



Cosima

Neobotix GmbH

Aug 17, 2026

Operating Instructions

1	Introduction	1
1.1	About This Documentation	1
1.1.1	Symbols and Conventions	1
1.1.2	Further Information	2
1.2	Legal Notes	2
1.2.1	Version Information	2
1.2.2	Liability	2
1.2.3	Downloads and Further Information	2
2	Cosima	3
2.1	Quickstart	3
2.1.1	Startup	4
2.1.2	Shutdown	4
2.2	Robot	4
2.2.1	Kinematics	4
2.2.2	Sensors	5
2.2.3	XY Table	5
2.2.4	Tool axis	5
2.2.5	Inclination	5
2.3	User Interface	5
2.3.1	Indicators	6
2.3.2	Start	7
2.3.3	Project Page	7
2.3.4	Job Page	9
2.3.5	Execution Page	12
3	ROX	14
3.1	Product Information	15
3.1.1	Intended Use	15
3.1.2	Improper Use	15
3.1.3	Working Area	16
3.1.4	Qualified Personnel	16
3.1.5	Safety Instructions	16
3.2	Operating Elements	17
3.2.1	Emergency Stop Buttons	18
3.2.2	Key Switch	18
3.2.3	Ethernet Port	18

3.2.4	Access to the On-Board Computer	18
3.2.5	Brake Release Button	18
3.2.6	LED Lighting	18
3.2.7	Charging Socket	19
3.2.8	Battery Activation Switch	19
3.2.9	Wireless Emergency Stop	19
3.3	Mechanical Properties	19
3.3.1	Dimensions	19
3.3.2	Absolute Maximum Ratings	22
3.3.3	Positions of Sensors	23
3.3.4	Electrical Properties and Miscellaneous Data	24
3.3.5	Connecting Additional Devices	24
3.4	Transport	24
3.4.1	Packaging	24
3.4.2	Unpacking the Robot	25
3.4.3	Moving the Robot in the Event of an Error	27
3.4.4	Shipping the Robot in the Neobotix Transport Box	28
3.5	Maintenance	30
3.5.1	Cleaning	30
3.5.2	Batteries	30
3.6	Taking out of Service	32
3.7	Legal Notes	32
3.7.1	EU Declaration of Conformity	32
3.7.2	RoHS Information	32
4	General Hardware Information	33
4.1	Key Switch	33
4.1.1	Turning on	33
4.1.2	Emergency Reset	33
4.1.3	Shutting down	33
4.1.4	Switching off	34
4.2	LC Display	34
4.2.1	Main View	34
4.2.2	The Info View	35
4.3	LED Lighting	36
4.4	Batteries	37
4.4.1	Battery Types	37
4.4.2	Charging	42
4.4.3	Recycling	43
4.5	Laser Scanners	44
4.5.1	Mode of Operation	44
4.5.2	Safety Instructions	45
4.6	Wireless Emergency Stop	45
4.6.1	Engaging the Wireless Connection	46
4.6.2	Stopping the Robot Remotely	46
4.7	Charging Stations	46
4.7.1	Inductive Wallbox	46
4.7.2	Automatic Charging Station	54
4.7.3	External Battery Charging Station	55
4.8	Connectors	56
4.8.1	TE Connectivity - HE14	56
4.8.2	Würth Elektronik - MPC4	58
4.8.3	Würth Elektronik - MPC3	59
4.9	Safety Instructions	60

4.9.1	General Safety Instructions	60
4.9.2	Briefing	61
4.9.3	Safety System	61
4.9.4	Cooperating with the Robot	62
4.9.5	Bringing into Service	62
4.9.6	Modification of the System	63
4.9.7	Expected Misuse	63
4.9.8	Configuring the Safety Fields	64
4.10	Safety Instructions (Manipulators)	65
4.10.1	Robot Arms	65
4.10.2	Laser Scanners	65
4.10.3	Working required from the Customer	65
4.11	Maintenance	66
4.11.1	Cleaning	66
4.11.2	Maintenance and Repairs	66
4.12	Qualified Personnel	67
4.13	Taking out of Service	68
4.13.1	Disassembly	68
4.13.2	Recycling	68
4.13.3	Mechanical parts	68
4.13.4	Electrical components	68
4.13.5	Batteries	69

1.1 About This Documentation

1.1.1 Symbols and Conventions

The following symbols and highlighting are used in this documentation:

Danger: Indicates a hazardous area or an immediately dangerous situation that could lead to serious injury or even death.
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Warning: Indicates a hazardous area or a potentially dangerous situation that could lead to serious injury or damages.

Attention: Indicates hazards or situations that can lead to minor injuries, damages or other negative effects.

Note: Indicates important information that must be observed for safe operation.

Tip: Provides helpful tips to make working with the mobile robot easier and more efficient.

- Lists contain several items of information on the same topic.
- Where possible and appropriate, they are prioritised, with the most important entry at the top.
- Lists do not claim to be exhaustive unless otherwise stated.

1. Instructions are numbered.

2. Numbered instructions must be followed in the given order.

1.1.2 Further Information

Further information, especially on customised configurations and systems, will be provided with your robot on delivery or [on request](#)¹. In most cases, all documents relating to your customised robot are also available in the [download area](#)² of our website.

1.2 Legal Notes

1.2.1 Version Information

The English part of this online documentation has been translated and is not the original. Please refer to the German version in case of uncertainties or questions.

1.2.2 Liability

Every care has been taken in the preparation of this manual which represents the state of technology at the time of its composing. However, inaccuracies or omissions might occur. Please inform Neobotix in case you notice any.

The Neobotix GmbH cannot be held responsible for any technical or typographical errors and reserves the right to make changes to the product and manual without prior notice. Neobotix makes no warranty of any kind with regard to the material contained within this document, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Neobotix GmbH shall not be liable or responsible for incidental or consequential damages in connection with the improper use of one or more of the products described in this manual.

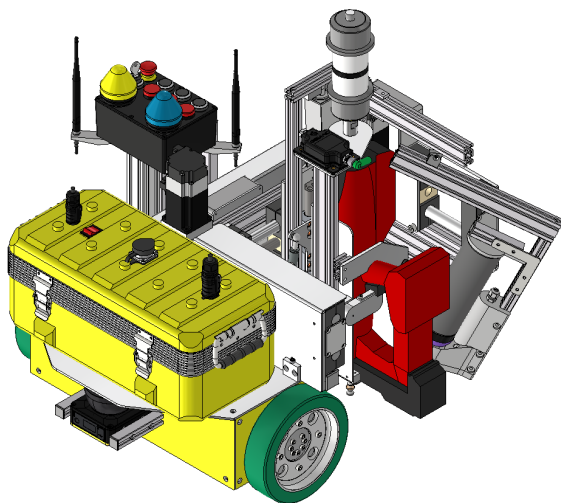
1.2.3 Downloads and Further Information

Additional information, data sheets and documentations, also for other products of Neobotix, can be found in the download section on our homepage: <https://www.neobotix-robots.com/service/downloads>.

¹ <https://www.neobotix-robots.com/contact/contact-details>

² <https://www.neobotix-roboter.de/login>

↓ Download as PDF³



Cosima is a robot and application for surveying and marking tasks at construction sites.

Given an external position reference (tachymeter, total station theodolite), the robot can autonomously work on a list of stakeout points and place and apply a tool at each one with millimetre precision. The tool can be chosen depending on the task at hand, for example marking spray, a paint marker or a nail gun.

2.1 Quickstart

Note: These instructions are meant as a guide and reminder for users already familiar with the system. They do not provide the necessary knowledge for a safe operation.

³ <https://neobotix-docs.de/hardware/en/Cosima.pdf>

2.1.1 Startup

- Turn on the battery by using the switch next to it.
- Turn on the robot by briefly turning the key switch clockwise. Wait until the LED strip lights up and completes the colorful startup pattern.
- Press the emergency stop button, release it again and confirm with a brief clockwise turn of the key switch. The xy table should now move to the end of both axes and then back to the middle.
- Press the X button on the gamepad to enable teleoperation mode. The LED strip should blink yellow. Hold the RB button while using the two joysticks to move the robot. Note that for safety reasons, both joysticks have to be at zero at the beginning of movement. If they are not, the gamepad will vibrate when the RB button is pressed. Move the robot conveniently close to the working area. Finally, press the B button to disable teleoperation mode.
- The robot sends out a wifi network named `cosima`. Connect to it with the control PC. In most cases you would use the handheld computer of the total station.
- On the control PC, open a browser and go to the site <http://192.168.0.100:8888/>. You should be greeted by the Cosima *User Interface* (page 5).
- Set up the external reference system (total station), set it to track the robot prism and enable data output. The connection indicator in the Cosima GUI should change from red to yellow or green.
- If the connection indicator is yellow, use teleoperation mode (see above) and drive the robot a few meters back and forth in a medium speed. The robot will calculate its angle in the external coordinate system. Once it is done, the connection indicator turns green. You can exit teleoperation mode now.
- Cosima is now ready to receive and execute jobs.

2.1.2 Shutdown

- Turn and hold the key switch anti-clockwise. The LED strip should start flashing white. As soon as the flashing stops, release the key switch.
- The LEDs will slowly fade while the robot is shutting down. This should take about 30 seconds.
- If the robot is not used for a longer period or if it should be transported, turn off the battery by using the switch next to it.

2.2 Robot

The robot platform is based on a heavily customized *ROX* (page 14) with differential drive. Even though it looks very different, most information about operation, safety and maintenance are still applicable. This page will focus on the differences and additions.

2.2.1 Kinematics

The robot has a differential drive kinematics, which means it can move forward/backward and turn on the spot with the rotary center between the traction wheels.

In idle mode and when powered off, the robot closes its brakes. The brake release button can be used to open the brakes and push the robot manually. Since the brakes need power, at least the battery must be switched on for this. Note that manual brake release during operation is considered a safety incident which must be confirmed afterwards by briefly turning the key switch (when the LEDs blink blue).

2.2.2 Sensors

The robot features a safety laser scanner to detect obstacles by measuring distances. If an obstacle gets too close to the robot while driving automatically, it will slow down and eventually stop and wait until the obstacle is removed. Teleoperation is still possible however. If the obstacle gets close enough to penetrate the scanner's safety field, the safety controller will inhibit any movement in a safe way (yellow LEDs). The only way to move the robot from here is the brake release button.

Tip:

- Any macroscopic object can be recognized as an obstacle, for example loose wires, grass or uneven floor.
 - Laser scanners have been known to be sensitive to direct sunlight or abrupt changes in lighting. Check the scanner display for error messages.
-

Attention: The robot does not have a way to detect holes or cracks in the floor. It is the operator's responsibility to ensure a safe environment. Dropping more than a few centimeters can damage the robot.

2.2.3 XY Table

The XY table consists of two linear axes mounted perpendicularly to allow for precise fine positioning.

When the robot arrives at a destination point, the table will first move to two reference points, read their absolute positions and then calculate the required fine position and move the tool there.

2.2.4 Tool axis

The tool axis contains the prism and the tool, mounted on top of one another.

The tool axis is attached to the robot with a quick-release fastener. To switch the tool, unplug all cables, open the lever and pull the axis up and sideways away from the robot. Then attach the axis with the new tool, close the lever and plug all necessary cables back in.

Before using the tool, make sure to enter the correct tool and prism offsets in the user interface.

2.2.5 Inclination

The inclination sensor enables the robot to calculate the tool position even on uneven surfaces. The sensor must be mounted in the correct orientation, i.e. "X" axis forward and "Y" axis to the left. Refer to the diagram printed or engraved on the sensor.

2.3 User Interface

The Cosima web based graphical user interface can be accessed with any modern browser. After connecting to the robot's wifi (cosima), it is available at <http://192.168.0.100:8888/>.

2.3.1 Indicators

Emergency State	
	Regular operating mode
	Emergency Button is pressed or Scanner Stop is active

Motion Mode	
	Automatic
	Joystick, Custom, None

Localization Mode	
	2D YAW: Good localization status.
	2D: Receiving position data from external reference system. Robot angle unknown.
	No input: The external reference system is either disconnected or not sending data.

Note: To process the data, the robot and the points must be on the same map, which is generated automatically during

the process. Therefore, you can only send the job to the robot if it has a good localization status (2D YAW).

2.3.2 Start

This is the application landing page. It provides a system status overview and the list of available projects.

2.3.2.1 Status Panel

The status table shows the following live values pulled from the robot.

Localization Current localization mode (2D YAW, 2D, N/A).

Motion Mode Current motion mode of the robot (Automatic, Joystick, Custom, None, N/A).

Projects Name of the currently active project on the robot.

Job Name of the currently active job, including execution progress.

EM State Emergency-stop state. Normal operation shows “FREE”. Other possible values: “Scanner Stop”, “EM Stop”, “Radio EM Stop”, “Soft EM Stop”.

2.3.2.2 Projects Panel

Lists all available projects sorted by last-modified date (newest first).

Creating a New Project

1. Click **New Project**
2. Enter a **Project Name** (required).
3. Optionally enter a **Description**.
4. Click **OK**

2.3.3 Project Page

This page shows all content belonging to a single project: its stakeouts and its jobs.

2.3.3.1 Filters

Use Filter fieldset to narrow the displayed points. Filters are also applied when exporting points.

2.3.3.2 Importing points

1. Click **Load from File**.
2. Select a *.csv* or *.txt* file.
3. The file is parsed and the points are added to the project. The *Source* field of the points is populated with the file name.

Note:

Supported file formats are: csv and txt.

Supported separators are: comma (,), semicolon (;), whitespace.

Column order is: ID -> East -> North -> Elevation

2.3.3.3 Exporting points

1. Apply any desired filters.
2. Click **Export**.
3. A CSV file named *cosima_<ProjectName>_date_time.csv* is downloaded.

Note: Column order is: ID -> East -> North -> Elevation -> Tool East -> Tool North -> Tool Elevation -> Delta East -> Delta North -> Delta Elevation -> Result -> Tool

2.3.3.4 Creating a point manually

1. Click **Create Point**.
2. Confirm with **OK** after filling in all the data.
3. Point is added to the project. The *Source* field of this point is set to *manual*.

2.3.3.5 Result History

Clicking a row in the Stakeout table opens a modal window where stakeout results can be seen and several actions on the stakeout can be performed.

Reject Adds new result to the stakeout with the status *rejected*.

Reset Adds new result to the stakeout with the status *reset*.

Delete Deletes stakeout from the project. All references in jobs remain unchanged.

2.3.3.6 Tool Error

This section describes the standard operating procedure for verifying stakeout accuracy and applying tool offset corrections. This procedure ensures that the physical markings correspond exactly to the designed project stakeout coordinates.

Step 1: Execute Stakeout Marking

- Mark one stakeout from the project.
- Make sure the stakeout is marked as **SUCCESS** in the project view.
- Ensure the physical mark is stable and clearly visible for verification.

Tip: Sometimes, it is possible to use an existing point from the project. Otherwise, a manually created point can be used for offset verification.

Step 2: Measure Real-World Coordinates

- Utilize a high-precision survey instrument, (e.g. Total Station) to capture the exact real-world coordinates of the physical mark.
- Record the precise **East** and **North** values.

Step 3: Access Stakeout Results

- Return to Cosima UI and navigate to the project page.
- Locate the specific stakeout item in the table.
- Open the **Results for Stakeout** modal.
- Activate **Tool Error** tab.

Step 4: Input Empirical Measurements

- Enter the exact **Measured East** and **Measured North** values captured during Step 2.
- The system will automatically compute the delta between the intended design point and the physical mark, displaying the calculated **Tool Error**.

Step 5: Apply Offset Adjustments

To compensate for the calculated discrepancy in future operations, you must manually apply the displayed tool error to the tool configuration.

Depending on whether this adjustment is for the current active job or a permanent tool profile, update one or both of the following locations:

- **For the Active Job:** Open the corresponding **Job**, activate the **Tool** tab. Then, add the displayed tool error values to the existing offset values.
- **For Global/Future Use:** Navigate to the **Settings** page, locate the corresponding **Tool Template** in the table and click **Edit**. Then, update **Tool** offset values and save.

Tip: Use multiple browser tabs for easier operation.

2.3.4 Job Page

The **Job** page is a central interface for managing a specific job within your project. It allows you to select and sequence stakeout points, visualize them on a map, and configure the tool that the robot will use during execution.

2.3.4.1 Interface Overview

The interface is divided into two primary sections:

- **Left Panel (Tabs & Actions):** Provides global actions (Save, Delete, Send to Robot) and allows switching between the **Map** and **Tool** views.
- **Right Panel (Points Management):** A dual-pane list interface for managing which points from the project are assigned to the current job.

2.3.4.2 Global Actions

Located at the top left of the interface, these buttons control the lifecycle of the job:

- **Save:** Saves any modifications made to the job. If there are unsaved changes, the icon turns orange as a visual indicator.
- **Delete:** Permanently deletes the current job from the project. You will be prompted to confirm this action.
- **Send:** Dispatches the job to the robot for execution.

Note: The system requires the robot's localization mode to be **2D YAW** before a job can be sent. If you have unsaved changes, you will be prompted to save them before sending.

2.3.4.3 Points Management

The right side of the screen features a dual-pane interface for selecting and organizing stakeout points.

Project Points (Left Column)

This column lists all available points within the project.

- **Filter:** Opens a dialog to filter the visible points based on their last stakeout result. When a filter is active the icon turns orange.
- **Select All / Select None:** Quickly select or deselect points.
- **Add:** Adds the currently selected project points to the job point list.

Tip: You can quickly access the project page by clicking the button with the project name.

Job Points (Right Column)

This list represents the actual sequence of points the robot will visit.

- **Select All / Select None:** Quickly select or deselect points.
- **Remove:** Removes the selected points from the job.
- **Reordering:** You can drag and drop individual points in this list to change the order in which the robot will approach them.

2.3.4.4 Map Tab

The **Map** tab provides a 2D spatial visualization of your project and job points.

- **Interactive Selection:** Clicking on points directly on the map will select them in the respective points management lists. Make sure **Select** mode is enabled.
- **Visual Context:** Helps in understanding the physical layout of the stakeout points and planning an efficient route.

2.3.4.5 Tool Tab

The **Tool** tab contains the configuration for the physical instrument mounted on the robot.

