

MiRHook



Operating Guide

en

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1 About this manual



1.1 Overview

This Operating Guide contains all essential information about how to start up and operate a MiRHook 100 and a MiRHook 200. It also includes necessary information about safe handling of the hook and technical specifications. The Operating Guide is intended for Mobile Industrial Robots' distributors as well as end users responsible for the daily operation of MiRHook 100 and MiRHook 200.

1.2 Document history

This table shows latest and previous versions of this document and their interrelation with product software releases.

Doc version	Release date	Description	HW version
1.0	01.02.2016	Document created.	
1.1	04.02.2016	General small corrections. Reworked section 7 Usage.	
1.2	10.04.2016	Major update throughout document.	
1.3	02.05.2016	Added space requirements for pick-up and reverse parking.	
1.4	20.09.2016	Updated for SW release 1.7. Configuration of hook missions made simpler.	
1.5	11.10.2016	Updated illustration for 4.1. and 4.3.	
1.6	24.10.2016	Appendix added: Updating the MiRHook software. Chapter 1: Notice added about requirements for light in the operation environment.	
1.7	10.11.2016	Description of driving space requirements changed (chapter 4.3)	
1.8	06.01.2017	Updated for SW release 1.8. Cart specifications changed. New section Modifying the gripper for different thickness and/or length.	
1.9	22-02-2019	New version for MiR Robot Interface 2.0. Major update throughout document. Includes both MiRHook 100 and MiRHook 200.	MiRHook 100 1.3 and MiRHook 200 1.2



1.3 Further information

You can download all manuals from the MiR website where you will also find training videos, product pictures and technical specifications.

- Manuals and more: www.mobile-industrial-robots.com/products

Your MiR distributor is your first point of contact for all service queries. Find distributor contact on our website.

- Distributor contact info: www.mobile-industrial-robots.com/distributors.

2 Hardware

2.1 Hardware

MiRHook 100 and MiRHook 200 is equipped with a camera, a gripper and an emergency stop for the complete system, i.e. the MiR100 robot and the hook.

The gripper can be exchanged for different cart types.

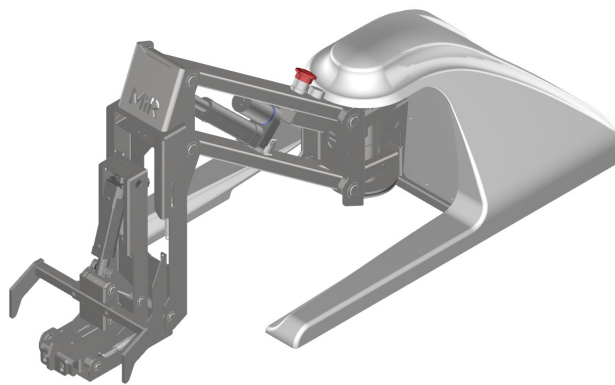


Figure 1. 3D drawing of MiRHook 100

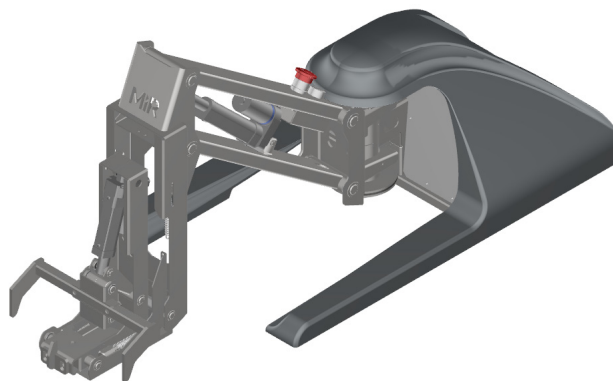
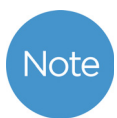


Figure 2. 3D drawing of MiRHook 200

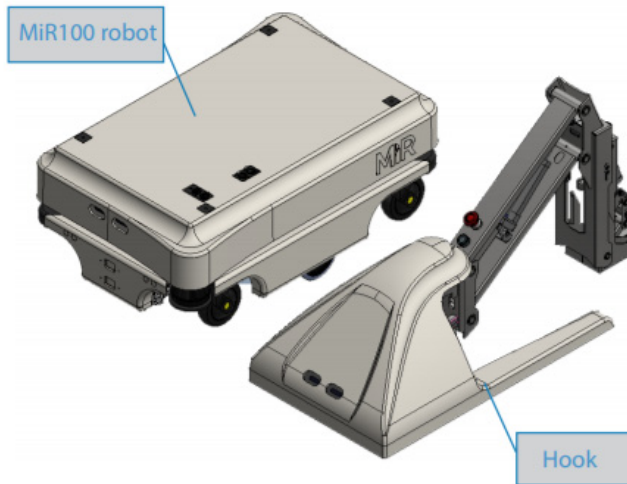


The robot can pick up carts only in normally illuminated environments since the 3D camera must be able to “see” the QR marker.

