

MiR 100

Mobile Industrial Robots
User Guide



Document version 1.4
Original version (en)

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Table of contents

1	Introduction.....	5
1.1	Document history.....	5
1.2	Product presentation.....	5
1.3	The delivery	6
1.4	Identification label.....	6
2	Safety.....	7
2.1	Safety concept	7
2.2	General safety instructions.....	7
2.3	Lithium battery	9
2.4	Safety circuit	10
2.5	Applied standards.....	10
3	Description.....	11
3.1	Vehicle main parts	11
3.2	Main components.....	12
3.3	Sensor systems	13
3.4	Light indicators	13
3.5	Drive modes.....	13
3.6	The vehicle's main functions	14
4	Technical specifications	15
4.1	Capacity	15
4.2	Dimensions	15
4.3	Main components.....	15
5	Getting started.....	17
5.1	Unpacking	17
5.2	Charging the vehicle	18
5.3	Placing the top module.....	19
5.4	Start the vehicle.....	19
5.5	Test the vehicle.....	20
5.6	Shutting down the vehicle.....	21
5.7	Packaging and transport.....	21
6	Maintenance.....	25
7	Tips and Troubleshooting	25
8	Disposal of battery, electronic and electric components.....	25
9	Service	25

Appendix A: Payload specifications.....26

Appendix B: MiR100 dimension drawings.....28

Appendix C: Declaration of conformity29

Appendix D: Accessories made standard as of release 1.530

 Application interface30

 Interface to docking station30

1 Introduction

This user guide contains information about the vehicle structure, use and maintenance. Latest version and further documentation of special applications are available at the support site <https://mirrobot.atlassian.net/servicedesk/customer/portal/1>.

The user guide is intended for retailers and end-customers responsible for or directly involved in the integration, operation and field maintenance of the MiR100. Users are expected to have a basic level of mechanical and electrical training. No prior knowledge about robots in general is required.

1.1 Document history

Version	Date	SW/HW version	Changes
1.0	21.04.2016	1.5	First edition
1.1	27.04.2016	1.5	Updates to instruction on emergency stop mounting
1.2	03-05-2016	1.6	Imperial units (US standard) added
1.3	04-07-2016	1.6.3	Update of Maintenance chapter and Declaration of conformity
1.4	15-07-2016	1.6.3	Appendix D added: information about interfaces to docking station and external applications

1.2 Product presentation

MiR100 is an automatic vehicle that can transport materials internally within factories, hospitals, department stores, supermarkets and a host of other industrial locations.

The user provides the destination of product delivery via a web interface. MiR100 can be set up to run a fixed route (Route), be called on demand (Taxi) or perform a more special operation (Mission).

MiR100 has a map that can be programmed the first time the vehicle is used. While operating, the MiR100 automatically avoids obstacles (people, furniture) that are not mapped. MiR100's internal map contains specific locations (office, hall, John's room, etc.) which can be used for logistical planning.

Each vehicle has its own network. See separate setupsheet.

The vehicle is controlled from a website (HTML5), which is accessed via a browser on a PC, smartphone or tablet.



1.3 The delivery

The box includes the following parts:

- The vehicle
- Emergency stop box and instructions for mounting (stored inside vehicle)
- Charging cable
- Setup sheet and declaration of conformity
- USB flash drive containing
 - Declaration of conformity
 - User Guide
 - Setup sheet
- Top Camera (optional)
- Tablet Kit (optional)



1.4 Identification label

The identification label of the MiR is placed inside the robot next to the rear scanner and shows the following information:

- | | |
|-------------------|---|
| CE | Mobile Industrial Robots ApS declares that the MiR100 meets the requirements of the applicable EC directives (see chapter 2 Safety) |
| Serial no. | The 15-digit serial number is a unique identifier of the robot |
| MiR100 X.X | Shows name and hardware version of the robot |







MiR100 identification nameplate example



2 Safety


2.1 Safety concept

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol. These notices shown below are graded by signal words to indicate degree of danger.

-  **Danger** indicates an immanently hazardous situation that **will** result in death or severe personal injury if proper precautions are not taken.
-  **Warning** indicates a potentially hazardous situation that **could** result in death or severe personal injury if proper precautions are not taken.
-  **Caution** indicates a situation that **could** result in minor personal injury or damage to the equipment if proper precautions are not taken.
-  **Notice** indicates a situation that **could** result in property damage if proper precautions are not taken.

2.2 General safety instructions

This section contains general safety notes. Some of safety notes are repeated or further specified in other sections of the manual and further safety notes are present throughout the manual.

-  **Warning**
 1. **Ensure proper mounting of loads during transport**
 Danger of personal injury from overturning robot or falling load
 All accessories and loads mounted on top of the vehicle should be fastened correctly and meet specifications. See section 5.3 and Appendix A Payload specifications.
 2. **Avoid leakage of fluid during transport**
 Danger of personal injury from leaking fluid
 Make sure that loads containing fluids do not leak during transport.
 3. **Use only the original charger**
 Danger of personal injury and/or damage to the vehicle
 Use of other charger than the one supplied by the manufacturer can ruin the battery and may cause fire.
 4. **Update maps to avoid hazards on the route**
 Danger of personal injury and/or damage to the vehicle
 Make sure to update maps with areas without drive surfaces such as stairways.
 5. **Do not drive vehicle irresponsibly**
 Danger of personal injury and/or damage to the vehicle
 The vehicle should not be driven over edges or in other ways operated irresponsibly.


Caution

1. **Do not use the vehicle to transport people**
Risk of personal injury and damage to the vehicle

The vehicle should never be used to transport people. This will revoke compliance with the standard EN 1525 Safety for unmanned trucks.
2. **Avoid gradients above 5% on the route**
Risk of personal injury and damage to the vehicle

The surface grade (ramps, etc.) cannot exceed 5% as this may cause skidding.
3. **Only drive on even and dry surface**
Risk of personal injury and/or damage to the vehicle
Wet and uneven surface may cause skidding.
4. **Do not overload the vehicle**
Risk of personal injury and/or damage to the vehicle

The maximum payload is 100 kg (220.5 lb.) for load on top of the vehicle. If exceeded it may cause overturning, falling load and damage to the vehicle.
5. **Do not use vehicle on board ships**
Risk of personal injury and/or damage to the vehicle

Unstable surface caused by moving vessel may cause the vehicle to skid.
6. **Turn off the main power immediately after removal of top cover**
Risk of personal injury and/or damage to the vehicle

Turn off the main power relay to avoid short circuit.


Notice

1. **Indoor use only**
Risk of damage to the vehicle

The vehicle is made for indoor use only and should never be used outdoor.
2. **Avoid small objects on the floor in the vehicle's area**
Risk of property damage and/or minor damage to vehicle

The vehicle cannot detect obstacles taller than 50 mm (2") and may overrun smaller objects.
3. **Remove unwanted objects from the floor in the vehicle's area**
Risk of inefficient execution of orders

The vehicle will go around objects that are not part of the map but this may influence the efficiency of the planned route.
4. **Avoid overheating of components**
Risk of damage to the vehicle or vehicle components

The ambient temperature in the vehicle's environment must not exceed 50° C (122° F).
5. **Avoid exposure the vehicle to excessively humid or dry environment**
Risk of damage to vehicle or vehicle components

The ambient humidity in the vehicle's environment must be within the specifications, see Technical specifications p.15.



