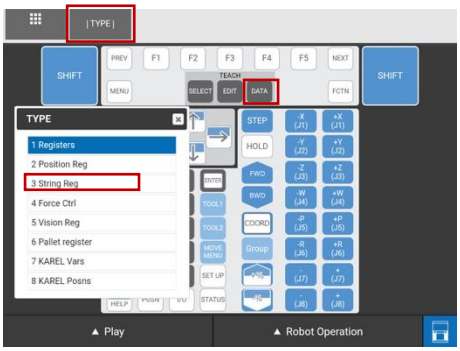
8 Set up MIRAI skills on the teach pendant

8.1 Add MIRAI skills to the DATA String Registers

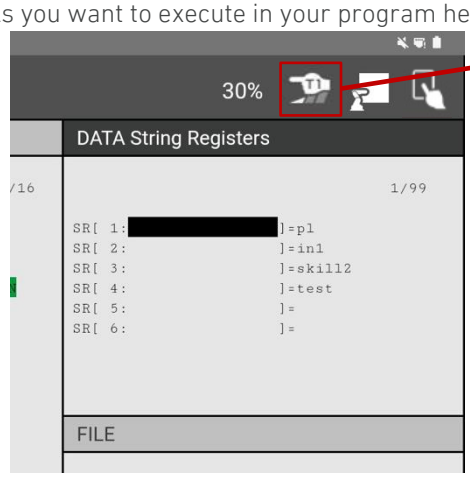
Enter the skill name in the DATA String Registers before adding any command to execute a MIRAI skill.

Step 1. To open the DATA String Registers, tap the desired display area to select the window, tap **DATA**, and tap **TYPE**.

Step 2. Select **3 String Reg.**



Step 3. Tap the right field of an empty register and then tap **ENTER** to add the name of the skill you want to execute (for example, SR[3:] = skill2). Ensure that the entered skill name is identical to the name in the MIRAI Training App and does not exceed 32 characters. If needed, you can add a comment or other relevant information about the skill in the left field of the register.
Add all skills you want to execute in your program here.



Remember: Operation mode must be **T1**.

If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.

8.2 Use the MIRAI_EXAMPLE Program

The MIRAI_EXAMPLE program provides a template of the main program used to execute a skill. This template includes the MIRAI_EXECUTE subprogram.

MIRAI_EXAMPLE includes three sections that must be included in the teach pendant's main program to properly execute MIRAI skills:

- **Configure initial settings:** Set the payload, frame, and tool. For details, refer to these sections:
  - Adding the MIRAI Tool in the Robot Program
- **Add trained skills to the FANUC controller:** Synchronize trained skills from the MIRAI controller with the FANUC controller. For details, refer to this section:
  - Synchronizing Trained MIRAI Skills to the FANUC Teach Pendant
- **Execute MIRAI skills**: Select the MIRAI skills to execute. For details, refer to this section:
  - Adding a Call to Execute a MIRAI Skill

MIRAI_EXAMPLE

```
  1:  !Sample MIRAI user program.
  2:  !User can modify some sections as
  3:  !desired.
  4:
  5:  !-------------------------------
  6:  !Initial settings. Please
  7:  !configure accordingly.
  8:  PAYLOAD[R[91]]
  9:  UFRAME_NUM=4
 10:  UTOOL_NUM=1
 11:
 12:  !Main TPE program must
 13:  !synchronize skills from the box.
 14:  !Do not remove this line and
 15:  !keep the position in the code.
 16:  CALL MIRAI(GetTrainedSkills,Blocking)
 17:
 18:  !-------------------------------
 19:  LBL[13]
 20:
 21:  !-------------------------------
 22:  !Sample program section. May be
 23:  !modified by the user.
 24:
 25:  !Robot initial position.
 26:L  P[1] 200mm/sec FINE
 27:
 28:  !Example of execution of a skill
 29:  CALL MIRAI_EXECUTE(3)
 30:
 31:  !Robot final position
 32:  //L  P[2] 100mm/sec FINE
 33:
 34:  JMP LBL[13]
 35:  !-------------------------------
[End]
```

Configure initial settings
Enter the initial settings for any FANUC Teach Pendant program. The payload must be set using Register [91].

Add trained skills to the FANUC controller
This command synchronizes the skills from the MIRAI controller with the robot controller.

Execute MIRAI skills
This command executes a specific skill. For example, Line 29 executes the skill stored in String Register SR[3]. Note that this program is an example and runs in a loop. Line 26 designates a point in space where we move the robot before executing the skill in the following line (Line 29).

> ⚠ NOTE:
> MIRAI_EXECUTE uses **UTOOL_NUM=0**. For details on how to use and configure tools according to the FANUC software version you are using, refer to Adding the MIRAI Tool in the Robot Program.

Do not modify the MIRAI_EXECUTE program if possible.

The MIRAI_EXECUTE program, shown below, is structured as follows:

- Lines 6 to 20 save the settings from your main program.
- Lines 24 to 39 set the MIRAI parameters.
- Lines 42 to 64 execute the MIRAI skill
- Lines 67 to 77 restore the settings from the main program after skill execution. This step is necessary because MIRAI_EXECUTE requires different initial parameters .
    - If you do not want the controller to return the last recorded values of the end state-related parameters as a list, you can remark the “Get results” section in lines 62 to 64.

8.2.1 Add the MIRAI Tool in the robot program

In the FANUC Teach Pendant, open or create the program you would like to add your MIRAI skill to.

It is important to add the correct MIRAI tool information in the initial settings of your program.

The **MIRAI_EXAMPLE** program is a template of a main program that can be used to execute the skill. This program includes the **MIRAI_EXECUTE** subprogram that will always use **UTOOL_NUM=0** which contains the tool information configured in the MIRAI Training App for the respective skill.

* Payload is not "1" anymore but R[91].

* UTOOL_NUM can be any UTOOL the customer has selected, because MIRAI_EXECUTE is using UTOOL_NUM=0. So there is no way the user can select tool 0 from the list of tools because it is just not possible. They can select from 1 to 10. That is why we are using zero (UTOOL_NUM=0) in MIRAI_EXECUTE.

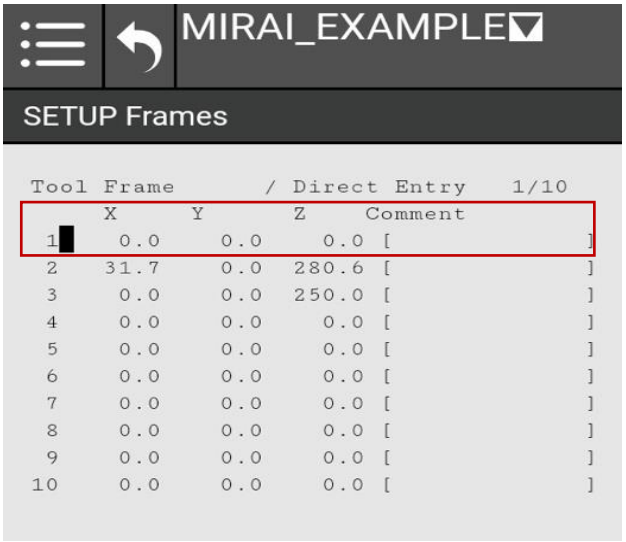
⚠ If you are using FANUC software version **V9.40P/49:**

If you need to use another tool configuration for other parts of your program/task you can use any of the other tools configured on FANUC Teach Pendant in your program by adding a line calling UTOOL_NUM=x. **Remember to switch back to this tool after a MIRAI skill execution.**

```
 5:  !-------------------------------
 6:  !Initial settings. Please
 7:  !configure accordingly.
 8:  PAYLOAD[R[91]]
 9:  UFRAME_NUM=4
10:  UTOOL_NUM=1
```

⚠ If you are using FANUC software version **V9.40P/58:**

Known issue (fix in progress): when you switch tools in a program, there is a delay of **15 seconds** after skill execution. To avoid this, do not switch tools and use only the UTOOL_NUM=1 in your program and set all values to "0".