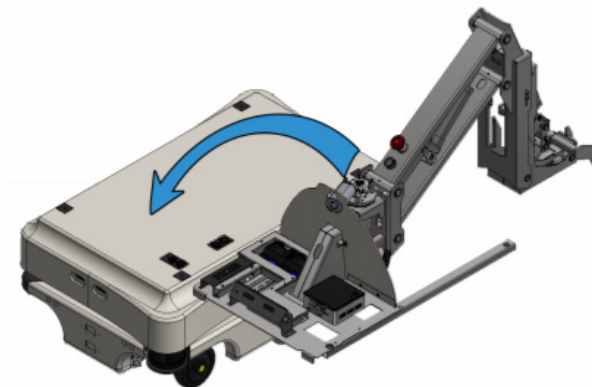
2.2 Mount the hook on a robot

The photos illustrate a MiR100 robot and a MiRHook 100, but MiRHook 200 is mounted on a MiR200 robot in the same way.

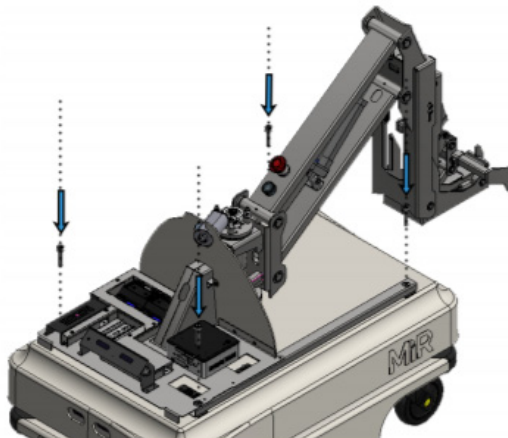
1.



2. Remove the hook cover and lift the hook onto the robot fitting the frame holes above the four mooring holes on the robot.

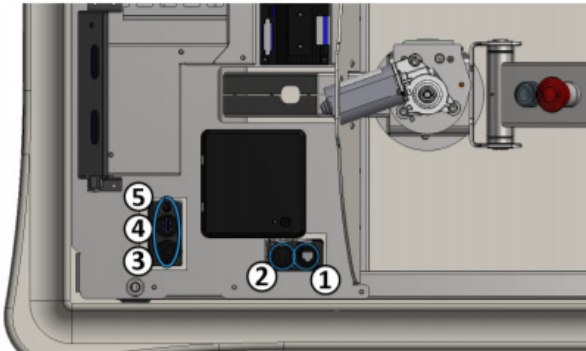


3. Mount the frame with the four bolts. Tighten the bolts to a torque of 47 (Nm) / [34.5 ft-lb].

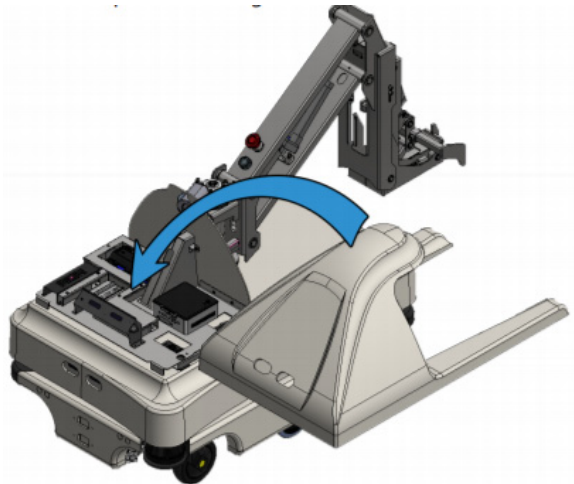


4. Connect cables and mount the antenna:

1. Network cable (from robot to hook PC)
2. Application hardware cable
3. Emergency stop cable
4. USB cable for top camera
5. Antenna connector



5. Place the cover on top of the hook frame. The cover is held in place with magnets.



6. The hook is now mounted on the robot.



3 Cart



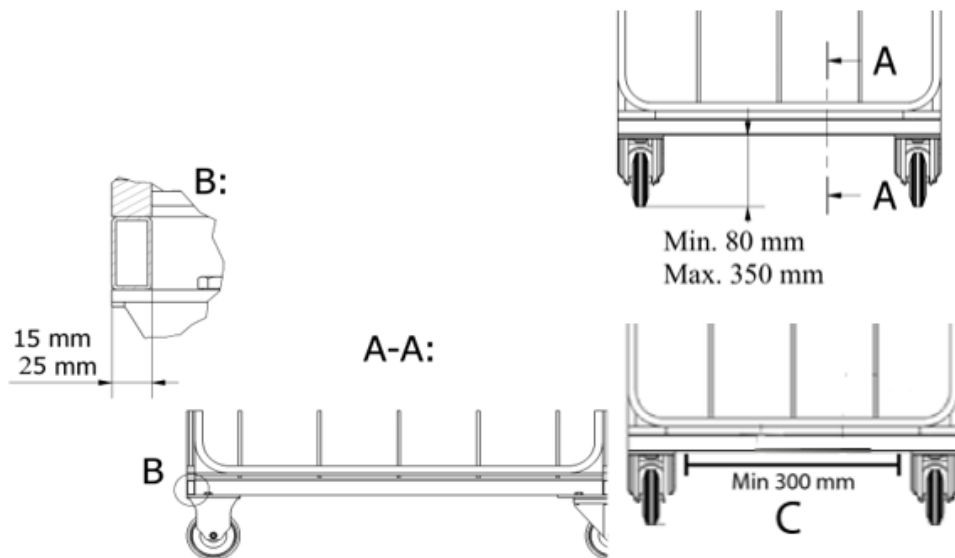
3.1 Cart specifications

MiRHook can accommodate carts with the following dimensions:

- Width: between 400 mm and 1500 mm.
- Height: maximum 2000 mm.
- Length: between 500 mm and 2400 mm.

