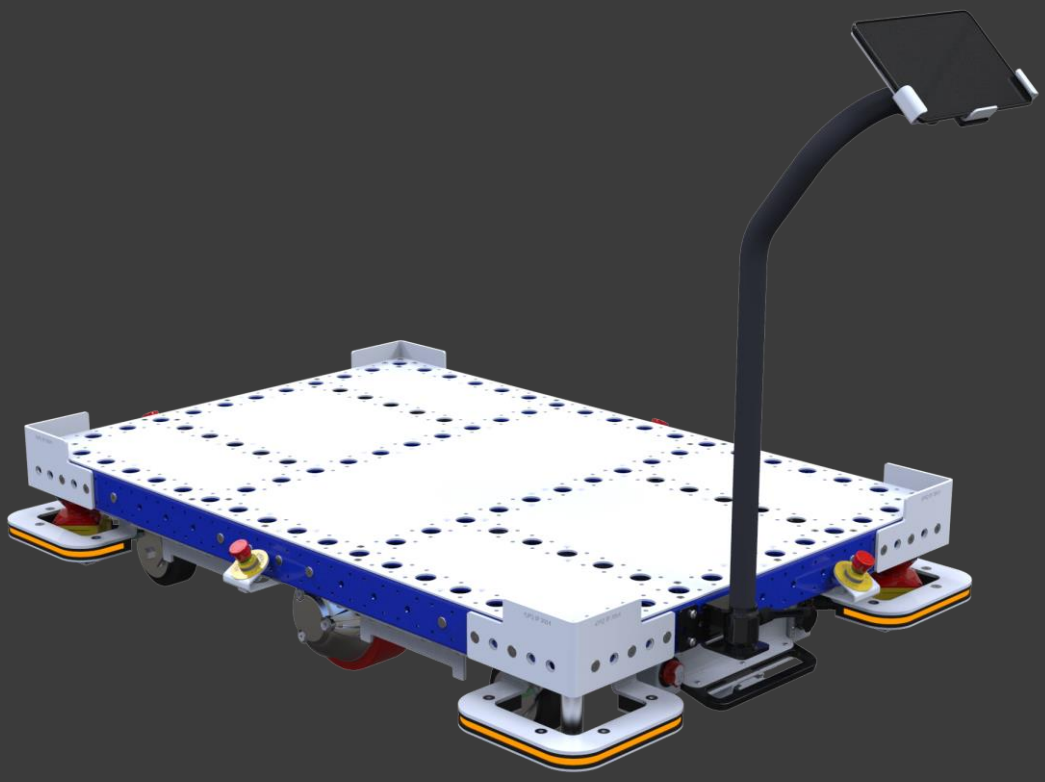
eQart®

User manual.

Date 01 / 2023

Revision 1.7



FLEXQUBE®

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Table of contents

1 Introduction to this document

This information will give you the following knowledge.

- Unboxing of the eQart.
- Startup, implementation, and operation of the eQart.
- Technical description of the eQart.
- Maintenance of the eQart.

1.1 Document history

Revision	Release date	Description	Hardware	Software	Cockpit
1.0	7 Jan 2020	Initial revision	1.0	2.7.4	1.2.2-01-04-20
1.1	8 Jan 2020	Formatted Content	1.0	2.7.4	1.2.2-01-04-20
1.2	30 Jun 2020	Cockpit revision	1.0	3.1.2	1.2.7-01-06-20
1.3	1 Jan 2021	App update	1.0/ 2.0	3.2.8	2.1.2-02-12-20
1.4	1 July 2021	General update	1.0/2.0	3.3.7	2.3.0-04-06-21
1.5	22 July 2022	Modular map guide + New functions with hardware 3.0	3.0	3.4.10 3.5.0	2.3.4-27-04-22
1.6	24 Nov 2022	Formatted content and added descriptions	3.0	3.4.10 3.5.0	2.3.4-27-04-22
1.7	18 Jan 2023	Formatted content	3.0	3.4.10 3.5.0	2.3.4-27-04-22

2 eQart Introduction

eQart is a simple, smart, and scalable automation concept designed for transports inside factories and warehouses. It is ideal for moving products on an assembly line or transporting goods throughout a plant or warehouse. The eQart provides easy and reliable point to point movement of everything from small parts to heavy pallets. The eQart is ideal for recurring transports such as A to B or circular flow layouts.

The eQart has a modular architecture enabling sizes from 910 x 840 mm up to 2520 x 2520 mm. The modules creating the eQart is the:

1. Brain Module
2. Motor Module
3. Battery Module
4. Safety Modules

The eQart navigates by using a camera-based visual system reading the contrast with a colored line that is applied on the floor – no cutting or drilling on the floor is needed. The colored line can be created with tape or paint. The method is a cost-effective and flexible guide path technology, allowing guide path implementation and changes to be made in minutes or hours. The eQart is controlled with a tablet application called "Cockpit" that allows the customer to easily control the eQart, create and modify routes.

2.1 Additional information about the eQart

All information regarding the eQart is shared through the FlexQube website together with the FlexQube Vimeo channel.

- **eQart Website** - https://www.flexqube.com/eqart/
- **eQart Support** - https://www.flexqube.com/customer-care/#eqart-support
- **eQart Learning Platform** - https://vimeo.com/showcase/eqartlearning

  A series of instructional videos to get started with the eQart:
  - eQart Unboxing Video - Unboxing the eQart on Vimeo
  - eQart Mapping - eQart feature mapping - eQart Learning on Vimeo
  - eQart Manual Drive - eQart Manual Drive | eQart Learning on Vimeo
  - eQart Line follow - Guide for line follow - eQart Learning on Vimeo
  - eQart Navigation - Navigation - eQart Learning on Vimeo
  - eQart Mission Planner - Mission Planner on the eQart on Vimeo

3 Safety

Before you start to operate the eQart make sure to read through the complete user manual, and especially all the safety-related information below.

3.1 Safety message types

Warning
A potentially hazardous situation that can result in death or serious injury.

Caution
A potentially hazardous situation that can result in small or moderate injury.

Notice
A potentially hazardous situation that can result in damage to property or equipment.

3.2 Important safety notifications

Make sure that the load on the eQart is placed and fastened correctly. If not, the load can fall off or create instability of the eQart.

Do not short circuit the battery. The battery is heavy and if not controlled properly, it could cause severe injury to nearby personnel.

Only use approved top structures from FlexQube that is kept inside the footprint of the eQart. Usage of any other top structure with a footprint larger than the eQart can cause serious injury.

The laser scanner has a planar reading area 150 mm above the floor. Any object below OR above this level will not be visible for the eQart. Make sure that the route is clear from obstacles that are not visible to the eQart safety systems. Otherwise, it can result in major damage and cause eQart to collide with objects and make the load fall off.

When doing any kind of troubleshooting on the eQart at least one emergency stop must be applied at all times during this work. Otherwise, there is a risk of unintended movements of the eQart.

To prevent fire or shock hazard, do not expose the eQart to rain or moisture.

When driving the cart in manual mode with the cockpit, make sure to always stay close to the eQart to have a proper view of its surroundings and access to one of the four emergency stop buttons.

The eQart contains following RF devices

- RFID reader – which was used to stop the cart at a station by detecting RFID tag.
- WiFi, BT device – which was used to wireless communication

These devices are likely to emit non-ionizing radiation which can harm to person, in particular those with active or non-active implantable medical devices.

3.3 eQart Certification

The eQart is certified according to the Machinery Directive 2006/42/EC, which includes the base platform for L x W (Length x Width) between 840 mm to 2520 mm (Minimum eQart size should be 910 mm x 840 mm). The eQart is certified and adheres to the following standards:

- EN1175:2000
- EN ISO 3691-4:2020
- EN ISO 12100:2010
- EN 12895: 2015 + A1: 2019
- EN 301 489-1
- EN 301 489-3
- EN 301 489-17
- EN 300 328 V2.1.1
- EN 300 330
- Safety standards: UL 3100
- FCC Part 15 subpart B
- FCC 15.107
- FCC 15.109
- FCC Part 15 subpart C
- FCC 15.247
- FCC Part 15 subpart C
- FCC 15.225

3.4 Intended use

The eQart is intended to be used:

- Only indoors in an industrial environment.
- On even surfaces with concrete or painted floors.
- In areas with limited access for the public.
- Only with approved top structures designed by FlexQube that is part of the complete eQart solution.

3.5 Inappropriate operation

To operate the eQart safely do not:

- Use the eQart for transporting people, this may cause the risk of serious injury.
- Use the eQart outdoors as it may cause damage to hardware and cause risk of personal injury.
- Tow other trolleys that have not been evaluated and approved by FlexQube.
- Overload the eQart with weight above its payload capacity as it may cause reduced performance, falling load, and instability of the eQart.
- Transport any corrosive, flammable, or explosive substances on the eQart.
- Control the eQart in manual mode from a long distance where the operator does not have a full view of the situation.
- Drive the eQart at top speed in manual mode close to objects and people, this can cause serious injury and damage.
- Control the eQart operations by Untrained operators.

- Use it without performing a risk evaluation of the full use scenario for normal operation.
- Walk in the travel path or directly toward the eQart.
- Run towards the eQart.
- Attempt to crawl over the eQart.
- Attempt to use the eQart as a stepladder.

3.6 Risk assessment of the complete application

The operator of the eQart is responsible for making a risk analysis of the complete use scenario and process in each implementation related to the user's facility. Examples of risks to consider are route planning, crossing traffic, safe loading and unloading of the eQart, etc.

3.7 Residual risks

- The operator suddenly moves into the eQart area from the side or towards the eQart travel direction.
- Crushing if, the operator comes in contact with non-protected areas of the eQart during operation.
- Crushing if the operator touches the eQart motors while they are in motion.
- Beware that when eQart may proceed without notice, especially of no obstacles are detected.

3.8 Safety functions

The eQart is equipped with a safety system to protect people, buildings, and equipment.

3.8.1 Collision avoidance

The eQart is equipped with 2 x safety lasers scanners from Hokuyo (UAM-05LP) ISO 13849-1 PL:D to avoid collisions with humans and objects. The collision avoidance system is divided into 3 different zones.

- **Slow down zone**
  When a person or object enters this zone the eQart is slowing down to 0.3 meters/second to increase safety.
- **Stop zone**
  When a person or object enters this zone, the eQart stops and will remain still until the object or person is removed from the zone. The eQart will beep and resume after 3 seconds.
- **Protection zone**
  The slowdown and stop function will in most cases avoid the activation of the protection system. If a person or object still ends up in the protection zone of the eQart, the protection safety function will be activated. This function is directly connected to the actuators of the eQart through a safety system. When the protection zone has activated, the power to the motors is cut off, and the brakes will be immediately applied to stop the eQart safely. The triggered protection zone must be reset in the cockpit before the eQart can continue the operation.

3.8.2 Emergency stops

The eQart is equipped with 4 x emergency stops placed on each of the 4 sides. When the emergency stop is pressed the power to the motors is cut off, and the brakes will be

immediately applied. Activation of the emergency stop must be reset in the cockpit before the eQart can continue the operation.

3.8.3 Fail-safe motors

In case of power loss, the eQart brakes are applied and the eQart motors are braked to avoid unintended motion of the eQart. The brakes can only be released by the activation of power. Activation of emergency stops must be reset in the cockpit before the eQart can continue the operation.

4 Product specification

4.1 eQart Specifications

- Weight of empty eQart (840 mm x 1260 mm) without battery: 170 kg.
- Max rated Capacity for eQart platform: 1000 kg (2200 pounds).

ATTENTION Max load capacity for each eQart application must be evaluated for each specific configuration where load type, load size, and load location are considered.

- eQart size range:
  - 910 mm x 840 mm (Smallest),
  - 2520 mm x 2520 mm (Largest)
  - The eQart can be configured to any size between the smallest and largest size in increments of 70 mm

Length \ Width	840	910	980	1050	1120	1190	1260	1330	1400	1470	1540	1610	1680	1750	1820	1890	1960	2030	2100	2170	2240	2310	2380	2450	2520
910	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
980	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1050	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1120	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1190	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1260	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1330	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1400	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1470	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1540	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1610	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1680	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1750	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1820	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1890	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1960	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2030	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2170	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2240	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2310	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2380	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2450	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2520	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

- Rated speeds:

	HW1.0/2.0	HW3.0
▪ Manual drive	0.9 m/s	1.0 m/s
▪ Automatic mode (normal zone)	0.7 m/s	1.0 m/s
▪ Automatic mode (slow zone)	0.3 m/s	0.3 m/s
▪ Recording	0.2 m/s	0.3 m/s

- Battery specification:
  - Type: Li-ion
  - Safety standard: IEC 62133: 2012
  - Weight: 10 kg
  - Dimension (mm): 340 x 210 x 70 (Length x Width x Height)
  - Rated capacity: 60 Ah
  - Capacity: 1554 Wh
  - Voltage: 25.9 V
  - Full charge: 2 hours
- Operating conditions:
  - Temperature: 0^{o}C to 40^{o}C
  - Altitude: < 2000m
  - Indoor use only
  - The floor should be dry and clean for the tape installation.
  - The installation place should be free from moisture.

The eQart serial number and **CE** Marking is stamped on a sign attached to the eQart base.

4.2 Nameplate & Markings

- The detail of the nameplate is as shown in the image below.
- Nameplate gives the primary data related to the eQart.
- The marked entry is dependent on customer configuration of the eQart.
- The serial number is the unique ID of each eQart.
- The UKCA, FCC Standard and CE certification marking is displayed on the nameplate according to requirements.
- The nameplate specifies the data of the eQart mass, the requirement of power, year of manufacture, max. load to be allowed and battery specification.

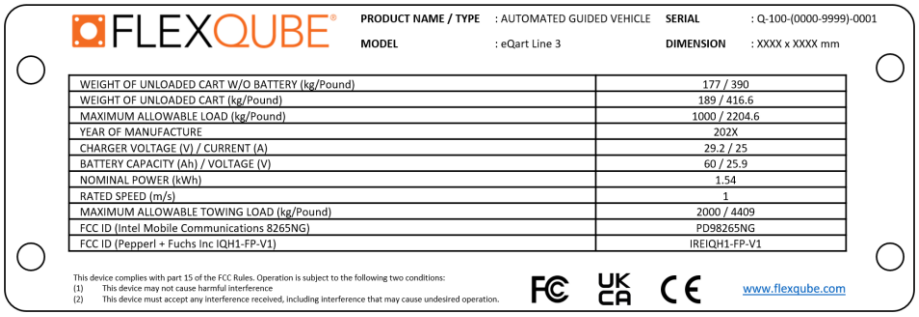


Figure 1 Example of the eQart Nameplate

5 Mechanical design

The eQart is based on eight smart modules enabling a high degree of scalability and flexibility in design.

1. Brain Module (onboard computer & visual system)
2. Battery Module
3. Motor Module
4. Emergency Stop Modules
5. Base Cart Module
6. LED Corner Module with safety scanner
7. LED Corner Module without safety scanner
8. Tablet Holder Module

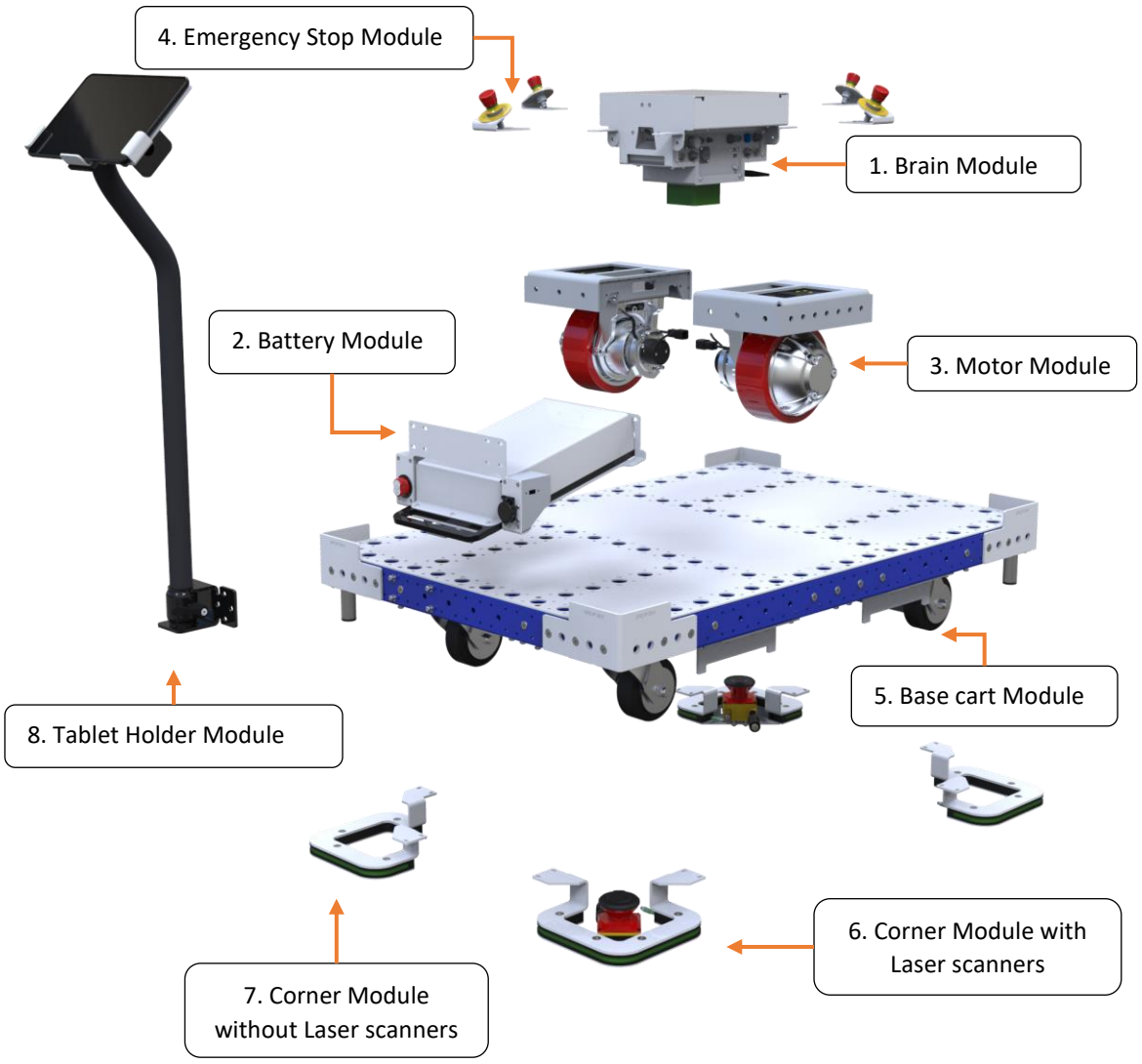


Figure 2 Exploded view of the mechanical design of the eQart.

5.1 Brain Module

The Brain Module contains the computing unit and cameras that handles the Line follow functionality.

- The Brain module is placed in the center in between the motor modules of the eQart.
- The Brain module and its onboard computer control all the systems/functionality of the eQart.
- The brain module is equipped with two cameras symmetrically on each side that uses a visual system to control the navigation of the eQart based on color and contrast.
- The brain module is equipped with a safety system to control emergency stops and activation of the protection zone through the laser scanners. The safety PLC is ISO 13849-1 certified.
- The brain is equipped with a buzzer to give sound signals to the user communicating safety or object detection.
- The RFID reader is used to identify the station on the line for the eQart.
- Emergency brake auto release functionality after protection zone trigger is implemented with hardware 2.0 & hardware 3.0.

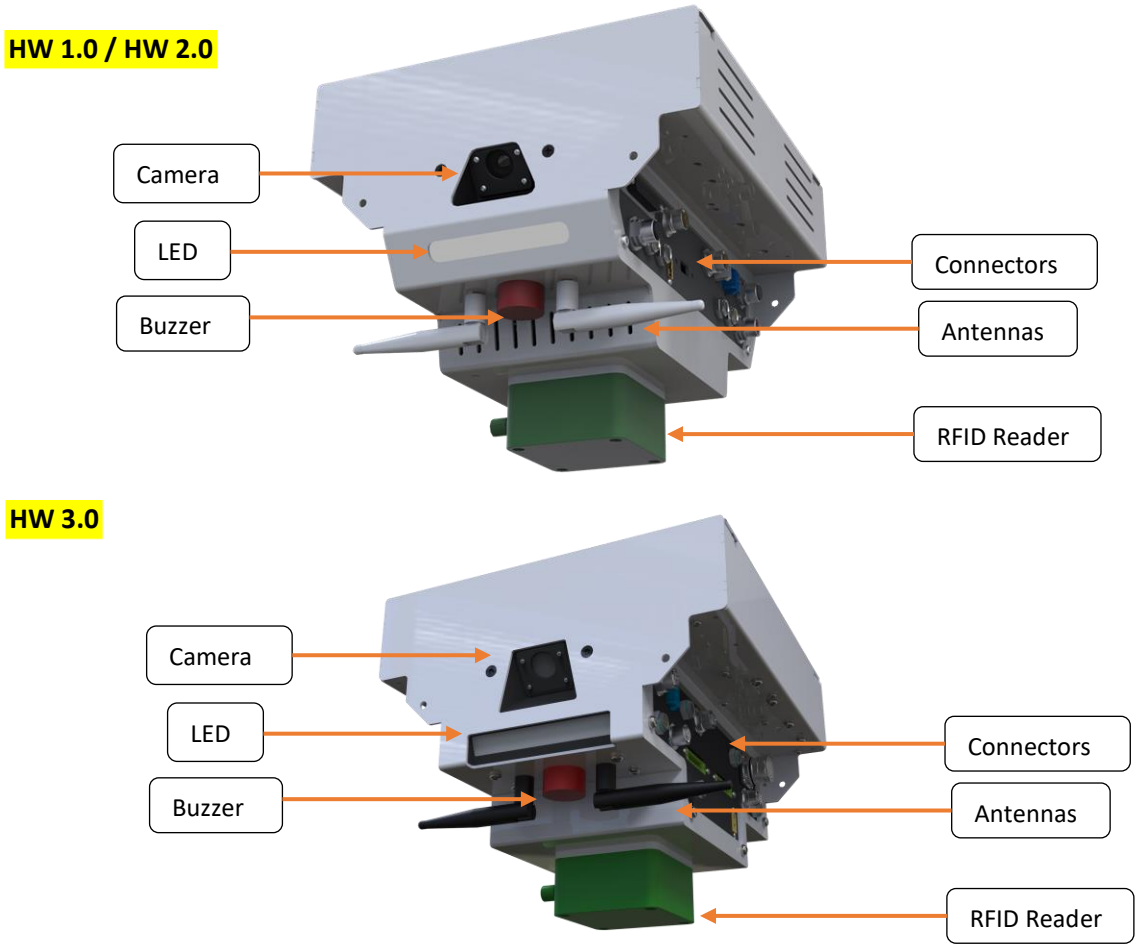


Figure 3 Brain Module

5.2 Battery Module

5.2.1 Swap Battery Module

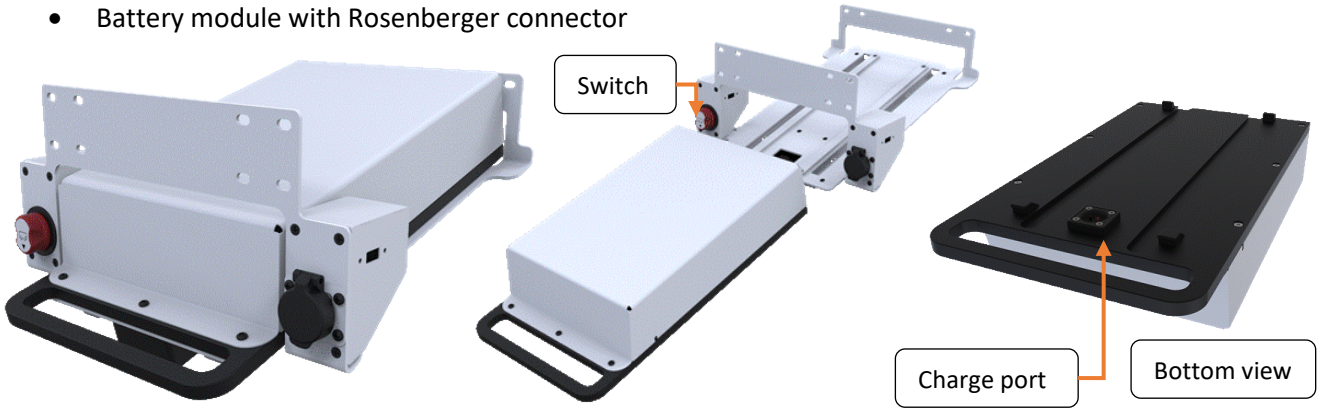
The Swap Battery Module is a removable battery that allows for simple swapping to handle all day operation with very low downtime.