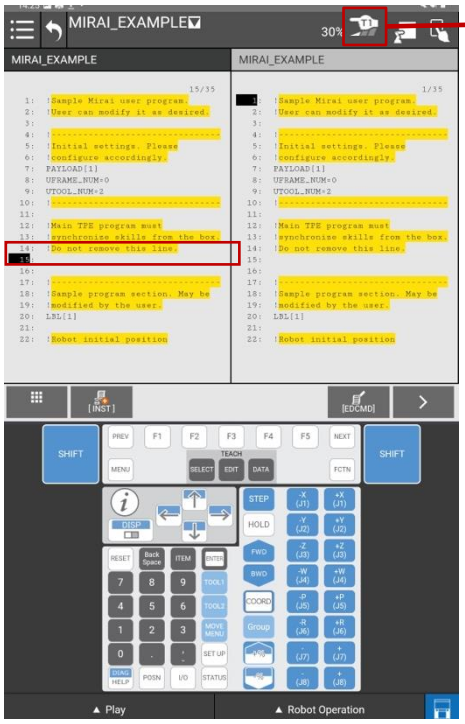
8.2.2 Synchronize MIRAI skills to the FANUC teach pendant

To synchronize all trained skills from the MIRAI controller you must add an instruction to call the MIRAI command at the beginning of your robot program once. This will allow you to execute any skill that you have also added in the DATA string registers (see "Adding Skills to the DATA String Registers")

```
14:  !Main TPE program must
15:  !synchronize skills from the box:
16:  CALL MIRAI(GetTrainedSkills,
  :  Blocking)
```

Follow the instructions to add the line in your program:

Step 1. Insert and select a line in the program for the command to synchronize the trained skills (e.g 15).



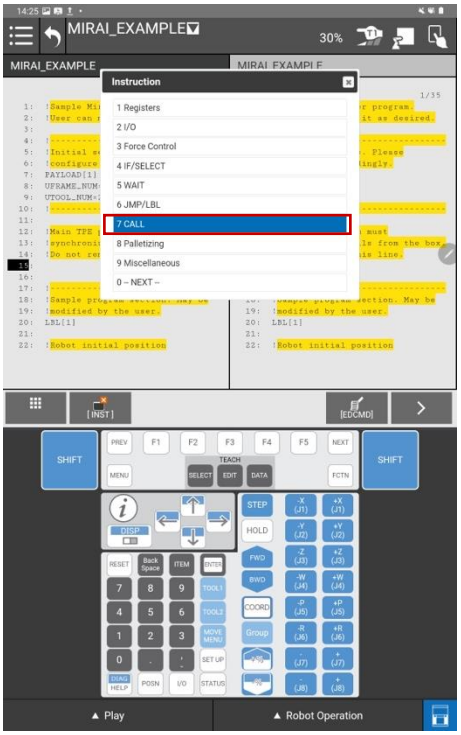
Remember: Operation mode must be **T1**.

If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.

Enable the Teach Pendant.

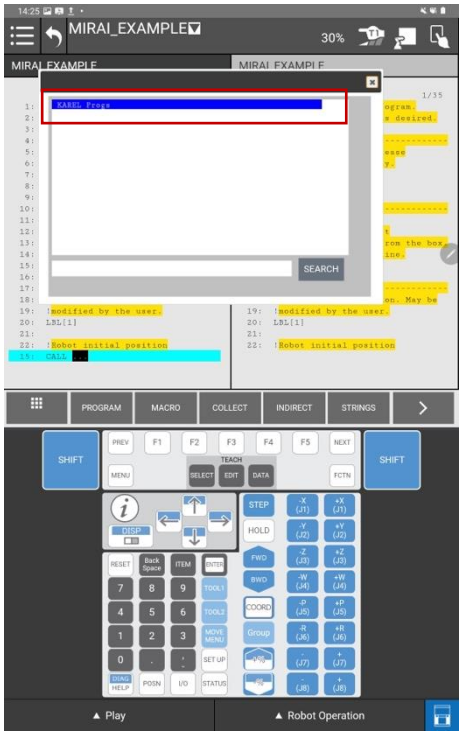
Step 2. Tap on the **[INST]** button

Step 3. Choose **[7 CALL]** from the list of available instructions.

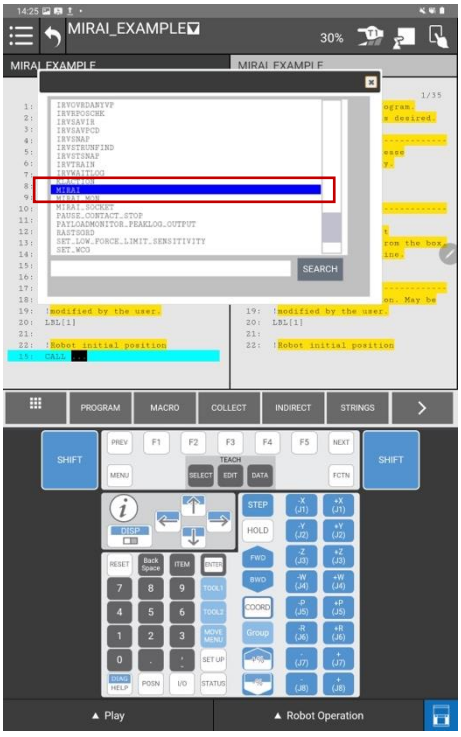


Step 4. Select [CALL program].

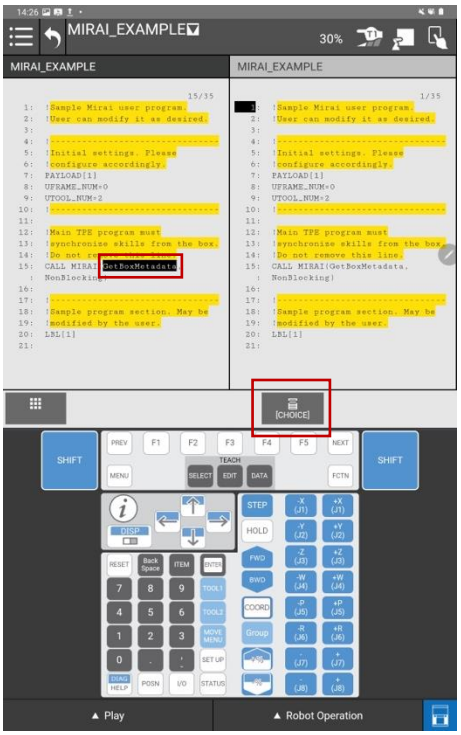
Step 5. Tap on the [COLLECT] button to open the KAREL Progs. Tap on [ENTER].



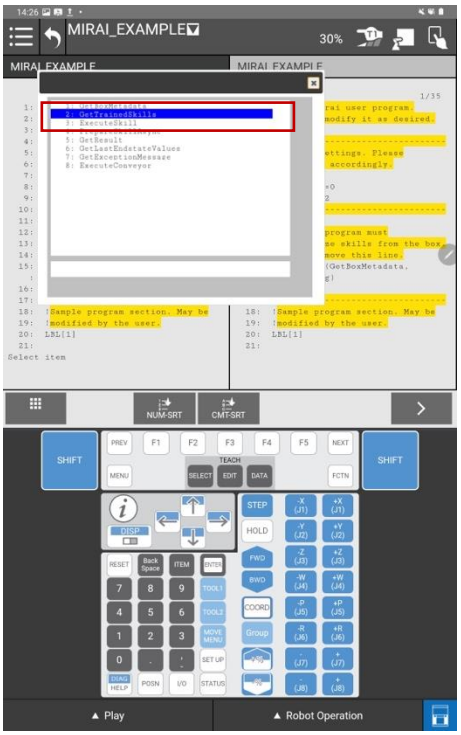
Step 6. Navigate to the program MIRAI and tap [ENTER].



