MiR250 Shelf Carrier User Guide

Date: 12/2023
Version: 3.0 (en)
Robot hardware version: 2.0
Top module hardware version: 1.0

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Original instructions (English)

Contact the manufacturer:

Mobile Industrial Robots A/S
Emil Neckelmanns Vej 15F
DK-5220 Odense SØ

www.mobile-industrial-robots.com
Phone: +45 20 377 577
Email: support@mir-robots.com

CVR: 35251235

Table of contents

1. About this document

This user guide explains how to set up and start operating your MiR250 Shelf Carrier robot. This guide also contains information regarding the external and internal components of MiR250 Shelf Carrier along with instructions for proper maintenance of the robot. You will also find information regarding safety and specifications needed to commission a safe MiR250 Shelf Carrier robot application.

NOTICE

Save this manual. It contains important safety and operating instructions.

1.1 Where to find more information

For the full documentation package and translations of manuals for MiR250 Shelf Carrier, go to: https://www.mobile-industrial-robots.com/product-documents/mir250-shelf-carrier-hw-20-sw-3-v1/.

For online courses to strengthen your understanding of MiR products, go to MiR Academy.

If you are looking for more documentation about all MiR products, go to MiR Support Portal where we have the following resources:

Documentation

- **Integrator Manuals** provide all the information you need to operate and maintain MiR robots. Integrator Manuals are available in multiple languages. These guides are intended for PCM (partly completed machinery) robots.
- **Quick starts** describe how you start operating MiR robots quickly. It comes in print in the box with the robots. Quick starts are available in multiple languages.
- **User guides** provide all the information you need to operate and maintain MiR products and how to set up and use top modules and accessories, such as charging stations, hooks, shelf lifts, and pallet lifts. User guides are available in multiple languages.
- **Risk assessment guide** describes how to conduct a risk assessment and provides some risk assessed use cases.
- **Commissioning guide** provides examples and guidelines to commission your robot successfully.

- **Interface guides** contain descriptions of all the elements of the robot interface and MiR Fleet interface. Interface guides are available in multiple languages.
- **Best practice guides** provide helpful information you can use when commissioning or operating your robot.
- **REST API references** for MiR robots, MiR Hooks, and MiR Fleet. HTTP requests can be used to control robots, hooks, and MiR Fleet.
- **MiR Network and Wi-Fi guide** specifies the performance requirements of your network and how you must configure it for MiR robots and MiR Fleet to operate successfully.
- **Migration guides** describe how to upgrade your MiR system from one major software version to the next.
- **Cybersecurity guide** provides important information and instructions to increase the cybersecurity of your MiR product.
- **How-to guides** are short guides providing instruction for maintenance, replacement, commissioning, and other tasks related to MiR products.
- **Troubleshooting guides** can help you determine the cause of an issue you are experiencing with your MiR product and how to resolve it.
- **Release notes** of new products and hardware updates that describe what has been changed and why.
- **Service notes** notify of issues identified in MiR products and changes that are applied.
- **Spare parts and additional products** list all spare parts and accessories you can order for robots.
- **Warranty** describes the MiR standard warranty agreement.
- **Certificates and declarations** for MiR products that prove compliance with standards.
- **Technical guides** provide in-depth information about how MiR products work.

Models and drawings

- **Wiring diagrams** are graphic representations of how the components in MiR robots are wired.
- **CAD files** of the robots that are made to scale can be used to help determine the dimensions of the robot or for illustrative purposes.

Resources

- **MiR Log Analytics** and **MiR Insights** are tools you can use to analyze how well your robots or fleet are performing. MiR Log Analytics is a free tool that lets you analyze recorded performance from error logs, and MiR Insights requires a paid license, but runs continuously alongside MiR Fleet to give real-time data on several metrics.
- **AprilTag** collection can be used instead of generating your own AprilTags.
- **Space calculator** determines the approximate amount of space your MiR robot will need to operate depending on the size of its footprint.
- **Community** is a forum of MiR users with a collection of questions, recommendations, webinars and other community driven material.
- **Marketing and brand portal** is a collection of our graphical elements where you can download color schemes, rendered images of the robots, and icons.

1.2 Version history

This table shows current and previous versions of this document.

Revision	Description
3.0	**Date:** 2023-12-05 **Robot HW:** 2.0 **Top module HW:** 1.0 • Updated for software version 3.x with new user interface and new features.
2.1	**Date:** 2023-11-16 **Robot HW:** 2.0 **Top module HW:** 1.0 • Updated sizes of the Protective fields. Affects section: Field switching and Personnel detection.

Revision	Description
	• Added information about when the different safety functions are active. Affects section Safety-related functions. • Improved the safety function descriptions and section structure, and added information about safety configuration. Affects section: Safety-related functions. • Added instructions to test the brakes and information about how the brakes work. New section: Mechanical brake function test. Affects sections: Maintenance, Brake test. • Added information and test results concerning stopping distances for driving without shelves and with a shelf, including maximum payload. Affects section: Stopping distances. • Added notice that the robot cannot detect forklift forks and empty pallets reliably. Affects section: General safety precautions. • Added description of how to lift the robot. Affects section: Transportation. • Added warning to ensure all personnel wear safety shoes. Affects section: General safety precautions. • Added warning regarding clearing missions. Affects section: Error handling • Added performance level of the safety functions, improved the safety function descriptions and section structure, and added information about safety configuration. Affects section: Safety-related functions and interfaces. • Expanded list of material you can find on MiR Support Portal and added a link to a documentation package page. Affects section: Where to find more information

Revision	Description
	• Changed name of Shared emergency stop function to System emergency stop function. Affects sections: Electrical interfaces and Safety-related functions and interfaces. • Added information about the new Ethernet port in the rear compartment. Affects section: Internal parts. • Updated process to sign into robot interface and connect to an external network. New section: Connecting the robot to a Wi-Fi network. Affects section: Connecting to the robot interface. • Added ESD check and safety component replacement to maintenance, and added description of effects if maintenance is neglected. Affects section: Maintenance. • Removed commissioning section and added reference to *MiR Commissioning Guide* instead. Affects section: Commissioning. • Updated status light table. Affects section: Light indicators and speakers. • Added sections: Specifications and Space requirements. • Changed structure and order of content • Updated copyright. • Updated reference to robot or MiR Fleet reference guide to interface guide. • Updated style.
1.5	**Date:** 2022-08-12 **Robot HW:** 1.0 **Top module HW:** 1.0

Revision	Description
	• Added more information about storage of robots and batteries. New section: Storage. • Added notice that cable chargers only charge the robot's battery to 80–90%. Affects section: Charging the robot. • Updated sections: Obstacle detection, Battery disposal, Disposal of robot, Interface specifications, Markers, and External parts. • Updated manual to ensure compliance with radio equipment directives. Affects sections: General safety precautions and Foreseeable misuse. • Added warning not to use two chargers to charge the robot simultaneously. • Added notice that cable chargers only charge the robot's battery to 80–90%. Affects section: Charging the robot. • Added information about laser scanner range. Affects section: Obstacle detection. • Added information about camera vertical angle. Affects section: Obstacle detection. • Added information about wheel wear down tolerance. Affects section: Maintenance. • General improvements throughout the manual.
1.4	**Date:** 2022-03-31 **Robot HW:** 1.0 **Top module HW:** 1.0 • Added sections: Enabling fast swap and Swapping out the lithium-ion battery. • General improvements throughout the manual.

Revision	Description
1.3	**Date:** 2020-11-30 **Robot HW:** 1.0 **Top module HW:** 1.0 • Added sections: Warranty, Markers, and Positions. • Updated section: Battery storage with Power save mode and Deep sleep mode. • General improvements throughout the manual.
1.2	**Date:** 2020-07-08 **Robot HW:** 1.0 **Top module HW:** 1.0 • Updated section: Operating hazard zones. • General improvements throughout the manual.
1.1	**Date:** 2020-07-01 **Robot HW:** 1.0 **Top module HW:** 1.0 • General improvements throughout the manual.
1.0	**Date:** 2020-06-26 **Robot HW:** 1.0 **Top module HW:** 1.0 • First edition

2. Product presentation

MiR250 Shelf Carrier is an autonomous mobile robot that can transport loads up to 300 kg indoors within production facilities, warehouses, and other industrial locations where access to the public is restricted.

MiR250 Shelf Carrier is a MiR250 robot with a MiR Shelf Carrier 250 top module mounted to it. It is designed to transport wheeled shelves indoors within production facilities, warehouses, and other industrial locations where access to the public is restricted.

MiR250 Shelf Carrier is classified as a driverless industrial truck.

Users operate MiR250 Shelf Carrier via a web-based user interface—see "Connecting to the robot interface" on page 48.

Program missions to send the robot to locations in its work areas. Missions can be initiated on demand or scheduled to run autonomously using an external system. The robot uses a map of its work area to plan paths between positions. While operating, the robot automatically avoids obstacles and personnel and replans its route if its chosen route is blocked.

For more information about how to set up the site, see *MiR Commissioning Guide*. You can find this guide on MiR Support Portal.

MiR250 Shelf Carrier transports shelves that are designed according to the specifications in "Shelf specifications" on page 148. To ensure that the robot has enough traction to transport a total payload of up to 300 kg, a traction kit is installed within the robot.

The total payload includes both the weight of the shelf and the load on the shelf.

2.1 Intended use

MiR250 Shelf Carrier is intended to be commissioned and used in indoor industrial environments where access for the public is restricted. For details about the environmental conditions in which MiR250 Shelf Carrier should operate, see "Specifications" on the next page.

MiR250 Shelf Carrier is intended to be commissioned according to the guidelines in *MiR Commissioning Guide*. This is a prerequisite for safe usage of MiR250 Shelf Carrier. You can find this guide on MiR Support Portal.

MiR250 Shelf Carrier is equipped with safety-related features that are purposely designed for collaborative operation where the robot operates without a safety enclosure or together with people—see "Safety-related functions" on page 79.

MiR250 Shelf Carrier is designed for and all risks are considered when it is used to transport shelves that fulfill the specification and design requirement described in "Shelf specifications" on page 148.

MiR250 Shelf Carrier is a completed MiR application that consists of a MiR250 with a mounted MiR Shelf Carrier 250. The application is CE marked as long as it is not modified or altered. However, a CE marked application does not guarantee a CE marked setup. It is the responsibility of the commissioner to commission MiR250 Shelf Carrier safely.

NOTICE

A safe machine does not guarantee a safe system. Follow the commissioning guidelines in *MiR Commissioning Guide* to ensure a safe system. You can find this guide on MiR Support Portal.

2.2 Specifications

For a complete list of all the robot specifications, see MiR Support Portal.

Robot specifications

Model	MiR250 Shelf Carrier
Maximum speed	2 m/s
IP rating	IP21
Maximum payload	300 kg (including the weight of the shelf)
Maximum supporting force on carrier pin	0 N

Operational draw (drawbar pull)	420 N
Emergency stop draw at high friction	728 N
Motor force at full current	700 N
Maximum inertia	22 kg × m^2

Battery

Battery model	MiR 48V Battery
Battery type	Lithium-ion
Battery weight	14 kg
Battery dimensions	495×210×75 mm

Environment

Maximum incline/decline	Not supported while carrying a shelf
Maximum traversable gap	20 mm
Maximum traversable step	20 mm
Storage temperature (3 month storage)	-20–45°C
Operation temperature	5–40°C
Floor surface condition	Clean and dry
Floor to wheel frictional coefficient	0.60–0.80 (recommended)

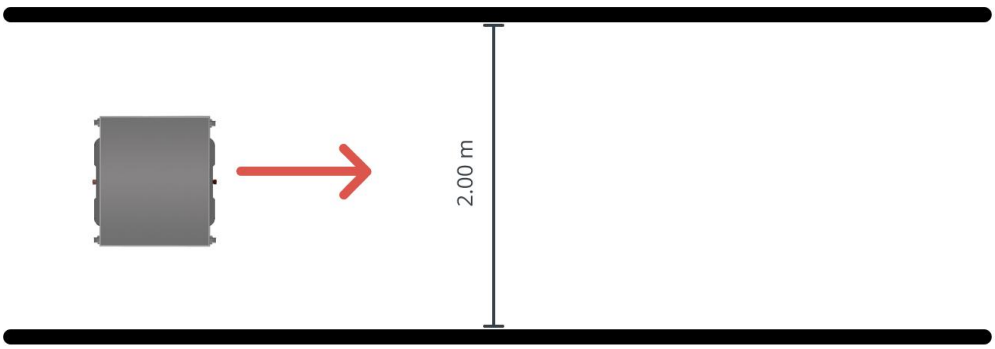
Material the robots cannot detect reliably	Transparent, translucent, glossy, reflective, and light emitting [1]
Optimal light conditions	Even and steady lighting (strong directional light can cause the robot to detect non-existent obstacles)
Relative humidity (non-condensing)	20–95%

2.3 Required space

The required space dimensions for your robot are illustrated in the following images. When the robot is carrying a shelf, the required space depends on the size of the shelf. These examples are suitable for a shelf with the dimensions 0.790 m × 0.800 m, a bar length of 0.550 m, a bar distance of 0.765 m.

For more information about how you can use zones and modified settings to reduce the space requirements, see *MiR250 Space Requirement Best Practices*. If you modify the footprint of the robot, you can use the Space calculator to determine an estimate of how much space the robot needs. You can find the guide and calculator on MiR Support Portal.

Figure 2.1 The required space when the robot drives straight



[1]We recommend either avoiding these materials, covering them with opaque and matte material the robot can detect, or ensuring the robot does not operate in areas with these materials.

Figure 2.2 The required space when the robot takes a 90° turn

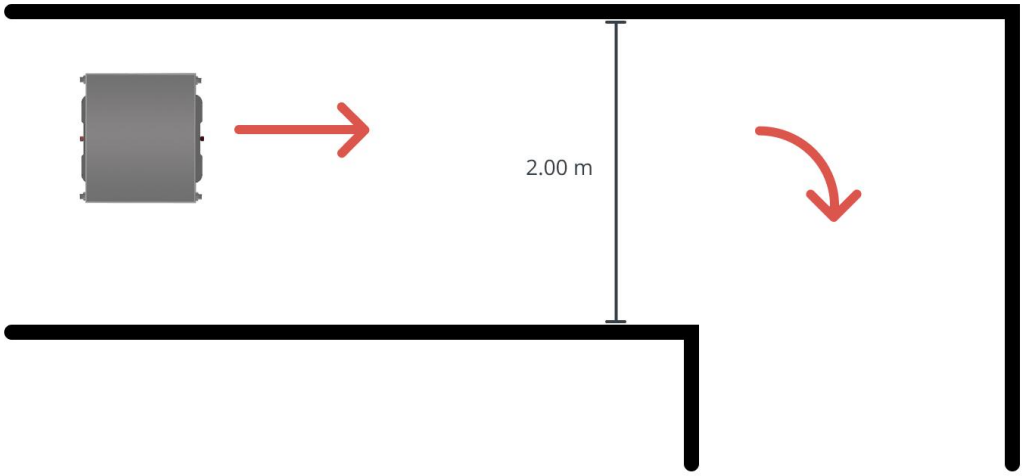


Figure 2.3 The required space when the robot drives through a doorway

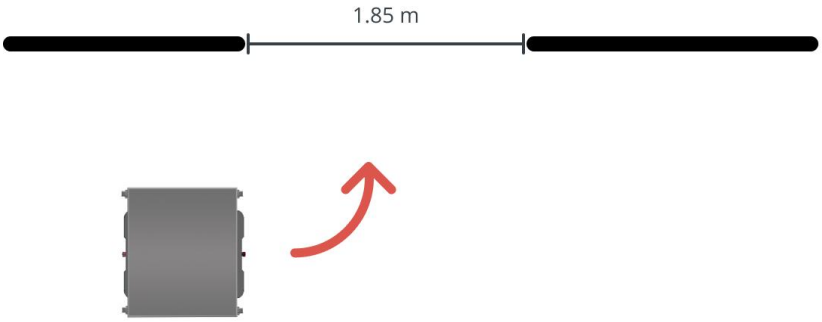


Figure 2.4 The required space when two robots pass each other

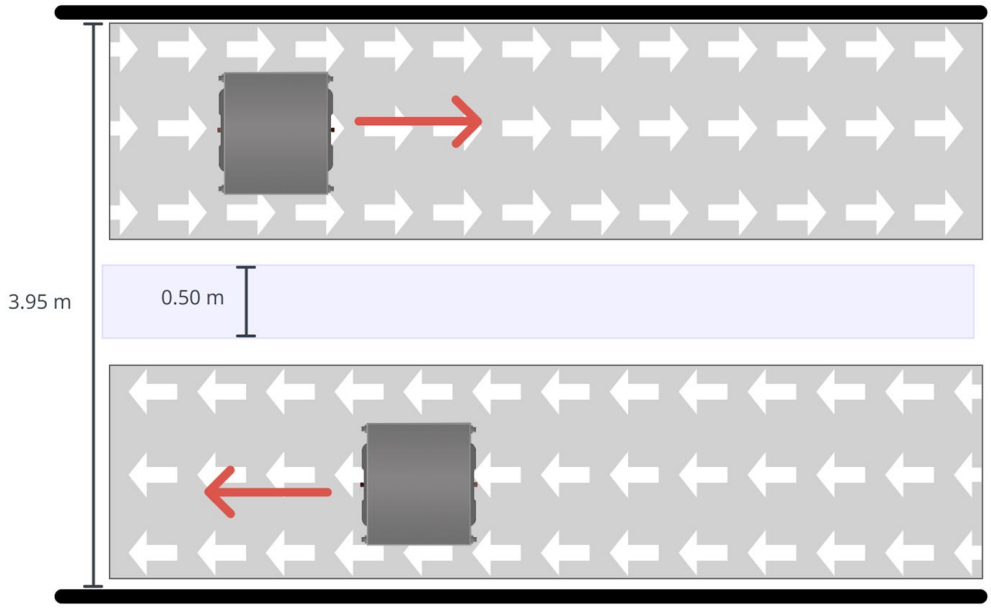
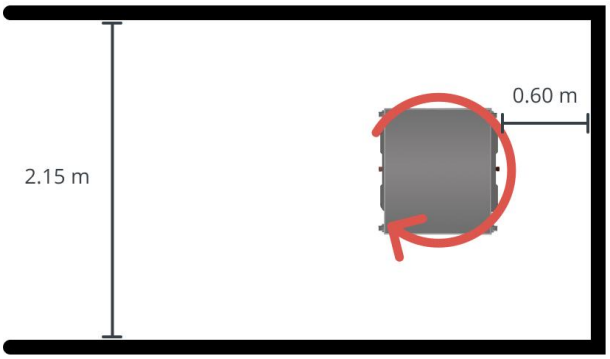


Figure 2.5 The required space when the robot pivots



2.4 Compatible products

The following accessories are available for MiR250 Shelf Carrier:

- **MiR Fleet**
  MiR robots can be operated individually or as a part of a fleet. MiR Fleet is the compatible fleet manager for MiR robots. MiR Fleet offers centralized control of robots throughout all of your facility. MiR Fleet is available as an installation file you can install on a server of your choice or as a computer server where MiR Fleet comes pre-installed. See *MiR Fleet Server Solution User Guide* and *MiR Fleet PC User Guide* for more information. You can find these guides on MiR Support Portal.
- **MiR Charge 48V**
  MiR Charge 48V enable MiR robots to recharge their batteries. Together with MiR Fleet, charging of robots can be fully automated, ensuring that robots never run out of power during missions.

2.5 How MiR Shelf Carrier 250 top module works

When MiR250 Shelf Carrier docks to a shelf, the carrier pins can be raised to pick up a shelf and lowered to place a shelf at a Shelf position.

MiR250 Shelf Carrier uses the shelf legs as markers to position itself correctly under the shelf.

MiR250 Shelf Carrier uses an I/O module in the safety PLC to monitor the position of the carrier pins. The control system in the robot uses two inputs and two outputs to control the pins in MiR Shelf Carrier 250 top module.

The outputs are used to control the position of the pins, and the inputs are used to signal the current position of the MiR Shelf Carrier 250 top module—see "Testing the top module" on page 72.

To see the menu options for the I/O modules under **Setup > IO modules**, the I/O module feature must be enabled—see "Enable the MiR250 Shelf Carrier feature" on page 70.

Table 2.1 Descriptions of how the robot's internal outputs control the shelf carrier

Output	Function
2	Lowers the carrier pins when active.
3	Raises the carrier pins when active.

Table 2.2 Descriptions of what the robot's internal inputs signal regarding the status of the shelf carrier

Input	Function
2	Is active when the carrier pins are down.
3	Is active when the carrier pins are up.

2.6 External parts

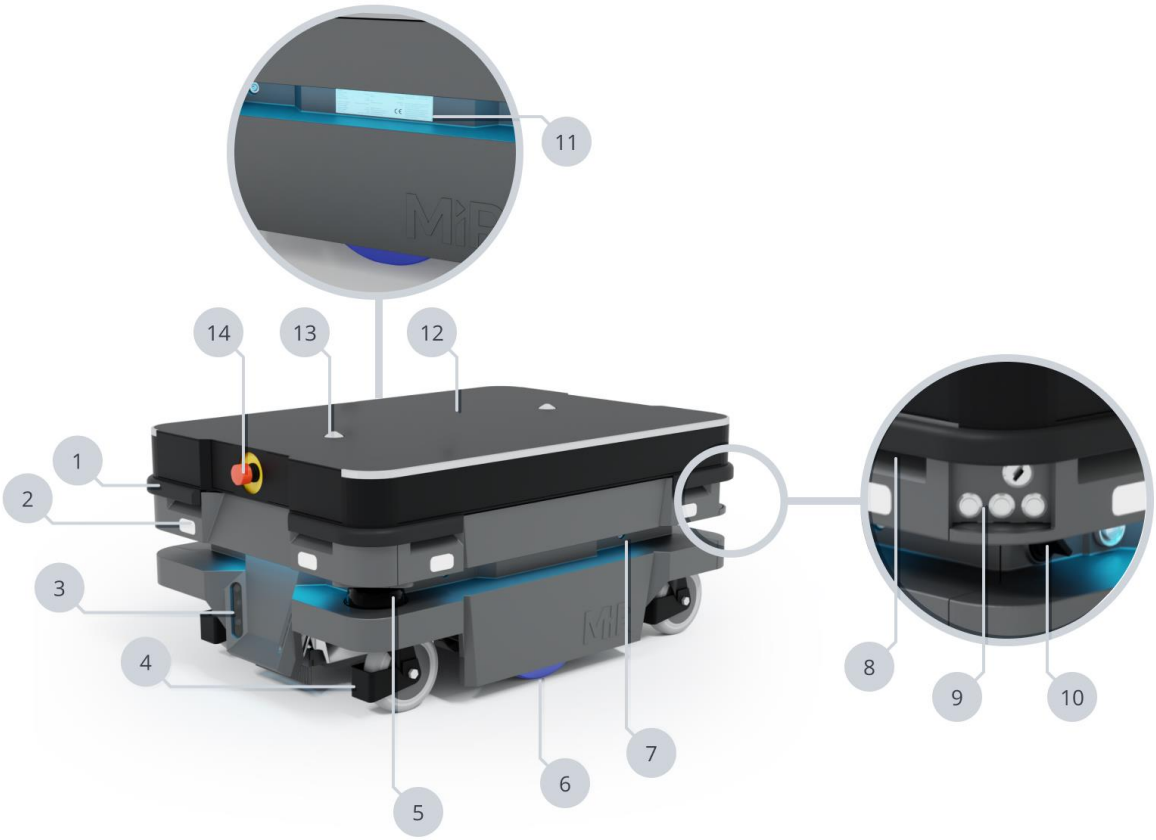


Table 2.3 Identification of the external parts in 2.6

Pos.	Description	Pos.	Description
1	Corner bumper: four pcs., one on each corner	2	Signal light: eight pcs., two on each corner—see "Light indicators and speaker" on page 65
3	3D depth camera: two pcs., both in the front	4	Caster wheel with foot guard: four pcs., one in each corner

Pos.	Description	Pos.	Description
5	nanoScan3 safety laser scanner: two pcs., in opposite corners	6	Drive wheel: two pcs., one on each side of the robot.
7	Status light: on all four sides of the robot—see "Light indicators and speaker" on page 65	8	Proximity sensor: eight pcs., two in each corner behind corner covers
9	Control panel—see "Control panel" on page 53	10	Manual brake release switch—see "Control panel" on page 53
11	Nameplate	12	MiR Shelf Carrier 250 top module
13	Carrier pin: two pcs., one on each end of MiR Shelf Carrier 250	14	Emergency stop button: two pcs., one on each end of MiR Shelf Carrier 250

2.7 Internal parts

Most internal parts of MiR250 Shelf Carrier are accessed through covers that open to different compartments—see "Accessing the internal parts" on page 110.

CAUTION

Removing covers from the robot exposes parts connected to the power supply, which can result in a short circuit that will damage the robot and could injure personnel.

- Before removing any covers, turn off the robot.
- Start by removing the rear cover, and disconnect the battery—see "Disconnecting the battery" on page 141.

Front compartment

Figure 2.6 Internal parts of the front compartment

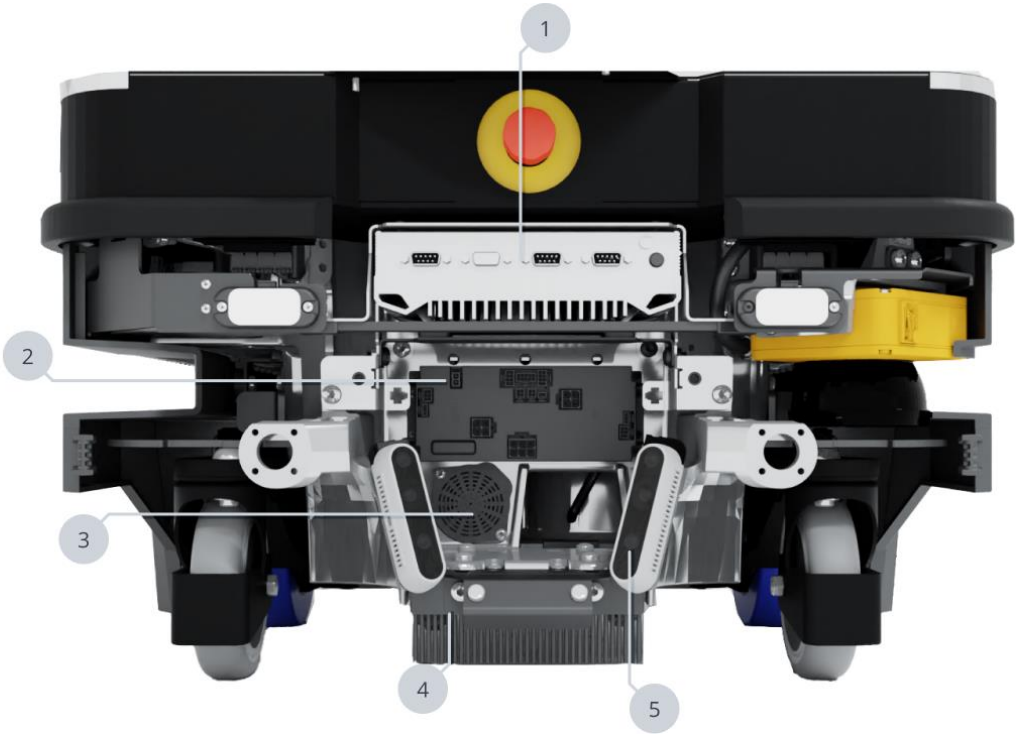


Table 2.4 Identification of internal parts in Figure 2.6

Pos.	Description	Pos.	Description
1	Robot computer	2	Motor controller carrier board
3	Speaker	4	Charging pads under robot and broom
5	3D cameras		

Rear compartment

Figure 2.7 Internal parts of the rear compartment

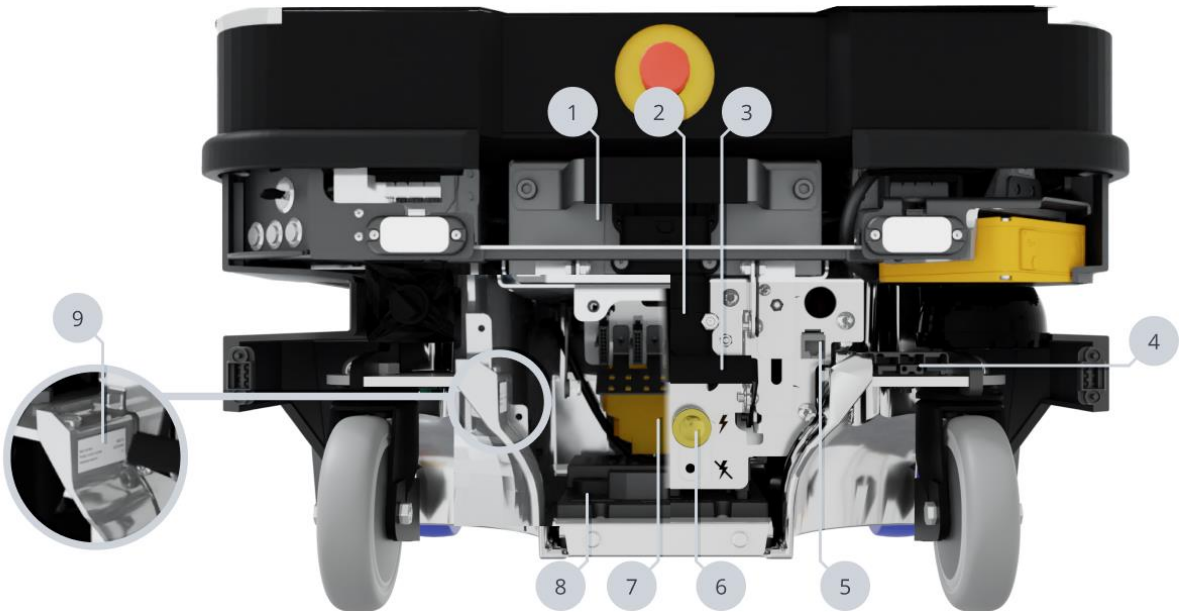


Table 2.5 Identification of internal parts in Figure 2.7

Pos.	Description	Pos.	Description
1	Battery	2	Battery connector
3	Battery lever	4	Cable charging interface
5	Ethernet port	6	Battery lever lock
7	Safety PLC	8	Power board
9	Identification label		

Side compartments

NOTICE

The unique nameplate of your robot is on the right side compartment cover. Make sure you do not swap the cover with covers from other robots.

Figure 2.8 Internal parts of the left side compartment

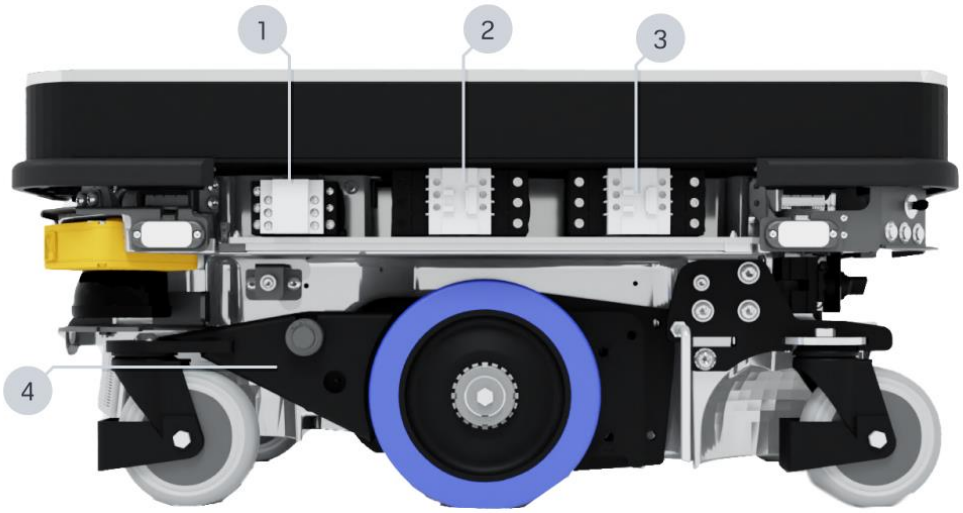


Table 2.6 Identification of internal parts in Figure 2.8

Pos.	Description	Pos.	Description
1	Safe Stop 1 (SS1) contactor	2	Safe Torque Off (STO) contactor
3	Safe Torque Off (STO) contactor	4	Bogie and drivetrain

Figure 2.9 Internal parts of the right side compartment

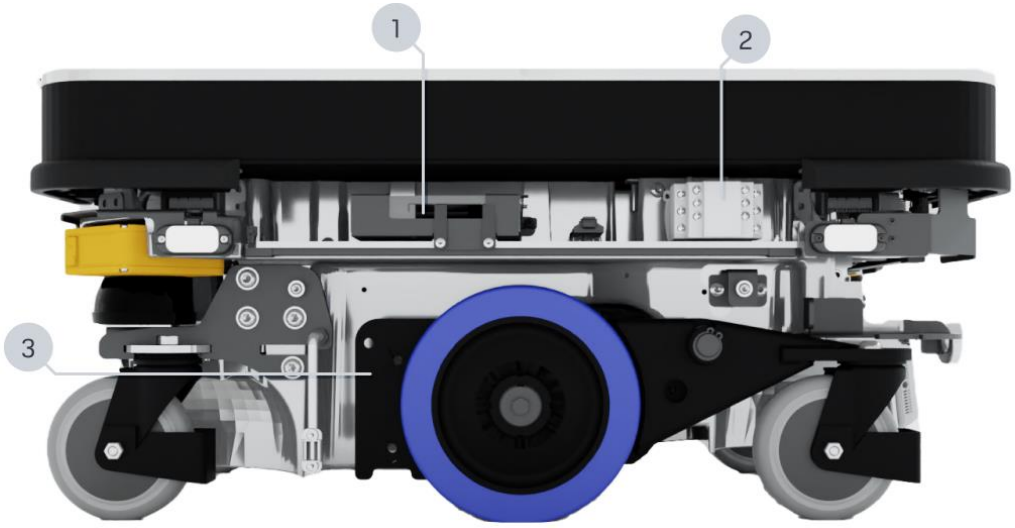


Table 2.7 Identification of internal parts in Figure 2.9

Pos.	Description	Pos.	Description
1	Switch	2	Safe Stop 1 (SS1) contactor
3	Bogie and drivetrain		

Top compartments

The top compartments are only accessible after the top module has been removed—see "Demounting the top module" on page 169.

For more information on electrical interfaces, see "Electrical interfaces" on page 176.

