MiR600 and MiR1350 Space Requirements

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Original instructions (English)

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1. About this document

This document describes how much free space MiR600 and MiR1350 require to execute common maneuvers with various MiR supported top modules. It also includes how much space is required around for robots to be able to dock. The values provided in this guide should be used for best practice.

Depending on the environment, setup, and configuration of the robot, the robot may be able to drive with less space than stated in this document. MiR guarantees that the robot can operate reliably if these space requirements are met and the operating conditions are as described in "Environment and setup conditions" on page 9. If the robot operates in a smaller area than described, you must test whether your robot can perform as intended when commissioning the robot.

Test the robot multiple times, keeping in mind that an adaptive mobile robot does not have perfect repeatability. The smaller the area the robot operates in, the higher the risk for the robot to occasionally fail the intended operation. A smaller operating area may also increase planning time and the frequency of errors and Protective stops.

If any space requirements are updated, they will be updated in the robot's specifications page available on MiR Support Portal before being updated in this guide. For the most up-to-date values, refer to the robot's specifications.

1.1 Version history

This table shows current and previous versions of this document.

Revision	Release date	Description
1.9	2024-07-03	Guide updated with newest specifications for MiR600 and MiR1350 hardware 2.0 robots General improvements throughout the manual.
1.8	2024-03-22	Guide updated with newest specifications.

Revision	Release date	Description
		Restructured table format. Restructured illustration format. Changed name from MiR600 and MiR1350 Space Requirement Best Practices to MiR600 and MiR1350 Space Requirements General improvements throughout the manual.
1.7	2023-10-27	Dimensions of the shelf used for performance specifications added. Distance to adjacent walls when picking up a shelf added. Space needed for pivoting added. Taking a 90° turn in a corridor corrected. Passing another robot illustration added.
1.6	2023-09-11	Guide updated with newest specifications. General improvements throughout the manual.
1.5	2023-08-09	Added new specifications for MiR Shelf Lift for driving straight, driving through a doorway, taking a 90° turn in a corridor, and distance between shelves.
1.4	2022-11-15	Guide updated with newest specifications. Small corrections and improvements throughout the guide.

Revision	Release date	Description
1.3	2022-07-20	Guide updated with newest specifications.
1.2	2022-04-04	Updated with space requirements for Bar-markers.
1.1	2022-03-01	Updated space requirements for driving straight, pivoting, and turning 90° corners.
1.0	2022-01-04	First edition.

1.2 Where to find more information

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

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

1.2.1 Documentation

- **Integrator Manuals** provide all the information you need to set up and prepare MiR robots for the commissioning process. It comes in print in the box with the robots. Integrator Manuals are available in multiple languages. These guides are 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. These guides are for CE robots.
- **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. These guides are for CE robots.
- **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. The Commissioning guide is available in multiple languages.
- **Interface guides** contain descriptions of all the elements of the robot interface and MiR Fleet interface. Interface guides are available in multiple languages.
- **Space requirements** 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.

1.2.2 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.

1.2.3 Resources

- **MiR Insights** is a tool you can use to analyze how well your robots or fleet are performing. MiR Insights requires a paid license. MiR Insights runs continuously alongside MiR Fleet to give real-time data on several metrics, but can also be used in Logs mode. Logs mode can analyze error logs and provide heatmaps for Wi-Fi signal strength and localization.
- **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.

2. Environment and setup conditions

For the space requirements described in this document to apply to your robot, the following conditions must be met:

- The floor is level, dry, and clean.
- The robot is clean and well-maintained.
- There is no load on the robot unless specified.
- The robot is driving within the operating conditions described on the MiR website under the product specifications.
- There is enough traction between the robot and the floor to prevent the wheels from slipping.
- The walls and objects around the robot can be detected by the safety laser scanners. This means they must be opaque, matte, and taller than 210 mm from the ground.
- There is no light interference that can affect the robot sensors, such as direct sunlight.
- The robot is not connected to MiR Fleet, unless specified otherwise. When robots are part of MiR Fleet and Collision avoidance is enabled, the robots need more space for maneuvering when close to other robots.
- The robot's **Desired speed** is set to the default speed of 0.8 m/s. This is the speed the robot tries to drive at, not necessarily the speed the robot always drives at. During each maneuver, the speed may vary depending on the route the robot plans. For example, the robot automatically slows down at turns.

These space requirements were determined through tests with the robot under the conditions described above. If your robot is operating under other conditions, this may affect the robot's space requirements. It is very important to test each robot operation during commissioning to determine if there is sufficient space.

Although you can set a **Desired speed** to guide the robot, the robot may automatically adjust its speed depending on the route and map of the robot. The speed of the robot can affect the space requirements.

