

Operation Manual

AGILOX ONE



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Translation of Original Operation Manual AGILOX ONE

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Revision History

Version 2021Q1

- Updated warning label explanations [1.9 - Warning Label Explanations](#)
- Added Maintenance Operation Mode [6.1.5 - Maintenance Operation Mode](#)
- Changes in [1.5 - Target Group](#)
- Updated Problems in [ANHANG V - Error Messages AGILOX Vehicle](#)
- Reorganization and supplements in chapter [2 - Safety](#) and [3.2 - AGILOX Vehicle](#)
- New optional weight monitoring
 - [3.2.12 - Optional Weight Monitoring](#)
 - [2.4.2.5 - Other Safety Features](#)
- Environmental conditions within the area of movement: no large air movements allowed.
 - [2.3.2.3 - Environmental Conditions within the Area of Movement](#)
- More detailed description of AGILOX Analytics Data Transfer
 - [3.4.3 - AGILOX Analytics Data Transfer](#)

1. General

1.1 Introduction

The AGILOX system has been designed and manufactured in line with state-of-the-art standards. To ensure its safe operation, all persons using it for their work must be properly trained and instructed. In addition to this requirement, please read this Operation Manual carefully and in its entirety.



INFORMATION

As our system is continually evolving, its manufacturer reserves the right to modify the illustrations contained in this documentation.

1.2 Operation Manual

This Operation Manual also contains the following sections as attachments:

- Commissioning Manual
- Battery Operation Manual / Safety Data Sheet
- Navigation Laser Scanner Documentation (Original Manual by manufacturer Pepperl+Fuchs)
- Safety Laser Scanner Documentation (Safety Instructions by manufacturer Sick)
- Charging Device and Charging Station Documentation
- Electrical System Documentation
- Protective Fields - Monitoring Cases for EPAL
- Spare Part Drawing AGILOX Basic and AGILOX Options
- AGILOX Maintenance Protocol CUSTOMER
- AGILOX Maintenance Protocol (by AGILOX North America, Inc.)
- SICK S300 Declaration of Conformity
- SICK S300 UL Certificate of Compliance
- MAYSER Ultrasonic Industrial Sensor - EC Declaration of Conformity
- MAYSER Ultrasonic Industrial Sensor - EC Type-Examination Certificate Nr.1437
- AGILOX Training Protocol System Operator
- AGILOX Training Protocol Administrator

This Original Operation Manual contains all relevant information for users and their staff regarding the operation of the AGILOX system as well as its installation and maintenance. Additionally, it contains important safety information and notes. Additional in-depth information about commissioning and administration can be found in the [Commissioning Manual](#). The Operation Manual forms part of the system and must be read and understood in its entirety by all responsible persons. The Operation Manual must be stored in such a way as to be always accessible to the operating staff while they are performing their assigned tasks and so that it can be consulted for information concerning the system's proper use.

1.3 Copyright

AGILOX North America, Inc. remains the sole holder of the copyright for this Operation Manual. For any unauthorized use of this Manual for competition-related purposes in whole or in part, the express approval of the manufacturer is required. Furthermore, these instructions must not be made available to any third parties.

1.4 Using Open Source Programs

AGILOX uses various open source software. These are the programs listed below.

- dhcpcd
<https://github.com/rsmpar/dhcpcd/blob/master/LICENSE>
- dmtxread
<https://github.com/dmtx/libdmtx/blob/master/LICENSE>
- dnsmasq (GPL)
<http://www.thekelleys.org.uk/dnsmasq/doc.html>
<https://www.gnu.org/licenses/gpl-3.0.html>
- dokuwiki (GPL)
<https://github.com/splitbrain/dokuwiki/blob/master/COPYING>
<https://www.gnu.org/licenses/gpl-3.0.html>
- fswebcam (GPL)
<https://github.com/fsphil/fswebcam/blob/master/LICENSE>
<https://www.gnu.org/licenses/gpl-3.0.html>
- gzip (GPL)
<https://www.gnu.org/licenses/gpl-3.0.html>
- imagemagick
<https://imagemagick.org/script/license.php>
- iptables (GPL)
<https://netfilter.org/licensing.html>
<https://www.gnu.org/licenses/gpl-3.0.html>
- jquery
<https://github.com/jquery/jquery/blob/master/LICENSE.txt>
- jsoneditor
<https://github.com/josdejong/jsoneditor/blob/develop/LICENSE>
- Linux Kernel (GPL)
<https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/plain/COPYING>
<https://www.gnu.org/licenses/gpl-3.0.html>
- mpg123 (LGPL)
<https://www.mpg123.de/>
<https://www.gnu.org/licenses/lgpl-3.0>
- nginx (BSD-Lizenz)
<http://nginx.org/LICENSE>
- PHP (PHP-Lizenz)
<http://php.net/license/index.php>
- sqlite
<https://www.sqlite.org/copyright.html>
- wpa_supplicant
https://w1.fi/wpa_supplicant/
- zbar (LGPL)
<https://github.com/ZBar/ZBar/blob/master/LICENSE>
<https://www.gnu.org/licenses/lgpl-3.0>

You may use all programs in accordance with the license. The licenses, their exact scope and disclaimers can be found in the header of the files themselves. The source code of the GPL parts is available on request.

1.5 Target Group

1.5.1 General

All persons operating the AGILOX vehicle must have carefully read and understood the technical documentation.

Trainees (apprentices) and interns may only operate AGILOX vehicles from the age of 18 and after instruction. Non-instructed persons and persons from outside the company without instruction (e.g. visitors,...) must be constantly accompanied by an instructed employee. Persons who stay in the working area of the vehicle (e.g. machine personnel,...) must be instructed about the behavior of the vehicle and about the possibilities of stopping the vehicle.

1.5.2 Shipping

The AGILOX vehicle will be shipped and delivered by a forwarding agent.

The AGILOX vehicle may only be loaded and unloaded by trained staff.

The AGILOX vehicle is to be unpacked by the commissioning team of AGILOX North America, Inc. or its system partner.

1.5.3 Commissioning

The AGILOX vehicle must only be commissioned by staff employed by AGILOX North America, Inc. or the AGILOX system partner.

The charging station(s) must only be installed by a professional electrician.

All staff requirements regarding the installation of the IT infrastructure on the customer's part will be defined by the system operator itself.

1.5.4 Operating Staff

Generally speaking, the AGILOX system is fully automated and does not require any input from operating staff.

Operating Staff:

The system's operating staff may perform the following actions on the AGILOX vehicle:

- Start and stop AGILOX vehicle
- Pause orders

Operating staff requirements:

- Minimum age: 18 years
- Must have read and understood the operation manual
- Must be expressly authorized and instructed by the system operator to operate the machine.

1.5.5 Operation and Fault Elimination

The system operator is responsible for the safe operation and fault elimination of the system. He must ensure that all measures specified in the operation manual, such as regular maintenance of the AGILOX vehicles, are observed.

Operator requirements:

- Minimum age: 18 years
- Must have a basic technical and logistical understanding
- Must have read and understood the operation manual
- Must have been trained on the AGILOX system by AGILOX North America, Inc., an AGILOX system partner or an in-house responsible person
- This training has to follow the training guidelines of and must be documented in the "Training Protocol System Operator".

1.5.6 System Administrator

Administrators are persons who operate and optimize the system. They can expand their own system with the existing range of functionalities and make changes to the operating areas.

Administrator requirements:

- Minimum age: 18 years
- Must have a basic technical and logistical understanding
- Must have read and understood both the operation manual and the commissioning manual
- Must have been trained on the AGILOX system by AGILOX North America, Inc., an AGILOX system partner or an in-house responsible person
- This training has to follow the training guidelines of and must be documented in the "Training Protocol Administrator".

1.5.7 Maintenance and Repair

Maintenance and repair are carried out exclusively by AGILOX North America, Inc. or an authorized AGILOX system partner.

1.6 Serial Number / Type Plate

The type plate is located at the back of the AGILOX vehicle.



Automated Guided Vehicle	
AGILOX	Type AGILOX ONE 1200
CE	SN 0000000
AGILOX Services GmbH Josef Haas-Straße 7a A-4655 Vorchdorf www.agilox.net	Date Manufactured 01/2020
	Vehicle Weight 400 kg
	Max. Rated Speed 1.4 m/s
	Max. Grade Capacity at Rated Load 1%
Max. Load Dimensions* 1200(47) x 800(31) x 1200(47) (L x W x H) [mm(in)]	
Max. Load Capacity* 1000 kg (2200 lbs)	
*may be lower according to inspection booklet.	

The type plate consists of two parts and contains the following information:

- Type
- Serial number (SN)
- Date of manufacture
- Vehicle weight
- Max. rated speed
- Max. grade capacity at rated load
- Manufacturer's name and address
- Maximum load capacity
- Maximum load dimensions

1.7 Typographic Conventions

Standard formats:

bold	important text, important passages
CAPITAL LETTERS	operating states
Courier	programming codes and examples

List formats:

1.	step-by-step instructions with a fixed sequence
2.	
•	lists without any fixed sequence
→	consequence or result of an instruction

1.8 Description of Warnings and Safety Information



DANGER

Non-compliance will lead to severe irreversible injuries or death.
Colorcode: #ff0000



WARNING

Non-compliance may lead to severe irreversible or fatal injuries.
Colorcode: Color #f5860b



CAUTION

Non-compliance may lead to minor or mid-level injuries.
Colorcode: Color #f6e807



NOTICE

Non-compliance may lead to damage to property.
Colorcode: #00b0f0



INFORMATION

Important information
Colorcode: #33cc33

1.9 Warning Label Explanations

	<p>This label is located on the front of the vehicle and means: Risk of injury due to unexpected start-up. The vehicle may suddenly start up and endanger people. The acoustic warning signals must be observed.</p>
	<p>This label is located on the front of the vehicle and means: The vehicle uses a voltage of 48V.</p>
	<p>This label is located on the control cabinet on the front of the vehicle and means: DANGER High Voltage. Turn off power before servicing.</p> <p>Electrocution hazard. Risk of electric shocks during maintenance work leading to severe burns and injuries. Turn off power before opening the control cabinet.</p>
	<p>This label is located on the inside of the control cabinet, next to the battery, and means: WARNING Hazardous voltage present with vehicle power off!</p> <p>Even with vehicle power off, there is still hazardous voltage present at the battery. Trained electrical specialists are permitted to use a pluggable discharging unit to de-energize the capacitor. The Five Electrical Safety Rules must be complied with</p>
	<p>This label is located next to the ON/OFF switch and means: WARNING Read and understand operation manual and especially all safety instructions before using the vehicle.</p>
	<p>This label is located next to the ON/OFF switch and means: WARNING Operate on Level Surfaces Only.</p> <p>The vehicle may only be operated on level surfaces. The permissible inclination in and across the direction of travel: < 1 %.</p>
	<p>This label is located on the back of the AGILOX vehicle and means: WARNING NO RIDING</p> <p>"Persons are prohibited from riding on the AGILOX vehicle"</p>

	<p>This warning label is located on the lifting scissors of the AGILOX vehicle and means: "Warning, risk of crushing!"</p>
	<p>This warning sticker is located on the navigation laser scanner and means "Class 1 Laser". These are harmless (eye-safe) and do not require any further action apart from the appropriate marking on the device, regardless of the wavelength emitted.</p>

1.10 Abbreviations and Acronyms

Action	Action a vehicle can perform. E.g. pickup, drop, drive, charge
AGIIO / AGILOX IO	AGILOX IO with up to 6 expansion boards for IOs, software licenses and parameter setting (3.1.2.4 - AGILOX IO)
AGILOX Analytics LTANA (old: AA)	Formerly "AGILOX Fleet Management Center". An analysis platform allowing customers to monitor their AGILOX fleet in real time around the clock. Its dashboard displays all the important figures (KPIs) regarding the AGILOX system and forms a portal leading to its lifetime service. 3.4 - Optional AGILOX Analytics
AGILOX BCO BCO (old: ADLAM)	AGILOX Box Carrier One: Load handler for 2 boxes or containers (max 600 x 400mm) incl. PLC control unit, data, and energy coupling
AGILOX OCF	Counterbalanced AGILOX vehicle with forks
AGILOX ONE / AGILOX ONE 1200	AGILOX vehicle with fork length 1200mm
AGILOX ONE 1400	AGILOX vehicle with fork length 1400mm
AGILOX ONE 1600	AGILOX vehicle with fork length 1600mm
AGILOX ONE 1800	AGILOX vehicle with fork length 1800mm
AGILOX vehicle(s)	An AGILOX vehicle used in a given operating area (AGILOX ONE or AGILOX OCF)
AGIPC / AGILOX Host Gateway	3.1.2.5 - AGILOX Host Gateway with stationary IPC
AGV	Automated Guided Vehicle
Area / Station Area	Several loading and unloading points grouped together.
Area of movement	The area in which the AGILOX vehicle is permitted to move.
BMS	Battery Management System
Carrier	Type of load, e.g. epal, epal3,...
Collective	A group of AGILOX vehicles can be defined.
Deadlock	A deadlock occurs, if two or more vehicles block each other and hinder each other from driving. The vehicles try to avoid such situations and solve them independently.
Driveline A	Drive unit front left and rear right

Driveline B	Drive unit front right and rear left
Emergency stop	Emergency braking of the AGILOX vehicle triggered by applying the emergency stop switch
Emergency halt	Emergency braking initiated by the AGILOX vehicle itself
EPAL	Also called EPAL1. EUR-pallet 800 x 1200 mm
EPAL3	Industrial pallet 1000 x 1200 mm
ERP	Enterprise Resource Planning
Failure	A failure occurring on the AGILOX vehicle, for example due to overloading or damaged components
FL	Front left
FR	Front right
HMI	Human Machine Interface; the user interface with a machine
IGV / ONEIGV (old: AGIGV)	AGILOX ONE Intelligent Guided Vehicle. Next Generation AGV, not needing a host computer.
Lift	Lifting unit
Local positioning	Searching for the actual position within the local area (which the AGILOX vehicle is currently at) after forgetting the last known position
Maintenance	Maintenance
MES	Manufacturing Execution System
Obstruction	Obstacle on the vehicle's drive way.
ONE12DS (old: AGIDS)	AGILOX Double Scissor Lift, Fork length 1200 mm
ONE12SS (old: AGISS)	AGILOX Single Scissor Lift, Fork Length: 1200 mm
ONE14SS	AGILOX Single Scissor Lift, Fork Length: 1400 mm
ONE16SS	AGILOX Single Scissor Lift, Fork Length: 1600 mm
ONE18SS	AGILOX Single Scissor Lift, Fork Length: 1800 mm
ONEAVE (old: ADCOA)	Optional Obstacle Avoidance, 3.2.10 - Optional Obstacle Avoidance
ONEBIU (old: ADCAM)	Optional camera for detection of Barcodes / QR Codes, 3.2.11 - Optional Detection of Barcodes
ONEDPE (old: ADCOL)	Optional AGILOX Design Package: All visible vehicle parts in AGILOX "GREEN" (Pantone 375C) are coated in customer color (RAL according to customers request)
ONEDPR (old: ADBRH)	Additional optional debris protection for drive wheels (brush, rubber lip or both, depending on requirements)
ONEESD (old: ADESD)	Additional ESD protection (optional)
ONEMCD (old: ADMOL)	Additional mobile charging unit, 3.1.2.7 - Mobile Charging Unit
ONESAS (old: ADDMS)	Optional ONE Safety Scale 3.2.12 - Optional Weight Monitoring
ONESCS (old: ADSLO)	Additional Charging System, 6.1.2.6 - Charging System
ONESLP (old: ADSPT)	Optional Signal Light Package consists of Floor Spot (Blue, Green, or Red) and Optional Fork Lights 3.2.14 - Optional Floor Spot 3.2.13 - Optional Fork Lights
ONEBCC (old: ADLAD)	Optional Preparation (plug, wiring, ...) on the vehicle for AGILOX Box Carrier for data and energy coupling

Parking position	All drive units are in a crossed position to prevent the vehicle from rolling away
Preposition	Preposition, that the AGILOX vehicle approaches prior to entering the station. Important for the entering direction.
Problem	Sequential issues, such as an occupied station that should be unoccupied or an obstacle in the vehicle's path
Protective safety field	A field around the AGILOX vehicle that is monitored and will stop the AGILOX vehicle if obstructed
Protrusion	A protrusion is any elements extending into the vehicle's driving path or area of movement at a given height (such as machines resting on their bases)
Report[ing]	Order History
Rotational	Describing the continuous circular motion of an object
RL	Rear left
RR	Rear right
S300	Safety laser scanner mounted at the front (left and right) of the AGILOX vehicle
Station	Location for acquiring or depositing goods
Translational	Describing the continuous motion of an object in a straight line
Union	All AGILOX vehicles working in the same area of movement
Vehicle(s)	An AGILOX vehicle used in a given operating area
Warning Field	An area around the vehicle, that is observed. When objects appear within the warning field, the vehicle slows down.
WMS	Warehouse Management Systems
Workflow	An accumulation of tasks (picking up loads, driving to a target, checks, depositing loads, etc.) summarized in an order.

2. Safety

This operation manual contains important safety and warning instructions as well as prerequisites which must be fulfilled by the operating, maintenance and servicing personnel during the entire service life of the system. The system operator must be aware of this before commissioning and is responsible for the safe operation of the system. It must be ensured that all measures specified in the operation manual, such as regular maintenance of the AGILOX vehicles, are observed.

All system operators are obliged to comply with national workplace regulations as well as with local safety and accident prevention rules.

The system operator is obliged to draw the attention of the personnel to possible dangers that could arise in connection with the AGILOX vehicle. Corresponding warning stickers must be kept legible in accordance with the legal requirements.

The system operator must take appropriate measures for any residual hazards.

System operators have to supplement this Operation Manual by the following information and documents:

- National health and safety regulations as well as environmental protection legislation (e.g. with regard to the handling of consumables)
- Instructions on plant-specific details concerning the organization of work, workflows, assigned staff as well as regulatory and notification requirements

2.1 Intended Use

AGILOX vehicles are intended for the automated, driverless conveyance of loads in plants within areas of movement defined prior to its commissioning. The AGILOX system is always composed of at least one AGILOX vehicle and a stationary charging station.

2.1.1 Modes of Operation

Automatic Mode

Operating mode for automatic operation of the vehicle.

The AGILOX vehicle automatically transports loads along predefined movement areas between at least one appropriately designed load pick-up and load delivery station, which, however, are not part of the AGILOX system. Monitoring and safety functions are activated.

The system is operated via a web-based terminal with indirect connection to the vehicle via the WLAN infrastructure. Transport orders are booked into the system and executed by the AGILOX vehicle(s) in a self-organized manner. Navigation is performed by the individual vehicle.

The load to be transported and the load handling attachment must be approved by the commissioning engineer of AGILOX North America, Inc. together with the system operator during commissioning.

Requirements for loads are specified in the operation manual. Loads must be secured by the system operator against slipping, tipping or falling over.

Actuation of one of the installed EMERGENCY STOP buttons brings the vehicle into a safe state.

The vehicle can be stopped (paused) at any time via a button on the vehicle or via the web-based terminal.

Manual Mode

Operating mode for fault elimination (level 1) and commissioning.

Monitoring and safety functions are activated.

Operation takes place via a web-based terminal device with indirect connection to the vehicle via the WLAN infrastructure. Driving commands are sent directly to the vehicle via the web-based end device. Actuation of one of the installed EMERGENCY STOP buttons brings the vehicle into a safe state.

Maintenance Mode

Operating mode for repair, fault elimination (level 2) and commissioning.

Monitoring and safety functions are deactivated.

Operation takes place via a web-based terminal exclusively via direct connection to the on-board WLAN access point. Activation of drives by two-hand operation.

EMERGENCY STOP immediately disconnects all drives from the power supply.

Any other uses beyond these purposes are considered unintended and may result in personal injuries as well as in damage to property and the AGILOX vehicle.

2.1.2 Operating / Movement Area

The AGILOX vehicle moves automatically on previously defined moving areas and transports loads fully automatically between at least one appropriately designed load pick-up and load delivery station, which, however, are not part of the AGILOX system.

The system operator is obliged to design the movement area for the AGILOX vehicle based on EN1525:1997; Appendix A. Some of these requirements have been stepped up (e.g. with regard to the gap dimensions of expansion joints) which means that the requirements specified in chapter [2.3 - Operating requirements](#) must be complied with accordingly. The system operator is responsible for ensuring that these requirements are met at all times.

The system operator is required to define and mark its danger zones (e.g. load acquisition and load depositing stations, charging stations, etc.) in coordination with the commissioning team. The minimum distances stipulated by EN1525:1997 must be complied with. The marked areas may only be entered by instructed persons and must not be blocked by persons or objects. The system operator is obliged to implement suitable organizational or engineering measures in this respect.

The area of movement must be free from any obstructions. Obstacles are detected by the AGILOX vehicle under certain conditions (if the obstacle is in the area detected by the safety laser scanners) and automatically bypassed, but this reduces the efficiency of the AGILOX system. The vehicle's driving path / area of movement must be free from protrusions such as the prongs of forklift trucks. If this is not observed, collisions and resulting damage may occur. The vehicle processes transports fully automatically and promptly. The direction of movement can be changed individually according to the definition of the area of movement. The vehicle can drive curves with any radius (up to turning at a standstill). Therefore, a change of direction can be expected at any time.

The designated transport path is always selected so that the movement radius is within this area.

Keeping the Area of Movement Clean

System operators must comply with the following requirements:

- All markings must be clearly and unmistakably recognizable as such, in particular in dangerous areas, as well as clearly visible. Make sure that these markings are kept clean at all times.
- The area of movement has to be kept clear of all obstacles that may impede the movement of AGILOX vehicles.
- Remove all liquids (such as water), dust, ice, etc. from the area of movement in order to prevent AGILOX vehicles from skidding, in particular in case of emergency braking.
- Ensure that the required floor conditions are properly maintained and that installations and equipment connected to AGILOX vehicles are kept in good repair.

2.1.3 Space requirements

The vehicle's driving path / area of movement must have a minimum width of 2,100 mm (for epal). Locations where this safety width is narrower than 2,100 mm must be passed through at reduced speed or not at all. A safety distance of at least 500 mm between the maximum width of the vehicle (incl. load) and any obstacles has to be allowed in the planning stage. The required safety distances need to be re-evaluated whenever unspecified load carriers are used.

An additional space with a minimum width of 2,100 mm in front of the vehicle that is free from any obstacles must be included so that the AGILOX vehicle will be able to pick up pallets without being obstructed.

For repairs and maintenance, a space of approx. 2 m is required on all sides around the vehicle.

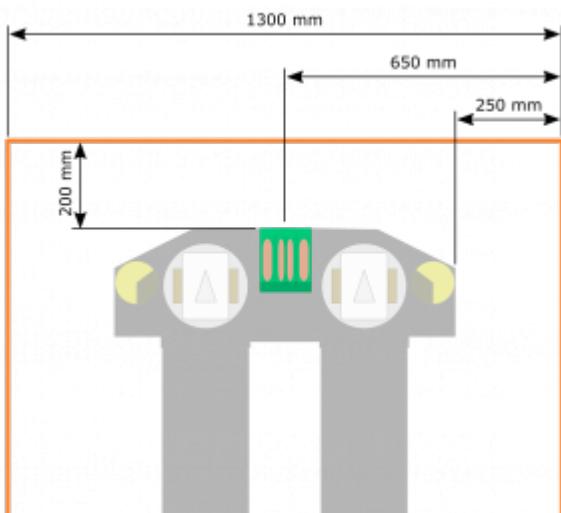


INFORMATION

The minimum widths and distances apply to AGILOX ONE 1200 and EPAL pallets. They must be adjusted for other vehicle types or load carriers. See [ANNEX IV - Operating Areas](#) for detailed information.

Distance between objects and the AGILOX vehicle at charging stations

Charging stations must be positioned in such a way as to ensure that the minimum width requirements specified in the figure below are met. The position is to be approved by the fire prevention officer.



INFORMATION

The minimum width requirements apply to EPAL pallets and need to be adjusted if larger load carriers are used.

2.1.4 Stability against Collapsing

Provided that the system is used as intended and the specified load values (dimensions, weight, center of gravity, rigidity) as well as the relevant movement area requirements are duly complied with, the AGILOX vehicle is stable against collapsing. In particular, however, it should be borne in mind that the system's area of movement must have only very slight gradients or slopes.

When loading or lifting AGILOX vehicle for maintenance purposes, it must only be hoisted above its specified attachment point.

The AGILOX vehicle must be properly secured when transported or shipped.

The lifting equipment must always be in a lowered position whenever manual tasks are performed on the vehicle.

2.1.5 Safety Information for Staff

All members of the system's operating staff are required to operate the AGILOX vehicles with the utmost care as well as in accordance with their intended purpose and this Operation Manual. In case of any malfunction, AGILOX vehicles must be put out of commission immediately and the relevant failure reported to the responsible department.

The operating staff must be in an adequate state of health in order to operate AGILOX vehicles. This requirement also includes the unimpeded ability to sense all visual and acoustic warning signals emitted by AGILOX vehicles.

Any work to be performed on AGILOX vehicles must only be carried out by trained maintenance and repair staff.

As a rule, one of the emergency stop switches must be activated when working on an AGILOX vehicle to prevent any accidental vehicle restarts.

Whenever maintenance tasks are performed on the vehicle while the vehicle's fork is in a lifted position, the fork must be secured against inadvertent lowering by means of a suitable object.

2.1.6 Qualifications

Requirements for the personnel are described in chapter [1.5 - Target Group](#).

2.1.7 Protective Equipment

System operators are required to provide personal protective equipment in appropriate sizes for their staff. Safety boots basically are to be worn in the entire area of movement for the AGILOX vehicles. However, specially marked walkways may be excluded from this requirement if they have been configured accordingly and internal company guidelines do not require safety shoes.

Additionally, hard hats, safety gloves or safety goggles may need to be worn when carrying out certain tasks described in this Operation Manual.

2.1.8 Daily Safety Checks / Visual Inspections

The system operator and/or its staff are required to perform safety checks according to following protocol on a daily basis:

- Maintenance Protocol CUSTOMER (Appendix)

In the event of any deviating operating behavior, such as noticeable noises (rattling, streaking, etc.), the shifting of pallets or in the event of mechanical bending, the AGILOX vehicle must be stopped immediately. The causes must be eliminated; if necessary, support must be contacted.

2.2 Reasonably Foreseeable Misapplications

Whenever the AGILOX vehicle is used for other tasks not described in Chapter [2.1 - Intended Use](#), or if any tasks are performed by untrained personnel, or if the system is modified after having been duly commissioned, all liability will pass from its manufacturer of the system to its operator.

The following uses are considered unintended uses and are therefore prohibited:

- Operation of the vehicle by untrained persons.
- Persons riding on, or being conveyed or lifted by means of, the vehicle
- Use of the system in areas not in compliance with the specified environmental conditions
- Use of the system in areas with a risk of falling, such as loading ramps, or in areas not included in the list of areas of movement defined by AGILOX North America, Inc. upon its initial commissioning, or when differing from any other specific configurations
- Use of the system outside the plant building (outdoors)
- Use of the system in cleanroom environments or EX-zones (areas subject to explosion hazards)
- Use in areas with uninstructed persons
- Use of the system in areas with danger of fire, potentially explosive atmospheres, corrosive areas or areas with a high concentration of dust, or conveying such substances
- Carrying out lifting tasks outside the vehicle's fully automated conveyance mode
- Manual conveyance of loads, except for the purpose of troubleshooting.
- Conveyance of loads with varying, not centrical or too high center of gravity
- Conveyance of loads protruding from the monitored area used by the AGILOX vehicle
- Moving the AGILOX vehicle in non-automated operation mode with lifted fork
- Acquiring and depositing loads in areas not identified as danger zones

2.2.1 Alterations and Modifications

System operators must not alter or modify the AGILOX system without proper authorization. In particular, this rule applies to its software and the AGILOX user interface. To be allowed to modify processes and workflows the responsible workers have to be trained by the manufacturer. All modifications must not violate the applicable rules and the operations manual.

If the system is modified after having been duly commissioned, all liability will pass from its manufacturer of the system to its operator.

2.3 Operational Requirements

2.3.1 Compliance with Engineering Limit Values

Non-compliance with engineering safety limit values may result in damage to property and accidents including severe injuries. Compliance with these engineering safety limit values is particularly important as far as safety is concerned.

2.3.2 Load and Load-Handling Equipment Requirements

Load and Load-Bearing Capacity	
Maximum transport weight (incl. load-bearing equipment)	
AGILOX ONE 1200 Single-Scissor Lifting System	1000 kg
AGILOX ONE 1200 Double-Scissor Lifting System	750 kg
AGILOX ONE 1400	750 kg
AGILOX ONE 1600	750 kg
AGILOX ONE 1800	750 kg
Standard load-bearing capabilities	
EURO pallets as well as all load containers certified by AGILOX North America, Inc. such as boxes or Düsseldorf pallets.	
All conveyed loads as well as any load containers must be undamaged and secured against tilting and slipping.	
Maximum effective lifting height of lifting fork	
AGILOX ONE 1200 with Double-Scissor Lifting System	1060 mm (max. conveying height: 1000 mm)
AGILOX ONE 1200 with Single- Scissor Lifting System AGILOX ONE 1400 AGILOX ONE 1600 AGILOX ONE 1800	550 mm (max. conveying height: 500 mm)
Maximum load dimensions (length / width / height)	
AGILOX ONE 1200	1200 mm / 1600 mm / 1200 mm
AGILOX ONE 1400	1400 mm / 1600 mm / 1200 mm
AGILOX ONE 1600	1600 mm / 1400 mm / 1200 mm
AGILOX ONE 1800	1800 mm / 1200 mm / 1200 mm
Center of gravity	
The load's center of gravity must be static and positioned in the middle of the vehicle and must not exceed a height of 600mm above the upper edge of the forks. The transport of loads with variable, off-center or too high center of gravity is prohibited.	
The permissible position of the load's center of gravity is shown in the load diagram.	
Other load requirements	
Other Load Requirements	
Loads to be conveyed must not be able to move while being conveyed as well as during abrupt acceleration or deceleration. Conveying substances such as open liquids or sand is not permitted. Liquid loads must be secured against spilling out Conveying hazardous or highly combustible substances is not permitted	

Depending on the load-carrier type, the maximum transport weight can be reduced even further. If pallets are picked up on the fork tips, the maximum weight is lower according to the table below.



Distance to vehicle's back	Max. transport weight Single-Scissor Lifting System	Max. transport weight Double-Scissor Lifting System	Max. transport weight AGILOX ONE 1800
0 - 50 mm	1000 kg	750 kg	750 kg
50 - 300 mm			
300 - 450 mm	750 kg	500 kg	
450 - 650 mm	500 kg	250 kg	500 kg
650 - 800 mm	250 kg		250 kg
> 800 mm		0 kg	

2.3.3 Environmental Conditions within the Area of Movement

Operating Area	
Indoors	In plants, production facilities and warehouses
Temperature	
Average ambient temperature for continuous operation	+ 25 °C
Maximum temperature short-term (up to 1h)	+ 40 °C
Minimum temperature	+ 5 °C
Temperature variations	-/+25°C /hour acc. to EN1525:1997
Notice:	When changing to other areas with different temperatures, it must be ensured that there is no condensation on or in the vehicle and on the optical sensor system.
Humidity	
Maximum humidity	80% at room temperature, no condensation
Minimum humidity	20% at room temperature, no condensation
Metres above mean sea level	
Metres above mean sea level	max. 2000 m
Air Pollution	
Dust	The system must not be used in environments with a high concentration of dust
Hazardous substances, EX-zones, gasses	The system must not be operated in areas subject to explosion or fire hazards (EX-zones) as well as corrosive environments.
Other	
Electromagnetic fields and WiFi	No WiFi or any electromagnetic fields must be present if they are within the frequency range used by AGILOX system or exceed critical power limits. According to EC Electromagnetic Compatibility directive 2014/30/EU
Light	No lasers or other light sources must be present which may irritate the laser scanner and other vehicle sensors. Direct and indirect sunlight leads to laser scanner malfunctions. Avoid parking the AGILOX vehicle under direct sunlight conditions.
Air movements	No large air movements (e.g. compressed air blasts) must be present, as these can lead to malfunctions of the ultrasonic sensors.
Vibrations	The driving path must be free from any vibrations or other impacts.

2.3.4 Floor Conditions of Area of Movement

Surface within Area of Movement Based on EN1525:1997	
Cleanliness	Industrial environments (mainly logistical): The drive tracks are to be kept clean and dry. Frictional properties and electrical leakage resistance must not be impaired by any chemicals, liquids, other types of contamination or any subsequent flooring modifications. The friction coefficient is of vital importance because it has a major impact on braking distance.
Material	Hard aggregate screed according to DIN 18560, Part 1, Part 5, minimum: Hard Aggregate Group A, Stress Group I
Evenness	The driving path must not contain any significant flatness imperfections.
Gradient/slope	Distance (m) / max. height difference (mm): 0,1 m / 2 mm 1 m / 4 mm 4 m / 10 mm 10 m / 12 mm 15 m / 15 mm
Inclination	Permissible inclination in and across the direction of travel: □ 1 %.
Expansion joints and gaps	Expansion joints and gaps must not be wider than 5 mm. Special care has to be put on the vertical displacement of the gap.
Floor covers	Floor covers are permitted if they do not conflict with the other specifications of the area of movement.
Friction of the Ground	
Friction	$\mu = 0,2 - 0,3$
Wheel material	Vulkollan or similar; select flooring materials ensuring the required friction coefficient. Plant operators have to ensure that the necessary amount of friction is not decreased by any contamination.
Load Bearing Capacity of the Ground	
Static load	6-8 N/mm ²
Dynamic load	12-16 N/mm ²
Minimum distributed load	2000 kg/m ²
Electrical Properties of the Ground	
Earth-leakage resistance	To avoid static electricity charges potentially damaging or destroying electrical components, earth-leakage resistance must not exceed 10 ⁶ Ω. $RE < 10e6 \Omega$, according to DIN 51953 2
Insulation resistance	$R > 50 * 10e3 \Omega$, DIN 57100, VDE 0100

2.3.5 Walls and Spatial Properties

Properties of Surroundings	
Contours	Any fixed and unmoving contours situated 1.825 mm above the ground must be identifiable. In its main direction of travel, the laser scanner must be able to permanently recognize at least 50% of the fixed contours in a full 360° visual field and at least 25% of the fixed contours in a 180° visual field. Apart from walls and columns, contours also include stationary machinery or other unchanging fixtures. Navigation (position sensing) may be impeded by the following materials: glass (including window panes), matt and black materials, wood. Similarly, a high proportion of temporary contour elements such as stacks of pallets or high-speed doors may also lead to localization deviations.
Sensor System	
Limitations of ultrasound features (according to Operation Manual)	Objects with strongly sound-absorbing surfaces such as open-pored foam materials, corduroy textiles, etc. cannot be detected reliably Objects with extreme sound-dividing shapes such as cone tips and similar cannot be detected reliably The temperature compensation functionality is unable to compensate strong temperature variations immediately These limitations, however, can be reduced by means of an optimized installation of signal generators or suitable parameter settings.
Navigation scanner requirements	See Attachment: Documentation Navigation_Laser Scanner (Pepperl+Fuchs) Do not point the laser into the sun. Protect the sensor against direct and prolonged sunlight. Prevent condensation from forming by ensuring that the sensor is not subjected to any major temperature fluctuations. Do not subject the sensor to aggressive chemicals. Keep the glass on the device clean.
Safety scanner requirements	See Attachment: Documentation Safety_Laser Scanner (manufacturer Sick) No retro reflectors must be visible at scanning height within a distance less than one meter to the protective field boundary.

2.4 Safety Features

2.4.1 Emergency Stop Switch

AGILOX vehicles have an emergency stop switch installed on either side (left/right) that will disconnect the drive units from their power supply when activated. This means that both the driving motion of the vehicle and the movements of its lifting equipment will be stopped immediately.

As soon as the emergency stop switch has been pressed, all drive units will brake at maximum deceleration and disconnected from their power supply, which means that the electrical braking functionality of the AGILOX vehicle will be deactivated, too.

Confirming an Emergency Stop

1. Unlock the emergency stop switch by giving it a turn.
2. Press the Start/Confirm pushbutton.

2.4.2 Personal Protection and Sensor Systems

2.4.2.1 Sensor System Overview



No.	Description
1	Navigation laser scanner (Not safety-oriented)
2	Distance sensor (Not safety-oriented)
3	Safety laser scanner
4	Ultrasound sensor
5	Scanners Obstacle Avoidance (former Collision Avoidance, not safety-oriented, optional)
6	DMS strain gauge for weight monitoring (optional)

2.4.2.2 Safety Laser Scanner - in the Direction of Travel

Persons within the system's area of movement are identified by means of two safety laser scanners (3) installed at the front corner points on both sides of the vehicle, resulting in a monitoring range of almost 360° in the height of 80mm (may vary depending on floor conditions). The area around the fork prongs, however, cannot be monitored due to the specific arrangement of the scanners. This is also where the ultrasound sensors (4) are mounted, monitoring the area around the fork prongs (see Chapter 2.4.2.3 - Ultrasound Sensors).

The protective safety field is monitored and switched automatically (speed and direction) depending on operational requirements and conditions. As soon as an obstacle leaves its protective safety field, an AGILOX vehicle will resume its run without any intervention on the part of the operating staff. As a result, manual confirmation is not required.

Whenever an emergency stop has been triggered, it needs to be confirmed by pressing the Start/Confirm pushbutton as soon as the danger in question has been eliminated in order to approve the AGILOX vehicle's resumption of travel.

2.4.2.3 Ultrasound Sensors

The ultrasound sensors in the fork prongs are used to monitor the area behind the AGILOX vehicle not covered by its safety laser scanner, resulting in a monitoring range of 360°.

Just like the protective safety fields generated by the safety laser scanners, the ultrasound sensors will be activated or deactivated depending on the situation at hand. This functionality has been designed to be safety-oriented.

2.4.2.4 Space between Forks

The distance sensor monitors the space between the forks of the vehicle. It will detect any person stepping between the forks whenever a fork is inserted into a pallet. Any such detection has to be confirmed manually by means of the Start/Confirm pushbutton. This functionality has not been designed to be safety-oriented and consequently does not offer full personal protection.

2.4.2.5 Other Safety Features

Load monitoring: A dedicated dual-channel sensor system is used to monitor the position of loads acquired by the AGILOX vehicle, thus preventing any slipping or an incorrect acquisition of loads. Any failures occurring in the course of load monitoring need to be confirmed by means of the Start/ACK pushbutton.

As an option, strain gauges can be installed as additional load monitoring system. The weight of the load is monitored. A change in weight is only allowed if the lift moves. The weight value is stored after each lift movement and when the blue button is pressed. If the currently measured value deviates from the stored value by more than approx. 25kg, an error message is triggered which must be acknowledged via the "ACK button".

2.4.3 Control Functionality in Case of Fire

This functionality requires a fire detection system in order to be implemented.

Its connection with the AGILOX IO will allow the AGILOX vehicle to realize when the fire detection system has been triggered, automatically bringing the vehicle to a standstill in a parking position. If the AGILOX vehicle is within the closing range of a fire protection door when the fire detection system is triggered, it will leave the area to allow the door to close without any obstruction. To ensure that the AGILOX vehicle can freely leave this area, the space around the fire protection door must be kept free from any obstacles by means of organizational or engineering measures. Any such measures will only be active while the AGILOX vehicle is traveling between two stations and deactivated during load transfer processes.

As it is theoretically possible that an AGILOX vehicle may come to a standstill on or near emergency escape routes, the vehicle will be parked without its brakes applied so that it can be moved out of the way manually. This functionality, however, can only be used when there are no gradients or slopes within the entire area of movement of the AGILOX vehicle.

This functionality has not been designed to be safety-oriented and can only be used when it has been correctly mapped and included in the definition of the vehicle's area of movement. This functionality is subject to acceptance testing and approval by the system operator's responsible fire protection officer.

2.4.4 Warning Labels

The labels on the AGILOX vehicle provide hazard warnings and form a major part of the safety equipment of AGILOX vehicles. Missing warning labels increase the risk of severe or fatal personal injuries.

- Attach the warning labels supplied together with the AGILOX vehicle accordingly
- Clean soiled warning labels
- Replace damaged and unrecognizable safety labels without delay

2.4.5 Signal Generators / Warning Signals

The AGILOX vehicle will trigger danger alerts by means of acoustic and/or visual warning signals. See Operation Manual chapter [7.2.1 - Acoustic Warning Signals](#) and [7.2.2 - Visual Warning Signals](#) for more details.

2.5 Specific Points of Danger

2.5.1 Electrical System



DANGER

Risk of fatal electric shock

Direct or indirect contact with live parts can result in life-threatening injuries.

- Opening of the housing only permitted by authorized persons
- Work on live components may only be carried out by a qualified electrician
- Electrical installation work for the charging station may only be carried out by a qualified electrician.

2.5.2 Scissor Lift



WARNING

Risk of crushing

The lifting equipment of the AGILOX vehicle may result in a risk of crushing.

- Be sure to wear safety shoes in dangerous areas
- No persons are allowed in the vicinity of AGILOX vehicle while their lifting equipment is in motion

2.5.3 Safety Laser Scanner

For more safety information regarding the safety laser scanner, please refer to the attachment with the applicable safety laser scanner documentation.

2.5.4 Battery

The charging unit and/or the parking site of AGILOX vehicles must not be exposed to direct sunlight due to the risk of the vehicle or its battery overheating. For more safety information please refer to the attachment containing the [Safety Data Sheet for the battery](#).

2.5.5 Charging Station and Charging Contacts



CAUTION

Fire hazard

Short-circuit between the charging plate and the vehicle housing and the resulting arc will cause the fire hazard.

This short circuit can be caused by:

- Electrically conductive waste (e.g. chips) lie on the loading plate and lead to short circuit with vehicle frame
- Vehicle not positioned exactly on loading plate or position of loading plate was not taught in correctly
- Charging plate was not attached properly and is too high, resulting in short circuit with vehicle frame
- Diameter of wheels too small, resulting in lower ground clearance of the vehicle. Short circuit with vehicle frame on loading plate possible

The following instructions should therefore be observed:

- Driving areas must be kept clean
- Follow the instructions for correct installation of the charging plate ([5.1.3 - Commissioning charging station](#)). The charging plate must not be fixed to the floor with double-sided adhesive tape or similar, but must be properly screwed to the floor. There must be nothing under the charging plate so that it becomes higher and could touch the vehicle frame.
- Wear of the wheels must be checked regularly (this is done in the course of the semi-annual maintenance by AGILOX North America, Inc. or a system partner).
- Teach the position of the AGILOX vehicle on the charging station correctly. The charging plate must be level with the vehicle frame at the front, or even disappear slightly behind the vehicle. Under no circumstances must the charging plate "protrude".



CAUTION

Fire hazard

Incorrect direction of approach or reversed polarity of the charging plate leads to a short circuit and there is a risk of fire.

- Checking the direction of polarity of the charging plate according to the approach direction of the vehicle before commissioning the charging station (see [5.1.3 - Commissioning charging station](#))

2.5.6 Danger Zones within the Area of Movement

Danger zones within the area of movement:

- Charging station
- Depositing station
- Acquisition station



WARNING

No persons and/or obstacle are allowed in danger zones. All danger zones must be clearly marked.

2.6 Life Cycles



DANGER

Other hazards in connection with the operating environment of the machine

Combinations of situations related to the operating environment can result in hazards to personnel.

- A risk assessment must be carried out by the system operator.



CAUTION

Risk of Crushing

Failure of a component of the lifting drive train can endanger persons

- Daily check by system operator:
 - Acoustic control
 - Visual control (ball of the bearing have fallen out)
 - Monitoring fault lifting current



CAUTION

Danger due to loss of stability

Vehicle loses stability due to a defect / wear of a drive unit, detachment or wear of a wheel, failure of a wheel bolt or failure of the wheel bearing.

- Daily check by system operator:
 - Acoustic control

2.6.1 Transport and Shipment

When shipping or transporting the vehicle, Guidelines VDI 2700 and VDI 2703 must be complied with at all times.

Detailed instructions for transport and unpacking of the AGILOX vehicle can be found in chapter [4 - Transport and Shipping](#)



CAUTION

Risk of transport damage

Transport damage may result in battery short circuits and subsequently to burns, fire and damage to electrical systems.

- AGILOX vehicles damaged during transport or shipment **must not** be put into operation
- Make sure that AGILOX vehicles as well as all other elements included in their scope of delivery cannot slip during transport and that they are treated with due care
- Special attention must be paid to the safe handling of the battery (see attachment containing the Safety Data Sheet for the battery)
- All batteries must be disconnected from the vehicle's electronic system during transport
- Please bear in mind that this load will be off-center when handled

The following transport requirements must be observed:

- Pull the key from the key switch and press at least one of the two emergency stop switches
- The lifting forks of the AGILOX vehicle must be in their lowermost position during transport
- The vehicle has to be loaded and unloaded from the transport truck using a suitable forklift truck or crane. All loading and unloading operations must only be carried out by authorized staff. Be sure to use the designated attachment point.
- Only the lifting tackle supplied together with the vehicle must be used
- During loading or unloading operations involving sloped surfaces, the AGILOX vehicle must be properly secured against accidentally rolling away by suitable means



WARNING

Risk of injury resulting from raised load

Severe injuries may occur during unloading due to the load falling over or dropping.

- AGILOX vehicles must only be unloaded by specialist staff
- Use appropriate personal protective equipment (hard hats and safety gloves)
- Only suitable transport structures (pallets, etc.) must be used for unloading the AGILOX vehicle
- Be sure to take the weights specified in relation to the AGILOX vehicle (including shipment box) into account
- Only the round sling supplied together with the vehicle must be used for unloading
- Only the lifting tackle supplied together with the vehicle must be used
- Be sure to take note of the warning information supplied on the vehicle's packaging
- The load containing the AGILOX vehicle must be properly secured while being shipped to its operating site
- Be sure to check that the vehicle is properly secured during transport



WARNING

Risk of falling during unloading

Risk of falling from transporting trucks due to slipping, tripping or falling which may lead to severe injuries.

- The AGILOX vehicle must only be unloaded by specialist staff
- Use appropriate fall-arresting equipment when climbing on the truck
- Take special care when fastening the load



WARNING

Risk of crushing

Crushing injuries may occur as a result of the AGILOX vehicle rolling away.