- eQart is equipped with a 60 Ah Li-ion battery.
- Special care must be taken when removing the battery module from the cart.

The on/off switch is located on the side of the battery module behind the charging port. The switch is activated by turning clockwise and switched off counterclockwise.

- The battery module is swappable. Once the battery is discharged, easily replace it with a charged battery.
- There are two types of swappable battery module.
    - Battery module with magnetic Rosenberger connector.
        - Hold & move upward the battery and take out with care.
    - Battery module with Higo connector. (Lever type connection)
        - Pull down the lever at bottom. The connection is disengaged.
        - Hold & move upward the battery and take out with care.

- Battery module with Rosenberger connector



- Battery module with Higo connector

Figure 4 Swap Battery Module

5.2.2 Fixed Battery Module

The Fixed Battery Module is a stationary battery package.

- The fixed battery module is only available with HW 1.0 & HW 2.0.
- The Fixed Battery module contains a 60 Ah Li-ion battery.
- The on/off switch is located on the bottom of the battery module. The switch is activated by turning clockwise and switched off counterclockwise.

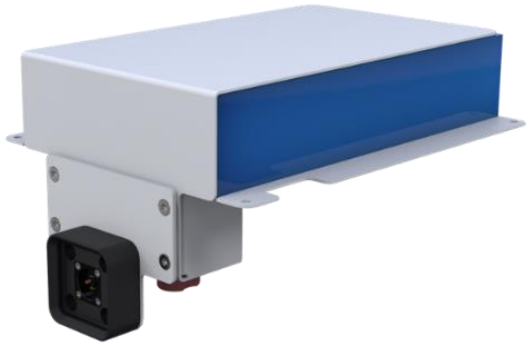
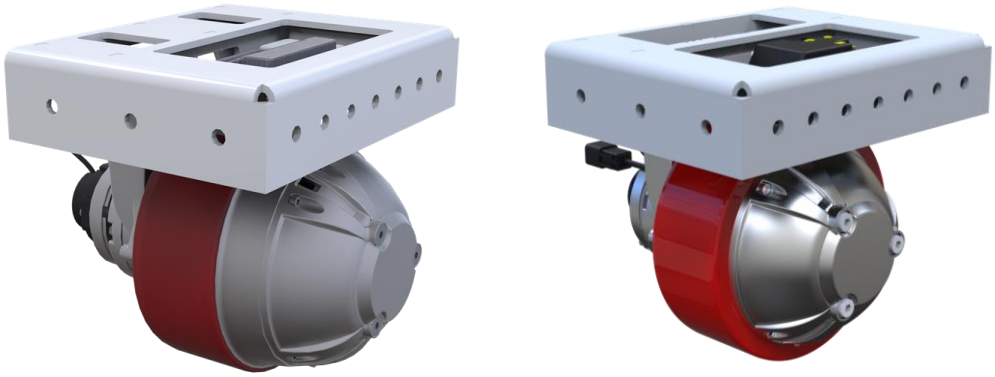


Figure 5 Fixed Battery Module

5.3 Motor Module

The Motor module contains the electric motor integrated with the motor wheel package and the motor controller.

- The motor wheel has a diameter of 200 mm and a width of 70 mm.
- Max speed of the motor wheel is 1.0 m/s
- The motor wheel is equipped with an encoder that provides a rotation signal from the motor shaft.
- The motor wheel is ISO 9001-2008 certified.
- **Brain 1.0** supports PMDC (i-drive) motor.
- **Brain 2.0** supports PMDC (i-drive) & BLDC (Italsea) motors.
- **Brain 3.0** supports BLDC (Italsea) motors.



PMDC motor

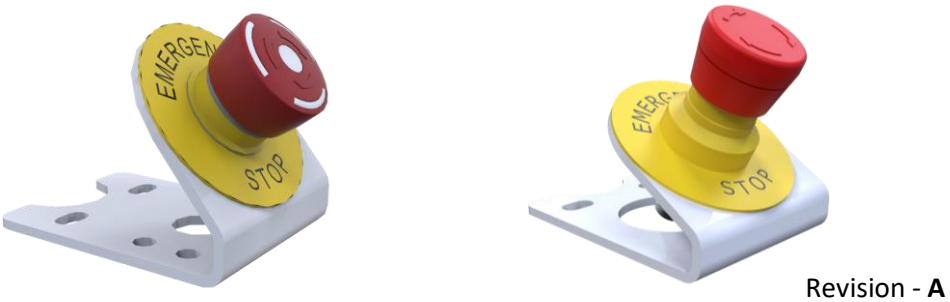
BLDC motor

Figure 6 Motor Module

5.4 Emergency Stop Module

The Emergency Stop Module has a physical button to trigger the safety system to trigger the brake of the eQart when in operation or to make sure the eQart is safe during maintenance.

- The emergency stop module is mounted on all four sides of the cart for easy access.
- The location of the emergency stop modules may vary depending on the application.
- The emergency stop is fully operational in both manual drive and line follow drive.
- The emergency stop is applied by the pushed-in position and is released by turning it clockwise.



Revision - **A**

Figure 7 Emergency Stop Module

5.5 FlexQube Base Cart

The base cart is created with FlexQube standard building blocks. These blocks are screwed together to create the eQart Platform.

- The base size can vary from 910 x 840 mm up to 2520 x 2520 mm in steps of 70 mm.
- The base can vary for different applications such as Mother-daughter eQart which can affect the load capacity and other aspects of the eQart.
- The load capacity of the base is up to 1000 kg (2200 pounds).

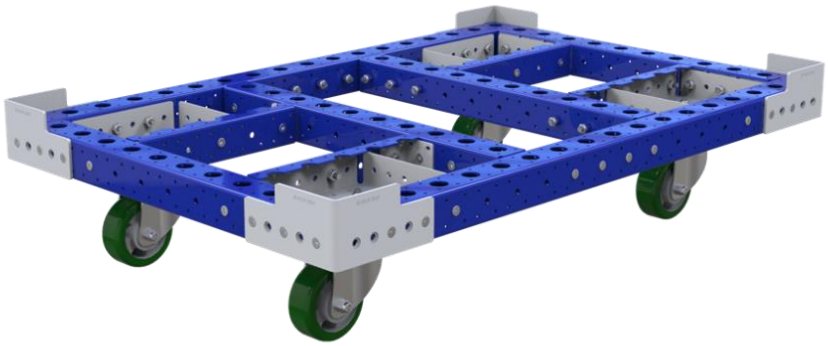


Figure 8 FlexQube Base Cart

5.6 LED Corner Module with Laser Scanner

The LED Corners is used to signal the status of the eQart to people in its vicinity. The Laser scanner is used to detect objects around the eQart.

- The LED Corner module with a safety laser scanner has a robust metal bracket mounted under the eQart with a full RGB LED strip and the safety scanner mounted inside.
- The LED lights indicates the traveling mode and status of eQart with flashing or steady light in different colors.
- Each eQart is equipped with 2 corner modules with a safety laser scanner that together creates a 360 degree of safety field.

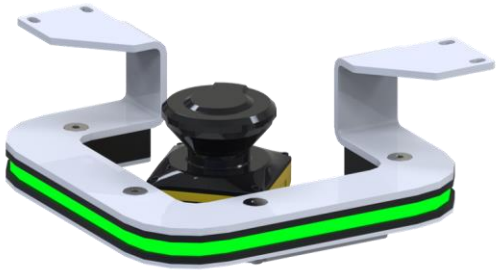


Figure 9 LED Corner module with laser scanner

5.7 LED Corner Module

The LED Corners is used to signal the status of the eQart to people in its vicinity.

- The LED Corner module has a robust metal bracket mounted under the eQart with a full RGB LED strip.
- The LED lights show the indication of traveling mode and status of the eQart with flashing or steady light in different colors.
- Each eQart is equipped with 2 LED Corner modules without a safety laser scanner mounted in opposite corners.

5.8 Tablet Holder Module

The Tablet Holder module is placed on the front side of the eQart or the side depending on the eQart application.

- The stand for the tablet can be used to store and charge the tablet via the USB-C charging cable integrated into the stand.
- When sending away the eQart to the next station the tablet should be stored in the holder to ensure the connection between the two is steady. This also prevents losing the connection.

Figure 10 Tablet Holder Module

6 Laser scanner functionality

The eQart is equipped with an ISO 13849:1 safety rated laser scanner used to detect objects in the eQart' s traveling path, bringing the cart to a safe stop before colliding with a person or an obstacle.

6.1 Laser scanners

The Laser scanners are supplied by Hokuyo and certified according to ISO 13849-1 cat D.

- The placement of the laser scanner on the eQart enables a 270°-protection zone. Each eQart is equipped with 2 laser scanners placed in opposite corners to create a safety field of 360 degrees.
- Laser scanners generate a 1mm thick plane projected parallel 150 mm above the floor, to detect people and objects.

6.2 Safety Zones

There are three protection zones with different areas of protection provided by the laser scanner:

  - Warning zone 2 (Green)
  - Warning zone 1 (Yellow)
  - Protection zone (Red)

- The laser zones can be configured depending on the customer application and stored as a predefined setting in the scanner software.
- The laser zones can only be customized before starting the eQart. It can be done by connecting through the included micro-USB cable or inserting a memory card into the Laser scanner accessing the software.

The laser scanner will switch between modes with different zone sizes depending on if it is:

  - On a station line color (Slow area)
  - On a main line color (Fast Area)
  - In manual mode

- The switching of modes is based on functionality in Brain 1.0.
- The switching of modes is based on motor speed in Brain 2.0 & Brain 3.0.

When the eQart is in line follow mode:

- When any obstacle is found in Warning zone 2 (Green), the eQart will slow down.
- When any obstacle is found in Warning zone 1 (Yellow), the eQart stops. It will resume after the obstacle is removed from warning zone 1.
- When any obstacle is found in the Protection Zone (Red), the eQart stops and brakes are applied. The red LED light blinks during this operation. When the protection zone is free from obstacles, the eQart will automatically reset. This zone is ISO 13849-1 certified.

- If the eQart stops and laser's optical window shows 85 error, then the user must clean the sensor's optical window with a cotton cloth.
- Clean the laser's optical window monthly.

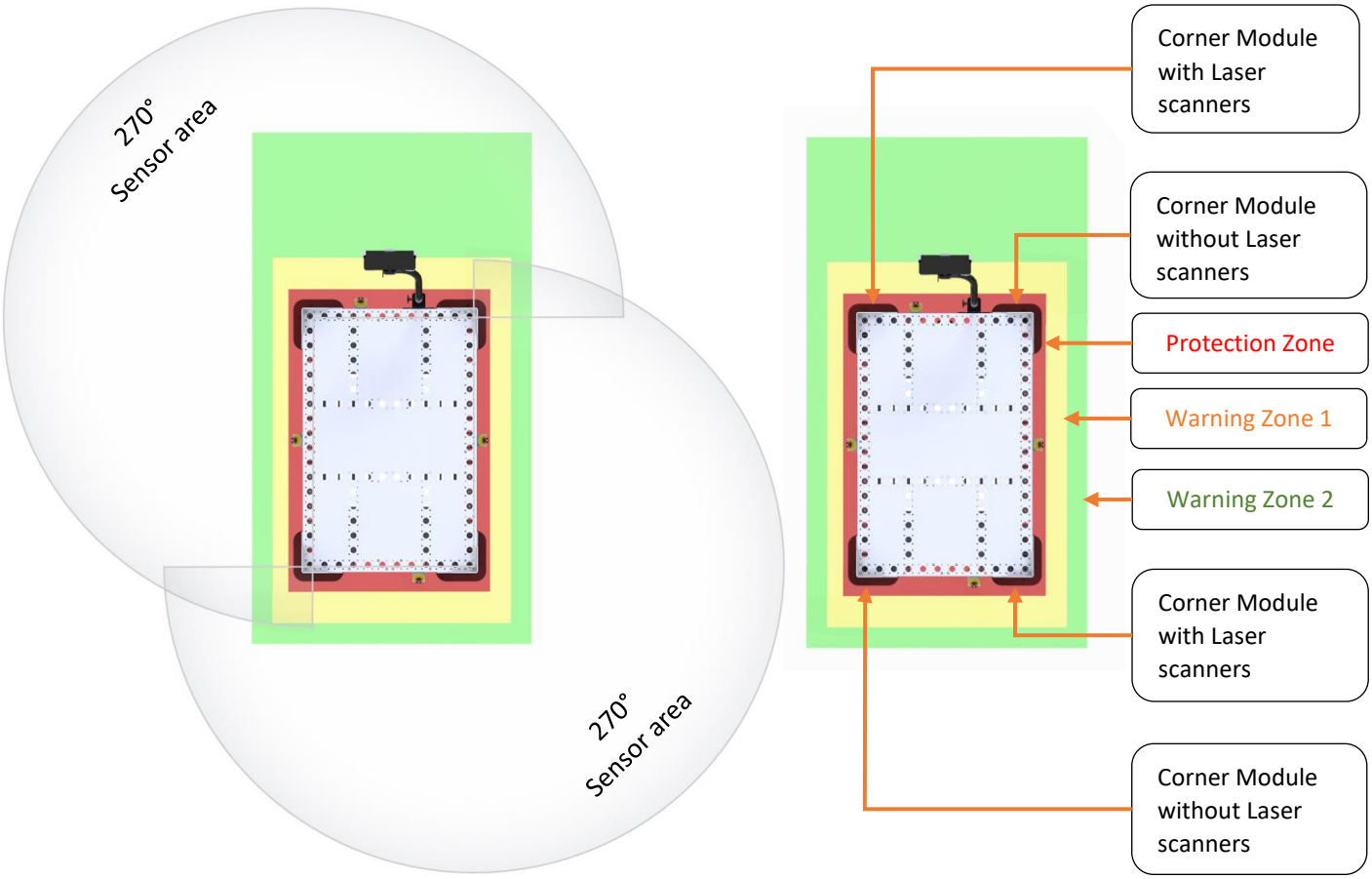


Figure 11 Sensor Operations

6.3 Lidar Error Code Troubleshooting

There section describes troubleshooting methods while lidar shows error code.

Error Number	Details	Possible reason	Solution suggestion
57	Area input connection error	Confirm the input status during area switching.	Check the encoder connection, lidar code
5B	Encoder speed error	Make sure the encoder speed is correctly configured	Check the lidar code
5C	Encoder error	Confirm the encoder input status.	Check the encoder connection
5D	Encoder speed error	Make sure the encoder speed is correctly configured	Check the lidar code
5E	Invalid area error (During Encoder is valid)	Confirm the input status during area switching.	Check the encoder connection, lidar code
5F	Encoder speed error	Make sure the encoder speed is correctly configured	Check the lidar code
64	Master-Slave communication error	Confirm the connection between master and slave.	Check the master and slave lidar connections Check the lidar code
7D	Slave unit 1 error	Check the error code on slave unit 1	Check the error code on slave lidar
80	Master unit error	Check the error code on master unit	Check the error code on master lidar
84, 85, B1-C0 C1	Optical window is contaminated	Clean the optical window	Clean the optical window

7 LED Light Functionality

The eQart has LED corner modules located in each corner of the eQart with RGB light that lights up or blinks according to the mode of operation.

7.1 For Manual Drive

LED indicates **ORANGE** light in the driving direction for manual drive operation, when switching direction in the eQart Cockpit the eQart will switch to the LEDs in the opposite direction.

1. Driving in the forward direction, 2 LEDs will blink orange in the driving direction.
2. Driving in the backward direction, 2 LEDs will blink orange in the driving direction.

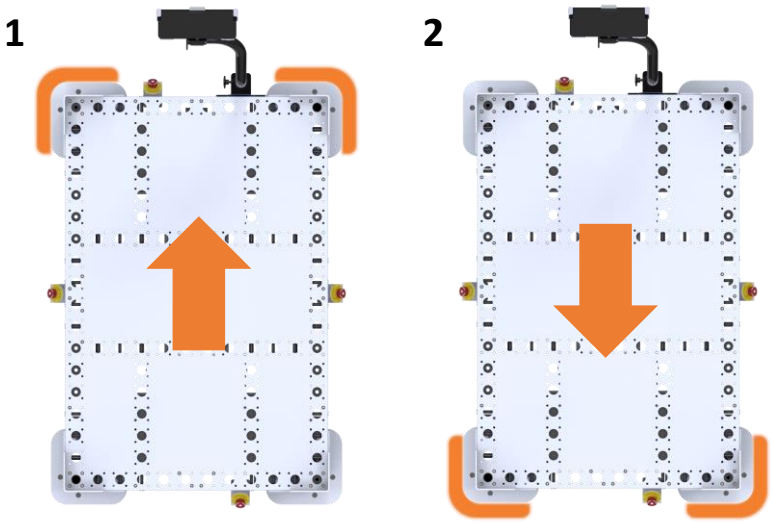


Figure 12 LED Operation for Manual drive

7.2 Line Follow Drive

When the eQart operates in Line Follow Drive it will only blink in the driving direction, when switching direction in the eQart Cockpit it will switch to the LEDs in the opposite direction.

1. The LEDs blink **GREEN** on 2 LEDs in the driving direction for line follow.
2. The LEDs will be **RED** on all 4 LEDs when any obstacle is found in the cart's laser protection area.
3. The LEDs blink **ORANGE** on all 4 LEDs when eQart reached on station and detection of line end.

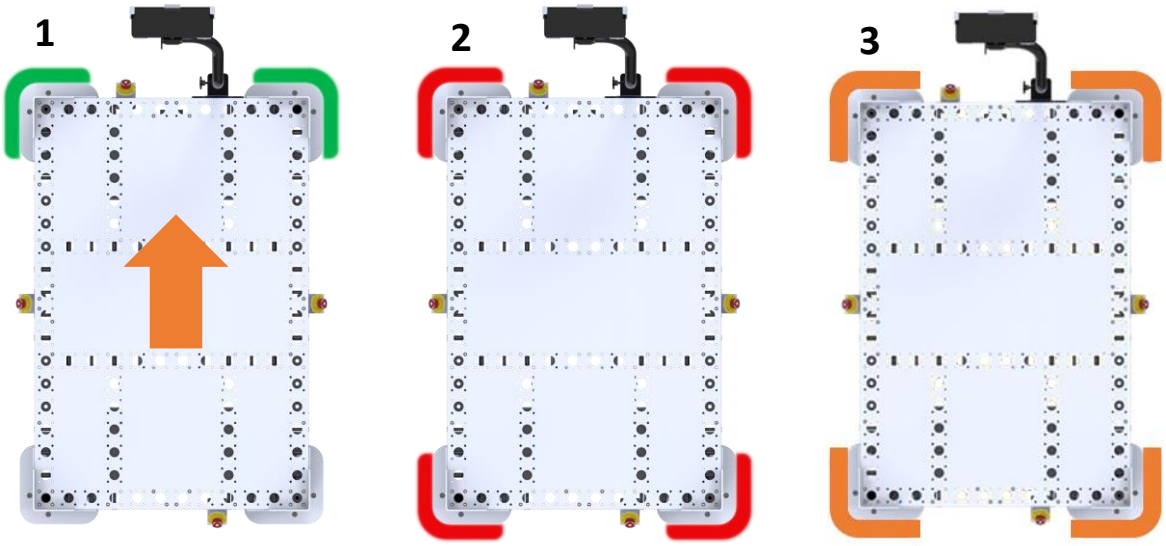


Figure 13 LED Operation for Line Follow drive

7.3 Additional Operation

1. The LED blink **PINK** on all 4 LEDs, for the find cart function.
2. The LEDs blink **BLUE**, for recording map function. The LEDs blink **GREEN** while passing through the junction during map recording. (For HW1.0 & HW 2.0)
3. The LEDs blink **GREEN** on all 4 LEDs when the eQart is starting up.