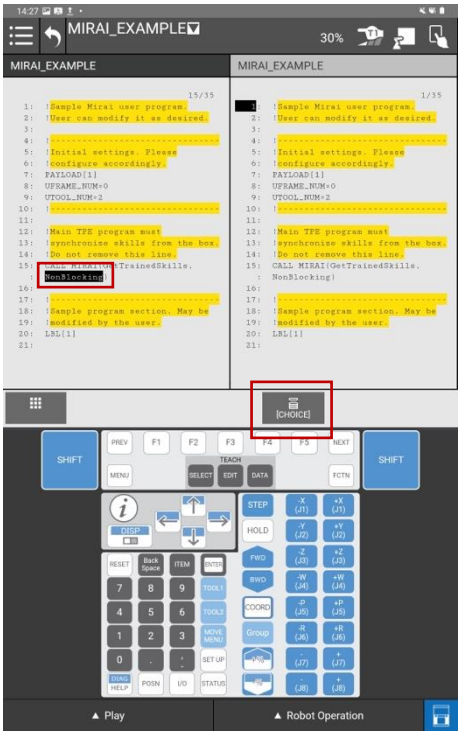
Step 7. Tap on the brackets behind the inserted CALL MIRAI command to select the argument GetBoxMetadata and tap on [CHOICE].

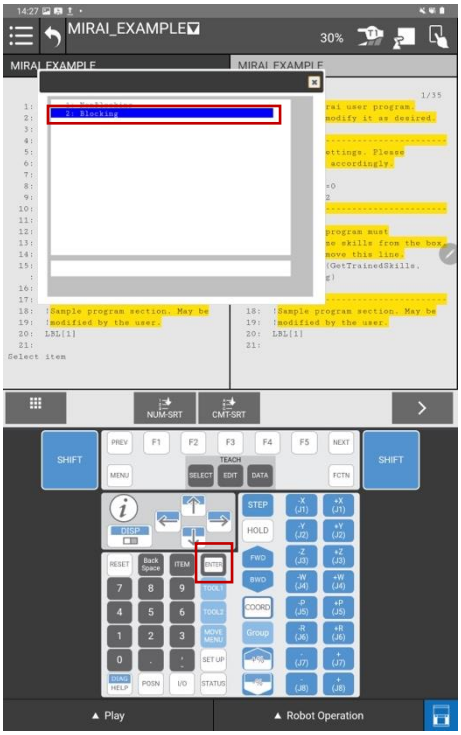


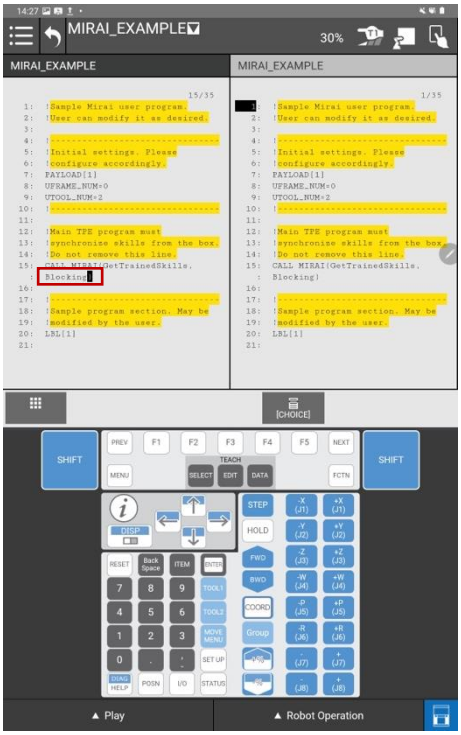
Step 8. Select "GetTrainedSkills" and tap on [ENTER].



Step 9. Tap on the brackets behind the inserted CALL MIRAI command to select the argument **NonBlocking,** then tap on **[CHOICE].**
Select **Blocking** and tap on **[ENTER]**
so that the program will wait for MIRAIs answer before continuing with the next command line.





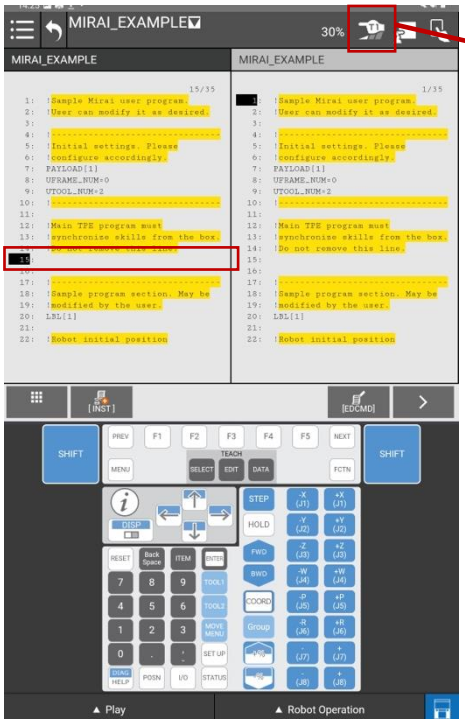


8.2.3 Add a call to execute a MIRAI skill

To execute a MIRAI skill you must add an instruction to call the MIRAI_EXECUTE command. Make sure you have already added the skill name in the DATA string registers (see Section 8.1) and have added the "MIRAI (GetTrainedSkills)" command in your robot program (see Section 8.2.2).

Set the operation mode to T1. If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.

Step 1. Insert and select a line in the program for the command to execute a MIRAI skill. The example below uses Line 15.

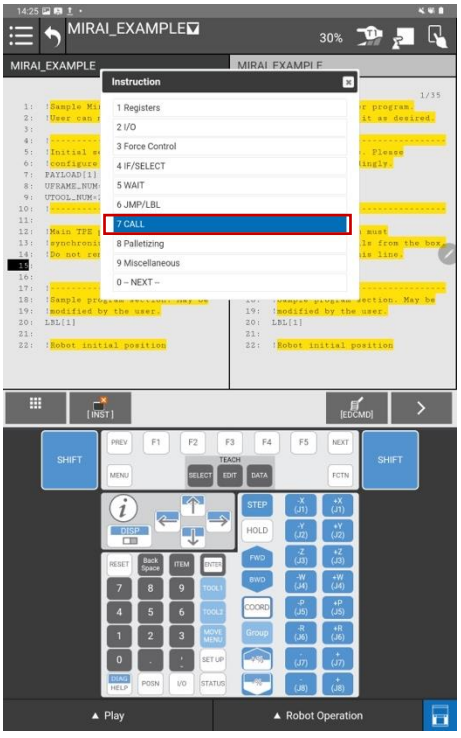


Remember: Operation mode must be **T1**.

If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.

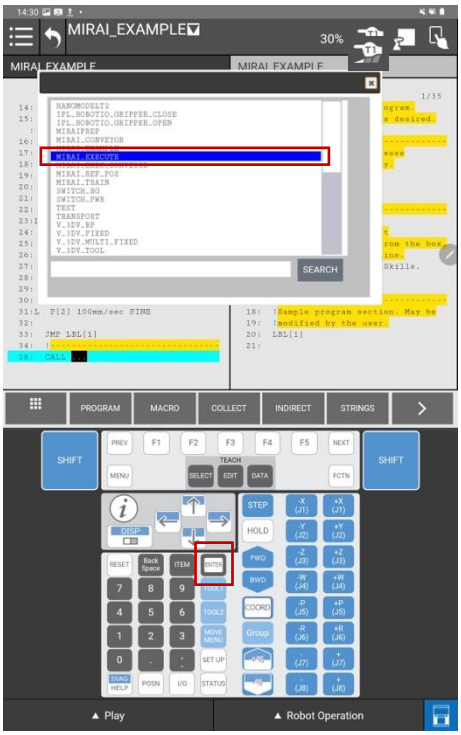
Step 2. Tap the **[INST]** button.

Step 3. Choose **[7 CALL]** from the list of available instructions.

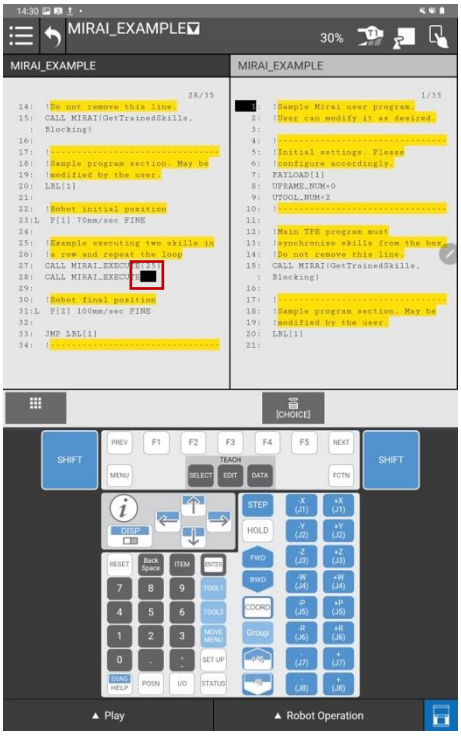


Step 4. Select **[CALL program]**.

