Operating guide (en)

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MiR Shelf Lift

Copyright and disclaimer

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Table of contents

1. About this document

This guide describes how to set up and use MiR Shelf Lift for MiR500/MiR1000. It includes information regarding safe usage, how to commission and operate MiR Shelf Lift, and how to create missions that use MiR Shelf Lift.

1.1 Where to find more information

At www.mobile-industrial-robots.com, several additional resources are available. To access more information, sign in to the Distributor site with your distributor account at http://www.mobile-industrial-robots.com/en/account/. The following resources are available:

- **Distributor site > Manuals**
  http://www.mobile-industrial-robots.com/en/account/manuals/
  This page contains the following resources:
  - **Quick starts** describe how you start operating MiR robots quickly. This document is 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 robots. User guides are available in multiple languages.
  - **Risk Analysis Guides** include guidelines for how to create a risk assessment of your robot solution.
  - **Commissioning guides** describe how to commission your robot safely and prepare it to operate in the workplace.
  - **Operating guides** describe how to set up and use add-ons, such as charging stations, hooks, shelf lifts, and pallet lifts.
  - **Getting started guides** describe how to set up products that are mainly software based, such as MiR Fleet and MiR AI Camera.
  - **Reference guides** contain descriptions of all the elements of the robot and MiR Fleet interface. Reference guides are available in multiple languages.
  - **REST API references** for robots, MiRHook, and MiR Fleet.
  - **MiR network requirements** specify the performance requirements of your network for MiR robots and MiR Fleet to operate successfully.

- **Distributor site > Download**
  http://www.mobile-industrial-robots.com/en/account/download/
  This page contains the following resources:
  - **Software** and **Product Release Notes** for your MiR product are displayed by selecting your product in the drop-down menu.
  - **CAD drawings** of MiR products are displayed by selecting **Show CAD-files**.
  - **Certificates** for the MiR products and Declarations of Conformity are displayed by selecting **Show Certificates**.
- **Distributor site > FAQ**
  https://www.mobile-industrial-robots.com/en/account/faq/
  This page contains frequently asked questions regarding MiR products.
- **Distributor site > How to**
  http://www.mobile-industrial-robots.com/en/account/how-to/
  This page contains how-to guides that describe how to perform specific tasks with MiR products.
- **Distributor site > Troubleshooting**
  https://www.mobile-industrial-robots.com/en/account/troubleshooting/
  This page contains troubleshooting guides to solve common issues with MiR products.
- **MiR Shelf Lift product page**
  robots.com/en/products/mir-add-ons/mir-shelf-lift/
  This page contains specifications, pictures, and brochures for MiR Shelf Lift.

1.2 Version history

This table shows current and previous versions of this document and their interrelations with hardware releases.

Revision	Release date	Description	HW
1.0	2019-10-20	First edition.	1.0

2. Safety

Read the information in this section before powering up and operating MiR Shelf Lift.

Pay particular attention to the safety instructions and warnings.

NOTICE

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

2.1 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 serious injury or death.

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.

2.2 Users

MiR Shelf Lift is only intended to be used by personnel that have received training in their required tasks.

There are three types of intended users for MiR Shelf Lift:

Commissioners

Commissioners[1] have received extensive training in the full use of MiR Shelf Lift and have the following main tasks:

- Commissioning the product. This includes creating maps and restricting the user interface for other users.
- Making the risk assessment.
- Determining the payload limit, weight distribution, and safe fastening methods of loads on MiR Shelf Lift.
- Ensuring the safety of nearby personnel when the robot is accelerating, braking, and maneuvering.

Operators

Operators have thorough knowledge of MiR Shelf Lift and of the safety precautions presented in the user guide of MiR500/MiR1000 and operating guide of MiR Shelf Lift. Operators have the following main tasks:

- Servicing and maintaining MiR Shelf Lift.
- Creating and changing missions and map positions in the robot interface.

Direct users

Direct users are familiar with the safety precautions in the operating guide and have the following main tasks:

- Assigning missions to MiR Shelf Lift.
- Fastening loads to MiR Shelf Lift properly.

All other persons in vicinity of MiR Shelf Lift are considered indirect users and must know how to act when close to the robot. For example, they must be aware that visibly marked operating hazard zones must be respected.

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[1] A user group responible for: comissioning the robot, creating a risk assessment, and determining safe payloads and methods of fastening loads.

3.1 General safety precautions

This section contains general safety precautions.

WARNING

Risk of injury if MiR Shelf Lift is not running on the correct software and is therefore not functioning properly.

- Ensure that MiR Shelf Lift is always running on the correct software.

WARNING

Risk of injury if a person is standing next to MiR Shelf Lift when it is docking to a shelf.

- 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 MiR Shelf Lift when it is docking to a shelf.

WARNING

Risk of injury, damage, and mechanical failure if MiR Shelf Lift is used to transport pallets or anything other than safely commissioned shelves.

- Only use MiR Shelf Lift to transport safely commissioned shelves.

WARNING

Risk of injury if a person puts their foot under a shelf that is being lowered by MiR Shelf Lift.

- All personnel must be instructed not to enter operating hazard zones and to wear safety shoes.

WARNING

Risk of injury if a person is standing in the blind spot of MiR Shelf Lift when pivoting with a shelf.

- Ensure that all nearby personnel are instructed not to stand close to MiR Shelf Lift when it is pivoting.

WARNING

Risk of serious hand injury if a person reaches in between MiR Shelf Lift and a shelf when the shelf is being picked up.

- 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 MiR Shelf Lift when it is docking to a shelf.

WARNING

Risk of serious hand injury if a person reaches in between MiR Shelf Lift and MiR500/MiR1000 when the lift is being lowered.

- 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 MiR Shelf Lift when it is placing a shelf.

CAUTION

Zones intended for placing and picking up shelves must be designated operating hazard zones.

- Ensure that all nearby personnel is instructed to stay clear of operating hazard zones when MiR500/MiR1000 with MiR Shelf Lift is in the zone or approaching the zone.

3.2 Risk assessment

You must make a risk assessment to achieve a safe installation. The risk assessment is the responsibility of the commissioner who must ensure that MiR Shelf Lift is commissioned safely in the environment it will be used in.

The risk assessment must cover not only MiR Shelf Lift itself, but also take into account potential load transfer stations, work cells, the work environment, and the robot that it is operating on. MiR does not take any responsibility for the creation of the risk assessment, but we provide information and guidelines that may be used in the *MiR 500 and MiR1000 Risk Analysis Guide* found on the Distributor Site under **Manuals**.

It is recommended that the commissioner follows the guidelines in ISO 12100, EN 1525, ANSI B56.5, or other relevant standards to conduct the risk assessment.

In EN 1525, clause 4, there is a list of significant hazards, hazardous situations, and events that can be used for inspiration.

3.3 Intended use

MiR Shelf Lift is a partly completed machine as defined in the EU machinery directive and does not have a CE mark. A correctly installed MiR Shelf Lift is covered by the CE mark of MiR500/MiR1000. However, a CE marked product does not guarantee a CE marked setup. It is the responsibility of the commissioner to safely commission MiR Shelf Lift.

MiR Shelf Lift 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 MiR500/MiR1000 should operate, see technical specifications on our website.

MiR Shelf Lift is intended to be commissioned according to Commissioning on page 33. This is a prerequisite for safe usage of MiR Shelf Lift.

MiR Shelf Lift is intended to transport shelves that fulfill the dimension specifications described in Shelf specifications on page 14.

NOTICE

The safety sections in this guide only addresses shelves with asymmetric legs and the corresponding configuration of the safety laser scanners.

3.4 Foreseeable misuse

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

- **Using MiR Shelf Lift to transport people**
- **Using MiR Shelf Lift on inclines**
- **Exceeding the maximum payload**
- **Positioning or fastening load incorrectly according to the specifications**
  Refer to the user guide of your robot for payload specifications.
- **Failing to make a risk assessment of the full installation**
  Refer to Risk assessment on the previous page.
- **Failing to follow the guidelines for commissioning**
  Refer to Commissioning on page 33.
- **Driving with anything other than safely commissioned shelves**
- **Use in medical and life critical applications**
- **Operating outside the permissible operating parameters and environmental specifications**
- **Use in potentially explosive environments**
- **Use outdoors**
- **Use in hygiene zones**

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:

- Risk of being run over, drawn in, trapped, or impacted when a person stands in the path of MiR500/MiR1000 or walks towards MiR500/MiR1000 while it is docking to a shelf.
- Risk of being crushed or trapped between MiR Shelf Lift and a shelf while the lift is picking up the shelf. Please notice the safety stickers on MiR Shelf Lift.

NOTICE

Other significant hazards may be present in a specific robot installation and must be identified during commissioning.

NOTICE

All risks and foreseeable misuses relevant to MiR500/MiR1000 also apply to MiR Shelf Lift. Refer to the MiR500/MiR1000 User guide for more information.

4. Product presentation

MiR Shelf Lift is a top application that can be mounted on a MiR500/MiR1000 robot and autonomously pick up and place shelves. The robot with a MiR Shelf Lift works indoors within production facilities, warehouses, and in a host of other industrial locations.

The payload of MiR Shelf Lift is 1,000 kg, but the payload consists of both the weight of the shelf and its load, and when mounted on MiR500/MiR1000, robot payloads apply.

- When mounted on MiR500, the maximum payload is 500 kg minus the weight of the shelf and MiR Shelf Lift.
- When mounted on MiR1000, the maximum payload is 1,000 kg minus the weight of the shelf and MiR Shelf Lift.

The commissioner or operator provides the destination of product delivery or pick up via the web-based robot interface. MiR500/MiR1000 with a MiR Shelf Lift can be set up to run a fixed route, be called on demand, and perform complex missions.

MiR Shelf Lift picks up standalone shelves that are not required to be in a docking station, pallet rack, or similar. MiR500/MiR1000 locate shelves solely by shelf positions on the map. For increased precision when docking, it is possible to use markers, such as VL-markers, to specify an exact position where the robot can dock to pick up a shelf.

MiR Shelf Lift is the only MiR Lift that can drive with the lift raised and thus the only lift that can transport shelves.

MiR500/MiR1000 with a MiR Shelf Lift drives with the same speed when transporting shelves as when driving without a top application. See technical specifications for MiR500/MiR1000 on the MiR website.

For MiR Shelf Lift to comply with safety standards and to function properly, shelves must be designed according to specifications supplied in Shelf specifications below.

4.1 Shelf specifications

MiR supports four variations of shelves for MiR Shelf Lift:

- Narrow shelf with asymmetric legs.
- Wide shelf with asymmetric legs.

- Narrow shelf with symmetric legs.
- Wide shelf with symmetric legs.

MiR Shelf Lift 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, MiR Shelf Lift is not intended to be used with shelves with symmetric legs. MiR has tested the docking procedure with shelves with symmetric legs but does not deliver standard configurations for the safety laser scanners nor describe safety or residual risks with this application.

NOTICE

Avoid making the legs of the shelves in high gloss material as this might affect docking.

Shelf with asymmetric legs

When building a shelf with asymmetric legs, it is important to use transverse stabilizers to keep the structure from tipping.

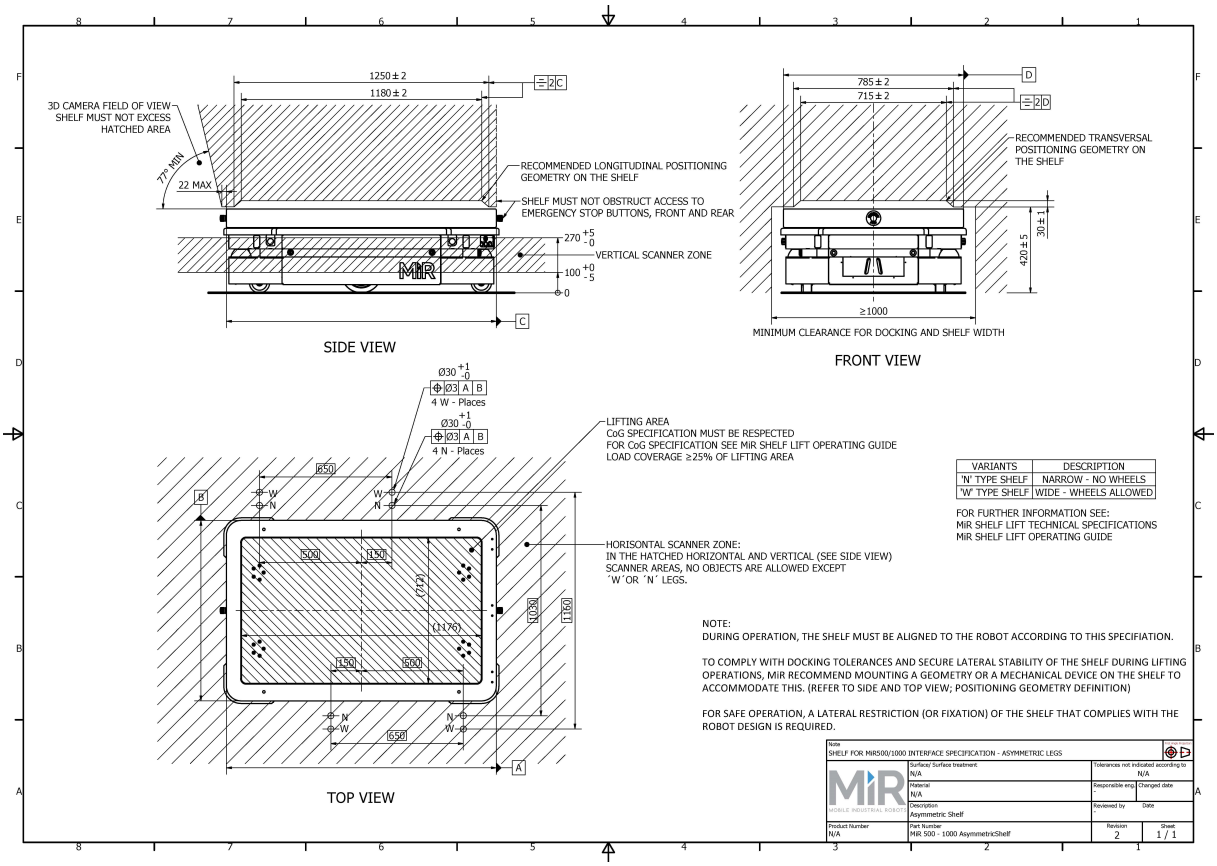


Figure 4.1. To be in compliance with the intended use of MiR Shelf Lift, follow these measurements when making narrow or wide shelves for MiR Shelf Lift with asymmetric legs.

Shelf with symmetric legs

CAUTION

Risk of injury if MiR Shelf Lift is used to transport a shelf with symmetric legs outside operating hazard zones.* See Mark potentially hazardous floor areas on page 41

- Only use MiR Shelf Lift in operating hazard zones when operating with shelves with symmetric legs.

**An operating hazard zone is a zone where the personnel detection means of the robot are reduced or muted, and where persons therefore risk colliding with the robot. The operating hazard zone must be clearly indicated by suitable signs or preferably floor markings. Confusion with other markings and signs must be avoided.*

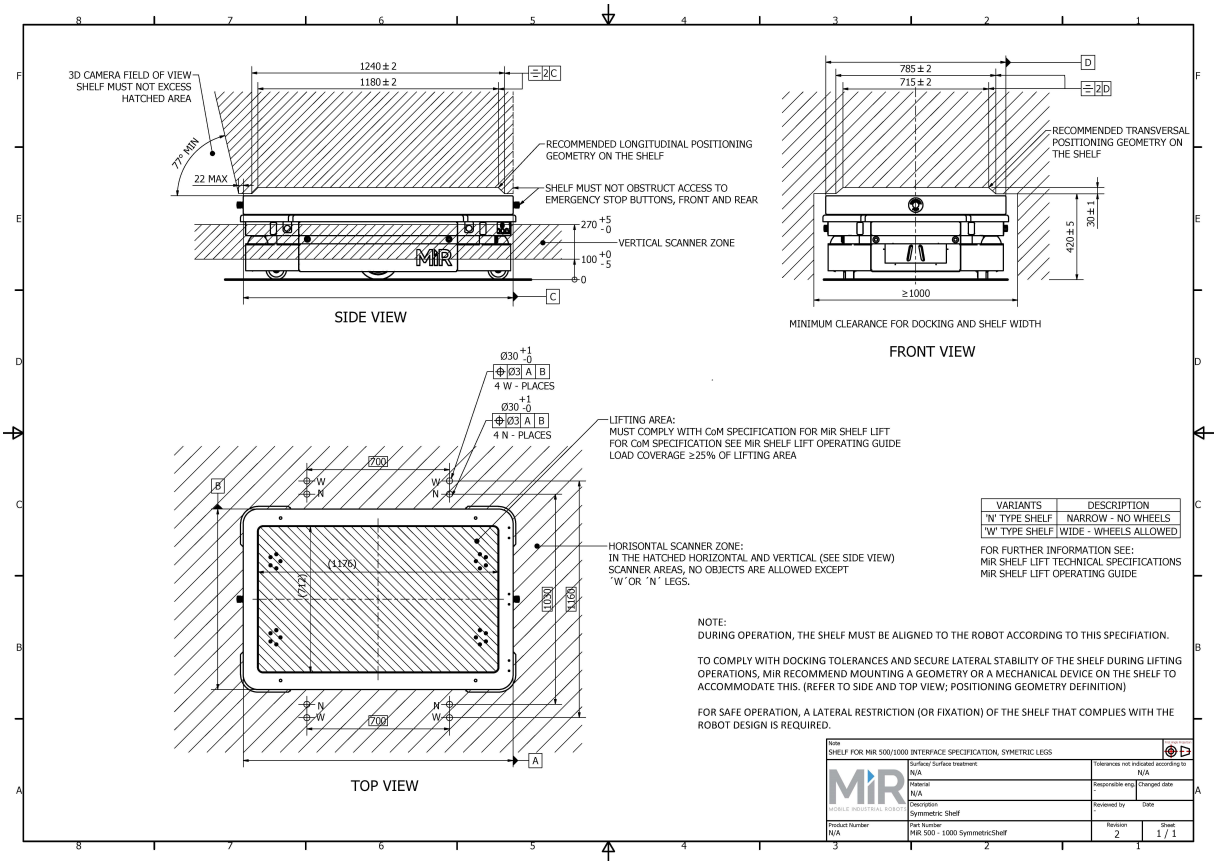


Figure 4.2. To be in compliance with MiR's docking tests, follow these measurements when making narrow or wide shelves for MiR Shelf Lift with symmetric legs.