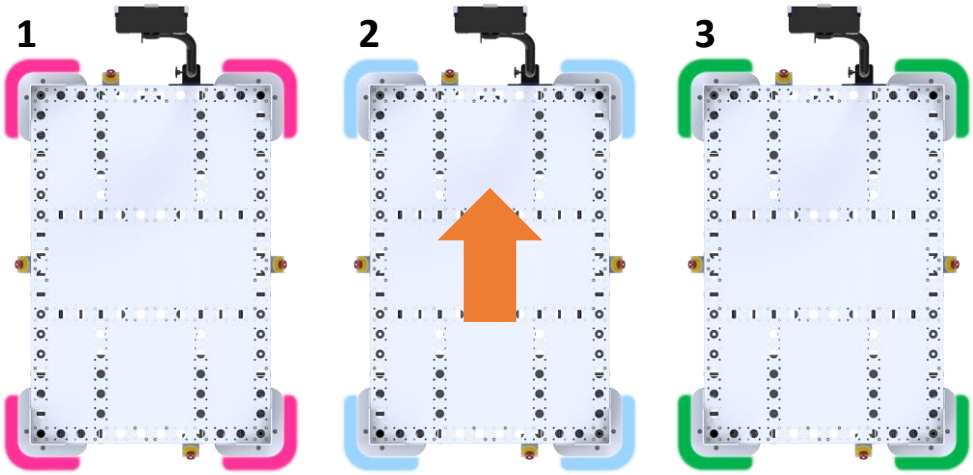


Figure 14 LED Indicators for additional operations

The following operations are only available with **HW 3.0**

A. The LED blink **GOLD** on all 4 LEDs, when junction start to finish in map recording.
B. The LEDs blink **Midnight BLUE**, when eQart is in sleep mode.
C. The LEDs blink **CYAN**, when eQart is ready to operate.
D. The LEDs blink **SADDLE BROWN** on 2 LEDs in driving direction when driving with maintenance drive.
E. The LEDs blink **ORANGE** on all corners, when in place degree rotation.

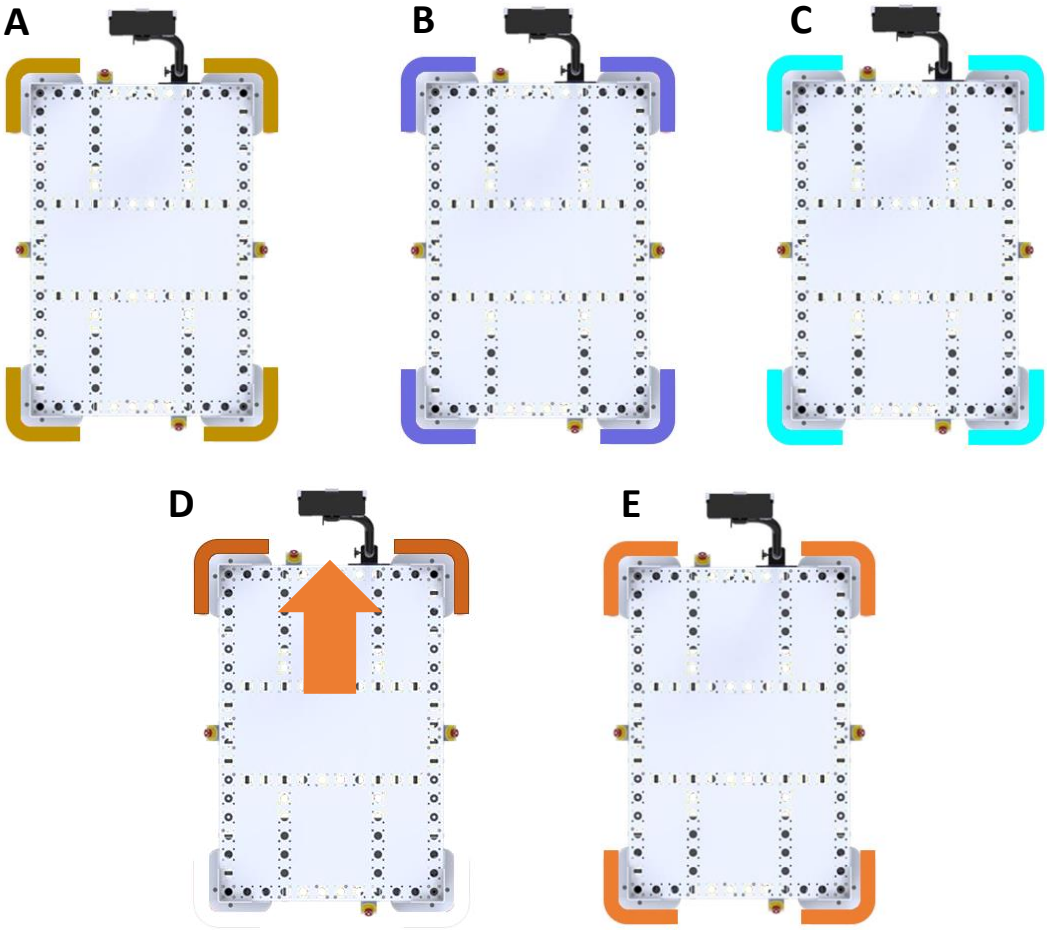


Figure 15 LED Indicators for additional operations

8 User applications

The eQart can be used for 3 different applications.

8.1 Stand alone

The eQart is operating only on its own, without integration to any other cart or equipment. A standalone eQart typically moves standard US/ EUR pallets or has a custom top structure designed by FlexQube to transport different types of goods.

8.2 Towing

The eQart can be used to tow tugger carts using either a tow bar or a hitch placed on the rear side of the eQart. An eQart used for towing needs 1000 kg (2200 lbs) of payload to ensure traction for good towing capability. An eQart can tow up to 2000 kg (4400 lbs) worth of tugger carts.

Warning
When towing carts behind the eQart the tugger train is not protected by the laser safety scanners and can´t detect objects in between. Perform a risk analysis according to ISO 12100:2010.

8.3 Mother/daughter

The eQart is operating as a Mother eQart that transports small daughter carts inside the laser safety zones. The eQart Mother can transport one or more small carts depending on the eQart design.

Figure 16 eQart stand alone & eQart Mother Daughter

9 Unpacking of the eQart

The eQart comes delivered in a wooden box including the eQart itself and all the accessories needed for set-up. Follow the procedure to safely unpack the eQart.

9.1 Accessories with the eQart

The eQart delivery comes with the following content as standard inside the wooden packaging box unless otherwise stated in the order confirmation:

- eQart x 1
- Android Tablet (eQart Cockpit) x1
- Blue floor marking tape x 10 (10x33 m)
- Red floor marking tape x 2 (2x33 m)
- RFID tag x 20
- Maintenance cables x 2
- Maintenance drive x 1

The following documentation comes included in the delivery:

- User Manual
- Installation (Get Started) manual
- CE declaration of conformity

9.2 Starting up the eQart

1. The eQart ON/ OFF switch is placed in front of the battery module. To start the eQart make sure to deactivate all emergency stop buttons.
2. Rotate the ON/OFF Switch clockwise to turn on the eQart as shown below.
3. The eQart needs 25-30 sec to startup. During the startup of the eQart, the LED will blink green.
4. The cockpit is connected with WIFI to the eQart from the factory. After the eQart boots up, the cockpit will automatically connect to the eQart, displayed as connected in the UI.
5. When the start-up is complete the LED will turn orange indicating the driving direction

The eQart switch can be removed in the third position furthest counterclockwise, this can be done during maintenance to avoid turning on the eQart by mistake.

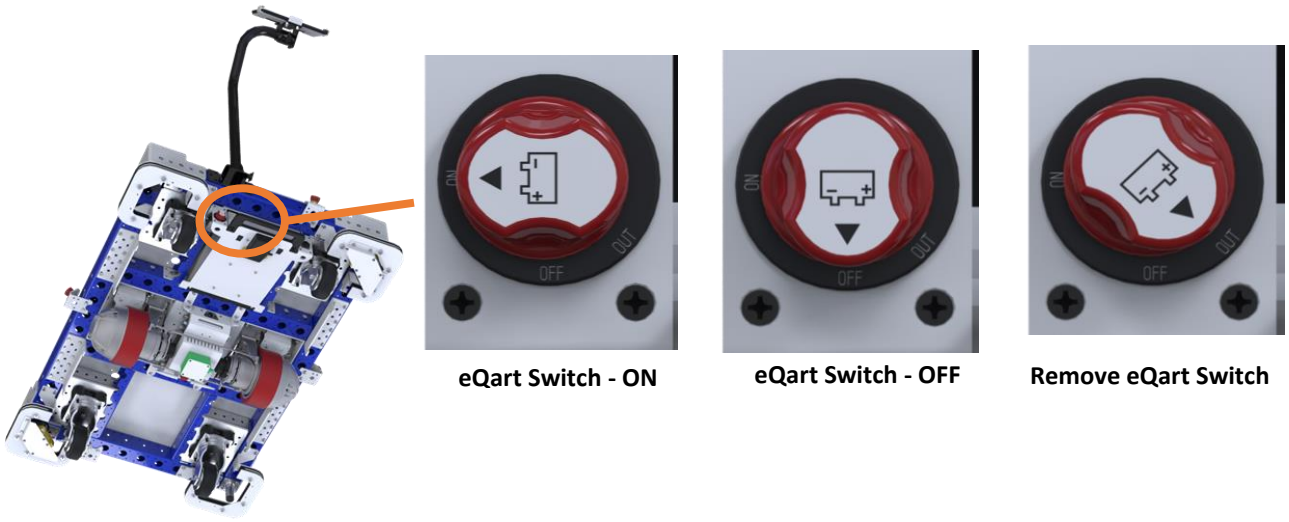


Figure 17 eQart ON/ OFF Switch

9.3 Unboxing of the eQart

ATTENTION Do not unload eQart with a forklift as it might damage sensitive parts.

ATTENTION Do not activate the main switch until eQart is fully out of the box and placed on the floor.

ATTENTION Do not use the Cockpit to drive out the eQart from the box.

Figure 18 eQart Package

Follow these points for unboxing of eQart:

1. Remove the screws in the lid which is attaching the front side and the top lid to the box.
2. Remove the front lid from the box.
3. Take off the top lid and place it on the floor as shown in the image. The eQart now has a ramp to roll out of the box.
4. Remove the included accessories and documentation from the box.
5. Remove the straps holding the eQart in place inside the box.

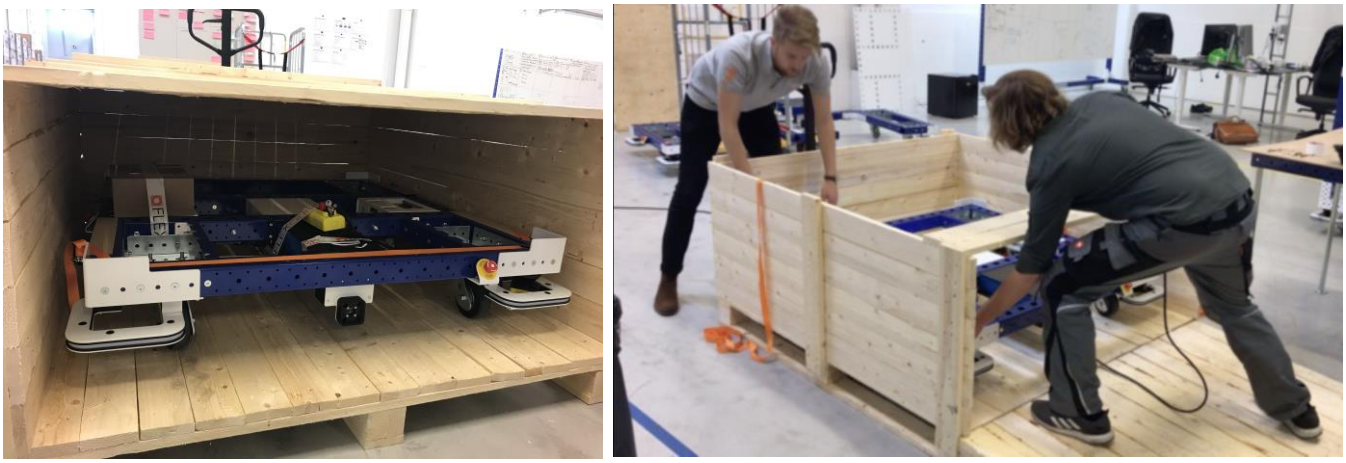


Figure 19 eQart Unboxing - 1

6. Attach the maintenance drive to the cart according to figure 19. Make sure emergency stop on maintenance drive is released.
7. When attaching the maintenance drive to the eQart a “click” should be present. This means brakes of the eQart is released.
8. Now the eQart can roll out of the box by manually pulling the eQart out of the box,


Figure 20 The eQart Unboxing 2

10 Cockpit Operation

The eQart is operated with the "**eQart Cockpit**" android application in the tablet. All operations, settings of the eQart are controlled by the eQart Cockpit.

This is how to operate the eQart Cockpit:

- To start up the eQart, turn on the ON/OFF switch clockwise located under the battery module.
- During the eQart boot up, the LED corner modules are blinking green.
- The operator must check that emergency stop buttons are released on the eQart.
- The eQart name is shown in the Wi-Fi settings of the tablet when it gets connected. This connection is protected with a password provided with the eQart delivery.
- Connect the eQart with a tablet, then open eQart application.

1. The eQart Cockpit app is also pin protected, the pin code will be provided with the eQart delivery.

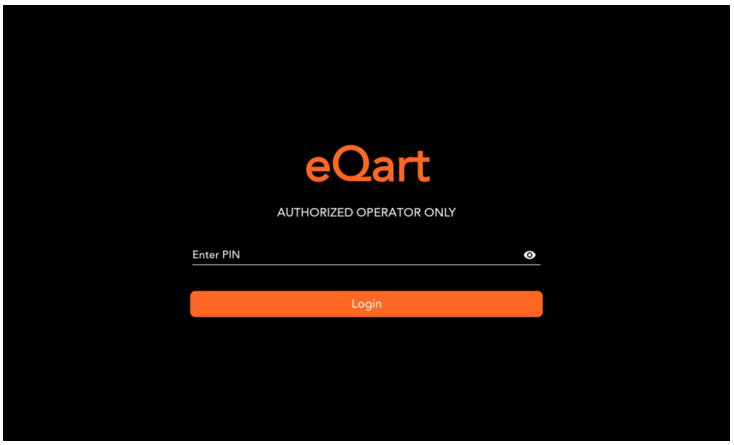


Figure 21 eQart Cockpit App lock

- The start screen in the Cockpit is the Main Menu where you can access all functionality of the app.
- There is also an option for lock setting in the top right of the main menu.
    - The lock setting is used to lock the android setting.
    - After locking, the user can't access the wifi setting. Users can´t access anything on the tablet, except the eQart Cockpit application.

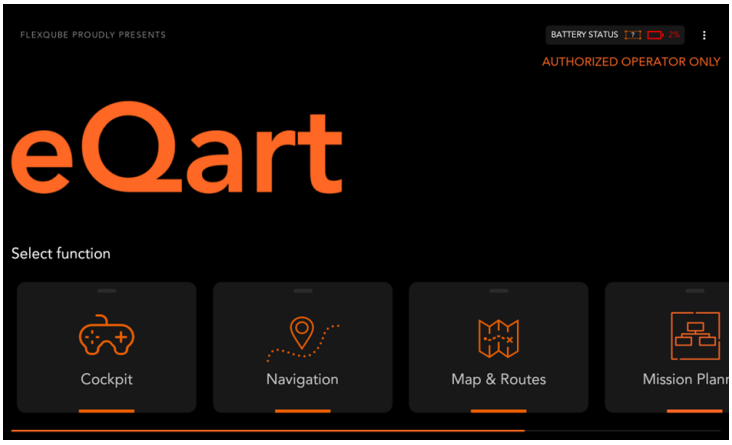


Figure 22 eQart Cockpit Main menu

2. Users can also change the language of the application. (English or German)

- When the eQart is not connected with wifi, the pop-up message shows that “You are not connected with eQart”.

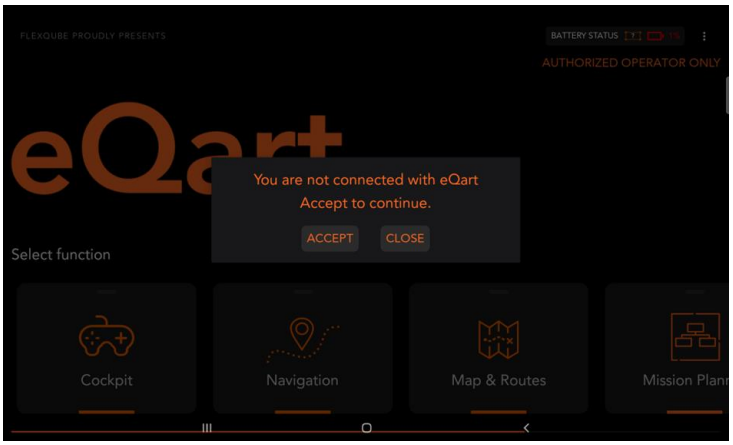


Figure 23 eQart Cockpit “Not connected” message

- In case, when the eQart is connected with one tablet and another user tries to connect to that eQart by another tablet, then the pop-up message will appear that “eQart is connected with another tablet”.

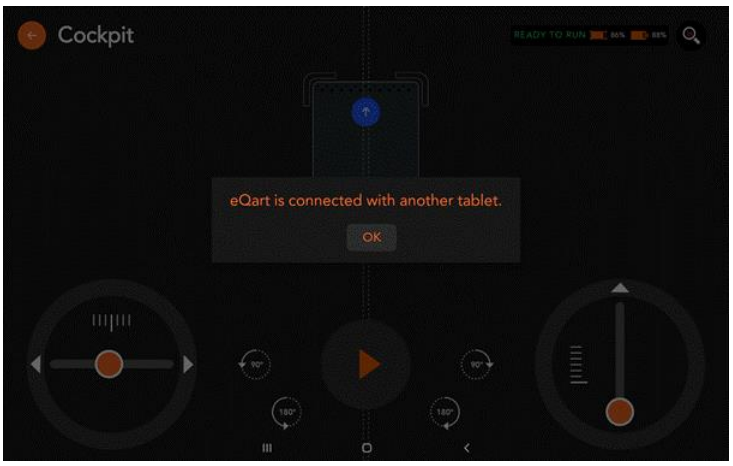


Figure 24 eQart Cockpit “connected with another tablet” message

There are five main functions in the eQart Cockpit located in the Main Menu:

1. **Cockpit**
2. **Navigation**
3. **Mapping**
4. **Mission Planner**
5. **Settings**

10.1 Cockpit

In the Cockpit mode, users can reach most of the functionality needed to use the eQart in daily operation.

Brain version 1.0

- If an obstacle is detected by the Laser scanners or an Emergency Stop is applied, then the pop-up message “Remove obstacles/Release eStop” will be displayed.
- The user must remove obstacles, if any, and check that the emergency Stop is not pressed.
- The error message can be removed by clicking on the pop-up message.
- If the object detected is not properly removed, the pop up will continue to appear.

Brain version 2.0 & 3.0

- If an obstacle is detected by a Laser scanner, then the pop-up message “Obstacles in eQart's Protection zone” will be displayed.
- Brain version 2.0 & 3.0 automatically resets the safety when the Laser scanners detects that the obstacle is removed. Then the pop-up message will be removed from the Cockpit.
- The brake is auto released in Brain version 2.0 & 3.0 so once the obstacle is removed from the warning or protection zone, the pop-up message is also removed.
- If the Emergency stop is applied, then “eSTOP was pressed, release eSTOP” will be displayed.

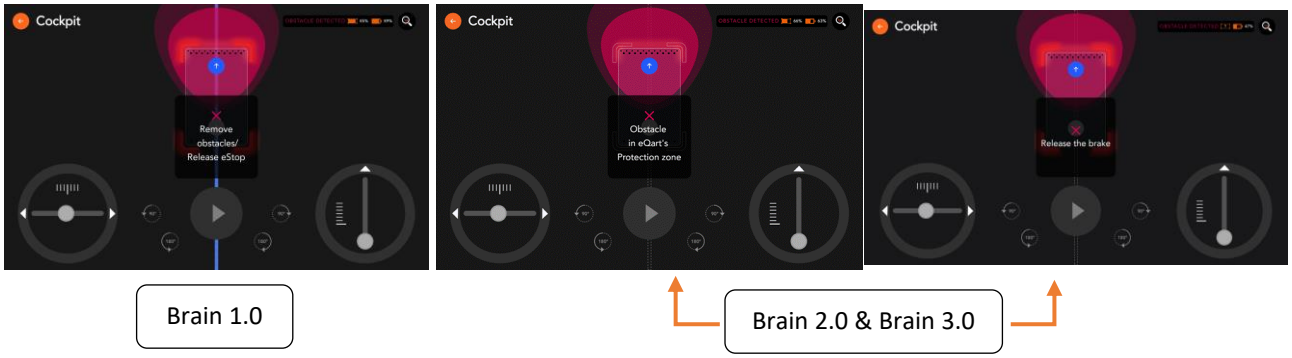


Figure 25 Warning Pop-up Message

10.1.1 Manual Drive

ATTENTION The user should never be more than 2 meters away from the eQart during the manual drive.

ATTENTION The user is always responsible of the eQart when driving in manual mode to avoid any collisions.

The eQart can drive manually controlled by the user in the eQart Cockpit.

1. The eQart can run with top speed of 0.7 m/s in line follow as well as manual mode with HW 2.0.
2. The eQart can run with top speed of 1 m/s in line follow as well as manual mode with HW 3.0.
3. eQart can turn left and right at various angles and speeds controlled by the left control slider.
4. Rotate the eQart by 90 or 180 degrees to the right or left around its center axis.
5. Orange light indication of LED in Driving direction.
6. The eQart will stop with Red light indication from the LED corner modules and a warning pop-up message in the cockpit if any obstacle is found.
7. The battery status is indicated in the Cockpit's top right showing the battery percentage of the eQart in the left battery indicator. The tablets battery life is indicated in the right battery indicator. The eQart status shows the name of the eQart that is connected with the tablet.
8. The connected eQart can be identified by pressing the “Find eQart” button which is on the top-right corner, the eQart will indicate by blinking purple on the LED corner modules.
9. If the eQart drives over a line on the ground in manual mode the blue line will light up and a pop up will appear in the eQart Cockpit, the eQart is then able to start line follow.
10. When the eQart travels through any station or stops at any station, the station name is shown on screen.
11. If a default map has been selected from a previously recorded map, the user has direct access to the navigation menu from the manual drive.
12. If the localized station in any existing mission, the user has direct access to the mission planner menu from the manual drive.
13. The application will be in sleep mode when the eQart is not moving.