Figure 2.10 Interfaces in the top compartments

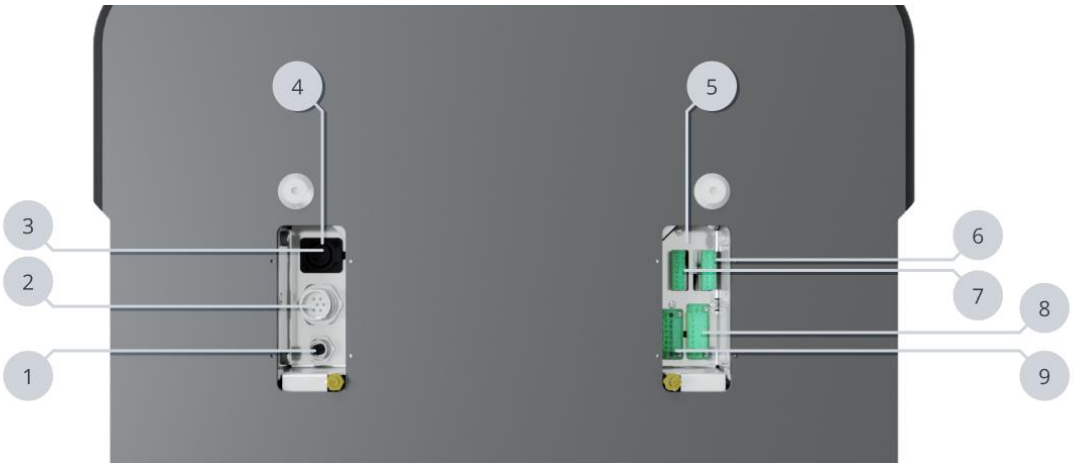


Table 2.8 Identification of interfaces in Figure 2.10

Pos.	Description	Pos.	Description
1	Ethernet	2	Auxiliary power connector
3	Emergency stop	4	Left top compartment
5	Right top compartment	6	General purpose outputs
7	General purpose inputs	8	Auxiliary safety functions I/Os A
9	Auxiliary safety functions I/Os B		

MiR Shelf Carrier 250

Figure 2.11 Internal parts in MiR Shelf Carrier 250

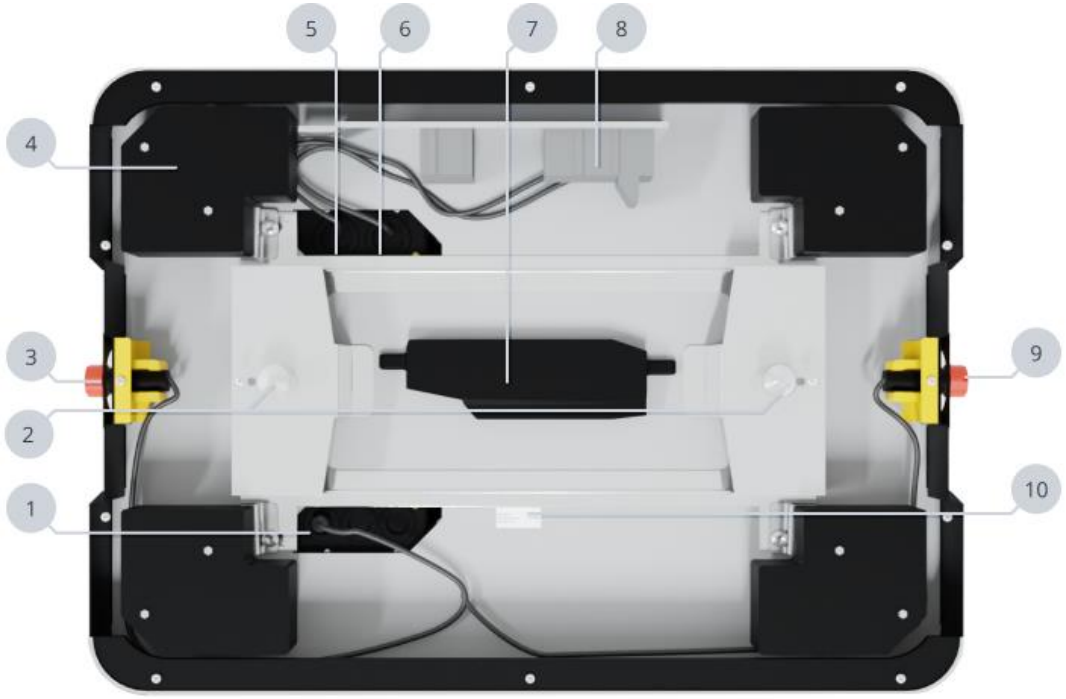


Table 2.9 Identification of internal parts in Figure 2.11

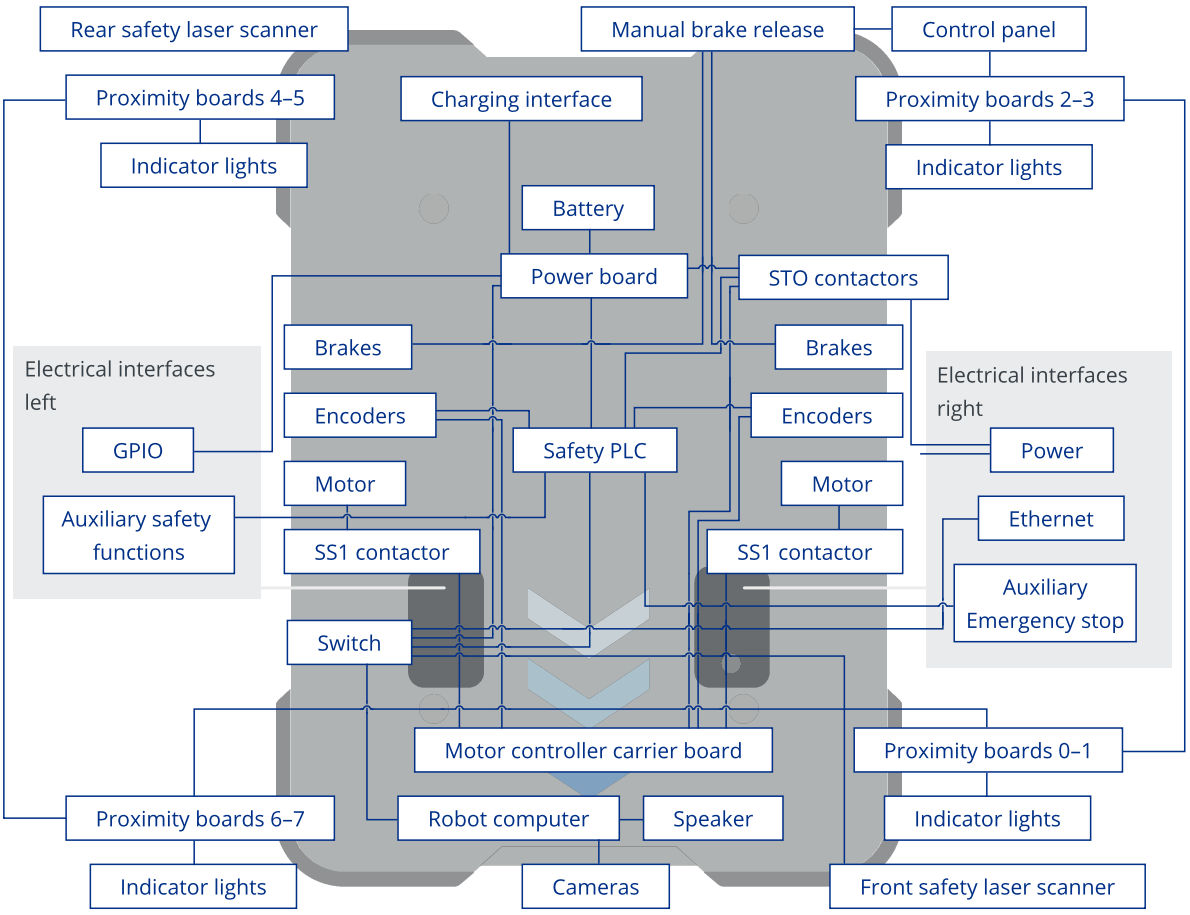
Pos.	Description	Pos.	Description
1	Emergency stop connector	2	Carrier pins
3	Front Emergency stop button	4	Weights
5	GPIO connectors	6	Auxiliary safety IO connectors
7	Lifting mechanism and actuator	8	Safety contactors K1 and K2
9	Rear Emergency stop button	10	Identification label

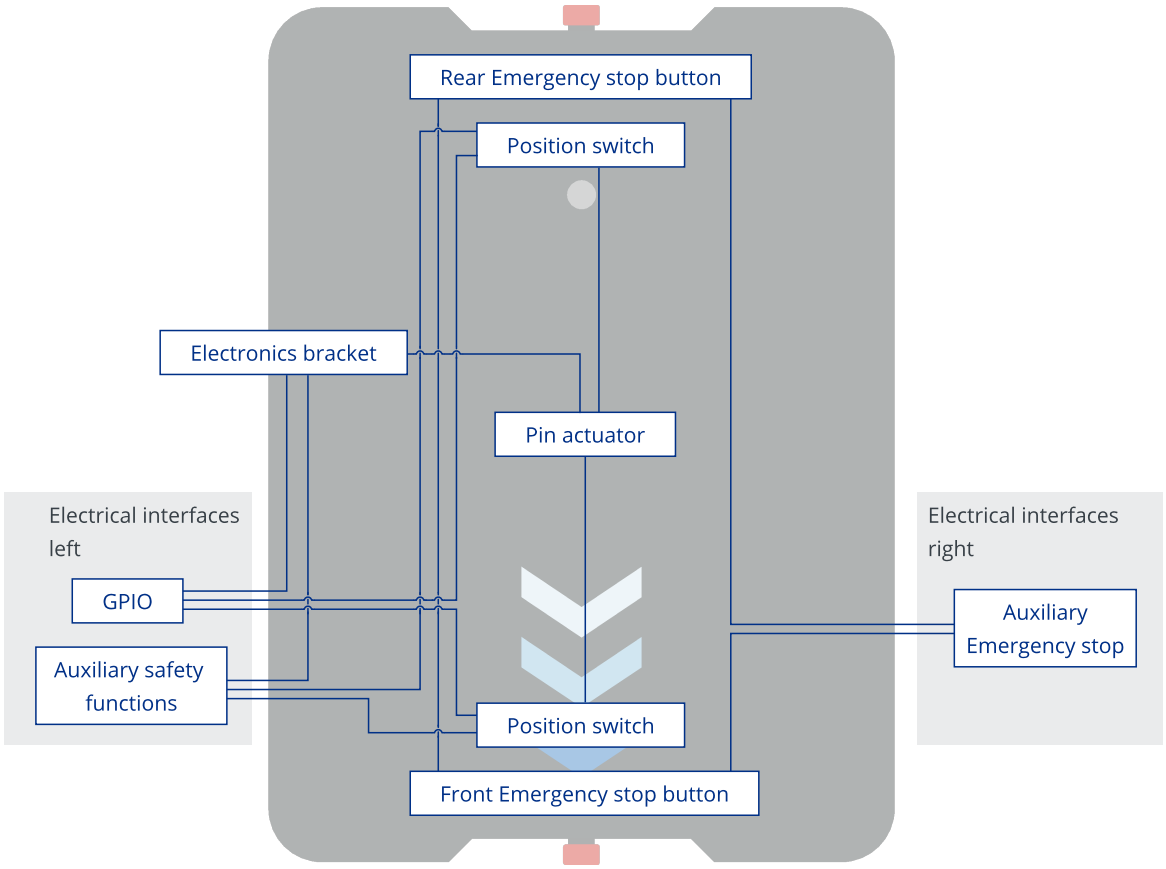
2.8 System overview

Figure 2.12 identifies the main functional components in MiR250 Shelf Carrier. They are organized in their approximate location inside the robot. To identify the exact location see "Internal parts" on page 23.

The lines between components indicate a significant connection either for communication or power. For more detailed schematics, see the wiring diagram for MiR250 Shelf Carrier on MiR Support Portal.

Figure 2.12 Overview of the internal components and how they are connected in MiR250 Shelf Carrier





2.9 Warranty

Mobile Industrial Robots offers a standard warranty on all products.

Contact your distributor to see the terms and extent of product coverage.

NOTICE

Mobile Industrial Robots disclaims any and all liability if MiR250 Shelf Carrier or its accessories are damaged, changed, or modified in any way. Mobile Industrial Robots cannot be held responsible for any damages caused to MiR250 Shelf Carrier, accessories, or any other equipment due to programming errors or malfunctioning of MiR250 Shelf Carrier.

3. Safety

Read the information in this section before powering up and operating MiR250 Shelf Carrier.

Pay particular attention to the safety instructions and warnings.

3.1 Safety message types

This document uses the following safety message types.

WARNING

Indicates a potentially hazardous situation that could result in death or serious injury. Carefully read the message that follows to prevent death or serious injury.

CAUTION

Indicates a potentially hazardous situation that could result in minor or moderate injury. Alerts against unsafe practices. Carefully read the message that follows to prevent minor or moderate injury.

NOTICE

Indicates important information, including situations that can result in damage to equipment or property.

Tells you where you can find more information about the topic.

3.2 General safety precautions

This section contains general safety precautions.

CAUTION

Harmful electromagnetic interference might be the result of having two radio modules transmitting at the same time. The robot is certified to have only one radio module active at any given time.

- Do not attach an access point or additional radio modules to the robot while it is connected to a wireless network.

CAUTION

If the robot starts up unexpectedly, there is a risk of injury to nearby personnel or damage to equipment.

- Inform personnel that robots may start driving without any warning.
- Design missions so the robot indicates to personnel that it will begin an action that makes it move. You can, for example, use a Play sound or Show light action to warn nearby personnel.

WARNING

If the robot is not running the correct software and is therefore not functioning properly, the robot may collide with personnel or equipment causing injury or damage.

- Ensure that the robot is always running the correct software.

WARNING

The robot may drive over the feet of personnel, causing injury.

- All personnel must be informed of the side Protective fields of the robot and be instructed to wear safety shoes near an operating robot—see "Field switching and Personnel detection" on page 86.

WARNING

The robot may drive into a ladder, scaffold, or similar equipment that has a person standing on it. Personnel risk fall injuries, and equipment may be damaged.

- Do not place ladders, scaffolds, or similar equipment in the robot's work environment.

WARNING

The robot may drive down staircases or holes in the floor and cause serious injury to personnel and damage to the robot and to equipment.

- Mark all descending staircases and holes as Forbidden zones on maps.
- Install physical barriers around descending staircases and holes that are in the robot's operating area. If the hazard is not close to the robot's operating area, it may be sufficient to use a Forbidden zone on its own.
- Keep the maps up to date.
- Inform personnel that the robot cannot detect descending staircases and holes in the floor in time to stop.

WARNING

Contact with live electrical parts can cause electric shock.

- Do not touch any internal components of the robot while it is powered.

CAUTION

This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

- Do not use the robot in residential environments.

NOTICE

The robot cannot reliably detect forklift forks or empty pallets. The robot may drive into forks or pallets causing damage to the robot's load, the robot, or equipment.

- Avoid leaving empty forklifts in the robot's operating environment.
- Inform personnel that the robot will not detect forklift forks or empty pallets.
- Inform personnel that the safety laser scanners are the only safety-rated sensors, but are limited to the scanner detection plane and are not intended for detecting forks and pallets. At any other height, only the 3D cameras and proximity sensors can potentially detect obstacles.
- Any modifications to the camera filter settings or the Obstacle clearing settings may affect how well the robot can detect obstacles in front of the robot, above or below the safety laser scanner detection plane. Test and evaluate the robot's performance after applying any changes to ensure the robot performs as intended.

WARNING

Personnel standing next to the robot when it is docking to a shelf risk being injured by an impact.

- Ensure that docking positions are clearly marked as operating hazard zones with visible tape or similar marking and that all personnel are instructed not to stand in the hazard zone when the robot is docking.

WARNING

The robot risks damage and mechanical failure if it is used to transport pallets or anything other than safely commissioned shelves. Nearby equipment and personnel risk damage or injury respectively if payloads fall from the robot.

- Only use the robot to transport safely commissioned shelves—see "Shelf specifications" on page 148.

WARNING

Personnel standing in the blind spot of the robot when it is pivoting with a shelf risk being struck and injured.

- Ensure that all nearby personnel are instructed not to stand close to the robot when it is pivoting.
- Inform personnel that the signal lights indicate when the robot is intending to turn or pivot—see "Light indicators and speaker" on page 65.

WARNING

If a load is positioned incorrectly on a shelf, the load may fall off causing serious injury to personnel and damage to the robot and to equipment.

- Ensure that every load is positioned correctly on the shelf. During commissioning, determine correct and safe methods of loading shelves.
- Conduct a brake test while the robot is transporting a fully loaded shelf—see "Brake test" on page 159.

WARNING

If the robot attempts to dock to a shelf and the carrier pins are raised or the robot is misplaced, the robot may push the shelf. The shelf may collide with personnel or equipment, resulting in injury or damage respectively.

- Ensure that docking positions are clearly marked as operating hazard zones with visible tape or similar marking, and that all personnel are instructed not to stand close to the robot when it is docking.

WARNING

If the robot does not attach to the shelf correctly due to pins being offset from their correct positions, the shelf can detach at any time. Uncertain control of the shelf may result in the shelf or its load colliding with personnel or equipment resulting in injury or damage respectively.

- Ensure the shelf is designed according to specifications—see "Shelf specifications" on page 148. The laser scanners will then be able to detect if the shelf is incorrectly positioned and will enter Protective stop before operating with the shelf.

WARNING

If the robot drives on a slope and loses grip of the attached shelf, the shelf or its load may collide with personnel or equipment causing injury or damage respectively.

- Do not operate MiR250 Shelf Carrier on slopes.

WARNING

If the robot transports a shelf with a load that extends the footprint of the robot, the load may collide with personnel or equipment causing injury or damage respectively.

- Do not load the shelves with loads that exceed the robot's footprint.

CAUTION

Robot malfunctions can cause an electrical fire, causing damage and injury to equipment and personnel.

- Personnel operating near the robot must be informed on how to use an ABC fire extinguisher to put out an electrical fire should the robot malfunction and catch on fire.

CAUTION

Risk of trapping or injury to personnel if robots malfunction or if personnel enter operating hazard zones.

- Personnel operating near the robot must be informed on how to engage the robot's Emergency stop function in emergency situations.
- Ensure that all personnel are instructed to stay clear of operating hazard zones when the robot is in the zone.

3.3 Warning label

MiR250 Shelf Carrier is supplied with a warning label that specifies that it is strictly prohibited to ride on the robot.

The label must be placed on the robot or top module so that it is clearly visible.

Figure 3.1 The warning label must be placed on the robot or top module

3.4 Foreseeable misuse

Any use of MiR250 Shelf Carrier deviating from the intended use is deemed as misuse. This includes, but is not limited to:

- Using the robot to transport people
- Using the robot on inclines outside the robot's specifications
- Making changes to the SICK configuration
- Driving the robot on cross slopes
- Exceeding the maximum payload
- Positioning or fastening loads incorrectly according to the specifications—see "Payload distribution and stability" on page 201
- Using Emergency stop buttons for anything other than emergency stops
- Driving the robot with anything other than safely commissioned shelves—see "Shelf specifications" on page 148.
- Using the robot in medical and life critical applications
- Operating the robot outside the permissible operating parameters and environmental specifications
- Using the robot in potentially explosive ATEX environments
- Using the robot outdoors
- Using the robot in hygiene zones

- Using MiR top modules that are not specifically made for MiR250
- Using the robot together with an external radio module that in any way results in simultaneously active radio transmitters

3.5 Residual risks

Mobile Industrial Robots has identified the following potential hazards that commissioners must inform personnel about and take all precautions to avoid when working with MiR250 Shelf Carrier:

- You risk being run over, drawn in, trapped, or struck if you stand in the path of the robot or walk towards the robot or its intended path while it is in motion.
- You risk being run over, drawn in, trapped, or struck if you stand in the path of the robot or walk towards it while it is driving in reverse. The robot only drives in reverse when undocking from a marker, such as a charging station or load transfer station.
- You risk being crushed or trapped if you touch the robot while it is in motion.
- You risk being run over, drawn in, trapped, or struck if you stand in the path of the robot or walk towards it while it is docking to a shelf.
- You risk being crushed or trapped between the robot and a shelf while the lift is picking up a shelf.
- You risk being crushed or trapped if the robot places a load outside a designated drop-off area due to faulty localization.
- You risk losing control of the robot if it is accessed by unauthorized users. Consider increasing the IT security of your product.

WARNING

Other significant hazards may be present in a specific robot installation. Failure to identify hazards may result in injury to personnel or damage to equipment.

- Identify all hazards specific to your robot installation during commissioning.

4. Getting started

To get the robot started, see the guide *MiR250 Shelf Carrier Quick Start* delivered with the robot, or follow these steps:

1. Unpack MiR250 Shelf Carrier—see "Unpacking MiR250 Shelf Carrier" on the next page.
2. Connect the battery—see "Connecting the battery" on page 139.
3. Connect to the robot's interface—see "Connecting to the robot interface" on page 48.
4. If you want, connect the robot to a Wi-Fi network—see "Connecting the robot to a Wi-Fi network" on page 50.
5. Drive the robot off the pallet using Manual mode—see "Operating the robot" on page 56.
6. Use *MiR Commissioning Guide* to start commissioning the robot and planning your site. For help using the robot interface, see *MiR Robot Interface Guide*. For in-depth information about how MiR products work, see *MiR Technical guides*. You can find these guides on MiR Support Portal.

4.1 In the box

The box contains:

- The MiR250 Shelf Carrier robot
- Two external antennas
- A SICK safety laser scanner optics cover cleaning cloth

- A MiR250 Shelf Carrier document folder containing the following printed documents:
  - *MiR250 Shelf Carrier Quick Start*
  - *The CE Declaration of Conformity* for your application
  - *Unpacking note*
  - *How to clean and test SICK safety laser scanners*

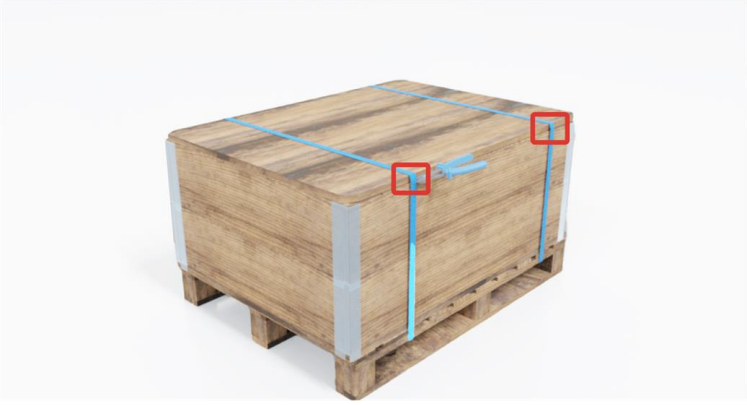
4.2 Unpacking MiR250 Shelf Carrier

Keep the original packaging for future transportation of MiR250 Shelf Carrier.

To unpack the robot, follow these steps:

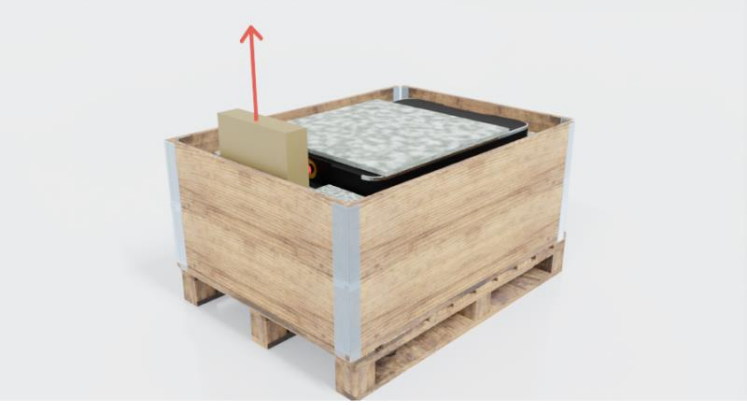
1. Place the box with the robot so that there is at least three meters of free space at the front or the back of the box. This is necessary as the robot drives out of the box on a ramp.

2. Cut the protective straps surrounding the box.



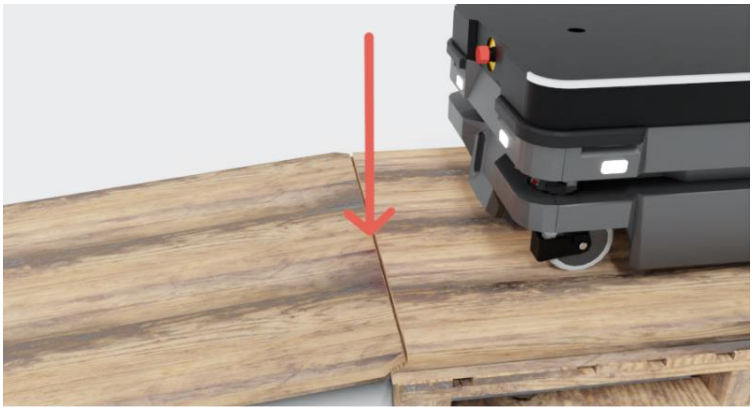
3 Remove the lid from the box.

4 Take the box with the antennas and printed documents out of the box.



5 Remove the pallet collars and the protective foam blocks.

6 Place the lid of the box so that you can use it as a ramp. Align the lid so that it is flush with the base of the box.



7 Screw on the two antennas, one on each end of the shelf carrier top module.

5. Usage

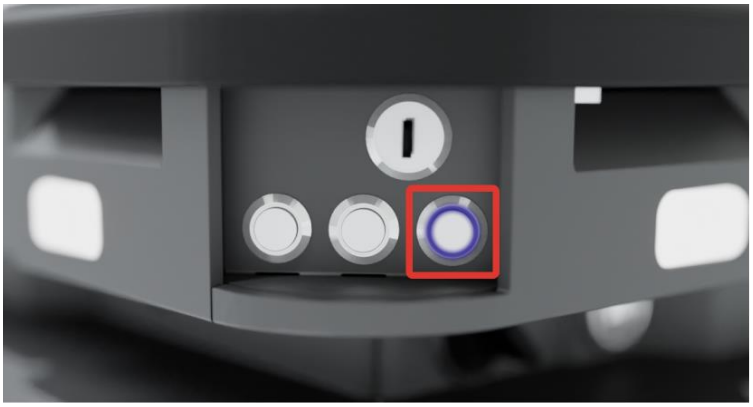
The following sections describe how the robot is operated and customized.

5.1 Powering up the robot

To power up the robot, follow these steps:

1. Make sure the battery is connected—see "Connecting the battery" on page 139.

2. Press the Power button for three seconds to turn on the robot.



The status lights waver orange, and the robot starts the software initialization process.

When the initialization process ends, the robot goes into Protective stop.

3 Press the Resume button to clear the Protective stop.

The robot is now ready for operation.

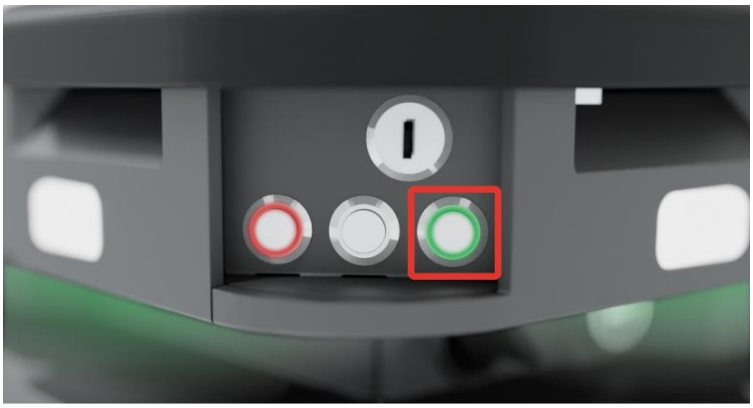
If you are not able to power up the robot upon delivery, see *MiR 48V Battery Technical Guide* to troubleshoot the issue. You can find this guide on MiR Support Portal.

5.2 Shutting down the robot

To shut down MiR250 Shelf Carrier, follow these steps:

1. Ensure that the robot is not moving or executing an action.

2. Press the Power button for three seconds.



3. Wait for the robot to finish the shutdown process. The status lights waver orange, and the Power button blinks red.

When the robot finishes the shutdown process, the status and signal lights go off.

When you shut down the robot for transportation, service, or repair, the battery must be disconnected—see "Disconnecting the battery" on page 141.

5.3 Connecting to the robot interface

When the robot is turned on, you can connect a PC, tablet, or phone to the robot's internal network via the RJ45 Ethernet port on the robot. Once connected, you can configure the robot's settings and connect it to a wireless network.

You can connect to the robot using an Ethernet cable or an access point. If you are located in North America, the EU, or a part of the EAC, you can purchase a MiR Access Point from MiR. Outside these areas, you need to use your own access point that is approved for use in your region. If you choose to use an access point, you must ensure that the robot is disconnected from the wireless network before attaching the access point to remain compliant—see "Connecting the robot to a Wi-Fi network" on page 50.

Whether you connect via Ethernet cable or an access point, it is recommended that your device is configured to DHCP. If you require a static IP on your device, assign an address above 192.168.12.150, and set the DNS server and Gateway address to 192.168.12.1.

CAUTION

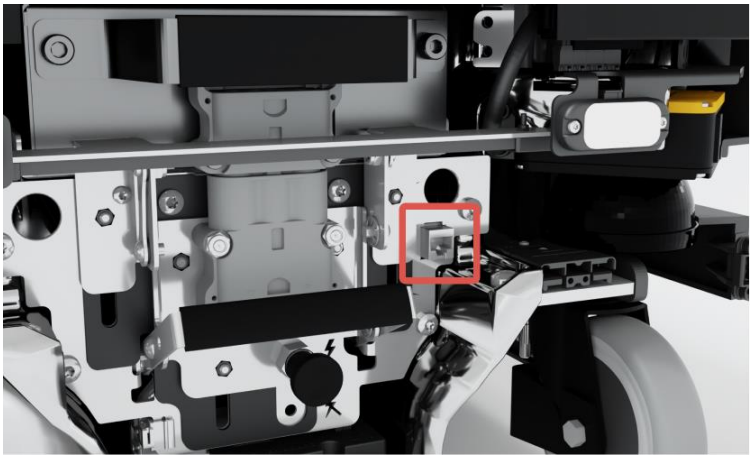
Harmful electromagnetic interference might be the result of having two radio modules transmitting at the same time. The robot is certified to have only one radio module active at any given time.

- Do not attach an access point or additional radio modules to the robot while it is connected to a wireless network.

To connect to the robot interface, follow these steps:

1. Remove the rear cover—see "Accessing the internal parts" on page 110.

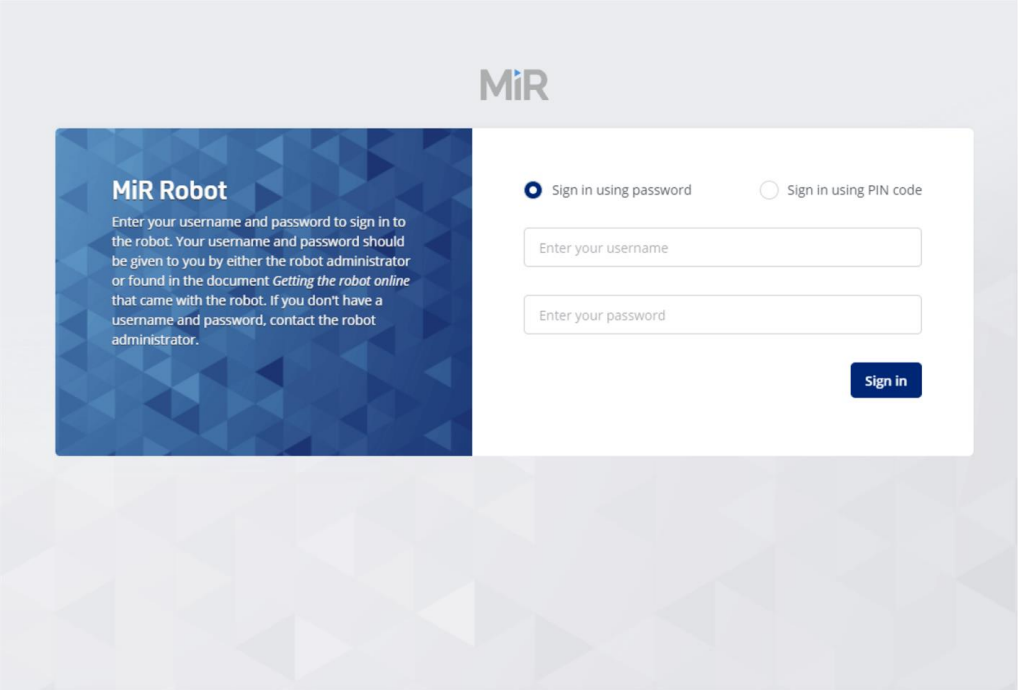
2. Locate the RJ45 Ethernet port in the rear compartment to the right of the battery fast-swap assembly.



3. Connect your device directly to the robot using an Ethernet cable, or connect an access point to the Ethernet port for a wireless connection.

4. If you are using an access point, connect your device to the access point. The MiR Access Point Wi-Fi has the following format: **MiR_3042XXXXX**. Use the password shipped with the access point to connect.

5 In a browser, go to the address **192.168.12.20** and sign in.



5.4 Connecting the robot to a Wi-Fi network

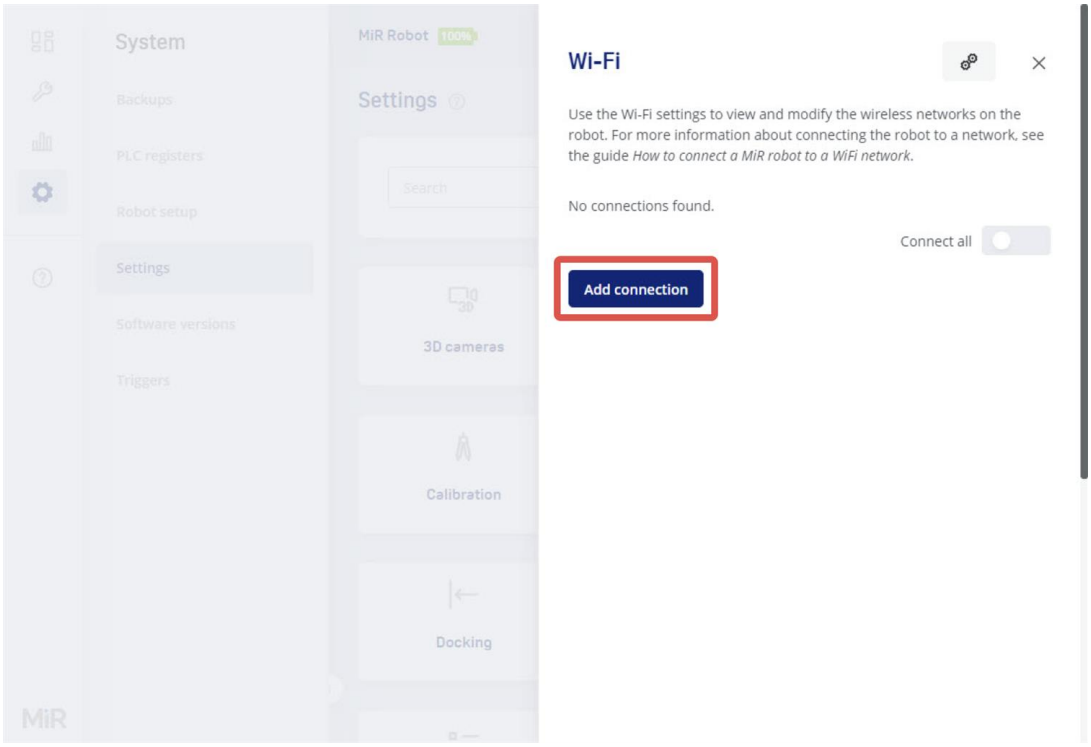
To communicate with the robot wirelessly without using an access point, connect the robot to your local Wi-Fi network. This enables you to access the robot interface via your Wi-Fi network by entering the assigned IP address of your robot in a web browser.

To connect the robot to a Wi-Fi network, follow these steps:

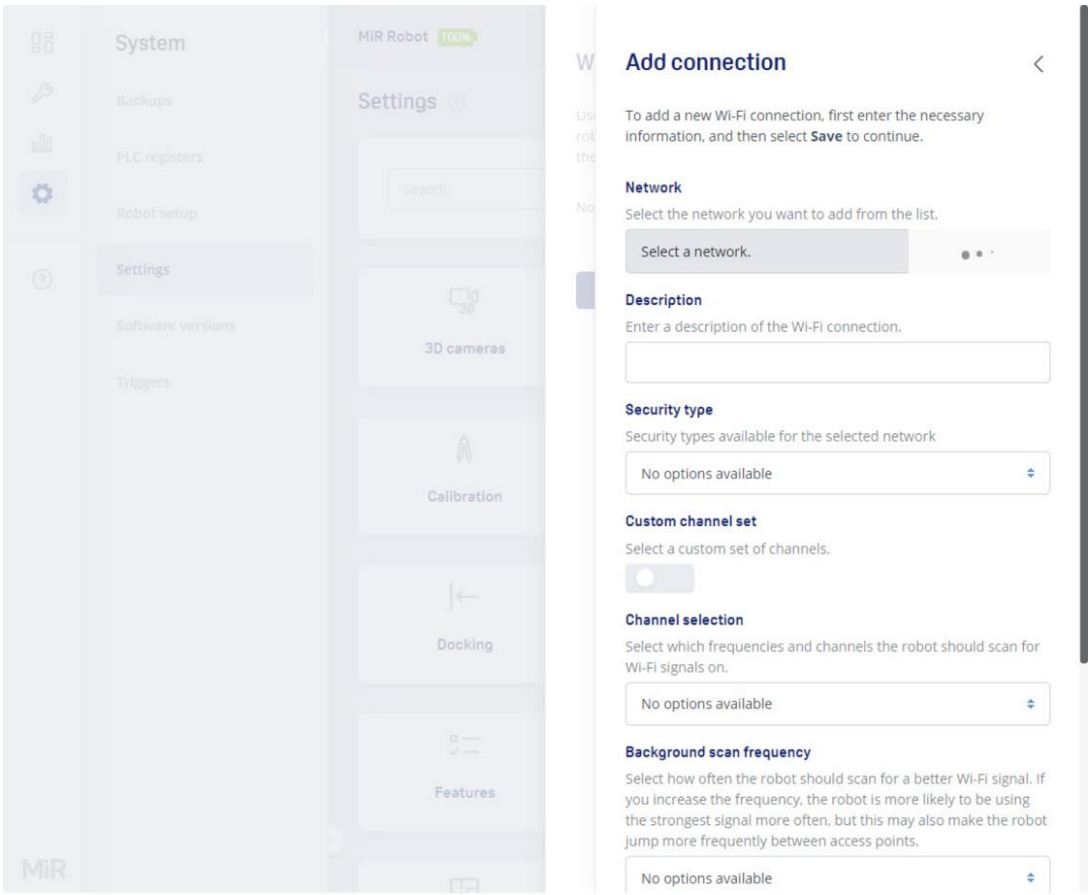
1 Connect to your robot as described in "Connecting to the robot interface" on page 48.

To comply with the robot's certification, you must use an Ethernet cable to avoid simultaneously active radio transmitters while setting up the connection to the local Wi-Fi network.

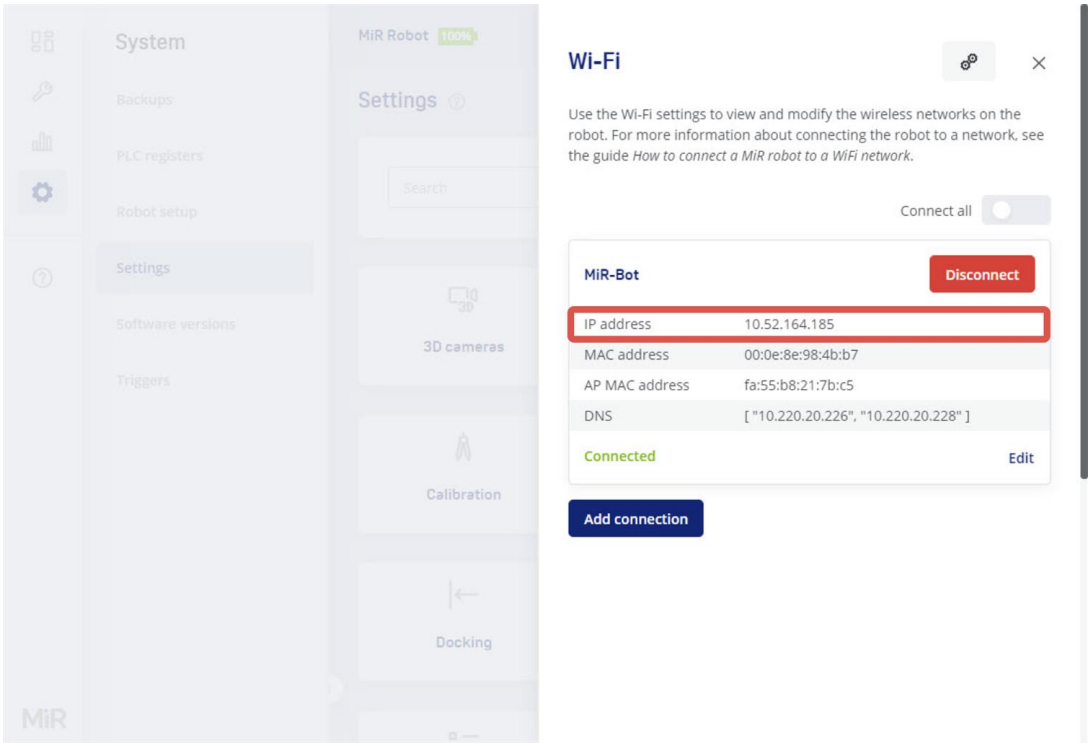
2 Go to **System > Settings > Wi-Fi**, and select **Add connection**.



3 Select the network you want the robot to be connected to, and fill out the displayed fields—see the guide *How to connect a MiR robot to a Wi-Fi network* for more information about the Wi-Fi settings. You can find this guide on MiR Support Portal.



4 Select **Add connection** when you have finished. The robot is now connected to the network. When you are connected to the same network, you can access the robot's interface by entering the IP address displayed under the connection description into your internet browser.