Tip: Each job has its own tool configuration. To reuse the same configuration in other jobs, save it as a template in the job configuration (Job->Tool->Tool Templates->Save Current Tool as Template) or create a new template in **Settings**.

Tool Templates

- **Tool Templates Button:** Opens a dialog to manage tool configuration.
- **Save Current Tool as Template:** Allows you to save your current offsets and control actions as a reusable template.
- **Apply Template:** Choose a previously saved template from the dropdown to instantly overwrite the current tool configuration in the job.

Configuration Parameters

- **Name:** A descriptive identifier for the tool.
- **Offsets (X, Y, Z):**
 - **Base:** Offset from the default tool mounting point (e.g. middle of the XY table) to the prism/tool axis. Depending on the robot model there can be multiple mounting options available i.e. XY table and fixed tool mount.
 - **Prism:** Offset from the **Base** (tool mounting point) to the prism attachment point. Normally X and Y should be left at 0 and Z is the distance above the ground.
 - **Tool:** Offset from the **Base** (tool mounting point) to the tool itself. Normally should be 0 - see *Tool Error* (page 8).
- **Fine Positioning:** A checkbox to enable high-precision tool positioning using XY table.

Control Actions

Defines the automated sequence of events triggered at each stakeout point.

- **Add Relay:** Adds a relay trigger to the sequence. You can specify the relay number and toggle its state (ON/OFF).
- **Add Wait:** Adds a timed delay in milliseconds to pause the sequence.
- **Delete:** Removes a specific action from the sequence.

2.3.5 Execution Page

The **Execution** page is the primary interface for monitoring and controlling an active job. It provides real-time visualization of the robot's progress, tool status, and execution controls.

2.3.5.1 Interface Overview

The interface is divided into two main sections:

- **Left Panel (Execution Map):** Displays a 2D map with real-time updates of the project layout, the active execution path, and the next stakeout point.
- **Right Panel (Controls and Status):** Contains the core controls for managing the executions state, tool parameters, and the remaining worklist.

2.3.5.2 Status and Context

At the top of the right panel, you can find the current operational context:

- **Project and Job Buttons:** Displays the names of the currently active project and job. Clicking these links will navigate you to their respective management pages.
- **Tool Information:** Shows the name of the active tool, whether **Fine Positioning** [FP] is enabled, and the **Tool Offset** [X, Y].
- **Next Point:** ID of the very next point the robot will approach.
- **State:** Displays current operational state of the robot (e.g. `IDLE`, `DRIVING`, `FINE_POSITIONING`).

2.3.5.3 Execution Controls

A set of buttons allows you to control the lifecycle and parameters of the execution:

- **Tool Countdown:** Displays the remaining countdown for the tool or ∞ if it is not set. Clicking this button opens a prompt that allows you to set or clear a new countdown value. Countdown decreases with each executed stakeout point. Once it reaches 0, the robot waits for user interaction (e.g. reload the tool magazine and reset the countdown value).
- **Trigger:** Displays the current trigger value which corresponds to a physical button on the robot. Depending on the hardware configuration this value should be set to 0, 1, 2 or 3. If the trigger is set, the robot pauses at each point and waits for the corresponding button to be pressed before moving on to the next point. When not set (-), the robot will automatically process the full stakeout sequence.
- **Execute / Pause:**
 - When the robot is idle or paused, the button shows **Execute**. Clicking it will begin or resume the job.
 - When the robot is operating, the button shows **Pause**. Clicking it will temporarily halt the robot's operation.

Note: The robot's motion mode must be set to `automatic` to begin execution.

- **Cancel:** Permanently stops the current execution. You will be prompted to confirm this action.

2.3.5.4 Worklist Management

The lower half of the right panel displays the sequence of remaining points in the active job.

- **List View:** Shows all points yet to be staked out, with the current/next point highlighted.
- **Skip Point (Arrow Down Icon):** Each point in the worklist has a **Skip** button. Clicking this button will skip the point and remove it from the robot's current worklist. You will be prompted to confirm before the point is skipped.

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The autonomous mobile robots ROX offer maximum flexibility and adaptability to individual requirements. At the same time, they have a uniform design and operating concept across all variants, thus simplifying subsequent extensions and adaptations of existing robot installations.

The modular carrier frame of the ROX robots can be adapted to the application's requirements in length, width and height and can be extended by load handling devices and manipulator arms.

Several kinematic systems are available for the undercarriage within the frame, each with its own advantages:

Diff The centrally positioned differential drive is very manoeuvrable and compact and the standard solution for simple applications.

Trike With the differential drive rigidly mounted on the front of the platform, very high stability is achieved at very low cost.

⁴ <https://neobotix-docs.de/hardware/en/ROX.pdf>

Argo The use of ArgoDrive modules gives this solution a high load capacity and the ability to move freely and smoothly in all directions at all times.

Meca (discontinued) Thanks to the Mecanum wheels, this more cost-effective variant can also move smoothly in all directions.

The power supply of the ROX platforms can also be adapted to the specific application. Classic *AGM batteries* (page 37) are available as a basic version, which are ideal for applications with a small budget and single-shift operation. If short charging times and continuous use or low weight are required, *LiFePO4 batteries* (page 38) batteries should be chosen.

Both battery technologies are available as mechanically identical battery packs, of which up to three packs of the same type can be connected in parallel to increase runtime.

Two control software solutions are available.

- **PlatformPilot⁵** is a professional AMR control software from Neobotix, developed mainly for industrial applications. It is easy to set up and use and offers the best support for omnidirectional robots.
- **ROS 2⁶** is an open-source framework that is very popular in research and development. It offers unmatched flexibility and the chance to integrate additional modules and functions, but requires solid background knowledge.

3.1 Product Information

3.1.1 Intended Use

The mobile robot has been designed for daily operation in factory workshops and test halls. It can be used for transportation of materials, parts and devices. Furthermore the mobile robot can easily be used in research projects as mobile carrier of sensor equipment, robot arms and other special devices.

Depending on the intended application the mobile robot can be used on its own, in combination with other robot vehicles and in combination with stationary systems. Furthermore, application specific extensions can be integrated into the basic platform. These might be a load handling device, a robot arm or special sensors.

The mobile robot has been designed with focus on indoor operation. It is not recommended to operate the mobile robot outdoors, especially during rain, fog or snow.

3.1.2 Improper Use

Danger:

- The mobile robot must not be used for transportation of passengers in any way. No person must ride on the robot itself, nor must the robot be used to move any other vehicle or hanger with passengers aboard.
- The mobile robot must not be operated in any publicly accessible area without assessment of risks. Additional safety measures may be required for public operation of the robot.
- The robot's operational safety has been assessed and ensured based on the intended use-cases and the configuration at delivery. If the robot is to be modified either permanently (e.g. by mounting additional components) or temporarily (e.g. by loading cargo) its safe operation must be assessed and approved.

⁵ <https://www.neobotix-robots.com/products/robot-software/neobotix-platformpilot>

⁶ <https://www.neobotix-robots.com/products/robot-software/ros-2>

- Without the safety approval described above, the mobile robot must at no times be used without supervision of a qualified operator if there are guests, passers-by or other people unfamiliar with the robot within the working area.
- The robot must never be operated in areas where there are staircases leading down, elevated platforms or other possibilities for falling or dropping down. This may cause serious injuries or death!

3.1.3 Working Area

The working area of the mobile robot must be protected against rain and have a sufficiently firm and clean floor. The floor must be even and horizontal.

Tip: Slopes, edges, steps and unevenness can result in problems when the robot is moving or with the localisation. Under some circumstances the robot might not be able to continuously determine its exact position and therefore might plan unnecessary or problematic paths or might even be unable to reach its destination.

Under certain conditions, rain or heavy splash water might enter the robot and cause damages. Flying sparks, heavy dust and similar dirt may affect or damage the sensors and thus might make the operation of the mobile robot inefficient or unsafe. Dirt and liquids on the floor may lead to slippage and problems of localisation and navigation.

The robot does not feature any sensor for detecting staircases, holes or other areas where it may drop down. In case of loss of localisation or faulty programming the robot might fall down such places.

Danger: Always check for and secure all places where the robot might drop down before bringing it into operation.

3.1.4 Qualified Personnel

This product must only be modified, commissioned, operated and serviced by qualified personnel.

The requirements on qualified personnel can be found at [Qualified Personnel](#) (page 67).

3.1.5 Safety Instructions

Please also check the general safety instructions for Neobotix robots which can be found at [Safety Instructions](#) (page 60).

3.1.5.1 Danger Areas

Undercarriage

The undercarriage of the ROX platforms is largely disguised and inaccessible during normal operation, with two exceptions.

Warning:

- The ground clearance of the ROX robots is such that feet and toes cannot be trapped under the chassis if the person concerned is wearing safety shoes. Please contact Neobotix if you have other requirements.
- The Mecanum wheels of the ROX-Meca are not fully enclosed and can be touched by deliberately reaching into the slot between the lower and upper hull sections. Therefore, make sure that the protective fields of the laser scanners are correctly set for each situation and that no passers-by or children can touch the robot.

Configuration of the Safety System

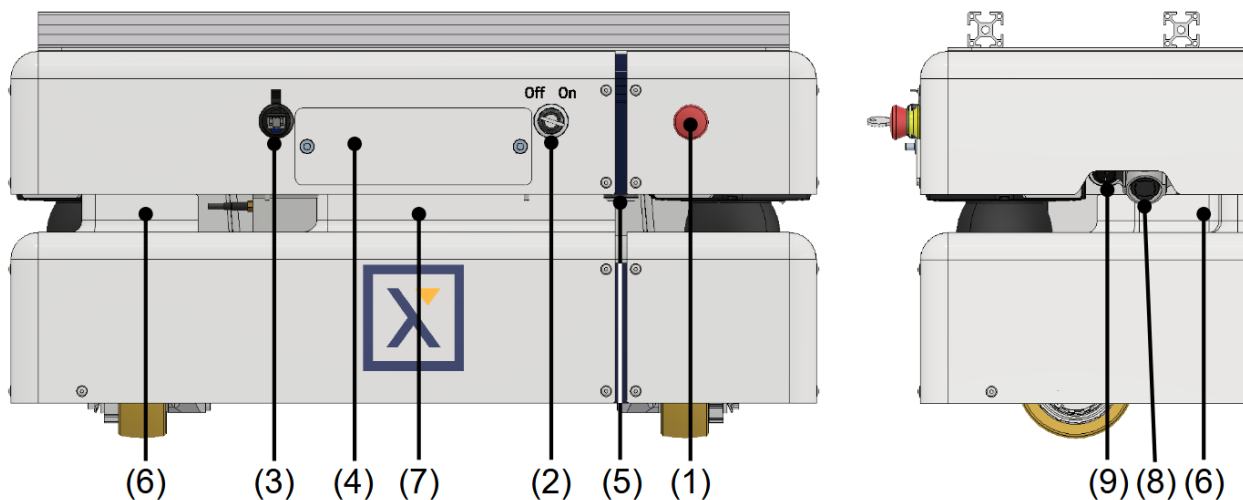
At delivery the safety system and the protective fields of the laser scanners are pre-configured with standard values. For many simple applications without special conditions and requirements, this configuration provides a sufficient level of safety.

Nevertheless, it is generally recommended to familiarise oneself with the safety system, the individual safety functions and the requirements of the respective application before commissioning the autonomous robot. In many cases, individual adjustments can further improve operational safety while minimising downtime and cycle times.

Danger: Incorrectly set protective fields or an incorrectly configured safety controller can result in serious injuries and damage! The responsibility for the safe operation of the autonomous mobile robot lies with the operator.

3.2 Operating Elements

The pictures below show the basic operating elements of the ROX platforms. Individual changes are described in the project specific documentation.



1	Emergency Stop Buttons
2	Key Switch
3	Ethernet Port
4	Access to the On-Board Computer
5	Brake Release Button (except for Argo models)
6	LED Indicators
7	Type Label
8	Charging Socket
9	Battery Activation Switch

3.2.1 Emergency Stop Buttons

When one of these buttons is pressed the robot is immediately set to emergency stop and all further movements are prevented. This state can be reset by unlocking the emergency stop buttons and turning the *Key Switch* (page 33) clockwise to position II for one second.

3.2.2 Key Switch

See *Key Switch* (page 33).

3.2.3 Ethernet Port

This connector provides access to the mobile robot's internal network. It can be used to change the safety controller's configuration if application specific settings are required.

3.2.4 Access to the On-Board Computer

All peripheral connections of the on-board computer are accessible at the back of the platform.

3.2.5 Brake Release Button

Pressing this button will open the motors' brakes, allowing the robot to be moved even while it is turned off. If the brakes are open while the robot is off red warning lights at the front right and rear left corner of the platform light up.

The safety system monitors the state of the brakes and will switch to emergency stop if they are opened manually. Resetting the emergency stop and actively driving the robot is only possible after the brakes have been closed again.

3.2.6 LED Lighting

See *LED Lighting* (page 36).

Note: The LED lighting of the ROX also indicates error states and therefore fulfils an important safety function. To ensure that the LEDs are working correctly, the robot should be restarted at least once a week and checked to ensure that the colour change described *here* (page 36) runs through all colours unchanged.

3.2.7 Charging Socket

The battery charger can be manually connected to this socket. Further information can be found at [Charging](#) (page 42).

3.2.8 Battery Activation Switch

When LiFePO₄ batteries are used, the ROX has a rocker switch that can be used to put the batteries into standby mode.

The battery management system (BMS) integrated into the LiFePO₄ batteries continuously monitors the condition of the batteries and prevents overcharging and deep discharging as well as damage due to overheating, overcurrent and the like. To do this, however, it requires energy that would discharge the batteries in a switched-off robot over a longer period of time. In standby mode, this energy requirement is significantly reduced and the robot can survive several weeks without recharging. However, in this mode, the outputs of the batteries are de-energised and the batteries can neither be charged nor can the robot be switched on.

Tip: Always switch the ROX batteries to standby mode if the robot is not expected to be used for several days or is already largely discharged and cannot be recharged promptly. Reactivation of deeply discharged batteries is possible but time-consuming. In this case, please contact Neobotix.

AGM batteries are always on and cannot be deactivated.

3.2.9 Wireless Emergency Stop

Please read [here](#) (page 45) on how to use the wireless emergency stop system.

3.3 Mechanical Properties

3.3.1 Dimensions

3.3.1.1 Common Dimensions of all Models

Description	Symbol	Value (mm)
Ground clearance of the cover	H1	30
Height of the scan plane	H2	189
Height of the emergency stop buttons	H3	267
Height of the top plate	H4	330
Height of the aluminium profiles	H5	360
Width of the aluminium profiles	W1	634
Width of the cover	W3	680
Centre distance of the outer profiles	L5	165

Type of aluminium profiles: [Misumi HFS6-3030](#)⁷

⁷ <https://uk.misumi-ec.com/vona2/detail/110302686450/?list=PageCategory>

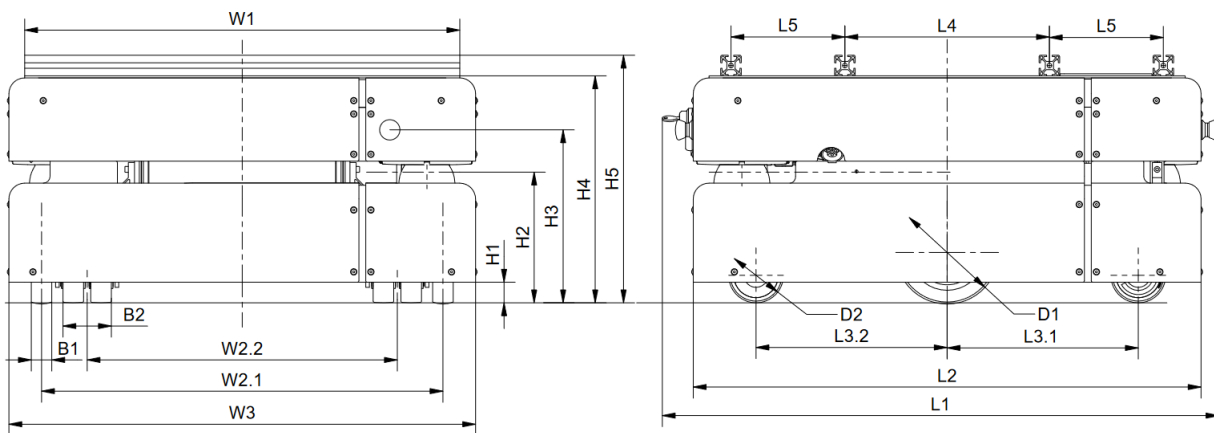
3.3.1.2 Common Dimensions of all Short Models (Diff, Trike, Argo)

Description	Symbol	Value (mm)
Overall length	L1	811
Length of the cover	L2	740
Centre distance of the inner profiles	L4	300

3.3.1.3 Common Dimensions of all Long Models (Meca, Dual Battery Platforms)

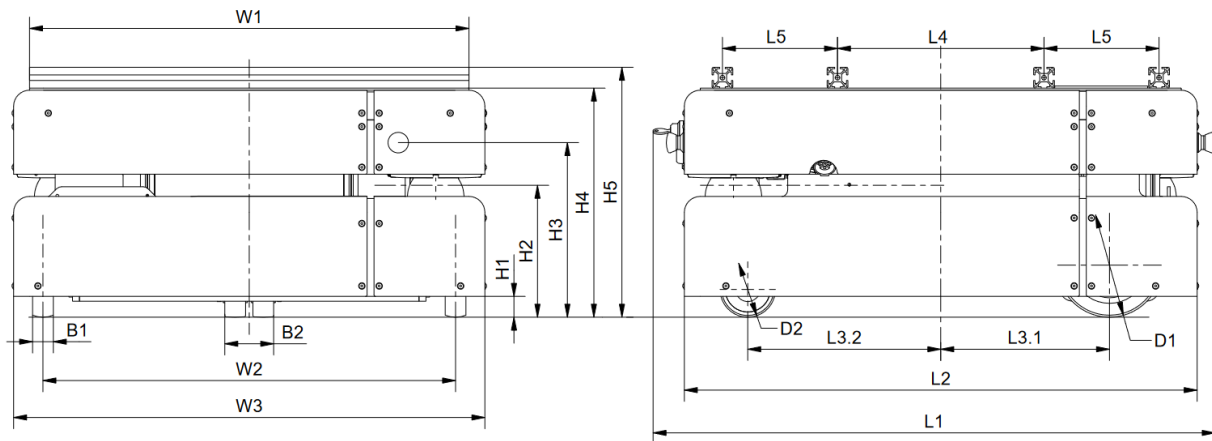
Description	Symbol	Value (mm)
Overall length	L1	1071
Length of the cover	L2	1000
Centre distance of the inner profiles	L4	585