14. Double-tap on the screen will wake up the tablet in case it has switched into hibernation.

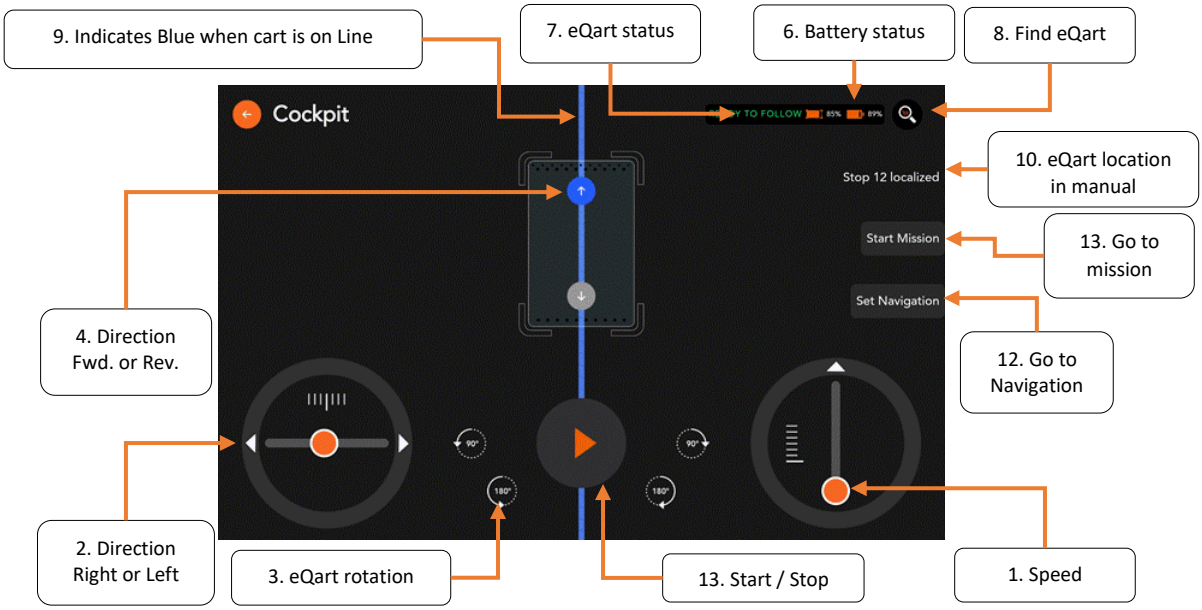


Figure 26 The eQart Cockpit Manual drive view

10.1.2 Line Follow

ATTENTION While operating in line follow mode the eQart will use its safety-rated laser scanners to avoid obstacles. But in a heavily trafficked forklift or pedestrian area, someone can move quickly into the safety zone and cause a collision if not paying attention.

The eQart can drive and navigate automatically in Line follow mode.

- The eQart can follow the line on the ground reading the contrast between the line color and the ground.
- As a standard, the eQart follows blue & red tape but this can be changed in the settings menu in the Cockpit. Blue line allows full speed and red is for slow down areas.
- By placing the eQart with its center on the line, the eQart will detect the line and the blue line will light up and a pop-up reading "Connected to the line" will appear in the eQart Cockpit, the eQart is then able to start line follow.
- The eQart has cameras in both driving directions. The camera detects the line with a computer vision system. The eQart will follow the line in its current driving direction.
- There are bright LED lights placed under the cameras at the bottom of the brain module to make lines visible to the eQart.
- Green lights will blink on the LED corner module in driving direction when the eQart follows the line.
- When the line is detected by the eQart, then that is shown on the screen. (see Figure 26 The eQart *Cockpit* Manual drive view)
- The function of the “Start/Stop” (13) button, shown as a play symbol is to start and stop the eQart in Line follow mode.
- By pressing the “Start/Stop” button, the eQart starts following the line in the direction indicated by the LEDs.

- The direction of the eQart is shown in the Cockpit by the lighted up LEDs in the eQart symbol indicating forward, this corresponds to the lit-up LEDs of the physical eQart.
- To drive in the opposite direction without turning, while standing still, press the down arrow on the eQart symbol. The interface will show the eQart turning 180 degrees and the eQart will switch direction by indicating the LEDs in the opposite direction.
- When driving on a straight main color line the full speed of the eQart is up to 0.7 m/s with HW 2.0 & 1 m/s with HW 3.0. At curves, the eQart will naturally slow down to handle navigation.
- When driving on a secondary color line, the eQart moves at a slowdown speed up to 0.3 m/s.
- Line follow does not work if the battery percentage is 10% or less.
- If any obstacle is found in the laser scanner's first warning zone, then the eQart slows down its speed while the object is in that zone.
- If the object enters the second warning zone the eQart will stop until the obstacle is removed, when the area is free the eQart will continue automatically.
- If any obstacle is found in the laser scanners protection zone, the eQart immediately stops, and a pop-up message appears in the eQart Cockpit. When the obstacle is removed the user needs to reset the eQart by closing the error message in the Cockpit.

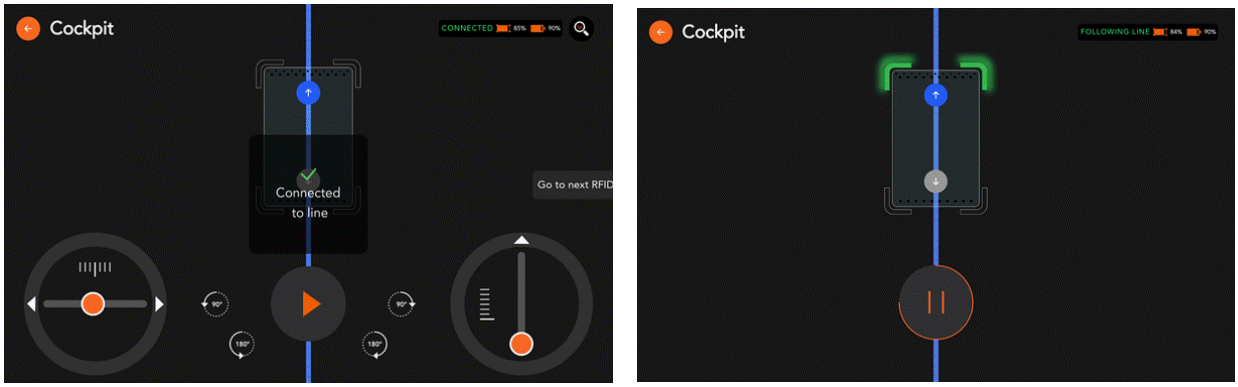


Figure 27 eQart Cockpit in Line Following Operation

10.2 Map & Routes

The eQart can record a map with all the routes to each of the stations mapped on the floor automatically. By using this map, the user can easily send the eQart to predefined stations around the factory.

- To record the map the eQart uses its electrical motor encoders to provide a signal to get the live location of the cart. The eQart tracks the movement by measuring how much distance it is traveling.
- In the eQart Cockpit, the user can see the current position of the eQart and the line it has recorded when it is creating the map.
- The eQart will record all straight paths, turns and junctions put down on the floor.
- When the eQart travels over an RFID tag, it automatically recognizes the RFID tag and creates a station in the map recording view.

10.2.1 Mapping guide

The Mapping guide gives instructions and guides how to create a robust and reliable tape layout.

1. **Apply tape and build route**

- The floor is dry and clean required for tape installation.
- When creating an intersection in the line always create a full junction to allow the eQart to access all 3 exits from all directions.
- The minimum corner radius should be 1.5 m.

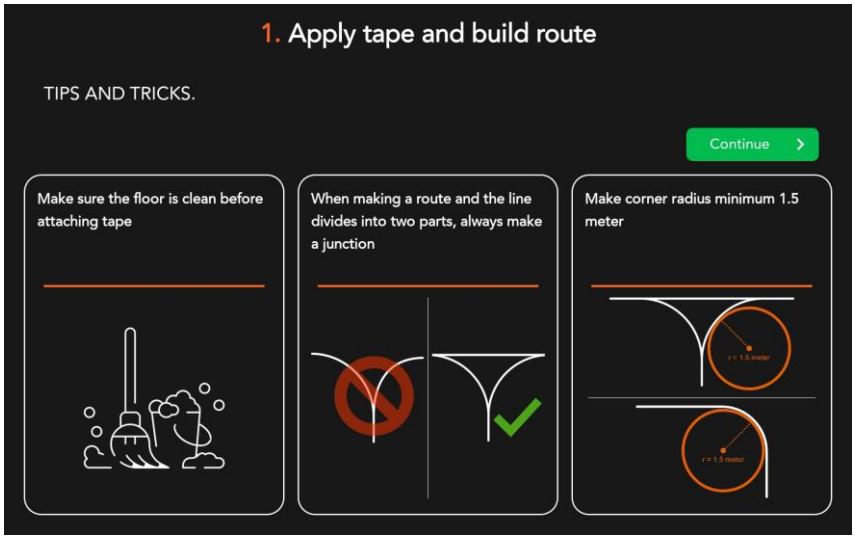


Figure 28 Step 1 in the mapping guide

2. Place tags

- The RFID tag is placed at all the positions where the eQart will make a stop as well as on all the endpoints in the layout.
- The RFID tag placed under approx. 600 mm of station color tape. The default setting station color tape is red and the main color is blue.
- For a circular path, there must be at least one RFID tag in the closed loop.

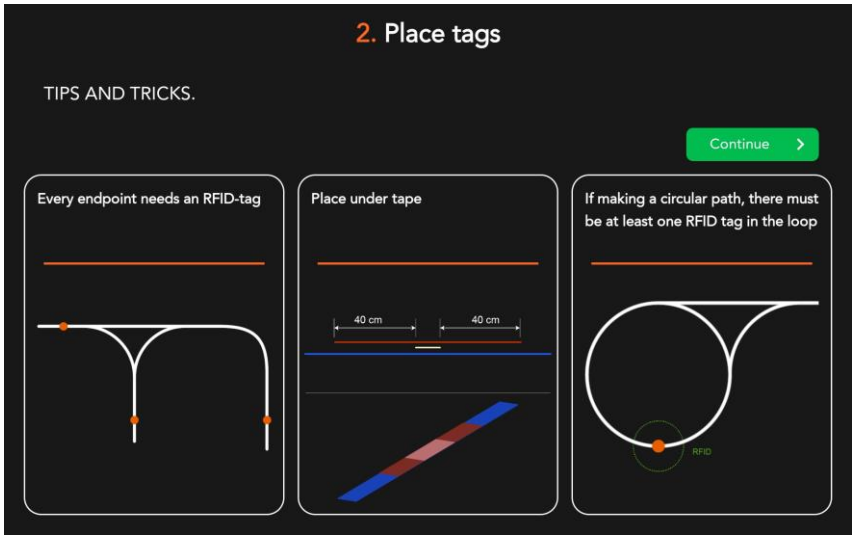


Figure 29 Step 2 in the mapping guide

3. Simple or Circular map

- There are two types of paths, a simple path, and a circular path, that the user picks to record the map.
- Simple path means there is not any closed loop in path.
- Circular path means there is one closed loop in path. There is a limit to max 1 loop in a recorded map layout.

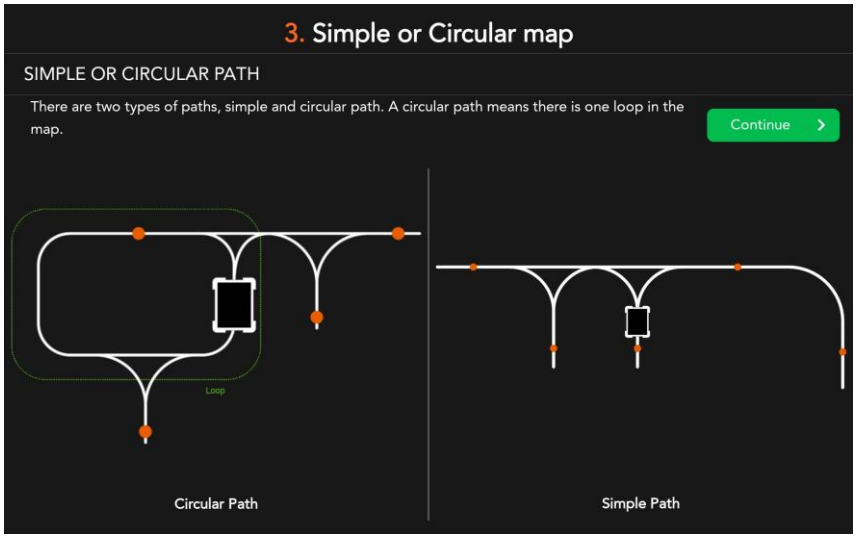


Figure 30 Step 3 in the mapping guide

4. Where to start recording

- Circular map: Always start recording the map facing a station in the loop.
- Simple map: Always start the recording facing one of the end stations.

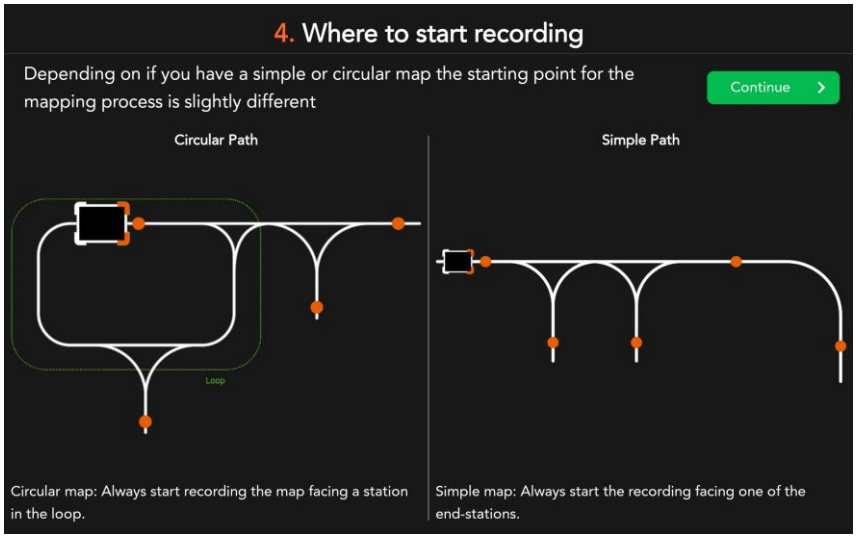


Figure 31 Step 4 in the mapping guide

5. Place the eQart

- Drive the eQart and place in line in front of the RFID tag.

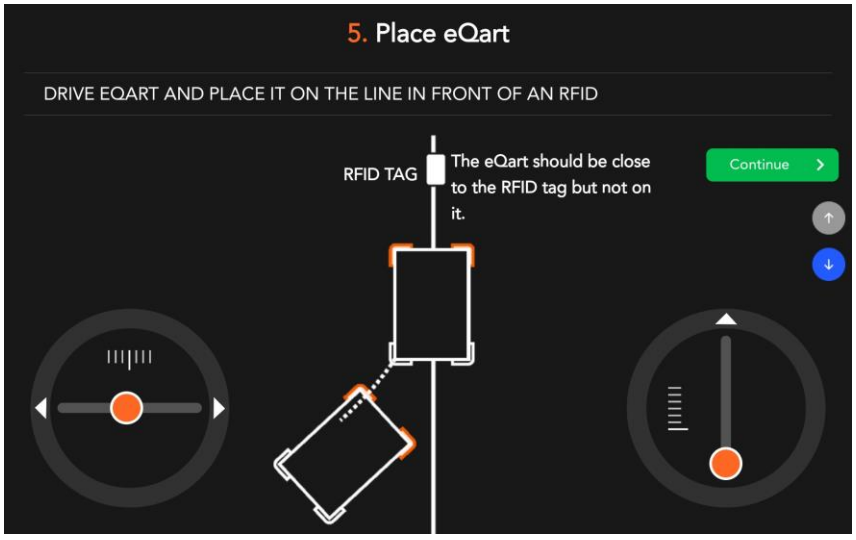


Figure 32 Step 5 in the mapping guide

6. Direction

- Make sure that the eQart LEDs are flashing Orange towards the RFID tag.

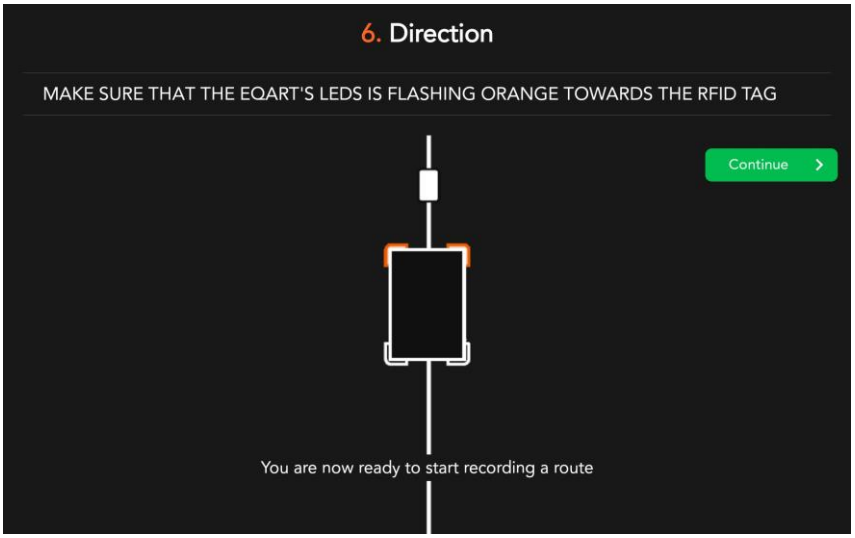


Figure 33 Step 5 in the mapping guide

10.2.2 Create a new route

ATTENTION When the eQart records a map it cannot be interrupted or notice any mistakes as it will require the eQart to restart the mapping from the start.

When creating a new map at a new location, the user first must create the map inside the factory by placing all the lines and stations needed to create the full layout.

- Make sure that the floor and tape line is clean before creating a new route.
- Create the line layout with all the paths, corners, and junctions needed following the instructions on how to create an optimal layout.
- All the RFID tags must be placed at the predefined stations throughout the layout.
- For all corners or junctions, the radius of curvature must be 1,5 m or larger.
- The speed of the eQart for the recording map is 0.3 m/s.
- The secondary color lines should always be used on top of RFID stations with 300 mm of the secondary color line before and after the stations (total of 600 mm) for both stations on the line and end station.
- The eQart automatically identifies the station by reading an RFID tag on the station and puts it as a station on the map with the RFID tag name and then continues towards the next station.
- eQart always turns **LEFT** when it moves around the layout during mapping to find all paths, corners, and intersections.
- A typical floor map is shown in Figure 34 Map Route on Floor.

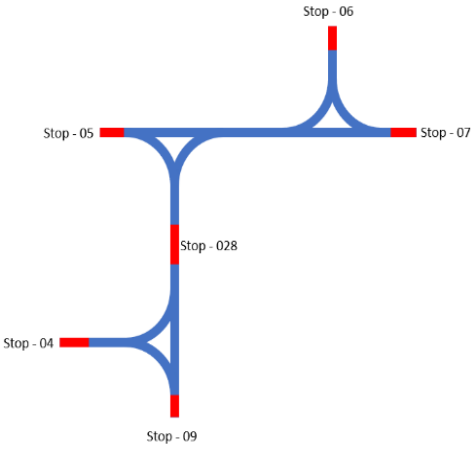


Figure 34 Map Route on Floor

To start the recording of a new map:

1. Go into the "Map & Routes" from the Cockpit Main menu.
2. Click on "+ Create new route"

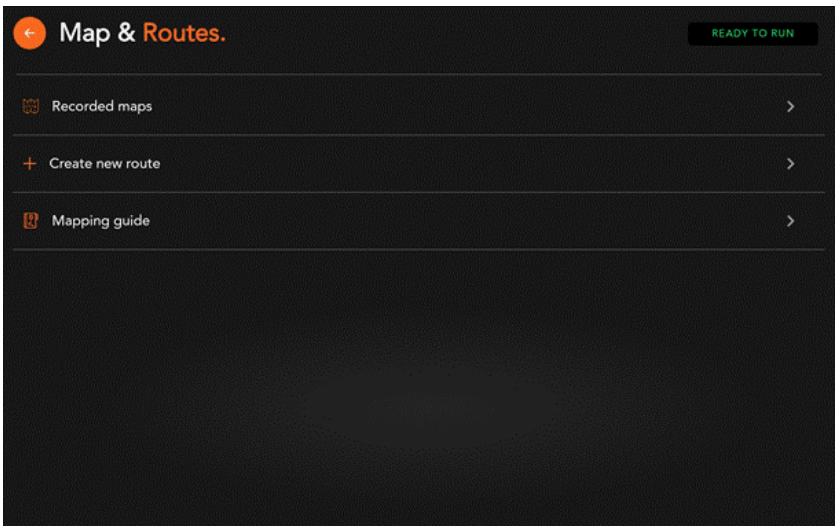


Figure 35 Map & Routes screen in the eQart Cockpit

Pick what type of map to record:

1. **Simple Path:** A simple path means that there is no closed loop in the path. Start recording a map from the end station placing the eQart center right before the RFID tag.
2. **Circular Path:** A circular path means there is One closed loop in the path. Start recording a map from a closed-loop inline station.

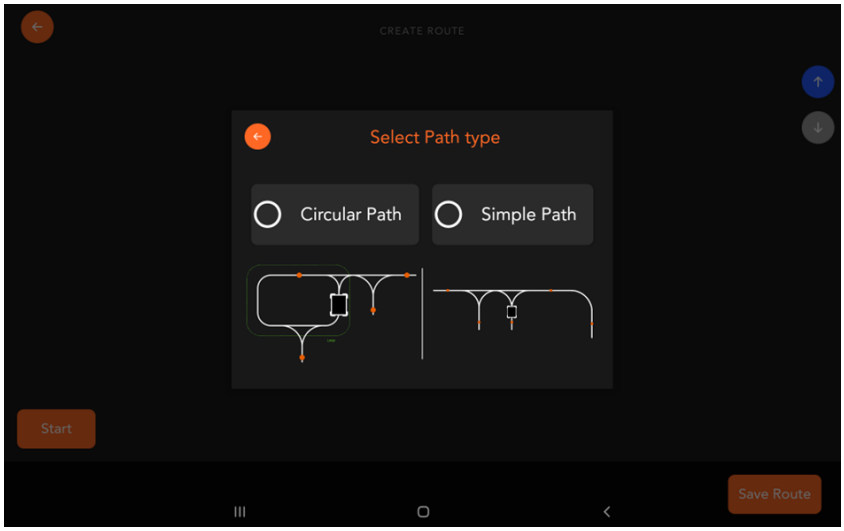


Figure 36 Select Path type screen in the eQart Cockpit

3. Press the start button to start the recording of the map layout. The live map generation is shown in the Cockpit.
4. When the eQart has recorded all the available paths and stations it will stop and mark itself as finished.
5. Now, press the save button to save the recorded map.
6. In "Map & Routes", the user can see the new map under "Recorded maps".
7. In the "Recorded maps" view the user can pick the recently recorded map and set it as the Standard map.
8. If the cart is on station and that station is on the map, then that station is selected as a source on the map.

Following is an example of how the eQart creates the map:

1. The eQart is located at **Stop - 04** and starts to create a map as shown in “Figure 37 Map Routing of eQart”.
2. When the eQart reaches at **Stop - 028**, the RFID tag installed under the line is detected. The eQart detects the location as **Stop – 028** as the RFID tag has been programmed. By using an integrated RFID reader on the eQart, it detects its position and saves the station name on the map.
3. The eQart continues its path recording and travels towards **Stop - 05** further down the line to the left.
4. The eQart does the same for all stations and generates the map.