To disconnect the robot from a Wi-Fi network, select **Disconnect**.

5.5 Control panel

MiR250 Shelf Carrier has a control panel in the rear-left corner of the robot.

Figure 5.1 The MiR250 Shelf Carrier control panel

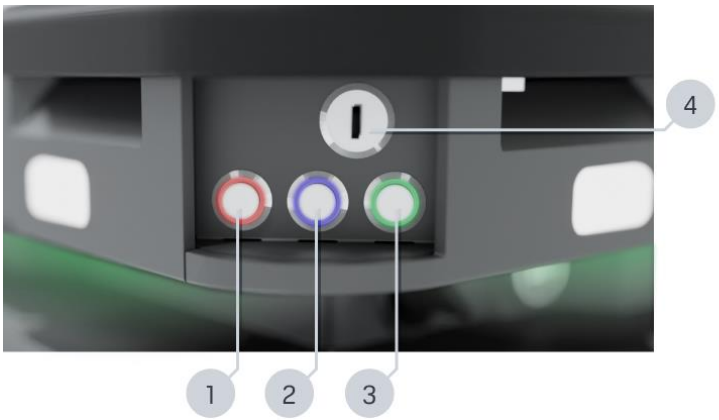


Table 5.1 Identification of items on the control panel in Figure 5.1

Pos.	Description	Pos.	Description
1	Manual stop button	2	Resume button
3	Power button	4	Operating mode key

Manual stop button

Pressing this button stops the robot. After pressing this button, you must press the Resume button to let the robot continue operating.

Color indication:

- Red: It is possible to engage the Manual stop.

Resume button

Pressing this button:

- Clears the Emergency or Protective stop state.
- Lets the robot continue operating after the Manual stop button was pressed or after the operating mode changes.
- Lets the robot start operating after powering up.

Color indication:

- Blinking blue: The robot is waiting for a user action. For example, press the button to clear a Protective stop or acknowledge the change of operating mode.

Power button

Pressing this button for three seconds turns the robot on or shuts it off.

Color indication:

- Blinking green: The robot is starting up.
- Green: Normal operation.
- Blinking blue: The robot is checking that the battery level is high enough to start up.
- Blinking red: The battery level is too low to start without additional charging, or the robot is shutting down.

The Operating mode key

The Operating mode key lets you switch between operating modes.

- Left position: Autonomous mode. Puts the robot in Autonomous mode.
- Middle position: Locked mode. The robot blocks the wheels; you cannot start a mission or drive the robot manually.
- Right position: Manual mode. Puts the robot in Manual mode.

For more information on operating modes, see "Operating the robot" on the next page.

5.6 Preventing unauthorized use

To prevent unauthorized users from accessing the robot:

- Keep passwords to connect to the robot interface and the robot components strictly confidential. Assign each robot user with their own user in the interface and make sure they each have a unique username and password.

- Follow guidelines in *MiR Cybersecurity Guide*. You can find this guide on MiR Support Portal.
- Always remove the Operating mode key from the robot when it is operating.

5.7 Operating the robot

MiR250 Shelf Carrier has three operating modes: Manual mode, Autonomous mode, and Locked mode.

Manual mode

In this mode, you can drive the robot manually using the joystick in the robot interface. Only one person can control the robot manually at a time.

Manual mode is only intended for initial setup, maintenance situations, or deadlocks.

To control the robot manually, you must connect to the robot interface—see "Connecting to the robot interface" on page 48.

CAUTION

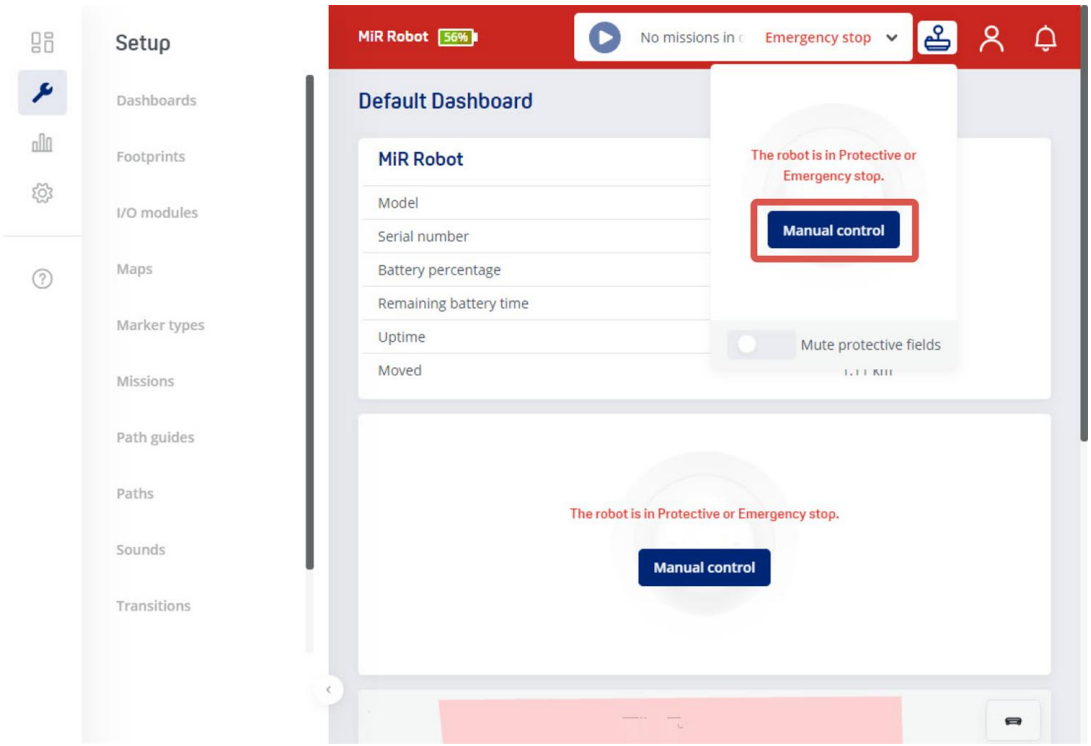
When driving the robot in Manual mode it is the driver's responsibility to ensure the safety of nearby personnel. Failure to be aware of the risks and operate the robot with caution can result in injury to personnel or damage to equipment.

- Drive carefully to avoid collisions with any personnel or objects when driving the robot in Manual mode.
- Avoid driving the robot manually without a clear visual of the robot.
- Be aware that you can drive the robot into Forbidden zones and Unpreferred zones on the map.
- Be aware that you can make the robot collide with obstacles even if you do not mute the Protective fields. If you mute the Protective fields the robot will not stop at all for detected obstacles—see "Muted Protective fields" on page 94.
- Manual mode is only intended for initialization and maintenance situations, including potential deadlocks.

To drive the robot in Manual mode, follow these steps:

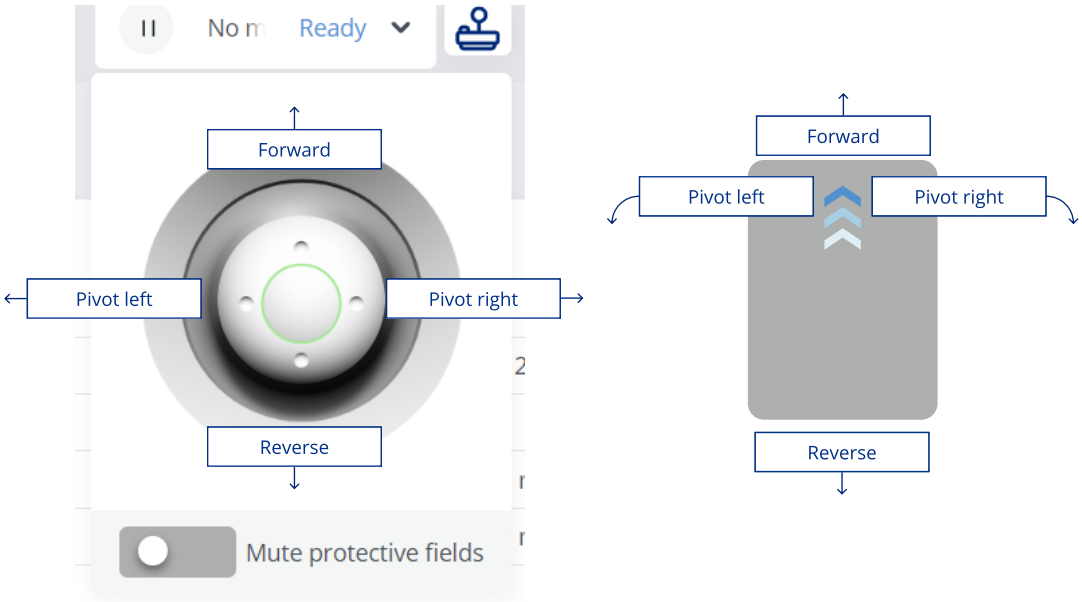
1. On the robot, turn the Operating mode key to Manual mode (turn it to the right). The robot enters Emergency stop.

2 In the robot interface, select **Manual control** under the joystick icon. The Resume button on the robot starts blinking.



3 On the robot, press the Resume button. The status lights turn blue, indicating that the robot is in Manual mode.

4 Use the joystick to move the robot. The robot will go back into emergency stop after a short time of inactivity.



Autonomous mode

In this mode, the robot executes the programmed missions. After switching the key to this mode, you can remove the key, and the robot will continue driving autonomously. In Autonomous mode, the joystick is disabled in the robot interface.

There are the following ways to make the robot drive autonomously in the robot interface:

- **Schedule a mission**
  To schedule a mission, go to **Setup > Missions**, and select **Queue mission**.

  For more information about creating missions and to see mission examples, see *MiR Commissioning Guide* and *MiR Robot Interface Guide*. You can find these guides on MiR Support Portal.

- **Send the robot to a location on the active map**
  To send the robot to a selected location, open the active map, either in a dashboard or the map editor, and select **Send robot to target** followed by the location and orientation you want the robot to drive to.

- **Send the robot to a position or marker on the active map**
  To send the robot to an existing position or marker, open the active map, either in a dashboard or the map editor, and select a position or marker followed by **Go to**.

Locked mode

In this mode, the robot blocks the wheels. You cannot start a mission or drive the robot when it is in Locked mode. You put the robot in Locked mode by putting the Operating mode key in the middle position—see "Control panel" on page 53.

5.8 Moving the robot by hand

Before moving the robot by hand, make sure the mechanical brakes are released—see "Manual brake release switch" on page 64.

To move the robot by hand, either push or pull it using the corner bumpers or the pull handles under the front and rear covers.

Avoid moving the robot by hand, as it can cause the robot to lose its localization.

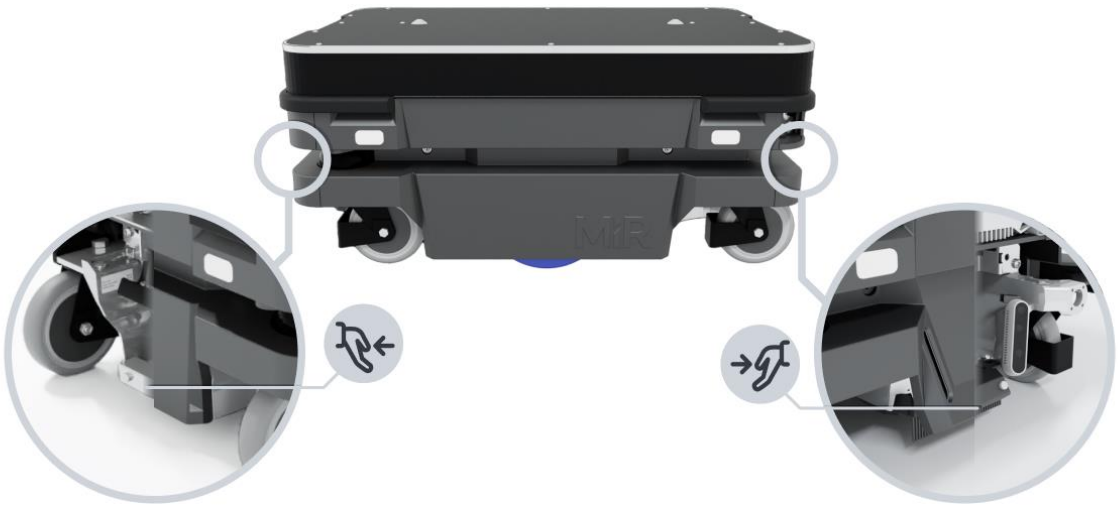
NOTICE

Moving the robot by hand forcefully may cause damage to the robot.

- If the robot is stuck, push or pull gently on the corner bumpers or the pull handles to move the robot.
- Do not push or pull the robot sideways.

Figure 5.2 When pushing the robot, only push on the corner bumpers or top module

Figure 5.3 When pulling the robot, use either the front pull handle or the rear pull handle



5.9 Types of stop

There are four different stopped states:

- Operational stop
- Protective stop
- Emergency stop
- Manual stop

The last three types of stop are monitored by the safety PLC.

When the robot is in Protective stop or Emergency stop, the robot loses connection CAN bus nodes 3, 4, and 20. The connection is re-established once the robot is brought out of Protective or Emergency stop.

Operational stop

The robot is in Operational stop when it is stopped through the robot interface either through a mission action or by pausing the mission. The top module and all moving parts are still connected to a power supply.

Protective stop

The robot enters Protective stop automatically to ensure the safety of nearby personnel. When the robot enters Protective stop, internal safety contactors are switched so the robot's top module and all moving parts of the robot do not receive power. You can hear the safety contactors emit audible clicks when they are switched.

When the robot is in Protective stop, the status lights of the robot turn red, and you are not able to move the robot or send it on missions until you bring the robot out of the Protective stop. The following cases describe the various Protective stops and how to bring the robot out of them:

- **A safety laser scanner detects an object in its active Protective field**
  Remove the object from the active Protective field—see "Field switching and Personnel detection" on page 86. The robot will resume its operating state after two seconds.
- **The robot finishes the startup process**
  The Resume button will flash after startup. Press the flashing Resume button to bring the robot out of Protective stop.

- **Switching between Manual mode and Autonomous mode**
  After turning the Operating mode key to switch operating modes, the robot enters Protective stop, and the Resume button flashes. Press the Resume button to bring the robot out of Protective stop.
- **The safety system detects a fault, or the motor control system detects a discrepancy**
  To bring the robot out of Protective stop, resolve the fault causing the error. Use information regarding the error from the robot interface to determine the fault. Go to **Monitoring > Hardware health** to find specific information on what caused the issue. For further guidance, see the troubleshooting guides to help troubleshooting the issue. You can find these guides on MiR Support Portal.

Emergency stop

The robot enters Emergency stop when an Emergency stop button has been pressed physically. When you press the Emergency stop button, internal safety contactors are switched so the robot's top module and all moving parts of the robot do not receive power. You can hear the safety contactors emit audible clicks when they are switched.

When the robot is in Emergency stop, the status lights of the robot turn red, and you are not able to move the robot or send it on missions until you bring the robot out of the Emergency stop. To do this, you must release the Emergency stop button and then press the Resume button. The Resume button begins flashing blue after you have released the Emergency stop button. If the robot is in Emergency stop, it will immediately resume an operating state after you press the flashing Resume button.

CAUTION

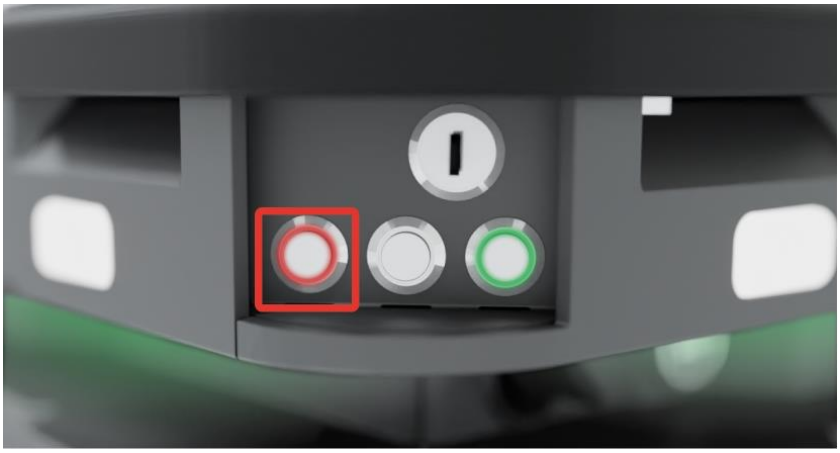
Emergency stop buttons are not designed for frequent use. If a button has been used too many times, it may fail to stop the robot in an emergency situation, and nearby personnel may be injured by electrical hazards or collision with moving parts.

- Only press Emergency stop buttons in emergencies.
- Check that all Emergency stop buttons are fully functional—see "Maintenance" on page 119.
- Use the robot interface to stop the robot in non-emergency situations.

Manual stop

The robot enters Manual stop when the red Manual stop button in the control panel is pressed. Manual stop brings the robot into the same state as a Protective stop where it can only be brought to an operational state by pressing the Resume button.

Figure 5.4 The Manual stop button is the left-most button on the control panel



5.10 Manual brake release switch

The Manual brake release switch is located below the control panel and releases the mechanical brakes on MiR250 Shelf Carrier. You release the robot's mechanical brakes by turning the Manual brake release switch clockwise.

Figure 5.5 Turn the Manual brake release switch clockwise to release the brakes

The mechanical brakes require electrical power to be released. To release the brakes, the robot must be connected to an active and charged battery when you turn the switch—see "Connecting the battery" on page 139.

When the robot is driving, the robot engages and releases the mechanical brakes automatically. You should only release the brakes manually when you want to move the robot by hand.

When you release the brakes manually, all power to the motors is cut. This means the robot loses connection to some of the CAN bus nodes and the robot does not receive data that it needs to localize itself. After moving the robot manually, you must correct the robot's location on the map—see the guide *How to use adjust localization*. You can find this guide on MiR Support Portal.

Once you engage the automatic brake system, the connection to the CAN bus nodes is re-established, and the robot can update its location on the map automatically.

The robot cannot operate while the mechanical brakes are released manually.

5.11 Light indicators and speaker

The robot uses its speaker and two types of light indicators to let people in the environment know what the robot is currently doing or planning to do.

- **Status lights**
  The LED light bands on all four sides of the robot use colors and light motion patterns to signal the current status of the robot.

- **Signal lights**
  The signal lights at the front and back of the robot show if the robot is about to turn a corner or go backward. Front lights are white and rear lights are red. Right and left turns are indicated by blinking.
- **Speaker**
  The speaker plays sounds to alert personnel. You can trigger sounds using zones and mission actions, and you can enable the robot to play warning sounds whenever the Protective fields are muted.

Figure 5.6 Light indicators on MiR250 Shelf Carrier

Table 5.2 Identification of light indicators in Figure 5.6

Pos.	Description	Pos.	Description
1	Signal lights	2	Status lights

Status lights

The LED light bands running all the way around the robot indicate the robot's current operational state. Colors may also be used as part of missions, but as standard, status lights indicate the statuses described below.

Red
Emergency stop or Protective stop

Green
Ready for job

Cyan
Drives to destination

Purple
Goal/Path blocked

Wavering white
Planning path

Orange
Mission paused

Wavering orange
Startup signal before PC is active

Fading orange
Shutting down robot

Blinking orange
Relative move, ignoring obstacles

Wavering purple and orange
General error

Blue
Manual drive

Wavering blue
Mapping

State of charge
Charging at charging station

Wavering cyan
Waiting for MiR Fleet resource or for another MiR robot to move

When the robot's battery reaches a critically low level of power (0-1%), the ends of the status lights flash red.

Signal lights

Signal lights are used to indicate the robot's immediate motion plans by signaling forwards-backwards-braking and left-right turns.

The signal lights work similarly to lights used on cars; white at the front, red at the back, and indicating a left or right turn by blinking.

When the robot drives with muted Protective fields, for example, when docking to a charging station, all signal lights blink yellow.

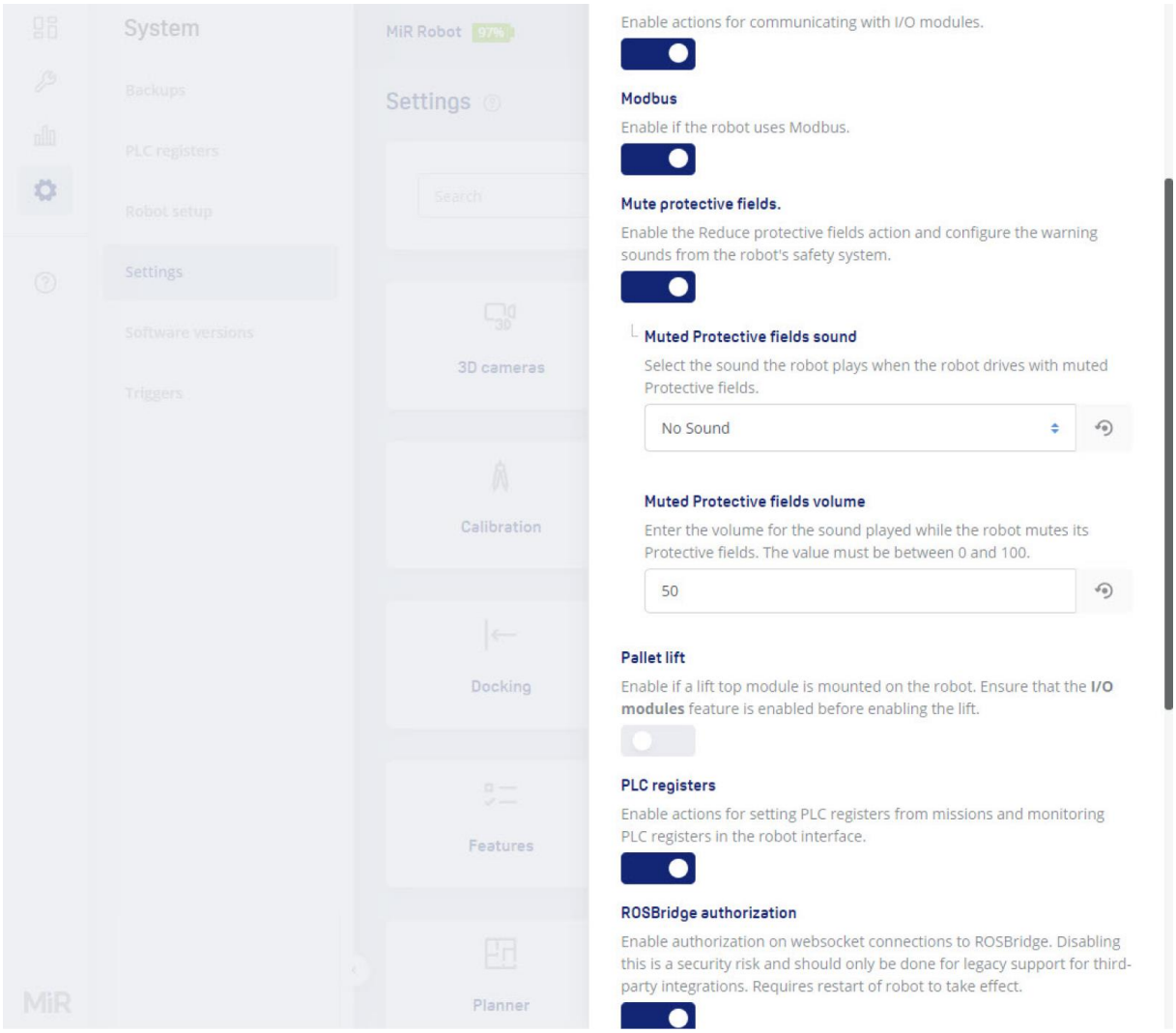
Speaker

In **Setup > Sounds**, you can upload new sounds to the robot or edit the volume and length of the default sounds.

Sounds can be used in missions and zones to alert or to attract people's attention.

For more information about how to set up sounds, see *MiR Commissioning Guide*. You can find this guide on MiR Support Portal.

When the robot drives with muted Protective fields it emits a warning sound. In **System > Settings > Features**, you can choose which sound the robot makes and the volume of the sound.



CAUTION

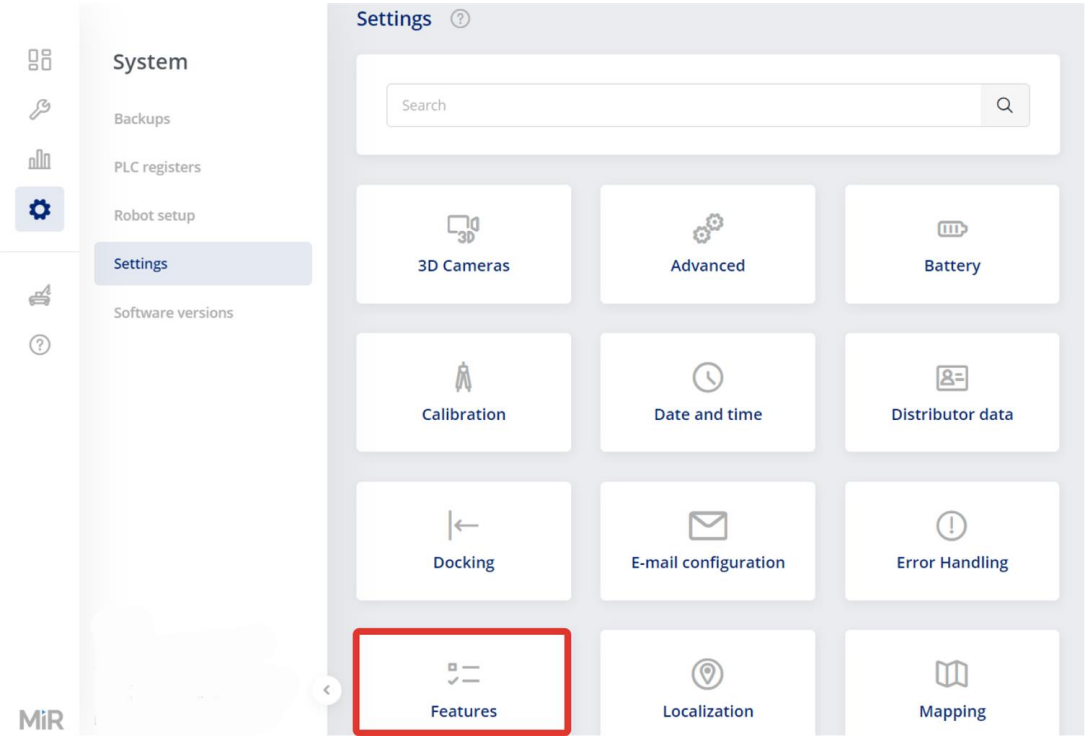
Unaware personnel may not see the robot in certain situations and risk colliding with the robot. This may result in injury to personnel or damage to equipment.

- Make sure to adjust the volume of the robot's warning sounds so they are audible in the robot's work environment.
- Implement warning sounds from the robot in missions and areas where it can reduce the risk of hazardous situations.
- Do not disable the sound in the safety system. This will also cause the robot to not comply with safety standards.

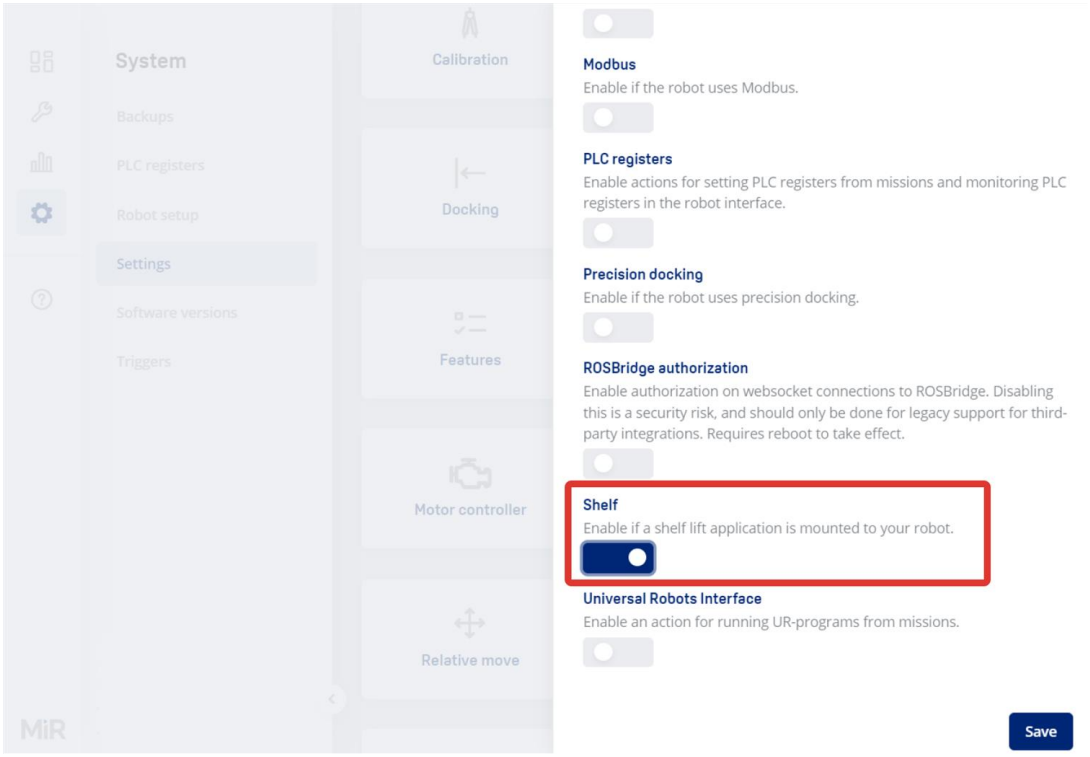
5.12 Enable the MiR250 Shelf Carrier feature

To access the MiR250 Shelf Carrier settings and mission menus, the MiR250 Shelf Carrier features must be enabled. To check that they are enabled, follow these steps:

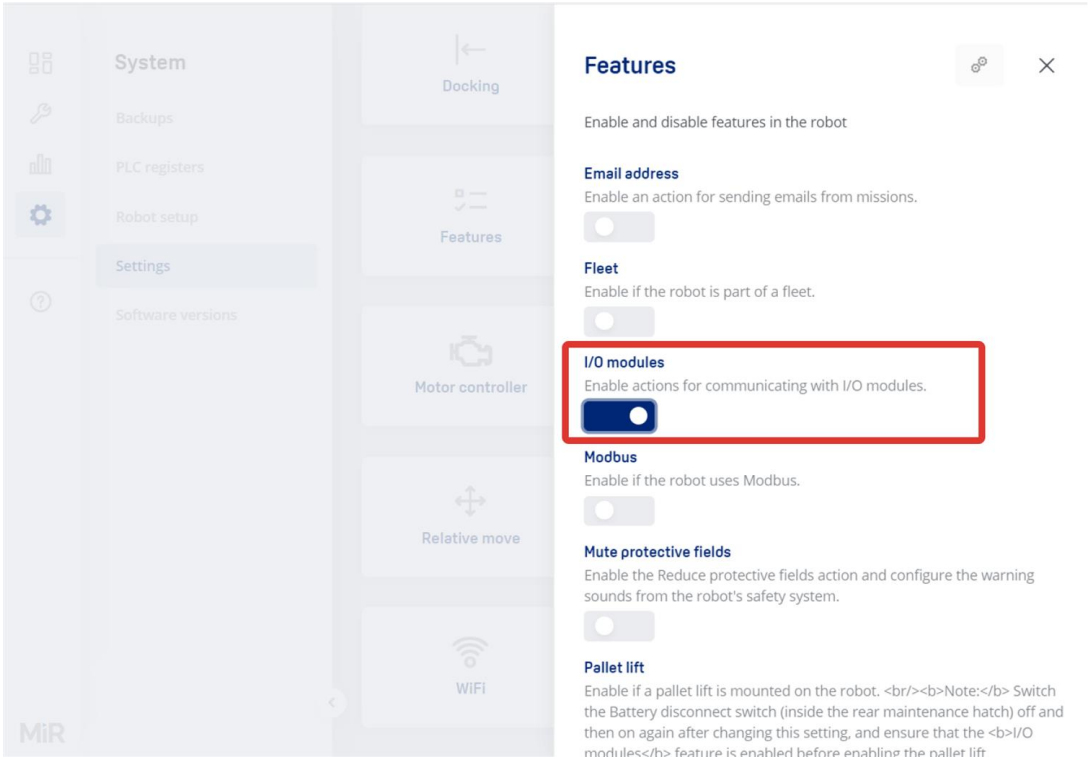
1. Sign in to the robot interface, and go to **System > Settings > Features**.



2 Enable the **Shelf** feature.



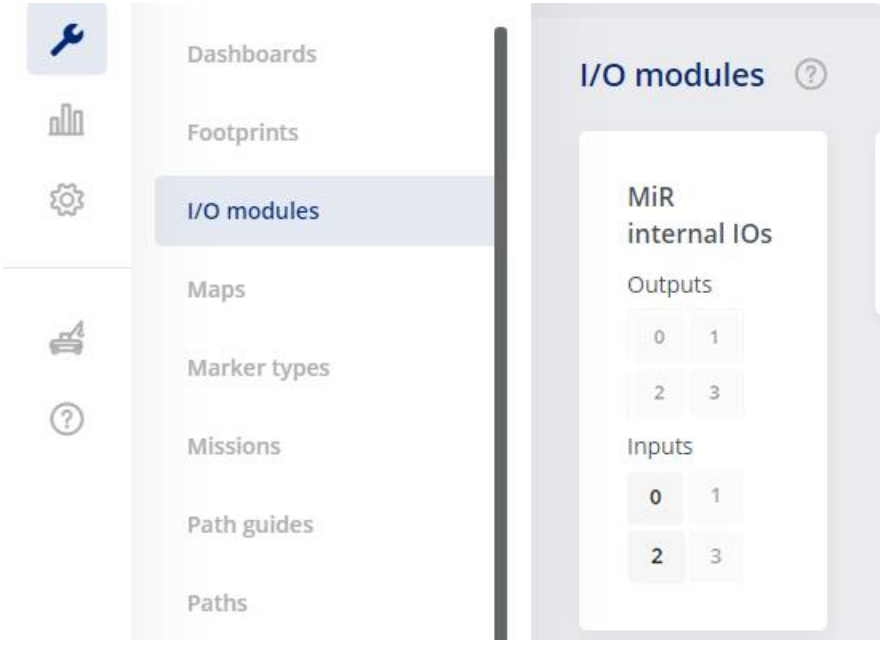
3 Under **I/O modules**, check that the modules are enabled. The MiR Shelf Carrier 250 top module communicates with the robot through I/O modules, so they must be activated for the shelf carrier to work.



5.13 Testing the top module

To test that the top module of MiR250 Shelf Carrier is configured and connected correctly, follow these steps:

1 Sign in to the robot interface, and go to **Setup > I/O modules**.



2 Under **MiR internal I/Os**, complete the following sequence, and verify that the robot executes the expected action:

a Under **Outputs**, select **3**. Verify that the carrier pins rise up.

b Once the pins are raised, verify that **3** under **Inputs** is active.

c Under **Outputs**, select **2**. Verify that the carrier pins lower into the robot.

d Once the pins are lowered, verify that **2** under **Inputs** is active.

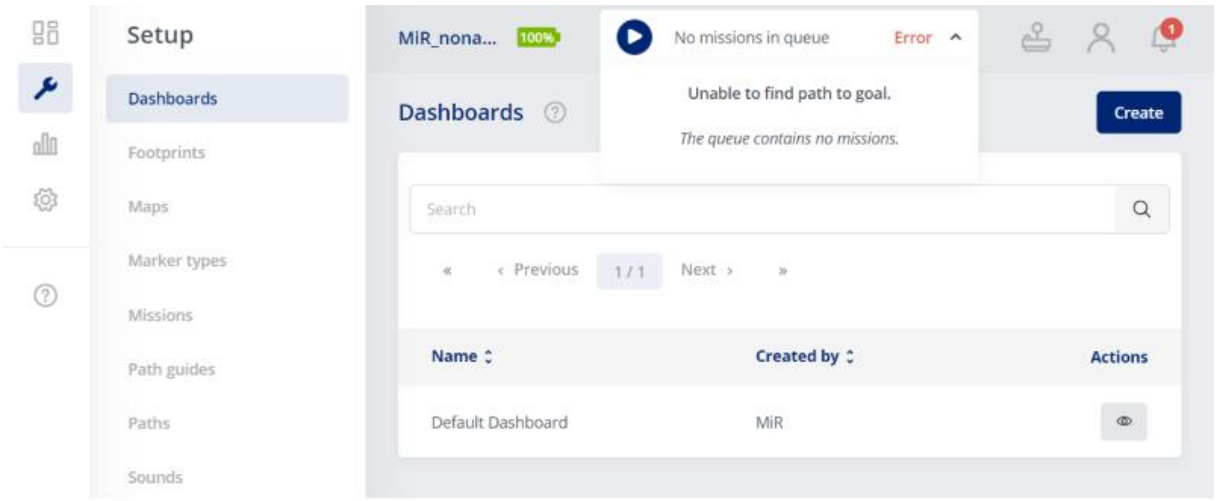
If the lift was raised and lowered as expected and the correct input feedback was received, MiR Shelf Carrier 250 is correctly installed.

If the shelf is correctly placed, but the pins are blocked when the robot tries to raise the pins, the robot will stop raising the pins and report an error stating that the GPIO current is out of bounds. Afterward, You must clear the error and start the robot again.

If MiR Shelf Carrier 250 did not operate correctly, verify that you have enabled the feature as described in "Enable the MiR250 Shelf Carrier feature" on page 70. If MiR Shelf Carrier 250 continues to fail, contact MiR Technical Support.

5.14 Error handling

The robot enters an error state when it can not solve a problem on its own.



Errors include:

- Hardware faults
- Failed localization
- Failure to reach destination
- Unexpected events in the system

An error triggers a Protective stop. The robot is paused until a user acknowledges the error and clears it.

Software errors

Software errors such as localization and failure to reach the goal destination can be prevented with the proper setup of maps and missions:

- Always test your missions under full observation and normal work environment conditions before leaving the robot to execute the missions autonomously.
- Use Try/Catch actions to make the robot react in a specific way if it fails to execute certain actions.
- Use Prompt user actions in missions that require intervention from users.
- Define forbidden areas with Forbidden or Unpreferred zones on the map.
- Remove noise from maps.
- Create Directional or Preferred zones to guide the robot around areas that are difficult for the robot to travel through.

For more information about commissioning your robot to fulfill these guidelines, and for setting up missions and error handling, see *MiR Robot Interface Guide* and *MiR Commissioning Guide*. You can find these guides on MiR Support Portal.

