



TMC300

Original instruction manual (en)

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1 Introduction

This document outlines the operational instructions of the ROEQ TMC300 and will be referenced as “the TMC300”, “the top module”, or “the product”.

This manual contains notices to be observed to ensure personal safety and to prevent damage to property.

Read this document before operating the product to achieve correct installation and commissioning in a safety manner.

Save this document for future reference.

1.1 About this product

The TMC300 is a partly completed machinery wrt. the European Machinery Directive [1]. As such it is not intended to be operated as a standalone unit, but rather as a component in a larger setup possibly involving a Robotize robot, other machinery, etc. Read the manual of the robot carefully before commissioning the combined solution.

The safety related aspects of this document pertain only to the ROEQ product and, to some extent, the interplay between the ROEQ product and other equipment. The integrator of the complete machine must consider any hazards and required remedies not included in the scope of this document.

The expected lifetime of the product safety system is 20 years, which should not be exceeded.

All abbreviations used throughout are summarized at page 56 of this document, along with all citations and elaborations of selected technical terms.

1.2 Target group

The instructions in this document are intended for integrators, operators, etc. wrt. the user groups defined in Appendix A, depending on the potential interaction with the product.

1.3 Hazard specification

Throughout the document, several directions and instructions are provided concerning the use and behavior of the product. The classification of the provided directions and instructions follows the outline in Appendix B.

1.4 Where to find information

General citations are presented as a number in brackets, e.g. [2], and a complete overview of citations is provided at page 56 of this document.

In addition to the information in this document; the partner portal (login required) within www.roeq.dk [2], contains a wide range of information e.g. software updates, user guides, safety configurations, 3D CAD files and more. Contact ROEQ technical support for access.

Support request to ROEQ technical support can be submitted via the support portal, following the link below: <http://support.roeq.dk/>

2 Safety

The following provides general safety instructions for operating the product. These must be carefully read before installation and operation of the product. The instructions are additional to the safety instructions for the robot, which are not repeated here but should be always heeded.

Further, always follow any site-specific instructions or legislation concerning, e.g.

- use of personal protection equipment,
- emergency procedures in the event of fire or similar,
- etc.

Site specific safety concerns, not relating specifically to the product, are not considered in this document.

In addition to the general remarks provided below, concrete safety remarks pertaining to specific scenarios for operating the product are provided within the relevant section of this document.

Deviations from the safety precautions outlined below and in the remainder of this document, compromise the safety assumptions, tests and designs conducted by ROEQ.

The integrator or end user responsible for the final installation of the ROEQ product, robot and possibly other machinery must always perform a risk assessment of the full installation, and act on any identified issues not covered.

2.1 Safety principle

The basic safety functionality of the robot is not modified, and all safety functions such as personnel detection, speed monitoring, Emergency Stops (E-stops), etc. remain unaltered when installing the ROEQ product.

ROEQ products incorporate additional safety functions that operate alongside the safety system of the robot, e.g. cargo monitoring, additional E-stops, speed reduction, etc. depending on the specific ROEQ product installed.

These functions may involve only the installed ROEQ product, or they may affect the robot as well. For example, if cargo monitoring functionality is installed, the ROEQ product may issue a protective stop for the robot, whenever it is detected, that cargo shifts out of place.

The safety system of the ROEQ product starts with the sensors installed in the product itself, and ends with the connection interface with the robot, i.e. the plugs connecting the robot and ROEQ product.

Suitable safety operations require the robot to be installed with the correct safety configuration, e.g.


- to react appropriately to safety signals from the ROEQ product,
- to provide the correct safety information for the ROEQ product.

For the products covered by this document, proper safety operation requires updating the robot safety configuration with an extended safety configuration provided by ROEQ, as part of the commissioning process.

For more information on the robot safety system, refer to the GoPal P35 Operators manual.

For more information about the ROEQ safety features, consult Section 3.5 of this document.

2.2 General safety precautions

 WARNING!	<p>Use a fully functioning and serviced robot for integration</p> <p>The robot used for integration with the product must be fully functioning and serviced in accordance with specifications from Robot manufacturers.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Personal injury from collisions caused by faulty robot.</i> <p>Follow the robot operating instructions and safety limitations</p> <p>The safety of the product is based upon the safety of a correctly operated robot.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Personal injury from faults/malfunctions caused by improper robot operation.</i> <p>Follow guidelines for correct handling</p> <p>Follow the guidelines in the Section 4 for correct handling and transporting the product.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Personal injury from ergonomic overload due to incorrect handling.</i> <p>Ensure proper installation and commissioning of the product</p> <p>The product must be fully and correctly installed as per the procedure of section 5.</p> <p>The product must be fully and correctly commissioned as per the procedure of Section 6.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Personal injury from overturning robot, falling load, incorrect operation, etc.</i> <p>Ensure proper mounting of load during locomotion.</p> <p>The transported goods must meet the stability requirements outlined in Section 7.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Personal injury from overturning robot or falling load during locomotion.</i> <p>Only transport approved cargo</p>
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	<p>The product must only be used to transport the cargo types outlined in Section 3.</p> <p>Do not use the product to transport people.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none">▪ <i>Personal injury due to falling load during locomotion</i> <p>Inform personnel about load transfer zones</p> <p>Load transfer zones must be set up as Operating Hazard Zones (OHZs), as described in Section 6.4.</p> <p>Personnel working near an OHZ must be aware of this and instructed to stay clear of the robot during load transfer.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none">▪ <i>Personal injury from collisions with cargo and/or robot.</i> <p>Ensure proper training of personnel</p> <p>The personnel involved in each task involving the product must comply with training guidelines for that task, as indicated in Appendix A.</p> <p>People and personnel in rooms/areas where the product is set to operate must at the very least be informed about the presence of the product, and its basic operating principle.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none">▪ <i>Personal injury from incorrect interaction with the product due to lack of training to complete a specific task.</i> <p>Driving area must be suitable for operation</p> <p>Make sure the area in which the product is used complies with the specifications of Section 6.</p> <p>Avoid large gaps, grooves, steps, debris, etc. in and on the floor, as the load may become unstable if the robot drives across such obstacles.</p> <p>Do not operate the product on sloped floors, as the load may become unstable.</p> <p>Wet and uneven surfaces may cause the robot to skid.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none">▪ <i>Personal injury from dropped or tipping cargo.</i> <p>Environment must be suitable for operation</p> <p>Respect the environmental limitations for operating the product outlined in Section 3.</p>
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	<p><i>Residual risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Faulty operation due to malfunctioning electrical equipment</i> <p>Avoid leakage of fluid during transport</p> <p>Make provisions to avoid leakages when transporting fluids.</p> <p><i>Residual risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Personal injury from leaking fluid</i> ▪ <i>Malfunctioning electrical equipment</i>
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2.3 Residual risks

In addition to the residual risks summarized in the documentation for the robot, ROEQ has identified the following potential risks that integrators must inform personnel about, and take appropriate measures to prevent:

- Getting hands and fingers crushed/pinched during mounting of the product.
- Getting limbs pinned or crushed between top module and cargo during docking operations.
- Getting pinned or crushed between robot and cart or docking stations during docking operations.
- Getting limbs pinned or crushed between the top module and the charging station of the robot.
- Getting crushed by cargo if the robot or cargo overturns during transport.
- Losing control of the TMC300 if accessed by unauthorized users
 - Consult the IT security guidelines of the Robotize robot.
- Cargo dropping or robot overturning due to hazardous robot movement.
- Cargo dropping or robot overturning due to faulty placement of cargo.


2.4 Emergency situations

Emergency Situations are highlighted in the following.

2.4.1 Emergency stopping

The product stops all internal and robot movement whenever an E-stop is thrown.

The product is equipped with dedicated E-stops, see Section 3, to be used in case of emergency.

 WARNING!	<p>Proper operation of the E-stops requires the correct robot safety configuration.</p> <p>The installed E-stops do not provide any direct stop of moving parts. Rather, they provide a signal path to communicate an E-stop to the robot. Any action based on any E-stop being thrown must be governed by the safety system of the robot.</p> <p>The proper safety configuration must be programmed into the robot prior to operation, to ensure proper operation of the product safety features.</p>
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2.4.2 Fire and explosions

The TMC300 has been designed to be without risk of explosion or catching fire.

Any fire and explosion risks related to the cargo being handled or transported by the product must be considered as part of the risk assessment for the full installation.

2.4.3 Applicable fire-fighting equipment

In case of fire involving the TMC300, employ fire-fighting equipment suitable for electric systems corresponding to the electric specifications of the product.

Personnel working near the Product must be trained in operating firefighting equipment.

3 Machine overview

The following provides an overview of the product with respect to the intended use, elements of misuse, key components, and technical details. Further, an overall description of the various safety functions of the product is provided in Section 3.5.

3.1 Intended use

The product is intended to be installed on a Robotize GoPal P35 robot.

The product contains a mechanism that raises and lowers a set of locking pins upon request, as illustrated in **Figure 1**.



Figure 1: Left: Pins lowered. Right: Pins raised.

When the locking pins are raised, the robot can latch onto a cart.

The mechanism enables the robot to pick up carts and transport cargo between locations, see **Figure 2**.

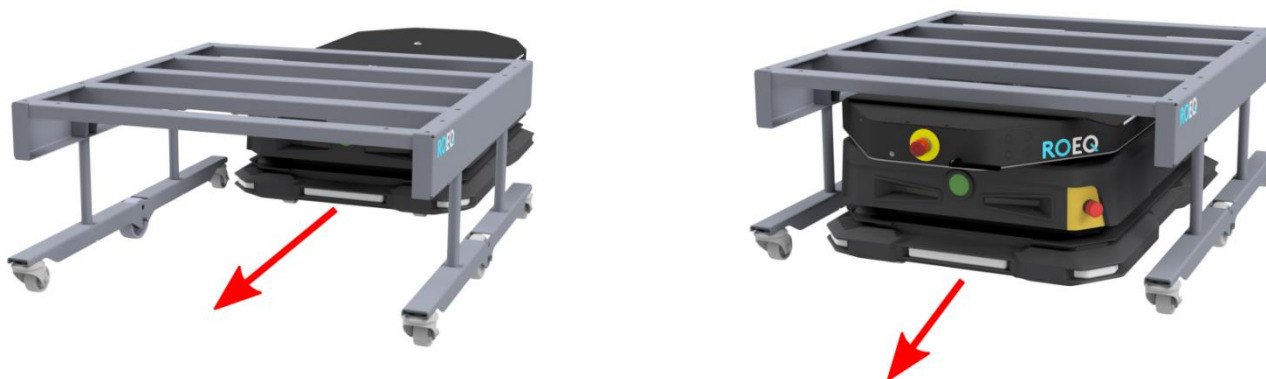



Figure 2: Left: Robot docking underneath cart. Right: Locking pins are engaged, and the robot can start locomotion to destination.

When arriving at the destination, the pins are retracted, and the robot undocks the cart.

 NOTICE!	<p>The TMC300 may only be used to transport compatible carts from the ROEQ product line.</p> <p>Consult the ROEQ support staff for details.</p>
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3.2 Machine description

Overview of the product and electrical connections.

3.2.1 Main components

The main components of TMC300 are summarized in **Figure 3** and **Table 1**.

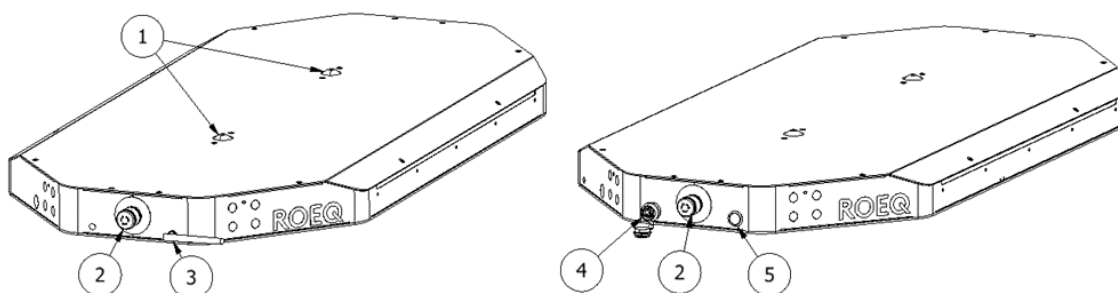


Figure 3: Left: Front. Right: Rear

Nr.	Description
1.	Locking pins

2.	E-stop button
3.	Wi-Fi antenna
4.	RJ45 connector
5.	ROEQ recovery button

Table 1: Main components of TMC300

ROEQ recovery button enables manual movement of the locking pins, see Section 10.3.

