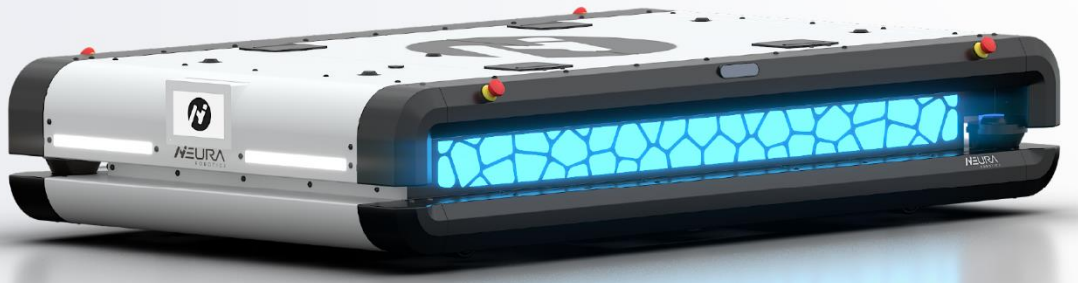
NEURA ROBOTICS

MAV®



User manual

Edition : 02 / 10.2022
Language EN

Copyright Notice

DOCUMENT HISTORY

Edition	Date	Change Log
01	02.2022	First edition
02	10.2022	Second edition

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1. ABOUT THIS DOCUMENT

1.1. How to Use This Manual

This manual contains information that is necessary to use the MAV robots. Please read this manual and make sure that you understand the safety, assembly, maintenance, and operation of the MAV series before attempting to use it.

Always keep this manual in a safe place where it will be available for reference during operation.

Please read and understand the instructions in *chapter 2,"General Safety Instructions" on page 7*. The user manual provides instructions for MAV operators from the following aspects:

- Safety Issue: The operator shall keep all safety instructions in mind.
- Product presentation: let operators to know more about MAV.
- Mechanical Installation: The operator shall follow the instructions when integrating and moving the robot.
- Electrical Installation: The operator shall follow the instruction when charging the AGV and working with the Batteries.
- Software Control: The operator will have a quick introduction AGV software in this manual. It can guide the operator to install software and take the first steps moving MAV.

1.2. Related Documents

The MAV robot system can be used as stand-alone, as part of a fleet or in combination with the NEURA Robotics robot arms (MAiRA and LARA). Also follow the instructions for the other system components. This includes:

- MAV Software manuals
- MAiRA User and Software manual (if required)
- LARA User and Software manual (if required)

1.3. Robot Models

This manual provides information for the following MAV models.

- MAV 1500
- MAV 500

When information varies between different MAV models, details are provided. When information is common to all MAV models, an illustration of a single robot model is typically shown.

1.4. Used Characters and Symbols

In this user manual, various elements are used to indicate special text meanings or especially important text passages.

Symbols and terms used in warnings

The below table defines the common safety warnings, symbols and terms that may exist in the content of using robots:

⚠	The general danger symbol warns of risk of serious injury when used with the signal words **CAUTION**, **WARNING** and **DANGER**. Follow all the instructions in order to avoid injuries or death.
NOTICE	Indicates a hazardous situation which, if not avoided, results in damage to or destruction of the device.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

Structure of warnings

⚠ SIGNAL WORD
Type and source of the danger **Consequences resulting from non-observance** ► Action for danger avoidance

Symbols and marks

►	**Action** Indicates a single action, e.g.: ► Switch on device.
1. **2.** **3.**	**Sequence of actions** Indicates a sequence of actions that must be performed in the specified order
Bold text	**Operating element or menu name** Indicates operating elements and menu names, e.g.: ► Press the **OK** button.
NOTE:	Important additional information or notes regarding exceptions and special cases.

1.5. Abbreviations

Abbreviation	Description
AGV	Automated Guided Vehicle
AI	Analog Input
ANSI	American National Standards Institute
AO	Analog Output
BMS	Battery Management System
DC	Direct Current
DIN	German Institute for Standardization
EMC	Electromagnetic Compatibility
EN	European Standard
ESD	Electrostatic Discharge
GND	Ground
GUI	Graphical User Interface
HMI	Human Machine Interface
I/O	Input / Output
ISO	International Organization for Standardization
MAV	Multi-sensing Autonomous Vehicle
PLC	Programmable Logic Controller
PL d	Performance Level d
SLAM	Simultaneous Localization and Mapping
USB	Universal Serial Bus
VDA	German Association of the Automotive Industry

1.6. Technical Support

NEURA Robotics GmbH will provide you with long-term technical services. If you have any technical problems or other needs during use, please visit our company website: www.neura-robotics.com, or directly contact our engineers.

Contact Information

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2. GENERAL SAFETY INSTRUCTIONS

2.1. Introduction

The MAV Robot System has been manufactured according to the accepted rules of safety and current technology. There is, however, still a danger of personal injury or damage to equipment if the following general safety instructions and the warnings before the steps contained in these instructions are not complied with.

- Read these instructions completely before working with MAV. The contents with warning signs need to be mastered and strictly followed.
- Always keep this manual in a safe place where it will be available for reference during operation.
- Always include the operating instructions when passing the MAV system on to third parties.

This chapter introduces the safety principles and specifications that should be followed when operating the mobile robot system. Integrators and users must read this manual carefully, and the contents with warning signs need to be mastered and strictly followed. Because the MAV robot is a mechanical equipment that moves at a certain speed, users need to fully understand the risks of operation and strictly follow and implement the specifications and requirements in this manual. Not taking the necessary safety measures during use or improper use may cause MAV failure or damage, and in severe cases may also lead to personal injury.

⚠	• NEURA Robotics GmbH is not responsible for any problems caused by damage, replacement or modification of MAV or its accessories in any way. λ • NEURA Robotics GmbH is not responsible for any damage to the MAV, accessories or any other equipment caused by programming errors or malfunctions

2.2. General Instructions

- Do not use the robot if it is damaged. Please contact the technical support personnel of NEURA Robotics GmbH immediately.
- Observe the regulations for accident prevention and environmental protection for the country where the device is used and at the workplace.
- Disconnect the power supply and install the robot and all electrical equipment in accordance with the requirements and specifications in this manual.
- NEURA Robotics GmbH shall not be liable for any damage or personal injury caused to the AGV due to errors in this script or improper operation of the AGV.
- Take care of potential hazards leading to injuries and equipment damages when working with the AGV system. Potential hazards are, for example:
  - Fingers being caught by AGV wheels or joints.
  - Sharp edges and sharp points on the tool or tool connector pierce the skin.
  - Sharp edges and sharp points on obstacles near the AGV trajectory puncture the skin.
  - Injured by a AGV collision.
  - Sprains or fractures due to the impact between the AGV's payload and a solid surface.
  - Consequences due to insecure bolts used to fix an external system or tool.
  - Items fall from the AGV, for example due to inadequate positioning.
  - Please note that the AGV can be set with a route for moving backwards.
- MAV is only allowed to be used under specified environmental conditions and applications. Prohibited uses include but are not limited to the following:
  - Used in flammable and explosive hazardous environments.
  - Device for moving or carrying people or other animals.

- Overload and overspeed operation.
- Run in direct sunlight.
- Run under rainy or high humidity conditions.

2.3. Safety Precautions

⚠ CAUTION

2.3.1. Operator Safety

Each operator using the robot system should receive training through the training course sponsored by NEURA Robotics GmbH or certified partners. The user needs to ensure that he fully masters the safe and standardized operation process and has the qualification for robot operation. For details of the training, please inquire with our company, see the official website for contact information.

1. The personnel who carry out mechanical installation, electrical installation, operation and maintenance should have professional knowledge and experience in related fields, be able to evaluate whether the machine is in a safe operating state after using protective equipment.
2. When operating the robot system, you must first ensure the safety of the operators. The general precautions are listed below. Please take appropriate measures to ensure the safety of the operators.
3. During the operation of the equipment, even if the robot seems to have stopped, it may be because the robot is waiting for the start signal and is in a state of about to move. Even in this state, the robot should be regarded as being in motion.
4. Locks should be set according to the needs, so that the person in charge of the operation cannot access the robot power supply.
5. Before starting the system and equipment for the first time, you must check whether the equipment and system are complete, whether the operation is safe, and whether any damage is detected. In this test, it is necessary to observe whether it complies with the effective safety production rules and regulations of the country or region, and all safety functions must be tested.
6. The user must check and ensure that all safety parameters and user programs are correct, and all safety functions are working properly. A person qualified to operate the robot is required to check each safety function. The robot can only be started after passing a comprehensive and careful safety test and reaching the safety level.
7. After the robot is installed and constructed, it is necessary to conduct a comprehensive risk assessment again and keep document records.
8. It is up to authorized personnel to set and change safety parameters such as speed, acceleration, and lidar protection range, and use passwords or isolation measures to prevent unauthorized personnel from changing or setting safety parameters. After the safety factor is modified, the related safety functions need to be analysed.
9. In the event of an accident or abnormal operation of the robot, you can press the emergency stop switch to stop the robot.

2.3.2. Running Safety

Ground Requirements

CAUTION	Ground Requirements

1. The ground shall be flat, and free from grooves, damages, pores, greasy dirt, glue or other contaminants.

2. There shall be no foreign objects on the floor, such as screws, rags, gloves, and thread cables that are easy to jam and entangle the wheels.

3. The sections of the work area shall be protected or marked with warning signs to remind other personnel that robots are coming in and going out.

4.- Floor loading capacity needed, when the AGV drive with max. load: between 1000Gk and 2000Kg (depending on the MAV Modell).

Load Safety

CAUTION	Load Safety

The end user is responsible for ensuring that the payload is correctly fixed on the MAV platform and that the payload will not shift during the movement of the MAV. For example, when transporting liquid containers, operators must take necessary precautions to prevent liquid sloshing, because it will affect the stability of MAV operation.

Ensure that the load is being carried by the lifting units and not by the MAV covers (Fig. 12).

Running in Elevator or Lifter

CAUTION	Running in Elevator or Lifter

1. Ensure that the elevator or lifter can bear the full weight of the robot and its load.
2. Ensure that no part of the robot is in contact with the car wall of the elevator or lifter.
3. Ensure that the robot would not move unexpectedly.
4. Ensure that the elevator meets the standards.

Application Environment

⚠	Application Environment

1. NEURA Robotics GmbH is not responsible for any damage to the robot or personal injury caused by script errors or improper operation of the robot.
2. Do not expose the robot to a permanent magnetic field all the time. Strong magnetic field can damage the robot.

2.4. Battery Safety

WARNING
Precautions for Battery Use ► The batteries are high-energy substances and must be used under certain technical conditions. ► Please use the original charger. It is prohibited to use the chargers of other brands; otherwise, it will cause irreversible damage to the battery.

To avoid damages or personal injury caused by abuse of the battery pack, please carefully read the following safety guidelines:

- The battery pack is exposed to the risks such as fire and explosion. Do not disassemble, crush, incinerate, heat or throw the battery pack into a fire.

- For battery packs in a scrapped state, they shall be disposed of in time according to local regulations on recycling or wastes.
- Do not put the battery pack in water or get it wet.
- Do not touch the positive and negative poles of the battery pack with the metal shell simultaneously.
- Do not short-circuit, overcharge or over-discharge the battery pack.
- Do not use or store battery packs near the heat sources (such as fire or heaters)
- Do not connect the positive and negative poles of the battery pack reversely.
- Do not pierce the battery pack shell with nails or other sharp objects, and do not hammer or step on the battery pack.
- Do not remove or repair the battery pack in any way without authorization.
- Do not hit, throw, or subject the battery pack to mechanical vibration or natural dropping.
- Do not mix battery packs of different types and brands.
- If battery pack emits peculiar smell, is hot, deformed or discolored, or has any other abnormal phenomenon, do not use it and move it out of the use environment.
- If the battery pack catches fire, use dry powder fire extinguishers, foam fire extinguishers, or sand etc. to put out the fire, and keep the battery pack away from the environment.

2.5. Modification

Do not modify the robot. Any modification of the robot may cause the unpredictable hazard to the user. Reconfigure the robot in accordance with the latest edition of all related service manuals. NEURA Robotics shall not be liable for failure or consequential damages.

2.6. Repair and Maintenance

Obey all safety instructions in this manual before carrying out any maintenance and repair work.

- Repair and maintenance work may only be carried out by qualified personnel.
- Be sure the system is completely powered off.
- Disconnect other energy sources connected to the robot. Take necessary precautions to prevent others from reconnecting the system energy during maintenance.
- Check the ground connection before restarting the system.
- Observe ESD regulations when disassembling the MAV.
- Avoid water or dust entering the robot arm or electrical control box.
- After maintenance and repair, a check must be carried out to ensure the safety level required by the service. When verifying, you must abide by effective national or local safety laws and regulations. Meanwhile, all safety functions should be checked.

Assembly, disassembly, commissioning, and operation require basic electrical and mechanical knowledge, as well as knowledge of the appropriate technical terms. They may therefore only be carried out by qualified electrical or mechanic personnel or an instructed person under the direction and supervision of qualified personnel.

Qualified personnel are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience as well as their understanding of the relevant conditions pertaining to the work to be done. Qualified personnel must observe the rules relevant to the subject area.

2.7. Device Malfunctions

- Only operate the device under the conditions and for the purposes for which it was designed.
- Periodically inspect the device for damages.
- Repair activities must be carried out only the specialists.

2.8. Integrator

The integrator is a person who designs, provides, manufactures, or assembles an integrated manufacturing system and is responsible for the safety strategy, including protective measures, control interfaces and connections of the control system.

2.9. Risk Assessment

Risk assessment is one of the most important tasks that the integrator must complete. The risk assessment does not only involve the AGV, but also consider peripheral modules, external structural modules, path planning, and the environment, etc.

It is recommended to carry out the risk assessment with reference to the guidelines in ISO 12100, ISO 3691-4, ANSI B56.5 or other relevant standards.

The risk assessment needs to consider three situations: the risk of robot installation, robot demonstration and the risk of running robot.

The risk assessment may infer that integrator need to connect additional security devices to protect themselves when working with the robot system.

2.9.1. Hazard Identification

The risk assessment should consider all potential contact between the operator and the robot during normal use and foreseeable misuse. Using AGVs without using peripheral safety guards requires a risk assessment to determine whether the relevant hazards will constitute an unacceptable risk, such as:

- It may be dangerous to handle toxic or other harmful substances.
- The operator's fingers may be caught by the robot.
- The danger of being collided by the robot.
- The danger that the robot payload is not correctly fixed in place.
- Danger caused by impact between the robot payload and a solid surface.