In addition, the carts must have a gripper area / gripper bar at the front, bottom part of the cart (typically a square tube) with the following dimensions:

- Position: 80-300 mm above floor, A
- Thickness: 15 to 25 mm, B
- Length: Min. 350 mm, C



For the robot to be able to locate and identify carts a QR-marker must be fixed on the front of the cart, see “Creating QR markers” on page 11.

3.1.1 Wheel configuration of the cart

The carts must be fitted with two rigid and two caster swivel wheels. The two rigid wheels can either sit on the front or the back of the cart.

Whether the robot will work better with rigid wheels on the front or the back depends on the maneuvering conditions on the individual site and should be assessed before the gripper bar is fixed. In general, the following rules of thumb apply:

Two rigid wheels on the back and two swivels on the front:

With this configuration, turning radius of the robot and the cart is larger but the driving is more stable. Reverse parking is easier.

Two swivels on the back and two rigid wheels on the front:

In areas with tight corner passages, the robot may turn the corners more easily with the rigid wheels on the front. If the rigid wheels are in the back, the cart makes a larger turning curve requiring more space.

4 Modifying the gripper



4.1 Modifying the gripper for different thickness and/or length

If the length or thickness of the cart is slightly out of the specification, then it is possible to modify the gripper. The gripper length can be altered by unscrewing the upper gripper and changing the length between the arms – This requires some machine work. The thickness can be changed by adding spacers to the mounting of the lower-gripper (see image below).

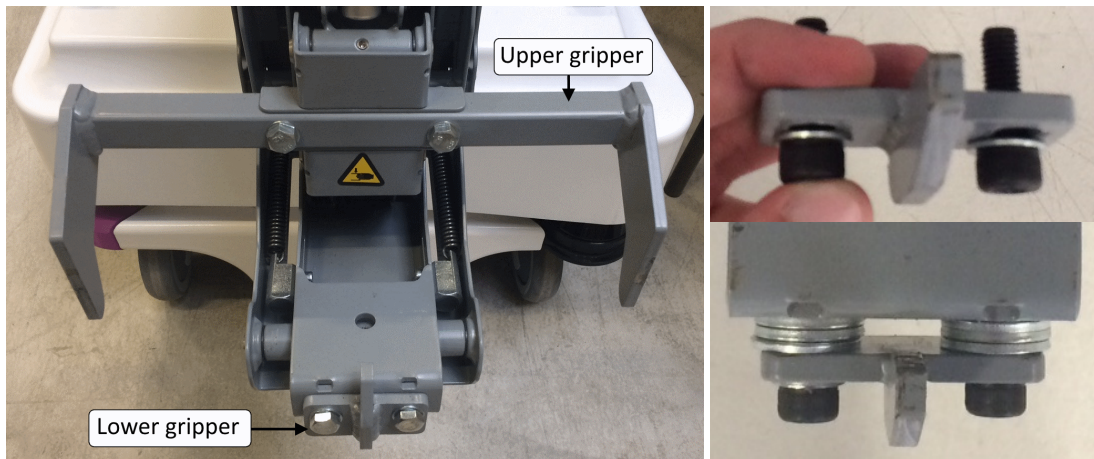


Figure 1. The gripper may be mechanically modified to accommodate carts that are slightly out of proportions



5 Space requirements



5.1 Space required to pick up a cart

As system operator, you are responsible of ensuring that MiR100/MiR200 has enough space to pick up a cart. When preparing to pick up a cart, the robot moves to a position in front of the given cart position (1.7 m from the position). The robot camera orients itself towards the QR marker before backing towards the cart. If misaligned more than 5 degrees, the robot will turn 90 degrees to the side to place itself on a line directly behind the cart.



Make sure the space around the robot is clear as the alignment is done without collision check.