To clear an error, select the red warning indicator in the interface, and select **Reset**.

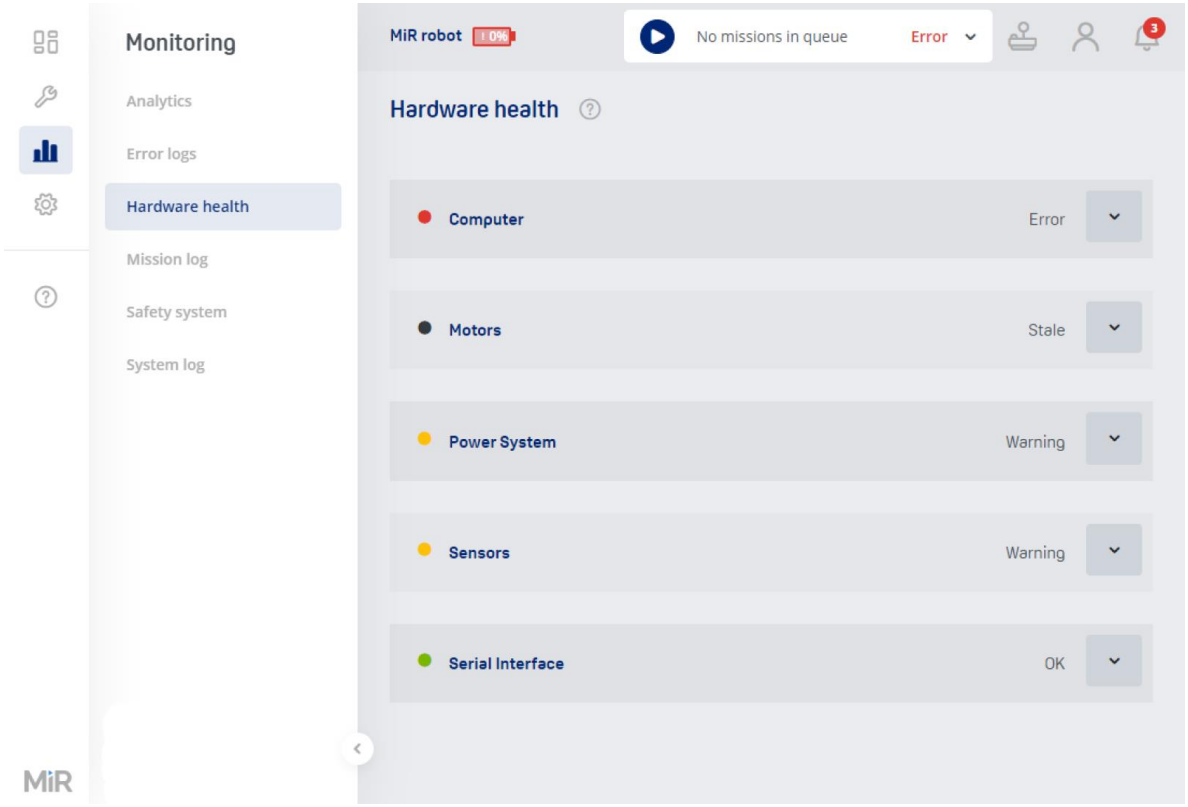
> **NOTICE**
> When the robot stops because of an error, it also cancels its current mission. After clearing an error, make sure the robot completes the task it was assigned, especially if the robot was transporting a load and did not finish delivering it.

Hardware errors

If the error is a fault in the hardware, either you will not be able to clear it, or the error will return until the fault is fixed. If this occurs, you can try to fix the issue with these actions:

- Turn your robot off and then on again. This resets the robot components and may resolve the issue.
- Check that the Emergency stop button is released.

- Check your robot for any physical damage such as cracks, dents, or severe scratches or contamination such as dust, dirt, and grease. Pay special attention to the 3D cameras, safety laser scanners, and drive wheels.
- Sign in to the robot interface and go to **Monitoring > Hardware health**. The interface displays which component is failing and often for what reason. This can help identify the source of the error. If an internal component is failing, turn off the robot, disconnect the battery, and have the commissioner or operator visually check the internal component for obvious faults.



- For further troubleshooting, see the MiR troubleshooting guides and the document *Error codes and solutions*. You can find these guides on MiR Support Portal.

6. Safety-related functions

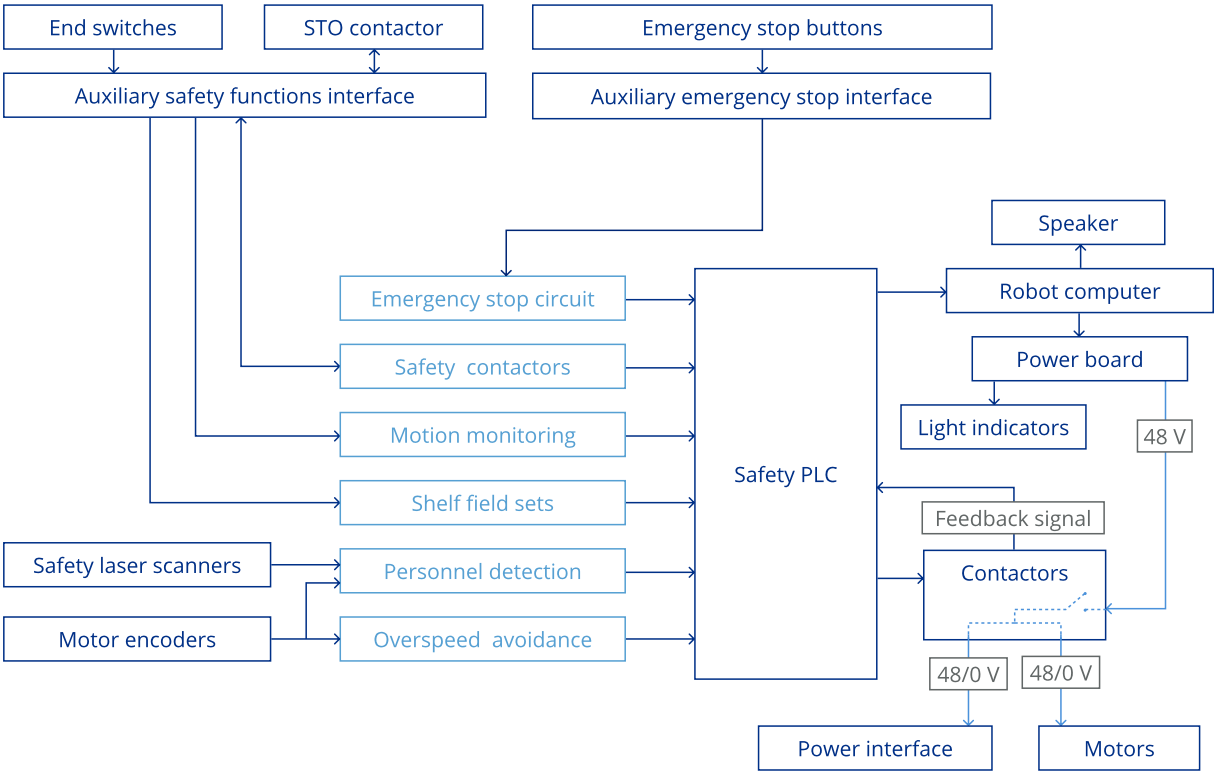
The robot's safety system is designed to mitigate significant hazards which could lead to injury.

For an overview of all the safety functions, see "Safety functions overview" on the next page.

MiR250 is designed with auxiliary safety functions interfaces. These interfaces are used in MiR250 Shelf Carrier to communicate between MiR250 and MiR Shelf Carrier 250.

The diagram in Figure 6.1 shows the inputs to these functions and how they are all connected and monitored in the safety PLC. The safety PLC is able to switch the safety contactors to cut off power to the robot motors and the top module whenever a Protective or Emergency stop is triggered—see "Types of stop" on page 62. Also, the safety PLC sends information to the robot computer. The robot computer displays the information in the robot interface (in **Monitoring > Hardware health**) and indicates if the robot is in Emergency or Protective stop with the status lights.

Figure 6.1 Overview of components involved in each safety function and interface



6.1 Safety functions overview

MiR250 Shelf Carrier is set up with the following safety configuration:

- **Description**: Standard configuration for driving with shelves v. 3.
- **Supported software version**: 2.14.5 and higher
- **Checksum**: 0x5AE8CE0C

Table 6.1 lists each safety function with its associated triggering event, reaction, reliability, and how it is realized.

The following terms are used in the table:

- **PFHd**: The Probability of dangerous Failures per Hour as defined in EN ISO 13849-1:2015
- **PL**: Performance Level as defined in EN ISO 13849-1:2015
- **Architecture**: As defined in EN ISO 13849-1:2015

Table 6.1 Overview of integrated safety functions in MiR250 Shelf Carrier

Function name	Description	PFHd, PL, and architecture
Overspeed	**Triggering event**: The speed of the robot exceeding the defined values in "Overspeed avoidance" on page 85. **Reaction**: Category 0 stop (IEC 60204-1) and mechanical spring-applied brakes engage. The robot enters Protective stop. **Reset function**: Press the Resume button on the robot. **Active**: Always	**PFHd:** 2.82×10^{-7} **PL:** c **Architecture:** Category 3

Function name	Description	PFHd, PL, and architecture
Field switching[1]	**Triggering event**: Selection of protective fields as a function of robot speed and the potential presence of a shelf—see "Field switching and Personnel detection" on page 86. **Reaction**: A predefined protective field is selected. **Reset function**: Continuous function. No action required. **Active**: Always	**PFHd:** 4.01×10^{-7} **PL:** d **Architecture:** Category 3
Personnel detection[2]	**Triggering event**: Safety laser scanners detecting an object in the active Protective field—see "Field switching and Personnel detection" on page 86. —or scanners detecting shelf legs when not expected. **Reaction**: Category 1 stop (IEC 60204-1) and mechanical spring-applied brakes engage. The robot enters Protective stop [3]. **Reset function**: Resumes automatically after 2 s of cleared Protective field.	**PFHd:** 7.36×10^{-7} **PL:** d **Architecture:** Category 2

[1]If you modify the SICK configuration file or apply another SICK configuration files, the PFHd and PL no longer apply. You must determine the new functional safety of the new configuration.

[2]If you modify the SICK configuration file or apply another SICK configuration files, the PFHd and PL no longer apply. You must determine the new functional safety of the new configuration.

[3]The robot will stop within the active Protective field if the payload, CoM, mass inertia moment, and friction coefficient are within specifications.

Function name	Description	PFHd, PL, and architecture
	Active: Always. Unless Protective fields are muted—see "Muted Protective fields" on page 94. Muting will enable Speed monitoring.	
Speed monitor	**Triggering event**: The speed of either drive wheel exceeds 0.3 m/s while the Protective fields are muted. **Reaction**: Category 0 stop (IEC 60204-1) and mechanical spring-applied brakes engage. The robot enters Protective stop. **Reset function**: Press the Resume button on the robot. **Active**: When Protective fields are muted.	**PFHd:** 2.82×10^{-7} **PL:** d **Architecture:** Category 3
Mode selection	**Triggering event**: Changing the operating mode of the robot by turning the Operating mode key—see "Control panel" on page 53. **Reaction**: Category 0 stop (IEC 60204-1) and mechanical spring-applied brakes engage. The robot enters Protective stop. **Reset function**: Press the Resume button on the robot. **Active**: Always	**PFHd:** 1.2×10^{-6} **PL:** c **Architecture:** Category 1
Emergency stop	**Triggering event**: Pressing any Emergency stop button on the MiR Shelf Carrier 250 top module—see "Emergency stop buttons" on page 85	**PFHd:** 5.93×10^{-8} **PL:** d

Function name	Description	PFHd, PL, and architecture
	Reaction: Category 0 stop (IEC 60204-1) (both for the drive motors and the pin actuator) and mechanical spring-applied brakes engage. The robot enters Emergency stop. **Reset function**: Release all Emergency stop buttons, and press the Resume button on the robot. **Active**: Always	**Architecture:** Category 3
Pin position monitor [1]	**Triggering event**: Shelf carrier pins in middle position while the speed exceeds 0.3 m/s. **Reaction**: Category 0 stop (IEC 60204-1) and mechanical spring-applied brakes engage. The robot enters Protective stop. The power to the shelf carrier pin motor is cut off. **Reset function**: Continuous function. No action required. **Active**: Always	**PFHd:** 4.57×10^{-6} **PL:** b **Architecture:** Category b
Manual stop	**Triggering event**: Pressing the Manual stop button on the control panel —see "Control panel" on page 53. **Reaction**: Category 0 stop (IEC 60204-1) and mechanical spring-applied brakes engage. The robot enters Manual stop.	**PFHd:** 4.29×10^{-6} **PL:** b **Architecture:**

[1] If you remove MiR Shelf Carrier 250, the functional safety performance will change depending on the new top module you mount. The PFHd and PL become ? × 10^{-7} and **d** respectively without a top module. If you mount another top module, add the PFHd of the top module to determine the resulting functional safety.

Function name	Description	PFHd, PL, and architecture
	Reset function: Press the Resume button on the robot. **Active**: Always	Category b
Manual restart	**Triggering event**: Pressing the Resume button on the control panel—see "Control panel" on page 53. **Reaction**: Re-enables the robot by releasing it from the Category 0 stop (IEC 60204-1) and by disengaging mechanical spring-applied brakes. **Reset function**: N/A **Active**: After triggering of Emergency stop, Overspeed, Speed monitor, Mode selection, Manual stop, or after a hardware fault.	**PFHd:** 4.29×10^{-6} **PL:** a **Architecture:** Category b
Manual brake release	**Triggering event**: Turning the Manual brake release switch on the robot—see "Manual brake release switch" on page 64. **Reaction**: Category 0 stop (IEC 60204). The robot enters Protective stop. **Reset function**: Press the Resume button on the robot. **Active**: Always	**PFHd:** 5.36×10^{-8} **PL:** d **Architecture:** Category 3

6.2 Emergency stop buttons

There are two Emergency stop buttons on MiR250 Shelf Carrier. When one of the buttons is pressed, it breaks the Emergency stop circuit triggering an Emergency stop. The Emergency stop circuit runs through both of the Emergency stop buttons and connects to the safety PLC through the Auxiliary emergency stop interface—see Figure 6.2.

Figure 6.2 The Emergency stop circuit in MiR250 Shelf Carrier

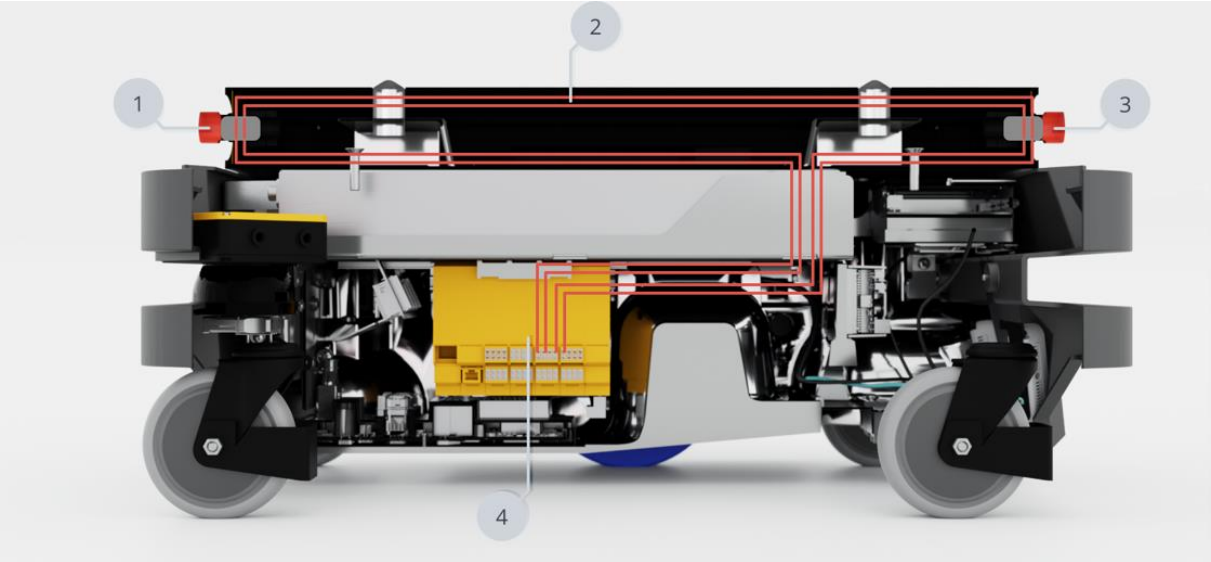


Table 6.2 Identification of parts in Figure 6.2

Pos.	Description	Pos.	Description
1	Front Emergency stop button	2	Emergency stop circuit
3	Rear Emergency stop button	4	Safety PLC

6.3 Overspeed avoidance

The Overspeed avoidance function prevents the robot from driving if the motor encoders measure that the robot is driving faster than the predefined safety limit. This can occur if there is a hardware error in the robot or if it drives down a steep slope. If the robot is driving faster than the predefined safety limit, it is immediately brought into Protective stop.

Speed limit forward direction:

- 1.3 m/s with a shelf
- 2.07 m/s without a shelf
- 0.3 m/s with shelf pins neither up or down (transition limit between the two states)

Speed limit in reverse:

- 1.3 m/s with and without a shelf.

Speed limit with muted Protective fields, regardless of direction:

- 0.3 m/s

Pivot speed limit:

- 0.75 rad/s (maximum 0.303 m/s speed difference between the drive wheels).

The pivot speed limit function itself does not ensure payload stability—see "Payload distribution and stability" on page 201.

If any speed limit is exceeded, the robot reports an error. You must clear the error and press the Resume button before the robot can continue operating.

6.4 Field switching and Personnel detection

The Field switching and Personnel detection safety functions are dependent on each other. The functions make the robot enter Protective stop when the laser scanners detect a person within a predefined area around the robot. This area is called a Protective field. There are several predefined Protective fields that increase in size as the robot drives faster. The robot stays in Protective stop until the active Protective field is cleared of obstacles for at least two seconds.

The Personnel detection function makes the robot stop when the laser scanners detect an obstacle wider than approximately 70 mm within the active Protective field.

The Field switching function makes the robot switch between predefined Protective fields according to the speed. The speed is determined from the robot's motor encoders.

Clear ahead

The robot drives when the area is clear.

Obstacle detected

The robot stops when it detects an obstacle.

MiR250 Shelf Carrier has different sets of Protective fields depending on whether it is driving with a shelf or not. The position of the shelf carrier pins determines which Protective field set is activated, and the speed and direction of the robot determines the size of the Protective field. The following sections describe the Protective fields when the robot is driving without a shelf and "Shelf-specific Protective fields" on page 98 describes the Protective fields when the robot is driving with a shelf.

NOTICE

Scanners measure distances to diffuse reflections, which means that a tolerance is added to the Protective fields to secure a safe detection of persons crossing the Protective fields. The tolerance distance is 65 mm.

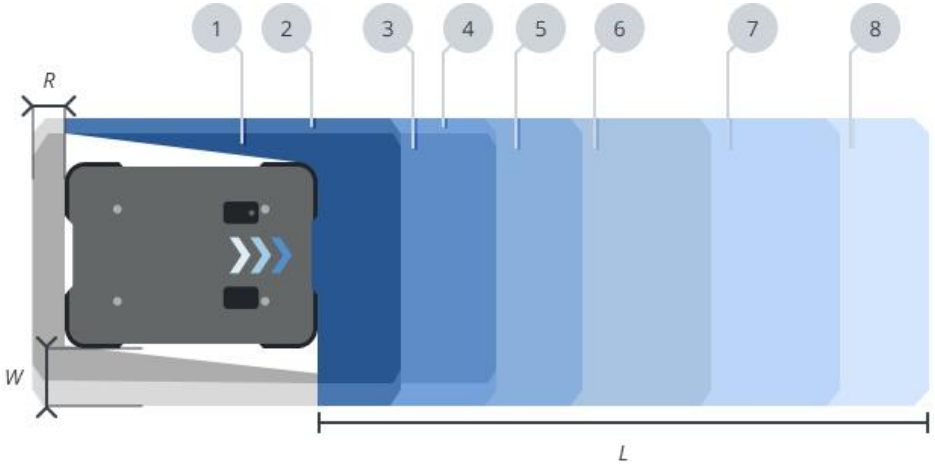
Protective fields when driving forward without a shelf

The following tables show speeds and the field ranges when driving forward without a shelf. Table 6.3 describes the length of the Protective field in front of the robot in different cases. Each case is defined by a speed interval that the robot may operate at. The cases in Table 6.3 correspond to the fields shown in Figure 6.3.

Table 6.3 Range of the robot's Protective fields within its forward speed interval cases without a shelf

Case	Speed	Front field length (*L*)	Field width (*W*)	Rear field length (*R*)
1	0.10 to 0.30 m/s and less than 15 deg/s	350 mm	140 mm	65 mm
2	0.10 to 0.30 m/s	350 mm	155 mm	65 mm
3	0.30 to 0.50 m/s and less than 15 deg/s	500 mm	140 mm	65 mm
4	0.30 to 0.50 m/s	500 mm	155 mm	65 mm
5	0.50 to 0.90 m/s	835 mm	155 mm	65 mm
6	0.90 to 1.30 m/s	1 310 mm	155 mm	65 mm
7	1.30 to 1.70 m/s	1 930 mm	155 mm	65 mm
8	1.70 to 2.07 m/s	2 625 mm	155 mm	65 mm

Figure 6.3 The Protective field contours when the robot drives forward without a shelf



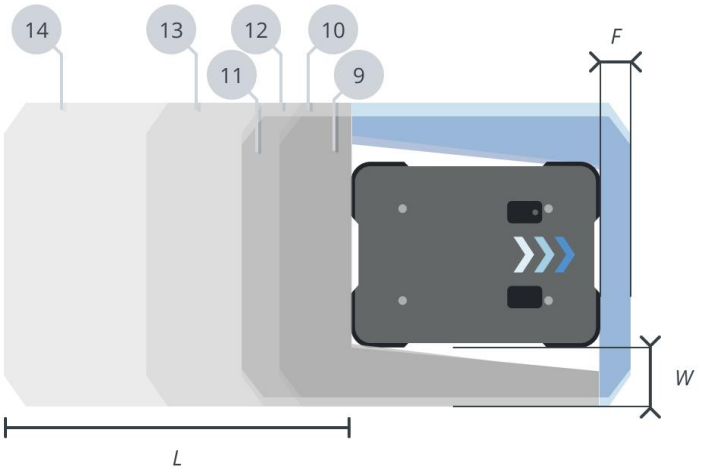
Protective fields when driving backward without a shelf

The following tables show speeds and the field ranges when driving backward without a shelf. Table 6.4 describes the length of the Protective field behind of the robot in different cases. Each case is defined by a speed interval that the robot may operate at. The cases in Table 6.4 correspond to the fields shown in Figure 6.4.

Table 6.4 Range of the robot's Protective fields within its backward speed interval cases

Case	Speed	Rear field length (*L*)	Field width (*W*)	Front field length (*F*)
9	0.10 to 0.30 m/s and less than 15 deg/s	200 mm	140 mm	65 mm
10	0.10 to 0.30 m/s	200 mm	155 mm	65 mm
11	0.30 to 0.50 m/s and less than 15 deg/s	350 mm	140 mm	65 mm
12	0.30 to 0.50 m/s	350 mm	155 mm	65 mm
13	0.50 to 0.90 m/s	685 mm	155 mm	65 mm
14	0.90 to 1.30 m/s	1 160 mm	155 mm	65 mm

Figure 6.4 The Protective field contours when the robot drives backward without a shelf



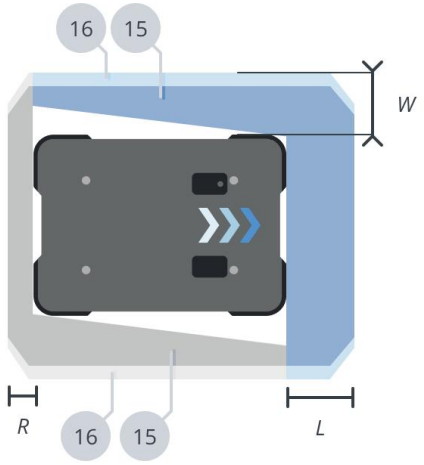
Protective fields when pivoting or at standstill without a shelf

Table 6.5 identifies the length of the Protective fields behind and in front of the robot, and the width of the field to either side of the robot when the robot is pivoting or at standstill without carrying a shelf. The cases in Table 6.5 correspond to the fields shown in Figure 6.5.

Table 6.5 Range of the robot's Protective fields when the robot pivots or is at standstill without a shelf

Case	Pivot speed	Front field length *L*	Rear field length *R*	Field width *W*
15	0 to 15 deg/s	250 mm	100 mm	140 mm
16	15 deg/s or more	250 mm	100 mm	155 mm

Figure 6.5 The Protective field contours when the robot pivots or is at standstill



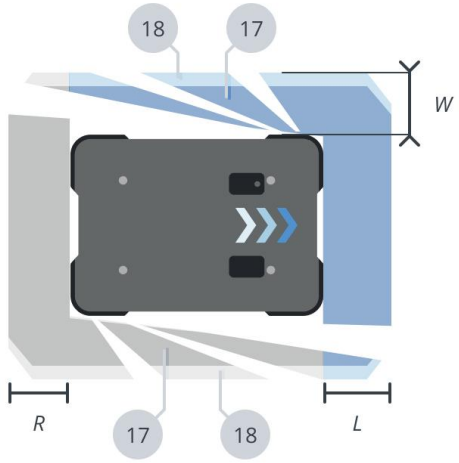
Protective fields when pivoting or at standstill with a shelf

Table 6.6 identifies the length of the Protective fields behind and in front of the robot, and the width of the field to either side of the robot when the robot is pivoting or at standstill while carrying a shelf. The cases in Table 6.6 correspond to the fields shown in Figure 6.6

Table 6.6 Range of the robot's Protective fields when the robot pivots or is at standstill with a shelf

Case	Pivot speed	Front field length *L*	Rear field length *R*	Field width *W*
17	0 to 15 deg/s	335 mm	335 mm	485 mm
18	15 deg/s or more	335 mm	335 mm	500 mm

Figure 6.6 The Protective field contours when the robot pivots or is a standstill with a shelf



Stopping distance

The Protective fields for each speed range have been sized so that the robot will stop before colliding with an object in its path. The results from the tests to validate the size of the Protective field are in the following tables for reference purposes. These tests were performed using a new robot without a shelf and with a shelf, including maximum payload, in laboratory conditions on a floor with a friction coefficient of 0.6 (±0.1).

NOTICE

The distances listed in the following tables cannot be guaranteed in any application, and are only included for example purposes. Actual stopping distances in any application will depend on many factors, including wear on the robot, loading conditions, and floor conditions, and must be confirmed on the site with the brake test procedure. A brake test for your specific setup must be performed as part of commissioning—see "Brake test" on page 159 and *MiR Commissioning Guide*. This guide can be found on MiR Support Portal.

Table 6.7 Stopping distances without a shelf

Speed	Test speed	Stopping distance
0.00 to 0.30 m/s	0.30 m/s	135 mm
0.30 to 0.50 m/s	0.50 m/s	285 mm
0.50 to 0.90 m/s	0.90 m/s	620 mm
0.90 to 1.30 m/s	1.30 m/s	1 095 mm
1.30 to 1.70 m/s	1.70 m/s	1 715 mm
1.70 to 2.07 m/s	2.07 m/s	2 410 mm

Table 6.8 Stopping distances with a shelf, including maximum payload

Speed	Test speed	Stopping distance
0.00 to 0.30 m/s	0.30 m/s	155 mm
0.30 to 0.50 m/s	0.50 m/s	305 mm
0.50 to 0.90 m/s	0.90 m/s	705 mm
0.90 to 1.30 m/s	1.30 m/s	1 130 mm

Muted Protective fields

When it is required that the robot moves close to surrounding objects, the robot can be configured to mute the Protective fields. This muting is by default enabled in the template missions for docking to known markers such as charging stations, or it can manually be configured for any customized mission.

CAUTION

Other risk reduction means must be implemented as muted Protective fields introduce a risk for collision with personnel in its path.

- Areas where Protective fields are muted must be marked as Operating hazard zones, and personnel must be informed not to enter the zone while the robot is operating in it—see *MiR Commissioning Guide*.

When the Protective fields are muted, the robot does the following:

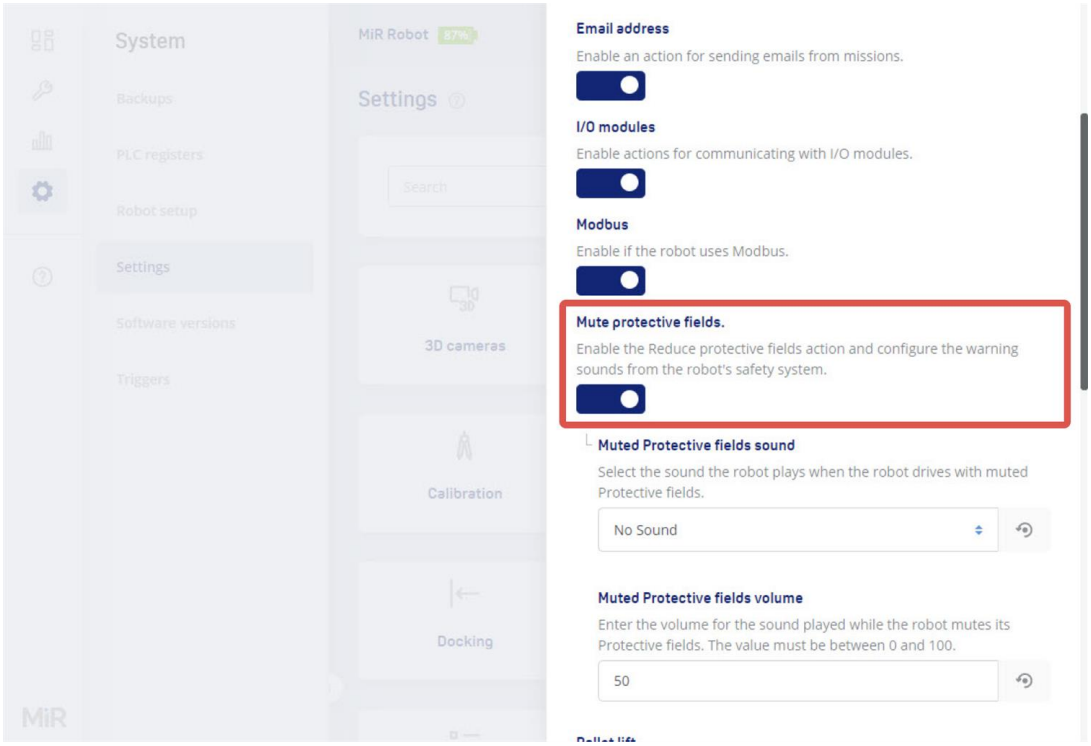
- Disables the Protective fields
- Ensures that the maximum speed is set to 0.3 m/s
- Flashes the yellow signal lights
- Emits audible warning sounds if configured to do so in the safety system settings—see "Light indicators and speaker" on page 65

User-configured muting of the Protective fields

There are two ways you can mute the Protective fields using the robot interface.

You can add the Mute protective fields action to a mission:

1. Enable **Mute protective fields** under **System > Settings > Features**.



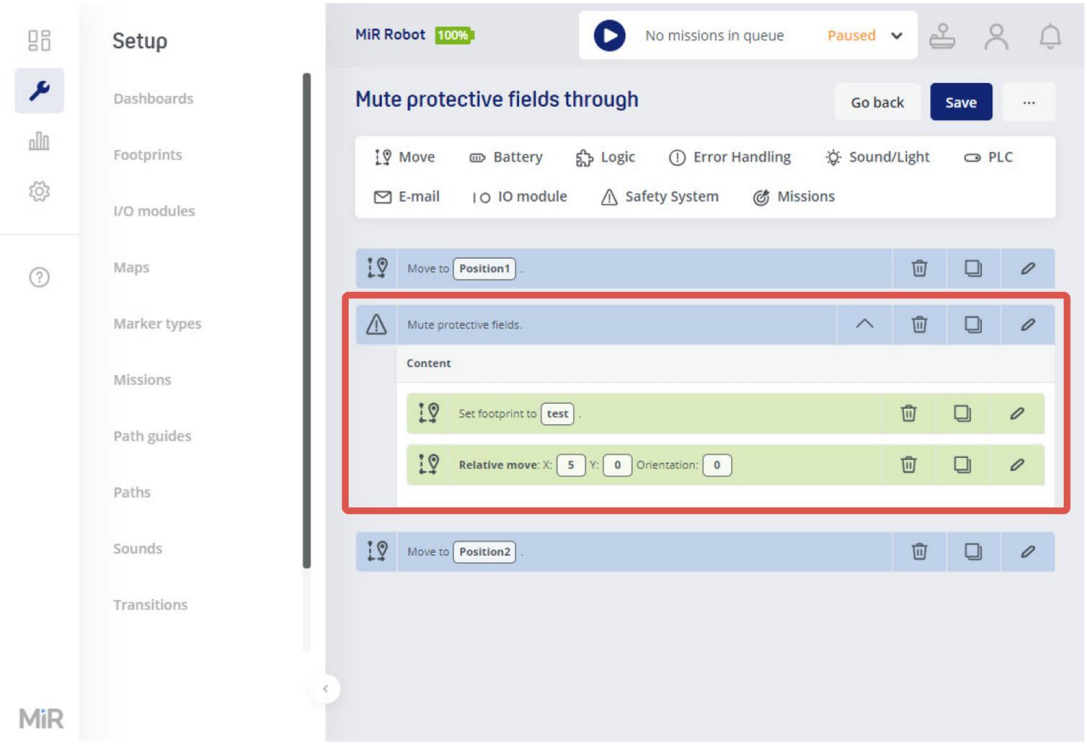
2. Under **Setup > Missions**, create or edit a mission.

3. Add the action **Mute protective fields** from the Safety system menu.

4. Edit the action parameters so the Protective fields are muted.

   MiR250 Shelf Carrier cannot mute specific Protective fields; you can either mute all or none of the fields. Otherwise, the robot reports an error.

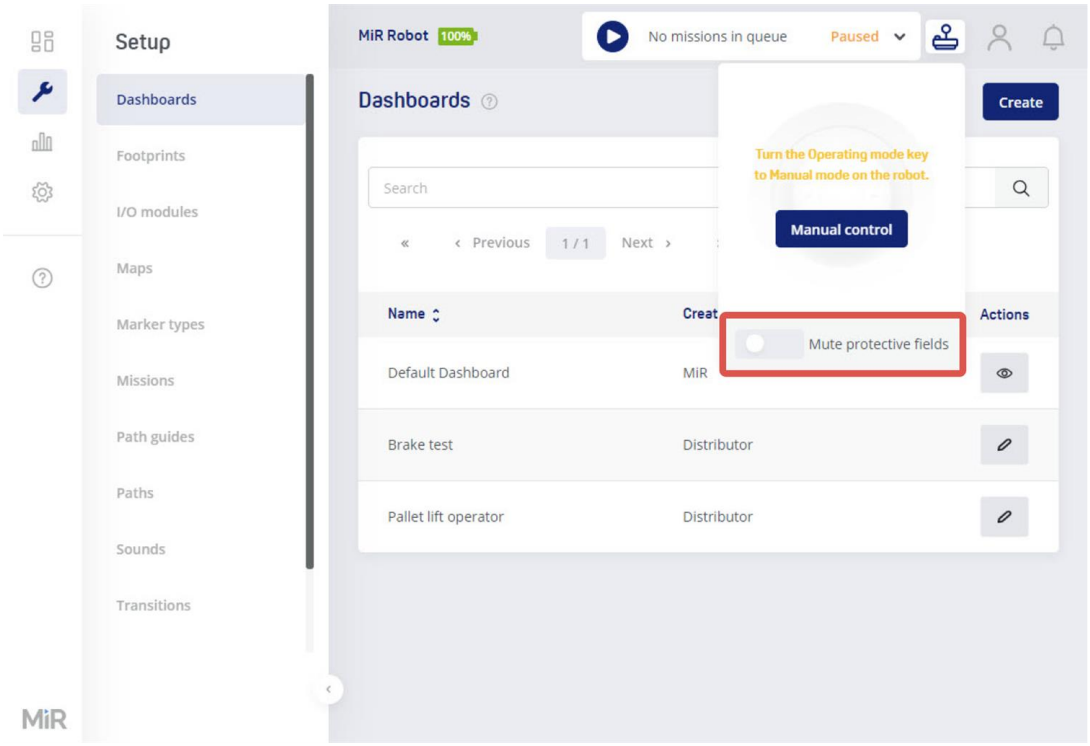
5 Add and drag all the actions you want the robot to execute with muted Protective fields inside the Mute Protective fields action.



You can mute the Protective fields when driving the robot in Manual mode:

1. Put the robot into Manual mode—see "Operating the robot" on page 56.

2. In the robot interface, select **Muted Protective fields** in the joystick control.



3. In the dialog box, select **Yes** to acknowledge the muting of the Protective fields.

If you are using Manual mode, you can mute the Protective fields without marking the area as an operating hazard zone. It is the responsibility of the user driving the robot to ensure that it does not damage equipment or injure personnel. The robot will not stop automatically for detected obstacles.

Pre-configured muting of the Protective fields

The Protective fields are automatically muted when the robot docks to most types of markers, including shelves. This ensures that the robot can drive closely to the marker without entering Protective stop.

The only marker that does not mute the Protective fields is the L-marker.

The Protective fields are muted from when the docking starts and until the robot has undocked and has started a new action that requires the robot to plan a path.

The Protective fields will remain muted during any Relative move action that comes right after the docking action. The Protective fields will also remain muted if you engage the Manual brake release—see "Manual brake release switch" on page 64.

For more information about markers, docking, and undocking, see *MiR Commissioning Guide*. You can find this guide on MiR Support Portal.

6.5 MiR Shelf Carrier 250 safety functions

When MiR Shelf Carrier 250 is mounted to MiR250, the electrical interfaces in the top compartments are no longer accessible.

The interfaces are used to communicate the position of the carrier pins and the state of the safety contactors in MiR Shelf Carrier 250. This information is used for integrated safety functions that are specific to MiR Shelf Carrier 250.