Integrators must measure such hazards and their associated risk levels through risk assessment and determine and implement appropriate measures to reduce the risk to an acceptable level. Please note that there may be other major hazards with certain robotic devices.

If the integrator’s risk assessment determines that there are hazards in its specific application that may cause unacceptable harm to the user, the integrator must take appropriate risk reduction measures to eliminate or minimize the hazards to an acceptable level. It is unsafe to use before taking appropriate risk reduction measures.

2.10. Emergency Stop Mechanism

All the moving parts of robot will stop when the emergency-stop is activated. After releasing the emergency-stop, no action of the robot is started. The emergency-stop cannot be used as a risk reduction measure, but it can be used as a secondary protection device. If multiple emergency-stop buttons need to be connected, they should be included in the risk assessment of robot application.

2.11. Responsibilities and Specifications

The safety of a complete AGV application depends on how the robot is integrated.

Integrators need to follow the laws and regulations of the host country and safety regulations and standards to conduct a risk assessment of the design and installation of the complete system.

Risk assessment is one of the most important tasks that integrators must complete.

The integrator of MAV robot needs to perform but not limited to the following responsibilities:

- Comprehensive risk assessment of complete robot systems.
- Confirm that the design and installation of the entire system is accurate.
- Provide training to users and staff.
- Create a complete system of operating specifications and clearly explain the use process.
- Establish appropriate security measures.
- Use appropriate methods during final installation to eliminate hazards or minimize all hazards to an acceptable level.
- Communicate residual risks to end users.
- Mark the integrator's logo and contact information on the robot.
- Archive related technical documents.

For access to applicable standards and legal guidelines, please visit www.neura-robotics.com.

All safety information contained in this manual should not be regarded as a guarantee of NEURA Robotics GmbH even if all safety instructions are followed, personal injury or equipment damage caused by operators may still occur.

NEURA Robotics GmbH is committed to continuously improving the reliability and performance of the product, and therefore reserves the right to upgrade the product without prior notice. NEURA Robotics GmbH strives to ensure the accuracy and reliability of the contents of this manual but is not responsible for any errors or missing information.

Robot controllers and robots are limited to the use of general industrial equipment and cannot be used in applications that violate the intended use.

2.12. Intended Use

MAV is only allowed to be used under specified environmental conditions and for general industrial equipment, such transferring parts or helping in the production.

Robot controllers and robots are limited to the use of general industrial equipment and cannot be used in applications that violate the intended use.

NEURA Robotics GmbH will not assume any liability for misuse. Misuse includes, but not limited to:

- Used in flammable and explosive hazardous environments.
- Device for moving or carrying people or other animals.
- Used in medical equipment and other devices related to human life.
- For devices that have a significant impact on sociality and publicity.
- Used in vibration environment of vehicles, ships, etc.

2.13. Warranty

In the principle of no prejudice to any claim agreement that may be reached between users (customers) and distributors or retailers, the manufacturer shall give customers a product quality warranty according to the following terms: If any defect occurs due to defective manufacturing or materials within 12 months after new equipment and its components are put into operation (not more than 15 months if transportation time is included), NEURA Robotics shall provide necessary spare components while users (customers) shall provide labor for replacement with spare components. Related components shall be maintained or replaced with another component embodying the up-to-date technological level. This product quality warranty is invalid if equipment defects are caused by improper handling or failure to observe related information described in the user manual. This product quality warranty does not apply to or extend to any maintenance performed by authorized distributors or customers such as installation and software downloading. Users (Customers) must provide a purchase receipt and purchase date as valid evidence of enjoying the product quality warranty. According to this product quality warranty, any claim must be made within two months when the product quality warranty is not obviously fulfilled. Any equipment or components replaced or returned to NEURA Robotics shall be owned by NEURA Robotics. Any other claim arising from or in connection with equipment is not within the scope of this product quality warranty. Any terms of this product quality warranty do not try to limit or exclude customers' legal rights as well as the manufacturer's liability for any casualties due to its negligence. The duration of this product quality warranty shall not be extended due to any services provided according to the terms of this product quality warranty. NEURA Robotics reserves the right to collect replacement or maintenance costs to customers without violating the principles of this product quality warranty. The preceding regulations do not imply any change of burden of proof, harming the interests of customers.

If equipment shows any defect, NEURA Robotics shall not bear any resulting damage or loss, e.g., production loss or damage to other production equipment

2.13.1. Disclaimer

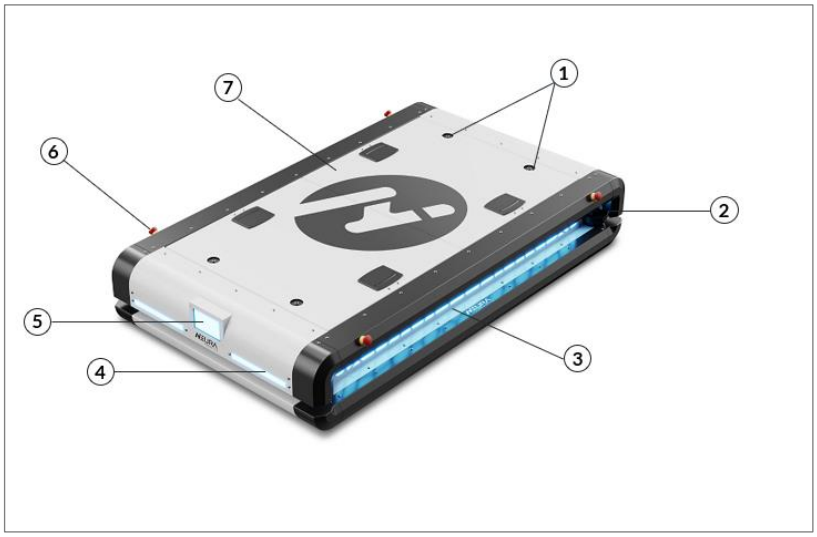
NEURA Robotics reserves the right to upgrade products without prior notice because it devotes itself to continual improvement on product reliability and performance. NEURA Robotics does its best to ensure the accuracy and reliability of the contents of this manual but disclaim any liability for any error or missing information.

3. PRODUCT DESCRIPTION

MAV® is a Multi-Sensing Autonomous Vehicle which is used for indoor intralogistics tasks and many other applications. It can autonomously transport items and navigate freely in its environment. It is a robotic assistant which will make the life of people working within production sites easier and therefore streamlines production.
Every second of a standing conveyor belt leads to an overall production stop since the operations are cascaded. With multiple MAV®s, one malfunctioning MAV® can be directly replaced by another one which keeps the production running and due to their autonomous navigation more flexible

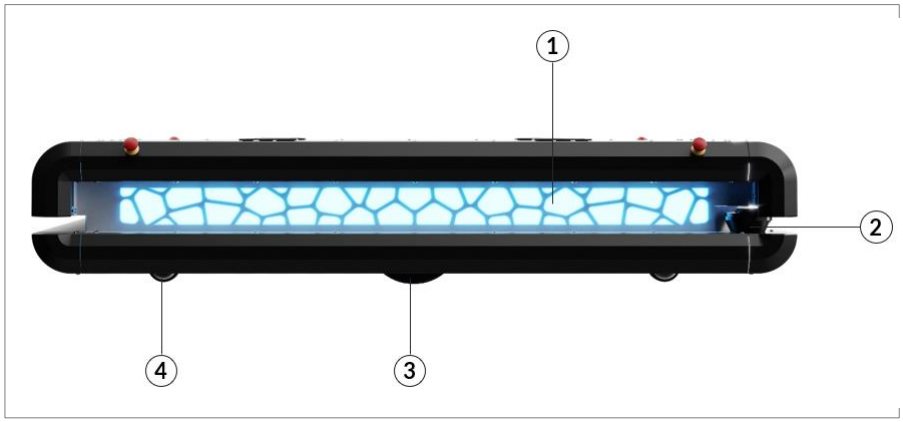
3.1. AGV body

3.1.1. Overview



1 Lifting Units
2 Laser Scanner
3 LED Status Light
4 Direction Indicator
5 HMI – Touch Screen
6 Emergency Stop Button
7 Cover

Fig. 1: Overview MAV body 1



1 LED Status Light
2 Laser Scanner
3 Drive Wheels
4 Universal Wheels

Fig. 2: Overview MAV body 2

LED Status light:

- Blue: MAV is moving
- Green: Powe on. MAV is not moving.
- RED: Malfunction. Error. Directionales
- Lateral LED brightness changing: MAV Batteries charging.

Direction Indicator - LED:

- White: front lights
- Red: taillights
- Orange: turn signal lights

3.1.2. Dimensions

Fig. 3: MAV 1500 Dimensions

Fig. 4: MAV Jr Dimensions

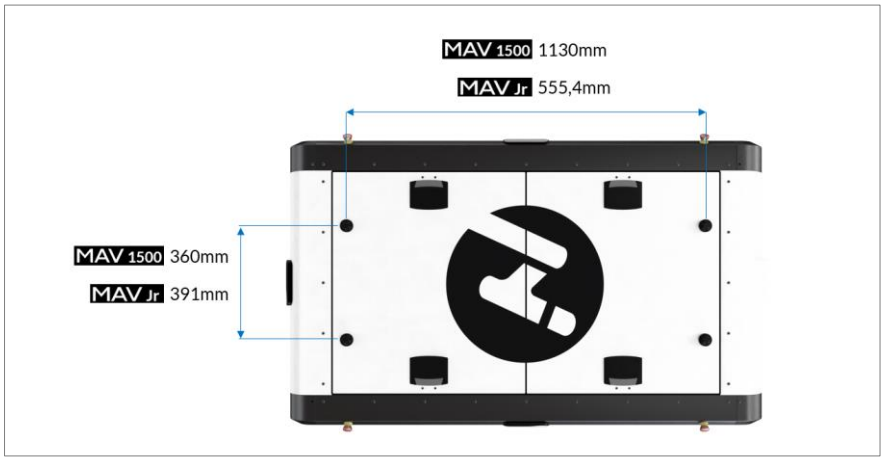


Fig. 5: Distance between Lifting Units

3.1.3. Safety concept

Two Sick safety laser scanners are installed on the diagonal of the MAV for automatic navigation and obstacle detection. The model is NANS3-CAAZ30AN1 NS3 PRO 3M. The detection height and detection range are defined as follows. The detection height of the safety laser scanner is 132mm, which can provide a 360° surrounding safety detection range. The MAV laser scanner are factory-set with 3 safety scanning areas: yellow-> deceleration zone, orange-> stop zone and red-> emergency stop zone. Different values can be set around to meet different application scenarios or working conditions. If different detection ranges are set, the corresponding acceleration, deceleration and speed parameters need to be adjusted.

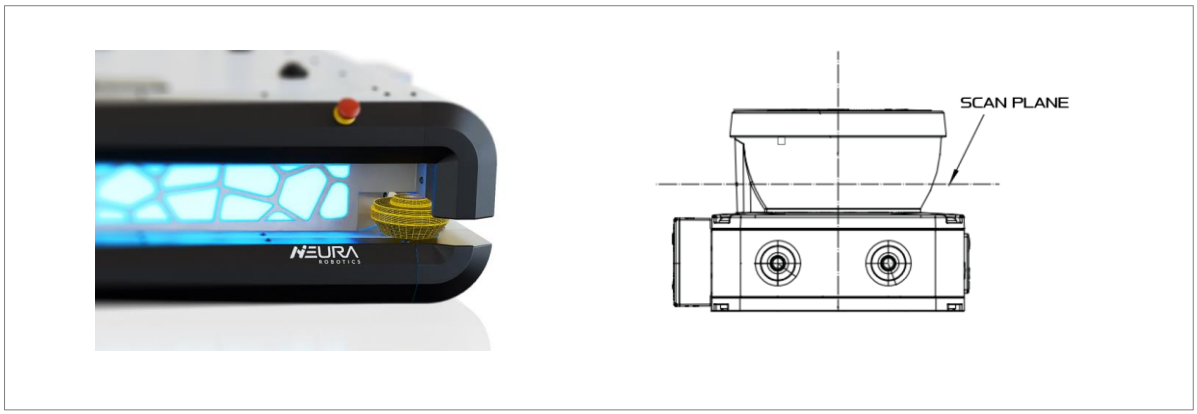


Fig. 6: Safety Scanner

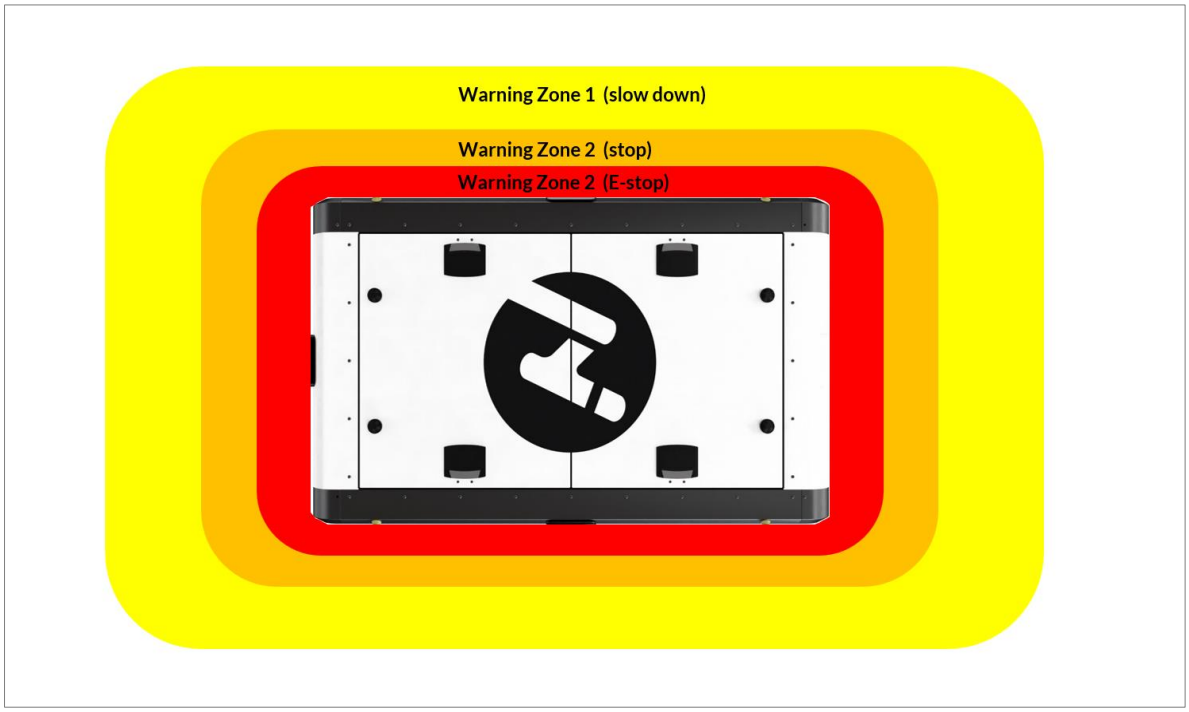


Fig. 7: Safety Scanners Monitoring Zones

3.1.4. Technical Parameters MAV1500

General Robot Specification	
Max. Payload	1500Kg
Loading Current	60A
Actuation	Differential Drive
Velocity	1.5m/s
Communication Interface	CAN
Outbound Interface	1 x Ethernet / 1 x CAN
IP Classification	IP54
Weight	400Kg
Dimensions	L1530mm x W910mm x H293mm
Positioning Accuracy	+-5mm
Safety Laser Scanner 360°	PLd/ Category 3 (ISO 13849-1)
Status Indicators	Programmable Status LEDs
Lifting Units	4 x 0-55mm á 400 Kg, 4 x 4000N
Battery Specification	
Battery	48VDC/ 120Ah
Supply Voltage	230V, 50-60Hz
Charging Time	2h
Up Time	10h
Inductive Charging	✓
Manual Charging	✓

⚠ CAUTION

Overloading

To avoid overloading, the load must always be correctly determined. Non-compliance can lead to the following damage:

- ► Motor overload /malfunction.
- ► Transmission overload /malfunction.
- ► Overloading / malfunction the entire mechanical structure.