Payload

The payload of MiR Shelf Lift is 1000 kg.

However, the same payload restrictions for MiR500/MiR1000 apply when MiR Shelf Lift is mounted to it. The maximum safe payload depends on the design of the shelf.

See Product presentation on page 14 for more information.

CAUTION

Risk of injury if excessive or incorrectly distributed loads are fastened to MiR Shelf Lift.

- Determine the maximum safe payload for your shelf and a secure fastening solution during commissioning.

5. Getting started

This section describes how to get started with MiR Shelf Lift. To be able to use MiR Shelf Lift with MiR500/MiR1000, your robot must be running software version 2.8.0 or higher.

The procedure for getting started with MiR Shelf Lift is the same for MiR500 and MiR1000 robots.

NOTICE

Read Safety on page 7 before powering up the robot.

5.1 In the box

This section describes the content of the MiR Shelf Lift box.

The box contains:

1. MiR Shelf Lift including cables
2. Four safety stickers
3. Anti-slip paper
4. A MiR Shelf Lift document folder containing the following printed documents:
   - MiR Shelf Lift Mounting guide
   - EC declaration of incorporation

5.2 Mounting MiR Shelf Lift

This section describes how to mount MiR Shelf Lift on MiR500/MiR1000. Before mounting, turn off the robot and read the section Safety on page 7.

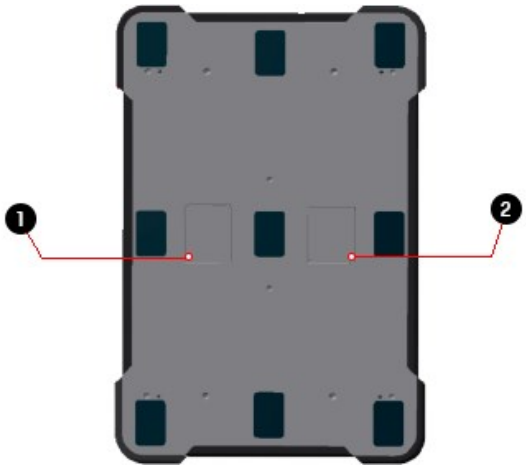
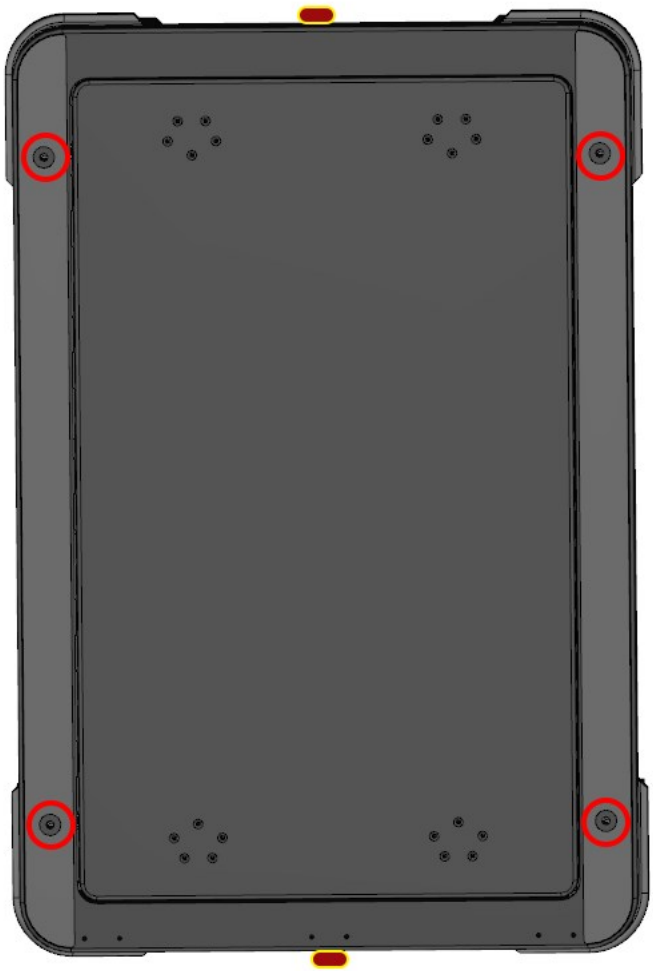


Figure 5.1. Top view of MiR500/MiR1000

Label	Description	Label	Description
1	Left cover plate	2	Right cover plate

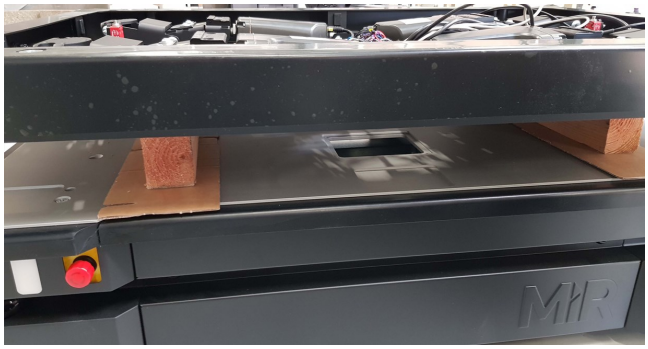
1. Remove the left and right cover plates.
2. Unscrew the four bolts from the lifting device.



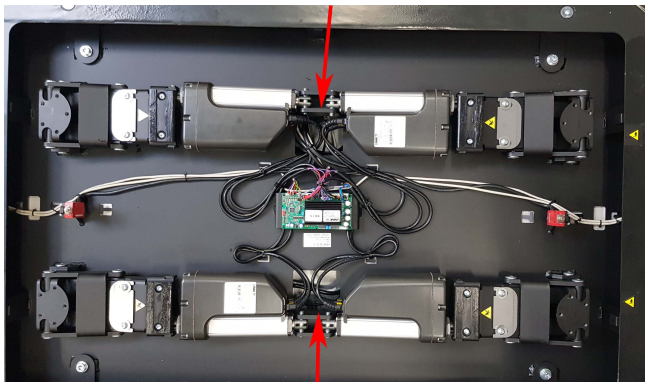
3. Screw in four M12x50 lifting eye bolts in the holes where you just removed the four bolts.

The bolts must be rated to carry at least 350 kg and should have a standard 1.75 mm thread pitch incline.

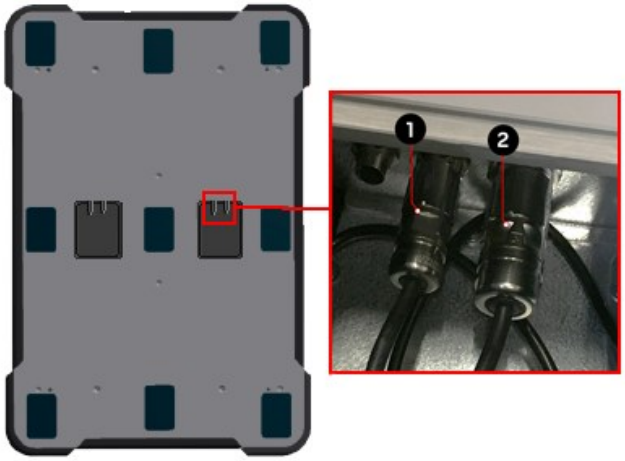
4. Use a crane to move the lift over the robot, and place the lift on four blocks of wood, enabling you to reach between the lift and the robot.



5. Remove the cables from the bag. Notice that there are two cables for each side of the lifting device. Feed the cables through the hole on the right side and vice versa with the left side.



6. Connect the plugs of the right-side cables with the socket in the right-side compartment of MiR500/MiR1000. These are the GPIO (1) and POWER (2) connections. Repeat the process for the plugs and sockets on the left side.

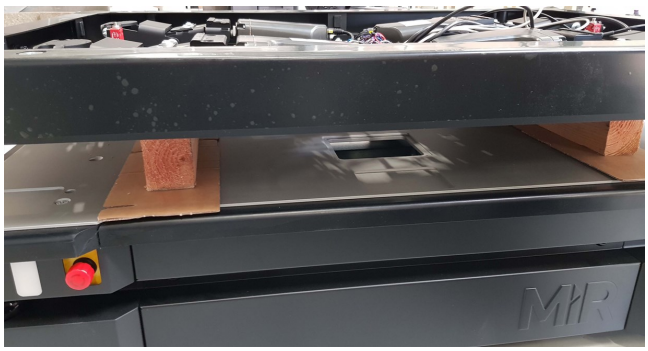


When connecting the plugs, make sure to turn the plug to the left to open the plug and to the right to close it once connected to its socket. The plugs only fit with their correct socket, so it is not possible to connect them incorrectly.

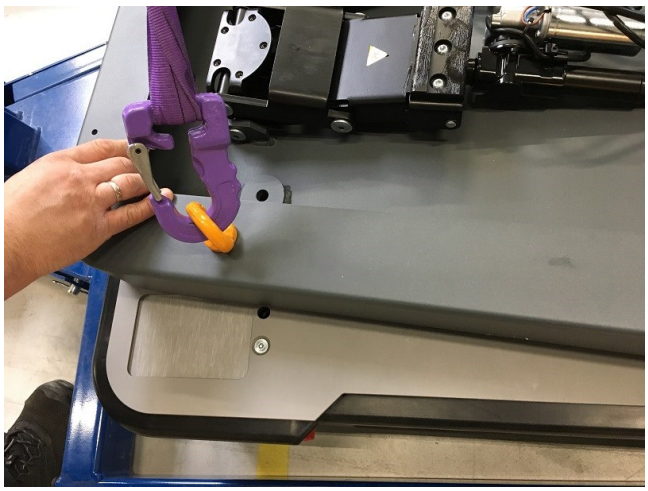
Fixing MiR Shelf Lift to MiR500/MiR1000

When fixing MiR Shelf Lift to MiR500/MiR1000, it is important to check that no cables are pinched between the devices. To avoid this, use cable ties to keep the cables together and safely out of the way.

1. Raise the lift slightly, and remove the wooden blocks from between the robot and Shelf Lift.



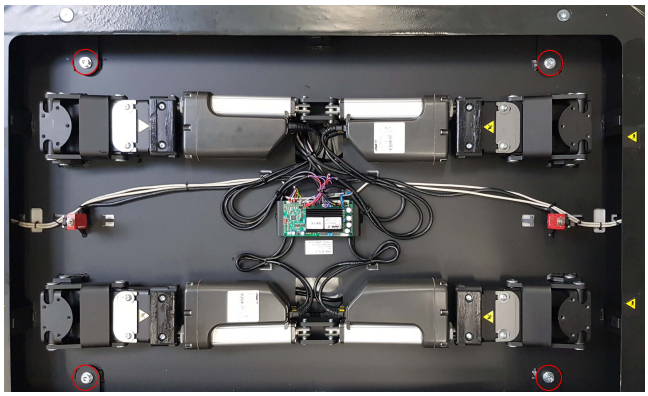
2. Lower the lift onto the robot.

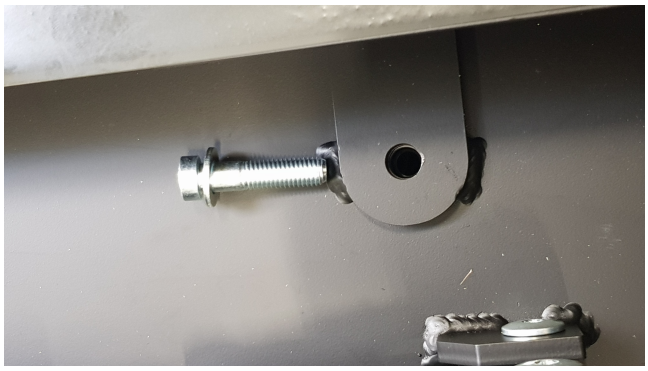


3. Place MiR Shelf Lift so that the white emergency stop chords run to the left when looking directly at the robot from the front.

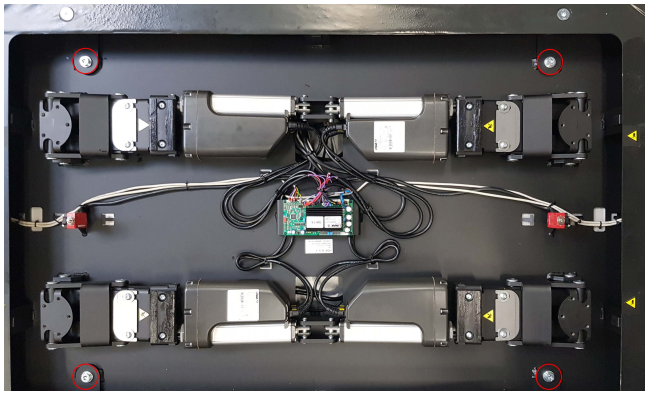
4. Dismount the crane, remove the lifting eye bolts, and remove the crane.

5. Screw in one of the four M12 bolts without tightening it completely.





6. Adjust the lift until the M12 mounting holes are correctly aligned, and screw in the remaining bolts. Ensure that all bolts are tightened completely.

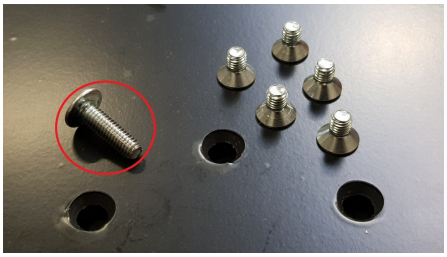


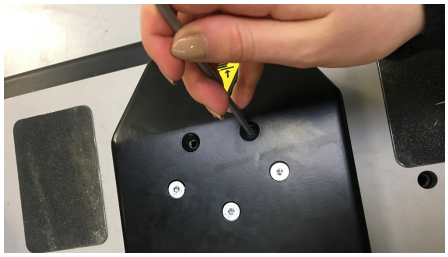
7. Screw in the four bolts that were removed for the eye bolts.

8. Put the lift cover on the lifting device using suction cups.

9. Screw in all twenty screws to fix the cover to the lifting device. Ensure the screws are plane with the lift cover.

If you are having difficulty screwing in the short bolts, start by using a long bolt to make the others easier to screw in. Remember to replace the long bolt with a short one when you are finished. You can also widen the holes using a hex key or other tool.





10. Put on the four safety stickers.

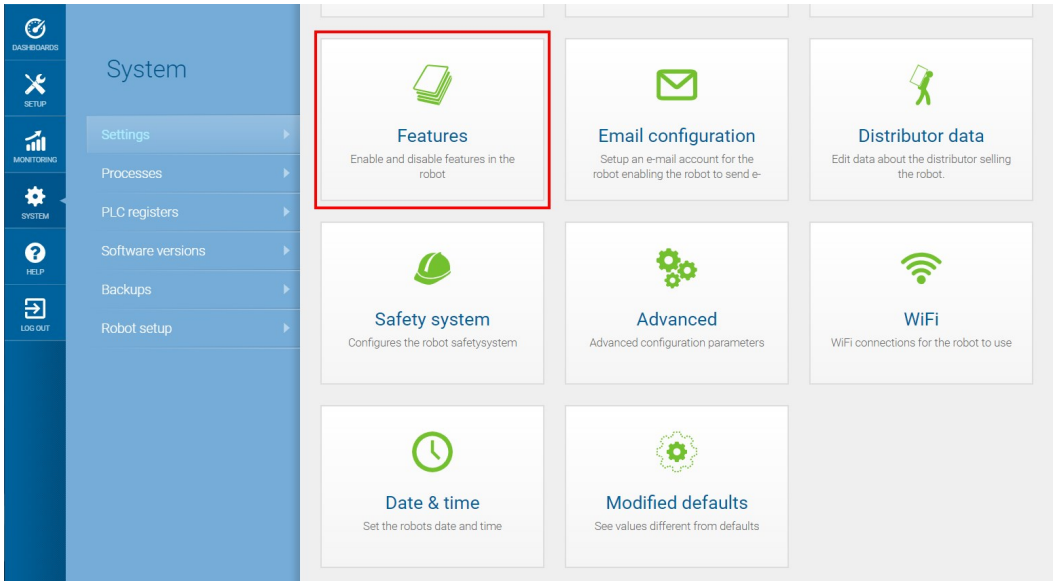
11. Put the anti-slip paper on the sides as shown in the image.

12. Four additional square pieces of anti-slip paper are included with the lift. It is optional to place these on the cover of the lift.

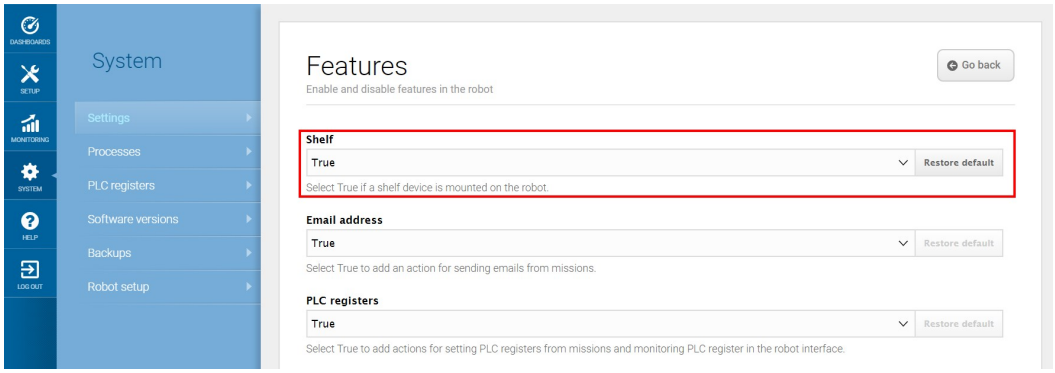
5.3 Enable MiR Shelf Lift feature

To access MiR Shelf Lift settings and mission menus, you must first enable them.