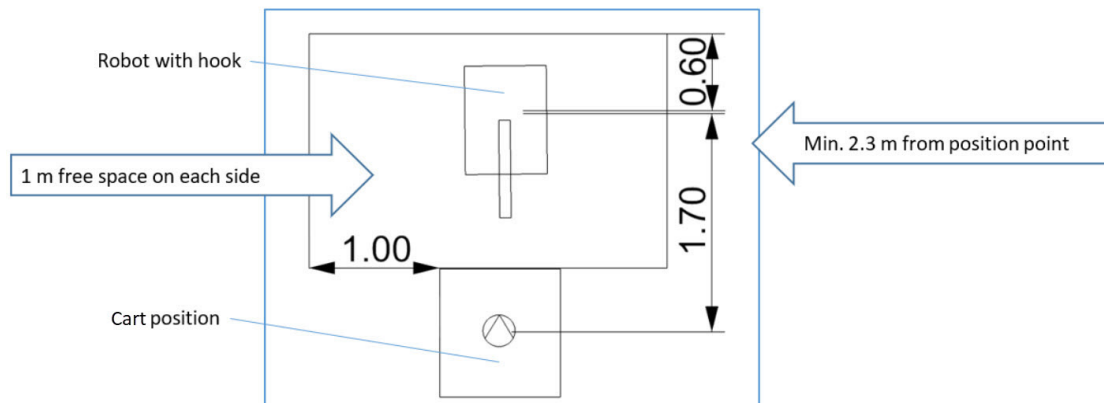


Figure 4 - Space required to pick up a cart

5.2 Basic principle of driving with a cart

Once a cart is attached to MiR100/MiR200, the robot does not reverse when going from position A to position B, see Safety on page 9. As a result, its dynamic obstacle avoidance capabilities are somewhat restricted compared to when a cart is not attached. The system operator needs to keep this in mind when choosing where to run MiRHook.

5.3 Space required to turn a corner

The space required to turn a corner depends on the combined length of robot and cart; a square measuring the total length of robot and cart plus 500 mm is the optimum space turning a corner (see Figure 5).

Tips:

1. Less than 500 mm may work in areas with no or few dynamic obstacles.
2. Driving pattern and sensibility to dynamic obstacles depend on whether the front or rear wheels of the cart are locked. If the corner space is limited, we recommend to test which works best in the individual case

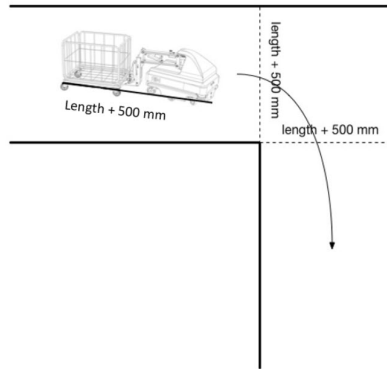


Figure 5 - Space required to turn a corner

5.4 Space required to park a cart

To park a cart, the robot needs at least 50 cm of space to either side of the cart. In addition, it cannot park the carts safely closer than 25 cm to any obstacles behind the cart. However, the robot can pick up a cart parked closer than 25 cm to any obstacles behind it (see Figure 6 - Parking space for carts).

Please note that it should be possible for the robot to park and pick up carts at an angle of less than 5° between the cart and the robot



Figure 6 - Parking space for carts

5.5 Space required to park cart in reverse

As system operator, you are responsible of ensuring that under normal operation MiR100/MiR200 has enough space to park the cart. The space required is a square in front of the position equal to the full length (MiR100/MiR200 + cart) plus 50 cm.

- The robot moves to a position sideways to the placement position (1.5 m either coming from the right or left side).
- The robot checks if the placement space is free and then moves with the cart so that the fixed wheels on the cart are 0.2 m from the center line in the placement position.
- The robot now moves itself with the cart to a position aligned with the position line and finally moves the cart into place.
- When reversing with a cart the robot will both warn with a loud beeping sound as well as blinking yellow color.



When reversing, make sure that the space around the robot is clear. It is mandatory to mark the cart areas as hazard zones, where only authorized personnel is allowed.

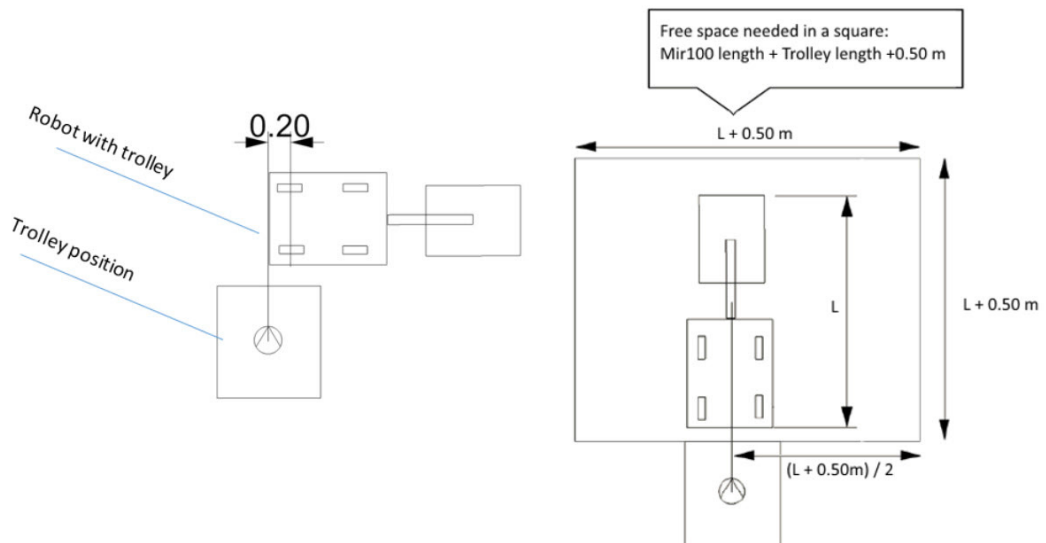


Figure 7 - Space required to park trolley in reverse.