3.1.5. Technical Parameters MAV Jr

General Robot Specification	
Max. Payload	500Kg
Loading Current	60A
Actuation	Differential Drive
Velocity	1.5m/s
Communication Interface	CAN + Ethernet
Outbound Interface	1 x Ethernet / 1 x CAN
IP Classification	IP54
Weight	300Kg
Dimensions	L1255mm x W678mm x H294mm
Positioning Accuracy	+-5mm
Safety Laser Scanner 360°	PLd/ Category 3 (ISO 13849-1)
Status Indicators	Programmable Status LEDs
Lifting Units	4 x 0-50mm á 200 Kg, 4 x 2000N
Battery Specification	
Battery	48VDC/ 72Ah
Supply Voltage	230V, 50-60Hz
Charging Time	1,2h
Up Time	5h
Inductive Charging	✓
Manual Charging	✓

⚠ CAUTION

Overloading

To avoid overloading, the load must always be correctly determined. Non-compliance can lead to the following damage:

- ► Motor overload /malfunction.
- ► Transmission overload /malfunction.
- ► Overloading / malfunction the entire mechanical structure.

3.1.6. Technical Parameters MAV 1500 and MAV Jr

Life Cycle	
Service Interval	12 Months
T1 Components Lifetime	min 36.000h
T2 Components Lifetime	Min 25.000h
Sensors	
Detection	Touchless Safe Obstacle Detection
Safety	SICK Safety Scanners
Software / Programming Features	
Operating System	NR Cruise Control / Robot application software
Open Architecture	3rd Party Apps, Acces to Low level Controllers & Sensors Data
Safety Features	Safe Speed Control
Smart GUI	NR Cruise Interface
Human Robot Interaction	Visual-, Audio- and Force- Feeedback, Motion Tracking, PC based GUI
Enviroment Visualization	Dynamic Mapping (SLAM), Pallet Identification, Dynamic Obstacle Bypass and Trajectory replacing.
Fleet Management	Formation Driving, Fleet Monitoring Tool

4. GETTING STARTED

⚠ WARNING

Heavy weight of the device

The robot system is, packed or unpacked, heavy. Improper handling may result in injury or damage to the device.

- ► Do not lift the robot (packed or unpacked) unassisted.
- ► Ensure that the at least two people are supporting during the unpacking process.
- ► Obey all safety precautions while moving the robot.
- ► Make sure that only certified personnel operate the lifting equipment.
- ► Use proper lifting equipment and ensure that the lifting equipment can withstand the weight of robot.
- ► NEURA Robotics cannot be held responsible for any damage caused by transportation of the equipment.

NOTICE

Condensation within the device

Condensation can damage the system electronics.

- ► Do not store, ship, or use your module under conditions where temperature fluctuations could cause condensation within the device.
- ► If your device was shipped in cold weather, leave it in its box and allow it to warm slowly to room temperature to avoid condensation.

4.1. Transportation

The following measures must be observed when transporting the robot:

- When lifting the robot, the moving parts should be fixed by appropriate measures to avoid unexpected movements during lifting and transportation, which may cause damage.
- Use proper lifting equipment. All regional and national guidelines for lifting shall be followed.
- NEURA Robotics is not responsible for any damage that occurs during transportation of the equipment.
- During transportation, ensure that the robot is stable and remains in place.
- Make sure that you follow the safety precautions while transporting the robot.

4.2. Storage Conditions

- This product must be shipped and stored in a temperature-controlled environment, within the range **-20°C to 60°C (-4°F to 140°F)**. The recommended **humidity is up to 75 percent**, non-condensing. It should be shipped and stored in the supplied package, which is designed to prevent damage from normal shock and vibration. You should protect the package from excessive shock and vibration.
- The product must always be stored and shipped in an upright position in a clean, dry area that is free from condensation. Do not lay the package on its side or any other non-upright position: this could damage the product.
- Make sure that you follow the storage safety instructions.

4.3. Unpacking

The following measures must be observed when unpacking the robot:

- The packed robot is placed at ground level near the installation site and has a stable position.
- Carefully remove the original packaging and keep it to be able to use it again when repacking the robot.
- Keep the original packaging after transport. Keep the packaging material in a dry place in case you need to repack and transport the robot in the future.

Depending of the AGV and the application, the robot can be unpacked using a forklift or the ramp function.

4.3.1. Using the Ramp

Step 1 Open the wooden box and check whether the contents are consistent with those on the packing list. If anything is missing or redundant, please contact your local sales office in time.

Step 2: Disassemble the packaging box and remove the MAV-Pallet fixing system.

NOTE: Depending on the MAV system, the fixing system consist in straps or screws that fix MAV to the pallet.

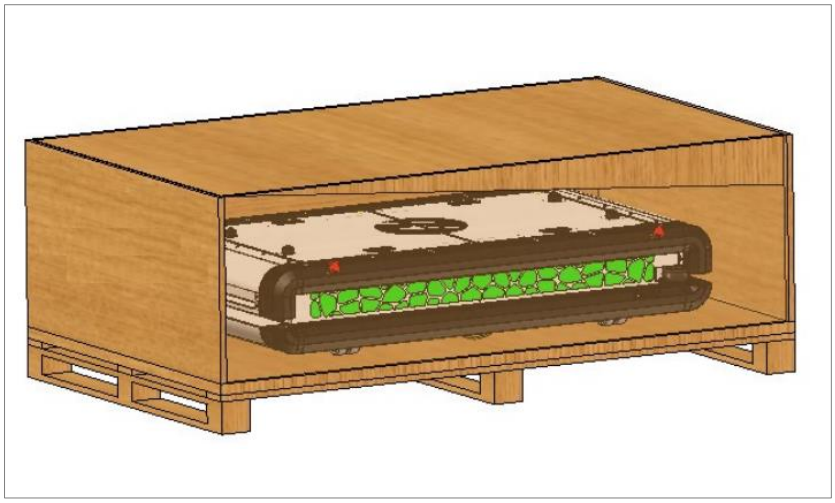


Fig. 8: MAV packing with ramp inclueded.

Step 3 Remove the top inclined plate and place it on the ground, so that the MAV can enter and exit the wooden box manually or automatically from the slope. Please consider that depending of the AGV the ramp can have of two parts. Be sure you are fixing the parts correctly using the draw latch.

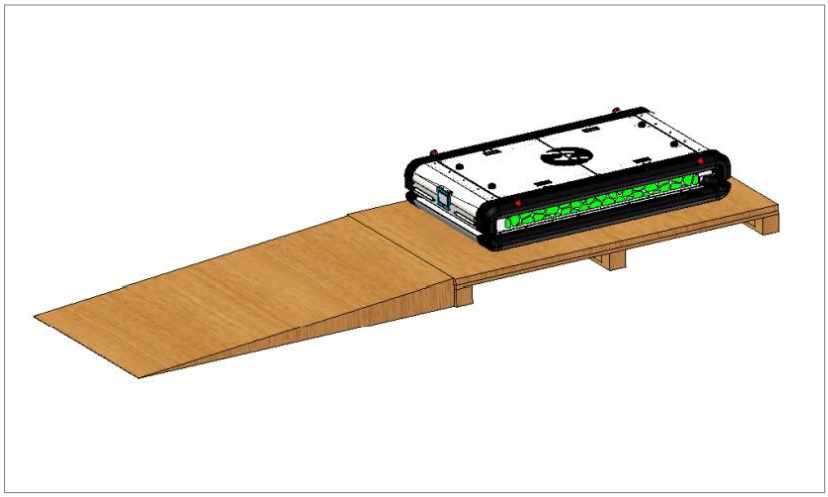


Fig. 9: Ramp prepared to download the AGV.

Step 4

Manually push down the MAV:

- Open the upper cover of the MAV
- Lift the drive units by loosen the screws as shown in figure 10, in order to move MAV freely.
- Push the MAV manually down. Pay attention to keep the MAV moving in a straight line during the pushing process.

⚠ WARNING

Heavy weight of the device

- ► Please consider the weight of the AGV by moving the device down. Unexpected forces can accelerate the system out of the desired zone.
- ► Don't loosen the screws completely to avoid a high acceleration.
- ► Pay attention to walk in a straight line and avoid going too close to the edge of the ramp.

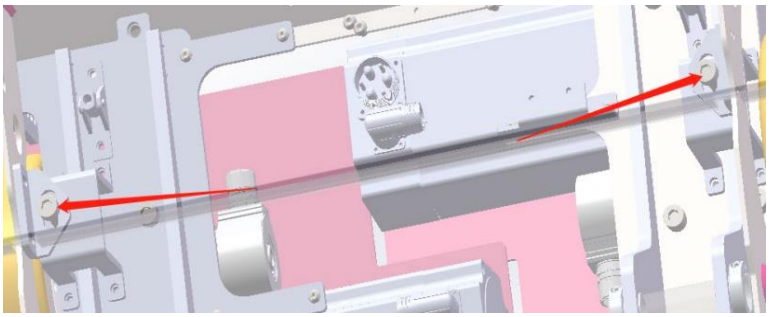


Fig. 10: Screws to get the drive units up.

Moving MAV manually using the software: manually operate the MAV out of the wooden box through the manual operation instruction using a laptop, tablet or cell phone. Follow the instructions in 4.4 and 6.1. 1..

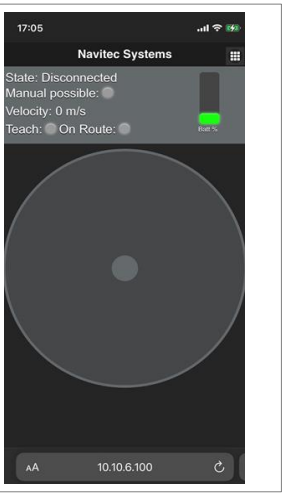


Fig. 11: Interface to move manually the AGV using a cell phone.

4.3.2. Using a Forklift or a Crane

If a forklift or crane is available, the AGV can be unpack using a mooring tape.

Step 1 Open the wooden box and check whether the contents are consistent with those on the packing list. If anything is missing or redundant, please contact your local sales office in time.

Step 2: Disassemble the packaging box and remove the MAV-Pallet fixing system.

NOTE: Depending on the MAV system, the fixing system consist in straps or screws that fix MAV to the pallet.

Step 3: Remove the covers of the MAV.

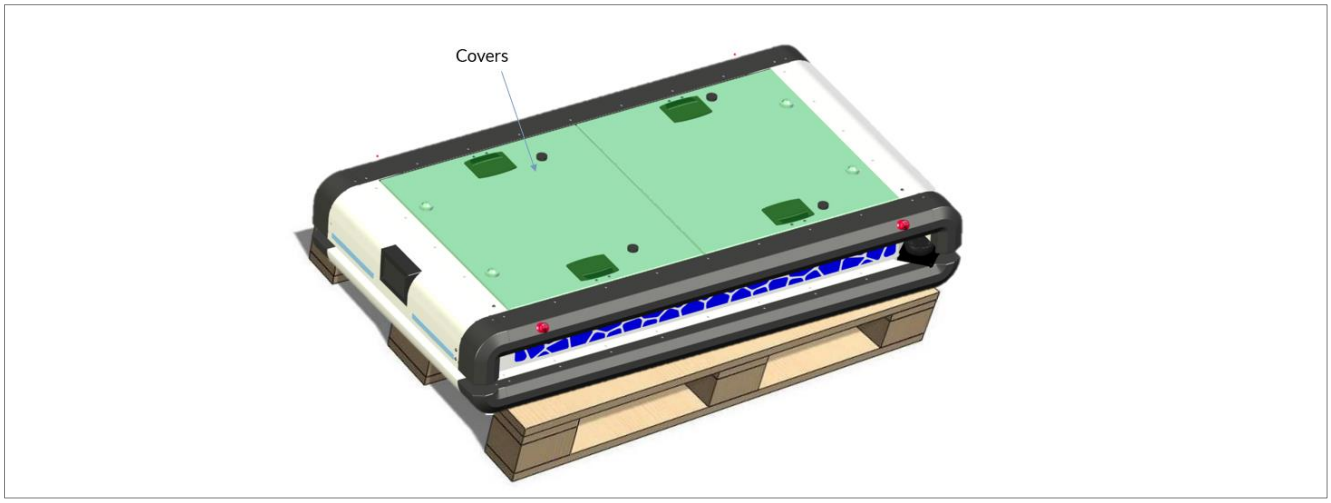


Fig. 12: Covers in green.

Step 4: Put the mooring tape and hook in the indicated areas (4x), as shown below.

Note: consider der warnings below.