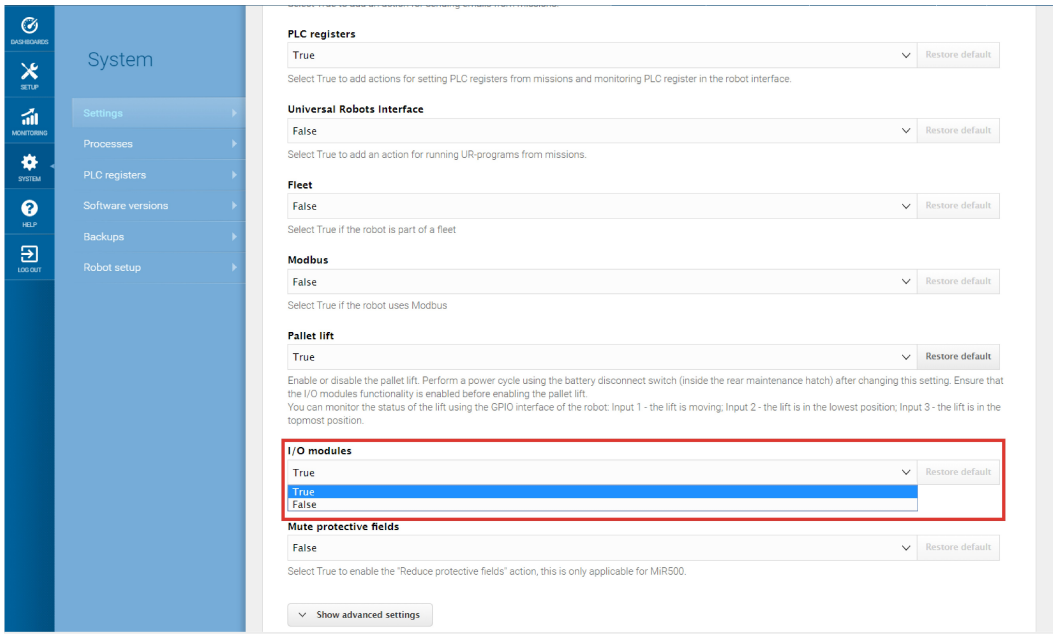
1. Sign in to the robot interface, and go to **System > Settings > Features**.



2. Under **Shelf**, select **True**.



3. Under **I/O modules**, select **True** if this is not set already. MiR Shelf Lift communicates with the robot through I/O modules, so they have to be activated for the shelf lift to work.

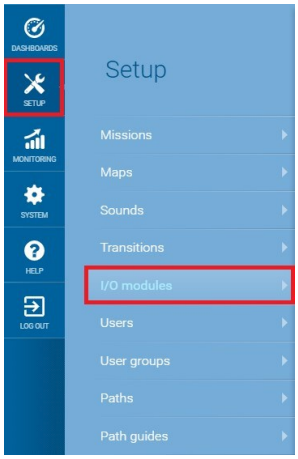


4. Under Pallet lift, select **True**.

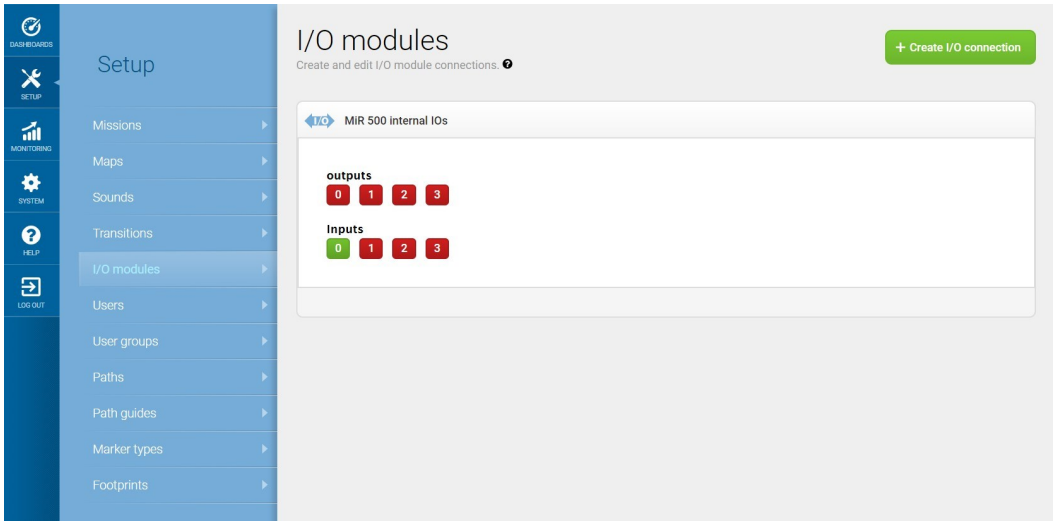
5.4 Testing MiR Shelf Lift

To test that the lift is mounted correctly, complete the following steps. Make sure the lift performs as expected in each step.

1. Turn on the robot, and sign into the robot interface.
2. Enable the lift and I/O module features as described in Enable MiR Shelf Lift feature on page 29.
3. In the robot interface, go to **Setup** > **I/O modules**.



4. Select **MiR500/MiR1000 internal IOs**. The following is displayed:



5. Select **0** under **outputs**, and wait for clicking sounds. This is the initialization of the calibration process.
6. Select **3** under **outputs** to raise the lift.
7. Select **2** under **outputs** to lower the lift.

If the lift is raised and lowered as expected in steps 6 and 7, the robot lift has been mounted and installed correctly. If not, go through the mounting steps again to verify that you have assembled the lift correctly. If you are not able to access the I/O module controls, verify that you have enabled the feature as described in Enable MiR Shelf Lift feature on page 29, and restart the robot by pressing the reset button.

If you continue experiencing issues, refer to the troubleshooting guide *MiR500/MiR1000 Lift or EU Pallet Lift is not moving* found on the Distributor site under Troubleshooting.

6. Commissioning

This section describes how to get started with MiR Shelf Lift.

6.1 Using MiR Shelf Lift

When MiR500/MiR1000 with a MiR Shelf Lift docks to a shelf, the lift can be elevated to pick up the shelf and lowered to place the shelf at a shelf position.

MiR Shelf Lift uses I/O modules and includes four inputs and four outputs. The tables below show the functionality of these. To use MiR Shelf Lift correctly, these internal I/O modules must be used.

The outputs are used to control the position of the MiR Shelf Lift, and the inputs are used to signal the current position and status of the MiR Shelf Lift.

To see the menu options for the I/O modules and the shelf lift, you must enable them first. See Enable MiR Shelf Lift feature on page 29 for more information.

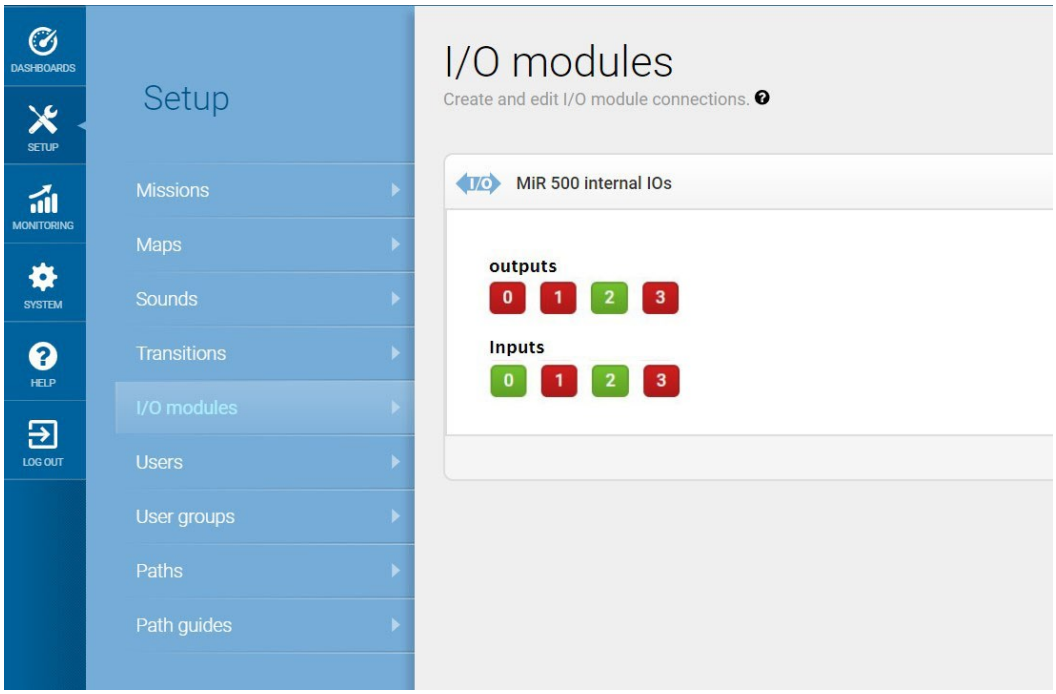
Output	Function
0	Initiates calibration process after five seconds
1	Stops or puts the lift in motion
2	Lowers the lift
3	Raises the lift

Input	Function
0	Indicates that there is an error from the lift controller
1	Lift is moving
2	Lift is either lowered or stopped, but not raised
3	Lift is raised

6.2 Resetting Lift after turning on the robot

To avoid unexpected movement the first time you use the lift, you must reset MiR Shelf Lift before operating it.

1. Sign in to the robot interface and go to **Setup > I/O modules.** Input 0 and input 2 will be high (green).
2. Set output 0 to set the input to high (green). Make sure it stays high for at least five seconds.
3. Wait for the lift to reset. It takes approximately 13 seconds and can be monitored in **Monitoring > System log**.

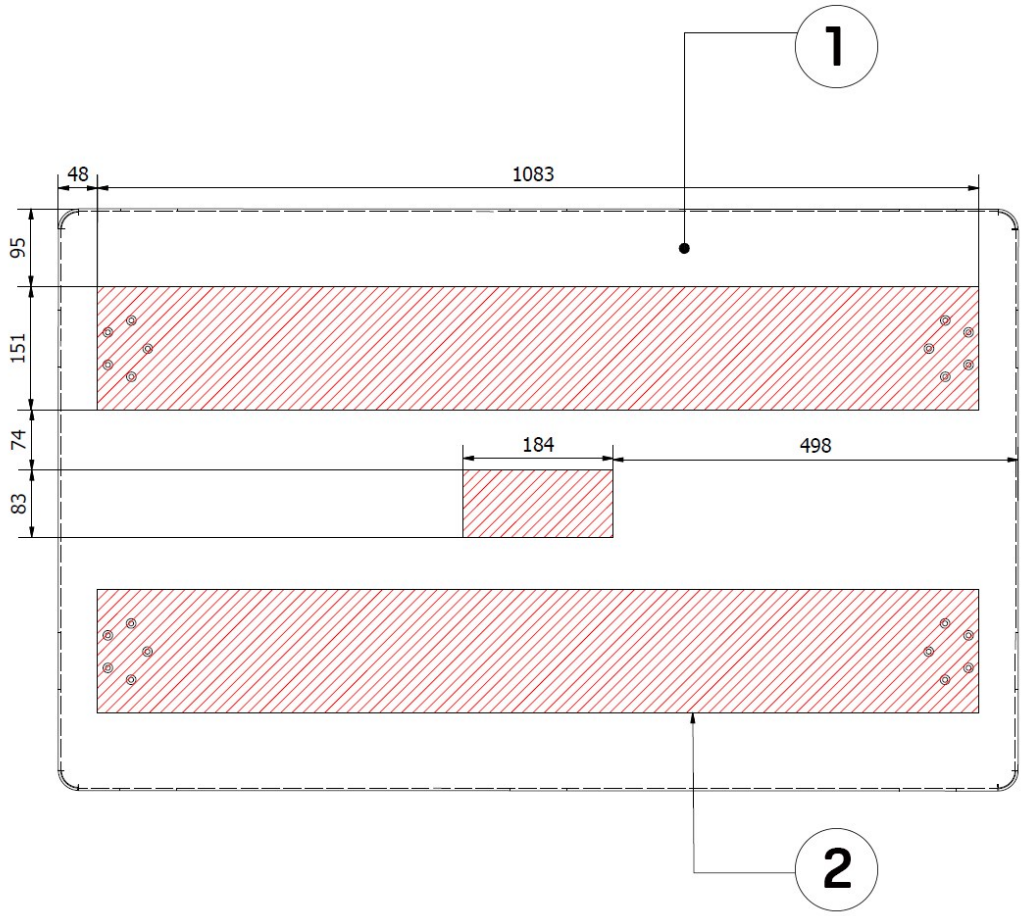


Consider recreating these steps as a mission that you can run every time you turn on the lift.

6.3 Lift modifications

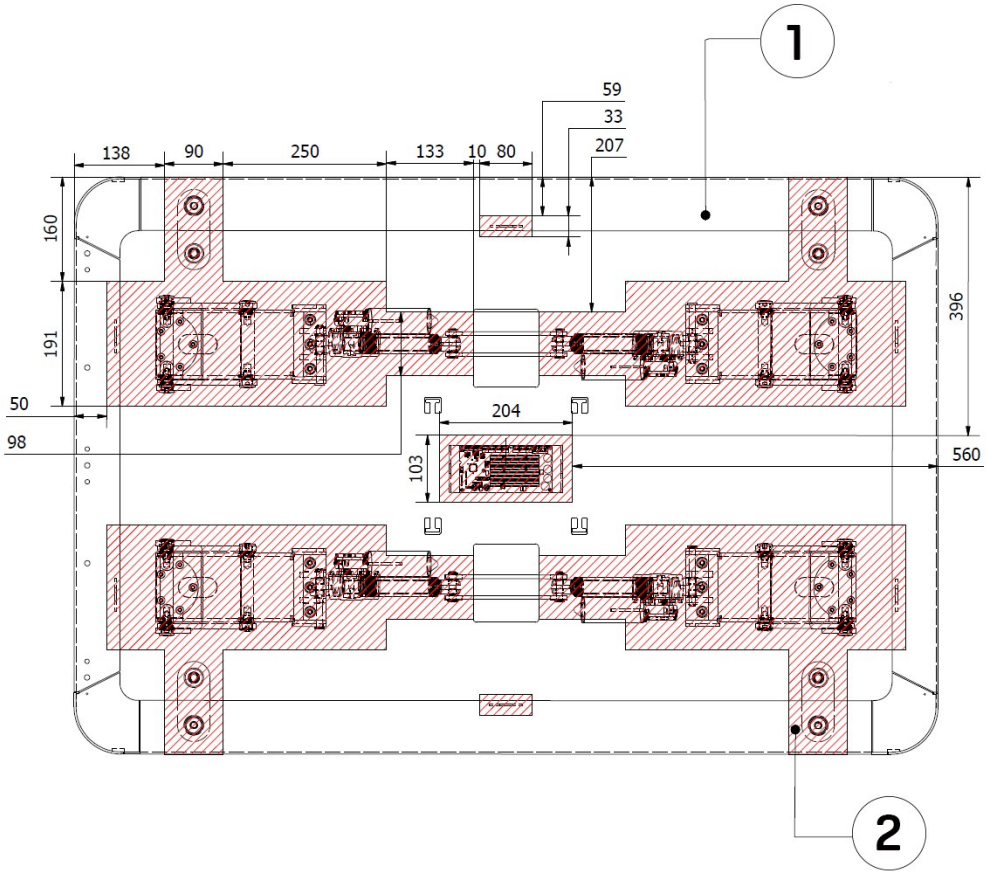
Additional holes can be added to the MiR Shelf Lift for custom applications. However, it is important not to damage any vital parts of the lift when doing so.

Top plate of the lift



1.	Material: Steel (S355) Thickness: 3 mm Treatment: Powder coating RAL 9005	2.	Areas marked with red indicate where you are not allowed to make modifications, such as drilling holes or mounting accessories.

Bottom frame of the lift



1.	Material: Steel (S355) Thickness: 3 mm Treatment: Powder coating RAL 7011	2.	Areas marked with red indicate where you are not allowed to make modifications, such as drilling holes or mounting accessories.

NOTICE

The drawings above only show where you can make minor modifications without damaging the product. You should not use it for any other measurements or calculations.

6.4 Adjusting the protective field sets

When MiR500/MiR1000 is driving with a shelf, the legs of the shelf are located in the protective field sets of the robot. For MiR500/MiR1000 to drive with a shelf without going into protective stop, the protective field sets need to be adjusted.

Safety laser scanner configurations

From software version 2.8.0, the robot software includes a standard configuration of the safety scanners for a wide shelf with asymmetric legs on both MiR500 and MiR1000 robots.

Additionally, users can download six different standard configurations from the robot interface. Configurations with asymmetric legs are available for:

- Both narrow and wide shelves for MiR1000 from product number V0001
- Both narrow and wide shelves for MiR500 robots from product number U0001 to U0159
- Both narrow and wide shelves for MiR500 from product number U0160 and higher

MiR500 robots from product number U0001 to U0159 have a gearing and top speed different from the later MiR500 robots, so they use different safety scanner configurations.

If used with shelves with symmetric legs, users can adjust the safety scanners manually.

Follow the how-to guide *How to adjust the field sets on MiR500/MiR1000 for MiR Shelf Lift* on the Distributor site to change the robot's safety scanners to comply with MiR Shelf Lift. The guide describes how to adjust the protective field sets manually and how to apply a standard configuration.

Asymmetric legs

Shelves with asymmetric legs obstruct the view of the safety scanners the least and create the smallest blind spots.

NOTICE

The blind spots in the illustrations below are wider than the legs (the small crosshairs) because the safety scanners need some tolerance on each side of the legs for small movements during transport to prevent the robot from going into unnecessary protective stops.