6 Accuracy

6.1 Accuracy

The robot parks and picks up carts with an accuracy of 20 cm radius from the specified position and with an angle difference less than 10° relative to the specified position.

Similarly, a cart is picked up at a given position if the cart is placed with the above accuracy.

Each cart is identified by its QR-marker. If several carts share the same QR-marker, the carts must be identical, and the QR-marker must be placed with 1 cm precision or ± 0.5 cm on all carts.

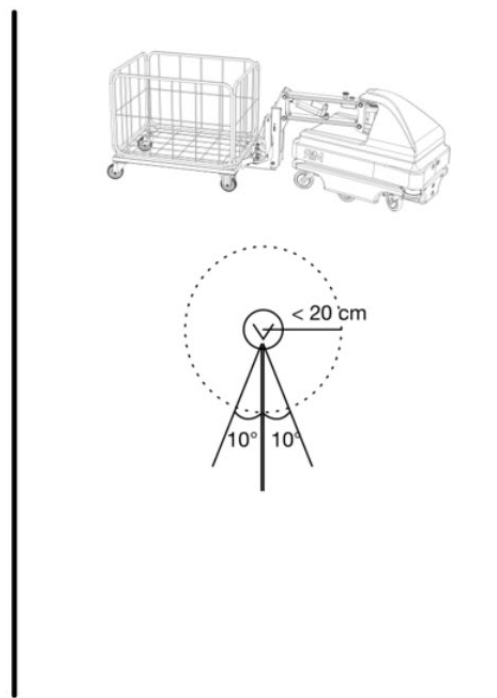


Figure 8 - Parking and picking up accuracy

Accuracy

7 Safety



7.1 Safety

Each individual application of MiRHook 100 and MiRHook 200 requires its own safety evaluation.

The robot cannot detect objects between the robot and the cart and it cannot detect objects behind the cart (the robot does not reverse as part of the route; however, it can reverse when parking a cart).

For the same reason it is not possible to drive more than one cart at a time, i.e. it is not allowed to chain carts together.

Two cameras are installed at the front of the robot: one on the lower robot skirt, detecting objects from 5-50 cm above the floor and one on the hook, detecting objects up to 200 cm above floor.

7.1.1 MiRHook 100

When driving with a cart the maximum speed of the robot is 5.4 km/h. MiRHook 100 can move carts with a total payload (incl. the weight of the cart itself) of 300 kg when driving on a horizontal, flat and clean concrete surface. MiR100 equipped with MiRHook 100 can drive on ramps with a maximum 5% inclination and a maximum payload (again incl. the cart itself) of 200 kg.

7.1.2 MiRHook 200

When driving with a cart the maximum speed of the robot is 4.0 km/h. MiRHook 200 can move carts with a total payload (incl. the weight of the cart itself) of 500 kg when driving on a horizontal, flat and clean concrete surface. MiR200 equipped with MiRHook 200 can drive on ramps with a maximum 5% inclination and a maximum payload (again incl. the cart itself) of 300 kg.

8 Creating QR markers

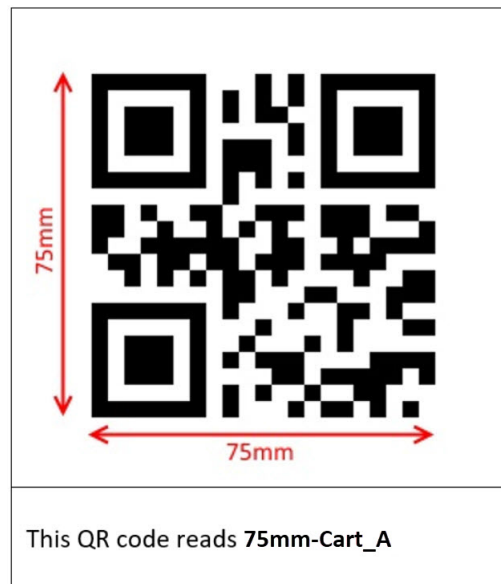


8.1 Creating QR markers

A QR marker is needed for MiRHook to identify the individual carts. The QR code contains the dimension of the marker and a unique name. The format is **SizeUnit-Name**.

- Size: the length of one of the sides of the quadratic QR code.
- Unit: the measuring-unit of the size, for example mm (millimeters) or in (inches) etc.
- "-": Remember the hyphen (-) which separates size and unit from the name.
- Name: a unique name displayed in the system.

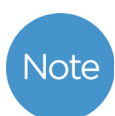
Example:



The recommended size of a QR marker is between 70 and 100 mm. But the system is open to all other sizes. The limit is whether the camera can see the QR marker or not.

QR markers can be created using any QR code generator. As long as the size is the same as stated in the QR-code, there is no requirements for how to create the codes. An easy and free method is to search the internet for QR code generators and use one of the many results.

Be sure to print a QR marker in 1:1 scale. If it does not match the size, it will not work.