- Please be mindful of the maximum allowable floor gradient
- Observe [2.5.3 - Floor Conditions of Area of Movement](#)

2.6.2 Assembly

The system operator is responsible for carrying out the required risk assessment for all installation work performed on the part of the customer and instructing its staff accordingly. The safety information given below provides only a few guiding principles for safe installation.



WARNING

Risk of crushing

Crushing injuries on the body, feet and hands may occur as a result of the AGILOX vehicle accidentally rolling away.

- Please be mindful of the maximum allowable floor gradient



WARNING

Risk of injury by concrete cutting machinery

The rotating parts of concrete cutting machinery (e.g. when laying the charging plate) may cause severe cuts or even lead to a loss of limbs.

- Use special care when cutting the recess for the charging plate
- All installation and mounting tasks must only be carried out by specialist staff
- Use proper personal protective equipment (hard hats and safety gloves).



WARNING

Risk of injury when mounting the charging station

Limbs may get caught or pulled into machinery by rotating parts when mounting the charging station

- Use special care when drilling mounting holes for the charging station
- All installation and mounting tasks must only be carried out by specialist staff
- Use proper personal protective equipment (hard hats and safety gloves)



WARNING

Risk of falling when mounting the charging station

Slipping, tripping or falling during installation work carried out on the charging station may lead to severe injuries.

- All installation and mounting tasks must only be carried out by specialist staff
- Lay and fix electrical supply cables (between charging plate and charging station) properly, secure against tripping and/or mark them.
- Use proper personal protective equipment (hard hats and safety gloves)



CAUTION

Noise hazard

Noise generated by drilling and cutting work carried out on the charging plate may lead to ringing ears (tinnitus).

- Any drilling and cutting work must only be performed by specialist staff
- Use proper personal protective equipment (ear protectors, hard hats and safety gloves)



CAUTION

Dust hazard

Dust generated by drilling tasks carried out in connection with the charging station or cutting work performed on the charging plate may lead to breathing difficulties and/or eye injuries.

- Exhaust dust from atmosphere during work
- Use proper personal protective equipment (safety goggles, protective mask, ear protectors, hard hats and safety gloves).



CAUTION

Risk of eye injuries

Splintering caused by drilling tasks carried out in connection with the charging station or charging plate may lead to eye injuries.

- Exhaust dust from atmosphere during work
- Use proper personal protective equipment (safety goggles, protective mask, ear protectors, hard hats and safety gloves).

2.6.3 Installation

The system operator is responsible for carrying out the required risk assessment for all installation work performed on the part of the customer and instructing its staff accordingly. The safety information given below provides only a few guiding principles for safe installation.

2.6.3.1 Charging Station and Charging Plate



DANGER

Fatal electric shock / risk of electrocution

Work on live supply lines cause electric shocks (e.g. when connecting charging equipment improperly to the mains) resulting in severe burns, serious injuries or even death.

- The charging station must only be connected to the mains by a electrical specialist
- Make sure that no voltage is present before starting work
- Use suitable personal protective equipment



WARNING

Risk of falling

Falling as a result of electric shocks occurring when connecting charging equipment improperly to the mains may lead to serious injuries.

- The charging station must only be connected to the mains by a electrical specialist
- Make sure that no voltage is present before starting work
- Use suitable personal protective equipment

2.6.4 Commissioning

2.6.4.1 AGILOX Vehicle Battery

The safety information concerning the battery must be complied with (see attachment containing the Safety Data Sheet for the battery).

The initial charging of the battery may lead to electrical hazards.



WARNING

Risk of fire

Risk of overheating / fire when batteries are charged too fast (e.g. when the maximum charging current is exceeded) or when charging damaged batteries (e.g. after accidents) – risk of severe injuries.

- Only permitted charging equipment must be used
- AGILOX vehicles with damaged batteries or battery accessories must not be put into operation!
- Vehicles may only be charged in the defined ambient conditions (e.g. temperature range!, etc.).

2.6.4.2 AGILOX Vehicle - Area Mapping and Acquisition



WARNING

Risk of crushing

Crushing hazards can occur in the following situations:

- Incorrect operation in manual mode causes the vehicle to hit a person.
- Due to incorrect machine configuration (fork length), the rear personal protection system (ultrasonic sensors in the fork tips) is switched off too early and persons are hit.
- When entering a station, a person passes between the vehicle and the pick-up station (via forks) and is squeezed between the vehicle and the load.

This can lead to serious injuries.

- Manual operation is protected by the authorization system.
- Manual operation may only be carried out by adequately trained and authorized persons.
- Only those personnel who are directly required for the work may be in the danger zone of the machine. In addition, it must be ensured that the smallest possible number of personnel are in the danger zone.
- Use safety shoes on the travel path / in the travel area.

2.6.5 Operation

2.6.5.1 AGILOX Vehicle Battery

The safety information concerning the battery must be complied with (see attachment containing the Safety Data Sheet for the battery).



WARNING

Fire Hazard There is a risk of overheating or fire due to:

- Overcharging of the battery due to malfunction of the BMS (no termination of the charging process although max. permissible cell voltage has been reached)
- Charging too fast (e.g. maximum charging current is exceeded)
- Charging at too high temperature
- Charging of a deep discharged accumulator
- Charging a damaged accumulator (e.g. after collision)
- Discharging too fast (max. discharge current exceeded, e.g. due to short circuit)

This can lead to serious injuries.

- Only approved chargers may be used.
- AGILOX vehicles with damage in the area of the accumulator must not be operated any further!
- Ambient conditions must be observed.

2.6.5.2 AGILOX Vehicle

The AGILOX vehicle must only be operated following proper start-up. A daily safety check/visual inspection must be performed on all AGILOX vehicles.

No persons must be present in the danger zone (e.g. at the load acquisition and load depositing stations, at the charging station, etc.) Furthermore, AGILOX vehicles must not be driven with its load raised when operated manually.



WARNING

Risk of death as a consequence of collisions with AGILOX vehicles

The personal protection system on the AGILOX vehicle is designed for objects located on the ground and in the vehicle's travel path. Moving objects and persons crossing or approaching the travel path shorten the stopping distance of the vehicle. This can lead to collisions and accidents with serious injuries and damage.

- Define the driving path / area of the AGILOX vehicle in the AGILOX user interface.
- Safety shoes must be worn in the driving area of AGILOX vehicles
- Persons are only allowed on the driving path or in the area of movement of AGILOX vehicles, if they are instructed in the vehicle's behavior
- Do not approach the vehicle
- Before crossing the driving path, check whether an AGILOX vehicle wants to pass.
- Use proper personal protective equipment when working within the area of movement of AGILOX vehicles



DANGER

Risk of death as a consequence of collisions

AGILOX vehicles are unable to detect obstacles when safety engineering performance limits and the movement area requirements are exceeded, which may result in fatal injuries or even death.

- Provide suitable barriers for working areas whenever tasks are to be performed within the area of movement of AGILOX vehicles
- If installing barriers for the area of movement is not possible, the system must be deactivated for the duration of such tasks



WARNING

Hazards due to sudden changes of direction

AGILOX vehicles are capable of avoiding obstacles independently which may put persons at risk. AGILOX vehicles are also able to change direction depending on specific circumstances. As AGILOX vehicles may make turns with any given radius (including U turns while stationary), a change of direction has to be expected at any time.

- Be sure to be mindful of acoustic and visual warning signals
- The AGILOX vehicle should not be passed.
- Only persons who have been instructed on the behavior of the vehicle are allowed to stay in the drive path.



CAUTION

Risk of injury due to unexpected start-up

The vehicle suddenly starts up and endangers people.

- Persons who are in the working area of the vehicle (e.g. machine personnel, ...) must be instructed about the behavior of the vehicle and about the possibilities of stopping the vehicle.
- The acoustic warning signals must be observed.



CAUTION

Risk of injury due to falling objects

Due to incorrect operating area design, the vehicle drives over an edge of the area (loading ramp, stairs,...) and endangers persons.

- Observe operating area design
- Use of the system in areas with a risk of falling, such as loading ramps, is prohibited.



WARNING

Risk of injury due to unsuitable surface conditions

Driving in areas with unsuitable surface conditions (e.g. extreme gradients/slopes) may jeopardize the safe operation of AGILOX vehicles, resulting in severe injuries and/or damage to property.

- Only drive on surfaces that are in conformity with the applicable specifications (see [2.3.4 - Floor Conditions of Area of Movement](#))
- Observe maximum transport weight



DANGER

Risk of collision due to lost position

After the AGILOX vehicle has been lifted from the ground (e.g. for maintenance or repair work), it might have lost its current position, which may lead to dangerous collisions or driving into restricted areas.

- Check the current position of the vehicle and force local positioning if necessary before putting the vehicle back into operation.
- Definition of driving areas only by trained personnel
- Mechanically secure critical areas



DANGER

Danger from other hazard events

In case of fire, the vehicle stops and blocks an escape route or fire door.

- The operating areas are to be designed in such a way that escape routes are not obstructed.
- A connection to a fire alarm system is possible. If fire is detected, a defined procedure is initiated.
- Whether these measures are sufficient must be evaluated with the customer in the risk assessment.
- The procedure for the event of fire can be affected by the following points:
 - Vehicle not in automatic mode
 - Vehicle in malfunction



WARNING

Risk of crushing

Carelessness while moving the lifting equipment and picking up transport structures (pallets, etc.) may lead to crushed hands and feet.

- No person is permitted to remain in danger areas while the lifting equipment is moving and the vehicle is backing up
- Be sure to be mindful of acoustic and visual warning signals whenever the lifting drive is active
- Persons are only allowed on the driving path or in the area of movement of AGILOX vehicles, if they are instructed in the vehicle's behavior
- Use proper personal protective equipment when working within the area of movement of AGILOX vehicles



WARNING

Risk of falling

Climbing or riding on AGILOX vehicles may lead to falls and result in severe injuries.

- Climbing or riding on AGILOX vehicles is not permitted



CAUTION

Risk of tripping

- No stepping over the forks



CAUTION

Risk of electrostatic discharge

In some operating environments, unwanted static charges may build up on the vehicle. This can result in sudden flow of electricity between the vehicle and a person caused by touching the vehicle.

- The static charge depends on operating conditions
- Additional ESD protection may be necessary



CAUTION

Risk of fire

Driving into or through areas that are subject to explosion protection can lead to dangerous situations.

- Driving in Ex-zones is not permitted

2.6.5.3 Conveying Loads by means of AGILOX Vehicles

All goods must be conveyed on transport structures (pallets, etc.) designed according to EN 13698 in immovable units. Whenever optional load-handling equipment is used, it has to be certified by AGILOX North America, Inc..

System operators are responsible for the safe conveyance of loads and required to take all necessary precautions.

- The maximum conveyance weight (including transport structures such as pallets, etc.) according to Chapter 2.3.2 - Load and Load-Handling Equipment Requirements must be complied with
- Conveying off-balance loads is not permitted



DANGER

Risk of death due to improper loading

Overloading and/or an improper distribution of loads will jeopardize the safe operation of AGILOX vehicles and may lead to severe injuries or damage to property.

- Be sure to comply with all regulations regarding the conveyance of loads
- Comply with the [Load and Load-Handling Equipment Requirements](#) (especially maximum transport weight, load center of gravity)
- In the entire system, no load carriers outside the specifications may be used.
- On floor stations, overweight is detected by the weight measurement. On conveyor systems, this must be done by the conveyor system.

For loads that do not meet specifications, an additional risk assessment for load handling must be performed by the system operator.



DANGER

Risk of death due to incorrect protective field configuration

An incorrect protective field configuration results in load carriers being larger than the active protective field set. Serious injuries and/or property damage due to collisions can result.

- The largest load carrier to be transported must match the protective field set.
- Only trained personnel may make adjustments to the protective fields.



DANGER

Risk of objects falling or being ejected

Incorrect configuration (load carrier, offset pickup,...) of the station leads to danger due to loads falling over.

- Configuration of stations only permitted by specially trained persons.



WARNING

Risk of injury due to the load falling down

The vehicle drives through an area that is too low and collides with lift or load. The load (or parts of the load) falls down and endangers persons.

- Definition of the movement areas only by trained personnel.
- The movement area must be designed and configured so that the vehicle does not collide with the building or building equipment (e.g. sprinklers,...) in any area.
- If this is not possible, the endangered areas must be considered specifically.



WARNING

Risk of crushing

When entering a station, a person passes between the vehicle and the pick-up station (via forks) and is crushed between the vehicle and the load.

- Persons are only allowed on the driving path or in the area of movement of AGILOX vehicles, if they are instructed in the vehicle's behavior
- Whenever the acoustic 'Backing up' signal on the AGILOX vehicle sounds, no persons must be present in the danger area
- Safety shoes must be worn in the danger area
- Whenever the visual 'Lifting/Lowering' signal on the AGILOX vehicle lights up, no persons must be present in the danger area

The exact load handling procedure is described in chapter [6.4.2 - Load Handling](#).



WARNING

Risk due to the load falling or tipping over

When picking up a load from a floor station or conveyor or when transferring a load to the conveyor, the load is not in the correct position and therefore tips over.

- Observe load handling limits.
- Correct configuration of the pick-up and drop-off stations.



WARNING

Risk of objects falling or being ejected

Persons may be put at risk when the position of the load is changed (e.g. due to slipping) as a result of excessive acceleration or deceleration.

- Any transport weight limitations must be complied with (no overloading)
- The load must have an adequate friction coefficient or be secured and positively locked to the transport vehicle to prevent slippage

Persons may also be put at risk when an AGILOX vehicle loses its lifted load due to improper load acquisition.

- Loads must always be properly centered



DANGER

Risk of crushing

Vehicle cannot pick up load carrier due to incorrect position of load carrier or other reasons. The load carrier requires manual intervention to resolve the situation. As long as the AGILOX vehicle is in automatic mode, there is a risk of crushing due to automatic restart!

- Before starting the troubleshooting, the vehicle must be brought into a safe state.
- This can be done by pressing an emergency stop button. The emergency stop prevents the automatic restart.



NOTICE

Risk of damage to property

A longer standstill period in loaded condition can result in flat spots being created on the driving wheels.

2.6.5.4 Block Storage



CAUTION

Risk of crushing

Risk of crushing when the vehicle is backing up and there is no adequate escape route.

- Block storage is an operational hazard area
- Work in this area only by instructed persons.

2.6.5.5 AGILOX IO



DANGER

Other hazard events

Incorrect definition or communication with other systems using AGILOX IO can lead to hazards.

- The interaction with other systems must be considered by the system operator in a separate risk assessment.
- On the basis of the risk assessment, the system operator must take appropriate measures to minimize risks

2.6.6 Servicing and Maintenance

As a general principle, all maintenance tasks must be carried out by AGILOX North America, Inc. or its system partner. If a system operator chooses to perform maintenance tasks themselves or fails to avail themselves of the maintenance package during the applicable warranty period, AGILOX North America, Inc. is unable to assume any liability for such AGILOX vehicles. Furthermore, the operator's maintenance staff must be duly instructed and authorized by AGILOX North America, Inc.. Maintenance tasks may only be performed by designated maintenance staff as well as in accordance with the relevant instructions given in Operation Manual chapter [7 - Maintenance and Repairs](#).



CAUTION

Risk of crushing

There is a risk of crushing when carrying out maintenance or servicing work underneath the vehicle.

- When working underneath the raised vehicle, the vehicle must be appropriately secured against falling and tipping over.
- Maintenance and repair work may only be carried out by qualified personnel.
- Correct personal protective equipment must be used.
- Only suitable loading aids may be used for lifting.
- The weight specification of the AGILOX vehicle must be observed.
- Only the supplied lifting gear and round slings may be used for lifting.



WARNING

Risk of injury

Risk of crushing, pushing, shearing, catching or getting pulled in by various components (drive unit, scissor lift) when carrying out maintenance or cleaning tasks.

- A visual warning signal emitted by the AGILOX vehicle will indicate that the vehicle is currently in maintenance mode
- All safety features are deactivated in maintenance mode
- During maintenance work on drive units or the scissor lift, the forks must be mechanically secured against unintentional lowering. (wooden beam in scissor)
- Lift the scissor lift only as high as needed for maintenance work.
- Be sure to press the emergency stop switch before carrying out cleaning tasks
- The battery must be disconnected when carrying out any tasks in the switch cabinet (load-breaking switch)



WARNING

Risk of injury

Risk of crushing or impact when driving in maintenance mode.

- A visual warning signal on the AGILOX vehicle indicates that the AGILOX vehicle is in maintenance mode.
- All safety functions are deactivated in maintenance mode.
- Maintenance mode may only be activated and used by trained persons



DANGER

Electrocution hazard

Risk of electric shocks during maintenance work leading to severe burns and injuries.

- Maintenance tasks may only be performed by specially instructed specialist staff
- Maintenance tasks must only be carried out in accordance with the Maintenance Manual
- Be sure to avoid touching any electrical components
- The Five Electrical Safety Rules must be complied with

Risks of electric shocks may also arise when the main breaker on the AGILOX vehicle has been deactivated and when the vehicle's casing is open. Electrical hazards may lead to injuries.

- Maintenance tasks must only be carried out in accordance with the Maintenance Manual
- Be sure to avoid touching any electrical components
- Trained electrical specialists are permitted to use a pluggable discharging unit to de-energize the capacitor
- The Five Electrical Safety Rules must be complied with



WARNING

Risk of crushing

Adjust zero position of the drive units at an incorrect angle will cause the vehicle to travel in a different direction than specified and endanger people.

- Adjusting zero position of the driving units may only be done by authorized persons after appropriate training

Adjusting the zero position of the lifting equipment in an incorrect position results in an incorrect zero position of the lift. This can lead to an incorrect protective field specification and endanger persons.

- Adjusting zero position of the lifting equipment may only be done by authorized persons after appropriate training



WARNING

Risk of impact

Due to incorrect connection of the LED strips (left and right reversed) after repair or maintenance work, the turn signal is displayed incorrectly. As a result, the AGILOX vehicle does not change the direction of travel in the expected direction and endangers persons.

- Work on the vehicle may only be carried out by qualified persons.
- After work on the vehicle, the affected components must be checked according to the checklist.
- Acoustic and optical signals must be checked cyclically by the system operator (daily check).



CAUTION

Risk of being pulled in or caught

During maintenance or repair work on the lifting spindles, they may start up automatically and endanger persons.

- When working on rotating parts, the automatic restart must be prevented.
- This can be done either by pressing the EMERGENCY STOP and/or by disconnecting the respective drive train

2.6.7 Disassembly, Decommissioning

The system operator is responsible for carrying out the required risk assessment for any disassembly tasks performed on the part of the customer and instructing its staff accordingly. The safety information given below provides only a few guiding principles for safe disassembly.



DANGER

Electrocution hazard

Risks resulting from electrical power, risk of electric shocks when disconnecting the system from the mains (switch cabinet, charging station, etc.).

- Only electrical specialists are permitted to disconnect the system from the mains
- Be sure that the power supplier on the customer's part has been properly de-energized
- Short-circuit and insulate the conductor after disconnecting the power supply line
- Prevent persons from entering the area or demount the power supply line



DANGER

Risks resulting from electrical power

Risks resulting from direct contact with the battery and the capacitors that may lead to severe injuries.

- Only electrical specialists are permitted to disconnect the system from the mains
- Be sure that the power supplier on the customer's part has been properly de-energized



WARNING

Risk of injury resulting from raised load

When lifting the vehicle into the packaging or when loading the boxed vehicle, serious injuries may occur due to tipping or falling of the load.

- AGILOX vehicles must only be loaded by specialist staff
- Use appropriate personal protective equipment (hard hats and safety gloves)
- Only suitable transport structures (pallets, etc.) must be used for unloading the AGILOX vehicle
- Be sure to take the weights specified in relation to the AGILOX vehicle (including shipment box) into account
- Only the round sling supplied together with the vehicle must be used for unloading
- Only the lifting tackle supplied together with the vehicle must be used
- Be sure to take note of the warning information supplied on the vehicle's packaging
- The load containing the AGILOX vehicle must be properly secured while transported
- Be sure to check that the vehicle is properly secured during transport



WARNING

Risk of falling during loading

Risk of falling from transporting trucks due to slipping, tripping or falling which may lead to severe injuries.

- The AGILOX vehicle must only be loaded by specialist staff
- Use appropriate fall-arresting equipment when climbing on the truck
- Take special care when fastening the load



WARNING

Risk of crushing

Crushing injuries may occur as a result of the AGILOX vehicle rolling away.

- Please be mindful of the maximum allowable floor gradient
- Observe [2.5.3 - Floor Conditions of Area of Movement](#)



WARNING

Risk of injury when disassembling the charging plate

Carelessness may cause severe cuts or even lead to a loss of limbs. Additionally, there is a risk of slipping, tripping or falling.

- Only specialist staff is permitted to carry out any disassembly tasks
- Use proper personal protective equipment (hard hats and safety gloves)



CAUTION

Noise hazard

Noise generated by disassembling the charging plate (e.g. chiseling) may lead to hearing defects.

- Any drilling, cutting or chiseling work must only be performed by specialist staff
- Use proper personal protective equipment



CAUTION

Dust hazard

Dust generated by disassembling the charging plate (e.g. chiseling or drilling) may lead to breathing difficulties and/or eye injuries.

- Exhaust dust from atmosphere during work
- Use proper personal protective equipment (safety goggles, protective mask, ear protectors, hard hats and safety gloves).



CAUTION

Risk of eye injuries

Splintering or dust resulting from drilling and cutting tasks when disassembling the charging plate may lead to eye injuries.

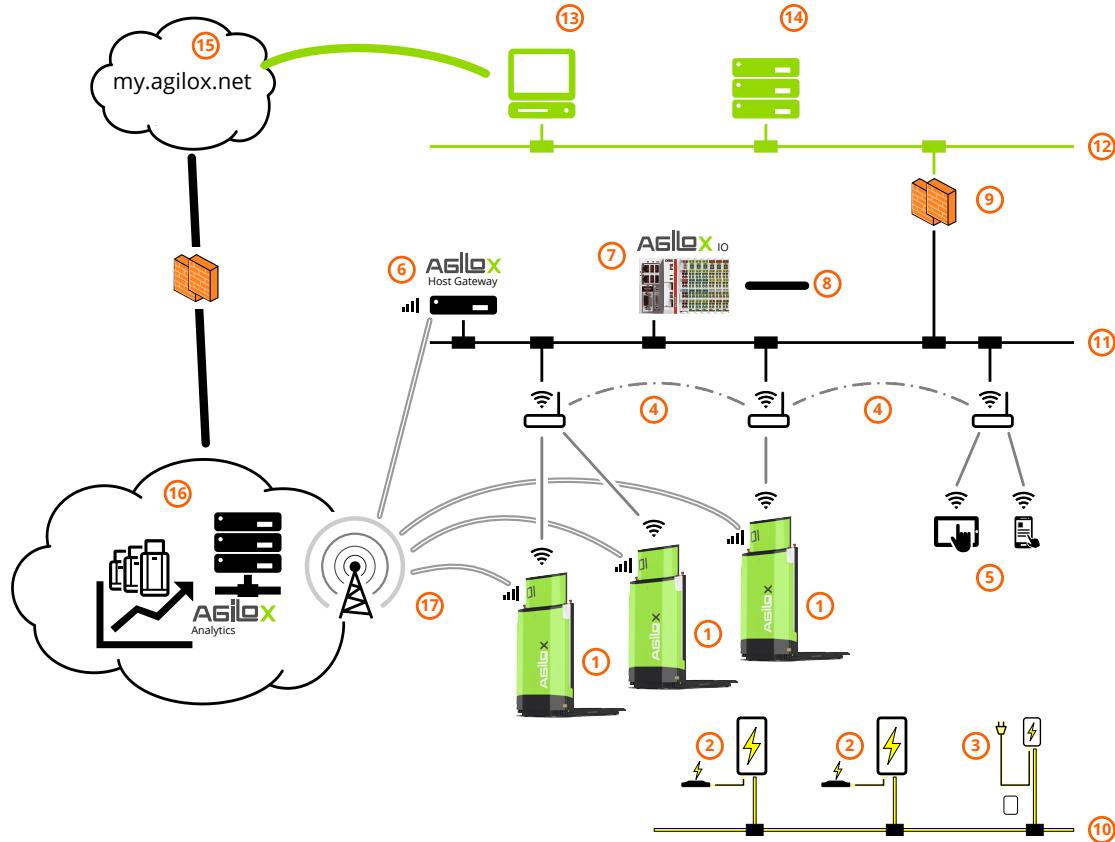
- Exhaust dust from atmosphere during work
- Use proper personal protective equipment (safety goggles, protective mask, ear protectors, hard hats and safety gloves).

3. Description

3.1 General Description of the AGILOX System

3.1.1 AGILOX System Overview

The AGILOX system is composed of vehicles, infrastructure, gateway-instances, control terminals, access to AGILOX Analytics and various aids.



No.	Description	No.	Description
1	AGILOX Vehicle	9	Firewall (<i>provided by customer</i>)
2	AGILOX Charging Station (ADSLO)	10	Energy supply (<i>provided by customer</i>)
3	AGILOX Mobile Charging Device (ADMOL)	11	AGILOX LAN (<i>provided by customer</i>)
4	WLAN Infrastructure (<i>provided by customer</i>)	12	Customer LAN (<i>provided by customer</i>)
5	Handheld operating device (<i>provided by customer</i>)	13	Office PC (<i>provided by customer</i>)
6	AGILOX Host Gateway (AGIPC, <i>optional</i>)	14	Host System(s) (<i>provided by customer</i>)
7	AGILOX IO (AGIIO, <i>optional</i>)	15	Internet
8	Input / Output Signals	16	AGILOX Analytics (<i>optional</i>)
		17	AGILOX M2M Communication (<i>optional</i>)

3.1.2 Brief Description of System Components

3.1.2.1 AGILOX Vehicle

The autonomous control system of AGILOX vehicles is based on a three-tier automation concept. One tier is used for navigation, routing and the mapping of swarm intelligence. Another tier is basically responsible for the control technology connections for the vehicle's driving and lifting units and for monitoring the mechatronic system. The third tier performs all the required safety-relevant tasks. Preventing collisions with persons and objects, however, is always given top priority.

AGILOX vehicles are in conformity with all European and national directives and regulations on the operation of automated guided vehicle systems. Continuous and failure-free operation is ensured by a comprehensive self-monitoring system that will identify any deviations immediately and initiate the required steps.

AGILOX vehicles have been designed to operate autonomously and will require interventions on the part of its operating staff (operators) only rarely.

AGILOX vehicles use both visual and acoustic signals to alert their surroundings. To this end, AGILOX vehicles are equipped with an optical control system and two separate light strips mounted on the side of the vehicle as well as a sound system for emitting acoustic signals. Every AGILOX vehicle uses an internal web server which, following authentication, provides a portal for the overall system, offering extensive functionalities as well as intervention and parameterization options. Its main components are the AGILOX vehicle control system and the visualization functionality.

On the navigation laser scanner there is a display on which the general status or the stop reason of the vehicle is shown textually.

3.1.2.2 HMI Terminal Devices

The AGILOX user interface can be manually operated by means of browser-enabled terminal devices to be supplied by the system operator. Almost any browser-enabled terminal device (smartphones, tablets, laptops, etc.) can be used to this end. In order to give our customers maximum freedom in the selection of the HMI device that corresponds to the respective customer requirements, the HMI device is not part of the AGILOX complete package.

The AGILOX user interface can be used to activate the manual operation mode for AGILOX vehicles as well as their maintenance mode provided that the key switch is in the appropriate position. The AGILOX user interface can also be used for calling up detailed diagnostic information on AGILOX vehicles in real time. By visualizing a vehicle's area of movement, the AGILOX user interface provides a comprehensive overview of the entire AGILOX system, also in real time. Additionally, visualization of the area of movement allows users to create and parameterize stations, generate or cancel orders and to display navigation and routing information. Operation Manual chapter [5.1.1.2 - Handheld Operating Device for the AGILOX User Interface](#), contains the applicable specifications.

3.1.2.3 AGILOX Analytics

Every AGILOX vehicle possesses an LTE modem with an integrated M2M SIM card with a global functionality. As an additional option, this connection can be used to continuously transmit AGILOX vehicle data (status, order situation, etc.) to the AGILOX Analytics system.

As soon as the AGILOX Analytics functionality has been activated, all AGILOX systems are subject to passive monitoring. The AGILOX Analytics program monitors error statuses and is able to notify users accordingly. The dashboard displays all important figures regarding the AGILOX system and forms the basis for an efficient Life Time Service Concept. To this end, error statuses are transmitted by the AGILOX fleet to the AGILOX Analytics system and evaluated centrally.

3.1.2.4 AGILOX IO

The AGILOX IO is an industrial control system (optionally Beckhoff or Siemens) with potential-free relay outputs and digital inputs (24VDC), which is connected to the AGILOX network. It can be used as an interface with the system operator's automation world and connects fieldbus systems and the IOs with the AGILOX network to ensure the required data exchange.

The control system is supplied in a control cabinet including power conditioning and only needs to be connected to 110-230V. It can also be implemented in an existing control cabinet by the customer. The correct voltage supply must then be ensured by the system operator.

A decentralized version is also available in which an EtherCat-Extension and IO boxes are used for the connection of peripheral components.

In order to operate an AGILOX IO, a network connection to the AGILOX network is required. This can be done either via a cable or via an optional WLAN access point in the control cabinet of the AGILOX IO. The AGILOX vehicles communicate with the AGILOX IO via TCP / IP telegrams.

In the basic version, the control of high-speed doors and the feedback on the status of the fire alarm system is implemented. The number of inputs and outputs for the high-speed doors can be adjusted as required.

The standard configuration for AGILOX IO with Beckhoff PLC is three output terminals and three input terminals which means 6 outputs and 12 inputs.

The standard configuration for AGILOX IO with Siemens PLC is a Siemens S7-1214C with 14 inputs and 10 outputs on board.

The AGILOX IO system, however, can handle up to 128 physical input signals and up to 32 physical output signals with correspondingly more I/O terminals or additional signal modules.

During commissioning, the correct IP address must be set on the AGILOX IO. Additional configuration (for example, at which inputs and outputs a high-speed door is connected) can be made via the AGILOX vehicles or the HMI.

To implement a fire alarm system, a 24VDC OK signal on AGILOX IO is required. Every AGILOX vehicle queries the status, as long as there is a network connection to the AGILOX IO. If the state goes to "FALSE", all vehicles stop.

The required network specifications are defined in Operation Manual, chapter [5.1.1 - IT Infrastructure and Network Technology](#).

3.1.2.5 Host Systems, Host Gateway (optional) and Assignment of Orders

There are three ways of assigning conveyance orders to an AGILOX vehicle.

Higher-level systems

One or more host systems (e.g. ERP, WMS, MES, machinery control system, etc.) will either directly broadcast drive orders or (optionally) transmit them via the AGILOX Gateway to the AGILOX system. Communication is ensured by means of a JSON interface.

Orders can be assigned via the AGILOX vehicles themselves or (optionally) via the AGILOX Gateway.

- Assignment of orders directly via the AGILOX vehicles:
Using genuine swarm intelligence, the AGILOX vehicles will manage the assignment and processing of orders within an AGILOX fleet.
The AGILOX vehicles in the AGILOX system can be accessed via office LAN as well as from within a given AGILOX network segment.
Every AGILOX vehicle is able to graphically visualize current processes and events within the AGILOX system.
- Assignment of orders via the optional AGILOX Host Gateway:
Orders can also be assigned to AGILOX vehicles via the AGILOX Gateway. Unlike AGILOX vehicles that may be temporarily switched off, the main advantage of the AGILOX Gateway is that it forms a fixed point of access within the system (fixed IP address).

Manual detection of workflows

AGILOX vehicles are able to carry out conveyance orders without higher-level systems as well. To this end, system operators can manually call up freely programmable workflows via the web interface.

Intelligent execution of routine processes

AGILOX vehicles are able to carry out conveyance orders without a host system or manual call-ups. To this end, an AGILOX vehicle will monitor the occupancy status of stations, pick up a pallet from an occupied station and convey it to a predefined destination. A classic practical example for this would be the disposal of production waste.

3.1.2.6 Charging System

Batteries are automatically charged by driving to a charging station. The vehicle is charged via a charging plate on the floor and corresponding charging contacts on the underside of the vehicle. One charging station per AGILOX vehicle is required and is included in its shipment.



The automated charging process depends on a large variety of parameters. To increase the service life of AGILOX vehicles and/or their batteries, an AGILOX vehicle may stop and remain at a charging station, however, without charging its battery. This will not impair the efficiency of the system as such a decision is made by an intelligent algorithm.

Pressing the emergency stop button will also interrupt the charging of the vehicle's battery. After eliminating the danger in question and resetting the emergency stop button, the start button needs to be pushed to be able to resume charging the vehicle's battery.

3.1.2.7 Mobile Charging Unit

During maintenance or unscheduled stops, the battery of an AGILOX vehicle can be charged conveniently by means of a mobile charging unit without any need to move the AGILOX vehicle to a stationary charging station. Each AGILOX fleet is delivered with one such charging unit.

The mobile charging unit is plugged into a power outlet (230V/16A) and connected to a charging socket installed on the AGILOX vehicle. The socket is placed underneath the middle or the side cover of the AGILOX vehicle.



To start charging the AGILOX vehicle, it has to be switched on and the emergency stop switch must not be pushed. The AGILOX System recognizes the mobile charging unit being plugged in and will automatically start charging.



No.	Description
1	Plug for Mobile Charging Unit

3.2 AGILOX Vehicle

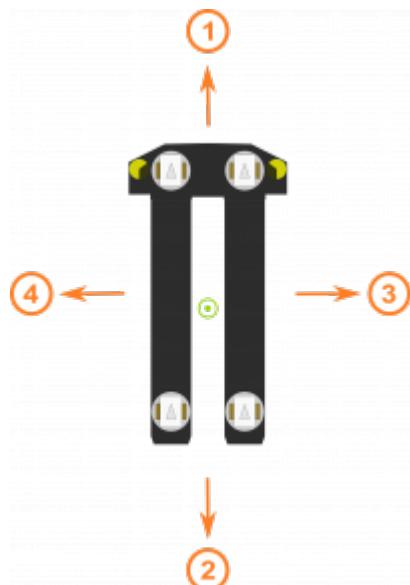
3.2.1 Description of the AGILOX Vehicle

The AGILOX vehicle is a driverless truck used to convey materials. It is equipped with a scissor lifting system for raising loads or load-handling equipment (such as pallets) from the floor and up to a height of 1000 mm. In its basic version, an AGILOX vehicle is able to convey EUR pallets. AGILOX vehicles are controlled using swarm intelligence without requiring a master computer. Orders are transmitted to the AGILOX vehicles via a WLAN system capable of intelligently distributing orders among the vehicles.

The navigation system of AGILOX vehicles does not require a fixed, installed infrastructure such as guiding tracks or magnetic points but rather uses the contours of its surroundings for this purpose. Energy is stored by LiFePo4 batteries, charged via charging contacts while the vehicles are transferring loads, thus ensuring 24/7 operation.

AGILOX vehicles use both visual and acoustic signals to alert the environment. To this end, AGILOX vehicles are equipped with an optical control system and two separate light strips mounted on each side of the vehicle as well as a sound system for emitting acoustic signals. For example, the color red stands for disturbance (continuous) or protective field violation (flashing), white for on the way with order, white blinking for a change of direction. The color blue means that the vehicle is in configuration mode. Acoustic signals can be heard during reverse or navigation problems. See Operation Manual [ANNEX II - Visual Signals](#) and [ANNEX I - Audio Signals](#) for detailed information.

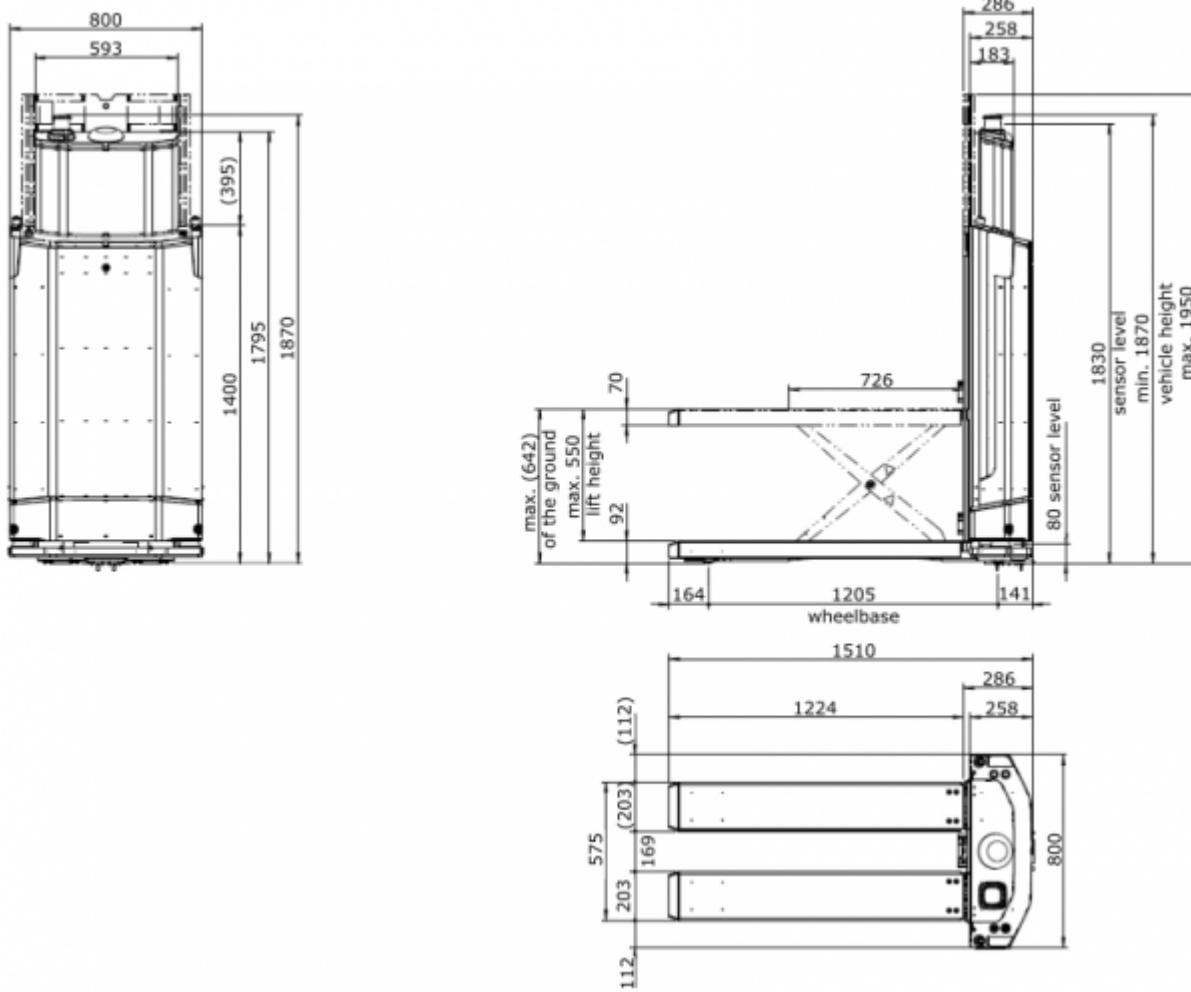
3.2.2 Direction of Travel - Definition



No.	Direction	No.	Direction
1	direction of travel (front)	3	right
2	direction of load (rear)	4	left

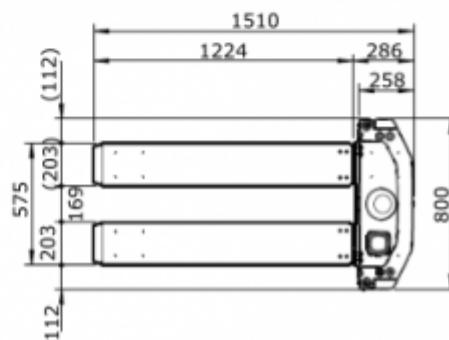
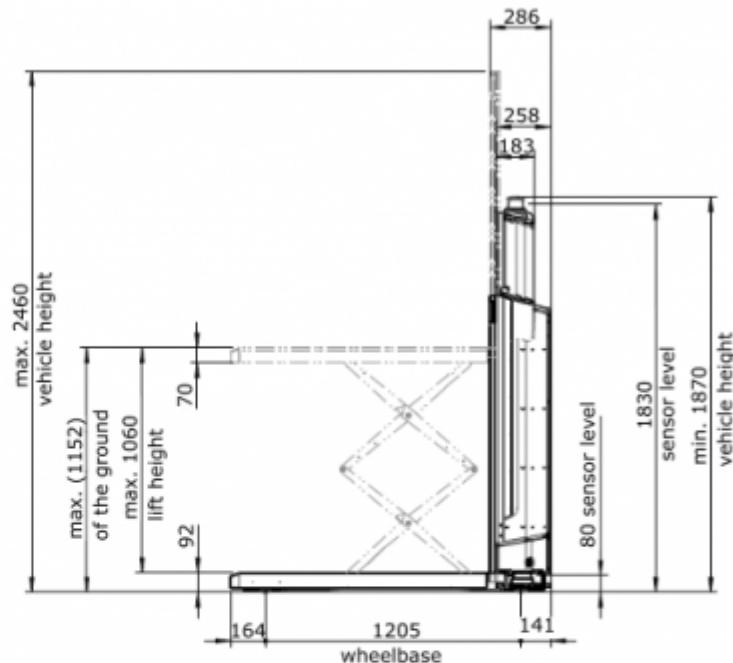
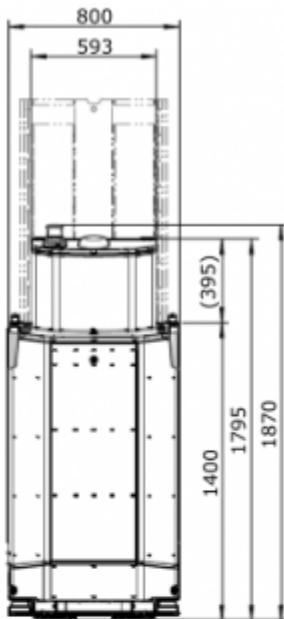
3.2.3 Dimensions

3.2.3.1 Single-Scissor Lifting System



	Dimensions			
Max. height	Lowered lifting equipment 1870 mm		Raised lifting equipment 1950 mm	
Max. width	800 mm			
Max. length	AGILOX ONE 1200 1510 mm	AGILOX ONE 1400 1710 mm	AGILOX ONE 1600 1910 mm	AGILOX ONE 1800 2110 mm
Fork width	203 mm			
Overall fork width	575 mm			
Max. lift height	550 mm (max. conveying height: 500 mm)			

3.2.3.2 Double-Scissor Lifting System (only for AGILOX ONE 1200)



Dimensions		
Max. height	Lowered lifting equipment 1870 mm	Raised lifting equipment 2460 mm
Max. width	800 mm	
Max. length	1510 mm	
Fork width	203 mm	
Overall fork width	575 mm	
Max. lift height	1060 mm (max. conveying height: 1000 mm)	

3.2.4 Control Elements on the AGILOX Vehicle



No.	Component	Function
1	Emergency stop switch	Immediate stopping of all movements
2	ON/OFF switch	Switching on the AGILOX vehicle
3	Key switch	Setting the operating mode <ul style="list-style-type: none">• Maintenance mode (key in left-hand position)• Manual operation (key in central position)• Automated mode (key in right-hand position)
4	Acknowledge pushbutton	The ACK pushbutton must be pressed whenever movements have to be carried out while the vehicle is in maintenance mode and after failures subject to mandatory operator confirmation occurred.
5	Start pushbutton	Starting the selected mode of operation Whenever failures subject to mandatory operator confirmation occur, this pushbutton must be pressed after the ACK pushbutton has been pressed, to reactivate the selected operation mode.

3.2.5 Navigation and Routing

Based on the data supplied by the laser scanner, the navigation algorithm developed by AGILOX Services Ltd. is able to calculate the current position of AGILOX vehicles within a given space. An AGILOX vehicle uses the contours of its surroundings (even highly complex ones) for a type of navigation that is exact to the millimeter. The system records contours using prominent features, points and edges within buildings and its fixtures. No reflectors are required in this process.

AGILOX vehicles are able to identify obstacles as such and bypass them provided that physical conditions and compliance with safety zones allow such a course of action.

Upon commissioning, the first AGILOX vehicle will prepare a map of its surroundings and make it available to all the other AGILOX vehicles. The basic map can be edited with simple graphic programs, e.g. to define the driving areas for the AGILOX vehicle. For example, restricted areas or preferred tracks can be parameterized graphically. So-called action areas can also be parameterized in the editor. Action areas are areas where interaction takes place. For example, the area in front of a high-speed door, where the interaction with this system is realized via the AGILOX IO.

All AGILOX vehicles of an entire AGILOX fleet are able to access the same up-to-date data pool. This means that for each fleet, a teaching/learning process is required only once as the AGILOX vehicles that are added to the AGILOX fleet later on will adopt both the configuration and the map of the first AGILOX vehicle.

Navigation is contour-based and completely independent of any fixed guiding tracks or magnetic points. Thanks to the intelligent processing of position data supplied by other AGILOX vehicles, the routing system of an AGILOX vehicle will detect dangerous situations and avoid potentially critical situations even before they occur.

3.2.6 Swarm Intelligence

The AGILOX system does not require a dedicated guidance system. The Host Gateway is merely there to receive jobs from one or more host systems and broadcast them directly into the AGILOX WLAN.

All pending drive orders are automatically distributed within the system among the AGILOX vehicles. The entire knowledge about the system, i.e. its layout, the surrounding conditions, information about stations, the current order situation, the system status of each AGILOX vehicle (e.g. its system history), is holistically distributed among all AGILOX vehicles.

If a state in the system changes as a result of the knowledge of an AGILOX vehicle, this vehicle communicates this to its surroundings, together with the new information-version. All other AGILOX vehicles, which have a lower information-version, adopt the new version. These updates are made every second continuously.

This exchange allows an AGILOX vehicle that is temporarily out of commission to be instantly up-to-date as soon as it restarts.

3.2.7 Drive Units

Each drive unit has two stepper motors propelling two drive wheels arranged opposite each other via a small gear mechanism. The entire drive unit is freely supported in its cradle and monitored by an angle sensor as to its position in relation to the overall system.

Special control algorithms permit any independent rotational and translational movement of the drive unit itself while also ensuring interacting rotational and translational changes of direction as well as movements in relation to the center of the AGILOX vehicle.