3.3.1.4 Dimensions of the ROX-Diff



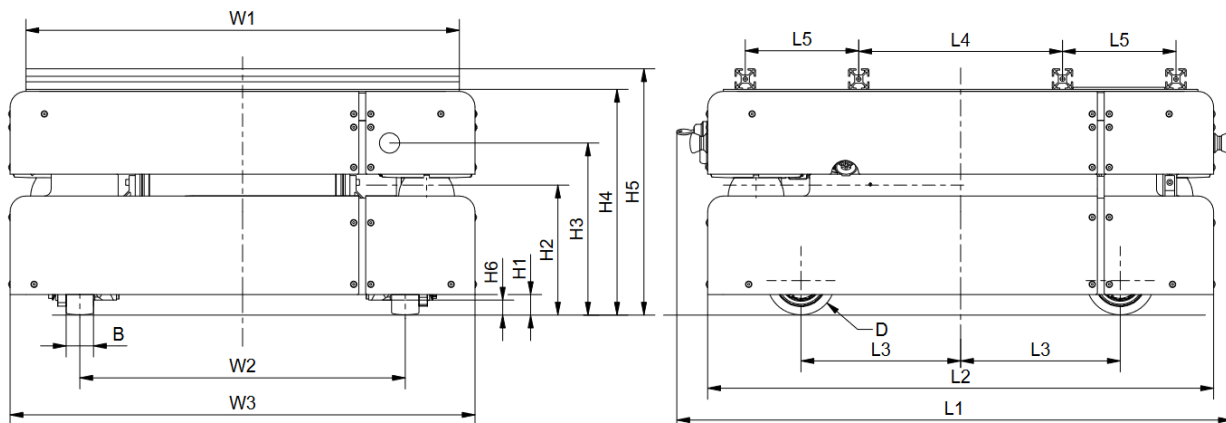
Description	Symbol	Value (mm)
Distance of the leading castor wheels to the platform centre	L3.1	204.5
Distance of the trailing castor wheels to the platform centre	L3.2	294.5
Track width of the drive wheels	W2.1	634
Track width of the castor wheels	W2.2	440
Width of the drive wheels	B1	30
Width of the castor wheels	B2	70
Diameter of the drive wheels	D1	150
Diameter of the castor wheels	D2	80

3.3.1.5 Dimensions of the ROX-Trike



Description	Symbol	Value (mm)
Distance of the drive wheels to the platform centre	L3.1	243.5
Distance of the castor wheel to the platform centre	L3.2	278.5
Track width of the drive wheels	W2	595.5
Width of the drive wheels	B1	30
Width of the castor wheels	B2	70
Diameter of the drive wheels	D1	150
Diameter of the castor wheels	D2	80

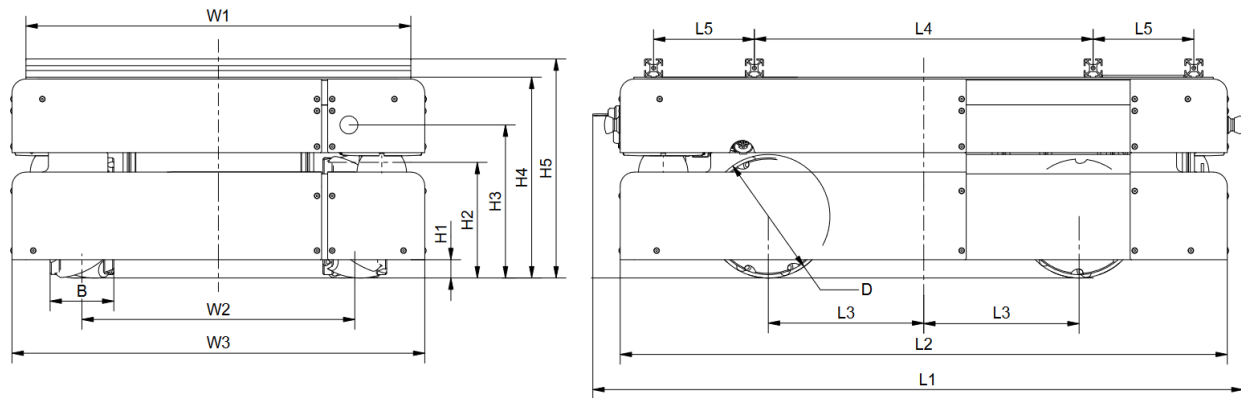
3.3.1.6 Dimensions of the ROX-Argo



Description	Symbol	Value (mm)
Distance of the drive wheels to the platform centre	L3	239
Ground clearance of the wheel carrier assembly	H6	21
Track width of the drive wheels	W2	458
Width of the drive wheels	B	40
Diameter of the drive wheels	D	100

3.3.1.7 Dimensions of the ROX-Meca

Note: The ROX-Meca model has been discontinued due to constructional constraints and is only available as a custom product on specific request.



Description	Symbol	Value (mm)
Distance of the drive wheels to the platform centre	L3	256
Track width of the drive wheels	W2	449.5
Width of the drive wheels	B	105
Diameter of the drive wheels	D	203.2

3.3.2 Absolute Maximum Ratings

Warning: Exceeding these ratings might cause malfunctions or damage the robot!

3.3.2.1 Common Maximum Ratings of all Models

Description	Unit	Value
Storage temperature	°C	-20 .. +50
Operating temperature (environmental temperature)	°C	0 .. +30

3.3.2.2 Maximum Ratings of the ROX-Diff

Description	Unit	Value
Payload	kg	300
Maximum speed	m/s	1.5
Maximum bumpiness to pass over (≤ 0.25 m/s)	mm	10
Maximum bumpiness to pass over (full speed)	mm	5

3.3.2.3 Maximum Ratings of the ROX-Trike

Description	Unit	Value
Payload	kg	300
Maximum speed	m/s	1.5
Maximum bumpiness to pass over ($\leq 0.25\text{m/s}$)	mm	15
Maximum bumpiness to pass over (full speed)	mm	5

3.3.2.4 Maximum Ratings of the ROX-Argo

Description	Unit	Value
Payload	kg	500
Maximum speed	m/s	2.0
Maximum bumpiness to pass over ($\leq 0.25\text{m/s}$)	mm	10
Maximum bumpiness to pass over (full speed)	mm	5

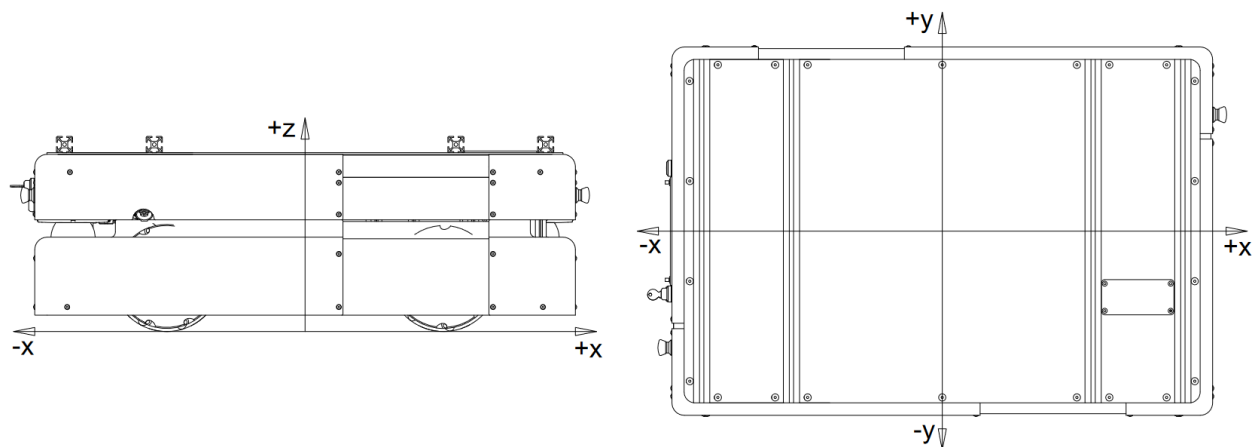
3.3.2.5 Maximum Ratings of the ROX-Meca

Description	Unit	Value
Payload	kg	400
Maximum speed	m/s	2.0
Maximum bumpiness to pass over ($\leq 0.25\text{m/s}$)	mm	10
Maximum bumpiness to pass over (full speed)	mm	5

3.3.3 Positions of Sensors

All distances are in millimetres, measured relative to the platform's coordinate system. All angles are in degrees, measured counter-clockwise from the driving direction.

“Short” indicates to the default values of the Diff, Trike and Argo models, “long” indicates to the default values of the Meca model.



Sensor	X-Pos. "short"	X-Pos. "long"	Y-Pos.	Z-Pos.	Angle a
Laser scanner front left	299	429	269	189	45
Laser scanner rear right	-299	-429	-269	189	225

3.3.4 Electrical Properties and Miscellaneous Data

3.3.4.1 Properties of Internal Components

Description	Unit	Value
Encoder resolution of the motors	Incr. / Rev.	4096
Nominal battery voltage	V	48
Maximum battery voltage	V	57.6
C5-Capacity of AGM batteries	Ah	26
Nominal capacity of LiFePO4 batteries	Ah	21
Weight of an AGM battery pack	kg	37
Weight of an LFP battery pack	kg	14

3.3.4.2 Other Properties

Description	Unit	Value
Weight of the ROX-Diff (LFP)	kg	62
Weight of the ROX-Trike (LFP)	kg	52
Weight of the ROX-Argo (LFP)	kg	97
Additional weight for AGM batteries	kg	+23
Expected working time	a	10
Intrusion protection	IP	12

3.3.5 Connecting Additional Devices

Various optional components can be connected to the central control board (RelayBoard) and other devices can be powered by it. It also offers connection options for four buttons, four digital inputs (24 V) and four solid state relay outputs.

A small number of free connection points is also available on the internal terminal blocks. If required, additional terminal blocks, connectors, voltage transformers and other connections can be integrated.

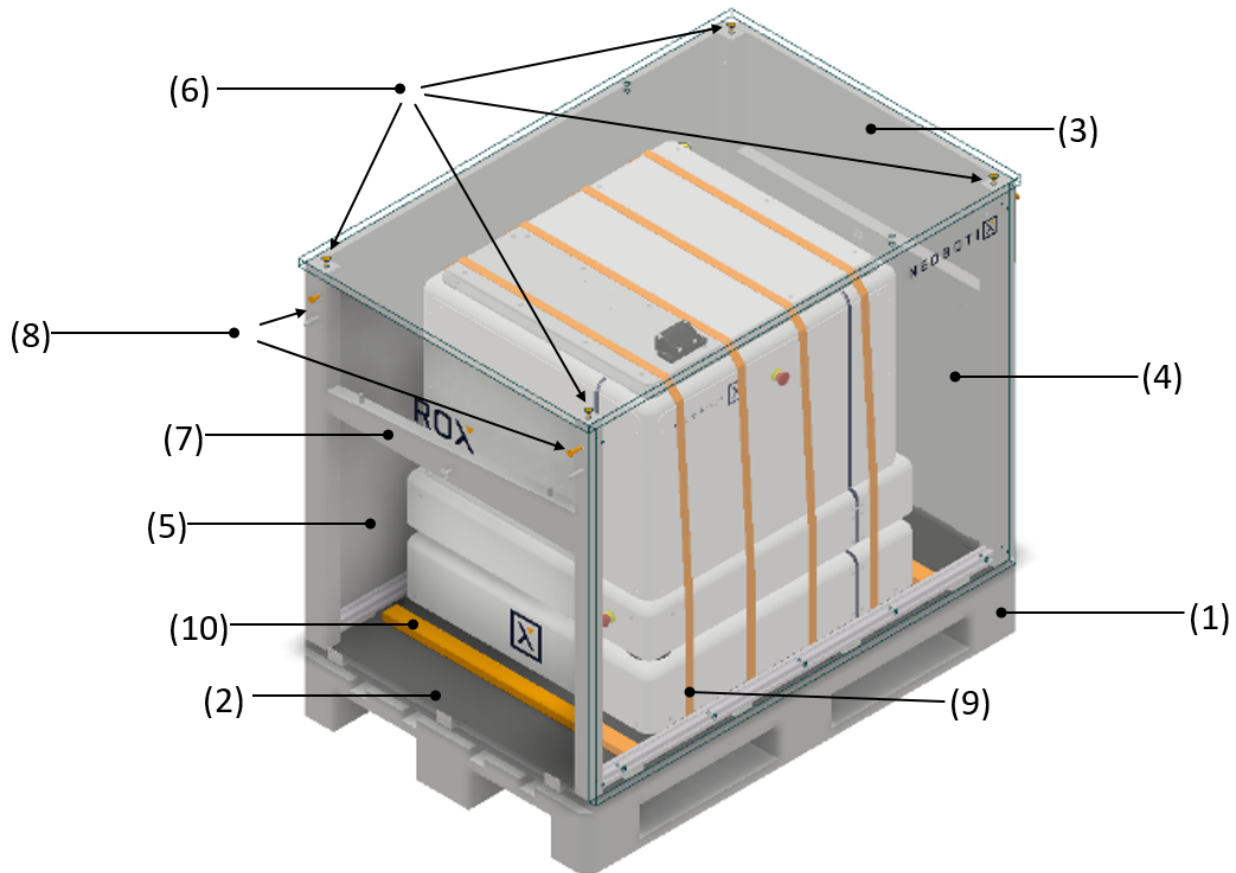
Further information and technical data are available on request.

Further information on the connectors used can be found at [Connectors](#) (page 56).

3.4 Transport

3.4.1 Packaging

The ROX mobile robot is supplied in a sturdy wooden crate that can also be used for subsequent transportation. If the original crate can no longer be used, for example due to superstructures and extensions, it is recommended that a new, appropriately sized crate is built.



The base of the transport box consists of a standard Euro pallet (1) with the dimensions 1200 mm x 800 mm x 144 mm. It can therefore be transported and moved using any standard industrial fork lift with a corresponding load capacity.

A base plate (2) is placed on the pallet, on which the robot is fixed during transportation.

The side walls and lid (3) of the transport box are not connected to the robot and are designed in such a way that they can be dismantled with little effort. The end walls (4) are attached to the base plate by hinges and remain attached to the box during loading and unloading. The long side walls (5) can be removed from the base plate by sliding them.

To prevent dust and dirt from entering the robot, the maintenance flap must be closed before transportation and all external plug connections must be plugged together or sealed with suitable protective caps.

Note: Depending on the buffer material used, it may be advisable to remove the key switch and transport it separately to prevent damage to the lock. You can find more information on this topic at [Operating Elements](#) (page 17).

3.4.2 Unpacking the Robot

Unpacking the robot takes up some space. You should therefore leave at least two meters of space around the transport box and at least four meters in front of the side marked “Ramp”. Unpacking should also take place on level ground.

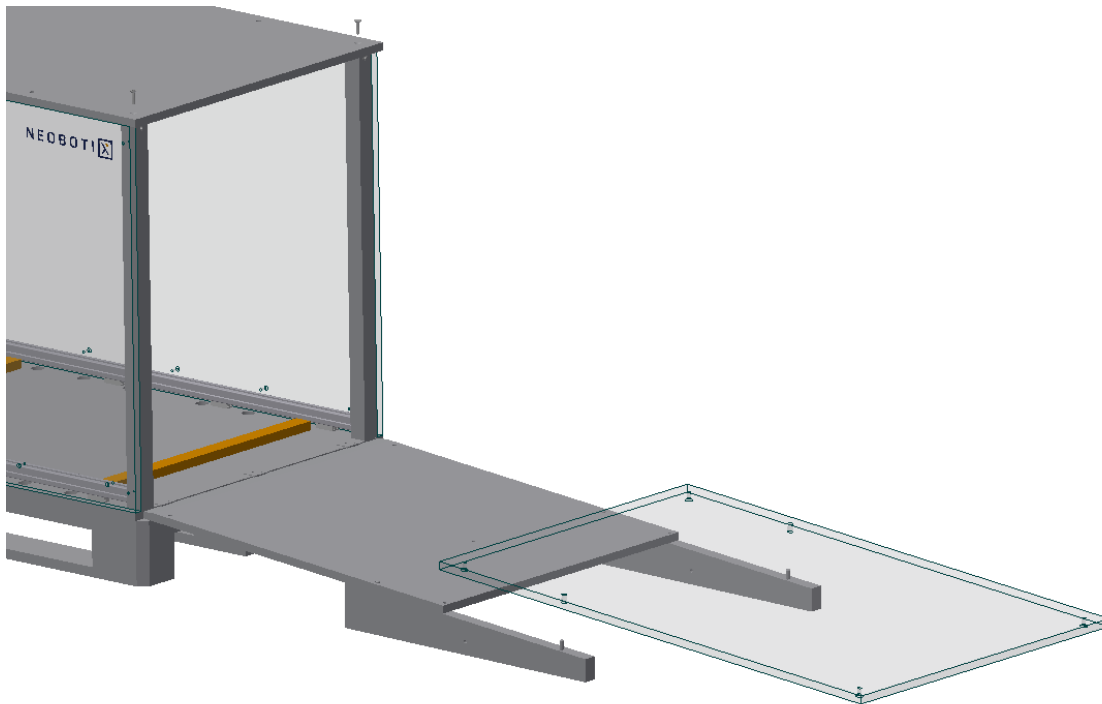
The following tools are required to unpack the robot:

- Safety knife
- Allen key 5 mm

- Cordless screwdriver with Torx T20 bit

Proceed as follows to remove the robot from the transport box:

1. First unscrew the four screws (6) on the cover, take it off and set it aside.
2. Remove the ramp wedges (7), which are attached to the inside of both end walls, by pulling the split pin on the fastening bolt. They will later serve as a base for the ramp. The bolts and cotter pins must not be refitted, but should be kept for later shipment with the transport box.
3. Unscrew both screws (8) on the end walls and fold these walls down until they rest on the floor.
4. Lift the end wall marked “Ramp” slightly and place the ramp wedges about halfway underneath it, as shown in the following illustration. Ensure that the higher end of the wedge points towards the transport box and that the corresponding dowel in the ramp wedge is inserted into the screw hole in the front wall.