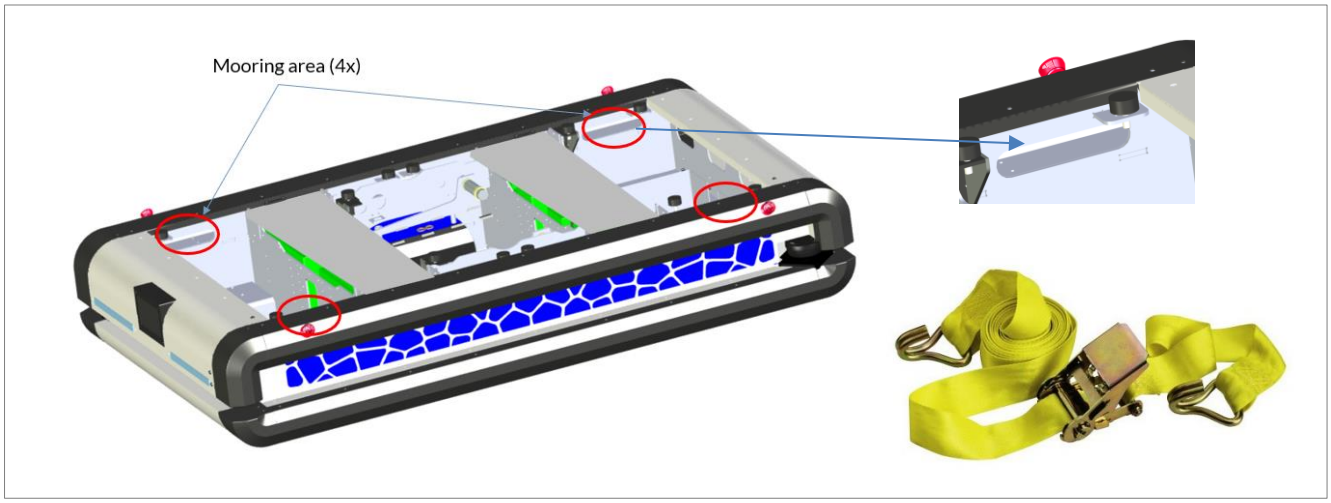


Fig. 13: MAV mooring areas and mooring tape with hook (example).

⚠ WARNING

- Be careful not breaking any cables or components during the installation the hooks.
- Be careful not damage any components when lifting the MAV.
- Be careful not to scratch the surfaces.

Step 5: Lift the MAV using the mooring tape and the forking or crane. Remove the pallet bellow.
Note: consider der warnings above.

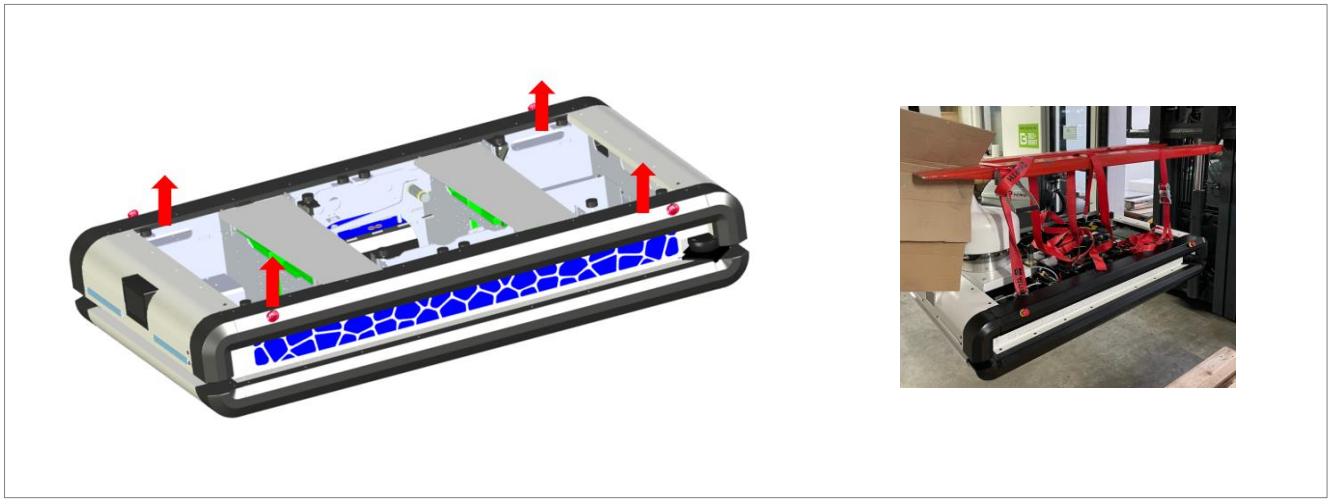


Fig. 14: Lifting MAV.

4.4. Power on MAV

Step 1 Press the power button or turn the power switch (depending on the model) on the rear operation panel to power on the robot.

Fig. 15: Power on/ Turning on Buttons.

Step 2 Press the white/green button on the rear operation panel to turn on the robot. After a couple of seconds, the LEDs the AGV will turn on (blue light) indicating MAV has been successfully turned on.

4.5. MAV Touchscreen

The MAV Touchscreen give different status information depending on the model.

- Battery status
- Buttons to move up and down the Lifting units
- Release hold button
- Go to destination button
- Error code
- Etc.

Fig. 16: Touchscreen Interface example 1.

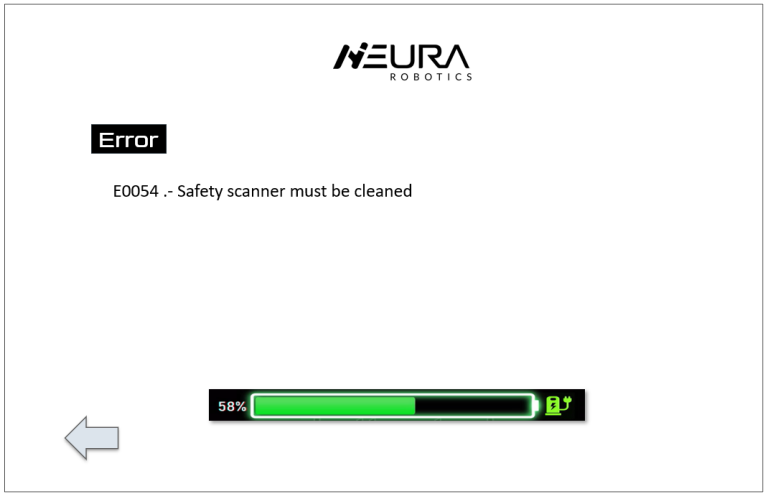


Fig. 17: Touchscreen Interface example 2.

If the touchscren is only showing the screensaver (NEURA Logo), touch the screen to activate the interface.

4.6. Identification Plate

On the back part of MAV you can find the identification plate. The serial number shown there is necessary to be able to communicate and program MAV.

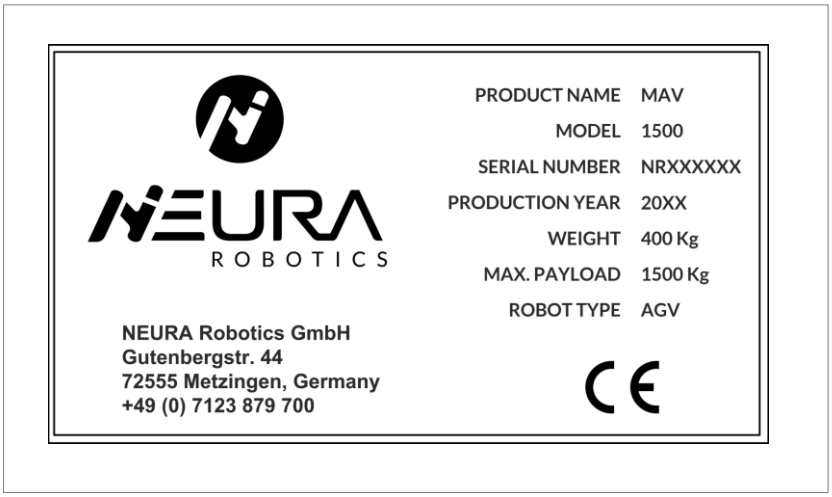


Fig. 18: Identification plate example.

5. BATTERY AND CHARGING

5.1. Battery System

The MAV's battery consists of a series battery pack, distributed at both ends of the car body. The standard capacity of the Battery pack can reach 120Ah. In some cases, the capacity can be higher.

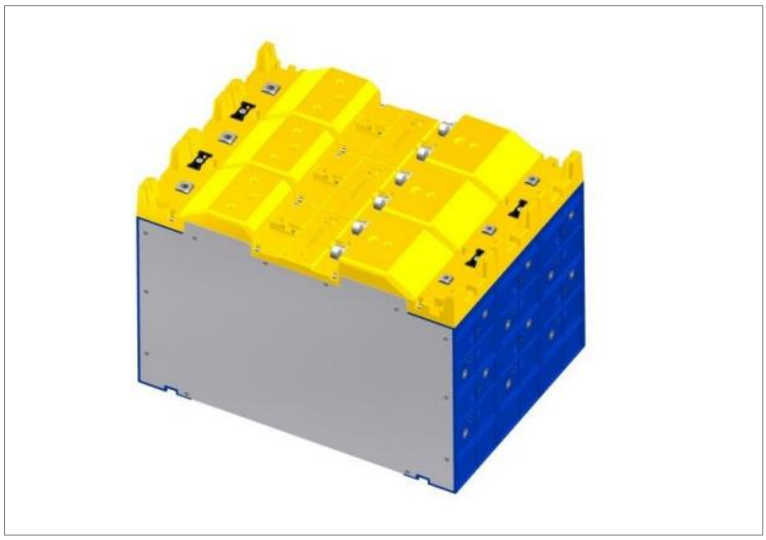


Fig. 19: Battery Pack example.

Battery Specification	
Battery type	Lithium-Nickel-ManganeseCobalt-Oxide with BMS
Nominal voltage	51.8V
Battery Weight	Approx 9.6kg per unit
Exp. cycle life at (0.5 C / 0.5 C), 22 °C ± 2 °C	> 80 % of initial capacity at 1,200 cycles
Safety function	Short circuit protection: 300A / 0.1ms
IP rating	IP30, not water resistant

⚠ WARNING

- ► It is forbidden to disassemble, hit, squeeze or throw into fire.
- ► If severe swelling occurs, please do not continue to use.
- ► Do not place in high temperature environment.

5.2. Correct use of the Battery System

- Verify the correct status of the battery before using the system for the first time.
- Charge the battery promptly after a low-capacity alarm. If the battery is not used for a long time, the battery should be half-charged and the battery should be charged every 6 months 3. When the battery pack is not in use, be sure to press the switch to turn it off.
- When the battery pack is not used for a long time (six months or more) and needs to be re-used, it needs to be charged according to the specification book or the supporting charger is fully charged before use.
- The battery should be installed in an air-circulating, dry and clean environment; avoid sources of fire and flammable materials when charging.
- The Battery pack is fitted with an electronic battery management system (BMS) with protection against unsafe conditions.

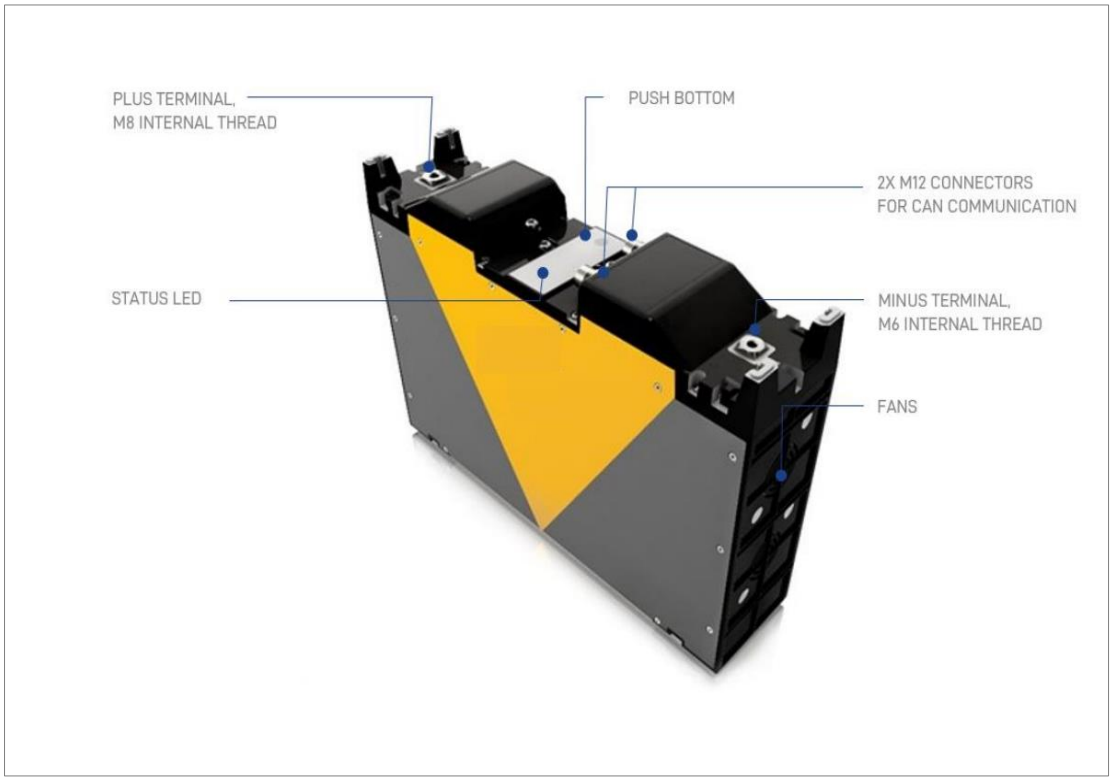


Fig. 20: Description of the Battery.

5.3. Battery Chargers

MAV Systems give the possibility to charge the Battery Pack using cables (manually) or an induction plate (wireless)

5.3.1. Manual Charging

MAV Batteries can be charged using the manual charger ALLtrac Plus 48 E 50 A46.

Fig. 21: ALLtrac Plus.

Manual Charger Specification	
Efficency	>96%
Supply voltage	230V AC
Output Voltage/Current	78V DC / 50A
Weight	16kg
Dimensions	447mm x 302mm x 169mm
Operating Temperature	- 10°C to + 40°C
IP rating	IP20

⚠ WARNING

- Verify every time the input and output sockets status; poor contact or damage in the sockets should be repaired, otherwise the system will not work correctly, or electric shocks and fire accidents could be presented.
- When charging, pay attention to ensure that the charger is ventilated.
- There is high voltage inside the charger, please do not open the case, otherwise there is a danger of electric shock.

MAV Manual Charging Operation Guidelines

The default battery power of MAV is 30%, and it needs to be charged when the power is lower than 20%.

Step 1: The socket for the manual charger is located (in the standard Version) behind the front cover on the right side, as in the picture below. To have access to the socket some screws and the cover must be removed. This charging possibility was design as a backup.