3.2.8 Load Acquisition

The AGILOX vehicle has been developed for conveying EURO pallets as well as pallets in conformity with the basic dimensions and the fork opening measurements of EURO pallets, i.e. also including plastic pallets, etc. Pallets can be picked up and delivered both from the ground and from suitable load-handling devices. Depending on the required lifting height and the vehicle type, the vehicle's lifting motions are performed by a stable double-scissor or single-scissor lifting system which can lift weights up to 1000 kg / 750 kg.

The AGILOX vehicle can automatically switch load handling equipment such as load bearing devices. For this purpose, a mechanical unit, an energy unit and a data transmission interface for defined bus systems can be integrated. A base unit for the construction of own load handling equipment is available.

The standard load bearing device is a double-container module, for the transport of 600 x 400 mm containers. The guide rails on the conveyor are adjustable and each handover-/adoption point is secured with an automatic lock.

For identification of the load, a camera system can be integrated in AGILOX vehicles, able to read a set of common, standardized QR codes as well as barcodes. The reading result can be used for a plausibility check or as a target definition in a self-sufficient system (without a host).

3.2.9 Battery

AGILOX has implemented the latest LiFePo4 battery system, characterized by excellent operational reliability. This means that thermal runaway and membrane fusion are considered impossible.

In comparison to conventional Lithium-Ion cells with lithium-cobalt (III) -Oxid (LiCoO₂) no oxygen is released, which prevents to ignite the cell under unfavorable conditions.

AGILOX batteries with integrated battery management system passed section 38.3 of the UN Manual of Tests and Criteria (UN38.3 Transportation Test).

The disadvantage of a slightly lower energy density is compensated by an intelligent charging system. The battery is charged by means of charging contacts in brief intervals, also during processes such as load acquisition. An unlimited number of charging plates can be laid; these plates are easily installed and merely require a 400V AC supply protected by a 16A fuse.

The maximum possible travel distance depends on the weight of the load concerned as well as on the characteristics of the route.



INFORMATION

For charging the battery, the AGILOX vehicle needs to be turned on and the Emergency-Stop Button must not be pushed. (An Emergency-Stop also stops the charging process)

For vehicles Version 04 and older, the battery management system is still supplied when the vehicle is turned off. This results in a discharge of the battery of around 1% a day.

3.2.10 Optional Obstacle Avoidance



CAUTION

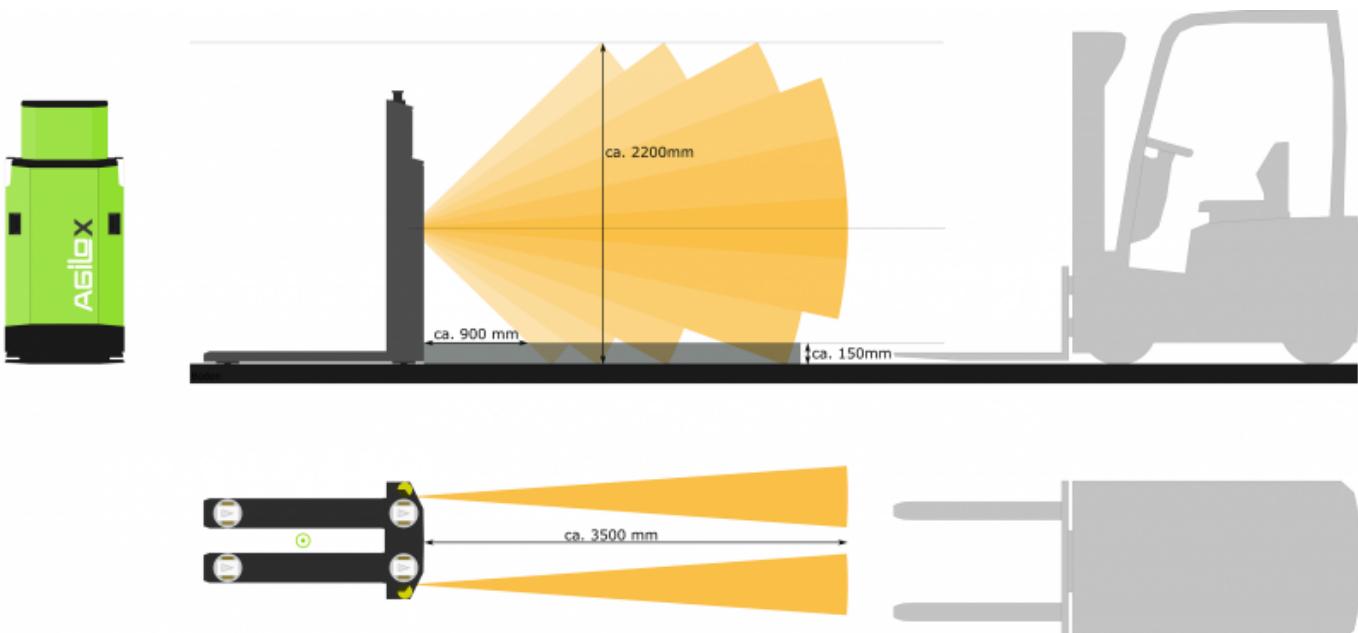
The optional Obstacle Avoidance is not part of the personal safety concept! This operation, does not guarantee collision-free operations.
Obstacles will only be detected within the monitored area.
Driving paths must be kept free of obstacles.

AGILOX vehicles can be equipped and supplied with an optional Obstacle Avoidance system that, apart from the person detection safety features required by law, is also able to identify obstacles up to the full height of the vehicle provided that they meet certain criteria. In order to avoid accidents involving your vehicles, please consult the manufacturer, if you have any doubts whether your vehicles are equipped with such a system. While the driving path still needs to be kept clear of obstacles, a basic Obstacle Avoidance system can be installed. This system, however, does not guarantee collision-free operations, and obstacles will only be detected within the monitored areas.

3.2.10.1 Optional Obstacle Avoidance

The sensor system allows monitoring at half the vehicle's height both on the left and the right of the vehicle. Its vertical field of vision covers 90° (45° upwards and 45° downwards). The sensors are mounted on the two exterior sheet metal panels about 10 cm inwards from their outer edges. The horizontal field of vision covers 8° (4° on the left and 4° on the right).

The lower 150mm are ignored by the system due to robustness against different floor conditions. At the top the monitoring range is limited to 2200mm.



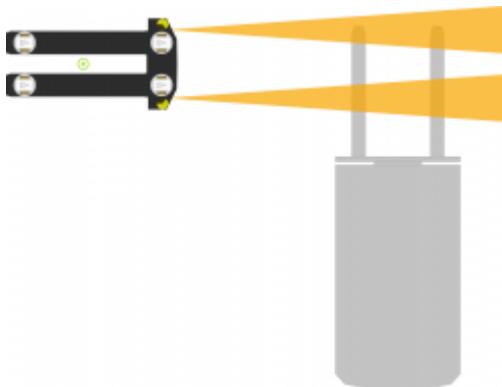


NOTICE

The lower 150mm are ignored by the obstacle avoidance system to be robust against different floor conditions.

Obstacles <150 mm therefore do not trigger a stop. This can lead to collisions!

Driving paths must be kept free of obstacles!



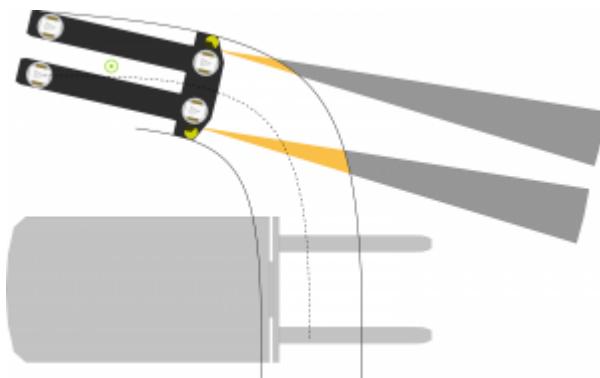
The vehicle monitors the entire braking distance +1000 mm when moving in a straight line. Whenever an object is detected within this monitored range, an emergency stop (not subject to mandatory operator confirmation) will be triggered and "Obstacle" can be read on the navigation scanner. After such an emergency stop has been triggered, there should be sufficient space between the vehicle and the object concerned so that it is still within the field of vision of the sensor system.

If an obstacle appears suddenly or is coming closer and shortens the braking distance, an emergency stop is triggered and the start button lights up. "Collision Avoidance" can be read on the navigation scanner and the start/confirm button needs to be pushed to continue.

In all cases, the vehicle will remain at a standstill as long as the relevant obstacle remains within the sensor system's field of vision. The vehicle will resume its journey after 5 seconds as soon as an obstacle disappears or cannot be detected any longer. The vehicle will initially move at 0.1 m/s for the first 10 seconds to ensure that any obstructions will be hit only lightly.

When making turns, the required space of the AGILOX vehicle is calculated and monitored. If an obstacle is detected within the monitoring area (yellow area), the vehicle behaves as when driving straight ahead.

Obstacles outside the curve (grey area) are ignored. Due to physical limits, turns can only be monitored to a limited extent and are therefore only partially monitored for collisions.

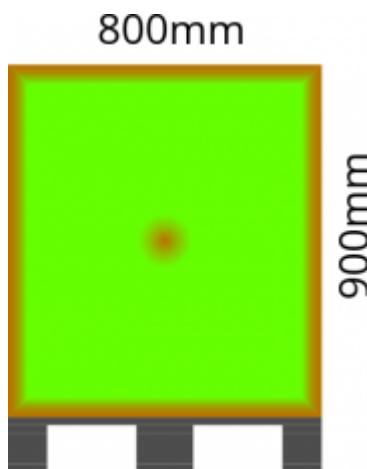


When driving in a straight line, the vehicle's sensor system will also monitor the ground. As soon as it detects floor levels below the current driving plane, it will trigger an emergency stop; in such cases, manual confirmation by an operator is required before the vehicle can resume its journey.

3.2.11 Optional Detection of Barcodes

Before the fork of an AGILOX vehicle is inserted below a pallet, a camera mounted on the back of the fork will be activated and begin to optimize light conditions. The fork is then continually inserted below the pallet until the front of the pallet (facing the AGILOX vehicle) reaches its optimum distance to the camera (focus and width: 800 mm). The AGILOX vehicle is able to automatically illuminate the front of the pallet to ensure barcode recognition as independently of its surroundings as possible. Direct sunlight or intense backlight, however, cannot be compensated and will interfere with the camera's illumination functionality. The vehicle will be briefly stopped for image acquisition purposes before the fork is finally inserted. As soon as the image has been acquired, it will be processed and the barcode will be extracted. All barcodes recognized by the system are saved in the relevant order and will be available for all subsequent processes.

Barcodes will be recognized on the fork insertion side within a range of W = 800 mm x H = 900 mm above the upper edge of EURO pallets. For tolerance reasons, the outer 50 mm should be avoided on all sides. 200 mm x 200 mm are to be avoided within the center of recognition to avoid recognition failures due to reflection.



The system currently supports Code 39, Code 128, 2/5 Interleaved, QR Code and Datamatrix barcode types. For Code 128, the system additionally detects if it is a GS1 barcode (former EAN-128/RSS) or not. Using Code 39 is not recommended as error identifiers are possible due to a lack of check routines. 2/5 Interleaved is captured without a checksum.

Module sizes:

- Code 39: min. 0,75 mm, max. 3mm
- Code 128: min. 0,75 mm, max. 3mm
- 2/5 Interleave: min. 0,75 mm, max. 3mm
- QR-Code: min. 2,00 mm, max. 10mm
- Datamatrix: min. 2,00 mm, max. 10mm

Smaller module sizes may be accommodated under ideal conditions. All barcodes have to be arranged vertically or horizontally, with a maximum permissible skew of 10°.

The following criteria are required to ensure successful recognition:

- Either no backlight or the backlight is completely obstructed by the pallet
- No direct sunlight on the fork insertion side
- No outside spotlights on the fork insertion side
- Black barcode on a white background, matte (non-reflecting)
- Not too big contrast ratio between barcode label and loading

3.2.12 Optional Weight Monitoring

As an option, strain gauges can be installed as additional load monitoring. The weight of the load is monitored. A change in weight is only allowed if the lift moves. The weight value is stored after each lift movement and when the blue button is pressed. If the currently measured value deviates from the stored value by more than approx. 25kg, an error message is triggered which must be acknowledged via the "ACK button". This monitoring only works with a lifting height of 20mm or more.

The monitoring can also be used to detect persons riding on the vehicle. For this purpose the standard lifting height must be set to at least 25mm.

3.2.13 Optional Floor Spot

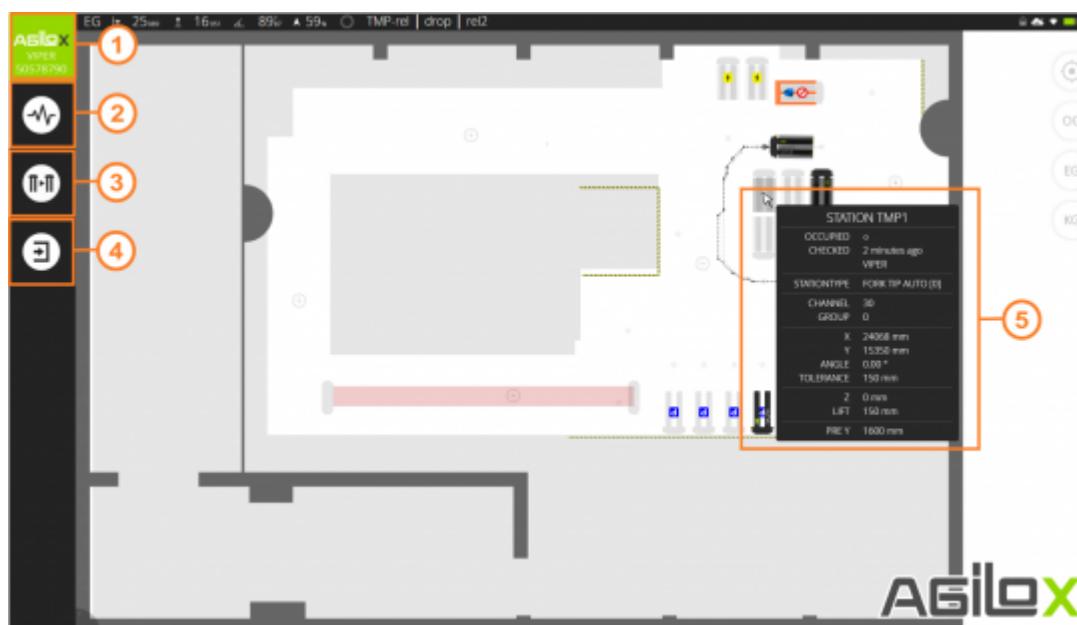
As an additional safety feature for people in the movement area, a LED spotlight can be installed on the AGILOX vehicle. The floor spot produces a light beam that displays as a dot on the floor in front of the AGILOX vehicle. The dot can be red, green or blue depending on the specifications and visually alerts people that there is an AGILOX vehicle approaching.

3.2.14 Optional Fork Lights

As an additional safety feature for people in the movement area, additional lights installed on the fork tips of the AGILOX vehicle signal changes of direction by flashing on the appropriate side of the AGILOX vehicle. Depending on the specifications, the lights can be yellow or white.

3.3 AGILOX User Interface (HMI)

The AGILOX user interface is used to start up and control the AGILOX vehicle. This interface can be called up independently of any terminal device, leaving system operators free to decide whether they wish to use a computer, a tablet or a smartphone. The AGILOX user interface has been designed as a web application which means that any terminal device only needs to be linked to the same WLAN segment as the AGILOX vehicle. To ensure smooth operation, a terminal device with a current operating system as well as a web browser is required.



See <https://youtu.be/31LTgULII8U> for walkthrough the hmi and Operation Manual chapter [6.2.2 - AGILOX User Interface Overview](#) for detailed information.

3.3.1 AGILOX HMI Security

3.3.1.1 Browser / Client

It is possible to install certificates in the AGILOX HMI. This encrypts the connection between an AGILOX and a client at the customer (smartphone or PC). Certificate and private key must be provided by the customer's IT department. The certificate must be resolved by the DNS server at the customer to the local IP of the AGILOX in order to establish a valid HTTP's connection.

3.3.1.2 Logging

Each AGILOX is equipped with a logging system. This ensures the traceability of actions of local AGILOX users (operating personnel, service technicians). These data are stored exclusively locally and can be evaluated by AGILOX North America, Inc. as required.

Note: The log data is stored in a FIFO procedure and, depending on the operating times of an AGILOX, goes back from a few weeks to several months.

3.3.1.3 Wi-Fi

The connection between several AGILOX systems or to a higher-level customer system takes place via a WLAN infrastructure. Current security standards require a Wi-Fi Protected Access 2 (WPA2) connection (provided by the customer).

WPA2 is based on the Advanced Encryption Standard (AES) and meets safety regulations for the exchange of data with FIPS 140-2. WPA2 addition, an 802.1X-based WLAN authentication (certificate-based among other things) possible. The corresponding certificates are to be provided by the customer.

All algorithms of the Linux WPA / WPA2 / IEEE 802.1X supplicant will be supported at 01.09.2017 (details see https://w1.fi/wpa_supplicant/).

An AGILOX fleet requires that the WLAN network is exclusively available (explicit SSID). Within the encrypted WPA2 network, data is partially transmitted through additional cryptographic measures at the application level.

3.3.1.4 Authentication

The AGILOX user interface requires the authentication of users wishing to actively influence the behavior of an AGILOX system. Upon commissioning, an admin-user will be created for the customer which can be used to operate AGILOX vehicles and manage other users.

3.3.1.5 Role-Based Access Control - Authorization

User access is managed within the AGILOX user interface by means of a role-based access concept.

Each user is assigned a certain role with corresponding rights. Four roles have been implemented, with higher-level roles also possessing the same rights as lower-level ones. Furthermore, higher-level users may also manage lower-level users.

Authorization Levels

Role	Authorization
VIS	Use of visualization and display of AGILOX vehicle information
WORKER	In addition to VIS rights: tasking of AGILOX vehicles, manual control, display order list, pause vehicle
LEADER	In addition to WORKER rights: station entering in manual control, Force local positioning, cancel orders
ADMIN	The highest authorization level. An ADMIN can add and delete stations, modify the area of movement, add new users and everything described in the commissioning manual

3.4 Optional AGILOX Analytics

3.4.1 General Information

AGILOX Analytics can be reached by opening the webpage: <https://my.agilox.net>

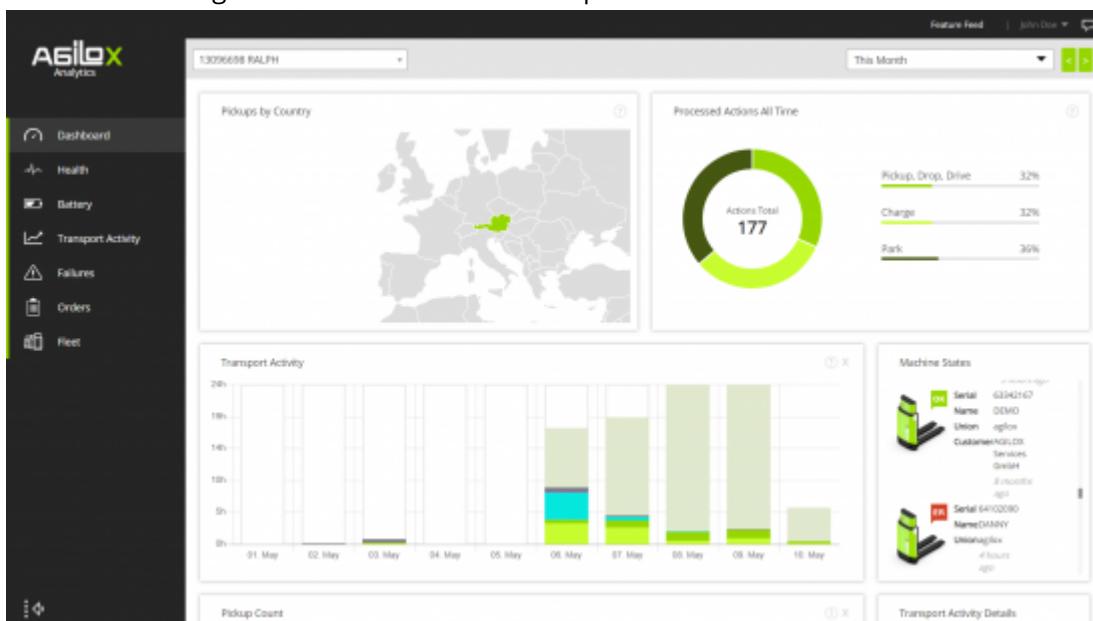


The LTE modem of every AGILOX vehicle continuously transmits vehicle data (status, order situation, etc.) to the AGILOX Analytics System.

As soon as the AGILOX Analytics functionality has been activated, all AGILOX systems are subject to a data analysis system. After an access to AGILOX Analytics has been requested, an e-mail is received including a link for changing the password for the login. After setting the password, the login works by using the e-mail address and the new password.

The dashboard can be customized and displays all important figures regarding the AGILOX system. Widgets can be added and removed from the dashboard by clicking the symbol on top of the widget. The menu bar on the side allows the navigation through the menu. The little question mark on top of every widget shows a short explanation about it in a tooltip. Tooltips show all information needed, which makes AGILOX Analytics self explaining.

The menu bar on top allows to choose data of a different AGILOX vehicle as well as the timeframe for the data. User Settings can also be made on the top.



3.4.2 AGILOX Analytics Security

3.4.2.1 Private APN

The connection of an AGILOX vehicle to AGILOX Analytics as well as the connection of the Life Time Service Team to an AGILOX unit takes place via a UMTS / LTE connection in a private APN network. A private APN network is a closed network area in the global network of our service partner T-Mobile, which can only be reached for AGILOX systems, AGILOX Analytics, and service systems of AGILOX North America, Inc..

This system significantly reduces the attack vector since third parties have no ability to establish active network connections to the AGILOX private APN network.

An exclusive peer-to-peer connection between an AGILOX system and AGILOX Analytics is consequently in use.

3.4.2.2 Browser/Client

The transport encryption between the user (browser) and AGILOX Analytics takes place via TLS. This connection, at the application level, complies with the current standard of security. TLS 1.2 (formerly SSL) certificates, RSA keys with 4098 bits and SHA256 as a hashing algorithm are used. The use of TLS certificates ensures that manipulation of data during transmission is not possible, that the identity of the server is guaranteed to the user and that data cannot be read by third parties.

The connection between the AGILOX North America, Inc. and an AGILOX DTS at the customer (for service purposes) takes place according to current safety standards by means of SSH (Secure Shell) protocol. In addition, there are secure passwords (at least 10 characters, alphanumeric, special characters) or private / public key authentication with min. 4096 bit RSA key length for use.

3.4.2.3 AGILOX Remote Maintenance

The connection between AGILOX North America, Inc. and an AGILOX AGV at the customer (for maintenance reasons) takes place according to the latest security standards via SSH (Secure Shell) protocol. To this end safe passwords (min. 10 characters, alphanumeric, special characters) or private/public key authentication with min. 4096 bit RSA key length are used.

3.4.2.4 Backend Code Security

On the server side, AGILOX Analytics was implemented with a security architecture with best practice security measures (password hashing, central input filters, prepared statements, etc.). In addition, hardened operating systems are in use on the servers. Redundant design of critical components ensures high availability.

3.4.2.5 Logging

AGILOX Analytics implements a logging system that records accesses from AGILOX machines or users. This ensures the traceability of all actions taken by client systems on the server.

3.4.2.6 Authentication

The authentication takes place via an email / password combination.

Initially, AGILOX North America, Inc. creates a user in AGILOX Analytics. The user will receive an e-mail from the system containing a unique link to the platform. With this link, the new user can set their password (at least 8 characters, alphanumeric, special characters) and then log on to the system.

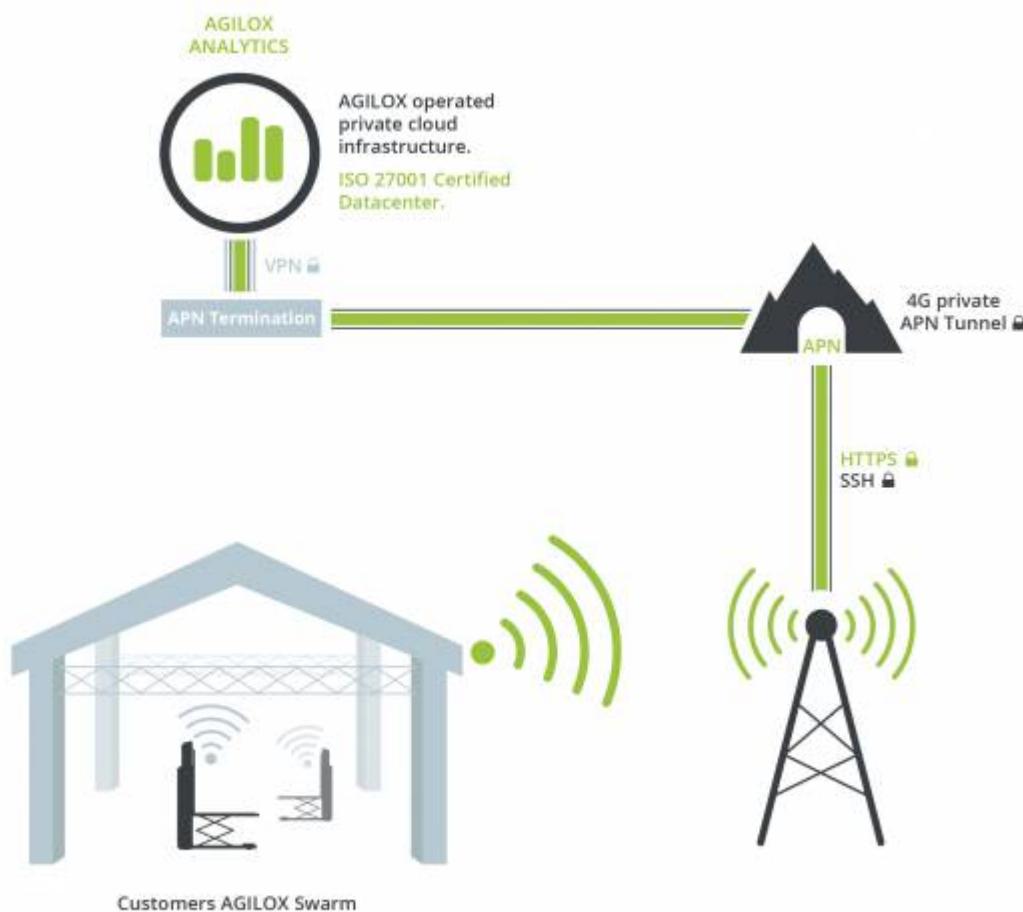
3.4.2.7 EU Data Protection

The storage of personal data at AGILOX Analytics occurs according to European data protection law. The transferred data are stored exclusively on servers in the European Union. Current server location is Linz (Austria), the data is processed in ISO 27001:2013 certified computer centers.

3.4.3 AGILOX Analytics Data Transfer

3.4.3.1 Infrastructure

All data processing and the provision of the web interface of AGILOX Analytics for the customer is carried out on hardware which is operated and maintained by AGILOX Services Ltd.. Server location is Linz / Austria. The connection to the AGILOX systems in the field is made via a private APN 3G/4G connection. It is terminated in Vienna at the connectivity provider Magenta (formerly T-Mobile). There is a VPN connection between the data centers of Magenta and AGILOX.



3.4.3.2 Private APN

The connection of an AGILOX system to AGILOX Analytics as well as the connection of the Life Time Service Team to an AGILOX system takes place via a UMTS / LTE connection in a private APN network.

A private APN network is a closed network area in the global network of our service partner Magenta (formerly T-Mobile), which can only be reached for AGILOX systems, AGILOX Analytics, and service systems of AGILOX Service Ltd..

This system significantly reduces the attack vector since third parties have no ability to establish active network connections to the AGILOX private APN network.

An exclusive peer-to-peer connection between an AGILOX system and AGILOX Analytics is consequently in use.

3.4.3.3 Data Transfer from AGILOX Analytics to AGILOX System

Port TCP/22 is used to create a tunnel for an HTTPS connection (TCP/443). This HTTPS connection is used by the AGILOX support team to access the AGILOX HMI to support the customer when solving problems. Over-the-air updates are also possible via this connection, always in consultation with the customer. The access is logged in our systems.

3.4.3.4 Data Transfer from AGILOX System to AGILOX Analytics

The AGILOX system transfers data to the AGILOX Analytics via HTTPS (TCP/443).

The transferred data is used to create performance reports which can be viewed by the customer in AGILOX Analytics. In addition, the transferred data helps the AGILOX support team to analyze problems.

The following data is currently transmitted once per hour, provided a connection exists:

- **Black Box Data:** Every second, an AGILOX vehicle records about 200 sensor values and stores them as binary blobs. In general, these binary data are compressed every hour and transmitted to the AGILOX Analytics.
Examples values are position x, position y, operation mode, battery cell voltage, state of buttons and switches, motor angles, etc.

Example:

17	24	SOC / IVI (signed short)
18		rotation drive unit front left
19		rotation drive unit front right
20		rotation drive unit rear left
21		rotation drive unit rear right
22	0	emergency stop
22	1	maintenance
22	2	manual
22	3	automatic
22	4	lamp quit
x	5	button quit
22	6	lamp start
22	7	button start
22	8	du_fl_recovery
22	9	du_fr_recovery
22	10	du_rl_recovery
22	11	du_rr_recovery

- **Order Data:** Executed orders/workflows that have been processed by an AGILOX vehicle are transferred to AGILOX Analytics.

Example: An excerpt from this dataset organised as a JSON structure: JSON structure describing an order/workflow.

```
{  
    "id": "xxxxxxxx2064070000",  
    "action": [  
        {  
            "action": "charge",  
            "target": [],  
            "stations": [  
                {  
                    "start": 1600809475,  
                    "station": "Charge1",  
                    "end": 1600809678  
                }  
            ]  
        },  
        {"priority": 0,  
        "type": "charge",  
        "workflow_name": "PLANCHARGE",  
        "recipient": {  
            "serialnumber": [  
                "xxxxxxxx"  
            ]  
        },  
        "serialnumber": "xxxxxxxx",  
        "loadcarrier": {  
            "width": 0,  
            "length": 0  
        },  
        "fork_length": false,  
        "status": 99,  
        "version": 26,  
        "timestamp": 1600809678,  
        "created": 1600809475,  
        "telemetry": {  
            "start": {  
                "distance": 1593994747,  
                "angle": 808138779,  
                "operatingtime": 25739340.04,  
                "carrier": 0,  
                "charge": 1022367.04,  
                "batterylevel": 78,  
                "position": [  
                    17283,  
                    226758,  
                    55859,  
                    10,  
                    28.  
                ]  
            }  
        }  
    ]  
}
```

3.4.3.5 Data Transfer and Swarm Intelligence

AGILOX systems within the same union have the possibility to transfer data of the whole swarm. If an AGILOX vehicle is moving in an area where LTE reception is not available, another AGILOX system in the swarm transmits the data for this one. However, remote support for an AGILOX vehicle outside the reception area is only possible to a very limited extent.

4. Transport and Shipping

All transport and shipping activities are required to fulfill the requirements defined in VDI 2700 and VDI 2703 standard created by "The Association of German Engineers (VDI)", titled as "Securing of loads on road vehicles - Securing of skips on skip loader vehicles and their trailers".

All packages must be handled with care and must be prevented from slipping or tipping over at any time during transportation.

AGILOX batteries with integrated battery management system passed section 38.3 of the UN Manual of Tests and Criteria (UN38.3 Transportation Test).



CAUTION

Risk of burns and fire due to faulty batteries

Transport damage may result in battery short circuits and cause burns, fire and damage to the electrical system.

- Be sure to comply with the warnings on the vehicle's shipment packaging
- Be sure to inspect the vehicle's shipment packaging



WARNING

Risk of falling

Risk of falling from transporting trucks due to slipping, tripping or falling which may lead to severe injuries.

- The AGILOX vehicle must only be unloaded by specialist staff
- Use appropriate fall-arresting equipment when climbing on the truck
- Take special care when fastening the load



WARNING

Risk of crushing

Crushing injuries on the body, feet and hands may occur as a result of the AGILOX vehicle accidentally rolling away.

- Please be mindful of the maximum allowable floor gradient

The following transport requirements must be observed:

- Pull the key from the key switch and press at least one of the two emergency stop switches
- Shut off all manual switch fuses
- The lifting forks of the AGILOX vehicle must be in their lowermost position during transport
- The vehicle has to be loaded and unloaded from the transport truck using a suitable forklift truck or crane. Be sure to use the designated attachment point.
- Only the lifting tackle supplied together with the vehicle must be used
- During loading or unloading operations involving sloped surfaces, the AGILOX vehicle must be properly secured against accidentally rolling away by suitable means

4.1 Unloading the AGILOX Vehicle



WARNING

Risk of injury resulting from raised load

Severe injuries may occur during unloading due to the load falling over or dropping.

- The AGILOX vehicle must only be unloaded by specialist staff
- Use appropriate personal protective equipment (hard hats and safety gloves)
- Only suitable transport structures (pallets, etc.) must be used
- Be sure to take the specified weights into account
- Only the material (rope) supplied together with the vehicle must be used for lifting
- Be sure to secure the load to be transported to the operating site while in transit
- Be sure to check all transport securing devices
- Be mindful of the load's center of gravity

The AGILOX vehicle will be shipped and delivered in a shipment box equipped with suitable transport securing devices by a forwarding agent. AGILOX vehicles must only be unloaded by specialist staff using suitable transport structures. One AGILOX vehicle including the shipment box it comes in weighs 630 kg.



WARNING

Risk of injury resulting from raised load

The center of gravity of the vehicle's shipment box is not centrally aligned. Accidents resulting in severe injuries may occur if this fact is ignored.

- Be mindful of the center of gravity of the shipment box and study the information given on its packaging

AGILOX vehicles damaged during transport or shipment **must not** be put into operation.

Unloading and storage requirements

Shipping box dimensions: 1870 x 980 x 1950 mm (L x W x H)

Temporary storage

AGILOX vehicles must not remain in temporary storage for a period exceeding one month. The environmental conditions specified in the corresponding table (reference [2.3.3 - Environmental Conditions within the Area of Movement](#)) must be complied with whenever AGILOX vehicles are stored temporarily. Shipment boxes must be stored in dry conditions.

4.2 Unpacking the AGILOX Vehicle

As a general principle, AGILOX vehicles will always be unpacked by the commissioning team employed by AGILOX North America, Inc.. Unpacking means that the AGILOX vehicle needs to be lifted from its shipment box.

1. Open transport casing lid and side wall according to picture



2. Remove all separately packed parts
3. Remove crossbar on top (1) and transport securing devices (2)



4. Fasten lifting tackle (shackle and round sling included in the shipment) to the appropriate attachment point on the back of the fork
5. Carefully raise the AGILOX vehicle by means of suitable lifting equipment



6. Pull box from under the AGILOX vehicle
7. Place AGILOX vehicle on the floor
8. Mount separately shipped parts (e.g. Navigation scanner)

4.3 Storage of AGILOX Vehicle and Spare Parts

4.3.1 AGILOX Vehicle

In case of long offline times, it is recommended to put the AGILOX Vehicle in a storage condition:

- make sure the AGILOX Vehicle is in a parking station or charging station
- shut off all manual switch fuses
- [Environmental conditions](#) need to be met also during storage

4.3.2 Battery

Please refer to the Battery Safety Data Sheet regarding the storage of batteries

- Store spare batteries in a cool, well ventilated room.
- Keep away from direct sunlight.
- Keep away from high humidity and water.
- Do not short-circuit.
- Observe recommended storage temperature: -40°C up to +60°C.
- Do not store battery together with flammable, oxidizing or acidic substances.

4.4 Repacking the AGILOX Vehicle

Please contact AGILOX North America, Inc. (support@agilox.net) if an AGILOX vehicle needs to be repacked and shipped to clarify the details of the return shipping process.

5. Commissioning

An AGILOX system is commissioned in several steps. Commissioning tasks must only be carried out by qualified staff. See [1.5 - Target Group](#) for the appropriate qualifications specified for such staff. System operators need to perform a number of tasks before the commissioning process can begin. Only then can the commissioning team employed by AGILOX North America, Inc. or its system partner start performing the required commissioning activities.

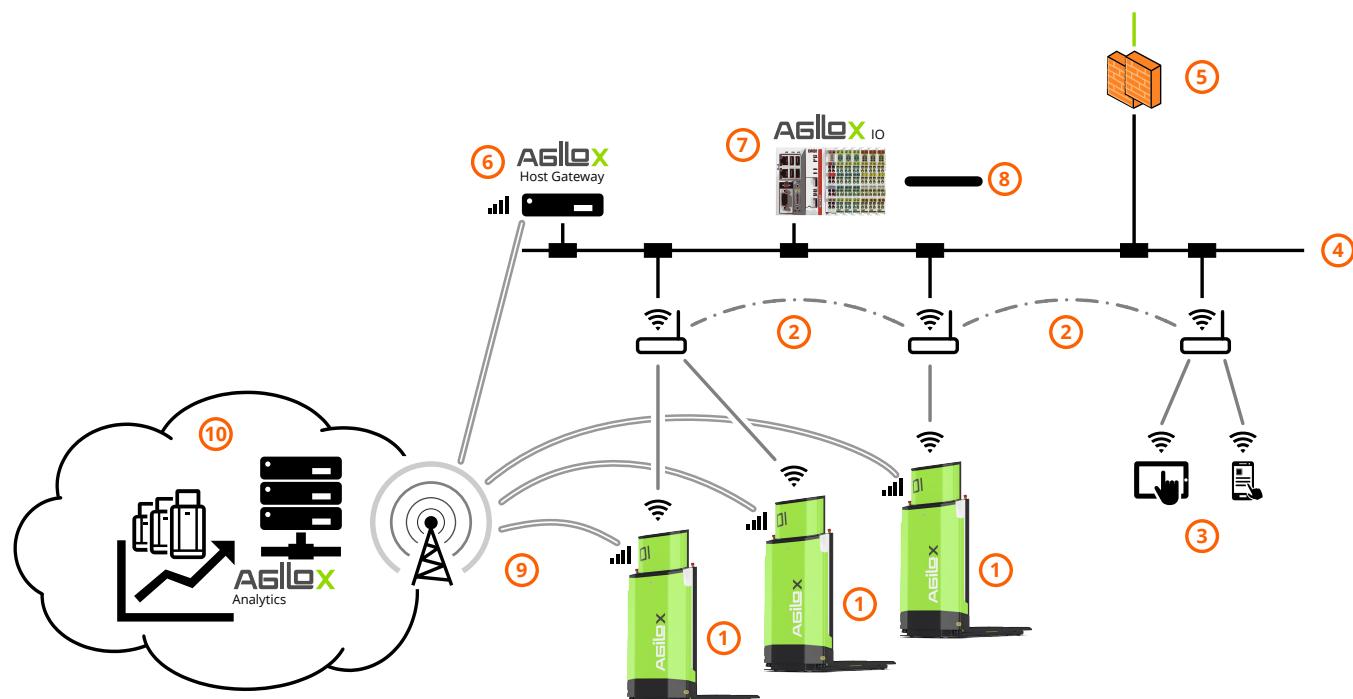
System operators need to implement the following preparatory measures:

- Provide the required IT infrastructure and network technology
- Ensure the specified environmental conditions
- Install the charging station(s)
- Prepare the interface
- Install the AGILOX IO (optional)

5.1 Measures to be Implemented by System Operators

5.1.1 IT Infrastructure and Network Technology

System operators must ensure that the required IT infrastructure and network technology is made available to the AGILOX system. System operators remain proprietor and operator of the IT infrastructure.



No.	Description	No.	Description
1	AGILOX Vehicle	6	AGILOX Host Gateway (<i>AGIPC, optional</i>)
2	WLAN Infrastructure (<i>provided by customer</i>)	7	AGILOX IO (<i>AGIO, optional</i>)
3	Handheld operating device (<i>provided by customer</i>)	8	Input / Output Signals
4	AGILOX LAN (<i>provided by customer</i>)	9	AGILOX M2M Communication (<i>optional</i>)
5	Firewall (<i>provided by customer</i>)	10	AGILOX Analytics (<i>optional</i>)

5.1.1.1 WLAN Infrastructure

Supported Wireless Standards

IEEE802.11 a/b/g/n/ac compliant 2.4GHz/5GHz.

Net Throughput Rate

The required minimum **net throughput rate** of wifi must equal or more than:

Net Throughput Rate = 0,8MBit/s * n * m, with

n representing the number of AGILOX Vehicles in the UNION and

m representing the number of AGILOX Vehicles concurrent connected on the same WiFi Access Point.

Calculated net throughput rate in **MBits/s**, depending on (**n**) number of AGILOX Vehicle in the UNION and (**m**) number of AGILOX Vehicles concurrent connected on the same WiFi Access Point.

	m																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
n	1	0,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	2	1,6	3,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	3	2,4	4,8	7,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	4	3,2	6,4	9,6	12,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	5	4,0	8,0	12,0	16,0	20,0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	6	4,8	9,6	14,4	19,2	24,0	28,8	-	-	-	-	-	-	-	-	-	-	-	-	-	
	7	5,6	11,2	16,8	22,4	28,0	33,6	39,2	-	-	-	-	-	-	-	-	-	-	-	-	
	8	6,4	12,8	19,2	25,6	32,0	38,4	44,8	51,2	-	-	-	-	-	-	-	-	-	-	-	
	9	7,2	14,4	21,6	28,8	36,0	43,2	50,4	57,6	64,8	-	-	-	-	-	-	-	-	-	-	
	10	8,0	16,0	24,0	32,0	40,0	48,0	56,0	64,0	72,0	80,0	-	-	-	-	-	-	-	-	-	
	11	8,8	17,6	26,4	35,2	44,0	52,8	61,6	70,4	79,2	88,0	96,8	-	-	-	-	-	-	-	-	
	12	9,6	19,2	28,8	38,4	48,0	57,6	67,2	76,8	86,4	96,0	105,6	115,2	-	-	-	-	-	-	-	
	13	10,4	20,8	31,2	41,6	52,0	62,4	72,8	83,2	93,6	104,0	114,4	124,8	135,2	-	-	-	-	-	-	
	14	11,2	22,4	33,6	44,8	56,0	67,2	78,4	89,6	100,8	112,0	123,2	134,4	145,6	156,8	-	-	-	-	-	
	15	12,0	24,0	36,0	48,0	60,0	72,0	84,0	96,0	108,0	120,0	132,0	144,0	156,0	168,0	180,0	-	-	-	-	
	16	12,8	25,6	38,4	51,2	64,0	76,8	89,6	102,4	115,2	128,0	140,8	153,6	166,4	179,2	192,0	204,8	-	-	-	
	17	13,6	27,2	40,8	54,4	68,0	81,6	95,2	108,8	122,4	136,0	149,6	163,2	176,8	190,4	204,0	217,6	231,2	-	-	
	18	14,4	28,8	43,2	57,6	72,0	86,4	100,8	115,2	129,6	144,0	158,4	172,8	187,2	201,6	216,0	230,4	244,8	259,2	-	
	19	15,2	30,4	45,6	60,8	76,0	91,2	106,4	121,6	136,8	152,0	167,2	182,4	197,6	212,8	228,0	243,2	258,4	273,6	288,8	
	20	16,0	32,0	48,0	64,0	80,0	96,0	112,0	128,0	144,0	160,0	176,0	192,0	208,0	224,0	240,0	256,0	272,0	288,0	304,0	320,0

Example of net throughput rate for WiFi standards

WiFi standard	net throughput rate [MBits/s]
WLAN 802.11b	1,0 to 4,4
WLAN 802.11a	5,0 to 25
WLAN 802.11g	5,0 to 25
WLAN 802.11n (WiFi 4)	5,0 to 240
WLAN 802.11ac (WiFi 5)	5,0 to 433



NOTICE

Swarm coordination is directly dependent on a stable wlan connection with wide enough bandwidth

If latencies rise above 250ms or individual bandwidth drops below the minimum throughput, it will lead to following problems:

- Wait time before driving to stations or taking orders
- Two vehicles getting too close to each other
- Deadlocks
- Collisions
- Unexpected Behavior

AGILOX recommends following WLAN configuration (best practice)

- **WiFi Standard:** WLAN 802.11ac (WiFi 5)
- **Roaming:** 802.11r (FT / FastTransition)
- **Security:** if EAP should be used, EAP-TLS is to be preferred (EAP-PEAP should be avoided if possible)

Security

Encryption via WPA2 – AES-CCMP PSK. WPA2 is based on the Advanced Encryption Standard (AES) and meets the data exchange security requirements according to FIPS 140-2 or 802.1X-based WLAN authentication (including certificate-based authentication). AGILOX supports all algorithm of the Linux WPA/WPA2/IEEE 802.1X Supplicant valid as of February 1, 2020 (see https://w1.fi/wpa_supplicant/ for details).

SSID

Ideally, AGILOX vehicles are operated with a dedicated SSID and/or VLAN isolated from the rest of the network. Access to and from this VLAN can so be limited by a firewall.

Infrastructure components

The AGILOX vehicle has a built-in Intel 8265 WiFi module.

Communication

Every AGILOX vehicle transmits UDP broadcasts sporadically to detect other vehicles and systems in the network automatically. This type of communication must be possible even over several access points. For the communication between AGILOX and external or assigning systems following ports need to be opened. Communication within VLAN should be possible unrestrictedly, for the sake of completeness these ports are also listed below (AGILOX ↔ AGILOX).

Port	Protocol	Direction of communication	Usage
80	TCP	Customer → AGILOX	AGILOX web interface
443	TCP	Customer → AGILOX	AGILOX web interface SSL (optional to port 80)
8100	TCP	Customer → AGILOX	AGILOX web service (order and state interface)
8443	TCP	Customer → AGILOX	AGILOX web service SSL (order and state interface, optional to port 8100)
123	UDP	AGILOX → Customer	NTP (Network time protocol) for synchronization of time between customer network and vehicles (optional, if NTP server is indicated)
8001	TCP	AGILOX → AGILOX IO	AGILOX communication with AGILOX IO for the connection of external systems (doors, conveyors, sensors, ...)