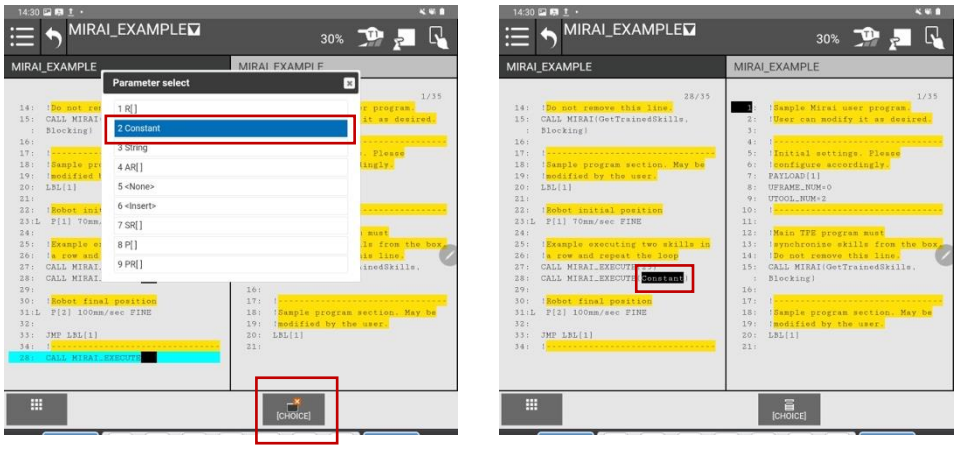
Step 5. Select **[MIRAI_EXECUTE]** from the list and tap **[ENTER]**.



Step 6. Tap the brackets behind the **CALL MIRAI_EXECUTE** command to select the argument.

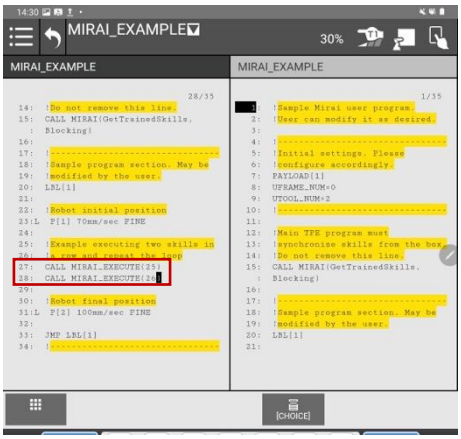


Step 7. Tap on **[CHOICE]** and select the parameter **[2 Constant]**.



Step 8. Enter the DATA String Register position of the skill you want to execute.
For details, see 6.1 Adding MIRAI Skill Names to the DATA String Registers.

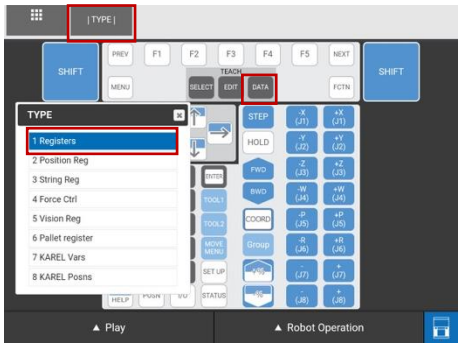
To execute two consecutive skills, use two CALL MIRAI_EXECUTE commands with the respective DATA String Register positions. The example below executes the two skills listed in in Lines 27 and 28.

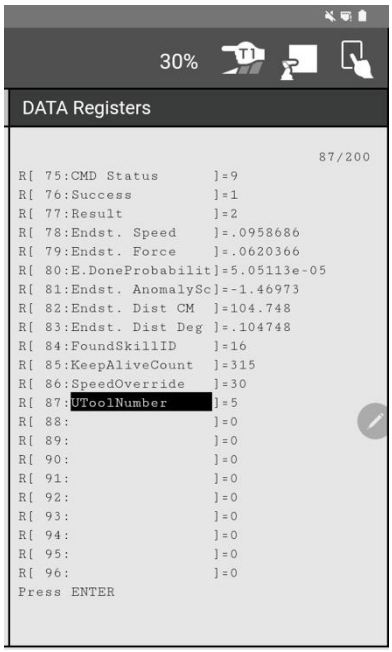


⚠ **NOTE:** MIRAI_EXECUTE always uses UTOOL_NUM=0 which contains the tool information configured in the MIRAI Training App for the respective skill.
If you need to use another tool configuration for other parts of your task, please check section "Adding the MIRAI Tool in the Robot Program" for more details regarding different FANUC software versions.

8.3 Return values of MIRAI functions

The DATA Registers window will display the return values of the MIRAI functions called during skill execution. Among other things this will allow you to understand which end state caused the skill to stop.
(Please see section 4.2 “Setting End State Parameters” in the MIRAI User Manual for MIRAI Training for setting the end state values in the MIRAI Training App)





To open the DATA Registers tap on the desired display area to select the window, tap on **[DATA]** and then on **[TYPE]**. Select **[1 Registers]**.

The returned value in register #77 [Result] will give information on the result of the skill execution as follows:

0 - No result to report. Skill not started or still running

1 - Skill execution ended by speed-based endstate

2 - Skill execution ended by force-based endstate

3 - Skill execution ended by visual endstate

4 - Skill execution ended by timeout

5 – Skill execution ended by position

6 - Skill execution ended by anomaly-based end state

7 – Skill execution ended by proximity-based end state

-1 - an exception occurred during skill execution.

Registers #78, 79, and 80 will return the end state threshold value reached during skill execution.

8.4 Change the operating mode

Once you have transferred your trained MIRAI skill to the robot program the operating mode can be set to other options than T1, e.g. AUTO.

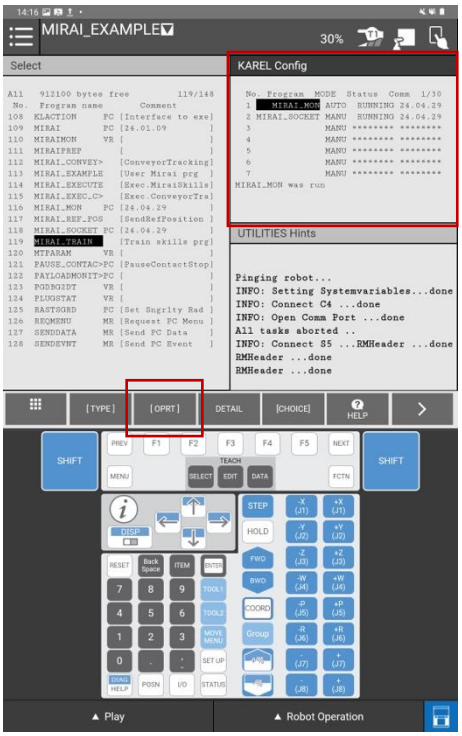
9 Troubleshooting

9.1 Communication issues

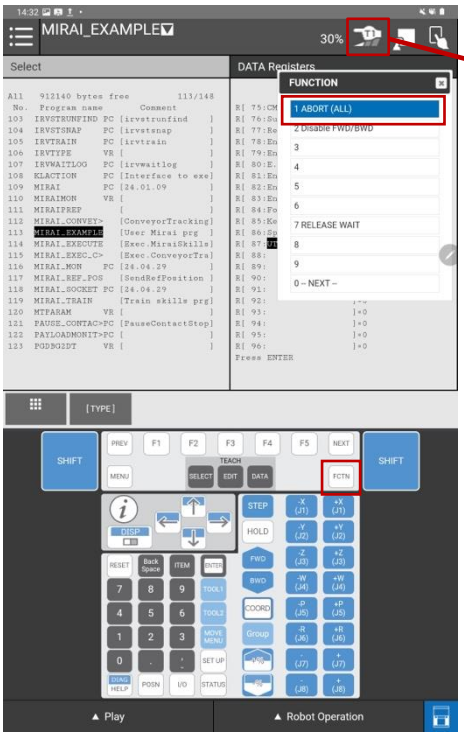
- Recheck the network configuration in the MIRAI Training App and the FANUC Teach Pendant – see section 4. Network Configuration

- Restart both monitoring (background) programs (MIRAI_MON and MIRAI_SOCKET) in [MENU] → [Setup] → [KAREL Config]. The [OPRT] option will allow you to either [1 RUN] or [2 ABORT] the program in the KAREL Configs.