6. **Do not expose the vehicle to water**

Risk of damage to vehicle or vehicle components

The vehicle is not designed for operation in wet environments, for example production environments where water vapors, squirts or jets occur.

7. **Do not remove components for separate use**

Manufacturer's warranty will be void

MiR takes not responsibility for damage to components removed from the vehicle and used for other purposes than the intended.

8. **Avoid blocking of sensors**

Reduced functionality

Laser scanners, cameras or other sensors should not be blocked as this will obstruct normal functionality of the vehicle.

2.3 Lithium battery

Lithium batteries are primary power sources with high energy content designed to represent the highest possible degree of safety.



Warning Potential hazard

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

Observe the following precautions when handling and using lithium batteries:

- Shut-off the battery when not in use.
- Do not short-circuit, recharge or connect with false polarity.
- Do not expose to temperature beyond the specified temperature range or incinerate the battery.
- Do not crush, puncture or disassemble battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode or ignite
- Do not allow the battery to get wet.
- In the event the battery leaks and the fluid gets into one's eye, do not rub the eye. Rinse well with water and immediately seek medical care. If left untreated, the battery fluid could cause damage to the eye.
- User only the original charger and never charge unattended.



2.4 Safety circuit

If a person or other moving object enters the safety zones for MiR100 where the planner due to response time, errors etc. does not respond, the safety circuit will force the robot into emergency stop and the robot stops immediately. When the person or object is out of the safety zone again, the emergency will reset automatically.

MiR100 is designed with total redundant electrical safety circuit including Sick Safety components. If any internal errors in the safety circuit occur, the robot will immediately go into emergency stop which means all moving parts will be voltage free by mechanical disconnection. Only when the redundancy is provided, it is possible to reset the emergency stop and continue.

2.5 Applied standards

The MiR100 vehicle meets the following directives:

2006/42/EC	The EU Machinery Directive Directive of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast).
2014/30/EU	The EU EMC Directive Directive of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (recast).
2014/35/EU	The EU Low Voltage Directive Directive of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical
1999/5/EC	The EU Radio Equipment Directive Directive of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.

In addition, the following standards or parts thereof are applied:

EN 61000-6-2	EMC: Immunity for industrial environments
EN 61000-6-4	EMC: Emission standard for industrial environments
EN 60601-1-1	EMC: Limit value for medicinal for medicinal equipment
EN 13849-1	Machine safety: General Construction
EN 13849-2	Machine safety: Validation
EN 13850	Machine safety: Emergency stop and the creation of this
EN 13855	Machine safety: Placement of safety measures
EN 1525	Safety for unmanned trucks
EN 1175-1	Safety for battery driven trucks

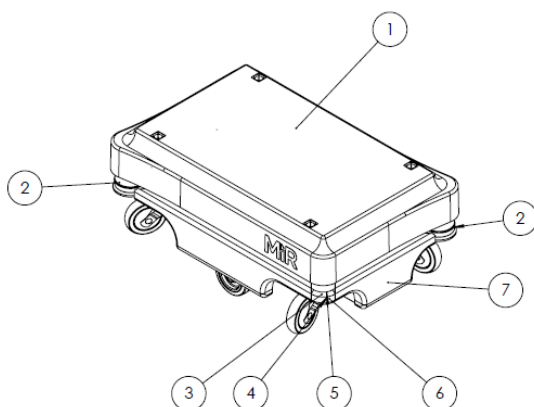
The manufacturer hereby declares that the MiR100 1.X vehicle meets the significant demands and other relevant regulations in the Machinery Directive 2006/42/EF.

See also appendix C.

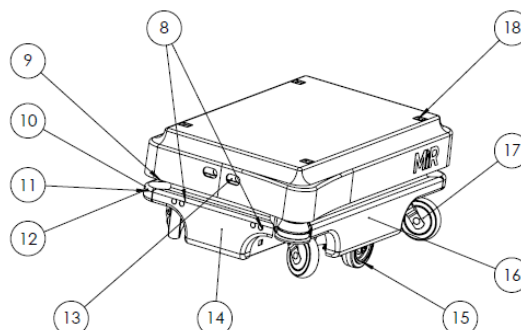


3 Description

3.1 Vehicle main parts



- 1 Top cover
- 2 Laser scanner
- 3 Rear edge cover
- 4 Caster wheel
- 5 Protection cover
- 6 Power port
- 7 Rear skirt

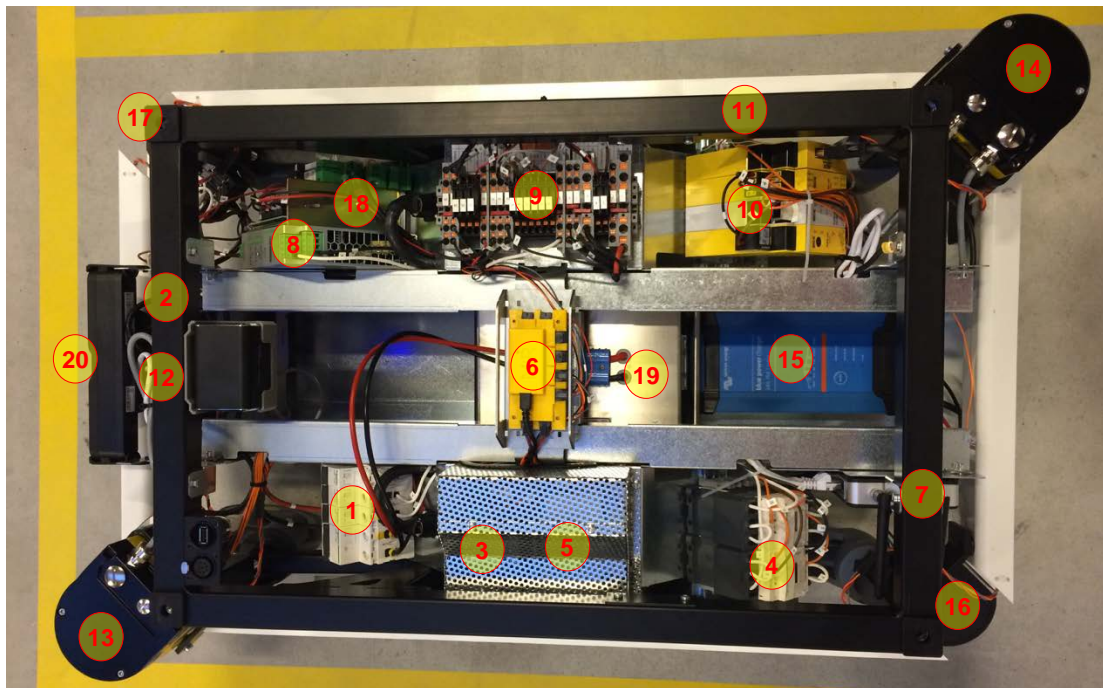


- 8 Ultrasonic sensors
- 9 On/Off button and scanner reset button (yellow)
- 10 Protective cover
- 11 HDMI port
- 12 USB port
- 13 3D Depth camera
- 14 Front skirt
- 15 Drive wheel
- 16 Side skirt
- 17 Caster wheel
- 18 Mooring holes

Parts Item	Description	Parts Item	Description
Laser scanner	Monitors plane at 20 cm height	On / Off button	Light signal given during startup and shutdown
Drive Wheel	Differential control	HDMI port	Connects a screen to the vehicle PC
Protective cover	Protects corners	USB port	Connects to the vehicle's PC
Scanner Reset button	Resets laser scanners	3D Depth Camera	Looks for objects on the floor and outside the laser plane
Power port	Connects 230V to charger	Caster wheel	Stabilizes vehicle
Skirts	Protects chassis	Mooring Holes	For mounting of top module
Top cover	Protects the main parts	Ultrasonic Sensor	Detects smooth surfaces