Intra-VLAN Communication

8100	UDP	AGILOX ↔ AGILOX	AGILOX Discovery Broadcast (to automatically detect other AGILOX vehicle in the network)
8443	TCP	AGILOX ↔ AGILOX	AGILOX web service for swarm communication (AGILOX to AGILOX)
	ICMP	AGILOX ↔ AGILOX	Ping between vehicles (optional)
123	UDP	AGILOX ↔ AGILOX	NTP (Network time protocol) for synchronization of time between vehicles

IPv6

IPv6 is not supported.

Roaming

AGILOX vehicles require a network as instantaneous and interruption-free as possible. Therefore AGILOX supports modern roaming methods according to 802.11r/k/v (FastTransition) as well as roaming on client side via cyclical scanning of the WLAN environment. The WLAN infrastructure must be available interruption-free on all driving areas and ideally support fast roaming methods.

IP Addressing

IP addresses can be assigned static or via DHCP to the AGILOX vehicle.



NOTICE

The net segments 10.99.0.0/24 and 10.98.0.0/24 must not be used by the customer.

5.1.1.2 Handheld operating device for the AGILOX User Interface

For commissioning and manual operation of AGILOX vehicles, the AGILOX system requires an off-the-shelf terminal device (e.g. a smartphone or tablet). Such terminal devices have to be purchased by the system operator and are not included in the scope of delivery of the AGILOX system.

Requirements for terminal devices:

- WLAN-enabled
- Minimum screen diagonal of 5 inches
- Equipped with a web browser with a Blink rendering engine (Google Chrome, Chromium), 2017 release (preferably Google Chrome)
- Only limited support for devices running on the iOS (Apple) operating system

5.1.1.3 AGILOX LAN including Firewall

The connection between several AGILOX systems is to be ensured via a WLAN infrastructure. In order to be able to operate, the AGILOX system requires its own network segment to be provided by its operator.

Appropriate firewalling must be provided to ensure security.

AGILOX vehicles tasked via a higher level system must be able to access the corresponding network segment. Similarly, optional peripheral systems such as the AGILOX IO or the AGILOX Host Gateway have to be capable of communicating with this network concept as well. Additionally, one or more roaming-enabled access points have to be assigned to the segment. The AGILOX System uses Intel network cards.

5.1.1.4 AGILOX M2M Communication (optional when using the AGILOX Analytics system)

The link between AGILOX systems and the AGILOX Analytics System as well as between AGILOX North America, Inc. and AGILOX vehicles for servicing purposes is ensured by a LTE connection in a **private APN network**.

Communication is ensured via the LTE net (mobile radio data transmission). In buildings with a known weak mobile phone reception, a suitable LTE network must be available to guarantee faultless use of this feature.

5.1.2 Environmental Conditions

5.1.2.1 Surface Conditions

Before the system can be commissioned, system operators have to ensure the required surface conditions. Special attention should be paid to cleanliness and the maximum gap dimensions between different shop floors.

5.1.2.2 Area of Movement

Before the system can be commissioned, system operators have to provide adequate areas of movement in conformity with specific requirements. Special attention should be paid to the minimum width of areas of movement as well as to the floor space requirements at load acquisition, load depositing and load transfer stations.

As regards the design of areas of movement, please refer to [ANNEX IV -Operating Areas](#) for a specification of the applicable framework conditions.



NOTICE

System operators always bear the sole responsibility for the ultimate safety concept. We recommend clarifying any issues in cooperation with authorities and bodies such as employers' liability insurance associations, government accident insurance agencies, the Works Council, the in-house health and safety department or the fire prevention department well in advance.

5.1.2.3 Contours for Positioning

AGILOX vehicles possess an intelligent positioning algorithm and require at least 20 % of the initially acquired contours to determine their position. After the system has been commissioned, contours should not be modified in any significant manner (see Operation Manual chapter [2.3.4 - Floor Conditions of Area of Movement](#) and [3.2.5 - Navigation and Routing](#)) anymore as this may impair the positioning accuracy of an AGILOX vehicle in extreme cases. It may be necessary for the system to reacquire ('learn') the area in question if it has been significantly changed.

In case of areas not in conformity with contour requirements, for example spaces with large wood paneling, system operators must get in touch with the manufacturer in order to coordinate measures designed to improve the visual characteristics of contours at the height of the vehicle's navigation scanner.

5.1.3 Commissioning of Charging Station

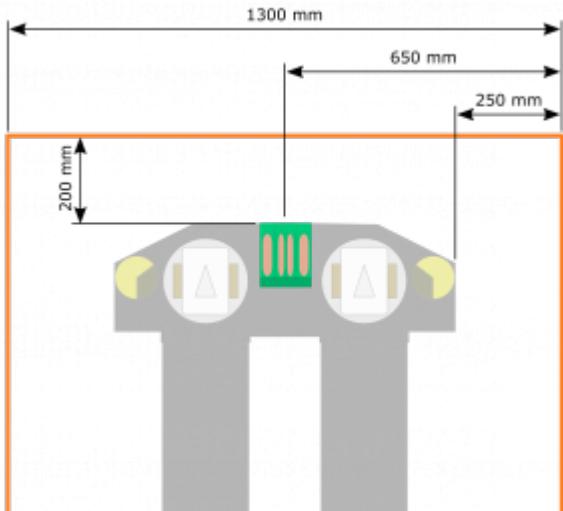
The charging plate is already pre-wired and only needs to be screwed to the floor at the right position. Use the enclosed drop in anchor and socket screws:

- Steel Drop In Anchor M8, fixing hole diameter 10mm, length 30mm
- M8 x 25mm Hex Socket Cap Screw Plain Stainless Steel



Distance between objects and the AGILOX vehicle at charging station

Charging stations must be positioned in such a way as to ensure that the minimum width requirements specified in the figure below are met. The position is to be approved by the fire prevention officer.

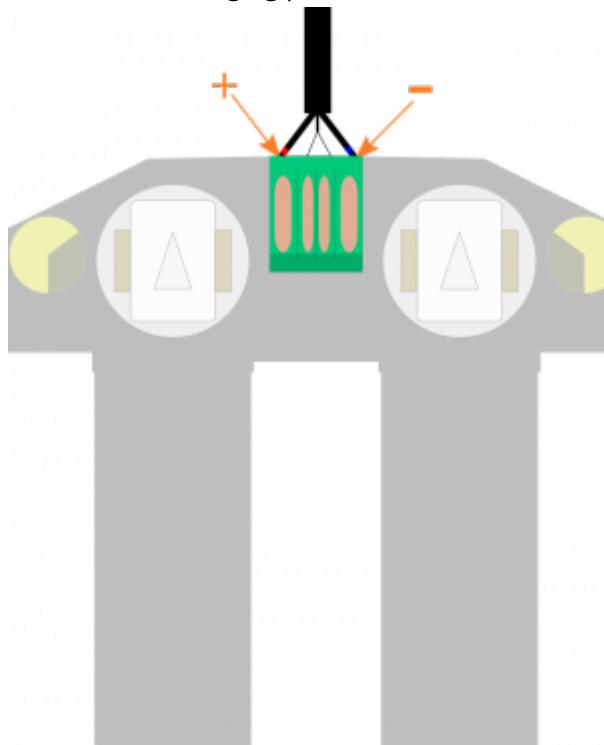


INFORMATION

The minimum width requirements apply to EPAL pallets and need to be adjusted if larger load carriers are used.

5.1.3.1 Orientation of the Charging Station

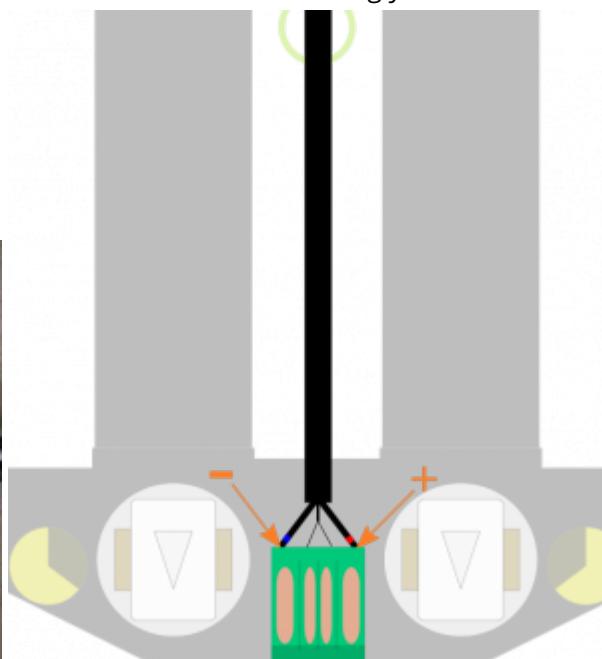
The Charging Station is designed in a way the AGILOX vehicle drives on it forwards with the forks away from the wall. The charging plate is also connected that way.



If the charging station should be driven on backwards (forks facing the wall), the connections of the charging plate need to be changed.

Therefore the two connections on the back of the charging plate (+ and -) need to be swapped. For this a 10mm socket wrench is needed.

In addition the cable needs to be fixed to the floor between the forks accordingly.



5.1.4 Preparing the Interface

Partner systems use the AGILOX JSON API for accessing information supplied by the AGILOX system or as an order interface for drive orders.

The optional Host Gateway can be commissioned by the commissioning team as well, if required.

There are several ways of how AGILOX vehicles can be assigned tasks:

- AGILOX intelligence (auto workflow)
- Manually initiated WFs via the HMI/URL/AGILOX IO web service
- Higher-level systems via interface

See Commissioning Manual [4.8 - JSON API](#) for detailed information.

5.2 General Commissioning Tasks for the AGILOX Vehicle

Initial commissioning will be carried out as soon as the customer's IT infrastructure as well as all charging stations have been put into operation. Initial commissioning will be performed by the commissioning team of AGILOX North America, Inc..

Tools:

All tools needed for commissioning will be provided by AGILOX North America, Inc..

5.2.1 Commissioning of vehicle electronics

For commissioning of the batteries the vehicle has to be charged to at least 60%. If this is not the case, the vehicle needs to be charged on the charging station or with the mobile charging device provided.

6. Operation

A safety check must be performed on the AGILOX vehicle on a daily basis according to following protocol:

- Maintenance Protocol CUSTOMER (Appendix)



DANGER

Risk of death as a consequence of collisions with AGILOX vehicles

AGILOX vehicles have been designed to come to a safe standstill in front of stationary obstacles. This means that approaching persons or objects may collide with an AGILOX vehicle coming the other way, resulting in collisions and accidents involving serious injuries and damage.

- Mark out all driving paths
- Persons are only allowed on the driving path or in the area of movement of AGILOX vehicles, if they are instructed in the vehicle's behavior
- Use proper personal protective equipment
- Be mindful of the limitations of safety technology

6.1 Controlling the AGILOX Vehicle

6.1.1 Turning on the AGILOX Vehicle

1. Turn the On/Off switch to the right.
2. The AGILOX vehicle will start up.
→ The Acknowledgment pushbutton lights up.
3. Press the Acknowledgment pushbutton
→ The Start pushbutton lights up.
4. Press the Start pushbutton
→ The AGILOX vehicle will now initialize the drive units. The AGILOX vehicle will be ready for use as soon as the initialization process has been completed.
5. Set the required operation mode by means of the key switch.

6.1.2 Turning off the AGILOX Vehicle

1. Turn the On/Off switch to the left.
→ The AGILOX vehicle will power down.

6.1.3 Automated Operation Mode

6.1.3.1 Description

In their automated operation mode, AGILOX vehicles will complete any conveyance orders transmitted to a single AGILOX vehicle or to the AGILOX fleet via the JSON interface or by means of other tasking options (see [3.1.2.5 - Host Systems, Host Gateway \(optional\) and Assignment of Orders](#)) fully automatically.

If two or more AGILOX vehicles are in operation, one AGILOX vehicle will coordinate the distribution of orders with all the other AGILOX vehicles. As a result, no higher-level control system is required for dispatching orders.

6.1.3.2 Activation

1. Turn the key switch to 'Automated Operation Mode' (right-hand position).
2. Press the Start pushbutton to confirm the change of operation mode.
→ The AGILOX vehicle is now in AUTOMATED OPERATION MODE

6.1.3.3 Activating/Deactivating the Pausing Functionality

In automated operation mode, AGILOX vehicles can also be paused, if required.

1. Press the Start pushbutton while in automated operation mode.
→ The AGILOX vehicle will interrupt the order it is currently carrying out
2. Press the Start pushbutton again.
→ The AGILOX vehicle will resume carrying out its order.

Additionally, the AGILOX vehicle or the union can be paused via the hmi, see [6.2.10 - Pausing the AGILOX Vehicle](#) for details.

6.1.4 Manual Operation Mode

6.1.4.1 Description

The manual operation mode allows AGILOX vehicles to be controlled manually. The manual operation mode of the vehicles is controlled in the AGILOX user interface. All safety features will be active (see [6.2.8 - Manual Operation](#)).

6.1.4.2 Activation

1. Turn the key switch to 'Manual Operation Mode' (central position).
2. Press the Start pushbutton to confirm the change of operation mode.
3. Initiate 'Manual Operation' in the AGILOX user interface. See [6.2.8 - Manual Operation](#).

→ The AGILOX vehicle is now in MANUAL OPERATION MODE



6.1.5 Maintenance Operation Mode



DANGER

Danger due to deactivated safety features!

In maintenance mode, all safety features will be disabled, posing a risk to the operational safety of AGILOX vehicles and potentially leading to severe injuries and/or damage to property.

- Pay particular attention whenever commands are executed
- The maintenance operation mode must only be activated by specially trained staff
- Prevent accidental or unauthorized activation of the vehicle's maintenance mode by pulling the key from the lock of the key switch

6.1.5.1 Description

Maintenance mode allows the vehicle to be controlled manually for troubleshooting **without active safety functions**.

6.1.5.2 Activation

1. Turn the key switch to 'Maintenance Operation Mode' (left position)
2. Press the Start pushbutton to confirm the change of operation mode.
3. Open 'Manual Operation' window in the AGILOX user interface.

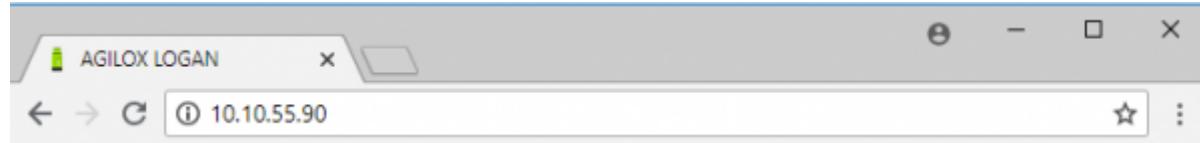


4. Connect a terminal device to the 'AGILOX-<Serial Number>' WLAN hotspot. The required password will be provided during the system operator training.
→ The AGILOX vehicle is now in MAINTENANCE OPERATION MODE

6.2 AGILOX User Interface (HMI)

6.2.1 Calling up the AGILOX User Interface on a Terminal Device

Enter the IP address assigned upon commissioning in your internet browser in order to call up the user interface on your terminal device.



INFORMATION

AGILOX North America, Inc. recommends using Google Chrome as your internet browser.

6.2.2 AGILOX User Interface Overview



INFORMATION

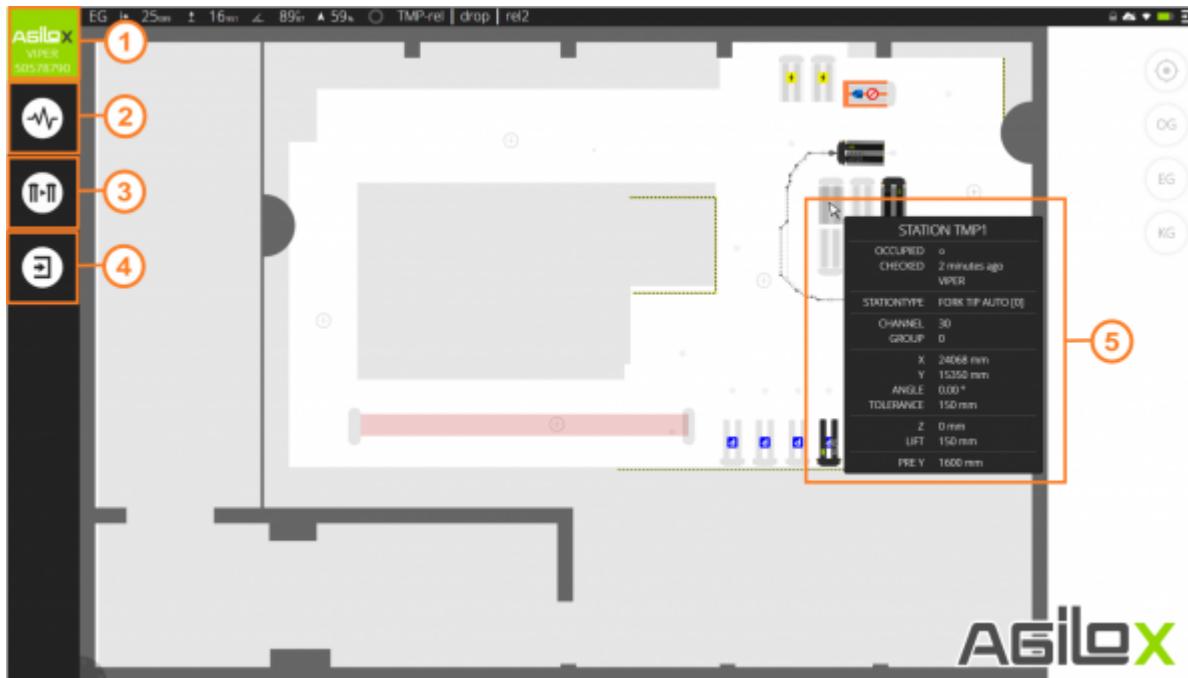
The movement area map including its acquisition and depositing station will be prepared upon commissioning and may vary to a large degree depending on the project concerned. This Operation Manual uses a symbolic representation of such a map.



No.	Description	Information
1	Menu bar	Selection of operation options; navigation to menu items
2	Status bar	Shows current floor, position (x, y and angle), navigation match, order status, malfunctions (errors, warnings), certificate, cloud and wifi information and battery status
3	Area of movement	Visualization showing Map (Commissioning Manual 4.5 - Map) with stations, block warehouses, AGILOX vehicles, etc.
		Station, occupied station, invalid occupied station (red) Symbols on the station show station parameters, all set station parameters are shown as icons above each other see Commissioning Manual 4.3.2 - Stations for more details
		Disabled Station
		Special Station Type Information active if any station type different from FORK TIP AUTO is selected See Tooltip on stations

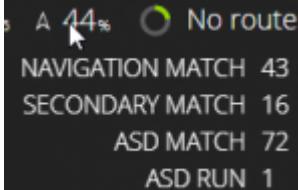
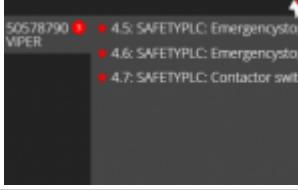
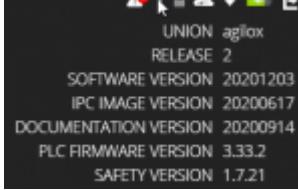
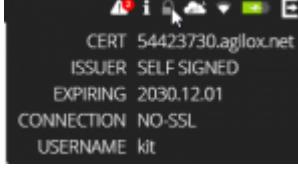
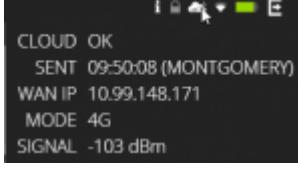
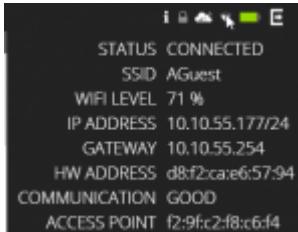
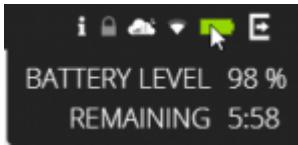
No.	Description	Information
		Station with special settings. More information can be found in the Tooltip.
		Charging station
		Parking station
		Possibility to park AGILOX Box Carrier on this station
		Waypoint
		Link Station, link to different floor or map section
		AGILOX vehicle In large maps, while zoomed out, a black circle around the AGILOX vehicles makes it easier to find them. A colored circle around an AGILOX vehicle means, that the AGILOX vehicle is not able to do orders (e.g. failure, manual control, process issue, start button,...). Depending on the reason, the circle has a different color. More information can be found in the tooltip.
		If the AGILOX vehicle stops because of obstruction (stop reason: Obstruction), the first scanned point of the obstacle is shown as a blue dot in the visualization.
4	Block warehouse including stations	
5	Customized logo	
6	Zoom to AGILOX vehicle	
7	Download map	See Operation Manual for Administrators 4.5 - Map for details.
8	Search Function	Search in visualization to find/jump to stations, waypoints and AGILOX vehicles.
9	Switch to a different floor	

Without users logging in, the AGILOX user interface will display the visualization and the AGILOX vehicle information by default. To show information of different AGILOX vehicles it is possible to switch between the different vehicles by clicking on the menu or double-clicking on the AGILOX vehicle. Additionally, there is an option to display more detailed information by means of tooltips.

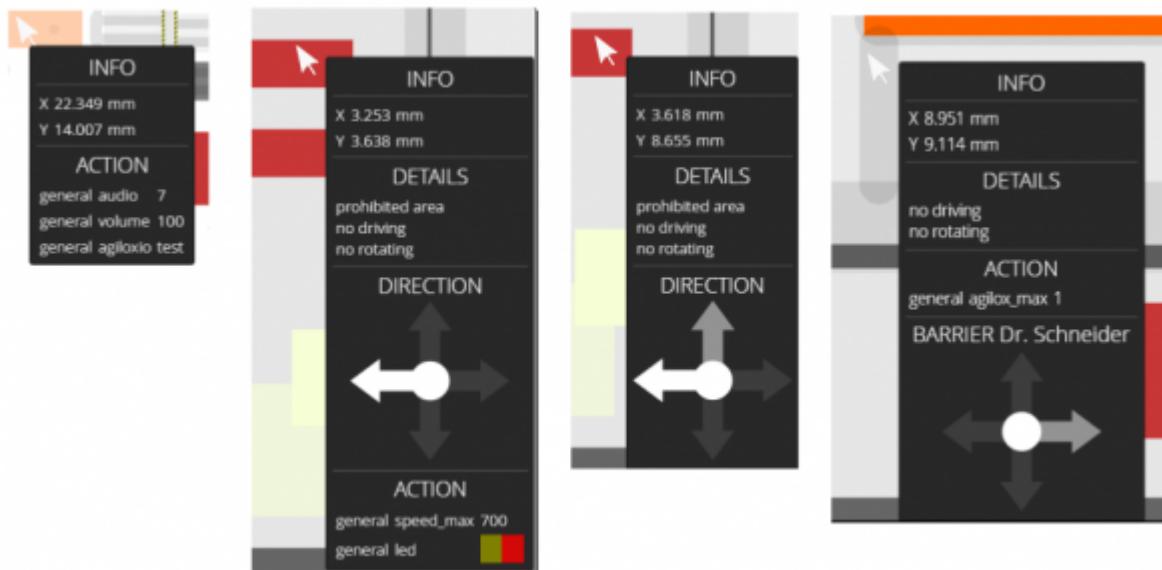


No.	Description	Information
1	Visualization	Show area of movement
2	Vehicle information	Show vehicle information
3	Switch to other vehicle	Switch to a different AGILOX vehicle
4	Log in	
5	Tooltip	Tooltips will be displayed whenever the mouse cursor hovers over a given element.

6.2.2.1 Tooltips on the status bar

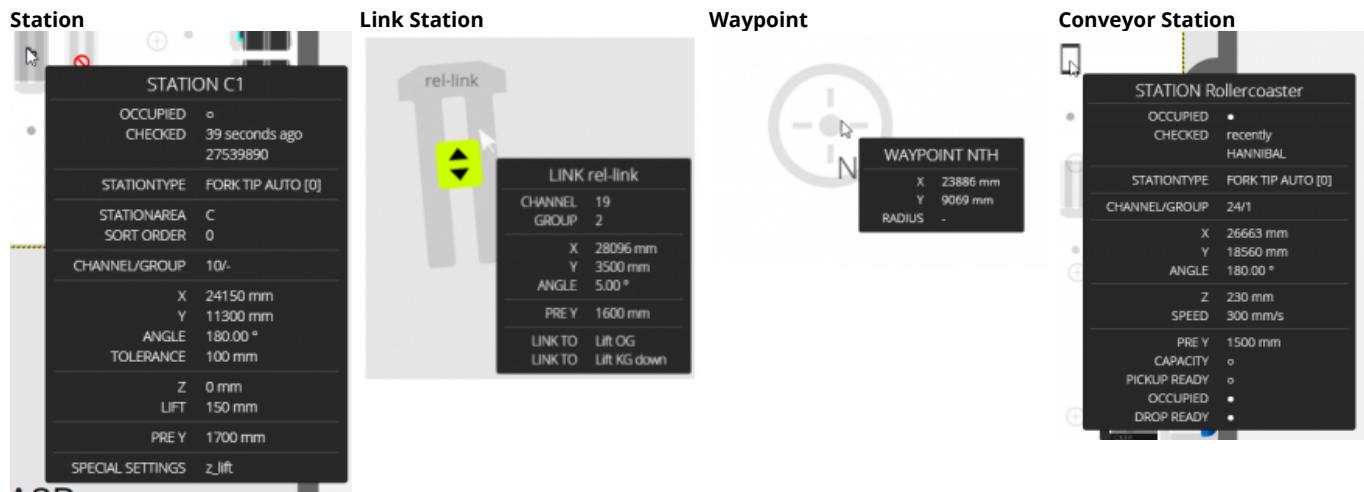
Navigation Match		NAVIGATION MATCH: Actual value from navigation scanner compared to initially acquired data from commissioning SECONDARY MATCH: Actual value from safety laser scanner compared to initially acquired data from commissioning ASD Match: Match between the created temporary map (ASD Map) and the actual data from navigation scanner. ASD Run: count of ASD maps created. See 6.4.9 - Navigation Match and Adaptive Smart Discovery (ASD) for details.
Error Messages / Warnings		Error Messages and Warnings for the entire union. See ANNEX V – Error Messages AGILOX Vehicle for details.
Information		General Information: Union Name, Software Release, Software Version, IPC Image Version, Documentation Version, PLC Firmware Version, Safety Version
Certificate		SSL Information. See Commissioning Manual 4.8.1.4 - Security for details. The lock symbol can be gray (no SSL), white (SSL) or red (SSL is expiring soon)
Cloud		Connection to AGILOX Analytics (optional) Cloud OK: Communication OK SENT: Last information sent to AGILOX Analytics system (by: Name of AGILOX vehicle) WAN IP: IP address of LTE modem on AGILOX vehicle MODE: current LTE modem mode SIGNAL: current Signal strength
WiFi Information		Wifi Information: Status, SSID, WIFI Level, IP Address, Gateway, HW Address, Communication, Access Point The Wifi symbol can be white (good communication), yellow (weak communication) or red (bad communication)
Battery Information		BATTERY LEVEL in percent REMAINING time in hh:mm (approximate)

6.2.2.2 Tooltips in the area of movement



Description	Information
Info	x and y coordinates
Details	Details about this position, if applicable
Direction	Directions set on action areas in Commissioning Manual 4.5.4.2 - Direction , or for barriers soft directions are shown in gray, hard directions are shown in white
Action	Actions according to map settings (Commissioning Manual 4.5.5 - Action Settings)
Barrier	Barriers are implemented during commissioning. They can be activated and deactivated in a timespan or by an input on the AGILOX IO. They are light gray, when deactivated and dark gray when activated. Barriers can also have directions, which are shown in the tooltip.

6.2.2.3 Tooltip on stations



Description	Information
Occupation	° not occupied, • occupied
Barcode	if the station is occupied and there is a barcode information for the load, it is shown here.
Checked	occupation of the station was last checked xx minutes ago, AGILOX vehicle that checked it
Stationtype	Stationtype information: Following station types are possible: FORK TIP AUTO, FORK TIP OFF, FORK TIP PROTECTIVE FIELD ONLY, FORK TIP ON Station types are specified during commissioning
Station Area Sort Order	Settings of Station (Commissioning Manual 4.3.2 - Stations)
Channel Group	Channel of block storage (all stations with same preposition are automatically in the same channel) Stations / Channels close to each other (preposition within 3000mm from each other) are automatically combined to groups
X Y Angle Tolerance	Position of Station according to Commissioning Manual 4.3.2 - Stations
Z	Entering lift height (Z)
Lift	Relative lift according to Commissioning Manual 4.3.2 - Stations
Speed	Conveyor speed
PRE Y	Preposition Y according to Commissioning Manual 4.3.2 - Stations
Link to	Station that the link station links to on a different floor.
Radius	Waypoint catch radius

Description	Information
Capacity	The status of the I/O signals is shown in the Tooltip for Conveyor Stations
Pickup ready	
Occupied	
Drop ready	

6.2.2.4 Tooltip on AGILOX vehicles



Information of the AGILOX vehicle is shown, such as IP address, serial number, navigation match / asd, carrier, protective setup (protective field setup/max. pallet size/red area/orange area), last seen, battery level, load information, stopped time, order information, status (automatic, manual, maintenance) and stop reason.

One * behind the Name of the AGILOX vehicle means, that this vehicle is currently the master, two ** means the vehicle is currently the floor-master, three *** means the vehicle is currently master and floor-master. The master is the vehicle with the currently highest serial number of the union. The master is responsible for occupation of stations, AGILOX IO,...

The floor master is the vehicle with the currently highest serial number of the floor. This vehicle is responsible for dedeadlocking.

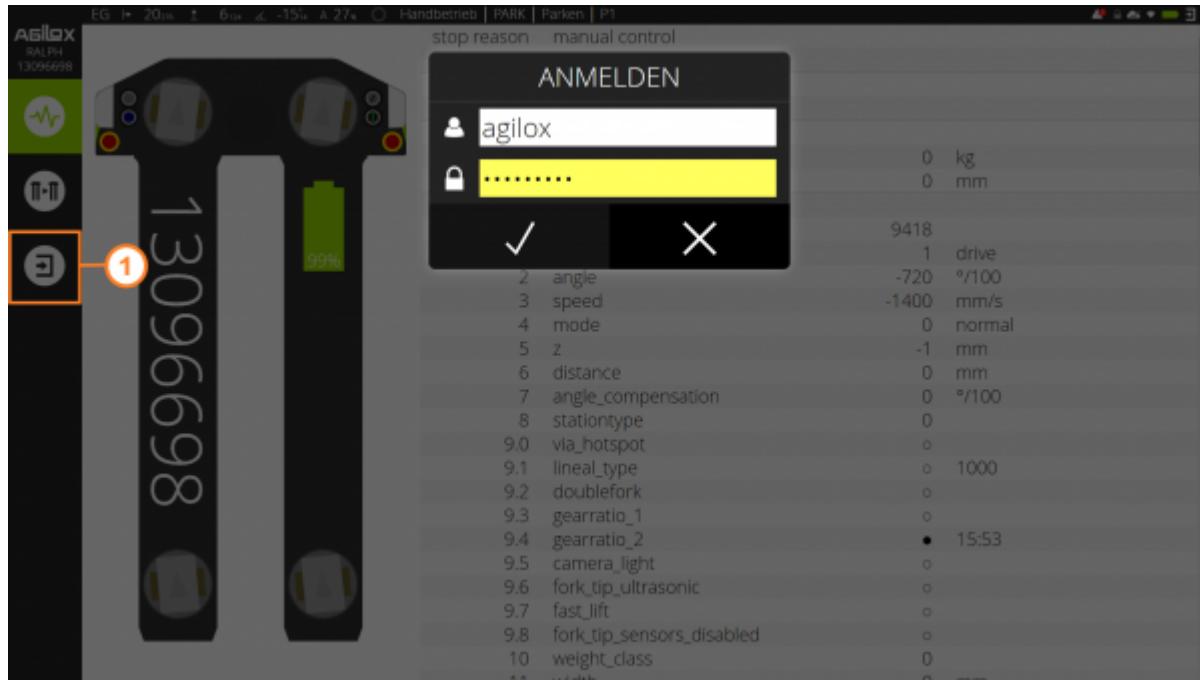
6.2.3 Vehicle Information



The vehicle information functionality provides an overview of all relevant vehicle data.

Parameter	Description
stop_reason	Shows the reason for the vehicle having come to a standstill, for example 'No order' if no orders are available for an AGILOX vehicle
step	Current flow control step
scan disp	Scanner Display: Text currently shown on navigation scanner.
measured	Weight and width of current load.
order	Parameters of current order
feedback	Current vehicle parameters such as speed, any breaches of the protective safety field or the vehicle's current mode of operation
battery	Current cell voltages of vehicle battery, total voltage and cell spread.
motor current	Current motor current of all drive units.
clearance	Current distance values of obstacle avoidance (former collision avoidance, optional)
led	Color of direction indicators.
wifi	List of all available wifi networks
weight sensors	Indicator about correctly installed and parameterized (valid) strain gauges

6.2.4 Login



No.	Description	Information
1	Login	Allows to log in

After logging in, the AGILOX user interface will display the functionalities relevant to the user and authorized for his/her role.

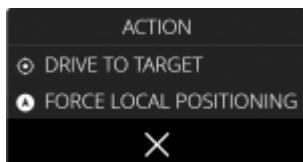
This Operation Manual describes all functionalities possible for LEADER login. Functionalities for administrators (ADMIN) can be found in the Commissioning Manual.

6.2.5 Visualization

6.2.5.1 Context Menus

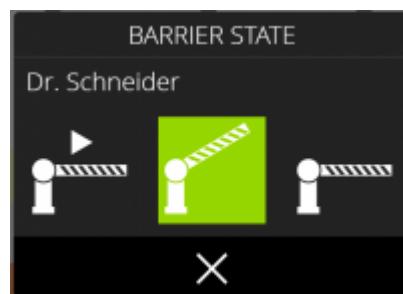
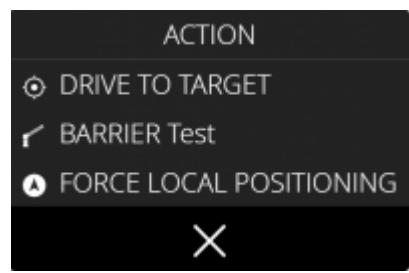
There are various context menus available in the visualization:

Context menu on free area:

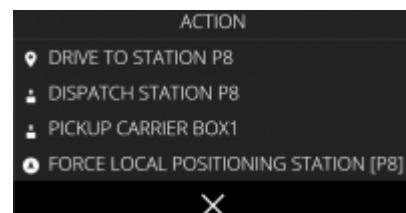
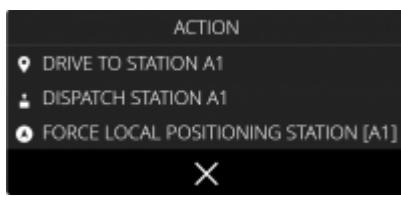


Description	Information
Drive to Target	Tell AGILOX vehicle to drive to this position.
Force Local Positioning	In case an AGILOX vehicle lost its position, it can be given an approximate position with this option. The AGILOX vehicle will then try to find its position in this area within a 5m radius.

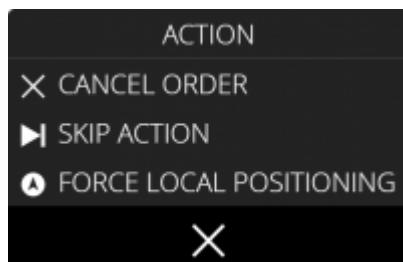
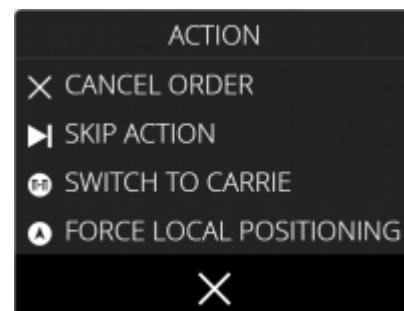
Context menu on barriers



Description	Information
Barrier <Barrier Name>	Adjust barrier: Barrier automatic, Barrier off, Barrier on

Context menu on station:


Description	Information
Drive to Station <Station Name>	Tell AGILOX vehicle to drive to the station.
Dispatch Station <Station Name>	Dispatch station manually. A destination can be chosen in the next step. There is no prior check if the load carrier fits for this AGILOX vehicle. This is only checked once the vehicle is on the station already.
Pickup Carrier	If there is a Box Carrier on the station, the Box Carrier can be picked up by an AGILOX vehicle.
Force Local Positioning Station [<Station Name>]	In case an AGILOX vehicle lost its position, it can be given an approximate position with this option. The AGILOX vehicle will then try to find its position in this area within a 5m radius.

Context menu on AGILOX vehicle:
AGILOX vehicle currently connected to on hmi:

AGILOX vehicle not connected to on hmi:


Description	Information
Cancel Order	Cancel current order
Skip Action	Skip current action
Switch to <AGILOX Name>	Switch to selected AGILOX vehicle.
Force Local Positioning	In case an AGILOX vehicle lost its position, it can be given an approximate position with this option. The AGILOX vehicle will then try to find its position in this area within a 5m radius.

6.2.5.2 Stations

To pickup loads and drop them stations need to be defined in the visualization window. Stations are also used to charge the AGILOX vehicle, for parking and to change floors.

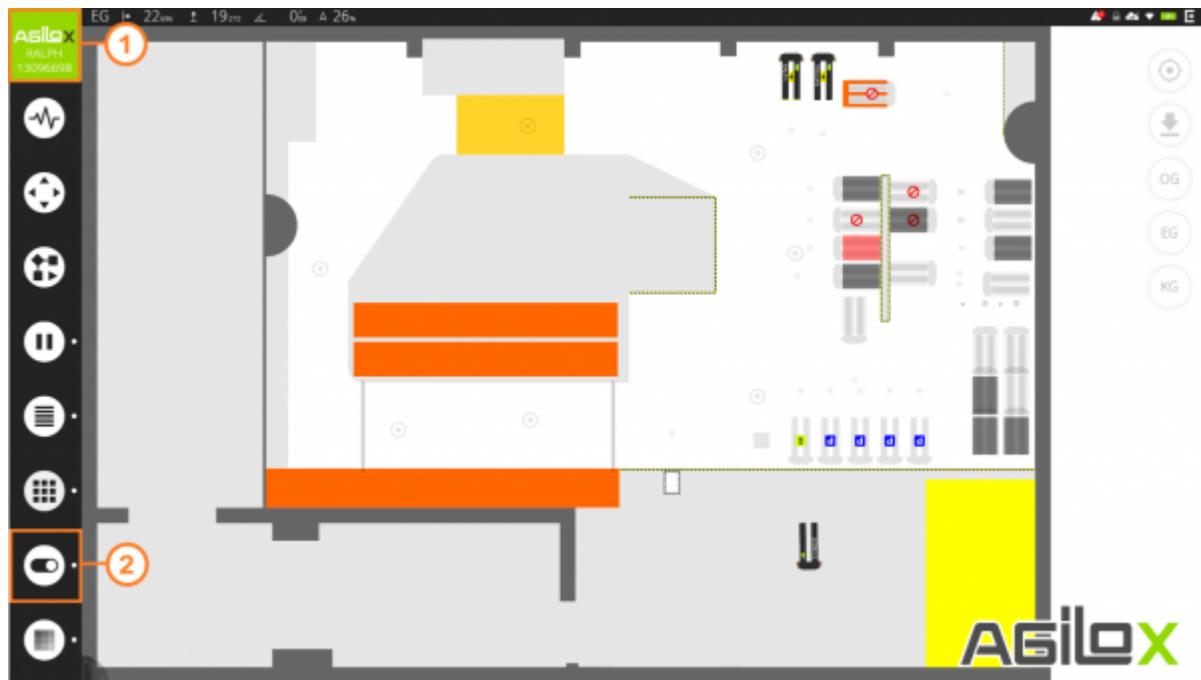
The occupation of the station is monitored by the AGILOX vehicles, when driving over their prepositions and is also shown in the visualization. If somebody removes a pallet, the AGILOX vehicles will notice that the next time driving over the preposition of that station. The validity of the stations is also determined. Stations are shown in red in the visualization, if they are not valid. Reasons for that can be a bad positioning of the pallet (outside the tolerance area) or an obstacle between the AGILOX vehicle and the station, etc.

Double-clicking on a station opens a station parameter window in which adjustments for the station can be made. There are different windows for different types of stations.

6.2.5.3 Stationareas

Two or more stations can be combined in a station area. The station area can be used as a target in workflows. The AGILOX vehicle will then try to find a proper station within the station area by itself. Station areas can also be used for block storage.

6.2.6 Visualization Toggles



No.	Description
1	Visualization
2	Visualization toggles



No.	Description	Information
1	Show route map in visualization	
2	Show scan data in visualization	
3	Ruler tool	For measuring distances and relative angle in the area of movement.

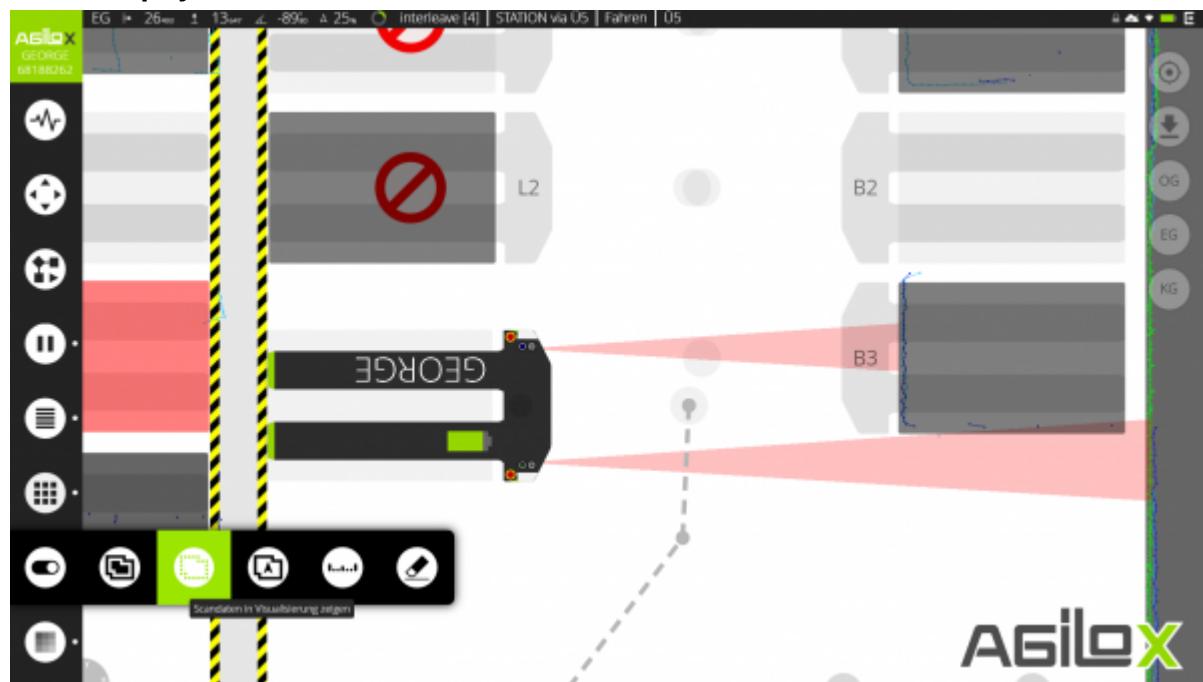
6.2.6.1 Show Route Map in Visualization



This map overlay shows the route map compiled during commissioning. The drawn-in areas are used as a basis for identifying possible paths.

Details for the different areas are shown in the tooltip.

6.2.6.2 Display Scan Data



This map overlay is used to visualize the data supplied by the three laser scanners installed on an AGILOX vehicle.

Map overlays help identify dynamic obstacles which will make an AGILOX vehicle stop.

The navigation laser scanner on top of AGILOX vehicles has been colored green in this illustration.

The two safety laser scanners installed near the bottom of the AGILOX vehicle is shown in light and dark blue.

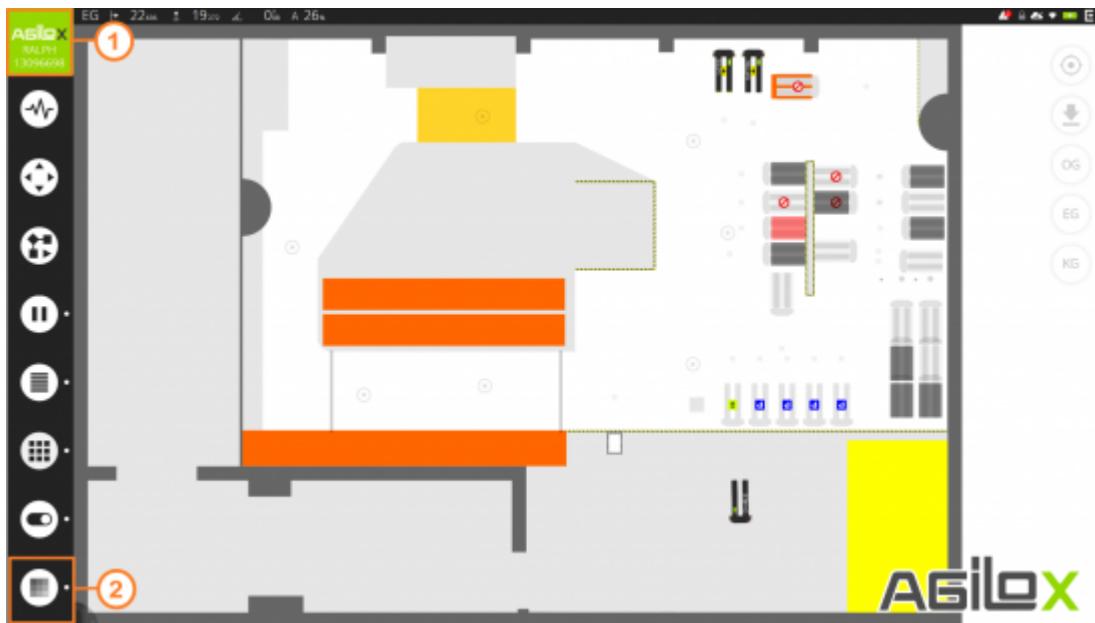
The optional obstacle avoidance sensors are shown in red.



INFORMATION

Obstacles breaching the protective safety field of an AGILOX vehicle are always (even with the switch in the OFF position) depicted large and in red.