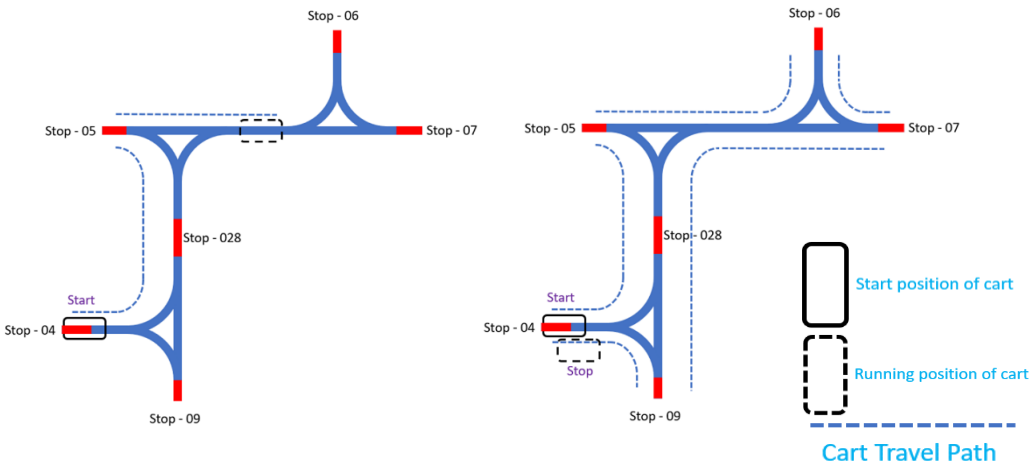


Figure 37 Map Routing of eQart

10.2.3 Recorded maps

- The saved maps are shown in the Recorded maps page in the eQart Cockpit.
- Users can delete these maps from the options menu.
- Users need to log in from the Settings menu with unique mail id and password to access the “Download maps” feature.
- Users can share these maps with different users.
- The recorded map is stored in the eQart Cockpit. It can also be uploaded to cloud storage using share functionality between different eQart.

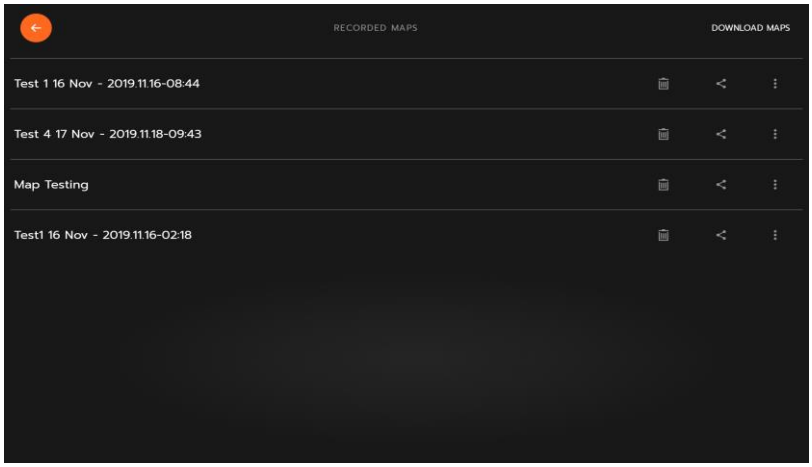


Figure 38 Recorded maps view

- All uploaded maps can be downloaded by selecting the Download Maps function.
- To edit the station's name, go to the "Edit" function from recorded maps.
- In the edit menu, the navigation direction can be selected as the “Clockwise” or “Counterclockwise” direction. This changes how the eQart decides to take turns in the mapped layout.
- Zoom and PAN functions are available in recorded maps.

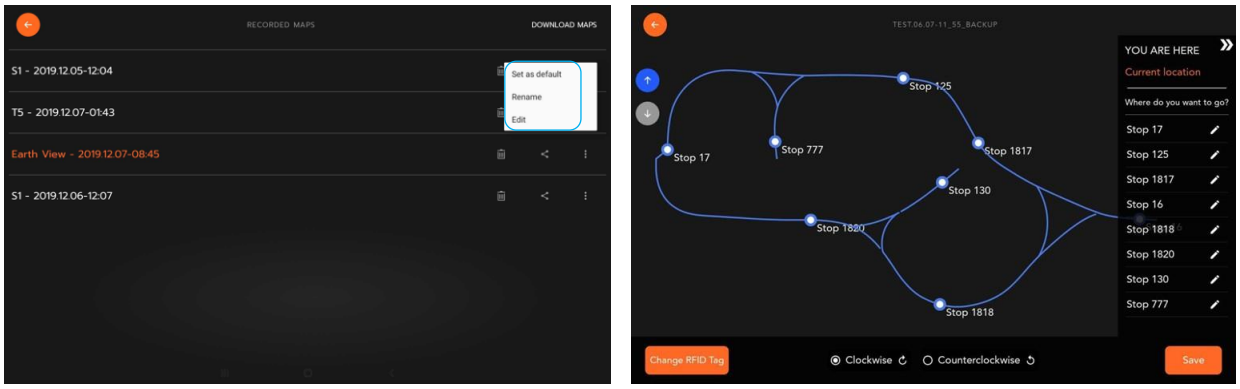


Figure 39 Recorded Maps

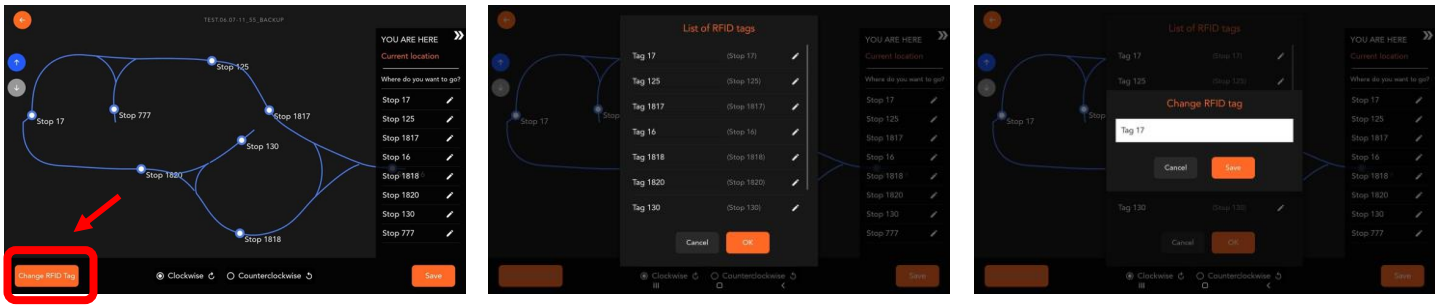


Figure 40 How to change the RFID tag

- If the RFID tag is lost, user can update with new RFID station by clicking **"Change RFID Tag".**
- Users can select one map as default which is then shown in the navigation menu.
- The map of the last example is shown "in Figure 41 Shortest route for the eQart between selected *stations*".
- For navigation, the User should select the stations. The application will select the shortest route and highlight the travel path on the map.
- If the cart is at **Stop – 126** and user select destination as **Stop – 125**, the eQart finds the shortest route. After pressing the start button the eQart starts to travel towards **Stop – 125**.

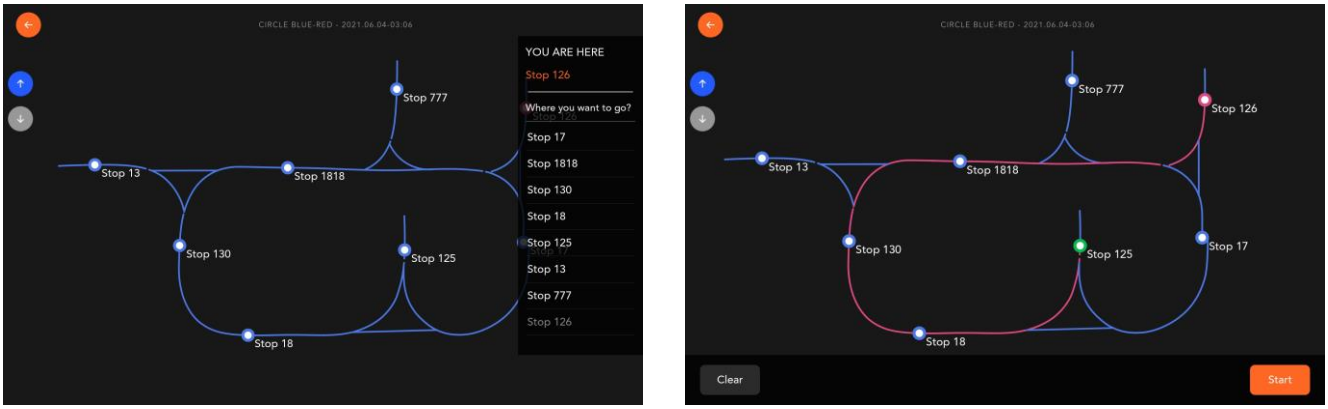


Figure 41 Shortest route for the eQart between selected stations.

10.3 Mission Planner

The eQart Mission Planner is used to program a series of task that will be performed by the eQart automatically without or with reduced operator interaction. This allows the users to program a custom mission that is adopted to a specific process. The eQart can navigate between a series of stations without any operator input as well as wait at a station for a fixed amount of time, wait for operator confirmation and looping the mission.

10.3.1 Create new Mission

To create a new mission, follow these steps:

1. Go into the "Mission Planner" from the Cockpit Main menu.
2. Create a new mission by pressing "+ Create New Mission".

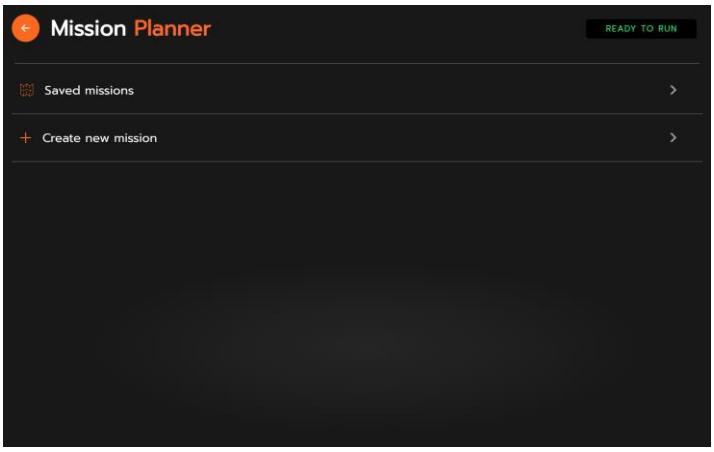


Figure 42 Mission planner start screen.

3. Pick a map that has been recorded previously to connect it to the mission. This map will be used in the mission planner.

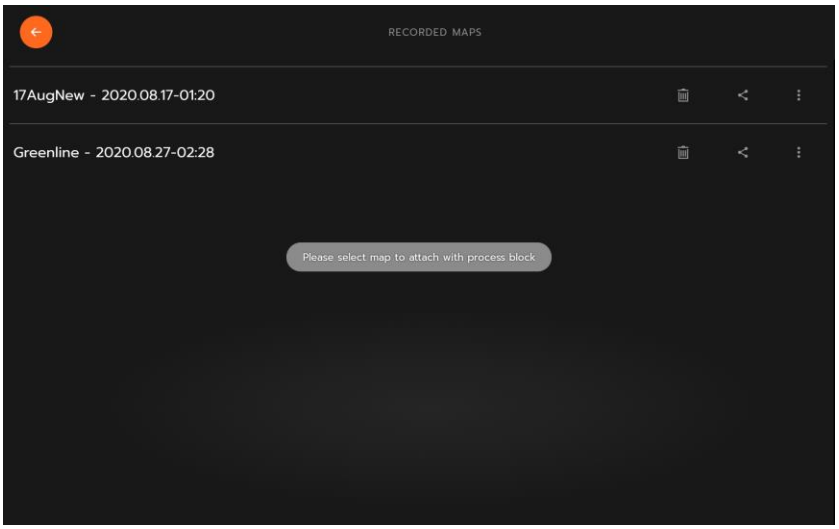


Figure 43 Mission planner, Attach a recorded map.

4. In the "Mission Planner" page the user is able to program a series of task by dragging and dropping the function blocks on the right-hand side into the mission sequence.

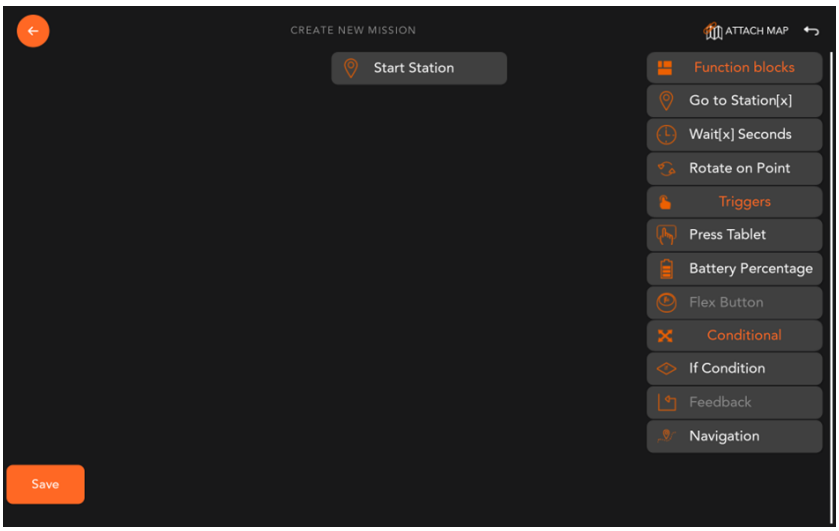


Figure 44 Mission planner programming view.

5. The first step is to pick which of the RFID-Station should be the "Start station", this is done by pressing Start station block and select the station.

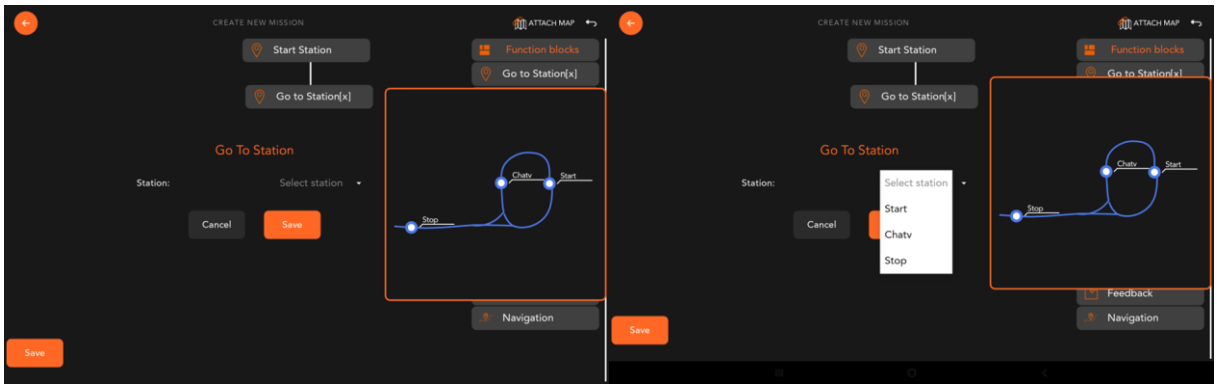


Figure 45 Mission planner adding "Start station".

6. The Mission planner sequence is following a flowchart type of architecture to present the mission representing the user process. The "Mission planner" have three categories of blocks:
   - Function blocks
   - Triggers blocks
   - Conditional blocks

Function blocks:

- **Go to Station (x)**
  The "Go to station (x)" block is used to tell the eQart to navigate to a RFID-Station on the map. After dragging and dropping the block into the mission flowchart in the center, press the block and select any of the stations except the source station.
  During select the station in block, the mini map window opens which helps user to select the desired station. By using the "**change path**" for close loop map, user can select the desired path.

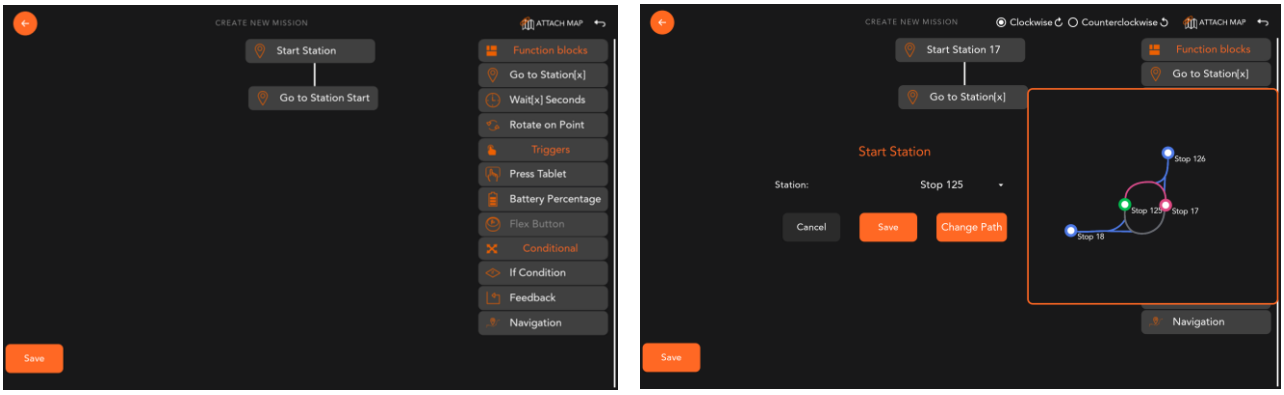


Figure 46 Mission planner, adding "Go to station".

- **Wait (x) seconds**
  The "Wait (x) seconds" block is used to tell the eQart to stay at a station, this can be used if the process requires a fixed amount of time for loading or unloading. After dropping the block into the flowchart, press the block to specify the time to wait in seconds.

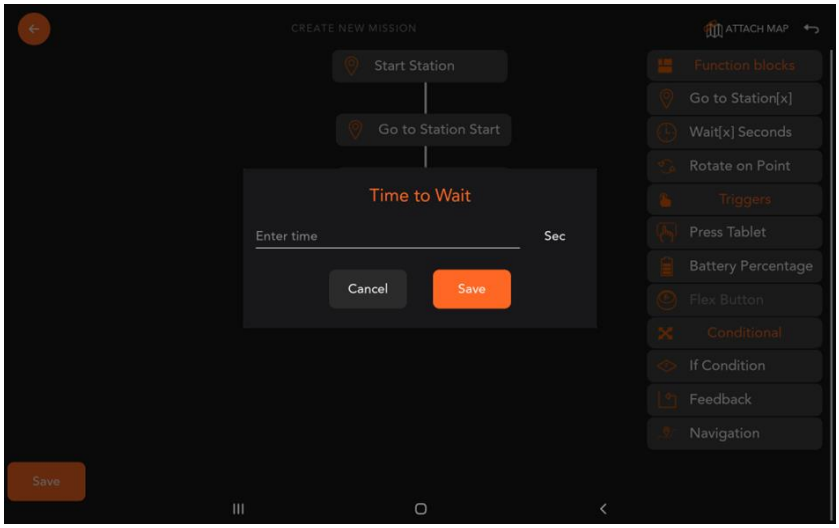


Figure 47 Mission planner, adding "Wait(x) seconds".

- **Rotate on Point**
  With "Rotate on point" the eQart will be turning around its own axis on point. Dragging the block into the flowchart and pressing the block to decide what type of rotation the eQart will perform. The change direction allows the eQart to either return backwards or if activated continue straight after the rotation. For more details, refer the bottom table which showing the final condition of cart after completion of the block.

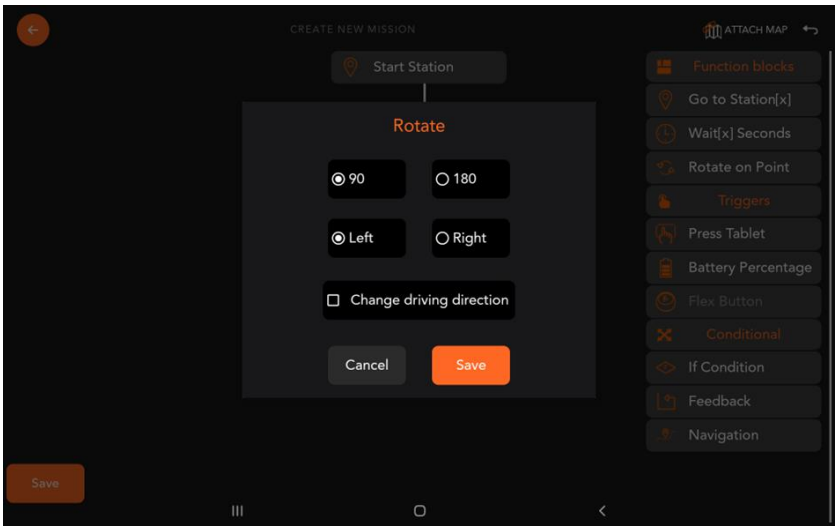


Figure 48 Mission planner, adding "Rotate on point".

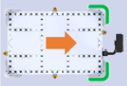
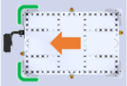
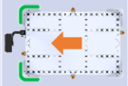
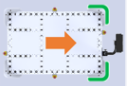
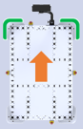
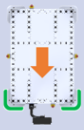
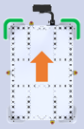
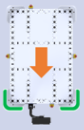
90	✓	✓	✓	✓	×	×	×	×
180	×	×	×	×	✓	✓	✓	✓
Left	✓	✓	×	×	✓	✓	×	×
Right	×	×	✓	✓	×	×	✓	✓
Change direction box	✓	×	✓	×	✓	×	✓	×
Start condition 	Final condition 	Final condition 	Final condition 	Final condition 	Final condition 	Final condition 	Final condition 	Final condition 

Figure 49 Final condition of the cart, after adding "Rotate on point".

Trigger blocks:

- **Press tablet**

The "Press tablet" block can be used to trigger a pop-up message on the tablet screen, this can be used to allow an operator to confirm when he has completed the task at that station. After confirming the trigger message, the eQart will continue with the mission.

- **Battery Percentage**

The "Battery percentage" block can be used in combination with the "If Condition" to decide to go to a station when battery level is low. After adding this block, define the battery level percentage that will trigger this block.