  Step 1 – Select MIRAI_MON and tap **[OPRT]**, select **[2 ABORT]**. Confirm with **[YES].** Do the same for MIRAI_SOCKET.
  Step 2 - Select MIRAI_MON and tap **[OPRT]**, select **[1 RUN]**. Confirm with **[YES].** MIRAI_MON will automatically restart the MIRAI_SOCKET program.
  MIRAI_MON should be in AUTO mode, MIRAI_SOCKET in MANU (manual) mode.



If you encounter issues with the execution of your program and/or when you are about to start executing a new program, we recommend aborting all programs on the FANUC Teach Pendant that might have stalled and could conflict with the new program.
To abort all programs, tap **[FCTN]** and select **[1 ABORT (ALL)]**.



Remember: Operation mode must be **T1**.

If it is not possible to select T1 mode, refer to the appendix Operation Mode Switch (T1, T2, Auto) with explanation on how to activate the operation mode via the teach pendant.

In case of a skill execution issue, see section "Enabling remote monitoring" in the MIRAI User Manual for MIRAI Training.
When switching robot control from Tablet TP to MIRAI, a slight twitch of about 1mm is expected. This does not affect skill training or execution.

9.2 OPC-UA connection issues

Issue: A "Failed to connect OPC-UA" error will occur if you do not wait for the "RMHeader...done" message to appear before tapping "Record episodes" or "Test & configure".

Recovery: If this error happens three times, recovery without user input is not possible. To resolve this, restart the MIRAI controller.

Reconnecting Methods

1. **Restart the Runtime**: This can help re-establish the connection.

2. **Abort and Restart Monitoring Programs**:
   a. Navigate to `MENU` > `Setup` > `KAREL Config.`.
   b. Abort both monitoring programs to stop socket communication.
   c. Restart the programs to establish a new connection.
   d. Check the state of the monitoring programs and ensure the "RMHeader...done" message appears on the FANUC User window.

3. **Restart Socket Communication**: Toggle DO[2067] when working with MIRAI2 to restart only the socket communication.

Tips for Avoiding OPC-UA Connection Issues

Patience and Vigilance: Continuously monitor the FANUC TP for error messages and alarms. Clear or reset all errors and ensure the deadman switch is pressed before continuing with the MIRAI Training App. Follow the correct sequence of interactions between the right and left hands.

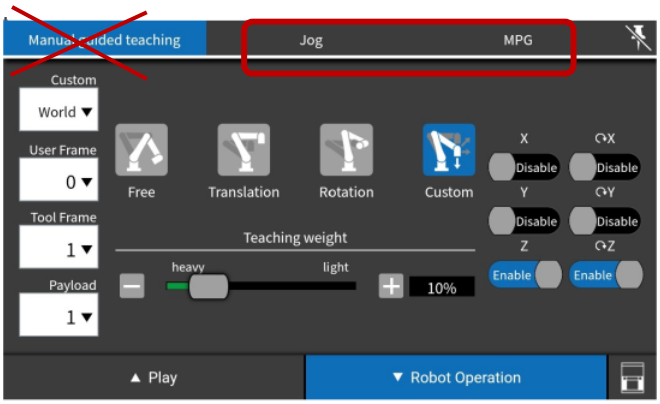
Handling SERVO Errors:

- Reset the servo system by pressing the operator panel FAULT RESET button or the teach pendant RESET key.
- Failure to reset a SERVO alarm on the FANUC TP will prevent the servos from powering up and cause failures in the KAREL monitoring programs when using the MIRAI Training App.

9.3 Cannot execute program from FANUC Teach Pendant in T1/T2 mode

To execute a program from the teach pendant, select the `Jog` or `MPG` tab.
Do not select the `Manual guided teaching` tab.

Switch back to `Play` to execute your program.



10 FANUC alarm codes on the teach pendant

This section provides information on FANUC error messages and alarms that may occur while using MIRAI. Alarm codes are listed in alphabetical order. Each entry gives the cause and remedy reproduced from the FANUC Alarm Code List and a MIRAI solution.

If you encounter an alarm not listed in this user manual, please refer to the FANUC Alarm Code List and the FANUC manual for your robot series controller. Alarms can vary by robot controller and may not be related to MIRAI.

10.1 CPMO-095 Too Large Jnt Cmd (G: i A: j)

Cause: A very large axis speed which may exceed the safety limit was detected. Letter `i` indicates the group number and `j` indicates the axis number in which this error was detected.

Remedy: (1) Axis speed can become very high during linear or circular motion which satisfies at least one of the following conditions:

- TCP travels near singular point.

- Tool posture changes largely.

For a remedy, modify the motion instruction as below so that this axis gets slower during this motion;

1. Divide the motion into two instructions using a mid point which is away from the singular point, or/and

2. Decrease the speed (feed rate) of the motion instruction, or

3. Change the motion format to J (Joint motion).

(2) If the remedy (1) does not resolve this alarm, Execute Diagnostic log function [FNCT menu / Diagnostic log] before you do other operation such as power off or jogging, and get the image backup. And contact your FANUC technical representative. If you cannot execute Diagnostic log function, document the events that led to the error and get the image backup. And contact your FANUC representative.

MIRAI solution: New points in the main program P[1] and/or P[2] on the FANUC Teach Pendant might have been copied from another program that used a different tool. As a result, the controller may not have updated these new points correctly, leading to payload alarms.

To prevent this issue, set new points with the current tool you are working with. Then cycle power on the robot controller to save the changes.

10.2 DPMO-024 Can't control orientation

Cause: DPM orientation is prohibited at non mode3 resume.

Remedy: Set $DPM_CFG.$ORI_CTL = FALSE.

MIRAI solution: If the deadman switch was released and you wish to resume the program, first abort all running programs. Then start running the main program again.

To abort programs on the FANUC Teach Pendant, press the [FCTN] key on the FANUC Teach Pendant keypad. Select the function [ABORT(ALL)].

10.3 INTP-103 (MIRAI_TRAIN,10) Program error

Cause: An error occurred while the program was running.

Remedy: Refer to the error cause code. Use MENU to display the Alarm Log screen.

MIRAI solution: You may not be able to add episodes or create a new skill. Follow the steps to resolve the `MOTN-113 Robot not calibrated alarm` , outlined in Section 10.7.

10.4 INTP-105 (MIRAI_TRAIN,1) Run request failed

Cause: Program cannot be started.

Remedy: Refer to the error cause code. Use MENU to display the Alarm Log screen.

MIRAI solution: Set Remote/Local setup to LOCAL. Then set UI signals to false, as outlined in Section 6, Operating MIRAI in T1 and AUTO mode.

10.5 MCTL-013 ENBL input is off

Cause: ENBL input on the UOP is off.

Remedy: Set ENBL input ON

MIRAI solution: Set Remote/Local setup to LOCAL. Then set UI signals to false, as outlined in Section 6, Operating MIRAI in T1 and AUTO mode.

10.6 MOTN-056 Speed limits used (G:%d^2)

Cause: Speed limits used.

Remedy: This is just a notification. You do not have to do anything for this warning message.

MIRAI solution: Not applicable.

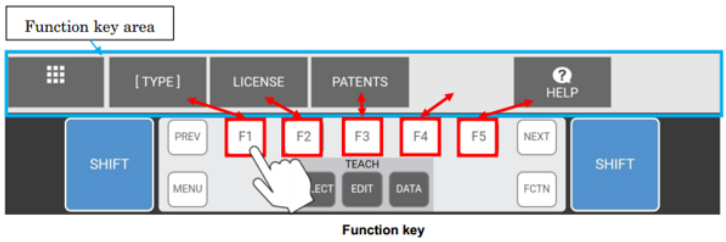
10.7 MOTN-113 Robot not calibrated

Cause: Robot not calibrated.