6.2.7 Heatmap Visualization



No.	Description
1	Visualization
2	Heatmaps

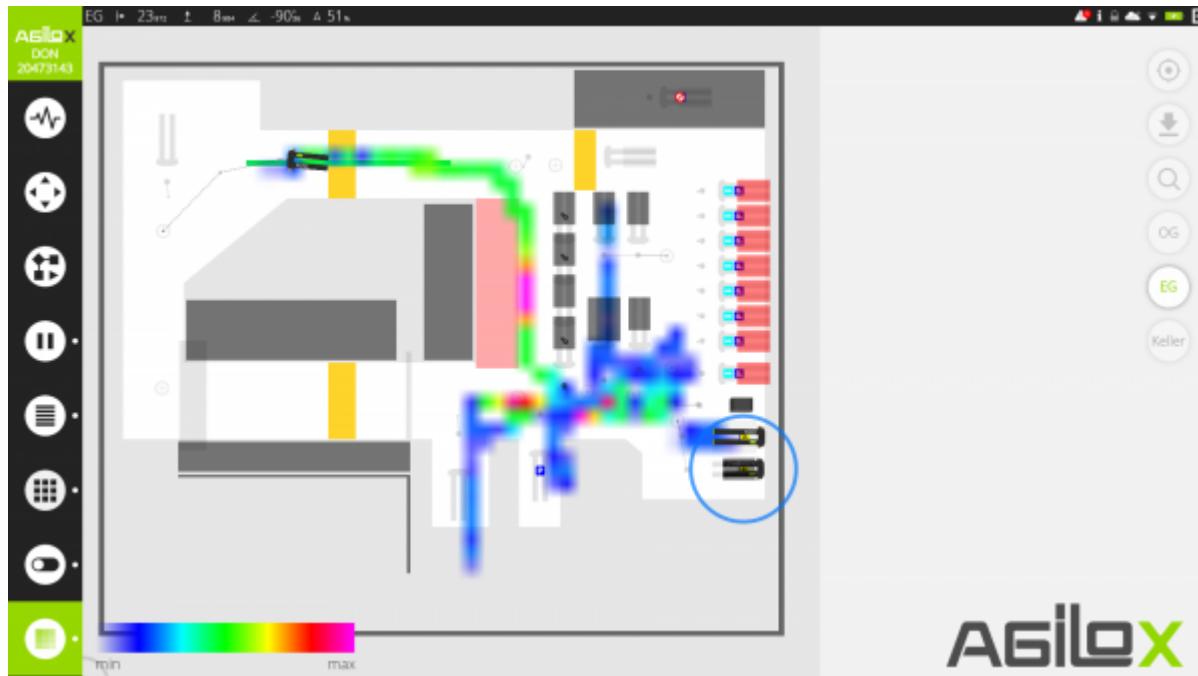
Various heatmaps are available for process analysis purposes. Heatmaps provide a quick visual overview of the following measurement values:



No.	Heatmap	Blue	Red
1	WIFI reception	bad reception	good reception
2	Modem reception	bad reception	good reception
3	Map quality	low accuracy	high accuracy
4	Position	rarely at this position	frequently at this position
5	Failure	few malfunctions	many malfunctions
6	Problem	few process issues	many process issues
7	Speed	low speed	high speed
8	Protective field	rarely at this position	frequently at this position
9	Turning angle	smaller turning angle	higher turning angle
10	Localization Jump	few localization jumps	many localization jumps
11	Vertical acceleration	low vertical acceleration	high vertical acceleration
12	Erase heatmap areas		

When traveling within its area of movement, every AGILOX vehicle will record a variety of measurements on a half-meter grid. These measurements will be visualized in color, with the mouse cursor additionally providing a tooltip displaying the corresponding values in percent.

6.2.7.1 Heatmap for Average Speed - Example:



6.2.8 Manual Operation

To enable the manual operation mode of an AGILOX vehicle, the key switch has to be turned to Manual Operation. (see [6.1.4 - Manual Operation Mode](#))



No.	Description	Information
1	Manual operation	
2	Manual lift	Manual raising and lowering of lifting equipment
3	Manual drive	Switch to: Manual driving / manual linear driving / Box Carrier (optional)
4	Allow Station Entering	Manual loading and unloading / manual deactivation of protective safety fields

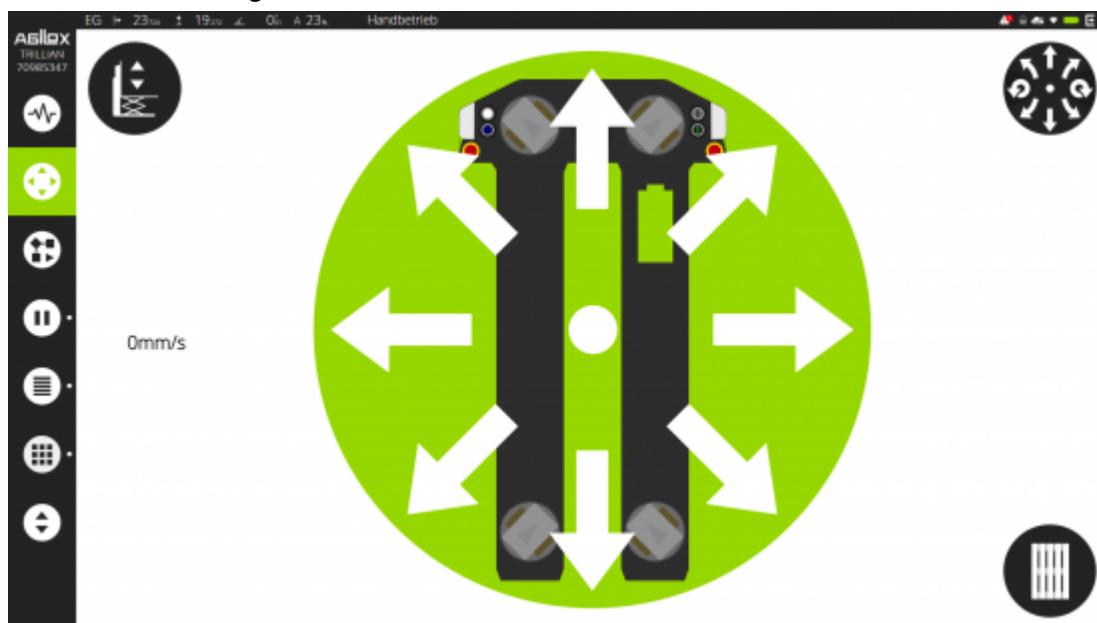
6.2.8.1 Manual Operation

Manual Driving



The AGILOX vehicle can be moved by clicking on the appropriate direction or pressing a finger to the touchscreen. The farther away from the center a user clicks, the faster the corresponding movement will be carried out.

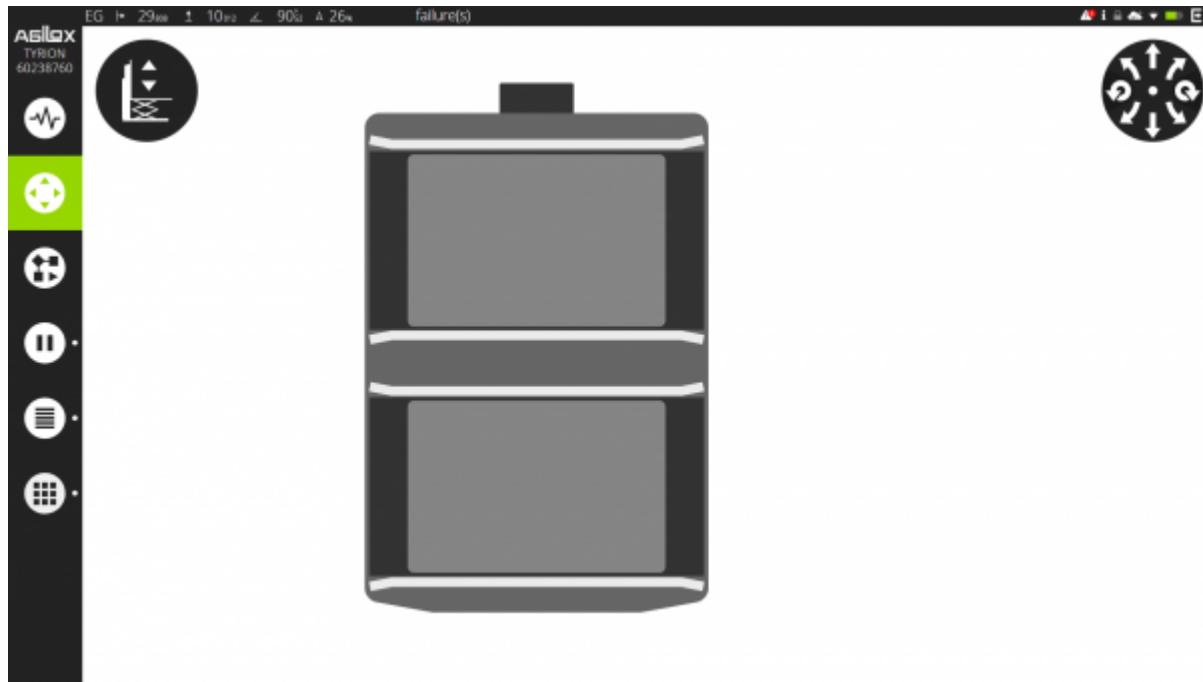
Manual Linear Driving



The AGILOX vehicle can be operated in parallel mode by clicking on the appropriate direction or pressing a finger to the touchscreen. The farther away from the center a user clicks, the faster the corresponding movement will be carried out.

Manual Operation Box Carrier

If a Box Carrier is loaded on the AGILOX vehicle it can be controlled manually.



6.2.8.2 Manual Lift



The load carrier can be lifted by clicking on it and move it in the appropriate direction. The current lifting height as well as the current set point is shown in the HMI.

6.2.8.3 Allow Station Entering



WARNING

Risk of injury due to collisions

The protective safety fields of AGILOX vehicles will be switched off during manual loading and unloading processes which may result in collisions and accidents causing severe injuries and damage.

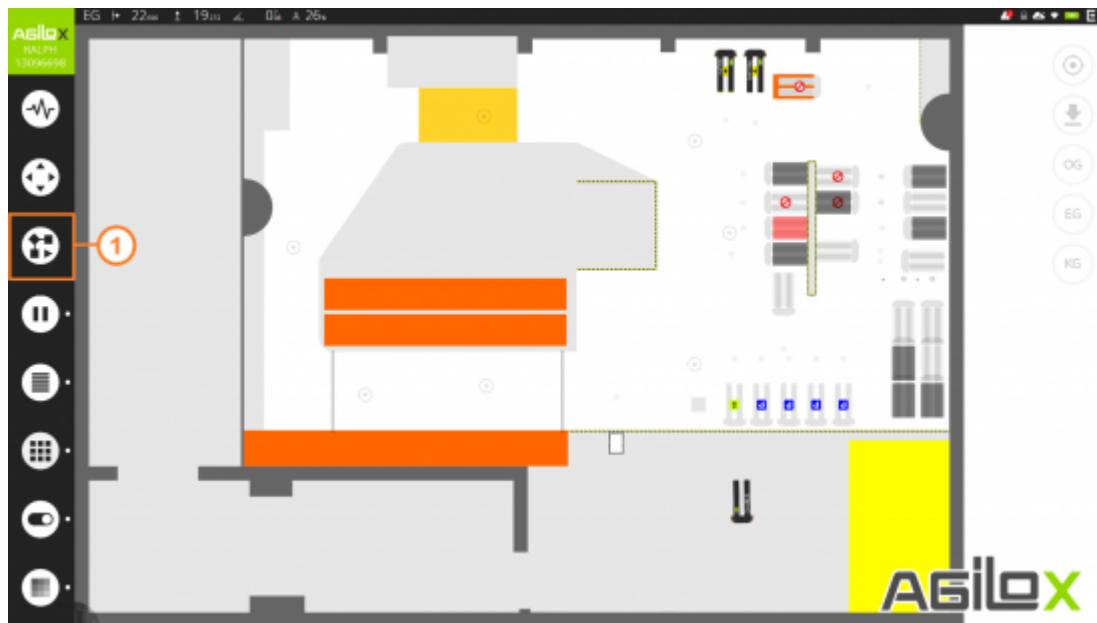
- Be particularly careful when initiating manual movements with the protective safety fields switched off



No.	Description
1	Manual operation
2	Allow Station Entering

Loading and unloading pallets by means of an AGILOX vehicle is only possible when the appropriate control button on the AGILOX user interface has been clicked, highlighting its symbol in blue. This safety features will be disabled and users consequently need to be particularly careful during manual operation processes.

6.2.9 Manual Tasking (Start Workflow)



No.	Description
1	Manual Tasking

There are three ways of tasking AGILOX vehicles:

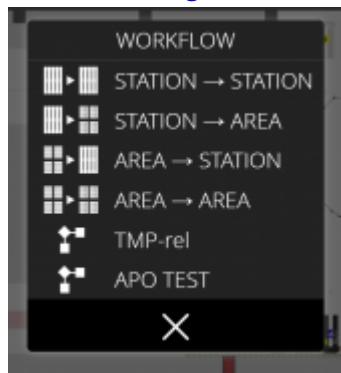
- Manual initiation of orders via the AGILOX user interface. All predefined tasks ('workflow') will be adapted according to the project concerned.
- Order originating from the Host System (ERP System)
- Predefined, project-specific workflows that are executed automatically.
→ Example: An AGILOX vehicle performing inspection patrols every 10 minutes which may then convey a pallet to the high-bay warehouse.

Tasking via the AGILOX user interface

Four default WORKFLOWS are available:

- STATION to STATION
- STATION to AREA
- AREA to STATION
- AREA to AREA

Apart from the system's default WORKFLOWS, project-specific WORKFLOWS can be created, too. See [Commissioning Manual 4.7 - Workflow Definition Language](#) for Details.

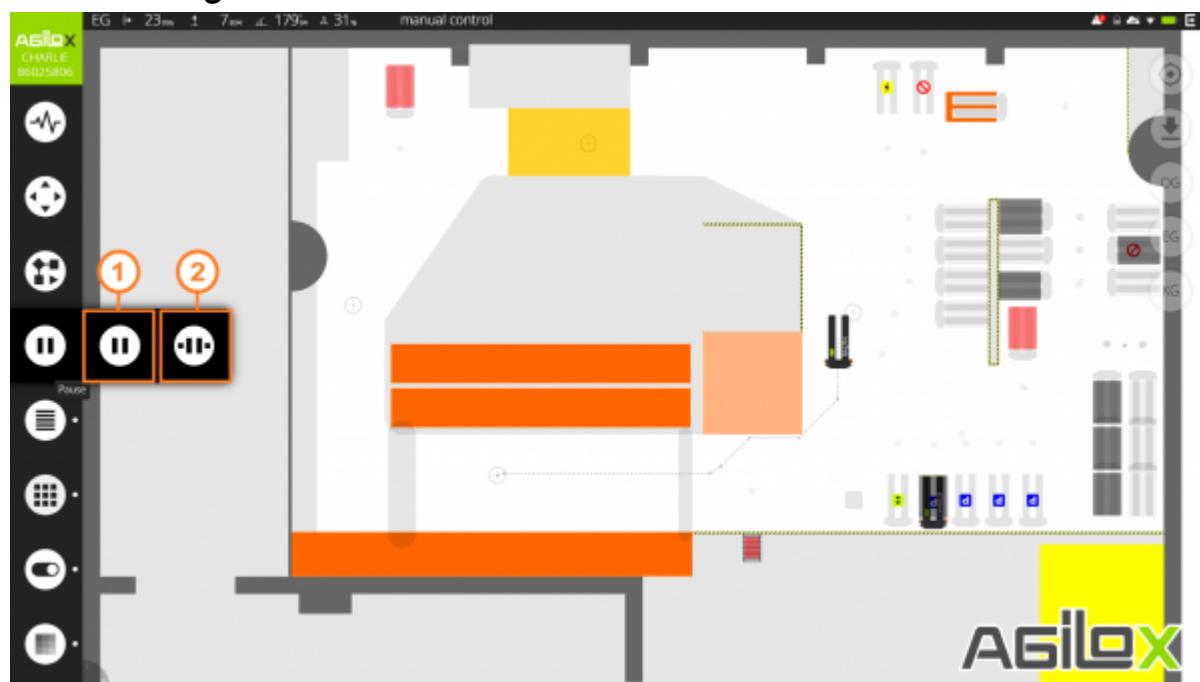


Example: Manual workflow STATION to AREA

An AGILOX vehicle is tasked with conveying a load from a station to a given area. Now choose the load acquisition station ('Source') and the stationarea.



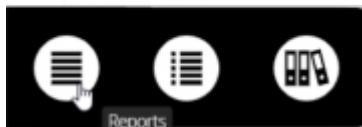
6.2.10 Pausing the AGILOX Vehicle



No.	Description	Information
1	Pause vehicle	The processing of orders by the selected AGILOX vehicle and the vehicle itself will be paused, without performing an emergency stop. The remaining UNION, however, will continue operating.
2	Pause union	The processing of orders and all vehicles of the union will be paused, without performing an emergency stop.

6.2.11 Reports

- 1
- 2



No.	Description	Information
1	Orders	Show all orders of the union.
2	Documentation	

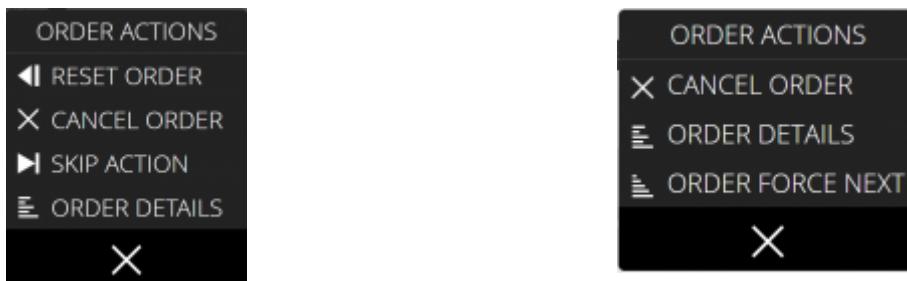
6.2.11.1 Orders

No.	Description	Information
1	Filter Time	Filter for time when orders were started: today, yesterday, this week or this month.
2	Filter AGILOX Vehicle	Filter for AGILOX vehicles, that processed the order.
3	Filter Order State	Filter for Order State.
4	Filter Order Type	Filter for Order Type.
5	Search	Text search for Orders.
6	Order	The last 100 Orders of the union are shown in the list. Old orders are deleted after 60 days automatically. By clicking on the order, order information is shown.
7	Order State	This Symbol shows the state of the order. The maximum amount of active and pending orders is limited to 100 x AGILOX vehicle count.
8	Order Progress	The Progress of the order is shown with this circle in %. A complete green circle means the order is done (100%).

No.	Description	Information
9	Order Information	This includes the full order id, order name, the actions of the order and their progress, a time stamp for creation of the order, the AGILOX vehicle processing the order and its serial number, the creator of the order, etc.
10	Order Actions	Clicking on this opens the order action window.

Order Actions

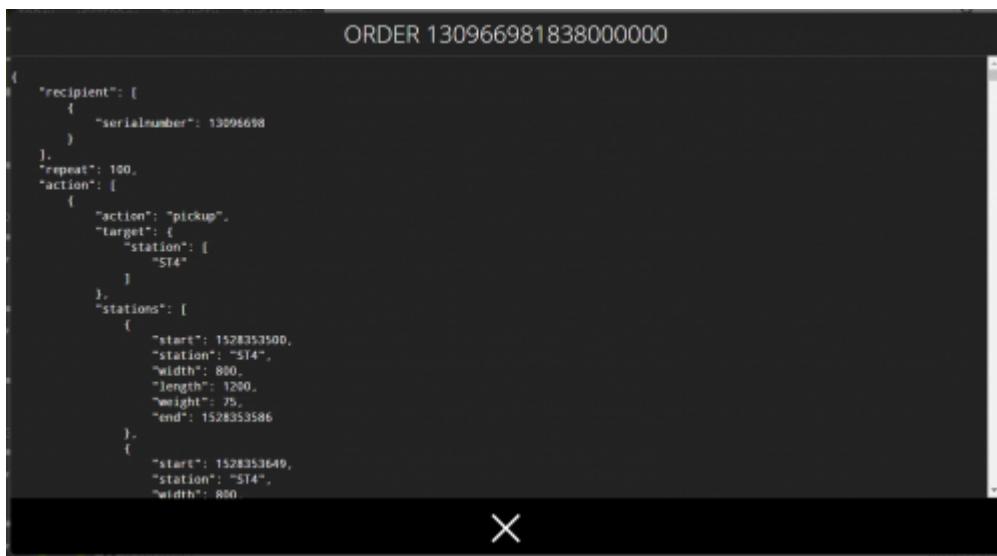
Depending on the state and type of the order, following order actions will be shown:



Description	Information
Reset Order	Restart order. This is only possible during the first order step of each run.
Cancel Order	Cancel this order.
Skip Action	Skip current action. This is only possible if connected to the AGILOX vehicle processing this order.
Order Details	View order details.
Order force next	For pending orders: Force this order to be done next, regardless of any priorities.

Order Details:

Order Details shows the detailed order definition. See [Commissioning Manual 4.7 - Workflow Definition Language](#) for more information.



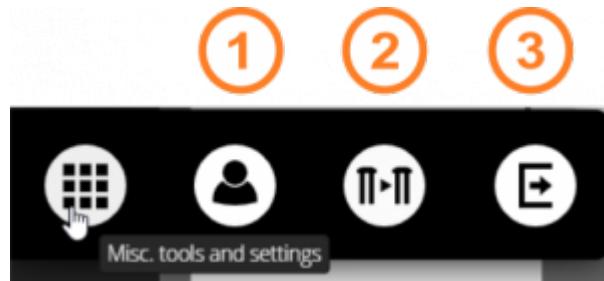
Automatic Orders

Following orders are created internally by the AGILOX software, if necessary:

Order	Description
PARK	The order "PARK" is created, when an AGILOX vehicle is standing somewhere and does not have an order (anymore). The AGILOX vehicle will drive to the next available parking station.
PLAN CHARGE	The order "PLAN CHARGE" is created, when the AGILOX vehicle has no order and the battery level is below 80% or if the current order is completed and the battery level is below 60%. The AGILOX vehicle will drive to the next available charging station.
FORCE CHARGE	The order "FORCE CHARGE" is created, when the battery level of the AGILOX vehicle sinks below 25%. The current order will be interrupted and the AGILOX vehicle will drive to the next available charging station. This is necessary to avoid the batter to be completely empty. There should be enough energy left to drive to the next available charging station, if there is no obstacle in the way.
DEDEADLOCK	If two AGILOX vehicles recognize that they are on each others route and a deadlock is happening, the order "DEDEADLOCK" will be created. One of the vehicles is looking for a position close by, that is not on the route of the other vehicle and will drive there to get out of the way of the other vehicle and resolve the deadlock.

6.2.12 Misc. Tools and Settings

In the system's misc. tools and settings, users can by default switch between the AGILOX vehicles of a UNION (7) and also log out (11), if they wish to do so. Administrators have access to additional functionalities.



No.	Description
1	User Management
2	Switch to other vehicle
3	Log out

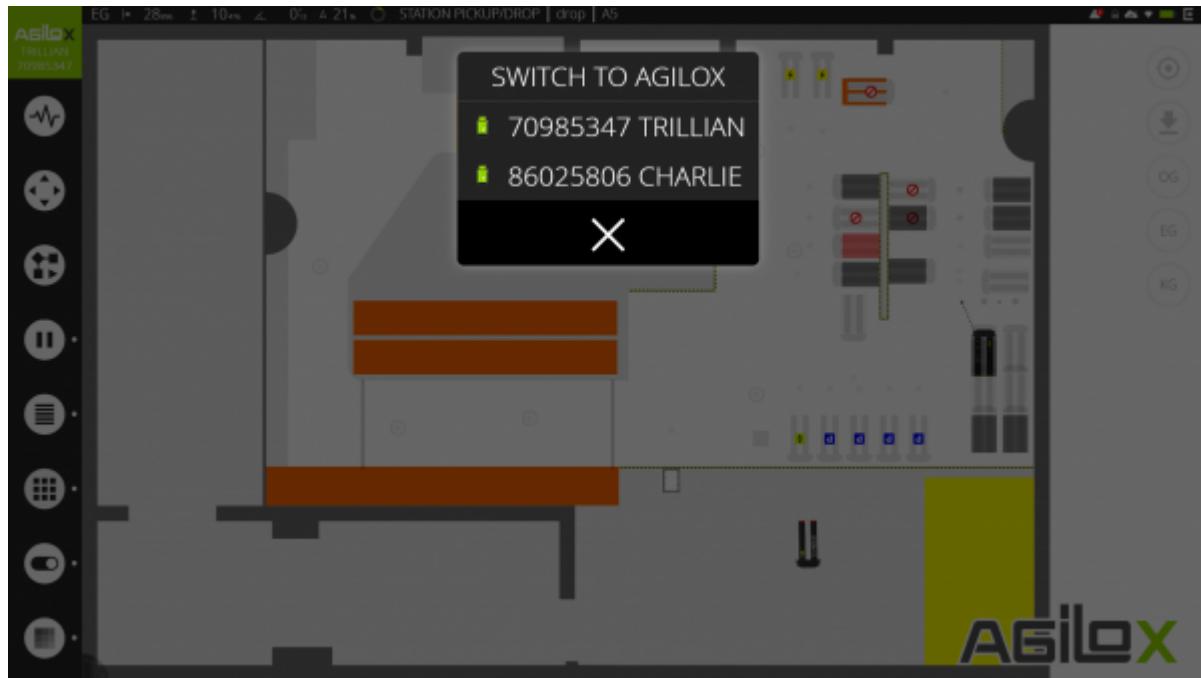
6.2.12.1 User Management



This option allows adding new users as well as changing their passwords, authorization levels and language. Additionally, users can be deleted here as well.

Role	Authorization
VIS	Use of visualization and display of AGILOX vehicle information
WORKER	In addition to VIS rights: tasking of AGILOX vehicles, manual control, display order list, pause vehicle
LEADER	In addition to WORKER rights: station entering in manual control, Force local positioning, cancel orders
ADMIN	The highest authorization level. An ADMIN can add and delete stations, modify the area of movement, add new users and everything described in the commissioning manual

6.2.12.2 Switching Vehicles (Switch to other vehicle)



Whenever AGILOX vehicles are tasked via the AGILOX user interface, the question of which AGILOX vehicle had originally issued a given order may be crucial. Furthermore, vehicle-specific data such as position, log files, scan data, etc. can only be displayed on the AGILOX vehicle concerned.

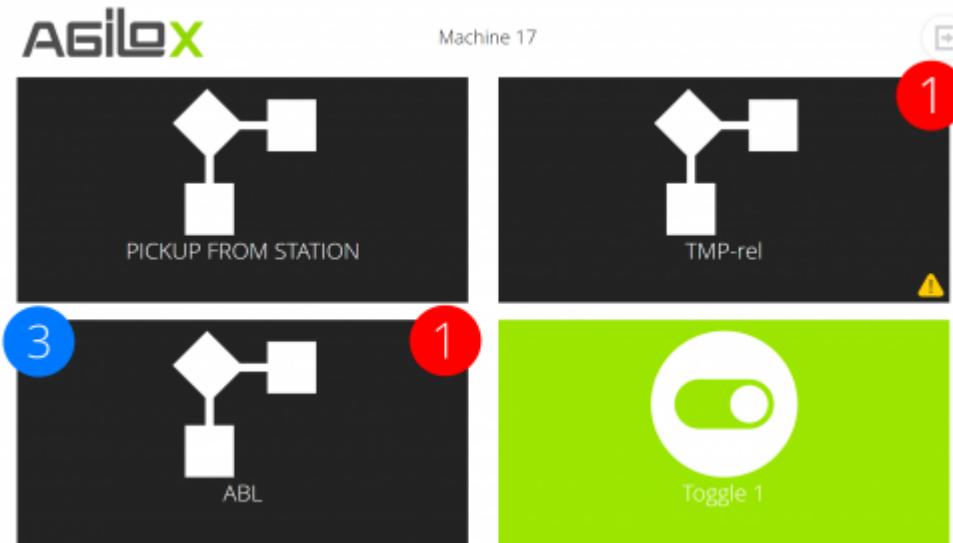
The 'Switch to the vehicle' functionality allows users to switch to any other vehicle within a UNION.

6.2.12.3 Log Out

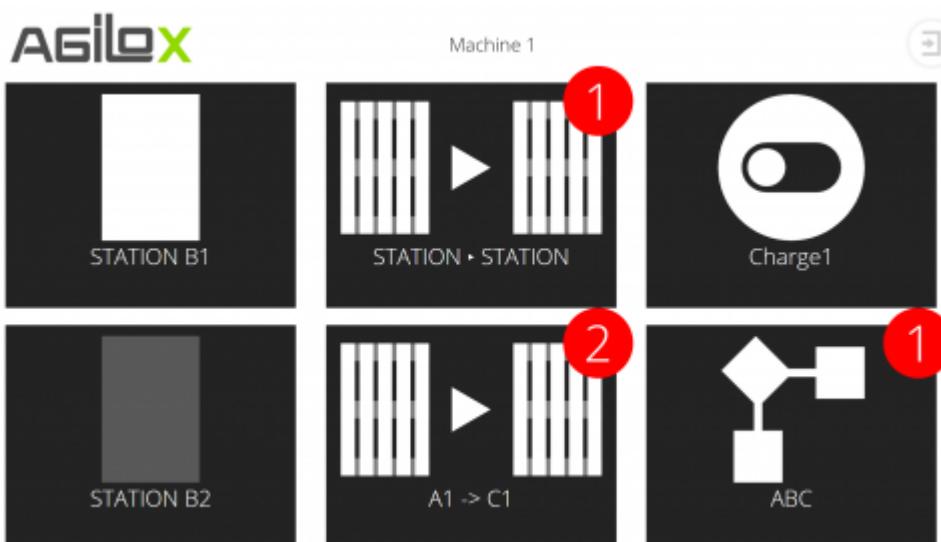
The current user will be logged out in the AGILOX user interface, preventing operation of AGILOX vehicles by uninstructed/unauthorized persons.

6.3 Workflow Views

6.3.1 Example for a workflow view (easy buttons):

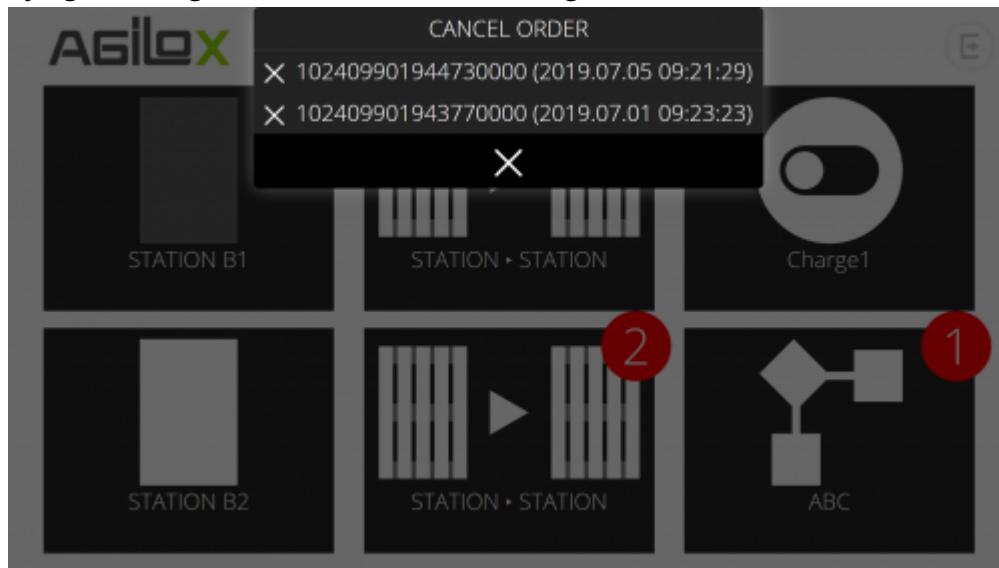


- The name of the workflow view is shown on top
- The red number is a feedback from the system and shows how many times this workflow is pending or already in progress. In this case 'ABL' is one time pending or already in progress.
- The blue number shows the number of suborders (e.g. supply/dispose), that this workflow created.
- The yellow triangle shows that the AGILOX vehicle has stopped due to a problem/failure.
- The Toggle is green when it is on and black when it is off.



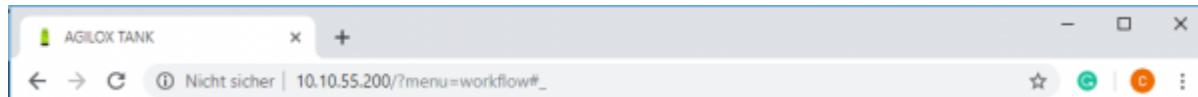
- Stations are white when they are occupied and grey when they are free.
- The same workflow can be present more than once with different variables.

By right-clicking on a workflow button existing orders with that workflow can be cancelled.

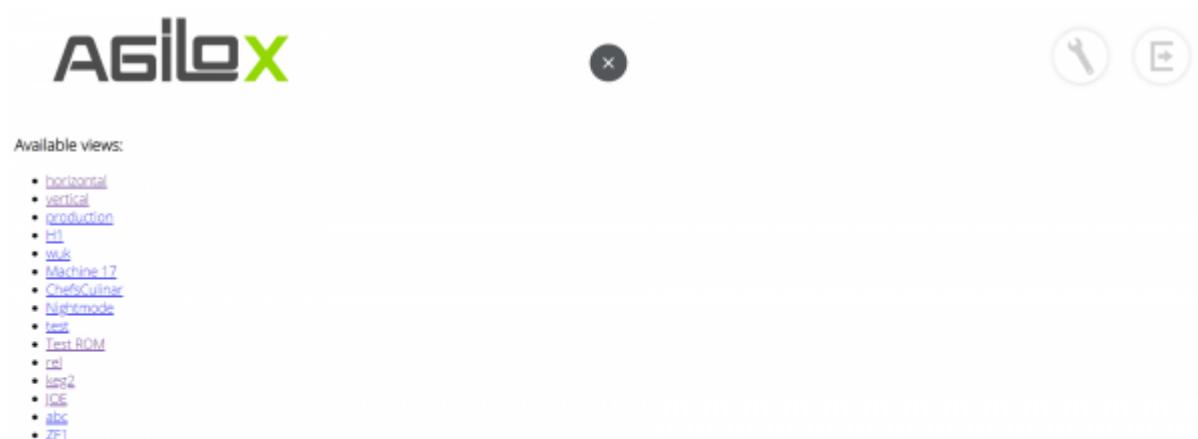


6.3.2 Available Workflow views

To see all available workflow views enter the IP address assigned upon commissioning in your internet browser followed by **/?menu=workflow**:



The available workflow views are shown and can be called.



6.4 Driving Dynamics

6.4.1 Protective Fields

Safety laser scanners are installed at the front corner points on both sides of the vehicle, which have protective fields consigned to them. The protective fields of the AGILOX vehicle are changing depending on situation and speed of the AGILOX vehicle.

Different protective field sets are possible within one AGILOX swarm.

The laser scanner level is at approx. 80mm above the ground. Depending on floor conditions the height can vary. Objects and Persons can only be detected by the safety laser scanner at this height.



The protective fields are shown schematically below. The exact dimensions for EPAL can be found in following attachment:

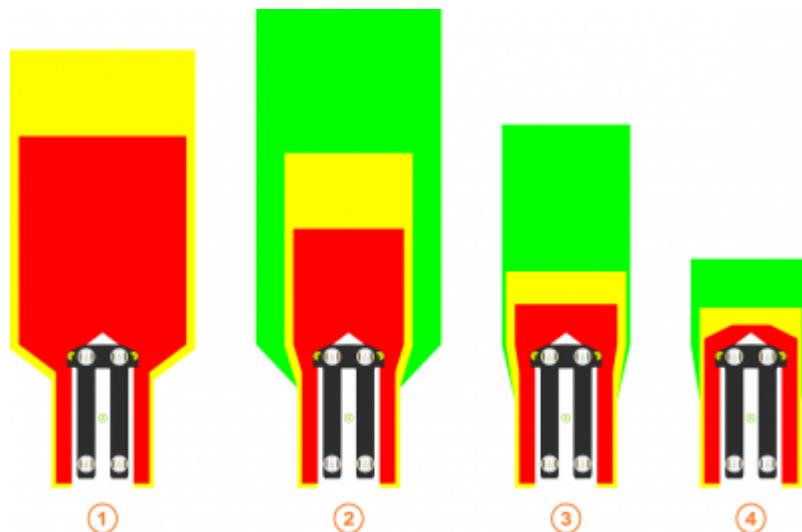
- Protective Fields - Monitoring Cases for EPAL

When objects appear within the safety field (red) the vehicle stops immediately.

When objects appear within the warning field 1 (yellow) the vehicle slows down.

When objects appear within the warning field 2 (green) the vehicle cannot increase its speed.

Protective Fields Straight:



No.	Description	max. Speed
1	straight, very fast	1400 mm/s
2	straight, fast	1000 mm/s
3	straight	500 mm/s
4	straight, slow	250 mm/s

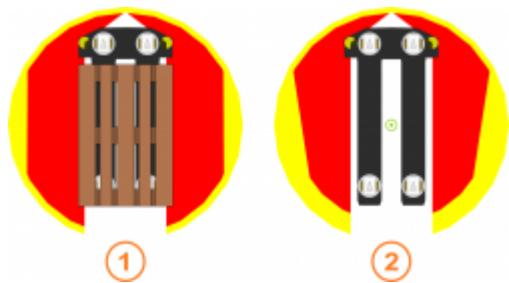
Protective Fields Curves:



No.	Description	max. Speed
1	Curve right/left	500 mm/s (36°/s for AGILOX ONE 1200)
2	Curve right/left tight	500 mm/s (36°/s for AGILOX ONE 1200)

For slow curves (max. speed 250mm/s) the same protective field as for slow driving straight is used.

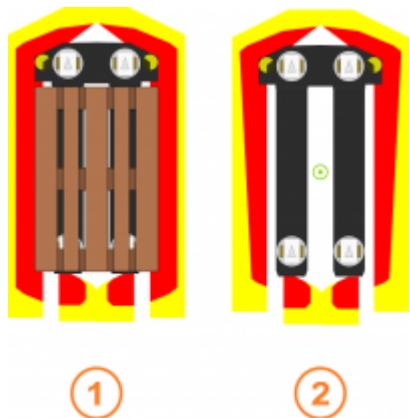
Protective Fields Circle:



No.	Description
1	Circle unoccupied
2	Circle occupied

Protective Fields Positioning

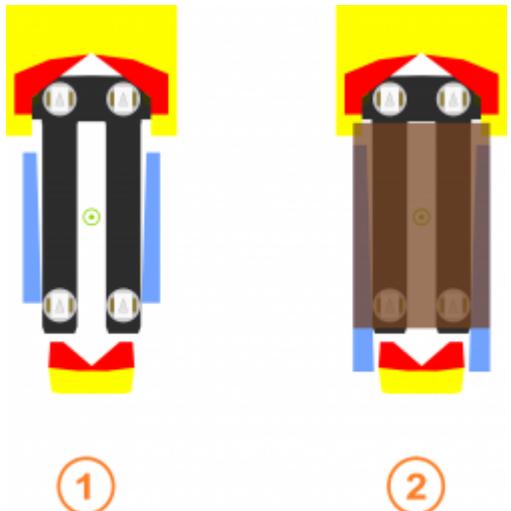
During positioning, before entering a station, the protective fields look as follows:



No.	Description
1	Positioning occupied
2	Positioning unoccupied

Protective Field Station

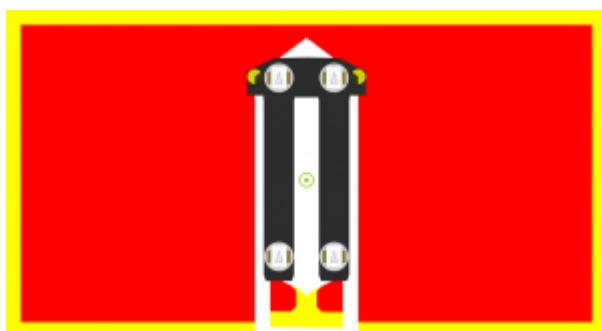
Within a station the following protective field is active. In addition to the protective field, the control system monitors the rear area near the forks (blue). This monitoring is dynamic and not fail-safe. If an obstacle is detected in this area, a "Protective Stop" is triggered. A special workflow can be defined for this purpose. If no workflow is defined, the AGILOX vehicle stops in this case and the start button lights up. The exact procedure for pickup and drop is explained later in this document.



No.	Description
1	AGILOX vehicle unoccupied (at pickup)
2	AGILOX vehicle occupied (at drop)

Protective Field Lift

When lifting above 300mm, the scissor lift is considered a source of danger. Therefore, when lowering the lift from above 300mm, with the AGILOX vehicle standing still and not being within a station, a big protective field is activated.

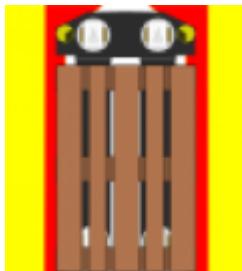


INFORMATION

- For stations with $Z>0$ the "Protective field station" is used.
- Stations with $Z>0$ must be designed in such a way that there is no danger from the scissor lift when lowering.

Protective Field Parallel Drive (Narrow Aisle)

For Narrow Aisles where the AGILOX vehicle uses parallel driving, the following protective field is used:



6.4.2 Load Handling



DANGER

- Stations for pick-ups and drops must be clearly marked.
- Persons are only allowed on the driving path or in the area of movement of AGILOX vehicles, if they are instructed in the vehicle's behavior
- If persons are standing within the area of those stations, the approach of AGILOX vehicles must be prevented.
- Observe safety instructions!



CAUTION

- The default lift height must be defined in a way the load is just above the safety scanner level, to keep the gap as small as possible.



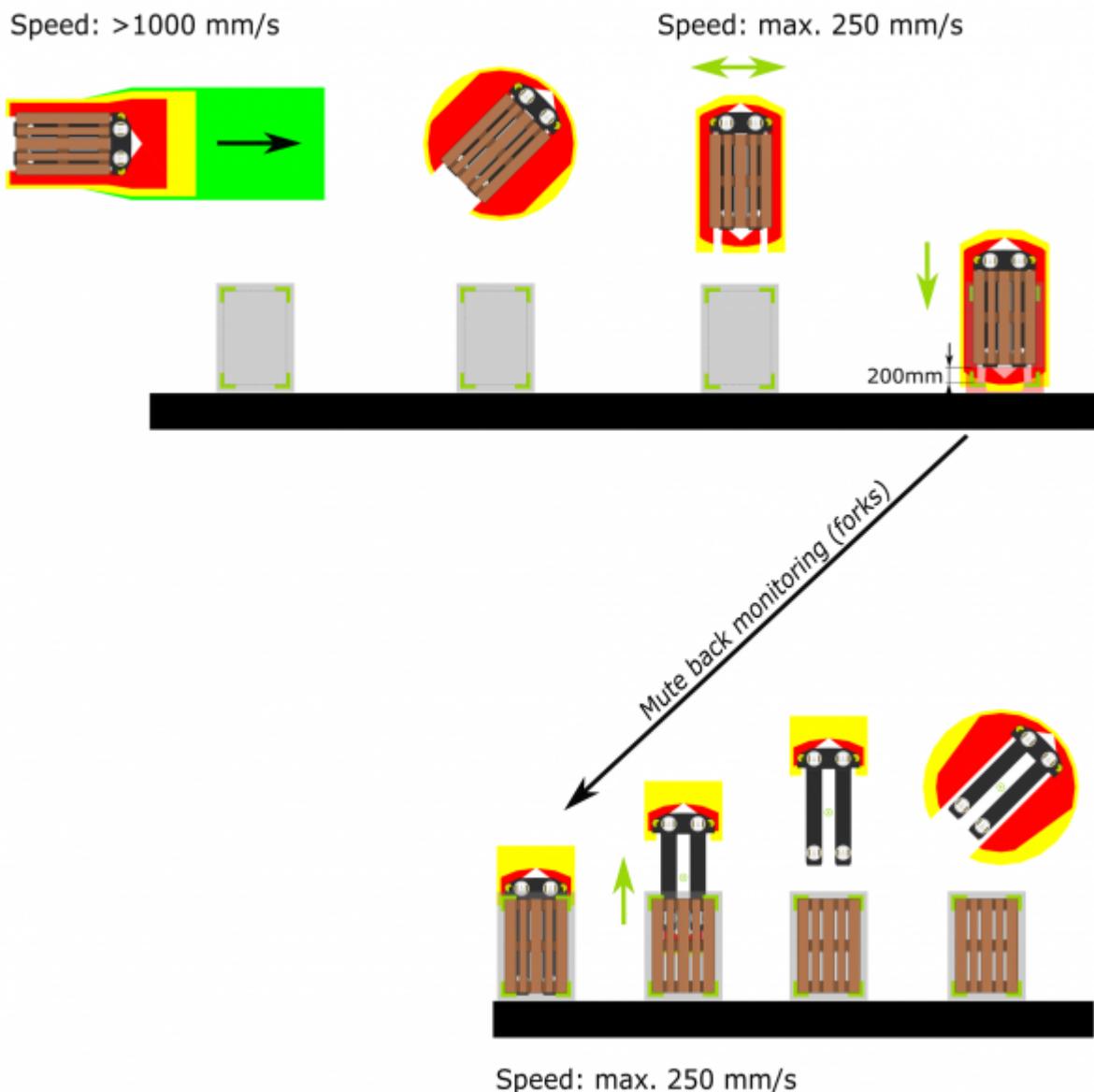
INFORMATION

When the vehicle's lift is in a position higher than 300 mm, it can only be lowered if:

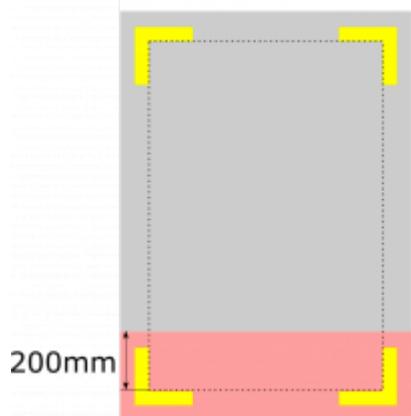
- the AGILOX vehicle has left the station and has reached a defined speed while driving forwards
- the AGILOX vehicle has left the station and there is enough space for the big protective field for lifting to be free
- the AGILOX vehicle is in a station configured with an according STATION TYPE

6.4.2.1 Drop to a Station (STATION TYPE = 0, Z = 0, SAFE DROP = ON)

- The loaded AGILOX vehicle drives to the pre-position of the drop station.
 - Once it has reached the pre-position, the AGILOX vehicle checks, whether the station is completely free. If the station is occupied, the vehicle stays in this position until the station is free or an alternate station has been found.
 - After the station has been checked and is completely free, the vehicle adjusts its position to drive into the station.
 - While driving into the station, the back area of the vehicle is monitored by the safety laser scanner and the ultrasound sensors. If an obstacle is detected, a STOP is triggered. This STOP has to be acknowledged manually. Once the vehicle is 200mm away from the target position, the monitoring in the back is turned off, to be able to drop the load close to a wall if needed.
 - Before lowering, the safety laser scanner checks one more time, if there is anything under the load. If the fork area is free, the load is lowered.
- Since the standard lift height is defined so that the pallet is just above the scanner level, there is no further monitoring of the fork area until the load is on the floor.