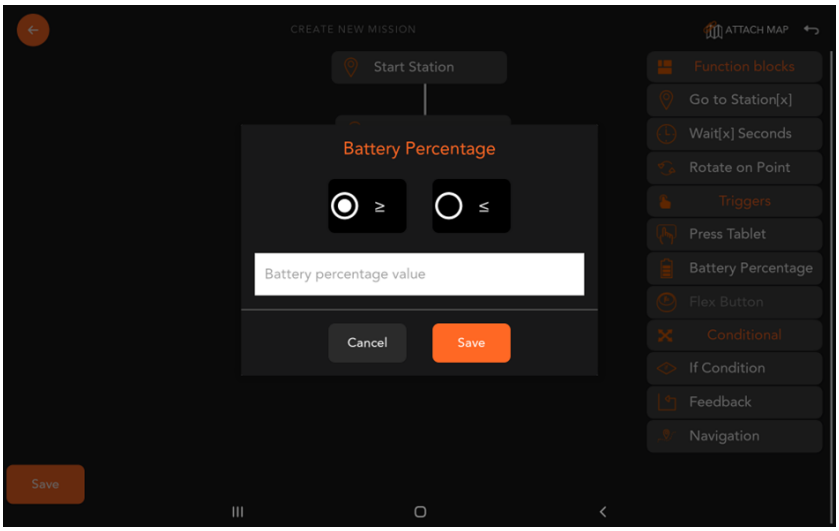


Figure 50 Mission planner, adding "Battery percentage".

- **Flex Button**

The "Flex button" block can be used as a physical replacement to the "Press tablet" where the user can press a physical Bluetooth button instead on the tablet. Pick any of the connected Flex buttons to trigger a request for the button to be pressed.

Conditional blocks:

- **If Condition**

With the "If Condition" the user can create a decision condition to allow the operator to pick between two different actions. When pressing the If Condition, a rhomb is created in the flowchart, then pick two different blocks and place on either side like below to create a decision tree. When using the mission, the Cockpit will display a pop-up message on the screen for the operator to pick.

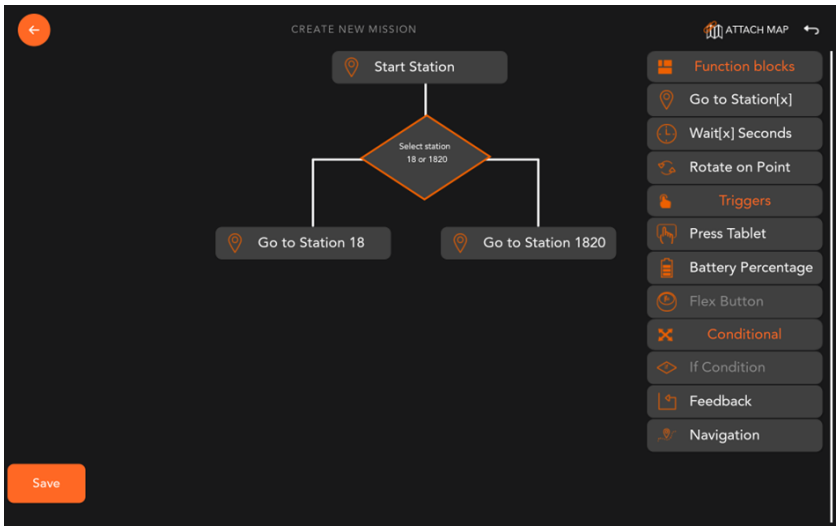


Figure 51 Mission planner, adding "IF condition".

- **Merge block**

By clicking on the block attached with IF condition tree, merge option show where user can merge the two blocks. After clicking merge, select the another function block.

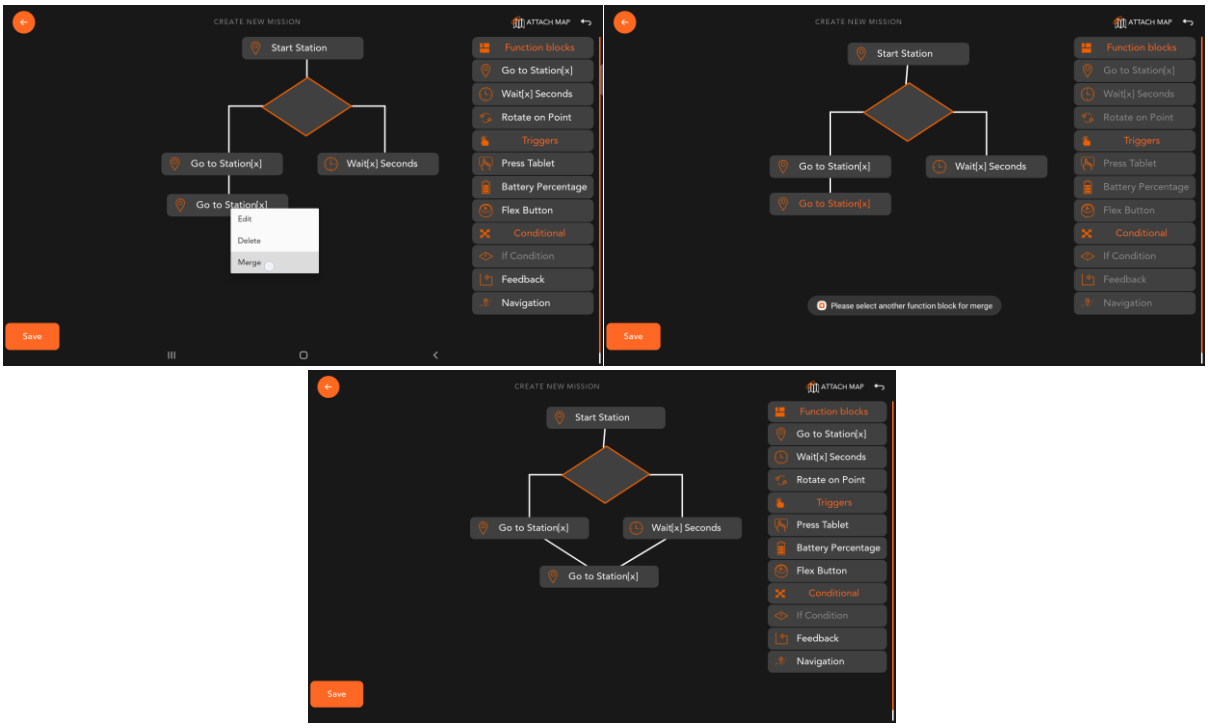


Figure 52 Mission planner, "merge block".

- **Feedback**

The "Feedback" block allows the user to create a loop in the mission to allow it to run continuously. This way the mission will be able to run all day until paused or interrupted. By pressing Feedback, the user will be prompted to first pick last block in the flowchart and then the second to specify to what block the loop should return to.

Figure 53 Mission planner, adding "Feedback".

By using a combination of these blocks, the user will be able to create any time of mission that is required for the user's process. When the mission is finalized, press "Save" and save the mission with appropriate name.

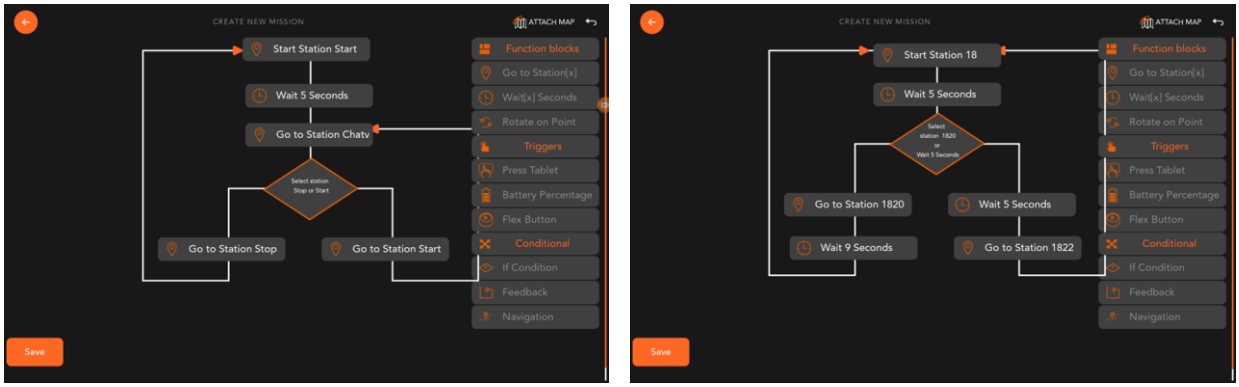


Figure 54 Mission planner, finalized mission.

- **Navigation**

The "Navigation" block allows the user to select a station from multiple stations available in the map. Working same as a "Go to station" block but user has multiple options available with this block. User can edit the navigation block to select the required stations for navigation block.

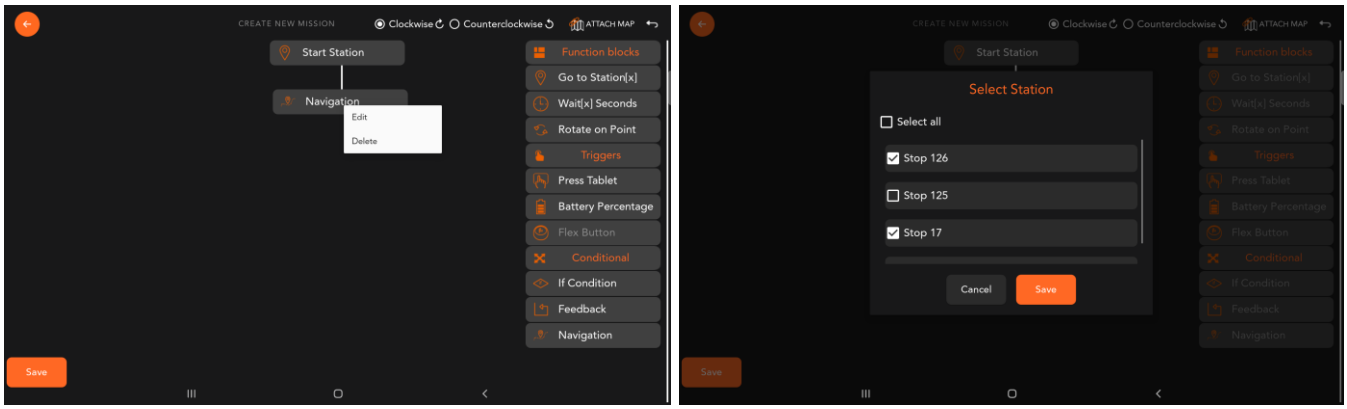


Figure 55 Mission planner, adding "Navigation".

10.3.2 Run Mission

ATTENTION The eQart must be located on top of the RFID tag on start station decided in the mission planner to be able to start the mission.

There are two ways to start a mission in the eQart cockpit:

1. By standing on top of a RFID-tag with the eQart inside the Cockpit menu, identified on the right-hand side in the interface, the "Start mission" button will appear. Pressing it will bring up the Mission menu.

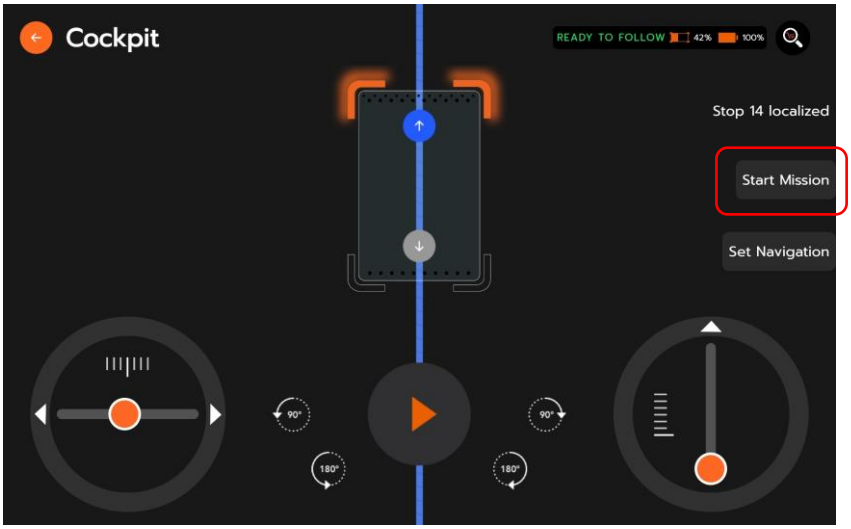


Figure 56 eQart Cockpit screen.

2. By pressing "Mission planner" in the main menu and then "Saved mission" will bring up the Mission menu.

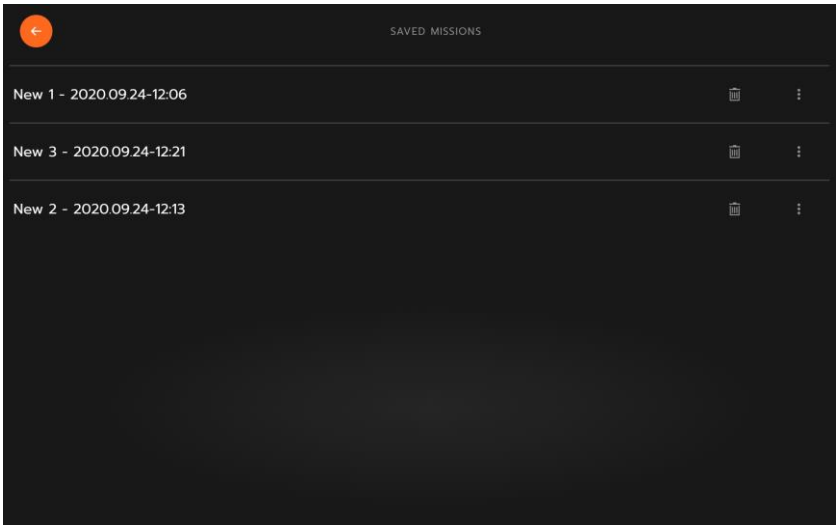


Figure 57 eQart Mission planner start screen.

3. In the Mission menu the user can press any of the saved missions which will bring up the mission view. If the eQart is located at the start station, the text will be marked in orange. By pressing "Start" the eQart will perform the mission as it was programmed.

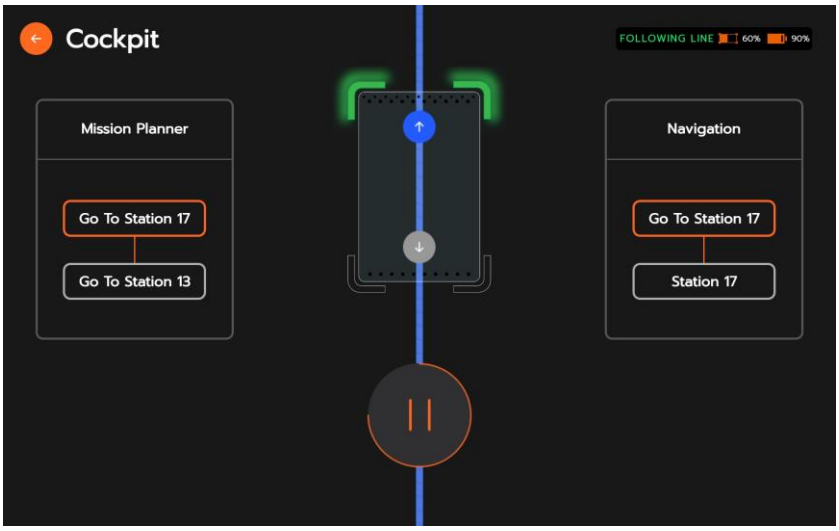


Figure 58 eQart Mission Planner view of a mission.

4. While running a mission the eQart Cockpit will display the mission sequence on the left-hand side simultaneously as the navigation sequence on the right-hand side. Below are some examples of the Cockpit screen while an eQart is running a mission.

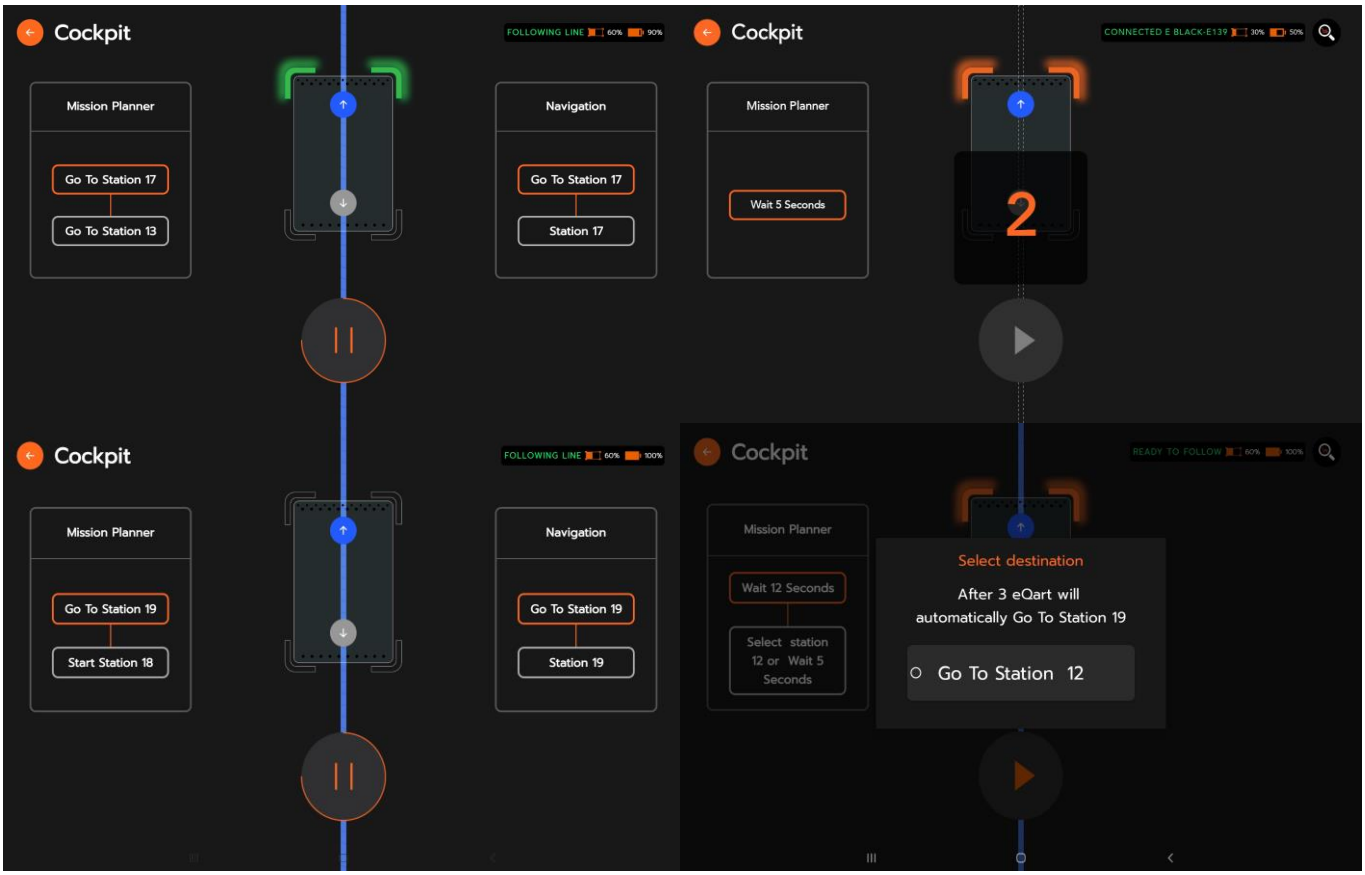


Figure 59 eQart Cockpit view while running the mission sequence.

10.4 Navigation

After recording the tape layout, the eQart will be able to use it to navigate autonomously using the recorded map. This way the eQart can travel between RFID-stations autonomously using line follow.

- First the user needs to select a Default map, this option is found pressing "Map & Routes" in the main menu, then "Recorded maps" which will show all the recorded maps. Pick the default map by pressing the three dots on the right side and pick "Set as default map",
- After selecting the default map, it will be highlighted with orange text.
- Select the path direction from the edit map.
- When the eQart has stopped on a station that has been recorded on the map, the eQart Cockpit shows the station as a source on the map.
- Users can select the destination station on the map and from the list.
- Before starting the navigation, make sure the eQart is oriented in the right direction by checking the blinking LED corner modules. The selected direction should match with the selected direction in the map.
- After selecting the destination station, press the start button.
- The eQart starts from the source station and navigates to the selected destination by following the line on the floor.

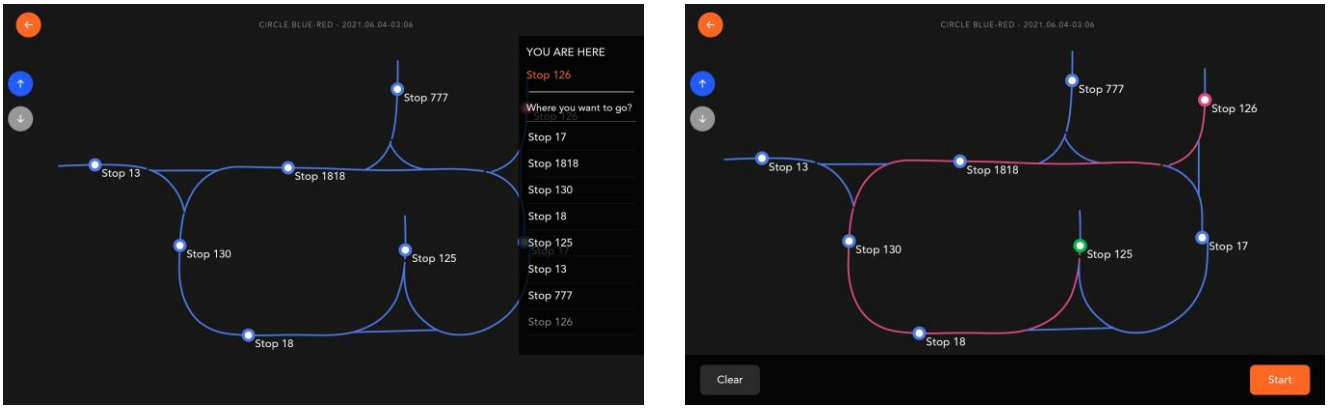


Figure 60 eQart Cockpit Navigation Function

10.5 Settings

In the Settings menu, the user can access the settings for both the eQart and the Cockpit.