Remedy: Calibrate the robot.

MIRAI solution: The robot may not be mastered because an image backup was restored in a different position. Follow these steps to calibrate the robot:

1. **Select the Tablet UI menu:**
   - Select the **[System]** menu
   - Select the **[Master/Cal]** option
2. **Reset the pulsecoder alarm:**
   - Select the option **[RES_PCA]** (Reset pulsecoder alarm)
3. **Enable Master/Cal menu** (if not available):
   - Navigate to **[Menu]** –> **[Next]** -> **[System]** -> **Variables**
   - Set the variable **[$MASTER_ENB]** to **1**.
   - The **[Master/Cal]** should now be available.
4. **Set "Mastering done" to TRUE**:
   - Select **[SYSTEM]** on the Tablet UI menu.
   - Select **[Variables]**
   - Search for the variable group **[$DMR_GRP]** and press **[Enter]** to open this group.
   - Check whether the variable **[$MASTER_DONE]** is set to TRUE. If it is FALSE, set it to TRUE using the options displayed on the Function key area of the Tablet Teach Pendant, depected below:



5. **Apply DCS parameters**:
   - Select the Tablet UI Menu
   - Select the **[System]** menu
   - Select **[DCS]**
   - Note: If you do not apply DCS parameters, you may encounter the following alarm: `SRVO-337 SERVO DCS PRMCHK alarm %x,%x`
6. **Cycle power on the controller.**

10.8 PRIO-230 EtherNet/IP Adapter Error (%d)

Cause: The robot EtherNet/IP Adapter Connection running on the robot is enabled and has an error. Refer to additional cause code text for further details.

Remedy: Alarm severity can be modified on the EtherNet/IP adapter configuration screen on a per connection basis, and last state behavior can be modified with $EIP_CFG.$KEEP_IO_ADP. Refer to the EtherNet/IP Operator's Manual for more information.

MIRAI solution: This functionality is included with the Ethernet/IP Adapter (R784) package If you are not using this functionality, you can disable it by following these steps:

1. Go to **I/O** and select **Ethernet IP**.

2. Disable the first connection (Adapter) by switching it from TRUE to FALSE.

10.9 SRVO-003 Deadman switch released

Cause: The deadman switch was not pressed when the teach pendant was enabled. Alternatively, the deadman switch was pressed strongly.

Remedy: Press the deadman switch to release it, then press **[RESET]** key. If the deadman switch is three position switch type, press the deadman switch to middle position to release it, then press **[RESET]** key. If this alarm cannot be reset, please take the following action.

1. Check the intermediate position of the deadman switch on the teach pendant.

2. Check that the mode switch on the operator's panel and the enable/disable switch on the teach pendant are at the correct positions.

3. Replace the teach pendant.

4. Check the mode switch connection and operation. If trouble is found, replace the mode switch.

5. Replace the emergency stop board.

MIRAI solution: Reset the alarm from the Teach Pendant's alarm panel and keep the deadman switch held in these situations:

b. Using the MIRAI Training App
c. Jogging the robot
d. Executing a program in T1 mode from the FANUC Teach Pendant

10.10 SRVO-037 IMSTP input (Group:%d)

Cause: The *IMSTP signal, which is a peripheral device I/O signal, is OFF. Number in the bracket shows the group number.

Remedy: Turn on the *IMSTP signal

MIRAI solution: Set Remote/Local setup to LOCAL. Then set UI signals to false, as outlined in Section 6, Operating MIRAI in T1 and AUTO mode.

10.11 SRVO-038 (G:1, A:5) Pulse mismatch (G:%d A:%d)

Cause: A pulse count detected at power-on differs from the one recorded at the last power-off. Numbers in the bracket show the group number and the axis number in the group. This could be due to the following:

1. The motor (Pulsecoder) was replaced, or the backup battery of Pulsecoder data was replaced.

2. A file (SYSMAST.SV) that had been saved at a different axis position was loaded.

3. The software brake setting is incorrect.

4. An incorrect brake type was set to the robot with two-axis brake option.

5. A file (SYSMAST.SV) that had been saved on another robot was loaded.

6. The axis position was changed with a brake release unit while the controller power is off.

7. The axis fell while the controller power is off due to a brake trouble.

8. The controller power went down during high speed motion.

9. The robot connection cable was connected to another robot.

Remedy: For the above cause 3 and 4, confirm the setup or brake type setting and correct setting. For the above cause 5, re-load SYSMAST.SV of the robot. Afterwards, PULSE RESET operation should be done. Refer to `MOTN-113 Robot not calibrated` for the PULSE RESET procedure.

Check whether the robot position on Teach Pendant is correct. If incorrect, re-mastering is required. If correct, move the cursor to $DMR_GRP[group].$MASTER_DONE on the system variable screen [6 SYSTEM / Variables], and select F4 TRUE. And then do calibrate on the MASTER/CAL screen [6 SYSTEM / Master/Cal], or cycle the power.

Note: The MASTER/CAL screen is not usually displayed. A person who has the operation qualification does.

10.12 SRVO-289 Smooth Stop

Cause: A Smooth Stop has been done.

Remedy: After this alarm, a Fence open or SVOFF input alarm is detected. See the remedy of those alarms for more information.

MIRAI solution: The deadman switch was released. Please keep the deadman switch held as indicated in Section 10.9, SRVO-003 Deadman switch released.

10.13 SRVO-337 SERVO DCS PRMCHK alarm %x,%x

Cause: DCS parameter error is detected.

- When controller power is cycled without pressing F4"OK" in the DCS apply menu, this alarm occurs.
- When an image restore is done and 'Yes' is selected for initialize DCS parameter, this alarm occurs.
- When an image restore is done and 'No' is selected for initialize DCS parameter, if the previous DCS parameters are different from what is in the image file, this alarm occurs.
- When `SYST-289 Cannot apply to DCS parameter` occurs at APPLY of DCS parameter, this alarm may occur after cycle power.
- When auto software update is done as an item in a DCS menu is changed, the alarm `SYST-212 Need to apply to DCS param` occurs, and the "Apply to DCS parameter" procedure is not done, this alarm occurs.

Remedy: 1. Do an APPLY of the DCS parameters.

2. Load backup files.

3. Replace the CPU card.

Before executing the remedy 4, 5, perform a complete controller back up as image to save all your programs and settings.

4. Replace the FROM/SRAM module, and restore the image backup.

5. Replace the main board, and restore the image backup.

Note: You need to cycle power to release this alarm

MIRAI solution: Follow the steps in Section 10.7, MOTN-113 Robot not calibrated.

10.14 SRVO-483 Input AUTO confirmation signal

Cause: Mode was changed to AUTO by TP mode select screen.

Remedy: Input AUTO confirmation signal by the switch outside of safeguard.

MIRAI solution: The system is not reset until the confirmation signal toggles from OFF to ON and back to OFF again. When the controller powers up in AUTO mode, an AUTO confirmation input is required. Any Digital Input (DI) can be used as the confirmation signal, which is defined as "Confirmation input for AUTO" in the "System Config" menu.

Example configuration for LR Mate 200iD/7 (Note: Your setup may vary depending on how the I/Os are controlled and wired internally on the CRMA15/16 boards):

1. **Set AUTO Confirmation Signal**:
   - Go to **MENU** > **System** > **Config**.
   - Select Item 59 "Confirmation for AUTO" and assign "1" as the DI signal, or choose any other suitable Digital Input.
2. **Assign DI[1]:**
   - Assign DI[1] to Rack 34, Slot 1, Start 36.
   - You can toggle this input using a push button wired to the previous Start signal or by using F [36] (switch ON and then OFF).

IMPORTANT: Ensure compliance with CE certifications and use a physical button for the AUTO confirmation signal. Micropsi Industries is not responsible for this configuration.