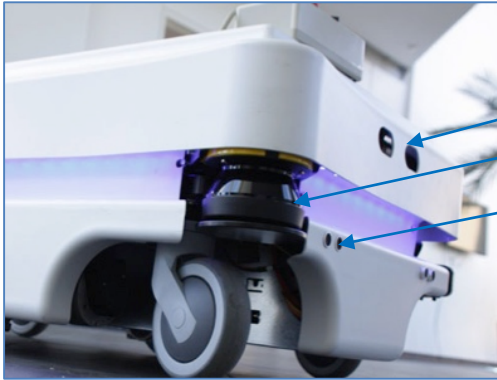
3.2 Main components



#	Component	Description	#	Component	Description
1	Breaker	Automatic fuse between batteries and components.	11	Optocoupler	Communications for emergency stop.
2	12V Power Supply	Power to the NUC and router.	12	NUC PC	The main computer.
3	Motor controller	Manages the two motor drives.	13	SICK laser scanner 1	Front laser scanner
4	Redundant drive	Relays controlled by SICK modules supplying the motor controller.	14	SICK laser scanner 2	Rear laser scanner.
5	Brake relay	Ensures immediate motor brake when emergency brake is activated.	15	Battery charger (hidden under emergency stop)	Internal mounted charger, for charging the battery.
6	MiR board	Interface board for gyroscope, accelerometer, ultrasound, light.	16	Charge port.	Battery charger port. When the power cable is connected; emergency stop is activated.
7	Router	Local network.	17	Start/Stop	On/Off Button Controls battery power.
8	24/24 V switch mode power supply	Provides safety components. Ensures stable voltage.	18	5V Power Supply	Power to the MiR board.
9	Fuse group	Plug connections to chassis and voltage supplies.	19	Battery	Main power for the robot.
10	SICK safety modules	Communication between sensor signals and control of the vehicle.	20	Front camera	Obstacles avoidance camera.



3.3 Sensor systems



External sensors

- Camera
- Laser scanner
- Ultrasonic sensors

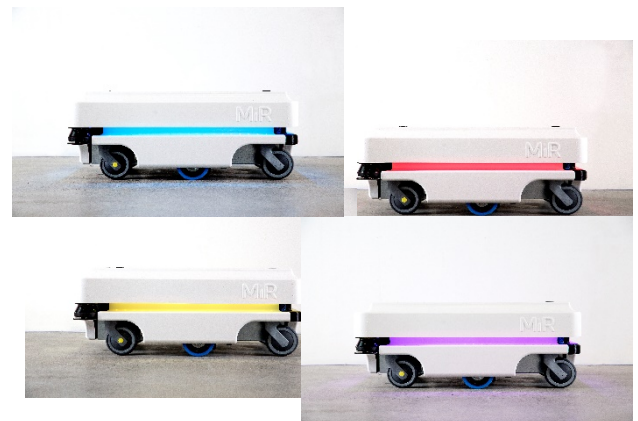
Internal sensors

- Gyro
- Motor encoder

3.4 Light indicators

The light signals on the MiR100 indicate the current operational state. Colors may be adapted to individual user needs but MiR100 is delivered with the following setup.

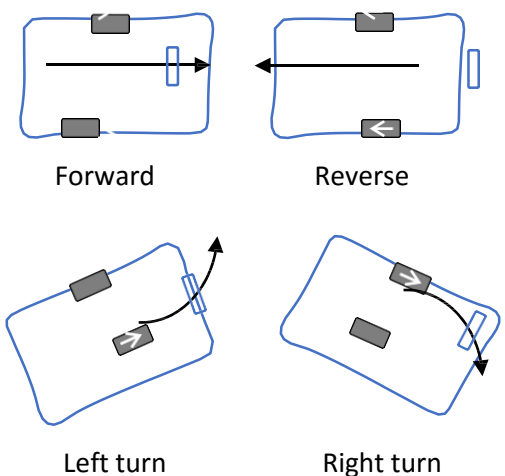
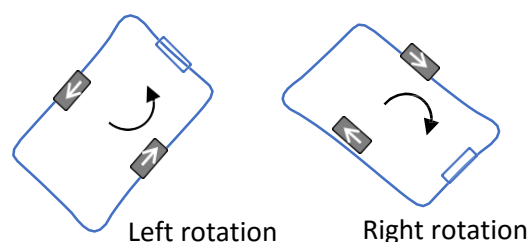
Red	Emergency stop
Green	Waiting for job
Cyan	Drives to destination
Purple	Goal / Path blocked
White	Executing non-moving mission
Yellow	Mission paused
Yellow wavering	Startup signal before PC is active
Yellow blinking	Relative move, ignoring obstacles
Yellow-purple	General error, e.g. hardware localization
Blue	Manual drive joystick



3.5 Drive modes

The vehicle has differentially geared steering for high maneuverability (see illustration). Two drive wheels are located in the middle of the vehicle, with one on each side.

The vehicle can generally operate in the same places as a wheelchair and can handle a 5% grade.





3.6 The vehicle's main functions

1. **Driving in a populated workspace**
The vehicle is designed to operate among people
2. **Overall route planning and local adjustments**
The vehicle plans a general route to its target destinations. When the vehicle encounters obstacles which are not in the map (like people and objects), adjustments are made to the route.
3. **Sound and light signals**
The vehicle continuously signals with light and sounds indicating its current mode, for example waiting for job, driving to destination, destination reached, alert mode.
4. **Planning of driving and receiving a package**
A web interface, which is accessed from a PC, smartphone or tablet, monitors the vehicle and gives the user easy and intuitive operation of the vehicle.
5. **Alert for "lost"**
If the vehicle comes to a situation where it cannot find a safe path to its destination, it stops, turn on the yellow-purple error lights and a customer defined catch action can be used to alert people or take other actions.
6. **Automatic deceleration for obstacles**
The vehicle has a number of built-in sensors which slows it down when detecting obstacles in front of the vehicle.
7. **Optimal surface operations**
The vehicle is made to run on a level, dry floor. The on vehicle-mounted sensors detect and avoid objects above 50 mm (2") from floor level.
8. **Internal map**
MiR100 uses an internal map for route planning. MiR100 can use a floor plan from a CAD system or can create a map by the user navigating the vehicle manually. The vehicle's sensors detect walls, doors, furniture and create a map based on this input. Destinations and positions are added; for example, the warehouse.



4 Technical specifications

4.1 Capacity

Load	
Load surface:	600 x 800 mm - ½ EU pallet (23.5" x 31.5")
Load weight:	Up to 100 kg (220.5 lb.) (See appendix A for payload specifications)
Speed and Performance	
Running time:	10 hours or 20 km (12.5 mi)
Maximum speed:	1.5 m/s (5 ft./s) corresponding to 5.6 km/hour (3.5 mi/h)
Maximum grade increase:	5% with 100 kg (220.5 lb.) load
Ambient temperature range:	+5° C to +50° C (+41° F to + 122° F)
Humidity:	10-95% non-condensing
Power supply	
Output voltage range:	26-24 V AC

4.2 Dimensions

See also dimension drawings in Appendix B.