Shut-off point when dropping up a load:

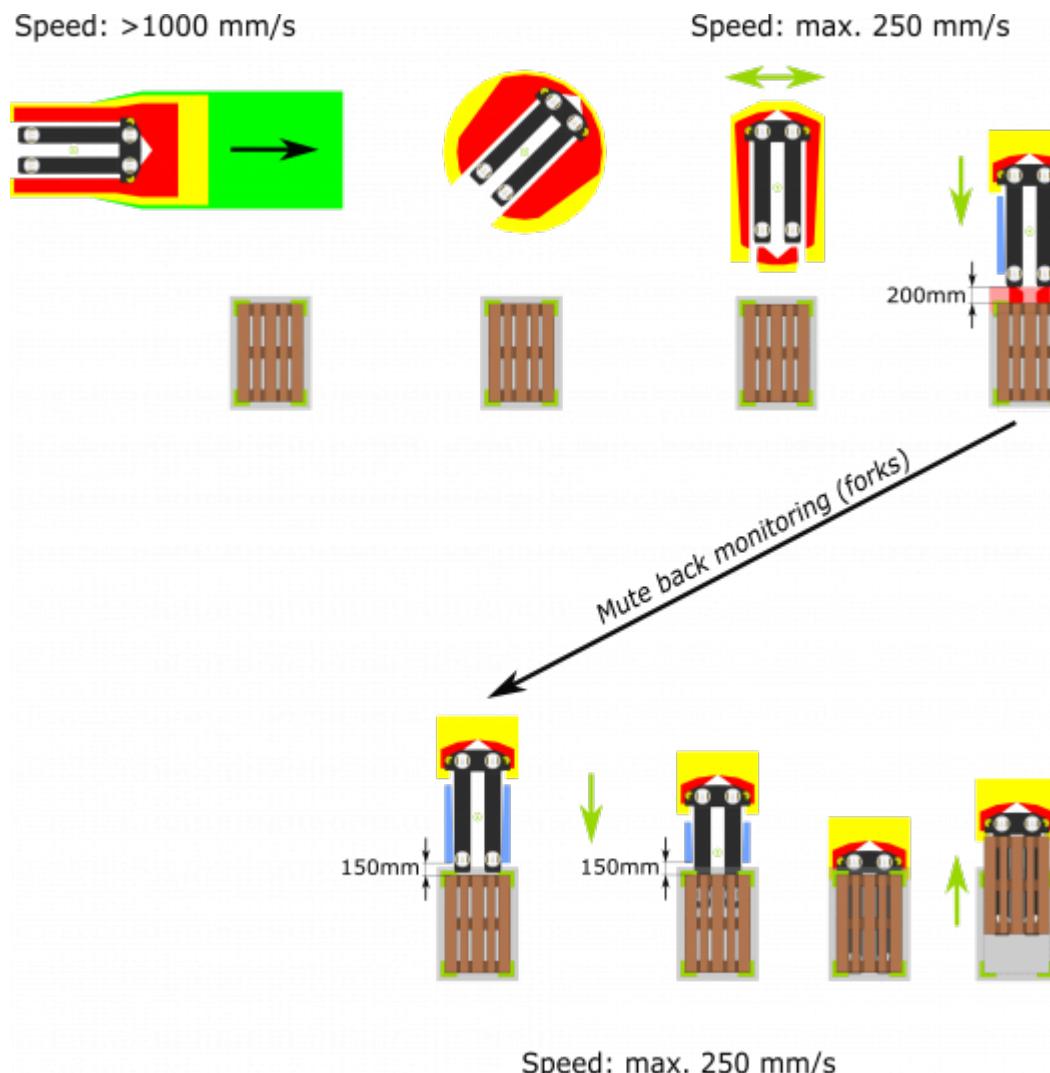


CAUTION

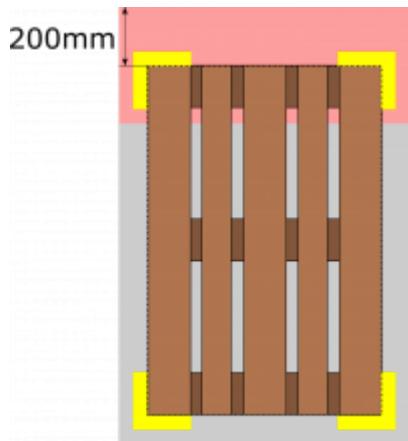
- Before lowering, the safety laser scanner checks once, if the space under the load is free.
- Since the standard lift height is defined so that the load is just above the scanner level, there is no further monitoring while lowering, as otherwise the load would be detected.

6.4.2.2 Pick up from a Station (STATION TYPE = 0, Z = 0)

- The unoccupied AGILOX vehicle drives to the pre-position of the pickup station.
- Once it has reached the pre-position, the AGILOX vehicle validates the occupation of the station. If the occupation of the station is invalid, the vehicle stays in this position until the occupation is valid or an alternate station has been found.
- After the occupation of the station has been checked and is valid, the vehicle adjusts its position to drive into the station (see [6.4.3 - Load Carrier Detection](#)).
- When entering the station, the rear area of the vehicle is monitored by the safety laser scanner and the ultrasound sensors in the forks. 200 mm before entering the load carrier, the rear monitoring by the ultrasound sensors is switched off so that the load carrier can be entered. The monitoring of the area between the pallet and the vehicle by the laser scanner (shown here in blue) is dynamic and not safety oriented. A small area in front of the pallet (150mm) is left without monitoring to allow the pallet to be entered. If an obstacle is detected, a "Protective Stop" is triggered. A special workflow can be defined for this case (see commissioning manual [4.7.11.2 - Protective Stop](#)). If no workflow is defined, the AGILOX vehicle stops in this case and the start button lights up.
- During entering the load carrier following monitoring features are active additionally:
 - Monitoring the position of the load carrier for pushing (tolerance range 150mm)
 - Monitoring AGILOX vehicle for driving against resistance (>100kg)



Shut-off point when picking up a load:



CAUTION

- The pre-position of the station needs to be kept as small as possible.
- Once the AGILOX vehicle has turned for entering, the area between the station and the vehicle must not be entered as long as the vehicle is in automatic mode.
- If it is necessary to enter the area between the AGILOX vehicle and the load in this situation, the vehicle needs to be switched to manual or maintenance operation mode first.

6.4.2.3 Drop to Stations with Z > 0 and STATION TYPE > 0 (e.g. Conveyor Station)

- The loaded AGILOX vehicle drives to the pre-position of the drop station.
- Once it has reached the pre-position, the AGILOX vehicle checks, whether AGILOX IO signals that the station is free. If the station is occupied, the vehicle stays in this position until either the station is free or an alternate station has been found.
- After the station has been signaled as free, the vehicle adjusts its position to drive into the station.
- While driving into the station, monitoring occurs according to the configured station type (see [6.4.4 - Station Types](#) below). If an obstacle is detected, a STOP is triggered. This STOP has to be acknowledged manually.
- The lowering of the load itself is not monitored. Elevated stations must be designed in such a way that there is no danger from the scissor lift when lowering!



CAUTION

- The pre-position of the station needs to be kept as small as possible.
- Starting from the pre-position, monitoring occurs according to the configured station type (see [6.4.4 - Station Types](#) below).
- Elevated stations must be designed in such a way that there is no danger from the scissor lift when lowering.

6.4.2.4 Pick up from Stations with Z > 0 and STATION TYPE > 0 (e.g. Conveyor Station)

- The unoccupied AGILOX vehicle drives to the pre-position of the pickup station.
- Once it has reached the pre-position, the AGILOX vehicle checks, whether AGILOX IO signals that the station is occupied. If the station is not occupied, the vehicle stays in this position until either the station is occupied or an alternate station has been found.
- After the station has been signaled as occupied, the vehicle adjusts its position to drive into the station.
- While driving into the station, monitoring occurs according to the configured station type (see [6.4.4 - Station Types](#) below). If an obstacle is detected, a STOP is triggered. This STOP has to be acknowledged manually.
- The pick up of the load within the station is not monitored. Elevated stations must be designed in such a way that there is no danger from the scissor lift during pick ups!



CAUTION

- The pre-position of the station needs to be kept as small as possible.
- Starting from the pre-position, monitoring occurs according to the configured station type (see [6.4.4 - Station Types](#) below).
- Elevated stations must be designed in such a way that there is no danger from the scissor lift during pick ups.

6.4.3 Load Carrier Detection

For picking up loads from the floor ($z=0$) the AGILOX vehicle is using a detection to recognize and compensate potential offsets or turns of the pallet.

Therefore, the AGILOX vehicle scans the surrounding of a station within a tolerance area. There are two different ways of load carrier detection, which can be adjusted in the system settings ([Commissioning Manual 4.3.7.1 - System Settings](#)):

- Tolerant Load Carrier Detection
- Strict Load Carrier Detection

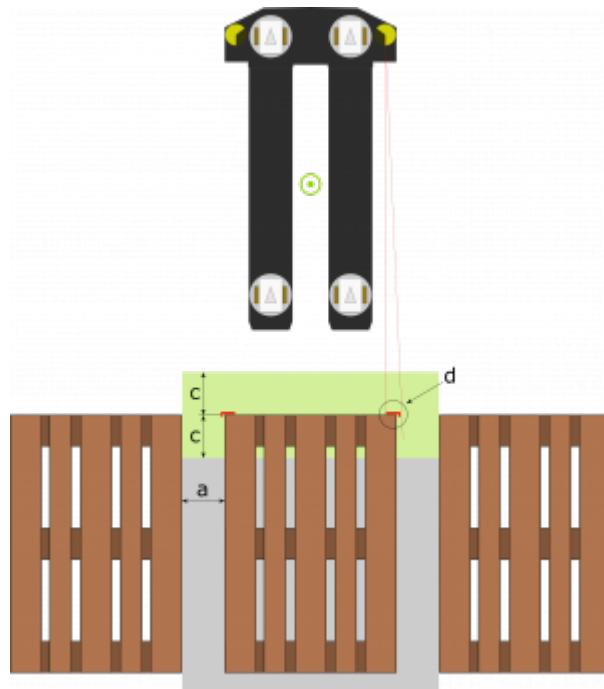
6.4.3.1 Tolerant Load Carrier Detection (Default)

The allowed tolerance area for the position of a load carrier is determined as follows:

The maximum offset left and right in both direction (a) equals the distance to the next station or 100 mm maximum. This offset can be set to a lower value in the station parameters (Tolerance X in [Commissioning Manual 4.3.2 - Stations](#)).

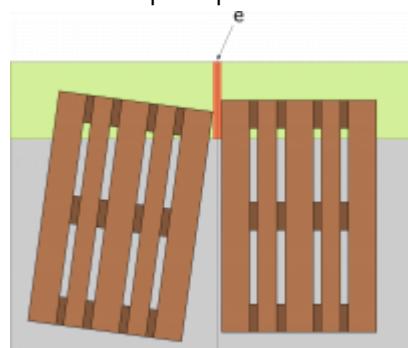
The offset (c) is set to 180 mm in both directions.

The edges of the load carrier are being searched for within the tolerance area (green). An edge is detected, if one scan point is at least 50 mm back from the one before (d). The AGILOX vehicle enters the station in the middle of the two detected edges of both sides.



If there is no edge detected within the tolerance area, this leads to a process failure.

If the detected edge is too close to the sides of the tolerance area (<15 mm), this also leads to a process failure. This means that the minimum distance between two stations (e) must be at least 30 mm, in order to detect and pickup the load carrier correctly.



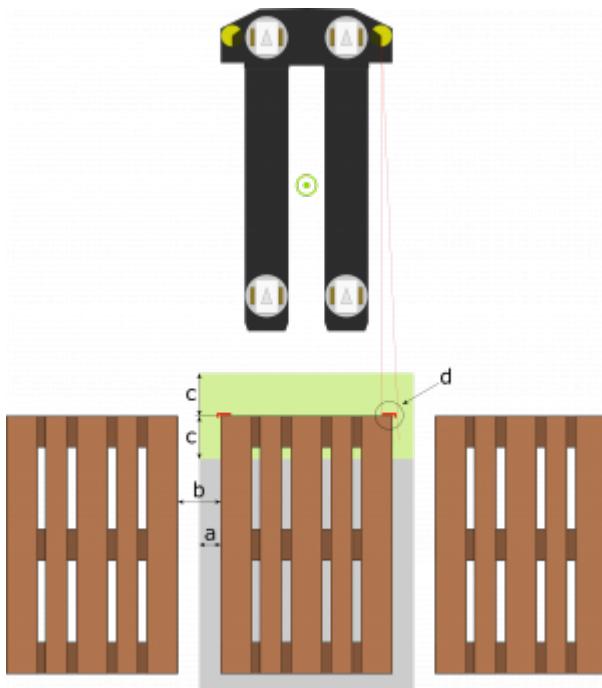
6.4.3.2 Strict Load Carrier Detection

For some load carriers the tolerant load carrier detection does not lead to a correct entering of the station. For example special load carriers like this:



In this case it is possible, that the AGILOX vehicle detects the inner edge of the foot on one side and the outer edge on the other side, and entering in the middle of the two detected edges would lead to a collision with the load carrier. To avoid this, the strict load carrier detection should be chosen in the system settings.

Compared to the tolerant load carrier detection, the strict load carrier detection uses half of tolerance area on left and right side (a). The offset (c) is set to 180 mm in both directions again. The edges of the load carrier are detected again, but this time the **outer edges** detected within the tolerance area are used to determine the entering of the station.



This means, that there must not be any contour 80 mm from the ground within the green area, that is not part of the load carrier!

If there is no edge detected within the tolerance area or the detected edge is outside the tolerance area, this leads to a process failure.

If the detected edge is too close to the sides of the tolerance area (<15 mm), this also leads to a process failure. This means that the minimum distance between two stations (e) must be at least 30 mm, in order to detect and pickup the load carrier correctly.

This method allows to detect special load carriers correctly. Because of the smaller tolerance area and the more delicate detection, this method should only be used where the tolerant load carrier detection does not lead to a satisfying detection of the load carriers.

6.4.4 Stationtypes

During Commissioning, the stationtypes for all stations are defined. The default stationtype is stationtype 0 (fork tip auto).

If the stationtype needs to be changed, the highest possible stationtype is preferred as it is the safest. Following stationtypes are possible:

- **FORK TIP AUTO [0]:** The sensors of the fork tips are activated and deactivated automatically (default). See Station Entering above.
- **FORK TIP OFF [1]:** The sensors of the fork tips are deactivated during station entering. Only for special cases, be very careful!
- **FORK TIP PROTECTIVE FIELD ONLY [2]:** The sensors of the fork tips are using the safety field for station entering.
- **FORK TIP ON [3]:** The sensors on the fork tips are active during station entering.

The station type is shown in the tooltip of the station in the visualization. A special symbol on the station shows that the station type is not "Fork tip auto".

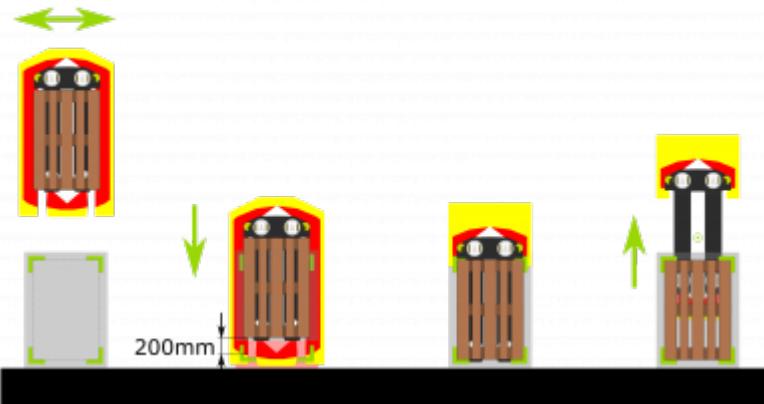
If stations are created, they automatically have stationtype 0 ("Fork tip auto"). Station types are automatically set to station type 0 ("Fork tip auto") when stations are copied, even if the original station has a different station type.

6.4.5 SAFE DROP / SAFE DROP +

In order to make dropping a load even safer, SAFE DROP or SAFE DROP+ can be activated on stations.

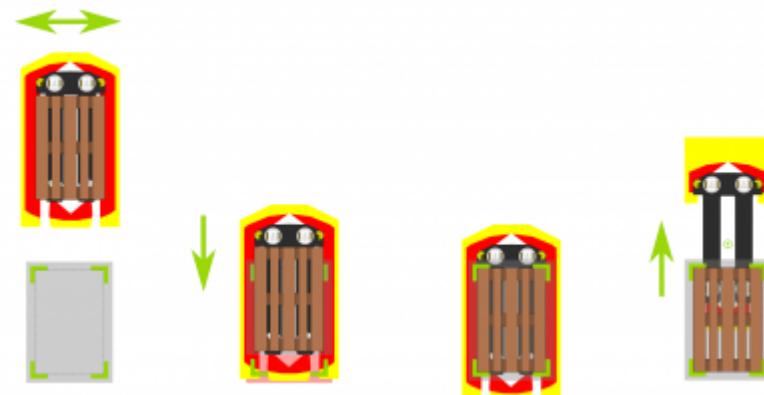
- **SAFE DROP ON:** station entering for dropping off a pallet is done with the bigger protective field "positioning" until 200mm before the end of the station. After that the system switches to the smaller protective field "station".

Speed: max. 250 mm/s



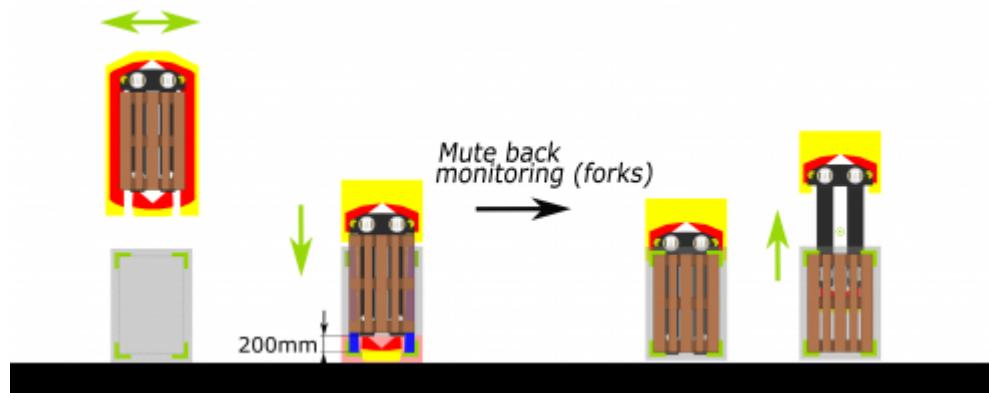
- **SAFE DROP + ON:** The complete station entering for dropping off a pallet is done with the protective field "positioning"

Speed: max. 250 mm/s



- **SAFE DROP OFF:** After positioning the system immediately switches to the protective field "station".

Speed: max. 250 mm/s



6.4.6 Current Monitoring during Station Entering



CAUTION

- The current monitoring during station entering is not part of the personal safety concept. This is no guarantee for safe operation, obstacles are only detected with a certain probability.
- The function can be activated or deactivated in the AGILOX system settings in the HMI.
- The function is only available starting as of control version 3.20.1
- The function is only active when the vehicle is occupied.
If the vehicle is empty when entering a station (e.g. for pick ups), the function is not active.

6.4.6.1 Description Current Monitoring during Station Entering

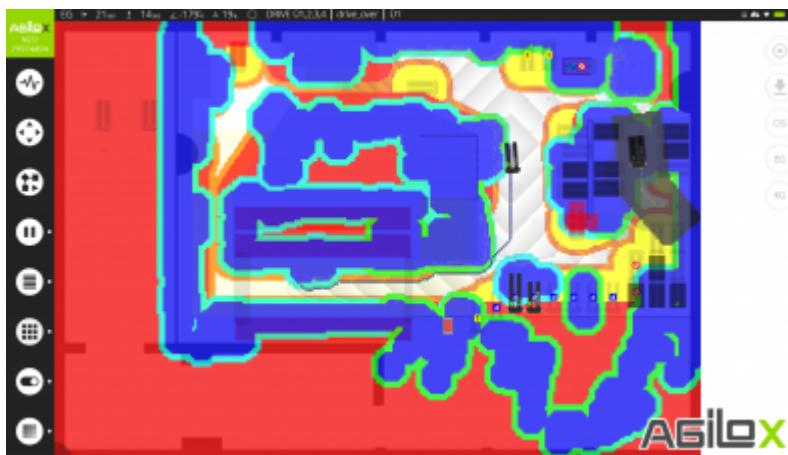
- The AGILOX vehicle determines the sum of all current motor currents during each occupied station entering.
- Depending on current speed, current load and current acceleration, a current limit is calculated.
- If the sum of the motor currents exceeds the calculated limit, an error is generated which needs to be acknowledged.

6.4.6.2 Limits of Current Monitoring during Station Entering

- Test Setup:
 - An occupied AGILOX vehicle enters a station
 - Behind the vehicle, a wooden EPAL with 100kg is laying on a normal industrial floor.
 - The current monitoring during station entering detects the collision immediately and generates an error which needs to be acknowledged.

6.4.7 Route Determination

Route determination is based on the live route map. In addition to the route map, which is created during commissioning, the live route map also contains all currently detected obstacles of the entire fleet and is updated every second.



When finding a route to the target, all possibilities and obstacles are considered at once. The determined route is checked for its cost every 2 seconds. Avoidance areas or soft directions defined in the map of movement, result in higher costs and therefore are being avoided if possible. If those areas are driven on, then as little as possible, but they are not ignored when finding a route.

Other AGILOX vehicles and their routes are always taken into account. AGILOX vehicles without a route are interpreted as soft one-way direction. This means AGILOX routes are avoiding each other and vehicles bypass each other, if the costs allow this and it is even possible. This also results in AGILOX vehicles potentially driving in a different direction to avoid another AGILOX vehicle or overlapping routes.

Fringe areas (orange areas of route map) are considered to cause higher costs and therefore avoided if possible.

This also applies to dynamic obstacles, which leads to AGILOX vehicles per definition staying away from obstacles as far as possible.

Tracks defined in the map of movement, reduce costs and affect everywhere. If a track is close by, also on white areas, it is always route-optimized preferred. With this option desired routes can be created, which are used as far as possible.

The AGILOX vehicle makes no short cuts, which would lead to a change of situation. Because of considering many different factors (tracks, avoidance, orange areas, ...) a short-cut cutting through those areas is not made.

A short-cut is also always only determined for the next meters which results in driving close to the sides.

AGILOX vehicles possess a memory for their surroundings to avoid obstacles and blocked passages. Obstacles are rated according to distance and time and are also forgotten again. The routing takes this rating into account and can therefore react dynamically to obstacles that have been seen recently. Information about obstacles is included in the live route map, which is also used by all other AGILOX vehicles in the fleet. This means that obstacles which are detected by another AGILOX vehicle are also taken into account in the route.

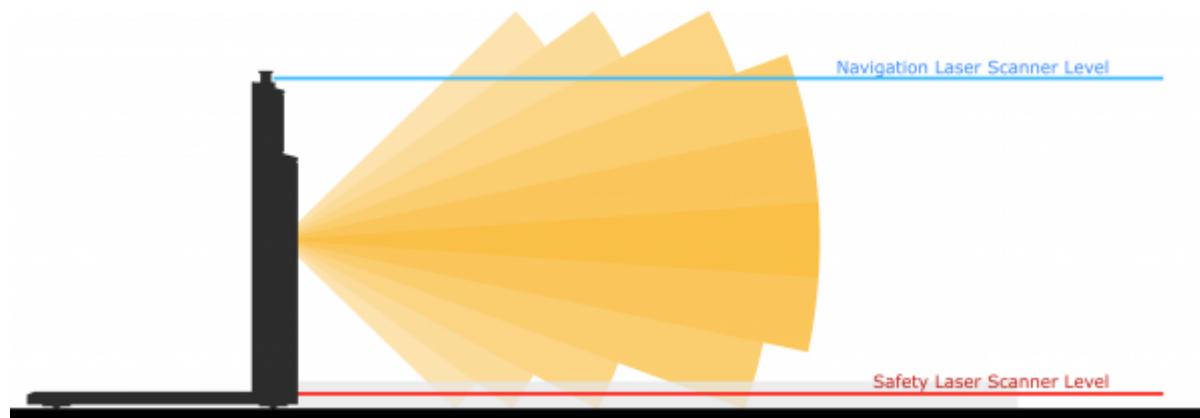
6.4.7.1 Obstacle Detection

The AGILOX vehicle can detect obstacles on two levels:

- approx. 80 mm above the floor by the safety laser scanner
- approx. 1830 mm above the floor by the navigation laser scanner

If the vehicle is equipped with optional obstacle avoidance sensors, an additional area in front of the vehicle can be monitored for obstacles. See [3.2.10 - Optional Obstacle Avoidance](#).

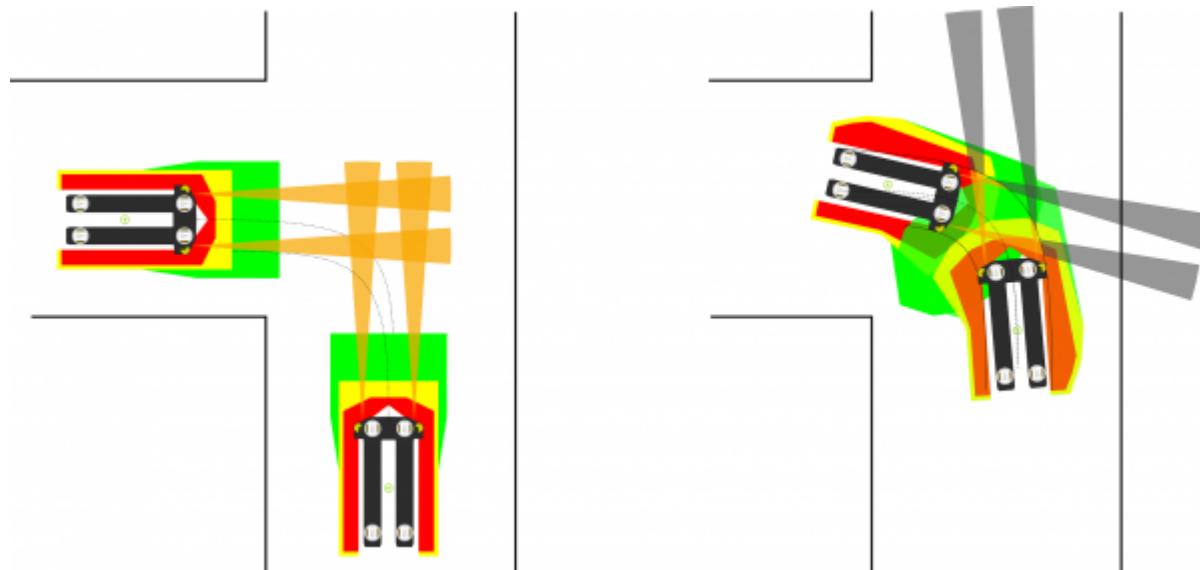
Obstacle Avoidance



6.4.7.2 WLAN Coverage in Junction Areas

At junctions or on corners, the sensor system would only detect another AGILOX vehicle at the very last moment. For this reason, route determination is designed in a way that other AGILOX vehicles and their routes are always taken into account and avoid each other as far as possible.

To avoid collisions, it is very important that there is good WLAN coverage in these areas to know the exact position and routes of all vehicles.



6.4.8 Station/Channel Locking

If not defined otherwise, a target station or the first channel of the action is locked, when the AGILOX vehicle is 15m away from it. The AGILOX vehicle stops if it is 8m from the target and the lock is not granted yet. If the AGILOX vehicle is less than 8m away from the target, it locks the target immediately will not start driving until the lock is granted.

Additionally also adjacent stations, closer than 2.5m from the target are also locked to avoid AGILOX vehicles blocking each other.

When an AGILOX vehicle is leaving a station, the station and adjacent stations are also locked, so that other vehicles cannot drive to the same station at the same time.

Charging stations and parking stations are always reserved exclusively for the AGILOX vehicle during target determination already, which means before the AGILOX vehicle starts driving there.

Furthermore an action of a Workflow can have the attributes "lock_immediate" and/or "lock_group", which are described in [Commissioning Manual 4.7.6 - Workflow Action Object](#).

6.4.9 Navigation Match and Adaptive Smart Discovery (ASD)

During driving the AGILOX vehicle compares the actual value from the navigation scanner to the initially acquired data from commissioning.

The Navigation Match tells the percentage of how many of the actual measuring points from the navigation scanner match the ones from commissioning.

In areas with low navigation match, the AGILOX vehicle can automatically use its temporary surroundings for navigation. By using the navigation scanner, the AGILOX vehicle creates its own temporary navigation map (ASD Map) to continue driving. The ASD Match shows the percentage match between the ASD Map and the actual data from navigation scanner. If ASD match sinks below a specific level, another temporary map is created. AGILOX vehicles can drive up to 200m creating more and more ASD maps.

ASD Run is the count of maps created.

When the AGILOX vehicle drives into a better known area again and the navigation match rises above 35% again, the ASD function shuts off automatically and all temporary ASD maps are deleted.

6.4.10 Speed Restrictions

6.4.10.1 At Bad WIFI Communication

Starting from 1 second latency to an AGILOX vehicle the speed of all vehicles is reduced to avoid collisions. No more reachable vehicles on stations, however, are ignored for this speed limitation. The multi-step speed restriction is related to the highest latency to an AGILOX vehicle.

Per 1 second latency the speed is reduced by 0.4m/s down to a minimum of 0.25m/s.

Starting from 1 second latency the Wifi symbol in the visualization is shown in yellow and from 3s latency it turns red. The communication quality is also shown in a tooltip on top.

When the communication gets better again, the speed is increased slowly again.

6.4.10.2 Close to other AGILOX vehicles

The AGILOX vehicle reduces its speed to 1m/s if another AGILOX vehicle is in the area of 5m around the vehicle.

If another AGILOX vehicle is within 2m, the velocity is reduced to 0,5 m/s.

6.4.10.3 With raised lift (lifting height > 300mm)

With a lifting height of > 300mm, the turning speed and curve speed is limited to 250mm/s and the normal travel speed to 500mm/s.

6.4.10.4 For parallel drive

When driving parallel with raised lift, the increased centre of gravity can lead to an increased risk of tipping. For this reason, starting with **control version 3.32.1**, the speeds for parallel driving were limited as follows.

Lifting Height	Single Scissor Lifting System	Double Scissor Lifting System
0 mm	500 mm/s	500 mm/s
0 - 160 mm	500 mm/s	250 mm/s
161 - 300 mm	250 mm/s	100 mm/s
> 300 mm	50 mm/s	50 mm/s

6.4.11 Behavior in Case of Fire

If a fire alarm system is implemented, the AGILOX vehicle behaves as follows in case of fire:

The AGILOX vehicle stops immediately and is looking for the closest point on the map in the orange area of the route map, that is not on a clearway area. This point is the vehicle's target. Avoidance areas are ignored in this case. When the target is reached, the start button is lit and the AGILOX vehicle is waiting for acknowledgment.

Alternatively, a workflow with the ID "fire" can be defined, which will be started in case of fire.

If the AGILOX vehicle is within a station when the fire alarm appears, it stops immediately, lights the start button and is waiting for acknowledgment.

If the AGILOX vehicle is on a charging station when the fire alarm appears, the start button also lights up and the vehicle is waiting for acknowledgment as well.

7. Maintenance and Repairs



DANGER

The safety instructions for servicing and maintenance in chapter [2.6.6 - Service and Maintenance](#) must be observed!

7.1 Training and Skills Required by Maintenance and Repair Staff

All maintenance staff needs to be trained by AGILOX North America, Inc.. Maintenance tasks must only be performed by assigned maintenance teams.

7.2 AGILOX Vehicle Error Messages

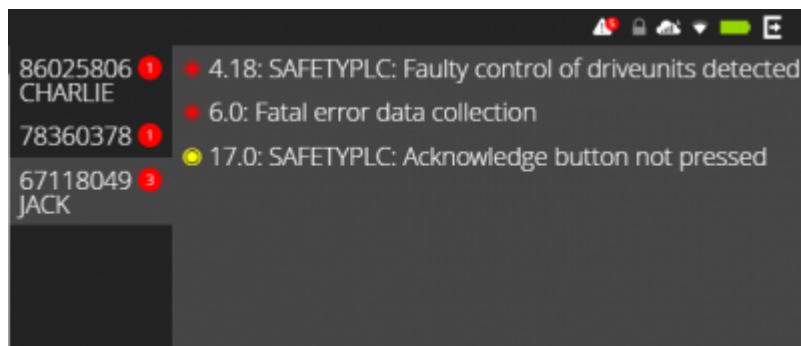
All error messages, warnings and process notifications will be displayed in the AGILOX user interface. Additionally, AGILOX vehicles will emit acoustic and visual warning signals.

7.2.1 Error Messages Displayed on the AGILOX User Interface

Error messages for the AGILOX system will be visualized in the status bar of the AGILOX user interface. You can call up a list containing current warnings, error and process messages by clicking on the triangle.

For a list of possible error messages, their causes and available elimination options please refer to the relevant attachment [ANNEX V – Error Messages AGILOX Vehicle](#).

Example for errors displayed on the AGILOX user interface:



7.2.2 Acoustic Warning Signals

As and when required, AGILOX vehicles will call attention to their presence by communicating with its surroundings via a loudspeaker.

see [ANNEX I - Audio Signals](#)

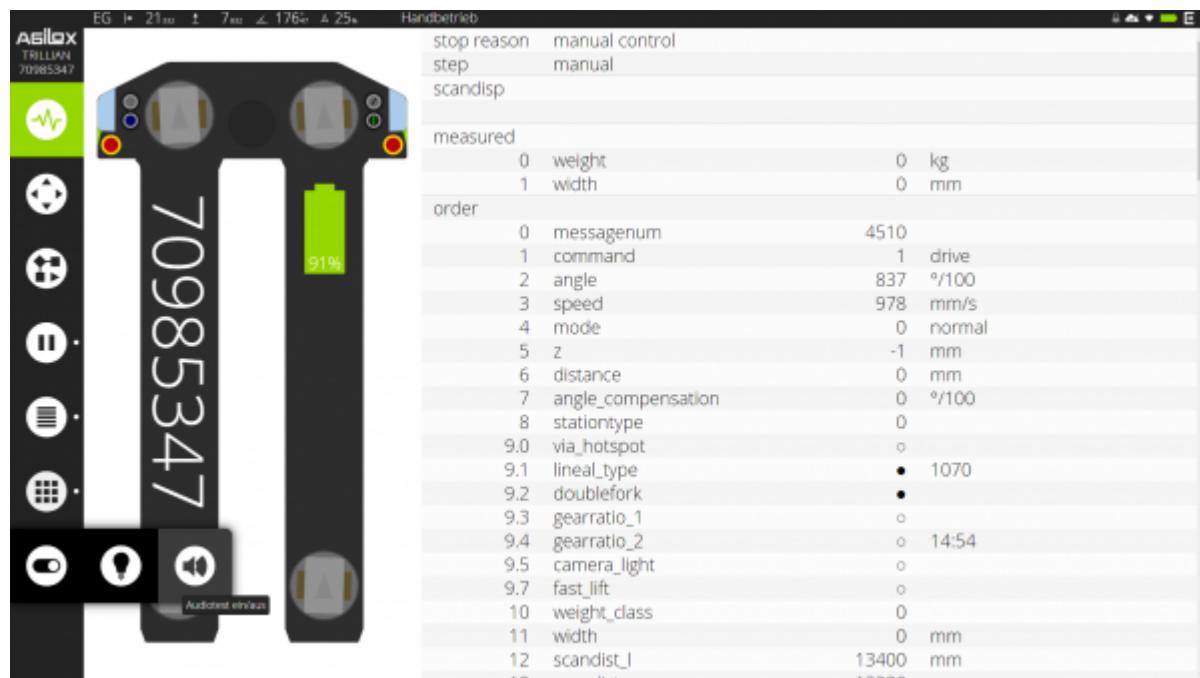
7.2.2.1 Audibility

System operators have to make sure that all persons will be able to notice acoustic warning signals within danger areas. To this end, it may be necessary to implement noise reduction measures.

7.2.2.2 Daily Checks

The AGILOX user interface is able to perform daily checks of the system's acoustic warning signals. Provided that all acoustic warning signals are fully functional, a pilot tone will be sounded when clicking on the loudspeaker symbol. If this pilot tone is not audible, the vehicle must remain shut down until this malfunction has been corrected.

User level ADMIN is required for this check.



7.2.3 Visual Warning Signals

see ANNEX II - Visual Signals

7.2.3.1 Direction Indicators

AGILOX vehicles signal changes of direction by flashing direction indicators, with the appropriate indicator flashing in white. Changes of direction, however, will not be preceded by flashing indicators when the vehicle spontaneously detects an obstacle.

7.2.3.2 Malfunctions Subject to Mandatory Confirmation

In case of malfunctions subject to mandatory confirmation, both indicators will start flashing, pulsing in red in addition to the triggered corresponding error messages. The relevant malfunction will be displayed on the HMI.

7.2.3.3 Daily Checks

The AGILOX user interface is able to perform daily checks of the system's visual warning signals. If the signal lights don't work the AGILOX vehicle is not ready for use and has to be turned off until the failure is repaired. User level ADMIN is required for this check.



7.3 Inspection Plan for the Area of Movement

System operators must comply with all movement area requirements at all times (see [2.1.2 - Movement Area](#)) and ensure that the area of movement is kept clean. To this end, the system's area of movement has to be inspected at regular intervals.

7.4 Maintenance Plan

7.4.1 System Operator

System operators are required to carry out the following recurring tasks on their AGILOX vehicles in accordance with the following maintenance protocol.

- Maintenance Protocol CUSTOMER (Appendix)

Furthermore, system operators must comply with the applicable national regulations stipulated in accordance with the Work Equipment Directive 2009/104/EC.

According to the Work Equipment Directive, recurring checks must be carried out by a suitable, qualified person in accordance with national regulations as well as every 4 years by an accredited test center. The system operator has to inform himself about national rules and regulations.

7.4.2 Manufacturer

The system operator must ensure that maintenance is carried out every six months and additionally a safety check is carried out annually by AGILOX North America, Inc. or an AGILOX system partner.

Maintenance is performed according to the following protocol:

- Maintenance Protocol (by AGILOX North America, Inc., Appendix)

If a system operator chooses to perform maintenance tasks themselves or fails to avail themselves of the maintenance package during the applicable warranty period, AGILOX North America, Inc. is unable to assume any liability for such AGILOX vehicles.

The Service Life of an AGILOX vehicle ends after 10 years.

At certain operating conditions, shorter maintenance intervals may apply according to the maintenance contract.

7.5 Maintenance

As a general principle, all maintenance tasks must be carried out by AGILOX North America, Inc. or a system partner. If a system operator chooses to perform maintenance tasks themselves or fails to avail themselves of the maintenance package during the applicable warranty period, AGILOX North America, Inc. is unable to assume any liability for such AGILOX vehicles.

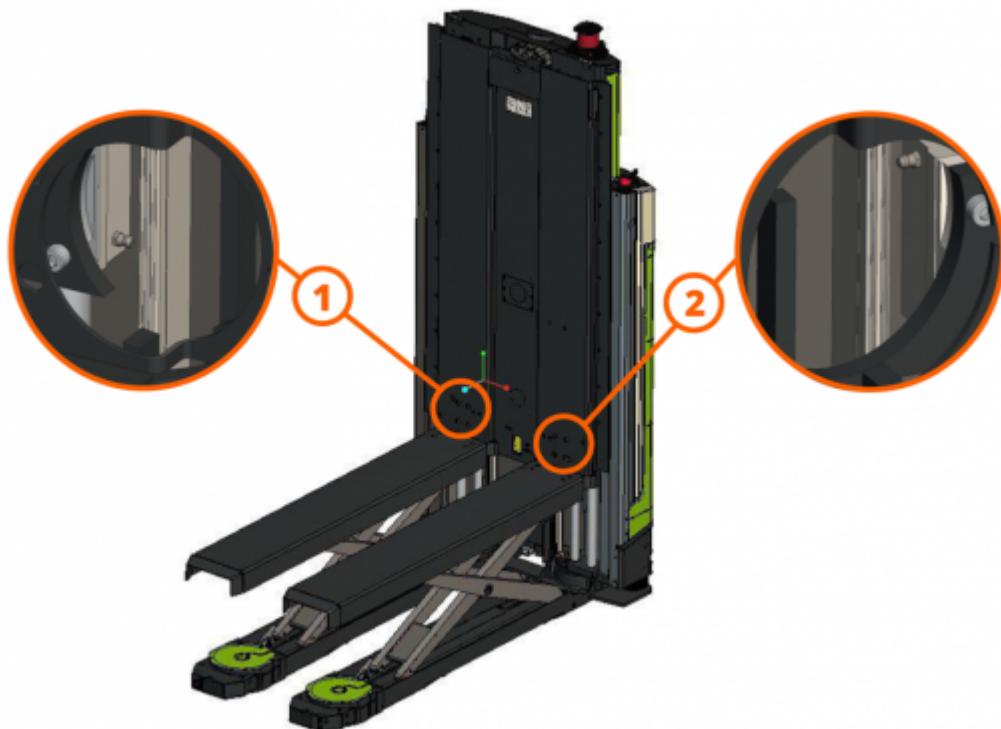
7.5.1 Mechanical System

7.5.1.1 Drive Units

- Tighten bolts with correct torque according to torque table (careful, aluminum!)

7.5.1.2 Lifting Spindle

1. Grease lubricating nipples (1) and (2) with THK GREASE OIL AFB-LF GRS (70G)-E (THK item number: 28511000701000)
2. Tighten bolts with correct torque according to torque table



7.5.1.3 AGILOX Vehicle in General

1. Check if bolts are properly tightened
2. Tighten bolts with correct torque according to torque table

7.5.2 Electronic System



DANGER

Risk of death due to electric shocks

Work carried out on, or in the vicinity of, live components may lead to fatal injuries or even death.

- Any such tasks must only be carried out by electrical specialists
 - Be sure to observe all general safety rules
 - The Five Electrical Safety Rules must be complied with
-
- Mechanical functional testing and visual inspection of charging contacts
 - Check springs of charging contacts

7.6 Cleaning



DANGER

Risk of crushing

Risk of crushed hands and feet due to unexpected movements by AGILOX vehicles

- Press the vehicle emergency stop switch to shut down the AGILOX vehicle before starting any cleaning tasks

7.6.1 Cleaning AGILOX Vehicle Components

7.6.1.1 Charging Contacts

Remove any dust and dirt from the charging contacts with a dry cloth

7.6.1.2 Drive Unit

Introduce pressurized air from below the vehicle to remove any dust from the drive unit

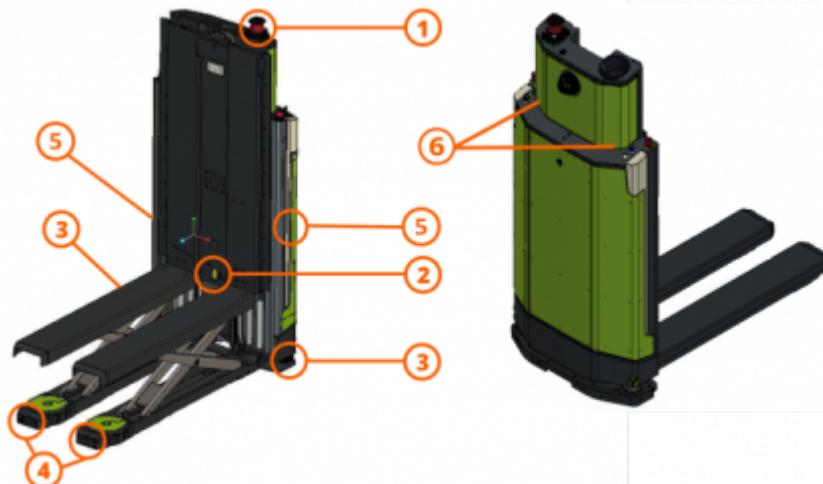
7.6.2 Cleaning the Sensors



NOTICE

The use of inadequate detergents may damage the vehicle's sensors.

- Do not use acetone or detergents containing solvents
- Do not use aggressive detergents
- Do not use abrasive detergents



Nr.	Description	Cleaning
1	Navigation laser scanner	Clean with a dry or moist soft cloth.
2	Distance and light sensors	Clean with a soft cloth and a plastic cleaner
3	Safety laser scanner	Clean with suitable special cloth according to manufacturer specifications and an antistatic plastic cleaner
4	Ultrasound sensor	Clean with a dry or moist soft cloth
5	Obstacle Avoidance System (former Collision Avoidance System, optional)	Clean with a dry or moist soft cloth
6	DMS strain gauges for weight monitoring (optional)	—

7.7 Durability of Components

Component	Manufacturer	Durability according to manufacturer specification
Rotary encoder drive units	ASM Ltd.	10 Years
Incremental-ruler lift	ASM Ltd.	10 Years
Sealing rings Ultrasound sensors	Mayser GmbH & Co KG	5 Years
Ultrasound sensors	Mayser GmbH & Co KG	10 Years
Safety laser scanner SICK S300	SICK AG	20 Years
Safety laser scanner SICK MicroScan 3	SICK AG	20 Years
Navigation laser scanner	Pepperl&Fuchs Ltd.	no information
Obstacle avoidance sensors	Pepperl&Fuchs Ltd.	no information
Battery Control CX9020	Beckhoff Automation Ltd.	5 Years
Battery Control CX5120	Beckhoff Automation Ltd.	5 Years
Safety control Beckhoff TwinSAFE	Beckhoff Automation Ltd.	20 Years
Safety control Flexisoft	SICK AG	20 Years

8. Decommissioning and Disposal

The manufacturer is prepared to take back all components by individual agreement. When disposing of AGILOX vehicles, system operators are required to ensure compliance with all local disposal regulations and guidelines.