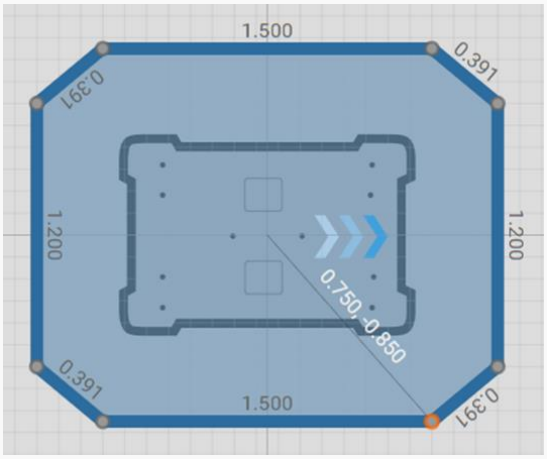
2.1 Robot settings

The required space dimensions are specified for the following robot setups:

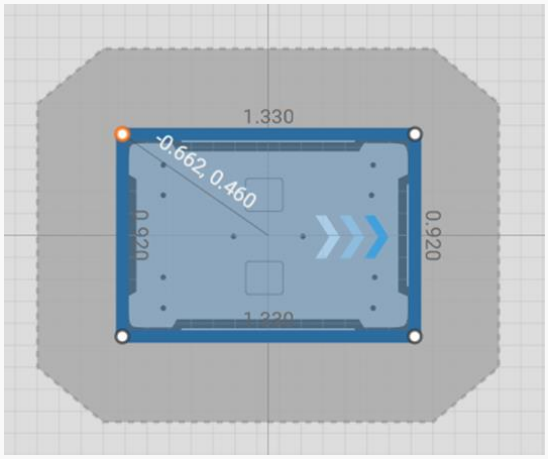
- **Default**
  The robot is running with the default footprint and settings for the robot. The robot's default footprint is slightly larger than the robot itself and the Protective fields are active. With these settings, the robot requires more space, but all of the safety and planning features work as intended.
- **Minimum**
  The robot's footprint is reduced to the smallest possible size—see 2— and the robot's Protective fields are muted. With these settings, the robot requires the least amount of space, but it compromises the safety of the robot.

  To be able to mute the Protective fields, you must first enable the feature under **Settings > Features**. You can then add Mute Protective fields actions to the robot's missions.

> **NOTICE**
> MiR does not recommend using the Minimum setup. When the footprint is reduced, the robot can plan routes that bring it too close to the edges of objects and make the robot initiate a Protective stop. Also, when the robot operates with muted Protective fields, you must mark the area as an operating hazard zone and inform personnel that the robot is operating with Compromised safety.



Default footprint



Minimum footprint

2.2 Performance evaluation

There are often two values provided for the space requirements:

- A *good* performance value. These are the values we recommend following where the robot should be able to execute a maneuver smoothly, without stopping, and without requiring intervention from a user.
- A *compromised* performance value. The robot will in most cases execute the maneuver correctly but may experience issues such as:
  - Driving slowly
  - Entering Protective stop
  - Reversing
  - Spending time on replanning its path
  - Failing the mission completely and requiring intervention from a user
  - May fail a small percentage of times (less than 5%)

  If you choose to use a compromised value, we recommend implementing a **Try/Catch** action in any relevant missions, so you can define the robot's behavior, in case it fails the maneuver.

2.3 Not available values and not recommended values

For some maneuvers, you may find the entry *N/A* or *not recommended* instead of space requirement measurements. These are used to indicate the following:

- *N/A* stands for *Not available* in this guide. These are maneuvers where we have not yet determined the space requirements. They will be updated as soon as the maneuver has been tested thoroughly in the described scenario.
- *Not recommended* is often used to indicate scenarios where:
  - There were only cases where the robot could perform the maneuver with Compromised performance, and there was a small change the robot could not perform the maneuver at all.
  - Modifications in the map or modifications to the robot's safety system did not reduce the space requirements. We do not recommend applying the modification if it does not reduce the required space for the robot to operate.

3. Robot maneuvers

The following sections describe the required space for robots to perform common navigation maneuvers.

The maneuvers in the following sections illustrate the robot traveling down a corridor, but the dimensions are also applicable for other obstacles and structures the robot may maneuver between.

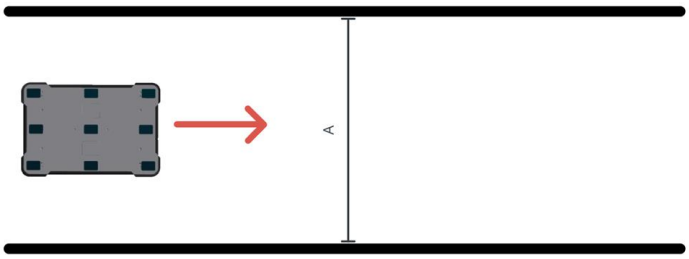
3.0.1 Driving straight

Table 3.1 Hardware 2.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width (A)	1.8 m	1.20 m

Table 3.2 Hardware 1.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width (A)	2.15 m	1.20 m



MiR600 and MiR1350 can either drive down a corridor with good performance or not at all. There are no corridor widths where it drives with Compromised performance.