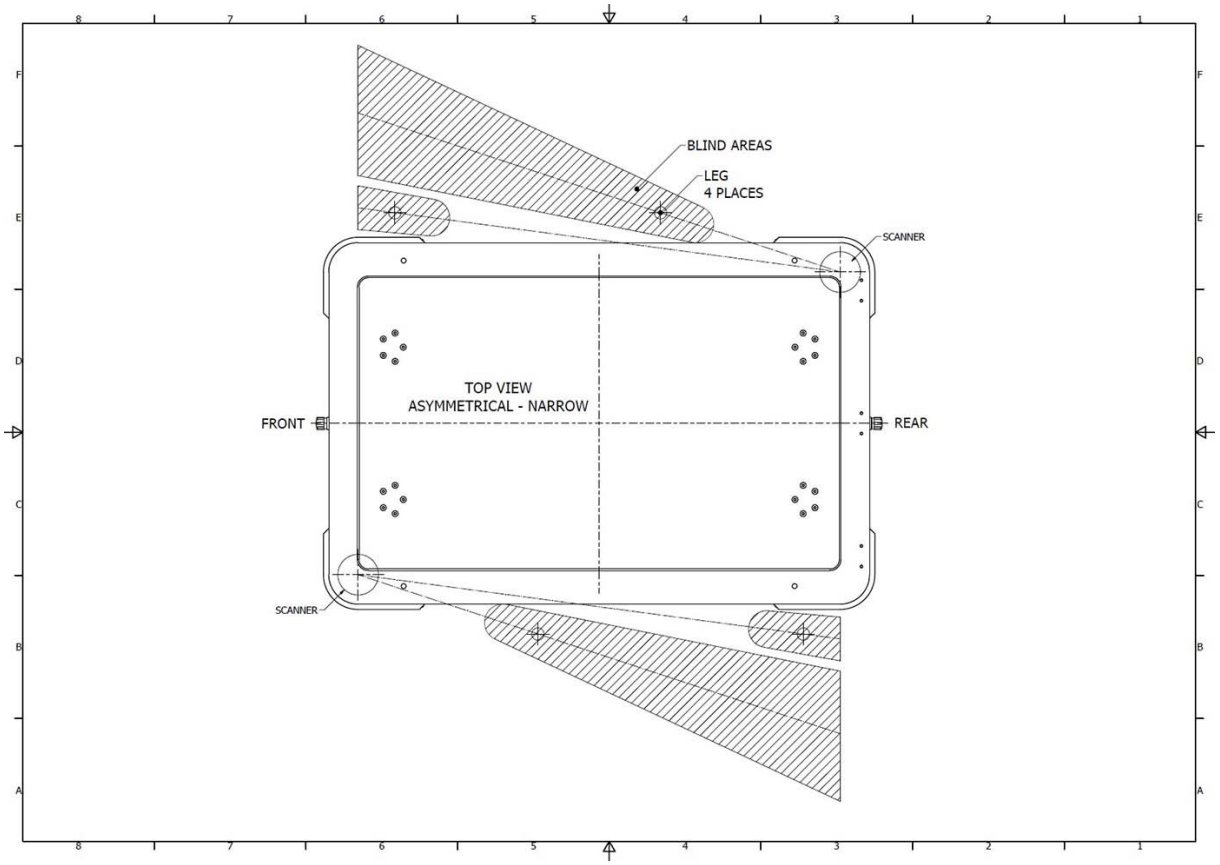


Figure 6.1. The blind spots with an asymmetric shelf with narrow legs. The small crosshairs are the shelf-legs.

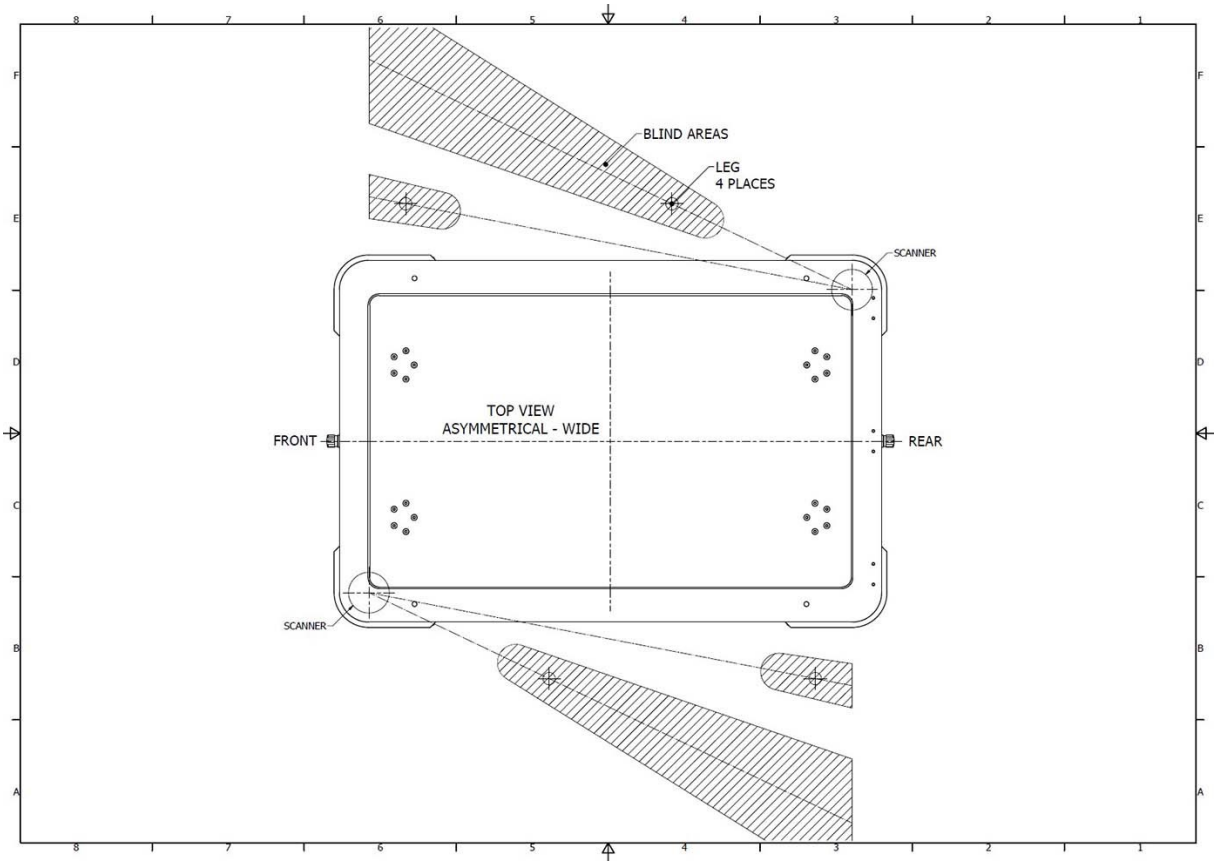


Figure 6.2. The blind spots with an asymmetric shelf with wide legs. The small crosshairs are the shelf-legs.

Symmetric legs

Shelves with symmetric legs create significantly larger blind spots for the robot than shelves with asymmetric legs because the legs interfere more with the field of view of the safety scanners.

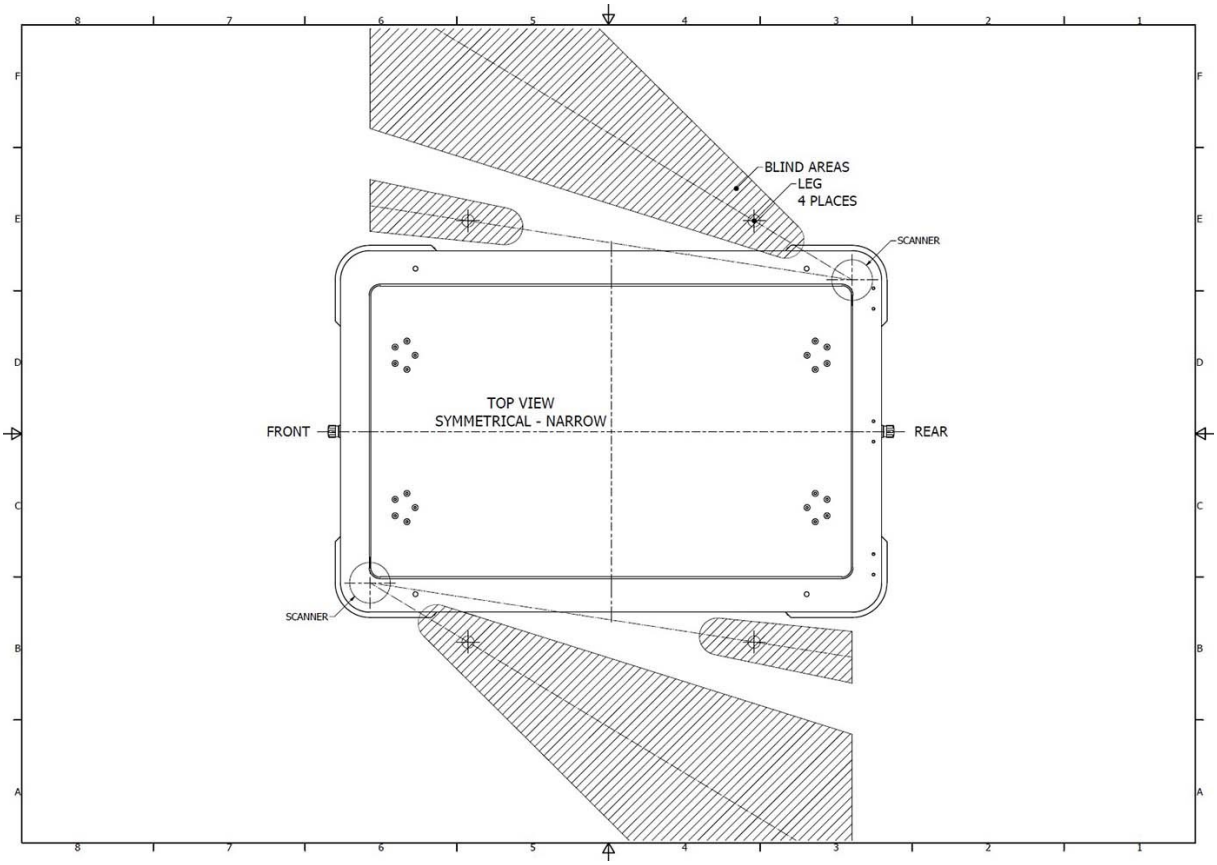


Figure 6.3. The blind spots with a symmetric shelf with narrow legs. The small crosshairs represent the shelf-legs.

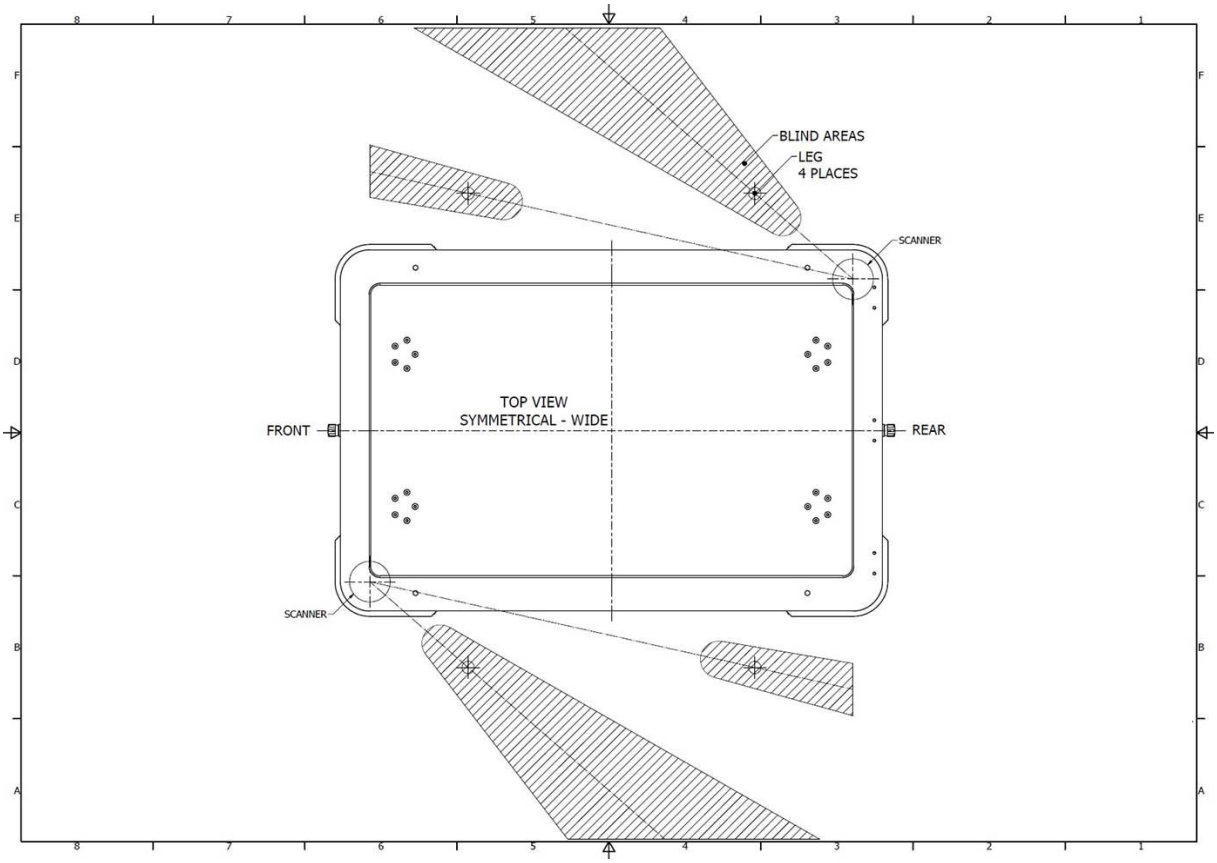


Figure 6.4. The blind spots with a symmetric shelf with wide legs. The small crosshairs represent the shelf-legs.

6.5 Mark potentially hazardous floor areas

Before taking your MiR Shelf Lift into use, it is necessary to mark up the floor in the area where MiR500/MiR1000 with MiR Shelf Lift docks to a shelf.

Why marking is required

When docking to a shelf, the robot mutes its Personnel detection means temporarily. This includes turning off the protective field sets around the robot.

The muting starts when the robot reaches the entry position approximately one meter from the shelf marker. To indicate this to people nearby, MiR500/MiR1000 slows down and starts blinking yellow, using the eight signal lights on the corners of the robot.

To avoid potentially hazardous situations as a consequence of the Muted personnel detection means, you must mark the physical area around the shelf position with tape or similar marking material.

For more information on Personnel detection means, see the MiR500/MiR1000 User guide.

Marking the operating hazard zone

The size of the operating hazard zone is based on the robot's path going to the shelf and takes into account that the robot may have to make a turn of up to 90° when docking to the shelf.

NOTICE

The operating hazard zone and the required space for docking are not the same. See Required free space on page 44.

Figure 6.5 illustrates where the floor markings should be for a single shelf. For multiple shelves, see Multiple shelves on the next page.

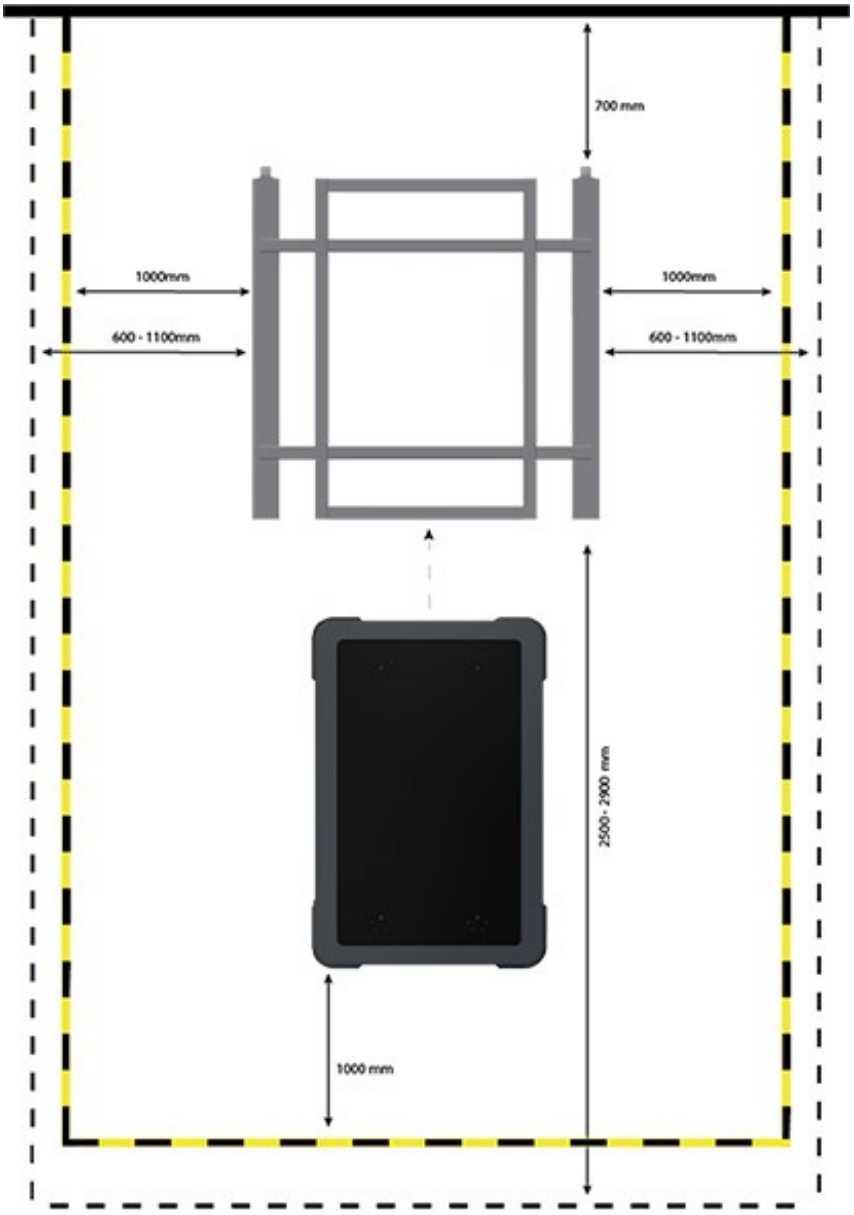


Figure 6.5. The floor around the shelf position must be marked to indicate an operating hazard zone, illustrated by the striped yellow and black line. The outermost black dashed line indicates the space needed to be held clear for a successful docking.

CAUTION

If you want to dock and/or undock to the shelf from both ends, or if you want to undock the shelf by going forward, the operating hazard zone needs to be of equal size on both ends of the shelf.

Required free space

This section describes the required free space around a shelf to ensure that the robot with MiR Shelf Lift can dock to it.

It is the commissioner's responsibility to ensure an installation that functions, so the commissioner must be aware that:

- The required space varies between specific local environments.
- The size and material of the obstacles surrounding the shelf influence the docking procedure.
- The more free space the robot has in front of the shelf, the closer the shelf can be placed to other obstacles.

The required free space for a successful docking is indicated in *Figure 6.5* with the black dashed line.

NOTICE

The space required for a successful docking can be larger than the operating hazard zone.