Shelf-specific Protective fields

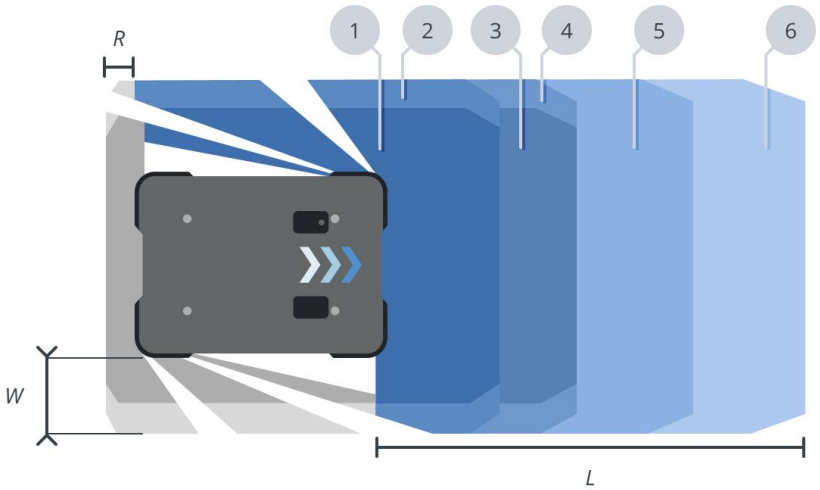
When the safety PLC registers that the carrier pins are raised, it is assumed that the robot is carrying a shelf. When the robot is carrying a shelf, its Protective fields are increased in length, but introduces blind spots to accommodate the shelf legs. The robot can drive with a maximum speed of 1.3 m/s while carrying a shelf, and the Protective fields are changed automatically to a set that is specifically used when the robot carries shelves. These Protective fields have the following changes compared to the set used when the robot drives without a shelf:

- They include blind spots in the shelf leg positions, so the shelf legs do not block the safety laser scanners.
- They have a longer forward and backward range—see Table 6.9.
- The fields are increased to 485 mm on the sides in cases 1 and 3 below, and 500 mm in cases 2 and 4-6.

Table 6.9 Range of the robot's protective fields within its forward and backward speed interval cases with a shelf

Case	Speed	Front field length (*L*)	Field width (*W*)	Rear field length (*R*)
1	0.10 to 0.30 m/s and less than 15 deg/s	445 mm	485 mm	290 mm
2	0.10 to 0.30 m/s	445 mm	500 mm	290 mm
3	0.30 to 0.50 m/s and less than 15 deg/s	595 mm	485 mm	290 mm
4	0.30 to 0.50 m/s	595 mm	500 mm	290 mm
5	0.50 to 0.90 m/s	995 mm	500 mm	290 mm
6	0.90 to 1.30 m/s	1 420 mm	500 mm	290 mm

Figure 6.7 The Protective field contours when the robot carries a shelf



The same changes apply to the backward driving Protective fields.

By default, the shelf-specific Protective fields are designed for shelves with dimensions and specific asymmetric leg positions supported by MiR—see "Shelf specifications" on page 148. This design minimizes the blind spots at the most critical areas.

Ensuring load is in its intended position

When the safety PLC registers that the carrier pins are about to be raised or lowered, it is assumed that the robot is either picking up or placing a shelf. It changes into a state where the safety PLC only allows very slow driving. This prevents the robot from driving too fast in case the pins do not insert correctly into the shelf or that the shelf is placed inaccurately.

Should the robot move too fast while lowering or raising the carrier pins, a Protective stop is triggered, and you must press the Resume button to bring the robot back to an operational state.

If the shelf is incorrectly placed, once the robot begins to move, the legs will obstruct the active Protective field and trigger a Protective stop.

Safety contactors

There are two safety contactors inside the top module. These contactors are used to cut the power to the carrier pin lifting mechanism. The safety PLC controls the contactors to ensure that power is only delivered to the lifting mechanism when it is safe for the carrier pins to change positions. There is also a feedback circuit through the safety contactors which the safety PLC monitors to make sure that the contactors are working correctly.

7. User training and responsibilities

When you hand over the robot application, you must ensure that all relevant users have received the necessary training and that there are training plans for future users and updates in the application.

The robot is only intended to be used by personnel that have received training in their required tasks.

NOTICE

The commissioner is obligated to provide information to limit hazards, and the training must address hazards from the risk assessment created during the commissioning.

7.1 User responsibilities

There are three main user types that interact with MiR250 Shelf Carrier. All other persons in the vicinity of the robot application are considered indirect users and must know how to act when they are close to the robot. For example, they must be aware that visibly-marked operating hazard zones must be respected.

Direct users

Direct users are familiar with the safety precautions in this manual and have the following main tasks:

- Assigning missions to the robot.
- Fastening loads to the robot application securely.
- Loading and unloading from a paused robot.

Operators

Operators have thorough knowledge of the robot application and of the relevant safety precautions. Operators have the following main tasks:

- Servicing and maintaining the robot application.
- Creating and changing missions and map features in the robot interface.
- Ensuring that visitors and personnel are properly equipped and briefed regarding robot safety before entering the robot's work environment.

Commissioners

Commissioners have thorough knowledge of all aspects of commissioning, safety, use, and maintenance of the robot application and have the following main tasks:

- Commissioning of the product. This includes creating maps and restricting the user interface for other users and making brake tests with a full payload.
- Conducting the risk assessment.
- Determining the payload limit, weight distribution, safe fastening methods, safe loading and unloading of loads on the robot application, and ergonomic loading and unloading methods if relevant.
- Marking operating hazard zones.
- Ensuring that operators and direct users receive the necessary training for their responsibilities—see "User training" below.

7.2 User training

When training direct users and operators, the training must adhere to the following:

- Be conducted in an area away from other workplace activities.
- Be conducted under the supervision of a trainer.
- Include all operating tasks.

Appropriate training records must be kept, and retraining must be supplied when new equipment is introduced, existing equipment is modified, or operating conditions are changed.

MiR Academy offers training material that covers most of the topics required for operators and direct users. We recommend operators to complete Bronze and Silver level training and direct users to complete Bronze level training at least. You can also apply for Specialist Classroom Training, which provides hands-on practice that builds on Bronze and Silver level training.

Training of direct users

Table 7.1 Training for operating the robot

Knowledge of	Trained to
Intended use	• Apply the robot for tasks it is designed and well-suited for. • Identify what environments the robot can safely operate in.
Light indicators and sounds	• Understand the robot's status and driving intentions.
All buttons and switches on the robot Buttons: Power, Resume, Manual stop, and Emergency stop Switches: Manual brake release and Operating mode switch (requires key)	• Turn the robot on and off. • Stop the robot manually. • Resume the robot after it has stopped. • Release the brakes manually to push or pull the robot by hand. • Change the robot's mode.
Charging interfaces and charging options	• Charge the robot.
Battery and battery connection	• Disconnect and connect the battery. • Remove the battery. • Handle the battery outside of the robot safely.
Operating instructions	• Send the robot to positions on the map and queue missions.

Table 7.2 Training for Emergency situations or event of failure

Knowledge of	Trained to
Emergency stop buttons	• Use Emergency stop buttons in case of an Emergency where the robot must be stopped immediately.
Errors	• Resolve common errors, and make the robot continue its mission or send it on a new one.
Escape routes and emergency procedure	• React correctly and quickly in an Emergency situation in case of any dangerous scenarios described in this manual or other unexpected scenarios.

Table 7.3 Training for safety

Knowledge of	Trained to
Floor markings	• Behave correctly and safely within pedestrian areas, operating hazard zones, and other marked areas on the site.
Stability characteristics with and without load	• Operate the robot correctly according to the load. • Load the robot correctly and below the maximum payload.
Residual risks and warning from the user guide for your robot	• Avoid or behave safely in any scenarios where the robot can pose a risk to personnel or equipment. • Maintain the means that have been applied to mitigate the risks.
The robot's safety functions	• Identify in which scenarios the robot's safety functions are not sufficient for maintaining safety, for example, when the robot's Protective fields are muted, and how to behave to ensure safety. • Interact confidently with the robot in scenarios where the safety functions ensure safety.

Table 7.4 Training for understanding how the robot works

Knowledge of	Trained to
Robot's sensors	• Identify cases where the sensors may not be able to detect obstacles. • Troubleshoot simple issues where the sensors are blocked, dirty, or are unable to detect the object type.
Navigation and localization	• Troubleshoot localization issues.
Global and local path planning	• Troubleshoot simple path planning issues where the robot's path has been blocked.
Wi-Fi	• Connect to the robot over Wi-Fi.
Ideal operating environments	• Ensure that the robot's work area supports the robot's requirements and limitations.

Table 7.5 Training for maintenance

Knowledge of	Trained to
Regular cleaning and checks	• Clean and check the robot regularly with the tasks in "Weekly cleaning tasks for all users " on page 119.

Training of operators

Operators must be trained in all of the same content as direct users and in the additional content in the following tables.

Table 7.6 Training for site configuration

Knowledge of	Trained to
Maps	• Update the map with new markers and positions. • Create new maps.
Missions	• Create application specific missions. • Improve mission robustness. • Nest missions and using variables to reuse mission material efficiently.
Footprints	• Create and apply the correct footprint for different loads and top modules.
Calibrations	• Calibrate the robot's sensors. • Calibrate markers, shelves, and carts.
Wi-Fi	• Identify symptoms of poor Wi-Fi coverage. • Identify ways to improve Wi-Fi coverage.

Table 7.7 Training for maintenance

Knowledge of	Trained to
Regular maintenance and replacement of parts	• Service and check the robot regularly with the tasks in "Maintenance tasks for operators" on page 121.
Internal parts	• Access the internal parts by removing covers. • Identify the robot's internal parts and know their purpose.

Table 7.8 Training for MiR Fleet

Knowledge of	Trained to
Robots on MiR Fleet	• Add and remove robots to and from MiR Fleet. • Troubleshoot synchronization issues. • Update the software version of robots.
Missions on MiR Fleet	• Schedule missions. • Review mission statuses.

8. Accessing the internal parts

Most internal parts of MiR250 Shelf Carrier are accessed through covers that open to different compartments.

See a video of the process on the MiR TechComm videos channel on vimeo.com.

CAUTION

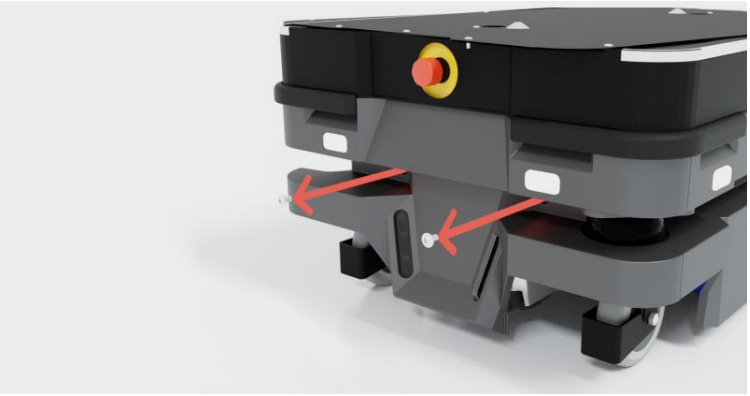
Removing covers from the robot exposes parts connected to the power supply, which can result in a short circuit that will damage the robot and could injure personnel.

- Before removing any covers, turn off the robot.
- Start by removing the rear cover, and disconnect the battery—see "Disconnecting the battery" on page 141.

8.1 Front compartment

To open the front compartment, follow these steps:

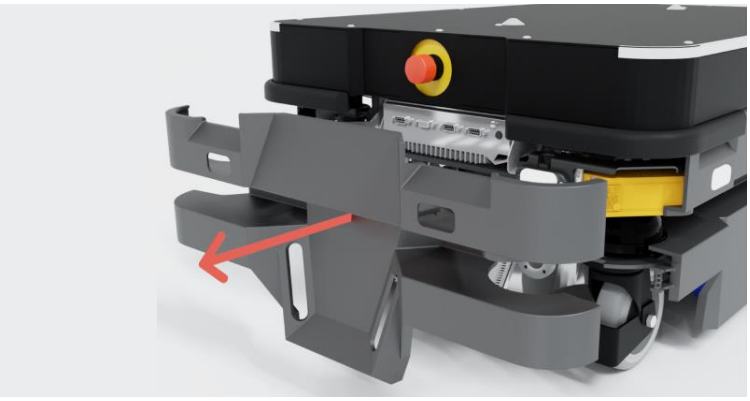
1. Unscrew the two screws holding the front cover. Use a T30 screwdriver.



2 Loosen the bottom corners one at the time by pulling out each corner.

3 Loosen the top corners one at the time by pulling each corner down, and then out.

4 Pull off the cover.

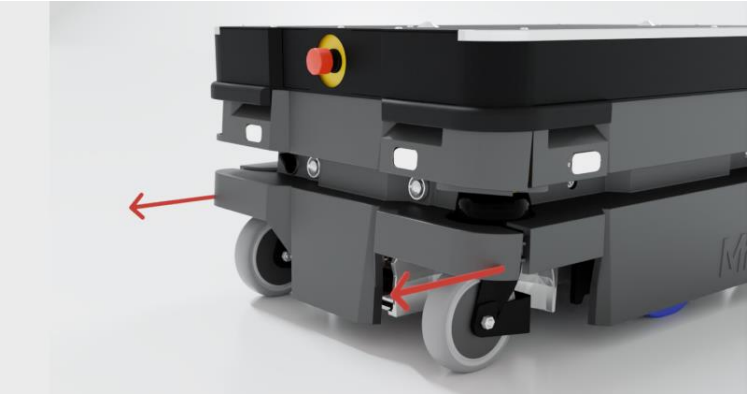


8.2 Rear compartment

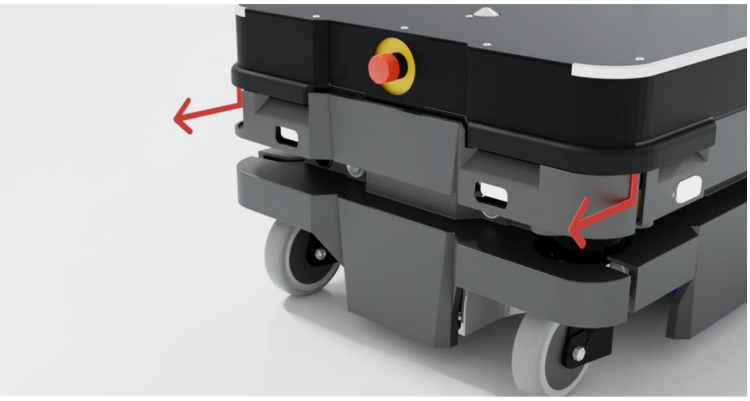
To open the rear compartment, follow these steps:

1 Push the two white buttons on the rear cover at the same time.

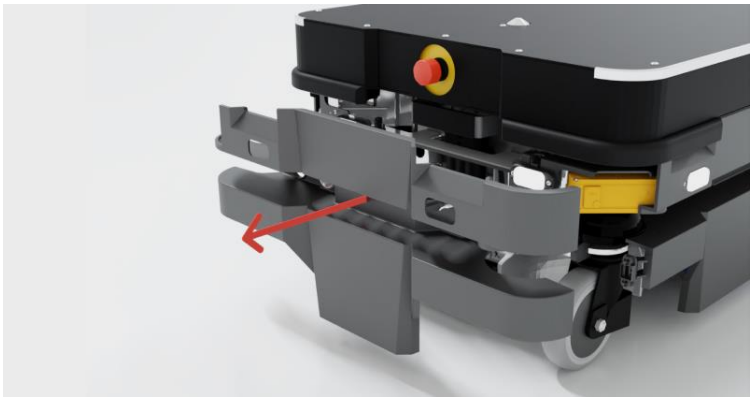
2 Loosen the bottom corners one at the time by pulling out each corner.



3 Loosen the top corners one at the time by pulling each corner down, and then out.



4 Pull off the cover.

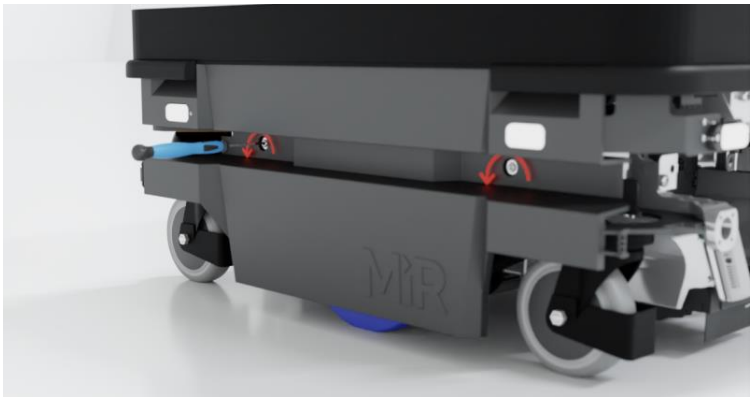


8.3 Side compartments

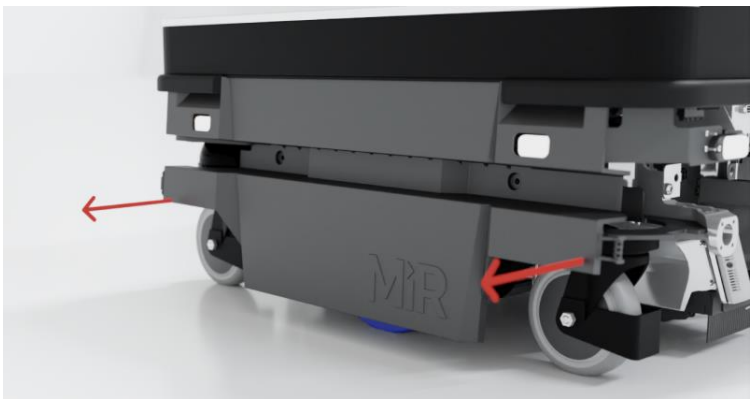
To open a side compartment, follow these steps:

1 Remove the front cover and rear cover—see "Front compartment" on page 110 and "Rear compartment" on page 112.

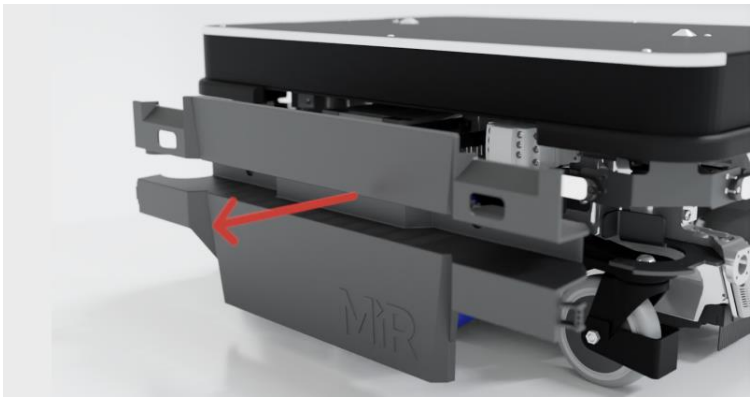
2 Turn the two screws counterclockwise. Use a T30 bit.



3 Loosen the bottom corners one at the time by pulling out each corner.



4 Pull off the cover.

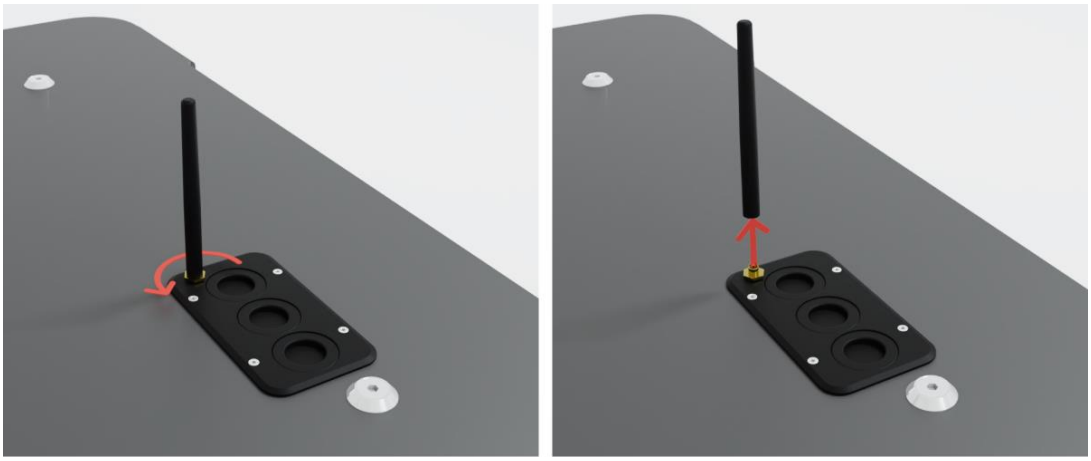


8.4 Top compartments

The top compartments are only accessible after the top module has been removed—see "Demounting the top module" on page 169.

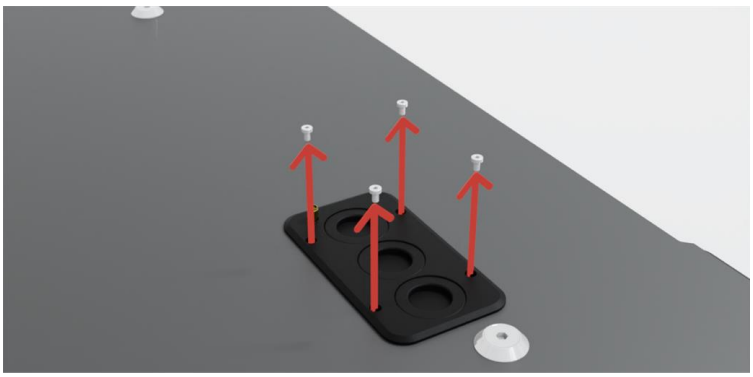
To open a top compartment, follow these steps:

1. Unscrew and remove the antenna from the top cover.

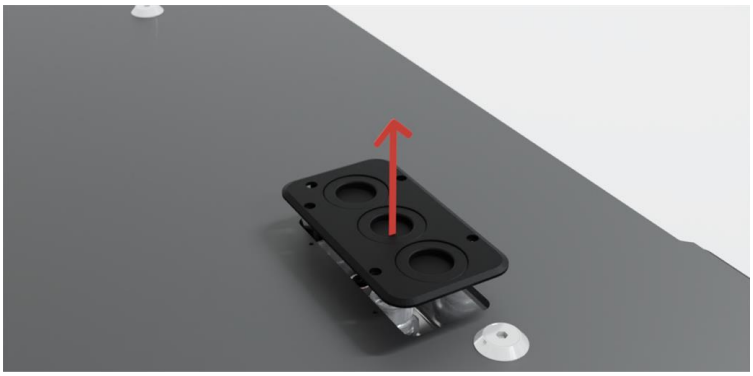


2. Unscrew the nut from the antenna connector, and push the antenna cable free of the cover. Use a 10 mm wrench.

3 Unscrew the four screws. Use a T10 bit.



4 Pull off the cover.



8.5 MiR Shelf Carrier 250

To access the internal parts of MiR Shelf Carrier 250, remove the top cover of the shelf carrier by unscrewing all 14 screws from the top cover and lifting off the plate.

9. Maintenance

The following maintenance schedules give an overview of regular cleaning and parts replacement procedures. It is recommended to make a maintenance plan to make sure that all maintenance tasks are done and that the responsible(s) are aware of their tasks.

The stated intervals are meant as guidelines and depend on the operating environment and frequency of usage of the robot.

Maintenance must be performed:

- In a clean and controlled environment.
- In an open area with sufficient space and escape routes according to standards and regulations of the country where the robot is installed.
- While the robot is shut down and disconnected from the battery.

See the sections "External parts" on page 22, "Internal parts" on page 23, and "Accessing the internal parts" on page 110 to see where the parts mentioned in the maintenance schedules are located and how to access them.

CAUTION

If the robot has been impacted, it may be structurally damaged, causing a risk of malfunction and injury to personnel.

- If you suspect the robot has suffered any damage, you need to conduct a thorough inspection to ensure that the robot's strength and structure is not compromised.

9.1 Weekly cleaning tasks for all users

Always disconnect the battery before performing maintenance tasks to prevent unexpected start-up—see "Disconnecting the battery" on page 141.

Table 9.1 Regular weekly checks and maintenance tasks

Parts	Maintenance tasks
Robot covers	Clean the robot on the outside with a damp cloth. Do not use compressed air to clean the robot.
Caster wheels (the four corner wheels)	Remove dirt with a damp cloth, and make sure nothing is entangled in the wheels.
Drive wheels (the two middle wheels)	Remove dirt with a damp cloth, and make sure nothing is entangled in the wheels.
Status lights	Check if the LED light band is intact. Ensure the light shows all the way around the robot. Clean with a soft cloth to ensure even lighting around the robot.
Signal lights	Check if the signal lights on the four corners blink and show light correctly.
Proximity sensors	Check for dust or dirt, and clean with a swab.
Safety marking on the floor	Check if the safety markings around operating hazard zones are intact and visible.
Information stickers	Check if the safety stickers, identification label, and nameplate on the robot are still intact and visible.

Parts	Maintenance tasks
Laser scanners	Clean the optics covers of the scanners for optimum performance. Use anti-static cleaning products, and avoid aggressive or abrasive cleaning agents. Make sure to also clean the top part of the optics cover. The contamination sensors scan the entire optics cover glass piece. In the robot interface under **Monitoring > Hardware health > Safety system > Emergency stop**, see if **Laser (Front) Contamination Error** and **Laser (Back) Contamination Error** is **False**. Static charges cause dust particles to be attracted to the optics cover. You can diminish this effect by using the anti-static plastic cleaner (SICK part no. 5600006) and the SICK lens cloth (part no. 4003353). See the manufacturer's own documentation.

9.2 Maintenance tasks for operators

The following maintenance tasks may only be executed by an operator or commissioner—see "User training and responsibilities" on page 101.

NOTICE

Only use approved spare parts. See the list of spare parts and the appropriate how-to guides. You can find these guides on MiR Support Portal.

Mobile Industrial Robots disclaims any and all liability if unapproved spare parts are used. Mobile Industrial Robots cannot be held responsible for any damages caused to the robot, accessories, or any other equipment due to use of unapproved spare parts.

Always disconnect the battery before performing maintenance tasks to prevent unexpected start-up—see "Disconnecting the battery" on page 141.

Check weekly		
Part	**Maintenance**	**Symptoms of neglect**
Safety laser scanners	Check for visual defects, for example cracks and scratches. Replace as needed. See the guide *How to replace the safety laser scanners on MiR250*. If only the optics cover is damaged, you can replace the cover alone. See SICK's documentation for nanoScan3 for instructions.	Robot goes into unexpected Protective stops or navigates around non-existent obstacles. Robot reports contamination errors.
Mechanical brakes	Test the mechanical brakes as described in "Mechanical brake function test" on page 131.	The mechanical brake system does not stop the robot or keep it in place at standstill.

Check monthly		
Part	**Maintenance**	**Symptoms of neglect**
Safety PLC	In the robot interface under **Monitoring > Hardware health > Communication**, see if the robot is running with the correct SICK configuration or if the warning **The SICK Safety PLC is running a non-standard configuration** is shown.	If the safety configuration file is ever modified, there is a risk of the robot colliding with personnel or equipment. Modifications to the safety configuration also invalidate the CE mark of the robot.

Check monthly		
Part	**Maintenance**	**Symptoms of neglect**
Robot hardware	In the robot interface under **Monitoring > Hardware health**, check if there are any warnings (marked with yellow).	Over time, a warning can become an error and will stop the robot from operating.
Front, rear, and side covers	Check mounting. Ensure the covers are even and are not in contact with the wheels. If you replace the cover with the robot's nameplate, make sure to mount a new copy of the nameplate to the replacement cover.	Covers hang loose, get scratched, do not protect the robot's internal parts, or are in contact with moving parts.
Speaker and signal lights	Check that all visual and auditory warnings function. Adjust or replace as needed. See the guide *Troubleshoot MiR250 sound not working*.	Speaker plays low or distorted sounds.

Check monthly		
Part	**Maintenance**	**Symptoms of neglect**
Charging pads/broom	Disconnect the battery on the robot. Using your hands, ensure that each pad moves up and down freely. Clean the charging pads using sandpaper—see the guide *How to clean the charging pads under MiR robots*. Also clean the pads on the charging stations. Clean the broom, and check that it is intact.	Contamination collects on the charging pads or they become stiff. Connection to the charging station becomes less reliable and charging is less effective.
3D cameras	Check for visual defects, for example cracks and scratches. To test the cameras, see the guide *How to test if the 3D cameras are working on MiR robots*. To calibrate, see the guide *How to calibrate a D435 3D camera*.	Robot navigates around non-existent obstacles or fails to detect obstacles.

Check monthly		
Part	**Maintenance**	**Symptoms of neglect**
Manual brake release switch	Confirm that the STO contactors have deactivated for the brakes. Go to Monitoring > Hardware health > Safety system - it should display "Robot is in Emergency stop (Manual Brake Release Switch)". Check if the Manual brake release switch functions by releasing the brakes and pushing the robot gently forward. Remember to enable the brakes again when done. To replace, see the guide *How to replace the Manual brake release switch on MiR250*.	Cannot release the brakes manually.

Check every three to four months		
Part	**Maintenance**	**Symptoms of neglect**
Control panel	Check that all buttons on the control panel function.	Pressing a button does not affect the robot.

Check every three to four months		
Part	**Maintenance**	**Symptoms of neglect**
MiR250 Shelf Carrier Emergency stop buttons	To check that the Emergency stop buttons work, push a button and check that the status light turns red and that the robot continues to be in Emergency stop until you press the Resume button. To replace, see the guide *How to replace the Emergency stop cable harness on MiR Shelf Carrier 250*.	Pressing a button does not bring the robot into Emergency stop.
Manual stop	To check that the Manual stop button works, push the button and check that the robot stops and that the Manual stop button blinks red.	Pressing the Manual stop button does not bring the robot into manual stop.
Resume button	To check that the Resume button works, first enable manual stop by pressing the Manual stop button. Press the Resume button and verify that this brings the robot out of manual stop.	Pressing the Resume button does not bring the robot out of manual stop.

Check every six months

Part	Maintenance	Symptoms of neglect
Drive wheels (the two middle wheels)	Check wheel surfaces for wear. If the center seam has been worn away, replace the wheels. You can also measure the diameter of the wheels to assess how worn down they are. Replace if the diameter is less than 197.5 mm. Replace in pairs. See the guide *How to replace the drive wheels on MiR250*. The robot's IMU must be calibrated after replacement of the wheels—see the guide *How to calibrate the IMU*.	Robot cannot travel over large steps and gaps without scraping the bottom of the robot. Robot swerves more if the wheels are uneven sizes. Localization becomes inaccurate due to inaccurately converted encoder data.

Check every six months		
Part	**Maintenance**	**Symptoms of neglect**
Caster wheels (the four corner wheels)	Check bearings by pressing against them and rotating them to feel any internal wear or damage. Check wheel surfaces for wear. If the center seam has been worn away, replace the wheels. You can also measure the diameter of the wheels to assess how worn down they are, and replace if the diameter is less than 122 mm. Replace all four caster wheels together. See the guide *How to replace the caster wheels on MiR250*.	Robot cannot travel over large steps and gaps without scraping the bottom of the robot. Robot swerves more if the wheels are uneven sizes.
Shelf carrier actuators and lifting mechanism	Check that the carrier pins can be raised and lowered smoothly and completely. To replace any part see the guide See the guides *How to replace the actuators and brackets on MiR Shelf Carrier 250*, *How to replace the electronics harness on MiR Shelf Carrier 250*, and *How to replace the pin engagement mechanism on MiR Shelf Carrier 250*	Cannot connect or release a shelf correctly. Reports errors or cannot correctly determine if it is in lowered state.

Check yearly or every 4 000 km

Part	Maintenance	Symptoms of neglect
ESD capability	Check the robot's electrical resistance by following the section *Testing the ESD compliance of MiR250* in the guide *How to replace the drive wheels on MiR250*. If the resistance is above 1×10^9 Ω, clean the wheels and test the resistance again. If the resistance is still out of bounds, replace the drive wheels.	Robot does not discharge static electricity.

Replace every 6 years

Part	Maintenance	Symptoms of neglect
Shelf Carrier encoders	Replace to ensure the reliability of the robot's safety functions.	The shelf carrier does not operate reliably.

Replace every 13 years

Part	Maintenance	Symptoms of neglect
Shelf carrier electronics harness	Replace to ensure the reliability of the robot's safety functions.	The shelf carrier does not operate reliably.

Replace every 13 years

Part	Maintenance	Symptoms of neglect
Position switch in Shelf Carrier top module	Replace to ensure the reliability of the robot's safety functions.	The shelf carrier does not operate reliably.

Replace every 20 years

Part	Maintenance	Symptoms of neglect
Emergency stop button(s)	Replace to ensure the reliability of the robot's safety functions.	Pressing the Emergency stop button does not bring the robot into Emergency stop.
Safety PLC	Replace to ensure the reliability of the robot's safety functions.	The robot begins reporting safety system errors.
STO and dynamic brake contactors	Replace to ensure the reliability of the robot's safety functions.	The robot begins reporting contactor errors.
Mechanical brakes	Replace to ensure the reliability of the robot's safety functions.	The robot reports mechanical brake errors.
Safety laser scanners	Replace to ensure the reliability of the robot's safety functions.	The robot does not detect obstacles reliably and reports safety laser scanner errors.

Replace every 20 years		
Part	**Maintenance**	**Symptoms of neglect**
Manual brake release switch and control panel	Replace to ensure the reliability of the robot's safety functions.	The robot does not react to pressed buttons reliably or reports errors or false button states.
STO relays of the Shelf Carrier top module	Replace to ensure the reliability of the robot's safety functions.	The robot begins reporting contactor errors.

9.3 Mechanical brake function test

The robot has two brakes on each drive wheel:

- A mechanical brake that is engaged by power-off, controlled directly from the safety PLC by the mechanical brake relays. The relays are monitored by a force-guided feedback signal back to the safety PLC.

  The mechanical brakes are always applied during any Protective or Emergency stop.
- A dynamic brake that is engaged by power-on, controlled directly from the safety PLC by the dynamic brake contactors. The dynamic brakes consist of two contactors that can short circuit the motor windings and thereby stop the wheel (permanent magnet motor). The dynamic brake relay has force-guided feedback signal, which is wired back to the safety PLC. The dynamic brakes are self-checked by this signal whenever they are actuated. If the dynamic brakes do not perform as expected, the robot interface reports a Dynamic brake error.

  The dynamic brakes are only applied when the Personnel detection safety function triggers a Protective stop. The mechanical brakes are also applied simultaneously.

Testing the control function

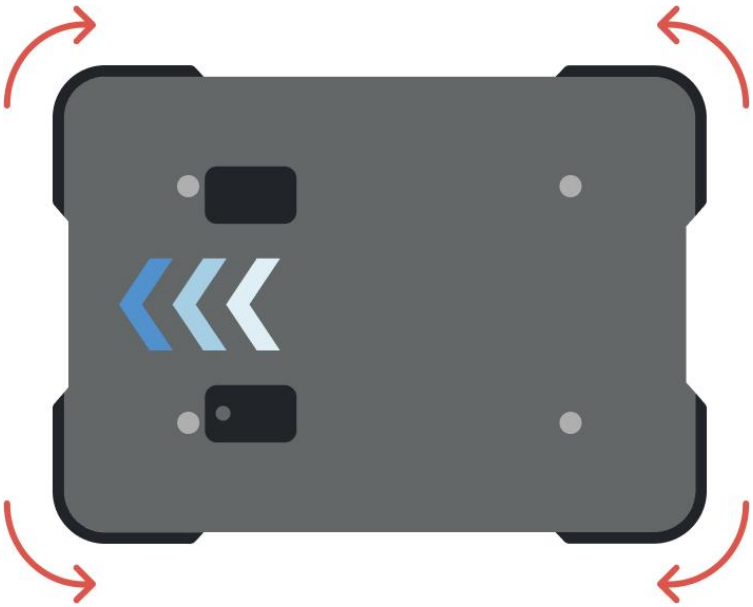
To test the mechanical and dynamic brakes, follow these steps:

1. Power up the robot—see "Powering up the robot" on page 45.

2. Verify that the manual brake release is not engaged—see "Manual brake release switch" on page 64.

3. Attempt to move or twist the robot by hand. Push it both left and right to test the brakes on both sides.

   If you are unable to move the robot in either direction, the brakes are functional. If you are able to produce any movement in the robot, one or both of the mechanical brakes are faulty. Contact MiR Technical Support—see *How to create a technical support ticket*. You can find this guide on MiR Support Portal.



4 Engage the manual brake release.

5 Attempt to move or twist the robot by hand. With the manual brake release on, the robot must be able to move freely on both drive wheels. If one or both wheels are still locked, contact MiR Technical Support—see *How to create a technical support ticket*. You can find this guide on MiR Support Portal.

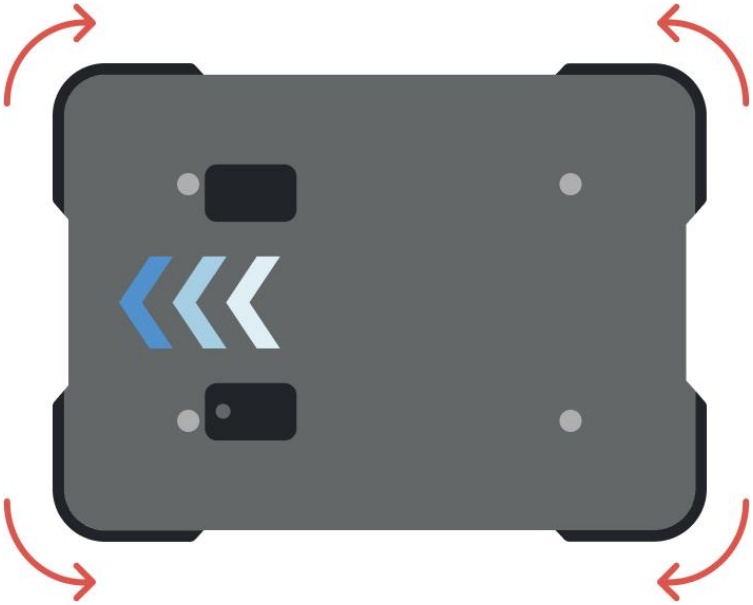
Testing the mechanical brakes

1 Verify that the manual brake release is not engaged.

2 Turn off the robot, and disconnect the battery in the left-side compartment—see "Disconnecting the battery" on page 141.

This is done to isolate the mechanical brakes, and to ensure that the dynamic brakes do not interfere.