Length:	850 mm (33.5")
Width:	600 mm (23.5")
Height:	350 mm (13.75")
Height above floor:	50 mm (2")
Weight without load	62.5 kg (137.75")

4.3 Main components

Battery ¹	
Battery type:	1 Li-ion battery
Capacity:	40 Ah, 24 V

¹) Lithium batteries are subject to special transportation regulations according to United Nations "Regulation of Dangerous Goods, UN 3481". Special transport documentation is required to observe these regulations. This may influence both transport time and costs.



Charging time:	Up to 3 hours (0-80% 2 hours)
SICK laser scanners (2pcs)	
Range:	270° visual protection
Visual indicators	
LED color light bar (on four sides):	Indication of operating status
Audio indicators	
Built-in loudspeaker:	3 W (below 60 dB)
Top module	
Maximum height from floor to top:	1800 mm (70.75")
Center of gravity:	Lower than 900 mm (35.5") above the floor



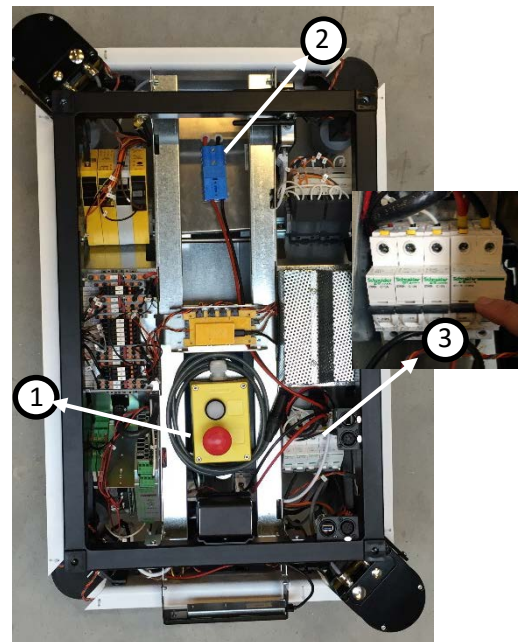
5 Getting started

5.1 Unpacking

- 1 Lift off the lid from the pallet and remove the top foam and side foam pieces; then remove the two pallet frames.



- 2 Lift off the top cover of the vehicle.
 - Remove the emergency stop box placed inside the robot, (1).
 - Connect the main power cable to the battery, (2).
 - Turn on the four relays. Start with the main power = the outer 32A, (3).



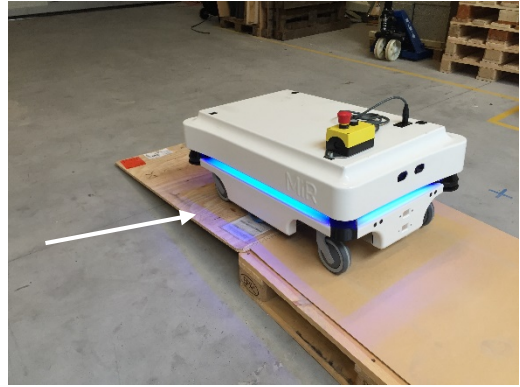
- 3 Put the cover back on, and fasten and connect the emergency stop box on top of the vehicle as shown in the enclosed instruction sheet.



- 4 Place the packaging top lid as a ramp as shown.

Using the manual joystick mode, you can now drive the vehicle down the ramp.

Note: It is recommended to drive it down backwards.



5.2 Charging the vehicle

To charge the vehicle:


1. Turn the vehicle off on the black On/Off button.
2. Add the charge plug to the vehicle.
3. Connect the charge cable to a regular power outlet.


After a maximum of 3 hours the vehicle is fully charged. The charger shows a green light when the battery is charged.

► **Tip:** Charging can start while the vehicle is shutting down (it can take up to a couple of minutes to shut down).

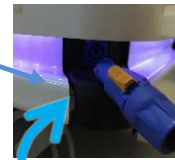
Remove charger:

1. Disconnect the charger from power.
2. Remove the charge plug from the vehicle.

 **Caution:** Do not leave the charger with the power turned on when not connected to the vehicle!

 **Notice:** Use only the original power cable.

Charge port



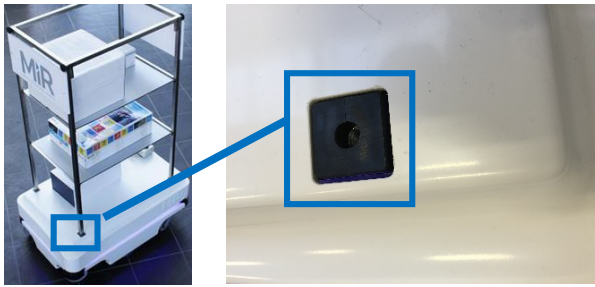
On/Off rotary knob





5.3 Placing the top module

Top modules and payload should be fastened using the self-tightening conically shaped mooring holes:



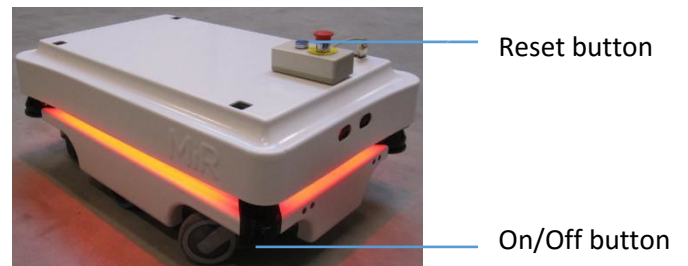
⚠ Caution: Before adding the top module, the emergency stop box must be removed and remounted on the top module in a position where it can be reached from all sides of the module.

ⓘ Notice: Stay within the specifications for weight and the payload's center of gravity, see Appendix A.

5.4 Start the vehicle

To start the vehicle:

1. Turn the black On/Off button on the front of the vehicle.
 - After five seconds, a yellow light will illuminate.
 - After one minute, it changes to a red light.
 - The computer system is now on.
2. Press the blinking blue reset button on the emergency box. The vehicle is now ready for operation.



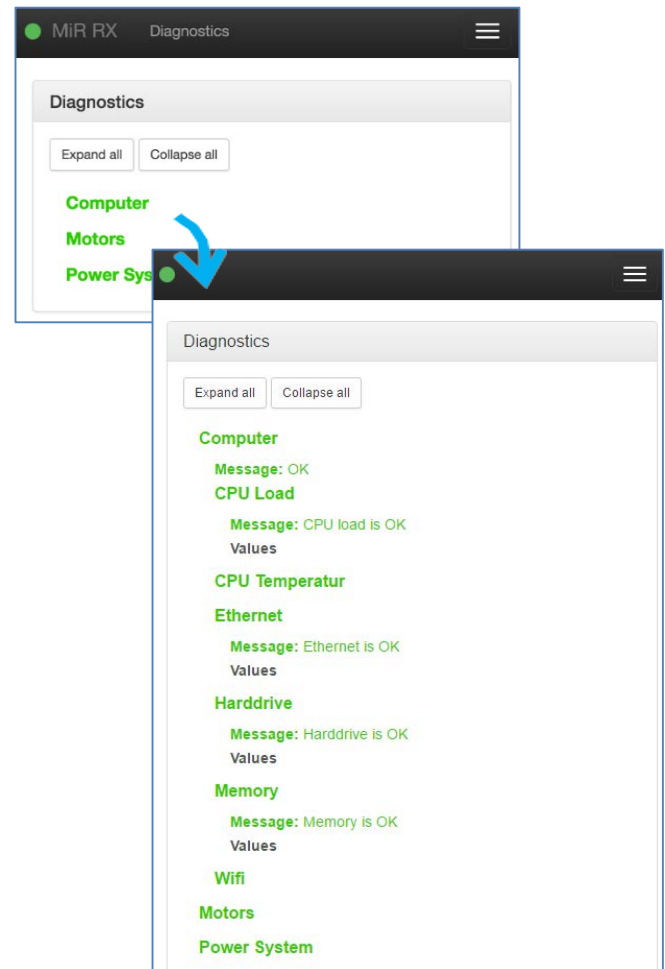
ⓘ Notice: The emergency stop button must be disengaged in order for the reset button to work.