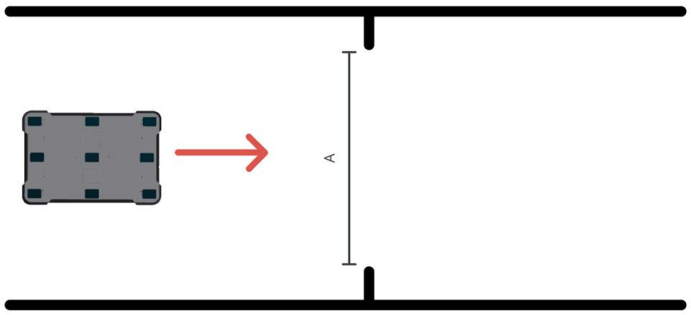
3.0.2 Driving through a doorway

Table 3.3 Hardware 2.0 robots

Description	Default footprint	Minimum footprint
Doorway width (A)	1.65 m	1.20 m

Table 3.4 Hardware 1.0 robots

Description	Default footprint	Minimum footprint
Doorway width (A)	1.65 m	1.20 m



3.0.3 Taking a turn around an obstacle or wall

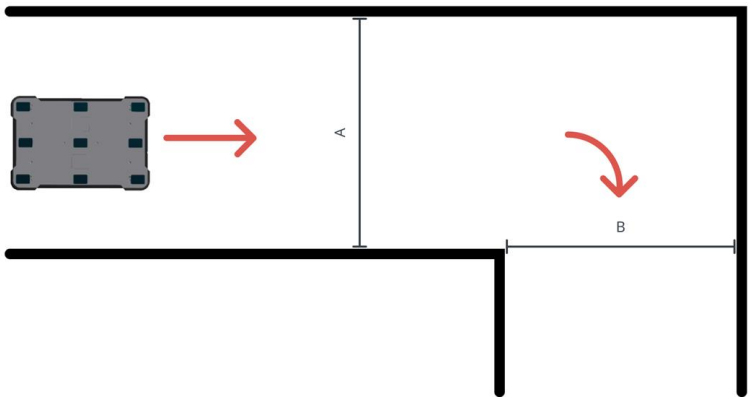
Table 3.5 Hardware 2.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width before and after turn (A)	1.85 m	1.55 m
Compromised	Corridor width before and after turn (B)	1.80 m	1.35 m

Table 3.6 Hardware 1.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width	2.20 m	1.55 m

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
	before and after turn (A)		
Compromised	Corridor width before and after turn (B)	2.15 m	1.35 m



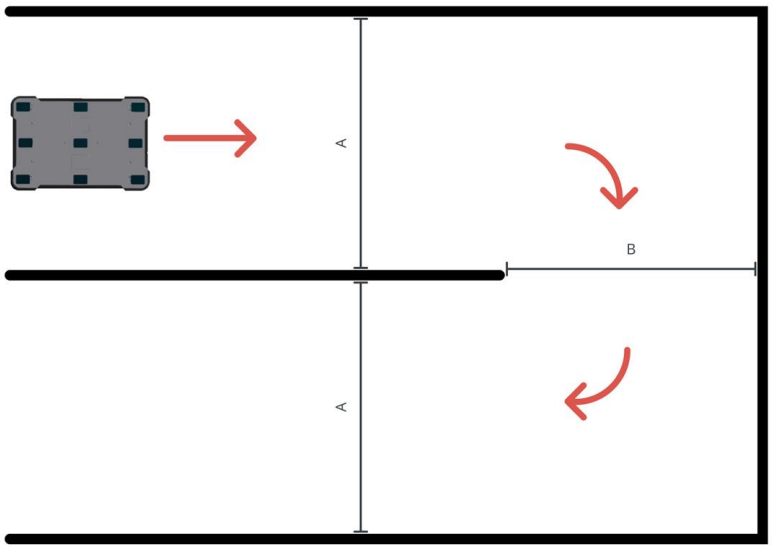
3.0.4 Taking a U-turn around an obstacle or wall

Table 3.7 Hardware 2.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width (A and B)	1.85 m	1.55 m
Compromised	Corridor width (A and B)	N/A	1.40 m

Table 3.8 Hardware 1.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width (A and B)	2.30 m	1.55 m
Compromised	Corridor width (A and B)	2.20 m	1.40 m



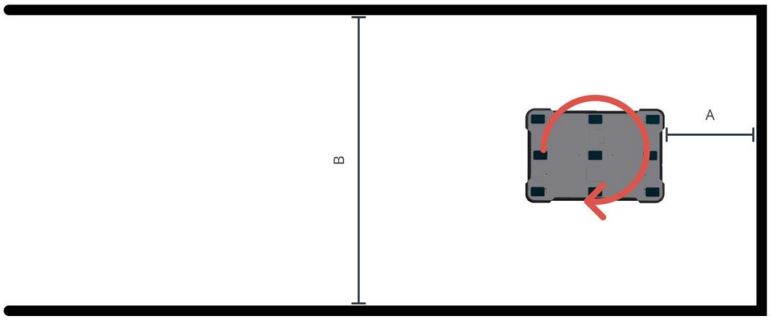
3.0.5 Pivoting

Table 3.9 Hardware 2.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Distance between robot and end wall (A)	N/A	N/A
Good	Corridor width (B)	2.30 m	1.85 m
Compromised	Corridor width (B)	N/A	N/A