5. Now place the lid of the box on the ramp wedges so that it is flush with the end wall and forms a continuous ramp. Make sure that the dowels are properly seated in the screw holes of the cover.
6. Remove the side panels from the base plate by sliding them a short distance lengthways and then lifting them off. The direction is marked on the inside.
7. Remove the protective film surrounding the robot. Do not use sharp objects to open the film.
8. You can now remove the straps (9) that hold the robot on the base plate. These are either white disposable straps, which can be cut with the safety knife, or reusable colored straps. These can be released using the buckle.

Attention: Be careful when loosening the straps and only cut where injury and damage to the robot can be ruled out.

9. If the robot is also fixed to the base plate with wooden strips (10), these must also be removed. To do this, simply remove the screws that connect the strips to the base plate.
10. If the batteries were shipped separately, they must now be *inserted and connected to the robot* (page 30).

11. *You can now start up the robot* (page 33).
12. Slowly drive the robot down the ramp and onto the floor. When moving the robot with the wireless joystick, exercise extreme caution and attention, as the drives react very sensitively to the movement of the joysticks. The speed can be temporarily reduced by pressing the creep speed button.

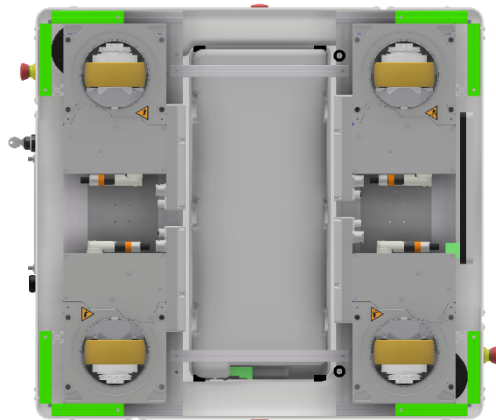
3.4.3 Moving the Robot in the Event of an Error

If the robot is in an error state and can no longer be moved by its own drives, it can be moved as follows:

- Provided the robot's charge level is high enough and the robot is switched on, you should first try to push the robot manually by pressing the *Brake Release Button* (page 18).
- If the robot cannot be moved, it should be transported using a workshop trolley or a pallet. There are two ways to lift the robot onto a pallet or workshop trolley.

3.4.3.1 Lifting the Robot by Hand

The robot can be gripped and lifted by at least two people at the designated points (green markings in the following image). It is also advisable to get another person to help pull the pallet away after lifting or to push a transport trolley under the robot.

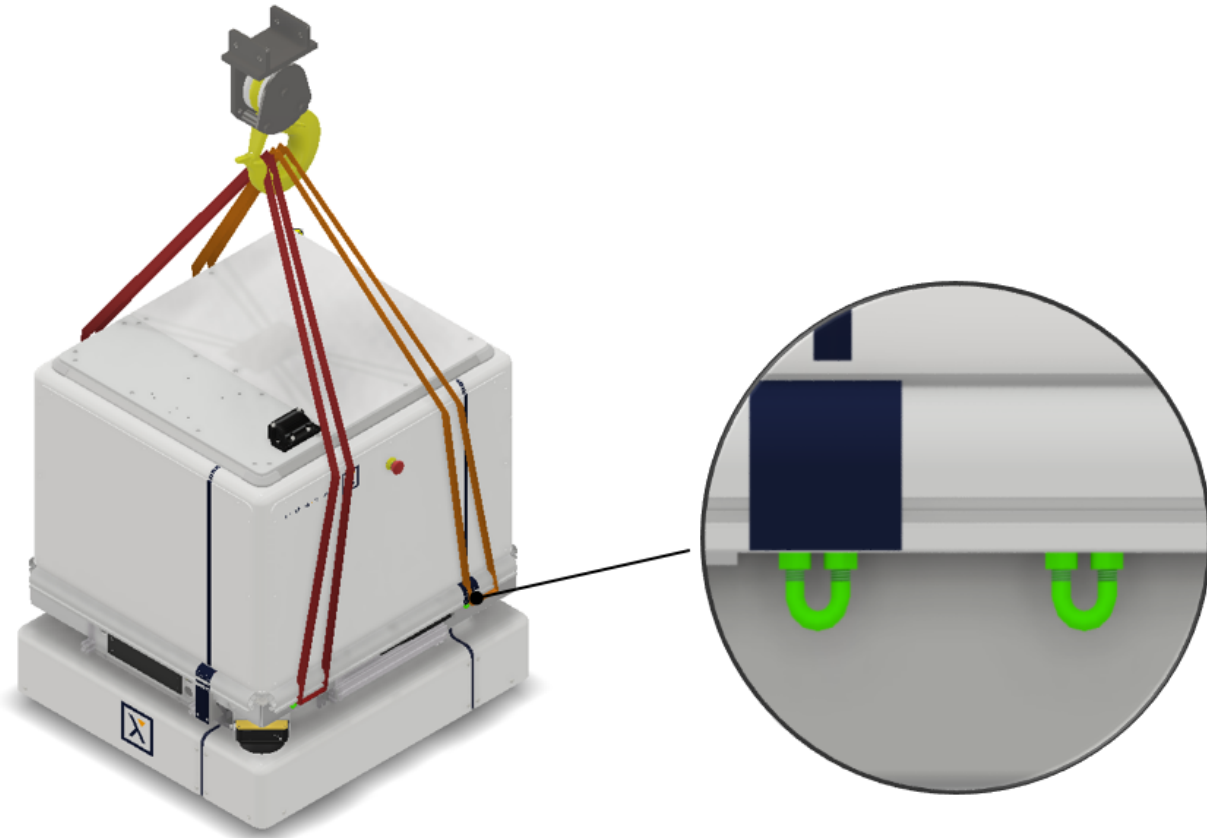


Attention:

- When lifting the robot, always observe the general principles of ergonomic working and wear appropriate protective clothing, especially safety shoes, to avoid injuries. If you have any questions, please contact the person responsible for occupational safety in your company.
- The robot must never be lifted by the sensors or other sensitive parts. These are not designed for such a load and can break off, which can lead to injuries and damage.

3.4.3.2 Lifting the Robot With a Crane

As an option, the robot can be equipped with strap lugs that allow it to be lifted by a workshop crane. The lugs are firmly mounted to the upper aluminum frame of the base platform and concealed behind the upper white plastic cover. Please unscrew the corresponding cover parts to gain access to the strap lugs. The enclosed tensioning straps can then be pulled through the lugs and hooked into the workshop crane above the robot.

**Warning:**

- Make sure that the load capacity of the crane is greater than the load to be lifted. Overloading the crane can cause the robot to fall and result in serious injury.
- If a robot is equipped with the strap lugs ex works, these are positioned in such a way that the robot does not tip over when being lifted. If changes are subsequently made to the robot, stability during lifting can no longer be guaranteed. The positioning of the lugs must be checked again and adjusted if necessary.

3.4.3.3 Moving the Robot on a Cart or Pallet

Always secure the robot when it is placed on a transport trolley or pallet to prevent it from sliding down during transportation.

Attention: When you park the trolley, make sure that the brakes of the trolley have been applied. In addition, never park the trolley on a sloping surface.

3.4.4 Shipping the Robot in the Neobotix Transport Box

If the robot is shipped again, it must be adequately secured in the transport box. The following general recommendations apply for positioning and securing the robot:

- Always transport the robot standing on all wheels. If you wish to jack up the robot, please contact Neobotix beforehand.
- Position and fix the robot centrally on the base plate so that no contact with an external wall is possible. Contact Neobotix if you need a larger transport box, for example because the dimensions of the robot have increased due to additional attachments.
- Use the holes in the base plate to fix the robot in place with the help of tensioning straps. When tightening the straps, make sure that
 - the belt runs over the robot for the shortest possible distance, thus preventing the belt from loosening during transportation,
 - no sensitive components are damaged by the belt,
 - the belt runs as perpendicular as possible to the base plate, so that the robot is better supported against lateral displacement,
 - you use a cardboard or similar as a protection between the robot and the tensioning belt to avoid scratches.
- Also ensure that the center of gravity is as low and central as possible to reduce the tendency of the transport box to tip over. Heavy dismantled components should be fixed as low as possible, ideally directly on the base plate.
- Secure loose objects such as the controller, battery pack, charger, charging station etc. against slipping with sufficiently strong straps or other measures and, if necessary, pack them in a cardboard box.

Note: The transport box should be marked on the outside with the following information (see DIN EN ISO 780:2021):

	
	“Fragile – Handle with care”
	
	“Do not stack”

3.4.4.1 Transport With AGM Batteries

If the key has been removed, there is no risk of the robot switching itself on or the batteries being discharged during transportation.

Note: Before transportation by air freight, it is nevertheless advisable to electrically disconnect the batteries from the robot to eliminate any risk. The batteries themselves are leak-proof encapsulated and approved for transportation by air freight. The relevant documents can be found in your download area or can be obtained from Neobotix on request.

3.4.4.2 Transport With LiFePO4 Batteries

Due to the applicable safety regulations, all transports of lithium-based batteries must meet the corresponding requirements.

Please contact Neobotix if you are planning to transport a robot with a LiFePO4 battery.

3.5 Maintenance

Information on hardware maintenance, cleaning and general precautions when working on the mobile robot can be found in *Maintenance* (page 66).

Maintenance of the Neobotix ROX is very easy and does not cause much work. As long as the advice in this chapter is kept in mind and the robot is treated accordingly, no major work is necessary.

Please mind the following:

- Always keep the robot clean. Dust and dirt might damage the moving parts or reduce the life expectancy. Metal splinters might cause short-circuiting.
- Check all connectors, especially the high current connectors, regularly and replace them if they show signs of wear.
- Never connect or disconnect any connectors under load. Always turn the robot off before changing any connections.

Warning: Always turn off the robot completely and disconnect both the battery and the charging device before working on the robot. Serious injuries and / or damages might occur if the robot is modified while it is still connected to a power supply!

3.5.1 Cleaning

To achieve a long life of the platform and guarantee a satisfying operation, the platform should be checked and cleaned regularly. General information on how to clean the robot and its sensors can be found in *Maintenance* (page 66).

3.5.2 Batteries

General information on the available battery type, as well as on battery maintenance and recycling, can be found at *Batteries* (page 37).

AGM batteries lose significant capacity after a few hundred cycles and often need to be replaced after just one or two years, depending on the application. LiFePO4 batteries, on the other hand, are designed for at least 10,000 cycles and do not need to be replaced until considerably later, if at all. Replacing the battery packs on the ROX is almost identical for both battery types and very simple.

Warning: If the mobile robot contains more than one battery pack:

- Never use AGM and LiFePO4 batteries in the same robot!
- Only use complete sets of battery packs and do not mix in battery packs from other robots.
- When charging the batteries outside of the mobile robot make sure to keep the charge levels and voltages of all battery packs identical. Please contact Neobotix if you need cable sets or tools for this.

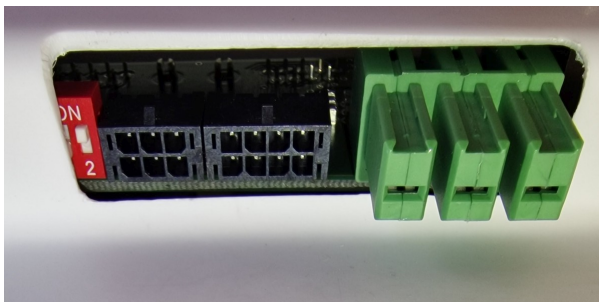
Combining battery packs with different ages or charge levels in the same robot can lead to high currents, overheating and heavy damage!

3.5.2.1 Removing the Batteries

1. Shut down the robot.
2. Disconnect the robot from the wired battery charger and move it away from the charging station.
3. In case of LiFePO4 batteries, deactivate the batteries by flipping the rocker switch. It must then be impossible to start up the robot.
4. Remove the screws of the side cover of the platform and take away the cover.
5. In case of LiFePO4 batteries, disconnect the communication cables with the black connectors from the batteries. Press the connectors' latch before pulling them off.
6. Disconnect the green high current connectors from the batteries.
7. Remove the screws of the aluminium profiles that hold the batteries in place and take the profiles away.
8. Carefully pull the battery packs out of the platform. Take care not to drop the packs when they reach the end of the supporting rails.
9. Additional steps might be required if the robot uses additional battery packs, e. g. in the cabinet on top of the platform.

3.5.2.2 Inserting the Batteries

1. Position the new battery pack on the start of the guide rails and push it all the way into the robot. In case of LiFePO4 batteries, take care to place the batteries into the correct slots, especially the pack with active CAN terminating resistor (see item 3. below).
2. Mount the aluminium profiles in front of the battery packs and fasten the screws.
3. In case of LiFePO4 batteries, plug all communication cables with black connectors back into the battery packs. Make sure that the red CAN terminating resistor switch is
 1. closed (position ON, outside) at the last battery pack, the one with only one communication cable connected.



2. open (position 2, inside) at all other battery packs.
4. Plug the high current cables with green connectors into all battery packs.
5. Remount the out cover and fasten all its screws.
6. In case of LiFePO4 batteries, activate the batteries by flipping the rocker switch if you plan to charge or use the robot soon.

3.6 Taking out of Service

We will gladly take back your disused robot free of charge if you cannot or do not want to dispose of it yourself. Please contact us via the contact options on [our website](#)⁸.

You can find further information about taking out of service and about recycling [here](#) (page 68).

3.7 Legal Notes

The general legal notes can be found at [Legal Notes](#) (page 2).

3.7.1 EU Declaration of Conformity



This product fulfils all relevant directives of the European Union. For further information please contact Neobotix.

3.7.2 RoHS Information



As *non-road mobile machinery* our mobile robots are explicitly exempted from the scope of the RoHS directive 2011/65/EU. We have nevertheless followed the underlying principles of RoHS and tried to reduce the use of harmful and dangerous substances in our products as much as possible.

⁸ <https://www.neobotix-robots.com/>

General Hardware Information

4.1 Key Switch

All Neobotix robots are equipped with a key switch to turn the robot on and off and to reset emergency stops. It can only be operated as long as the key is inserted.

4.1.1 Turning on

To start the robot, turn the key clockwise (towards position `On`) and then release again.

If the robot has an *LC Display* (page 34), it will light up instantly and show “READY” when the robot is operational. If the robot has *LED lighting* (page 36), the LEDs will cycle through all available colors once the robot becomes operational and then display the robot’s status.

4.1.2 Emergency Reset

After an emergency stop was issued and the emergency buttons have been unlocked again, the safety system can be reset. Turn the key clockwise (towards position `On`), hold for about one second and then release again.

Depending on the model, the robot will show the status change either through the LC display or through the LEDs.

4.1.3 Shutting down

Turn the key counter-clockwise (towards position `Off`) and hold for a few seconds to initiate the shutdown. If an LC display is present, it will show a message, if LEDs are present, they will signal the shutdown procedure.

During the shutdown process, the platform software (if running) terminates and shuts down the operating system.

In case the on-board computer is shut down remotely via the GUI of the control software, the robot will turn off automatically.

4.1.4 Switching off

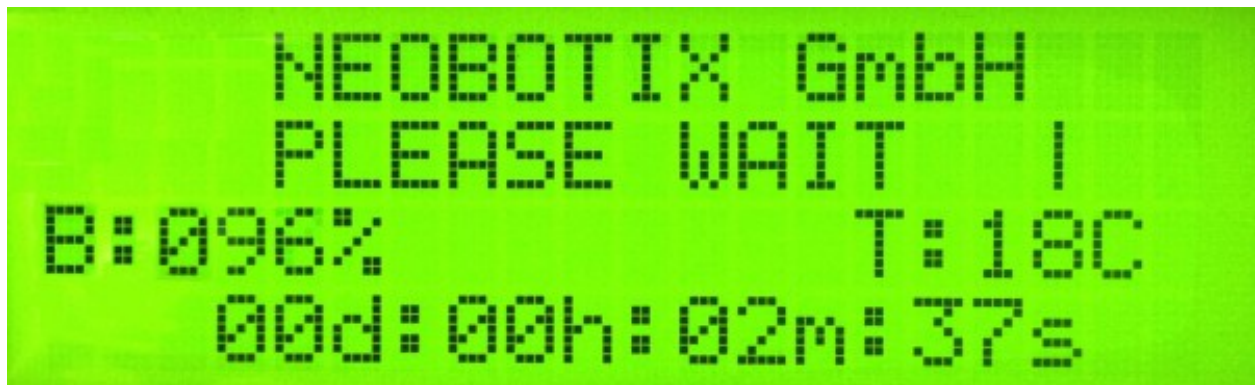
To immediately turn off the robot without waiting for the on-board computer to shut down, turn the key switch counter-clockwise (towards position **OFF**) and hold it until the LCD or LED light switches off.

Note: With this method, the robot is shut down by cutting the power supply. This may damage the on-board computer's hard- and software.

4.2 LC Display

Some Neobotix robots are equipped with an LC display to display current status information.

4.2.1 Main View



4.2.1.1 Messages

The first line can be used to print messages sent from ROS, PlatformPilot or any other high level control software. The default message is “NEOBOTIX GmbH”.

4.2.1.2 Status

The second line indicates the robot's current status.

PLEASE WAIT The control software is not yet connected to the robot's main control board.

READY The control software is active and the robot is fully operational.

EMERGENCY STOP One of the emergency stop buttons has been pressed.

TURN KEY → Reset the safety system by turning the key switch clockwise for about one second.

SCANNER STOP An obstacle has been detected within the laser scanner's safety field. As soon as the obstacle has been removed, the safety system will be reset automatically. If a Flexi Soft safety controller is installed, all stops are indicated with this message.