5.5 Test the vehicle

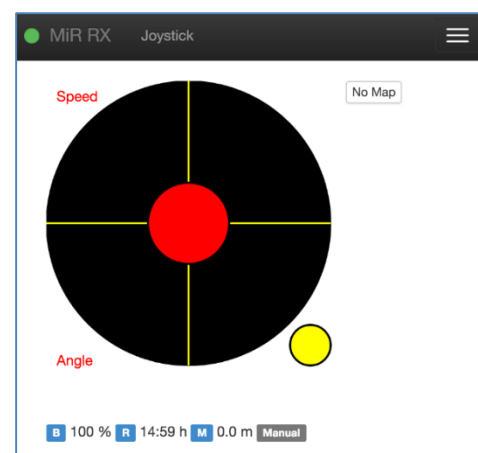
Before the first drive, test the vehicle:

1. Log on to the MiR Web Interface for the vehicle – see attached setup sheet.
2. Go to Service > Status > Diagnostics.
3. Make sure that all components work: click on individual components or click on Expand all. Check that each sub component works. Status should be green and read OK.



Manual operation of the vehicle happens through the MiR Web Interface via the “joystick”.

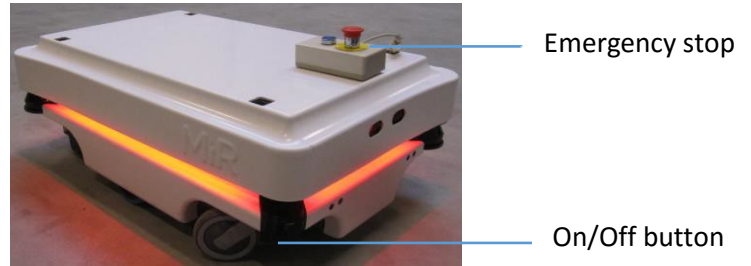
- ▶ Tip: For more information, see MiR Web Interface user guide



5.6 Shutting down the vehicle

To turn off the vehicle:

1. Use the emergency stop – press the red button.
That will turn off the power to the motors.
2. Turn the black On/Off button on the front of the vehicle.
3. Wait for the light to turn off - there is now no more power going to the vehicle.



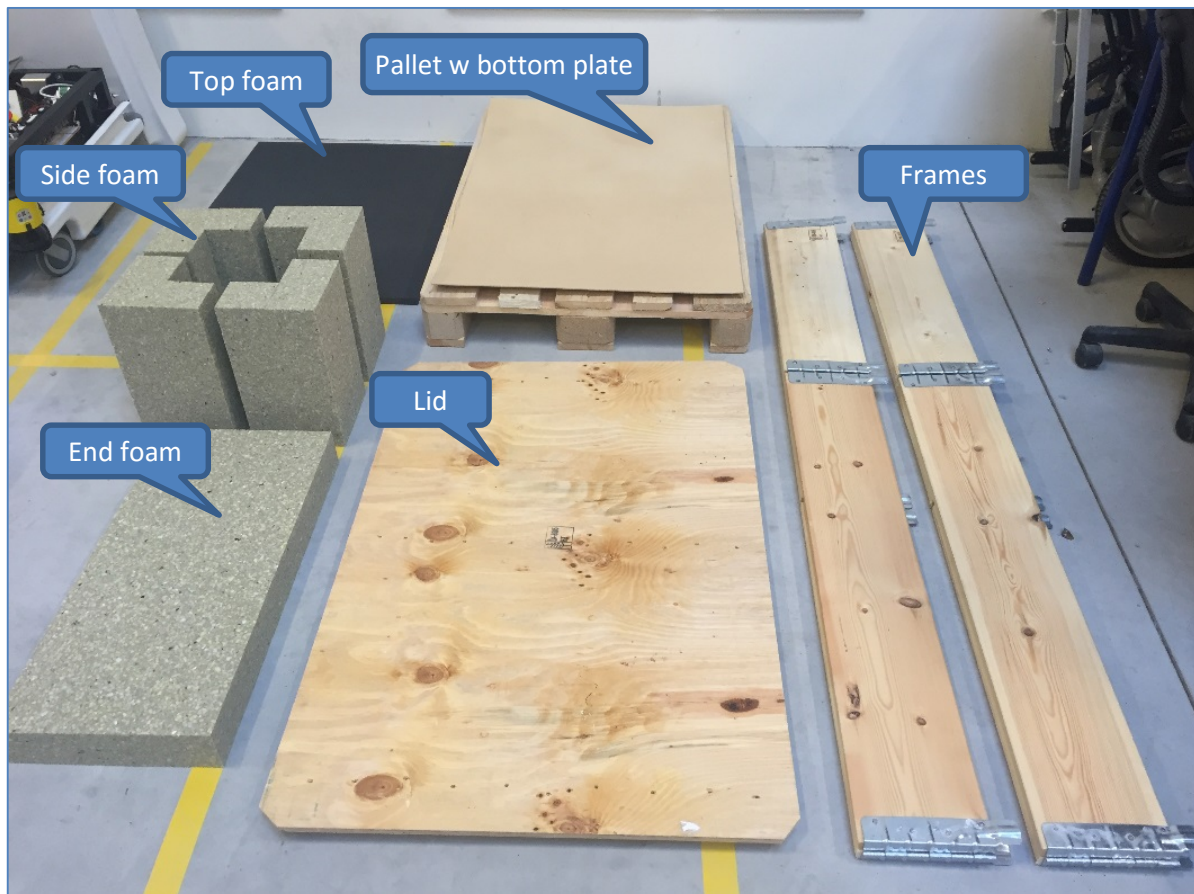
5.7 Packaging and transport

⚠ Caution: Turn off automatic relays during transport
Make sure all relays are turned off as described below.

⚠ Caution: Special requirements for transport with lithium battery
Transport of the vehicle with battery should follow regulations as described in Technical specifications, p 15.

To prepare the vehicle for transportation:

Use the original packaging when transporting the vehicle. Shown below is the packaging on a wooden pallet:





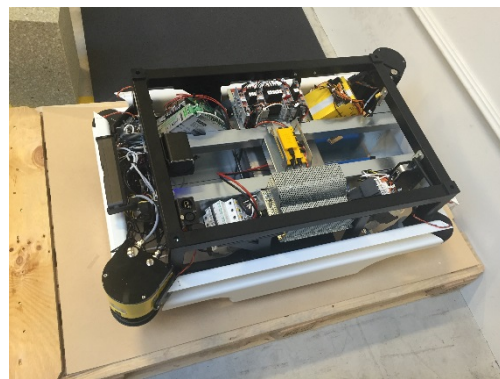
- 1 Place the packaging top lid as a ramp on the pallet.

Using the manual joystick mode, you can now drive the vehicle onto the pallet.