10.15 SYST-322 Auto status check time out

Cause: Continuous robot movement for more than 90 seconds triggers alarm a `SYST-322 auto status check time out` incollaborative mode:

- Training episodes can be recorded for up to 3 minutes (180 seconds) in the MIRAI Training App.
- FANUC collaborative robots have a safety confirmation system that periodically performs an Auto Status Check. By default, robots in collaborative mode cannot move continuously beyond the Status Check Time Limit of 1.5 minutes (90 seconds). After this period, the controller issues a `SYST-322 auto status check time out` alarm, stopping the robot.
- After the alarm is triggered, the robot cannot be guided manually or with the recording assistant, and the episode will be lost.

Remedy: Increase the Auto Status Check Time Limit by following these steps:.

1. **Open the Menu on the teach pendant**: Navigate to **MENU** > **SYSTEM** > **DCS** > **Collaborative Robot**.
2. **Scroll to the Auto Status Check section** and enable **Flex Time Limit.**
3. **Set the Time Limit Input**:
   - Select **R** as the variable type.
   - Enter the numeric register you will use for your new time limit.

4. Apply the changes:
   - Use the PREV button on the FANUC Teach Pendant to go back.
   - Apply DCS parameters, enter the confirmation code, and hit OK to confirm.
5. Restart the robot controller:
   - Cycle power to the robot controller.
   - After rebooting, enter your new time limit in the selected numeric register.
     - The maximum value is 10000s. If you input a value outside the range of 1-10000, the default value (10000s) will be used.

MIRAI solution: To record episodes of more than 1.5 minutes, up to 3 minutes, in collaborative mode, we recommend the following configuration for the DCS settings:

Auto Status Check:		
Check during Moving	[Disable]	OK
Flex Time Limit	[Enabled]	OK
Time Limit Input	R[94]	
Warning Output:	DO[0]	
Time Setting:	10000s	

Note that for Time Limit Input, we use Register data R[94], but you can select any empty register.
For this value in R[94] we use the maximum value of 10000s. You can change the time limit dynamically.

10.16 SYST-325 Payload error is detected %x,%x

Cause: The payload setting of Collaborative Robot is different from the actual payload.

Remedy: Verify the payload setting is same as the actual payload. The low accuracy of the payload setting causes this alarm.

- If the external force exceeds the payload error limit, the accuracy of payload[kg] might be low.
- If not, the payload[kg] or the accuracy of the position of the center of gravity might be low. From t force just after the payload change, you can roughly see the error of the payload[kg].

MIRAI solution: This error may occur during skill creation when using a force/torque sensor. Ensure that the payload is configured properly in the MIRAI training app using the MIRAI CoG Wizard. If the error persists, it might be due to the inability to adjust guiding sensitivity during skill creation. In this case, disable collaborative mode during skill creation. After the skill is created, re-enable collaborative mode.

10.17 SYST-348 Payload Monitor (Force) warning

Cause: Collaborative Robot Payload Monitor detects Force exceeds warning value set in the collaborative screen.

Remedy: Resolve the root cause of the external force. Or increase the warning value in the collaborative screen

MIRAI solution: No action needed. This warning may occur while you are guiding the robot. It is related to the payload configuration on the FANUC controller.

10.18 TPIF-270 Clear Browser Cache

Cause: You are connecting to a controller that has a different version from your previous connection. This alarm appears when using the Tablet TP.

Remedy: Please clear the browser cache. Do not exit from the Fanuc APP. This operation can usually be found in the browser's settings under one of the following menu items: 'History', 'Network', 'Safety', or 'Edit', depending on the browser.

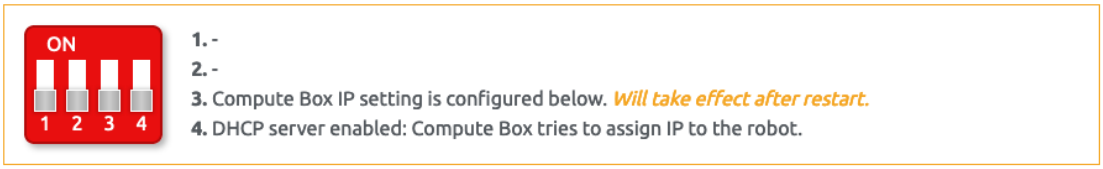
MIRAI solution: Clear the cache by following these steps:

1. **Open Drawer Menu**: Slide right from the left side of the Tablet TP app screen to open the drawer menu.
2. **Clear Cache**: Select **Clear cache**. A dialog will appear with the message "Clear the cache and exit the Tablet TP".
3. **Confirm Action**: Select **OK**. The cache will be cleared, and the Tablet TP app will close.
4. **Restart App**: Restart the Tablet TP app. This action will automatically close the FANUC App and clean the cache.

11 Appendix

11.1 Configure the OnRobot Compute Box

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. Your PC should automatically receive an IP from the Compute Box in the range of 192.168.1.*
5. Open your web browser and go to 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 another IP if you are working in a different subnet).
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, 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 a web browser and enter: http://192.168.100.15 (or the IP address for your subnet)
4. You should see the sensor's configuration page if everything is set up correctly.

11.2 Configure the ATI Sensor

1. Connect the Ethernet cable from the force/torque sensor or Net F/T Box to your computer's ethernet port.
1. Power the sensor ON and wait 30 seconds.
2. Open your web browser and navigate to : http://192.168.1.1 to access the ATI Net F/T homepage.
3. 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.
4. 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.