3 Attempt to move or twist the robot by hand. Push it both left and right to test the mechanical brakes in either side. If you are unable to move the robot in either direction, both mechanical brakes are functional. If you are able to produce any movement in the robot, one or both of the mechanical brakes are faulty. Contact MiR Technical Support—see *How to create a technical support ticket*. You can find this guide on MiR Support Portal.



10. Storage

The main component that can be affected by storage is the robot's battery. It is important to keep track of the battery percentage both before and while the robot or battery is in storage to ensure the battery is not damaged by being undercharged.

10.1 Preparing the robot for storage

If you are taking the robot out of operation for any duration, we recommend the following:

- Charge the robot's battery before storage.
- Store the robot in an area at room temperature with a non-condensing relative air humidity—see specifications on MiR Support Portal. Temperatures and humidity below or above the specifications will shorten the service life of the battery.
- Disconnect the battery from the robot before storing the robot—see "Disconnecting the battery" on page 141. You can store the battery inside the robot, but keeping the battery connected to the robot greatly reduces the storage time. Make sure to disconnect the battery completely.
- Protect the battery immediately after removing it from the battery charger or robot. Never allow any moisture or foreign particles to get into the battery. If you store the battery outside the robot, you can protect the battery by storing it in a clean and airtight container or plastic wrap.
- Check the state of charge of the battery regularly, and make sure to recharge the battery if the state of charge is low. Always disconnect the battery after checking or charging it.

10.2 Storage time

The storage time of the robot and battery depends on the battery's state of charge, the storage conditions, and the battery version. For more information about storage time, see *MiR 48V Battery Technical Guide*. You can find this guide on MiR Support Portal.

The storage times in this guide apply for new batteries. Over time, the storage time will shorten.

CAUTION

If the battery is stored incorrectly or stored for too long, it will reach an undercharged state where the battery cells may be damaged or the battery shuts down permanently.

- Always check that the battery is disconnected before storing the robot. If the battery is connected to the robot, the storage time is reduced significantly.
- Check the battery percentage and charge the battery regularly to ensure it is not undercharged.

Table 10.1 Overview of battery modes where the battery stops supplying power

Battery percentage	Mode	Reactivate method
Low or battery unused for longer time	Power save mode	• Disconnect the battery from the robot for 30 seconds, reconnect it to the robot, wait 30 seconds, and then turn on the robot. • Connect a 48V cable charger directly to the battery while the battery is disconnected from the robot, or connect MiR Cable Charger Lite 48V 3A to the robot's charging interface while the battery is connected to the robot.
Critically low	Deep sleep mode	Depending on how long the battery has been in Deep sleep, you may be able to revive it using MiR Cable Charger Lite 48V 3A.

To properly troubleshoot any battery issues and for information about the exact time periods and battery voltages that trigger the transitions between states, see *MiR 48V Battery Technical Guide*. You can find this guide on MiR Support Portal.

11. Battery and charging

The robot is powered by a fast swap lithium-ion battery that can be charged inside the robot with a MiR cable charger or a MiR Charge 48V charging station. Instructions for charging depend on the charger type and are described in the guides included with each charger.

The battery supplied with the robot is equipped with a battery management system (BMS). The BMS is integral to the battery and ensures the battery remains within the normal region while charging and discharging. Overvoltage protection, undervoltage protection, and overcurrent protection for charge and discharge, and temperature protection are all provided by the BMS. The battery is also fused to protect against severe overcurrent events.

See *MiR 24V Battery Troubleshooting and Technical Guide* for more information. You can find this guide on MiR Support Portal.

NOTICE

Do not parallel couple the battery with more batteries. Parallel coupling the batteries will result in the batteries shutting down.

WARNING

Using a charging device different from the one supplied by the manufacturer can cause a fire and thereby burn injuries to nearby personnel and damage to the robot and equipment.

- Only use an original MiR charger.

WARNING

Lithium-ion battery packs may get hot, explode, or ignite and cause serious injury if they are misused electrically or mechanically.

Observe the following precautions when handling and using lithium-ion batteries:

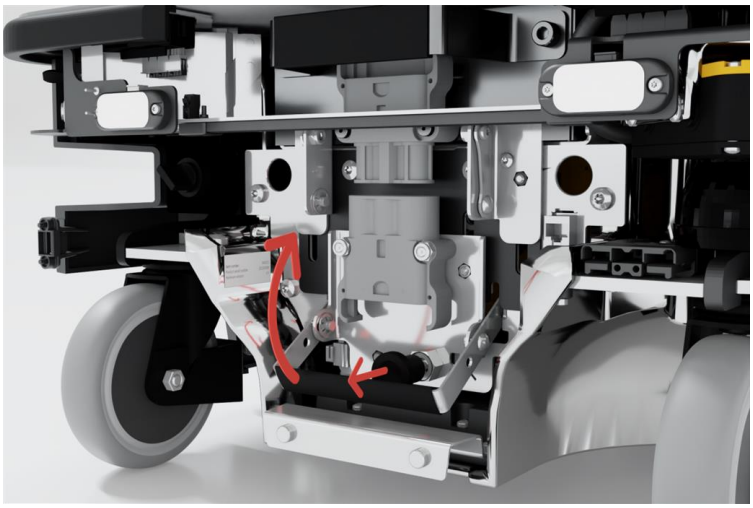
- Do not short-circuit, recharge, or connect with false polarity.
- Do not connect or charge a potentially defective or damaged battery.
- Do not expose to temperatures beyond the specified temperature range or incinerate the battery.
- Do not crush, puncture, or disassemble the battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode, or ignite.
- Do not allow the battery to get wet.
- In the event the battery leaks and the fluid gets into one's eye, do not rub the eye. Rinse well with water, and immediately seek medical care. If left untreated, the battery fluid could cause damage to the eye.
- In case of fire, use water to put out the fire. There is no need for special extinguishing media.
- Do not touch damaged batteries with bare hands. Only personnel using suitable Personal Protection Equipment (PPE) and tools should handle damaged batteries.
- Isolate the battery and keep clear if the following conditions are observed:
  - The battery exhibits abnormally high temperatures.
  - The battery emits abnormal odors.
  - The battery changes color.
  - The battery case is deformed or otherwise differs from the normal electrical or mechanical condition.
- Do not modify or manipulate of the battery. This may lead to considerable safety risks and is therefore prohibited.
- Never smoke or allow an open spark or flame in the vicinity of the robot's battery.
- Do not use the battery for anything other than MiR250 Shelf Carrier.

11.1 Connecting the battery

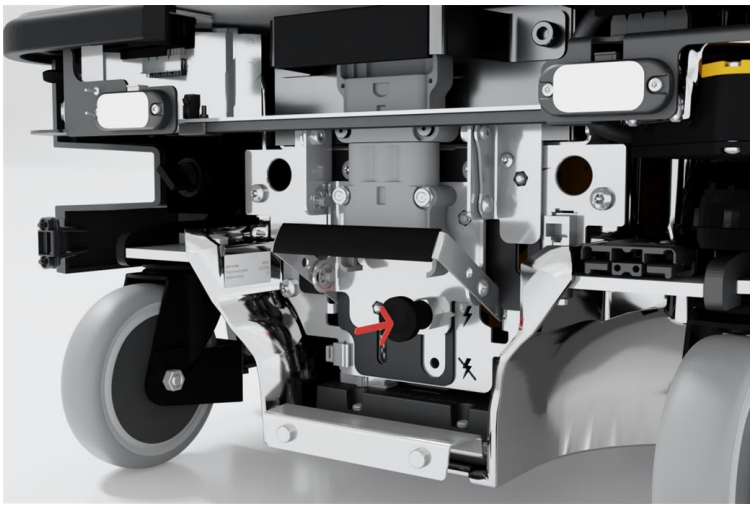
To connect the battery to the robot, you need to open the rear compartment—see "Accessing the internal parts" on page 110.

To connect the battery to the robot, follow these steps:

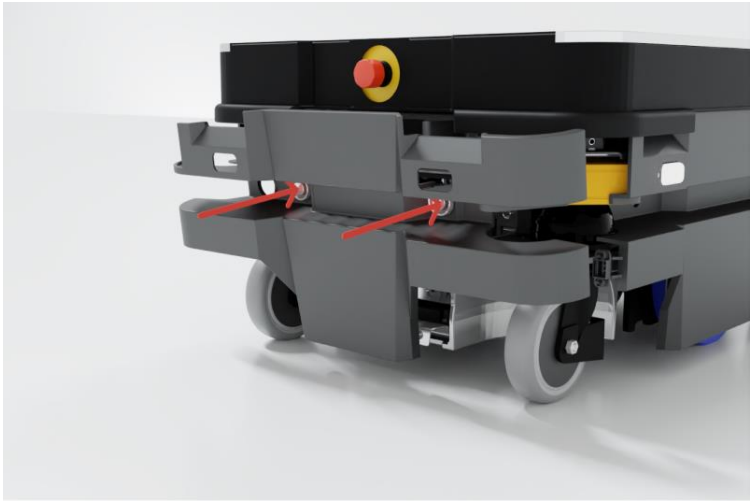
1. Pull the battery lock pin out while pushing the battery lever up.

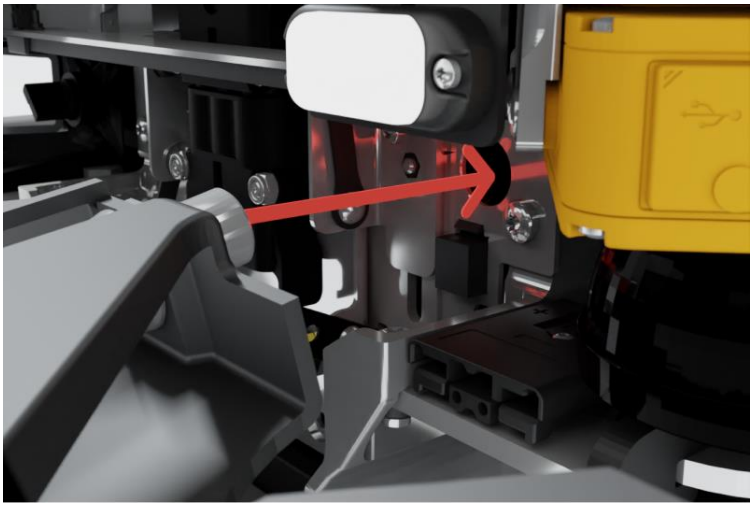


The battery lock pin will click into place and lock the battery connector once the battery lever has been pushed all the way up.

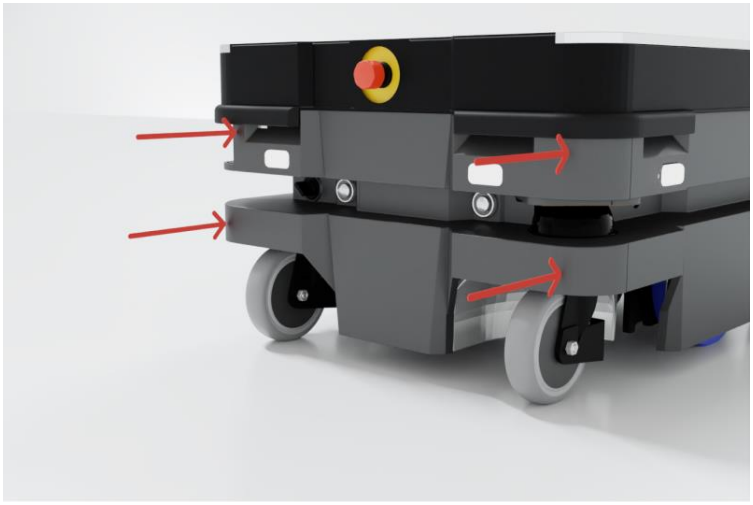


2 Reattach the rear cover by tilting it slightly so that the bottom points forward while inserting it into the two attachment sockets. Press the two white buttons while attaching the cover to the robot.





3 Click the cover in place one corner at the time.



11.2 Disconnecting the battery

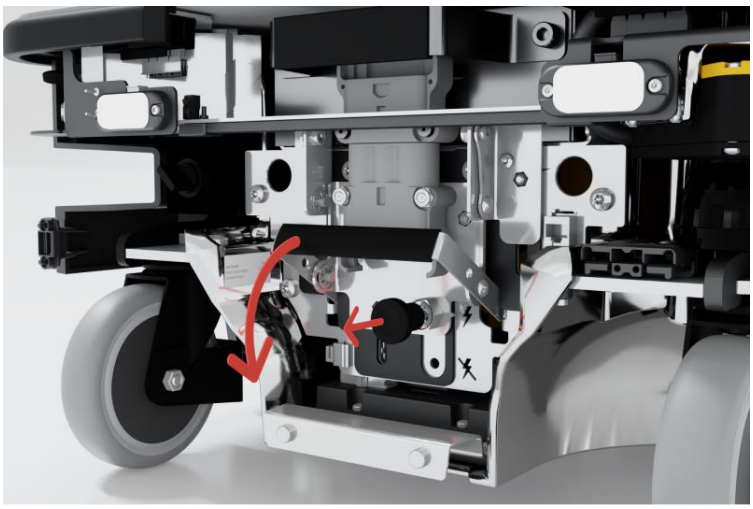
The battery can be disconnected for complete separation of all power to the robot. Disconnect the battery whenever the robot is to be transported, undergo maintenance, or stored for over 24 hours. This prevents unnecessary discharge, risk of electrocution, and risk of short circuiting.

Prior to disconnecting the battery, shut down the robot as described under "Shutting down the robot" on page 47. Ensure that the robot is not connected to any charging device.

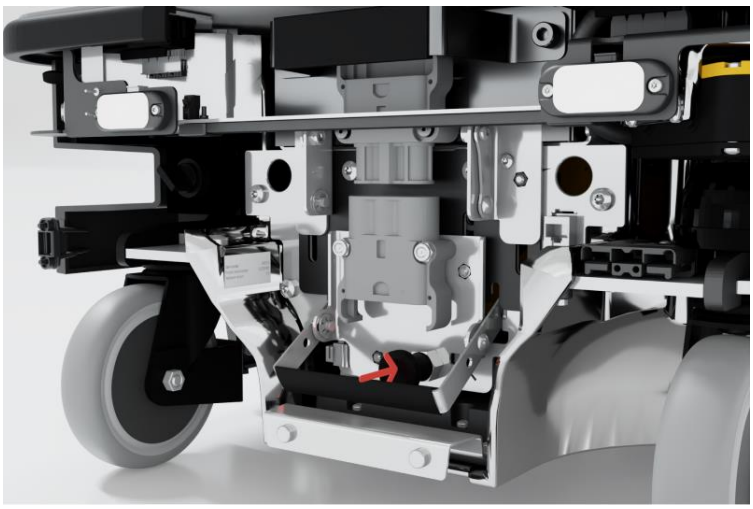
To disconnect the battery, follow these steps:

1. Access the rear compartment—see "Accessing the internal parts" on page 110.

2. Pull the battery pin out while pulling the battery lever down. Confirm that a gap opens between the battery and the battery connector as the handle is pulled down.



The battery lock pin will automatically click into place and lock the battery connector once the battery lever has been pulled all the way down.



If you have enabled fast swap—"Enabling fast swap " on the next page—you can remove the battery by pulling the battery handle.

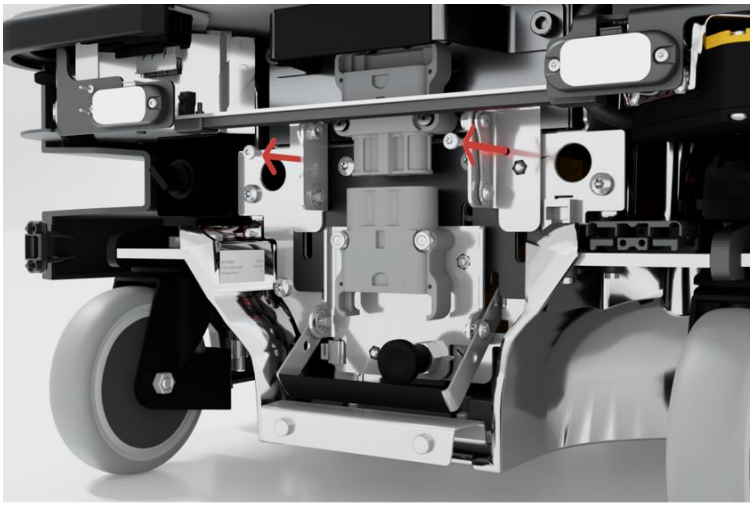
11.3 Enabling fast swap

To be able to remove the battery without taking off the top cover of the robot, you must connect a set of levers to the Battery lever—this is known as enabling the fast swap-option. You only need to do this once, and it is only relevant if you need to remove the battery regularly.

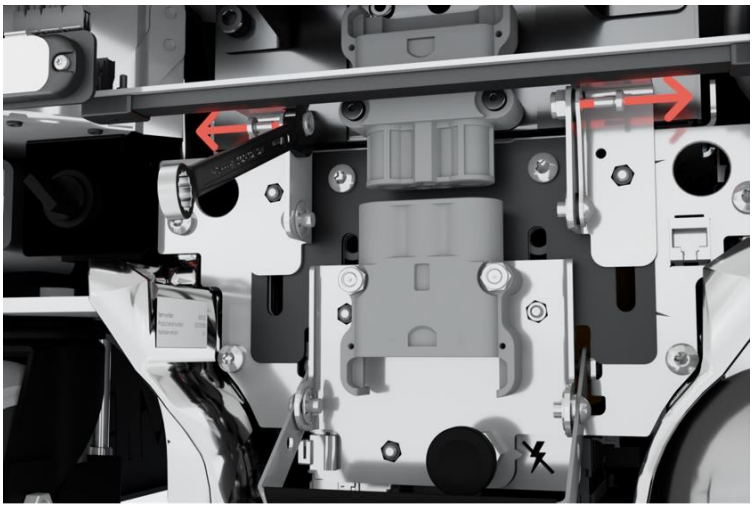
To enable the fast swap-option on the robot, follow these steps:

1. Disconnect the battery—see "Disconnecting the battery" on page 141.

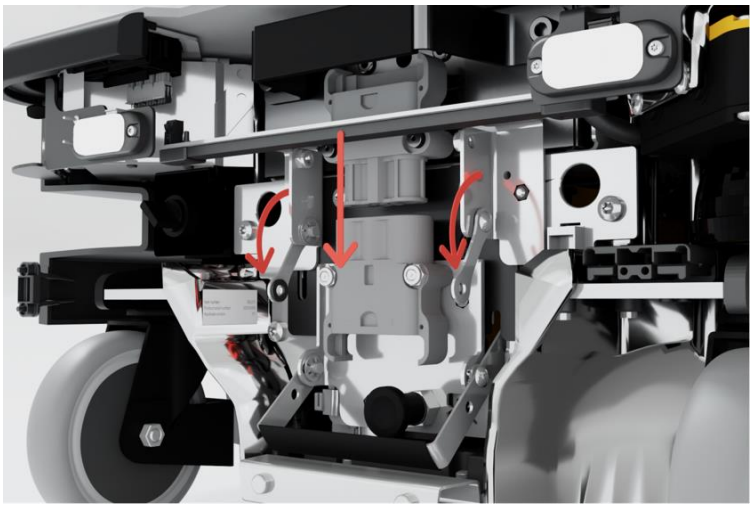
2. Unscrew the two small screws mounting the status light bracket to the battery plate. Use a T20 bit.

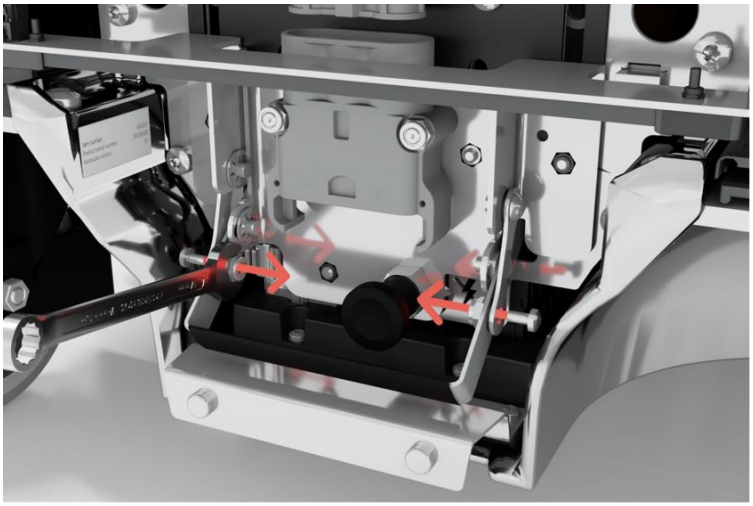


3 Unscrew the two bolts and washers keeping the fast-swap levers raised. Use a 10 mm hex bit for the bolts and a 10 mm hex wrench to keep the nuts in place.



4 Pull the status light bracket down and fasten the two levers to the battery lever using the same two bolts, washers, and nuts.





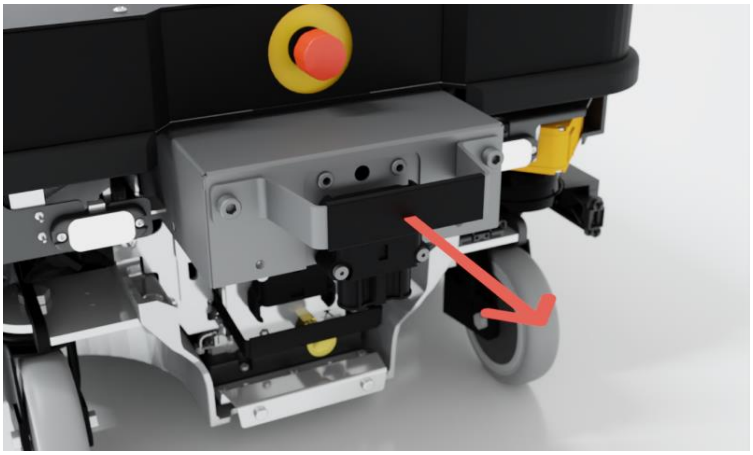
11.4 Swapping out the lithium-ion battery

To be able to remove the battery, you must first enable the fast swap-option in your robot—see "Enabling fast swap " on page 143.

To swap out the battery, follow these steps:

1. Disconnect the battery—see "Disconnecting the battery" on page 141.

2. Pull out the battery.



You can now replace the battery.

3. Do these steps in reverse when putting in the battery.

12. Operating hazard zones

Operating hazard zones are areas that must be visibly marked to comply with safety standards in EN 1525 and ISO 3691-4. They must adhere to the following:

- The operating hazard zone borders must be at least one meter from the identified hazard in all directions.
- Personnel must be instructed to stay clear of operating hazard zones when a robot is approaching.
- It is not allowed to have work stations in operating hazard zones.

Areas where you must apply operating hazard zones for MiR robots are:

- Areas where the robot drives with muted Protective fields.
- Areas with inadequate clearance for escape routes.

WARNING

When the robot is in an operating hazard zone, there is a risk of injury to any personnel within the zone.

- Ensure that all personnel are instructed to stay clear of operating hazard zones when the robot is in the zone.

You can add zones to the map in the robot interface to mitigate the risks to personnel in operating hazard zones. We recommend considering whether adding the following zones can reduce the risks in an operating hazard zone:

- Speed zones can be used to reduce the speed of the robot to the minimum robot speed.
- Sound and light zones can be used to add acoustic and visual warnings when the robot drives into the zones.

For more information about zones, see *MiR Robot Interface Guide*. For examples of operating hazard zones, see *MiR Commissioning Guide*. You can find these guides on MiR Support Portal.

13. Shelf specifications

MiR does not provide any standard shelves for MiR250 Shelf Carrier. You must create and design your own shelf type or purchase suitable shelves that meet the design requirements.

MiR250 Shelf Carrier is intended to be used with shelves with asymmetric legs. MiR has described safety and residual risks according to intended use and has tested the docking procedure with this application. MiR only provides standard configurations for the safety laser scanners for shelves with asymmetric legs.

Shelves with symmetric legs create significantly larger blind spots for the robot compared to shelves with asymmetric legs because the legs interfere more with the field of view of the safety laser scanners. Therefore, MiR250 Shelf Carrier is not intended to be used with shelves with symmetric legs.

The shelves must have a set of at least four wheels that enable MiR250 Shelf Carrier to transport the shelf without lifting it.

MiR recommends caster wheels with a 100 mm diameter and low rolling resistance.

13.1 Dimensions

Figure 13.1 illustrates the dimensions of supported shelves that must be within a certain range. The blue shaded area indicates where the shelf must be placed. MiR250 Shelf Carrier can accommodate shelves with the dimensions in Table 13.1.

Figure 13.1 Side view (left) and rear view (right) of shelf dimensions. The red hatched area is the scanner zone. Only the legs of the shelf may be located in this area.

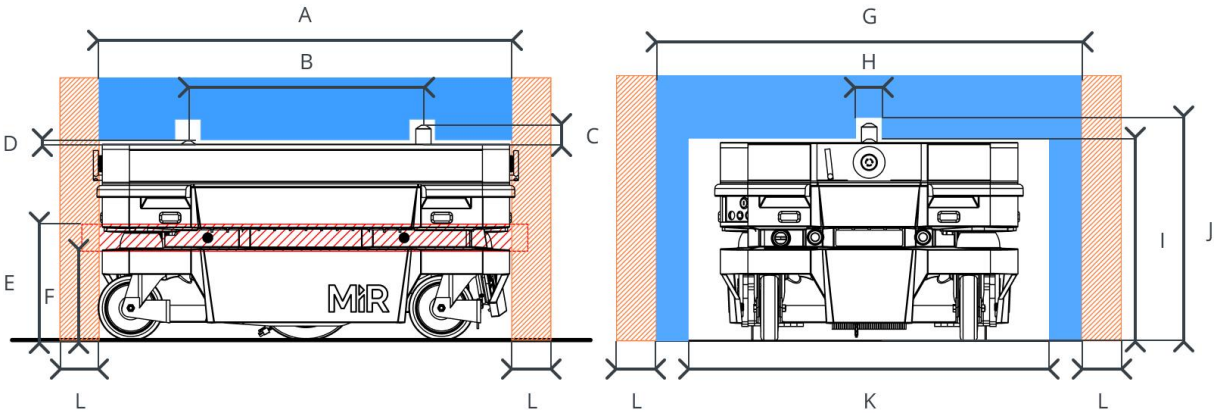


Table 13.1 Required shelf dimensions

Pos.	Description	Pos.	Description
A	Shelf length: maximum 790 mm	B	Distance between centers of pins: 450 mm (± 1)
C	Pin height when raised: 36.4 mm	D	Pin height when lowered: 6.5 mm
E	Distance from ground to upper boundary of scanner view: minimum 222 mm	F	Distance from ground to lower boundary of scanner view: maximum 170 mm[1]
G	Shelf width: maximum 800 mm	H	Pin hole diameter: 30.9 mm (± 0.1)
I	Leg height: 383 mm (+3/-0)	J	Pin hole height from ground: minimum 425 mm
K	Docking clearance: minimum 680 mm[2]	L	Additional shelf footprint width: maximum 75 mm[3]

The red hatched area marks the scanner zone. Only the shelf legs may be positioned in this area. Any other objects in the scanner zone will trigger a Protective stop.

[1]In some cases, this value can approach 175 mm. This depends on the distance from the robot and if there is a slight tilt in the scanners. If you design a shelf with parts other than the legs that are higher than 170 mm, you must test these shelves with all MiR250 Shelf Carrier robots.

[2]This value is relevant at any heights outside of the laser scanner view. The laser scanners must only detect the shelf legs positioned as described in "Leg dimensions and positions" on the next page for the robot to be able to dock to the shelf.

[3]If the caster wheels are extending the maximum shelf width with more than 75 mm, the caster wheels must be fitted with foot guards to mitigate risk of injury to personnel.

WARNING

If any of the shelf dimensions are exceeded, the shelf is not supported by MiR. MiR takes no responsibility if the shelf or its load collides with personnel or equipment if the shelf specifications are not met.

- Ensure that the shelves MiR250 Shelf Carrier transports meet the shelf specifications provided in this section.

CAUTION

If the caster wheel offset (L) from the shelf footprint is exceeded, personnel risk their feet getting run over and crushed by heavy shelves.

- Ensure that the shelves MiR250 Shelf Carrier transports meet the shelf specifications provided in this section.

13.2 Leg dimensions and positions

MiR only supports shelves made with four asymmetrical legs. Each leg must be 20 mm in diameter (+1/-0) and positioned as shown in Figure 13.2. If the legs are placed outside the described positions, the safety system will trigger a Protective stop each time the robot tries to drive with the shelf.

The robot uses the legs as markers to dock to the shelf correctly. It is therefore important that the legs are correctly placed and that the legs are made of a material that the safety laser scanners can detect reliably.

The inside of the legs must be coated with a non-reflective material that has a light, neutral color. We recommend using a matte light gray.

Figure 13.2 Top view of the robot. The red hatched area marks the scanner zone. Only the four legs indicated with circles can be placed in the zone at the defined positions.

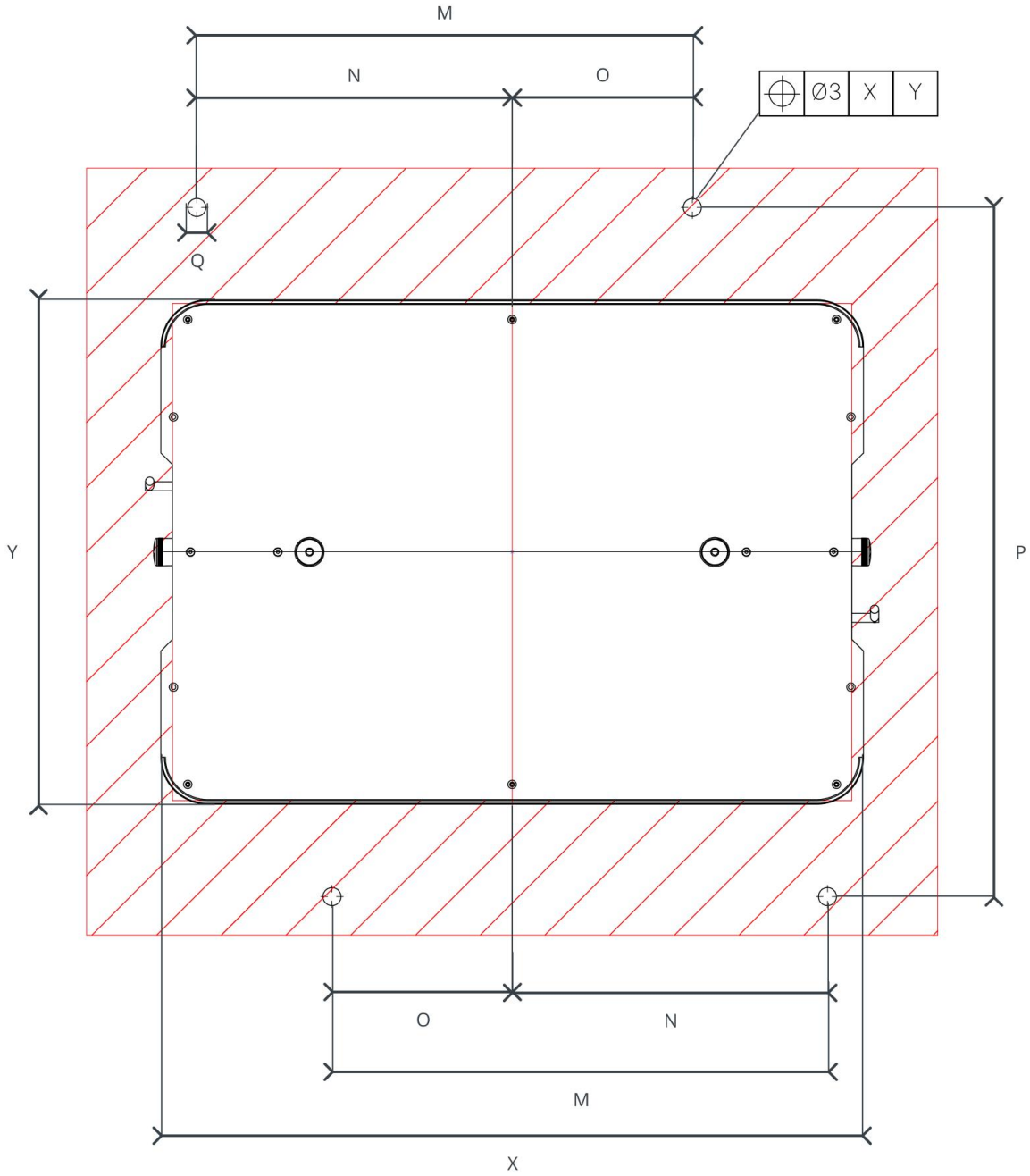


Table 13.2 Dimensions for shelf leg positions

Pos.	Description	Pos.	Description
M	Distance between legs on side: 550 mm	N	Displacement from robot's center: 350 mm
O	Displacement from robot's center: 200 mm	P	Distance between legs on opposite sides: 765 mm
Q	Leg diameter: 20 mm (+1/-0)		

13.3 MiR250 Shelf Carrier footprints

MiR250 Shelf Carrier comes with two new footprints: **MiR250 Mk2 shelf** and **MiR250 Mk2 Shelf Carrier base**, which are used when driving with a shelf and when driving without, respectively. These footprints are made specifically to be compatible with the SICK configuration that applies to MiR250 Shelf Carrier hardware version 2.0. If using a MiR template pickup or place mission, the correct footprint is automatically selected based on what the robot is doing.

The **MiR250 Mk2 Shelf Carrier base** footprint is set as the default footprint from production. The **MiR250 Mk2 shelf** footprint will automatically be selected in existing missions using the default MiR250 Shelf footprint from MiR250 Shelf Carrier hardware version 1.0.

See "Required space" on page 17 for more information.

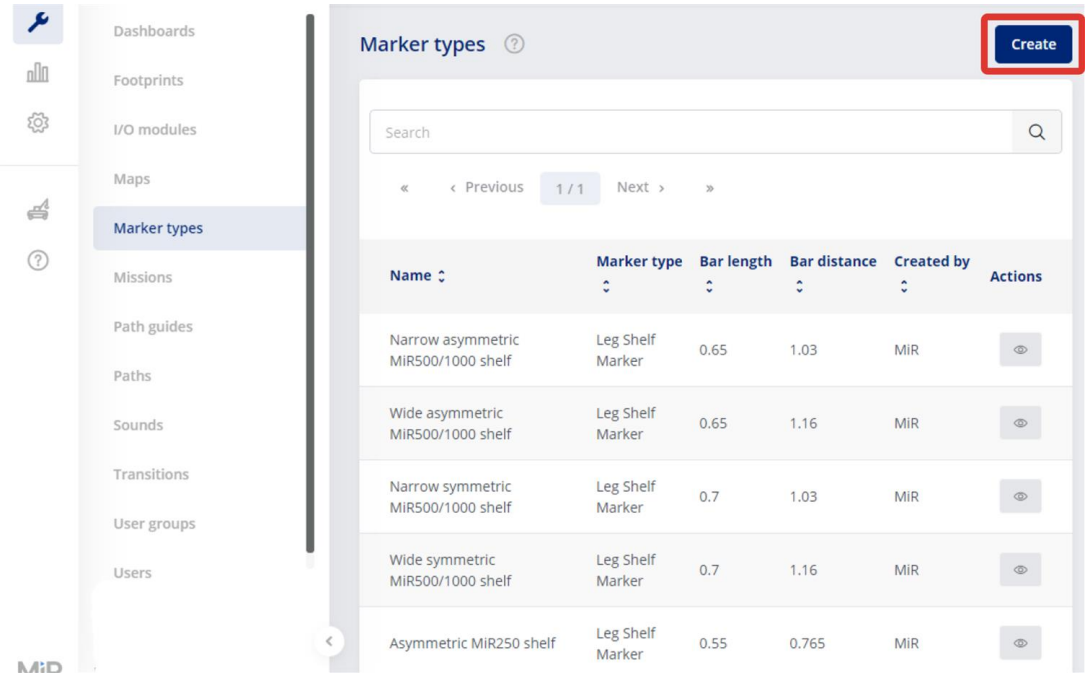
13.4 Creating a marker type

Before creating missions with shelves, you need to define the different marker types that your robot will be docking to. Marker types are used to define what type of shelf is located on a Shelf position and how the robot docks to it, ensuring that the robot picks up the shelf correctly.

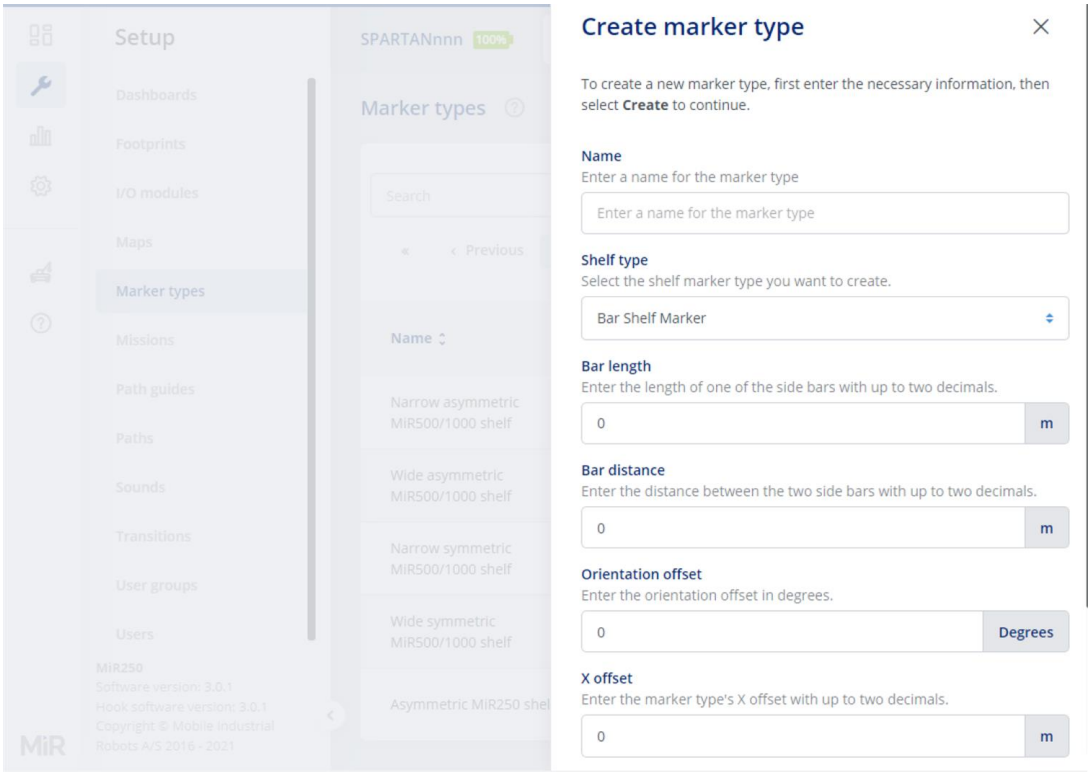
If you are using a shelf that has dimensions supported by MiR—see "Shelf specifications" on page 148—you can use the default marker type **Asymmetric MiR250 shelf**.