Multiple shelves

If you have multiple shelves next to each other, it is important to place the shelves with enough space between them to ensure a correct docking procedure.

Between every shelf, there must be at least 600 mm of free space and an additional 700 mm space to the nearest obstacle behind the shelf, as shown in *Figure 6.5*.

Multiple shelves using VL-markers

However, if you use VL-markers, shelves can be placed significantly closer to other shelves or obstacles: 150 mm on both sides and behind the shelf.

For more information on how to dock to VL-markers, see Placing positions closer using VL-markers on page 52.

CAUTION

Risk of getting trapped or crushed if standing in the operating hazard zone.

- To fulfill the safety requirements, there must be an escape route of at least 500 mm either behind the shelves or between every other shelf.

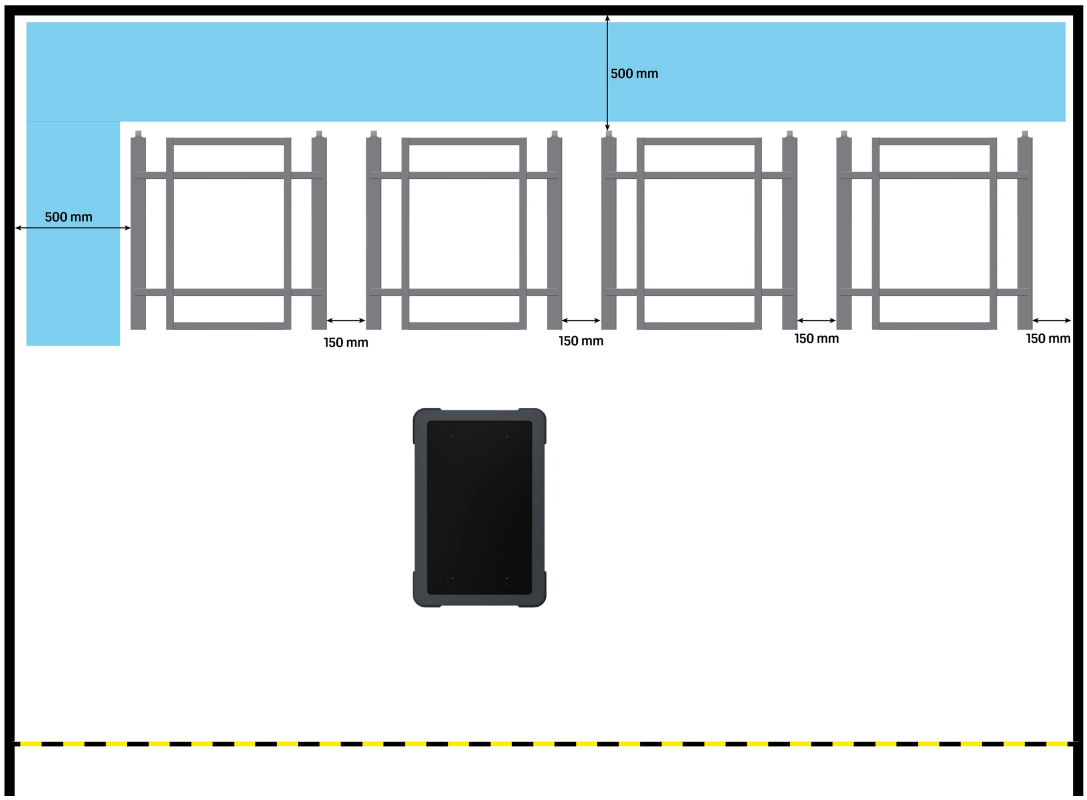


Figure 6.6. Multiple shelves placed close to each other using VL-markers with a 500 mm escape route behind them. The blue area indicates the escape route.

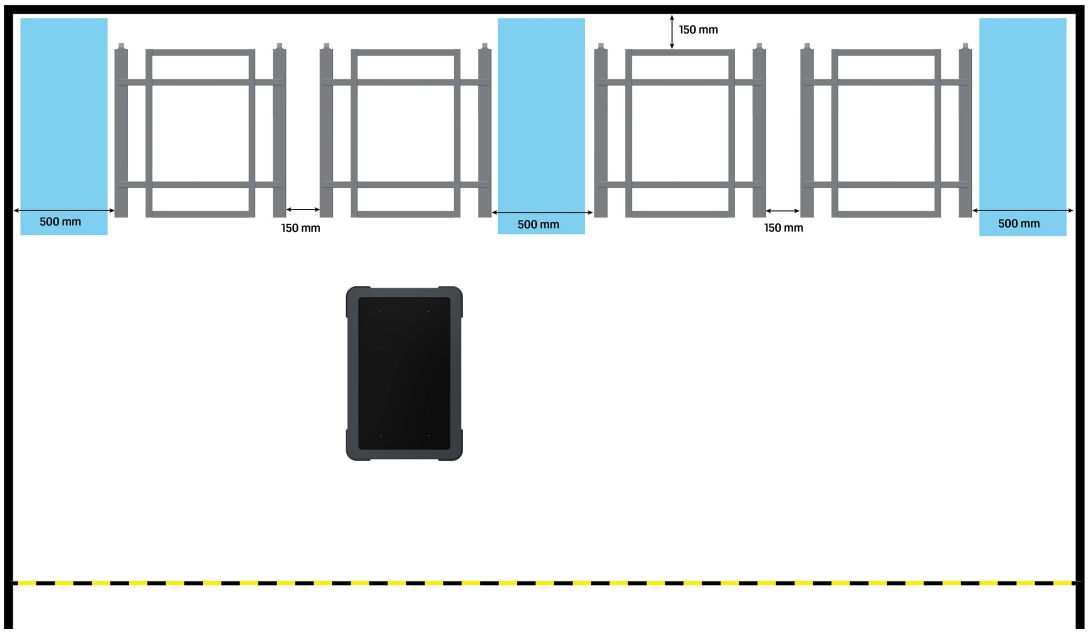


Figure 6.7. Multiple shelves placed close to each other using VL-markers with a 500 mm escape route between every other shelf. The blue areas indicate the escape routes.

7. Usage

It takes several steps in the robot interface to set up the robot to pick up and place shelves with a MiR Shelf Lift mounted on top of MiR500/MiR1000.

This guide describes how to create a pick up and place shelf mission and a reverse docking shelf mission, and it describes how to create marker types and set footprints.

The pick up and place shelf mission makes the robot with MiR Shelf Lift go to a shelf position, pick up a shelf, and then go to a shelf position and place the shelf. The reverse docking shelf mission makes the robot go to a shelf position and dock to it in reverse.

The examples use template missions within the missions. These template missions are included in the robot software.

The steps for creating the mission examples are described in this chapter and are outlined in the following points:

- Creating a marker type below. You must define the dimensions of the various types of shelves your robot transports.
- Setting shelf positions on the map on page 50. The positions of shelves must be defined on the robot map so the robot knows where to go to pick up or place shelves.
- Placing positions closer using VL-markers on page 52
- Creating footprint on page 58. You can define the dimensions of the various types of shelves your robot transports if they are not supported by MiR and included in the robot interface.
- Creating a pick up shelf and place shelf mission on page 60
- Reverse docking shelf mission/creating marker type on page 65

MiR Shelf Lift docks to shelves with 10 mm and 1° precision.

7.1 Creating a marker type

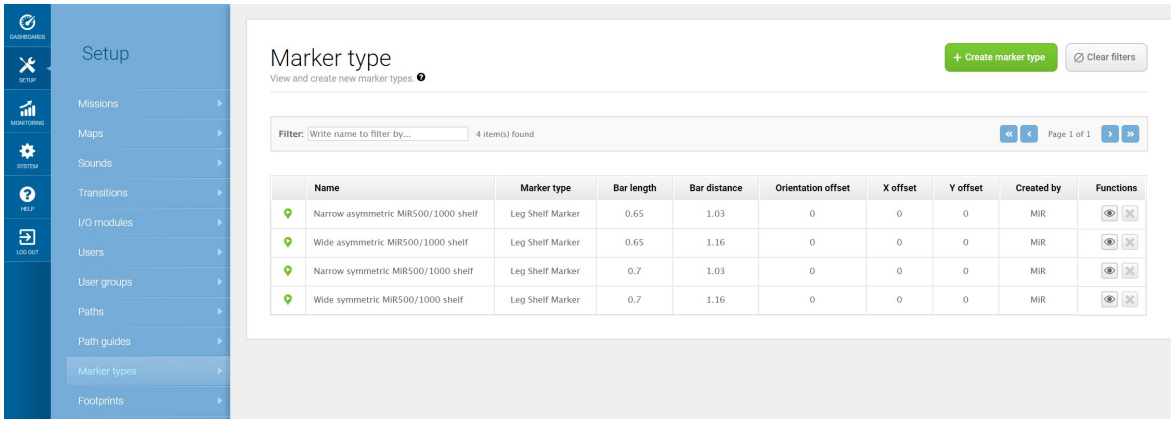
Before creating missions with shelves, you need to define the different marker types that your robot will be docking to. This information is used when the robot is docking to a shelf to ensure that it picks up the shelf correctly.

Marker types determine what type of shelf is located on a shelf position and how the robot docks to it. Marker types are selected when choosing docking parameters in a docking mission.

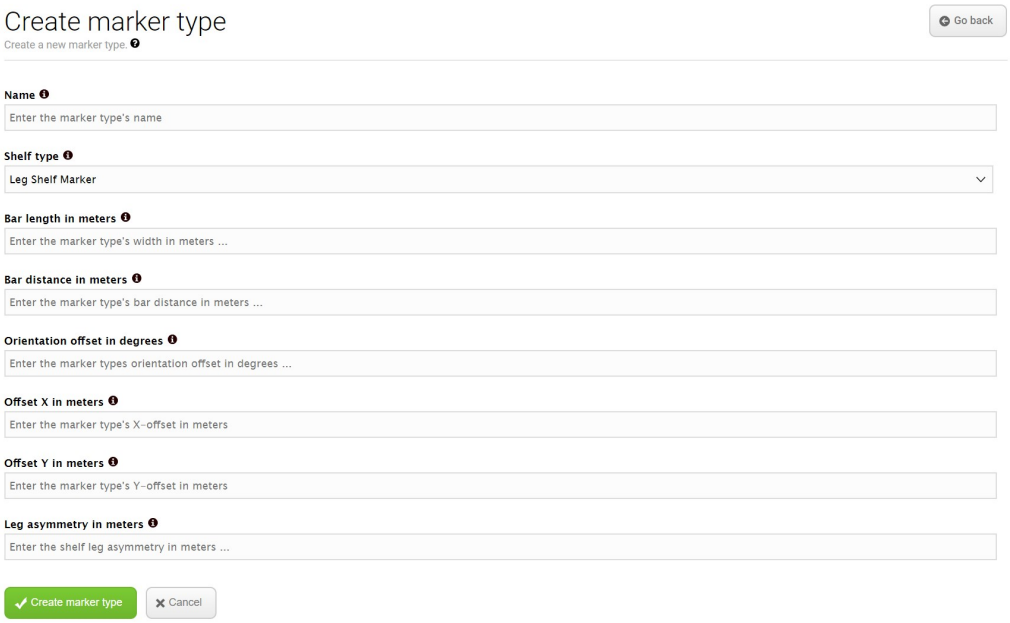
By default, you can choose between four marker types in the robot software: wide and narrow shelves with asymmetric legs and wide and narrow shelves with symmetric legs. See Shelf specifications on page 14. If your shelf has different specifications, or if you want to dock differently to the shelf, you need to create a new marker type.

To make the robot interface display shelf options, you must enable the feature as described in Enable MiR Shelf Lift feature on page 29.

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



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



- **Name**: Is used to identify the shelf type when using it in mission actions.
- **Shelf type**: Is used to identify which type of shelf that is going to be used. **Bar shelf markers** are for MiR100 and MiR200 robots, and **Leg shelf markers** are for MiR500 and MiR1000 robots.
- **Bar length in meters**: Is used to identify the length of one of the side bars of the shelf. These dimensions are the same as those identified in Shelf dimension specifications and define the size of the shelf.
- **Bar distance in meters**: These are also defined in Shelf dimension specifications and specify the width of the shelf, defined as the distance between the two bars inner side to inner side.
- **Orientation offset in degrees:** Is used to define the robot's position when docking to the shelf. A 180 value will make the robot dock in reverse.
- **Offset X in meters**: Is used to adjust how far forward the robot should go under the shelf when picking it up. By default, the robot should dock to the center. With a positive X-offset, the robot will move more forward, and a negative value will move it backward.

- **Offset Y in meters**: Is used to adjust how far to either side the robot goes under the shelf when picking it up. By default, the robot should dock to the center. With a positive Y-offset, the robot will move more the left side, and a negative value will move it to the right.
- **Leg asymmetry in meters:** Is used to indicate the offset between the two front legs. A zero value means symmetry.

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

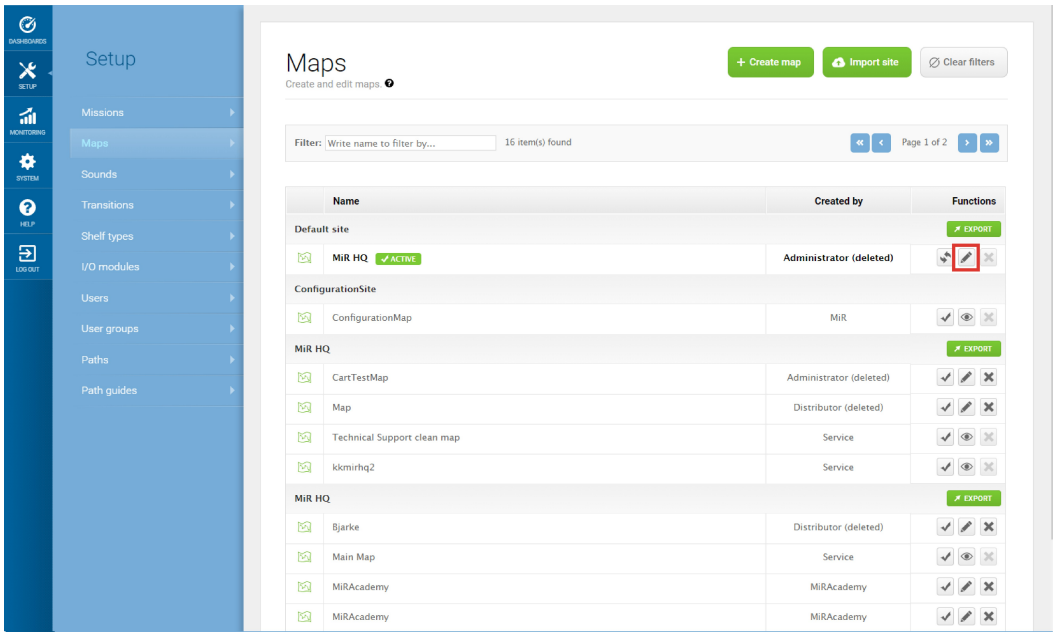
3. Select **Create marker type** when you are done. The shelf type is now displayed in the list of shelf types.

7.2 Setting shelf positions on the map

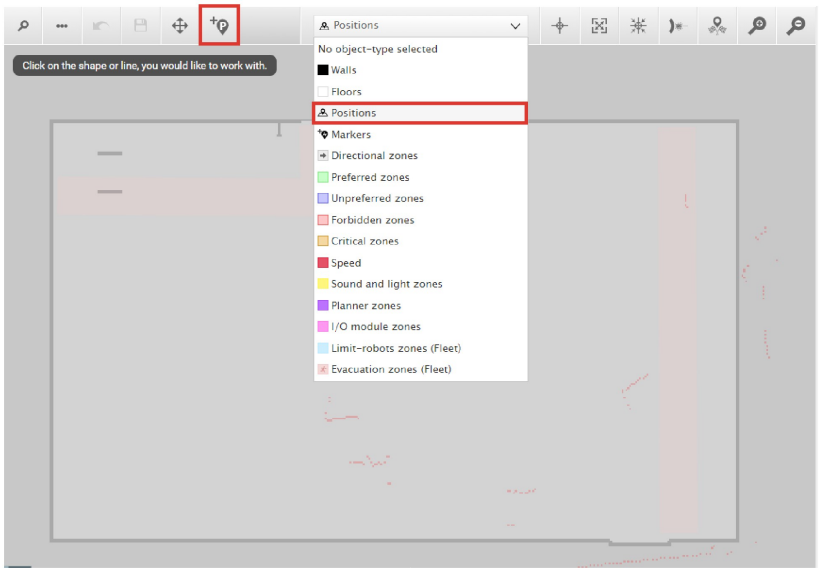
The shelf positions must be defined in the map. It is only at shelf positions that the robot is able to pick up shelves.

Follow these steps to create a shelf position:

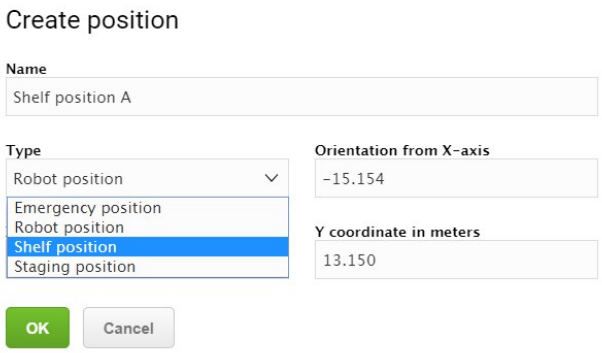
1. To create a new position, go to **Setup > Maps**. Select **Edit** for the active map.



2. Within the editor, select **Positions** in the **Object-type** drop down menu, and then select the **Draw new position** in the editor tools.



3. Select the point on the map where you want the shelf position to be placed.
4. In the **Create position** dialog box, name the position, and under **Type**, select **Shelf position**.



5. Select **OK** to create the shelf position. The position is now visible on the map.

If you want to make more than one position on the map, repeat the previous steps. Make sure that the minimum distances between shelf position fulfill the dimensions specified in Mark potentially hazardous floor areas.

7.3 Placing positions closer using VL-markers

If you need to dock with greater precision or have shelves placed close to obstacles or other shelves, you can do so by creating shelf positions in front of VL-markers.

When placing shelves, make the robot with MiR Shelf Lift dock to the VL-marker (see Docking to a VL marker in a place shelf mission on the next page), and when picking up shelves, make it dock to the shelf position in front of the VL-marker.