Table 3.10 Hardware 1.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Distance between robot and end wall (A)	0.85 m	0.75 m
Good	Corridor width (B)	2.75 m (MiR600) 2.85 m (MiR1350	1.85 m
Compromised	Corridor width (B)	2.80 m	Not recommended

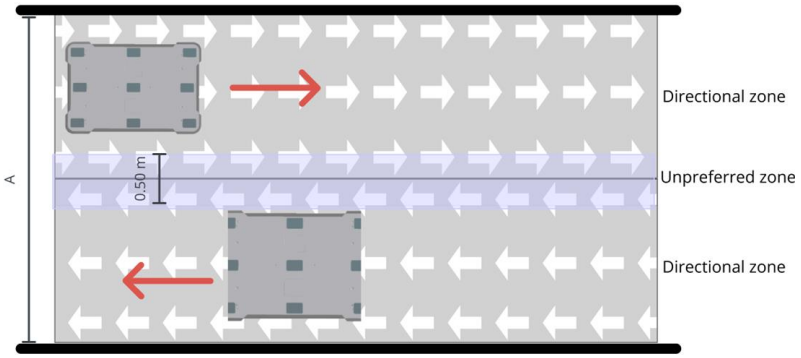


3.0.6 Passing another robot

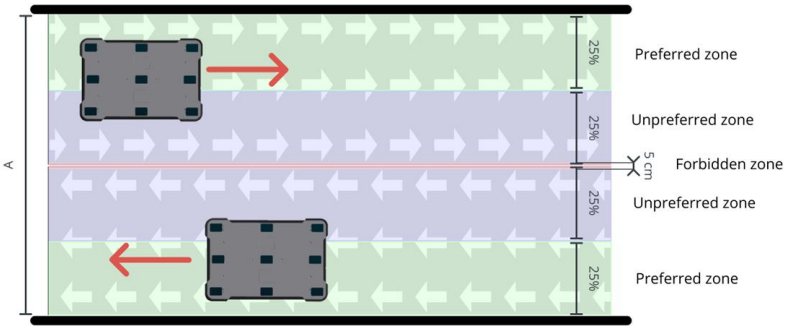
If you have any aisles that are wide enough to let two robots pass each other, we recommend managing these aisles with two Directional zones. This prevents robots from blocking each other in the aisle.

We recommend two possible setups:

- A simple setup where you have two Directional zones, one in each direction, and an Unpreferred zone between them in the middle.



- An extended setup where you add Preferred and Forbidden zones to the simple setup. These help robots to drive closer to the walls, thus reducing the amount of space required.



NOTICE
The values in this section are only applicable for robots that are connected to MiR Fleet with Collision avoidance enabled. If your robots are not connected to MiR Fleet, they may need more space than the provided values if the nearest obstacle is another fleet robot.

Table 3.11 Hardware 2.0 robots

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width (A)	3.5 m	2.70 m
Compromised	Corridor width (A)	3.45 m	N/A

Table 3.12 Hardware 1.0 .

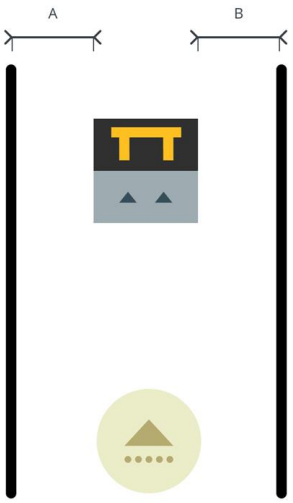
Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width (A)	4.25 m	2.70 m
Compromised	Corridor width (A)	4.10 m	2.65 m

3.0.7 Minimum space to adjacent wall for a MiR Charge 48V

Where the walls are long enough to cover the entry position.

Table 3.13 All robot versions

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	To the left of marker (A)	400 mm	150 mm
Good	To the right of marker (B)	900 mm	600 mm

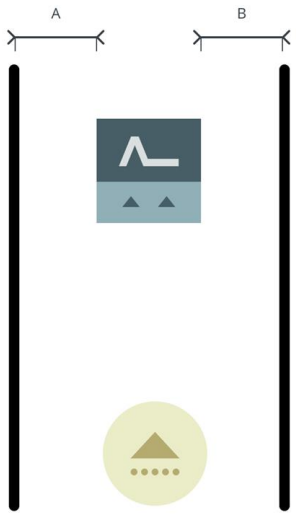


3.0.8 Minimum space to adjacent wall for a VL-marker

Where the walls are long enough to cover the entry position.