CHARGING The robot is currently charging its batteries.

SHUTDOWN IN XXs The robot will turn itself off in a few seconds.

BATTERY VOLTAGE LOW The battery voltage is critically low and the robot will soon shut down to prevent a deep discharge. Further information can be found in the next section.

MOTOR ERROR At least one motor is reporting an error. This state is quit automatically as soon as all motors are operational again.

SAFETY RELAY FAIL One of the safety relays is damaged. Please contact Neobotix.

POWER RELAY FAIL The power relays are damaged. Please contact Neobotix.

EMSTOP BUTTON FAIL One of the emergency stop buttons does not operate properly. Please contact Neobotix.

CHARGE RELAY FAIL The charging relay is damaged. Please contact Neobotix. The charging contacts might still be connected to the batteries!

CHECKSUM ERROR The protocol versions of the control software and the RelayBoard do not match. Please check the wiring and the log output of your software.

4.2.1.3 Battery Charge Level

B:096% The current charge level of the batteries. Due to the batteries characteristics the actual battery voltage may be higher than the platform's rated main voltage.

Nominal voltage	Shut-down	Working range	Charging
24 V	≤ 22 V	23 V .. 25 V	25 V .. 29 V
48v	≤ 44 V	46 V .. 52 V	52 V .. 59 V

4.2.1.4 Temperature

T:20C This is the temperature (in °C) inside the platform, measured at the RelayBoard.

4.2.1.5 Uptime

00d:00h:02m:37s The bottom line shows the uptime since startup in days, hours, minutes and seconds.

4.2.2 The Info View

This view mode is not available in all robot types.



4.2.2.1 Version Information

The first line of this view shows the hardware version (HV) and the software version (SV) of the RelayBoard. For software updates please contact Neobotix.

4.2.2.2 Serial Number

The second line shows the serial number (SN) of the RelayBoard.

4.2.2.3 Status Information

The third line indicates the current configuration of the software and the state of the hardware components.

The asterisk (*) indicates that the RelayBoard did not yet receive a valid configuration from the control software. After configuration it will be replaced by a C.

The right part shows the state of all CAN bus devices. Motors are indicated by an M, the IOBoard by an I and the USBoard by a U. Devices that are not installed are marked by a dash (-) and devices that failed to connect are marked by an F.

4.3 LED Lighting

All ROX platforms feature LED lights on all sides in the gap between upper and lower platform cover. The robot's current status is indicated as follows.

Color	Pattern	Description
Multiple	Smooth transition	Self-check at startup. In case of interruptions or unusual patterns please shut down the robot and contact Neobotix.
Red	Constant	Regular emergency stop, check emergency stop buttons and wireless emergency stop system, unlock them, and reset the system by turning the key switch clockwise.
Red	Blinking, slow	Non-critical error, e. g. brake release button is pressed.
Red	Blinking, fast	Critical error, please contact Neobotix.
Yellow	Constant	Scanner stop, remove obstacle from the safety field or switch safety field, robot will continue operating automatically.
Yellow	Blinking, slow	Platform is moving.
Yellow	Blinking, fast	Working device or robot arm is active.
Green	Constant	Robot is ready but idle.
Green	Pulsing, slow	Robot is in standby mode.
Blue	Blinking, slow	A manual reset via the key switch is required.
Cyan	Blinking	Charging has been initiated, but has not started yet.
Cyan	Pulsing	Charging in progress.
Cyan	Constant	Charging is finished.
White	Blinking, fast	Command to shut down has been detected, hold the key switch until the LEDs light up white and start fading.
White	Fading	Robot is shutting down and will switch off in a few seconds.
Multiple	Repeated	Control software has never been started and the system is in a minimal mode. This pattern is usually only visible during the assembly of the robot.

4.4 Batteries

4.4.1 Battery Types

4.4.1.1 AGM Batteries

AGM batteries (Absorbent Glass Mat) are lead acid batteries that contain a fibreglass mesh between the battery plates. This mesh contains the electrolyte and prevents leakages even if the batteries are stored upside down or when the outer casing is cracked. This technology is well proven, cheap and widely available. Its drawbacks are a low energy density, resulting in high weight for a given capacity, and a limited number of charge-discharge cycles.

Their capacity will reduce over time until at some point (approximately after two years of use) the robot's available uptime is no longer sufficient and the batteries need to be replaced.

There are several measures to prolong the life of AGM batteries and to save costs and resources:

- Recharge the robot whenever possible.
- Avoid deep discharge and reaching the automatic shut-down voltage.
- Charge the robot while it does not need to move, for example while programming for several hours.
- Disconnect the battery charger from the robot after the charging cycle has been completed. The AGM batteries in Neobotix robots are designed for cyclical use and not for standby under continuous external power supply.

- Do not leave the robot with empty batteries for a long time.

Lead batteries in AGM design are generally very tolerant and significantly less dangerous than traditional lithium-ion-batteries. Heat, age or wrong treatment may nevertheless cause damages.

Attention: Regularly check the battery's condition, at least once every month! The following points indicate battery damages:

- Deformation or stretching of the battery's casing
- White or brownish spots at the battery contacts or other metal parts
- Excess heat
- Strong smell of sulphur
- Liquid below the battery

As soon as you notice any kind of damage the batteries must no longer be used and must not be charged any further! Please contact Neobotix immediately.

4.4.1.2 LiFePO4 Batteries

Lithium iron phosphate batteries, also known as LiFePO4 or LFP batteries, are a rather recent development in lithium-ion battery technology. They provide several benefits compared to AGM batteries as well as other lithium-ion designs.

LiFePO4 batteries are not necessarily smaller than AGM batteries but save about 60% of weight at the same nominal capacity. Under actual use conditions their usable capacity is even higher than that of AGM batteries, because they can be fully discharged. Similar deep discharge of AGM batteries quickly leads to loss of capacity or other damages.

Thanks to their chemistry LiFePO4 batteries provide a very stable output voltage and support fast charging. This not only reduces the recharge time significantly but also allows short periodic charging at convenient locations inside the workspace. When done properly this in-process-charging enables the robot to operate 24/7 without being taken out of operation for recharging.

LiFePO4 batteries are intrinsically much more stable than other lithium based designs. In addition our LiFePO4 batteries also contain a sophisticated battery management system (BMS) that constantly monitors their condition and health. The status information of the BMS is read by the robot's control software and used to indicate potential problems.

There are several measures to prolong the life of LiFePO4 batteries and to save costs and resources:

- Keep the state of charge between 20 % and 80 %, if possible.
- Different from AGM batteries, LiFePO4 batteries cannot be completely discharged and immediately be recharged because their integrated BMS will enter protective under-voltage shutdown when reaching 0 % SoC. When this happens the batteries need to be manually reactivated as described below. Simply connecting the normal battery charger is not sufficient in this state.
- LiFePO4 batteries will handle both short in-process charging cycles and high current charging much better than AGM batteries do. Nevertheless, the longer the individual charging cycles and the lower the charging current, the better the effect on the overall life expectancy.

Warning: If you notice anything unusual about the LiFePO4 batteries immediately switch off the robot, stop charging and contact Neobotix!

Tip: The integrated battery management system of the LiFePO4 batteries monitors the voltage and current and uses this to calculate the charge status of the battery modules. The end of charging at 100 % battery charge serves as the reference point. To ensure that the charge level can be reliably determined at all times, the batteries must be fully charged regularly, preferably once a week.

If the batteries are not charged to 100 % over a longer period of time, the reliability of the charge level estimation decreases continuously. As a result, less capacity can actually be utilised and, in the worst case, the batteries switch off unexpectedly due to undervoltage.

Waking up of LiFePO4 Battery Packs

Lithium-based batteries may only be transported with a low residual charge and in a safe condition. For this purpose, the rechargeable batteries used by Neobotix can be set to a special power-down mode in which the battery management system only consumes minimal energy and the battery can no longer be activated without further ado.

Note: In the event of a fault or deep discharge, the batteries also switch to power-down mode and can be woken up again in most cases as described here.

To wake up a battery pack, proceed as follows:

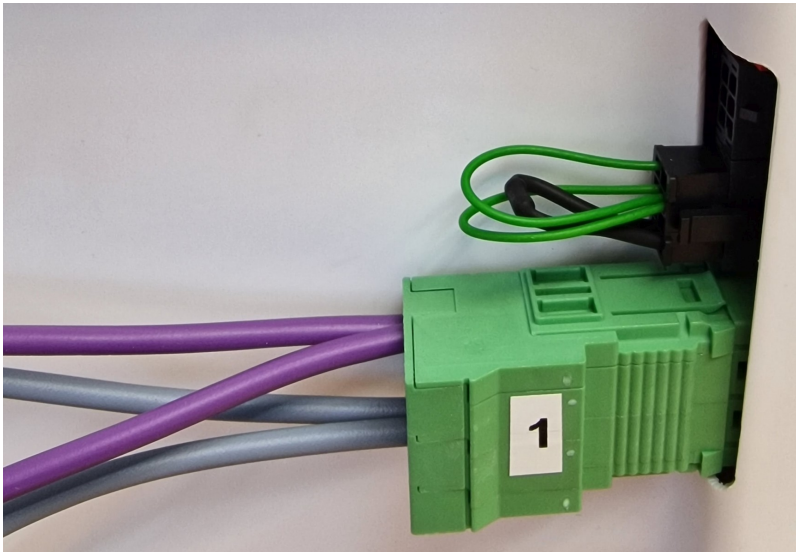
1. Plug the supplied dummy plug into the 8-pin communication connector of the battery.



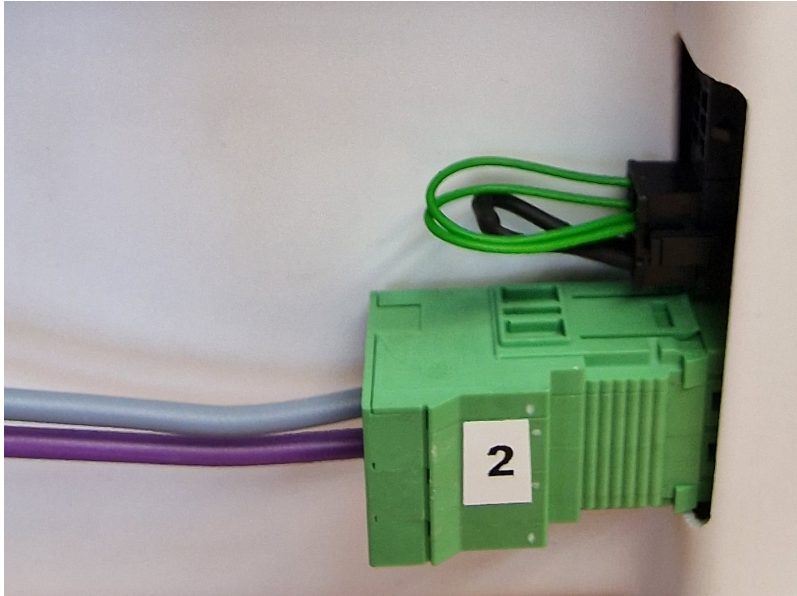
2. Connect the power supply unit to mains.



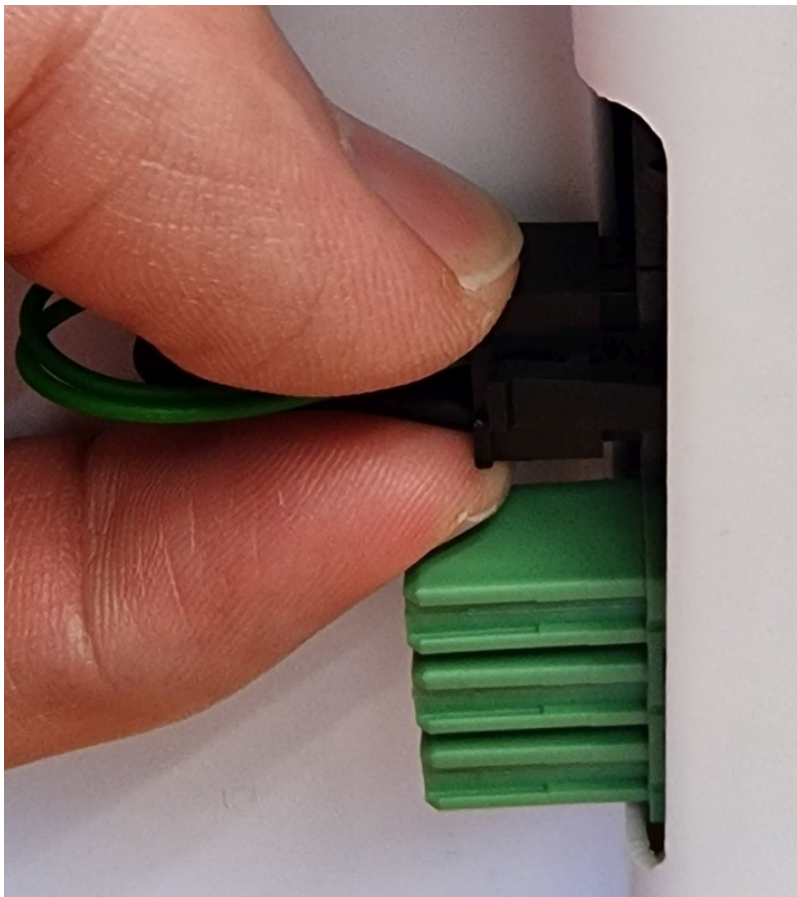
3. Plug the green high-current connector 1 into the main connection of the battery and unplug it again after approx. one second. To do this, do not pull on the cables but grasp the plug on the sides of the green housing.



4. Plug the green high-current connector 2 into the main connection of the battery and unplug it again after approx. one second.



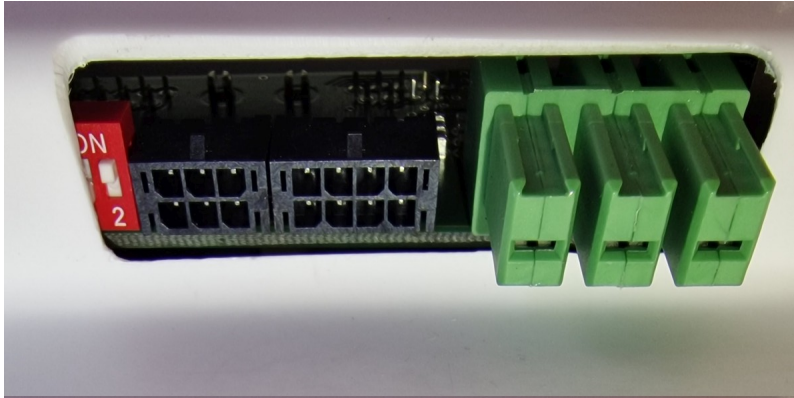
5. Unlock the dummy plug by pressing the catch and carefully pull it off the battery. Do not pull on the cables, but grasp the plug on the sides of the black housing.



6. The battery is now in sleep mode and can be installed and used.

Warning: When installing the batteries, make sure not to mix batteries from several robots. The combination of battery packs of different ages and especially with different charge levels can cause damage to the batteries and the electrical system of the robots.

Note: Also make sure that the battery packs are installed in the correct position in the robot. For the last battery pack in the system, to which only one communication cable with a black plug is connected, the CAN terminating resistor must be activated. To do this, push the white switch in the red DIP housing outwards to the ON position. If more than one battery pack is used, the resistor must not be activated on the remaining battery packs (position 2, inside).



4.4.2 Charging

4.4.2.1 With Charging Station

The usage of our different charging stations is documented at [Charging Stations](#) (page 46).

4.4.2.2 With external Battery Charger

The battery of the mobile robot consists of several batteries connected in series and / or in parallel. The resulting battery pack can be charged conveniently and safely by using the provided battery charger.

The battery charger needs a power supply of 230 VAC, 50 Hz.

The charger must be placed in a dry environment. Do not cover the housing, so appropriate cooling is possible, and avoid direct sunlight.

First connect the battery charger to the charging connector and then turn on the charger. After the battery has been fully charged first turn off the battery charger and then disconnect the cable.

Warning:

- Never connect or disconnect the battery charger while it is switched on! Increased wear of the contacts due to electric arcs may occur. The battery or other electrical components may be damaged.
- Always make sure that the charging connector is fully inserted into the socket and properly secured. An incomplete or insufficient connection can cause high heat and significant damages.

- Only use batteries and chargers supplied by Neobotix. Using unsuitable batteries or battery chargers can lead to serious damages, injuries and hazards!

Recharging is done completely automatic after the connection is established and the battery charger is connected to the main power supply and switched on. For recharging it does not matter whether the robot is switched on or off. The only difference is the time needed for a full recharge. With the on-board electronic active, a recharge might take significantly longer, depending on the workload of the on-board computer.

The battery charger features an overload protection, thus allowing the robot to be permanently (e.g. overnight) connected to the charger. If the robot remains switched on while being connected to the charger (e. g. while programming) it might be necessary to switch the battery charger off and on once a day.

Please also read the documentation that was supplied together with the battery charger.

4.4.2.3 With integrated Battery Charger

Some robots feature an integrated battery charger. These robots can be charged by first plugging the charging cable into the robot's charging socket and then plugging the other end into a normal power outlet as described above.

Warning: Always make sure that the charging connector is fully inserted into the socket and properly secured. An incomplete or insufficient connection can cause high heat and significant damages.

The charging process starts automatically once the connection to mains has been made. As with the external charger the robot can be charged both when switched on or off.

4.4.3 Recycling

Both battery types used in Neobotix robots are leak proof and very safe.

Warning: They still contain highly reactive chemicals and must never be opened or damaged to avoid serious damage or injuries!