It is recommended to use less than 17 characters in the QR code. Example "75mm-Cart_A" is 11 characters long. If more characters are added, then the QR-code will change format and it will become more difficult to detect.

9 Set up MiRHook

9.1 Setting up MiRHook in the Robot interface

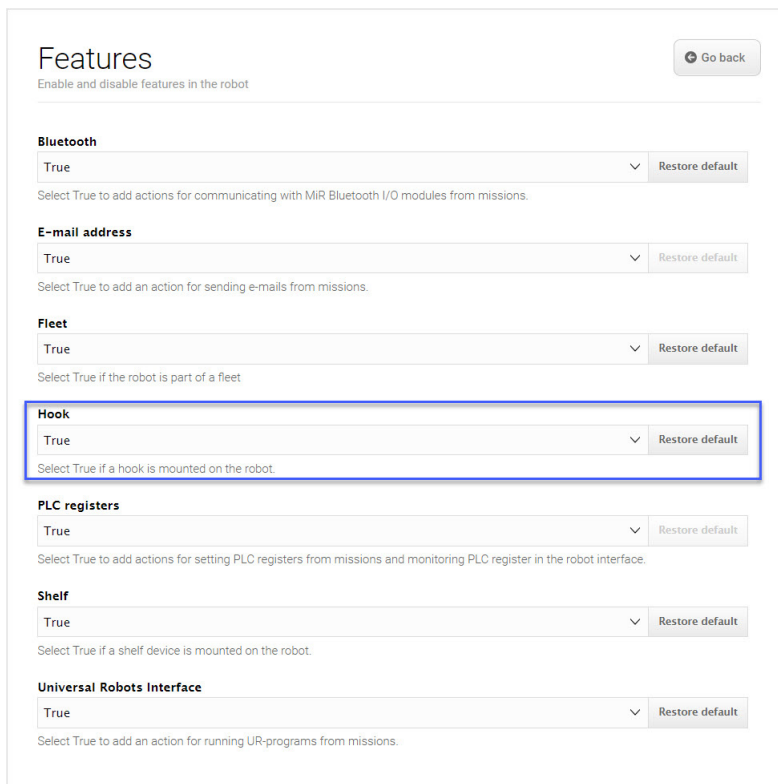
Preparation of the MiRHook to pick up and deliver carts accurately involves a number of setup and test procedures some of which are found in the Hook section others in different sections of the user interface. In brief, the steps are as follows:

1. Activate the Hook under External features in the System settings section. This will open the Hook section in the main menu bar of the user interface.
2. Perform a short manual test and a homing (zero-point calibration) of the hook in the Manual control section.
3. Create minimum one cart type and one cart in the Carts section.
4. Calibrate the relation between robot and cart in the Carts section.
5. Create a mission to test and confirm that the setup was done correctly.

9.2 Enable the Hook feature in the Robot interface

The Hook related menus are not automatically shown in the MiR Robot interface. To enable those, the Hook feature must be activated.

1. In the Robot interface, go to **System > Settings > Features**.
2. Under **Features**, enable the Hook and select **Save changes**. You will now have access to the menu items that allow the set-up of the carts.



The screenshot shows the 'Features' configuration page. At the top, there is a 'Go back' button. Below the title, there is a subtitle: 'Enable and disable features in the robot'. The page lists several features, each with a dropdown menu and a 'Restore default' button. The 'Hook' feature is highlighted with a blue border. The 'Hook' feature is currently set to 'True'.

Feature	Value	Action
Bluetooth	True	Restore default
E-mail address	True	Restore default
Fleet	True	Restore default
Hook	True	Restore default
PLC registers	True	Restore default
Shelf	True	Restore default
Universal Robots Interface	True	Restore default

9.3 Perform a short manual test

Before creating cart types and carts, a short manual test must be performed to see if the hook is correctly connected.

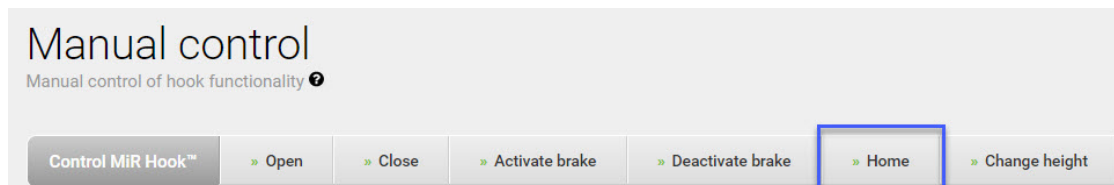
In Manual control, perform the following steps:

- Open: opens the hook gripper.
- Close: closes the hook gripper.
- Activate brake: allows horizontal movement of the hook arm. Push the arm manually.
- Deactivate brake: always deactivate the brake when manually driving with a cart.
- Home: set the hook to home position (390mm).
- Change height: set the current height of the arm.

9.4 Perform a homing of the hook

A homing raises the hook to its topmost position and is used as a zero-point calibration of the hook. Homing must be performed as the first action to center the arm.