Table 3.14 All robot versions

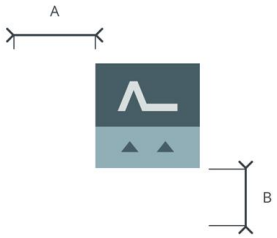
Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	To the left of marker (A)	750 mm	450 mm
Good	To the right of marker (B)	750 mm	450 mm



3.0.9 Minimum space around VL-markers

Table 3.15 All robot versions

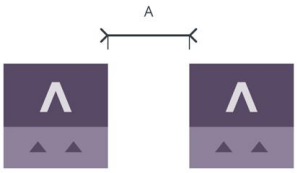
Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	To the sides of the marker (A)	500 mm	300 mm
Good	In front of the marker (B)	3 250 mm	3 100 mm



3.0.10 Minimum distance between V-markers

Table 3.16 All robot versions

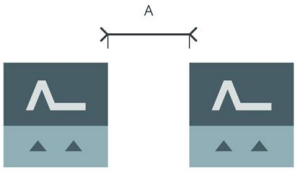
Robot performance	Description	With default robot setup
Good	With fast docking (A)	280 mm
Good	With slow docking (A)	220 mm



3.0.11 Minimum distance between VL-markers

Table 3.17 All robot versions

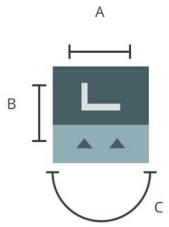
Robot performance	Description	With default robot setup
Good	With fast docking (A)	30 mm
Good	With slow docking (A)	20 mm



3.0.12 Positioning accuracy docking to L-marker (in controlled conditions)

Table 3.18 All robot versions

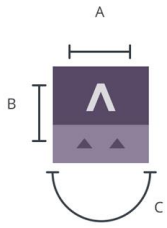
Robot performance	Description	With default robot setup
Good	X-axis (A)	± 3 mm
Good	Y-axis (B)	± 3 mm
Good	Yaw (C)	± 0.25°



3.0.13 Positioning accuracy docking to V-marker (in controlled conditions)

Table 3.19 All robot versions

Robot performance	Description	With default robot setup
Good	X-axis (A)	± 20 mm
Good	Y-axis (B)	± 20 mm
Good	Yaw (C)	± 2°

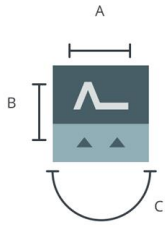


3.0.14 Positioning accuracy docking to VL-marker (in controlled conditions)

Table 3.20 All robot versions

Robot performance	Description	With default robot setup
Good	X-axis (A)	± 2 mm

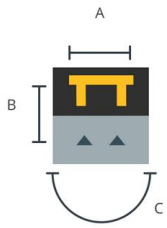
Robot performance	Description	With default robot setup
Good	Y-axis (B)	± 3 mm
Good	Yaw (C)	± 0.25°



3.0.15 Positioning accuracy docking to Bar-marker (in controlled conditions)

Table 3.21 All robot versions

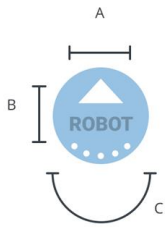
Robot performance	Description	With default robot setup
Good	X-axis (A)	± 10 mm
Good	Y-axis (B)	± 5 mm
Good	Yaw (C)	± 0.75°



3.0.16 Positioning accuracy moving to Robot position (in controlled conditions)

Table 3.22 All robot versions

Robot performance	Description	With default robot setup
Good	X-axis (A)	± 100 mm
Good	Y-axis (B)	± 83 mm
Good	Yaw (C)	± 3.4°