The RJ45 connector can be used to connect directly to the TMC300 to manage product errors, logs and setup of the top module, elaborated in Section 7 and 10.

3.2.2 Employed materials

No hazardous materials are used in the product:

- the main mechanical parts are made from aluminium or steel (powder coated, stainless, or galvanized).
- other minor internal parts are made from polymer and rubber.
- all electronics are RoHS compliant.

3.2.3 Electric connections

The product is connected to the robot via several cables installed in the plugs of the robot cable compartment. The cables are listed in **Table 2** and are illustrated in **Figure 4**.

Nr.	Cable	Nr.	Cable
1	C01 - Safety and regulated power	2	C02 - Unregulated power
3	C05 - Ethernet to M8 cable		

Table 2: The cables connecting the TMC300

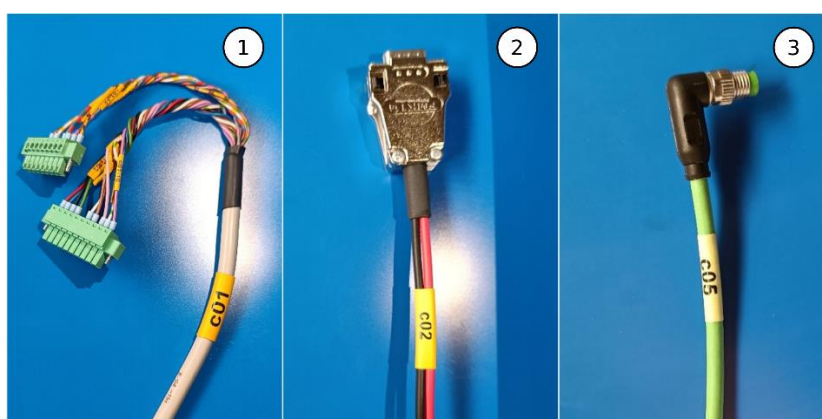


Figure 4: Overview of the TMC300 cables

3.2.4 Identification label

The product is equipped with an identification label located on the inside of the top module, visible when the top cover is removed from the product, as illustrated in **Figure 5**.

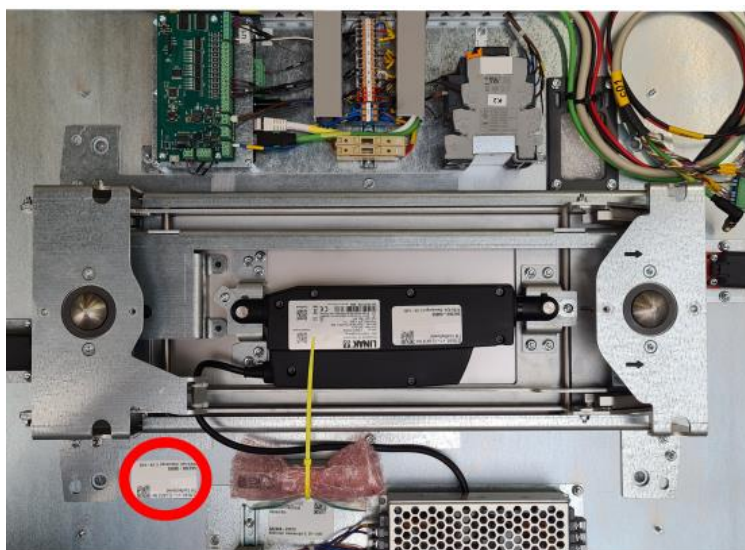


Figure 5: Identification label of TMC300

The identification label includes a serial number which is read as follows:

S/N: 1.00 277A1000 00100

→ Sequential identification number
→ Internal product number
→ Hardware version

Use the serial number to ensure the hardware version is compliant with the instruction manual version and include the number in the ticket if ROEQ support is needed.

3.3 Environmental specification

TMC300 is only intended to be operated in indoor industrial environments near informed people and personnel as per the specifications of Appendix A.


The product must not be installed or operated in areas open to the public.

The ground must be even, without slopes, steps, grooves or other abrupt height variations. Further, the ground must be without significant amounts of dust, dirt, and debris such as gravel, rocks, screws, etc.

Avoid operating the product on slopes.

Avoid driving in areas with obstructions and always keep all driving paths clean and free for obstacles.

Only use the product in environments not exceeding corrosion class C2 [3].

 WARNING!	<p>Only use the product indoors.</p> <p>The electronics of the product are not protected for outdoor operations.</p> <p><i>Risks:</i></p> <ul style="list-style-type: none"> ▪ <i>Rain, snow and excessive dust or dirt may damage the product</i> ▪ <i>Risk of faulty operation</i> <p>Do not operate the product on slopes</p> <p>Accidentally dropping or intentionally placing wheeled carts on slopes may result in uncontrolled run-away of the cart.</p> <p><i>Risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Risk of personnel injury from colliding with run-away cart.</i> <p>Do not use the product in corrosive or highly chemical environments.</p> <p>The product is not designed to withstand harsh environments:</p> <p><i>Risk:</i></p> <ul style="list-style-type: none"> ▪ <i>Risk of product malfunction or structural collapse from increased degradation.</i> <p>Do not use the product in explosive or sterile environments, etc.</p> <p>The product is not designed to satisfy any additional requirements for operating in special conditions.</p>
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3.4 Foreseeable misuse

Any use or application deviating from the intended use stated in this document is misuse of the product and must be avoided.

This includes, but is not limited to:

- Faulty installation
 - *Each step of the installation process must be carefully followed.*
- Incomplete product commissioning.
 - *Each step of the commissioning process described must be carefully followed, including the safety system test, assessment of the environment, and the potential configuration of features.*
- Omitting to make a risk assessment of the full installation.
 - *The TMC300 is marketed as partly completed machinery. As such, the final installation of the TMC300, cart, robot and, potentially, other equipment, may pose site- or installation specific hazards that have not been considered in the design and construction of neither robot nor ROEQ product.*

- *To comply with the European machinery directive [1], a full risk assessment and CE-marking must be made after the final machine installation is complete.*
- Failure to maintain a suitable operating environment.
 - *A suitable environment is crucial for safe and stable operation of the installation.*
- Omitting to test the safety system.
 - *To ensure continued operation of the installed safety features, the safety system of the robot as well as the product must be tested yearly, following the directions of Appendix C.*
- Failing to maintain the product.
 - *Safe operation of the product is conditioned on the maintenance specifications being followed.*
- Disregarding the proper training/information for people and personnel.
 - *Proper training of people and personnel is an important aspect of the safety surrounding the ROEQ products.*
- Lifting the product incorrectly by hand.
 - *The product is heavy and should be handled accordingly. Use appropriate lifting techniques and equipment for installing and dismantling the product.*
- Transporting improper cargo.
 - *The safety surrounding the transport of cargo is conditioned on the cargo loaded onto the product complying with the cargo requirement specification, Section 3.6.3.*
- Failing to properly secure cargo before transporting.
 - *Cargo must be properly secured for transport to prevent sliding or dropping.*
 - *This may involve installing custom fixtures, adding friction tape, etc.*

Additional elements of foreseeable misuse likely exist for other equipment included in the installation.

3.5 Safety system

The TMC300 has an integrated safety system that functions alongside that of the robot.

The TMC300 safety system governs all identified, unacceptable risks relating to the product.

Risk reduction is obtained via the following Safety Functions (SFs), each with the indicated Performance Level (PL) with respect to EN ISO 13849-1:2023 [4].

Any residual risks related to the operation and use of the TMC300, not governed by the safety system, is summarized elaborated in this document, Section 2, 6, and 7.

3.5.1 Safety functions

When the TMC300 is correctly installed and commissioned, it presents the following safety functionality:

- **SF1: Robot safety stopped when locking pins operates – PL c**

When the main contactor is enabled to power the locking pins, the robot will be put into a safety stop.

- **SF2: Robot unable to drive when locking pins are neither up nor down – PL c**
The TMC300 will signal the robot to activate zone sets that does not allow the robot to move when the locking bolts are neither in top nor bottom position.
- **SF3: Extended zones for carts and misplaced cart detection – PL c**
The safety scanner zones are designed to detect the cart if it is misplaced on the robot. The TMC300 signals the robot to change to these zones when the locking pins are in top position.
- **SF4: Maximum speed reduced when driving with carts – PL c**
Using the robot's safety scanner zones, the robot will be safety stopped if surpassing 1.25 m/s.
- **SF5: Emergency stops – PL d**
Enforce an E-stop whenever an E-stop button is pressed on the robot or the TMC300.

3.6 Technical specifications

The overall technical specification of the product is summarized in the following.

3.6.1 Physical properties

The physical properties of TMC300 is summarized in **Table 3**.

Dimensions	
Length	1200 mm [47.2 in]
Total length (w. e-stops)	1270 mm [50.0 in]
Width	600 mm [23.6 in]
Height	76 mm [3.0 in]
Weight	38.5 kg [84.9 lb]
Maximum towing/lifting capacity	300 kg [661 lb]

Table 3: TMC300 technical specifications


3.6.2 Electric properties

The electrical properties are listed in **Table 4**.

Electrical properties	
Nominal operating voltage	24 V
Maximum steady current draw	4.5 A
Nominal current draw	1 A
Minimum operating temperature	5° C
Maximum operating temperature	40° C
Minimum temperature for storage/transport	-5° C
Maximum temperature for storage/transport	55° C
Maximum humidity (non-condensing)	85 %

Table 4: TMC300 electrical specifications and requirements

3.6.3 Cargo specifications

	TMC300 may only be used to transport compatible carts from the ROEQ product portfolio – Consult the ROEQ support for elaborations.
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The transported cargo must always comply with the requirements and specifications provided in the documentation of the employed cart, e.g. in terms of weight, physical dimensions, placement of Center of Mass (COM), etc.

The default configuration of the robot safety zones is made for cargo dimensions (length x width):

1200 mm [47.2 in] x 890 mm [35 in]

4 Transportation, handling and storage


The product must be transported, handled and stored as described below.

4.1 Transportation and storage

The product must be transported within the transport box provided, or an equivalent enclosure.

During transport and storage, the environmental conditions of Section 3.6.2, **Table 4**, must be followed.

4.2 Handling

	With respect to the training levels outlined in Appendix A, handling of the TMC300 must be performed by authorized personnel, or trained personnel under supervision of authorized personnel.
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Remove the top cover of the TMC300 to access the anchor points for using suitable lifting equipment to handle and install the product, see **Figure 6**.

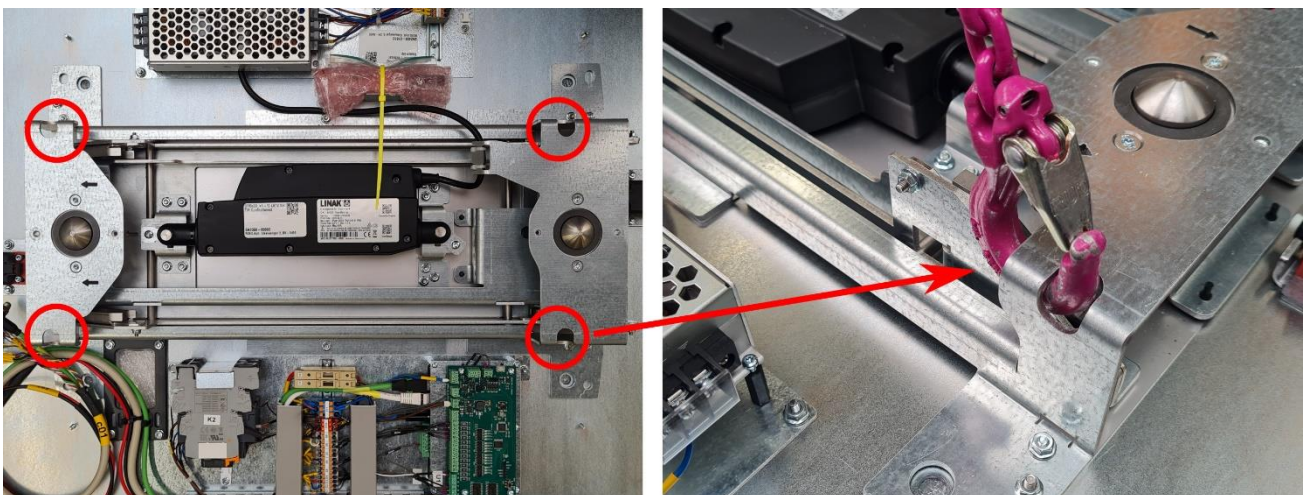




Figure 6: Anchor points

The weight of the top module without top cover is 28.5 kg [63 lb.]. Any manual lifting of the TMC300 should always involve two people.