Note: It is recommended to back the vehicle onto the pallet.



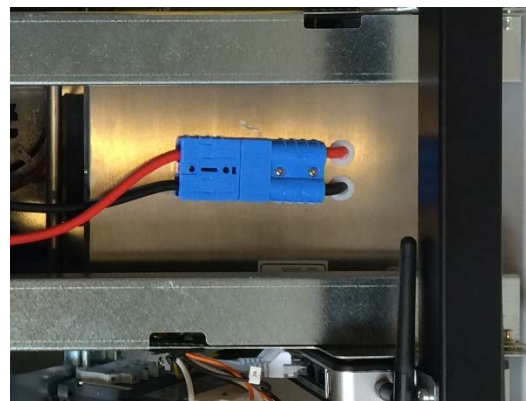
- 2 Turn the vehicle off, dismount the emergency stop, and remove the top cover.



- 3 Turn off the four relays.



- 4 Remove the pole cover form the battery.



- 5 Place the dismantled emergency stop on top of the battery



- 6 Put the top cover back on and place the pallet frames



- 7 Fit the end foam in the rear and the side foam in each corner.

▶ Tip: the side foam is easily added by first placing the foam diagonally by the two laser scanners. During placement you can move the vehicle to make sure it is centered correctly.



- 8 Place the top foam on top of the vehicle.



- 9 Place the lid and tie down the box making sure the lid does not come undone.



6 Maintenance

Test the vehicle regularly and clean it with a damp cloth (No compressed air).

1. Remove dirt from wheels.
2. Check the wheels for wear and tear. The caster wheels should be replaced once a year.
3. Clean the optics cover of the laser sensors regularly for optimal performance. Avoid aggressive or abrasive cleaning agents.

Note: Static charges cause dust particles to be attracted to the optics cover. You can diminish this effect by using the anti-static plastic cleaner (SICK part no. 5600006) and the SICK lens cloth (part no. 4003353) See manufacturer's own documentation.

4. Make sure that the holes for the camera and ultrasound are unobstructed.
5. For spare parts contact MiR support.

7 Tips and Troubleshooting

- If the vehicle experiences an emergency stop, pull it to an unobstructed area.
- If MiR shows an error message on the way to destination, check if the destination is blocked or if the vehicle does not drive well:
 1. Make sure that the vehicle's destination corresponds with its position on the map.
 2. Check that the camera is unobstructed and working.
 3. Check that status is OK in the Diagnostic menu in the MiR Web Interface.
 4. Check that the wheels are unobstructed and not tangled up in anything.

8 Disposal of battery, electronic and electric components

Battery, electronic and electric equipment may not be disposed of in the municipal waste disposal services under observance of the Directive 2002/96/EC on waste electronic and electrical equipment (WEEE).

Such waste material can be returned to a locally approved disposal service. Observe the specific regulations valid in your country.

9 Service

If you need to have the vehicle serviced, contact your retailer.

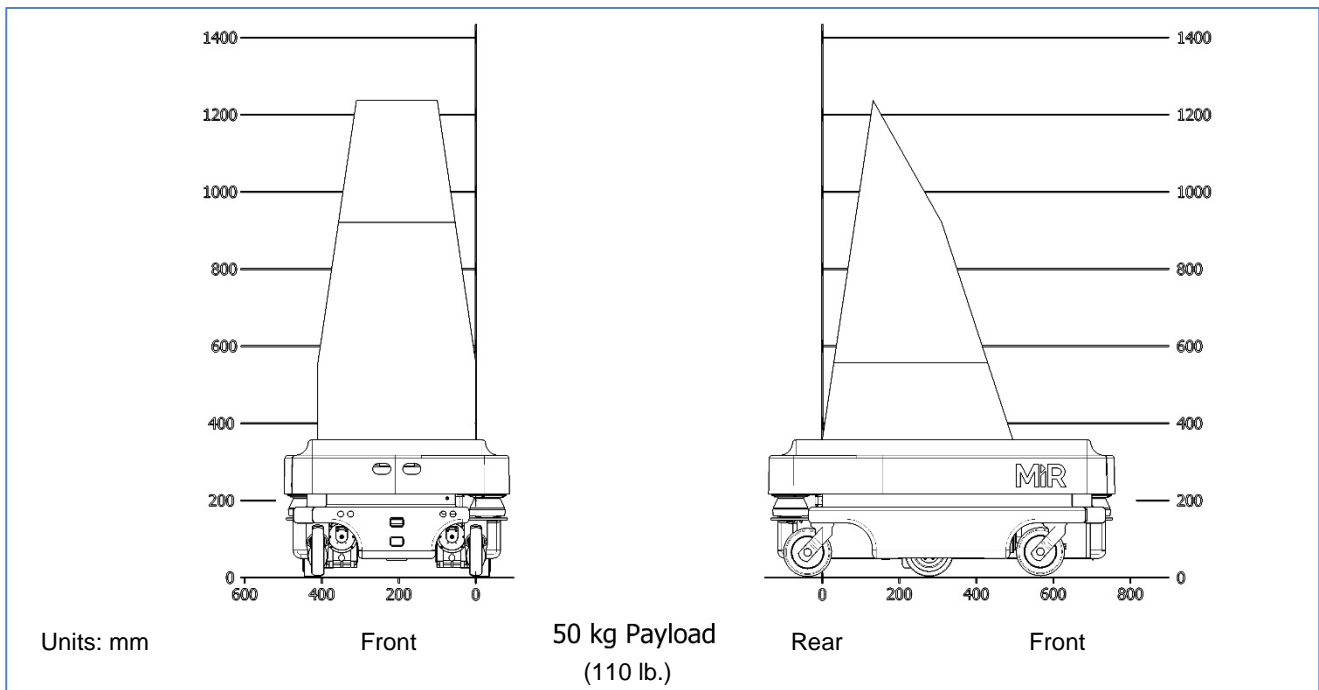
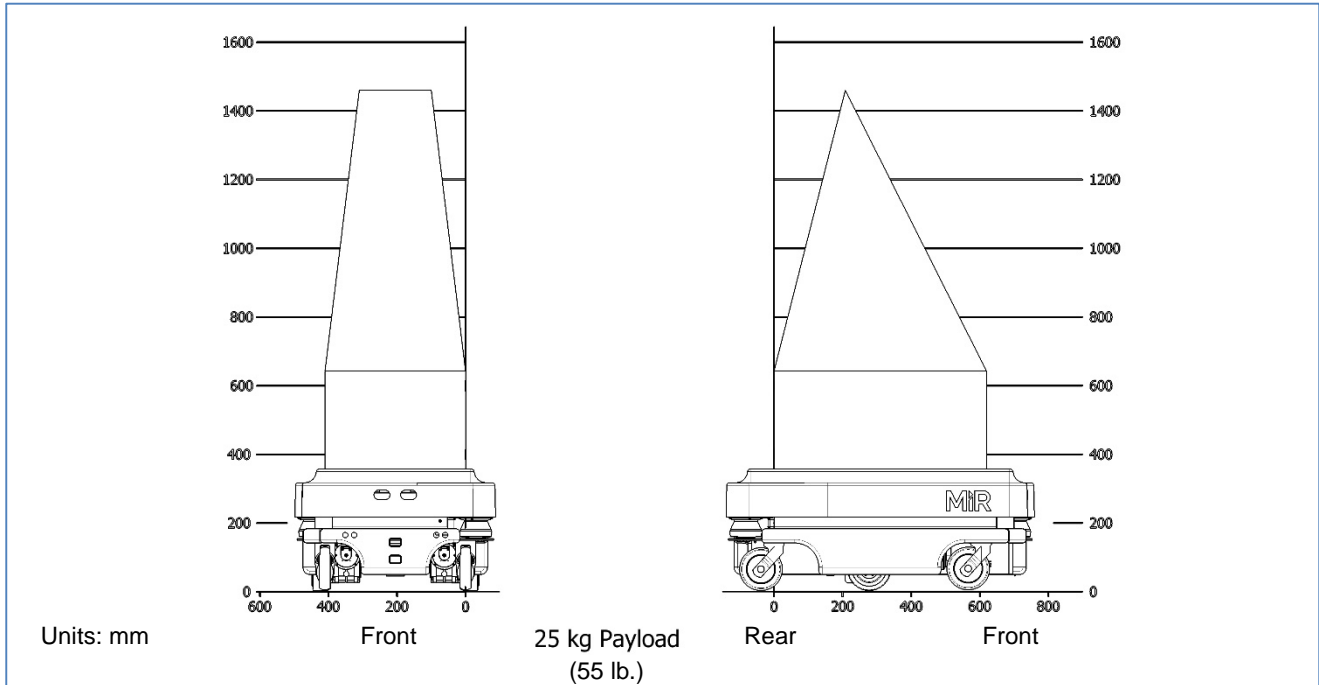
Find contact information on Mobile Industrial Robot's website:

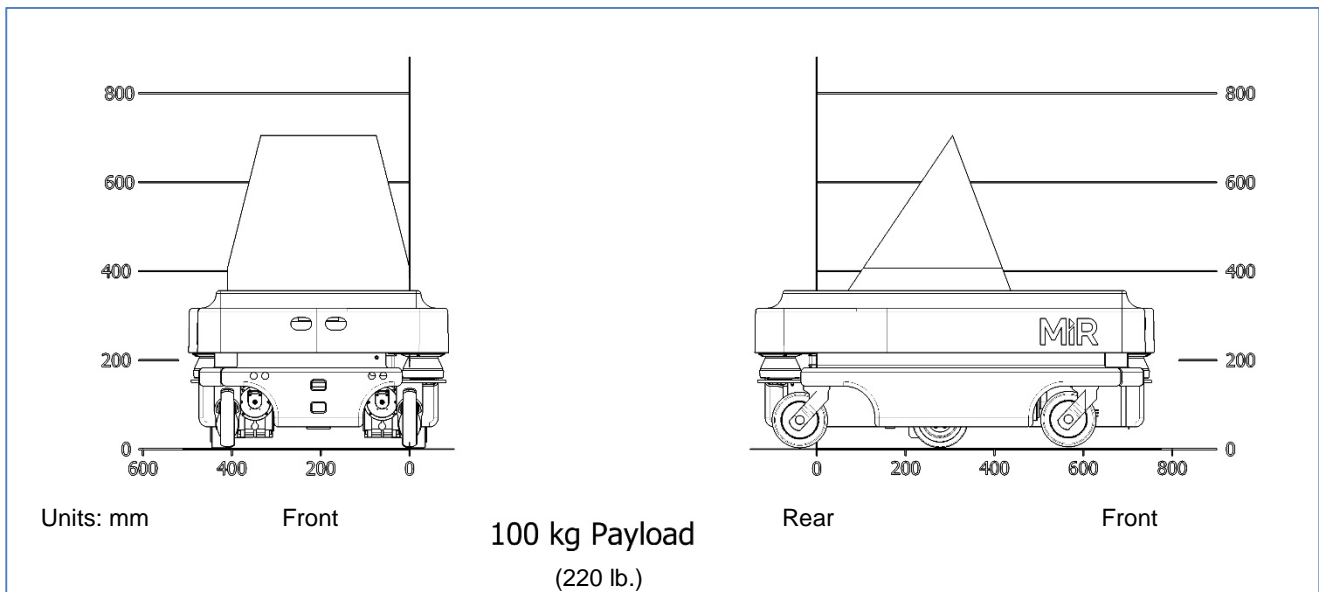
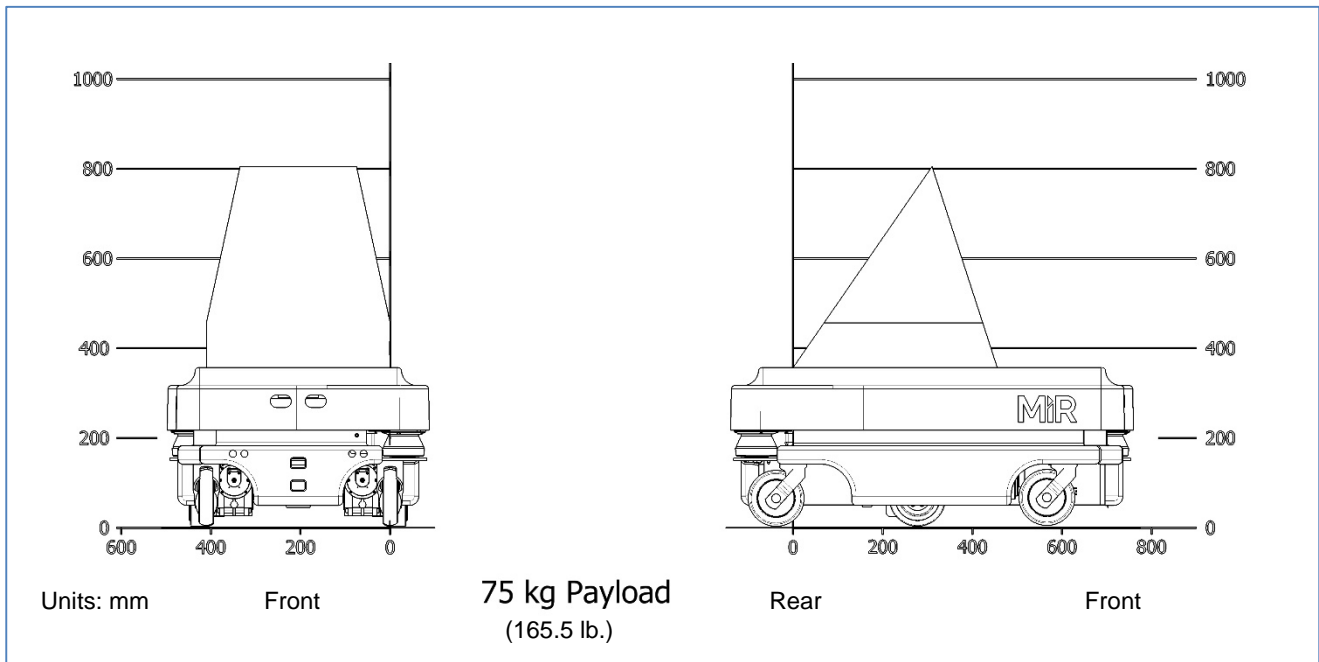
<http://mobile-industrial-robots.com/en/retailers/>