There are three tabs in Settings:

- General
- Configuration
- Diagnosis

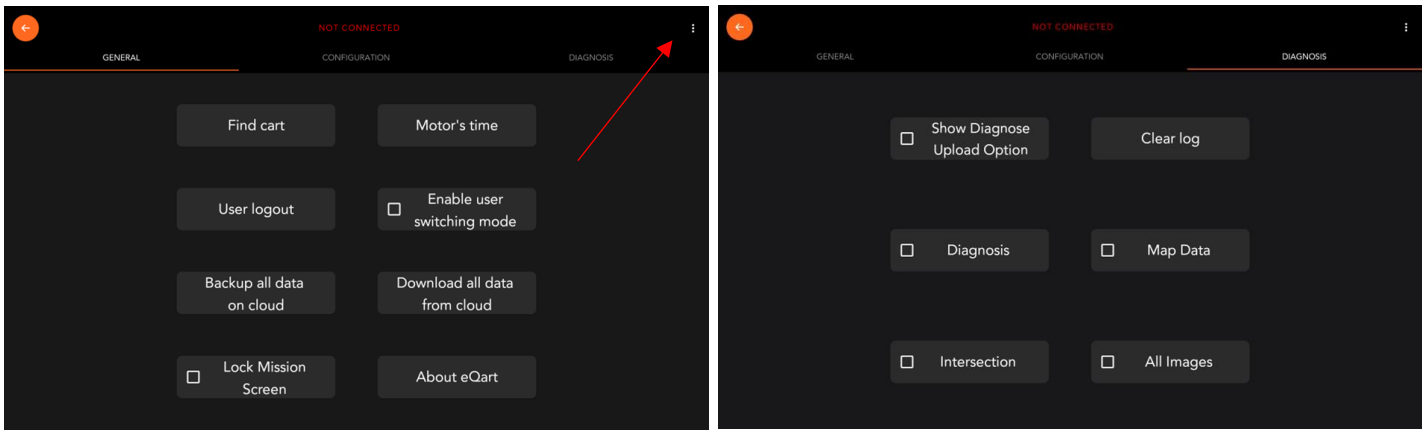


Figure 61 eQart Settings – General.

Updating the Cockpit application and eQart Firmware

- In the top right corner of the settings menu there are three vertical dots, click on it to get the option to “Update App”
- To Update the App the tablet needs to have an internet connection using either the 4G connection or local WIFI.
- Click on Update App to download and install the latest firmware for the eQart automatically.

10.5.1 Settings > General

Find eQart

Purpose of "Find eQart" is to identify the connected eQart for specific Cockpit, when the user clicks on the "Find eQart" button, the buzzer sounds on the connected eQart and LED modules blinks with purple light.

Motor's time

In the "Motor´s time" view the Cockpit will display the total running time of the electric motors of the eQart.

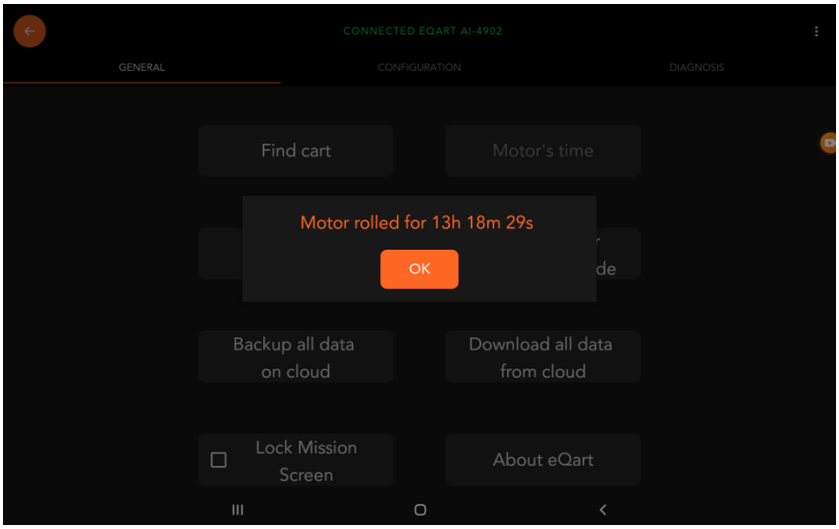


Figure 62 eQart Motor modules drive time.

User login

Users can log in to the cloud account. This will be used for sharing the maps or downloading the app and for the assign eQart function. User login is necessary so that map can be shared with authorized users only.

This action requires that the eQart Cockpit is connected to the internet.

Note It is not mandatory to login to use the eQart.

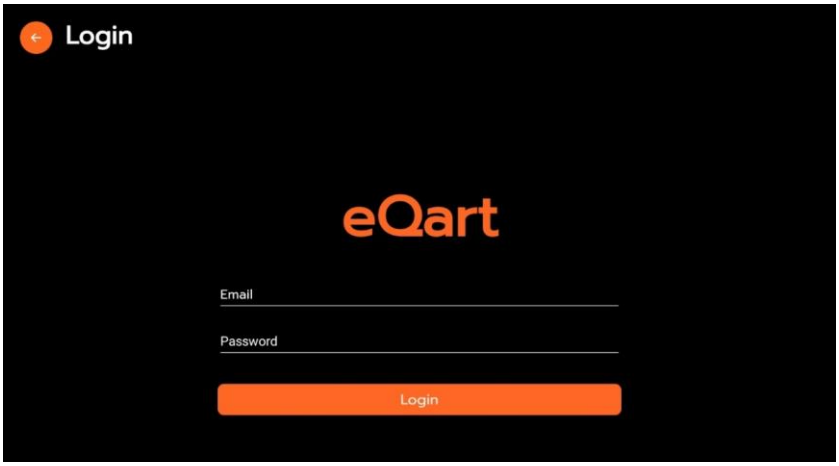


Figure 63 eQart Cloud login screen.

Back up all data on cloud

User can store their map and mission at cloud by clicking on this button. The log in must require for this.

Download all data from cloud

User can store their map and mission at cloud by clicking on this button. The log in must require for this.

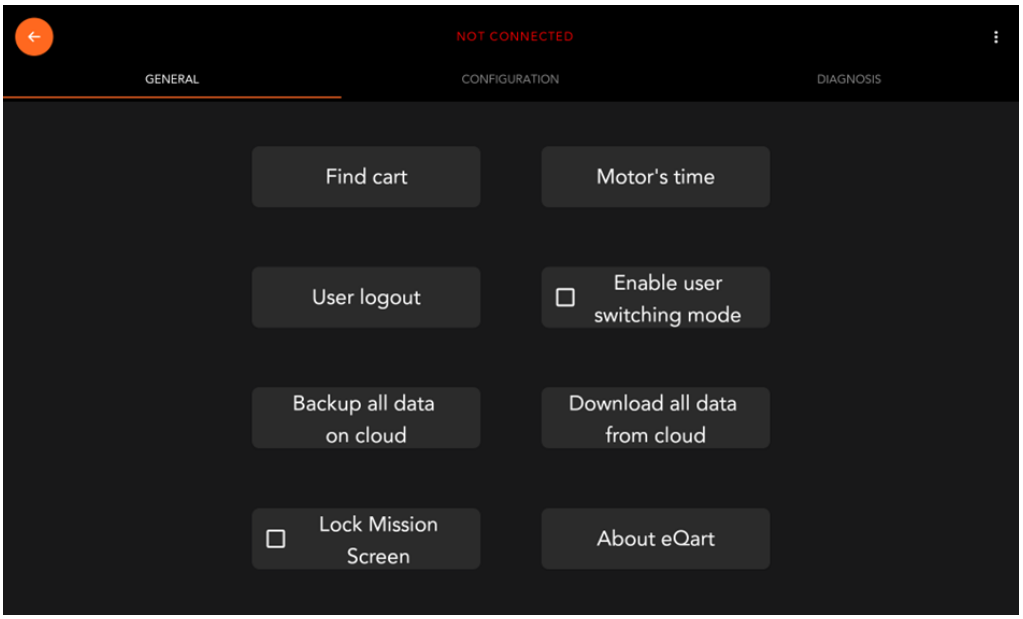


Figure 64 eQart settings – Back up and download data from cloud.

Lock Mission Screen

By checking the box, it enables the password protection for the running mission. By entering the correct password, user can exit the mission screen.

By clicking on the lock button, user can change the password.

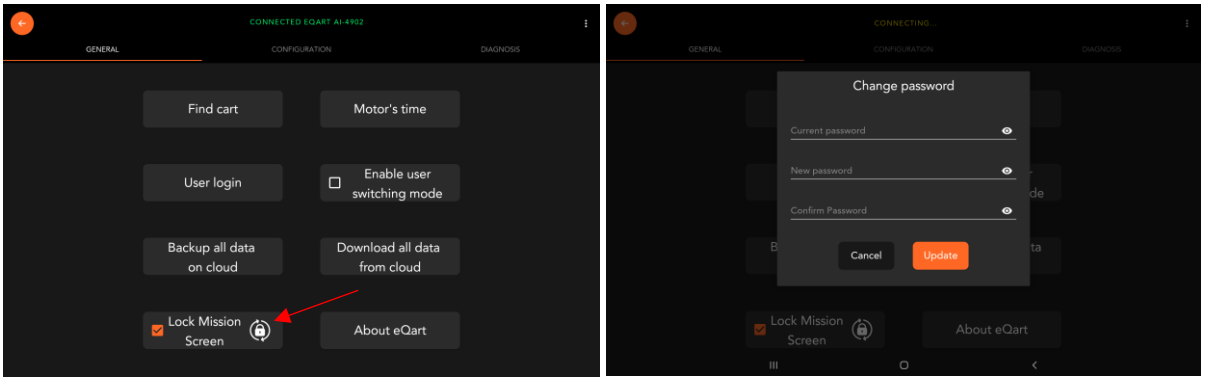


Figure 65 eQart settings – lock mission screen.

About eQart

The “About eQart” view will display the current version of the Android application, eQart Firmware, and Hardware version.

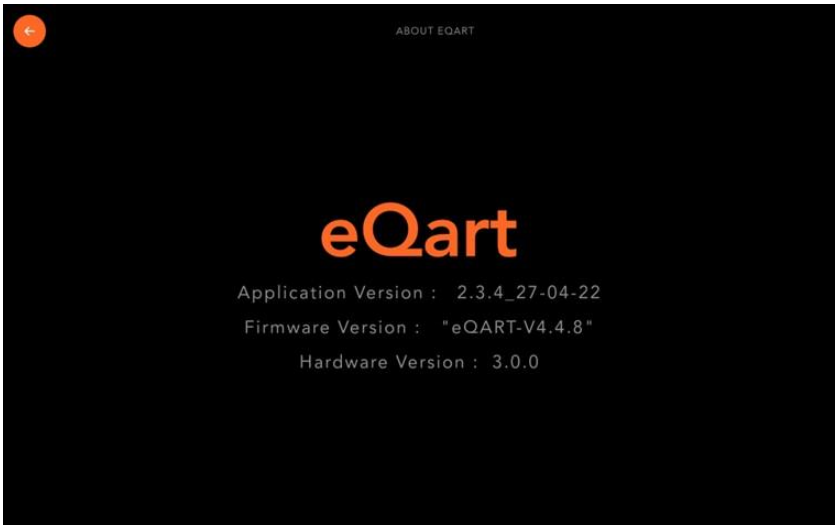


Figure 66 eQart settings - About eQart screen.

10.5.2 Settings > Configuration

The “Configuration” settings are mainly used while setting up the eQart for the first time or to change any settings related to the configuration of the eQart.

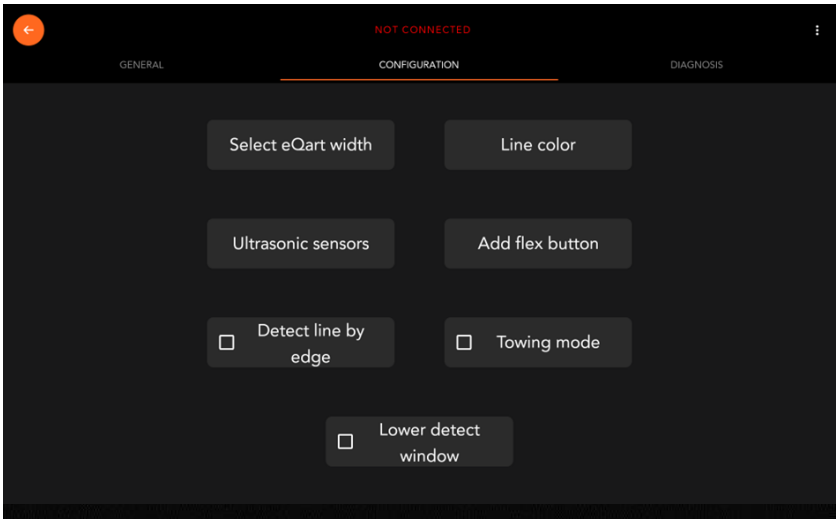


Figure 67 eQart settings - Configuration.

Select eQart size

During eQart´s first set-up, it is necessary to select the eQart size. Since the eQart has a modular design some of its functions like map recording, 90 and 180-degrees rotation, line follow, etc. are dependent on the eQart size.

- Pick the width specified in the eQart product documentation or measure it manually.

- The width is specified in the eQart product documentation or by measuring it manually.
- **Note** This is only required for the initial start-up of the eQart.

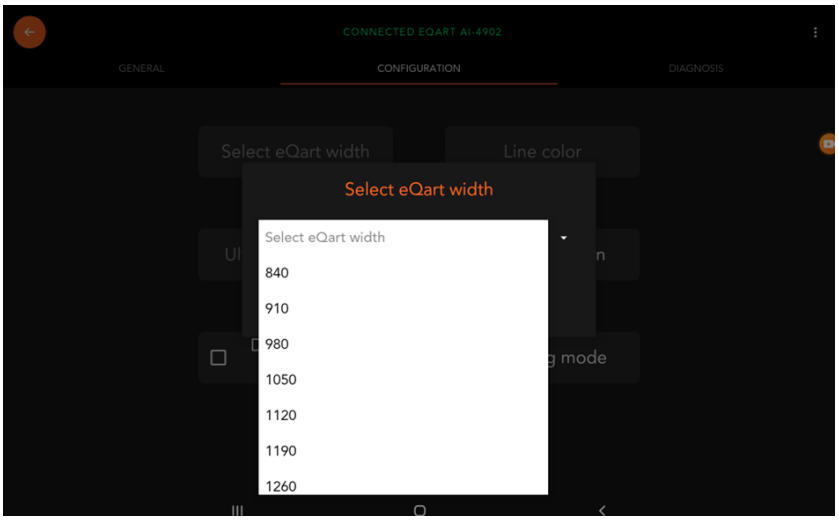


Figure 68 eQart settings – Select eQart size.

Line color

To ensure that the eQart line follow functionality is robust, the user can customize the line colors to Increase contrast between the line and the floor.

- In the "Line color setting," the user can select the "Main line color" and the secondary "Station Line Color (RFID)".
- “Main line color” is the line color used for the main lines in path indicating a full speed area, allowing speeds up to 0.7 m/s with HW 2.0 and up to 1 m/s with HW 3.0.
- The “Station Line Color (RFID)” is the color used over RFID tags and in slow down areas. On the Station Line Color, the eQart slows down to 0.3 m/s.
- The user must select different colors for the main and station line type.

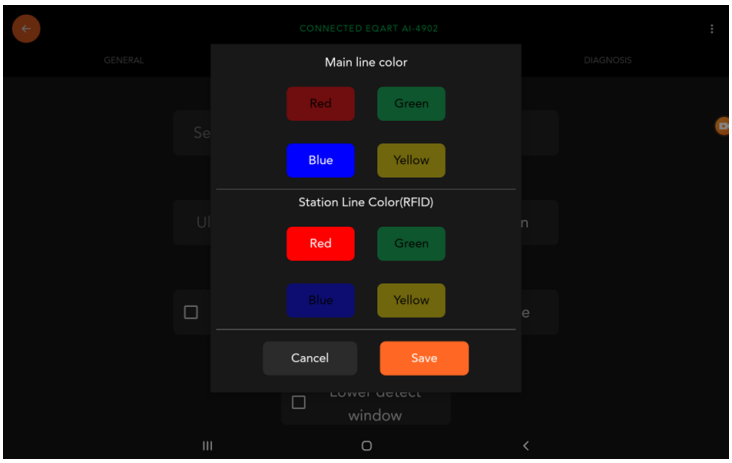


Figure 69 eQart settings – Line color.

Ultrasonic sensors

The Ultrasonic sensors are an optional custom feature of the eQart. Users can opt for the extra Ultrasonic sensors option. The laser sensor can only detect objects in a single plane at a height of 160mm. For the users where the objects can be higher than this plane, the laser sensor cannot detect them.

With additional ultrasonic sensors mounted and it will detect objects of various heights depending on the angle of the sensors. The ultrasonic sensor range can detect objects in a 3D view in front of itself in ranges from 400mm to 1000mm. Pick the distance depending on the user case to decide how long from an object the eQart will stop.

With the eQart typically two sensors are aimed to the front and two to the back. depending on the driving direction the two sensors in the front or the back will be activated. Use "Activate all sensors" to make all four sensors to detect object at the same time. This will allow the user to place four sensors in one direction.

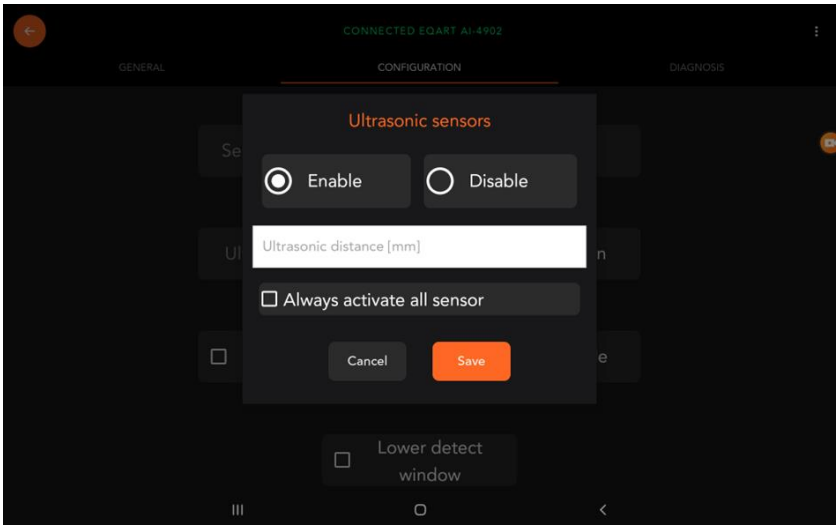


Figure 70 eQart settings – Ultrasonic sensors.

Add flex button

the Flex button is an external Bluetooth button that integrates with the eQart to be used to interact with the mission planner. The button connects to the eQart and can then be used as a physical trigger in a mission instead of interacting with the tablet in a process.

To sync the button press "Scan new flex button" then press and hold the Flex button until it is synced with the tablet. The Flex button can then be renamed to further clarify its function or position related to the process. The Flex button command can now be added in the Mission planner.

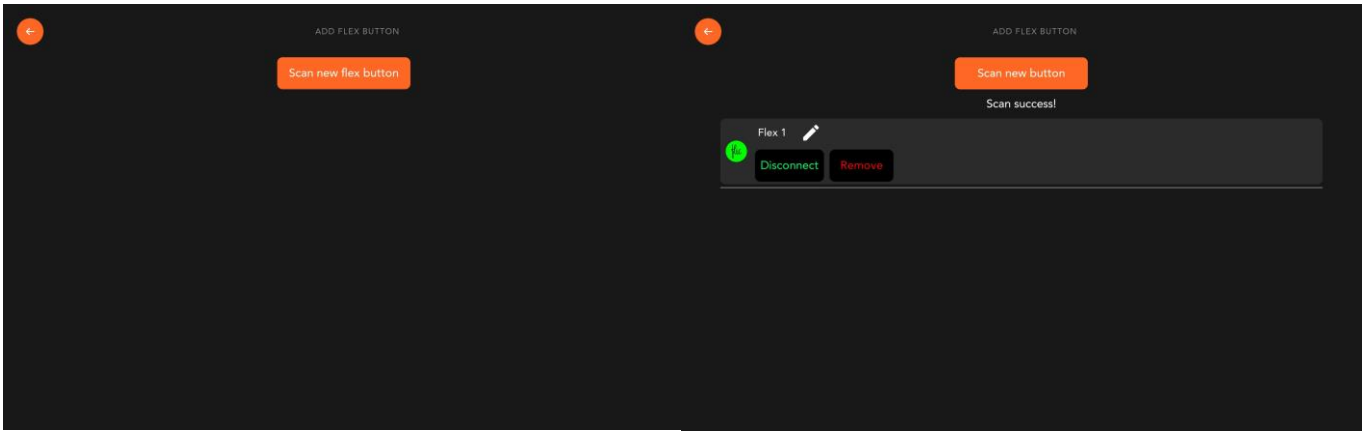


Figure 71 eQart settings – Add Flex Button.

Lower detect window

When the eQart faces light or color issue due to upper side of image, user can enable lower detect window. Now the eQart will use lower part of image for line following.

Detect line by edge

When this block is enabled, eQart will use the edges of tape for line detection during line follow. The eQart's logic internally switches the color detection and edge detection logic.

Towing mode

When towing mode is enabled and line follow operation start, the buzzer sounds and the LEDs blink PINK for 2 seconds then eQart will start line follow. During line follow, the LEDs will blink GREEN for 5 seconds (LEDs will blink Dark Magenta with **HW 3.0**) and then LEDs continue to blink as in normal line follow operation.

10.5.3 Settings > Diagnosis

Show Diagnose Upload Option
By checking this box, it enables the feature that the image upload option show while line end detection. But for this, ALL IMAGES DIAGNOSIS LOG MUST BE ENABLE.

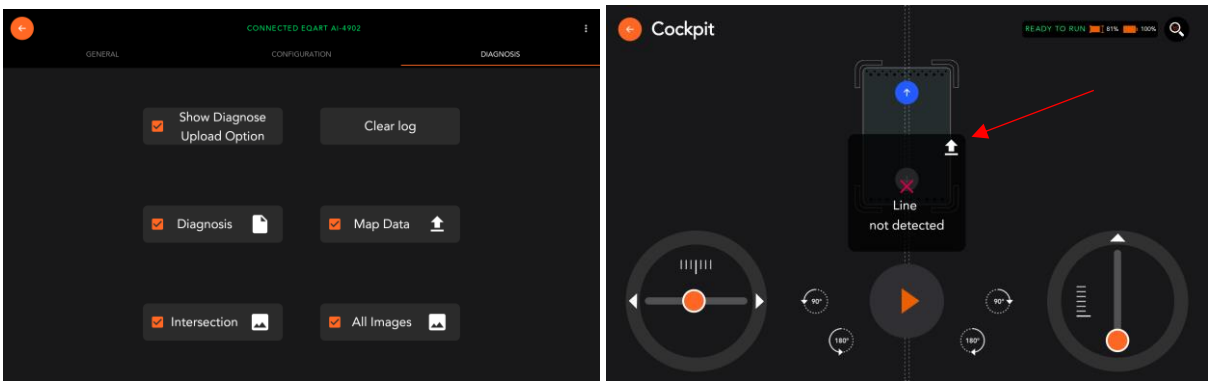


Figure 72 eQart settings – Diagnosis.