When the top module is correctly installed, as per section 5, the robot and top module can be lifted together, using the anchor points in the top module.

5 Assembly and installation

The installation procedure of TMC300 is outlined in the following. Be sure to read and follow the instructions of each step carefully.

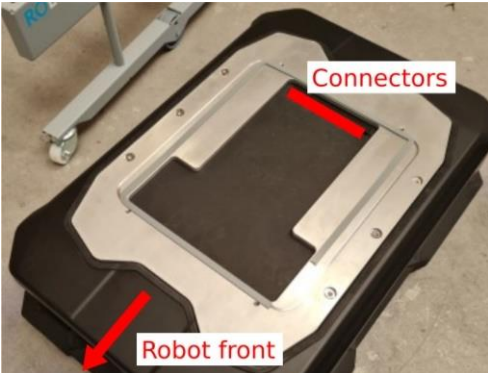
	With respect to the training levels outlined in Appendix A, handling of the TMC300 must be performed by authorized personnel, or trained personnel under supervision of authorized personnel.
	The robot's safety PLC cannot be accessed when the top module is installed. Be sure to have the newest version of the robot safety PLC configuration installed on the robot before installing the TMC300.




5.1 Required tools

The following tools are needed to complete the installation:

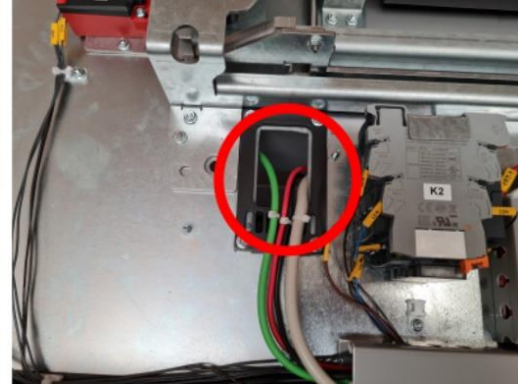
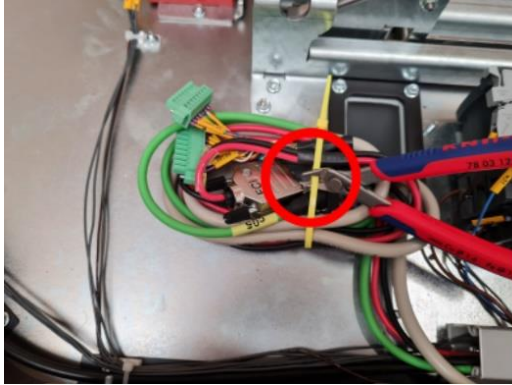
1. Torx key or screwdriver size 20
2. Torx key or screwdriver size 45
3. 5 mm hex key

5.2 Installation procedure

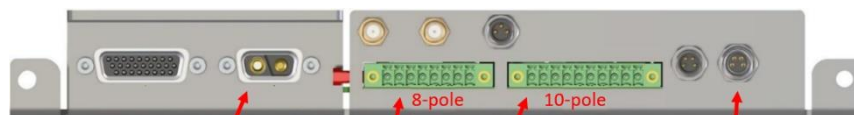
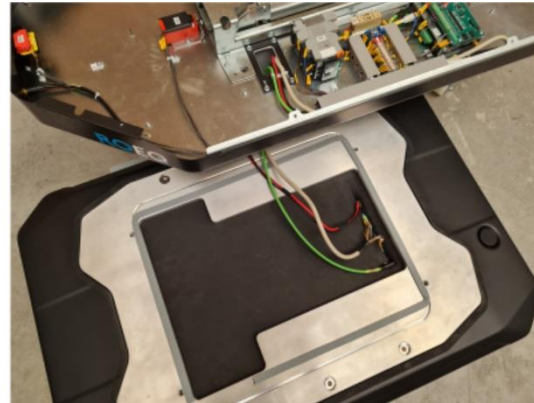
Step	Instruction and illustration
1.	Turn off the robot before installation.
2.	Prepare the robot for the installation of top module: <ol style="list-style-type: none">1. Remove the top plate from the robot.2. Place the adapter plate, included with the top module, on top of the robot. Make sure the adapter is oriented as shown. 

3.	<p>Using a torx 45 screwdriver, fasten the adapter plate with the 6 M8x30 with a torque of 28 Nm:</p> 
4.	<p>Using a torx 20 screwdriver, remove the four screws and take off the top cover. Save the screws.</p> 
5.	<p>Place the top module on the edge of a ROEQ cart or similar, close to the robot. Make sure the cable-cutout in the bottom of the top module is overhanging the edge of the cart.</p> 

6. Cut the yellow cable tie that retains the top module cables and feed them through the cable-cutout.

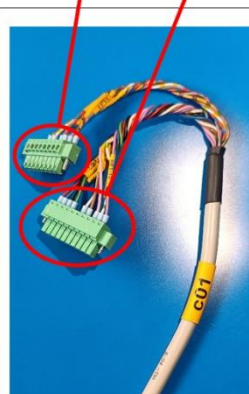


7. Connect each cable from the top module to the robot.



C02 – Cable connector requires correct orientation to mate correctly.

Tighten screws as part of installation.



C01 – Cable consists of two connectors: 8-pole and 10-pole.

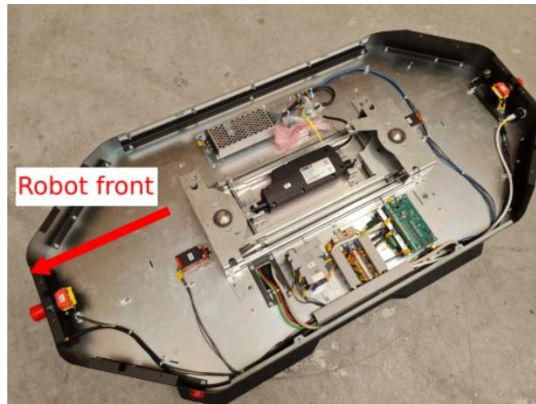
Tighten screws as part of installation.



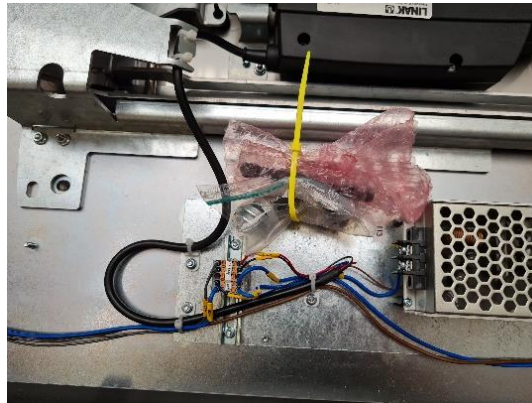
C05 – Cable connector has to be oriented correctly to align with mating connector.

Tighten screw as part of installation.

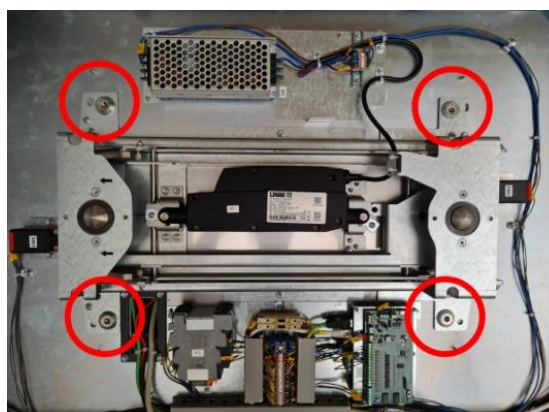
8. While making sure not to pull or damage the cables and connectors, carefully place the top module on the robot. Make sure no cables are pinched between the robot and top module.





9. Cut the yellow cable tie holding the accessory zip bags.



10. Align the four mounting holes.
Using a torx 45 screwdriver, fasten the top module with 4 M8x40 countersunk screws with a torque of 28 Nm, each with a countersunk finishing washer.



11.	<p>Place the top cover onto the top module.</p> <p>Using a torx 20 screwdriver, fasten the cover with 16 M4x 12 countersunk screws, including those from step 4. Tighten the screws with a torque of 2 Nm.</p>
	
12.	<p>Mount the Wi-Fi antenna from step 9 on the front of the top module.</p>
	

This concludes the installation of the product.

6 Commissioning

The commissioning process is an important part of setting up the TMC300 and verifying that it operates in the desired manner, and that all safety features function as intended.



With respect to the training levels outlined in Appendix A, commissioning **must** be performed by authorized personnel, or trained personnel under supervision of authorized personnel.

The mandatory steps of the commissioning are:

- 6.1 Prepare the environment
- 6.2 Perform a risk assessment

- 6.3 Robot safety configuration
- 6.4 Prepare operating hazard zones
- 6.5 Prepare robot
- 6.6 Verify cargo fitness
- 6.7 Verify safety system
- 6.8 Create cart transfer

6.1 Prepare the environment

Inspect the environment in which the TMC300 and robot are intended to operate. Remedy any deviations from the intended environment outlined in Section 3.3, while also respecting the environmental requirements and constraints of the robot documentation.


It must also be verified that openings, doorways, etc. have an appropriate width and height to allow for sufficient clearance when the robot passes. This must account for the height of the robot itself, as well as the height of TMC300, cart, and transported cargo.

6.2 Perform a risk assessment

As the TMC300 is partly completed machinery, it is necessary to make an overall risk assessment of the complete application within which the TMC300 is integrated, as well as the environment it will be operated in.

This is to maintain safety when all individual components are joined together in an overall installation.

The final risk assessment is the responsibility of the commissioner.

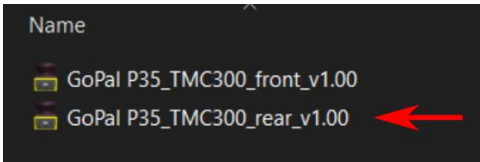
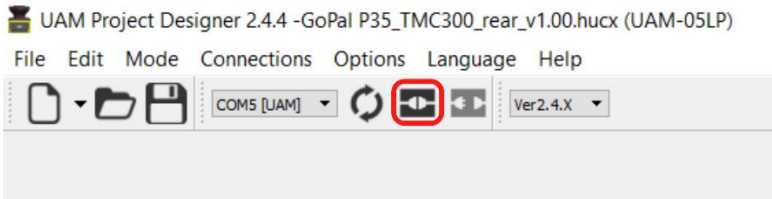
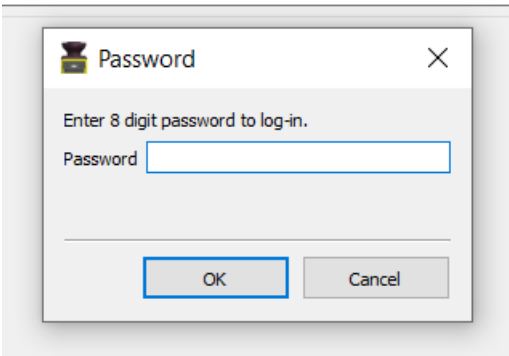
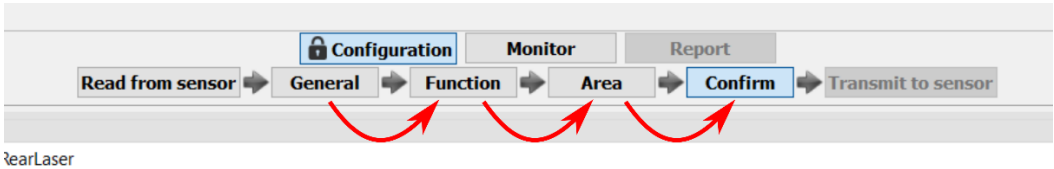
	ROEQ does not take any responsibility for the performance of the risk assessment but provides information and guidelines that may be used in this section.
---	--

It is recommended that the commissioner follows the guidelines in DS/EN ISO 12100:2011 [5], or a similar relevant standard to conduct the risk assessment.