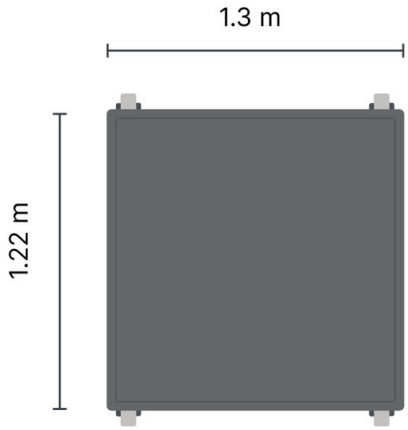


4. Shelf lift maneuvers

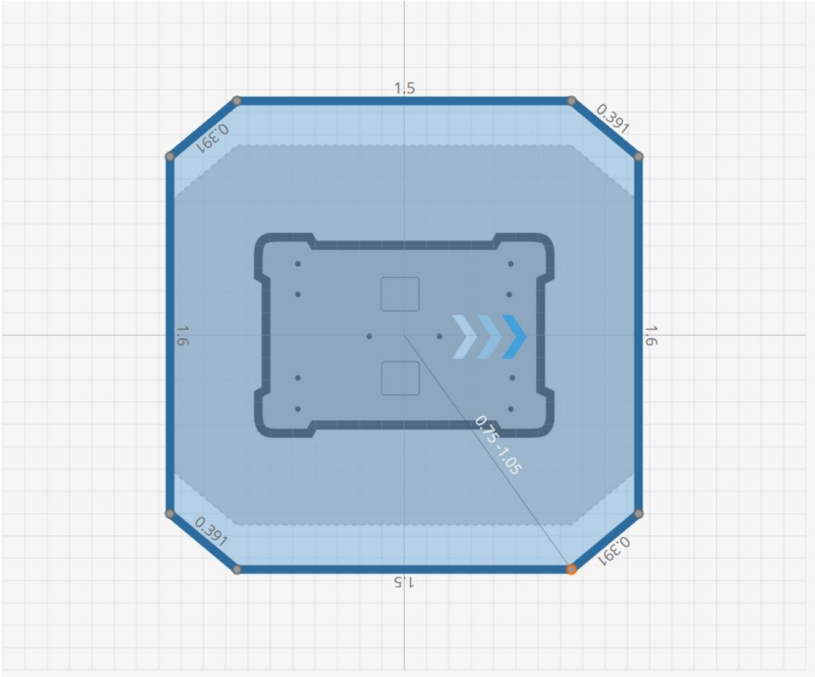
The following sections describe the required space for robots with MiR Shelf Lift to perform common navigation maneuvers. The maneuvers in the following sections illustrate the robot traveling down a corridor, but the dimensions are also applicable for other obstacles and structures the robot may maneuver between.

The values in the following sections were determined using:

- A shelf with the dimensions 1.22 m wide, 1.3 m long, and 0.54 m high, and no additional payload.



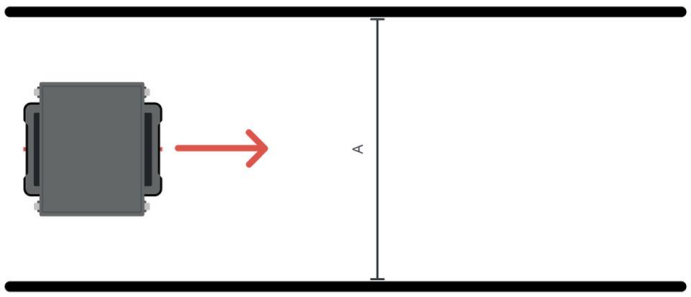
- The standard wide shelf footprint for MiR600 and MiR1350.



4.1 Driving straight

Table 4.1 All robot versions

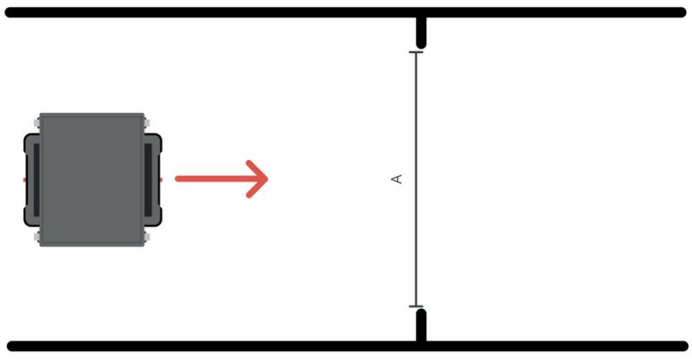
Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width (A)	2.40 m	N/A
Compromised	Corridor width (A)	1.80 m	1.60 m



4.2 Driving through a doorway

Table 4.2 All robot versions

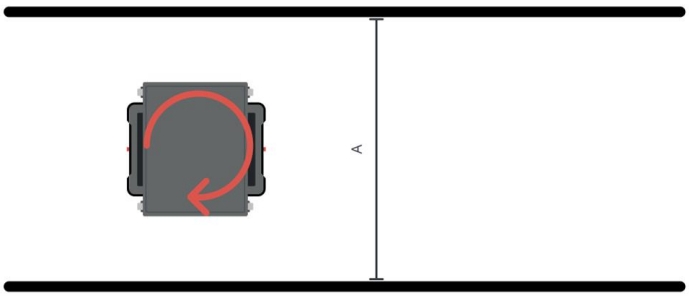
Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Doorway width (A)	2.35 m	1.65 m
Compromised	Doorway width (A)	1.65 m	1.60 m



4.3 Pivoting

Table 4.3 All robot versions

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width (A)	2.8 m	N/A
Compromised	Corridor width (A)	2.05	N/A