1. In the Robot interface, go to **Hook > Manual control**.
2. Under **Hook** actions, select **Home** and wait until the hook stops moving.
3. Select **Deactivate brake**.
4. Manually push the arm close to 0 degrees.
5. Select **Activate brake**.
6. Homing is now complete.



9.5 Create an overall cart type

The cart type(s) used for towing jobs must be defined. This is done to accommodate multiple carts of the same type. The procedure is as follows:

1. In the Robot interface, go to **Hook > Carts > Create Cart > Create / Edit Type**.
2. Under **Cart types**, select **Create type**.
3. Enter the following information:
 - a. A custom name for this type of cart
 - b. The length (to gripper area), width and height (from floor) of the cart.
 - c. The offset from the center of the locked wheels to the front of the cart (gripper bar).

Note

The locked wheels can be either at the front or the back of the cart. Locked wheels at the back will give a higher offset value.

Create cart type

All carts must be attached to a named cart type, specifying length, width, height and locked wheels offset of the cart.

Name:

Width in meters: **Height in meters:**

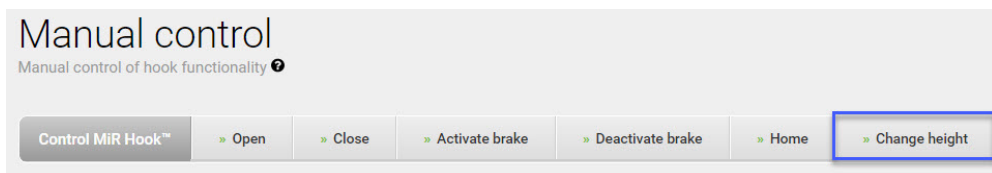
Length in meters: **Locked wheels offset in meters:**



4. Select **OK**.

9.6 Calibrate a specific cart in the MiR system

The next step is to calibrate the relation between MiRHook and the cart. In the **Manual control** menu under **Hook** you must now enter values into the **Change height** field to define Entry and Lock heights for the hook to use when docking to and gripping a cart.



When a value is entered in **Change height** and the button is pressed, the Hook will move up or down depending on the chosen value (see Figure 8). The value represents the height from the bottom of the Hook to the ground (mm).

1. First, insert a height which enables the Hook to go underneath the cart. Remember this value as **Entry height**, for later use.
2. Place the cart over MiRHook 100 / MiRHook 200.
3. Now enter a height which enables the hook to grip the bottom frame (gripper bar) without lifting or pushing the cart. This step may require some trial and error until you have the correct height. When done, remember this value as **Lock height**.
4. Change the height back to **Entry height** and make sure the cart is still positioned over MiRHook 100 / MiRHook 200.

- Now attach the QR-marker to the cart so that the camera on MiRHook 100 / MiRHook 200 can see the QR-marker when MiRHook 100 / MiRHook 200 is ready to grip the cart.



The QR-marker must be placed straight on the cart grating. Otherwise the camera may have problems reading the code.



If the camera can see the QR-marker, the position values are displayed. Otherwise, the fields will just display N/A.

Live marker results	
Marker name	Trolley_B
X	-0.00 m
Y	-0.00 m
Z	0.16 m

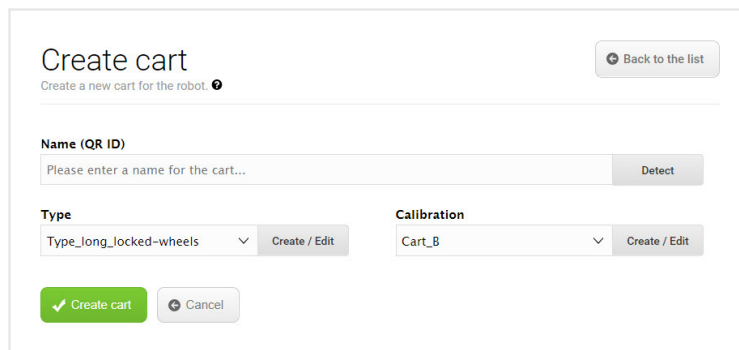
The calibration is now completed. Do not move the robot, hook or cart and continue with the next step.

9.7 Create a specific cart in the Robot interface

The next step is to set up a cart in the Robot interface:

- Go to **Hook > Carts** and select **Create Cart**.
- Select the cart type you created before.
- For calibration select **Create/Edit** and select **Create calibration** and click **Detect**. Make sure the hook is in the Entry height position and that the camera can see the QR-marker. If done correctly, the Cart name and Entry height [mm] will be shown, if not, the values will display N/A and the calibration must be redone.
- Enter the Lock height in mm (the height that was set in step 3 in section 9.4)
- Enter drive height (usually equal to the lock height)

6. Select **OK**. Now the cart is registered in the Robot interface.



9.8 Test the setup

To test the setup, move the cart approximately one meter away from the robot and create a mission with one action **Pick up cart** and launch it. The action **Pick up cart** has two parameters, **Position** and **cart** ; if both are left blank, MiRHook will try to lock to any known cart.







Note

When you move the cart away from the robot, the X, Y and Z values must still show under **Live marker results**. If they read N/A, it means that the cart has been moved too far away.