Creating a VL-marker

Before creating the marker, you must ensure that the robot is localized correctly on an active map. If in doubt, you can check if the red lines representing the laser scanner line match the black lines on the map as shown in *Figure 7.1*.

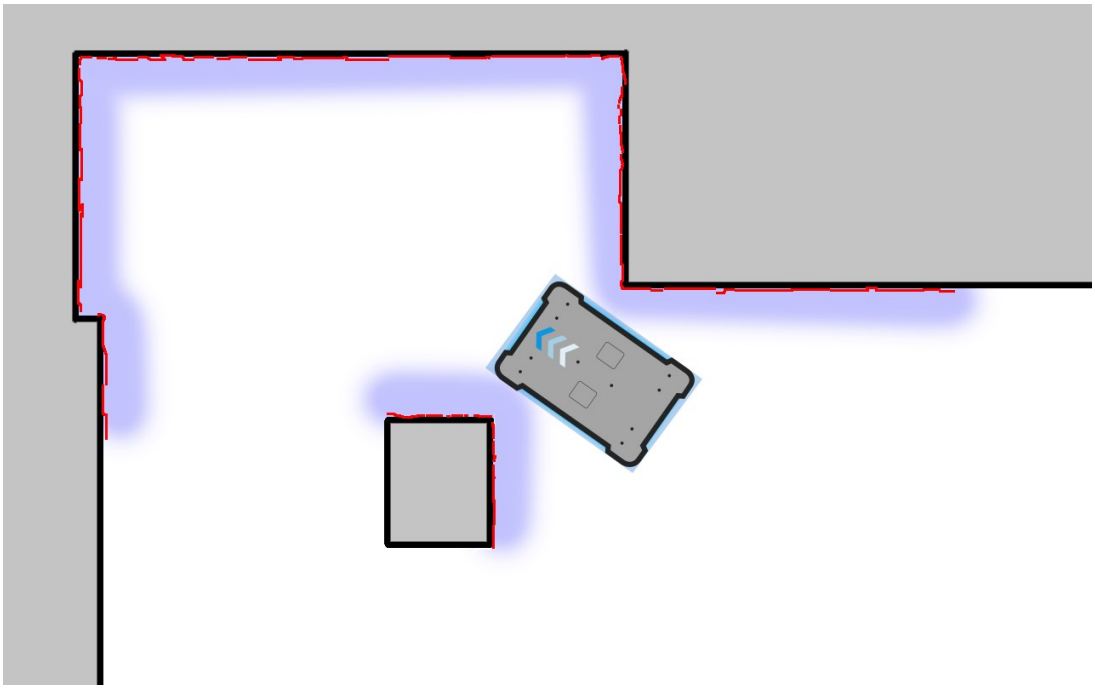
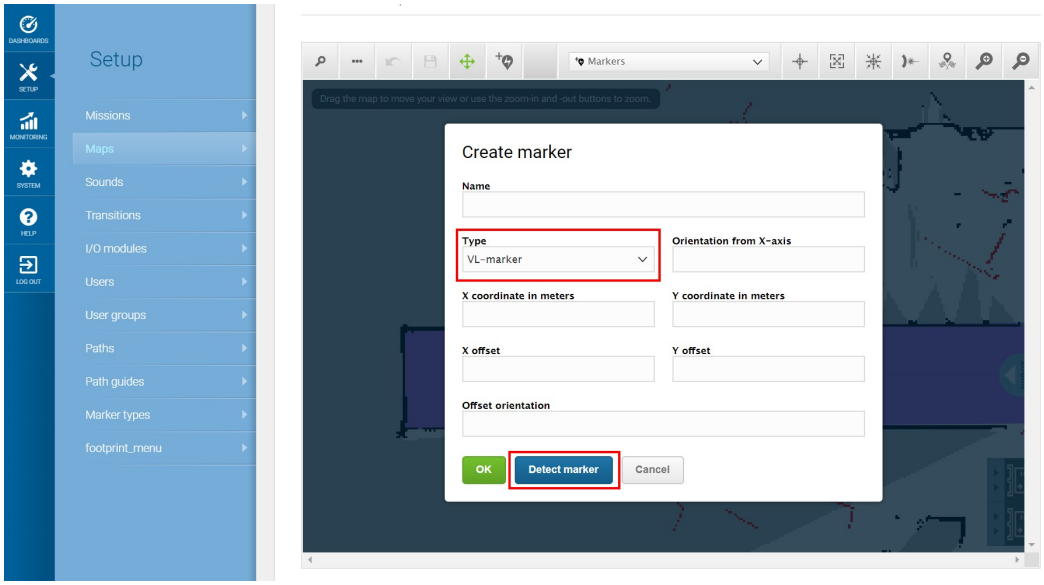


Figure 7.1. The red lines represent the obstacles the laser scanners detect. The robot is localized correctly when the red lines align with the black lines that represent walls.

Once the robot is localized, it is possible to insert a VL-marker correctly on the map using the following steps:

1. Set your VL-marker where you want the robot with MiR Shelf Lift to dock.
2. Manually drive your robot to the VL-marker so the robot is facing the marker.
3. Go to **Setup > Maps** and select **Edit** for the active map.

4. Within the editor, select **Markers** in the **Object-type** drop down menu, and then select **Draw new marker** on the editor tools bar. Choose **VL-marker** and then **Detect marker**.



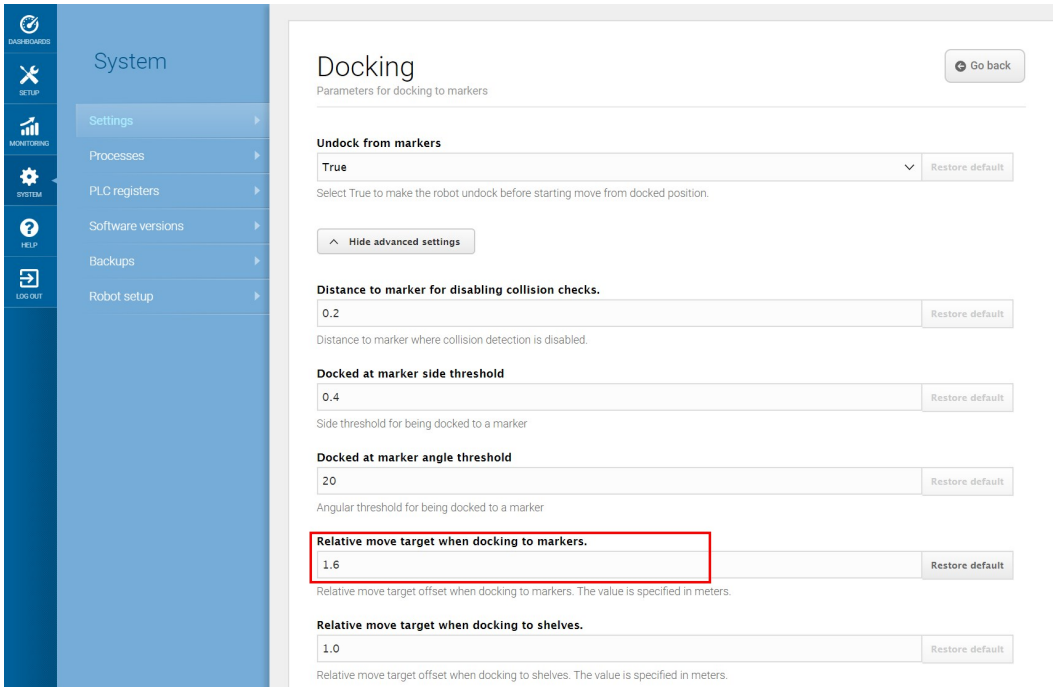
The X, Y, and orientation values will automatically be filled out with the current position of the robot. Set the offsets to 0. If you want to dock to the marker in reverse, set the **Offset orientation** to 180.

If the robot is too far from the VL-marker, a message that the robot failed to locate the marker is displayed. Try moving the robot closer, and ensure that the front safety laser scanner is positioned in front of the VL-marker.

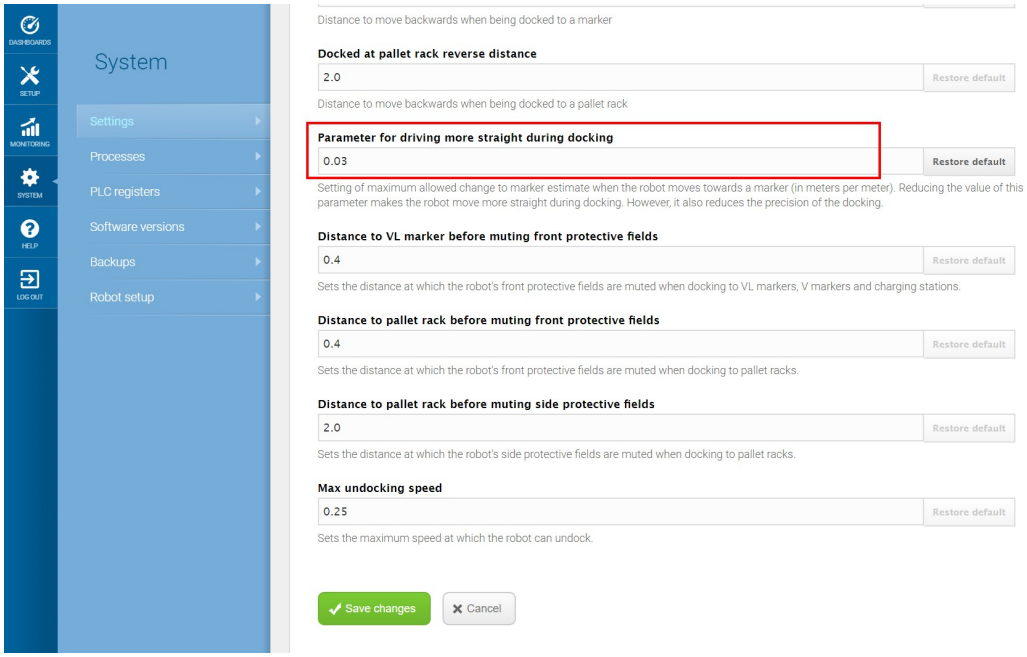
5. Select **OK** to create the marker. The marker is now visible on the map.

Docking to a VL marker in a place shelf mission

1. In **System > Settings > Docking**, set **Relative move target when docking to markers** to 1,6 m. This will make the robot go to a position 1,6 meters in front of the marker before docking. Select **Save changes**.

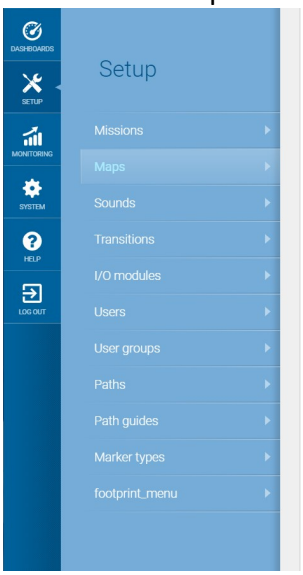


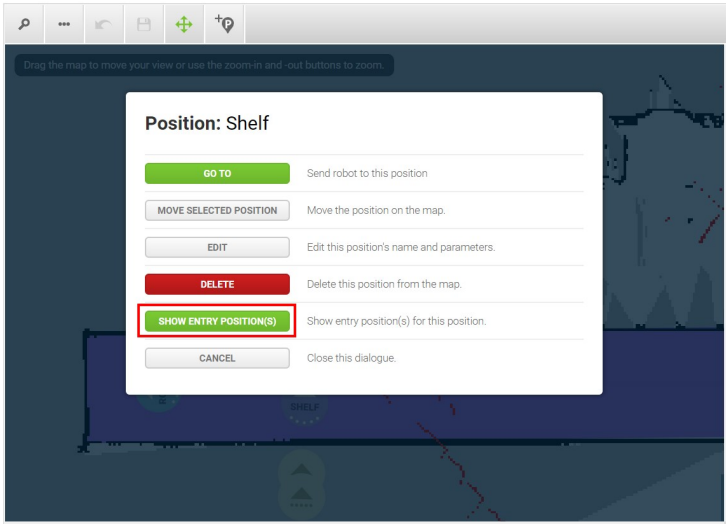
2. If the robot lurches when docking, you can reduce the amount of corrections it is allowed to make when docking under **System > Settings > Parameter for driving more straight during docking**. Set the parameter to 0.03 or lower. Select **Save changes**.



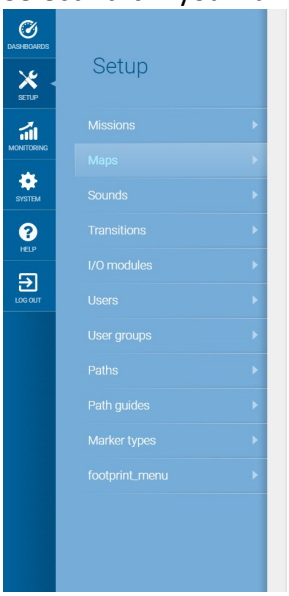
3. Create a shelf position directly in front of the VL-marker you created. See Placing positions closer using VL-markers on page 52

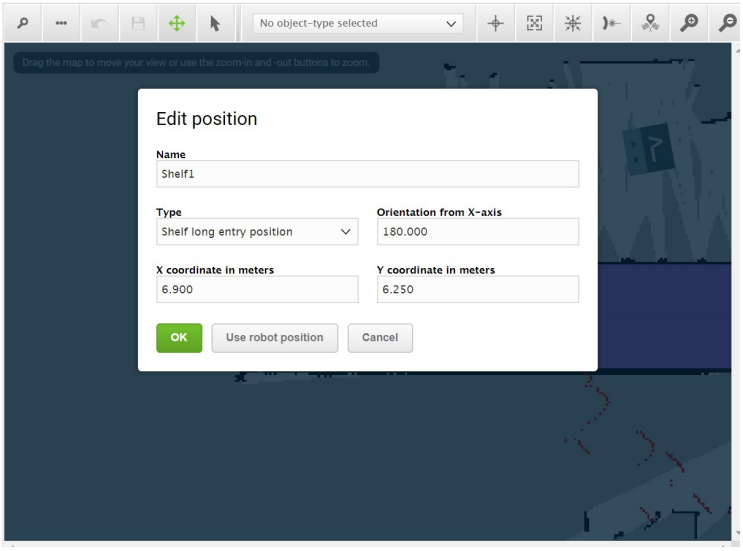
4. Select the shelf position on the map. Then select **Show entry position**.





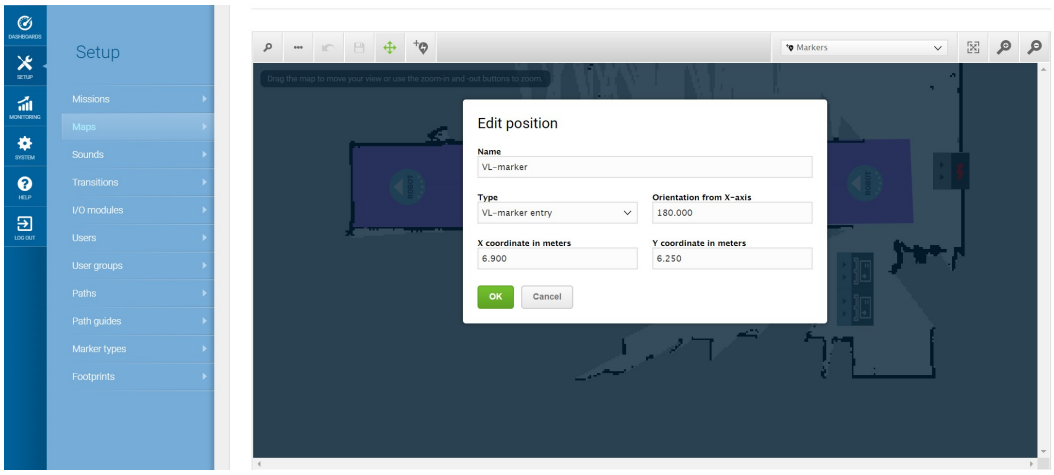
5. Two entry positions appear. They indicate where the robot will go to first when docking to the position. The entry position furthest from the shelf position is for MiR Shelf Lift. Select **Edit** if you want to adjust the entry position.





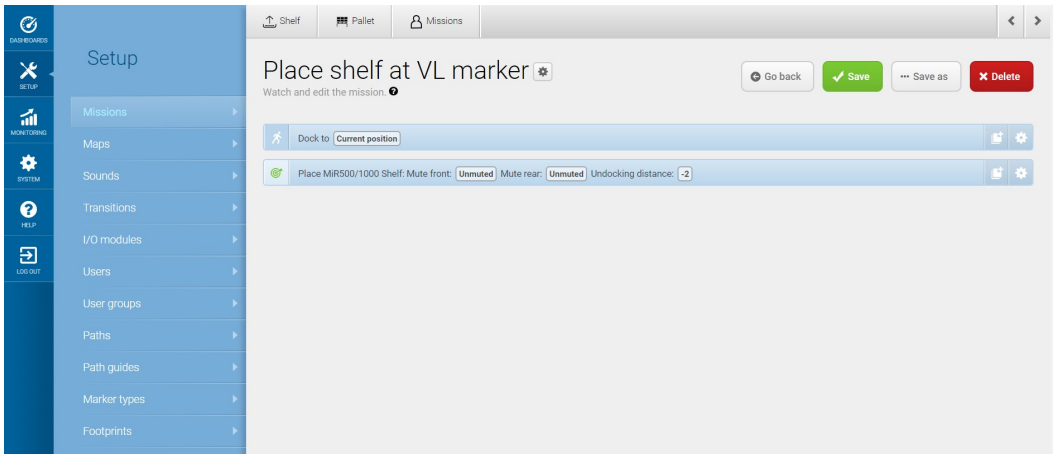
6. Select the VL-marker on the map. Then select **Show entry position**.

7. Select the VL-markers entry position, and place the position directly in the same coordinates on the map as the entry position of the shelf position.