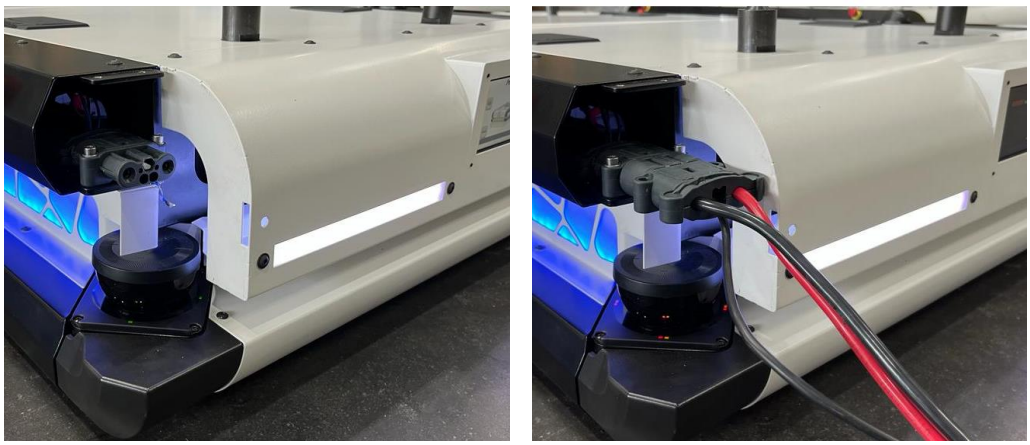


Fig. 22: Socket location.

Step 2: Connect the manual charger plug to the socket.
Step 3: Turn on the charger to start charging.

5.3.2. Wireless Charging

For the convenience of users, MAV provides a wireless charging system, which is composed of a transmitter module, a transmitter coil, a receiver module, and a receiver coil. The receiving end module and the receiving end coil are fixed on the bottom surface of the rear part of the vehicle body. The MAV can be automatically charged at the charging position when it is idle. The main specifications of the wireless charging system are as follows.

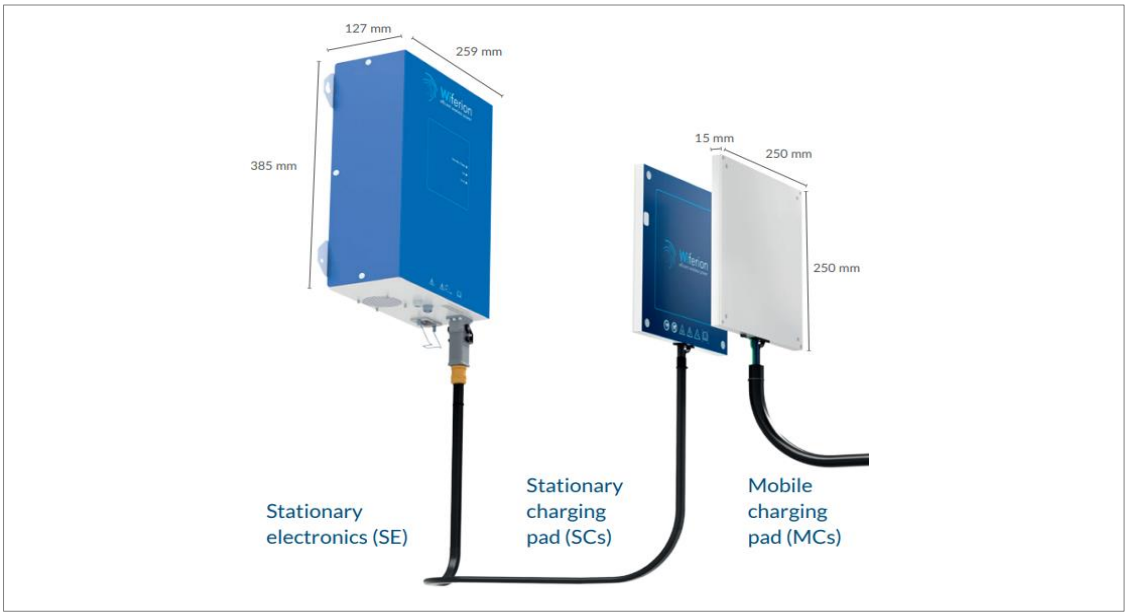


Fig. 23: etaLINK 3000.

etaLINK 3000 Specification	
Supply voltage	230V AC
Output Voltage/Current	15to 60 V DC / up to 50A
Frequency	50 / 60 Hz
Clearance	5 to 40mm
Operating Temperature	- 10°C to + 40°C

Basic LED signals

- Green slowly flashing: Standby, no communication to mobile side.
- Green steady: Power transferring. υ Green fast flashing: Battery full.
- Yellow: System warning, power is still transferred.
- Red steady: System error, no power is transferred.

The etaLINK 3000 system operates wear- and maintenance-free under normal industrial conditions. Its recommended to make regular inspections of the system components as an early warning of any damage from external effects.

⚠ WARNING

- ► The charging system must not be exposed to naked flames or incandescent bulbs.
- ► Batteries must be charged in a well-ventilated environment only.
- ► Persons with a cardiac pacemaker or metal implants may directly in contact with the Inductive plate when running.
- ► Electrically conductive objects, especially steel objects, must be avoided in the area directly around the edges of the coils during charging. Such objects should be kept at least 10 mm from the outside edges of the coils.
- ► The connection cables of the mobile coil may not be installed with thermally insulating materials so that any heat generated can be dissipated to the surroundings.

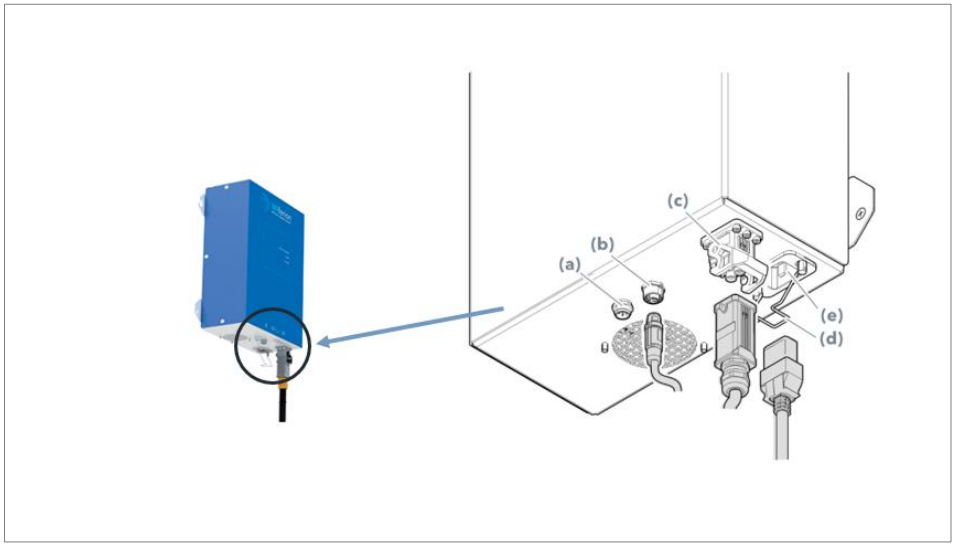


Fig. 24: etaLINK 3000 – Electrical connection.

(a) CAN Socket
(b) IrDa socket
(c) Coil socket
(d) Retaining bracket
(e) Mains input socket

MAV Wireless Charging Operation Guidelines

The default battery power of MAV is 30%, and it needs to be charged when the power is lower than 20%.

Step1: Connect the power supply of the wireless charging transmitter module,

Step2: Drive the MAV car above the transmitter coil, align the receiver coil on the car body with the transmitter coil, and then start charging

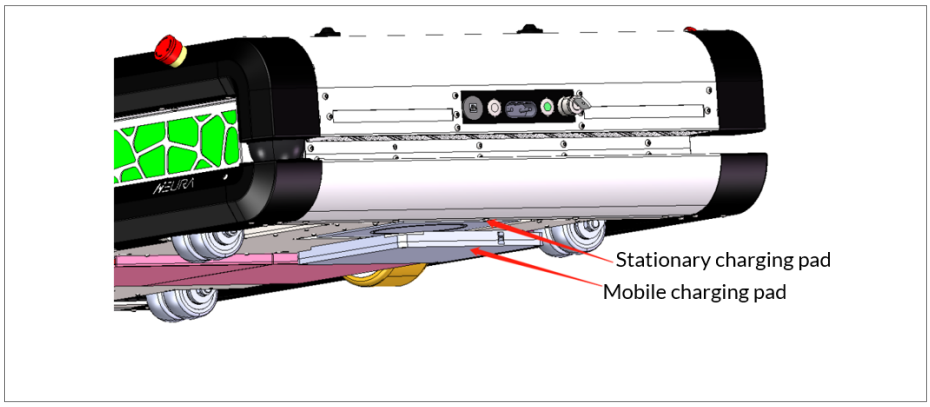


Fig. 25: Charging pads.

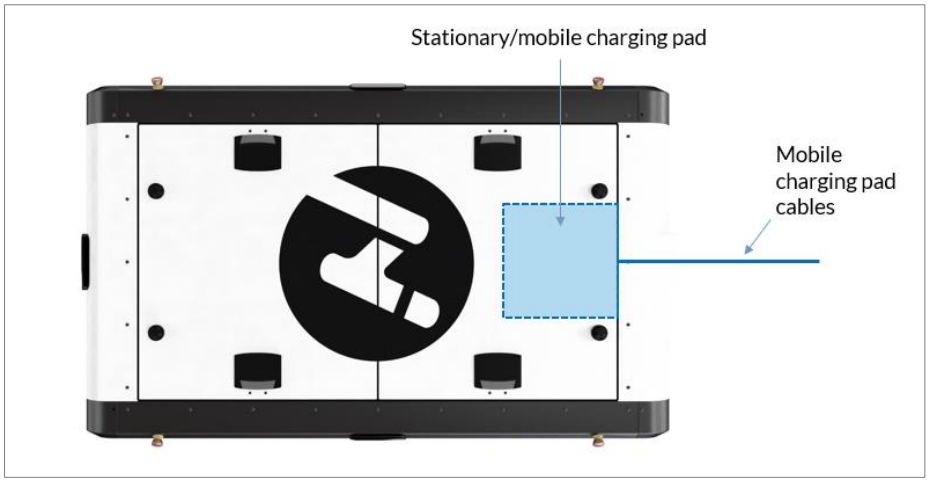


Fig. 26: Charging pad positions.

6. AGV SOFTWARE INSTRUCTIONS

6.1. Introducing MAV Software

NEURA Robotics works together with Nativec System to automate MAV. Thanks to the Navitec experience and NEURA Know How and innovative thinking, MAV can work in every possible application.

To automate MAV, a natural feature navigation, also called SLAM (simultaneous localization and mapping) navigation, is used. Laser scanners identify objects in the environment and the system compares these measurements with previously created map points to position and navigate MAV.

If needed, a highly flexible fleet management solution is available. High traffic density, dead-lock free, complex route systems, precise docking, automatic pallet/load finding. Fully integrated with the factory environment.

Different vehicle types and third-party vehicles in the same system are possible (VDA 5050).

In this user guide you will fine only a short Introduction about the software. This introduction will help you to make the first steps using and programming MAV.

The complete Software Guides are available:

- Navithor Tools
- Navitrol Monitor
- Navitor Fleet

Please contact NEURA Robotics or your Integrator to get the Software guides if needed.

6.2. Connecting to MAV

Step1: A connection to the vehicle's internal router must be established.

- Connect your system (computer, cell phone, etc) with the WiFi of MAV. The WiFi name corresponds to the MAV Serial number (e.g.: NR226851). The Serial number can be found in the identification plate.
- MAV WiFi Password: **NeuraRobotics**

Step2: Go to network settings and reconfigure the "IPV4" your computer using the following IP address:

- IP address: 10.10.6.157
- Subnet mask: leave empty (it will be filled in automatically)
- Default gateway: leave empty (it results from establishing the WiFi connection)

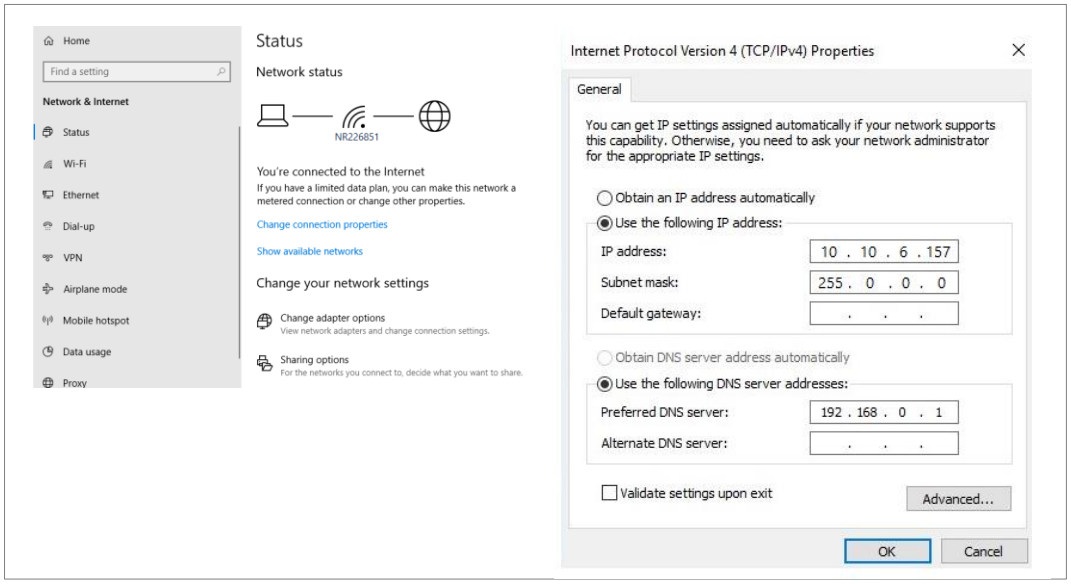


Fig. 27: IPV4 Parameter.

Step3: Open your Browser and enter the following IP 10.10.6.100 in the addres bar.