The risk assessment must be used to determine any additional safeguards, markings, access restrictions, etc. required in addition to what is already provided by the product, to ensure the safety of the personnel around the TMC300.

The risk assessment should at least consider the need for:

- Access restrictions around load transfer zones
- Safety distances around the TMC300
- Additional markings or pictograms or warning signs
- Information for users and where to keep it

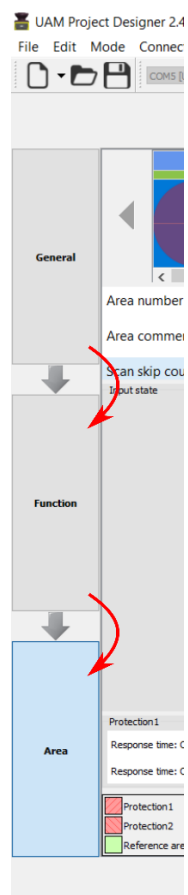
2.	<p>1. Open the rear scanner configuration received on the USB that comes with the top module</p> <p>Note: the file names in the figures are for illustration and may differ from the actual file names. Use Table 5 as reference for correct file names.</p> 
3.	<p>1. Click on the connect button</p> 
4.	<p>1. Use the password: 12345678</p> <p>2. Click OK</p> 
5.	<p>Navigate to: <i>Function → Area → Confirm</i></p> 

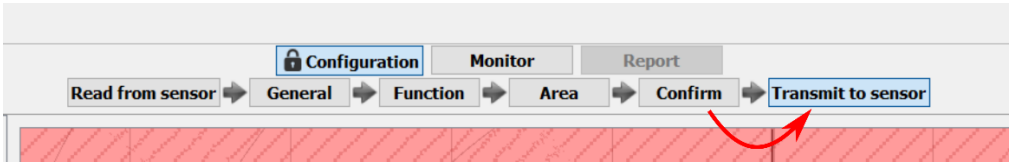
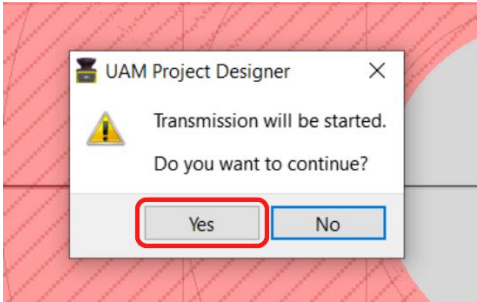
6. Verify the checksum matches the checksum in **Table 5**.

Product information	
Product identity	RearLaser
User name	Robotize
Date	2024/08/30
Configuration ID (Complete settings)	0x81869C31
Configuration ID (Without IP configuration and Date)	0x0766192F

Note: the checksums in the figure are for illustration and may differ from the actual checksums.

7. Navigate to:
Function → *Area*



8. Navigate to:
Transmit to sensor
- 
9. 1. Click Yes
- 
10. Redo the instructions on the front scanner



WARNING!

Verify checksum

It is important to verify the checksums by comparing the configuration checksums from **Step 6** to the checksums in **Table 5** to ensure the correct safety configuration has been uploaded to the scanner.

Robot set-up and configuration file name	Checksums
Front scanner: GoPal P35_TMC300_front_v1.xx.hucx	0x
Rear scanner: GoPal P35_TMC300_rear_v1.00.hucx	0x

Table 5: Laser scanner configuration and checksum [Configuration ID (Without IP configuration and Date)]

6.3.1 Checksum to configuration file

Using the .JSON configuration file (see section 6.5) provided by ROEQ the following can be skipped as the .JSON file already contains the correct SHA-256 checksums.

If not using the ROEQ configuration file, the SHA-256 checksums in **Table 6** must be added to the .JSON configuration file.

SHA-256 checksums
front_lidar_checksum:
rear_lidar_checksum:

Table 6: SHA-256 checksums to the configuration file

6.4 Prepare operating hazard zones

6.4.1 Load transfer zones

As described in the summary in Section 2.3, there is an increased risk of getting crushed, pinned, etc. around the TMC300 and carts during load transfers.

As per DS/EN ISO 3691-4:2023 [6], the area around the load transfer zones is classified as OHZs and must be clearly marked with signs, paint, floor-tape etc. as exemplified in **Figure 7**.



Figure 7: Load transfer areas must be marked as OHZs, e.g. using tape, paint, signs, etc.

Further, personnel must be instructed to stay clear of operating hazard zones when a robot is approaching for TMC300 cargo transfer.

The OHZ must have an escape route of at least 50 cm on both sides to other fixed obstacles, walls, etc., as illustrated in **Figure 8**.

The specific size of the OHZs should be based on the risk assessment c.f. Section 6.2.

Space requirements

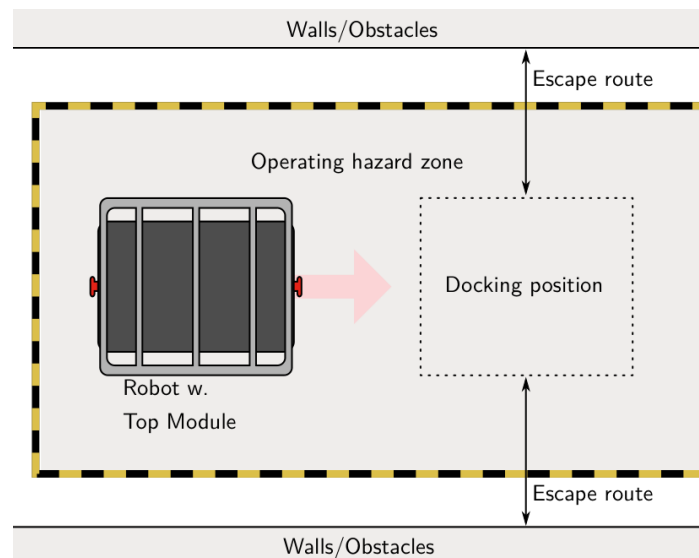


Figure 8: Docking positions must be in an OHZ

There must be a suitable escape route around the load transfer zones, both when approaching docking locations to pick up and drop off cargo. The illustrated docking location represents the load transfer described in Section 3.1.

6.4.2 Charging station

The charging station(s) to the GoPal P35 must be within an OHZ(s) as the contour of the TMC300 protrudes beyond of the front of the GoPal P35, presenting a risk of getting limbs crushed between the top module and charging station. The OHZ(s) must be made in a similar fashion to those mentioned in Section 6.4.1.

6.5 Prepare robot parameters

The Robotize robot - top module interface is configured by uploading a configuration file. The file specifies how the two systems communicate, what actions can be performed by the top module, compatibility versions and information about the safety configuration.

The content and format of the configuration file is defined by Robotize, for details about how to modify the file, please see the GoPal P35 documentation.

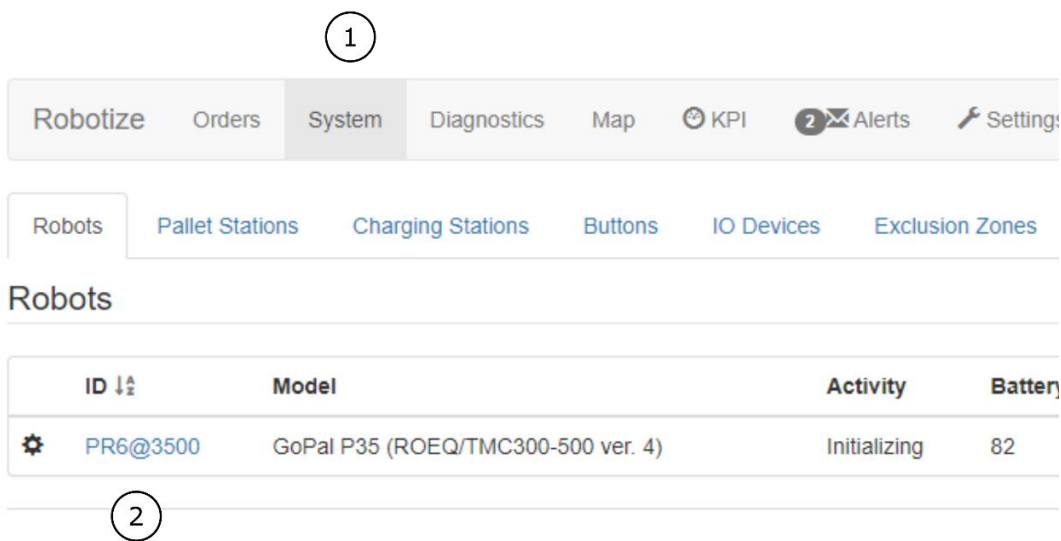
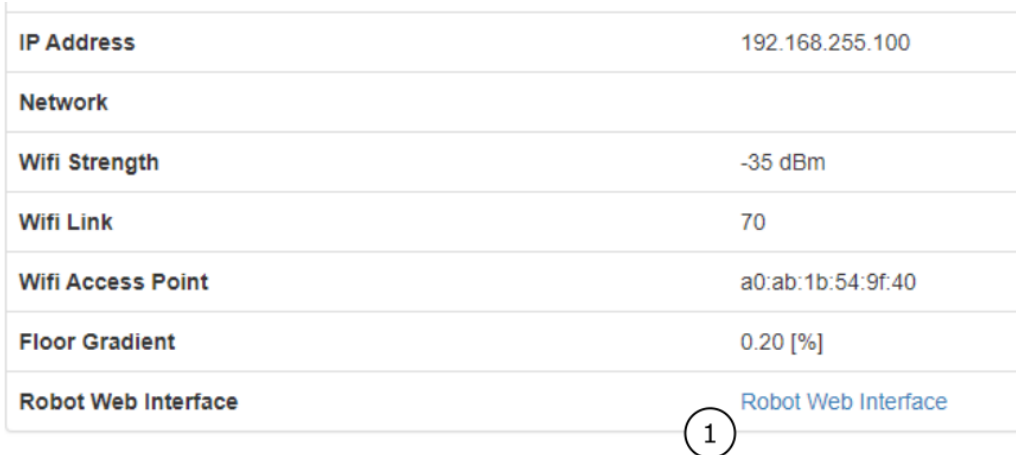
ROEQ provide a default configuration file, that can be used as is or be a baseline for modifications. The file can be provided on request.

6.5.1 How to modify configuration file


The configuration file can be modified in a text editor, such as notepad. The content is based on the JSON format, where the structure is defined by Robotize.

6.5.2 Upload configuration file

Following the previous sections, a configuration file can now be uploaded to a desired GoPal P35 robot. The configuration file can either be uploaded by having directly connection to the robot, having the robot in "Local" mode, or be uploaded to the robot via the Dispatcher as described in the following instructions.