With this mission, the robot will attempt to fetch any cart visible to the MiRHook camera. If the hook does not find the cart, the calibration must be redone going through the above steps again.




After a successful **Pick up cart** action, now create and run a **Place cart** action. The action **Place cart** has three parameters **Position**, **Reverse into place** and **Release cart**. Select position from drop-down list, decide if MiRHook should release the cart after the cart is parked and change No to Yes if you want the cart to be backed into place.


 Place cart


Position 
Position B Cart  

Current position

Release cart 
Yes  

Reverse into place 
No  

	If possible, always use missions when locking / unlocking carts.
---	--

	Do not drive the robot in manual mode with the brake activated as this may damage the motor. Use Change height with the hook closed.
---	---

10 Map

10.1 Setting robot and cart positions in the map

To create **Pick Up Cart** and **Place Cart** missions, cart positions must be defined in the map. To do this, navigate to either **a dashboard with a map** or the **loaded map** and select **Create new position**. Under **Position type**, select **Cart position**.



If you want to set the position where the robot with cart is placed right now, the position will be placed below the center of the cart. If no cart is attached when you select **Use robot position**, the position will be placed below the center of the robot.

Create position

Name
Cart position A

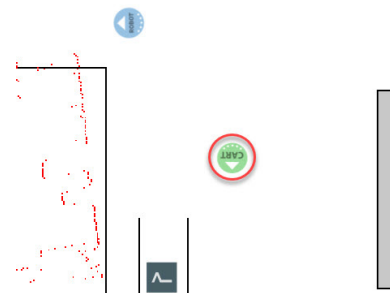
Type
Cart position

Orientation from X-axis
-88.290

X coordinate in meters
15.550

Y coordinate in meters
19.850

OK Cancel



Map

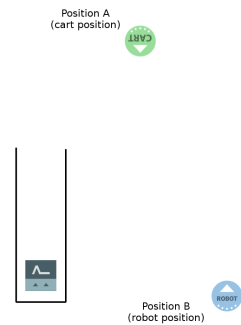
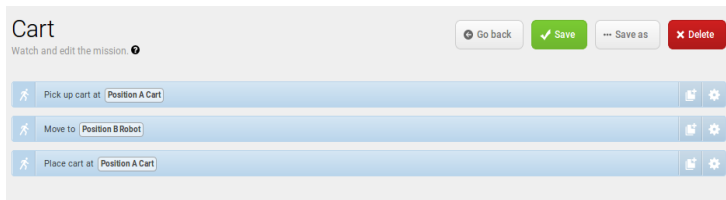
11 Example



11.1 Example of a small application

The task at hand is to pick up a cart at position A, drive with the cart attached to position B and return it to position A. This can be done in the following way:

First define two positions, A and B. Position A is used for picking up and placing carts and must be defined as a cart position. Position B is a normal Robot position which the robot with hook can move to, but not to pick up or unload a cart.



1. **Pickup cart:** Position is a predefined cart position type named Position A Cart and the specific cart is named Cart_Food_01.
2. **Place Cart:** The robot will move to and park the cart in this position. It will not be parked in reverse, and the robot will release the hook from cart and move forward a bit as a final action.



Example

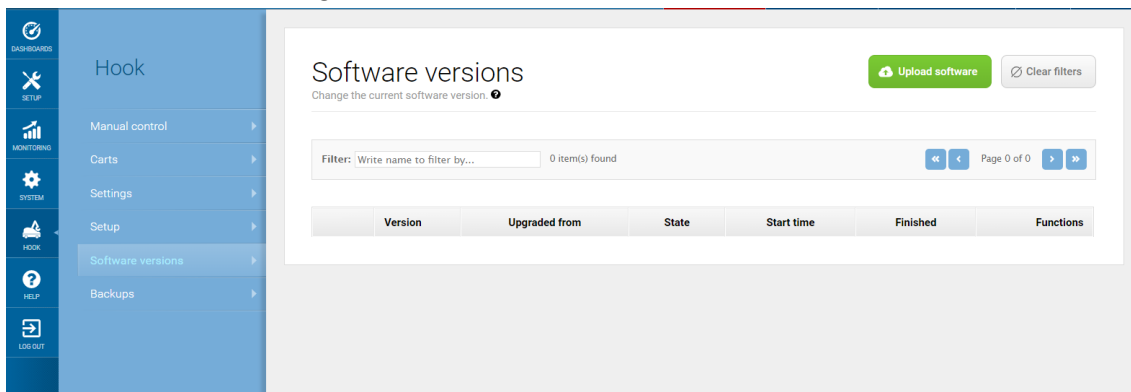
12 Updating MiRHook software



12.1 Update MiRHook software

Follow this procedure to upgrade MiRHook software:

1. Go to the Distributor site on our website: www.mobile-industrial-robots.com/account and select **Downloads**. Select product, go to the newest version and download the latest software file.
2. In the Robot interface, go to **Hook > Software versions**.



4. Select **Upload software** and select the file containing the new software version.
5. The hook will now upgrade to the latest software version.



Robot and Hook use the same software release file. They must run the same software version, but they need to be updated individually.



Updating MiRHook software