11.3 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'
```

11.4 Operation Mode Switch (T1, T2, Auto)

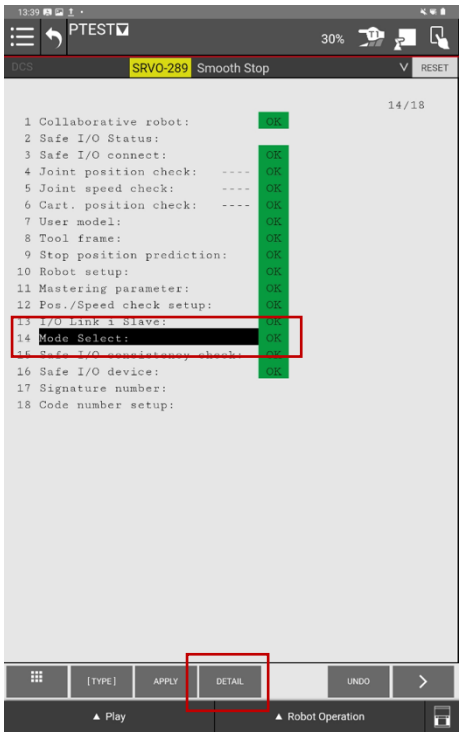
To operate the robot with the MIRAI Training App, the operation mode must be T1, the Teach Pendant (TP) must be enabled and you must hold the Dead man switch.

If you release the Dead man switch while using the MIRAI Training App, you will get an alarm `SRVO-289 Smooth Stop` and `SRVO-003 Deadman switch released` together with a message in the MIRAI Training App. To reset the alarm on the Tablet TP, you need to hold the deadman switch in the middle position and click in RESET button on the TP keyboard.

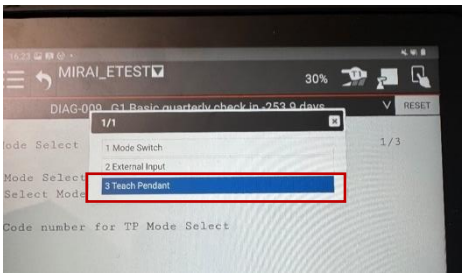
In this appendix, we explain how to configure the selection mode through the Teach Pendant for a FANUC R-30iB Mini Plus controller and CRX-10iA/L robot model. If you are working with a different robot controller please refer to the **«FANUC Robot series R-30+B/R-30+B Mate/R-30+B Plus/R-30+B Mate Plus/ R-30+B Compact Plus/R-30+B Mini Plus CONTROLLER OPERATOR'S MANUAL (Basic Function)« (B-83284EN/10).**

If your R-30iB Compact Plus or R-30iB Mini Plus controller does not have an operator panel, you will need to use the TP Mode Select function to adjust the mode switch function setting to use a Teach Pendant.

Step 1. Go to **Menu -> System -> DCS -> Mode select.**
Tap on **[DETAIL]** to enter to the configuration of this Mode Select function.

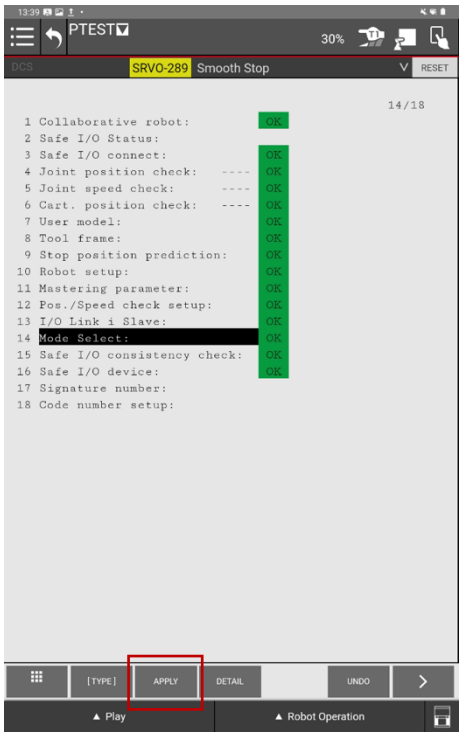


Step 2. Select [3 Teach Pendant].



Step 3. The configuration should be set as shown below:

Step 4. Go to the previous window and tap on **[APPLY]** to save the settings.



Step 5. Cycle power the robot controller to save the changes.

11.5 Enable Free-Hand Teaching on the robot controller after installing MIRAI

11.5.1 Configure AUTO mode on robot controller

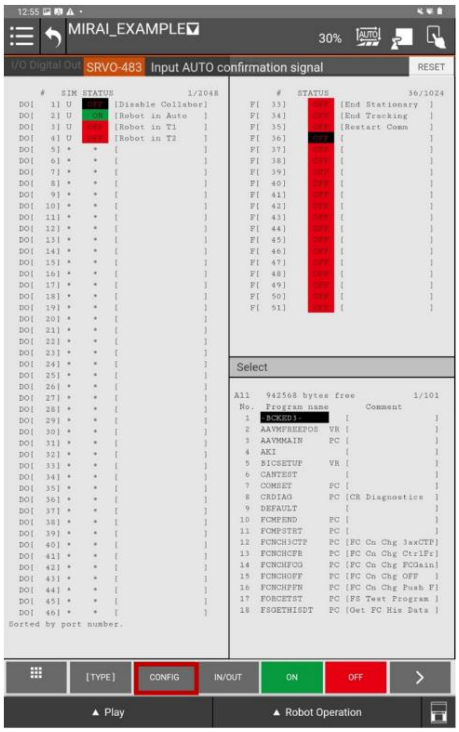
Switch to [AUTO]. Open [DI/DO] settings of the robot. Press [Config].

Any Digital Input (DI) can be used as the confirmation signal. The confirmation signal is defined as

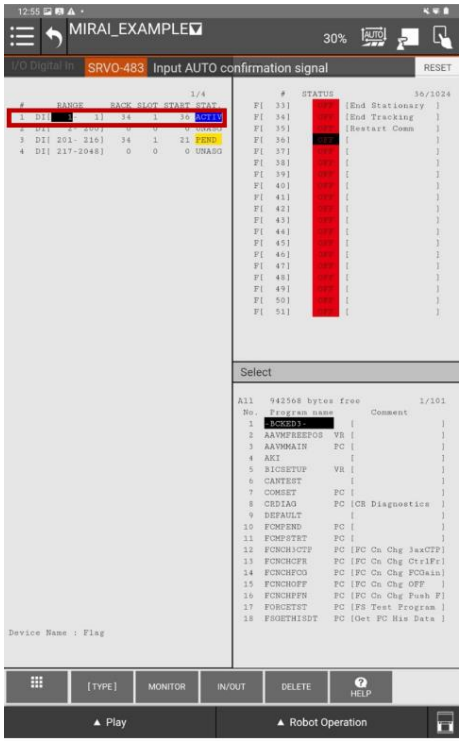
“Confirmation input for AUTO” on the “System Config” menu.

This configuration was tested on CRX-10iA and LRMate-200iD/7L:

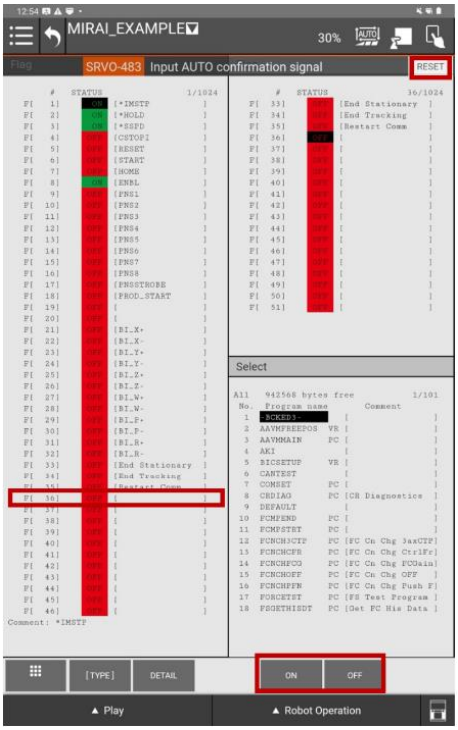
- Set DI [1] as AUTO confirmation signal in MENU -> System -> Config. Select Item 59 “Confirmation for AUTO” and put “1” as the DI signal.
- Assign DI [1] to Rack 34, Slot 1, Start 36
- You can toggle the Input F [36] via flags and wire a real physical button to the board of your robot controller to make use of the AUTO mode (according to safety regulations).



Switch to [INPUTS] and add the marked line to the configuration. Cycle power after pressing [ENTER].



Go to [I/Os]. Open [Flags]. Toggle Flag 36 ON and OFF. [RESET] Error Message.



11.5.2 Enable Free Hand Teaching in AUTO Mode

Open [Robot Operation] and enable [Free Hand Teaching]

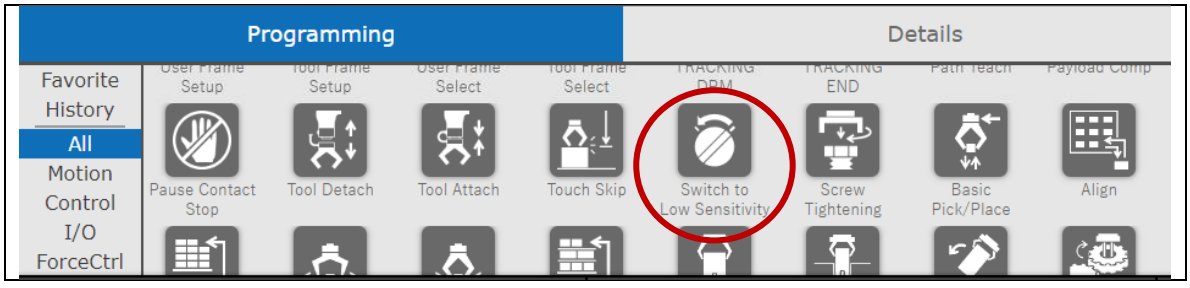
11.6 Switch to Low Sensitivity instruction (CRX Series)

During skill execution using the FANUC Teach Pendant, it is sometimes advisable to switch to LOW sensitivity to prevent alarms from excessive forces, which can cause the robot to stop. At LOW sensitivity, the robot will stop for significant forces, like collisions, but the alarm triggered will not stop the robot unless a collision occurs The Low sensitivity key function might be needed when using the gripper, so each specific use case should be tested.

NOTE: This functionality is specific to FANUC and not linked to MIRAI. Therefore, the operator must take responsibility and check the following FANUC user manual for more information:

FANUC Robot series R-30iB Plus/R-30iB Mate Plus/R-30iB Mini Plus CONTROLLER TABLET UI OPERATOR'S MANUAL A-97606-06956EN/13, Section 4.3.36 Switch to Low Sensitivity (CRX series only)

To access the "Switch to Low Sensitivity" special key function go to `Menu` > `Teaching` > `Editor` on the tablet teach pendant.



11.7 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 extensively tested and used in projects. 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+)

12 Declaration of incorporation

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

Ronnie Vuine, Chief Product Officer

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