Step	Instructions and illustrations
1.	Prerequisites for uploading configuration file: <ol style="list-style-type: none"> Valid configuration file (.JSON) Robotize Dispatcher server running Laptop connected to Dispatcher Interface GoPal P35 robot is ON and in remote mode
2.	<ul style="list-style-type: none"> Access Robotize Dispatcher Interface with a web browser (see Robotize documentation) <ol style="list-style-type: none"> Navigate to [System] Select robot from list  <p>The screenshot shows the Robotize Dispatcher Interface. The top navigation bar has tabs: Robotize, Orders, System (selected), Diagnostics, Map, KPI, Alerts (with a notification icon), and Settings. Below this, there are sub-tabs: Robots (selected), Pallet Stations, Charging Stations, Buttons, IO Devices, and Exclusion Zones. The 'Robots' section displays a table with columns: ID (with a sort icon), Model, Activity, and Battery. The table contains one entry: a gear icon, ID 'PR6@3500', Model 'GoPal P35 (ROEQ/TMC300-500 ver. 4)', Activity 'Initializing', and Battery '82'. A circled '1' is above the 'System' tab, and a circled '2' is below the robot list.</p>
3.	<ol style="list-style-type: none"> Navigate to the bottom of the page and select [Robot Web Interface] A new tab will open in the browser  <p>The screenshot shows the bottom of the Robotize Dispatcher Interface. It lists various system information: IP Address (192.168.255.100), Network, Wifi Strength (-35 dBm), Wifi Link (70), Wifi Access Point (a0:ab:1b:54:9f:40), Floor Gradient (0.20 [%]), and Robot Web Interface. The 'Robot Web Interface' link is highlighted with a blue underline. A circled '1' is next to the link.</p>

- 4.
1. Navigate to the wrench icon in the new browser tab
 2. Type in the User name and Password
 3. Login

Control Status Diagnostics Mapping  Language en

robotize

Login


User name admin Enter your user name

Password Enter your password

Remember me ☐ Keeps login for 2 weeks

Login

- 5.
1. Select menu [Top Module Config]
 2. Press [Upload top module config] a new window will open

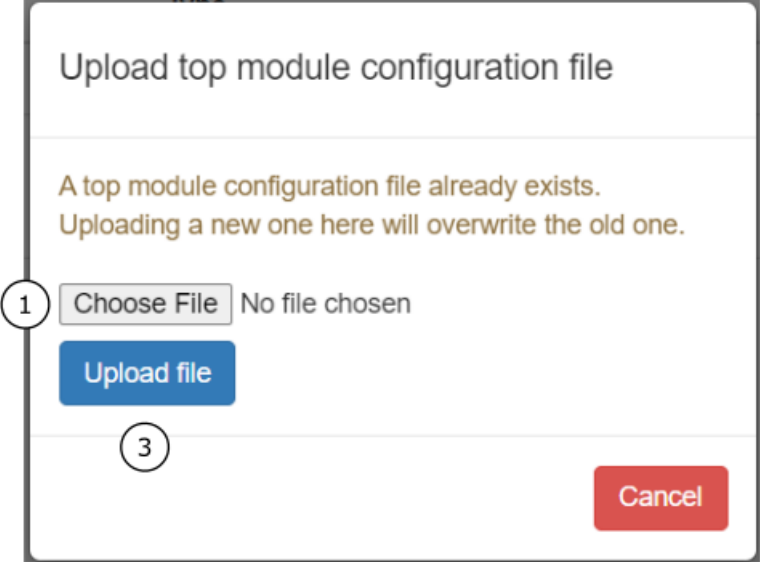
Control Status Diagnostics Mapping  Language en admin Logout

Production Info Production Housekeeping Calibration Test Safety Inspection Spare Parts Replacement Maintenance Tools Top Module Config

Top Module Config

Manufacturer	Type	Version
ROEQ	TMC300-500	4

Upload top module config Remove top module config

6.	<ol style="list-style-type: none"> 1. Select [Choose File] 2. Locate .JSON file on laptop 3. Press [Upload file] 
7.	1. Reboot the robot


6.6 Verify cargo fitness

Before using the TMC300 to transport cargo, the cargo itself must be verified to be suitable for transport in terms of the requirements laid out by Section 3.6.3.

6.6.1 Stability during transfer and transport

Verify that the mechanical property of the cargo is within the specified limits defined in Section 3.6.3.


Verify that the load is sufficiently secure and stable to not tip over during locomotion.

 WARNING!	<p>Ensure stability and load distribution on the cart</p> <p>The TMC300 does not monitor the position of the cargo on top of the cart.</p> <p>The user must verify that the cargo stability during locomotion is acceptable.</p>
--	---

6.7 Verify safety system

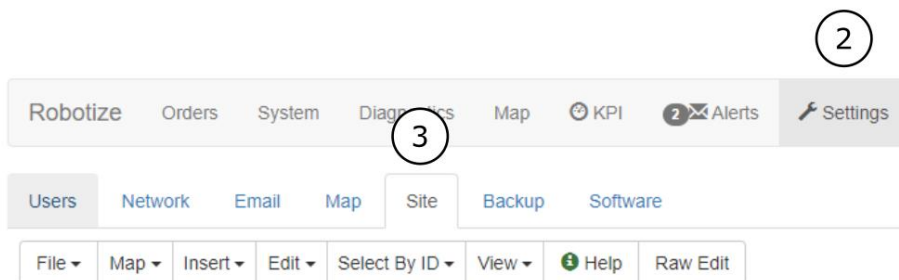
The functionality of the safety system in terms of the SFs introduced in Section 3.5.1, must be verified as part of the commissioning of the TMC300.

The test procedure along with acceptance/rejections criteria are summarized in Appendix C.

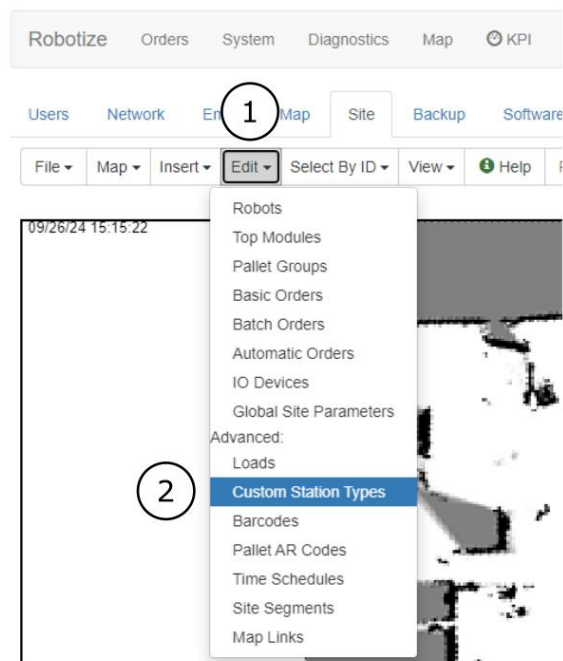
 WARNING!	<p>The functionality of the safety system must be verified prior to first use of the product.</p>
--	---

6.8 Create cart transfer basic order

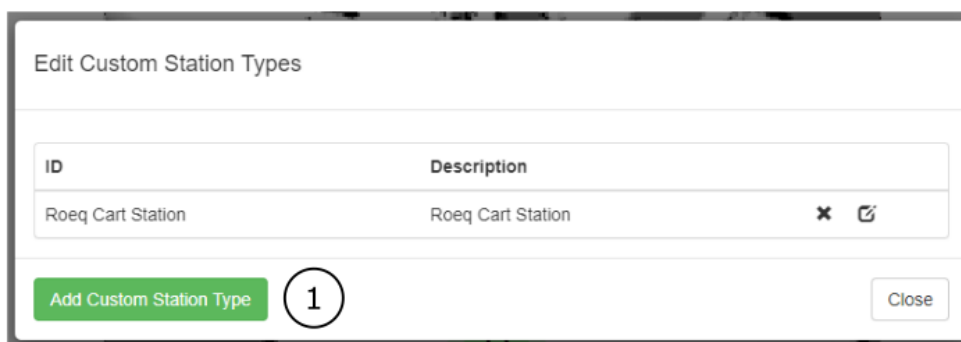
This section will enable the user to get a quick start with the ROEQ top module installed on a GoPal P35 robot with a step-by-step process of setting up a demo order. This order includes pickup of cart at a “pallet station” location, moving it to a “parking position” location and delivering it to pallet station again. For further documentation and more advanced features, please refer to documentation from Robotize.

Step	Instructions and illustrations
1.	Prerequisites for creating basic order: <ol style="list-style-type: none"> 1. Valid configuration file on robot 2. Robotize Dispatcher server running 3. Laptop connected to Dispatcher Interface 4. GoPal P35 robot ON and in remote mode 5. Map and site configuration completed 6. Available ROEQ Cart500 compatible with TMC300 7. TMC300 is installed on the GoPal P35 robot as described in Section 5 8. The TMC300 is commissioned as described in Section 6
2.	<ol style="list-style-type: none"> 1. Access Robotize Dispatcher Interface with a web browser 2. Navigate to [Settings] 3. Select [Site] 

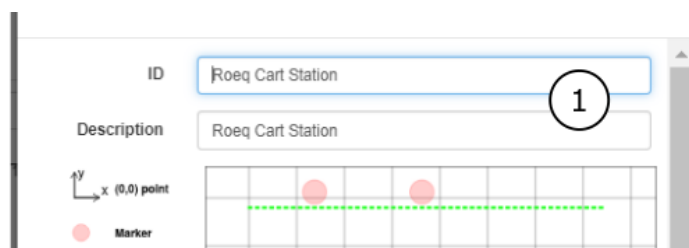
- 3.
1. Select [Edit]
 2. Select [Custom Station Types]
 3. A new window will open



- 4.
1. Press [Add Custom Station Type]
 2. A new window will open



- 5.
1. Fill in suitable [ID] and [Description] for the cart station



- 6.
1. Fill in values for markers (x,y) as shown
 - 0.275 / -0.025
 - 0.275 / 0.825
 - 0.725 / -0.025
 - 0.725 / 0.825
 2. [Maneuver Width] is set to 0.720 and
 - [Has Pallet Shelves] must be checked
 3. [X-Docked] must be set to 0.500
[Y-Docked] must be set to 0.400
 4. Press Save

The screenshot shows the TMC300 configuration interface. At the top, there is a legend with symbols for 'Marker' (red dot), 'Wall' (red line), 'Y-Docked' (blue dashed line), and 'Maneuver width limit' (green dashed line). Below the legend is a grid with a coordinate system (x, y) and a grid interval of 0.2 m. Four red markers are placed on the grid at coordinates (0.275, -0.025), (0.275, 0.825), (0.725, -0.025), and (0.725, 0.825). Below the grid is a table for 'Markers (x, y)' with four rows, each containing the x and y coordinates and a 'Remove' button. A circled '1' is next to the first row. Below the table is an 'Add marker' button. Below that is a 'Maneuver Width' input field set to 0.72000, with a circled '2' next to it. Below the width field are several checkboxes: 'Has Walls', 'Use Walls For Localization', 'Use Two Samples Control', 'Has Reflective Markers', 'Has Pallet Shelves' (checked), and 'Has Stop Marker'. Below these are 'X-Docked' and 'Y-Docked' input fields set to 0.50000 and 0.40000 respectively, with a circled '3' next to the 'Y-Docked' field. At the bottom right are 'Save' and 'Cancel' buttons.

Legend:

- Marker
- Wall
- Y-Docked
- Maneuver width limit

Grid interval: 0.2 m

Markers (x, y)

0.27500	-0.02500	Remove
0.27500	0.82500	Remove
0.72500	-0.02500	Remove
0.72500	0.82500	Remove