To create a new marker type, follow these steps:

1. To create a new marker type, go to **Setup > Marker types**, and select **Create**.

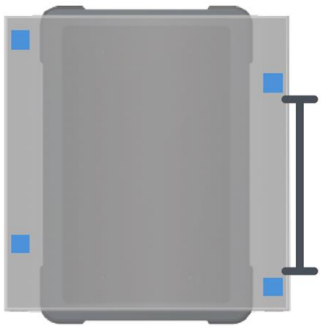


2 Fill in the parameters with the dimensions of your shelf. Each parameter is described below.

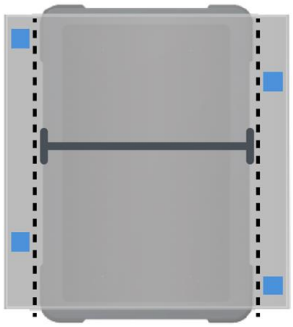


- **Name**: Identifies the shelf type when using it in mission actions. The marker-type name must be unique.
- **Shelf type**: Identifies the type of shelf that is going to be used. **Bar shelf markers** are for MiR100 and MiR200 robots, and **Leg shelf markers** are for MiR250, MiR500, MiR600, MiR1000 and MiR1350 robots.

- **Bar length in meters**: Defines the distance between a set of legs parallel with the robot.



- **Bar distance in meters**: Defines the distance between a set of legs perpendicular to the robot. This can also be interpreted as the width of the space under the shelf where the robot docks.



- **Orientation offset in degrees:** Adjusts the angle of the robot's orientation when docking to the shelf. A value of 180 will make the robot dock in reverse. A positive offset turns the robot counterclockwise, and a negative value turns it clockwise.
- **Offset X in meters**: Adjusts how far forward the robot should go under the shelf when picking it up. By default, the robot docks to the center. A positive X-offset moves the robot more forward, and a negative value moves it backward.
- **Offset Y in meters**: Adjusts how far to either side the robot goes under the shelf when picking it up. By default, the robot docks to the center. A positive Y-offset moves the robot more the left side, and a negative value moves the robot more to the right.
- **Leg asymmetry in meters:** Defines the offset between the two front legs. A zero value means the legs are symmetrical.

If the robot is not docking correctly, try adjusting the X and Y offsets.

3 Select **Create** when you are done. The marker type is now displayed in the list of marker types.

14. Commissioning overview

Commissioning should be done without any load on the robot, except when doing brake tests where the robot should have a load equaling the heaviest load it will be driving with.

Only persons assigned with the commissioning task should be present during commissioning.

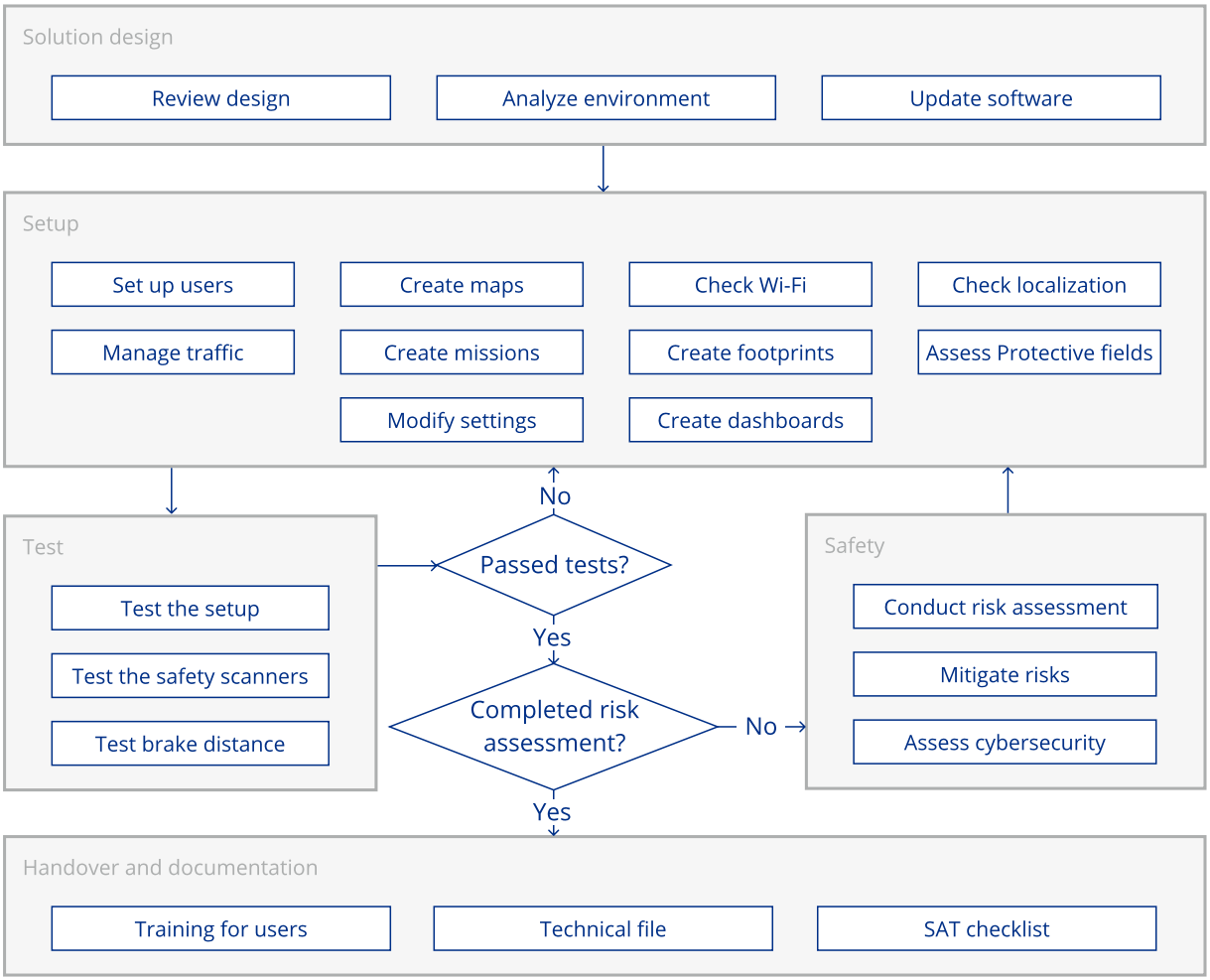
MiR Commissioning Guide contains a site acceptance checklist with the core tasks that are part of commissioning the MiR robot.

Commissioning is an iterative process that requires you to adjust the set up as issues and possible optimizations arise. Make sure to test all changes frequently and review all tasks once they are all complete. The basic commissioning process flow is illustrated in Figure 14.1.

There will also be more integration-specific commissioning tasks that are not in this guide and will depend on the design of the solution and integration. Persons responsible for commissioning are also responsible for determining all other tasks required to commission the robot safely.

For more information about each commissioning step, see *MiR Commissioning Guide*. You can find this guide on MiR Support Portal.

Figure 14.1 Flow diagram of the commissioning process



15. Brake test

It is the responsibility of the commissioner to perform an adequate test of the robot's braking capability under the driving conditions the robot will be operating in. The brake test must be executed:

- With maximum payload.
- Within each speed interval for each Protective field.
- At the steepest supported decline in the robot's work area.

The commissioner must iteratively adjust the modifiable parameters and then run a brake test until the robot successfully stops in time in every test.

15.1 Dependent factors

The braking distance of the robot is particularly dependent upon the parameter in Table 15.1. If the robot fails a brake test, you must either modify a chosen parameter to reduce the distance, or you can increase the size of the robot's Protective fields to make the robot stop sooner. To change the Protective fields, see *MiR Commissioning Guide*.

WARNING

The Protective fields are configured to comply with the safety standards of MiR250 Shelf Carrier. Modifications may prevent the robot from stopping in time to avoid collision with personnel and equipment. Any modifications of the SICK configuration requires a new CE certification of the robot and compliance to all safety standards listed in the specification of the application and in other way declared.

- Do not modify the safety system without a competent third party to evaluate the safety of the design and performance of the robot after the modifications are applied.

Table 15.1 Parameters affecting the robot's brake distance

Parameter	Design consideration for Protective fields
Top module	Adjust the length, width, and shape of the Protective fields accordingly to match the footprint of the top module if it extends beyond the top

Parameter	Design consideration for Protective fields
	cover of the robot. Adjust the shape of the Protective fields accordingly to create cutouts for cart or shelf legs in the view of the scanners.
Robot speed	Speed affects the braking distance according to a quadratic relationship. For example, 2× higher speed means 4× longer braking distance. The higher the maximum speed in a monitoring case, the longer the Protective field must be.
Mass moment of inertia	A higher mass moment of inertia increases the braking distance when the robot pivots. The higher the mass moment of inertia, the wider the Protective fields must be.
Payload weight	A higher payload increases the braking distance when the robot drives straight. The higher the payload, the longer the Protective fields must be.
Payload position	When the payload's center of gravity is behind the drive wheels, it increases the braking distance when the robot drives straight. The further the center of gravity is behind the drive wheels, the longer the Protective fields must be.
Floor surface friction	A lower friction between the wheels and floor increases the braking distance. The lower the frictional coefficient, the longer the Protective fields must be.
Floor surface grade	When the robot is driving down a decline, it increases the braking distance. The steeper the maximum slope the robot drives down, the longer the Protective fields must be.

15.2 Brake test method

This section presents a recommended approach for conducting linear and pivot brake tests for this purpose.

Test setup

In order to conduct brake tests for verifying robot Protective fields, the following items are needed:

- **Robot**: the robot including its top module and maximum payload.
- **Brake test area**: approximately 3 m × 10 m; or the distance it takes for the robot to reach maximum speed and stop safely.
- **Custom joystick in robot user interface**: joystick widget with customizable speed available from MiR software version 2.11.0.
- **Tape measure**: minimum 1 m of measuring length.
- **Test object**: An object such as a cardboard box or similar that the robot can safely collide with. Recommended size: 200 mm high and 600 mm wide (approximating a cross-section of a human body lying on the ground).

Custom joysticks

Create custom joysticks in the robot interface that set maximum speeds for the robot that correspond to the monitoring cases.

- **Number of custom joysticks**: Should be equal to the number of Protective field monitoring cases. If you are using the standard SICK configuration, you will need seven—see "Safety-related functions" on page 79.
- **Custom joystick speed**: Should be specified 0.05 m/s below the upper limit of the monitoring case speed interval.

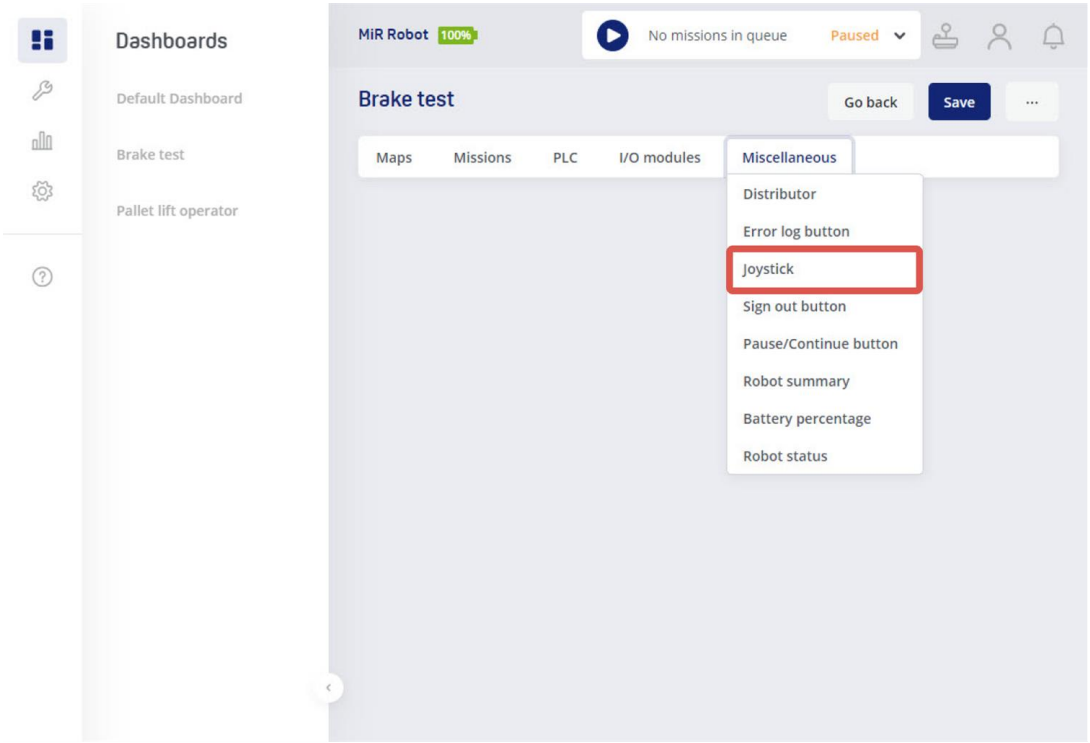
  If the 0.05 m/s margin is not used, MiR cannot guarantee that the robot will not overshoot the speed interval threshold and activate the Protective fields for the next monitoring case.

  Monitoring cases for reverse driving are represented as negative values to indicate the direction of locomotion. To make the robot reverse, push the joystick directly backward.

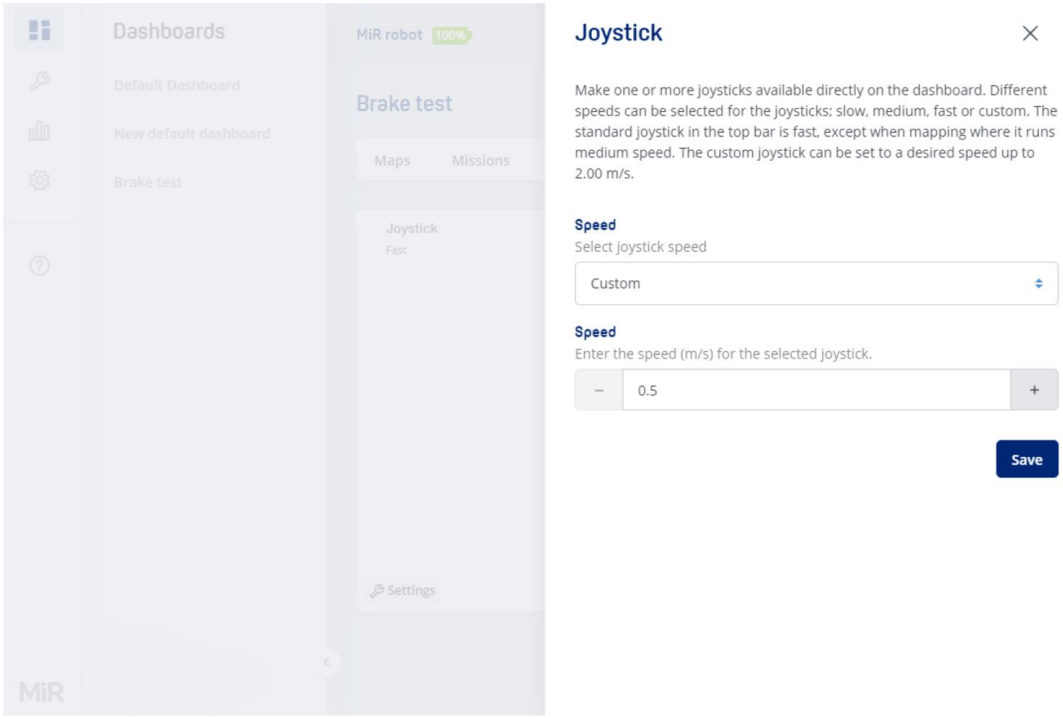
To create custom joysticks for a brake test, follow these steps:

1. In the robot interface, go to **Dashboards** and create a new dashboard.

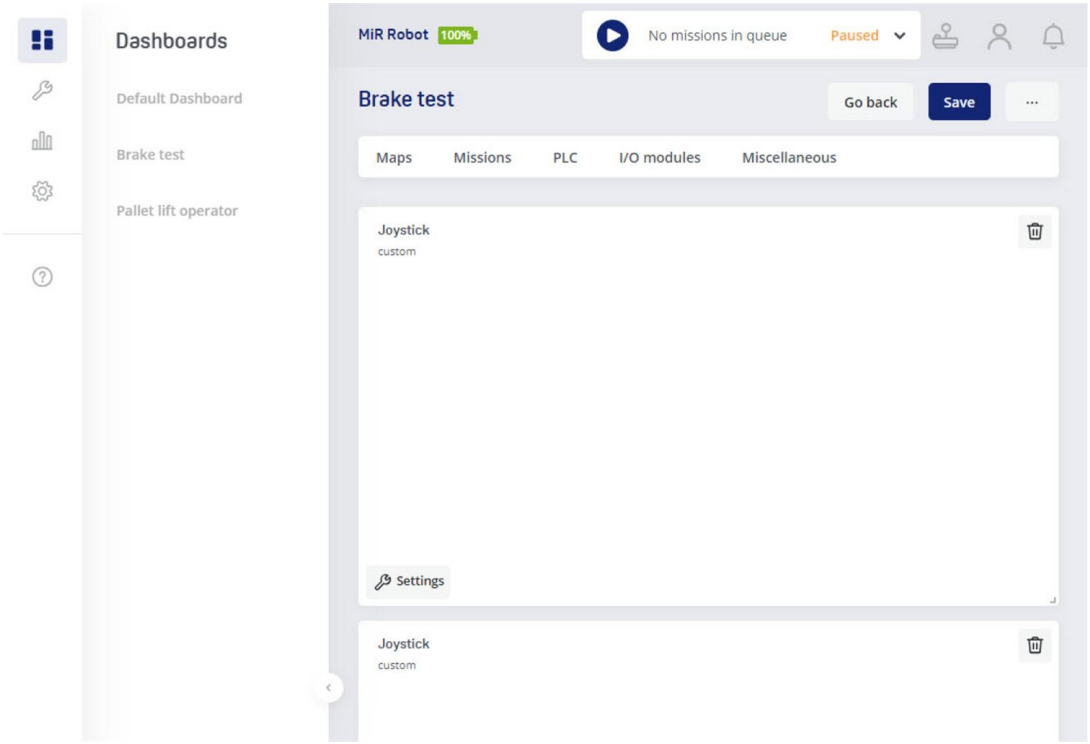
2. In the top menu of your new dashboard, select **Miscellaneous > Joystick** to create a new joystick.



3 Set **Joystick speed** to **Custom**, and set the first **Custom driving speed** to the desired speed in m/s. Select **Save** to apply.



4 Repeat step 5 and 6 until you have the desired number of joysticks with the required Custom driving speed settings on your dashboard.



Method

The following two sections describe how to perform a linear brake test and pivot brake test.

Linear brake test

A linear brake test must be conducted to ensure that the length of the Protective fields of the robot are correctly configured for each monitoring case and the planned payload.

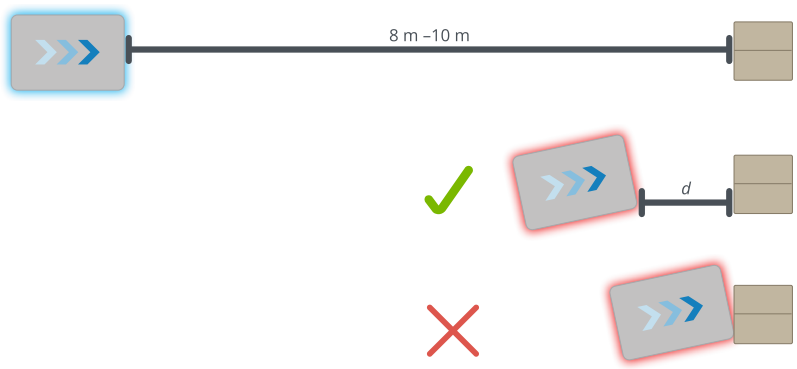
After driving the robot toward a test object and braking occurs, the distance *d* between the stopped robot and the test object should be measured and recorded for each brake test. Before conducting a linear brake test, a pass criterion for the test must be defined.

Pass criterion = acceptable distance d for the site (we recommend 215 mm as a starting point, or 65 mm if personnel wear safety shoes).

To conduct a linear brake test for forward and reverse driving, follow these steps:

1. Place a static test object front and center relative to the driving path of the robot—see Figure 15.1.
2. Using the joystick for the lowest speed, push the joystick directly forward for forward driving (or directly backward for reverse driving) to drive the robot straight towards the test object.
3. Once the robot has completed braking and come to a complete stop near the test object, measure and record the distance *d* from the part of the robot that is closest to the test object.
4. Repeat steps 2–3 a total of five times for the selected joystick speed.
5. Repeat steps 2–4 for each joystick speed.

Figure 15.1 Linear brake test diagram



The test is considered passed when the distance *d* is equal to or greater than the pass criterion value. Likewise, the test is considered failed when the distance *d* is less than the pass criterion value. “P” for Pass or “F” for Fail should be recorded for each test in the test matrix.

Table 15.2 Linear brake test example matrix

	Forward driving speed (m/s)							Reverse driving speed (m/s)				
	0.1	**0.3**	**...**					**-0.1**	**-0.3**	**...**		
Test 1												
Result												
d (mm)												
Test 2												
Result												
d (mm)												
Test 3												
Result												
d (mm)												
Test 4												
Result												
d (mm)												
Test 5												
Result												
d (mm)												

Pivot brake test

The pivot brake test must be conducted to ensure that the width of the standstill Protective field for the robot is sufficient to prevent a collision when the robot is pivoting on its axis with maximum payload.

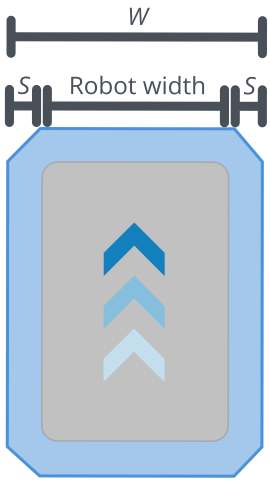
If you are using the default SICK configuration, the standstill Protective field corresponds to monitoring case 1 (0 to 0.1 m/s) for forward and reverse driving.

After pivoting the robot toward a test object and braking occurs, the distance *p* between the stopped robot and the test object should be measured and recorded for each brake test. Before conducting a pivot brake test, a pass criterion for the test must be defined.

Pass criterion = acceptable distance p for the site (we recommend 215 mm as a starting point, or 65 mm if personnel wear safety shoes).

Determine the distance *S* for object placement relative to the side of the robot.

Figure 15.2 Illustration of W and S



To conduct a pivot brake test to the left and right of the robot, follow these steps:

1. Place a static test object a distance *S* to the left of the front-left corner of the robot (or to the right of the front-right corner of the robot). Make sure the object is placed just outside of the standstill Protective field so that the robot is not in Protective stop—see Figure 15.3.

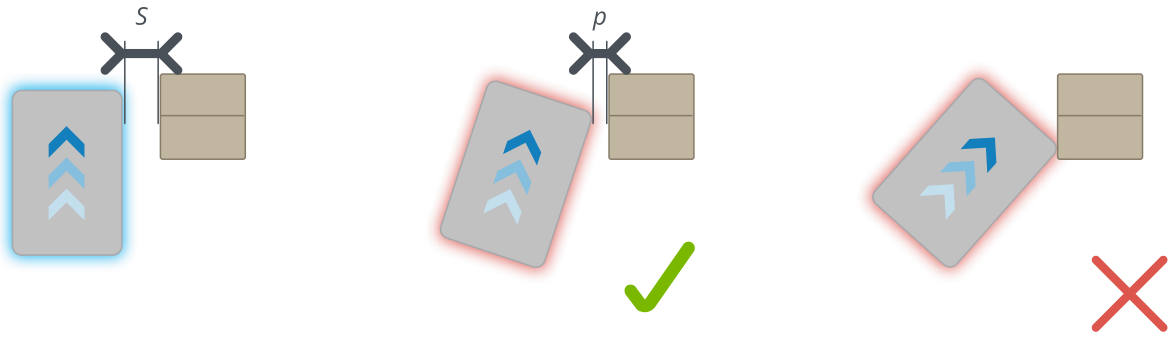
2. Positioned in front of the robot and using the joystick for monitoring case 1, push the joystick directly to the left for pivoting the robot in a clockwise direction (or directly to the right for pivoting the robot in a counterclockwise direction) toward the test object.

3. Once the robot has completed braking and come to a complete stop near the test object, measure and record the distance *p* from the part of the robot that is closest to the test object.

4. Repeat steps 2–3 a total of 5 times.

5. Repeat steps 1–4 for pivoting the robot to the right toward a test object.

Figure 15.3 Pivot brake test diagram



The test is considered passed when the distance *p* is equal to or greater than the pass criterion value. Likewise, the test is considered failed when the distance *p* is less than the pass criterion value. “P” for Pass or “F” for Fail should be recorded for each test in the test matrix.

Table 15.3 Pivot brake test example matrix

	Left	Right
Test 1		
Result		
p (mm)		
Test 2		
Result		
p (mm)		
Test 3		
Result		
p (mm)		
Test 4		
Result		
p (mm)		
Test 5		
Result		
p (mm)		

16. Demounting the top module

If you need to access the robot from the top, you must demount MiR Shelf Carrier 250. This can be required when troubleshooting issues or replacing robot components.

CAUTION

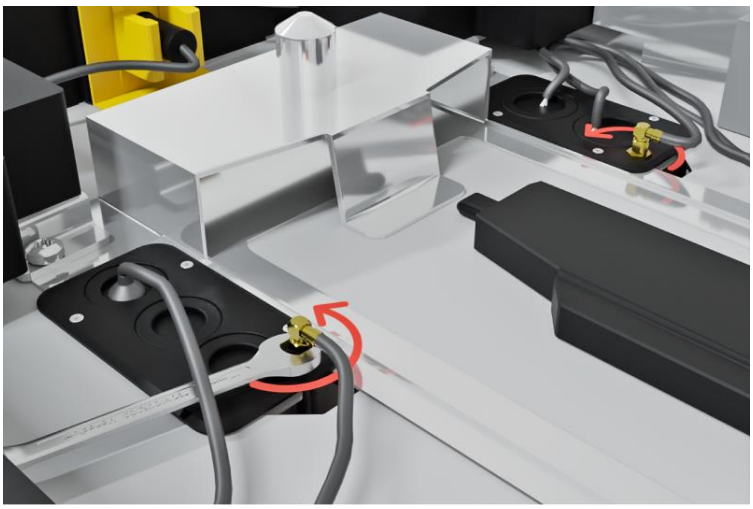
Removing covers from the robot exposes parts connected to the power supply, which can result in a short circuit that will damage the robot and could injure personnel.

- Before removing any covers, turn off the robot.
- Start by removing the rear cover, and disconnect the battery—see "Disconnecting the battery" on page 141.

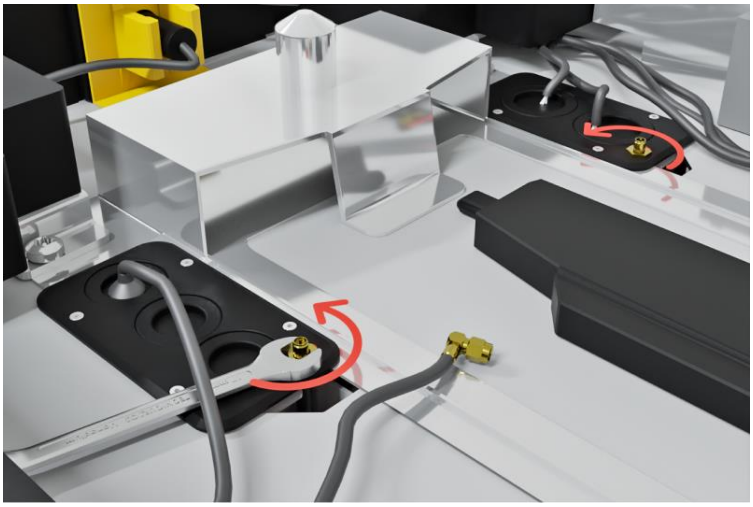
To demount the top module, follow these steps:

1. Remove the 14 screws from the top plate. Use a T20 bit.

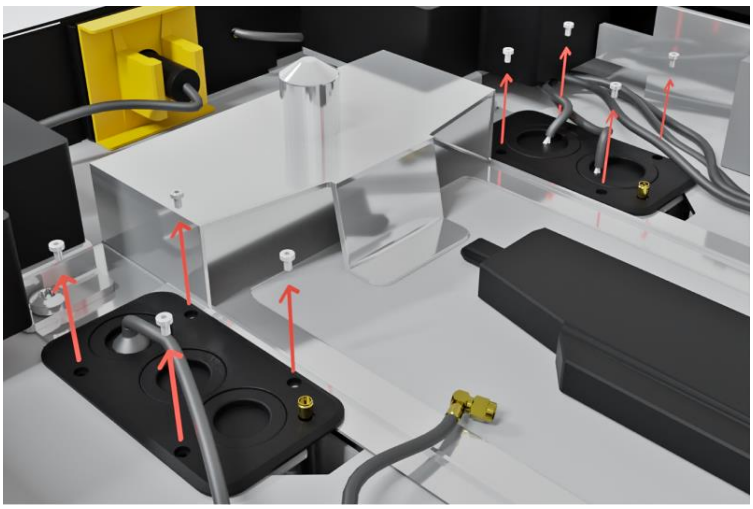
2 Remove the antenna extension cables. Use an 8 mm wrench.



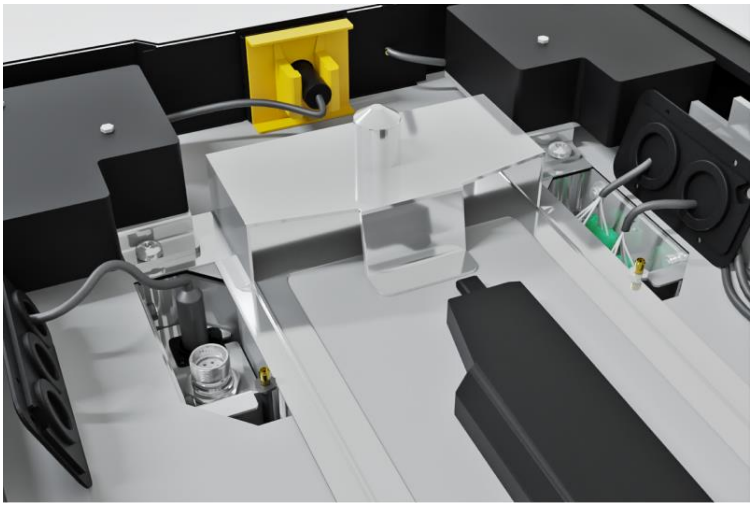
3 Unscrew the nuts from the antenna connectors. Use an 8 mm wrench. Save the nuts for later. They will be reused after mounting the top plate.



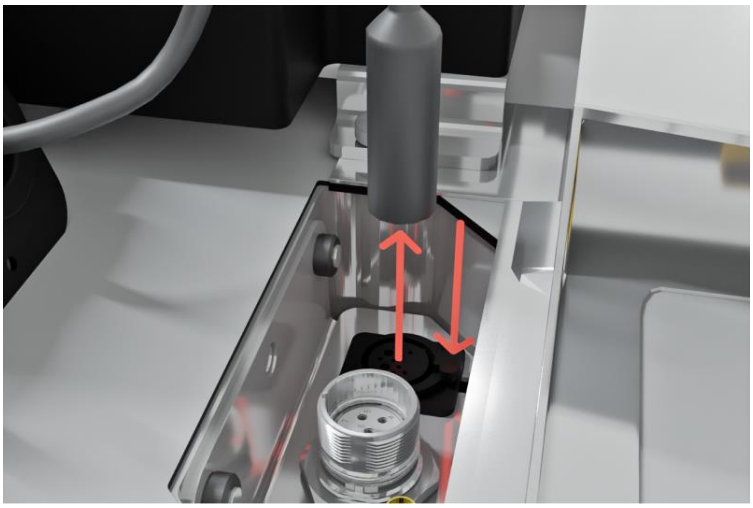
4 Unscrew the eight M3 screws for the top compartment covers. Use a T10 bit.



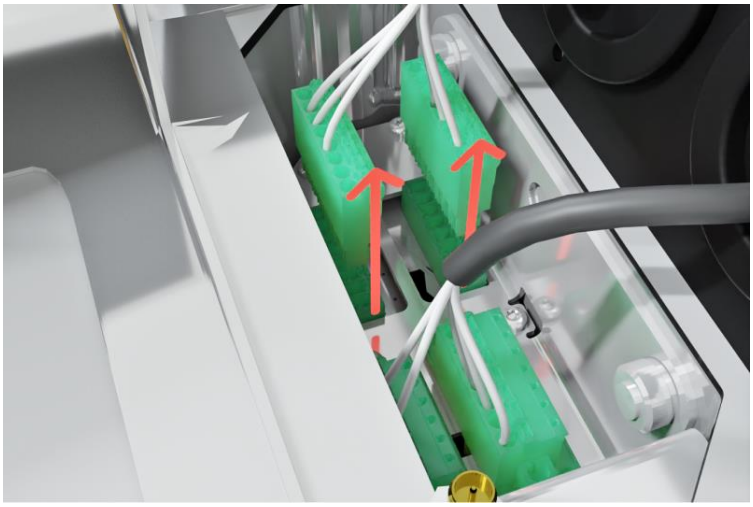
5 Move the top compartment covers to the side to gain access to the top compartment I/O.



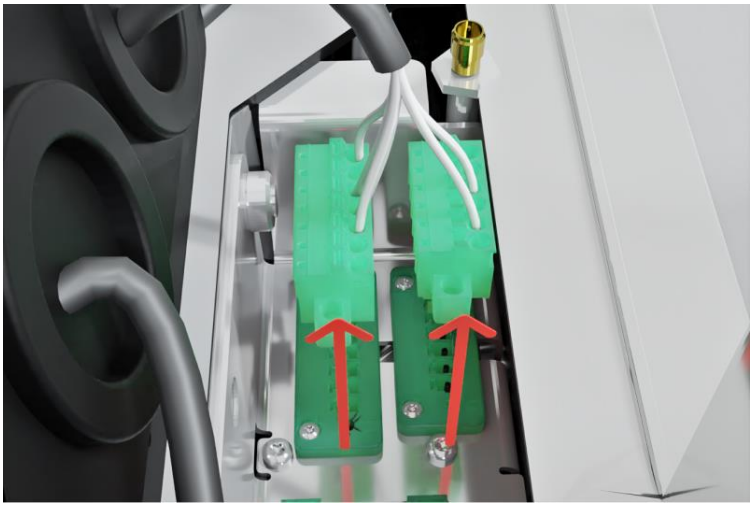
6 Unplug the Emergency stop connector by pressing down on the release switch and pulling upward in the connector. Do not pull on the cable, pull on the connector.



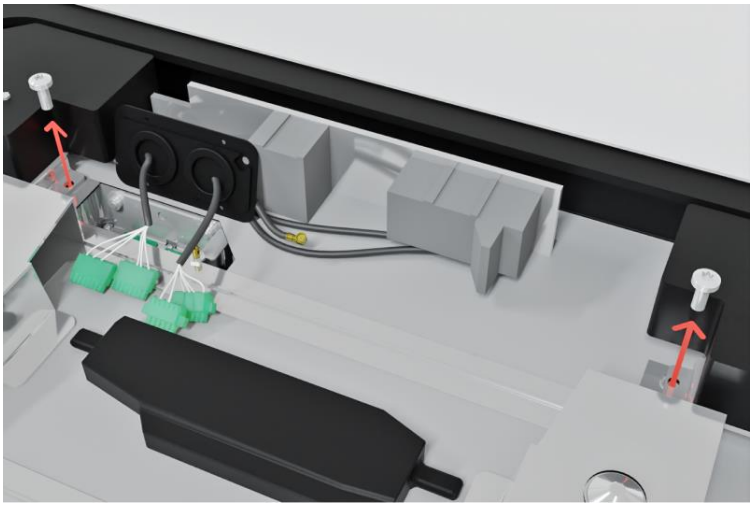
7 Unplug the two GPIO connectors. Do not pull on the cables, pull on the connectors.

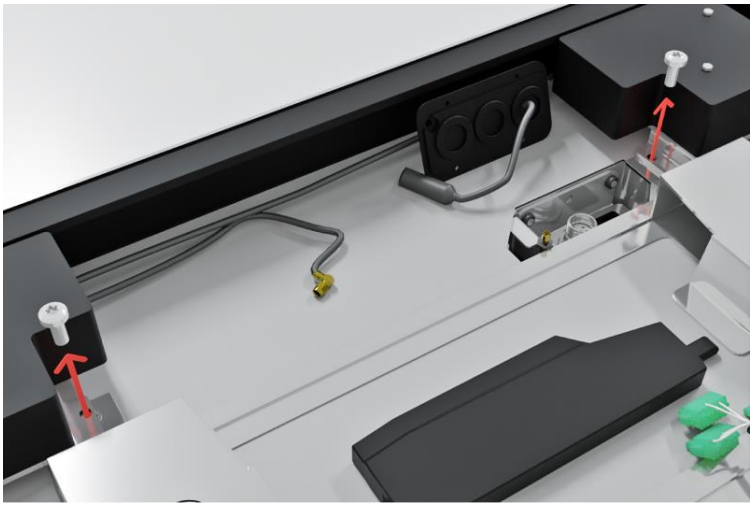


8 Remove the four screws from the Auxiliary safety function connectors using a small flat-head bit, and then unplug the connectors. Do not pull on the cables, pull on the connectors.



9 Remove the four bolts that hold the shelf module in place. Use a T45 bit.





10 Carefully lift the shelf module off the robot. It is recommended to have two persons lifting the module.

After completing the maintenance that required you to remove MiR Shelf Carrier 250, you can mount the top module again by following the guide *How to mount MiR Shelf Carrier 250 to MiR250*. You can find this guide on MiR Support Portal.