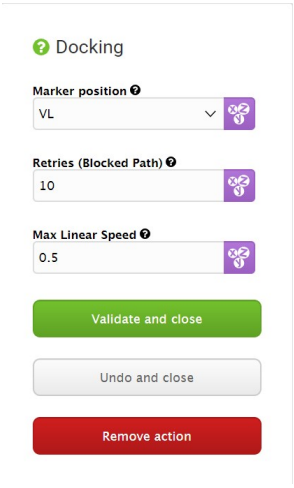
8. Go to **Setup > Missions** and create a new mission.
9. Give the mission a name, for example *Place shelf at VL marker*. Select the group and site you want it to belong to. Select **Create mission**.
10. Select the following actions:
    a. In the **Move** menu, select **Docking**.
    b. In the **Shelf** menu, select the **Place MiR500/1000 Shelf** template mission.

The mission dialog should look like this:

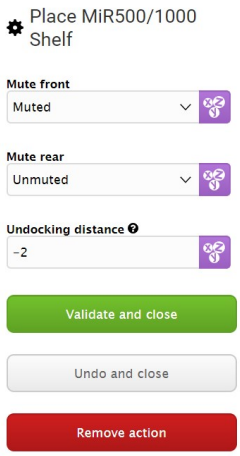


The following steps describe which parameters each action should be set to. To modify the parameters, select the gearwheel ⚙ of the action in question to open the dialog of that action.

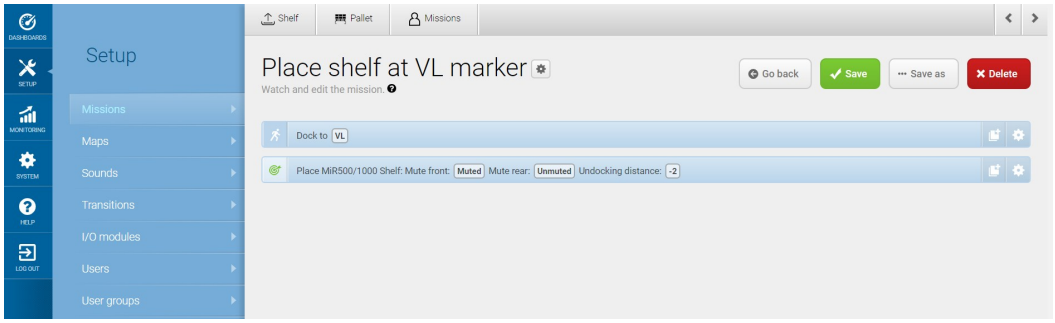
6. Under **Dock to**, select the VL marker under **Marker position**. Select **Validate and close**.



7. Under **Place MiR500/1000 Shelf**, select **Mute front** to mute the safety scanners on the front when docking. When docking to a VL-marker, the robot must mute either the front or back safety scanners depending on whether the robot docks forward or in reverse.
8. Under **Undocking distance**, select the undocking distance in meters. A negative value makes the robot undock in reverse, and a positive value will make the robot move forward when undocking. Select **Validate and close**.



9. Select **Save** to save the mission. The mission should look like this:



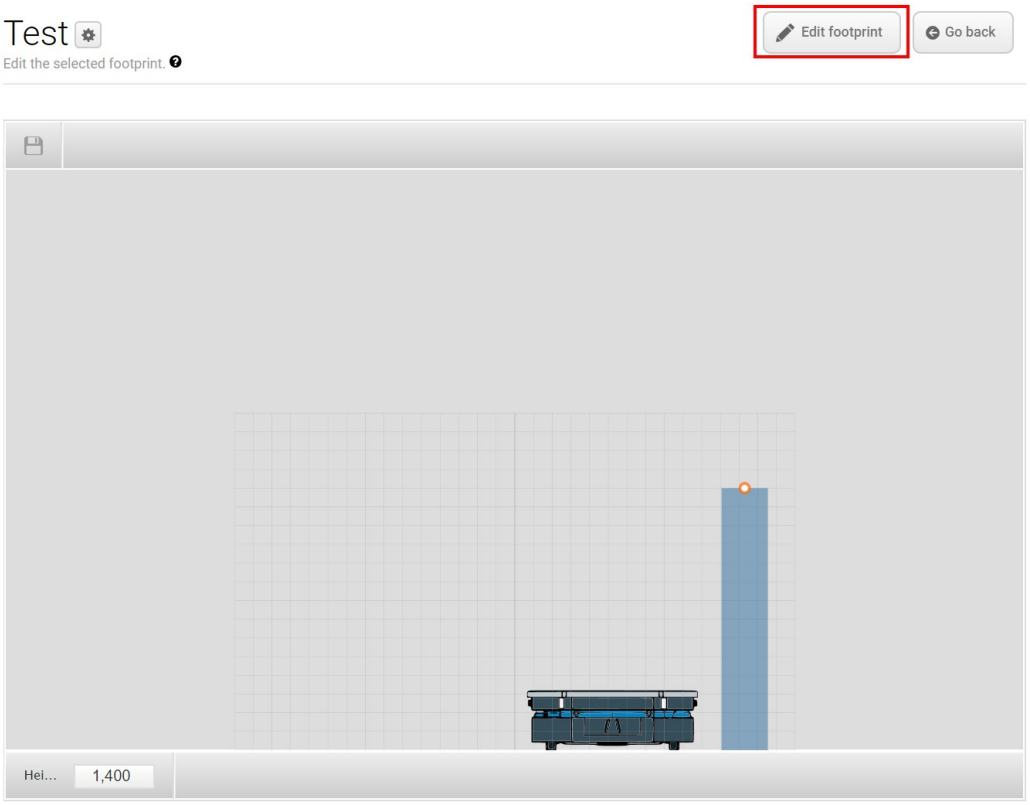
7.4 Creating footprint

This section describes how to create footprints using the footprint menu. See the how-to guide *How to change the robot footprint* on the Distributor site.

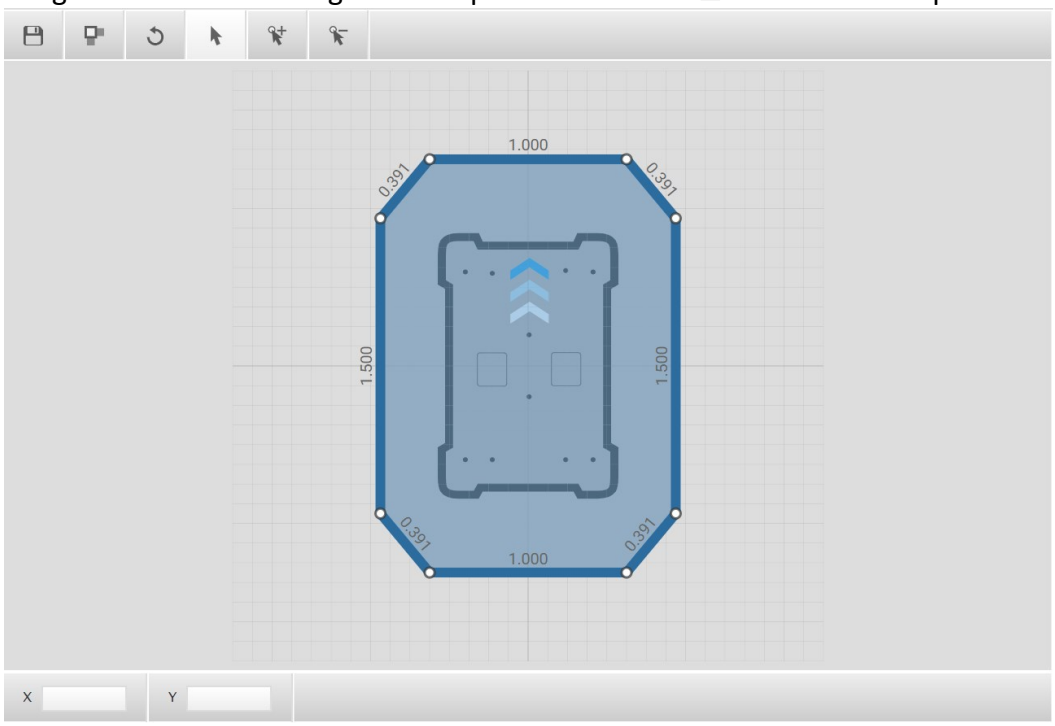
In the footprint menu, you can create your own footprints to use in missions. The robot interface comes with default footprints for a MiR Shelf Lift with a wide or narrow shelf.

If you are using a shelf with dimensions not supported by MiR (see Shelf specifications on page 14), you must create your own footprint that fits the dimension of the shelf.

1. In **Setup > Footprints**, select **Create footprint** and name the footprint.
2. Select **Edit height/Edit footprint** if you need to change the height of the footprint.



3. Drag the corners to change the footprint. Select **Save** to save the footprint.



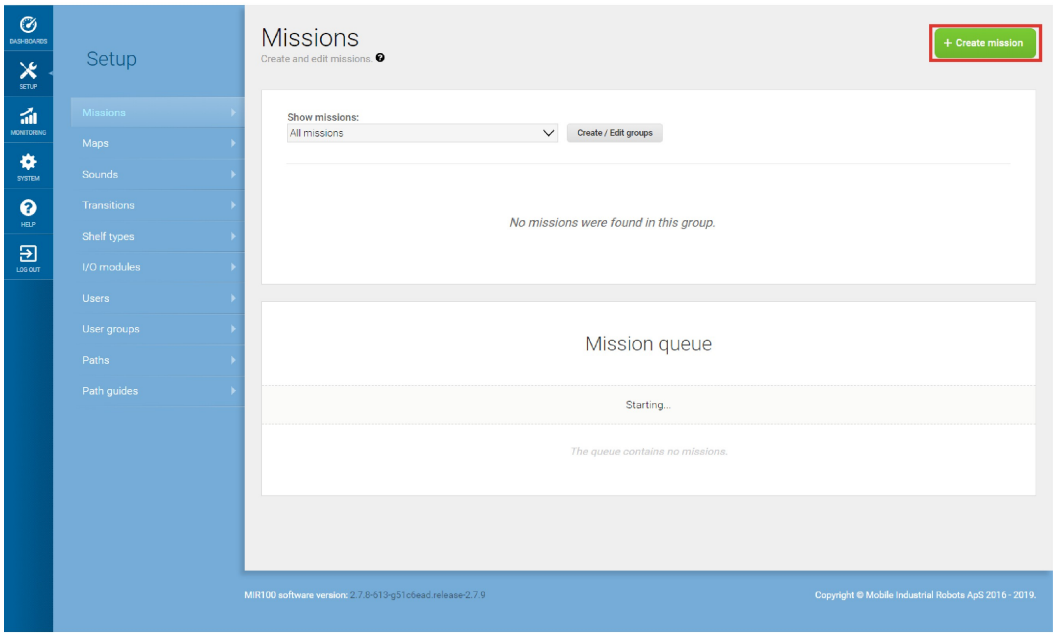
7.5 Creating a pick up shelf and place shelf mission

This section describes how to create a pick up and place shelf mission.

To create the mission, it is assumed you have completed the following:

- Enabled the shelf feature, as described in Enable MiR Shelf Lift feature on page 29
- Created a shelf position, as described in Setting shelf positions on the map on page 50
- Placed a physical shelf at the shelf position.

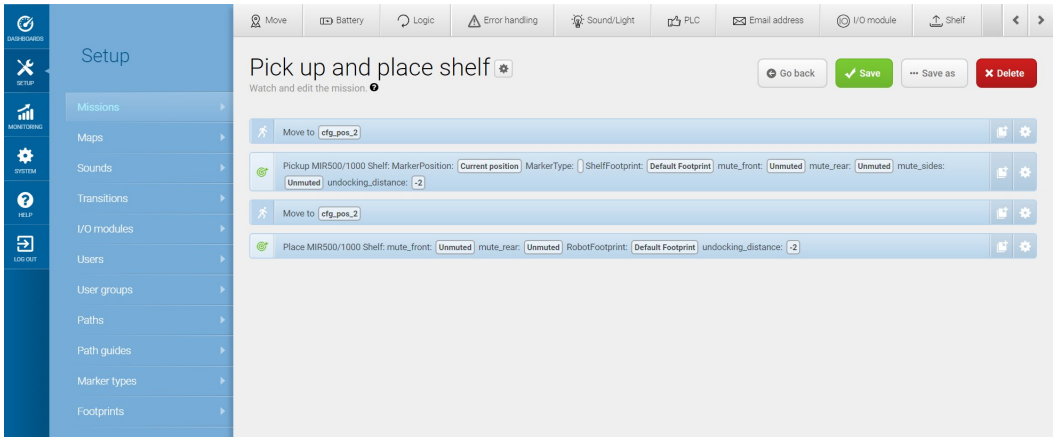
1. Go to **Setup** > **Missions**. Select **Create mission**.



2. Give the mission a name, for example *Pick up and place shelf*. Select the group and site you want it to belong to. Select **Create mission**.

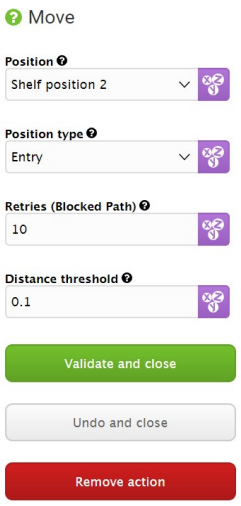
3. Select the following actions:
    a. In the **Move** menu, select **Move.**
    b. In the **Shelf** menu, select the **Pick up MiR500/1000 Shelf** template mission.
    c. In the **Move** menu, select **Move.**
    d. In the **Shelf** menu, select the **Place MiR500/1000 Shelf** template mission.

The mission dialog should look like this:

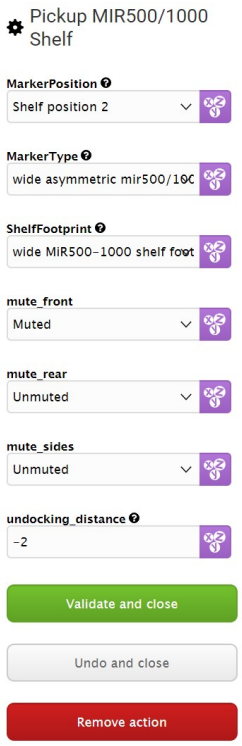


The following steps describe which parameters each action should be set to. To modify the parameters, select the gearwheel ⚙ of the action in question to open the dialog of that action.

4. Under **Move to**, select the shelf position you want to dock to.
5. Under **Position type**, select **Entry**. Select **Validate and close**.

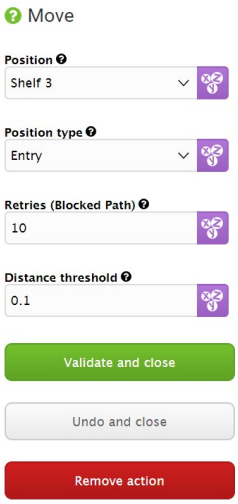


6. Under **Pick up MiR500/1000 Shelf**, set the **Marker position** to the position you want to dock to.
7. Under **Marker type**, choose the marker type that fits the dimensions of your shelf.
8. Under **Shelf footprint**, select the footprint that matches the footprint of your shelf. If you are using a shelf with dimensions not supported by MiR (see Shelf specifications on page 14), you can create your own footprint (see Creating footprint on page 58).
9. Under **Mute front**, **Mute rear**, and **Mute sides**, select if you want the safety scanners to be muted on the front, rear, or sides while undocking. This can be necessary if the shelf is located near other obstacles (see Mark potentially hazardous floor areas on page 41).
10. Under **Undocking distance**, choose the undocking distance in meters. A negative value makes the robot undock in reverse, and a positive value will make the robot move forward when undocking. Select **Validate and close**.

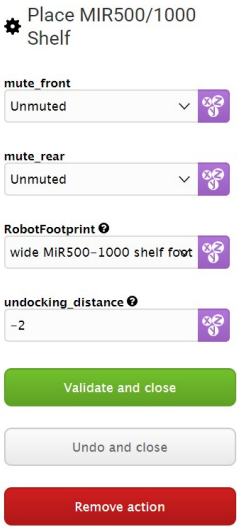


11. Under **Move to**, select the shelf position you want to dock to.

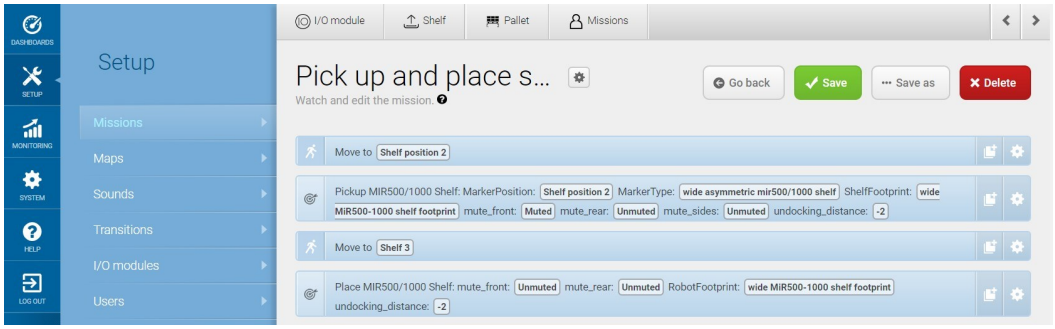
12. Under **Position type**, select **Entry**. Select **Validate and close**.



13. Under **Place MiR500/1000 Shelf**, select **Mute front** or **Mute rear** if you want the safety scanners to be muted on the front or rear. This can be necessary if the shelf is located near other obstacles (see Mark potentially hazardous floor areas on page 41). The safety scanners are muted to the sides by default in the place shelf template so the robot doesn't go into protective stop when driving away from the shelf.
14. Under **Footprint**, select the footprint that matches your shelf.
15. Under **Undocking distance**, select the undocking distance in meters. A negative value makes the robot undock in reverse, and a positive value makes the robot move forward when undocking. Select **Validate and close**.



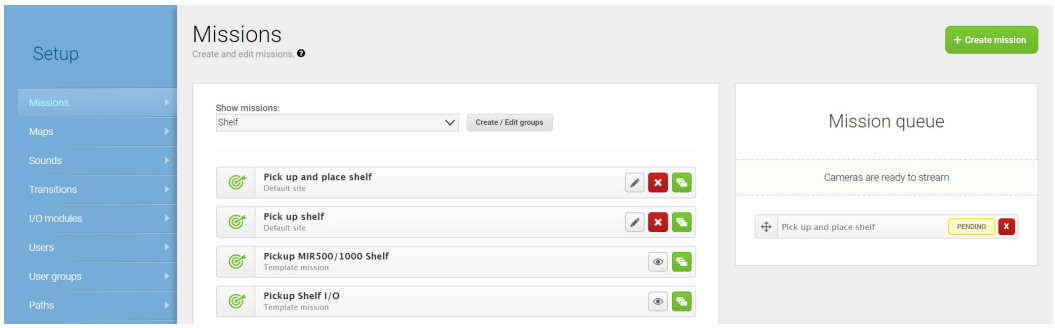
16. Select **Save** to save the mission. The mission should look like this:



Testing the mission

To test that the robot executes the mission correctly, you can try running the mission.