The System Page opens and the AGV can be moved manually after the Request Control-> Manual "on" is activated (in the upper right corner)

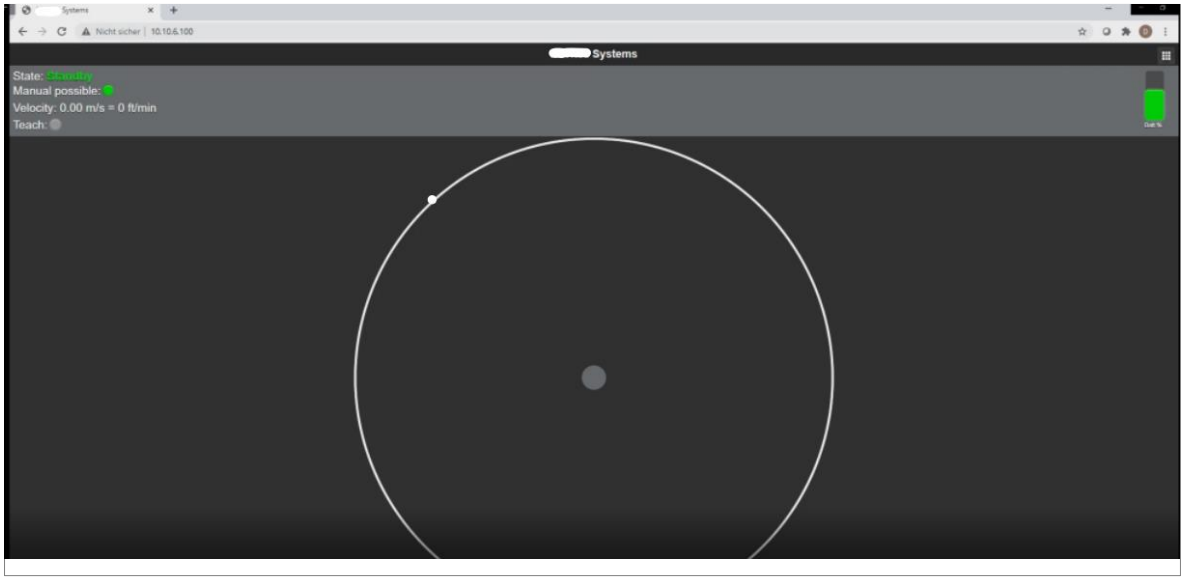


Fig. 28: System Page in the Web Browser.

⚠ WARNING

Before driving MAV following checks and activities must be carried out:

- MAV has no visible damage.
- No loose or broken parts. These can cause serious injury during startup
- Guards are fully functional and properly installed.
- Persons are outside the danger zone.
- Identification plate corresponds to the purchased product.

Step4: Go back to the main window and use your finger or mouse to move MAV.

NOTE: be careful not to accelerate too fast.The finger swipe must be smooth.

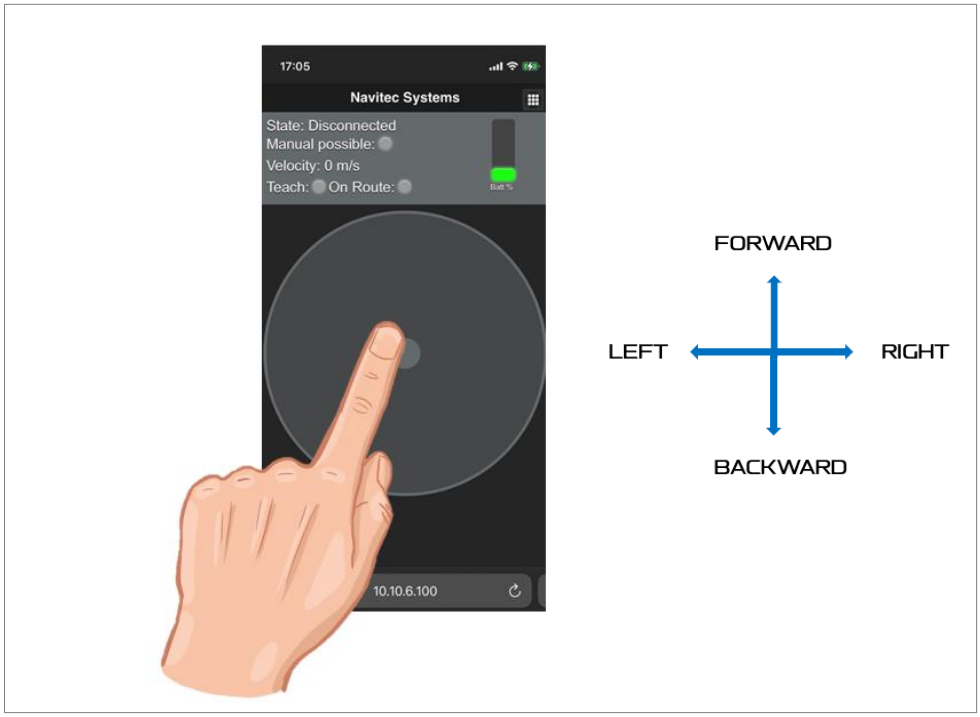


Fig. 29: Moving MAV Manually

Step5: The enviroment can be scanned and saved to be used in the route planning as a map. To do that the software must be in "Teach Mode".

- In the same "Request Control Menu", activate "Teach" to start saving the enviroment.
- Move MAV through the area you want to scan to later create a map. The vehicle has to be moved manually in the entire environment in order to generate the data. If the "non-stop" is activated the teach process must be started again.
- Stop the "Teach Mode" when the desire environment is scanned. The data is saved as a file and contains all relevant information.

An additional Windows based **Tool** is used to export the recorded data to a model.

Fig. 30: Request Control Menu

6.3. Introducing to Navithor Tools

6.3.1. Creating a new Project

Step1: Open the software Navithor tools: “Navithor tool.exe.”
Step2: The login window will show up. Default password for login is **ntnavitec**.
The password can be reset or changed if needed.

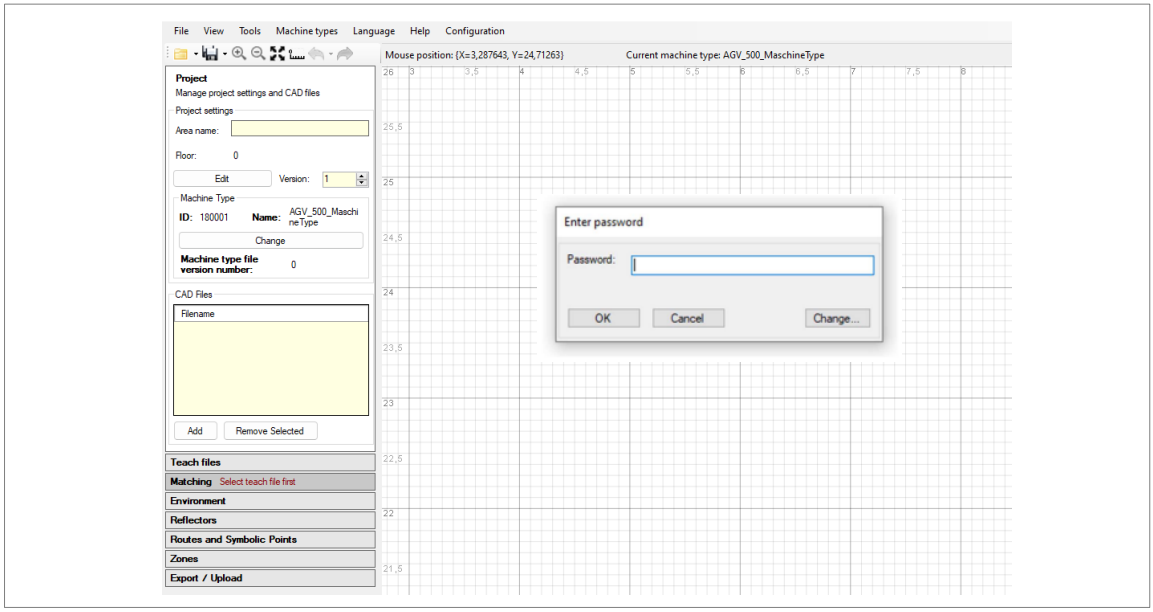


Fig. 31: Navithor User Interface.

Step2: The login window will show up. Default password for login is **ntnavitec**.
The password can be reset or changed if needed.

Step3: Open or create a new Project.

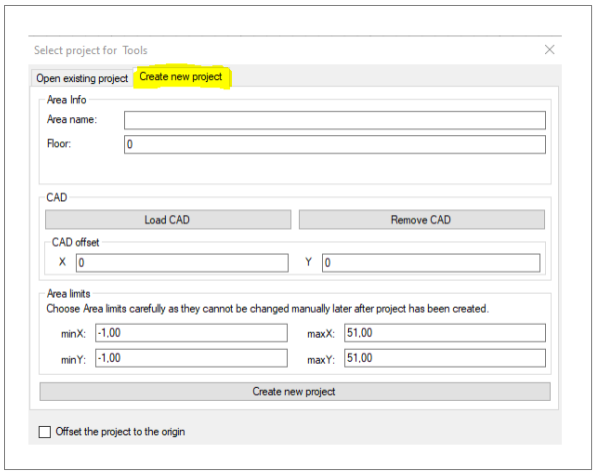


Fig. 32: Project window .

Step 4: Assign a name; define area limits and create new project.

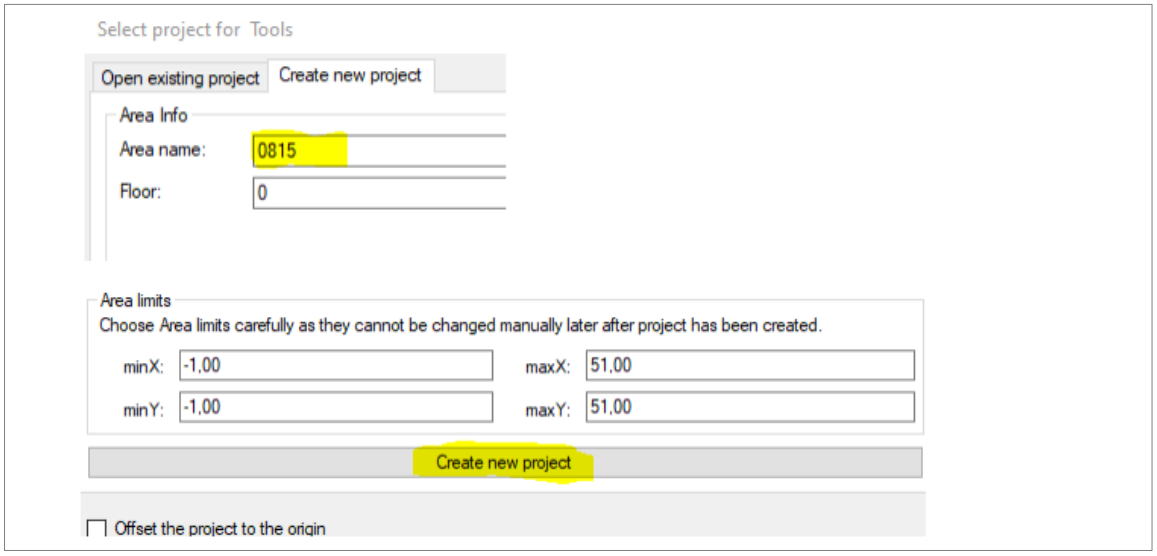


Fig. 33: Create a Project.

Step 5: The machine parameters must be selected an added into the project. Select the parameters according to your AGV when the program ask for it.

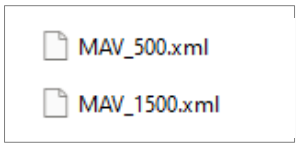


Fig. 34: Machine Parameter

6.3.2. Selecting and Loading Teach files from AGV

Step 1: After scanning an area (as explained in 6.1.1 , step 5), go to the Teach file Menu and load the teach files from the AGV .

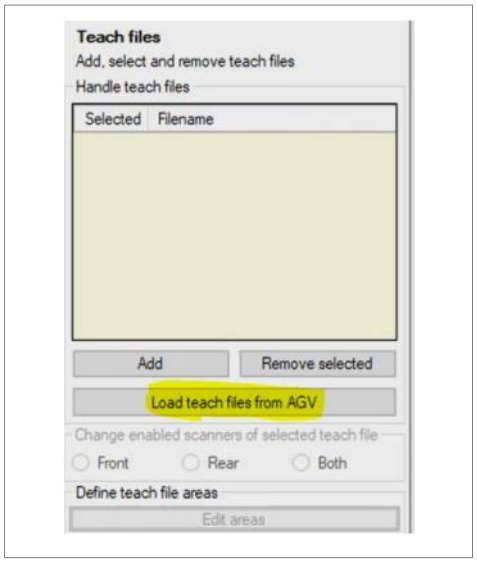


Fig. 35: Teach files menu

Step 2: Select the corresponding AGV for your project and press “Connect and Search for files”.

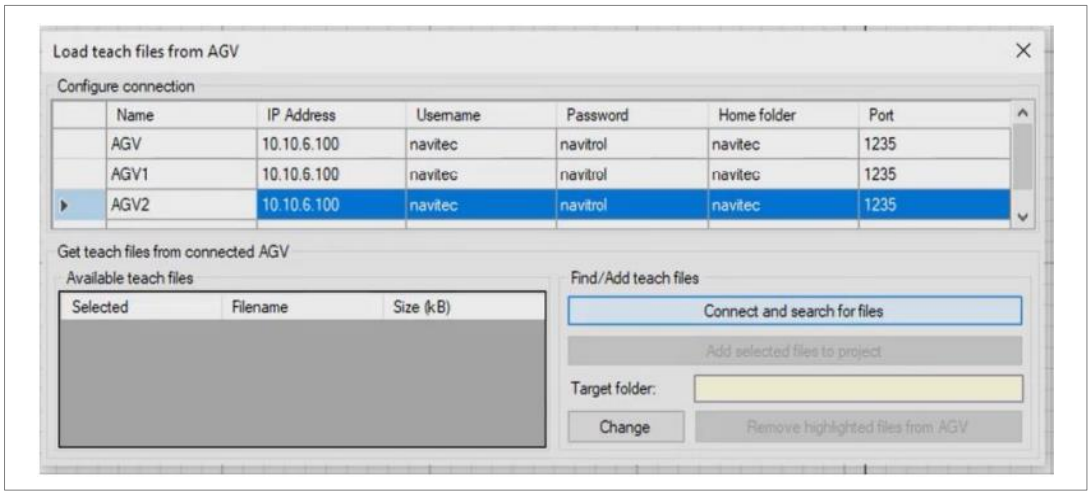


Fig. 36: Teach files window

Step 3: Select the desired map (usually is the newest one) and “add selected files to project”. Be careful to select only one map.