8.1 Batteries

Please refer to the Battery Safety Data Sheet regarding the disposal of batteries.

8.2 Packing Materials

Store the shipment box or dispose all packaging materials according to local regulations and guidelines.

9. Engineering Specifications

General AGILOX Vehicle Data	
Length / Width / Height in driving position	
AGILOX ONE 1200	1510 mm / 800 mm / 1870 mm
AGILOX ONE 1400	1710 mm / 800 mm / 1870 mm
AGILOX ONE 1600	1910 mm / 800 mm / 1870 mm
AGILOX ONE 1800	2110 mm / 800 mm / 1870 mm
Length / Width / Height in lifted position	
AGILOX ONE 1200 with Double-Scissor Lifting System	1510 mm / 800 mm / 2460 mm
AGILOX ONE 1200 with Single-Scissor Lifting System	1510 mm / 800 mm / 1950 mm
AGILOX ONE 1400	1710 mm / 800 mm / 1950 mm
AGILOX ONE 1600	1910 mm / 800 mm / 1950 mm
AGILOX ONE 1800	2110 mm / 800 mm / 1950 mm
Vehicle Weight	
AGILOX ONE 1200	400 kg
AGILOX ONE 1400	435 kg
AGILOX ONE 1600	460 kg
AGILOX ONE 1800	480 kg
Additional AGILOX Vehicle Data	
Detection area barcode scanner (optional)	W=800 mm x H=900 mm above upper edge of EURO pallet Detection distance 700 mm
Height of navigation scanner plane	1830 mm
Height of safety scanner plane	80 mm
IP Protection Class	IP20
Center of gravity	Located approximately at the intersection of the diagonal of the forks
Positioning accuracy	+/- 4mm (in standstill and at map quality >= 25%)
Weight measurement accuracy	+/- 50kg
Lifting speed lifting when empty / lowering	66 mm/s
Lifting speed lifting with load	33 mm/s
Lifting speed Maintenance mode	1.67 mm/s
Sound level of warning signals (distance 1m)	min. volume setting: approx. 78dB max. volume setting: approx. 90dB

Drives	
Drive units	Electric motors
Tire material	Vulkollan (96 Shore)
Number of drive units	4 units
Drive power per drive unit	400 W
Maximum speed when driving forward	1.4 m/s
Maximum speed when driving curves	0.5 m/s (equivalent to 36°/s for AGILOX ONE 1200)
Battery (according to the manufacturer's specification)	
Battery technology	High Power Lithium Ion Battery, Phosphate-Based (Battery-Pack with Lithium-Ion Cells) - LiFePo4
Battery manufacturer	VOLTLABOR Ltd.
Nominal voltage	46.2 VDC
Nominal capacity	20 Ah
Nominal energy	924 Wh
Voltage range	28.0 VDC to 50.4 VDC
Std. charging current	20 A (1 C)
Max. charging current	80 A (4 C) only at >10°C Cell temperature
Std. discharge current	80 A (4 C)
Max. discharge current	100 A (5 C)
Max voltage	50,4 V (3,6 V / cell)
Min voltage	35 V (2,5 V / cell)
Battery protections, monitoring	Voltlabor BMS
Fuse	120 A
Operating temperature	-30°C to +55°C
Storage temperature	-40°C to +60°C
Transport of battery with integrated battery management system	UN38.3 passed
Number of batteries	1 unit

Charging station (according to manufacturer's specifications)

Manufacturer	Zivan s.r.l.
Type	NG5
Power supply	480V AC / 15A / 60Hz, NEMA or IEC plug
Output max.	48V DC / 80A

Mobile Charging Device (according to manufacturer's specification)

Manufacturer	Zivan s.r.l.
Type	NG1
Power supply	115V AC (+/- 10%) / 13A / 50-60 Hz
Output max.	48V DC / 18 A

10. Warranty, Liability, Repairs

During the vehicle's warranty period, repairs must only be performed by the manufacturer or persons authorized by the manufacturer.

11. Declaration of Conformity (Excerpt)

This declaration of conformity is valid for the described product.

AGILOX Services Ltd. herewith confirms that the product complies with the following guidelines and standards.

- **EC Machinery directive 2006/42/EC, Annex II 1A**
- **EC Electromagnetic Compatibility directive 2014/30/EU**

The following national or international standards and specifications have been applied:

- **ÖNORM EN 1525: 1997-12-01**
(Safety of industrial trucks - Driverless trucks and their systems)
- **ÖNORM EN ISO 12100: 2013-10-15**
(Safety of machinery - General principles for design - Risk assessment and risk reduction)
- **ÖNORM EN ISO 13849-1: 2016-06-15**
(Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design)
- **EN 61000-6-4:2007 +A1:2011**
Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
- **EN 61000-6-2:2005**
Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments

The declaration of conformity become invalid, in case the intended use specified in the operation manuals as well as other requirements of the operating instructions are violated!



INFORMATION

Please see attachments for complete Declaration of Conformity.

ANNEX I - Audio Signals

Audio id	Situation
0	start up
1	shut down
2	manual touch start
3	manual touch end
4	no position from navigation task
5	teach done
6	files updated
7	general warning
8	failure or problem
9	obstruction
10	no station left
11	battery low
12	order done
13	teach in progress
14	maintenance move
15	fire alarm
16	driving backwards (low pitch)
17	plc mech problem
18	surveillance
19	navigation latency
20	order start
21	order canceled
22	init setup started
23	teach failed
24	route snapshot
25	audio test
26	start button 500ms
27	poor sight
28	collision
29	order run done
30	volume test - restart after 10s standstill
31	driving backwards (high pitch)
32	standing, obstacle approaching
33	no station left - waiting for interaction
	after 10 s standstill
102	

ANNEX II - Visual Signals

Situation	Color	Signal Pattern
turn	white / yellow (depending on system settings)	blinking depending on direction
protective field	red	blinking depending on side
collision prevention	red	fast blinking
access point	blue	fading
fire alarm	red	fast blinking
no PLC feedback	red	static
battery low	yellow	blinking
initializing or autosection	white	fast blinking
failure	red	fading
start lamp is on	dark white	fading
pause	cyan	fading
obstruction	white	fast blinking
problem	orange	fading
no route	orange	fading
manual back	cyan	fast blinking
automatic back	white	fast blinking
action led depending on action definition (map settings)	according to action definition	according to action definition
manual idle	cyan	fading
manual & bad match & teach recommended	cyan	fast blinking
manual	cyan	static
charge	green	fading
maintenance idle	yellow	fading
maintenance	yellow	static
idle	white	fading
order active	white	static
rotating	white	blinking on both sides
automatic	semi-white	static

ANNEX III - Energy Management

Energy management is designed for maximum productive performance. The automated charging process depends on a large variety of parameters.

The Battery consists of 14 cells with 3.3V per cell. The current battery level as well as the cell voltages and the total voltage are shown in vehicle information on AGILOX user interface.

Planned Charge (plan)

The plan level is designed to prefer charging over the start of the next order.

Default: 60%

The battery plan charge level can be adjusted in the system settings ([4.3.7.1 - System Settings](#)).

If an order is finished and the battery level is below this level, AGILOX creates a charging order itself.

If there are no orders to process, the AGILOX vehicle will create a charging order already at a battery level lower than 80%.

Planned End of Charging (plan_end)

Default: 80%

The accumulator of the AGILOX vehicle is always charged to 100%.

The Planned End value defines from which percentage charging can be interrupted manually via the context menu.

Emergency Charge (low)

Default: 25% or smallest cell voltage below 3.16V

Falling below this limit, the current order will be retained and a emergency-charge-order is created automatically. The reason for this behavior is the importance, not to empty the battery completely. With few capacity left, AGILOX should have enough time to reach the charging station, if no obstruction is blocking its way.

Shutdown

Default: 20% or smallest cell voltage below 3.13V

If the battery level drops below 20% and the AGILOX vehicle is standing still for 2 minutes, with no attempt to drive (e.g. an error occurred or no order in manual mode), the vehicle will initiate a shutdown.

If the battery level drops below 20% and the AGILOX vehicle is standing still for 5 minutes, with no possibility to drive (e.g. protective fields, no movement despite a drive order) the vehicle will initiate a shutdown.

If the battery level is below 20% at a startup of the vehicle, the vehicle will automatically shut down again after 1 minute, if no button is pushed.

This behavior is necessary for not deep discharging the battery. A worker or manager has some battery left to fix the problem and enable AGILOX to drive to a charging station.

Emergency Shutdown

When the smallest cell voltage value drops below 3.0V, there is no movement possible anymore. Emergency Charge is necessary ([Mobile Charge Unit](#)). If not charged immediately, system will shut off after 45 Seconds.

Deep Discharge

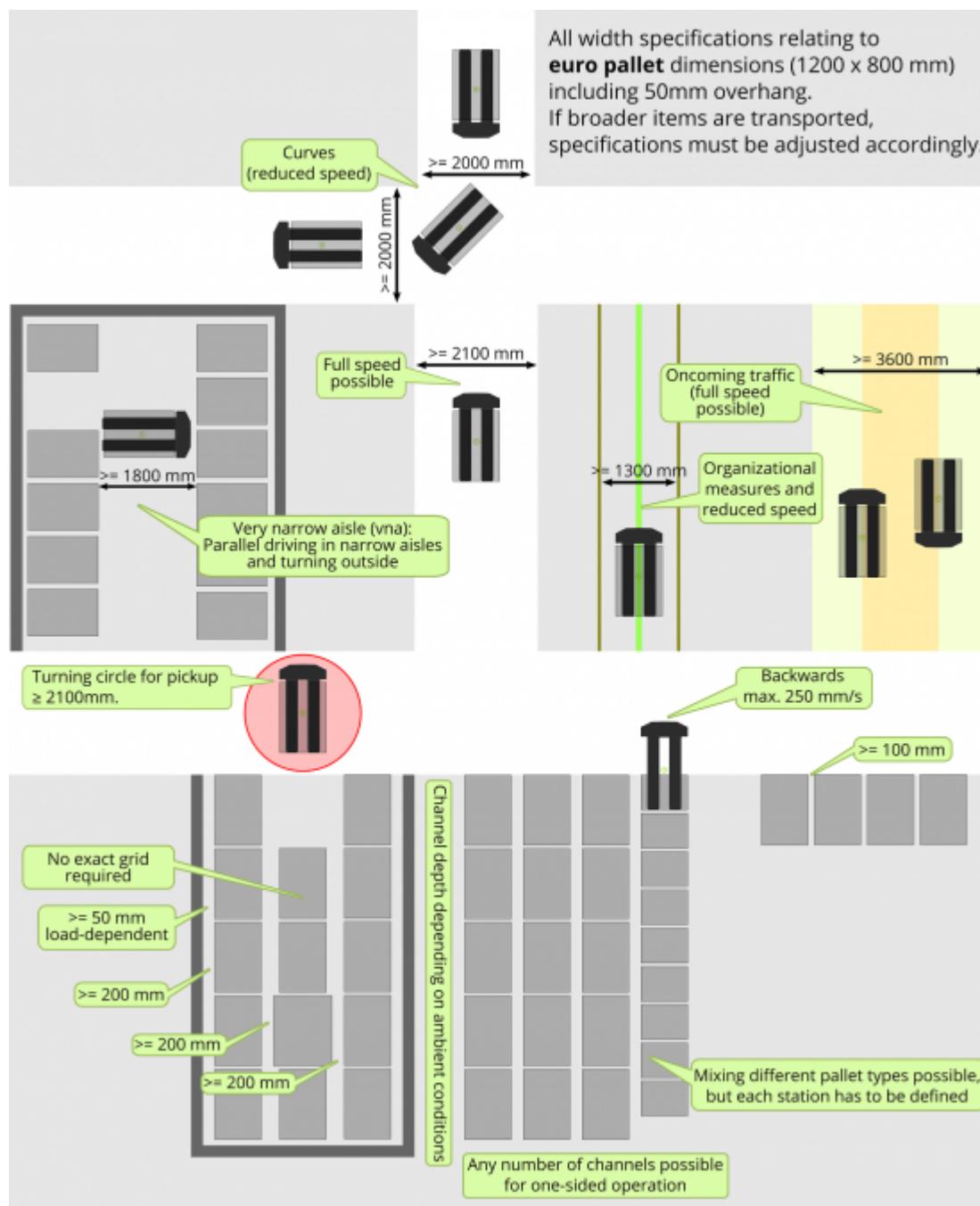
If the smallest cell voltage value drops below 2.1V, the battery is deep discharged and needs to be exchanged. Deep discharged batteries must not be charged and operated anymore. The AGILOX vehicle will shut down immediately.

ANNEX IV - Operating Areas



NOTICE

System operators always bear the sole responsibility for the ultimate safety concept. We recommend clarifying any issues in cooperation with authorities and bodies such as employers' liability insurance associations, government accident insurance agencies, the Works Council, the in-house health and safety department or the fire prevention department well in advance.



Pallet type	Width at 1.4 m/s optimal conditions	Width at 1.0 m/s optimal conditions	Width minimal optimal conditions	Turning circle for pickup
Euro pallet W=800mm/L=1200mm	>= 2100 mm	>= 1500 mm	>= 1300 mm	>= 2100 mm
Industrial pallet W=1000mm/L=1200mm	>= 2300 mm	>= 1700 mm	>= 1500 mm	>= 2200 mm
Euro pallet crosswise W=1200mm/L=800mm	>= 2500 mm	>= 1900 mm	>= 1700 mm	>= 2300 mm
AGILOX ONE 1400				
Pallet W=800mm/L=1400mm	>= 2200 mm	>= 1600 mm	>= 1300 mm	>= 2300 mm
Pallet W=1000mm/L=1400mm	>= 2300 mm	>= 1800 mm	>= 1500 mm	>= 2400 mm
Pallet W=1200mm/L=1400mm	>= 2500 mm	>= 2000 mm	>= 1700 mm	>= 2500 mm
AGILOX ONE 1600				
Pallet W=800mm/L=1600mm	>= 2200 mm	>= 1600 mm	>= 1400 mm	>= 2500 mm
Pallet W=1000mm/L=1600mm	>= 2400 mm	>= 1800 mm	>= 1600 mm	>= 2600 mm
Pallet W=1200mm/L=1600mm	>= 2500 mm	>= 2100 mm	>= 1800 mm	>= 2800 mm
AGILOX ONE 1800				
Pallet W=800mm/L=1800mm	>= 2300 mm	>= 1700 mm	>= 1400 mm	>= 2700 mm
Pallet W=1000mm/L=1800mm	>= 2500 mm	>= 1900 mm	>= 1600 mm	>= 2750 mm
Pallet W=1200mm/L=1800mm	>= 2600 mm	>= 2100 mm	>= 1800 mm	>= 2800 mm

Very Narrow Aisle (VNA)

AGILOX Type	Width for parallel driving optimal conditions
AGILOX ONE (L=1200mm)	>= 1800 mm
AGILOX ONE 1400 (L=1400mm)	>= 2000 mm
AGILOX ONE 1600 (L=1600mm)	>= 2200 mm
AGILOX ONE 1800 (L=1800mm)	>= 2400 mm

Oncoming Traffic (other AGILOX vehicles)

Pallet type	Oncoming traffic width at 1.4 m/s optimal conditions	Oncoming traffic width at 1.0 m/s optimal conditions	Oncoming traffic minimal width optimal conditions
Euro pallet W=800mm/L=1200mm	>= 3600 mm	>= 2900 mm	>= 2600 mm
Euro pallet crosswise W=1200mm/L=800mm	>= 4400 mm	>= 3700 mm	>= 3400 mm
Industrial pallet W=1000mm/L=1200mm	>= 4000 mm	>= 3300 mm	>= 3000 mm
AGILOX ONE 1400			
Pallet W=800mm/L=1400mm	>= 3700 mm	>= 2900 mm	>= 2600 mm
Pallet W=1000mm/L=1400mm	>= 4100 mm	>= 3300 mm	>= 3000 mm
Pallet W=1200mm/L=1400mm	>= 4500 mm	>= 3700 mm	>= 3400 mm
AGILOX ONE 1600			
Pallet W=800mm/L=1600mm	>= 3800 mm	>= 3000 mm	>= 2600 mm
Pallet W=1000mm/L=1600mm	>= 4200 mm	>= 3400 mm	>= 3000 mm
Pallet W=1200mm/L=1600mm	>= 4600 mm	>= 3800 mm	>= 3400 mm
AGILOX ONE 1800			
Pallet W=800mm/L=1800mm	>= 3900 mm	>= 3000 mm	>= 2600 mm
Pallet W=1000mm/L=1800mm	>= 4250 mm	>= 3400 mm	>= 3000 mm
Pallet W=1200mm/L=1800mm	>= 4600 mm	>= 3800 mm	>= 3400 mm

ANNEX V – Error Messages AGILOX Vehicle

The table below provides an overview of possible AGILOX error messages, their reasons and solutions. If an error cannot be solved with the help of this documentation please contact AGILOX support.

Failures

Failures #0.00 to #0.31



0.0 DU-FL1: Error communication fieldbus

Communication to motor controller not possible

Solution:

- Reset error
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2, -PLC-ECAT-W3) on condition and if plugs are tightly seated, unplug all cables and plug them back in once
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- If error cannot be reset, restart vehicle



0.1 DU-FL1: Error motor controller

Error motor controller FL1

Solution:

Circuit breaker

- Check if 48V circuit breaker -EMS-U1.9 is active

Power contactor

- Check if contactor -DU-K2 is closed (LED "DEVICE" is lit)
- If contactor is not active, try to reset error; if there is no further error the contactor should be active again

Plug motor controller

- Check if the black plug at motor controller -DU-FL1 is tightly seated
- Check if all wires at the black plugs are tightly seated

Replace drive unit

- There might be a short circuit within the cable or a motor of a drive unit might be faulty; replacement of drive unit is necessary

Replace motor controller

- If problem persists, motor controller needs to be replaced



0.2 DU-FL1: Following error

Motor FL1 is not able to follow the requested speed

Solution:

- Check if encoder wires at motor controller -DU-FL1 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.3 DU-FL1: Velocity feedback not valid

Velocity feedback of motor FL1 invalid

Solution:

- Check if encoder wires at motor controller -DU-FL1 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.4 DU-FL2: Error communication fieldbus

Communication with motor controller not possible

Solution:

- Reset error
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2, -PLC-ECAT-W3) on condition and if plug is tightly seated, unplug all cables and plug them back in once
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- If error cannot be reset, restart vehicle

⚠ 0.5 DU-FL2: Error motor controller

Error motor controller FL2

Solution:

Circuit breaker

- Check if 48V circuit breaker -EMS-U1.10 is active

Power contactor

- Check if contactor -DU-K2 is closed (LED "DEVICE" is lit)
- If contactor is not active, try to reset error; if there is no further error the contactor should be active again

Plug motor controller

- Check if the black plug at motor controller -DU-FL2 is tightly seated
- Check if all wires at the black plugs are tightly seated

Replace drive unit

- There might be a short circuit within the cable or a motor of a drive unit might be faulty; drive unit needs to be replaced

Replace motor controller

- If problem persists, motor controller needs to be replaced

⚠ 0.6 DU-FL2: Following error

Motor FL2 is not able to follow the requested speed

Solution:

- Check if encoder wires at motor controller -DU-FL2 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.7 DU-FL2: Velocity feedback not valid

Velocity feedback of motor FL2 invalid

Solution:

- Check if encoder wires at motor controller -DU-FL2 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.8 DU-FR1: Error communication fieldbus

Communication with motor controller not possible

Solution:

- Reset error
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2, -PLC-ECAT-W3) on condition and if plug is tightly seated, unplug all cables and plug them back in once
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- If error cannot be reset, restart vehicle

⚠ 0.9 DU-FR1: Error motor controller

Error motor controller FR1

Solution:

Circuit breaker

- Check if 48V circuit breaker -EMS-U1.3 is active

Power contactor

- Check if contactor -DU-K1 is closed (LED "DEVICE" is lit)
- If contactor is not active try to reset error; if there is no further error the contactor should be active again

Plug motor controller

- Check if the black plug at motor controller -DU-FR1 is tightly seated
- Check if all wires at the black plugs are tightly seated

Replace drive unit

- There might be a short circuit within the cable or a motor of a drive unit might be faulty; drive unit needs to be replaced

Replace motor controller

- If problem persists, motor controller needs to be replaced

⚠ 0.10 DU-FR1: Following error

Motor FR1 is not able to follow the requested speed

Solution:

- Check if encoder wires at motor controller -DU-FR1 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.11 DU-FR1: Velocity feedback not valid

Velocity feedback of motor FR1 invalid

Solution:

- Check if encoder wires at motor controller -DU-FR1 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.12 DU-FR2: Error communication fieldbus

Communication with motor controller not possible

Solution:

- Reset error
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2, -PLC-ECAT-W3) on condition and if plug is tightly seated, unplug all cables and plug them back in once
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- If error cannot be reset, restart vehicle

⚠ 0.13 DU-FR2: Error motor controller

Error motor controller FR2

Solution:

Circuit breaker

- Check if 48V circuit breaker -EMS-U1.4 is active

Power contactor

- Check if contactor -DU-K1 is closed (LED "DEVICE" is lit)
- If contactor is not active, try to reset error; if there is no further error the contactor should be active again

Plug motor controller

- Check if the black plug at motor controller -DU-FR2 is tightly seated
- Check if all wires at the black plugs are tightly seated

Replace drive unit

- There might be a short circuit within the cable or a motor of a drive unit might be faulty; drive unit needs to be replaced

Replace motor controller

- If problem persists, motor controller needs to be replaced

⚠ 0.14 DU-FR2: Following error

Motor FR2 is not able to follow the requested speed

Solution:

- Check if encoder wires at motor controller -DU-FR2 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.15 DU-FR2: Velocity feedback not valid

Velocity feedback of motor FR2 invalid

Solution:

- Check if encoder wires at motor controller -DU-FR2 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.16 DU-RL1: Error communication fieldbus

Communication with motor controller not possible

Solution:

- Reset error
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2, -PLC-ECAT-W3) on condition and if plug is tightly seated, unplug all cables and plug them back in once
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- If error cannot be reset, restart vehicle

⚠ 0.17 DU-RL1: Error motor controller

Error motor controller RL1

Solution:

Circuit breaker

- Check if 48V circuit breaker -EMS-U1.7 is active

Power contactor

- Check if contactor -DU-K1 is closed (LED "DEVICE" is lit)
- If contactor is not active, try to reset error; if there is no further error the contactor should be active again

Plug motor controller

- Check if the black plug at motor controller -DU-RL1 is tightly seated
- Check if all wires at the black plugs are tightly seated

Replace drive unit

- There might be a short circuit within the cable or a motor of a drive unit might be faulty; drive unit needs to be replaced

Replace motor controller

- If problem persists, motor controller needs to be replaced

⚠ 0.18 DU-RL1: Following error

Motor RL1 is not able to follow the requested speed

Solution:

- Check if encoder wires at motor controller -DU-RL1 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.19 DU-RL1: Velocity feedback not valid

Velocity feedback of motor RL1 invalid

Solution:

- Check if encoder wires at motor controller -DU-RL1 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.20 DU-RL2: Error communication fieldbus

Communication with motor controller not possible

Solution:

- Reset error
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2, -PLC-ECAT-W3) on condition and if plug is tightly seated, unplug all cables and plug them back in once
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- If error cannot be reset, restart vehicle

⚠ 0.21 DU-RL2: Error motor controller

Error motor controller RL2

Solution:

Circuit breaker

- Check if 48V circuit breaker -EMS-U1.8 is active

Power contactor

- Check if contactor -DU-K1 is closed (LED "DEVICE" is lit)
- If contactor is not active, try to reset error; if there is no further error the contactor should be active again

Plug motor controller

- Check if the black plug at motor controller -DU-RL2 is tightly seated
- Check if all wires at the black plugs are tightly seated

Replace drive unit

- There might be a short circuit within the cable or a motor of a drive unit might be faulty; drive unit needs to be replaced

Replace motor controller

- If problem persists, motor controller needs to be replaced

⚠ 0.22 DU-RL2: Following error

Motor RL2 is not able to follow the requested speed

Solution:

- Check if encoder wires at motor controller -DU-RL2 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.23 DU-RL2: Velocity feedback not valid

Velocity feedback of motor RL2 invalid

Solution:

- Check if encoder wires at motor controller -DU-RL2 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.24 DU-RR1: Error communication fieldbus

Communication with motor controller not possible

Solution:

- Reset error
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2, -PLC-ECAT-W3) on condition and if plug is tightly seated, unplug all cables and plug them back in once
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- If error cannot be reset, restart vehicle

⚠ 0.25 DU-RR1: Error motor controller

Error motor controller RR1

Solution:

Circuit breaker

- Check if 48V circuit breaker -EMS-U1.5 is active

Power contactor

- Check if contactor -DU-K2 is closed (LED "DEVICE" is lit)
- If contactor is not active, try to reset error; if there is no further error the contactor should be active again

Plug motor controller

- Check if the black plug at motor controller -DU-RR1 is tightly seated
- Check if all wires at the black plugs are tightly seated

Replace drive unit

- There might be a short circuit within the cable or a motor of a drive unit might be faulty; drive unit needs to be replaced

Replace motor controller

- If problem persists, motor controller needs to be replaced

⚠ 0.26 DU-RR1: Following error

Motor RR1 is not able to follow the requested speed

Solution:

- Check if encoder wires at motor controller -DU-RR1 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.27 DU-RR1: Velocity feedback not valid

Velocity feedback of motor RR1 invalid

Solution:

- Check if encoder wires at motor controller -DU-RR1 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.28 DU-RR2: Error communication fieldbus

Communication with motor controller not possible

Solution:

- Reset error
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2, -PLC-ECAT-W3) on condition and if plug is tightly seated, unplug all cables and plug them back in once
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- If error cannot be reset, restart vehicle

⚠ 0.29 DU-RR2: Error motor controller

Error motor controller RR2

Solution:

Circuit breaker

- Check if 48V circuit breaker -EMS-U1.6 is active

Power contactor

- Check if contactor -DU-K2 is closed (LED "DEVICE" is lit)
- If contactor is not active, try to reset error; if there is no further error the contactor should be active again

Plug motor controller

- Check if the black plug at motor controller -DU-RR2 is tightly seated
- Check if all wires at the black plugs are tightly seated

Replace drive unit

- There might be a short circuit within the cable or a motor of a drive unit might be faulty; drive unit needs to be replaced

Replace motor controller

- If problem persists, motor controller needs to be replaced

⚠ 0.30 DU-RR2: Following error

Motor RR2 is not able to follow the requested speed

Solution:

- Check if encoder wires at motor controller -DU-RR2 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

⚠ 0.31 DU-RR2: Velocity feedback not valid

Velocity feedback of motor RR2 invalid

Solution:

- Check if encoder wires at motor controller -DU-RR2 are tightly seated
- Check if the 4 supplying wires at the lower part of motor controller are tightly seated
- Reset error
- If error cannot be reset, restart vehicle
- If error is recurring, an autosection needs to be done for the respective drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)
- If none of these actions helps, the drive unit needs to be replaced

Failures #1.00 to #1.31

⚠ 1.0 BMS: Error different cell voltage

Battery cells have different charging levels

Solution:

- Battery must not be used any longer and needs to be replaced

⚠ 1.1 BMS: Cell voltage out of limit

Voltage of one or more cells exceeds or drops below limit

Solution:

Cell voltage too high

- Wait a few minutes then try to reset error

Cell voltage too low

- If cell voltage drops below the limit, the vehicle shuts down right after start, the battery needs to be replaced

⚠ 1.2 BMS: Cell/total voltage not valid

Total voltage of all cells does not match total voltage value

Solution:

- Contact support

⚠ 1.3 BMS: Error charging

Charging cycle could not be started or was interrupted unexpectedly

Solution:

- Check if charging device is connected to power supply and powered on
- Check if vehicle is positioned adequately on charging plate
- Check if key switch is turned to automatic mode
- Check if vehicle is powered on, make sure emergency stop is not active and acknowledge button is not active (blue button is not lit)
- Check if circuit breakers -EMS-F1 and -EMS-F2 inside the vehicle are active
- Check if the 48V circuit breakers -EMS-U1.3 and -EMS-U1.4 inside the vehicle are active
- Check the cabling between charging device and charging plate - check the plug for the start-stop signal at the charging device
- Check and clean charging plate on floor and current collector plate on vehicle

⚠ 1.4 BMS: Error communication fieldbus

Data communication BMS interrupted

Solution:

- Check all plug connection on accumulator
- Check 24V power supply of BMS (according to electrical documentation)

Solution (vehicles with external BMS until 10/2018):

- Check if BMS (battery management system) -BMS-U1 (in the upper part of vehicle behind the green cover) is active (small switch on right side of device)
- Check all plug connections of BMS
- Check if 24V circuit breaker -EMS-U3.7 is active, – DC/DC-converter top right in cabinet -BMS-DCDC must be lit green
- Check status of BMS
 - If green LED on BMS blinks 1x every 10 seconds everything is OK
 - Red LED blinks 1x:
 - Voltage of one or more cells is too high
 - wait until BMS has discharged the respective cells adequately
 - Red LED blinks 2x:
 - Voltage of one or more cells is too low
 - Check cabling between battery and BMS
 - Check total voltage of battery: If voltage drops below 38V the battery needs to be replaced, contact support
 - Red LED blinks 3x:
 - Difference of individual cell voltages is too high
 - Check cabling between battery and BMS
 - Check total voltage of battery: If voltage drops below 38V the battery needs to be replaced, contact support
 - Red LED blinks 4x or 5x:
 - Temperature too high
 - Check plug of temperature sensor on BMS
 - Power off vehicle and wait until battery cooled down, contact support
 - Red LED blinks 6x:
 - Number of cells on DIP-switch of BMS is incorrect
 - Check DIP-switches (from left to right): ON - OFF - OFF - OFF - ON - OFF - ON - ON
 - Red LED blinks 7x:
 - Temperature too low
 - Check plug of temperature sensor on BMS
 - Shut down vehicle and take it to a warmer area, wait for a couple of hours to let vehicle adapt to warmer temperature, do not power it on until then
 - Red LED blinks 8x:
 - Error temperature sensor
 - Check cabling of sensor, replace sensor if necessary
 - Red LED blinks 10x:
 - Measuring error BMS
 - Check cabling between battery and BMS
 - Check total voltage of battery: If voltage drops below 38V the battery needs to be replaced, contact support
 - Red LED blinks 12x:
 - Error current measurement
 - Check current sensor -BMS-SHUNT connection to BMS
 - Check if all cables at -BMS-SHUNT are tightly seated
 - If necessary replace shunt-resistor, contact support
 - Red LED blinks 9x, 11x, 13x, 14x or 15x:
 - Internal BMS-error, device needs to be replaced, contact support

⚠ 1.5 Sum error 24V

At least one 24VDC circuit breaker has tripped

Solution:

- Check 24VDC circuit breakers (-EMS-U3)
- If a circuit breaker cannot be reset or is lit red, contact support

 1.6 Sum error 48V

At least one 48VDC circuit breaker has tripped

Solution:

- Check 48VDC circuit breakers (-EMS-U1)
- Switch on all 48VDC circuit breakers
- If a circuit breaker cannot be reset or is lit red, contact support

 1.7 Battery Overcurrent

Battery Overcurrent protection has been triggered

Solution:

- Battery needs to be changed

 1.8 Battery Overtemperature

Battery Overtemperature protection has triggered

Solution:

- Battery needs to be changed

 1.9 Battery Undertemperature

Battery Undertemperature protection has triggered

Solution:

- Battery needs to be changed

 1.10 Battery Overvoltage

Battery Overvoltage protection has triggered

Solution:

- Battery needs to be changed

 1.11 Battery Undervoltage

Battery Undervoltage protection has triggered

Solution:

- Battery needs to be changed

 1.12 Battery Temperature Sensor Error

Battery Temperature Sensor is defektive

Solution:

- Battery needs to be changed

 1.13 Battery Current Sensor Error

Battery Current Sensor is defektive

Solution:

- Battery needs to be changed

⚠ 1.14 Battery Voltage Sensor Error

Battery Voltage Sensor is defektive

Solution:

- Battery needs to be changed

Failures #2.00 to #2.31

⚠ 2.0 DU-FL: Rotation angle feedback timeout

Requested rotation angle cannot be reached

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cabling of drive units at motor controllers (in the lower part of cabinet)
- Check if there is a mechanical blockade: Lift vehicle with an adequate lifting device; push the respective drive unit upwards and check if it is moving smoothly by turning it +90° to -90°
Also turn every single wheel by hand to check its smoothness
- Check all drive unit motors by moving every wheel separately in maintenance mode (vehicle must be lifted)
If one of the wheels does not turn, check the cabling, otherwise replace the drive unit
After replacing a drive unit an autosection and a readjustment of zero-position have to be done in maintenance mode

⚠ 2.1 DU-FL: Rotation angle out of limit

Rotation angle of drive unit out of limit

Solution:

- Turn key switch to maintenance mode and then back to either manual- or automatic mode
After pressing the acknowledge button the vehicle automatically tries to bring the drive unit back in position
- If error recurs and the drive unit cannot be brought back in position automatically, try to readjust the drive unit in maintenance mode
- If this is not possible, lift vehicle with an adequate lifting device and check smoothness of drive unit and every wheel
- Check all drive unit motors by moving every wheel separately in maintenance mode (vehicle must be lifted)
If one of the wheels does not turn, check the cabling, otherwise replace the drive unit
After replacing a drive unit an autosection and a readjustment of zero-position have to be done in maintenance mode

⚠ 2.2 DU-FL: Rotation angle not valid

Response of drive unit rotation angle invalid

Solution:

- Check cabling of respective rotation encoder (encoder: -DU-XX-B1, cable: -DU-XX-W1)
- Lift vehicle with an adequate lifting device, remove the respective drive unit and check the magnet in the center on top of drive unit for damages. Clean it if necessary.
- Replace rotation encoder, contact support

⚠ 2.4 DU-FR: Rotation angle feedback timeout

Requested rotation angle cannot be reached

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cabling of drive units at motor controllers (in the lower part of cabinet)
- Check if there is a mechanical blockade: Lift vehicle with an adequate lifting device; push the respective drive unit upwards and check if it is moving smoothly by turning it +90° to -90°
Also turn every single wheel by hand to check its smoothness
- Check all drive unit motors by moving every wheel separately in maintenance mode (vehicle must be lifted)
If one of the wheels does not turn check the cabling, otherwise replace the drive unit
After replacing a drive unit an autosection and a readjustment of zero-position have to be done in maintenance mode

⚠ 2.5 DU-FR: Rotation angle out of limit

Rotation angle of drive unit out of limit

Solution:

- Turn key switch to maintenance mode and then back to either manual- or automatic mode
After pressing the acknowledge button the vehicle automatically tries to bring the drive unit back in position
- If error recurs and the drive unit cannot be brought back in position automatically, try to readjust the drive unit in maintenance mode
- If this is not possible, lift vehicle with an adequate lifting device and check smoothness of drive unit and every wheel
- Check all drive unit motors by moving every wheel separately in maintenance mode (vehicle must be lifted)
If one of the wheels does not turn, check the cabling, otherwise replace the drive unit
After replacing a drive unit an autosection and a readjustment of zero-position have to be done in maintenance mode

⚠ 2.6 DU-FR: Rotation angle not valid

Response of drive unit rotation angle invalid

Solution:

- Check cabling of respective rotation encoder (encoder: -DU-XX-B1, cable: -DU-XX-W1)
- Lift vehicle with an adequate lifting device, remove the respective drive unit and check the magnet in the center on top of drive unit for damages. Clean it if necessary.
- Replace rotation encoder, contact support

⚠ 2.8 DU-RL: Rotation angle feedback timeout

Requested rotation angle cannot be reached

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cabling of drive units at motor controllers (in the lower part of cabinet)
- Check if there is a mechanical blockade: Lift vehicle with an adequate lifting device; push the respective drive unit upwards and check if it is moving smoothly by turning it +90° to -90°
Also turn every single wheel by hand to check its smoothness
- Check all drive unit motors by moving every wheel separately in maintenance mode (vehicle must be lifted)
If one of the wheels does not turn, check the cabling, otherwise replace the drive unit
After replacing a drive unit an autosection and a readjustment of zero-position have to be done in maintenance mode

⚠ 2.9 DU-RL: Rotation angle out of limit

Rotation angle of drive unit out of limit

Solution:

- Turn key switch to maintenance mode and then back to either manual- or automatic mode
After pressing the acknowledge button the vehicle automatically tries to bring the drive unit back in position
- If error recurs and the drive unit cannot be brought back in position automatically, try to readjust the drive unit in maintenance mode
- If this is not possible, lift vehicle with an adequate lifting device and check smoothness of drive unit and every wheel
- Check all drive unit motors by moving every wheel separately in maintenance mode (vehicle must be lifted)
If one of the wheels does not turn, check the cabling, otherwise replace the drive unit
After replacing a drive unit an autosection and a readjustment of zero-position have to be done in maintenance mode

⚠ 2.10 DU-RL: Rotation angle not valid

Response of drive unit rotation angle invalid

Solution:

- Check cabling of respective rotation encoder (encoder: -DU-XX-B1, cable: -DU-XX-W1)
- Lift vehicle with an adequate lifting device, remove the respective drive unit and check the magnet in the center on top of drive unit for damages. Clean it if necessary.
- Replace rotation encoder, contact support

⚠ 2.12 DU-RR: Rotation angle feedback timeout

Requested rotation angle cannot be reached

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cabling of drive units at motor controllers (in the lower part of cabinet)
- Check if there is a mechanical blockade: Lift vehicle with an adequate lifting device; push the respective drive unit upwards and check if it is moving smoothly by turning it +90° to -90°
Also turn every single wheel by hand to check its smoothness
- Check all drive unit motors by moving every wheel separately in maintenance mode (vehicle must be lifted)
If one of the wheels does not turn, check the cabling, otherwise replace the drive unit
After replacing a drive unit an autosection and a readjustment of zero-position have to be done in maintenance mode

⚠ 2.13 DU-RR: Rotation angle out of limit

Rotation angle of drive unit out of limit

Solution:

- Turn key switch to maintenance mode and then back to either manual- or automatic mode
After pressing the acknowledge button the vehicle automatically tries to bring the drive unit back in position
- If error recurs and the drive unit cannot be brought back in position automatically, try to readjust the drive unit in maintenance mode
- If this is not possible, lift vehicle with an adequate lifting device and check smoothness of drive unit and every wheel
- Check all drive unit motors by moving every wheel separately in maintenance mode (vehicle must be lifted)
If one of the wheels does not turn, check the cabling, otherwise replace the drive unit
After replacing a drive unit an autosection and a readjustment of zero-position have to be done in maintenance mode

⚠ 2.14 DU-RR: Rotation angle not valid

Response of drive unit rotation angle invalid

Solution:

- Check cabling of respective rotation encoder (encoder: -DU-XX-B1, cable: -DU-XX-W1)
- Lift vehicle with an adequate lifting device, remove the respective drive unit and check the magnet in the center on top of drive unit for damages. Clean it if necessary.
- Replace rotation encoder, contact support

⚠ 2.16 MOC: Error checking configuration

Parameters of motor controllers are incorrect

Solution:

- Check all 48V circuit breakers (-EMS-U1) and 24V circuit breakers (-EMS-U3)
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- Check if all black plugs at motor controllers are tightly seated
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2 and -PLC-ECAT-W3), possibly unplug all and plug them back in
- Turn the key switch to maintenance mode, then back to automatic mode and reset error
The controller will try to rewrite the needed parameters to motor controllers
- Restart vehicle
- If error recurs, contact support

⚠ 2.17 MOC: Error initializing closed loop

Initial drive of drive units not successful

Solution:

- For vehicles with a gear ratio of 18/50 the load has to be put down before initialization
Switch to manual mode and bring the lift down to a height of 0mm
Then switch back to automatic mode and retry to initialize
- Check all 48V circuit breakers (-EMS-U1) and 24V circuit breakers (-EMS-U3)
- Check if all motor controllers are connected firmly to each other (no gap between single controller cards)
- Check if all black plugs at motor controllers are tightly seated
- Check if all wires at the black plugs are tightly seated
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2 and -PLC-ECAT-W3), possibly unplug all and plug them back in
- Turn the key switch to maintenance mode, then back to automatic mode and reset error
The controller will try to reinitialize
- Restart vehicle
- If error recurs, contact support

⚠ 2.18 Collision detected

Collision has been detected due to a significant change of speed

Solution:

- If collision of vehicle is true: Move vehicle to an empty area in manual- or maintenance mode, check vehicle for damages, reset error
- No obvious collision: Check ground for heavy dirt or damages, if necessary clean or repair related spots
- In some cases this error might be the result of a faulty drive unit
Check if one of the drive units is twisted by using the HMI
Check if the respective drive unit rotates correctly in maintenance mode
Check for mechanical damages on the respective drive unit or cables
Perform an autosection for the respective drive unit

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

Replace drive unit

⚠ 2.19 Risk of falling

Risk of falling detected

If option „obstacle avoidance“ is installed, vehicle is capable of recognizing a step downwards and stops in front of it

Solution:

- Use manual mode to move vehicle to an empty area
- Investigate reason why vehicle is driving in that area, set corrective actions to avoid that vehicle is moving to risky areas
- Reset error

⚠ 2.20 DU-FL not in zero-position

Drive unit FL is not in zero-position

When adjusting a drive unit to zero-position the system checks, if the respective drive unit is in a plausible rotation angle

Solution:

- If not already done, mount drive unit with a bolt in 0°-position and adjust drive unit to zero-position
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Set Initial Rotation Angle for Drive Unit](#)
- If error recurs, check rotation angle of drive unit in HMI (info-page)
If drive unit is twisted 180° (arrow is pointing towards the tip of the fork), check orientation of rotary encoder and the drive unit's magnet
- Contact support

⚠ 2.21 DU-FR not in zero-position

Drive unit FR is not in zero-position

When adjusting a drive unit to zero-position the system checks, if the respective drive unit is in a plausible rotation angle

Solution:

- If not already done, mount drive unit with a bolt in 0°-position and adjust drive unit to zero-position
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Set Initial Rotation Angle for Drive Unit](#)
- If error recurs, check rotation angle of drive unit in HMI (info-page)
If drive unit is twisted 180° (arrow is pointing towards the tip of the fork), check orientation of rotary encoder and the drive unit's magnet
- Contact support

⚠ 2.22 DU-RL not in zero-position

Drive unit RL is not in zero-position

When adjusting a drive unit to zero-position the system checks, if the respective drive unit is in a plausible rotation angle

Solution:

- If not already done, mount drive unit with a bolt in 0°-position and adjust drive unit to zero-position
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Set Initial Rotation Angle for Drive Unit](#)
- If error recurs, check rotation angle of drive unit in HMI (info-page)
If drive unit is twisted 180° (arrow is pointing towards the tip of the fork), check orientation of rotary encoder and the drive unit's magnet
- Contact support

⚠ 2.23 DU-RR not in zero-position

Drive unit RR is not in zero-position

When adjusting a drive unit to zero-position the system checks, if the respective drive unit is in a plausible rotation angle

Solution:

- If not already done, mount drive unit with a bolt in 0°-position and adjust drive unit to zero-position
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Set Initial Rotation Angle for Drive Unit](#)
- If error recurs, check rotation angle of drive unit in HMI (info-page)
If drive unit is twisted 180° (arrow is pointing towards the tip of the fork), check orientation of rotary encoder and the drive unit's magnet
- Contact support

Failures #3.00 to #3.31

⚠ 3.2 LIFT-L: Error motor controller

Error lifting motor controller on left side -LI-U1

Solution:

- Check connections of lifting motor to controller (3 plugs to be checked)
- Check if all 48V circuit breakers (-EMS-U1) and all 24V circuit breakers (-EMS-U3) are active
- Check if 24V supply and 48V supply are connected correctly
Check screws at the green plug of 48V supply
Check if the green plug is locked in place properly
- If error cannot be reset, restart vehicle, contact support

⚠ 3.3 LIFT-R: Error motor controller

Error lifting motor controller right side -LI-U2

Solution:

- Check connections of lifting motor to controller (3 plugs to be checked)
- Check if all 48V circuit breakers (-EMS-U1) and all 24V circuit breakers (-EMS-U3) are active
- Check if 24V supply and 48V supply are connected correctly
Check screws at the green plug of 48V supply
Check if the green plug is locked in place properly
- If error cannot be reset, restart vehicle, contact support

⚠ 3.4 LIFT: Error communication fieldbus

EtherCAT communication with gateway for lifting motor controller (-LI-ECAT1) not possible

Solution:

- Check the entire EtherCAT cabling (PLC-ECAT-W1, PLC-ECAT-W2 and PLC-ECAT-W3)
unplug all cables and plug them back in once
- Check if all 24V circuit breakers (-EMS-U3) are active
- If error cannot be reset, restart vehicle, contact support

⚠ 3.5 LIFT: Height difference LE/RI out of limit

Lifting height left and right different

Solution:

- Check if rear panel is mounted correctly / is not out of angle
Both forks need to hold the same height above ground
If applicable readjust rear panel in maintenance mode
- If rear panel is straight and both forks hold the same height above ground lower lift in manual mode until fork is at the bottom
Switch to maintenance mode
Adjust lift to zero-position

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Adjust Zero Position for Lift](#)

⚠ 3.6 LIFT: Height LE/RI out of limit

Lifting height left and right out of limit

Solution:

- Contact support, a wrong fork type might be set (double fork/single fork)
- If this error occurs when lift is at the bottom the zero-position needs to be adjusted 1 - 2mm higher
Use manual or maintenance mode to lift forks to a height of 2mm
In maintenance mode adjust lift to zero-position

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Adjust Zero Position for Lift](#)

If this error occurs when lift is fully lifted possibly lower the height of respective stations

⚠ 3.7 LIFT: Height value not plausible for zero-position

Lift is not in zero-position

When adjusting lift to zero-position the system checks, if lift is at a plausible height

Solution:

- Lower lift in manual or maintenance mode down to bottom and readjust zero-position
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Adjust Zero Position for Lift](#)
- Contact support

⚠ 3.8 LIFT-L: Overload detected

Torque limit lifting motor left exceeded

Solution:

- Check if maximum bearing weight has been exceeded (depending on fork type, size of carrier and length of forks)
[2.3.2 - Load and Load-Handling Equipment Requirements](#)
- If this is the case, switch to manual or maintenance mode and try to drop the load, then reset error
- If error recurs, although maximum weight of load is not exceeded contact support

⚠ 3.9 LIFT-R: Overload detected

Torque limit lifting motor right exceeded

Solution:

- Check if maximum bearing weight has been exceeded (depending on fork type, size of carrier and length of forks)
[2.3.2 - Load and Load-Handling Equipment Requirements](#)
- If this is the case, switch to manual or maintenance mode and try to drop the load, then reset error
- If error recurs, although maximum weight of load is not exceeded contact support

⚠ 3.10 INIT: Lift not ready for init

Lift is not in correct position for initializing drive units

After a restart all drive units need to be initialized (repeated rotation of drive units back and forth)

For vehicles with a gear ratio of 18/50 either lift must be lowered or vehicle must not be loaded

Solution:

- Lower lift in manual or maintenance mode down to bottom
- Possibly drop load
- Reset error

⚠ 3.11 LIFT: Overload detected

Torque limit lift exceeded

Solution:

- Check if maximum bearing weight has been exceeded (depending on fork type, size of carrier and length of forks)
[2.3.2 - Load and Load-Handling Equipment Requirements](#)
- If this is the case, switch to manual or maintenance mode and try to drop the load, then reset error
- Reset error

⚠ 3.12 LIFT: Error communication fieldbus - RS485

RS485 communication between gateway (-LI-ECAT1) and lifting motor controller (-LI-U1 and -LI-U2) not possible

Solution:

- Check entire RS485 cabling (two black clamps)
Unplug all cables and plug them back in once
- Check if all 24V circuit breakers (-EMS-U3) are active
- Check if all 48V circuit breakers (-EMS-U1) are active
- Check cabling and plugs at lifting motor controllers
- If error cannot be reset restart vehicle, contact support

⚠ 3.13 Error weight sensor calibration

An error has occurred during calibration of the weight monitoring sensors.