Add marker

Maneuver Width: 0.72000

Has Walls: ☐

Use Walls For Localization: ☐

Use Two Samples Control: ☐

Has Reflective Markers: ☐

Has Pallet Shelves: ☒

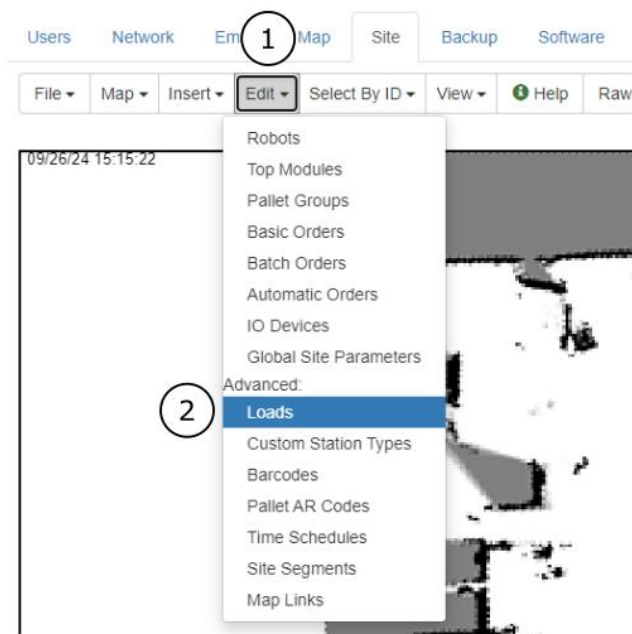
Has Stop Marker: ☐

X-Docked: 0.50000

Y-Docked: 0.40000

Save Cancel

- 7.
1. Select [Edit]
2. Select [Loads]
3. A new window will open



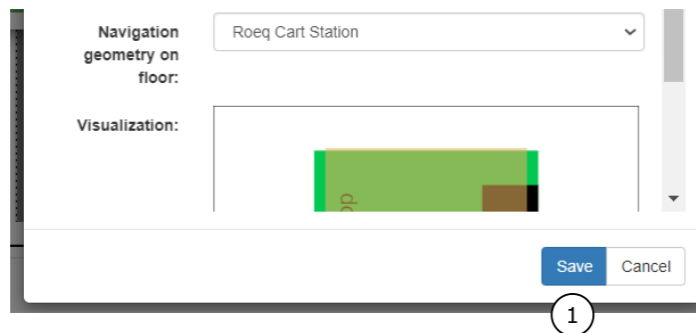
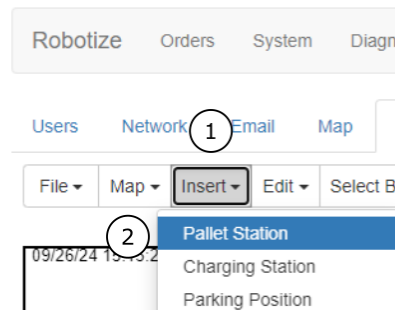
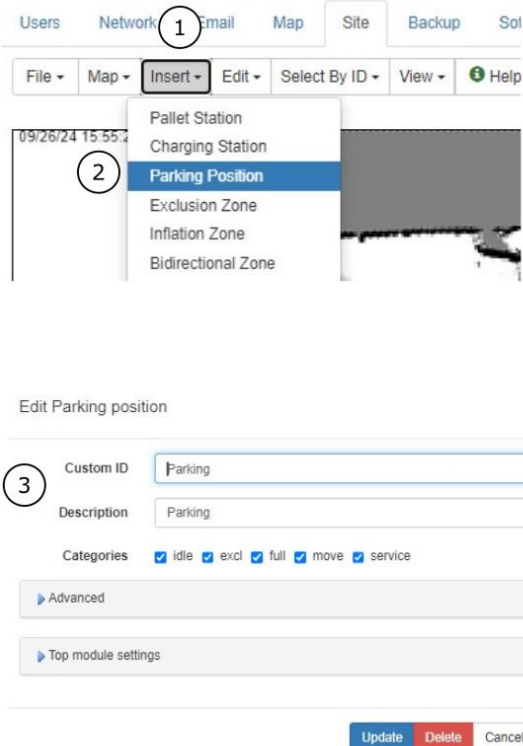
- 8.
1. Fill in suitable ID and Description for the load
2. [Type] is selected as *Cargo*
3. Dimension may vary based on payload footprint

The screenshot shows the 'Load' configuration form. It has the following fields: ID (text input, value: 'Roeq Cart Load'), Description (text input, value: 'Roeq Cart Load'), Type (dropdown menu, value: 'Cargo'), Width (text input, value: '0.89'), and Length (text input, value: '1.26'). Red circles with numbers 1, 2, and 3 are placed over the ID, Type, and Length fields respectively.

- 9.
1. [Speed Limit] must be set to 1.2 with load
2. [Oversize Type] set to *Load*
3. [Navigation geometry on floor] set to *Roeq Cart Station*

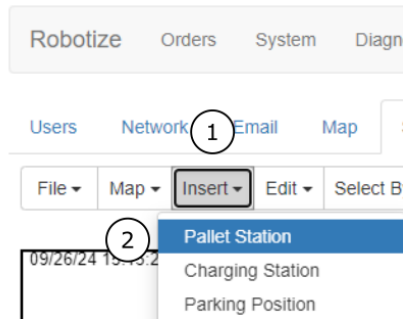
The screenshot shows the 'Load' configuration form with the following fields: Speed Limit (text input, value: '2.40'), Oversize Type (dropdown menu, value: 'Load'), and Navigation geometry on floor (dropdown menu, value: 'Roeq Cart Station'). Red circles with numbers 1, 2, and 3 are placed over the Speed Limit, Oversize Type, and Navigation geometry on floor fields respectively.

10. 1. Press Save

11. 1. Select [Insert]
2. Select [Pallet Station]11. 1. Select [Insert]
2. Select [Pallet Station]
3. Place on map and give suitable name and description

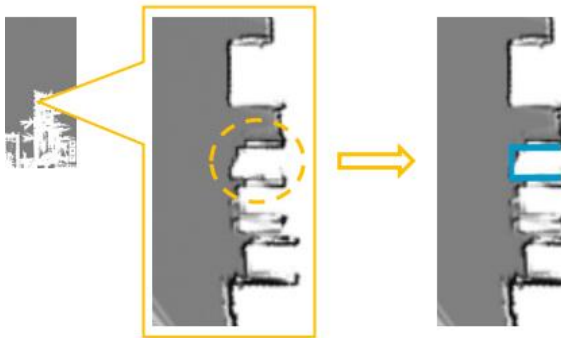
12.

1. Select [Insert]
2. Select [Pallet Station]



13.

1. Place pallet station on map



14.

- Edit pallet station by clicking on it
1. Set ID and write fitting description
2. Set type to [Position on the floor]
3. Set checkmarks as shown

The screenshot shows the 'Edit Pallet station' dialog box. It has a title bar 'Edit Pallet station'. Inside, there are three input fields: 'Custom ID' with the value 'Roeq Cart Spot' (circled with a yellow circle and the number '1'), 'Description' with the value 'Roeq Cart Spot', and 'Type' with the value 'Position on the floor' (circled with a yellow circle and the number '2'). Below these is an 'Advanced' section with a dropdown arrow. Inside the 'Advanced' section, there are three checkboxes: 'Disable 3D Camera Obstacle Detection' (checked), 'Disable Pre-docking Pallet Presence Check' (checked), and 'Disable Post-docking Pallet Presence Check' (unchecked). Below these are four more checkboxes: 'Tight', 'Mute Laser Safety', 'Require Load Status Ok', and 'Enforce Order Priority On Pickup'. A yellow circle with the number '3' is around the 'Disable Pre-docking Pallet Presence Check' checkbox. At the bottom of the dialog are three buttons: 'Update' (blue), 'Delete' (red), and 'Cancel' (white).

- 15.
1. Set pallet type to [Default]
 2. Set Load Type to [Previously defined custom load]
 3. Set Pallet clearance to value of 10.00

Edit Pallet station

☐ Require Load Status Ok
☐ Enforce Order Priority On Pickup

Pallet Type Default 1

Allow Oversized Loads ☐ Enabled

Load Type Roeq Cart Load 2

Max. Load (kg) 250

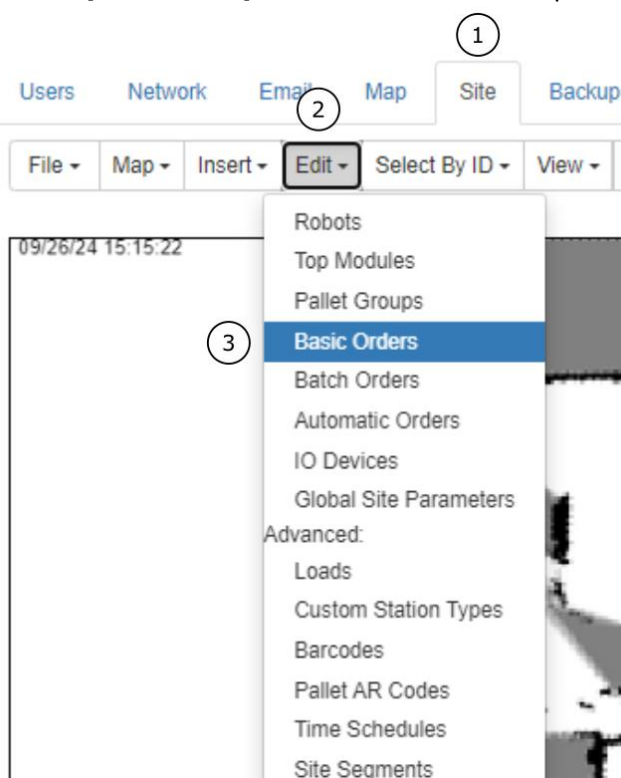
Max. Undocking Velocity (m/s) ☐

Load Status Alarm No alarm

Pallet Clearance 10.00 3

Update Delete Cancel

- 16.
1. Select [Site]
 2. Select [Edit]
 3. Select [Basic Orders] and a new window will open



- 17.
1. Give the order an ID
 2. Select [Advanced]
 3. Select [Add state] and fill in as shown:

- State name: [001]
- Pick up at: [Pallet station ID]
- Next state: [002]
- On event [Immediately]

Edit Basic Order Roeq Demo Order

1 ID: Roeq Demo Order

Order type: Simple Advanced 2

State Machine: Add State Add Global Transition Add Variable Clear State Machine

3 Start state 001

States

State name	001	Remove
Action	Pick up at	
Destination	Roeq Cart Spot	
Transitions	Add transition	

Transitions out of this state

Next state	002	Remove
On event	Immediately	

Save Save A Copy Cancel

- 18.
1. Add state with name 002
 2. Set Action to [Go to] and Destination to [Parking ID]
 3. Fill in transition as shown:
- Next state: [003]
 - On event: [Immediately]
 - Enabled when: [After the action of this state is done]

1 State name 002 Remove

2 Action Go to

Destination Parking

Transitions Add transition

Transitions out of this state

3 Next state	003	Remove
On event	Immediately	
Enabled when	After the action of this state is done	

19.

1. Add state with name 003
2. Set action to [Deliver at] and Destination to [Pallet station ID]
3. Fill in transition as shown:
 - Next state: [(end order)]
 - On event: [Immediately]
 - Enabled when: [After the action of this state is done]

State name: 003

Action: Deliver at

Destination: Roeq Cart Spot

Transitions: Add transition

Transitions out of this state

Next state: (end order)

On event: Immediately

Enabled when: After the action of this state is done

20.

1. Save site config and reboot robot

21.

Order can now be issued to selected robot

1. Select [Orders]
2. Select [Basic Orders]
3. Click paper plane icon to send order

Orders

ID	Source	Order Description	Pickup	Delivery	Status	Robot
Roeq Demo Order		Start: (001) Pick up at Roeq Cart Spot. • immediately after action is done, switch to state 002.			50	

Cancel All Orders

Custom Orders Basic Orders Batch Orders Automatic Orders

Priority: 50

22.

1. Set high priority [1]
2. Select robot from list and assign order, Submit order

Submit order Roeq Demo Order

Priority: Low High 1

Assignment: Assign to PR6@3500


Target delivery time: In 10 minutes

Keep in queue until time: 12:00:00

Submit Cancel

7 Operation

Following installation and commissioning of the TMC300, it may be used.

 NOTICE!	With respect to the training levels outlined in Appendix A, operation may be conducted by authorized or trained personnel.
---	--

7.1 Top module system

The top module can be updated using the top module support site. The support site can be accessed by connecting an Ethernet cable between the RJ45 connector at the rear of the module (see **Figure 3** in conjunction with **Table 1**) and a laptop.

When connecting the Ethernet interface, the top module will provide a valid IP address for the laptop, if it is configured for DHCP. If not, the laptop must be configured in address range 10.0.1.0/24.

To access the site, open a browser to <http://10.0.1.1>.

The support site shows the model and version of the top module, along with multiple menu items as illustrated in **Figure 9**.