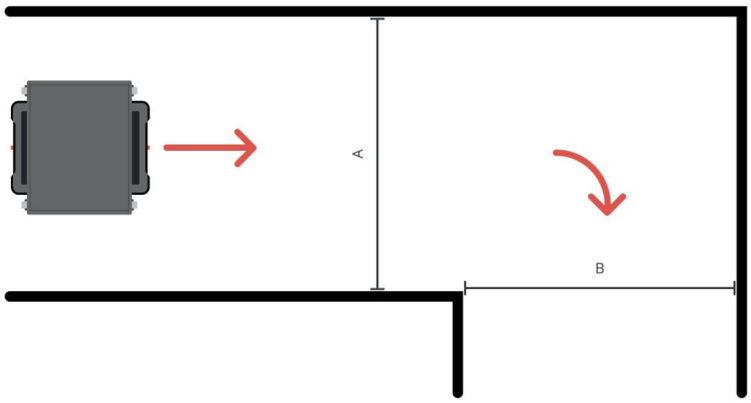


4.4 Taking a 90° turn in a corridor

Table 4.4 All robot versions

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Corridor width before and after	2.45 m	N/A

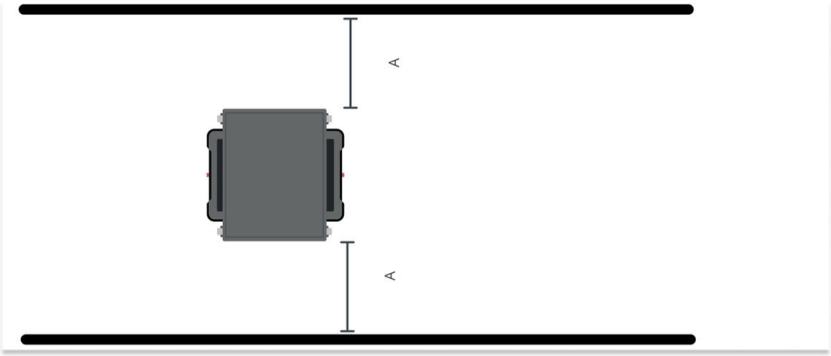
Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
	turn (A)		
Compromised	Corridor width before and after turn (B)	1.95 m	1.70 m



4.5 Distance to adjacent walls when picking up a shelf

Table 4.5 All robot versions

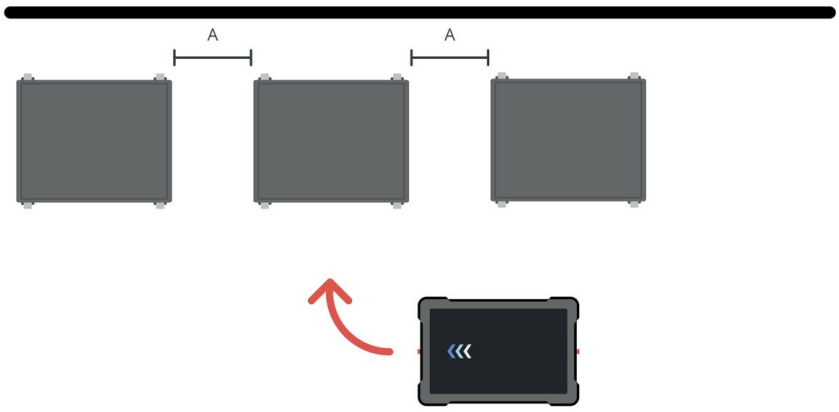
Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Distance between shelves and an adjacent wall (A)	0.75 m	0.65 m



4.6 Distance between shelves

Table 4.6 All robot versions

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Distance between shelves placed in a row (A)	0.65 m	0.35 m
Compromised	Distance between shelves placed in a row (A)	0.60 m	0.25 m



5. Pallet racks and Bar-markers

The following sections describe the required space for robots with a pallet lift top module to dock to pallet racks and Bar-markers.

5.1 Space between pallet racks and Bar-markers

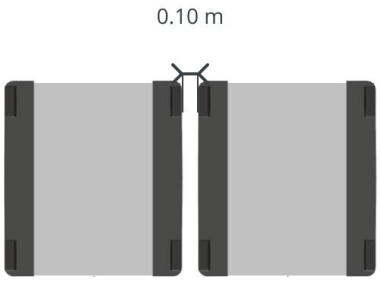
If you have multiple pallet racks or Bar-markers next to each other, it is important to place them with enough space between them to ensure a correct docking procedure.

Between every pallet rack or Bar-marker there must be at least 0.10 m of free space. This is also applicable for robots connected to MiR Fleet where Collision avoidance is enabled.

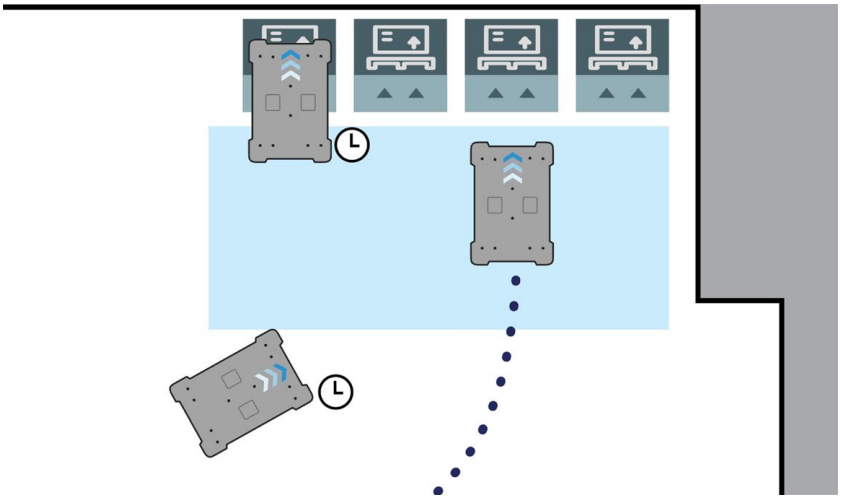
CAUTION

Risk of entrapment or injury to personnel if pallet racks or other physical markers are placed without enough space for personnel to safely move away from the area.