Solution:

- Lift height needs to be 150 mm for calibration
- Check cabling of sensors
- Possibly sensor error

Failures #4.00 to #4.31



4.0 SAFETYPLC: Hardware error

Communication between safety PLC and safety laser scanner disrupted

Solution:

- Check cabling between safety PLC and safety laser scanner (cable -LS-L1-EFI and -LS-R1-EFI)
- Check all black plugs at safety-PLC
- If one of the safety laser scanners is in error status (red LEDs on device are lit) restart vehicle
- If error persists replace laser scanner, contact support



4.1 SAFETYPLC: Error safety scanner

Error safety laser scanner

Solution:

- Clean laser scanner
- Check if all 24V circuit breakers (-EMS-U3) are active
- This error cannot be reset so restart vehicle
- If error recurs, contact support



4.2 SAFETYPLC: Stop error drive unit group A

Driveline A has not stopped properly – emergency stop activated

Safety-PLC checks, if a stop request actually led vehicle to stop

Drive unit FR or RL could not be stopped successfully

Solution:

- Check if all 48V circuit breakers (-EMS-U1) are active
- Check cabling of drive units
- Reset error
- If error recurs, contact support



4.3 SAFETYPLC: Stop error drive unit group B

Driveline B has not stopped properly – emergency stop activated

Safety-PLC checks, if a stop request actually led vehicle to stop

Drive unit FL or RR could not be stopped successfully

Solution:

- Check if all 48V circuit breakers (-EMS-U1) are active
- Check cabling of drive units
- Reset error
- If error recurs, contact support



4.4 SAFETYPLC: Stop error lift

Lift has not stopped properly – emergency stop activated

Safety-PLC checks, if a stop request actually led vehicle to stop

Lift could not be stopped successfully

Solution:

- Check if all 48V circuit breakers (-EMS-U1) are active
- Check cabling of lifting motor controllers (-LI-U1 and -LI-U2)
- Reset error
- If error recurs, contact support

⚠ 4.5 SAFETYPLC: Emergency stop left

Emergency stop left pushed

Solution:

- Release left emergency stop and reset error
- If this error occurs although emergency stop button has not been pushed:
 - Check cabling between safety PLC (-PLC3-IO1) and emergency stop button
 - Check plugs at safety PLC (-PLC3-IO1)

⚠ 4.6 SAFETYPLC: Emergency stop right

Emergency stop right pushed

Solution:

- Release right emergency stop and reset error
- If this error occurs although emergency stop button has not been pushed:
 - Check cabling between safety PLC (-PLC3-IO1) and emergency stop button
 - Check plugs at safety PLC (-PLC3-IO1)

⚠ 4.7 SAFETYPLC: Contactor switched off

Power contactor switched off

Following error due to another safety related critical error (emergency stop pushed, faulty monitoring of drive units etc.)

Solution:

- Reset error

⚠ 4.8 SAFETYPLC: Contactor feedback not valid

Response of power contactor invalid

Solution:

- Check cabling between power contactors -DU-K1 / -DU-K2 / -LI-K1 / -LI-K2 and safety PLC (-PLC3-IO1)
- Check plugs at safety PLC (-PLC3-IO1)
- Contact support

⚠ 4.9 SAC: Faulty control of drive units detected - PLC1

Faulty control of drive units detected by PLC1

The rotation angle or speed of a drive unit deviates too much from target value

Solution:

- A drive unit might be twisted because of an obstacle on the ground: Remove obstacle
- Check all 48V circuit breakers (-EMS-U1)
- Check rotation angle of drive units in HMI; if error recurs for the same drive unit, perform an autosection or replace drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 4.10 SAC: Faulty control of drive units detected - PLC2

Faulty control of drive units detected by PLC2

The rotation angle or speed of a drive unit deviates too much from target value

Solution:

- A drive unit might be twisted because of an obstacle on the ground: Remove obstacle
- Check all 48V circuit breakers (-EMS-U1)
- Check rotation angle of drive units in HMI; if error recurs for the same drive unit, perform an autosection or replace drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 4.11 SAC: Faulty control of lift detected - PLC1

Faulty control of lifting device detected by PLC1

The actual lifting height deviates too much from target value

Solution:

- Reset error, if error recurs, contact support

⚠ 4.12 SAC: Faulty control of lift detected - PLC2

Faulty control of lifting device detected by PLC2

The actual lifting height deviates too much from target value

Solution:

- Reset error, if error recurs, contact support

⚠ 4.13 SAC: Lift occupation not valid detected - PLC1

Faulty occupation detected by PLC1

Solution:

- Check occupation: Carrier must be loaded correctly (correct distance to rear panel), possibly the carrier got out of place
- If carrier is loaded correctly, check angle of distance sensor in rear panel, it might need to be adjusted further up

⚠ 4.14 SAC: Lift occupation not valid detected - PLC2

Faulty occupation detected by PLC2

Solution:

- Check occupation: Carrier must be loaded correctly (correct distance to rear panel), possibly the carrier got out of place
- If carrier is loaded correctly, check angle of distance sensor in rear panel, it might need to be adjusted further up

⚠ 4.15 STATION-ENTRY: Distance to station not valid

Distance to station invalid

Solution:

- If carrier got out of place or got too far from target position: Correct position of carrier
- If there is an obstacle in the area next to or between forks, remove obstacle and reset error

⚠ 4.16 STATION-ENTRY: Rear protective field violated

Rear safety field violated when entering station

Solution:

- Find reason for safety field violation and remedy issue
- Reset error

⚠ 4.17 STATION-ENTRY: Driven distance not valid

Driven distance in station invalid

When entering a station the driven distance is monitored

Solution:

- If carrier got out of place or got too far from target position: Correct position of carrier
- If error recurs, contact support

⚠ 4.18 SAFETYPLC: Faulty control of drive units detected

Faulty control of drive units detected by safety PLC

The rotation angle or speed of a drive unit deviates too much from target value

Solution:

- A drive unit might be twisted because of an obstacle on the ground: Remove obstacle
- Check all 48V circuit breakers (-EMS-U1)
- Check rotation angle of drive units in HMI; if error recurs for the same drive unit, perform an autosection or replace drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 4.19 SAFETYPLC: Faulty control of lift detected

Faulty control of lifting device detected by safety PLC

The actual lifting height deviates too much from target value

Solution:

- Reset error, if error recurs, contact support

⚠ 4.20 SAFETYPLC: Error communication fieldbus

Communication to safety PLC interrupted

Solution:

- Check if all 24V circuit breakers (-EMS-U3) are active
- Check all EtherCAT-cables (-PLC-ECAT-W1, -PLC-ECAT-W2 and -PLC-ECAT-W3), unplug all cables and plug them back in once
- Check if all modules of safety PLC are seated properly and close to each other on the mounting rail, possibly push them together
- Replace EtherCAT cable

⚠ 4.21 Monitoring IPC not valid

Monitoring IPC invalid

Solution:

- Check if all 24V circuit breakers (-EMS-U3) are active
- Check all EtherNet cables (IPC-LAN, PLC-MLAN)
- Contact support

⚠ 4.22 SAFETY PLC: Weight monitoring not valid

Weight monitoring system has detected an invalid weight change

Weight change is only allowed when the lift is moving.

Solution:

- Check load
- Reset error

Failures #5.00 to #5.31

⚠ 5.0 DU-FL1: Winding currents not valid

Current of both motor phases differ

Solution:

- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Check cabling of drive unit (from motor controller to motor within drive unit)
- Replace drive unit

⚠ 5.1 DU-FL1: Limit motor current exceeded

Error motor current monitoring

Solution:

- Lift vehicle and make sure drive unit can be easily moved (push drive unit up and turn it right and left)
- Check if driving wheels can be easily moved
- Check condition of driving wheels
- Remove drive unit and check condition of cables
- Perform autosection

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 5.4 DU-FL2: Winding currents not valid

Current of both motor phases differ

Solution:

- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Check the cabling of drive unit (from motor controller to motor within drive unit)
- Replace drive unit

⚠ 5.5 DU-FL2: Limit motor current exceeded

Error motor current monitoring

Solution:

- Lift vehicle and check if drive unit can be moved easily (push drive unit up and turn it right and left)
- Check if driving wheels can be easily moved
- Check condition of driving wheels
- Remove drive unit and check condition of cables
- Perform autosection

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 5.7 DU-FL: Autosection error

Error performing autosection

Solution:

- Make sure all errors are reset and vehicle status is acknowledged (white button is not lit)
- The manual charging device must not be connected
- Check if all 48V circuit breakers (-EMS-U1) are active
- Check entire cabling from motor controller to drive unit
- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Replace drive unit
- If error recurs, contact support

⚠ 5.8 DU-FR1: Winding currents not valid

Current of both motor phases differ

Solution:

- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Check the cabling of drive unit (from motor controller to motor within drive unit)
- Replace drive unit

⚠ 5.9 DU-FR1: Limit motor current exceeded

Error motor current monitoring

Solution:

- Lift vehicle and check if drive unit can be moved easily (push drive unit up and turn it right and left)
- Check if driving wheels can be easily moved
- Check condition of driving wheels
- Remove drive unit and check condition of cables
- Perform autosection

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 5.12 DU-FR2: Winding currents not valid

Current of both motor phases differ

Solution:

- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Check the cabling of drive unit (from motor controller to motor within drive unit)
- Replace drive unit

⚠ 5.13 DU-FR2: Limit motor current exceeded

Error motor current monitoring

Solution:

- Lift vehicle and check if drive unit can be moved easily (push drive unit up and turn it right and left)
- Check if driving wheels can be easily moved
- Check condition of driving wheels
- Remove drive unit and check condition of cables
- Perform autosection

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 5.15 DU-FR: Autosection error

Error performing autosection

Solution:

- Make sure all errors are reset and vehicle status is acknowledged (white button is not lit)
- The manual charging device must not be connected
- Check if all 48V circuit breakers (-EMS-U1) are active
- Check entire cabling from motor controller to drive unit
- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Replace drive unit
- If error recurs, contact support

⚠ 5.16 DU-RL1: Winding currents not valid

Current of both motor phases differ

Solution:

- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Check the cabling of drive unit (from motor controller to motor within drive unit)
- Replace drive unit

⚠ 5.17 DU-RL1: Limit motor current exceeded

Error motor current monitoring

Solution:

- Lift vehicle and check if drive unit can be moved easily (push drive unit up and turn it right and left)
- Check if driving wheels can be easily moved
- Check condition of driving wheels
- Remove drive unit and check condition of cables
- Perform autosection

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 5.20 DU-RL2: Winding currents not valid

Current of both motor phases differ

Solution:

- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Check the cabling of drive unit (from motor controller to motor within drive unit)
- Replace drive unit

⚠ 5.21 DU-RL2: Limit motor current exceeded

Error motor current monitoring

Solution:

- Lift vehicle and check if drive unit can be moved easily (push drive unit up and turn it right and left)
- Check if driving wheels can be easily moved
- Check condition of driving wheels
- Remove drive unit and check condition of cables
- Perform autosection

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 5.23 DU-RL: Autosection error

Error performing autosection

Solution:

- Make sure all errors are reset and vehicle status is acknowledged (white button is not lit)
- The manual charging device must not be connected
- Check if all 48V circuit breakers (-EMS-U1) are active
- Check entire cabling from motor controller to drive unit
- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Replace drive unit
- If error recurs, contact support

⚠ 5.24 DU-RR1: Winding currents not valid

Current of both motor phases differ

Solution:

- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Check the cabling of drive unit (from motor controller to motor within drive unit)
- Replace drive unit

⚠ 5.25 DU-RR1: Limit motor current exceeded

Error motor current monitoring

Solution:

- Lift vehicle and check if drive unit can be moved easily (push drive unit up and turn it right and left)
- Check if driving wheels can be easily moved
- Check condition of driving wheels
- Remove drive unit and check condition of cables
- Perform autosection

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 5.28 DU-RR2: Winding currents not valid

Current of both motor phases differ

Solution:

- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Check the cabling of drive unit (from motor controller to motor within drive unit)
- Replace drive unit

⚠ 5.29 DU-RR2: Limit motor current exceeded

Error motor current monitoring

Solution:

- Lift vehicle and check if drive unit can be moved easily (push drive unit up and turn it right and left)
- Check if driving wheels can be easily moved
- Check condition of driving wheels
- Remove drive unit and check condition of cables
- Perform autosection

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosection for Drive Unit](#)

⚠ 5.30 DU rotation angle not valid, reset necessary

Zero-positions for drive unit angles not set or saved, adjustment of zero-positions necessary

Solution:

- Mount all drive units with bolts
- In maintenance mode connect to HMI
- Adjust zero-positions on maintenance page

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Set Initial Rotation Angle for Drive Unit](#)

- Remove bolts

⚠ 5.31 DU-RR: Autosection error

Error performing autosection

Solution:

- Make sure all errors are reset and vehicle status is acknowledged (white button is not lit)
- The manual charging device must not be connected
- Check if all 48V circuit breakers (-EMS-U1) are active
- Check entire cabling from motor controller to drive unit
- Check if black plug at motor controller is tightly seated
- Check if all wires of black plug at motor controller are seated properly
- Replace drive unit
- If error recurs, contact support

Failures #6.00 to #6.31

⚠ 6.0 Fatal error data collection

Fatal error in communication of data

Solution:

- Check all EtherCAT-cables (PLC-ECAT-W1, PLC-ECAT-W2 and PLC-ECAT-W3), unplug all cables and plug them back in once
- Contact support

⚠ 6.1 Fatal error data collection - IPC

Fatal error in communication of data - IPC

Solution:

- Check EtherNet cabling (IPC-LAN, PLC-MLAN), unplug and plug back in all cables
- Contact support

⚠ 6.2 Fatal error data collection - PLC1

Fatal error in communication of data - PLC1

Solution:

- Check EtherNet cabling (IPC-LAN, PLC-MLAN), unplug and plug back in all cables
- Contact support

⚠ 6.3 Fatal error data collection - PLC2

Fatal error in communication of data - PLC2

Solution:

- Check all EtherCAT-cables (PLC-ECAT-W1, PLC-ECAT-W2 and PLC-ECAT-W3), unplug all cables and plug them back in once
- Contact support

⚠ 6.4 Fatal error data collection - PLC3

Fatal error in communication of data - PLC3

Solution:

- Check all EtherCAT-cables (PLC-ECAT-W1, PLC-ECAT-W2 and PLC-ECAT-W3), unplug all cables and plug them back in once
- Contact support

⚠ 6.8 Box carrier: Pickup timeout

Timeout during box pickup

Solution:

- Check position of boxes and correct it if necessary
- Reset error

⚠ 6.9 Box carrier: Drop timeout

Timeout during box drop

Solution:

- Check position of boxes and correct it if necessary
- Reset error

 6.10 Box carrier: Double pickup detected

Pickup of two boxes detected

Solution:

- Check position of boxes and correct it if necessary
- Reset error

 6.16 Error sensor drive unit angle FL

Error sensor drive unit angle FL

Solution:

- Check cabling of respective sensor
- Replace sensor
- Contact support

 6.17 Error sensor drive unit angle FR

Error sensor drive unit angle FR

Solution:

- Check cabling of respective sensor
- Replace sensor
- Contact support

 6.18 Error sensor drive unit angle RL

Error sensor drive unit angle RL

Solution:

- Check cabling of respective sensor
- Replace sensor
- Contact support

 6.19 Error sensor drive unit angle RR

Error sensor drive unit angle RR

Solution:

- Check cabling of respective sensor
- Replace sensor
- Contact support

 6.20 Error sensor lift height L

Error sensor lift height L

Solution:

- Check cabling of respective sensor
- Contact support

 6.21 Error sensor lift height R

Error sensor lift height R

Solution:

- Check cabling of respective sensor
- Contact support

⚠ 6.22 Error sensor load distance

Error sensor load distance

Solution:

- Check cabling of respective sensor
- Contact support

⚠ 6.23 Error sensor lift current

Error sensor lift current

Solution:

- Check cabling of respective sensor
- Contact support

Failures #7.00 to #7.31

⚠ 7.0 IPC: Current limit exceeded when driving into station

Current limit exceeded when driving into station

Solution:

- Deactivate feature in settings
[Commissioning Manual 4.3.7.1 - System Settings - Union Configuration](#)
- Investigate reason for drag, possibly solve issue
- Lift vehicle with adequate lifting device and make sure that driving wheels can easily be moved

⚠ 7.1 IPC: Speed deviation detected

Speed deviation between localization and drive units detected

Solution:

- Contact support

⚠ 7.2 IPC: Faulty control of drive units detected

Faulty control of drive units detected by IPC

The rotation angle or speed of a drive unit deviates too much from target value

Solution:

- A drive unit might be twisted because of an obstacle on the ground: Remove obstacle
- Check all 48V circuit breakers (-EMS-U1)
- Check rotation angle of drive units in HMI; if error keeps recurring for the same drive unit, perform an autosetup or replace drive unit
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosetup for Drive Unit](#)

⚠ 7.3 IPC: Lift occupation not valid

Faulty occupation detected by IPC

Solution:

- Check occupation: Carrier must be loaded correctly (correct distance to rear panel), carrier possibly got out of place
- If carrier is loaded correctly, check angle of distance sensor in rear panel, it possibly needs to be adjusted up

⚠ 7.4 IPC: Driven distance in station mode not valid

Traveled distance in station mode invalid

When entering a station the driven distance is monitored

Solution:

- If carrier got out of place or got too far from target position: Correct position of carrier
- If error recurs, contact support

⚠ 7.5 IPC: Distance to station not valid

Distance to station invalid

Solution:

- If carrier got out of place or got too far from target position: Correct position of carrier
- If there is an obstacle in the area next to or between the forks, remove obstacle and reset error

⚠ 7.6 IPC: Stop error drive units

Vehicle was not stopped correctly – emergency stop activated

IPC detected a problem when checking if its stop request actually led the vehicle to stop

Solution:

- Check if all 48V circuit breakers (-EMS-U1) are active
- Check cabling of drive units
- Reset error
- If error recurs, contact support

⚠ 7.7 IPC: Stop error lift

Lift has not stopped properly – emergency stop activated

IPC detected a problem when checking if its stop request actually led the vehicle to stop

Solution:

- Check if all 48V circuit breakers (-EMS-U1) are active
- Check cabling of lifting motor controllers (-LI-U1 and -LI-U2)
- Reset error
- If error recurs, contact support

Warnings

Warnings #16.00 to #16.31



16.0 DU-FL1: Closed loop not active

Initial drive of drive units not yet performed

Solution:

- Reset error
- If there are any other issues after pressing the acknowledge button or restarting the vehicle, make sure to solve those first
- If error cannot be reset, restart vehicle



16.1 DU-FL2: Closed loop not active

Initial drive of drive units not yet performed

Solution:

- Reset error
- If there are any other issues after pressing the acknowledge button or restarting the vehicle, make sure to solve those first
- If error cannot be reset, restart vehicle



16.2 DU-FR1: Closed loop not active

Initial drive of drive units not yet performed

Solution:

- Reset error
- If there are any other issues after pressing the acknowledge button or restarting the vehicle, make sure to solve those first
- If error cannot be reset, restart vehicle



16.3 DU-FR2: Closed loop not active

Initial drive of drive units not yet performed

Solution:

- Reset error
- If there are any other issues after pressing the acknowledge button or restarting the vehicle, make sure to solve those first
- If error cannot be reset, restart vehicle



16.4 DU-RL1: Closed loop not active

Initial drive of drive units not yet performed

Solution:

- Reset error
- If there are any other issues after pressing the acknowledge button or restarting the vehicle, make sure to solve those first
- If error cannot be reset, restart vehicle



16.5 DU-RL2: Closed loop not active

Initial drive of drive units not yet performed

Solution:

- Reset error
- If there are any other issues after pressing the acknowledge button or restarting the vehicle, make sure to solve those first
- If error cannot be reset, restart vehicle

 16.6 DU-RR1: Closed loop not active

Initial drive of drive units not yet performed

Solution:

- Reset error
- If there are any other issues after pressing the acknowledge button or restarting the vehicle, make sure to solve those first
- If error cannot be reset, restart vehicle

 16.7 DU-RR2: Closed loop not active

Initial drive of drive units not yet performed

Solution:

- Reset error
- If there are any other issues after pressing the acknowledge button or restarting the vehicle, make sure to solve those first
- If error cannot be reset, restart vehicle

 16.8 BMS: Temperature value not valid

Error of one of the battery temperature sensors

Solution:

- Check black plugs on top of battery
- Contact support

 16.9 BMS: Battery temperature limit high exceeded

Temperature of battery too high

Solution:

- Power off vehicle immediately
- Open cabinet and unplug blue battery plug on the bottom left
- Contact support

 16.10 BMS: Battery temperature limit low reached

Temperature of battery too low

Solution:

- Power off vehicle immediately
- Open cabinet and unplug blue battery plug on the bottom left
- Contact support

⚠ 16.11 BMS: Voltage low

Battery current too low

Vehicle will shut down

Solution:

Vehicle positioned on charging plate

- Start vehicle (in case it is not active)
- Turn key switch to automatic mode
- Reset error
- Charging process starts
- If charging process does not start, contact support

Vehicle not positioned on charging plate:

- Open cabinet / Open right side cover
- Connect manual charging device to power source
- Connect charging device to vehicle by using red plug
[3.1.2.7 - Mobile Charging Unit](#)
- Reset error
- Charging process
- If charging process does not start, contact support

⚠ 16.12 BMS: Shutdown initiated

Vehicle shuts down

Information message:

Vehicle is going to shut down shortly

⚠ 16.13 BMS: Shutdown requested

Vehicle intends to shut down

Vehicle stops, drive units rotate into park position and vehicle shuts down

Information message:

Vehicle intends to shut down

Vehicle shuts down as soon as it stopped and drive units are in park position

⚠ 16.14 BMS: Wait time before next charging cycle

Pause until next charging cycle

Information message:

Before starting a new charging cycle vehicle must rest for a certain period of time

⚠ 16.15 BMS: Manual charging device connected

Manual charging device connected

Information message:

As long as a manual charging device is connected vehicle cannot be moved

⚠ 16.16 Rotation angle not valid, reset necessary

Rotation angle not valid, adjustment to zero-position necessary

Solution:

- Mount all drive units with bolts
- In maintenance mode connect to HMI
- Adjust zero-positions on maintenance page
- Remove bolts

[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Set Initial Rotation Angle for Drive Unit](#)

 16.17 DU-FL: Rotation angle reset active

Rotation angle of drive unit FL is being reset

Solution:

- Wait until reset is done (a few seconds)
- If message does not disappear, contact support

 16.18 DU-FR: Rotation angle reset active

Rotation angle of drive unit FR is being reset

Solution:

- Wait until reset is done (a few seconds)
- If message does not disappear, contact support

 16.19 DU-RL: Rotation angle reset active

Rotation angle of drive unit RL is being reset

Solution:

- Wait until reset is done (a few seconds)
- If message does not disappear, contact support

 16.20 DU-RR: Rotation angle reset active

Rotation angle of drive unit RR is being reset

Solution:

- Wait until reset is done (a few seconds)
- If message does not disappear, contact support

 16.21 LIFT: Height reset active

Height measuring system is being reset

Solution:

- Wait until reset is done (a few seconds)
- If message does not disappear, contact support

 16.22 Height value not valid, reset necessary

Value of height measuring system invalid, reset (adjustment to zero-position) necessary

Solution:

- Switch to maintenance mode
- Lower lift down to zero-position (ca. 2mm above mechanical zero-position)
- Adjust height measuring system to zero-position in HMI \\Commissioning Manual 4.3.7.4 - Maintenance Mode (Vehicle Maintenance) - Adjust Zero Position for Lift

 16.23 DU-FL: Autosecure active

Autosecure active

Solution:

- Keep acknowledge button pressed until autosecure is done and warning disappears
- If message does not disappear, contact support

 16.24 DU-FR: Autosecure active

Autosecure active

Solution:

- Keep acknowledge button pressed until autosecure is done and warning disappears
- If message does not disappear, contact support

 16.25 DU-RL: Autosecure active

Autosecure active

Solution:

- Keep acknowledge button pressed until autosecure is done and warning disappears
- If message does not disappear, contact support

 16.26 DU-RR: Autosecure active

Autosecure active

Solution:

- Keep acknowledge button pressed until autosecure is done and warning disappears
- If message does not disappear, contact support

 16.27 LIFT: Not initialized

Initialization of lifting motor control failed

Solution:

- Turn key switch to maintenance mode, then back to automatic mode
- If message does not disappear, contact support

 16.28 LIFT: Controller configuration not valid

Parameters of lifting motor control invalid

Solution:

- Turn key switch to maintenance mode, then back to automatic mode
- If message does not disappear, contact support

 16.29 LIFT: Height LE/RI out of limit

Lifting height left and right out of limit

Solution:

- If lift is in bottom position, turn key switch to maintenance mode and move up lift 2-3mm
- Adjust zero-position to this height in HMI, then switch back to either manual or automatic mode
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Adjust Zero Position for Lift](#)
- If message does not disappear, contact support

 16.30 Encoder alignment missing, autosecure necessary

Encoder alignment missing, autosecure necessary

Solution:

- Perform Autosecure
[Commissioning Manual 4.3.7.4 - Maintenance Mode \(Vehicle Maintenance\) - Autosecure for Drive Unit](#)
- If error recurs after restarting the vehicle, the controller needs to be exchanged

 16.31 Firmware versions of motor controllers differ

Motor controllers have different firmware versions

Solution:

- Exchange motor controllers, to have same firmware versions on all of them
- Contact support

Warnings #17.00 to #17.31

 17.0 SAFETYPLC: Acknowledge button not pressed

Acknowledge button not pressed

Solution:

- Press acknowledge button to release drive units or lift in maintenance mode

 17.1 SAFETYPLC: External stop request

Emergency stop request triggered

Solution:

- If warning recurs, contact support

 17.2 STATION-ENTRY: Distance to station not valid

Distance to station invalid

Solution:

- If carrier got out of place: Correct position of carrier
- Reset error

 17.3 SAC: Drive unit monitoring warning

Warning angle monitoring of drive units

One drive unit twisted

Vehicle tries to adjust orientation automatically

Solution:

- If warning recurs, contact support

 17.4 SAFETYPLC: Safety scanner left dirty

Safety scanner left dirty

Solution:

- Clean laser scanner
- Restart vehicle

 17.5 SAFETYPLC: Safety scanner right dirty

Safety scanner right dirty

Solution:

- Clean laser scanner
- Restart vehicle

 17.6 Data collection warning - IPC

Data collection warning - IPC

Solution:

- Check EtherNet cabling (IPC-MLAN, PLC-LAN), unplug all cables and plug them back in once
- Contact support

 17.7 Safety verions and PLC version not compatible

Safety PLC software version and PLC software version are not compatible

Solution:

- Update safety PLC or PLC
- Contact support

 17.8 LIFT-L: Bad sensor signal

Bad sensor signal from height sensor L

Significant jump in measured values detected

Solution:

- If error recurs, contact support

 17.9 LIFT-R: Bad sensor signal

Bad sensor signal from height sensor R

Significant jump in measured values detected

Solution:

- If error recurs, contact support

 17.10 DU-FL: Bad sensor signal

Bad sensor signal from angle sensor of drive unit FL

Significant jump in measured values detected

Solution:

- If error recurs, contact support

 17.11 DU-FR: Bad sensor signal

Bad sensor signal from angle sensor of drive unit FR

Significant jump in measured values detected

Solution:

- If error recurs, contact support

 17.12 DU-RL: Bad sensor signal

Bad sensor signal from angle sensor of drive unit RL

Significant jump in measured values detected

Solution:

- If error recurs, contact support

 17.13 DU-RR: Bad sensor signal

Bad sensor signal from angle sensor of drive unit RR

Significant jump in measured values detected

Solution:

- If error recurs, contact support

 17.14 LIFT-CURRENT: Bad sensor signal

Bad sensor signal from lift current sensor

Significant jump in measured values detected

Solution:

- If error recurs, contact support

 17.16 SAC: Drive unit monitoring warning - SAFETYPLC

Warning angle monitoring of drive units

One drive unit twisted - detected by safety PLC

Vehicle tries to adjust orientation automatically

Solution:

- If error recurs, contact support

 17.17 SAC: Drive unit monitoring warning - PLC1

Warning angle monitoring of drive units

One drive unit twisted - detected by PLC1

Vehicle tries to adjust orientation automatically

Solution:

- If error recurs, contact support

 17.18 SAC: Drive unit monitoring warning - PLC2

Warning angle monitoring of drive units

One drive unit twisted - detected by PLC2

Vehicle tries to adjust orientation automatically

Solution:

- If error recurs, contact support

 17.19 SAC: Drive unit monitoring warning - DU-FL

Warning angle monitoring of drive units

Drive unit FL twisted

Vehicle tries to adjust orientation automatically

Solution:

- If error recurs, contact support

 17.20 SAC: Drive unit monitoring warning - DU-FR

Warning angle monitoring of drive units

Drive unit FR twisted

Vehicle tries to adjust orientation automatically

Solution:

- If error recurs, contact support

 17.21 SAC: Drive unit monitoring warning - DU-RL

Warning angle monitoring of drive units

Drive unit RL twisted

Vehicle tries to adjust orientation automatically

Solution:

- If error recurs, contact support

 17.22 SAC: Drive unit monitoring warning - DU-RR

Warning angle monitoring of drive units

Drive unit RR twisted

Vehicle tries to adjust orientation automatically

Solution:

- If error recurs, contact support

Warnings #18.00 to #18.31

 18.0 Lamp test active

Lamp test active

Activation and deactivation in HMI

 18.1 Data collection not valid

Data collection invalid

Solution:

- If warning does not disappear within short time: Contact support

 18.2 Startup: Press start button

Startup of vehicle

Solution:

- Start button needs to be pressed

 18.3 Invalid firmware version

Firmware versions of PLC1 and PLC2 not compatible

Solution:

- If warning does not disappear within short time: Contact support

 18.4 Distance monitoring triggered

Distance sensor between forks detected an unexpected obstacle

Solution:

- Check space between fork and remove obstacle

⚠ 18.8 DU-FL1: Velocity warning maintenance mode

Velocity warning in maintenance mode

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cable connections at the motor controllers (in the lower part of the control cabinet)

⚠ 18.9 DU-FL2: Velocity warning maintenance mode

Velocity warning in maintenance mode

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cable connections at the motor controllers (in the lower part of the control cabinet)

⚠ 18.10 DU-FR1: Velocity warning maintenance mode

Velocity warning in maintenance mode

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cable connections at the motor controllers (in the lower part of the control cabinet)

⚠ 18.11 DU-FR2: Velocity warning maintenance mode

Velocity warning in maintenance mode

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cable connections at the motor controllers (in the lower part of the control cabinet)

⚠ 18.12 DU-RL1: Velocity warning maintenance mode

Velocity warning in maintenance mode

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cable connections at the motor controllers (in the lower part of the control cabinet)

⚠ 18.13 DU-RL2: Velocity warning maintenance mode

Velocity warning in maintenance mode

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cable connections at the motor controllers (in the lower part of the control cabinet)

⚠ 18.14 DU-RR1: Velocity warning maintenance mode

Velocity warning in maintenance mode

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cable connections at the motor controllers (in the lower part of the control cabinet)

⚠ 18.15 DU-RR2: Velocity warning maintenance mode

Velocity warning in maintenance mode

Solution:

- Check if all 48V circuit breakers -EMS-U1 are active
- Check cable connections at the motor controllers (in the lower part of the control cabinet)

Problems

➊ 1 Missing information for action start

Vehicle cannot start next action due to missing information

A host system might not have responded to a request or a bar code could not be read

Solution:

- Check workflow and possibly define exception handling

➋ 2 –

–

➌ 3 –

–

➍ 4 Occupied at pickup

Vehicle wants to pick up but is already occupied

Occupied vehicle cannot pick up load

Solution:

- Check/rewrite workflow

➎ 5 Empty at drop

Vehicle is supposed to drop but has no load

Vehicle without load cannot drop load

Solution:

- Check/rewrite workflow

➏ 6 Lift height not plausible

Actual lift height does not meet expected lift height

Solution:

- Restore legal conditions and change mode (manual/auto) to reset parameters

➐ 7 Wait for station

Vehicle is waiting for station condition

A condition has been defined for the respective station (e.g. clearance by AGILOX I/O) which is not fulfilled

Solution:

- Wait for condition to be fulfilled
- Check workflow, possibly define alternatives and how to response to timeout

! 8 No position from navigation

Vehicle unable to determine its position

Solution:

- Restart vehicle
- If issue cannot be solved, contact support
- Force global/local positioning (only possible in a high map-match area of ~40%)
- Move vehicle into high map-match area and force global/local positioning
- Check map/outlines
- Check scanner connections

! 9 Navigation error

Vehicle unable to determine its position

Solution:

- Restart vehicle
- If message does not disappear, contact support
- Force global/local positioning (only possible in a high map-match area of ~40%)
- Move vehicle into high map-match area and force global/local positioning
- Check map/outlines
- Check scanner connections

! 10 Action task watchdog missing

Issue control-IPC

Solution:

- Restart vehicle
- If message does not disappear contact support

! 11 No target determined

No target determined for current order-action

Solution:

- Target station (or entire area) is blocked?
→ Min. one station needs to be released
- Trying to drop a wide carrier onto a narrow station?
- A station was renamed but not the associated workflow?
→ Possibly rewrite workflow

! 12 No pallet detected

Order was placed to pick up from an empty station

Solution:

Make sure there is a carrier on station
alternatively rewrite workflow (use event: no_station_left)

! 13 Pallet out of area

Pallet too far from defined coordinates

Solution:

- Move pallet back in position
- Increase distance between stations to grant more space for pallet detection
- Check pallet for damages

! 14 –

! 15 Pallet distance error

A pallet was detected but distance to taught coordinates is too significant (>0.5m from taught coordinates)

Solution:

- Place pallet more accurately onto pickup station

! 16 No data from safety scanner

Safety scanner is not communicating values

Solution:

- Restart vehicle
- If message does not disappear contact support

! 17 Load distance not plausible

Position of pallet changed while vehicle was entering station

Solution:

- Possibly pallet is pushed out of place by vehicle when entering station
- Check pallet for damages, check min. height of pallet base
- Make sure safety laser scanners are clean

! 18 Lift not allowed

Vehicle wants to adjust lift to station but is not positioned on a station

Solution:

- Vehicle was manually moved out of station (e.g. emergency stop was triggered) and therefor is unable to finish action
- Switch mode (manual/auto) to reset action

! 19 –

! 20 Cannot detect load carrier width

Vehicle could not determine load carrier width

Carrier might be damaged or not allowed

Non-EPAL carriers must be approved by AGILOX North America, Inc.

Solution:

- Carrier must be approved by AGILOX North America, Inc.
- Check carrier for damages
- Make sure safety laser scanners are clean

! 21 Load carrier too wide

Carrier is wider than station specifies

e.g. vehicle wants to pick up carrier from an 800mm EPAL station but recognizes a wider carrier

Solution:

- Only supply carriers as defined in station parameters
- Change station parameters to allow wider carriers

! 22 No station entering with active ASD

Map-match too low for station

Map quality too poor for vehicle to enter station safely

Solution:

- Reteach map in that area
- Mount static contour elements and reteach station
- Define temporal exceptions (in accordance with AGILOX North America, Inc.)

! 23 –

–

! 24 Load carrier too wide for target

Picked up carrier is too wide for target station

Vehicle has detected that pallet is too wide for target station

Solution:

- Make sure that wide carriers are only to be dropped on adequate stations
- If target is a station area make sure enough wide stations are defined in the area

! 25 –

–

! 26 Load carrier too long for target

Picked up carrier is too long for target station

Vehicle has detected that pallet is too long for target station

Solution:

- Make sure that source station and target station are specified for same max. length
- If target is a station area make sure enough long stations are defined in the area

! 27 No conveyor for pickup

Vehicle wants to pick up load but no position left on box carrier

Solution:

- Check/rewrite workflow

! 28 No conveyor for drop

Vehicle wants to drop load from box carrier but box carrier is empty

Solution:

- Check/rewrite workflow

! 29 Conveyor position error

Box carrier out of position

Solution:

- Check position of box carrier

! 30 No route to target

No route to target station

Solution:

- Check position and target of vehicle

! 31 Lift limit exceeded

Lift limit exceeded

Solution:

- Check configured height of station

! 32 Memory task watchdog missing

Issue control-IPC

Solution:

- Restart vehicle
- If message does not disappear contact support

! 33 No way to drive free

Vehicle could not determine a way to drive free

Vehicle must drive itself free but is not able to due to missing empty space in that area

Solution:

- Remove obstacles which hinder vehicle to move
- Relieve vehicle by moving it in manual mode

! 34 Carrier occupation unexpected

Vehicle's occupation unexpected

e.g. pickup up from a raised station with too low lifting setting (so load stays on its place instead of being lifted by the vehicle)

Solution:

- Check station parameters

! 35 Station entering prohibited for safety reasons

Cannot enter station safely as it's lift height is too low for safe_drop

With "Safe Drop", the safety laser scanners remain active during station entry, thereby the load must not block the scanning area (approx. 80mm above the floor).

Solution:

Raise entering height

alternatively disable safe drop (**ATTENTION: Safety risk!**)

ANNEX VI - AGILOX Feature Feed

Archive

20200731

- **AGILOX User Interface (HMI)**

Added map match and asd match to agilox vehicle tooltip
[6.2.2.4 - Tooltip on AGILOX vehicles](#)

20200702

- **AGILOX User Interface (HMI)**

New heatmap design.
[6.2.7 - Heatmaps](#)

20200518

- **Audio Signals**

After 10 seconds of standstill, an acoustic signal is triggered. Before starting movement again another signal is trigger 2 seconds prior the movement starts.
[ANNEX I - Audio Signals](#)

20200304

- **Barcode Types**

Implemented detection of GS1 barcodes (former EAN-128 / RSS) for Code 128 barcodes.
[3.2.11 - Optional Detection of Barcodes](#)

20191212

- **AGILOX User Interface**

The current floor is highlighted.
[6.2.2 - AGILOX User Interface Overview](#)

20191030

- **AGILOX User Interface**

New function to force a pending order to be done next.
[6.2.11.1 - Orders](#)

20191029

- **Workflow Views**

Workflow view now shows workflow view title on top.

[6.3.1 - Example for a Workflow View \(Easy Buttons\)](#)

- **AGILOX User Interface**

Pick up Box Carrier from station using context menu.

[6.2.5.1 - Context menus](#)

New symbol and tooltip for stations with special settings

[6.2.2 - AGILOX User Interface Overview](#)

20190924

- **Workflow Views**

Yellow triangle shows if the vehicle has stopped for some reason (failure, obstruction, ...).

[6.3.1 - Example for a Workflow View \(Easy Buttons\)](#)

- **Manual Operation**

New manual control interface for Box Carrier

[6.2.8.1 - Manual Operation](#)

20190806

- **Tooltips**

conveyor AGILOX IO states in vis tooltip

[6.2.2.3 - Tooltip on Stations](#)

- **Heatmaps**

New heatmap for vertical acceleration

[6.2.7 - Heatmap Visualization](#)

20190626

- **Tooltips**

added documentation version to system info in status bar

[6.2.2.1 - Tooltips on Status Bar](#)

20190613

- **Workflow Views**

New Workflow Views Concept with new features.

[6.3 - Workflow Views](#)

- **Audio Signals**

New audio signal for "no station left" or "waiting for interaction"

[ANNEX I - Audio Signals](#)

- **Tooltips**

Waypoint catch radius is shown in waypoint tooltip.

[6.2.2.3 - Tooltips on Stations](#)

20190506

- **Orders**

maximum pending and active orders now limited to 100 x agilox count

[6.2.11.1 - Orders](#)

20190412

- **Driving Dynamics**

"fire" workflow as optional replacement for default behaviour implemented

[6.4.11 - Behavior in case of fire](#)

- **AGILOX User Interface**

obstructions now are shown in visualization

[6.2.2 - AGILOX User Interface Overview](#)

20190401

- **Driving Dynamics**

speed_max no more considered for rotation

- **Energy Management**

The battery will be charged to 100% every 20th charging cycle.

[ANNEX III - Energy Management](#)

20190322

- **AGILOX HMI**

Removed AGILOX circle rotation to raise client browser performance

[6.2.2 - AGILOX User Interface Overview](#)

- **Driving Dynamics**

Ignore no more reachable AGILOX vehicle on station for speed limitation on weak connection

[6.4.10 - Speed Restrictions](#)

20190319

- **Driving Dynamics**

Limit speed to 1m/s if foreign agilox is within 5m and to 0.5m/s if foreign agilox is within 2m.

[6.4.10 - Speed Restrictions](#)

20190308

- **Driving Dynamics**

System wide redesign of map setup for allowing different protective field sets to drive in one swarm.

[6.4.1 - Protective Fields](#)

Ignite start lamp while charging if fire alarm occurs.

[6.4.11 - Behavior in Case of Fire](#)

20190215

- **AGILOX HMI**

Visualization stations now show possibility for carrier drop.

[6.2.2 - AGILOX User Interface Overview](#)

- **HMI Manual Operation**

Manual lift now shows current lift situation and setpoint.

[6.2.8.2 - Manual Lift](#)

20190201

- **HMI Vehicle Information**

motor current visualization

[6.2.3 - Vehicle Information](#)

20181211

- **HMI Visualization**

Rooler tool also shows the relative angle now.

20181129

- **Visual Signals**

led signal when rotating

[ANNEX II - Visual Signals](#)

20181123

- **HMI Visualization**

AGILOX tooltip now shows protective field setup

[6.2.2.4 - Tooltip on AGILOX vehicles](#)

- **HMI Visualization**

new heatmap showing localization jumps to identify hot spots of them

[6.2.7 - Heatmap Visualization](#)

- **Audio Signals**

new acoustic warning sign of obstacle is getting closer when standing because of obstacle

[ANNEX I - Audio Signals](#)

20181102

- **HMI Reports**

new order report filter for order type

[6.2.11.1 - Orders](#)

- **HMI Visualization**

new spinning circle around AGILOX vehicles for finding them in large maps while zoomed out

spinning colored circle around AGILOX vehicles, which are not able to do orders (failure, process error, manual control, ...)

[6.2.2 - AGILOX User Interface Overview](#)

20181029

- **HMI Visualization**

LTE signal mode and raw value in tooltip.

[6.2.2.1 - Tooltips on the status bar](#)

20181028

- **HMI Visualization**

Search in VIS to find/jump to stations, waypoints and AGILOX vehicles.

[6.2.2 - AGILOX User Interface Overview](#)

20180921

- **HMI Visualization**

Added information about time stopped to agilox tooltip

[6.2.2.4 - Tooltip on AGILOX Vehicle](#)

20180831

- **HMI Visualization**

Added link and link target information to station tooltip.

[6.2.2.3 - Tooltip on Stations](#)

20180823

- **Live Route Map**

New HMI functionality **Live Route Map**

[6.2.6 - Visualization Toggles](#)

- **Driving Dynamics**

Parking and charging stations are locked exclusively.

[6.4.8 - Station/Channel Locking](#)

20180718

- **Barcode Types**

New supported barcode type **Datamatrix**

[3.2.11 - Optional Detection of Barcodes](#)

- **Locking**

New Station/Channel locking

[6.4.8 - Station/Channel Locking](#)

20180711

- **HMI Visualization**

Communication status implemented to status bar. Wifi symbol shows white, yellow or red color depending on communication quality

[6.2.2.1 - Tooltips on Status Bar](#)

- **HMI Reports**

New order status "retained" and report filter for this status.

[6.2.11 - Reports](#)

- **Drive Dynamics**

Speed restriction at Bad WIFI Communication

[6.4.10 - Speed Restrictions](#)

20180703

- **HMI Visualization**

New Visualization for Stations. Icon on top of each other, new icon for Station Type Information.

[6.2.2 - AGILOX User Interface Overview](#)

20180524

- **New Route determination: Route2**

Routes are rated according to their costs. Some possible routes cause higher costs and are therefore avoided as much as possible, but not ignored when finding a route.

[6.4.7 - Route Determination](#)

20180326

- **Stations**

The validity of stations is determined. Stations are shown in red in the visualization, if they are not valid.

[6.2.2 - AGILOX User Interface Overview](#)