1. Go to **Setup > Missions**.
2. Select **Queue mission** next to the mission you just created. The mission is now added to the **Mission queue**.
3. Select **Continue** to start the mission.
4. Watch the robot execute the mission, and verify that it performs as expected.



WARNING

When MiR500/MiR1000 with a MiR Shelf Lift docks to a shelf position, the robot mutes Personnel detection means and blinks yellow. Do not step in front of the robot and keep a safe distance to the shelf. See Safety on page 7 for more information.

7.6 Reverse docking shelf mission/creating marker type

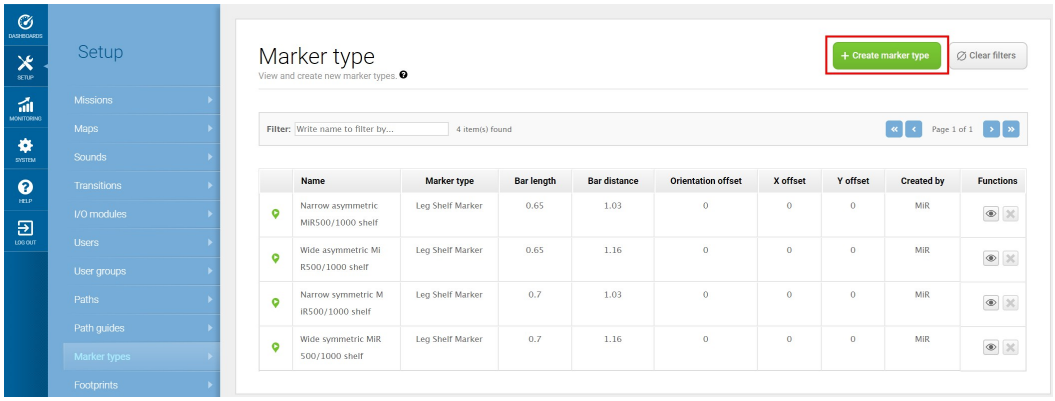
This section describes how to use marker types to create a mission where the robot docks to a shelf in reverse. See Creating a marker type on page 47for more information on marker types.

To create the mission, it is assumed you have completed the following:

- Enabled the shelf feature, as described in Enable MiR Shelf Lift feature on page 29
- Created a shelf position, as described in Setting shelf positions on the map on page 50
- Placed a physical shelf at the shelf position.

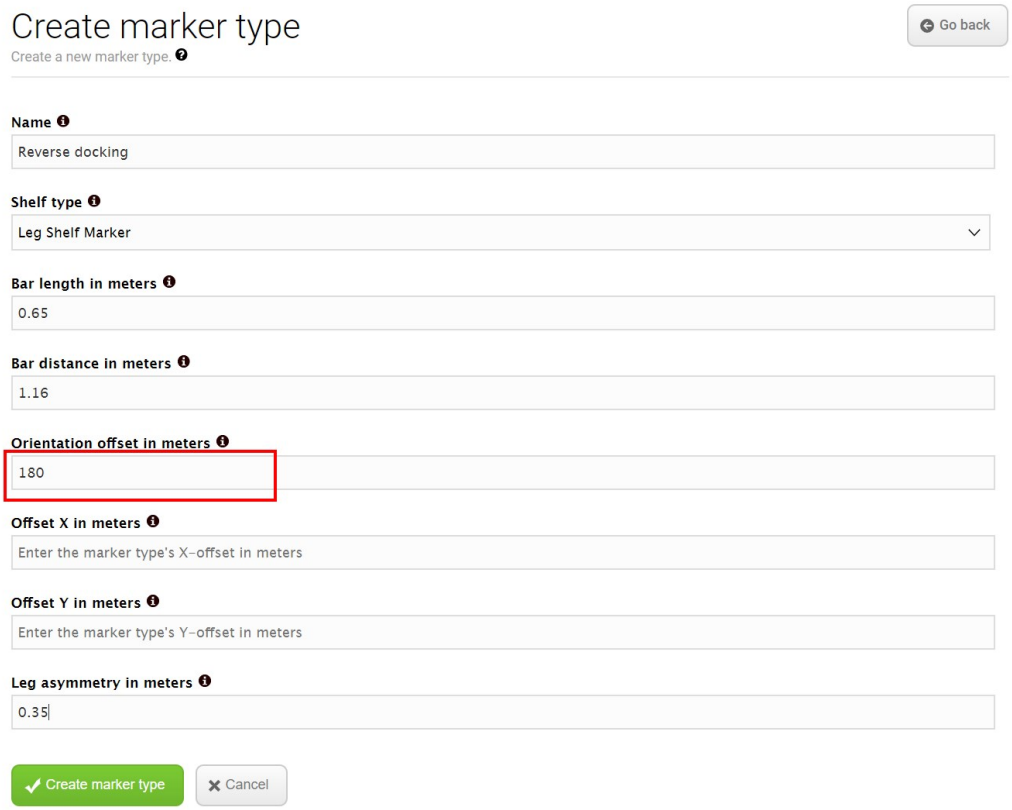
To dock to a shelf in reverse, you first need to create a specific marker type.

1. Go to **Setup** > **Marker types**. Select **Create marker type**.



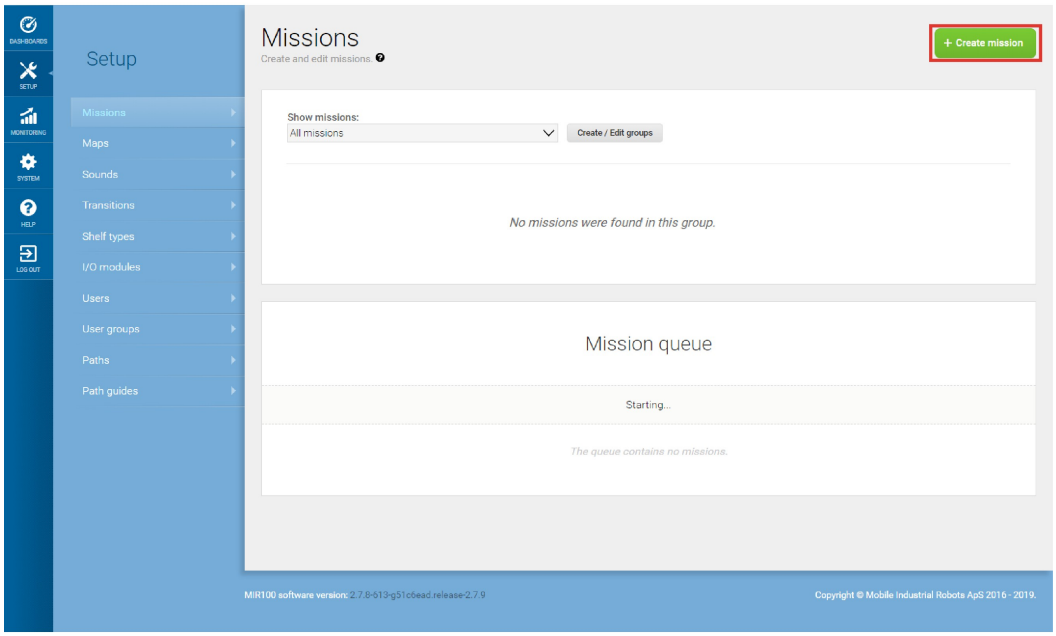
2. Give the marker type a name, for example *Reverse docking*.
3. Select **Leg shelf marker** under **Marker type** and put in the correct information for your shelf. See Creating a marker type on page 47

4. Under **Marker type orientation offset**, select 180. This tells the robot to turn 180 degrees when docking to this marker type. Select **Create marker type** to save the marker type.



After you have created the reverse docking marker type, you need to apply it in a mission.

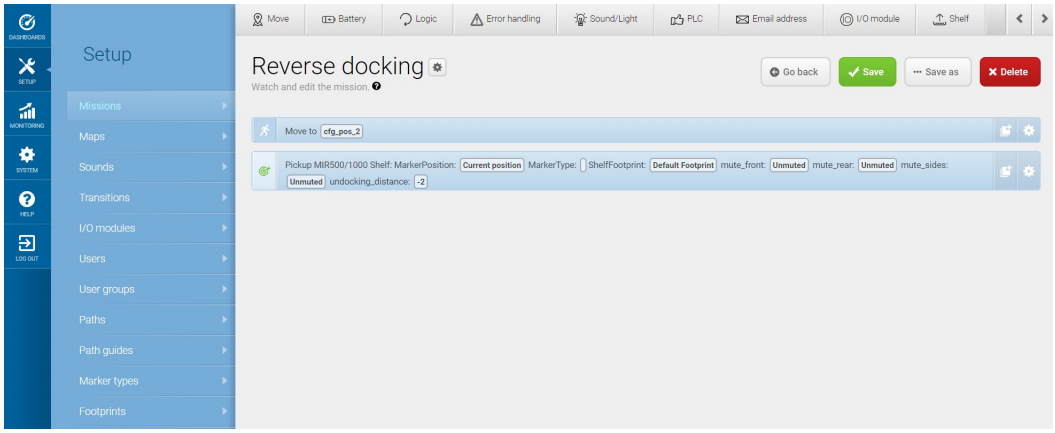
5. Go to **Setup > Missions > Create Mission**



6. Give the mission a name, for example *Reverse docking*. Select the group and site you want it to belong to. Select **Create mission**.

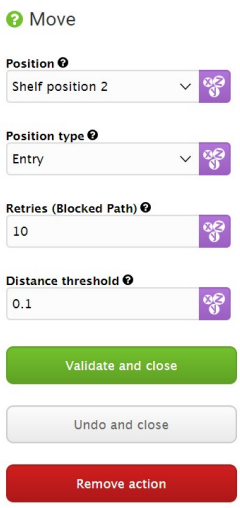
7. Select the following actions:
    a. Under **Move**, select **Move**.
    b. In the **Shelf** menu, select the **Pick up MiR500/1000 Shelf** template mission.

The mission dialog should look like this:



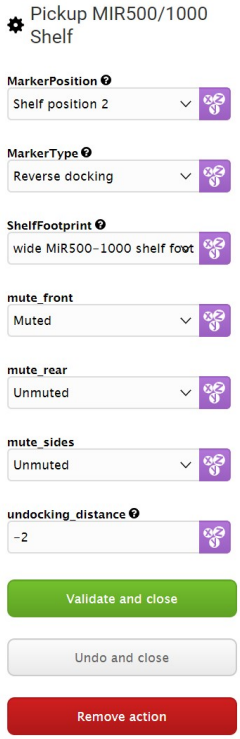
The following steps describe which parameters each action should be set to. To modify the parameters, select the gearwheel ⚙ of the action in question to open the dialog of that action.

8. Under **Move to**, select the shelf position you want to dock to.
9. Under **Position type**, select **Entry**. Select **Validate and close**.

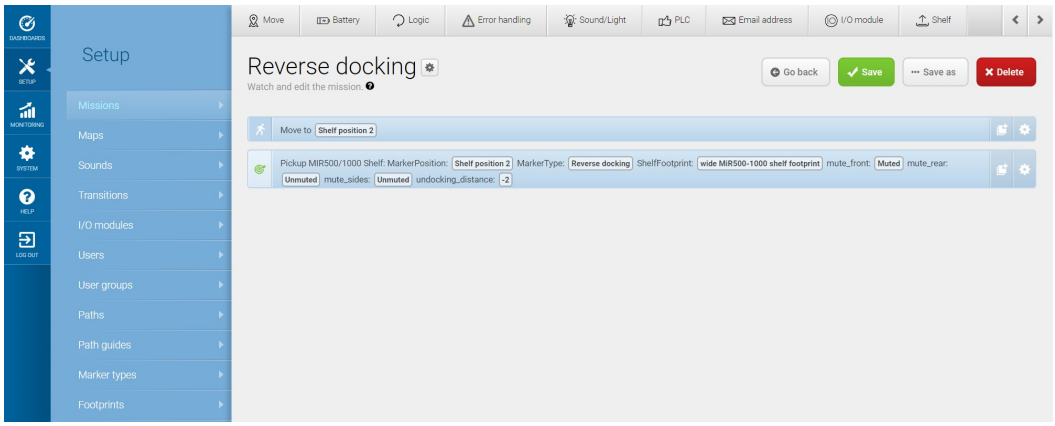


10. Under **Pick up MiR500/1000 Shelf**, set the **Marker position** to the position you want to dock to.
11. Under **Marker type**, choose the marker type you have created for reverse docking.

12. Under **Mute front**, **Mute rear**, and **Mute sides**, select if you want the safety scanners to be muted on the front, rear, or sides while undocking. This can be necessary if the shelf is located near other obstacles (see Mark potentially hazardous floor areas on page 41).
13. Under **Undocking distance**, choose the undocking distance in meters. A negative value makes the robot undock in reverse, and a positive value will make the robot move forward when undocking. Select **Validate and close**.



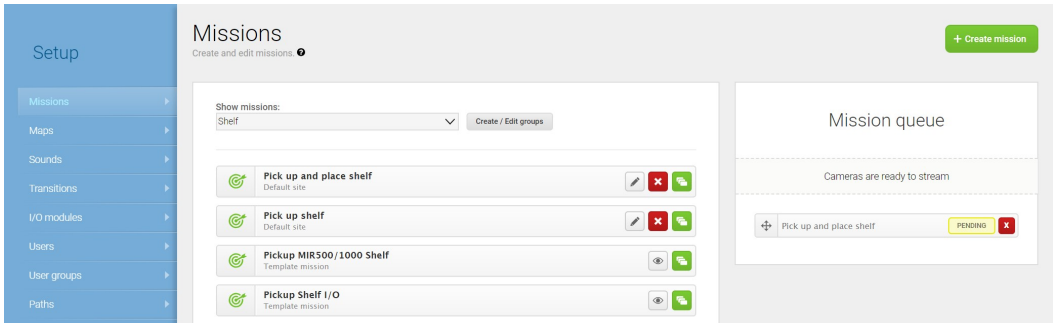
14. Select **Save** to save the mission. The mission should look like this:



Testing the mission

To test that the robot executes the mission correctly, you can try running the mission.

1. Go to **Setup > Missions**.
2. Select **Queue mission** next to the mission you just created. The mission is now added to the **Mission queue**.
3. Select **Continue** to start the mission.
4. Watch the robot execute the mission, and verify that it performs as expected.



WARNING

When MiR500/MiR1000 with a MiR Shelf Lift docks to a shelf position, the robot mutes Personnel detection means and blinks yellow. Do not step in front of the robot and keep a safe distance to the shelf. See Safety on page 7 for more information.

8. Maintenance

The following maintenance schedules give an overview of regular cleaning and parts replacement procedures.

The stated intervals are indicative and depend on the operating environment and frequency of usage of the robot.

NOTICE

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

8.1 Regular weekly checks and maintenance tasks

Once a week, carry out the following maintenance tasks:

Parts	Maintenance tasks
Top plate and sides	Clean the MiR Shelf Lift on the outside with a damp cloth. Do not use compressed air.

8.2 Regular checks and replacements

The following table contains the parts you should check and in which intervals:

Part	Maintenance	Interval
Actuators	If slack or unusual noises start to occur, replace the actuators with approved spare parts from MiR.	Actuators last for approximately 60.000 fully loaded lift cycles.

Part	Maintenance	Interval
Emergency stop	To check that the emergency stop buttons work, push a button and check that the red status light turns on, and that the robot continues to be in emergency stop until you press the reset button.	Every three to four months according to EN/ISO 13850 Safety of machinery - Emergency stop function.
Safety marking on the floor	Check if the safety markings around operating hazard zones are intact and visible.	Check every six months and replace as needed.
Safety stickers	Check if the safety stickers on MiR Shelf Lift robot are still intact and visible.	Check every six months and replace as needed.

9. Troubleshooting

This section describes how to handle some of the common issues experienced with MiR Shelf Lift. If the solutions described below do not remedy the issue, generate an error log as described in the how-to guide *How to generate an error log for Technical Support*, and send it to Technical Support with a description of the issue you are experiencing. The how-to guide is found on the Distributor site.

9.1 Shelf options are not available in the robot interface

If you are not able to create shelf positions or new shelf types, and the shelf actions are not available in the mission editor, go to **System > Settings > Features**. Under **Shelf**, select **True** in the drop down menu.

9.2 Robot docking imprecisely or not docking at all to shelf

If the robot is not able to drive under the shelf to dock to it, check the dimensions you specified in the marker type. If the dimensions are incorrect, the robot may not be able to dock. The dimensions must be specified in meters. See Creating a marker type on page 47.

9.3 Robot turning strangely when docking

If the robot turns strangely when docking to a shelf, there may be an issue with the legs. There are two common causes for the robot not being able to dock to a shelf correctly:

- The legs are reflective, or there are obstructions under the shelf. Make sure the area under the shelf is clear, and that the legs are not in a very high gloss material.
- The laser scanner covers may need to be cleaned. Refer to the maintenance chapter in the MiR500/MiR1000 User guide.

9.4 Robot placing shelf imprecisely

If the robot does not place shelves precisely enough for your application, you will need to use a docking marker, such as VL. This will increase the accuracy of the shelf placement. Markers should only be used to increase the accuracy of shelf placement and cannot be used to increase the accuracy of picking up shelves. See Placing positions closer using VL-markers on page 52.

9.5 Robot going into protective stop while driving with shelves

If the robot goes into protective stop while driving with shelves, it might be because the field sets of the safety laser scanners need adjustment. See Adjusting the protective field sets on page 37 for more information.

10. Glossary

C

Commissioner

A user group responible for: comissioning the robot, creating a risk assessment, and determining safe payloads and methods of fastening loads.

O

Operating hazard zone

A zone where the personnel detection means of the robot are reduced or muted to a level where personnel safety is at risk.