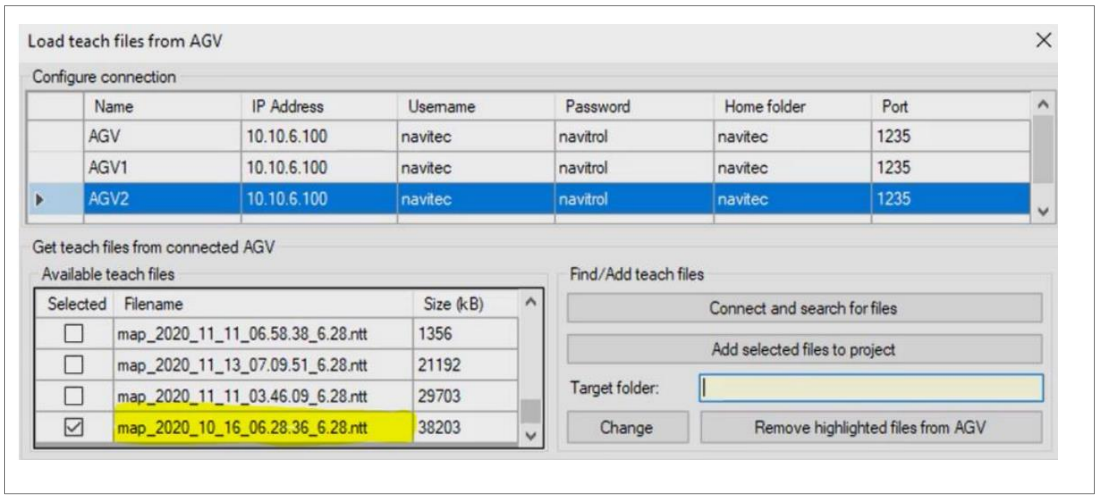


Fig. 37: Selecting teach files for the project.

This procese could last a couple of minutes

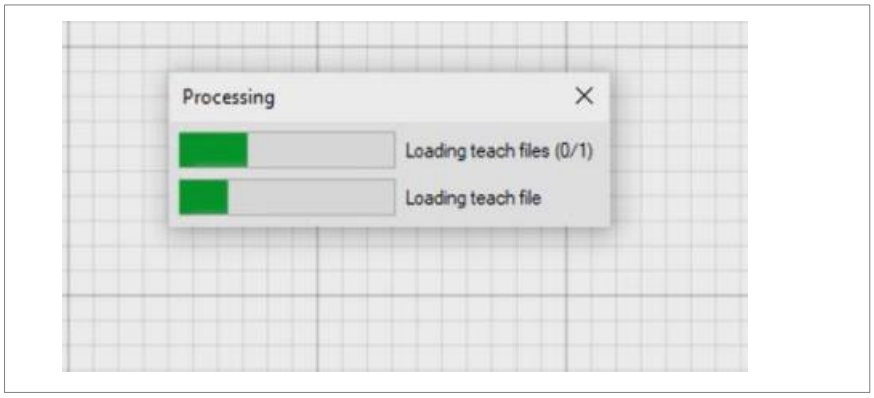


Fig. 38: Loading a map to the project.

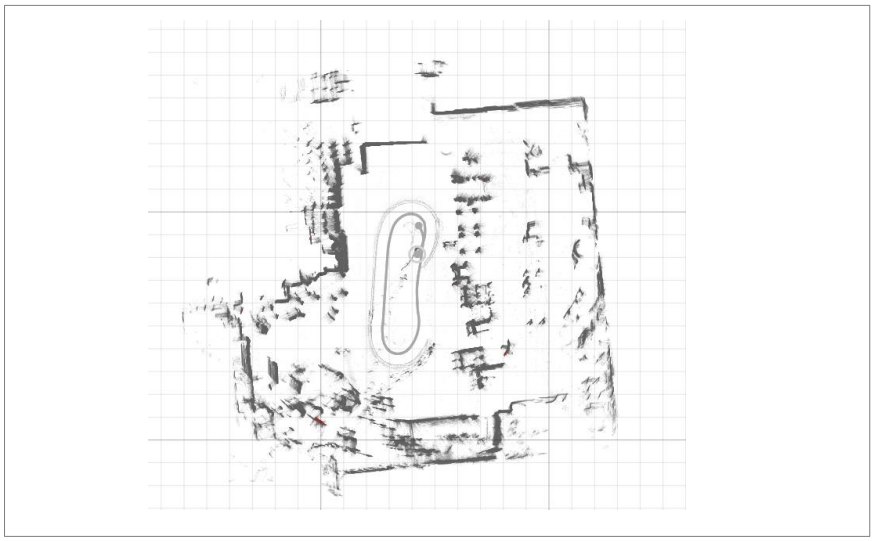


Fig. 39: Selected teach files from the AGV.

6.3.3. Matching and Generating Environment Points

Matching

The purpose of matching is to create uniform map from the raw measurements. Select “Matching” in the menu.

In the menu the option “Inter Match” can be selected as standard for the uncomplicated maps:

- Select the map with doble click. The completely scann must turn pink.
- Click “intern Match” and after some seconds you can select “finalize selected”.

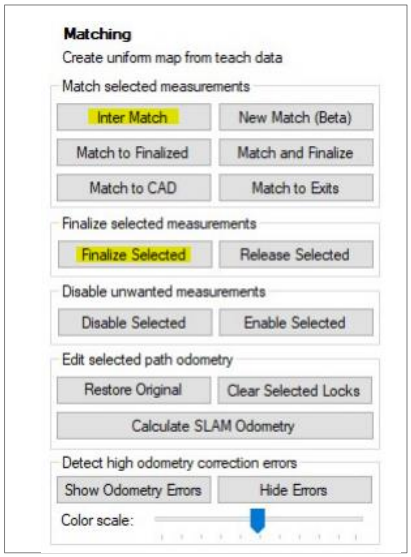


Fig. 40: Matching Menu.

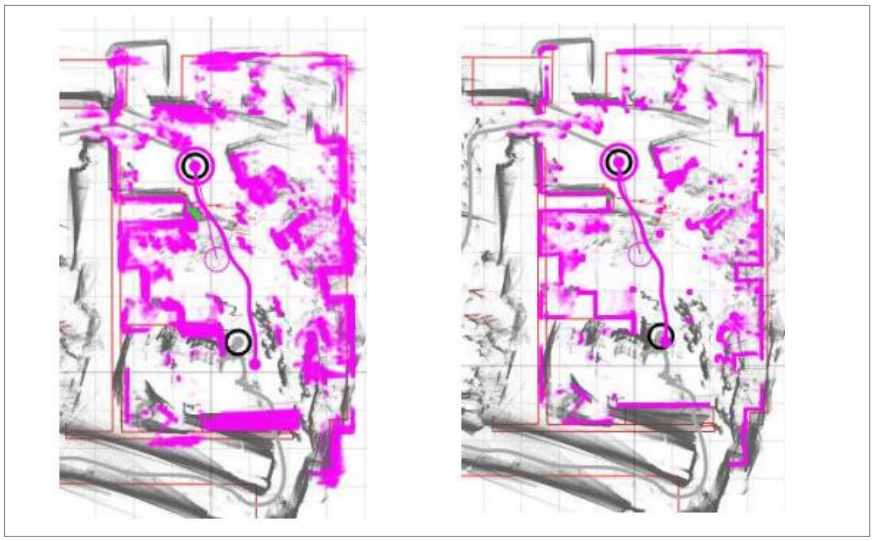


Fig. 41: Data without matching (left). Data with matching (right).

Environment

Environment point generation is the next step after the measurements have been matched. Select “Environment” in the menu.

Step 1: Select Generate Environment > Generate.

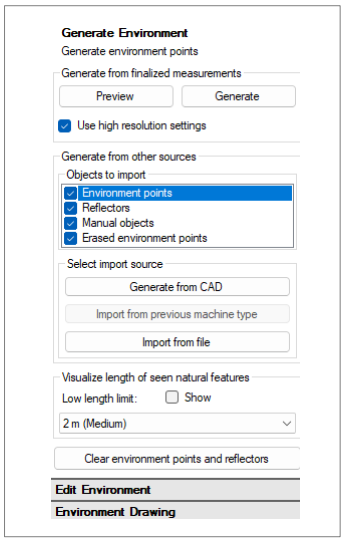


Fig. 42: Environment Menu.

Step 2: Edit environment> Manual erase tools> Erase: It is important to remove all contours that do not correspond to fixed objects. For example: persons, chairs, etc. This will avoid the software looking for non-existent objects when moving.

NOTE: the erased areas will only be deleted internally in the software.

Fig. 43: Erase unrelevant areas.

6.3.4. Routes and Symbolic Points

Routes and Symbolic points menu are used to configure what routes AGV's are allowed to drive, adding speed limit to specific route segment(s) and defining symbolic points to represent interactable locations.

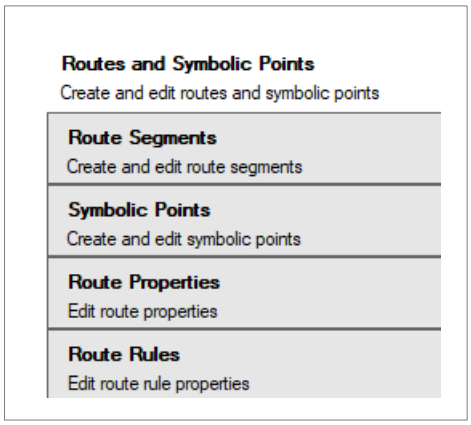


Fig. 44: Route and Simbolic Points.

Route segments

Routes consist of nodes and segments between nodes. Each node may be linked with segments to one or several other nodes. Nodes are defined by two properties, location and direction. When two nodes are linked, a route segment is automatically formed between the nodes.

- Select "Draw Routes" and create a segments

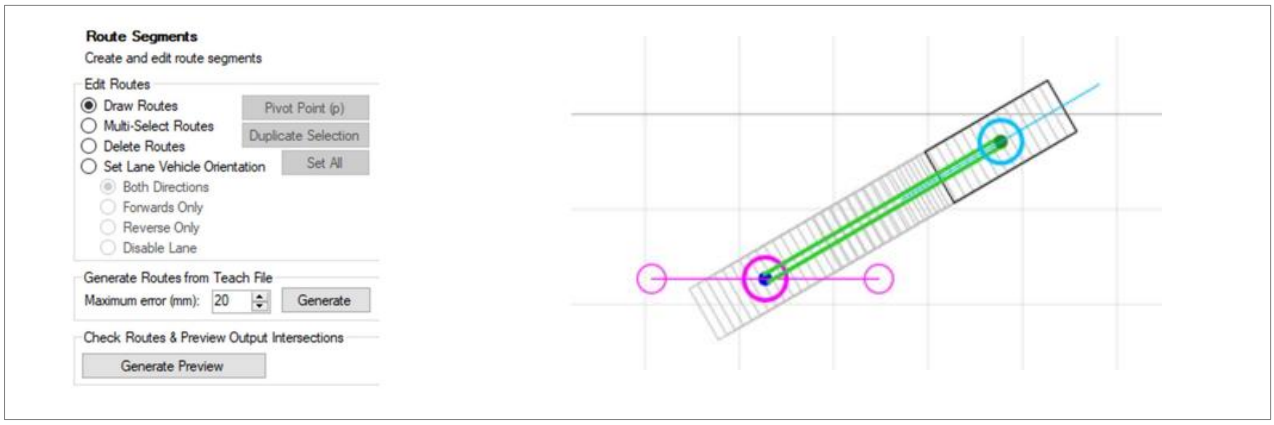


Fig. 45: Route Segments Menu (left), creating a segment (right).

- If no node is selected, clicking empty space creates a new node. A node can be selected by clicking it and deselected by clicking it again.
- When a node is selected its location can be changed by dragging the node. The direction of a selected node can be rotated by dragging the direction vector of the node.

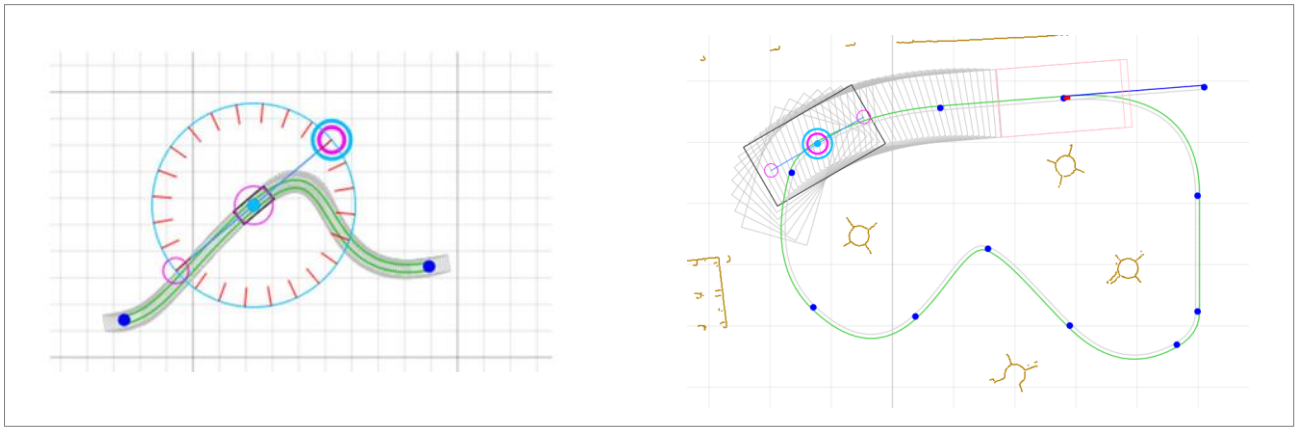


Fig. 46: Rotating a node (left), Moving a node on segment (right).

- Each route segment can be driven in different directions.
- Different route properties and rules can be modify as well in the options.

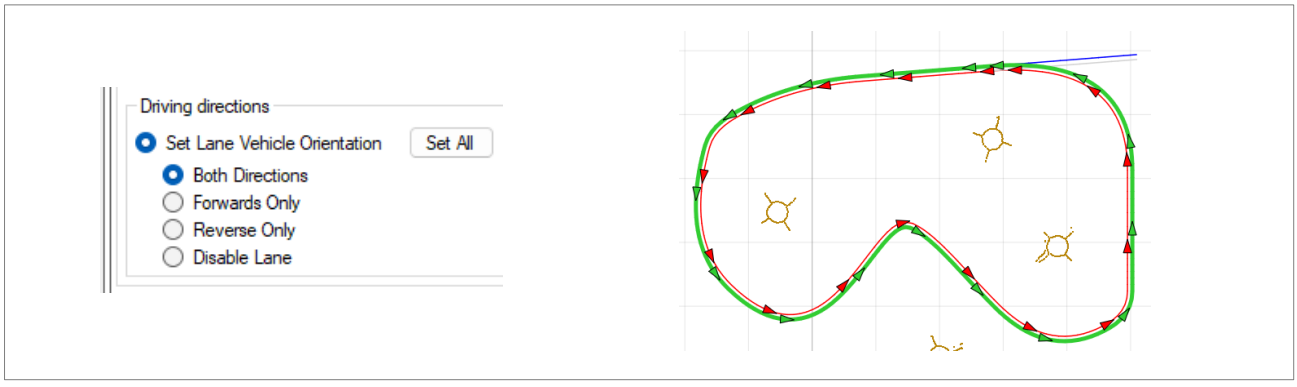


Fig. 47: Segments with a reverse and a forward direction.