Attention:

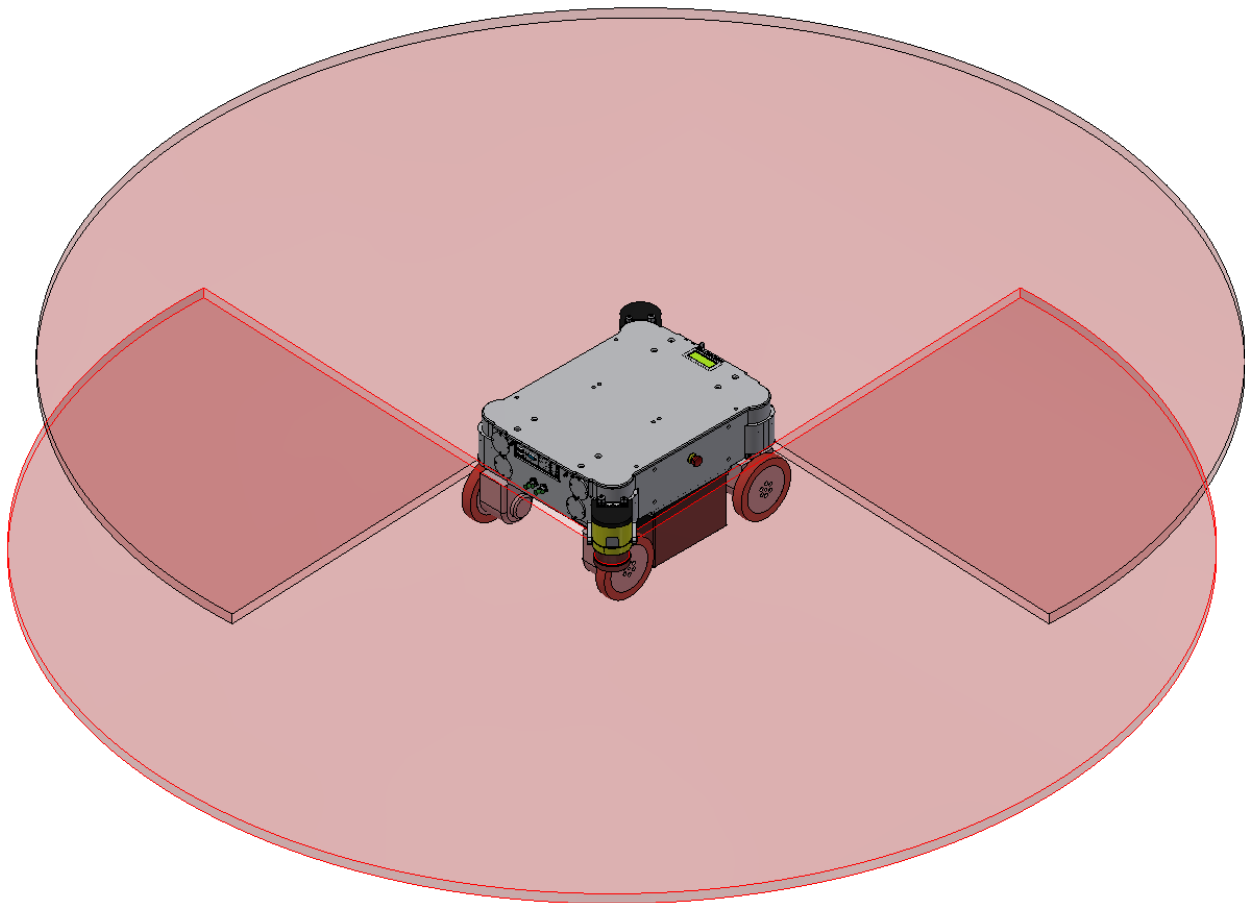
- Under European law all kinds of batteries must only be returned to certified recycling companies. Please get in touch with Neobotix if you are unsure about how to recycle or dispose of used batteries.
- You can also return all old or wasted batteries from your Neobotix product to Neobotix free of charge for proper recycling.
- Please make sure to fully cover the battery contacts to guarantee their electrical insulation before shipping or disposing of old batteries. This will prevent short circuiting, damages and injuries.

4.5 Laser Scanners

4.5.1 Mode of Operation

The safety laser scanners installed in mobile robots emit an invisible infrared laser beam that is reflected by obstacles and detected by the sensor head. The distance between the sensor and the obstacle can be precisely determined from the travel time of the beam. The sensor head rotates so that the beam effectively scans a plane perpendicular to the axis of rotation.

If the scanner is used in a mobile robot for localisation and collision avoidance, it is usually mounted upright so that the scanning plane is parallel to the floor. According to common AMR standard (DIN EN ISO 3691-4), the scanner should be mounted at a maximum height that allows objects 200 mm high to be reliably detected. This ensures that people lying on the floor are also detected and protected. Modern safety laser scanners have a field of view of over 270° and, when mounted on opposite corners of the robot platform, enable seamless monitoring of the area around the robot.



The safety laser scanners not only provide measurement data of the working environment, which is used for localisation and path planning, but also monitor the robot's surroundings for obstacles and possible collisions. For this purpose, areas around the robot can be defined in which detected objects automatically trigger various reactions.

This function is a fundamental part of the safety concept of the mobile robots. You can find more information at [Safety Instructions](#) (page 60) and specifically at [Safety Fields](#) (page 63) as well as in the safety instructions that you receive on delivery.

4.5.2 Safety Instructions

The laser scanners are devices of laser class 1 or 1M and completely harmless during normal use.

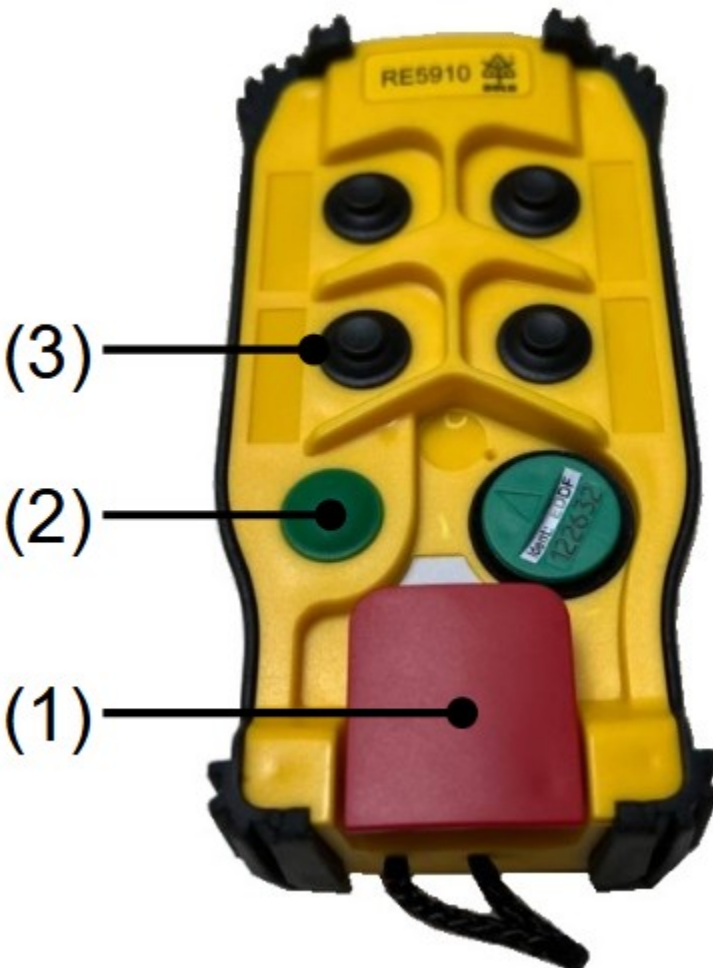
Danger: Laser scanners that are laser class 1M devices might be used for special projects and requirements. These are only eye-safe as long as no optical instruments such as magnifying glasses or binoculars are used.

As it is usually not immediately recognisable from the outside which type of laser scanner has been installed, optical instruments should generally not be used to look into the laser beam.

4.6 Wireless Emergency Stop

Additionally to the existing safety system, all robot platforms can be optionally equipped with a wireless emergency stop system.

Note: If a radio emergency stop system is installed, it is necessary to turn the key switch once clockwise (towards position On) after starting the robot in order to activate the radio receiver.



4.6.1 Engaging the Wireless Connection

1. Pull the red button (1) on the handset upwards to activate the sender.
2. Wait until the two LEDs next to the red button have stopped flashing.
3. Press the green button (2) on the handset to engage the safe connection.
4. Turn the platform's key switch clockwise (towards position On) to reset the safety system and switch to normal operation.
5. The bottom left button (3) can be used in the same way as the key switch to reset the robot after an emergency stop if the safety system is configured accordingly.

4.6.2 Stopping the Robot Remotely

There are four ways to trigger an emergency stop remotely:

- Pressing the red button on the handset. This is the intended operation and can be reset as described above.
- Placing the handset in the charging bay. Whenever the handset is charged in the charging bay it is considered inaccessible to the operator who might be needing it. Since this would be an unsafe situation the system will automatically trigger an emergency stop. To reset this, remove the handset from the charging bay and follow the steps described in the section above.
- The handset's battery runs out. The radio connection between handset and receiver is constantly maintained as long as the red button is not in its lower (pressed) position and will drain the battery. If the battery level is too low to keep up a stable connection the receiver will switch to emergency stop. Please press the red button or recharge the handset whenever it is not in use.
- The radio connection is interrupted. The connection between handset and receiver can also be lost when the distance is too big or when the radio signal is dampened or blocked by obstacles like machines or building structures. In rare cases high electromagnetic noise from big machinery might also cause connection problems.

4.7 Charging Stations

4.7.1 Inductive Wallbox

4.7.1.1 General Information

All ROX robots and some of the older robot types can be charged via the inductive charging station Wallbox. This is possible both for robots with AGM batteries as well as LiFePO4 batteries. The charging station works completely wear-free and the charging curve is automatically adapted to the battery type used by the robot controller. This makes it ideal for in-process charging during the ongoing operation in order to maximize the working time of the autonomous robot.

Note: The efficiency of inductive fast charging of LiFePO4 batteries is significantly higher and the charging time is considerably shorter than with AGM batteries. We therefore expressly recommend the use of LiFePO4 batteries if automatic charging via the inductive charging station is desired.

Warning: The wired battery charger and the inductive charging station must never be used at the same time! Despite protective features in both devices there is a theoretical chance of malfunctions that could potentially lead to severe damage and the destruction of the chargers or the robot.

Tip: To be able to use the inductive charging station, the mobile robot must be switched on and ready for operation. If the robot is switched off, it can only be charged using the wired charger.

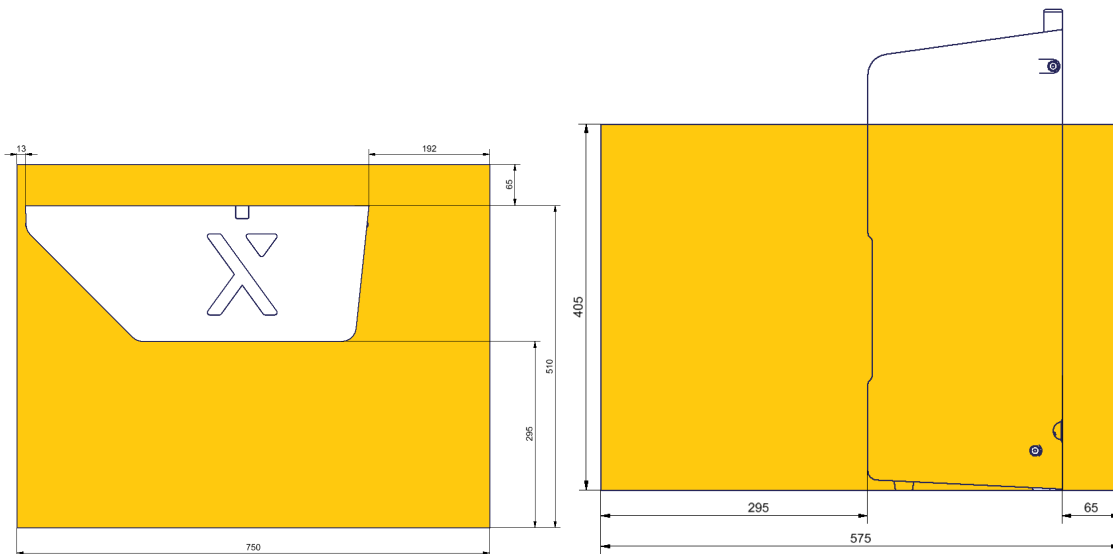
Please take this into account when planning your application.

4.7.1.2 Safety Information

The Neobotix Wallbox features several protective mechanisms and is easy to set up and connect. Nevertheless the following advice must be taken into account to enable safe operation of the Wallbox.

Increased Magnetic Fields

The ROX Wallbox uses strong electromagnetic fields to transmit the charging power to the mobile robot. To prevent harmful effects on people or animals, no living creatures may be in the vicinity of the coils during the charging process. The area marked in yellow in the following illustrations is generally to be regarded as a danger zone.



Danger: Interference with pacemakers!



It is possible to influence the function of a pacemaker within the effective range. Interference with a pacemaker can be life-threatening for the wearer. Persons with pacemakers or metallic implants must not enter the effective range.

Warning: Increased Magnetic Field!



The increased magnetic field can be harmful to living beings. No living creatures may be in the danger zone during the charging process. It is essential to keep the area directly between the robots in the area of the coils clear, as otherwise the permissible exposure limits may be exceeded!

This electromagnetic field only occurs during the charging process and is automatically cancelled when the robot stops charging, is removed from the charging station or is switched off. The field emanates exclusively from the wallbox; the mobile robot itself cannot generate a field.

To be absolutely certain that the area around the wallbox can be entered while a robot is currently at the station, the wallbox's power cable can simply be unplugged from the socket.

Increased Temperatures

The Wallbox achieves an efficiency that is comparable to conventional, wired chargers. Nevertheless, relatively high power losses occur at high charging outputs, which can lead to the Wallbox and the mobile robot heating up. Especially when using AGM batteries, which can only cope with low charging currents, the efficiency is significantly lower and the heating is noticeably higher.



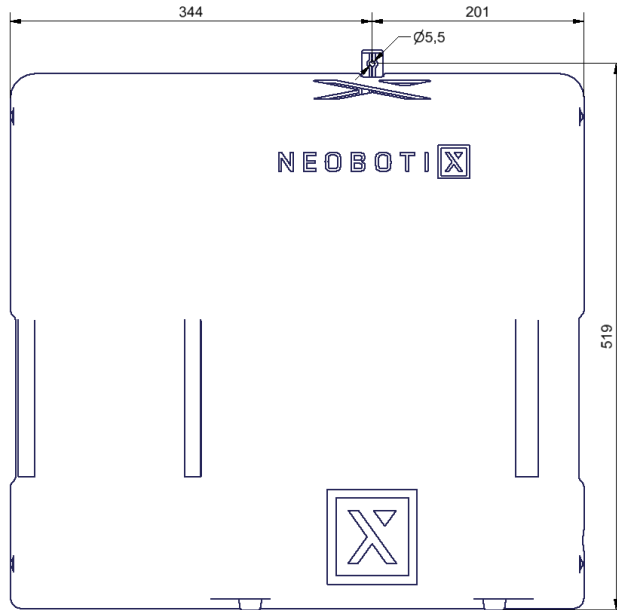
Warning:

The housing of the Wallbox and the front of the mobile robot may have an increased temperature. Do not touch these parts and allow all housings to cool down before working on the system.

4.7.1.3 Installation

Mechanical Installation

The ROX Wallbox has four rubber feet that give it a secure stand. In principle, it can therefore also be used free-standing in the room. However, in order to minimise access to the danger zone described above and to avoid tripping hazards as well as unintentional movement of the wallbox, it should preferably be placed against a wall and secured to it. For this purpose, the wallbox has a fixing point above the cover. The fixing material is not included in delivery. Please ensure correct installation.



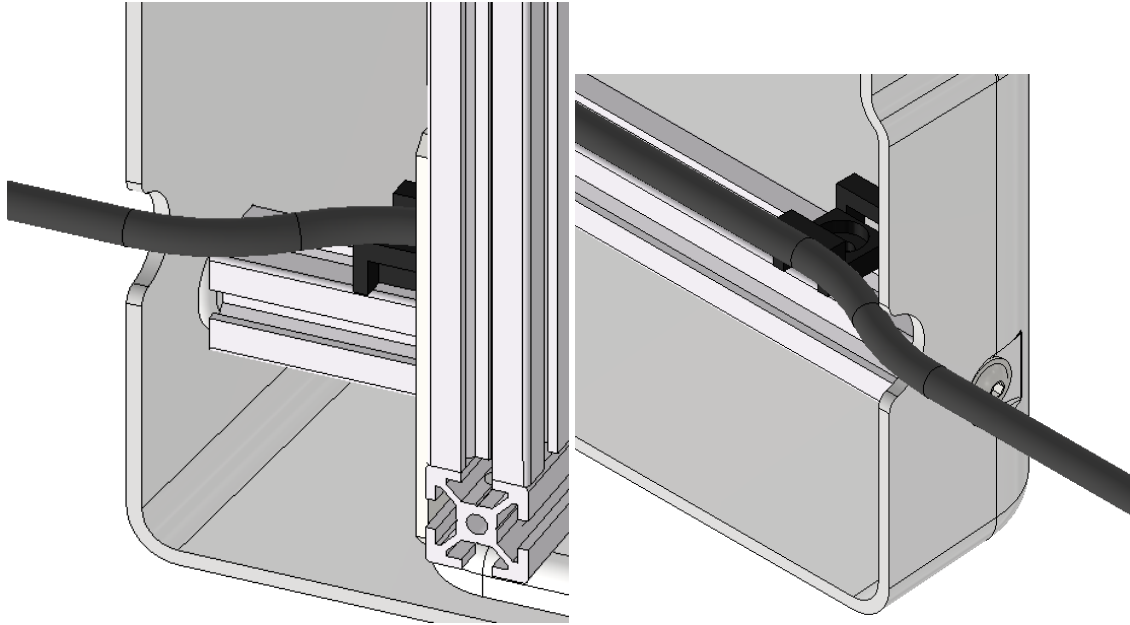
Please consider the following points when planning the charging process and positioning the Wallbox:

- The wallbox and, above all, a charging robot must not be an obstacle or become a tripping hazard. Escape and rescue routes in particular must remain clear according to the applicable safety regulations.
- To approach the Wallbox, the robots require sufficient free travelling distance in front of the charging point. There should be an approach distance of at least 1 metre straight towards the wallbox, if possible 1.5 metres. Otherwise, in unfortunate cases, the lateral offset may not be sufficiently compensated and the efficiency may drop or charging may fail.
- The charging process generates noticeable waste heat due to the high power. The Wallbox should therefore preferably be installed in a cool environment with sufficient airflow. Direct sunlight, waste heat from other machines or air congestion should be avoided.