NOTICE

When mounting the top module to the robot, make sure that no cables are pinched beneath the top module. This may damage the cables and prevent the top module from working correctly.

NOTICE

When screwing in the large screws that mount MiR Shelf Carrier 250 to the robot, tighten the screws to a torque of 15 Nm.

When screwing in the small screws that mount the top cover to MiR Shelf Carrier 250, tighten the screws to a torque of 2.5 Nm.

17. Electrical interfaces

This section describes how MiR Shelf Carrier 250 interfaces with MiR250.

> **NOTICE**
> Read "Safety" on page 32 before using the electrical interface.

When MiR Shelf Carrier 250 is mounted to MiR250, the electrical interfaces are no longer accessible.

MiR250 Shelf Carrier has seven electrical interfaces divided into two groups:

- Robot's left side:
  - Power
  - Emergency stop
  - Ethernet
- Robot's right side:
  - GPIO A
  - GPIO B
  - Auxiliary Safety Functions A
  - Auxiliary Safety Functions B

17.1 Left side interfaces

This section describes the general purpose interfaces that are used to interface to the top module on the left side of the robot.

Emergency stop

For more information on how the Emergency stop interface is used, see "Emergency stop buttons" on page 85.

Figure 17.1 The pins of the Emergency stop interface

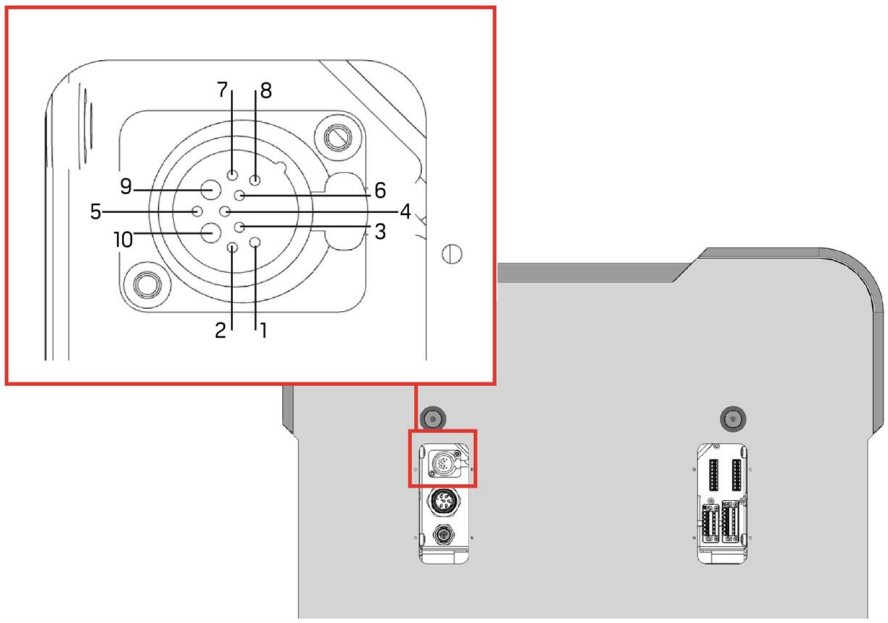


Table 17.1 Description of pins in the Emergency stop interface

Pin no.	Description
1	**Signal name:** SAFE_RETURN **Type:** Ground **Standard function:** Return for lamp signal. **MiR Shelf Carrier 250 function:** Unused.
2	**Signal name:** Test output 1 **Type:** Output **Standard function:** Safety output 1. Should be connected through Emergency stop buttons to pin 4. **MiR Shelf Carrier 250 function:** Connects to pin 5 through the Emergency stop buttons.

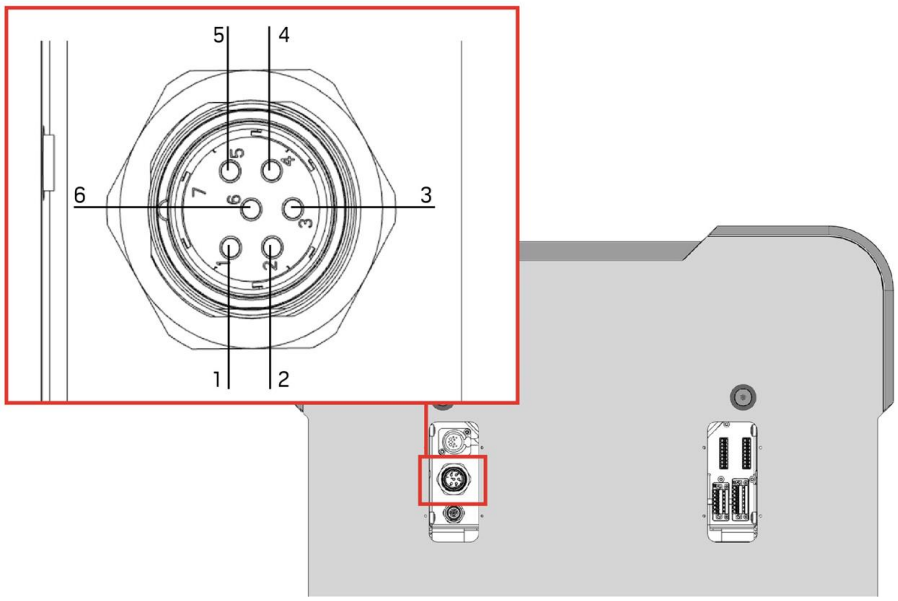
Pin no.	Description
3	**Signal name:** Test output 2 **Type:** Output **Standard function:** Safety output 2. Should be connected through Emergency stop buttons to pin 5. **MiR Shelf Carrier 250 function:** Connects to pin 4 through the Emergency stop buttons.
4	**Signal name:** E-stop 1 **Type:** Input **Standard function:** Safety input 1. Should be connected through Emergency stop buttons to pin 2. **MiR Shelf Carrier 250 function:** Connects to pin 3 through the Emergency stop buttons.
5	**Signal name:** E-stop 2 **Type:** Input **Standard function:** Safety input 2. Should be connected through Emergency stop buttons to pin 3. **MiR Shelf Carrier 250 function:** Connects to pin 2 through the Emergency stop buttons.
6	**Signal name:** Restart **Type:** Input **Standard function:** Safety input 3. When receiving 24 V will restart the Emergency stop.

Pin no.	Description
	MiR Shelf Carrier 250 function: Unused.
7	**Signal name:** RST_LAMP_24_V **Type:** Output **Standard function:** 24 V output for powering the lamp on the Emergency stop box. **MiR Shelf Carrier 250 function:** Unused.
8	Not connected to the robot
9	Not connected to the robot
10	Not connected to the robot

Power

This interface is not used when MiR Shelf Carrier 250 is mounted to MiR250.

Figure 17.2 The pins of the Power interface



NOTICE

Connecting power and ground signals to the chassis while stacking the 24 V and 48 V power supplies can lead to severe damage to the robot.

- Never connect power and ground signals to the chassis, and never stack the 24 V and 48 V power supplies.

NOTICE

Connecting 48 V power supplies to 24 V pins or vice versa can lead to severe damage to the robot.

- Never connect 48 V power supplies to 24 V pins or vice versa.

NOTICE

The robots are not designed to absorb inverse current from top modules. This can damage the electrical components inside the robot, and the top module will likely not work as intended.

- Never connect a top module that can deliver an inverse current to the robot interfaces.

Table 17.2 Description of the pins in the Power interface

Pin no.	Description
1	**Signal name:** 48V power **Max. current:** 10 A **Voltage range:** 42 V to 54 V, with reference to pins 2 and 4 **Type:** Output **Standard function:** Always active when robot is on. Intended for high-power loads like motors and actuators. The maximum current across pins 1 and 3 combined is 10 A. You cannot draw 10 A from both of the pins at the same time. The maximum capacitance of devices connected to pins 1 and 3 is 2 000 µF combined. If your device has a higher capacitance, you must integrate your own softstarter that keeps the current under 2 A for the first 100 ms, and thereafter under 10 A. **MiR Shelf Carrier 250 function:** Unused.
2	**Signal name:** GND **Type:** Ground **Standard function:** Power ground. **MiR Shelf Carrier 250 function:** Unused.
3	**Signal name:** 48V safe power **Max. current:** 10 A **Voltage range:** 42 V to 54 V, with reference to pins 2 and 4 **Type:** Output

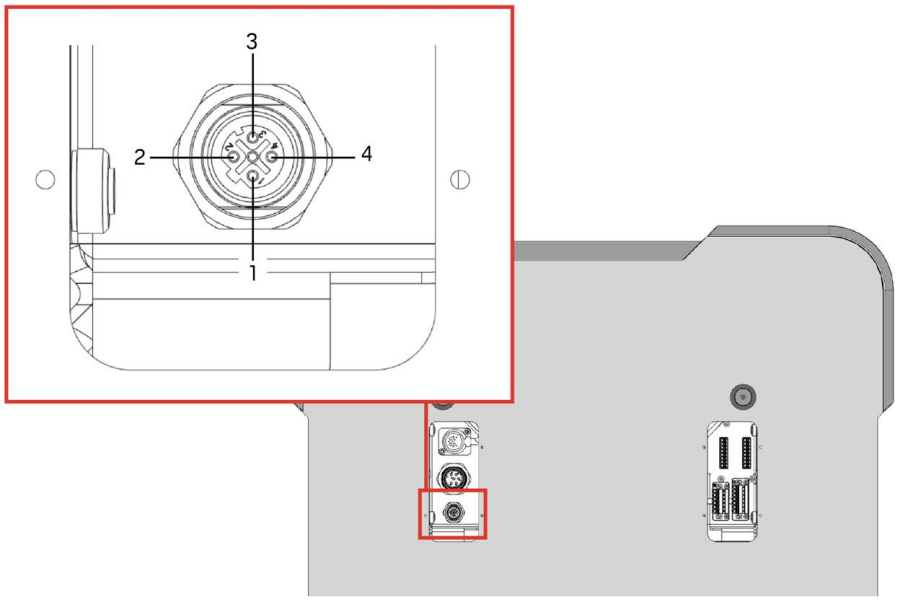
Pin no.	Description
	Standard function: Inactive in case of a Protective or Emergency stop. This output is controlled by the internal safety PLC through the STO contactor to ensure that power is always disconnected from this pin in case of a Protective or Emergency stop. Intended for high-power loads like motors or actuators. The maximum current across pins 1 and 3 combined is 10 A. You cannot draw 10 A from both of the pins at the same time. The maximum capacitance of devices connected to pins 1 and 3 is 2 000 µF combined. If your device has a higher capacitance, you must integrate your own softstarter that keeps the current under 2 A for the first 100 ms, and thereafter under 10 A. **MiR Shelf Carrier 250 function:** Unused.
4	**Signal name:** GND **Type:** Ground **Standard function:** Power ground. **MiR Shelf Carrier 250 function:** Unused.
5	**Signal name:** Isolated 24V **Max. current:** 2 A **Voltage range:** 22.8–25.2 V, with reference to pin 6 **Type:** Output **Standard function:** Must be used with pin 6 to be galvanically isolated from the rest of the robot. Still provides 24 V even when the robot is in Emergency or Protective stop. **MiR Shelf Carrier 250 function:** Unused.

Pin no.	Description
6	**Signal name:** Isolated GND **Type:** Ground **Standard function:** Must be used with pin 5 to be galvanically isolated from the rest of the robot. **MiR Shelf Carrier 250 function:** Unused.
7	Unassigned

Ethernet

This interface is not used when MiR Shelf Carrier 250 is mounted to MiR250.

Figure 17.3 The pins of the Ethernet interface



The communication interface is 10/100 Mbps Ethernet using an M12 connector—see "Electrical interfaces" on page 176.

Various protocols can be supported, for example Modbus. For more information on how to use Modbus, see the guide *How to use Modbus with MiR robots*. You can find this guide on MiR Support Portal.

The Ethernet interface is not used in MiR250 Shelf Carrier.

Table 17.3 Description of the pins in the Ethernet interface

Pin no.	Signal name	Pin no.	Signal name
1	TX+	2	RX+
3	TX-	4	RX-

17.2 Right side interfaces

This section describes the general purpose interfaces that are used to interface to the top module on the right side of the robot.

GPIO A and B

In the robot interface, under **Setup > I/O modules > MiR internal I/Os**, you can indirectly control the GPIO pins—see what the internal I/Os in the robot interface do in "How MiR Shelf Carrier 250 top module works" on page 20. Note that the input and output values in the interface do not directly control the corresponding GPIO pins in the electrical interface.

Figure 17.4 Example of input 2 registered as active by the robot

Whenever you use outputs 2 or 3 in the robot interface to move the carrier pins, a safety sequence is initiated across the output pins in the GPIO interface—see Table 17.4 for pin descriptions. The robot sets the GPIO outputs as follows:

1. Output pins 1, 3, and 5 are deactivated to ensure the pins are not moving.
2. Output pin 7 is activated to activate the safety STO relay in the shelf carrier.
3. Output pin 1 is activated to provide power to the shelf carrier actuator.
4. Output pin 3 or 5 is activated to raise or lower the pins respectively.

Figure 17.5 Pin numbers for the GPIO interfaces

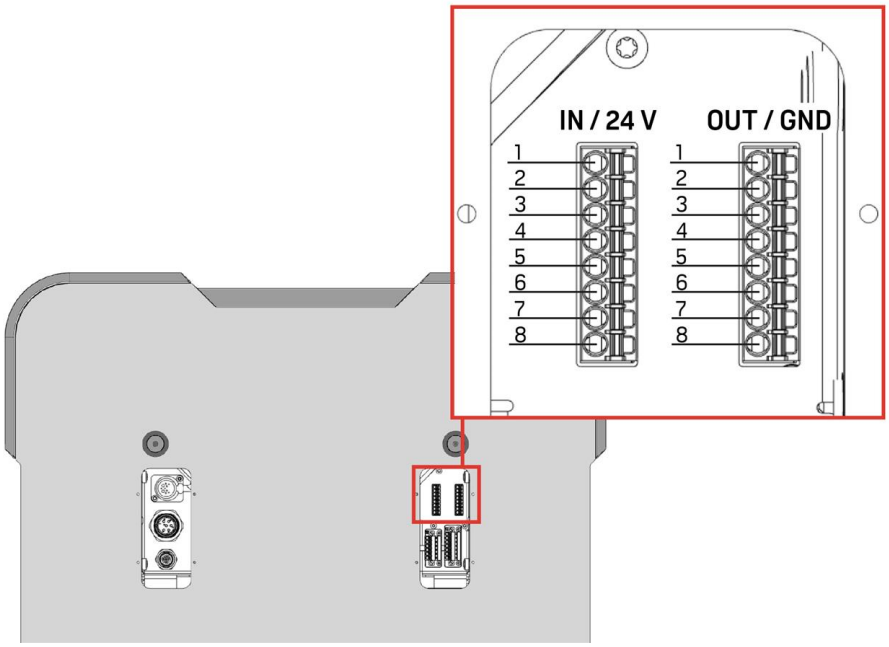


Table 17.4 Description of the pins in the output interface

Pin no.	Description
1	**Signal name:** OUT1 **Type:** Output **Standard function:** Output 1. Maximum 1 A at 24 V. **MiR Shelf Carrier 250 function:** Is active when the carrier pins are free to move.
2	**Signal name:** GND **Type:** Ground **Standard function:** Protected return. **MiR Shelf Carrier 250 function:** Unassigned.

Pin no.	Description
3	**Signal name:** OUT2 **Type:** Output **Standard function:** Output 2. Maximum 1 A at 24 V. **MiR Shelf Carrier 250 function:** When active, the carrier pins are raised.
4	**Signal name:** GND **Type:** Ground **Standard function:** Protected return. **MiR Shelf Carrier 250 function:** Unassigned.
5	**Signal name:** OUT3 **Type:** Output **Standard function:** Output 3. Maximum 1 A at 24 V. **MiR Shelf Carrier 250 function:** When active, the carrier pins are lowered.
6	**Signal name:** GND **Type:** Ground **Standard function:** Protected return. **MiR Shelf Carrier 250 function:** Unassigned.
7	**Signal name:** OUT4 **Type:** Output **Standard function:** Output 4. Maximum 1 A at 24 V.

Pin no.	Description
	MiR Shelf Carrier 250 function: When active, MiR Shelf Carrier 250 is able to move the carrier pins. This is only permitted when the robot's speed is below 0.3 m/s.
8	**Signal name:** GND **Type:** Ground **Standard function:** Protected return. **MiR Shelf Carrier 250 function:** Protected return.

Table 17.5 Description of the pins in the input interface

Pin no.	Description
1	**Signal name:** IN1 **Type:** Input **Standard function:** Input 1. **MiR Shelf Carrier 250 function:** Is active when the carrier pins are lowered.
2	**Signal name:** 24V **Type:** Output **Standard function:** 24 V output. 2 A maximum. **MiR Shelf Carrier 250 function:** Unassigned.
3	**Signal name:** IN2 **Type:** Input

Pin no.	Description
	Standard function: Input 2. **MiR Shelf Carrier 250 function:** Is active when the carrier pins are raised.
4	**Signal name:** 24V **Type:** Output **Standard function:** 24 V output. 2 A maximum. **MiR Shelf Carrier 250 function:** Unassigned.
5	**Signal name:** IN3 **Type:** Input **Standard function:** Input 3. **MiR Shelf Carrier 250 function:** Unassigned.
6	**Signal name:** 24V **Type:** Output **Standard function:** 24 V output. 2 A maximum. **MiR Shelf Carrier 250 function:** Unassigned.
7	**Signal name:** IN4 **Type:** Input **Standard function:** Input 4. **MiR Shelf Carrier 250 function:** Unassigned.

Pin no.	Description
8	**Signal name:** 24V **Type:** Output **Standard function:** 24 V output. 2 A maximum. **MiR Shelf Carrier 250 function:** Unassigned.

Auxiliary Safety Functions A and B

The Auxiliary safety functions interfaces are designed to support Emergency and Protective stops and other safety functions.

Figure 17.6 The pins of the Auxiliary safety functions interfaces

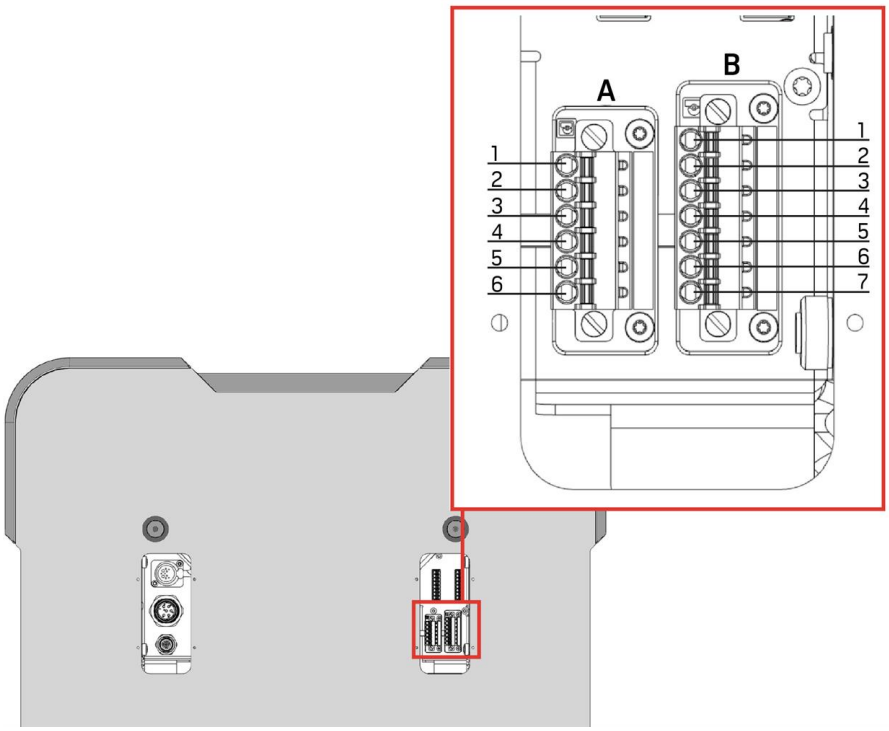


Table 17.6 Description of the pins in the Auxiliary safety function interface A

Pin no.	Description
1	**Signal name:** Test output 1 **Type:** Output **Standard function:** 24 V test signal. Sends test pulses (not on constantly). **MiR Shelf Carrier 250 function:** Unassigned.
2	**Signal name:** STO feedback 1 **Type:** Input **Standard function:** When inactive, the robot enters Protective stop. If this pin and the other Safeguarded stop pin are unequally set for a period greater than three seconds, the robot must be restarted. **MiR Shelf Carrier 250 function:** Feedback from top module safety relay 1.
4	**Signal name:** Pins down **Type:** Input **Standard function:** When inactive, the robot goes into Emergency stop. **MiR Shelf Carrier 250 function:** Indicates when the carrier pins are lowered .
4	**Signal name:** STO control **Type:** Input **Standard function:** When inactive, the robot drives with reduced speed. The reduced speed function is not a safety-rated function. **MiR Shelf Carrier 250 function:** Indicates to the safety PLC that the pins will move. The safety PLC turns on the STO contactor in the top module and

Pin no.	Description
	monitors the speed of the robot.
5	**Signal name:** Pins down out **Type:** Output **Standard function:** Is active when the robot is standing still. **MiR Shelf Carrier 250 function:** Indicates when the carrier pins are lowered.
6	**Signal name:** NC **Type:** Output **Standard function:** Is inactive when the robot is in Emergency stop. **MiR Shelf Carrier 250 function:** Unassigned.

Table 17.7 Description of the pins in the Auxiliary safety function interface B

Pin no.	Description
1	**Signal name:** Test output 2 **Type:** Output **Standard function:** 24 V out test signal. Sends test pulses (not on constantly). **MiR Shelf Carrier 250 function:** Unassigned.
2	**Signal name:** STO feedback 2 **Type:** Input **Standard function:** When inactive, the robot enters Protective stop. If this pin and the other Safeguarded stop pin are unequally set for a period greater than

Pin no.	Description
	three seconds, the robot must be restarted. **MiR Shelf Carrier 250 function:** Feedback from top module safety relay 2.
3	**Signal name:** Pins up **Type:** Input **Standard function:** When inactive, the robot goes into Emergency stop. **MiR Shelf Carrier 250 function:** Indicates when the carrier pins are raised.
4	**Signal name:** NC **Type:** Input **Standard function:** When inactive, the robot drives with reduced speed. The reduced speed function is not a safety-rated function. **MiR Shelf Carrier 250 function:** Unassigned.
5	**Signal name:** STO activation **Type:** Output **Standard function:** Is active when the robot is standing still. **MiR Shelf Carrier 250 function:** Signals when to activate the safety relays.
6	**Signal name:** Pins up out **Type:** Output **Standard function:** Is active when the robot is standing still. **MiR Shelf Carrier 250 function:** Indicates when the carrier pins are raised.

Pin no.	Description
7	**Signal name:** SAFE_RETURN **Standard function:** Safe return for output signals. **MiR Shelf Carrier 250 function:** Unassigned.

18. Transportation

This section describes how to lift the robot and how to pack the robot for transportation.

18.1 Lifting MiR250 Shelf Carrier

To lift MiR250 Shelf Carrier, follow these steps:

1. Remove MiR Shelf Carrier 250.

2. Remove the four M8 mounting bolts in the top plate of the robot. Use a T45 bit. Tighten the bolts to 15 Nm when remounting them.

3 Mount the four M8 × 16 mm eye bolts that came with the robot to the mounting holes. Make sure to screw the eye bolts all the way in. Do not tighten the bolts over 7.5 Nm. The eye bolts should be oriented in parallel to the opposite diagonal bolt to ensure stable lifting.

4 Use an appropriate lifting device to lift the robot. The lifting device should be capable of lifting at least 400 kg.

18.2 Packing the robot for transportation

Before packing the robot for transportation:

- Shut down the robot—see "Shutting down the robot" on page 47.
- Disconnect the battery—see "Disconnecting the battery" on page 141.

Use the original packaging materials when transporting the robot.

Figure 18.1 The packing materials

The packaging materials are:

- The bottom of the box (the pallet)
- The lid of the box (the ramp)
- The walls of the box
- Protective foam blocks: Side blocks and the top layer
- Protective corner braces

To pack the robot, repeat the steps in "Unpacking MiR250 Shelf Carrier" on page 41 in the reverse order.

You do not need to remove the top module from the robot.

NOTICE

Pack and transport the robot in an upright position. Packing and transporting the robot in any other position voids the warranty. You can find our warranty policy on MiR Support Portal.

18.3 Transporting the battery

Lithium-ion batteries are subject to special transportation regulations according to United Nations Regulation of Dangerous Goods, UN 3171. Special transport documentation is required to comply with these regulations. This may influence both transport time and costs. Different regulations apply depending on the mode of transportation.

When transporting lithium-ion batteries:

- Transport the batteries in their original packaging. If there is no original packaging, we recommend using a lithium-ion battery storage box.

  The robot can be used as original packaging, provided the battery is disconnected from the robot and is securely locked in the robot. If you enabled the fast-swap feature on the robot, you must revert the configuration to how it was when you received the robot so the status light bracket keeps the battery in place even when the battery is disconnected from the robot.
- Do not expose the battery to direct sunlight.
- Do not expose the battery to temperatures above 35° C.
- Do not expose the battery to air humidity above 85%.

WARNING

Lithium-ion battery packs may get hot, explode, or ignite and cause serious injury if they are misused electrically or mechanically.

Observe the following precautions when handling and using lithium-ion batteries:

- Do not short-circuit, recharge, or connect with false polarity.
- Do not connect or charge a potentially defective or damaged battery.
- Do not expose to temperatures beyond the specified temperature range or incinerate the battery.
- Do not crush, puncture, or disassemble the battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode, or ignite.
- Do not allow the battery to get wet.
- In the event the battery leaks and the fluid gets into one's eye, do not rub the eye. Rinse well with water, and immediately seek medical care. If left untreated, the battery fluid could cause damage to the eye.
- In case of fire, use water to put out the fire. There is no need for special extinguishing media.
- Do not touch damaged batteries with bare hands. Only personnel using suitable Personal Protection Equipment (PPE) and tools should handle damaged batteries.
- Isolate the battery and keep clear if the following conditions are observed:
  - The battery exhibits abnormally high temperatures.
  - The battery emits abnormal odors.
  - The battery changes color.
  - The battery case is deformed or otherwise differs from the normal electrical or mechanical condition.
- Do not modify or manipulate of the battery. This may lead to considerable safety risks and is therefore prohibited.
- Never smoke or allow an open spark or flame in the vicinity of the robot's battery.
- Do not use the battery for anything other than MiR250 Shelf Carrier.

19. Disposal

According to the European directive 2012/19/EU, Article 2, paragraph 4) d) and 4) e) (WEEE directive), MiR robots are not in scope of the directive.

The robot is therefore not classified as WEEE and can be disposed of in accordance with the applicable local regulations.

> **NOTICE**
>
> You must disconnect and remove the battery before disposal of the robot—see "Disconnecting the battery" on page 141.

Legal obligations apply to the robot's battery. Disposing used batteries in the household waste is prohibited.

A recycling label indicates that the battery needs to be recycled and not disposed as municipal waste—see Figure 19.1. Contact your distributor to get specific information about their take back service.

Figure 19.1 Battery disposal symbols

20. Payload distribution and stability

WARNING

Load falling or robot overturning if the load on MiR250 Shelf Carrier is not positioned or fastened correctly can cause damage to equipment and injury to personnel.

- Ensure that the load is positioned and fastened correctly.

MiR250 Shelf Carrier is designed to tow load placed on a shelf designed according to the guidelines in "Shelf specifications" on page 148. MiR250 Shelf Carrier is not designed to drive with load placed on the robot.

MiR250 Shelf Carrier can tow up to 300 kg, including the weight of the shelf, however, how to distribute the weight and remain stable during driving depends on the design of the shelf and must be determined by stability calculations. The maximum height of the payload on the shelf must be determined during commissioning.

See "Specifications" on page 15 for information needed for stability caluculations.

The stability calculation must be verified by a test according to ISO 3691-4 2023, 5.3.2.

CAUTION

Risk of injury to personnel if excessive or incorrectly distributed loads are fastened to the MiR250 Shelf Carrier.

- Determine the safe maximum payload for your shelf application during commissioning.

21. Declaration of Conformity example

EC Declaration of Conformity

EC-overensstemmelseserklæring | Декларация за съответствие на ЕС | EU izjava o sukladnosti
EG-Konformitätserklärung | EU Verklaring van overeenstemming | EÜ vastavusdeklaratsioon
Declaración de conformidad UE | EU-vaatimustenmukaisuusvakuutus | Δήλωση συμμόρφωσης ΕΕ
Dichiarazione di conformità UE | EU Prohlášení o shodě

Product:/Produkt/Produkt/Producto/Prodotto/продукт/Product/Tuote/Produkt/Proizvod/Toode/Προϊόν	MiR250 Shelf Carrier
Type:/Type/Art/Tipo/Genere/Тип/Type/Tyyppi/Typ/Tip/Tüüp/Τύπος	Driverless Truck
Serial number:/Serienr./Seriennr./N.º de serie/N° de série/Nr seryjny/Número de série/Sériové č./Numero di serie/Serijski broj/Seerianr/Αρ. Σειράς	102900011
Year of construction:/Fremstillingsår/Baujahr/Año de fabricación/Anno di costruzione/Година на изграждане/Bouwjaar/Valmistusvuosi/Rok zkonstruování/Godina proizvodnje/Ehitusaasta/Έτος κατασκευής	2023

The undersigned certifies that the above-mentioned model is produced in accordance with the following directives and standards. The authorized person is authorized to compile the technical file.

Il sottoscritto certifica che il modello di cui sopra è prodotto in conformità alle seguenti direttive e norme. The authorized person è la persona autorizzata a costituire la documentazione tecnica.

Níže podepsaná osoba potvrzuje, že výše uvedený model je vyráběn v souladu s následujícími směrnicemi a normami. The authorized person je oprávněná k sestavování technické dokumentace.

Undertegnede bekræfter, at ovennævnte model er fremstillet i overensstemmelse med følgende direktiver og standarder. The authorized person er autoriseret til at sammensætte den tekniske fil.

Долуподписаното лице удостоверява, че гореспоменатият модел е произведен в съответствие с директивите и стандартите по-долу. The authorized person носи отговорност за съставянето на техническото досие.

Potpisnik potvrđuje da je prethodno navedeni model proizveden u skladu sa sljedećim direktivama i normama. The authorized person ovlašten/ovlaštena je za sastavljanje tehničke dokumentacije.

Der Unterzeichner erklärt, dass die oben genannte Maschine in Übereinstimmung mit den folgenden Richtlinien und Normen hergestellt wurde. The authorized person ist bevollmächtigt, die technischen Unterlagen zusammenzustellen.

De ondergetekende verklaart dat het bovengenoemde model is geproduceerd in overeenstemming met de volgende richtlijnen en normen. The authorized person is gemachtigd om het technisch dossier samen te stellen.

Allakirjutanu kinnitab, et ülalpool nimetatud mudel on toodetud kooskõlas järgmiste direktiivide ja standarditega. The authorized person on volitatud koostama tehnilist dokumentatsiooni.

El abajo firmante certifica que el modelo indicado arriba se fabrica de conformidad con las siguientes directivas y normas. The authorized person está autorizada para compilar el archivo técnico.

Allekirjoittanut vakuuttaa, että edellä mainittu malli on valmistettu seuraavien direktiivien ja standardien mukaisesti. The authorized person on valtuutettu kokoamaan teknisen tiedoston.

υπογεγραμμένος δηλώνει ότι το ανωτέρω μοντέλο παράγεται σύμφωνα με τις οδηγίες και τα πρότυπα που ακολουθούν. The authorized person είναι εξουσιοδοτημένος να καταρτίσει τον τεχνικό φάκελο.

EC Machinery Directive 2006/42/EC	EN ISO 3691-4:2023, except Clause 4.4, 4.8.2.3, 4.9.4, 4.10, 4.14, 5.1, 6 and Annex A EN ISO 12100:2010	EN ISO 13850:2015 EN ISO 13849-1:2015
Radio Equipment Directive 2014/53/EU	EN IEC 61000-6-4:2007/A1:2011 EN IEC 61000-6-2:2005/AC:2005 EN 12895:2015+A1:2019	ESTI EN 300 328 ESTI EN 301 489-1 ESTI EN 301 489-17 ESTI EN 301 893

Mobile Industrial Robots A/S
Emil Neckelmanns Vej 15F
Odense SØ, Denmark

Signature:
Kevin Dumas
2023-11-13

Authorized person:
Claus Jørgensen

22. Glossary

A

Action parameter

The parameters in an action that you can customize to your site.

Action variable

A variable is a flexible value that can be set each time you run a mission or nest the mission in another mission. Use variables when you want to reuse the same mission for similar robot tasks.

Autonomous mode

Mode in which the robot drives autonomously based on the missions you assign to it.

C

Commissioner

Commissioners have thorough knowledge of all aspects of commissioning, safety, use, and maintenance of MiR250 Shelf Carrier and have the following main tasks: commissioning the product, including creating maps and restricting the user interface for other users; making the risk assessment; determining the payload limit, weight distribution, and safe methods of fastening of loads to MiR250 Shelf Carrier; and ensuring the safety of nearby personnel when a MiR robot is accelerating, braking, and maneuvering.

D

Dashboard

A dashboard is a visual display of the robot's data and enables certain functions that can be adjusted to fit certain users.

Direct user

Direct users are familiar with the safety precautions in the User Guide and have the following main tasks: assigning missions to MiR250 Shelf Carrier, fastening loads to MiR250 Shelf Carrier securely, and loading and unloading from a paused robot.

Dynamic obstacle

Dynamic obstacles are obstacles that are moved around, such as pallets, crates, and carts. These should not be included when creating a map.

E

Emergency stop

Emergency stop is a state the robot enters when an Emergency stop button has physically been pressed. When the robot is in Emergency stop, the status light of the robot turns red, and you are not able to move the robot or send it on missions until you bring the robot out of Emergency stop. To do this, you must release the Emergency stop button and then press the Resume button.

F

Footprint

A footprint set in the robot interface defines the size of the robot and its top module or load. It consists of a horizontal shape around the robot that should be slightly bigger than the robot itself to ensure that there is enough space along the calculated path, and a maximum height that ensures the robot does not try to drive under low obstacles. The horizontal shape is defined as coordinates relative to the robot's center.

G

Global path

The global path is the route the robot calculates that leads it to its goal position.

I

Identification label

The identification label is the label that is mounted to the product in production. The label is used to identify the components in your MiR application. It identifies the product model, the hardware version, and the product serial number.

L

Light indicators

The light indicators consist of status lights and signal lights. The status lights are used to indicate the robot's current status, and the signal lights are used to indicate the robot's driving intentions.

Local path

The local path is the route the robot creates within its immediate vicinity that guides it around obstacles while still following the global path.

Localization

The method used by the robot to determine its position on the map relative to where it is in the work environment.

M

Manual mode

The mode in which you can drive the robot manually using the joystick in the robot interface.

Map

A map is a representation of the operating area of the robot. A basic map contains walls and floor that indicate where the robot can drive. You can add various map elements to determine how you want the robot to drive.

Mapping

Mapping is the process of manually driving the robot around to create a new map. The robot uses its sensors to detect walls and obstacles and generates a map of the area based on this input.

Marker

A marker of a physical entity that the robot can dock to. This enables the robot to position itself accurately relative to the marker.

Marker type

A marker type is a description of a shelf that MiR robots can dock to. You must have a marker type for each type and size of shelf you want your robot to be able to transport.

MiR application

A MiR application is either a single MiR product or a combination of MiR products that is able to execute certain tasks. A MiR application is often a MiR base robot combined with a MiR top module. If a custom top module is used, the CE mark on the nameplate of the base robot does not extend to the top module.

MiR robot interface

The MiR robot interface is the web-based interface that enables you to control your MiR robot. It is accessed by connecting to the same network as the robot and entering the robot's IP address in a browser.

Mission

A mission is a user-defined series of actions the robot can be set to perform on demand. A mission can be a simple transportation task between defined positions or a more complex job that includes both moving between positions and performing actions, such as unloading a pallet, moving to a charging station when the battery is low, or sending an email on arrival at a position.

Muted Protective fields

When the Protective fields are muted, the robot moves at a reduced speed, and the Protective field sets are minimized so the robot does not enter Protective stop until it is very close to an obstacle.

N

Nameplate

The nameplate is mounted on your robot from production. The nameplate identifies the MiR application model, application number, mechanical and electrical specifications.

Noise

With MiR robots, noise in maps refers to recorded data that originates from interfering elements. This can be physical obstacles that make the robot record walls where there are none or more subtle interferences that can make recorded walls appear pixelated.

O

Operating hazard zone

Operating hazard zones are areas where the robot drives with muted Personnel detection and areas with inadequate clearance for personnel to work close by the robot.

Operator

Operators have thorough knowledge of MiR250 Shelf Carrier and of the safety precautions presented in the User guide of MiR250 Shelf Carrier. Operators have the following main tasks: servicing and maintainingthe robot, and creating and changing missions and map positions in the robot interface.

P

Payload

The payload is the weight the robot carries. The maximum payload is the maximum weight the robot can carry, including the weight of any top modules, shelves, carts, or other devices.

Position

A position is a set of X-Y coordinates on the map that you can send the robot to.

Protective fields

The Protective fields are a part of the Personnel detection safety function. They are contours surrounding the robot that change size depending on the speed of the robot. When a safety laser scanner detects a person or object within the active field, the robot enters Protective stop until the field is clear.

Protective stop

Protective stop is a state the robot enters automatically to ensure the safety of nearby personnel. When the robot enters Protective stop, the status light of the robot turns red, and you are not able to move the robot or send it on missions until it is brought out of Protective stop. The robot goes into Protective stop in a number of situations: if a safety laser scanner detects an object in its active protective field, when the robot finishes the startup process, when the robot has switched between Manual mode and Autonomous mode, if the safety system detects a fault, or if the motor control system detects a discrepancy.

R

REST API

REST API is used by MiR Fleet and MiR robots to communicate status data and orders.

S

Shelf

A shelf can be picked up by a MiR robot with a shelf lift top module mounted to it.

Site

A site is the overall container of any number of maps and all data relevant to the map, such as missions, features, robot groups, and transitions.

Static landmark

Static landmarks are obstacles that cannot be moved, such as walls, columns, and fixed structures. These must be included on the map and are used by the robot to localize itself.

X

X-Y coordinates

The robot's map is based on a Cartesian coordinate system. Every point on the map can be defined as an X-Y coordinate.