Appendix A: Payload specifications

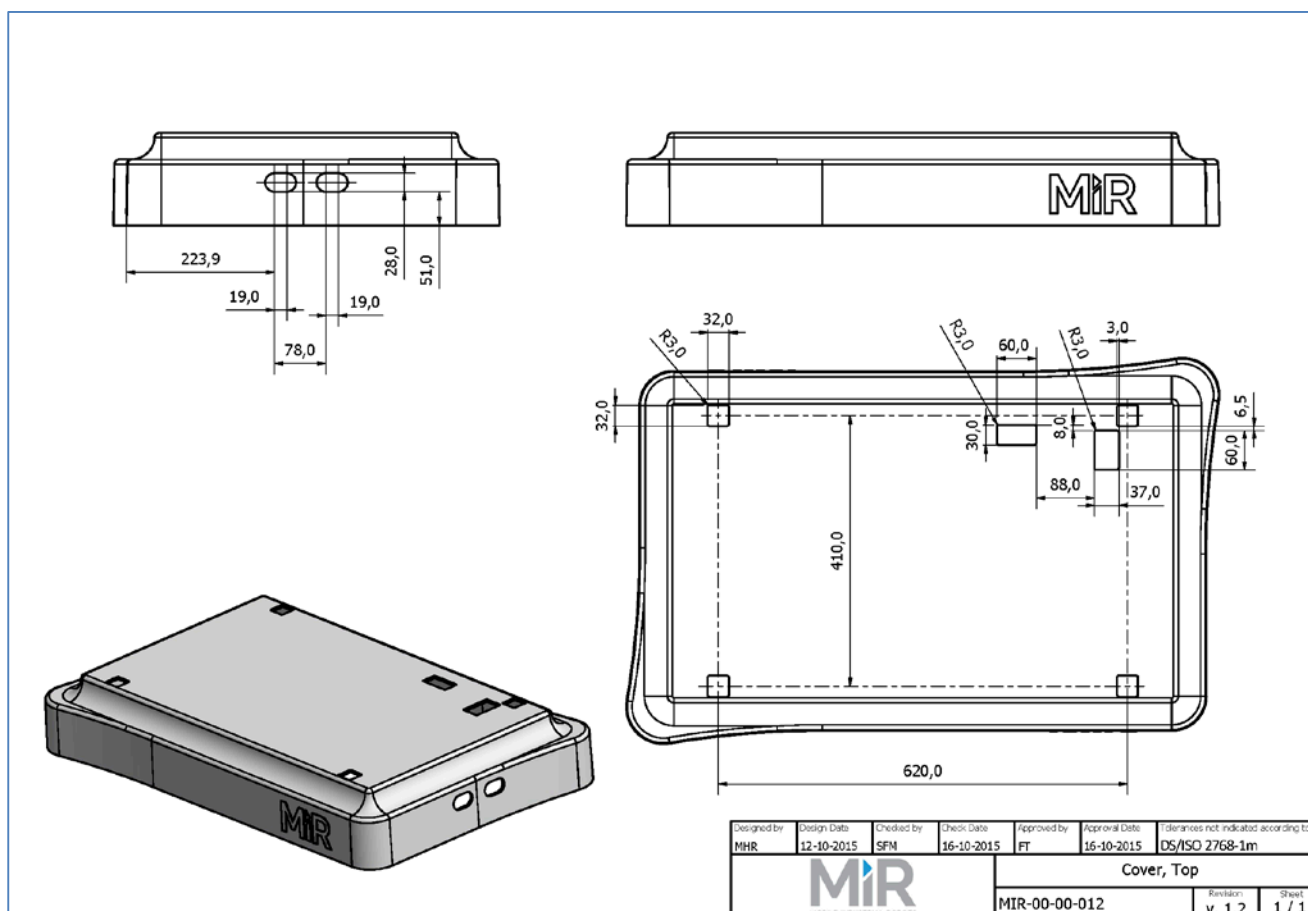
The following drawings illustrate the center of mass (CoM) specifications for safe operation at different payloads.

Maximum load height should be 1.8 m (6 ft.).






Appendix B: MiR100 dimension drawings



Appendix C: Declaration of conformity



Declaration of Conformity for MiR100 1.5

I:
Niels Jul Jacobsen
Mobile Industrial Robots ApS
Emil Neckelmanns Vej 15F
DK-5220 Odense SØ

hereby declare that the product
MiR100 1.5 Serial no. 160100000150092 and higher
an automatic vehicle for handling

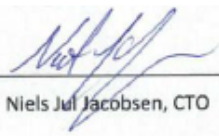
is in conformity with the applicable requirements of the following documents:

Ref. no.	Title
2006/42/EC	The EU Machinery Directive Directive of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast).
2014/30/EU	The EU EMC Directive Directive of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (recast).
2014/35/EU	The EU Low Voltage Directive Directive of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.
1999/5/EC	The EU Radio Equipment Directive Directive of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.

and by harmonized European standards or parts thereof:

Ref.no.	Title
EN 61000-6-2	EMC: Immunity for industrial environments
EN 61000-6-4	EMC: Emission standard for industrial environments
EN 60601-1-1	EMC: Limit value for medicinal for medicinal equipment
EN 13849-1	Machine safety: General Construction
EN 13849-2	Machine safety: Validation
EN 13850	Machine safety: Emergency stop and the creation of this
EN 13855	Machine safety: Placement of safety measures
EN 1525	Safety for unmanned trucks
EN 1175-1	Safety for battery driven trucks

Odense 04/07/2016



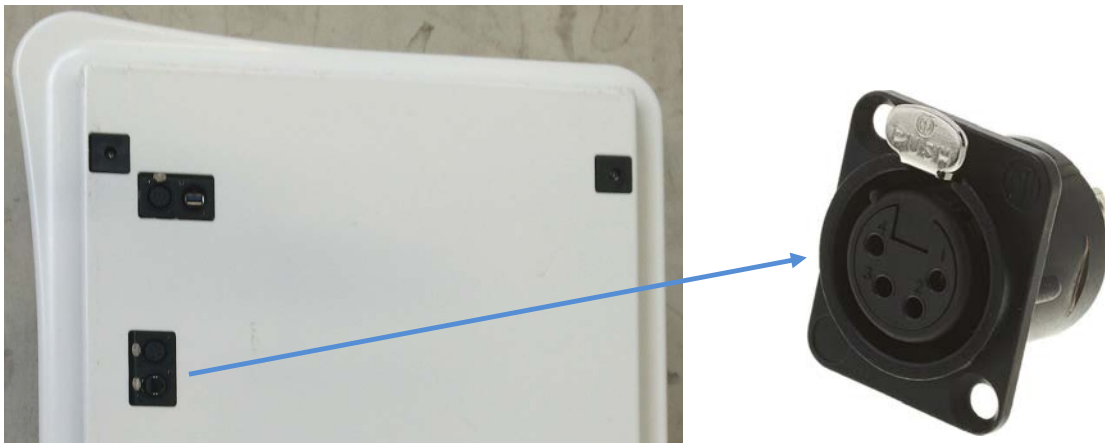
Niels Jul Jacobsen, CTO

Appendix D: Accessories made standard as of release 1.5

As of release 1.5 the MiR100 comes with application interface and interface to docking station as standard.

Application interface

The application interface has an RJ45 ethernet connector and a Neutrik FC4 FDL1-B connector (enlarged picture) for connection to external hardware such as hook.



Pin number	Signal name	Max. current	Remarks
1	Battery voltage	3A	Always on
2	Battery voltage	3A	Starts with the robot
3	Battery voltage	10A	Stops by emergency stop
4	GND	10A	Ground

Tabel 1: Neutrik FC4 FDL1-B pin connectors

Interface to docking station

The two pad connectors on the front skirt of the MiR100 are used to connect to corresponding charging poles for automatic charging with the MiR100 Docking station.