Symbolic Points

Symbolic points are the target points to which vehicles can be driven to and where various actions can be executed.

- A new symbolic point is created by clicking on a route node.
- Symbolic point properties can be changed via the tool menu on the left.

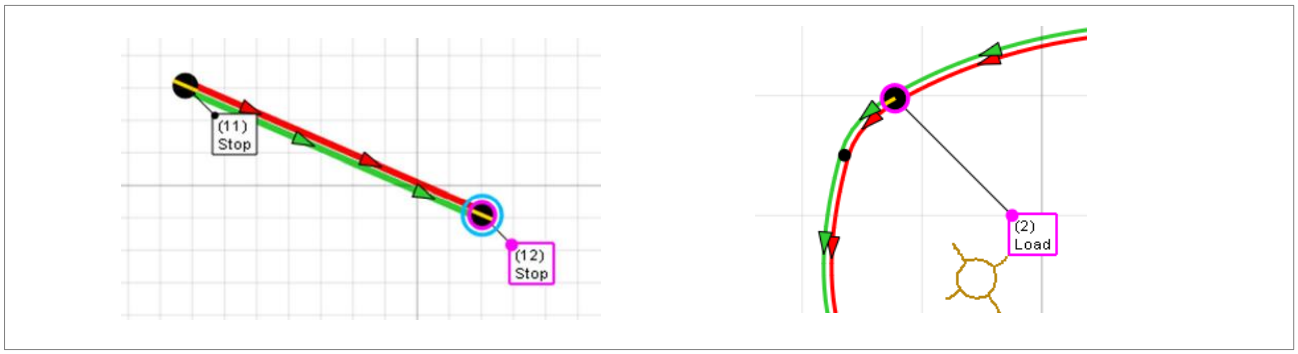


Fig. 48: Segments with simbolic points.

6.3.5. Export /Upload

When the driving area is defined, data needs to be transferred to Navitrol/MAV.

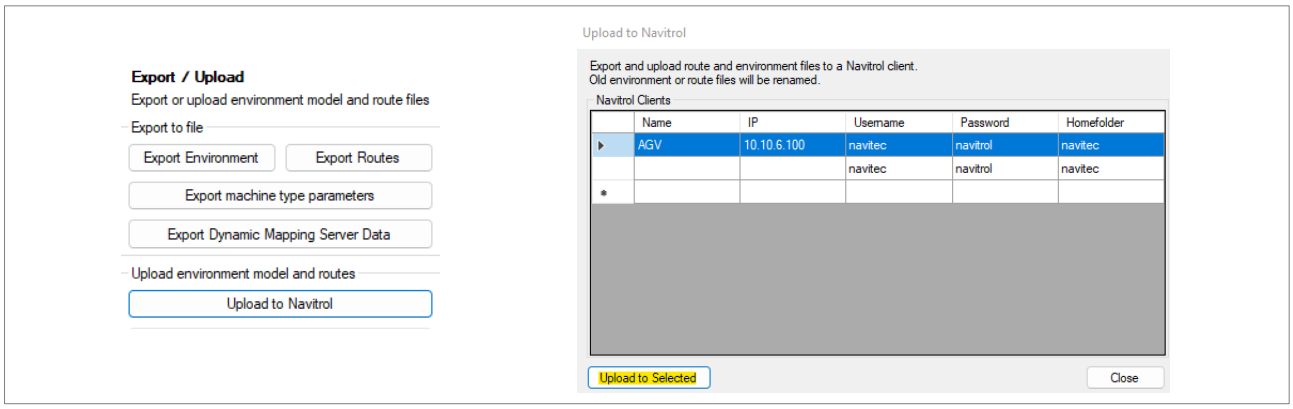


Fig. 49: Uploading to Navitrol.

6.4. Introducing to Navitrol Monitor

6.4.1. Starting Program and connecting to MAV

Step1: Open the software Navitrol tools: “NavitrolMonitor.exe.”

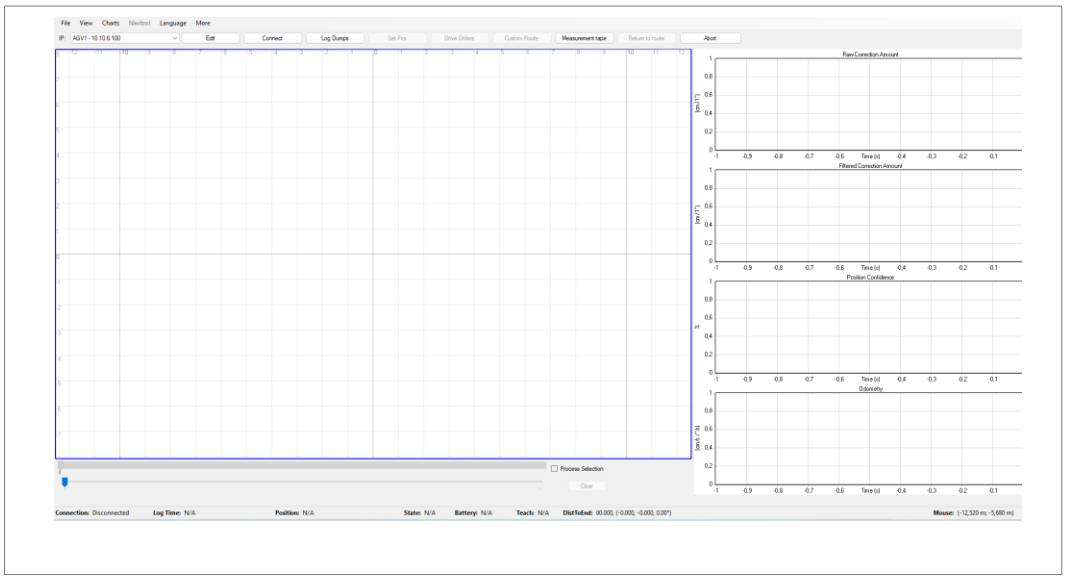


Fig. 50: Navitrol User Interface.

Step2: The login window will show up. Default password for login is **ntnavitec**.

The password can be reset or changed if needed.

Step3: Set Name and IP for each AGV you want to connect. IP addresses can be added or modified also later.

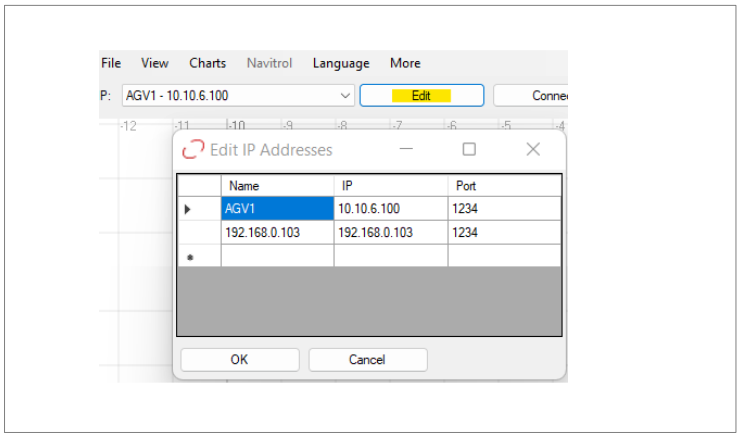


Fig. 51: Editing AGV Parameters.

Step4: Connect to MAV. The connection status can be verified in the lower left corner of the window.

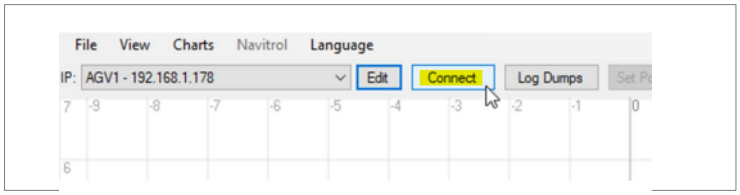


Fig. 52: Connecting to MAV.

Step5: the initial position from the AGV can be set with the “Set Pos” Button.

Pressing the button causes monitor to go into state where machine location can be shown on the map by pressing the right mouse button. Position can be rotated by keeping the right mouse button pressed.

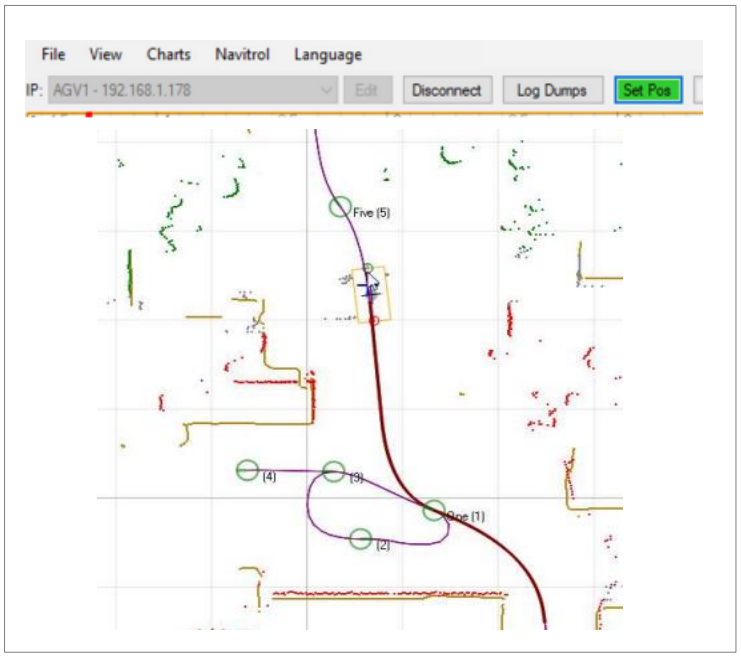


Fig. 53: Setting Position.

Make sure that the installation space according to the robot working space and the size and specification of the electrical control box.

6.4.2. Driving Vehicle

Drive Orders

Step1: with the menu “driving orders” is possible to drive the vehicle.

- Moving the mouse on the map shows whether the route to the mouse location can be found.
- This software can be used to make a production simulation. Stopping points and route points can be selected.
- Wait time at each location can be edited. Drive can be started with Drive button and stopped with Stop button.

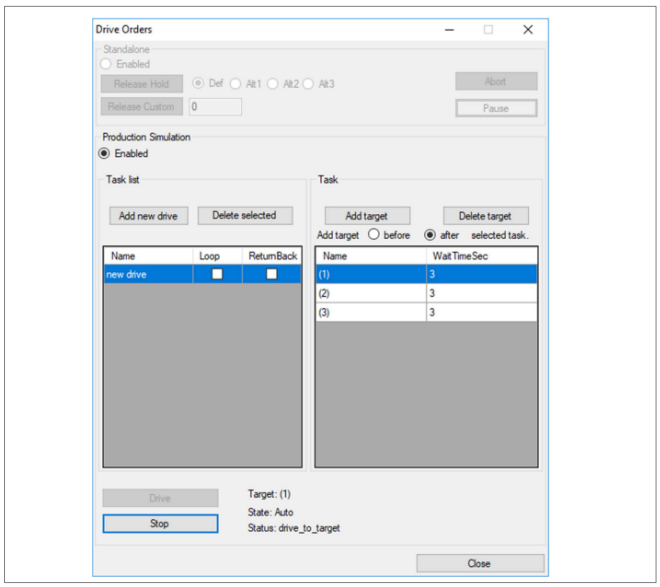


Fig. 54: Drive Orders options.

Custom Route

Pressing Custom Route opens a separate window where the speed can be selected and with right click on the map to a route can be created.

Fig. 55: Custome Route.

NOTICE

Improper use of the AGV

► This User Guide gives only a small introduction about the use of the software. If more detailed Info is require please consult the Software user guide.

DANGER

Improper handling of the AGV

Improper handling of the device can lead to serious injuries.

7. MAINTENANCE, SERVICE AND RERAIR

7.1. Maintenance and Repair

Regular maintenance work must be performed on MAV system to ensure its normal functioning. The AGV must be repaired when it malfunctions due to environmental influences or improper operation of the user, or a certain component of the MAV system exceeds the normal service life.

7.2. Safety Instructions

- Before performing maintenance operations, make sure that the AGV has stopped in safe conditions.
- All maintenance and service/repair work must be performed by partners, or NEURA Robotics GmbH.
- Make sure that all the maintenance and service/repair work must be performed in accordance with the safety instructions in this manual.
- All parts must be returned to the NEURA Robotics according to the service manual.
- All the personnel involved in the maintenance and repair on robot system must read and must comply with all local and national safety regulations for the location in which the AGV is installed.
- Perform the inspection checks after maintenance and repair work on MAV system is completed.

7.3. Maintenance Intervals

7.3.1. Routine Inspection

Make sure that the following activities are checked daily to ensure the robot system function and safety,

Item	Operating state	Inspection point	Solution
Charging Cables	OFF	► Check the cables for any cracks or damages or loose	► If the cables are damaged or cracked, please replace them immediately
White covers and AGV frames	OFF	► Check the surfaces for any cracks or damages or loose	► Please replace/repair them timely
Bolt, screw	OFF	► Check the screws/bolts of the covers are loose	► If the bolts and screws are loose, please torque tighten them
Emergency stop switch and LED indicators and buttons	ON	► Check the whether the LED indicators are displayed normally, and emergency stop switch is working regularly	► If that happens, please replace the corresponding components timely

7.3.2. Periodic Inspection

To ensure the function and safety of the robot system, please perform the following checks periodically.

Item	Period	Remark
Warning, Safety labels	1 week	► Ensure labels are present and legible. ► Replace them if necessary.
Laser Scanners	1 week	► Clean the optical surfaces with an appropriate cloth and plastic cleaner.
Check the charging Station	1 month	► Make sure that all plugs are inserted correctly.
Check emergency buttons	1 month	► Press the emergency switch and the IO E-Stop in open-loop status. ► Verify that each shuts off power.
Check robot mounting screws	3 months	► Follow the robot installation process.
Check the Wheels	3 months	► Verify the condition of the driving wheels bandages. ► Verify the condition of the supporting wheels bandages.

The AGV must be checked at least once per year by an authorized person. These recurring tests are part of the essential visual and functional tests, during which the condition of the components is assessed with regard to wear, corrosion, damage and structural or other changes. The completeness and effectiveness of the safety devices must also be determined. Dismantling may be necessary to assess wearing parts. Defects and components close to a defect must be replaced. All tests are to be arranged and documented by the operator

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Document number: NR543799
Version: 08.2022