Clear log
By clicking this, all the diagnosis logs will be erased.

Diagnosis

- The Diagnose Mode is used to debug any faults or errors of the eQart.
- To start the eQart Line-follow Diagnosis you check the diagnosis box in the "Diagnosis" menu.
- When checked, go to the Cockpit menu, and start either Line-follow or Navigation to a station with the eQart.
- While in line follow mode, the eQart will create a Debug Log showing the selected line colors, detected obstacles in LIDAR warning-1 and warning-2 zones, pressed emergency brake, destination station in navigation, camera FPS, hardware failures, etc.

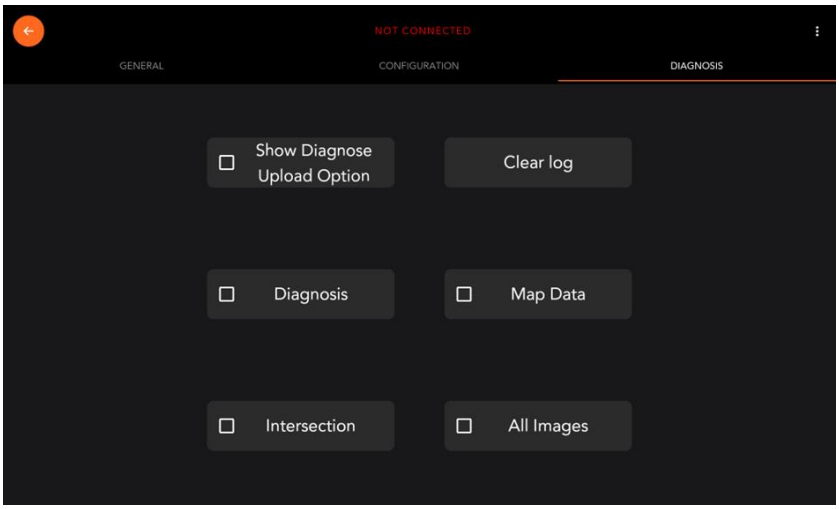


Figure 73 eQart settings – Diagnosis.

- **Note** The eQart will only create a Debug log for one line follow action after it is checked. If the eQart is put into line-follow mode a second time the Debug Log will be removed automatically.
- Access the debug log located in the "Diagnosis" menu immediately after the line follow the operation.
- Manual driving will not remove the Debug log created after the line follow operation.

- To check the Debug log, click on the file icon to the right of the "Diagnosis" button as shown below:
- The Debug log will present all the actions the eQart has recorded while in Diagnosis mode.

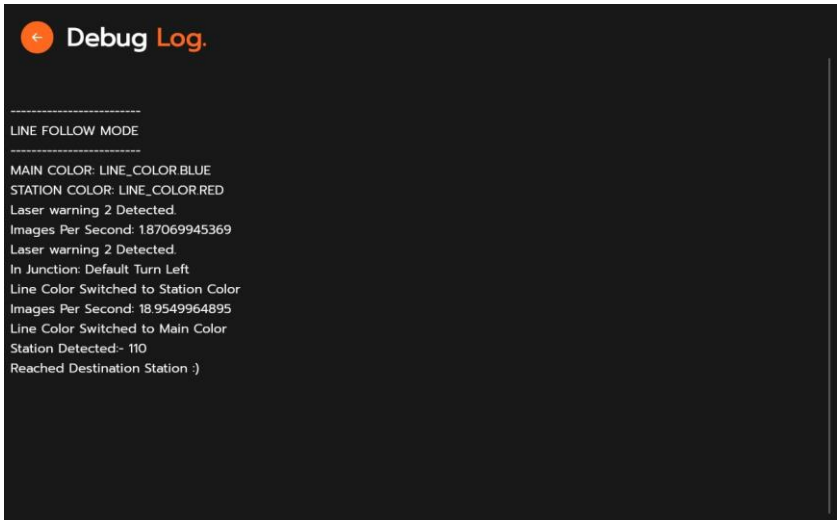


Figure 74 eQart settings – Debug log.

Map Data

When recording a Map for Navigation the eQart will use encoder data, RFID- stations, and junction data to create the full map.

- If there are any issues while recording the map, the user can share the data with FlexQube support at help@flexqube.com.
- The support will analyze the data and give feedback on whether there are any bugs or mistakes in the map creation.
- To start the eQart Map Data Diagnosis, check the Map Data box in the "Diagnosis" menu.
- To upload the data to the cloud Server, click the upload icon to the right of the "Map Data" button as shown below:

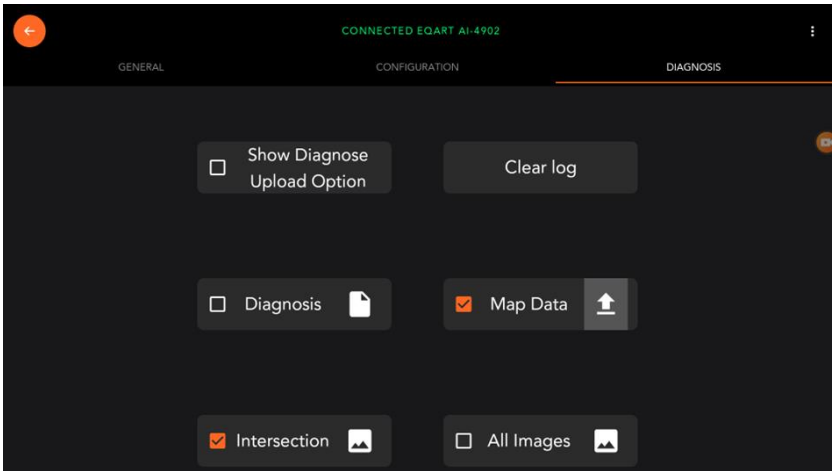


Figure 75 eQart settings – Map Data.

- On Successful data file upload, the user will see a message reading "File uploaded successfully" displayed on the screen as below:
- **Note.** To upload "Map Data" the eQart Cockpit must be logged in to the Cloud server and have an internet connection.

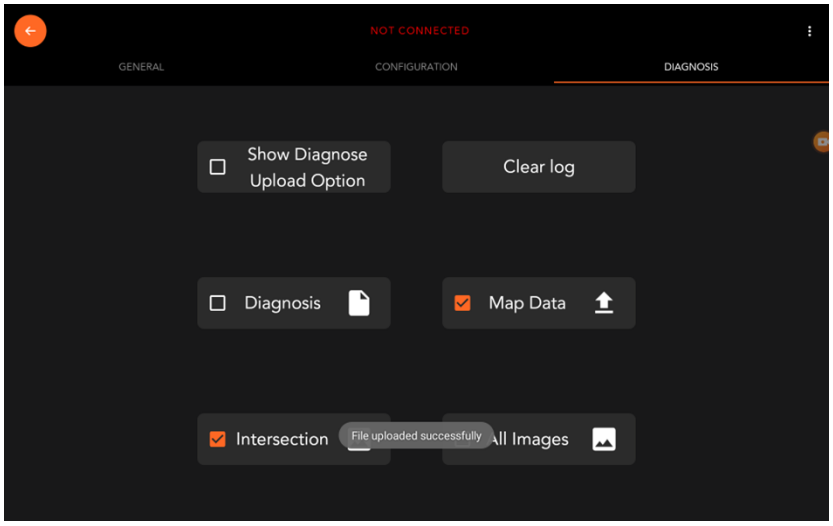


Figure 76 eQart settings – Map Data upload.

Intersection

During navigation or map creation the eQart will follow the line and looking for any intersections in its travel path.

- If the eQart detects a faulty intersection while in line-follow mode it will lead to an error in the left/ right turning sequence.
- If the eQart is in Map recording mode, the faulty intersection will lead to an error in the Map creation where it will not be usable in Navigation mode.
- To start the eQart Intersection Diagnosis, check the Intersection box in the "Diagnosis" menu.
- To see the intersection images, click on image icon to the right of the "Intersection" button as shown below:

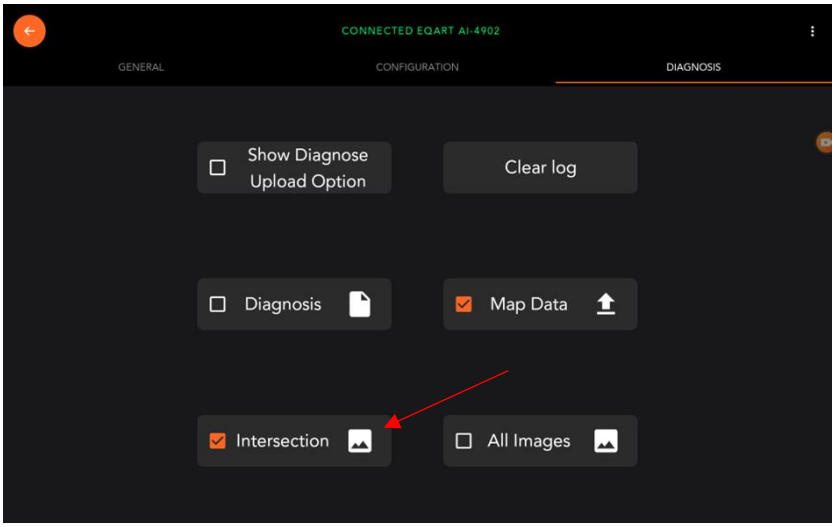


Figure 77 eQart settings – Intersection.

- In the Intersection Images log you will see all the images of the intersection that the eQart recorded as shown below:

Figure 78 eQart settings –Intersection images.

All Images

To make a general diagnosis for the line follow function or the Map recording the All images diagnosis can record all the images that eQart sees.

- To start the All Images Diagnosis, check the All images box in the "Diagnosis" menu.
- To see camera images during navigation or map creation mode, click on the image icon to the right of the "All Images" button as shown below:
- In the All Images log you will see the images recorded as shown below:

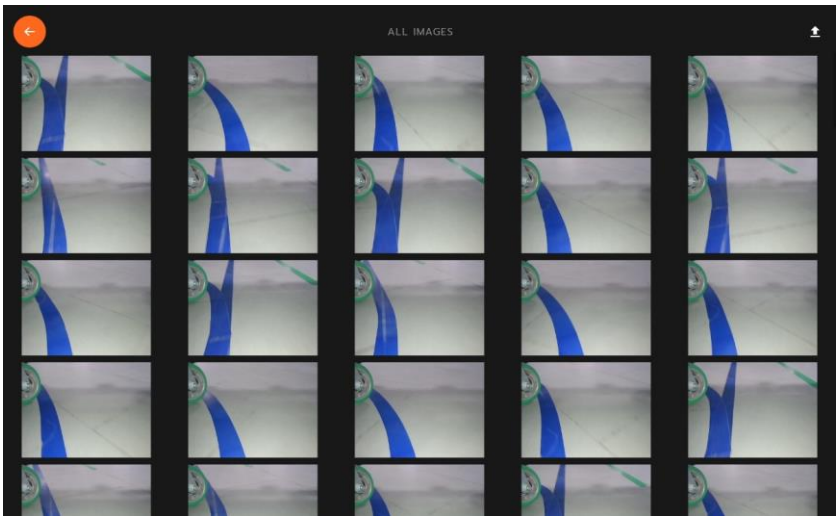


Figure 79 eQart settings – All images.

11 Maintenance Drive

WARNING. Please read through safety instructions before using the Maintenance drive.

When the eQart is stuck, and it is not possible to operate the eQart using the Cockpit, the user can use the Maintenance drive.

- Cases when Maintenance Drive can be used:
  - If a loaded eQart stops in the laser sensor protection zone where the obstacle is a fixed object like a wall or a machine, then in such condition, the user cannot use the android application for any movement.
  - To unload the eQart from its delivery box.

  For HW 1.0/2.0
- During the use of maintenance drive, the user must apply any one emergency stop on the cart.

  For HW 3.0
- During the use of maintenance drive, the user must release all emergency stops on the cart.
- To connect the maintenance drive to the eQart, plug in the cable of maintenance drive in the port besides battery.
- The operation in maintenance drive:
  - Forward drive
  - Reverse drive
  - Emergency stop
- There is a lock with a key in the maintenance drive pendant to cut of the operation.
- The user must hold the pendant in such a way that the key lock is in the bottom side as in “Figure 80 Maintenance drive”.
- In the hand holding position the top, black button is for driving forward and the lower white button is for driving in reverse.

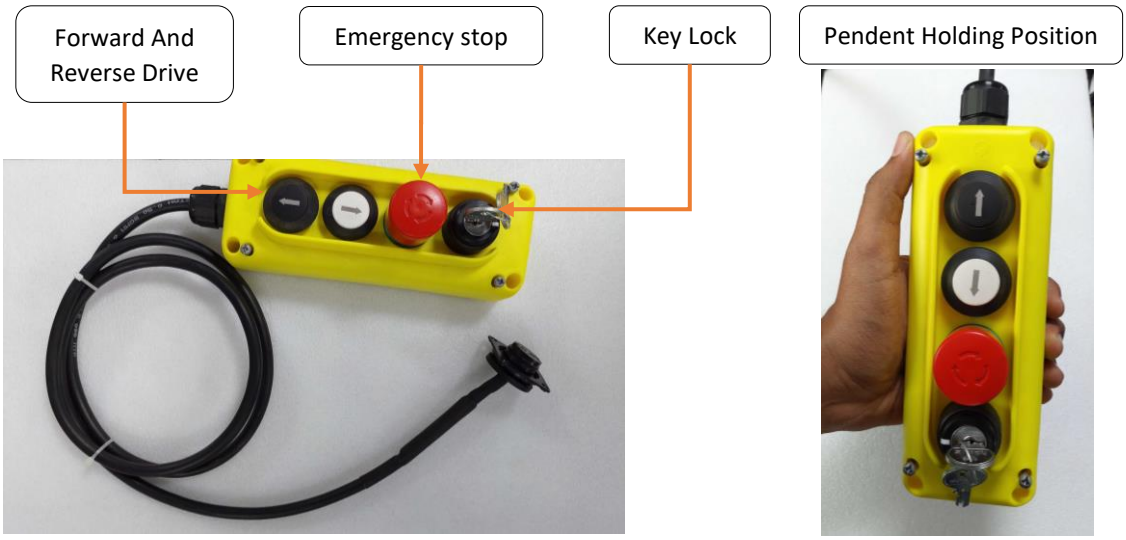


Figure 80 Maintenance drive

12 Maintenance

To ensure safe usage and long life for the eQart the following procedures must be followed regularly.

12.1 Lockout/ Tagout (LOTO) Safety Procedure

The LOTO safety procedure is used when the eQart is in service or maintenance condition.

- The only source of energy for the eQart is the battery module where the ON/ OFF Switch is located.
- To cut off the power rotate the eQart ON/ OFF switch counterclockwise to shut it down.
- The ON/ OFF Switch breaks the power source, and the operator can work in a safe condition.
- The ensure a long life of eQart and the battery module, turn off the eQart regularly when not in active use.

12.2 Battery

- The eQart has a 60Ah Li-ion Battery Module. The battery module is heavy and if not controlled properly, it could cause severe injury to nearby personnel.
- Do not operate the eQart if the voltage falls below 23 VDC.

12.3 Charging

- The charger should be CE, UL certified.
- The charger ratings must as follow:
    - Input range: - 100-240 AC 50-60hz
    - Charging voltage: - 29.4v (7 cell)
    - Charging current: - 20-25A
- The user plugs in the battery charger connector manually into the specified charging port on the battery.
- Ensure that the battery is not charged over long durations of time as this might degrade battery life over time.
- The battery should be outside of the cart When charging the battery.

12.4 Maintenance operation

ATTENTION. Check that the Emergency Stop button is applied while performing maintenance, as well as the main switch, should be OFF.

The recommended Maintenance schedule is presented in the table below. The operator is responsible for doing regular cleaning, checkups, and smaller maintenance tasks.

Part	Maintenance and replacements	Interval
eQart Frame	If any parts are damaged or screws are missing, order and replace the components.	Check monthly and replace if needed
Swivel wheels	Check for loose bolts or bad bearings and check for wear in the wheel.	Check monthly and replace if needed.
Motor Modules	Check for loose bolts and damages or wear on the wheel.	Check monthly and replace if needed.
Battery Module	Check if the battery module is damaged or the battery life is degraded. If the battery cells are damaged it can be hazardous. The battery is rated for 700 charge cycles.	Check monthly and replace if needed.
Brain Module	Check for any damages, loose cables or missing components.	Check monthly and replace if needed.
Emergency stop	Check that the button works and triggers the emergency stop brakes.	Check every 3 months acc. to ISO 13850.
Laser Scanners	Check for damages and error codes.	Check every week and replace if needed.
LED corners	Check for any damages and that all LEDs light up.	Check every month and replace if needed.

12.4.1 eQart Module service

To service the eQart modules, access under the eQart is needed to be able to replace the modules. To perform the service, it is needed to lift or flip over the eQart.

- **Brain Module**
  - Ensure that the Brain module is up to date with firmware updates by checking the eQart Cockpit updates.
  - Regularly check for any physical damage to the module or the cameras.

  To remove the Brain module, follow these steps:
  - Unscrew and remove the top plate from the base frame of the eQart.
  - Remove all cables connected to the Brain module.
  - 4 black angle plates need to be removed under the eQart that attaches the Brain module to the base frame.
  - Unscrew the 8 screws and remove the angle plates.
  - The brain module is now loose to be removed from the top side of the eQart.

- **Motor Module**
  - Regularly check for physical damage to the motor module.

  To remove the Motor module, follow these steps:
  - Disconnect the cables connected between the Motor and Brain module.
  - Remove the two threaded rods connecting the two motor modules.
  - Remove the 8 screws attaching the Motor module to the Base frame.
  - The Motor module is now loose to be removed from the bottom side of the eQart.

- **Battery Module**
  - Regularly check for physical damage to the battery module as this can result in critical failure of the battery.

  To remove the swap battery, follow these steps:
  - Turn of the main switch located on the front of the battery module.
  - Unlock the battery and lift it in the handle and slide it out from the battery dock.
  - Replace the discharged battery with a fully charged battery.

  To remove the Battery module, follow these steps:
  - Disconnect the power cable and BMS cable connected to the battery module.
  - Remove the 4 screws in the corners of the battery module.
  - The Battery module is now loose to be removed from the bottom side of the eQart.

- **Base Cart Structure**
  - Regularly check for physical damage to the Base frame is this can indicate a collision resulting in other modules getting damaged.
  - Make sure that the swivel casters are in good condition and check for any loose screw attachments.
  - All parts can easily be replaced if damaged.

- **Corner Module**
  - Regularly check for physical damage to the Corner module and especially to the Laser sensor.
  - Regularly clean the Laser scanners sensor window from dust or debris.
  - Make sure that all the LED lights function properly as this signals the safety of the surroundings. If it is damaged it should be replaced.

  To remove the Corner module, follow these steps:
  - Disconnect the LED light cable and the Laser sensor cables connected to the Brain module.
  - Remove the 4 self-tapping screws attaching the Corner module to the Base frame.
  - The Corner module is now loose to be removed from the eQart.

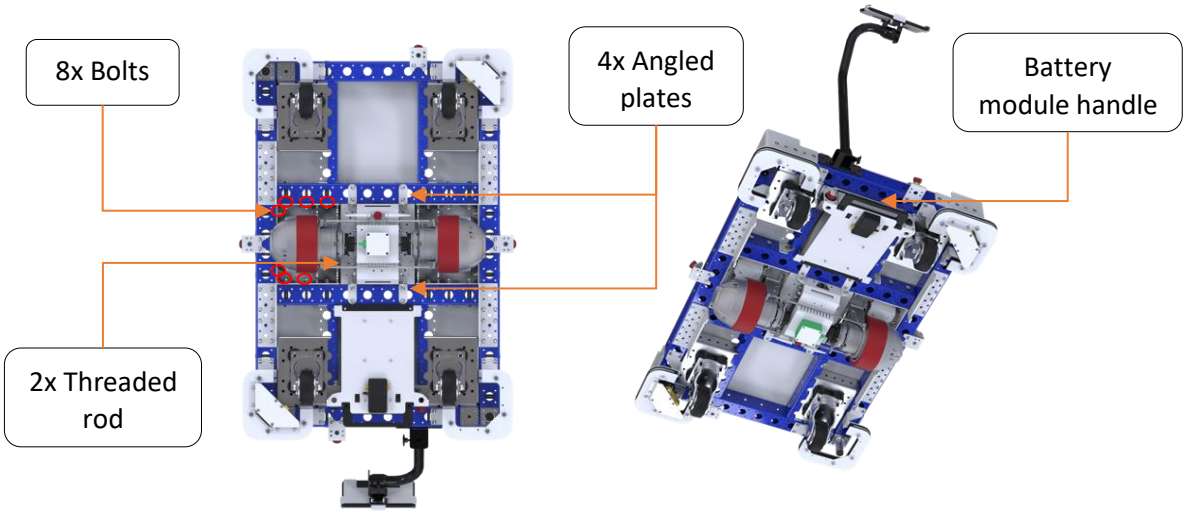


Figure 81 Bottom of eQart showing the eQart modules.

12.5 Maintenance Schedule

The recommended Maintenance schedule is presented in the table below. The operator is responsible for doing regular cleaning, checkups, and smaller maintenance tasks.

Part name	Maintenance	Interval
eQart Frame	Check for damages due to collisions, damaged or loose cables, and loose screws. Clean any dust build-up.	Every week
Brain Module	Check for damages and loose cables. Clean the camera window.	Every month
Battery Module	Check for damages as the battery module is sensitive to collisions.	Every month
Motor Module	Check for damages, wear of the wheel, and clean the wheel surface.	Every month
Laser scanner	Check for damages or error codes on the LEDs. Clean the sensor window.	Every week
LED corners	Check for damages or fault LEDs. Clean the LED-corner.	Every month

12.6 Major Fault

If the eQart has stopped while obstructing passageways or similar scenarios:

- In the first hand use the included Maintenance drive, connecting the cable to the port besides battery to enable the operator to drive the eQart away.
- If the electric motors are not working, keep the maintenance drive cable plugged into the port besides battery to release the brakes of the Motor module to be able to roll away the eQart manually. This will work only with HW1.0 & HW 2.0 not work for HW 3.0.

- As a last step, the eQart can be lifted with a forklift by the included fork pockets under the eQart. Please note that many parts under the eQart are fragile so lift with caution.
- If the eQart is malfunctioning due to technical issues or due to physical damage caused by a collision do not operate the eQart as the safety cannot be guaranteed.
- If the eQart is not functioning correctly, or need any modules replaced or serviced, please contact the FlexQube Support (Details specified on the last page).

List of Figures

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