- Pallet racks and physical markers must be placed to ensure sufficient escape routes—see the user guide for your robot's pallet lift application.



When you place pallet racks or Bar-markers close together, robots cannot dock and undock simultaneously to adjacent pallet racks or Bar-markers without entering Protective stop. If you are using MiR Fleet, consider placing a Limit-robots zone in front of the pallet racks or Bar-markers to prevent this.



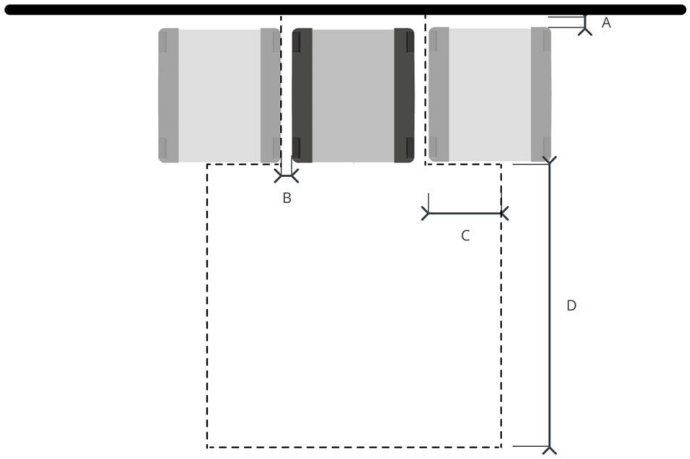
5.2 Docking to pallet racks

To ensure that the robot can dock to a pallet rack smoothly and without stopping, there must not be any obstacles around the pallet rack within the area described in the table below. You must use the default entry position for these values to apply.

Table 5.1 All robot versions

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	Behind the pallet rack/Bar-marker (A)	N/A	N/A
Good	Between pallet racks (B)	0.10 m	0.10 m
Good	To the sides of the pallet rack (C)	0.70 m	0.30 m

Robot performance	Description	With default robot setup	With minimum footprint and muted Protective fields
Good	In front of the pallet rack (D)	2.70 m	2.40 m



The required distance in front of the pallet rack reflects the minimum corridor width required for the robot to pivot—see "Robot maneuvers" on page 12. This means that if your robot operates with a different footprint, the change in the required pivoting space must also be applied here.

If the robot is not docking smoothly, it can help to explicitly include an action to drive the robot to the pallet rack's Entry position before docking.

6. Charging stations

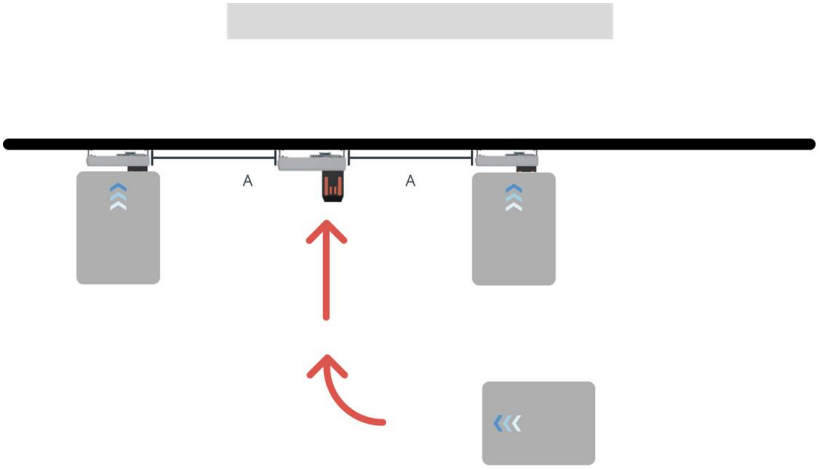
The following section describes the space required around MiR Charge 48V stations for the robot to be able to dock to them successfully.

> **NOTICE**
> The values in this section are only applicable for robots that are not connected to MiR Fleet. If your robots are connected to MiR Fleet, they may need more space than the provided values if the nearest obstacle is another fleet robot.

6.0.1 Space between charging stations

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

In the default setup there must be at least 1.10 m of free space (A) between every charging station for robots to be able to dock while another robot is in the adjacent station. Valid on All robot versions



6.1 Docking to charging stations

This value is not yet available.