Electrical Installation

The mains cable of the wallbox can be routed out of the housing either on the left or right. To prevent the cable from being crushed between the wall and the wallbox, the cable can be secured to the inner profile frame of the wallbox using a cable socket and a cable tie. If the cable cannot remain as it is in the as-delivered state and needs to be routed to the opposite side, proceed as follows:

1. Cut the originally used cable tie. **Take care not to damage the cable!**
2. Route the cable inside the panelling and underneath the electronics housing to the other side of the wallbox.
3. Use the enclosed additional cable tie to secure the cable to the cable socket.



The Wallbox can be connected to a normal AC power socket. If extension cables must be used, they must be designed for at least the rated power of the Wallbox.



The Wallbox is a protection class I device and requires a protective earth connection for the mains cable.

Note: Install a common trip type circuit breaker with a rating of 16A. Additionally, ensure that the breaker has a short-time withstand current limit of minimum 10 kA.

Warning: In case of internal isolation failures, this product may cause a DC current in the PE conductor. To protect against electrical shock, only use an RCD (Residual-Current Device) of Type B on the supply side of the Wallbox. It is important to note that no other equipment should be connected to this specific RCD.

4.7.1.4 The Charging Process

Basic Function

The basic procedure for inductive charging is as follows.

1. The robot is positioned at the optimum distance a few millimeters in front of the Wallbox.
2. The application control initiates charging via a software command.
3. A data connection between robot and station is established automatically and the charging process begins. The robot is set to charging state with reduced power use and all movements stopped. Do not press any emergency stop button while charging!

4. Charging may be stopped due to the following events or measures:

1. The batteries are fully charged. The robot recognises the end of charging, reports it to the higher-level control system if necessary and automatically stops charging or switches to conservation charging mode.
2. Charging is ended by the application control. This can happen after a predefined time has elapsed or when the main application reaches a certain state. The charging process is ended by the robot and it switches back to pure battery operation.
3. One of the emergency stop buttons on the robot is pressed. In this case, the robot stops the charging process immediately. It can only be resumed after the button has been unlocked and the emergency stop status has been reset. Charging does not re-start automatically but has to be initiated by the application control.

Note: This is not a certified safety function. If increased safety requirements apply to your application, please contact Neobotix.

4. The robot is shut down or switched off. In both cases, charging is ended automatically and can only be resumed once the robot has been restarted and is ready for use.
5. The robot is mechanically removed from the charging station. The charging system recognises when the receiver coil in the robot is too far away from the transmitter coil in the station and then automatically interrupts the charging process. The magnetic field emanating from the charging station is immediately cancelled and cannot be restored until the charging process is properly restarted.

Simple Automatic Operation

For the simplest version of automatic charging, the Wallbox must be installed in a fixed location and the exact robot position for charging must be found manually once. The charging position should be stored as coordinates or as a station.

1. The robot moves to this charging position in automatic mode while switching the motion parameters and safety fields.
2. Charging is performed as described above.
3. The robot moves away from the station and resumes operation.

Note: The collision avoidance parameters and the laser scanners' safety fields need to be adjusted before the robot can move very close to the station. After leaving the Wallbox these settings must be changed back to the safe default values.

A 3-step approach was found to be best to ensure a reliable docking process. Examples are available in the supplied software package.

Fully Automatic Operation With Contour Detection

To simplify the setup of automatic charging and increase the reliability of the charging process, Neobotix offers a fully automatic solution in which the Wallbox is automatically detected in the environment and approached. This means that minor relocations of the Wallbox, for example due to conversions or cleaning, are no longer a problem. In addition, the corresponding robot position does not have to be determined individually and with millimetre precision for each Wallbox, which saves a considerable amount of time and eliminates careless errors.

In order to use the automatic charging with contour detection, the Wallbox has to be positioned approximately at its intended position. The allowed tolerances in position and orientation depend on the environment conditions. An

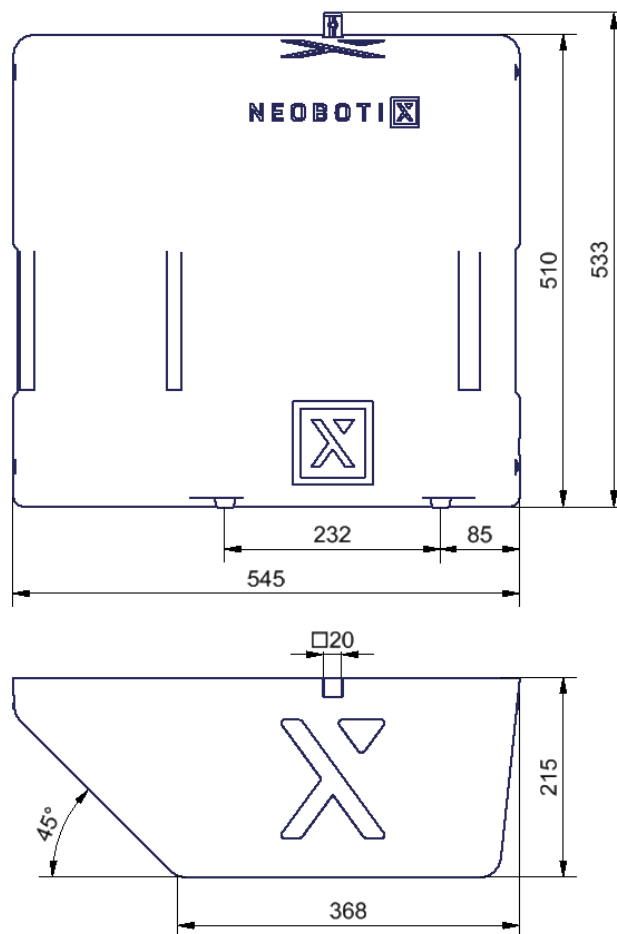
initial reference position for the robot has to be defined. We recommend a position approximately 2 m in front of the Wallbox. The automatic process is as follows:

1. The robot moves to the reference position in automatic mode.
2. The automatic function is started by a service call depending on the application setup.
 1. The robot then tries to recognize the contour of the charging station at the intended position and automatically performs a multi stage docking process.
 2. Charging is either performed automatically or as described above.
 3. Depending on the software setup, the robot performs an undocking and moves back to the reference position
3. Normal operation can be resumed.

Tip: Contour detection can also be used for other shapes and applications if required. Please contact us if you are interested in this feature.

4.7.1.5 Technical Data and Miscellaneous Information

Dimensions



Property	Unit	Value
Maximum airgap between coils	mm	30
Maximum airgap between Wallbox and ROX	mm	15
Maximum allowed misalignment	mm	30
Nominal efficiency		93%
Supply voltage	V (AC)	220-240
Supply voltage frequency	Hz	50-60
Nominal system power	W	2800
Rated current of the circuit breaker	A	16
Residual Current Device type		B

Disposal



Defective and disused electrical appliances must not be disposed of with household waste but must be handed in to separate collection points for reuse or recycling.

If you are unable or unwilling to dispose of your old Neobotix Wallbox yourself, Neobotix will be happy to do this for you. You can simply return your Neobotix Wallbox to us or send it to us by post or carrier. Alternatively, we can arrange to collect it from you or send you a shipping label for free return.

You can find further information and contact details [on our website⁹](https://www.neobotix-robots.com/contact/contact-details/disposal-of-electrical-devices).

4.7.1.6 Legal Notes

The general legal notes can be found at [Legal Notes](#) (page 2).

EU Declaration of Conformity



This product fulfils all relevant directives of the European Union.

RoHS Information



⁹ <https://www.neobotix-robots.com/contact/contact-details/disposal-of-electrical-devices>

This product complies to the RoHS directives 2011/65/EU (RoHS 2) and 2015/863/EU of the European Parliament and the Council on the restriction of the use of hazardous substances in electrical and electronic equipment.

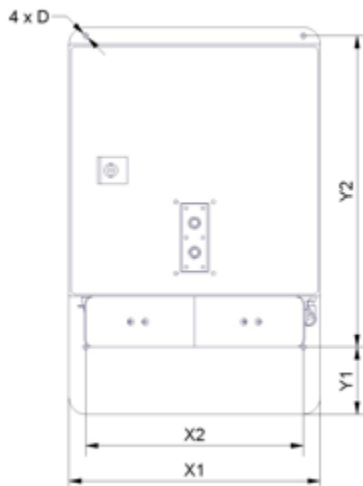
4.7.2 Automatic Charging Station

The automatic charging station is very robust and can easily be installed and integrated into the robot's program.

In order to allow a fast and trouble-free docking, there needs to be some free space to each side of the station and to the front. Find a place that can be easily accessed by the robot when it needs to recharge but in which neither station nor robot are obstacles to anybody. A power outlet must be nearby for the battery charger to be plugged in.

Please mind the following when choosing the stations mounting place:

- In order to have the charging contacts on the correct height, the bottom edge of the station's backplate must be placed directly on the floor.
- The charging station must be mounted to a stable wall. Please contact Neobotix if you need a free-standing charging station.
- The station must be mounted centred at the rear end of a free path that is at least 1.0 m wide.
- When using more than one station, please keep a grid of at least 1.0 m width.



4.7.2.1 Dimensions

The dimension of the charging station varies depending on the robot. The dimensions can be found in the table below:

Robot	X1	X2	Y1	Y2	D
MP-400	300	260	80	370	6.6
MP-500	300	260	110	360	6.6
MPO-700	300	260	192	370	6.6
MPO-500	340	320	40	290	6.6

4.7.2.2 After Installation

After installing the charging station please check the height of the charging contacts and if the robot can reach the station without problems.

Attention: Only plug in the power cable after successfully checking these two points. The charging station requires the same power supply as the external battery charger.

To allow automatic charging the battery charger inside the station needs to remain switched on at all times. Despite the open contacts which the robot needs for charging, there is no danger of electric shock or short-circuiting due to the charger's control mechanism. There will only be a current if the device has detected the correct batteries.

Note: In normal operation, the platform's charging contacts are disconnected from the batteries by a power relay on the platform's RelayBoard. This relay can be controlled by software.

Attention: The wear of the electrical components can be reduced by stopping the charging process only after the batteries have been fully charged and the charging current is reduced.

4.7.3 External Battery Charging Station

If the robot is equipped with the battery quick change system the battery set that is currently not in use can be recharged in an external battery charging station.

Place the charging station on the floor and make sure that it will not slip. The station can either be placed directly in front of a wall or can be screwed to the floor.

Make sure that the input voltage selection switch is set correctly and then connect the charging station to an ordinary power outlet. Before installing any batteries always make sure that the integrated battery charger is switched off. The main power switch is located directly beside the power cable connector.

Batteries can only be charged as a complete set of two identical batteries with the same charge level. Place the batteries onto the station's base plate between the aluminium profiles with the handles on top and the battery contacts facing towards the station's rear. Then slowly push the batteries into the station until they touch the vertical plate and are flush with the station's front.

The green LED at the side of the battery charger will light up constantly when the batteries are fully charged. They can remain inside the charging station until they are needed.

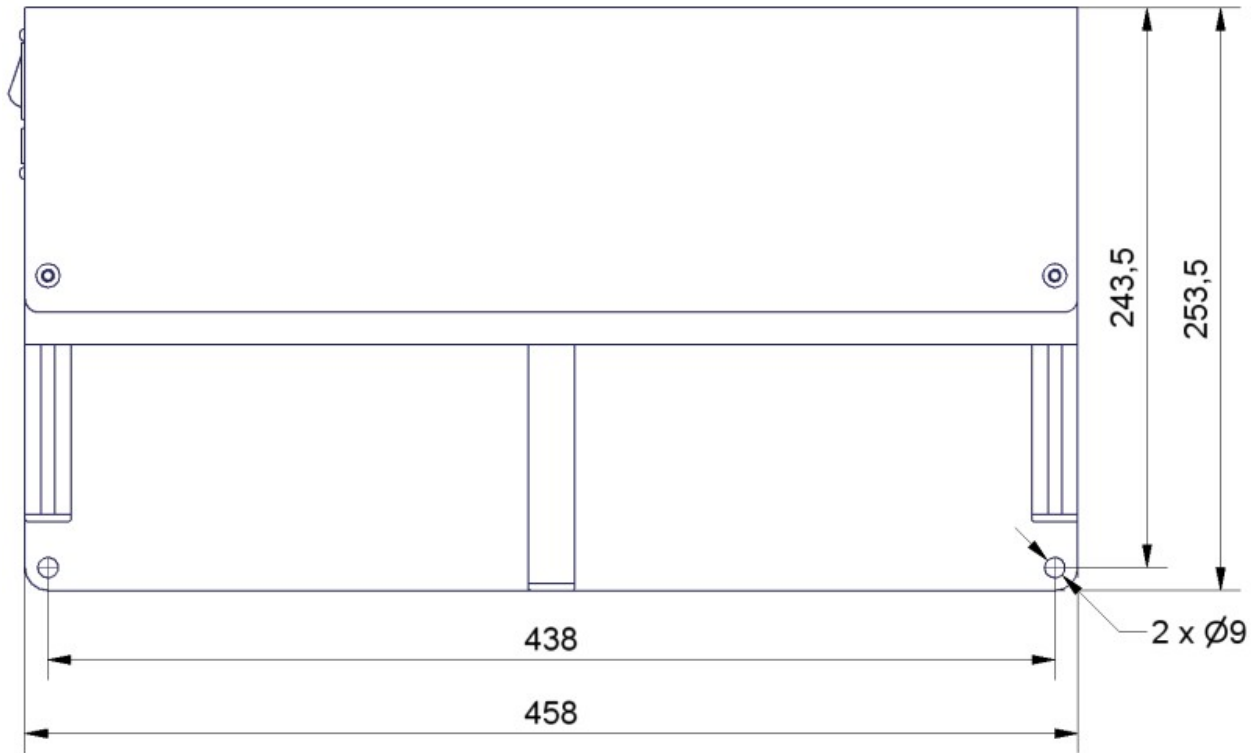
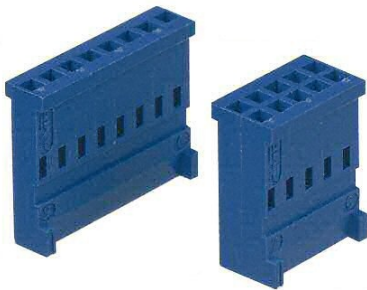


Fig. 1: Dimensions of the charging station

4.8 Connectors

4.8.1 TE Connectivity - HE14



Pins	TE Connectivity	Farnell	RS Components
3 pins, 1 row	281838-3	429582	532-333
4 pins, 1 row	281838-4	429594	532-349
5 pins, 1 row	281838-5	429600	532-355
6 pins, 2 rows	281839-3	429650	532-406
8 pins, 2 rows	281839-4	429661	532-412
10 pins, 2 rows	281839-5	429673	532-428
12 pins, 2 rows	281839-6	429685	532-434

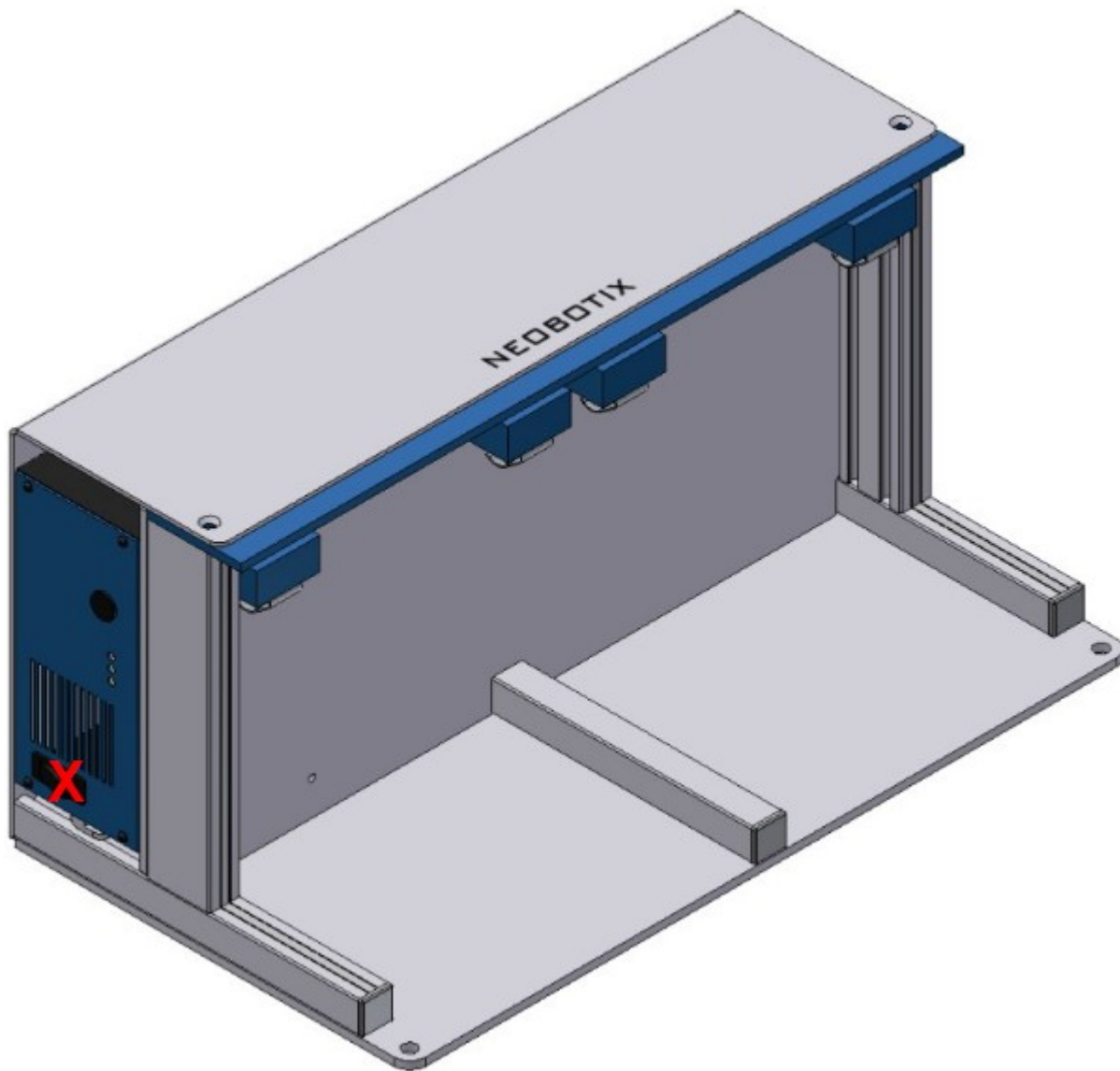
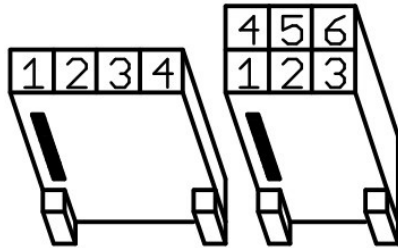


Fig. 2: Position of the main power switch (X)



Crimp contacts	TE Connectivity	Farnell	RS Components
AWG 28-24	182734-2	429715	532-456

In Neobotix products the pin assignment of the HE14 connectors is as shown below.