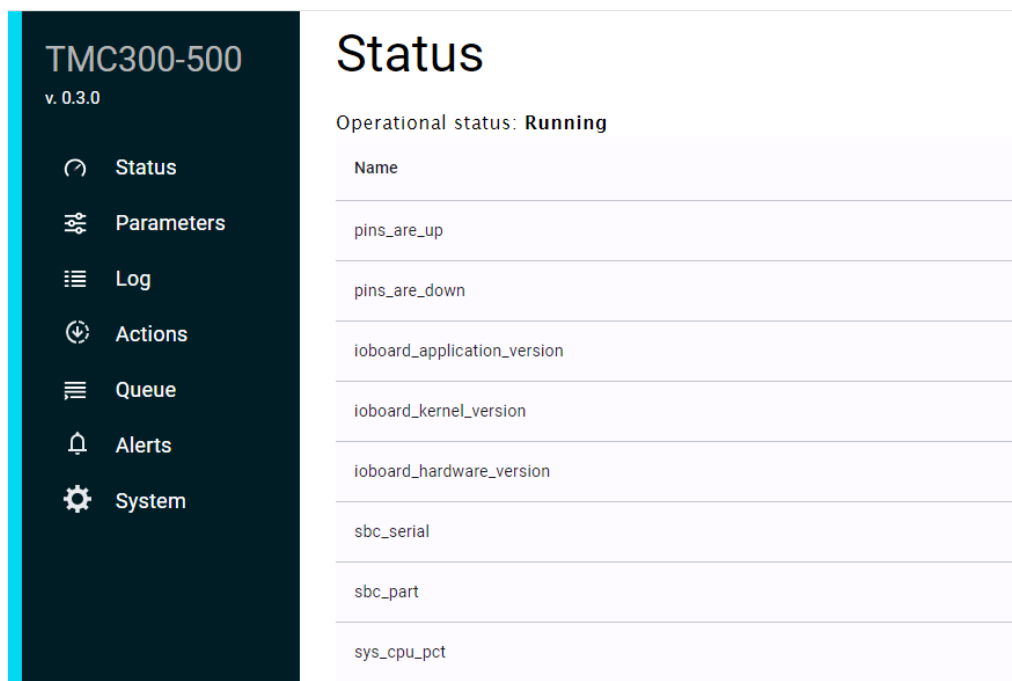


Figure 9: Support and Status site of the TMC300

7.1.1 Parameters

The top module can have multiple parameters configured. Parameters are saved in the internal computer and are persistent even after a power cycle.

7.1.2 Actions

The top modules action can be activated directly, independent of the GoPal P35 robot. By pressing an action and selecting Start, the action will be performed by the top module.

If the robot is in E-stop, the actions cannot be performed.

The top module has two defined actions:

1. Pickup
When started, the pins will be raised, to hold the cart.
2. Deliver
When started, the pins will be lowered, to release the cart.

7.1.3 Queue

The queue shows a list of performed actions, since the top module was powered on. When selecting an entry, the duration and result of the action can be seen.

7.1.4 System

The system menu can perform three actions as illustrated in **Figure 10**, and are used as described below:

1. Software update
To update the internal applications, a ROEQ provided update can be uploaded by pressing the "Upload..." button. The upload starts after a user selects a *.roeq* file and presses OK.
When uploaded, status will be shown if the update can be successfully installed or not.
2. Log files
When the "Download logs" button is pressed, internal computer compresses the recorded logfiles to a single compressed *.zip* file. Download is automatically started when compressed.
The log files can be inspected by ROEQ support.
3. Reboot
The top module computer can be manually restarted, by pressing the "Reboot" button. When pressed, the system will shut down and start again. The support site is not available while this is performed.
A reboot can in rare cases take up to two minutes but is normally ready again within 20 seconds.

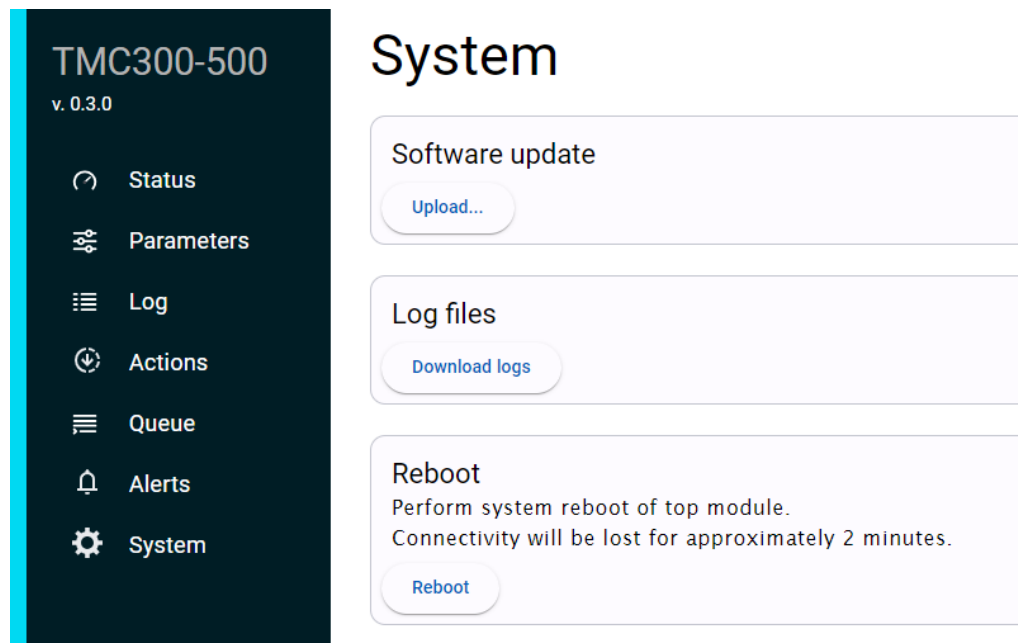


Figure 10: System site

7.2 Contingency scenario

The TMC300 is installed with a recovery button to allow recovery in case the top module becomes unresponsive and needs to be serviced.

See Section 10.3 for details.

7.3 Safety during operation

7.3.1 Safety stop during operation

During pickup and drop-off of carts, where the locking pins are moved either up or down, the robot will activate scanner zones that will always put the robot into a safety stop if the robot should try to move, preventing it from moving with a cart that is not properly attached.

The safety stop will be automatically lifted once the locking pins have fully transitioned.

7.3.2 Safety summary

The safety functions will override the operation of the robot and TMC300, in any situation where safety is compromised.

This includes but is not limited to the scenarios outlined in **Table 7**.


Scenario	System response
An E-stop is thrown at any time	The E-stop is mitigated from robot to TMC300, and vice versa.
The locking pins are not fully expanded	The robot activates zones on the safety laser scanner that will put the robot into a safety stop if the robot tries to move.
The locking pins are fully up, but the cart is not properly attached	The robot safety laser scanners will detect the cart being misplaced and put the robot into a safety stop.
The robot detects the locking pins being both up and down	Activates scanner zones that will not allow the robot to start moving.


Table 7: Exemplified fault scenarios governed by the TMC300 safety system


8 Maintenance

The TMC300 is in principle maintenance free in the expected operating life span of at least 5 years, however external inspection of significant damage to the product, that can compromise safety, must be carried out daily, see **Table 8**.

8.1 Regular maintenance and cleaning

 NOTICE!	With respect to the training levels outlined in Appendix A, regular cleaning must be performed by authorized or trained personnel.
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 WARNING!	<p>Be sure to provide a safe setting before maintaining the product, i.e.</p> <ul style="list-style-type: none"> ▪ Ensure that the robot is turned off. ▪ Ensure that no cargo is being transferred while personnel are cleaning or maintaining the product.
--	--


 NOTICE!	<p>Avoid aggressive or abrasive cleaning agents.</p> <p>Avoid excessive amounts of water when cleaning.</p> <p>Do not use compressed air inside the product.</p>
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Part	Procedure	Interval
General	Clean the TMC300 on the outside with a damp cloth. Do not use compressed air.	Every month / as needed

Mechanical components	<p>Perform an external inspection to verify that the mechanical components are without dents, cuts, tears, signs of rust or corrosion, etc.</p> <p>In case of significant dents, deformations, etc. consult ROEQ support for further inspection or repair instructions, and potentially replacement parts.</p>	Daily
Carts	<p>Perform an inspection to verify that the cart is without dents, cuts, tears, signs of rust or corrosion, etc.</p> <p>Follow any further maintenance provisions from the specific cart instructions.</p> <p>In case of significant dents, deformations, etc. of the cart, or damages to the reflector markings, consult ROEQ support for inspection instructions, or potential replacement parts.</p>	Daily


Table 8: Regular maintenance and cleaning of TMC300.

8.2 Verifying safety functionality

	<p>With respect to the training levels outlined in Appendix A, safety system verification must be performed by authorized personnel, or trained personnel under supervision of authorized personnel.</p>
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A test of the safety functions presented in Section 3.5.1 must be conducted yearly to verify continued functionality of the various safety measures.

The test procedure along with acceptance/rejections criteria are summarized in Appendix C.

	<p>If a safety functionality has been inadvertently activated as part of day-to-day operation, that function may be exempted from additional verification, e.g. if an E-stop is known to have been used during an emergency.</p> <p>As none of the installed safety measures are intended to be activated by normal operation, it is however expected that all safety functions should undergo yearly verification.</p>
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9 Decommissioning

The procedures to follow during decommissioning of the product are provided in the following.

	<p>With respect to the training levels outlined in Appendix A, decommissioning must be performed by authorized personnel, or trained personnel under supervision of authorized personnel.</p>
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9.1 Disabling and dismantling

Turn off the robot and disconnect the battery, as similarly described for the installation process in Section 5.


The TMC300 can then be dismantled and removed by following the reverse procedure for installation as detailed in Section 5.

9.2 Scrapping

The TMC300 must be discarded in accordance with the applicable legislation at the time and location of where the product is being scrapped, with respect to the materials comprising the product as outlined in Section 3.2.2.

10 Troubleshooting

This section is provided in support of Section 6 and Section 7 to provide additional troubleshooting suggestions in case of contingency events.

	With respect to the training levels outlined in Appendix A, troubleshooting may be conducted by authorized or trained personnel.
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This initial section provides information about the general support tools:

- Troubleshooting the top module
- The ROEQ support portal: For submitting request to ROEQ technical support
- Contingency recovery

10.1 Troubleshooting the top module

During normal operation, the top module is operated using the Robotize applications, but in case of failure or unexpected behavior, the top module has a dedicated support site.

The support site can be accessed by connecting an Ethernet cable between the RJ45 connector at the rear of the module (see **Figure 3** in conjunction with **Table 1**) and a laptop.

When connecting the Ethernet interface, the top module will provide a valid IP address for the laptop, if it is configured for DHCP. If not, the laptop must be configured in address range 10.0.1.0/24.

To access the site, open a browser to <http://10.0.1.1>.

The support site shows the model and version of the top module, along with multiple menu items as illustrated in **Figure 11**.

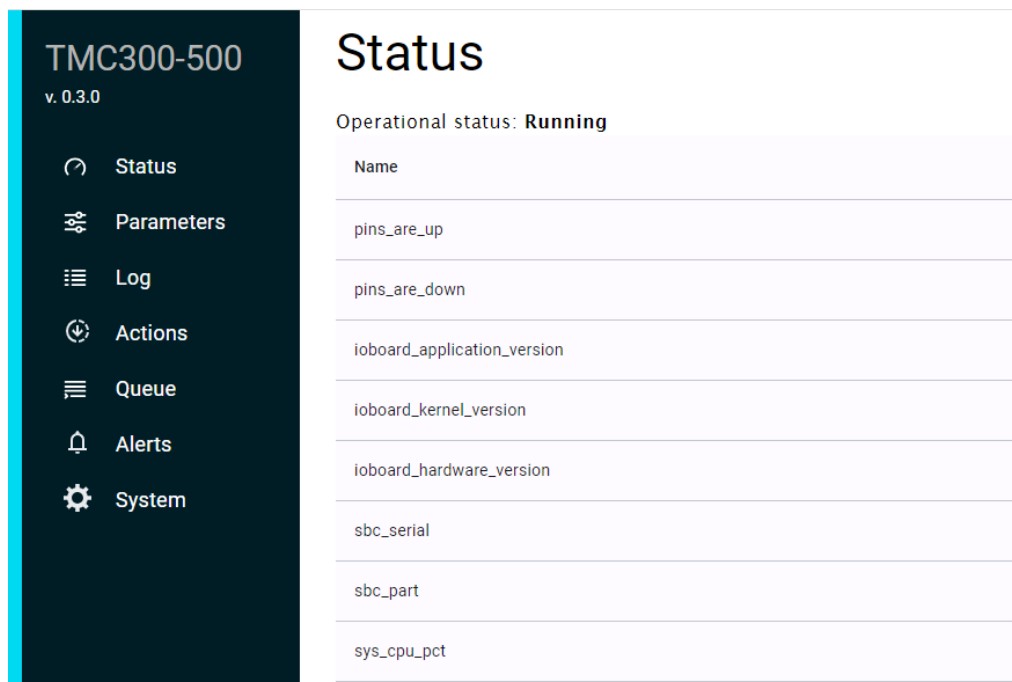


Figure 11: Support and Status site of the TMC300

The following menus can help troubleshooting the TMC300.

10.1.1 Status

The status page shows relevant status parameters from the top module, including pin positions, application versions and details about the internal computer.