4.8.2 Würth Elektronik - MPC4

Please check the [Würth Elektronik online catalogue](https://www.we-online.com/en/products/components/overview)¹⁰ for details on the MPC4¹¹.



Pins (in 2 rows)	Würth Elektronik
2	649002113322
4	649004113322
6	649006113322
8	649008113322
10	649010113322
16	649016113322

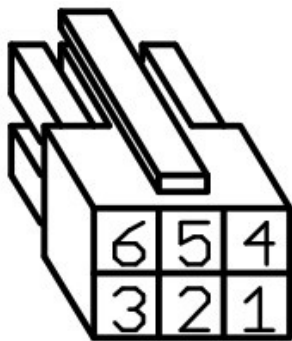
¹⁰ <https://www.we-online.com/en/products/components/overview>

¹¹ https://www.we-online.de/katalog/de/em/connectors/wire-to-board/wr_mpc4/



Crimp contacts	Würth Elektronik
AWG 24-18	64900613722

In Neobotix products the pin assignment of the MPC4 connectors is as shown below.



4.8.3 Würth Elektronik - MPC3

Please check the [Würth Elektronik online catalogue](https://www.we-online.com/en/products/components/overview)¹² for details on the MPC3¹³.



Pins (in 2 rows)	Würth Elektronik
4	662004113322
6	662006113322
12	662012113322

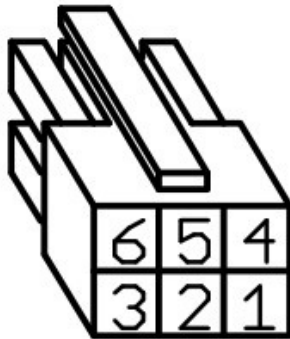
¹² <https://www.we-online.com/en/products/components/overview>

¹³ https://www.we-online.de/katalog/de/em/connectors/wire-to-board/wr_mpc3/



Crimp contacts	Würth Elektronik
AWG 24-20	66200113722

In Neobotix products the pin assignment of the MPC3 connectors is as shown below.



4.9 Safety Instructions

4.9.1 General Safety Instructions

This page contains general safety instructions and information that applies to all Neobotix robots.

Note: Depending on the chosen options and customisation of your robot additional safety instructions may apply. Please also check the documentation of the actual robot model that you are working on to ensure a safe and trouble free operation.

The mobile robot (in all varieties and models based on it) is an autonomous vehicle that is not only capable of performing very different tasks but can also react dynamically to its environment. Under some circumstances this might result in situations in which the robot's behaviour appears to be surprising or incomprehensible to persons who do not know the robot in detail.

Because of this it is essential that all of the following safety instructions are followed at all times. A safe and efficient operation of the robot can only be achieved under this condition.

4.9.1.1 Emissions

All the components and sensors used in Neobotix robots are safe to use and do not emit any dangerous radiation.

- The laser scanners are devices of laser safety class 1 or 1M. Further information can be found at [Laser Scanners](#) (page 44).
- The ultrasonic sensors are safe for both humans and animals.
- None of the electronic devices and components will heat up to a dangerous degree.

4.9.2 Briefing

Due to the complexity of the robot system it is strongly recommended to attend a training. This online documentation is only provided as a work of reference when facing minor or common problems. All other problems, mistakes and difficulties can best be avoided by an in-depth training for programmers and a proper briefing for operators.

Attention: Always make yourself familiar with the robot, its control and behaviour before starting your work or setting up autonomous processes. Every other concerned person (e. g. workers, programmers, visitors etc.) should also be briefed accordingly.

4.9.3 Safety System

The mobile robot is equipped with several safety features. Additional features can be installed if necessary. Before starting to work with the robot a risk assessment may be required to determine whether the present safety features provide a sufficient level of safety.

Warning: Some of the safety features, especially the laser scanner, might have been reduced or even disabled in order to make transport to the customer's site possible or more convenient. These features must be set up and tested by a qualified technician prior to the first operation of the robot system!

4.9.3.1 Emergency Stop Buttons

As soon as one of the emergency stop buttons is pressed, all drives are immediately disconnected from power and the safety brakes of all motors (if equipped) are engaged.

Additional information on the emergency stop buttons and the reset procedure can be found in the specific documentation of your robot model.

4.9.3.2 Laser Scanners

The safety approved laser scanners can monitor user-defined safety fields in front of or around the robot which are dynamically activated according to the current velocity of the platform. If required these fields can also be activated by an application specific control software. In this case only the control software is responsible for the correct activation of the safety fields according to the current condition

Note: Please note that in omnidirectional robots the safety fields can only be activated by software and not depending on the robot's speed.

As soon as a person or obstacle is detected within the currently active safety field the robot is immediately set to emergency stop. The stop will be reset automatically after the field has been cleared. No manual reset is required in this case.

The laser scanners have been approved as safety device with Performance Level d and SIL2. They fully replace the mechanical safety bumpers which have been required for autonomous vehicles in their early days.

4.9.3.3 Special Functions

In case third-party software is meant to run on the robot or on the remote control computer this software can be enabled to trigger an emergency stop and or to reset the safety system. Additional safety devices can also be integrated into the mobile robot.

Please contact Neobotix if you plan to implement any special functions.

4.9.4 Cooperating with the Robot

4.9.4.1 Close Proximity

As long as the robot is not in full emergency stop, a minimum distance should always be kept. Direct contact to the active robot system is to be avoided.

Warning: Climbing up onto the mobile platform and / or riding on it are not allowed at any time.

4.9.4.2 Medium Proximity

When approaching the robot or working in its presence, increased attention and caution are required. The safety features of the mobile robot have to be set at such a level that imminent dangers can be detected and that injuries or damages can be avoided.

In case the safety features have to be reduced due to the requirements of the process it might be necessary to prohibit the presence of people in the robot's surrounding. In these cases only the owner of the robot system can be held responsible for the safe operation.

4.9.4.3 General Surrounding

As long as the safety features of the mobile robot are set up properly, the presence of people and vehicles in the robot's wider working area is allowed. Please contact Neobotix for further advice if needed.

All people working in the same area as the robot should nevertheless be informed about the robot's behaviour and the possible dangers. Appropriate behaviour and consideration are necessary.

4.9.5 Bringing into Service

After installing the mobile robot and also after making changes to the environment or the work processes a supervised test-run has to be performed. This test has to cover all possible steps of the process. Autonomous operation must not be resumed without a successful test-run.

This also applies to modifications of routes and target positions, parameters, environmental conditions and higher level control systems.

Repairs, maintenance work and other changes in the system's hardware should also be followed by a test-run.

Note: The Neobotix GmbH cannot be held responsible in any way for injuries or damages which are caused by any problem that could have been detected or prevented by a supervised test-run.

4.9.6 Modification of the System

If you intend to perform any kind of mechanical, electrical or software modification and feel unsure about the process, please contact Neobotix. Some detailed information or instruction might be necessary.

In case one or more robots are to be modified, it is strongly recommended to consult Neobotix in order to provide the appropriate training and information for all technicians and programmers. The functions and safety of all modified robots have to be checked and ensured before bringing them into service.

Attention: All warranties are void in case of any unauthorised or improper modification of the mobile robot system. All responsibilities for the further operation of the robot are devolved to whoever commands or executes such modifications.

4.9.7 Expected Misuse

4.9.7.1 Passenger Transportation

Danger: Transporting passengers on or by the mobile robot is dangerous and strictly prohibited. The Neobotix GmbH cannot be held responsible for any injuries and / or damages caused to or by transporting passengers with the mobile robot.

4.9.7.2 Safety Fields

The laser scanners' safety fields must be configured and tested by the operator prior to taking the robot into service. If more than one safety field are to be used they need to be dynamically activated according to the current state and intended action of the robot.

Warning: The operator takes full responsibility for the safe activation of the safety fields. Safety fields that are set up incorrectly or have been activated faultily will result in an unsafe and possibly dangerous operation of the mobile robot.

4.9.7.3 Working Area

When choosing and preparing the working area special care has to be taken to ensure both a reliable localisation and motion control. The robot must never be operated in areas where there are staircases leading down, elevated platforms or other possibilities for falling or dropping down.

The localisation system of the mobile robot requires clearly visible landmarks and a high quality map of the surrounding. Further information on this topic can be found in the documentation of the used software. Please contact Neobotix in case of any problems.

The motion control system of the mobile robot will only work reliably on an even ground and without slippage. Dirt like dust, sand, oil or water may cause the wheels to slip and the robot to move uncontrolled. This might even result in a loss of localisation which might make the robot leave the predefined path and enter prohibited or dangerous areas.

Danger: The robot must never be operated in areas where it might fall down staircases, loading ramps or similar.

4.9.7.4 Mechanical Overload

The defined maximum payload must not be exceeded. Overloading the robot may lead to reduced life expectancy of the drives and to damages to the robot. It might also affect the driving properties, resulting in unwanted movements and might even cause the robot to leave the predefined paths.

4.9.7.5 Electrical Overload

The robot's on-board power supply must not be overloaded. Extreme overload may lead to overheating, damages to the electrical installation and to short circuiting.

Please contact Neobotix before modifying the electrical system of the mobile robot.

4.9.7.6 Modifications

The robot must always be turned off and disconnected from all power sources before any modification is carried out. Working on the robot while it is connected to a power source or turned on results in the risk of electrical shock to the worker and damages to the robot.

Note: Additional information on maintenance and hardware modifications can be found at [Maintenance](#) (page 66).

4.9.8 Configuring the Safety Fields

To achieve both high agility and a safe operation, the safety fields of the laser scanners must be configured and activated according to the intended motion. Prior to the first operation the safety fields have to be defined with consideration of the application's requirements, the working environment and the desired speed. If the safety fields are to be actively selected instead of being automatically activated, the wiring may need to be changed and a routine to select and activate the safety fields has to be implemented in the control software.

Warning: At delivery a set of safety field is defined which will avoid collisions in most situations. These settings must be tested and, if necessary, be adjusted prior to the first operation. Otherwise the required level of safety cannot be guaranteed.

The configuration and diagnostics software CDS from Sick can be used to conveniently configure the scanners' safety fields. The configuration cable that was included in delivery can be used to connect the scanners to the serial port of any external computer running the CDS.

Note: The Sick default password is SICKSAFE.

4.10 Safety Instructions (Manipulators)

4.10.1 Robot Arms

4.10.1.1 Universal Robots

The robot arms from Universal Robots were designed for direct interaction with humans. Their safety features limit their speed and power and significantly reduce the potential to cause injuries or damages.

Warning: Nevertheless the robot arm may hit people or obstacles before its safety features come into effect. When equipped with a dangerous tool, serious injuries may be caused.

4.10.2 Laser Scanners

The robot arm may reach beyond the laser scanners' safety fields that were originally set up for transport and delivery. In order to ensure a safe operation of the mobile manipulator, the safety fields must be adjusted to cover the robot arm's work space whenever possible and to prevent collisions between the arm and any person nearby.

4.10.3 Working required from the Customer

Mobile manipulators are very complex robot systems. The applications in which they will be used could not be foreseen in detail during the development of the robot. Therefore, beside any modifications needed for certain research work or experiments, some very basic tasks must be completed before the mobile manipulator can be used safely.

- An assessment of risks must be performed by the customer to identify the different measures needed to guarantee a safe operation.
- All safety measures required for safe operation have to be implemented by the customer according to the assessment of risks and under the customer's responsibility.
- The higher level control software for the mobile manipulator has to be provided and installed by the customer. The safe operation of the robot greatly depends on the proper and reliable functioning of this software. Therefore it must be made sure that the robot's speed and workspace are limited to a safe level and that all axes are coordinated properly at all times.

In order to achieve a safe operation of the mobile manipulator, several measures might be required. The following list gives a short and incomplete overview of possible measures.

- Using the laser scanners area monitoring feature for collision avoidance.
- Adding safety bumpers to the robot.
- Limiting speed, power and work area of the robot arm.
- Adding covers and shielding on the mobile manipulator.

Note: Additional actions might be required to guarantee the appropriate level of safety!

4.11 Maintenance

4.11.1 Cleaning

Before any cleaning starts the robot should be set into emergency stop by pressing one of the emergency stop buttons. It can also be switched off altogether. This precaution is recommended both for cleaning the robot and for cleaning the robot's workspace.

Attention: If the robot is not set to emergency stop or switched off it might move in an unexpected way, causing collisions or injuries!

4.11.1.1 Wheels

Over time the wheels might pick up dirt which should be removed regularly. A thick layer on the wheels can cause vibrations and noise when the robot is moving.

A layer of dirt on the castor wheels or the trailing cable also may reduce the robot's capability to safely discharge electrostatic charge.

4.11.1.2 Sensors

Cleaning the various sensors is indispensable to assure that the robot can move safely and swiftly through its environment.

Attention: Be very careful not to scratch the cover of the laser scanner or the membranes of the ultrasonic sensors. Damaging these components might cause severe malfunctions!

4.11.2 Maintenance and Repairs

4.11.2.1 General Precautions

Please mind these general precautions that will make working on the robot safer and more efficient.

- Only qualified personnel may do maintenance, repairs or modifications on the robot. The requirements on qualified personnel can be found at *Qualified Personnel* (page 67).
- Before starting any work always unplug the mains connection and disconnect the robot from the battery charger and the automatic charging station.
- Disconnect all batteries from the robot.
- Follow the applicable common safety guidelines for working on electrical systems.

4.11.2.2 Wear and Tear

The mobile robot has been designed for longest possible operational life and is almost maintenance free. It is nevertheless advisable to regularly check the robot and all related devices and components for signs of wear.

- Mechanical damages to operating elements, covers and other components will reduce protection against contact. They might also cause delayed and surprising malfunctions.

- Damages, deformations or dirt on the drive and castor wheels can cause unsafe or inaccurate movements and lead to loss of localisation.
- Vibrations and increased noises during operation can be indicators of something chafing or of mechanical overload.
- Unusual heat can point to mechanical or electrical overload or to batteries that are worn out and should be replaced.
- A reduced uptime between charging cycles is often caused by old batteries that have lost a significant part of their capacity.

4.11.2.3 Repairs

In case of any questions regarding repairs or replacement parts please get in touch with Neobotix. We are always happy to support you.

Please mind the following points in any case:

- Only use replacement parts with features and properties identical to those of the original parts.
- Always mount all covers and hull parts properly and securely after finishing your work.
- Make sure to reconnect and fix all electrical connections, especially shieldings and earthing straps.

4.11.2.4 Batteries

The batteries need to be checked regularly and have to be replaced after some time. Additional information on the batteries can be found at [Batteries](#) (page 37).

4.12 Qualified Personnel

This product must only be modified, commissioned, operated and serviced by qualified personnel. Qualified personnel are defined as persons who

- due to their specialist training and experience have adequate knowledge for the work at hand,
- have been instructed by the responsible robot operator in the operation of the robot or its parts and the currently valid safety guidelines,
- are sufficiently familiar with the applicable official health and safety regulations, directives and generally recognised engineering practice (e.g. DIN standards, VDE stipulations, engineering regulations from other EC member states) that they can assess the work safety aspects of the product and
- have access to this manual and who have read it.

The following groups of persons are generally not considered qualified:

- Employees, interns or other academic staff not familiar with the product,
- visitors and guests,
- all members of other departments of the company or institution in which the product is operated.

This list is not intended to be exhaustive.

4.13 Taking out of Service

4.13.1 Disassembly

Once the mobile robot has reached the end of its lifetime it should be disassembled and its components should be recycled.

Tip: Before the robot can be disassembled the battery charger, any other external power supply and the batteries must be disconnected from the robot. It is strongly recommended to wait for at least 30 minutes after disconnecting all power sources before starting the disassembly. This will help to discharge any electrical energy that might be left in the system.

Disassembly of the robot should be done by qualified personnel only, preferably someone who has already worked on the robot in the past and knows its technical details. This will ensure

- fast and trouble-free disassembly,
- reduced risk of injuries or damages to components that are to be reused and
- proper sorting of parts according to materials and way of recycling.

More information on qualified personnel can be found at [Qualified Personnel](#) (page 67).

4.13.2 Recycling

4.13.2.1 Reusable components

Many components of the mobile robot (e. g. the servo motors and the amplifiers) have a very long life expectancy and will most probably still be usable when the overall system has reached the end of its lifetime.

Please check carefully which components can be reused immediately or in later projects and make sure that they are removed with care.

Tip: Reusing components does not only help the environment by reducing resource consumption but will also save a significant amount of money.

4.13.3 Mechanical parts

The frame and the other mechanical parts of the robot are mostly made from aluminium or steel. Both materials should be separated completely and can then be sold to certified recycling companies.

4.13.4 Electrical components

Electronic scrap and electrical wires are both a source of valuable resources as well as a threat to the environment and must not be treated like consumer waste.

Attention: All electrical wires and components must therefore be collected and sold to or deposited at the appropriate recycling facilities.
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4.13.5 Batteries

Note: You can find information about the batteries and the recycling process at [Batteries](#) (page 37).