The operational status shows either “Running”, or a failure state. The status information is updated in near real time and can be inspected while operations are performed.

10.1.2 Log

The log menu shows resent log messages generated by the top module. The log messages can be used during troubleshooting, to determine if anything failed to perform.

10.1.3 Alerts

The alerts show momentary error states, if a problem is identified an alert is listed until the problem is solved. The list is empty if no problems have been identified.

10.2 ROEQ support portal

Technical questions and support requests can be submitted via the ROEQ support portal:

<https://support.roeq.dk/>

10.3 Contingency recovery

The TMC300 is installed with a recovery button, see **Figure 3** and **Table 1** in Section 3.2.1.

For service, support or test purposes, the recovery button may be used to manually raise or lower the locking pins.

The robot must not be in E-stop while using the recovery button.

To operate the button, the user must press and hold the button, which will activate the locking pins in the following way:

- If the locking pins are fully raised, the locking pins will **lower**
- If the locking pins are partly raised, the locking pins will **lower**
- If the locking pins are fully lowered, the locking pins will **rise**

The button must be pressed for 5 seconds before any operation is started.

Appendix A – User groups and level of training

The operation instructions in this document are intended for the personnel groups presented in **Table 9**.

Personnel group	Training level	Intended product interaction
Integrators	Authorized personnel	Integrating the product into the overall machine installation, e.g. wrt. <ul style="list-style-type: none"> ▪ Unpacking, handling and installation ▪ Commissioning ▪ Maintenance and decommissioning
Operators	Trained personnel	Partial interaction and day-to-day operation and troubleshooting the installation
Nearby people	Informed Personnel	Anyone working or occupying the area around the product during operation, without direct interaction.

Table 9: Personnel groups interacting with the product.

The training levels listed above refer to the level of information, experience, and training a personnel group must receive before participating in the listed activities involving the product. The training levels are elaborated in **Table 10**.

Training level	Experience/training activities
Authorized personnel	<p>Able-bodied people, at least 18 years of age, with in-depth experience and understanding of the robot operation, design, and construction, including the safety system.</p> <p>In-depth understanding of the construction and operating principle of the TMC300, including the operating interface in terms of functional and safety behavior.</p> <p>Authorized personnel is expected to have access to, and have read, the documentation of both the robot and TMC300, and have possibly received technical training for installing, operating or servicing the respective products as per. the guidelines of Robotize or ROEQ.</p>
Trained personnel	<p>Able-bodied persons, at least 18 years of age, with practical experience in operating the robot, including basic understanding of the operating principle.</p> <p>Trained personnel are assumed to have read the documentation for the product, and that this documentation is readily available.</p> <p>Trained personnel have received supervised instructions on operating the robot and TMC300, e.g. from authorized personnel.</p>
Informed personnel	<p>Must be informed by trained or authorized personnel of the presence of any robots incorporated with the TMC300.</p> <p>Must further be informed about the basic behavior of the robot and TMC300 as well as the safety precautions when being near the robot and TMC300, including the location of emergency stops, and location and identification of OHZs.</p> <p>In case of impeding physical, sensory or mental handicaps, interactions and working distance to the TMC300 must be limited/adjusted accordingly.</p>

Table 10: Training levels for interacting with the product.

Appendix B – Hazard specification

Throughout the document, several directions and instructions are provided concerning the use and behavior of the product. The classification of the provided directions and instructions follows the outline provided below.

Table 11 outlines the severity and potential consequence of a hazard, or failure to follow the guidelines provided and specifications, concerning ROEQ products.





 DANGER!	Indicates an immanently hazardous situation that will result in death or severe personal injury if proper precautions are not taken.
 WARNING!	Indicates a potentially hazardous situation that could result in death or severe personal injury if proper precautions are not taken.
 CAUTION!	Indicates a situation that could result in minor personal injury or damage to the equipment if proper precautions are not taken.
 NOTICE!	Indicates general information without direct safety relevance, but could be important to ensure proper operation, integration, etc.

Table 11: Classification of different hazards and notifications.

Appendix C – Safety system details

This section provides details concerning the safety system to elaborate on the information given in other parts of this document.

C.1 Safety system details

The safety systems of the TMC300 are summarized below:

- **SF1: Robot safety stopped when locking pins operates – PL c**
When the main contactor is enabled to power the locking pins, the robot will be put into a safety stop.
- **SF2: Robot unable to drive when locking pins are neither up nor down – PL c**
The TMC300 will signal the robot to activate zone sets that does not allow the robot to move when the locking bolts are neither in top nor bottom position.
- **SF3: Extended zones for carts and misplaced cart detection – PL c**
The safety scanner zones are designed to detect the cart if it is misplaced on the robot. The TMC300 signals the robot to change to these zones when the locking pins are in top position.
- **SF4: Maximum speed reduced when driving with carts – PL c**
Using the robot's safety scanner zones, the robot will be safety stopped if surpassing 1.25 m/s.
- **SF5: Emergency stops – PL d**
Enforce an E-stop whenever an E-stop button is pressed on the robot or the TMC300.

C.2 Safety components

The safety functions provided are comprising of the following hardware components forming the TMC300 safety system:

- Main contactor supplying power to the locking pins mechanism
- Limit switch indicating the locking pins mechanism is fully up
- Limit switch indicating the locking pins mechanism is fully down
- Relay for routing signals
- E-stop buttons and appertaining contacts
- *Encoders and laser scanners from the robot safety hardware*

The last item above is to emphasize that the safety functions of the TMC300 to some extent dependent on the robot hardware.

C.3 Safety system categories

For each of the safety functions of the TMC300, the following describes

- which components take part in the safety function
- category the safety function is implemented as
- what PL the safety function obtains

Figure 12 illustrates the safety system structure, including categories and PL levels of the various subsystems with reference to DS/EN ISO 13849-1:2023 [4], were

- Yellow boxes indicate components in the TMC300 safety system
- Orange boxes indicate the robot safety system
- Arrows indicates the exchange and flow of safety information
- Dashed boxes indicate the subsystems defined for category classification

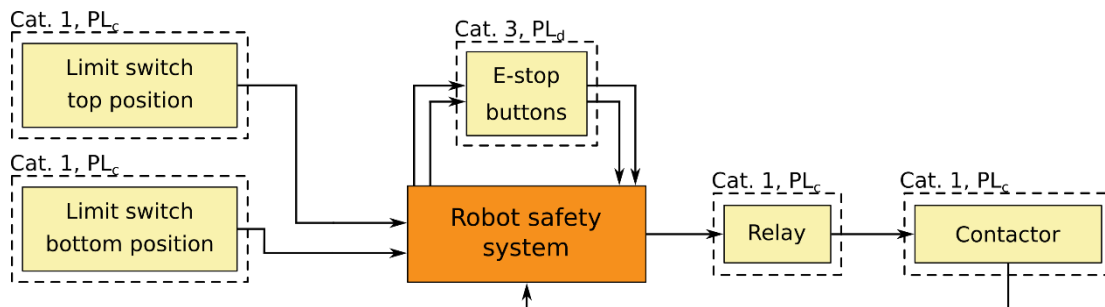




Figure 12: Detailed breakdown of the safety system, with system categories and PL.

C.4 Testing of safety system

The following outlines the procedure for verifying the integrity of the safety system with respect to the safety functions outlined in Section C.1.

Test of the safety system must be conducted during commissioning of the TMC300. It is further required to go through the tests once every year.

	<p>Provide a safe setting for conducting the tests</p> <p>The test of each safety function deliberately introduces contingency scenarios that do not occur in regular operation.</p> <p>To do so in a safe manner, the tester must remove any cargo from the TMC300 that may pose a hazard and bring the robot/TMC300 to a confined area, that may be cleared, marked, restricted, etc. in way that is found appropriate to ensure that no unacceptable risk occurs during tests.</p>
	<p>The process outlined here does not validate the safety system of the robot.</p> <p>Testing the robot safety system is a separate process that must be conducted as per the specifications of Robotize.</p>

SF1 – Robot safety stopped when locking pins operates	
Test process	<ol style="list-style-type: none"> 1. Make sure the robot is not in a Safety stop or E-stop <ul style="list-style-type: none"> ▪ In the robot interface, the input “top_s_stop_out” must be “0” 2. Make the locking pins move up or down <ul style="list-style-type: none"> ▪ Either by using the top module support site (see Section 7.1) or using the robot interface 3. In the robot interface, verify the robot initiates a Safety stop while the locking pins are operating <ul style="list-style-type: none"> ▪ In the robot interface, the input “top_s_stop_out” must be “1” 4. When the locking pins are either fully up or down <ul style="list-style-type: none"> ▪ Verify the robot resets the Safety stop, “top_s_stop_out” is “0”
Pass criteria	The robot is in safety stop when the locking pins are neither in top nor bottom position
Actions in case of fail	Contact ROEQ support

SF2 – Robot unable to drive when locking pins are neither up nor down	
Test process	<ol style="list-style-type: none"> 1. The scanners checksums on the robot must match those in Table 5 2. Make sure the locking pins are in bottom position <ul style="list-style-type: none"> ▪ In the robot interface, the input “top_pattern_0_out” is “1” ▪ In the robot interface, the input “top_pattern_1_out” is “0” 3. Make the locking pins move up <ul style="list-style-type: none"> ▪ Either by using the top module support site (see Section 7.1) or using the robot interface 4. While the locking pins are neither in top nor bottom position <ul style="list-style-type: none"> ▪ The input “top_pattern_0_out” is “0” ▪ The input “top_pattern_1_out” is “0” 5. When the locking pins are in top position <ul style="list-style-type: none"> ▪ The input “top_pattern_0_out” is “0” ▪ The input “top_pattern_1_out” is “1”
Pass criteria	<p>The checksums must match.</p> <p>The “top_pattern” signals must behave as described above.</p>
Actions in case of fail	Contact ROEQ support

SF3 – Extended zones for carts and misplaced cart detection	
Test process	The SF2 test also verifies SF3
Pass criteria	SF2 test is passed
Actions in case of fail	Contact ROEQ support

SF4 – Maximum speed reduced when driving with carts	
Test process	The SF2 test also verifies SF4
Pass criteria	SF2 test is passed
Actions in case of fail	Contact ROEQ support

SF5 – Emergency stops	
Test process	<ol style="list-style-type: none"> 1. The robot must not be in an E-stop 2. Press one of the E-stop buttons on the top module 3. Verify the robot enters an E-stop 4. Release the E-stop button <ul style="list-style-type: none"> ▪ Confirm the robot is still in E-stop when the E-stop is released 5. Reset the E-stop on the robot 6. Redo step 1-4 on the other E-stop button on the top module
Pass criteria	The Robot enters and leaves the E-stop as described above
Actions in case of fail	Contact ROEQ support

Bibliography

- [1] **European Parliament and of the Council.** *Directive 2006/42/EC of the European Parliament and of the Council of May 2006 on machinery, and amending Directive 95/16/EC.* Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32006L0042>.
- [2] **ROEQ Website.** <https://roeq.dk/>
- [3] **DS/EN ISO 12944-2:2017.** *Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 2: Classification of environments.*
- [4] **DS/EN ISO 13849-1:2023.** *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design.*
- [5] **DS/EN ISO 12100:2011.** *Safety of machinery – General principles for design – Risk assessment and risk reduction.*
- [6] **DS/EN ISO 3691-4:2023.** *Industrial trucks – Safety requirements and verification – Part 4: Driverless industrial trucks and their systems.*

Abbreviations

CAD Computer Aided design	5	PL Performance Level	15, 16, 52, 53
COM Center of Mass	17	ROEQ ROEQ Aps	passim
DHCP Dynamic Host Configuration Protocol.	42, 47	RoHS Restriction of Hazardous Substances.....	12
E-stop Emergency Stop	passim	SF Safety Function	15, 54
IP Internet-Protocol.....	42, 47	USB Universal Serial Bus.....	24, 25
OHZ Operating Hazard Zone	8, 28, 29, 50		

Glossary

CE An administrative marking that indicates conformity with health, safety, and environmental protection standards for products sold within the European Economic Area.....	15
GoPal P35 Robotize robot with 250 kg maximum payload.....	passim
Locking pins Pins extended out from the the top module to allow engagement with carts.....	passim
TMC300 ROEQ top module for dragging carts with a payload of up to 300 kg.	passim